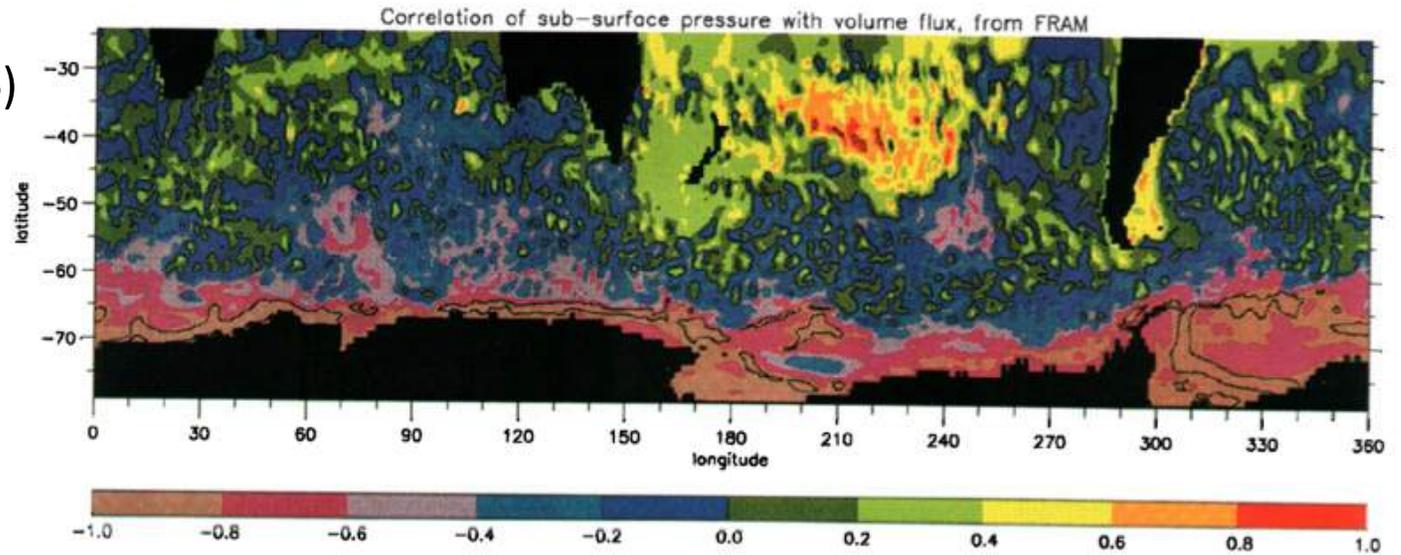


Forcing and effects of the “Southern Mode”, the near-uniform circumpolar barotropic fluctuation over the Antarctic continental shelf

