Wave study using high-resolution models in Antarctica

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Objective of this talk

- To show how high-resolution models resolve gravity waves and how they compare to observations, other high-resolution models, and parameterized gravity waves.

Outline

- High-resolution model comparisons (WRF, ECMWF, and GFS)
- High-resolution model resolved GWs vs. Parameterized GWs.
- Comparisons of simulated GWs and observed GWs (lidar and SABER)
- Wave spectrum analysis
- Summary

ECMWF-T1279

European Centre for Medium-Range Weather Forecasts (ECMWF) – T1279 has horizontal resolutions of 0.15 degree with 91 vertical levels from November 2012 to March 2014. (3-hourly, vertical resolution is ~1 km and higher in the lower atmosphere.

WRF

The Weather Research and Forecasting (WRF) Model has horizontal resolutions of 0.37 degree. Data are only available from 160°W to 10°E and 45°N to 10°S in 2005.

GFS

The Global Forecast System (GFS) is a weather forecast model produced by the National Centers for Environmental Prediction (NCEP). Horizontal resolutions is 0.25 degree. Data are only available from Feb 2015 to 2016.

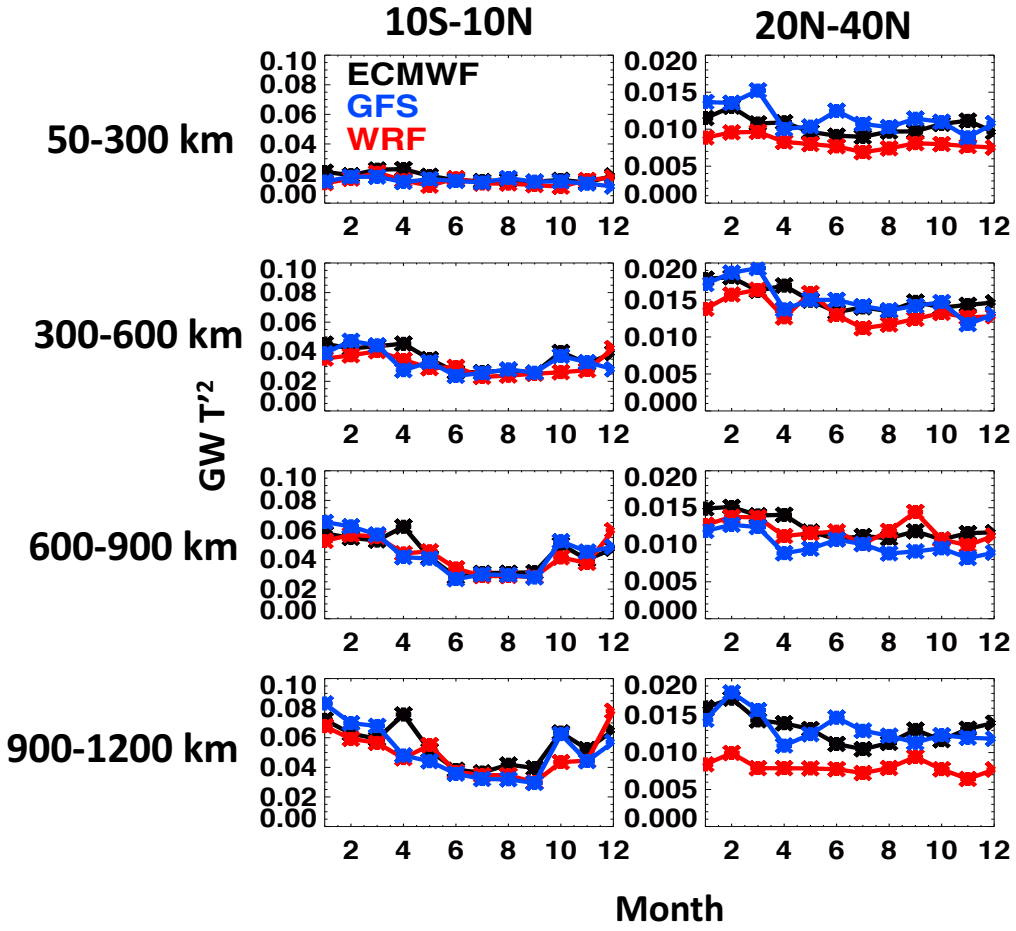
WACCM

The Whole Atmosphere Community Climate Model (WACCM) uses a lindzen-type GW parametrization scheme with physically based GW source (orographic, convection, and frontal system).

