

# Planetary waves observed in the MLT region with a meteor radar at Ferraz station, Antarctica

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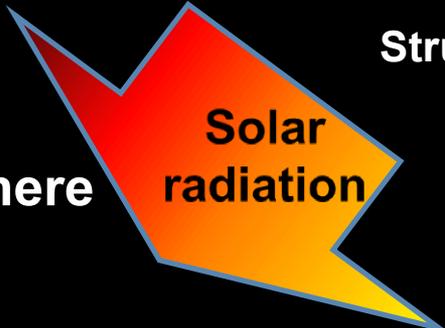
# Structure and dynamics of the Earth's atmosphere

**Magnetosphere**



**Sun and geomagnetic processes**

**Solar radiation**



radiative,  
dynamical,  
thermal,  
chemical,  
and electrodynamical

processes

**IONOSPHERE**



Atmospheric Tides  
Planetary Waves  
Gravity Waves

110 km

**MLT region**

**Mesosphere-Lower Thermosphere**

**Middle**

60 km



**Low**

**Atmosphere**

10 km

**Meteorology**

The dynamics of the MLT region are dominated by large-scale waves and tides that propagate up from below.

As they propagate up through the atmosphere they interact with mean winds and other wave modes, dissipating their energy and momentum, which contributes to the wind and temperature field variability.

The purpose of this work is to examine the planetary wave activity in the upper mesosphere and lower thermosphere - MLT region, from wind data by meteor radar at Ferraz station, Antarctica.

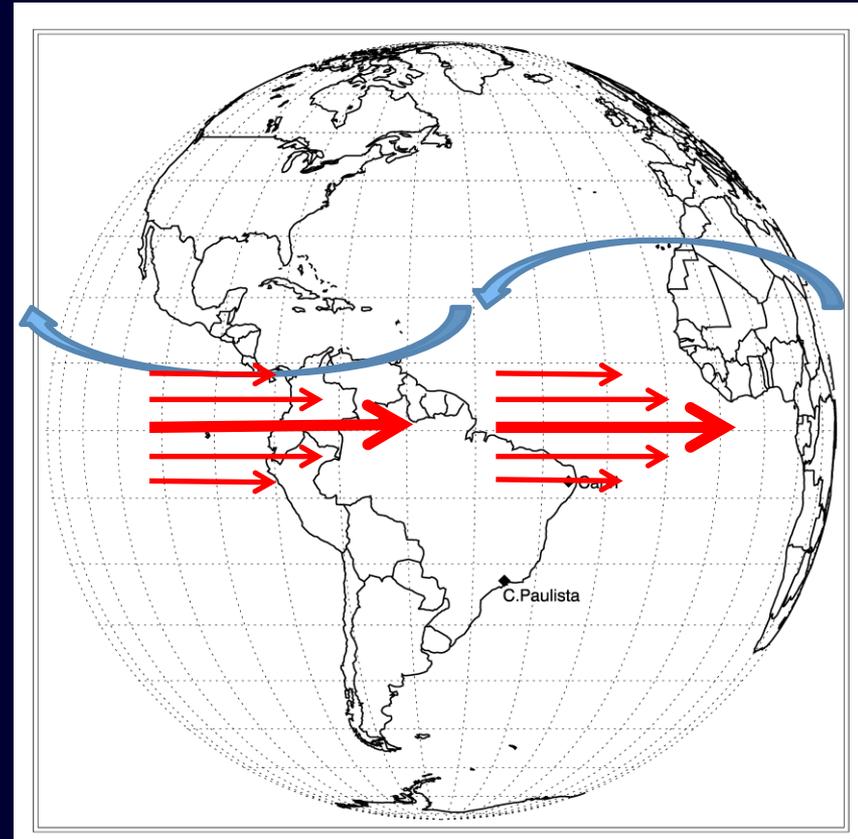
# Planetary Waves

Planetary waves are propagating large scale disturbances with low zonal wavenumbers.

- Typically planetary waves assume periods of  $\sim 2, 4, 5, 10,$  and  $16$  days in the MLT region
- Oscillations with a period of  $\sim 6.5$  days are also observed

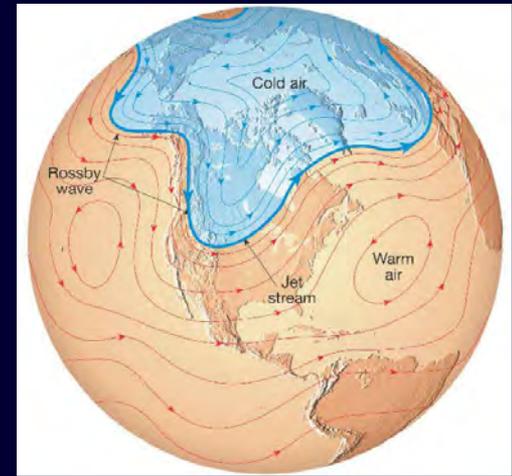
In the equatorial region, due the small Coriolis effect, atmospheric waves acquire a different character, allowing the propagation of some distinct wave modes like

- Kelvin wave  $\Rightarrow$  eastward
- Mixed Rossby-gravity wave  $\Rightarrow$  westward



# Planetary Waves

Quasi-stationary Rossby waves are the dominant disturbances in the extratropical winter stratosphere and lower mesosphere



Stationary Rossby waves with low zonal wavenumbers (typically wavenumbers 1–3) can propagate vertically where the background zonally averaged zonal wind is westerly.

