Antarctic Circumpolar Current

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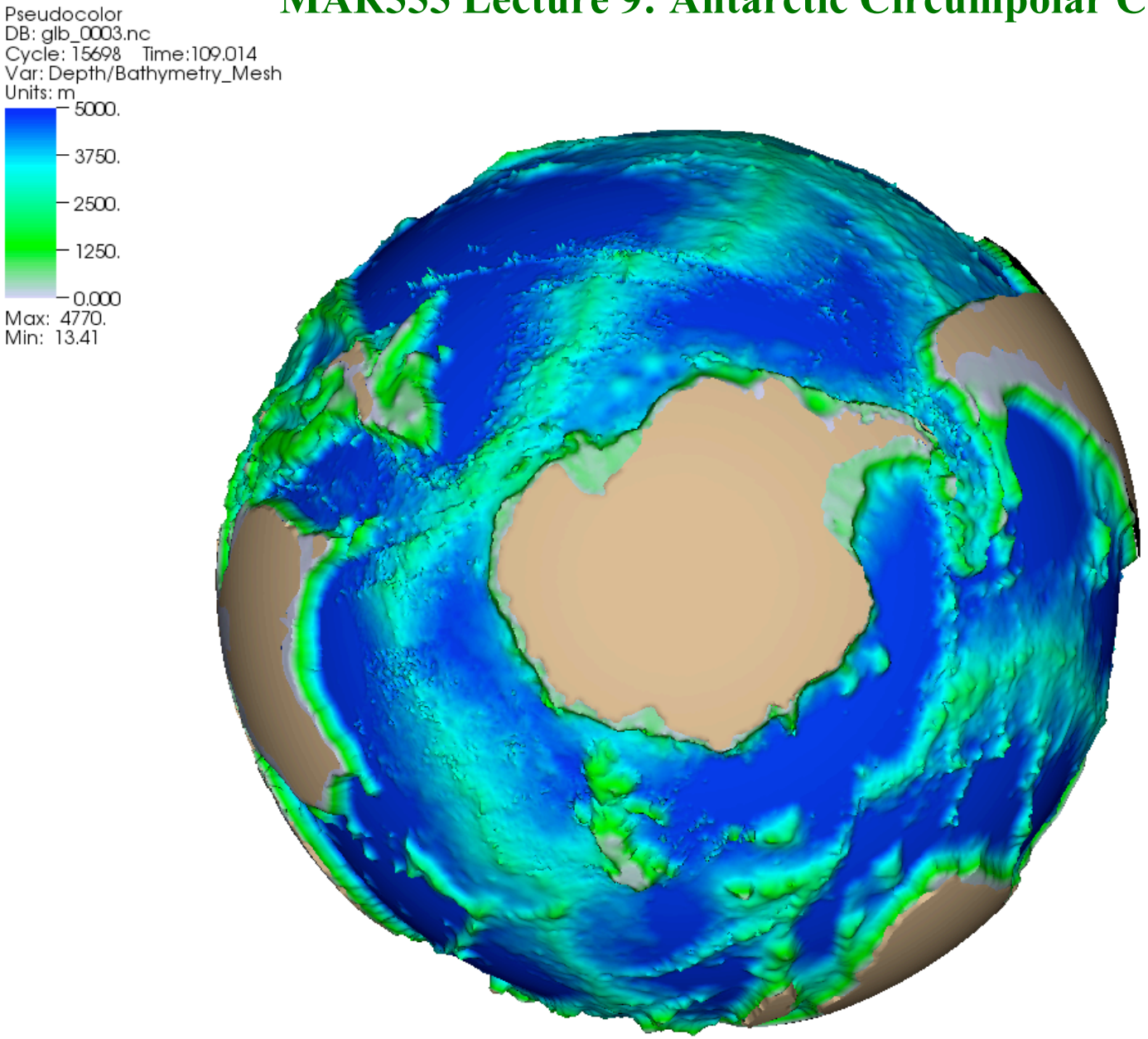
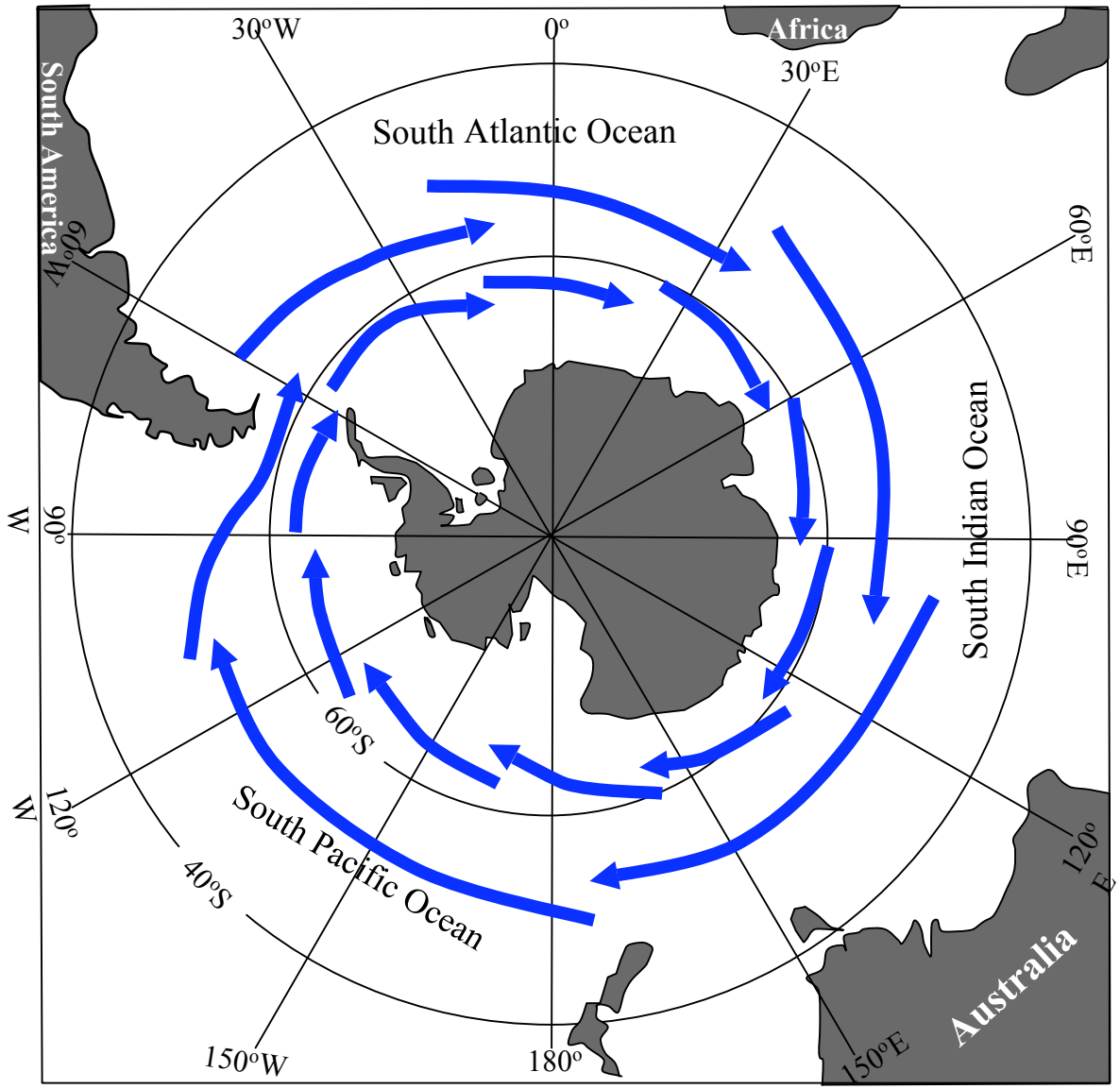
General Physical Oceanography
MAR 555