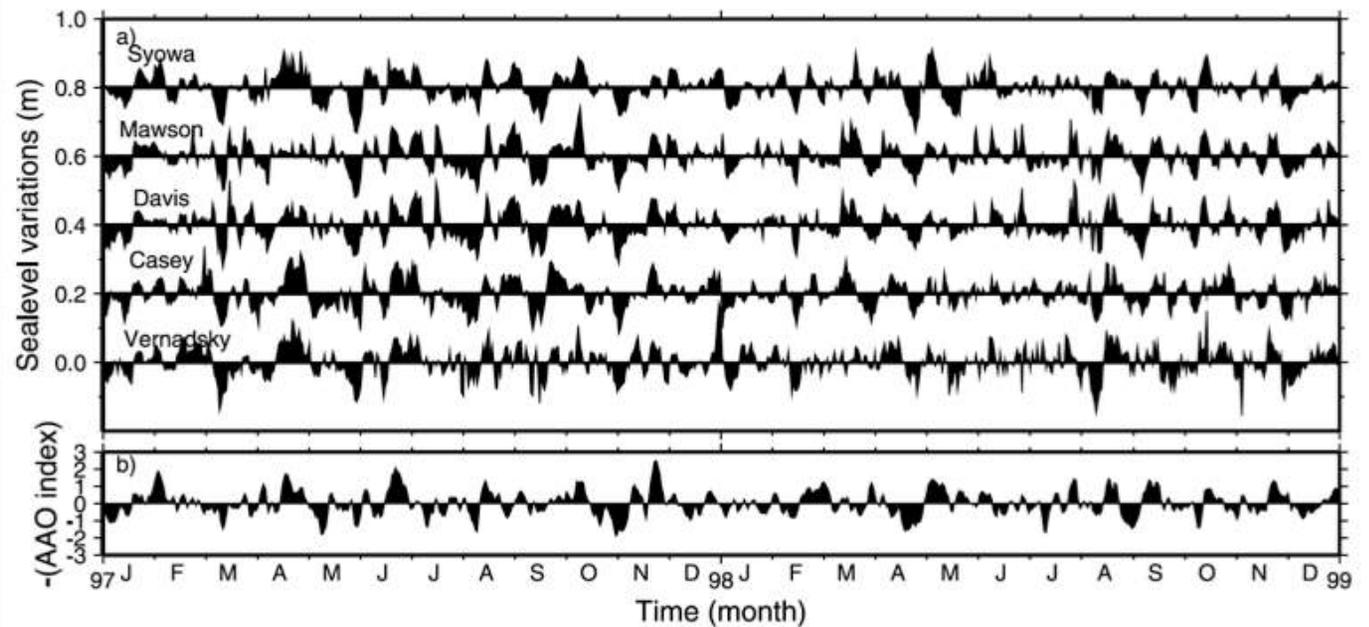
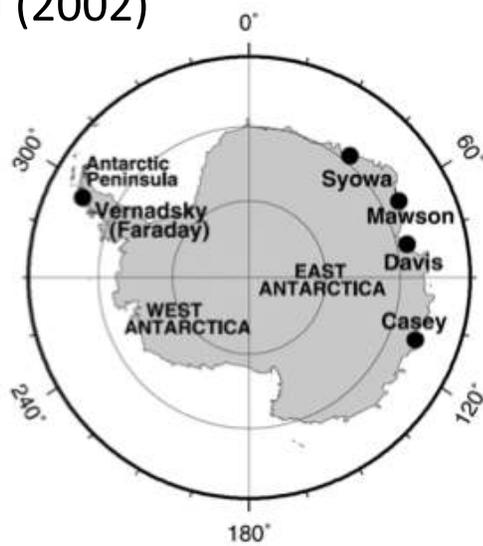
Ichiro Fukumori, Ou Wang, and Ian Fenty
(JPL/Caltech)

“Southern Mode” Hughes et al. (2014)

Woodworth et al. (1996)



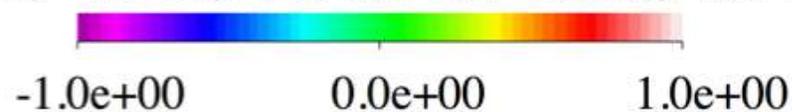
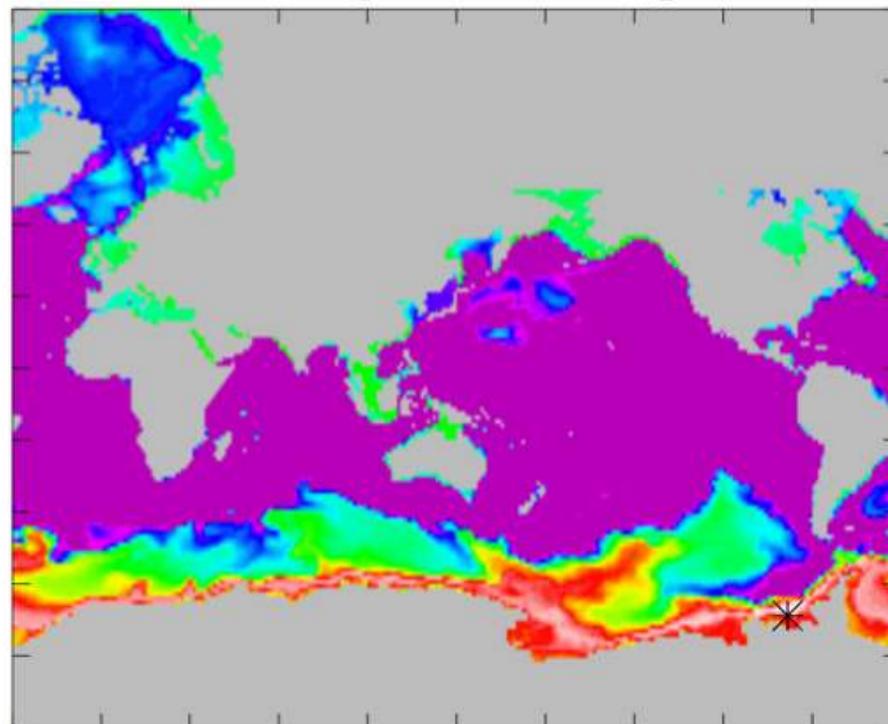
Aoki (2002)



