High Latitude Atmosphere-Ocean Coupling in Sea-Level Records

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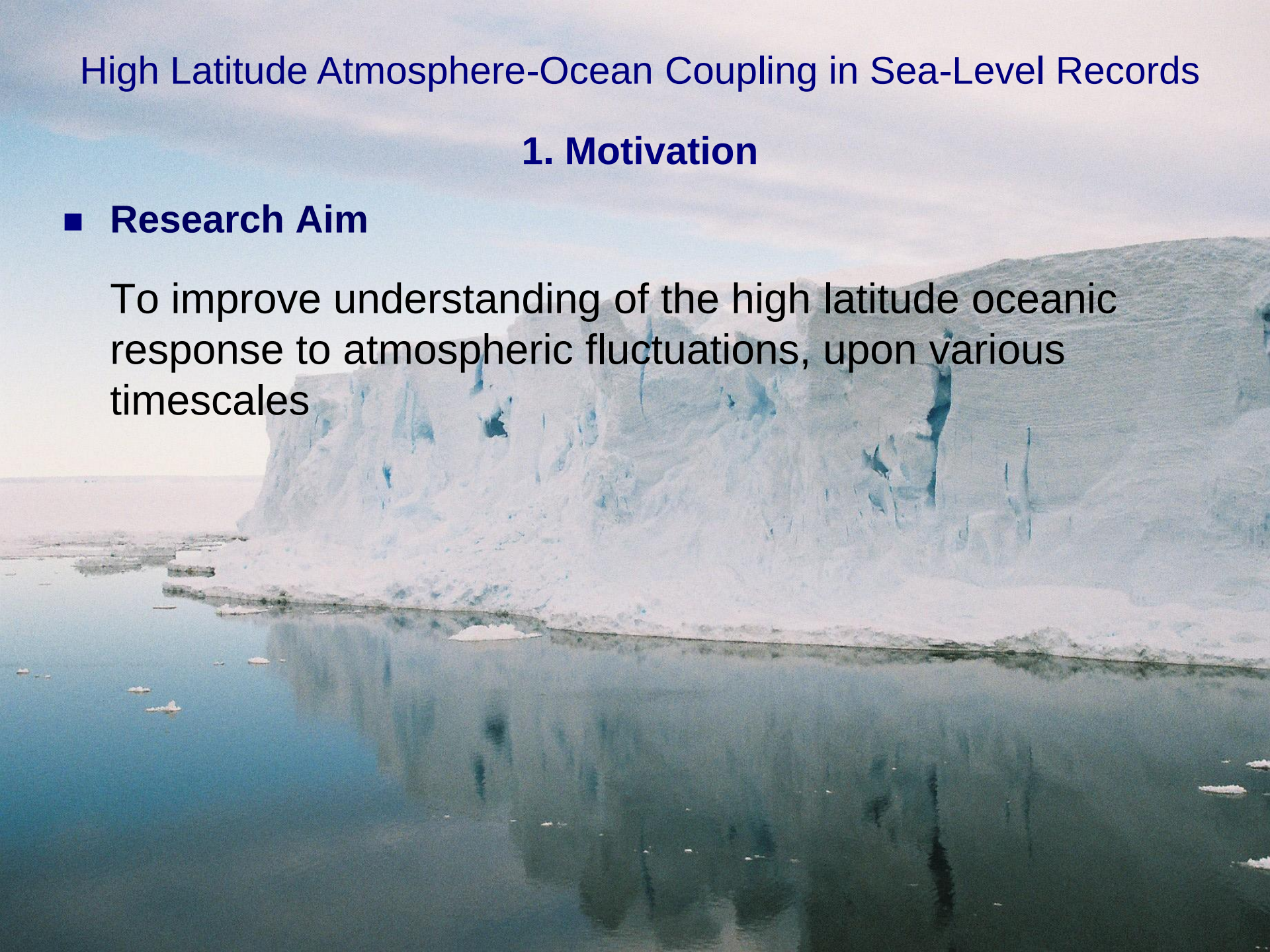
1. Motivation

- **Research Aim**

  To improve understanding of the high latitude oceanic response to atmospheric fluctuations, upon various timescales



