

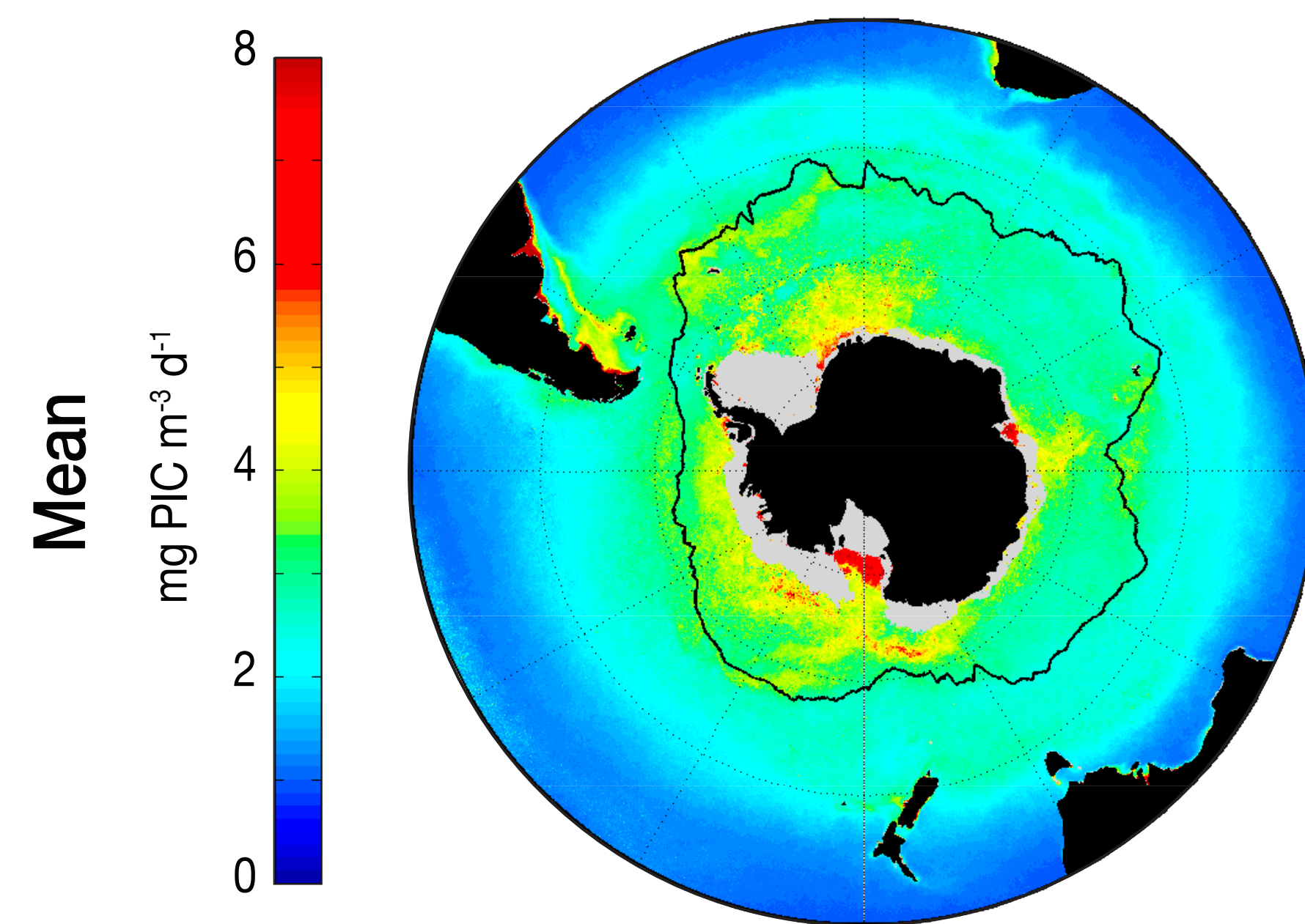
# Recent trends in Southern Ocean Biogeochemistry

