# What Role Does Zonal Wave Three Play in Influencing Antarctic Temperature?

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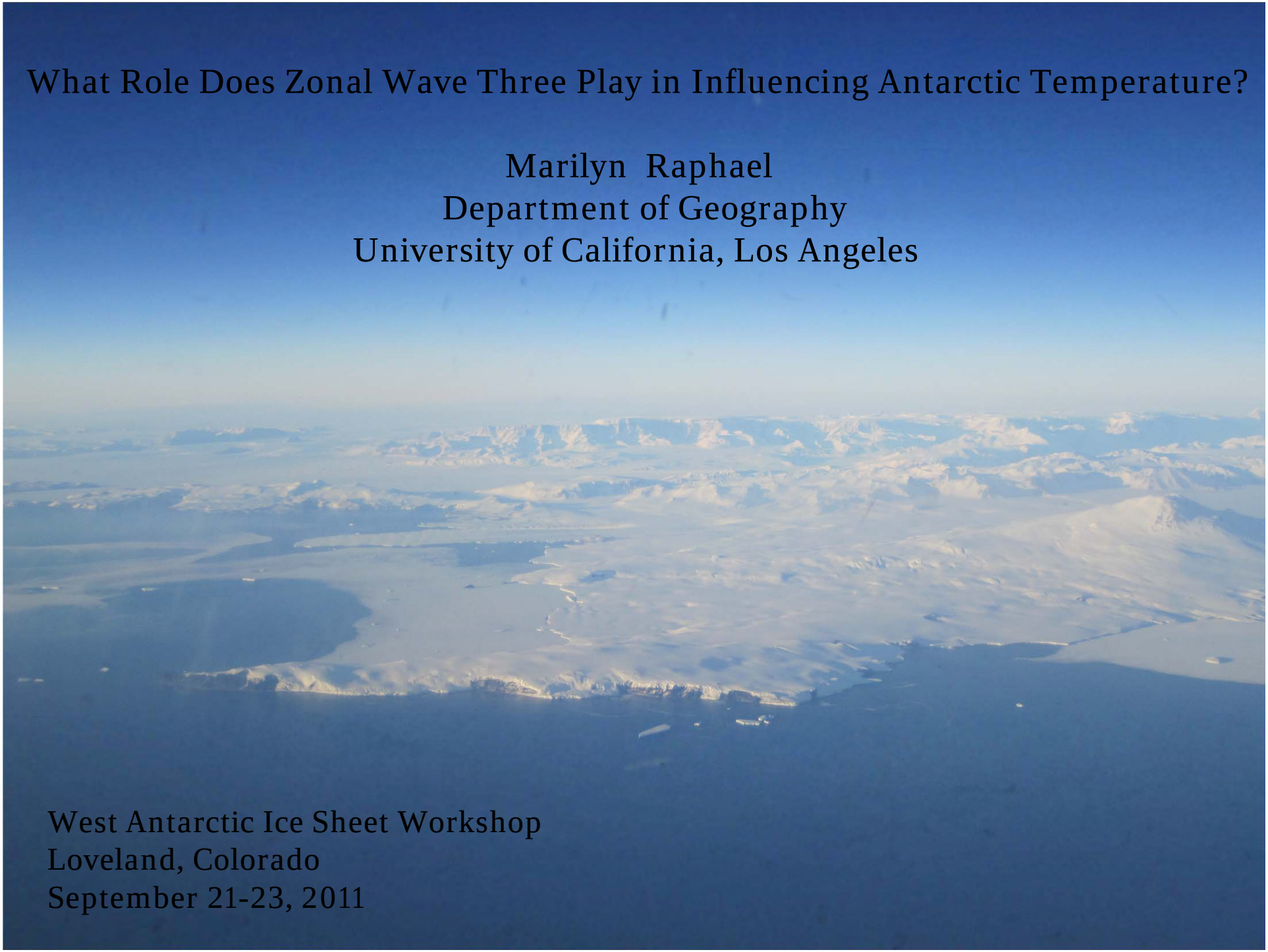
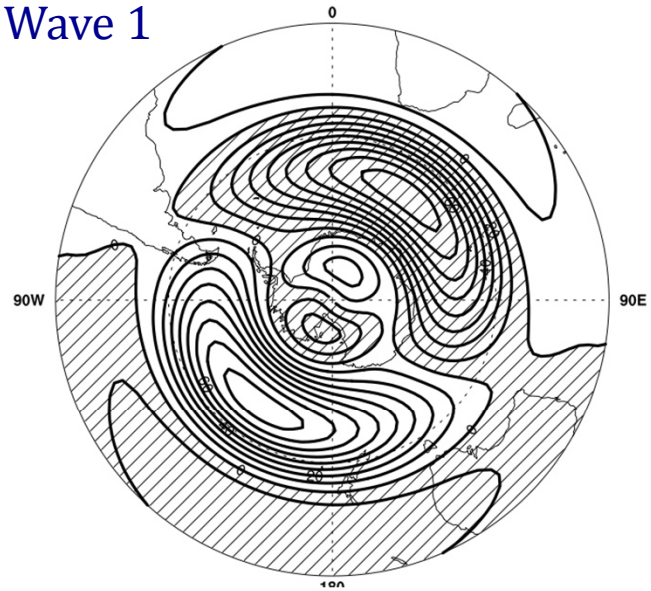
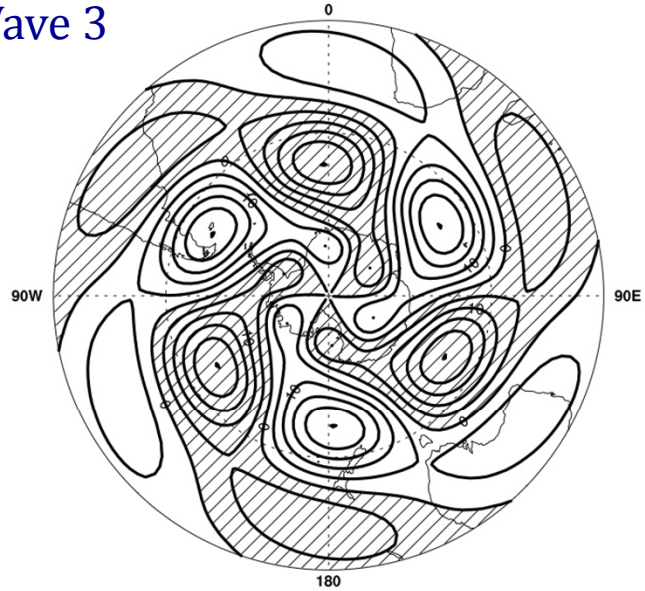