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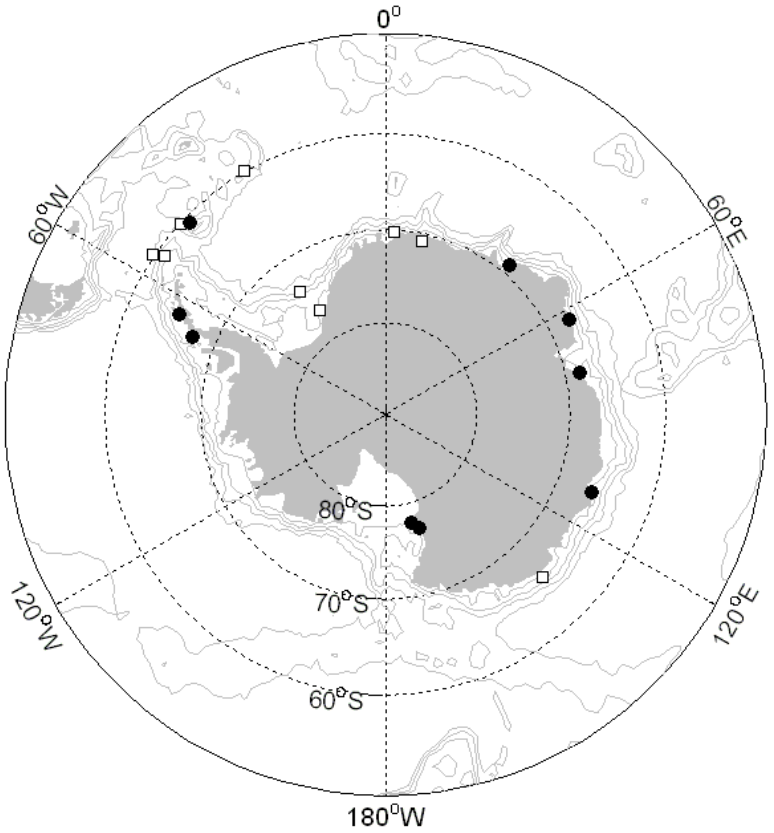
2. Data & Methods

- **Southern Ocean**
- Short record
  - low spatial resolution (18 stations)
  - high temporal resolution
- Useful for analysis of subseasonal to interannual variability



Locations of tide gauges (circles) and bottom pressure recorders (squares)

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2. Data & Methods

- **Southern Ocean**

- Daily means detrended
- Tide gauge data corrected to give subsurface pressure (SSP)
- Seasonal cycle removed
- Long period tides eliminated by low-pass filtering
- Used statistical analysis including Empirical Orthogonal Functions (EOFs) and crosscorrelations

- **Focusing upon:**

- Coherence of fluctuations
- Variability explained by atmospheric fluctuations
- Recurring or propagating features
- Comparison with models

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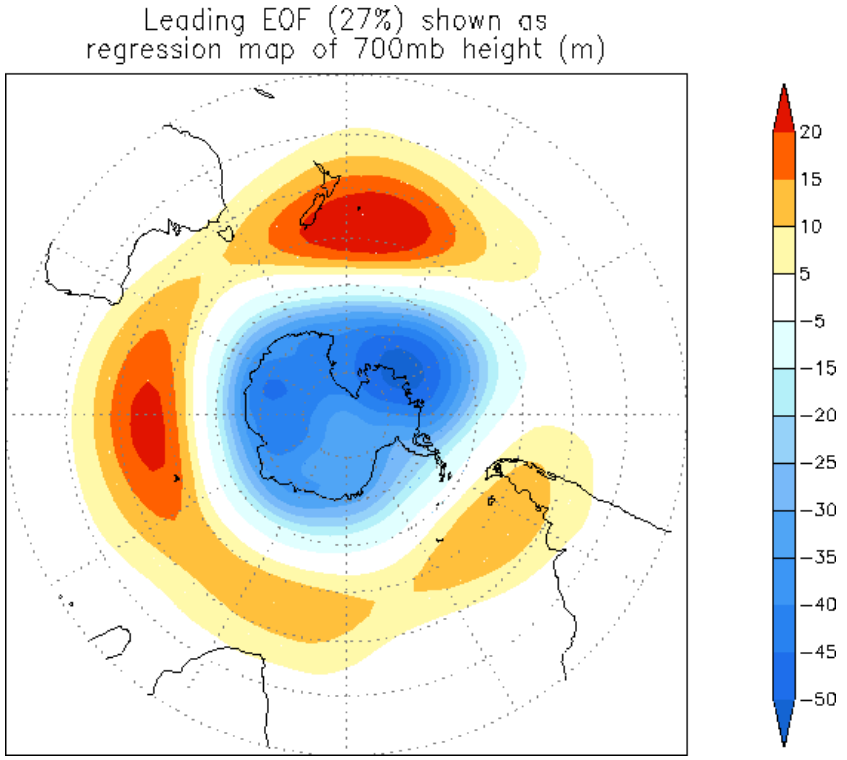
2. Data & Methods