Natalie Freeman and Nicole Lovenduski

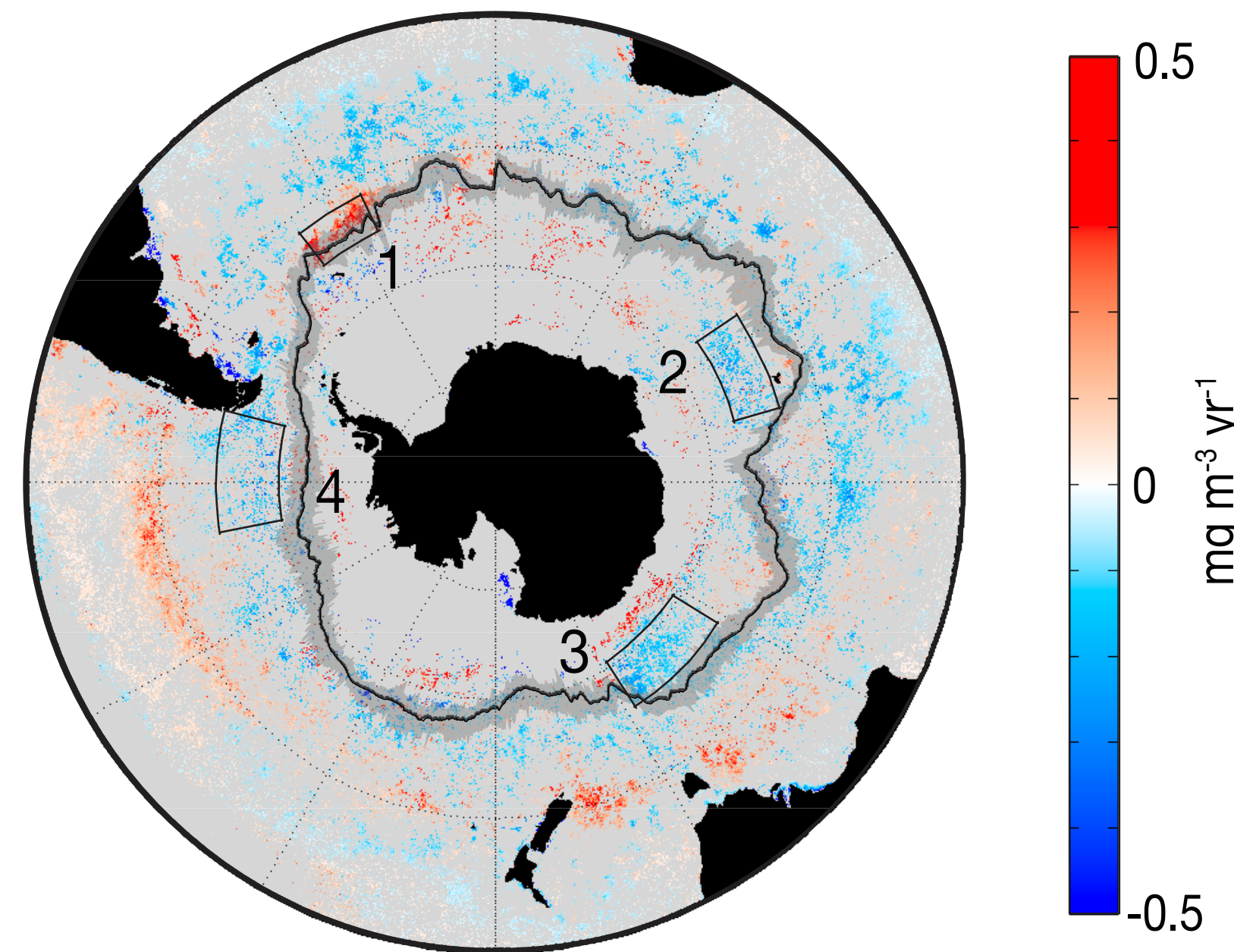
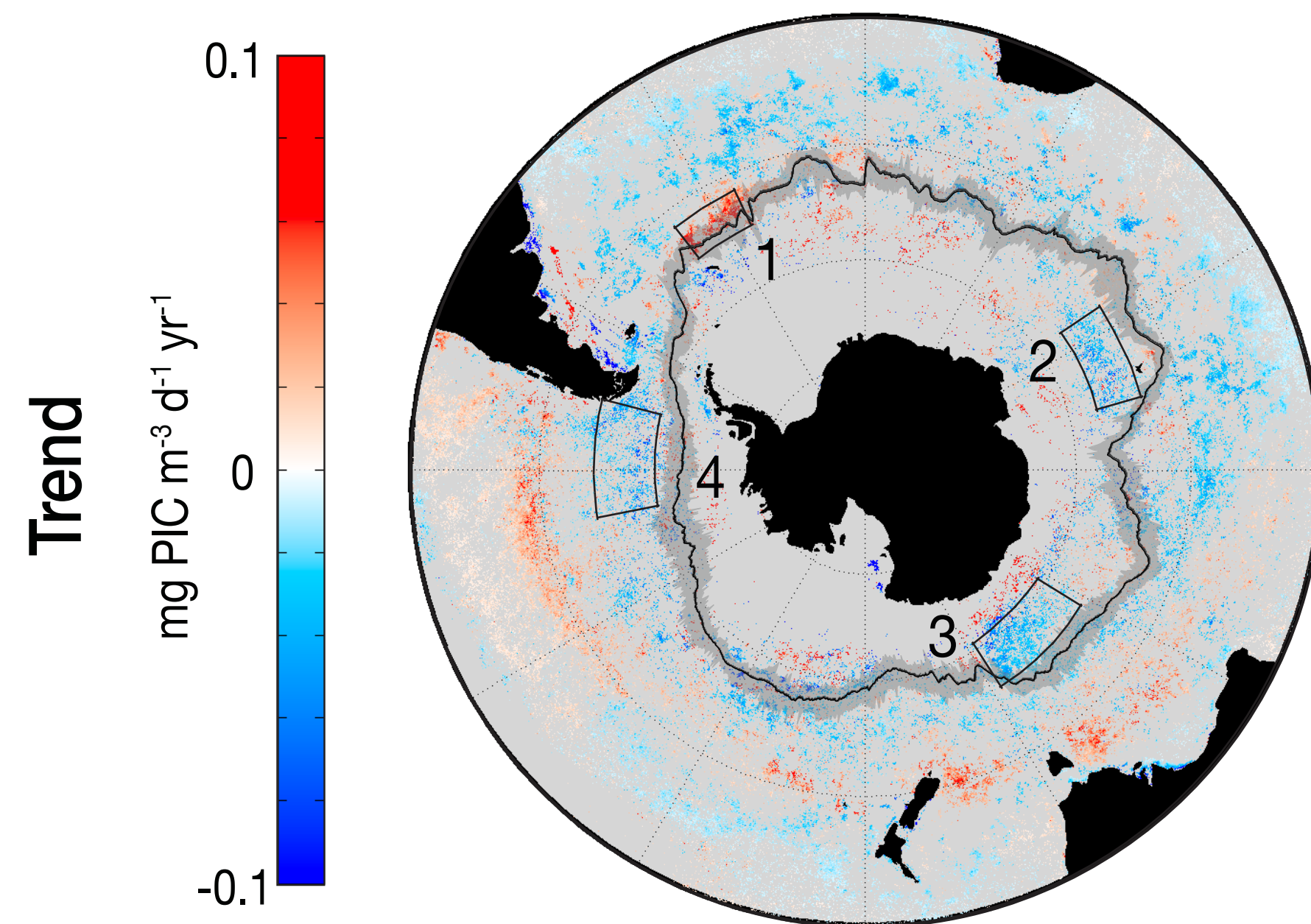
