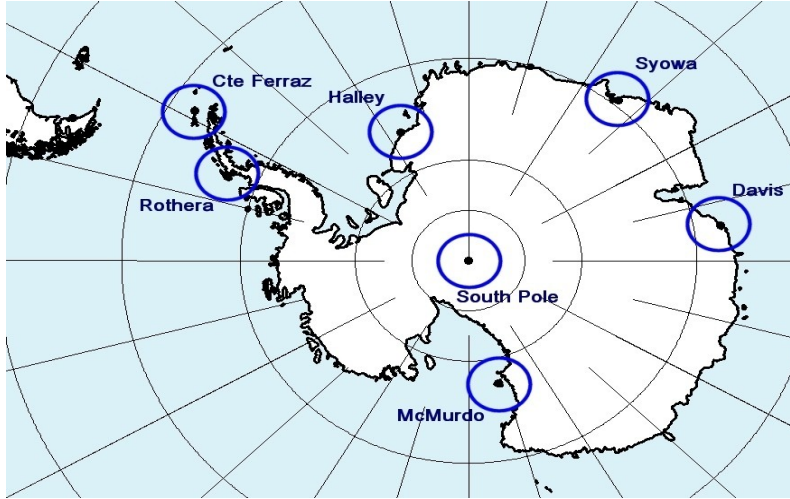


Planetary Wave Activities
of Winter 2014
and Possible Link to
MW Observations in the MLT

Yucheng Zhao, Mike J. Taylor, P.-D. Pautet, S.
Eckermann, T. Moffat-Griffin, M. E. Hervig, W.R.
Pendleton, Jr., H.L. Liu, and J. M. Russell, III

Introduction

ANGWIN (Antarctic Gravity Wave Instrument Network)

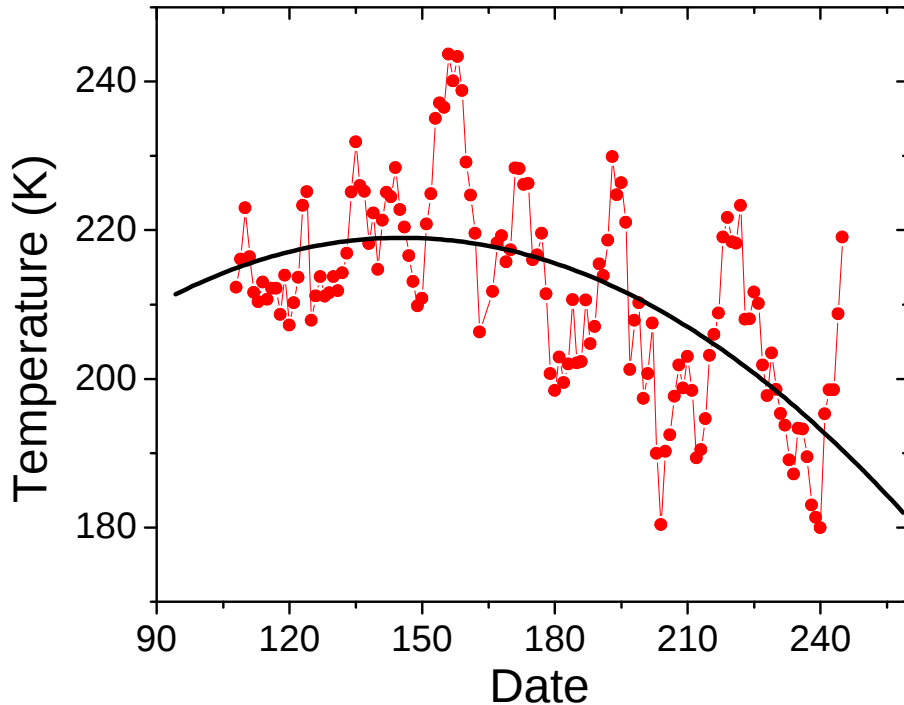


AMTM at South Pole

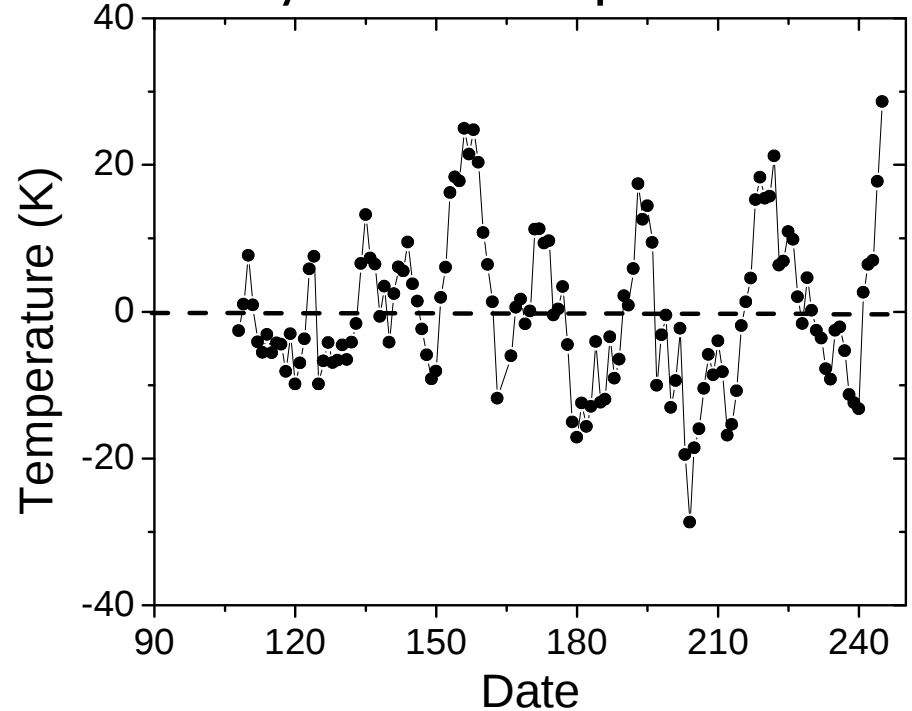
- Advanced Mesospheric Temperature Mapper (AMTM) at South Pole Station (2010-to date)
- Infrared OH (3,1) band intensity and rotational temperature mapping (at ~ 87 km)
- Temporal resolution: 30 sec.
- Continuous measurements over past 6 winter seasons under 24-hours of “darkness” (April-August)