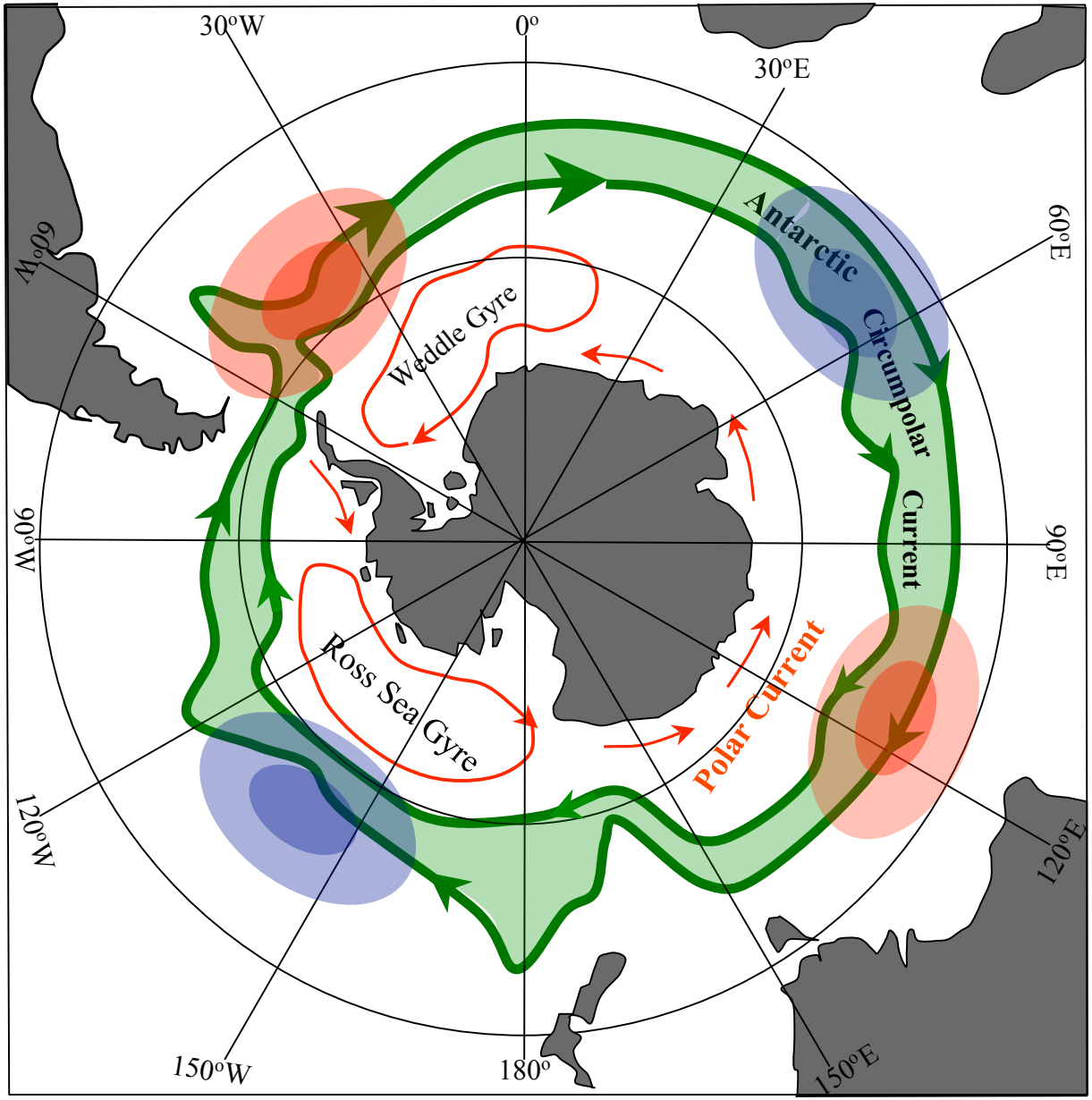
School for Marine Sciences and Technology
Umass-Dartmouth

MAR555 Lecture 9: Antarctic Circumpolar Current



Antarctic Circumpolar Region prevails the eastward zonal wind





The Antarctic Circumpolar Current (ACC) moves eastward around the Antarctic

ACC velocity: 4 to 20 cm/s

ACC features two maximum jets and

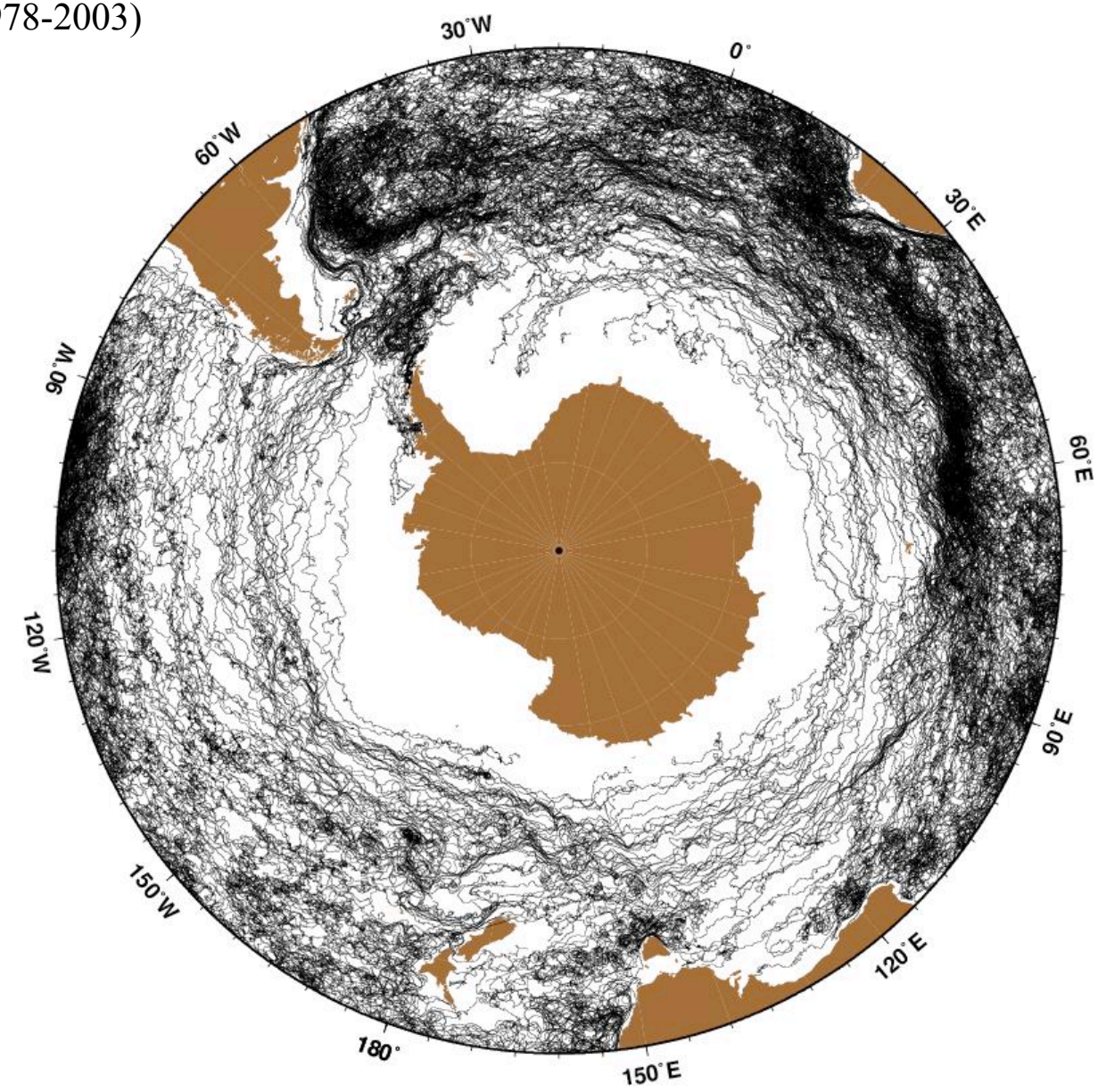
two colder pools;
two warmer pools
(2-3° C colder or warmer)

