

Mesosphere and lower thermosphere dynamics over Peru using multi-static specular meteor radar configurations

Acknowledgements:

- N. Pfeffer
- M. Clahsen
- K. Kuyeng

J. L. Chau¹, J. F. Conte¹, R. Latteck¹, J. Suclupe², M. A. Milla³, R. Rodriguez⁴ N. Pedatella⁵

¹Leibniz Institute of Atmospheric Physics, University of Rostock, Kühlungsborn, Germany

²Radio Observatorio de Jicamarca, Instituto Geofisico del Peru, Lima, Peru

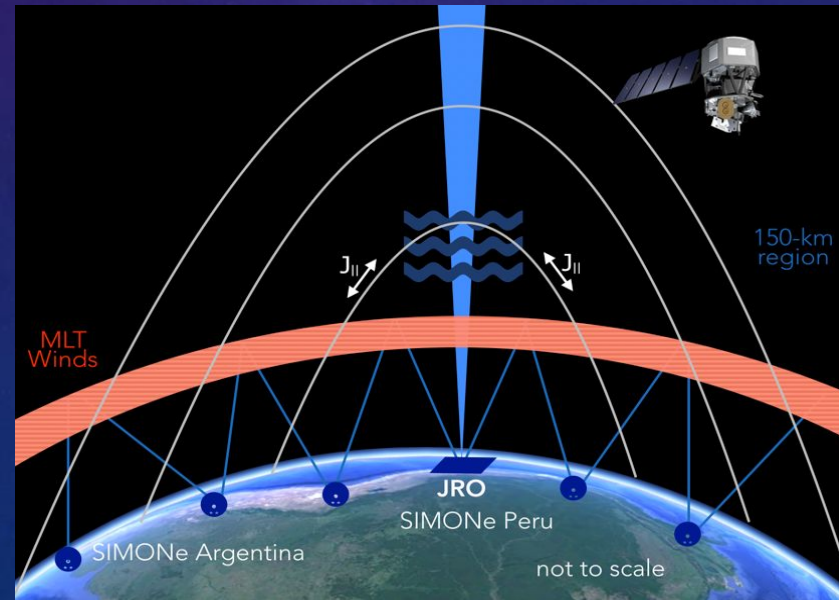
³Pontifica Universidad Catolica del Peru, Lima, Peru