South Pole 2014: Large Amplitude PW

Daily Mean Temperature

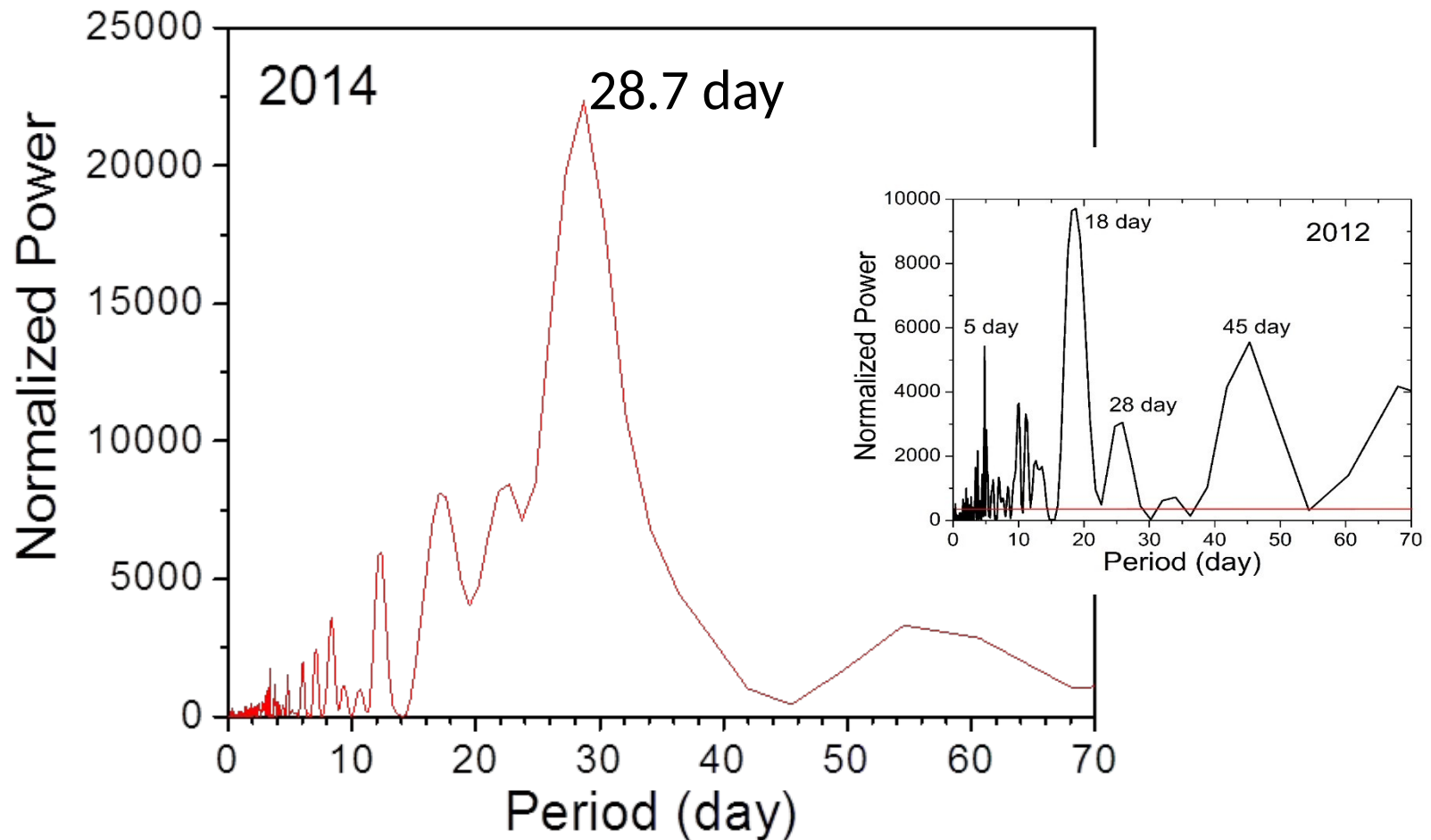


Daily Mean Temperature



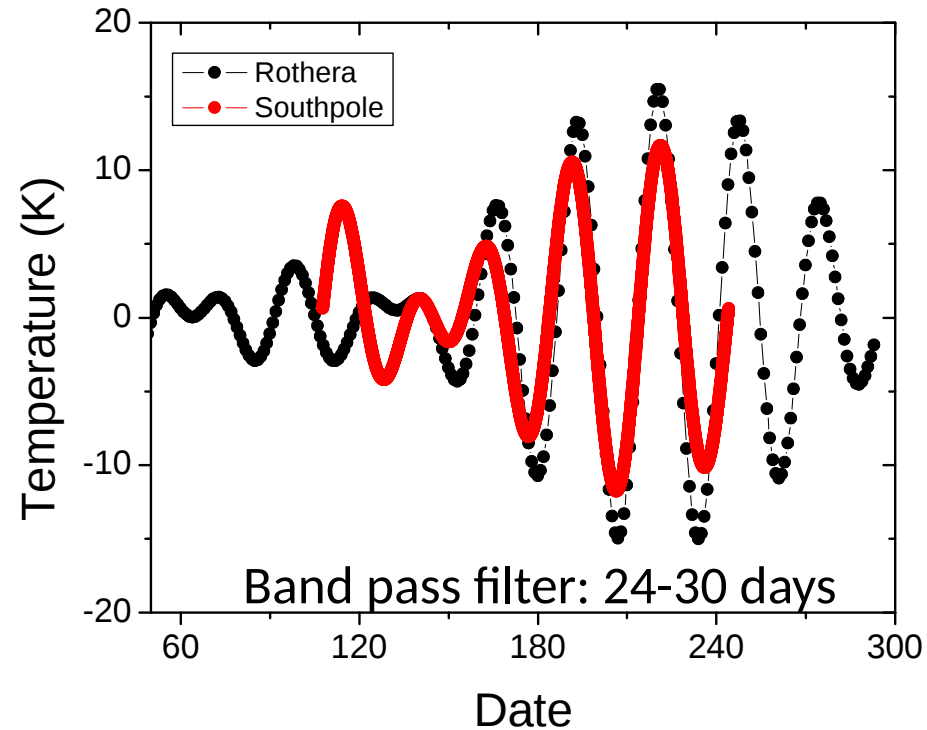
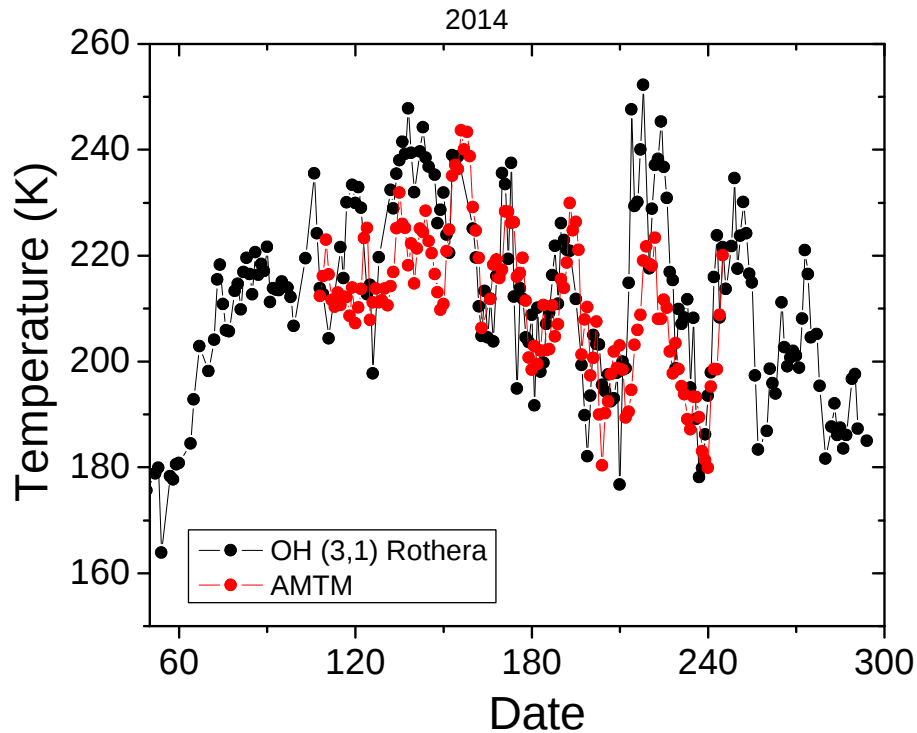
- Large coherent oscillation starting in June (~day150)
- ~ 4.5 cycles observed
- Max amplitude ~12K.

