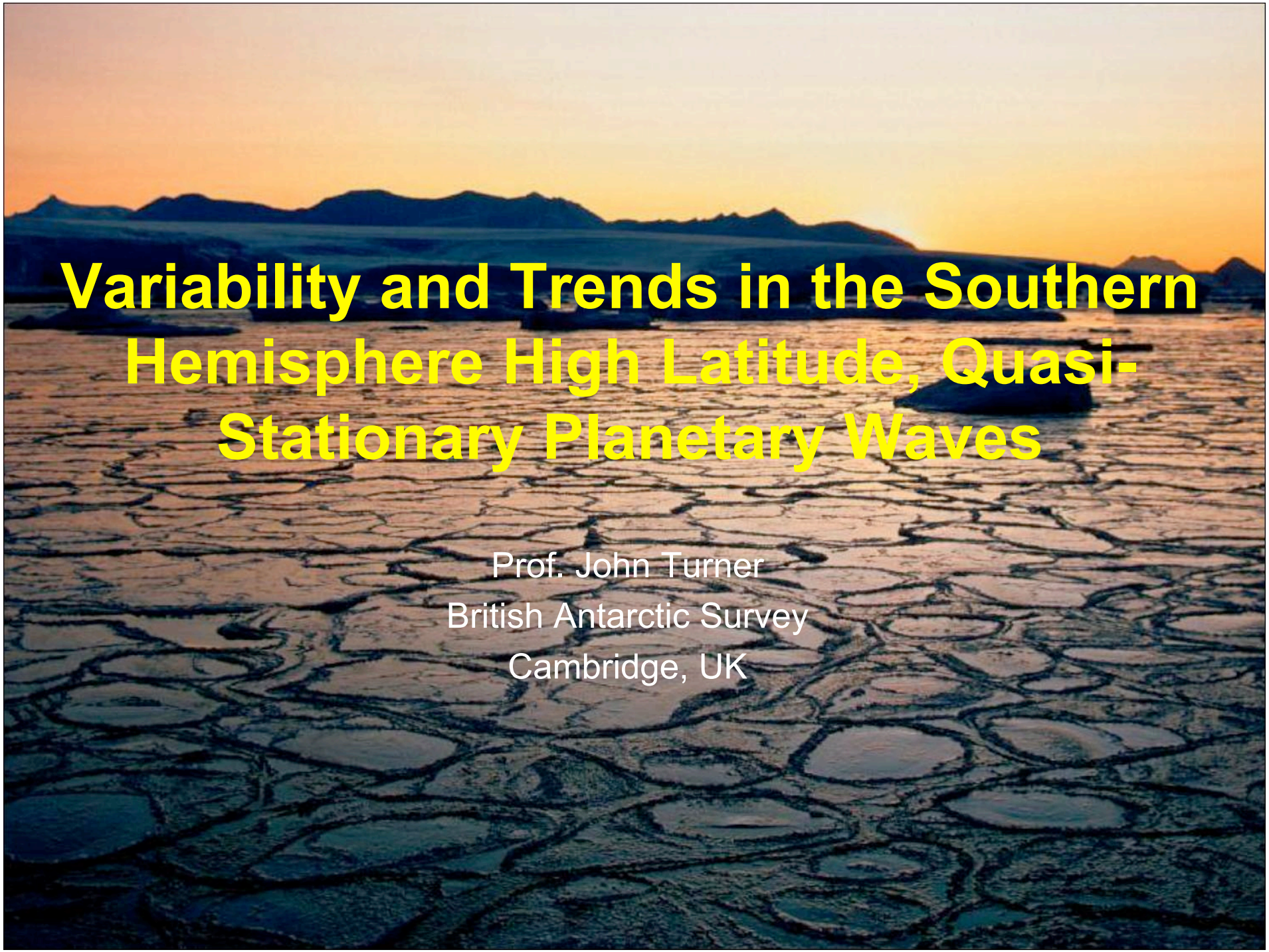
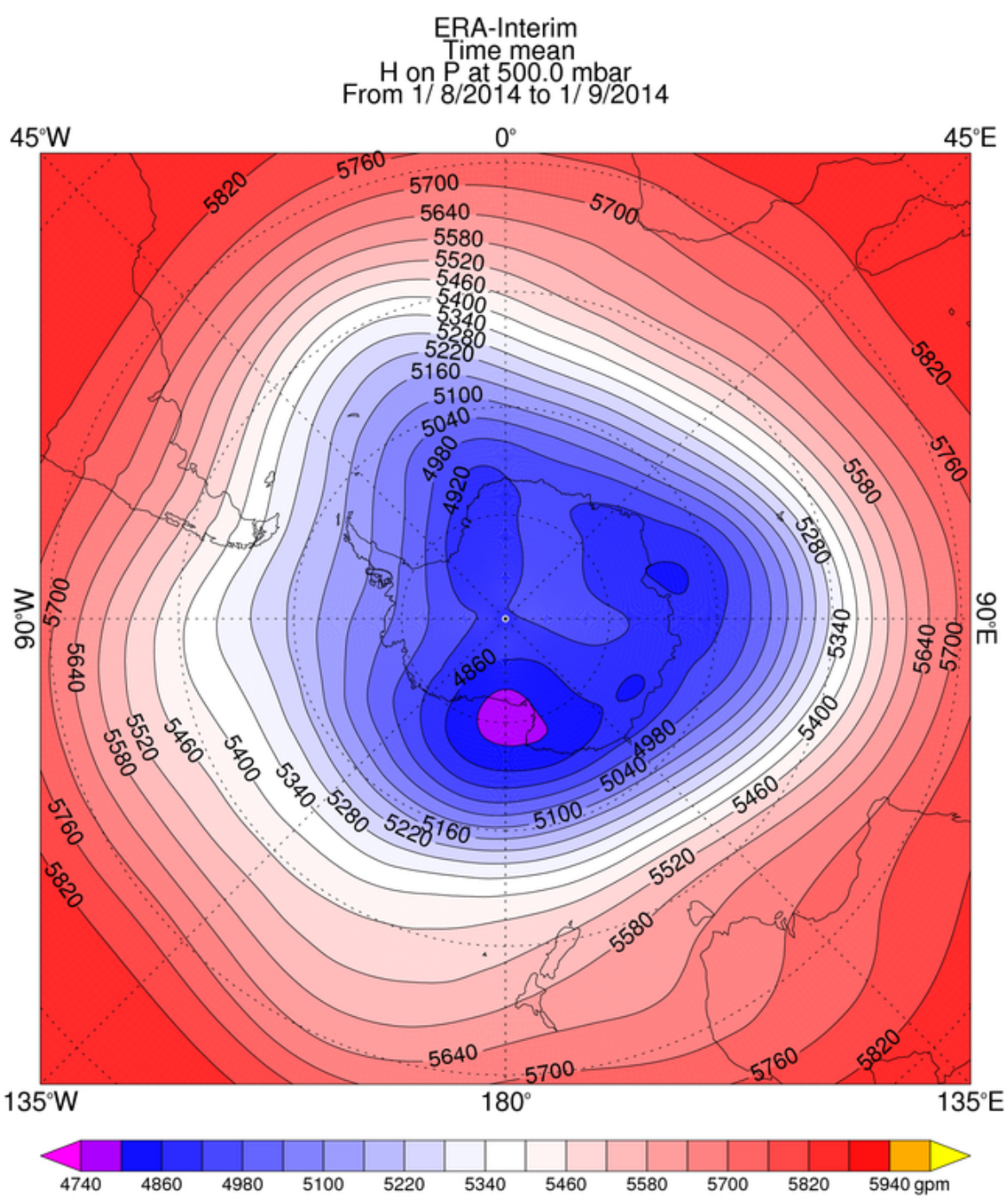