⁴Universidad de Piura, Piura, Peru

⁵HAO, NCAR, Boulder, CO, USA

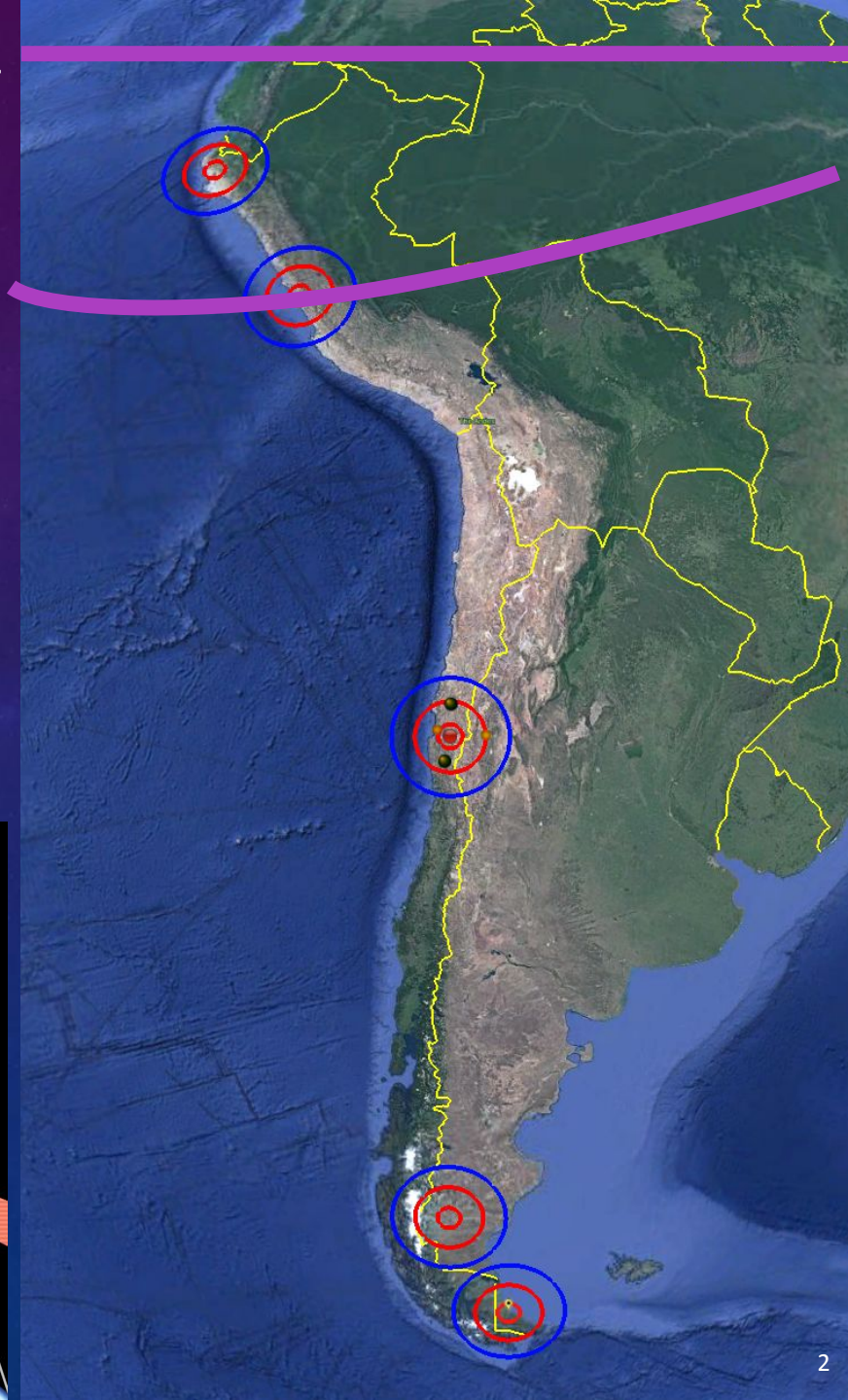
Outline

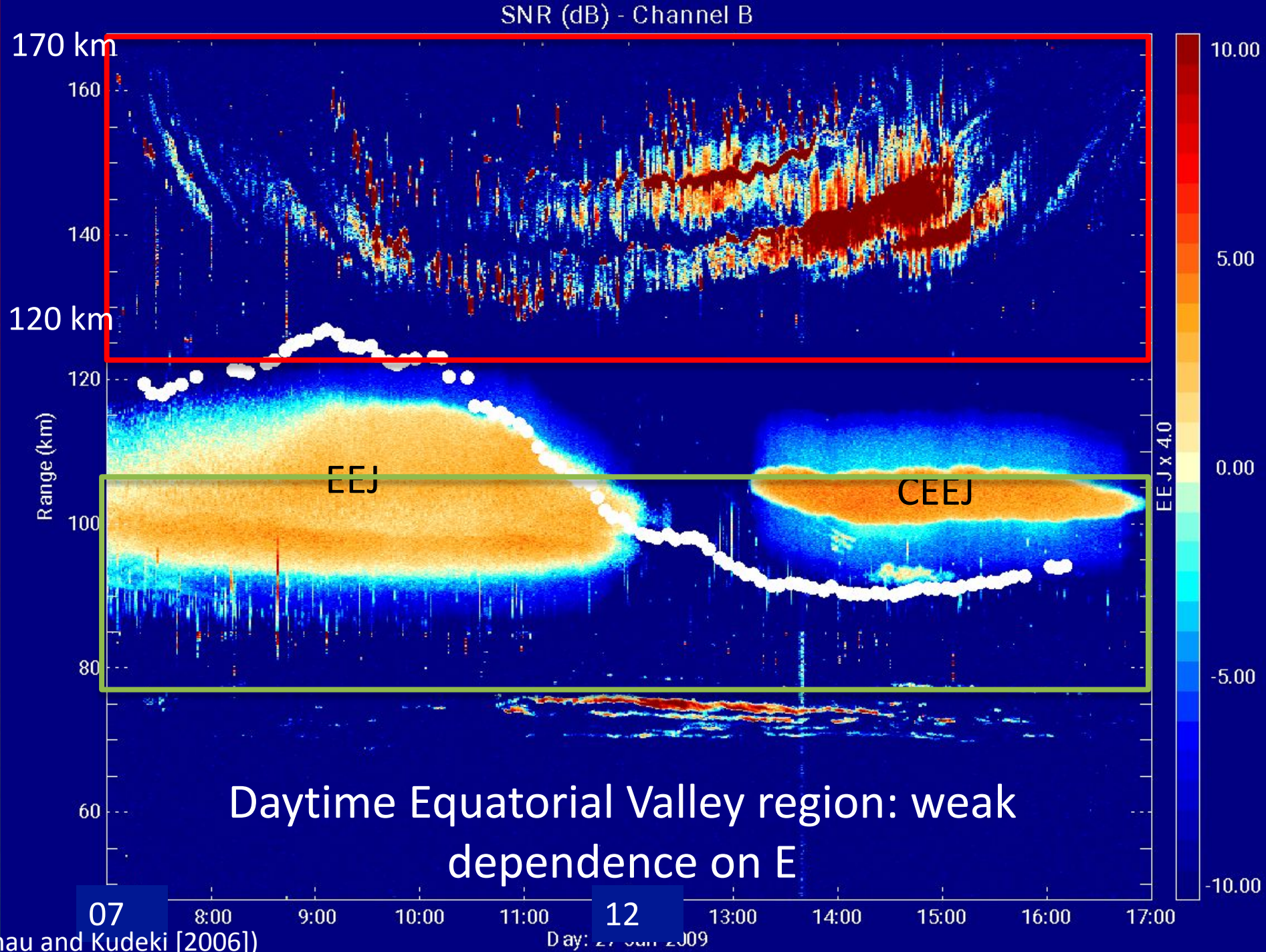
- Introduction to equatorial valley region
- Multistatic specular meteor networks: MMARIA and SIMONe
- SIMONe Peru
 - Jicamarca vs Piura comparisons
- Summary



