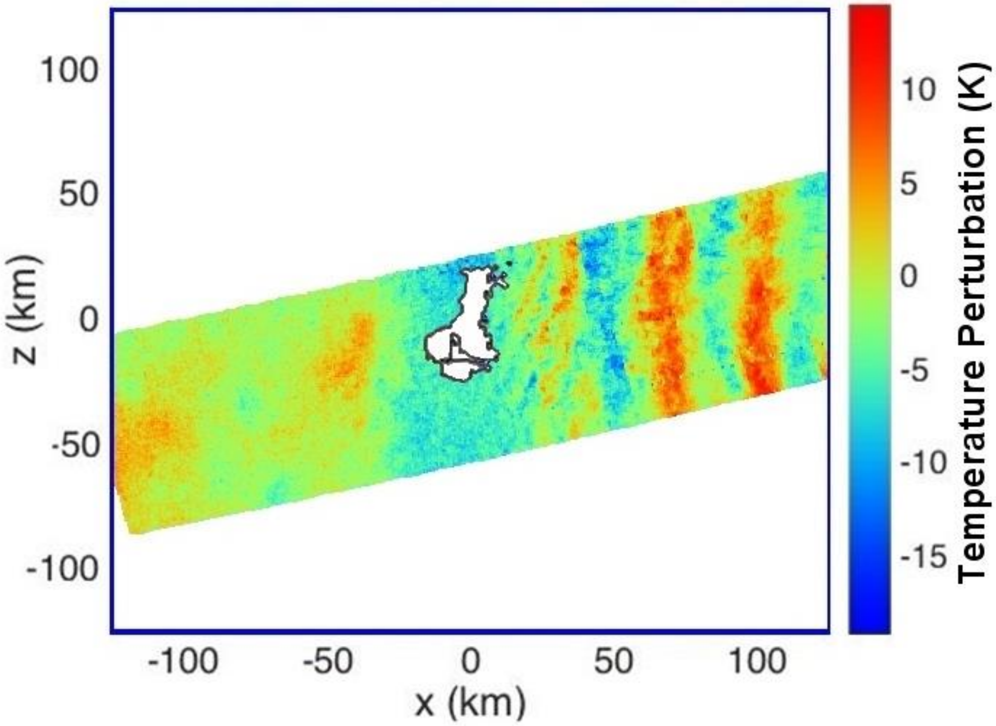
GV AMTM Results and Work-in-Progress…

P.-D. Pautet, M.J. Taylor and many more

CASS, Utah State University, Logan UT

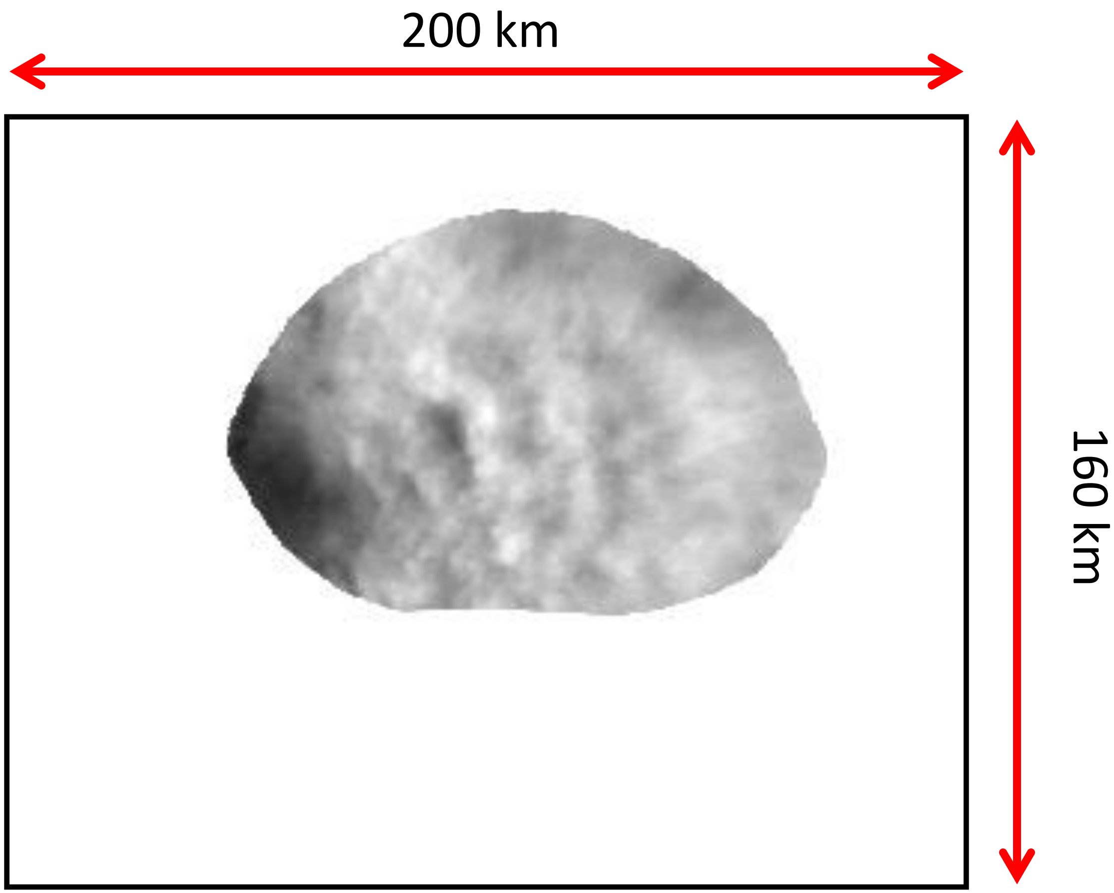
DEEPWAVE meeting, Monterey, Dec 2015

JGR RF23 Paper



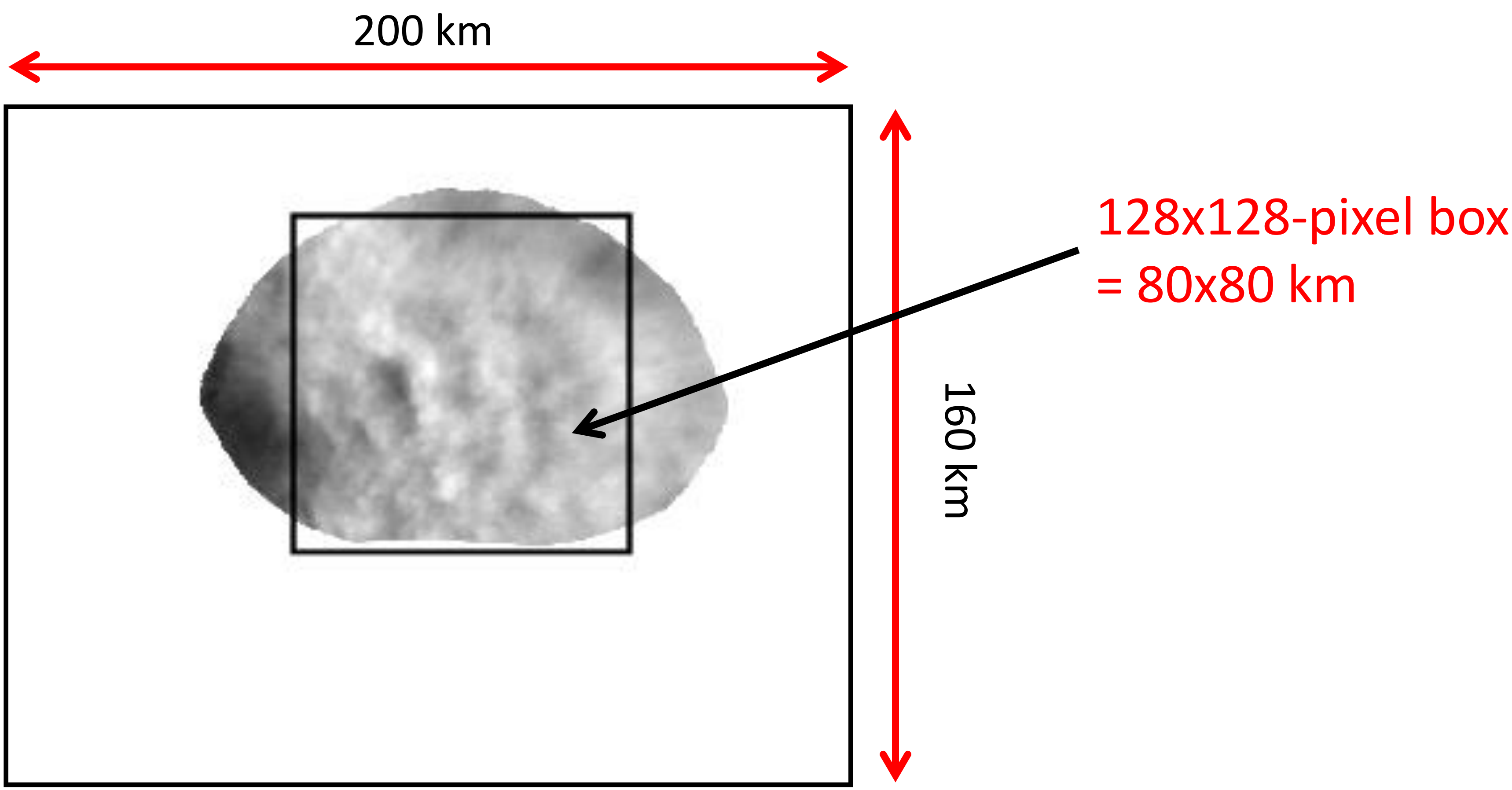
Accepted with minor edits.
Thanks to all the co-authors for their help!
Still need a few more things…

New Stuff: Trying to Quantify the GWs Observed by the AMTM?

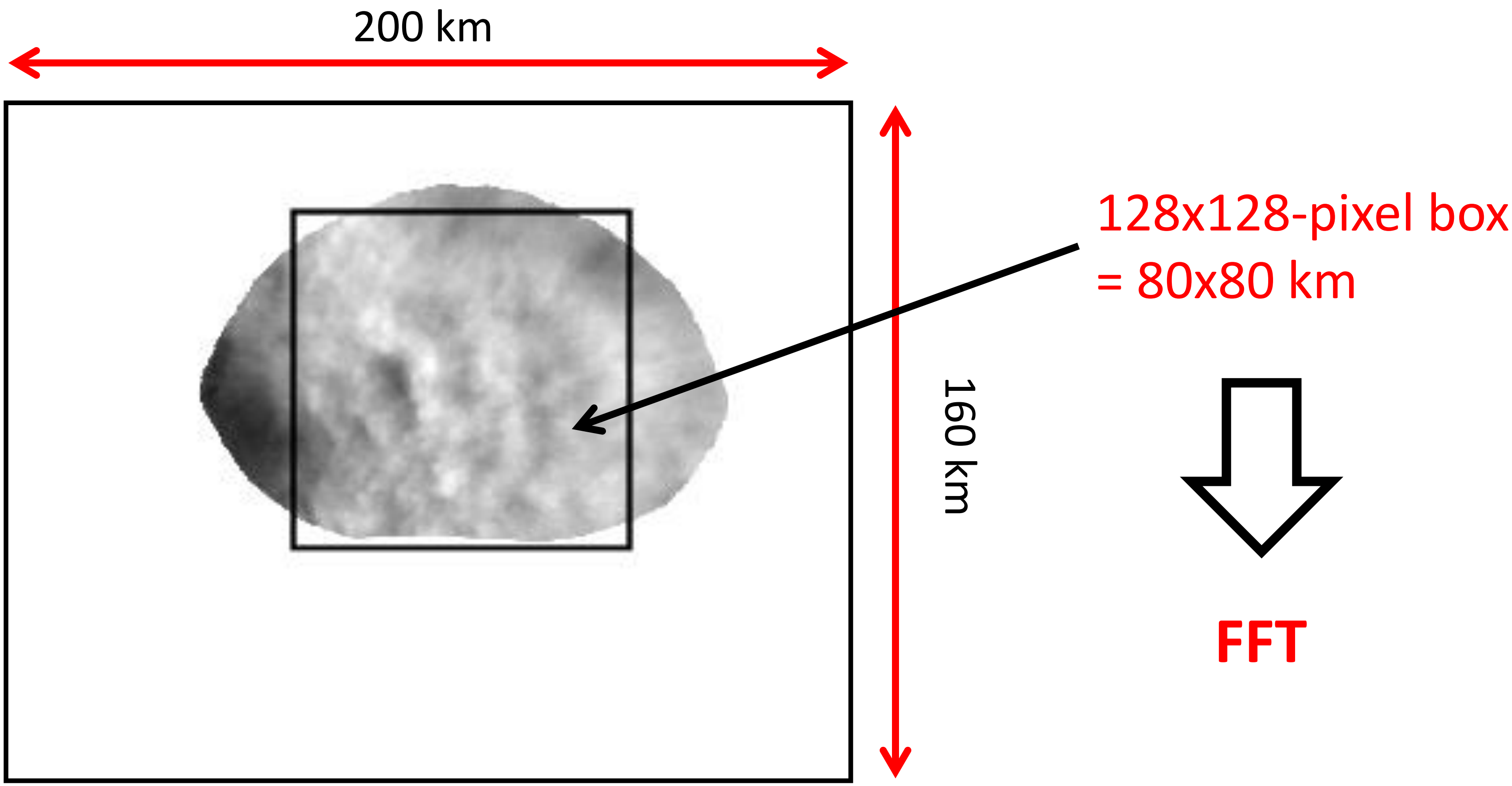


Weird shape for the fov of the zenith camera

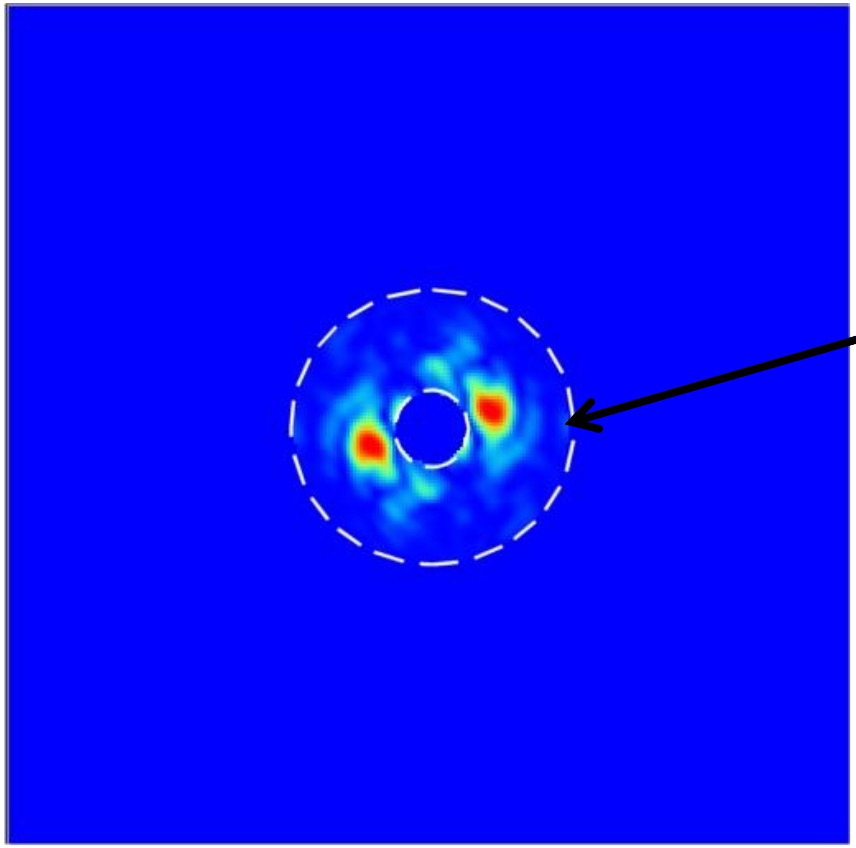
New Stuff: Trying to Quantify the GWs Observed by the AMTM?



New Stuff: Trying to Quantify the GWs Observed by the AMTM?



Small-Scale GW Power Spectrum

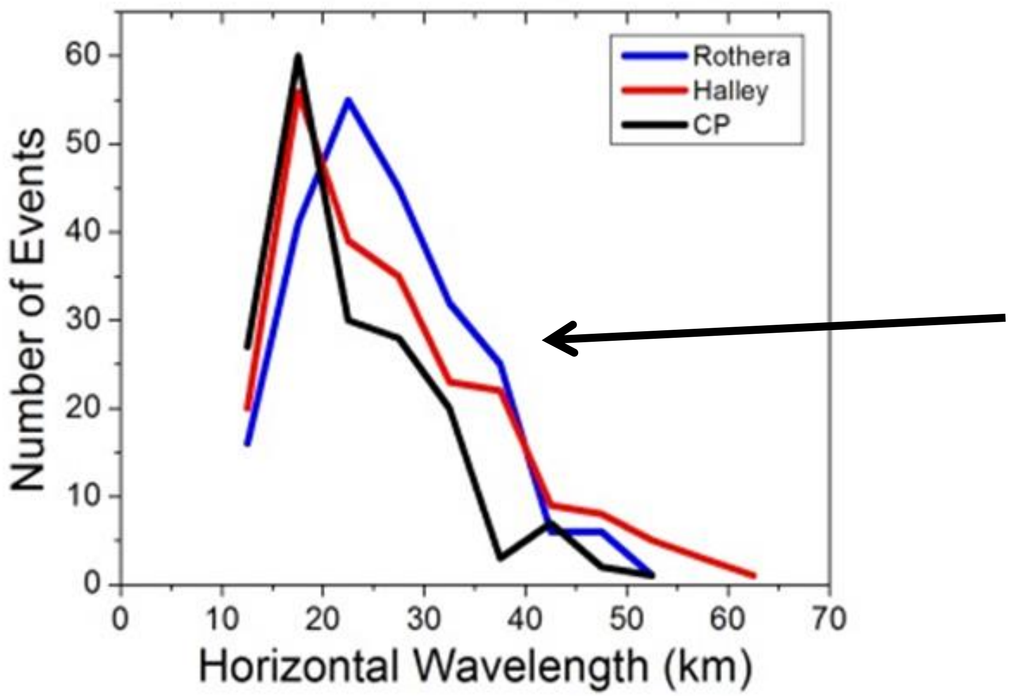


Integration of the power between the 2 circles = GWs with horizontal wavelength between 10 and 40 km

Small-Scale GW Power Spectrum

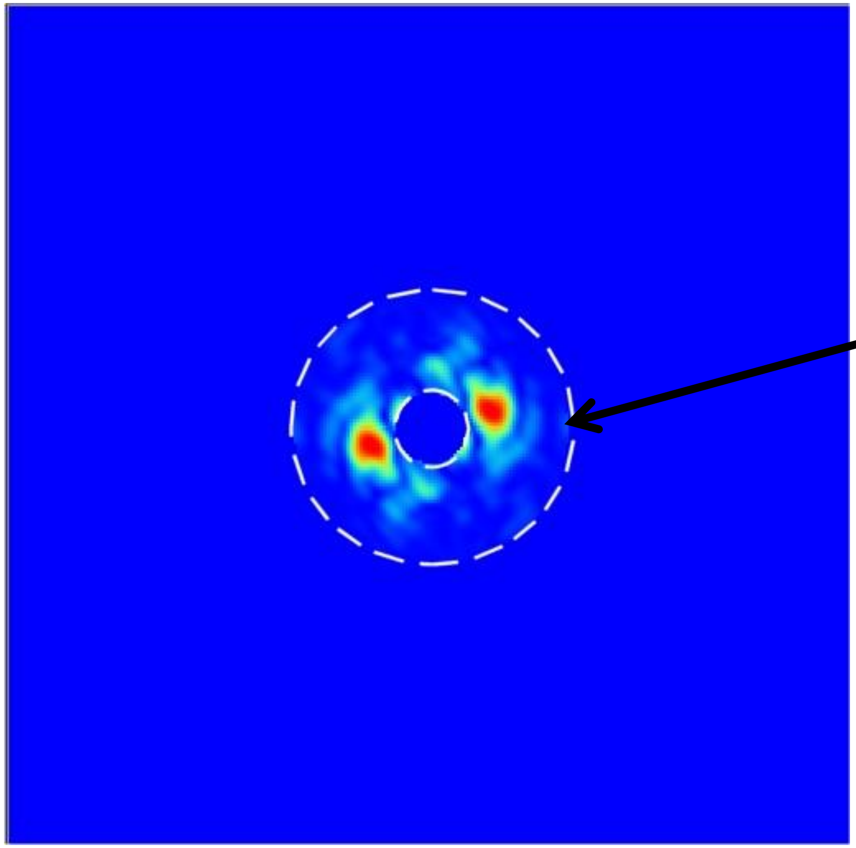
Short range of wavelengths, but:

- <10km, probably instabilities
- >40km, fov too small (only 80km!)
- Still representative of small scale GWs :



Typical horizontal wavelength distributions obtained using all-sky imagers at high (Rothera, Halley) and low (Cachoeira Paulista) latitudes (Nielsen et al., 2009)