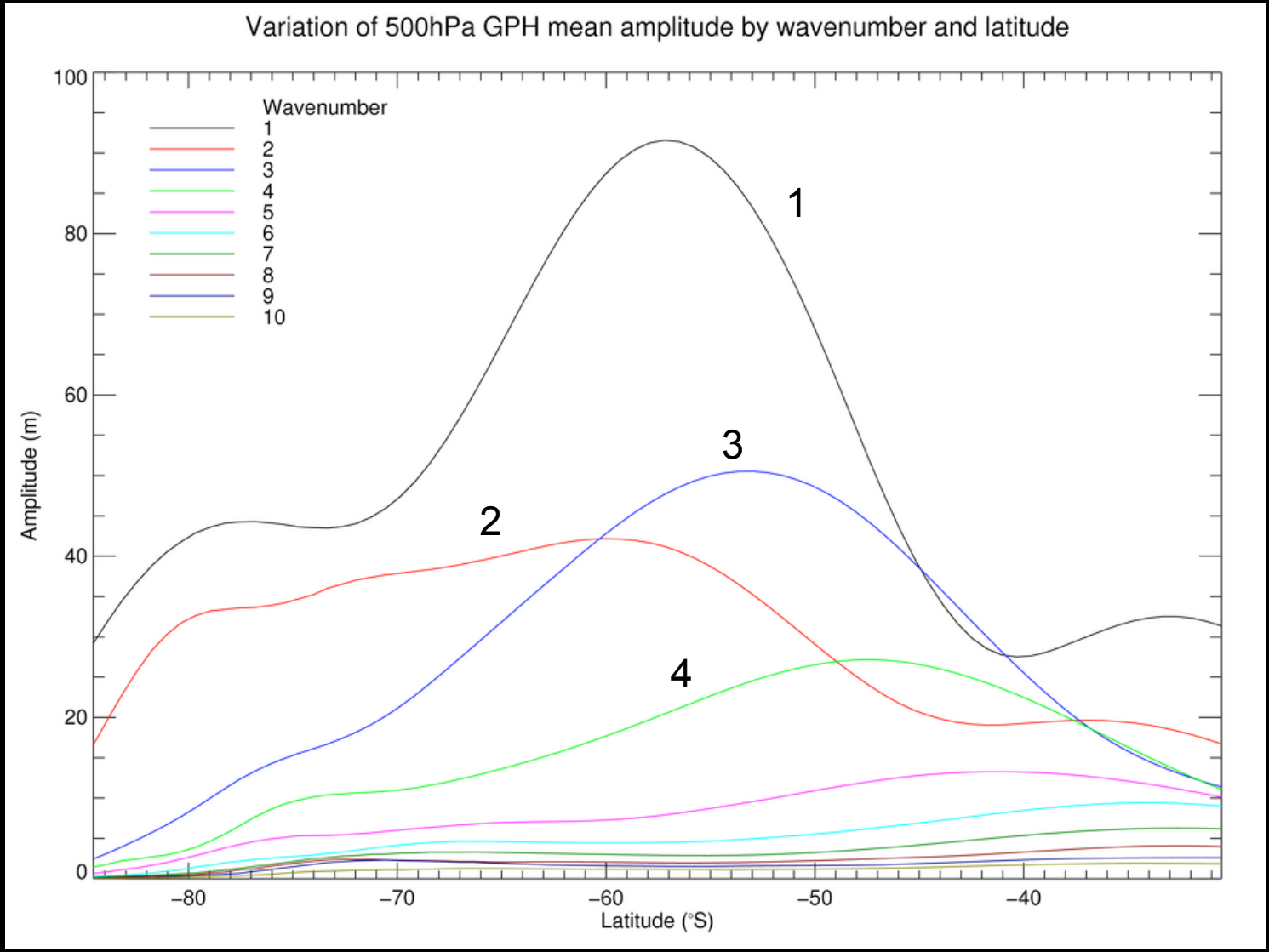
Variability and Trends in the Southern Hemisphere High Latitude, Quasi-Stationary Planetary Waves

Prof. John Turner
British Antarctic Survey
Cambridge, UK



August 2014 Monthly Mean 500 hPa Height Field from the ERA-Interim Reanalysis

The Variability of the Amplitudes With Latitude



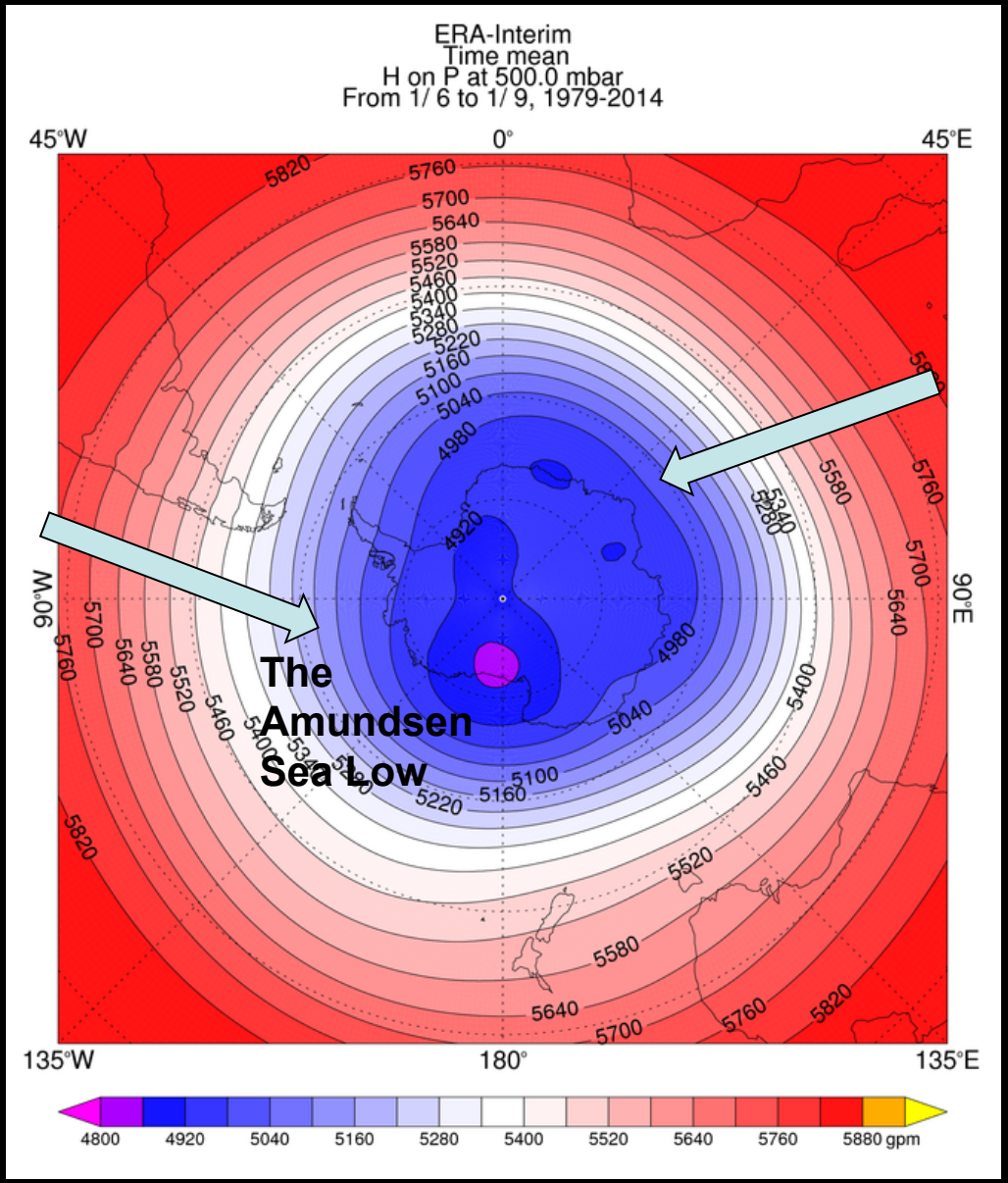
Mean amplitudes of waves 1 -10 over 30 – 90 S. 1979 - 2013

The Mean Amplitudes of Waves 1 to 4

Wave number	Summer (DJF)	Fall (MAM)	Winter (JJA)	Spring (SON)	Year
1	71.4 (18.4)	80.0 (19.1)	100.5 (22.8)	81.5 (17.3)	83.3 (13.1)
2	32.9 (10.9)	40.5 (12.1)	44.4 (12.9)	41.7 (11.2)	39.8 (6.2)
3	36.3 (8.1)	44.8 (11.1)	48.4 (12.6)	38.9 (12.3)	42.1 (4.4)
4	20.6 (6.4)	19.4 (7.4)	17.0 (4.6)	13.6 (4.3)	17.6 (2.9)

