

Subsurface warming of West Antarctic Peninsula waters by East Antarctica coastal winds

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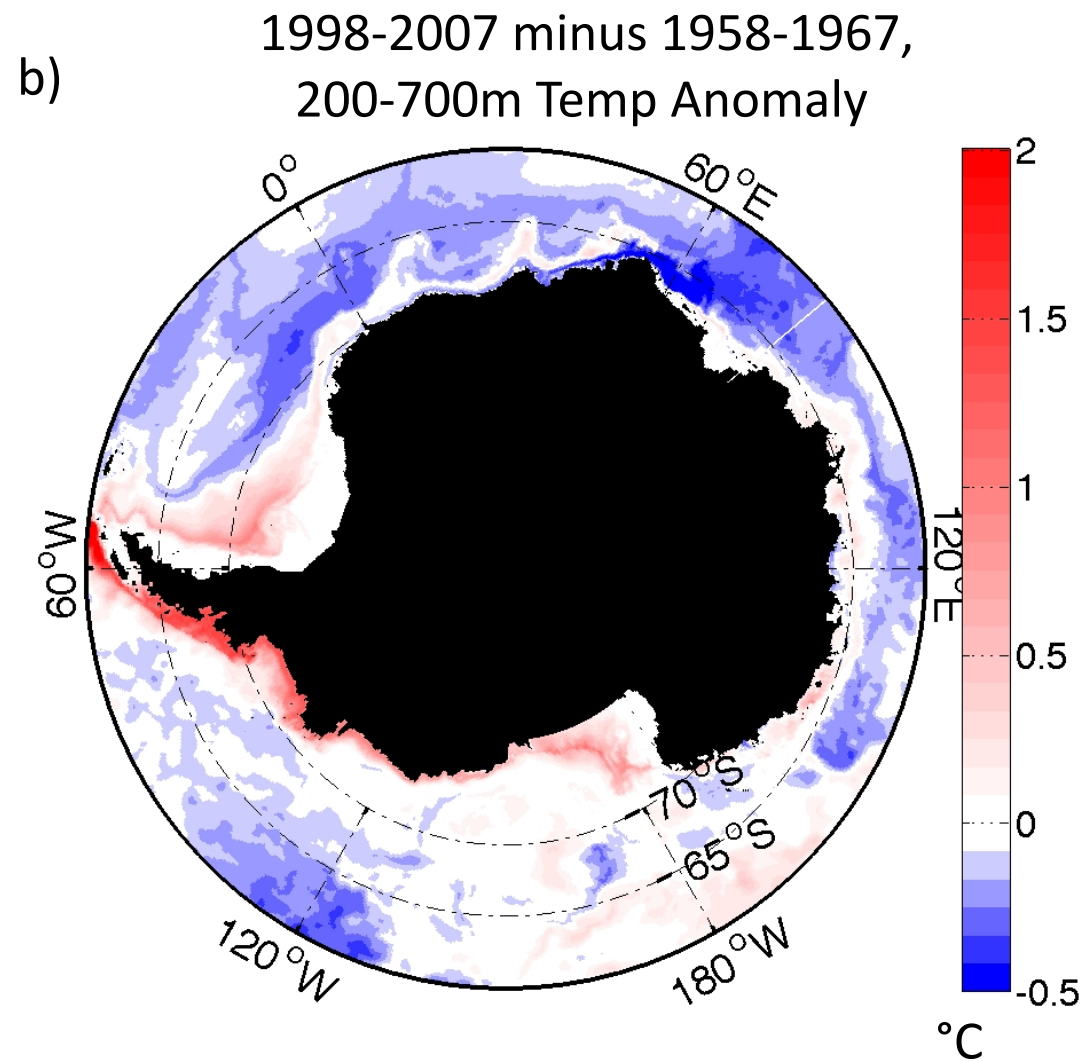


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CLIMATE SYSTEM SCIENCE

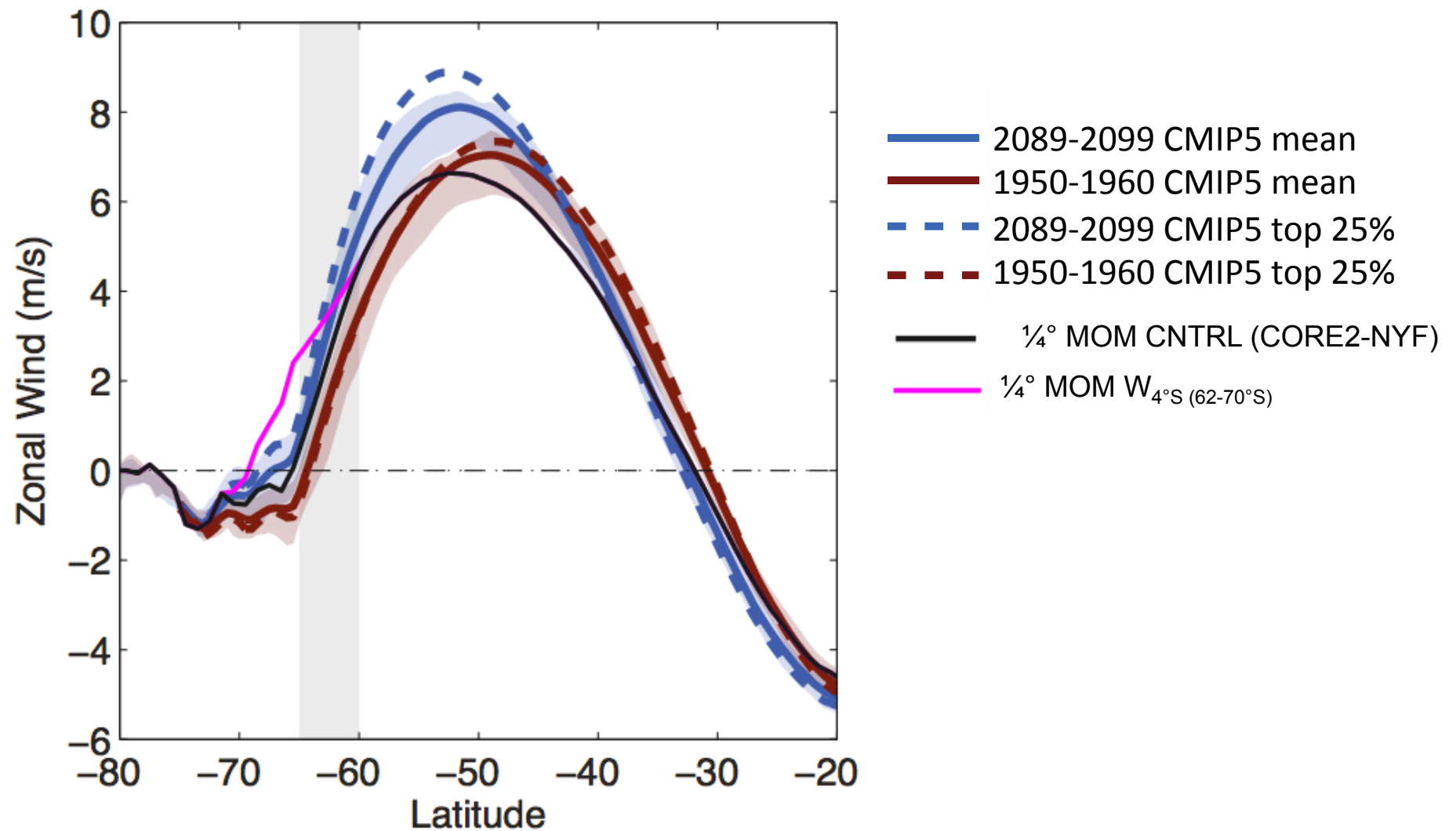
paul.spence@unsw.edu.au



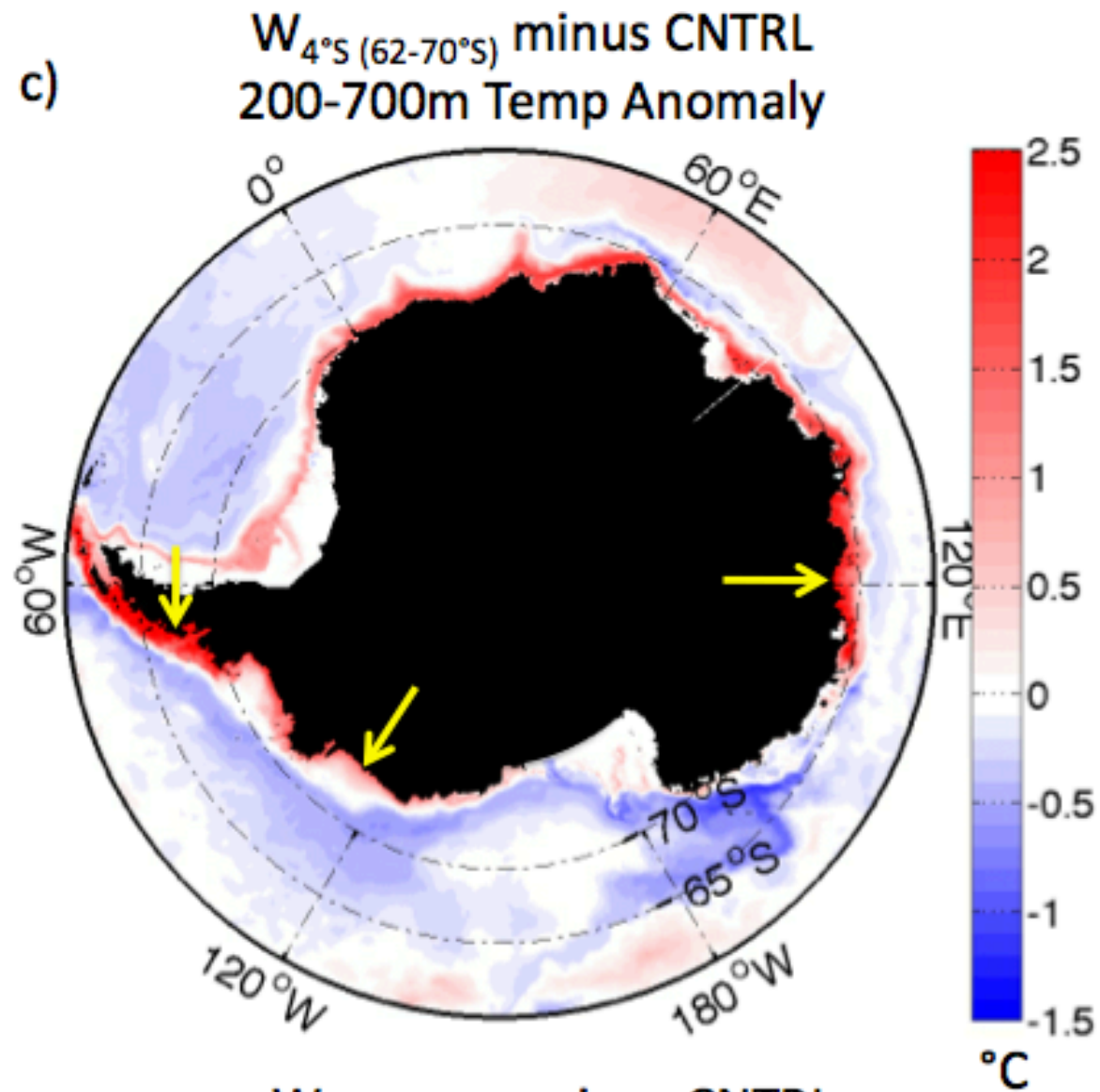
1/4° MOM5 with 1998-2007 minus 1958-1967 atmospheric state



