Investigating Mesospheric Wave Activities at High Latitude Stations and South Pole

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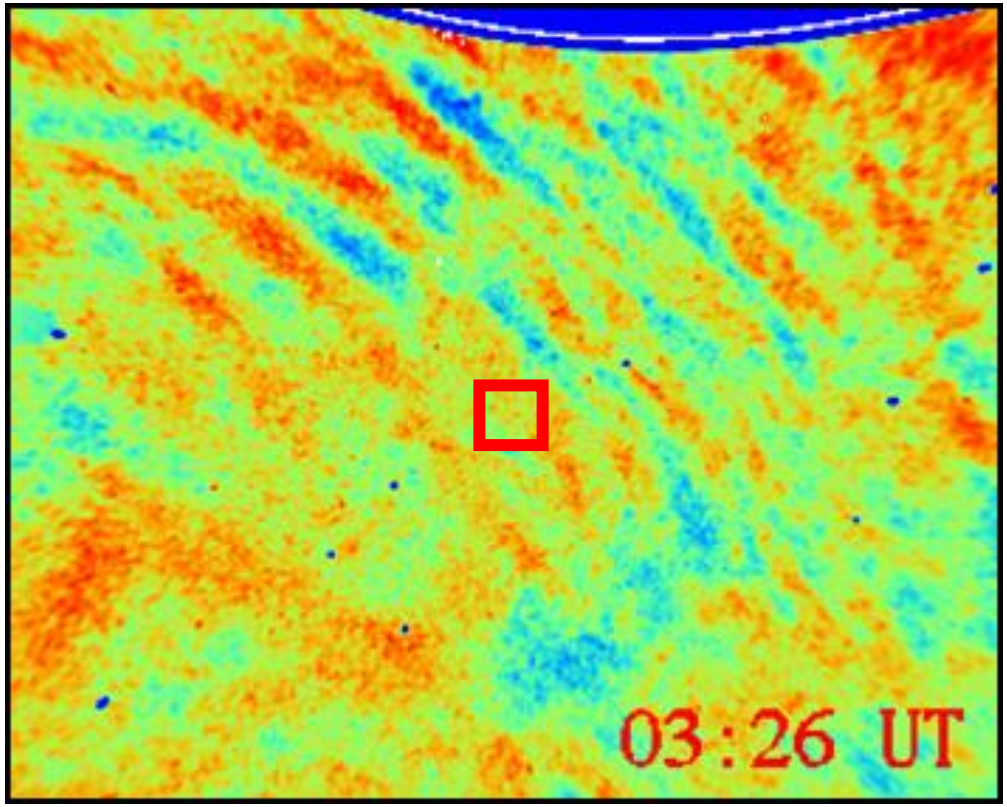
High-Latitude Research Using an Advanced Mesospheric Temperature Mapper (AMTM)

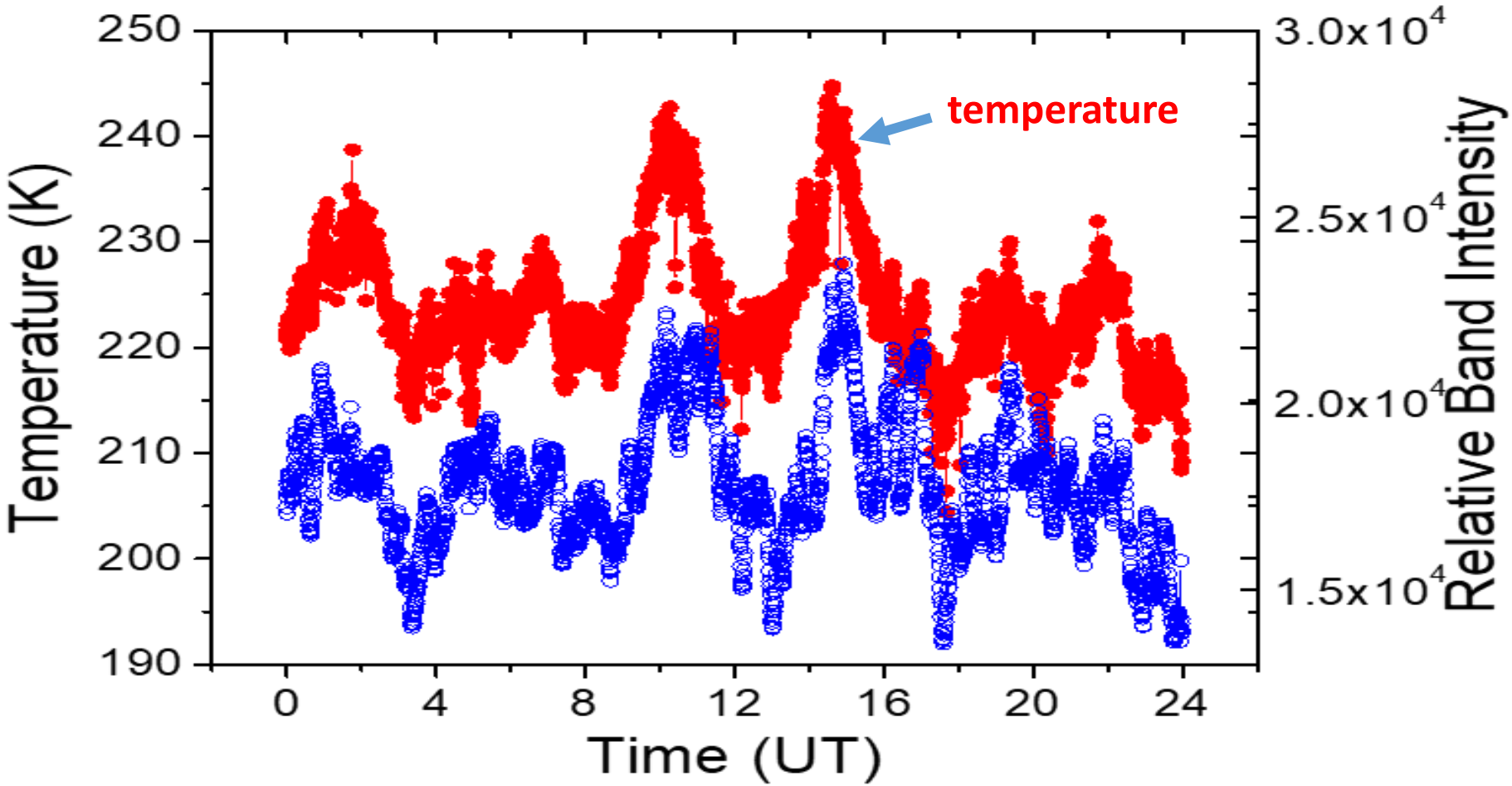
- The AMTM sequentially observes selected emission lines in the OH (3,1) band to derive high-quality temperature maps @ ~85 km.
- Temperature precision/pix ~2 K in 30 sec.
- High-latitude capability as emission lines avoid auroral contamination.
- 2 AMTM operational since 2011: ALOMAR, Northern Norway (69.3°N), and at South Pole (90°S) Antarctica.
- 3rd AMTM installed at McMurdo station (78°S) 2017.
- Oct 2017, one of the AMTMs was relocated from ALOMAR to Poker Flat Research Range (65°N)