Over 55-65 S for 1979 – 2013. SD in parentheses

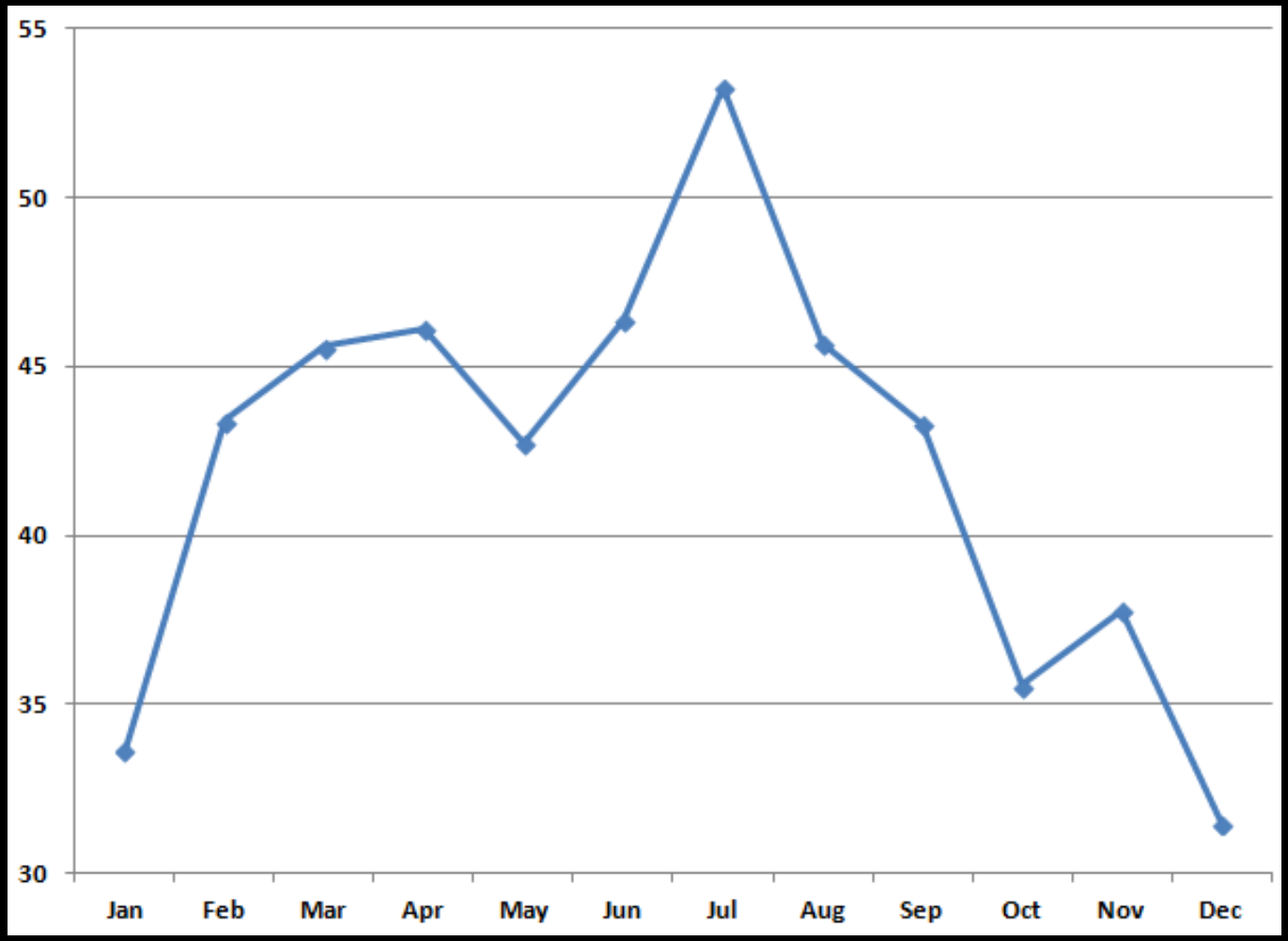
The 1979 – 2014 Mean Winter 500 hPa Height



