DEEPWAVE:
Meteoric Plasma Dynamics Radar System

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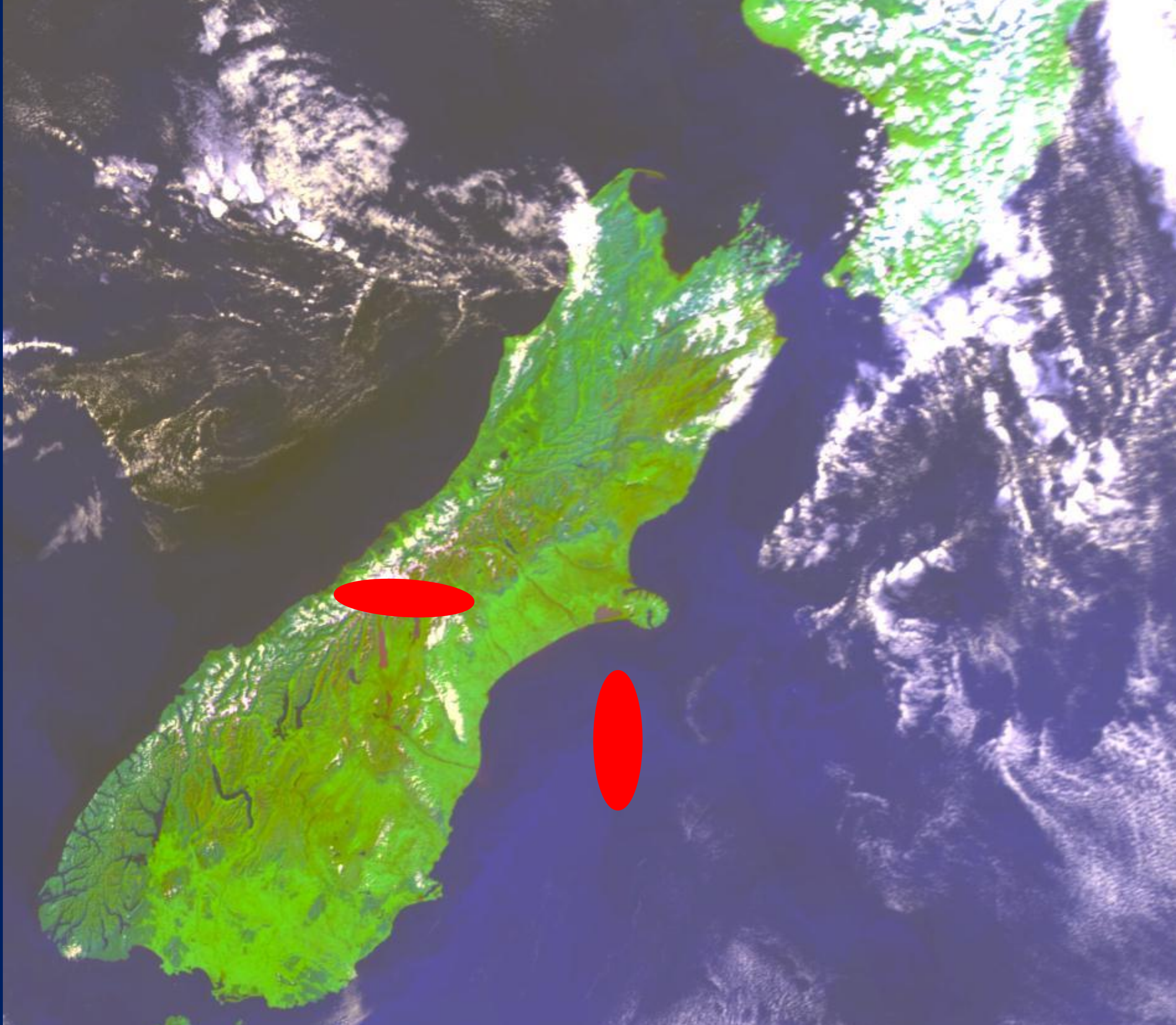
DEEPWAVE Jan 21 2014

1. Radar facility for Meteor plasma probing
2. Measuring wind speeds and
   turbulent structure 80 – 110 km
4. Optical probing from Mount John.




Waimakariri River
Christchurch
Lyttelton Harbour
Banks Peninsula
Lake Ellesmere
Akaroa
Kaitorete Spit
Rakaia River

Kaikorete spit – looking west

Meteor Orbit Radar transmitter 26 MHz:

Looking North-East

Meteor Orbit Radar transmitter 26 MHz:

Looking North

PROGRAMME:

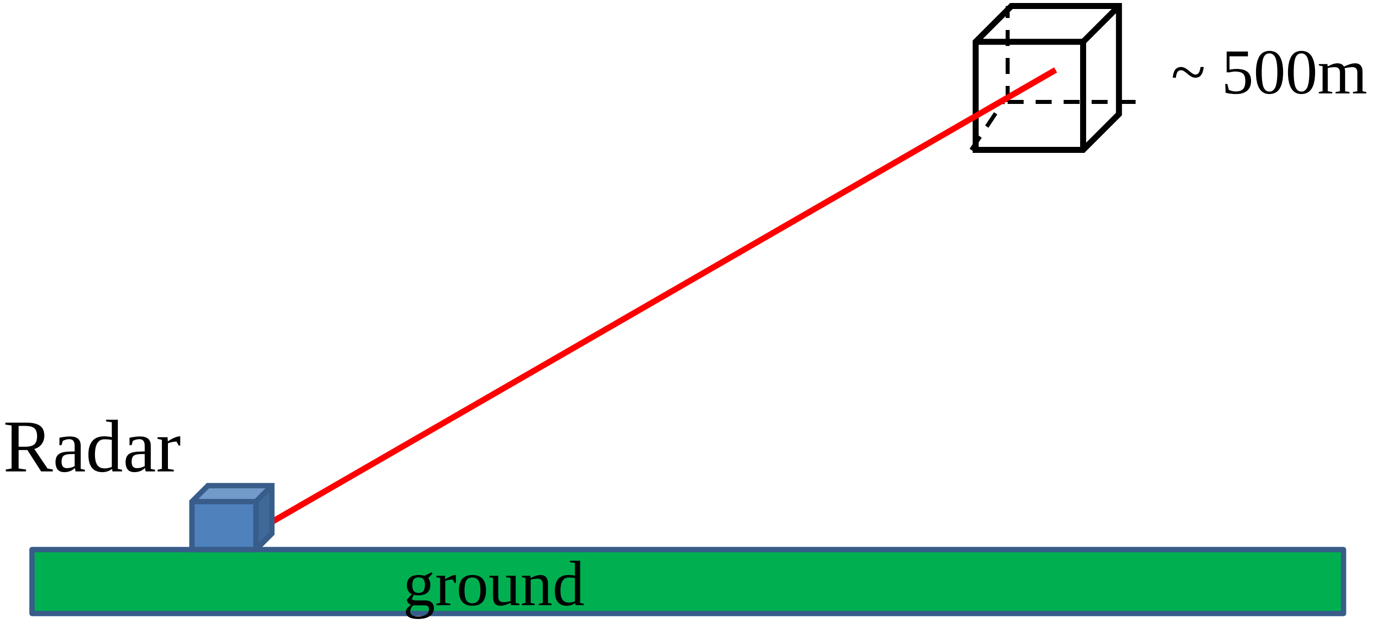
1. Atmospheric wind patterns 80 – 110 km

2. Small scale effects: wind-shear and turbulence

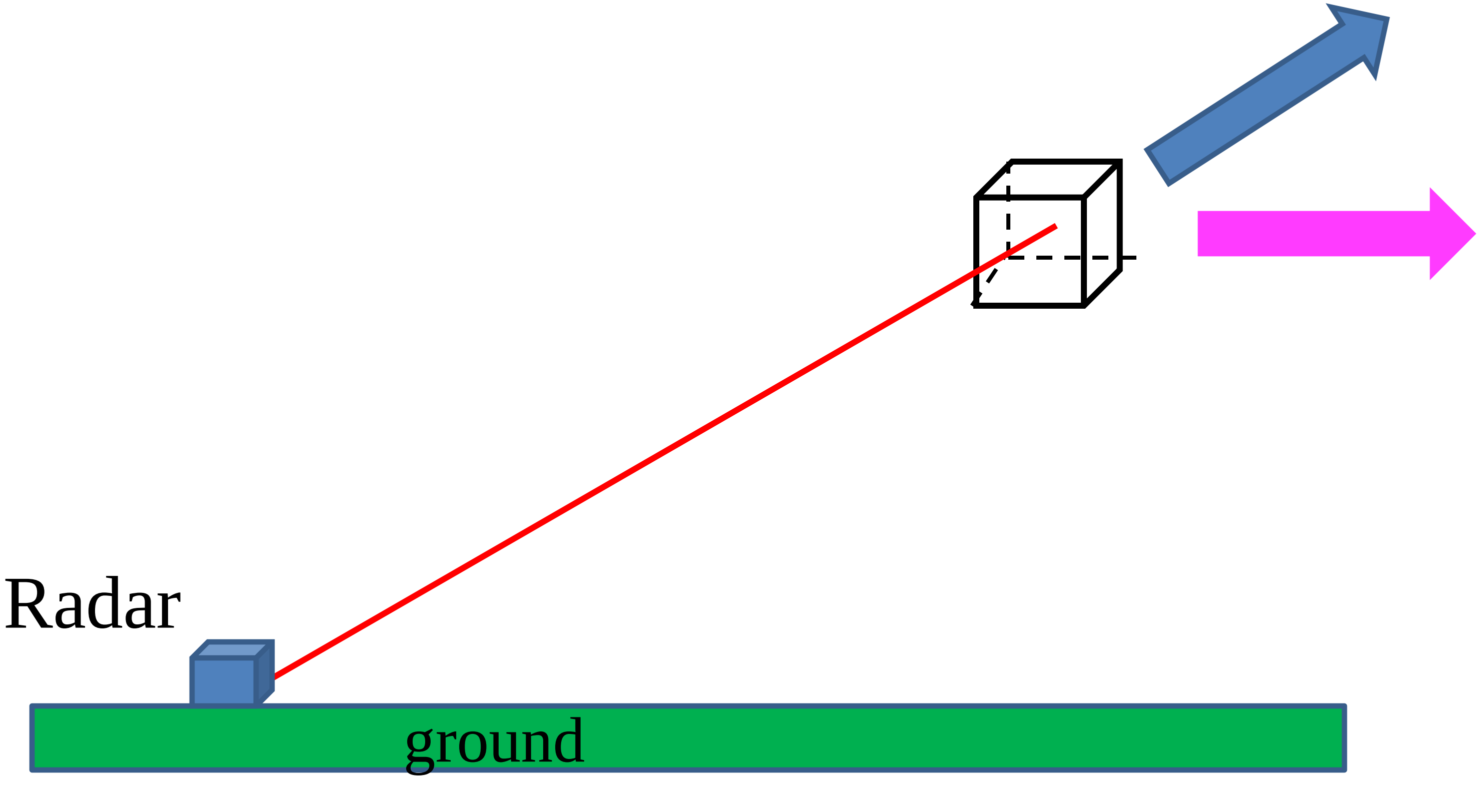
Phase behaviour of radar scattering from meteoric plasma:

