EGU General Assembly 2022

Unsupervised classification identifies coherent thermohaline structures in the Weddell Gyre

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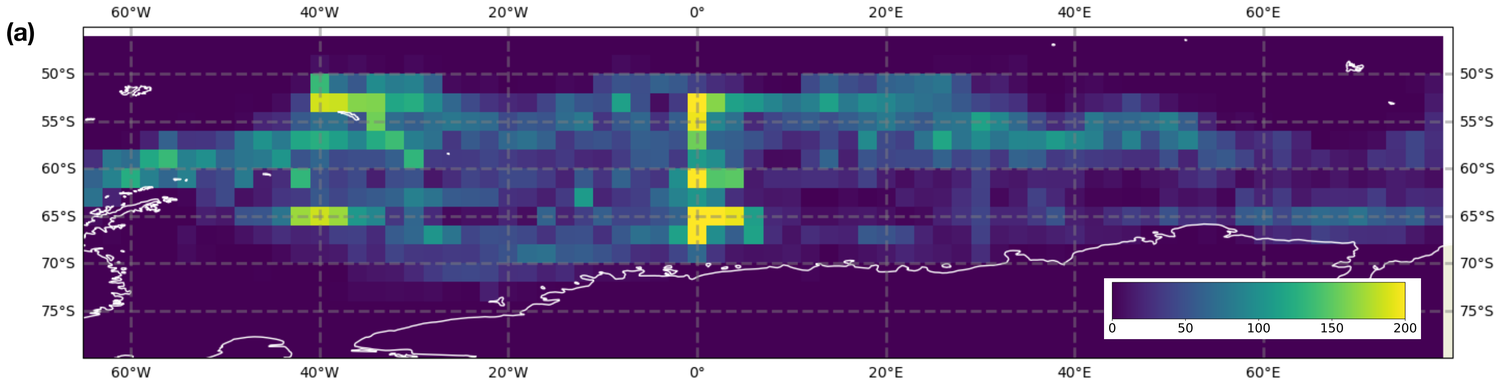
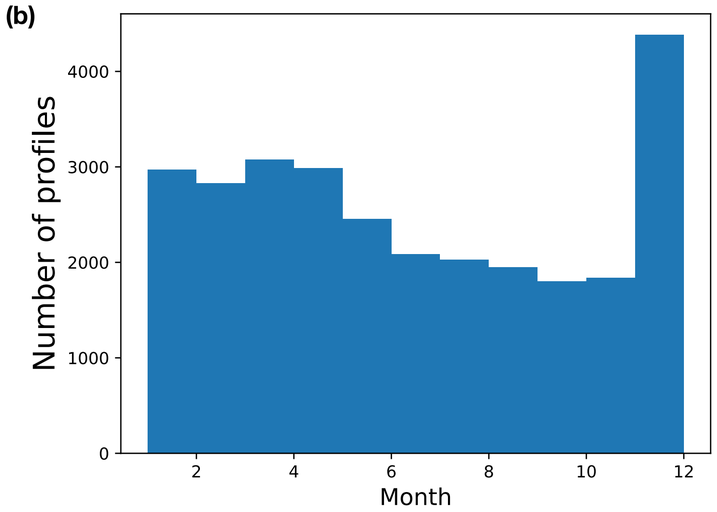
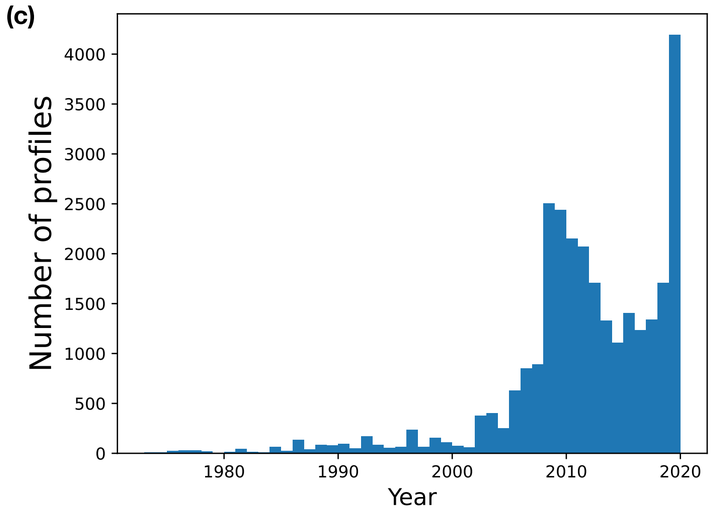
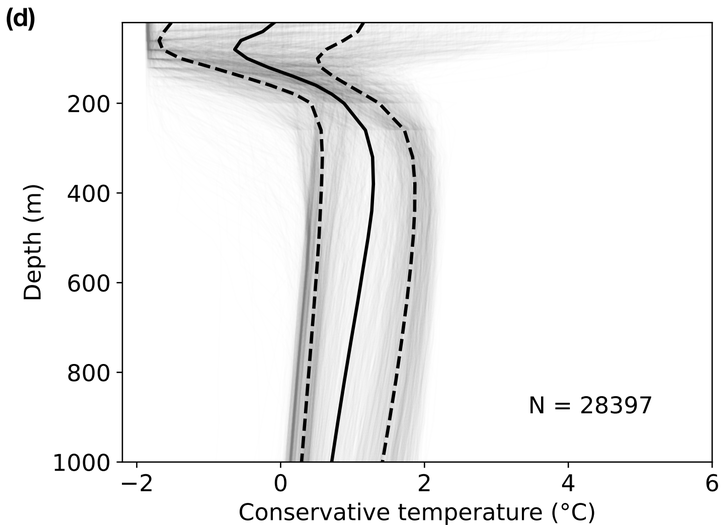
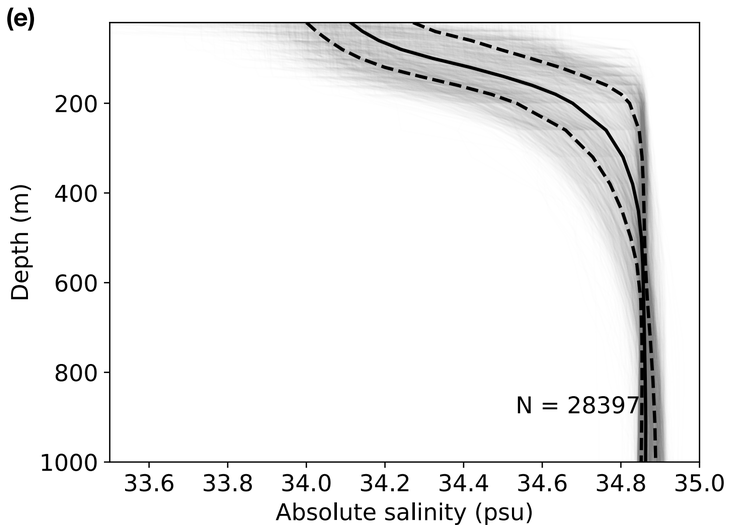