Propagates along the Antarctic Circumpolar Current (ACC) and takes 8-9 years to travel around a circle.

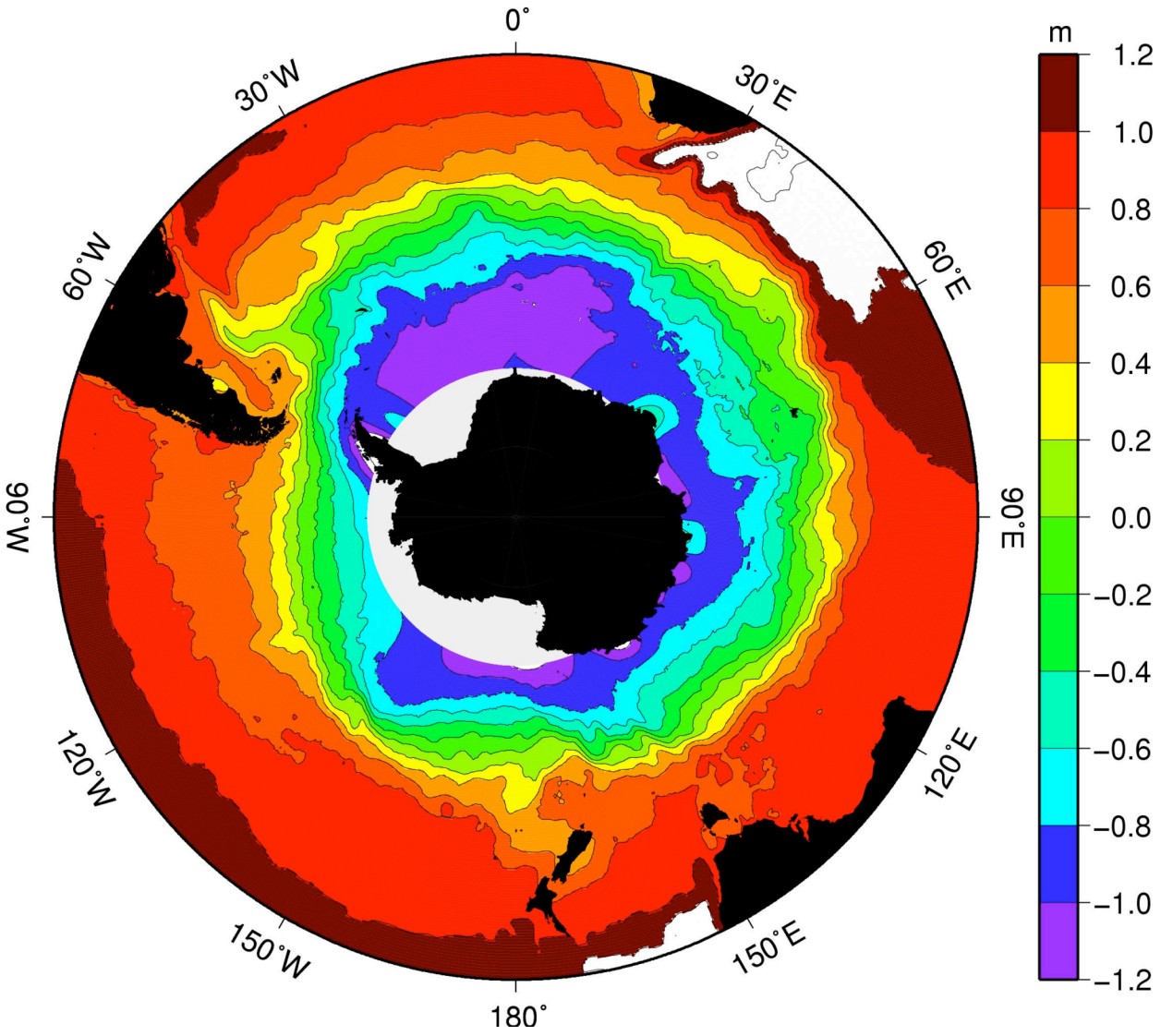
ACC is driven by the wind and density gradient.

Trajectories of drifters (Smith et al., http://oceancurrents.rsmas.miami.edu/southern/antarctic-cp.htm)l

(1978-2003)

