



PERÚ

Ministerio  
del Ambiente

Instituto  
Geofísico del Perú

Radio  
Observatorio de Jicamarca

# Wind retrieval obtained from simultaneous 30 MHz and 50 MHz JASMET (Jicamarca All-Sky METeor radar) Observations

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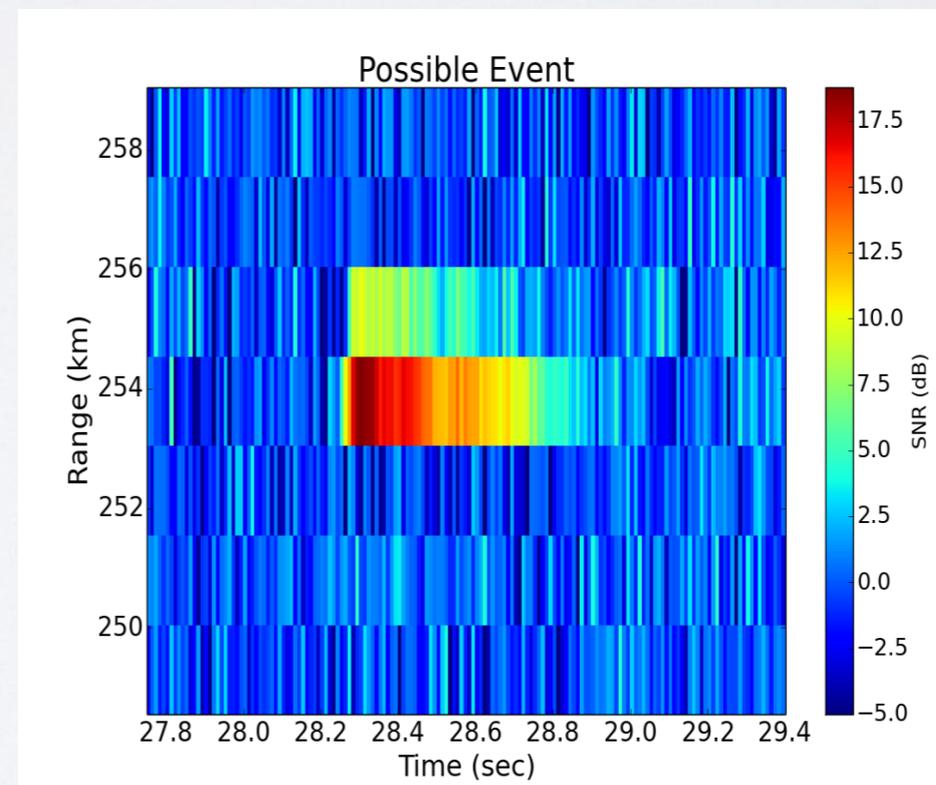
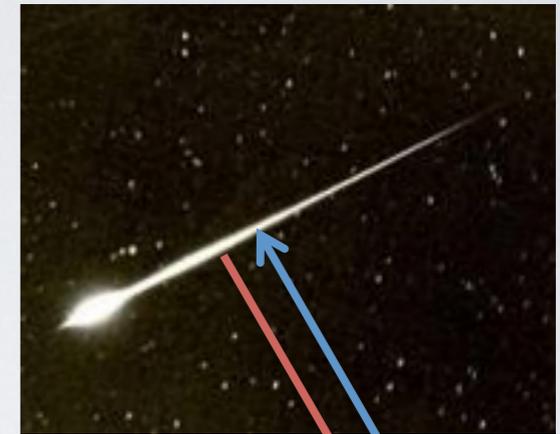
<sup>2</sup>Stanford University, California, USA

# Motivation & background

- Monitor MLT dynamics through winds, which are important for gravity waves, atmospheric tides, sporadic E, climate models.
- Meteoroids create a plasma column when they collide with atmospheric molecules, which reflect radio waves.
- JASMET 50 MHz was installed at Jicamarca in 2006, but it does not operate continuously but only on special campaigns.
- JASMET 30 MHz was installed at Jicamarca in 2013 for testing before moving it to its final location at the Huancayo Observatory - HUA (approx. 290 km from Jicamarca in the Peruvian Andes 3336 m.a.s.l.) where it will be fully operational.

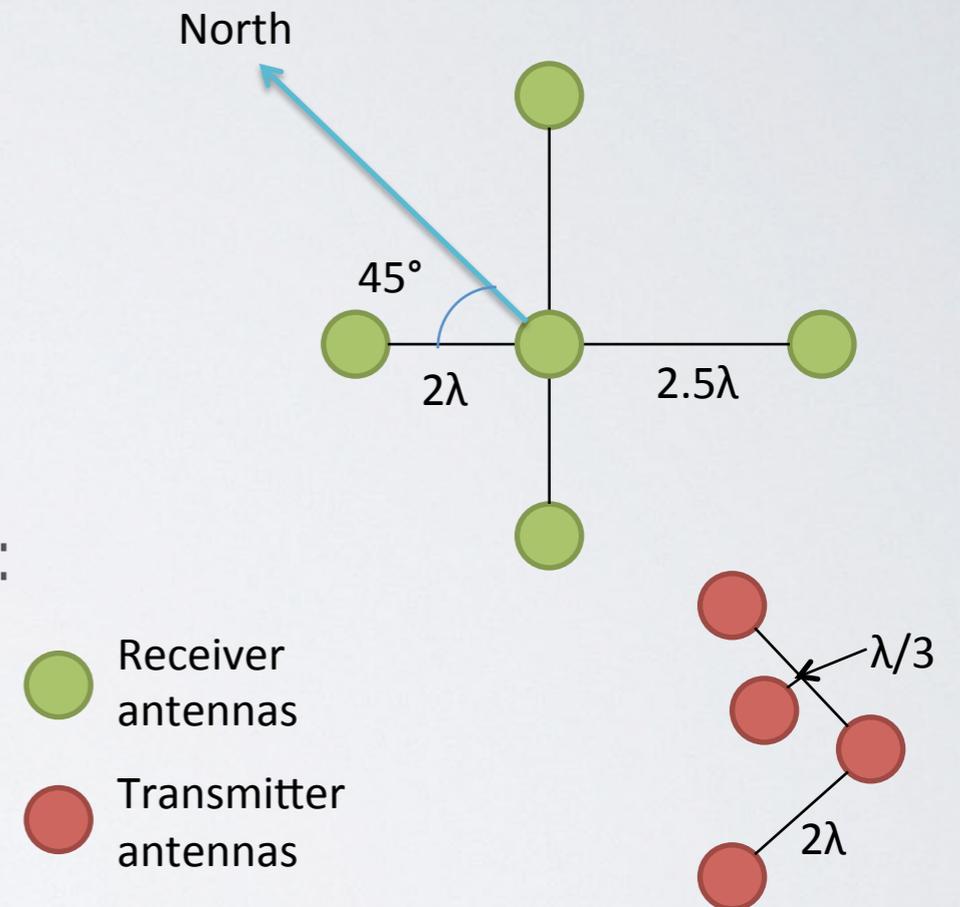
# Specular meteors

- Specular condition: Only meteoroids traveling perpendicular to the radar beam will be detected
- Doppler shift must be independent of meteor velocity
  - We can measure winds!



# Jicamarca All-Sky METeor (JASMET) Radar: Experiment Setup

- 50MHz and 30MHz Jicamarca All-sky Meteor (JASMET) collocated radars
- 4 Tx Yagi antennas pointing in each cardinal direction,  $45^\circ$  off zenith, 20kW peak power
- 5 receiving two-element folded dipole antennas:
  - One center receiver
  - Four outer receivers spaced  $2\lambda$  and  $2.5\lambda$  from center receiver
- Receiver spacing allows for accurate and precise angle of arrival measurements



$$50 \text{ MHz} : \lambda = 6 \text{ m}$$

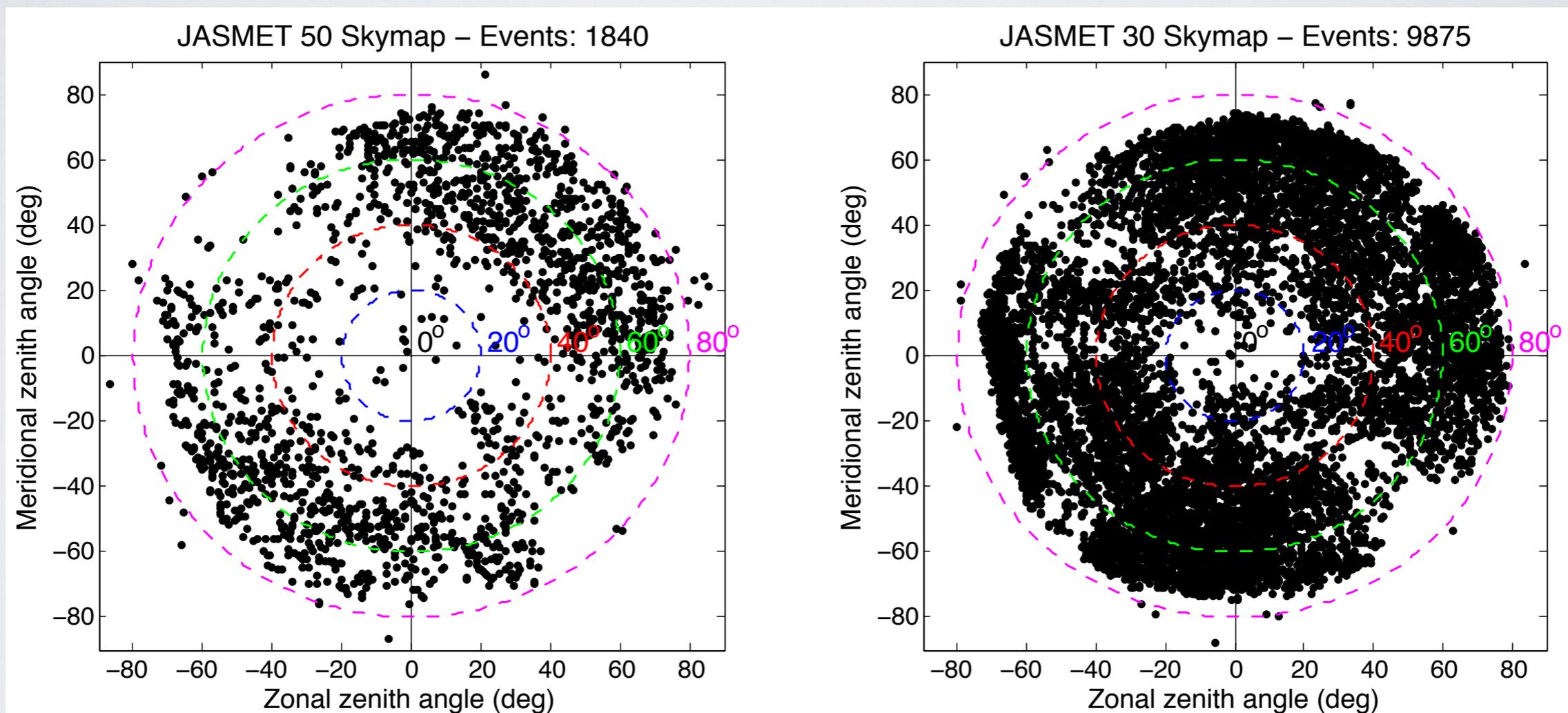
$$30 \text{ MHz} : \lambda = 10 \text{ m}$$

# JASMET Campaigns

- 3 campaigns with simultaneous JASMET 30 and JASMET 50 observations:
  - 20 - 22 August 2013: mainly over night
  - 29 - 31 October 2013: Validation: w/ mesospheric echoes measurements
  - 14 - 16 April 2014
- Processed following D. A. Holdsworth, I. M. Reid, and M. A. Cervera, Buckland Park all-sky interferometric meteor radar, Radio Sci. 39 (2004), RS5009.

