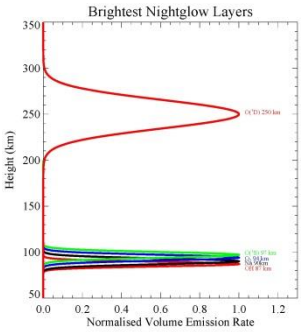
Mesospheric GW imaging during DEEPWAVE 2014

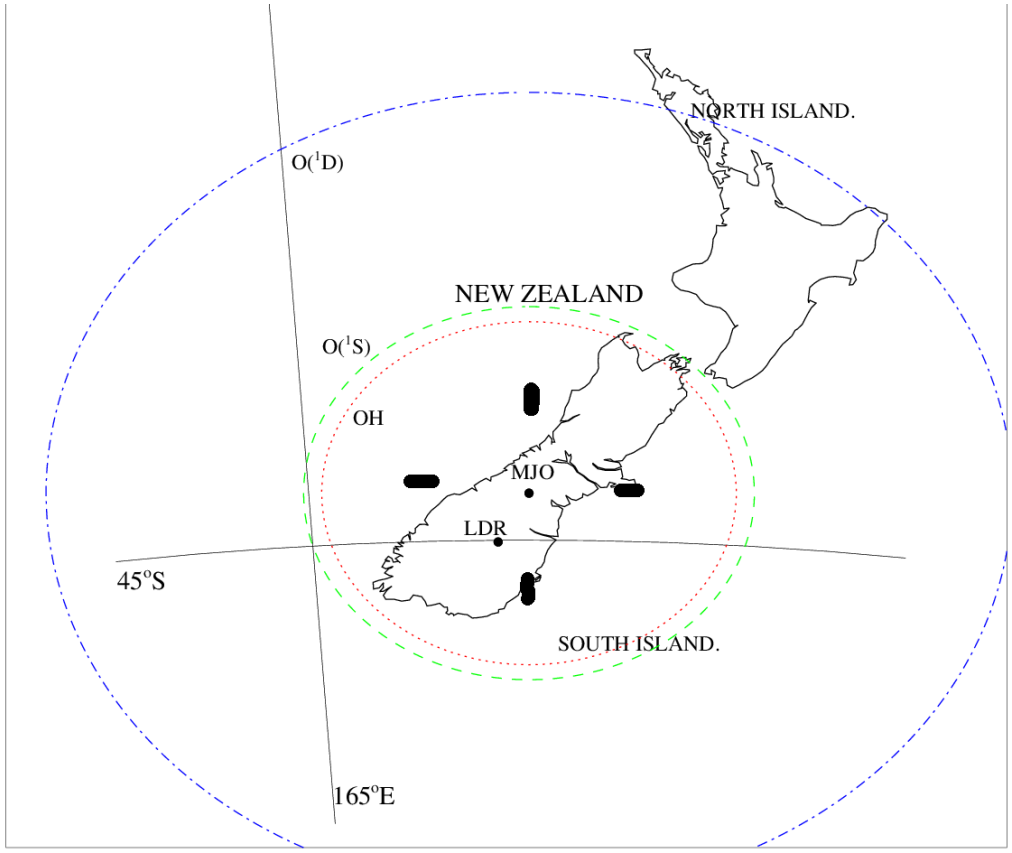
Steve Smith, Boston University

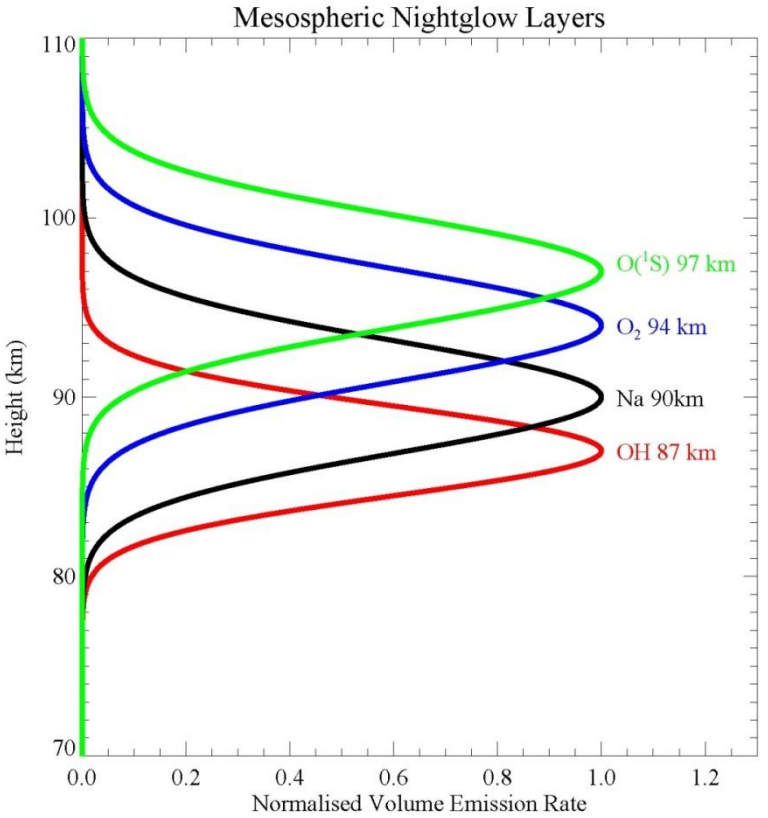


All-sky imagers:

Mt John Observatory OH, Na, O_2, O(^{1}S), O(^{1}D)

Lauder OH, Na, O_2, O(^{1}S)