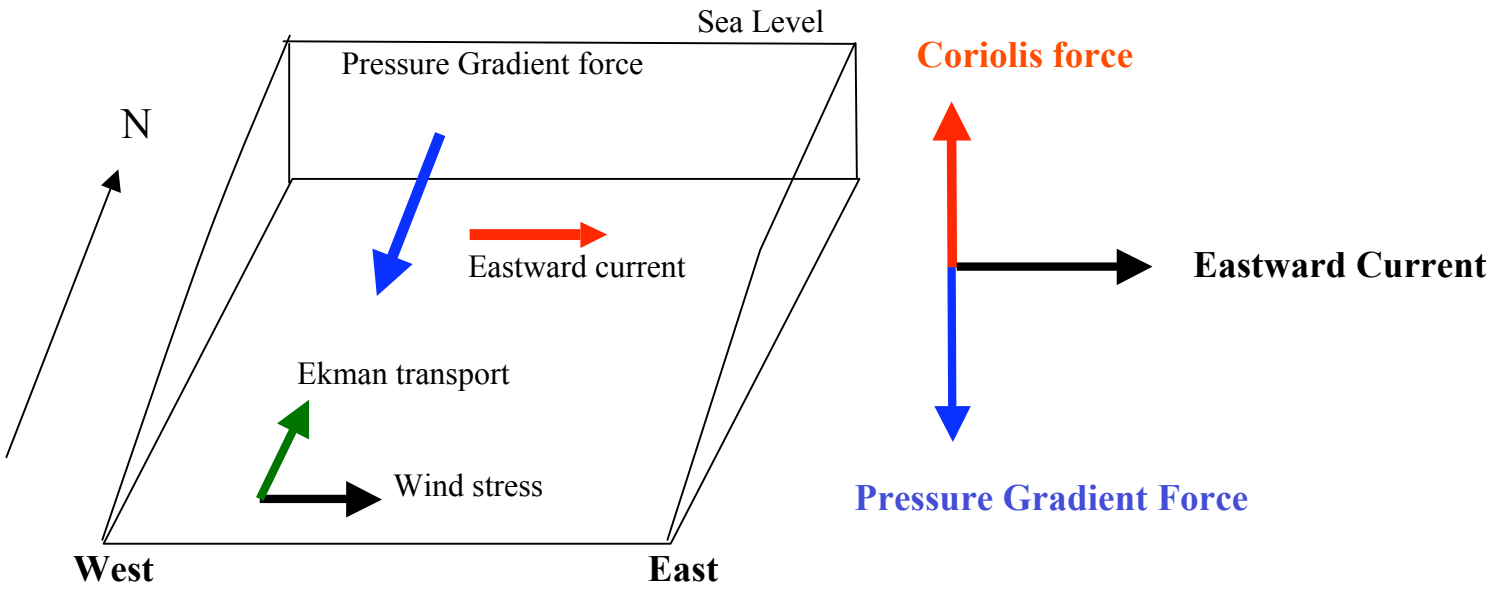


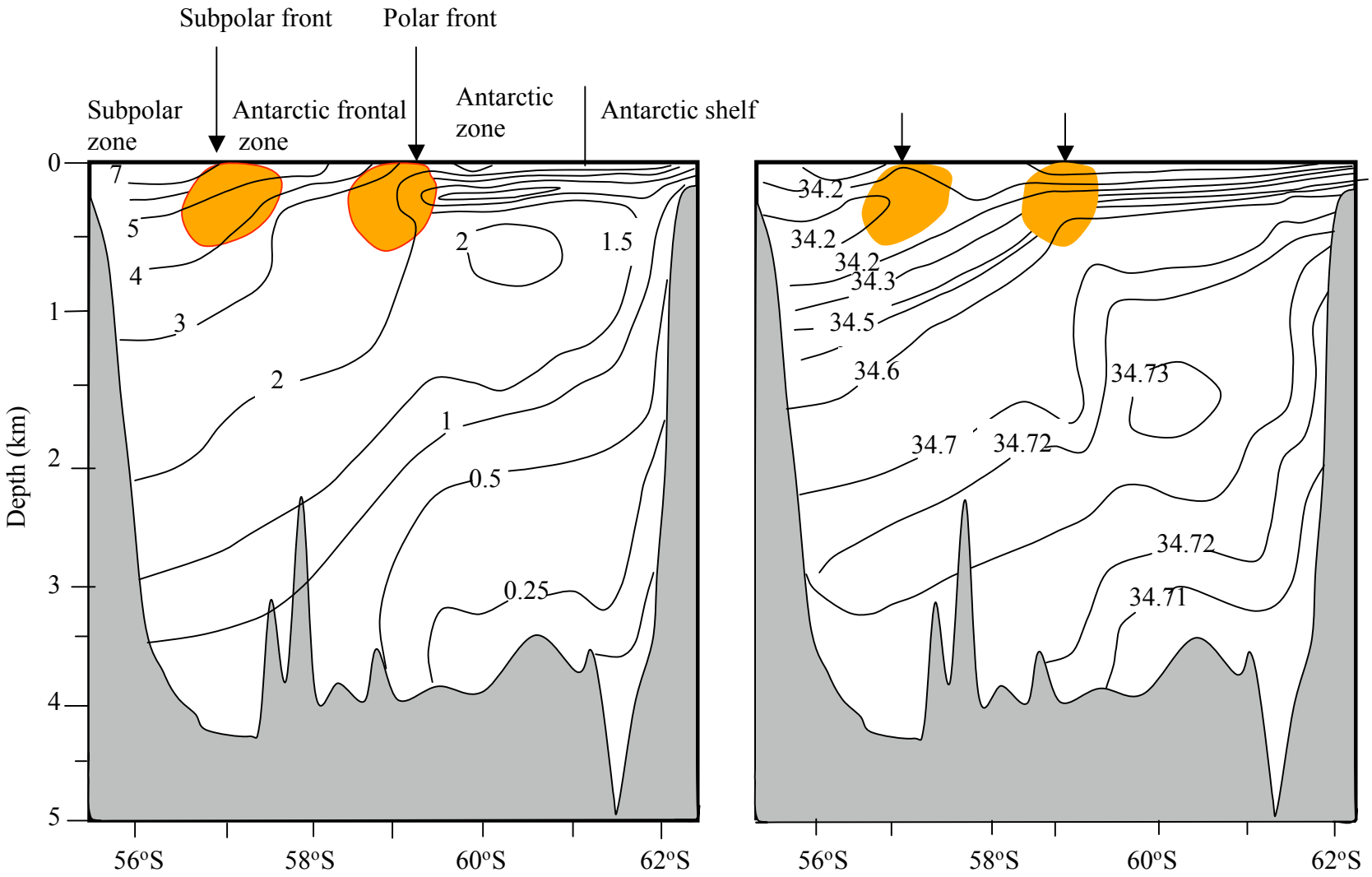
The Sea Surface Height (SSH) (Dynamic Height)



