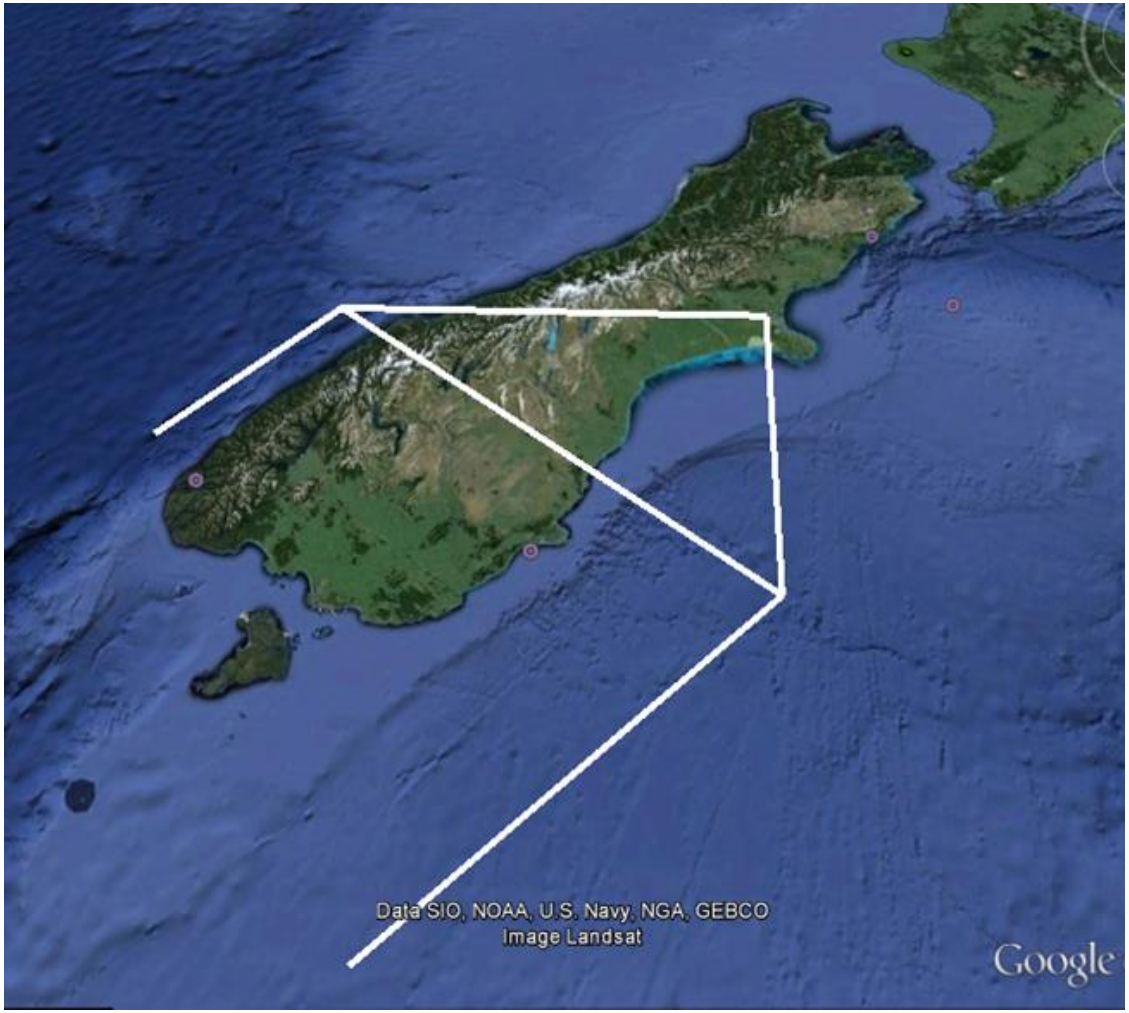
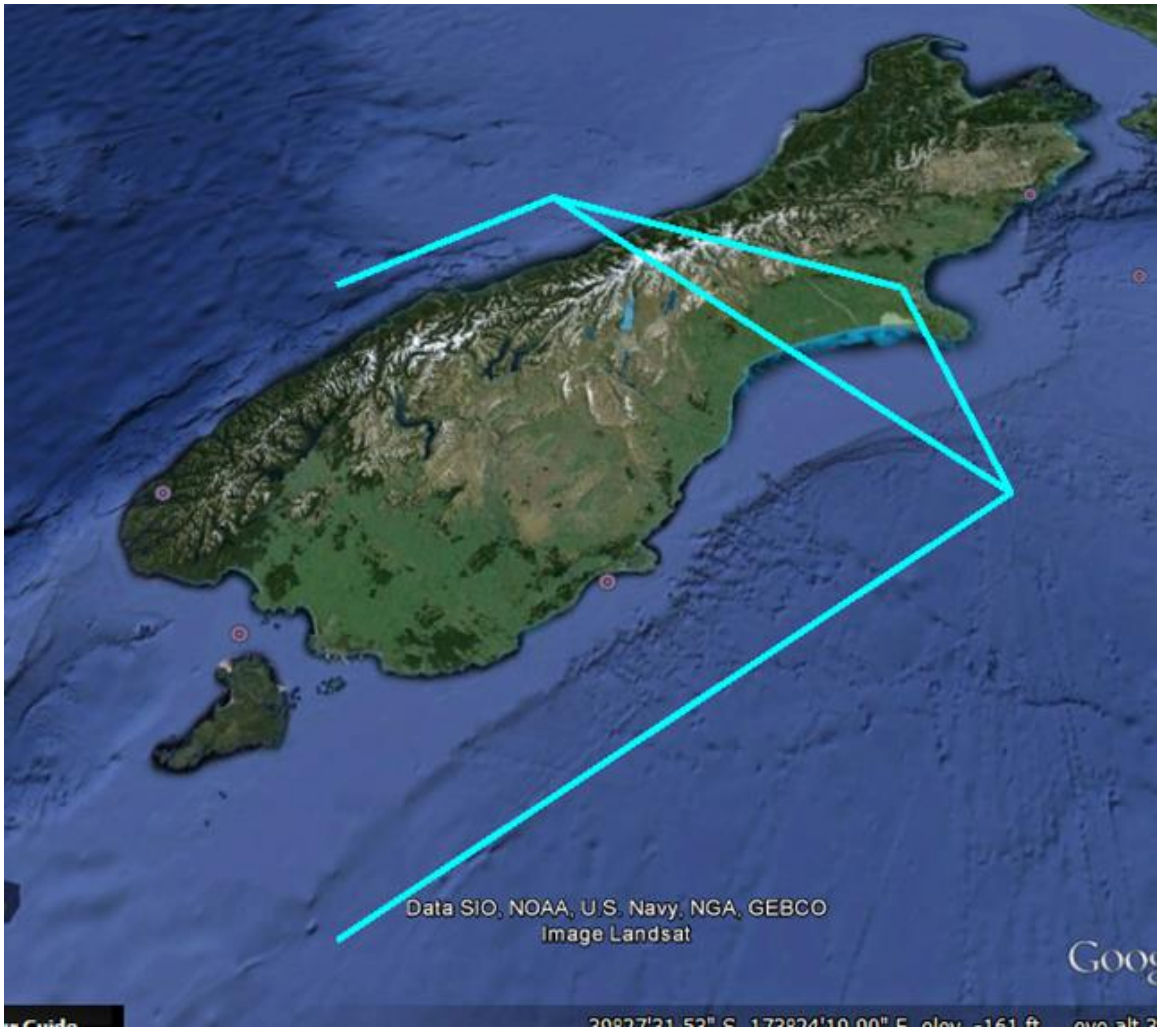
Deepwave GV Flight Level Data: Comparing RF04 and RF05