Spectral Analysis of Large Amplitude PW



- Lomb-Scargle Spectral Analysis (>300,000 data points)
- Winter Spectrum dominated by **~28 day oscillation**

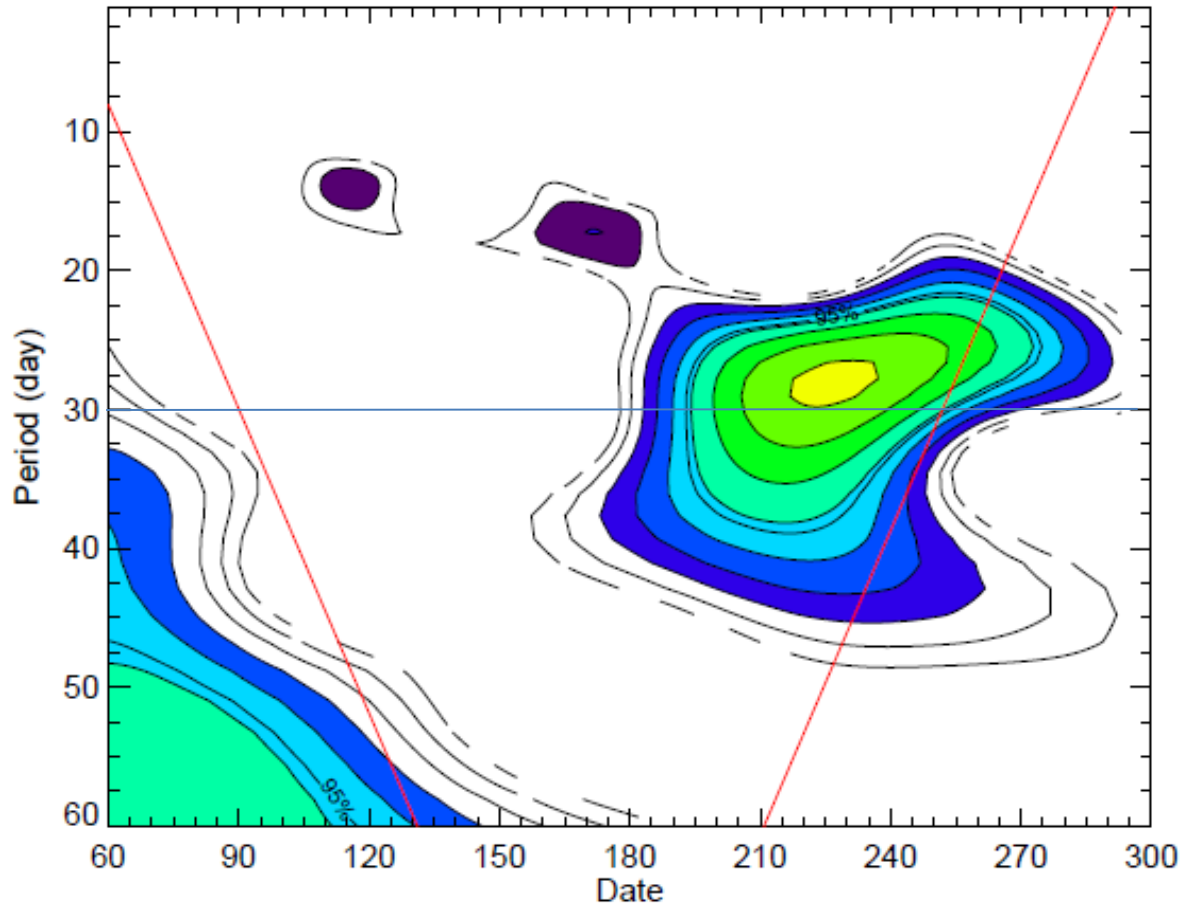
Temperature Comparison with other ANGWIN Sites: Rothera and South Pole



Rothera: IR Spectrometer (67.5°S , 292°E)

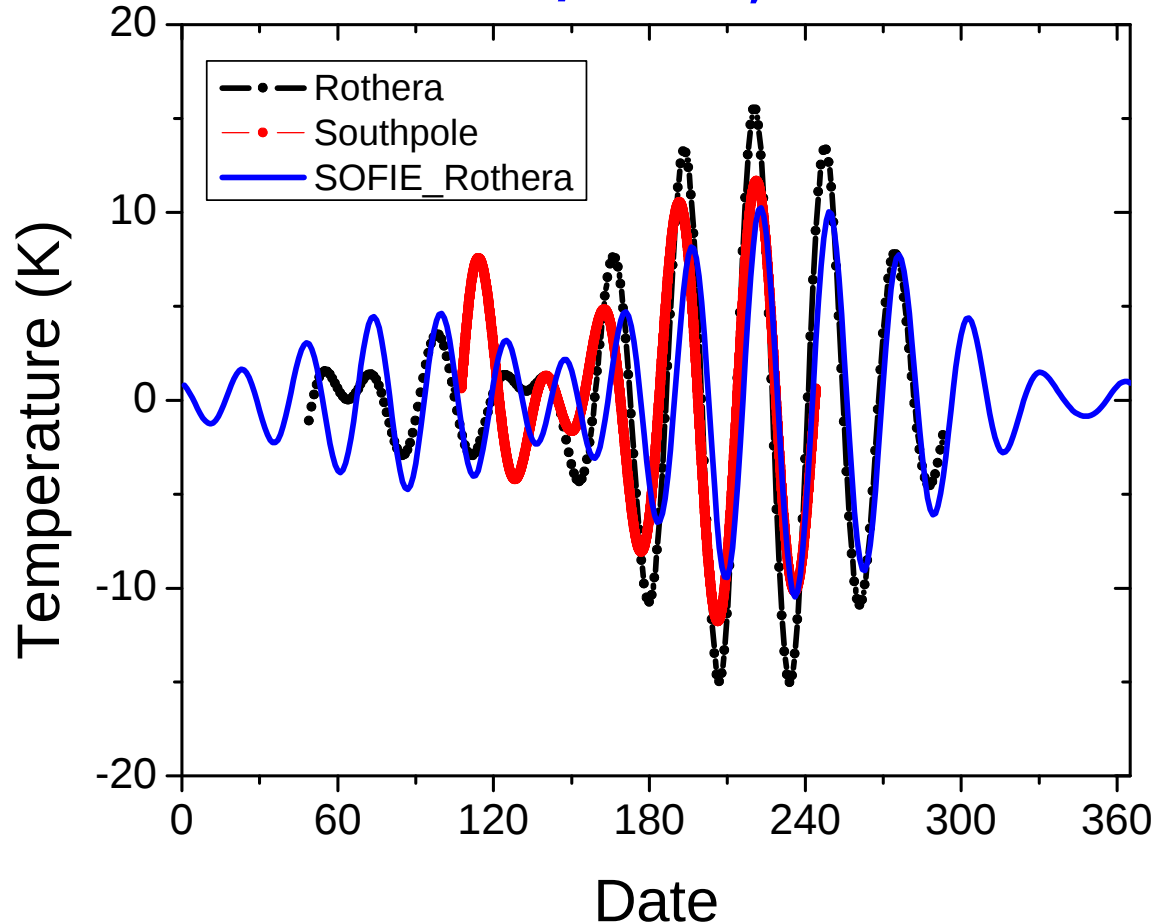
- Strong 28 day PW detected in OH temperature
- PW data duration 1.5 cycles longer
- In phase oscillation and larger amplitude ($\sim 15\text{K}$) than SP
- Filtered data (right) identifies a clear wave packet.