- **Atmospheric Variability**
- Southern Annular Mode

  Air pressure contrast between polar low and mid-latitude high
- Semi-Annual Oscillation

  Fluctuations in sea-level pressure patterns affecting strength of Westerlies
- Southern Oscillation

  Originally defined as Tahiti/Darwin pressure contrast



Loading pattern of the SAM

(www.cpc.noaa.gov)

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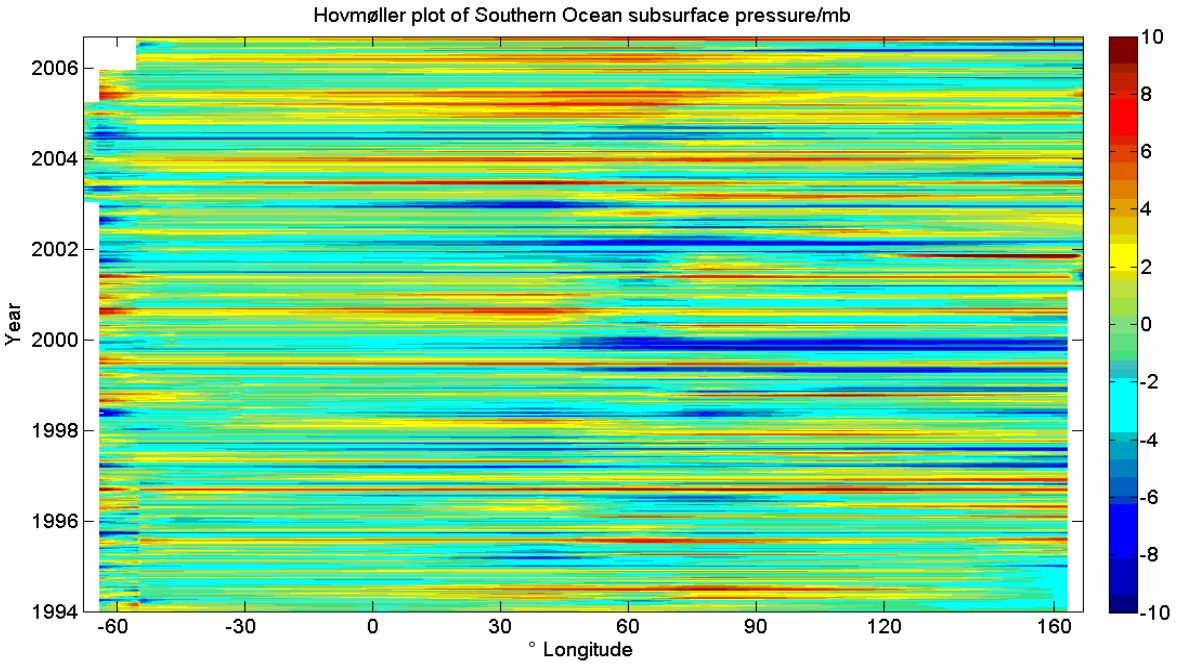
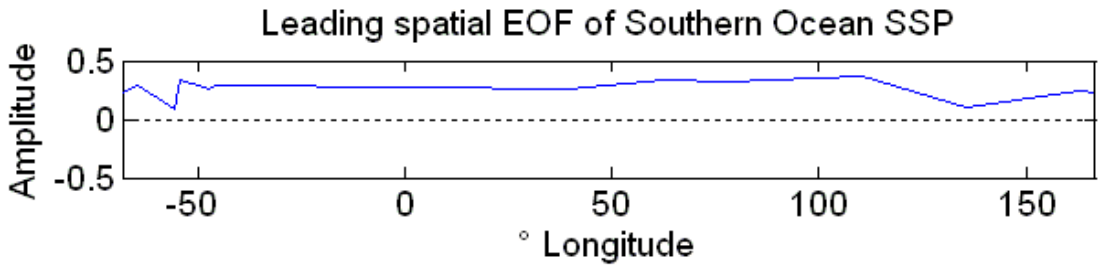
3. Results