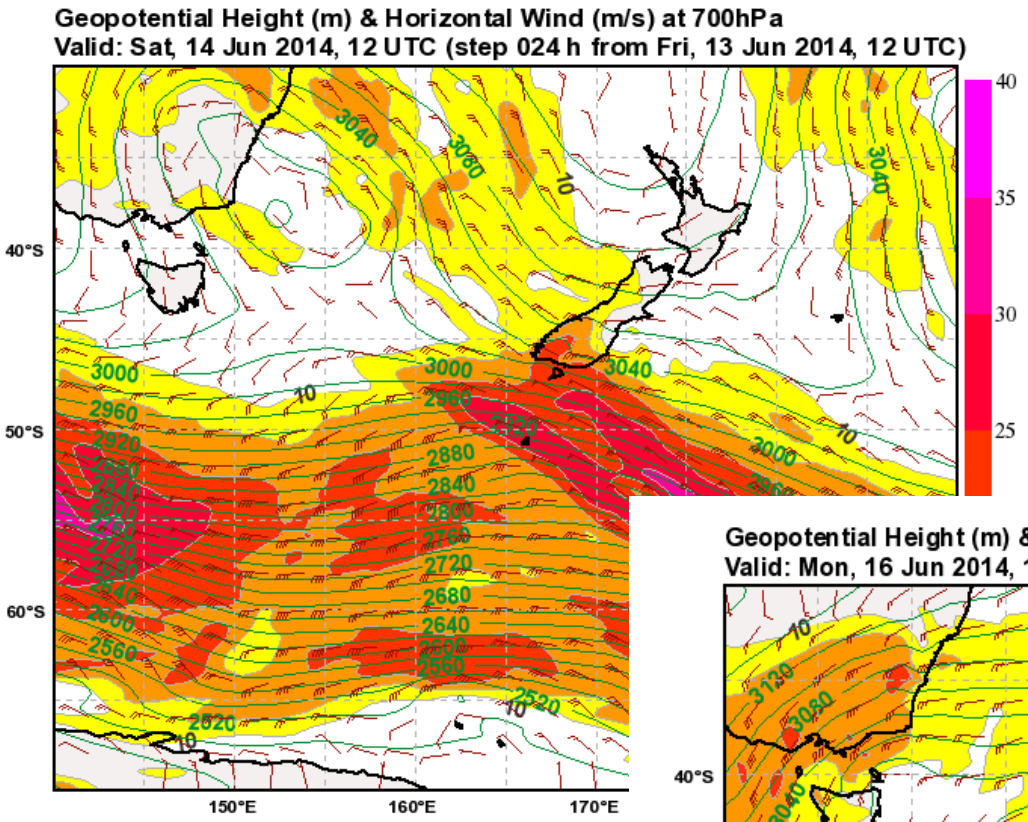
Ron Smith, Alison Nugent, Chris Kruse and many others