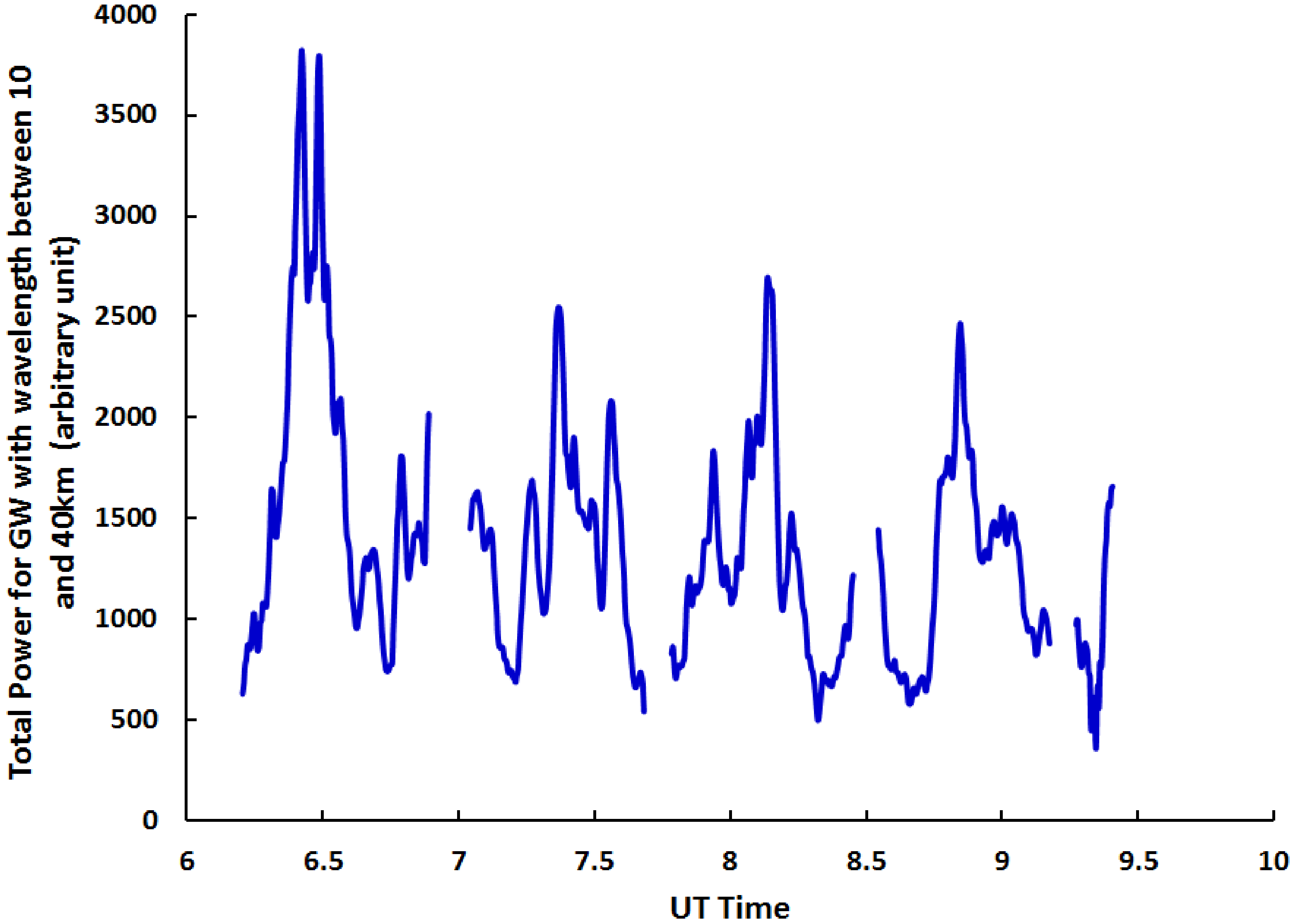
Small-Scale GW Power Spectrum



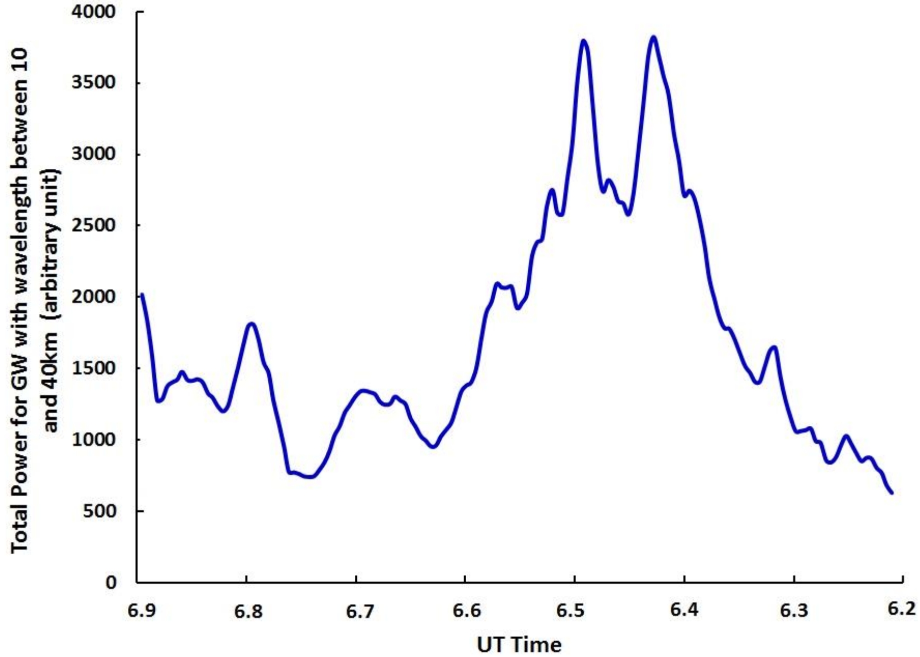
One spectrum for each OH $P_1(2)$ image, minus the turns, and take off and landing when cloudy.

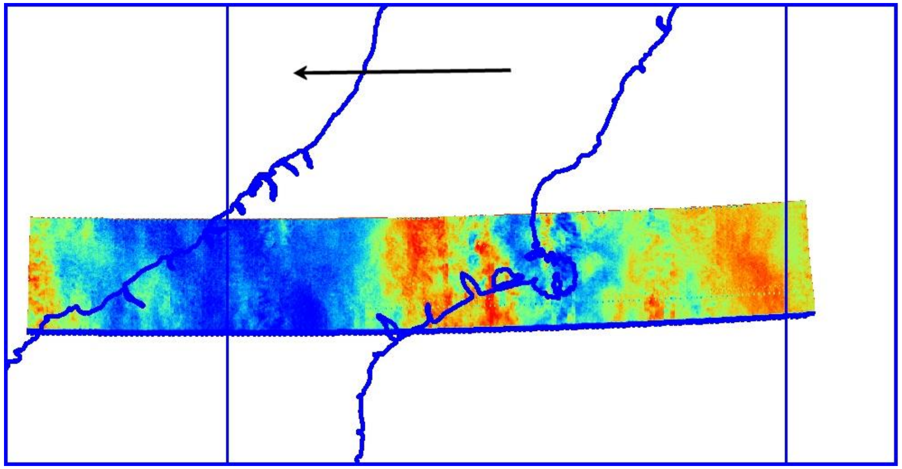
➡ GW power evolution vs time and/or location

Example: Famous RF22

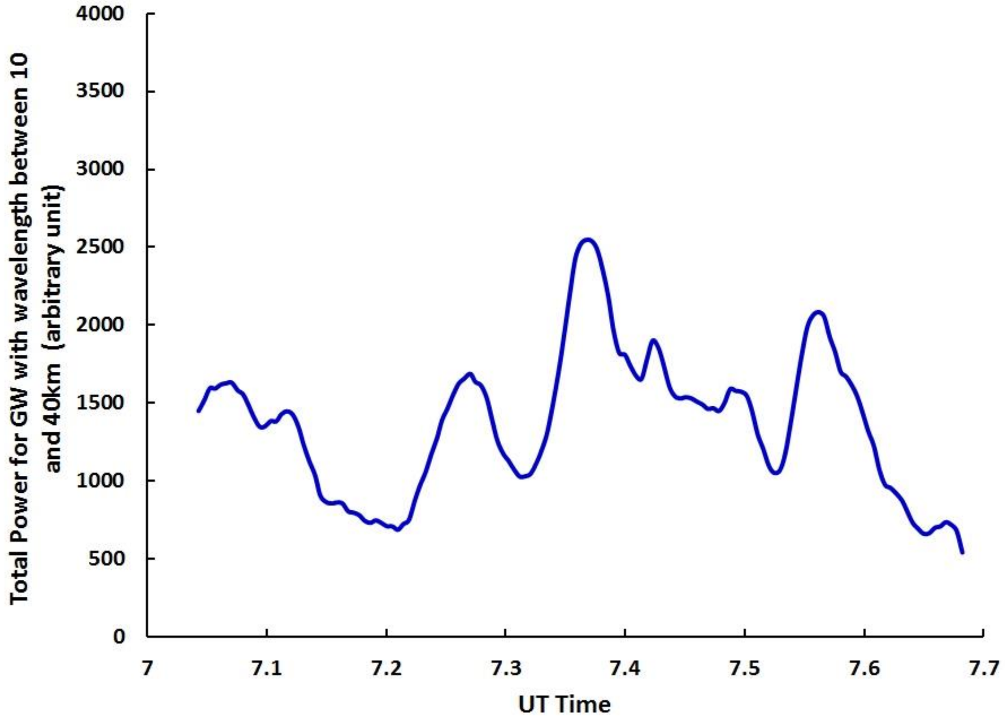


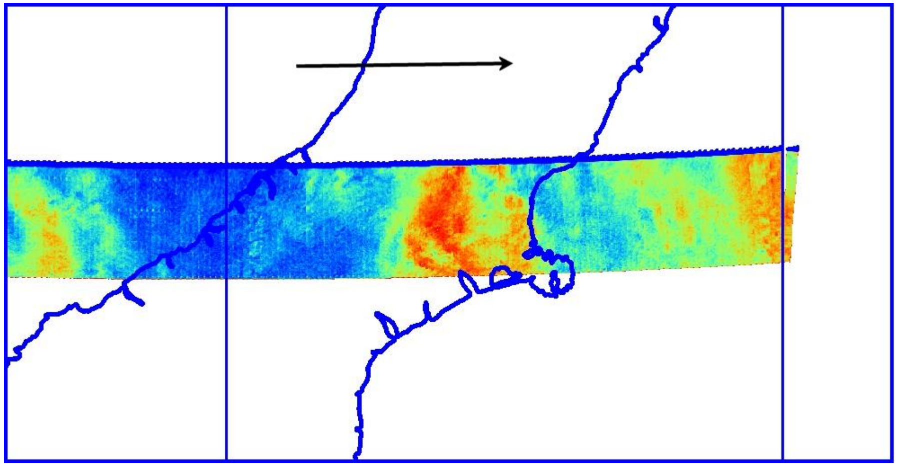
Example: Famous RF22 – First Leg



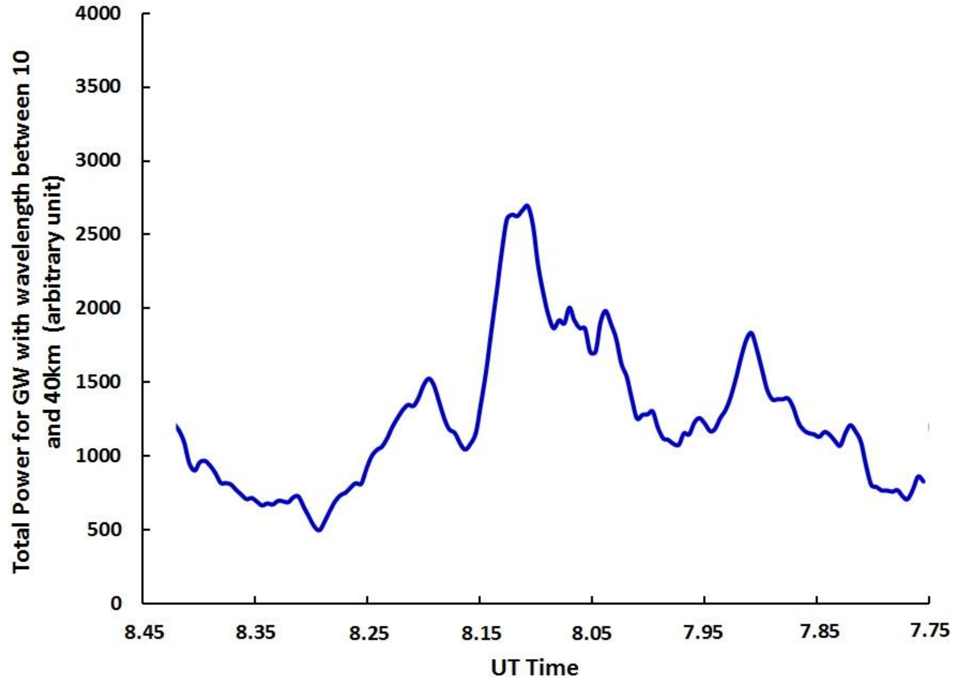


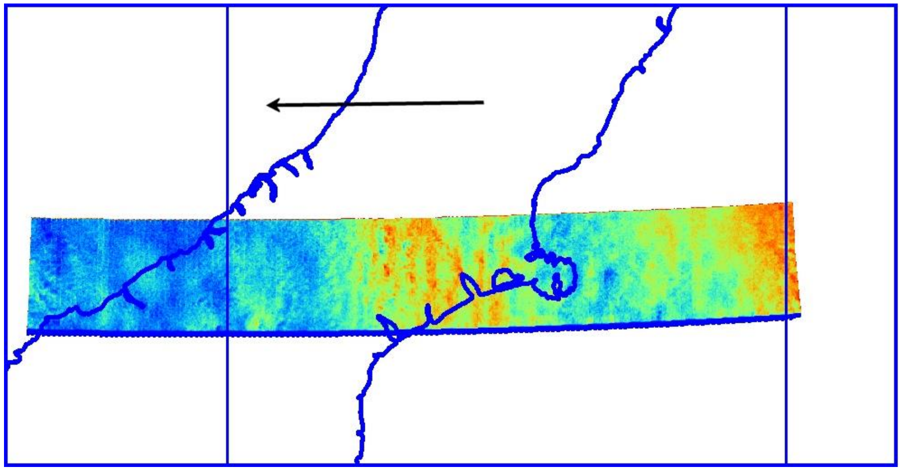
Example: Famous RF22 – Second Leg



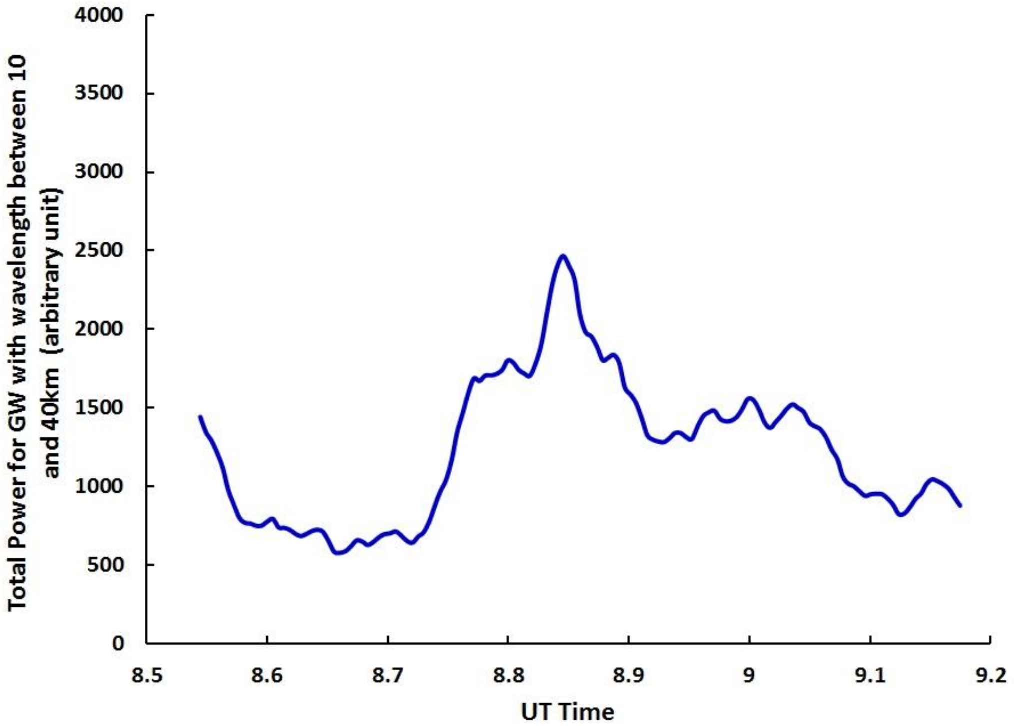


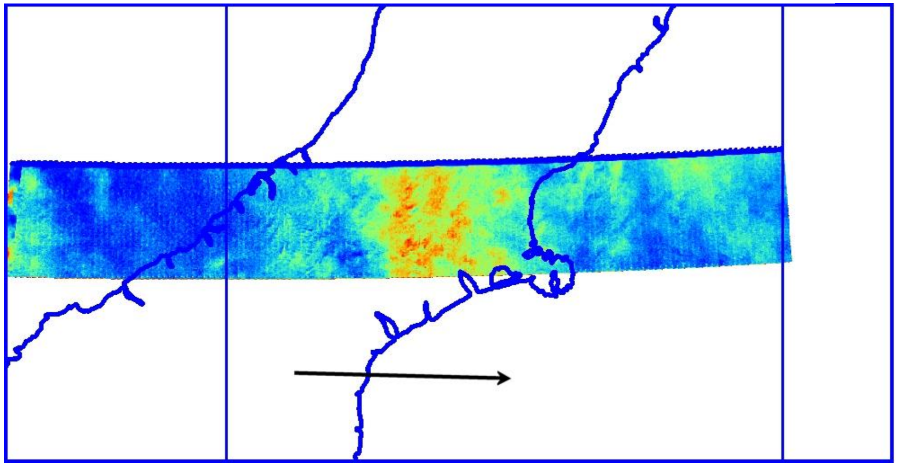
Example: Famous RF22 – Third Leg





Example: Famous RF22 – Fourth Leg





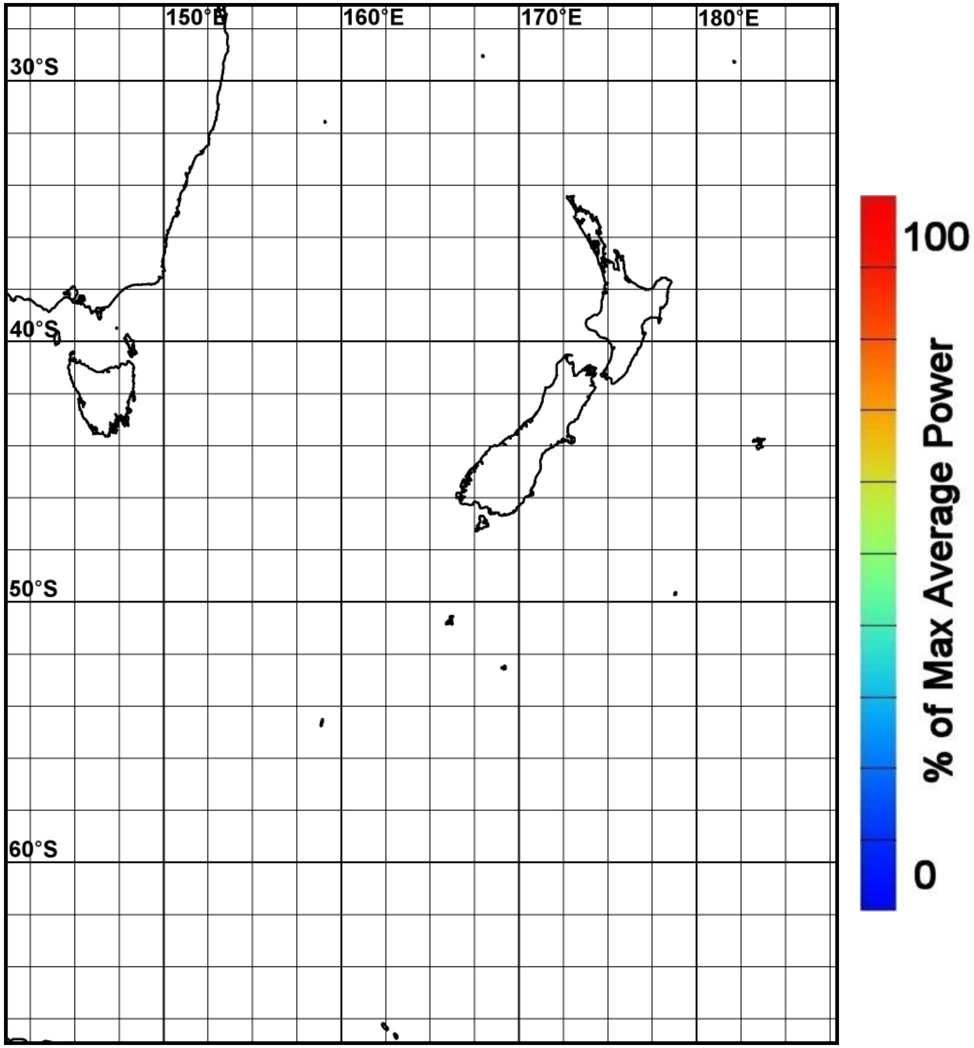
Small-Scale GW Power Regional Distribution

Power measurements for all the images taken during DEEPWAVE gathered in small regions (2.5° in longitude x 2 ° in latitude)

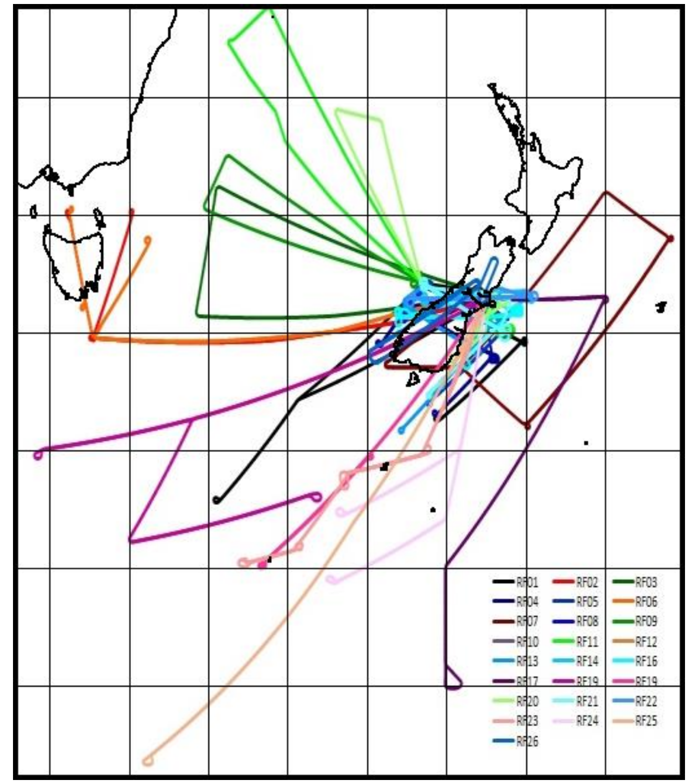
- Average value for each bin
- Standard deviation for each bin
- Regional distribution?