AMTM Temperature Map



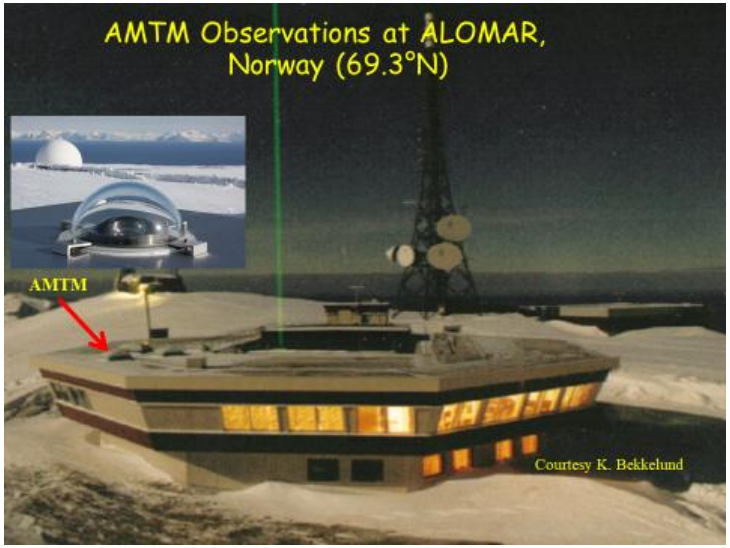
- Zenith temperature (20x20 central pixels)

Daily Temperature Measurements



>2,500 data pts/24 hours

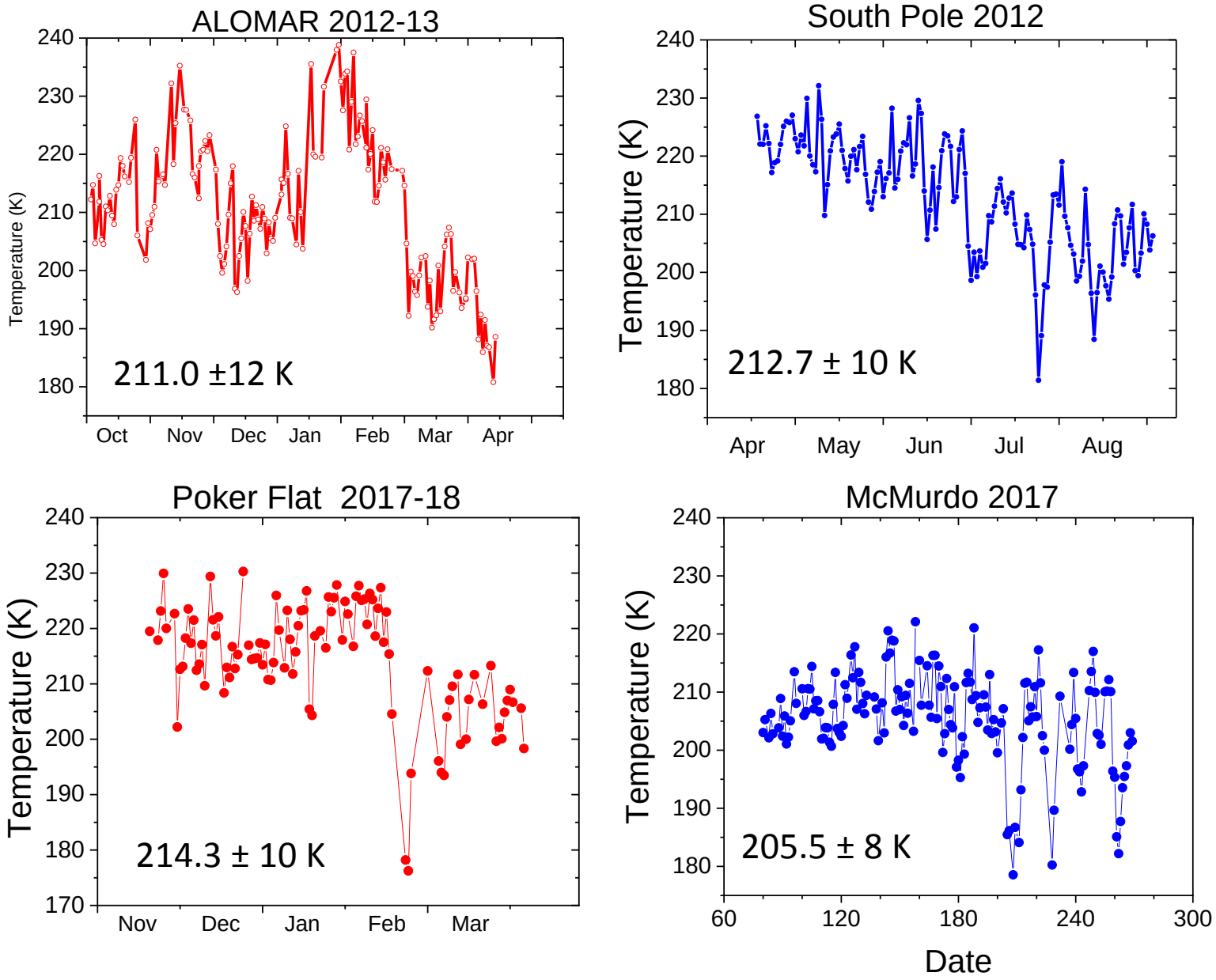
High latitude Sites: South and North



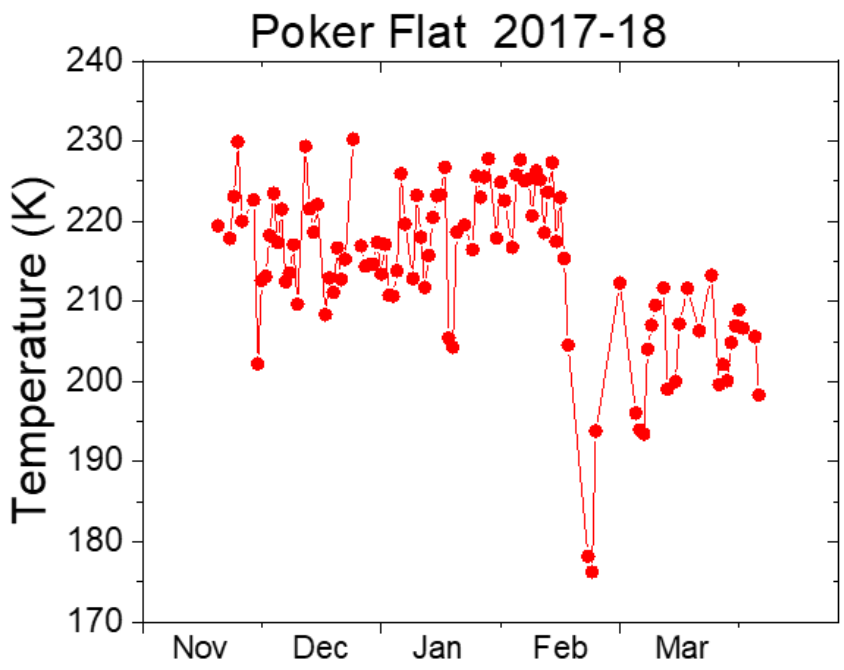
Sites and Data

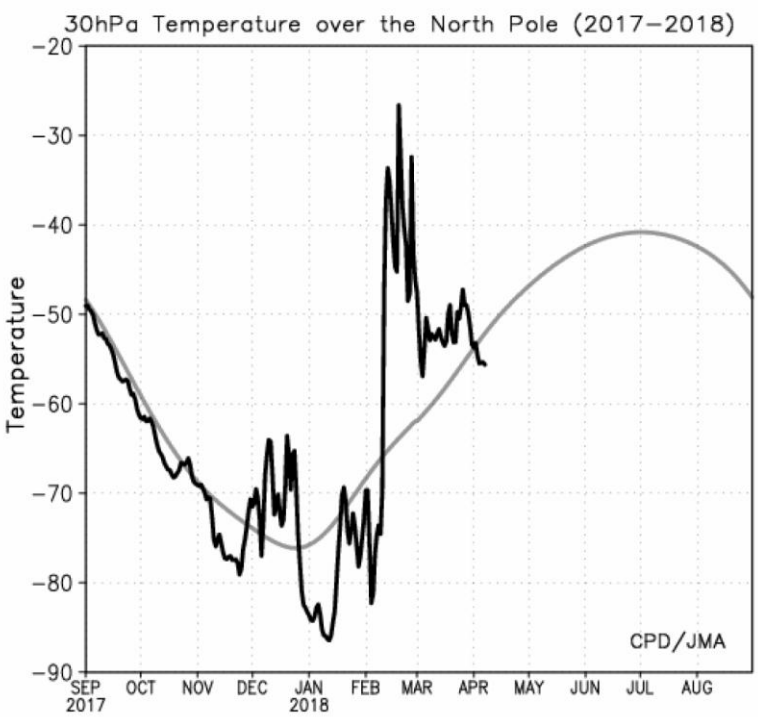
	ALOMAR	South Pole	McMurdo	PFRR
Latitude	69.3° **N**	90° **S**	78° **S**	65° **N**
Season starting date	Oct 1	April 19	March 21	Nov. 1 (2017)
Season ending date	April 15	August 31	September 30	April
Season duration	6.5 Months	4.5 months	>6 months	~6 months
Daily data duration	longest ~16-17 hours	Mostly 24 hours	Some 24 hours	~16 hours