We aim to identify coherent profile types using temperature and salinity profiles from the Weddell Gyre region

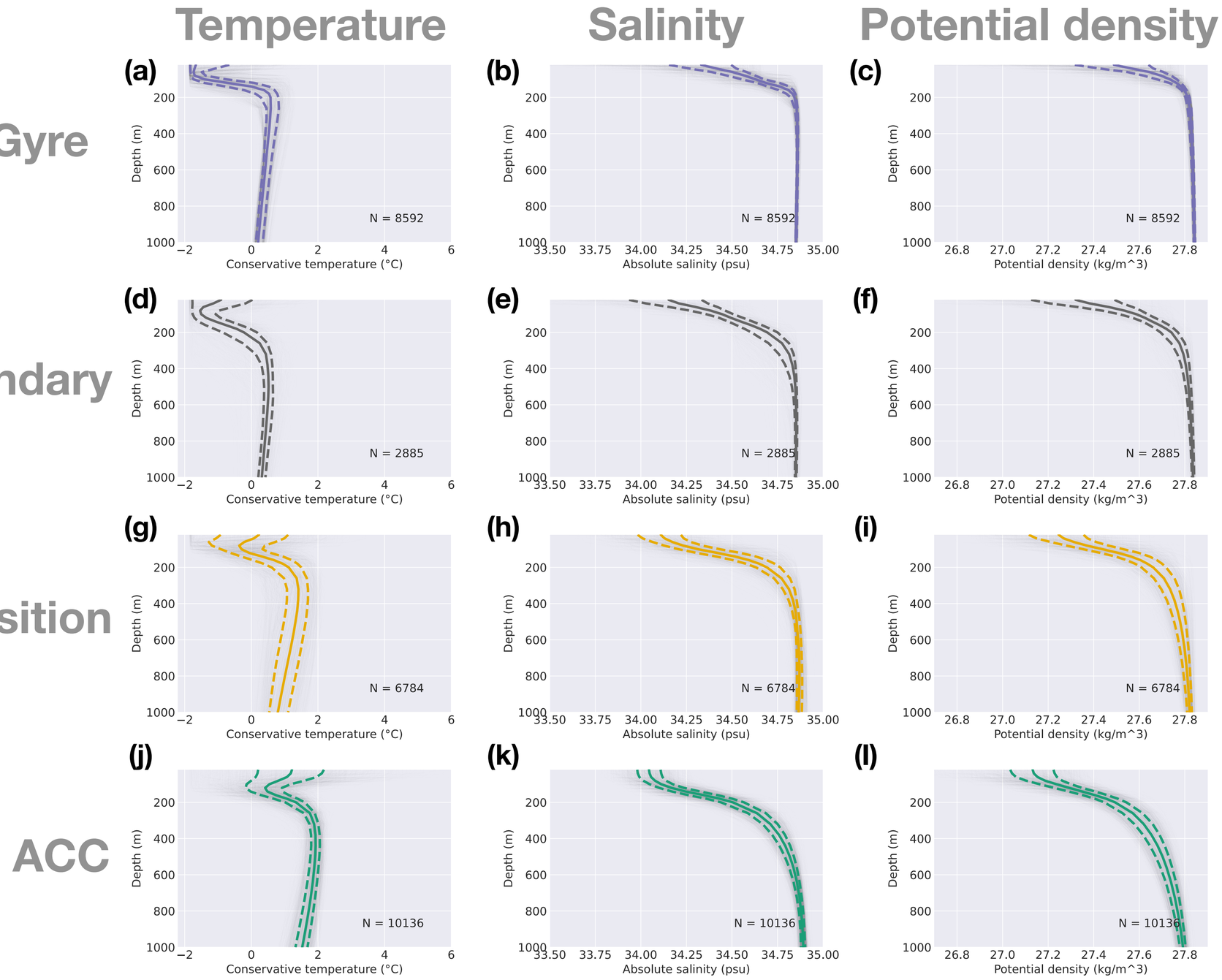
Data: Argo profiles and ship-based CTD profiles