Geog.. EQ

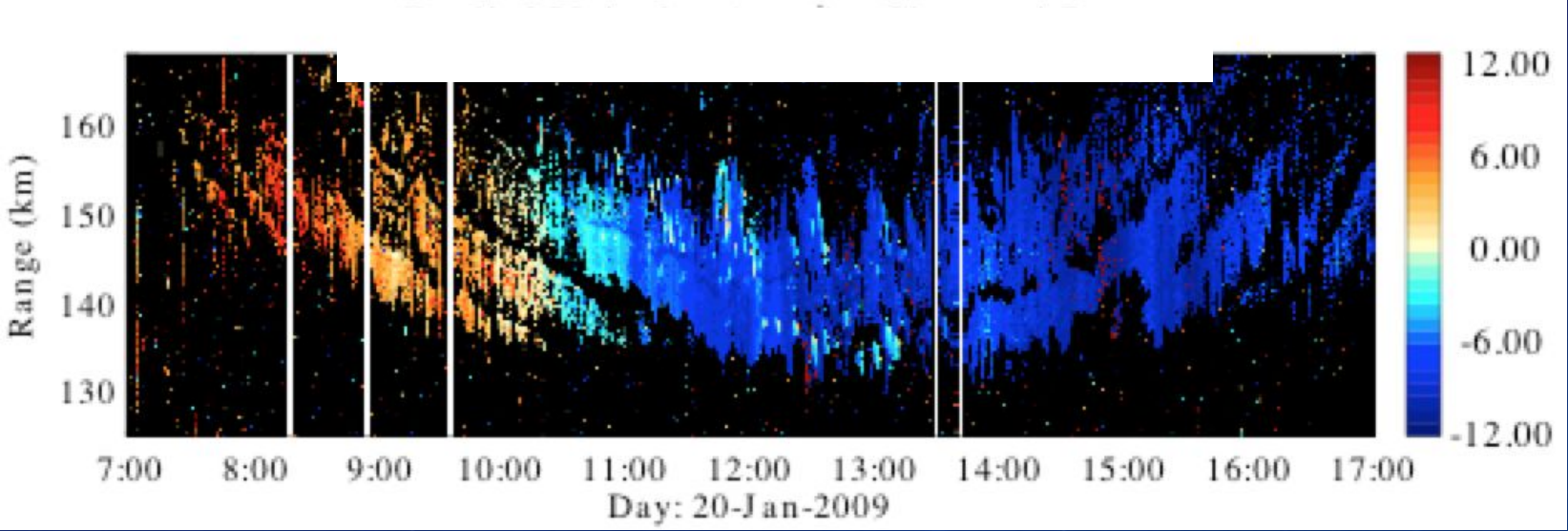
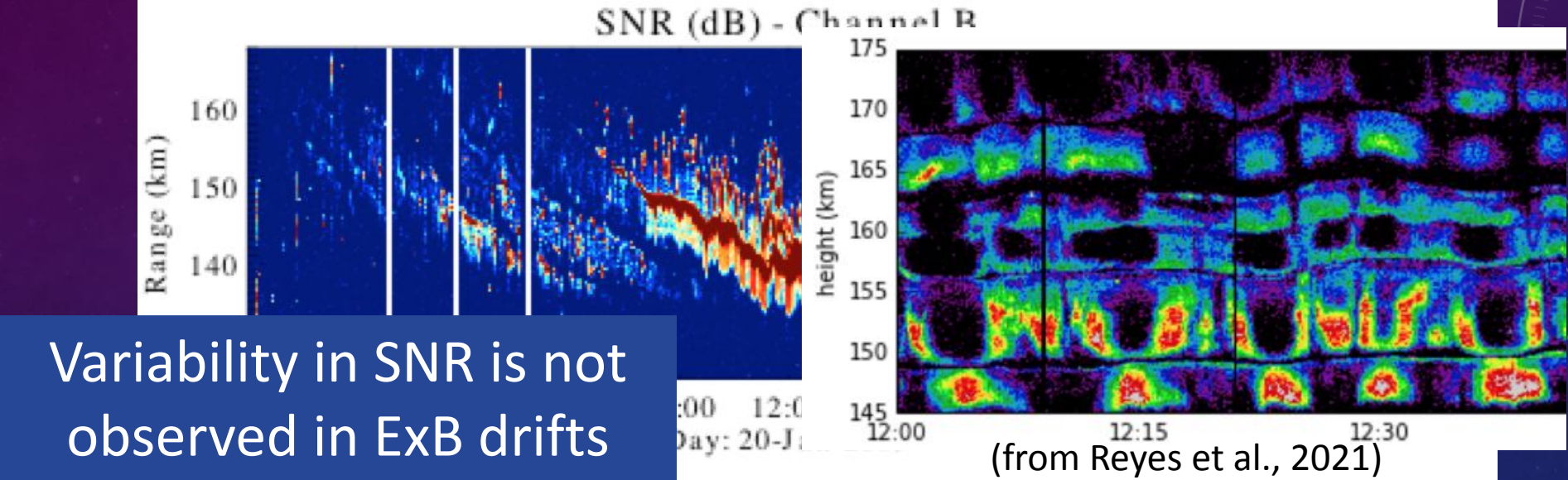
Mag. EQ