West Antarctic Ice Sheet Workshop
Loveland, Colorado
September 21-23, 2011

Zonal Wave 1
FFT

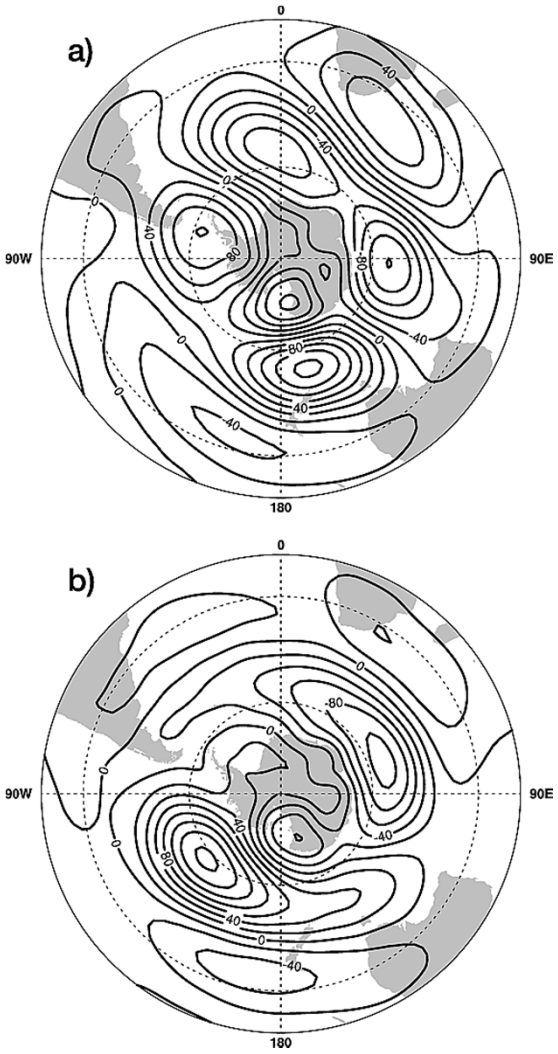



Zonal Wave 3
FFT

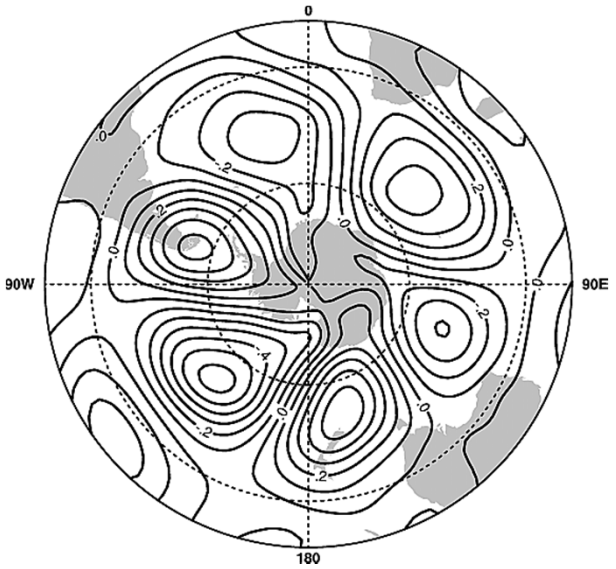




Annual Average Zonal Anomaly in the 500mb Geopotential Height Field

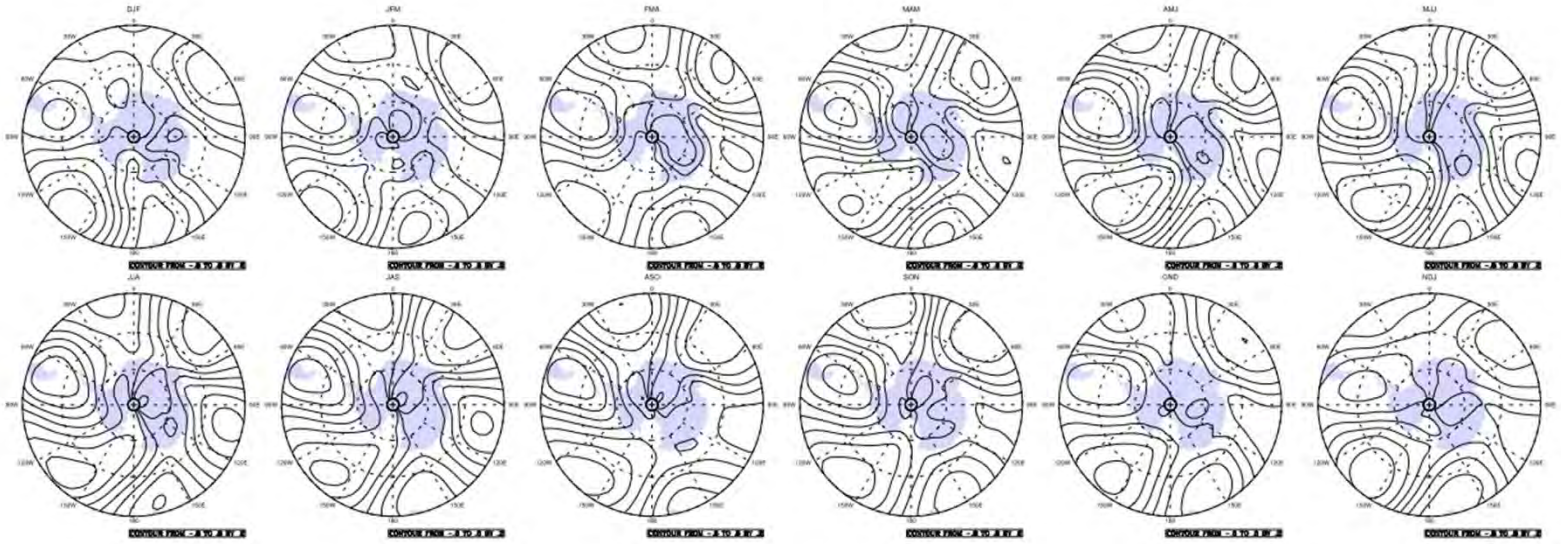



Composite of the 500 hPa zonal anomaly Geopotential height field for the a) positive And b) negative phases of the ZW3 index.