Wavelet Results for Rothera



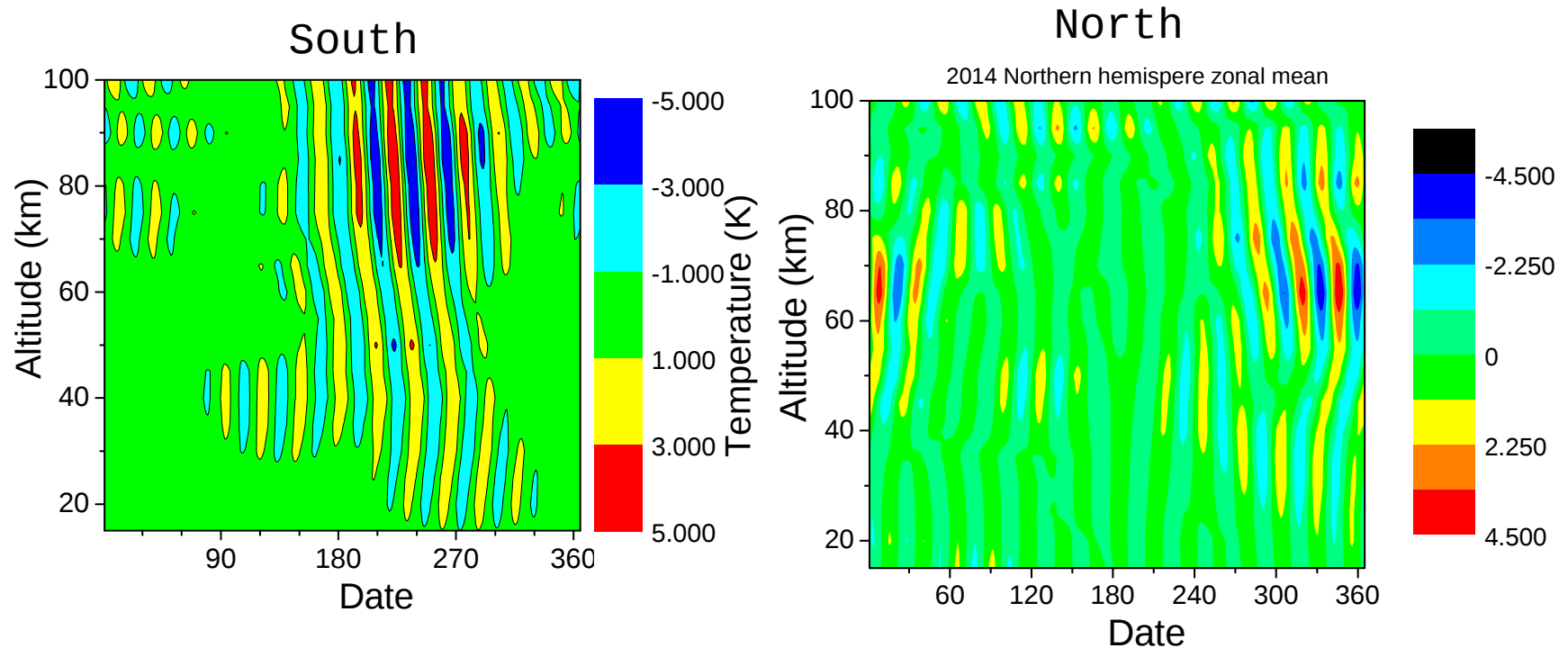
- Strong wave activity during the later half of the winter season.
- Broad spectrum: PW period between 20-30 days (not solar driven).

Comparison SOFIE/AIM, S-P and Rothera



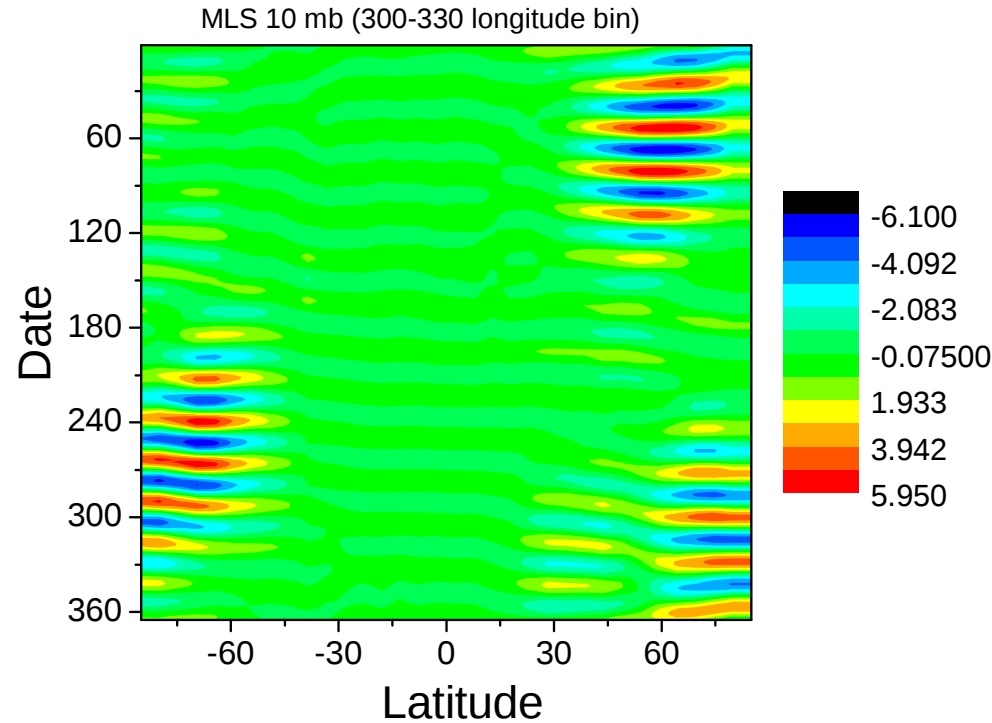
- NASA AIM Satellite: SOFIE limb temperature data at 85 km over Rothera. longitude (30° sector)
- Strong 28 day oscillation observed in all three data sets, ~6 cycles.
- Similar wave packet amplitudes and in-phase growth/decay

Vertical Structure (SOFIE)



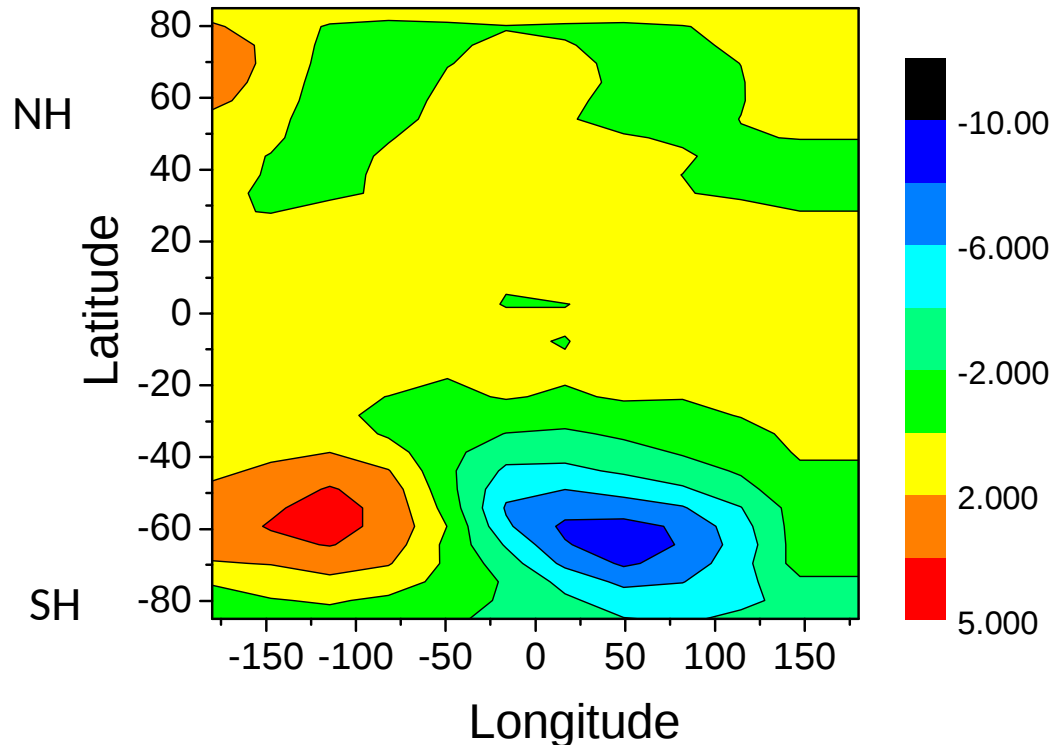
- Similar amplitude to southern hemisphere structure but maximum at lower altitude (~60-70 km)
- Estimated vertical wavelength ~20 km (compared with ~30 km in SH)

Latitude Extension at Lower Altitudes (MLS)