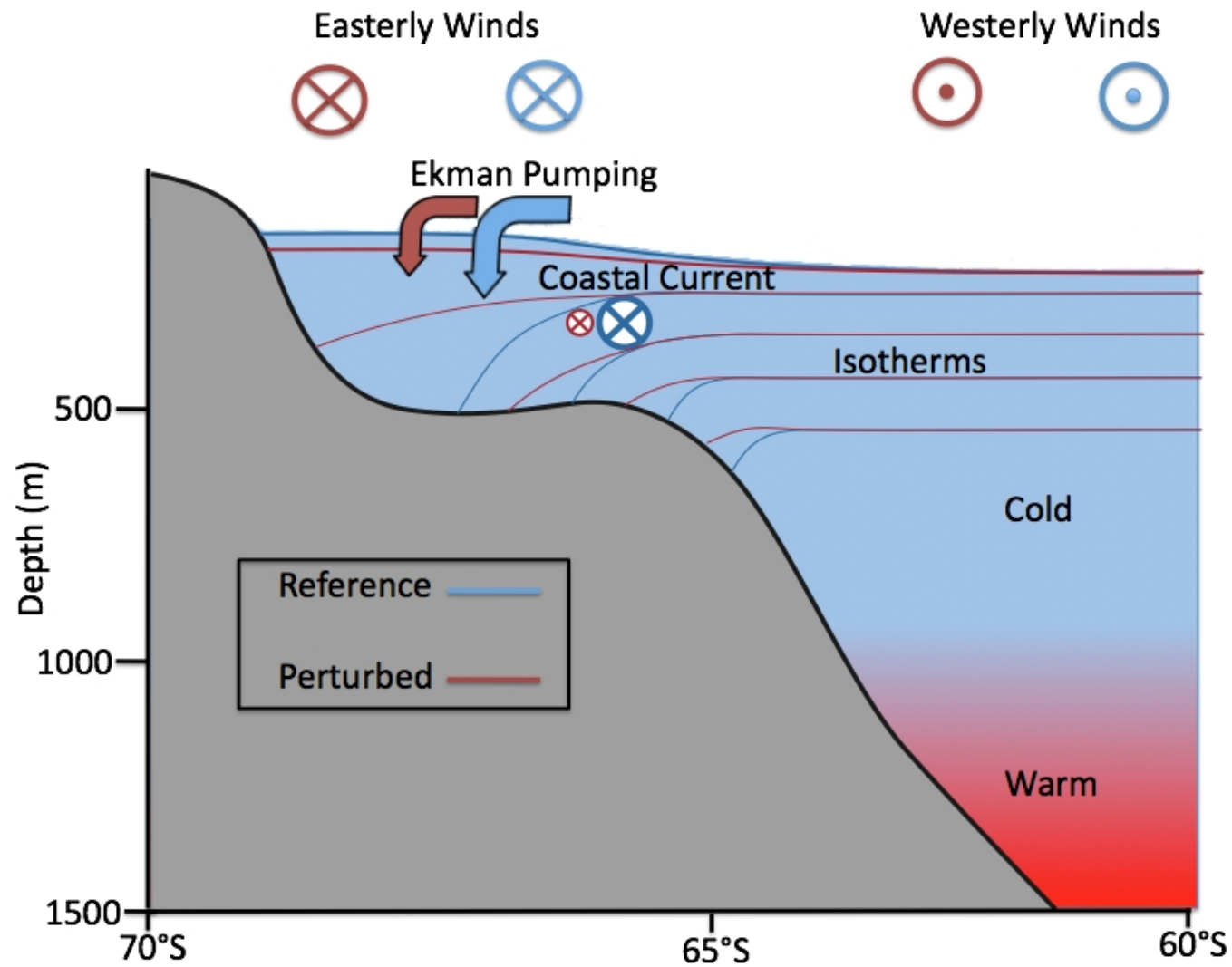
CMIP5, Observed and Idealized Wind Forcing



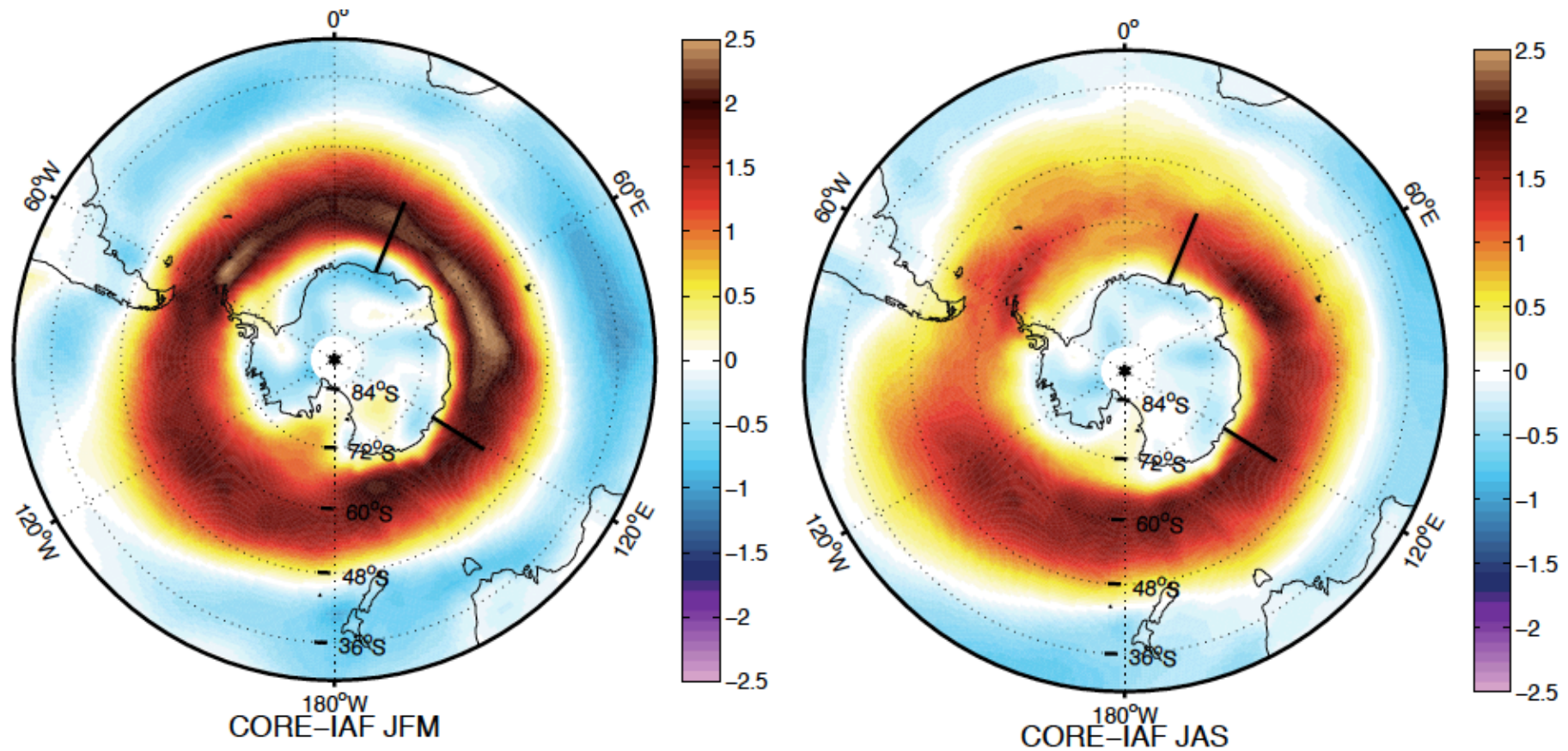
1/4° MOM Response to 15 years of Circumpolar Wind Shift



