Mesospheric Small-Scale GWs Characteristics + DEEPWAVE vs GW_LCYCLE 2

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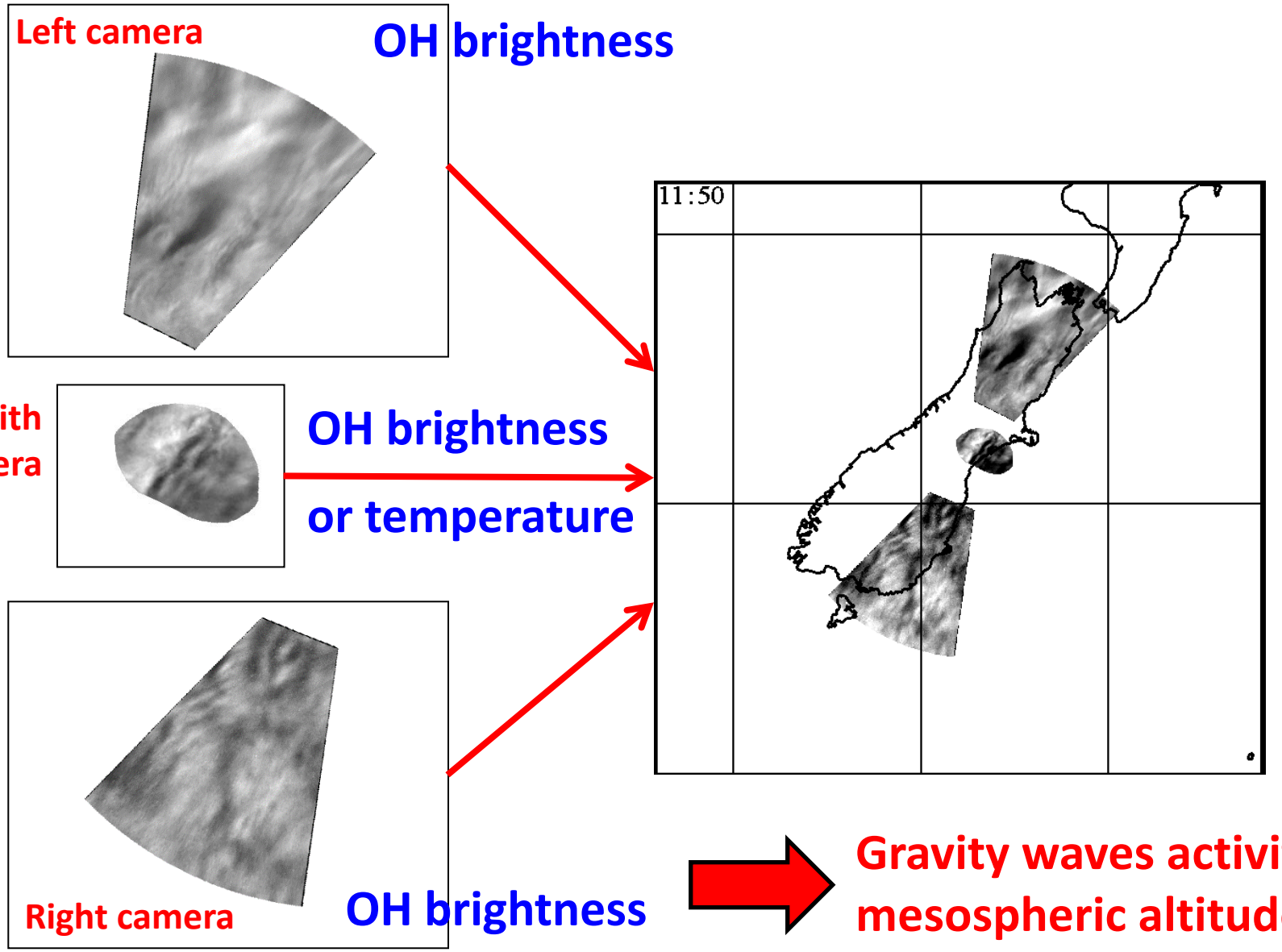
DEEPWAVE meeting, Monterey, Dec 2016

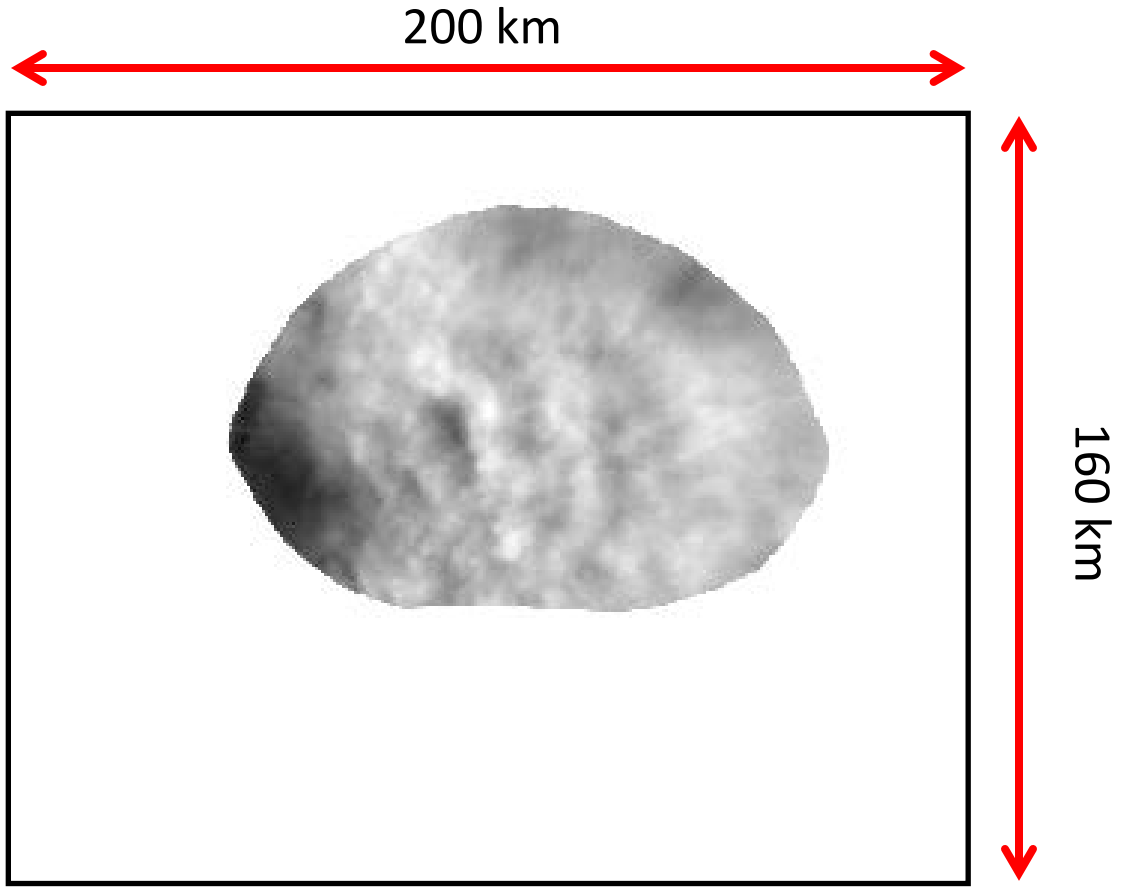
GV Upper Atmosphere Imagers

1 zenith imager (temperature + OH intensity)
+ 2 side cameras (just OH intensity)

Projection on a Geographical Map

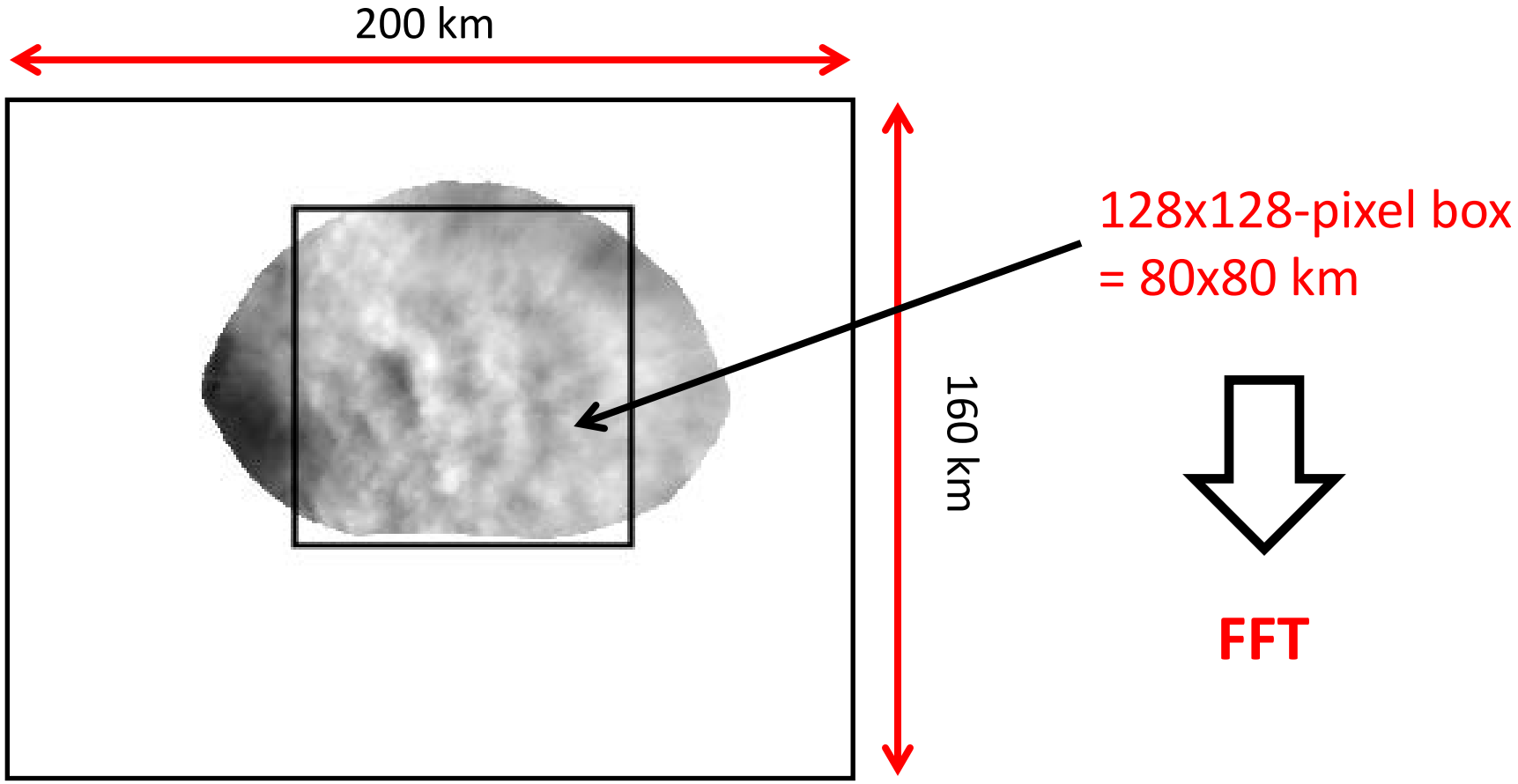


Quantifying the GWs Observed With the Zenith Imager

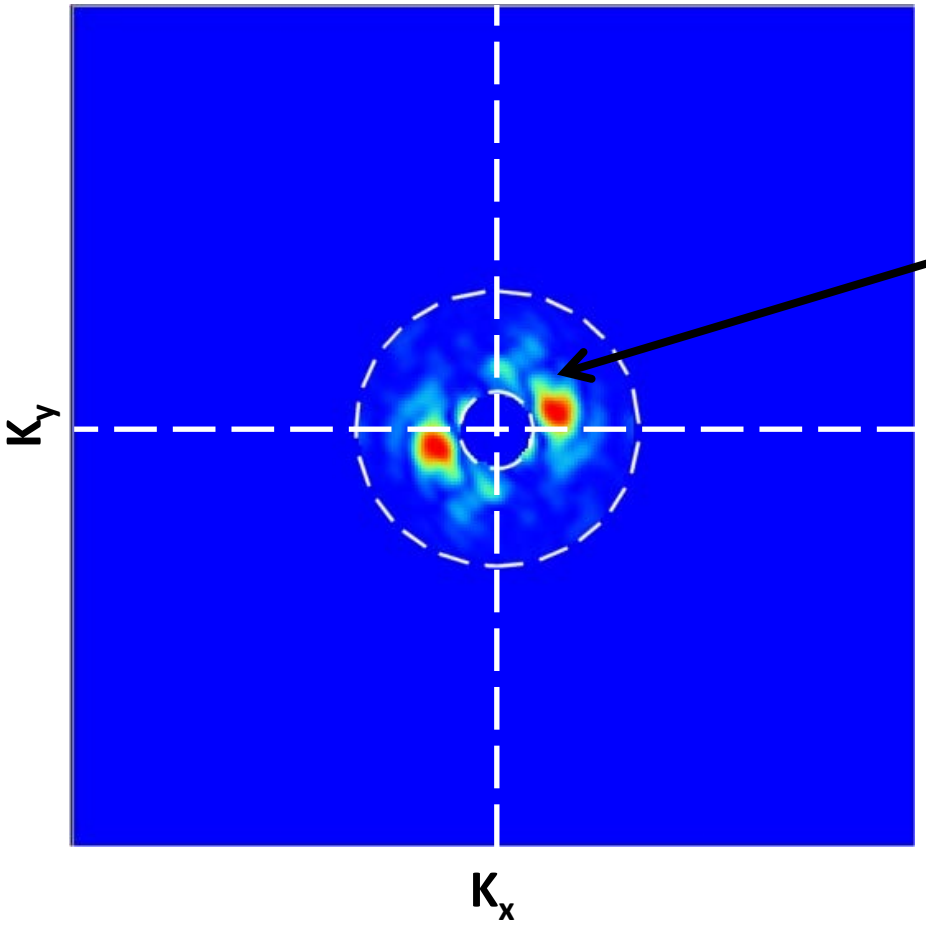


Irregular shape for the field-of-view of the zenith camera

Quantifying the GWs Observed With the Zenith Imager



Small-Scale GW Power Spectrum



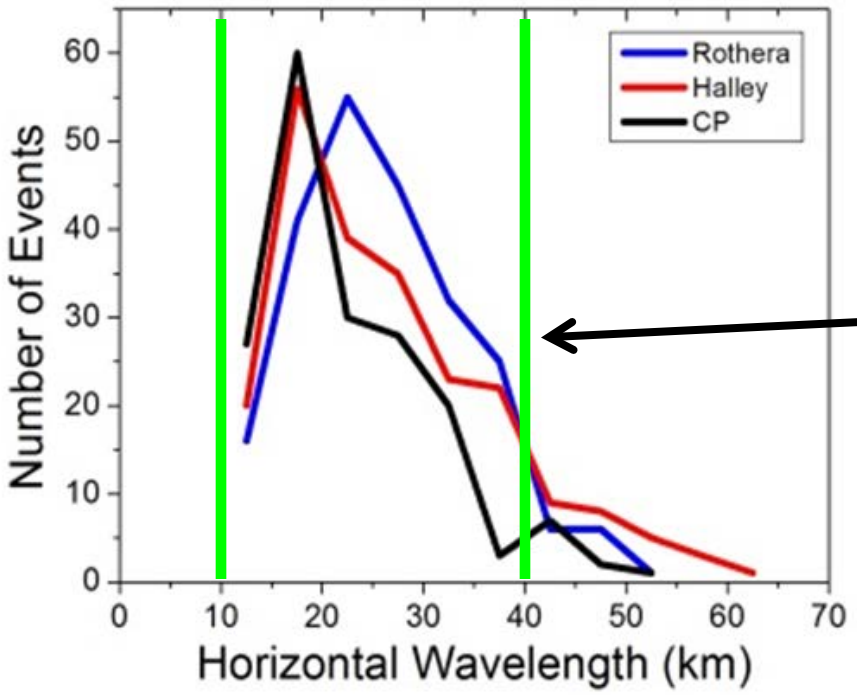
Integration of the power between the 2 circles
This power corresponds to the average temperature perturbation generated by the GWs

GWs with horizontal wavelength between 10 and 40 km

Small-Scale GW Power Spectrum

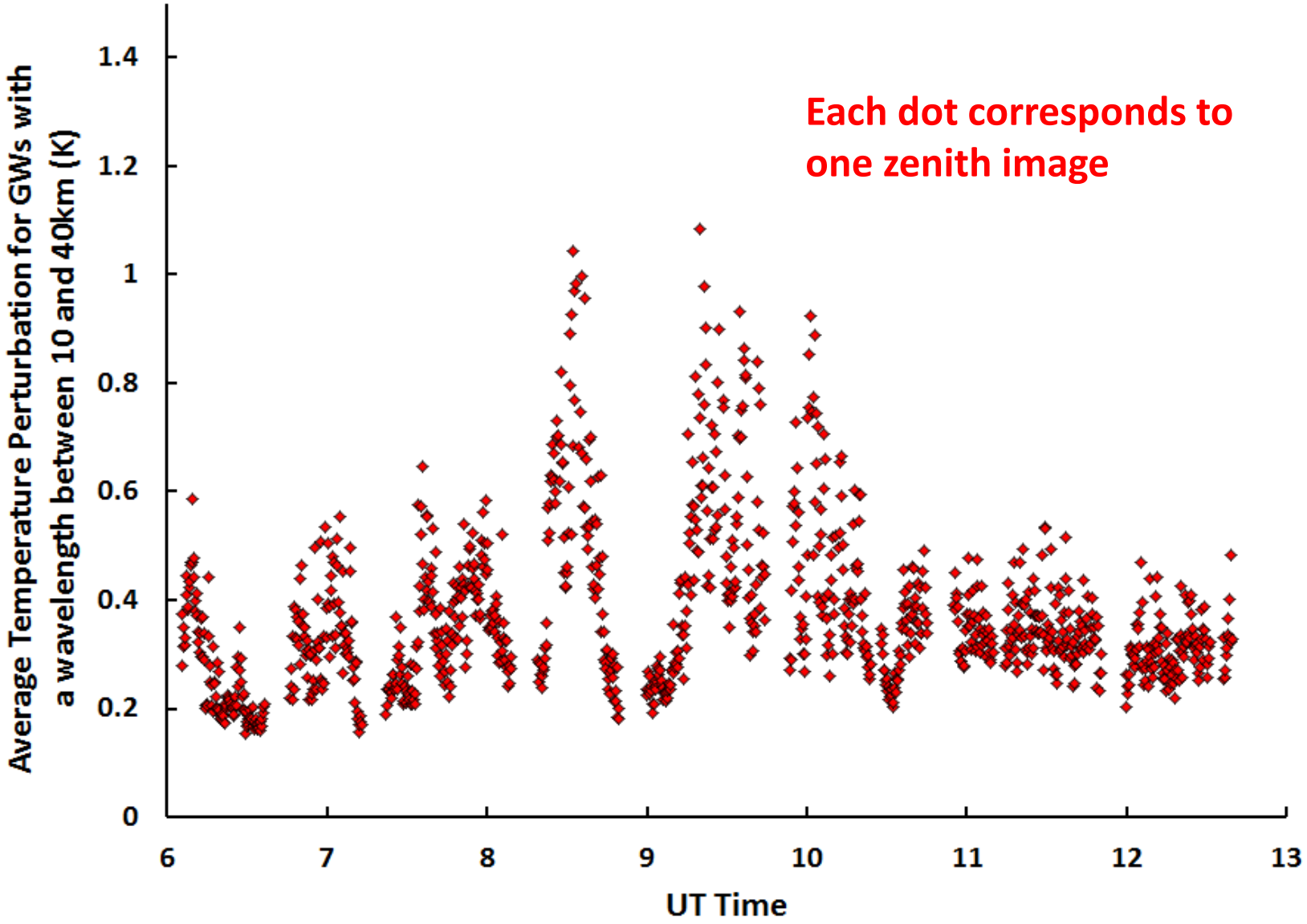
Short range of wavelengths, but:

- <10km, probably instabilities
- >40km, difficult to measure because of the small field-of-view (only 80km)
- Still representative of small scale GWs :



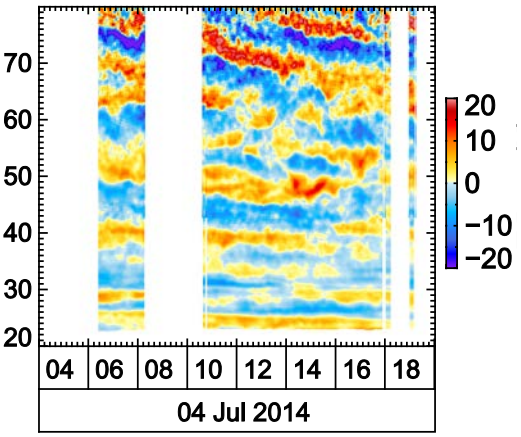
Typical horizontal wavelength distributions obtained using all-sky imagers at high (Rothera, Halley) and low (Cachoeira Paulista) latitudes (Nielsen et al., 2009)

Power vs Time - Example: RF16

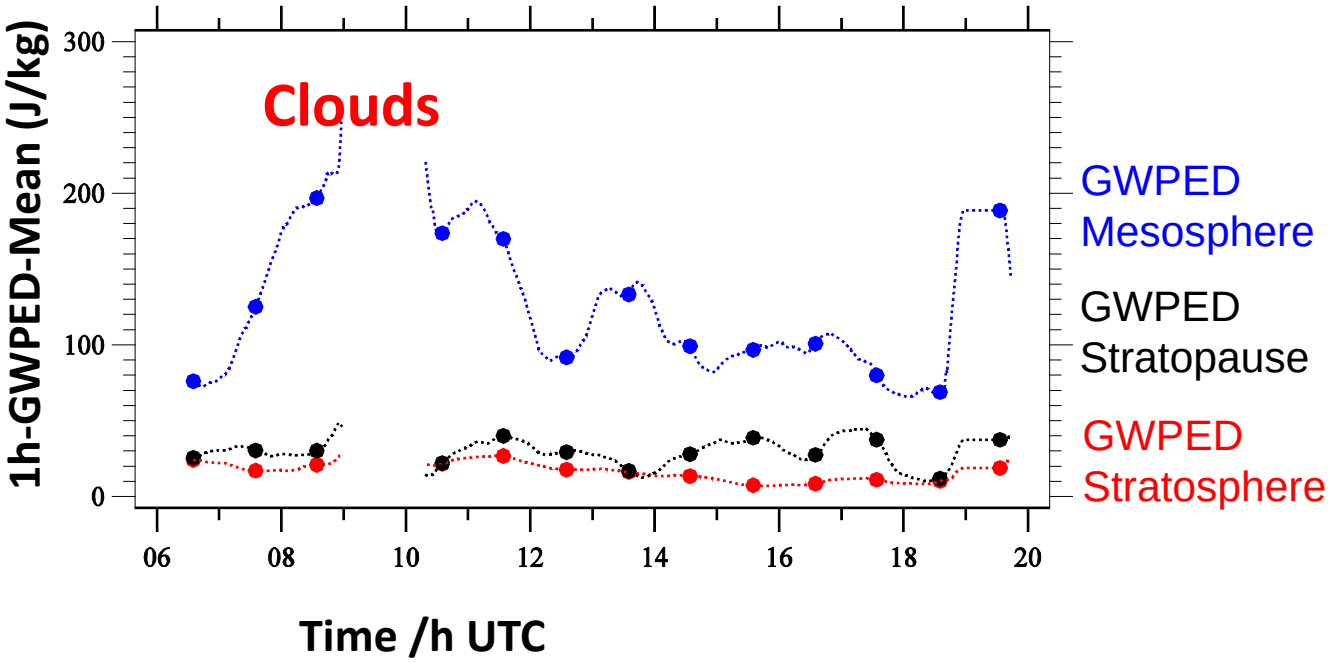


Ground-Based Data (Courtesy M. Bramberger)

$$E_p(z) = \frac{1}{2}\frac{g^2}{\overline{N^2(z,t)}}\overline{\left(\frac{T'(z,t)}{T_0(z,t)}\right)^2}$$

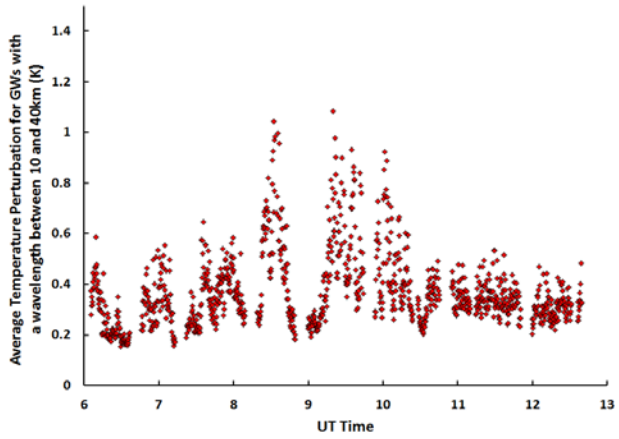


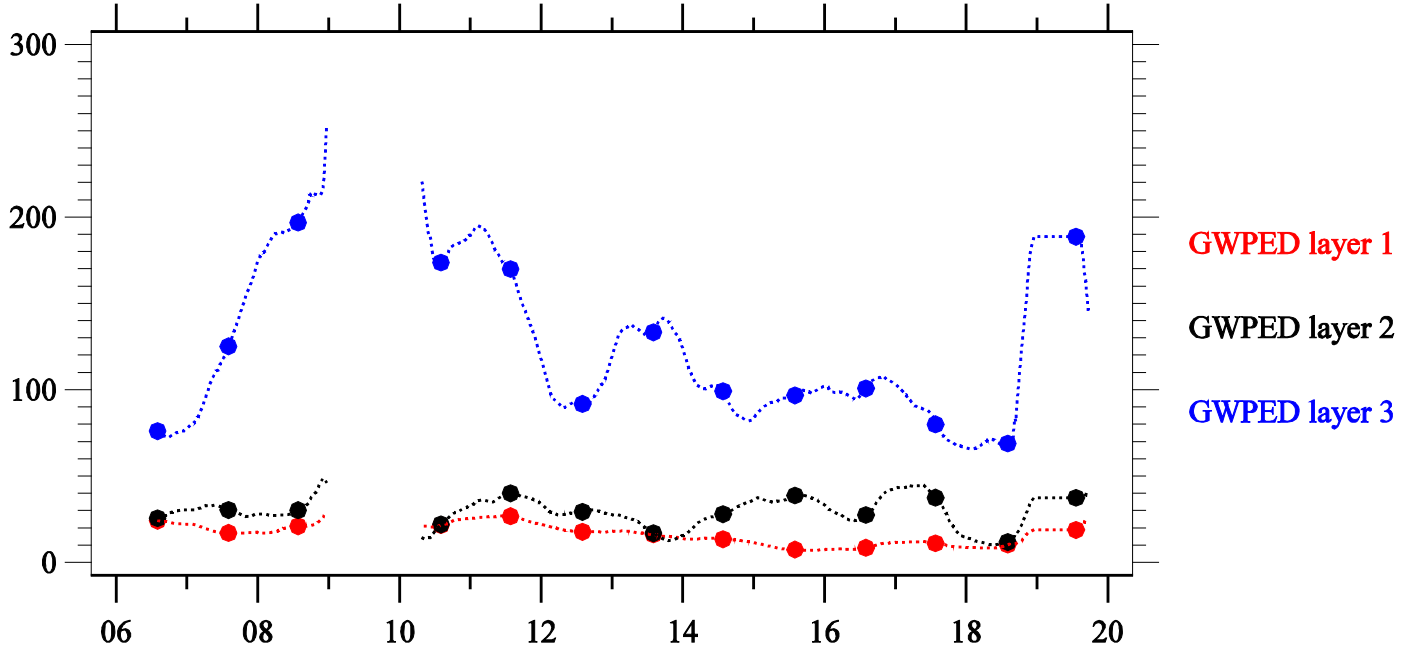
- Dots: 3h mean
- Dotted line: running mean



Between 06 and 12 UTC mesospheric gravity wave activity seems to be uncoupled from Stratosphere