RF04 Mt Aspiring Track; June 14

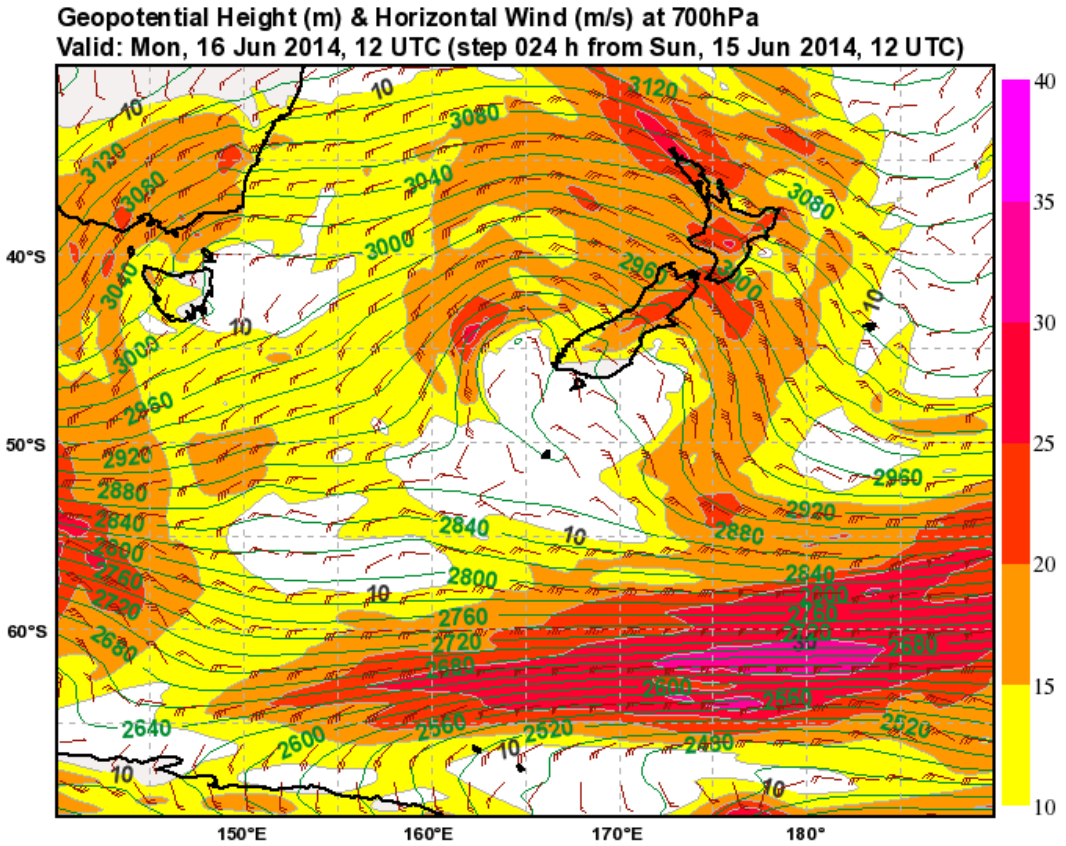


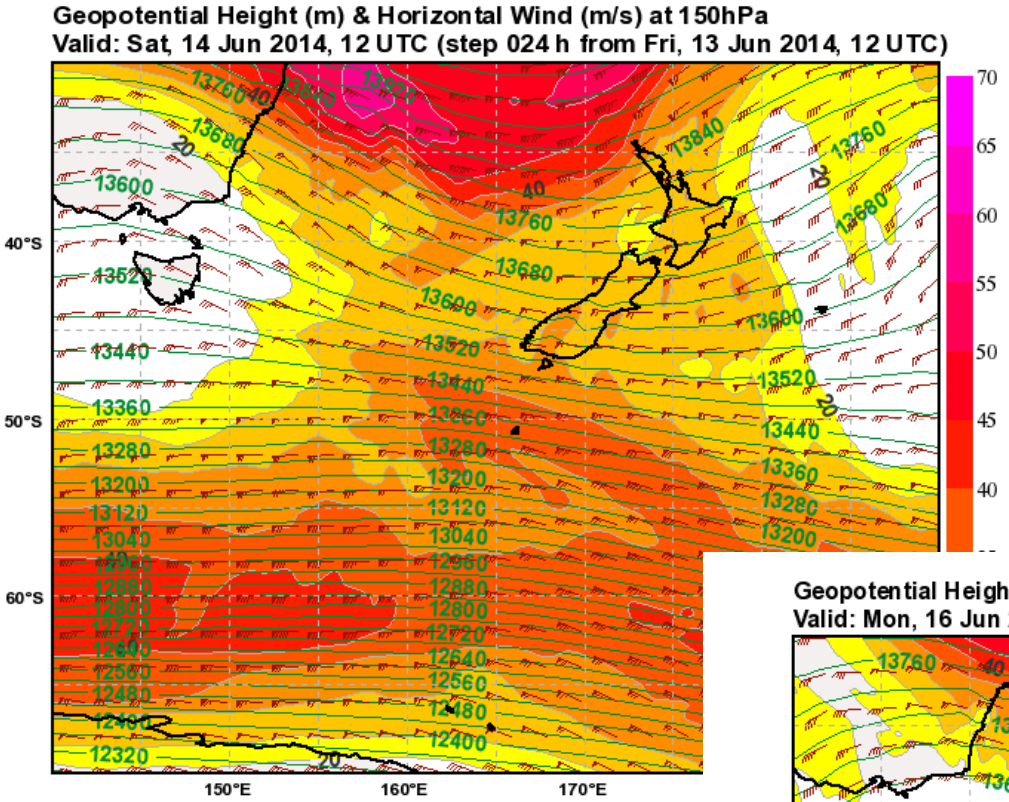
RF05 Mt Cook Track; June 16



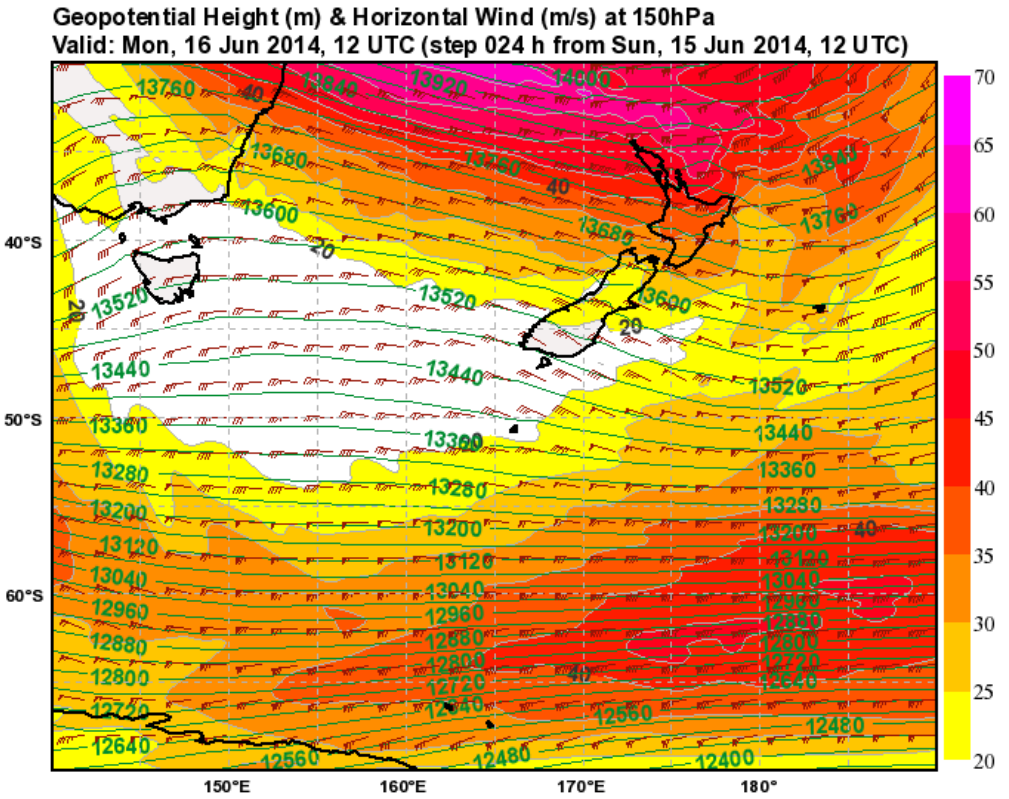


ECMWF Forecast

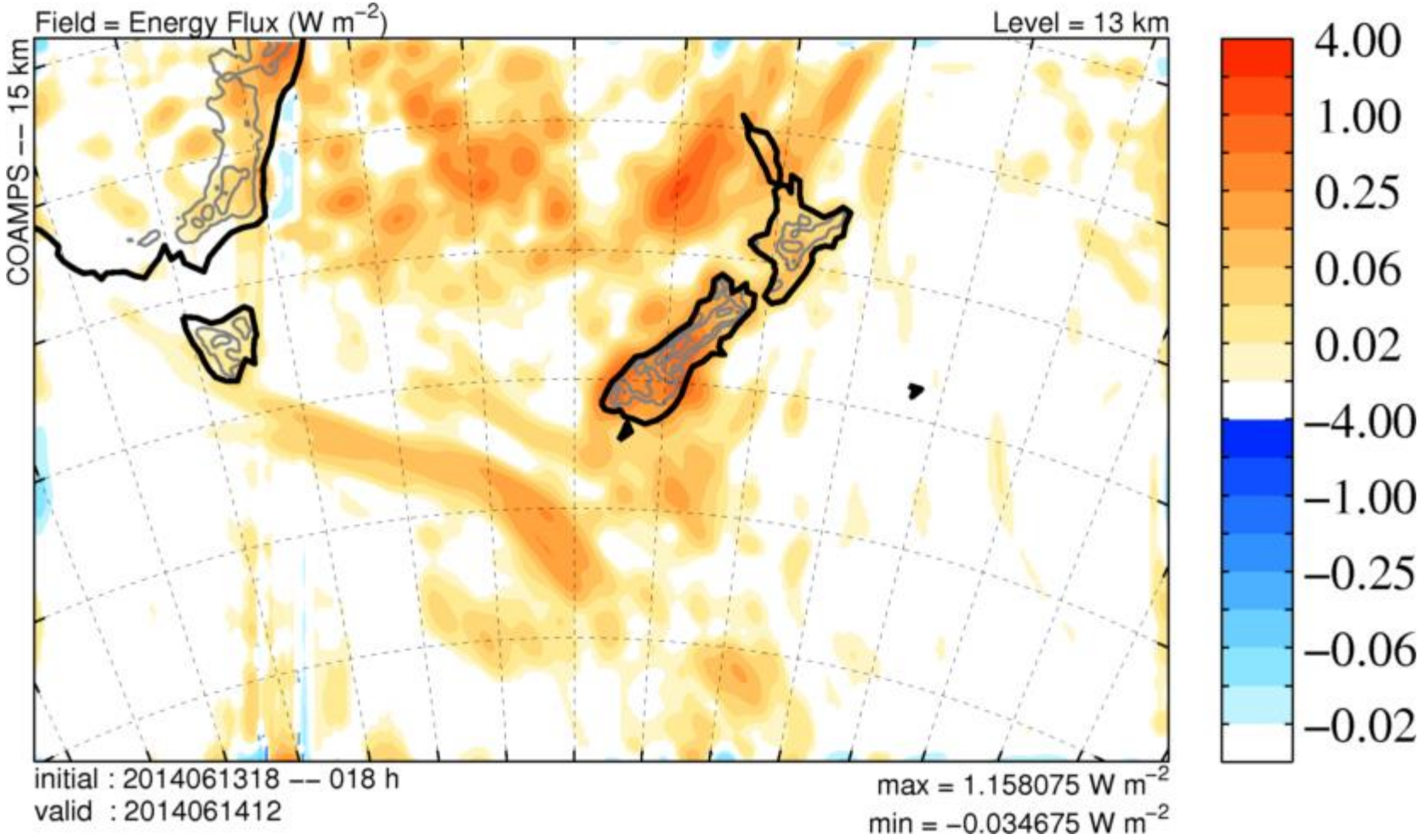




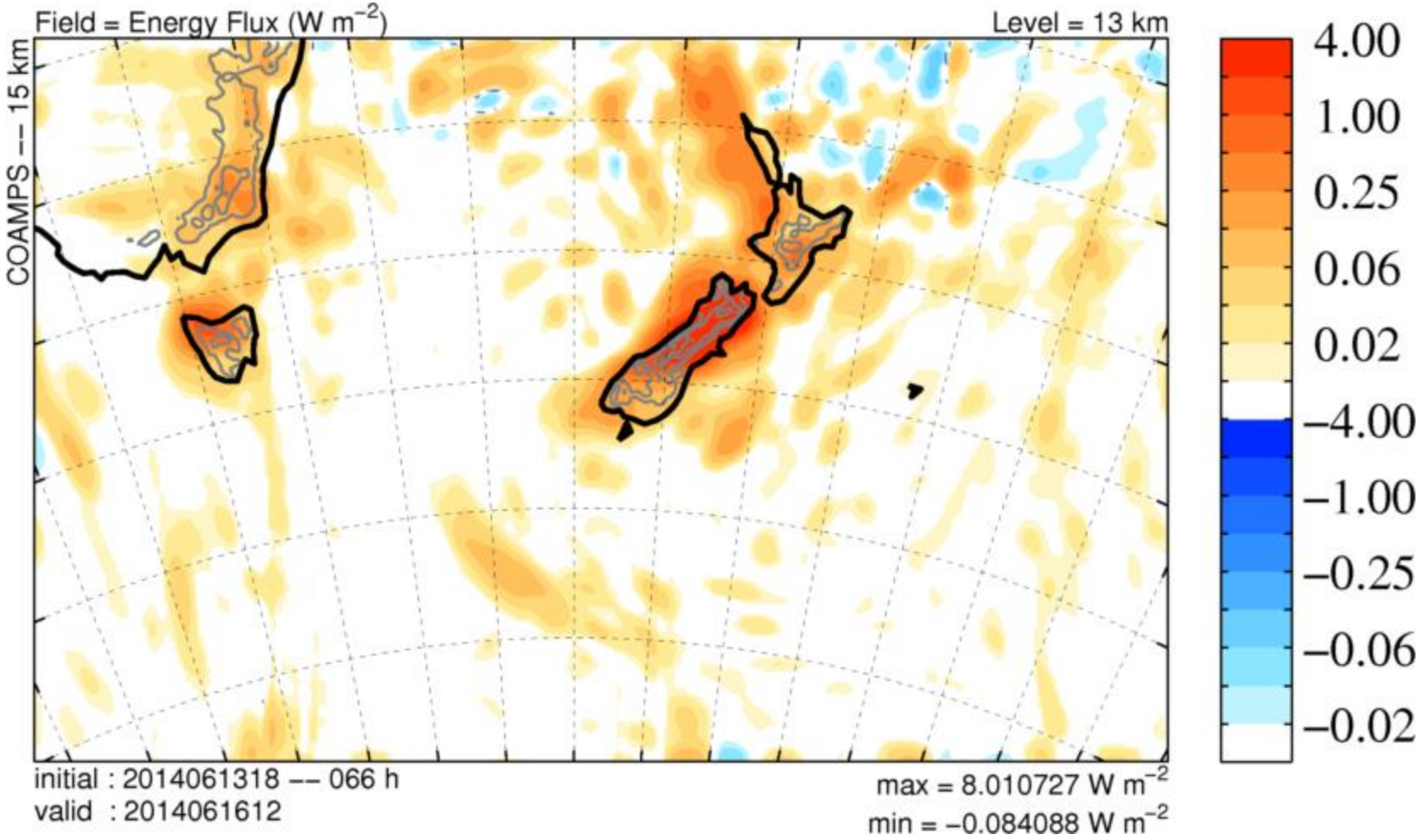