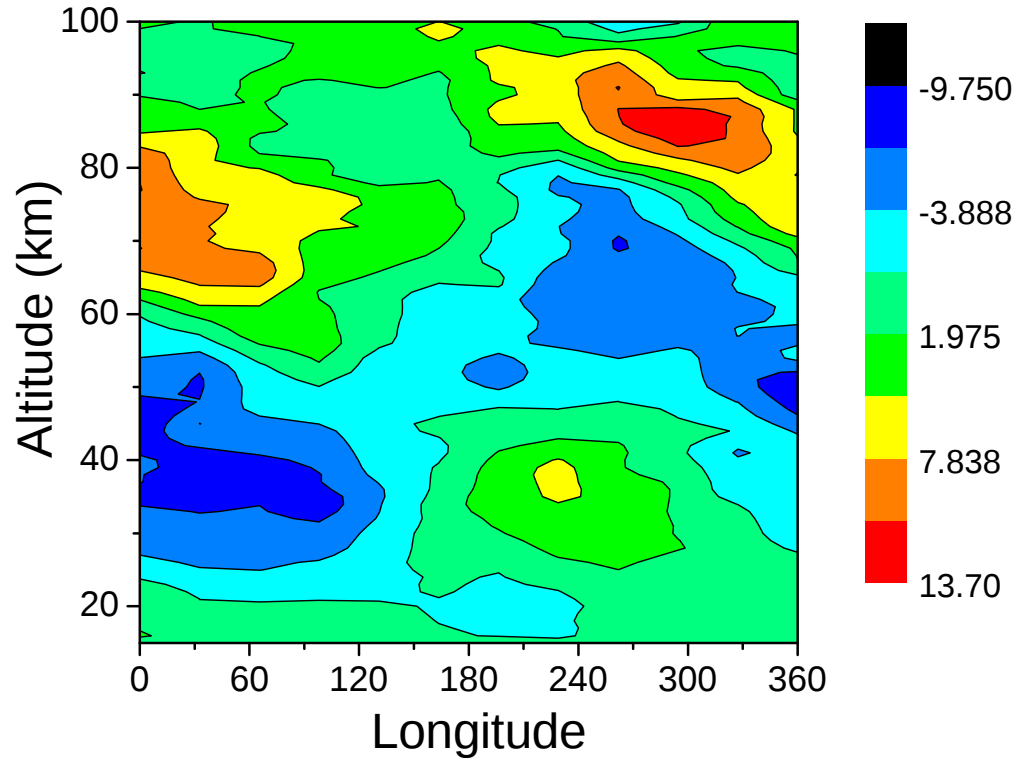
- **MLS temperature** results showing latitudinal extent at 10 hPa (~30 km)
- A winter-time high latitude event existing in both hemispheres-30 km.
- Similar amplitude North and South (~5K)

Zonal PW Structure at 10 hPa (Day 247)



- **MLS temperatures** showing latitude and longitude structure of the 28 day oscillation at ~ 30 km
- **Clear zonal wave #1 structure in the S-H with peaks at $\sim 60^\circ$ S**
- **Stronger peak at Davis longitude (blue) that at Rothera (red) – opposite to what was observed at mesopause.(OH region)**

PW Vertical Structure on Day 247



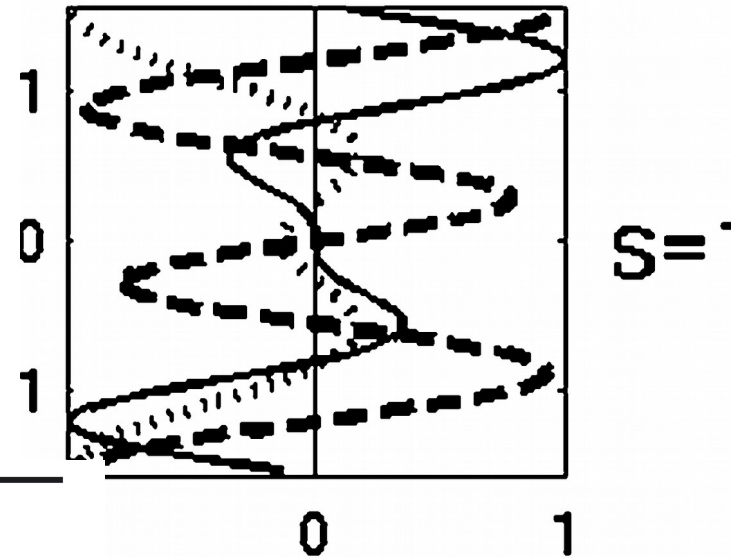
- **SOFIE temperatures** showing vertical structure in the 28 day oscillation on day 247 (~peak of event).
- **Clear zonal wave #1 structure below ~80 km** (similar to MLS at 10hPa)
- **Above 80 km the PW structure is localized to ~240-360° longitude** (Rothera) as previously determined.

Other days show some localization of the PW structure

Theoretical latitudinal structure of Rossby (1,4) mode

$$l - s = 4$$

Madden, 2007



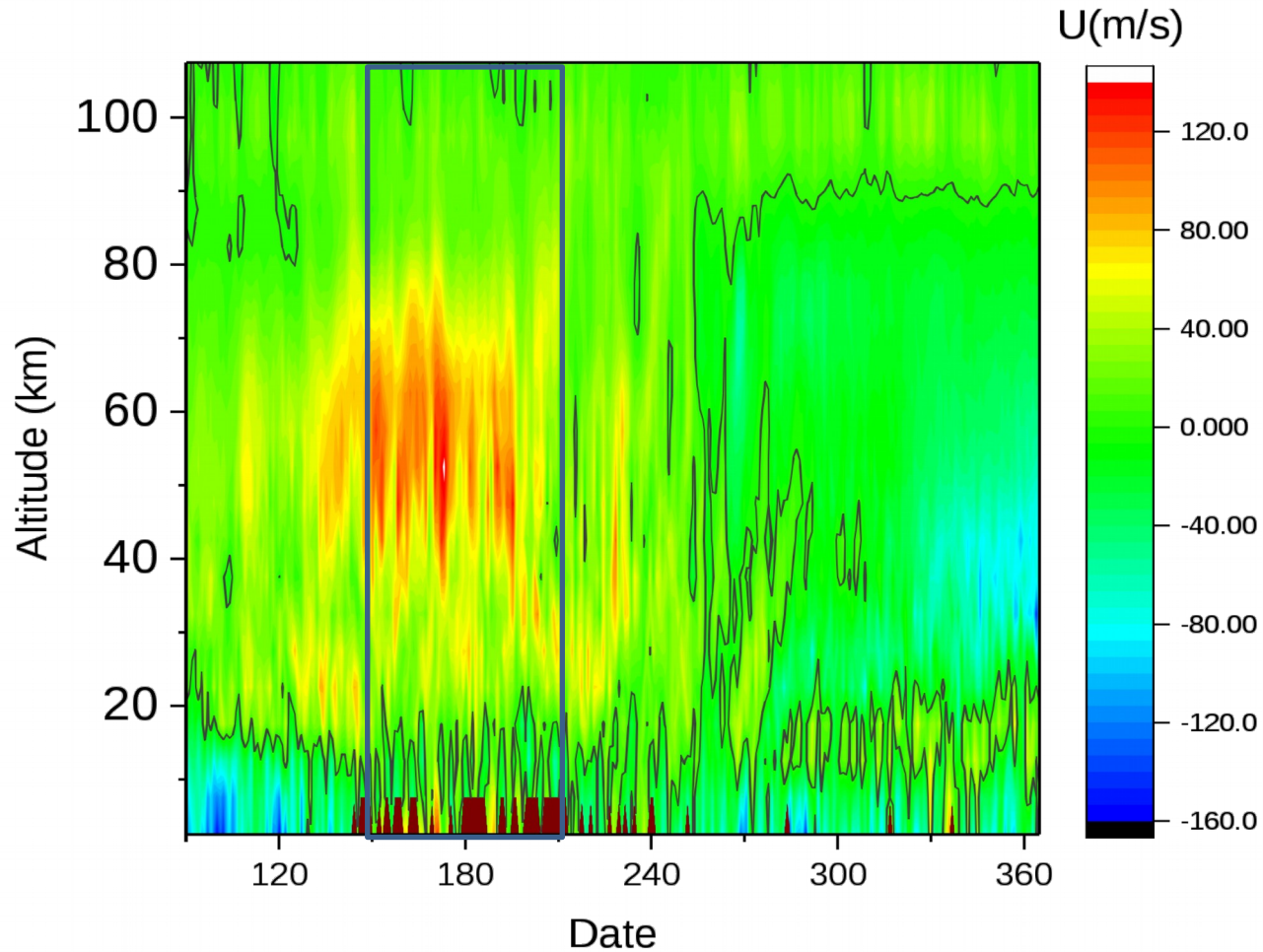
Periods (d)