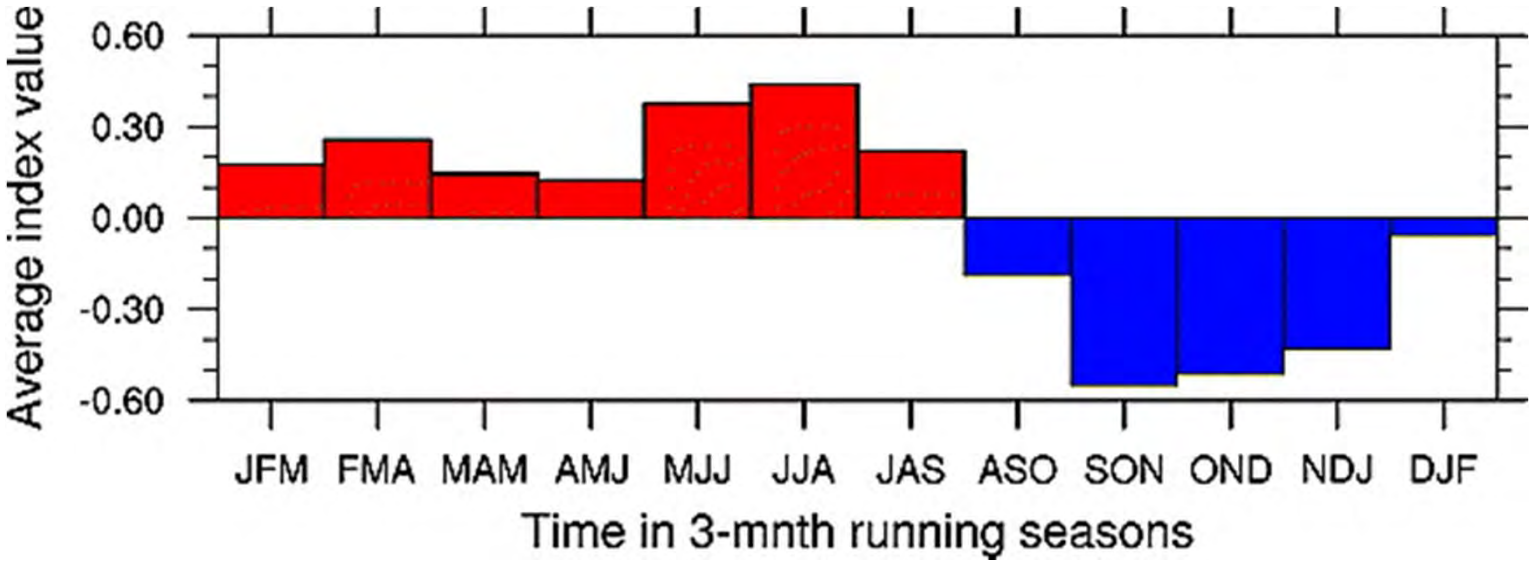



Correlation of the ZW3 index with the zonal anomaly geopotential height field at 500mb.