Analysis Method (Model Data)

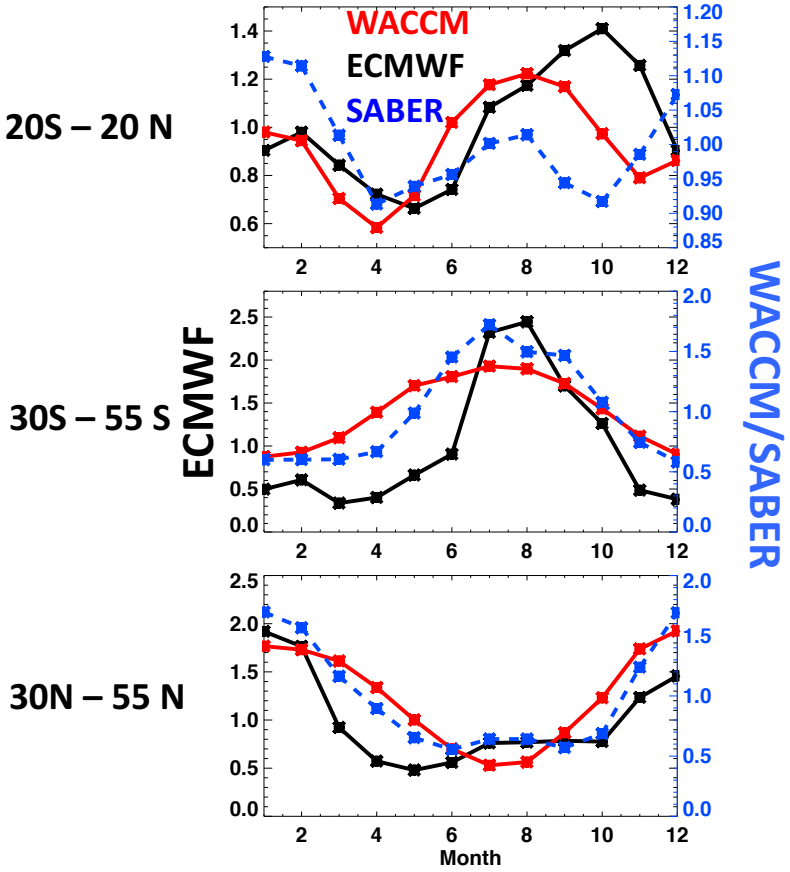
- Method 1: Gravity wave (T’) is extracted using wavelet analysis. Waves are separated in 50-300 km, 300-600 km, 600-900 km, and 900-1200 km zonal wavelength.