# JASMET Campaigns

23 August 2013

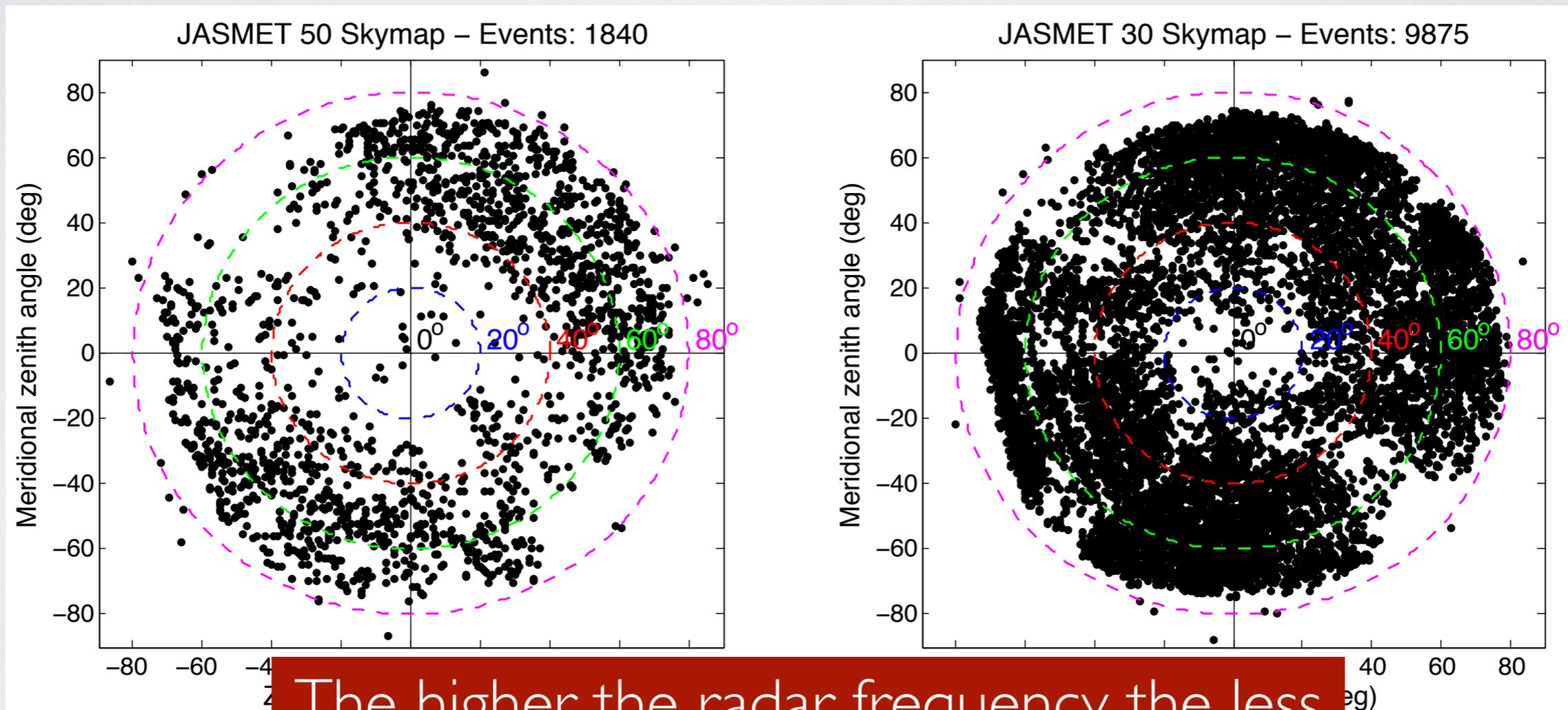


12 hours of data

~5 times more meteors

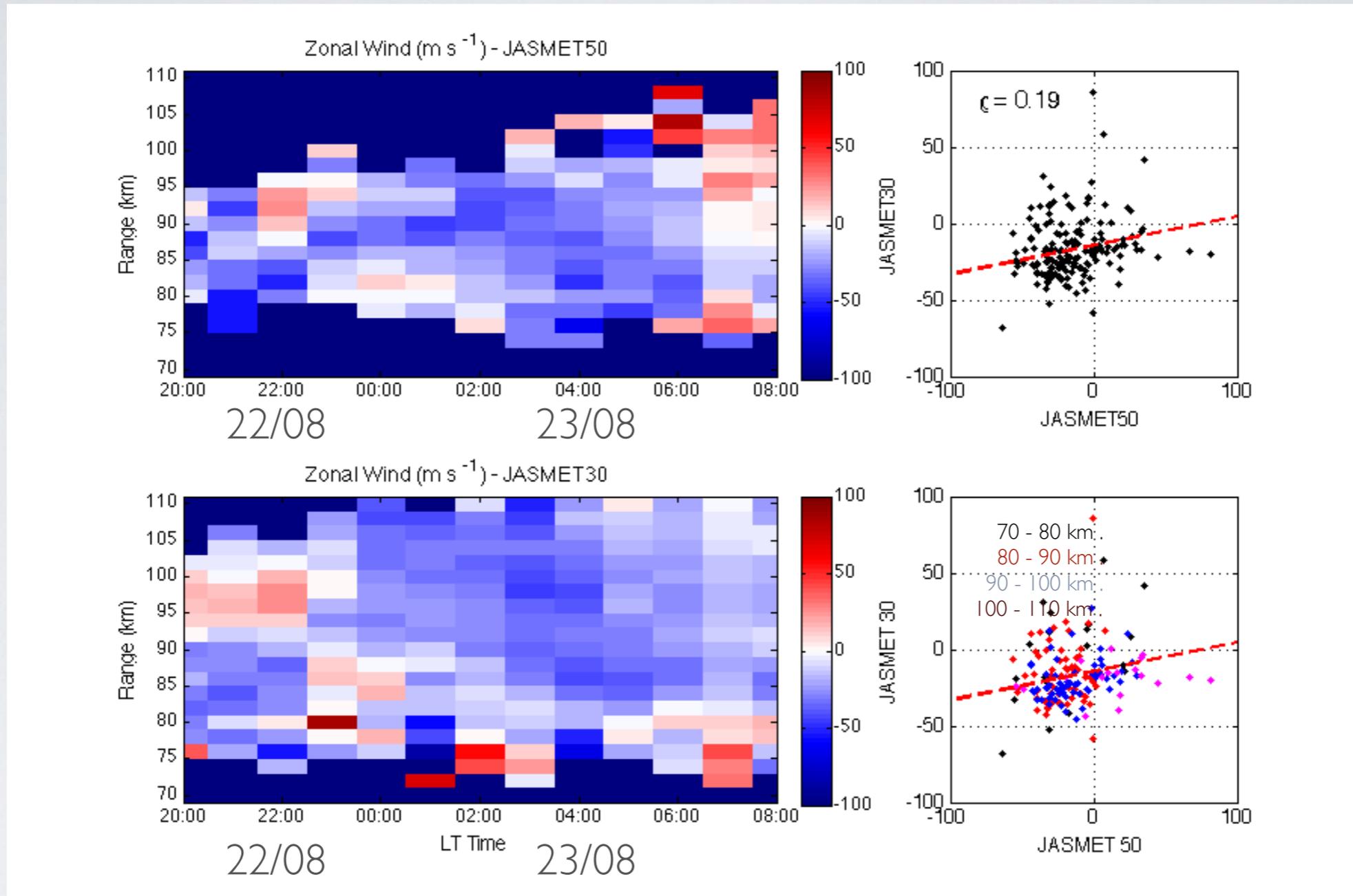
# JASMET Campaigns

23 August 2013



The higher the radar frequency, the less probability that meteors will be detected by the radar system.