Conservation of angular momentum is the restoring force that governs the wave dynamics.

Traveling planetary-scale waves can achieve high amplitude in the MLT.

The periods of traveling waves cluster around periods associated with atmospheric normal modes.

# Data used in this study

In this work were used equatorial measurements of the meteor winds, which has been recorded from February 2011 to mid-February 2012.



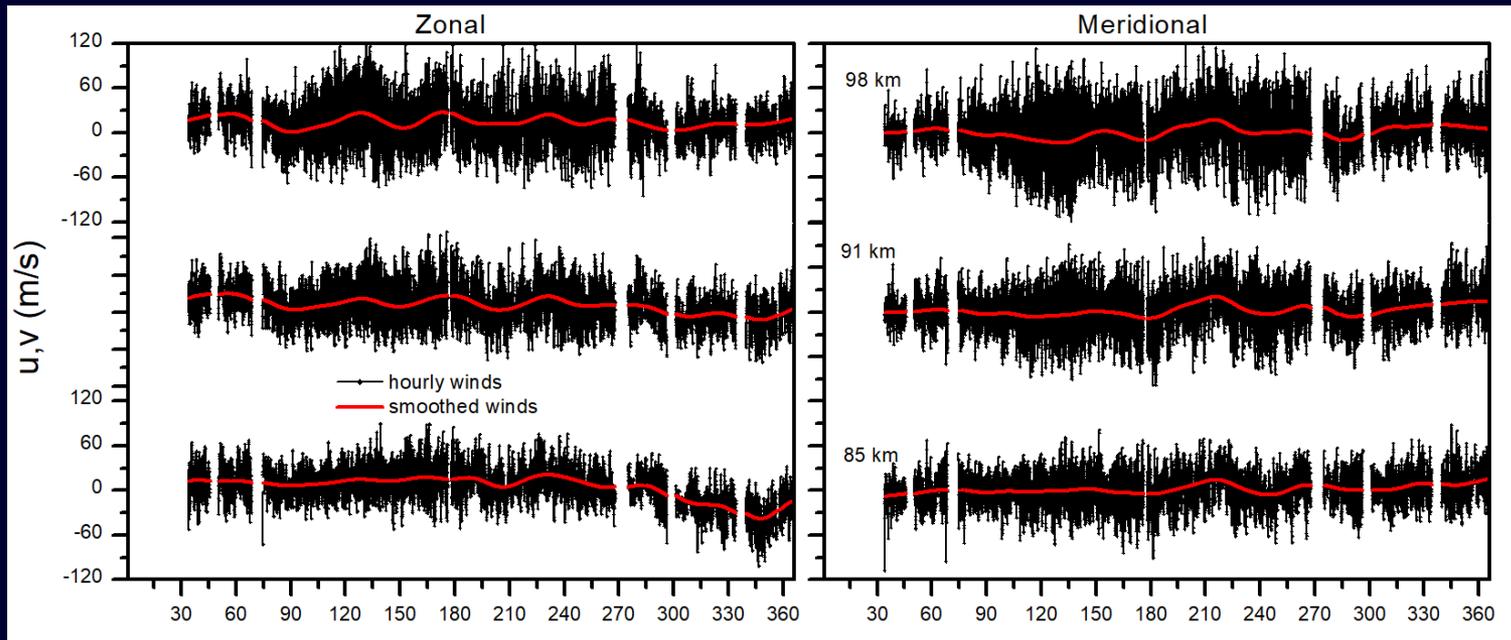
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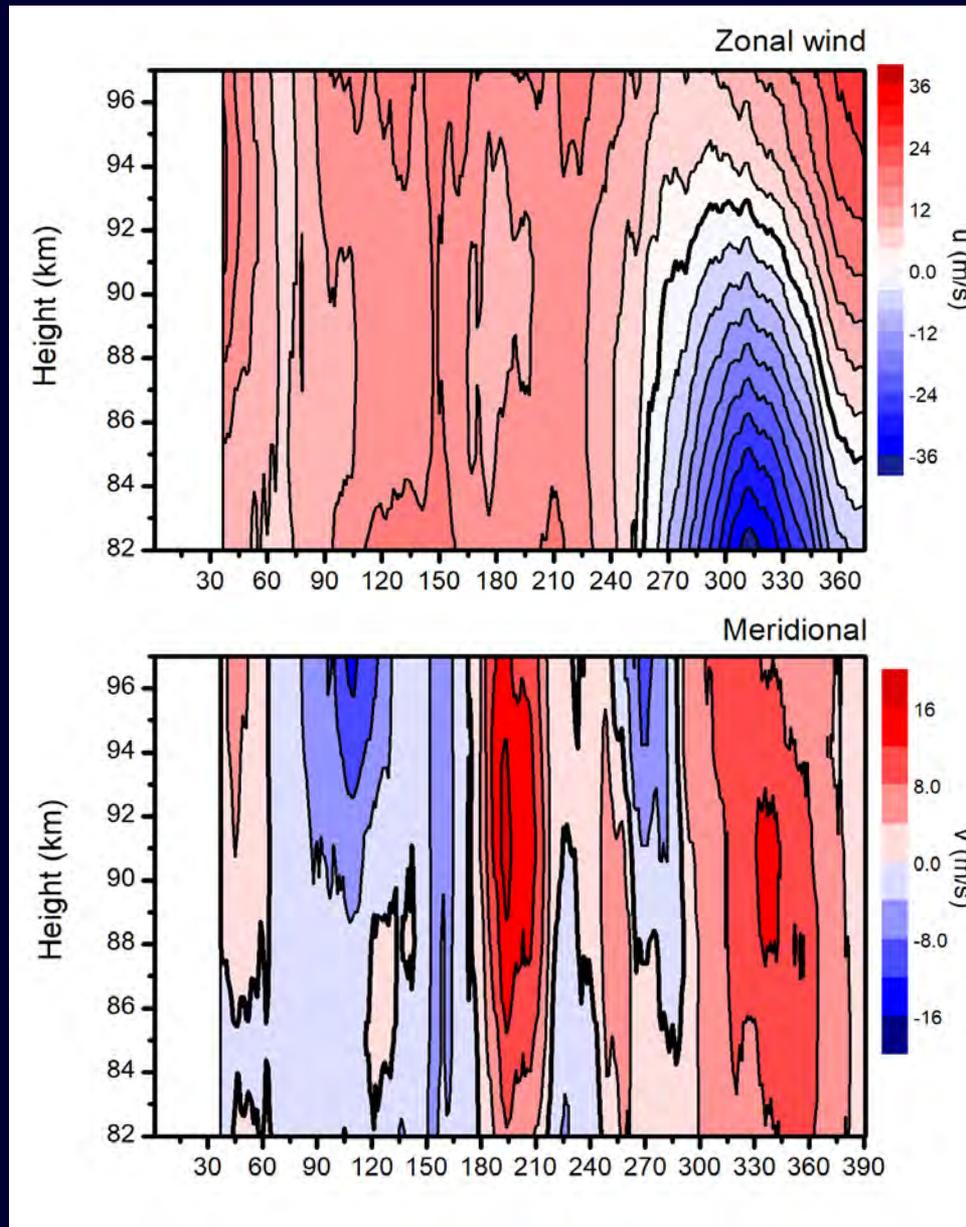
The winds were collected from a from meteor radar at Ferraz station ( $62.1^{\circ}\text{S}$ ,  $58.4^{\circ}\text{W}$ ), Antarctica.