Gravity Wave Monthly Mean Comparison
ECMWF, GFS, and WRF

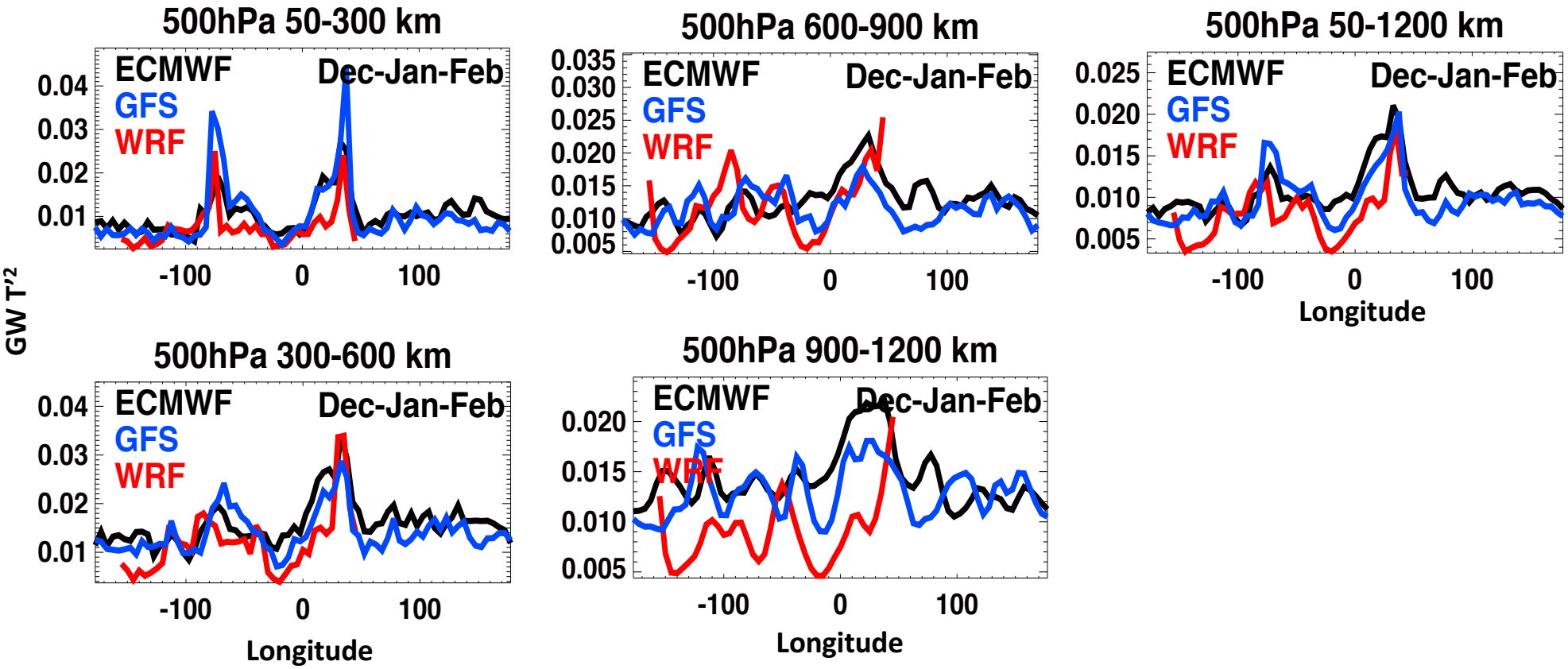


GW temperature variance at 500 hPa from WRF (red), GFS (blue), and ECMWF (black) averaged over 160°W-45°E.

Comparison between WACCM, ECMWF, and SABER



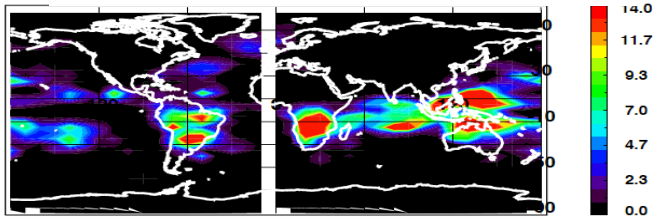
Climatology of gravity waves from ECMWF, WACCM, and SABER @ 10 hPa



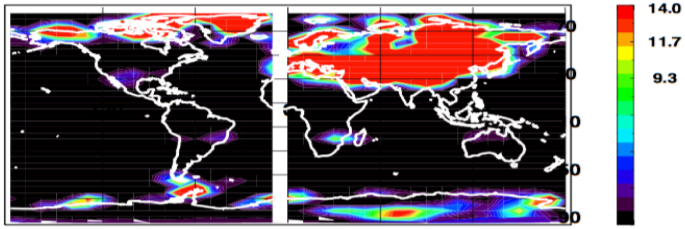
Longitudinal variations of GWs at 500 hPa obtained from WRF (red), GFS (blue), and ECMWF (black) averaged over 15°S-15°N.

