

Sources of heterogeneous variability and trends in Antarctic sea-ice

- Southern Hemisphere sea-ice has exhibited regions of increase and decrease
- To elucidate the drivers of the observed heterogeneous sea-ice trends
- Use a comprehensive set of ocean–sea-ice simulations (1990–2007) to elucidate the drivers of the observed heterogeneous sea-ice trends

Richard Matear, Terence J. O’Kane, James S. Risbey & Matt Chamberlain (Nature Communication 2015)

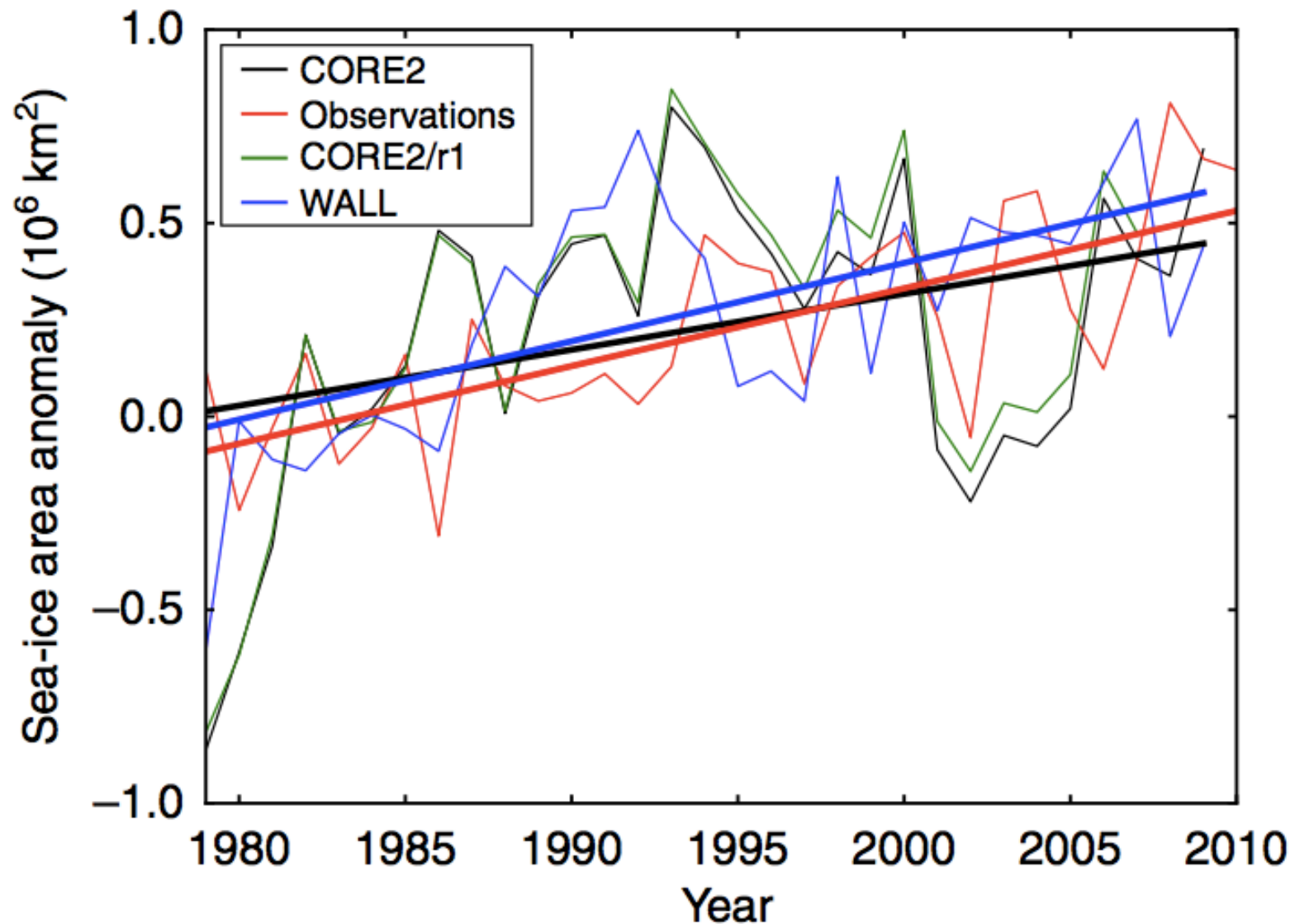
Model Simulations

Table 1 | Brief description of the model simulations.

