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Appendix A:
Complete submissions to PER

Nyrstar Port Pirie Smelter Transformation Proposal

Public Environmental Report: Submissions from Public Consultation Phase

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1 Government Submissions

1.1 Port Pirie Regional Council

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Port Pirie
Regional Council

Council Reference: I20313/690.26
DPTI Reference: 2013/05087/01

AJ:JC

18 September 2013

The Minister for Planning
Attention: General Manager, Assessment
Statutory Planning Branch
Department of Planning, Transport & Infrastructure
Level 5, GPO Box 1815
ADELAIDE SA 5000

Dear Mr Kleeman,

NYRSTAR Port Pirie Transformation Proposal – Public Environment Report

I refer to your letter dated 5 August, 2013 requesting Council's views on the Nyrstar Port Pirie Transformation Proposal Public Environment Report.

Port Pirie Regional Council would like to reiterate its strong continual support for the Nyrstar Transformation Project. Council believes the project will not only transform Nyrstar's business but will also be the catalyst for transforming the economy and the face of the City of Port Pirie. The project, when combined with the Targeted Lead Abatement Program, will achieve the community's objectives of reducing lead in the blood levels of our children. This will significantly assist Council and its partners attract more people, tourists, and business investment to the City. The project will create economic activity and opportunities during construction and provide certainty for others to invest in the City for the long term.

For the above reasons, Port Pirie Regional Council strongly supports the Nyrstar Transformation Project.

Yours sincerely

Dr Andrew Johnson
CHIEF EXECUTIVE OFFICER

1.2 SA Health

Government of South Australia
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Mr Robert Kleeman
General Manager Assessment
Planning and Assessment Branch
Department of Planning, Transport
and Infrastructure
GPO Box 1815
ADELAIDE SA 5001

Dear Mr Kleeman

Thank you for your letter of 7 August 2013 to Dr. Chris Lease enclosing the Public Environmental Report (PER) for the Port Pirie Smelter Transformation proposal by Nyrstar. Since this matter falls within my branch's responsibilities I am responding to your request for comment.

We thank the Department of Planning, Transport and Infrastructure for consulting the Department for Health and Ageing (DHA) and wish to advise that DHA has no further comment to add to those that were made during the development of the PER, except for the clarification outlined below.

There has been some confusion over the number of children that have blood lead levels equal to or exceeding 10 µg/dL. The number of children tested in 2012 and found to have a blood lead level above 10 µg/dL was reported in the 2012 annual *Technical Paper 2012/4* (available on the SA Health web site). This report indicates that 142 tested children (including surrogate results) had blood lead levels ≥10 µg/dL (table 1 of the report). Without explanation or reference, the PER states on a number of occasions that 200 children remain with blood lead levels ≥10 µg/dL. The figure of 200 children appears to have been calculated by extrapolating the reported 95th percentile to the *whole population of children* aged 0-4 years using the ABS census estimate of the population size. This is a legitimate use of the statistic but it would have been preferable if the method had been explained as a projection of the number of children ≥10 µg/dL and referenced in the text avoiding confusion by some who have read both the PER and the *Technical Report 2012/4.*

If you require further information, please don't hesitate to contact me.

Yours faithfully

Dr. David Simon
Director, Scientific Services Branch
Public Health Services
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17 September 2013

1.3 EPA

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Robert Kleeman
Manager, Planning and Assessment Branch
Planning Division
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Dear Mr Kleeman

PORT PIRIE SMELTER TRANSFORMATION –PUBLIC ENVIRONMENTAL REPORT

Thank you for providing the Environment Protection Authority (EPA) with the Nyrstar Port Pirie Smelter Transformation Proposal Public Environmental Report (PER) in accordance with Section 46C(5)(a)(i).

The EPA coordinates comments on behalf of the Environment and Conservation Portfolio. Hence a report from both the EPA and the Department of Environment, Water and Natural Resources are attached for consideration. Zero Waste declined to comment on the PER.

Environment Protection Authority

The EPA is supportive of the intent of the transformation project.

At this stage the EPA has insufficient detail to undertake a full assessment of the information presented. In particular, to verify the predicted improvements to air quality post transformation. Many assumptions and statements made in the PER are unverified. Specifically the EPA does not have enough information to verify modelling data and hence confirm the likely improvements as stated in the PER.

The PER has proposed two different options to discharge cooling water into the marine environment from the transformation proposal. The PER currently does not specify which option will be preferred to discharge cooling water from the transformation. The EPA requires additional information to undertake a more detailed review and analysis of the proposal. Given this, it would be beneficial if Nyrstar nominated a preferred option to focus this additional work and to reduce unnecessary work on unlikely options.

The EPA also wishes to highlight the need for Nyrstar to work with an EPA accredited site contamination auditor to carefully plan the construction program.

Detailed comments on these issues are provided in **Attachment A** to assist Nyrstar in preparing its response document.

Department of Environment, Water and Natural Resources

Relevant DEWNR officers have reviewed the PER and its comments are provided in **Attachment B**, including the following key concerns:

- Climate change adaptation – as per previous advice, the PER misrepresents DEWNR's position re addressing coastal inundation and provides insufficient justification for the chosen protection strategy

- Cooling water dispersion - the modelling for thermal discharges appears to be minimal and based on limited data – additional work, including data collection and modelling, is required
- Acid Sulphate Soils (ASS) - the PER misrepresents CSIRO mapping on ASS (which is a guide only) and lacks detail in the draft OEMP and CEMP on the management of ASS – DEWNR recommends regard to the Coast Protection Board's Strategy for Implementing CPB Policies on Coastal Acid Sulfate Soils in South Australia and further consultation with the agency.

For further information on this matter, please contact Kym Pluck on 8204 9289 or kym.pluck@epa.sa.gov.au.

Yours sincerely

Keith Baldry

OPERATIONS DIRECTOR

ENVIRONMENT PROTECTION AUTHORITY

Date: 19 September 2013

Attachment A – Environment Protection Authority

Nyrstar proposes to redevelop its primary lead smelting process located at Port Pirie. The proposed transformation proposes an upgrade and redevelopment of the current Sintering, Blast Furnace, Acid Making Operations and associated infrastructure and equipment, including construction and operation of:

a) a new Stage 1 Enclosed Bath Smelting Facility (to replace the current Sinter Plant);

b) a new Stage 1 Oxygen Plant Facility;

c) a new Stage 2 Enclosed Bath Smelting Facility (to replace the existing Blast Furnace);

d) a new Sulphur Capture (Acid Plant) System (to replace the existing Acid Plant);

e) the current ‘intermediate materials storage area’;

f) storage areas for mineral concentrate and raw materials;

g) an upgraded sea water intake cooling system; and

h) associated earthworks.

Hence, this PER has been developed in accordance with the Guidelines for the preparation of a Public Environment Report: Port Pirie Smelter Transformation (Mid North) issued by the South Australian Development Assessment Commission in May 2013.

1. **At this stage modelling does not cover all those components (for which approval is being sought) listed in the development application and Government Gazette, 28 February 2013. Air quality modelling must consider all parts of the proposal for which development approval is being sought.**

Air Quality

This section describes EPA’s assessment on information provided on air quality impacts from the existing and proposed transformation of the smelter in PER. The assessment was undertaken against SA EPA Guidelines for Air Quality Impact Assessment using Design Ground Level Concentrations (DGLC) and SA EPA Guidelines for presenting air pollution modelling output and the National Environment Protection Measure for Ambient Air Quality (Air NEPM). During this assessment process EPA considered relevant information such as EPA’s air quality monitoring data and reports such as Hibberd, MF, ‘Preliminary Analysis of Meteorological and Lead data from Port Pirie Monitoring Sites’ (July 2012) and PAE Holmes 2012 report on ‘Fugitive Metals Emissions Study’.

The main features of the Transformation with respect to air emissions are:

- The sinter plant will be replaced with a new enclosed bath smelting furnace with modern emissions capture and treatment
- The existing blast furnace will be enclosed with upgraded emissions capture and treatment.
- The new larger capacity acid plant which is estimated to decrease SO_2 emissions from tall stack by 90%.
- A preliminary estimate of the change in lead emissions is a reduction to approximately 47% of modelled emissions.

In reviewing the modelling data presented in the PER the EPA notes lead was over predicted on the western side and under predicted on the eastern side of the township. Thus the modelling output is not correct on a directional basis due to either source estimation or meteorological effects.

Based on the assessment of the information presented in the PER, the air quality modelling needs re-examination based on the following observations:

2. **Clarification is required of the post transformation production rate of lead for the plant. The PER in figure 15.1 indicates this is 262,000 tpa of lead bullion; but table 7.2 and elsewhere assumes current production rates (under 200,000 tpa).**

   A column should be added to Table 7.2 to show estimated emissions at post transformation production rate.

3. **The EPA acknowledges that, due to wetter weather, PM10 levels have decreased state wide over the last couple of years and that current levels do not exceed NEPM limits. However, Nyrstar is expected to demonstrate whether the upgrade will increase or decrease PM10 levels by modelling with zero background.**

4. **Given the air NEPM standard for sulfur dioxide is 200ppb as an hourly average and the PER shows that the Oliver Street site is only just outside the modelled 200ppb contour, further justification is required to enable EPA to verify the sulfur dioxide modelled predictions presented in the PER.**

5. **The EPA acknowledges that given the complex nature of the process the model can only be used as an estimate of what may happen post-transformation and on going monitoring is required for particulates and sulfur dioxide to improve the model. The EPA will require a detailed monitoring plan to be prepared to it satisfaction, however there is little benefit to this occurring at this stage of the process. This could be left to post approval and hence recommends to DAC and the Minister for Planning that this matter form a reserved matter in the final decision.**

6. **Further detail around model verification is required to enable the EPA to verify modelling results. Further information is needed to justify not using 24 hour measured lead data to validate the model.**

7. **The EPA requires clarity on the types of dust monitors used to collect lead in air data used for modelling.**

8. **Model Set-Up**

   The EPA acknowledges that background is omitted from modelling. This results in higher estimates of dust emissions from the smelter and greater error in the model

   a. **There are a variety of models available and choice often depends on site location, what is being modelled and the number of point sources. The EPA will require an explanation as to why Calpuff was selected and whether it would create different predictions from alternative models such as TAPM.**

   b. **The effects from existing buildings was not fully taken into account in the model. The EPA will require an explanation regarding what impact incorporating buildings would have on the model.**

9. **Sulfur dioxide impact assessment**

   Scenario: Acid Plant Trip

It is not clear to the EPA's what action Nyrstar would undertake in the event of an acid plant trip to minimise environmental impact. Further clarification is required regarding risk of event and the anticipated sulfur dioxide emissions during plant trips.

10. **Construction Environment Management Plan (CEMP)**

The EPA is satisfied with the draft CEMP as presented in Appendix J of the PER for assessment purposes. Preparation of the final CEMP should be conditioned or reserved to ensure any final CEMP is prepared to the satisfaction of the EPA. The final CEMP should consider the following matters (and those also referred to in subsequent sections):

The continuous TEOMs at Oliver St and The Terrace and Nyrstar sites will monitor construction and demolition dust. Thought should be given to use this or similar data to inform a dust management plan.

Table 3-1 (appendix J)

The wording needs to be improved as although contractors, employees, consultants will have responsibility for their work Nyrstar will have overall responsibility

Table 5-1 (appendix J)

Dust from any demolition and construction is important as it is likely to contain heavy metals – it is not clear how it will be dealt with, any plan must include the ability to take actions and stop work as needed based on feedback.

Marine

The Nyrstar smelter has been in place for over 120 years and has had a significant, widespread and permanent adverse impact on the marine environment. The activities at the smelter have resulted in the discharge or deposition of metals (largely lead, zinc, cadmium and manganese) into the waters at two main locations;

1- Port Pirie Harbour where ships are loaded and location of the historical discharge of liquid waste (pre 1939), and

2- First creek which is a small mangrove lined tidal creek, and the location of the liquid waste discharge (post 1939).

There are also other pathways for metals from Nyrstar entering the marine environment which are typically not considered, including atmospheric deposition and stormwater runoff.

The historical and recent discharges and subsequent dispersion of metals from these locations has resulted in gross metal contamination throughout the entire Port Pirie, Weroona Bay and Germein Bay areas, which has resulted in significant changes to the benthic habitats, fish and invertebrate populations throughout this region (Ward et al 1986; Ward and Hutchings 1996; Edwards et al 2001). Additionally since 1996 there has been a Fisheries closure prohibiting the taking of shellfish from a large proportion of Germein Bay due to the risk from eating metal contaminated shellfish.

While liquid wastes discharged from the smelter into First creek have reduced since the construction of the PETS plant, the discharge does not comply with the *Environment Protection (Water Quality) Policy 2003* (WQEPP). There are also current and legacy contamination present at both first creek and the Harbour sites. This is important to note in the context of some of the implications of the current proposal.

The PER describes the potential risks to the marine and coastal environment from the transformation including construction activities and the operation of the new components. The major interaction with the marine environment is the use of marine cooling water through the new process. This cooling water will have a biocide added and the result will be a thermal effluent approximately 10 degrees above the intake (ambient) temperature. The PER has proposed two different options to discharge cooling water into the marine environment from the transformation proposal. These are: discharge of thermal effluent into First creek with the existing liquid discharge; and the creation of a new diffuser outfall within the Port Pirie Harbour to discharge cooling water. The PER currently does not specify which option will be preferred to discharge cooling water (thermal effluent) from the transformation so each option will be discussed as it is presented.

There are a number of other aspects documented in the PER to be addressed as a part of the review process, these include:

- Clearance of seagrass to trench outfall pipe
- Entrainment or entrapment of marine biota in the intake structure
- Discharge of surfactant as a biocide in the thermal effluent
- Dredging of contaminated sediment to install a new caisson at the harbour

11. **Until Nyrstar nominate which discharge option is preferred the EPA is unable to undertake a more detailed review and analysis of the proposal. Further work will be required to address data gaps and uncertainty. This is discussed further below.**

Discharge of thermal effluent into First creek

The model outputs have been interrogated and the 10th percentile (worst 10% of the time) suggests that scenario 3 offers the best option for minimising impact on First creek (see summary table below). The EPA acknowledges that current discharge results in a temperature increase of 9^{o}C near discharge point.

Scenario	**Estimated temperature increase above ambient downstream**	**Estimated temperature increase above current**	**Extent of impact**	**Temperature increase at discharge point**
1	4-8^{o}C	3-4^{o}C	Upper and lower reaches	9^{o}C
2	3-4^{o}C	1-2^{o}C	Upper and lower reaches	8^{o}C
3	1-2^{o}C	-3-0^{o}C	Upper reaches only	6^{o}C

This scenario is likely to improve the quality of the discharge from Nyrstar in First creek, however there are a number of questions that would need further work if this proposed scenario was the preferred option. These include:

12. **Refinement of the hydrodynamic model including a bathymetric survey of Germein Bay in order to improve the predictive capability of the model including the intertidal areas beyond the mouth of First creek.**
13. **Detailed long term collection of water quality data (including temperature, salinity, pH etc.) and meteorological data to validate the model including the intertidal areas. This matter could form a condition or reserved matter on the final approval.**

Potential biological impact of a thermal effluent discharge in First creek

If the preferred option was scenario 3 the likely response would be an improvement in quality due to the dilution of the existing discharge, resulting in an overall temperature reduction of the combined discharges. The PER suggests that due to the increased flow (3-4 x current) it is likely that there may be erosion of contaminated sediments. This would mobilise metals from the upper reaches of First creek and deposit them further down stream.

An evaluation of whether the discharge of thermal effluent into First creek is likely to impact on the ecology of the environment a moot point given the ~75 years of metal and thermal discharge in the creek. A reduction in the temperature of the effluent by mixing it with the existing discharge in First creek will result in an improvement in the quality of the discharge.

If Nyrstar chose to pursue the First creek option they must undertake further work to show:

14. **An understanding of the potential for, and magnitude of, erosion, transport and fate of the contaminated sediments from the upper reaches of First creek due to the increased flow of effluent.**

Discharge of thermal effluent into Port Pirie Harbour

The second option for the discharge of thermal effluent has been proposed to be via a diffuser in the deeper water (~ 8 m) of the Port Pirie Harbour. This scenario will allow the warmer water to rise to the surface entraining and mixing with ambient seawater, providing more efficient dilution than the First creek option.

Nyrstar's consultants have undertaken both near field and far field modelling to assess the dilution and dispersion characteristics of the proposed discharge (1.64 m^3/sec @ 10^{o}C above ambient). No diffuser design requirements were supplied so two generic diffuser designs have been modelled as a conceptual phase, one with 12 ports and a second with 18 ports. Other diffuser design variables were maintained constant.

Figure 3-1 of the BMT WBM report "*Port Pirie marine modelling assessment of cooling water discharges to the marine environment"* show that 70% of the time the current velocity was less than 0.1 m/sec. The report states that the results with the 12 port diffuser were the better of the two configurations tested. Figure 4-4 shows that the minimum dilution achieved from the 12 port diffuser was marginally above 5.0 when currents were greater than 0.1 m/sec (ie 30% of the time). This suggests that while the diffuser could achieve the requirement of no more than 2.0^{o}C above ambient (equal to a dilution factor of 5.0), there is very little margin for error under higher flow conditions.

15. **If the discharge to Port Pirie River is the preferred option, further work will be needed to optimise the diffuser design and refine the model to understand the conservatism in the predictions and achieve the best outcome.**

After the near field scenario has been resolved, the PER has looked at the effect of the thermal effluent on the far field condition of the entire Port Pirie River. The far field modelling suggests that the dispersion of thermal effluent in the Harbour is considerably better than the scenarios within First creek, with the conclusion that the deeper and wider Port Pirie River has a greater capacity to dilute the effluent. The far field model suggests that a temperature increase of 0.5-1.5^{o}C over ambient temperature extends approximately 1.5km north (out of the river) and 3km south of the discharge (further into the river). This modelling indicates that there is an asymmetry in the tidal signatures in the Port Pirie River resulting in a greater flood tide (incoming) than ebb tide (outgoing). This results in lower flushing in the upper reaches of the river. It should also be noted that due to inaccuracies of the bathymetry in the intertidal areas the model did not perform as well in the Port Pirie River area.

The proposed scenario of the discharge of thermal effluent into Port Pirie River is likely to achieve the requirement of less than a 2.0^{o}C temperature rise (@ 20m from the diffuser) compared to ambient in the near field. There are still significant uncertainties in the far field model due to the observation of a tidal asymmetry in the river, the way the near field model links to the far field model and considerable assumptions made with the bathymetry. If this scenario is the preferred option, there are a number of aspects that would need further work to reduce the uncertainty. These include:

16. **A bathymetric survey throughout the Port Pirie River and intertidal areas to better resolve the hydrodynamic model and improve the predictive capability of the model and refine the understanding of the tidal asymmetry**
17. **Further temporal far field modelling to indicate the dissipation of heat in the upper reaches of the Port Pirie River as a consequence of the reduced flushing, to show the long term temperature rise in the upper reaches as a result of the thermal discharge**
18. **Optimisation of the intake and outfall locations in order to avoid short circuiting of the cooling water. It is likely that the location of the outfall should be located as close to the mouth of the river as possible to avoid this.**

Potential biological impact of a thermal effluent discharge in Port Pirie River

As stated above, the Port Pirie Harbour is significantly and permanently impacted by metals from the facility, whether through historical discharge (pre 1939), or a combination of recent or historical spillage of material from the wharf, atmospheric deposition from stack or fugitive emissions and discharge of contaminated groundwater into the harbour. The biological investigations suggest only sparse communities in the Harbour region, which given the metal contamination is not surprising. If the proposal to discharge the thermal effluent into Port Pirie River was pursued, it is likely that this would not improve the condition of the harbour, but importantly it would not further deteriorate its condition. The slight increase in temperature of the water over a small area is unlikely to change the metal solubility or bioavailability within the contaminated sediments and the flow will not significantly change the hydrodynamics of the harbour. The construction of the intake and outfall structures will need very careful dredging to ensure that contaminated sediments are not dispersed (refer to further discussion later).

Clearance of seagrass to trench outfall pipe

The section above describes optimisation of the location of the outfall pipe in order to avoid the possibility of short circuiting. This process needs to take into account the likelihood of clearance of seagrass or other sensitive biological community.

19. **The CEMP must ensure Nyrstar and any contractors take all reasonable and practicable measures to avoid impacting on any sensitive biological community whether through the location of the pipe or the methodology of construction (eg: horizontal directional drilling).**

Entrainment or entrapment of marine biota in the intake structure

The transformation process proposes to use 1.64 m^3/sec of marine water as a flow through cooling system. In order to draw this water in an additional caisson is proposed to be located next to the existing caisson structure. The intake flow rate for this structure is proposed to be in the vicinity of 0.6 m/sec. Work undertaken for large seawater intake facilities (Adelaide and BHP desalination plants) suggests that a intake flow rate of less than 0.2 m/sec is likely to reduce the likelihood of entrainment and entrapment of marine biota such as slightly motile larvae.

20. **It is therefore required that the intake structure be designed to have an intake velocity of no more than 0.2 m/sec.**

Dredging of contaminated sediment to install a new caisson at the harbour

The installation of a new caisson and the installation of the diffuser pipe (if the Port Pirie River option is taken) are likely to require dredging of the highly contaminated sediments. The volume estimated in the PER is 1550 m^3 of sediment. Given its highly contaminated condition it is likely that there will need to be very stringent conditions on the dredge operator to prevent the generation of plumes of contaminated sediment. The PER proposes that turbidity would temporarily (1-2 weeks) increase up to 1 kilometre from the dredge site, which the EPA considers to be unacceptable. Metals will likely bind to sediment particles and turbidity plumes will therefore also be high in metals which may be toxic to any exposed marine organisms.

21. **The dredge operator must adequately control all turbidity generation so that any plume is controlled within adequate control mechanisms which reduce the movement of this pollution. The CEMP for the dredging operator must include pollution control mechanisms that are effective in deep, tidal environments in order to reduce the likelihood of metal contaminated turbidity plumes spreading away from the dredge site. It is recommended that Nyrstar and the dredge operator consult organisations experienced in dredging of highly contaminated sediments to ensure that practices at Port Pirie are undertaken using the best available technology.**

The PER does not state the fate of dredge spoil.

22. **Given its likely highly contaminated condition the EPA requires confirmation of the intention to dispose of the spoil.**
23. **It's important any CEMP ensures that this material is disposed of at an EPA approved location to receive contaminated waste.**

Dewatering of the spoil is discussed later in the site contamination section.

24. **If the installation of the new caisson and diffuser pipeline (if the Port Pirie river option is taken) includes the need for piling in the marine environment then an underwater noise management plan must be developed to address the potential for impacts on marine mammals and other sensitive receivers.**

Discharge of surfactant as a biocide in the thermal effluent

The cooling water is proposed to be dosed with a biocide "Mexel 432" which acts as a surfactant and is stated in the PER to be non toxic to mammals, bacteria, algae, crustaceans, molluscs and fish. This information is seen to be incorrect as literature suggests that the product is toxic to at least mussels, fish and algae. Therefore the concentration that will be used is paramount to enable a risk assessment of the proposed discharge of this chemical. It is understood that the dose rate will be reliant on construction and operational variables and is unlikely to be known with certainty until the infrastructure has been built.

25. **Nyrstar must provide details of the likely dosing of any water treatment chemicals proposed to be used in order for the EPA to undertake an adequate assessment of risk.**

Site Contamination

The EPA understands from the PER and its own dealings with the site that there are site contamination issues present and any proposed activities undertaken at the Port Pirie Smelter site must not further pollute the environment and cause further harm.

The EPA considers that the activities proposed in Nyrstar Transformation Public Environments report may increase the level of risk of site contamination due to the proposed earth movements and sludge dewatering.

Appropriate consideration must be given to maintaining the current hydraulic head balance of the surface and groundwater during the construction works, earth movements and the dewatering or recharging of surface water and groundwater. This is to ensure that potential risks to human health and/or the environment are avoided.

26. **Given the significant issues at the site the EPA requires that the construction environmental management plan (CEMP) be prepared by a person of suitable relevant competency (refer to schedule B9 of the *National Environment Protection (Assessment of Site Contamination) Amendment Measure* (1999)) and in accordance with relevant site contamination and audit guidelines issued by the EPA. The CEMP must be prepared to the reasonable satisfaction of the EPA and incorporate information regarding the prevention of groundwater contamination.**

It is appropriate that site contamination auditor engaged for the site review endorse the construction environmental management plan for the site.

Noise

Noise from the Site as a Result of the Upgrade

Nyrstar were asked to demonstrate that not only the new elements of the upgrade complied with Cl.20 of the *Environment Protection (Noise) Policy 2007* but also noise for the whole of the site comply with the ongoing 'operational' noise levels required by Cl.18 of the noise policy.

The outdoor noise levels required by the noise policy are derived by reference to the Port Pirie Development Plan zoning for both the noise source and the noise sensitive receiver.

The noise levels required by Cls. 18 & 20 of the noise policy and the noise levels the PER predict will be achieved are show in the tables below.

The predicted noise levels are conservative (lower than may be experienced most of the time) because the modelling assumed worst case meteorological conditions for the transmission of noise from the noise source to the noise sensitive receivers.

Receiving Zone/Policy Area	Noise levels* required by Cl.20(3) & 20(4)# of the noise policy for components of the upgrade. **dBA Leq**	The noise levels* predicted by the PER for components of the upgrade. **dBA Leq** Source: Table 9, p.17 ARUP Acoustic assessment 25 July 2013
Residential/policy area 1	52 day/45 night/60Max* night #	45
Commercial policy area 13	61 day/53 night	46
Regional centre policy area 11	57 day/50 night**	44
Public purposes	61 day/53 night	47
Rural coastal	59 day/50 night	47

* When measured and adjusted in accordance with Cl.13 & 14 of the noise policy.

** Cl. 5(6) applies where there is an intervening locality at least 100m wide.

Cl.20(4) & Cl.3 "quiet locality".

Receiving Zone/Policy Area	Ongoing, all of site, operational noise level* to be met at sensitive receivers in receiving zone/policy areas to comply with Cl.18 of noise policy. **dBA Leq**	The noise levels* predicted by the PER for all of site, operational noise*. **dBA Leq** Source: Table 10, p.17 ARUP acoustic assessment 25 July 2013
Residential/policy area 1	61 day/53 night	53
Commercial policy area 13	66 day/58 night	56
Regional centre policy area 11	62 day/55 night**	55
Public purposes	66 day/58 night	56
Rural coastal	64 day/55 night	54

* When measured and adjusted in accordance with Cl.13 & 14 of the noise policy.

** Cl. 5(6) applies where there is an intervening locality at least 100m wide.

Cl.20(4) & Cl.3 "quiet locality".

The noise predictions assume that there will be no significant noise 'character' that requires adjustment of the predicted noise levels pursuant to Cl.14(3) of the noise policy.

Construction Noise

The *ARUP Port Pirie Smelter Upgrade Acoustic Assessment*, 25 July 2013 (page 25) states that if/when the noise level reaches a level deemed by the noise policy to have an adverse impact on amenity (greater than 45dBA Leq and/or 60dBA Lmax) it will not occur on a Sunday or public holiday or between 7pm and 7am on any other day. This requirement needs to be built into the CEMP, including who the responsible body will be.

Literature cited:

Edwards, J. W., K. S. Edyvane, V. A. Boxall, M. Hamann and K. L. Soole, 2001, 'Metal levels in seston and marine fish flesh near industrial and metrpolitan centres in South Australia', *Marine Pollution Bulletin*, 42,(5): 389-396.

Gaylard, S., 2009, A risk assessment of threats to water quality in Gulf St Vincent, Environment Protection Authority, Adelaide: 169 pp.

Thomas, I. M., R. C. Ainslie, D. A. Johnston, E. W. Offler and P. A. Zed, 1986, 'The effects of cooling water discharge on the intertidal fauna in the Port River estuary, South Australia', *Transactions of the Royal Society of South Australia*, 109,(4): 159–172.

Ward, T., R. Correll and R. Anderson, 1986, 'Distribution of cadmium, lead and zinc amongst the marine sediments, seagrasses and fauna, and the selection of sentinel accumulators, near a lead smelter in South Australia', *Marine and Freshwater Research*, 37,(5): 567-585.

Ward, T. J. and P. A. Hutchings, 1996, 'Effects of trace metals on infaunal species composition in polluted intertidal and subtidal marine sediments near a lead smelter, Spencer Gulf, South Australia', *Marine Ecology Progress Series*, 135: 123-135.

Attachment B – Department for Environment Water and Natural Resources

Climate change adaptation (Section 15.5)

- The third paragraph requires correction and clarification:
  "The Inter-governmental Panel on Climate Change (IPCC) has modelled global climate and climate influences and produced scenarios of accelerated sea level rise. Based on this work, South Australia's Coastal Protection Board recommends that ~~a mid range~~ an allowance for sea level rise of 0.3 m by 2050, and a further 0.7 m to 2100, be assumed for South Australia. Additionally, the IPCC has emphasised increased magnitude and frequency of extreme events, such as storm surges, as part of the likely climate change scenarios (Coastal Protection Board 2004)."

  Note: The latter reference is not included in the list of References on page 224

- The fourth paragraph states:
  "DEWNR has recommended that, to meet the requirements of the Coastal Protection Board's minimum site levels and floor levels for coastal developments, the site be raised by a further 0.7 m or be practically protected against a further 0.7 m of sea level rise (T. Huppatz, 2013, pers. comm., 14 June 2013). Where raising a site is impractical, such as at Nyrstar Port Pirie, DEWNR may accept an alternative management option. A levee bank is an alternative and acceptable option to protect from sea level rise and wave effects (T. Huppatz, 2013, pers. comm., 14 June 2013)."

  However that misrepresents DEWNR's position (as per the attached email, dated June 14, 2013), which was that there were three possible options; namely raising site and floor levels as per the CPB recommended levels, accommodating the inundation, or a levee bank. However, the PER only mentions the first and last option, does not indicate the recommended site and floor levels (only the further 0.7m to meet the Board's requirements to 2100) and states that a levee bank is an alternative and acceptable option of addressing the 2100 levels (as opposed to DEWNR's 'could be').

- The final two paragraphs state:
  "PPRC have constructed a levee bank to protect various areas of the city, including the CBD, from coastal inundation. Nyrstar is currently investigating the best options for extension of the PPRC levee into the smelter's boundaries as part of the Site Levee Bank project. The options under consideration will protect the smelter from inundation, the CBD against floodwaters flowing through the smelter and the possibility of contaminated liquors entering the Port Pirie River as floodwaters ebb. The location of the proposed levee bank is shown in Figure 15-2. Nyrstar will continue to work with the PPRC to address this issue. Climate change adaptation is an ongoing issue that is being addressed by the Site Levee Bank project, separate from the Transformation."

  This suggests that a levee bank is the chosen protection strategy but the PER does not provide any justification for why it was chosen over the other two options, nor does it demonstrate that the levee bank option is viable or practicable. That needs to be resolved.

Cooling water dispersion (Section 12.4)

The modelling for thermal discharges appears to be minimal and is informed by limited data. The report in Appendix H recommends considerable additional work, including data collection and modelling, and DEWNR concurs that this is necessary. A decision needs to be made as to the chosen option, or at least a preferred option. Three options are presented, discharge to First Creek only, discharge to First Creek and Port Pirie River, or pre-mixing of streams and discharge to the river only. Of these, the second option would seem to compound the damage and so would seem less preferable. However, additional modelling would clarify this. It would also be preferable that the Zostera beds were avoided, and erosion would need to be managed.

Also, more data is needed on the flushing rates for the Port Pirie River, as there is a probability that warm water would not be exchanged with the more open coast, but be retained in the river which might create larger temperature increases.

Acid Sulphate Soils

Section 11.2.4 states:

> *Potential Acid Sulphate Soils associated with the St Kilda Formation have been defined by mapping in the area (CSIRO 2013). This formation has been substantially covered by slag and other fill beneath the main operational area, consequently most of the Transformation works will not disturb these sediments. However, north of the smelter and along the Port Pirie River margin, these natural sediments are either exposed or are close to ground surface during relatively low tides, and as such may be encountered during Transformation related activities. The risk and management measures associated with this issue are further discussed in Section 11.3.2 and Section 11.4.*

However the CSIRO mapping on acid sulfate soils is indicative only. More complete risk assessment criteria and development guidelines are contained in the references provided in the DEWNR email referred to above, namely:

- The Coast Protection Board's (CPB) policy on Acid Sulfate Soils contained in Appendix 2 of the CPB policy document (2012) at: http://www.environment.sa.gov.au/About_Us/Coast_Protection_Board/Policies_strategic_plans
- The Coast Protection Board's Strategy for Implementing CPB Policies on Coastal Acid Sulfate Soils in South Australia (otherwise known as the Coastline 33 document, 2003) at:

  http://www.environment.sa.gov.au/About_Us/Coast_Protection_Board/Coastal_acid_sulfate_soils

Where coastal acid sulfate soils are disturbed without appropriate management and remediation, they pose a significant threat to development and the natural environment. The release of acid and metal ions into the environment can cause:

- major habitat degradation and loss of biodiversity (acidic scalds or drain spoils remain either unvegetated or are suitable only to acid tolerant species)
- massive kills of fish, crustaceans, shellfish and other organisms
- damage to fish skin leading to infection by the fungus, Aphanomyces sp., which causes epizootic ulcerative syndrome (EUS), also known as red-spot disease
- localised anoxic conditions in waters
- a decrease in plant diversity/domination by acid-tolerant plants
- harmful algal blooms.

Additionally, the lowering of pH would increase the likelihood of metals in sediments being mobilised, so it is particularly important that Acid Sulfate Soil, and any other acid from the plant, is carefully managed.

The risk and management measures discussed in Sections 11.3.2 and 11.4 of the PER are limited to mention of a future Construction Environment Management Plan (CEMP) and an Operational Environment Management Plan (OEMP). However, the draft CEMP and draft OEMP in Appendix J and K, respectively, do not have sufficient detail on the management of Acid Sulfate Soil.

As per the Coast Protection Board's Strategy for Implementing CPB Policies on

Coastal Acid Sulfate Soils in South Australia:

> *The acid sulfate soils component of an Environment Management Plan should specifically include a distribution map and/or cross-sectional diagrams of acid sulfate soil occurrence, potential on- and off-site effects of soil disturbance and groundwater levels, mitigation and treatment strategies for iron sulphide oxidation and surface water and groundwater contamination, monitoring requirements and verification testing, handling and storage of neutralising agents, and containment strategies.*

DEWNR should be further consulted regarding this.

Biosecurity and invasive species

Section 12.5.9 mentions obligations regarding ballast water discharges etc. In addition, if new structures are placed underwater, they should be monitored for the first few years to make sure the bare structures do not provide a substrate for opportunistic invasive species.

Native vegetation clearance/SEB offset

Sections 12.5.11 (Seagrass clearance off–sets) and 12.6 (Construction impacts) imply that if there is a loss of seagrass, payment into the Native Vegetation Fund is optional, whereas it is a requirement of Regulation 5(1)(c)(vi) of the *Native Vegetation Regulations 2003*.

Nyrstar's commitment in relation to native vegetation (in the table following the Executive Summary) correctly identifies that a payment would need to be made into the Native Vegetation Fund to achieve a Significant Environmental Benefit (SEB) in compliance with the *Native Vegetation Act 1991.*

Ruppia

Figure 12-2 (Coastal and marine communities near Port Pirie based on aerial photography interpretation) needs to be ground-truthed. It would be very unusual to have so much Ruppia on the exposed edge of the mudflats. This needs to be clarified.

Table of Contents/Appendices

The list of Appendices is not in the location indicated (instead it appears at the end of the PER preceding the various Appendices).

1.4 DEWNR

From: Huppatz, Tony (DEWNR) <Tony.Huppatz@sa.gov.au>
Sent: Friday, 14 June 2013 5:10 PM
To: stephen@cooe.com.au
Cc: Ward, Alex (DEWNR)
Subject: Port Pirie Smelter - Sea flooding and CASS

Hi Stephen:

As promised yesterday, please find following our comments on the sea flooding and coastal acid sulfate soil issues:

Sea Flooding

The levels that DEWNR recommends for Port Pirie as meeting the Coast Protection Board's minimum site and floor levels for coastal development are as follows:

100 year ARI water level (1% exceedance proobability): 2.85m AHD
Sea level rise allowance to 2050: 0.3m
Wave effects: 0.2m

Minimum site elevation to meet the CPB's requirements to 2050: 3.35m AHD
Minimum floor level (includes freeboard of 0.25m): 3.6m AHD

To meet the Board's requirements to 2100, development should either be raised by a further 0.7m or be able to be practically protected against a further 0.7m of sea level rise.

In circumstances for which raising sites is impractical for operational reasons, developers should ensure that the development could accommodate water reaching the relevant site elevation recommendation (2050 or 2100). This might, for example, allow water to flow into/through buildings, but all vulnerable equipment (mechanical, electrical, etc) is elevated to the recommended floor level.

A levee bank could be an alternative and acceptable means of addressing the 2100 levels (rather than the raising of sites or the accommodation option discussed above) provided that the sites remain above current Mean Sea Level plus 1 metre (that addresses the projected 2100 Mean Sea Level).

Coastal Acid Sulfate Soils

The relevant policy on Acid Sulfate Soils in contained in Appendix 2 of the **Coast Protection Board policy document** (2012) at:
http://www.environment.sa.gov.au/About_Us/Coast_Protection_Board/Policies_strategic_plans

The *Coastline 33* document may also be useful:
http://www.environment.sa.gov.au/About_Us/Coast_Protection_Board/Coastal_acid_sulfate_soils

Regards

Tony Huppatz
Senior Planner
Public Land and Coastal Conservation
Department of Environment, Water and Natural Resources

Level 1, 1 Richmond Road, Keswick
GPO Box 1047 Adelaide SA 5001

Phone: 8124 4885
Fax: 8124 4920
Email: tony.huppatz@sa.gov.au

1.5 SAMFS

From: Kilsby, Phil (SAMFS)
Sent: Monday, 23 September 2013 5:08 PM
To: Webb, Lee (DPTI)
Cc: Smith, Christopher (SAMFS)
Subject: Port Pirie smelter

Lee

As discussed this morning, the responses contained within the Public Environment Report appear to satisfy MFS requirements

Regards

Regional Commander Phil Kilsby GradDipFI, GIFireE.
Far North & Eyre Regional Command
Mobile: 0428 896 757 Office: 08 8642 2399
Email: kilsby.phil@samfs.sa.gov.au

1.6 TSD

In reply please quote 2013/07270/01, 7937500
Enquiries to Matthew Henderson
Telephone (08) 8343 2811
Facsimile (08) 8343 2725
E-mail dpti@sa.gov.au

Government of South Australia
Department of Planning, Transport and Infrastructure

TRANSPORT SERVICES DIVISION

77 Grenfell Street
Adelaide SA 5001

GPO Box 1533
Adelaide SA 5001

Telephone: 61 8 8343 2222
Facsimile: 61 8 8343 2585

18 September 2013

Mr Robert Kleeman
General Manager, Assessment
Planning and Assessment Branch
Department of Planning, Transport and Infrastructure
5th Floor, 136 North Terrace
ADELAIDE SA 5000

Dear Mr Kleeman,

PUBLIC ENVIRONMENTAL REPORT SUBMISSION

Proposal	Port Pirie Smelter Transformation
Applicant	Nyrstar
Location	Port Pirie

I refer to the above Public Environmental Report (PER) forwarded to the Transport Services Division (TSD) of the Department of Planning, Transport and Infrastructure (DPTI). The proposal involves upgrading the Smelter to new technologies that are anticipated to significantly reduce the health impacts of the Smelter on the Port Pirie community. Although this is the primary motivation, there remains the possibility that the upgrade works and/or changes to the nature of operations may lead to impacts upon the surrounding transport networks. Subsequently, the following comments are provided:

TSD has previously provided comments on the Guidelines (see email dated 4 April 2013 from Marc Hryciuk to Lee Webb) and the draft PER (see email dated 23 July 2013 from Matthew Henderson to Lee Webb and others). TSD has consistently maintained that some form of traffic analysis is required to ensure that any traffic impacts that result from the proposal can be appropriately managed.

Subsequently, the department has requested that a formal assessment of the potential traffic impacts of the proposal be undertaken that addresses the following:

1. Provides traffic volume data for affected routes
2. Indicates anticipated time of day of vehicle movements
3. Provides detail of the types and numbers of vehicles (i.e. heavy vehicles, passenger vehicles, any oversize or overmass vehicles) anticipated to access the site
4. Undertakes assessment of the impact on the rail crossings within Port Pirie of any increase in traffic volumes

5. Details current tonnages exported via road, rail and sea respectively
6. Details expected future tonnages exported by road, rail and sea respectively

To expand upon Point 3, the department would appreciate the proponent providing detail of any oversize/overmass vehicles anticipated to use the DPTI road network and expected haul routes for these vehicles.

TSD is unaware of whether the proponent has commenced or undertaken the above traffic assessment. TSD considers it imperative that the above work be undertaken to inform future Traffic Management Plans for the construction and operation phases of the proposal.

CONCLUSION

Whilst Transport Services Division - DPTI does not object in-principle to the proposal, the issues raised above need to be adequately addressed within the PER process. The traffic impact assessment requested above should be completed and forwarded to TSD for assessment. This would ideally be undertaken prior to, or at the time of, the proponent submitting their response document to allow TSD to consider the possible impacts upon transport networks prior to submitting a final response in respect of the PER.

Furthermore, the Transport Services Division would appreciate the opportunity to review the applicant's response document and to provide recommended conditions for the development.

Yours sincerely,

MANAGER, TRAFFIC AND ACCESS STANDARDS

2 Public Submissions

2.1 Nyrstar ‘Shopfront’

A NEW PORT PIRIE
Transforming the future

TRANSFORMATION COMMUNITY CONSULTATION PROCESS
WEDNESDAY 21ST AUGUST - FRIDAY 30TH AUGUST, 2013
CENTRO PLAZA, PORT PIRIE

For the future we all want.

Do you have any feedback or questions about the Transformation of the Port Pirie Smelter?

Will this really go ahead?
Will there be more metals processed?
What is causing the emissions
will the stack stay?
Where is funding coming from?

Do you have any feedback or questions about Nyrstar?

Are Nyrstar onboard financially?

Information collected will be reviewed and made available to the public as part of the review process for the Public Environment Report and Development Application Process.

Would you like us to personally respond to you as well? If so, please supply us with your contact details:

Your Name: **Phone:**

Your Email Address:

Your Mailing Address:

If you would like more information about the Transformation please go to the website: **www.portpirietransformation.com** or phone Gail Bartel, Corporate Communications Manager, Nyrstar Port Pirie Smelter on 8638 1208.

For the future we all want.

nyrstar

A NEW PORT PIRIE
Transforming the future

TRANSFORMATION COMMUNITY CONSULTATION PROCESS
WEDNESDAY 21ST AUGUST - FRIDAY 30TH AUGUST, 2013
CENTRO PLAZA, PORT PIRIE

For the future we all want.

Do you have any feedback or questions about the Transformation of the Port Pirie Smelter?

Do you have any feedback or questions about Nyrstar?

ARE MEMBERS OF THE PUBLIC / EX-EMPLOYEES ABLE TO GET LEAD-IN-BLOOD TESTS?

Information collected will be reviewed and made available to the public as part of the review process for the Public Environment Report and Development Application Process.

Would you like us to personally respond to you as well? If so, please supply us with your contact details:

Your Name: [redacted] **Phone:** [redacted]

Your Email Address:

Your Mailing Address: [redacted]

If you would like more information about the Transformation please go to the website: **www.portpirietransformation.com** or phone Gail Bartel, Corporate Communications Manager, Nyrstar Port Pirie Smelter on 8638 1208.

For the future we all want.

nyrstar

A NEW PORT PIRIE
Transforming the future

TRANSFORMATION COMMUNITY CONSULTATION PROCESS
WEDNESDAY 21ST AUGUST - FRIDAY 30TH AUGUST, 2013
CENTRO PLAZA, PORT PIRIE

For the future we all want.

Do you have any feedback or questions about the Transformation of the Port Pirie Smelter?

* - IF E WASTE IS NO LONGER PART OF TRANSFORMATION. DUE TO ADDITIONAL CONTAMINANTS IS TRANSFORMATION STILL VIABLE AND LIKELY TO ~~SEE~~ LEAD TO NYRSTAR TURNING FUTURE PROFITS?

* WHAT IMPACT WILL TRANSFORMATION HAVE ON THE NUMBER OF EMPLOYEES AT THE PLANT AND WILL THE NATURE OF JOBS CHANGE?

* WHAT WILL HAPPEN TO BUILDINGS ON SITE THAT WILL NO LONGER BE PART OF THE NEW PROCESS?

Do you have any feedback or questions about Nyrstar?

WILL THESE OLDER AREAS ON SITE BE REHABILITATED OR JUST LEFT?

Information collected will be reviewed and made available to the public as part of the review process for the Public Environment Report and Development Application Process.

Would you like us to personally respond to you as well? If so, please supply us with your contact details:

Your Name: **Phone:**

Your Email Address:

Your Mailing Address:

If you would like more information about the Transformation please go to the website: **www.portpirietransformation.com** or phone Gail Bartel, Corporate Communications Manager, Nyrstar Port Pirie Smelter on 8638 1208.

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nyrstar

A NEW PORT PIRIE
Transforming the future

TRANSFORMATION COMMUNITY CONSULTATION PROCESS
WEDNESDAY 21ST AUGUST - FRIDAY 30TH AUGUST, 2013
CENTRO PLAZA, PORT PIRIE

For the future we all want.

Do you have any feedback or questions about the Transformation of the Port Pirie Smelter?

Will the Power plant bilding be demolished ?
Is the Blast Furnace going to continue operating ?
Will e-waste be treated ?
Will the smelter produce different metals ?

Do you have any feedback or questions about Nyrstar?

Information collected will be reviewed and made available to the public as part of the review process for the Public Environment Report and Development Application Process.

Would you like us to personally respond to you as well? If so, please supply us with your contact details:

Your Name: [redacted] **Phone:**

Your Email Address:

Your Mailing Address:

If you would like more information about the Transformation please go to the website:
www.portpirietransformation.com or phone Gail Bartel, Corporate Communications Manager, Nyrstar Port Pirie Smelter on 8638 1208.

For the future we all want.

nyrstar

A NEW PORT PIRIE
Transforming the future

TRANSFORMATION COMMUNITY CONSULTATION PROCESS
WEDNESDAY 21ST AUGUST - FRIDAY 30TH AUGUST, 2013
CENTRO PLAZA, PORT PIRIE

For the future we all want.

Do you have any feedback or questions about the Transformation of the Port Pirie Smelter?

why not produce your own electricity?

what does this mean for the existing blast furnace?

will this increase production?

Will production be stopped/reduced during construction?

Do you have any feedback or questions about Nyrstar?

This will be good for the community

Information collected will be reviewed and made available to the public as part of the review process for the Public Environment Report and Development Application Process.

Would you like us to personally respond to you as well? If so, please supply us with your contact details:

Your Name: **Phone:**

Your Email Address:

Your Mailing Address:

If you would like more information about the Transformation please go to the website: **www.portpirietransformation.com** or phone Gail Bartel, Corporate Communications Manager, Nyrstar Port Pirie Smelter on 8638 1208.

For the future we all want.

nyrstar

A NEW PORT PIRIE
Transforming the future

TRANSFORMATION COMMUNITY CONSULTATION PROCESS
WEDNESDAY 21ST AUGUST - FRIDAY 30TH AUGUST, 2013
CENTRO PLAZA, PORT PIRIE

For the future we all want.

Do you have any feedback or questions about the Transformation of the Port Pirie Smelter?

Will it be going ahead?
a bit of uncertainty?
Will the Blast furnace be changed?

Do you have any feedback or questions about Nyrstar?

Information collected will be reviewed and made available to the public as part of the review process for the Public Environment Report and Development Application Process.

Would you like us to personally respond to you as well? If so, please supply us with your contact details:

Your Name: **Phone:**

Your Email Address:

Your Mailing Address:

If you would like more information about the Transformation please go to the website: **www.portpirietransformation.com** or phone Gail Bartel, Corporate Communications Manager, Nyrstar Port Pirie Smelter on 8638 1208.

For the future we all want.

nyrstar

2.2 Doctors for the Environment

Doctors for the Environment Australia
www.dea.org.au

Submission on the Public Environmental Report for the Proposed Port Pirie Smelter Transformation

September 2013

Submission from
Doctors for the Environment Australia Inc.
David Shearman, Hon Secretary
College Park House, 67 Payneham Road
COLLEGE PARK SA 5069
Phone: 0422 974 857
Email: admin@dea.org.au
www.dea.org.au

Doctors for the Environment Australia (DEA) is an independent national organisation of medical doctors which advocates on health issues due to environmental factors. DEA has examined the report (Public Environmental Report) of Nyrstar's environmental consultants (COOE) on the Nyrstar Transformation of the Port Pirie lead smelter.

The purpose of this submission is to emphasise that, while the proposed Nyrstar Transformation of the lead smelter at Port Pirie considerably advances the health of Port Pirie residents, the environmental lead exposure of residents still remains of concern to us.

Lead is universally acknowledged to be a neurotoxin adversely affecting brain development and cognitive ability as well as having other systemic effects. Maternal blood lead levels even **less than 5** µg/dL are associated with reduced foetal growth (US National Toxicology Program), half the limit acceptable to Australia's National Environment Protection (ambient Air Quality Measure (2003). The impact of the Transformation will be such that 10-15% of Port Pirie children will have blood lead levels of **more than 10** µg/dL; possibly reducing to 5% of children in the long term, according to Nyrstar's Environmental Report.

As discussed in Nyrstar's report, there is convincing evidence of past and present pollution of Port Pirie by lead and other chemicals as a result of lead-smelting. Taylor and colleagues (2013, http://dx.doi.org/10.1016/j.envpol.2013.03.054) provide the most recent data on this. For example, in 2010-11, the Port Pirie smelter released 44 tonnes of lead into the atmosphere (National Pollution Inventory, 2012). Lead can be measured in the atmosphere, on surfaces and in the soils of Port Pirie, all at very high levels (Taylor et al., 2013).

Doctors for the Environment submits that the Environment Protection Agency restrictions on lead emissions, as published in National Environment Protection (Ambient Air Quality) Measure (2003), be strengthened, from yearly limits that obscure spikes in emission, to weekly or daily limits. Even so, knowing the variations in lead emissions does not address the issue adequately. Furthermore, it is clear that a clean-up of lead contamination in the environment around the smelter is impractical for reasons of very widespread existing, as well as continuing, pollution. Even without any further lead emission, children are likely to accumulate sufficient existing environmental lead to reach levels of 3 µg/dL.

Doctors for the Environment Australia submits; therefore, that communities in lead-contaminated suburbs need to be offered an opportunity to re-locate to clean areas.

Past practices have brought us to this situation. Denial of its serious nature and procrastination by governments at all levels ought to cease. SA citizens, SA Governments, Local Governments and smelting companies, together, have been the cause of the continuing problem of urban pollution in Port Pirie. The only effective solution is for South Australians as a whole to take responsibility for the mistake, support their fellow citizens in Port Pirie, and pay for the relocation of Port Pirie suburbs away from the smelter or pay for the relocation of the smelter away from the town.

2.3 Mark Parnell (MLC)

From: Parnell <Parnell@parliament.sa.gov.au>
Sent: Tuesday, 17 September 2013 8:43 PM
To: DPTI:Port Pirie Smelter; DPTI:PD DAC & Major Developments Panel
Cc: Bradshaw, Peter (DMITRE); Kleeman, Robert (DPTI)
Subject: Port Pirie Smelter Transformation PER submission

Dear Sir,

Please accept this submission to the public consultation process for the PER for the Pt Pirie Smelter Transformation

The first point to note is that it is not easy for members of the public to find out HOW to make a submission and TO WHOM it should be addressed. The relevant information is missing from the official Major Development web site devoted to this project (http://www.sa.gov.au/subject/Housing%2C+property+and+land/Building+and+development/Building+and+development+applications/Major+development+applications+and+assessments/Major+development+proposals/Port+Pirie+Smelter+Transformation)
and the DMITRE site as well. The PER document itself does not even include a section on how to make a submission. You could have done better engaging with the community on this.

In relation to the Smelter transformation project, I think this is an important project that could help ensure the ongoing viability of the Port Pirie smelter and associated industries. It provides an opportunity to maintain a key industrial asset and considerable local employment in one of South Australia's most important regional centres.

The main concern I have is whether the operator is proposing to do enough to reduce ongoing pollution, particularly lead pollution, given its known adverse effects on the health and development of young children. I want the project to succeed, but I think the PER is inadequate in identifying whether this is the best that can be done.

In my view, the parents of Port Pirie shouldn't have to choose between having healthy children and having a job. They are entitled to both.

The modelling associated with the Smelter Transformation Project anticipates a reduction on ongoing emissions of lead to the surrounding environment of around 50%. However, what is missing from the PER is any detailed analysis of what would be required to reduce ongoing pollution by a greater factor, say 80% or 90%. A key feature of Environmental Impact Assessment is supposed to be an evaluation of "alternatives". This PER does not seriously address this issue. The only "alternative" proposed is to "do nothing". There is no suggestion that an alternative could have been to do even better in relation to lead pollution reduction:

> Alternatives to the Transformation include continuation of current operations and resulting social and environmental impacts, potentially resulting in closure of the facility due to environmental or mechanical issues. Closure of the facility would result in significant direct and indirect social, environmental and economic impacts. Closure will likely result in the loss of employment opportunities, significant outflow of private investment, closure of local schools, hospitals and associated service industry, loss of revenue from the port facilities and significantly reduced tax revenue to national, state and local governments and export income.

So, from the operator's perspective, it's "my way or the highway". There is no serious attempt to evaluate technologies and processes that would deliver better outcomes. The only alternative presented is a "do nothing" alternative. This is poor process and Nyrstar should be required to go back and evaluate options that provide better environmental outcomes. The PER represents an evaluation of what the proponent is prepared to do, not what they should be required to do.

In relation to the sources of lead pollution that impact on the residents of Port Pirie, it is clearly a combination of both ongoing pollution and legacy pollution. It is noted that the overall reduction in blood levels anticipated in the PER is dependent on factors outside the smelter transformation and to a large extent, outside the proponent's control. It is noted that the proposed TLAP is similar to previous commitments which have not resulted in the anticipated reduction in children's blood-lead levels, which have been getting worse in recent years.

> The Targeted Lead Abatement Program (TLAP) will identify current and potential future community lead exposure reduction strategies and assess which are likely to have the greatest impact in reducing children's blood lead levels. Nyrstar and the South Australian Government have made a commitment to pursue the TLAP for a period of 10 years to achieve the long term objectives of the program.

Recent published reports showing the level of lead contamination in public playgrounds and in soil samples taken from public parks shows that there is far more that needs to be done to reduce public exposure to lead, even when ongoing lead emissions are reduced as a result of the smelter transformation.

When the Governor gives Development Approval to the Smelter Transformation, the proponent's "commitments" should at the very least be reflected in binding conditions of Development Approval. The conditions should set out the detail of the "commitment" to the TLAP including timeframes and the amount of money being put towards this project by Nyrstar and the State Government. Whilst these conditions are not enforceable by the community (by virtue of s.48E), these commitments form a significant part of the overall environmental improvement in Port Pirie and they ought to be formalised in the final approval by way of specific conditions. This means that they will at least be enforceable at the suit of the Minister. In my submission, it would be inadequate to incorporate these TLAP commitments into a vague obligation to undertake the development "in accordance with the PER", as is common in Major Development approvals.

I note the submission from Doctors for the Environment which points out that lead is universally acknowledged to be a neurotoxin adversely affecting brain development and cognitive ability as well as having other systemic effects. Maternal blood lead levels even **less than 5** µg/dL are associated with reduced foetal growth (US National Toxicology Program), half the limit acceptable to Australia's National Environment Protection (ambient Air Quality Measure (2003).

According to the PER, the impact of the Transformation will be such that 10-15% of Port Pirie children will still have blood lead levels of **more than 10** µg/dL; possibly reducing to 5% of children in the long term. However, if the more stringent US National Toxicology Program standard was to be followed, it is likely that half the children of Port Pirie would still have blood lead levels "of concern", even after the commissioning of the new smelter.

Other recent studies reported in the media have shown that exposure to excessive levels of lead as children increases the likelihood of a person developing problems later in life, including an increased propensity to substance abuse. http://www.theaustralian.com.au/news/health-science/study-links-high-lead-levels-to-anxiety-alcohol-problems/story-e6frg8y6-1226714820398

I have no doubt that concern about the likely change to lead exposure standards in coming years is the main reason the Government introduced legislation into State Parliament to effectively nobble the EPA and prevent it from exercising full responsibility for pollution licensing. With the passage of this legislation, the EPA is now prevented from changing the lead-in-air concentrations in the licence for 10 years unless the operator or the Manufacturing Minister agrees.

This is bad law, which sets a bad precedent for future industrial development in this State. Sadly, it is now a standard feature of negotiations between industrial developers and the Government that demands are made and acceded to that the EPA be sidelined in the name of "regulatory certainty". It happened with Onesteel in Whyalla, BHPB at Olympic Dam and even the ill-fated Penola Pulp Mill. The recent Port Pirie legislation was a vote of No Confidence on the part of the Government and Opposition in the ability of the EPA to do its job properly and according to law.

I look forward to your consideration of the points made in this submission.

Yours faithfully,

Mark Parnell MLC, LLB, BCom, MRUP

PS. Click here to sign up for updates from Greens MPs

Follow Mark on **Facebook** and **Twitter**

Mark Parnell, Member of the Legislative Council, **parnell@parliament.sa.gov.au**
Parliamentary leader, Greens SA
Parliament House, North Terrace, Adelaide SA 5000   Ph. 08 8237 9111
www.markparnell.org.au

2.4 Epuron

EPURON

Level 11, 75 Miller St
NORTH SYDNEY, NSW 2060
Fax 02 9922 6645
Ph 02 8456 7400

16 September 2013

Minister for Planning
Attention: Robert Kleeman, General Manager,
Assessment (Statutory Planning)
Department of Planning, Transport and Infrastructure
GPO Box 1815
ADELAIDE SA 5000

By email: dpti.portpiriesmelter@sa.gov.au
copy to: john.wilson@nyrstar.com

Dear Minister,

Port Pirie Smelter Transformation

I write in response to the public exhibition of the Port Pirie Smelter Transformation. As the Mayor of Port Pirie and others have publicly stated - Port Pirie is the smelter and the smelter is Port Pirie and accordingly given the significance of the smelter to the town it is important for the transformation to proceed on a number of grounds including economic and social.

However, it is important that the Transformation, in addressing some of the health and emissions issues it currently faces, does not create other emissions and health problems. Now is an opportunity for the Port Pirie Smelter, through its Transformation to take advantage of the opportunity to both reduce all emissions now and to diversify it's energy options into the future.

The PER details the upgraded processes proposed and the associated emissions and environmental impacts. It also seeks to have the environmental and operational standards and limits set through licences which are not to be varied for 10 years. This condition is sought to provide the regulatory certainty required for the investment decision. While it is important for the town that the project proceed it is also important that it does so with a view to the future.

We are now in 2013 and ten years ago, in 2003, the only large wind turbine in South Australia was a 0.15 MW unit at Coober Pedy. It would have been beyond the expectations of most that within 10 years, on a particularly windy week in August, 50% of the power needed in South Australia would be provided by wind energy.

The PER notes that Nyrstar uses 286,000 MWh of electricity and 1 petajoule of natural gas per annum. The proposed transformation will require 20 MW of additional electricity. It is proposed, but not certain, that the transformation will include a heat recovery and cogeneration facility with a net operating electricity output of between 4.8 MW and 8.1 MW depending on the designed configuration.

The power required for the Transformation includes not only an additional 20 MW but also new substation infrastructure at the Allendale substation (currently operating at capacity) and also upstream augmentation.

While the emissions intensity of the operations will reduce, the actual emissions will increase. The current carbon dioxide equivalent emissions (ktCO_2-e) is 350 kt which produces 365 kt of product. The transformed plant will have higher carbon emissions of 500 ktCO_2-e which will be generated in the manufacture of almost 600 kt of product including lead, zinc, copper, sulphuric acid, silver and gold. Accordingly while the carbon intensity will reduce by 0.12 tCO_2-e/tonne of product, the actual carbon emissions will increase by 150 ktCO_2-e – an increase of over 42%.

Section 15.4 of the PER notes that "Nyrstar Port Pirie seeks to contribute to South Australia's climate change mitigation measures by minimising the emissions intensity of its operations".

Epuron applauds this recognition of the impact of climate change. However, we note that the PER does not properly assess alternate energy supply options available to the plant in the form of solar or wind energy options.

Epuron believes that the plant is very well located for both solar and wind energy options to be co-located at the site. Our initial investigations indicate that both the solar and wind energy resources at the site are excellent on a world scale. As a result, based on the strong government support available, Epuron believes that a solar farm or wind farm in the capacity of 10-30MW would be viable at the site and could lead to a lower operating cost for the site in the long term due to the combined benefits of:

- Reduced electricity purchases
- Reduced electricity network charges
- Sale of renewable energy certificates
- Potential funding assistance via the Clean Energy Finance Corporation and other government bodies

Nyrstar note in their Energy and Greenhouse gases page under Sustainability on their website:

> *Energy represents over 35 per cent of Nyrstar's operating costs – in 2010 costing us over €250 million (globally). Being in an industry that competes globally on cost structure, and with a cost curve that is relatively flat, even small changes in our operating costs can significantly affect our competitiveness.*
>
> *So any increase in our energy costs due to emissions trading schemes, particularly for electricity, will have a marked economic impact on our business. (Most of our greenhouse gas emissions relate to the electricity we use rather than from direct emissions from our production plants, so our carbon footprint is in fact highly dependent on the regional electricity generation source.)*

We contend that on this particular site, the economic impact of installing renewable energy options is likely to be positive. Further, this does not have to come at any capital cost to Nyrstar as a number of renewable energy companies would be interested in building, owning and operating the plant under an electricity take off agreement with Nyrstar.

The Transformation project provides the ideal opportunity to transform a significant portion of the energy supply system for the smelter at the same time. Accordingly, we consider that such an installation should at least be assessed as part of the PER, or at least a commitment made to carry out a detailed feasibility analysis of both options which would include the installation of wind and solar monitoring equipment to confirm the resource available at the site. Epuron believes Arena grant funding can be sourced to assist with the monitoring of wind and solar resource in the first instance.

Nyrstar Port Pirie is in a position to understand the consequences of climate change given its low lying plant and the requirement to include two new levees to protect the plant from flooding by coastal inundation and to ensure contaminated liquors do not enter the Port Pirie River. The PER notes that the South Australian Department of Environment, Water and Natural Resources is prepared to accept the levees as actions to meet the requirements of the Coastal Protection Board's minimum site levels and floor levels for coastal developments to address accelerated sea level rise.

The Transformation is well placed to reduce not only its emissions intensity but also its emissions, and in so doing also safeguard the long term cost of its electricity by installing a portion of the additional power it needs from renewable sources – either wind or solar. Renewable energy plant can be installed behind the meter, reducing transmission costs and significantly lowering both the Transformation's emissions and its exposure to power price increase. This reduction in emissions would also benefit both the local community and the South Australian communities around the power generation stations which service the smelter.

Yours sincerely,

DONNA BOLTON
d.bolton@epuron.com.au

nyrstar
Resources for a changing world

Appendix B:
Port Pirie marine cooling water discharge modelling

A part of BMT in Energy and Environment

Port Pirie Marine Cooling Water Discharge Modelling: Additional Far Field Assessments

R.B20232.002.00.AdditionalWorks.docx
October 2013

Port Pirie Marine Cooling Water Discharge Modelling: Additional Far Field Assessments

Offices

Brisbane
Denver
Mackay
Melbourne
Newcastle
Perth
Sydney
Vancouver

Prepared For:	Nyrstar Port Pirie Pty Ltd.
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Client Reference	

Title :	Port Pirie Marine Cooling Water Discharge Modelling: Additional Far Field Assessments
Author :	Daniel Botelho, Ryan Shojinaga
Synopsis :	This project details additional far field assessments of the temperature increase resulting from cooling water discharges from an outfall in the Port Pirie River.

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1 INTRODUCTION

Nyrstar recently submitted a Public Environmental Review (PER) to upgrade its smelter at Port Pirie to a state-of-the-art poly-metallic processing and recovery facility. More specifically, the proposed upgrade considered replacing the existing sinter plant with a state-of-the-art oxygen enriched bath smelting furnace, coupled to an electricity cogeneration facility and a new sulphuric acid plant. These new facilities would require an upgraded sea water intake and an expanded cooling water discharge system. The cooling water thermal effluent would be ultimately disposed in the marine environment near Port Pirie (Nyrstar 2013).

BMT WBM prepared a high-level study to support Nyrstar in coming to a decision on the pre-feasibility of different discharge options (BMT WBM 2013). In particular, the study considered the following matters:

- Whether a diffuser in the Port Pirie River could be successfully designed to meet South Australian Environmental Protection Agency (SA EPA) water quality guidelines regarding temperature increase in the near field; and
- The far field dispersion of the thermal effluent discharged at different locations, and also considering different discharge temperature increases in relation to the intake water temperature.

The SA Government (SA EPA and Department of Environment, Water, and Natural Resources (DEWNR) has reviewed and issued their submissions with respect to the PER. Their submissions raised the following issues with regards to the marine discharge study:

1. Further work was needed to optimise the diffuser design to provide a better understanding of the conservatism in the model predictions.
2. Further temporal far field modelling was required to demonstrate that heat will not accumulate in the upper reaches of the Port Pirie River (in the case of outfall discharges in the Port Pirie River).
3. Optimisation of the intake and outfall locations would be required to avoid short circuiting of the cooling water.
4. A bathymetric survey of Germein Bay, and detailed long term collection of water quality and meteorological data are required to validate model predictions for the First Creek options.

Nyrstar has elected to advance the option of discharging the effluent from an outfall in the Port Pirie River. As such, only items 1 to 3 above remain relevant for the pre-feasibility aspects of the Nyrstar thermal discharge. This report describes and presents additional results of near and far field numerical modelling undertaken to address the issues raised by SA Government in the PER submission.