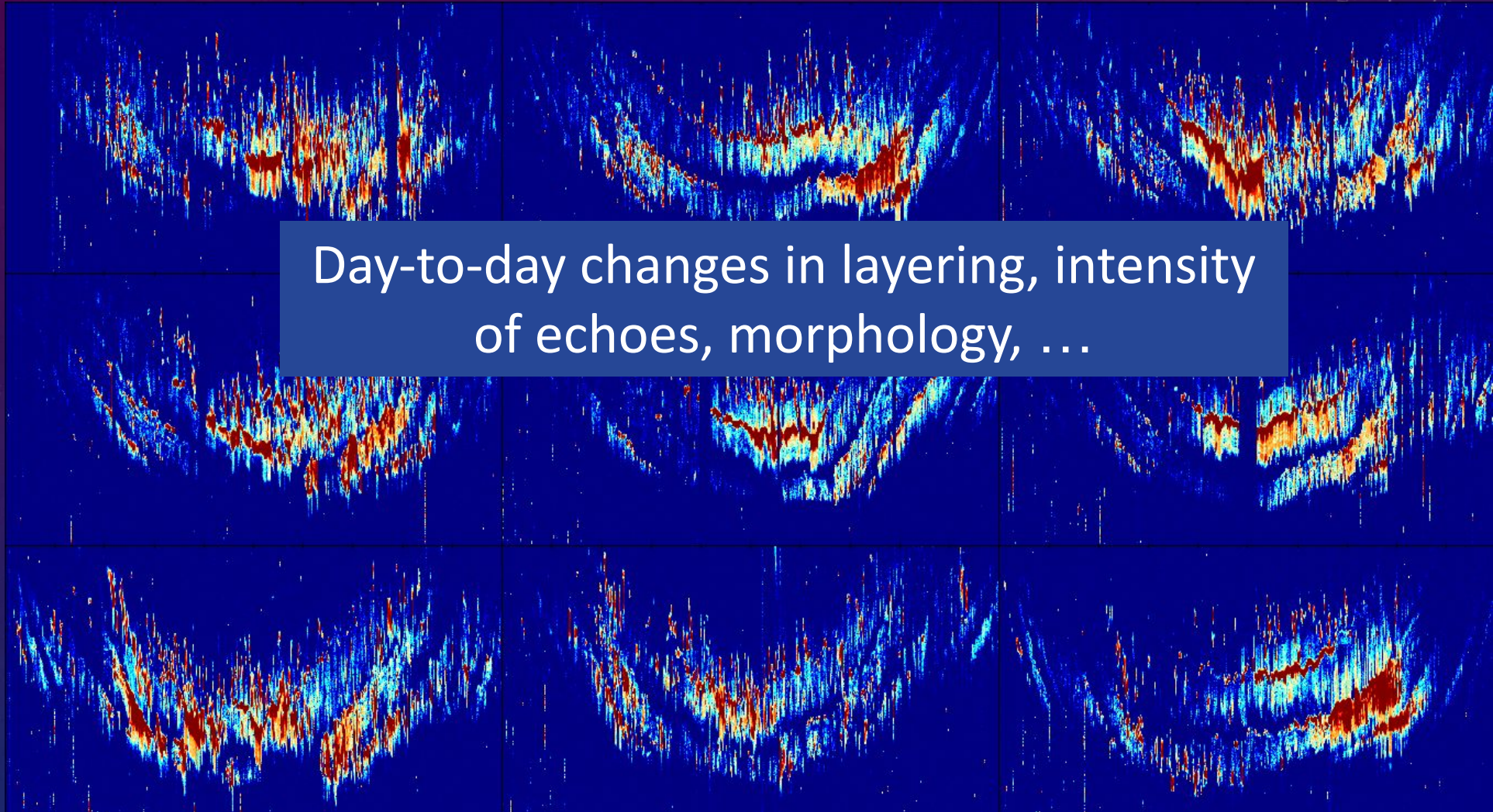


(adapted from Chau and Kudeki [2006])