22-23 August 2013

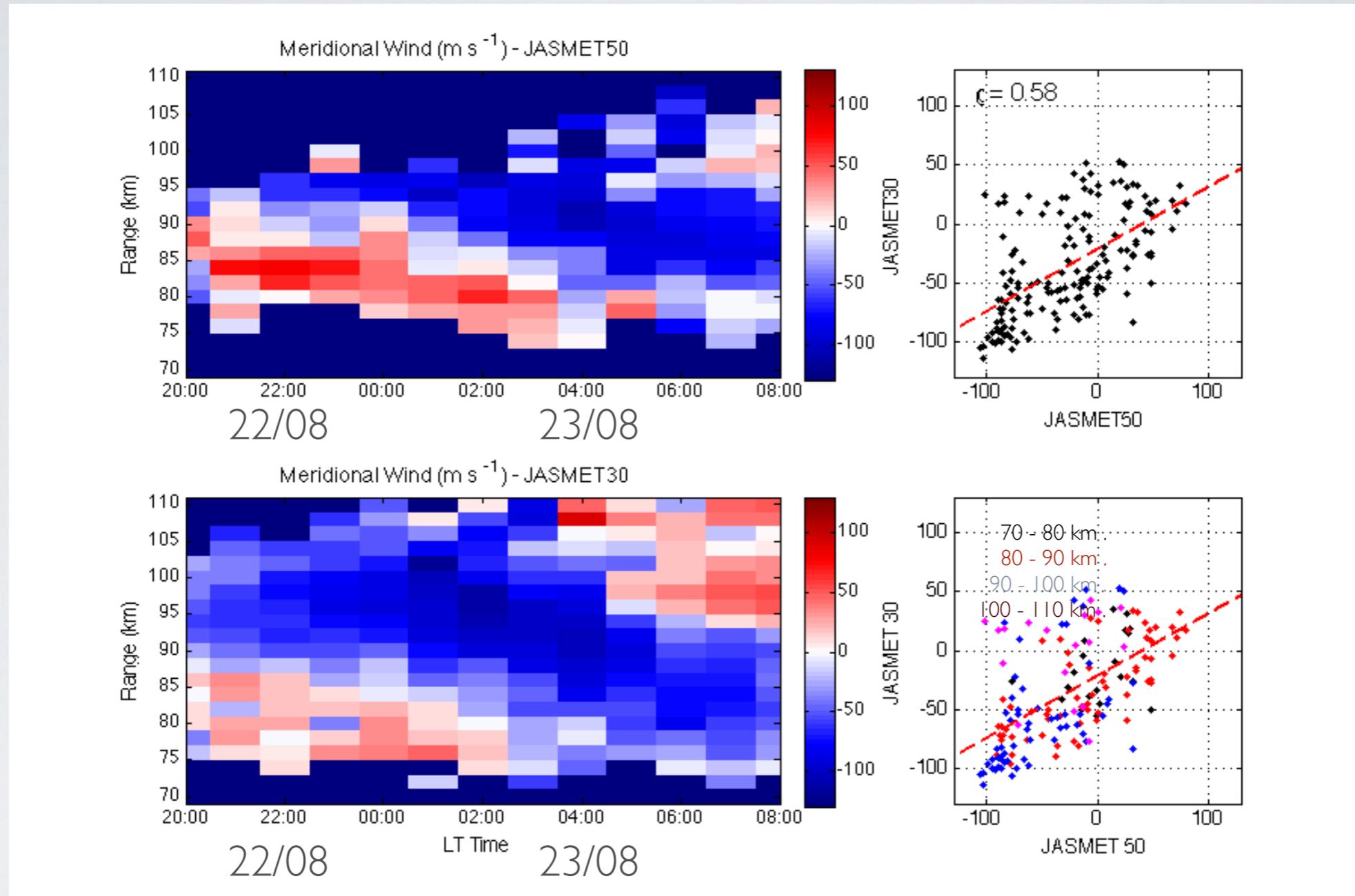


# Wind Estimates

Zonal (+E) Wind

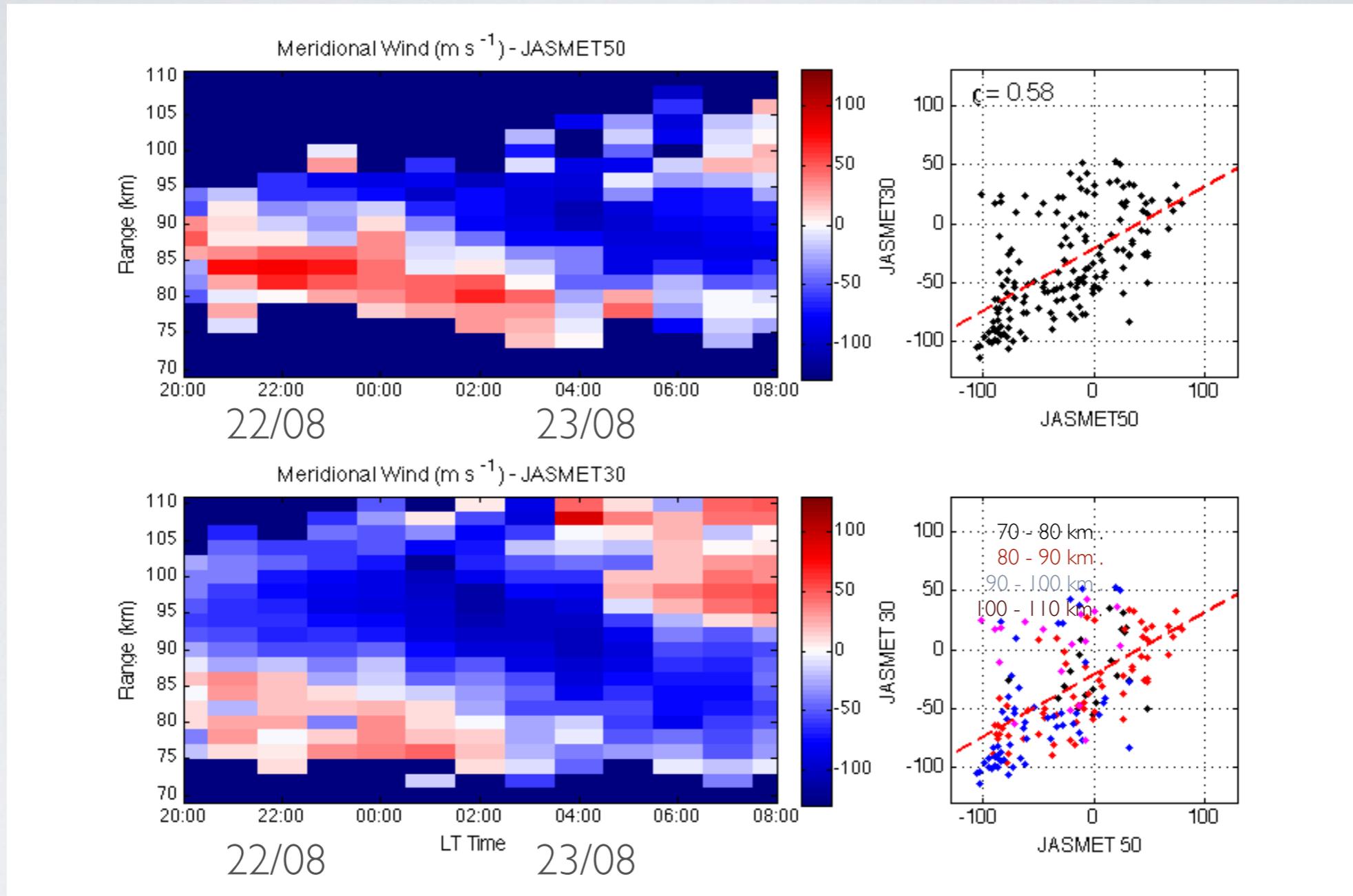


22-23 August 2013



# Wind Estimates

Meridional (+N) Wind

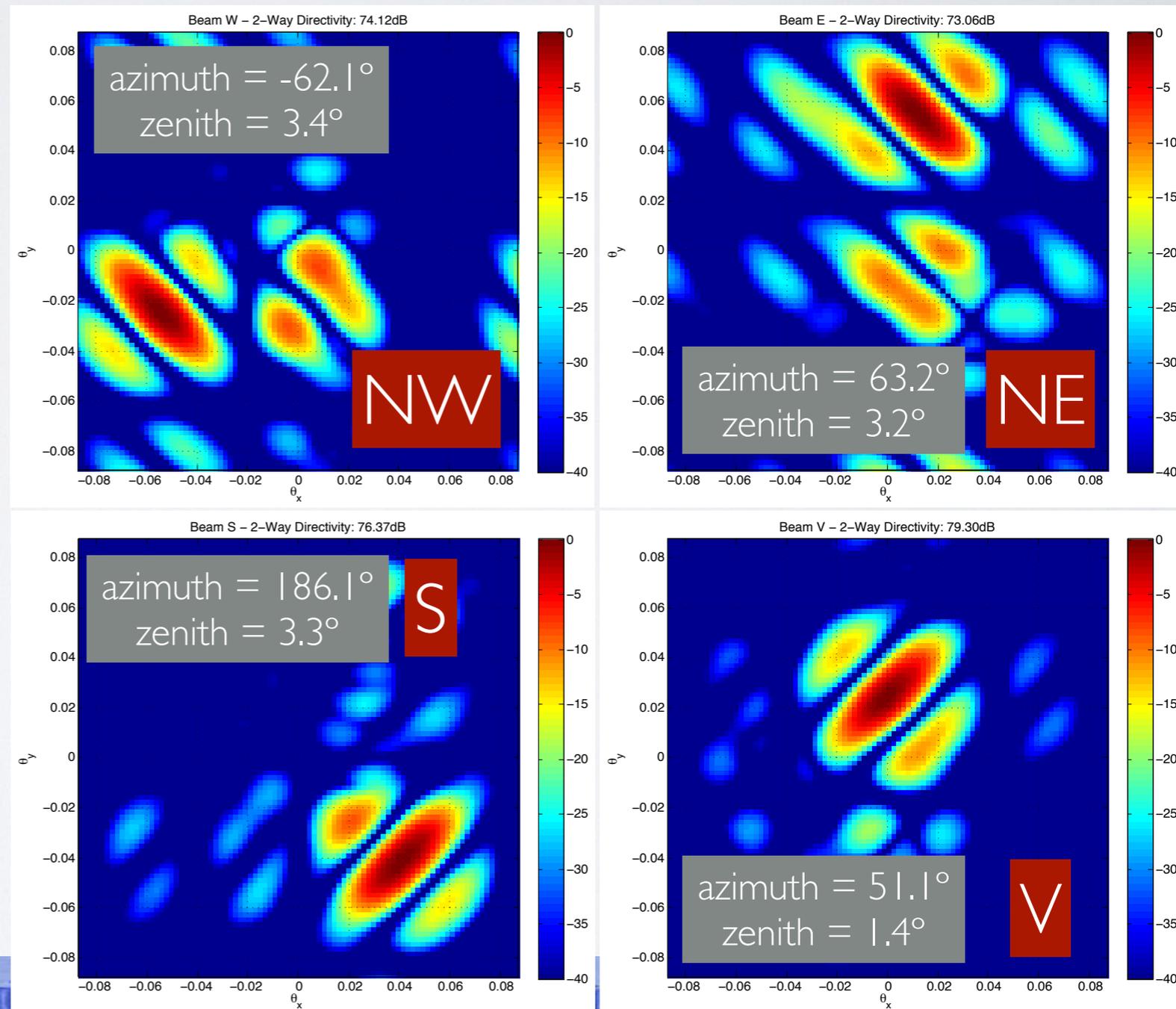


# Wind Estimates

Higher correlations can be obtained after correction of initial height

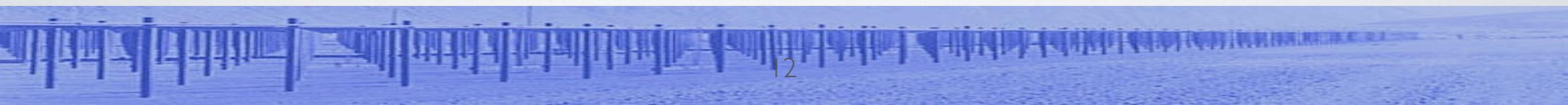