# Data Series

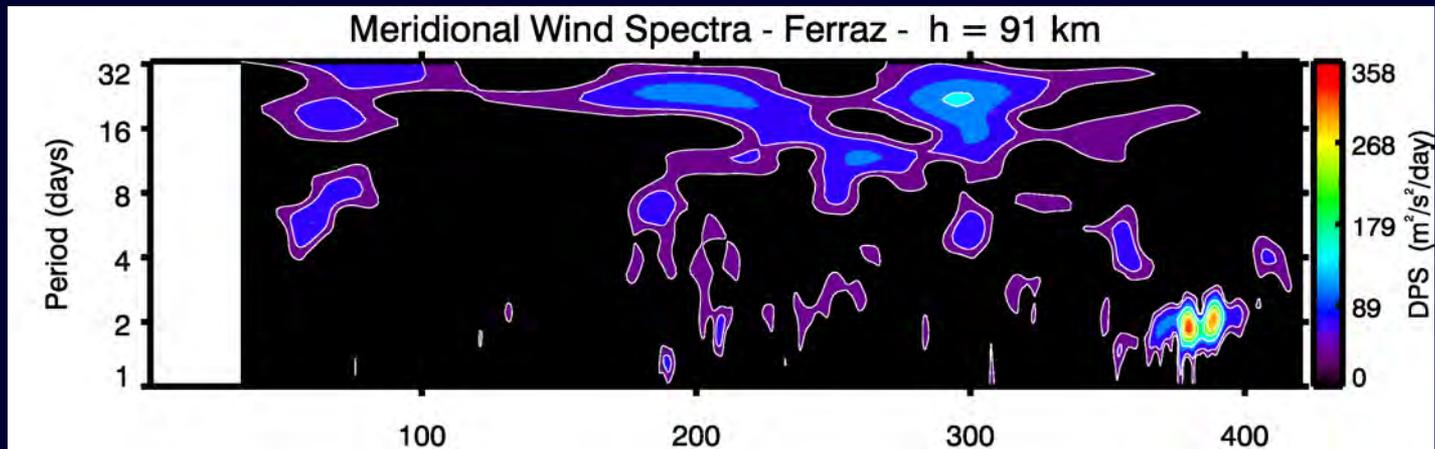
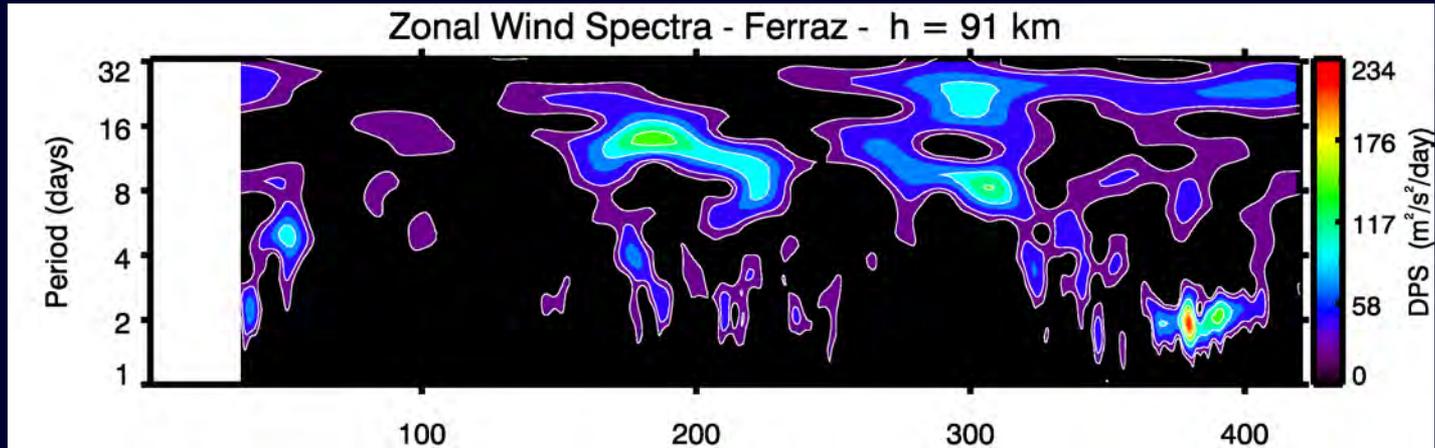
Hourly zonal and meridional winds