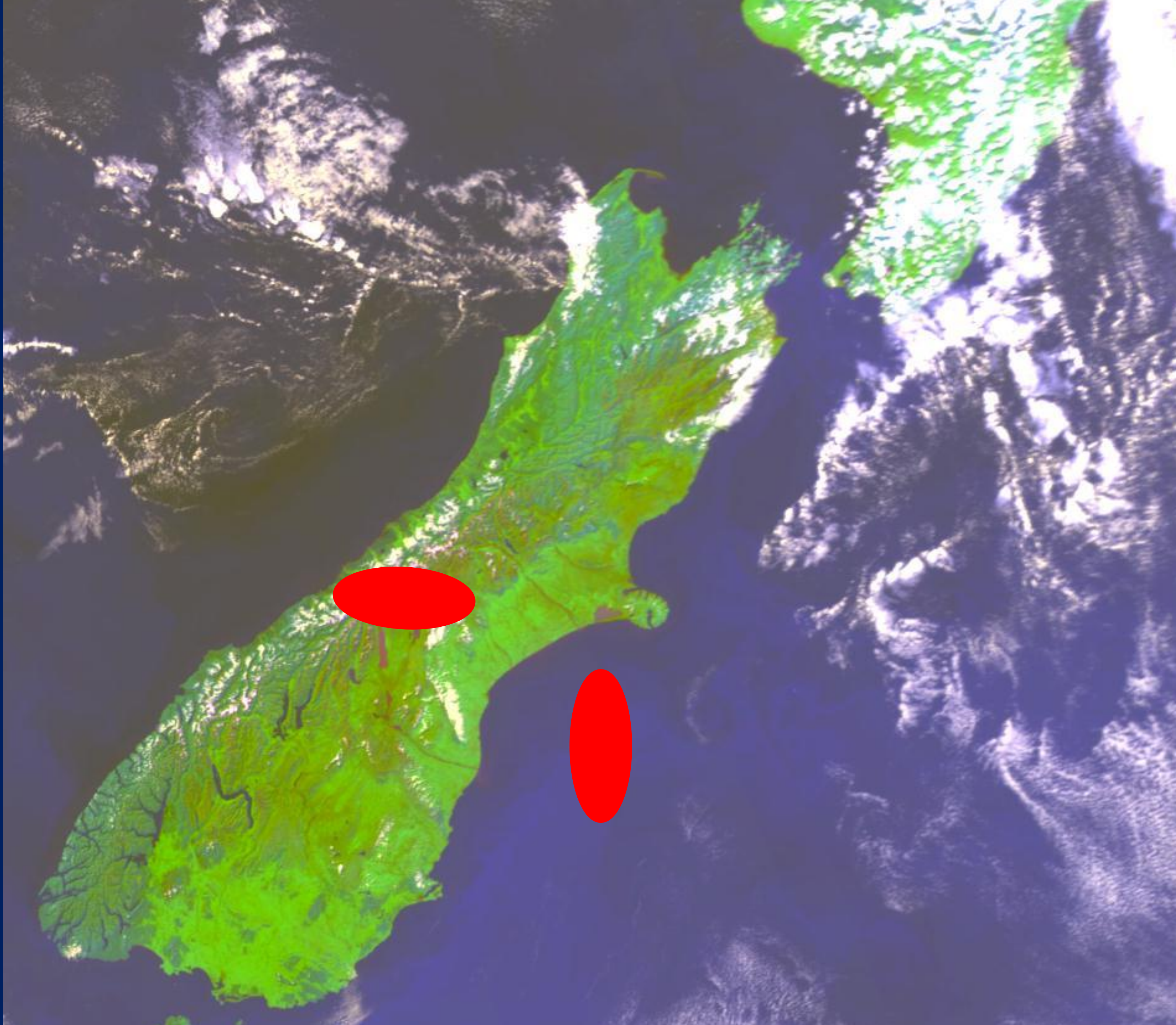
Sampling rate of echoes ~ 1 per second

Plasma location resolution



Radial phase signature &Wind components

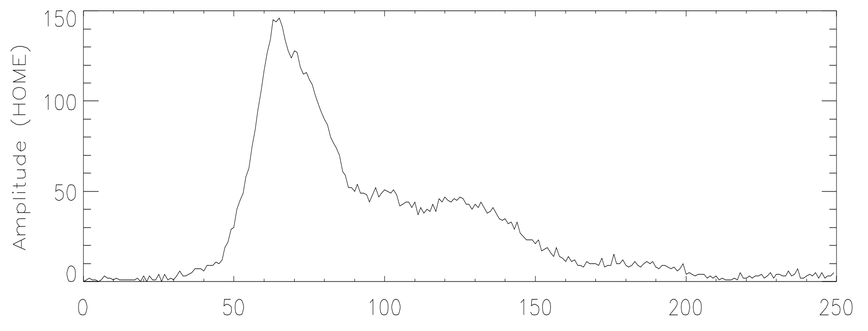




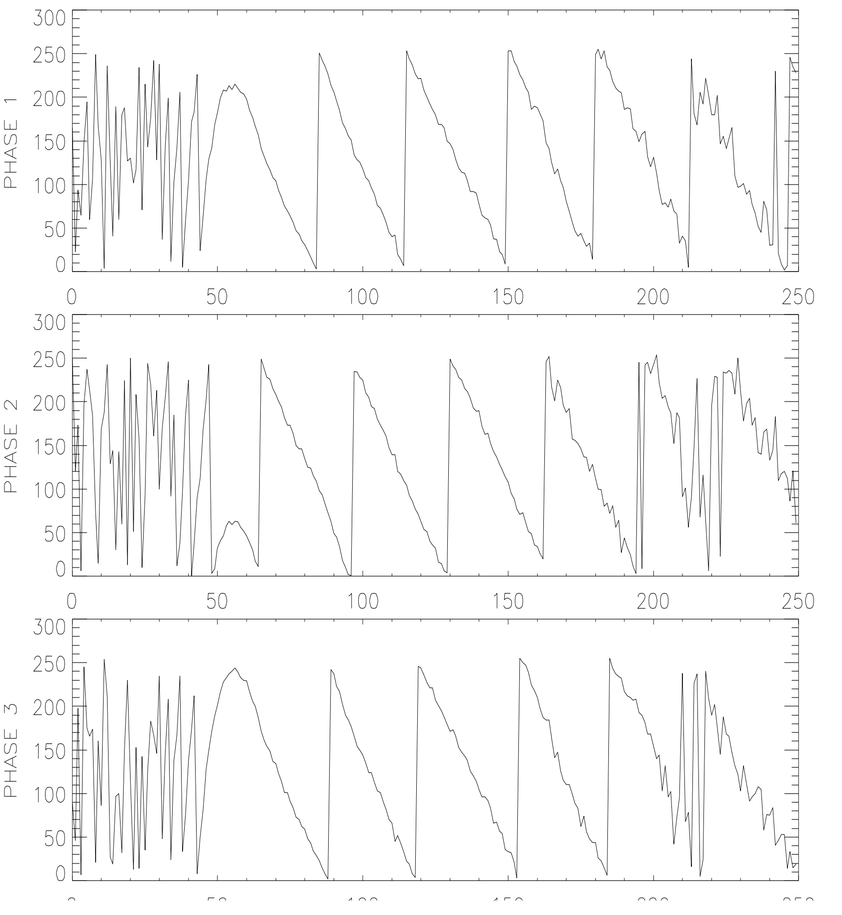
Phase records to provide radial wind speed