1.1 Study Components

The following components were developed in this phase of the study:

1. Preliminary outfall design optmisation. While the report has shown the proposed outfall in the Port Pirie River was always compliant with present SA EPA Water Quality Guidelines EPA 2003), the SA EPA raised an issue with the time interval adopted for checking compliance with a new proposed draft policy (EPA 2012). The compliance analysis was re-performed for the requested weekly time interval and a broader set of outfall design possibilities were considered to demonstrate the dilutions obtained in the previous assessment could be improved.
2. Integration of the near field model with the far field model presented in BMT WBM (2013) was undertaken to provide more realistic temperature simulations in the case of the proposed discharge.
3. Far field model simulations were undertaken for extended periods of time to assess the heat impacts at different seasons of the year and whether heat accumulation would occur in the Port Pirie River.
4. Adoption of these far field model results and optimised near field results in order to test the compliance of the proposed outfall with the new SA EPA Water Quality Policy (EPA 2012).
5. Adoption of these far field model results to verify the possibility of short circuiting of the cooling water between the intake and outfall locations.

1.2 Report Outline

This report is structured as follows:

1. Section 2 presents a site description relevant to the study area;
2. Section 3 presents the preliminary design optimisation for a range of outfall characteristics;
3. Section 4 presents the far field model integration with the near field and the associated far field model results in terms of the dispersion of the thermal effluent plume in the Port Pirie River;
4. Section 5 presents a brief discussion of the study findings; and
5. Section 6 presents the study conclusions and recommendations.

2 SITE DESCRIPTION

2.1 Spencer Gulf

The Nyrstar facility is located at the margins of Port Pirie River near its mouth at Spencer Gulf, in South Australia. Spencer Gulf is a large (length approximately 300km, mean width approximately 60km) and relatively shallow (mean depth approximately 22m) semi-enclosed sea (Figure 2-1). The Gulf has an approximate triangular shape, bounded by the Yorke Peninsula to the east, the Eyre Peninsula to the west and the Southern Ocean to the south (Figure 2-1).

Flow in the Gulf is largely influenced by tides, which have significant spatial variation. In particular, the mouth in the southern end and the head in the northern end have a semidiurnal tidal elevation character, whereas at the centre of the Gulf, near Wallaroo, the tidal elevations are predominantly diurnal (Easton 1978). The tidal elevation range is relatively small at the mouth (0.6 m at Pondalowie Bay) of the Gulf and progressively increases up to 2.7 m in the head of the Gulf (BMT WBM 2011).

Predominant tidal harmonics in Spencer Gulf are the diurnal components K1 and O1, and the semi-diurnal components M2 and S2 (Nunes and Lennon 1986). Both diurnal and semi-diurnal components have similar amplitudes to each other. The semi-diurnal harmonics are phase-cancelling and enhancing at every 14.8 days, whilst the diurnal harmonics at every 13.7 days. As a result periods of low tidal amplitude occur approximately every 6 months, when both diurnal and semi-diurnal components cancel each other. These tides are a notorious feature of the South Australian gulfs, known as “dodge tides”. Due to the small tidal amplitudes, tidal flow becomes severely reduced over part of the neap cycle period (Easton 1978). However, it has been shown that during dodge tides flow velocities can still exceed 30 cm/s in some parts of the Gulf, such as near Port Bonython (BMT WBM 2011).

Temperature and salinity are predominantly influenced by the local meteorology and increased residence times within the northern areas of Spencer Gulf (Nunes and Lennon 1986). Over the annual cycle, mean water temperature ranges between 12 and 24°C Spencer Gulf. Salinity ranges over the annual cycle vary more widely spatially, from ~43 to 48 g/L at the head of the Gulf, to ~38 to 39 g/L at Wallaroo (Nunes and Lennon 1986), and ~35.5 to 37.0 at the mouth (Herzfeld et al. 2009). Strong evaporation north of Point Lowly drives these high salinities at the head of the Gulf and results in the development of a broadscale north-south salinity gradient during summer. This gradient is relaxed during autumn and winter due to the combined effects of reduced evaporation and a large scale ejection of salt from the Gulf (Nunes et al. 1990).

Given the Gulf’s width, the salt ejection is influenced by the Earth’s rotation forming a cyclonic (clockwise) gyre motion south of Port Bonython (Nunes and Lennon 1986). In autumn through winter, this gyre brings colder, less saline southern water up the Gulf along the western shore and more saline warmer water down the Gulf along the eastern shore (Nunes-Vaz et al. 1990). Nunes (1985) data shows temperature and salinity gradients that form across the Gulf between False Bay, off Whyalla, and Germein Bay, off Port Pirie (Figure 2-2).

2.2 Port Pirie

Port Pirie is a coastal town on the southern shore of Germein Bay located approximately 230 km north of Adelaide and approximately 37 km across the Gulf from Whyalla (Figure 2-1). The city of Port Pirie and the Nyrstar smelter are located in the western margin of the Port Pirie River, where a port facility operates to receive concentrates used in the metal processing (Figure 2-3).

Little is known about the hydrodynamics near Port Pirie; more specifically, no hydrodynamic modelling studies have been undertaken in the area. Recently, hydrodynamic studies have been conducted as a result of environmental studies for a desalination plant outfall near Port Bonython in the opposite margin of the Gulf (BMT WBM 2011). These studies show that bathymetric features are very important in determining the intensity and direction of the flow resulting from the tides. For example, flow is quite vigorous (up to 1.5 m/s, mean 0.50 m/s) through a deep channel known as “the Rip” between Point Lowly and Ward Spit (BMT WBM 2011 - see Figure 2-2 for locations). On the other hand, vortices form on the lee side of Point Lowly, considerably reducing the flow intensity (maximum of approximately 0.3 m/s during ebb tides, BMT WBM 2011).

For this project, a targeted field measurement program was undertaken for model validation purposes and to specifically obtain local hydrodynamic data. The instruments were deployed between 04 April and 08 May 2013, inclusive of approximately two full spring neap tidal cycles. The measurements consisted of:

- Velocity data obtained from Acoustic Doppler Current Profilers (ADCPs) at two separate locations; and
- Conductivity-Temperature-Depth (CTD) data at four separate locations.

These measurements are described in BMT WBM (2013) and a summary is provided in Table 2-1. The deployment locations are presented in Figure 2-3.

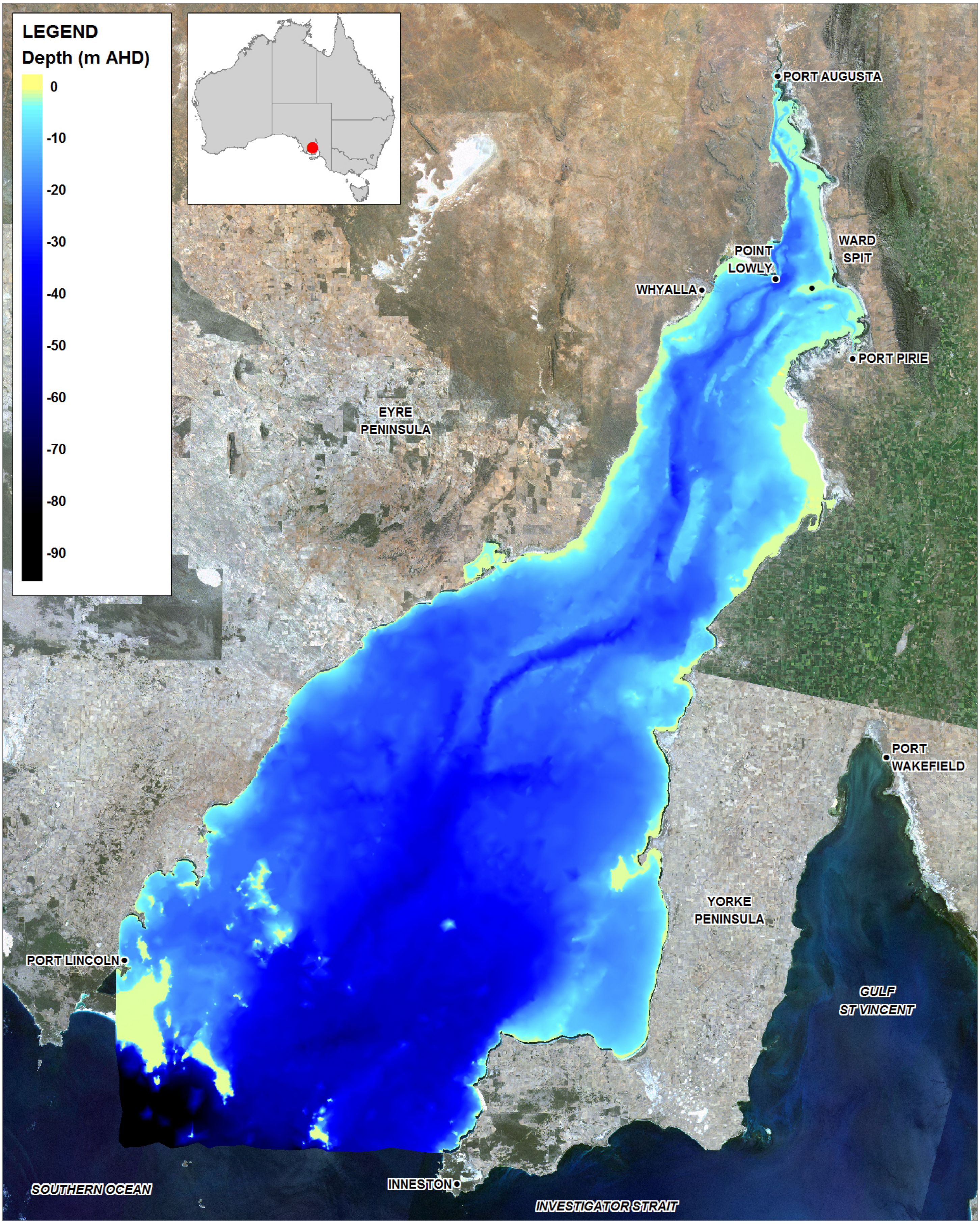
2.2.1 ADCP Measurements

ADCP Measurements at Site 1 are more relevant in the Port Pirie River and are presented in Figure 2-4. Average and maximum velocities were 0.09 m/s and 0.59, respectively. The velocities at Site 1 were generally higher in the flooding tides and lower in the ebbing tides. The three neap tide periods indicate velocities remain below 0.1 m/s throughout the water column for a few days.

The velocity directions at Site 1 were oriented in the NW-SE directions, with markedly abrupt change in directions with the change in tidal phases (Figure 2-4).

2.2.2 CTD Measurements

CTD temperature and salinity measurements are presented in Figure 2-5 and Figure 2-6, respectively. All sites present similar trends of decreasing salinities and temperature, as expected for this time of the year. Site 1, the most relevant inside the estuary, presented stratification of salinity (up to approximately 2 units) and temperature (up to 1 ^{o}C), while sites offshore (Sites 3 and 4) were relatively well mixed (BMT WBM 2013). Temperature inside the estuary (Site 1) was generally lower than offshore and salinity was higher (Figure 2-5 and Figure 2-6). Sites 3 and 4 presented excessive conductivity sensor drifting, such that salinity measurements were not reliable.



Title:
Spencer Gulf Location and Bathymetry

Figure: **2-1**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Approx. Scale

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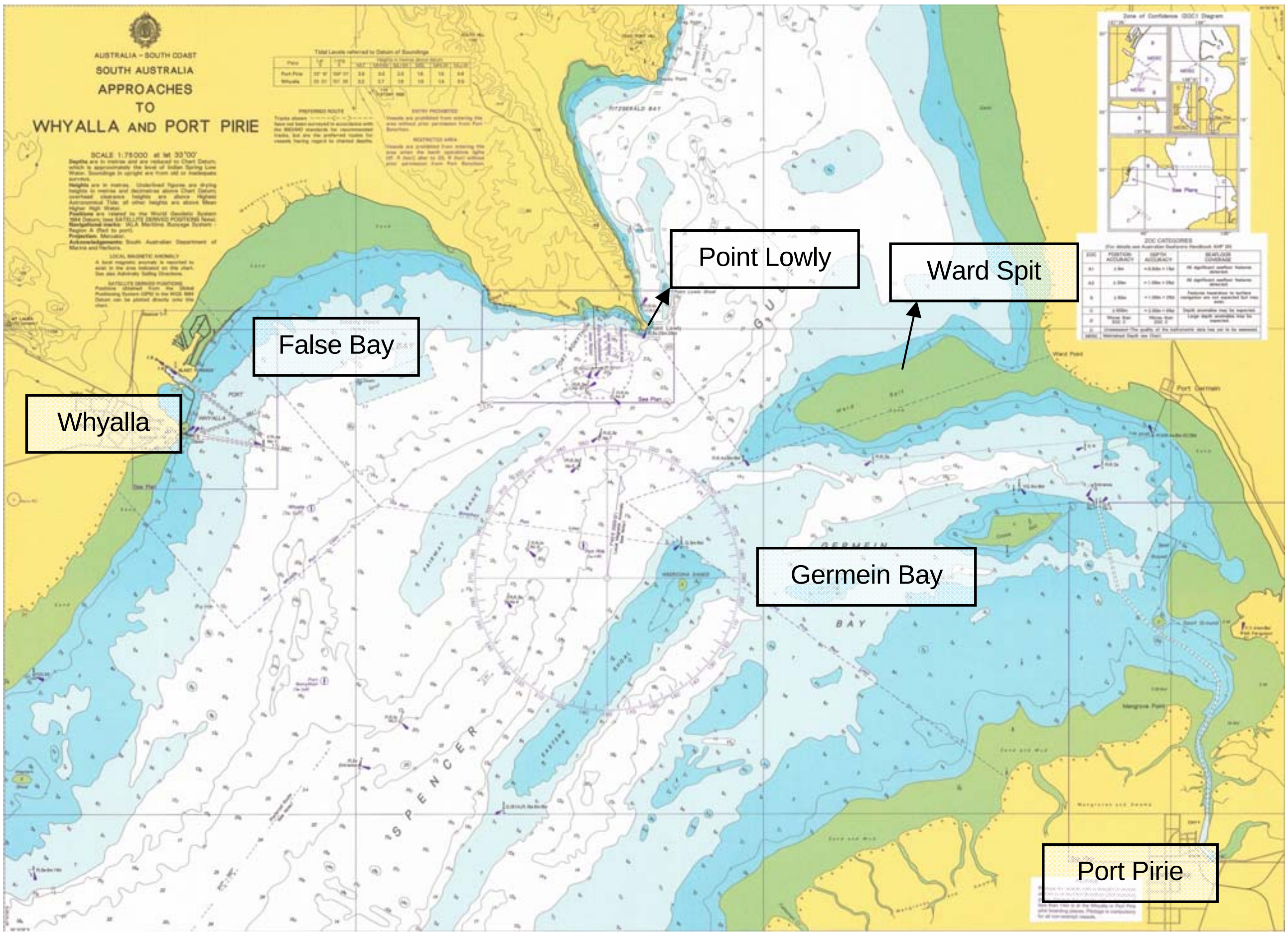

Figure 2-2 Approaches to Whyalla and Port Pirie (Chart AUS 136, AHS 2000). Scale shown does not apply.

Title:

Port Pirie, Nyrstar Facilities and Sampling Stations

Figure: 2-3

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Table 2-1 Summary of measurements specifically undertaken for model development

Measurement Type	Station	Location		Measurement Interval	Measured Variables
		Longitude	Latitude		
Vertical Velocity Profile (ADCP)	1 (~7 m depth)	138° 0’ 58.1’’ E	33° 9’ 12.2’’ S	05/04/2013 to 08/05/2013	Current speed and direction (and backup water depth)
	2 (~6 m depth)	137° 58’ 49.3’’ E	33° 5’ 32.8’’ S		
Conductivity Temperature and Depth (CTD)	1 (~7 m depth) top and bottom	138° 0’ 58.1’’ E	33° 9’ 12.2’’ S	05/04/2013 to 08/05/2013	Temperature, conductivity (salinity and density), and pressure (depth)
	2 (~6 m depth)	137° 58’ 49.3’’ E	33° 5’ 32.8’’ S	05/04/2013 to 05/05/2013	
	3 (~5 m depth) top and bottom	137° 56’ 20.2’’ E	33° 0’ 00.1’’ S	05/04/2013 to 08/05/2013	
	4 (~6 m depth) top and bottom	137° 57’ 18.5’’ E	33° 6’ 52.4’’ S	05/04/2013 to 08/05/2013	

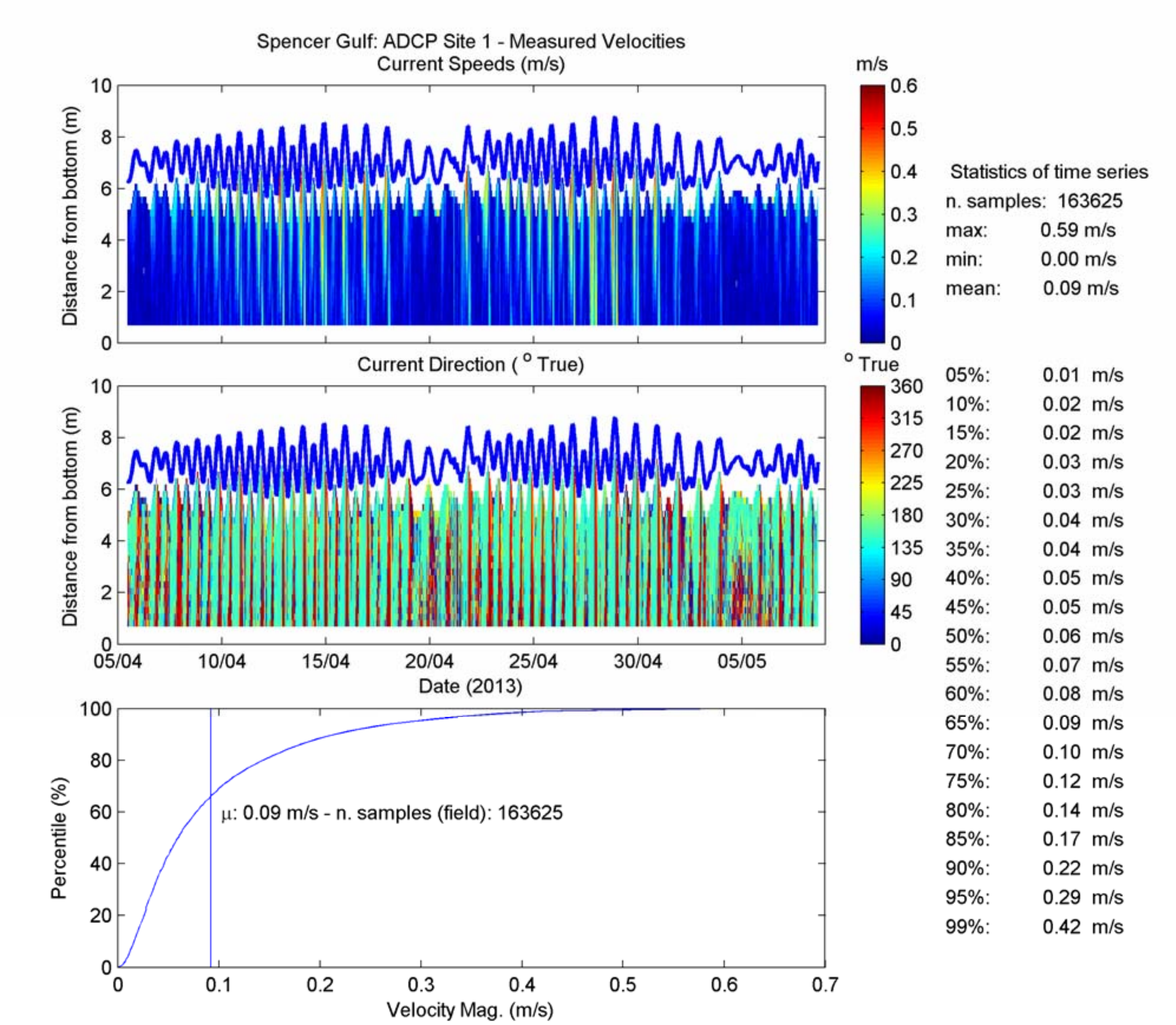

Figure 2-4 ADCP Measurements at Site 1

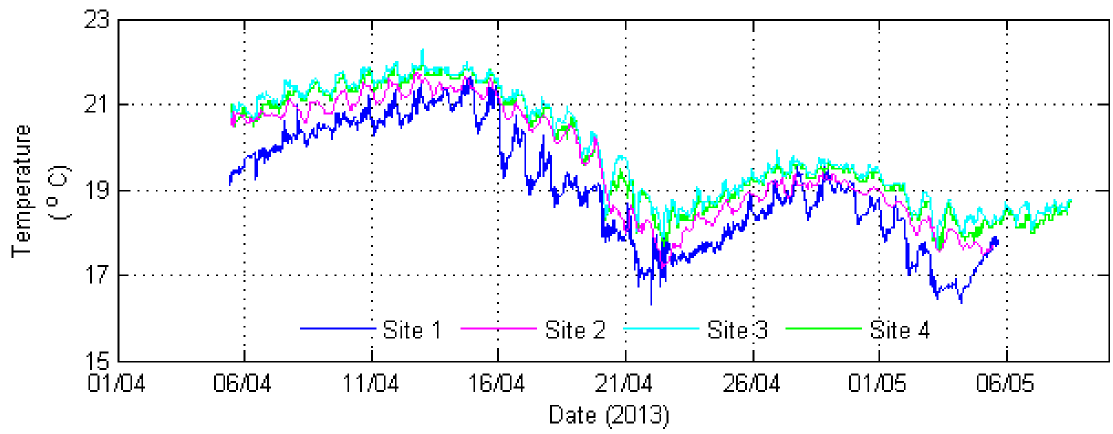

Figure 2-5 CTD Temperature Measurements – Comparisons at Surface between All Sites

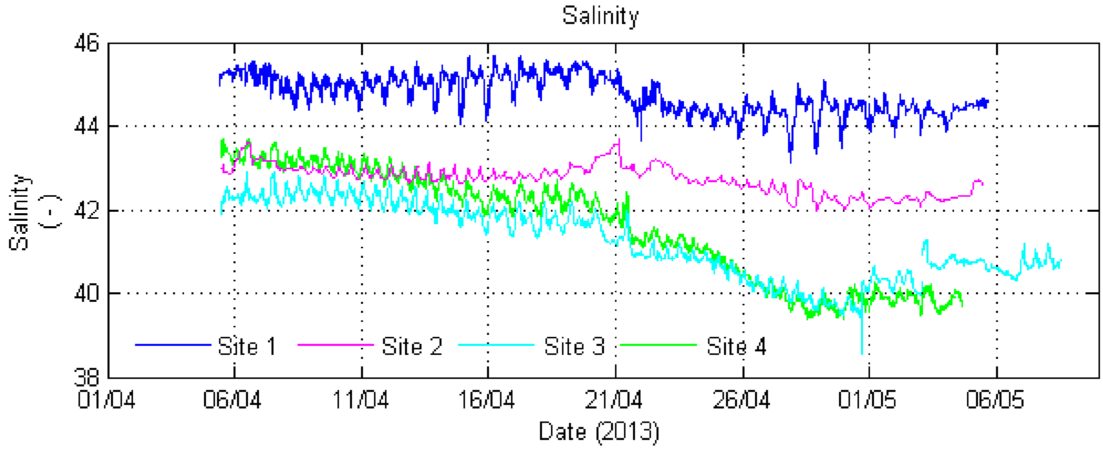

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Figure 2-6 CTD Salinity Measurements – Comparisons at Surface between All Sites

2.2.3 Existing Discharge

The existing smelter cooling system extracts water at the intake location shown in Figure 2-3. Cooling water is discharged at an average 0.62 m^3/s flow rate to a flume (PP02 in Figure 2-3) that serves as conduit to First Creek, approximately 1.6 km downstream. Cooling water is ultimately delivered to Spencer Gulf according to the tidal motion within First Creek. A five year monitoring study showed that the increased temperatures associated with the cooling water is confined to First Creek, while little difference in temperature was found between the mouth of First Creek and control sites offshore (NRS 2007). These results were consistent with far field simulations presented in BMT WBM (2013).

2.2.4 Proposed Discharge

Four potential outfall locations as indicated by points PP02 to PP05 in Figure 2-3 were under consideration in the upgraded operations (BMT WBM 2013). The existing discharge, also at PP02, discharges via First Creek, whilst the potential outfalls at PP03 to PP05 would discharge cooling water directly to Port Pirie River. Whilst the navigation charts show the Port Pirie River channel is maintained in excess of 8.0 m for the Port Pirie activities, recent sounding near PP05 indicate a depth of approximately 6.4 m.

The observed tidal asymmetry indicates that the Port Pirie River (i.e. stronger flows during flood tides) is not well flushed and that the discharge at PP05 is the preferred option in the Port Pirie River (BMT WBM 2013). Nyrstar has now elected to proceed with this option, such that PP05 is the only location considered in this study.

The proposed cooling water system would require an additional 1.64 m^3/s cooling water flow rate and assumes a 10 ^oC temperature increase in relation to the intake.

3 PRELIMINARY OUTFALL OPTIMISATION

BMT WBM (2013) presented two sets of preliminary designs to demonstrate an outfall in the Port Pirie River was always compliant with present SA EPA Water Quality Guidelines (EPA 2003). However, the lowest dilutions obtained with the BMT WBM (2013) demonstration design were just enough to meet these guidelines. In this Section, we extend the suite of design configurations considered to demonstrate further improvement in dilutions can be achieved even with limited outfall optimisation.

3.1 Water Quality Guidelines

The existing Environment Protection (Water Quality) Policy 2003 (SA EPA 2003) does not have a specific guideline addressing temperature increases due to effluent discharges. As a general rule, the SA EPA negotiates appropriate guidelines on a case by case basis. Based on precedents in South Australia, the SA EPA is likely to require that temperatures resulting from the disposal of cooling water into the Port Pirie River are no greater than 2 °C above the ambient temperature 20 m from the outfall (S Gaylard, SA EPA, *pers. comm.* 24 May 2013). This guideline is hereafter referred to as present guideline.

It is also relevant that a draft Environment Protection (Water Quality) Policy 2012 (SA EPA 2012), based on the ANZECC/ARMCANZ 2000 Water Quality Guidelines, is likely to replace the existing policy in 2014. The new policy requires that the resultant median water temperature does not exceed the 80th percentile (i.e. 20^{th} percentile temperature exceedence) of the ambient water temperature at the edge of an agreed mixing zone. This mixing zone is likely to be specified at 20 m from the outfall, as per the present guidelines.

BMT WBM (2013) applied this statistical analysis over one month period of the available CTD data at Site 1 and verified compliance of the design with the EPA (2012) draft guidelines. Following review of the PER, SA EPA indicated this analysis should be carried out over a seven-day period. In this Section, verification of compliance for this period of analysis is presented.

Both present and draft guidelines apply to a distance 20 m from the diffuser and therefore require investigation with near field models (i.e. a far field model is generally too coarse to resolve the near field mixing characteristics).

3.2 Optimisation Methodology

Diffuser assessments were undertaken to determine the dilution achieved for a range diffuser and ambient characteristics and to determine which combination of parameter values would result in compliance with temperature objectives. This assessment examined mixing achieved by varying the following parameters to determine dilutions:

- Port diameter;
- Number of ports;
- Diffuser length; and
- Ambient velocity.

The diffuser parameters (diameter, port number and length) represented the variables for modification while ambient velocity was varied to determine the performance of each diffuser configuration for the breadth of background velocities at the site.

The process of assessment entailed varying one parameter at a time (e.g., port diameter) while the other parameters remained fixed. Three values for each parameter were assessed, resulting in 81 unique combinations (3 x 3 x 3 x 3) of diffuser and ambient conditions. These parameters and the values used in the near field modelling are presented in Table 3-1. It is noted that for ambient velocity, the 20th-, 50th- and 80th-percentile values were selected from the ADCP located at Site 1.

Table 3-1 Diffuser Assessment Parameter Space and Values

Variables	1	2	3
Port Diameter, Ø (mm)	120	160	20
Manifold Length, *L* (m)	25	50	75
Number of Ports, *n*	6	8	10
Ambient Velocity, V_{AMB} (m/s)	0.03	0.06	0.14
Ambient Velocity (%-ile)	20th	50th	80th

3.3 Remaining Channel and Diffuser Parameters

Several additional parameters were required for modelling the diffuser configurations. These static (non-variable) parameters were applied from the previous assessment or updated from information provided by Nystar. These parameters are presented in Table 3-2.

The diffuser manifold was assumed to be located nearest the western bank of the channel and oriented parallel with the direction of the channel. The ports were directed toward the middle of the channel away from the nearest channel bank.

To minimise the potential for the plume to impinge upon the water surface, thus potentially resulting in impacts to the visual aspects of the channel, the ports were oriented horizontal to the water surface (0 degrees).

Finally, the channel width and distance to the nearest bank were determined by analysing the channel characteristics in proximity (80m upstream and downstream) of the initial (nominal) diffuser location (PP05) assuming a water depth at the outfall location of 6.4m. Within the vicinity of the nominal location, the most conservative channel characteristics were selected (i.e., narrowest and closest to the west bank). Figure 3-1shows the nominal and worst-case locations relative to the bathymetry of the channel. Figure 3-3 shows cross sections at these locations with an approximate diffuser located within 6.4m depth of water. The worst-case cross section represents the channel characteristics used in the modelling.

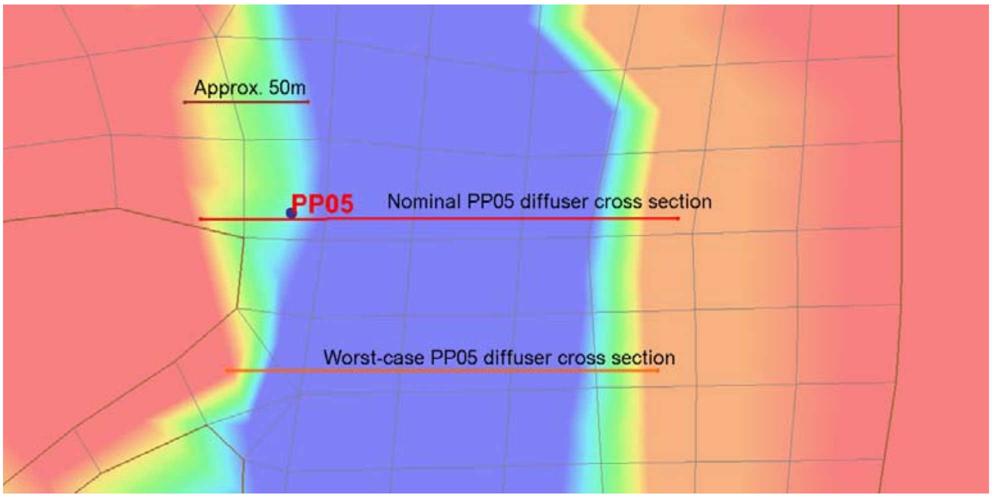

Figure 3-1 Potential Diffuser Locations at PP05, Including the Worst-Case Location

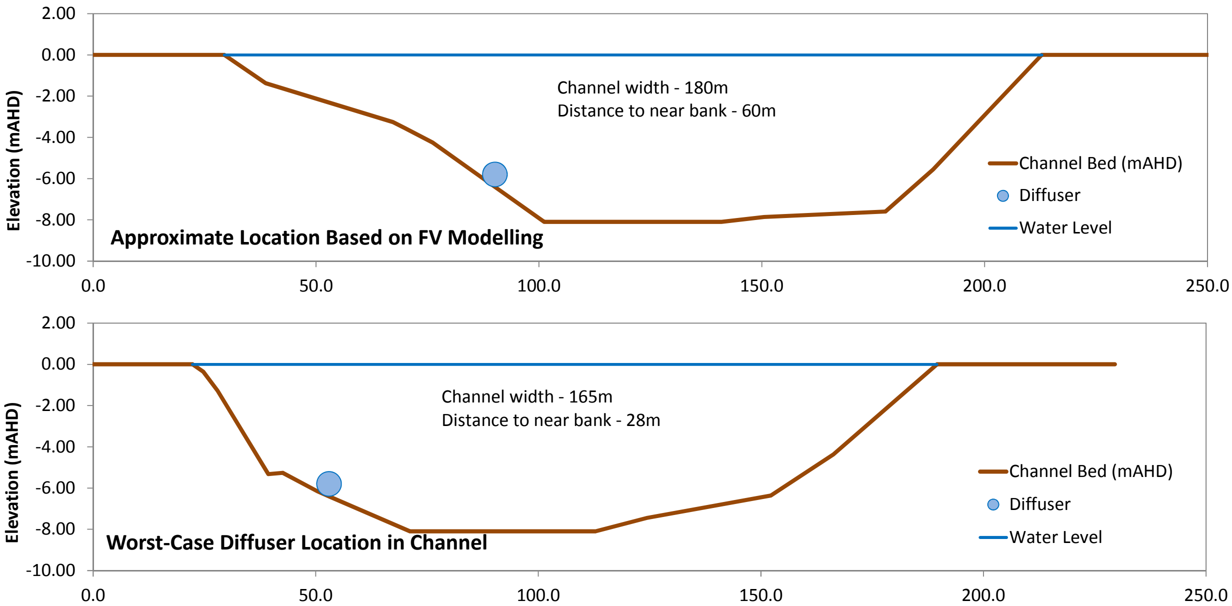

Figure 3-2 Nominal and Worst-Case Channel Cross Sectional Geometry

Table 3-2 Channel and Diffuser Characteristics

Static Variable	Value
Water depth at discharge (m)	6.4
Manifold diameter (m)	1.2
Port riser height (m)	0.1
Depth of discharge (m)	5.1
Vertical discharge angle (deg)	0
Channel Width (m)	165
Distance from Near Bank (m)	28

3.4 Water Properties

Densities of the discharge and receiving water were calculated using temperature and salinity and relationships developed by McCutcheon et al (1993). The values used for these are summarised in Table 3-3. The density properties of discharge and receiving water were calculated based on temperature and salinity. A total discharge flow rate of 1.64 m^3/s was used in these assessments. These values were applied from the previous Port Pirie near field modelling (BMT WBM 2013).

Table 3-3 Physical Water Properties

Water Characteristics	Background	Discharge
Discharge Flow Rate (m^3/s)	--	1.64
Temperature (°C)	25	35
Salinity (psu)	35	35
Density, ρ (kg/m^3)	1023.4	1020.0

3.5 Modelling Packages

These assessments were carried out using the CORMIX (Cornell Mixing Zone Model; Jirka et al 1996) mixing modelling software. CORMIX is a United States EPA-approved modelling packaged used for modelling the dilution of wastewater discharge to surface water. CORMIX is capable of modelling multiport diffuser in relatively shallow water. Some of these parameters were also modelled in Visual Plumes (Frick et al 2003) to provide some additional context of possible mixing from the diffuser configurations. In particular, the 6-port, 160-mm port-diameter diffuser was modelled at the 3 diffuser lengths and 3 ambient velocities (see Table 3-1). It is noted these tools were also used in BMT WBM (2013).

3.5.1 Model Configurations

For each outfall specification (i.e. number of ports) and ambient condition (i.e. 7 ambient velocities and 2 ambient temperatures), only one CORMIX configuration and one Visual Plume model configuration were set-up and executed, including:

- CORMIX assuming multiple ports (slot line discharge) at the specified distance from the bank;
- Visual Plumes assuming multiport diffusers.

Adoption of these configurations was undertaken to provide sensitivity and confidence in the modelling results and took into consideration the most conservative (in terms of presenting the lowest dilutions) of the configurations (i.e. CORMIX).

3.6 Results

Results are summarized in tables presenting the following results:

- Dilution of the discharge at 20m from the outfall;
- The change (increase) in temperature above background at 20m from the outfall; and
- Comparison of CORMIX and UM3 results.

3.6.1 Dilutions

Table 3-4 presents the dilution factors at 20 m from the outfall for all of the parameters. Included in Table 3-4 are the instantaneous jet velocities of the diffuser configuration in metres per second. It should be noted the jet velocity is a function of the port diameter and number of ports (total port discharge area), and independent of diffuser length and ambient velocity. Additionally, the jet velocity is the exit velocity at the port and not applicable to anywhere else within the plume.

The diffuser which demonstrated the greatest dilution (35.7) was the 50m, 6-port, 120 mm port-diameter configuration at low ambient velocity (0.03m/s). The smallest dilution (5.0) occurred with the 75m, 10-port, 200 mm port-diameter diffuser at medium ambient velocity (0.06 m/s).

Mixing and dilution were primarily dependent on jet velocity, and secondarily on diffuser length. In particular, dilution was shown to be largely controlled by total port area which is directly related to the port diameter and number of ports. Increased jet velocities corresponded to increased dilution.

Diffuser length presented a lesser effect in comparison to jet velocity but was still important in the optimisation of the diffuser. This is further discussed with the comparisons with Visual Plumes below.

The CORMIX modelling demonstrated that greater ambient velocity resulted in less dilution. This is likely because of the relationship between the rate of entrainment (mixing of receiving water and discharge) and the degree to which the plume is deflected (i.e. advected in the flow direction) with limited mixing beyond the 20m perimeter. For the same discharge configuration, at higher ambient velocities, CORMIX showed the plume was advected before significant mixing at 20 m from the diffuser in comparison to lower ambient velocities.

3.6.2 Temperature Increase

Table 3-5 presents the resulting change in temperature above background for each diffuser configuration and ambient velocity at 20m from the outfall. The change in temperature was calculated using the following equation:

$$\Delta T = \frac{T_o + (D-1)\cdot T_a}{D} - T_a$$

where T_o is the discharge temperature at the diffuser nozzle, T_a is the background temperature, and D is the dilution factor from Table 3-4.

With relation to changes in temperature at 20m, the maximum temperature change was calculated to be 2.0 °C corresponding to the dilution factor of 5. The smallest change in temperature was 0.3 °C corresponding to the dilution factor of 35.7.

3.6.3 Comparison of CORMIX and Visual Plumes

Table 3-6 presents a comparison of CORMIX and Visual Plumes results for the 6-port, Ø160 diffuser over the range of diffuser length and ambient velocity conditions.

CORMIX results demonstrated shorter diffusers typically yielded higher dilution factors, however it should be noted that CORMIX assumes the configuration as a rectangular (2-dimensional) slot discharge, as if the discharge plumes were completely merged from exiting the port nozzles. This assumption neglects significant amount of mixing along the interface of the plumes of each individual port prior to merging and this is likely the reason for the superior mixing observed from the shorter diffusers. Nevertheless, this assumption is conservative in that respect. Also, in comparison and more intuitively, the Visual Plumes modelling typically showed that longer diffusers resulted in greater dilution.

It should be noted that for some discharge configurations, the change of value for one parameter resulted in a large change in dilution. For example, the 6-port, Ø120 diffuser resulted in a dilution factor of almost 30 for the 25m diffuser, however only 10-11 for the 50 and 75m diffuser. This is due to a change in flow classification and associated mixing regime in CORMIX whereby the penetration and dilution of discharge from the longer diffuser into the cross-current was reduced (i.e. the jet has a lesser momentum flux), as a result of the assumed slotted discharge.

Contrastingly, CORMIX demonstrated similar dilutions occurring at the low ambient velocity, whilst Visual Plumes predicted higher dilutions at higher ambient velocities. Additionally, as mentioned previously, Visual Plumes generally demonstrated increased dilution as the length of the diffuser increased. These comparisons suggest that CORMIX is providing conservative results in terms of dilutions.

For detailed design more sophisticated technologies such as Computational Fluid Dynamics (CFD) are recommended for clarification of best diffuser length performance.

Table 3-4 Diffuser Configuration Modelling: Dilution Factors at 20m

	Port Diameter, Ø (mm)	No. of Ports, *n*	Jet Velocity (m/s)									
Ambient Velocity (m/s)				0.03			0.06			0.14		
Diffuser Length, *L* (m)				25	50	75	25	50	75	25	50	75
	120	6	24.2	35.0	35.7	29.8	34.0	34.0	27.8	29.7	11.2	10.2
		8	18.1	30.2	30.8	25.7	29.1	28.9	23.4	9.9	10.2	9.2
		10	14.5	26.9	27.4	22.8	25.8	25.3	20.4	9.3	9.3	8.3
	160	6	13.6	26.1	26.5	22.0	24.9	24.4	19.6	9.2	9.1	8.0
		8	10.2	22.4	22.7	18.8	21.1	20.4	17.7	8.3	7.9	7.4
		10	8.2	19.9	20.1	16.6	18.5	17.7	5.6	7.5	7.1	6.9
	200	6	8.7	20.6	20.8	17.2	19.3	18.5	5.7	7.8	7.3	7.1
		8	6.5	17.7	17.8	14.7	16.2	5.6	5.3	6.7	6.7	6.4
		10	5.2	15.7	15.7	12.9	14.1	5.3	5.0	5.9	6.2	5.9

Table 3-5 Diffuser Configuration Modelling: Temperature Change at 20m (Above Background)

	Port Diameter, Ø (m)	No. of Ports, *n*									
Ambient Velocity (m/s)			0.03			0.06			0.14		
Diffuser Length, *L* (m)			25	50	75	25	50	75	25	50	75
	120	6	+0.29	+0.28	+0.34	+0.29	+0.29	+0.36	+0.34	+0.89	+0.98
		8	+0.33	+0.32	+0.39	+0.34	+0.35	+0.43	+1.01	+0.98	+1.09
		10	+0.37	+0.36	+0.44	+0.39	+0.40	+0.49	+1.08	+1.08	+1.20
	160	6	+0.38	+0.38	+0.45	+0.40	+0.41	+0.51	+1.09	+1.10	+1.25
		8	+0.45	+0.44	+0.53	+0.47	+0.49	+0.56	+1.20	+1.27	+1.35
		10	+0.50	+0.50	+0.60	+0.54	+0.56	+1.79	+1.33	+1.41	+1.45
	200	6	+0.49	+0.48	+0.58	+0.52	+0.54	+1.75	+1.28	+1.37	+1.41
		8	+0.56	+0.56	+0.68	+0.62	+1.79	+1.89	+1.49	+1.49	+1.56
		10	+0.64	+0.64	+0.78	+0.71	+1.89	+2.00	+1.69	+1.61	+1.69

Table 3-6 Comparison of CORMIX and Visual Plumes Results

Ambient Velocity (m/s)	0.03			0.06			0.14		
Diffuser Length, *L* (m)	25	50	75	25	50	75	25	50	75
CORMIX	26.1	26.5	22.0	24.9	24.4	19.6	9.2	9.1	8.0
Visual Plumes	31.2	32.2	32.2	33.8	36.6	38.3	36.7	44.7	44.4

3.6.4 Comparison with Water Quality Guidelines

3.6.4.1 Non-Optimised Diffuser

In BMT WBM (2013), the ability of the outfalls to meet the existing Environment Protection (Water Quality) Policy 2012 and new draft Environment Protection (Water Quality) Policy 2012 guidelines was tested. It was shown that an 80 m outfall with a 12-port diffuser could meet the present guideline (EPA 2003) as it achieved dilutions of 5.0 or higher all the time. To test compliance with the new draft policy (EPA 2012) the following procedure was adopted:

The lowest dilutions obtained at 20 m from the diffuser were used to produce a look-up table (assuming linear interpolation) of dilution as a function of ambient velocities (

1. Table 3-7);
2. Temperature as measured by the CTD (Figure 2-5) were used to represent ambient conditions;
3. Cooling water discharges temperatures were calculated by adding 10 ^{o}C to the ambient conditions;

Temperatures at 20 m from the diffuser were calculated using the ADCP measurements (Figure 2-4) to represent ambient velocities and the obtain dilutions from the look-up table (

4. Table 3-7);
5. The 50th percentile temperature at 20 m from the diffuser and the 80th percentile dilution from the data presented in Figure 2-5 (Site 1) were calculated, so comparisons with the guideline could be performed.

Table 3-7 Dilution as a Function of Ambient Velocity (12-port diffuser presented in BMT WBM, 2013)

Ambient Velocity (m/s)	0.00	0.02	0.05	0.10	0.20	0.25	0.50
Dilution	13.6	12.7	11.2	5.0	5.1	5.2	5.2

BMT WBM (2013) presented an analysis for one month of data collected between 06 April and 06 May 2013 (bottom temperatures) and between 06 April and 05 May 2013 (top temperatures). These results are summarized in Figure 3-3 and Table 3-8.

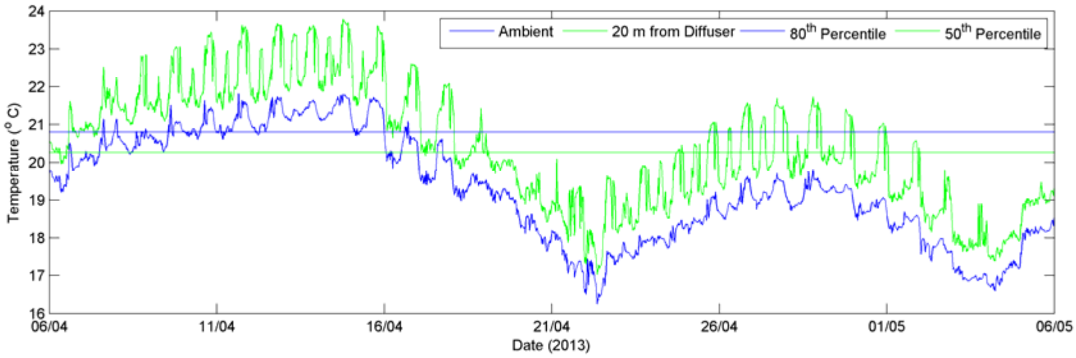

Figure 3-3 Comparison of Ambient Temperatures (blue) and Temperatures at 20 m from Diffuser (green) for April 2013. Straight Lines refer to 80th percentile ambient temperature (blue) and 50th percentile temperatures 20 m from diffuser (green) considering a one month period of analysis as per BMT WBM (2013).

Table 3-8 Temperature Values for Adoption in the New Proposed Guidelines considering a one month period of analysis as per BMT WBM (2013)

Number of Ports	Measurement Location	80th Percentile Ambient Temperature	50th Percentile Temperature 20 m from Diffuser	Acceptable
12	Top	20.80 °C	20.26 °C	Yes
	Bottom	20.56 °C	20.08 °C	Yes

Subsequently to the SA EPA PER review, the analysis was undertaken for seven day periods (as opposed to the 30 day period described above). For the seven day period, the analysis was conducted successively for each 7 days of data available. That is: the 50th and 80th percentiles calculated in Step 5 above were repeated between 06 April and 12 April, then for the period between 07 to 13 April, etc., up to the period between 28 April and 05 May. Thus, a time series was produced at a daily interval for both the 50th percentile of ambient temperatures and the 80th percentile of temperatures at 20 m form the diffuser. The results for this 7-day period of analysis are presented in Figure 3-4.

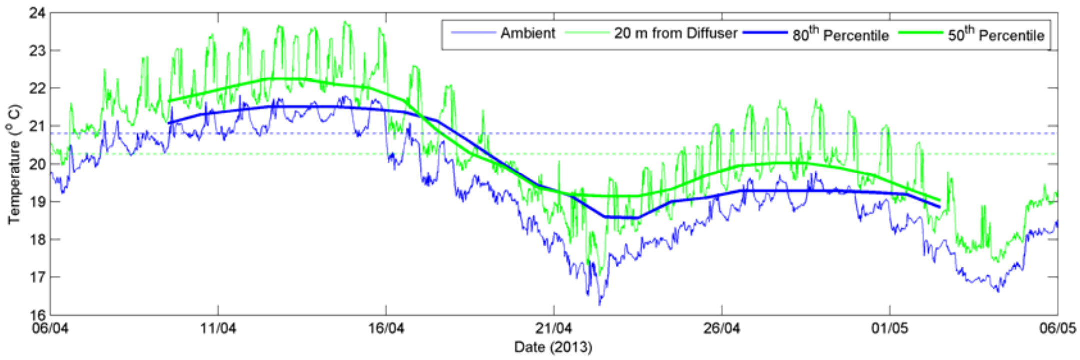

Figure 3-4 Comparison of Ambient Temperatures (blue) and Temperatures at 20 m from Diffuser (green) for April 2013. Thick lines refer to 80th percentile ambient temperature (blue) and 50th percentile temperatures 20 m from diffuser (green) considering a 7 day period of analysis. Dashed lines refer to the analysis considering the 30 day period.

The results presented in Figure 3-4 show that the diffuser would not be compliant all the time using a 7-day period of statistical analysis. In fact, only the period between 17/04 (i.e. taken as the mid-week day within the 7-day period of analysis) and 21/04 was compliant. The compliance only occurred because the range of ambient temperature variation within the period was generally larger (i.e. due to the accentuated cooling trend). For periods with a smaller temperature range there is very little difference between the minimum and maximum temperature, such that compliance becomes very difficult to achieve. For example, ambient temperature variation between 06/04 and 13/04 is only 2.6 °C.

3.6.4.2 Optimised Diffuser

The same analysis reported above was undertaken for the optimised diffuser. This diffuser refers to a 25 m manifold with six ports of 12.0 cm diameter each. The dilutions as a function of ambient velocities for this design were obtained from the CORMIX model and are presented in Table 3-9. The temperature results are shown in Figure 3-5. The diffuser was shown to be compliant throughout the entire period of analysis. Note that despite the very good dilutions obtained with this design, compliance was barely achieved for periods between 09/04 and 13/04, and between 27/04 and 29/04. These periods were characterised by the occurrence of spring tides (i.e. low dilutions at 20 m from the diffuser) coinciding with little weekly temperature variation (i.e. small separation between minimum and maximum ambient temperature).

Table 3-9 Dilution as a Function of Ambient Velocity (optimised diffuser in this study)

Ambient Velocity (m/s)	0.00	0.02	0.05	0.10	0.20	0.25	0.50
Dilution	35.3	35.2	34.4	32.1	12.3	12.6	12.5

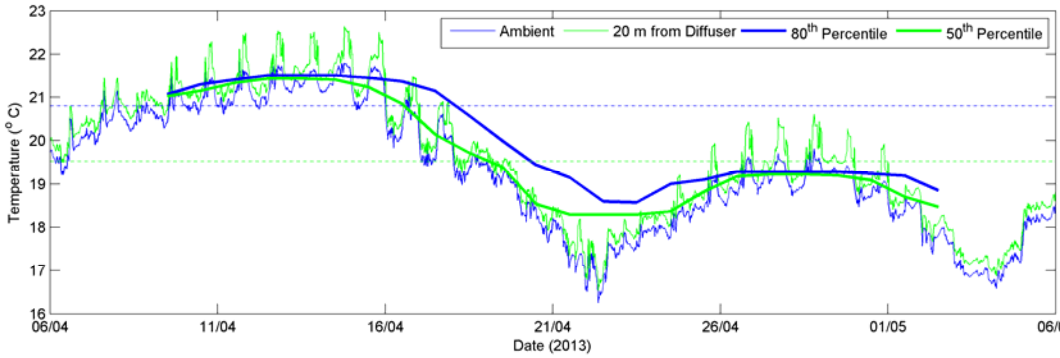

Figure 3-5 Comparison of Ambient Temperatures (blue) and Temperatures at 20 m from Diffuser (green) for April 2013 for the Optimised Diffuser. Thick lines refer to 80th percentile ambient temperature (blue) and 50th percentile temperatures 20 m from diffuser (green) considering a 7 day period of analysis. Dashed lines refer to the analysis considering the 30 day period.

4 FAR FIELD MODELLING

The far field model TUFLOW FV set-up and executed for the original PER submission (BMT WBM 2013) was also adopted in the current study. The model comprised the whole of Spencer Gulf with high resolution in the areas of interest near Port Pirie. The model was shown to reproduce the tidal features throughout the Gulf and performed particularly well in terms of reproducing current velocities offshore of First Creek. In the Port Pirie River, although performance was not as good as in the offshore area, the model reproduced the essential features of the hydrodynamics and was considered fit for the purpose and consistent with the conceptual nature of this study. Temperatures in the water column were particularly well reproduced. This model is briefly described below.

4.1 Model Description

The numerical modelling framework adopted in the present study was based on the three-dimensional TUFLOW FV modelling suite. TUFLOW FV is a coupled 3D hydrodynamics (HD) and advection-dispersion (AD) model that adopts a flexible mesh to define the computational domain. A baroclinic model configuration with density coupling from both temperature and salinity fields was applied in order to represent stratification processes that occur within Spencer Gulf.

Adoption of a flexible mesh model allowed adjustment of the spatial resolution of the computational domain to apply high resolution in the Port Pirie River and areas immediately offshore of First Creek. Computational efficiency was achieved by progressively reducing model resolution away from these areas of interest.

4.2 Model Extent and Mesh Definition

The Spencer Gulf model domain extended over an area of approximately 22,000 km^2. The southern limit of the domain extended from West Cape (Inneston) to Wedge Island, and from Wedge Island to Thistle Island. The land boundaries extended along the Eyre and Yorke Peninsulas to the head of the Gulf at Port Augusta. The model coverage area is presented in Figure 4-1.

The mesh resolution varied between 40 m inside the Port Pirie to approximately 3 km near the Gulf's mouth (Figure 4-1 and Figure 4-2). Horizontal cell sizes near First Creek were maintained below 100m, typically between 60 and 80 m. Careful consideration was given to delineate the navigation channel approaching Port Pirie as well as the several tidal creeks surrounding Port Pirie. However, the reach of First Creek between PP02, where effluent is delivered, for about 2.0 km towards the ocean is too narrow to be resolved by the model, and as such was not included in the domain. The model mesh is shown in Figure 4-1 and Figure 4-2.

The model adopted a z-coordinate scheme with layer thicknesses of 1 m between -3.0 and -8.0 m AHD, and progressively increasing to 10 metres between -50.0 and -60.0 m AHD. Five sigma layers were used to between -3.0 m and the model free surface. A maximum of 21 layers were resolved in the deeper sections of the model domain.

4.3 Bathymetry

The bathymetry data was obtained from a Digital Elevation Model (DEM) of Spencer Gulf produced from a combination of local navigation charts (AUS 136, AUS 776 to 778). This DEM was then referenced to AHD (Australian Height Datum) to provide for a consistent vertical datum over the entire domain. The resulting bathymetry is presented in Figure 2-1.

A shortcoming of the bathymetry based on the navigation charts is the lack of specification of bed elevations in the intertidal areas, which were initially specified at 0.0 m LAT (approximately -1.7 mAHD – see Figure 2-2 and Figure 4-3 below). As can be seen in the Google Earth image in Figure 2-3, the underwater relief nearshore and in the Port Pirie River is not flat as suggested in the navigation charts (Figure 4-3).

In the absence of more refined information, we undertook an adjustment of the bathymetry in an attempt to obtain a more realistic description in the intertidal areas of the model. The details of the bathymetry adjustment are described in BMT WBM (2013) and the resulting bathymetry adopted in the modelling is shown in the right panel of Figure 4-4. Although the specification of the bathymetry was raised as the main issue affecting model performance (BMT WBM 2013), insufficient time and resources were available to undertake a bathymetric survey in the intertidal areas of Port Pirie River. As such, no further model calibration was performed. For progressing this conceptual project phase to more detailed stages, a bathymetric survey will be required.

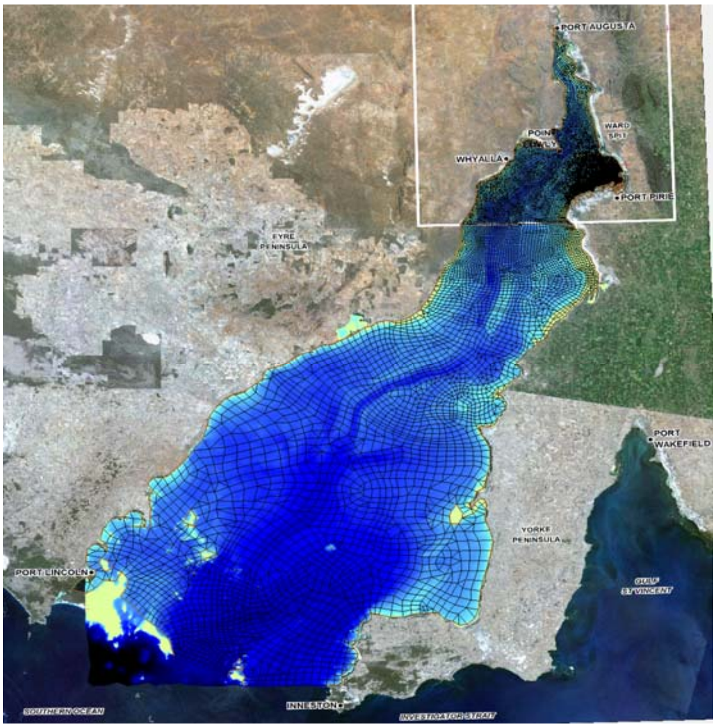

Figure 4-1 Model Extent and Numerical Mesh

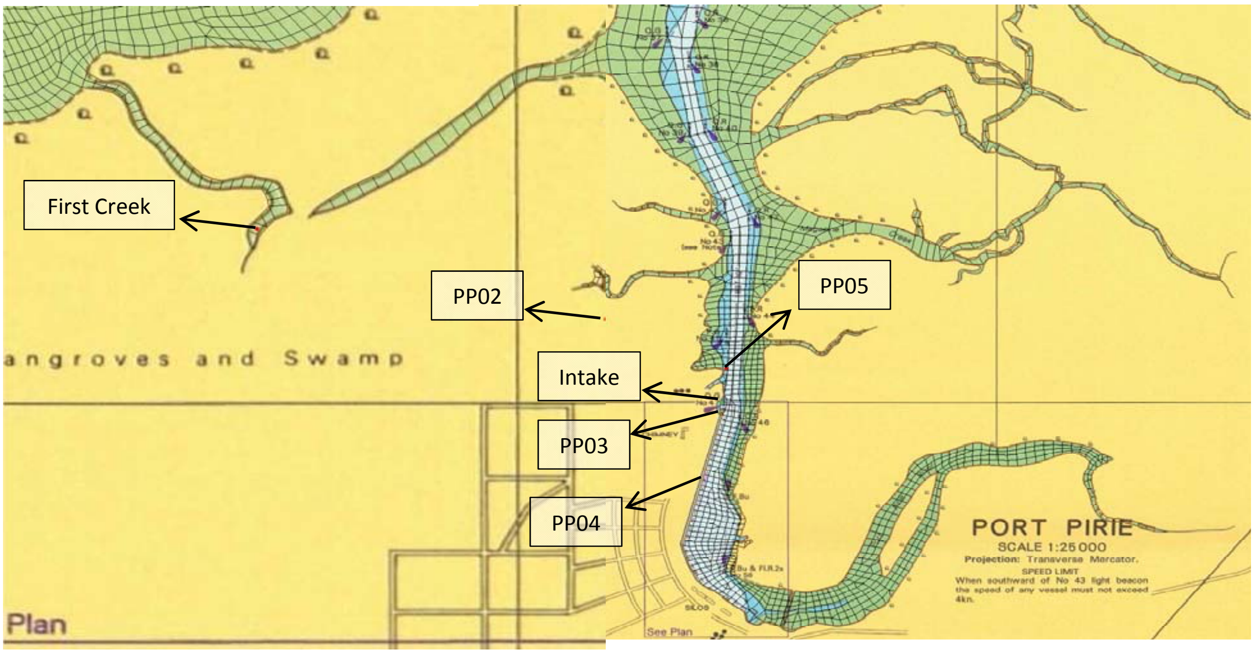

Figure 4-2 Numerical Mesh near Port Pirie. The mesh is superimposed on AUS 136 charts (AHS 2000). The images are a composite of the Approaches to Whyalla chart and the Port Pirie chart. Scale shown does not apply.

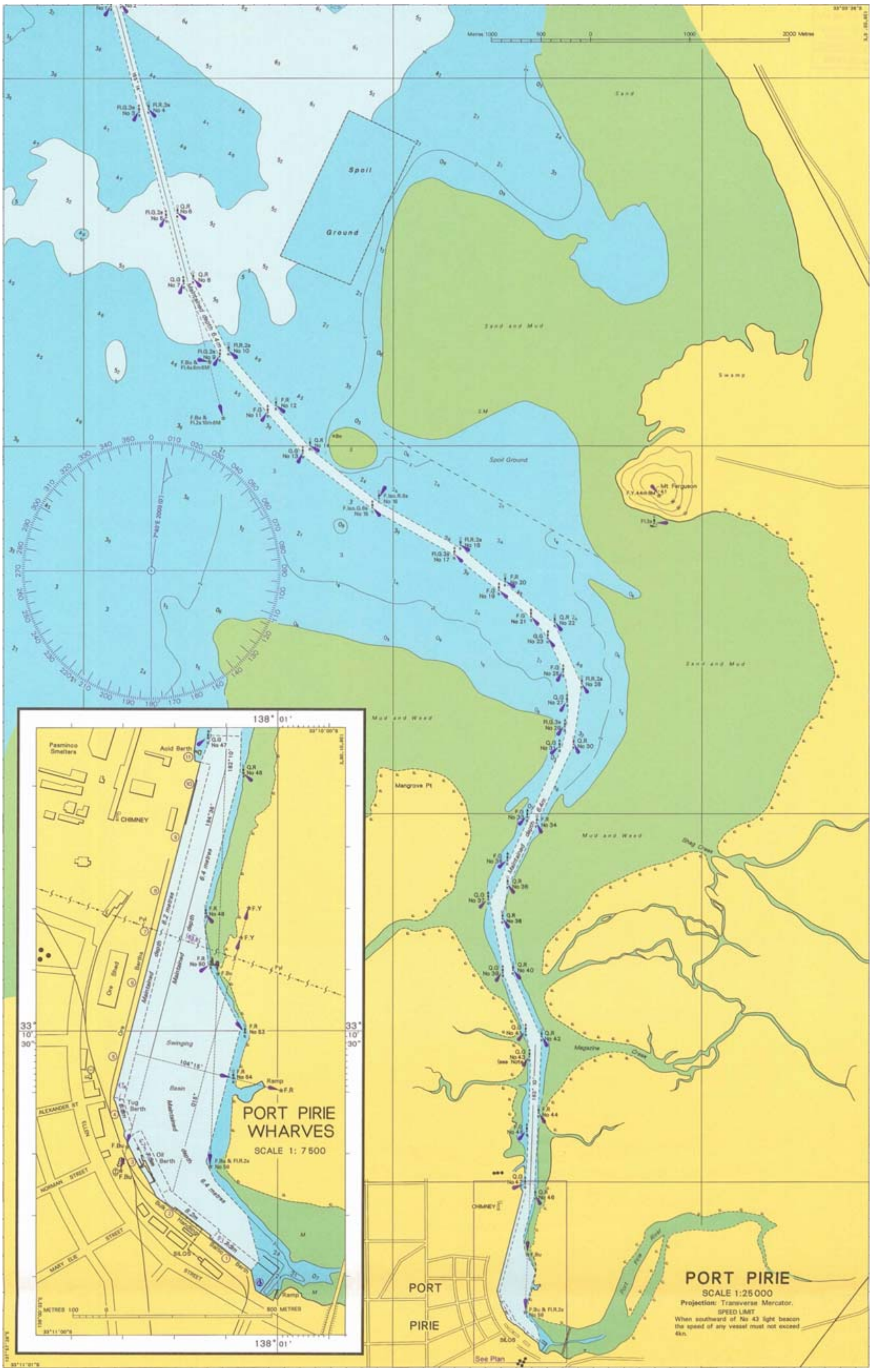

Figure 4-3 Bathymetry within Port Pirie and Port Pirie Wharves (Chart AUS 136, AHS 2000). Scales shown do not apply.

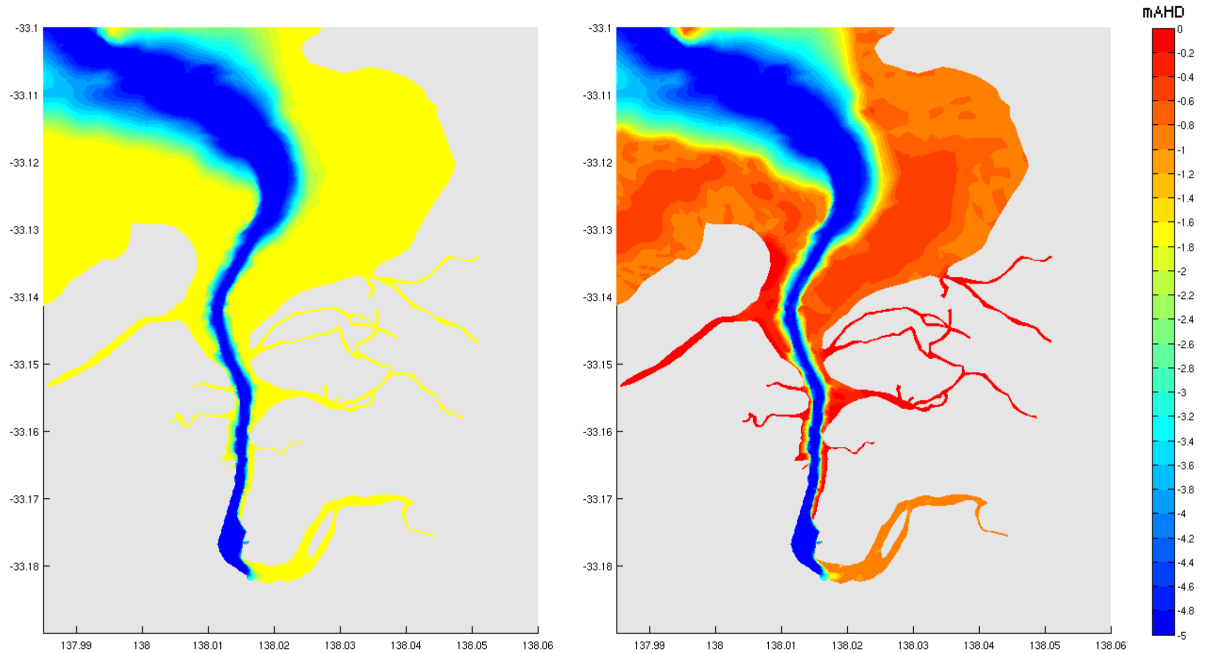

Figure 4-4 Development of Bathymetry in the Intertidal Areas near Port Pirie. Left Panel: Intertidal areas at a constant elevation corresponding to 0.0 m LAT (~ -1.7 m AHD). Right Panel: Arbitrarily adjusted bathymetry.