Comparison between WACCM, ECMWF, and SABER (January)

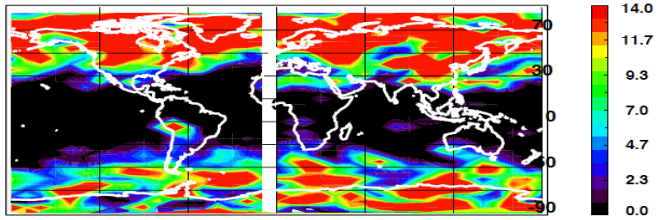
WACCM Convection @ 10 hPa



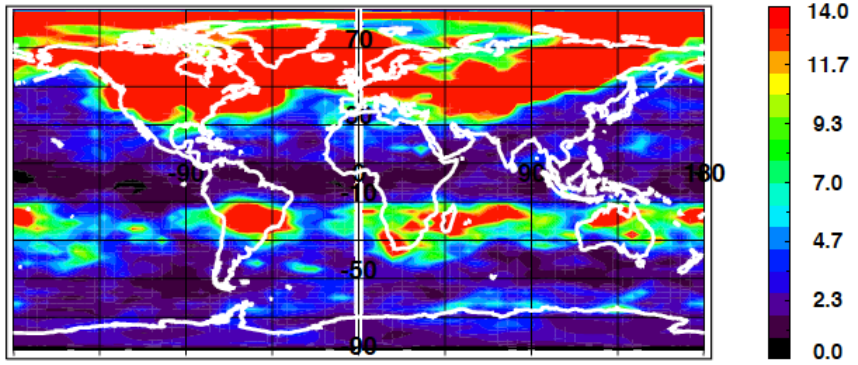
WACCM Orography @ 10 hPa

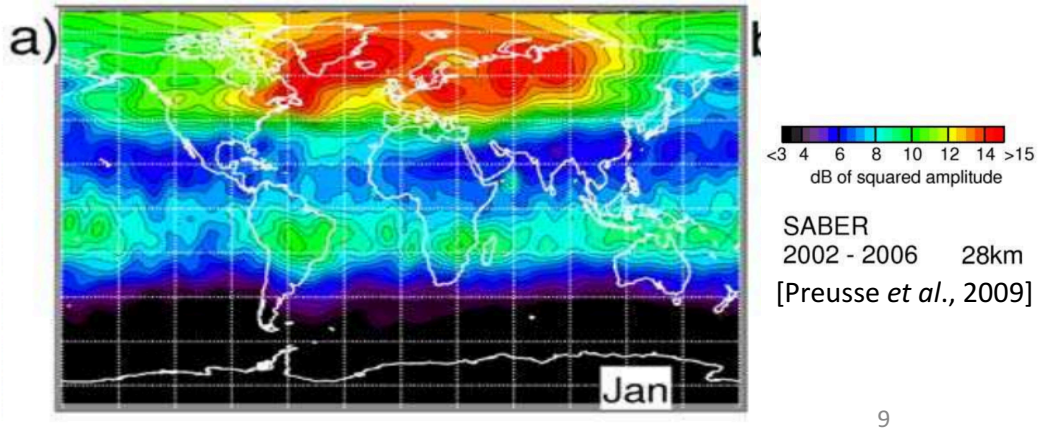


WACCM Front System @ 10 hPa



ECMWF all @ 10 hPa

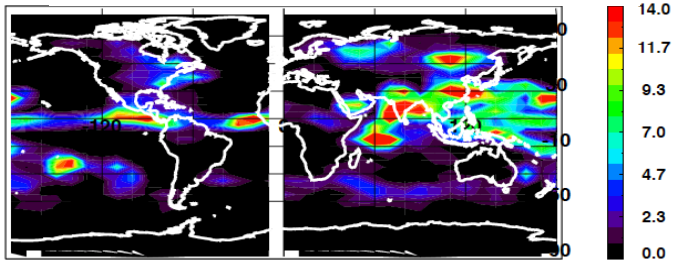




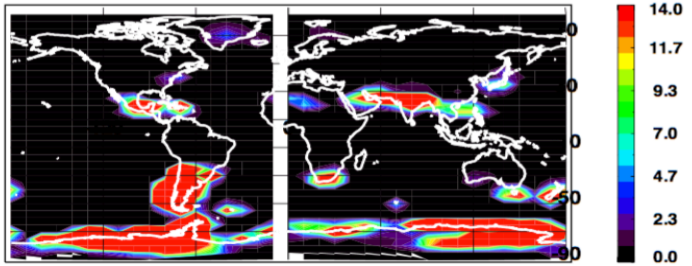
[Preusse *et al.*, 2009]