ECMWF forecast



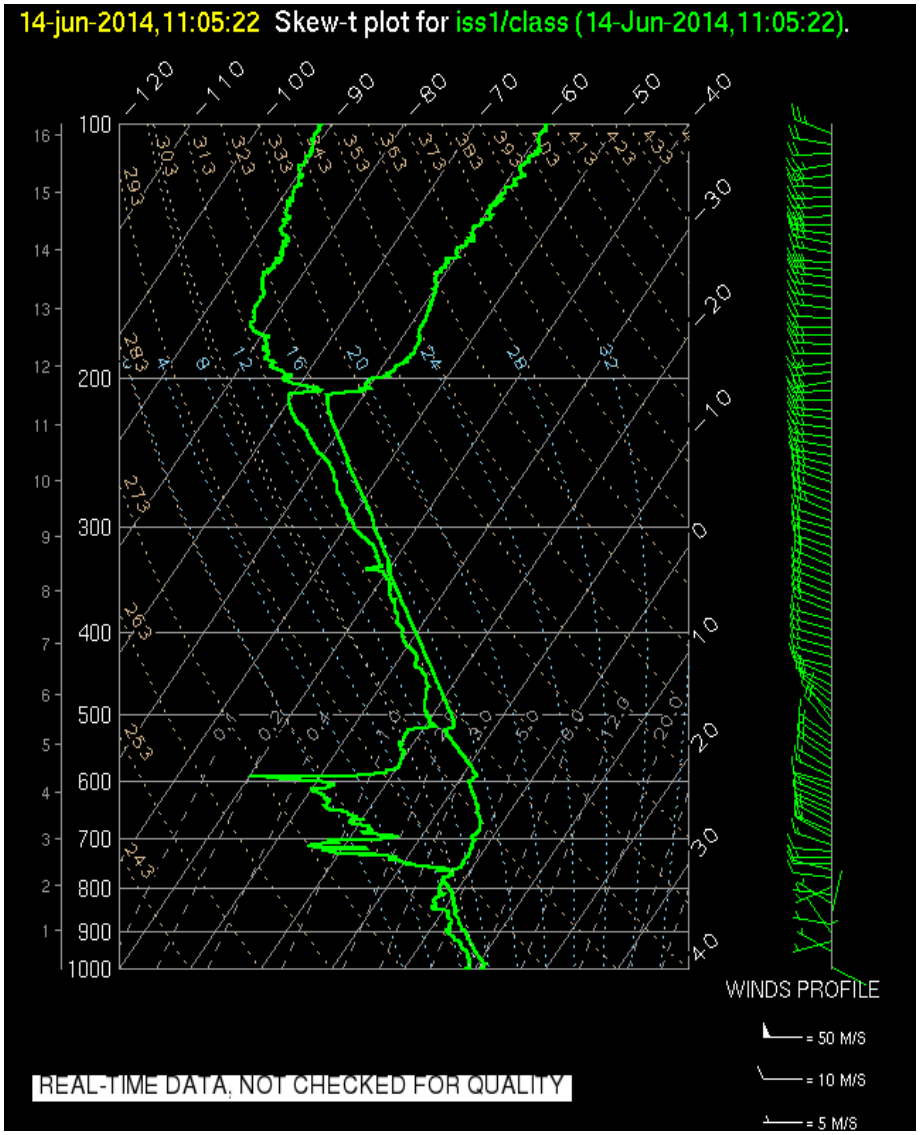
COAMPS predicted EFz RF04

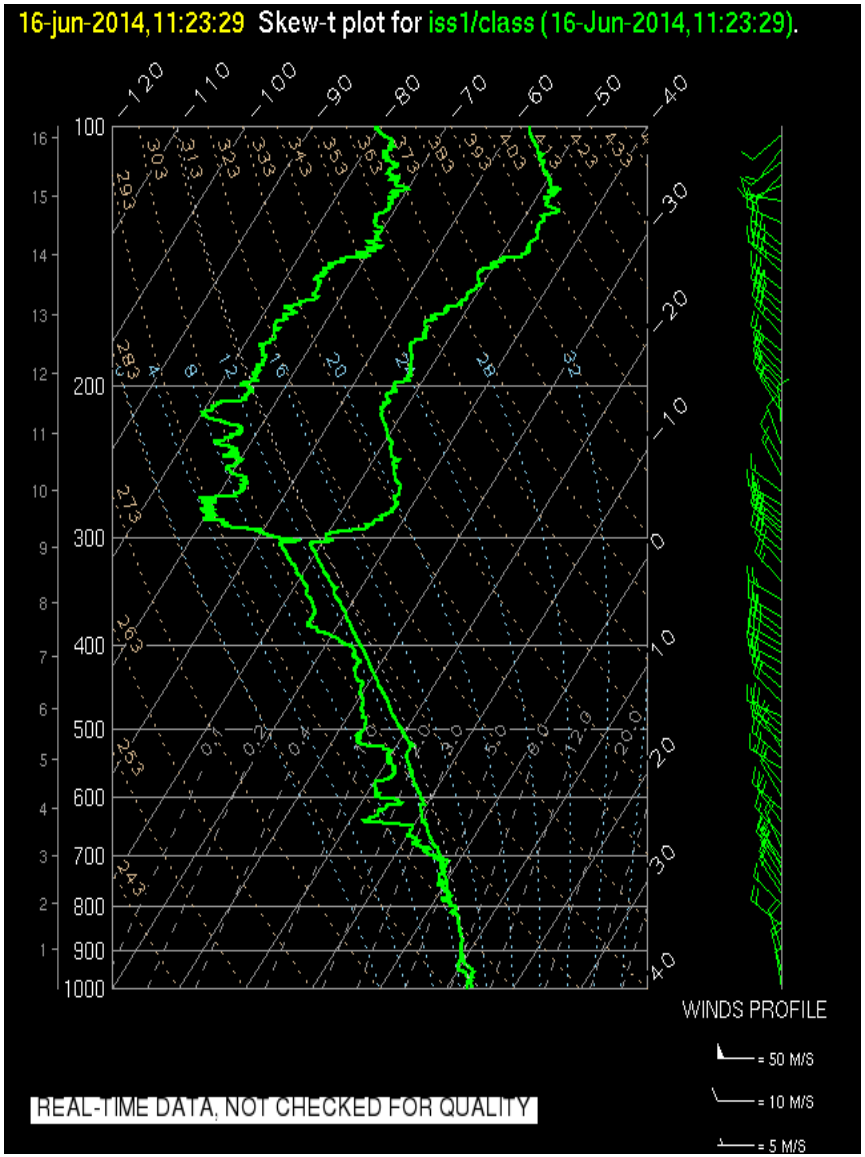


COAMPS predicted EFz RF05



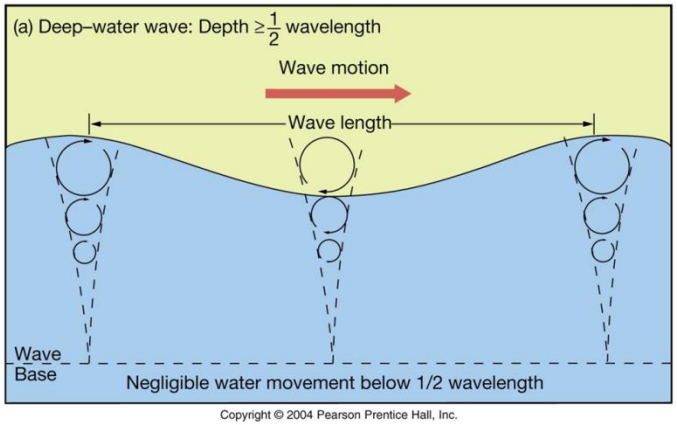
ISS Hokitika sounding: 1200UTC





Trapped gravity waves on a temperature discontinuity