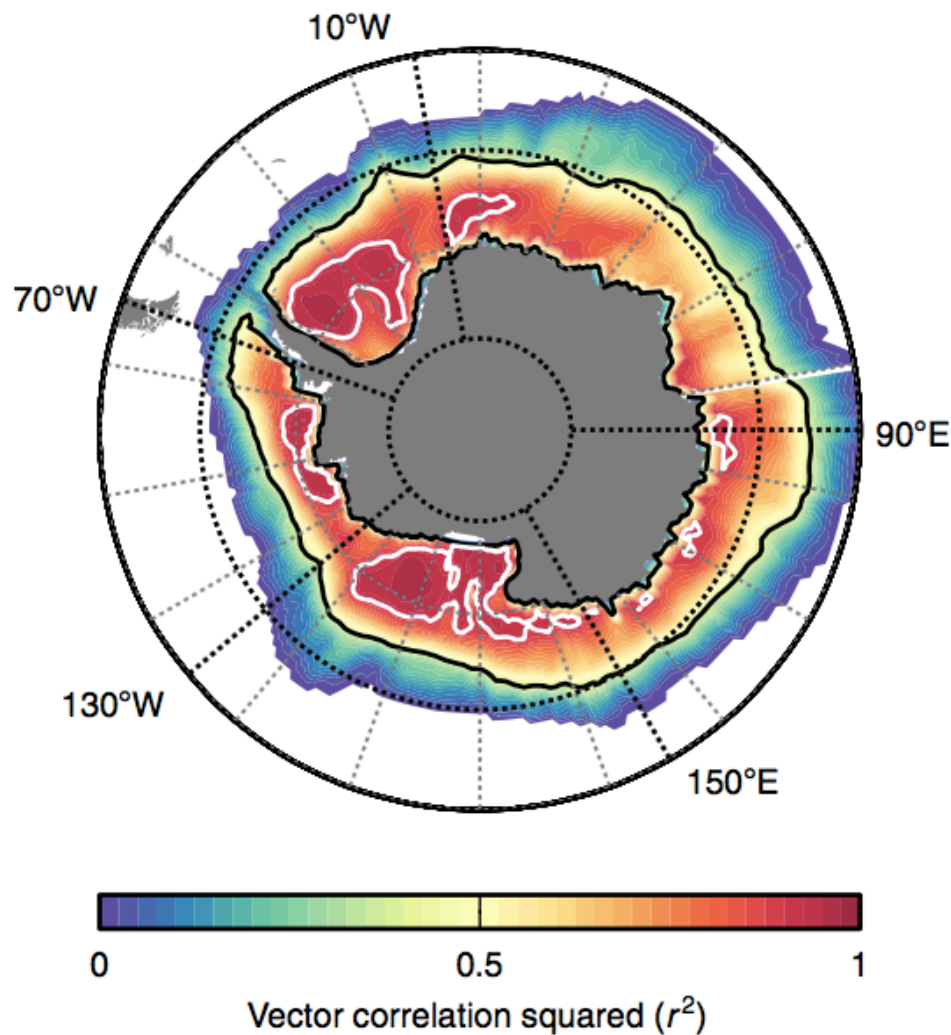
Simulation	Description
CORE2	Full CORE2 interannually varying forcing
CORE1	CORE1 nominal year forcing
SAM	CORE1 forcing plus SAM component of the winds*
ENSO	CORE1 forcing plus ENSO component of the winds*
ENSO + SAM	CORE1 forcing plus ENSO and SAM components of the winds*
WHF	CORE1 plus high-frequency component of CORE2 winds*
WALL	CORE1 forcing with CORE2 winds
WALLa	CORE1 forcing with CORE2 winds and air temperatures

*Wind components are only modified south of 30°S.