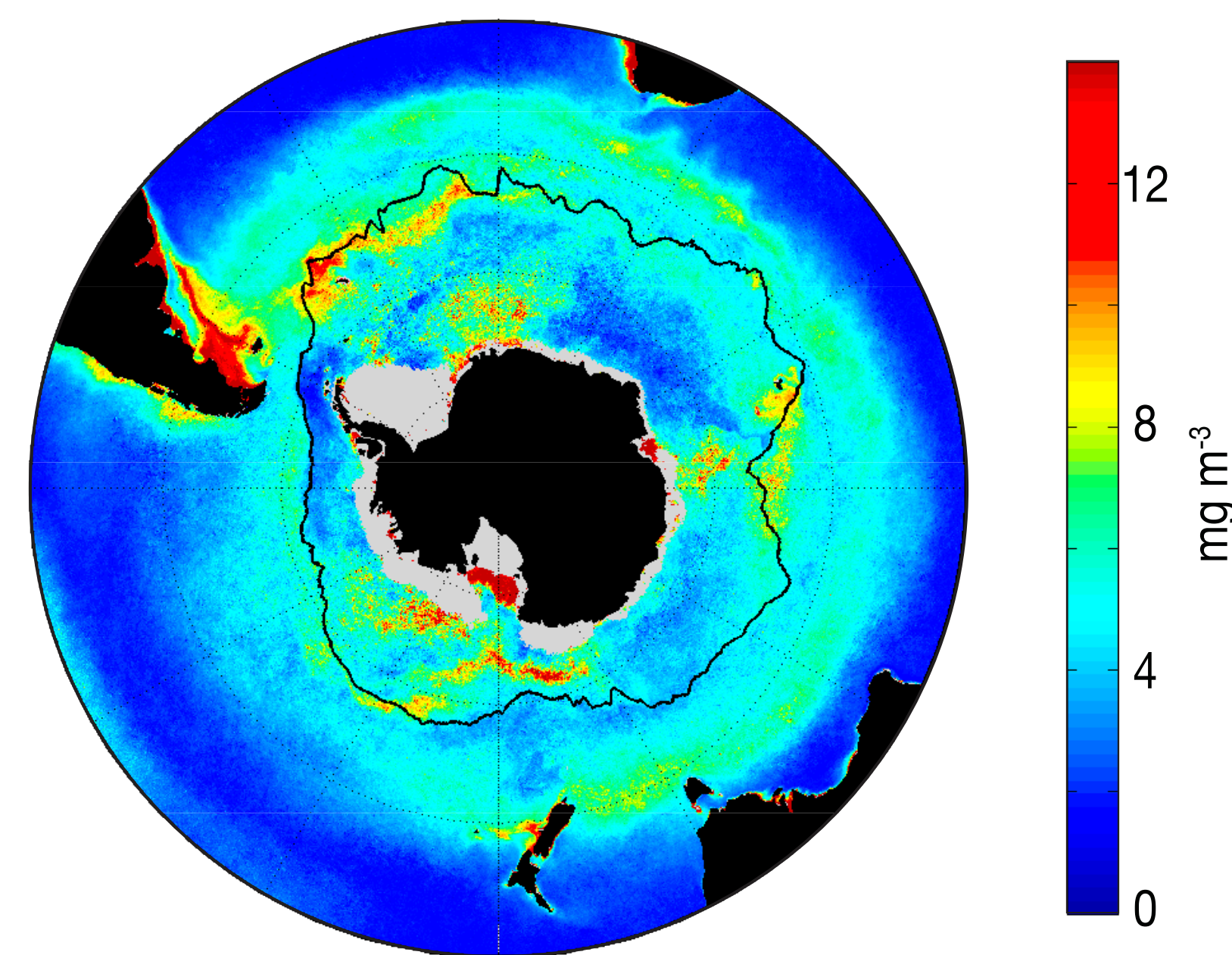
# Recent trends in the location of the Polar Front