- **Coherence**
- Striped pattern suggests fluctuations are coherent
- Leading EOF
  - positive amplitude
  - explains 51.8% of SSP variability
- Change between Syowa and Mawson
  - due to differences in latitude?
- Westwards propagation?





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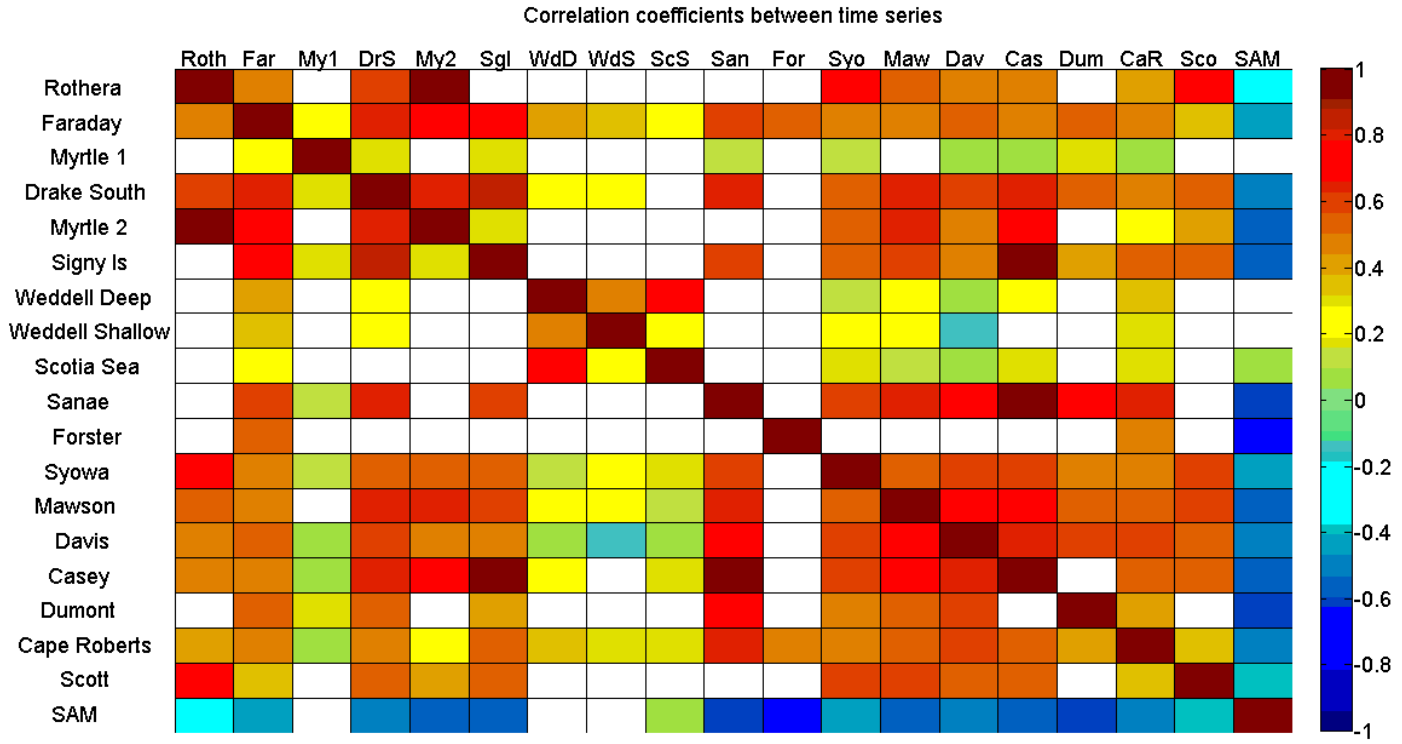
3. Results

- **Correlation Matrix – zero lag**



Neighbouring stations well-correlated e.g. AA Peninsula, Western Indian sector.