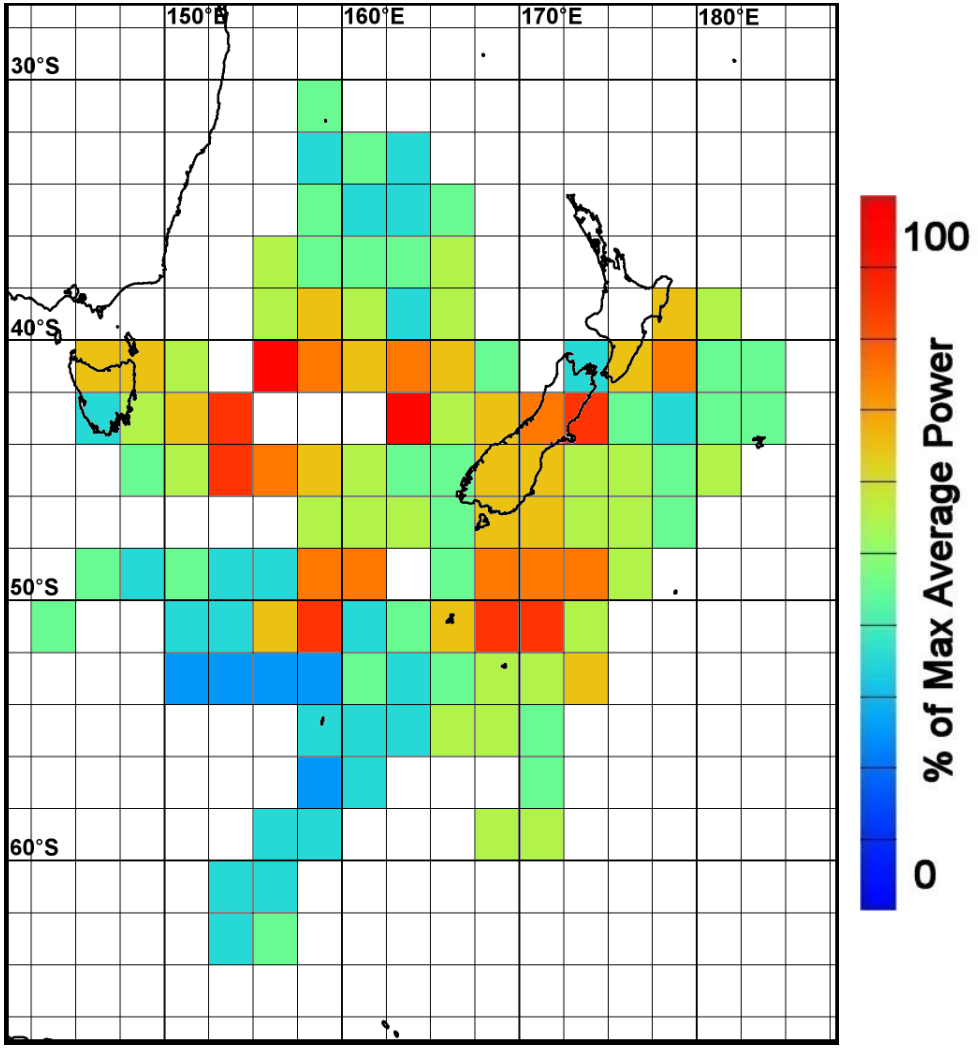
Comparison AMTM Power vs Lidar GWPED



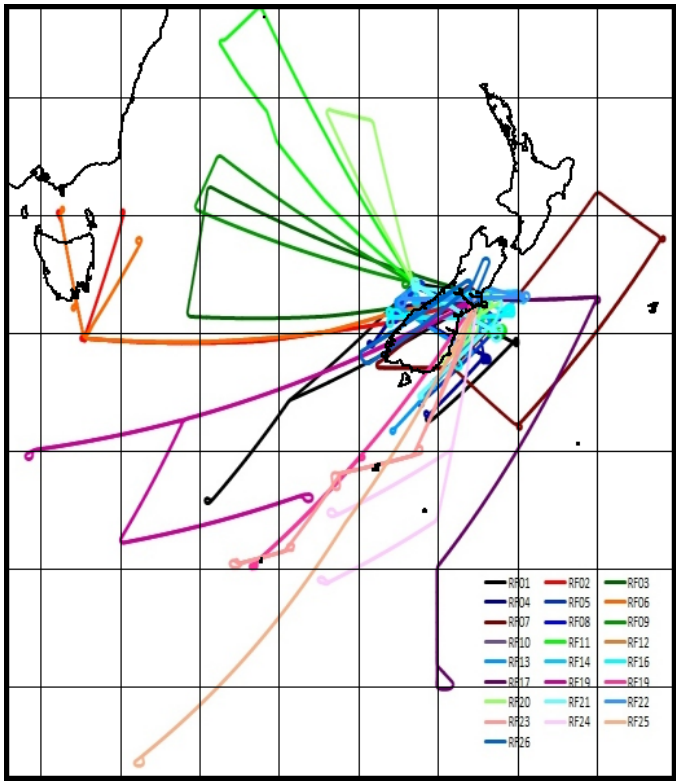


Small-Scale GW Power Regional Distribution

Average power



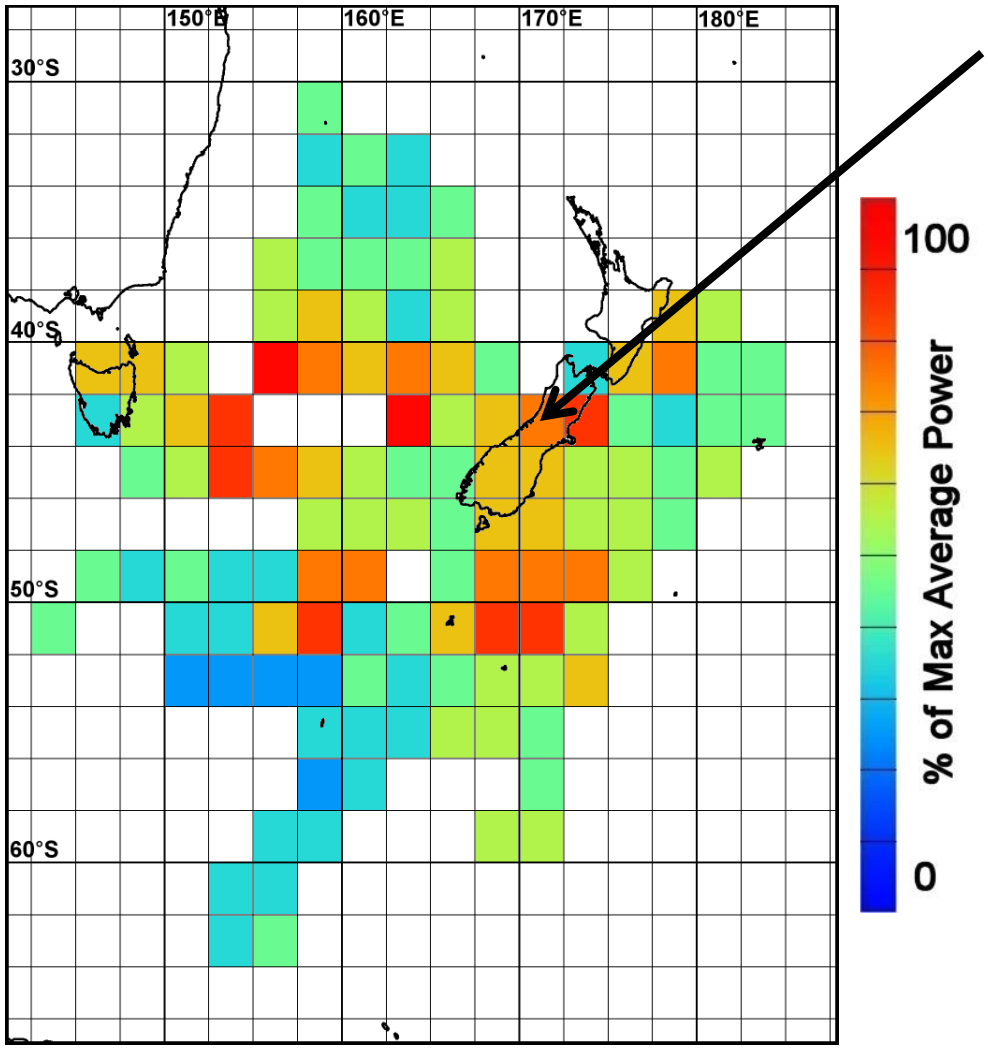
25 nighttime flights



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

Small-Scale GW Power Regional Distribution

Average power

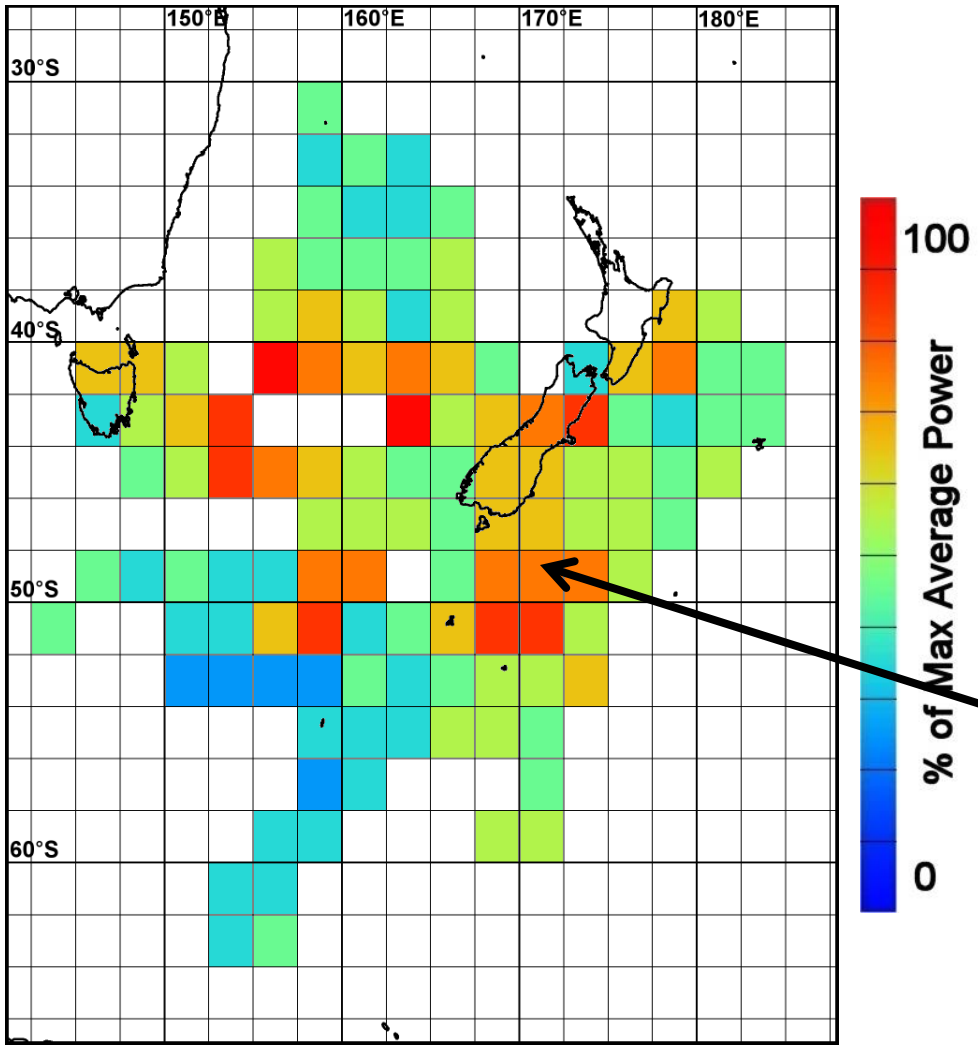


Large over NZ

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

Small-Scale GW Power Regional Distribution

Average power

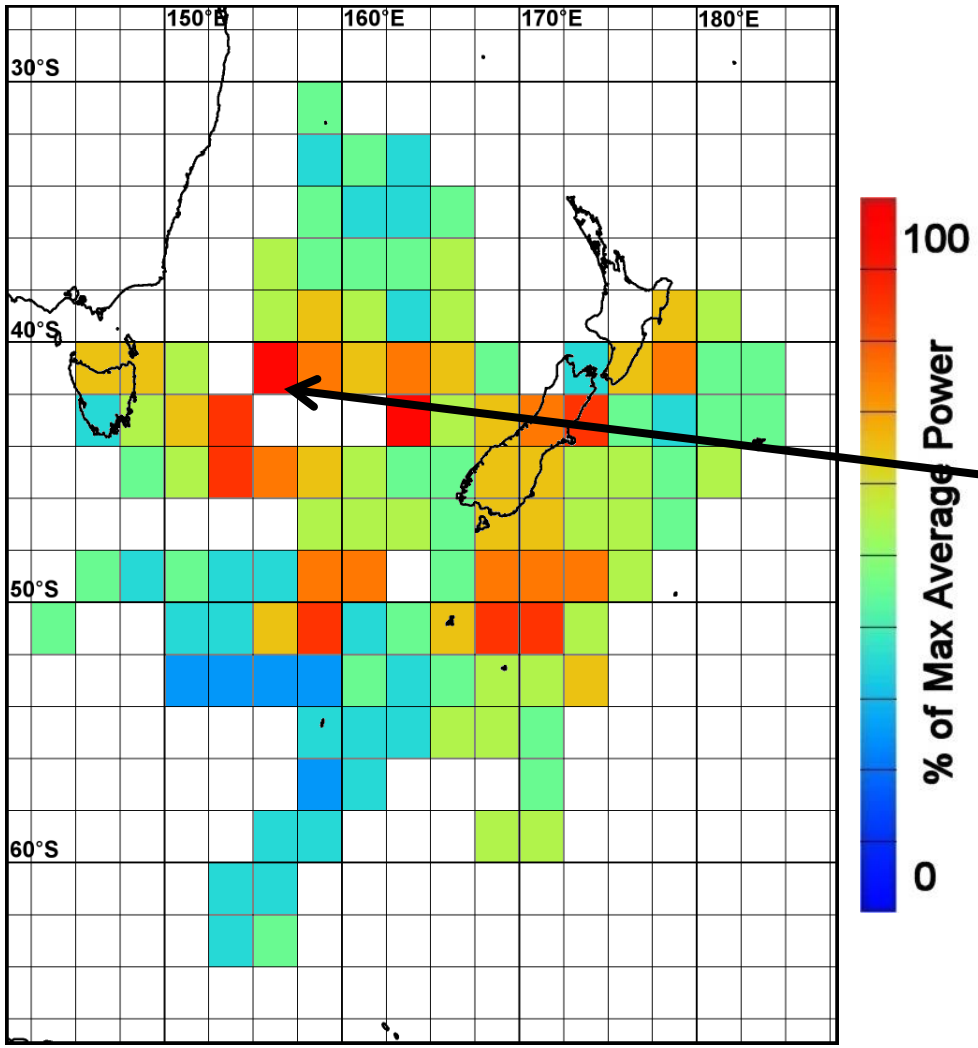


Trailing waves +
Auckland Island effect

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

Small-Scale GW Power Regional Distribution

Average power

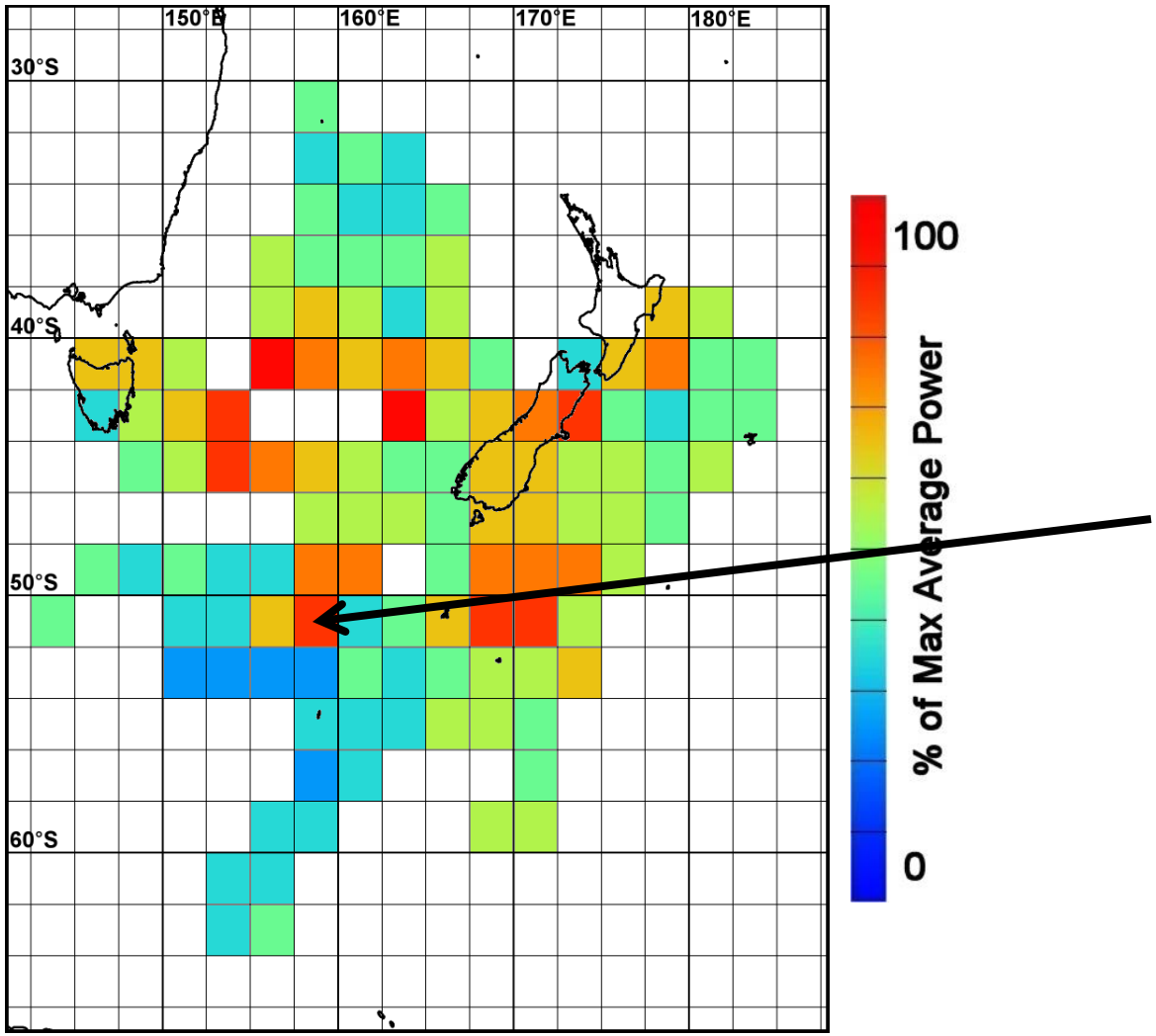


Lots of small scale GWs over the Tasman Sea, east of Tasmania

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

Small-Scale GW Power Regional Distribution

Average power

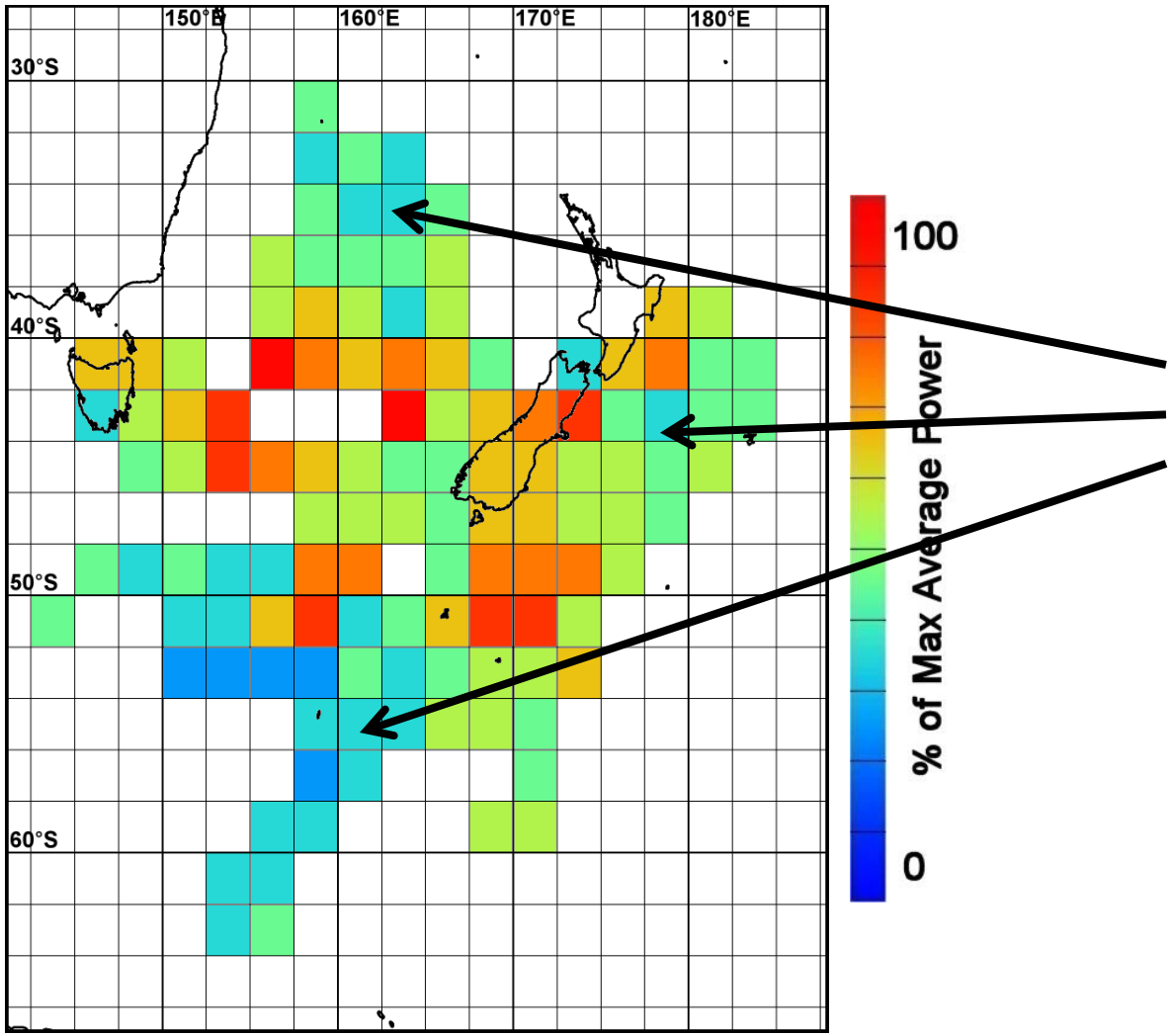


Only due to
one flight (RF01)

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

Small-Scale GW Power Regional Distribution

Average power

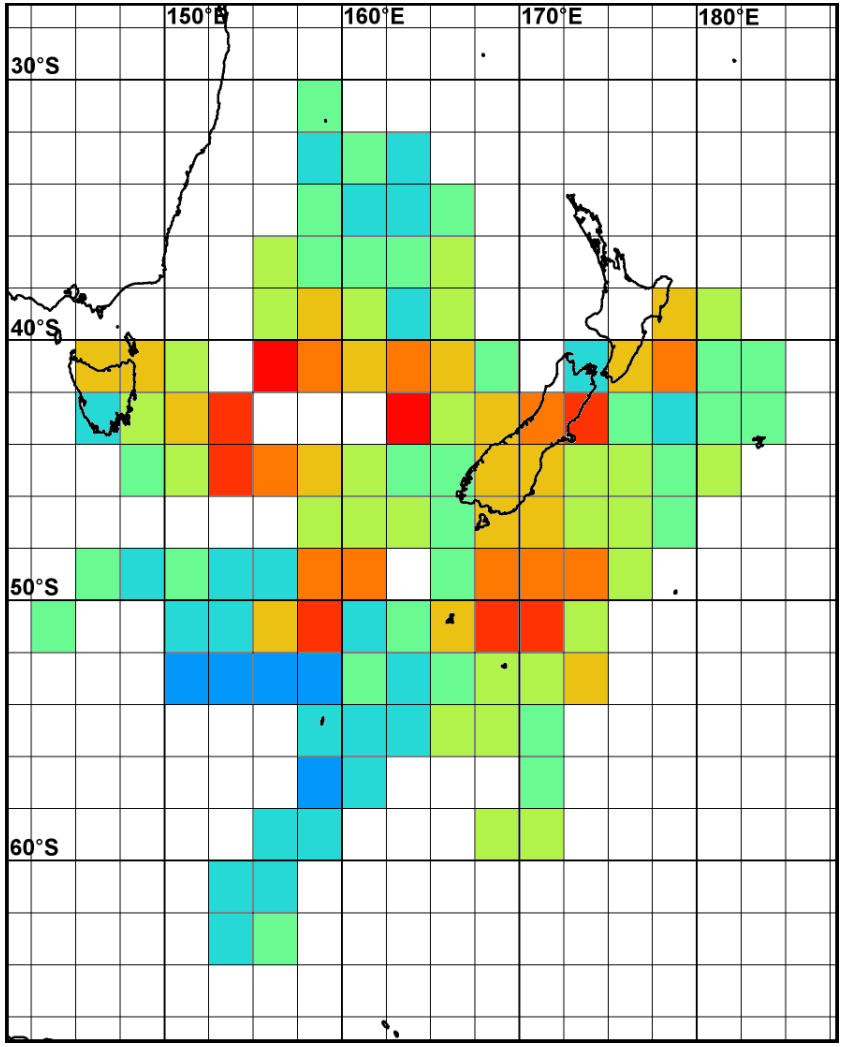


Not much over the North of Tasman Sea, Pacific Ocean and Southern Ocean

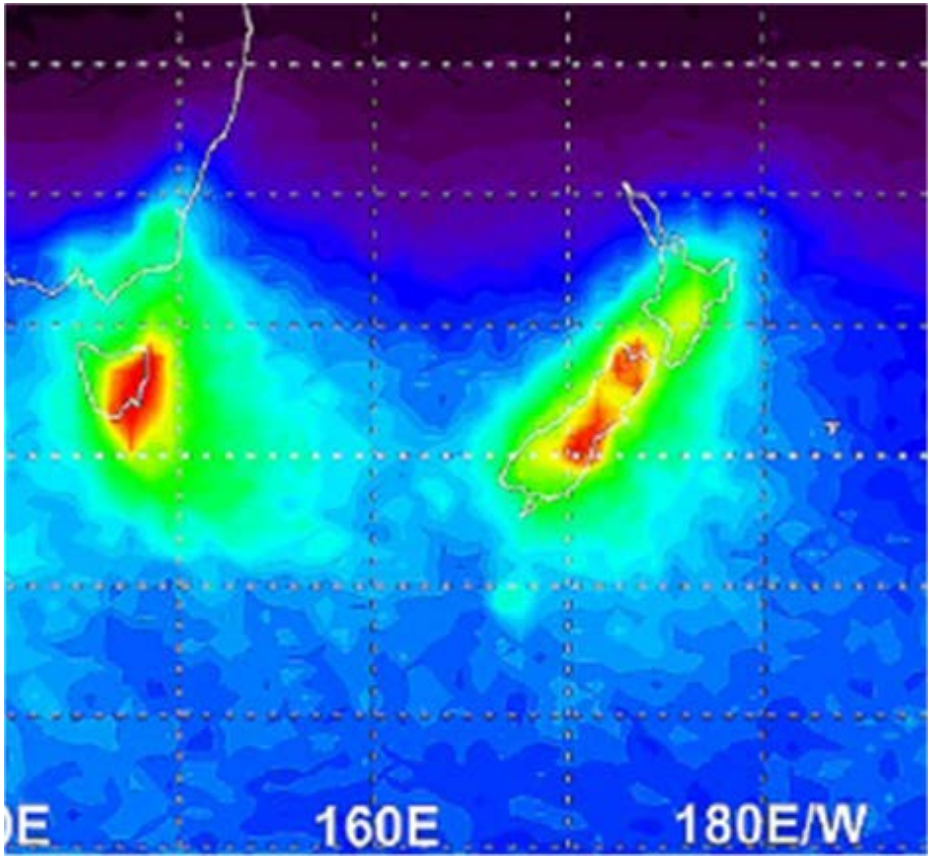
Each square is 2.5° (longitude) x 2° (latitude)

Comparison with Stratospheric Measurements

Average power

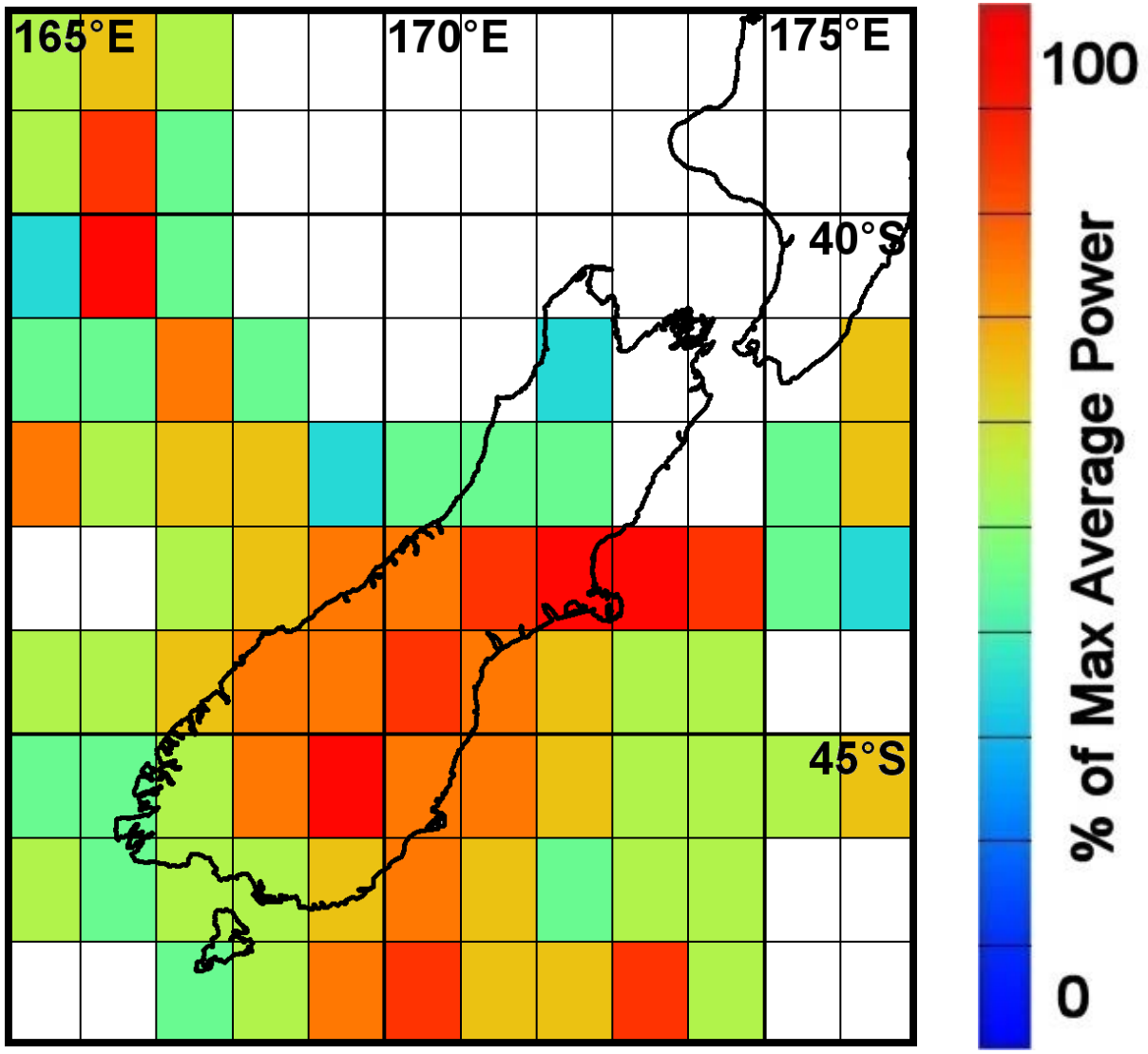


Each square is 2.5° (longitude) x 2° (latitude)

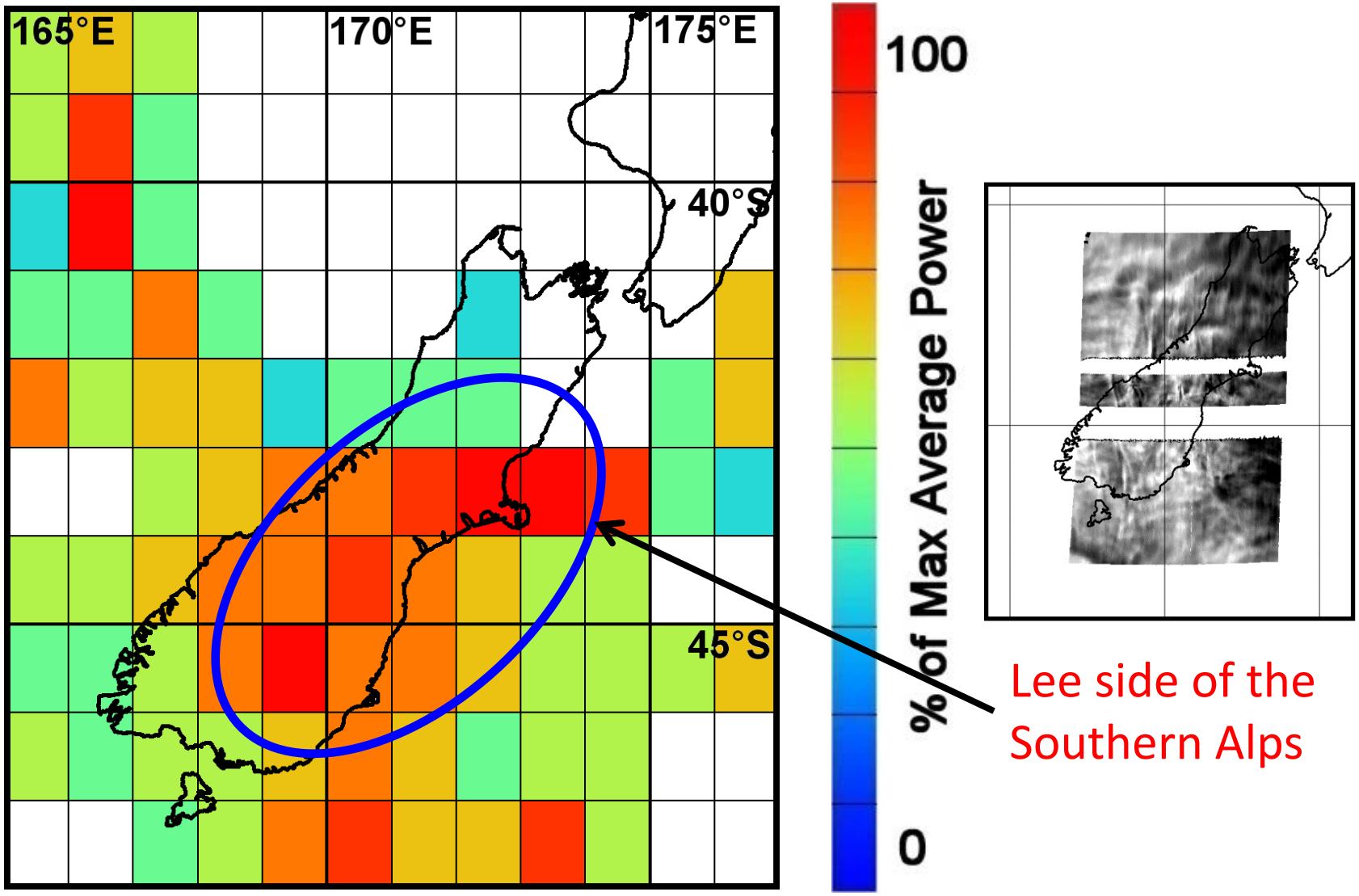


AIRS GW RMS brightness temperature during July 2003-2011 at 2 hPa (~41 km, courtesy Steve Eckermann)

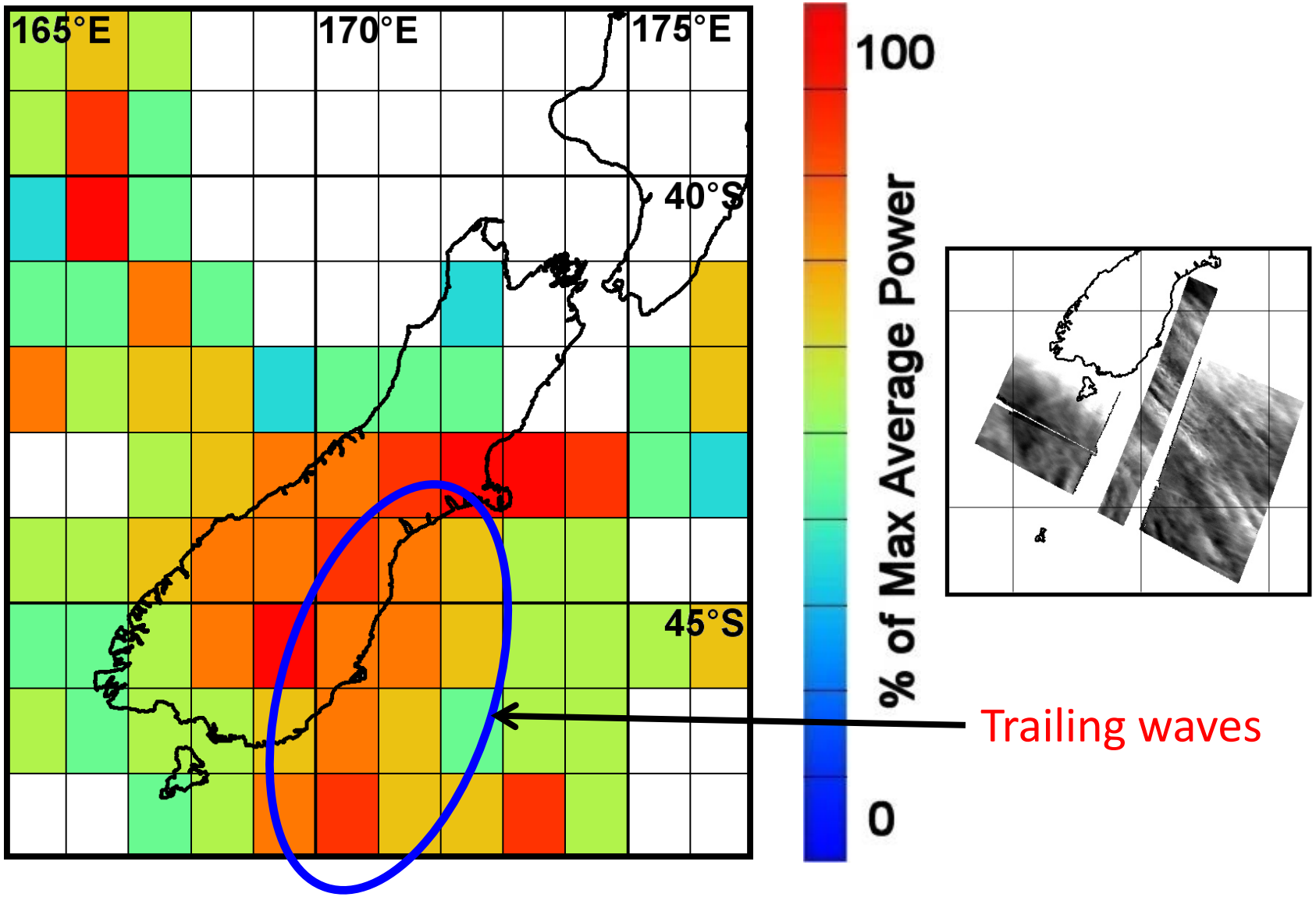
Small-Scale GW Power Over NZ (1°x1°)



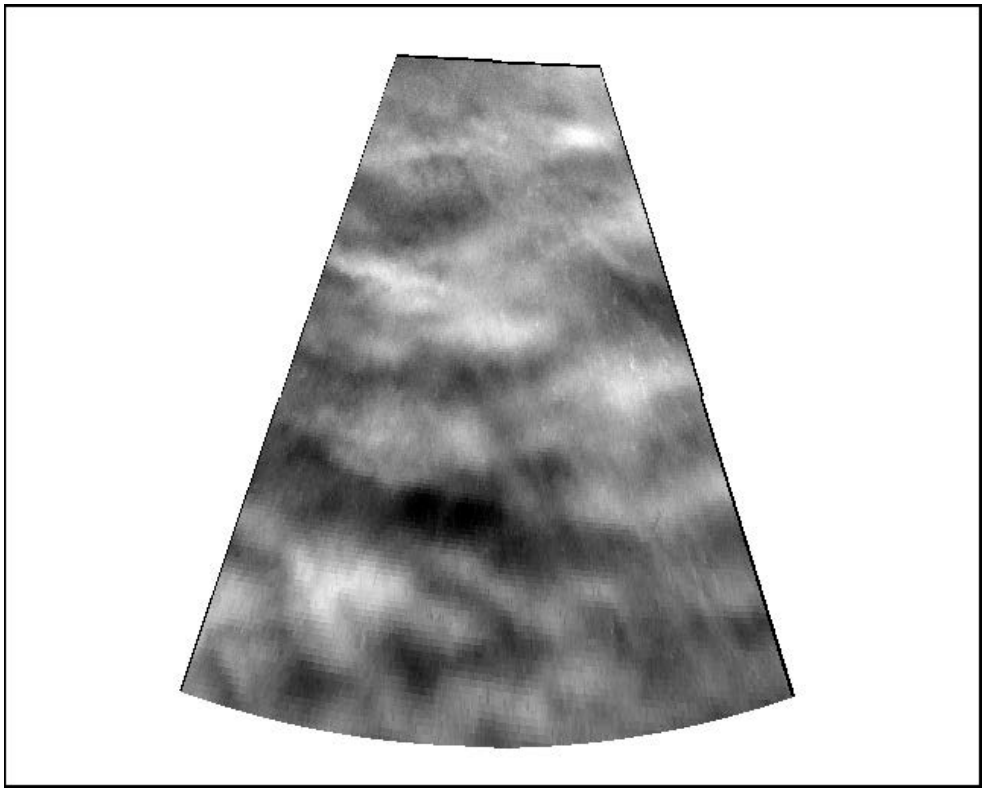
Small-Scale GW Power Over NZ (1°x1°)



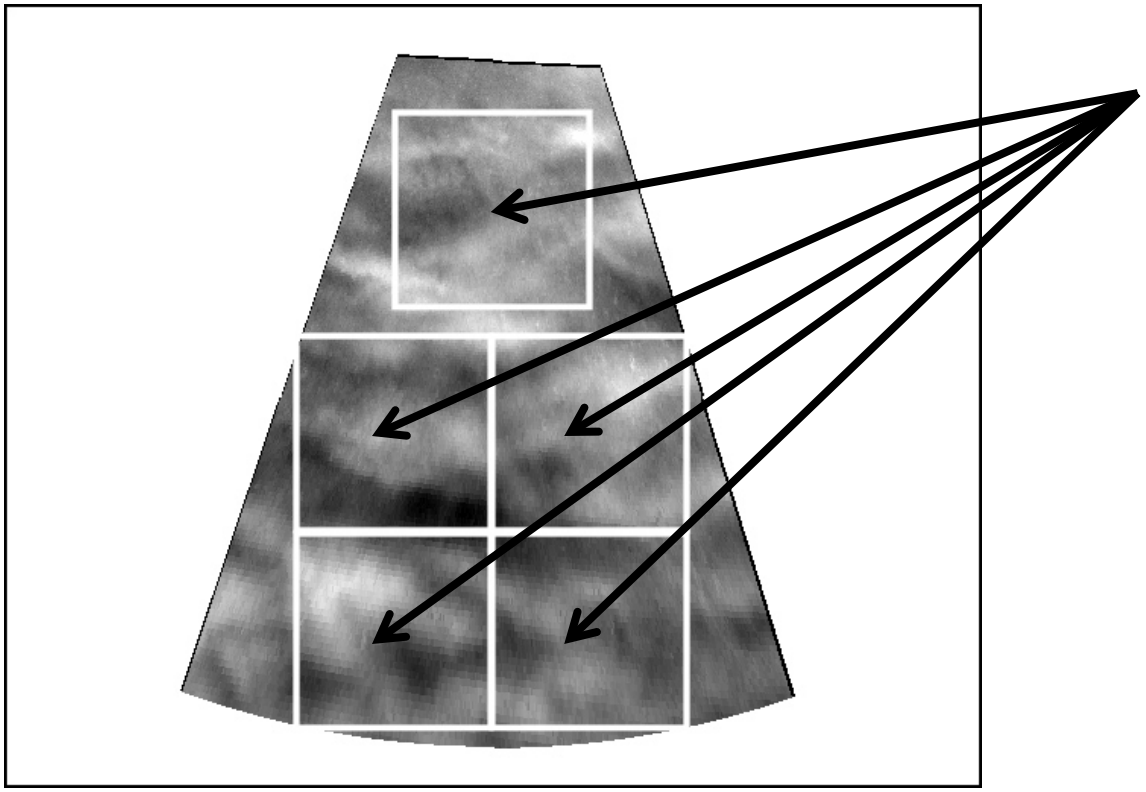
Small-Scale GW Power Over NZ (1°x1°)



What's new (1)?
Quantifying the GWs Observed With the Side Imagers

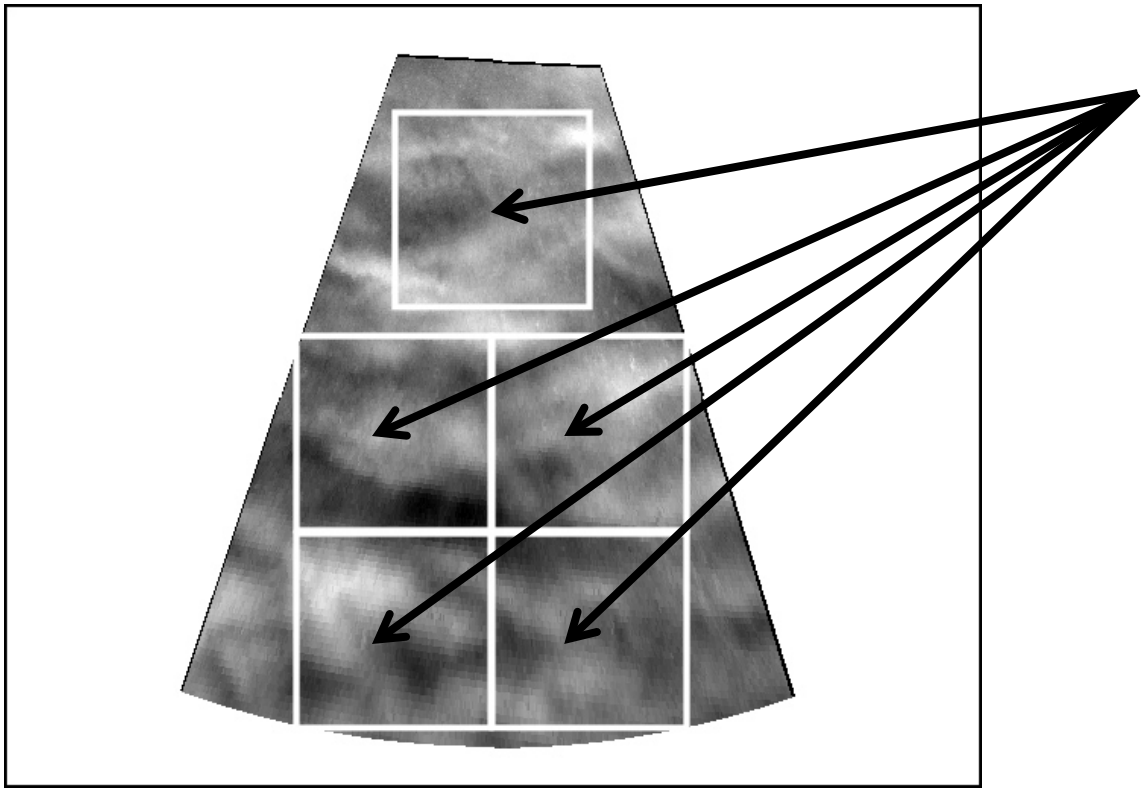


Quantifying the GWs Observed With the Side Imagers



Five 128x128-pixel boxes (80x80 km)

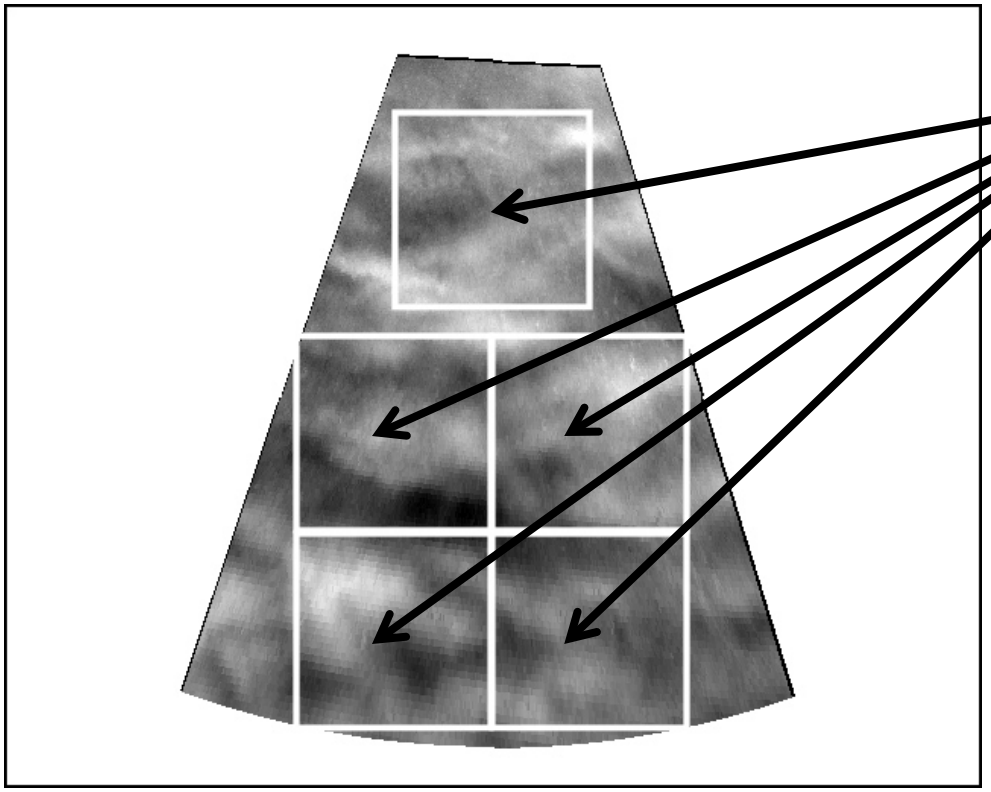
Quantifying the GWs Observed With the Side Imagers



Five 128x128-pixel boxes (80x80 km)

FFT

Quantifying the GWs Observed With the Side Imagers

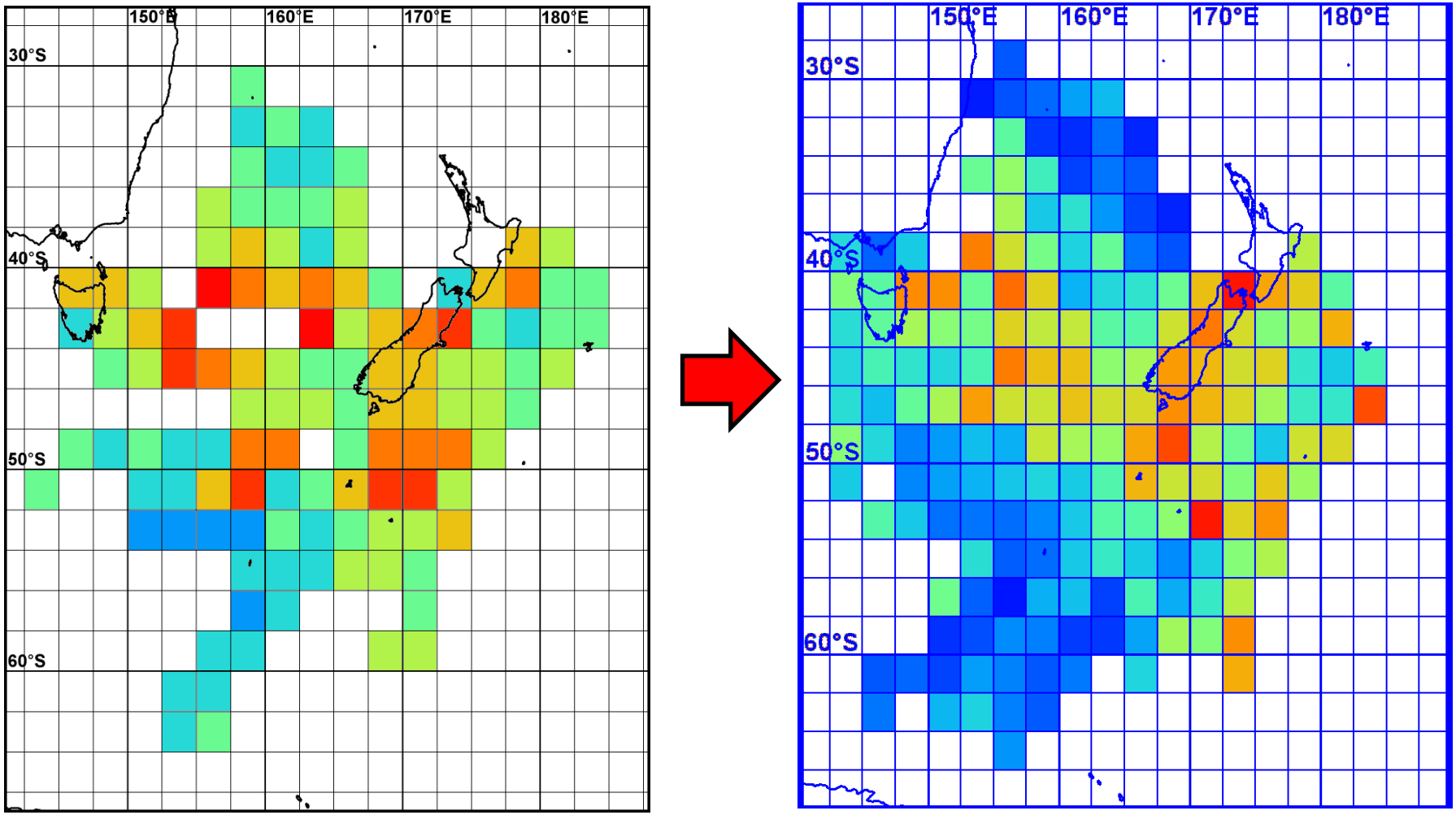


Five 128x128-pixel boxes (80x80 km)