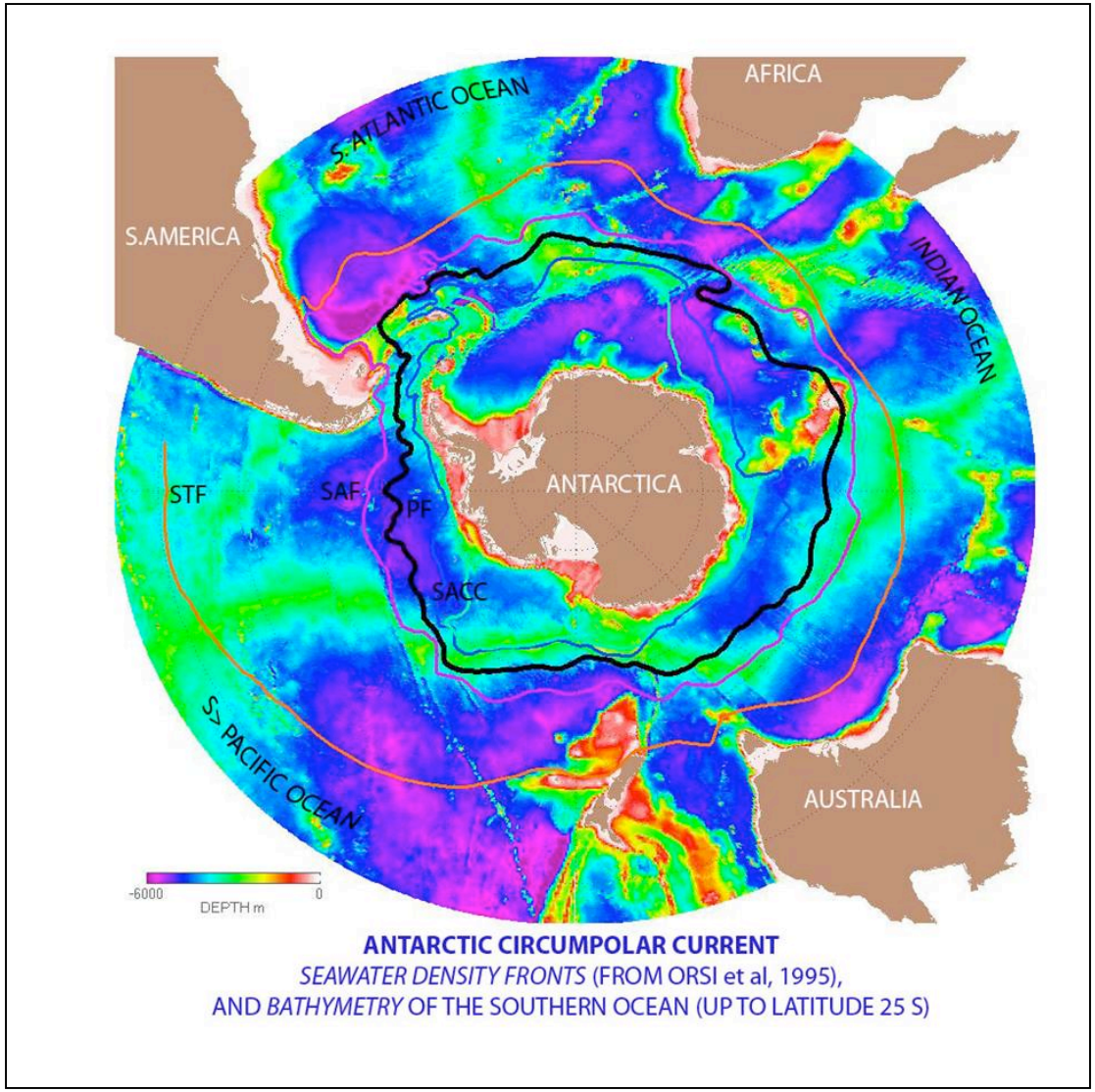
From Dr. Sarah Gille at SIO: SSH is calculated by the analysis of drifter,altimeter, GRACE, and hydrographic data (Nikolai Maximenko and collaborator)

The Wind-induced Eastward Current



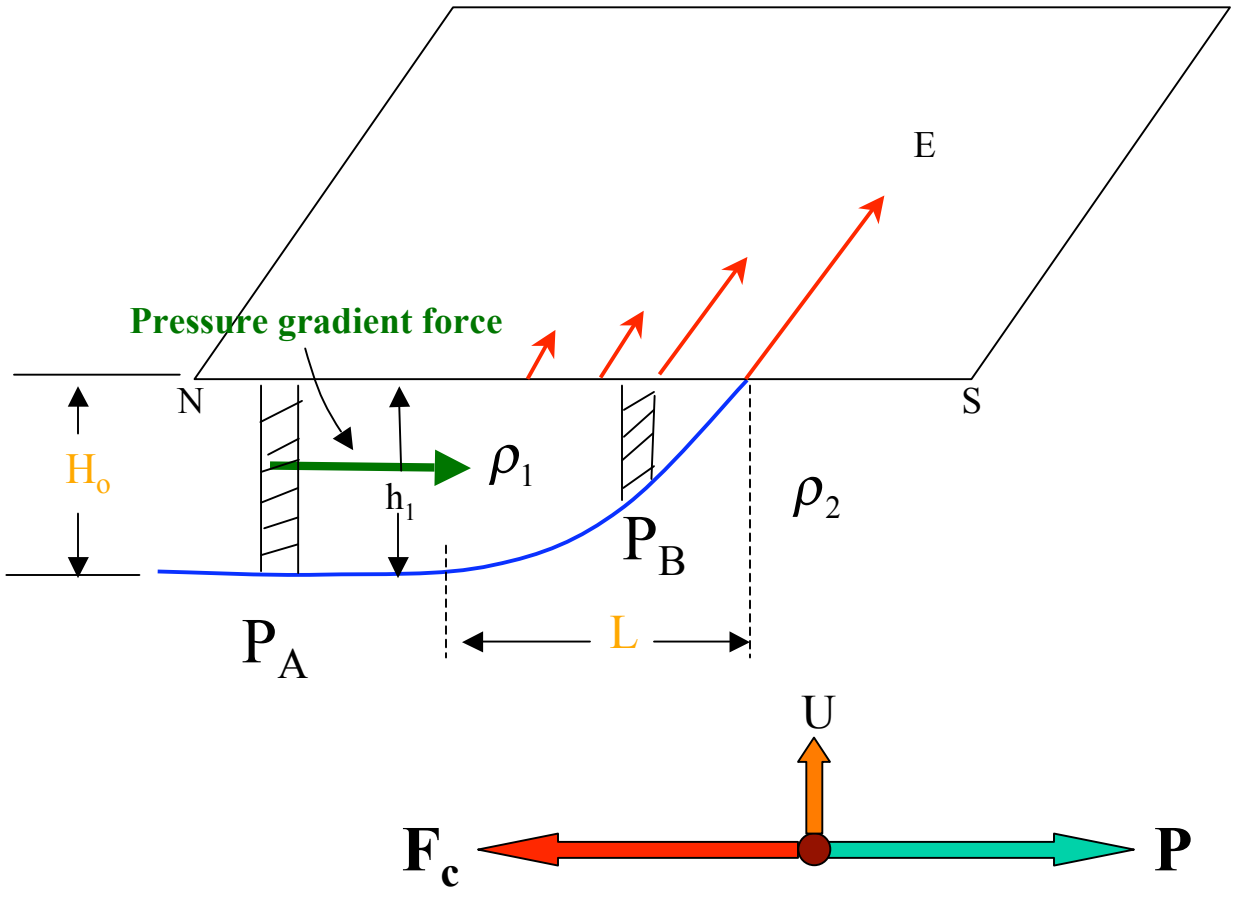

Subpolar front
Polar front
Subpolar zone
Antarctic frontal zone
Antarctic zone
Antarctic shelf
Depth (km)
0
1
2
3
4
5
7
5
4
3
2
1
0.5
0.25
2
1.5
34.2
34.2
34.2
34.3
34.5
34.6
34.73
34.7
34.72
34.72
34.71
56°S
58°S
60°S
62°S
56°S
58°S
60°S
62°S