Jones et al., *in prep.*

For more info on profile classification models, see: Maze et al. (2017), Jones et al. (2019), Houghton and Wilson (2020), Rosso et al. (2020), Boehme and Rosso (2021), Thomas et al. (2021), Sonnewald et al. (2021)

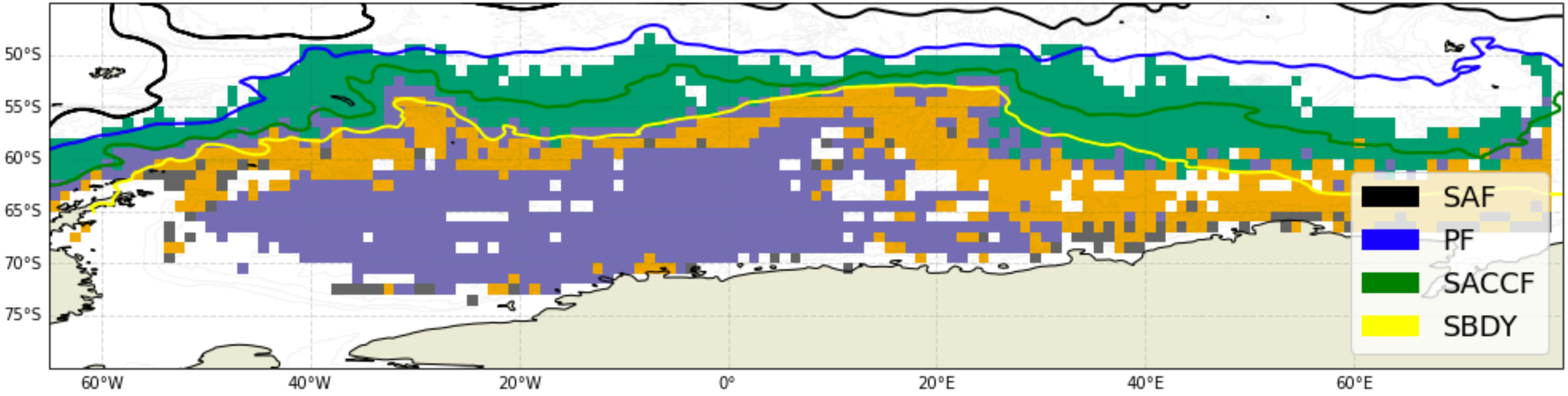
We use a *profile classification model* and identify four coherent profile types

They are salt stratified, as expected, with different density structures



Jones et al., *in prep.*

The spatial distribution of the profile types shows the separation between the Weddell Gyre, the ACC, and a transition region between the two

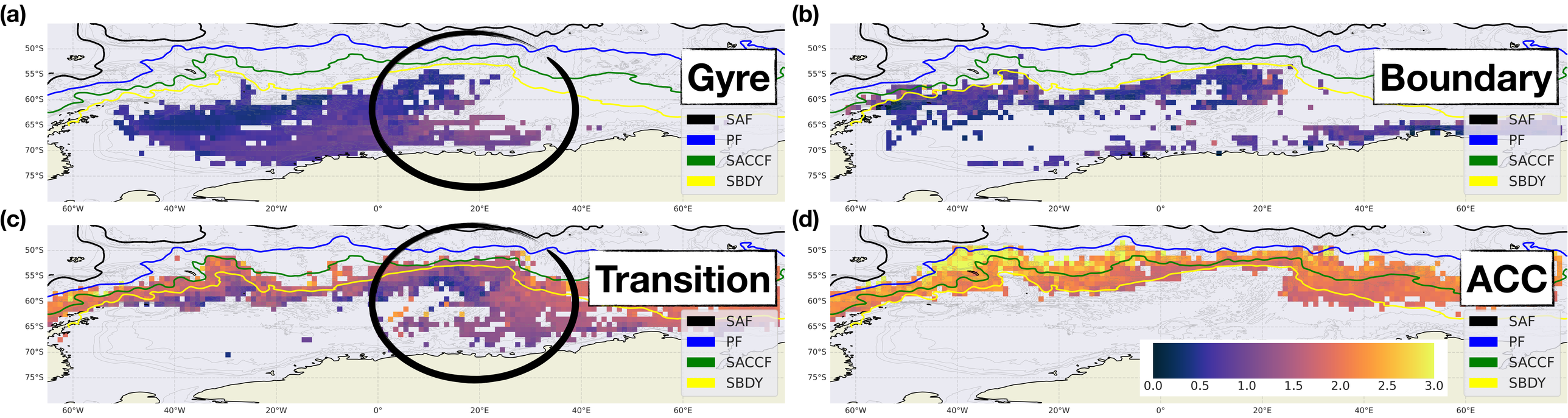


ACC | Gyre | Transition | Boundary

Jones et al., *in prep.*

Profile label in each 1°x1° grid cell

Maximum temperature features a signature of CDW intrusion into the eastern extension of the Weddell Gyre