Echo amplitude

Echo Phases



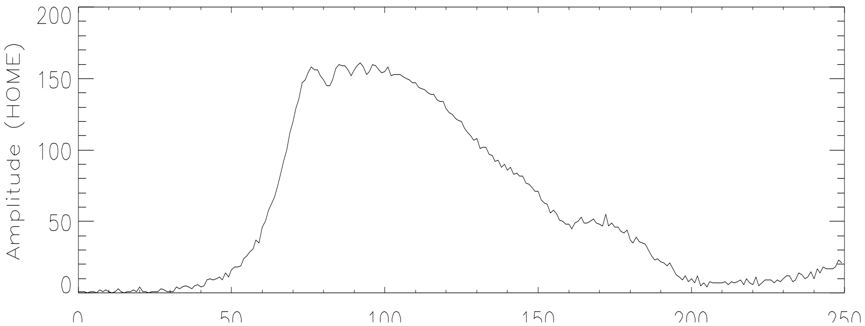
Radar pulses



Phase decrease with time-
Target receding

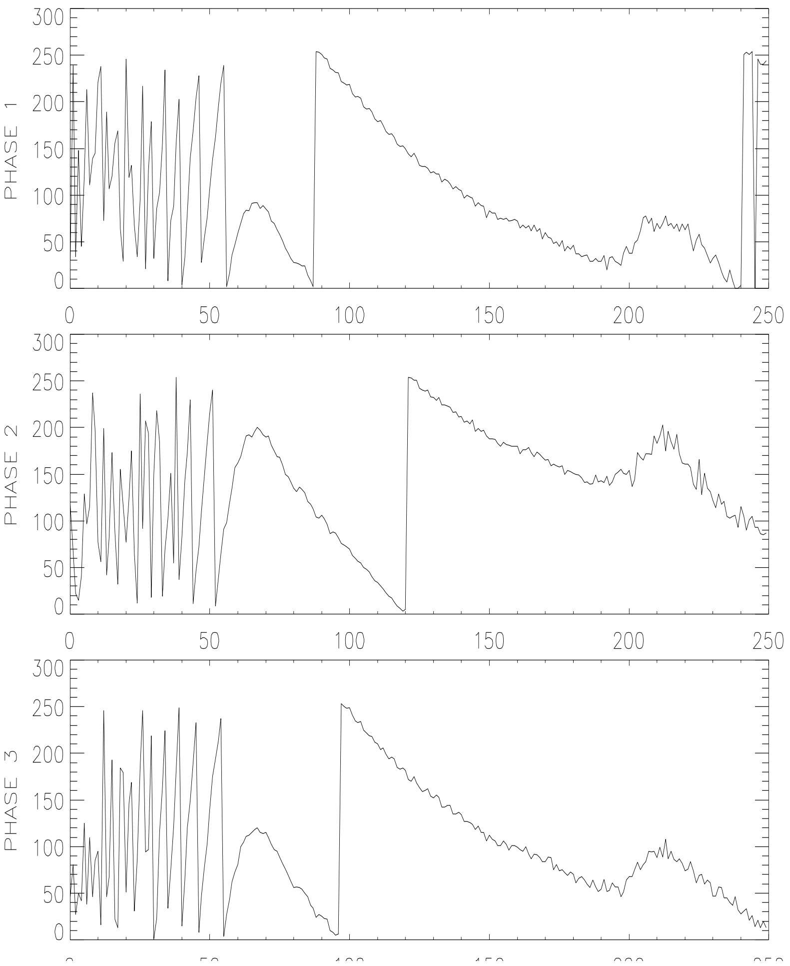
Radar pulses

Echo amplitude



Radar pulses

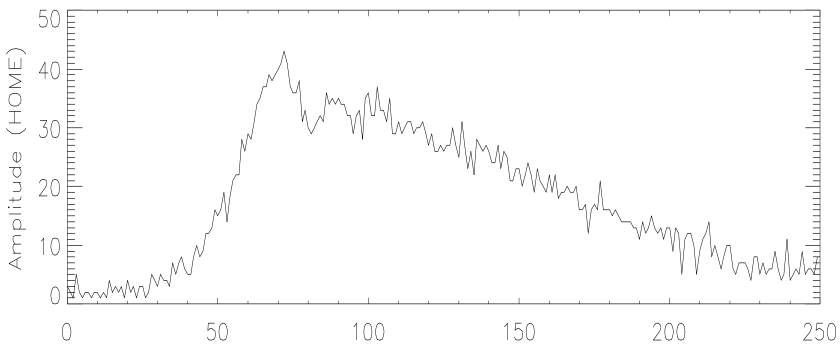
Echo Phases



Phase decrease with time-
Target receding

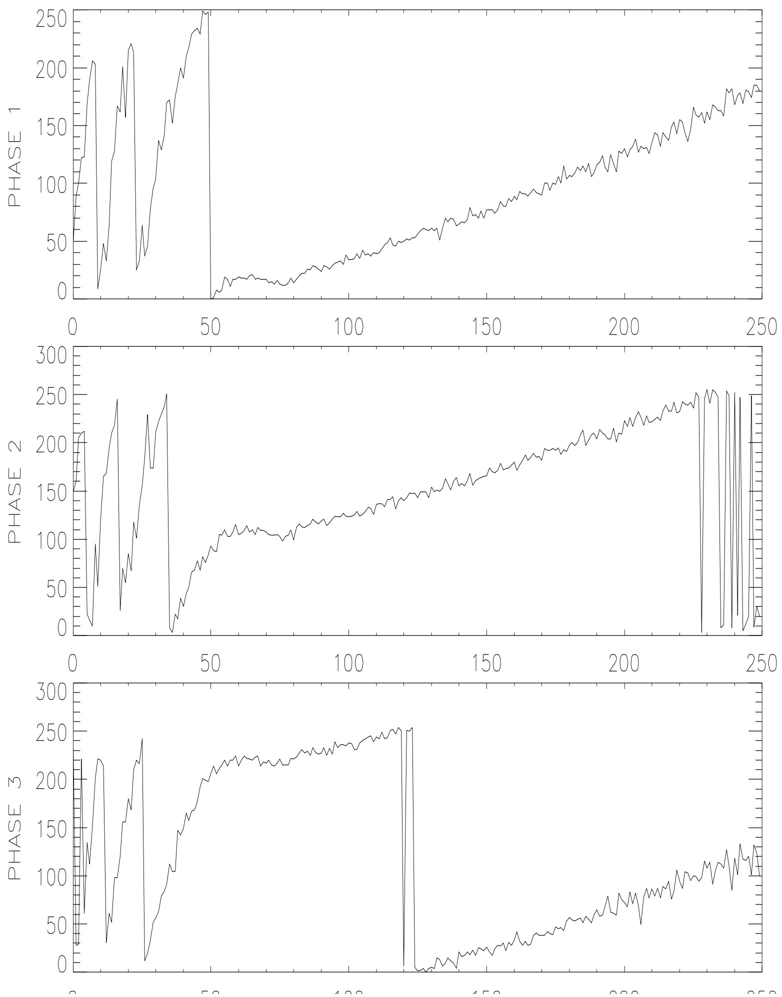
Radar pulses

Echo amplitude



Radar pulses

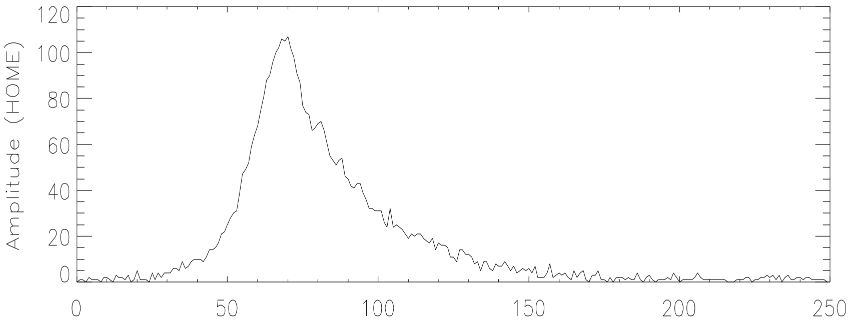
Echo Phases



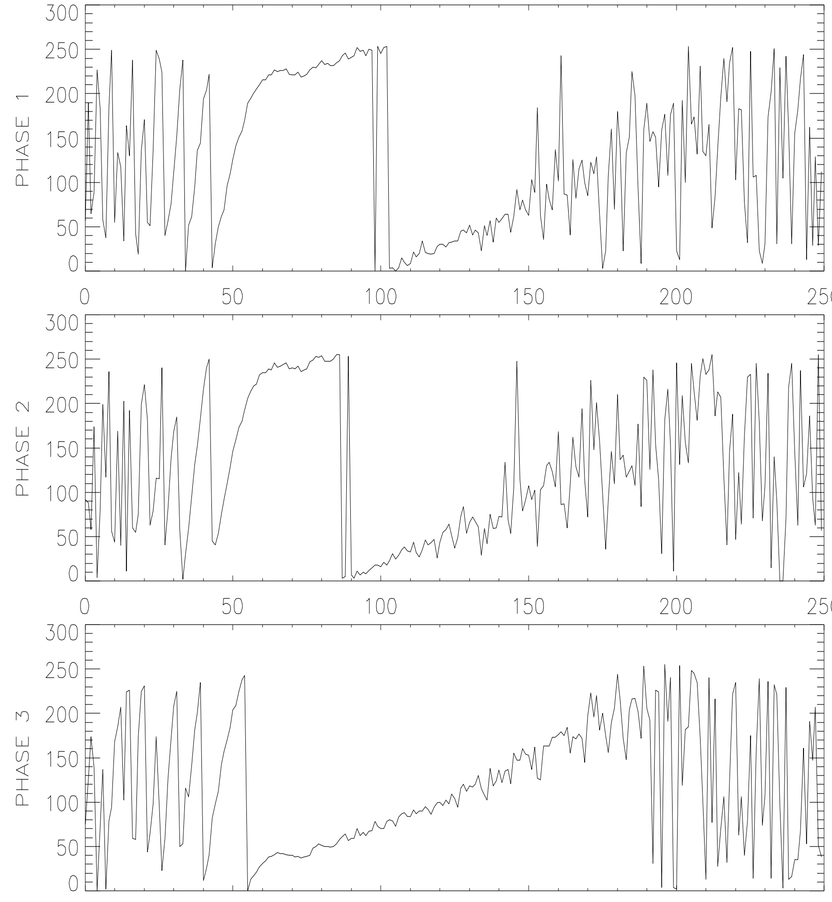
Phase increase with time-
Target approaching