Small-Scale GW Power Regional Distribution

Average power

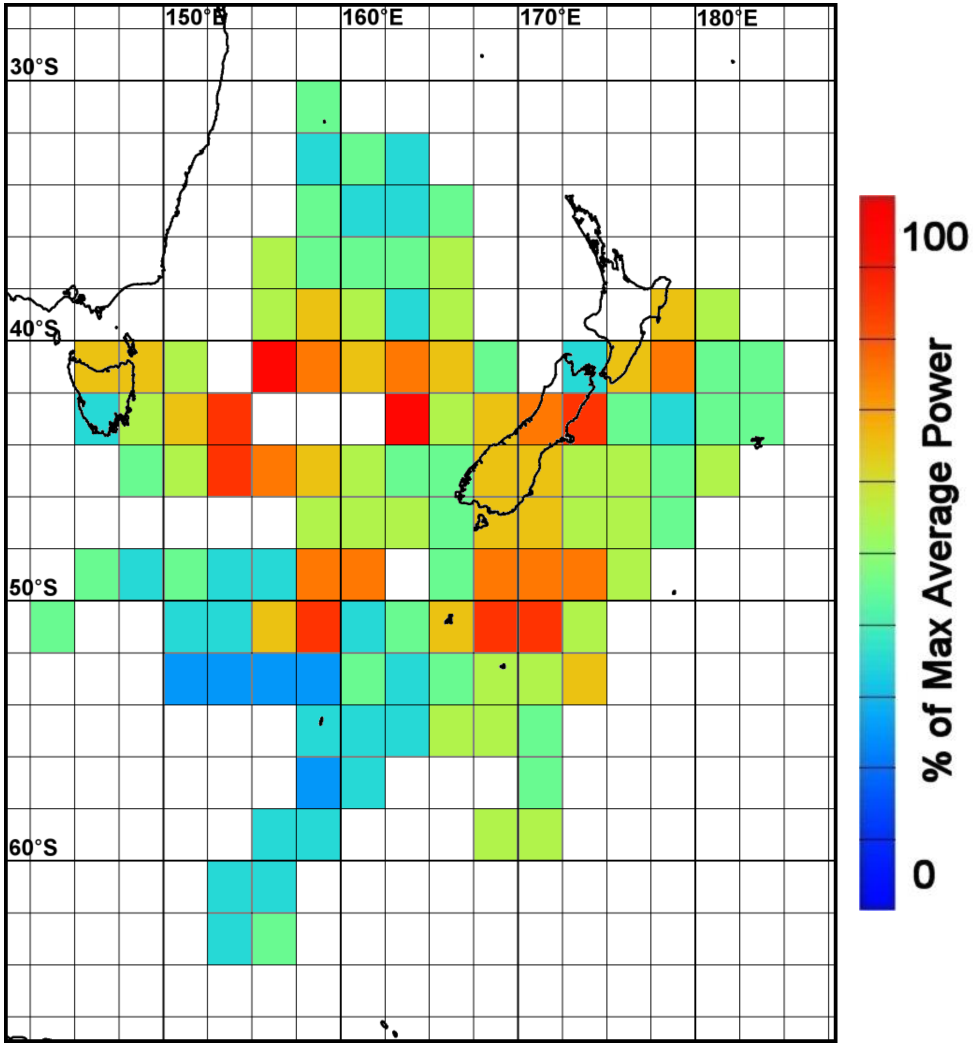


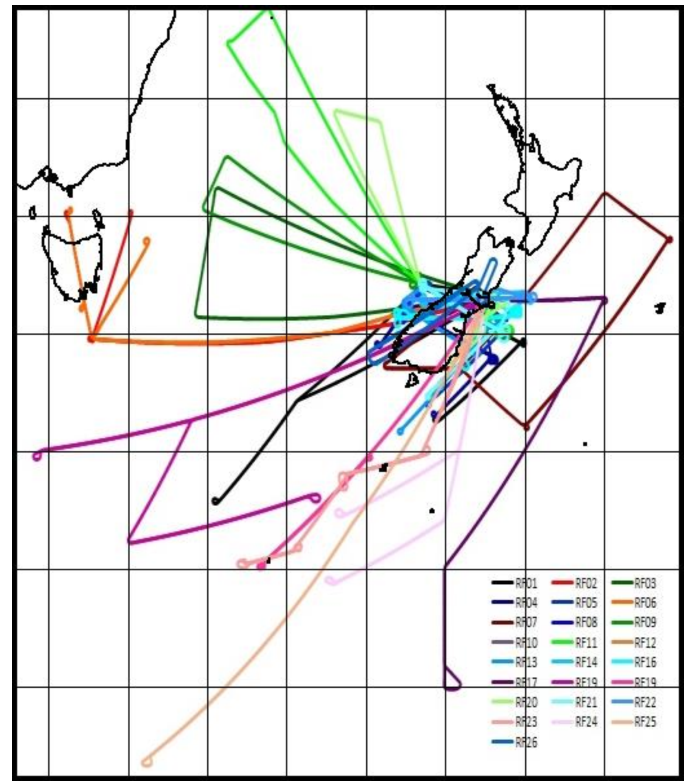
Each square is 2.5° (longitude) x 2° (latitude)



Small-Scale GW Power Regional Distribution

Average power

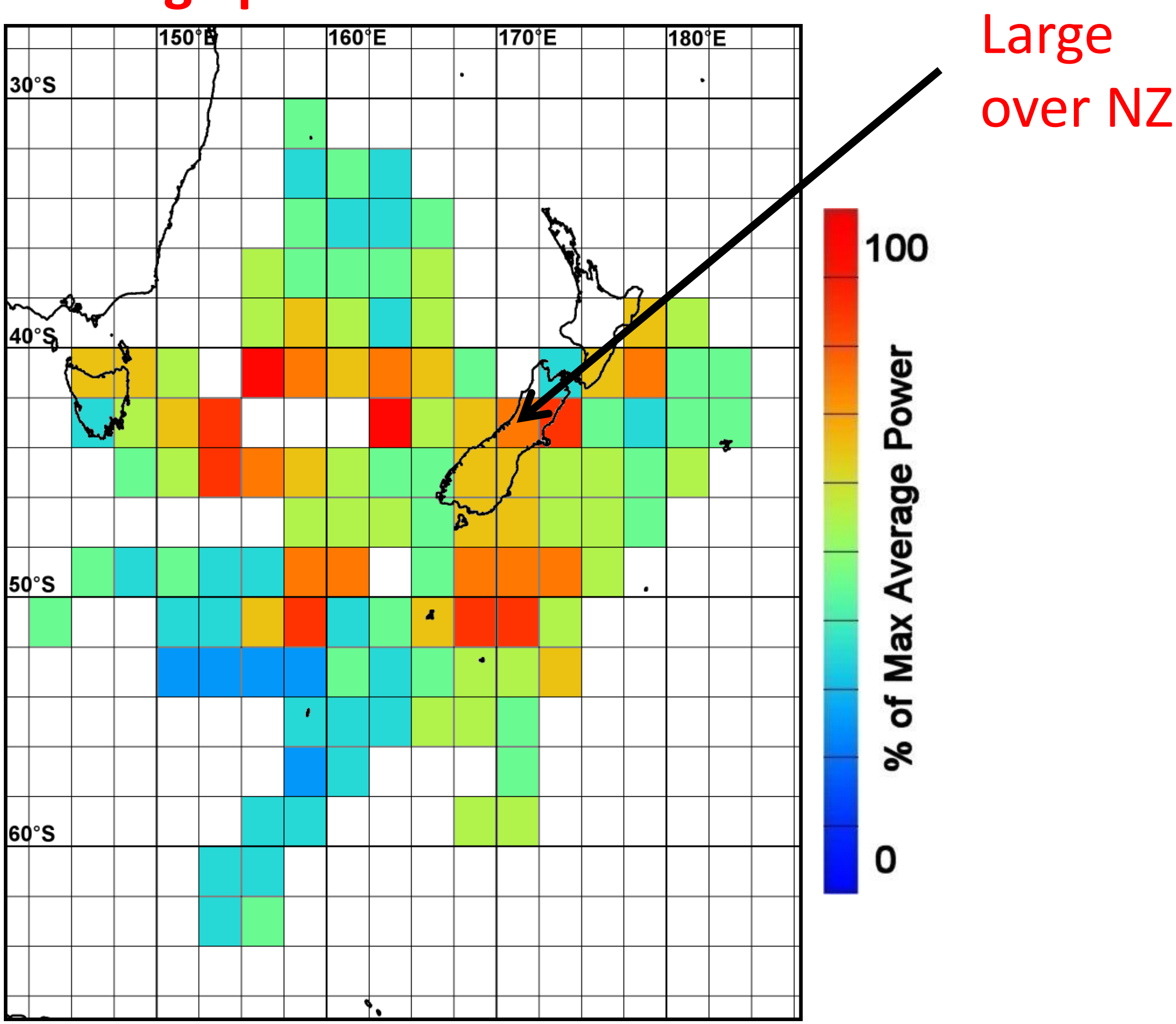




Each square is 2.5° (longitude) x 2° (latitude)

Small-Scale GW Power Regional Distribution

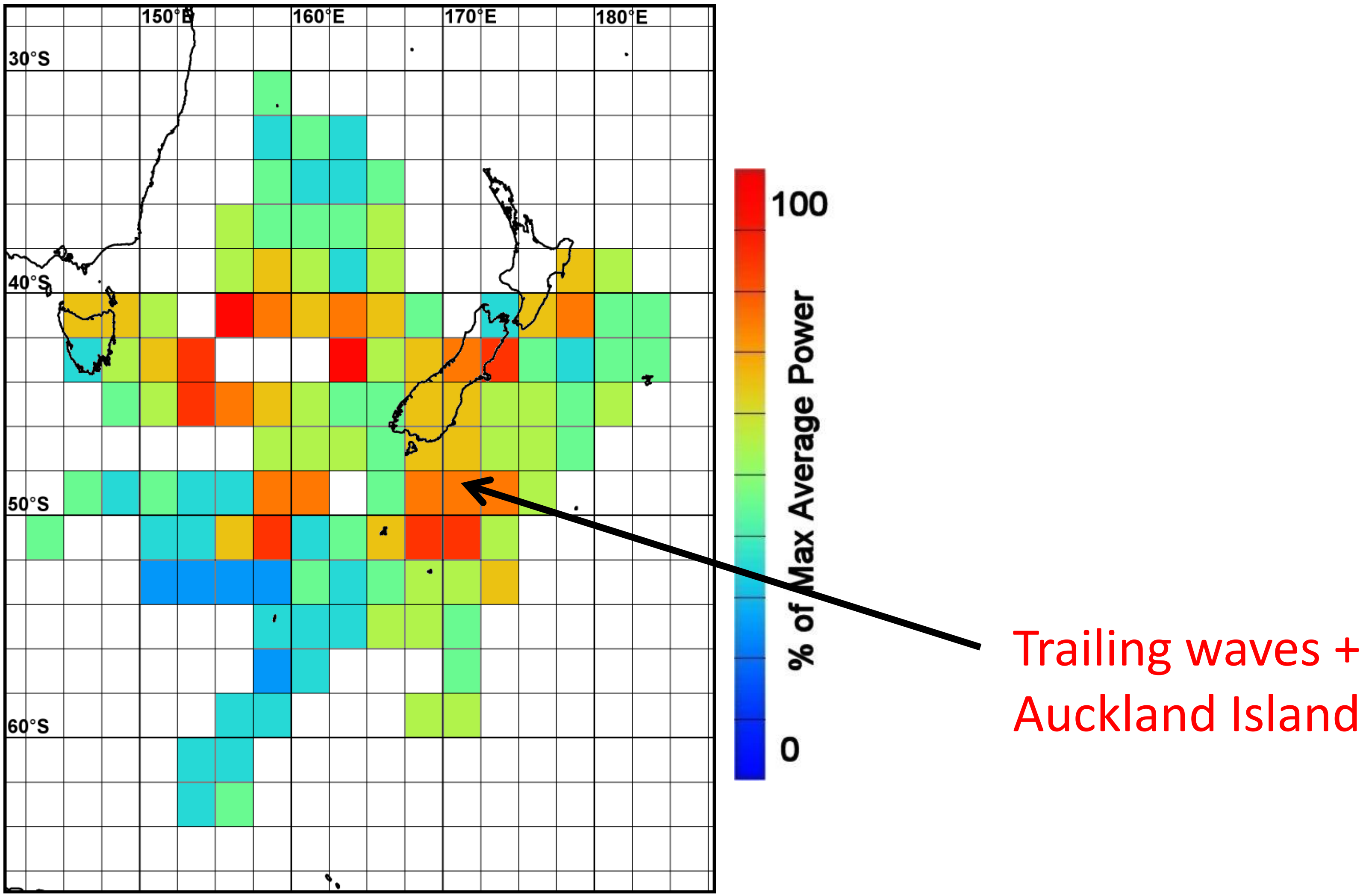
Average power



Each square is 2.5° (longitude) x 2° (latitude)

Small-Scale GW Power Regional Distribution

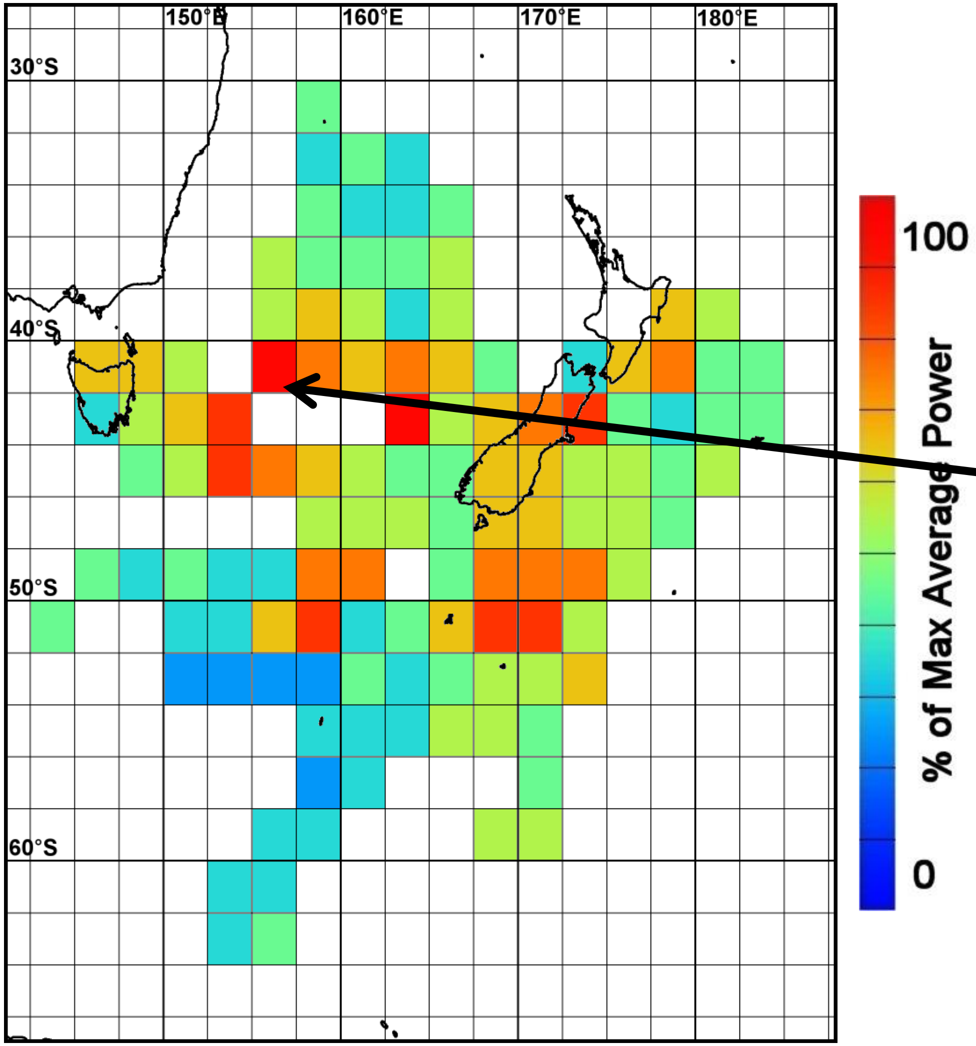
Average power



Each square is 2.5° (longitude) x 2° (latitude)

Small-Scale GW Power Regional Distribution

Average power

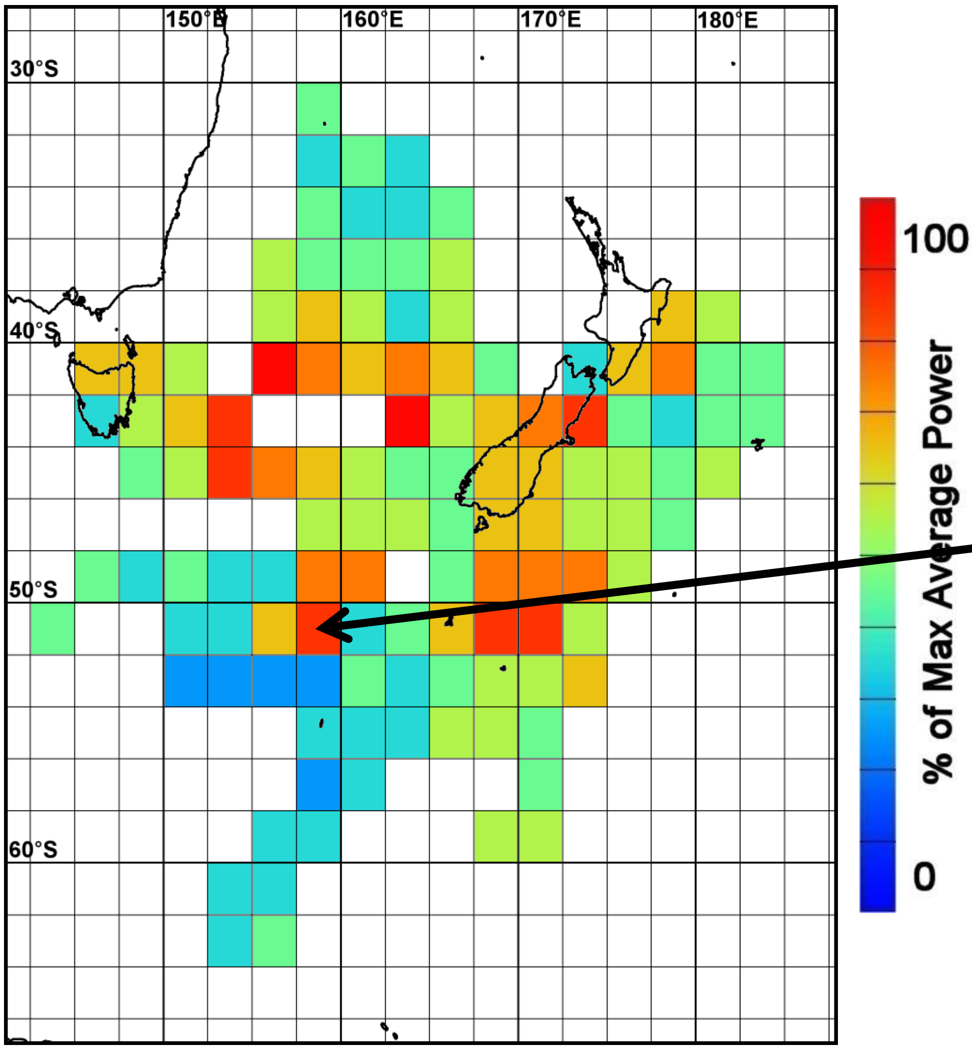


Lots of small scale GWs over the Tasman Sea

Each square is 2.5° (longitude) x 2° (latitude)

Small-Scale GW Power Regional Distribution

Average power

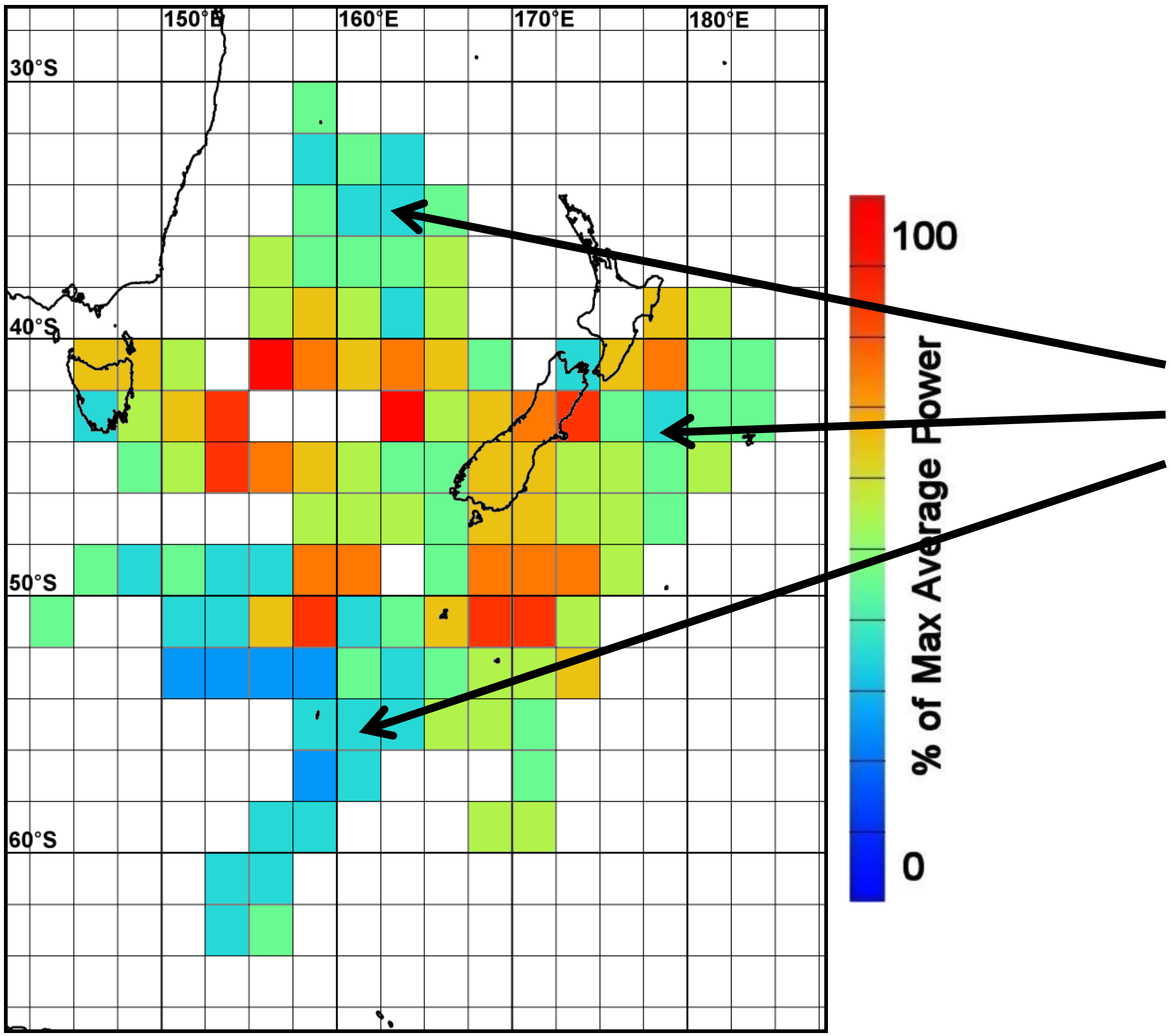


Only due to 1 flight (RF01)

Each square is 2.5° (longitude) x 2° (latitude)