Wave 1 ridge

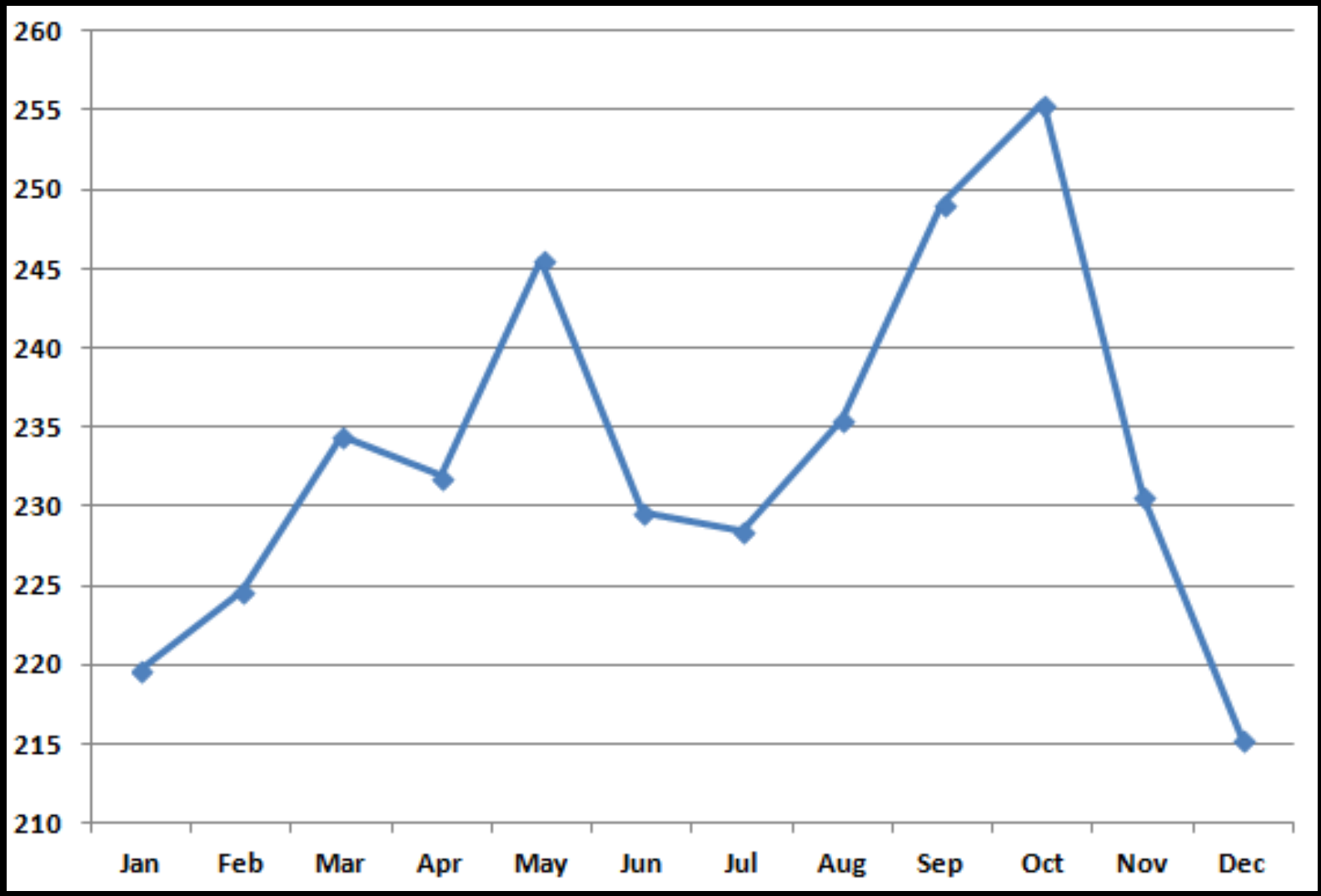
Wave 1 trough

The Annual Cycle of Wave Number 1 Amplitude



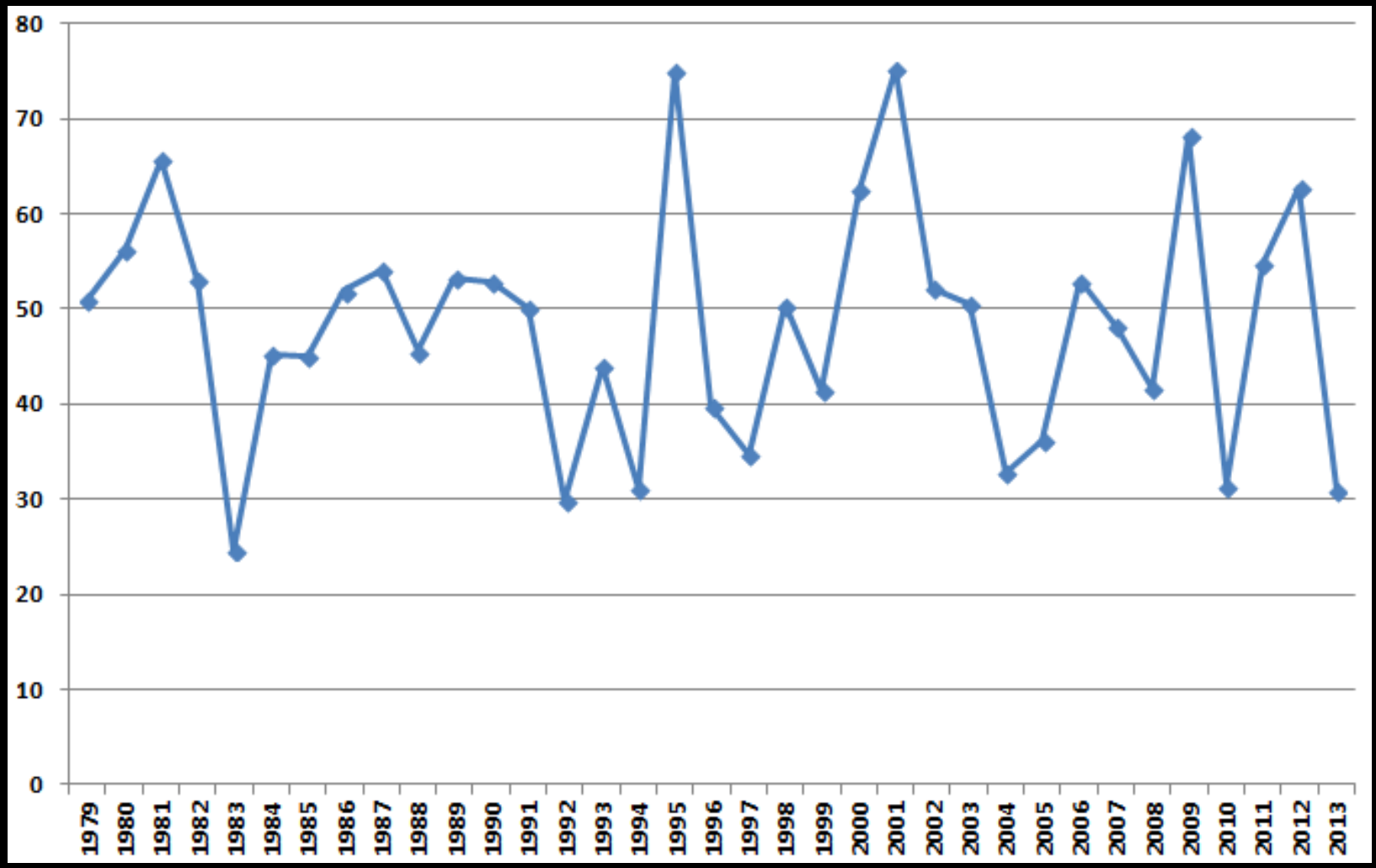
1979 – 2013

The Annual Cycle of Wave Number 1 Phase



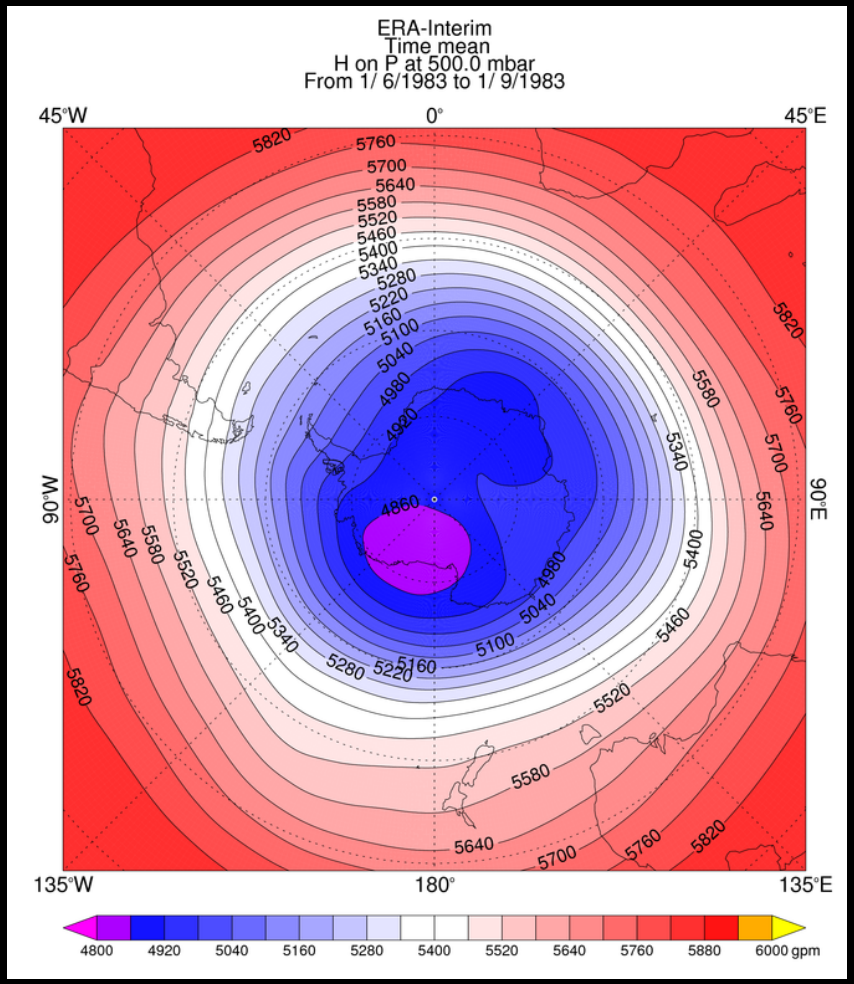
1979 – 2013

The Winter Amplitude of Wave Number 1

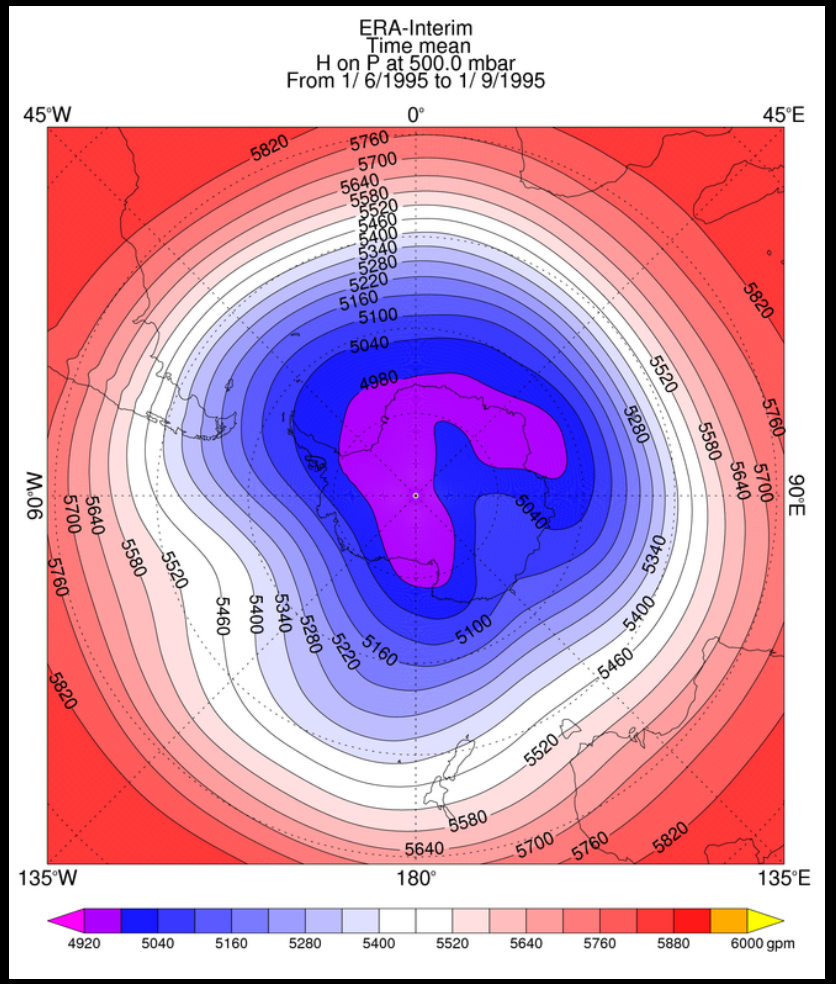


1979 – 2013

Extremes of Winter Wave Number 1 Amplitude

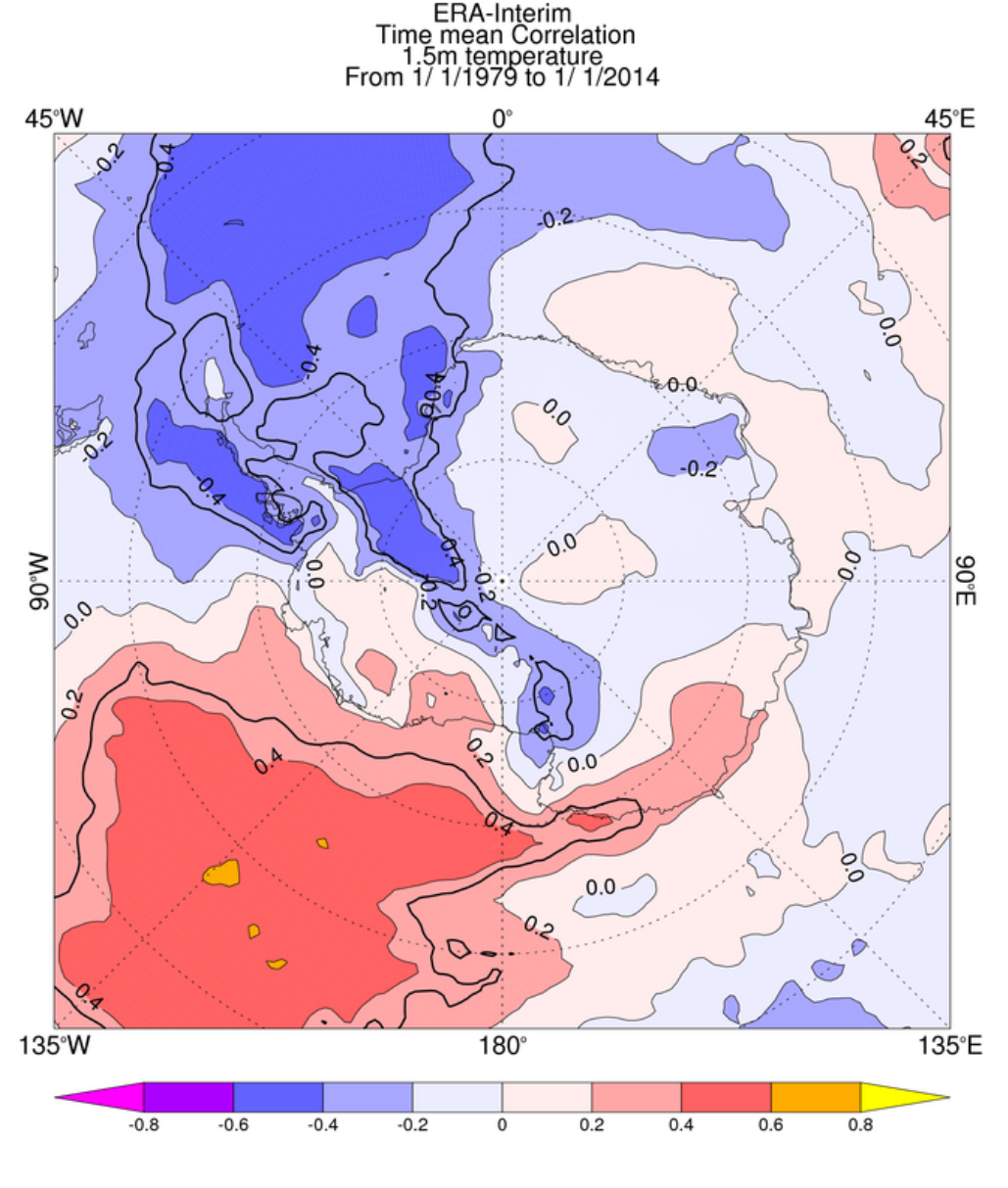


Small amplitude 1983