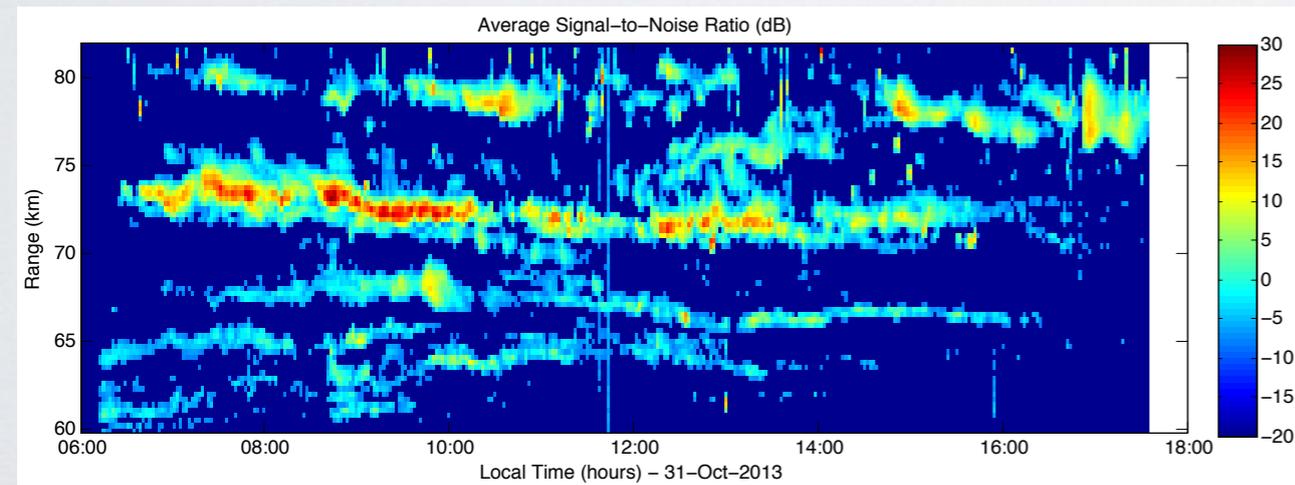
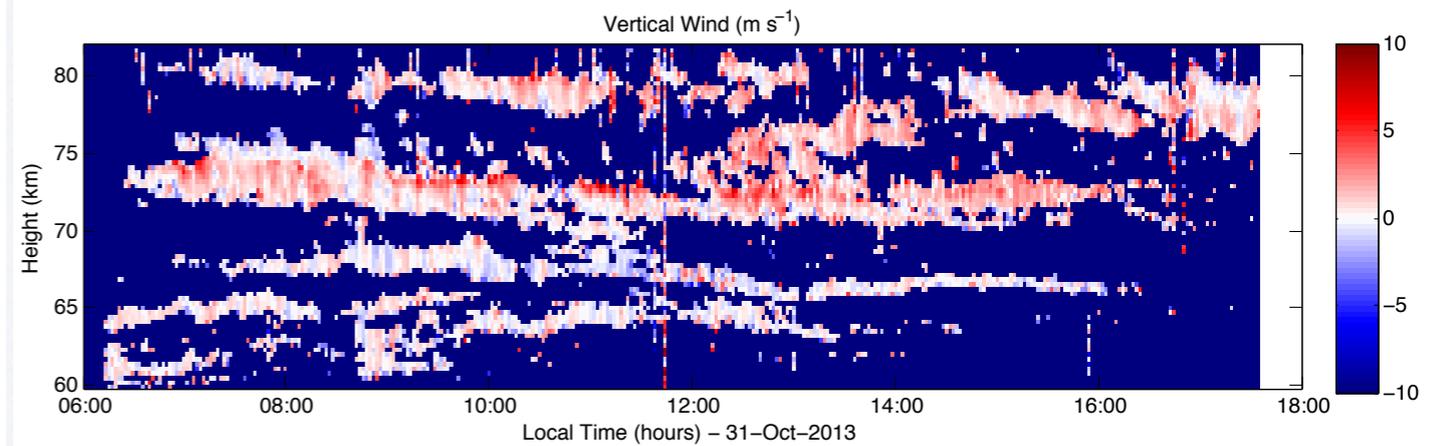
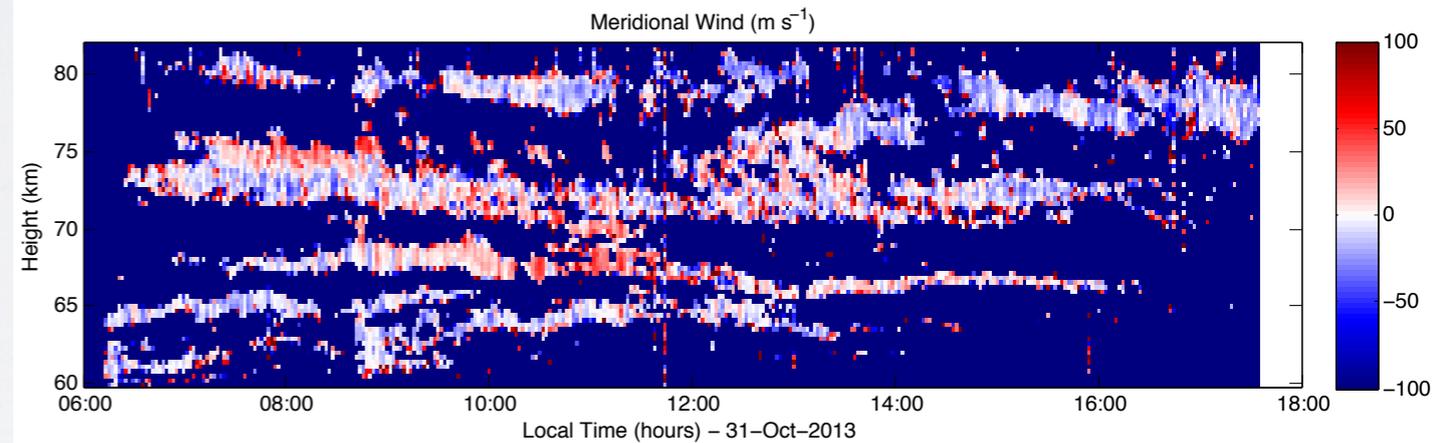
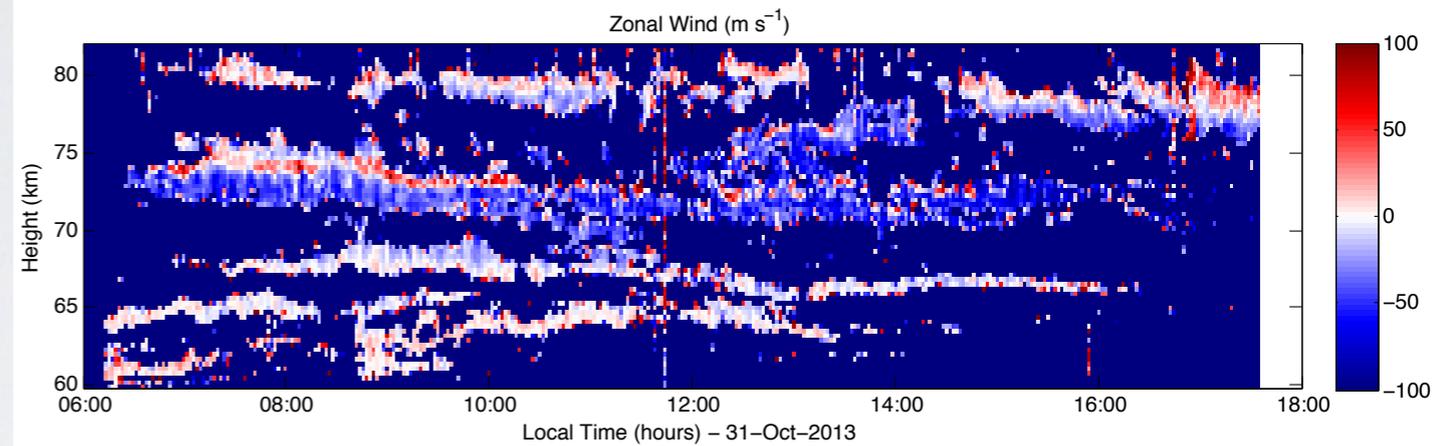
# Validation: Mesospheric winds experiment

- Measure daytime mesospheric echoes and compute mesospheric winds using Doppler beam swinging (DBS) technique
- 4 simultaneous beams: NW, NE, S, and V