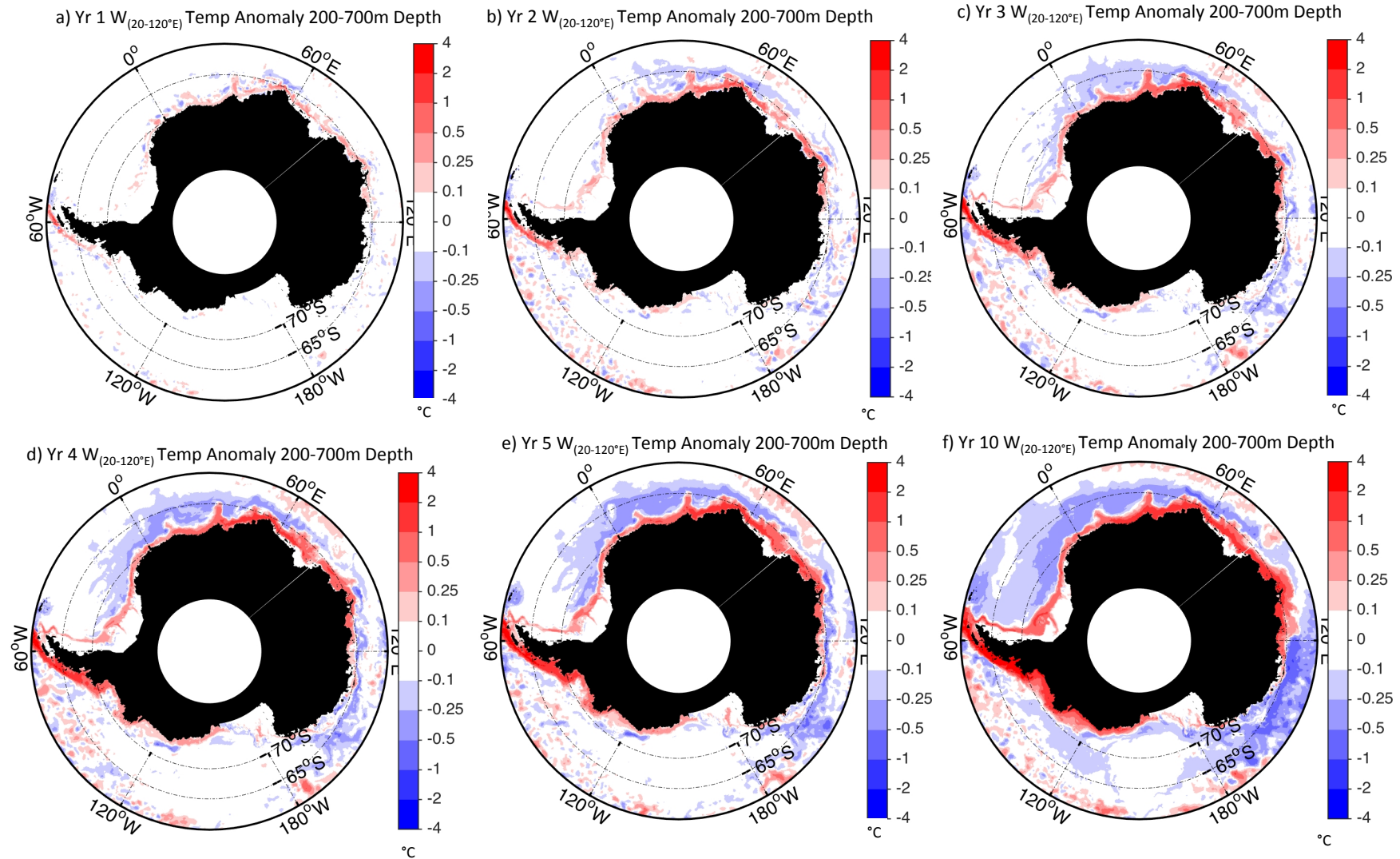
Schematic of Antarctic coastal ocean response to a local poleward wind shift.



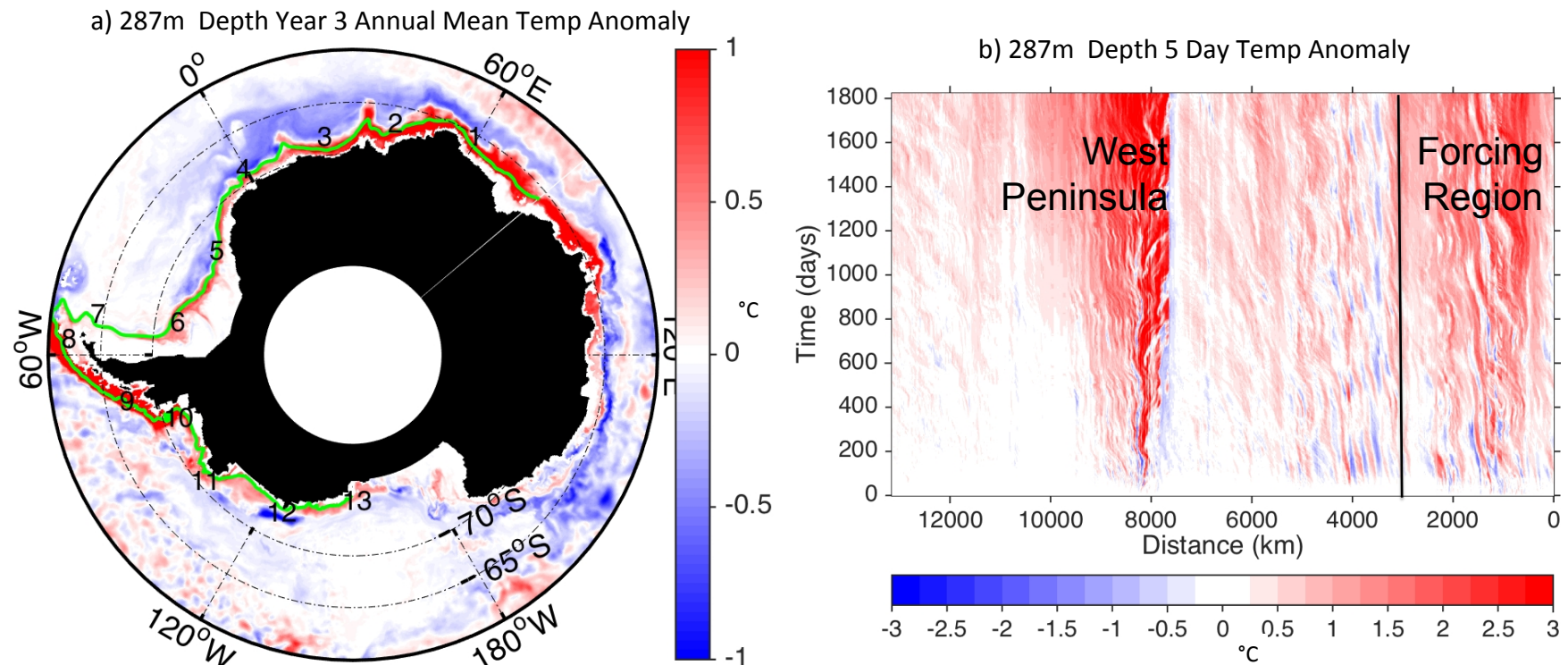
SAM zonal wind regression and East Antarctic wind shift forcing



East Antarctic Winds Cause West Peninsula Warming.



287m Temp Hovmoeller Following Coastal Contour

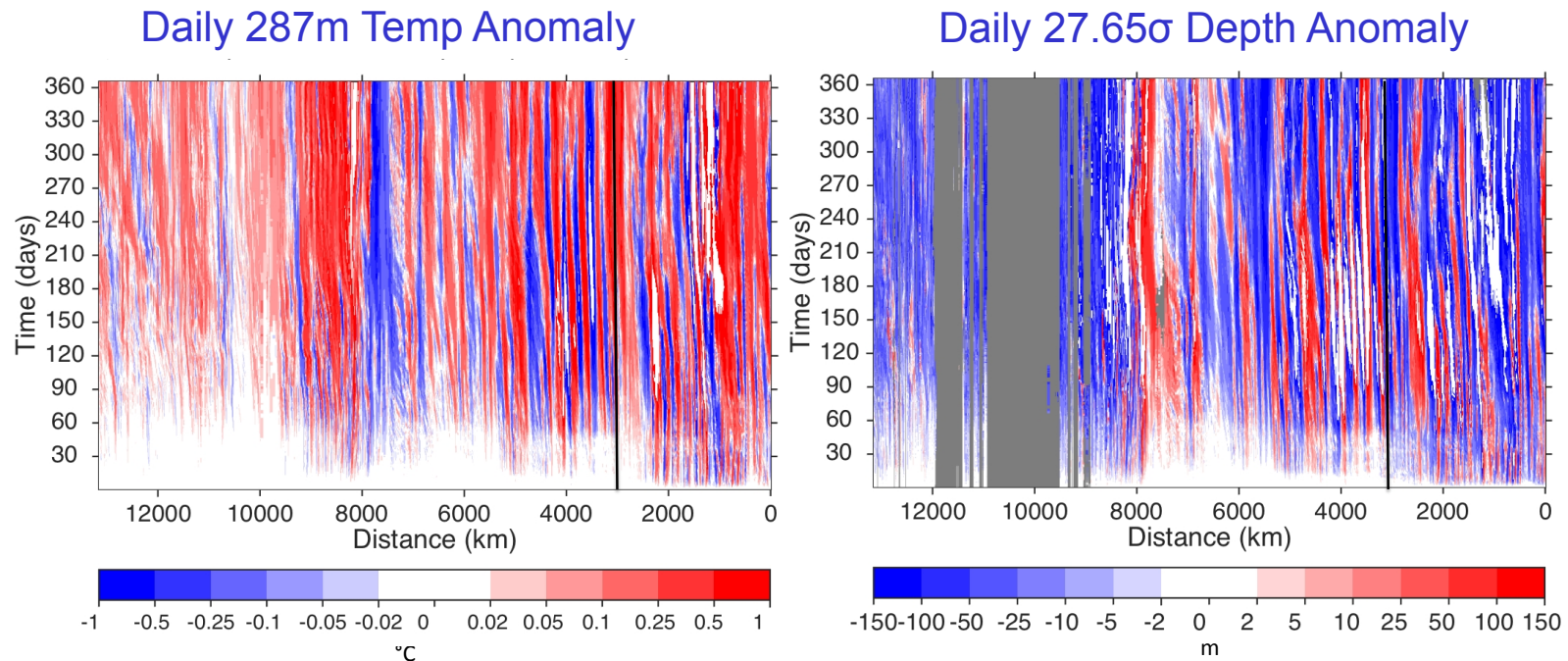


Heat Advection :

current speed $\sim 0.1\text{m/s}$, distance $\sim 6000\text{km}$

advection transport timescale ~ 694 days

Ensemble Anomalies Following Coastal Contour



Barotropic Kelvin Waves :