SSPs are generally anticorrelated with Southern Annular Mode (SAM)

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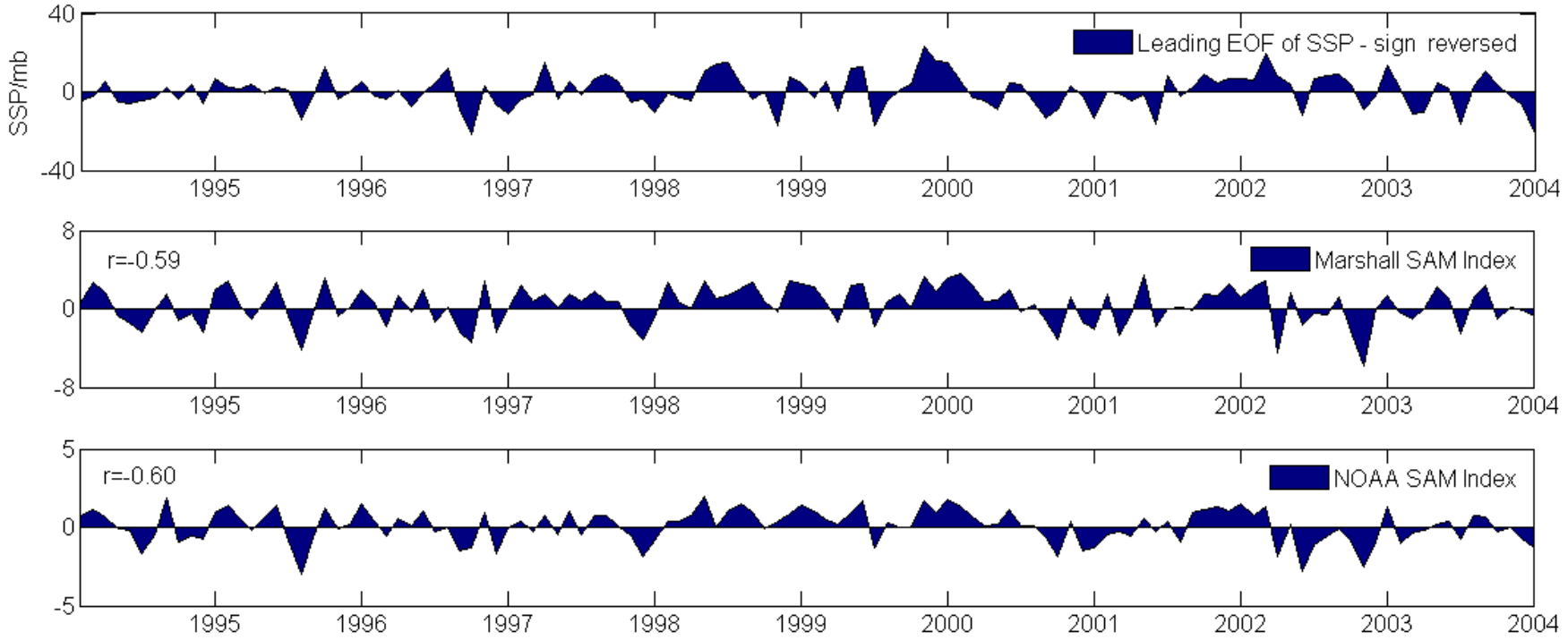
3. Results

- **Atmospheric Fluctuations**

Leading EOF - explains 51.8% of SSP variability

- good anticorrelation with the SAM (leading atmospheric mode)