Winter Season Daily Mean Temperatures



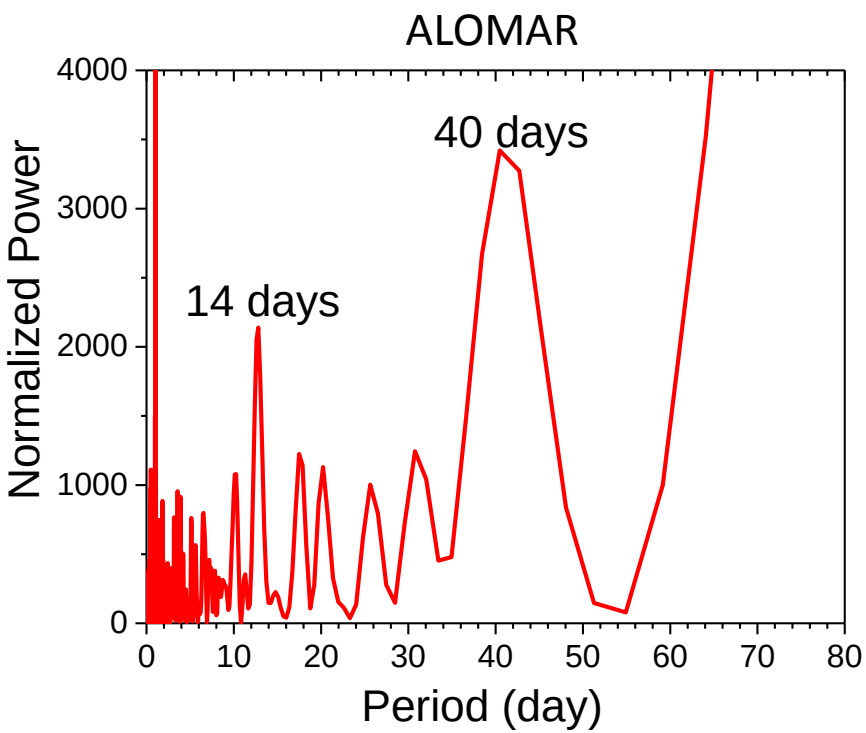
The Major Sudden Stratospheric Warming (SSW): 12 February 2018