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## Calcification Rate

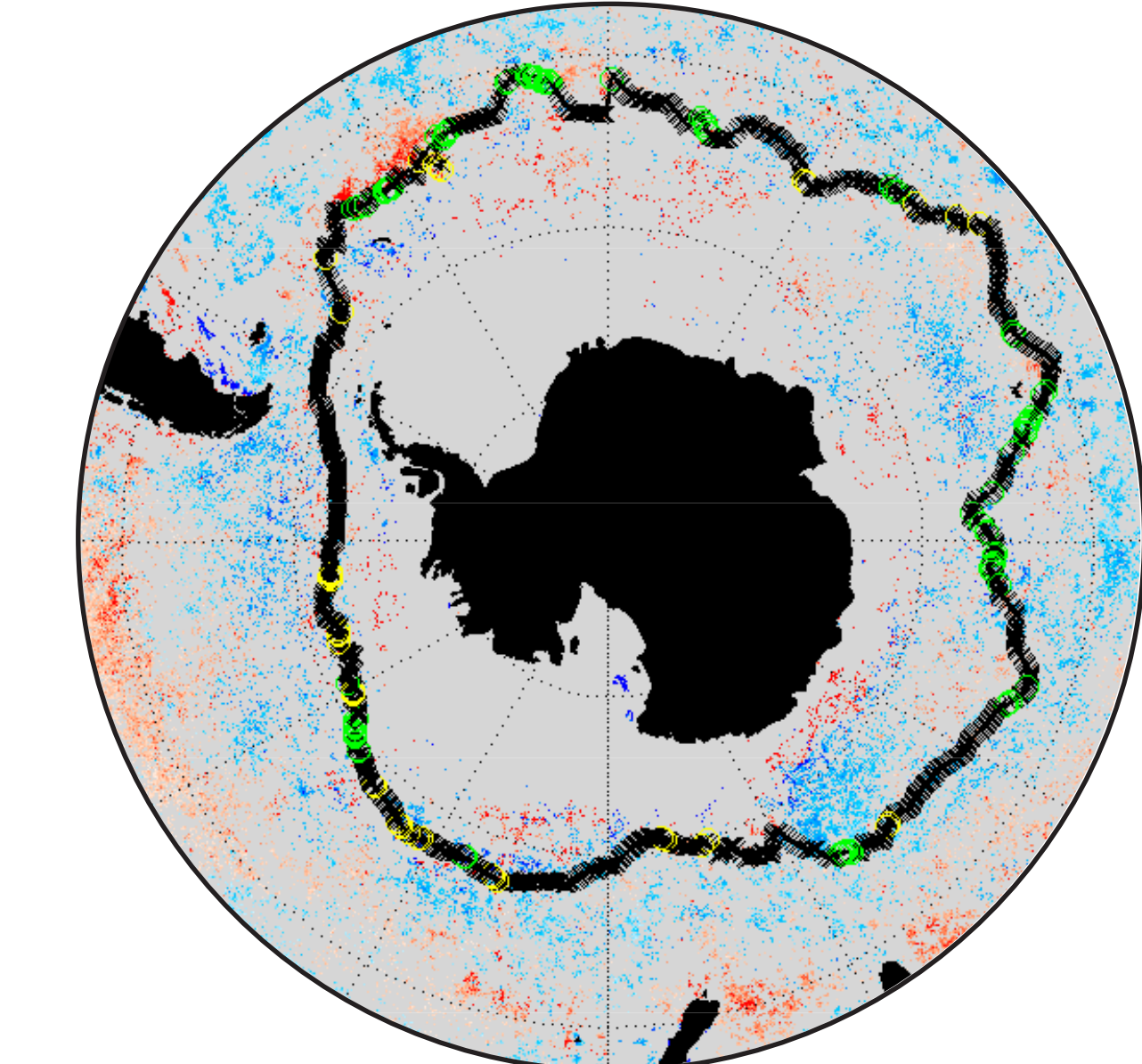
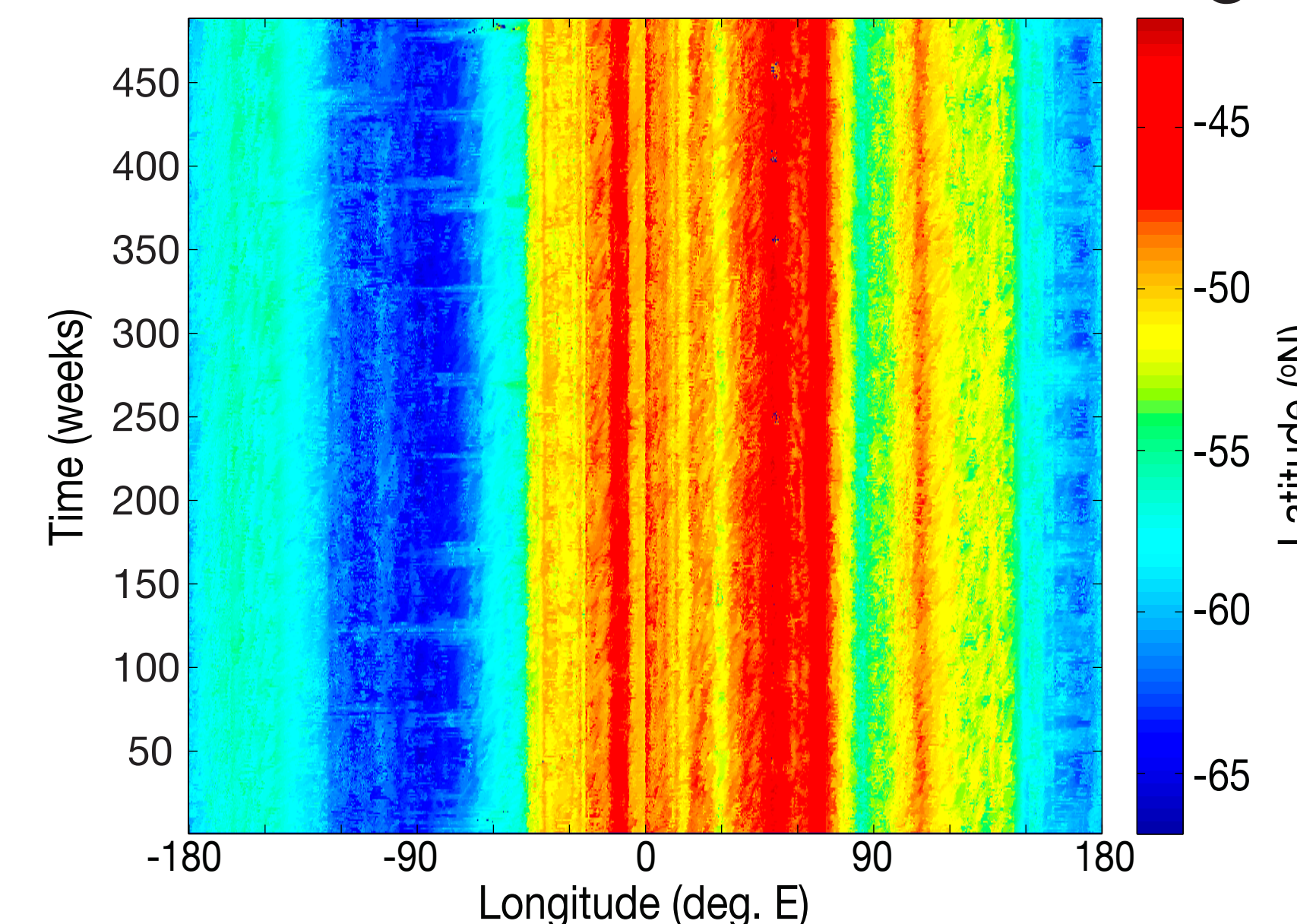


