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

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“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;

\[
J(t) \approx \sum_i \sum_x \sum_{\Delta t} \frac{\partial J}{\partial \phi_i(x, \Delta t)} \delta \phi_i(x, t - \Delta t)
\]

forcing \( i \) at location \( x \) & time \( t-\Delta t \)

adjoint gradient

Southern Mode OBP at time \( t \)

along bathymetry gradient

cross bathymetry gradient

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

x \( 9.8 \text{ cm}/(\text{N/m}^2) \)
Cause of the “Southern Mode”

Wind is responsible for the “Southern Mode”

\[ J(t) \approx J_{\text{wind}}(t) = \sum_{i=\text{wind}} \sum_{x} \sum_{\Delta t} \frac{\partial J}{\partial \phi_i(x, \Delta t)} \phi_i(x, t-\Delta t) \]
Identify where the “Southern Mode” is forced by evaluating explained variance from wind at each location;

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