Comparison between WACCM, ECMWF, and SABER (July)

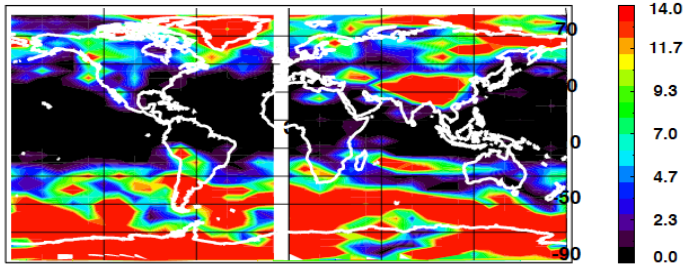
WACCM Convection @ 10 hPa



WACCM Orography @ 10 hPa



WACCM Front System @ 10 hPa



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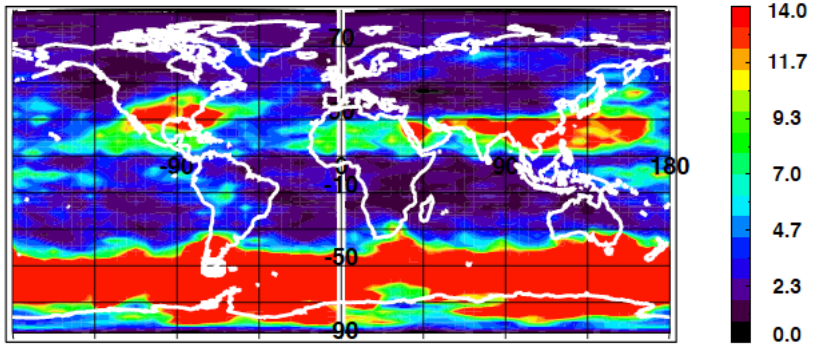
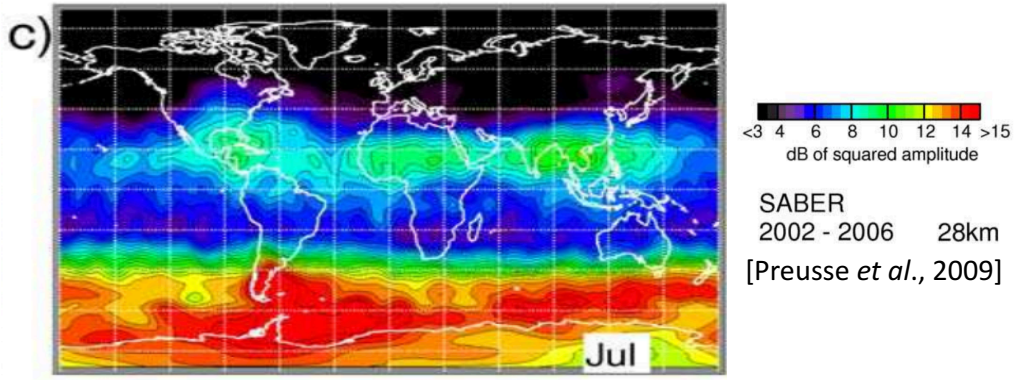
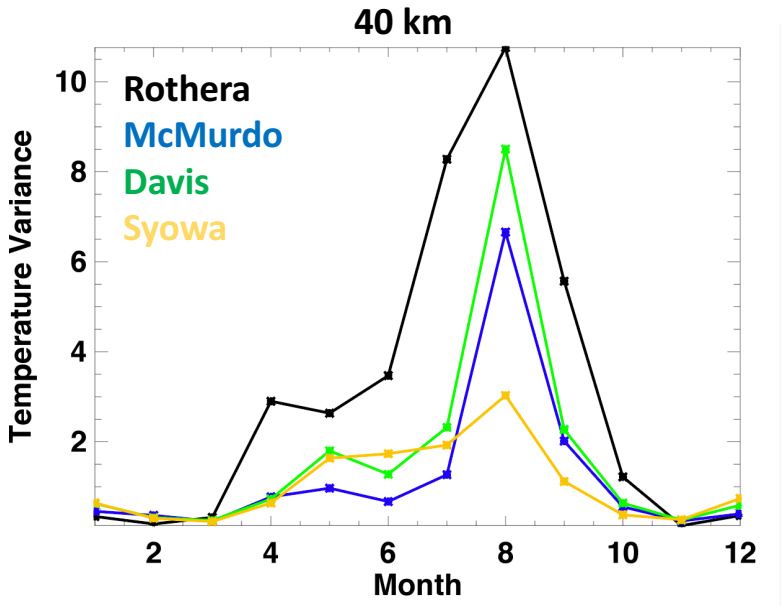