- $g' = g\left(\frac{\Delta\theta}{\theta}\right)$
- $\lambda = [4\pi]\left(\frac{U^2}{g'}\right)$



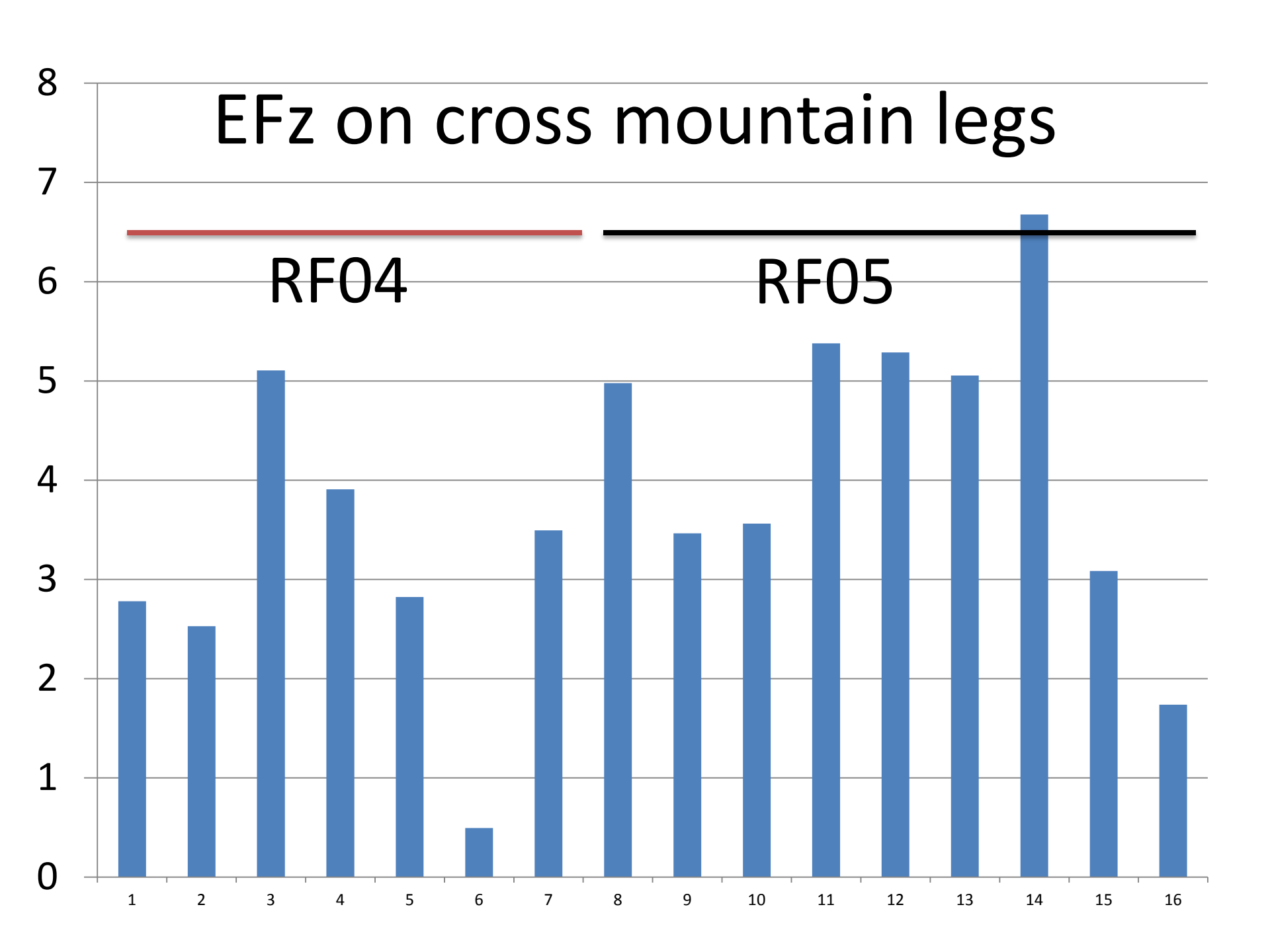
- Trapped waves are generated by the longer vertically propagating wave as it passes through the tropopause inversion (i.e. secondary wave generation)