4.4 Simulation Periods

Two three-month simulation periods were chosen to show the discharge thermal plume dispersion in the far field. These periods were selected to encompass both winter and summer conditions and were ultimately used to verify the potential for heat accumulation in the estuary as a result of the discharge. This issue was raised by the SA EPA given the relatively poor flushing of the Port Pirie River. However, heat exchange (both sensible, latent and radiative) with the atmosphere is also increased at larger temperatures, therefore abating the effects of limited flushing.

The periods for the simulations included:

1. January to March 2013: this period consists of summer conditions.
2. July to September 2012: this period consists of winter conditions.

Warm-up periods of at least two months were used in the simulations.

4.5 Boundary Conditions

4.5.1 Boundary Conditions

The hydrodynamic model was forced by tides at the ocean boundaries, wind stresses and other meteorological variables at the free surface, and the existing and proposed cooling water discharges. The data source was the same as given in BMT WBM (2013). The meteorological conditions are presented in Figure 4-5 and Figure 4-6.

Tides – tidal forcing was comprised of surface water elevations specified at the southern boundary of the domain. The elevations were derived from harmonic constituents at Pondalowie Bay using the Seafarer Tides software. Tidal levels were provided at every 15 minutes. For each of the tidal locations, daily temperature and salinity obtained from data assimilation global circulation models were adopted.

Meteorology – meteorological forcing at the free-surface consisted of wind speed and direction, air temperature, relative humidity, cloud cover (to estimate long wave radiation) and short wave radiation. With exception of solar radiation, data was sourced from the BoM station 018120 (Whyalla Aero). Solar radiation was available from BoM station 023304 (Adelaide Airport). Solar radiation at Adelaide Airport was deemed excessively high when contrasted with May-2009 data collected at Port Bonython (see BMT WBM 2011). While the data at Port Bonython peaked between 600 and 800 W/m^2, the Adelaide Airport data peaked above 1000 W/m^2. A scale factor of 0.65 was therefore applied to the Adelaide Airport data before adoption in the model. All meteorological data were available at every hour.

Existing Intake and Discharge – The existing intake and the discharge at First Creek ("Intake" and "First Creek" points annotated in Figure 4-2) were considered in the simulation by adopting a constant flow rate of 0.73 m^3/s. A temperature increase of 8 ^oC between the intake and the point of insertion of the discharge in the model was assumed. This assumption was based on spot measurements undertaken by Nyrstar, which indicated a temperature difference between intake and point PP02 (Figure 4-2) of approximately 9 ^oC (David Wilsthire, *pers. comm.*). Another 1 ^oC loss was assumed between point PP02 and the point of insertion in the model, again based on spot measurements undertaken by Nyrstar personnel at First Creek (David Wiltshire, *pers. comm.*).

4.5.2 Drag Coefficient

Following BMT WBM (2013), a constant Mannings coefficient of 0.022 was adopted to parameterise the bottom drag in TUFLOW FV.

Figure 4-5 Meteorological Boundary Conditions (Summer Conditions)

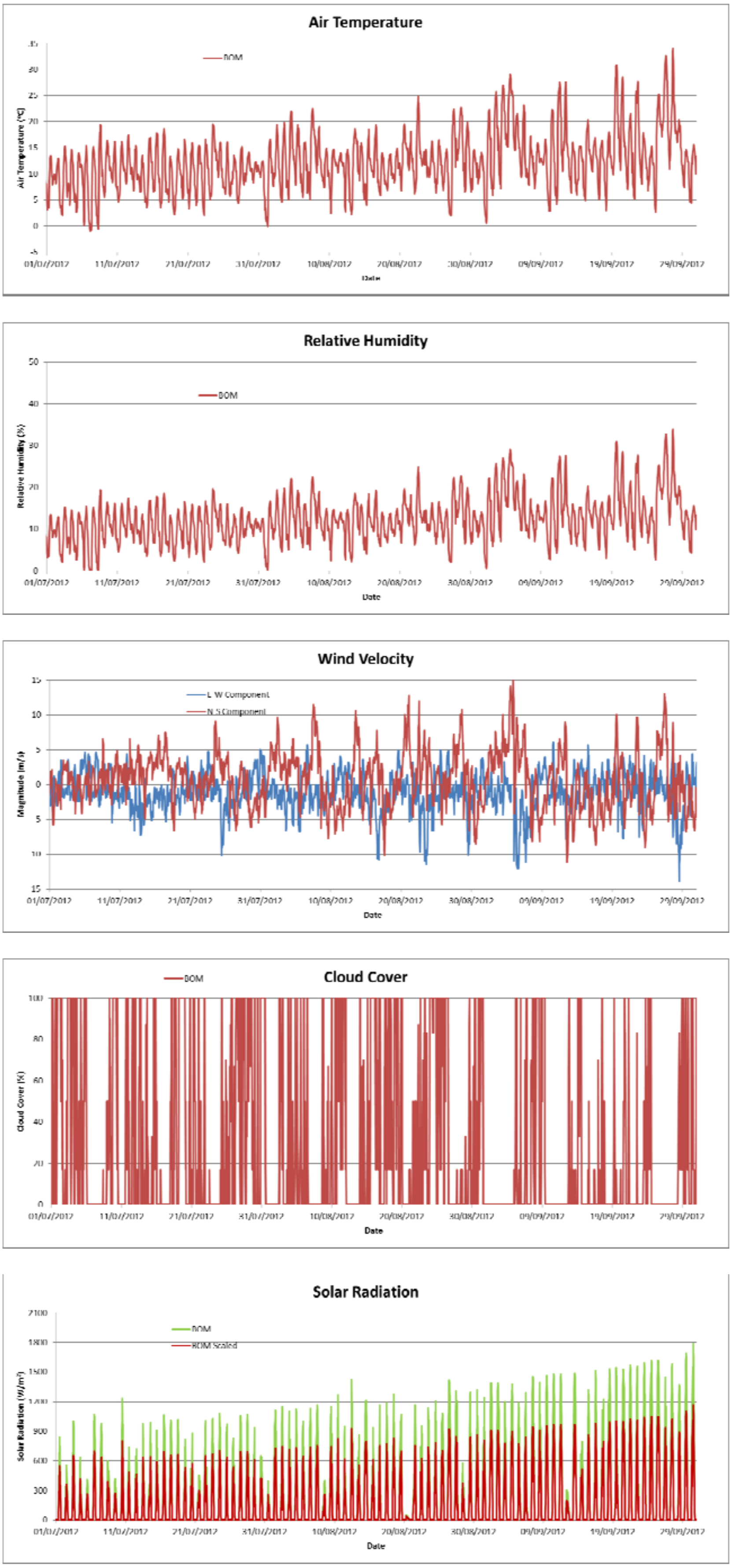

Figure 4-6 Meteorological Boundary Conditions (Winter Conditions)

4.5.3 Initial Conditions

A cold start was adopted for velocity and water levels. Initialisation of salinity and temperature data was based on data collected by Dr. Rick Nunes-Vaz (Nunes 1985) on November 1982 (summer simulations) and February 1983 (winter simulations). Additionally, the same data from global assimilation models adopted at the open ocean boundary were used to complement the model initial conditions.

In First Creek, a constant stratification of 7 ^{o}C was imposed along its length (top and bottom). Again, this was based on spot measurements along the Creek (David Wiltshire, pers. comm.).

4.6 Baseline Conditions

The baseline condition adopted in this study was designed to quantify the temperature increases associated with the effect of the cooling water discharge in relation to existing conditions and as such included the First Creek discharge, the existing intake and initial stratification. This baseline is referred to as existing baseline in BMT WBM (2013). Both summer and winter simulations were undertaken for the baseline.

4.7 Discharge Scenario

The discharge scenario considered the 12-port outfall configuration discharged in the Port Pirie River and presented in BMT WBM (2013) in addition to the existing discharge to First Creek (0.73 m^3/s and a temperature increase in relation to the intake of 9 ^{o}C).

Table 4-1 Discharge Characteristics to Port Pirie River

Outfall location	Flow Rate m^3/s	Temp. increase (^{o}C)	Salinity increase (%)	Initial Stratification in First Creek ^{o}C
PP05	1.64	10	0	7.0

4.7.1 Near field Integration

In order to produce more realistic temperature simulations in the far field, the near field model results presented in BMT WBM (2013) and in Section 3.6.4.1 were integrated in the boundary conditions representing the outfall. The adopted integration follows the same methodology described in Botelho et al. (2013), which was previously devised for the brine discharge of a desalination plant in Port Bonython (BMT WBM 2011). This methodology is briefly described below.

The TUFLOW FV model has a horizontal grid resolution of approximately 40 m in the location of the proposed outfall. While this represents a relatively high resolution for a hydrodynamic model covering the entire Spencer Gulf, this resolution is unable to properly account for the near field mixing of the proposed thermal discharge. If one adopted the proposed discharge temperature directly into the hydrodynamic model, unrealistic temperatures (also plume dilutions, salinities and any other scalars involved) would result in the location and immediate vicinity of the diffuser, as these would not take into consideration the extent of the near field dilution, which occurs at spatial scales very similar to the grid resolution (as an example, see BMT WBM 2013). As such, BMT WBM developed an injection method that preserves the heat being discharged whilst adopting the realistic temperatures, salinities, and dilutions based on the results of the near field CORMIX simulations presented in BMT WBM (2013). This is a critical element of this study that ensures consistency between near and far field predictions.

Step 1. Depth-averaged velocities for ebb and flood tides were obtained from the velocity profiles measured in April 2013 field campaign at Site 1 (see BMT WBM 2013).

Step 2. The cumulative distribution of velocity magnitudes was calculated.

Step 3. CORMIX simulations were performed for each of these representative profiles (Section 3.6.4.1);

Step 4. The near field CFD results were tabulated to express the function between depth-averaged ambient velocities and plume dilution (Section 3.6.4.1).

Step 5. Baseline Spencer Gulf hydrodynamic simulations (i.e., without the inclusion of the proposed discharge) were processed for the provision of background depth-averaged velocities.

Step 6. Dilutions as a function of the modelled background velocities were obtained from the table produced in step 4.

Step 7. Temperature and salinity at the boundary cells representing the proposed diffuser were computed as a function of the dilutions obtained in step 6. The fluid entrained in the plume was assumed to have scalar characteristics of the depth-averaged water column in the background baseline simulations.

Step 8. Outfall discharges were re-computed to balance the heat flux in the discharge. The final scalars and discharges used as boundary conditions were calculated as follows.

Given the following problem data:

T_a - Ambient temperature (depth averaged salinity in the background simulation)

S_a - Ambient salinity (depth averaged salinity in the background simulation)

T_o - Temperature at diffuser nozzle (from background simulation plus 10 ^oC)

S_o - Salinity at intake (equal to the salinity at diffuser nozzle)

C_o – Tracer concentration at diffuser nozzle (equals 1)

Q_o – Discharge at nozzle (equals 1.64 m^3/s in this example)

D – Dilution at 20 m from the diffuser (given by the “look-up” table)

The following quantities are used as boundary conditions in the model:

T – Temperature at 20 m from the diffuser

C – Tracer concentration at 20 m from the diffuser (equals D for C_o = 1)

S – Salinity at 20 m from the diffuser

Q - Discharge at 20 m from the diffuser

In order to conserve the discharge heat flux:

$$QC = QD = Q_o C_o = const.$$

Such that

$$Q = \frac{Q_o C_o}{D}$$

Temperatures (T), salinity and concentrations were computed as follows:

$$T = \frac{T_o + (D-1)T_a}{D}$$

$$S = \frac{S_o + (D-1)S_a}{D}$$

$$C = \frac{C_o}{D}$$

The assumed boundary conditions for temperature and salinity in the model were given by *T* and *S*, respectively.

Step 9. A heat sink was introduced to remove excess entrained heat and the required sink was distributed at bottom cells in the domain. The excess entrained heat originates from a background temperature that is different from zero (as opposed to the tracer field used for the mass balance that has a zero baseline background). This heat sink was required such that no numerical (artificial) heat would accumulate in the computational domain as a result of the injection method. The excess entrained heat ($\Delta(QT)$) is obtained in terms of temperature by the following relationship:

$$\Delta(QT) = QT - Q_o T_o$$

with the variables as defined above. Outflow boundary condition cells were set up such that $\Delta(QT)$ could be removed from the computational domain.

It is noted that at any time the magnitude of the heat sink discharge was proportional to the dilution, such that the maximum outflow rates occurred during neap tides, when the near field processes provided superior dilution (see Section 3.6.4.1). An example of data used in the near field integration process is presented in for September 2012

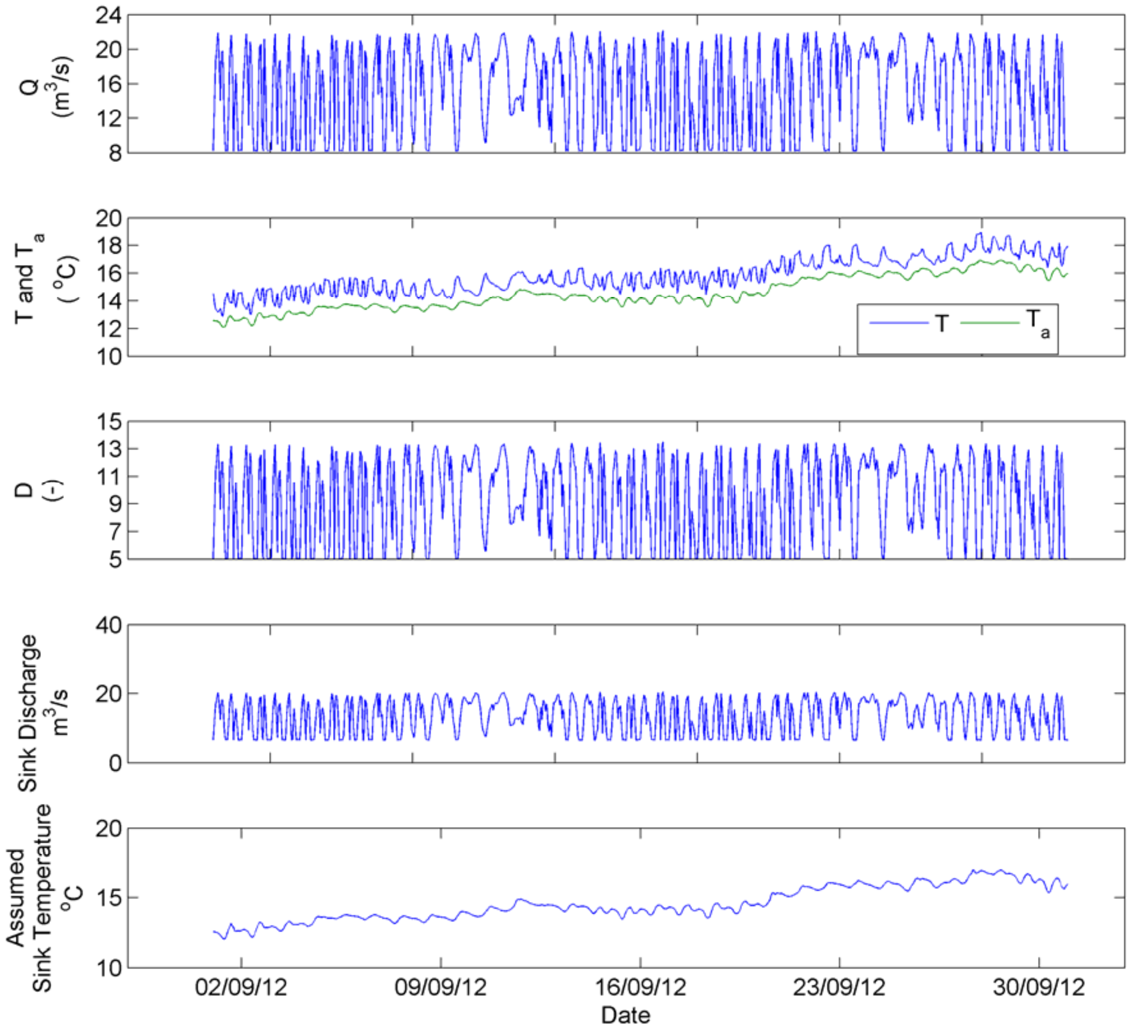

Figure 4-7 Data Used in and Resulting from the Near Field Integration (September 2012).

4.8 Assessment Methodology

4.8.1 Heat Accumulation

A methodology was devised for comparisons between the discharge scenarios and the existing baseline, so as to verify whether heat would accumulate in the Port Pirie River. A step by step of the methodology is provided below:

For each of the simulations performed (baseline and discharge scenario), 0^{th} (maximum), 10^{th}, and 50^{th} (median) percentile temperature exceedences were calculated in each surface cell of the model domain. The calculation of statistics was obtained from time series corresponding to the following periods of analysis:

- Summer simulations:
    - o 01 January to 01 February 2013;

- 01 February to 01 March 2013;
- 01 March to 01 April 2013; and
- 01 January to 01 April 2013.

- Winter simulations:
  - 01 July to 01 August 2012;
  - 01 August to 01 September 2012;
  - 01 September to 01 October 2012; and
  - 01 July to 01 October 2012.

Each of the 0th, 10th and 50th percentile exceedences obtained from the existing baseline conditions were subtracted from the corresponding percentile exceedence obtained from the discharge scenario.

These differences, obtained in each surface cell of the model domain, were then mapped. The extent of which increased temperatures were observed across any given month was visually contrasted to the other months and with the full 3 month period of analysis.

4.8.2 Short-Circuit between Discharge and Intake

Existing and proposed intakes are located approximately 400 m from the proposed discharge. The potential for short circuit between intake and discharge was assessed by computing the difference between baseline and discharge scenarios at the location of the existing and proposed intakes.

4.9 Results

4.9.1 Summer Baseline Maps

The summer 10th percentile temperature exceedence maps for the existing baseline are respectively shown in Figure 4-8 to Figure 4-11. They are presented for purposes as they are later used to illustrate the differences between the discharge scenario condition and the baseline. All other percentiles are presented in Appendix A. The following general features can be seen in these maps:

1. There is an increasing trend in the 10th percentile temperature from January to March 2013 ;
2. The temperatures in the deeper areas were generally higher than the intertidal areas.
3. For the baseline, there is a clear influence of the existing discharge in the temperatures at First Creek in all percentile exceedences (see BMT WBM 2013).
4. The three month period map (January to March 2013) is more similar to the February 2013, than the other months.

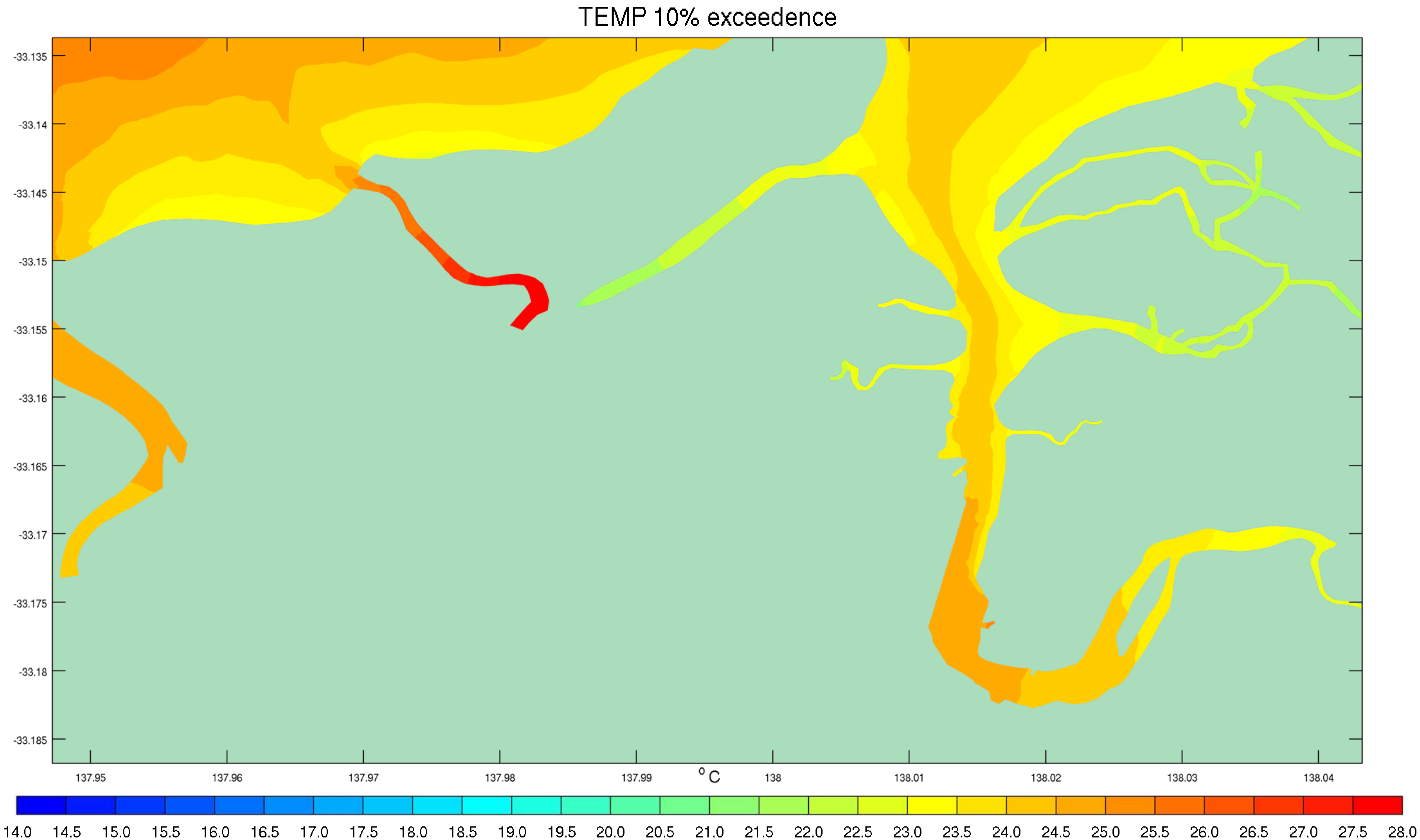

Figure 4-8 10th Percentile Temperature Exceedences – Existing Conditions January 2013

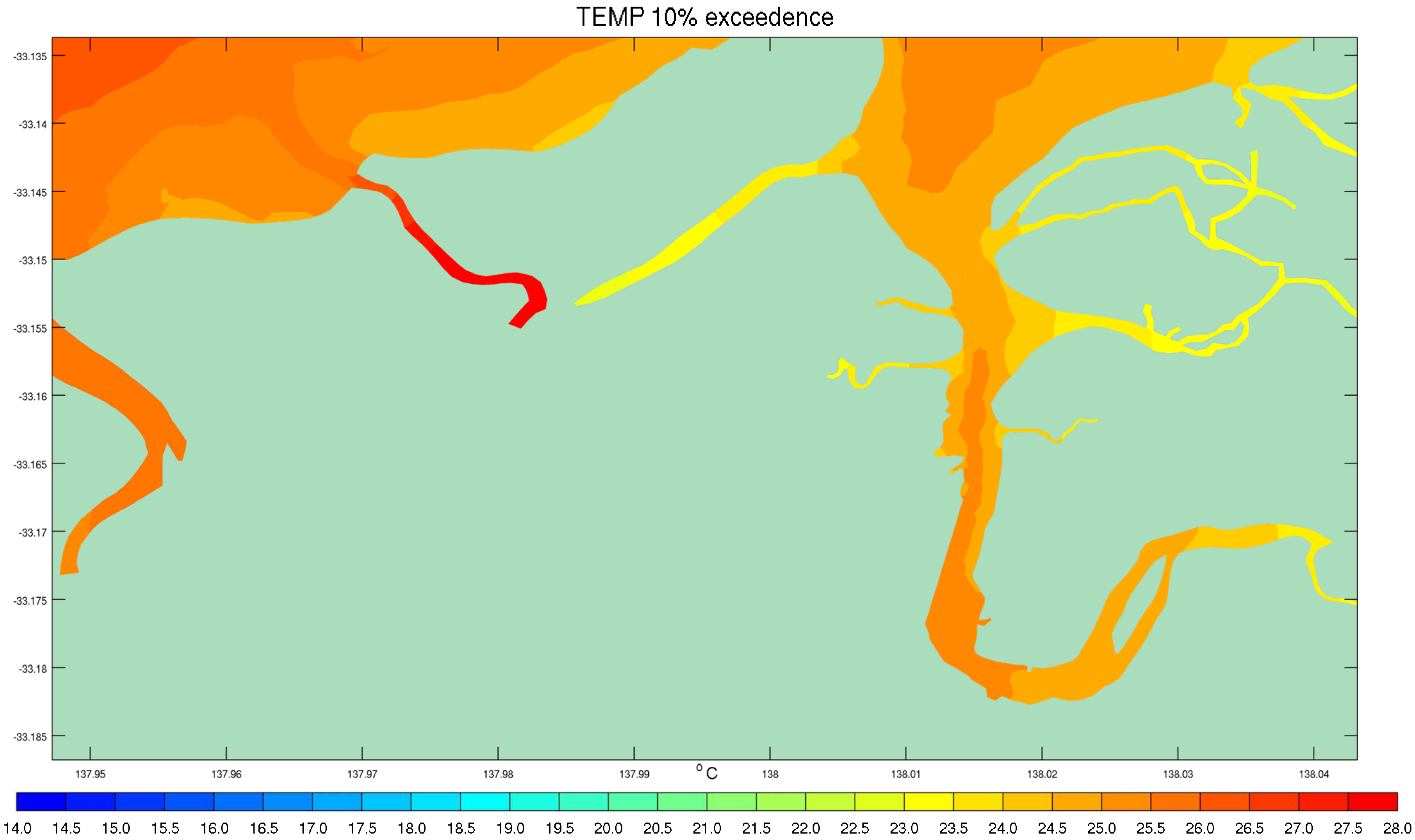

Figure 4-9 10th Percentile Temperature Exceedences – Existing Conditions February 2013

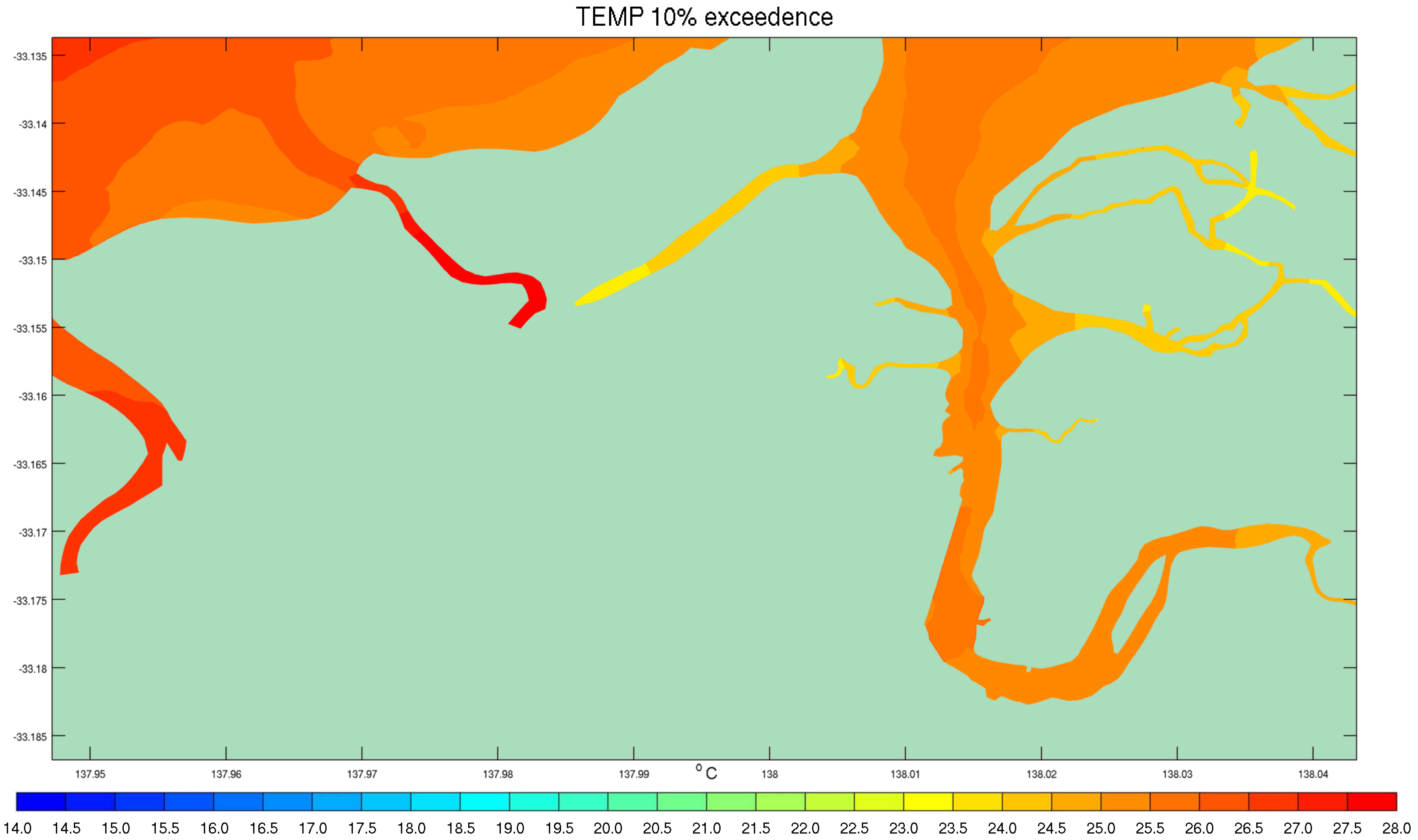

Figure 4-10 10th Percentile Temperature Exceedences – Existing Conditions March 2013

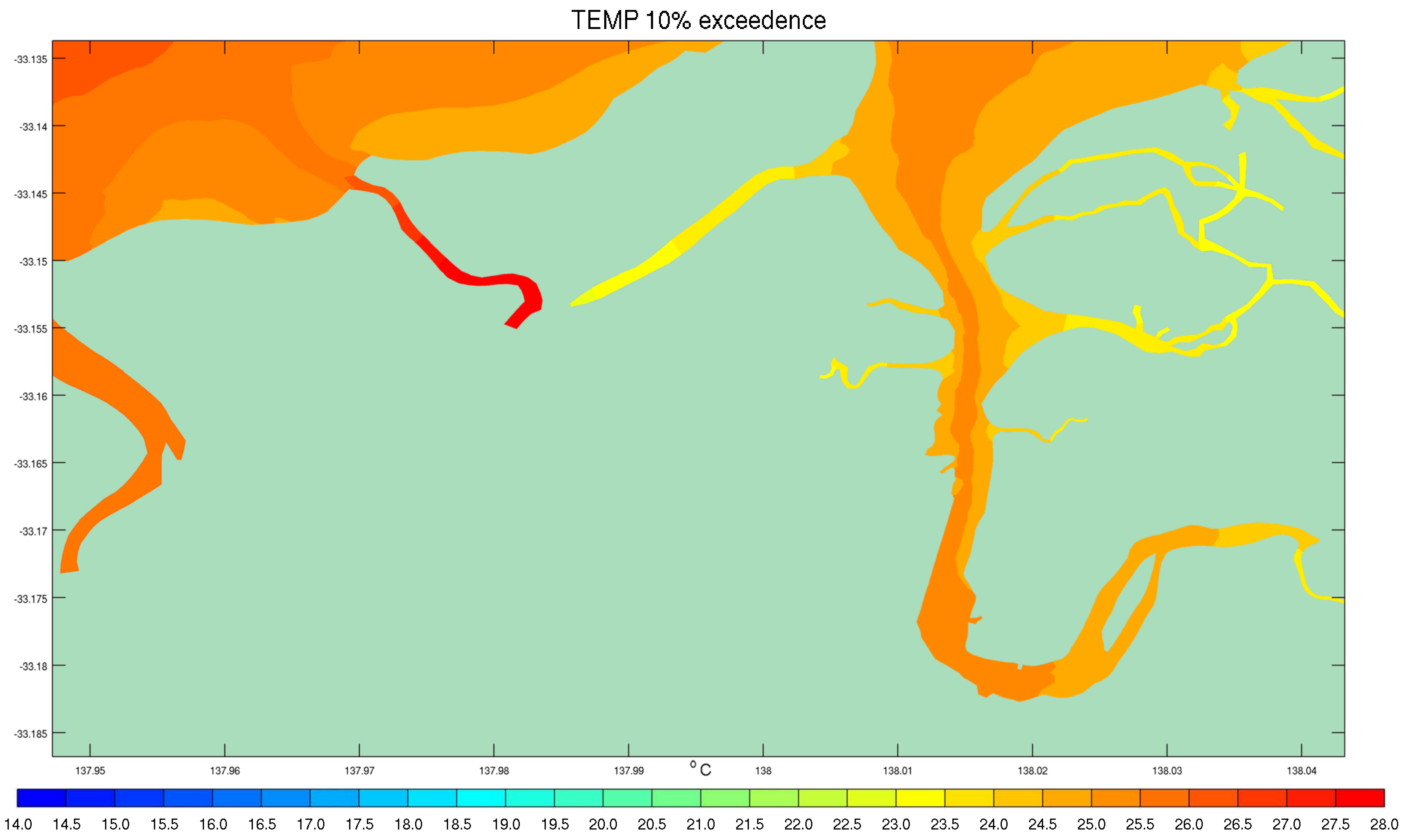

Figure 4-11 10th Percentile Temperature Exceedences – Existing Conditions January to March 2013

4.9.2 Winter Baseline Maps

The winter 10th percentile temperature exceedence maps for the existing baseline are respectively shown in Figure 4-12 to Figure 4-15. All other percentiles are presented in Appendix B. The following general features can be seen in these maps:

1. There is an increasing trend in the 10th percentile temperature from July to September 2012 ;
2. The temperatures in the deeper areas were also generally higher than the intertidal areas, with exception of July, where the gradient was less pronounced;
3. Again, for the baseline, there is a clear influence of the existing discharge in the temperatures at First Creek in all percentile exceedences (see BMT WBM 2013).
4. In general, the three month period map (January to March 2013) presents temperatures between August 2013 and September 2013.

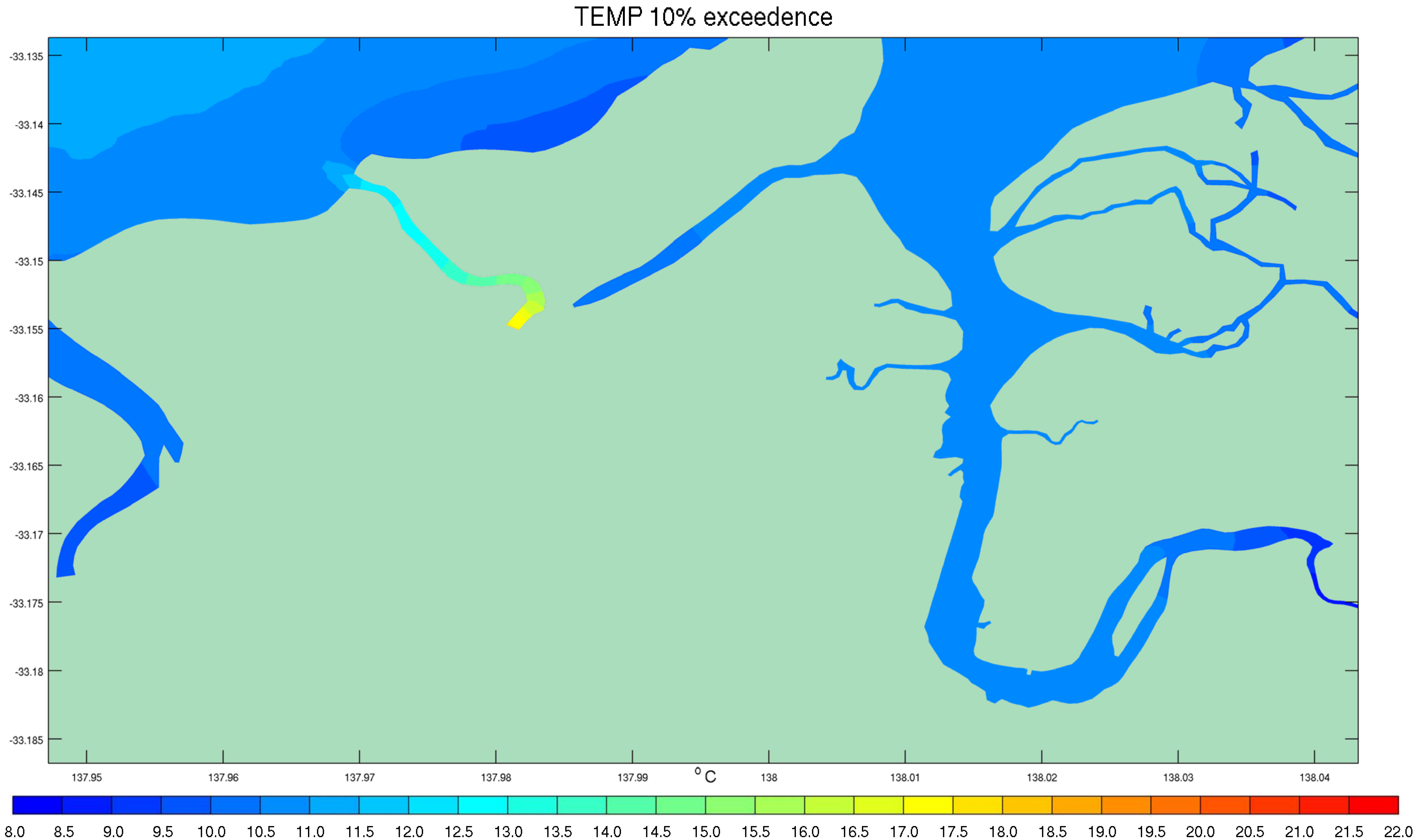

Figure 4-12 10th Percentile Temperature Exceedences – Existing Conditions July 2012

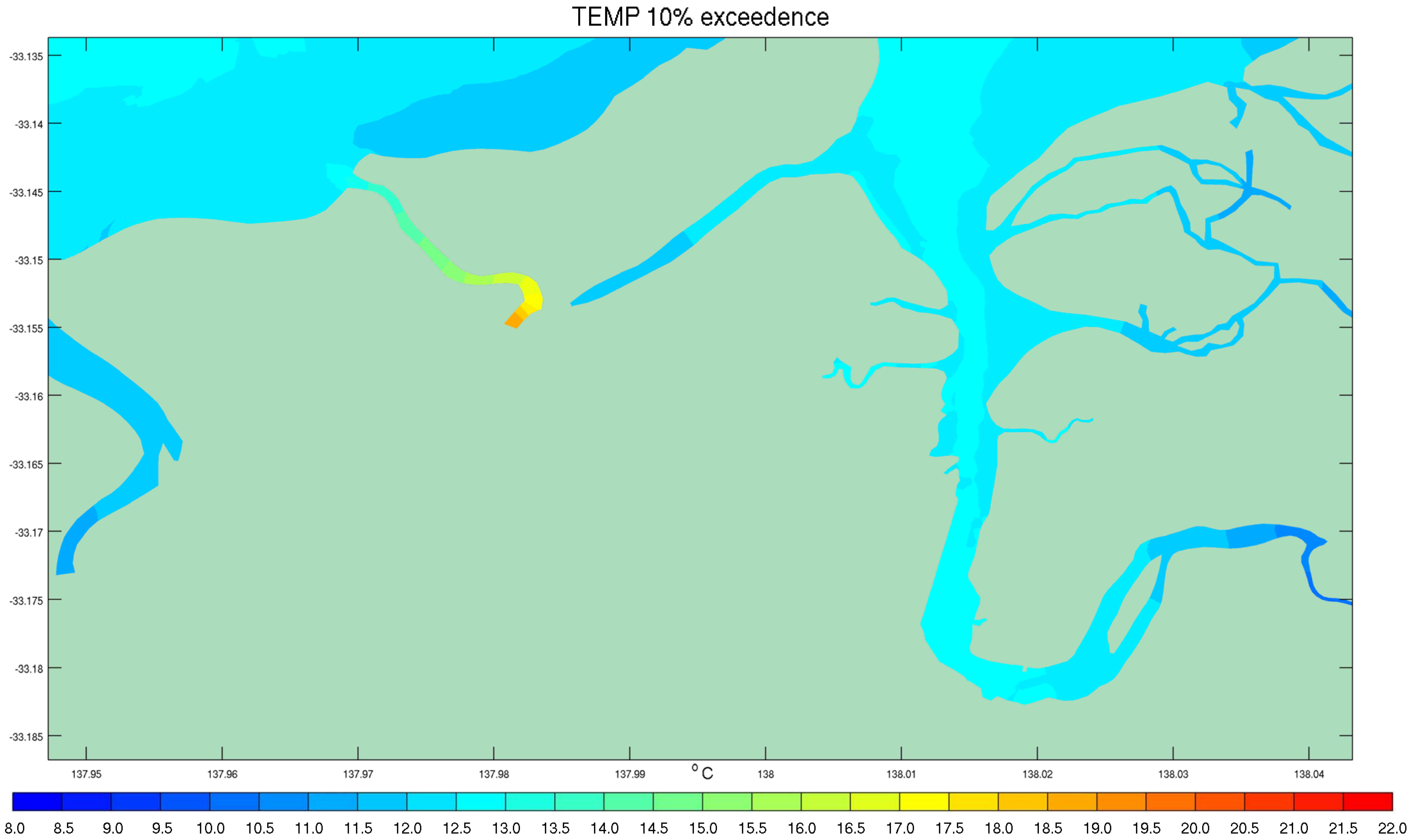

Figure 4-13 10th Percentile Temperature Exceedences – Existing Conditions August 2012

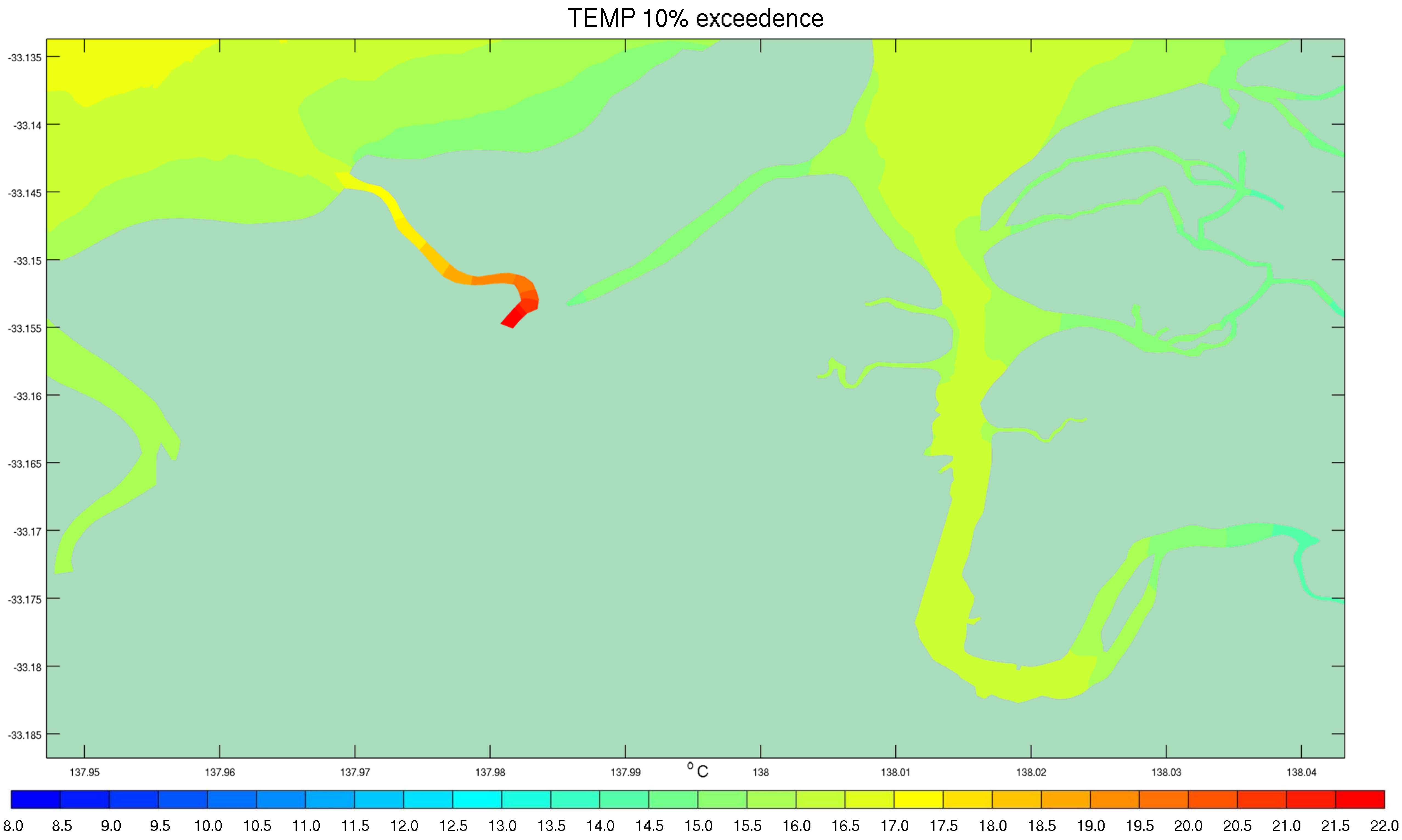

Figure 4-14 10th Percentile Temperature Exceedences – Existing Conditions September 2012

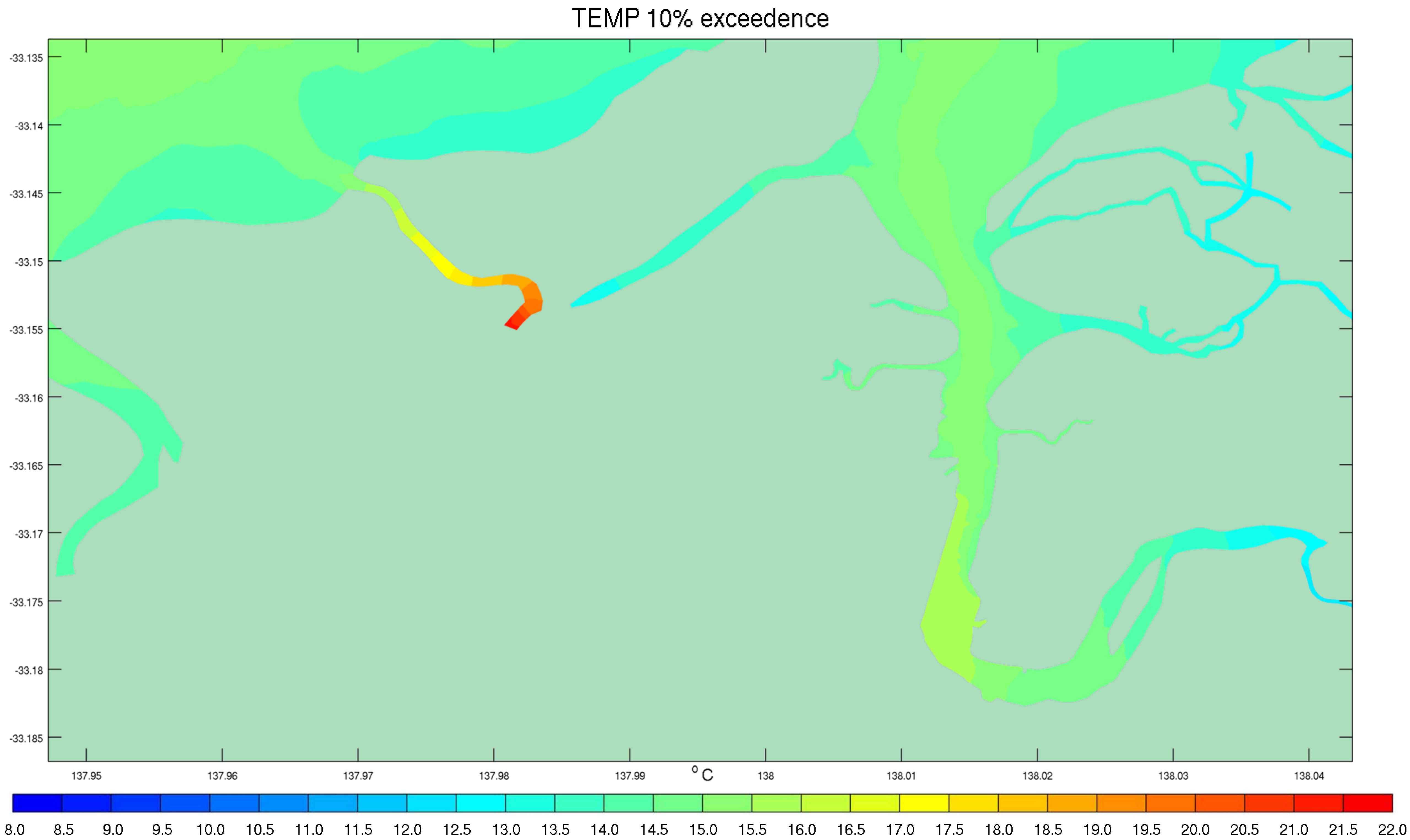

Figure 4-15 10th Percentile Temperature Exceedences – Existing Conditions July to September 2012

4.9.3 Summer Discharge Scenario Maps

The summer 10th percentile temperature exceedence maps for the discharge scenario are respectively shown in Figure 4-16 to Figure 4-19. They are presented for illustrative purposes. All other percentiles are presented in Appendix C. The following general features can be seen in these maps:

1. The same trends shown in the existing condition also occur for this scenario, this was expected given the discharge scenario simulations have the same meteorological boundary conditions;

2. The temperatures were slightly higher than the baseline from the southern tip of the Port Pirie River to the mouth;

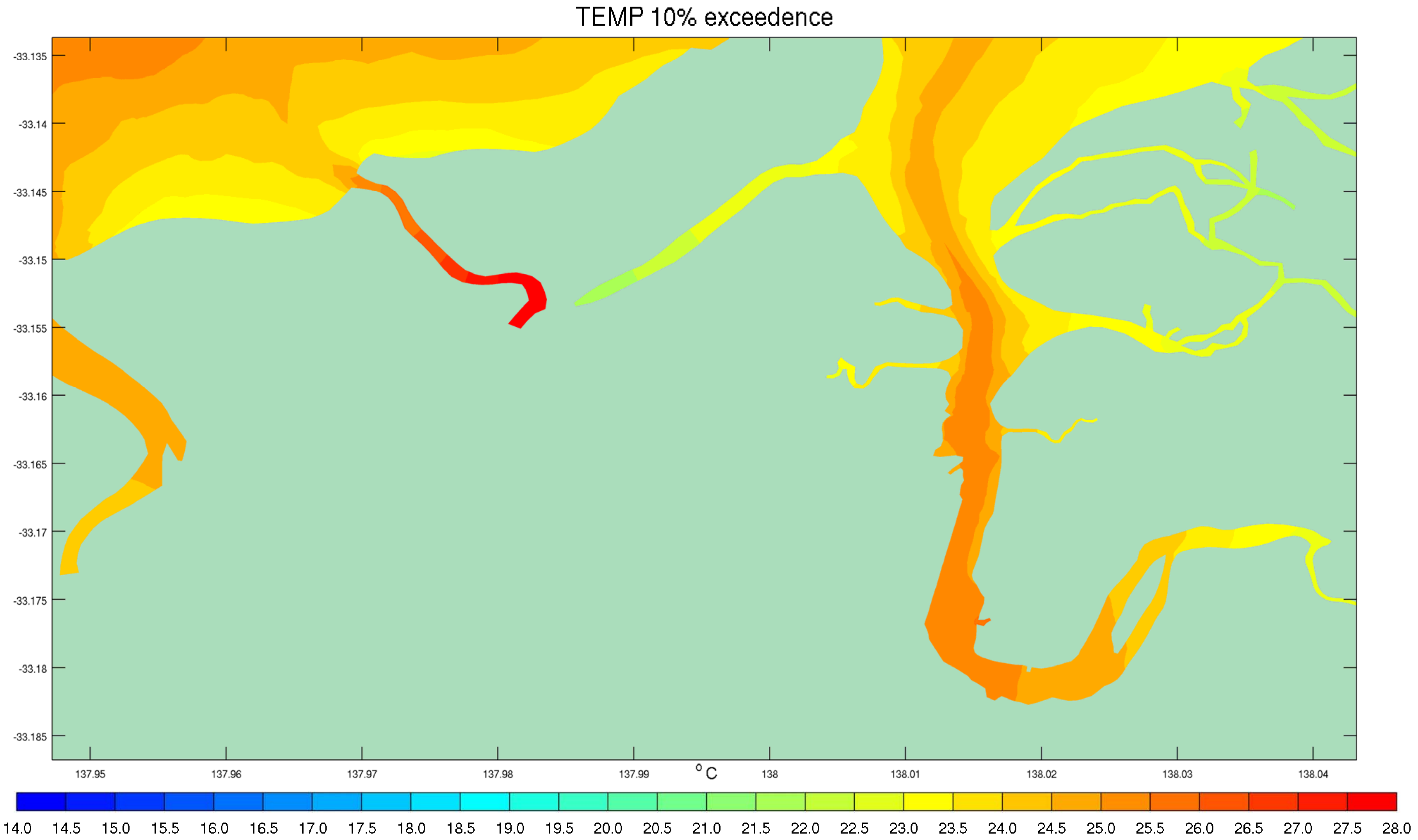

Figure 4-16 10th Percentile Temperature Exceedences – Discharge Scenario Conditions January 2013

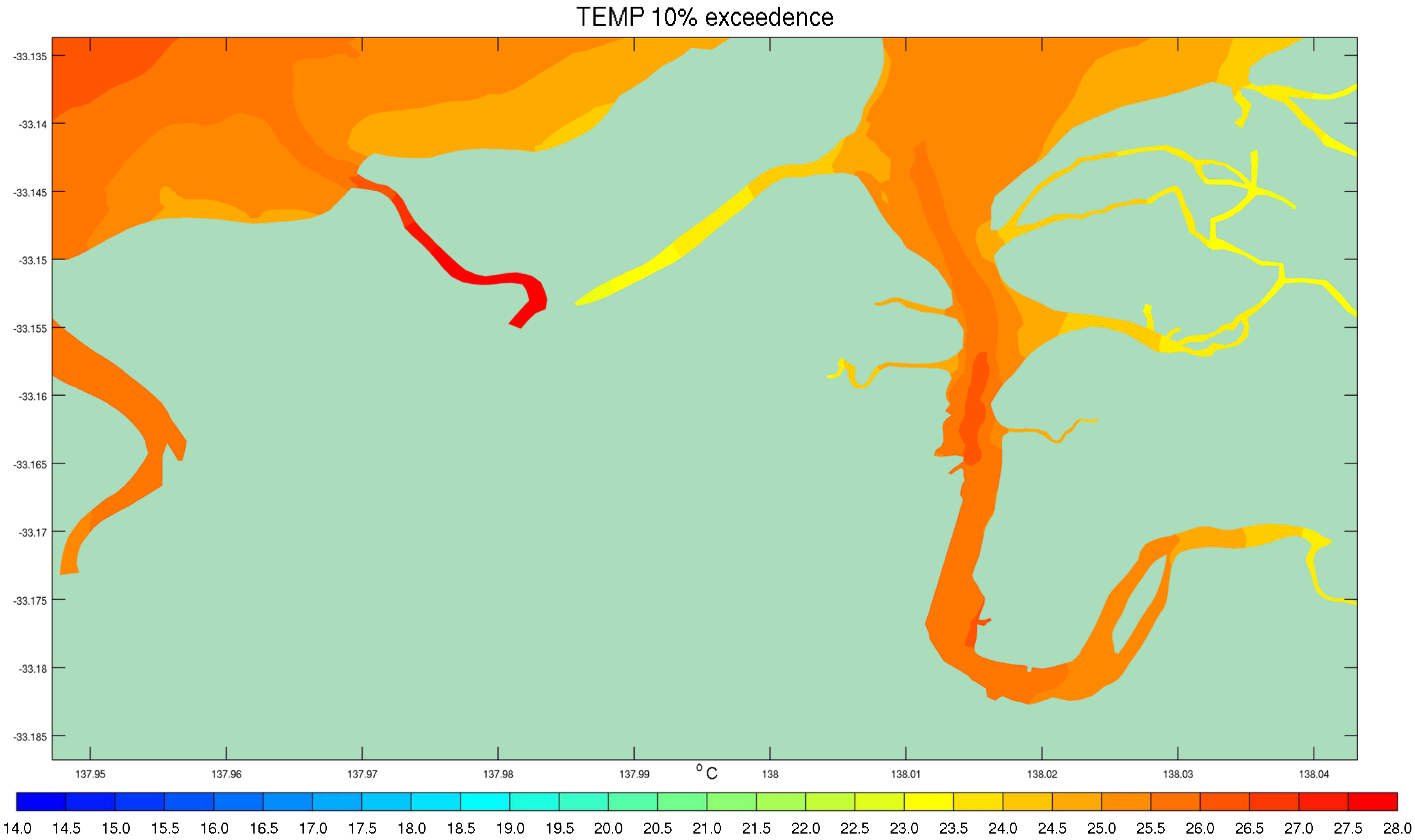

Figure 4-17 10th Percentile Temperature Exceedences – Discharge Scenario Conditions February 2013

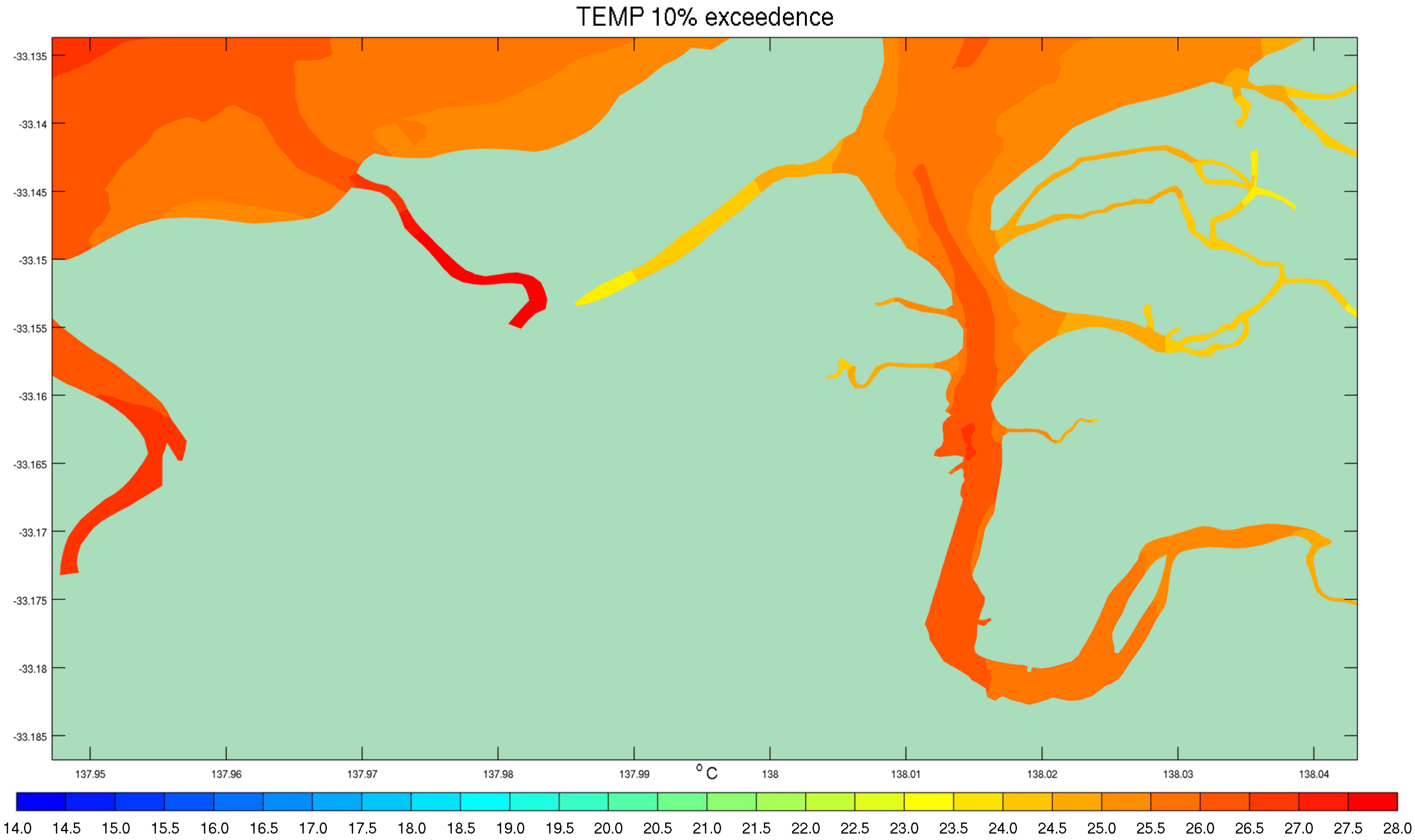

Figure 4-18 10th Percentile Temperature Exceedences – Discharge Scenario Conditions March 2013

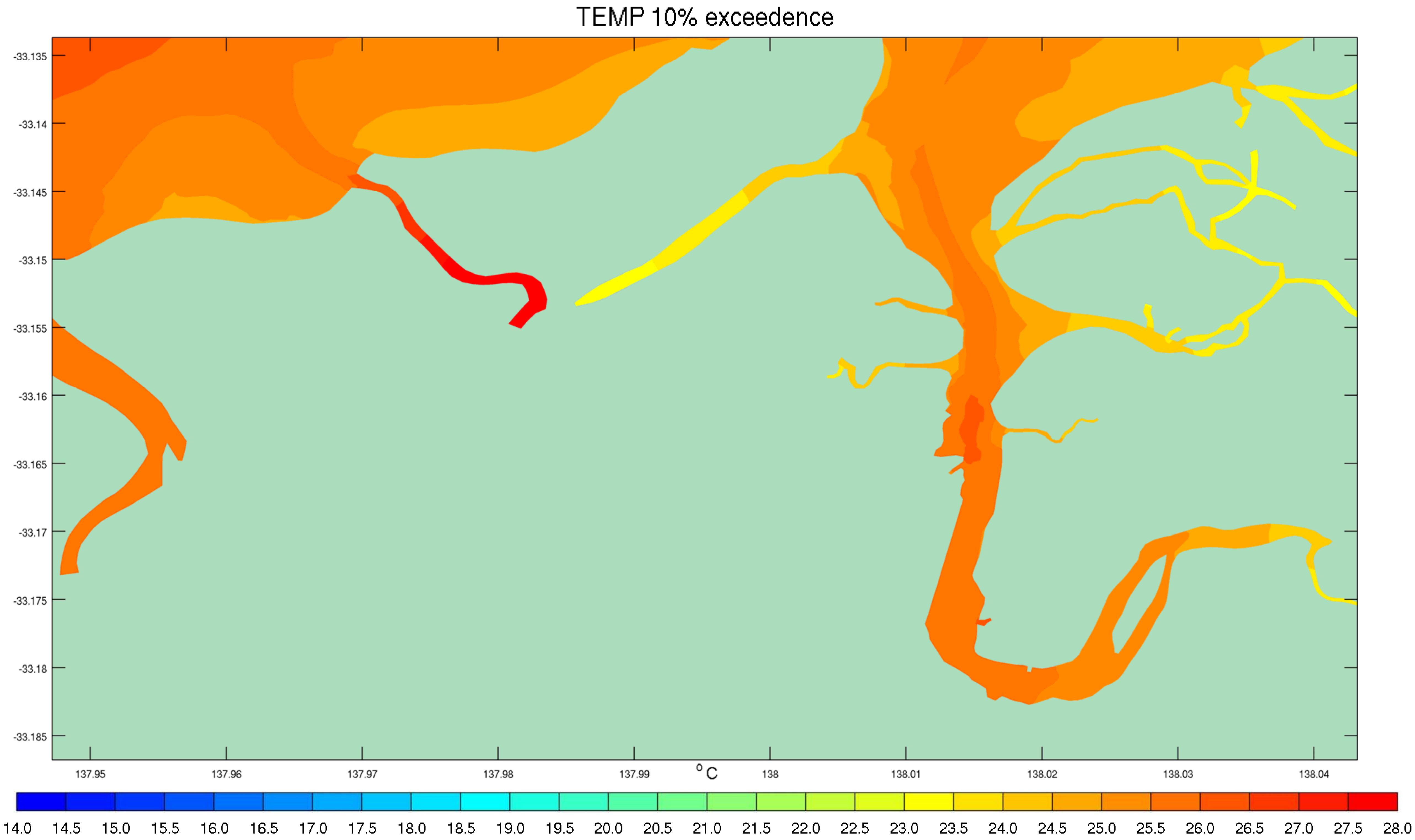

Figure 4-19 10th Percentile Temperature Exceedences – Discharge Scenario Conditions January to March 2013

4.9.4 Winter Discharge Scenario Maps

The winter 10th percentile temperature exceedence maps for the discharge scenario are respectively shown in Figure 4-20 to Figure 4-23. They are presented for illustrative purposes. All other percentiles are presented in Appendix D. The following general features can be seen in these maps:

1. Again the same trends shown in the existing condition also occur for this scenario, this was expected given the discharge scenario simulations have the same meteorological boundary conditions;

2. However, in July, a temperature gradient is more pronounced along the Port Pirie River as a result of the discharge;

3. Contrastingly, August shows a more uniform temperature along the entire Port Pirie River; in the discharge scenario in comparison to the baseline;

4. In September both baseline and discharge scenarios present gradients along the Port Pirie River;

5. Again, the temperatures were slightly higher than the baseline from the southern tip of the Port Pirie River to the mouth.