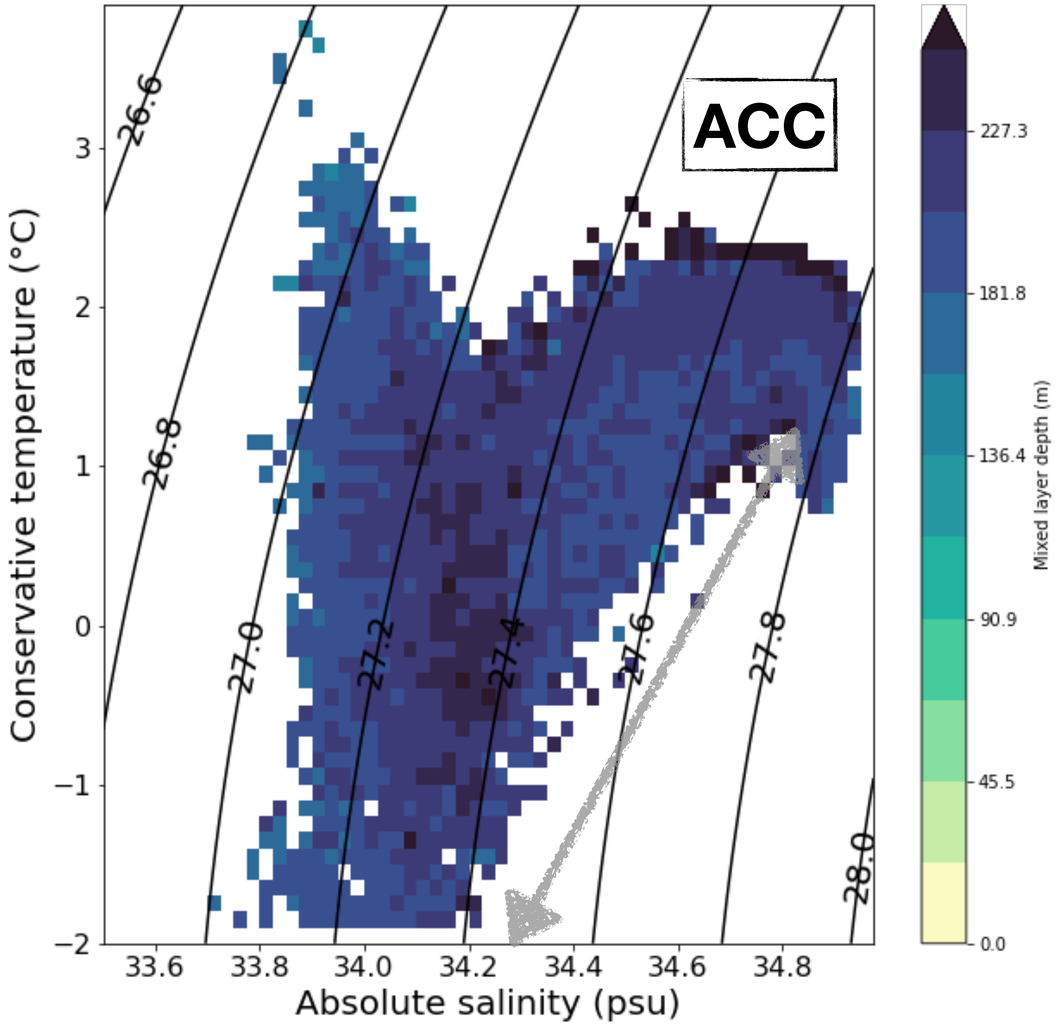


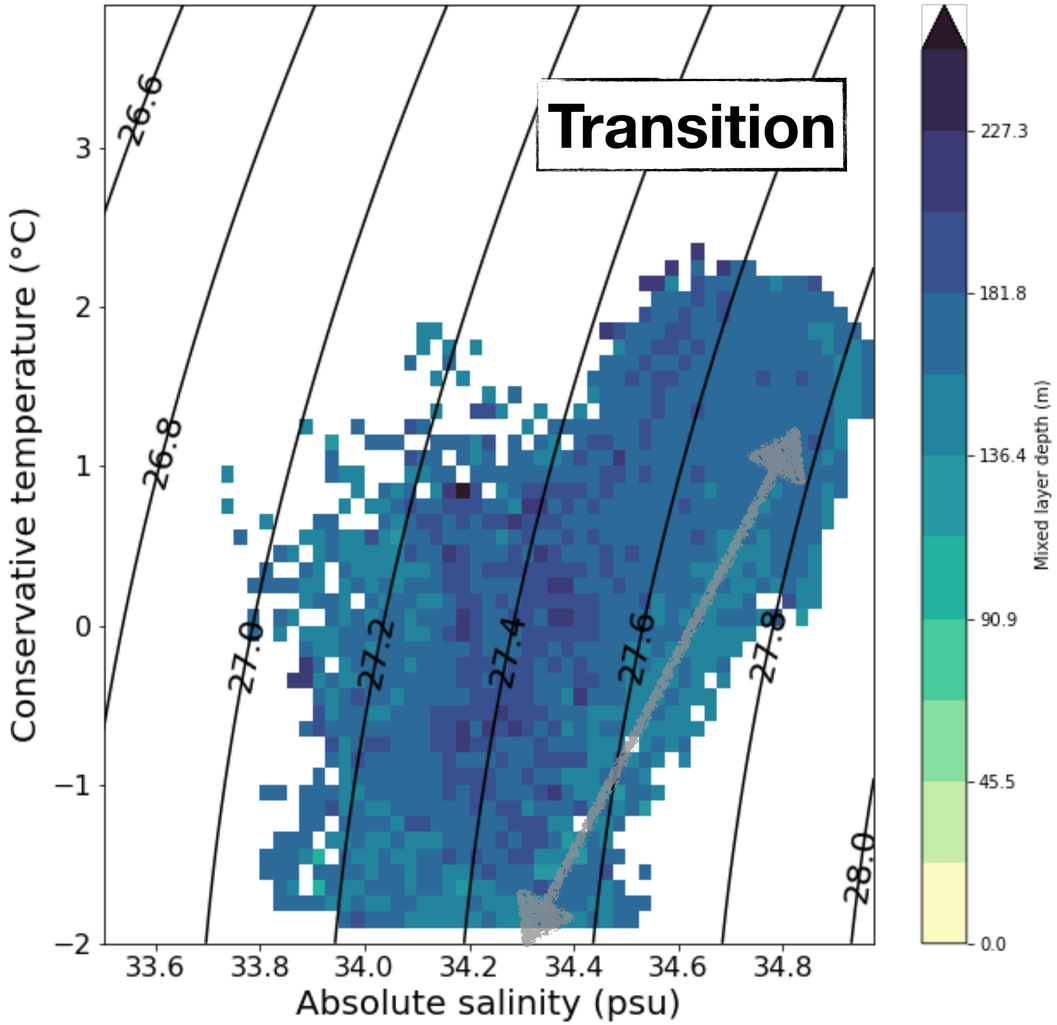
Maximum temperature by class (°C)

Jones et al., *in prep.*

Max temperature by class, in each 1°x1° grid cell

Signature of mixing between winter water and underlying waters: largely absent in the ACC, present in the transition region





Evans et al. (2018)
Jones et al., *in prep.*

JJA mixed layer depth, binned into 2D T-S histograms

ACC class shows possible warming, shoaling of max. temperature

Gyre class more highly variable, may be connected to wind stress variability

Maximum temperature

Depth of maximum temperature