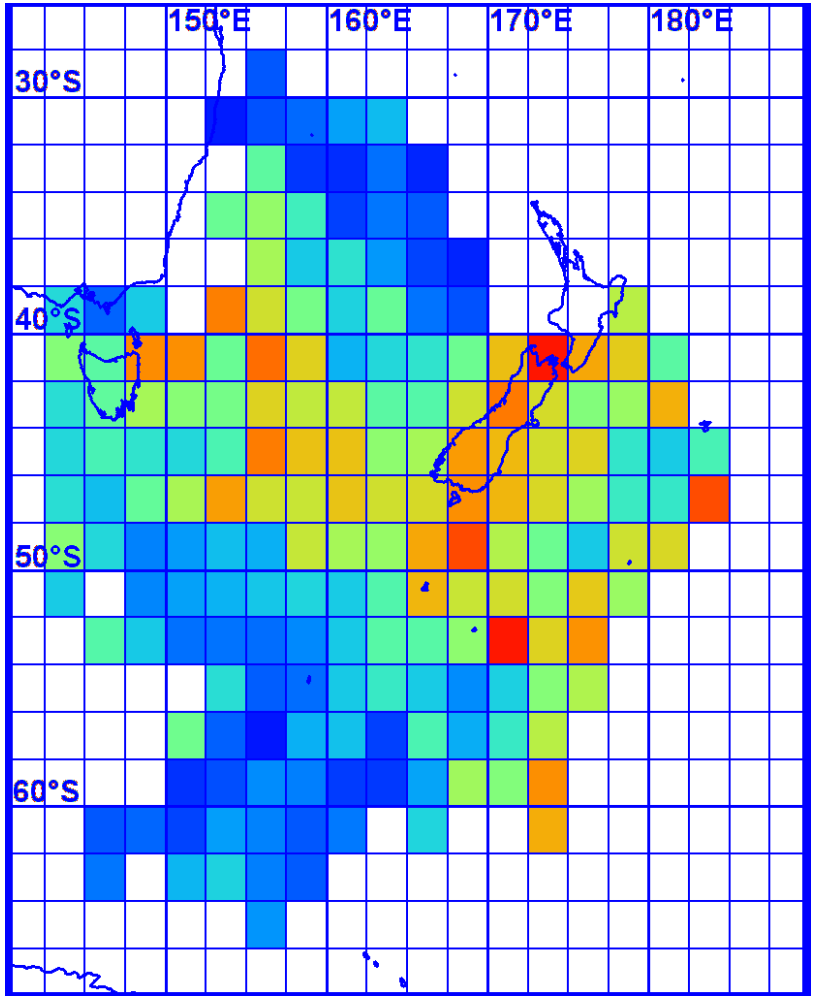
FFT

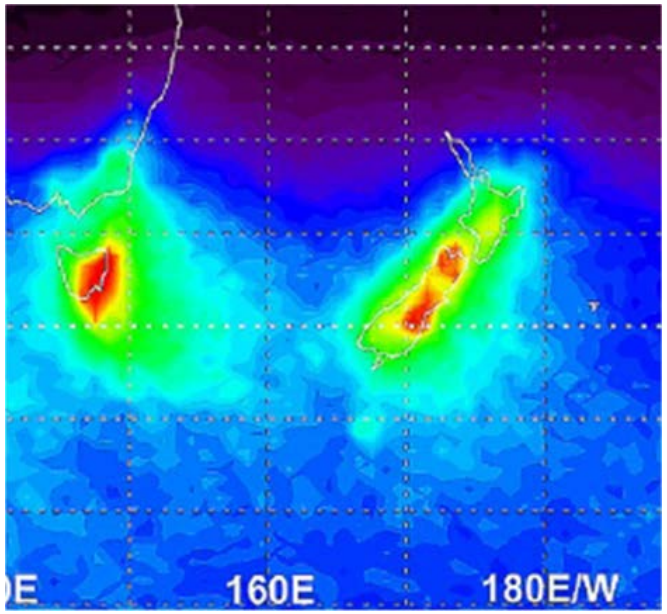
Power for GWs with $10<\lambda_x<40$ km

Small-Scale GW Power Regional Distribution with 3 Cameras



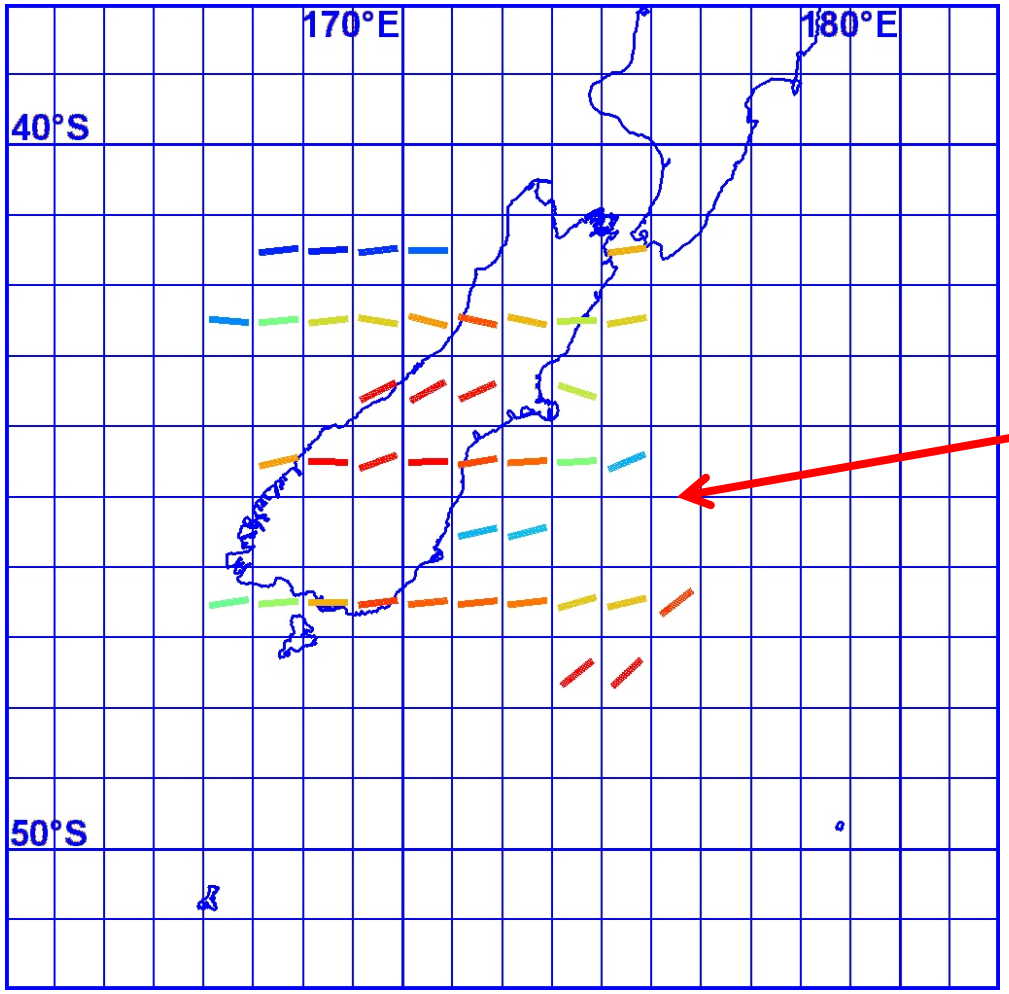
Small-Scale GW Power Regional Distribution with 3 Cameras





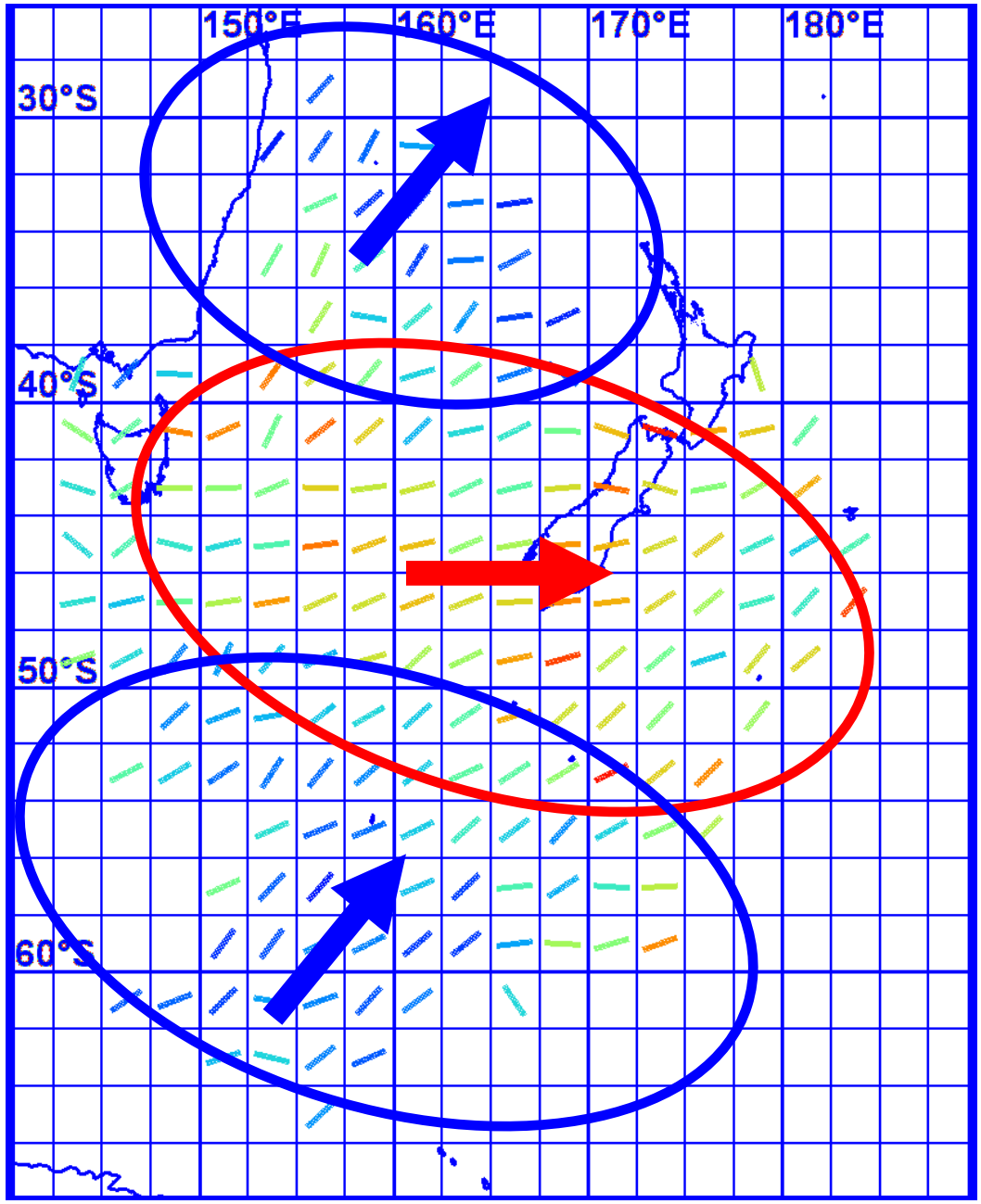
- Using only OH brightness, not temperature
- Similar distribution over a larger region
- Regions with larger power better defined

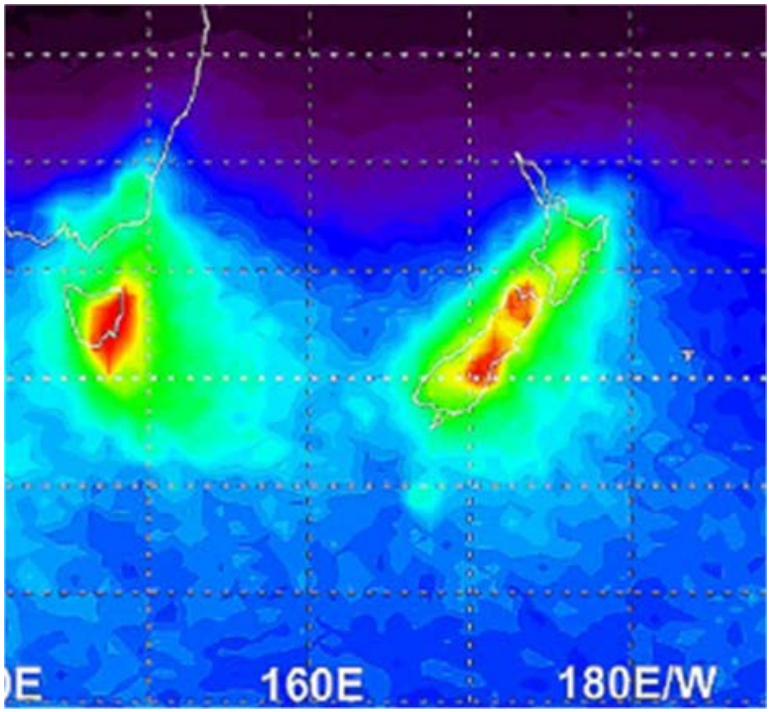
What's new (2)?
GW Direction – Example: RF16

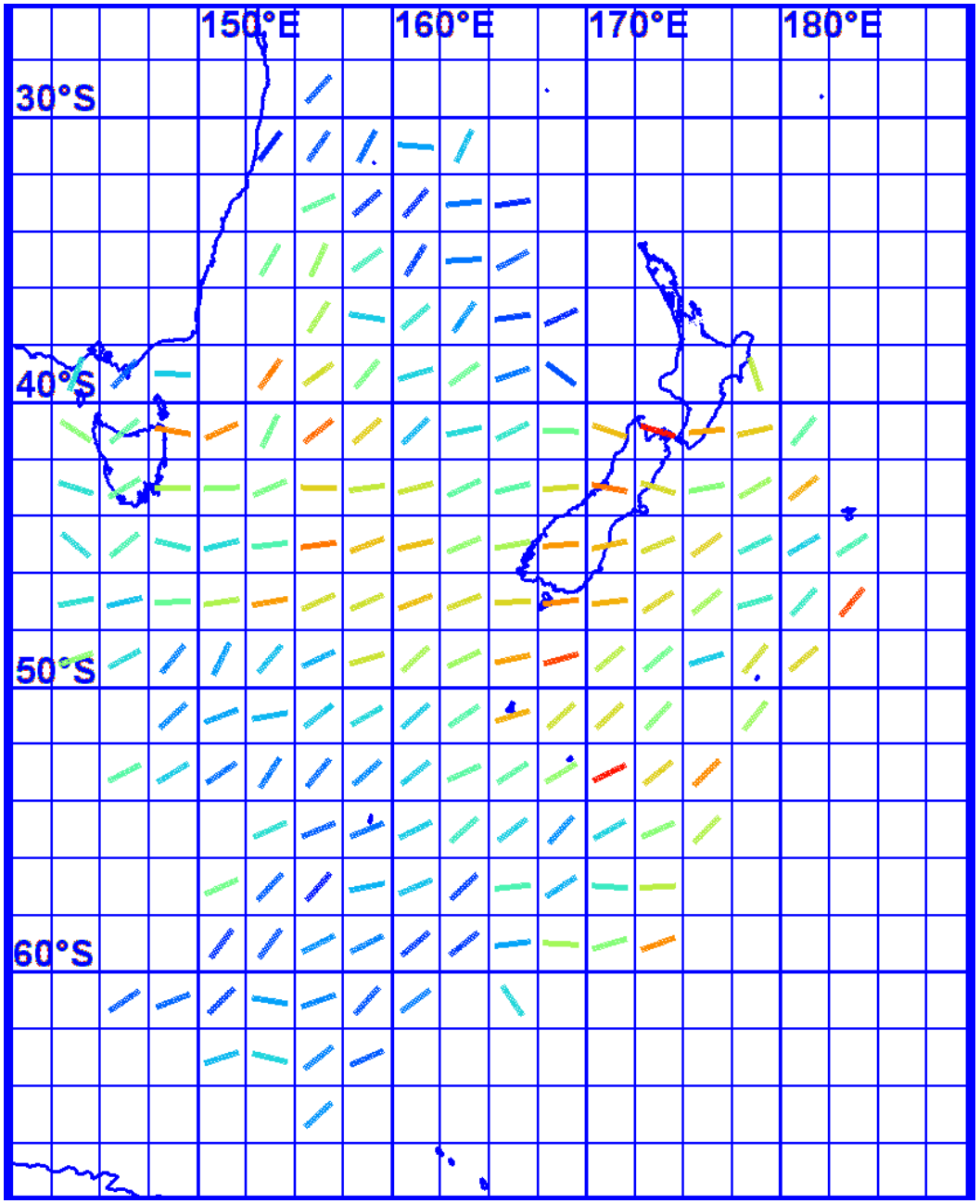


It's also possible to use the spectrum to look at the main direction of propagation by integrating over the 10-40km range and looking at the distribution vs angle.
For RF16, the highest power (red) was just above the mountains and most of the GWs propagated in the East-West direction (since we use only single images, there is a 180° ambiguity and we cannot tell if they were going towards the East or the West with this method).

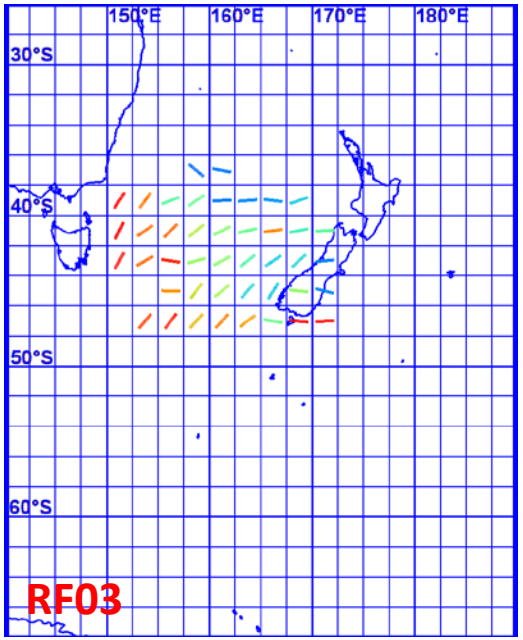
Small-Scale GWs
($10<\lambda_x<40$km)
Power and
Direction for all
25 Flights

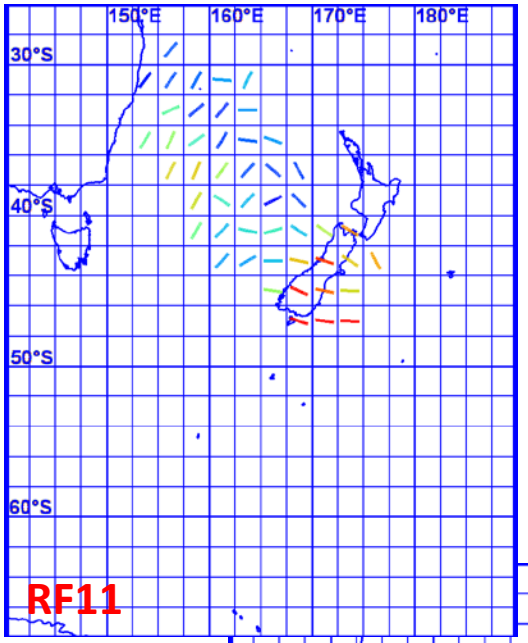


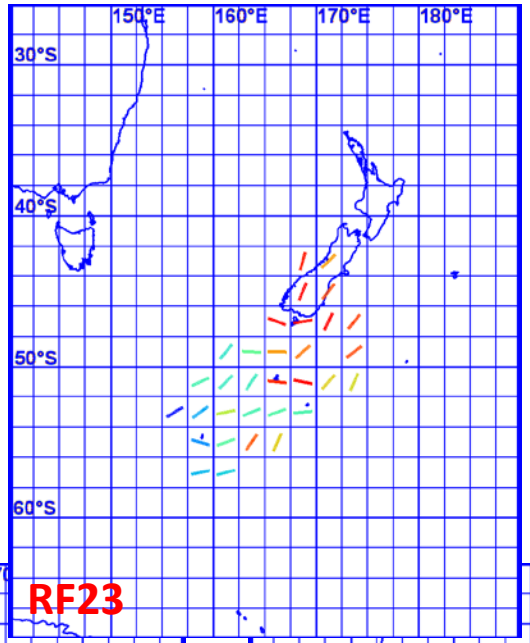

160E
180E/W

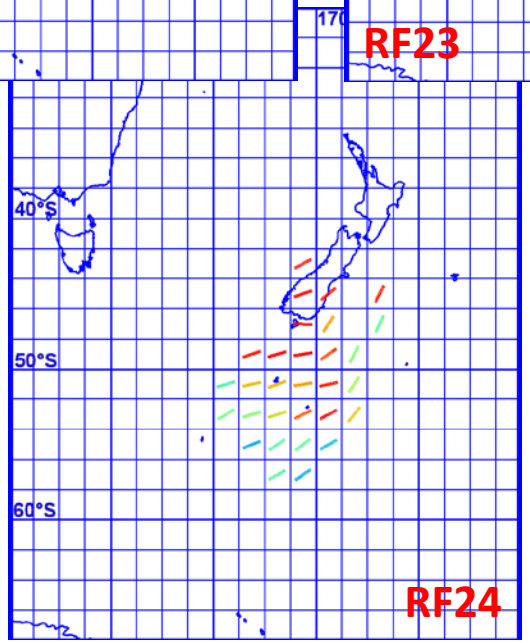

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

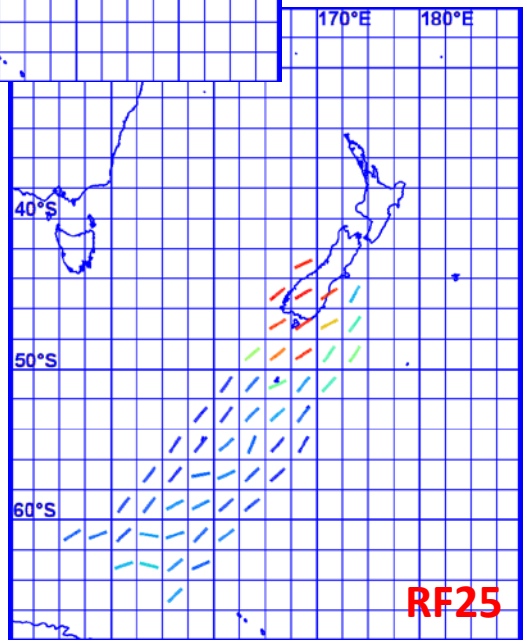
Mountains vs Oceans





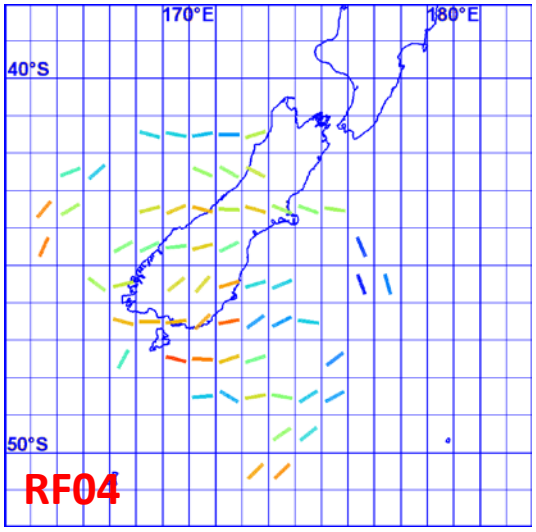


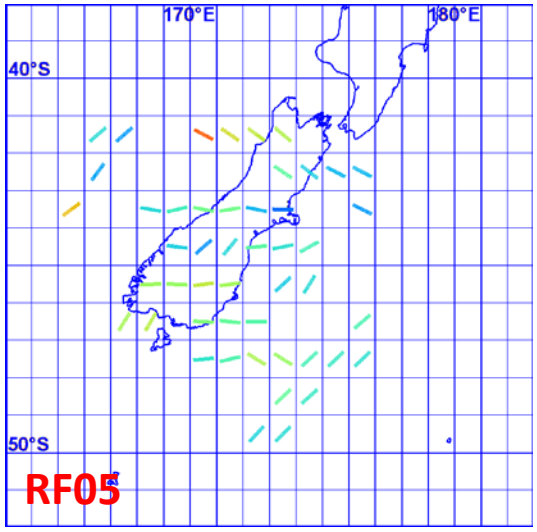


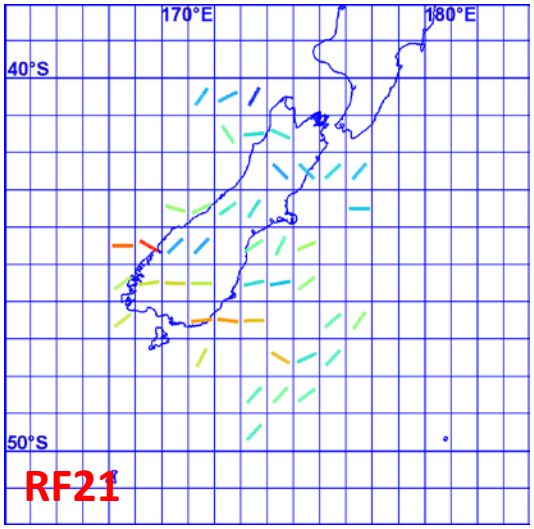


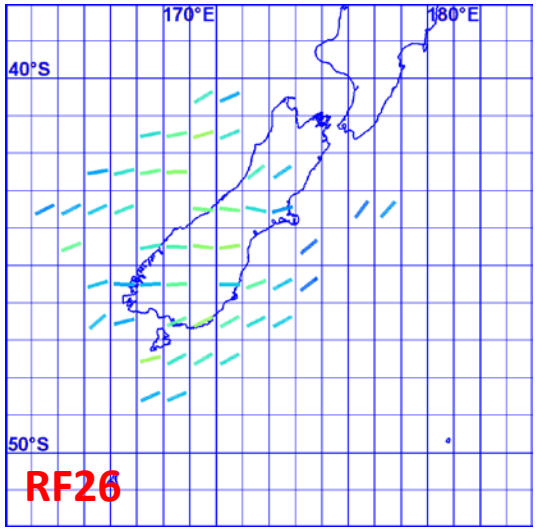
- Strong difference land vs ocean during the same flight