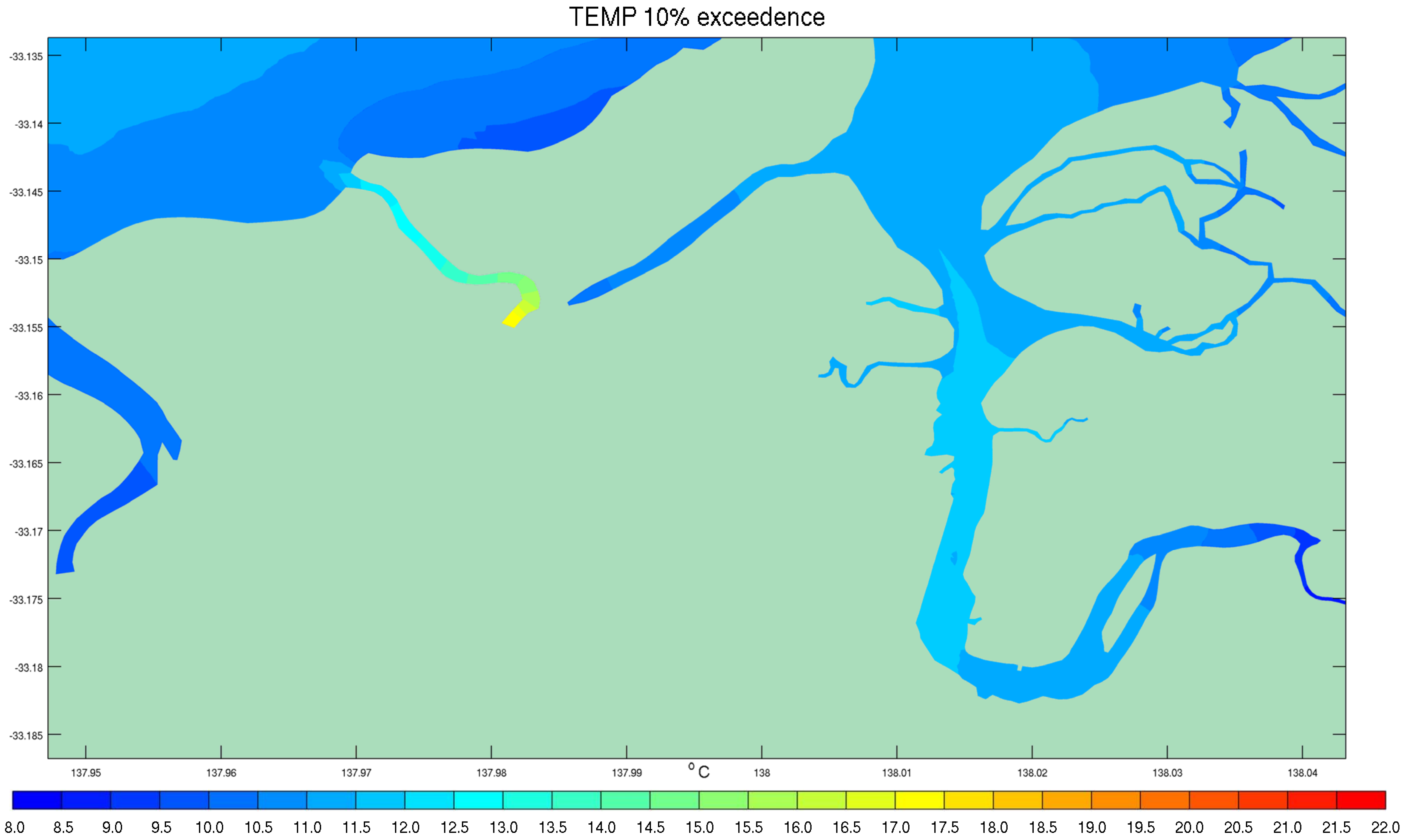

Figure 4-20 10th Percentile Temperature Exceedences – Discharge Scenario Conditions July 2012

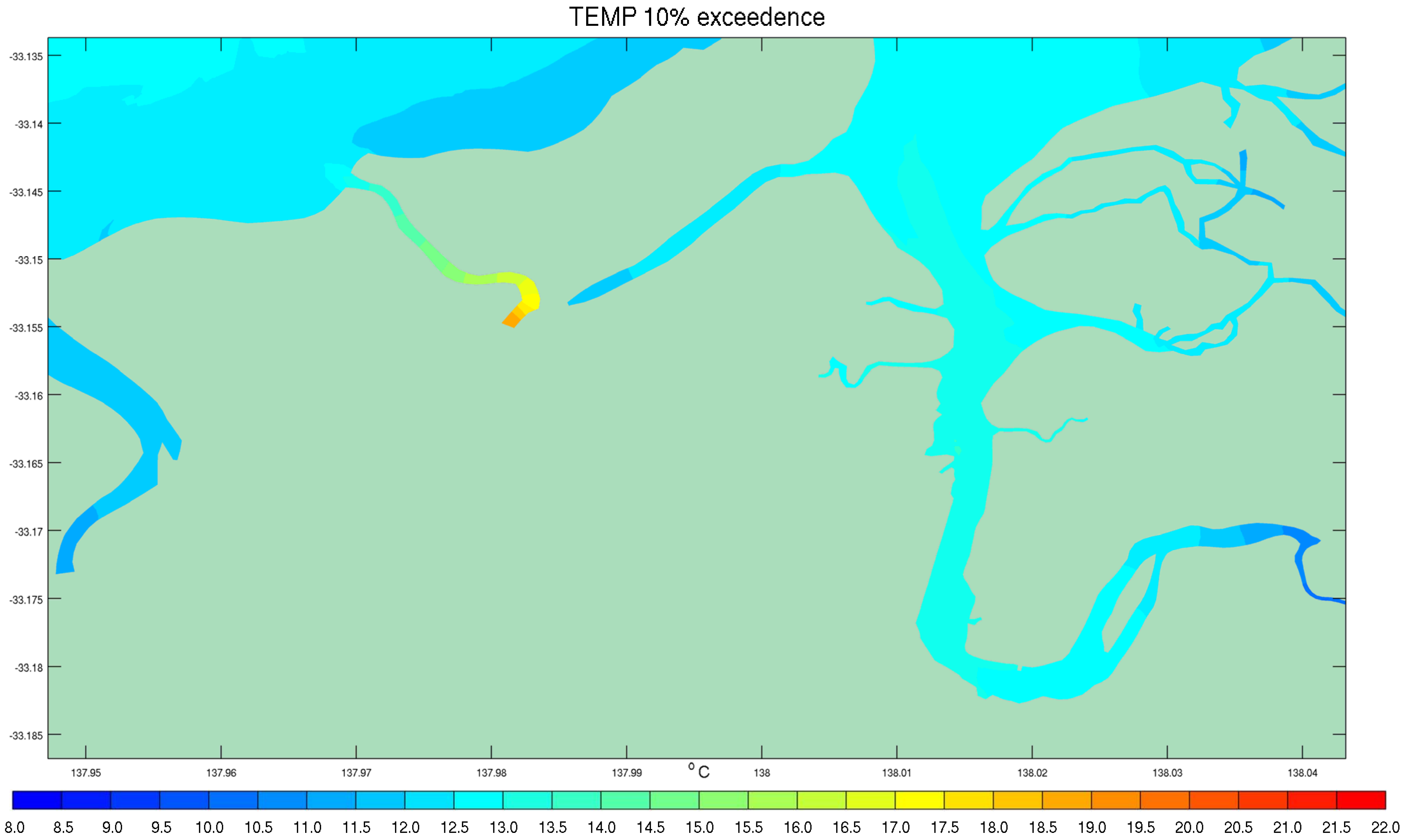

Figure 4-21 10th Percentile Temperature Exceedences – Discharge Scenario Conditions August 2012

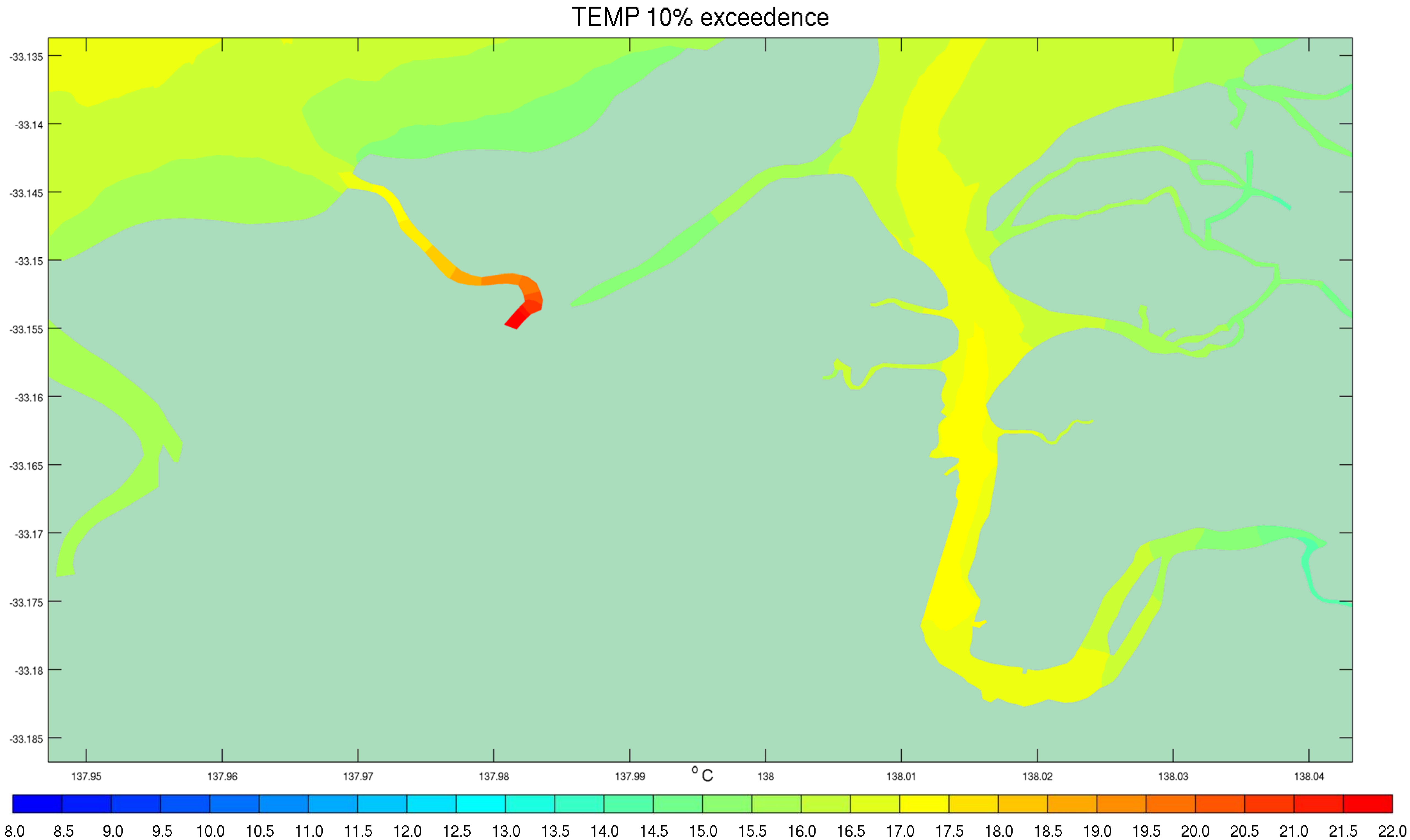

Figure 4-22 10th Percentile Temperature Exceedences – Discharge Scenario Conditions September 2012

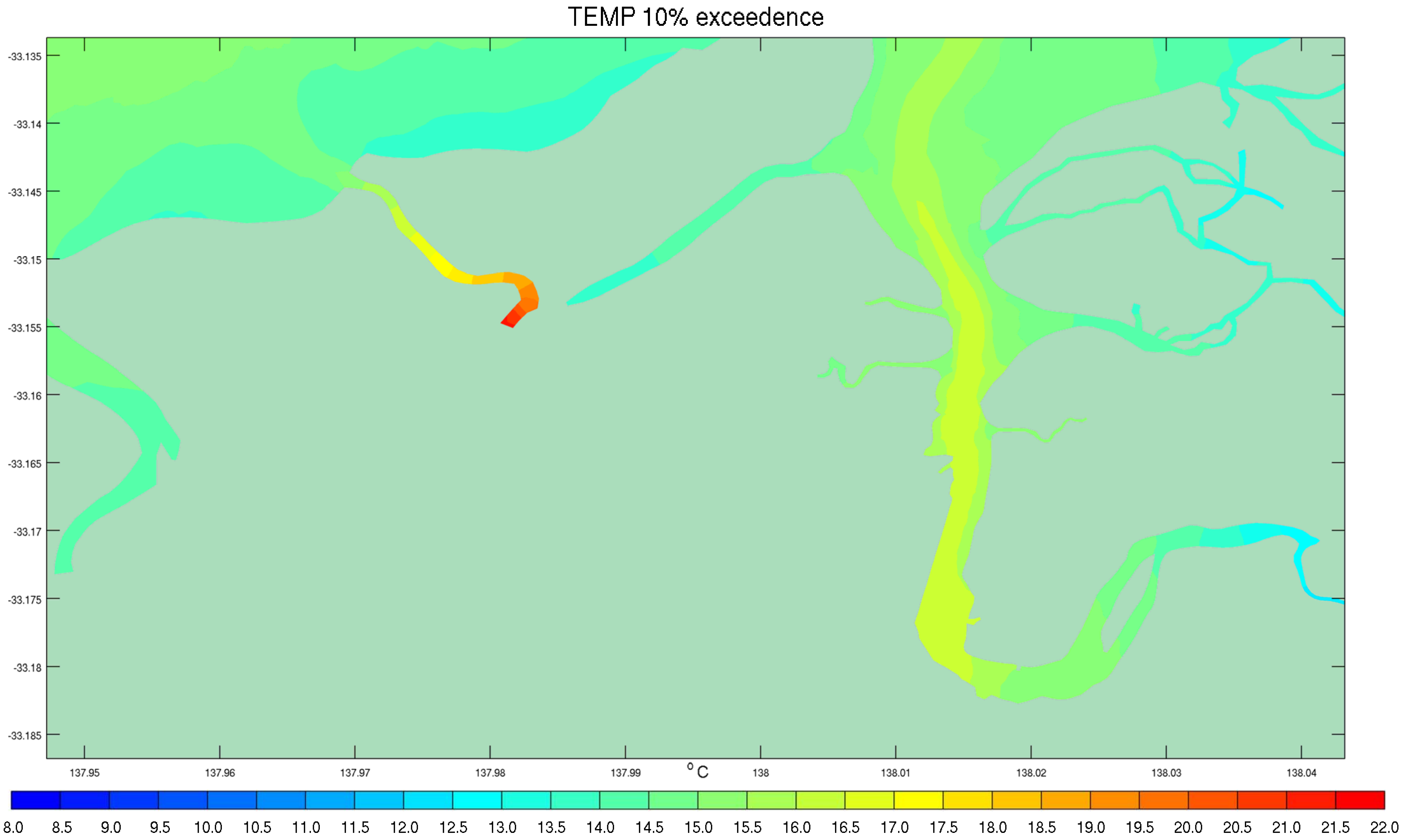

Figure 4-23 10th Percentile Temperature Exceedences – Discharge Scenario Conditions July to September 2012

4.9.5 Summer Percentile Difference Maps

Results of the 10th temperature exceedence differences between the discharge scenario and the baseline in summer are presented below in Figure 4-24 to Figure 4-27. All other exceedences present a similar outcome and are presented in Appendix E. For the purpose of comparisons to the baseline, these results were sufficient to illustrate the total extent of the area of influence of the discharge.

The following general features can be seen in these maps:

1. In contrast to BMT WBM (2013) temperature exceedence differences are smaller than 2 ^oC everywhere, this is a direct result of integrating the near field dilution in the far field model;

2. As alluded to above, temperature exceedence differences shows the discharge scenario with increased temperatures over the entire length of the Port Pirie River;

3. The temperature exceedence differences were generally below 1.5 ^oC throughout the Port Pirie River, with smaller differences towards the mouth and up the river;

4. The month of March presented the smallest area with exceedence temperature differences above 0.2 ^oC and February presented the largest area;

5. The month of January presented the largest extension of exceedence temperature differences towards the Port Pirie River mouth;

6. These results indicate that the model spinning was sufficiently long to allow an approximate balance between heat input due to the discharge and heat loss with the interaction with the atmosphere, such that the area of influence of the discharge is approximately constant;

7. The results over the three-month period show the same characteristics for the exceedence temperature differences observed in the one-month periods in isolation.

4.9.6 Winter Percentile Difference Maps

Results of the 10th temperature exceedence differences between the discharge scenario and the baseline in winter are presented below in Figure 4-28 to Figure 4-31. All other exceedences present a similar outcome and are presented in Appendix F.

The following general features can be seen in these maps:

1. Again, all temperature exceedence differences are smaller than 2 ^oC everywhere, this is a direct result of integrating the near field dilution in the far field model;

2. Similarly to summer conditions, temperature exceedence differences shows the discharge scenario with increased temperatures over the entire length of the Port Pirie River;

3. The temperature exceedence differences were generally below 1.2 ^oC throughout the Port Pirie River, with smaller differences towards the mouth and up the river;

4. The month of July presented the smallest area with exceedence temperature differences above 0.2 ^{o}C and August presented the largest area. These areas were however not too dissimilar;

5. These results also indicated that the model spinning was sufficiently long to allow an approximate balance between heat input due to the discharge and heat loss with the interaction with the atmosphere, such that the area of influence of the discharge is approximately constant and heat does not build up with time;

6. Again, the results over the three-month period show the same characteristics for the exceedence temperature differences observed in the one-month periods in isolation.

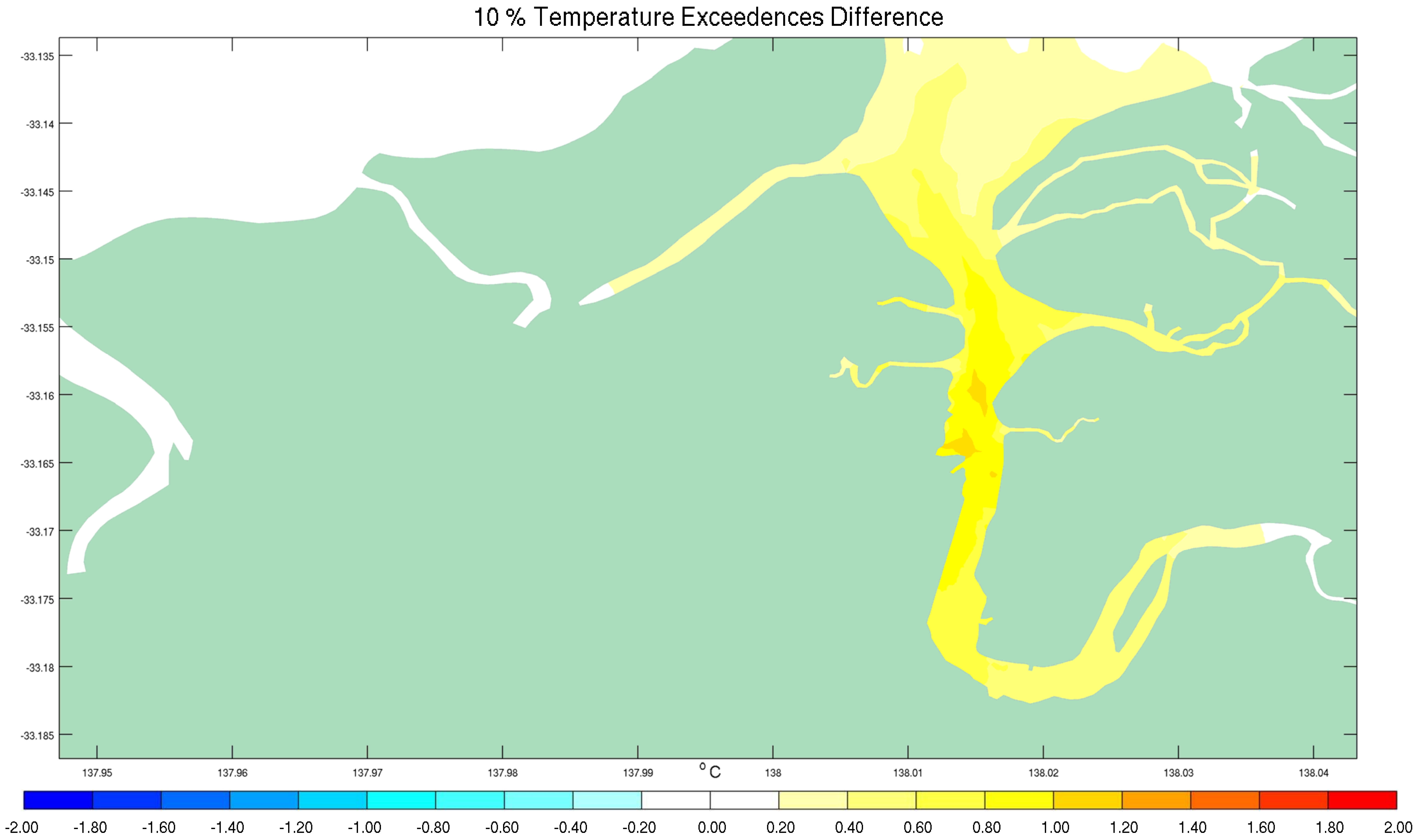

Figure 4-24 10th Percentile Temperature Exceedences Differences - January 2013

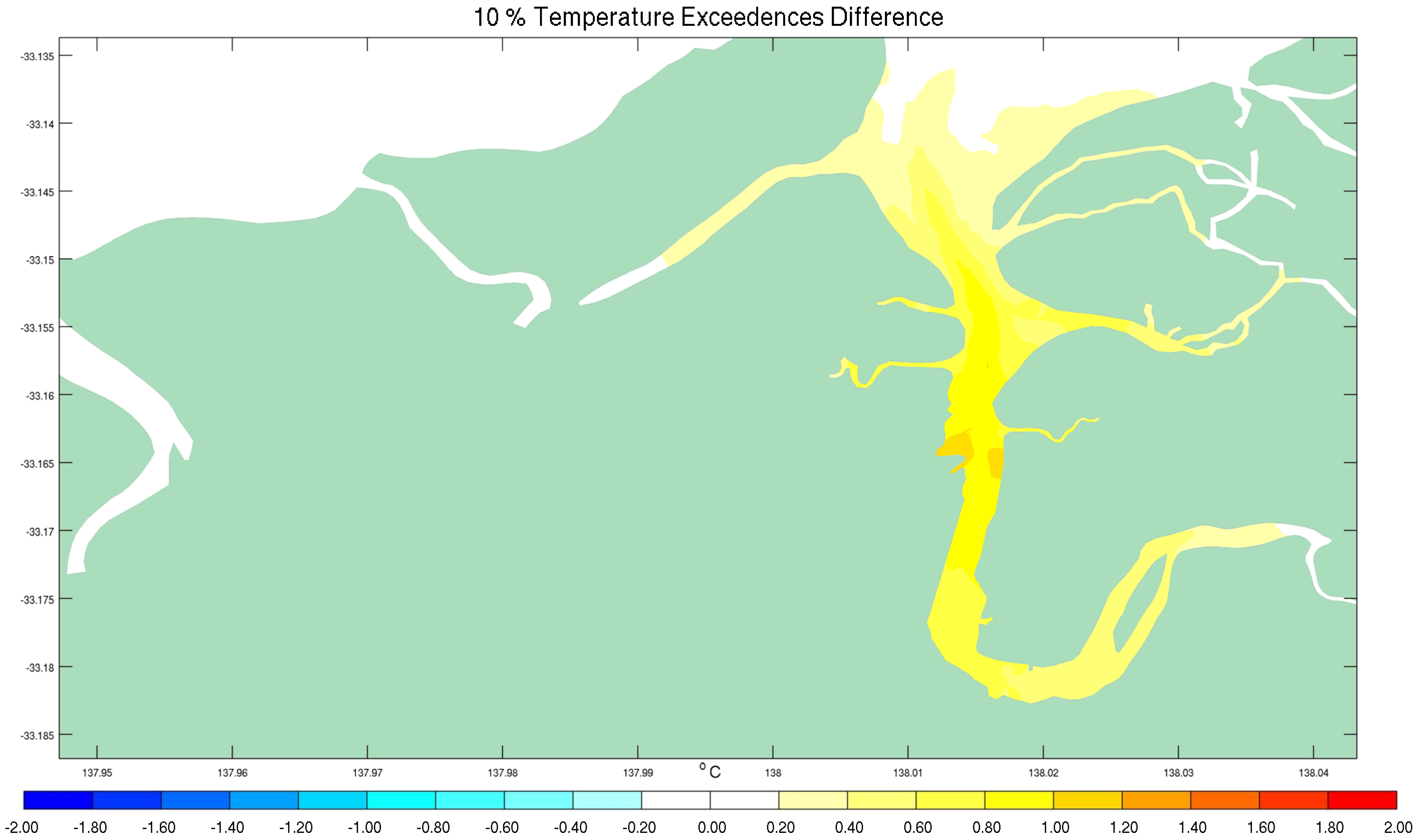

Figure 4-25 10th Percentile Temperature Exceedences Differences - February 2013

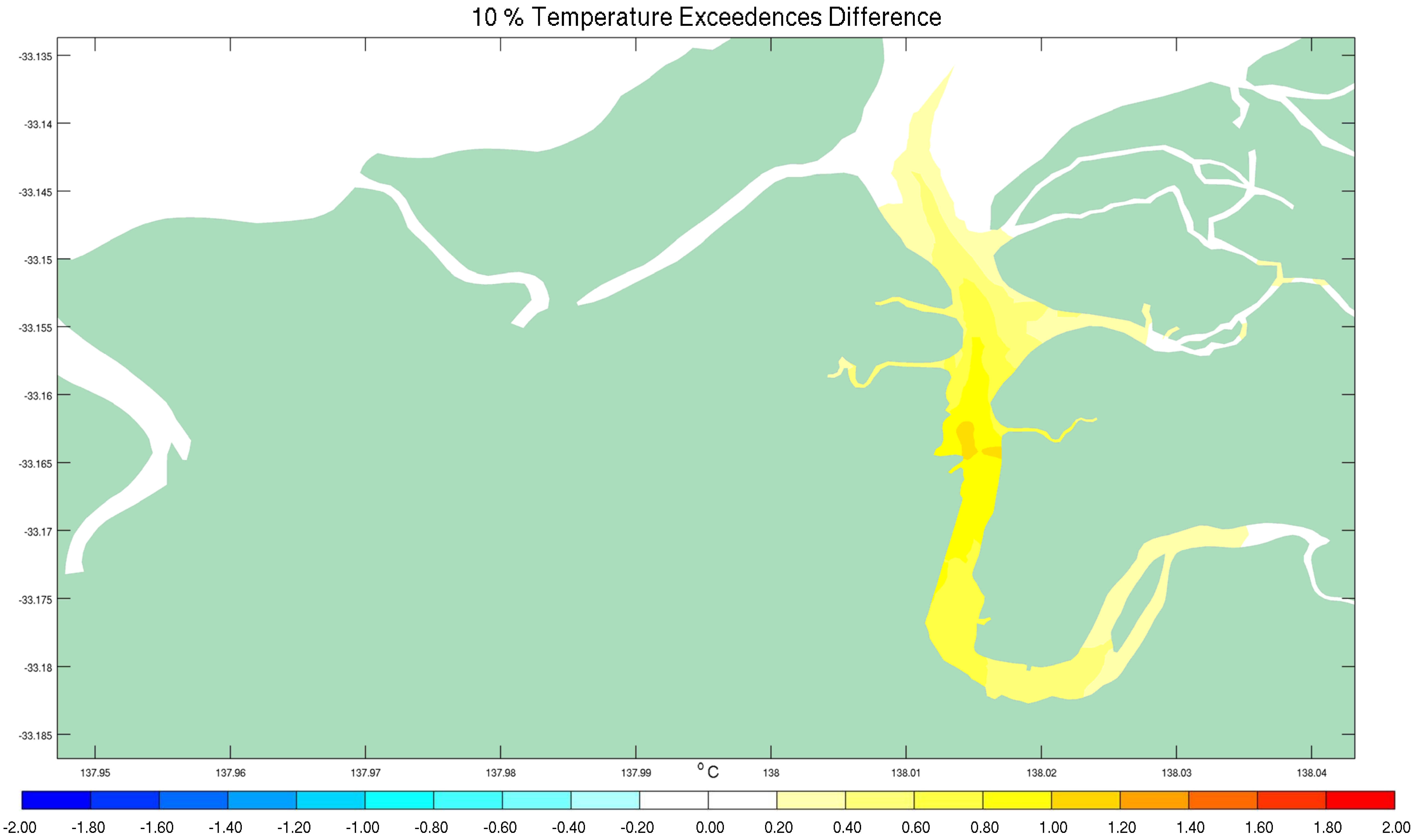

Figure 4-26 10th Percentile Temperature Exceedences Differences - March 2013

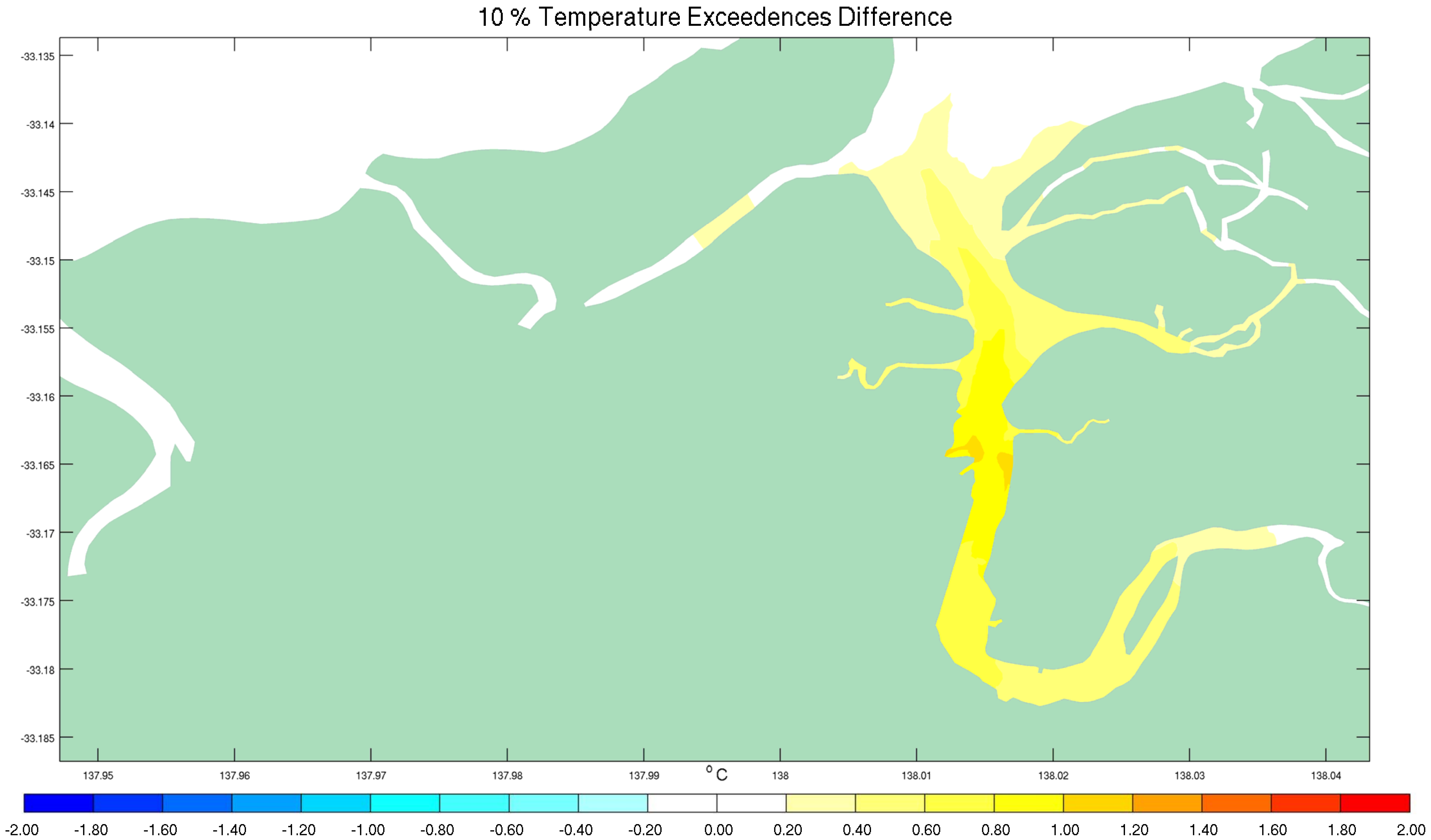

Figure 4-27 10th Percentile Temperature Exceedences Differences - January to March 2013

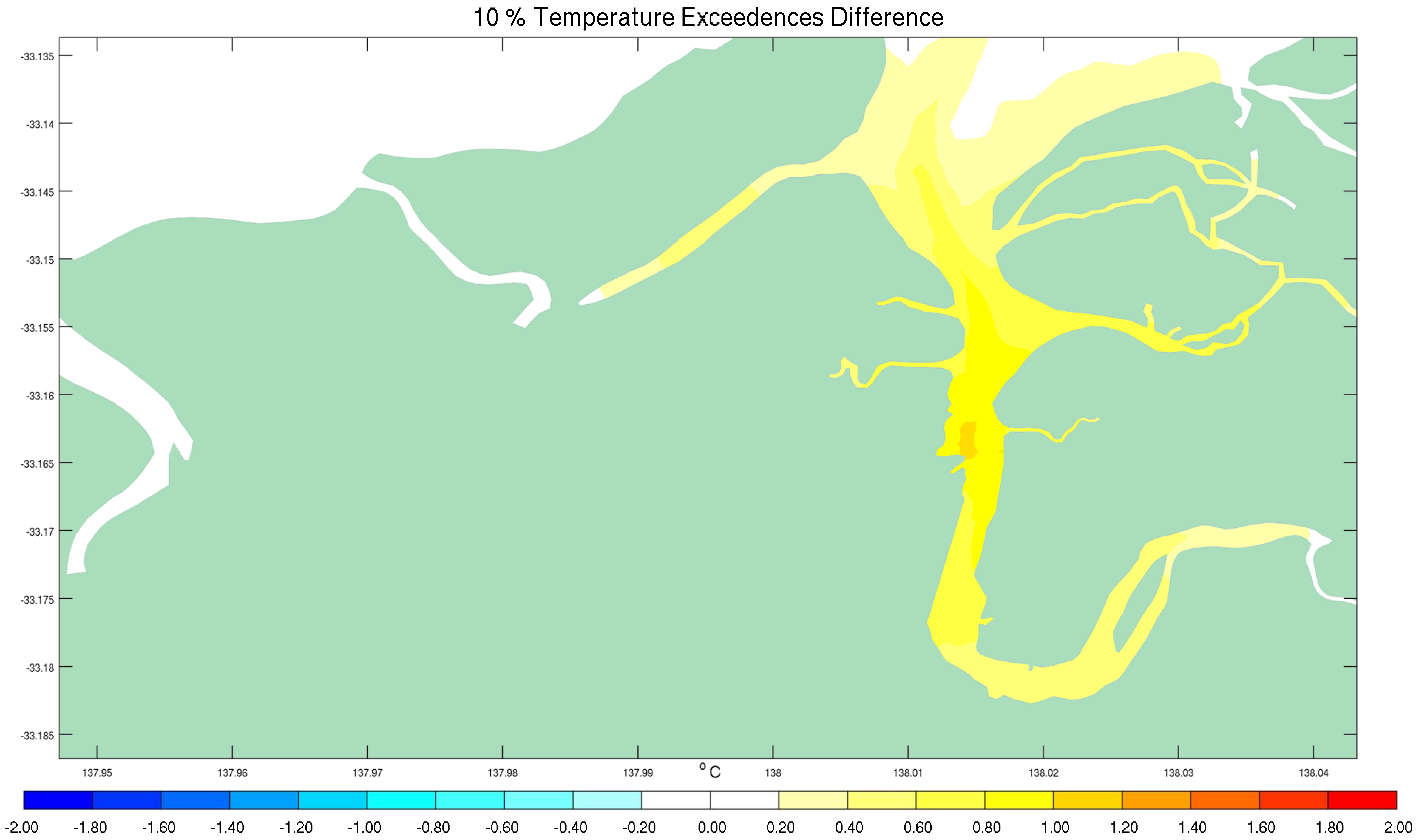

Figure 4-28 10th Percentile Temperature Exceedences Differences - July 2012

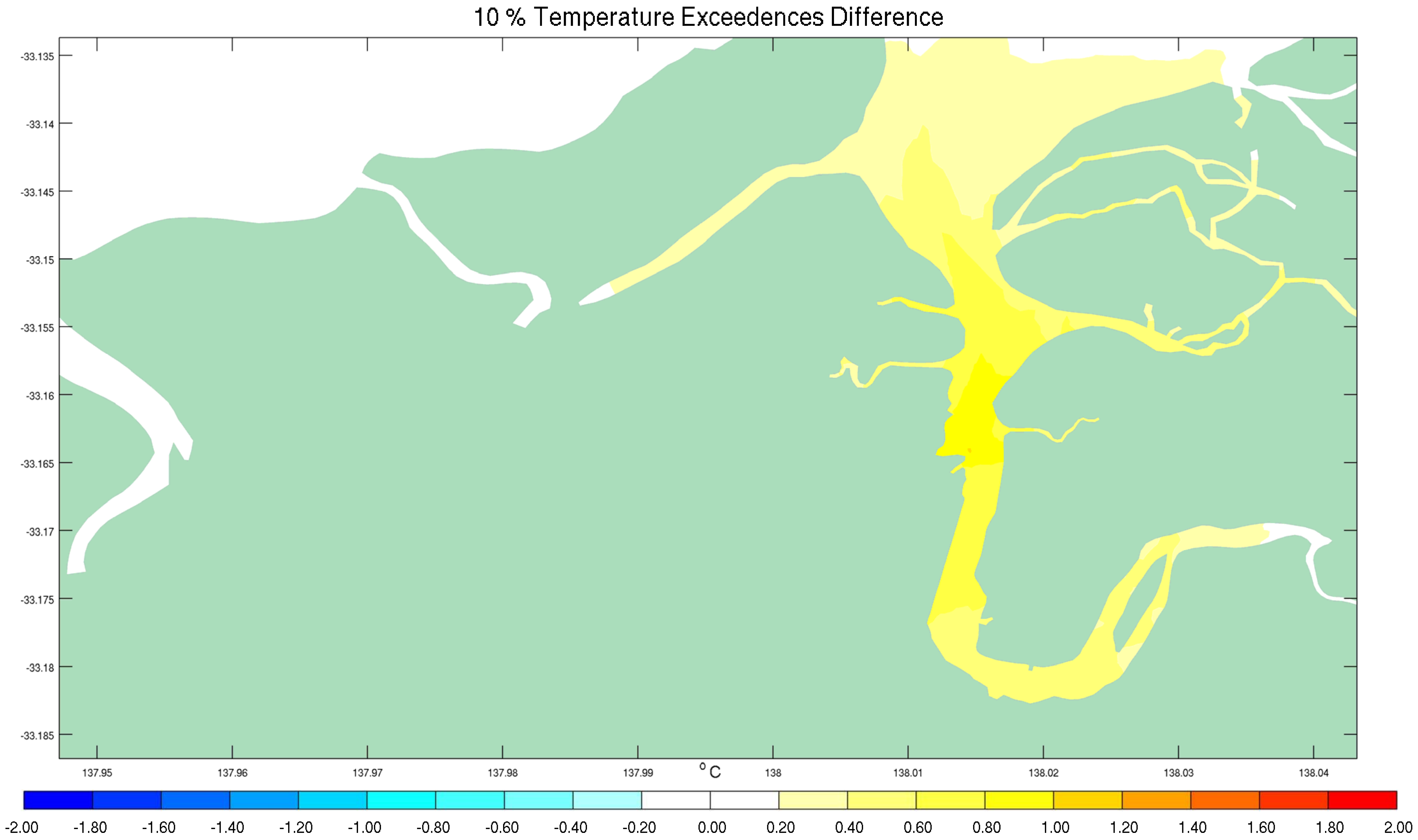

Figure 4-29 10th Percentile Temperature Exceedences Differences - August 2012

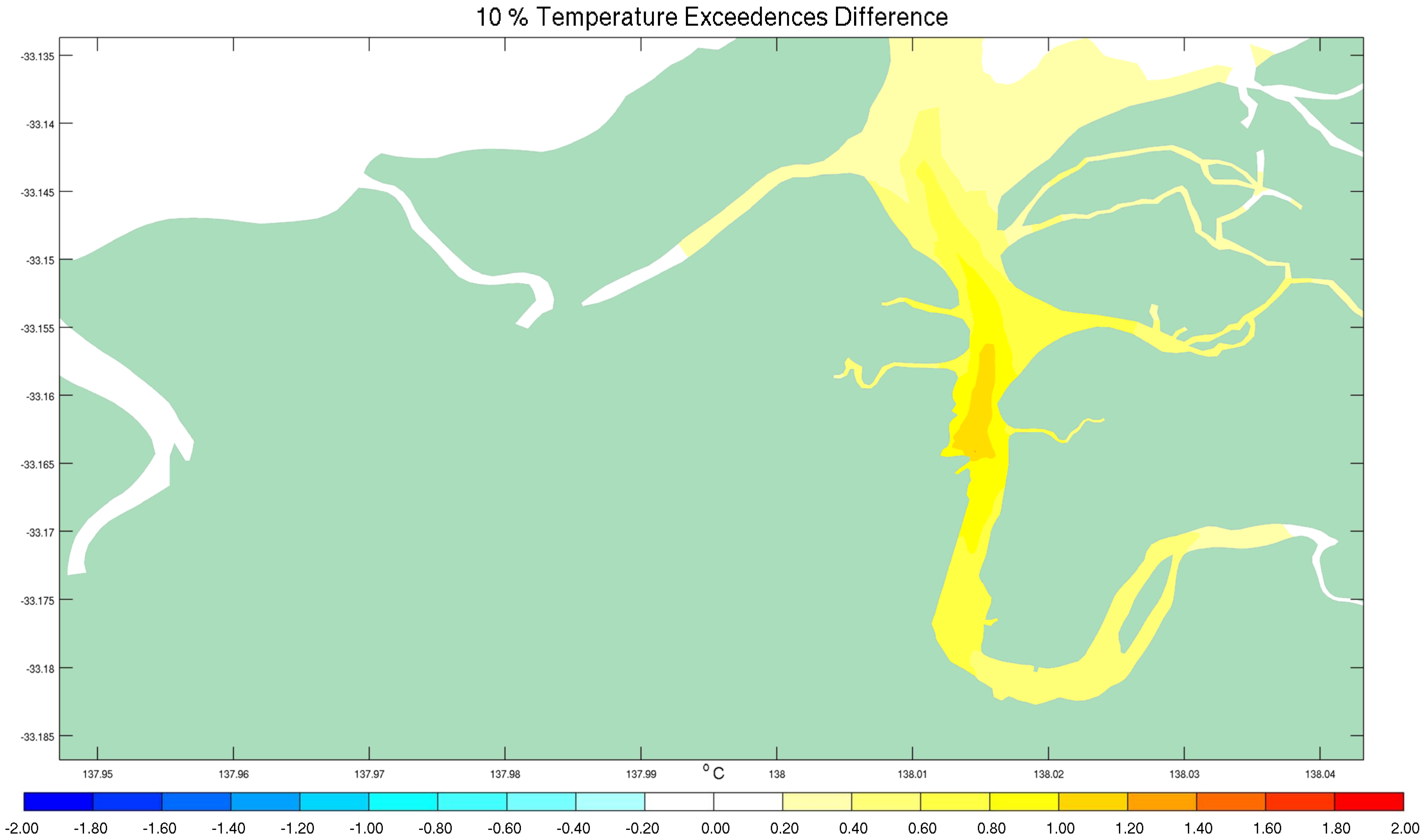

Figure 4-30 10th Percentile Temperature Exceedences Differences - September 2012

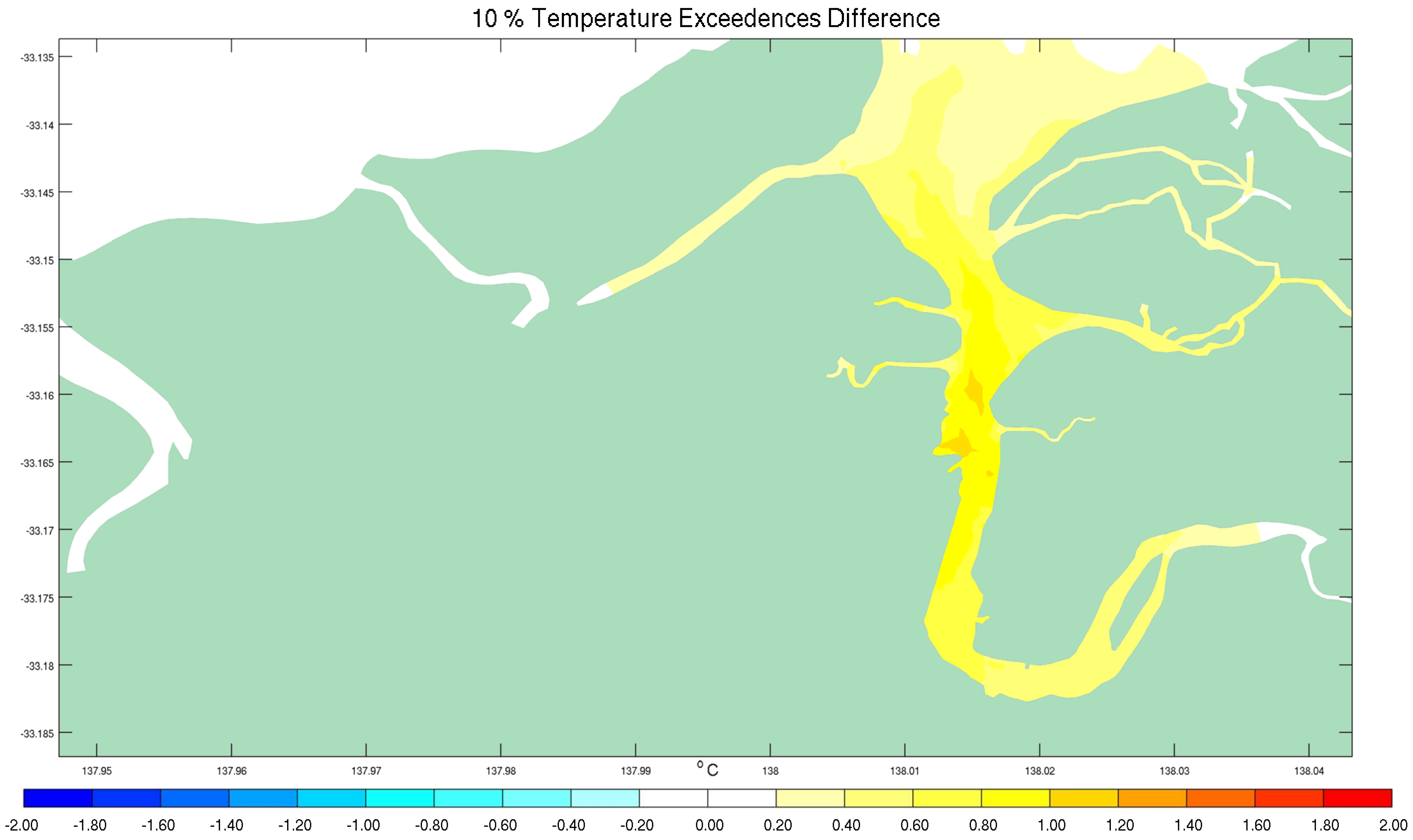

Figure 4-31 10th Percentile Temperature Exceedences Differences – July to September 2012

4.9.7 Short Circuit between Intake and Discharge

The temperatures at the proposed intake for the baseline and discharge scenario simulation in summer are presented in Figure 4-32. A similar figure for the existing intake is presented in Figure 4-33. Winter simulations presented similar results and are not shown for brevity.

The results show that the discharge had some influence on the temperatures at the intake. The differences in temperatures were in the range of 0.3 °C and 1.8 °C, depending on ambient conditions. This is relatively little in comparison to temperature ranges over the year (approximately 12 to 24 °C). Noting that that these simulations were undertaken with the demonstration design developed in BMT WBM (2013), an optimised diffuser would result in lesser temperature influences from the discharge on the temperatures at the intakes.

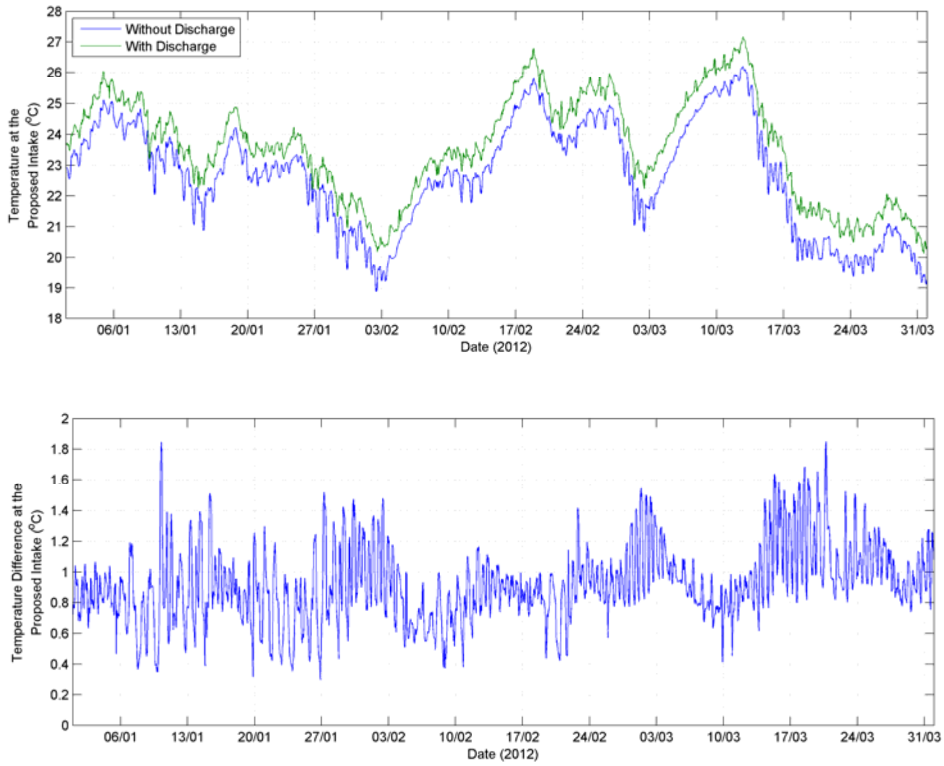

Figure 4-32 Upper Panel: Temperature at the Location of the Proposed Intake for Summer Simulations. Lower Panel: Temperature Difference between Discharge Scenario and Baseline at the Location of the Proposed Intake for Summer Simulations

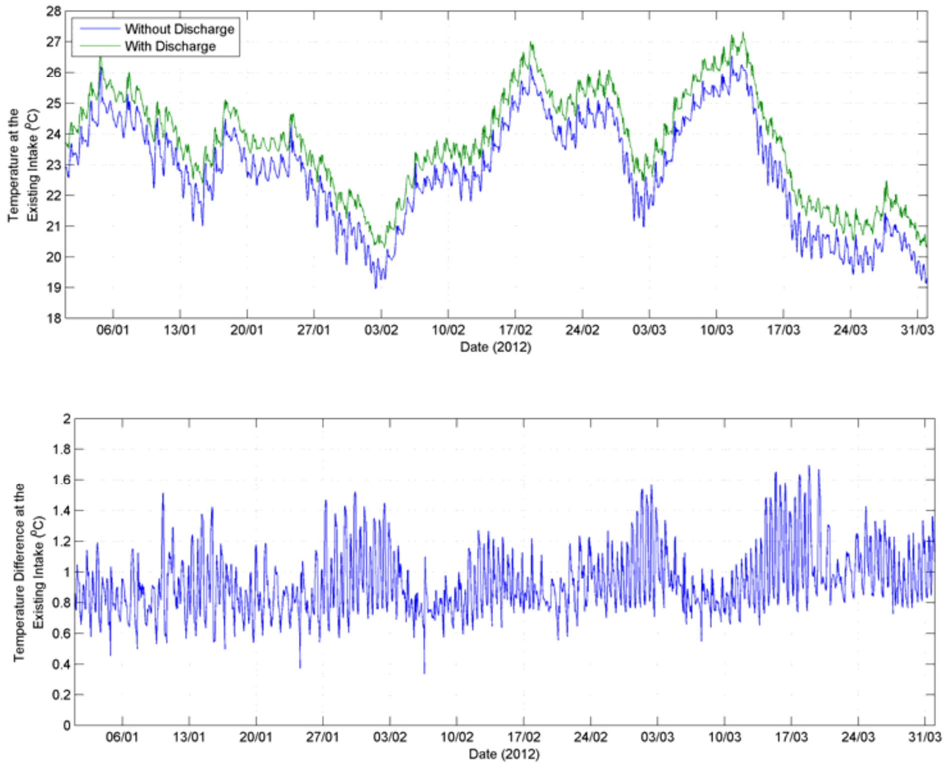

Figure 4-33 Upper Panel: Temperature at the Location of the Existing Intake for Summer Simulations. Lower Panel: Temperature Difference between Discharge Scenario and Baseline at the Location of the Existing Intake for Summer Simulations.

5 DISCUSSION

This report describes additional modelling assessments for a cooling water discharge in Port Pirie, South Australia. This cooling water discharge will form part of the infrastructure required to transform the existing Nyrstar multi metals recovery plant into a state-of-the-art poly-metallic processing and recovery facility. The findings of this study addressed some of the issues raised by the SA Government on the original Public Environmental Review document.

5.1 Preliminary Outfall Optimisation

The range of outfall design parameters investigated in this study was not exhaustive, but was sufficiently wide to demonstrate dilutions obtained in BMT WBM (2013) could be considerably improved. These design parameters do not take into consideration issues such as bed scouring (noting the horizontal ports), outfall cavitation and visual impact of the plume reaching the surface. These questions must be answered at a more detailed stage in the life cycle of the Smelter Upgrade project.

The main result of this preliminary optimisation was that the diffuser in the Port Pirie River could safely comply with present EPA (2003) guidelines.

Although it was shown that this is possible with one of the design parameter sets, compliance with the draft proposed guidelines may be difficult to achieve if statistical analysis is to be undertaken over a 7 day period. The difficulty arises because the range of ambient temperatures maybe too narrow, requiring very large dilutions to achieve compliance. This may present itself as a challenge in the shallow water column and relatively short distance of 20 m from the diffuser. Practical **implementation from a reporting perspective may also be problematic, given the mathematical** approach required for the analysis.

Some discrepancy in dilution results arose between CORMIX and Visual Plumes, particularly in the case of increased diffuser length, keeping the same number of ports and port diameter. This is likely an artifact of the schemes adopted in CORMIX, as larger spacing between ports should allow for more vigorous mixing of the effluent discharged from each port. For detailed design, it is recommended that a more robust CFD tool be used for diffuser optimisation.

5.2 Heat Accumulation in the Port Pirie River

The framework used to integrate the near field results in the far field modelling produced more realistic temperatures in the Port Pirie River in comparison to BMT WBM (2013). The results showed that, in comparison to the existing conditions, there will be some heating of the Port Pirie River from its Southern tip to its mouth at Germein Bay. Notwithstanding this, the heating will be generally less than 1.5 ^{o}C everywhere.

Results also show that the model was in approximate equilibrium between the discharge heat input and the heat exchange with Spencer Gulf and the atmosphere. As a result heat did not accumulate over the Port Pirie River as the simulations progressed in time (both summer and winter). Also the areas where temperature differences between discharge scenario and baseline did not extended over time.

It should be noted that these simulations incorporate the BMT WBM (2013) demonstration diffuser design, and as such, lesser temperature increase along the Port Pirie River would be expected.

5.3 Short Circuit between Intake and Diffuser

The far field model results indicated that there would be some influence of the diffuser on the temperatures at the proposed and existing intake locations. The temperature increase would be relatively small compared to the seasonal variation of ambient temperatures. As such, it is expected that the cooling process took into consideration such increased temperatures as safety factor in its design. Moreover, as already mentioned above, these simulations incorporate the BMT WBM (2013) demonstration diffuser design, and as such, lesser temperature increase along the Port Pirie River would be expected with an optimised diffuser design.

6 CONCLUSIONS

From the assessment conducted in this report the following could be concluded:

1. An outfall can be designed to meet present EPA (2003) guidelines.
2. Compliance with the draft EPA (2012) guidelines may be problematic if analysis is to be undertaken at a 7-day period.
3. Heat will not continuously build-up along the Port Pirie River as a result of the proposed discharge, despite the slight temperature increases expected.
4. There will be some influence of the discharge resulting in slight temperature increases at the existing and proposed intake locations.

It is recommended that:

1. A bathymetric survey be undertaken in the intertidal areas within the area of the study as a precursor for improved model performance within the Port Pirie River area.
2. Detailed outfall design should consider :
    a. a more robust framework such as Computational Fluid Dynamics should be used to resolve the discrepancies between CORMIX and Visual Plumes; and
    b. the unsteady effects of tidal reversals in the Port Pirie River. CFD should also be adopted as the tool for such a study.