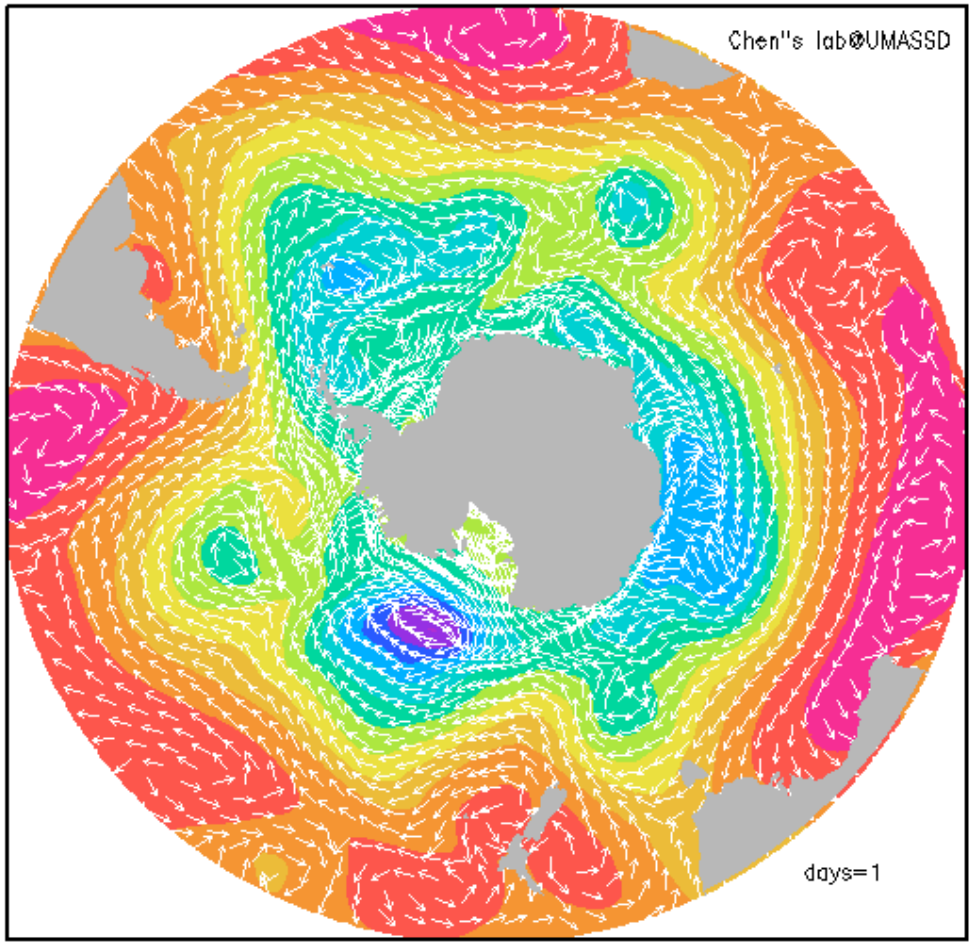
Locations of density fronts in the southern ocean-from NASA JPL website



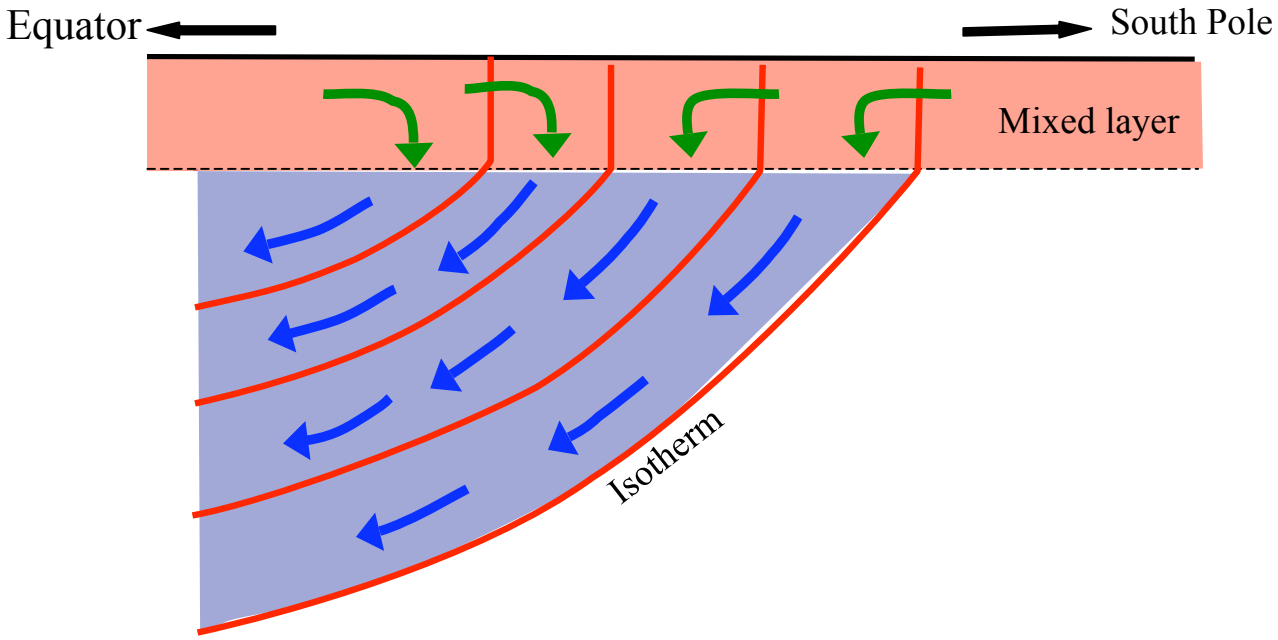
http://www.jpl.nasa.gov/media/20051206a/images/pic2.jpg