NZ Weather during Deepwave

	Mt John	Lauder	RF#
May 2014			
24	Clear, waves.	Clear, waves.	-
25	Cloud rain. Waves glimpsed	Cloud rain. Waves glimpsed	-
26	Clear, waves ripples. Standing?	Clear, waves ripples. Standing?	-
27	Cloud. Waves glimpsed in 1-2 images	Cloud. Waves glimpsed in 1-2 images	-
28	Cloud, rain. Waves glimpsed.	Cloud, rain. Waves glimpsed.	-
29	Cloud. Waves glimpsed in 1 image.	Total cloud. Clear last 2 images	-
30	Clear. Large curved standing waves.	Clear. Large curved standing waves.	-
31	Some cloud. Waves. Frontal wave	Some cloud. Waves. Frontal wave	-
June 2014			
1	Clear, some waves and ripples	Clear, some waves and ripples	-
2	Clear, waves from SW	Clear then cloud	-
3	Clear, waves from SW	Total cloud	-
4	Cloud	Mainly cloud	-
5	Cloud and rain	Cloud and rain	RF#
6	Rain early, cloud, clearing later	Rain, cloud, moon	1
7	Cloudy, marginal	Moon, cloud	-
8	Moon, cloud	Moon, cloud	-
9	Moon, rain, cloud	Moon, cloud	-
19	Moon, cloud	Moon, cloud	-
11	Moon, cloud	Moon, clear at end, marginal	2
12	Moon	Moon	-
13	Full Moon 04:11UT – imager off	Full Moon 04:11UT – imager off	-
14	Moon,cloud	Moon, cloud	3
15	Moon	Moon	4
16	Cloud, moon, 1-2 clear images	Cloud, moon 1-2 clear images	5
17	Cloud,rain,moon.	Cloud, clearing, moon, some waves	
18	Clear early with waves, moon later	Clear early with waves, moon later	6
19	Clear early with waves, moon later	Clear early with waves, moon later	7
20	Cloudy, moon	Cloudy, moon	8
21	Clear with standing waves	Clear with standing waves	-
22	Clear with waves	Clear with waves	-
23	Clear with waves & ripples	Clear with waves & ripples	-
24	Cloud	Cloud	9
25	Cloud, clearing later	Cloud, some images.	10
26	Cloud early, clearing, standing waves	Cloudy	-
27	Cloudy, clearing, standing waves	Cloudy, clearing, standing waves	-
28	Clear, cloudy later. Waves.	Cloudy, waves	11
29	Cloud, rain ~4 poss. images	Cloud,rain ~1-2 poss. images	12
30	Cloud early, clearing later	Cloud early, clearing later	13
July 2014			
1	Cloud, clear periods. Waves.	Cloudy, some waves.	14
2	Clear, some cloud. Waves	Cloudy, some waves glimpsed.	-
3	Only darks	Mostly cloud. Later waves then quiet.	15
4	Cloudy then stand. waves. Bore at end.	Cloudy then stand. waves. Bore at end.	16
5	Cloudy but standing OH waves obs.	Cloudy, 1-2 images show OH waves.	17
6	Some cloud. Standing waves in west.	Mainly cloud. 1-2 clear wave images	-
7	Cloudy. Frontal wave in clear period.	Cloudy. Frontal wave in clear period.	18
8	Cloud	Total cloud	19
9	Moon, cloud	Moon, cloud	-
10	Moon. Last 1-2 images. OH waves	Moon, cloud	20
11	Moonlight – no useful images	Moonlight – no useful images	21
12	Full Moon 11:25UT – imager off	Full Moon 11:25UT – imager off	-
13	Moonlight – imager off	Moonlight – imager off	22
14	Moonlight, clear. Wave images early on	Moonlight, clear. Wave images early on.	23
15	Clear, waves. Moon later	Clear, waves. Moon later	24
16	Clear, waves. Moon later	Clear, waves. Moon later	-
17	Cloud, moon, rain	Cloudy with Waves. Moon later	-
18	Clear, some cloud. Moon. Waves.	Clear, some cloud. Moon. Waves.	25
19	Cloud	Cloud, poss. Waves glimpsed	-
20	Clear early then cloud	Cloud, several clear images waves	26
21	Cloud during night. OH bore glimpsed.	Cloud. Dark bore in OH	
22	Cloud, 1 poss. useful image	Cloud	
23	Clear, waves		
24	Clear, waves and a bore	No data	
25	Clear, waves all night	No data	

Useable nights 6 June – 20 July

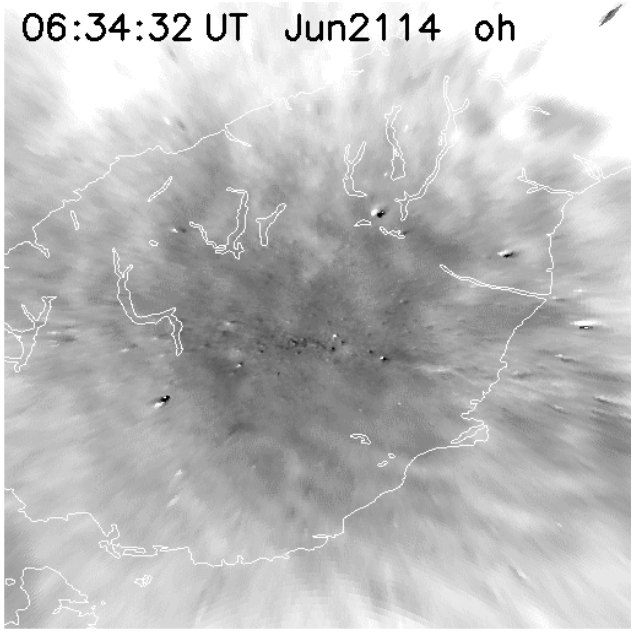
Mt John

20 nights (45%) 6 **19**

Lauder

17 nights (38%) 11 **17**

21 June 2014



1. Wave breaking ~10-12 UT

Large-scale waves: λ_h~ 120 km (σ = 35 km)

I/I_0 = 3-10%

Stationary/standing waves – dithering in position.

Momentum fluxes (unit mass):