7 REFERENCES

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APPENDIX A: TEMPERATURE EXCEEDENCES FOR THE EXISTING BASELINE IN SUMMER

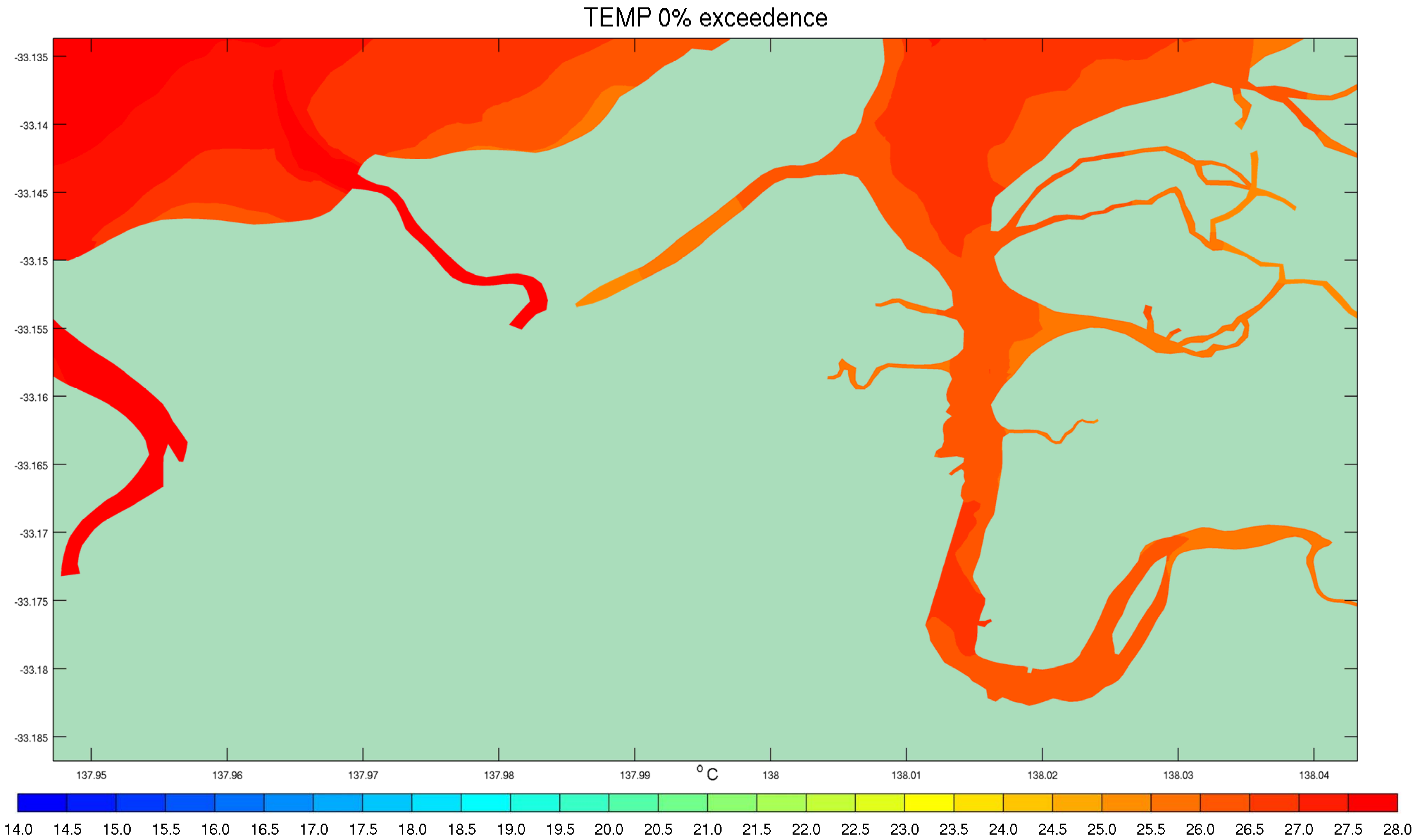

Figure A- 1 0th Percentile Temperature Exceedences – Existing Conditions January 2013

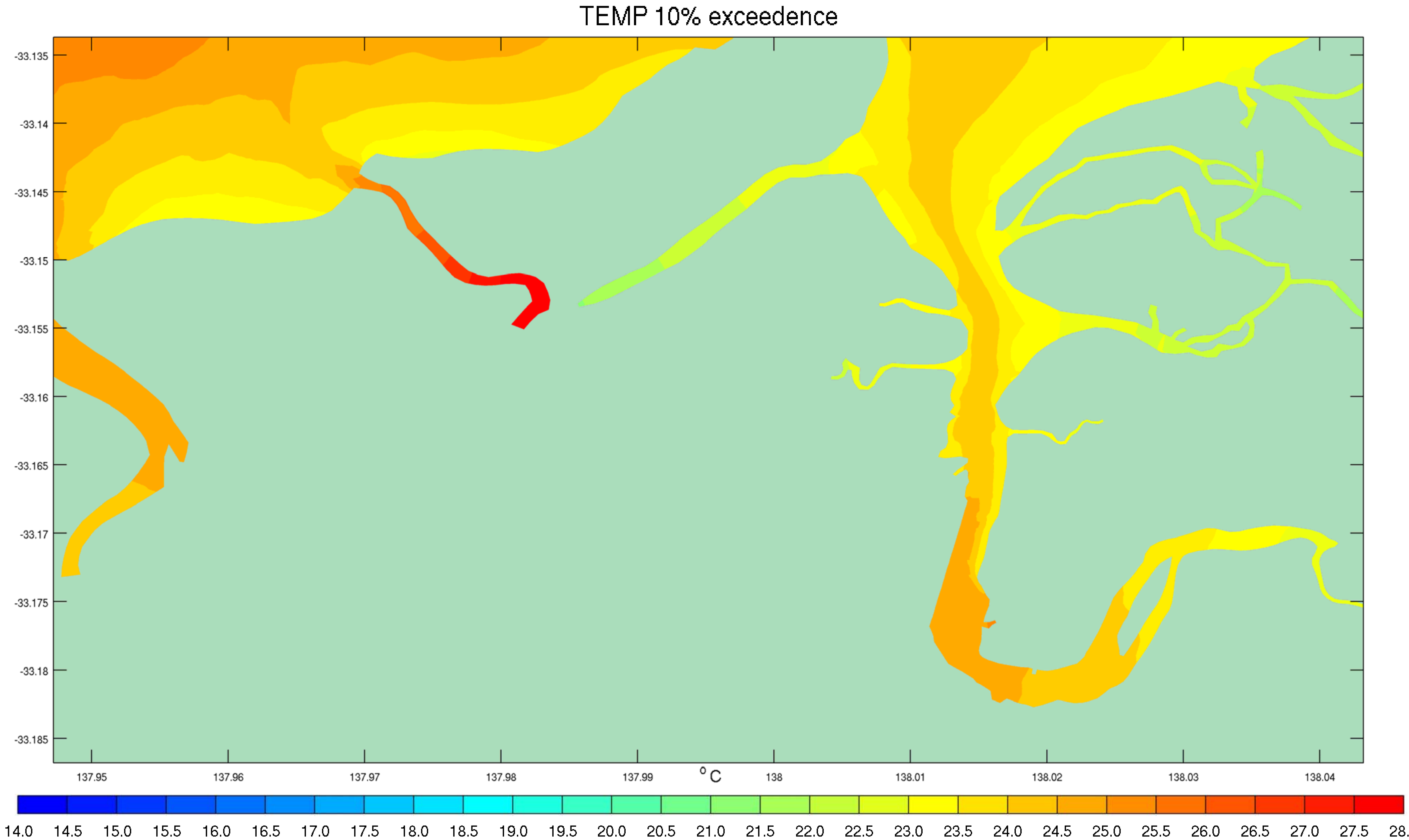

Figure A- 2 10th Percentile Temperature Exceedences – Existing Conditions January 2013

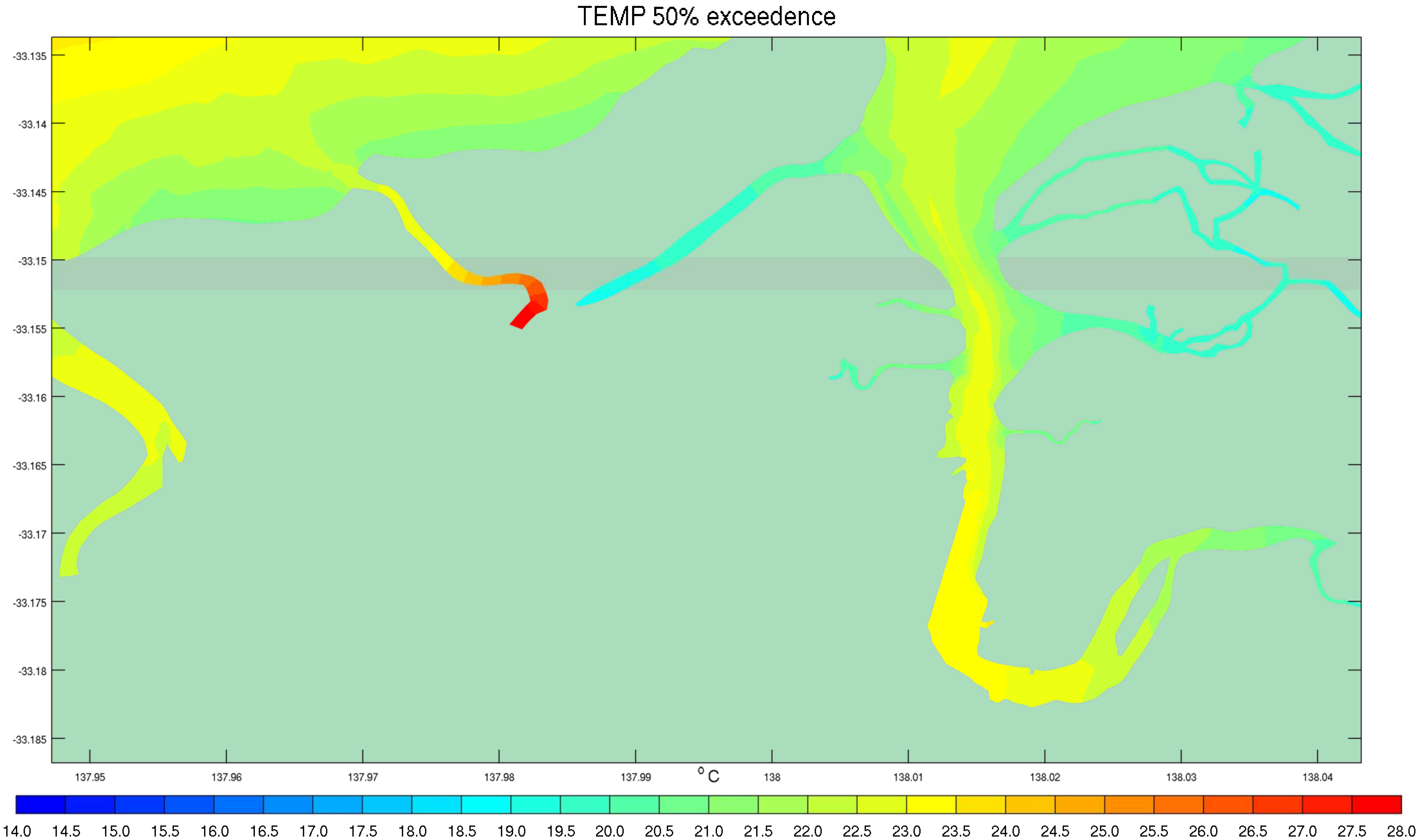

Figure A- 3 50th Percentile Temperature Exceedences – Existing Conditions January 2013

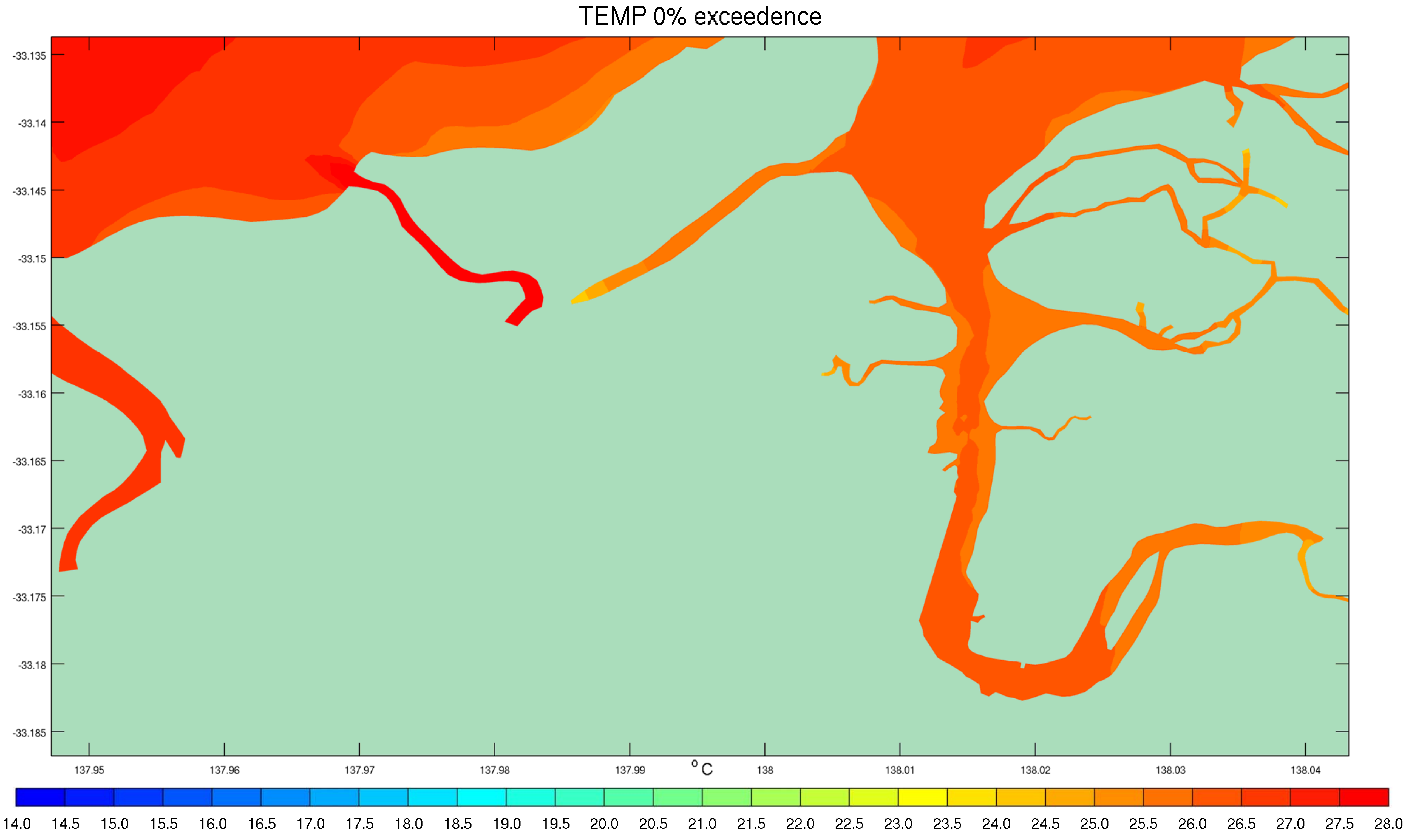

Figure A- 4 0th Percentile Temperature Exceedences – Existing Conditions February 2013

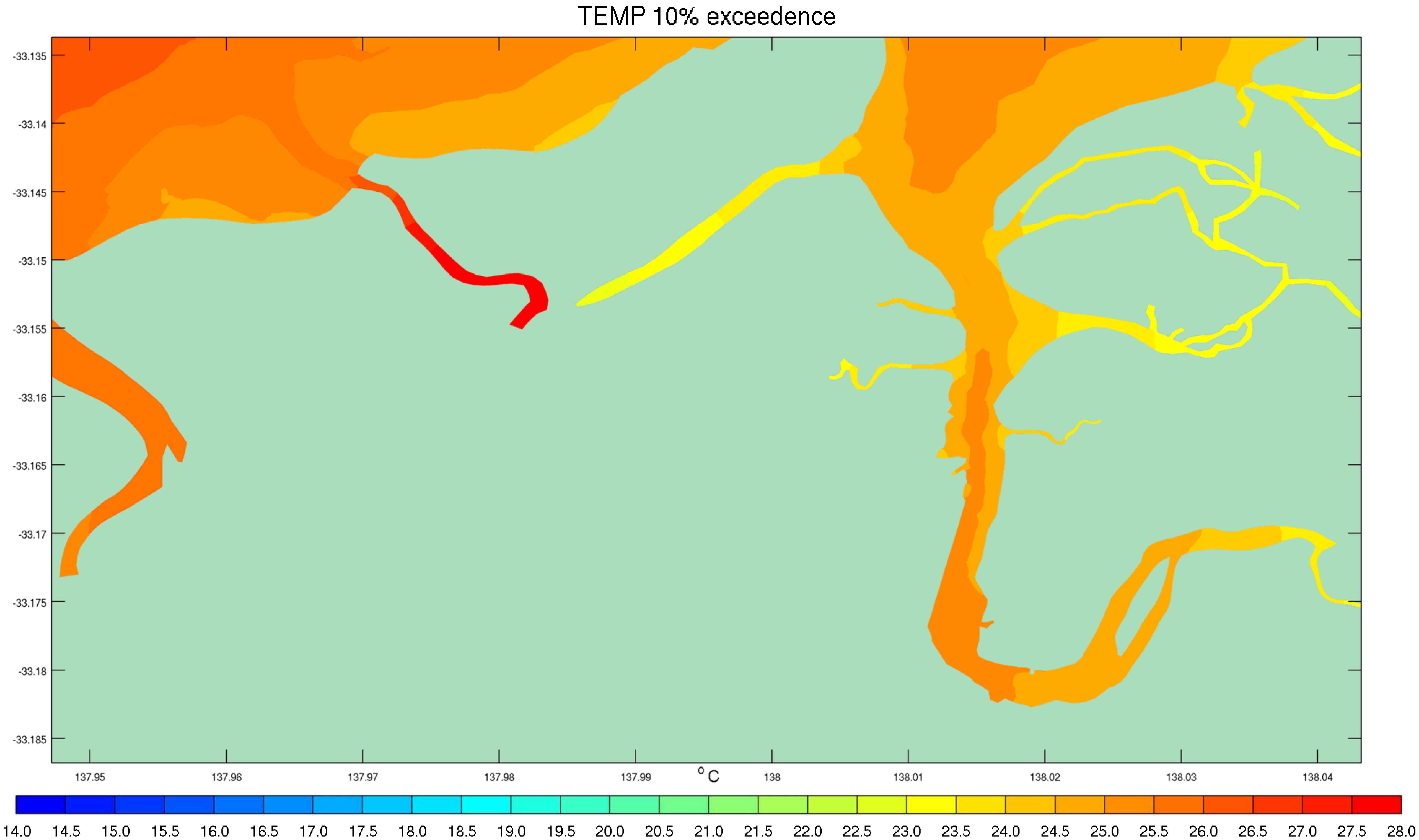

Figure A- 5 10th Percentile Temperature Exceedences – Existing Conditions February 2013

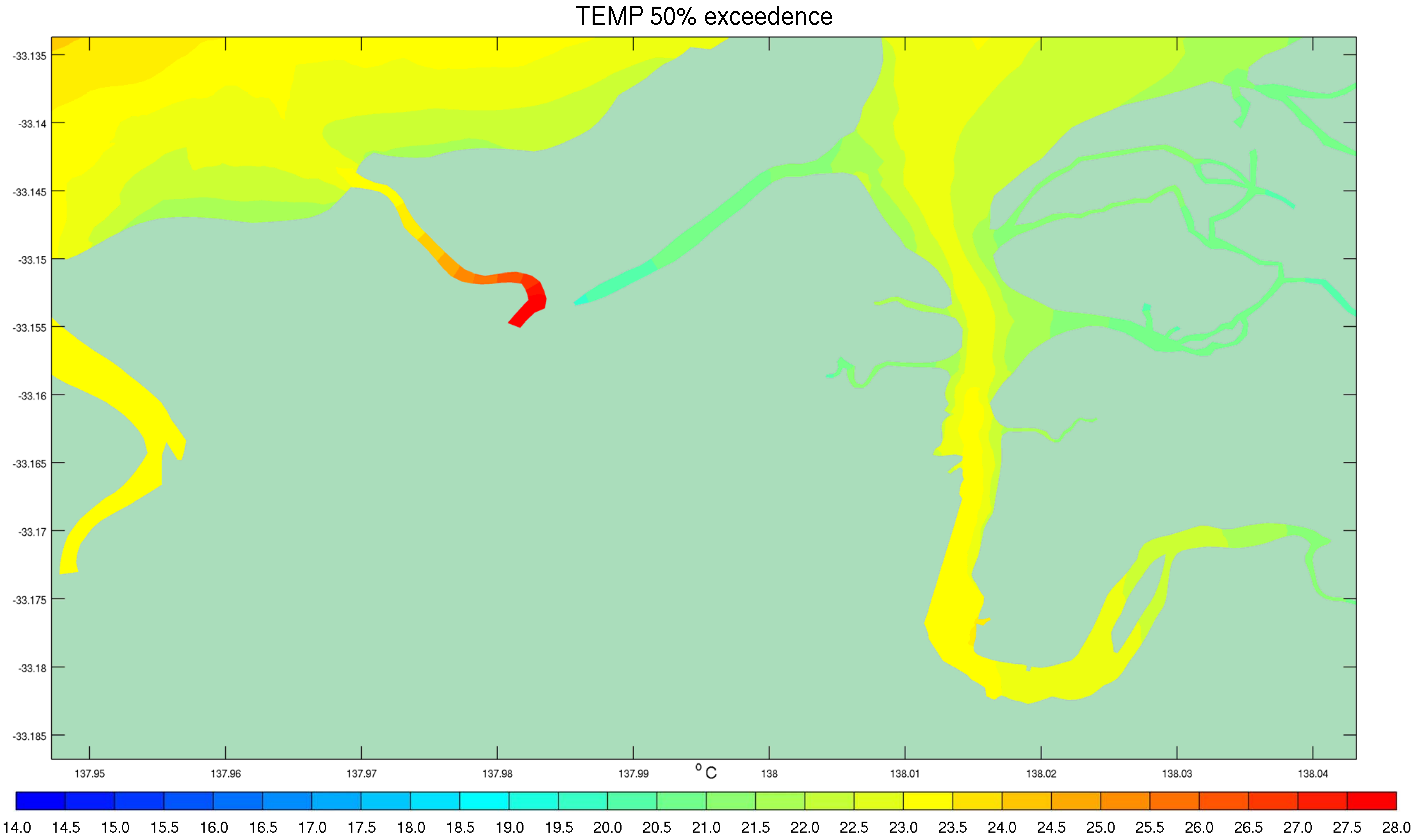

Figure A- 6 50th Percentile Temperature Exceedences – Existing Conditions February 2013

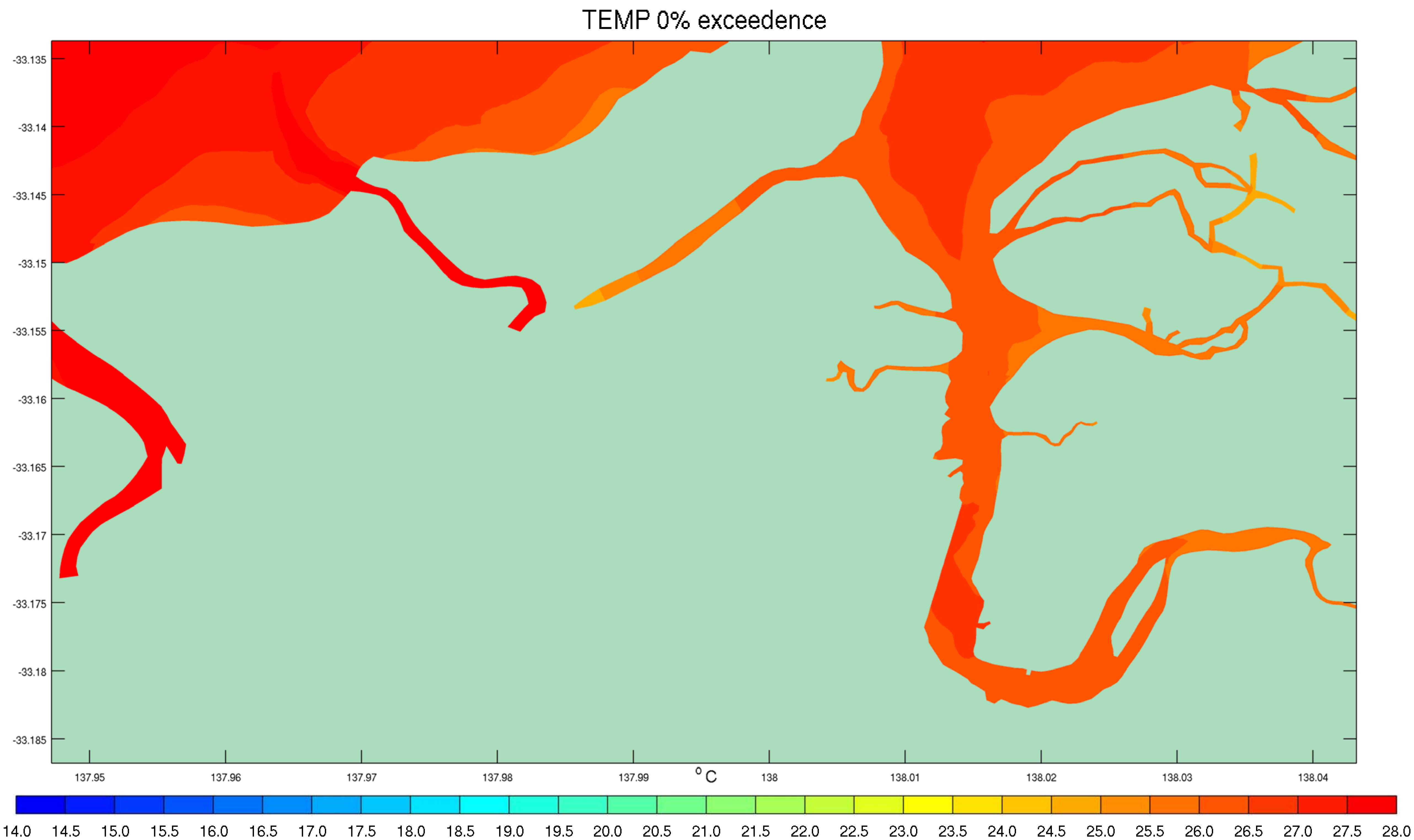

Figure A- 7 0th Percentile Temperature Exceedences – Existing Conditions March 2013

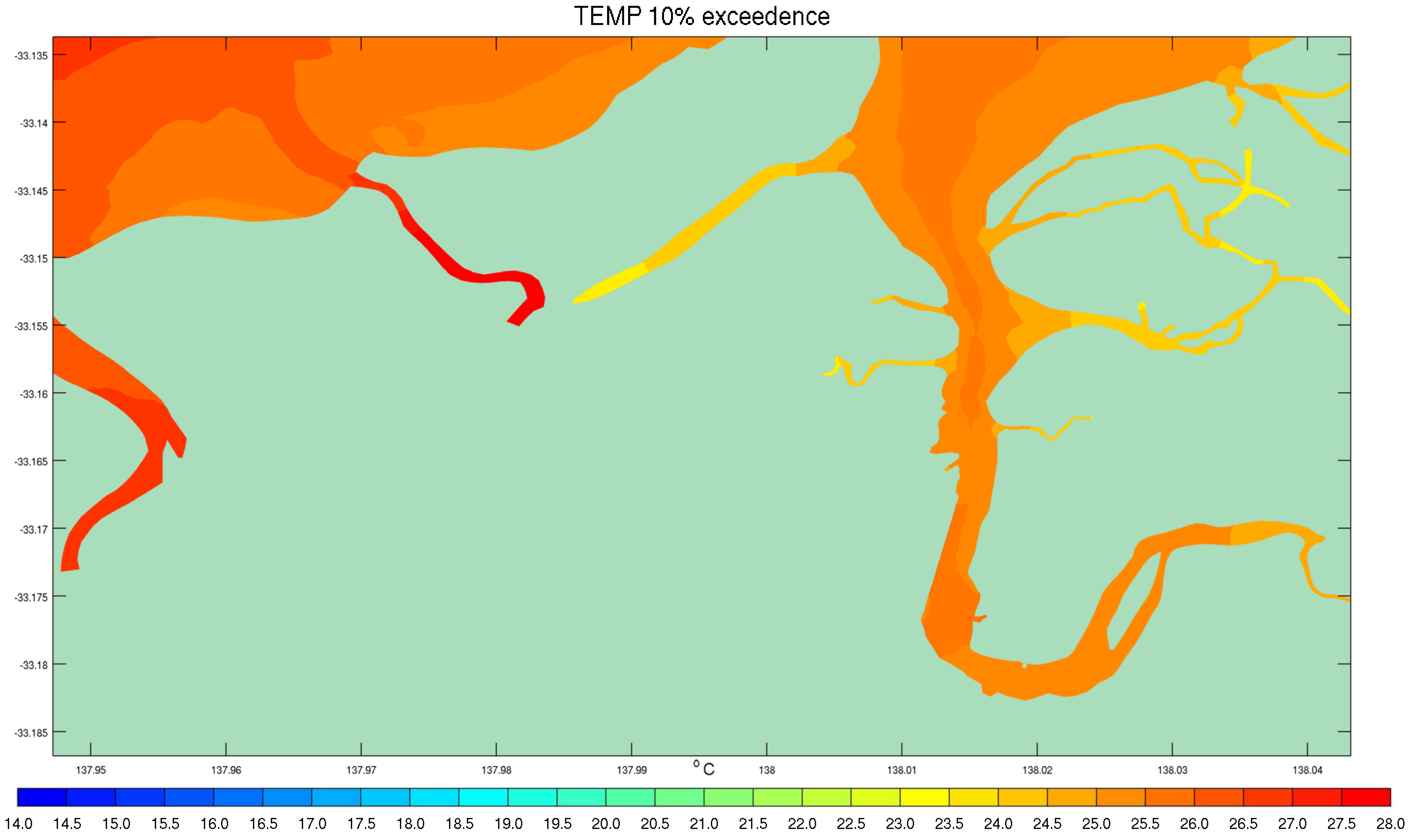

Figure A- 8 10th Percentile Temperature Exceedences – Existing Conditions March 2013

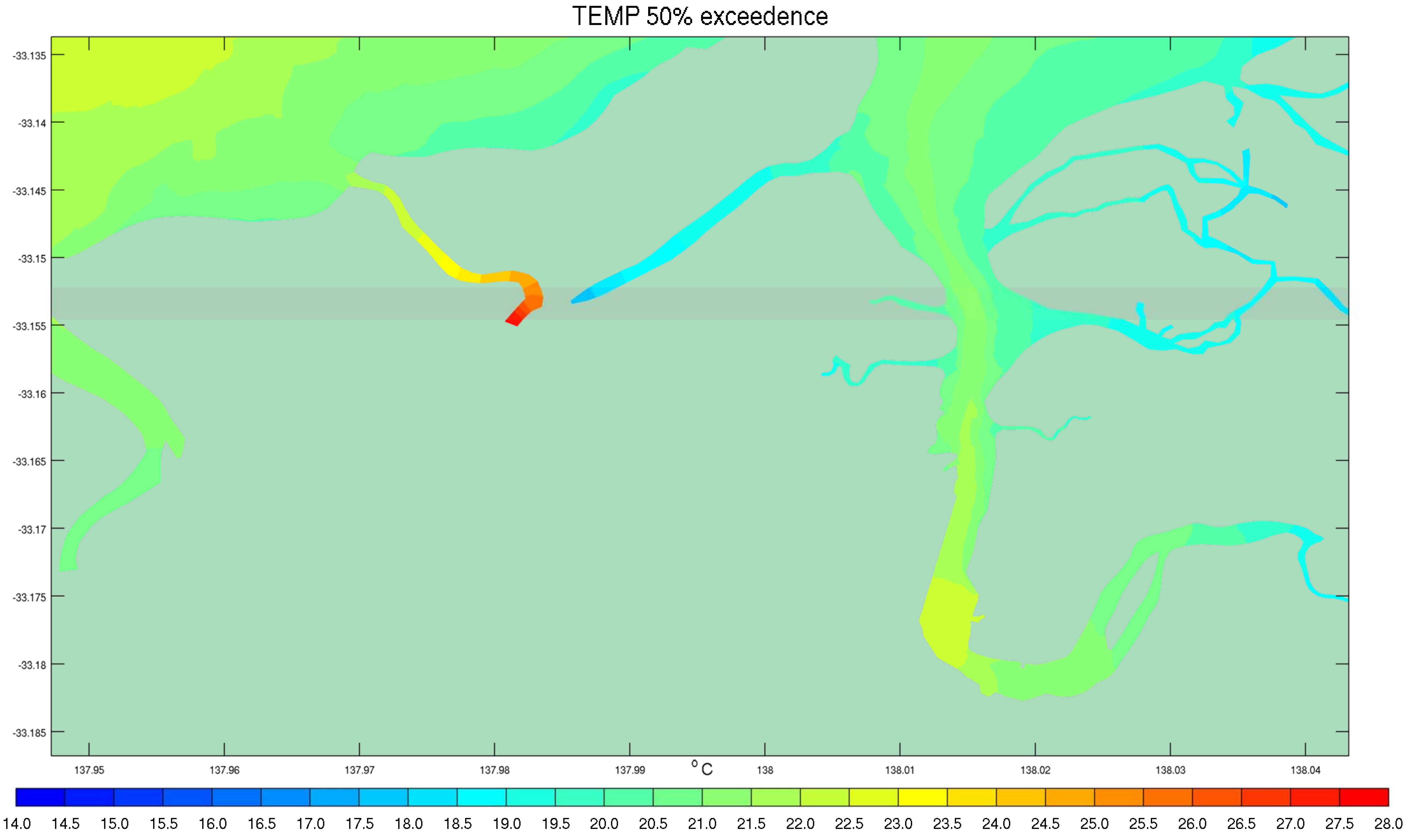

Figure A- 9 50th Percentile Temperature Exceedences – Existing Conditions March 2013

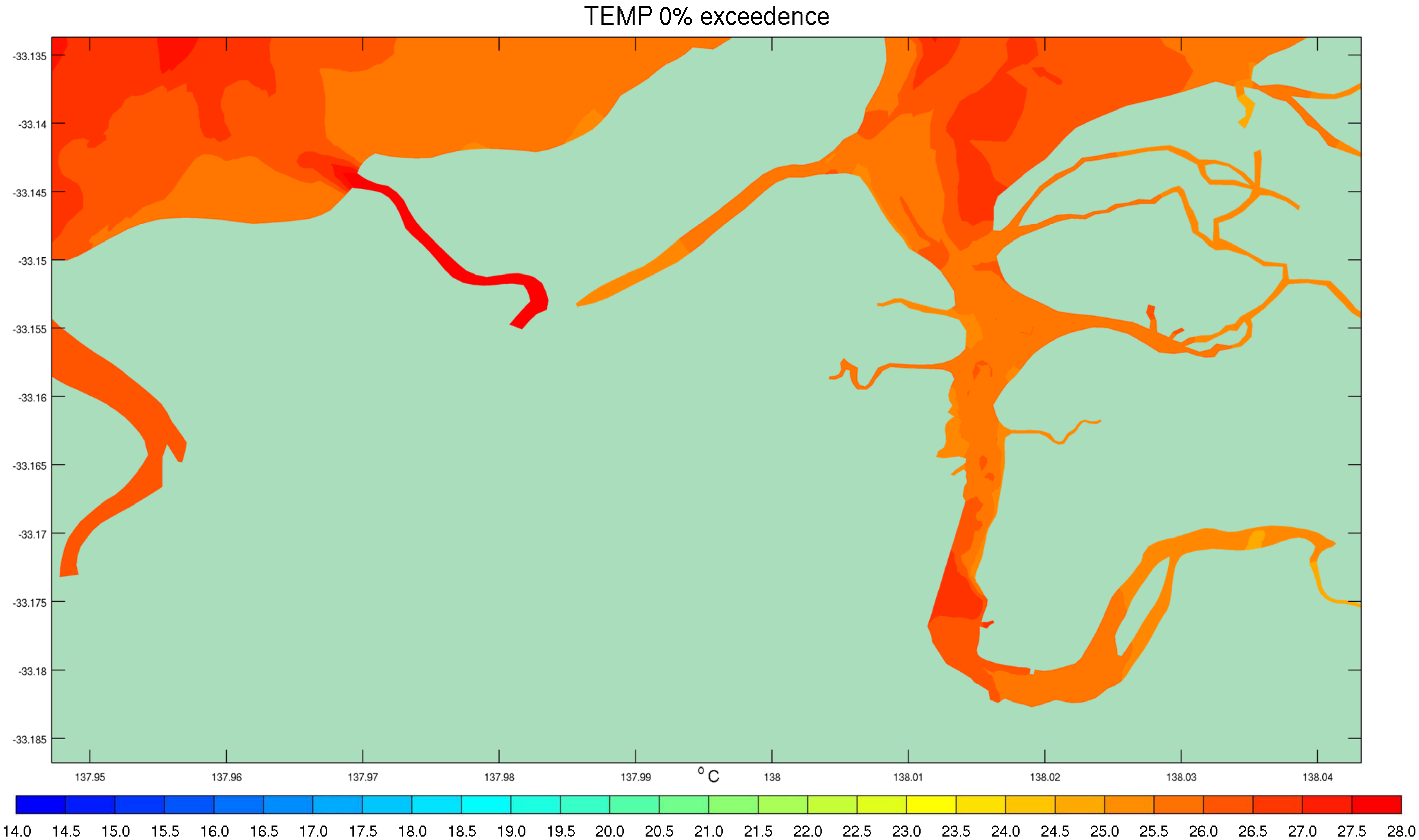

Figure A- 10 0th Percentile Temperature Exceedences – Existing Conditions January to March 2013

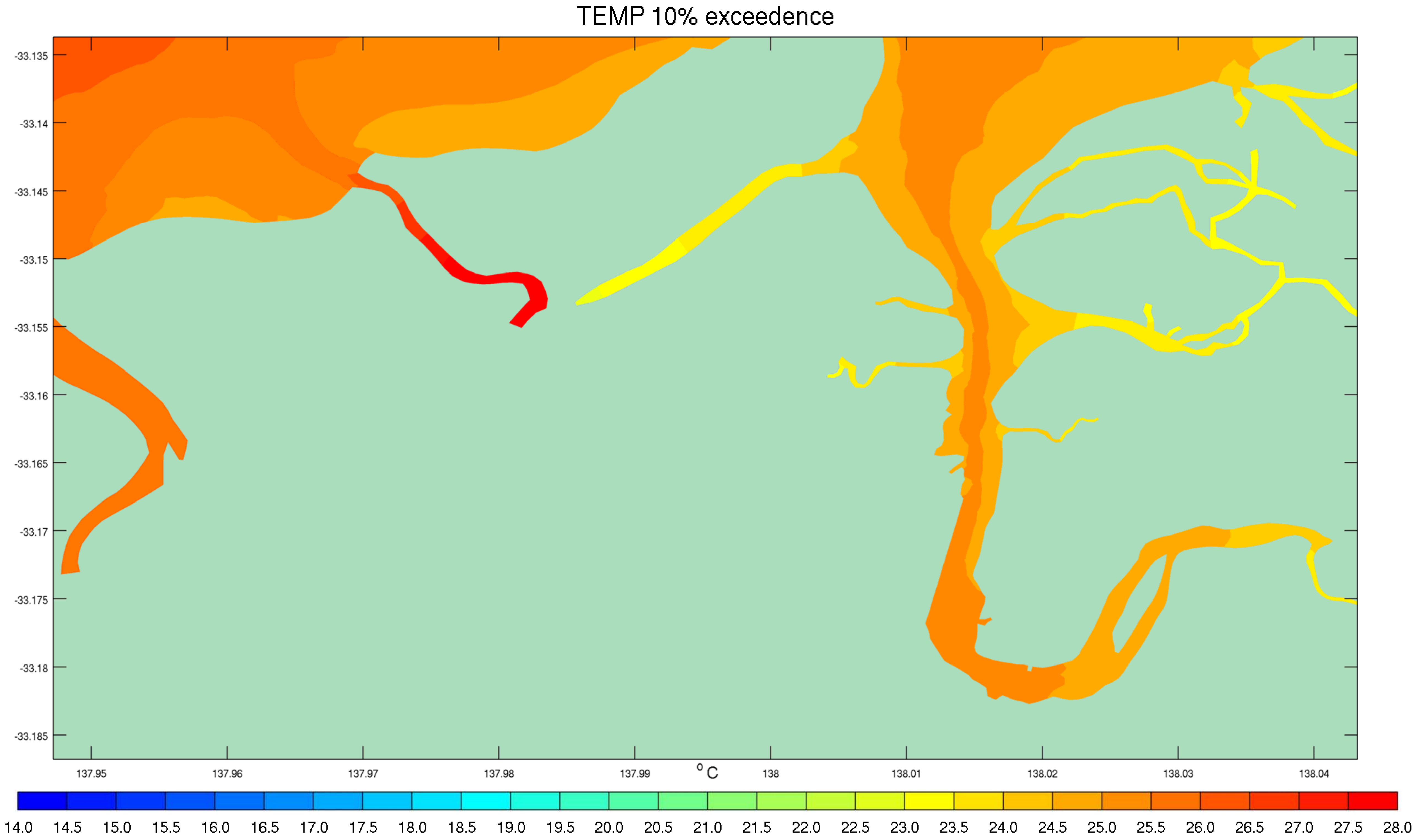

Figure A- 11 10th Percentile Temperature Exceedences – Existing Conditions January to March 2013

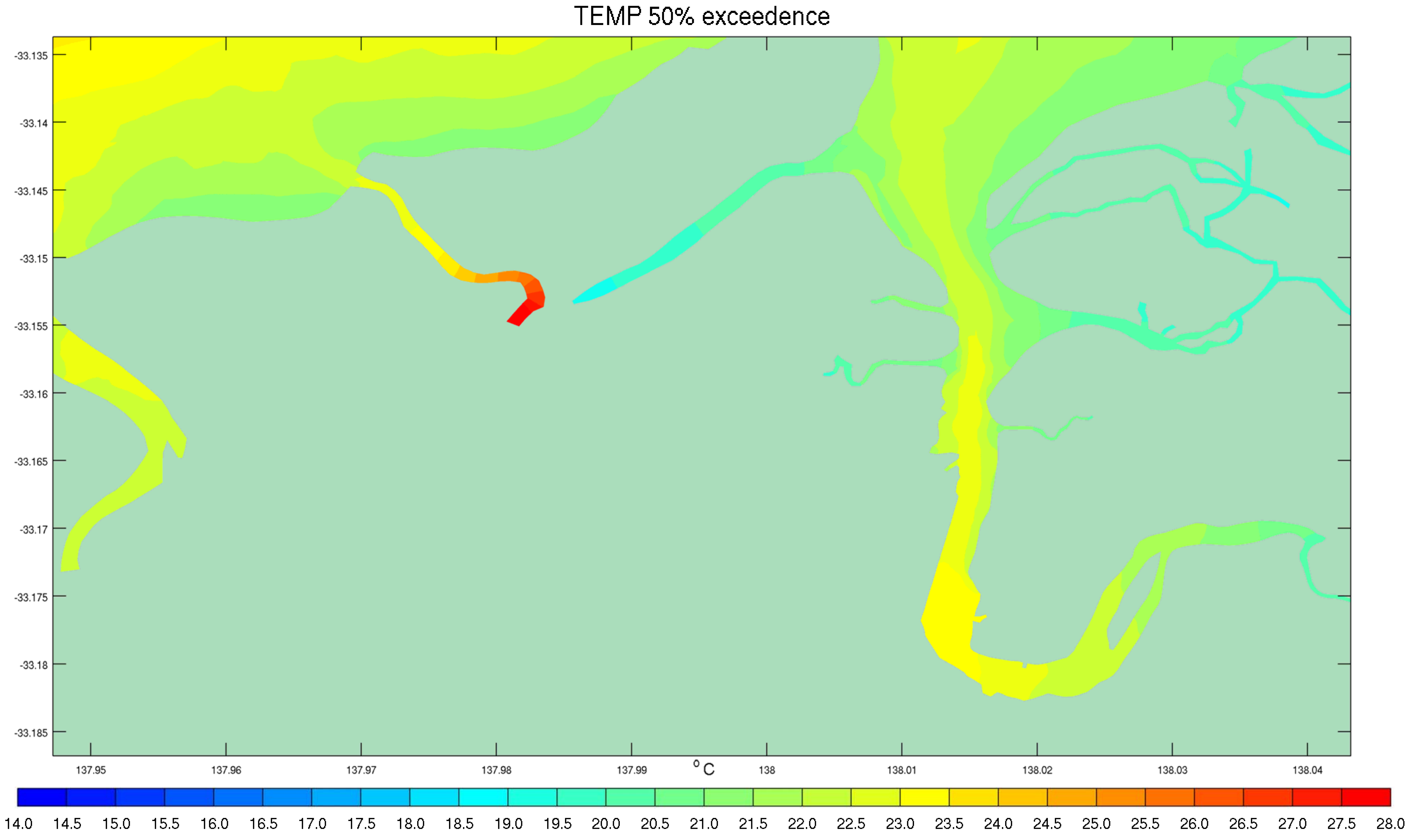

Figure A- 12 50th Percentile Temperature Exceedences – Existing Conditions January to March 2013

APPENDIX B: TEMPERATURE EXCEEDENCES FOR THE EXISTING BASELINE IN WINTER

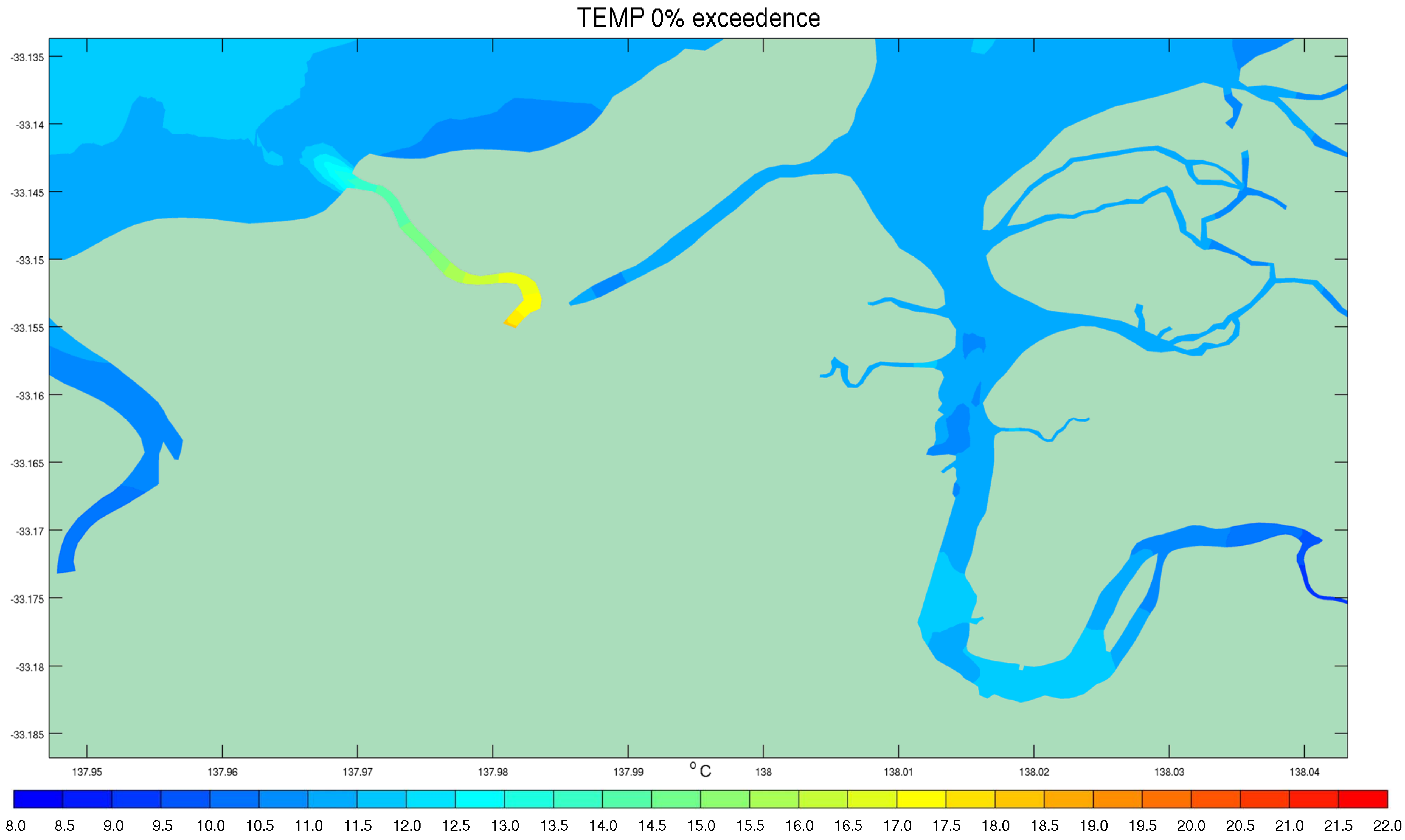

Figure B- 1 0th Percentile Temperature Exceedences – Existing Conditions July 2012

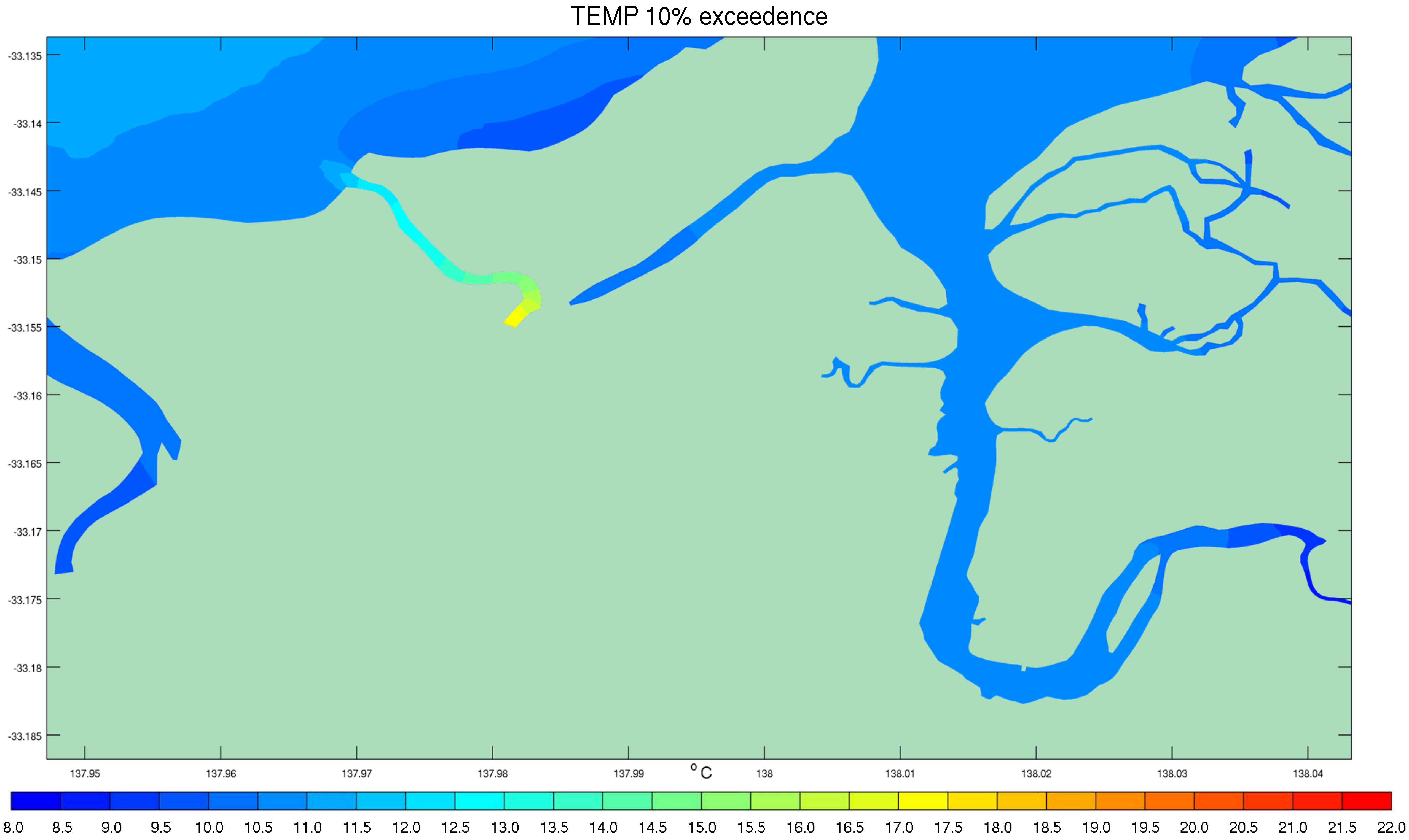

Figure B- 2 10th Percentile Temperature Exceedences – Existing Conditions July 2012

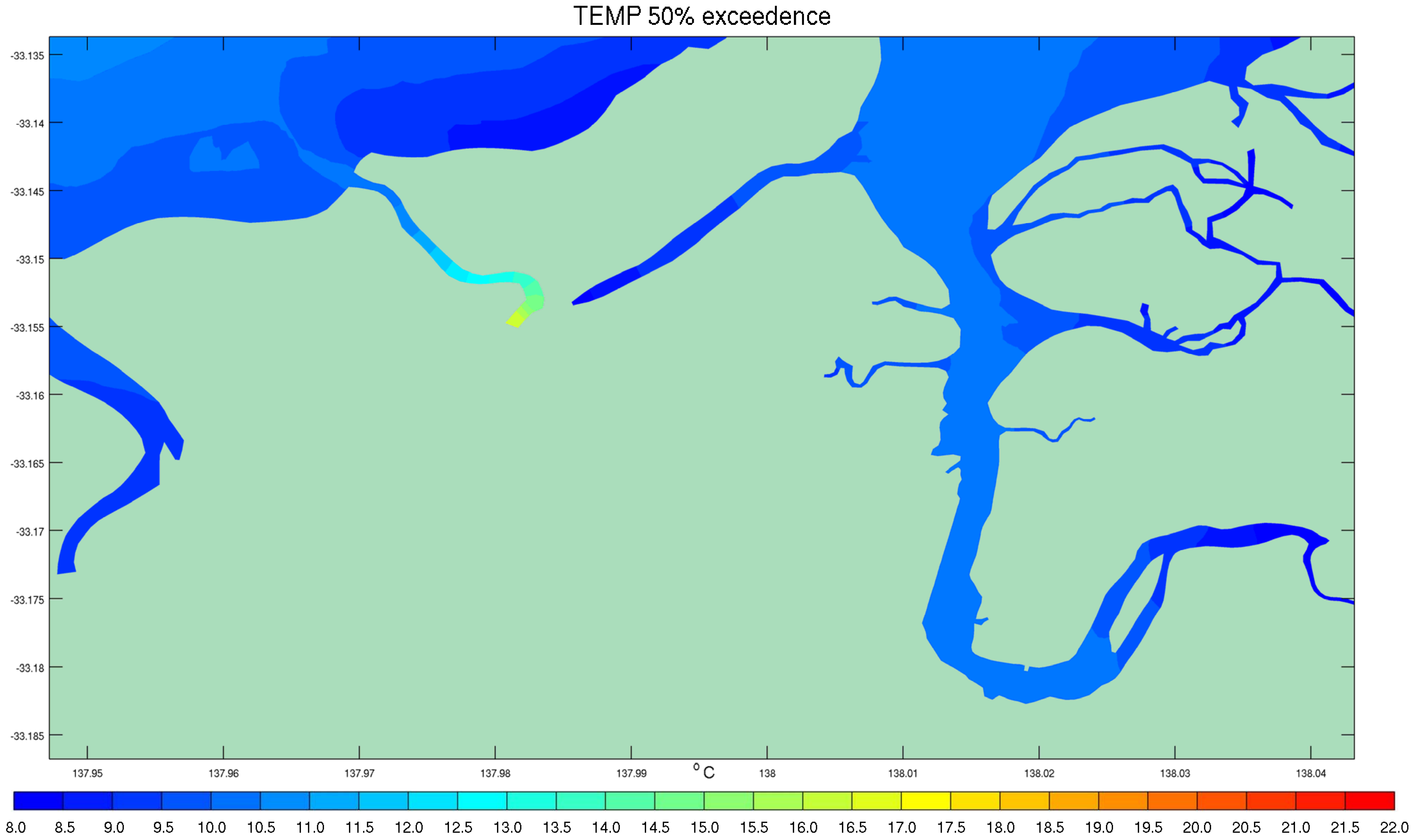

Figure B- 3 50th Percentile Temperature Exceedences – Existing Conditions July 2012

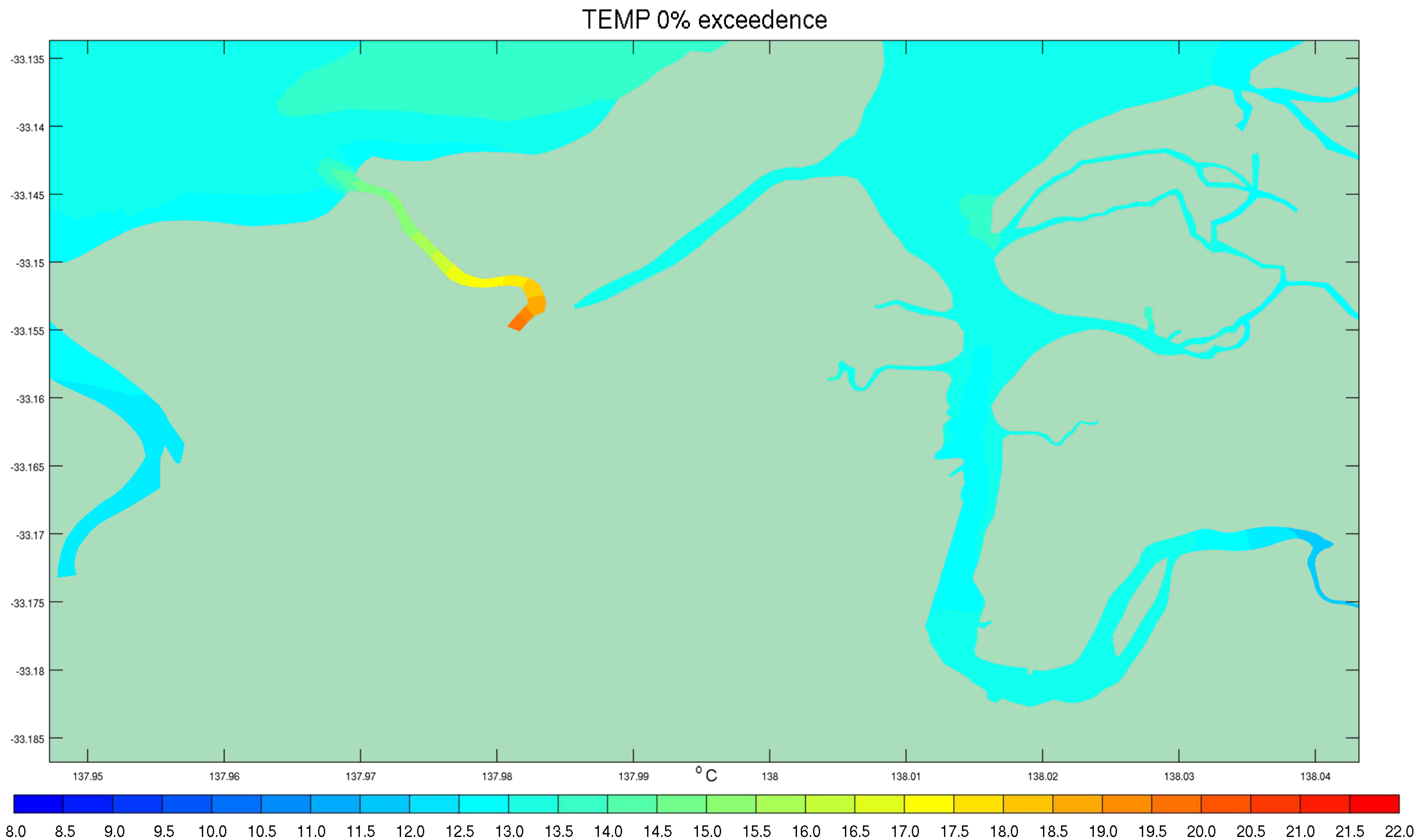

Figure B- 4 0th Percentile Temperature Exceedences – Existing Conditions August 2012

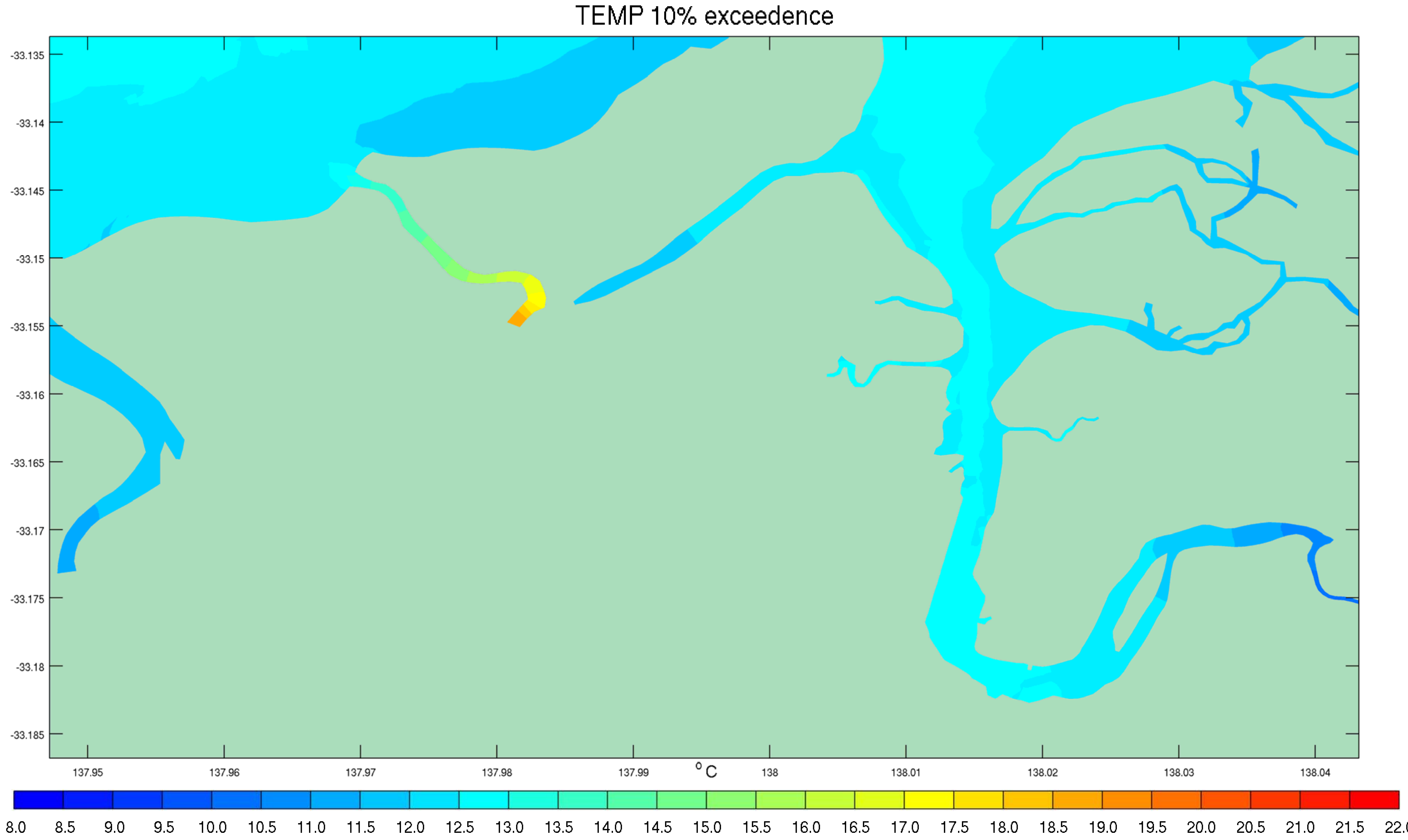

Figure B- 5 10th Percentile Temperature Exceedences – Existing Conditions August 2012

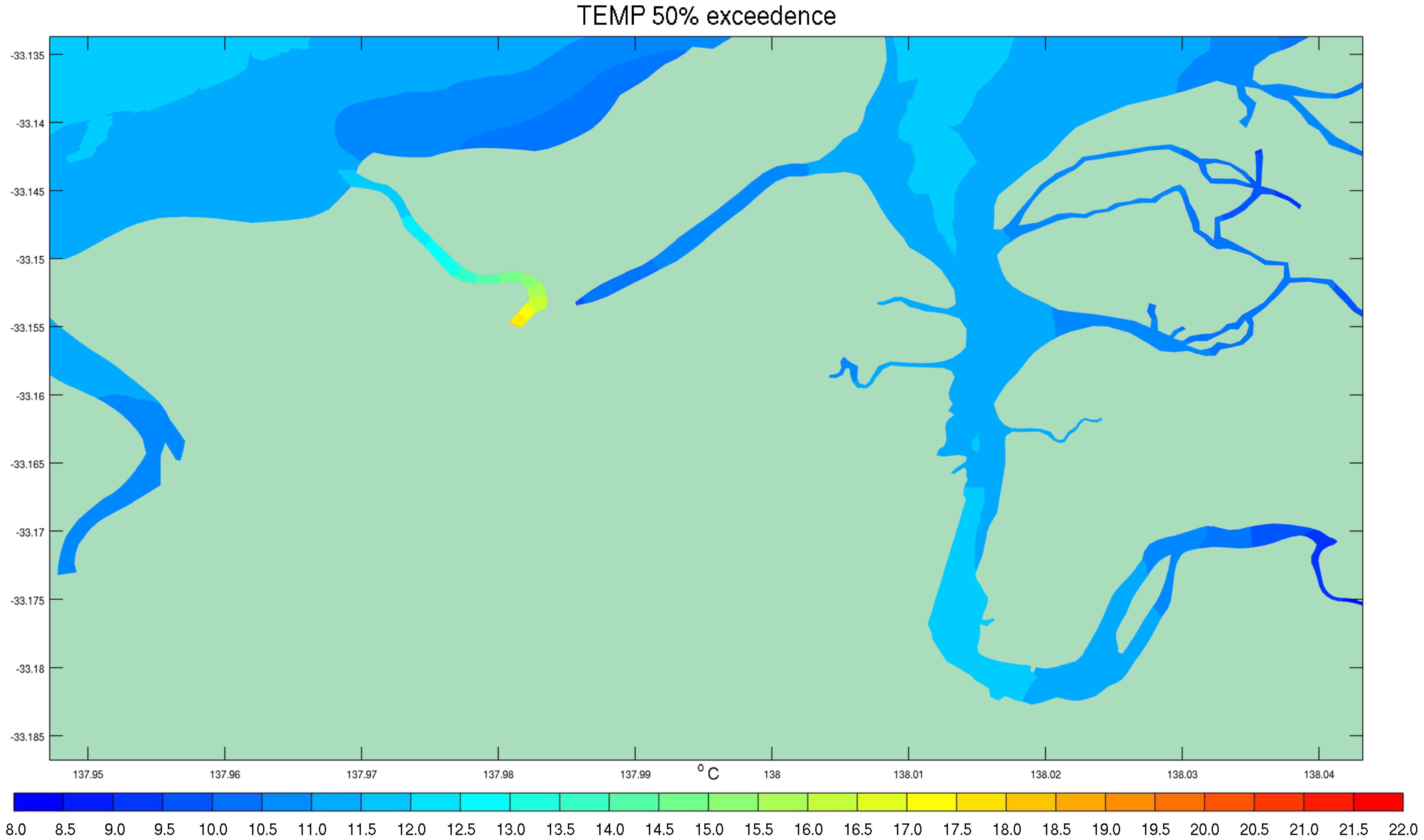

Figure B- 6 50th Percentile Temperature Exceedences – Existing Conditions August 2012

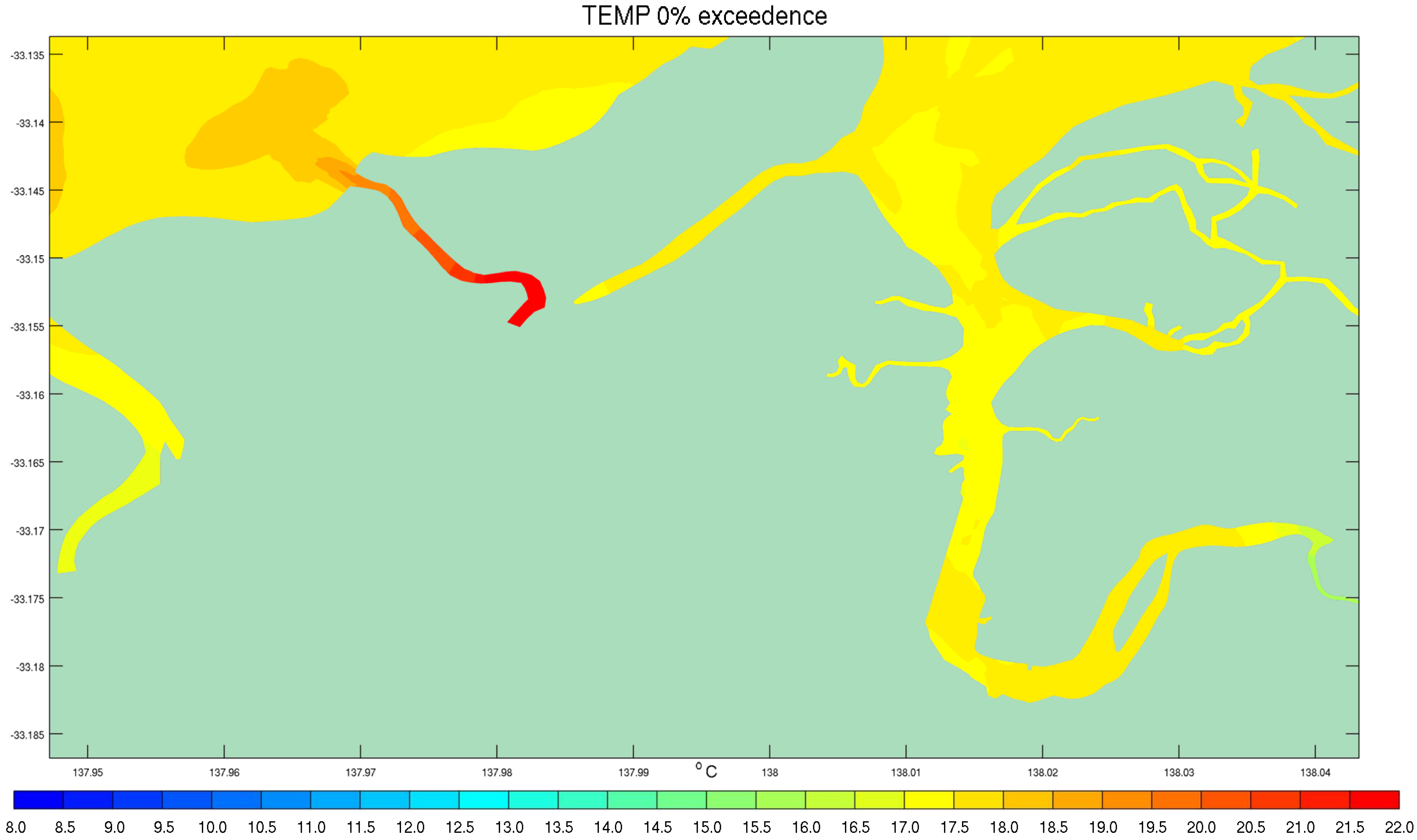

Figure B- 7 0th Percentile Temperature Exceedences – Existing Conditions September 2012

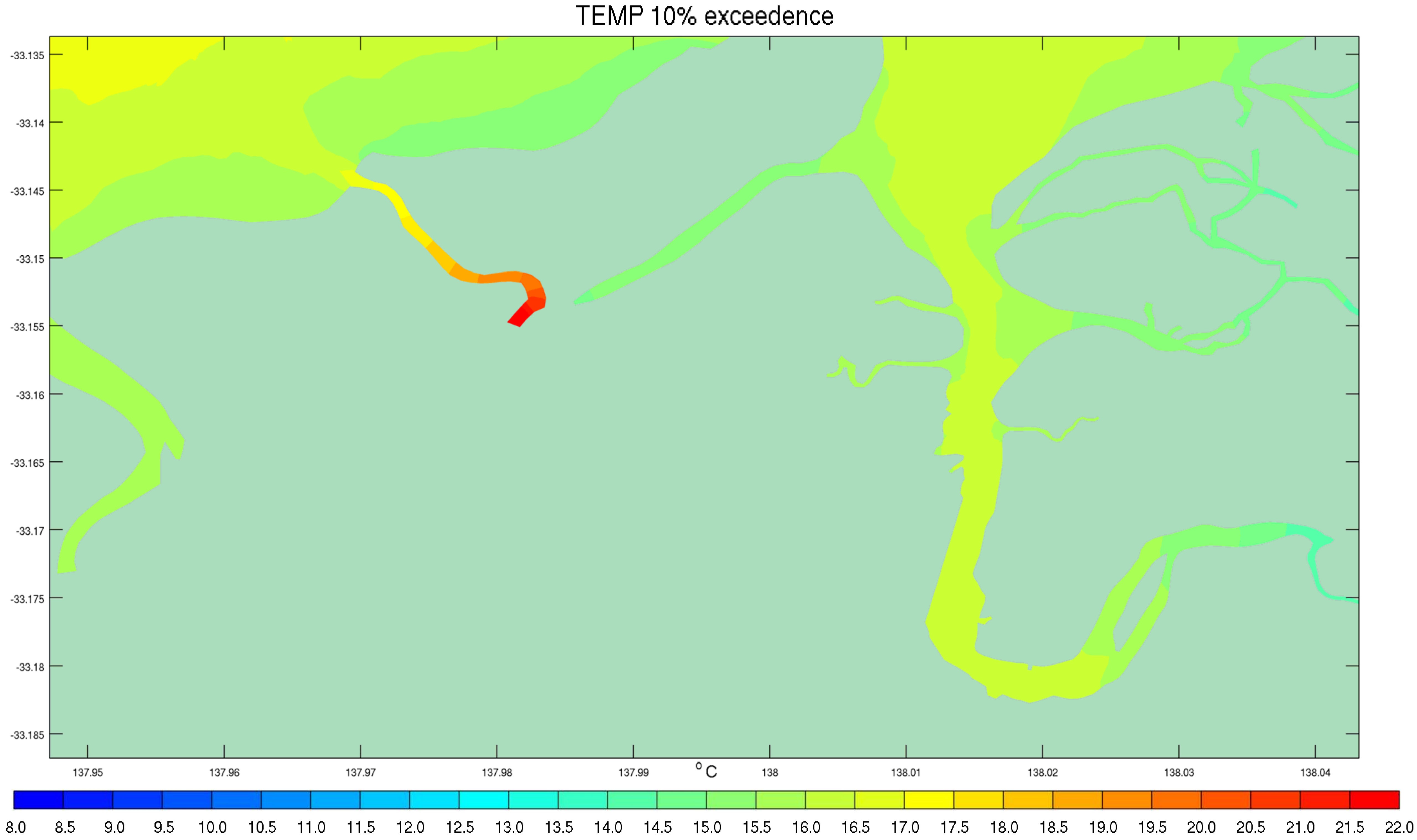

Figure B- 8 10th Percentile Temperature Exceedences – Existing Conditions September 2012