Geostrophic Current at A Density Front



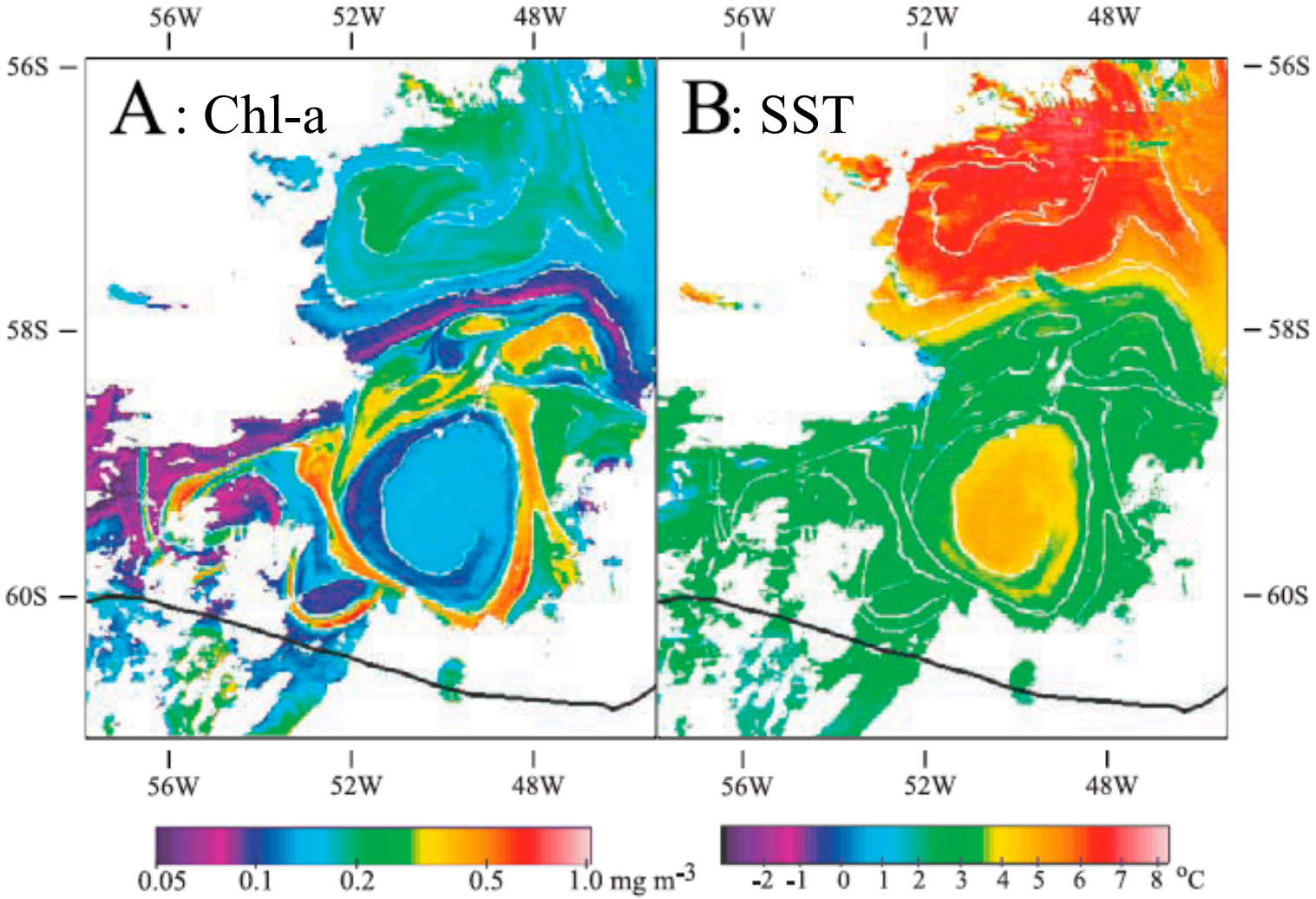

Chen''s lab@UMASSD
days=1

Circumpolar Frontal Subduction



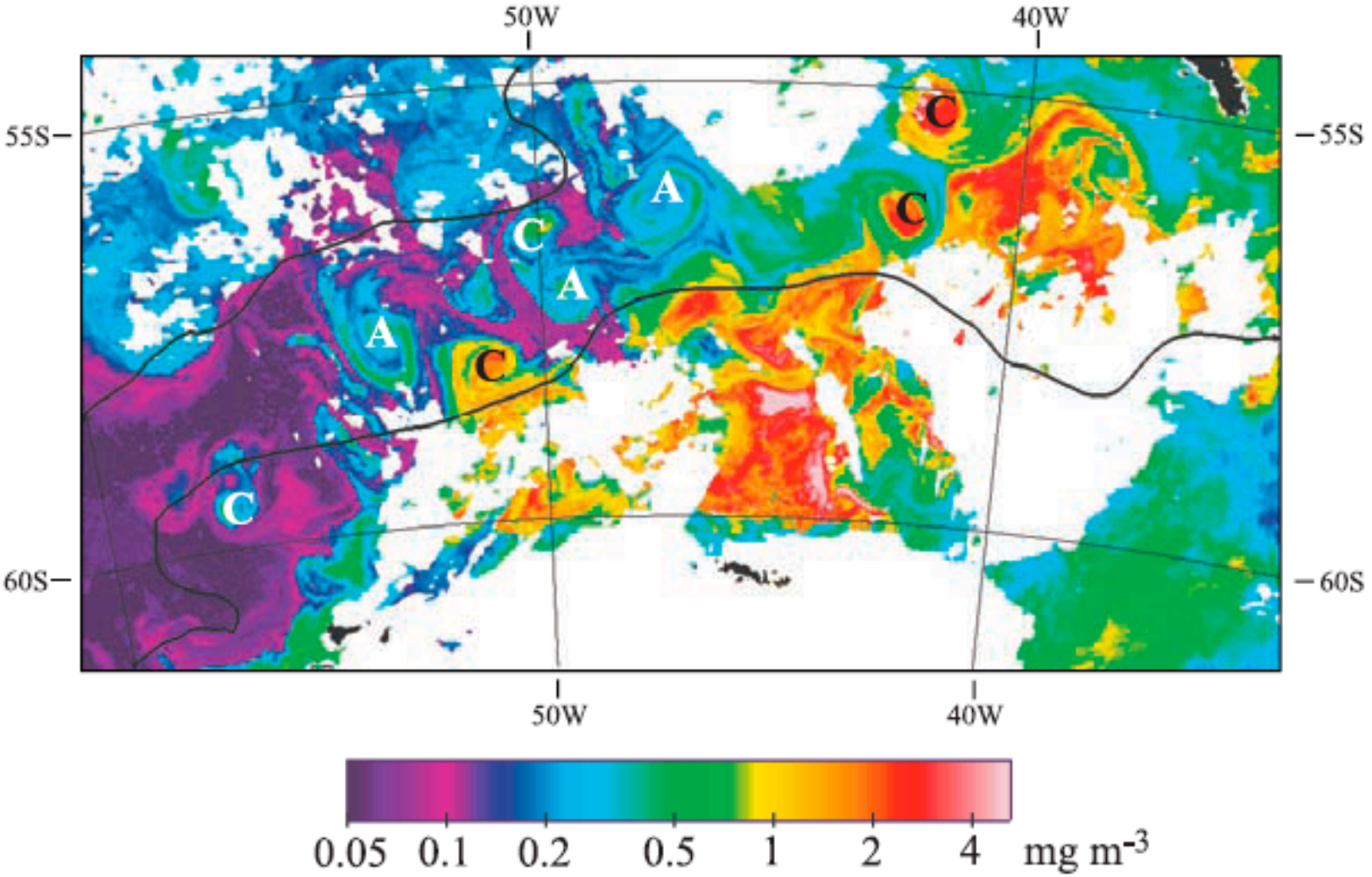
Horizontal wind-induced current convergence and cooling causes the subduction of the water from the mixed layer to the weekly mixed thermocline layer in the sub-polar frontal zone. These waters will move downward along the isotherm surface (or density surface) to the deep region.