# Mean winds

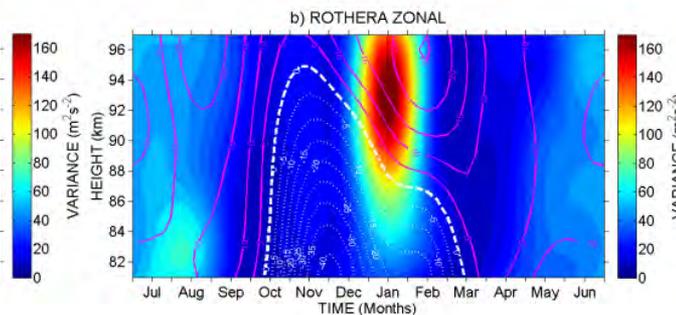
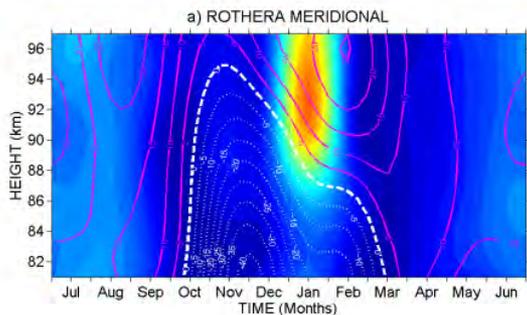
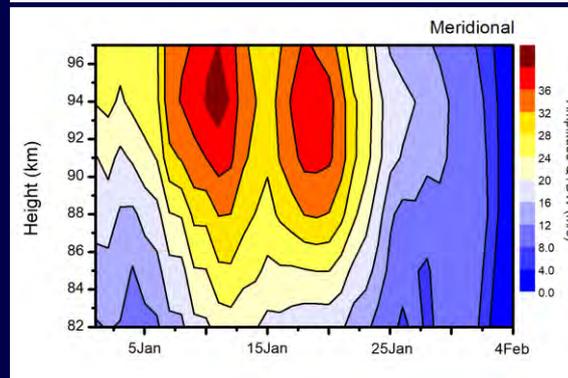
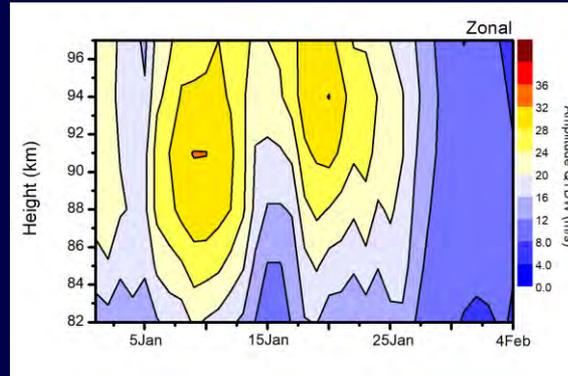
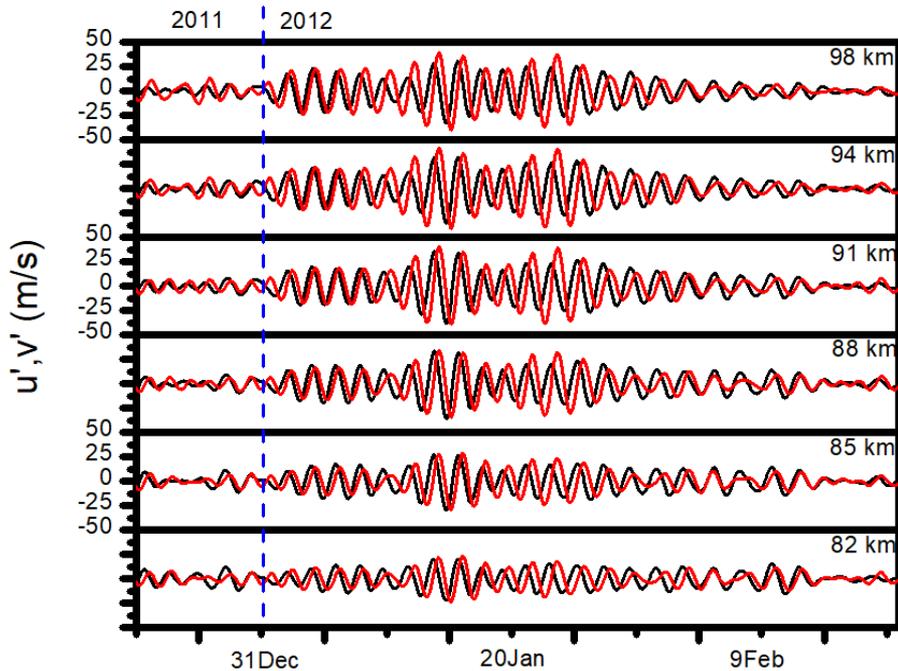


# Wind Spectra



# Quasi-two-day wave (summer 2011/2012)

The quasi-two-day wave is a prominent feature of the MLT region, which maximize soon after the summer solstice.