Small-Scale GW Power Regional Distribution

Average power

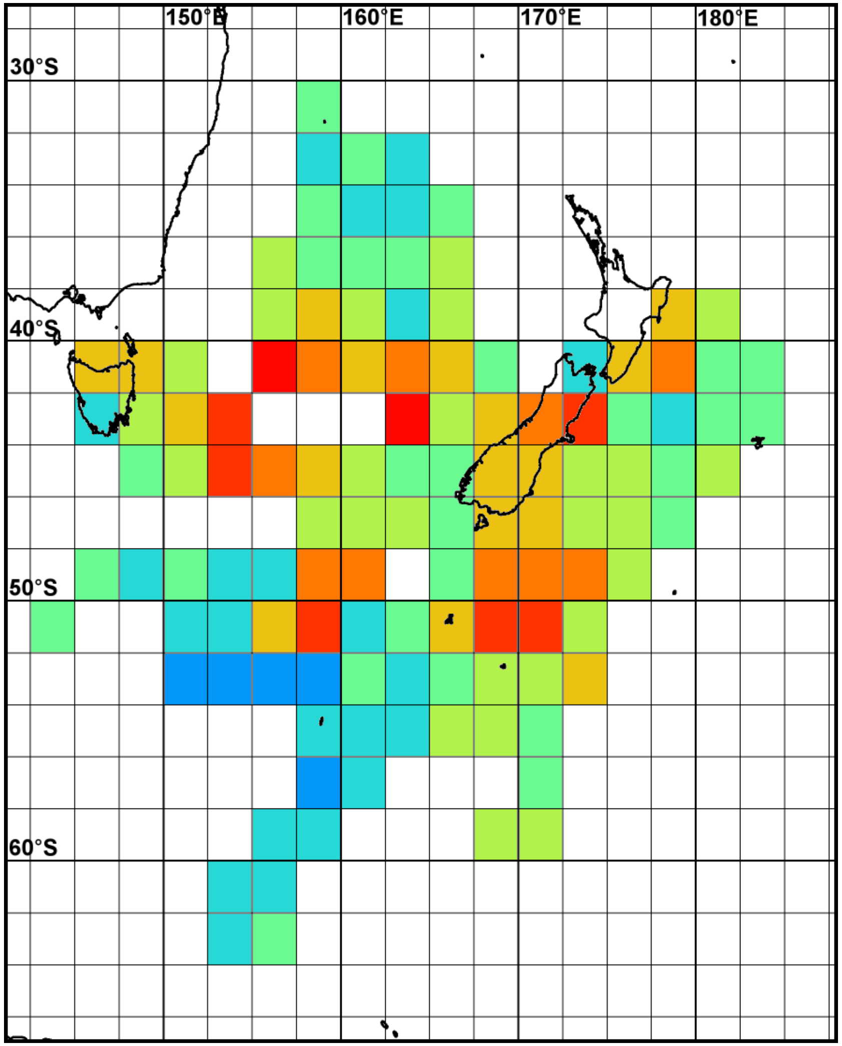


Not much over North of Tasman Sea, Pacific Ocean and Southern Ocean

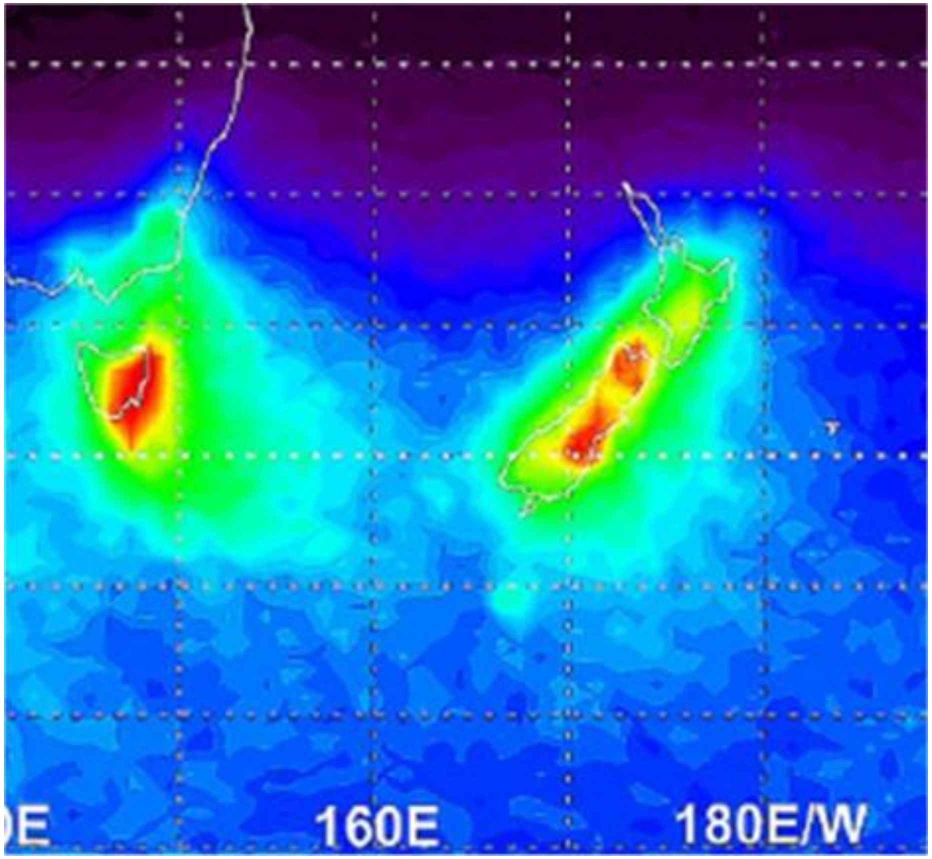
Each square is 2.5° (longitude) x 2° (latitude)

Comparison with Stratospheric Measurements

Average power



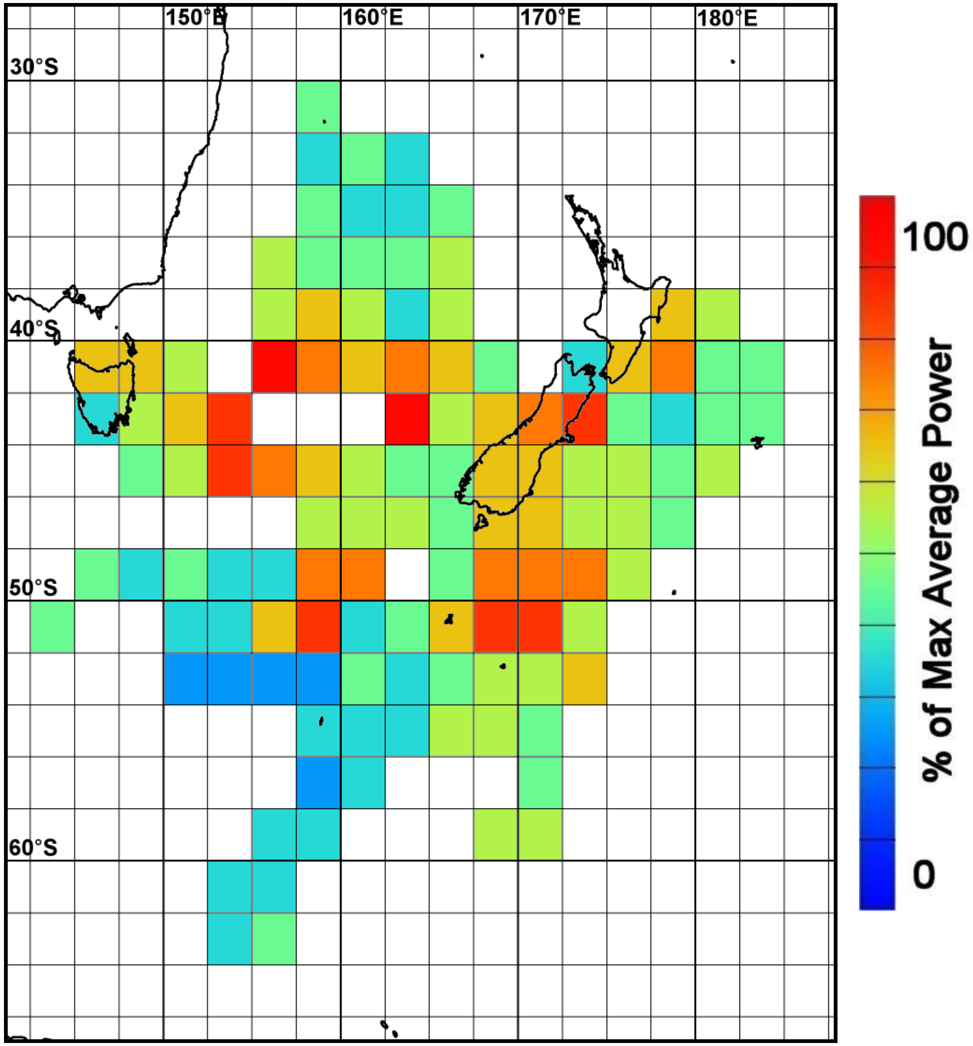
Each square is 2.5° (longitude) x 2° (latitude)



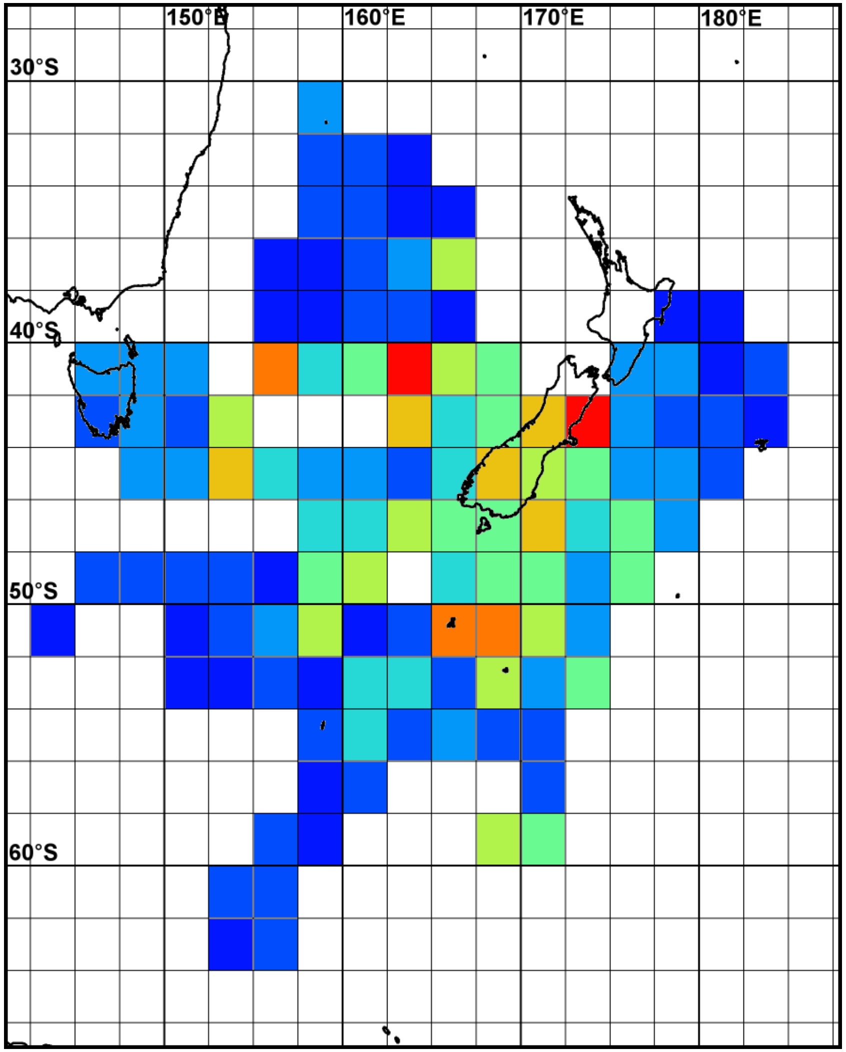
AIRS GW RMS brightness temperature during July 2003-2011 at 2 hPa (~41 km, courtesy Steve Eckermann)

Small-Scale GW Power Regional Distribution

Average power

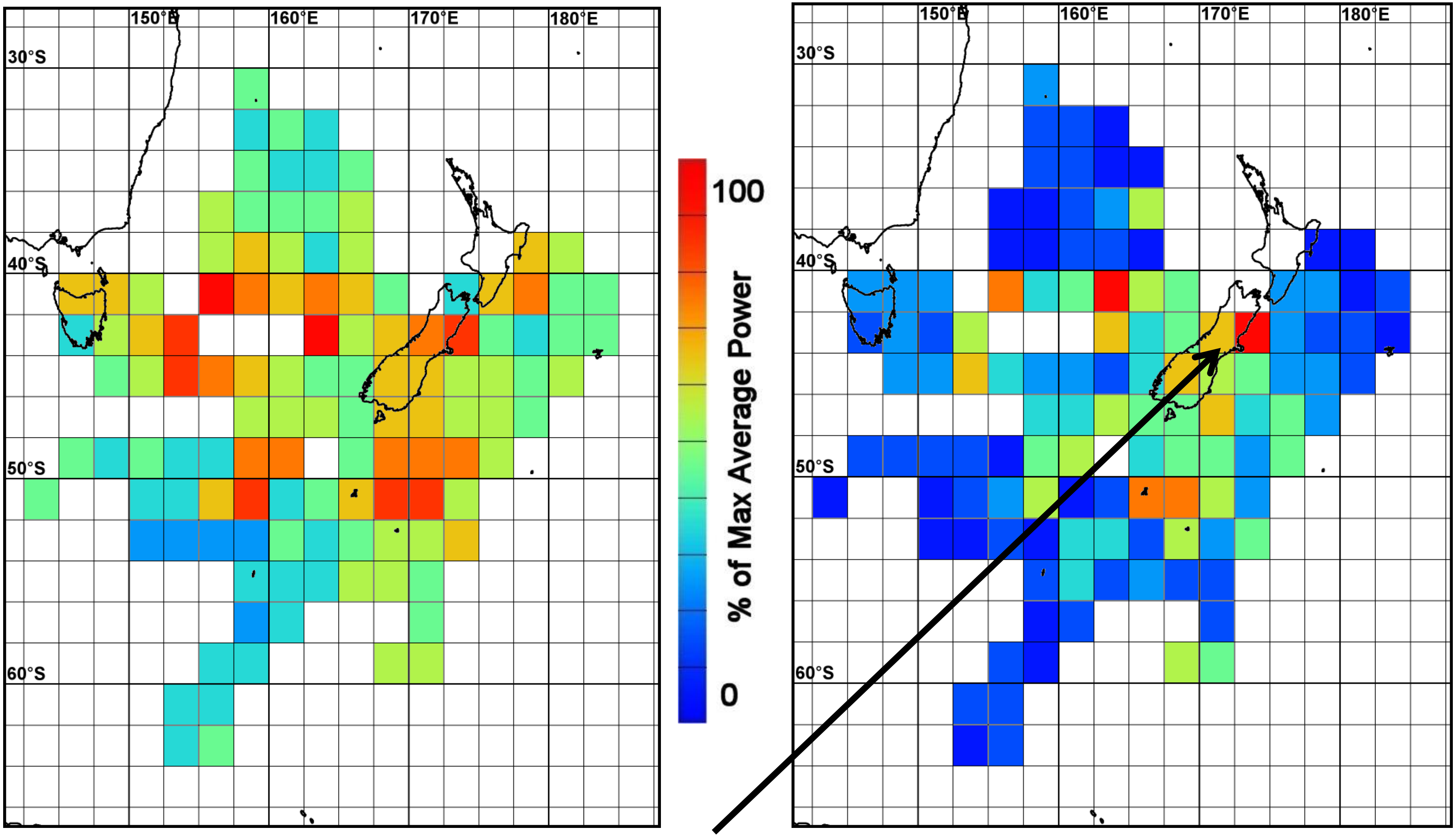


Standard deviation



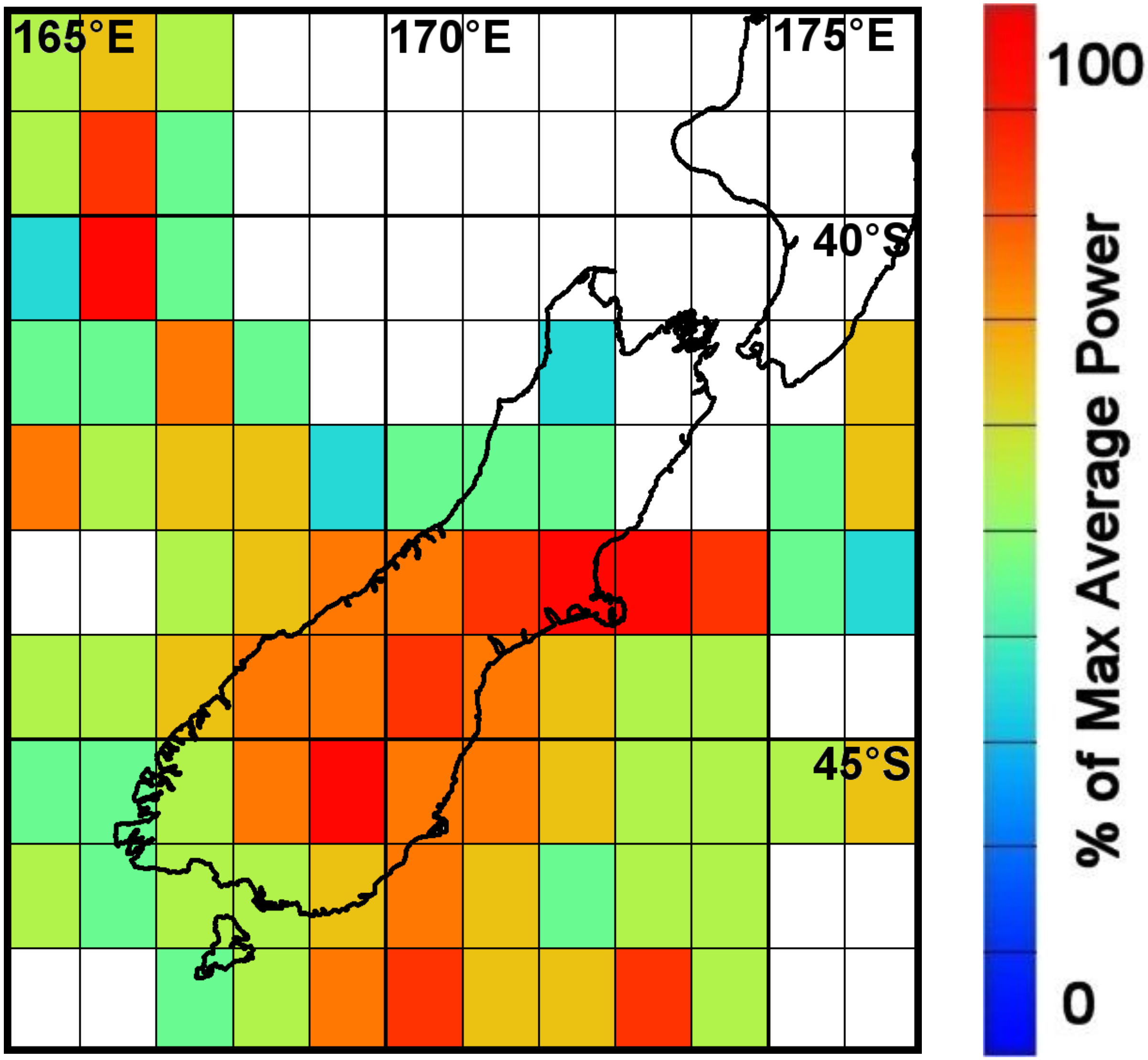
Small-Scale GW Power Regional Distribution