11:20:57 UT: 9.1 m^2s^{-2}

11:32:29 UT: 5.1 m^2s^{-2}

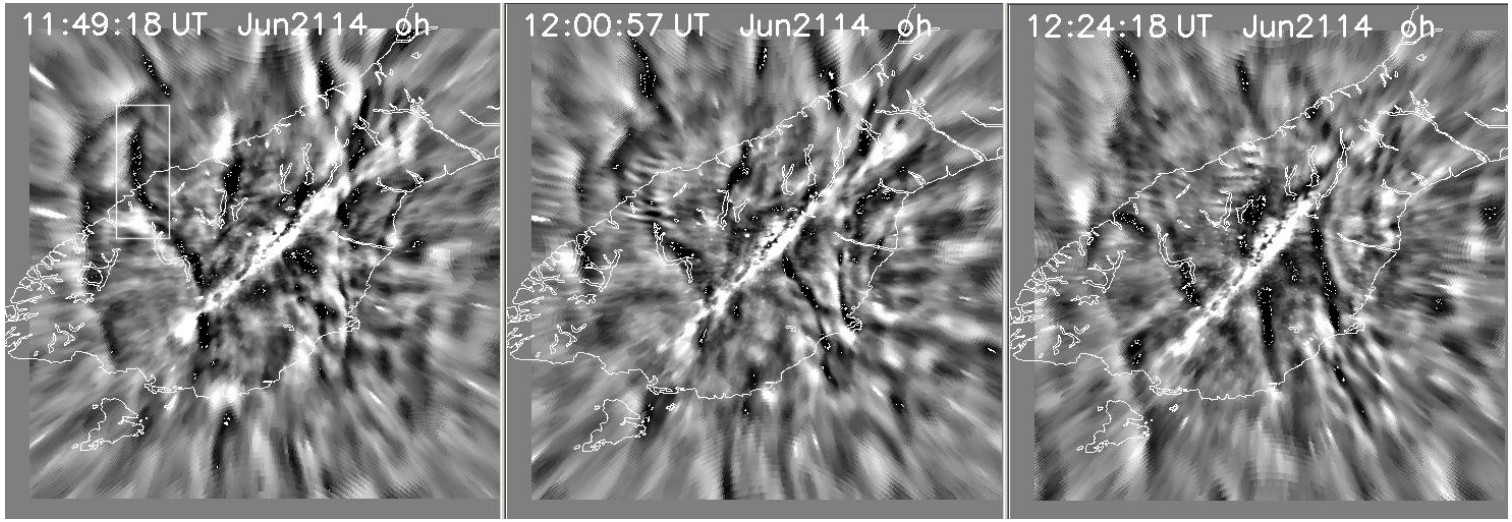
11: 51:54 UT: 0.5 m^2s^{-2}

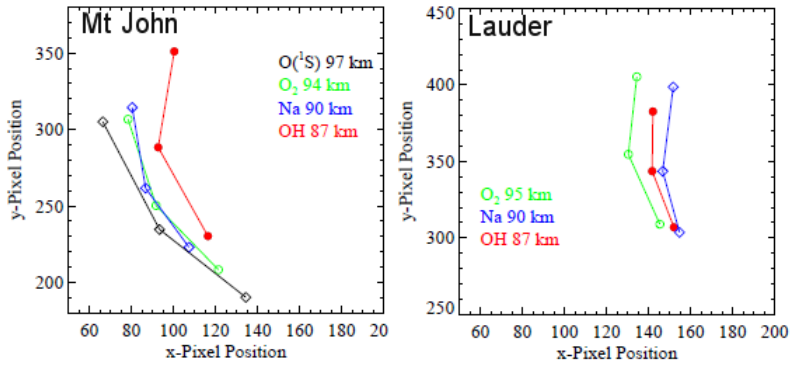
Small-scale waves: λ_h~ 11.6 - 16.5 0 km (σ = 2.9 km)

I/I_0 = 4%

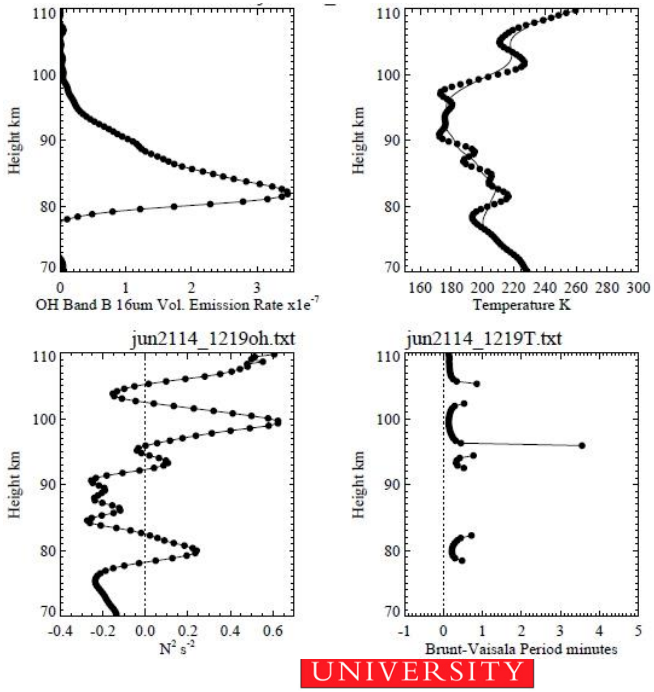
- instabilities due to wave breaking.

21 June 2014





SABER OH and temperature profiles



Lauder: v=2.7±0.8 ms^{-1}

FPI winds (U = 58 ms^{-1}) yields λ_z= 41 km (N=0.01 s^{-2})

OH layer ~82 km – lower than mean altitude.

I/I_0 = 8% λ_h= 48 km Fm = 48.6 m^2s^{-2}

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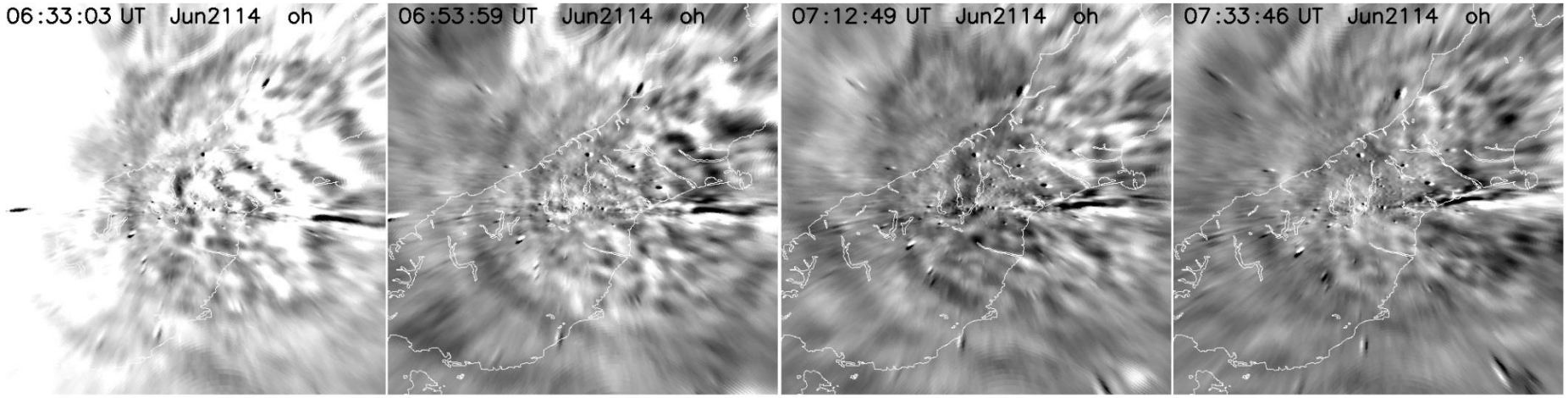
21 June 2014

2. Concentric Gravity Waves over South Island

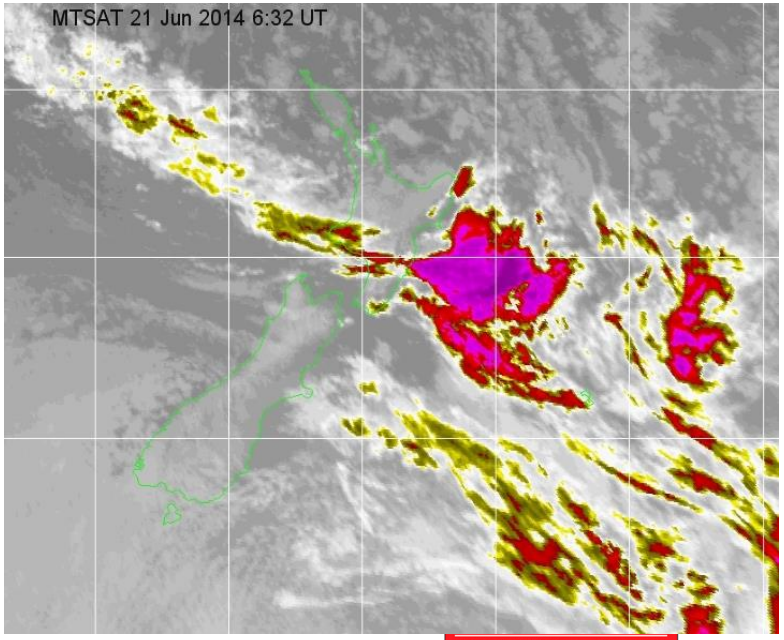


No wind data yet. OH/O_2 phase: λ_z = 56 km

Observed at MJ and Lauder

OH: λ_h = 98.7± 4.7 km v_{obs}= 48.0 ± 6.8 ms^{-1}
I/I_0 = 1-2% Fm = 1.1 m^2s^{-2}