The Southern Mode in ECCO V4r3

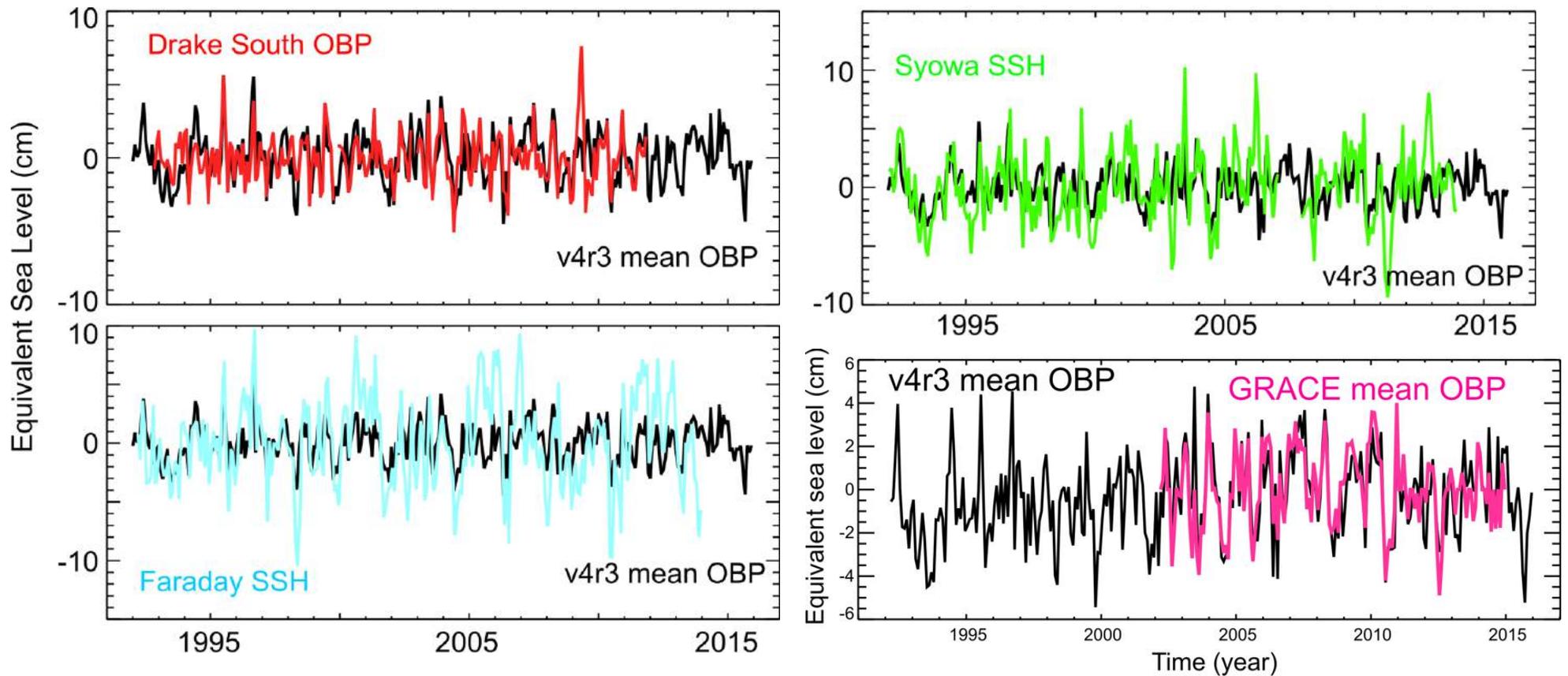
OBP is coherent with nearly uniform amplitude across the Antarctic Shelf around Antarctica