Average power **Standard deviation**

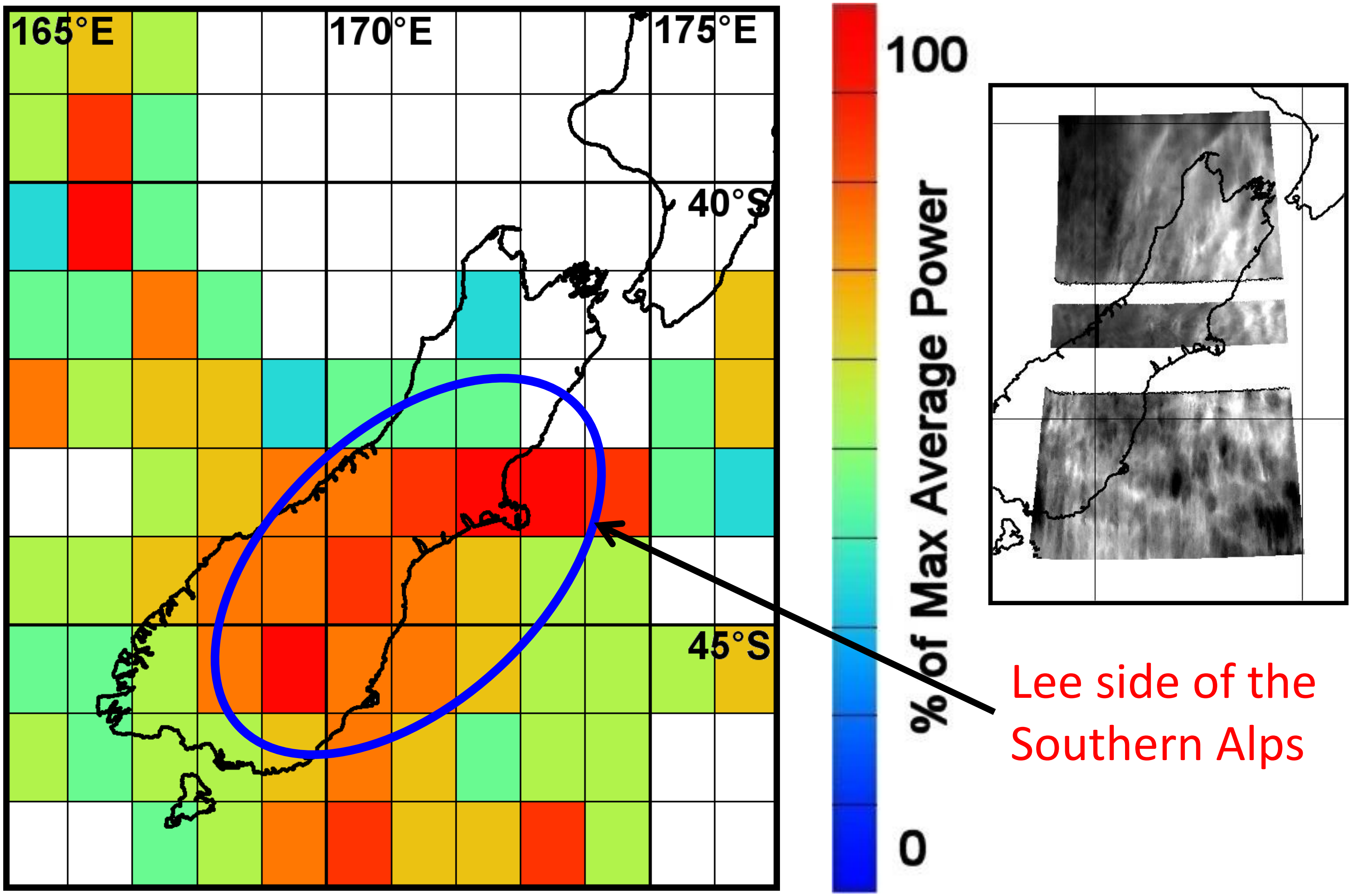


Larger variability over NZ: quiet nights vs active nights

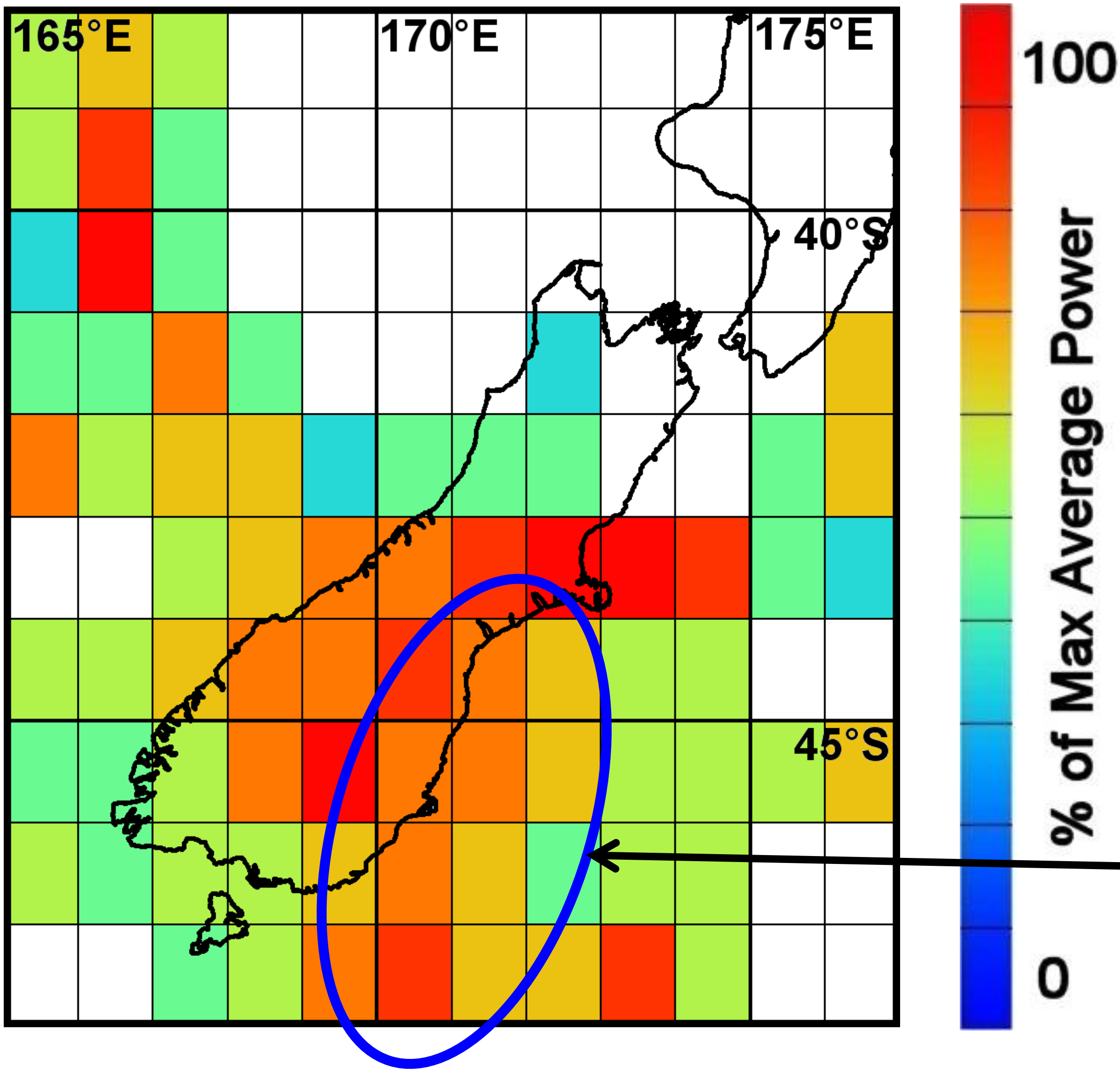
Small-Scale GW Power Over NZ (1°x1°)

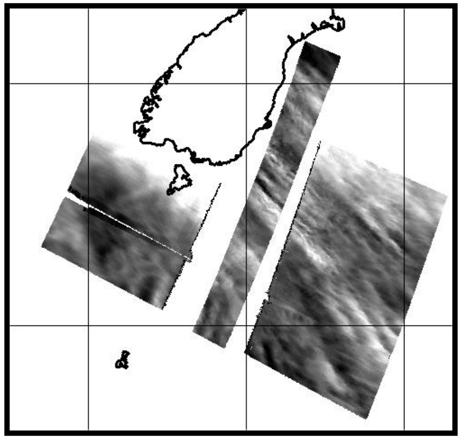


Small-Scale GW Power Over NZ (1°x1°)



Small-Scale GW Power Over NZ (1°x1°)



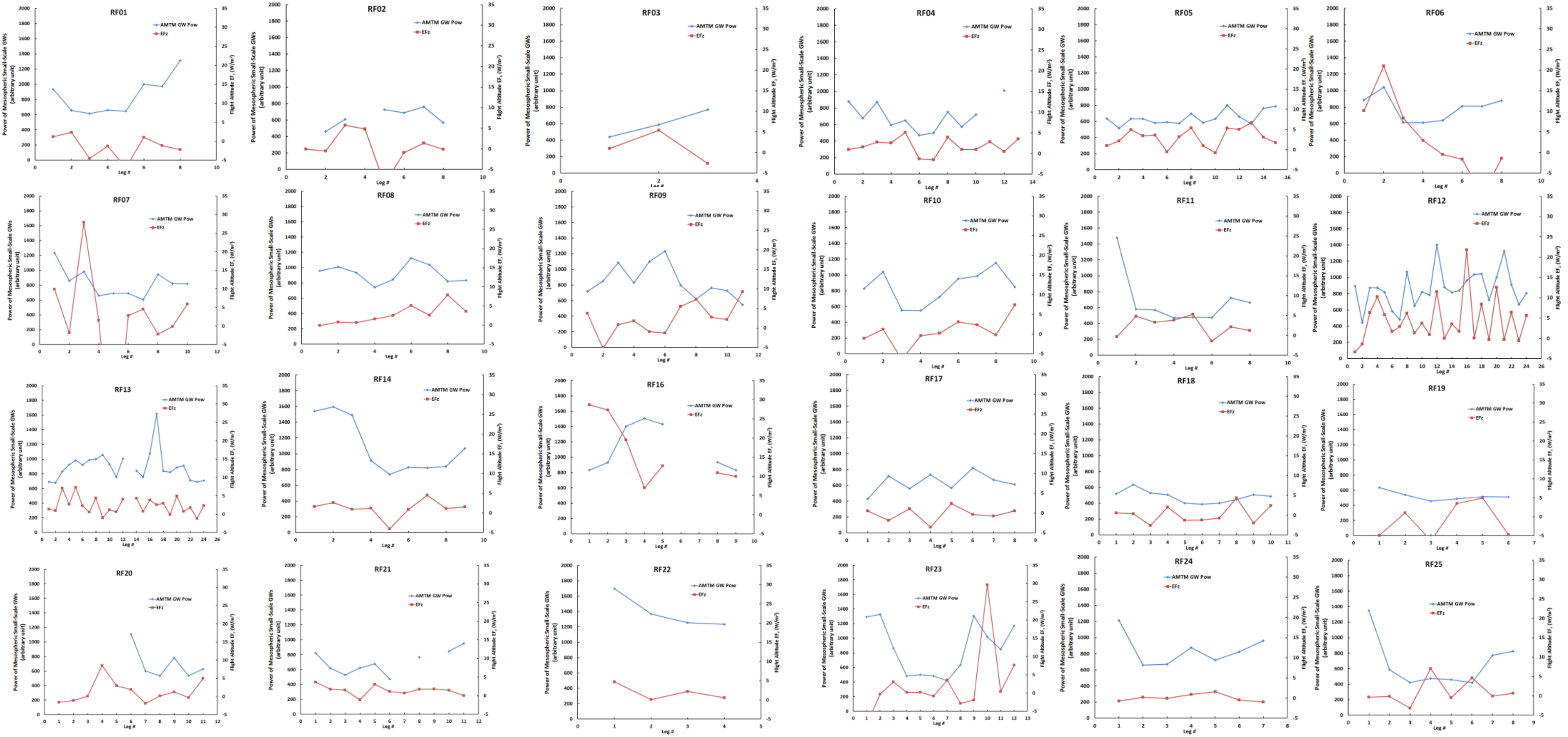


Trailing waves

Small-Scale GW Power

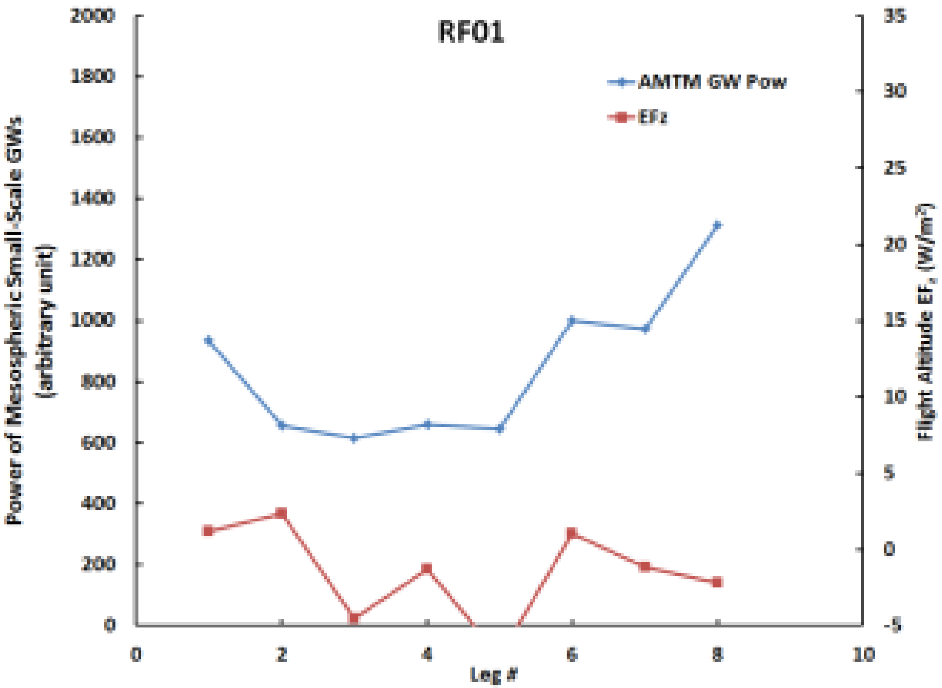
- Distribution similar to stratospheric measurements
- Higher power over NZ and east of Tasmania
- Smaller power over the open oceans
- Larger variability over NZ

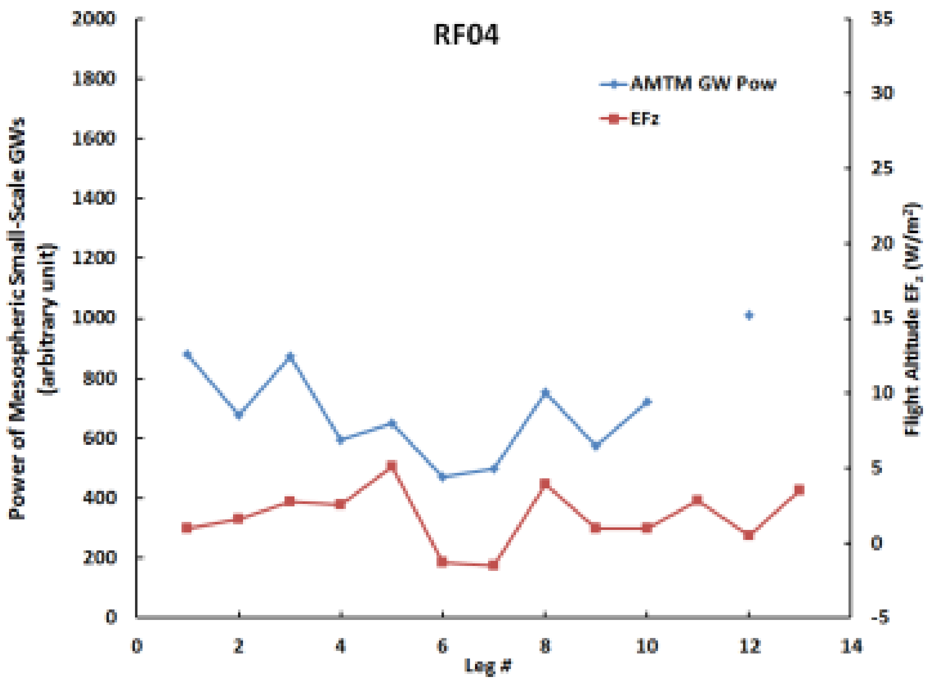
Comparison With Lower Atmosphere Measurements (Courtesy of R. Smith et al.)



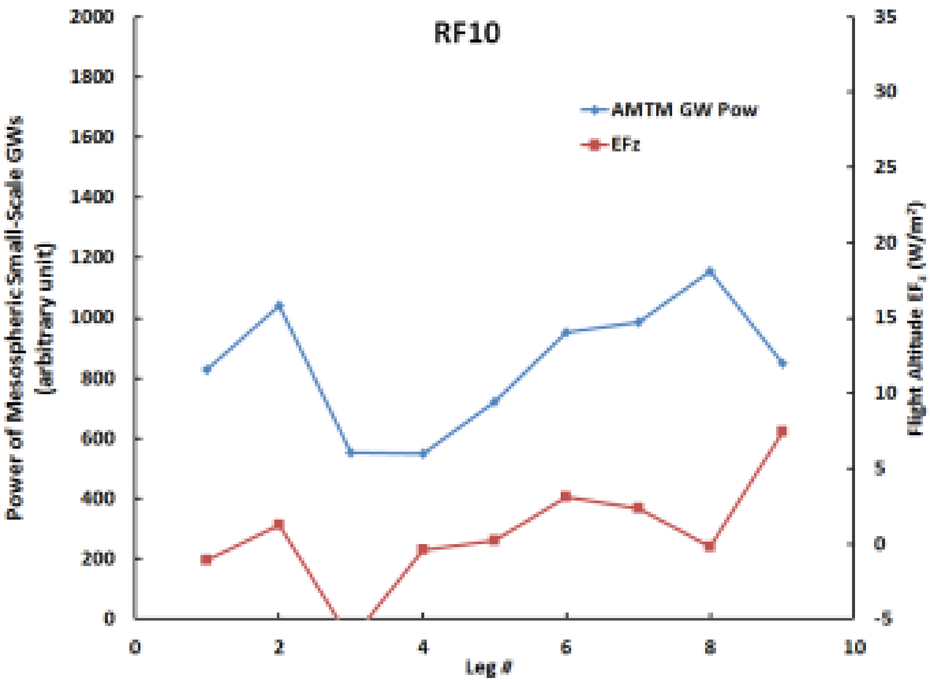
Surprisingly they track well most of the time

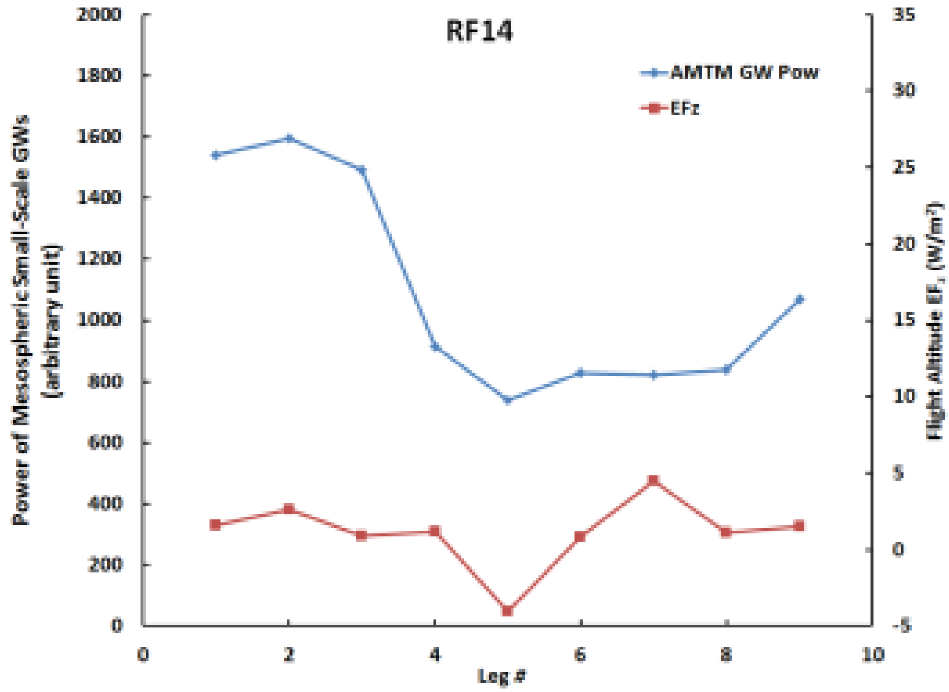
Comparison With Lower Atmosphere Measurements



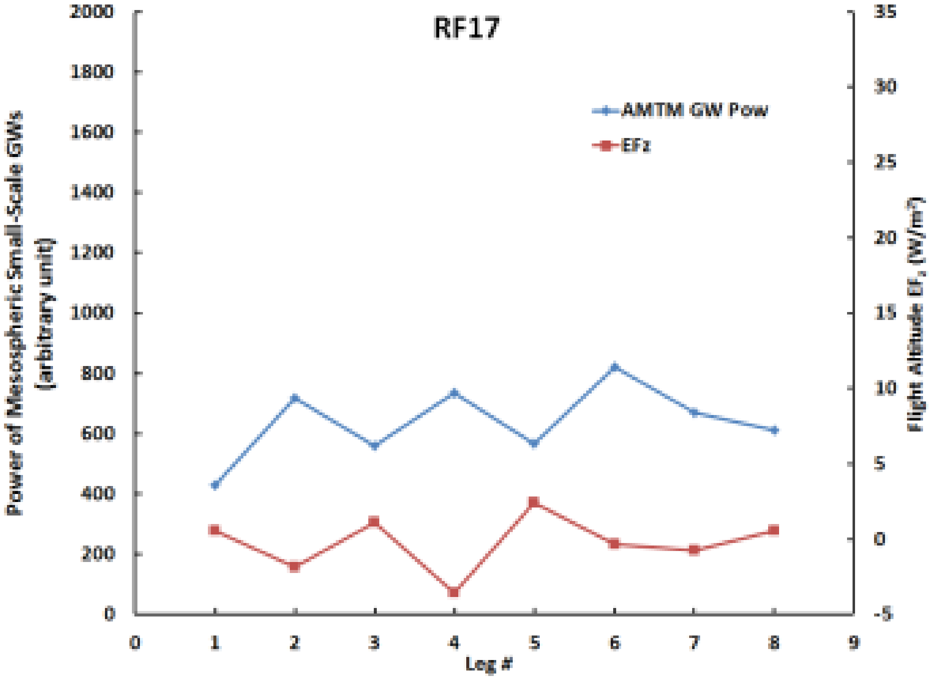


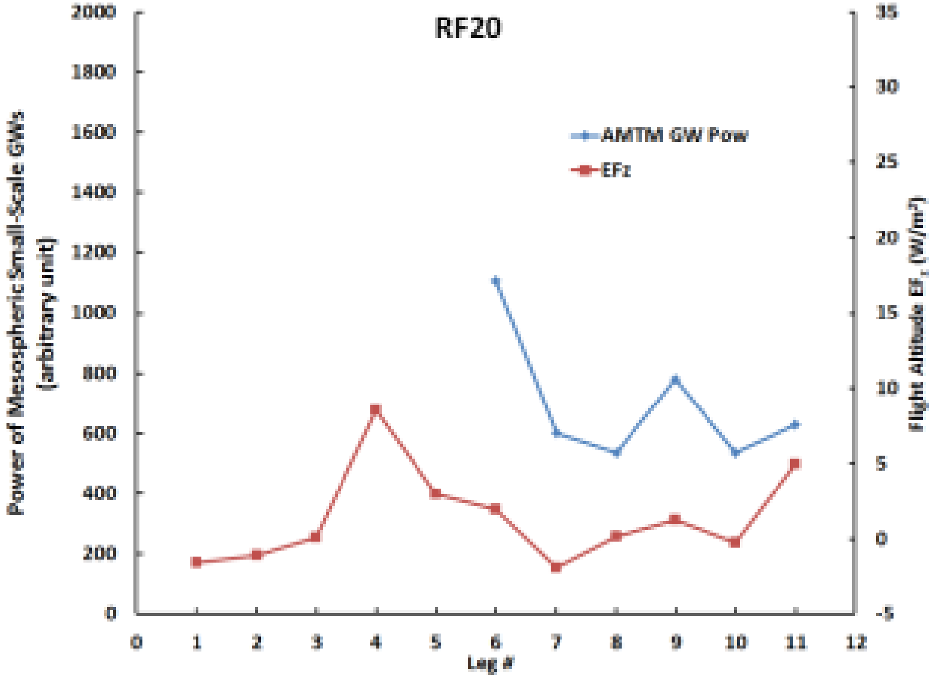
Comparison With Lower Atmosphere Measurements