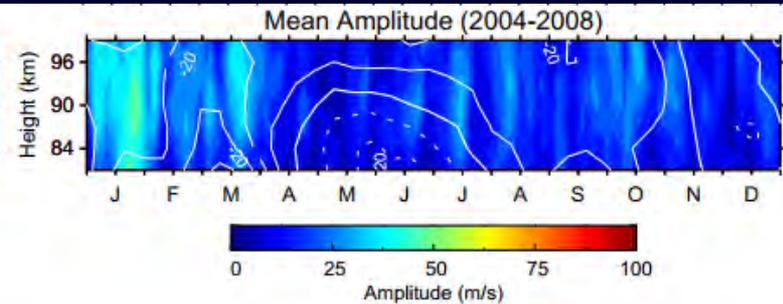
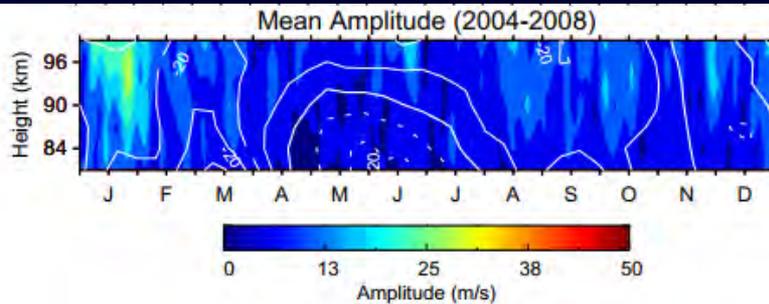
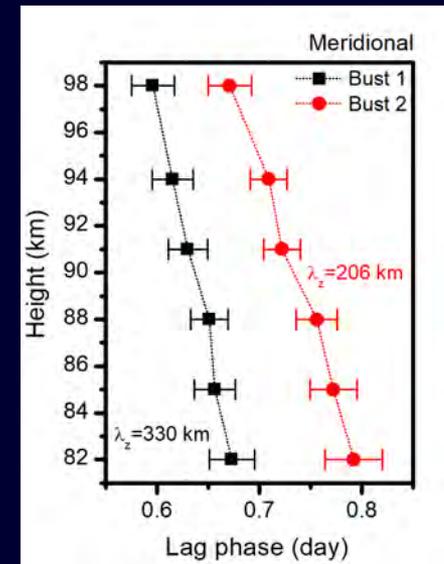


April 2005 to December 2008

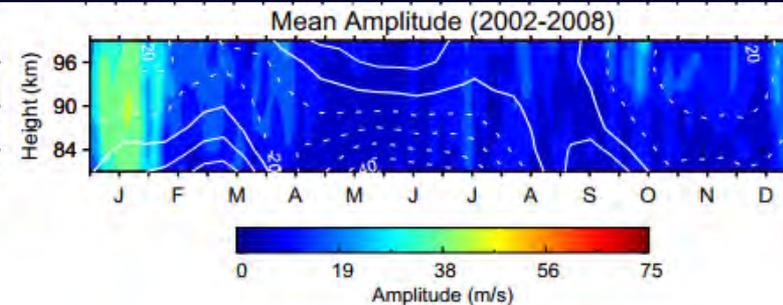
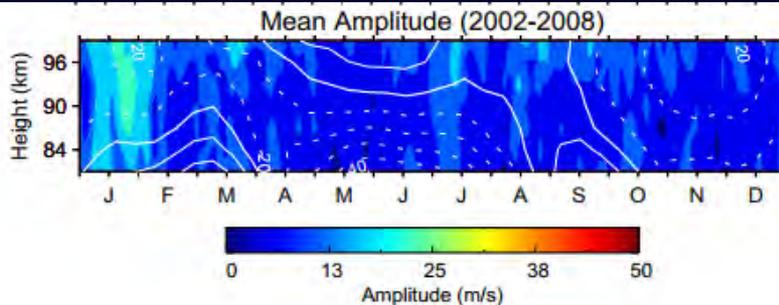
Tunbridge and Mitchell, 2009