Radar pulses

Echo amplitude



Echo Phases

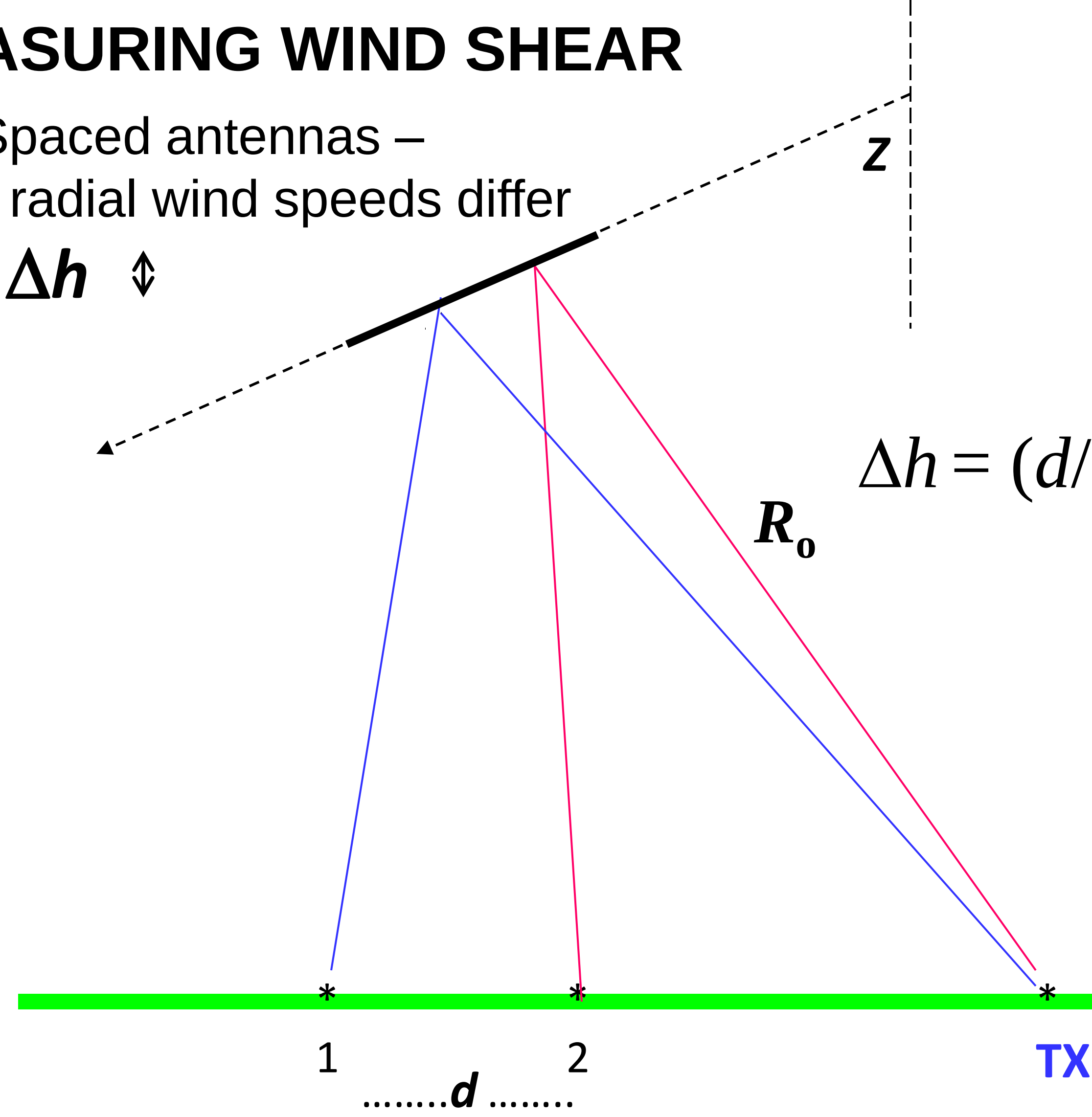


Phase increase with time- Target approaching

Radar pulses

MEASURING WIND SHEAR

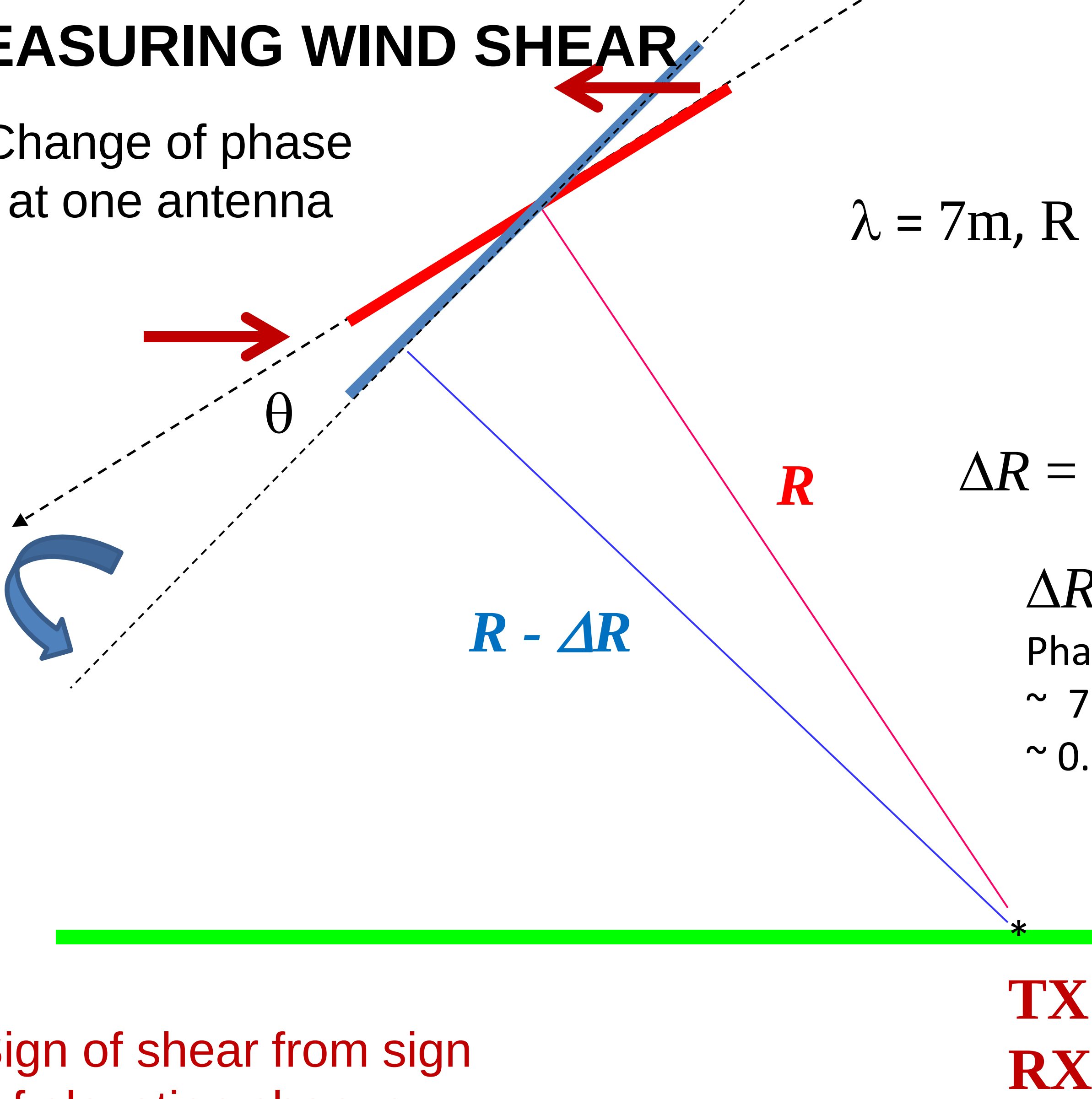
1. Spaced antennas –
   radial wind speeds differ



$$\Delta h = (d/2).\sin Z.\cos Z$$

MEASURING WIND SHEAR

2. Change of phase
at one antenna



$$\Delta R = 0.5\, R\, \theta^{2}$$

$$\theta \sim S \sin Z$$

$$\lambda = 7\text{m},\ R \sim 200\ \text{km},\ Z \sim 60^{o}$$

$$S \sim 1\ \text{ms}^{-1}\ \text{km}^{-1}$$

$$\Delta R = 0.5\ 200\ 10^{3}\ (10^{-3})^{2}\ .\ 0.8$$

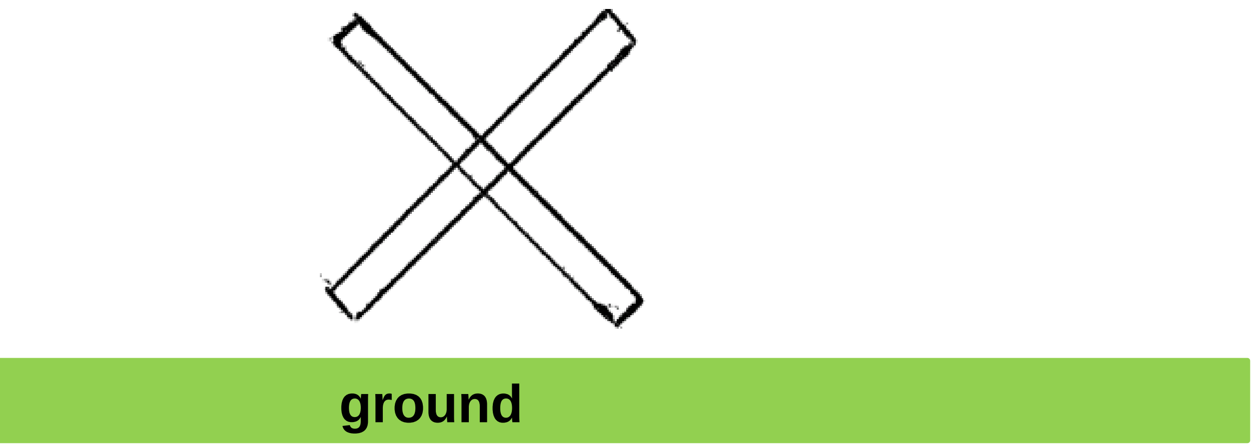
$$\Delta R \sim 0.1\ \text{m s}^{-1}$$

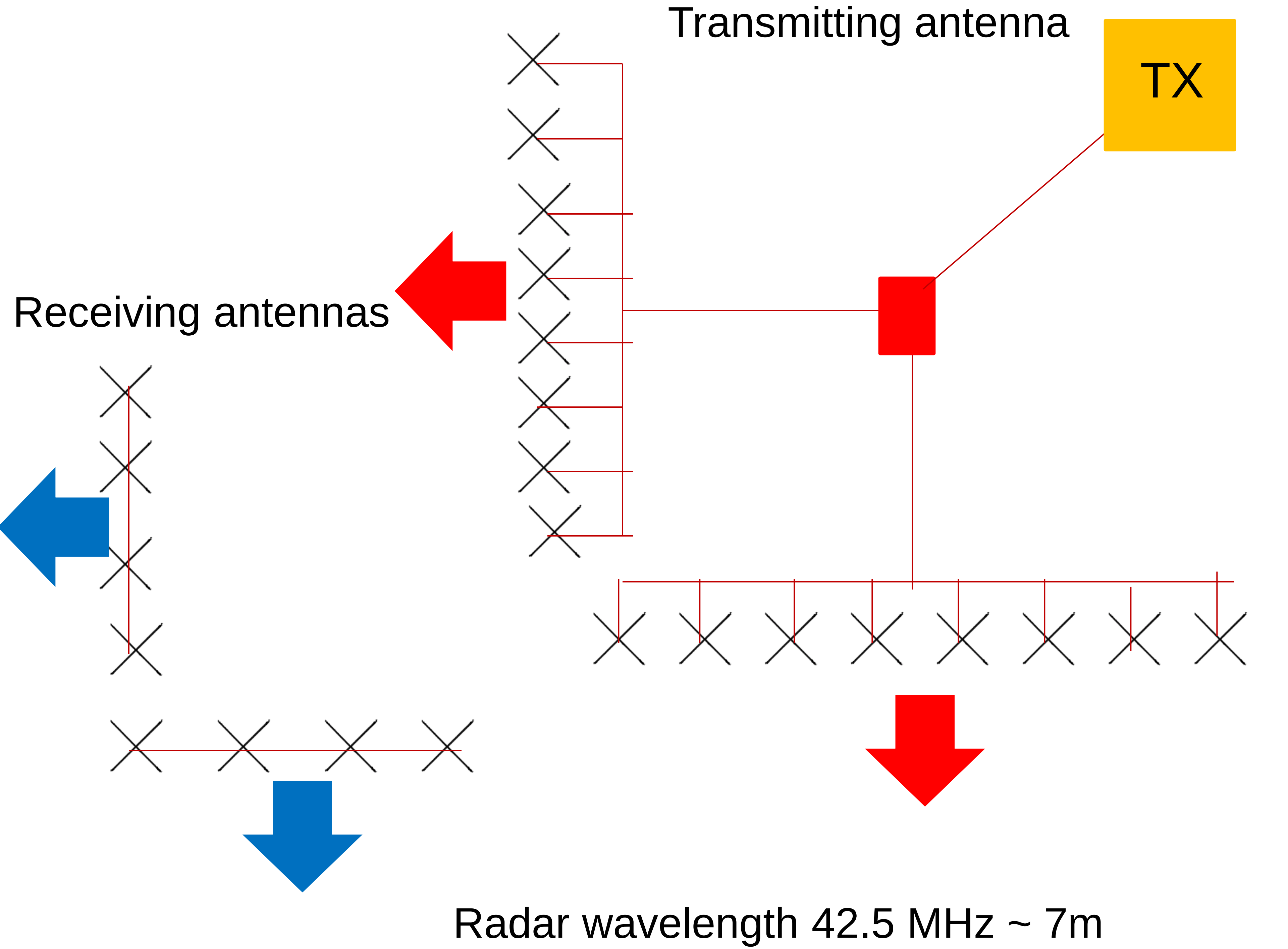
Phase change twice this
~ 7 deg per second
~ 0.018 degrees per radar pulse

Sign of shear from sign
of elevation change

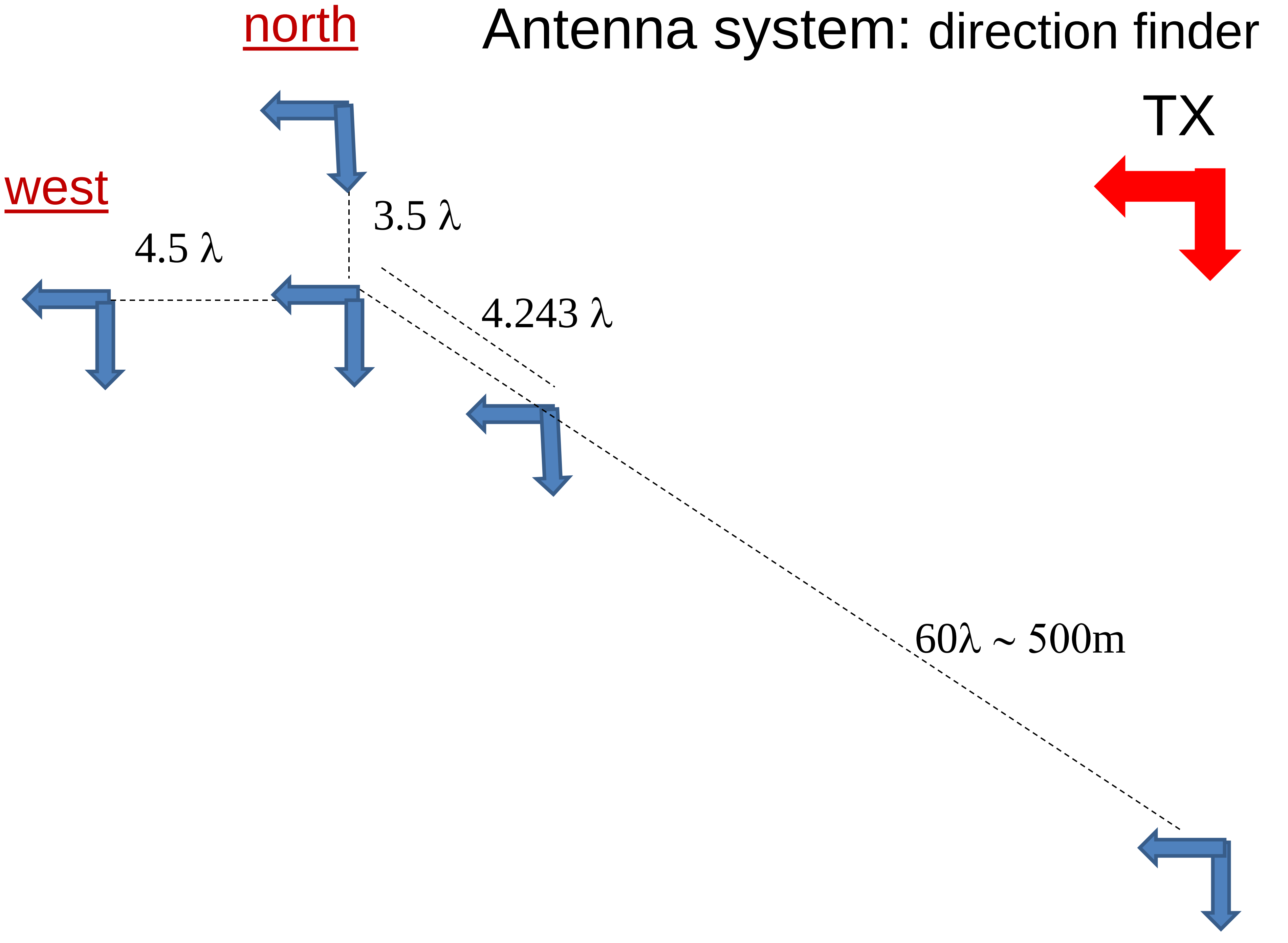
System **uses** **Circular Polarisation** – reduces any effects of plasma resonance distorting the phase record