Jones et al., *in prep.*

Discussion and conclusions

- Unsupervised classification is emerging as a useful data analysis tool in oceanography (for a review, see Sonnewald et al., 2021)

- Applied south of the Polar Front, we identify four coherent types of thermohaline structure, each with physically interpretable features

- The ACC and the transition region have different mixing signatures on a temperature-salinity diagram

- Possible warming and shoaling of max. temp. surface in ACC (more work needed)

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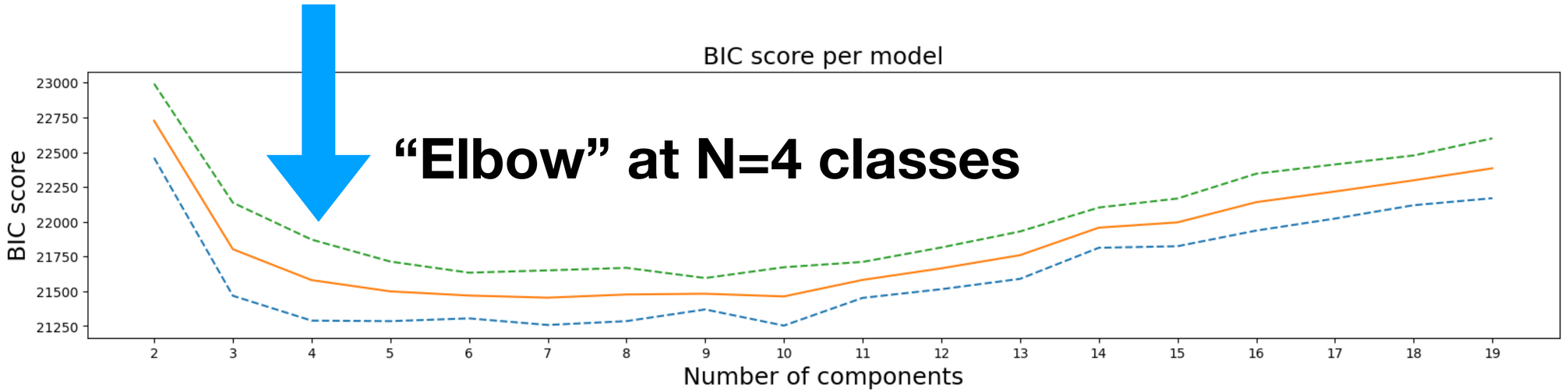
Supplemental Slides