OBP variance at each location explained by OBP near Amundsen Sea



The Southern Mode in ECCO V4r3

V4r3 OBP is consistent with in situ & satellite observations



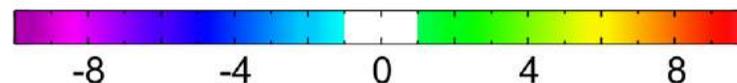
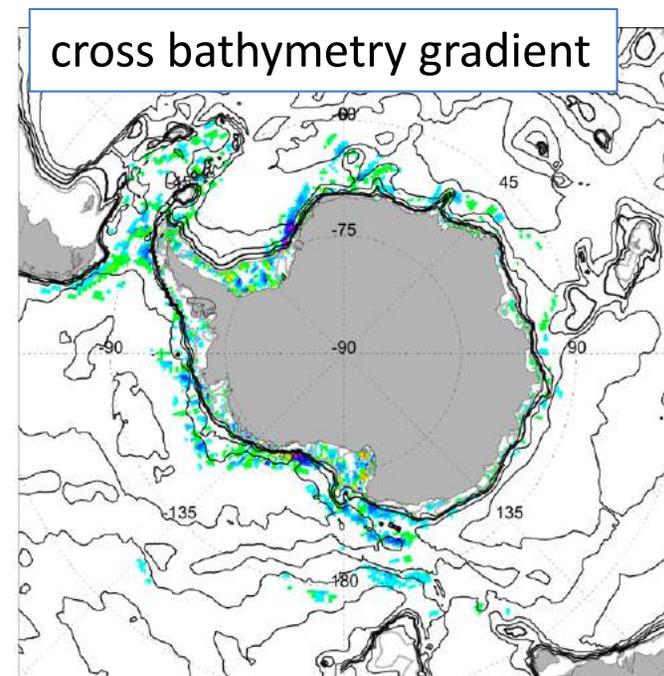
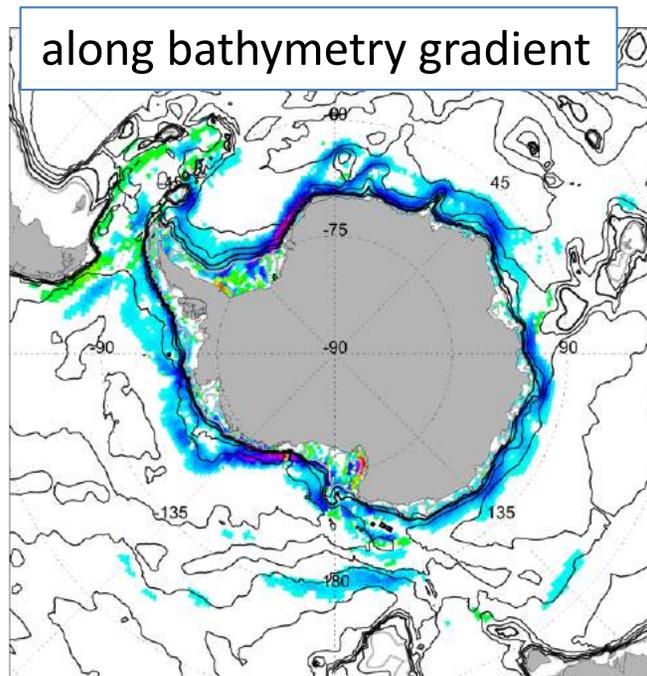
Cause of the “Southern Mode”