Suggests it is the oceanic counterpart to the SAM



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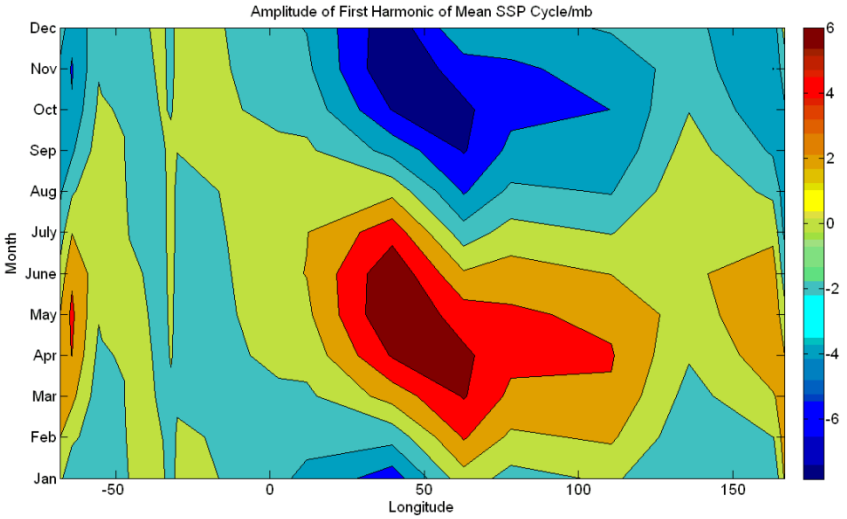
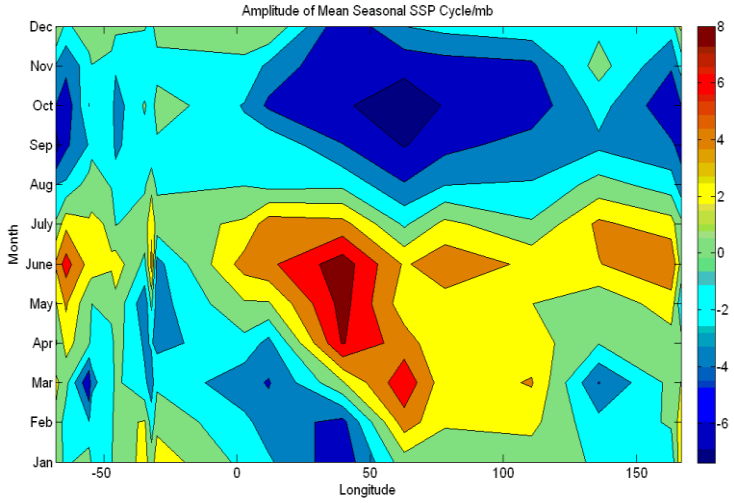
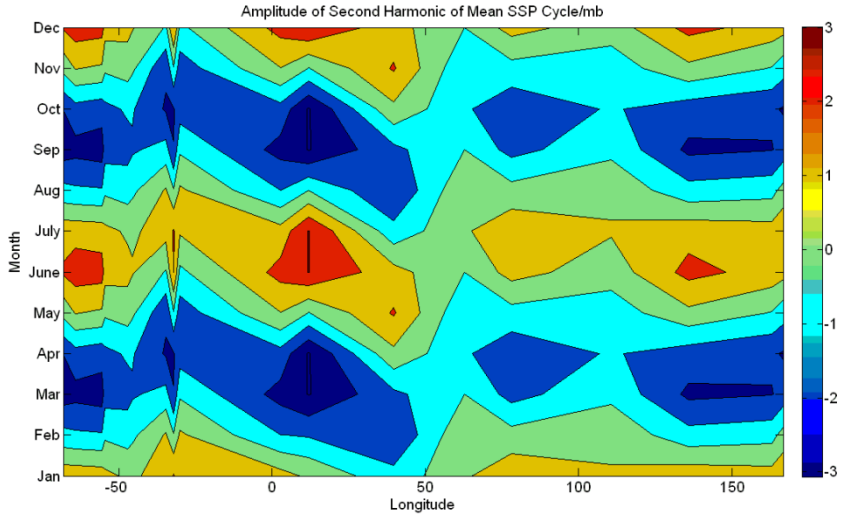
3. Results