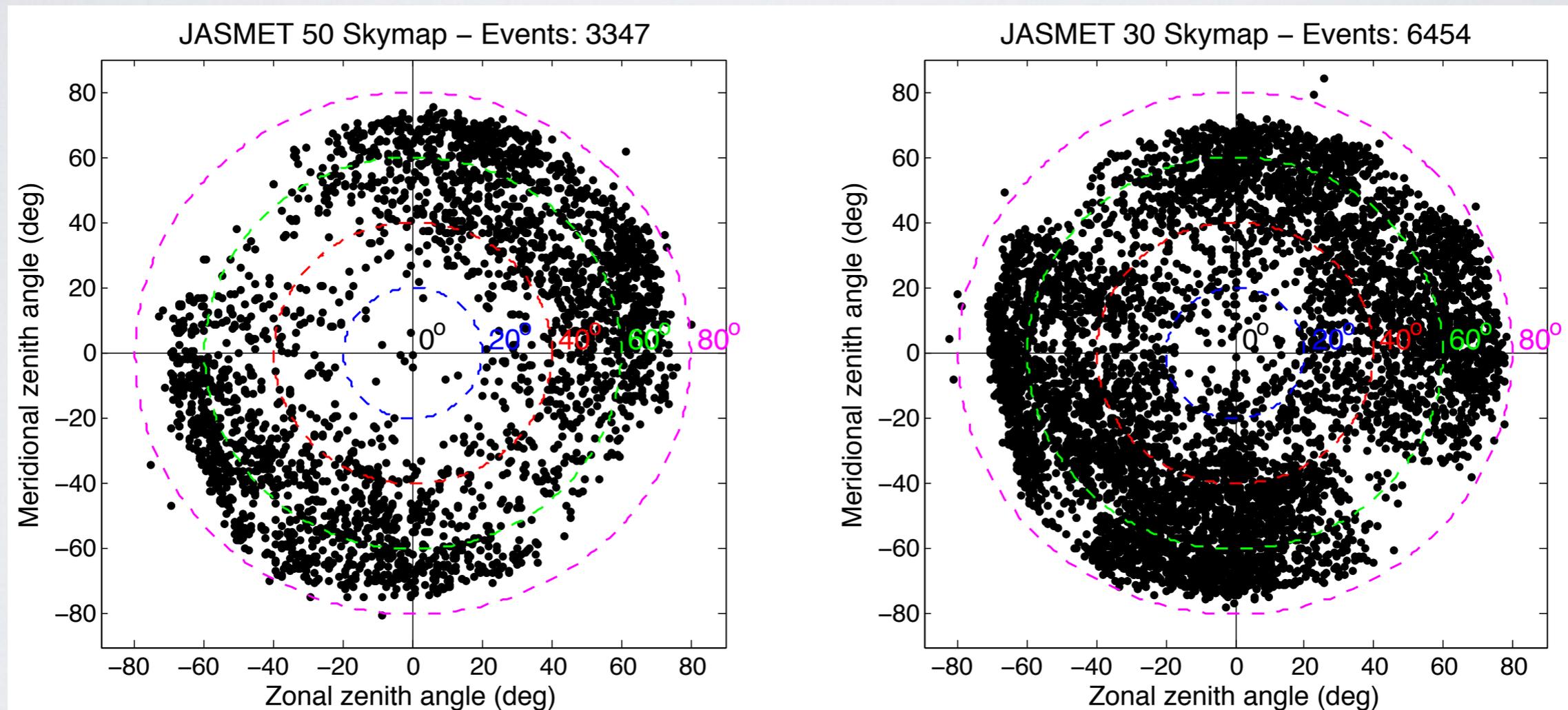
# Mesospheric winds calculations (MST Mode)