Mountain Flights – Small Power



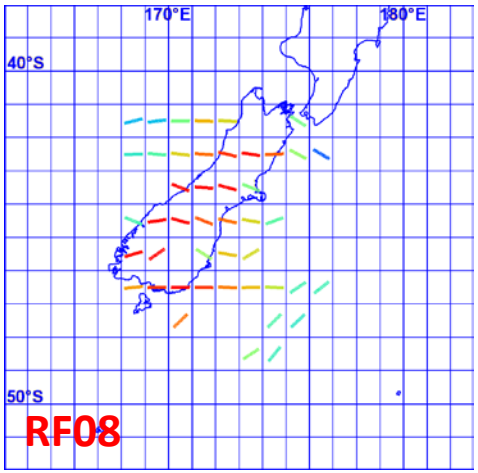


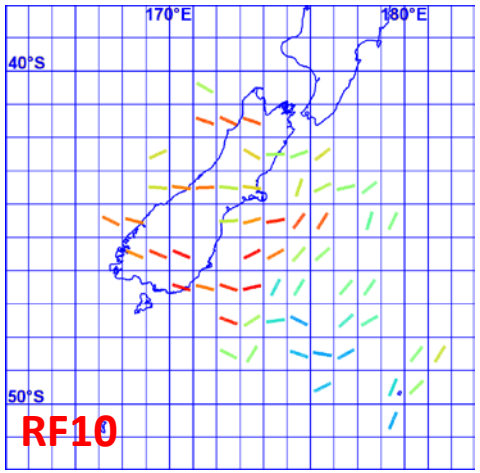


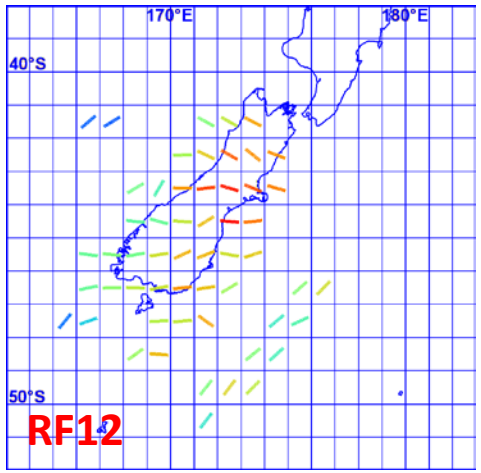


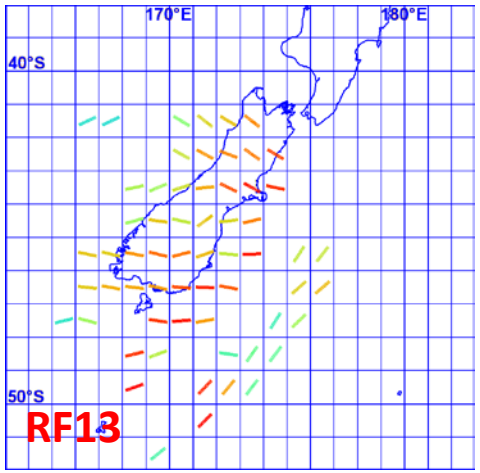
- Weak GW power
- Direction ~NE

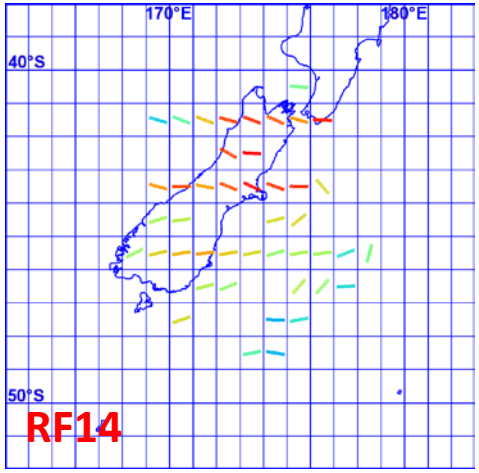
Mountain Flights – Large Power

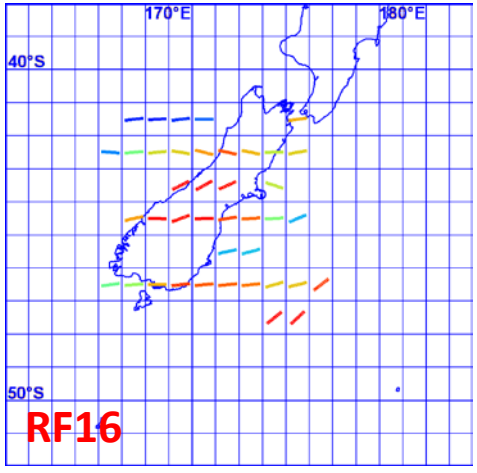


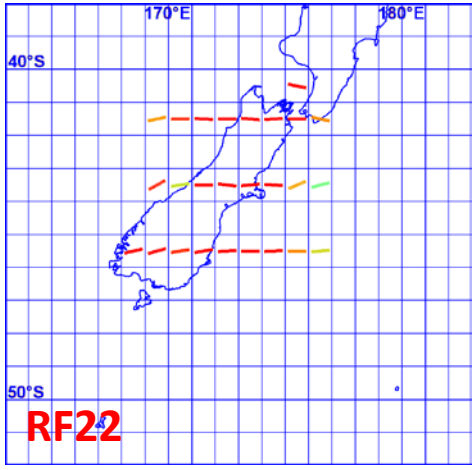






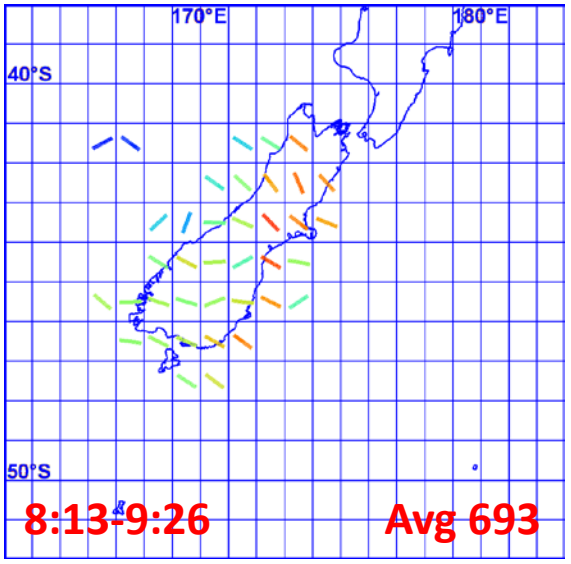


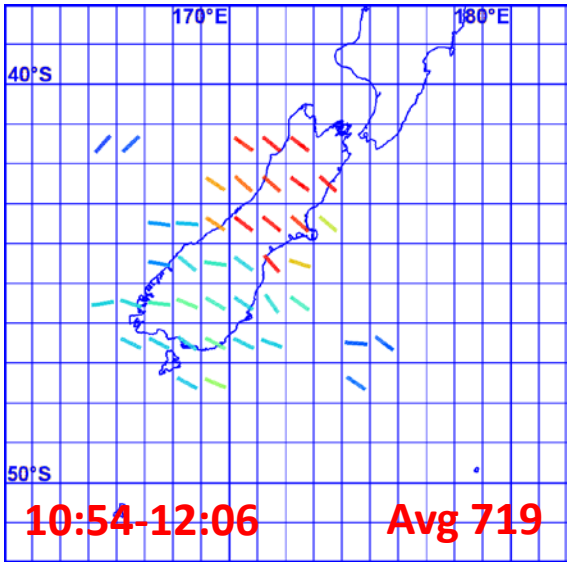


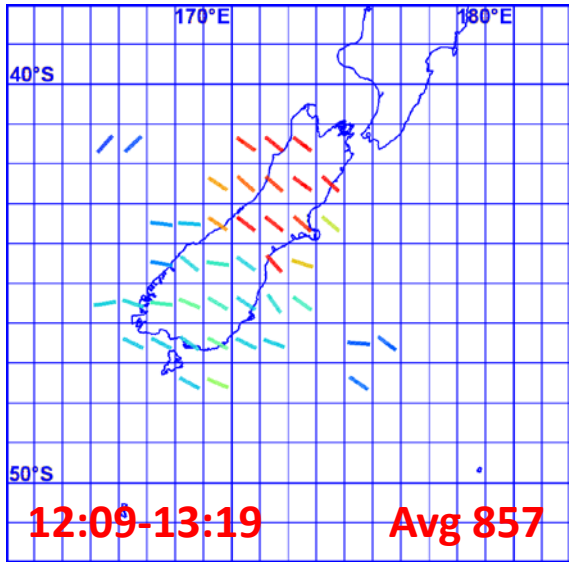


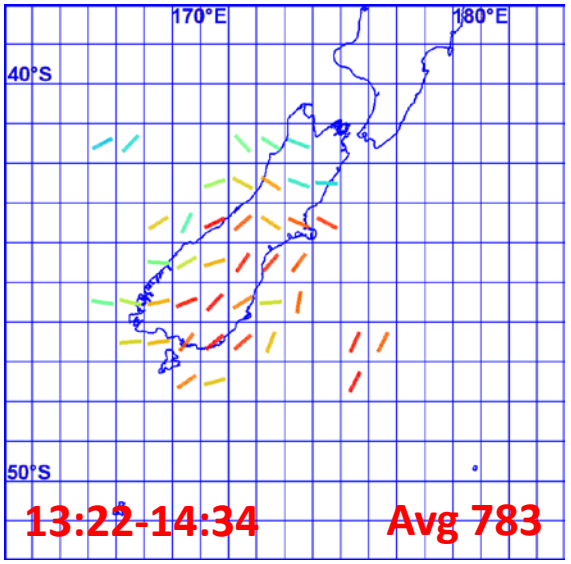
- Larger GW power
- Direction ~E or ~SE

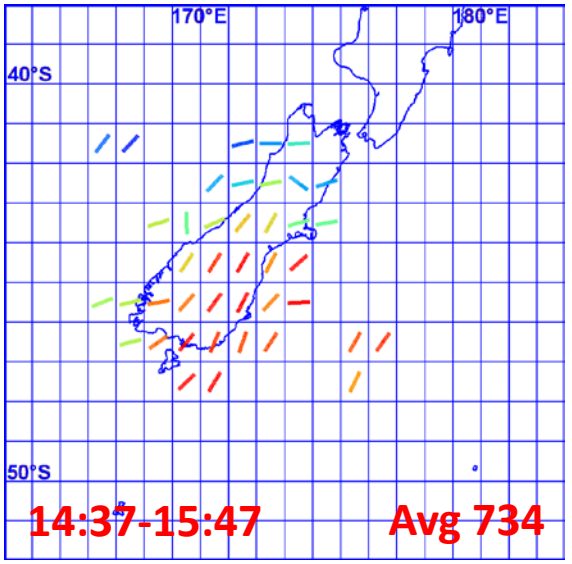
Evolution Power/Direction RF12

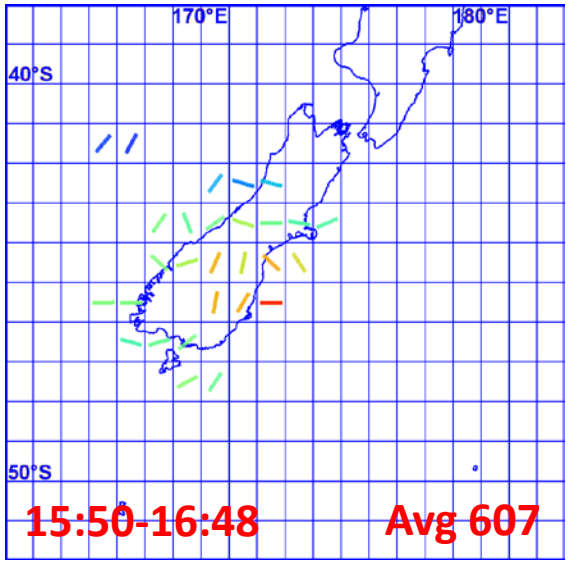




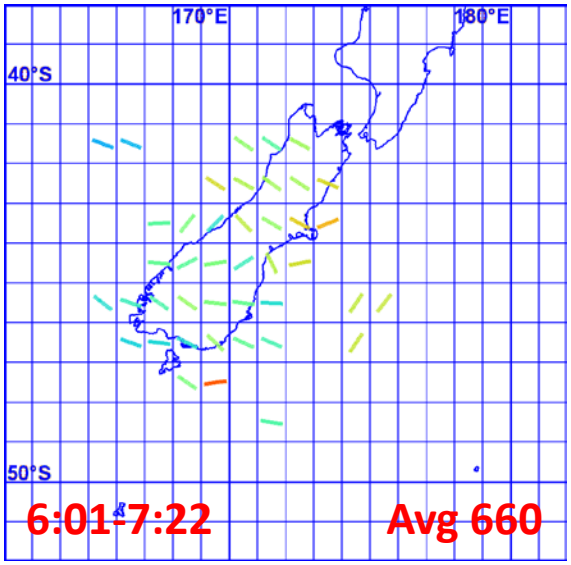


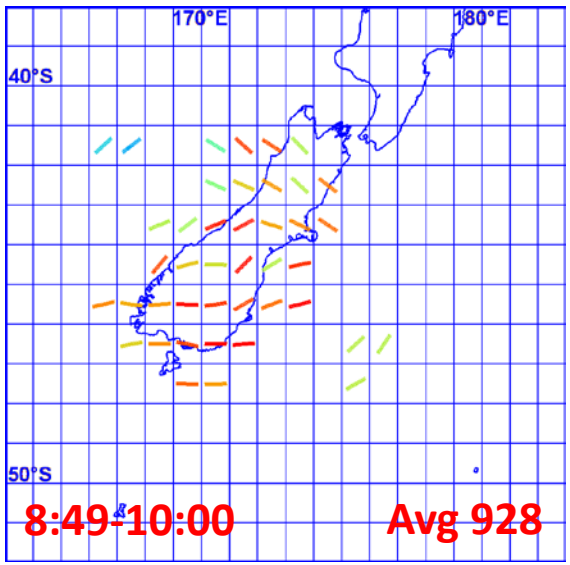


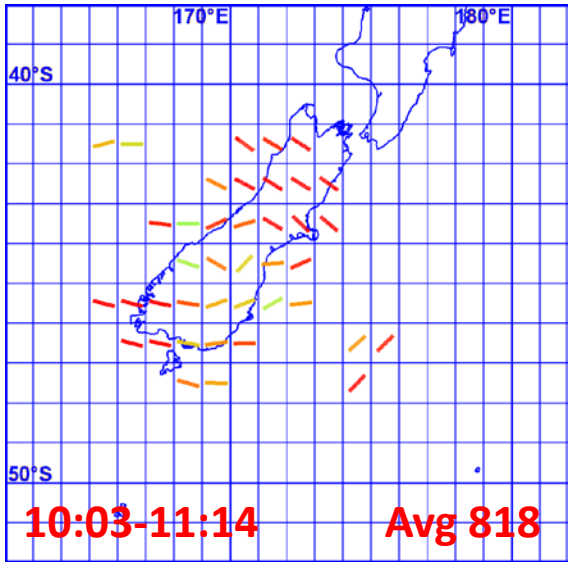


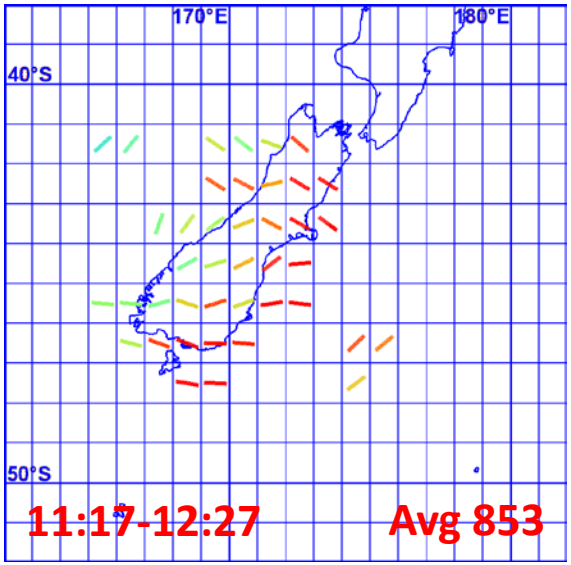


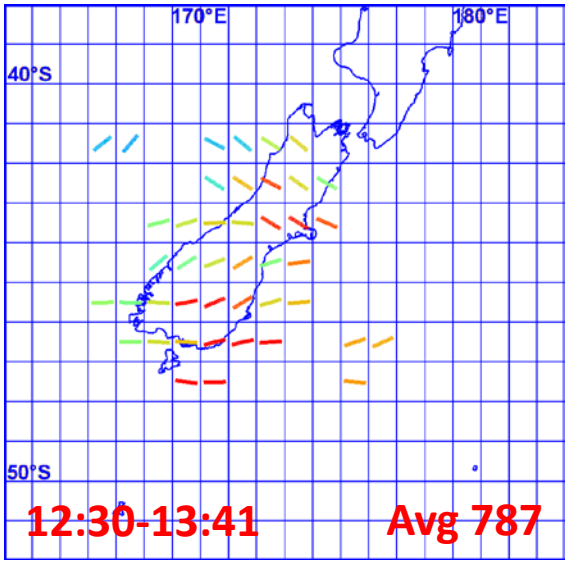
Evolution Power/Direction RF13

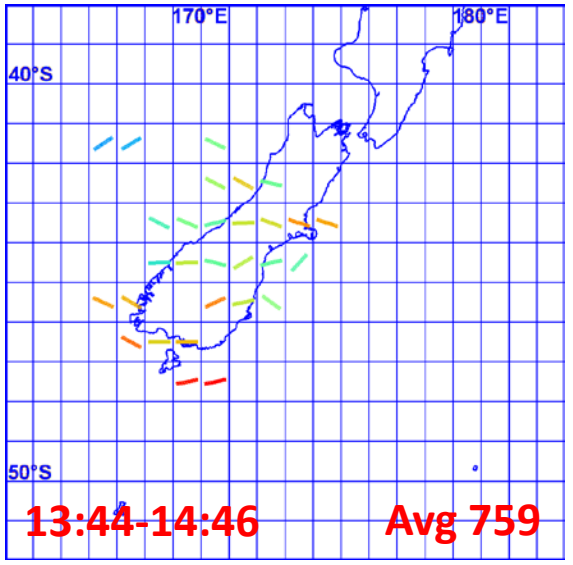










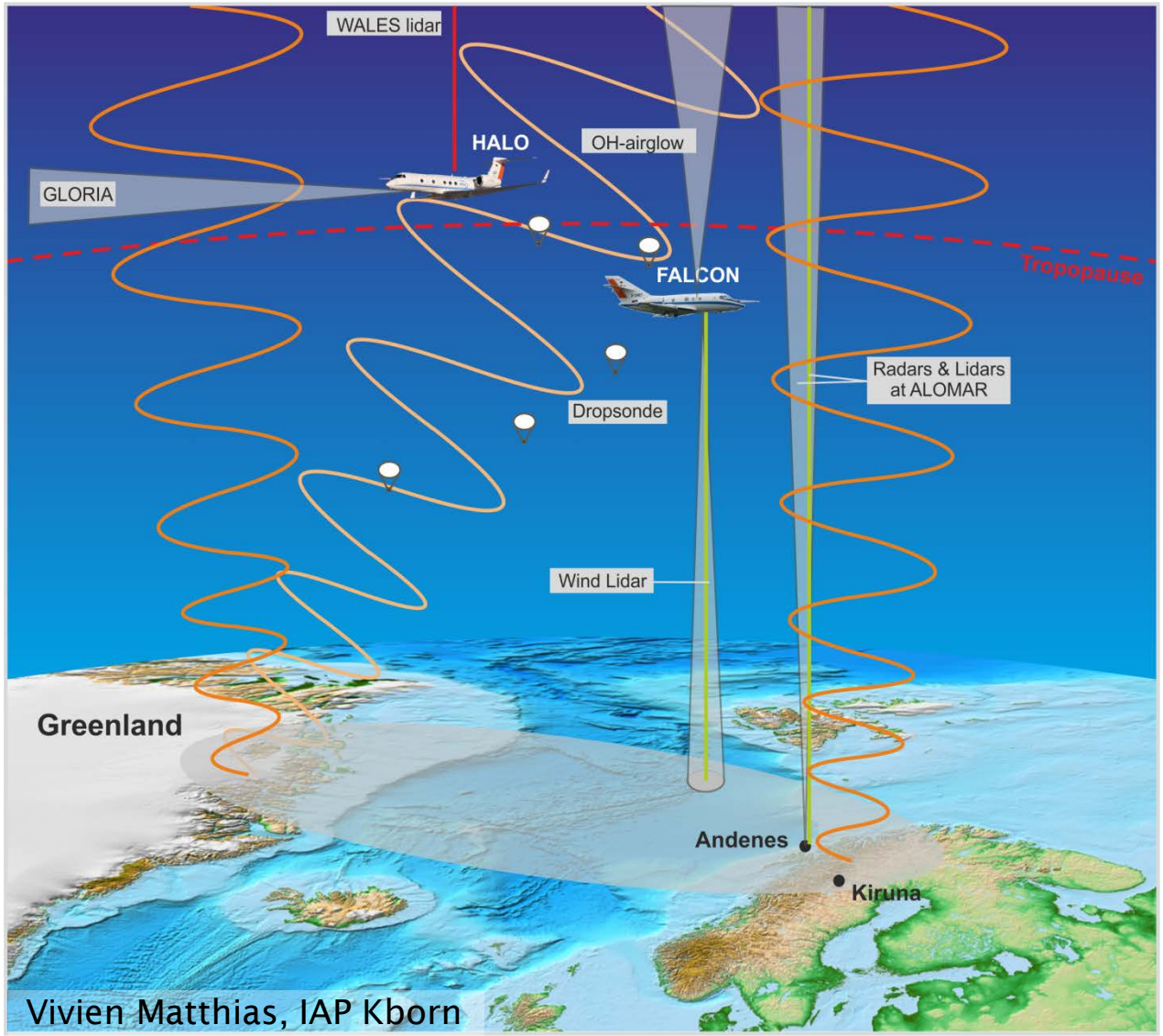


Small-Scale GWs Power

- Small-scale GWs ($10<\lambda_x<40$km) power and direction (180° ambiguity)
- Nightly evolution
- MW flights vs forcing
- Comparison lands vs oceans: average power and direction different if over land or over ocean
- Comparison with lower altitude measurements? Does it make sense?

The GW-LCYCLE2 Project Within ROMIC

Partners: DLR, KIT, FZJ, IAP and international partners

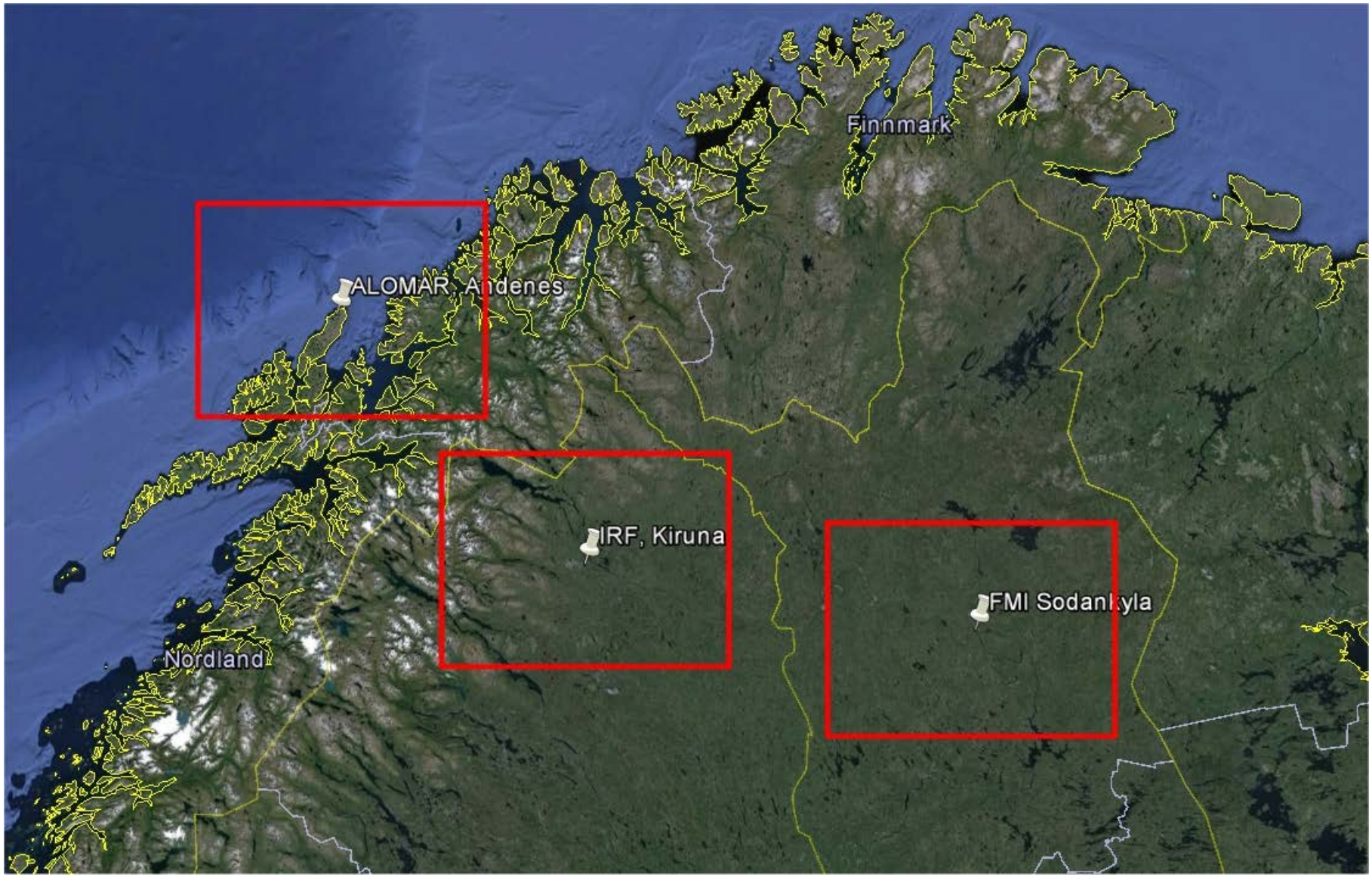


BMBF Research Initiative: ROMIC (Role of the Middle atmosphere In Climate)
2014 -2017

DFG Research Group: MSGwaves (Multiscale Dynamics of Gravity Waves)
2014-2020

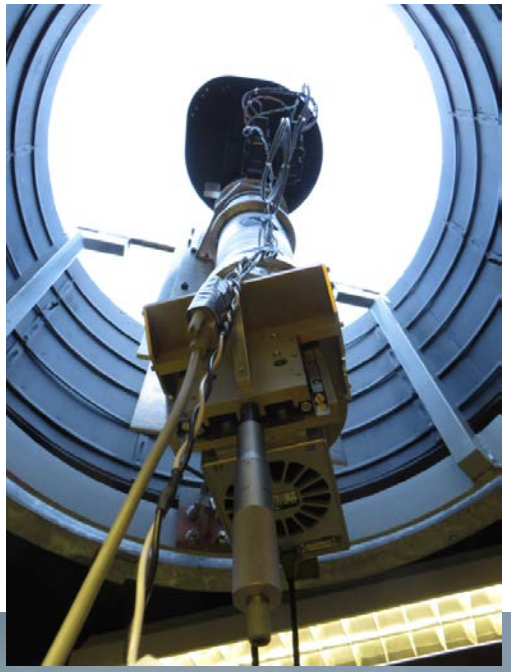
GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

AMTM Locations and Approximate FOVs

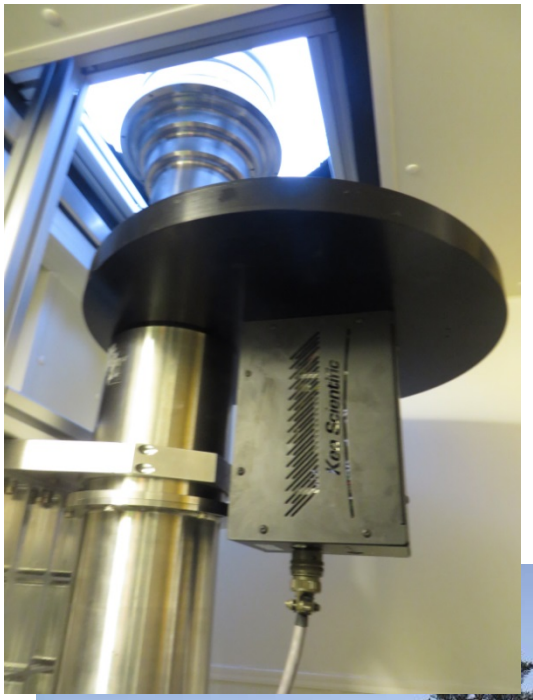


ALOMAR, Norway

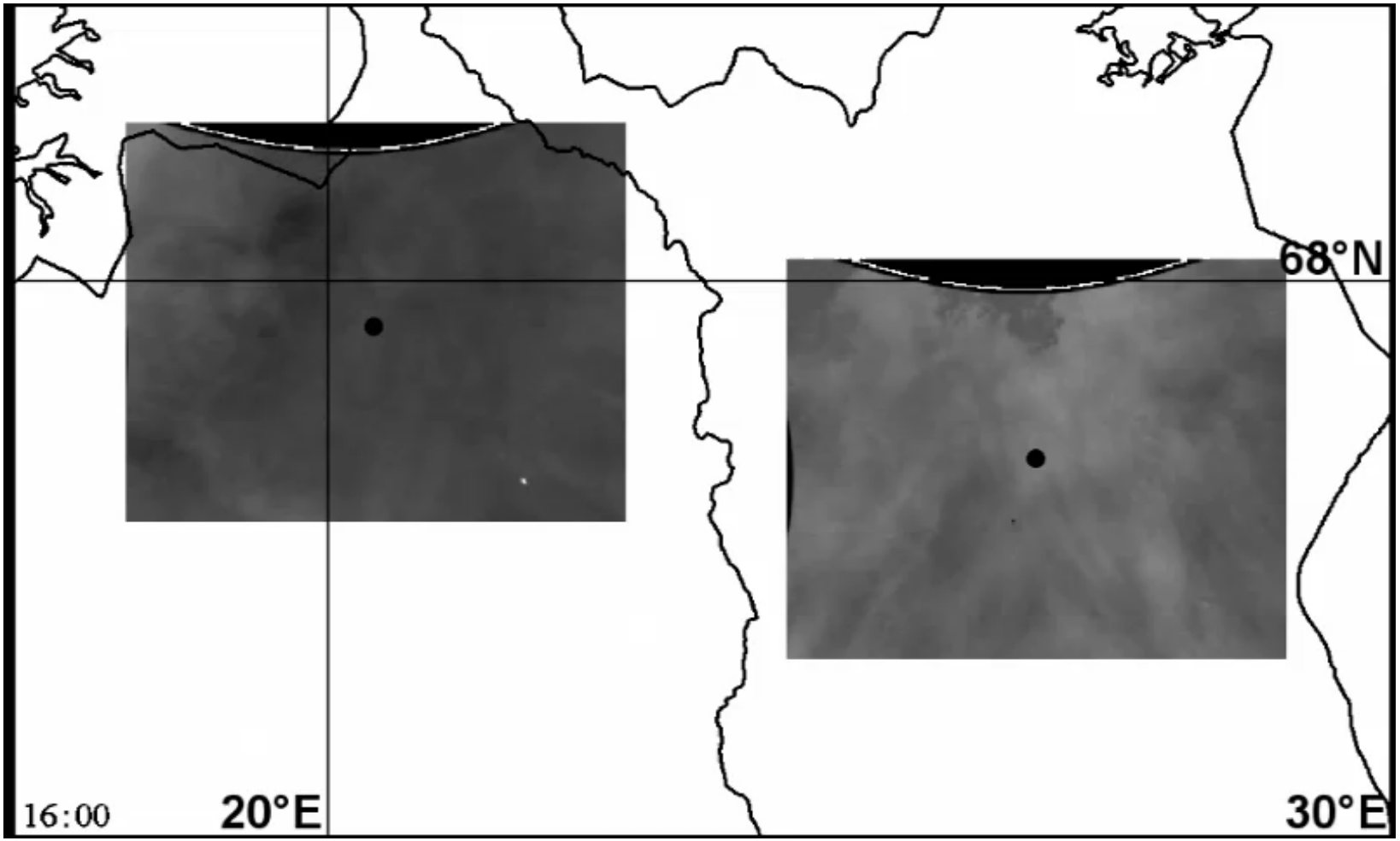
IRF, Sweden



FMI, Finland

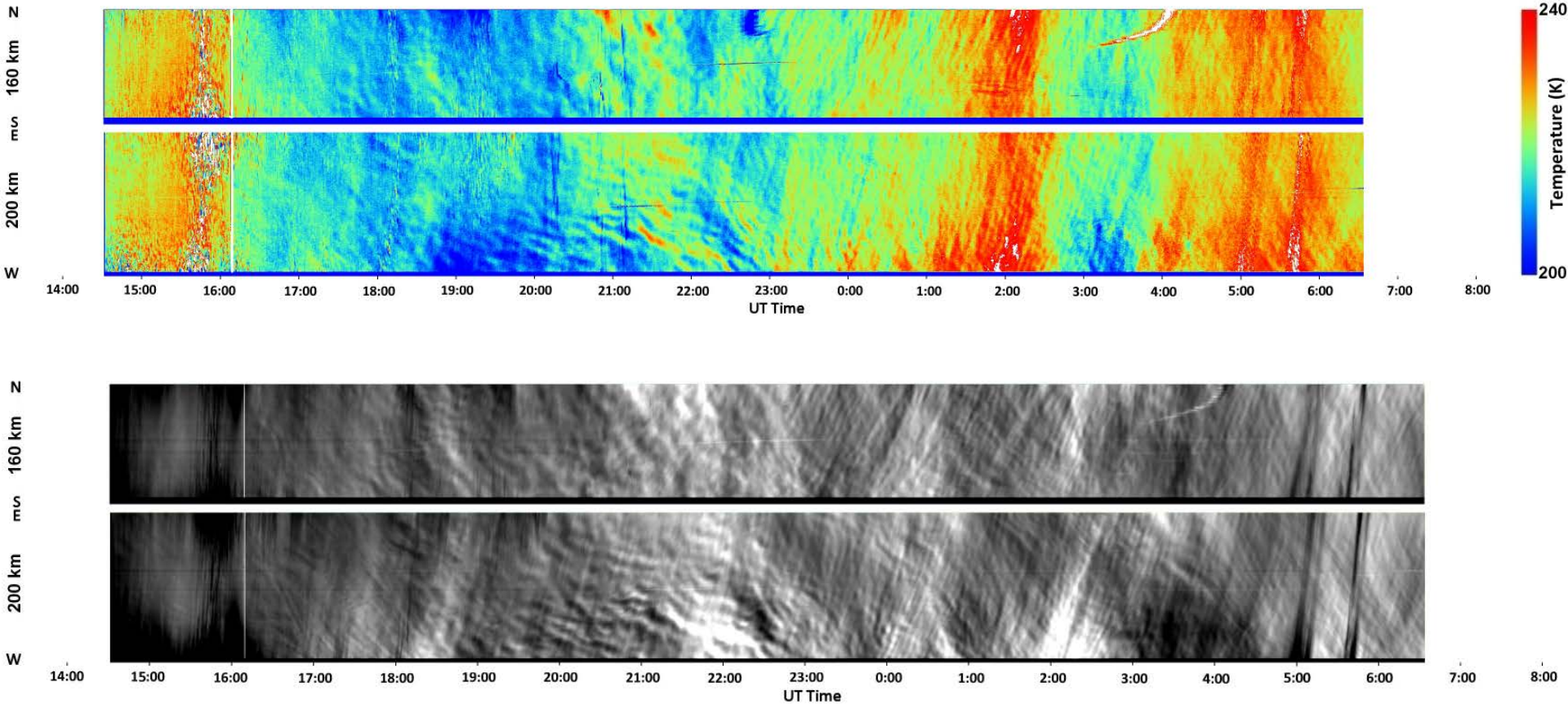


Mesospheric Mountain Waves Over Kiruna and Sodankylä – Dec 13-14, 2015



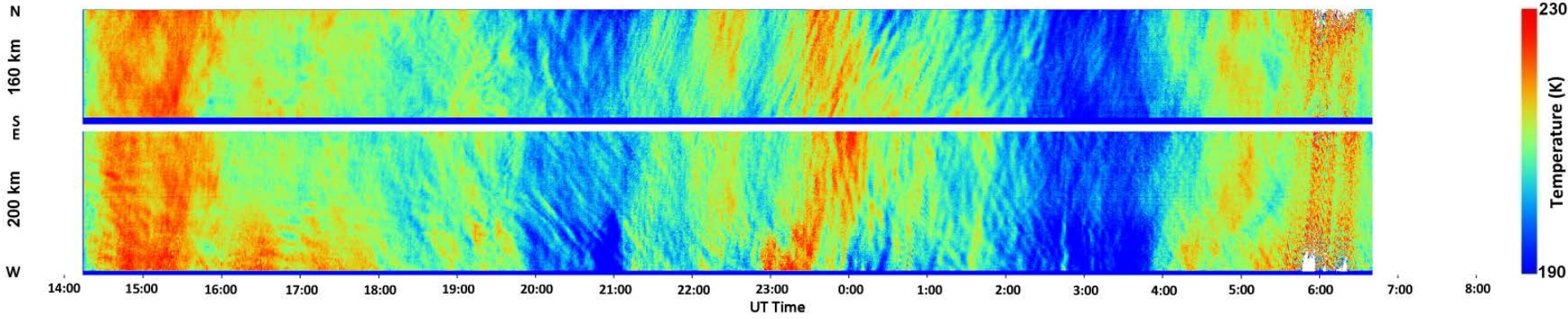
Mountain Waves Kiruna

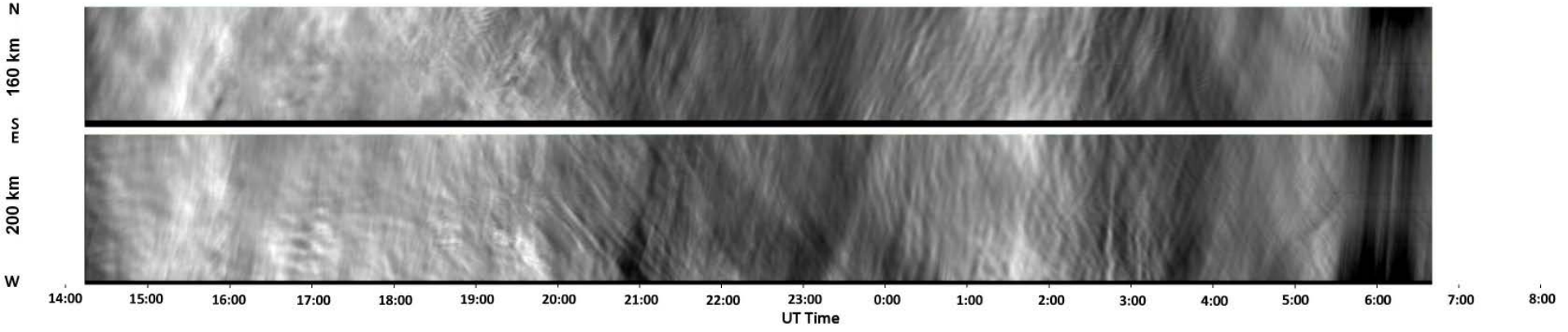
Nov 28-29



Mountain Waves Kiruna

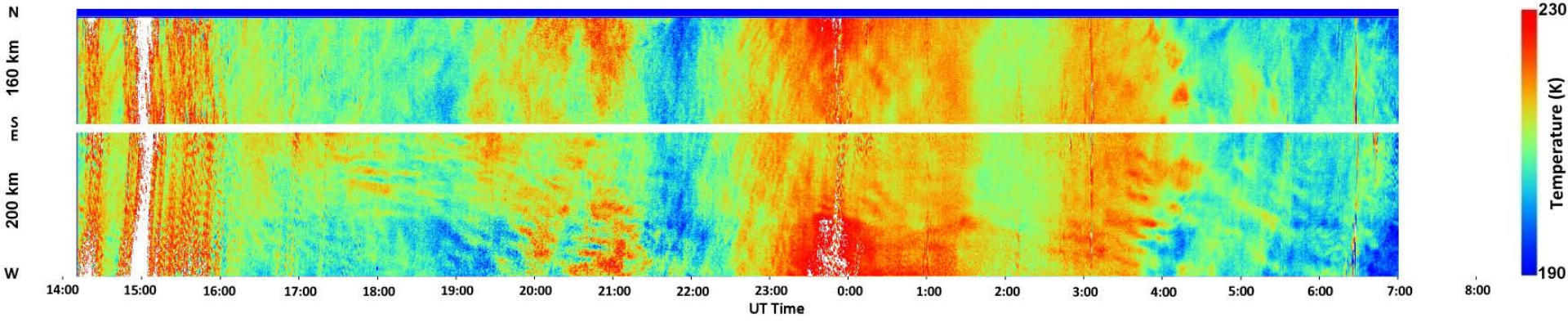
Dec 04-05

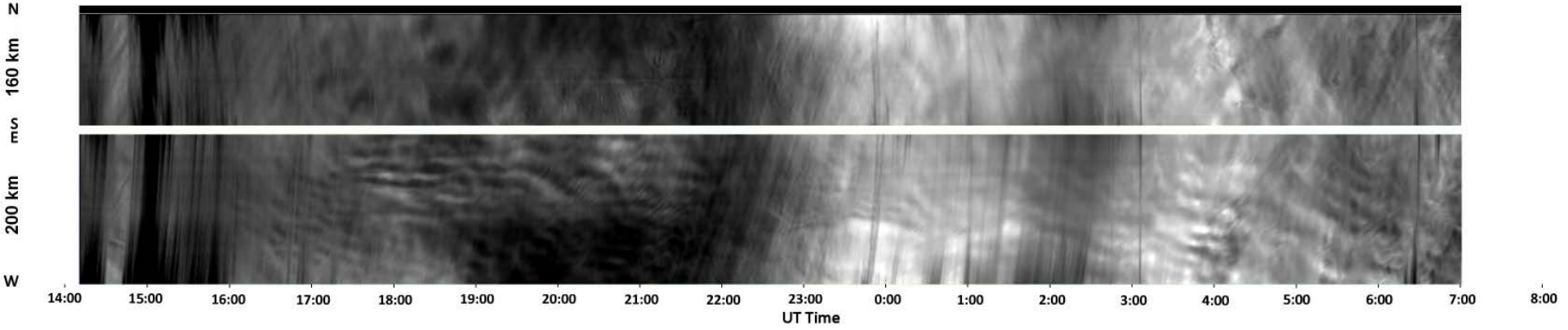




Mountain Waves Kiruna

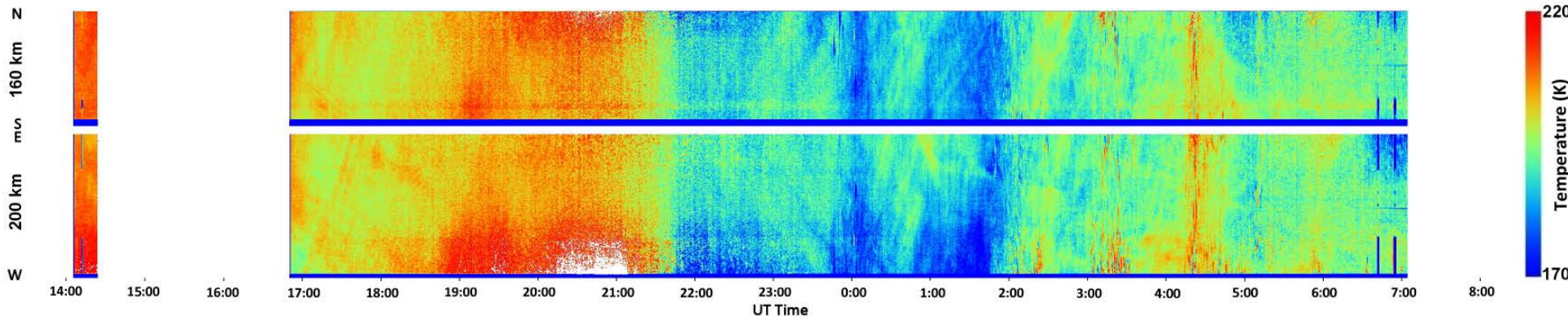
Dec 13-14

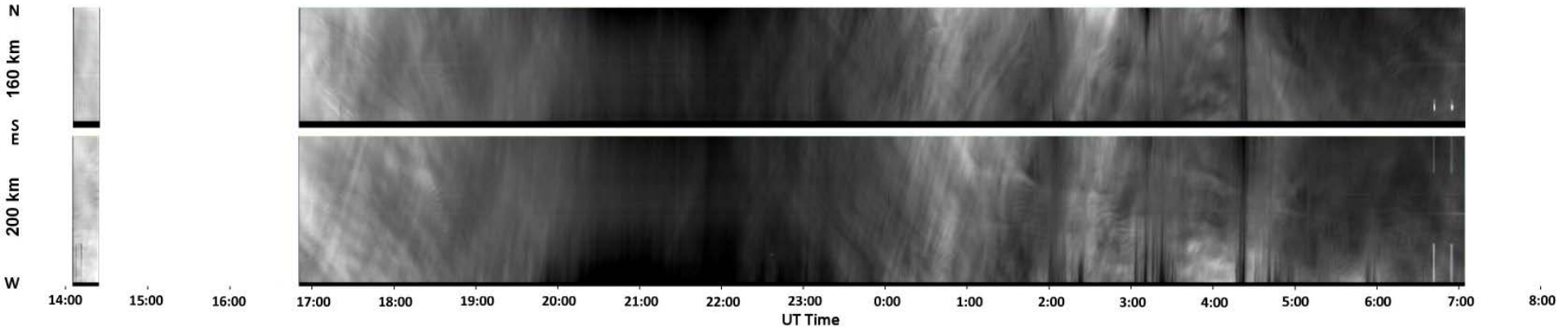




Mountain Waves Kiruna

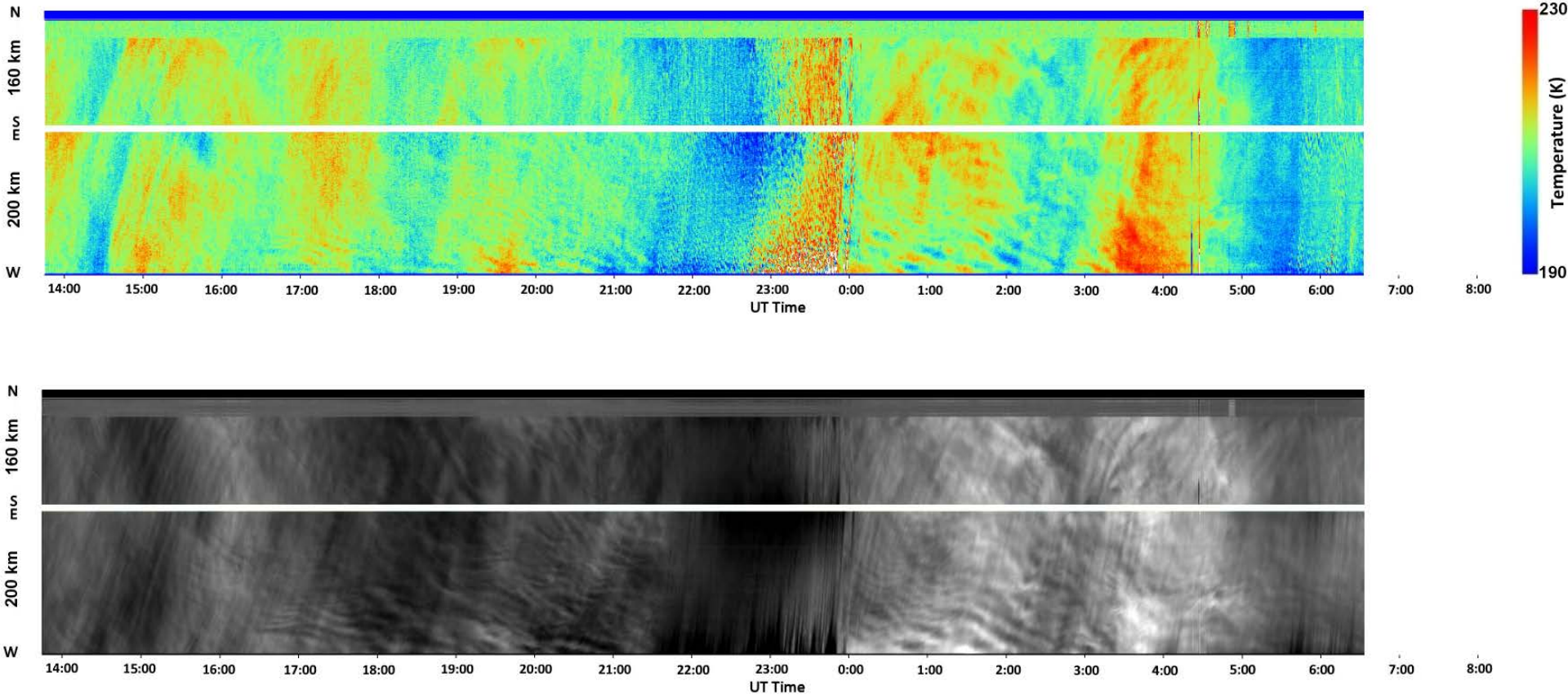
Dec 15-16



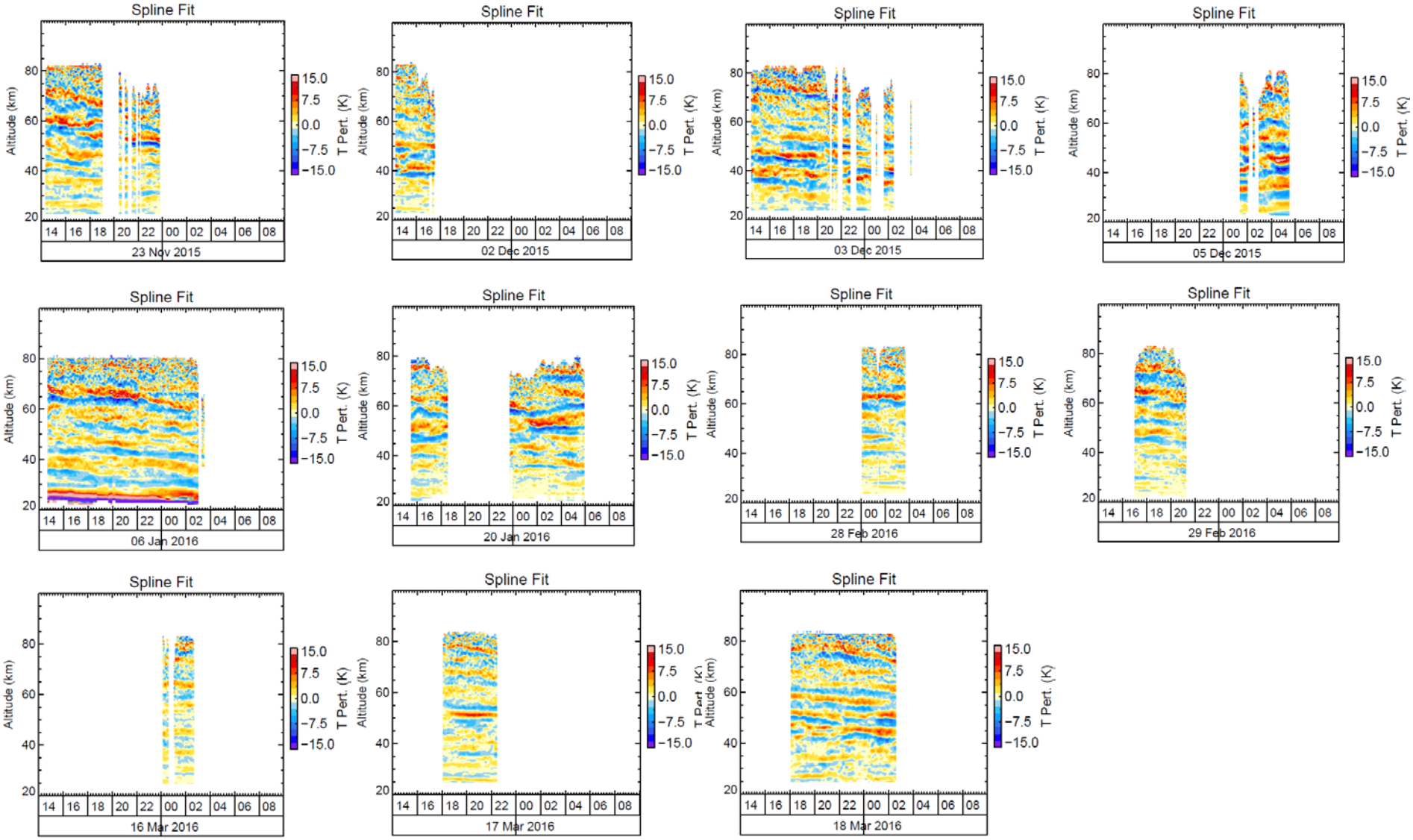


Mountain Waves Sodankylä

Dec 13-14

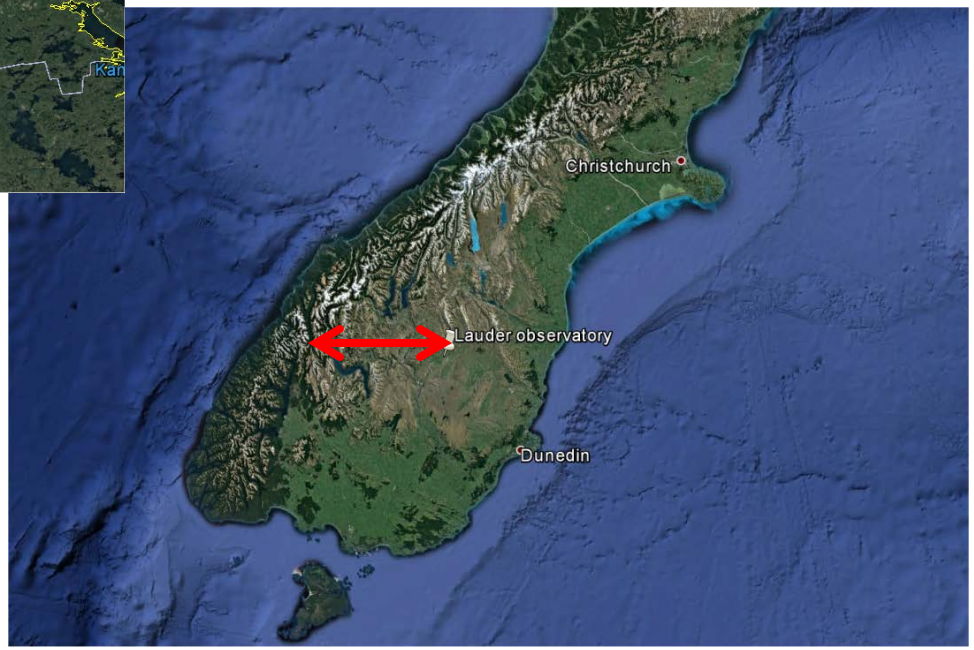


Many MWs in Rayleigh Lidar Data



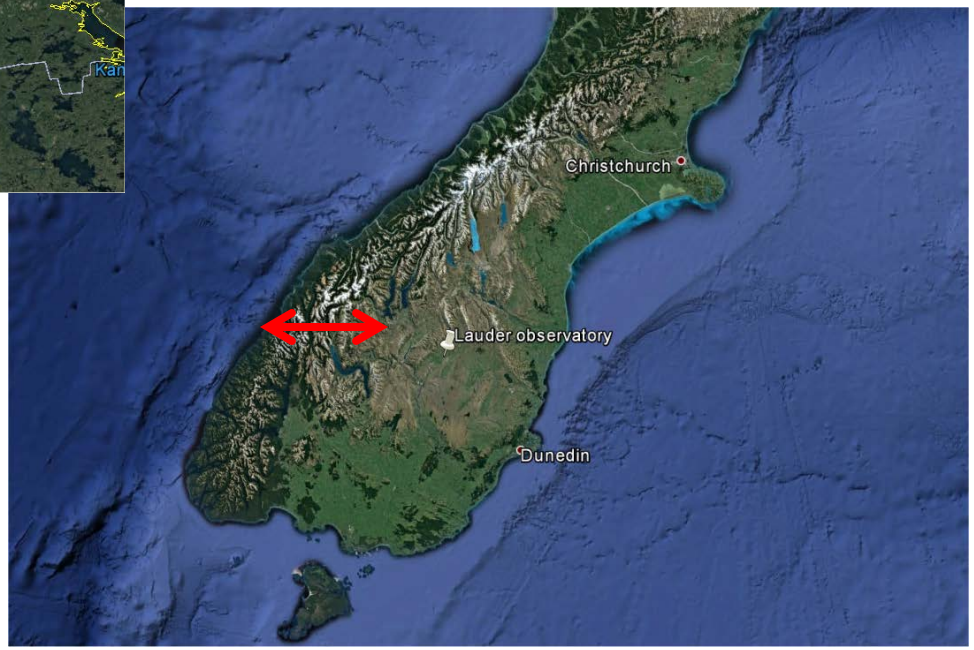
Differences NZ-Scandinavia

- **Same distance to the mountains (100-150km) for Lauder and Kiruna**



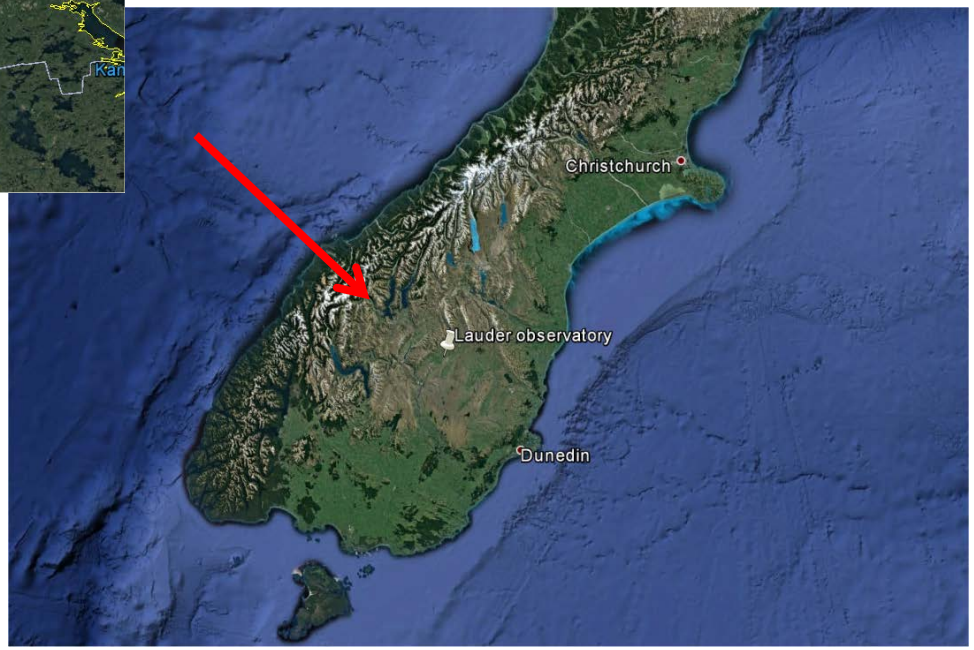
Differences NZ-Scandinavia

- **Same distance to the mountains (100-150km) for Lauder and Kiruna**
- **W-E size: ~150km for S, ~100 km for NZ**