Daytime Valley Echoes: Power and Electric field variability

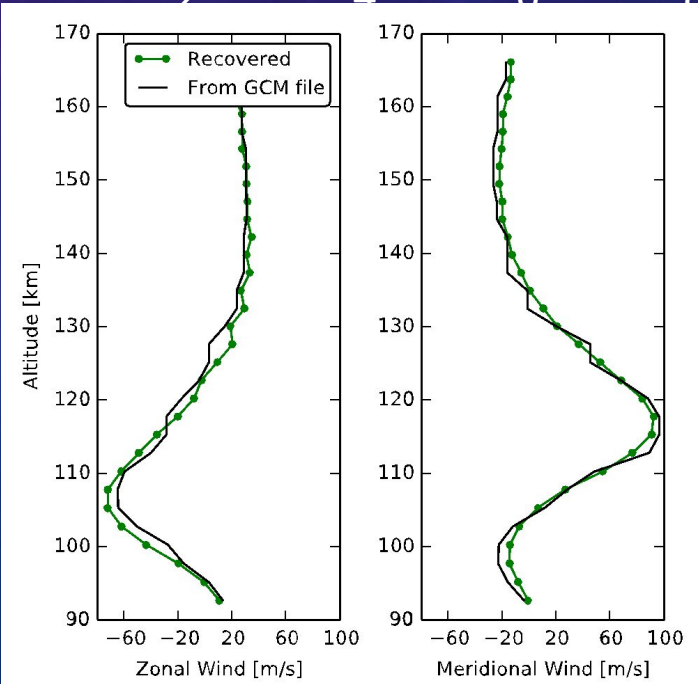
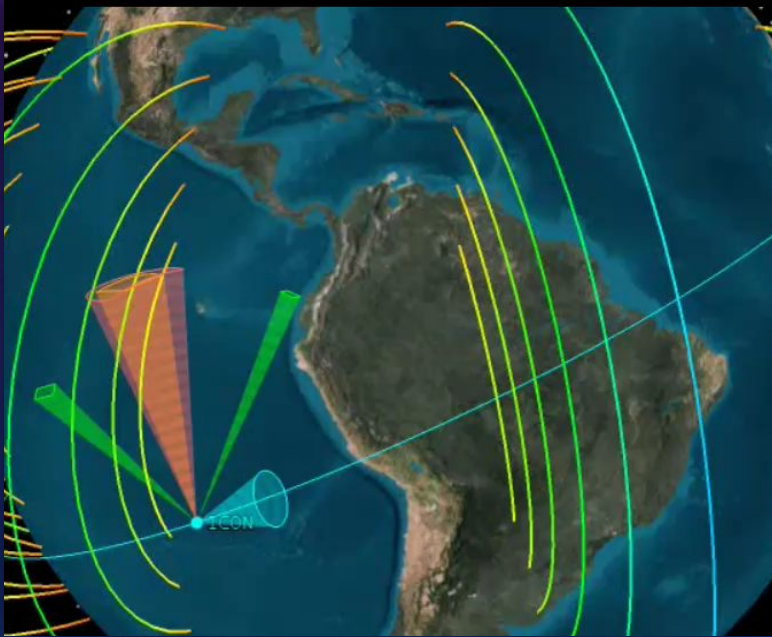
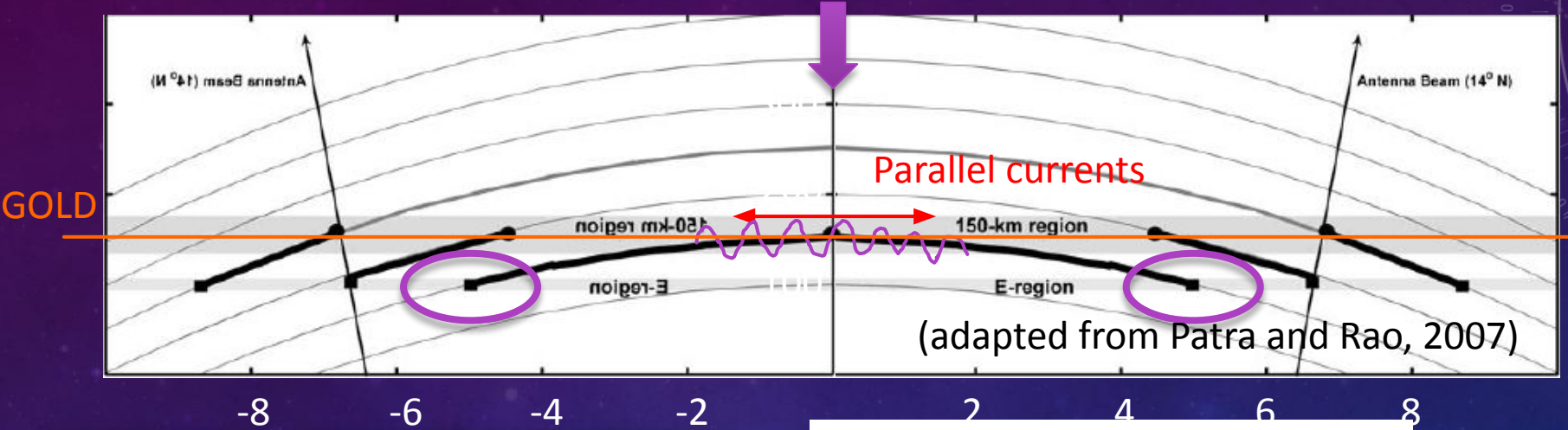


Daytime Valley Echoes: Day-to-day variability



(adapted from Chau Kudeki [2013])