Selecting the number of classes: the answer depends on the level of detail required

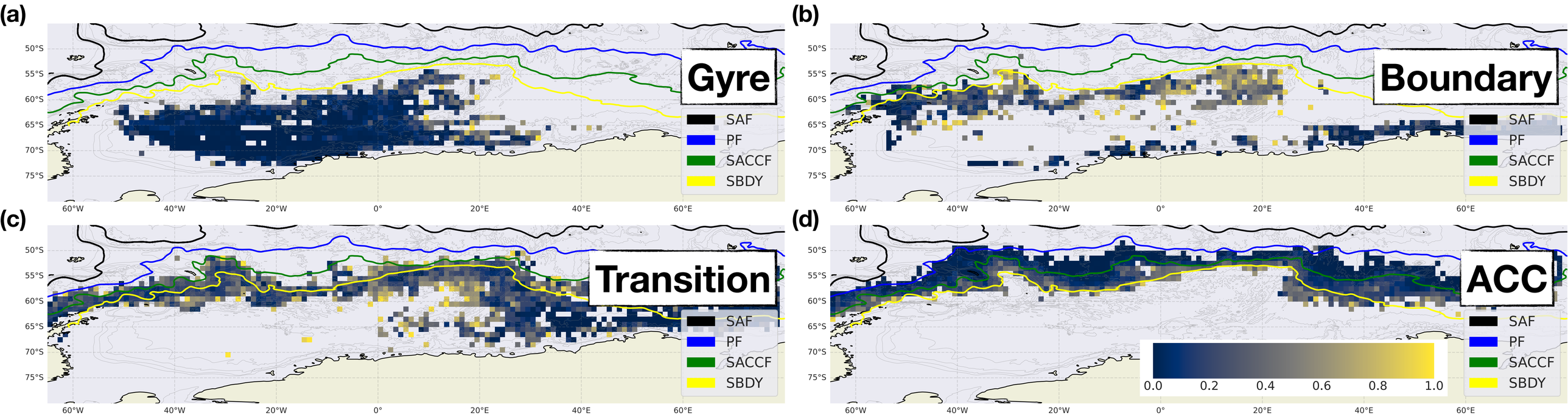
BIC = Bayesian information criterion



Fewer classes: captures dominant structures, simpler to interpret

More classes: captures more subtle structures, requires more complex interpretations

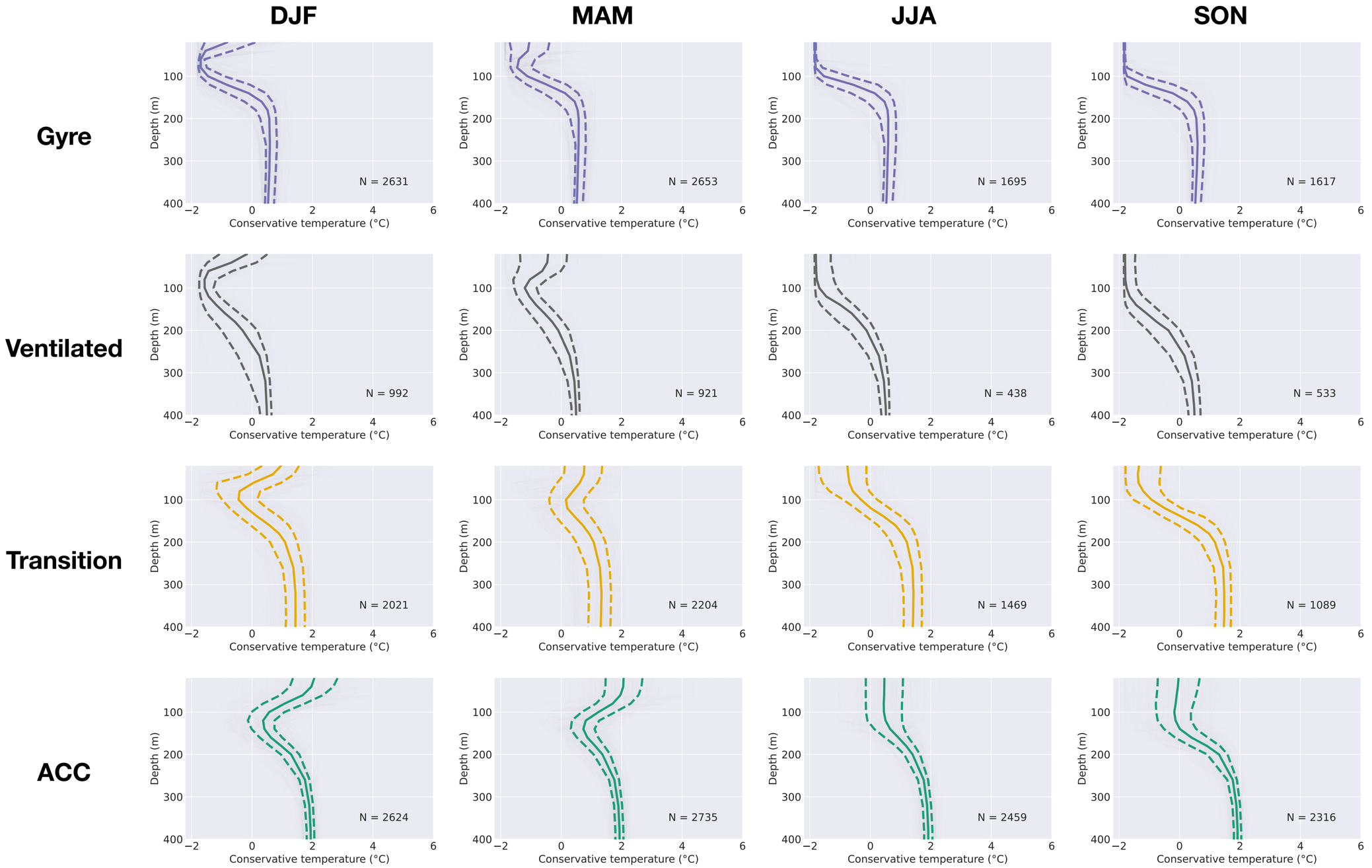
I-metric shows the boundaries between profile types, including mixing regions