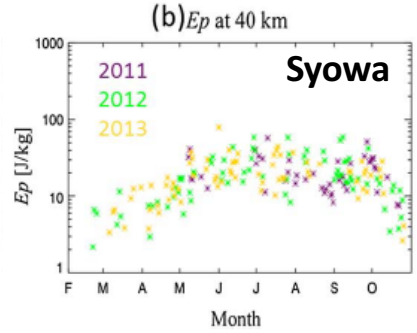
[Preusse *et al.*, 2009]

ECMWF and Lidar Comparison

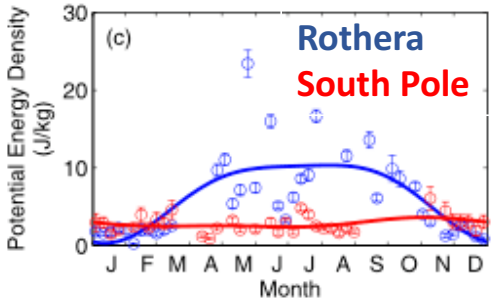
ECMWF



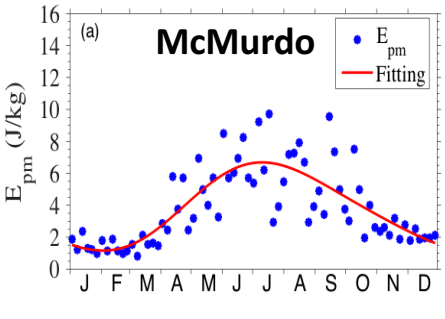
Lidar



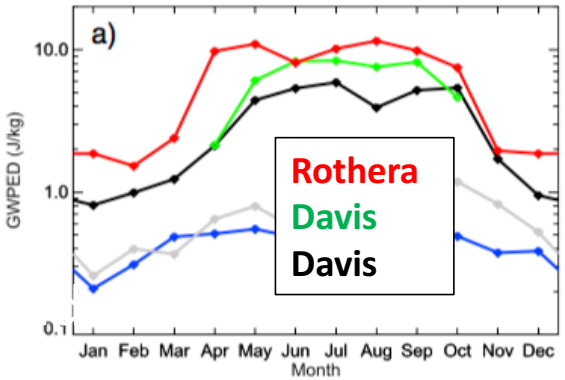
[*Kogure et al.*, 2017]



[*Yamashita et al.*, 2009]