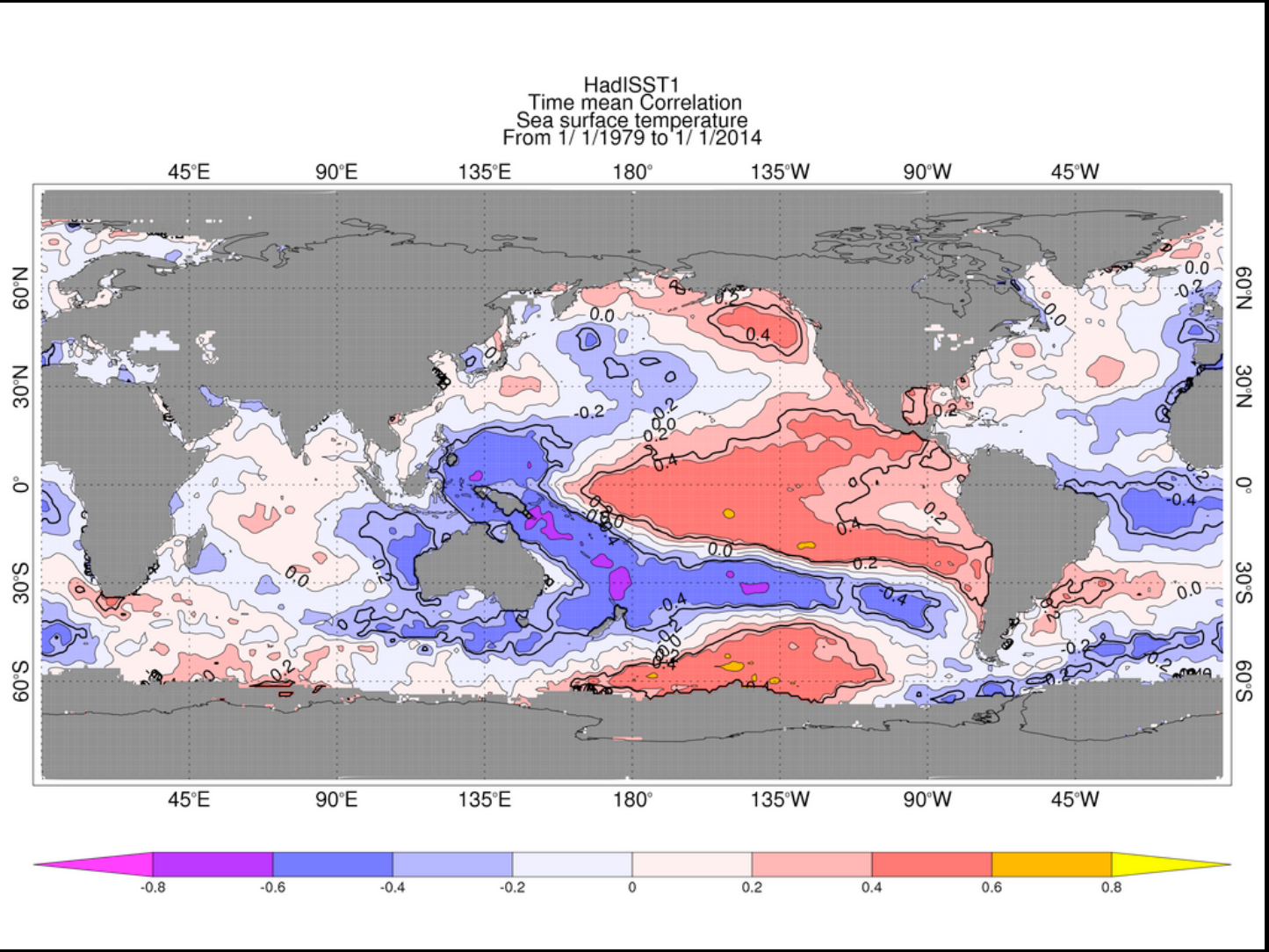
Large amplitude 1995

The Impact of Changes in Wave Number 1 Amplitude



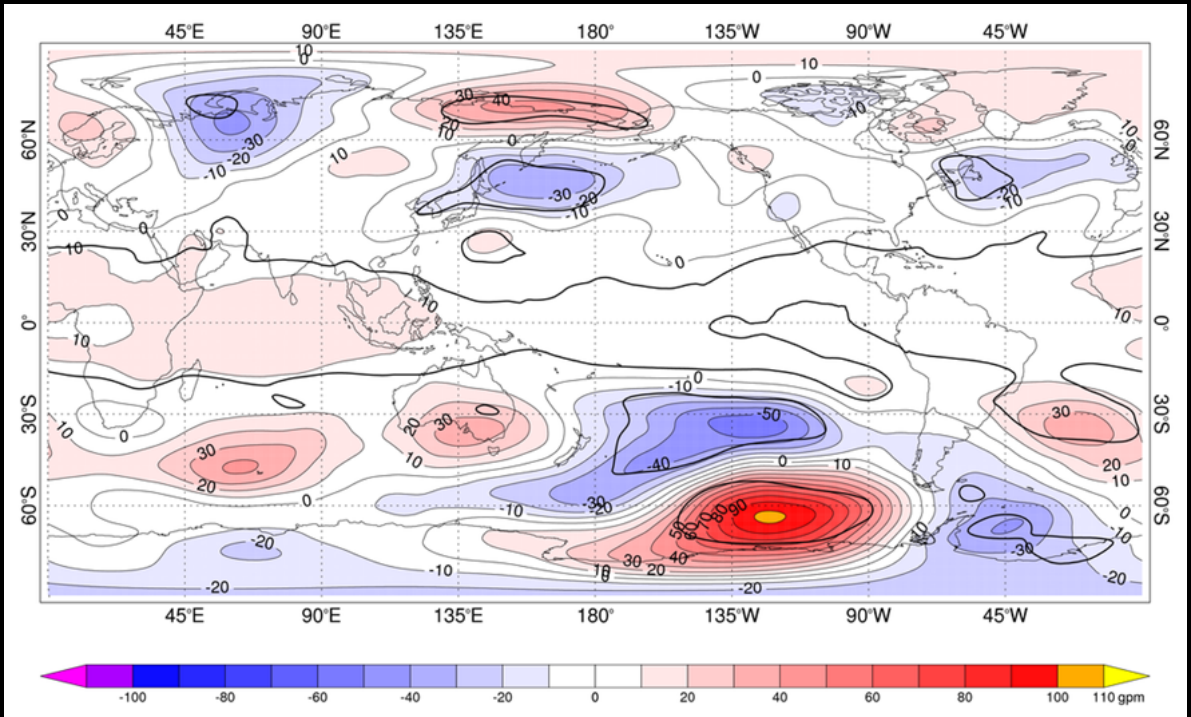
The correlation of annual mean 1.5 m air temperature with the annual mean amplitude of wave number 1 for 1979-2013. Areas where the correlations are significant at $p < 0.05$ are enclosed by a bold line.

Forcing of the Wave Number 1 Amplitude



Correlation of the annual mean amplitude of wave number 1 with annual mean SSTs