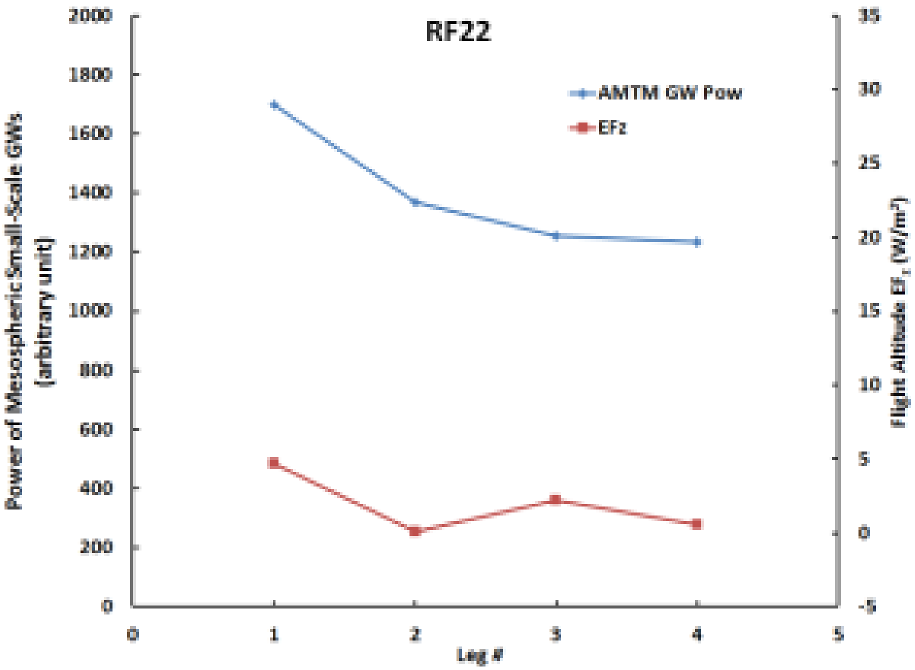


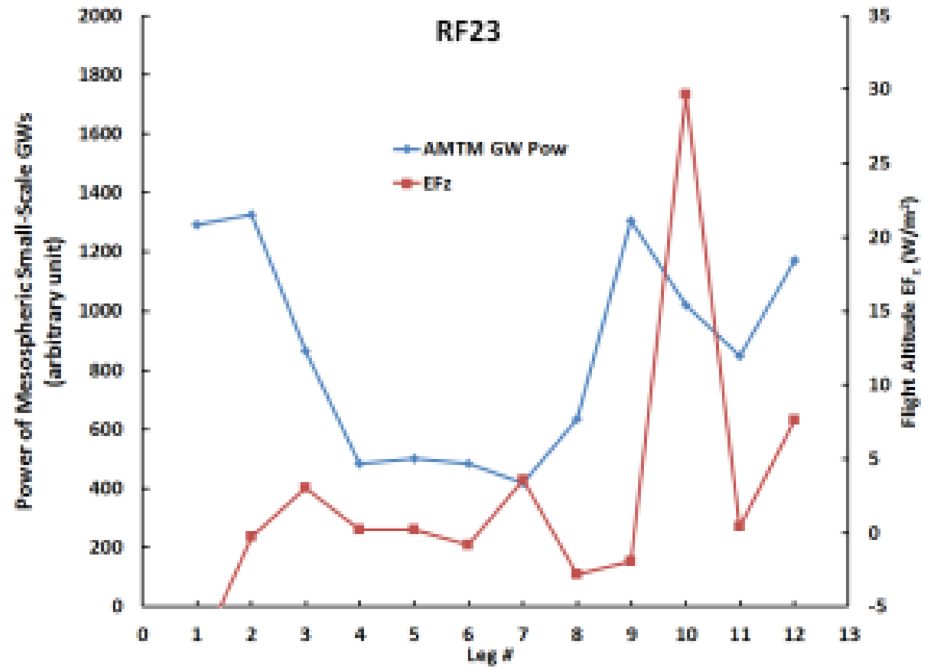
Comparison With Lower Atmosphere Measurements





Comparison With Lower Atmosphere Measurements

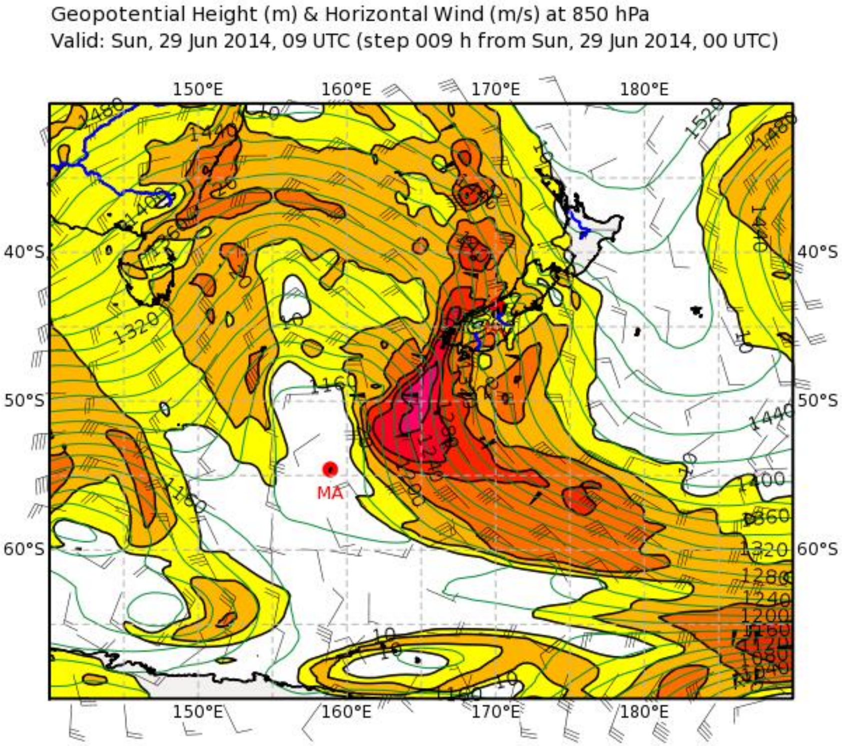


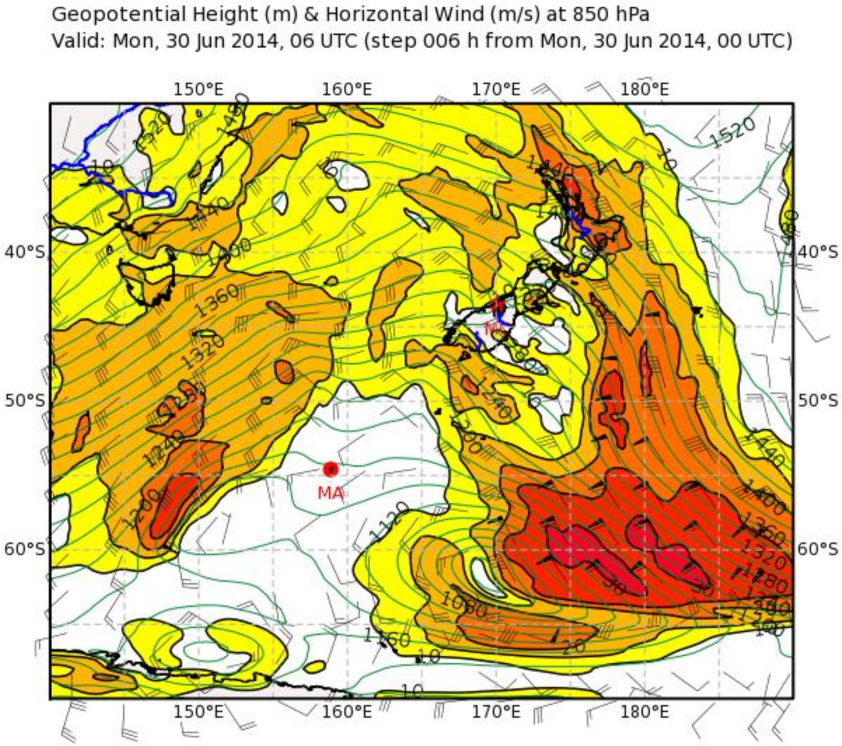


Comparison With Lower Atmosphere Measurements

- Not supposed to do that (not so straightforward, time difference, lots of things happening between troposphere and mesosphere)
- But they track relatively well!
- Both have small values over the open oceans
- From small to large over NZ, depending on the wind forcing

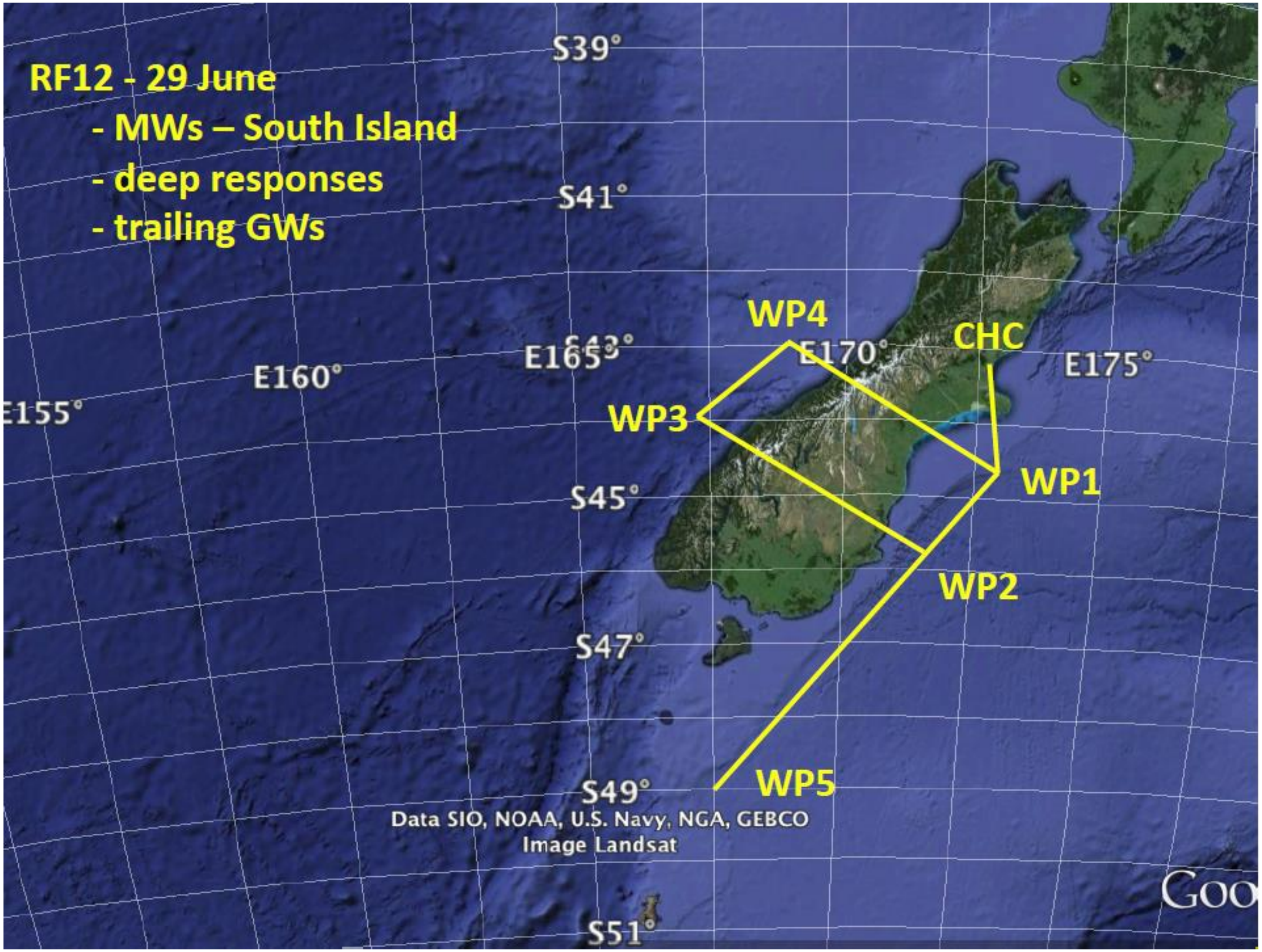
Comparison RF12 vs RF13



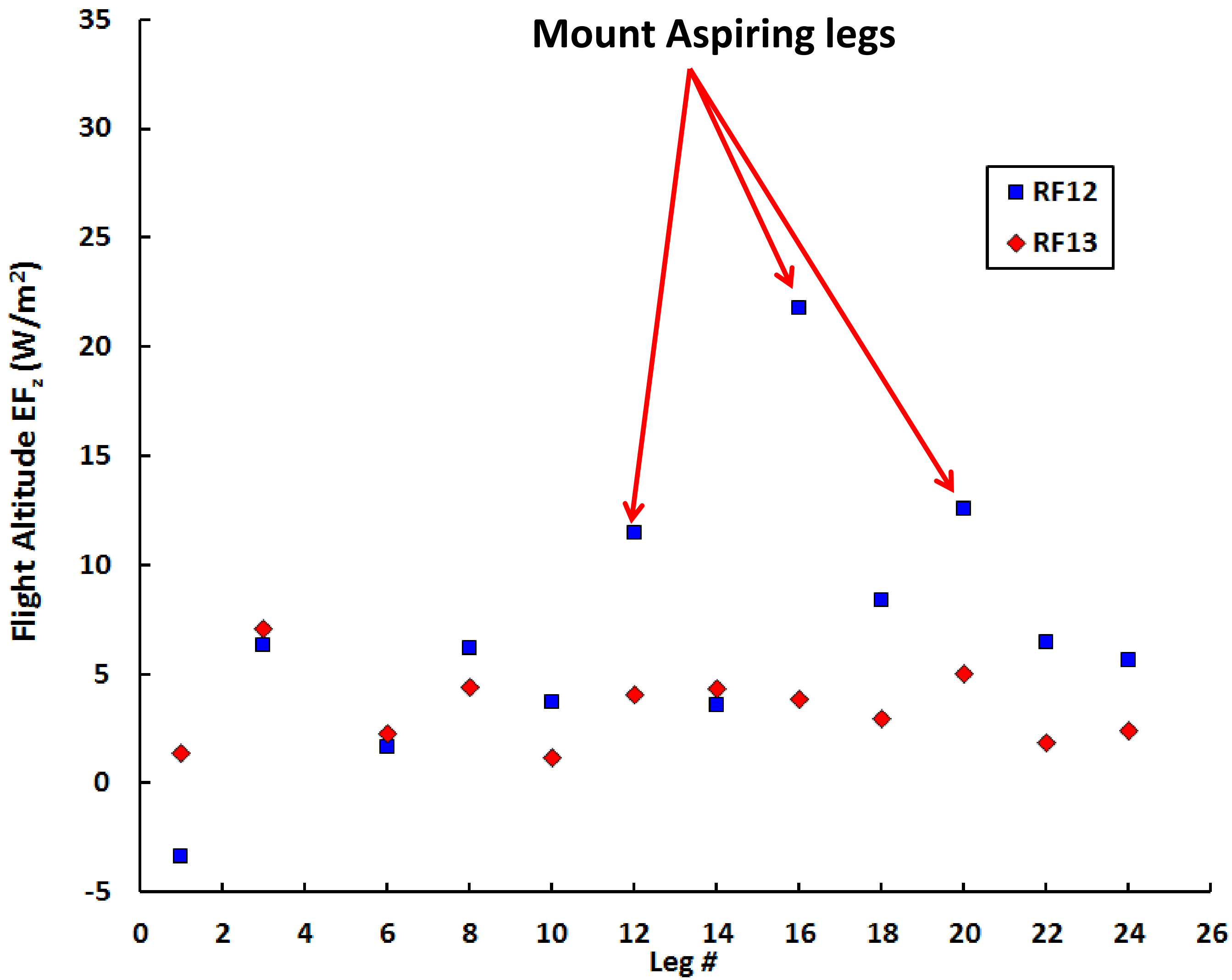


ECMWF Forecast (850hPa)

Flight Track

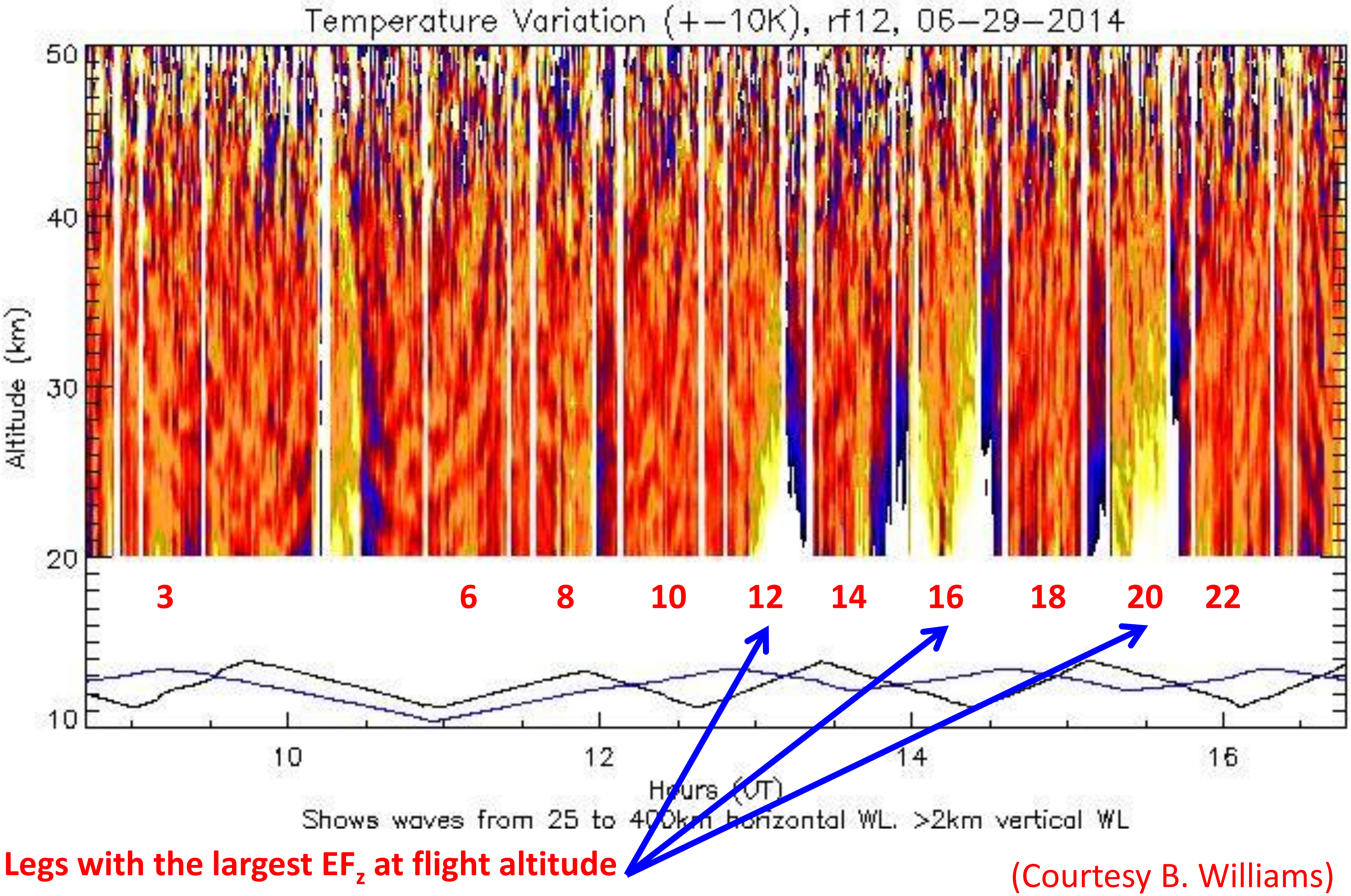


Flight Altitude EF_z (Cross-mountain legs only)



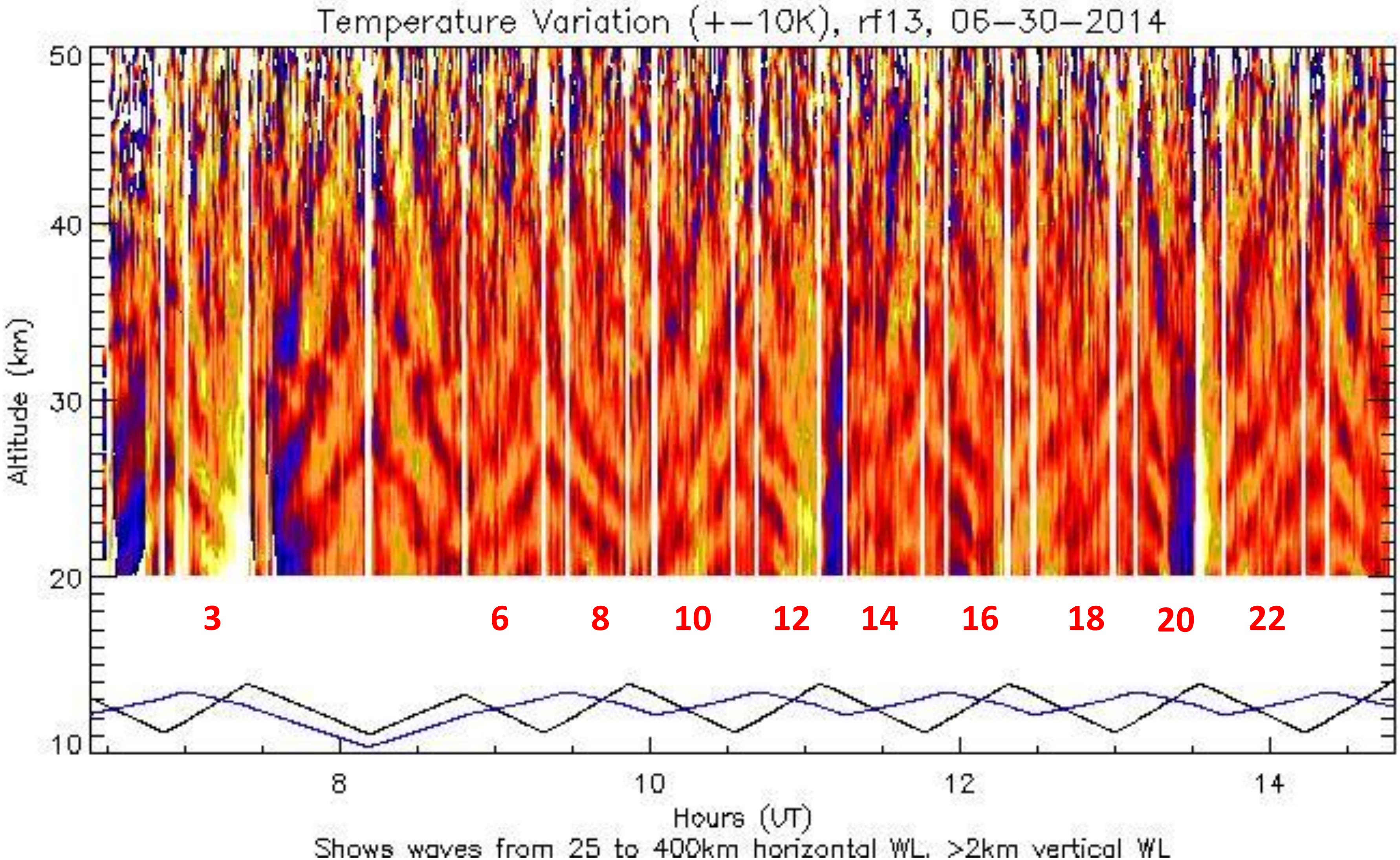
(Courtesy R. Smith et al.)