Zonal asymmetry by season

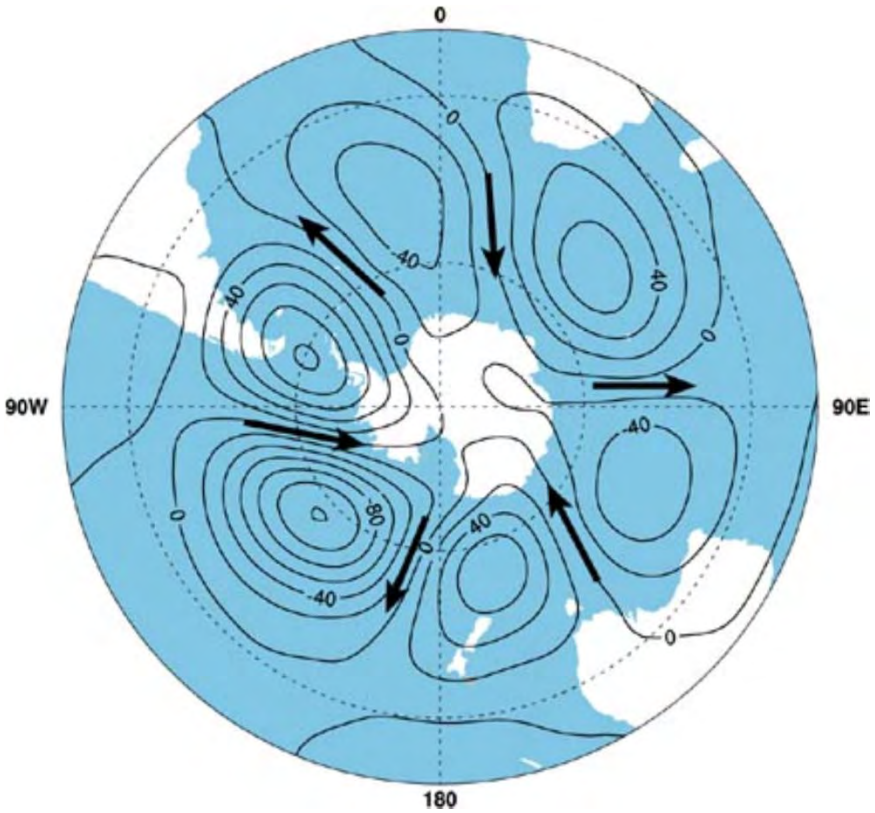


Zonal wave three by season

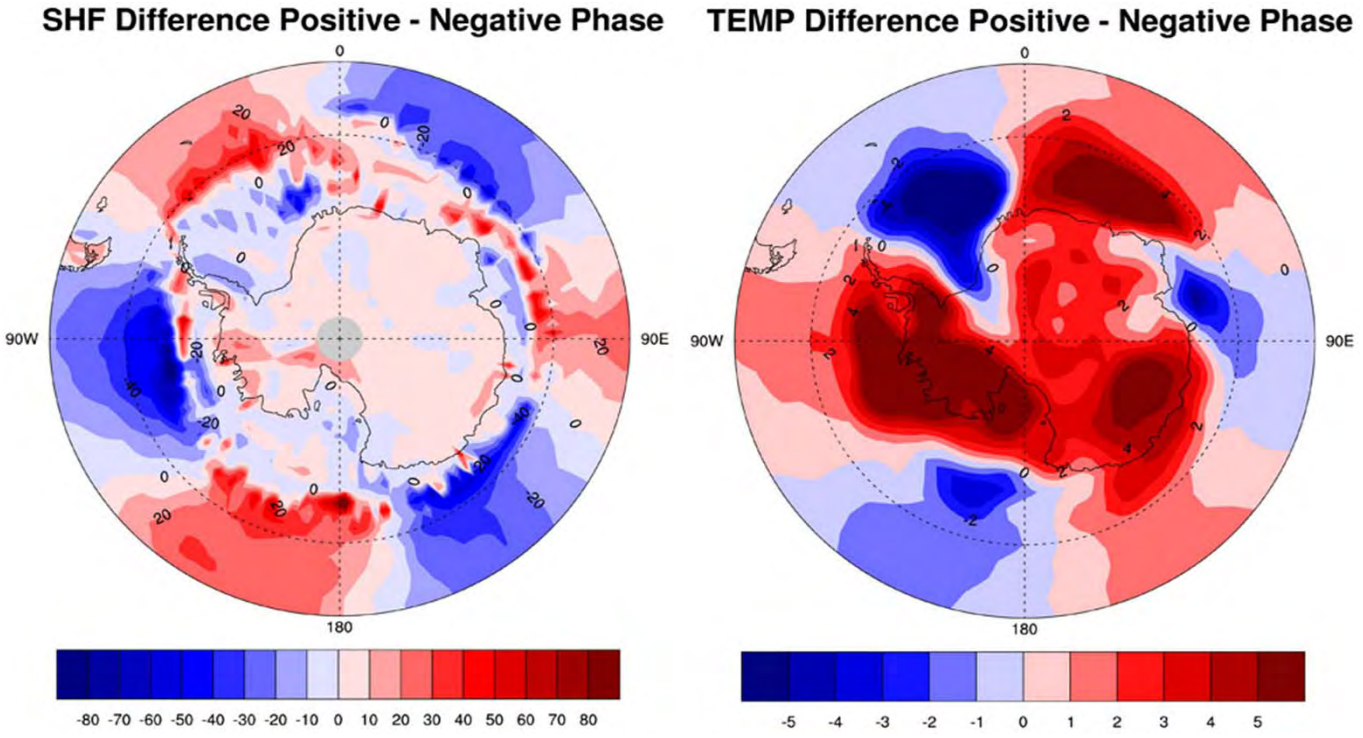



Seasonal averages of the zonal wave three index

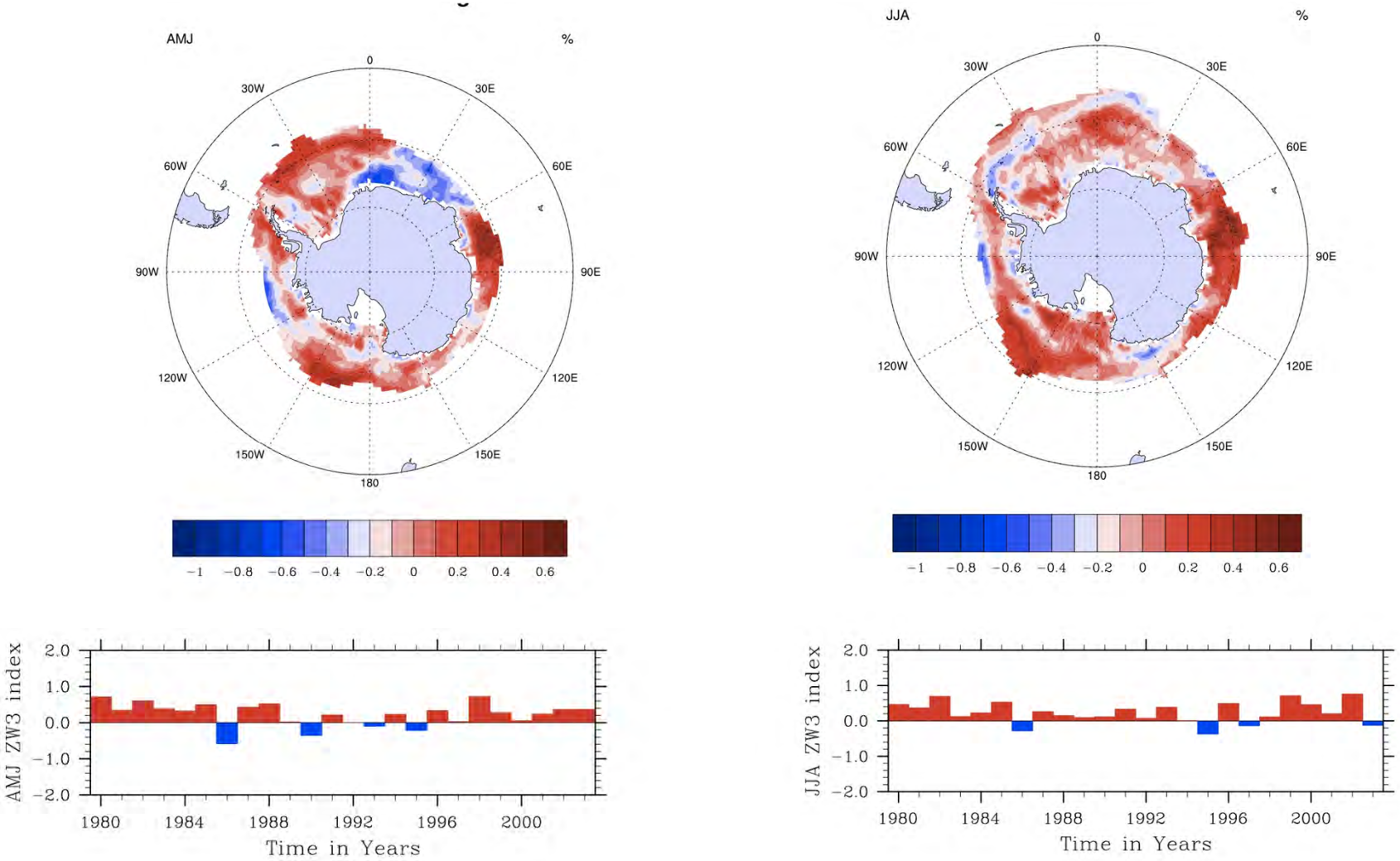
## Influence of zonal wave three on the circulation