## Particulate Inorganic Carbon



Maps of Southern Ocean summer (DJF) mean state of and linear trends in calcification rate and particulate inorganic carbon, corrected for the presence of summer sea ice. Only those trends significant at the 95% level are shown. The black line and gray shading indicate the average summer location of the Antarctic Polar Front. Boxes indicate regions singled out for further analysis.

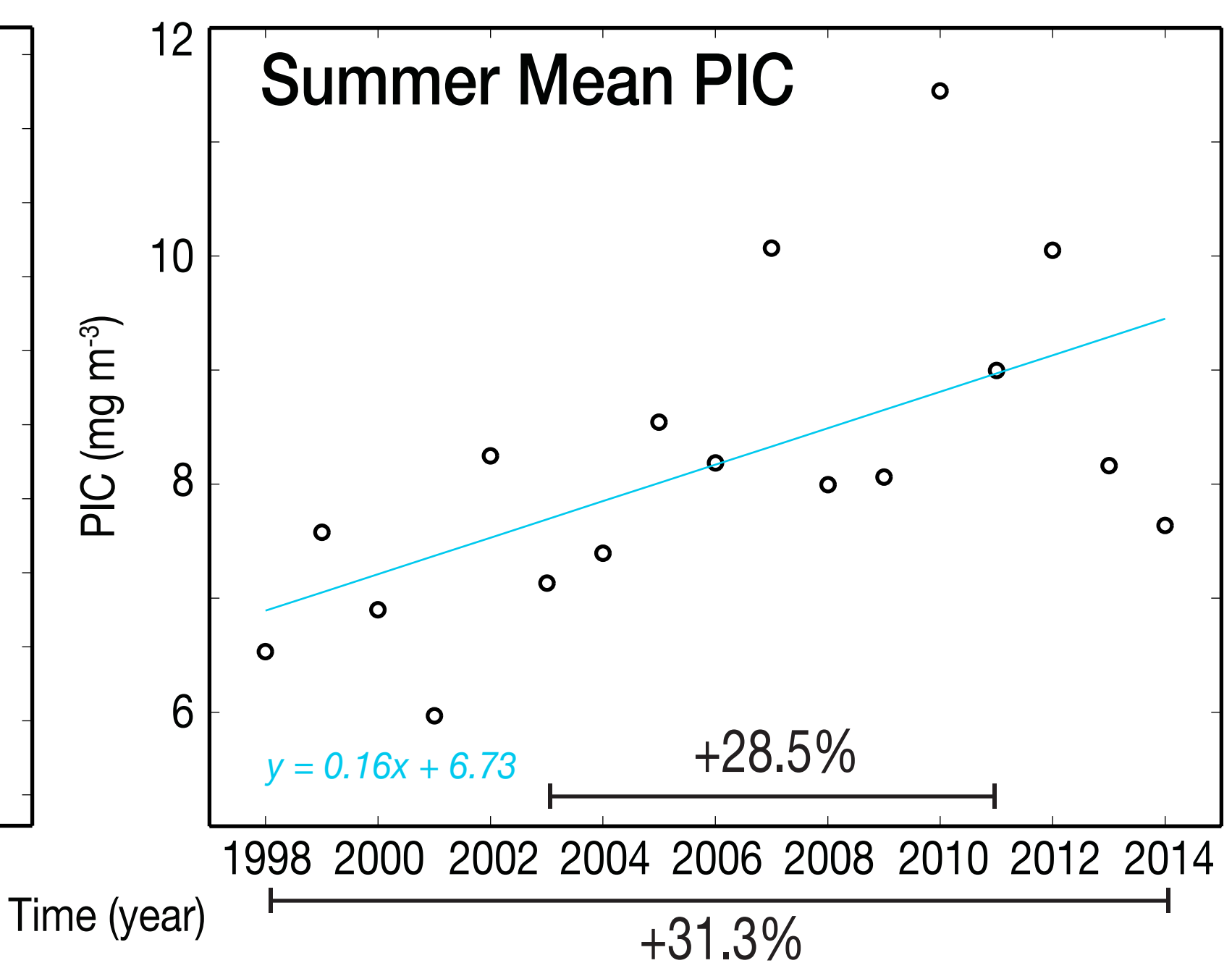
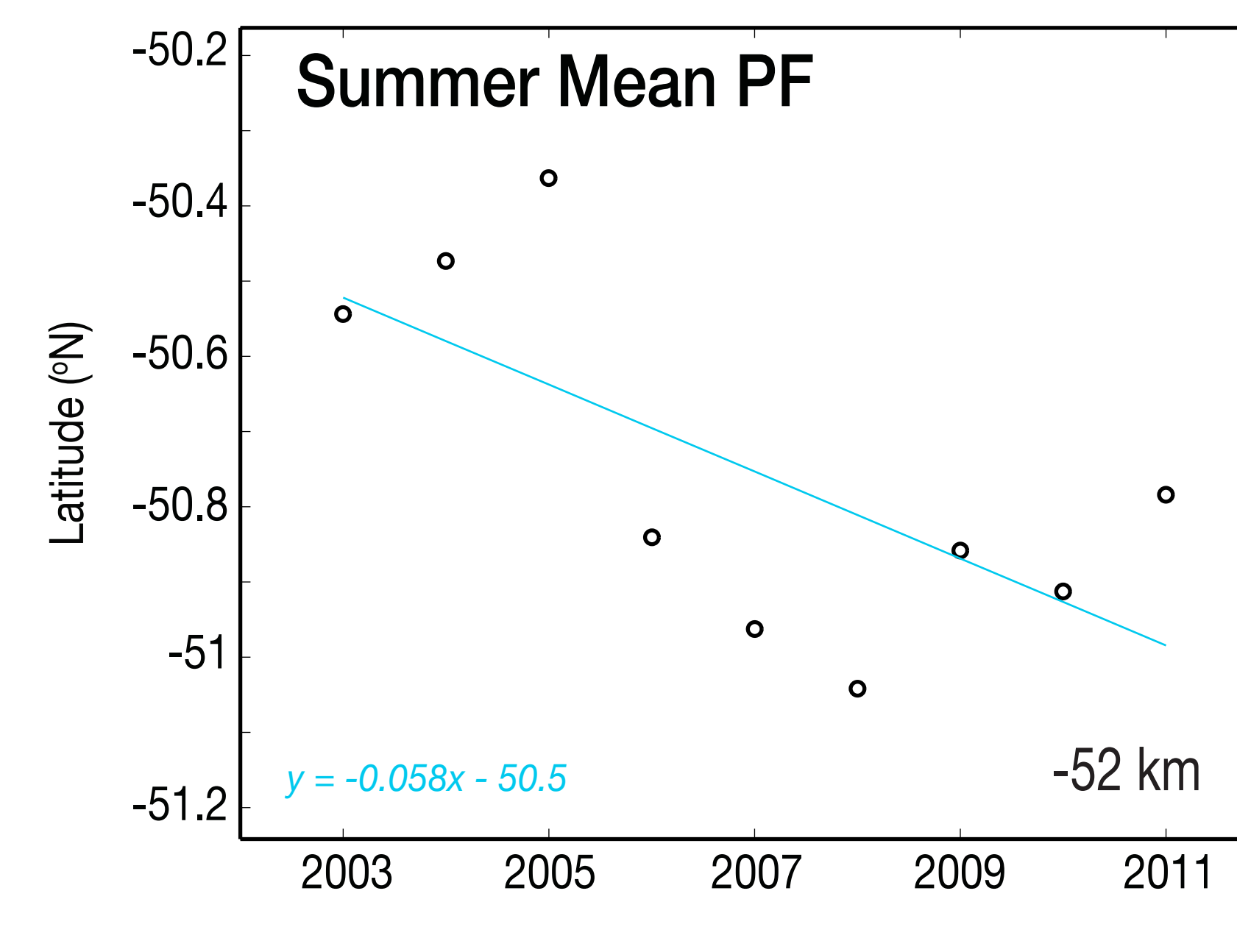
## Tracking the Polar Front