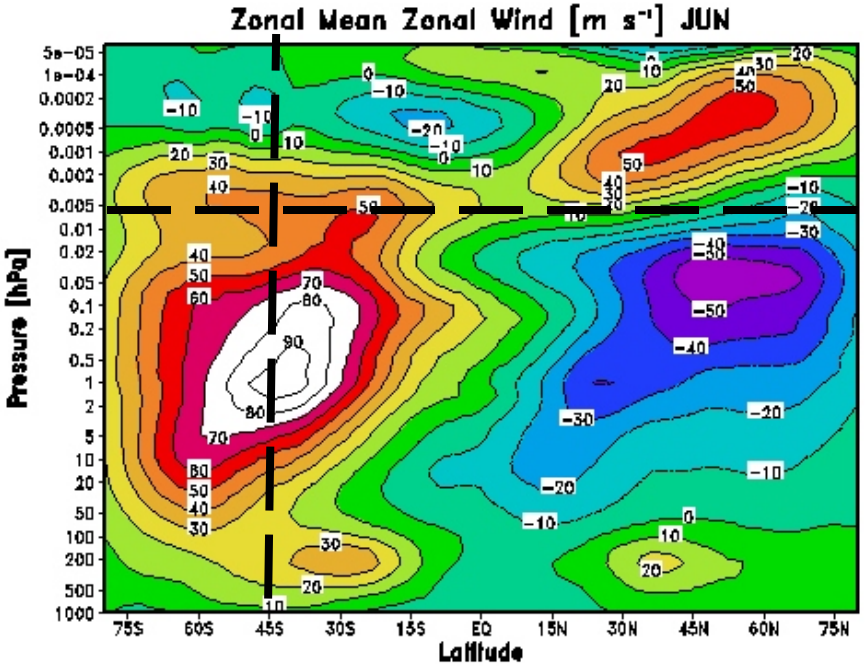
Differences NZ-Scandinavia

- **Same distance to the mountains (100-150km) for Lauder and Kiruna**
- **W-E size: ~150km for S, ~100 km for NZ**
- **Mountain top: ~2000m for S, ~3000m for NZ**



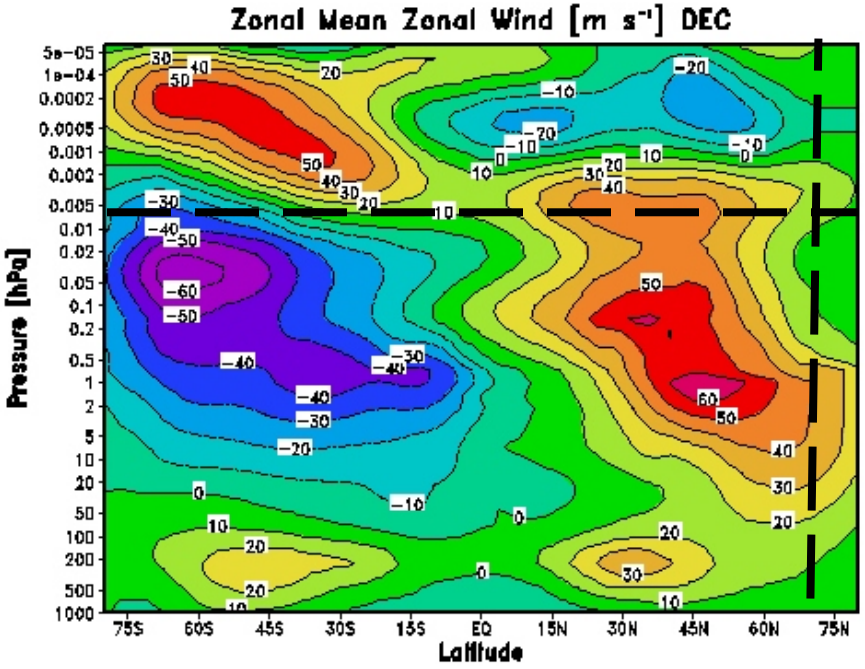
Effect of Horizontal Wind

Lauder



- Larger winds (max ~90m/s @ ~50km)
- Goes to ~0m/s @ ~95km
- MWs should reach OH layer most of the time (if their amplitude is not too large)

Scandinavia

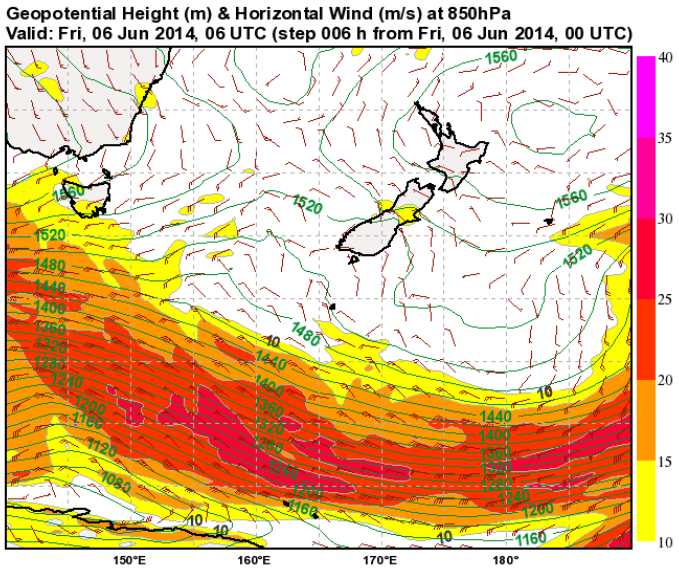


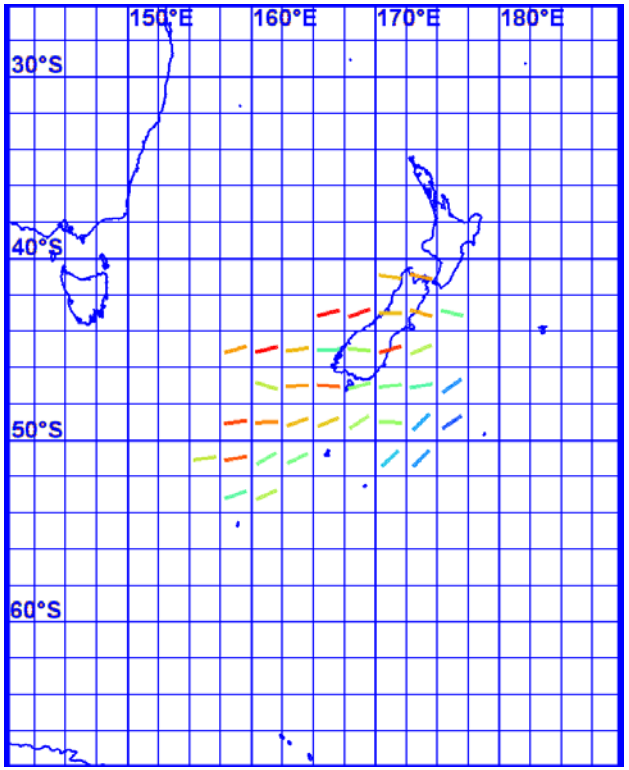
- Smaller winds (max ~40m/s @ ~40km)
- Second maximum at MLT altitude
- Goes to ~0m/s @ ~60km
- MWs might reach OH layer under the right circumstances

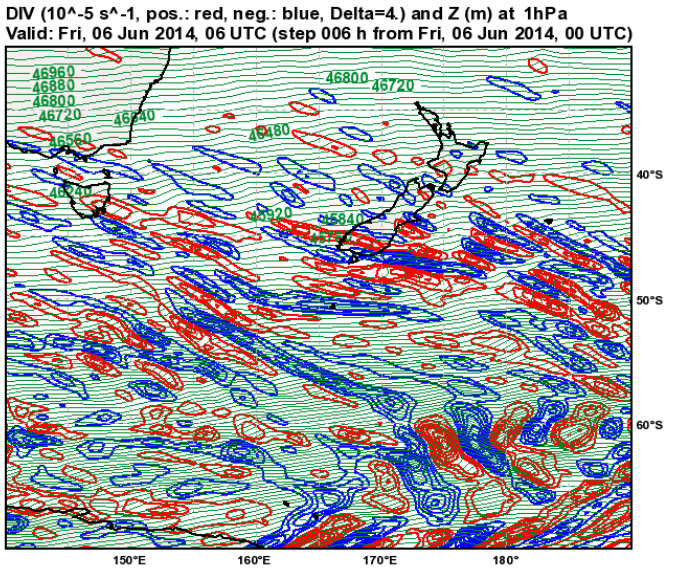
DEEPWAVE vs GW_LCYCLE 2

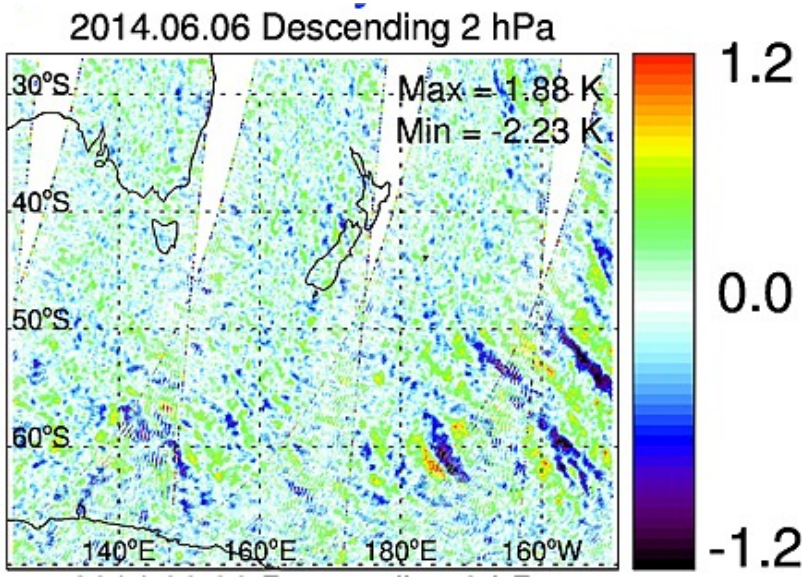
- Similar geographical situations for Lauder and Kiruna in 2 different hemispheres
- MWs rarely observed over Kiruna, 70% occurrence over Lauder
- Smaller horizontal wind at higher latitude may create critical levels at lower altitude, stopping MWs from reaching the MLT
- Other possibility: the MWs over Kiruna/Sodankylä have a shorter vertical wavelength (≤ 8km), thus cannot be observed with an AMTM (but can be detected by a Rayleigh lidar)

RF01

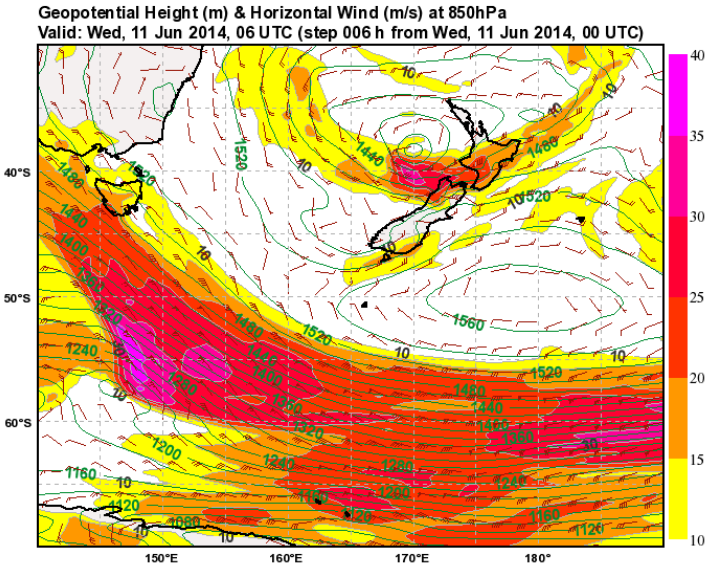

Geopotential Height (m) & Horizontal Wind (m/s) at 850hPa
Valid: Fri, 06 Jun 2014, 06 UTC (step 006 h from Fri, 06 Jun 2014, 00 UTC)
40°S
50°S
60°S
150°E
160°E
170°E
180°
40
35
30
25
20
15
10

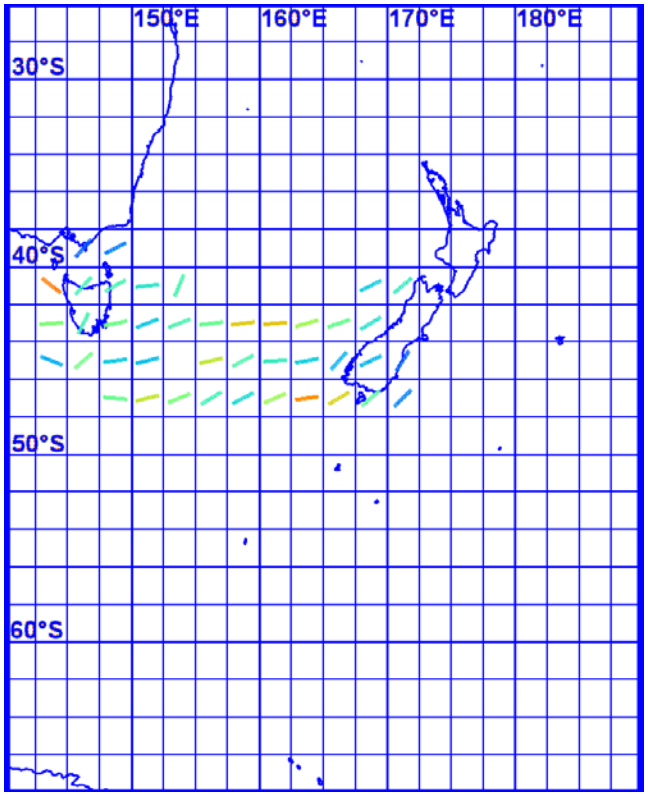

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

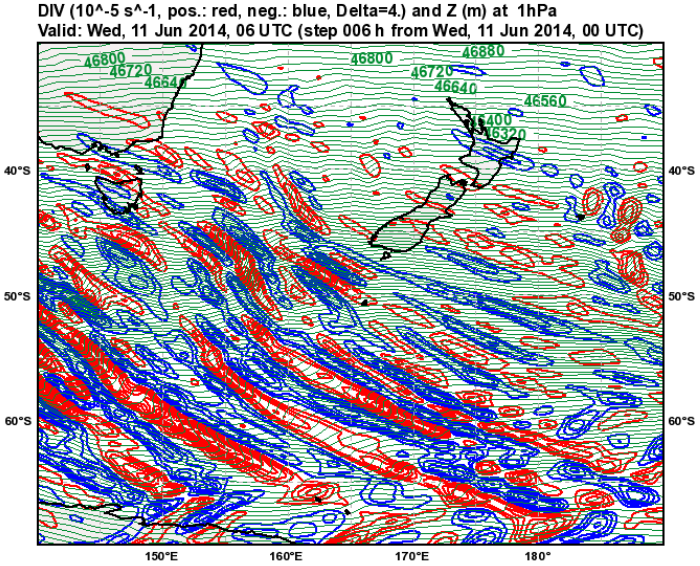

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1hPa
Valid: Fri, 06 Jun 2014, 06 UTC (step 006 h from Fri, 06 Jun 2014, 00 UTC)
40°S
50°S
60°S
150°E
160°E
170°E
180°

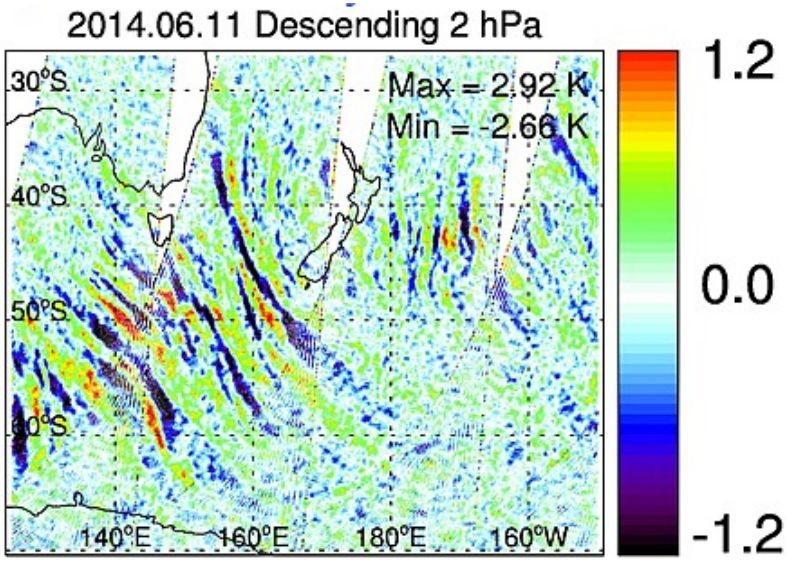

2014.06.06 Descending 2 hPa
Max = 1.88 K
Min = -2.23 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

RF02

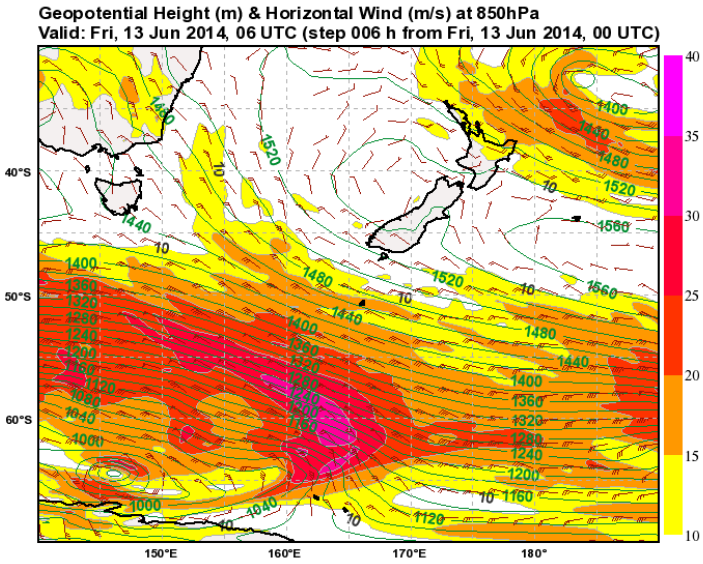

Geopotential Height (m) & Horizontal Wind (m/s) at 850hPa
Valid: Wed, 11 Jun 2014, 06 UTC (step 006 h from Wed, 11 Jun 2014, 00 UTC)
40°S
50°S
60°S
150°E
160°E
170°E
180°
40
35
30
25
20
15
10

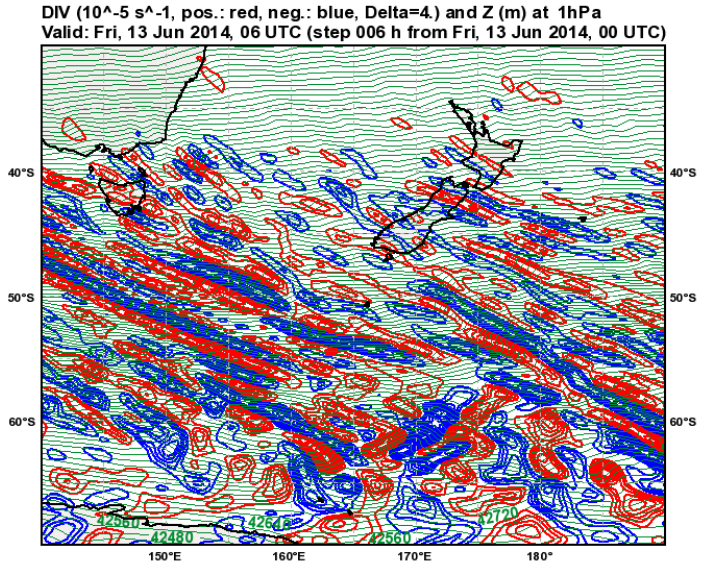

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

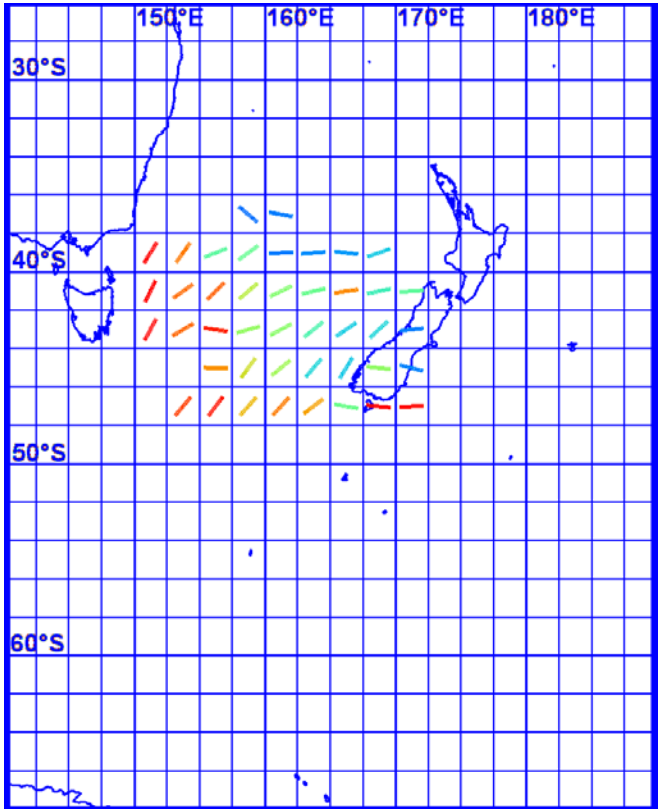

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1hPa
Valid: Wed, 11 Jun 2014, 06 UTC (step 006 h from Wed, 11 Jun 2014, 00 UTC)
40°S
50°S
60°S
150°E
160°E
170°E
180°

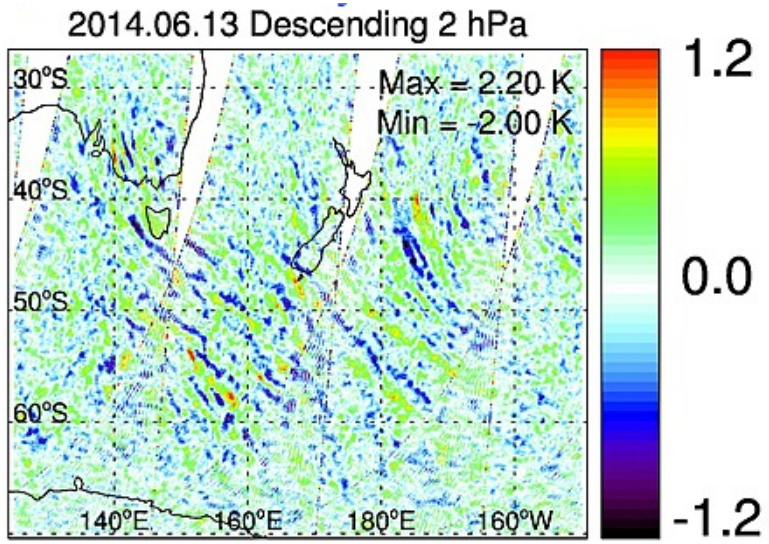

2014.06.11 Descending 2 hPa
Max = 2.92 K
Min = -2.66 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

RF03

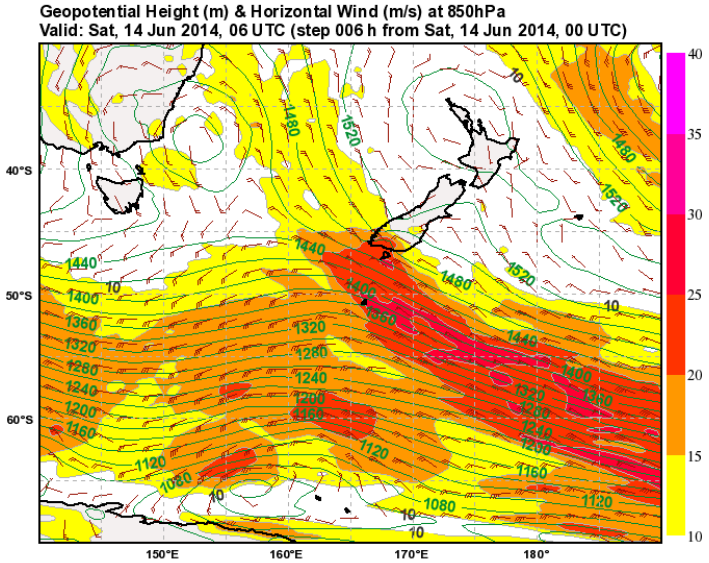

Geopotential Height (m) & Horizontal Wind (m/s) at 850hPa
Valid: Fri, 13 Jun 2014, 06 UTC (step 006 h from Fri, 13 Jun 2014, 00 UTC)
40°S
50°S
60°S
150°E
160°E
170°E
180°
40
35
30
25
20
15
10

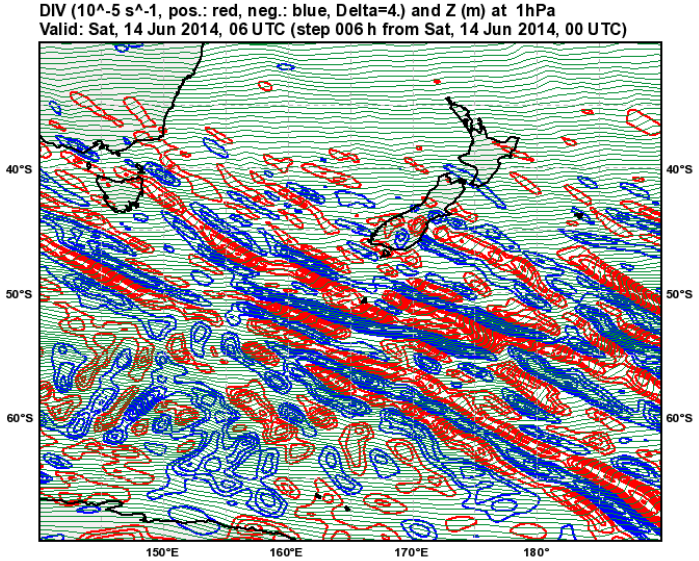

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1hPa
Valid: Fri, 13 Jun 2014, 06 UTC (step 006 h from Fri, 13 Jun 2014, 00 UTC)
40°S
50°S
60°S
150°E
160°E
170°E
180°


150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S


2014.06.13 Descending 2 hPa
Max = 2.20 K
Min = -2.00 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

RF04


Geopotential Height (m) & Horizontal Wind (m/s) at 850hPa
Valid: Sat, 14 Jun 2014, 06 UTC (step 006 h from Sat, 14 Jun 2014, 00 UTC)
40°S
50°S
60°S
150°E
160°E
170°E
180°
10
15
20
25
30
35
40


DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1hPa
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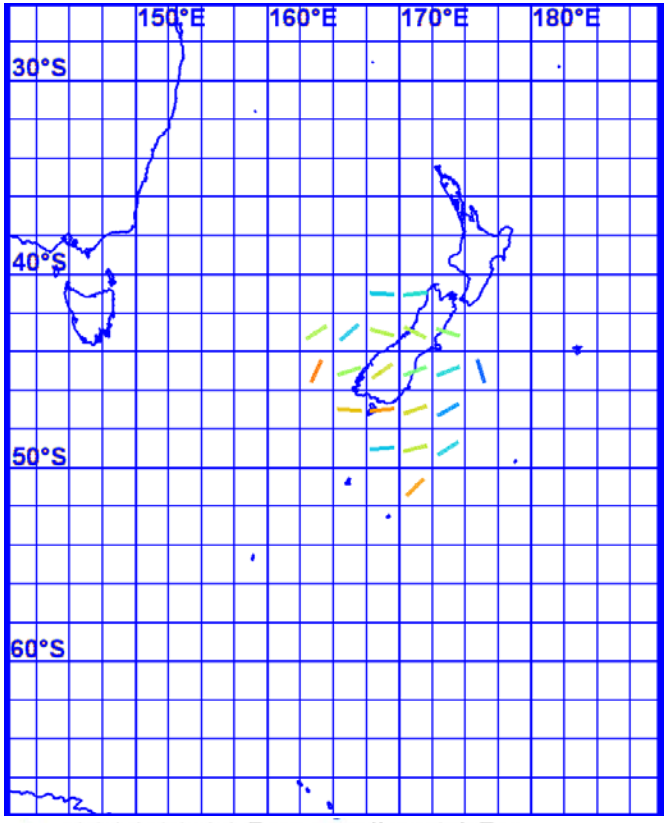
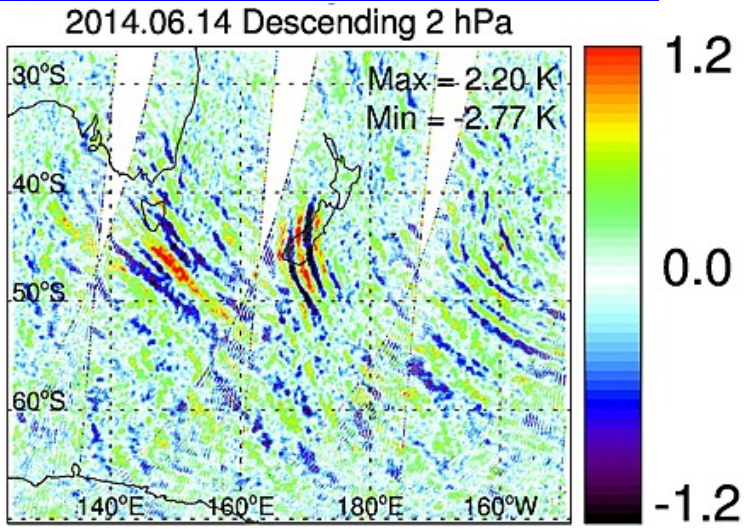
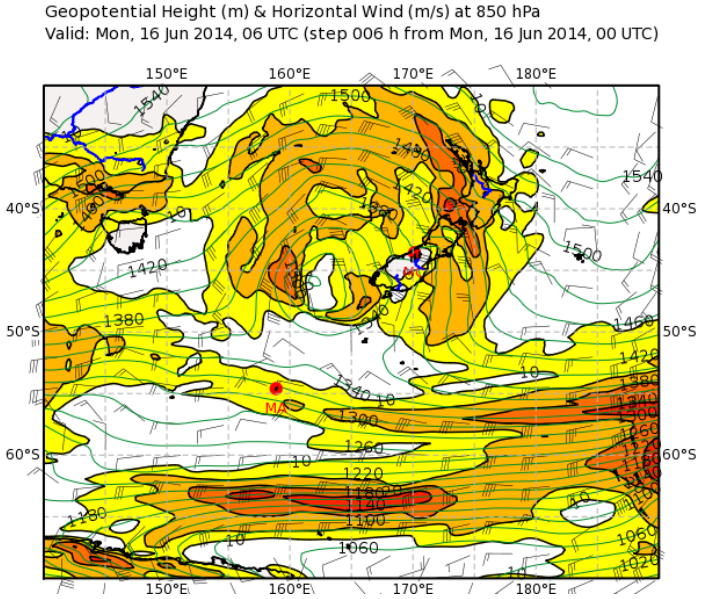
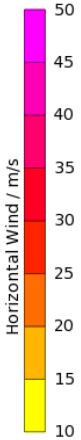
40°S
50°S
60°S
150°E
160°E
170°E
180°

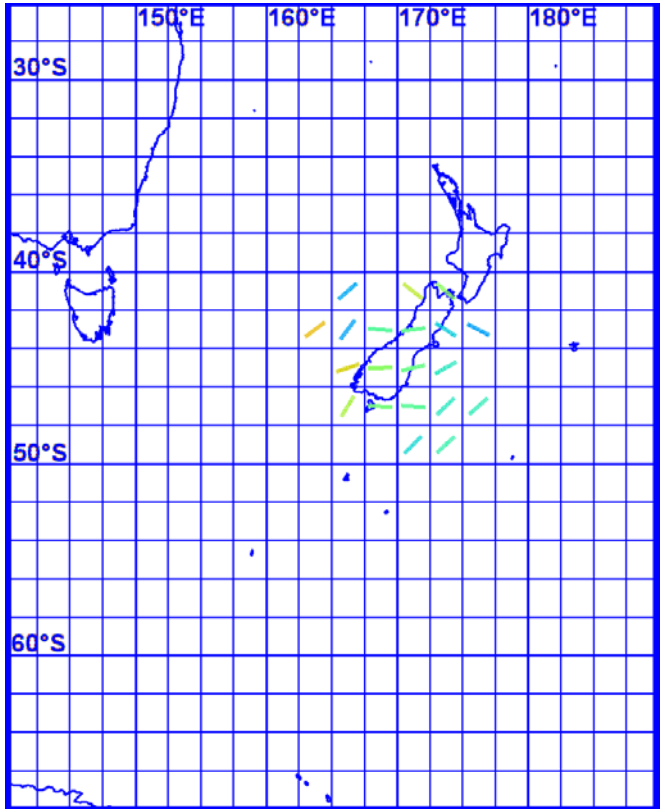

150°E
160°E
170°E
180°
30°S
40°S
50°S
60°S

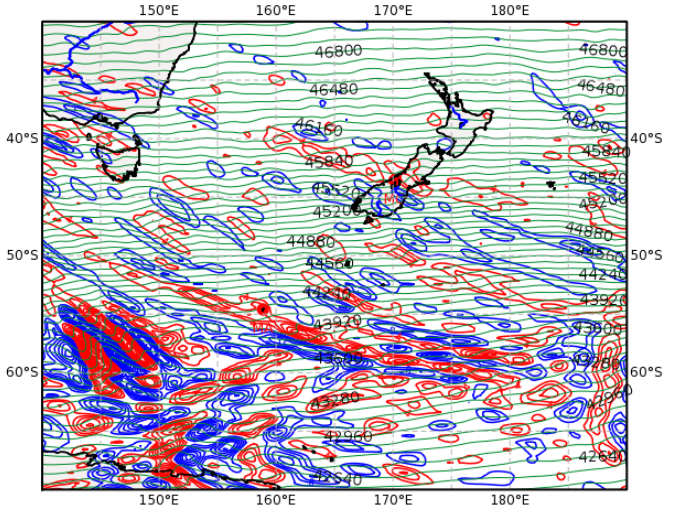

2014.06.14 Descending 2 hPa
Max = 2.20 K
Min = -2.77 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

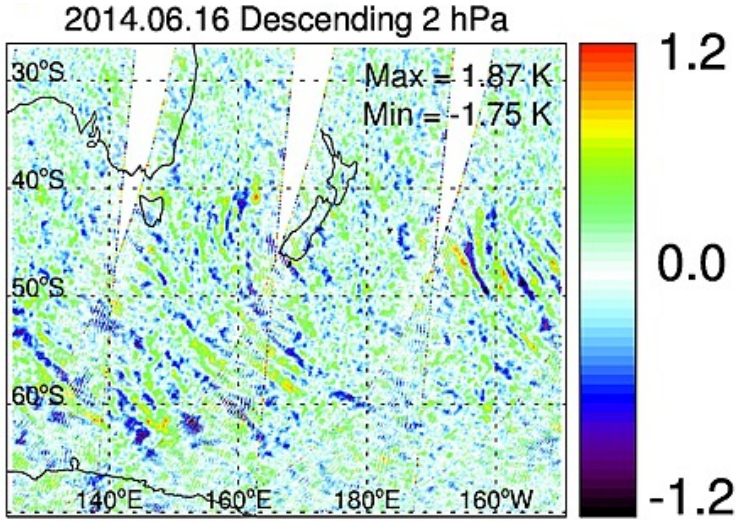
RF05


Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Mon, 16 Jun 2014, 06 UTC (step 006 h from Mon, 16 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S