Identify the forcing responsible for the “Southern Mode” by adjoint gradient decomposition;

Southern Mode OBP at time t \nearrow $J(t) \approx \sum_i \sum_{\mathbf{x}} \sum_{\Delta t} \frac{\partial J}{\partial \phi_i(\mathbf{x}, \Delta t)} \delta \phi_i(\mathbf{x}, t - \Delta t)$ \nwarrow forcing i at location \mathbf{x} & time $t - \Delta t$

\nwarrow adjoint gradient

gradient with respect to weekly wind stress anomaly at 4-weeks lag

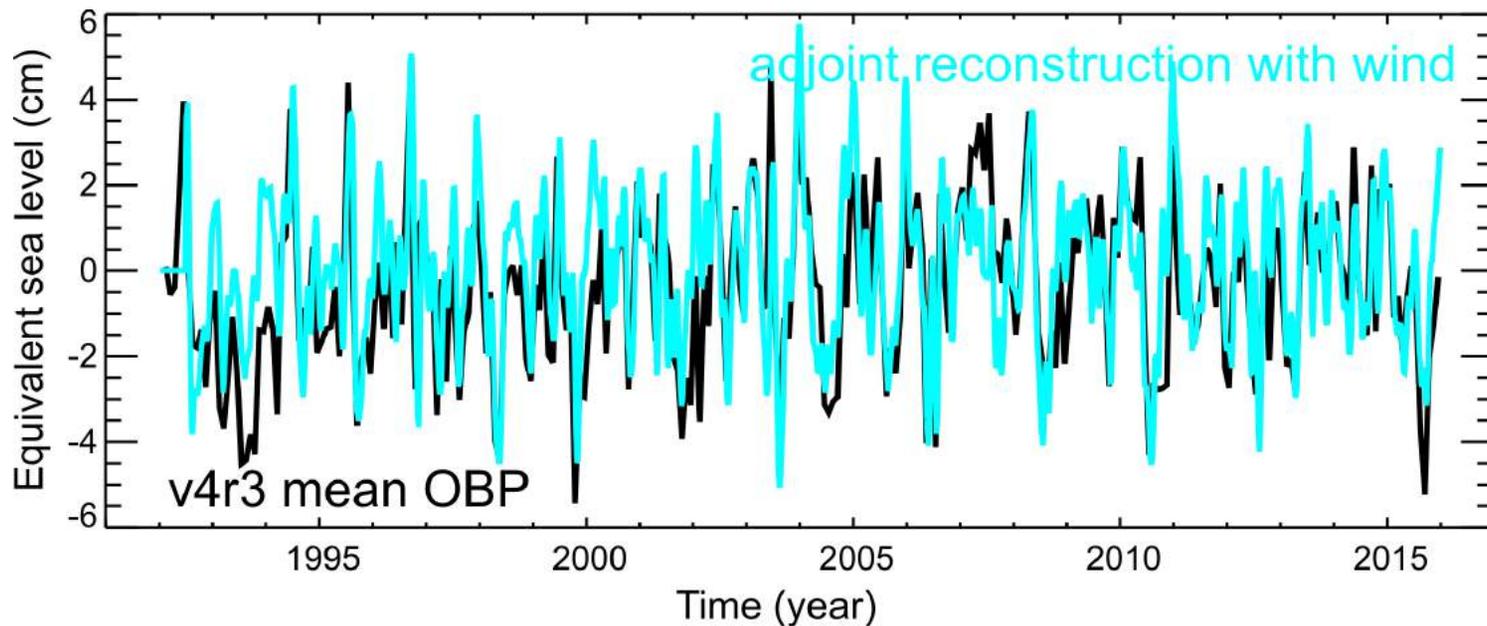


$\times 9.8 \text{ cm}/(\text{N}/\text{m}^2)$

Cause of the “Southern Mode”

Wind is responsible for the “Southern Mode”