significant shifts:  
northward  
southward

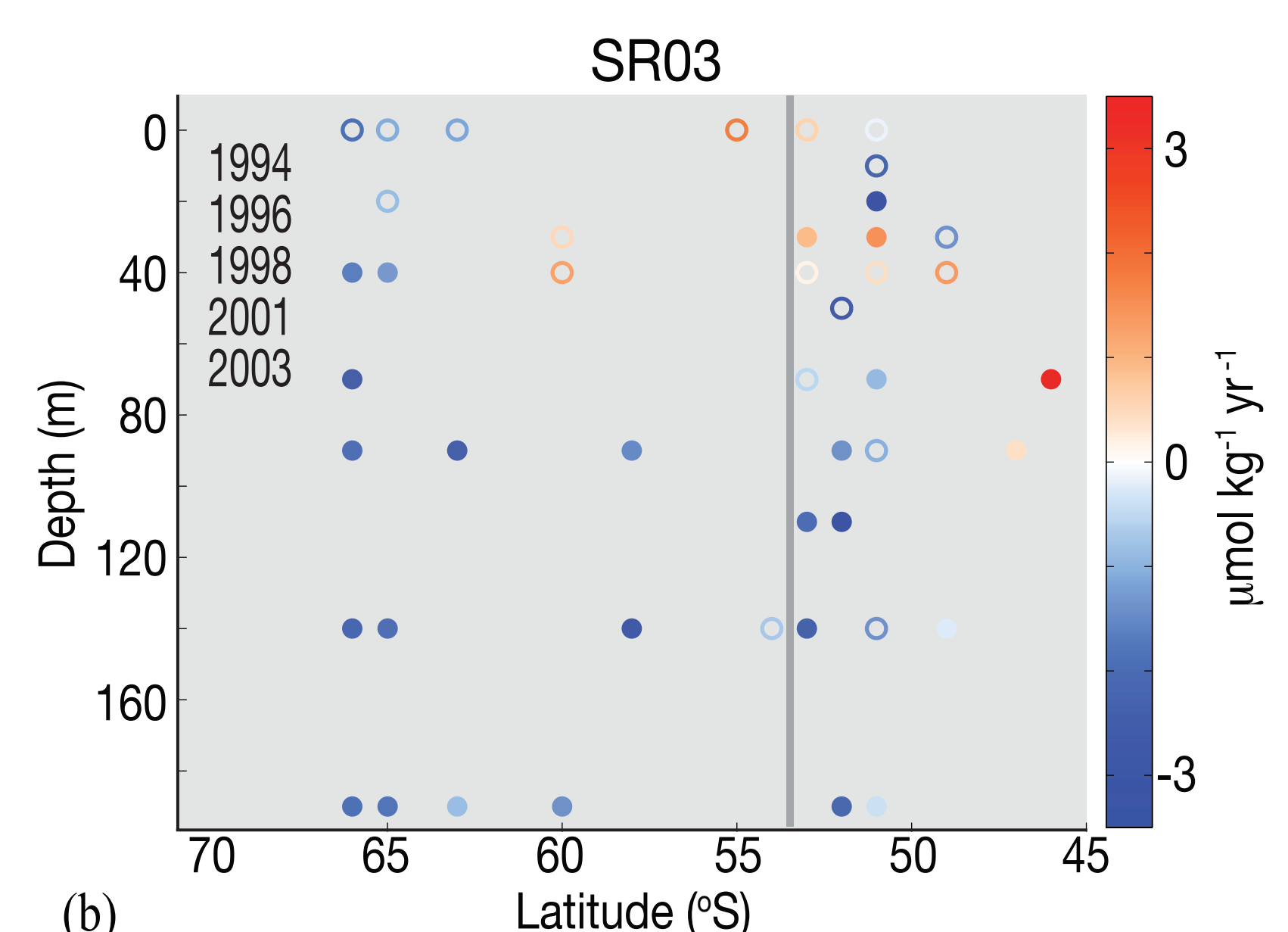
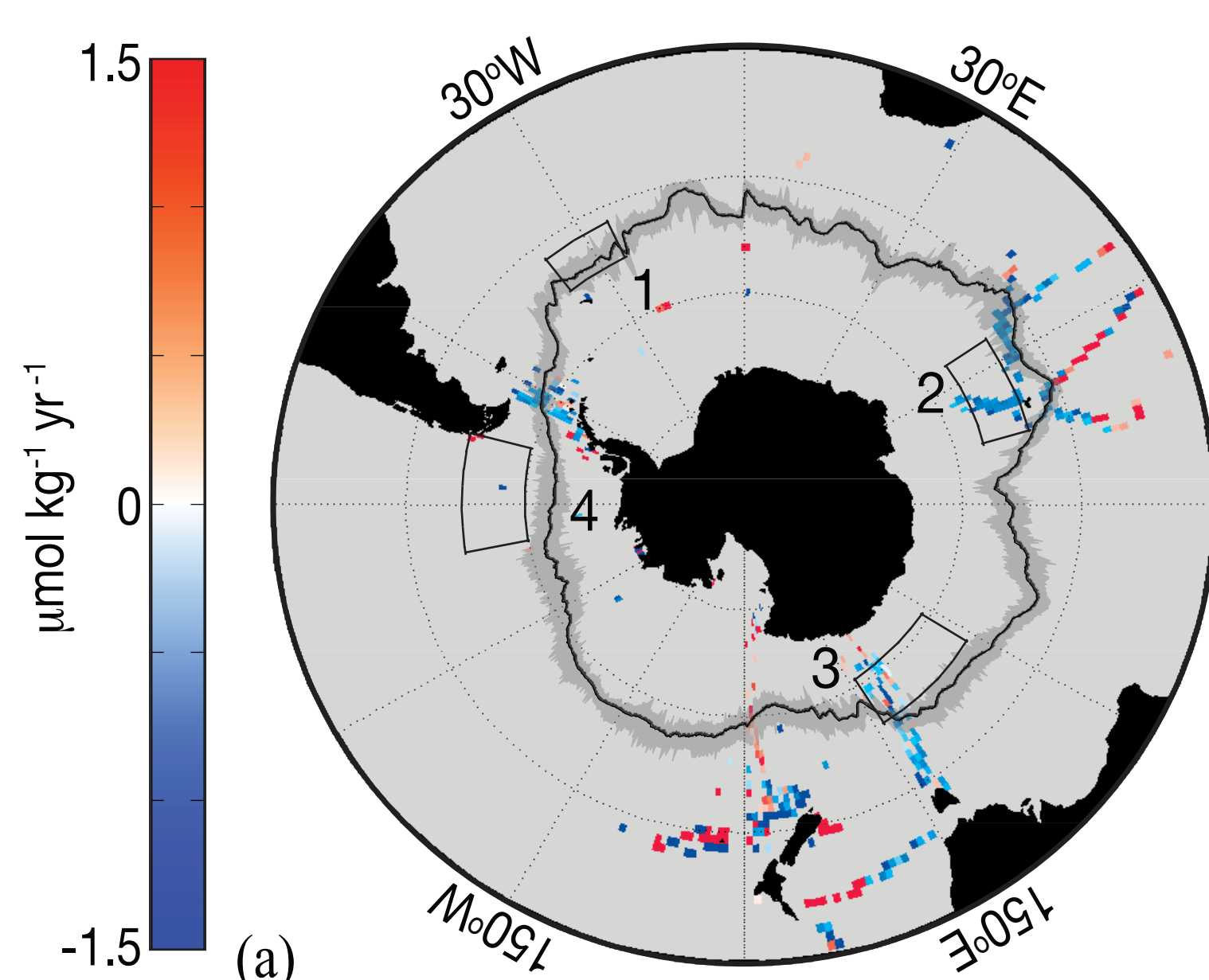
(left) Latitudinal position of Polar Front mapped from weekly AMSR-E SSTs from June 2002 to September 2011 (Dong et al (2006) for methodology. (right) Summer mean position of PF (black) overlain on calcification trends: northward and southward migrations from the mean indicated in color.