January 28,2004



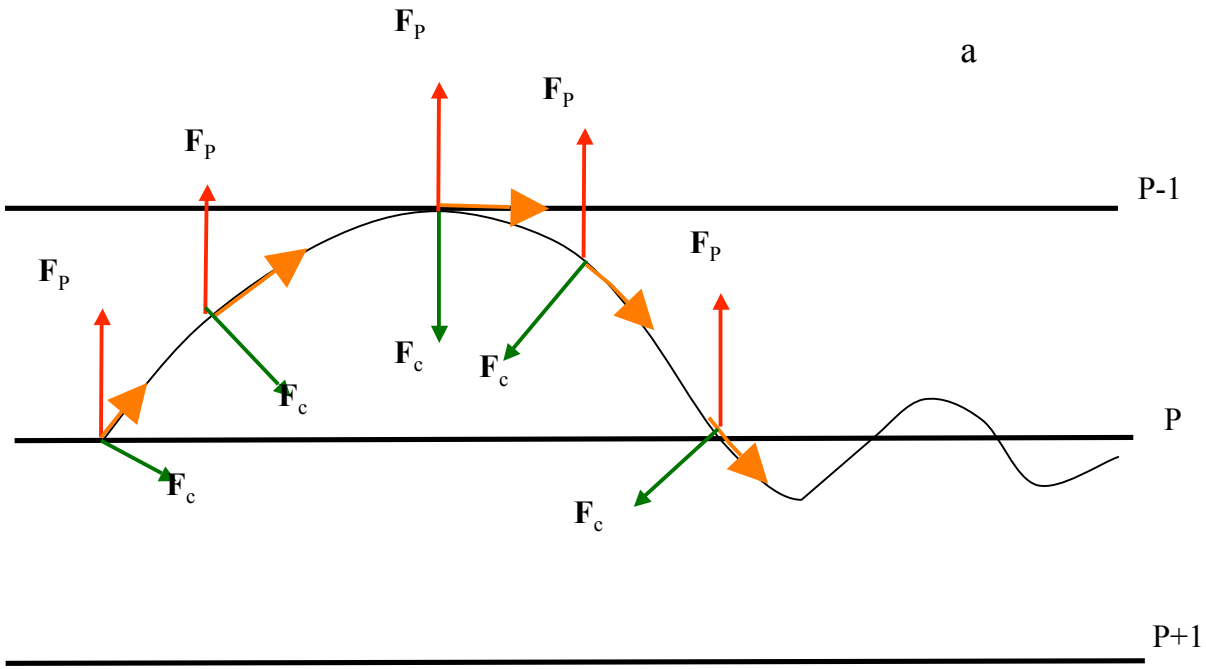
From Kahru et al. (2007)-JGR-Ocean

Chl-a concentration (January 26-30, 2005)



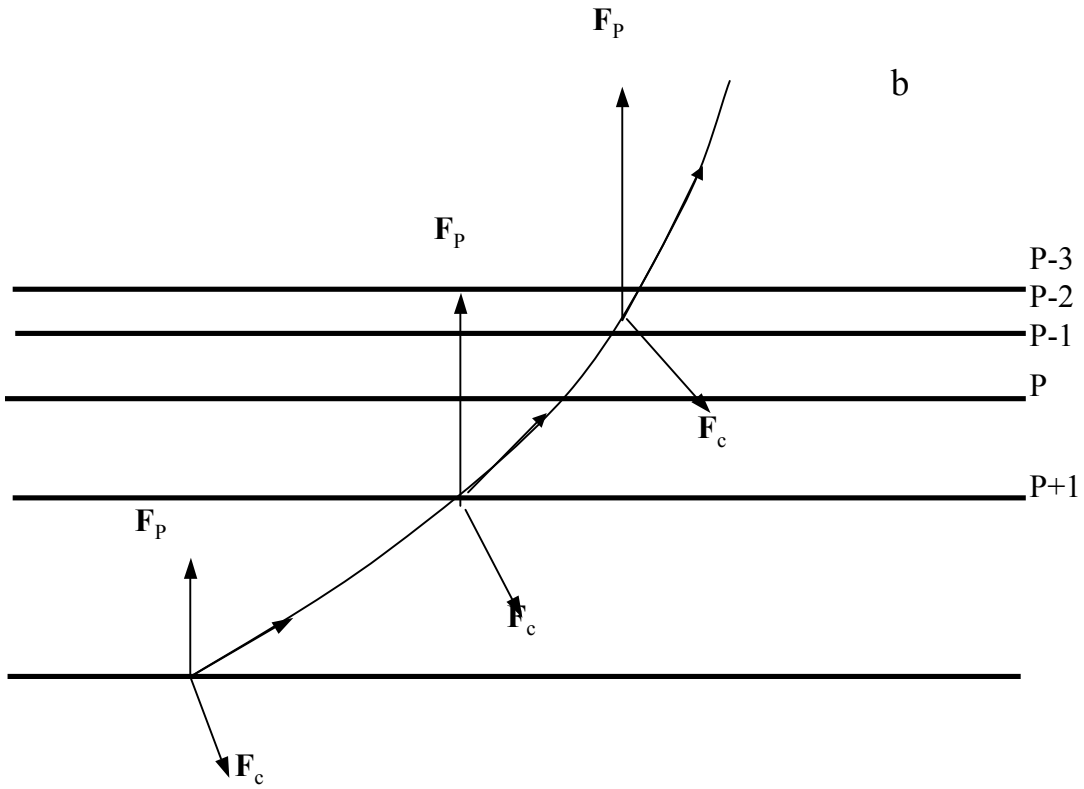
From Kahru et al. (2007)-JGR-Ocean

Geostrophic Instability



Pressure gradient remains unchanged (with uniform space of pressure contours), while the Coriolis force increases with the increase of the velocity.

Stable!

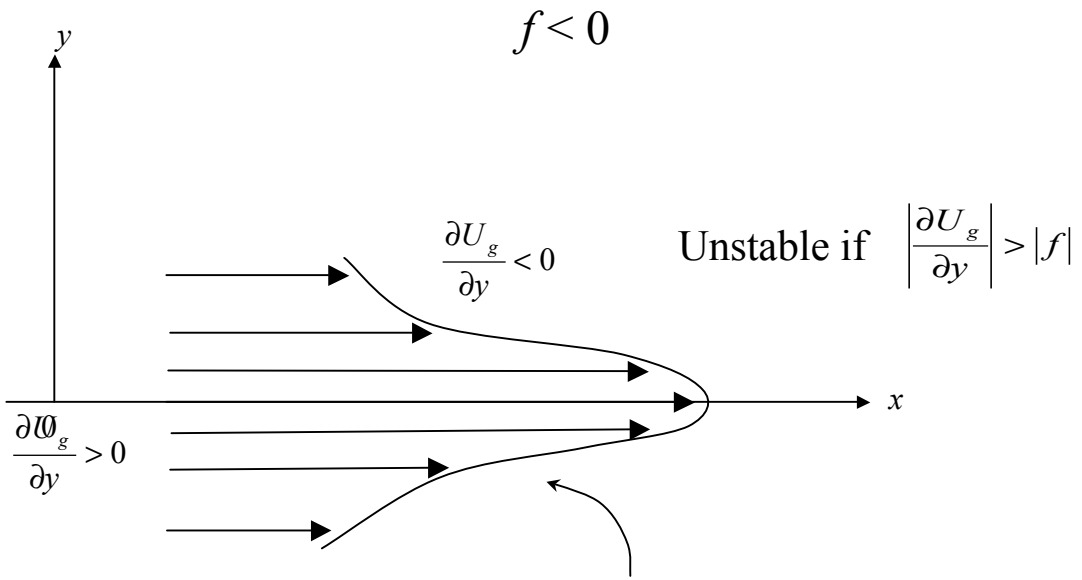


The increase rate of the horizontal pressure gradient is larger than the increase rate of the Coriolis force:

Unstable!

The criterion condition of the barotropic instability on the southern hemisphere:

Vorticity $f - \frac{\partial U_g}{\partial y} = \zeta_a \begin{cases} > 0 & \text{Unstable} \\ = 0 & \text{Neutral} \\ < 0 & \text{Stable} \end{cases}$



(Note: this is the supplemental material that is not required for this fundamental PO course.