$$v = \sqrt{gH} = \sqrt{9.8 * 500} = 70m/s$$

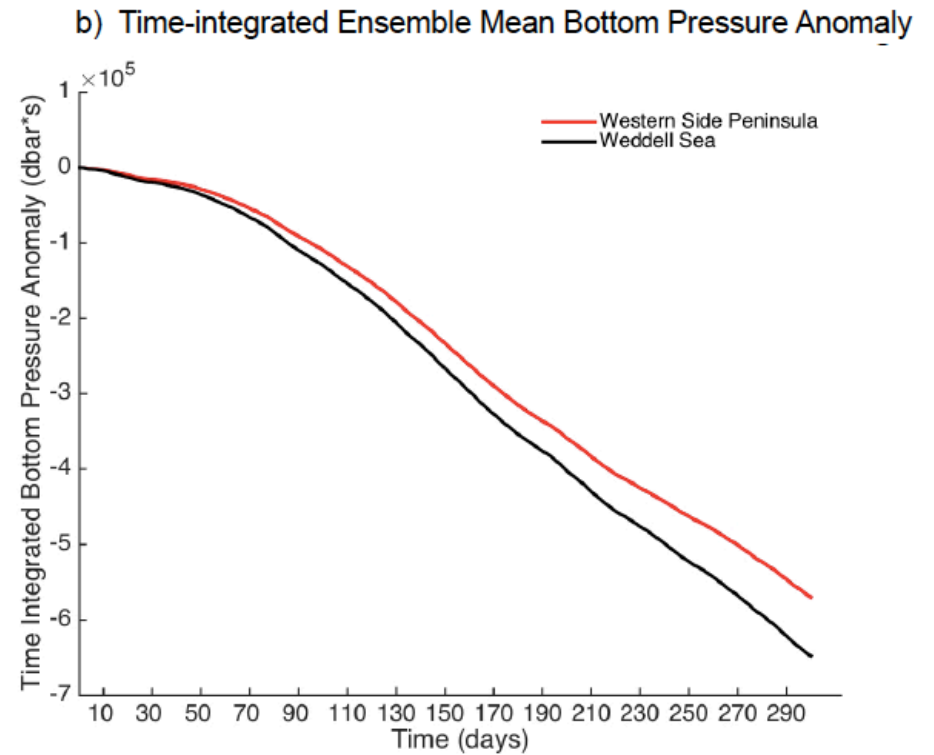
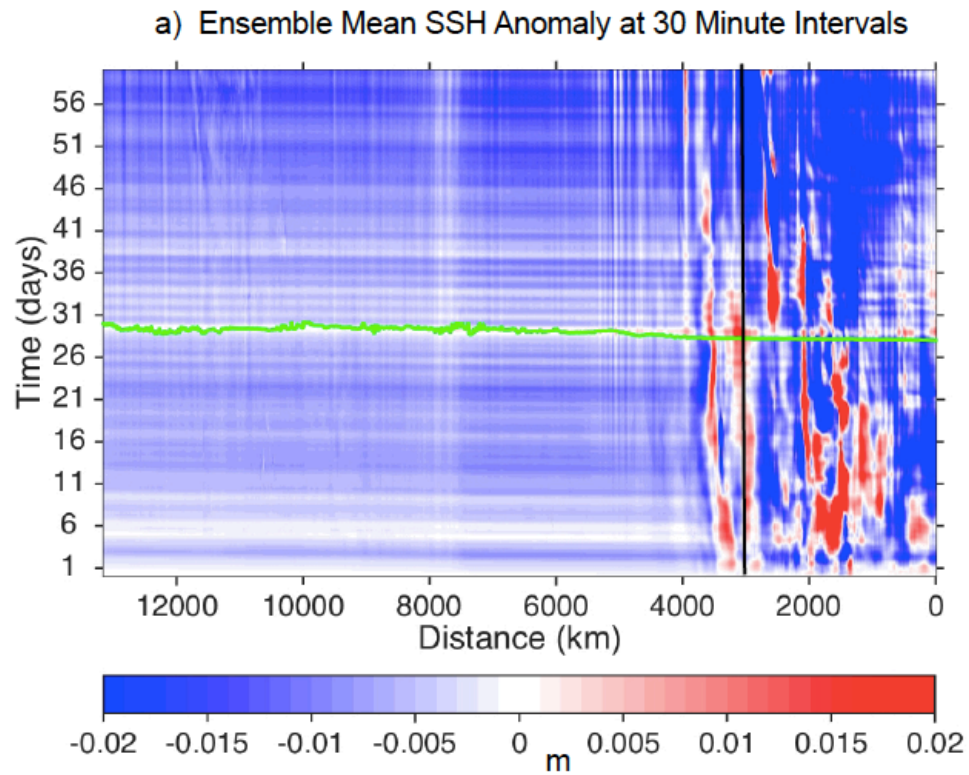
barotropic waves travel 6000km in ~ 1day

Baroclinic Kevlin Waves :

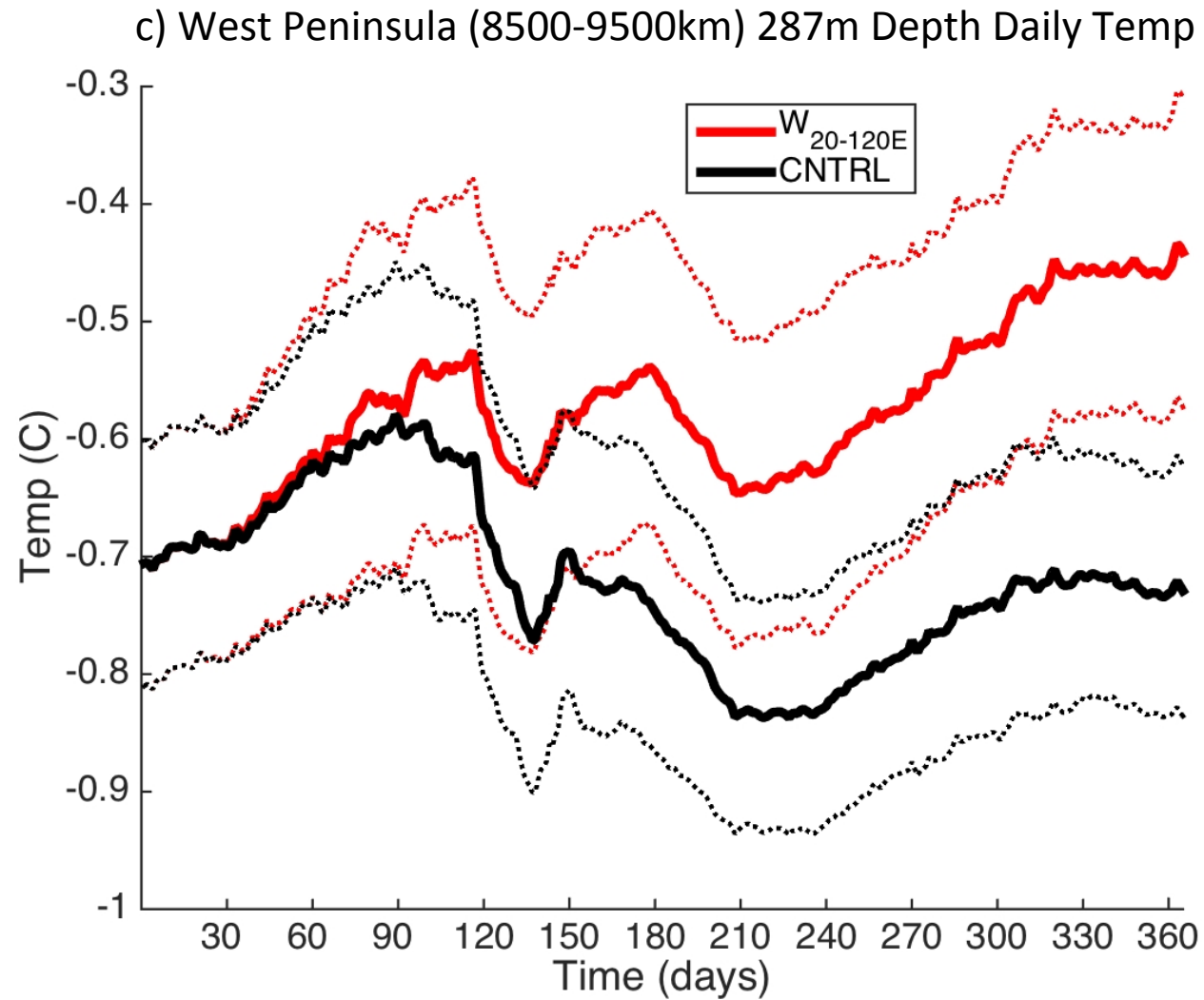
$$v = \sqrt{g'H'} = \sqrt{\frac{g^*(\rho_2 - \rho_1)}{\rho_2} * H_1} \approx \sqrt{\frac{9.8 * (0.15)}{1027} * 200} = 0.53m/s$$

baroclinic waves travels 6000km in ~ 130days

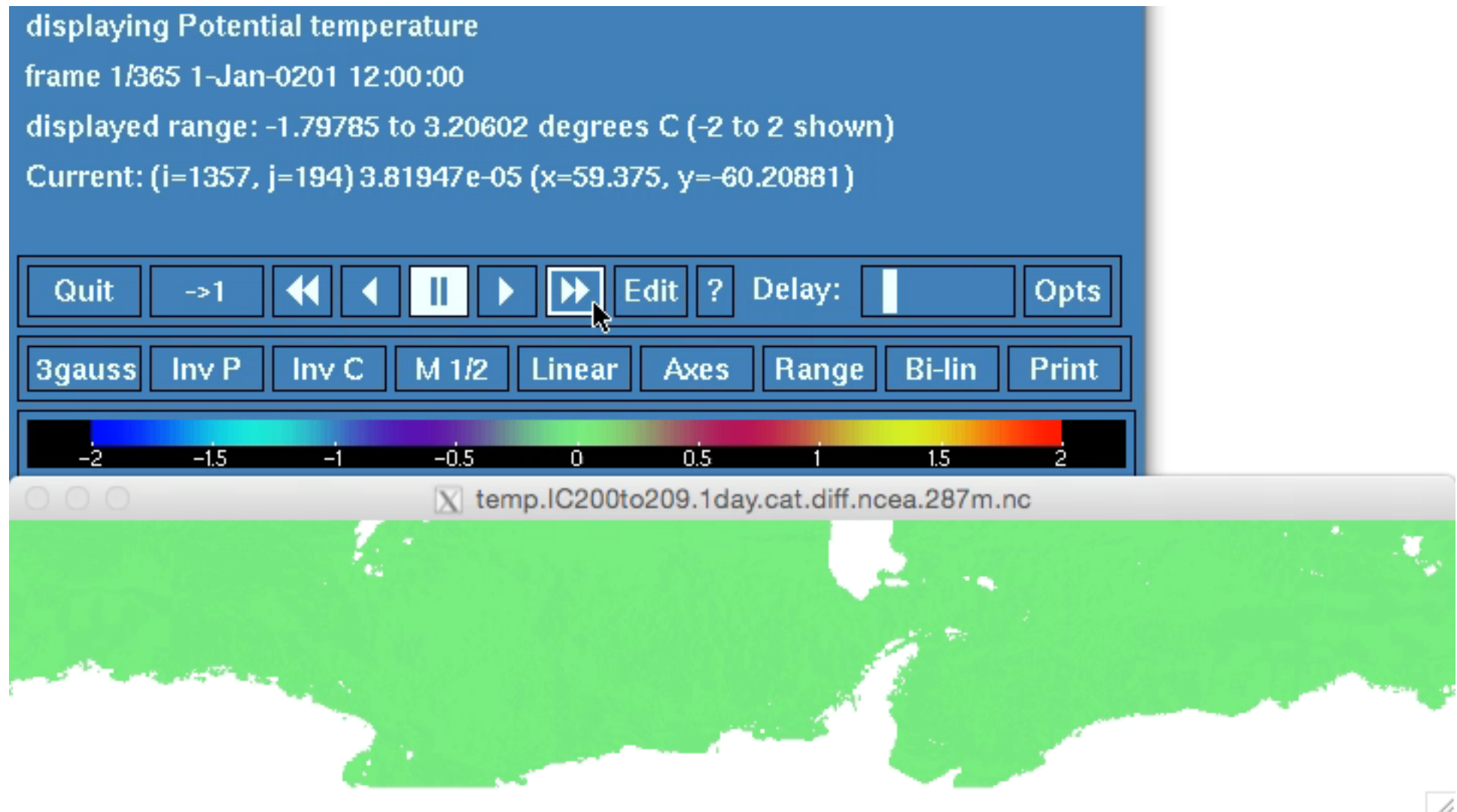
Ensemble Anomalies Following Coastal Contour