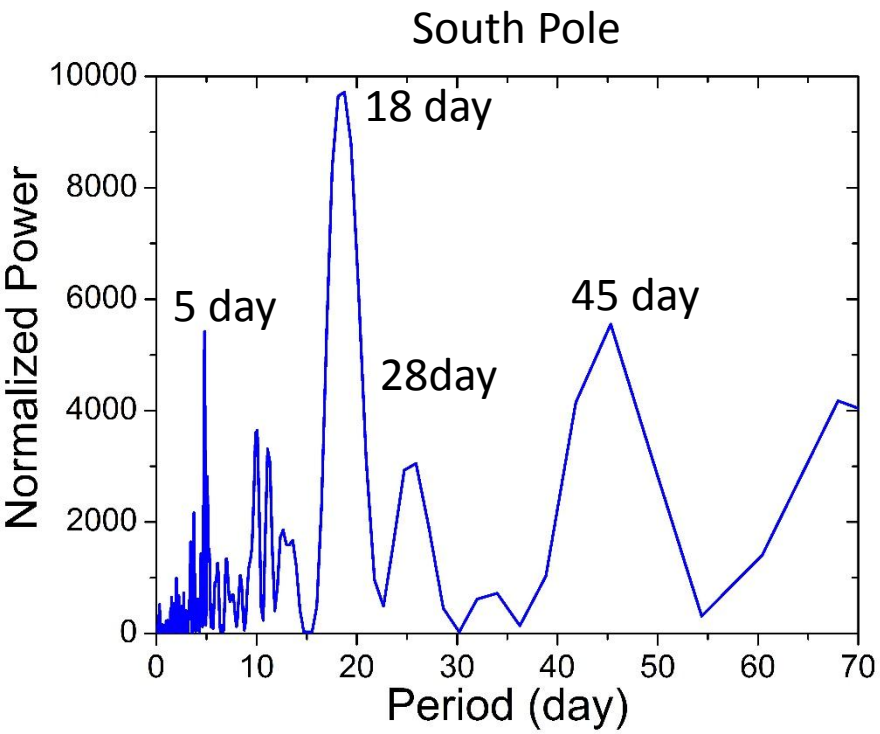




Kaoru Sato: 2nd Information related to ICSOM-3 and request of data

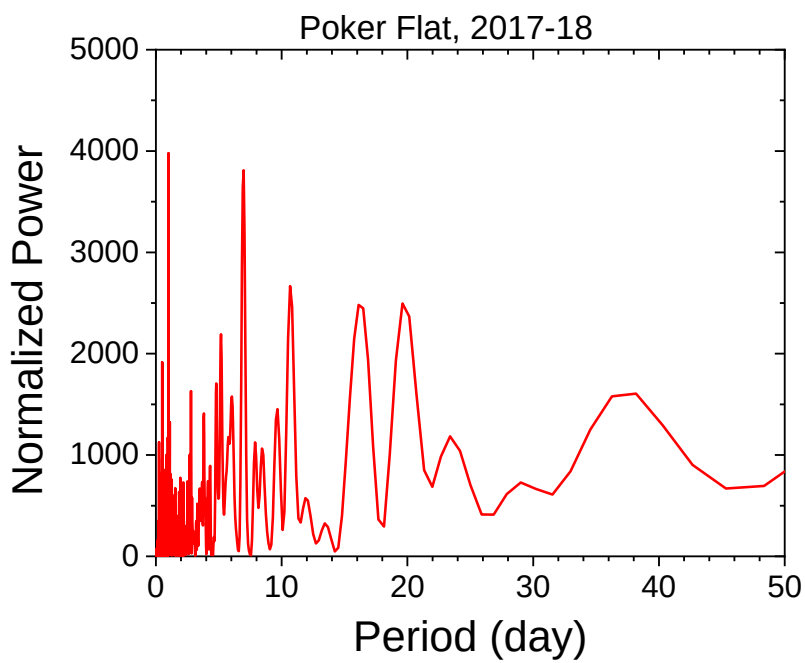
Planetary Wave Activities

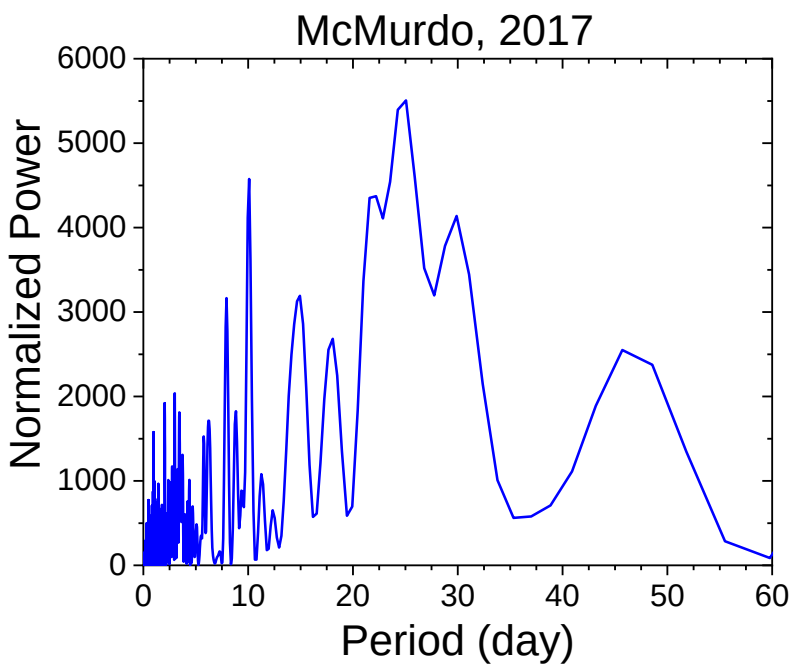




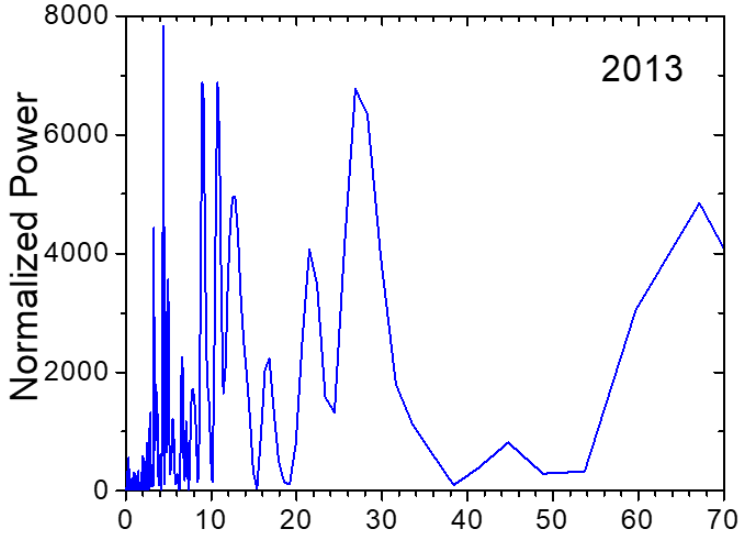
- Rich spectrum from both sites
- Planetary waves with different periods were observed