Each element:
crossed dipole with reflector and
fed via λ/4 phase section




Transmitting antenna
TX
Receiving antennas
Radar wavelength 42.5 MHz ~ 7m

Antenna system: direction finder



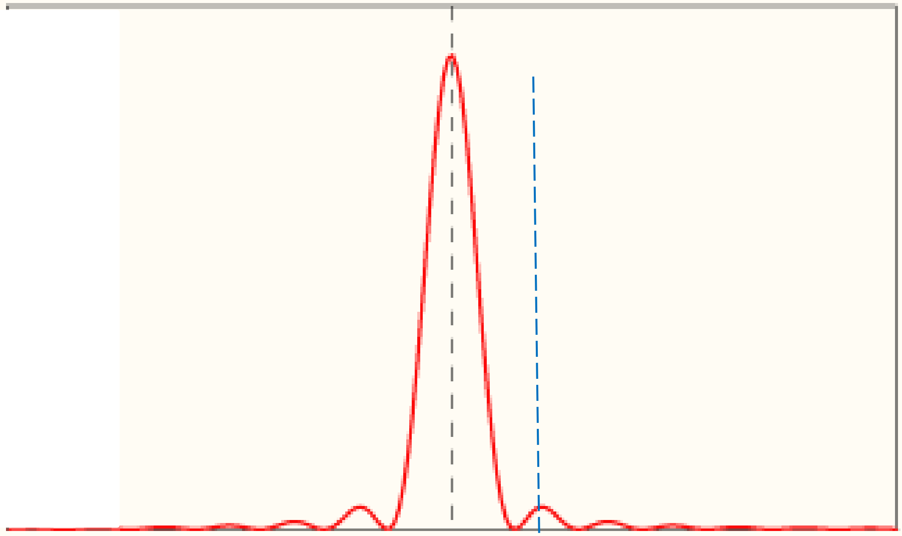
View looking east from height ~300m

View looking south from height~ 100m

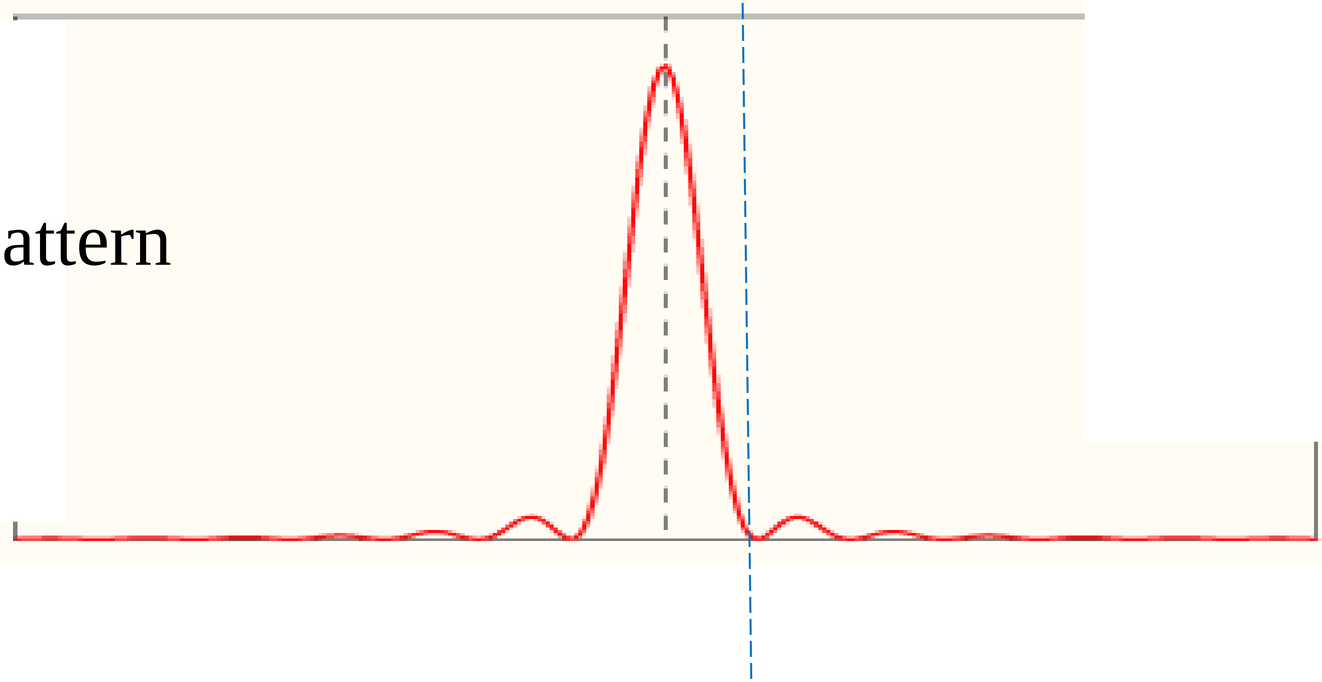
View looking south from ~ 200m

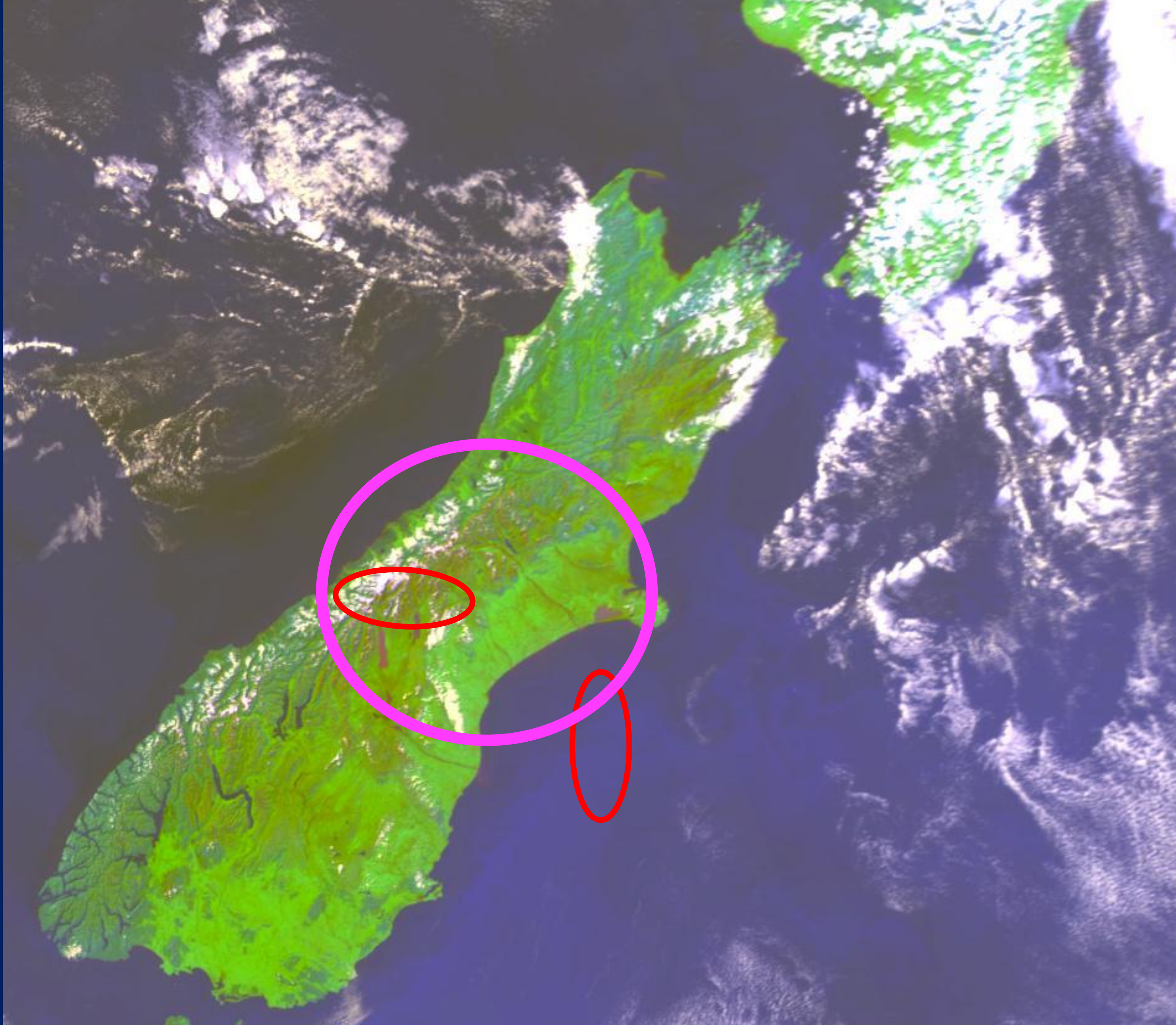
Patterns reduce side-lobes

TX pattern



RX pattern






Multi-wavelength All-Sky Imager
Steve Smith Bo
Fabry-Perot Interferometer

All-Sky Imager fish-eye lens and dome.

All-Sky Imager fish-eye lens and dome.