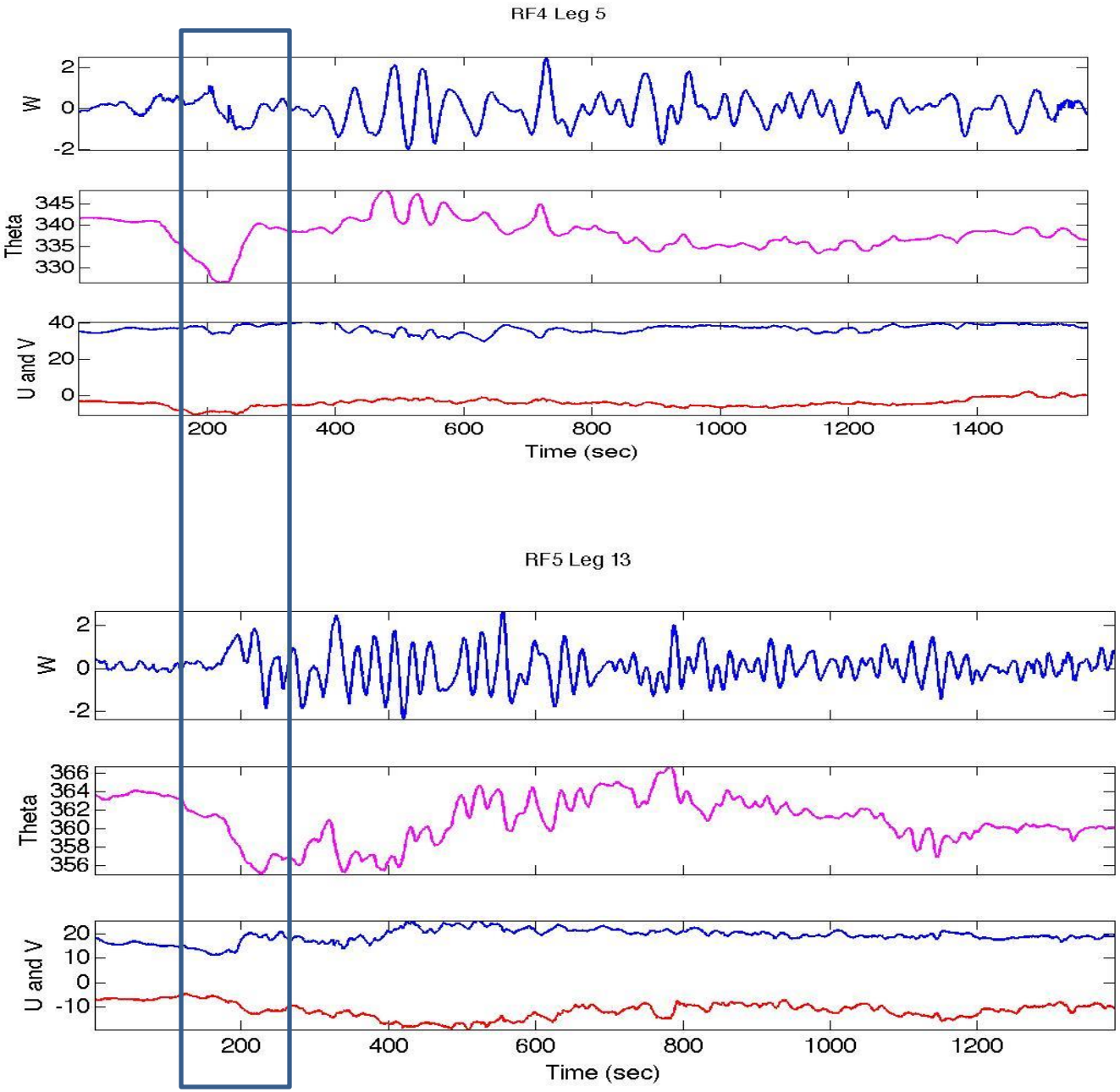
Trapped wave formula

Wind Speed (m/s)	$\Delta\theta$ (K)	Predicted wavelength (km)
15	10	10.8
20	10	15.3
25	10	23.9