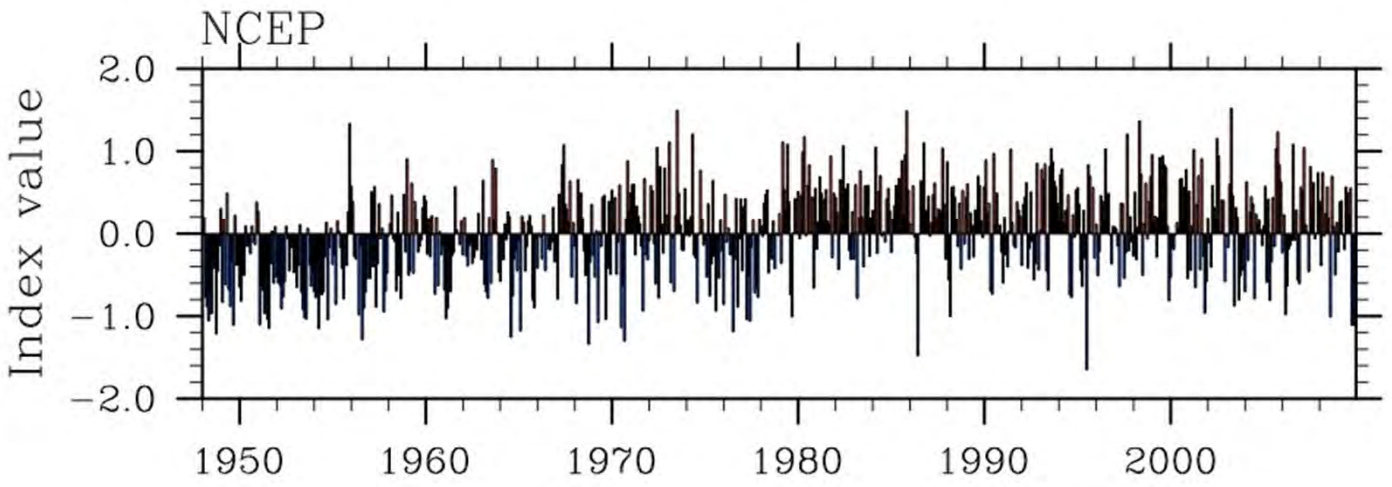

- Preferred regions of equatorward and poleward flow. Equatorward flow would bring colder air and poleward flow, warmer.
- Has the potential to influence the Antarctic sea-ice region by influencing the meridional transport of heat in the atmosphere and ocean.




When the amplitude of Zonal Wave Three is high, i.e. there is pronounced meridionality in the circulation, warmer air is transported further poleward on the eastern side of the ridges and the flux of sensible heat from atmosphere to ocean (or surface) is larger.

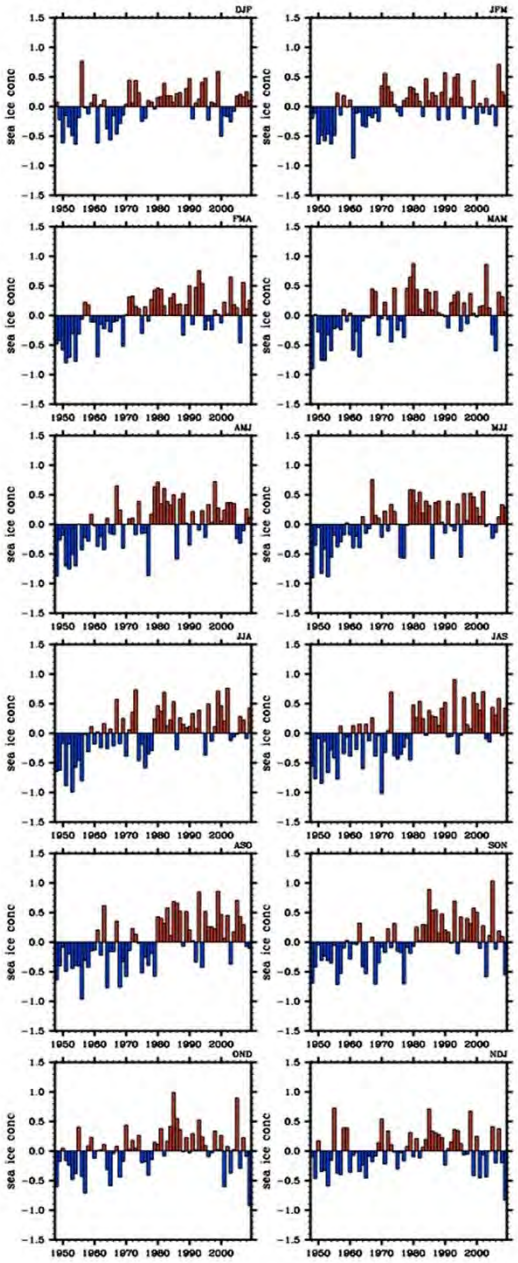



ZW3 correlated with sea ice concentration for
Falls and Winters from 1980 – 2003
(*NCEP Reanalyses and HadIsst2 datasets*)




Time series of seasonal zonal wave 3 index 1948 – 2009
(calculated from NCAR-NCEP Reanalyses)