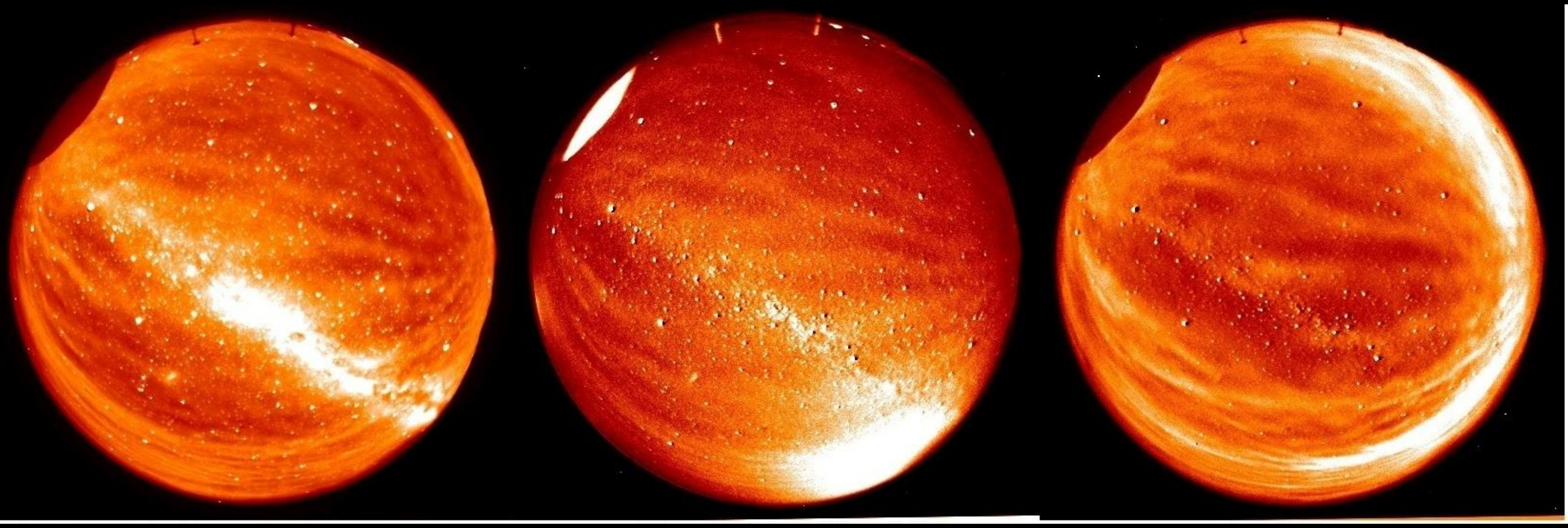
Two periscopes of FPI background

Multi-wavelength All-Sky Imager:

OH	800 nm	87 km
O (^1S)	577 nm	96
Na (^2S)	589 nm	90
O (^1D)	630 nm	250

All-Sky sampling
Provides: patterns of emission ~ 0.1 deg'
Horizontal speeds ;
accurate positions

Mount John four band spectral Imager



OH Na OI

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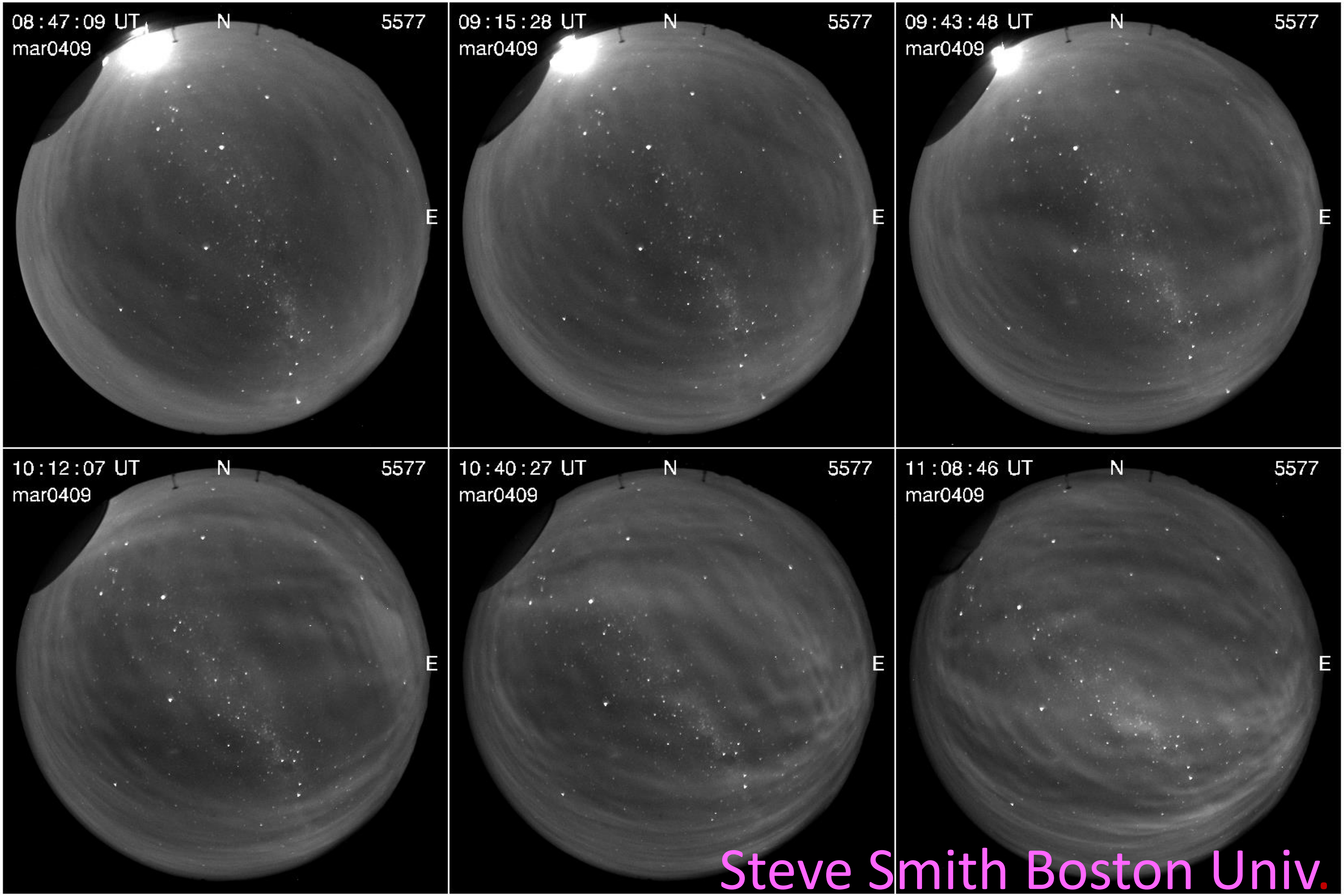
Mount John All-Sky 557.7 nm O ^{1}S



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Maps of wave structure at heights ~ 95 km

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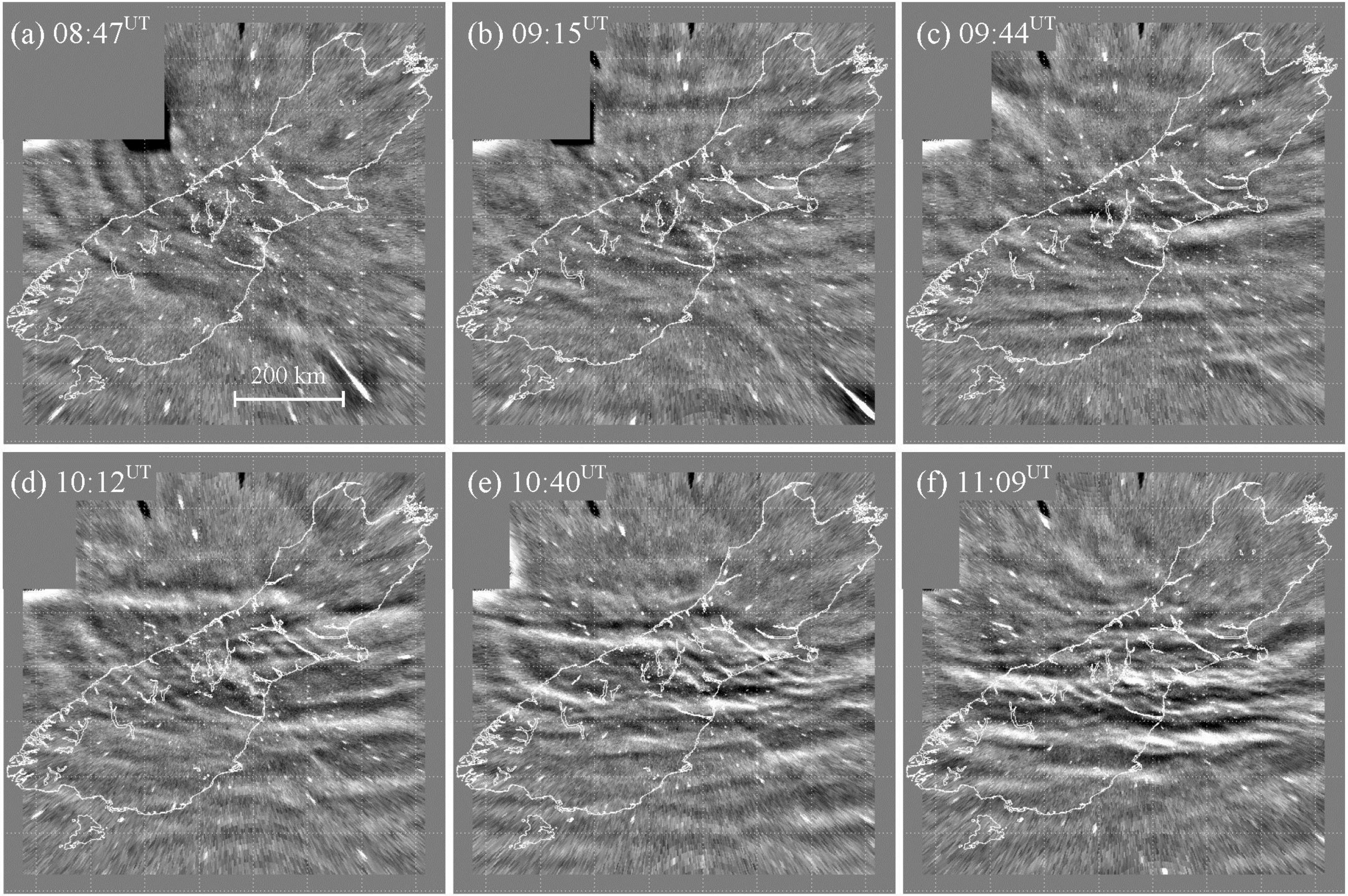