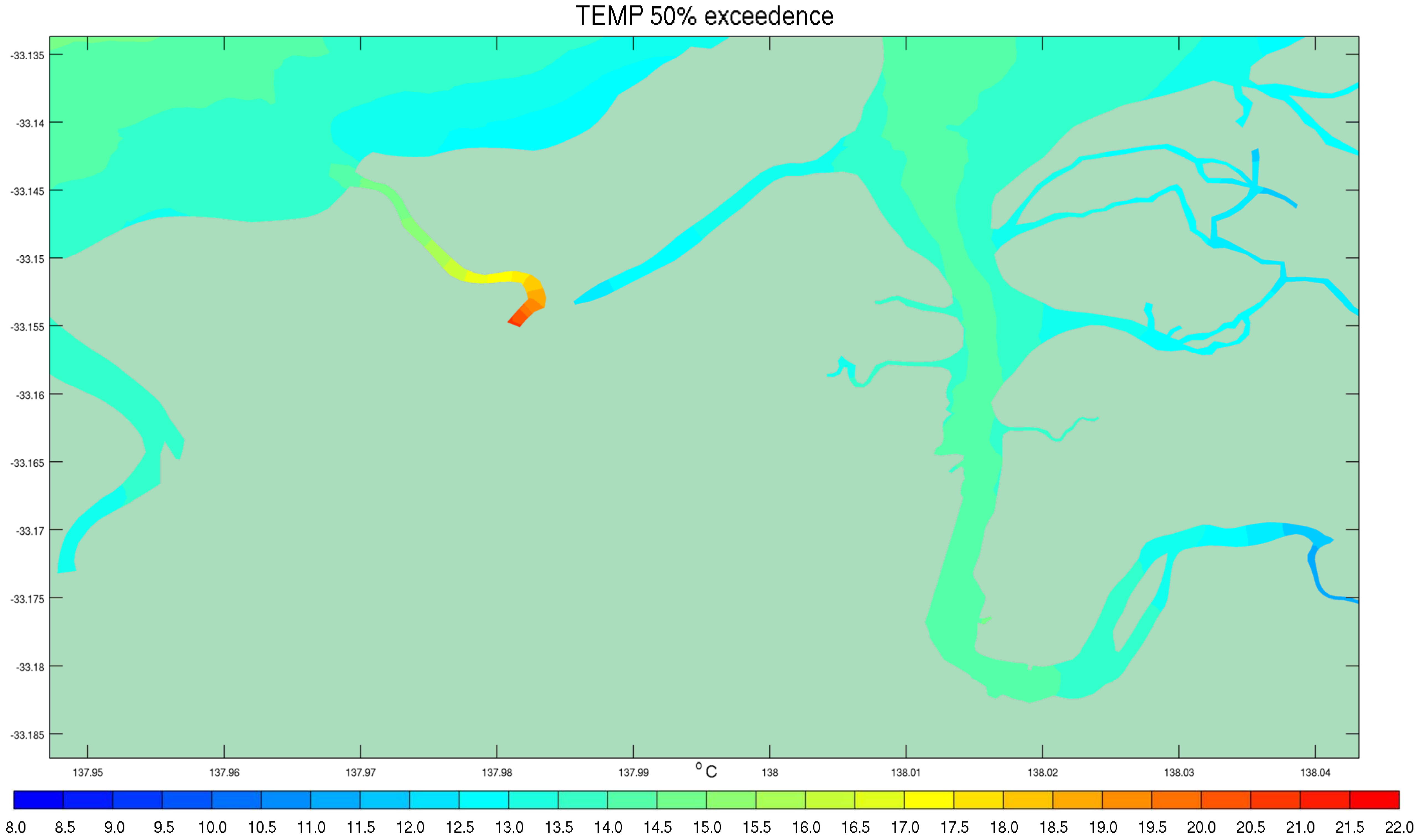

Figure B- 9 50th Percentile Temperature Exceedences – Existing Conditions September 2012

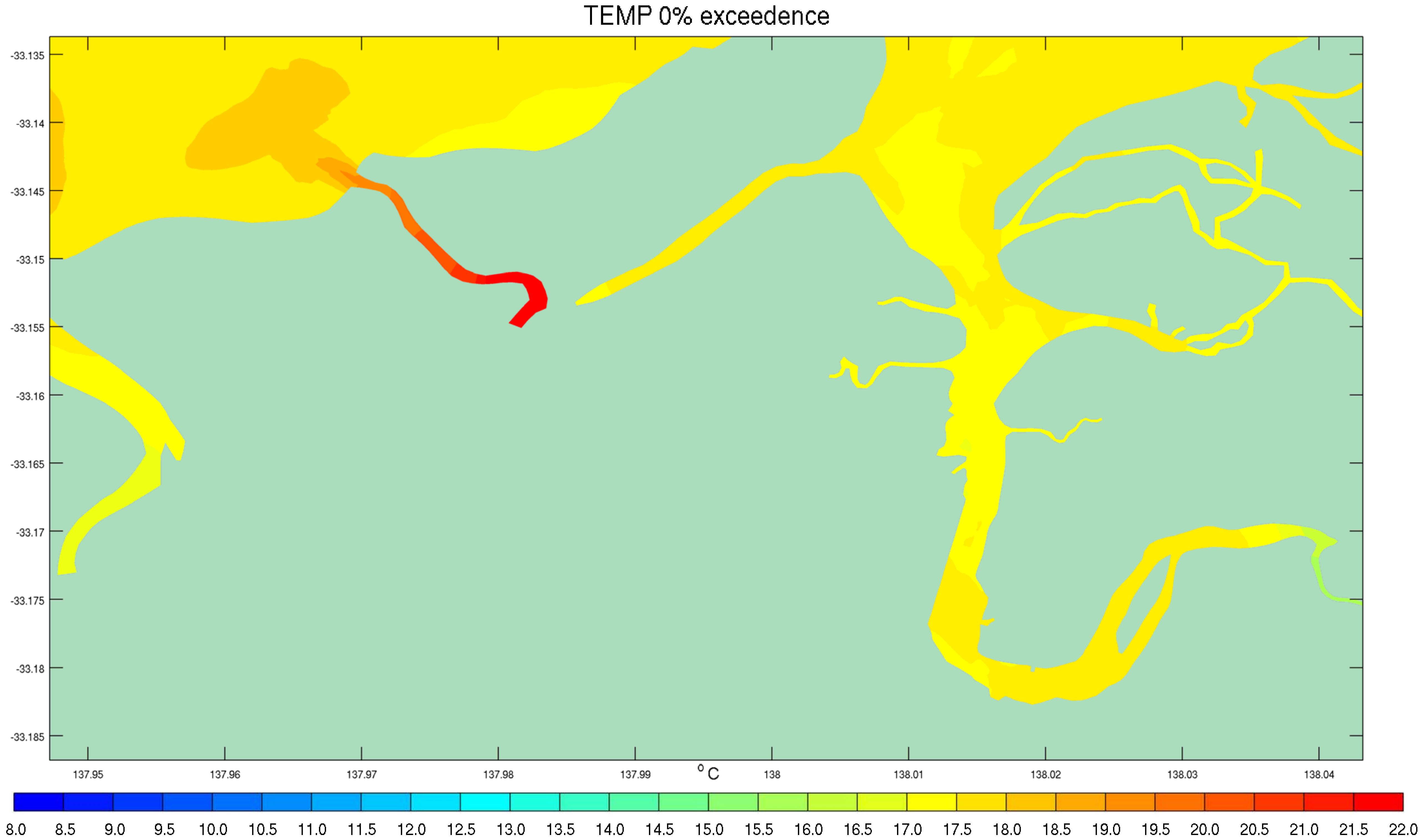

Figure B- 10 0th Percentile Temperature Exceedences – Existing Conditions July to September 2012

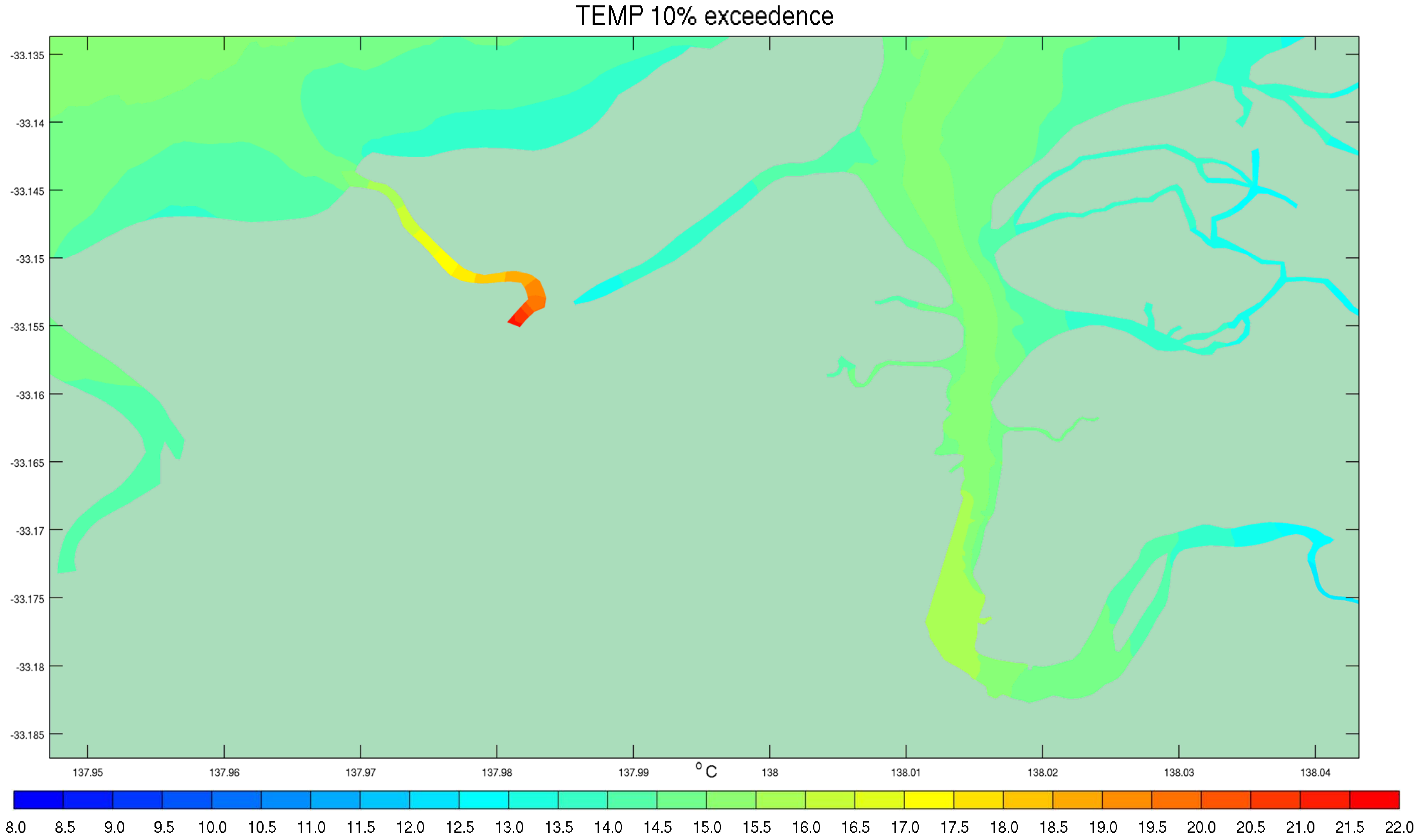

Figure B- 11 10th Percentile Temperature Exceedences – Existing Conditions July to September 2012

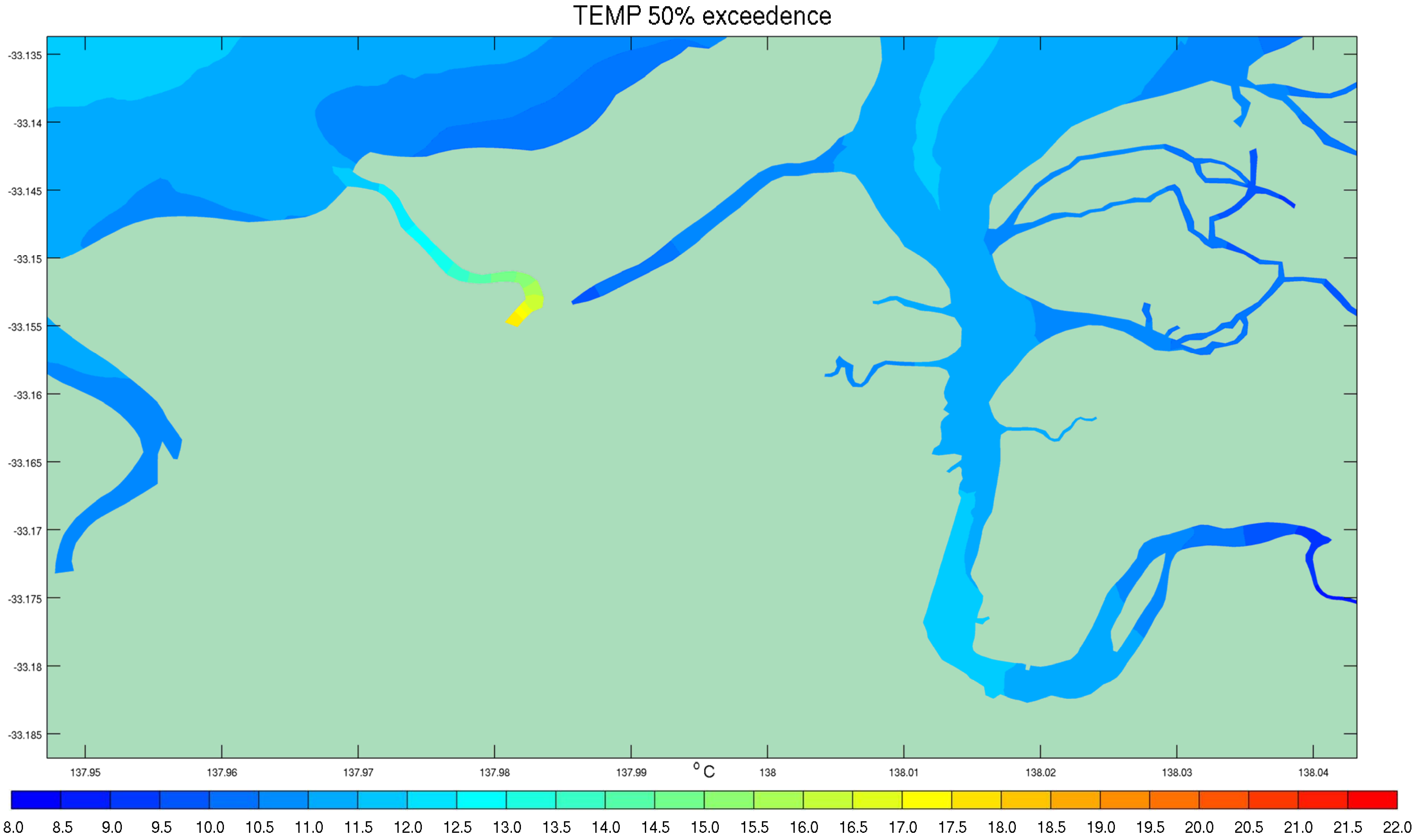

Figure B- 12 50th Percentile Temperature Exceedences – Existing Conditions July to September 2012

APPENDIX C: TEMPERATURE EXCEEDENCES FOR THE DISCHARGE SCENARIO IN SUMMER

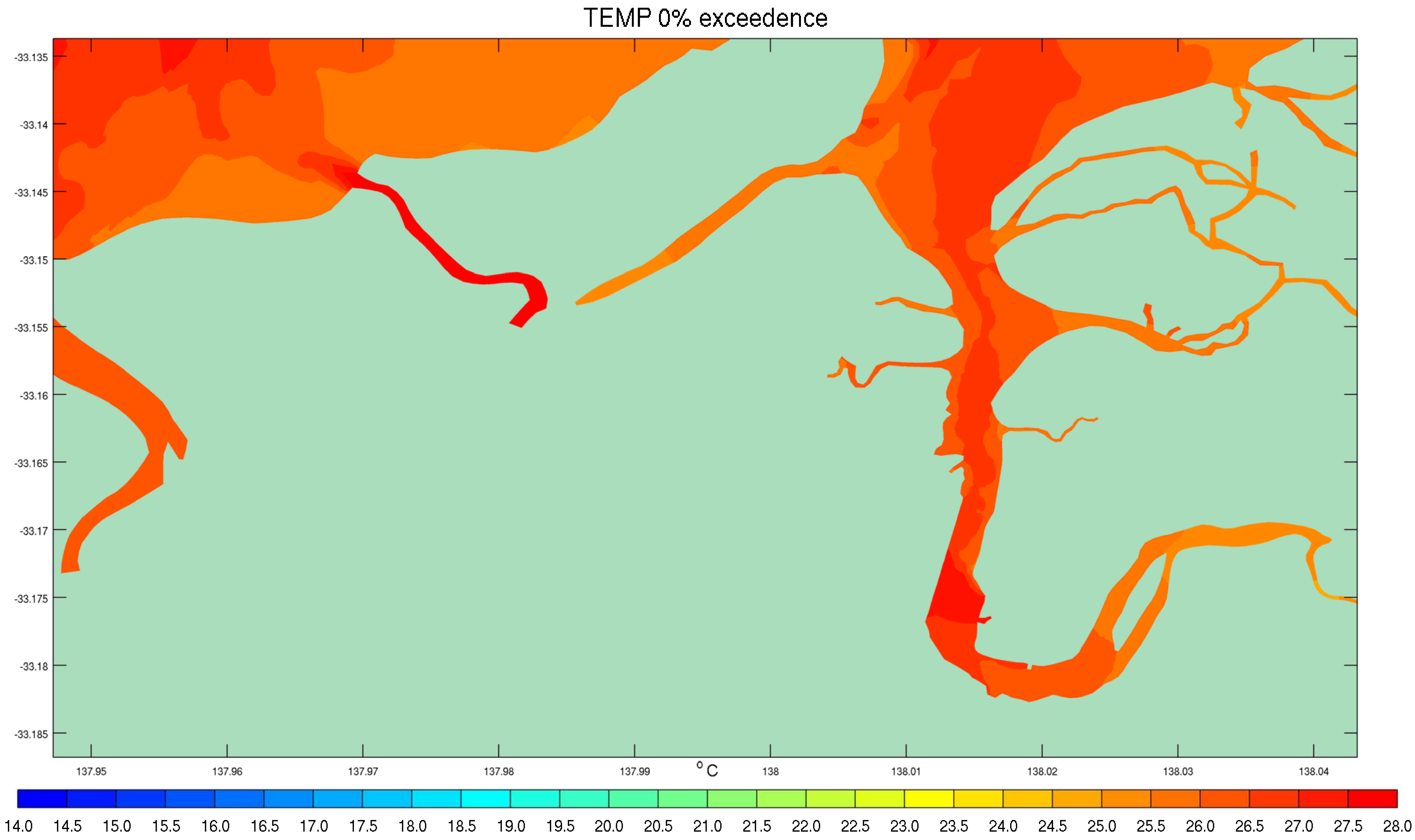

Figure C-1 0th Percentile Temperature Exceedences – Discharge Scenario Conditions January 2013

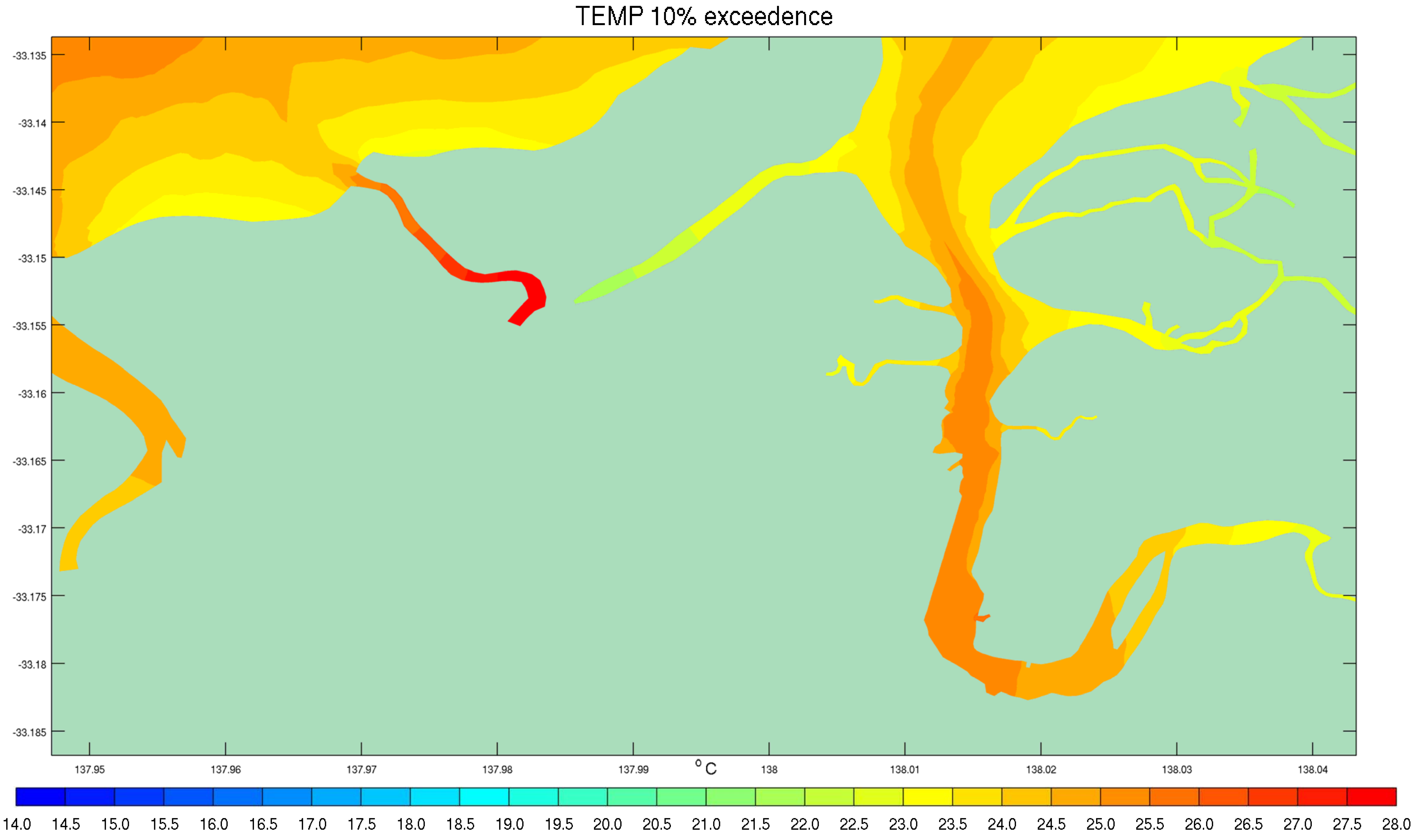

Figure C-2 10th Percentile Temperature Exceedences – Discharge Scenario Conditions January 2013

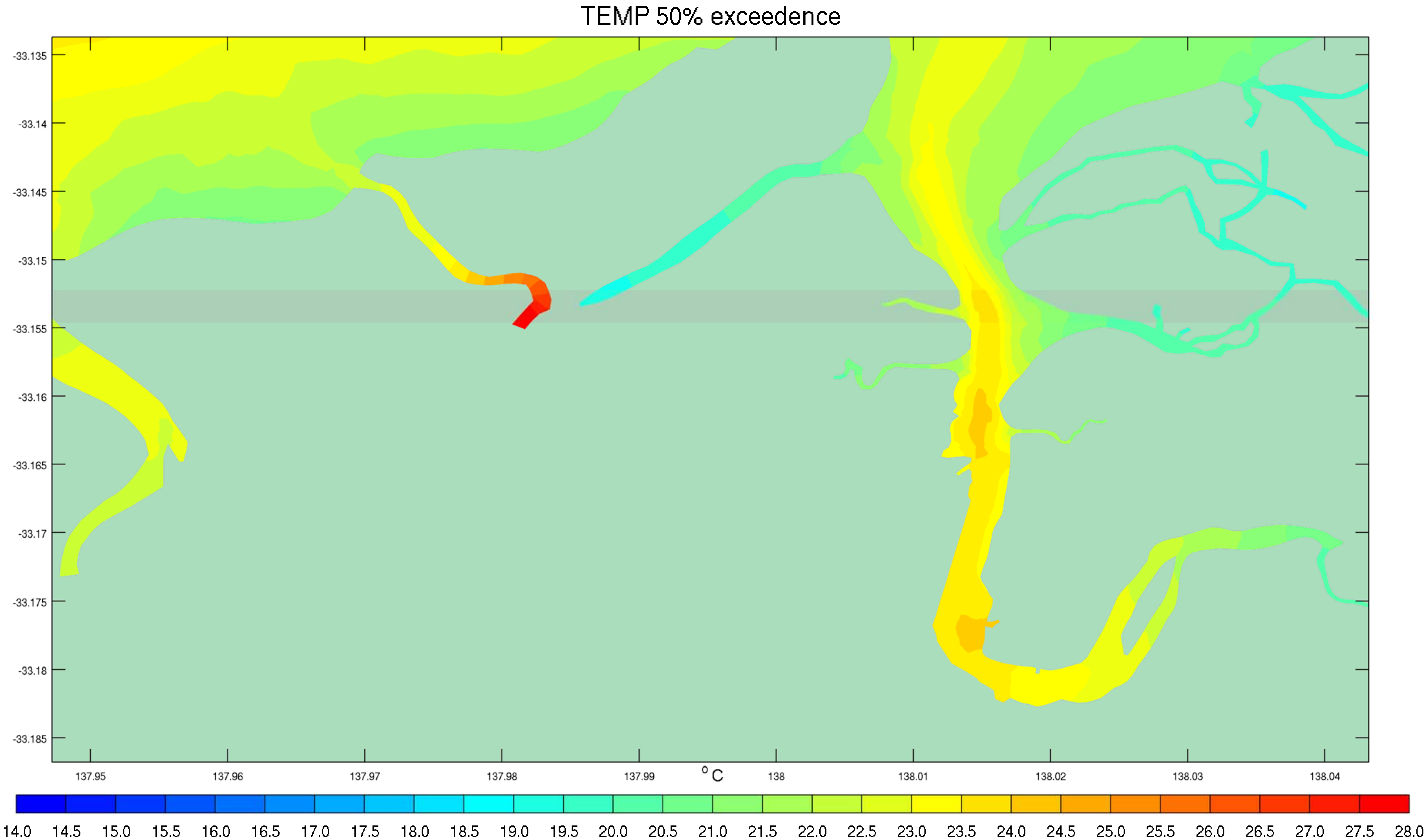

Figure C-3 50th Percentile Temperature Exceedences – Discharge Scenario Conditions January 2013

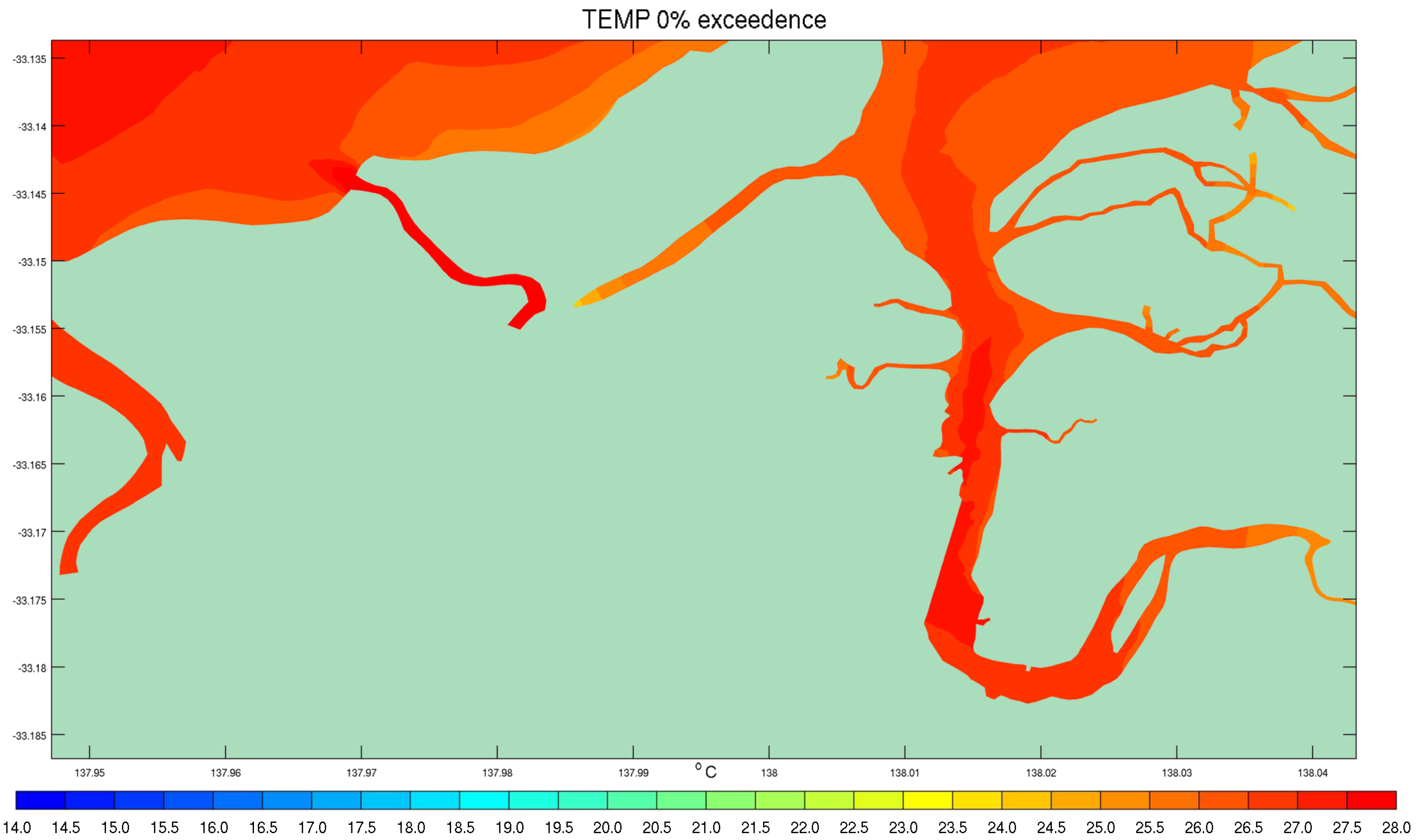

Figure C-4 0th Percentile Temperature Exceedences – Discharge Scenario Conditions February 2013

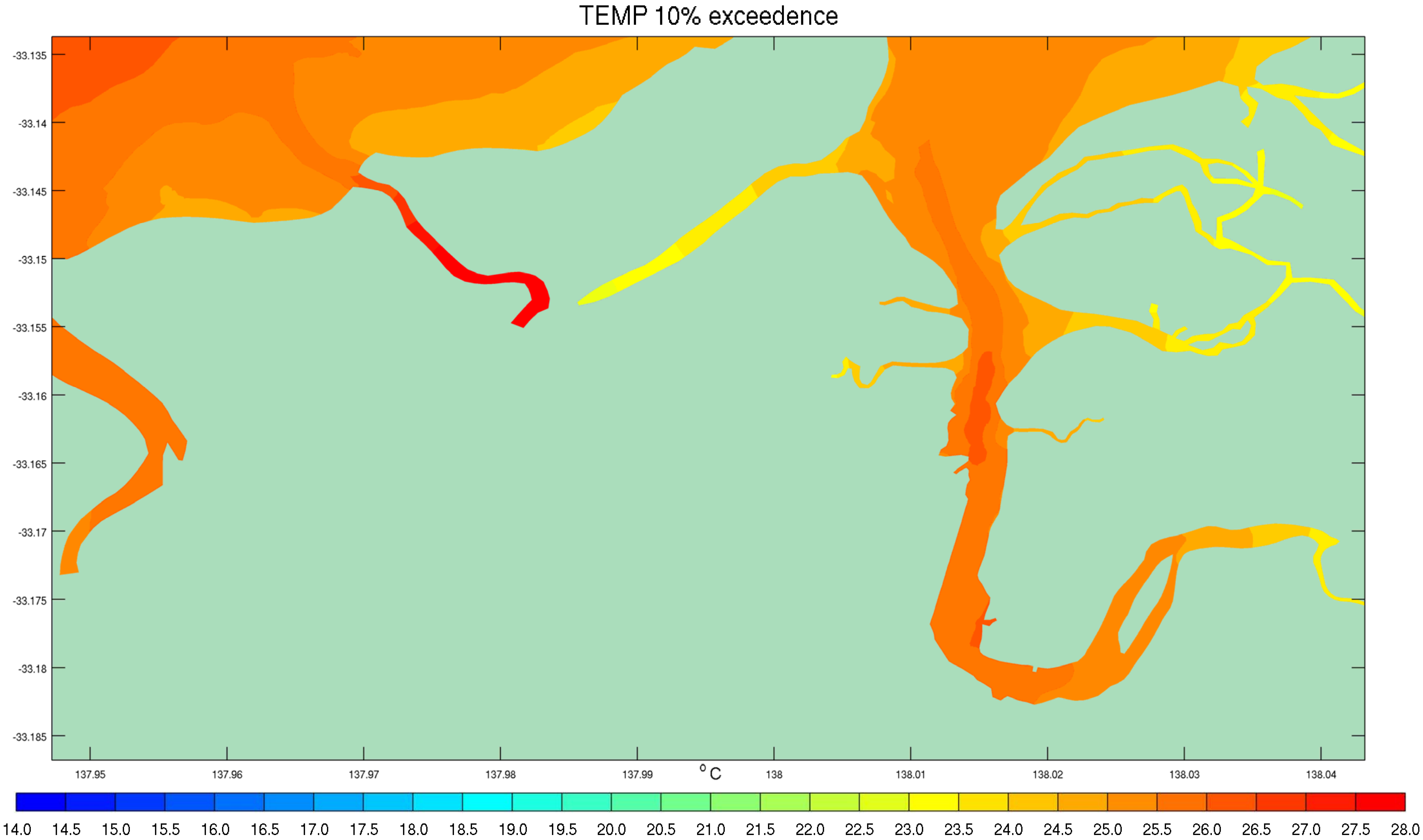

Figure C-5 10th Percentile Temperature Exceedences – Discharge Scenario Conditions February 2013

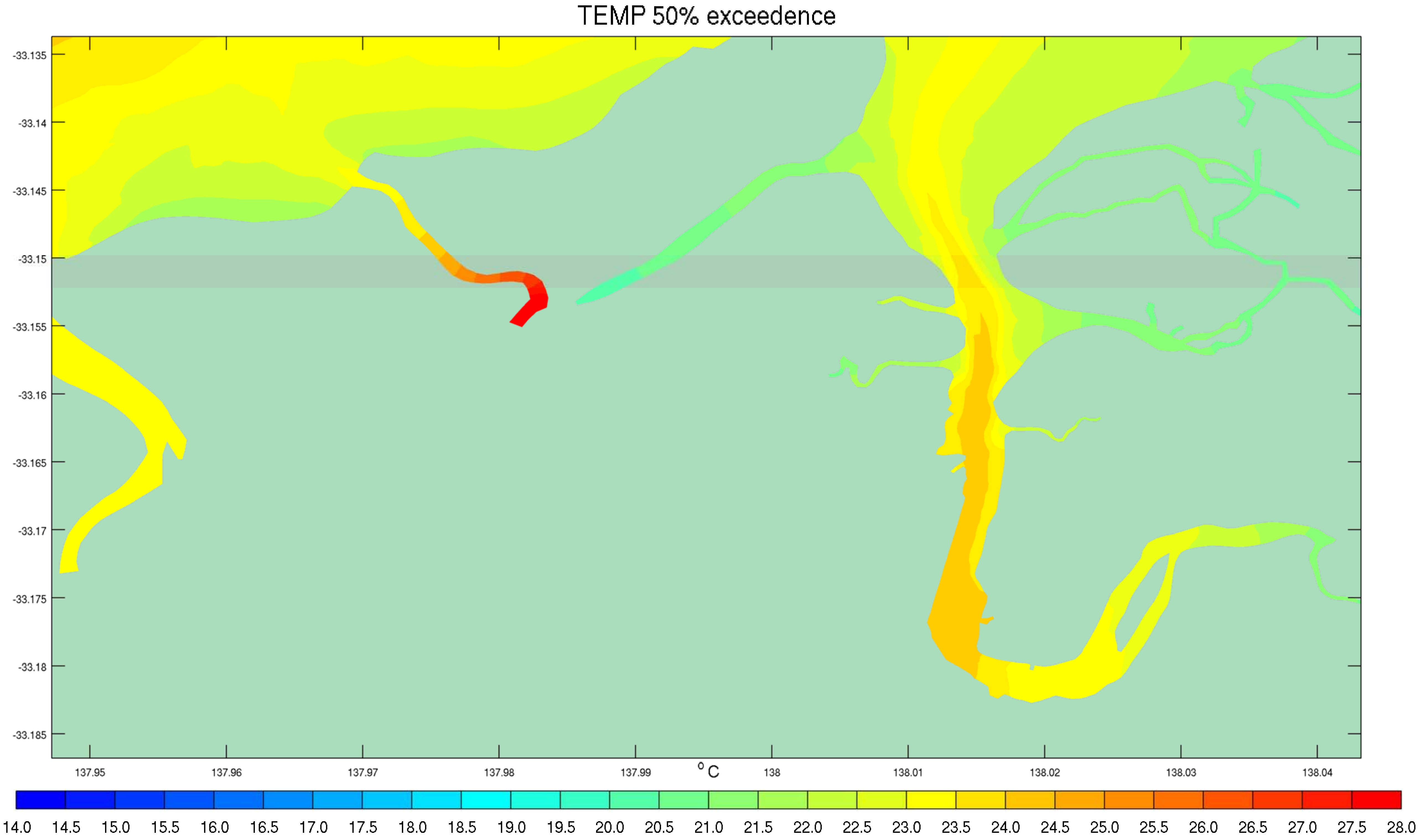

Figure C-6 50th Percentile Temperature Exceedences – Discharge Scenario Conditions February 2013

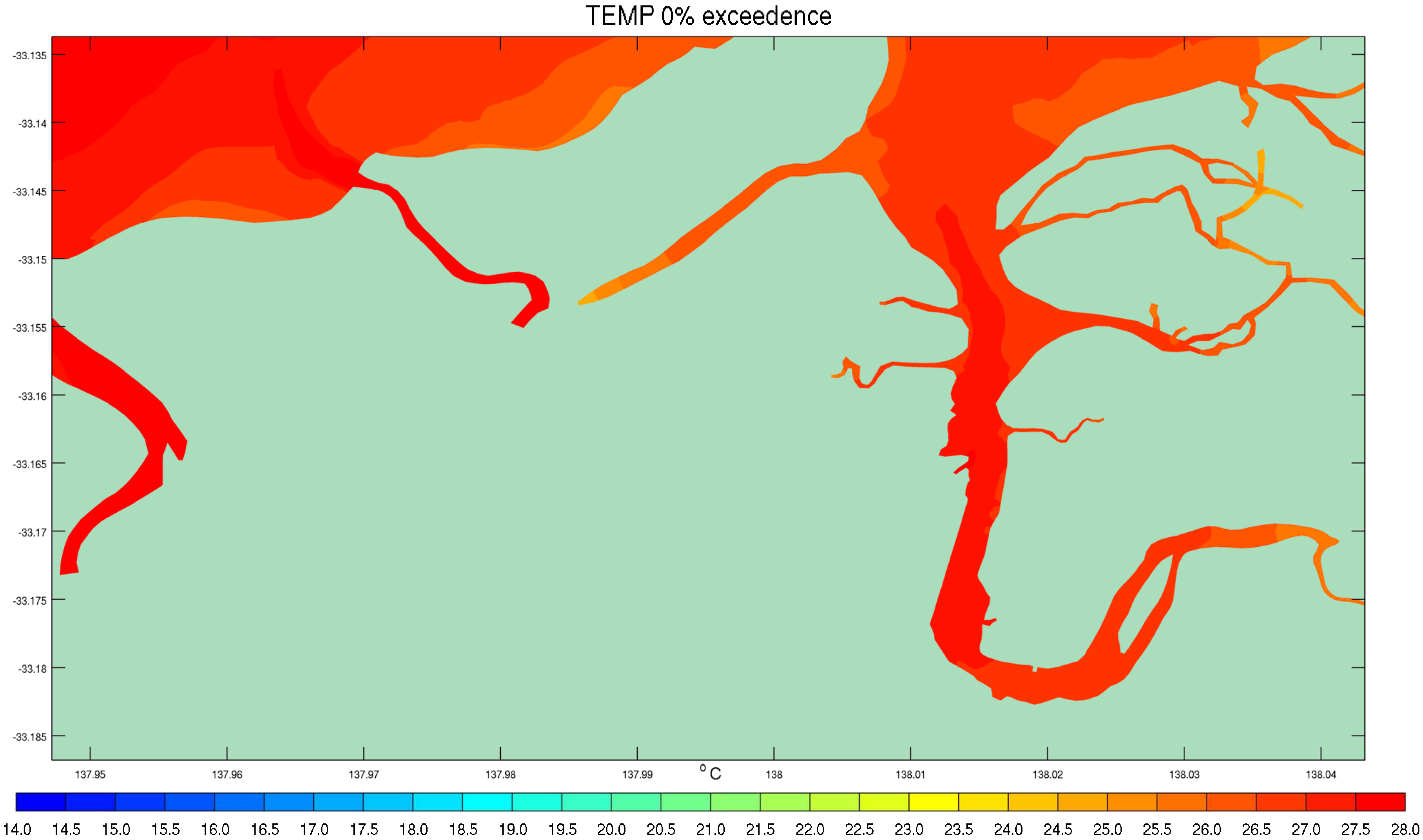

Figure C-7 0th Percentile Temperature Exceedences – Discharge Scenario Conditions March 2013

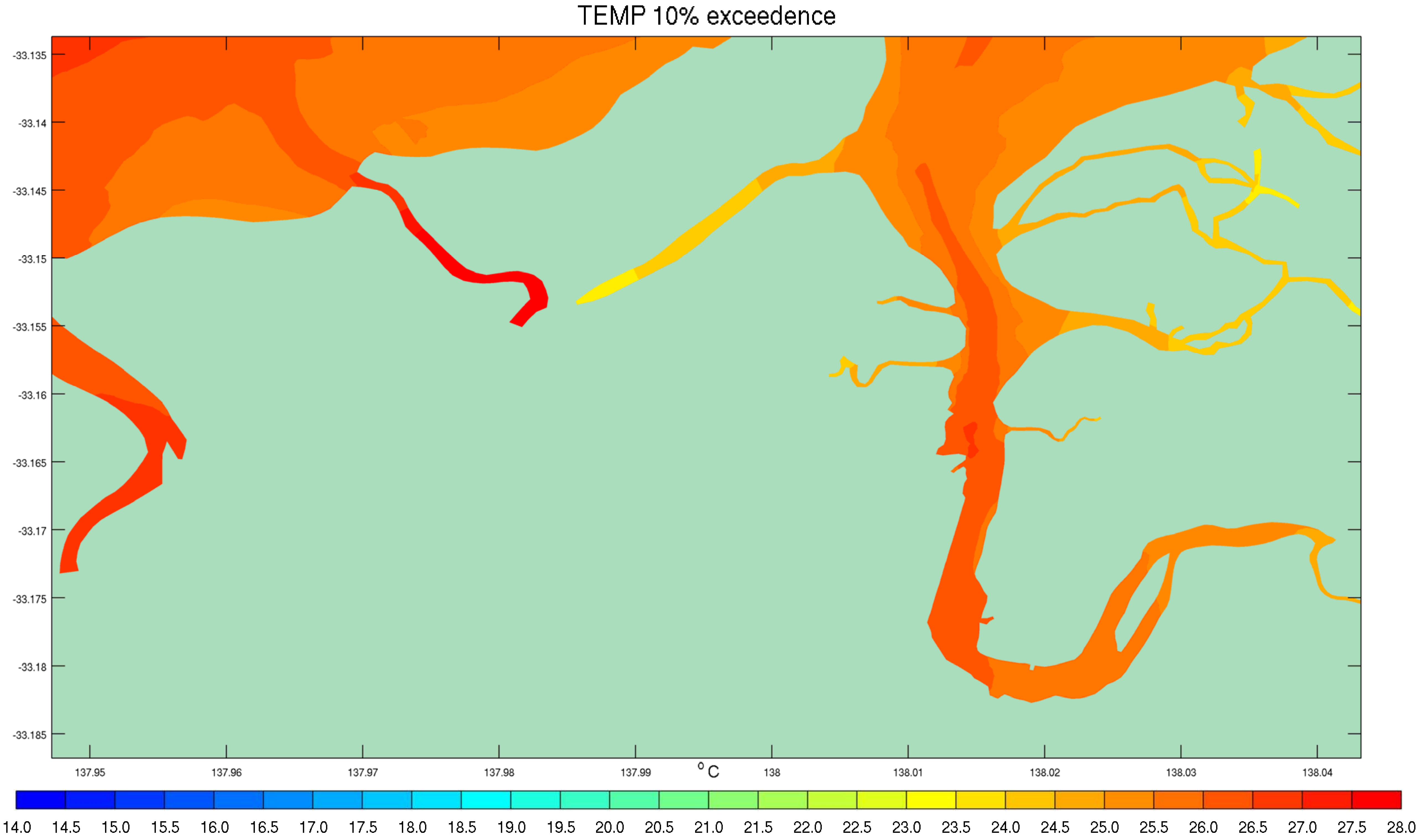

Figure C-8 10th Percentile Temperature Exceedences – Discharge Scenario Conditions March 2013

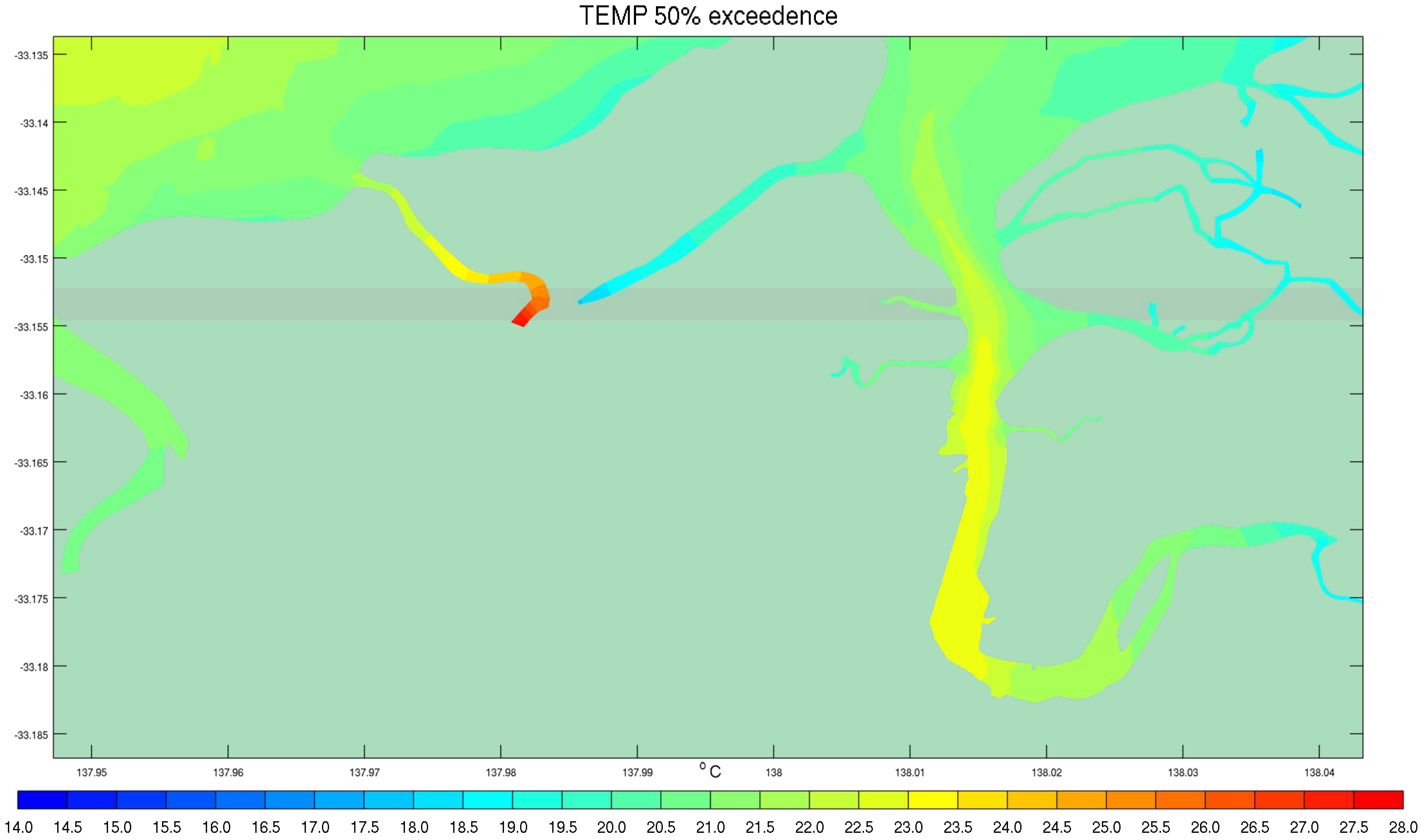

Figure C-9 50th Percentile Temperature Exceedences – Discharge Scenario Conditions March 2013

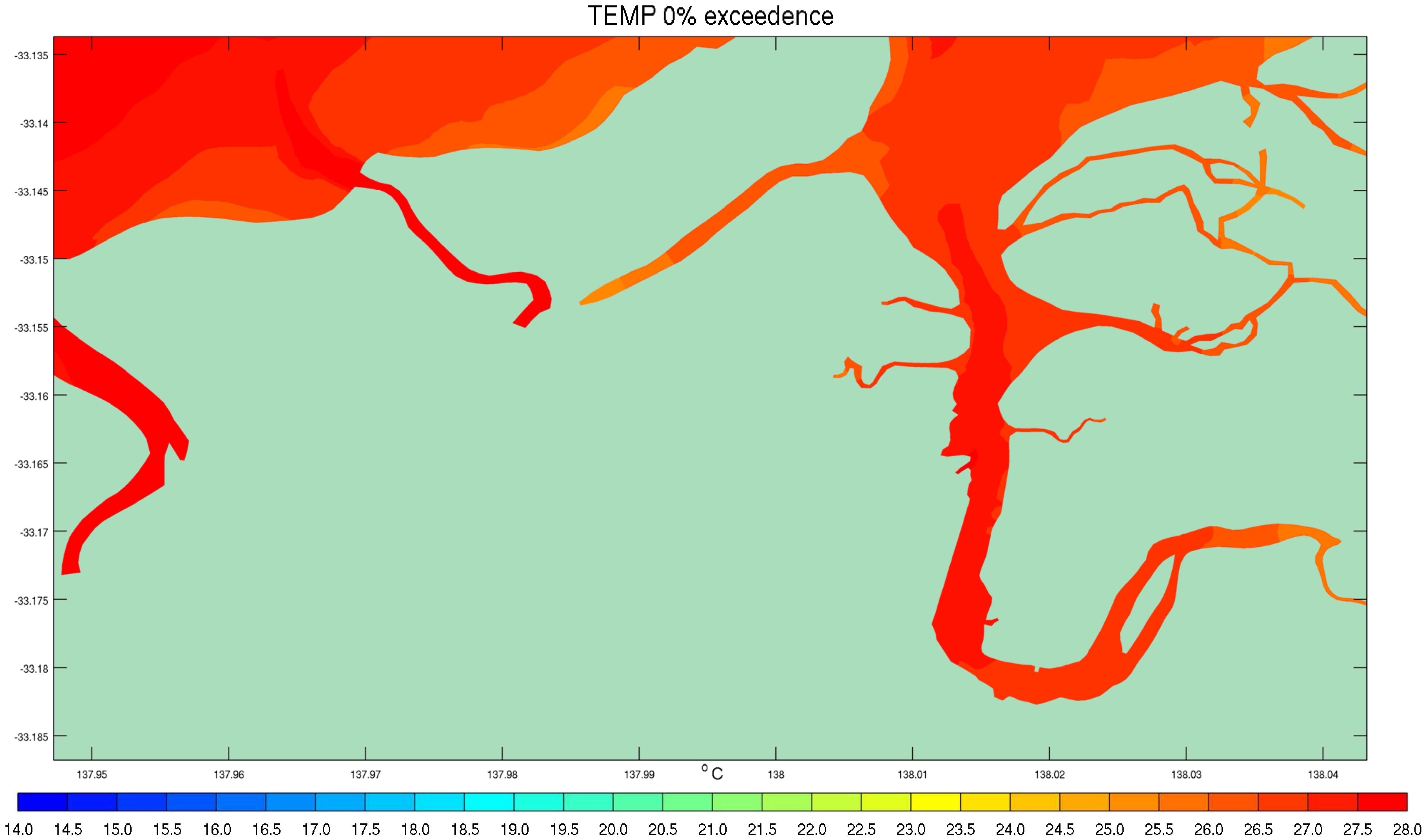

Figure C-10 0th Percentile Temperature Exceedences – Discharge Scenario Conditions January to March 2013

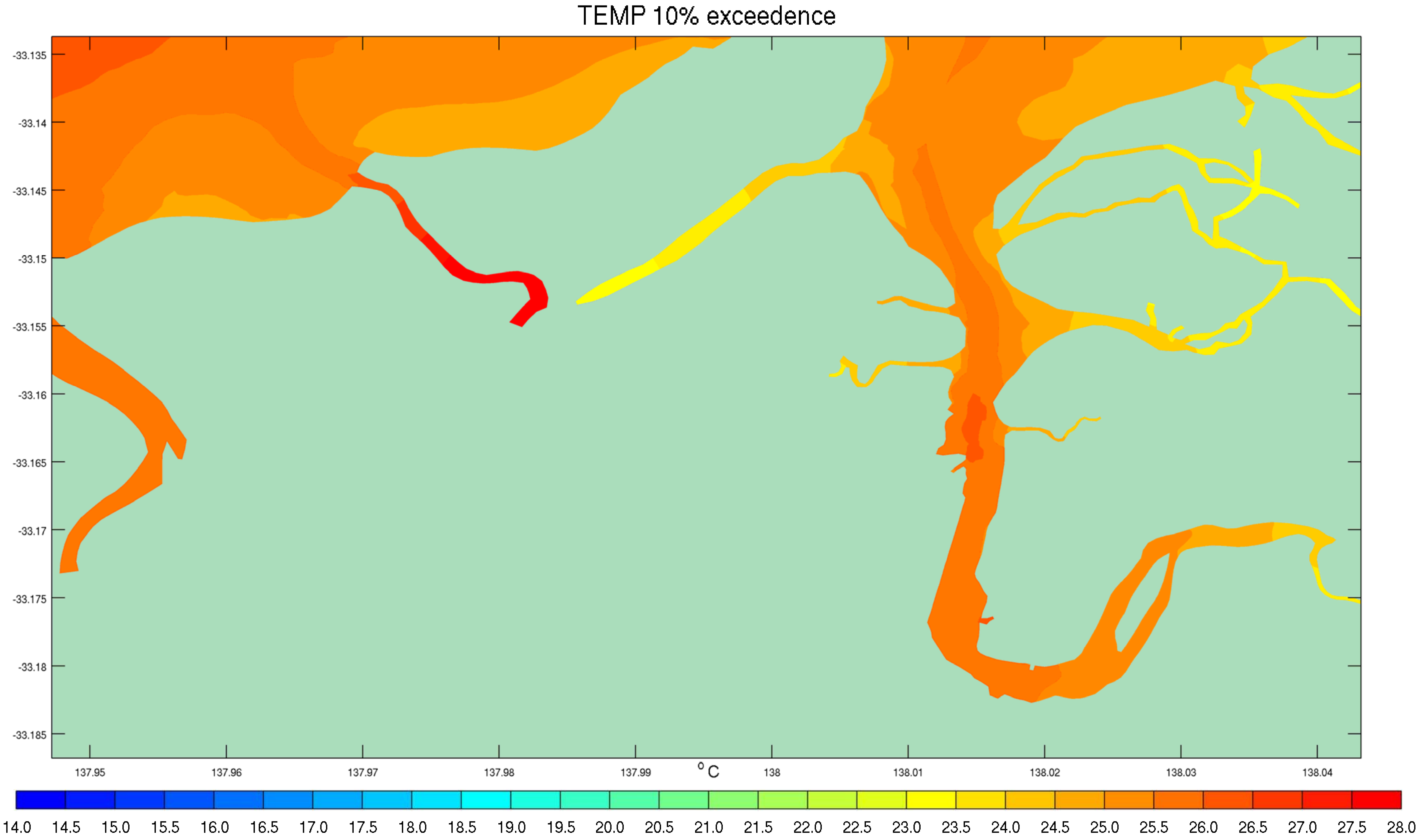

Figure C-11 10th Percentile Temperature Exceedences – Discharge Scenario Conditions January to March 2013

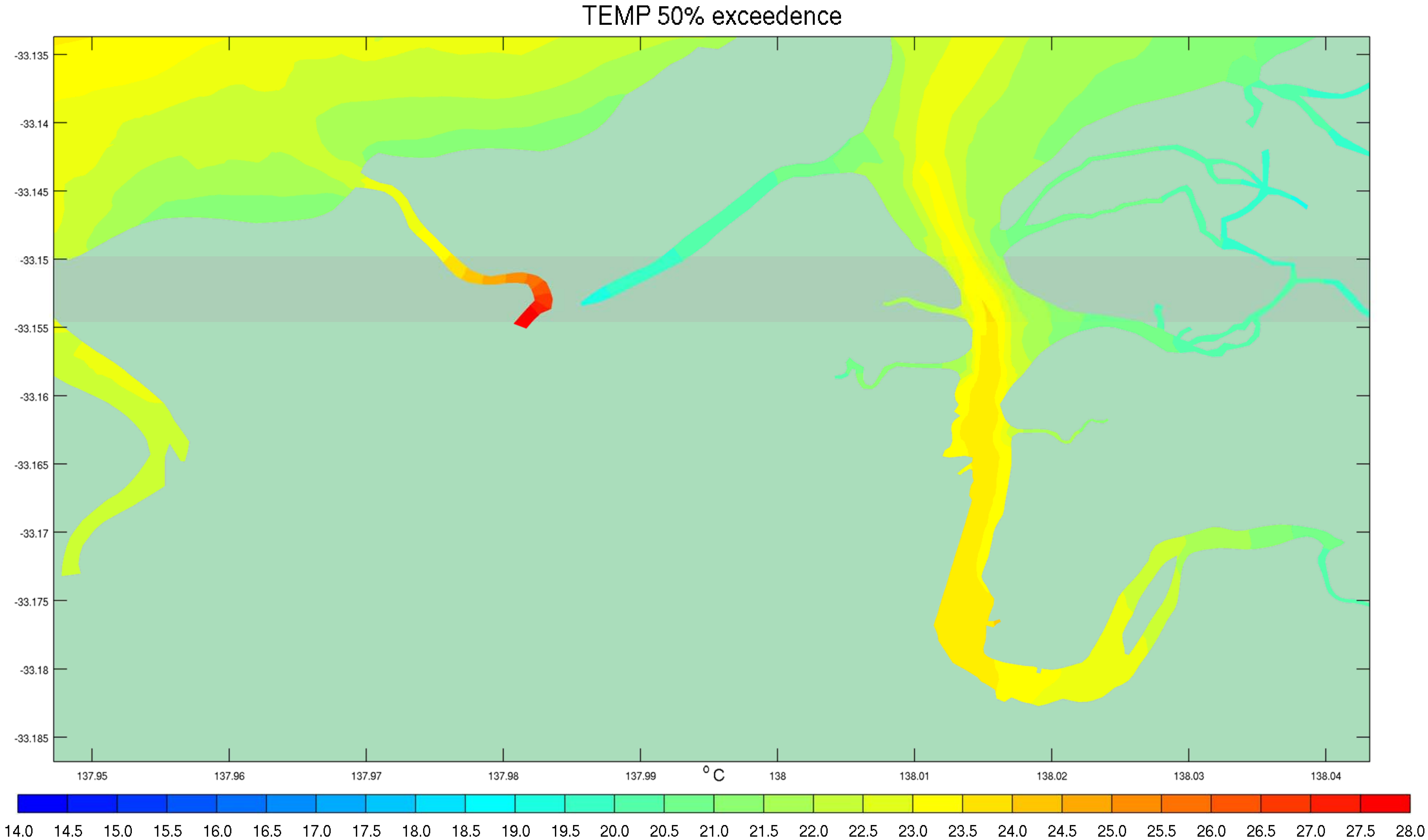

Figure C-12 50th Percentile Temperature Exceedences – Discharge Scenario Conditions January to March 2013

APPENDIX D: TEMPERATURE EXCEEDENCES FOR THE DISCHARGE SCENARIO IN WINTER

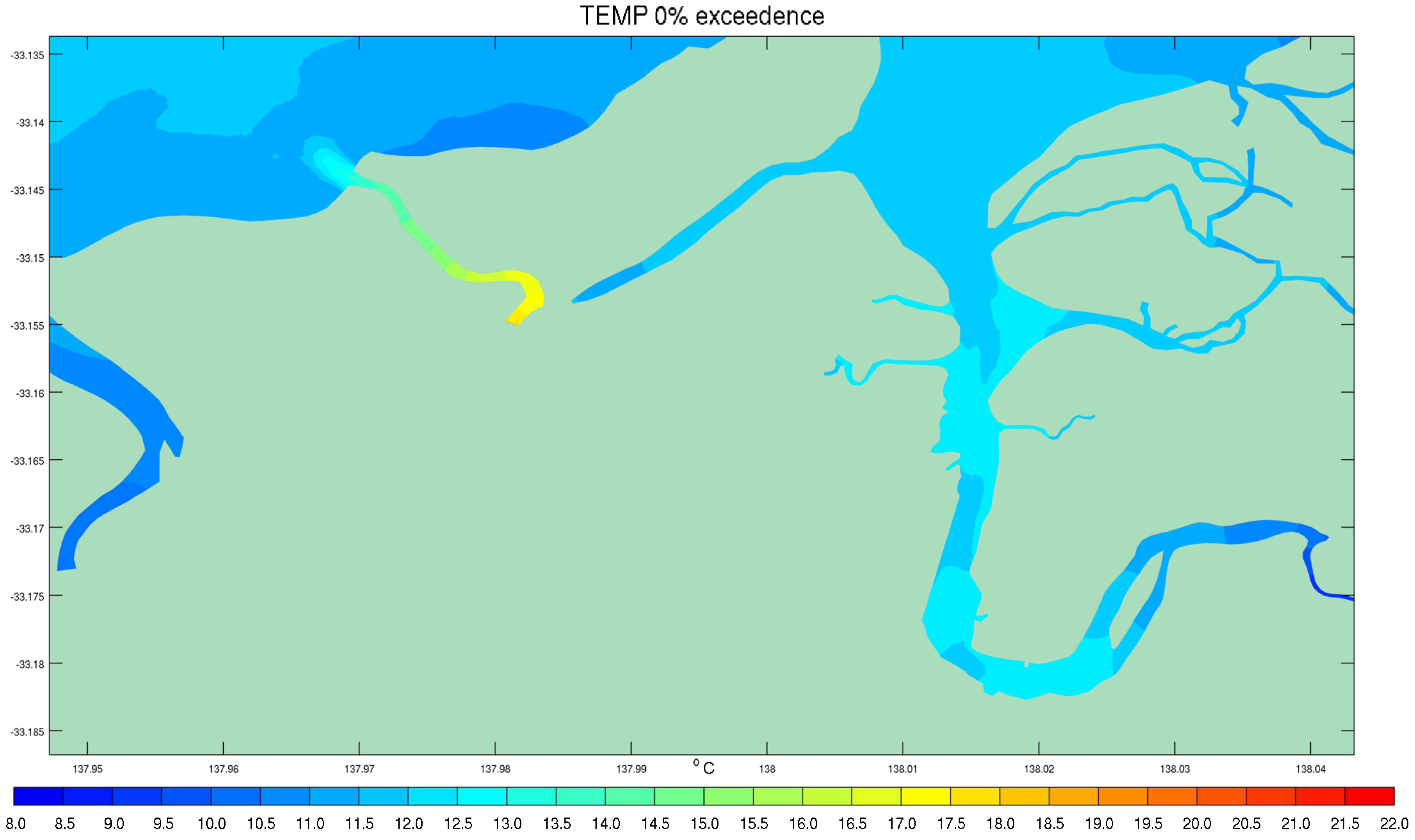

Figure D- 1 0th Percentile Temperature Exceedences – Discharge Scenario Conditions July 2012