## Region 1: Case Study



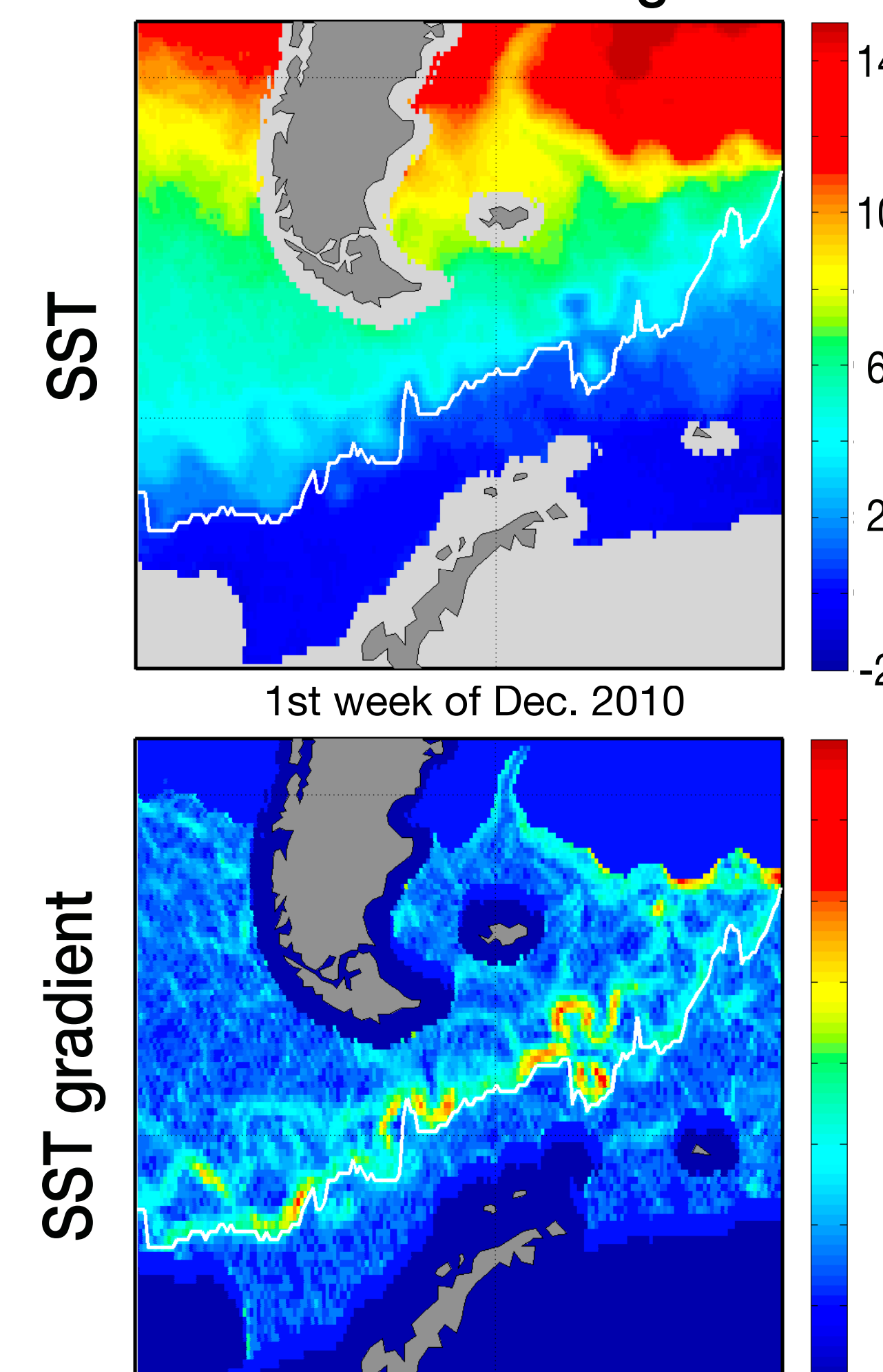
Large region of the Atlantic sector where positive trends in PIC correspond to a significant southward shift in the mean position of the Polar Front. This migration may have reduced surface silicic acid availability here and therefore the ability of diatoms to effectively compete for nutrients.

## Changes in Carbonate Ion



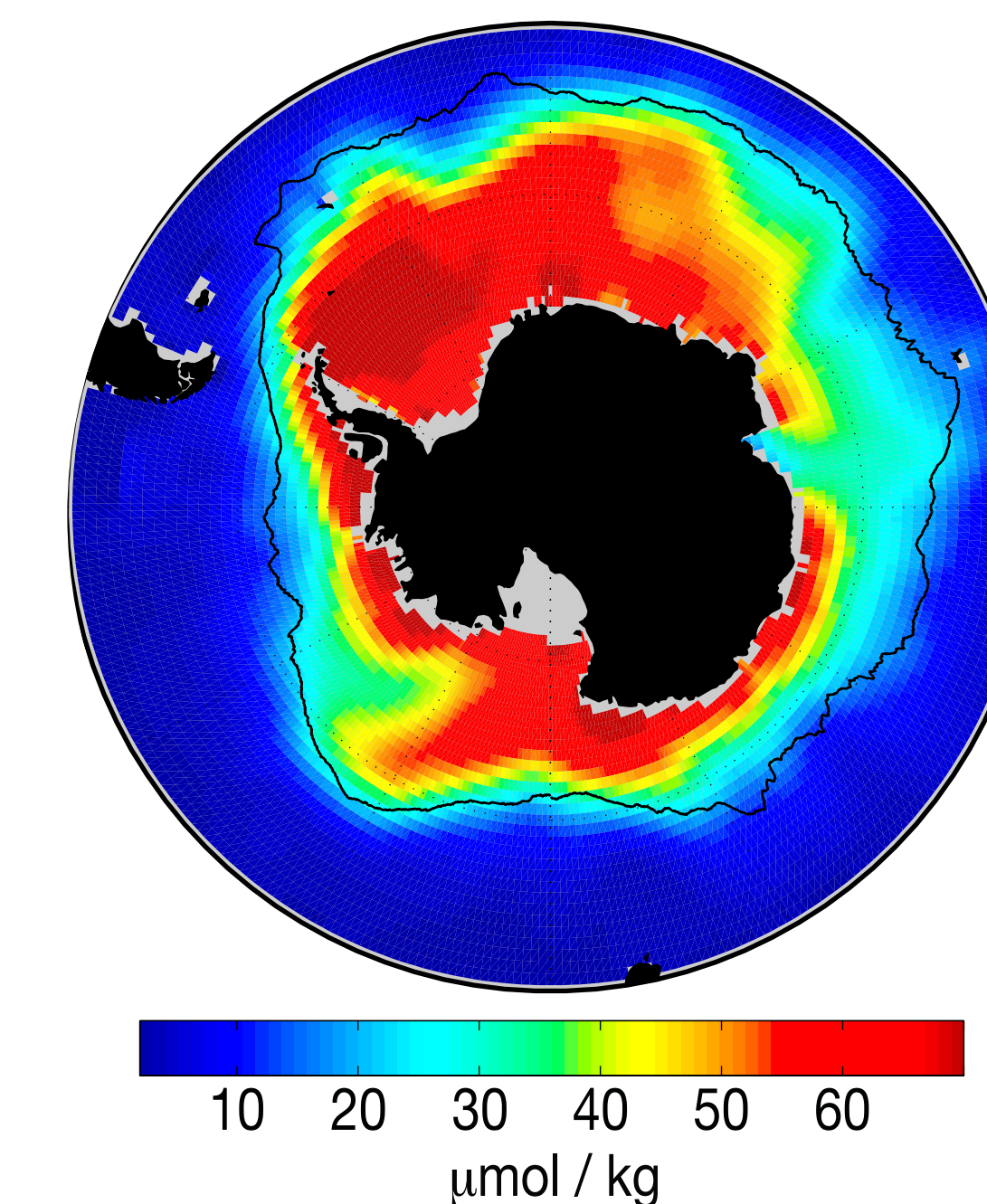
(a) Significant trends (at the 95% level) in summer surface carbonate ion from continuous underway  $f\text{CO}_2$  (1998-2011) and  $p\text{CO}_2$  (1998-2013). (b) All trends in the zonal mean carbonate ion concentration at depth from bottle data along repeat transect SR03 in our Region 3, where filled circles indicate significance and open circles, otherwise. Summer mean position of AMSR-E Polar Front indicated in black/gray.