Tropical Influences



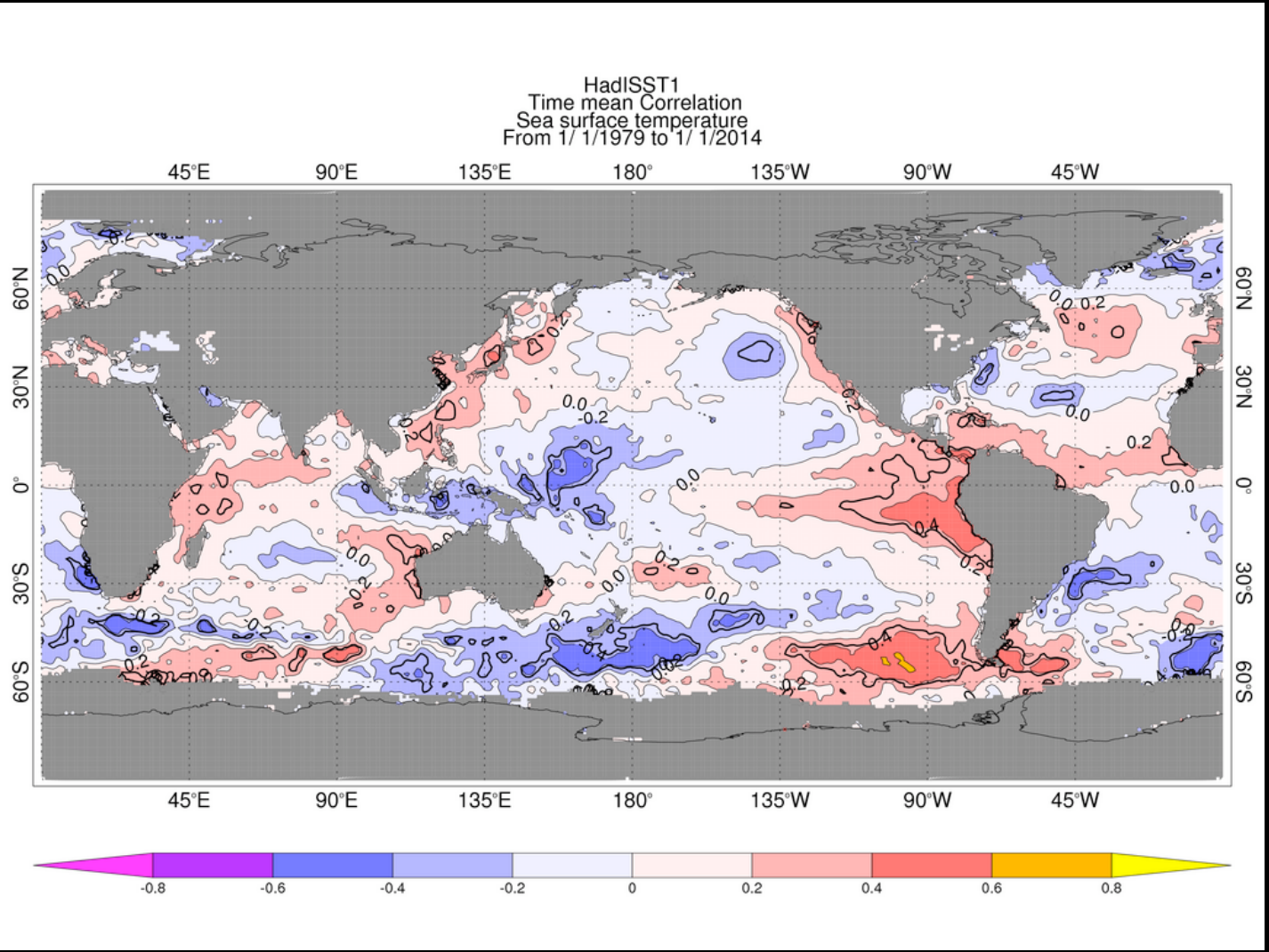
During El Nino events a wave train is established to the Amundsen – Bellingshausen Sea

The differences in 500 hPa geopotential height (gpm) between the austral winters when the tropical Pacific was in the El Niño (1982, 1987, 1991, 1997, 2002) and La Niña (1981, 1984, 1985, 1988, 1989, 1999, 2000) phases of the ENSO cycle. Areas where the differences are significant at $p < 0.05$ are enclosed by a bold line.