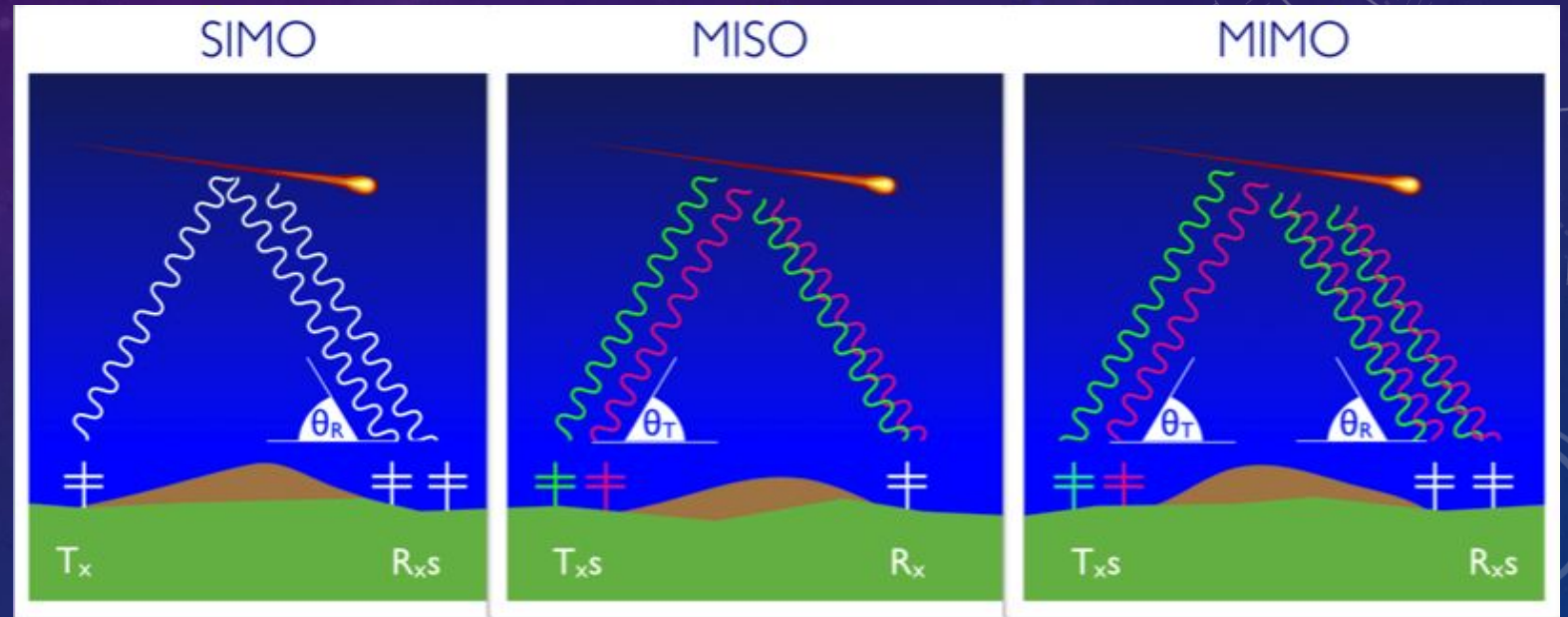
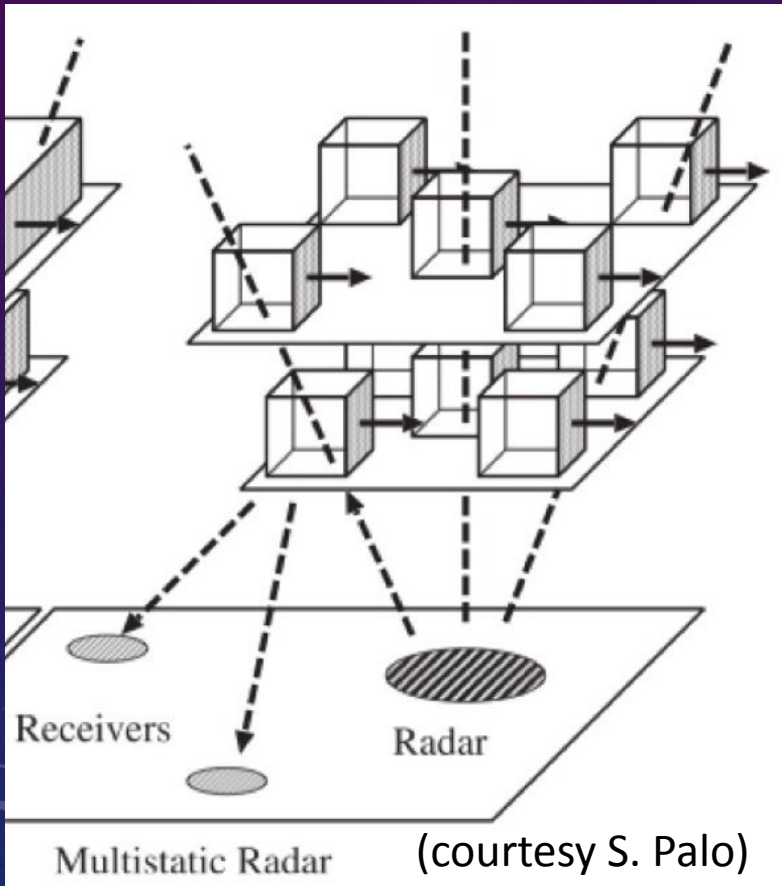
Valley daytime Echoes + Conjugate E region



Expected
MIGHTY
winds
from ICON

Multistatic specular meteor radar and SIMONE

SIMONE: Spread Spectrum Interferometric Multistatic meteor radar Observing Network