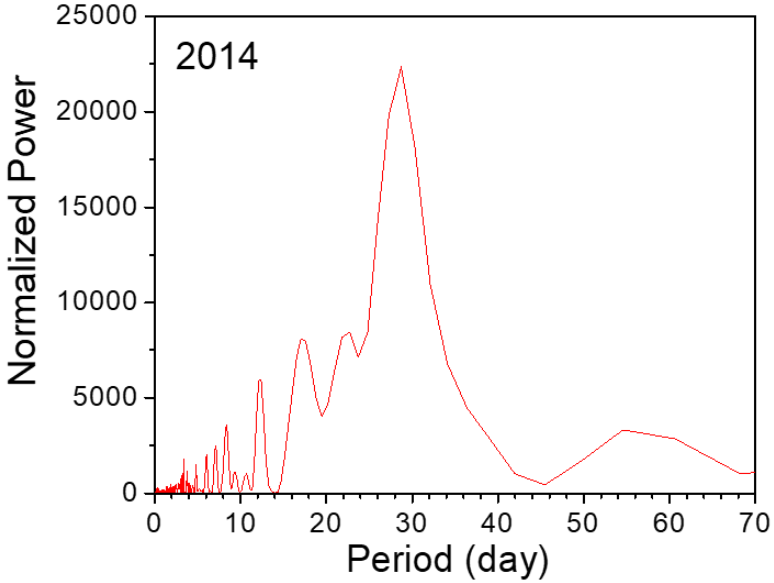
Planetary Wave Activities

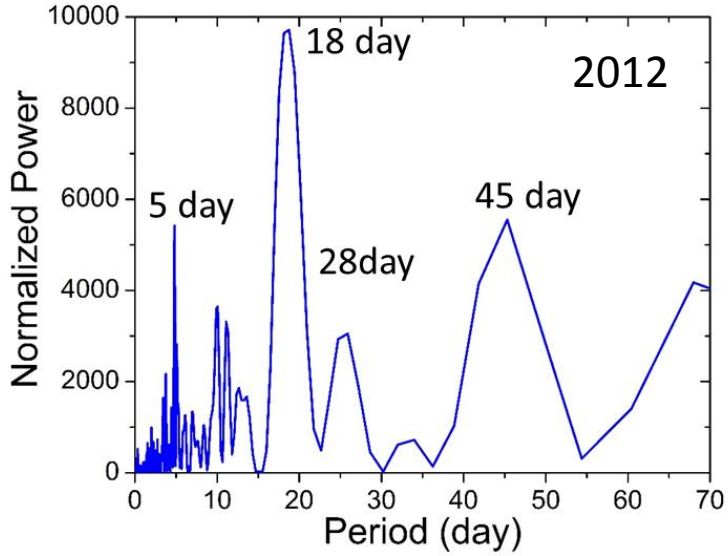


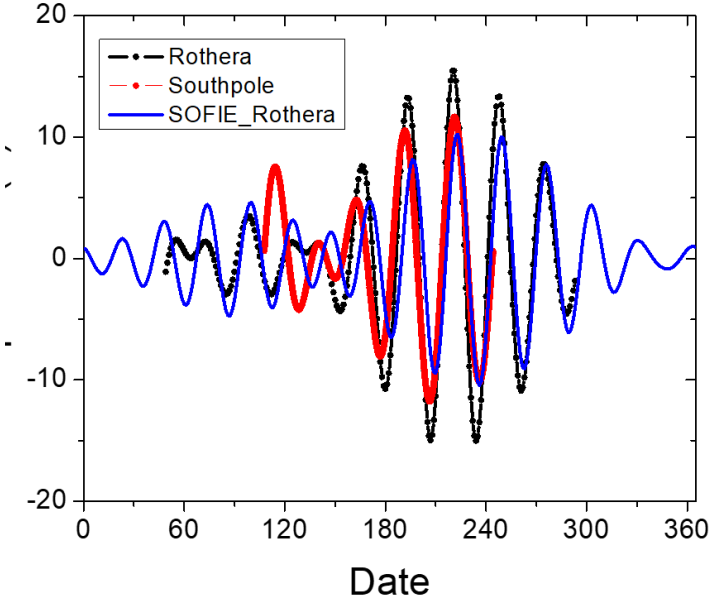


Mesospheric Planetary Waves Observed at South Pole

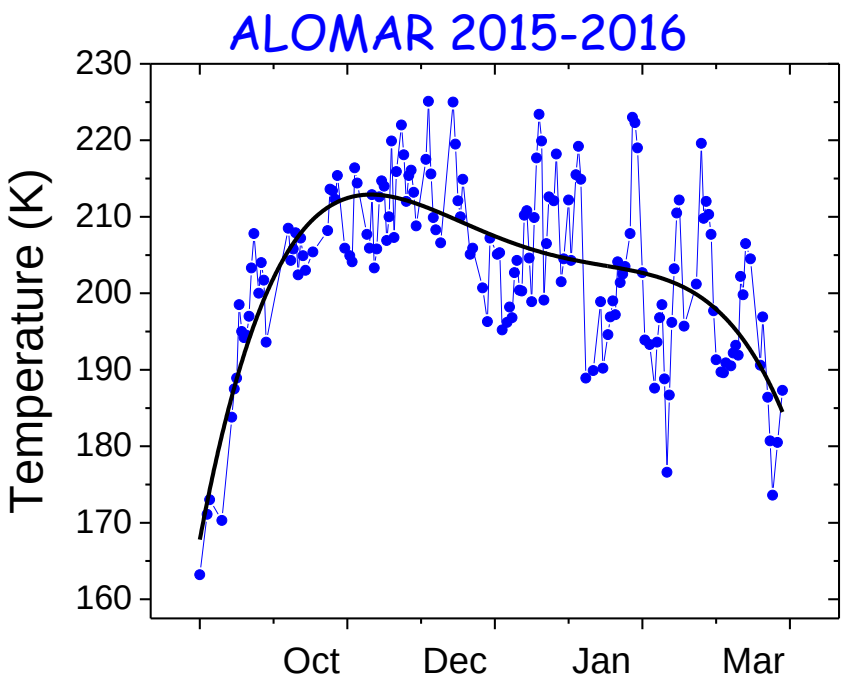


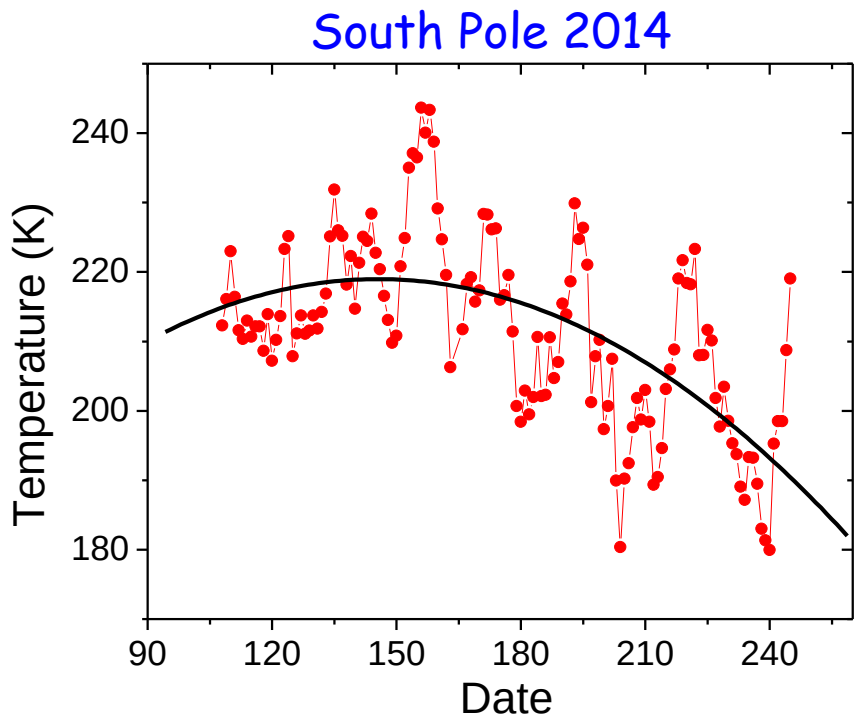






Planetary Wave Activities at ALOMAR (a year later)

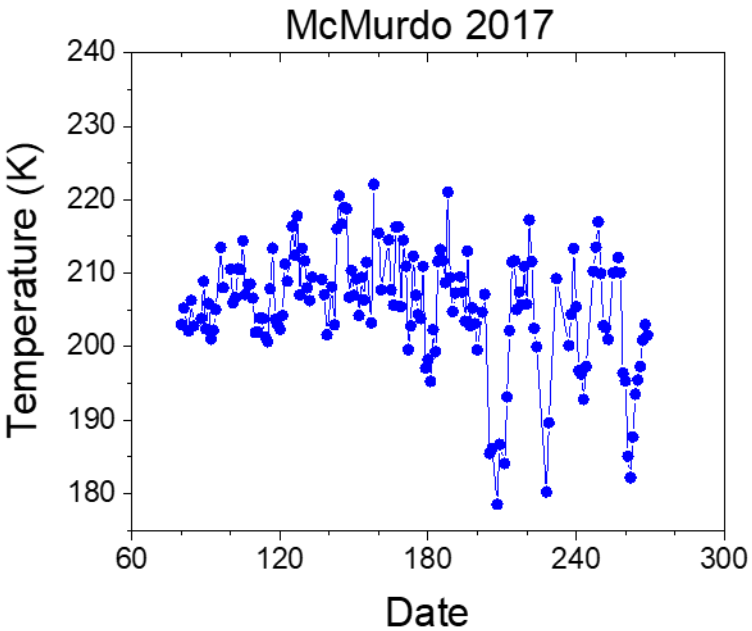


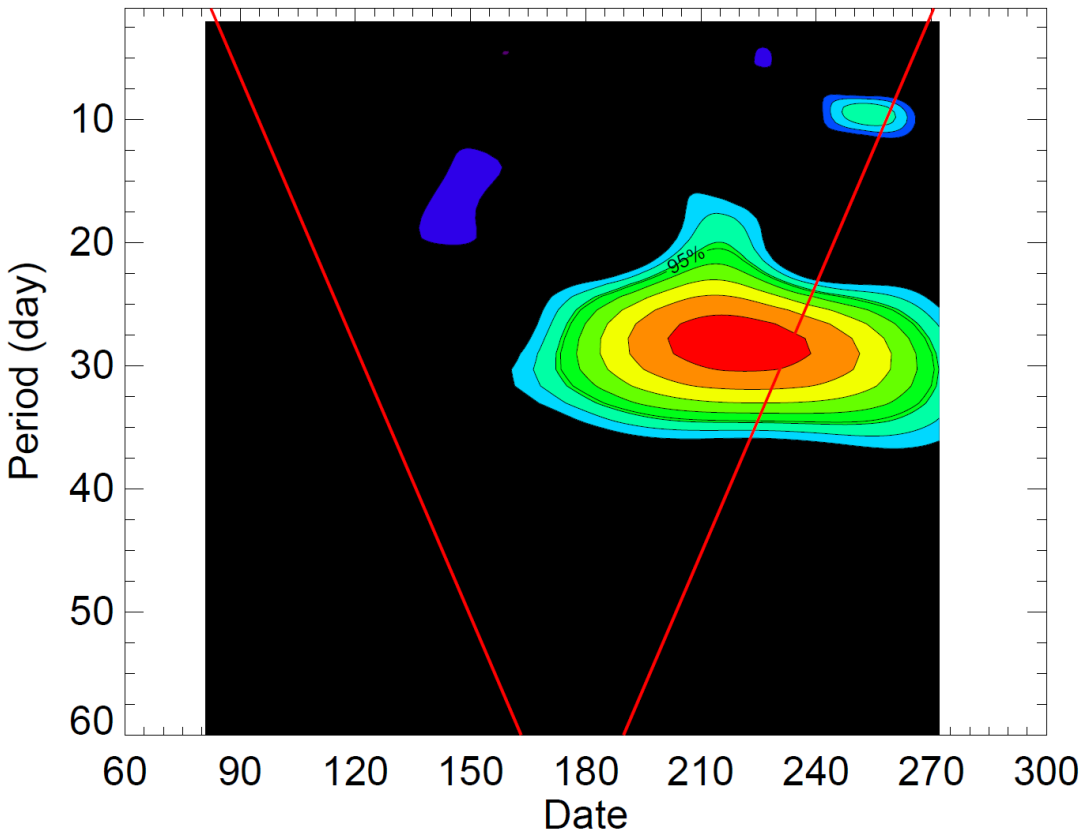


Similar wave was observed during the 2015-16 winter season at ALOMAR. Period~ 23 days