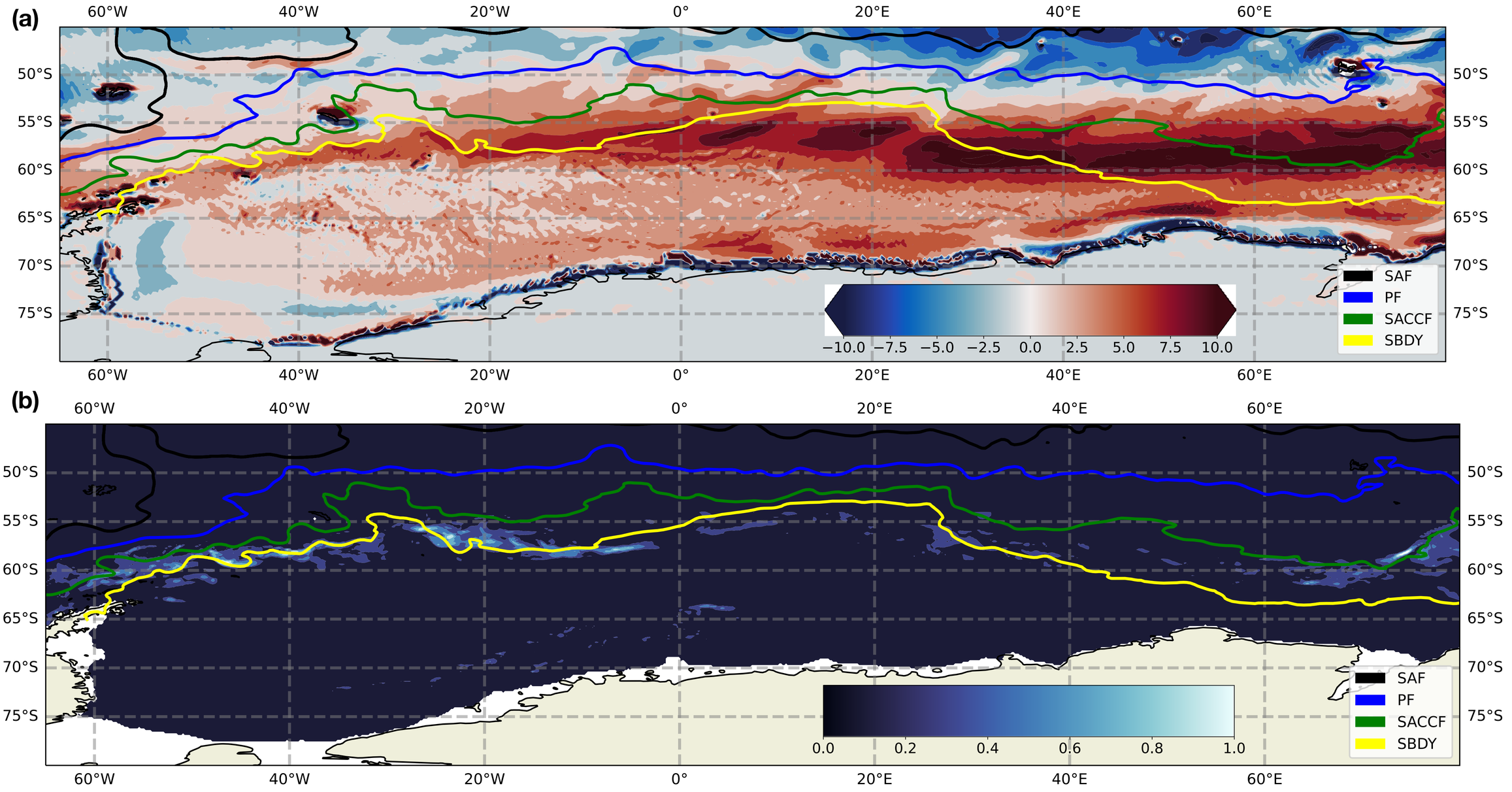


0 : not likely to be at a boundary between classes
1 : likely to be at a boundary between classes