Daytime experiment:  
06:00 - 18:00 LT  
31 Oct 2013



# JASMET Campaigns

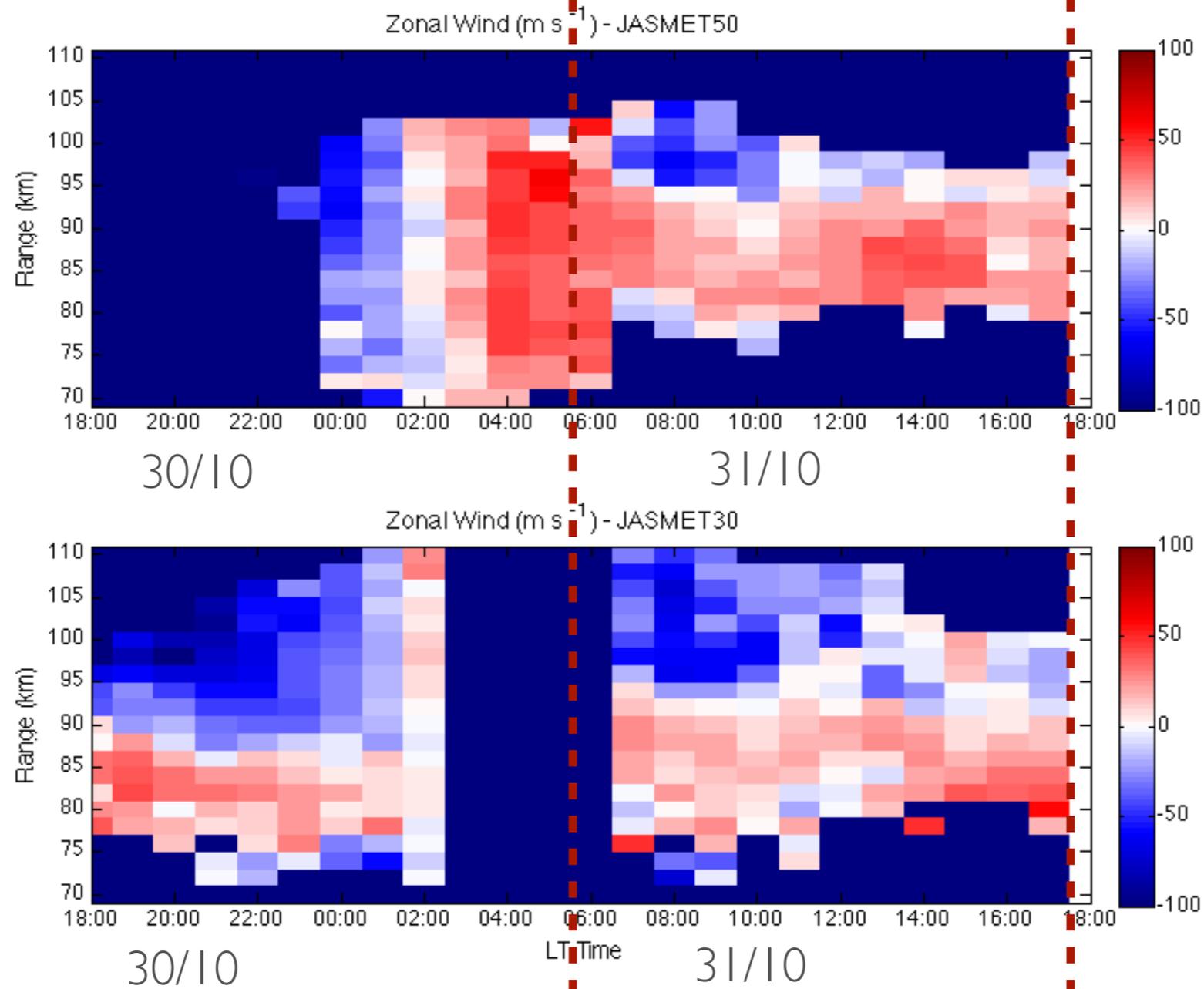
30-31 October 2013



18 hours of data

20 hours of data

30-31 October 2013

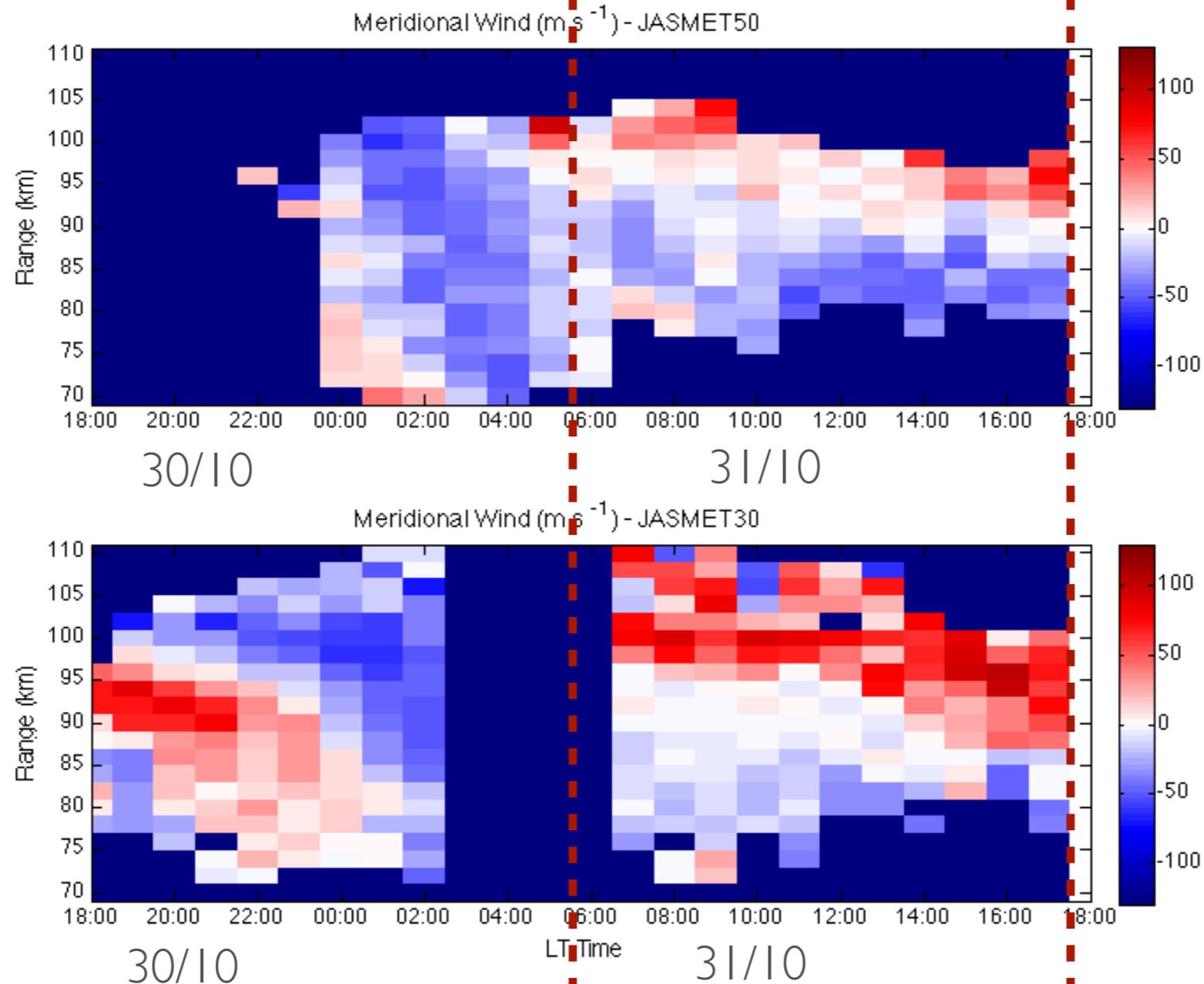


# Wind Estimates

Zonal (+E) Wind



15-16 April 2014



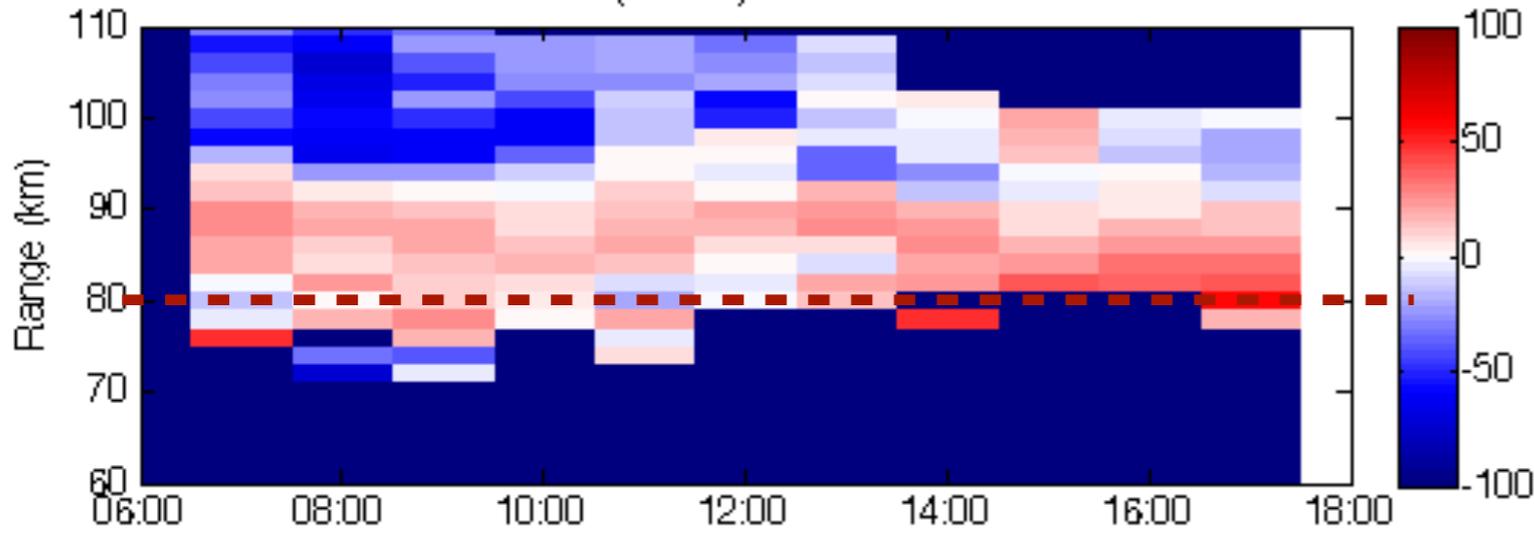
# Wind Estimates

Meridional (+N) Wind

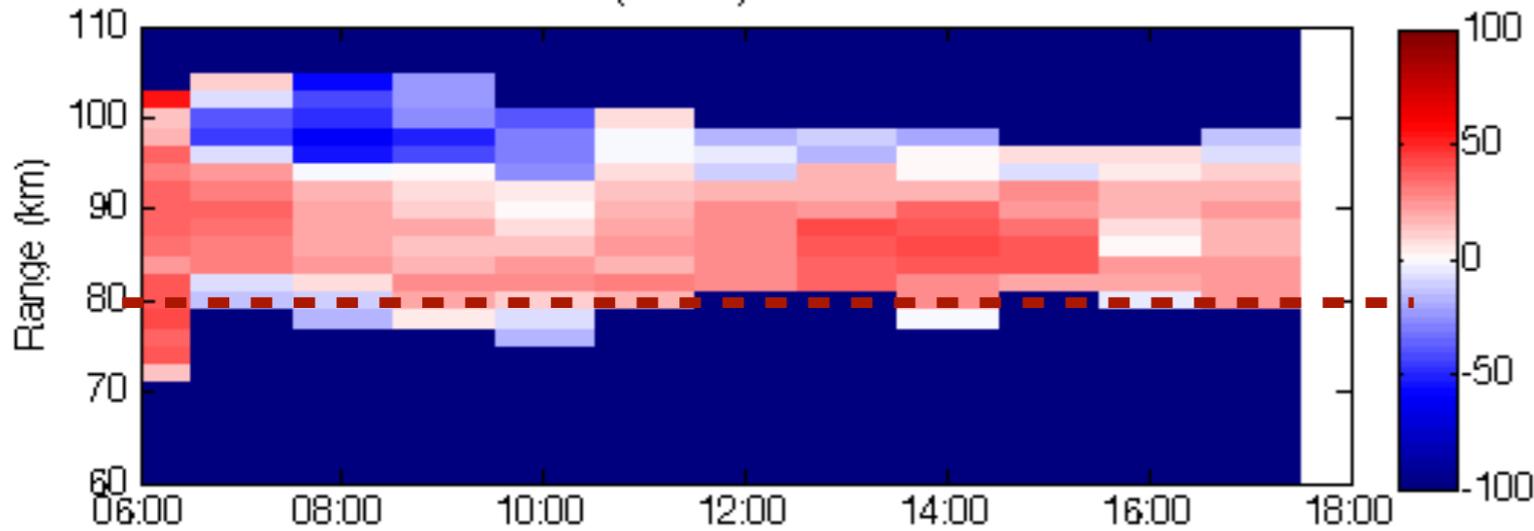


# Wind Estimates Zonal (+E) Wind

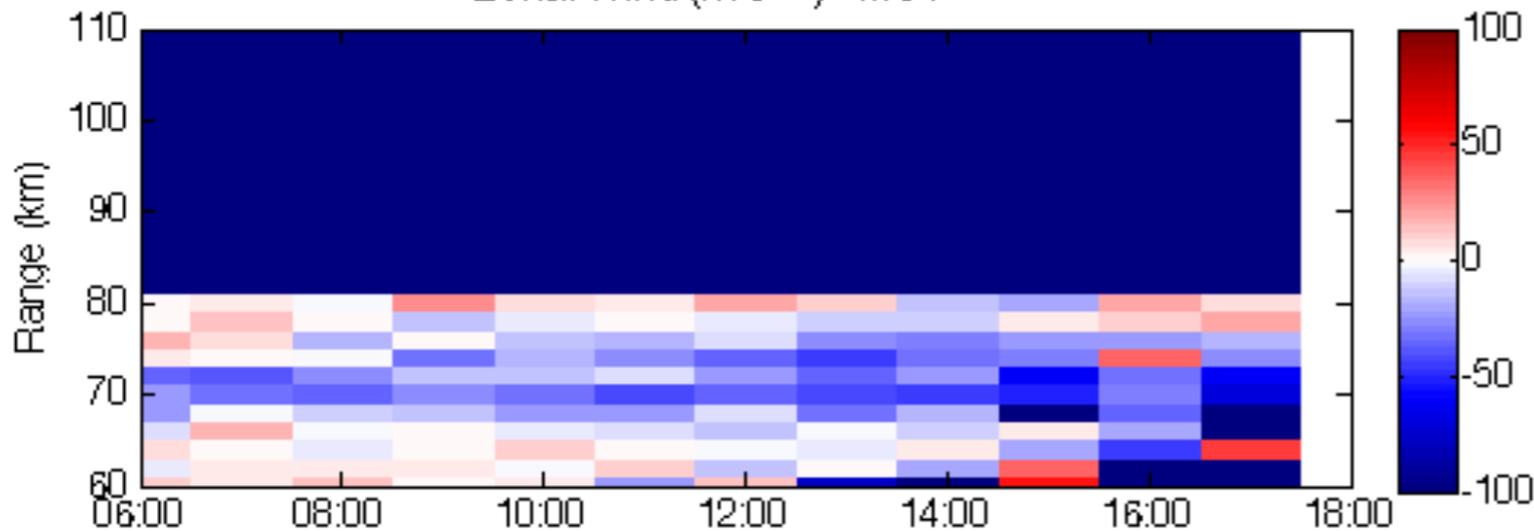
Zonal Wind ( $\text{m s}^{-1}$ ) - JASMET 30