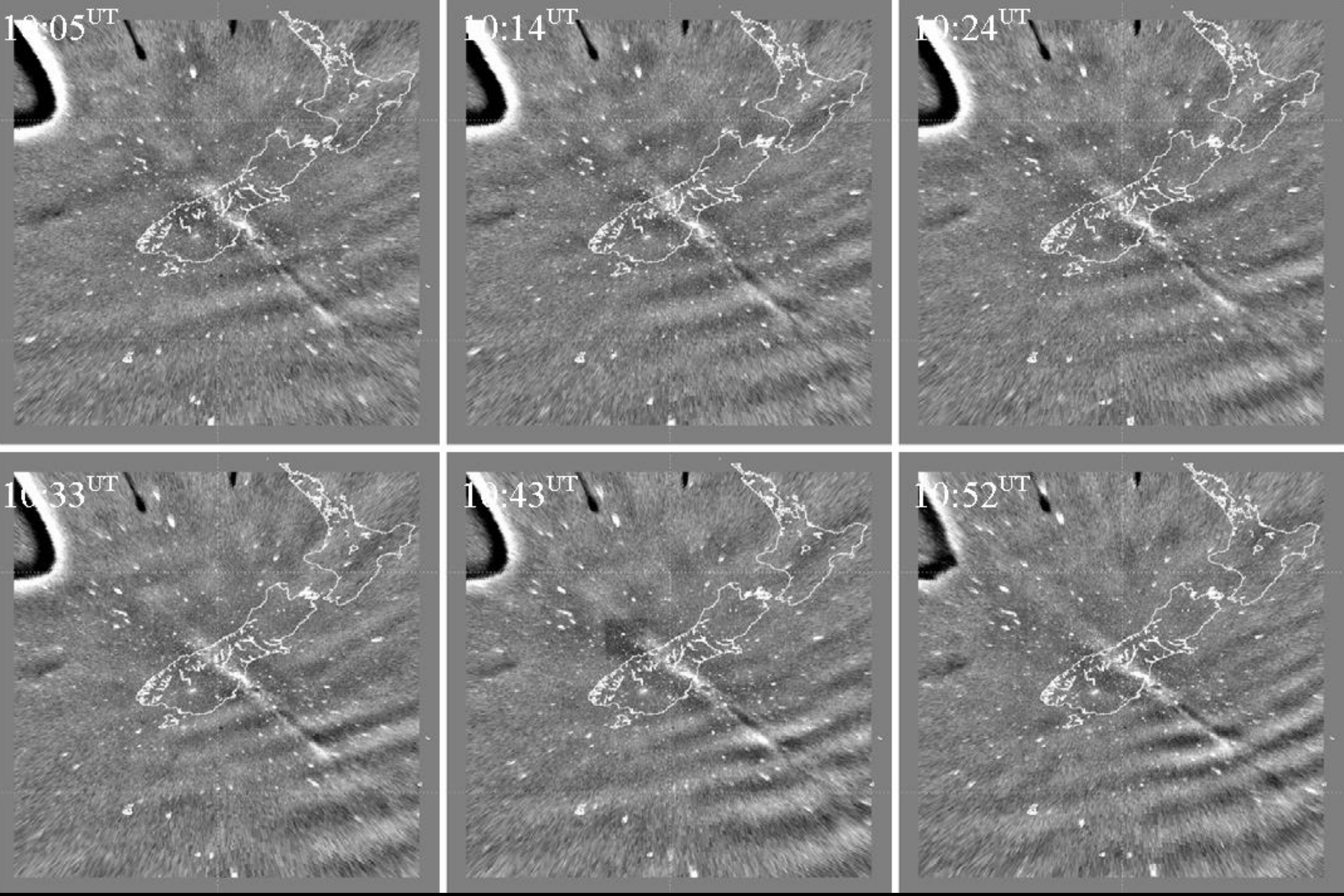

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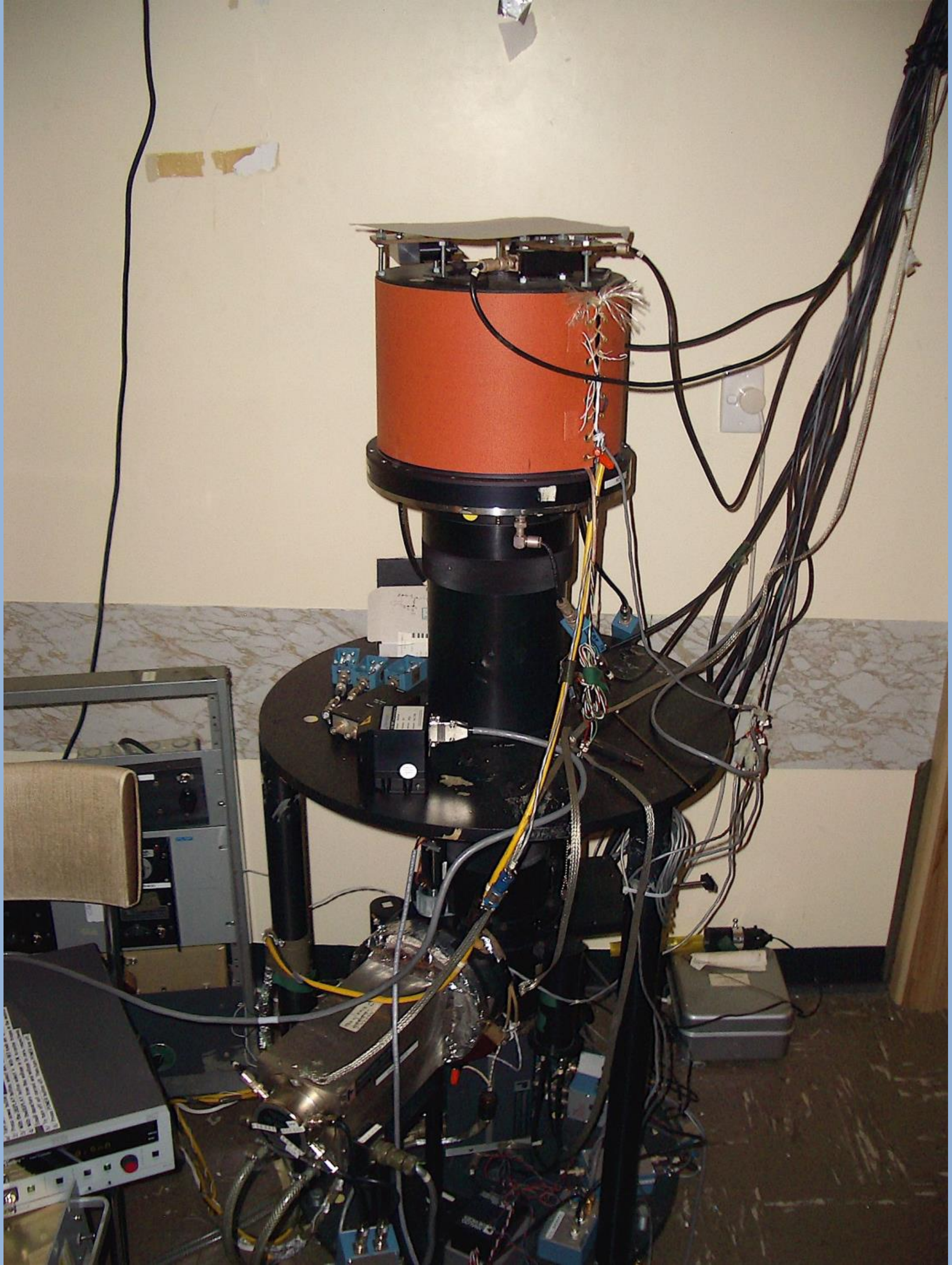
Fabry-Perot Interferometer:

OH 800 nm 87 km
O_2 860 nm 94
O (^1S) 577 nm
O (1D) 630 nm

Samples N, E, S, W at ~ 20 degrees and zenith ;
 approx positions
Provides - Horizontal speeds and temperatures;

FPI



Support for DeepWave

Adrian McDonald, University of Canterbury

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

- SNOW WEB deployment in Southern Alps.
- CL51 Ceilometer deployment in Southern Alps or Canterbury Plains.
- Hosting radiosonde receiver station on Rutherford building.
- Support for balloon launching (some financial commitment will be required if this is needed significantly).
- Potential office space if required.

SNOW WEB: Hardware development

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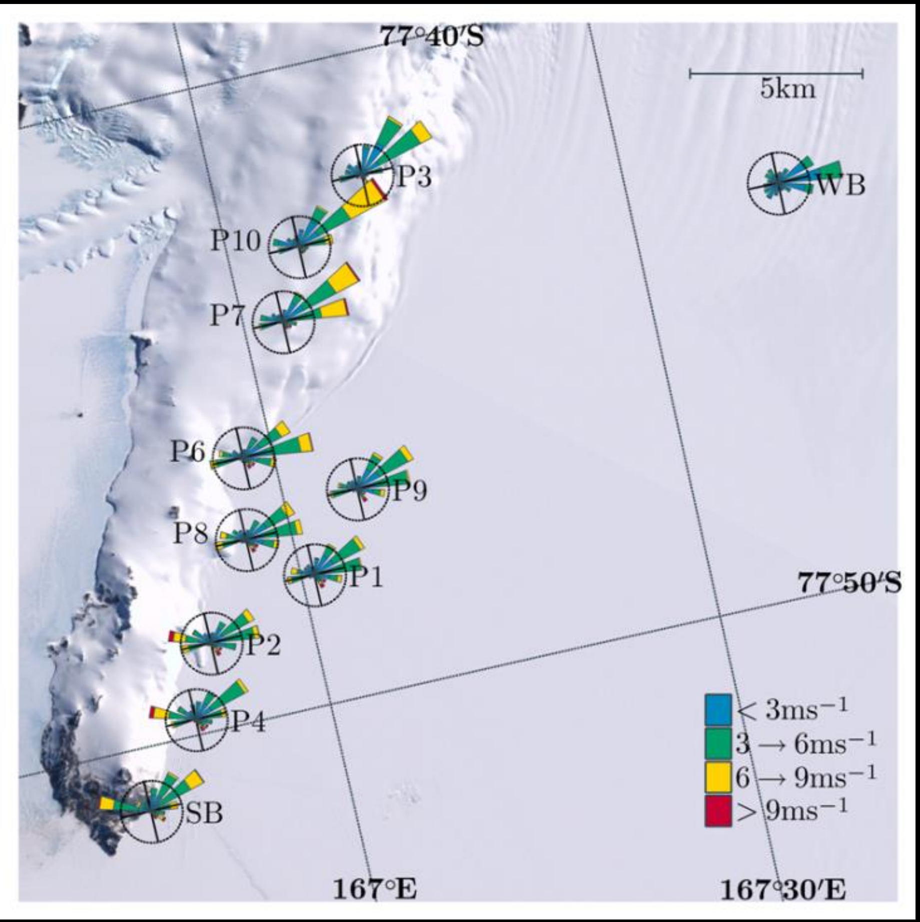
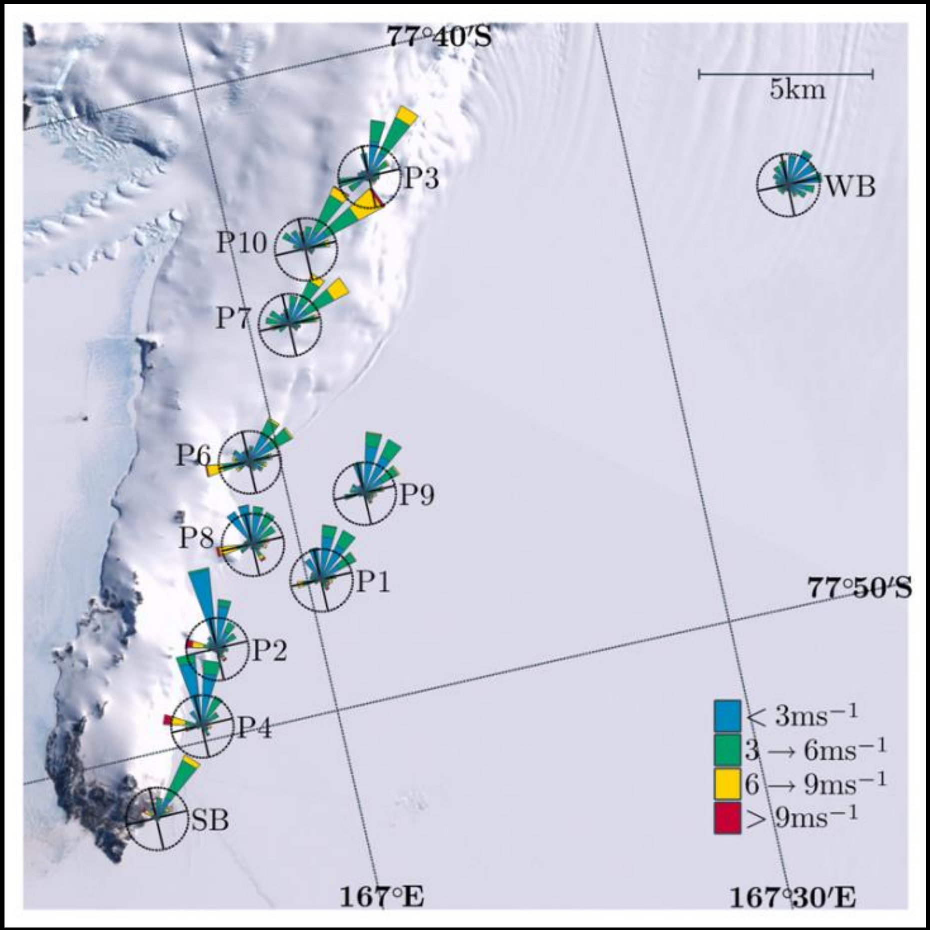
Our capability in hardware development has allowed us to develop an expandable Zigbee-enabled environmental monitoring system.