Horizontal Wind / m/s
50
45
40
35
30
25
20
15
10

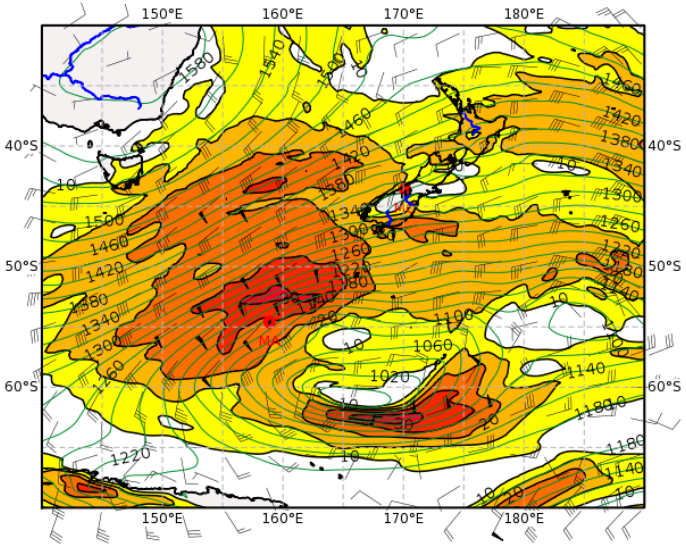

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

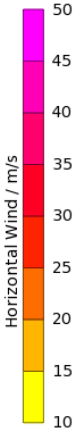

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Mon, 16 Jun 2014, 06 UTC (step 006 h from Mon, 16 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S

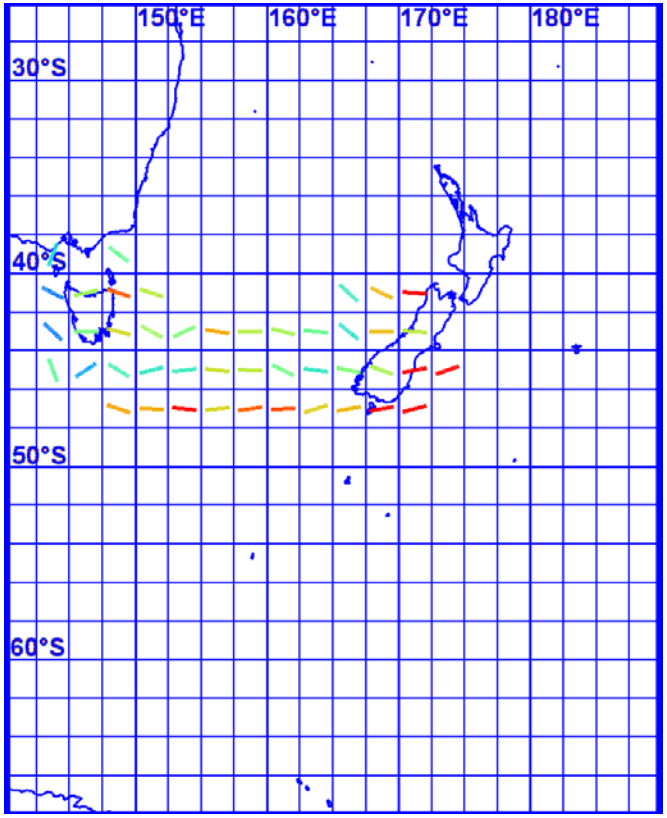

2014.06.16 Descending 2 hPa
Max = 1.87 K
Min = -1.75 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

RF06

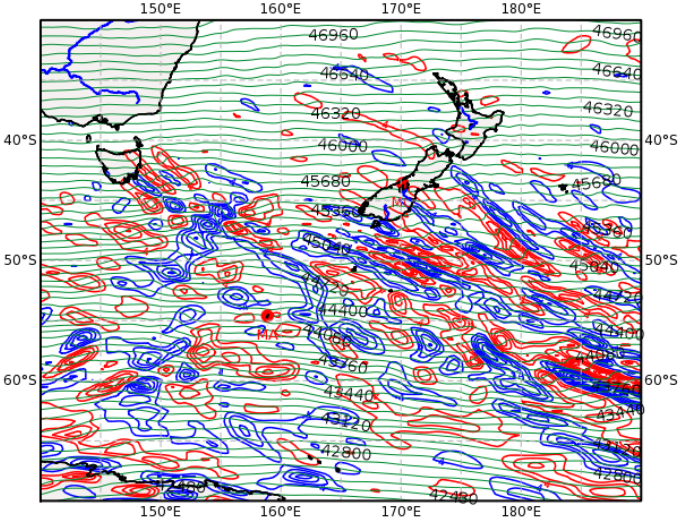
Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Wed, 18 Jun 2014, 06 UTC (step 006 h from Wed, 18 Jun 2014, 00 UTC)

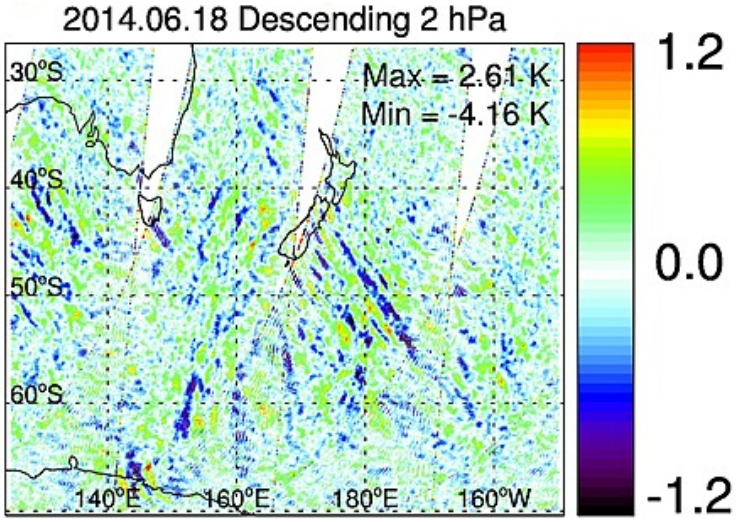






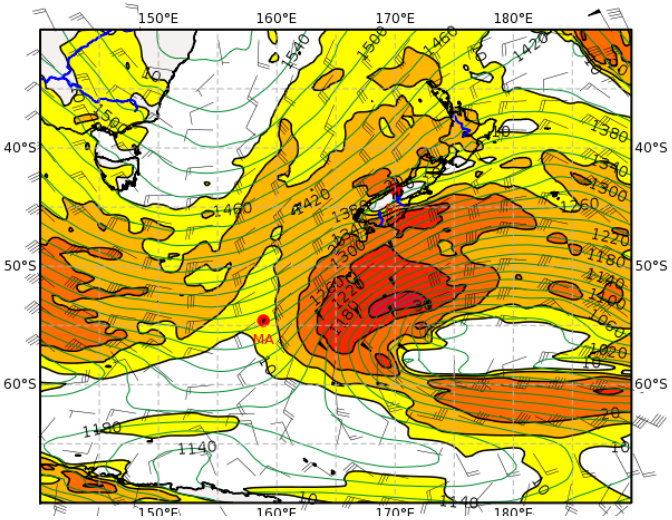
DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Wed, 18 Jun 2014, 06 UTC (step 006 h from Wed, 18 Jun 2014, 00 UTC)

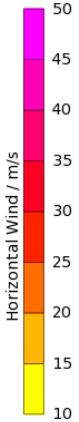


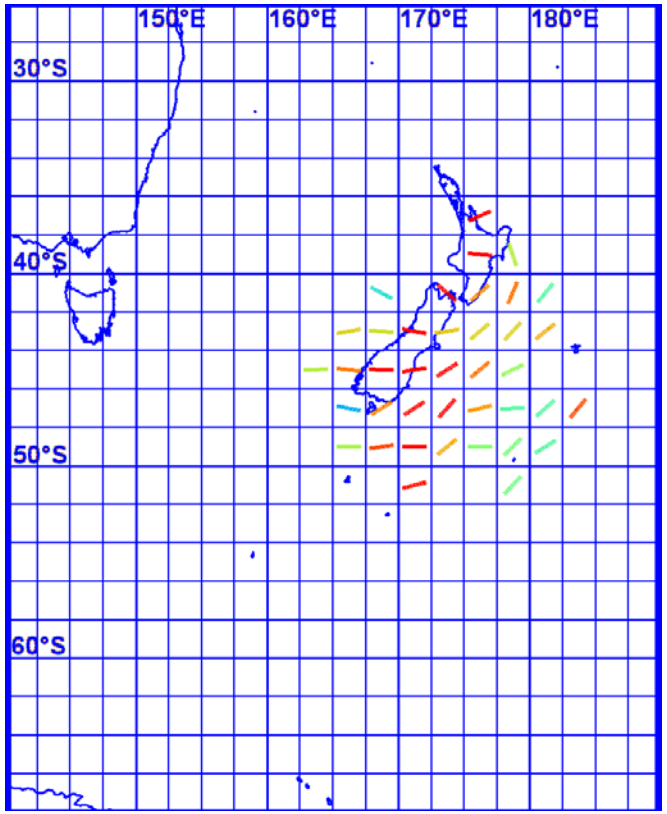


RF07

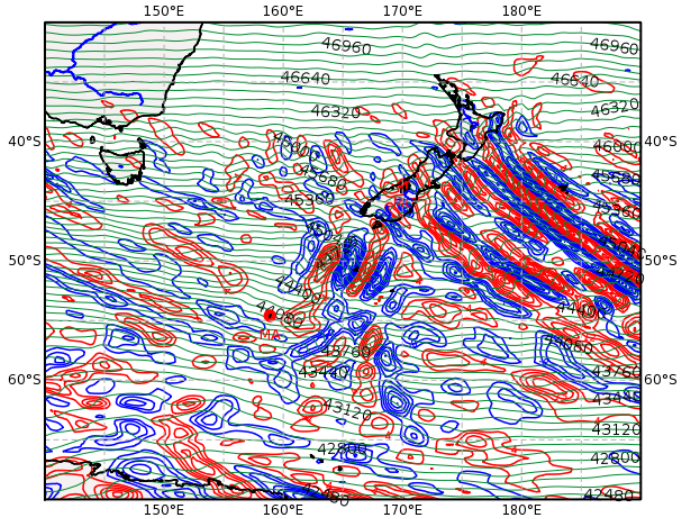
Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Thu, 19 Jun 2014, 06 UTC (step 006 h from Thu, 19 Jun 2014, 00 UTC)

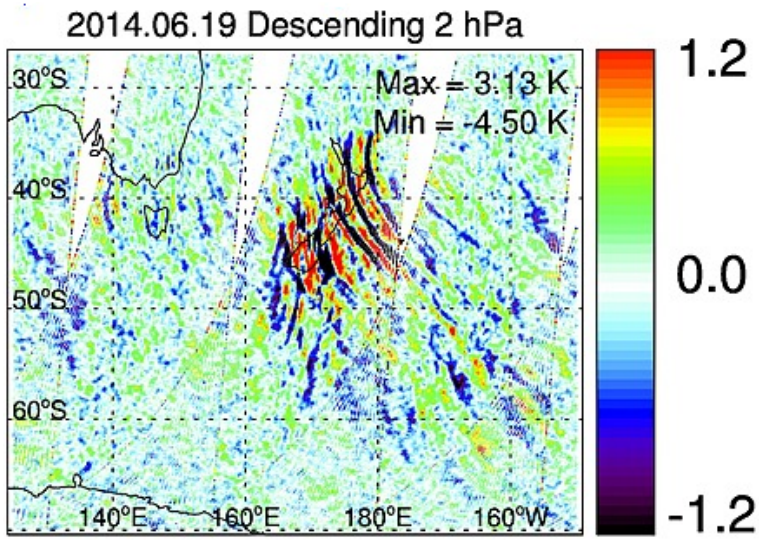




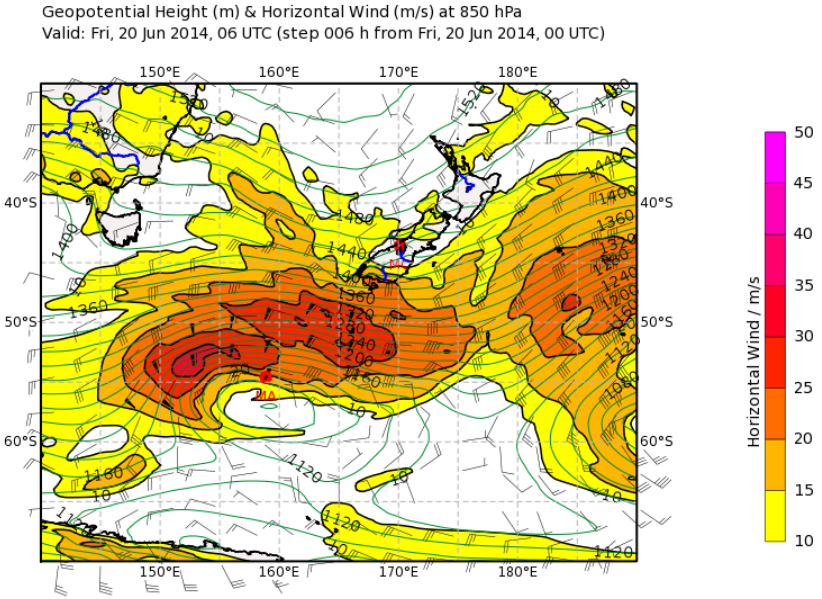


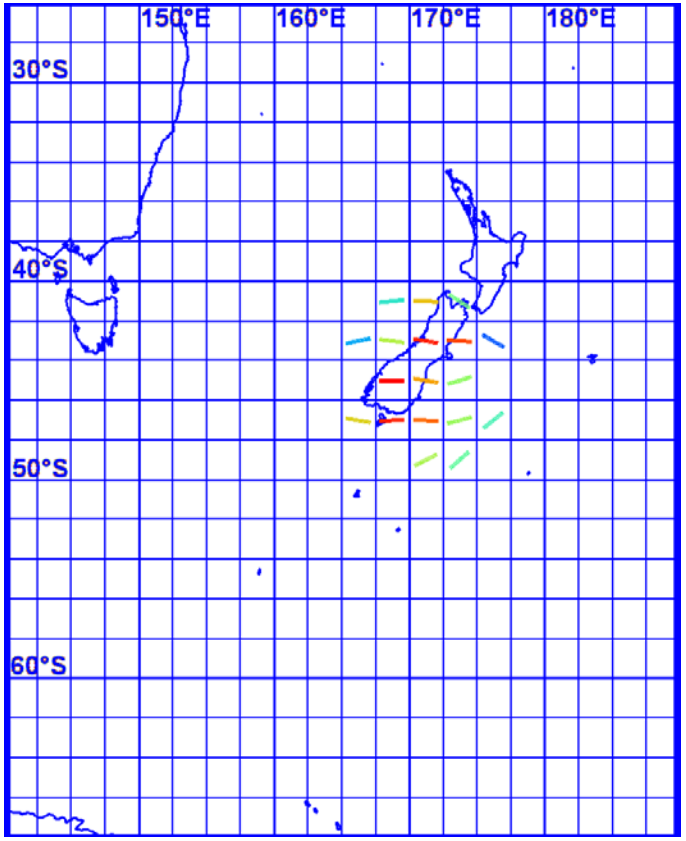
DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Thu, 19 Jun 2014, 06 UTC (step 006 h from Thu, 19 Jun 2014, 00 UTC)

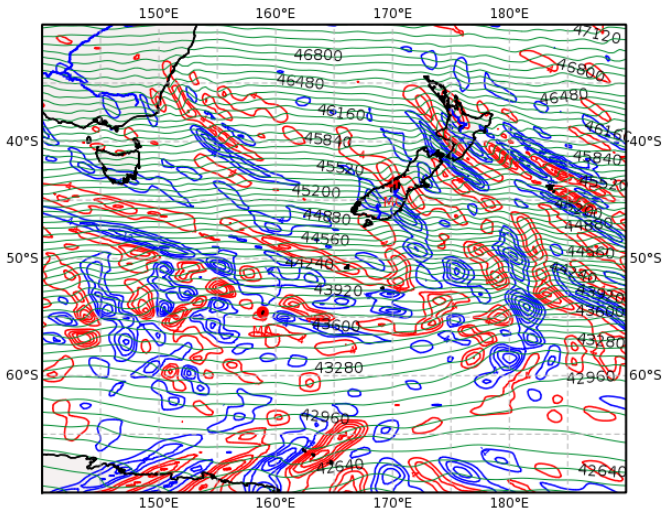


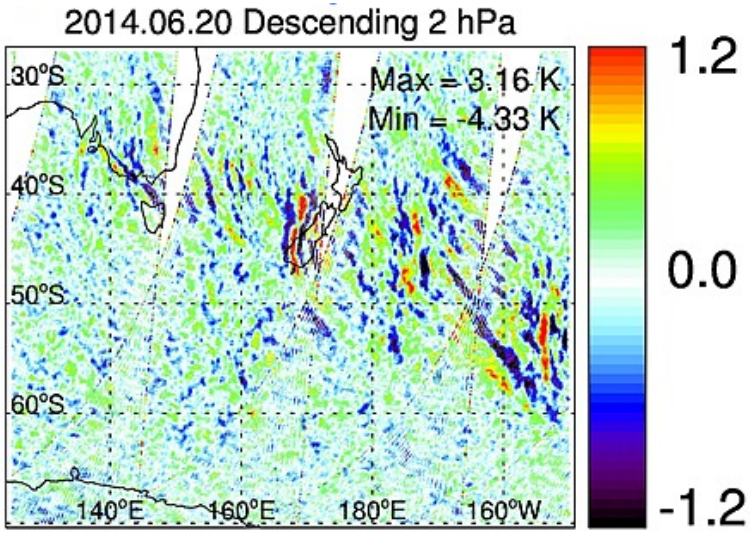


RF08

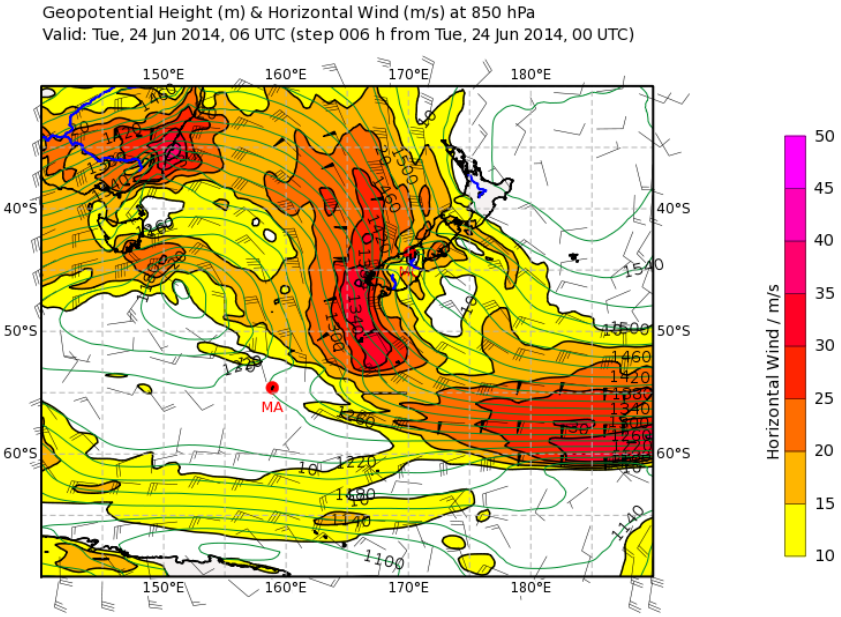

Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Fri, 20 Jun 2014, 06 UTC (step 006 h from Fri, 20 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S
Horizontal Wind / m/s
50
45
40
35
30
25
20
15
10

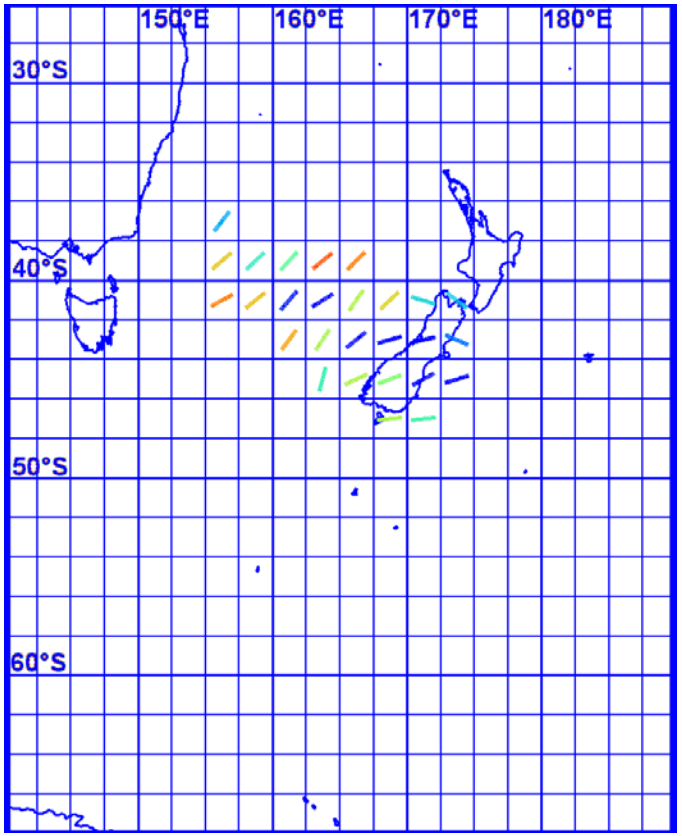

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

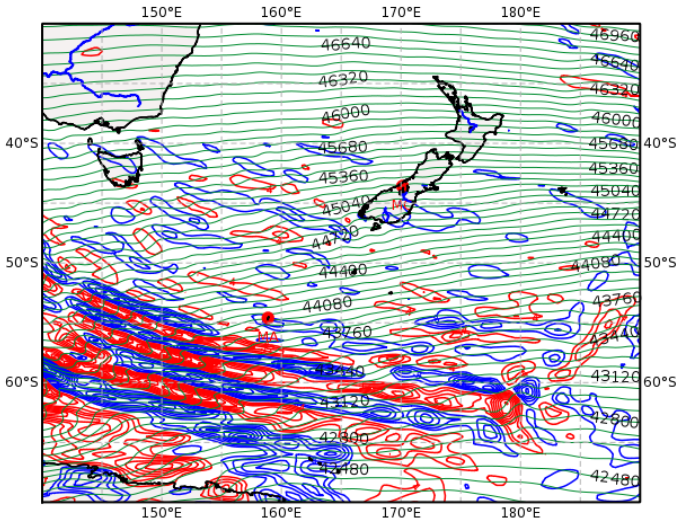

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Fri, 20 Jun 2014, 06 UTC (step 006 h from Fri, 20 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S

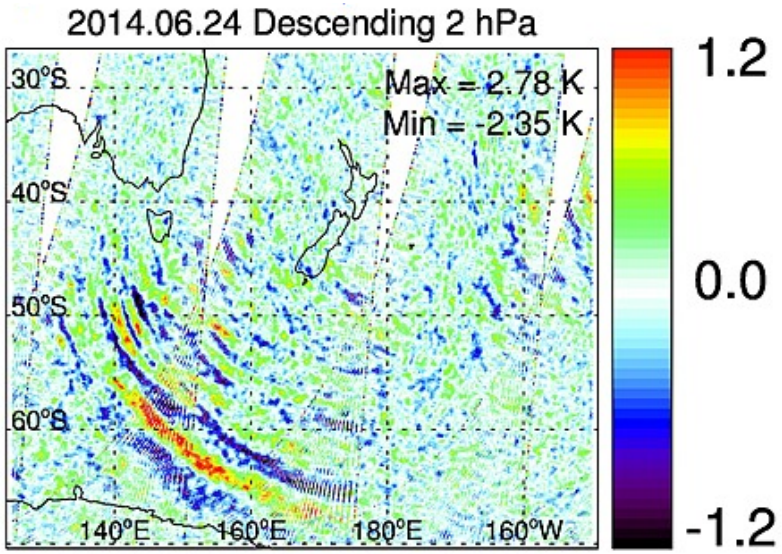

2014.06.20 Descending 2 hPa
Max = 3.16 K
Min = -4.33 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

RF09


Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Tue, 24 Jun 2014, 06 UTC (step 006 h from Tue, 24 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S
MA
Horizontal Wind / m/s
50
45
40
35
30
25
20
15
10

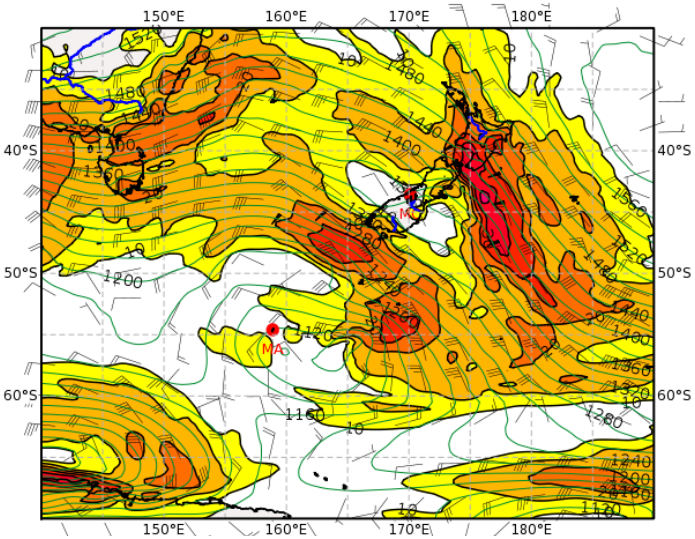

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

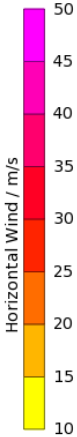

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Tue, 24 Jun 2014, 06 UTC (step 006 h from Tue, 24 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S
MA

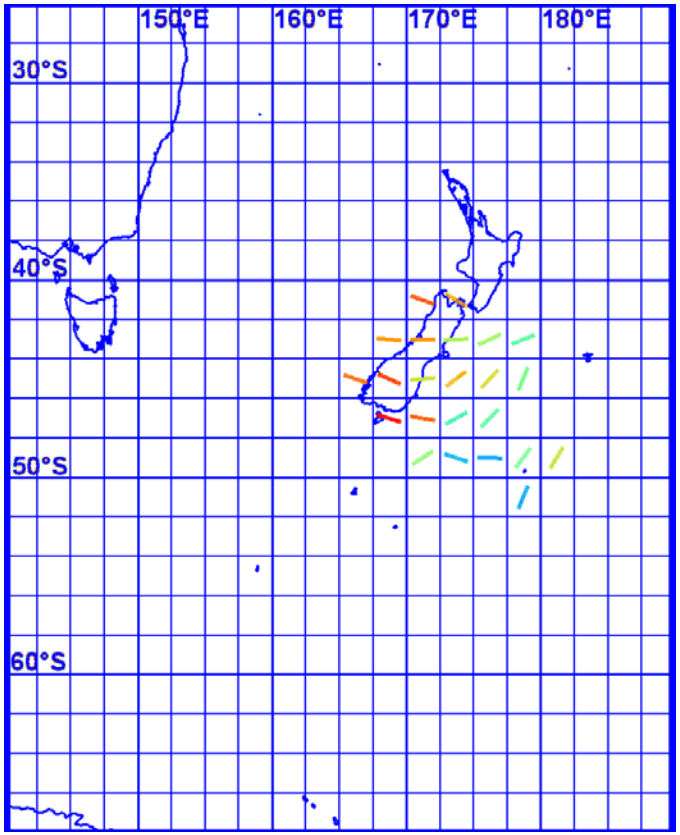

2014.06.24 Descending 2 hPa
Max = 2.78 K
Min = -2.35 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

RF10

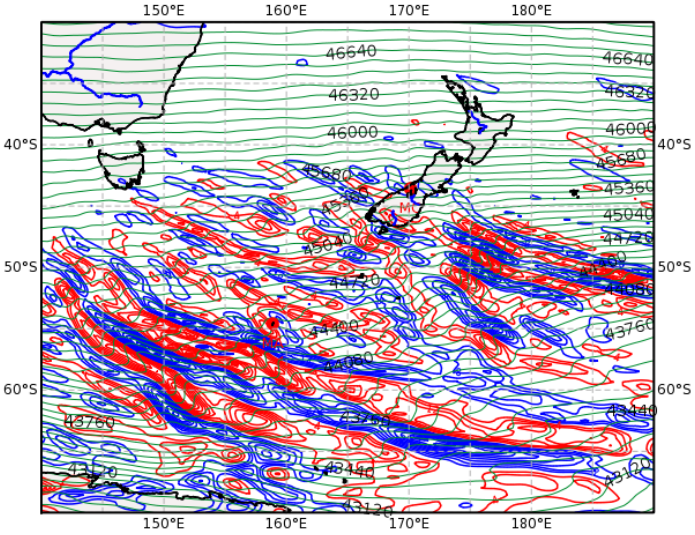
Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Wed, 25 Jun 2014, 06 UTC (step 006 h from Wed, 25 Jun 2014, 00 UTC)

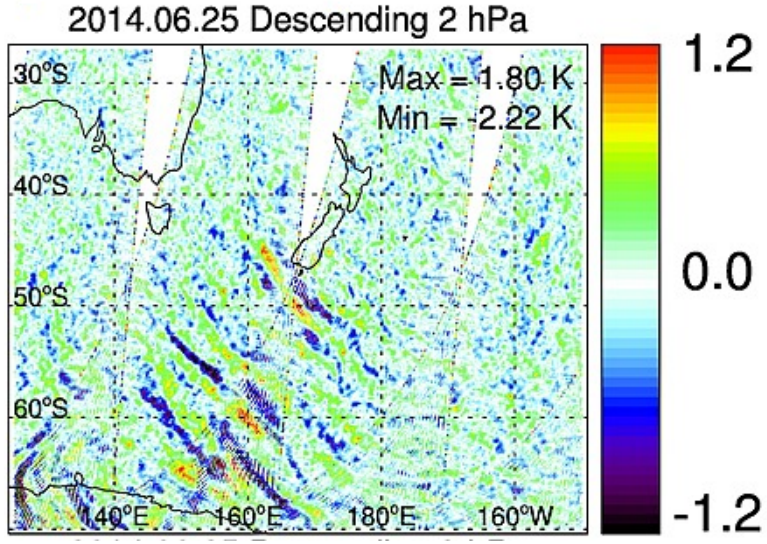




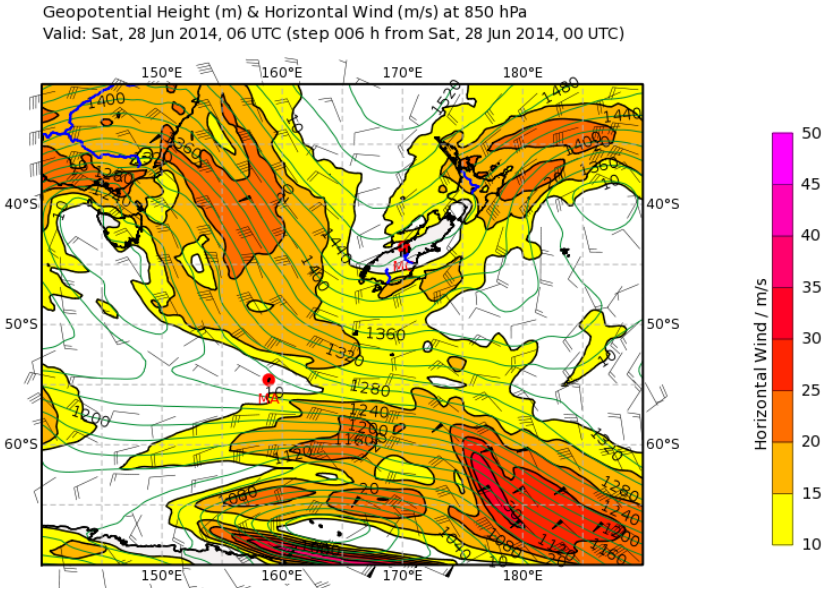


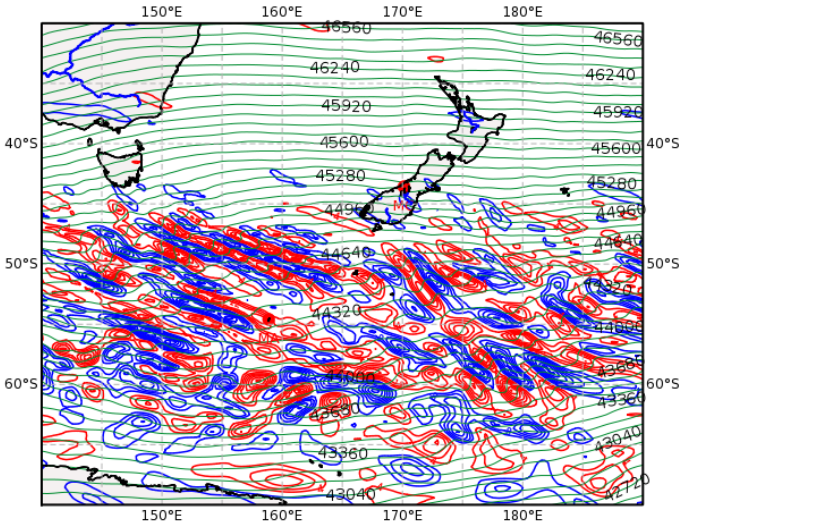
DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Wed, 25 Jun 2014, 06 UTC (step 006 h from Wed, 25 Jun 2014, 00 UTC)

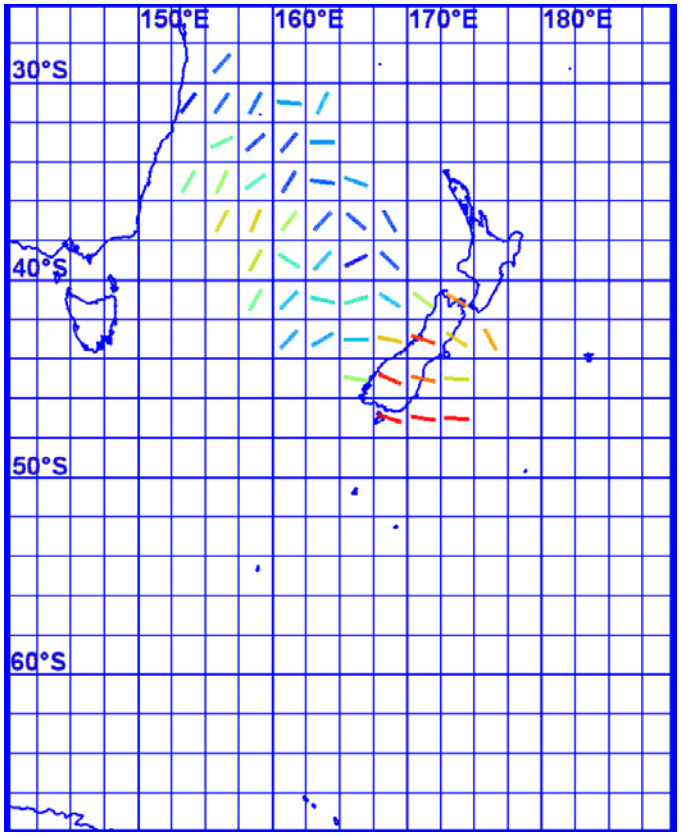


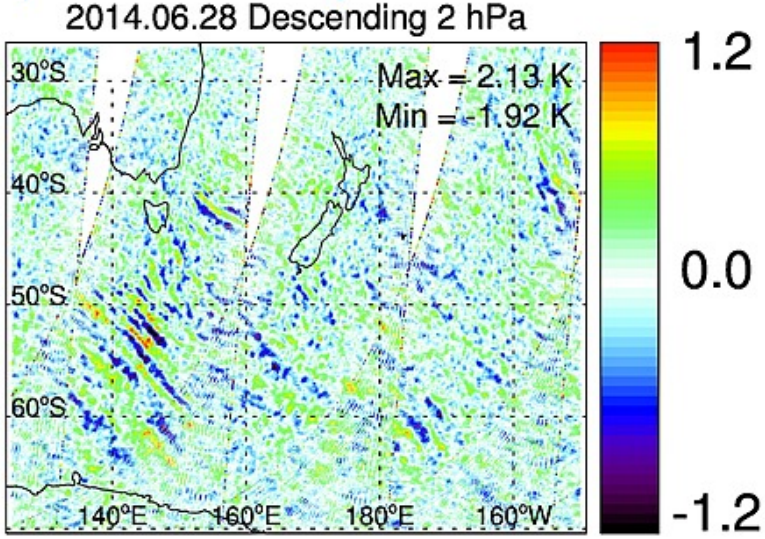


RF11

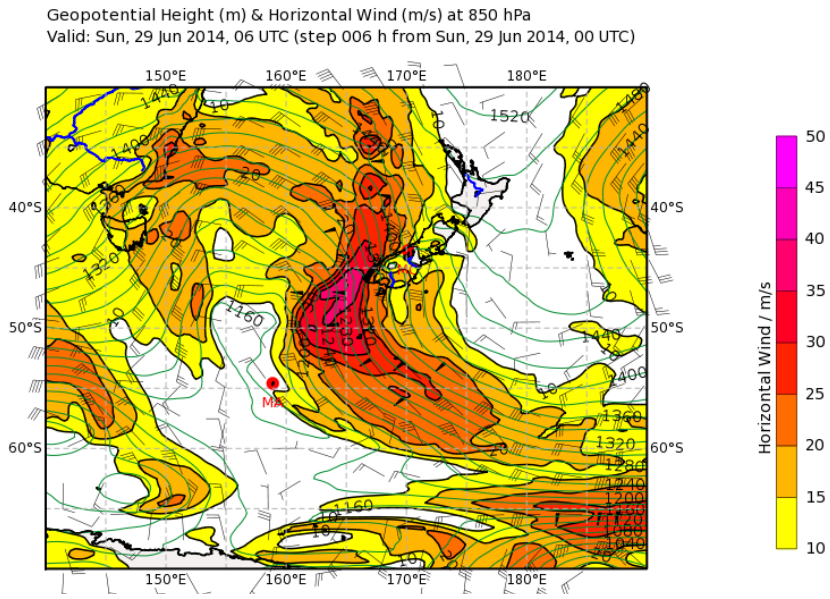

Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Sat, 28 Jun 2014, 06 UTC (step 006 h from Sat, 28 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S
Horizontal Wind / m/s
50
45
40
35
30
25
20
15
10

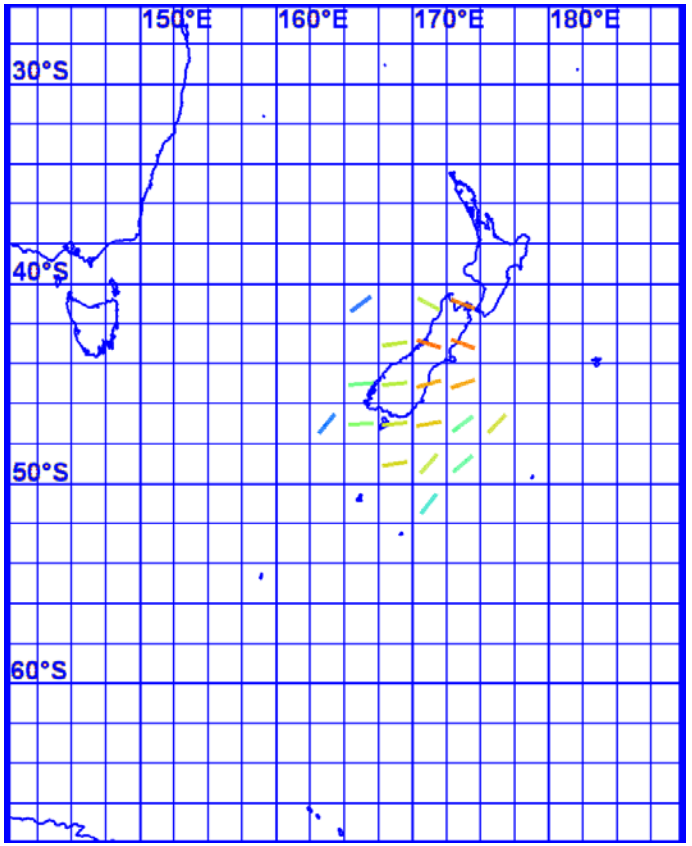

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Sat, 28 Jun 2014, 06 UTC (step 006 h from Sat, 28 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S