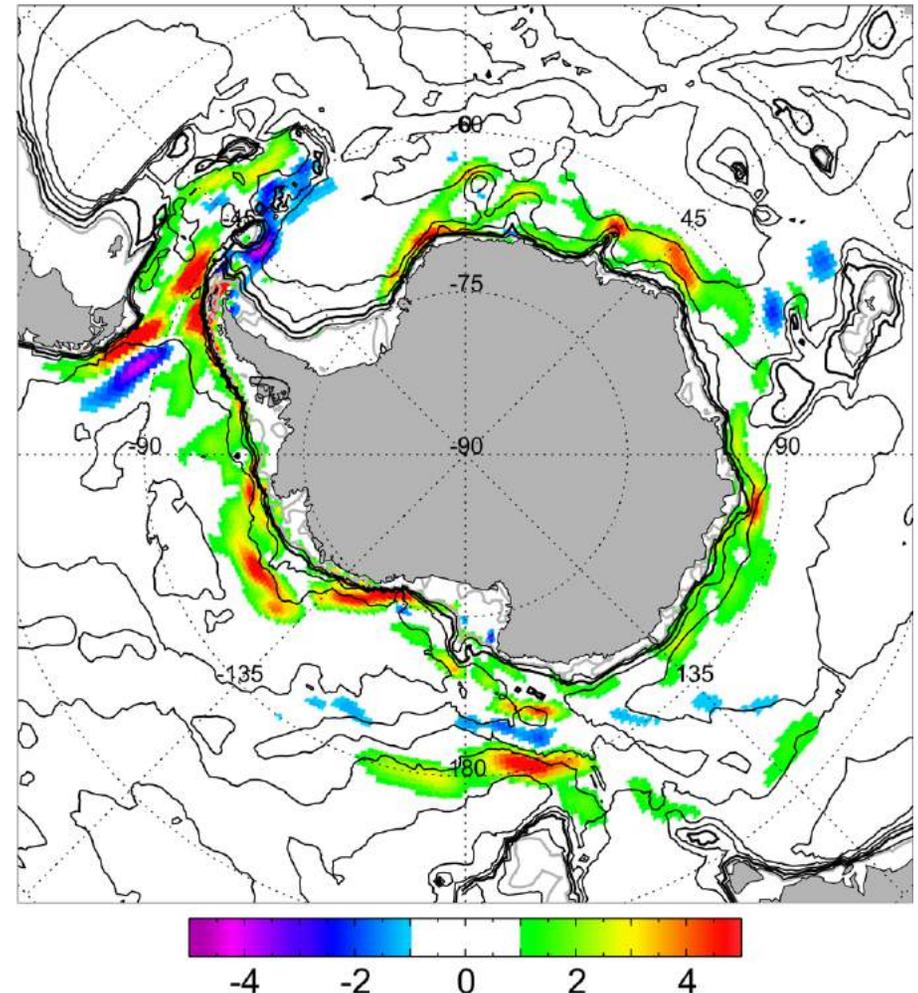
$$J(t) \approx J_{\text{wind}}(t) \equiv \sum_{i=\text{wind}} \sum_{\mathbf{x}} \sum_{\Delta t} \frac{\partial J}{\partial \phi_i(\mathbf{x}, \Delta t)} \delta \phi_i(\mathbf{x}, t - \Delta t)$$



Cause of the “Southern Mode”

Identify where the “Southern Mode” is forced by evaluating explained variance from wind at each location;

$$1 - \frac{\text{var} \left\{ J_{wind} - \sum_{i=wind} \sum_{\Delta t} \frac{\partial J}{\partial \phi_i(\mathbf{x}, \Delta t)} \delta \phi_i(\mathbf{x}, t - \Delta t) \right\}}{\text{var} \{ J_{wind} \}}$$



Summary

- The “southern mode” is driven by along-bathymetry winds along the Antarctic continental slope that varies with bathymetry, proximity to the continent, and variations in the wind,
- Until there are multi-decadal observations around Antarctica, V4r3 provides a unique tool to study variations in this region.