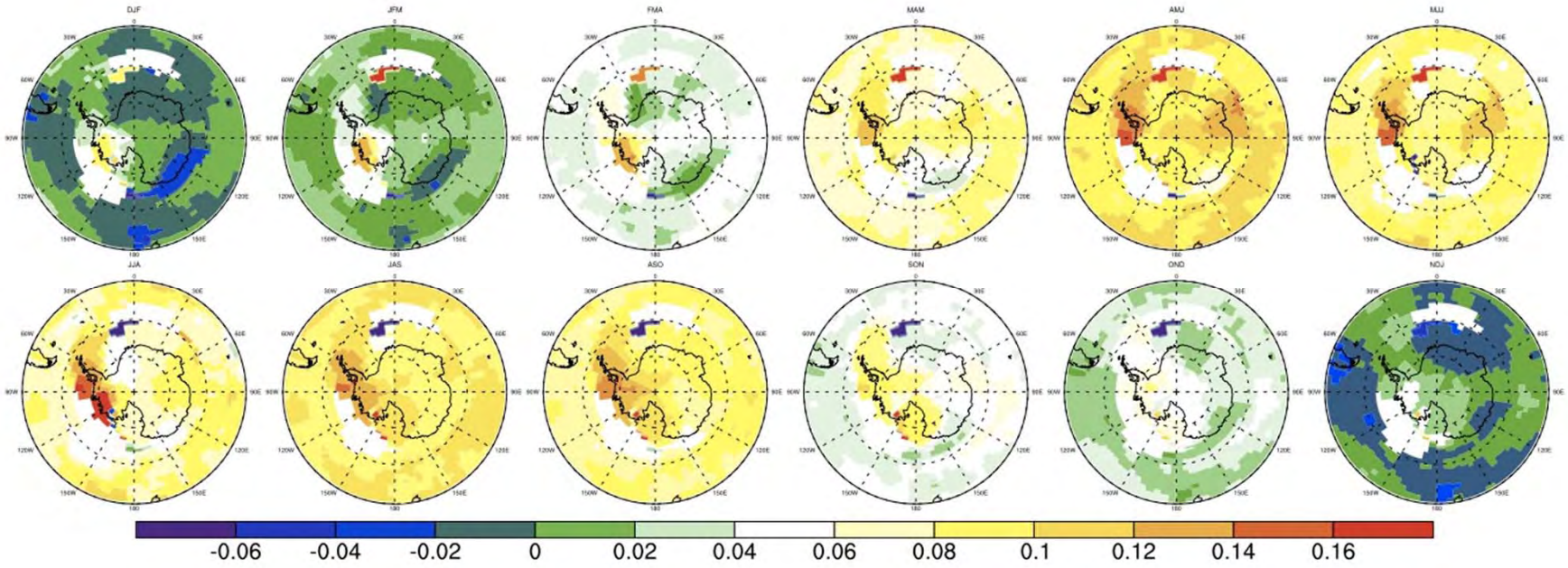
In common with a number of other atmospheric variables ZW3 experienced a change dating from approximately 1980. This was manifested as a shift to more positive values of the index – the meridionality of the geopotential height field increased.




The shift towards more positive values occurred across all seasons. In spring more negative values begin occurring in the late 1990s.

Seasonal values of the 500mb zw3 index from 1948-2009

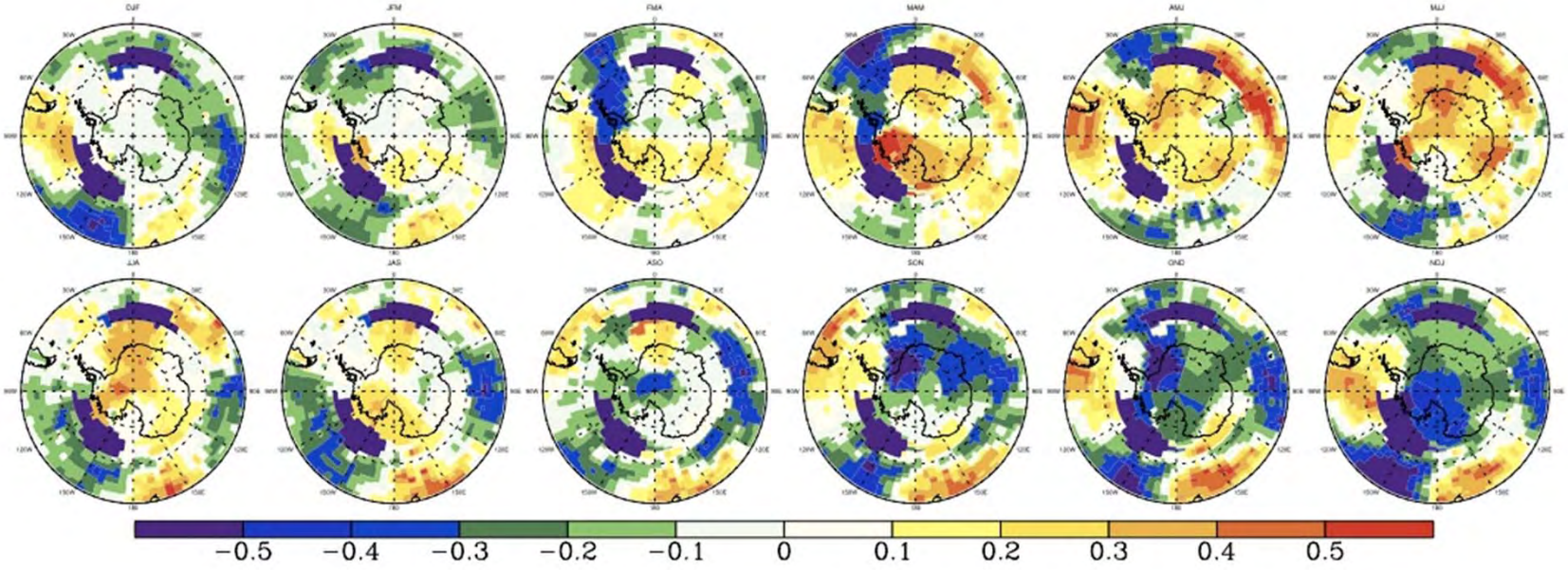
# Trend in GISTEMP temperature anomalies




According to this dataset Antarctic is warming in most seasons except the warmer ones. Parts of West Antarctica are warming all year. Not all of the trend is significant.