Divergent Rossby waves on a Sphere DJF winds (Kasahara, 1980: JAS)

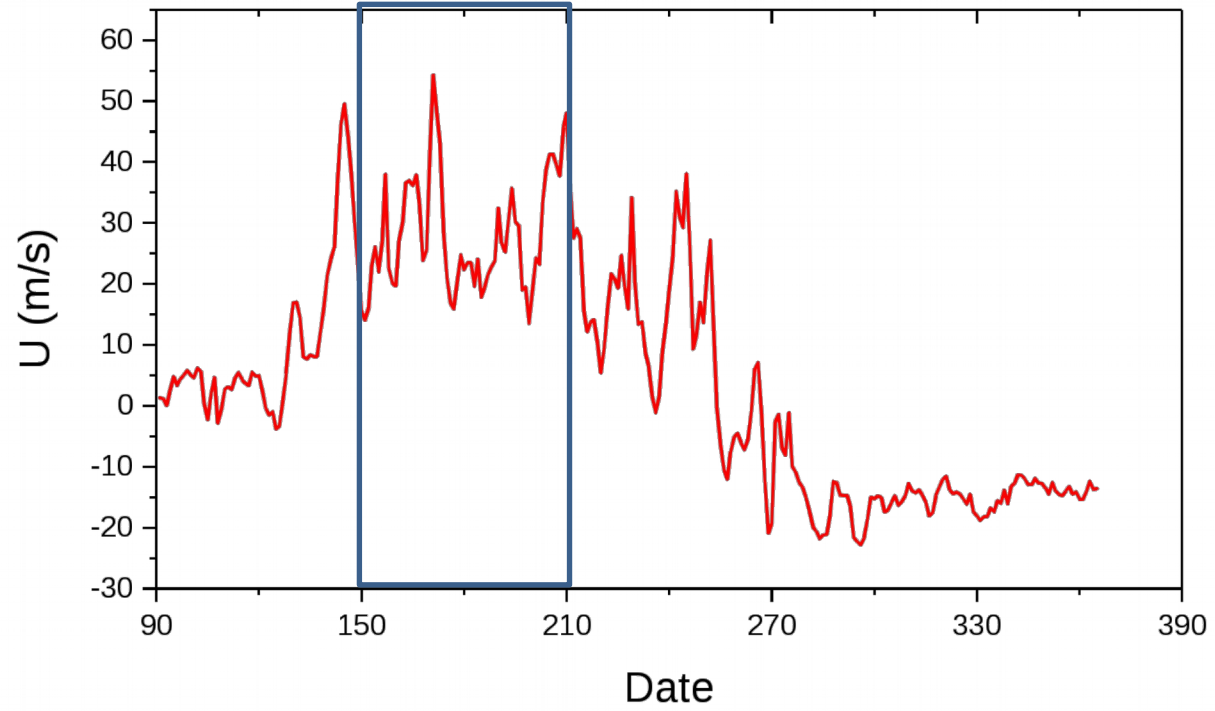
$s \backslash l - s$	0	1	2	3	4
1	1.20	4.85	9.91	18.39	28.08
2	1.71	3.84	7.27	14.23	21.47
3	2.30	4.28	7.40	13.65	–
4	2.90	5.21	8.20	13.55	–

Note: s = zonal wavenumber l = meridional index.

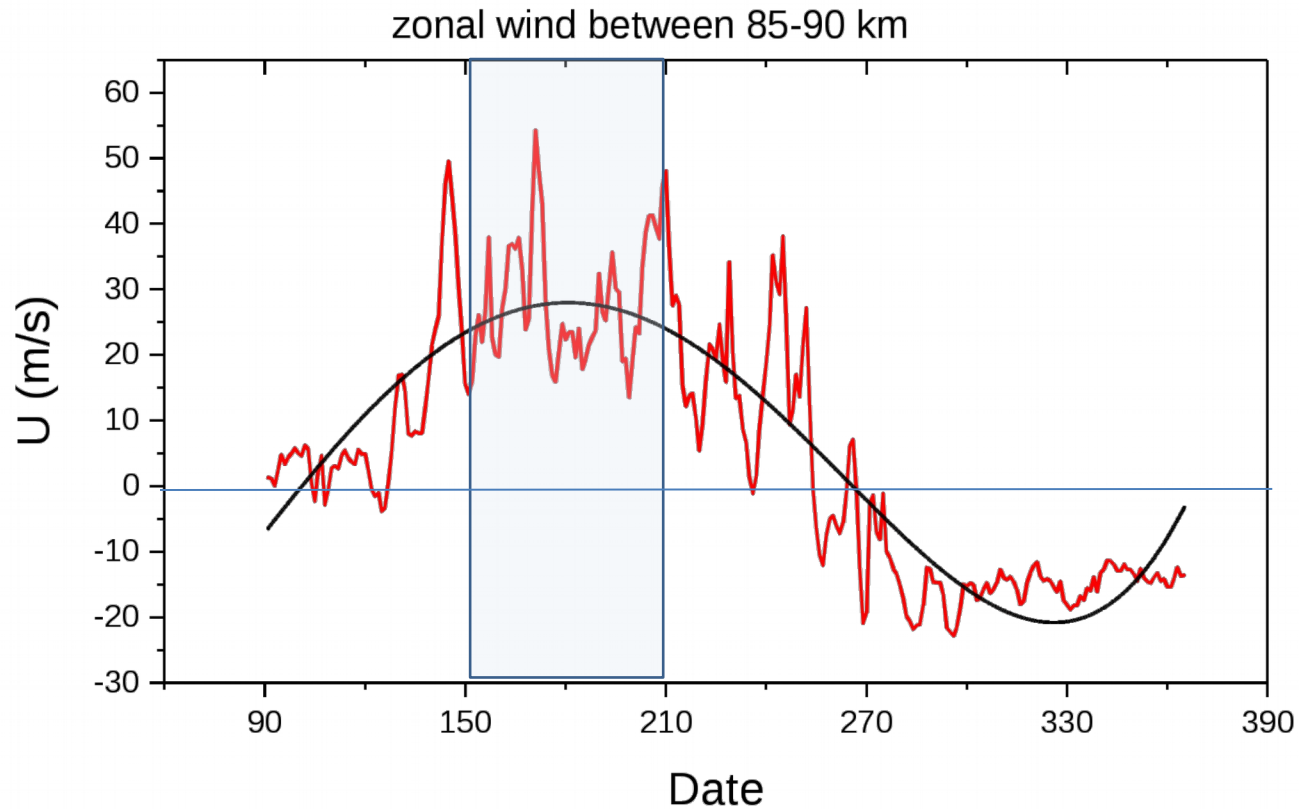
NAVGEM Zonal Wind @ 00 UT (50S-40S, 170E-180), 2014