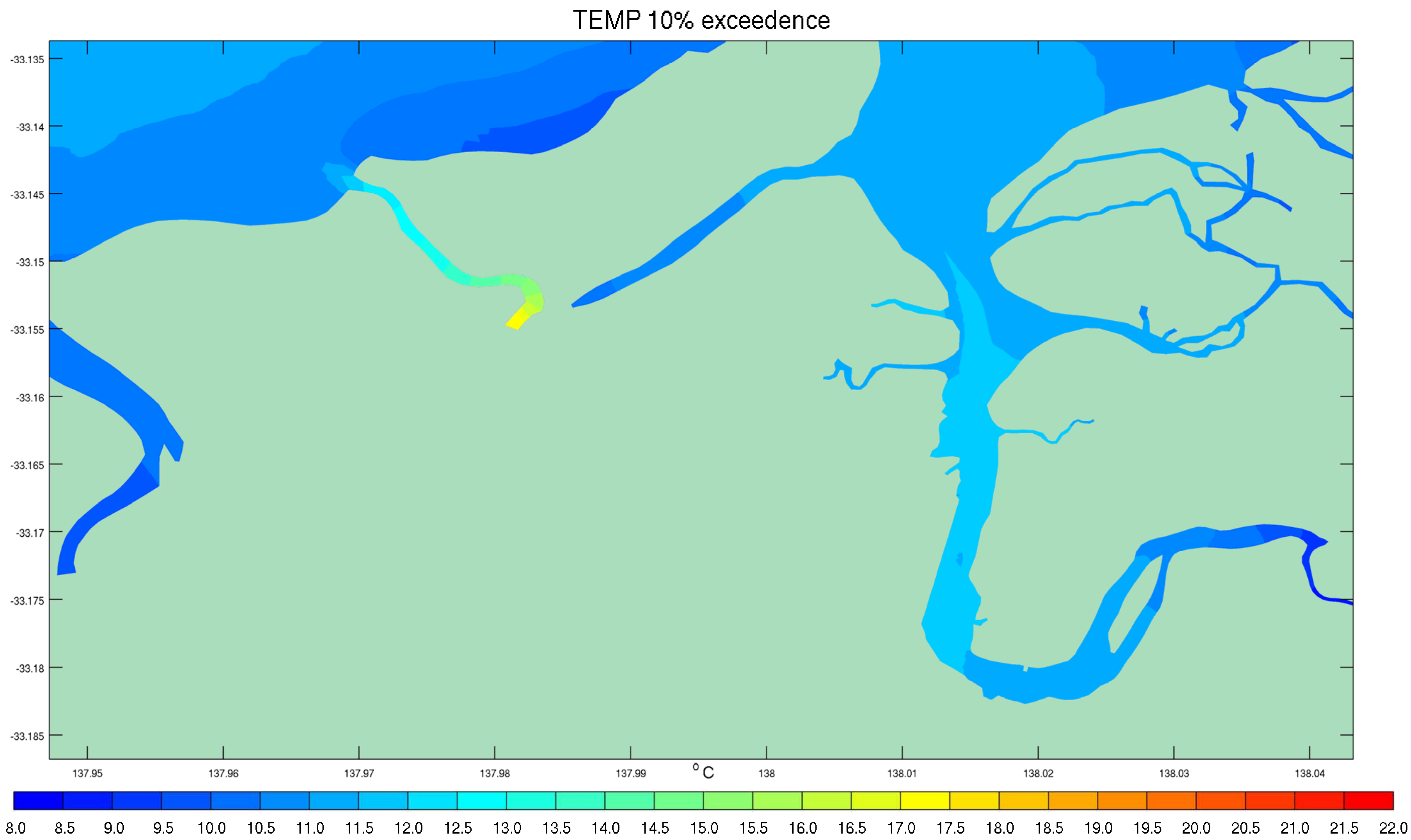

Figure D- 2 10th Percentile Temperature Exceedences – Discharge Scenario Conditions July 2012

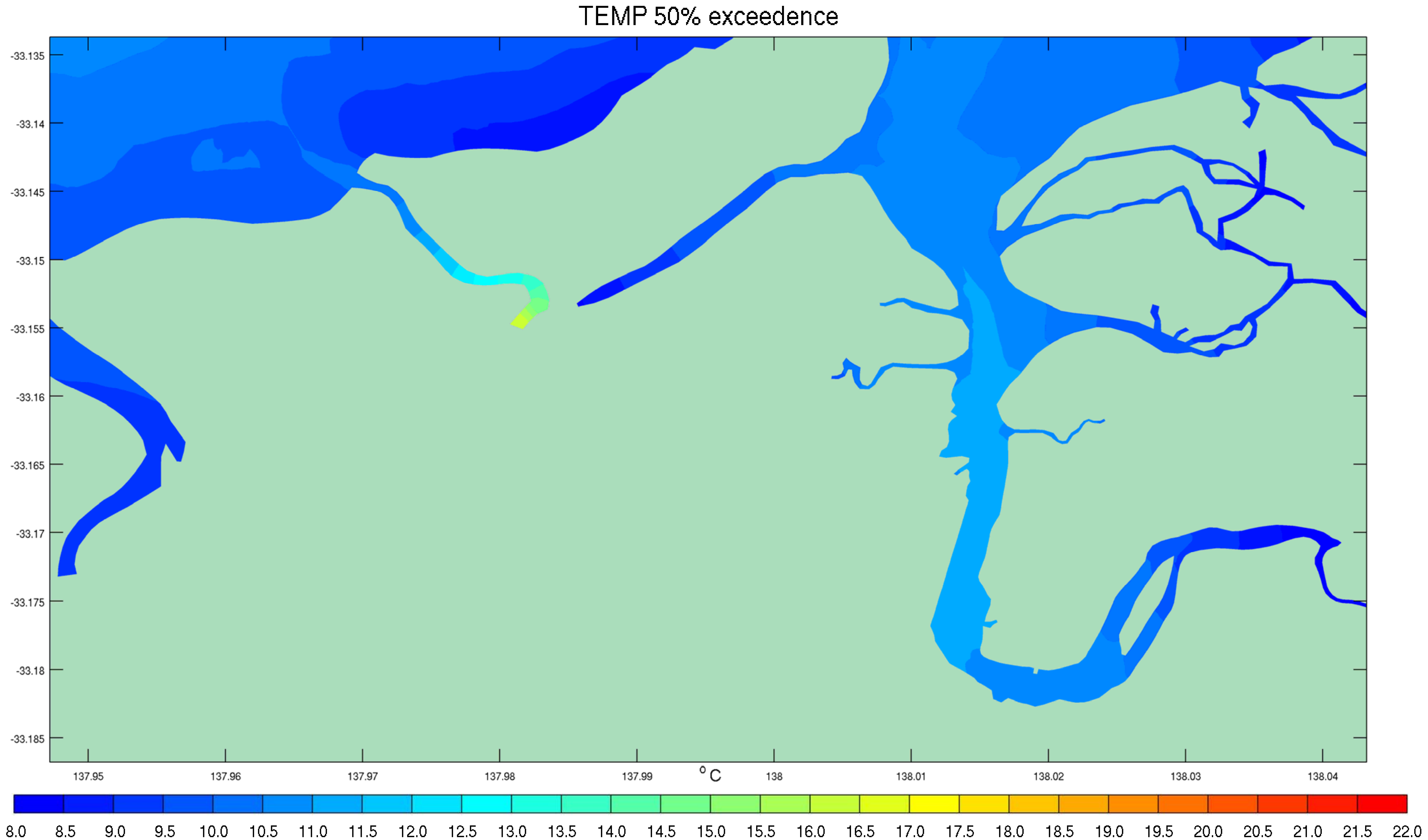

Figure D- 3 50th Percentile Temperature Exceedences – Discharge Scenario Conditions July 2012

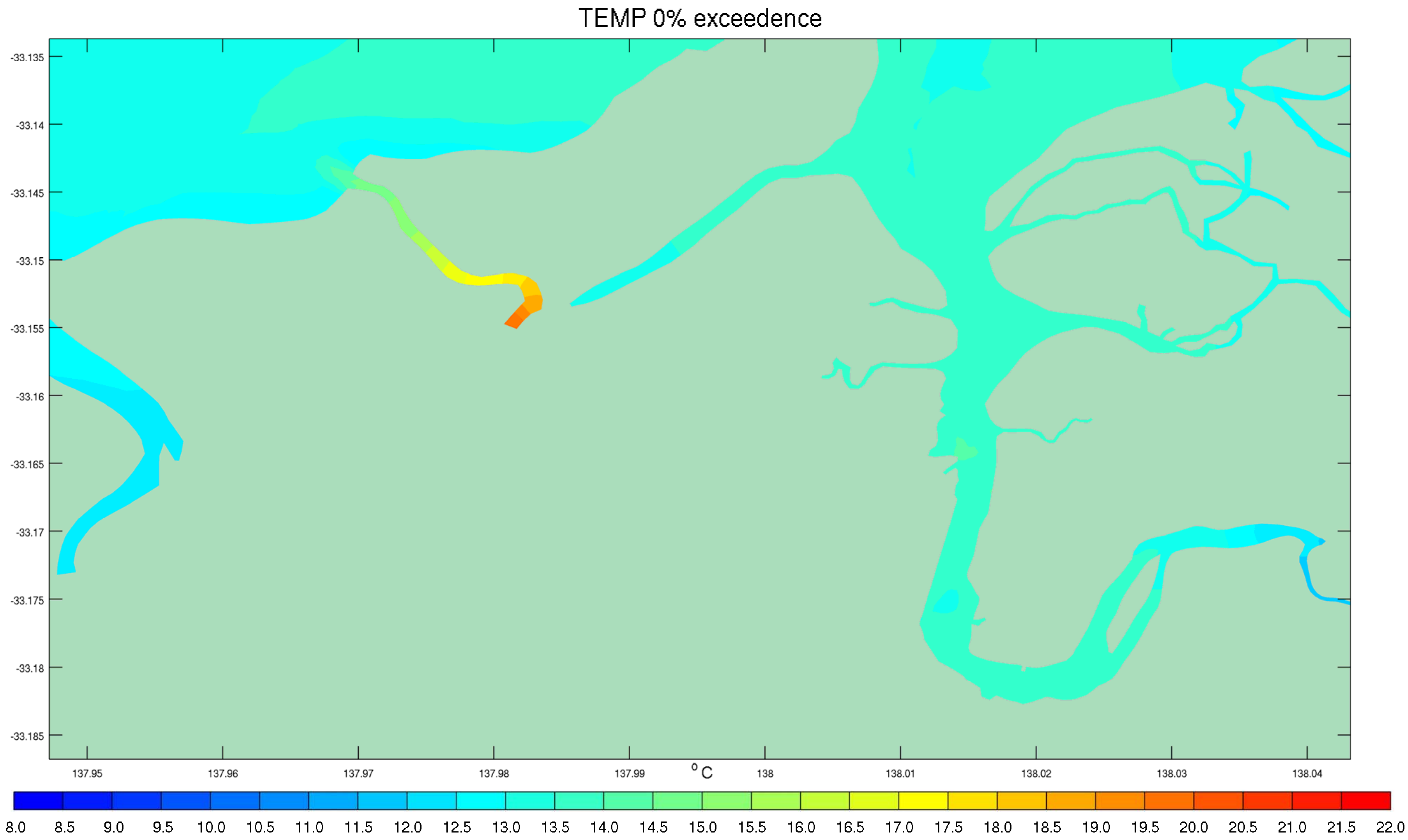

Figure D- 4 0th Percentile Temperature Exceedences – Discharge Scenario Conditions August 2012

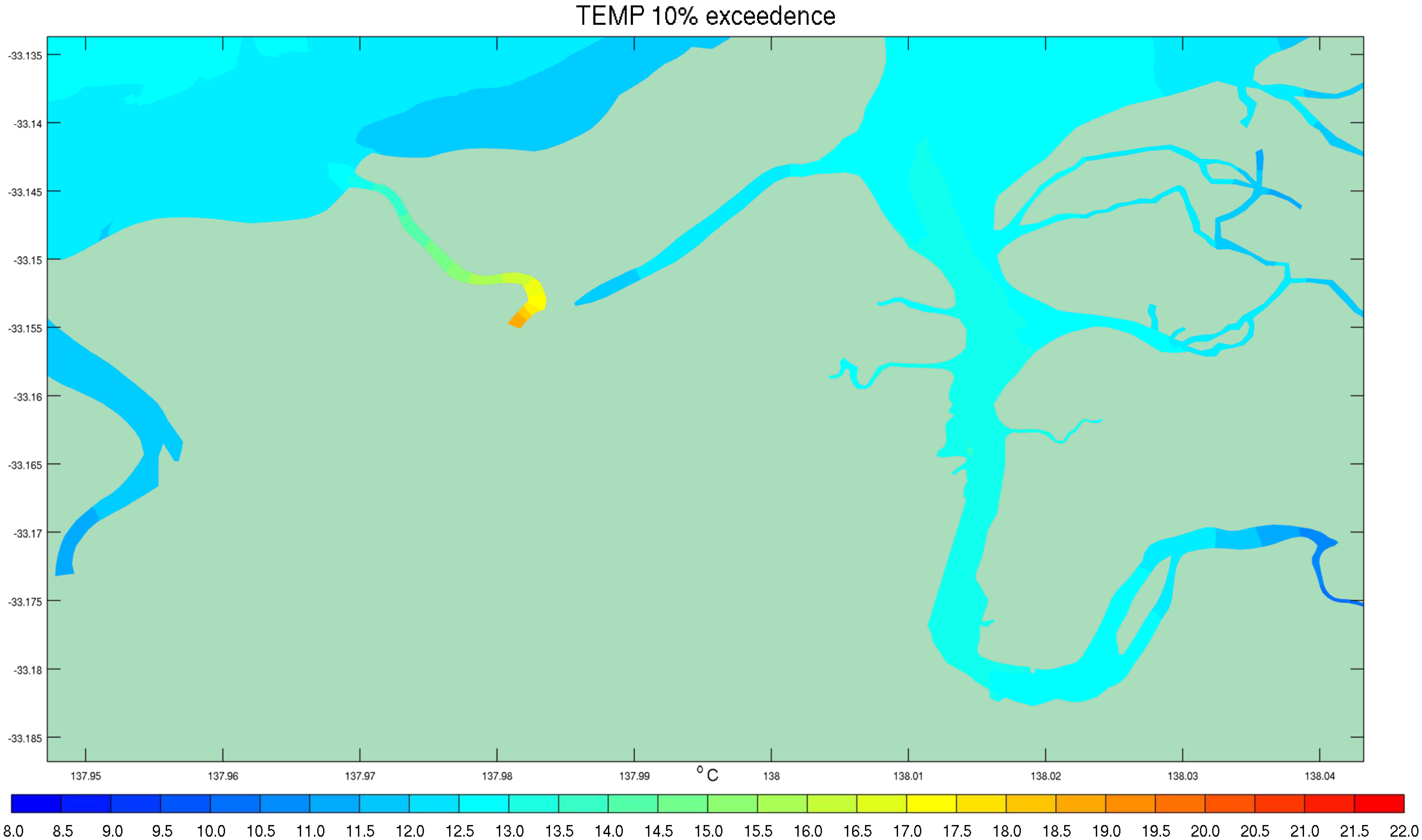

Figure D- 5 10th Percentile Temperature Exceedences – Discharge Scenario Conditions August 2012

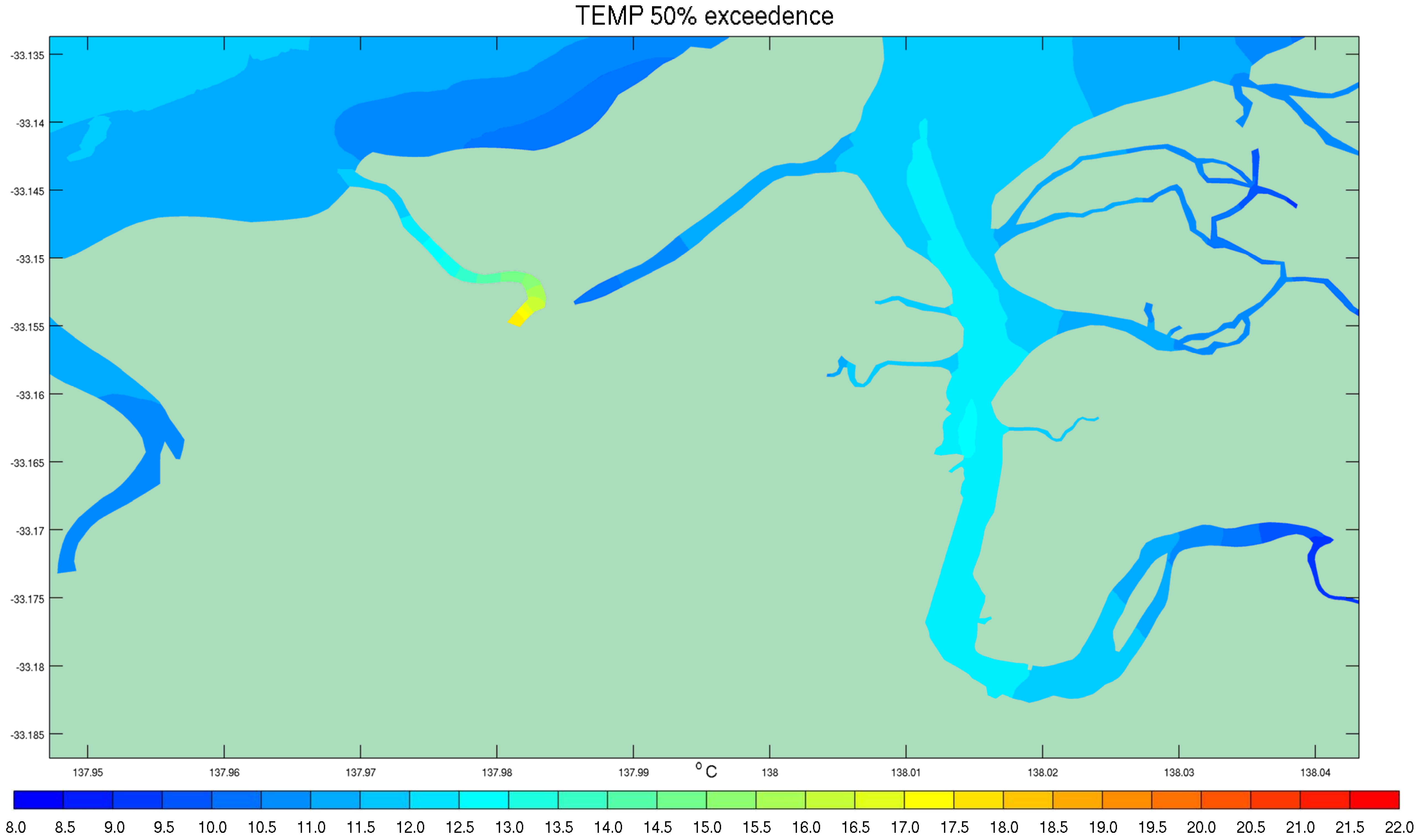

Figure D- 6 50th Percentile Temperature Exceedences – Discharge Scenario Conditions August 2012

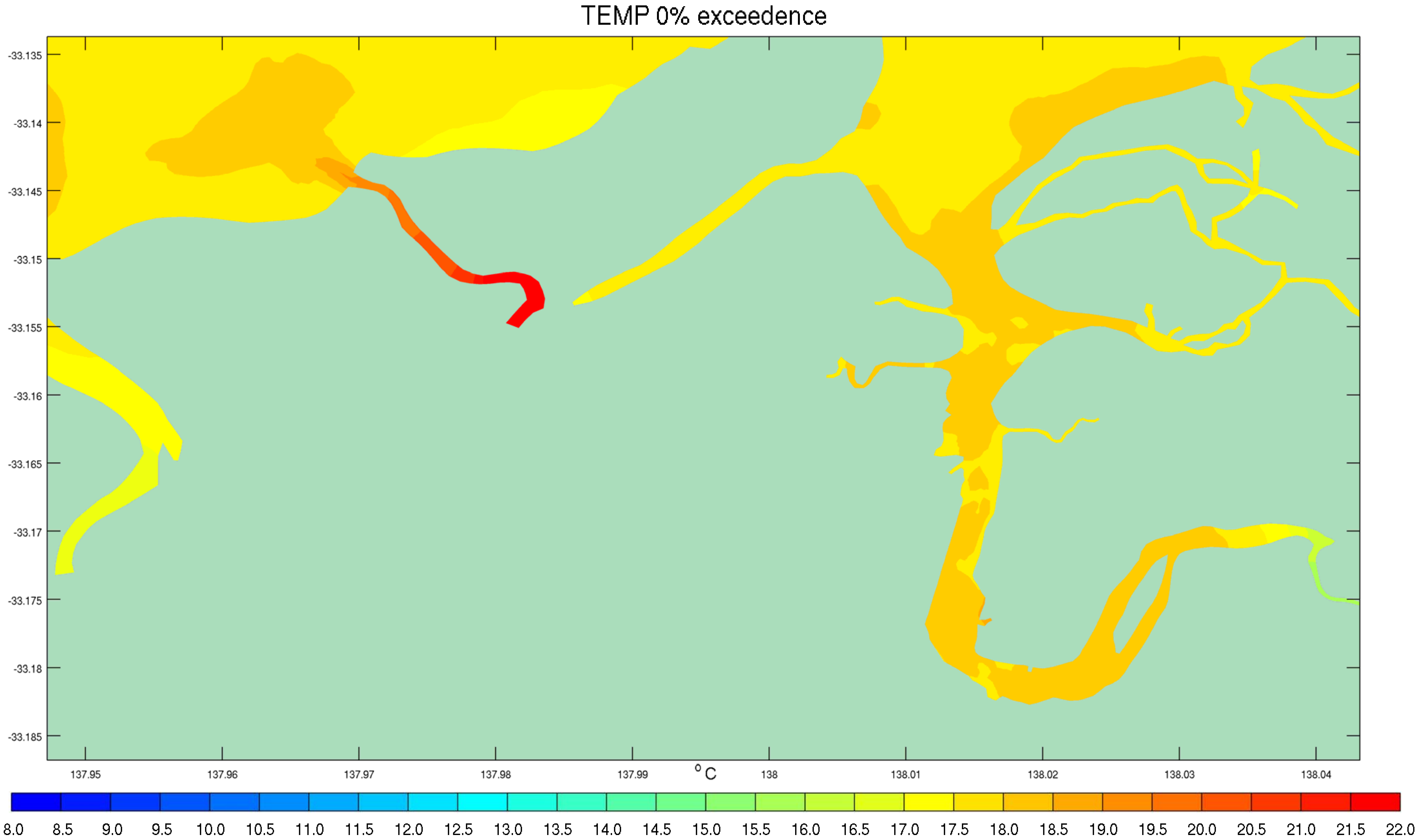

Figure D- 7 0th Percentile Temperature Exceedences – Discharge Scenario Conditions September 2012

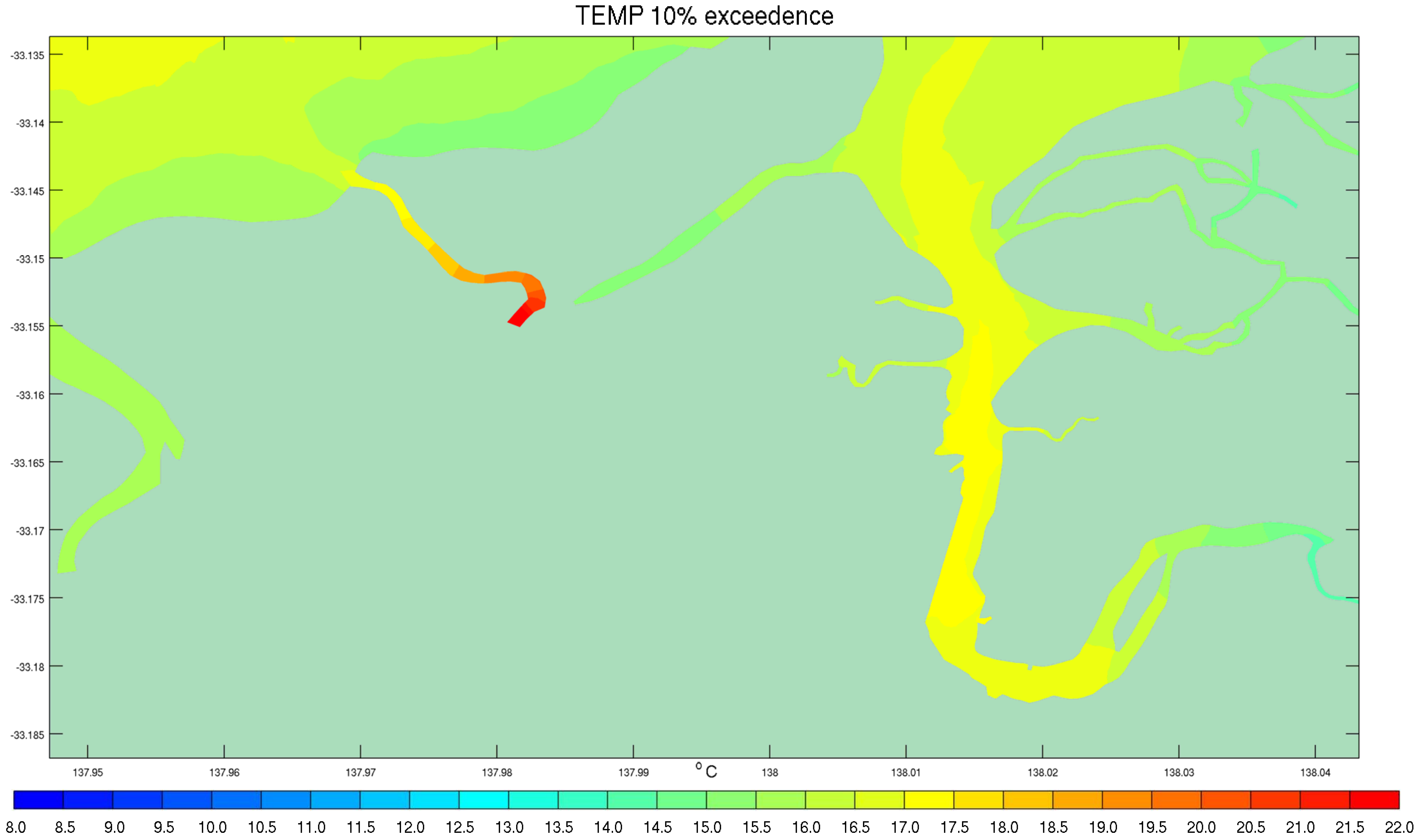

Figure D- 8 10th Percentile Temperature Exceedences – Discharge Scenario Conditions September 2012

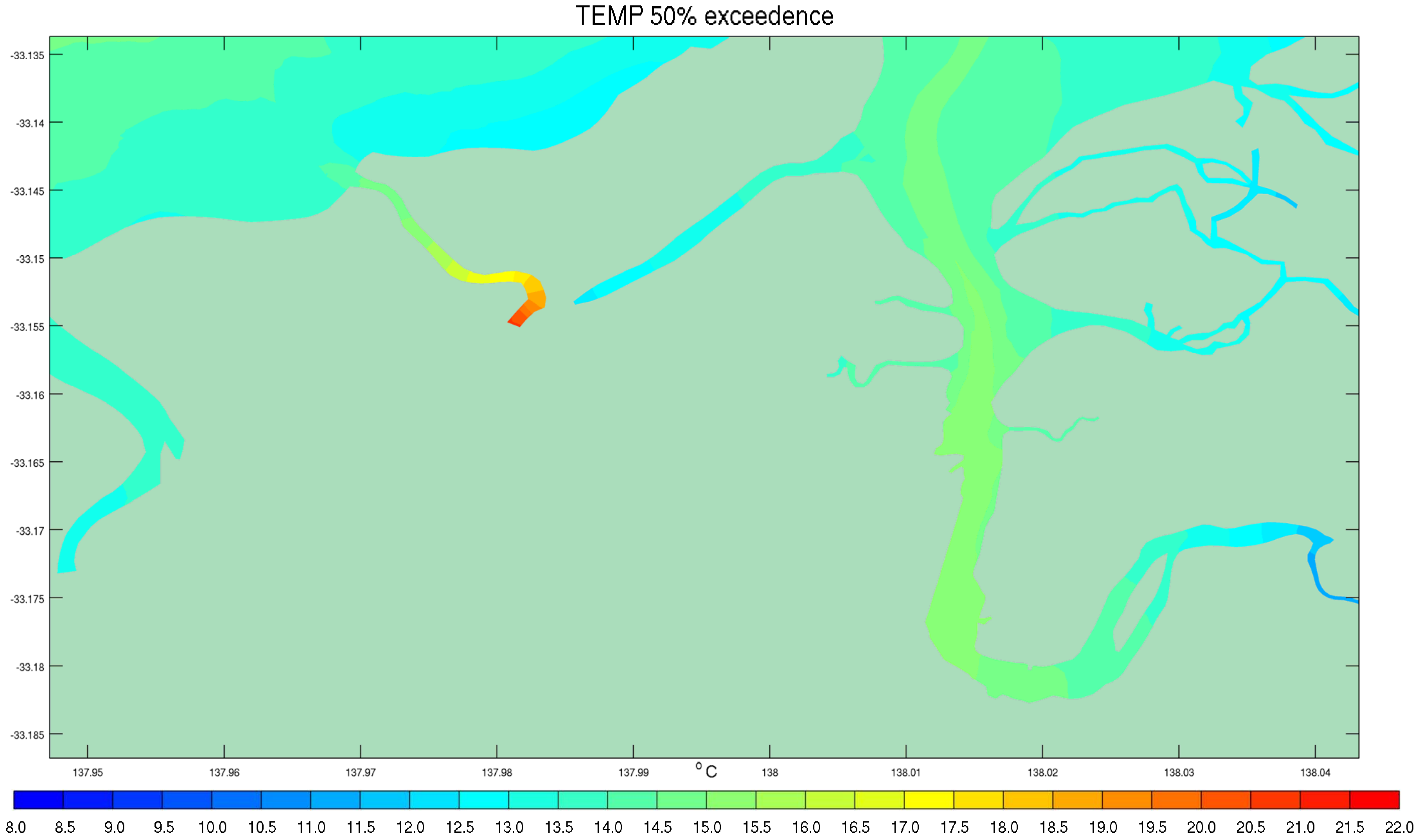

Figure D- 9 50th Percentile Temperature Exceedences – Discharge Scenario Conditions September 2012

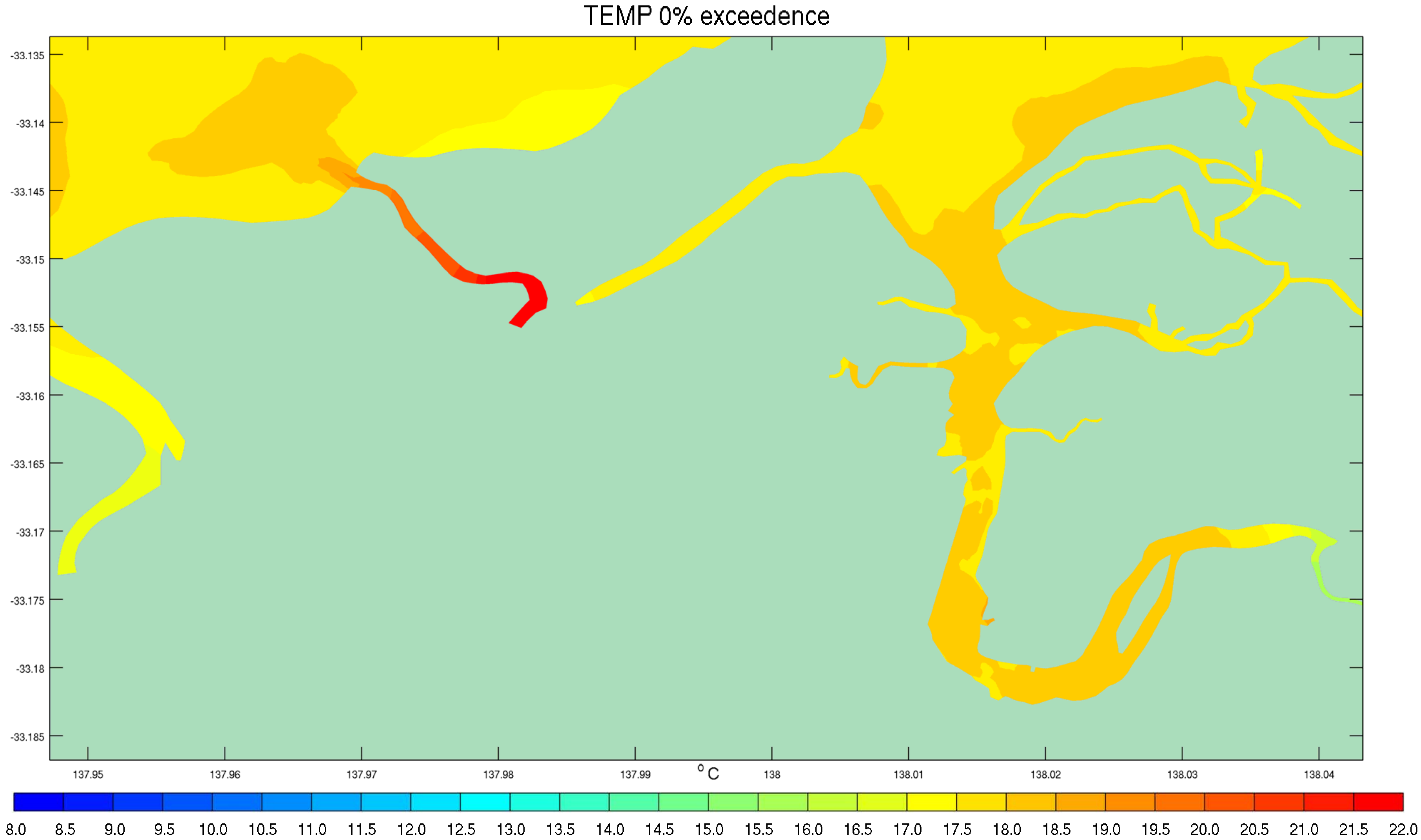

Figure D- 10 0th Percentile Temperature Exceedences – Discharge Scenario Conditions July to September 2012

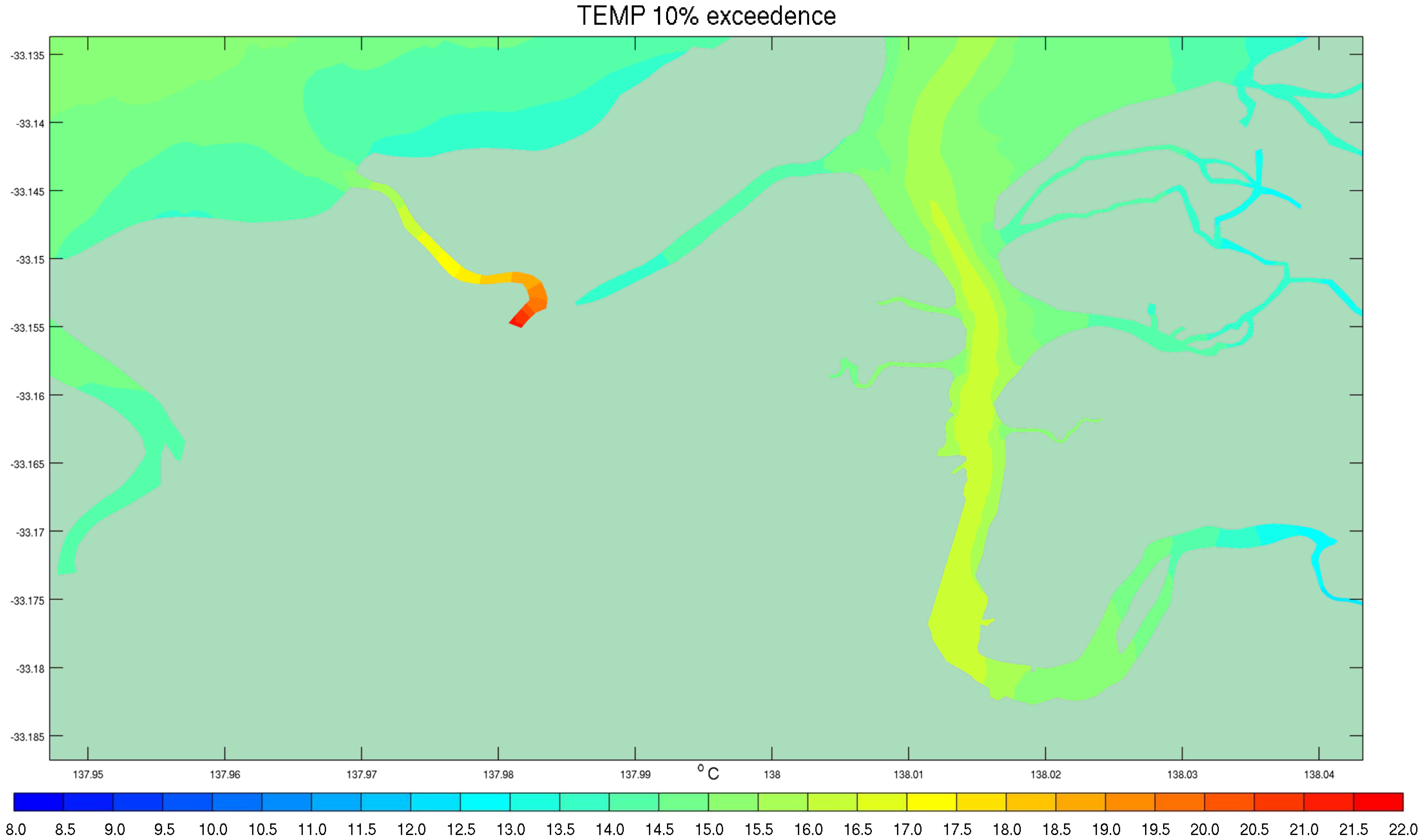

Figure D- 11 10th Percentile Temperature Exceedences – Discharge Scenario Conditions July to September 2012

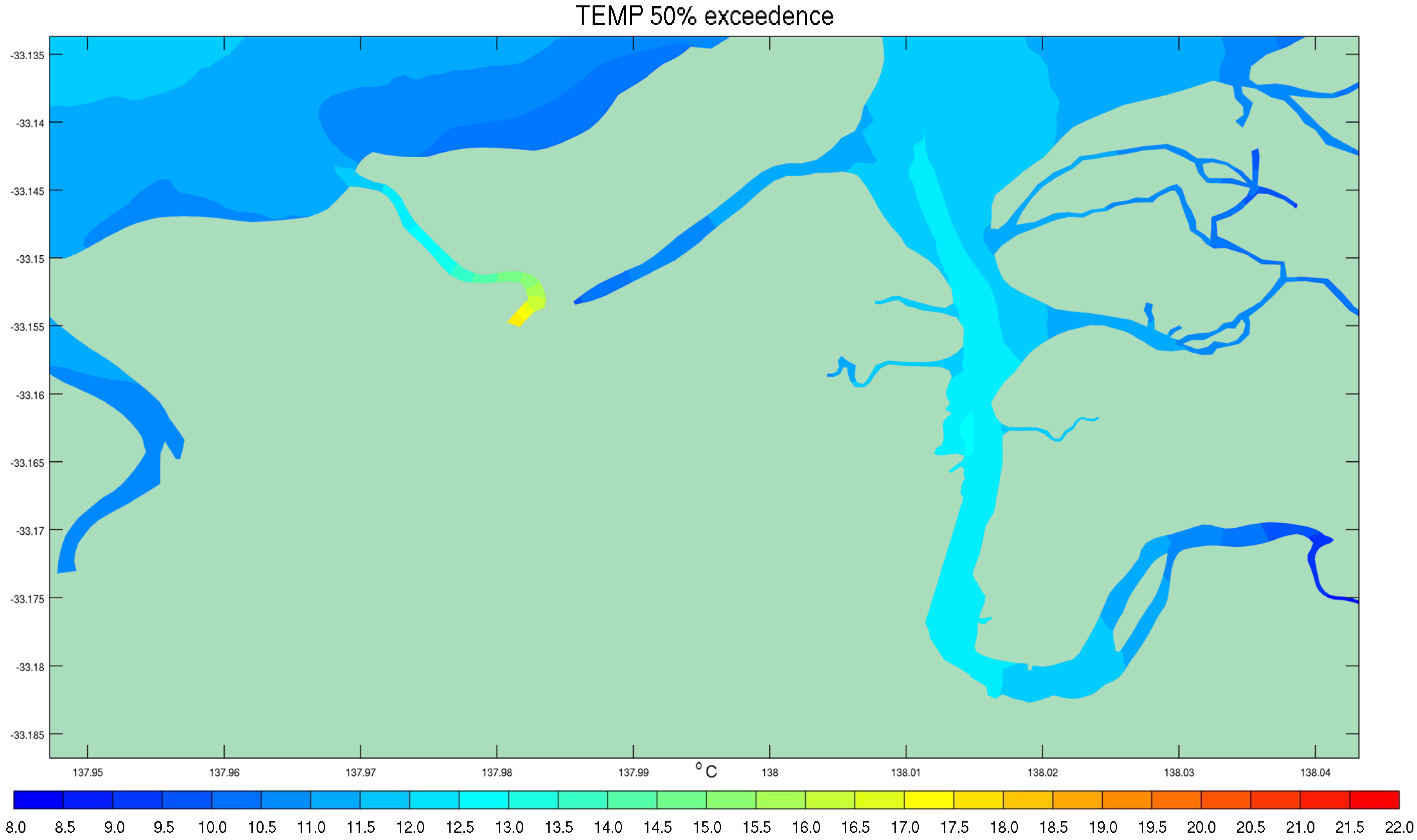

Figure D- 12 50th Percentile Temperature Exceedences – Discharge Scenario Conditions July to September 2012

APPENDIX E: TEMPERATURE EXCEEDENCES DIFFERENCES BETWEEN DISCHARGE SCENARIO AND EXISTING BASELINE IN SUMMER

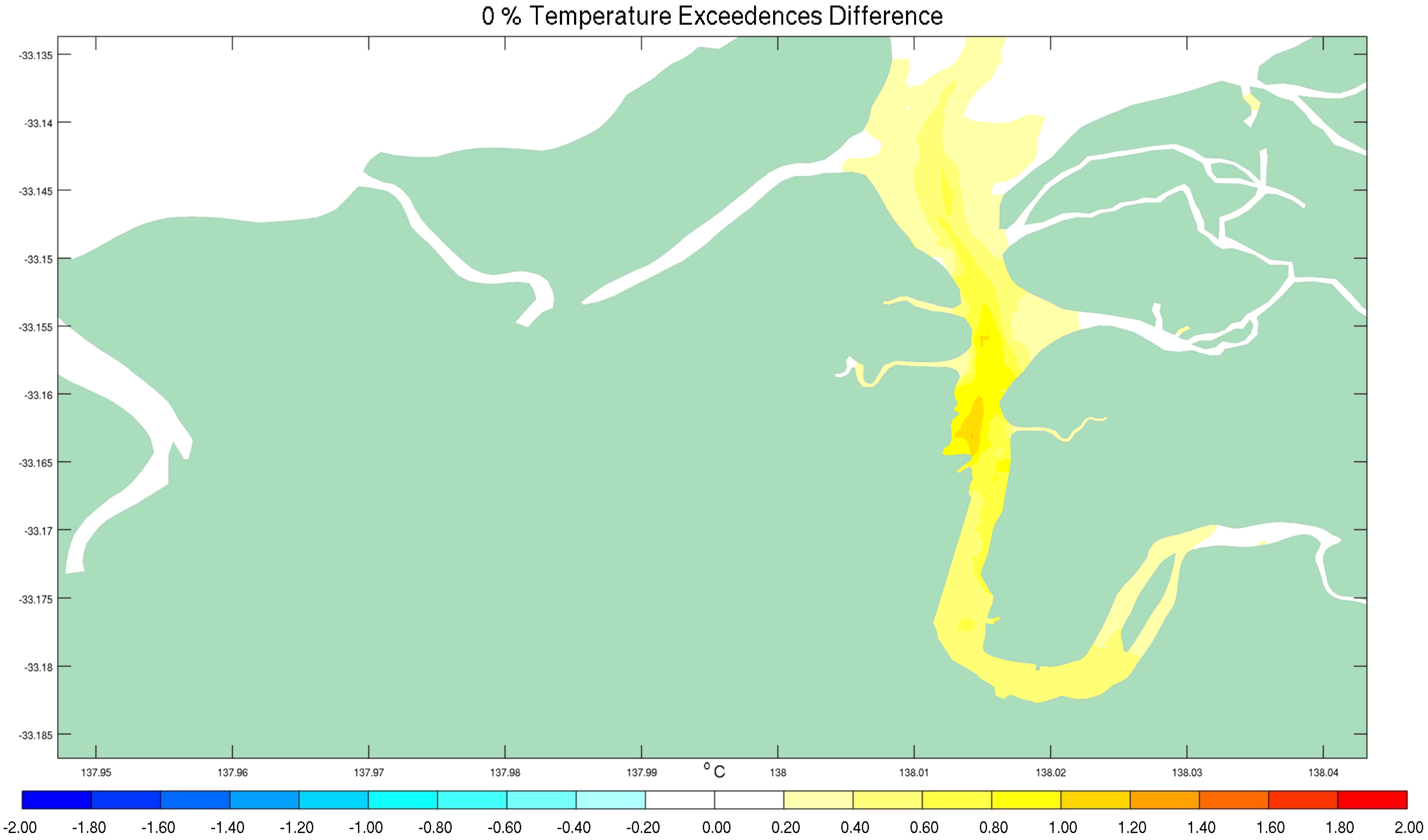

Figure E- 1 0th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions January 2013

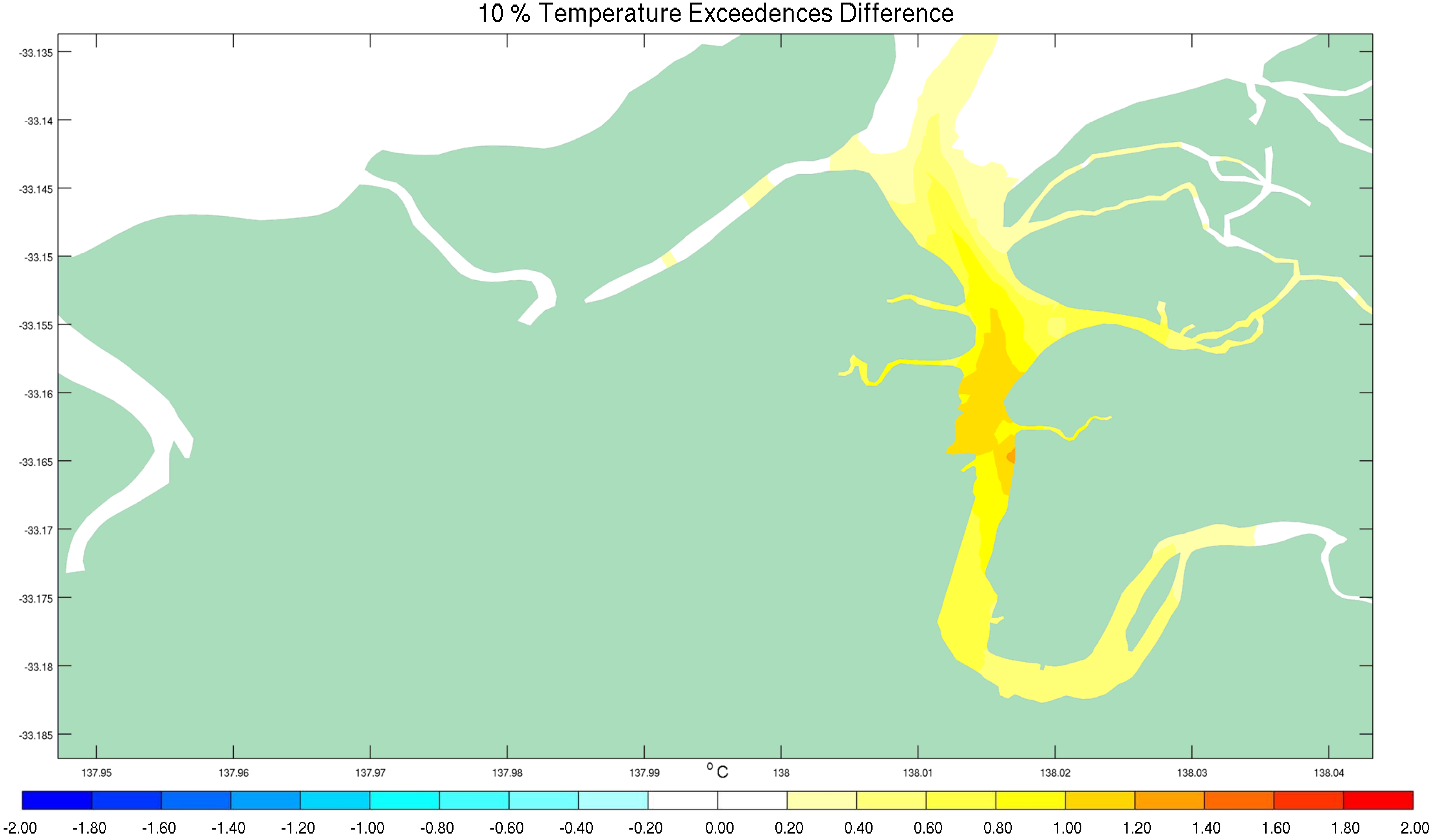

Figure E- 2 10th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions January 2013

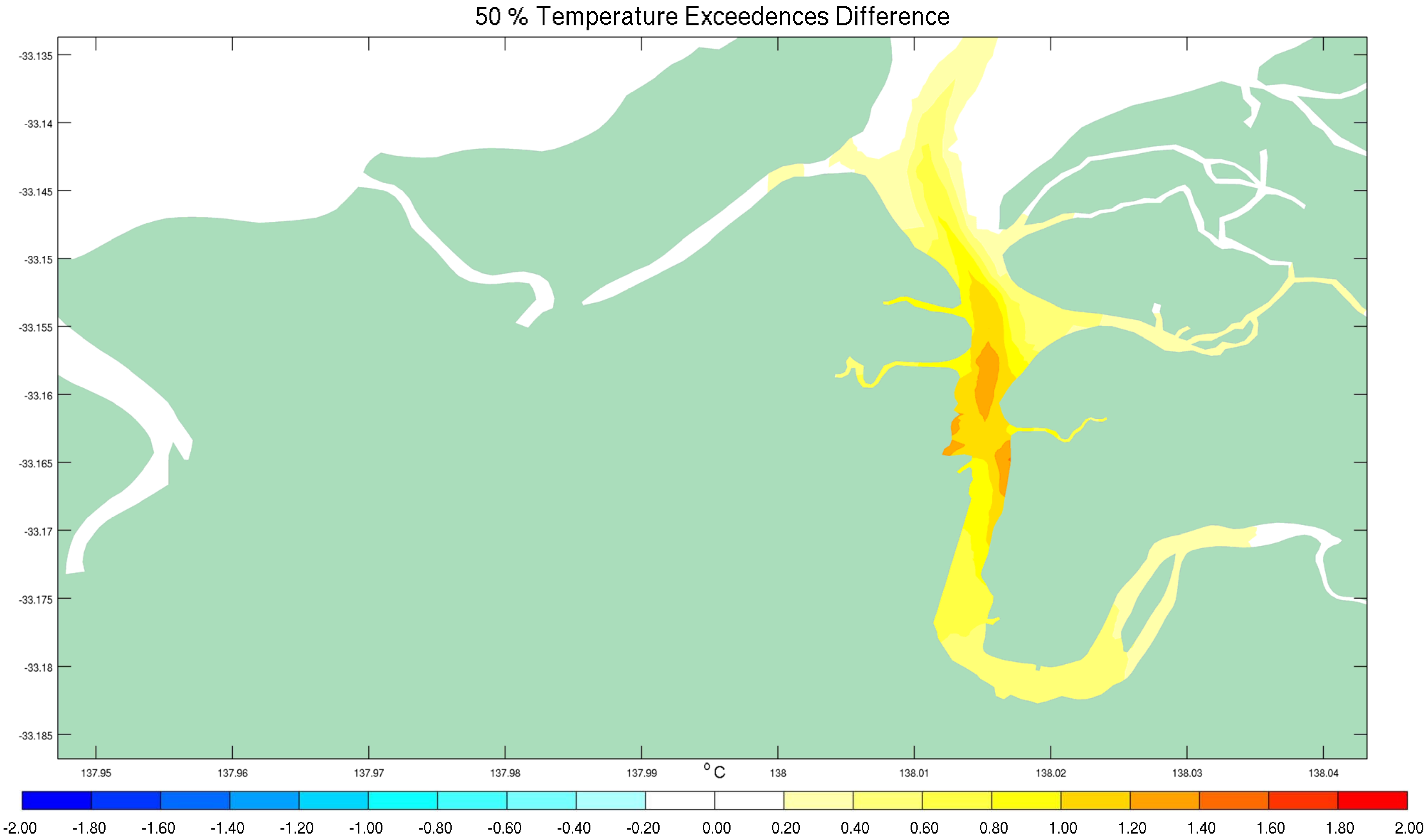

Figure E- 3 50th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions January 2013

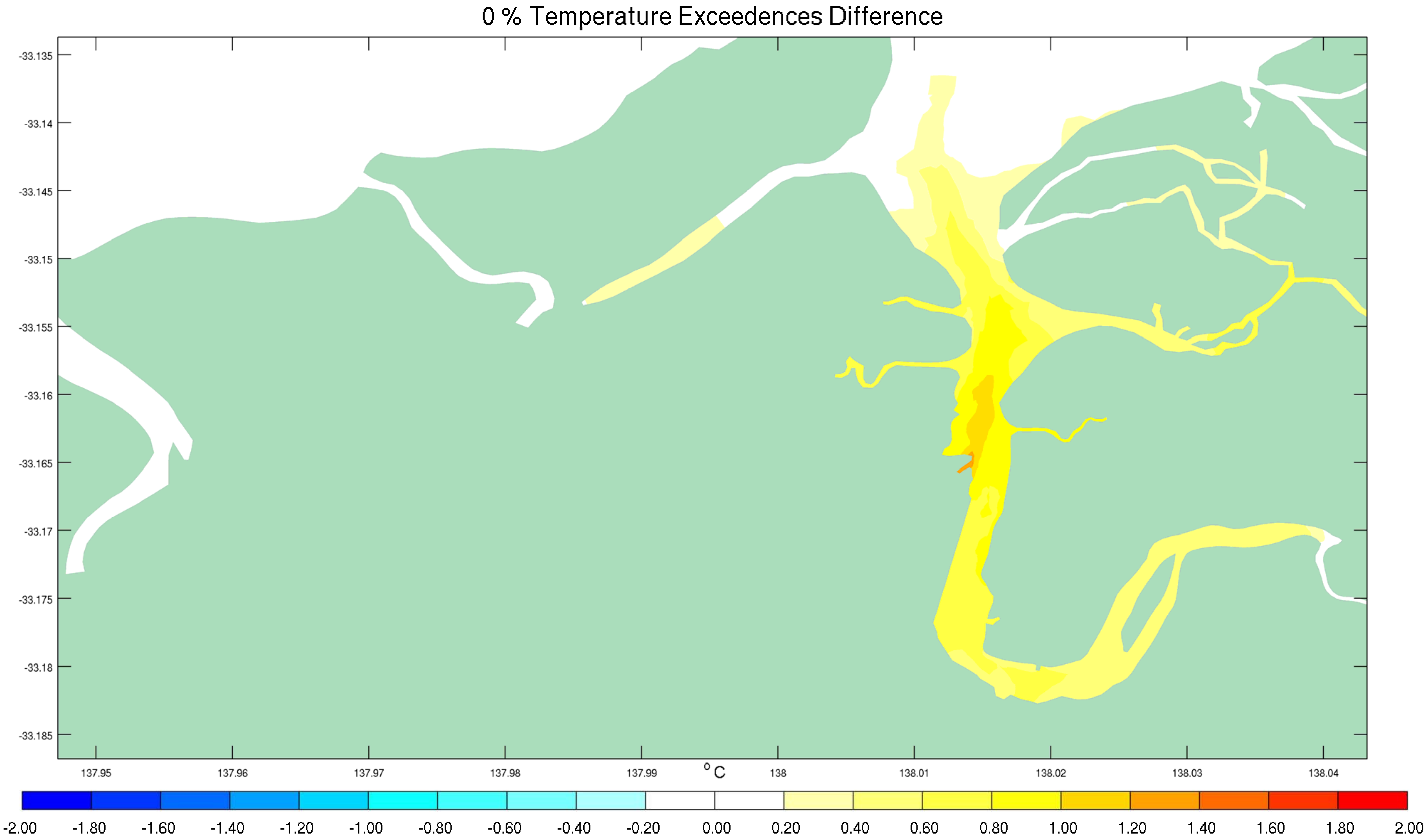

Figure E- 4 0th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions February 2013

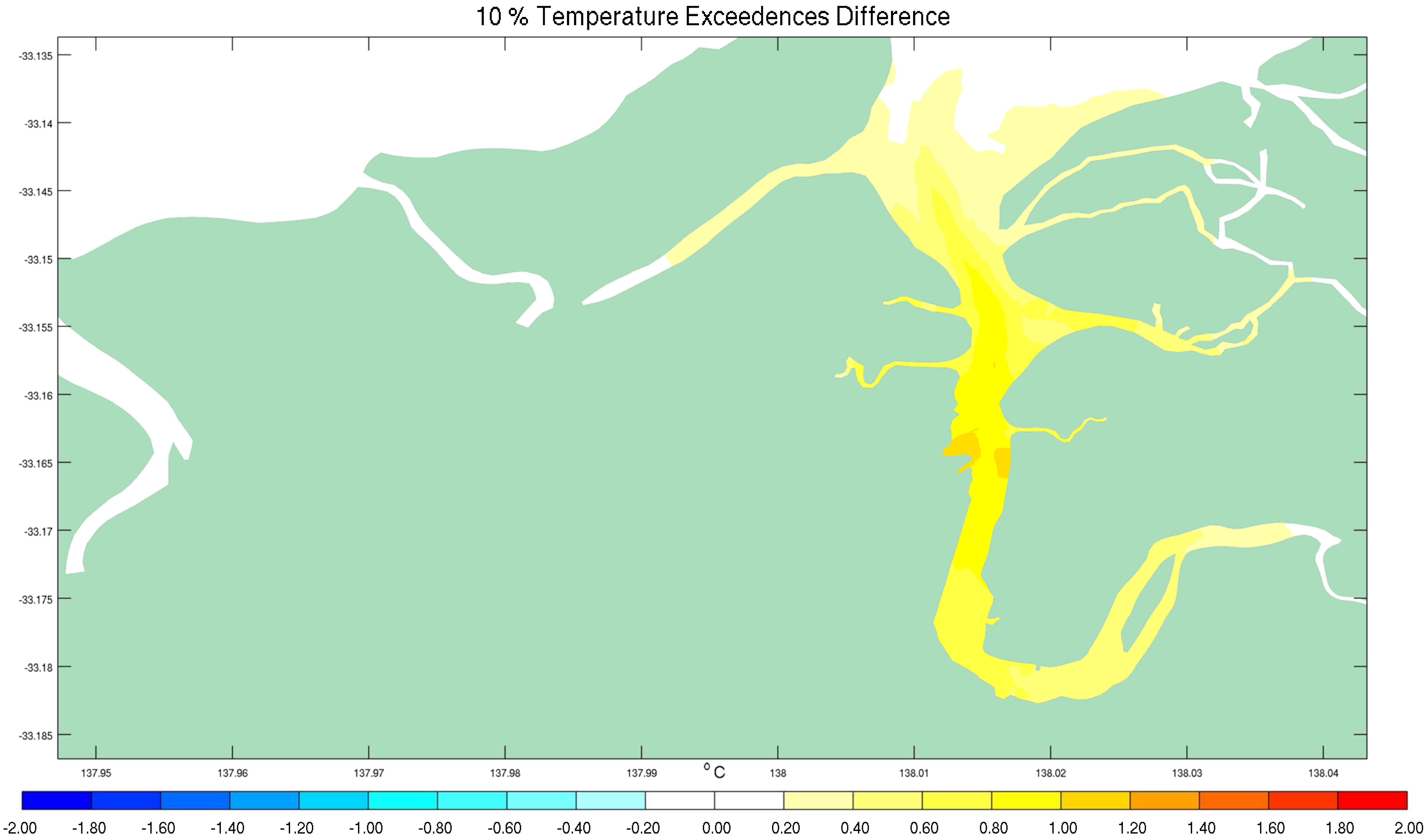

Figure E- 5 10th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions February 2013

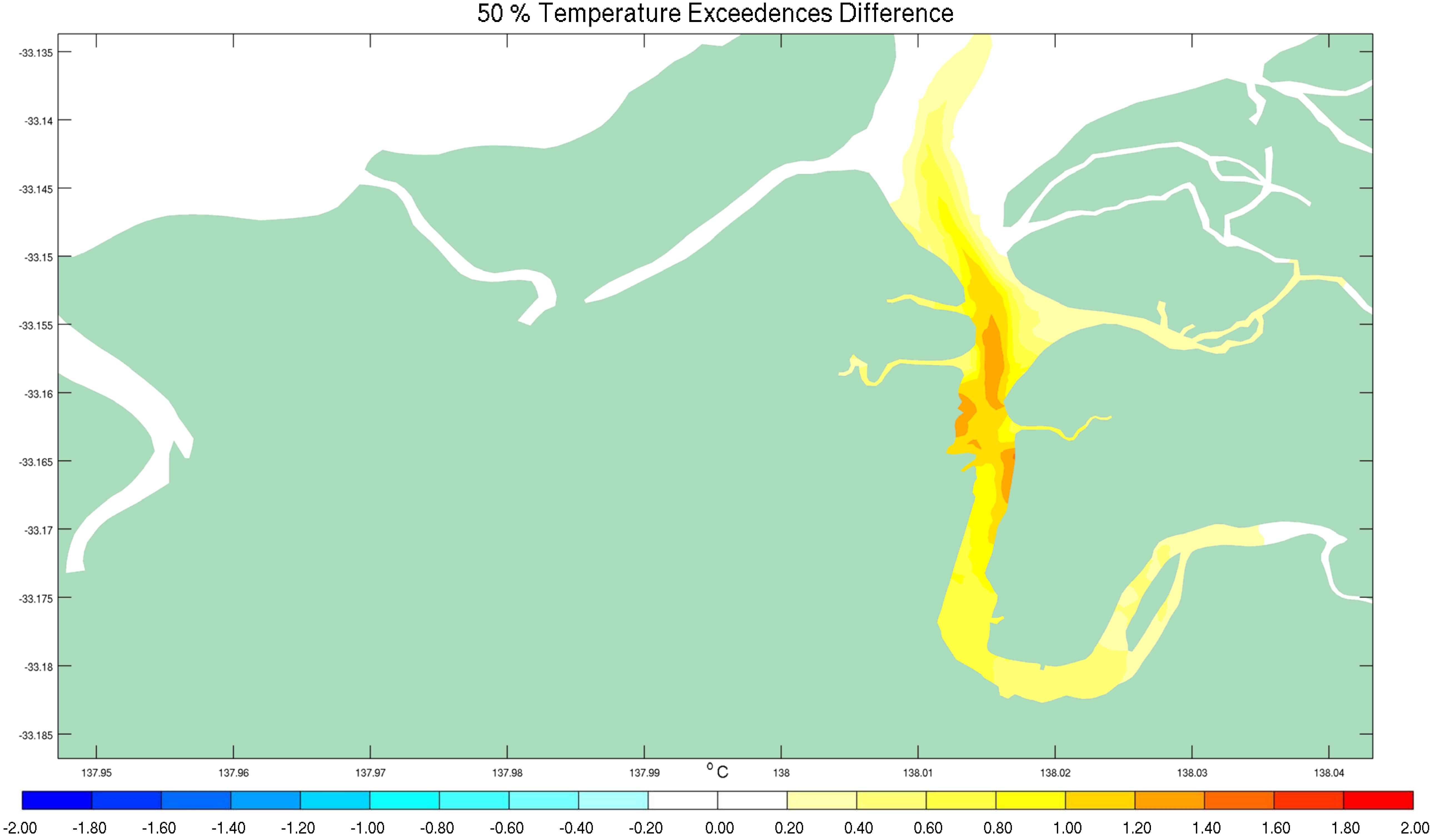

Figure E- 6 50th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions February 2013

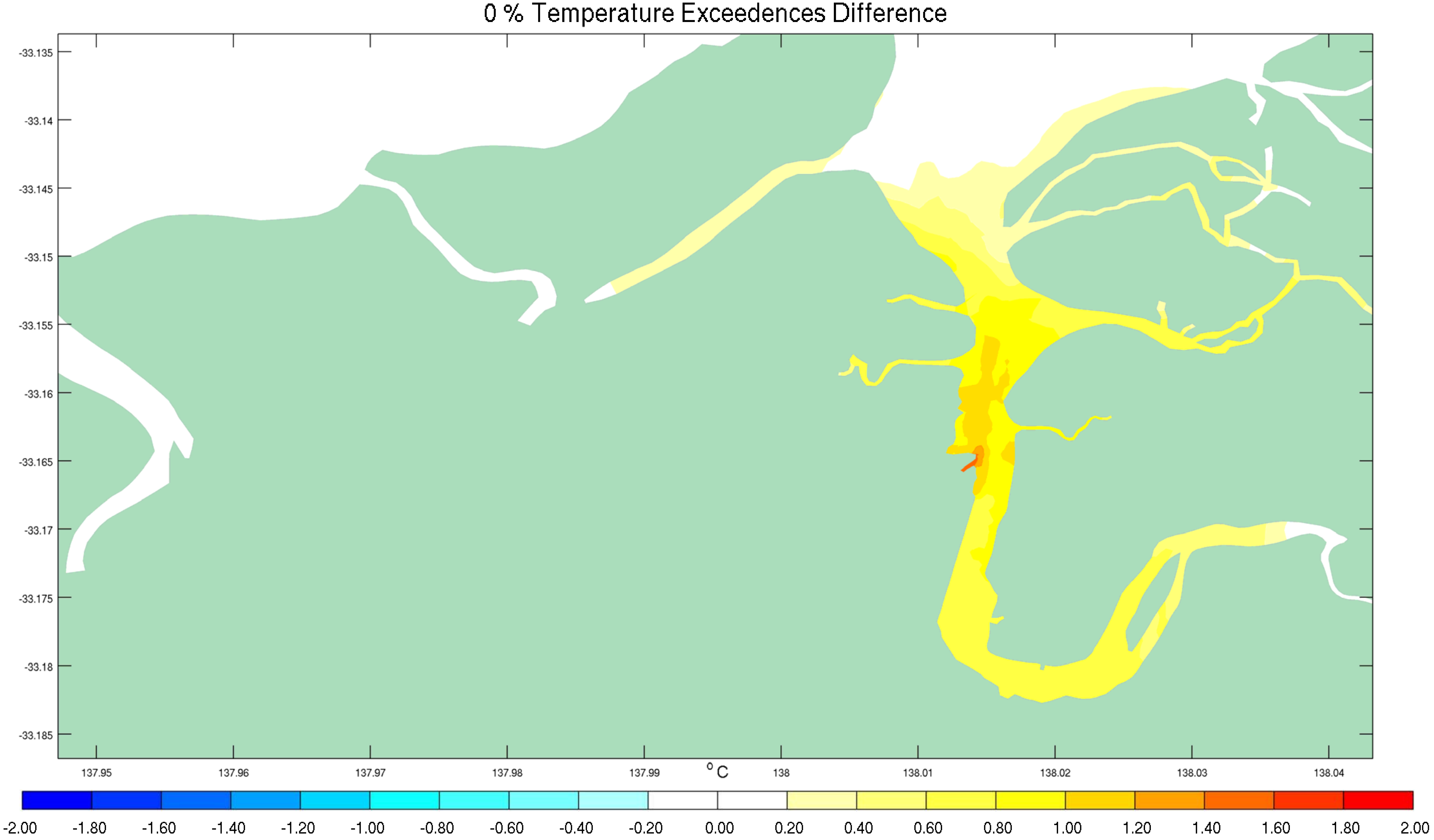

Figure E- 7 0th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions March 2013