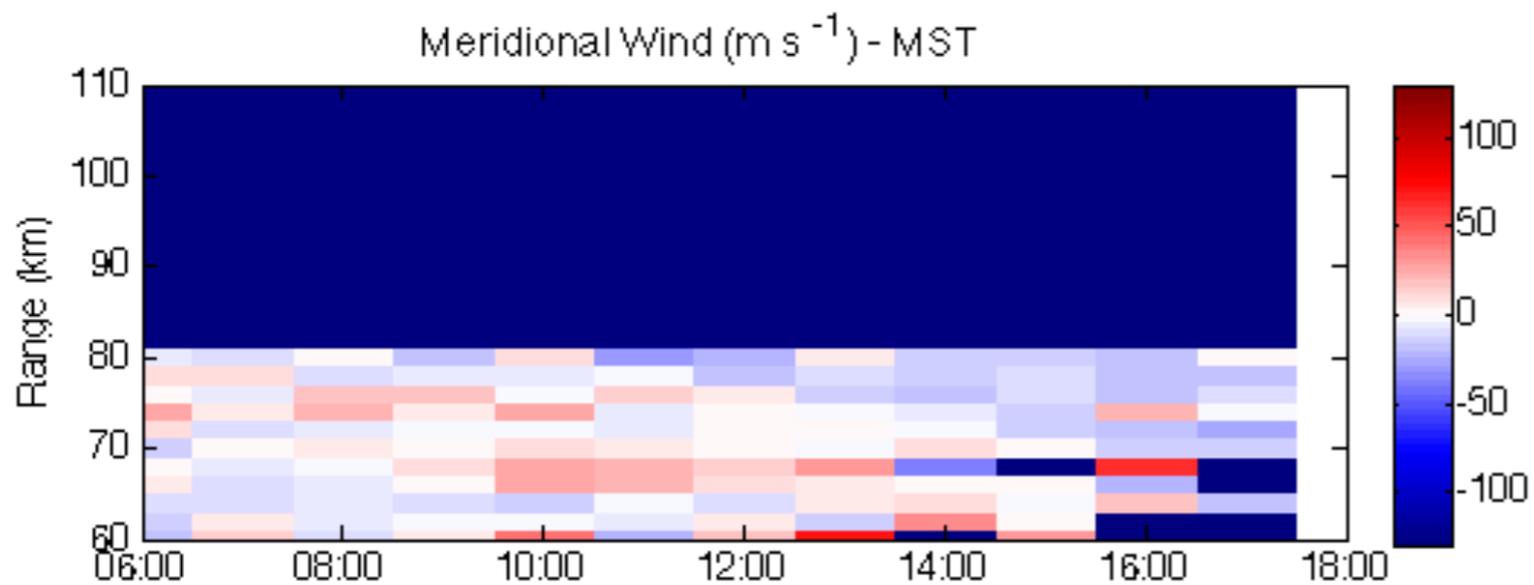
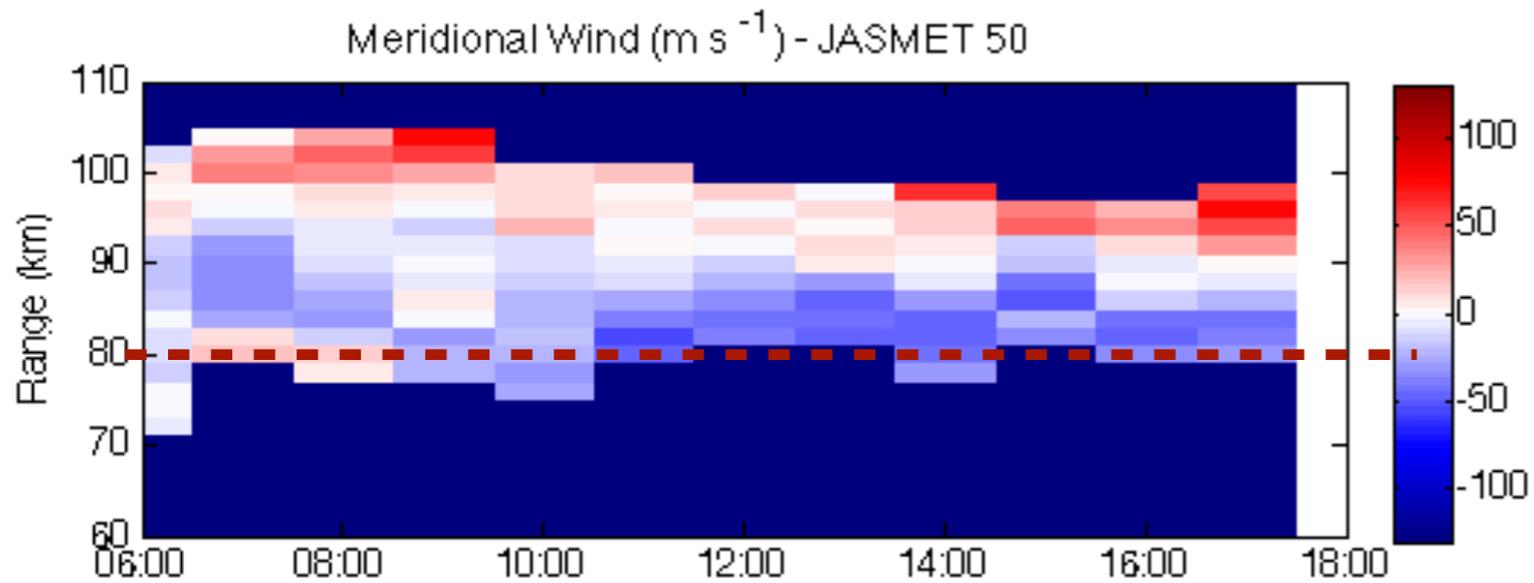
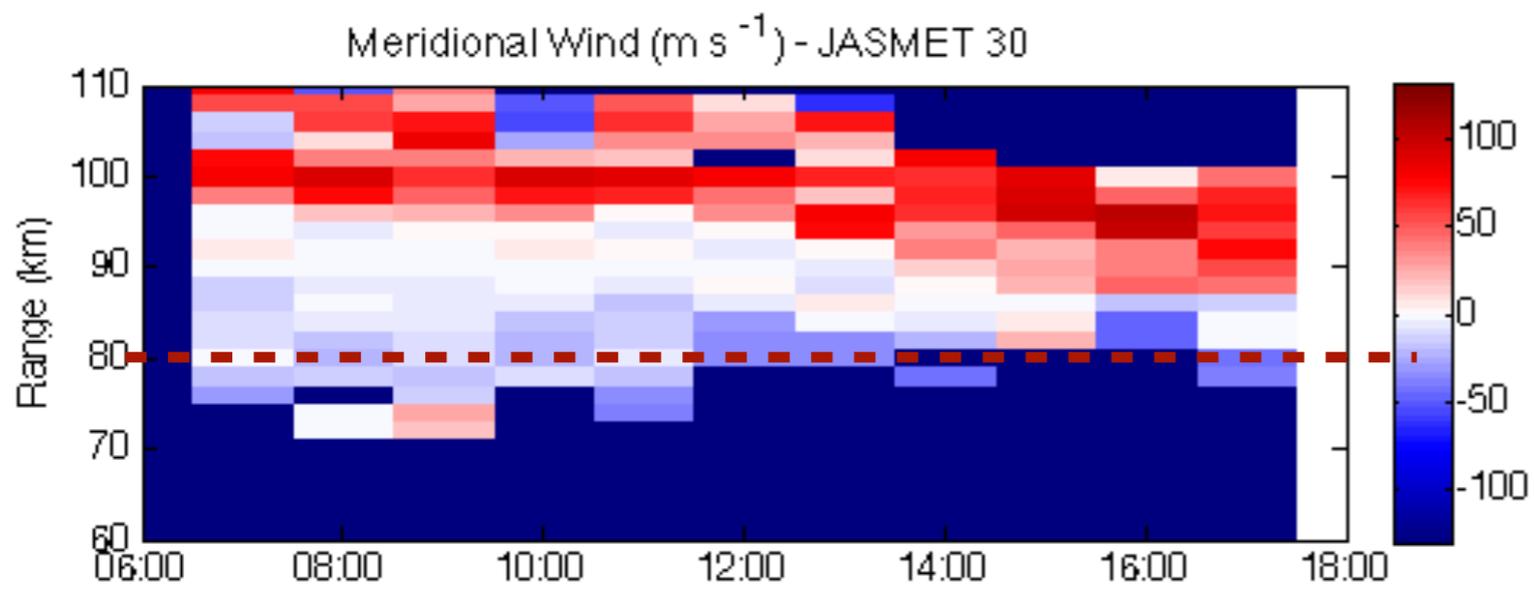
Zonal Wind ( $\text{m s}^{-1}$ ) - JASMET 50