# Vertical wavelenght

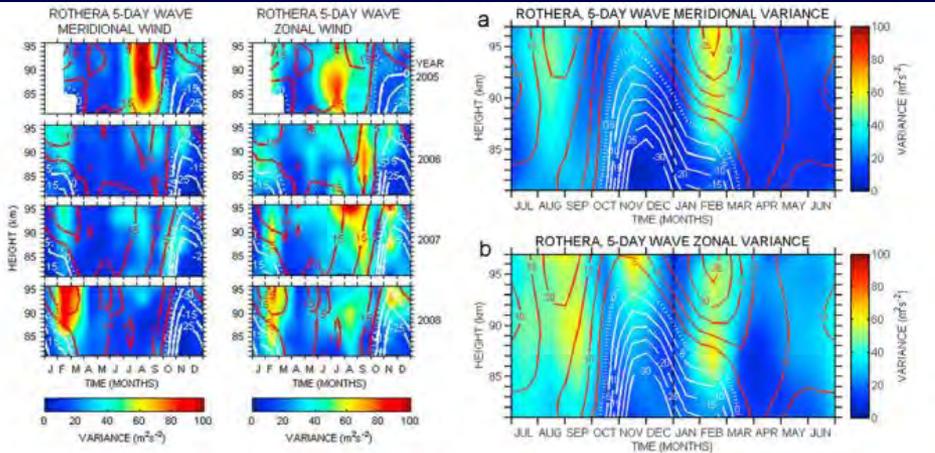
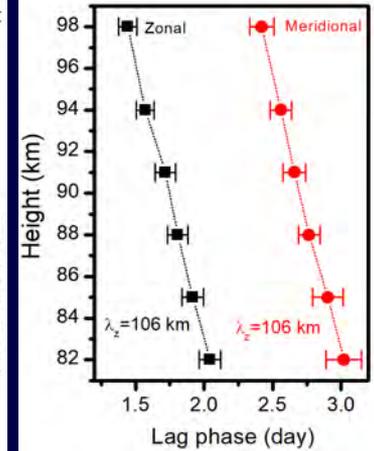
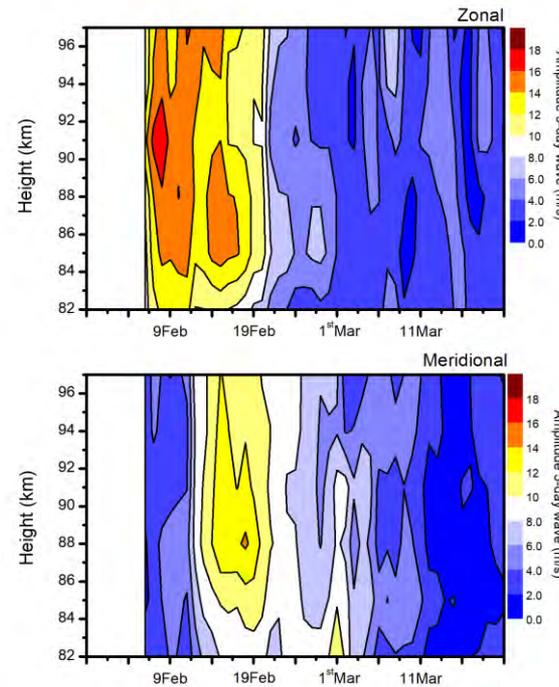
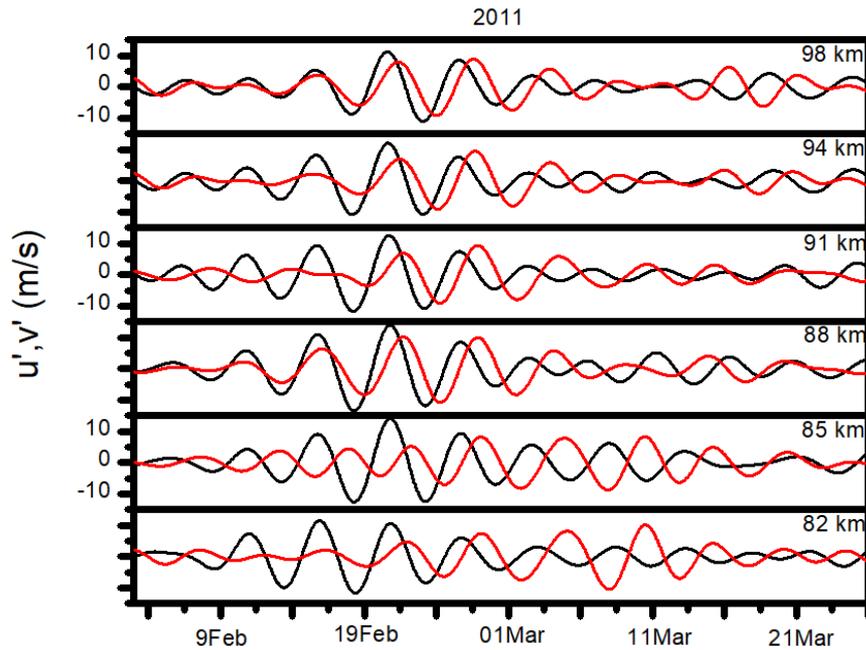
São João do Cariri  $\lambda_z = 40$  km



Cachoeira Paulista  $\lambda_z = 65$  km



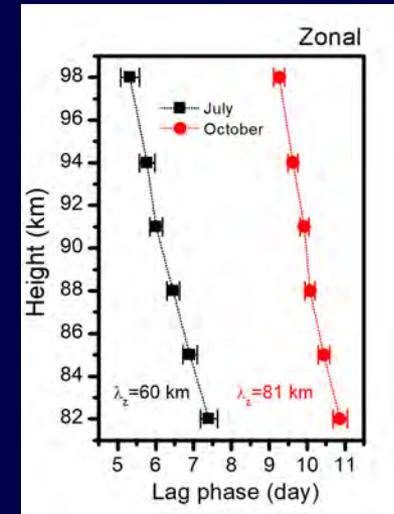
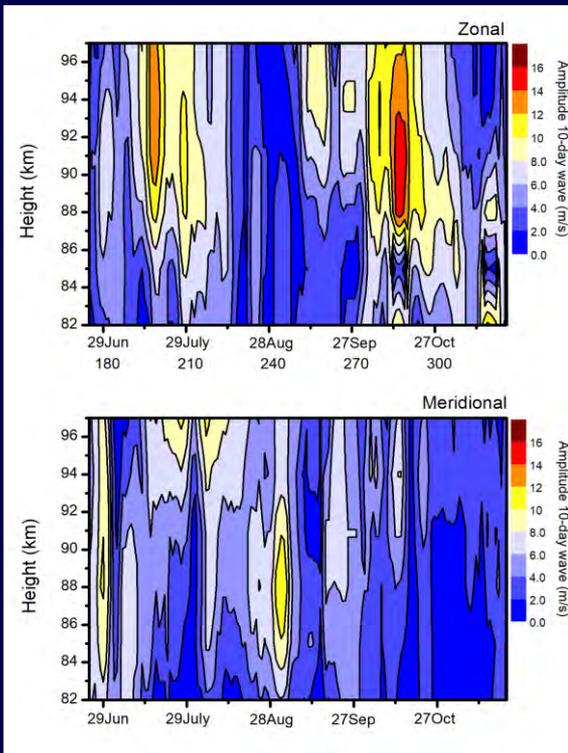
# 5 day wave (summer 2011)