Deeper ASL – SAM positive and/or La Nina

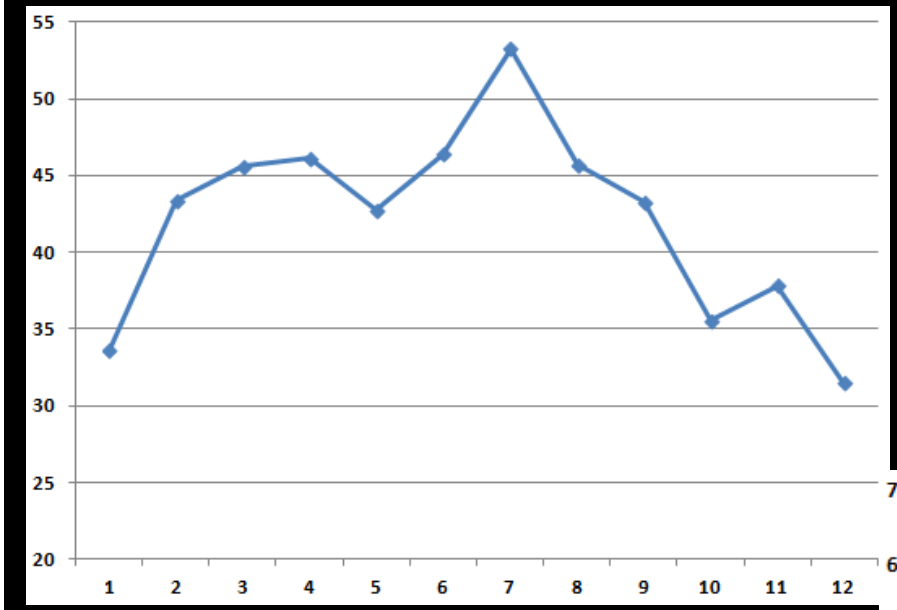
Weaker ASL – SAM negative and/or El Nino