Data from: Hansen et al, 2010: Global surface temperature change.
Rev. Geophys., 48, RG4004, doi:10.1029/2010RG000345

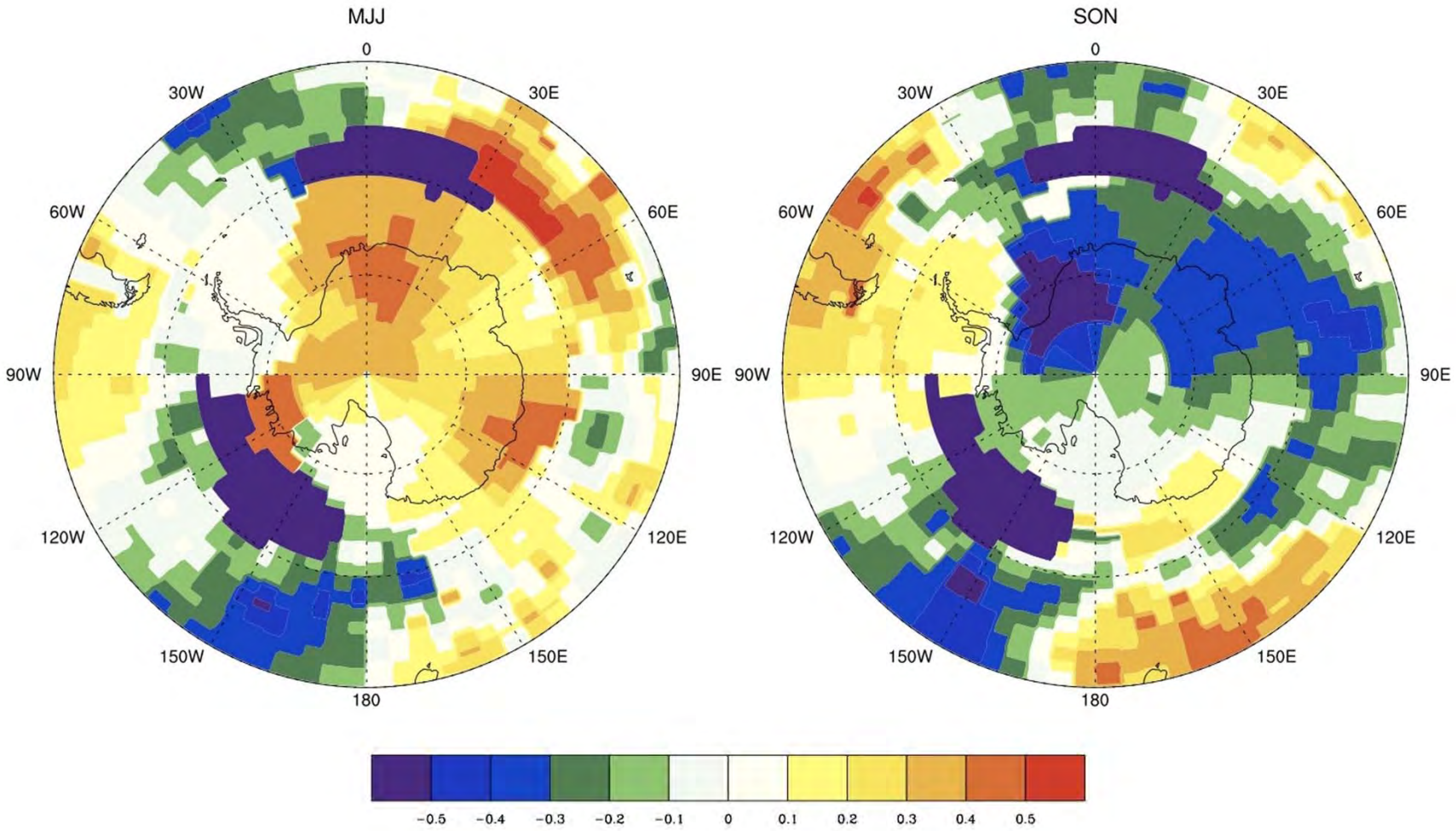
Seasonal ZW3 index correlated with GISTEMP – 1980-2009.