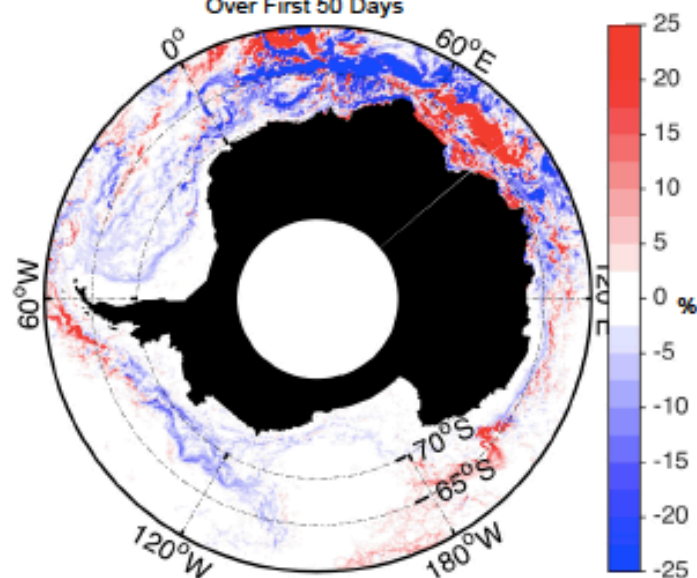
Ensemble 287m Temp Anomaly Along West Peninsula Coast



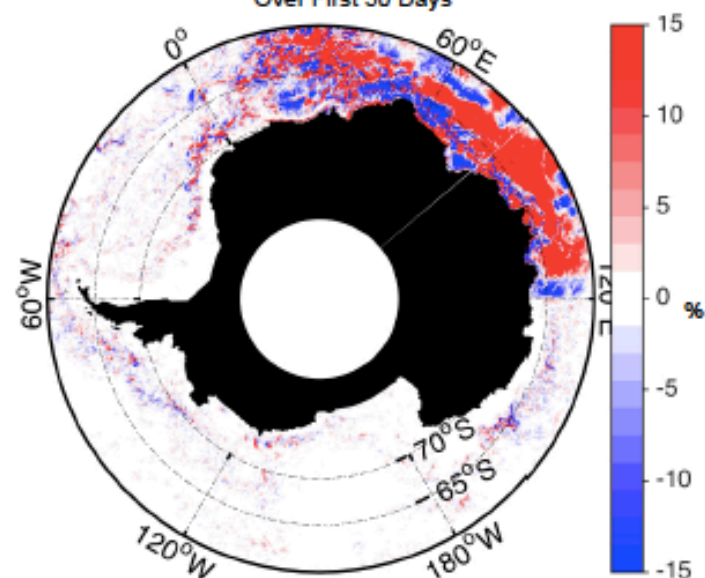
Daily Temp Ensemble Anomalies at 287m for 1 year



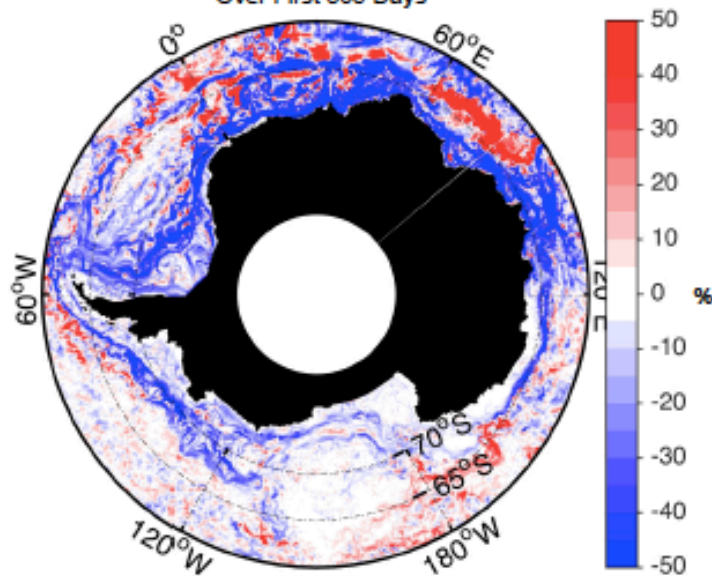
e) % Change in Barotropic Depth Integrated Kinetic Energy
Over First 50 Days



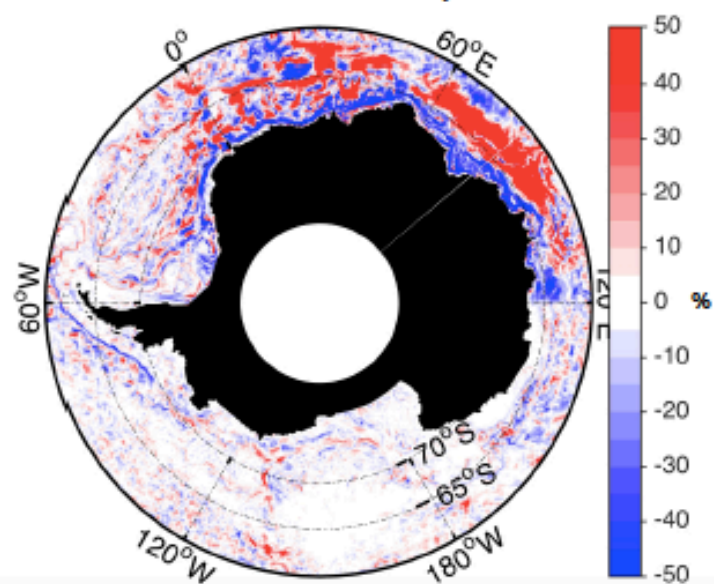
f) % Change in Baroclinic Depth Integrated Kinetic Energy
Over First 50 Days



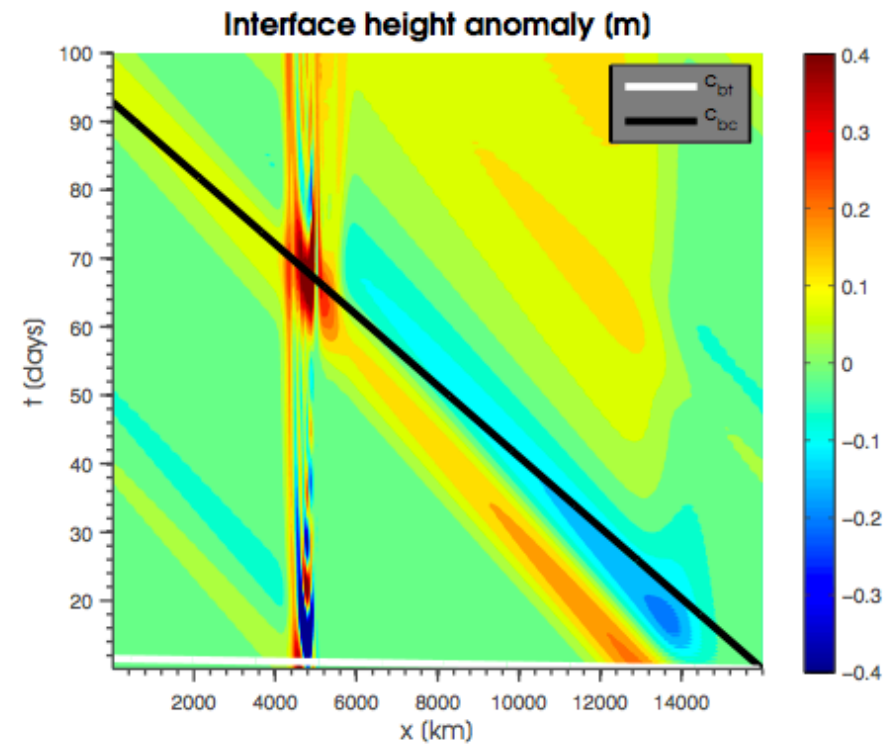
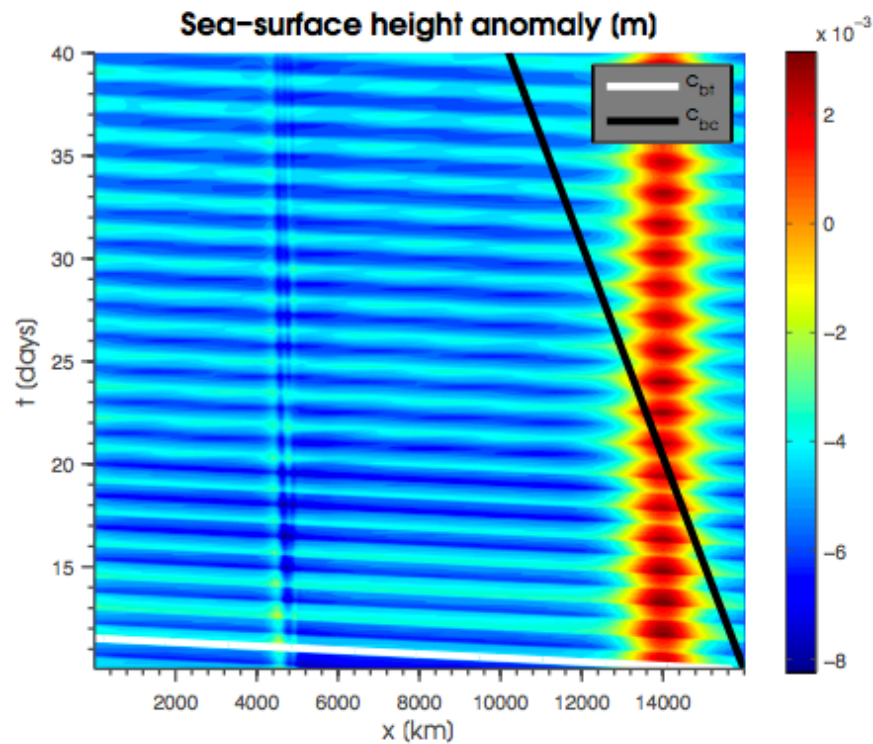
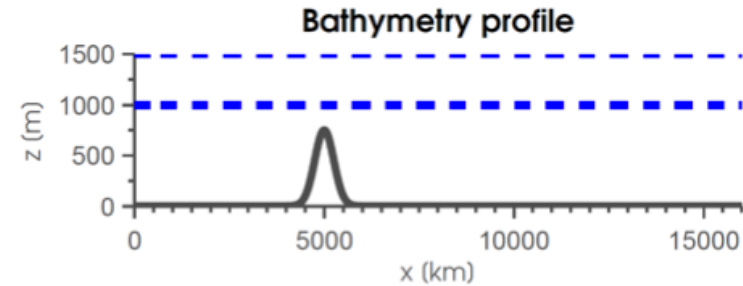
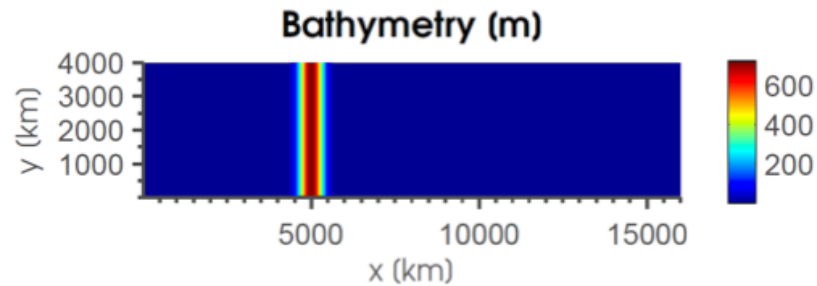
g) % Change in Barotropic Depth Integrated Kinetic Energy
Over First 365 Days