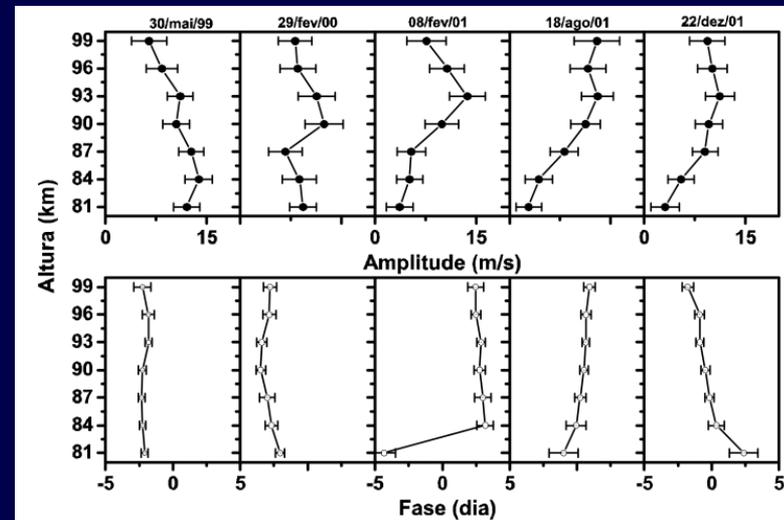
April 2005 to December 2008

Day and Mitchell, 2010

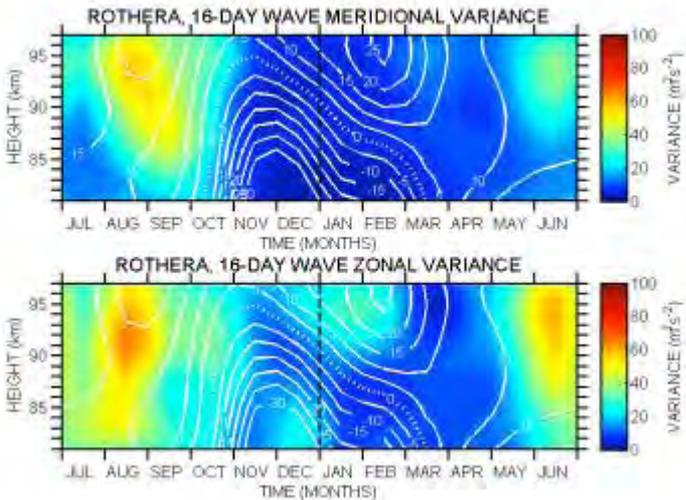
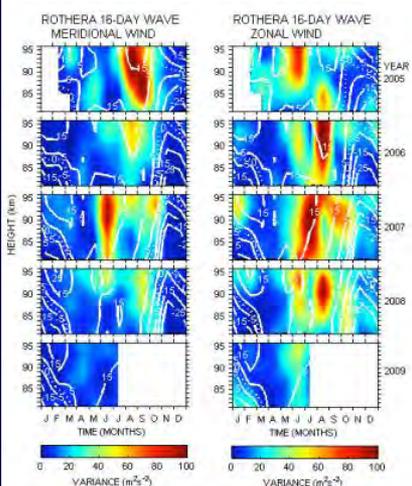
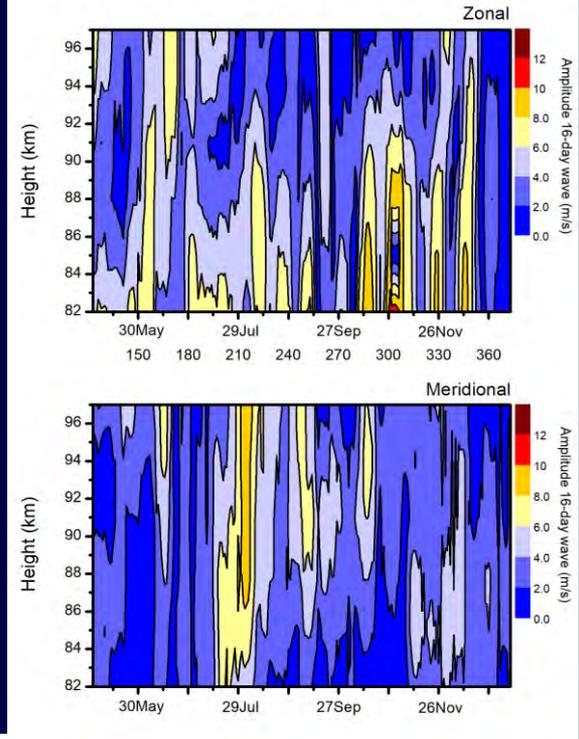
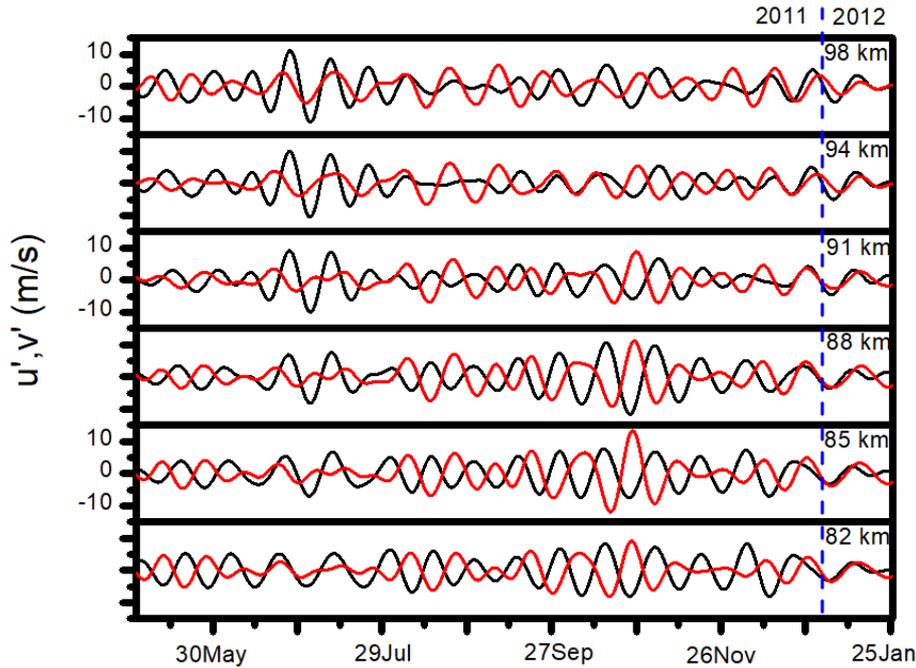
# 10 day wave (winter and spring)