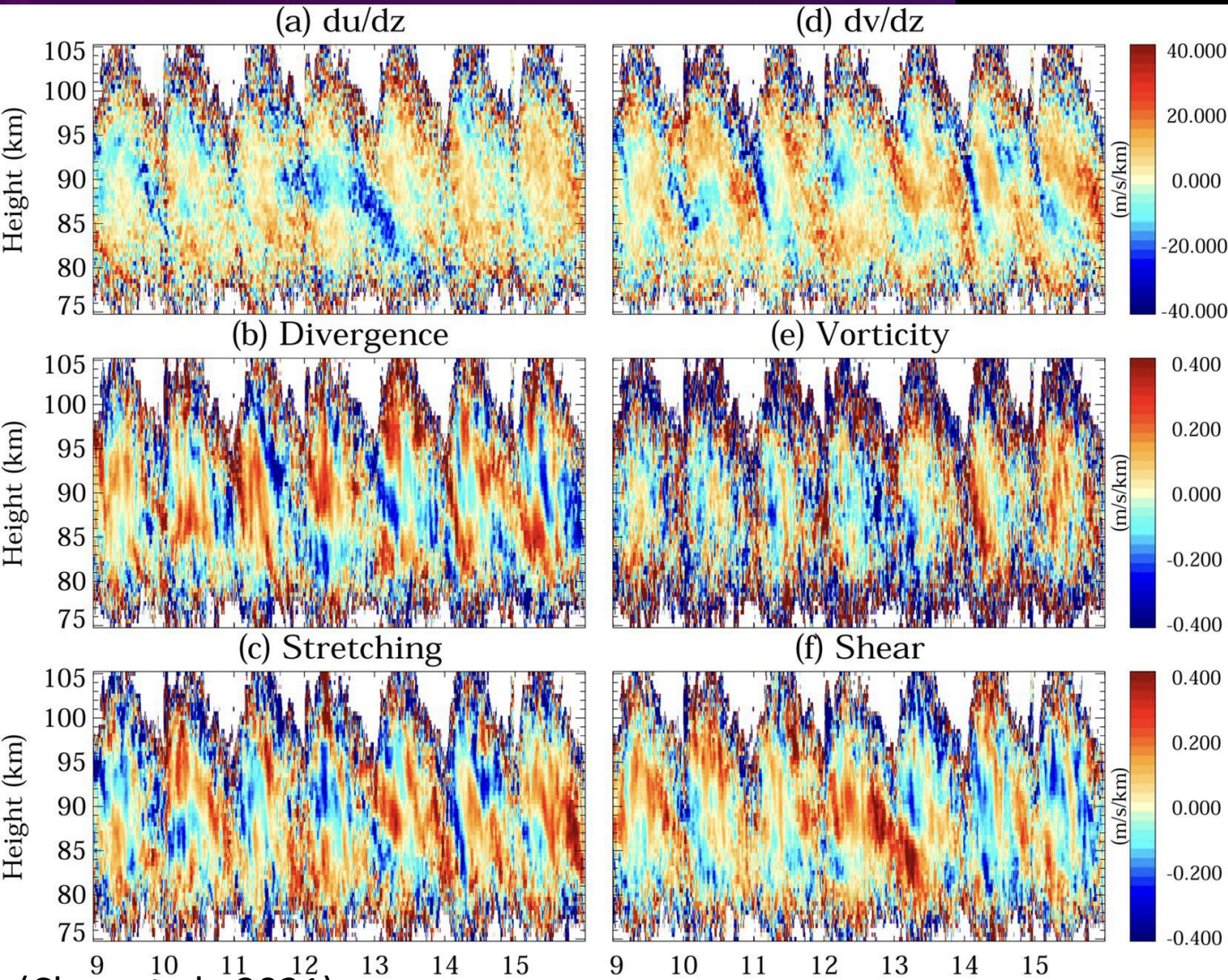
CONDOR (30°S)
MMARIA-SAAMER (54°S)

SIMONE-Piura (5°S)
SIMONE Jicamarca (12°S)
SIMONE Argentina (49°S)

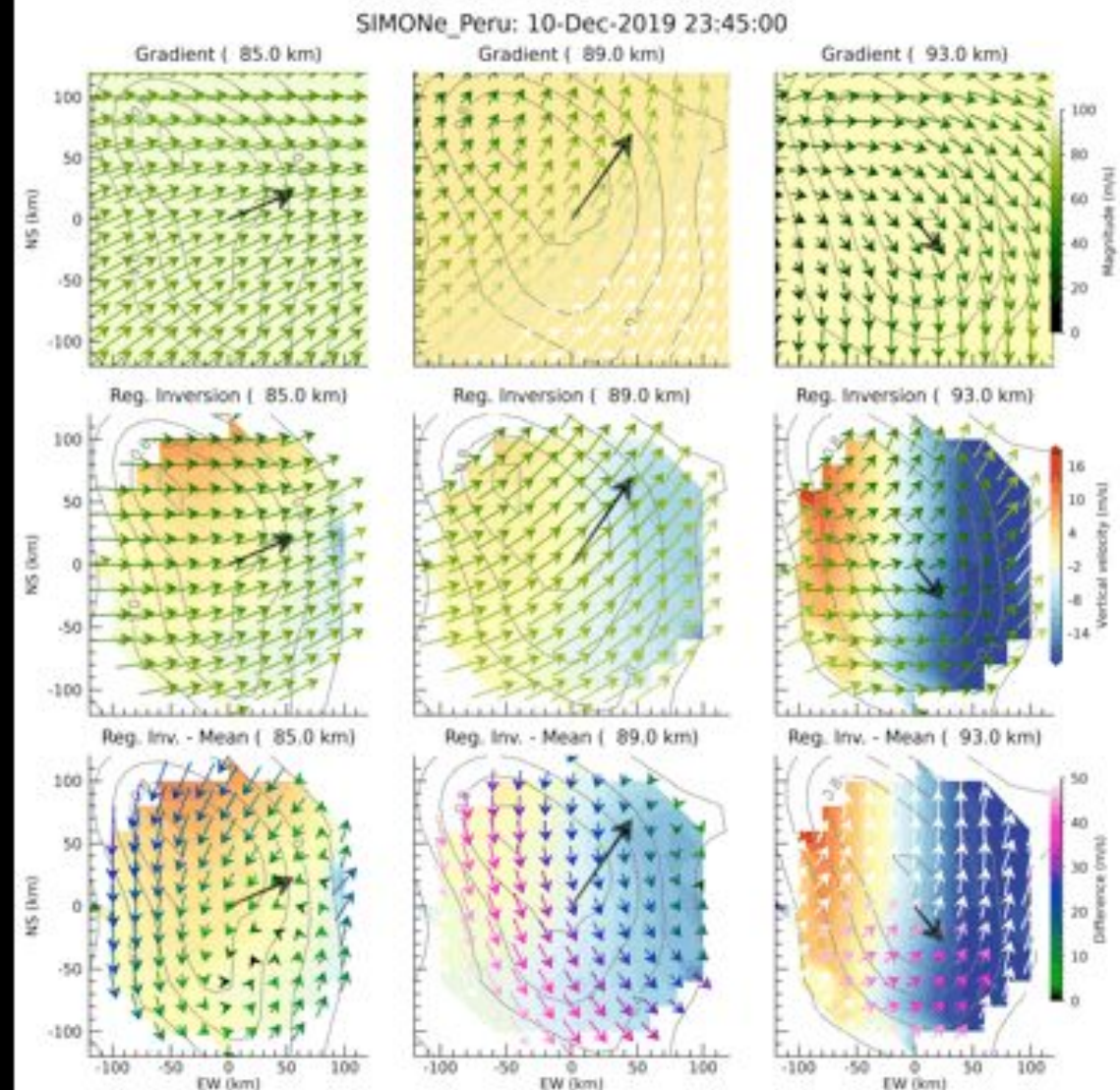
(Chau et al., 2019)