- **Semiannual Oscillation**
- Annual cycle dominates around East Antarctic, but semi-annual component pronounced elsewhere
- Perhaps SAO-induced changes in Westerlies & Easterlies produce Ekman transport on or offshore. Clearer at latitudes most affected by Easterlies







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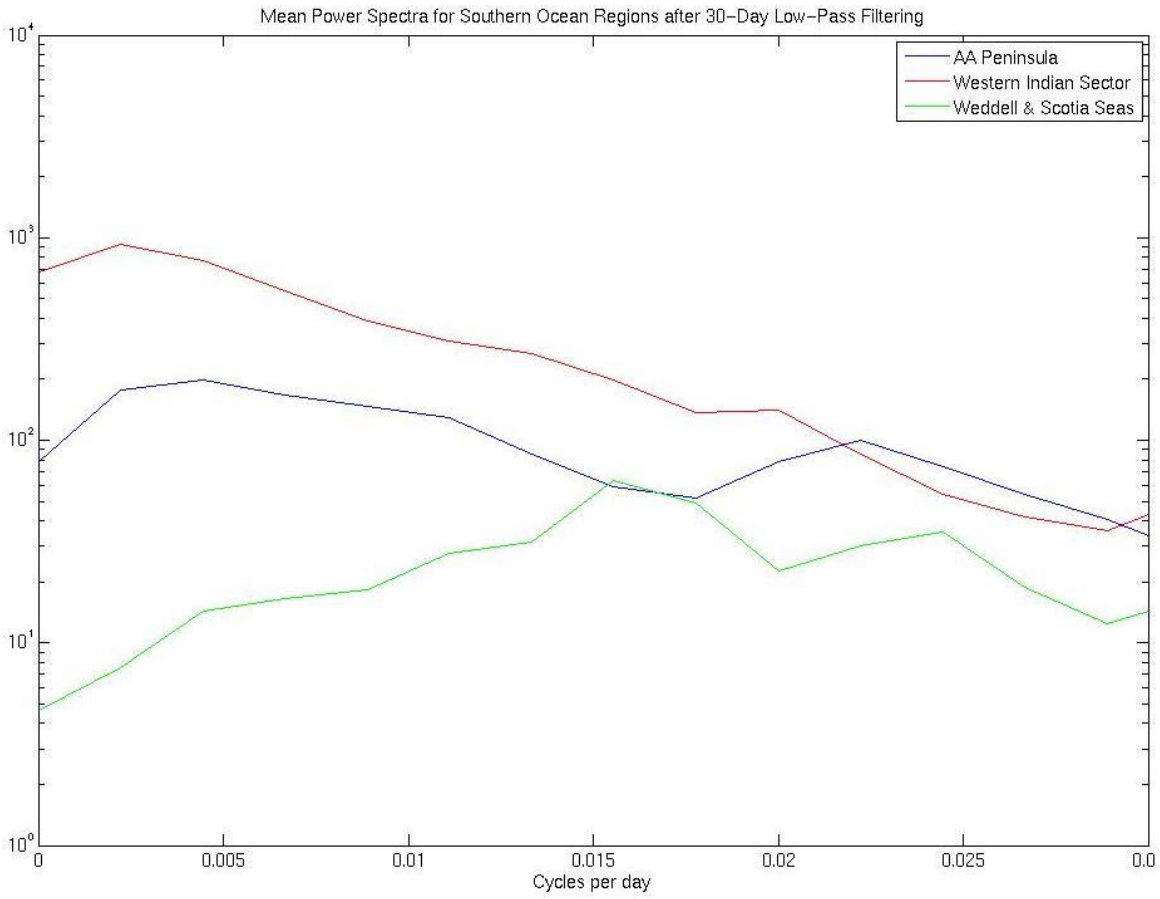
4. Results