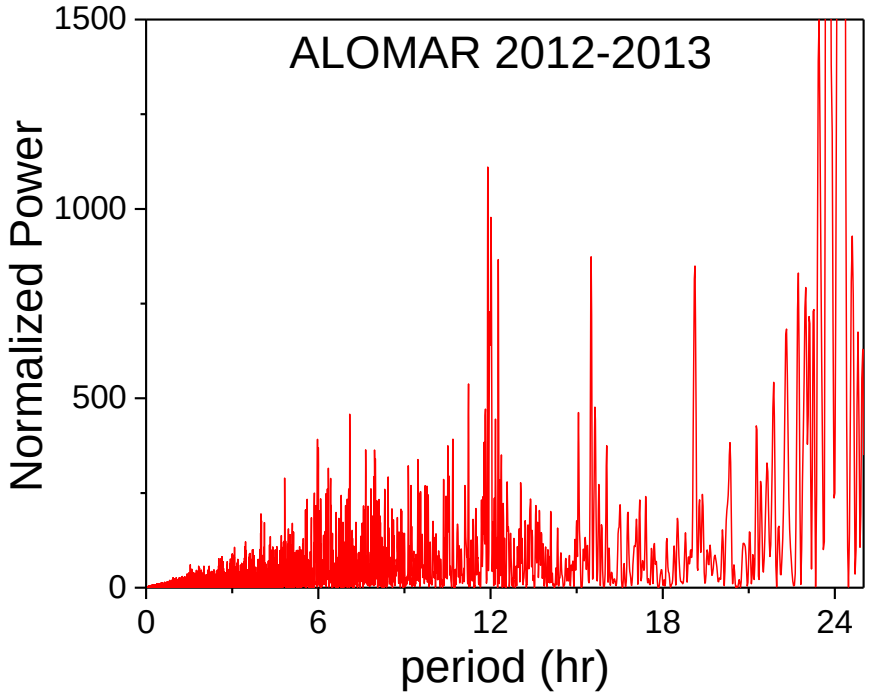
The PW Mike and Dominique Mentioned:

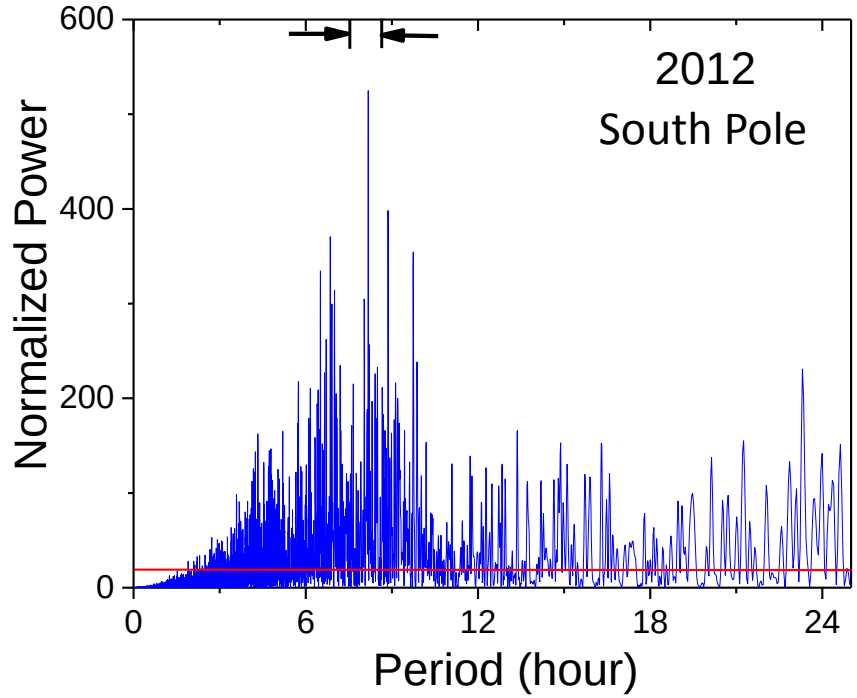
McMurdo 2017: the return of the 28 day Rossby wave?





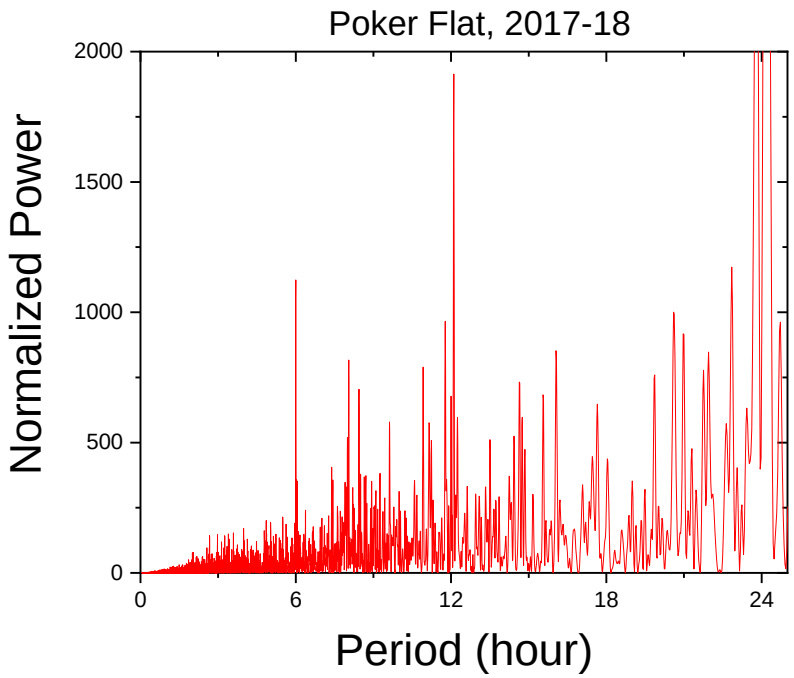
Gravity Wave/Tide Spectrum

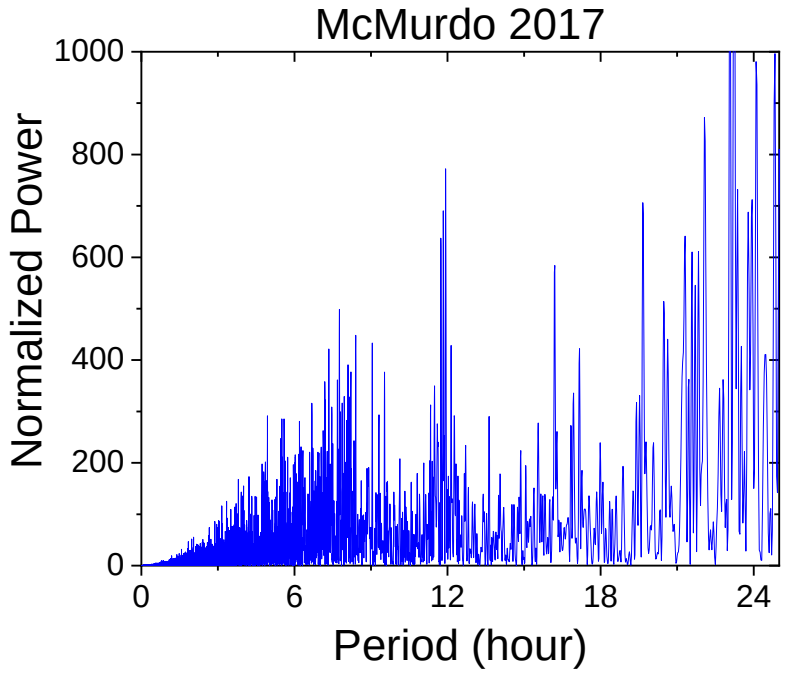




- ALOMAR:
  - Strong semidiurnal tides
  - Gravity waves 3-10 hours
- South pole:
  - No/very weak tides
  - Strong gravity wave activities with periods 4-10 hours