SNOW WEB allows the possibility of rapidly expanding the density of observations of atmospheric (wind velocity, temperature, pressure and humidity) and cryospheric (ice velocity and snow depth) properties over broad regions.

SNOW WEB: Model Validation





model

observations

Mesoscale model output (left) and SNOW WEB observations in Antarctica from the 2011/2012 deployment show the model misrepresents the impact of topography on the flow.

SNOW WEB: A Movie

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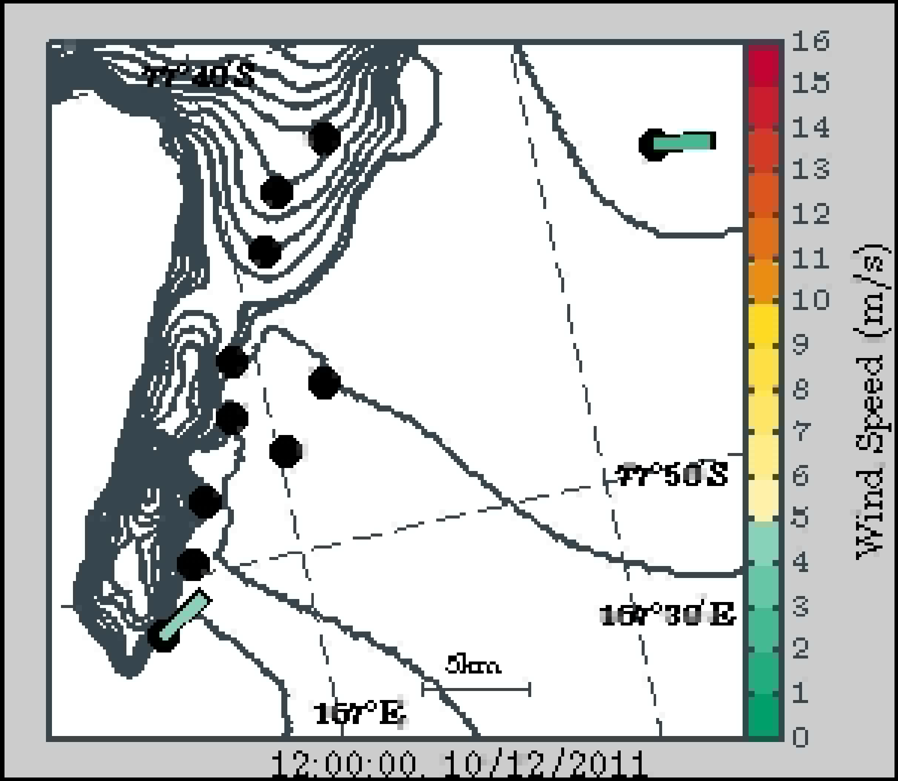
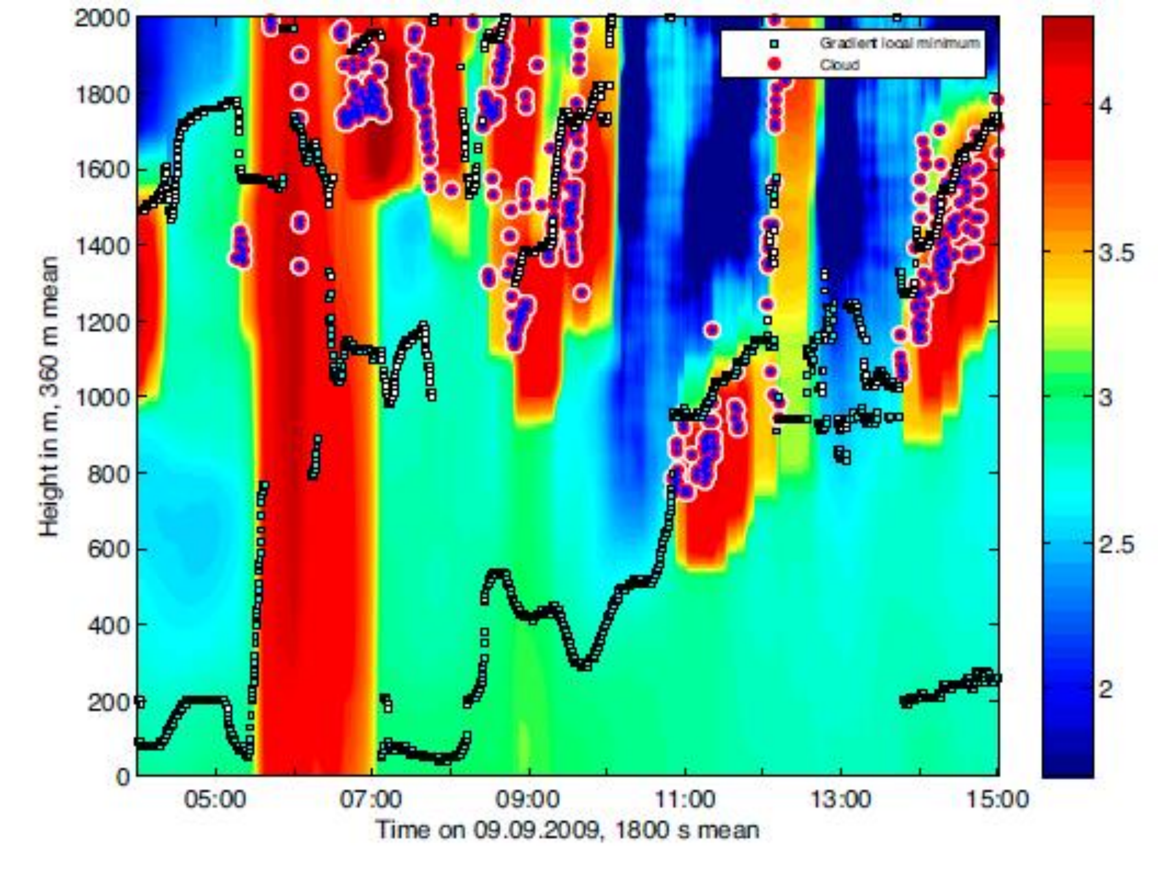
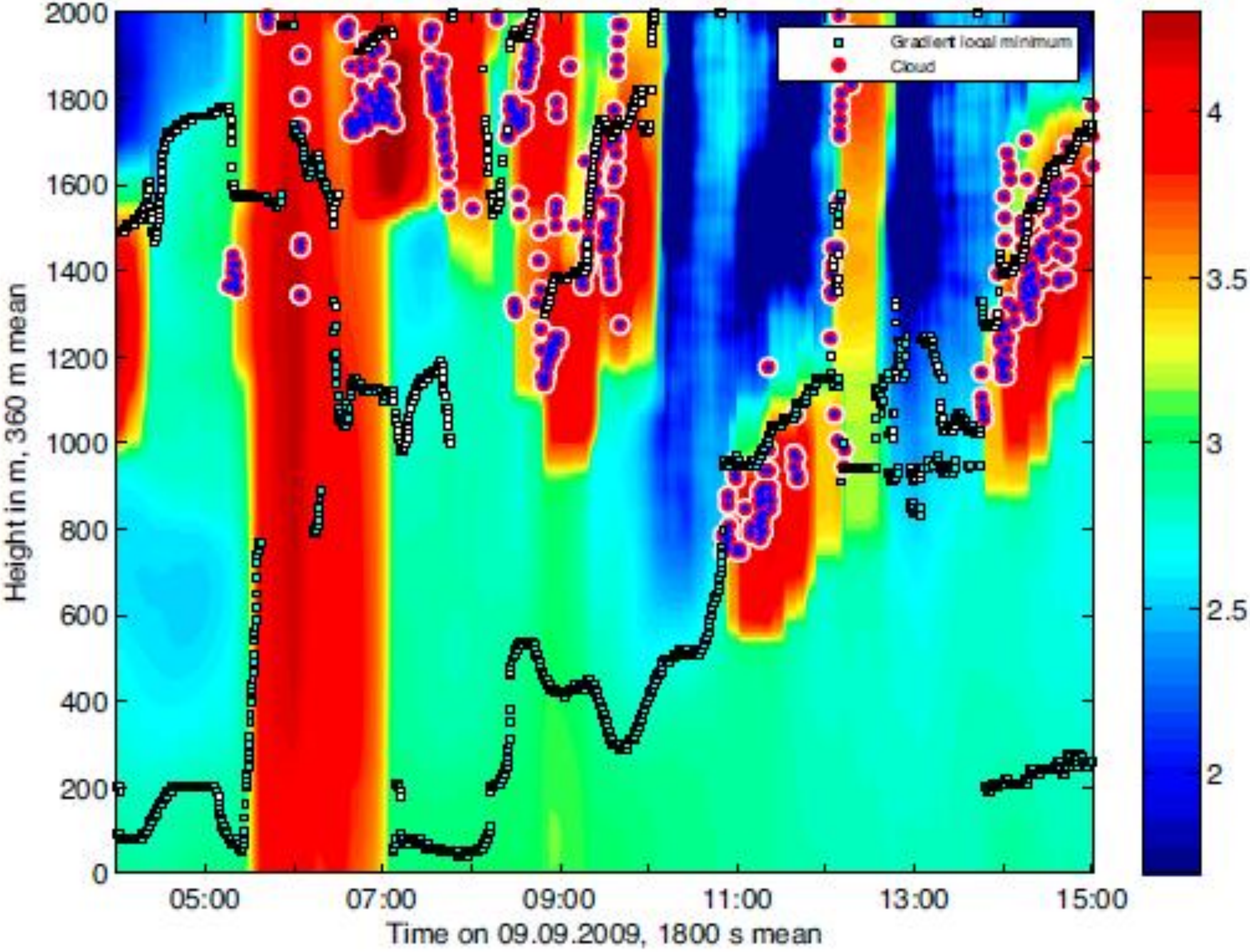


CL51 Vaisala Ceilometer

CL51 Vaisla Ceilomter can be used to examine cloud and boundary layer heights by examining backscatter.





Gradient local minimum
Cloud
Height in m, 360 m mean
Time on 09.09.2009, 1800 s mean
2000
1800
1600
1400
1200
1000
800
600
400
200
0
05:00
07:00
09:00
11:00
13:00
15:00
4
3.5
3
2.5
2