Jones et al., *in prep.*

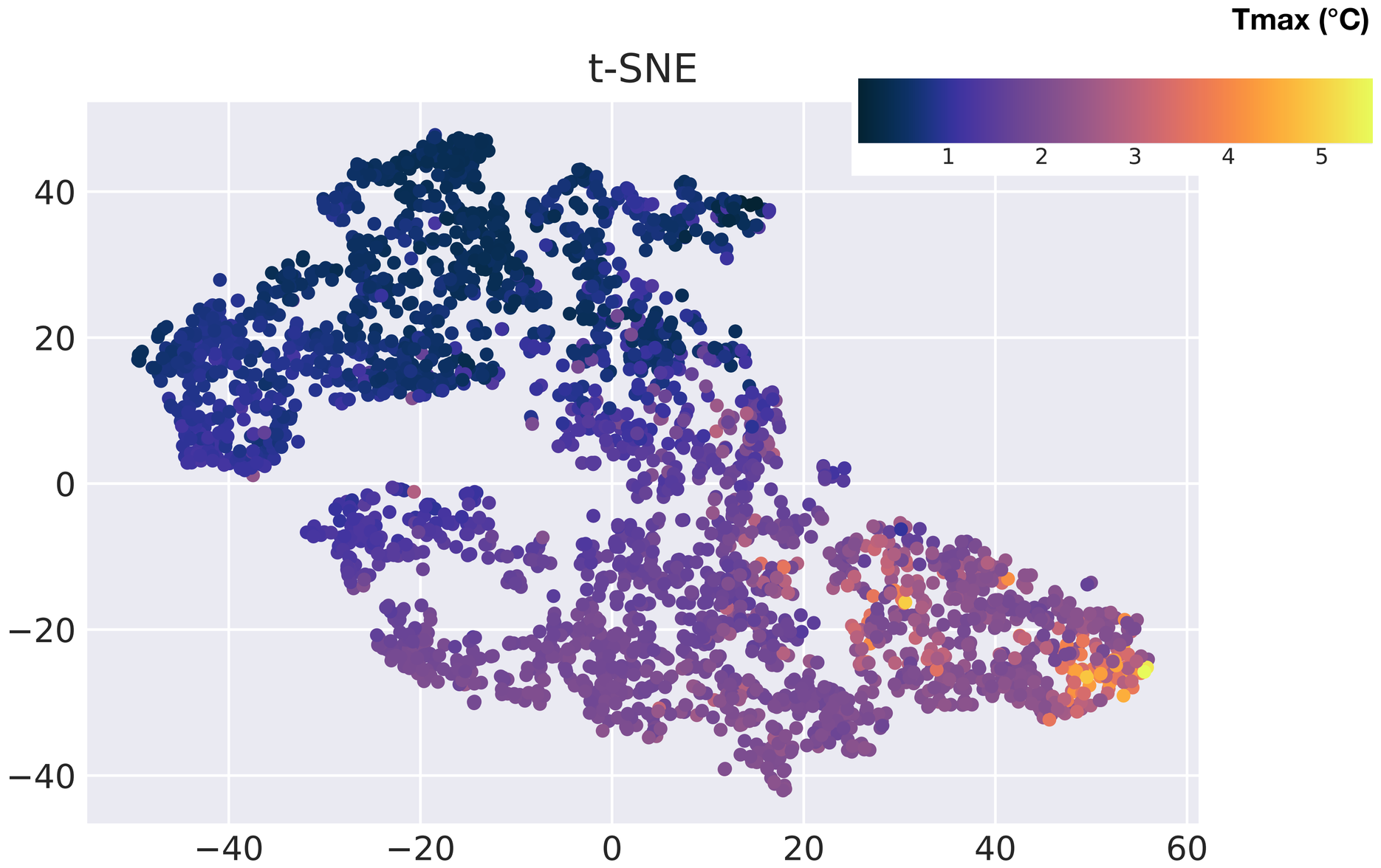
i-metric by class, in each 1°x1° grid cell


DJF
MAM
JJA
SON
Gyre
Ventilated
Transition
ACC
Depth (m)
Conservative temperature (°C)
N = 2631
N = 2653
N = 1695
N = 1617
N = 992
N = 921
N = 438
N = 533
N = 2021
N = 2204
N = 1469
N = 1089
N = 2624
N = 2735
N = 2459
N = 2316



a) Observationally-derived upwelling/downwelling from ocean surface stress

(b) Flux from sea ice freezing (brine rejection), at the sea ice edge as shown in SOSE.


Tmax (°C)
t-SNE
1
2
3
4
5
40
20
0
−20
−40
−40
−20
0
20
40
60