Antarctic Annual Sea-Ice Area Anomaly



Vector Correlation between the Apr-Oct winds and sea ice drift

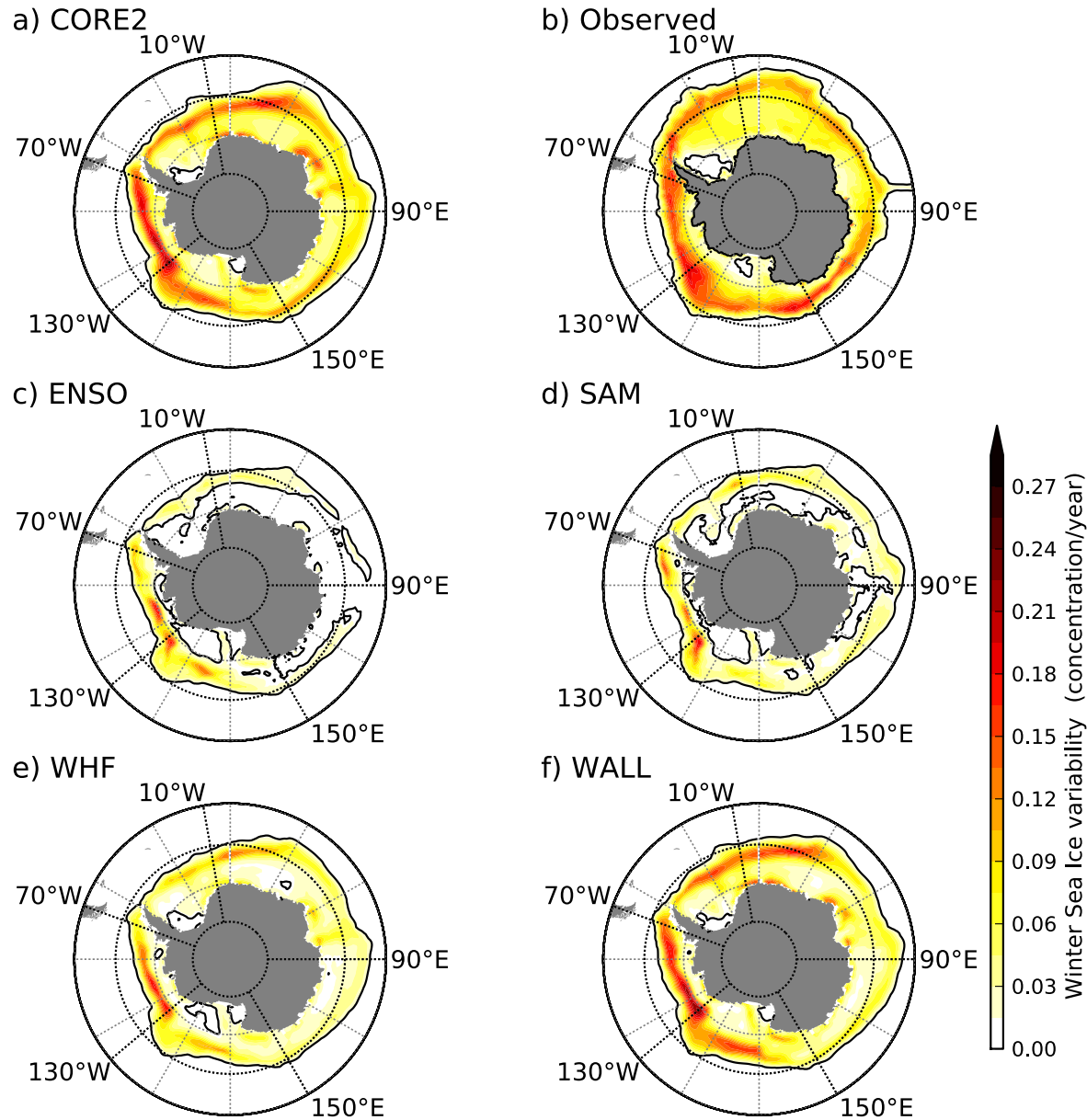


- Black line $r=0.4$