- **Recurring and/or propagating features**

  No evidence of recurring features in autocorrelations and periodograms

  Crosscorrelations failed to identify propagating features in SSP



Mean Power Spectra for Southern Ocean Regions

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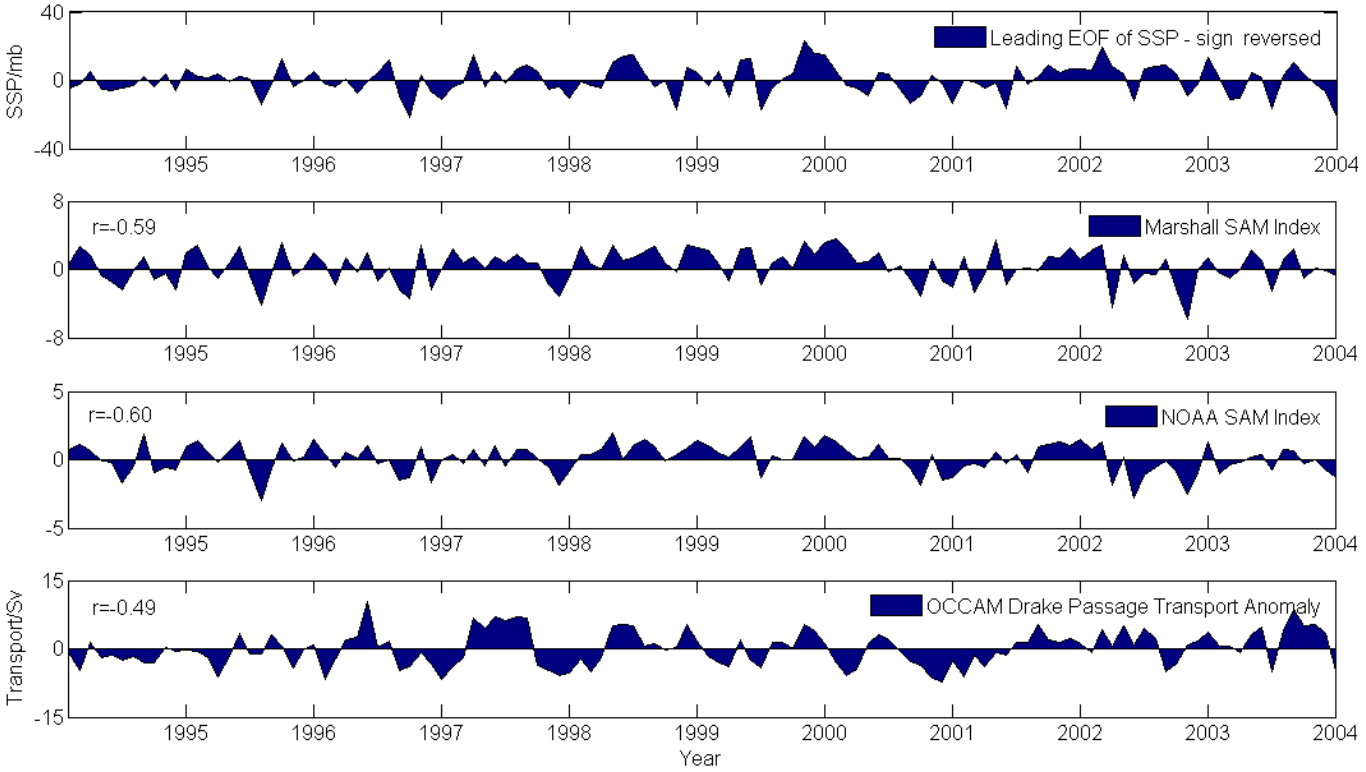
4. Preliminary Conclusions

- Synchronous pattern dominates SSP around Antarctica
- Well-correlated with the SAM
- Possible latitude-dependent SAO signal - to be investigated using wind field
- Little evidence of propagating or recurring features

5. Other work in progress

- Correlations with other atmospheric indices
- Comparisons with baroclinic and barotropic models


SSP/mb
40
0
-40
Leading EOF of SSP - sign reversed
r=-0.59
Marshall SAM Index
8
0
-8
r=-0.60
NOAA SAM Index
5
0
-5
Transport/Sv
15
0
-15
r=-0.49
OCCAM Drake Passage Transport Anomaly
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year