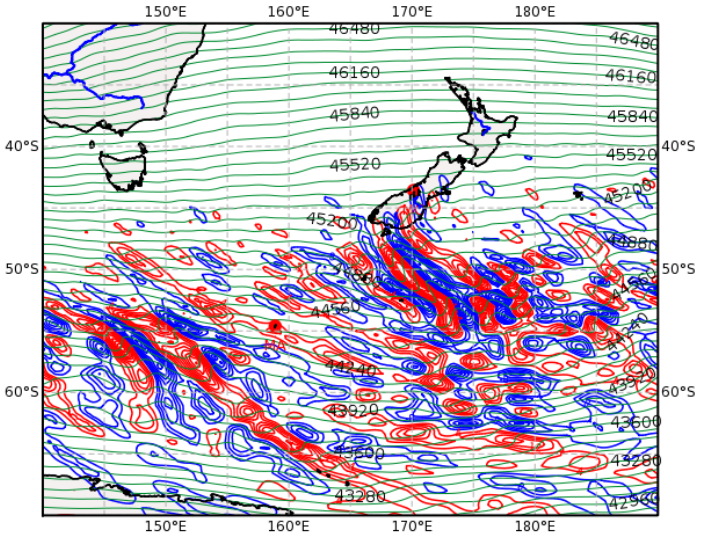

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

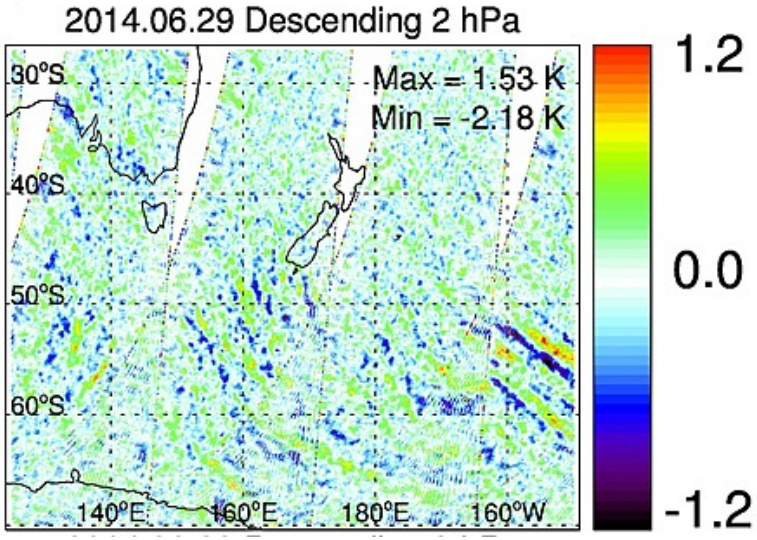

2014.06.28 Descending 2 hPa
Max = 2.13 K
Min = -1.92 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

RF12

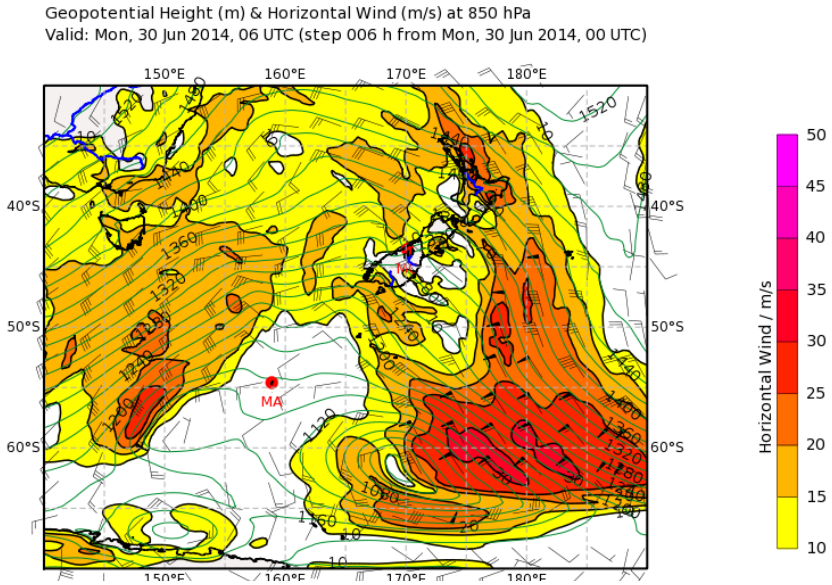

Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Sun, 29 Jun 2014, 06 UTC (step 006 h from Sun, 29 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S
Horizontal Wind / m/s
50
45
40
35
30
25
20
15
10

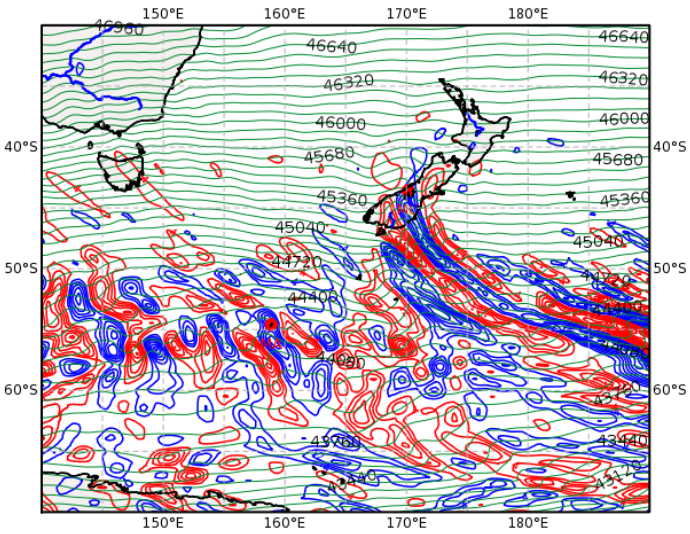

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

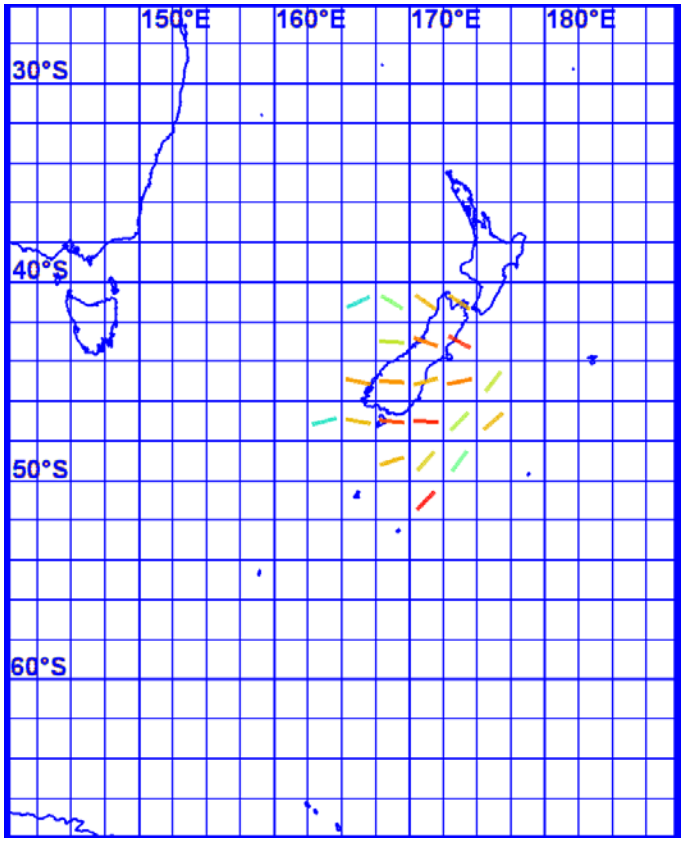

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Sun, 29 Jun 2014, 06 UTC (step 006 h from Sun, 29 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S

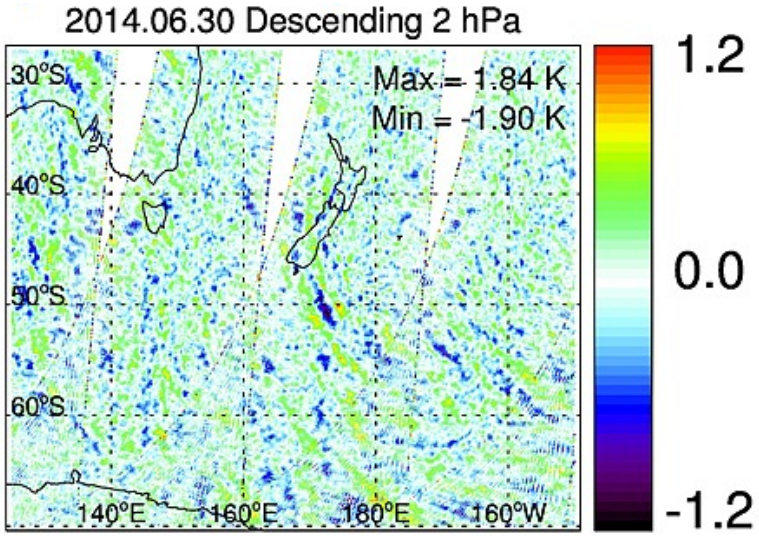

2014.06.29 Descending 2 hPa
Max = 1.53 K
Min = -2.18 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

RF13


Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Mon, 30 Jun 2014, 06 UTC (step 006 h from Mon, 30 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S
MA
Horizontal Wind / m/s
50
45
40
35
30
25
20
15
10

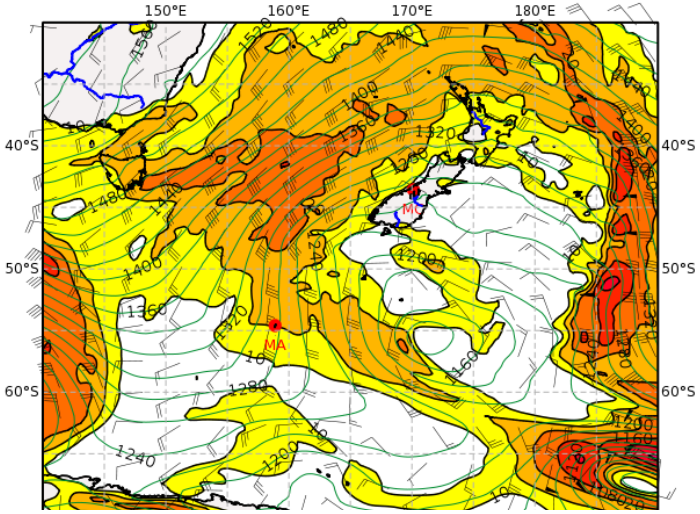

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Mon, 30 Jun 2014, 06 UTC (step 006 h from Mon, 30 Jun 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S

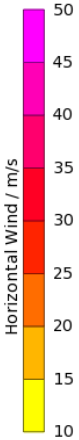

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

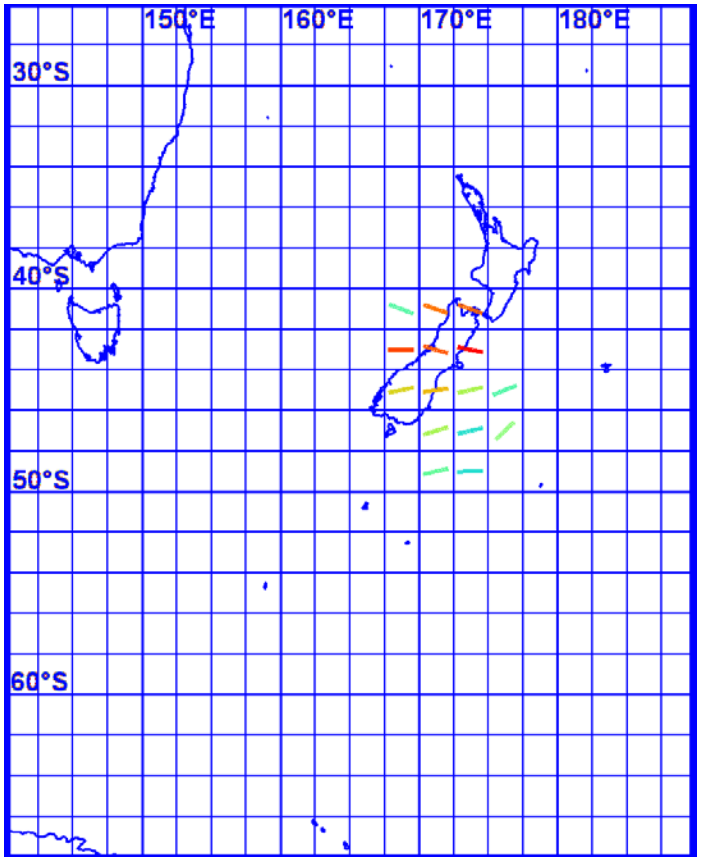

2014.06.30 Descending 2 hPa
Max = 1.84 K
Min = -1.90 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

RF14

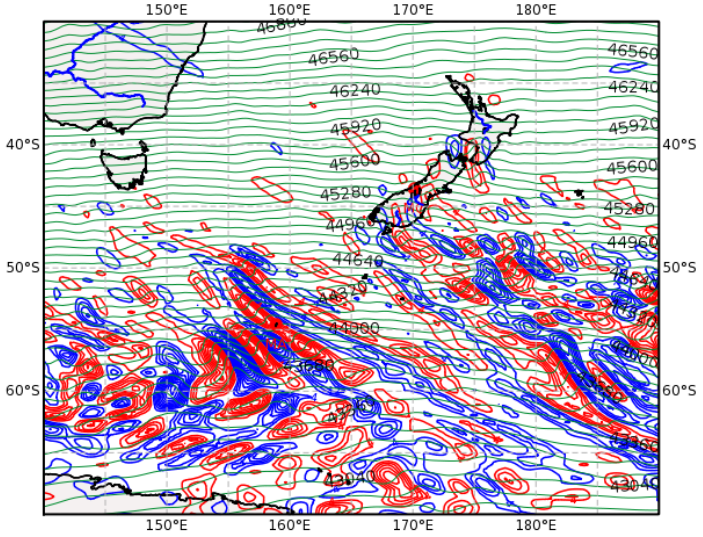
Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Tue, 01 Jul 2014, 06 UTC (step 006 h from Tue, 01 Jul 2014, 00 UTC)



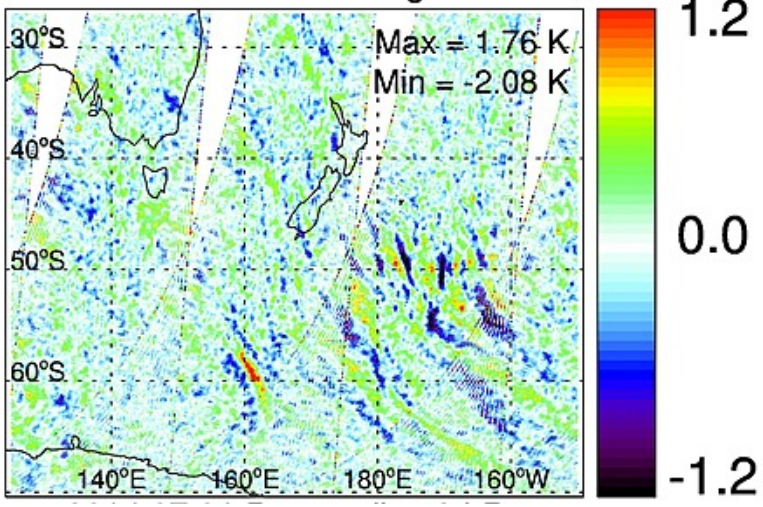




DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Tue, 01 Jul 2014, 06 UTC (step 006 h from Tue, 01 Jul 2014, 00 UTC)

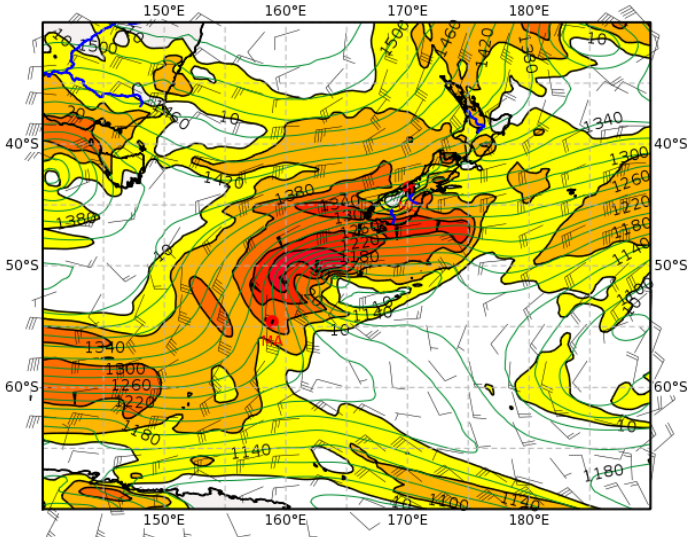


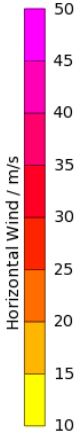
2014.07.01 Descending 2 hPa

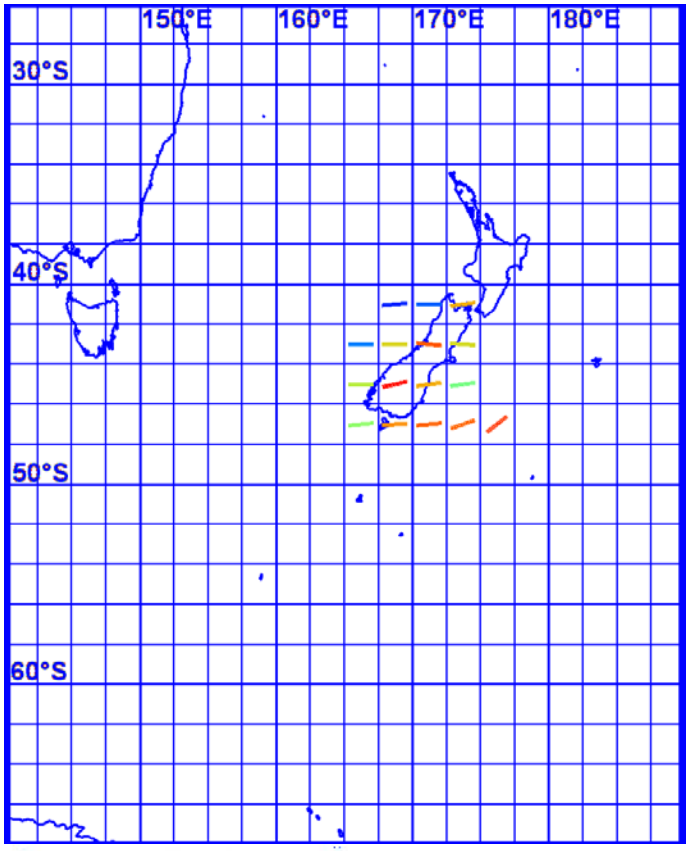


RF16

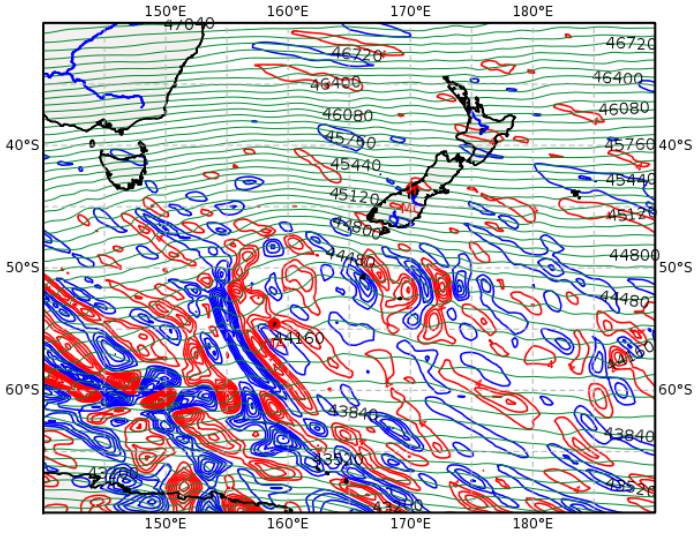
Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Fri, 04 Jul 2014, 06 UTC (step 006 h from Fri, 04 Jul 2014, 00 UTC)



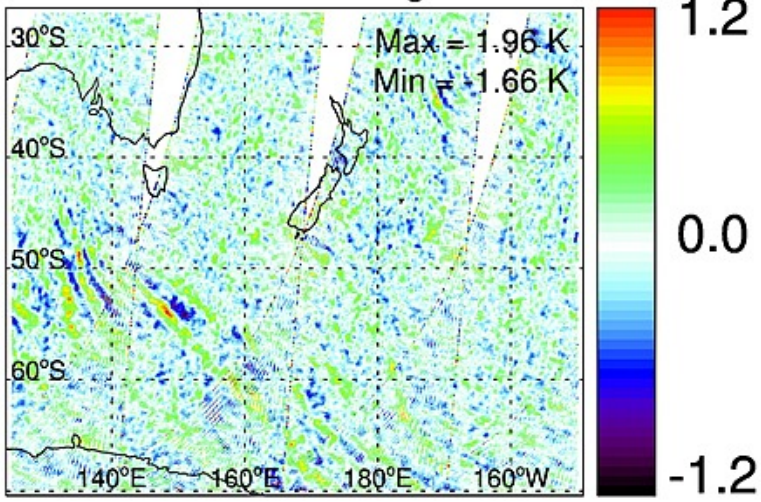




DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Fri, 04 Jul 2014, 06 UTC (step 006 h from Fri, 04 Jul 2014, 00 UTC)

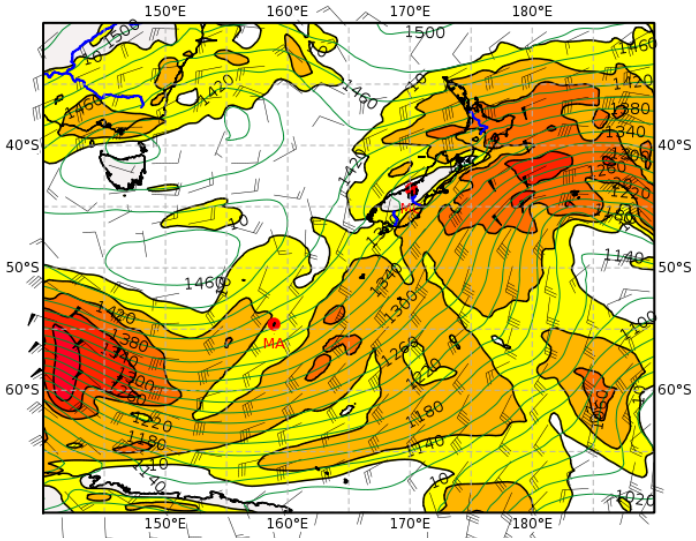


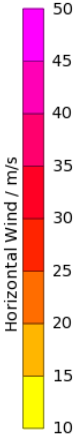
2014.07.04 Descending 2 hPa



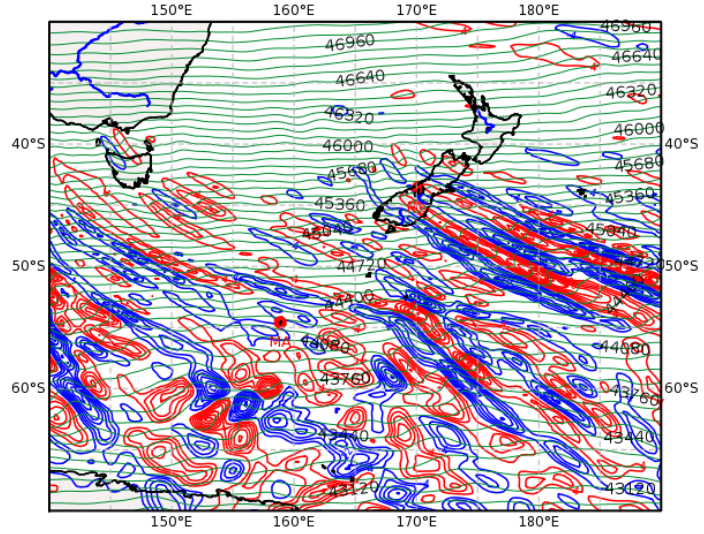
RF17

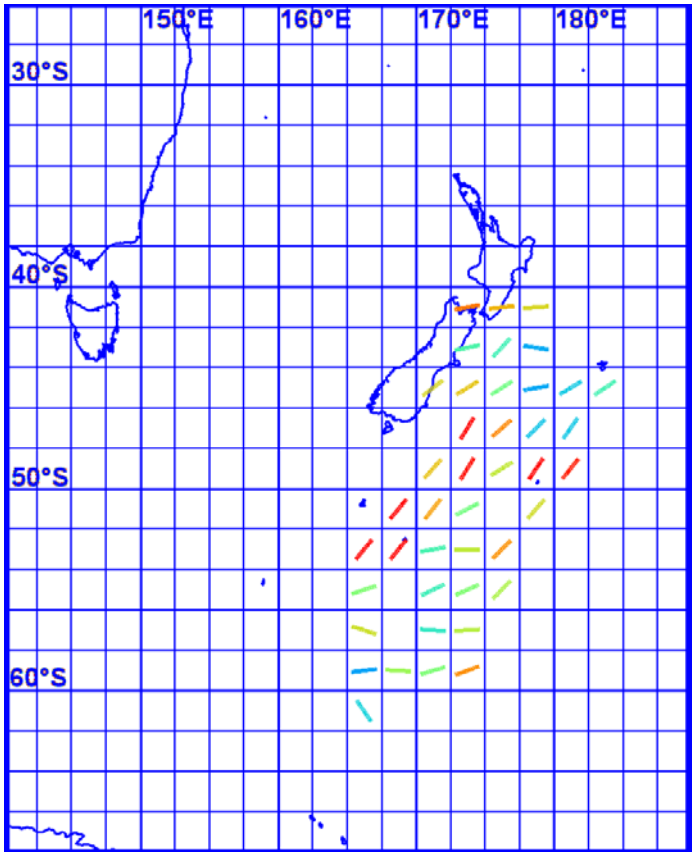
Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Sat, 05 Jul 2014, 06 UTC (step 006 h from Sat, 05 Jul 2014, 00 UTC)



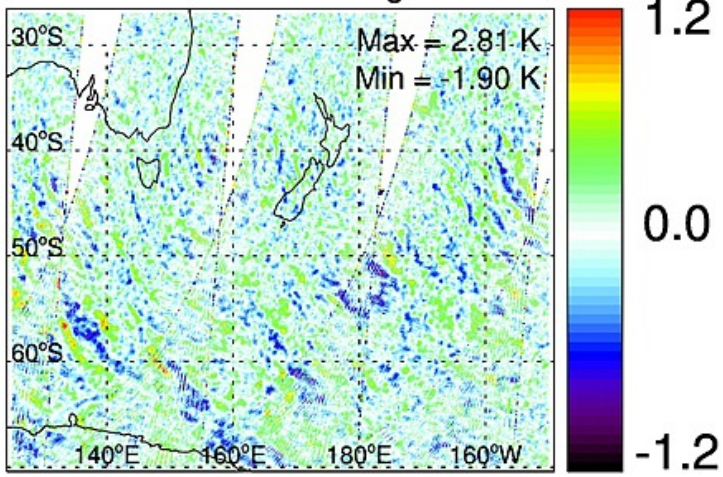


DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Sat, 05 Jul 2014, 06 UTC (step 006 h from Sat, 05 Jul 2014, 00 UTC)



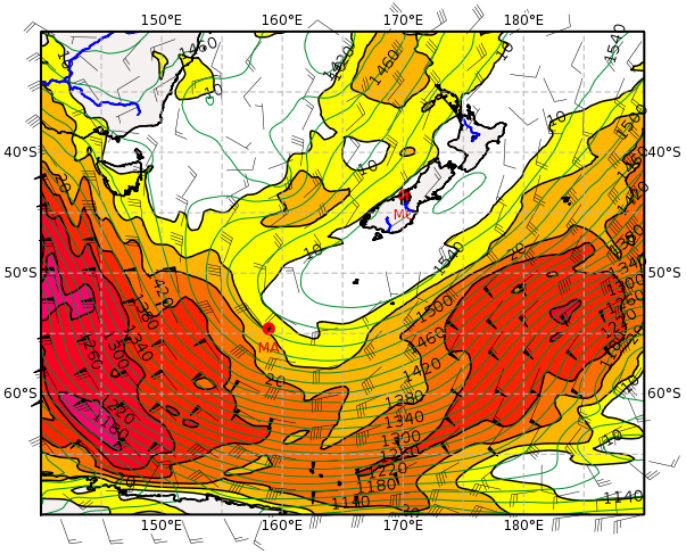


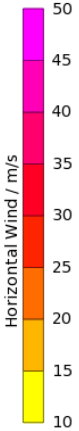
2014.07.05 Descending 2 hPa



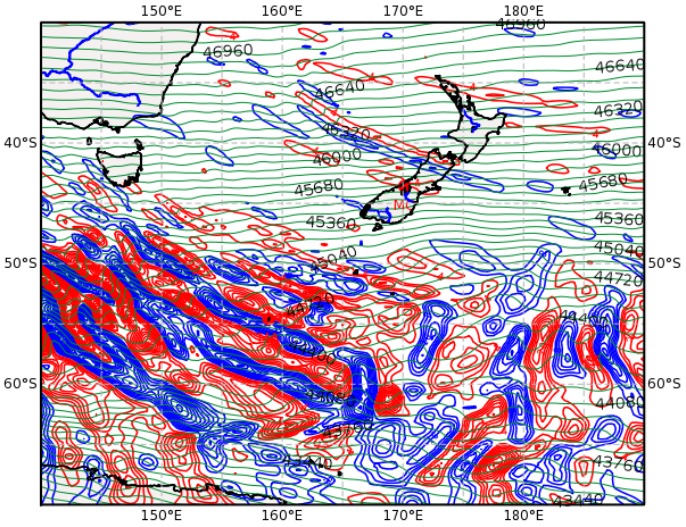
RF18

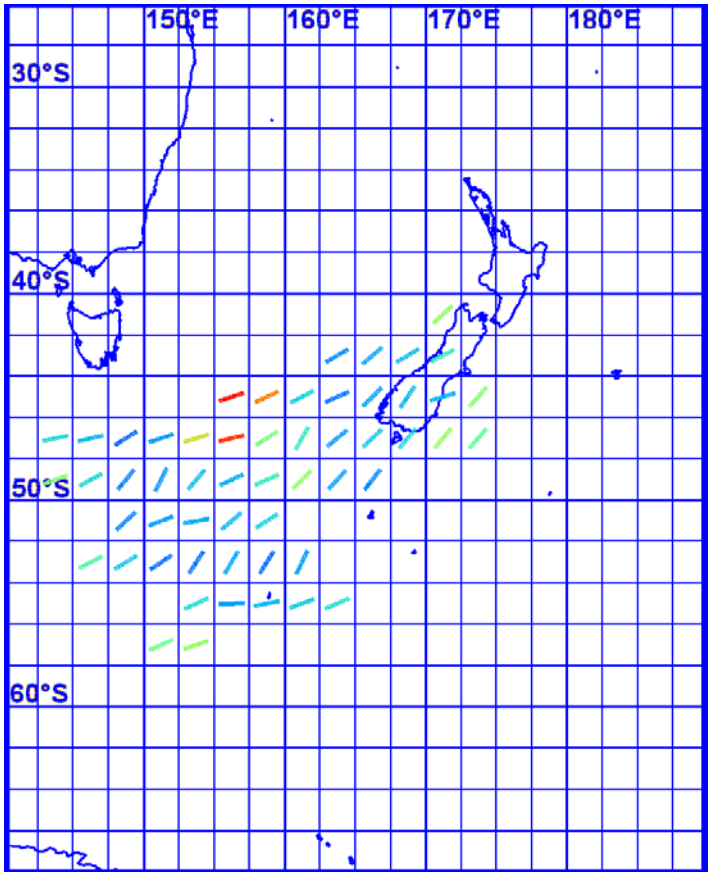
Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Mon, 07 Jul 2014, 06 UTC (step 006 h from Mon, 07 Jul 2014, 00 UTC)



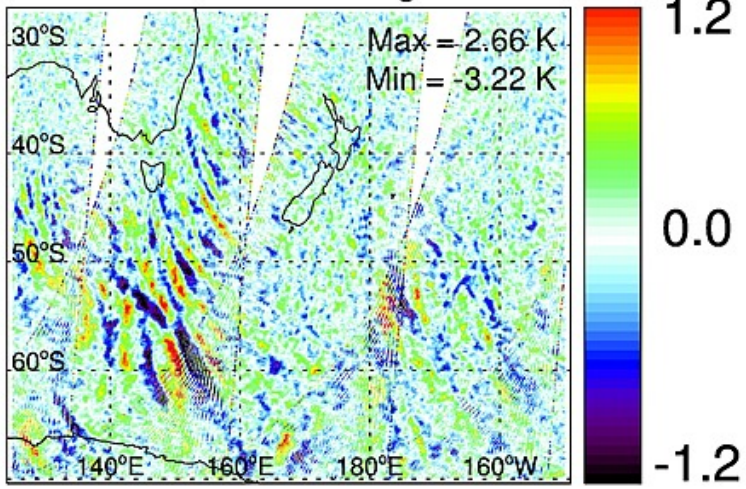


DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Mon, 07 Jul 2014, 06 UTC (step 006 h from Mon, 07 Jul 2014, 00 UTC)



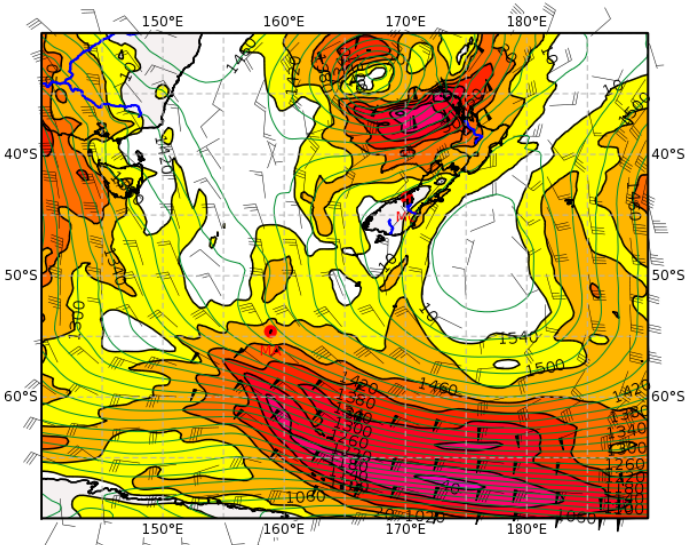


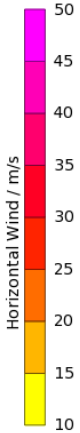
2014.07.07 Descending 2 hPa



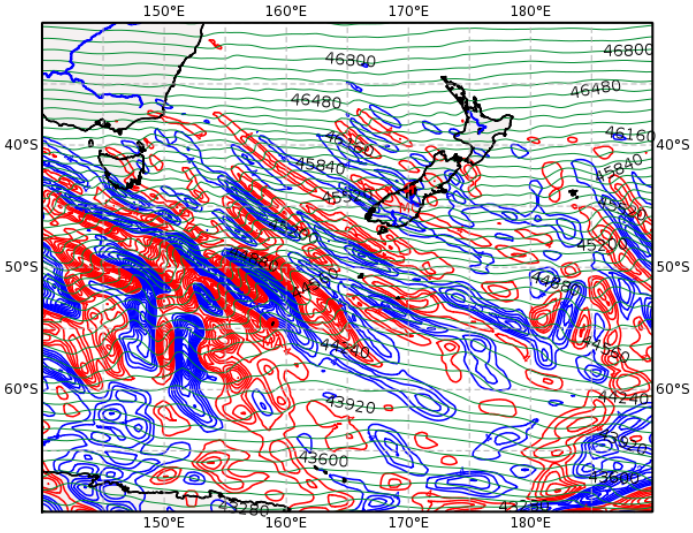
RF19

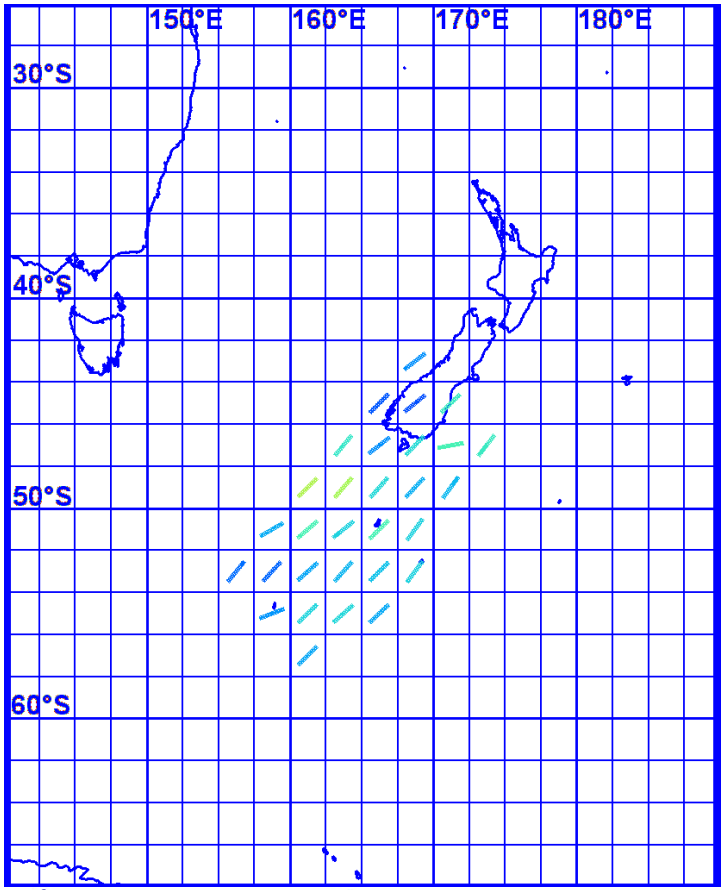
Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Tue, 08 Jul 2014, 06 UTC (step 006 h from Tue, 08 Jul 2014, 00 UTC)



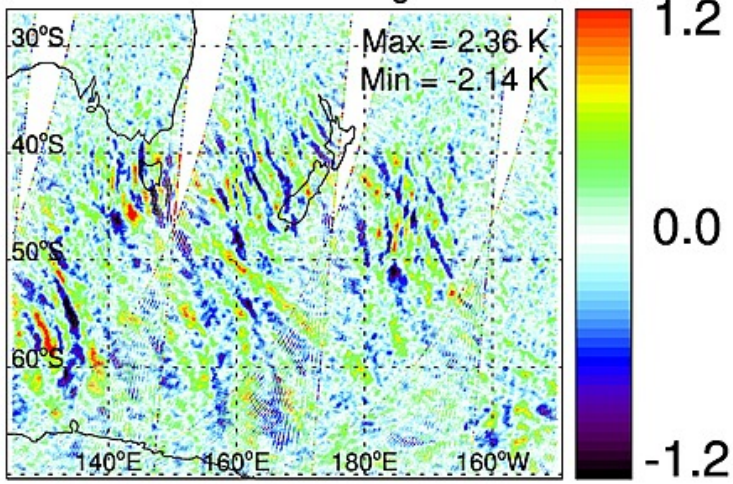


DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Tue, 08 Jul 2014, 06 UTC (step 006 h from Tue, 08 Jul 2014, 00 UTC)