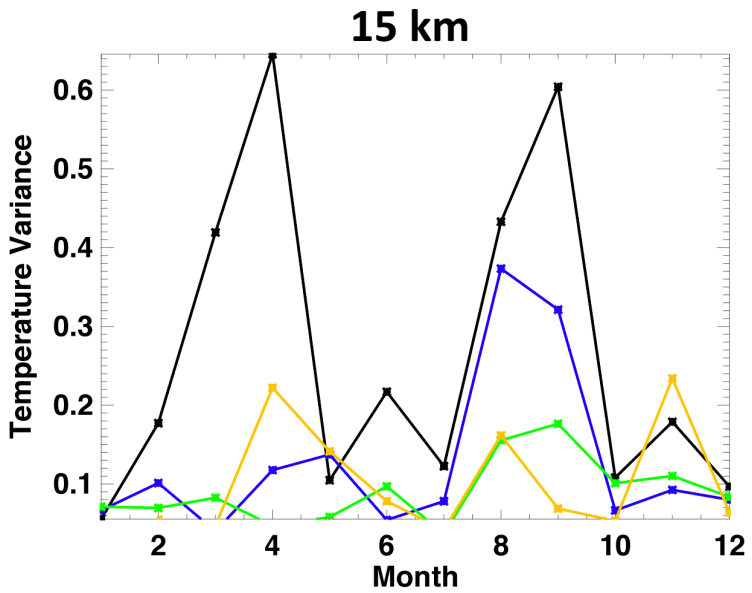


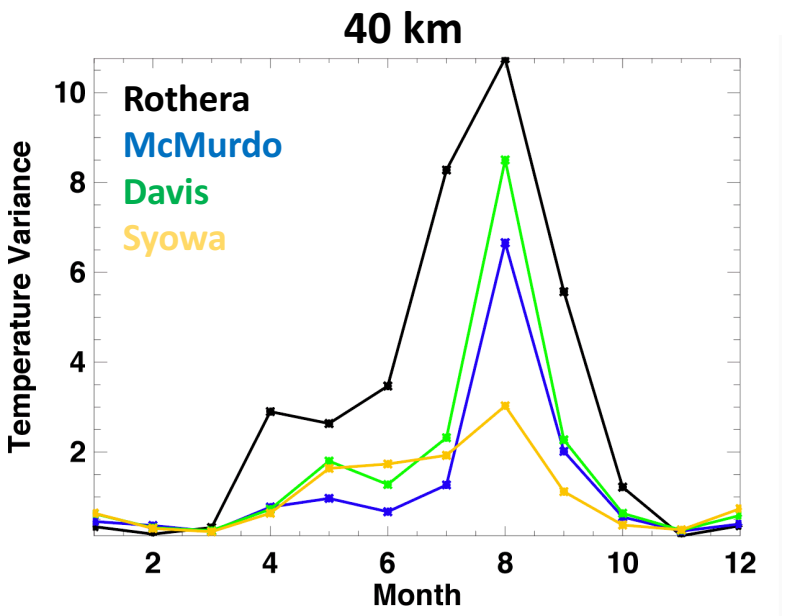
[*Chu et al.*, 2018]



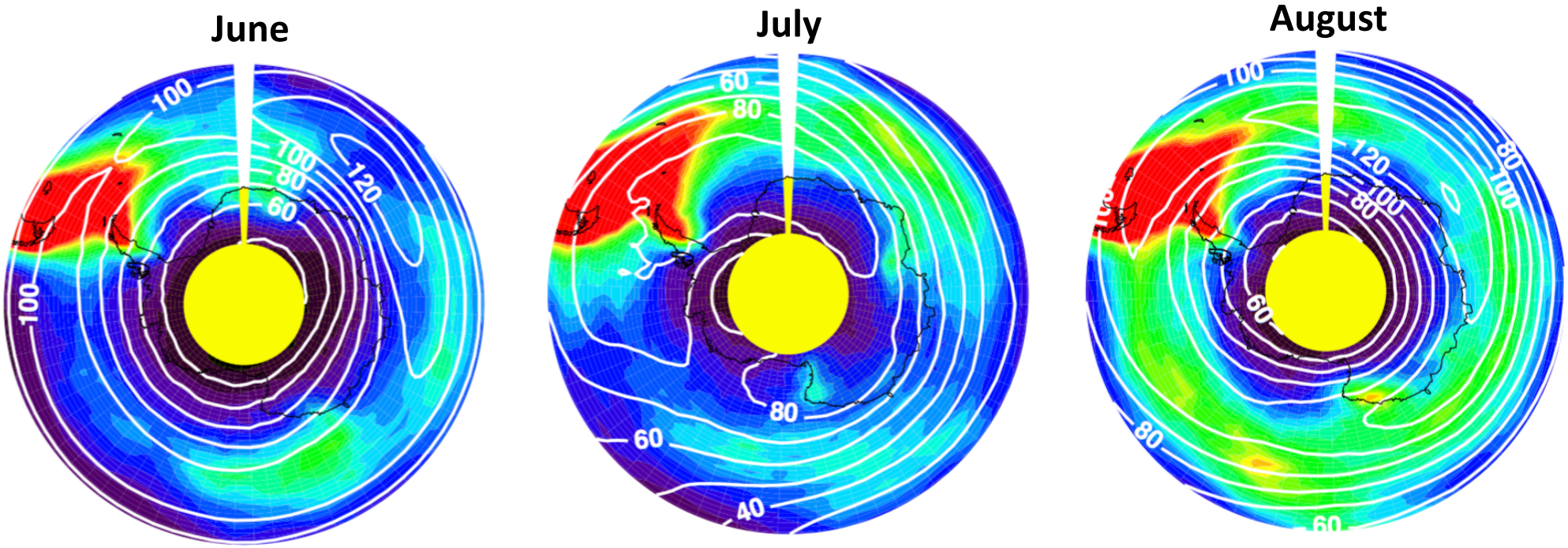
[*Kaifler et al.*, 2015]