Cachoeira Paulista  $\lambda_z \sim 50 \text{ to } 104 \text{ km}$



# 16 day wave (summer 2011)

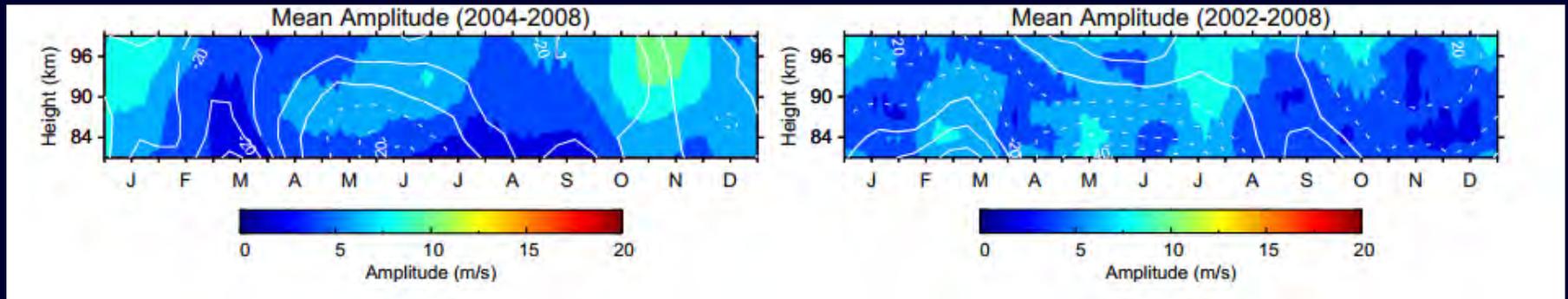
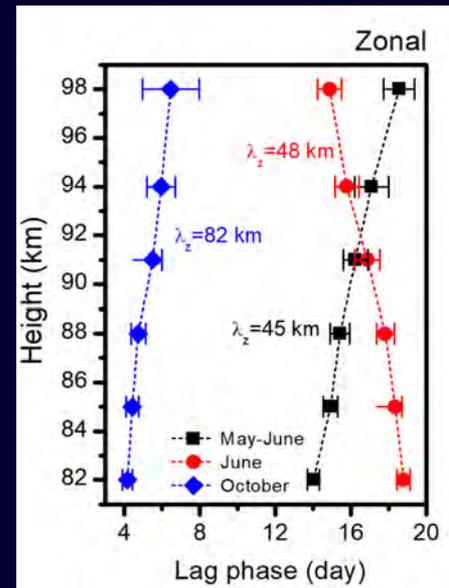


Day and Mitchell, 2010

# Vertical wavelenght

## São João do Cariri

- $\lambda_z \sim 55$  km (April–June),
- $\lambda_z \sim 80$  km (August–September)
- $\lambda_z \sim 50$  km (October–December)



# Summary

Wind measurements from meteor radar at Ferraz station, Antarctica obtained from February 2011 to mid-February 2012, have been used to examine the planetary wave activity in the upper mesosphere and lower thermosphere MLT region.

The presence of planetary wave oscillations with periods around 2 and 5 days have been observed during summer.

From late autumn to late spring we have observed presence of waves with periods of around 10 and 16 days.

**Thank you for your attention!**