- White line $r=0.9$

Figure 2 | Vector correlation between the April-October time series of

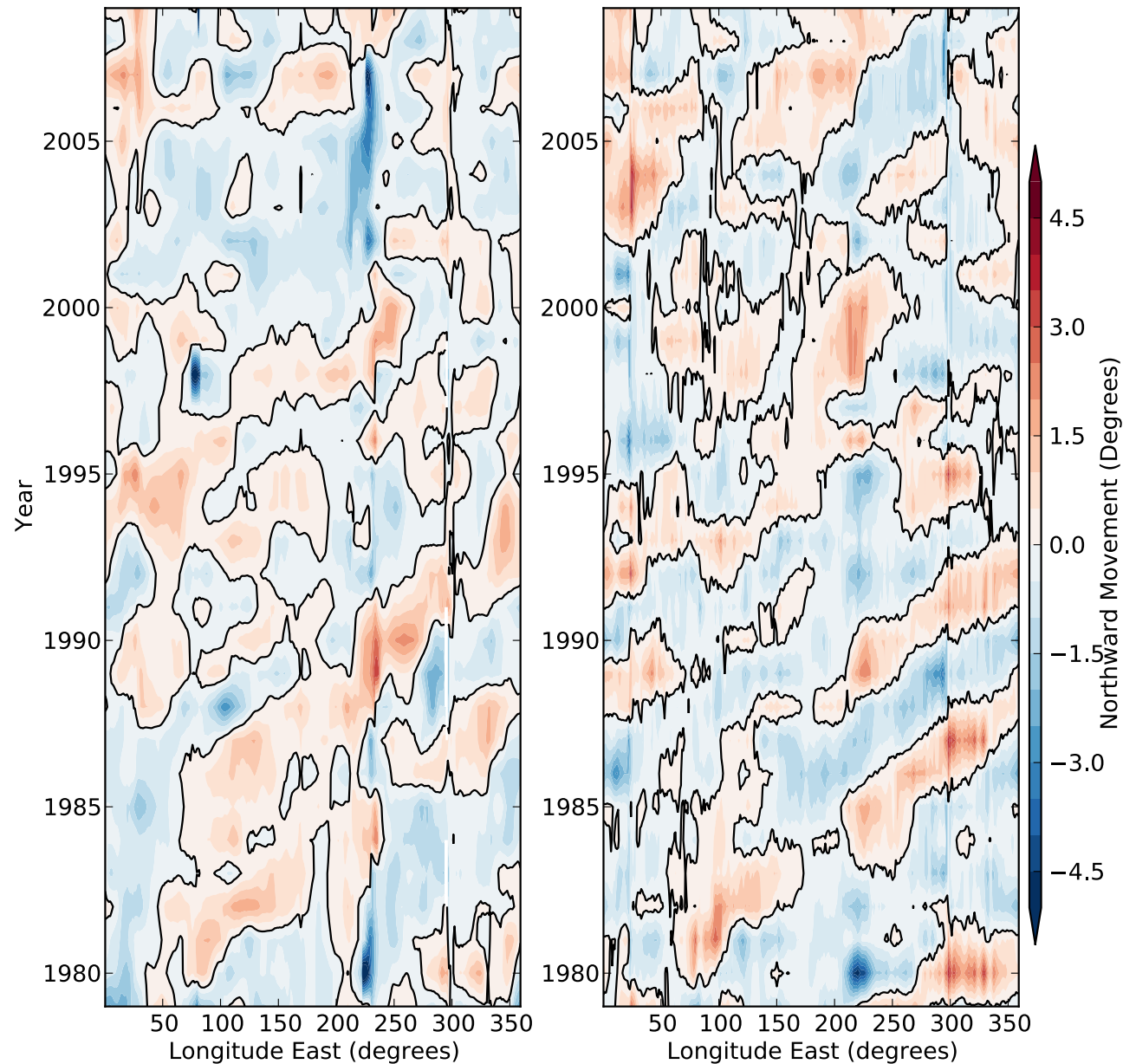
Model and Observations:

Standard deviation in winter sea-ice concentration



a) CORE2

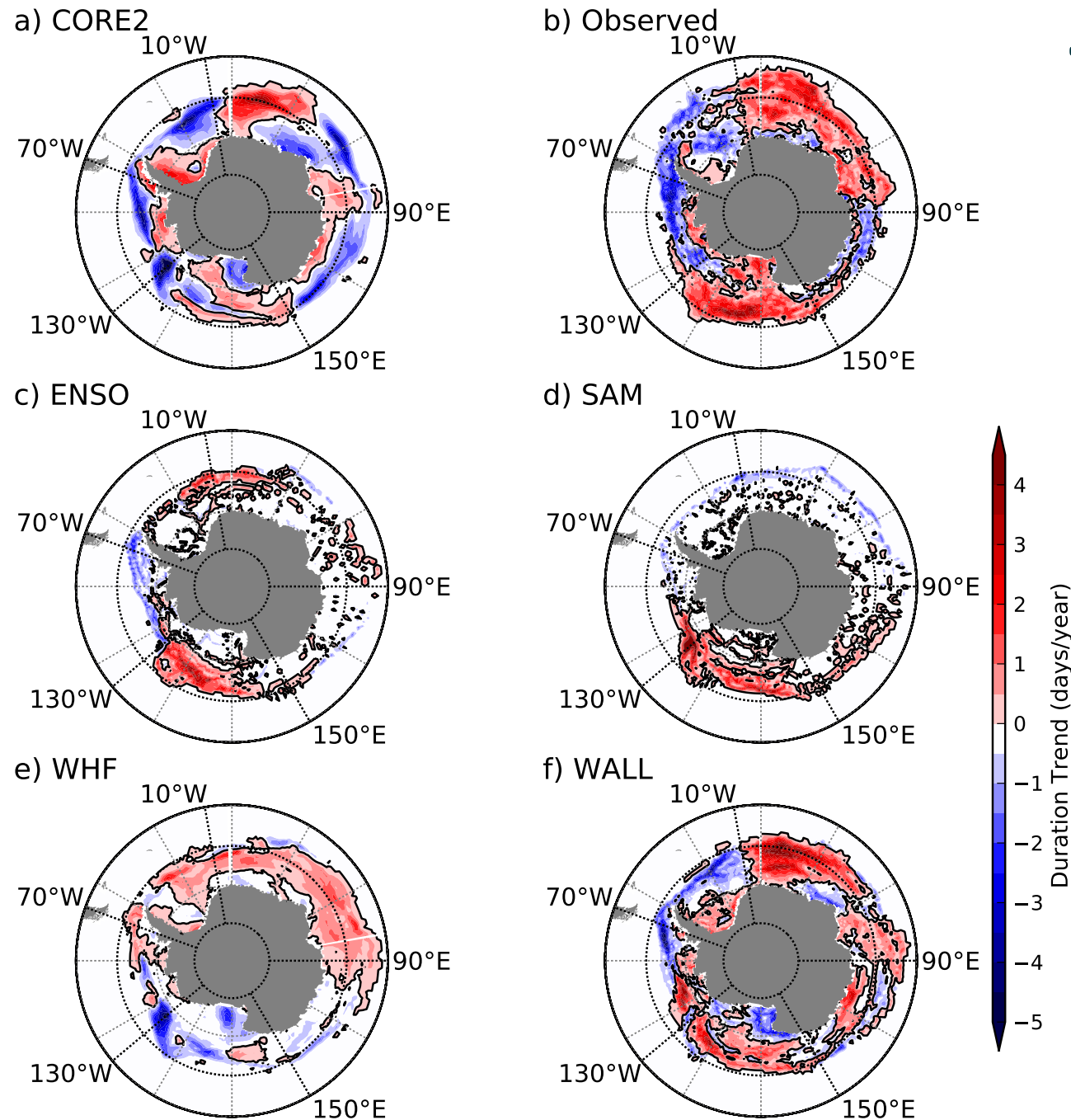
b) Observed



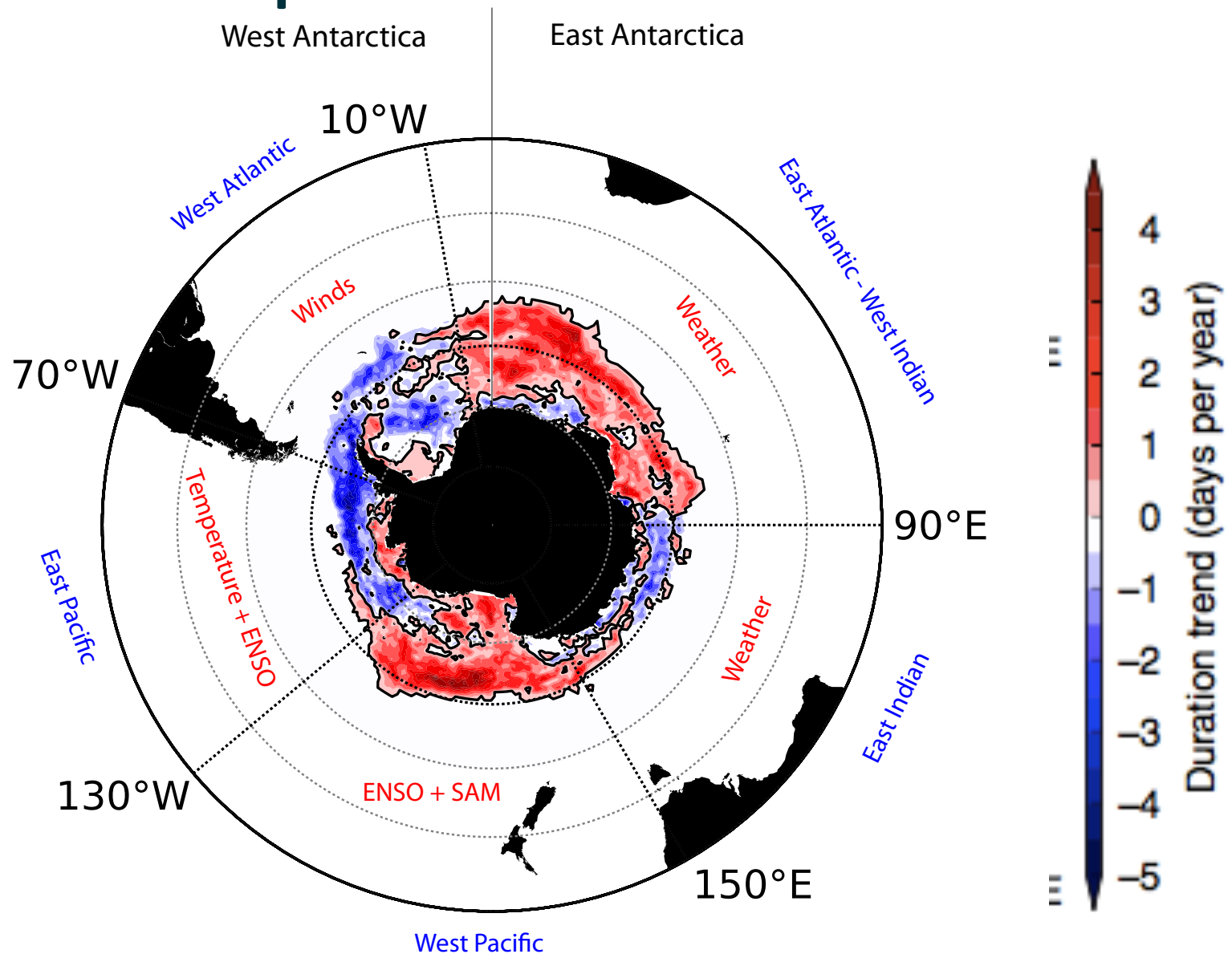
Model and Observations

**Hovmoller plot
around Antarctica
showing north–south
departures in winter
sea-ice extent from
the 1979 to 2007
averaged position**