O_2: λ_h = 107.8 ± 12.6 km v_{obs}= 52.4 ± 3.2 ms^{-1}
I/I_0 = 1-2% Fm = 0.6 m^2s^{-2}



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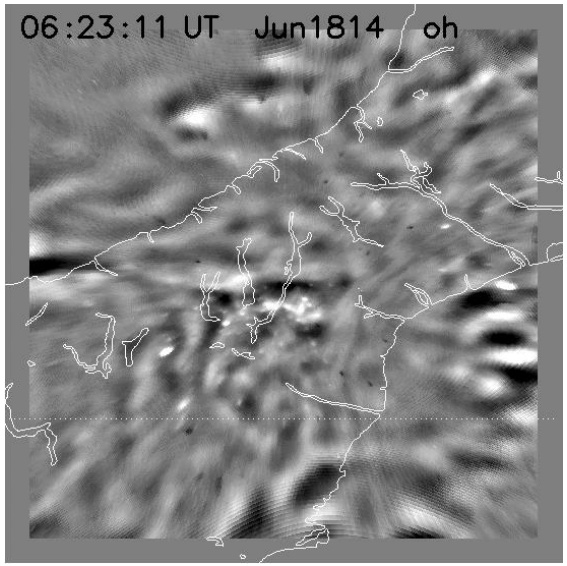
18 June 2014 RF6

Turbulent mountain wave breaking



OH

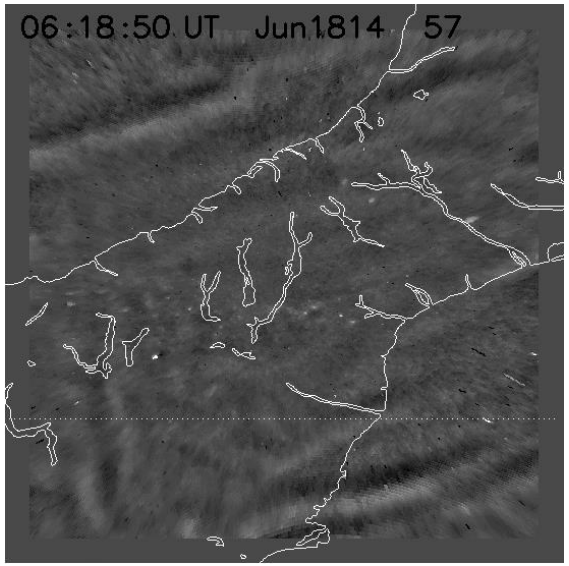
λ_h = 42 ± 7 km

I/I_0 = 10-15%

5577:

λ_h = 41 ± 8 km

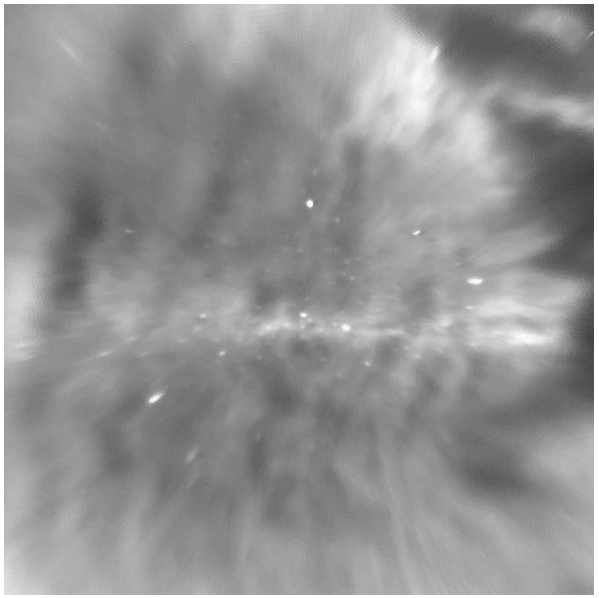
I/I_0 = 10-18%

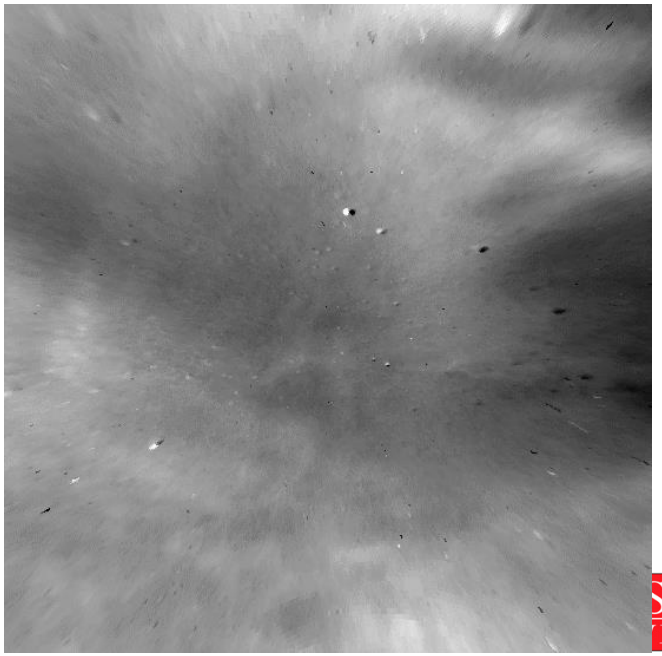


OH 87 km

5577 97 km

Small-scale 5577 wave activity weaker and lags OH activity

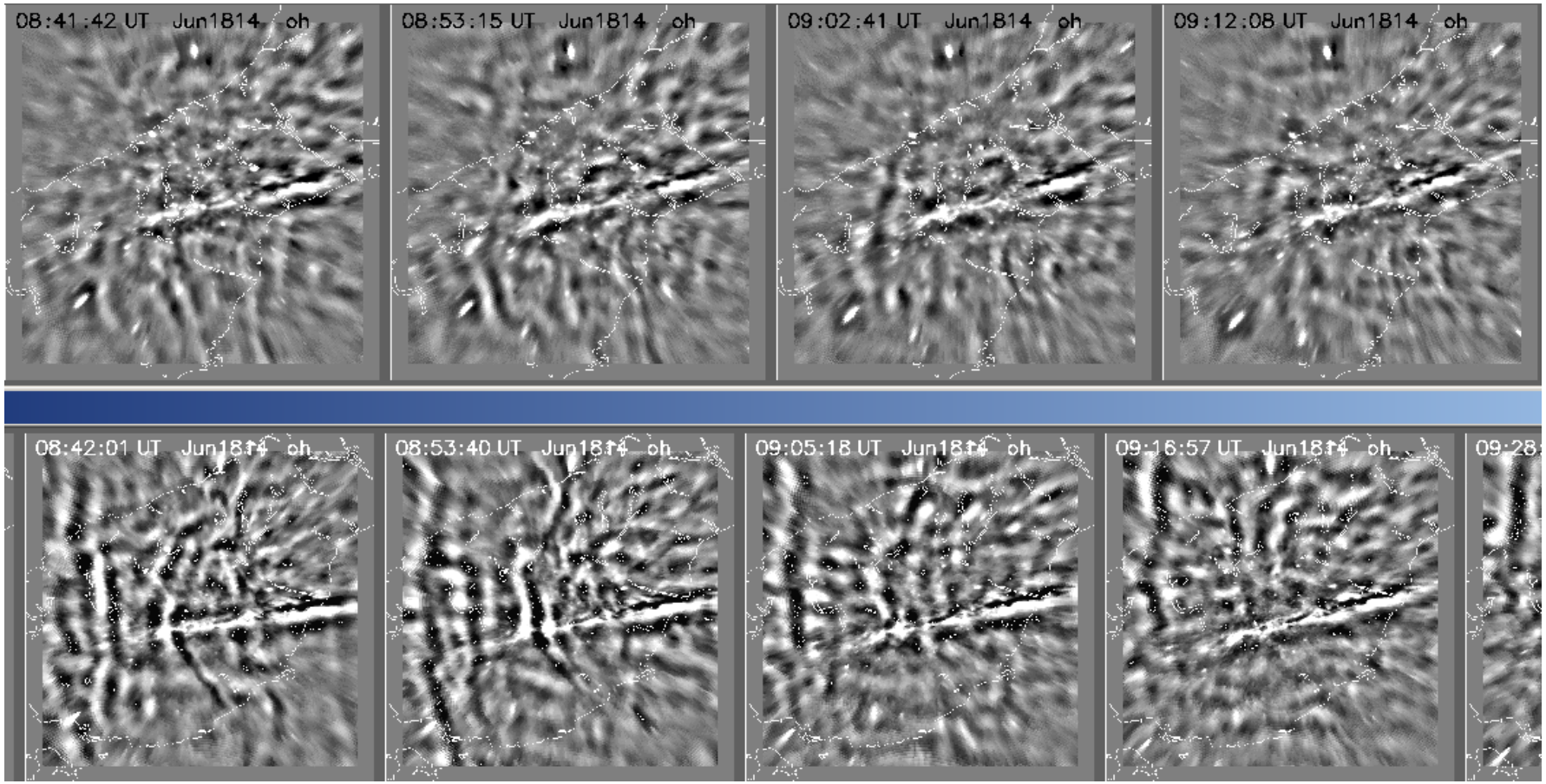




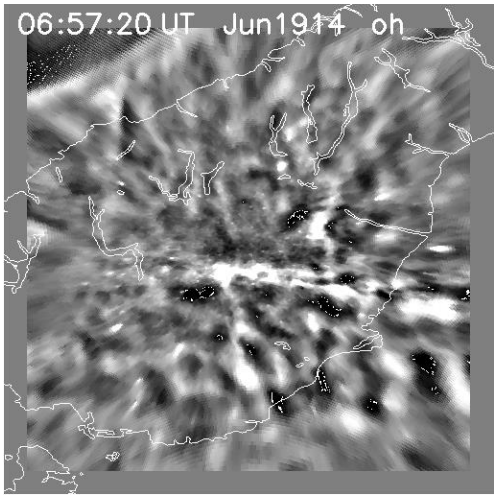
18 June 2014 RF6

Turbulent mountain wave breaking

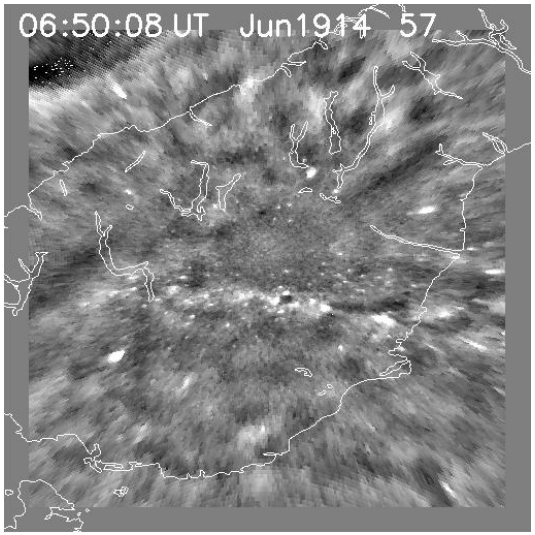
Geographical variations in GW activity - OH at Mt. John and Lauder