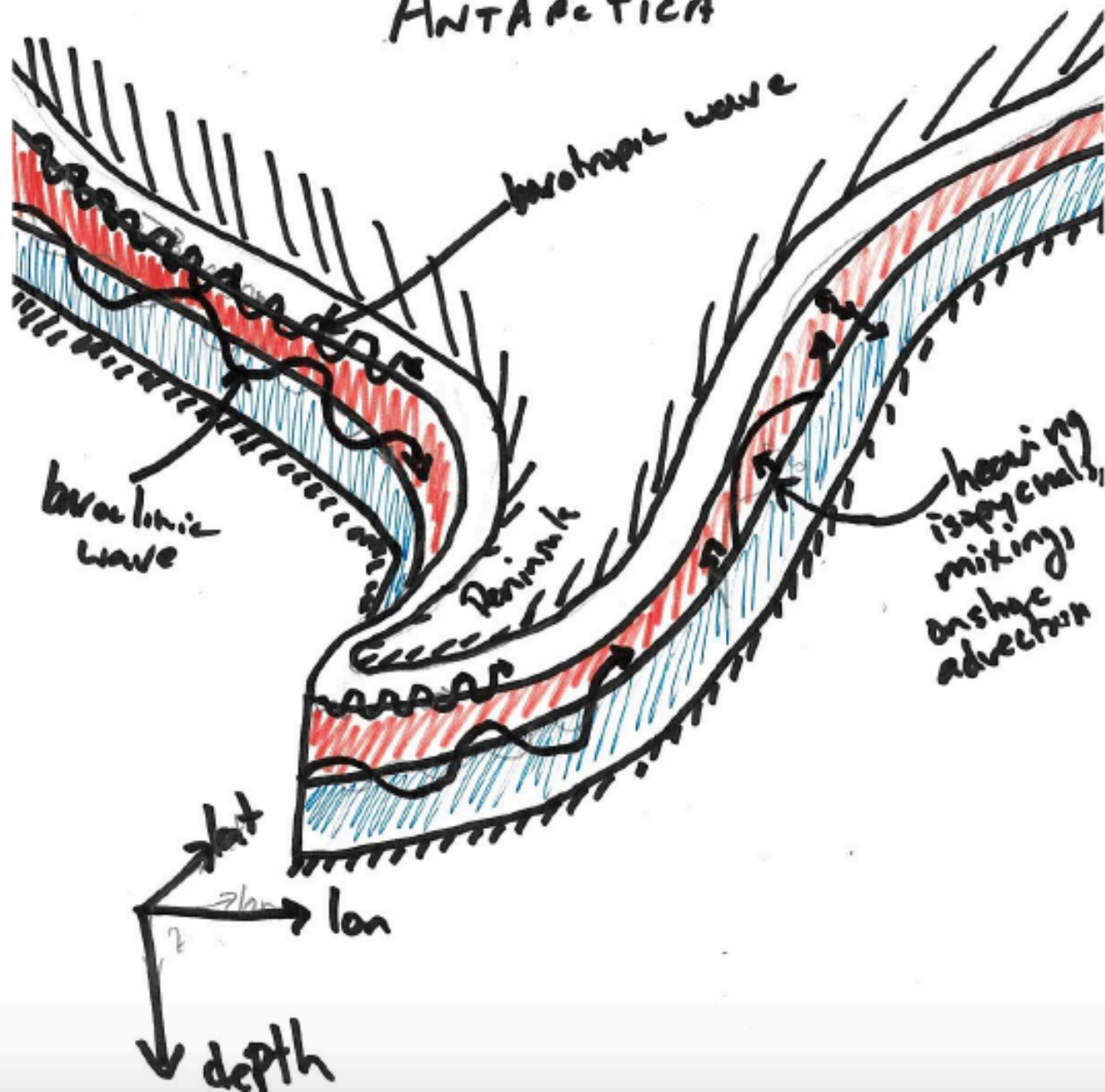
h) % Change in Baroclinic Depth Integrated Kinetic Energy
Over First 365 Days