Energy flux calculations from flight level data

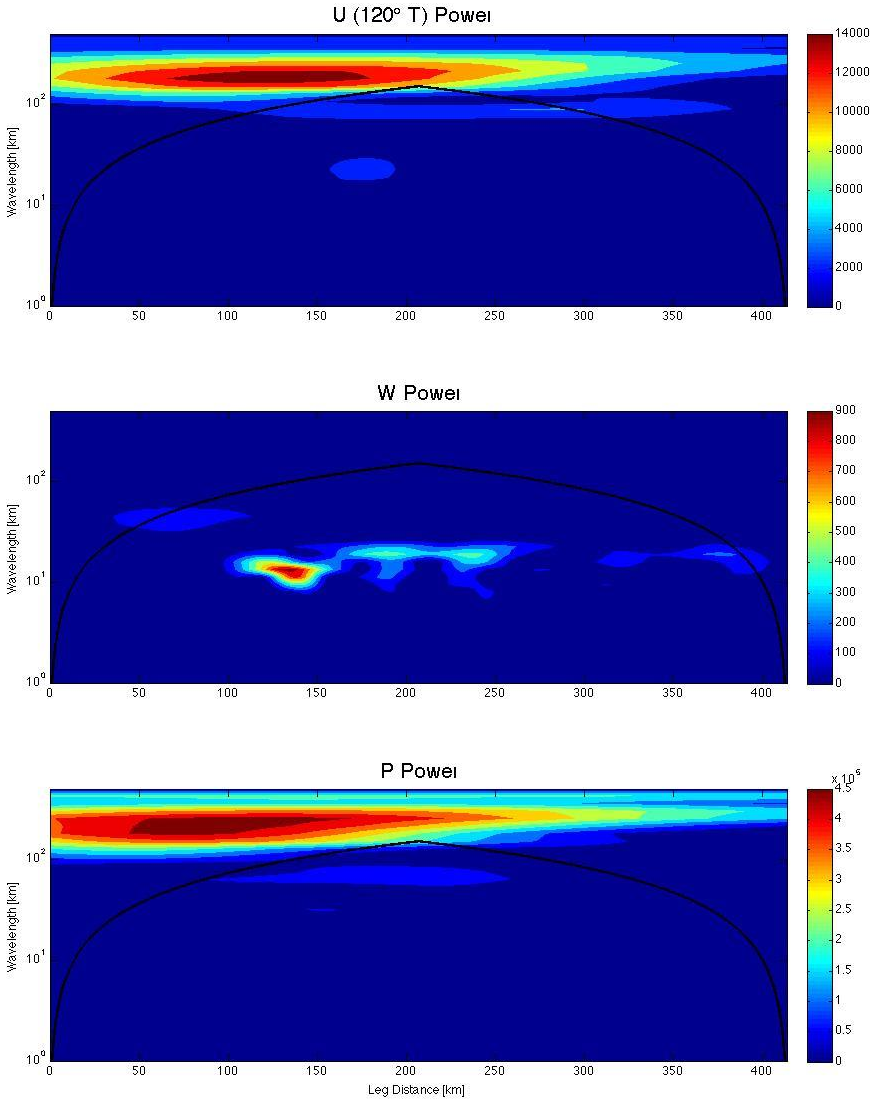
- Use nose-cone gust probe and inertial navigation to determine w(t)
- Use static pressure corrected for fuselage airflow and aircraft altitude (OmniStar DGPS) to determine p(t)
- Compute EFz=p'w'
- Units: Watts per square meter
- Represents vertical wave propagation
- See Smith et al, 2008 JAS

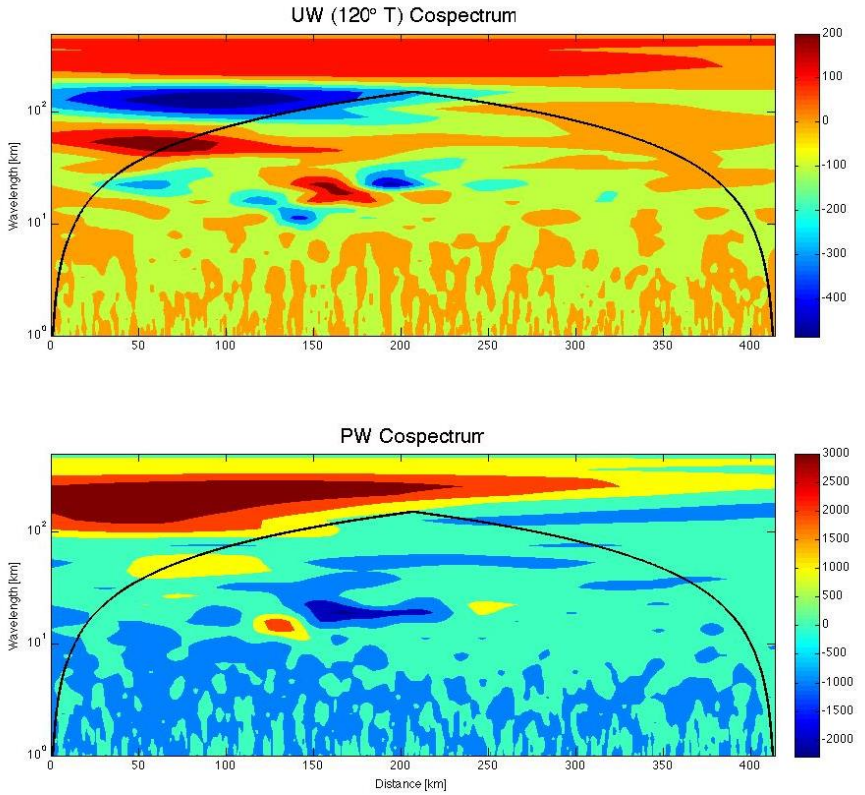

EFz on cross mountain legs
RF04
RF05
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16