19 June 2014 RF7

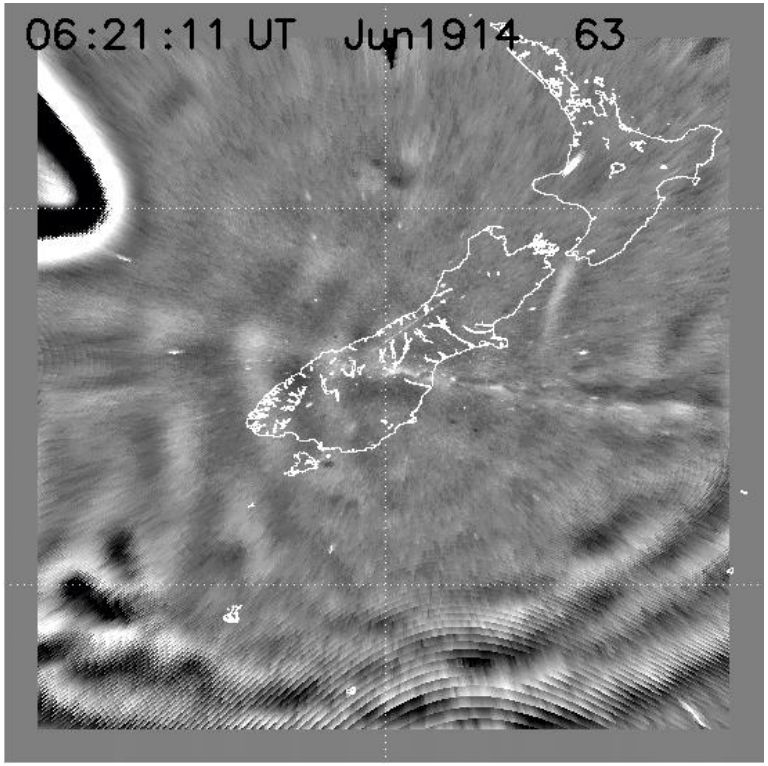


OH 87 km



5577 97 km

Strong mountain wave-breaking with evidence of M-T coupling

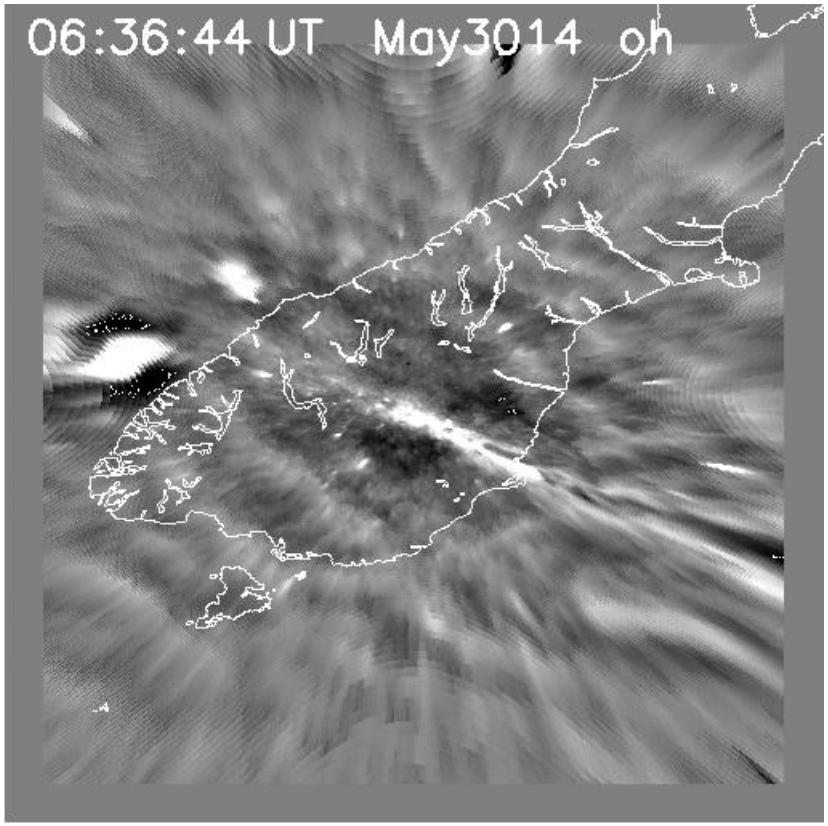


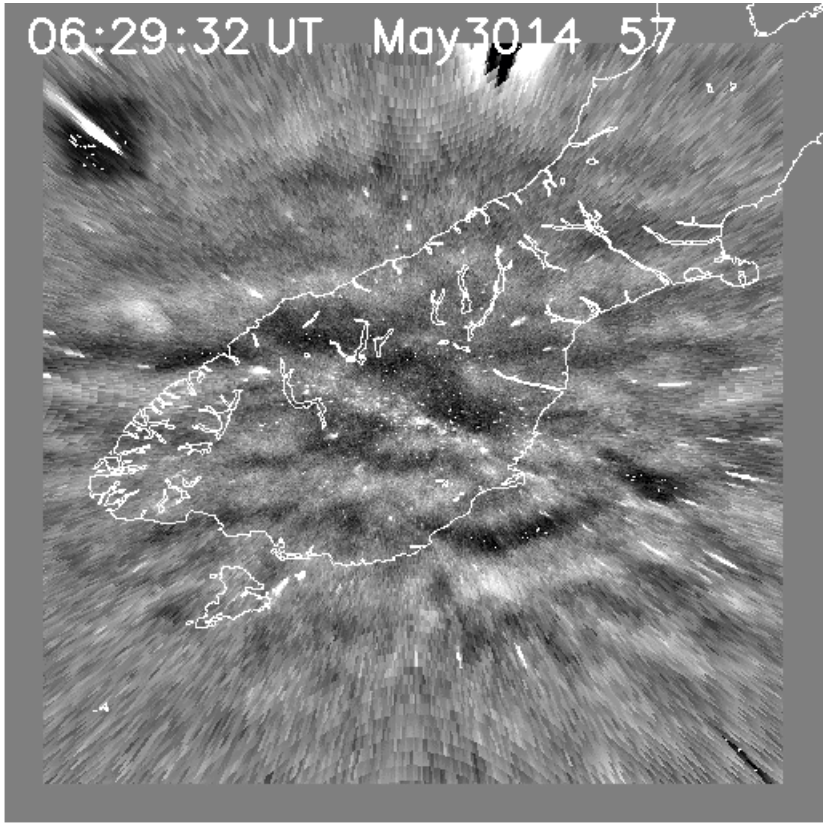
6300 250 km

Similar to event reported by Smith et al. (2013).

30 May 2014

Large-scale standing mountain wave breaking





Small-scale waves: λ_h = 20 ± 2 km I/I_0 = 1.5%
Large-scale waves: λ_h = 51 ± 2 km I/I_0 = 3-4%