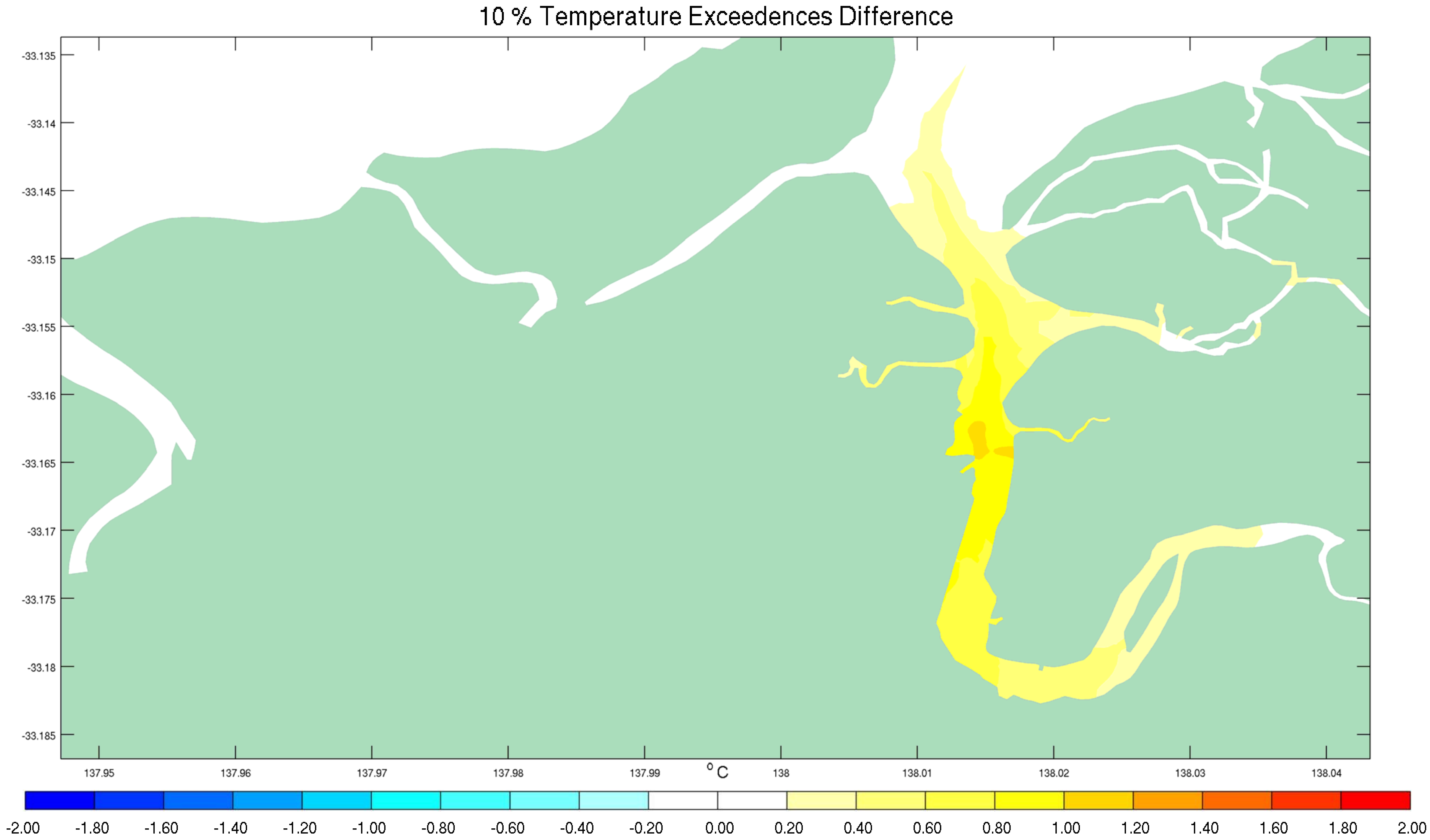

Figure E- 8 10th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions March 2013

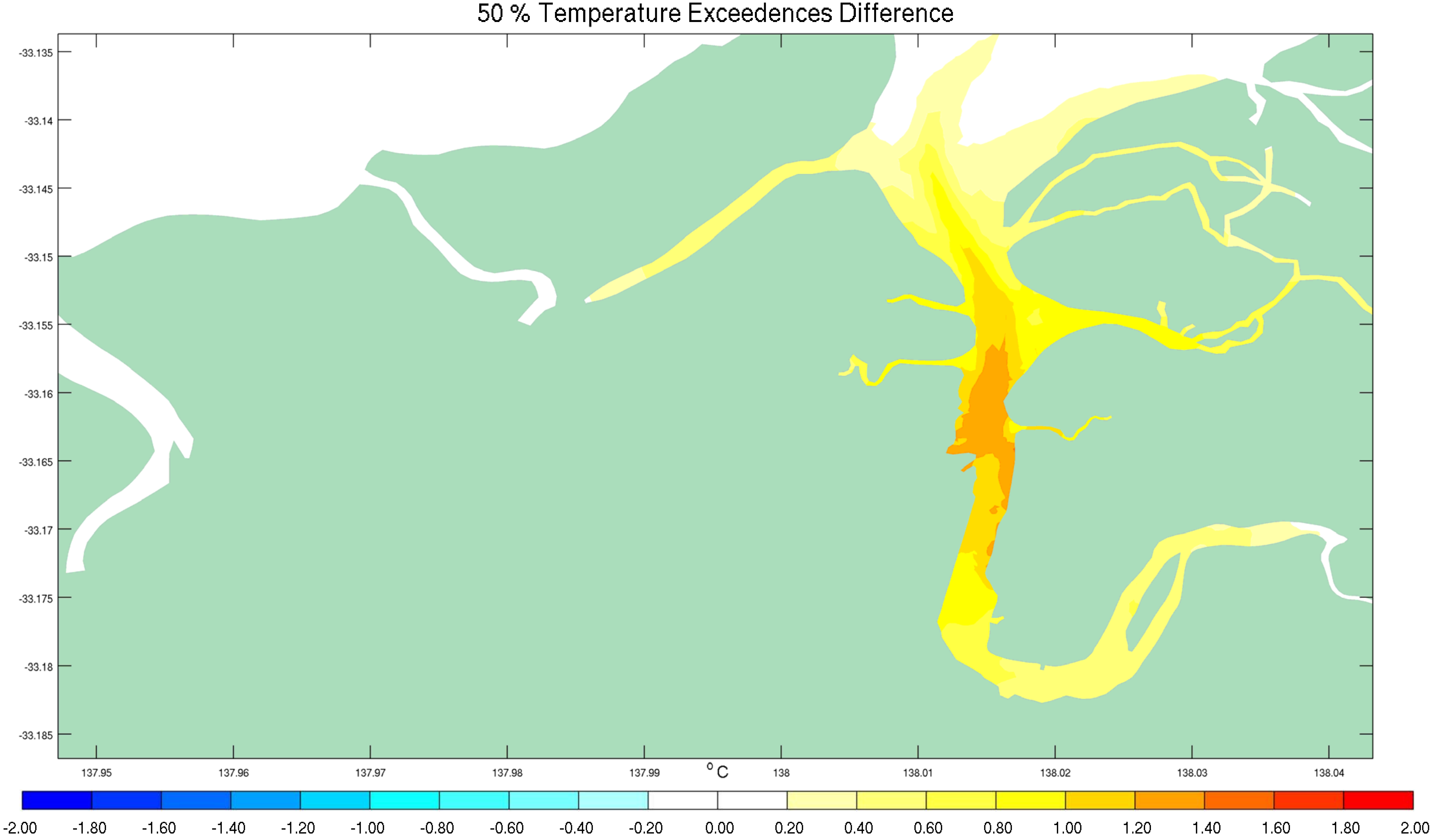

Figure E- 9 50th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions March 2013

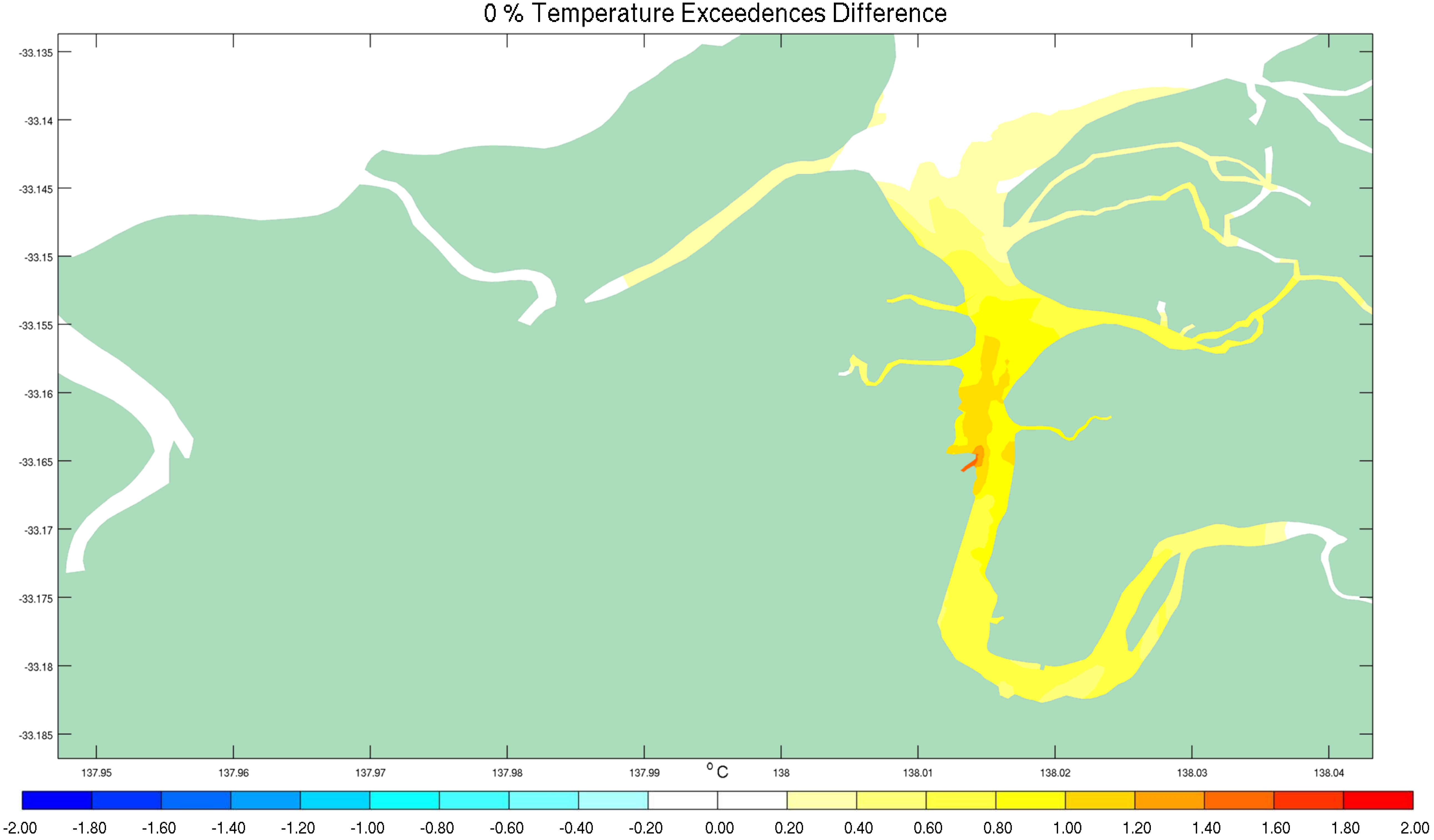

Figure E- 10 0th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions January to March 2013

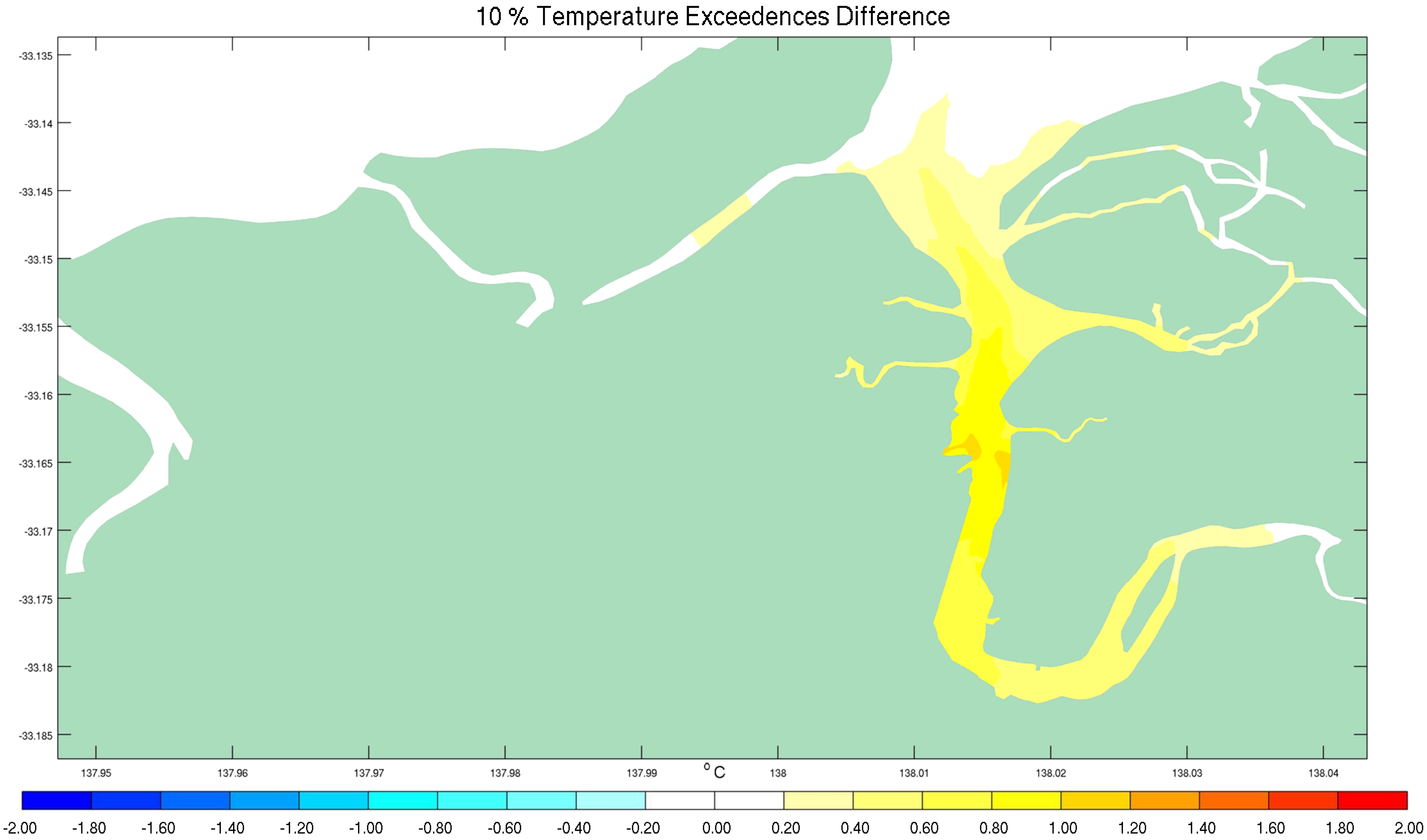

Figure E- 11 10th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions January to March 2013

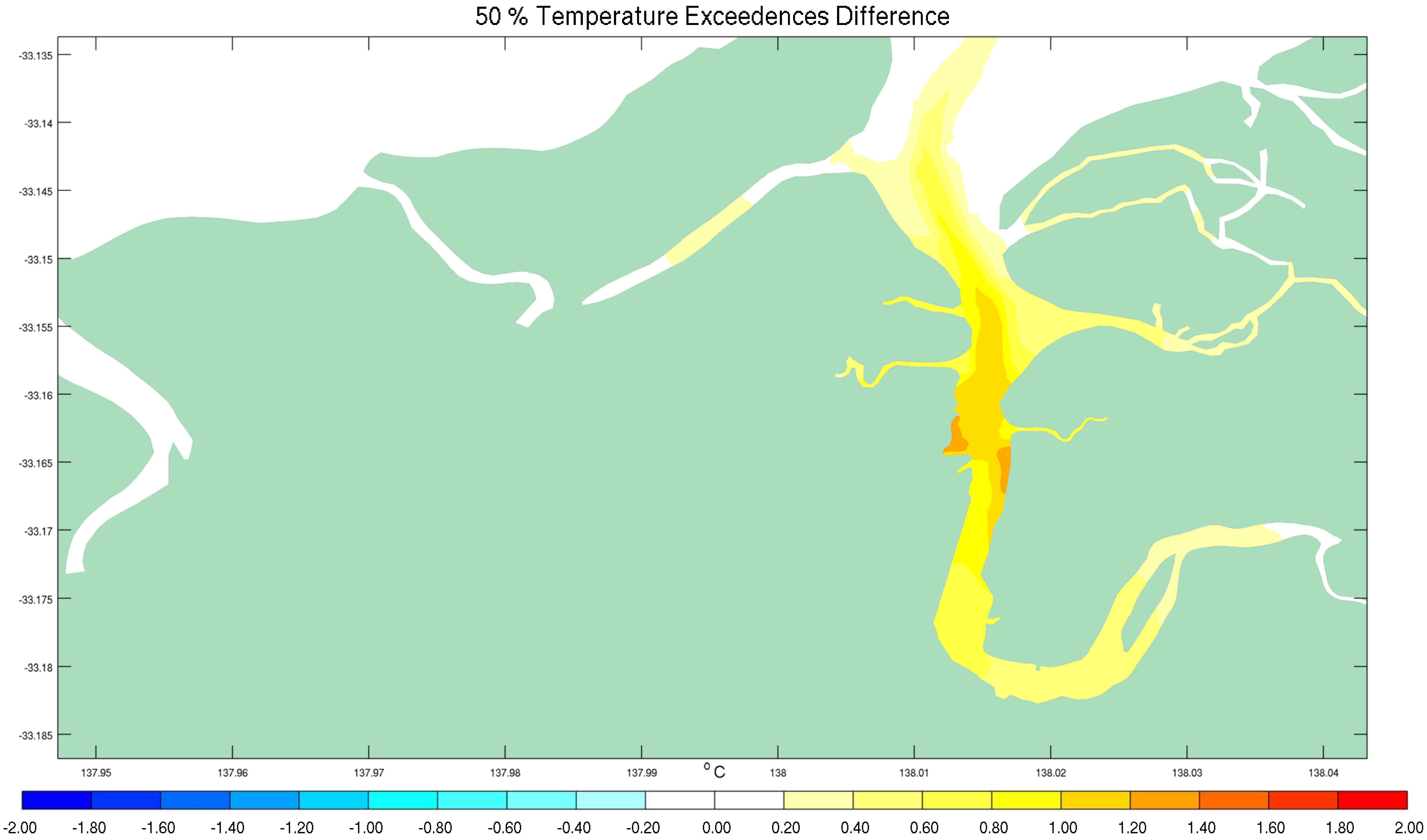

Figure E- 1250th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions January to March 2013

APPENDIX F: TEMPERATURE EXCEEDENCES DIFFERENCES BETWEEN DISCHARGE SCENARIO AND EXISTING BASELINE IN WINTER

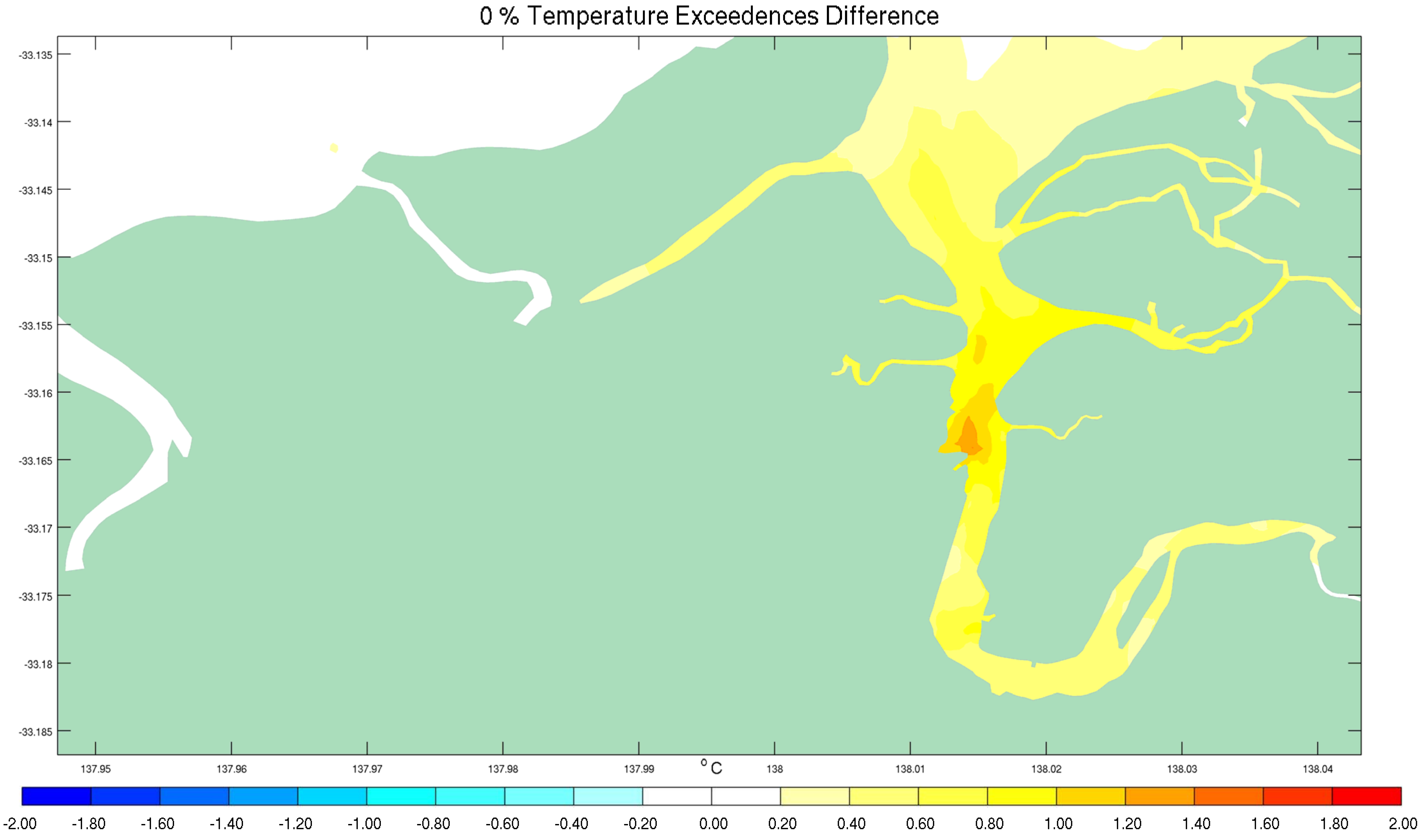

Figure F-1 0th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions July 2012

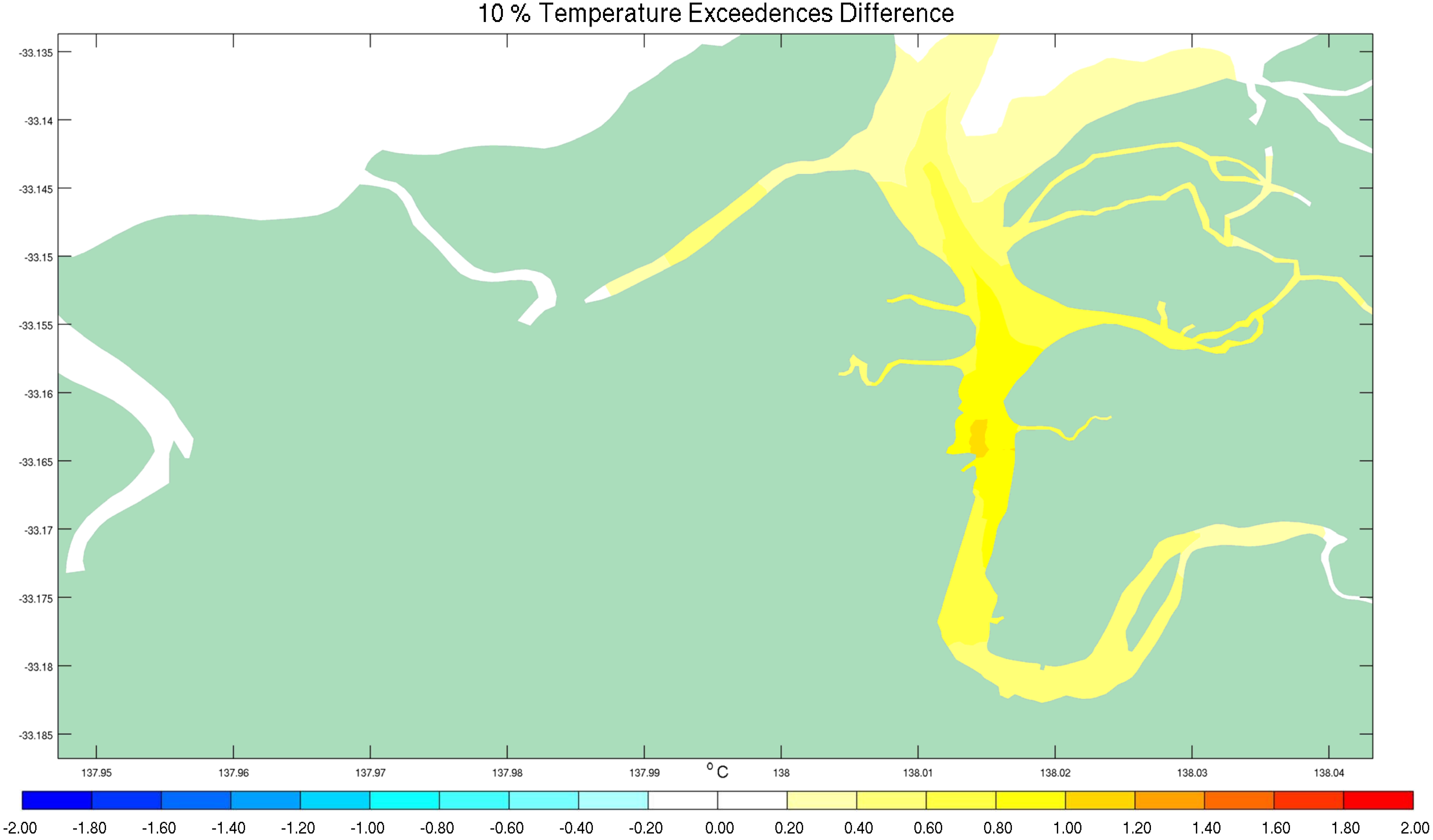

Figure F-2 10th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions July 2012

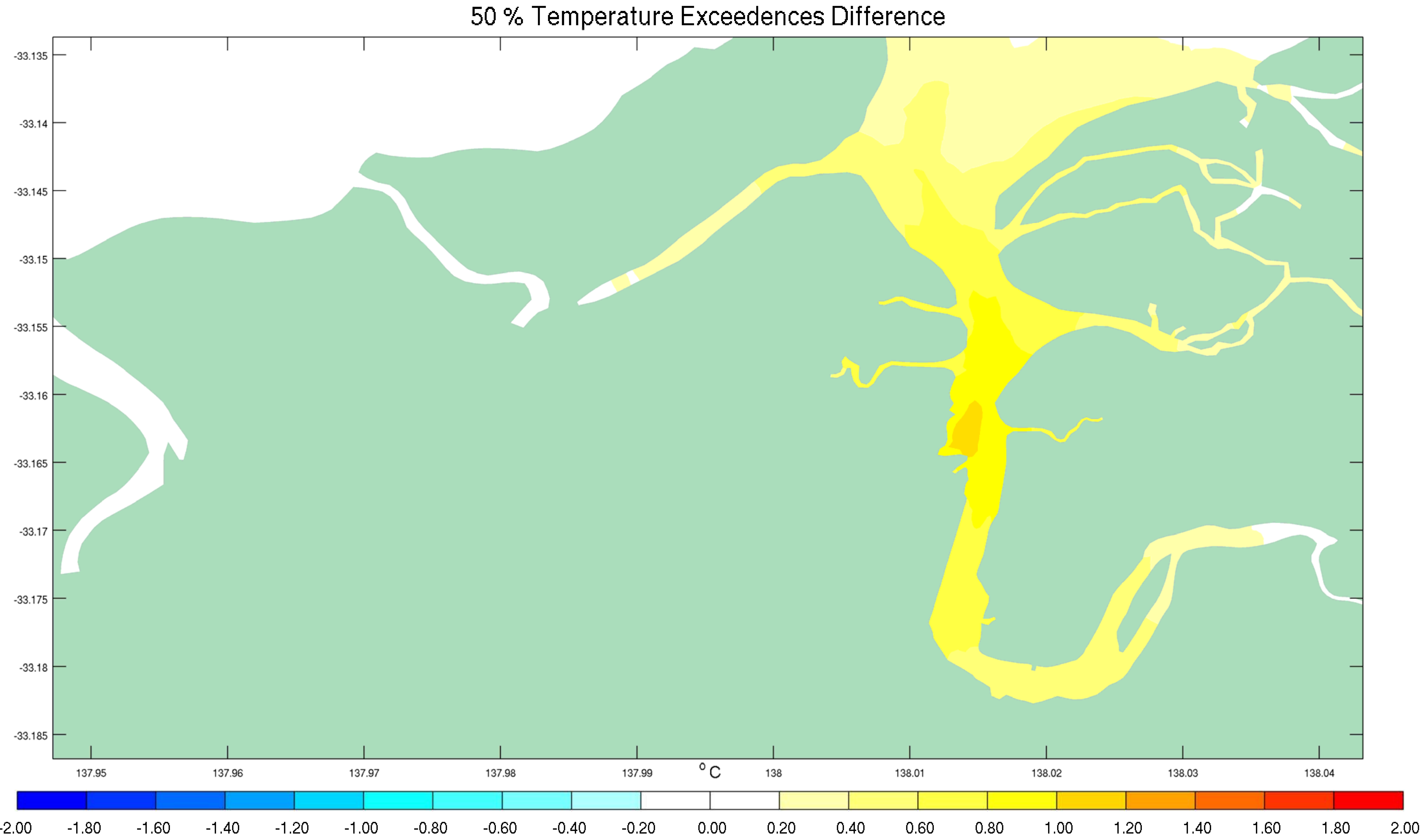

Figure F-3 50th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions July 2012

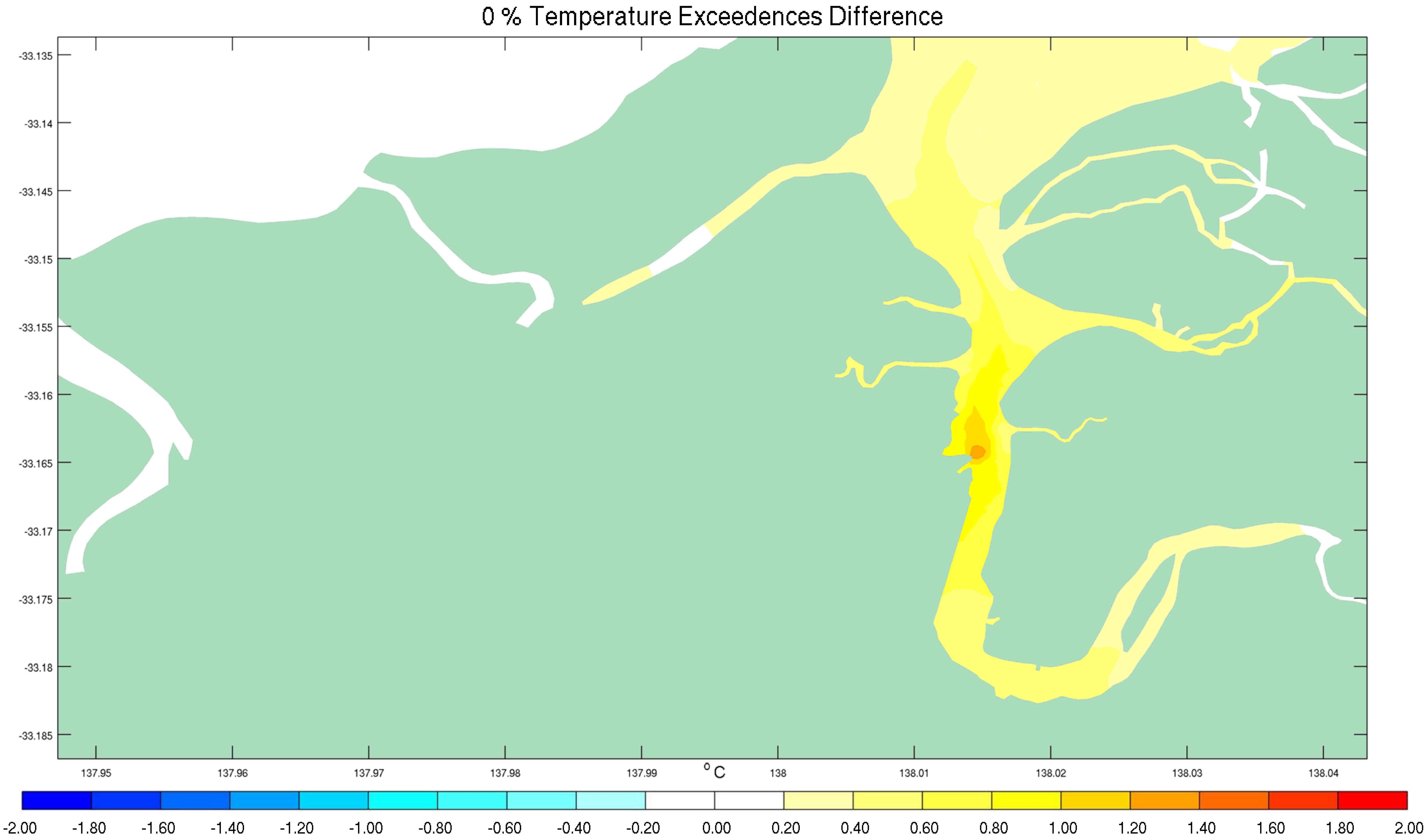

Figure F-4 0th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions August 2012

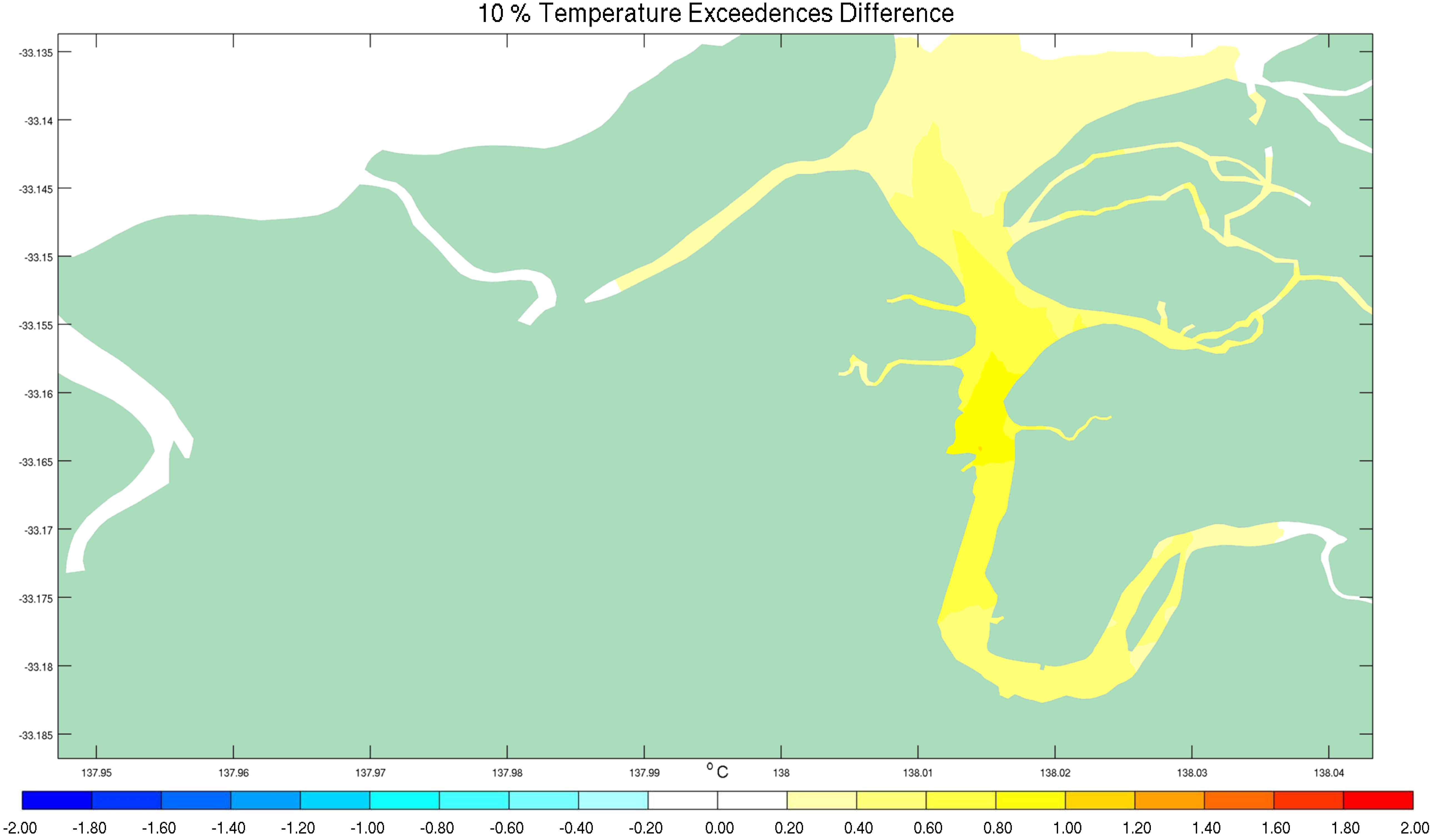

Figure F-5 10th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions August 2012

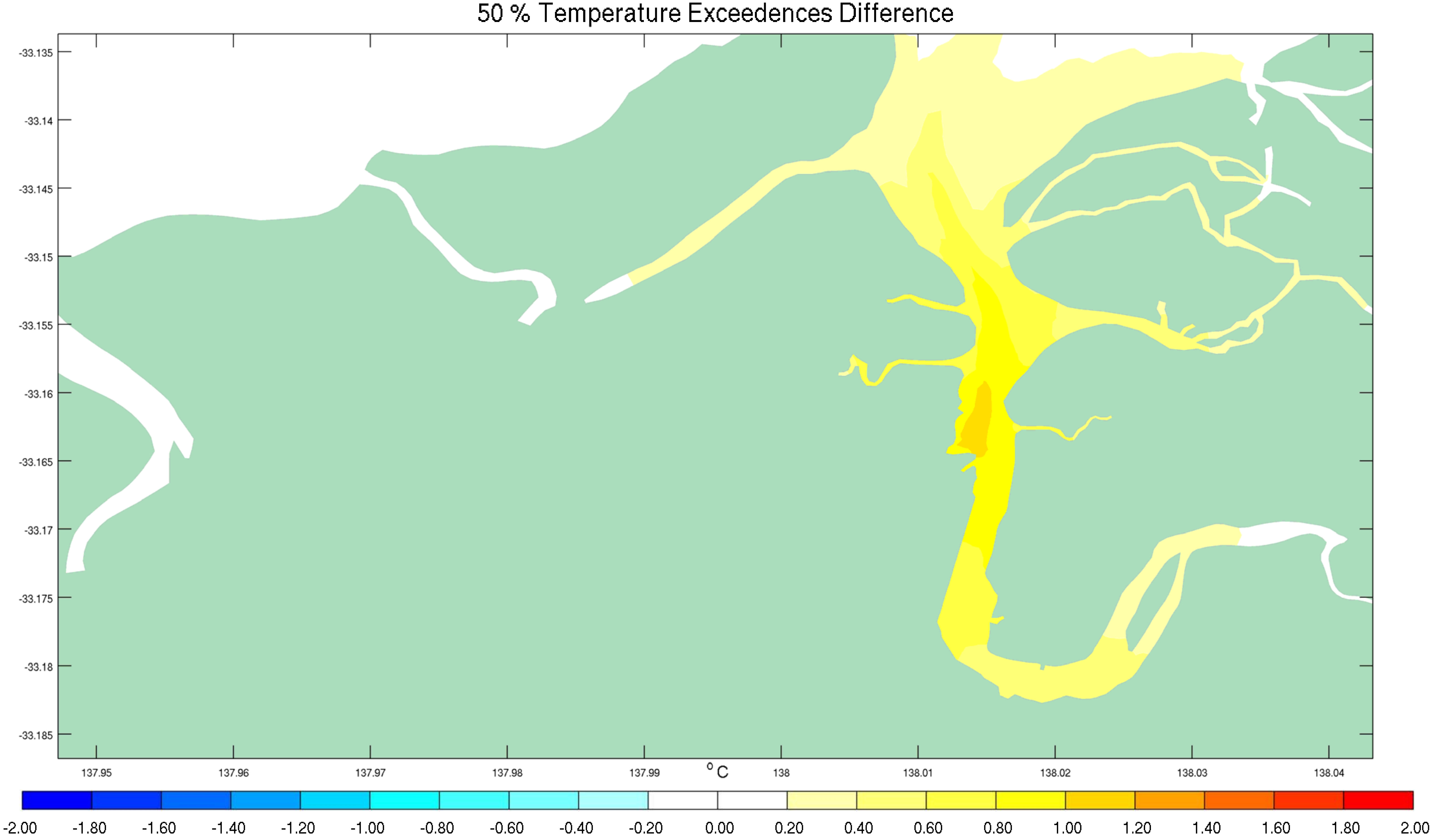

Figure F-6 50th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions August 2012

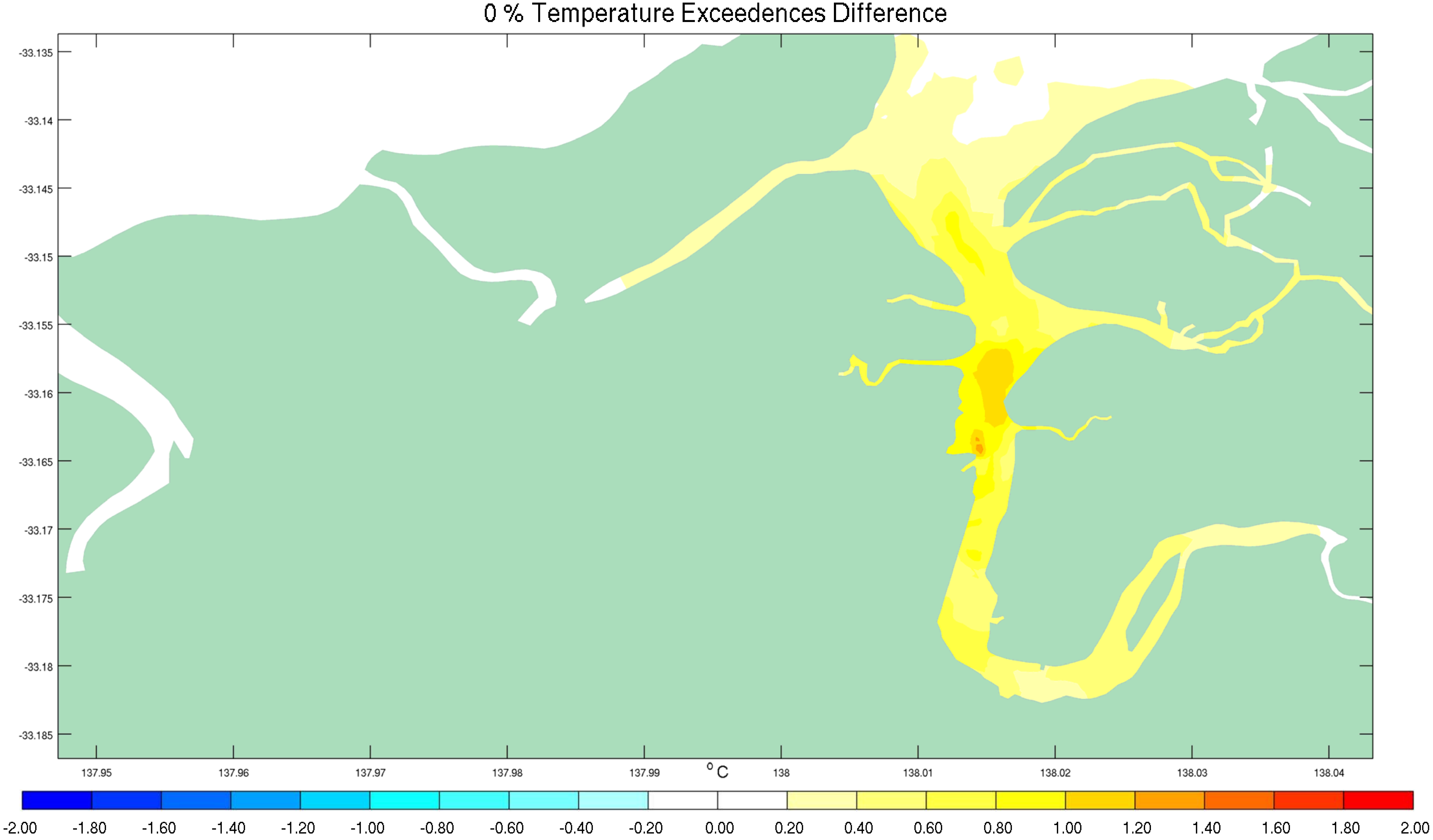

Figure F-7 0th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions September 2012

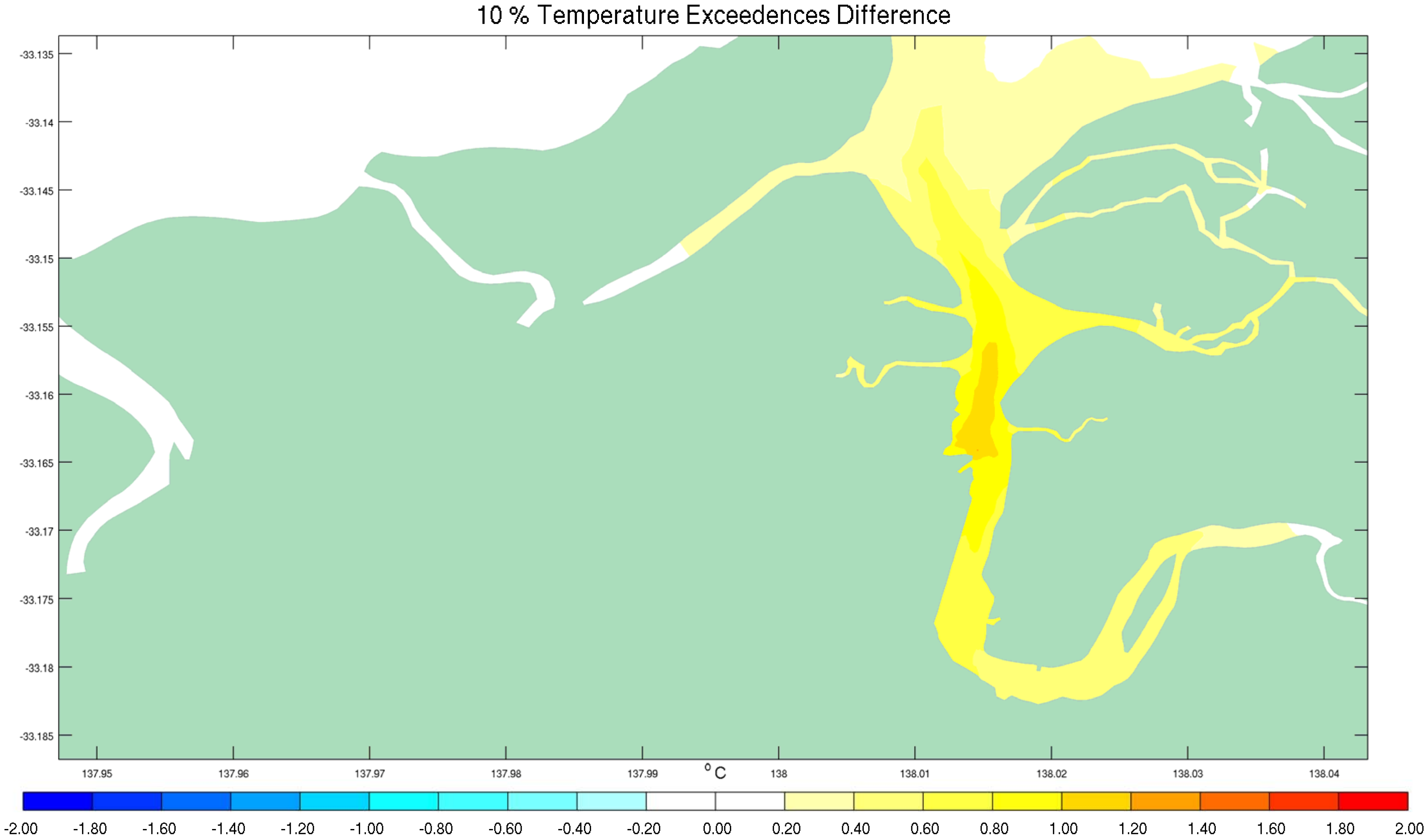

Figure F-8 10th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions September 2012

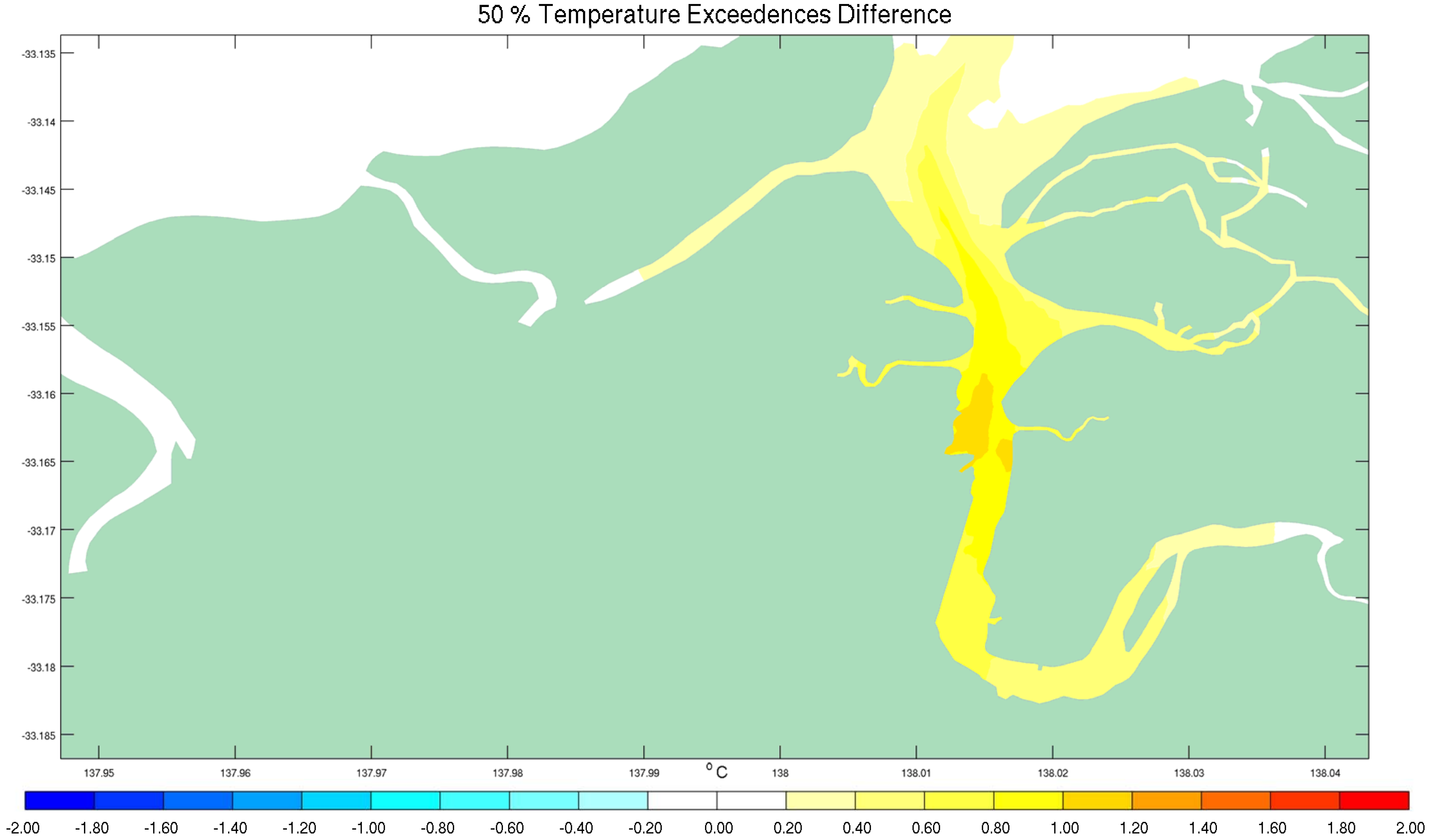

Figure F-9 50th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions September 2012

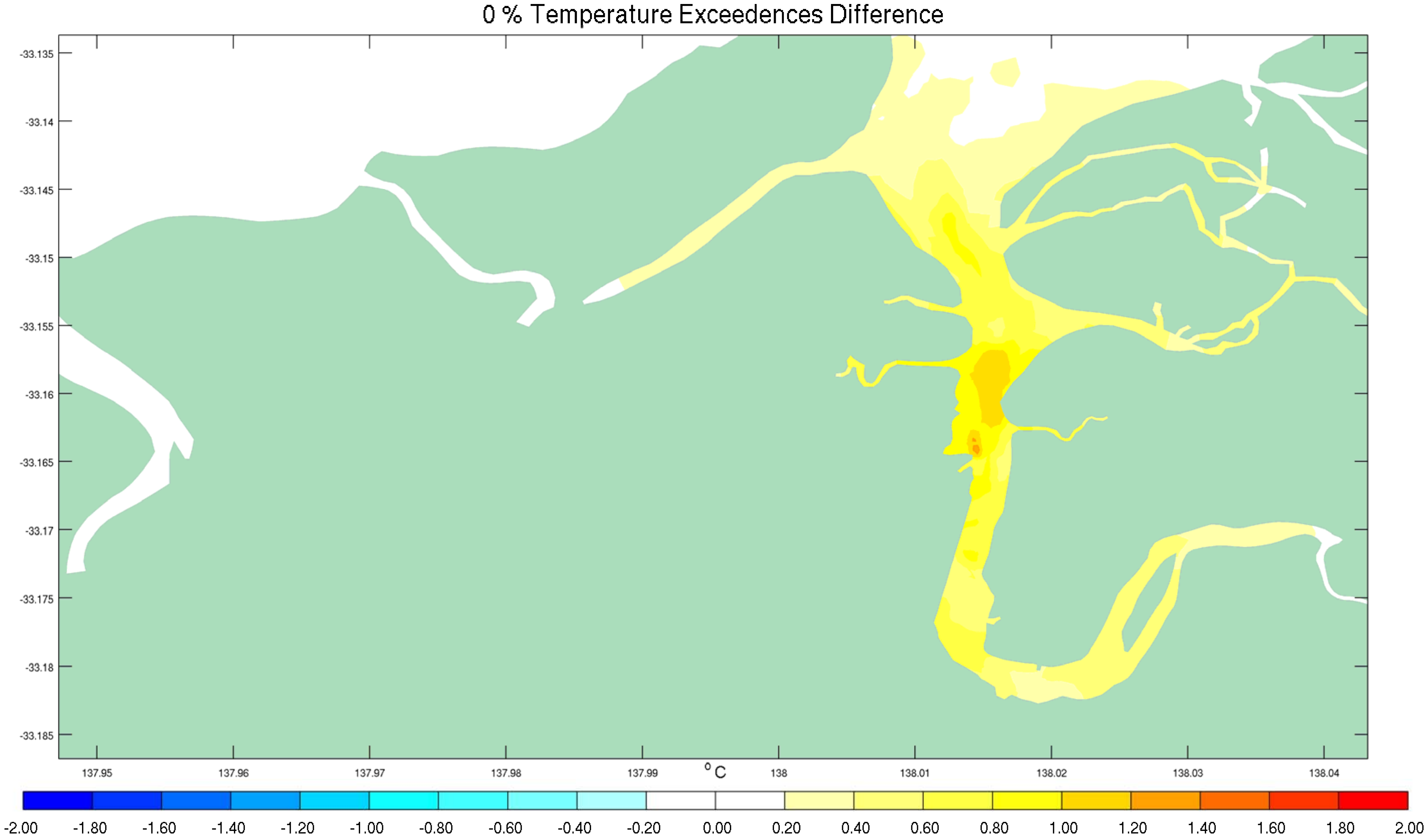

Figure F-10 0th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions July to September 2012

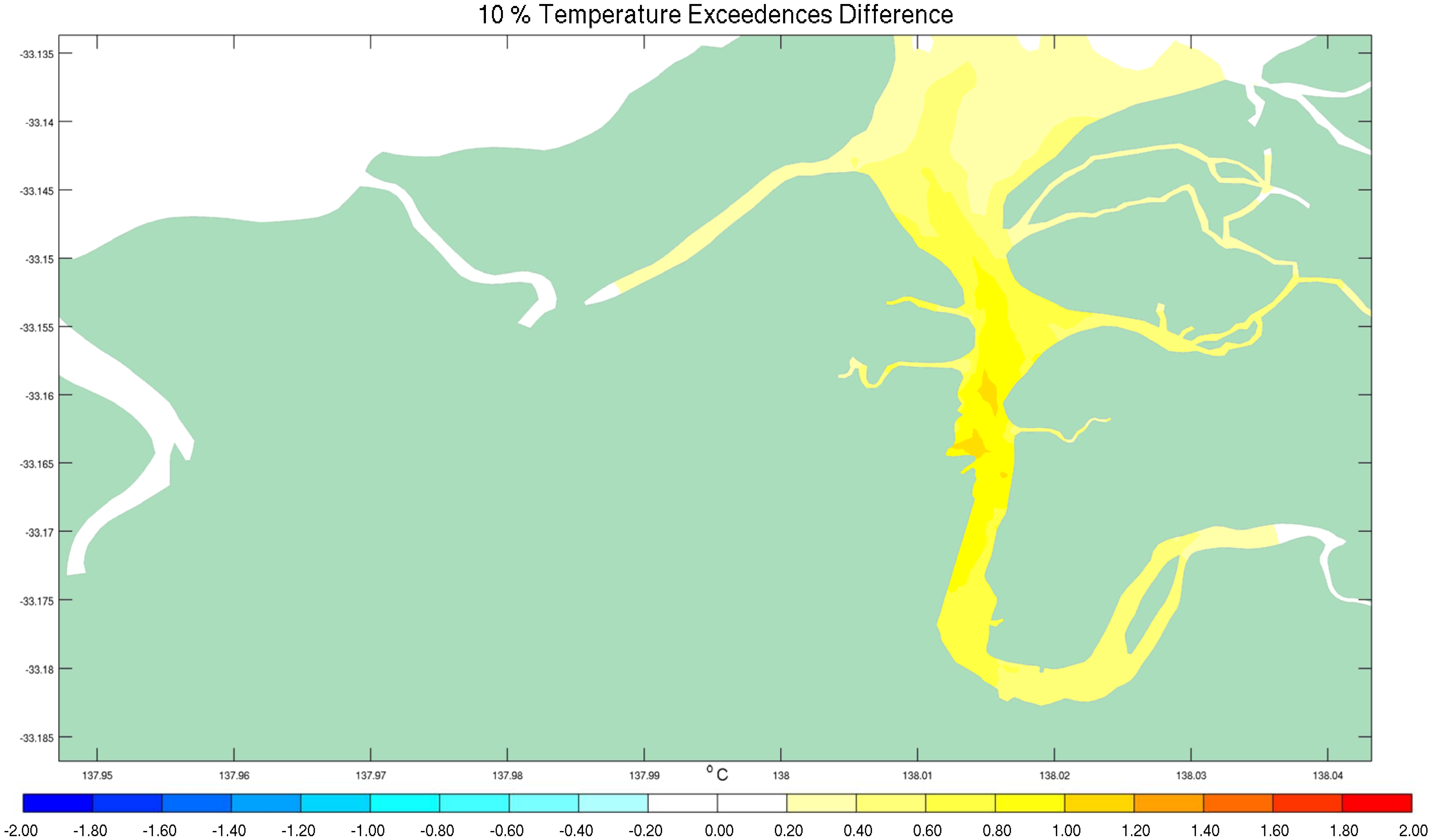

Figure F-11 10th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions July to September 2012

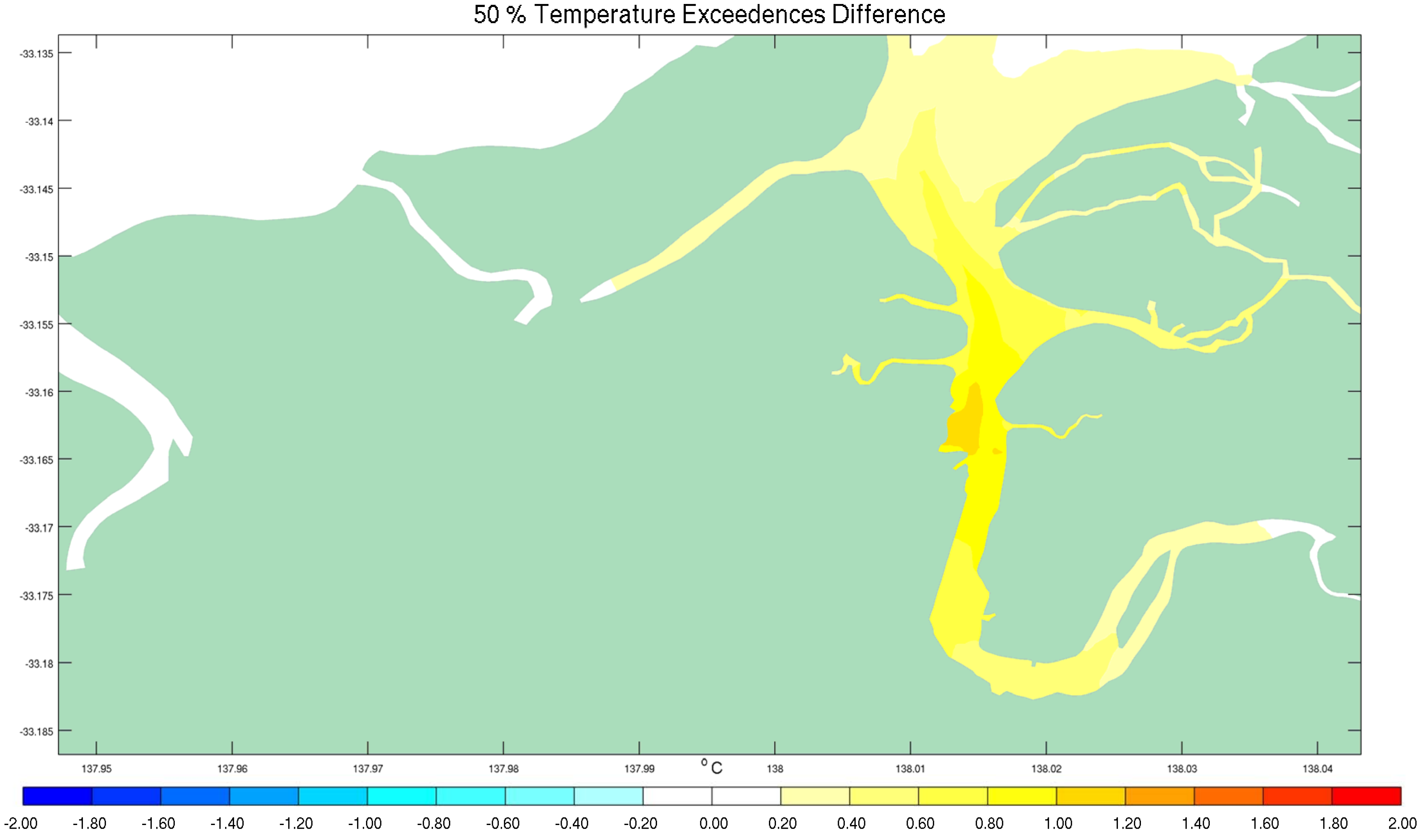

Figure F-12 50th Percentile Temperature Exceedences Difference between Discharge Scenario and Existing Conditions July to September 2012

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