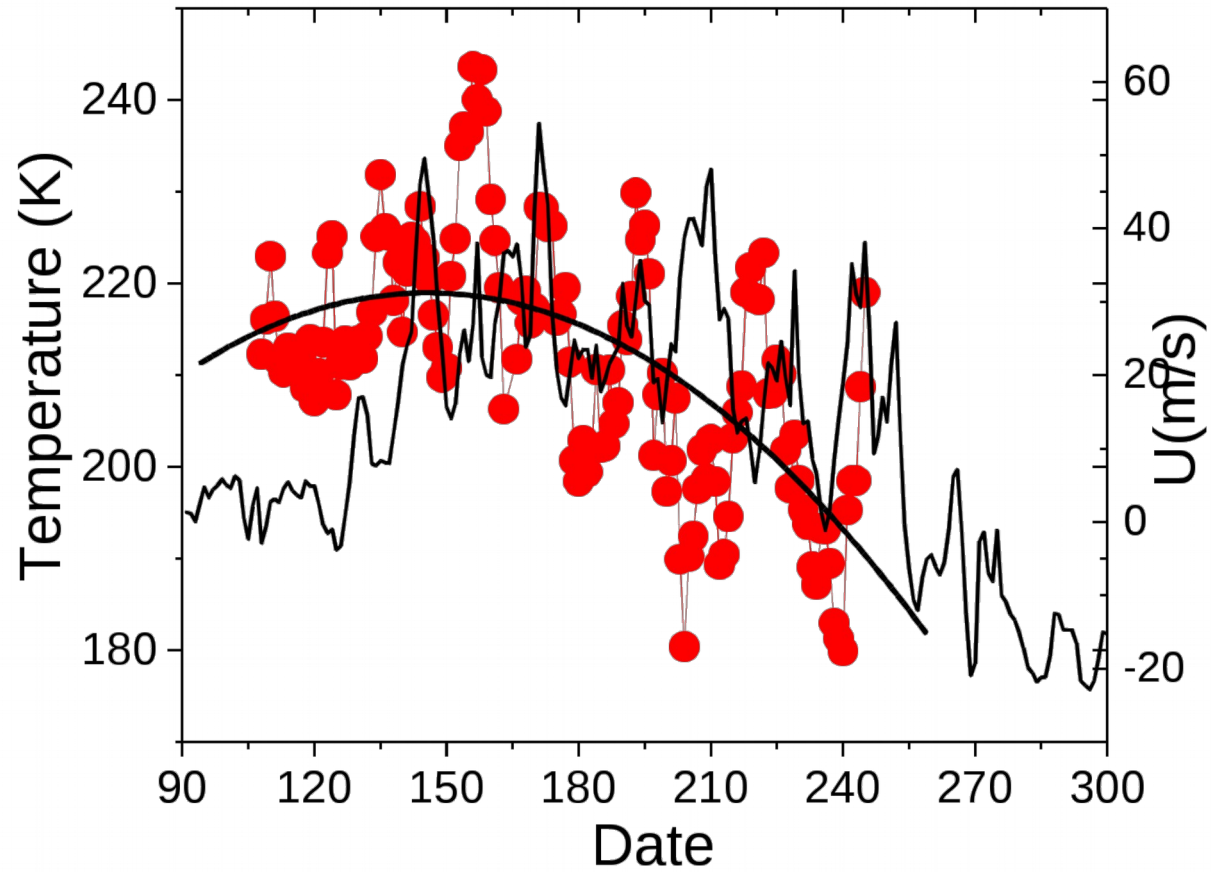
zonal wind between 85-90 km



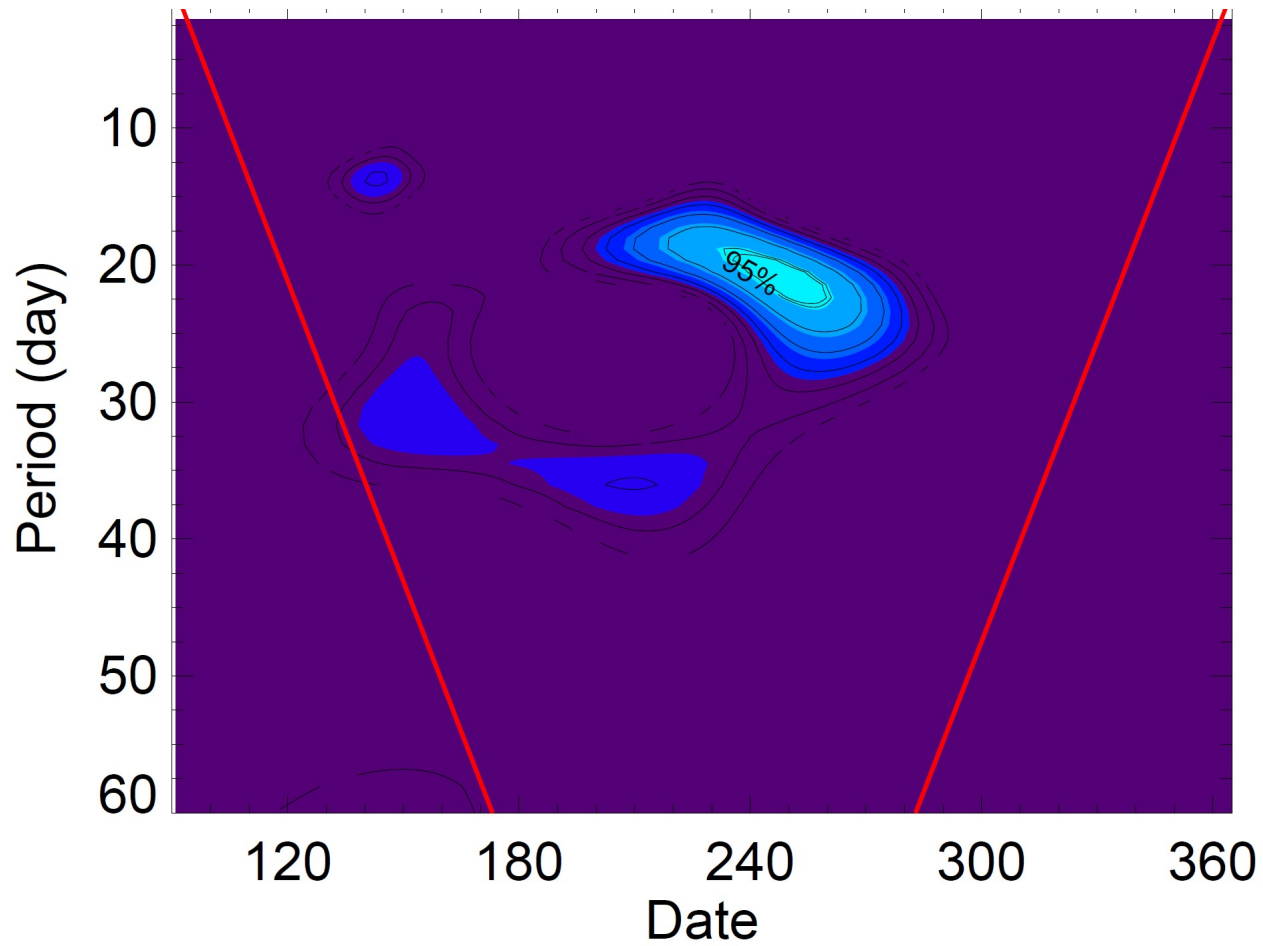
Wind enhanced by the long period Oscillations



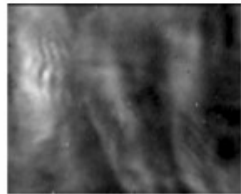
U and T (South Pole)



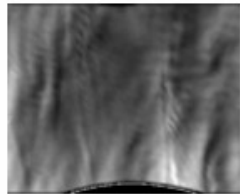
Rossby (1,4) mode?



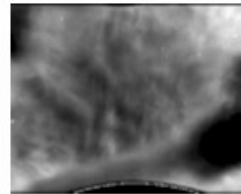
18 Other MW Candidates...