Large-scale waves: λ_h = 43 ± 4 km I/I_0 = 14-15%

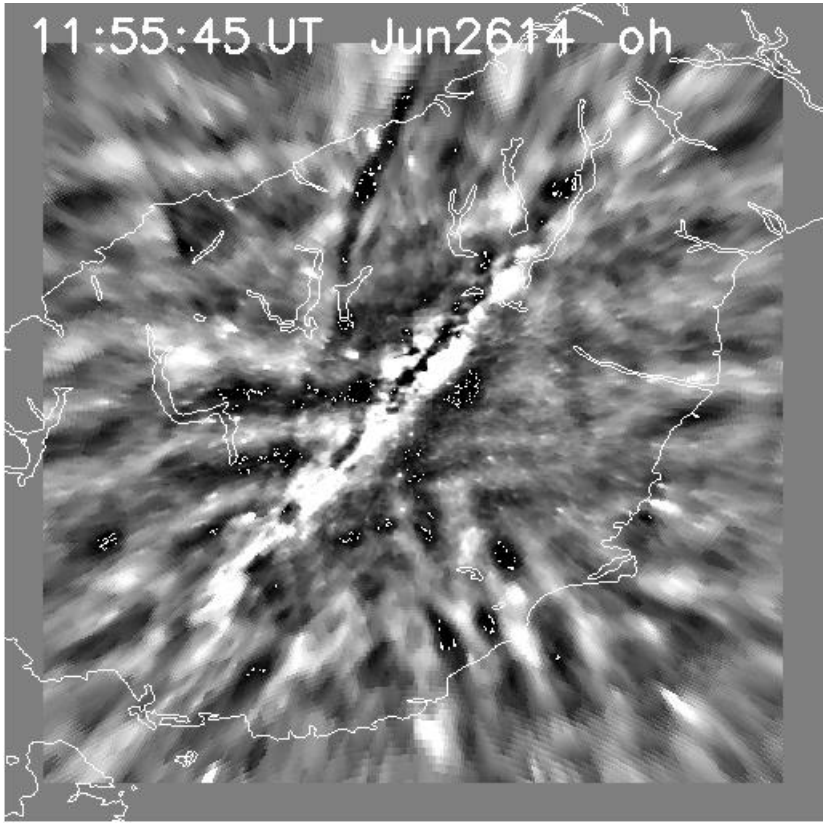
26 June 2014

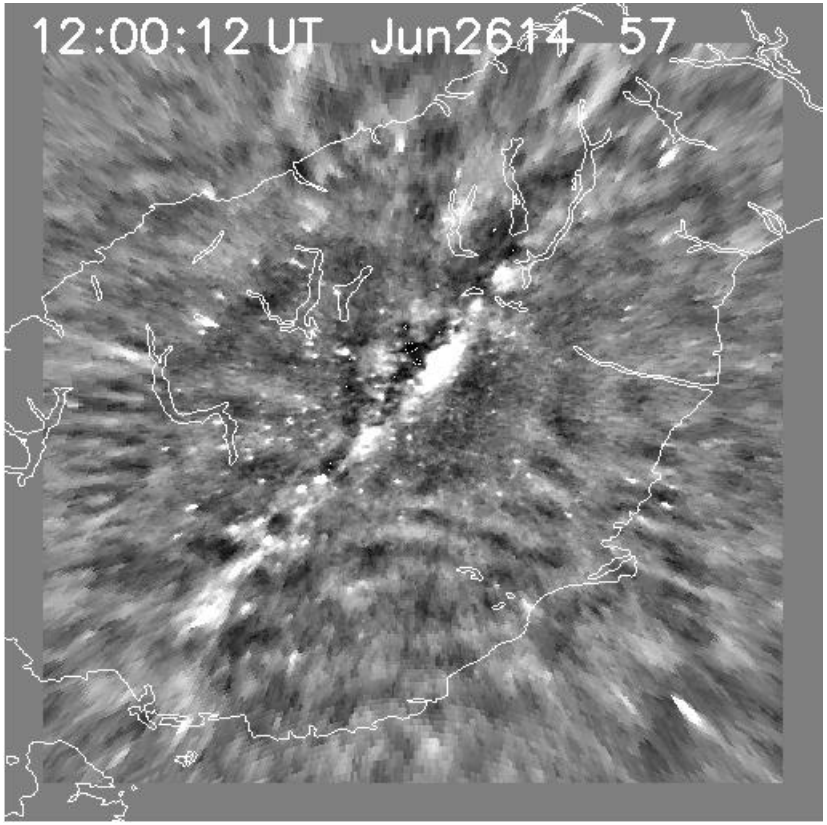
Mountain wave breaking over South Island

Brightness ampl.: OH 1%, Na 2-3%, O_2 7-13%, 5577: 5-13%,

Occurrence: ~10-13UT OH λ_h = 41 ± 11 km 5577: ripples ~15 km.

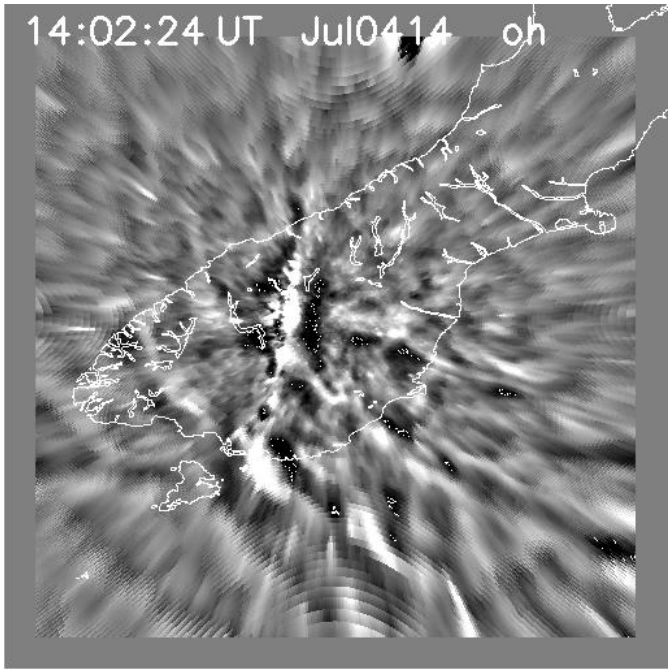
GW's in 6300 emission also





4 July 2014 RF16

Multi-scale gravity waves



OH:

Small scale: 18 km

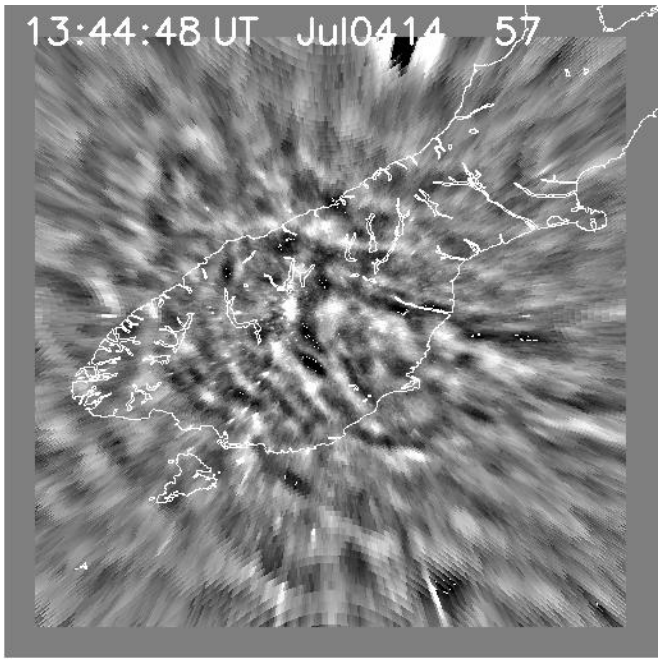
Large scale: 62 km

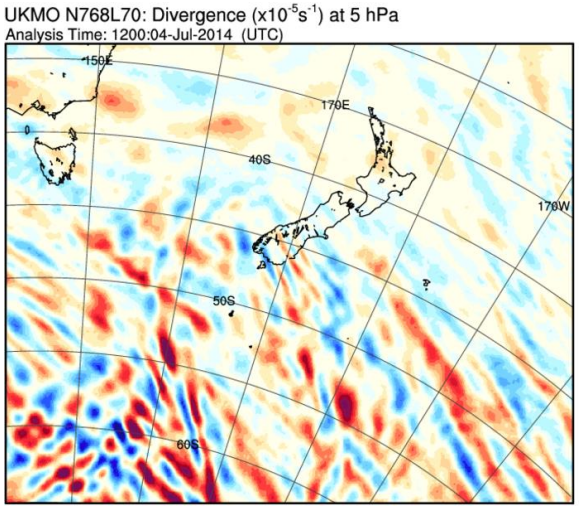
5577:

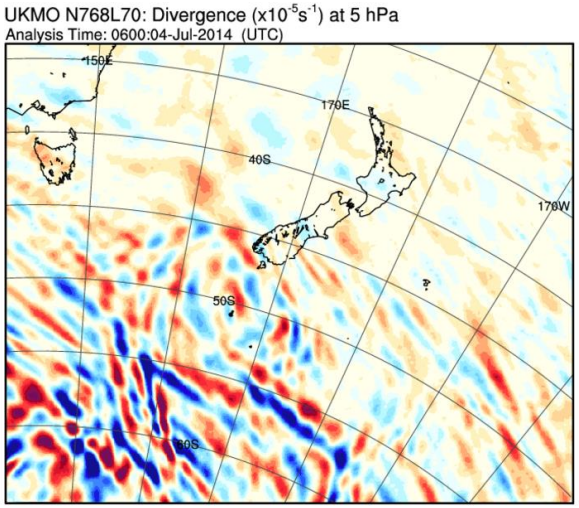
Large-scale: 99 km

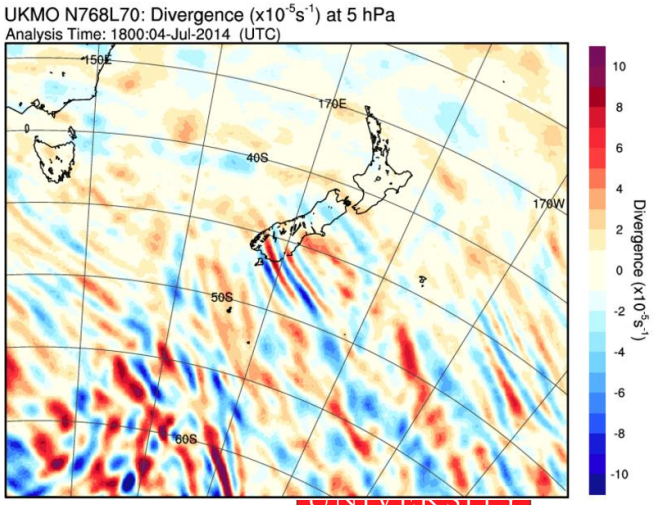
Small-scale: 20 km

- atop larger-scale GW's

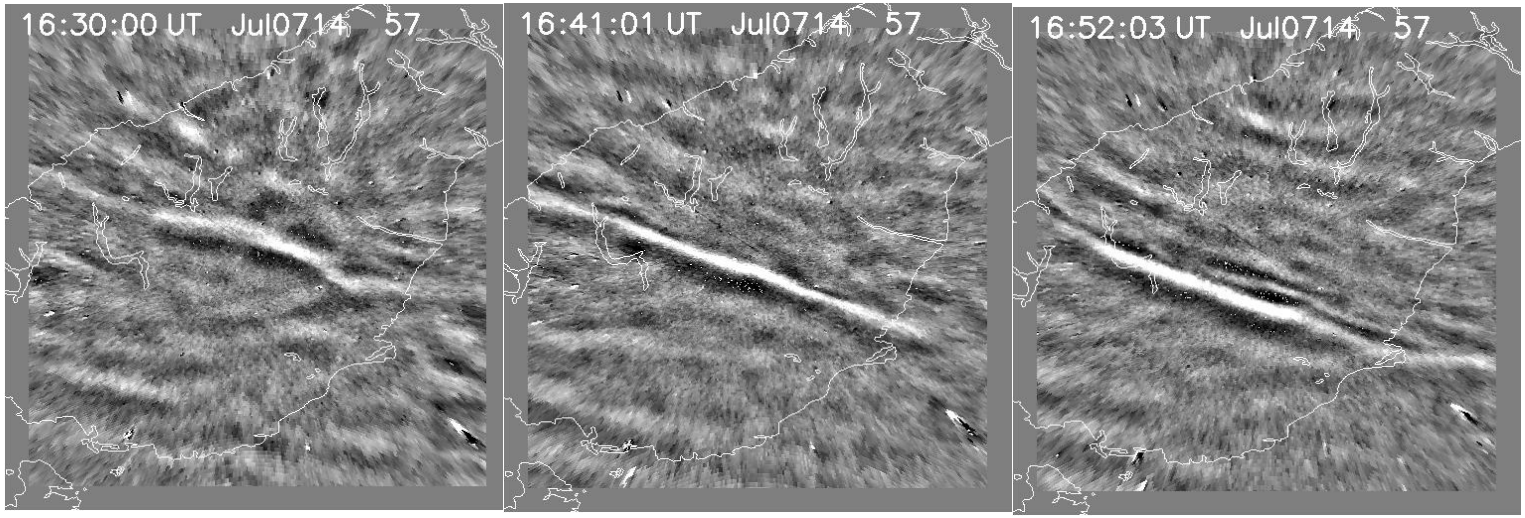




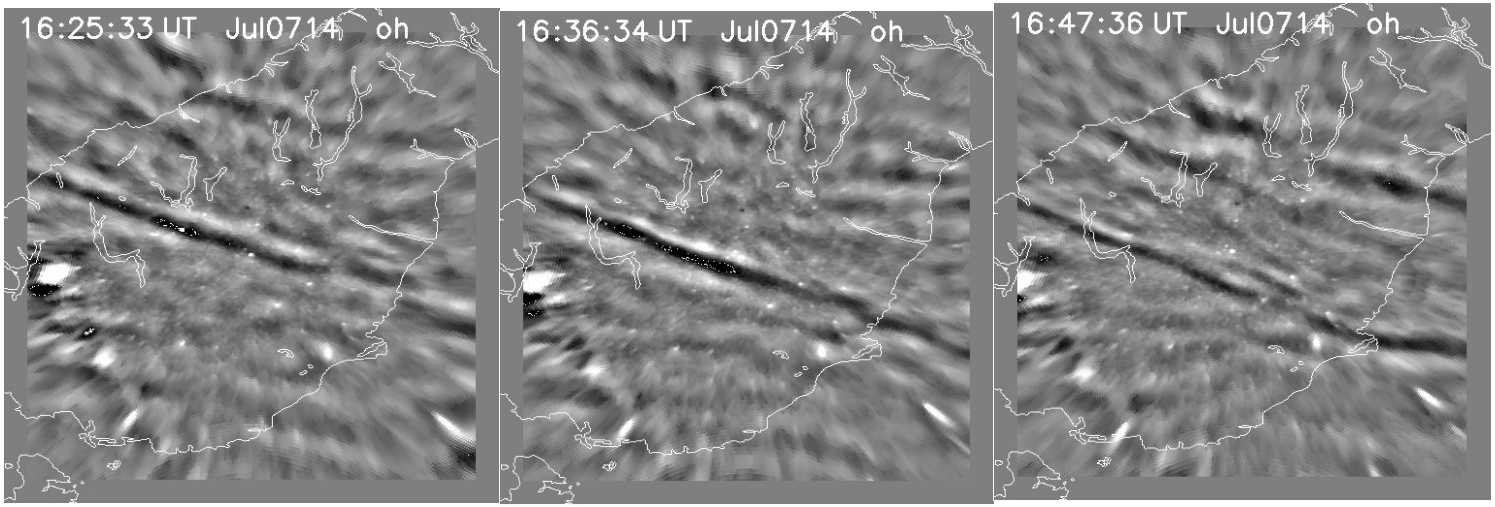




7 July 2014 RF18
Frontal gravity wave, Bore



5577: v=38 ms^{-1} FWHM=6-9 km λ_h=18,13 km I/I_0=14-20%



OH: v=26 ms^{-1} FWHM=7-9 km λ_h=21 km I/I_0=12-19%

Numerous additional nights' available:

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