ECMWF : Comparisons (Two Altitudes)

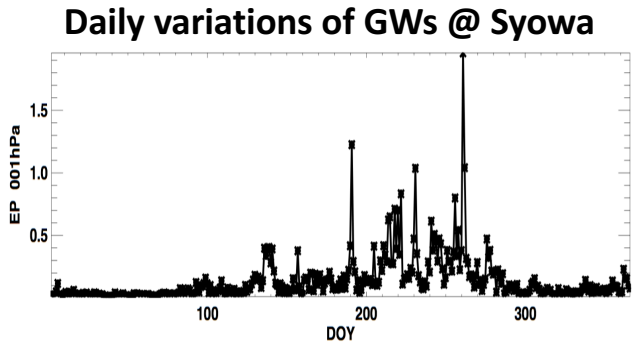


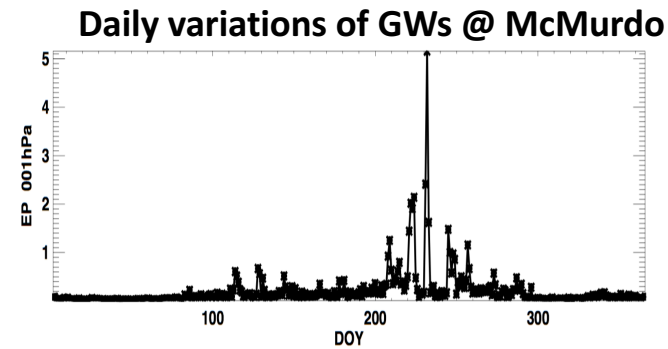


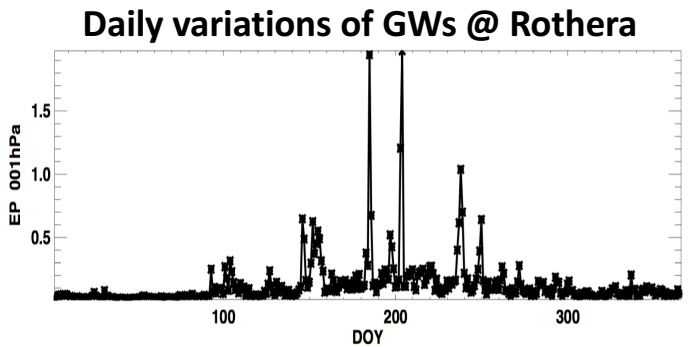
Month to Month Variations



Wavelet Analysis (~40 km)







Summary

- High-resolution models can resolve gravity waves and general structure and climatology of gravity waves generally agree with lidar and satellite observations.

- Resolved GWs and parametrized GWs show some discrepancy.

- In ECMWF, there are some periodic variations (10 days, 30 days etc). Further analysis will be done to understand what causing this variations.