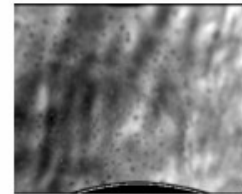
May 30-31
18:36 UT



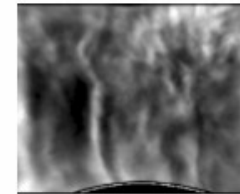
June 02-03
10:12



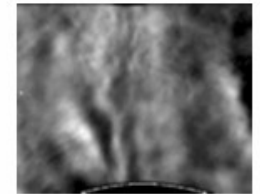
June 04-05
17:51



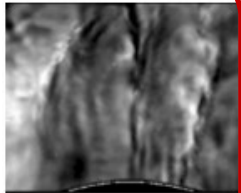
June 17-18
11:59



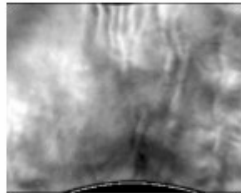
June 18-19
08:49



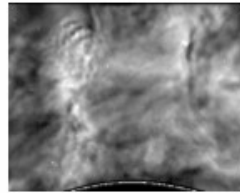
June 19-20
15:02



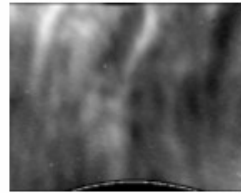
June 21-22
11:30



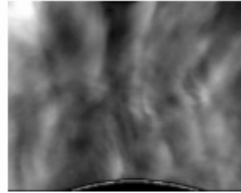
June 23-24
12:32



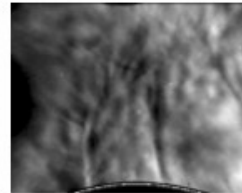
June 26-27
11:32



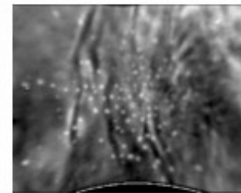
June 27-28
11:35



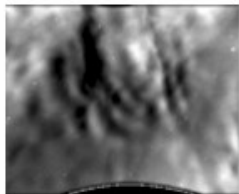
June 28-29
15:05



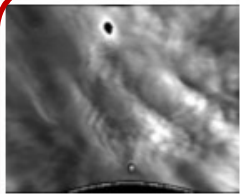
June 30-01
13:03



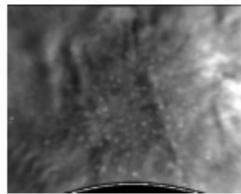
July 01-02
14:00



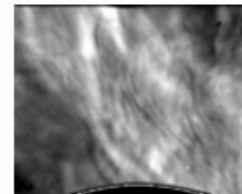
July 03-04
13:29



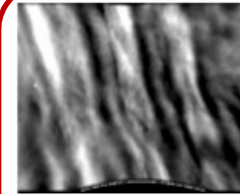
July 14-15
15:09



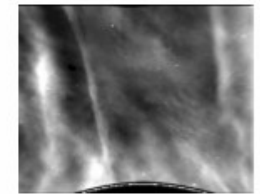
July 15-16
07:06



July 16-17
17:11

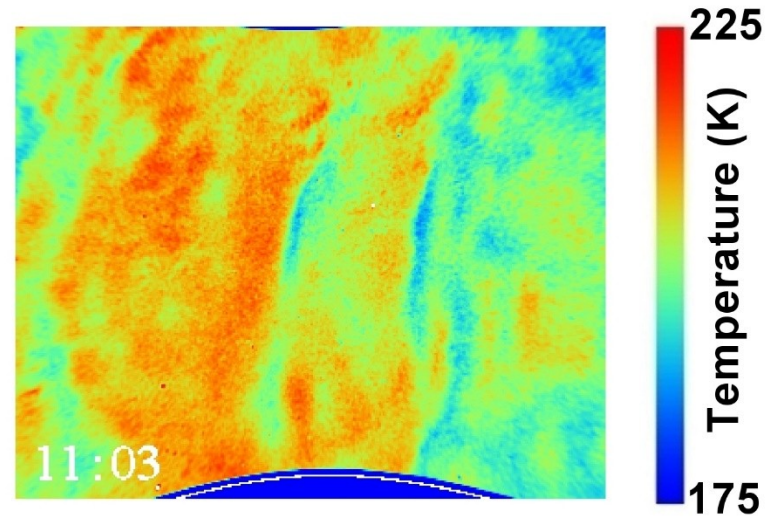
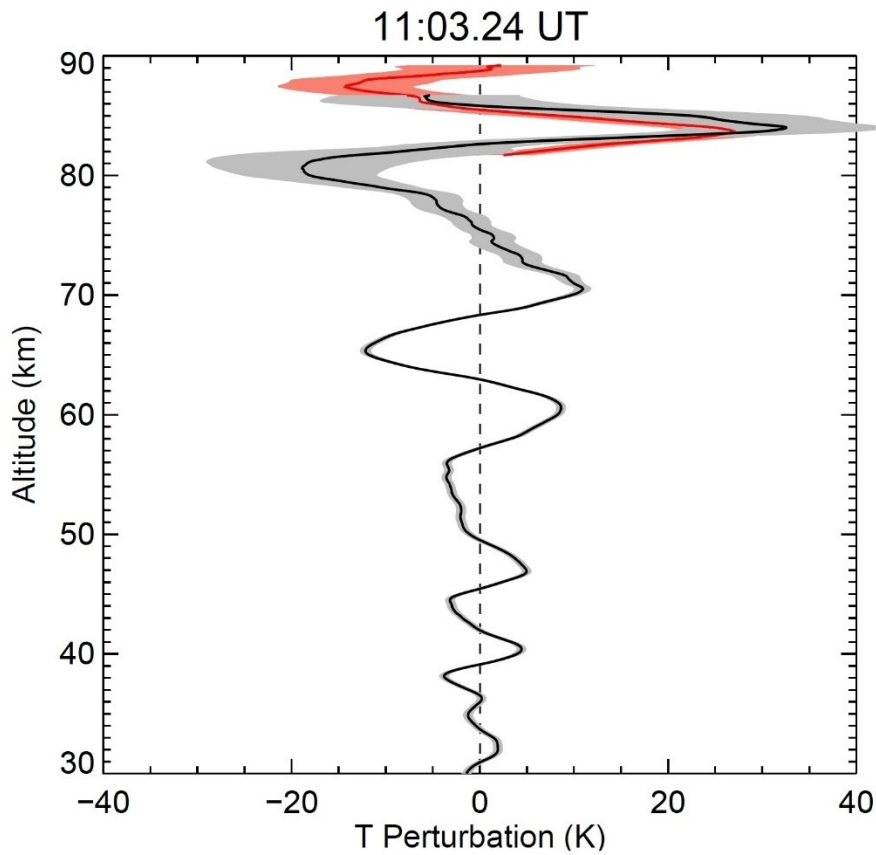


July 17-18
12:53

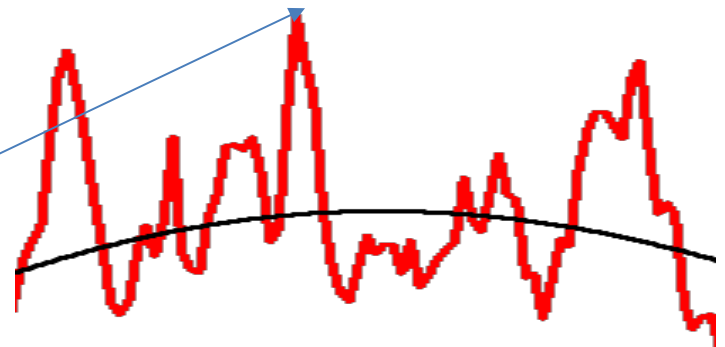


July 18-19
08:26

June 21-22, 2014



June 20, 2014



Future plan

- lidar and our AMTM measurements of the MWs -> correlation between the zonal wind and MW occurrence in the mesopause region.
- Bandpass filter NAVGEM temperature to compare with current results
- NAVGEM wind signature of this Rossby mode