Trends in sea-ice duration over the 1990–2007 period in days per year



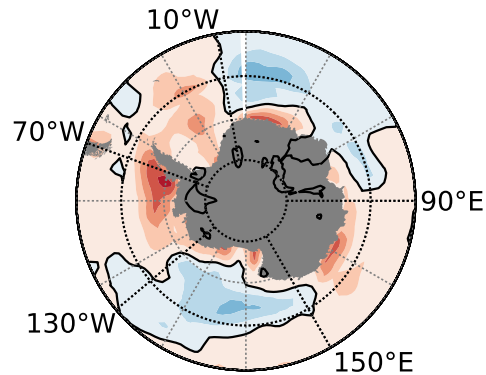
Summary: Observed trends in sea-ice duration for ⁸ the 1990–2007 period



Summary

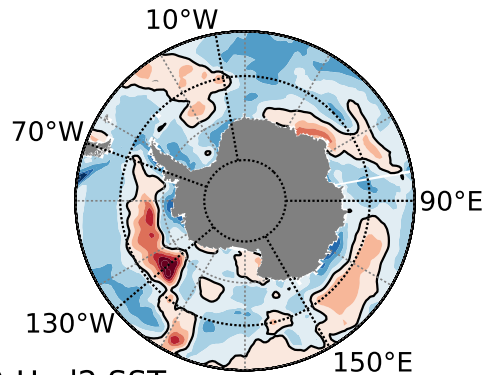
- Show wind variability is an important determinant of the heterogeneous pattern of the variability and trends in Southern Hemisphere sea-ice.
- Only in the West Pacific region does Southern Annular Mode wind forcing contribute significantly to the trend in sea-ice duration.
- El Niño Southern Oscillation wind forcing contribution to the sea-ice duration trend is confined to the Atlantic and Pacific.
- In the Indian Ocean, weather is a significant driver of the sea-ice duration trend.
- Only in the East Pacific region is wind forcing alone insufficient to give rise to the observed sea-ice decline and must be augmented by warming to reproduce the observations.

a) Air Temperature

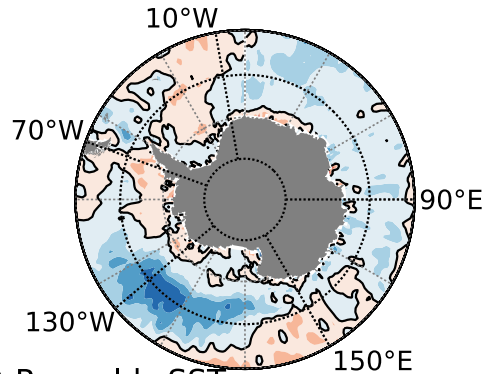


-1.5 -1.0 -0.5 0.0 0.5 1.0 1.5
 Air Temperature Trend (C /decade)