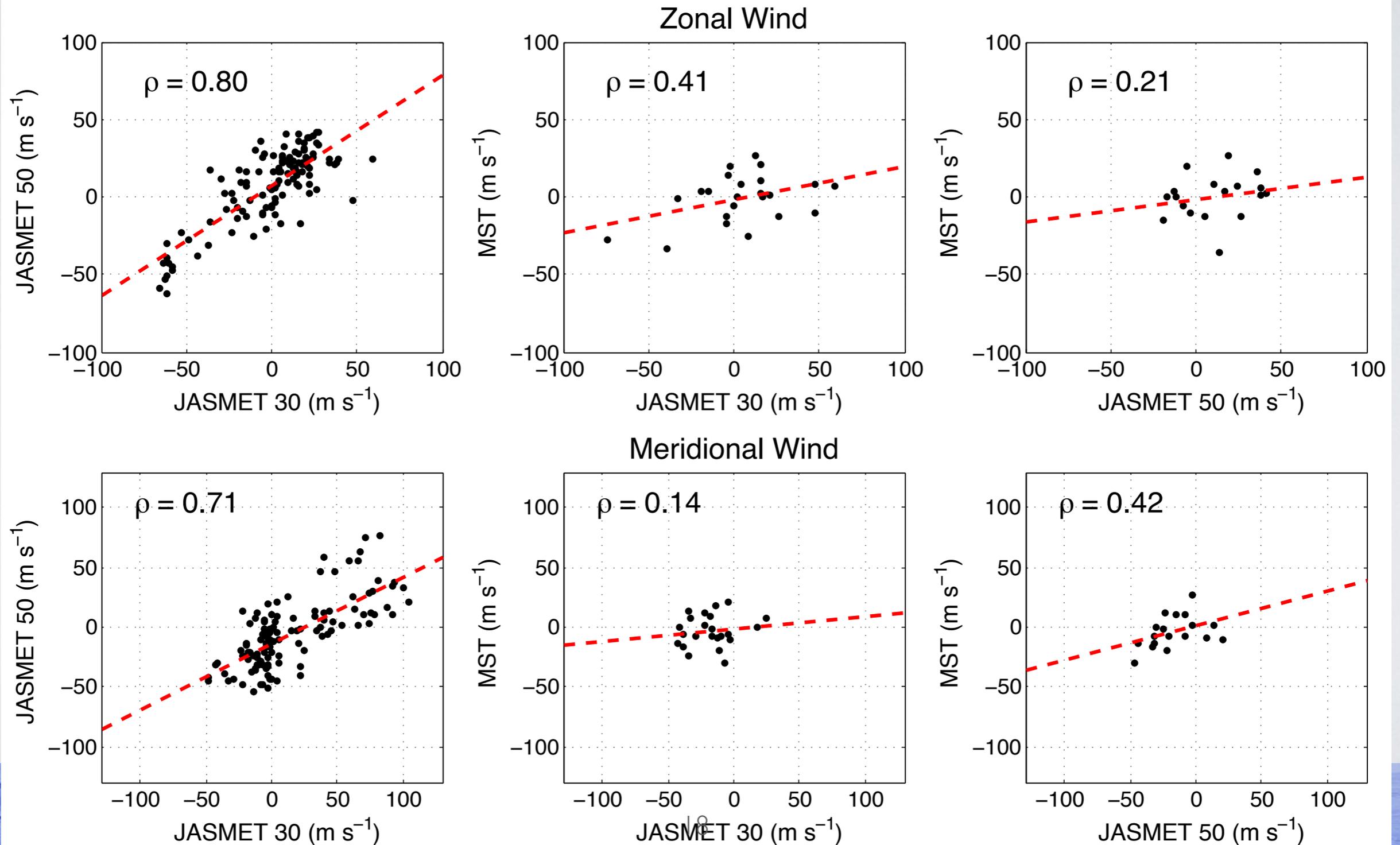
Zonal Wind ( $\text{m s}^{-1}$ ) - MST



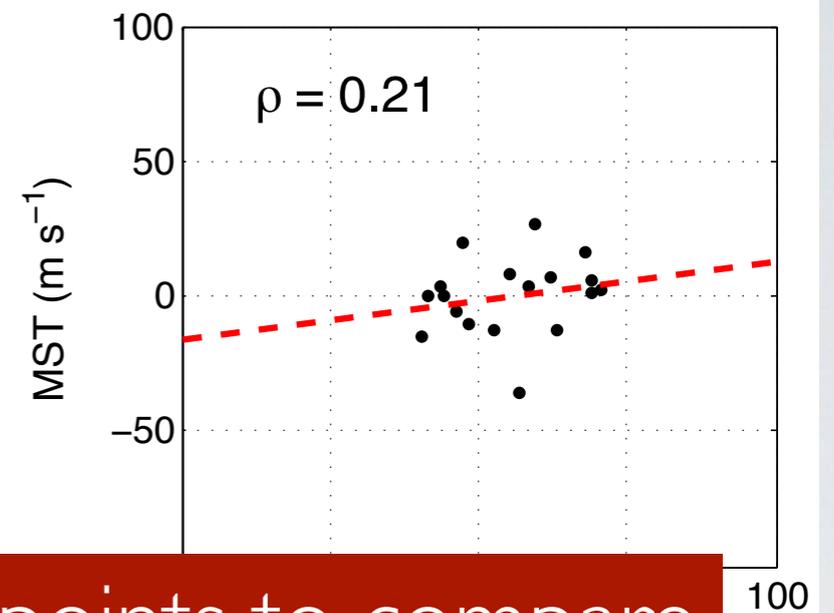
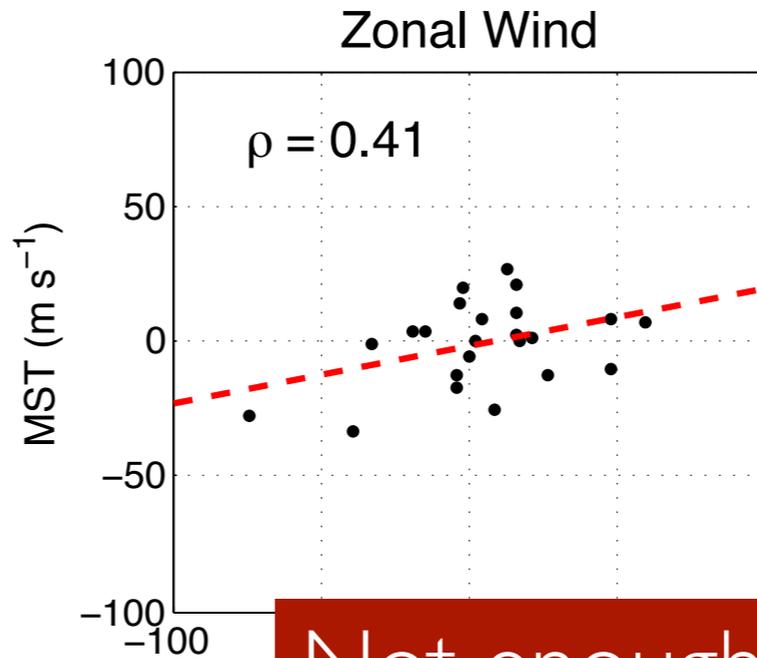
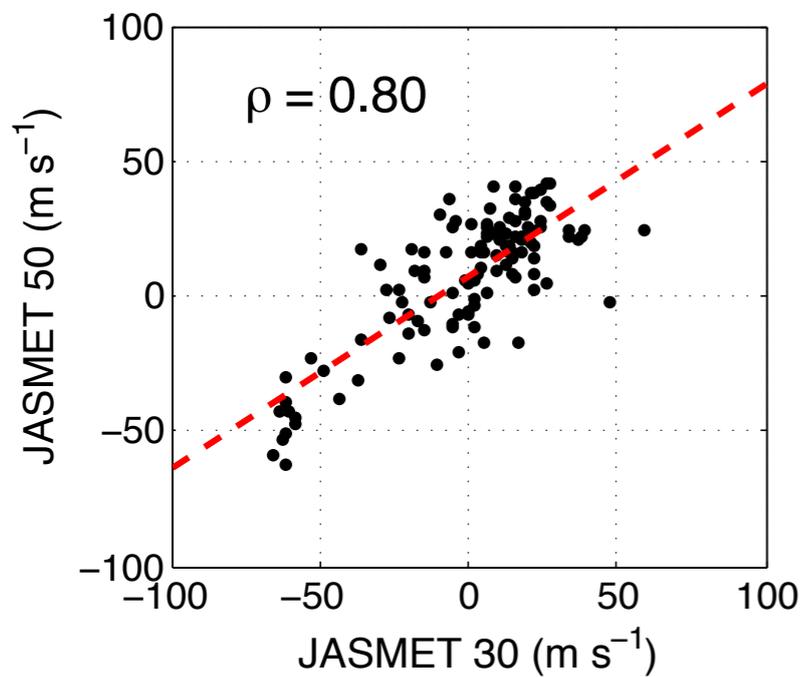
# Wind Estimates Meridional (+N) Wind



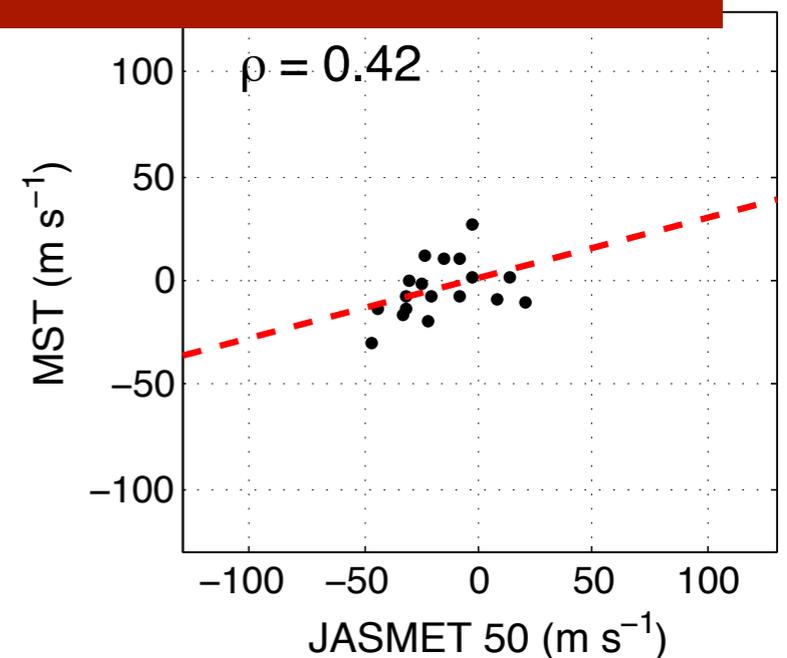
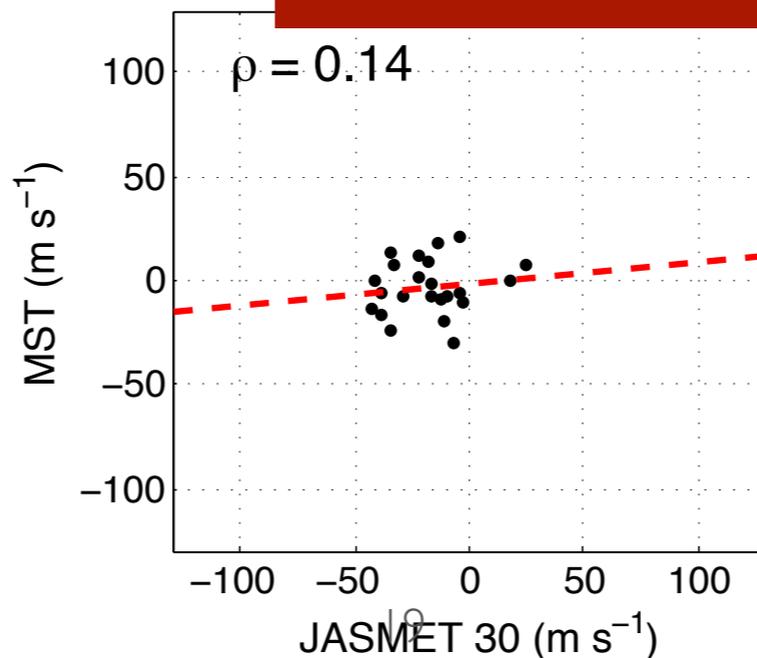
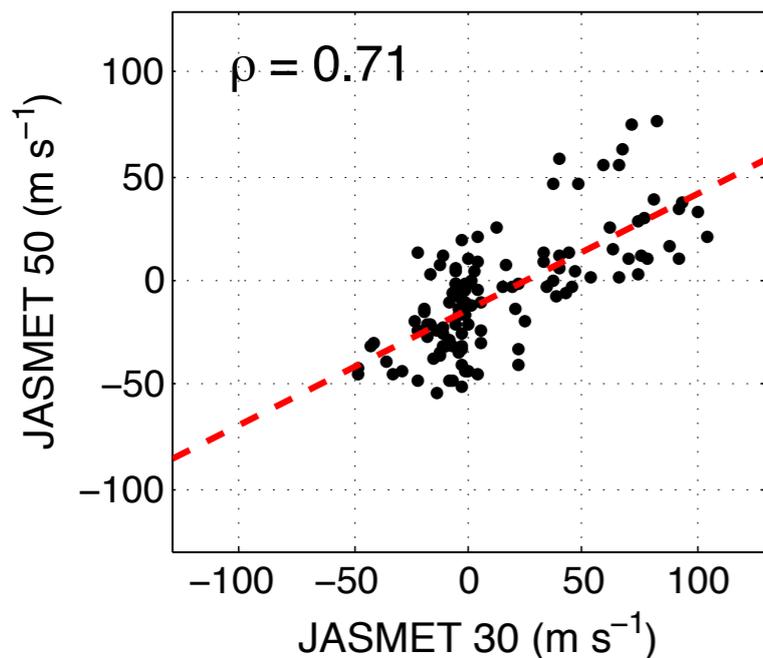
# JASMET 30, JASMET 50, and MST Comparisons



# JASMET 30, JASMET 50, and MST Comparisons



Not enough points to compare  
with MST mode



# Conclusions and future work

- JASMET 30 system is **ready** for its deployment in HUA where MLT winds will be obtained routinely.
- JASMET 30 detects more meteors than JASMET 50, which in turn allows estimation of winds at more ranges and with lower errors.
- Comparison between the estimates at 30 MHz and 50 MHz are in reasonable agreement. Careful calibration of initial height is needed for better agreement. Additionally, more coordinated experiments are needed.
- Comparison with mesospheric echoes was not possible because the maximum height without getting EEJ contamination was 85 km at JRO.
- Better comparison can be done using High-Power Non-Specular Meteor Trails for MLT winds (Oppenheim et. al. 2014)