Southern Alps

RF04 Leg 5

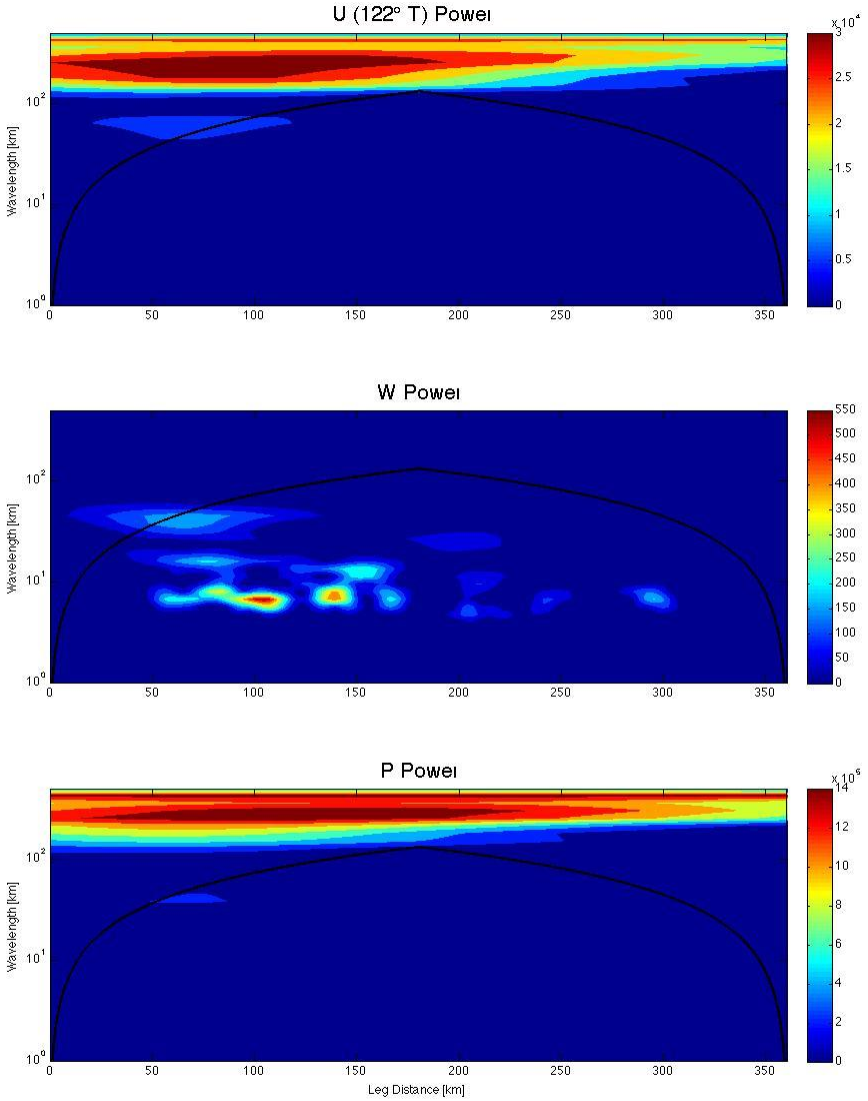


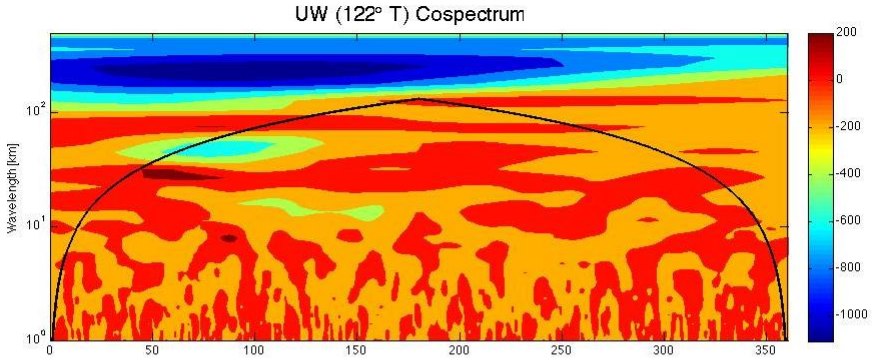


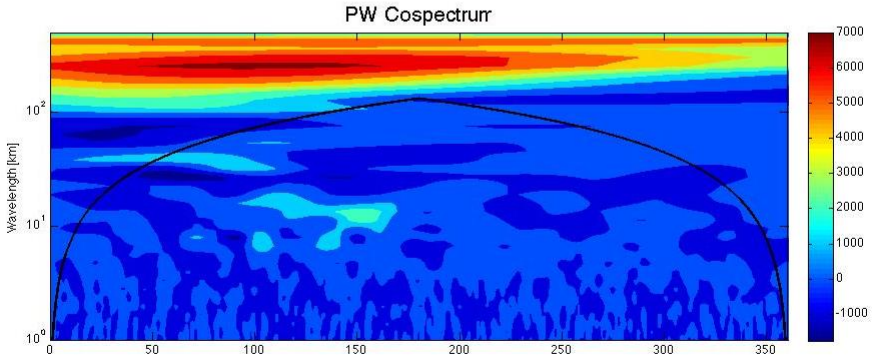
Wavelet analysis of flight level data

Chris: Following Woods and Smith 2009

RF05 Leg 13



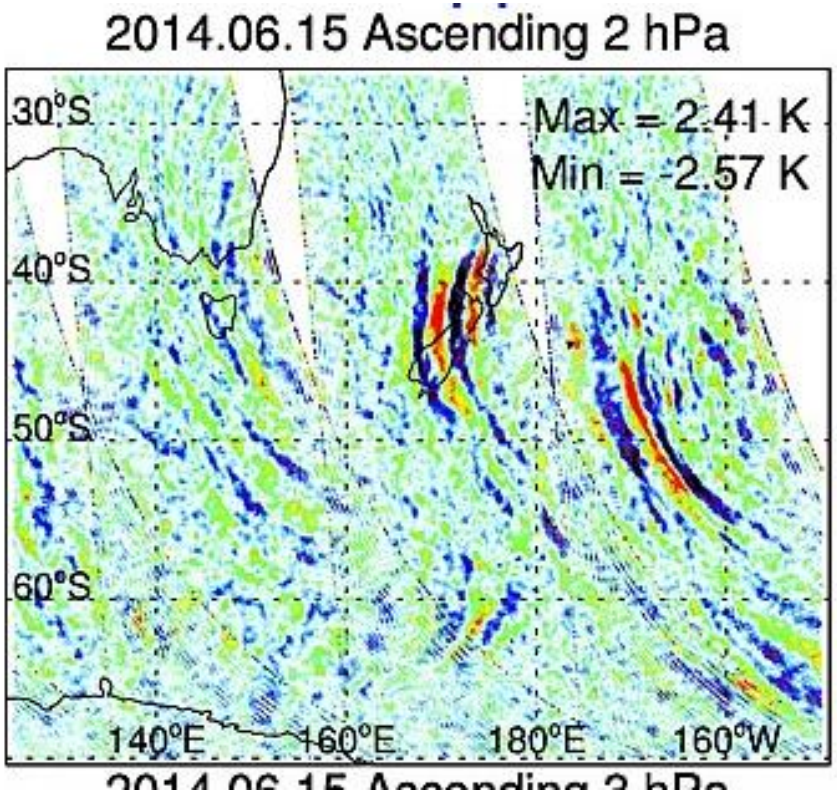


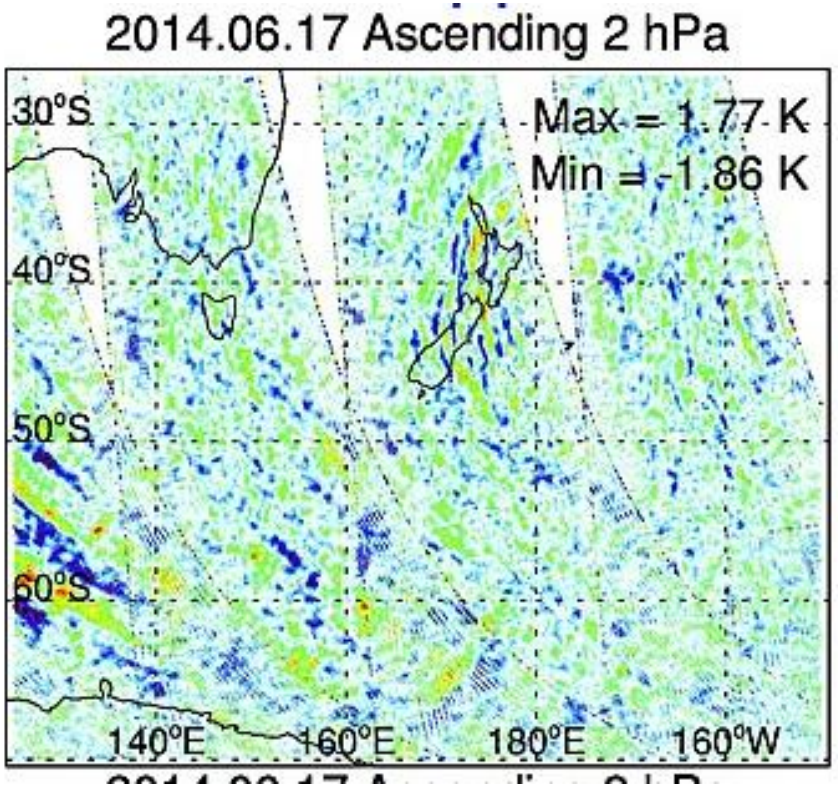


Wavelet analysis of flight level data

Chris: Following Woods and Smith 2010

AIRS temperature anomalies at 2hPa





Conclusions

- RF04 and RF05 were different in detail but shared
  - NW flow
  - Upstream blocking
  - Tropopause inversion
  - Trapped waves
  - EFz between 3 and 6 W/m2 (modest values)
- The short trapped waves carry no vertical energy or momentum flux.
- The flux-carrying waves are longer and harder to see in the WIC trace.
- Aircraft EFz agrees in order-of-magnitude with the COAMPS forecast (but averaging is done differently)
- Wavelet co-spectra nicely separate the trapped and vertically propagating waves.
- Upper level response is stronger on RF04