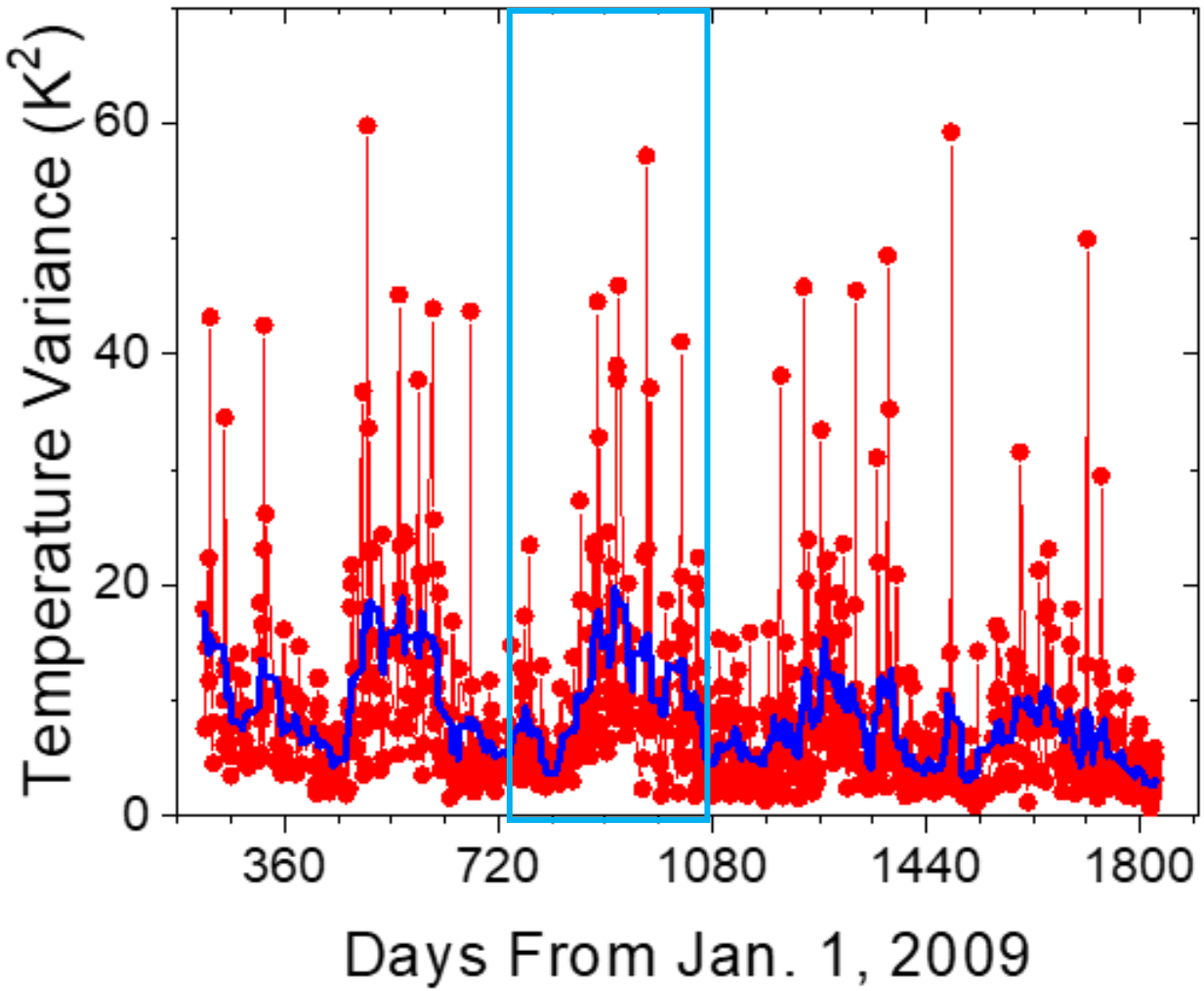
GW/Tidal spectrum at PFRR and McMurdo





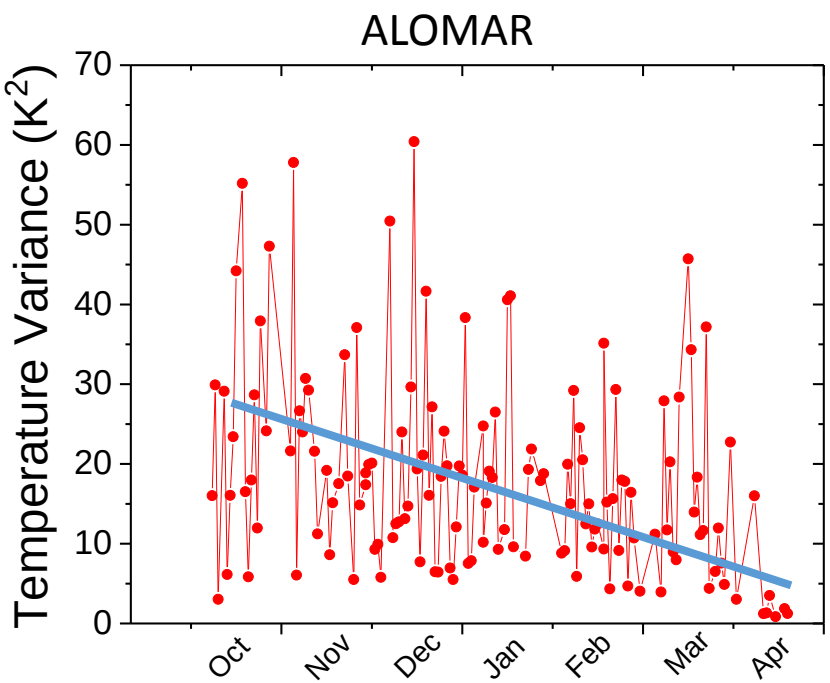
- Similar GW spectrum
- Clear tidal signature at Poker Flat

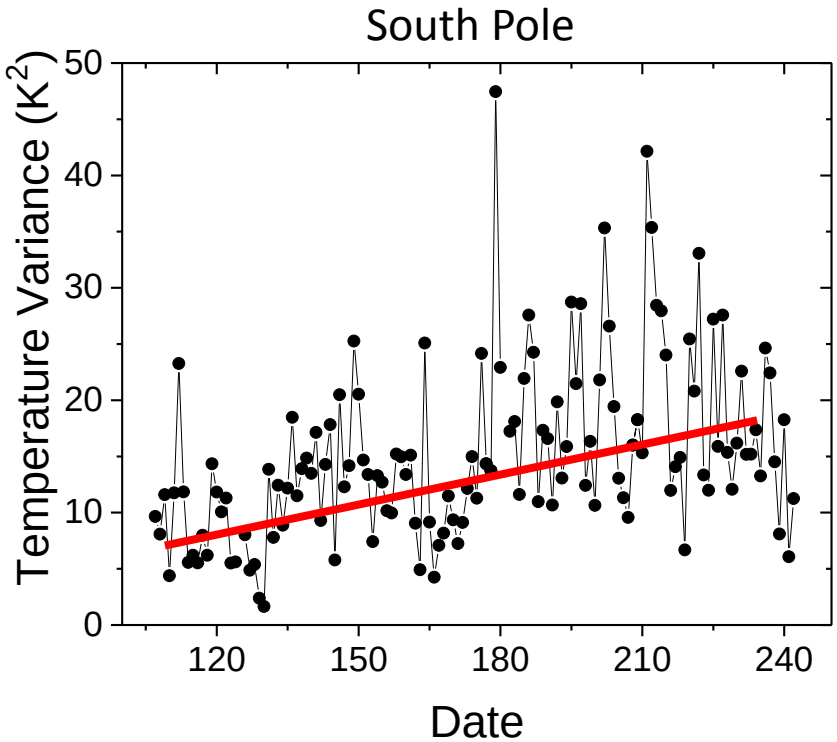
The Mid-Latitude GW Activities (Chile, 30°S)



Gravity wave energy peaked in the middle of each winter season.