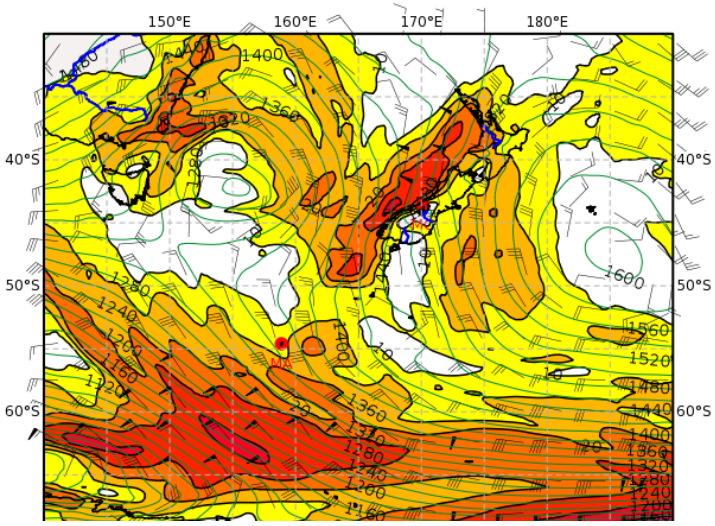


2014.07.08 Descending 2 hPa

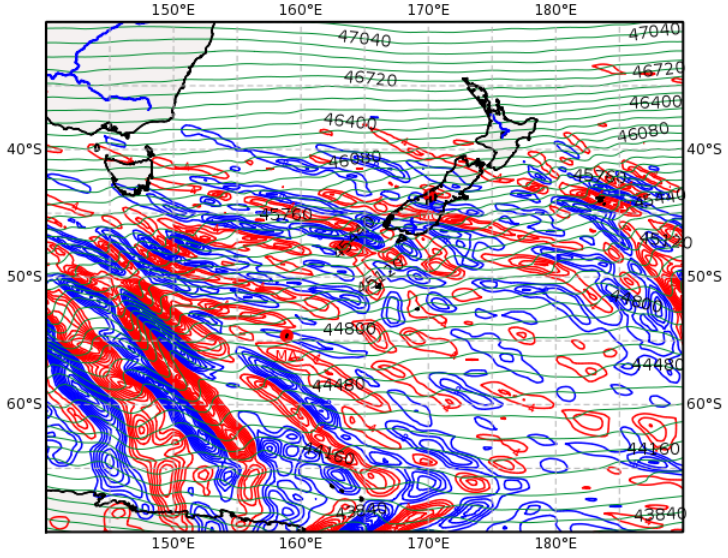


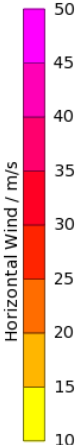
RF20

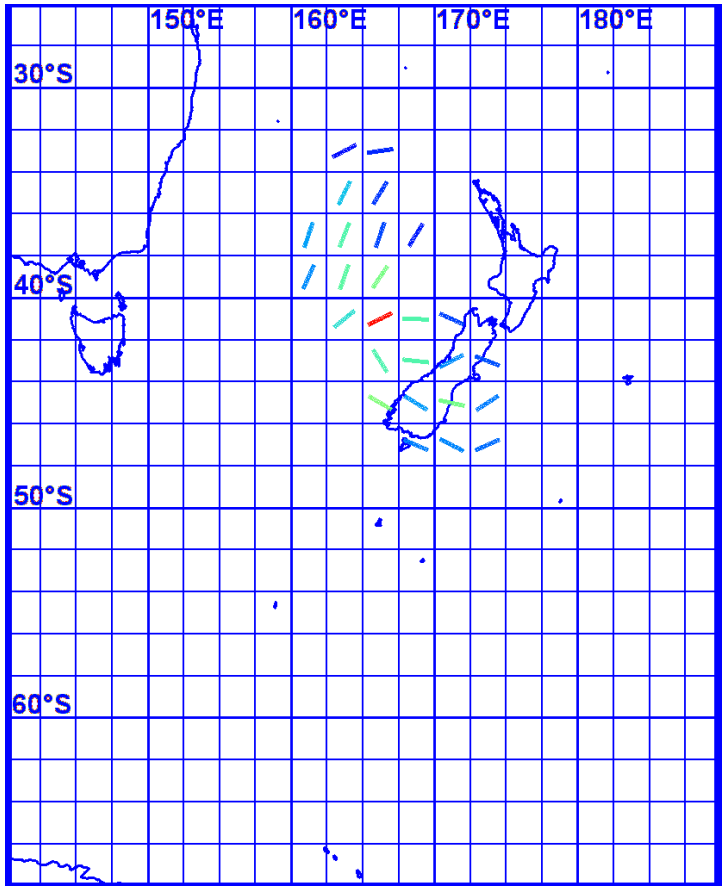
Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Thu, 10 Jul 2014, 06 UTC (step 006 h from Thu, 10 Jul 2014, 00 UTC)



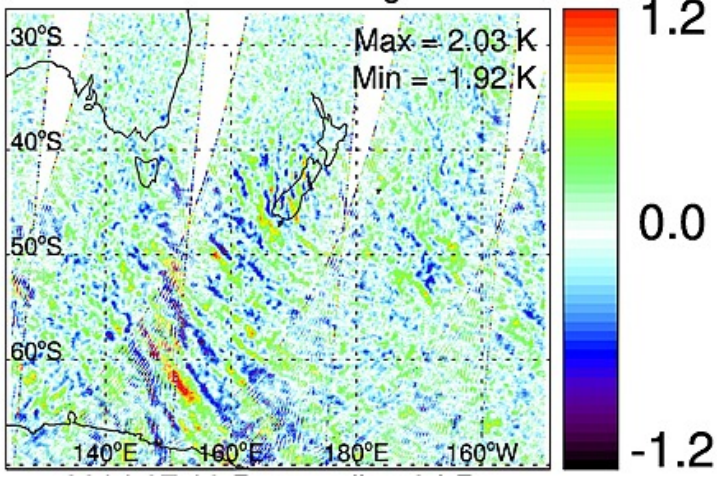
DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Thu, 10 Jul 2014, 06 UTC (step 006 h from Thu, 10 Jul 2014, 00 UTC)



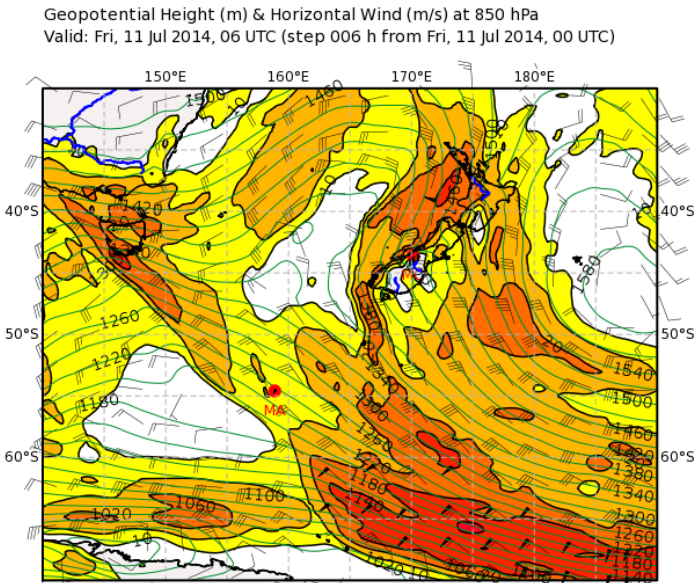


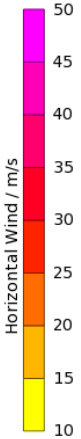


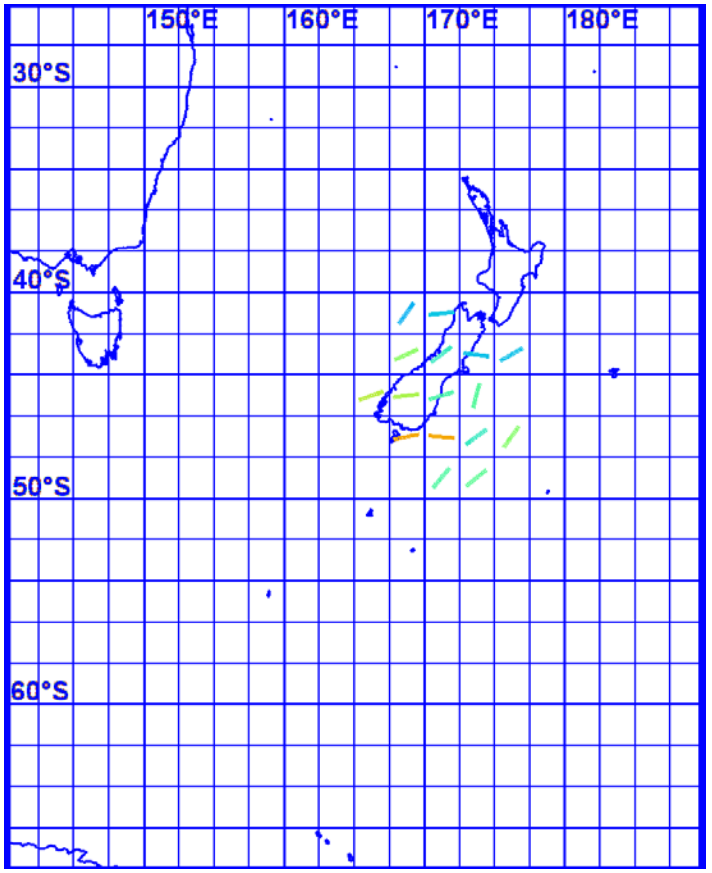
2014.07.10 Descending 2 hPa

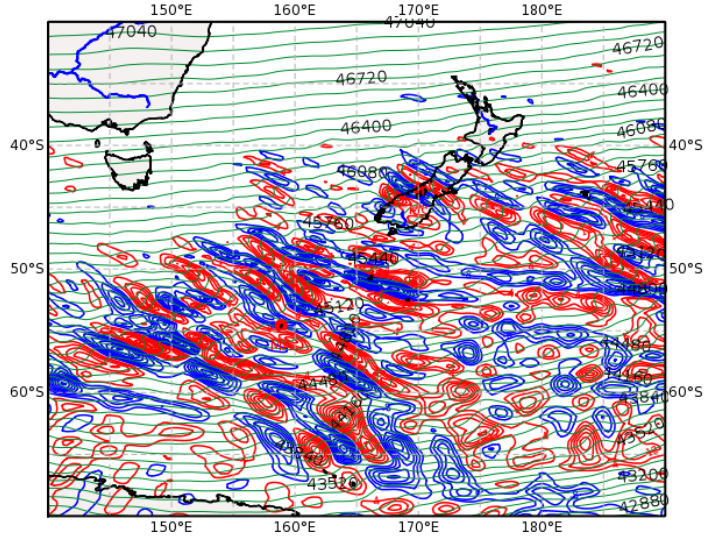


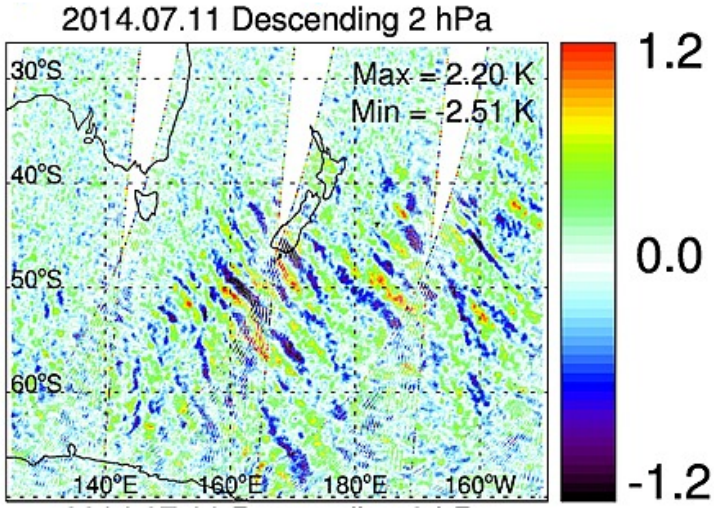
RF21


Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Fri, 11 Jul 2014, 06 UTC (step 006 h from Fri, 11 Jul 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S

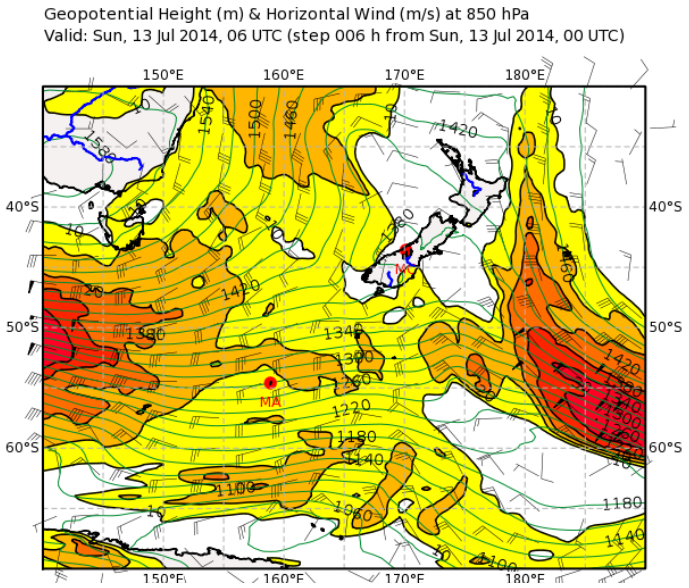

Horizontal Wind / m/s
50
45
40
35
30
25
20
15
10

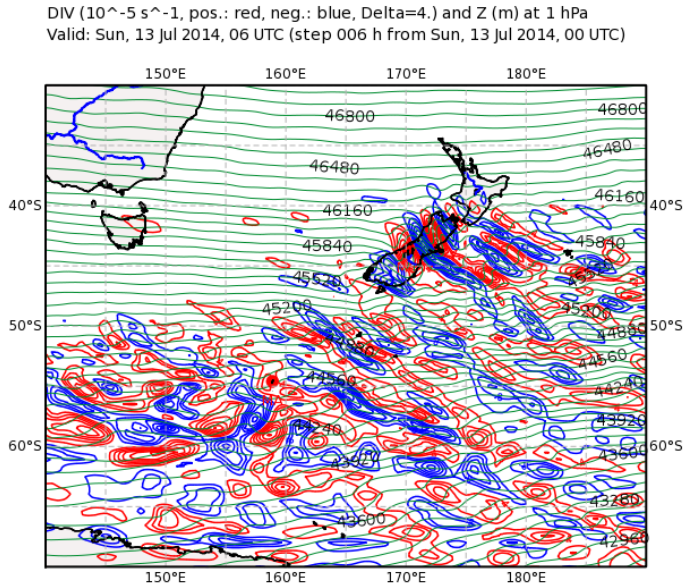

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

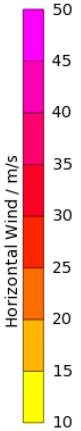

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Fri, 11 Jul 2014, 06 UTC (step 006 h from Fri, 11 Jul 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S

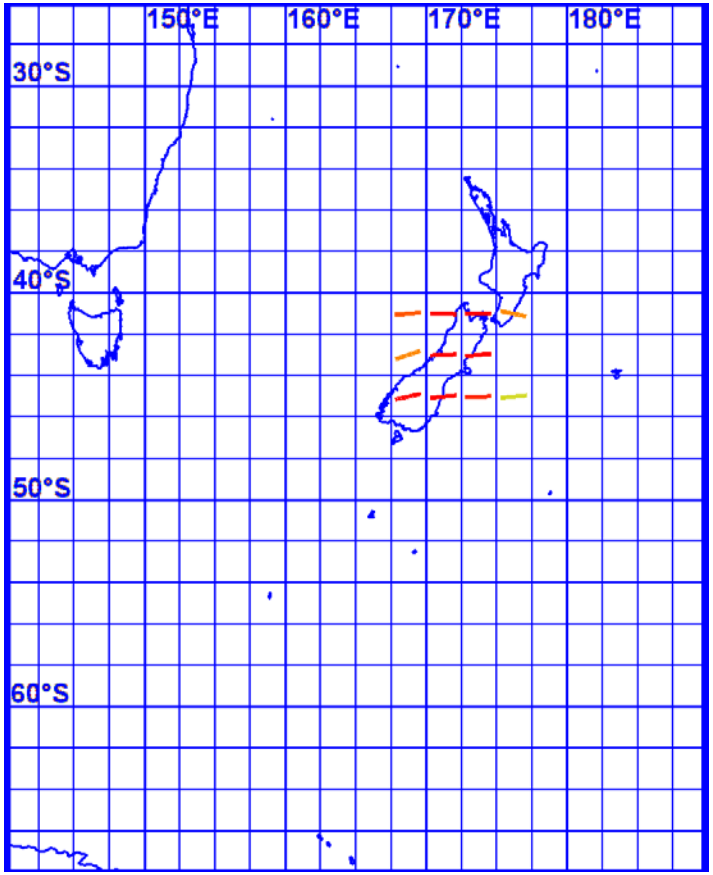

2014.07.11 Descending 2 hPa
Max = 2.20 K
Min = -2.51 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

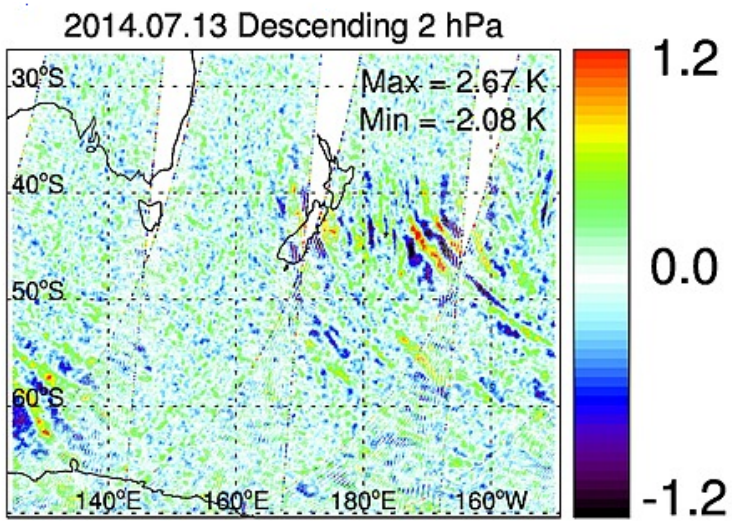
RF22


Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Sun, 13 Jul 2014, 06 UTC (step 006 h from Sun, 13 Jul 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S

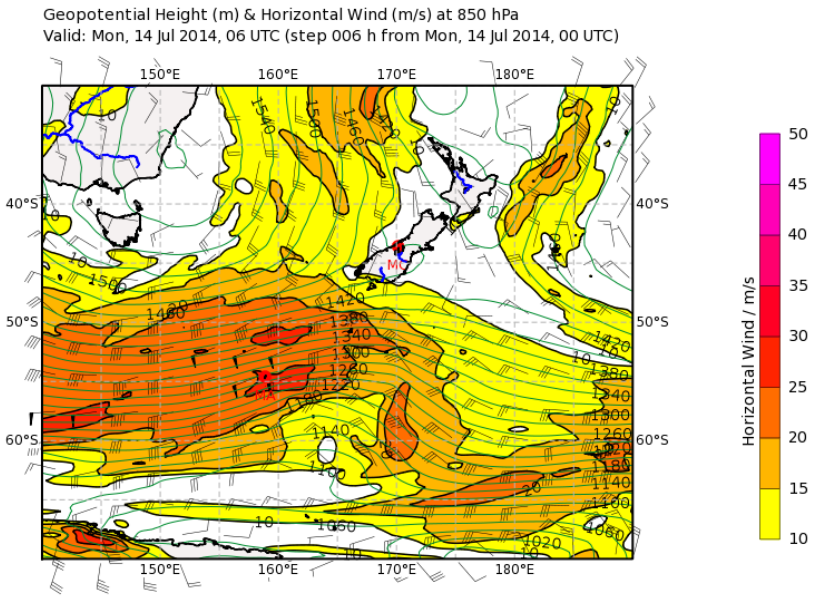

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Sun, 13 Jul 2014, 06 UTC (step 006 h from Sun, 13 Jul 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S

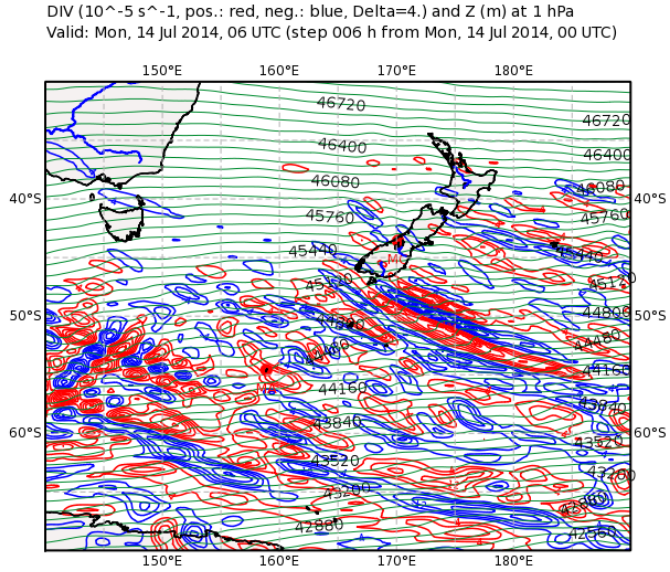

Horizontal Wind / m/s
50
45
40
35
30
25
20
15
10

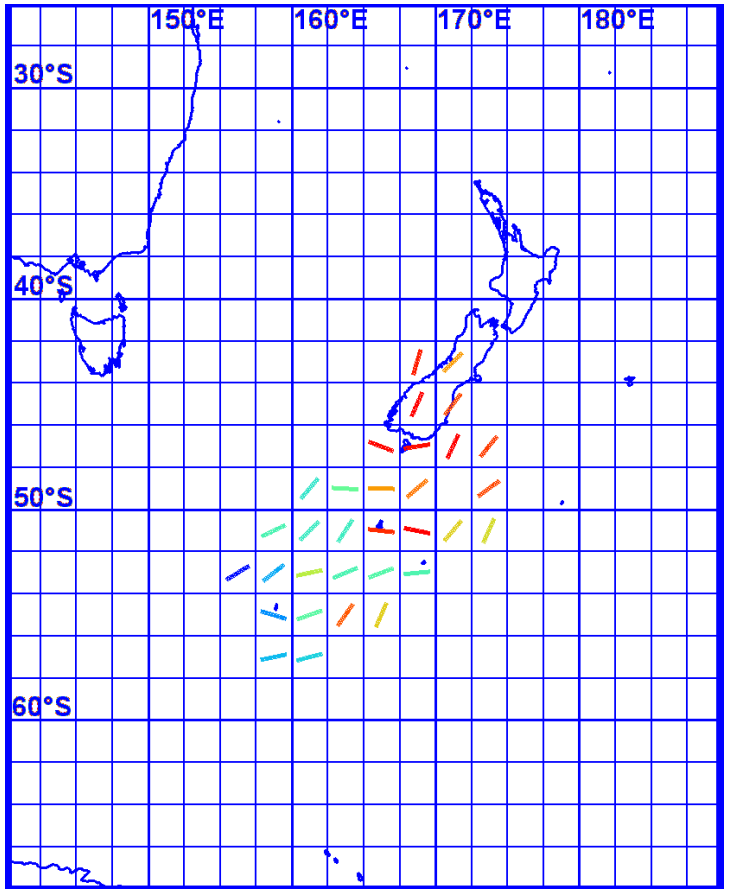

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

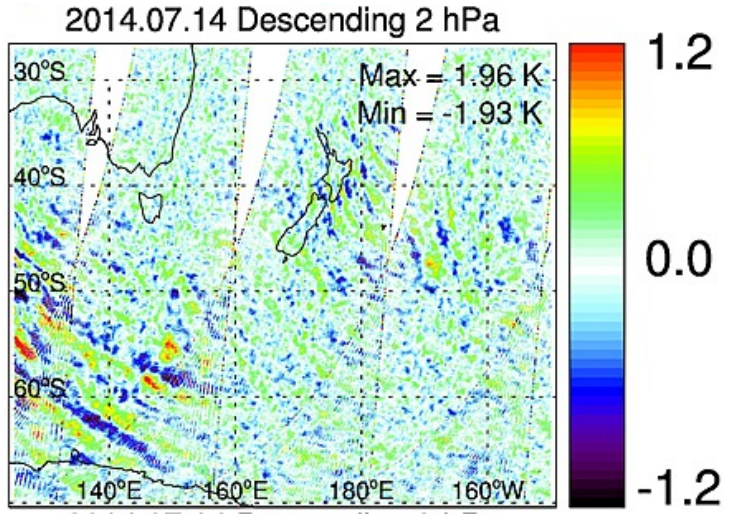

2014.07.13 Descending 2 hPa
Max = 2.67 K
Min = -2.08 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

RF23


Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Mon, 14 Jul 2014, 06 UTC (step 006 h from Mon, 14 Jul 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S
Horizontal Wind / m/s
50
45
40
35
30
25
20
15
10

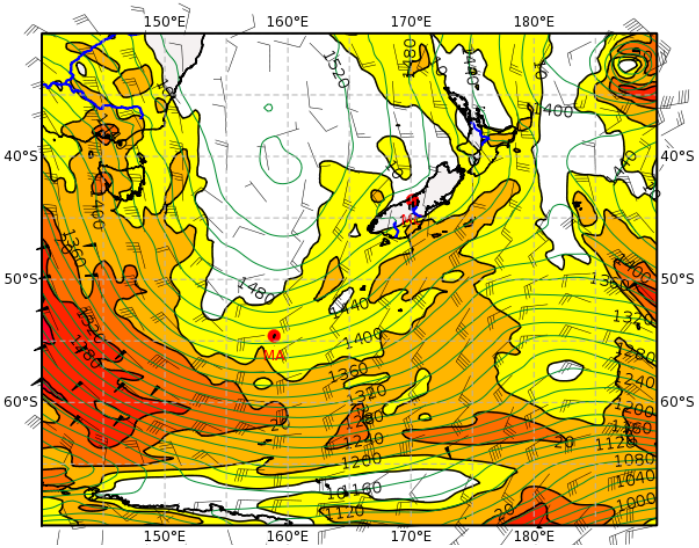

DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Mon, 14 Jul 2014, 06 UTC (step 006 h from Mon, 14 Jul 2014, 00 UTC)
150°E
160°E
170°E
180°E
40°S
50°S
60°S

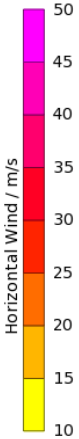

150°E
160°E
170°E
180°E
30°S
40°S
50°S
60°S

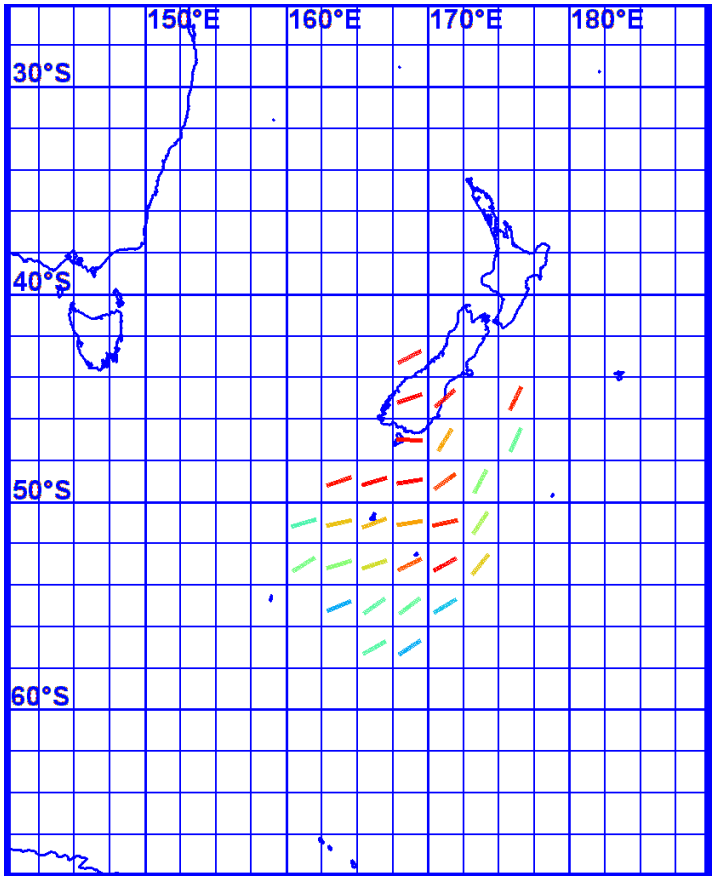

2014.07.14 Descending 2 hPa
Max = 1.96 K
Min = -1.93 K
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
1.2
0.0
-1.2

RF24

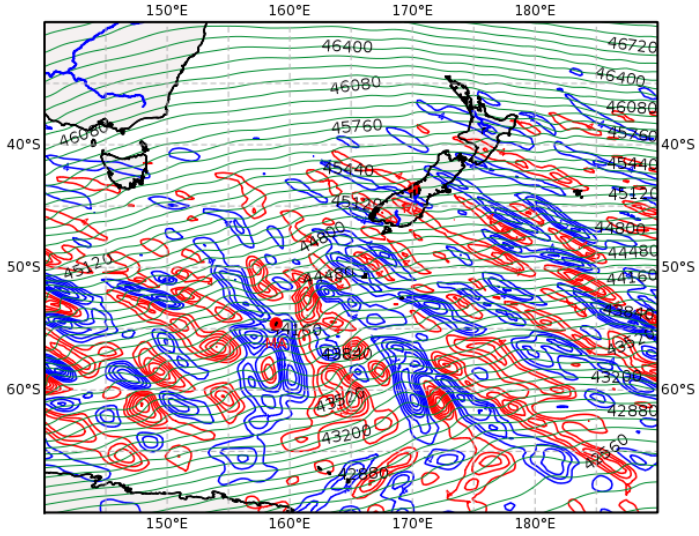
Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Tue, 15 Jul 2014, 06 UTC (step 006 h from Tue, 15 Jul 2014, 00 UTC)



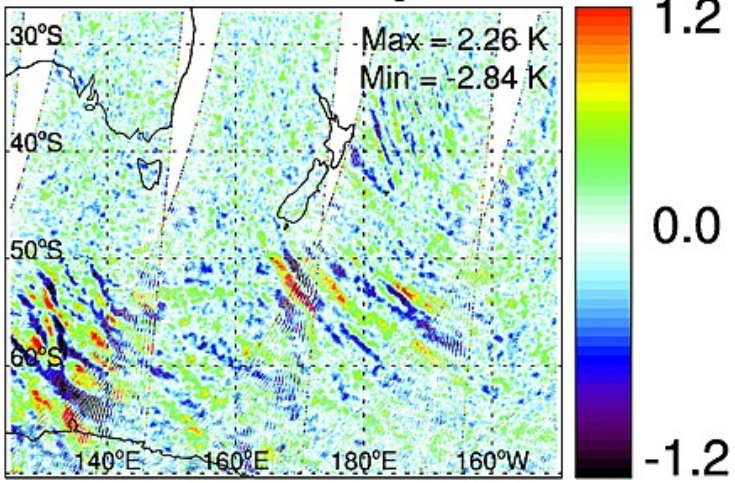




DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Tue, 15 Jul 2014, 06 UTC (step 006 h from Tue, 15 Jul 2014, 00 UTC)

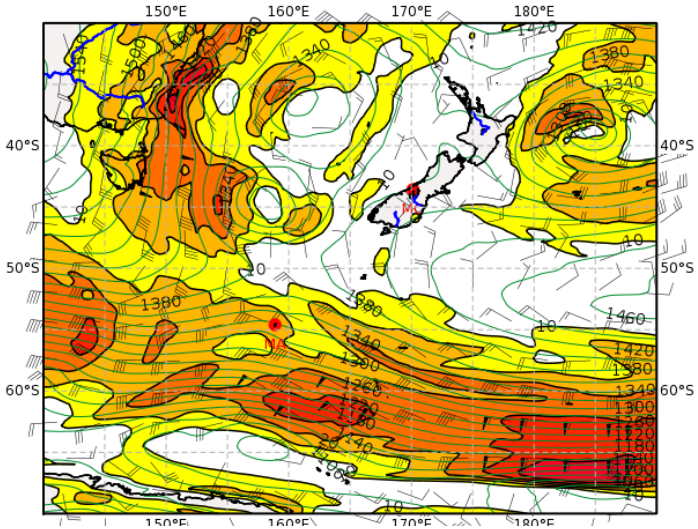


2014.07.15 Descending 2 hPa

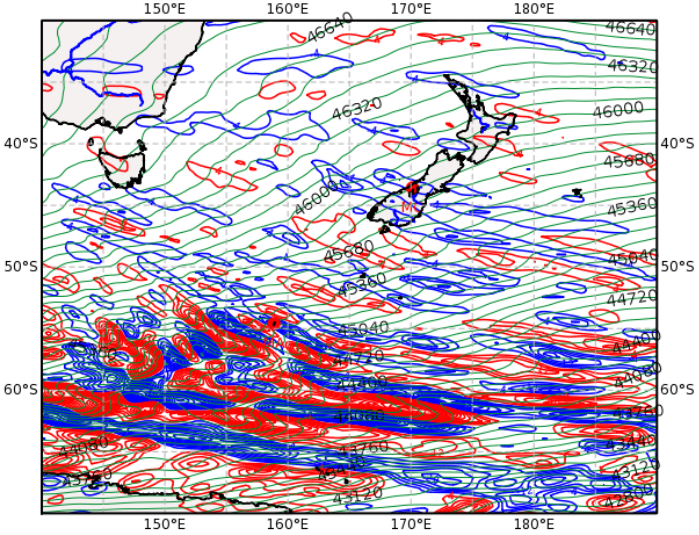


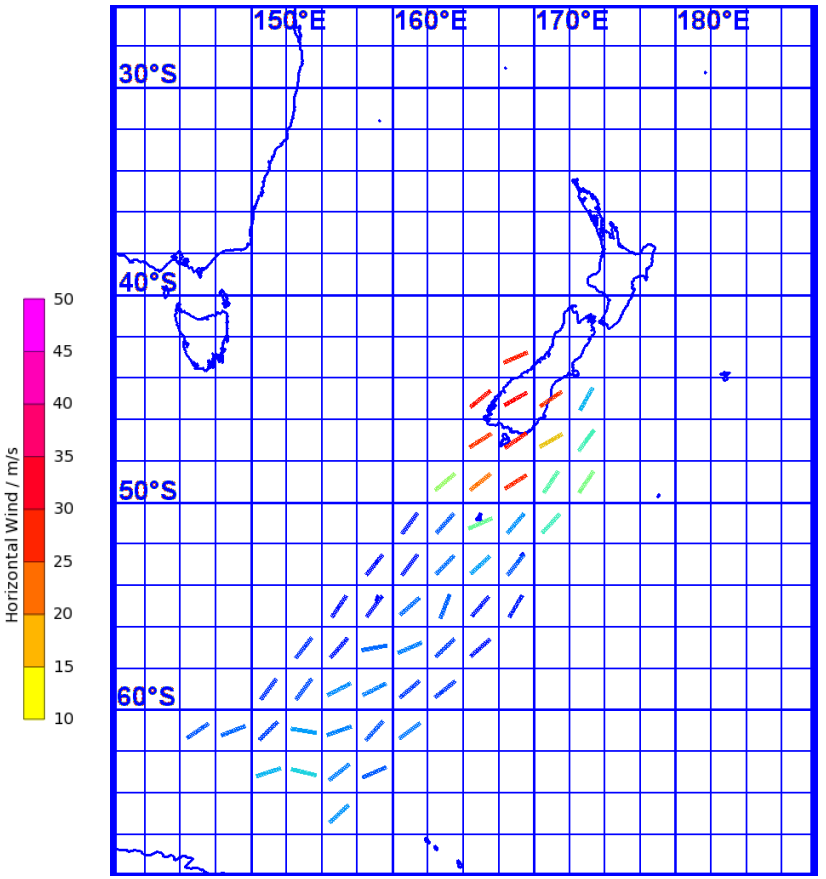
RF25

Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Fri, 18 Jul 2014, 06 UTC (step 006 h from Fri, 18 Jul 2014, 00 UTC)

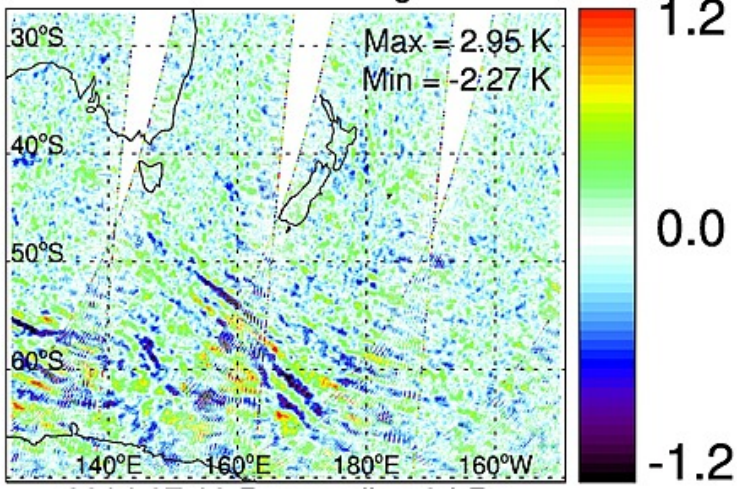


DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Fri, 18 Jul 2014, 06 UTC (step 006 h from Fri, 18 Jul 2014, 00 UTC)



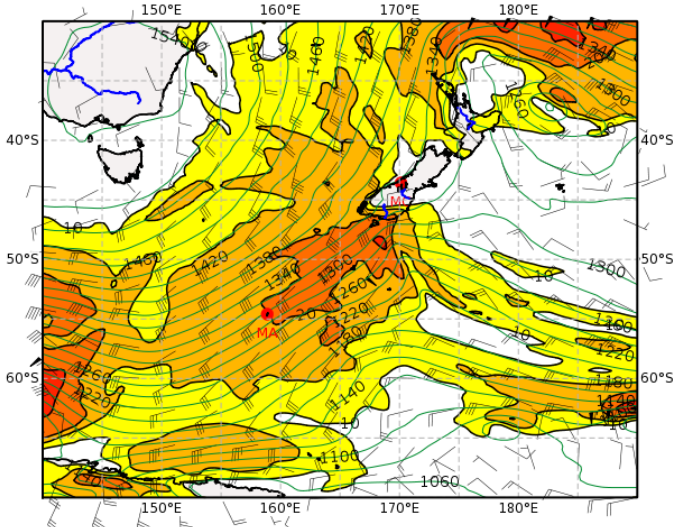


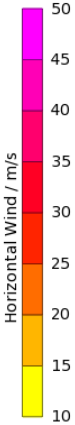
2014.07.18 Descending 2 hPa

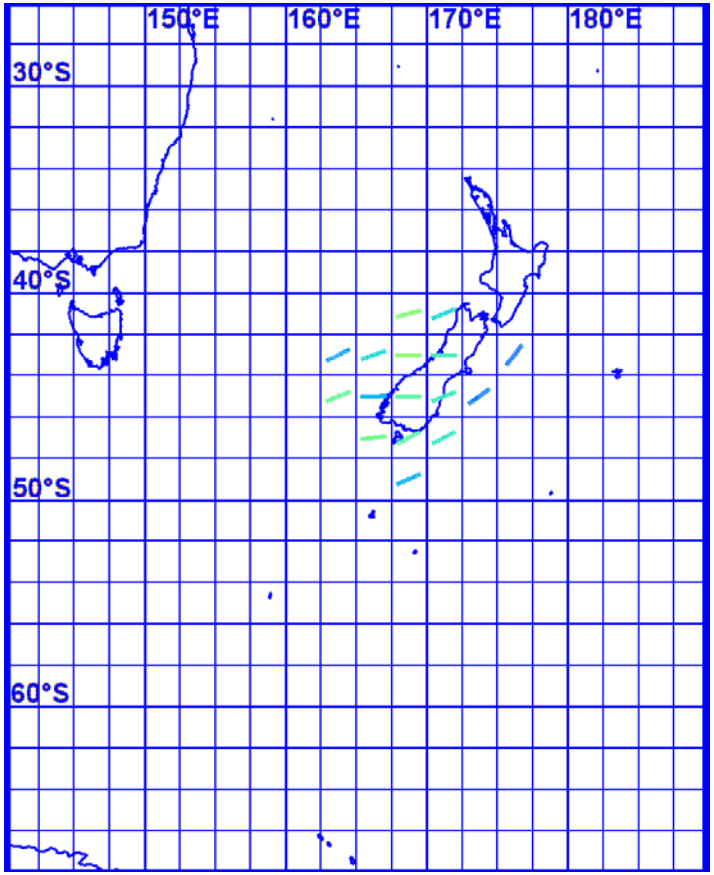


RF26

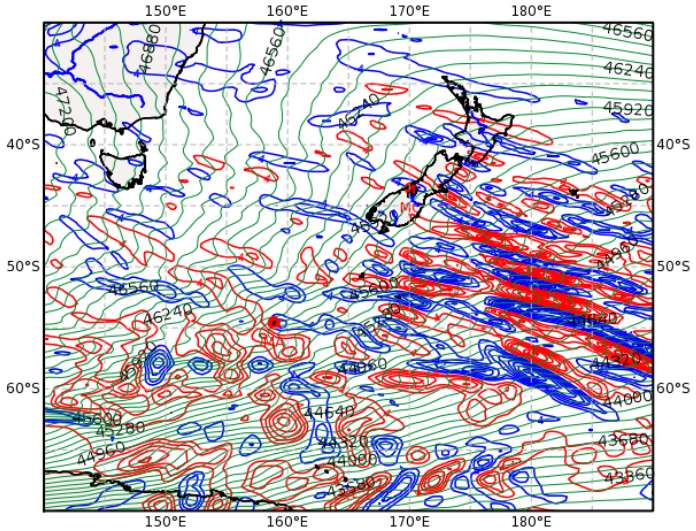
Geopotential Height (m) & Horizontal Wind (m/s) at 850 hPa
Valid: Sun, 20 Jul 2014, 06 UTC (step 006 h from Sun, 20 Jul 2014, 00 UTC)







DIV (10^-5 s^-1, pos.: red, neg.: blue, Delta=4.) and Z (m) at 1 hPa
Valid: Sun, 20 Jul 2014, 06 UTC (step 006 h from Sun, 20 Jul 2014, 00 UTC)



2014.07.20 Descending 2 hPa