Idealized Model Simulations of Coastal Kelvin Waves



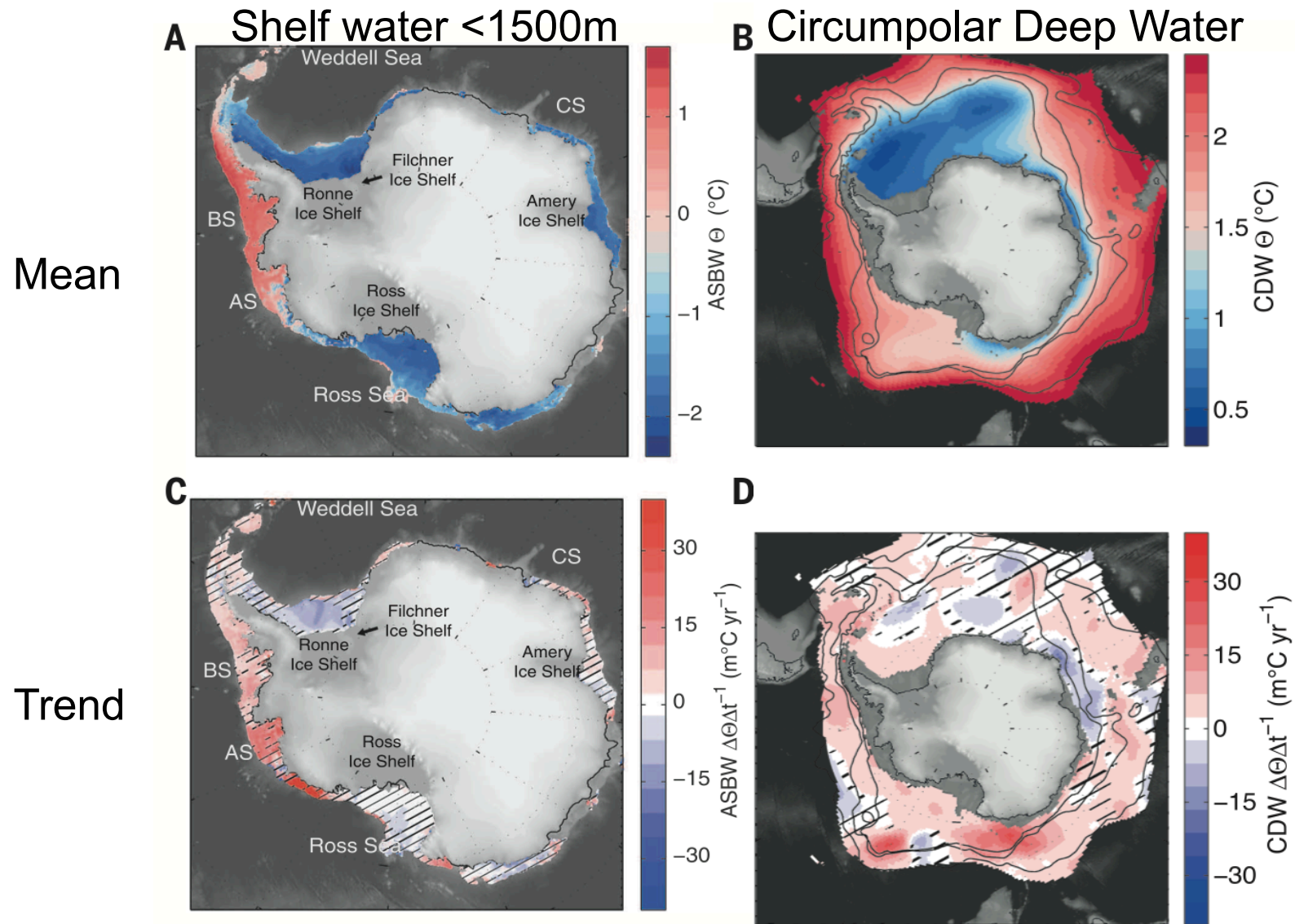
ANTARCTICA



Summary

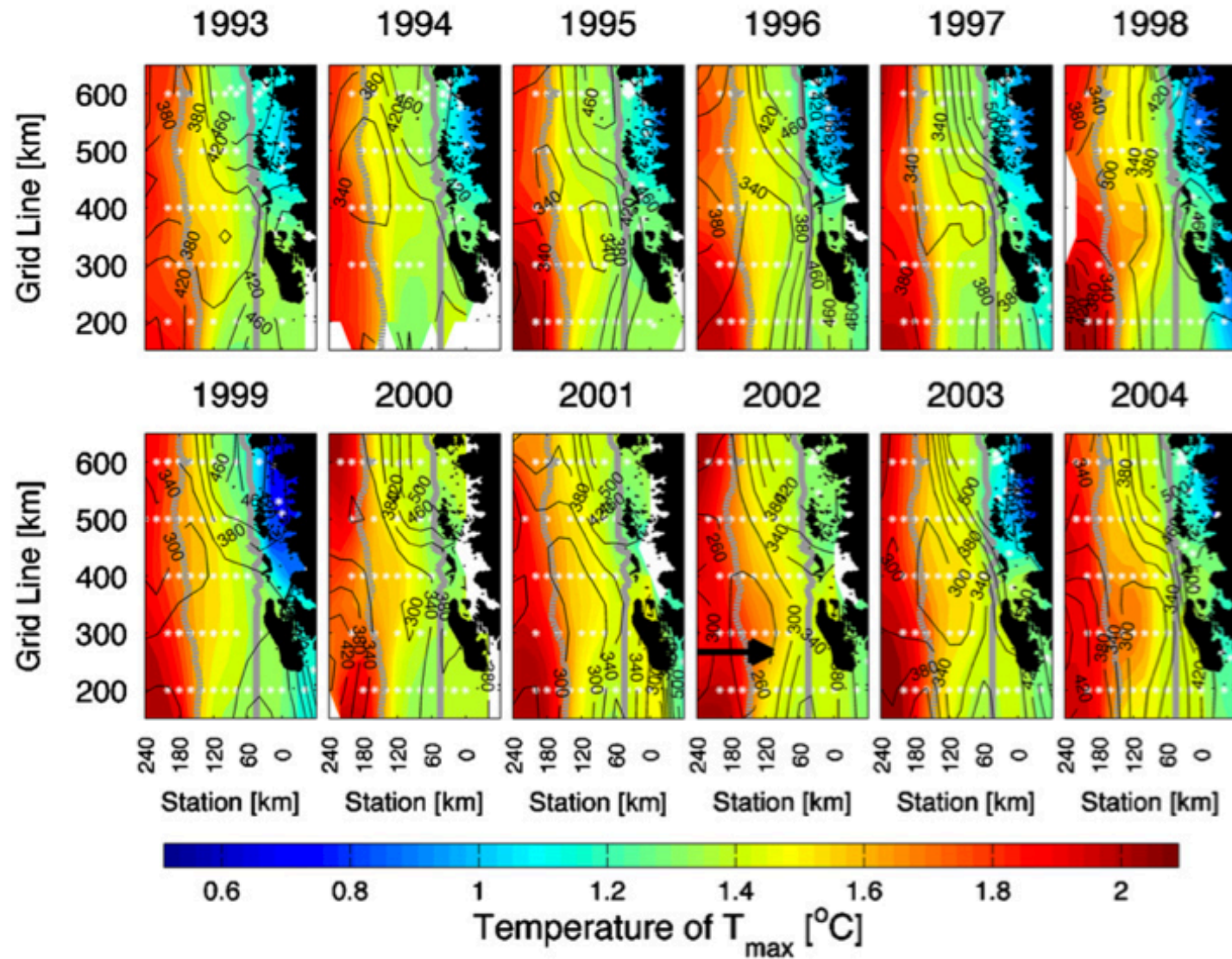
- A poleward wind shift at the latitudes of the Antarctic Peninsula leads to intense warming of subsurface Antarctic coastal waters.
- A local wind shift decreases coastal Ekman pumping, and weakens the Antarctic Slope Front and coastal currents
- Rapid intense warming of subsurface Antarctic coastal waters can also be driven by coastal wind forcing ~10,000km away.
- The distant winds generate coastal waves that lower SSH by ~10cm and subsurface isopycnal layer depths by ~150m.
- The distant wind effects need to be considered in regional Antarctic modelling studies

Observed Temporal Means and Trends (1975-2012)



Schmidtke et al., 2014

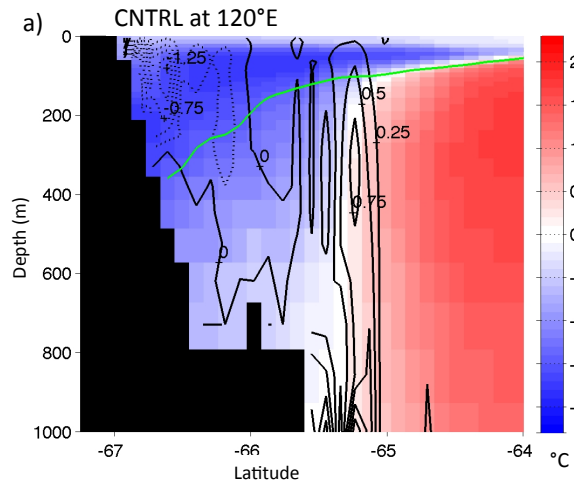
Palter Observations: West Antarctic Peninsula (1993-2004)



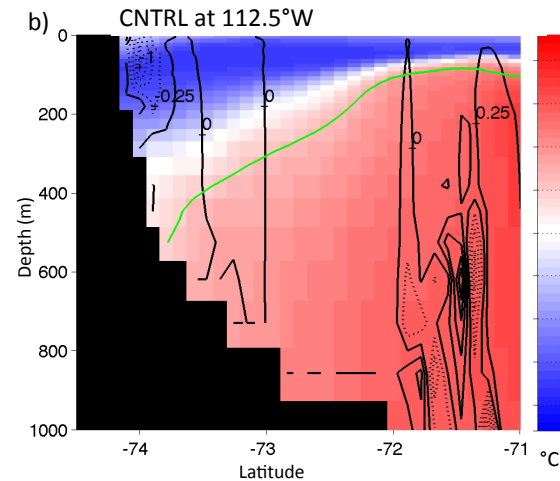
Martinson et al., 2008

Vertical Slices of Temp (colors), Vertical Velocity (black contours) and density (green line)

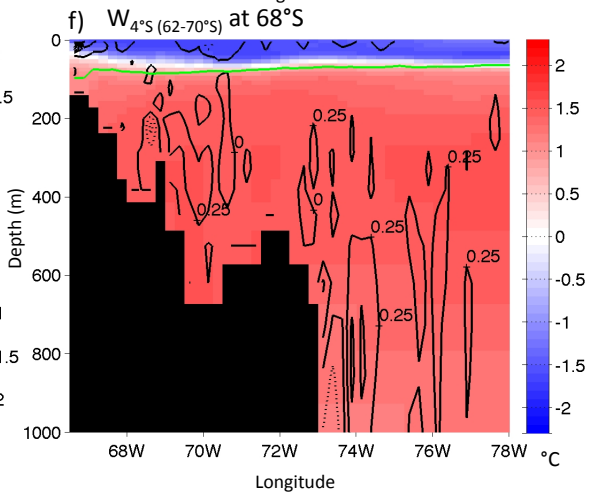
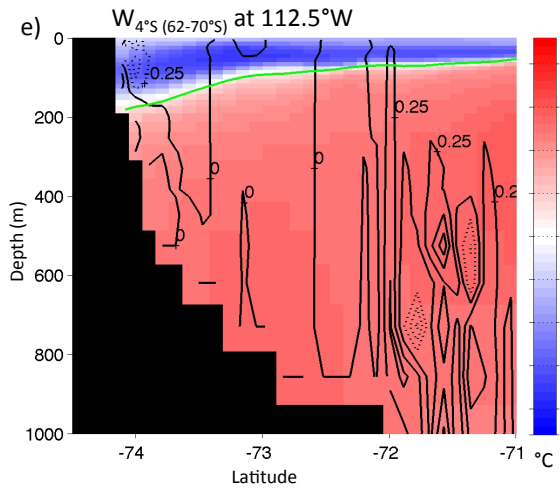
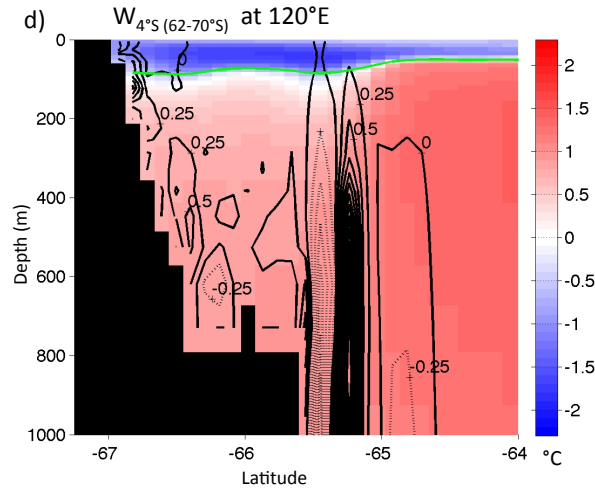
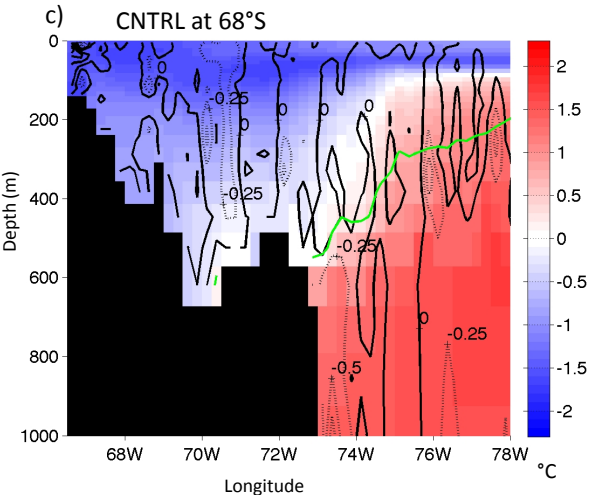
Wilkes Glacier