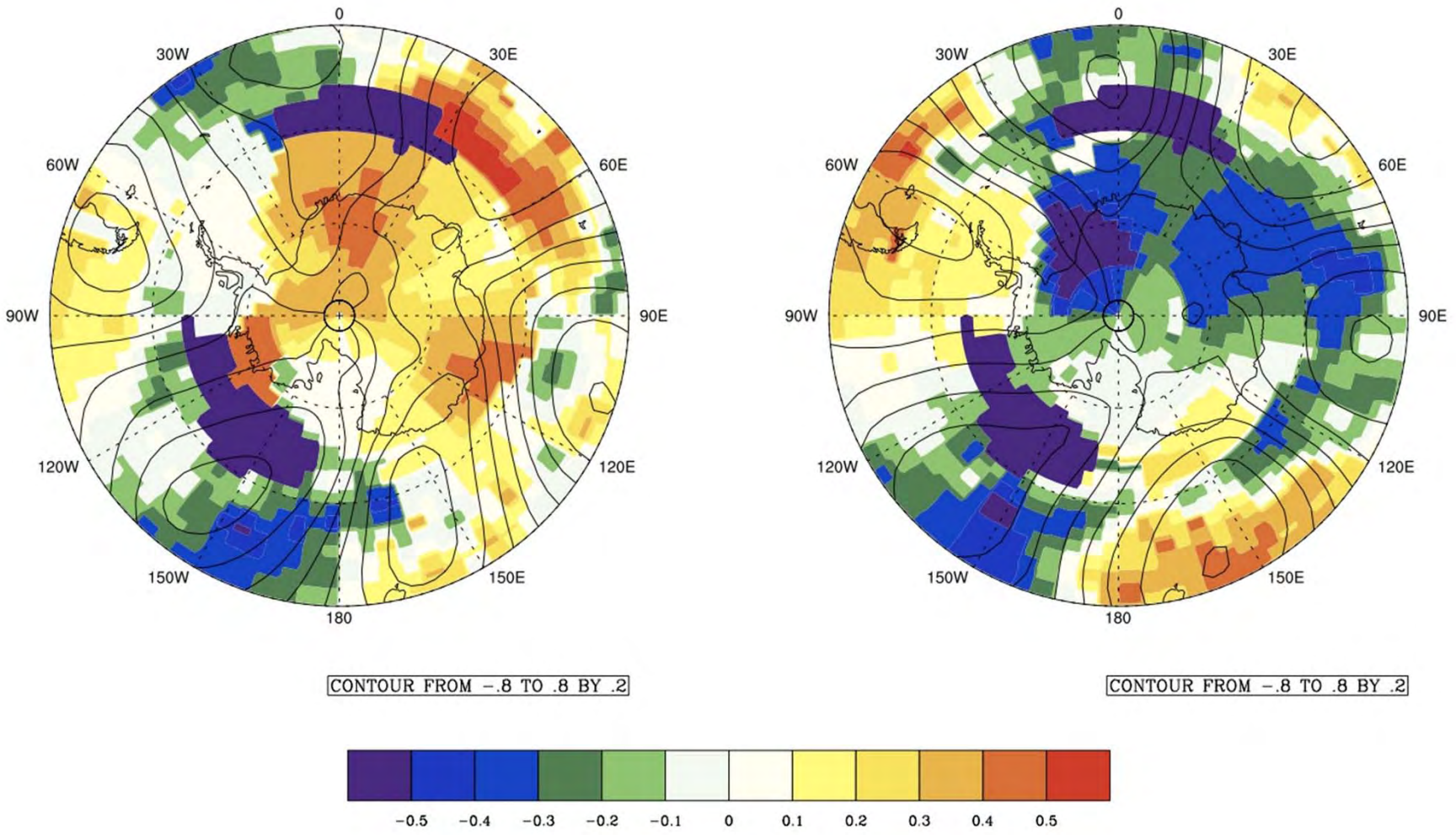



Note that ZW3 sloshes so patterns of correlation change with location of the ridges and troughs of the zonal wave.

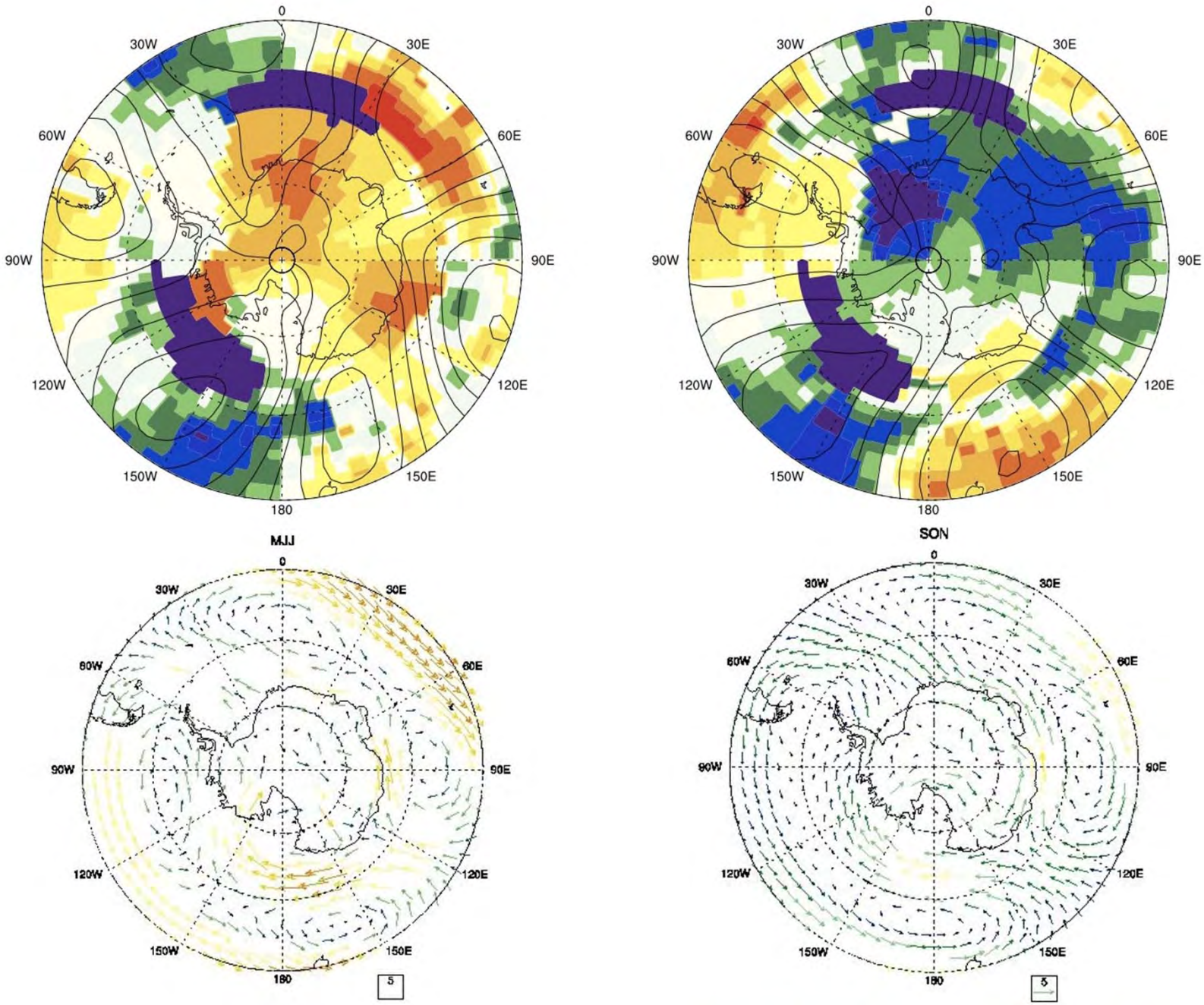
The strength of the correlation changes seasonally with late autumn, early winter exhibiting the strongest association.

# ZW3 correlated with GISTEMP 1980–2009






ZW3 pattern over correlations of ZW3 index with GISTEMP for MJJ (strong positive; left) and SON (strong negative; right) index




Seasonal uv vector wind

***Summary:***

There seem to be  clear correlations between Antarctic surface temperature and zonal wave three, where the latter acts as an agent of advection.

These relationships vary in strength and by season

To understand more clearly the variability in Antarctic temperatures and links With the large scale atmospheric circulation it is necessary to do a more in depth, complete, seasonal analysis.  Annual analyses “hide” the true nature of the relationships and therefore of the variability.

Going forward – other existing surface datasets need to be examined using ZW3.