Rayleigh Lidar – RF12



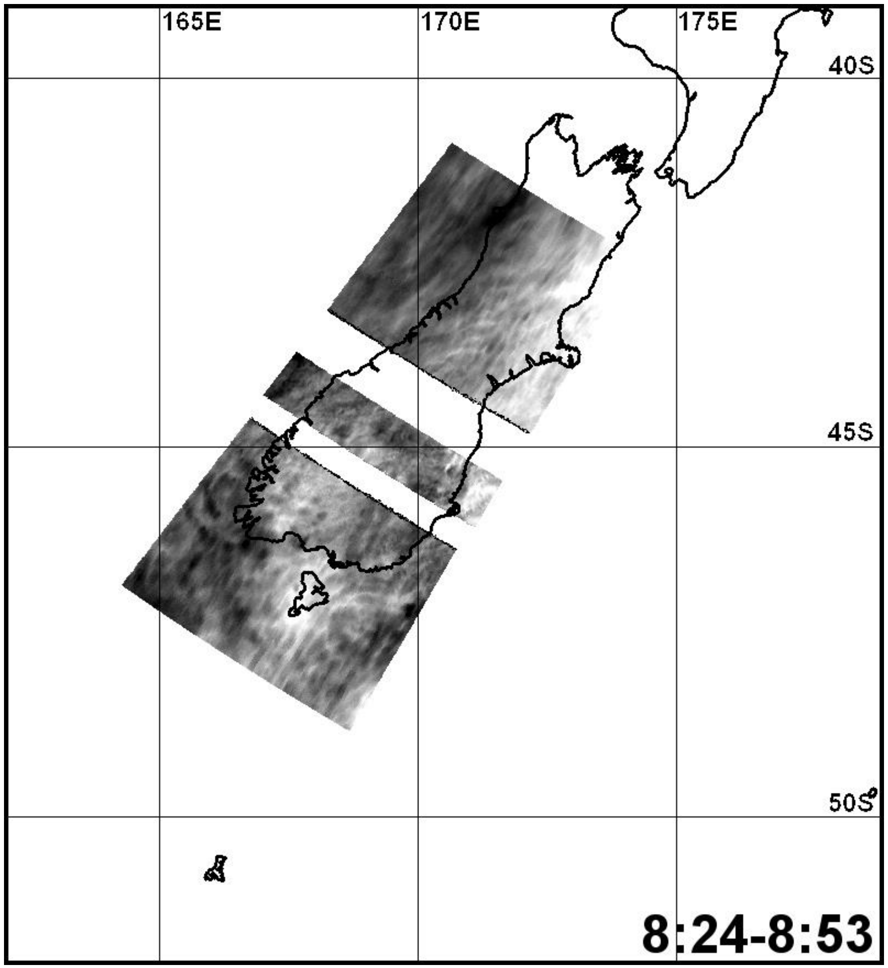
(Courtesy B. Williams)

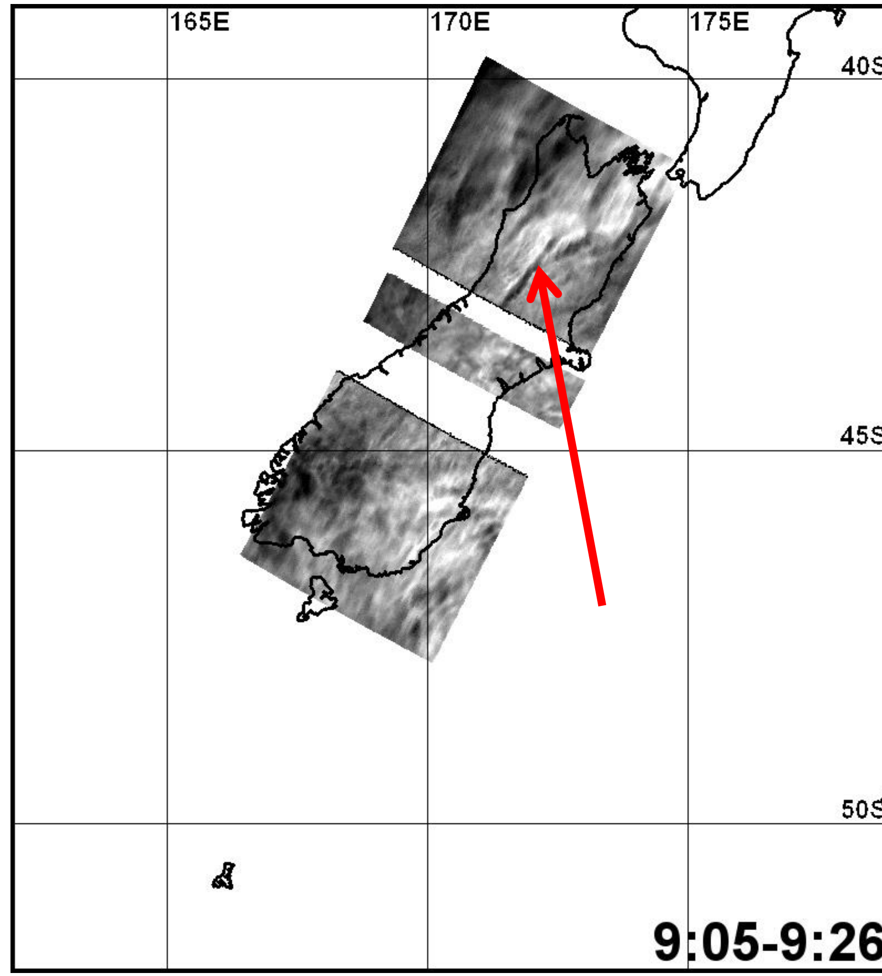
Rayleigh Lidar – RF13



(Courtesy B. Williams)

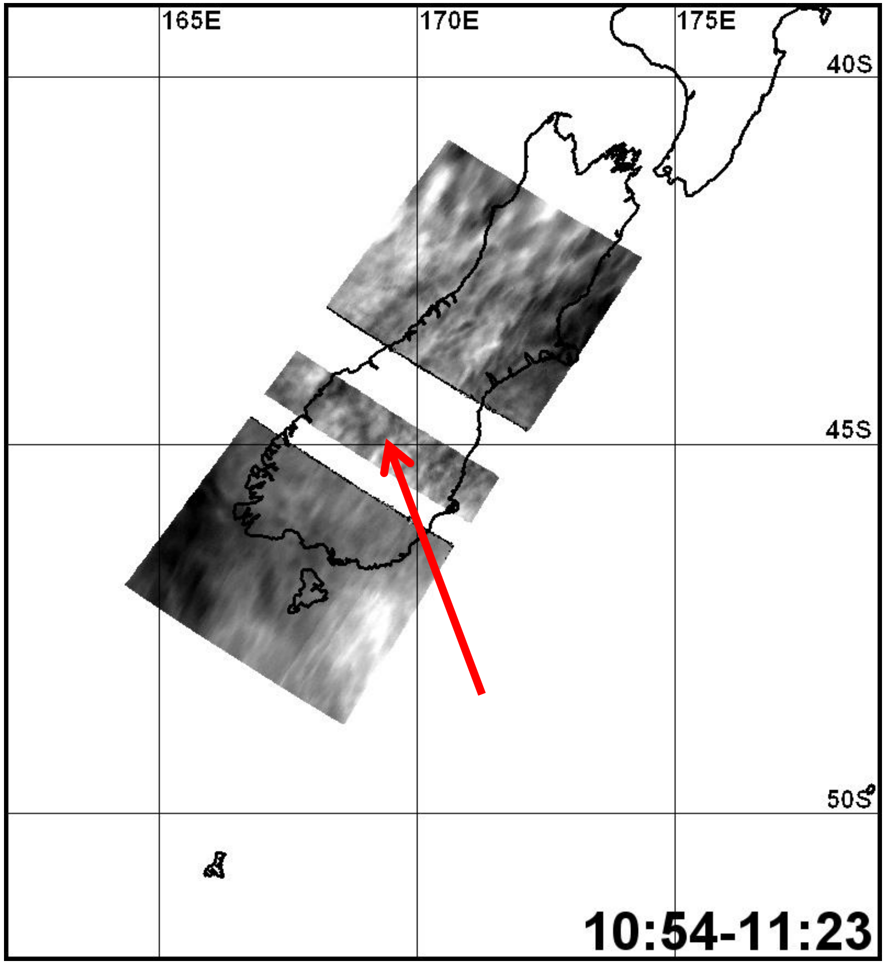
Mesospheric OH Emission – RF12



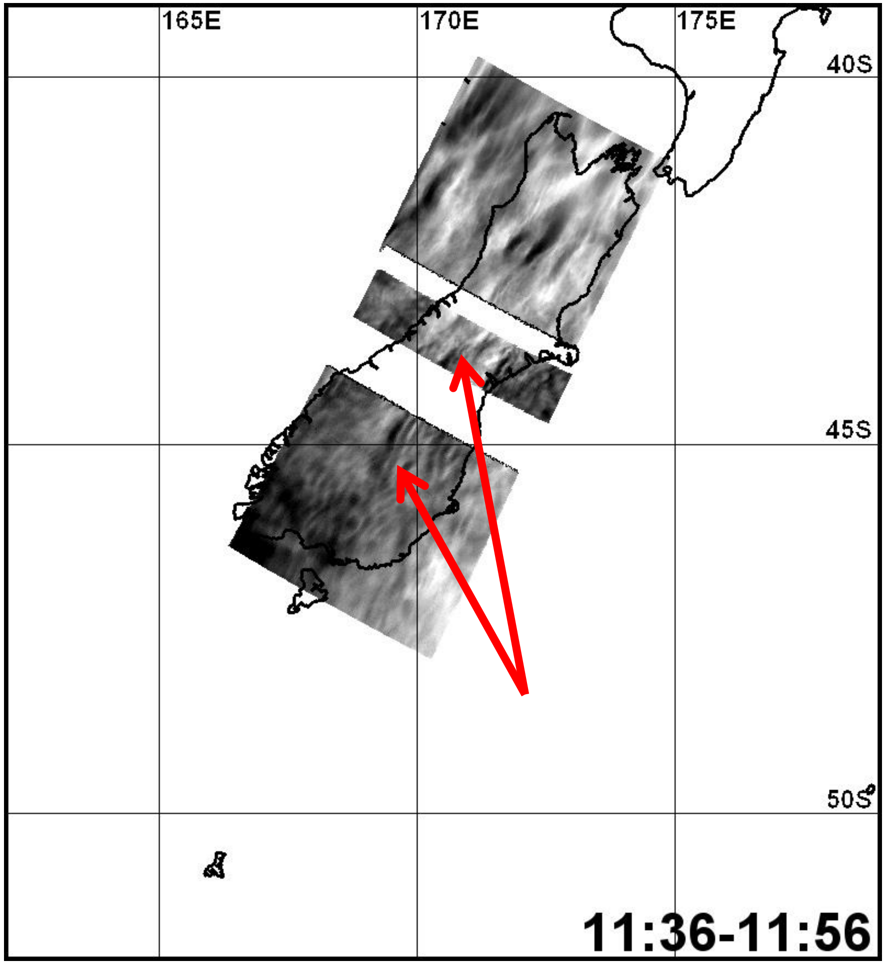


First 2 cross-mountain legs: nothing over Mt Cook or Aspiring
but a single structure further north after 9:00