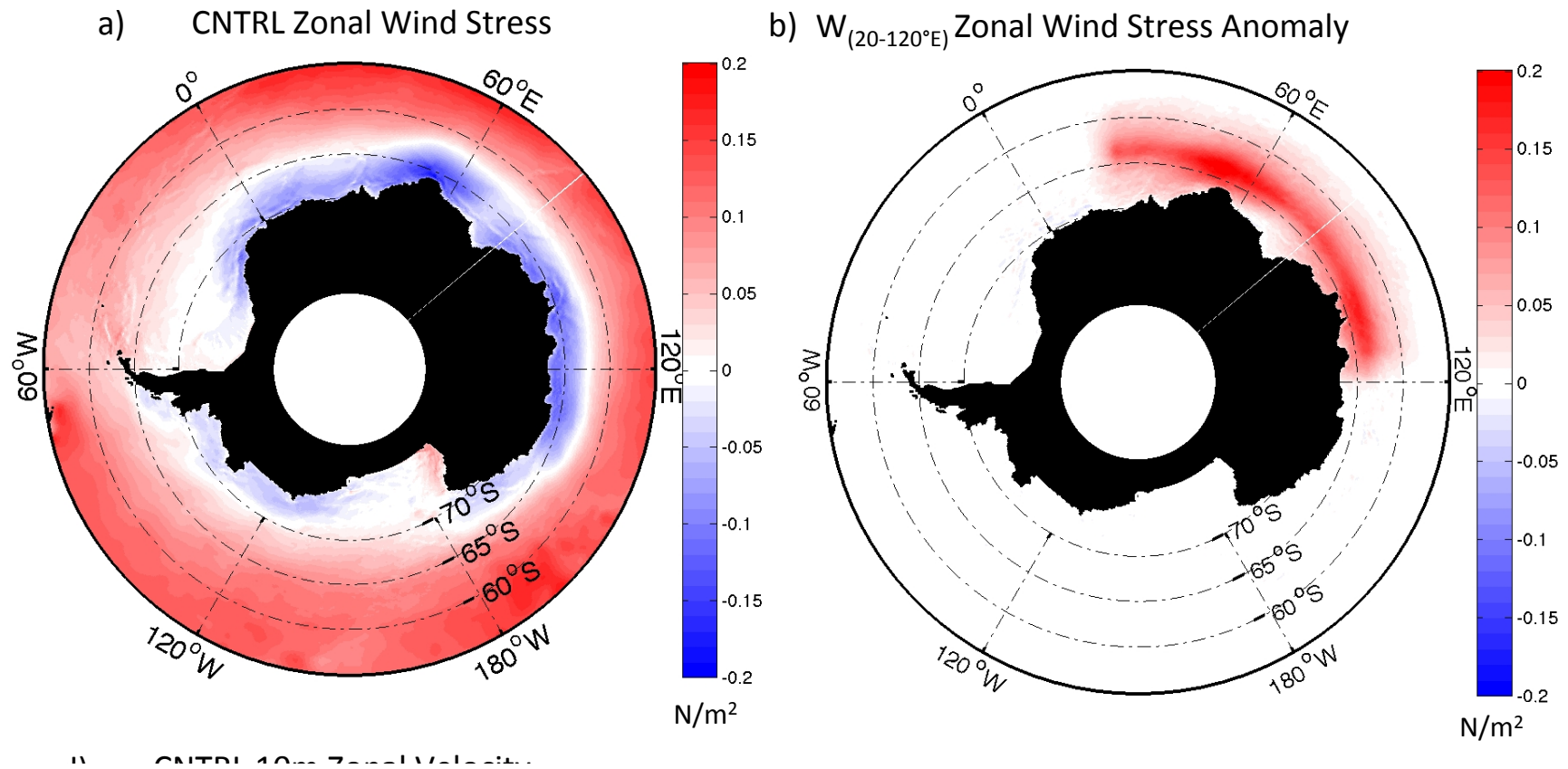
Amundsen Sea



Fallieres Coast

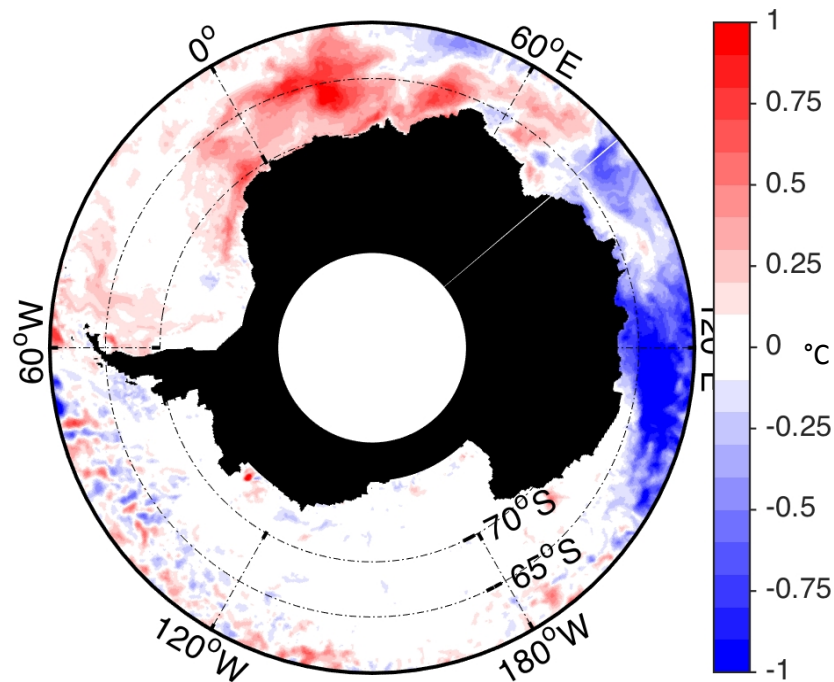


SAM related East Antarctic wind shift forcing

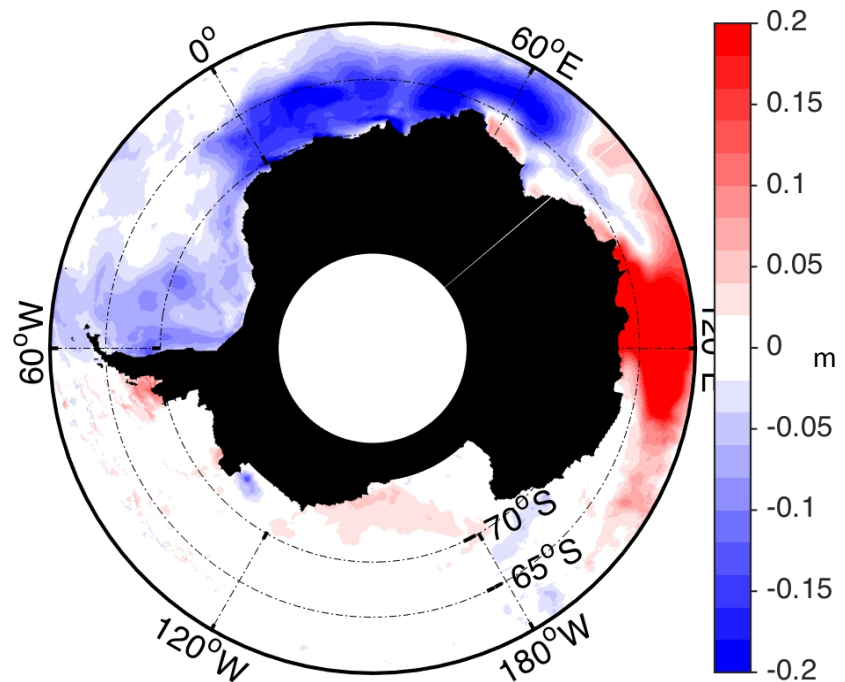


Little Change in West Peninsula SST or Sea Ice

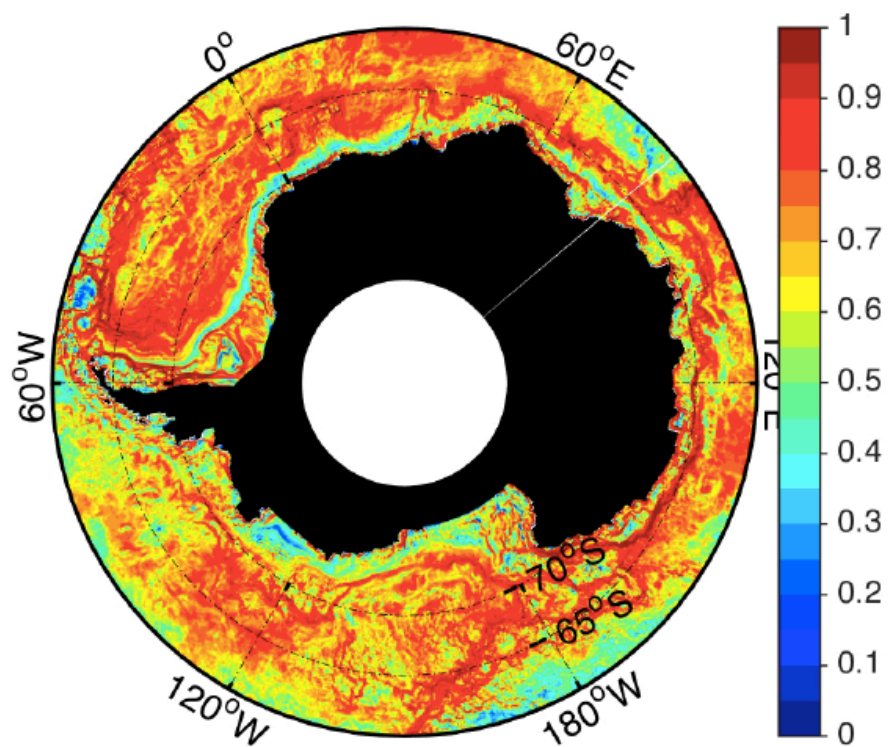
a) $W_{(20-120^{\circ}E)}$ Yr 5 Annual Mean SST Anomaly



b) $W_{(20-120^{\circ}E)}$ Yr 5 Annual Sea Ice Thickness Anomaly



c) Barotropic/Total Depth Integrated Kinetic Energy in CNTRL



d) Baroclinic/Total Depth Integrated Kinetic Energy in CNTRL