Daily Temperature Variance (GW activities)





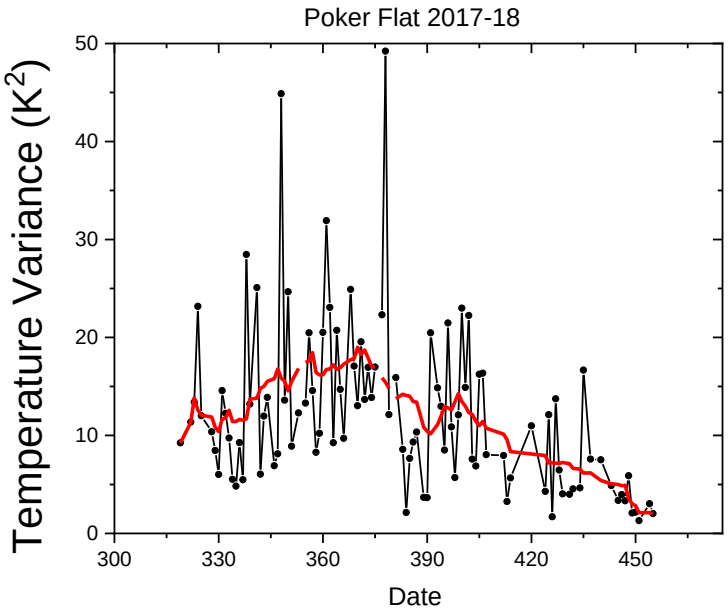
The variance from both sites are of similar values

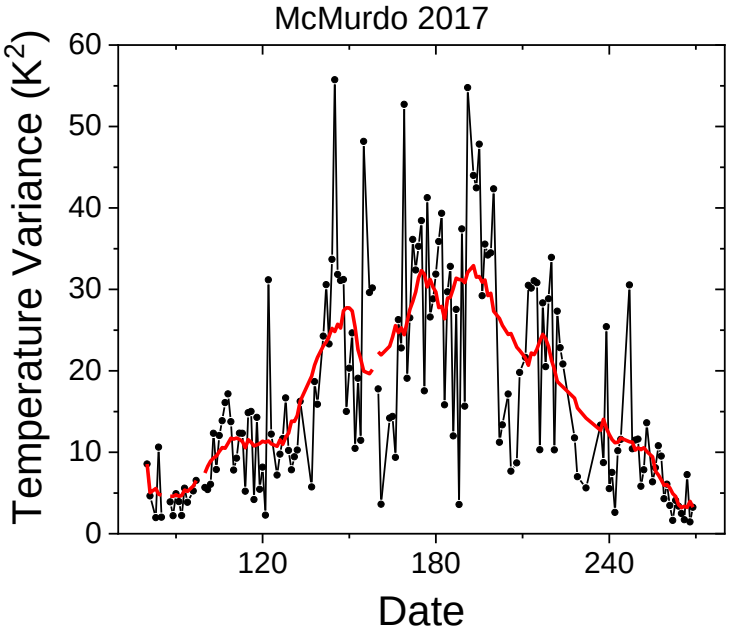
ALOMAR: wave energy decreased

South Pole: wave energy increased

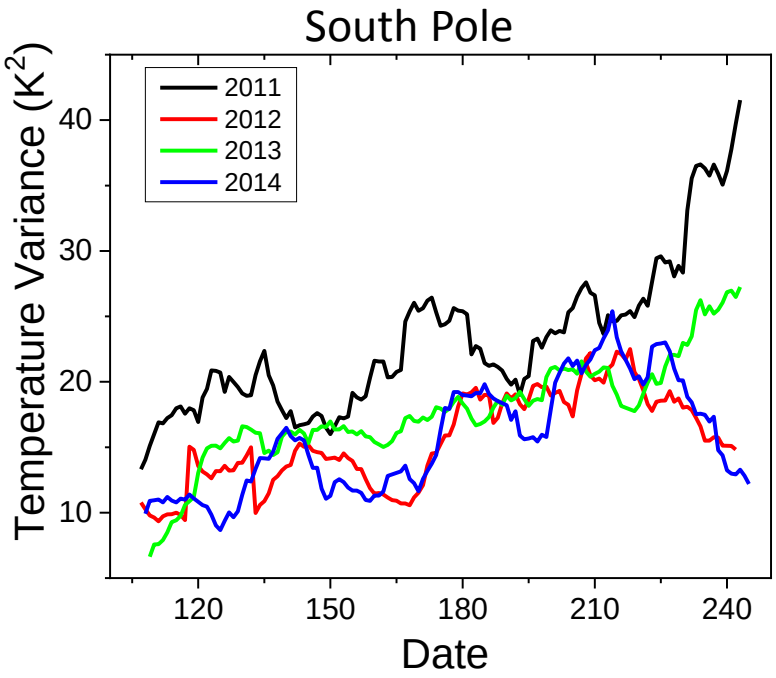
Yoshiki and Sato (2000): gravity wave energy peaked in spring in the stratosphere (SH)

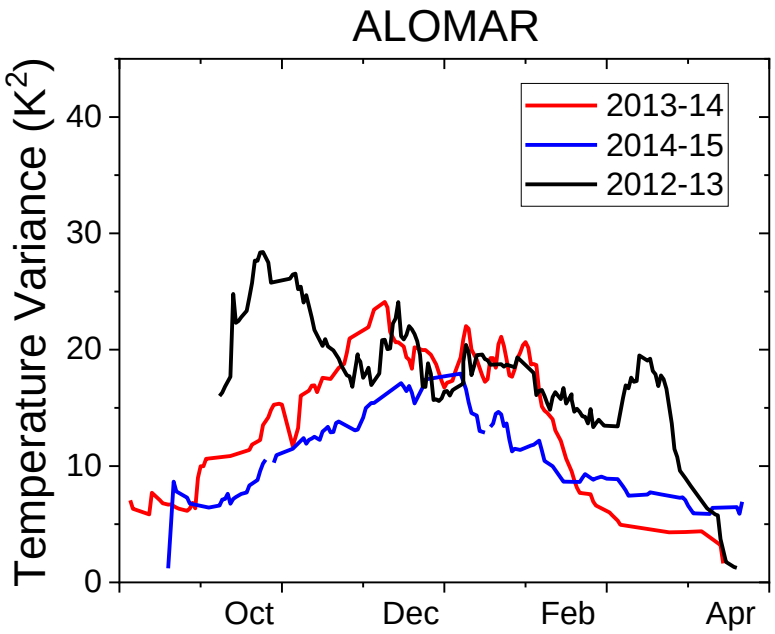
Daily Temperature Variance (GW activities)





Multi-Year:
South Pole vs. ALOMAR





Summary

- Winter time mesospheric temperature data from four unique sites, ALOMAR, PFRR, McMurdo and South Pole stations, showed similarities and differences during winter seasons.
- Similar winter time mean temperature for all stations but clear decrease through the winter for 3 stations other than PFRR which showed SSW signature in Feb.
- Different planetary waves were observed from all sites and year-to-year variability in planetary wave activities for South Pole and ALOMAR.
- Short-period gravity wave spectrum are similar. However, strong semi-diurnal tides were observed at 3 high latitude stations, while no/weak tidal signatures at South Pole during winter season.
- During the winter season, gravity wave energy increased at South Pole.
- The other three high latitude stations, wave energy peaked in the middle of the winter season except for 2012-13 season at ALOMAR where the wave energy decreased through the winter.
- **Questions:**

  What contribute to the change of the GW energy variation during the winter season? Lower atmospheric sources, filtering conditions?