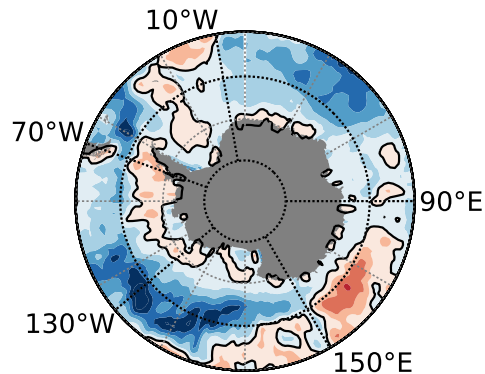
c) CORE2 SST



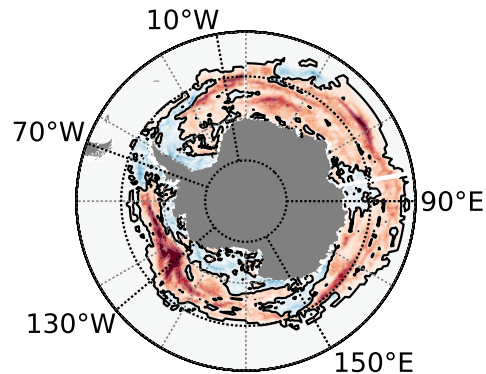
d) Had2 SST



e) Reynolds SST



b) WALL - CORE2

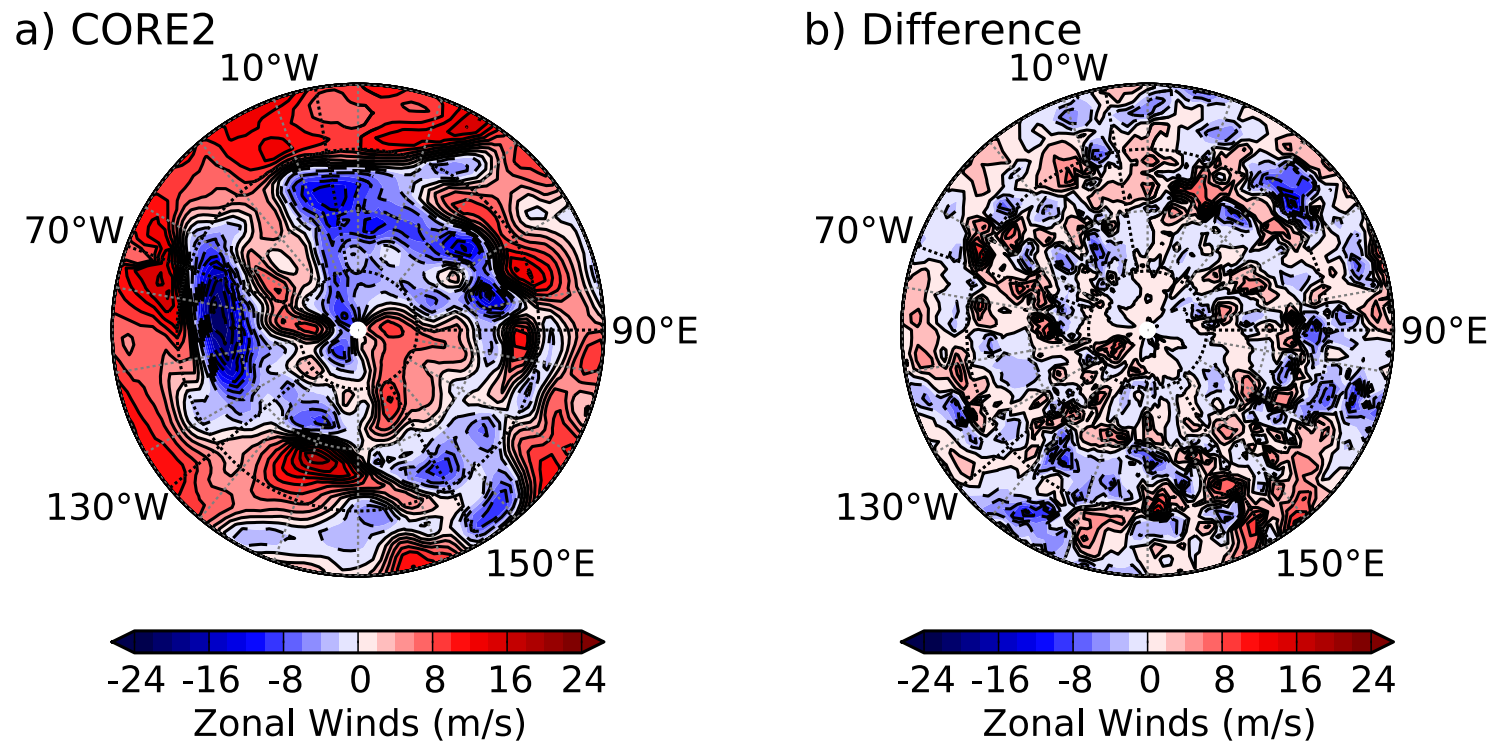


-4 -3 -2 -1 0 1 2 3
 Difference in Duration Trend (days/year)

-0.4 -0.2 0.0 0.2 0.4
 SST Trend (C /decade)

For the 1990–2007 period, trends in annual mean air and sea-surface temperatures and in sea-ice duration.

Example of the Wind difference between CORE2¹¹ and WHF



MOTIVATION AND APPROACH

To elucidate the drivers of the observed heterogeneous sea-ice trends

From model simulation explore processes driving the decadal trends in Antarctic Sea Ice

Used a suite of experiments with different components of the winds to force the ocean sea-ice model