Mesospheric OH Emission – RF12

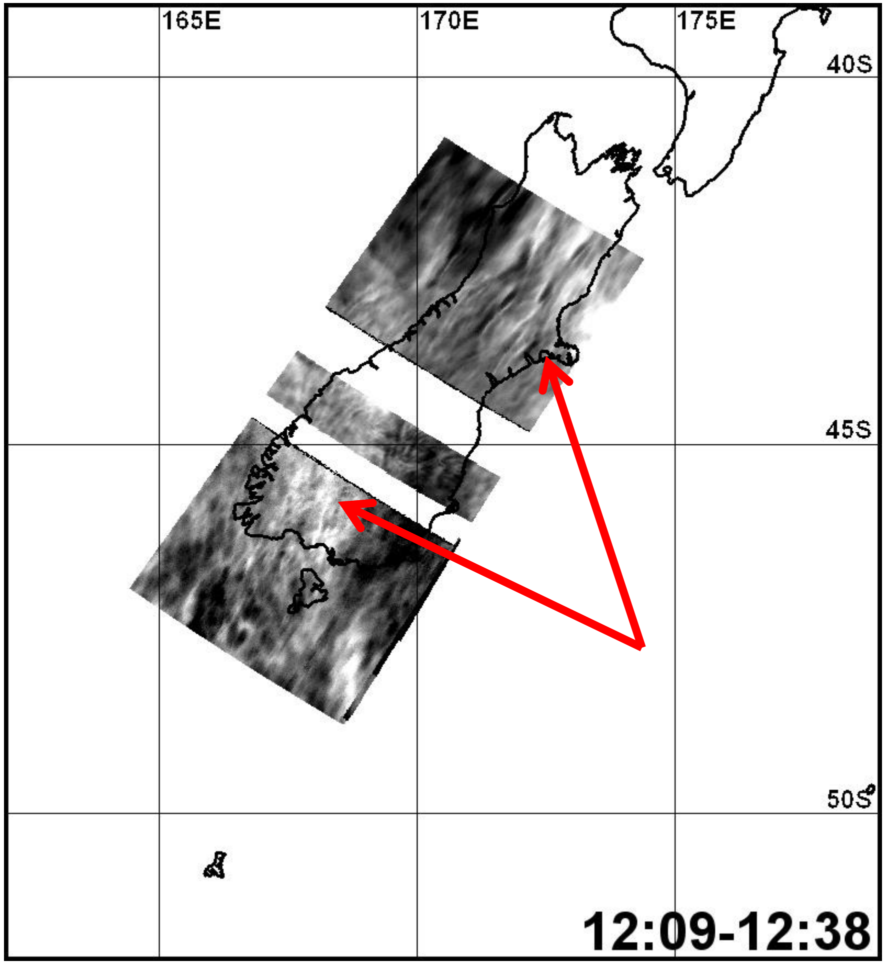


11:00 Beginning to appear

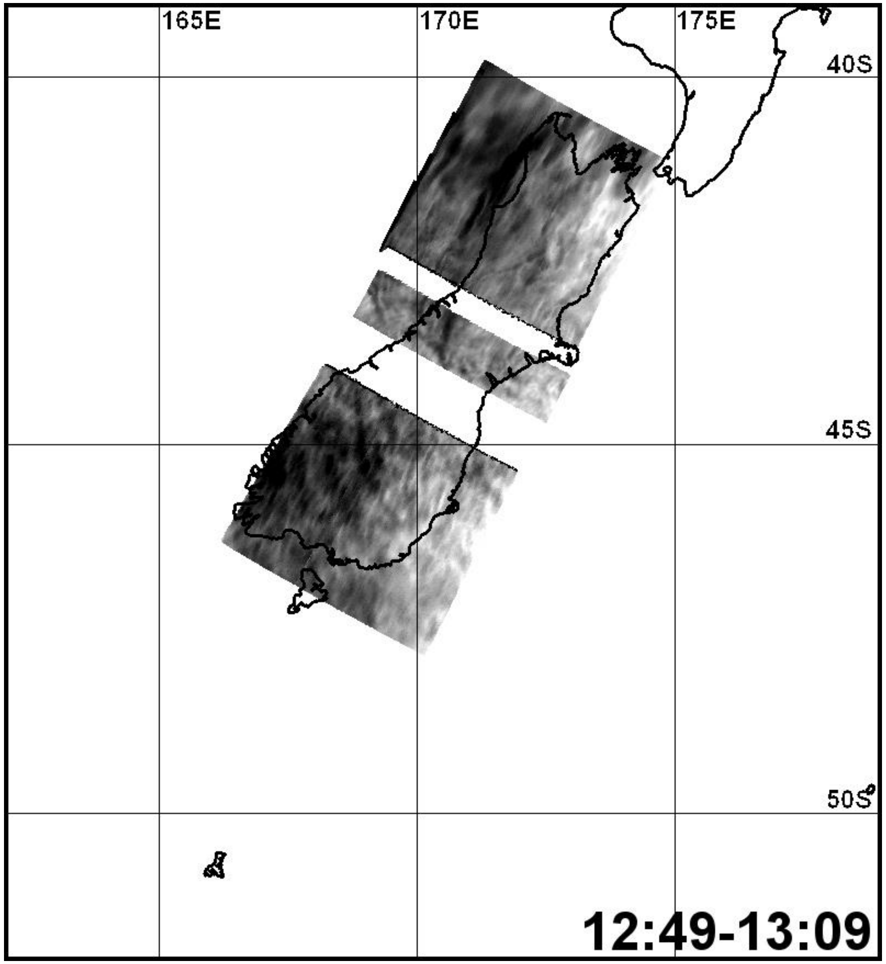


11:45 Visible over Mt Cook and Mt Aspiring, not very large extend

Mesospheric OH Emission – RF12

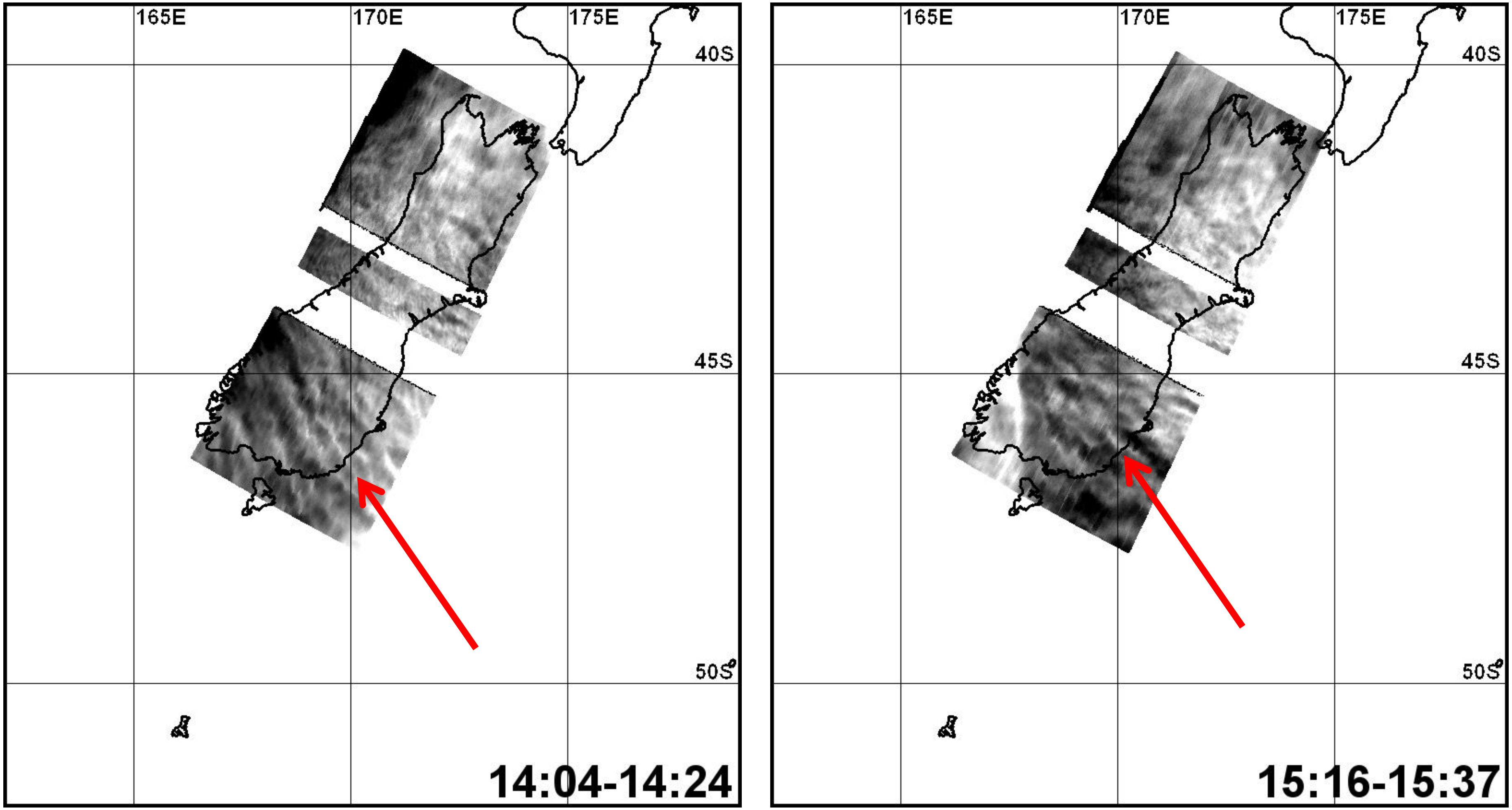


12:00-12:30 Full extent



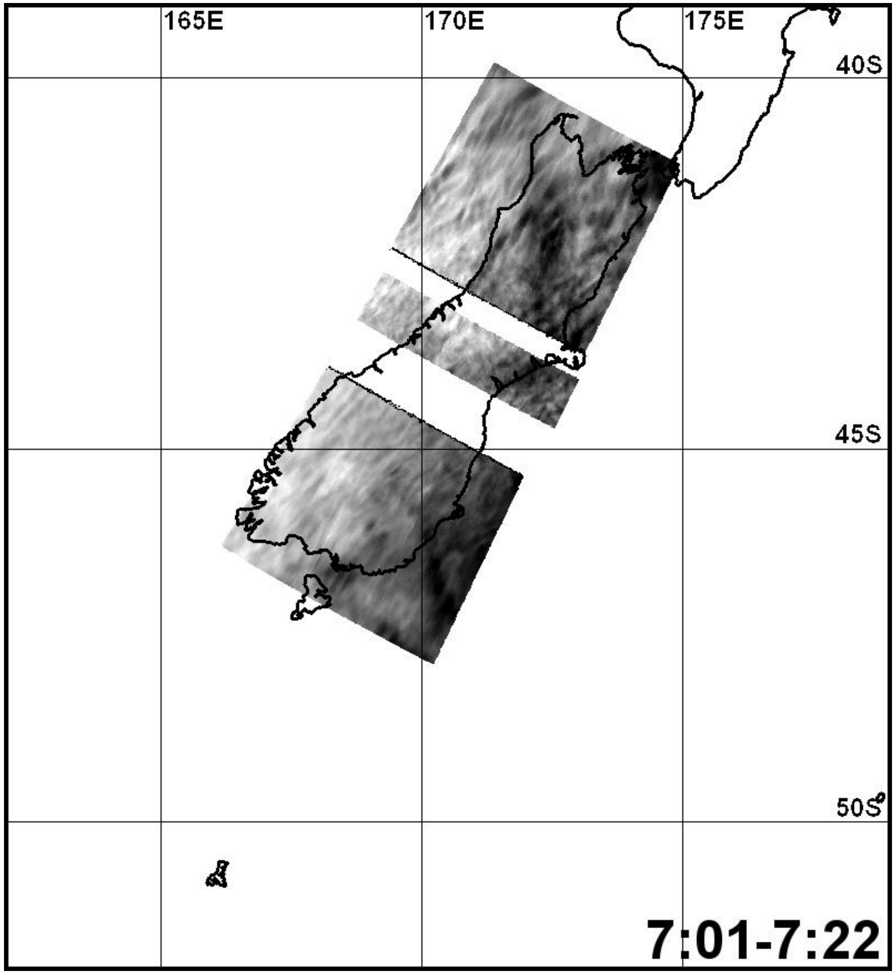
Starting to disappear after 13:00

Mesospheric OH Emission – RF12

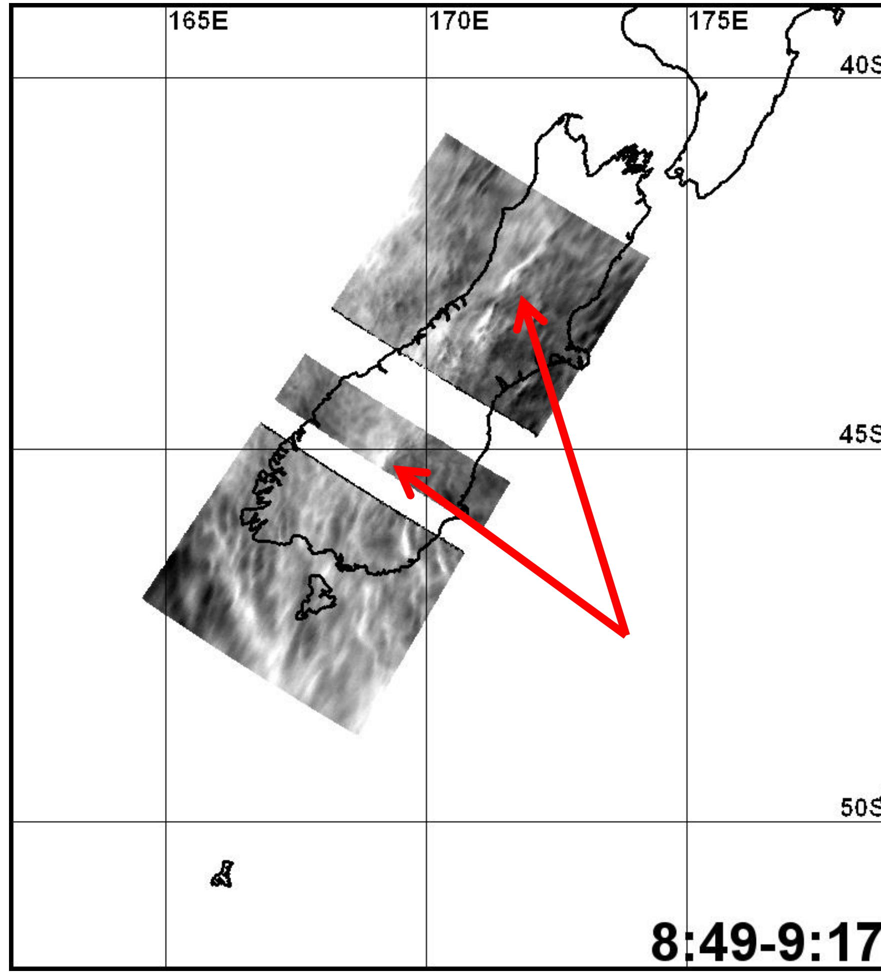


After 14:00, replaced by trailing waves coming from the South

Mesospheric OH Emission – RF13

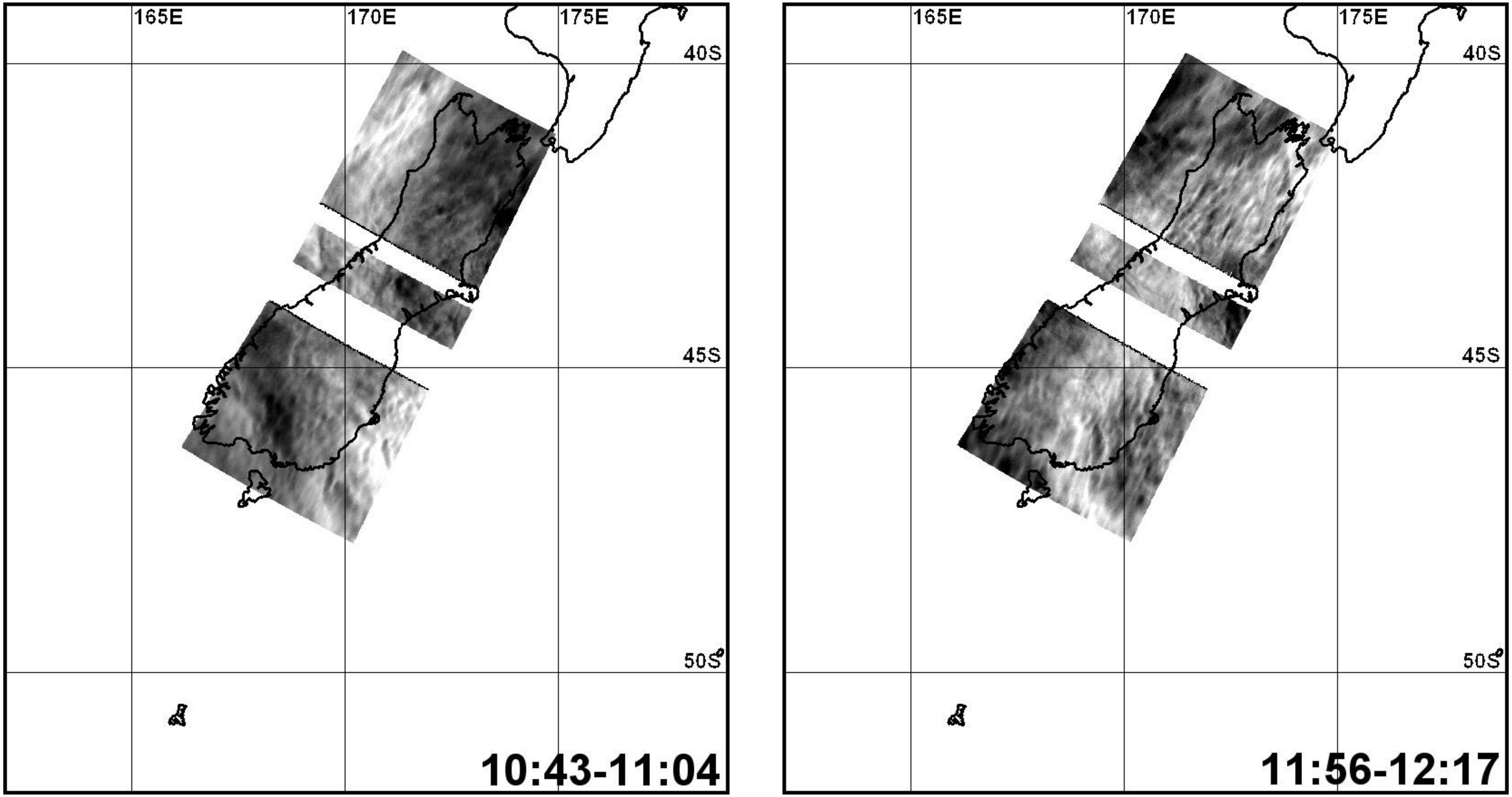


Extended weak GW field until 7:30



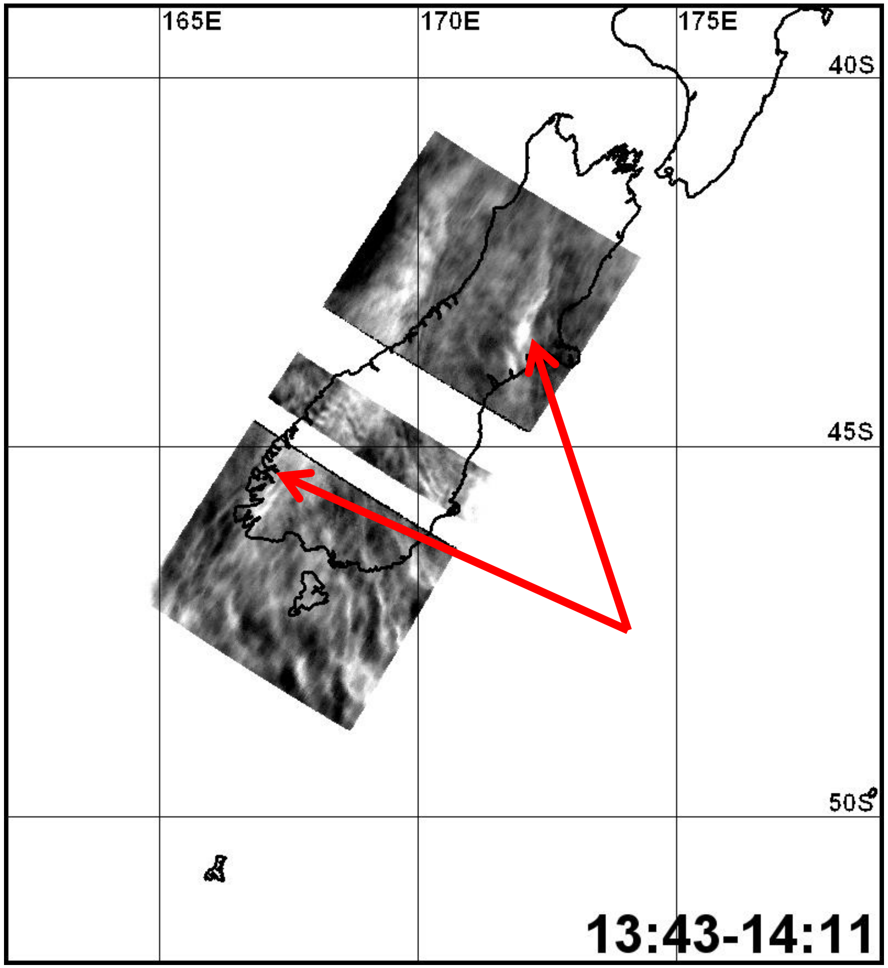
MW-like structures visible between 8:30 and 10:00

Mesospheric OH Emission – RF13



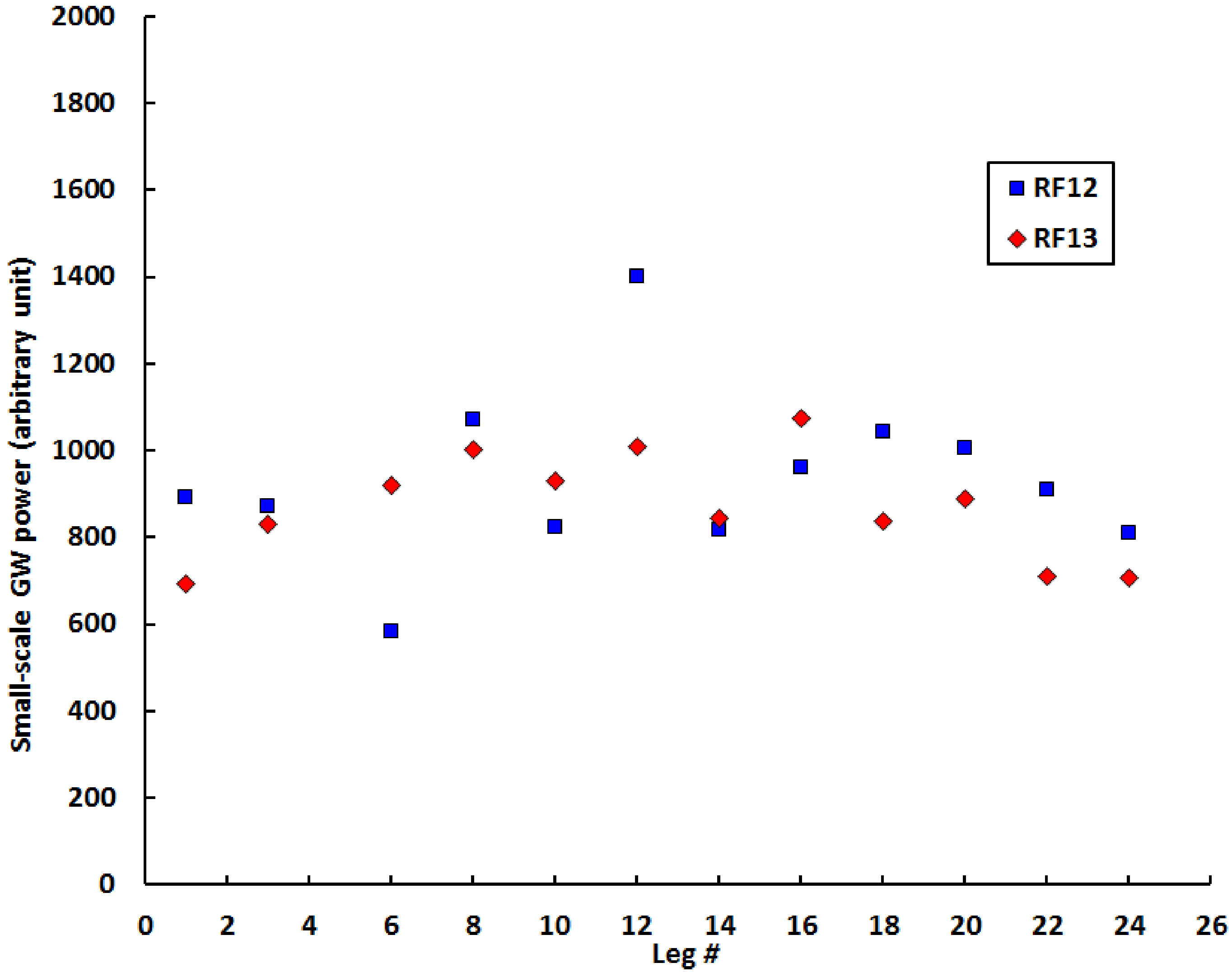
Extended GW field from 10:00 to 13:00, no more sign of MW

Mesospheric OH Emission – RF13

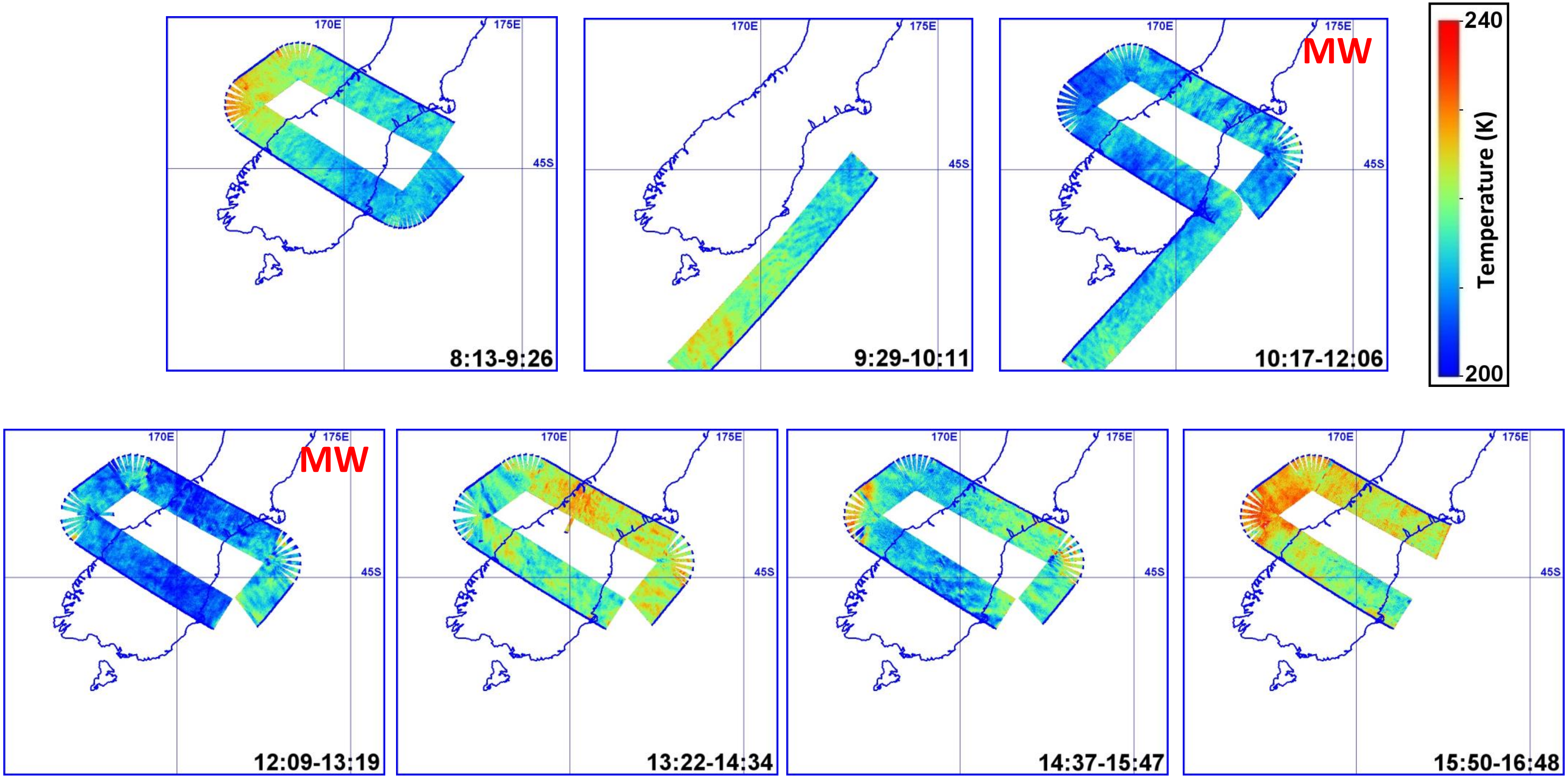


After 13:30 strong large-scale
MW structures

Mesospheric Small-Scale GW Power (Cross-mountain legs only)

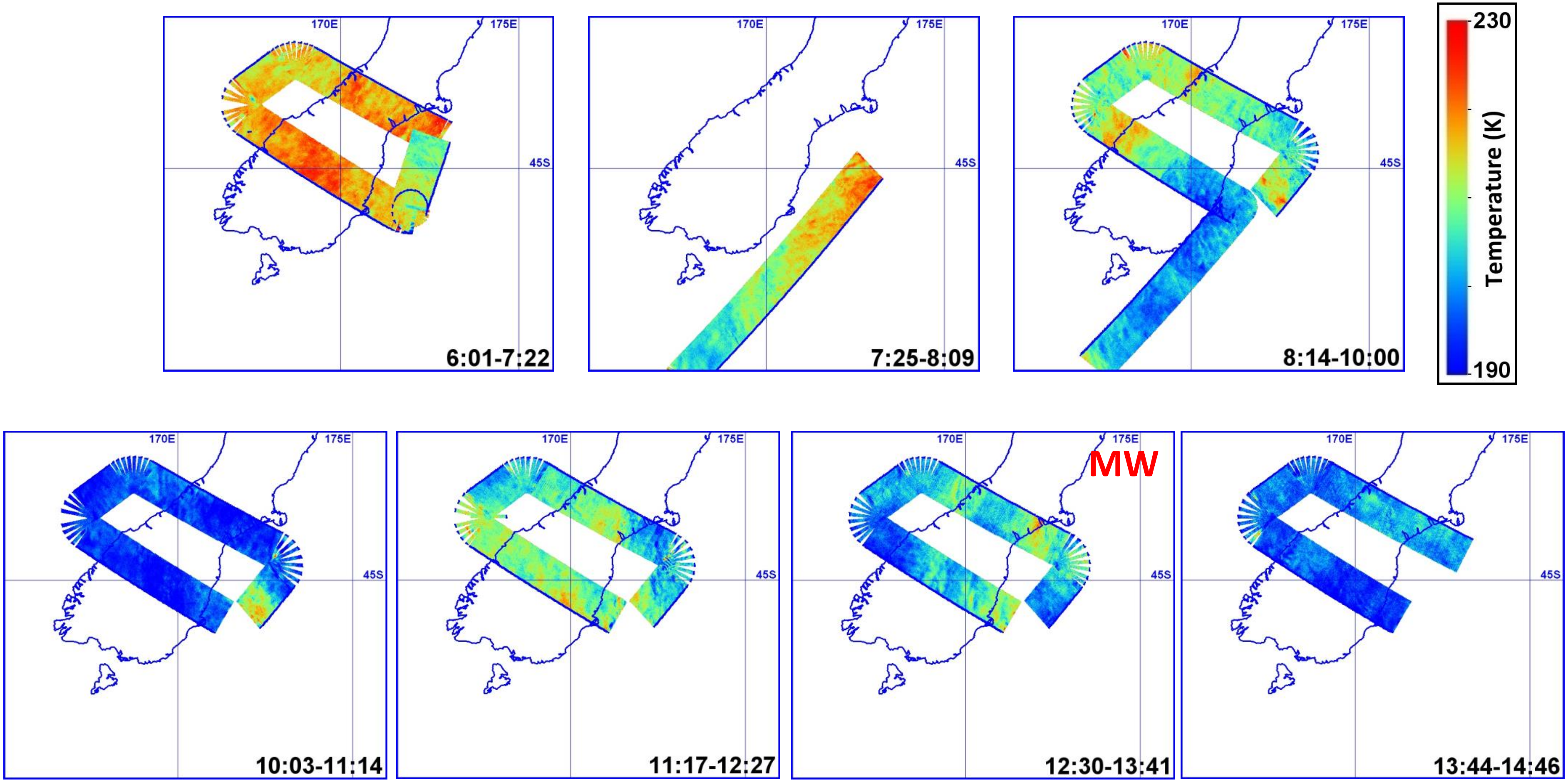


Temperature Keograms – RF12



Average temperature ~217K

Temperature Keograms – RF13



Average temperature ~207K

Comparison RF12 vs RF13

- Strong difference in forecasted forcing
- Higher EF_z between legs 12-20 for RF12, especially over Mt Aspiring
- Almost constant EF_z during RF13
- But presence of intermittent MW-like structures in the mesosphere during both nights!
- Don't seem to be associated with a warm phase for both nights
- Extended small-scale GW field during RF13, aligned with the mountains, until ~13:00
- "Trailing waves" after 14:00 (seem to appear at the end of RF13 as well)