Forcing of the Wave Number 1 Phase

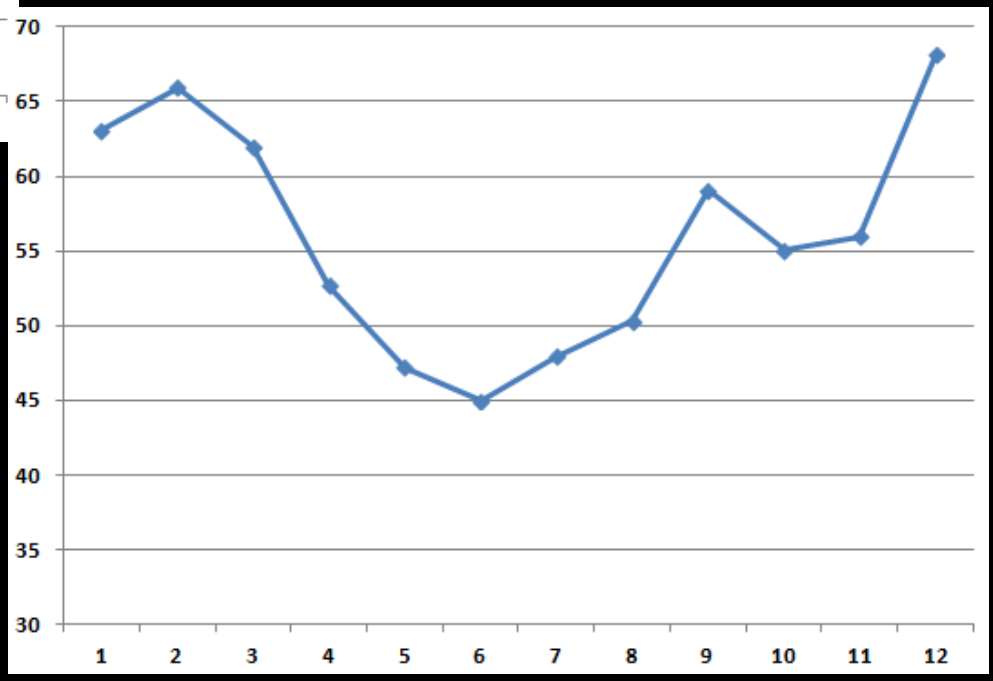


Correlation of the annual mean phase of wave number 1 with annual mean SSTs

The Annual Cycles of Wave Number 3

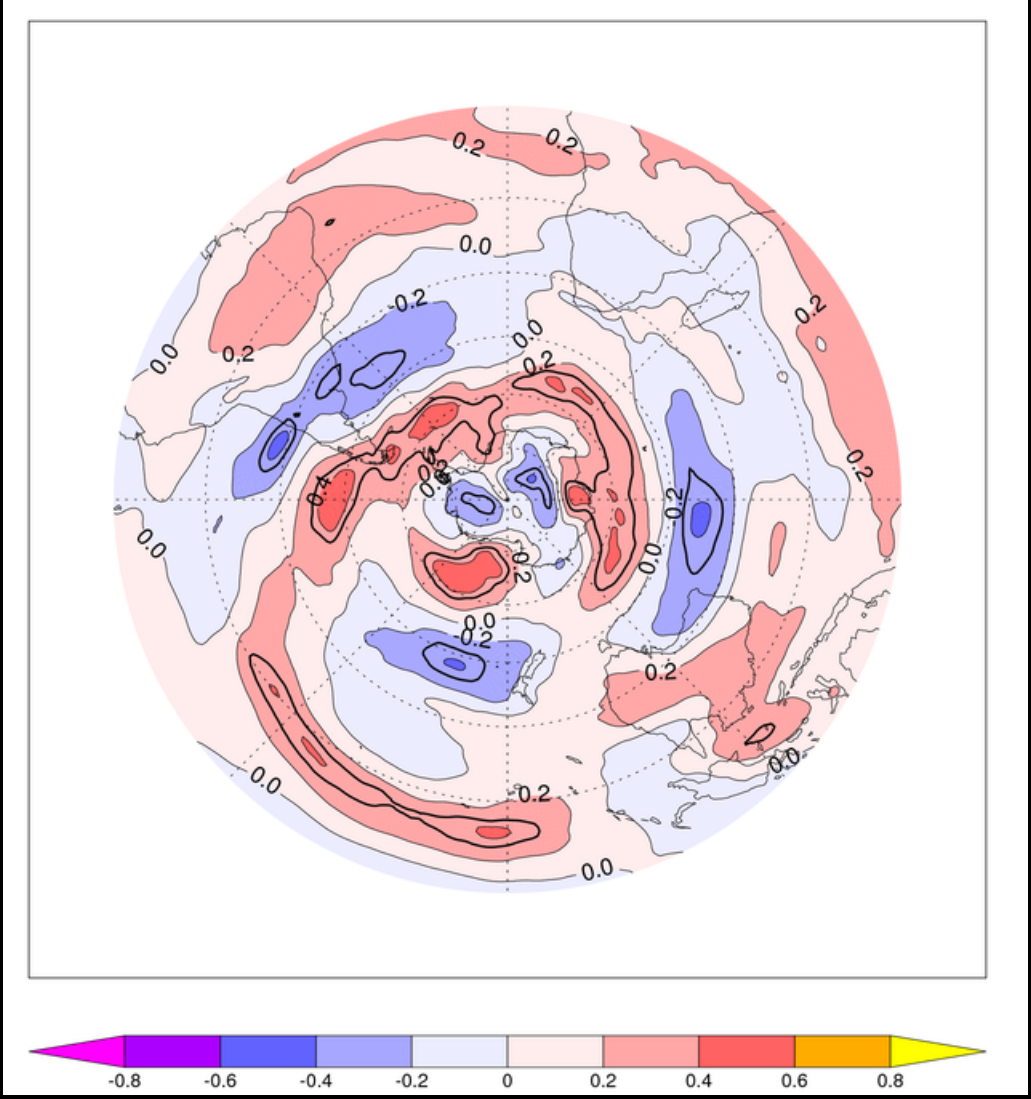


Amplitude



Phase

The Forcing of Wave Number 3 Phase



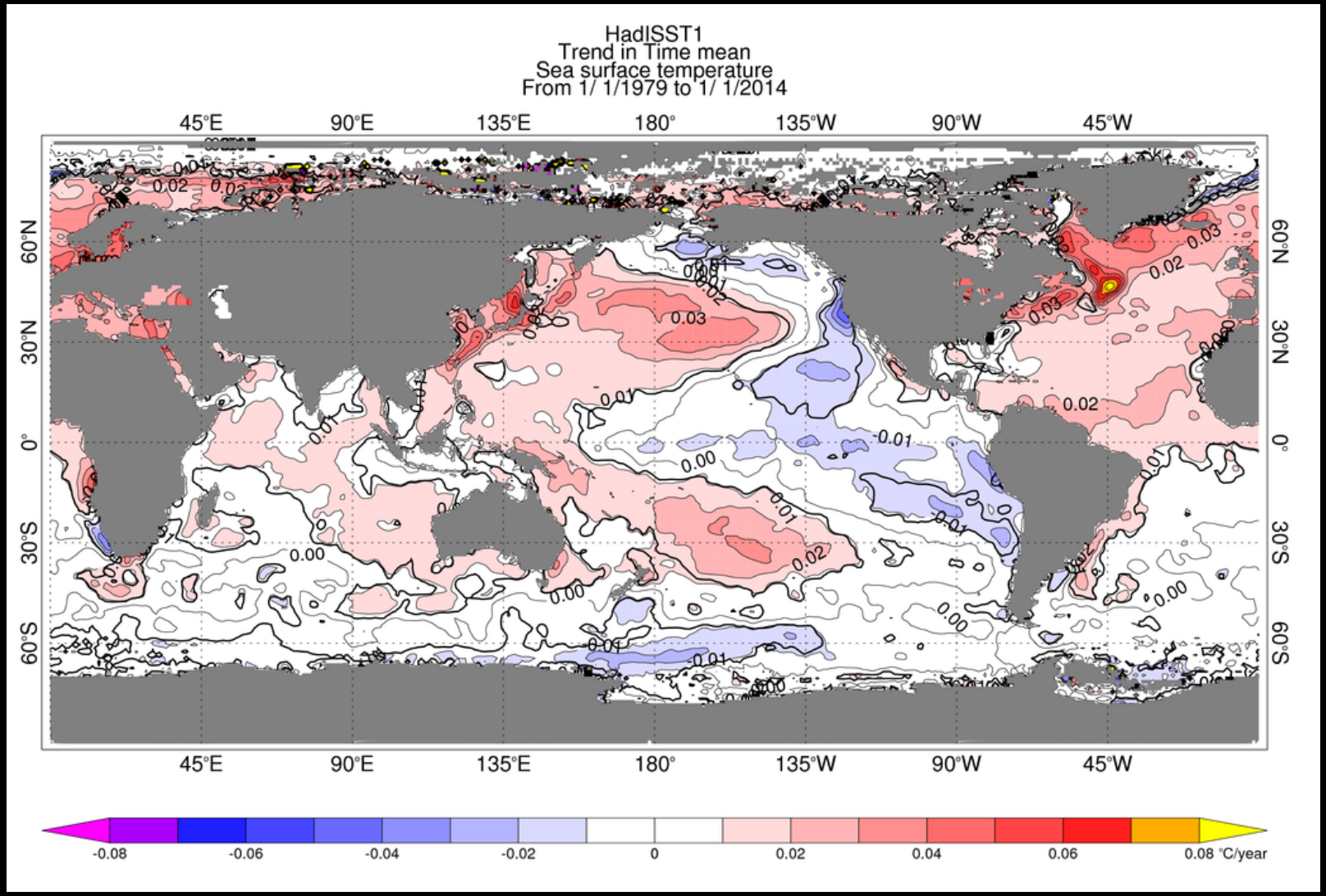
The correlation of wave 3 phase and 500 hPa zonal wind. Annual.

The Trends in the Amplitudes of the Waves

Wave number	Summer	Fall	Winter	Spring	Year
1	-0.82	-4.77	-5.81	-4.47	-3.64*
2	-0.46	0.75	-0.35	1.83	0.58
3	2.29	-2.61	-0.50	1.36	0.11
4	-0.28	-1.64	-0.47	1.12	-0.15

1979 - 2013

The Trends in Annual Mean SSTs



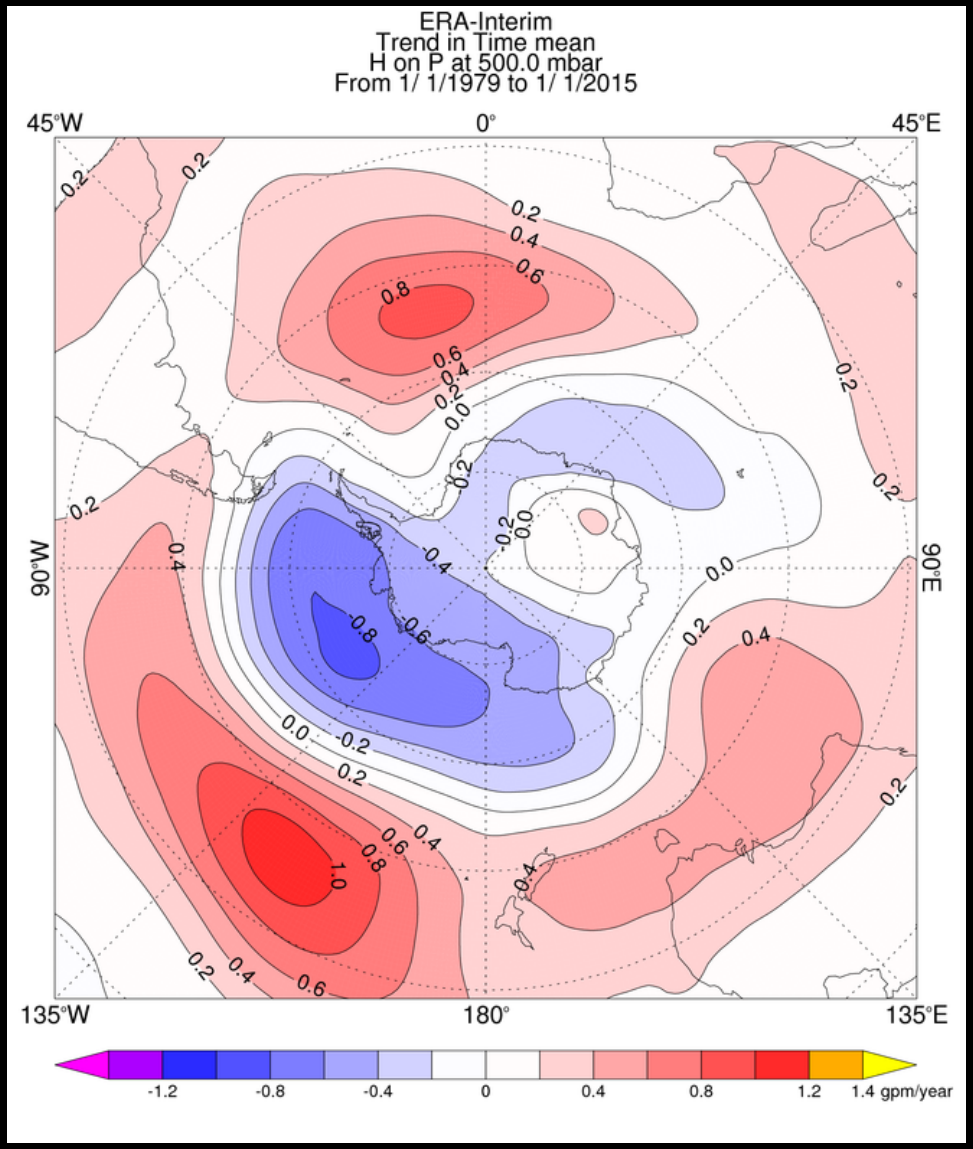
1979 - 2013

The Trends in the Phases of the Waves

Wave number	Summer	Fall	Winter	Spring	Year
1	1.17	0.62	1.39	2.57	1.08
2	4.38	9.15	0.82	4.63	4.24
3	0.54	0.32	1.46	2.81	1.06
4	-0.19	-1.58	-2.69*	2.81	-0.31

1979 - 2013

The Trend in Annual Mean 500 hPa Height



1979 - 2014

Conclusions

- Wave Number 1 has the largest amplitude of the planetary waves and its amplitude is strongly influenced by tropical SSTs and especially the ENSO cycle.
- The amplitude is greater during the El Nino phase because of the strong teleconnection to the Amundsen Sea where the wave 1 ridge is located.
- There are significant influences of wave 1 variability on the Antarctic surface temperature field.
- Wave 3 is strongly influenced by the strength of the westerlies over the Southern Ocean and therefore the ozone hole and the SAM.
- Since 1979 the amplitude of wave number 1 has decreased, which is consistent with the slight cooling (La Nina phase) of temperatures across the central Pacific. However, natural/intrinsic variability of the waves is large and may have played a major role.


Thank you