## Drake Passage

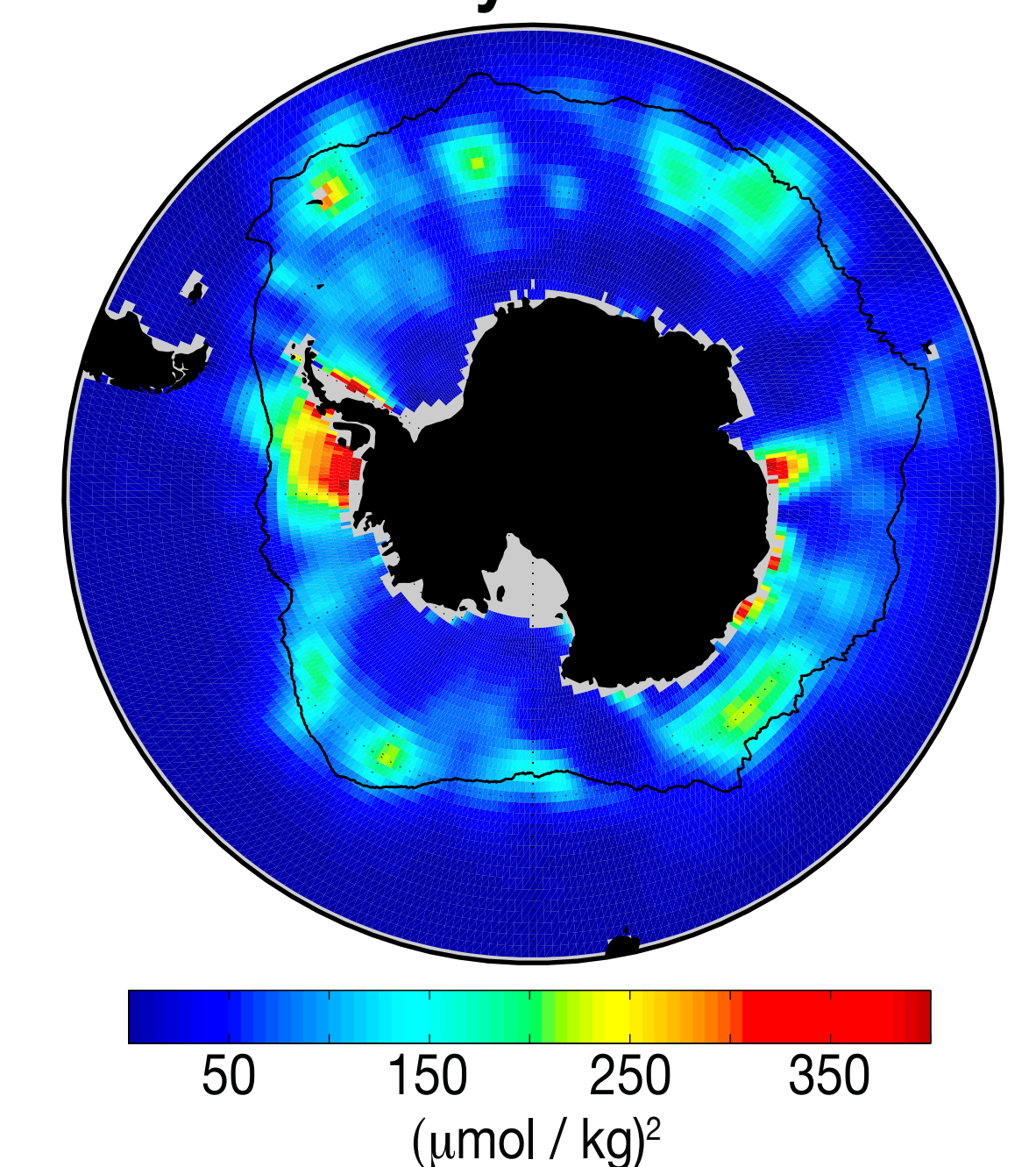


## Future Work

### Annual Mean Silicate

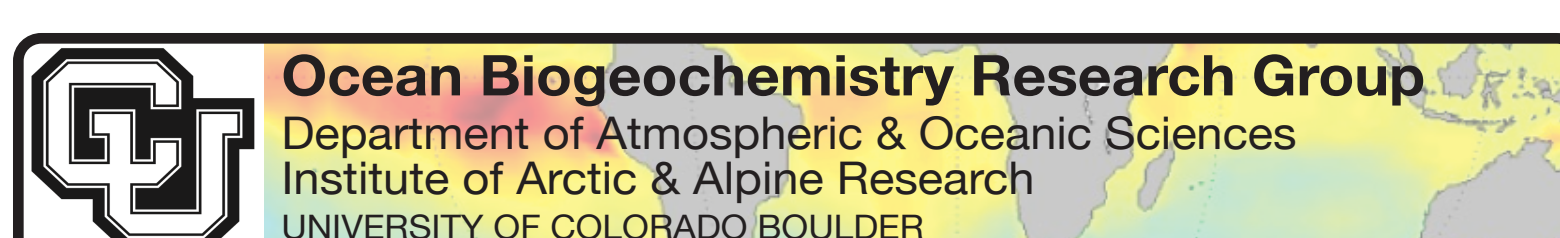


### Monthly Variance



(left) Example snapshot of AMSR-E SST and computed absolute SST gradient in Drake Passage. AMSR-E Polar Front location shown as white contour.

(above) Annual mean silicate concentration from World Ocean Atlas (2013) and monthly variance computed from monthly climatologies. The Moore et al. (1999) PF as black contour.



This material is based upon work supported by the National Science Foundation Graduate Research Fellowship under Grant No. DGE 1144083.

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