MLT mesoscales (10s to 100s km): First-order statistics

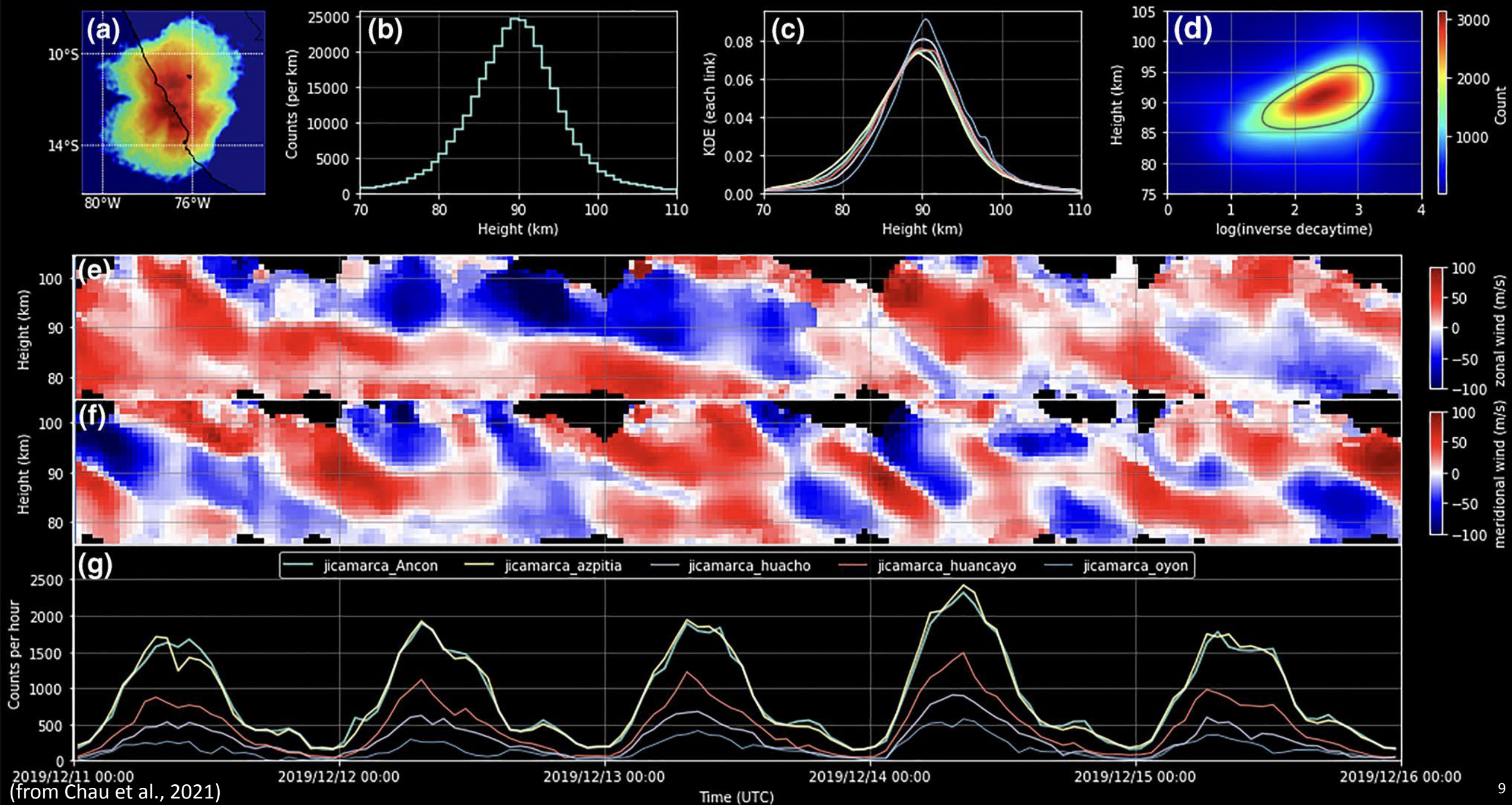
Derived MLT parameters from gradient method



Derived MLT wind fields



mmaria_multilink_simone-peru 2019_12



SIMONe Peru

Geog.. EQ

SIMONe Piura

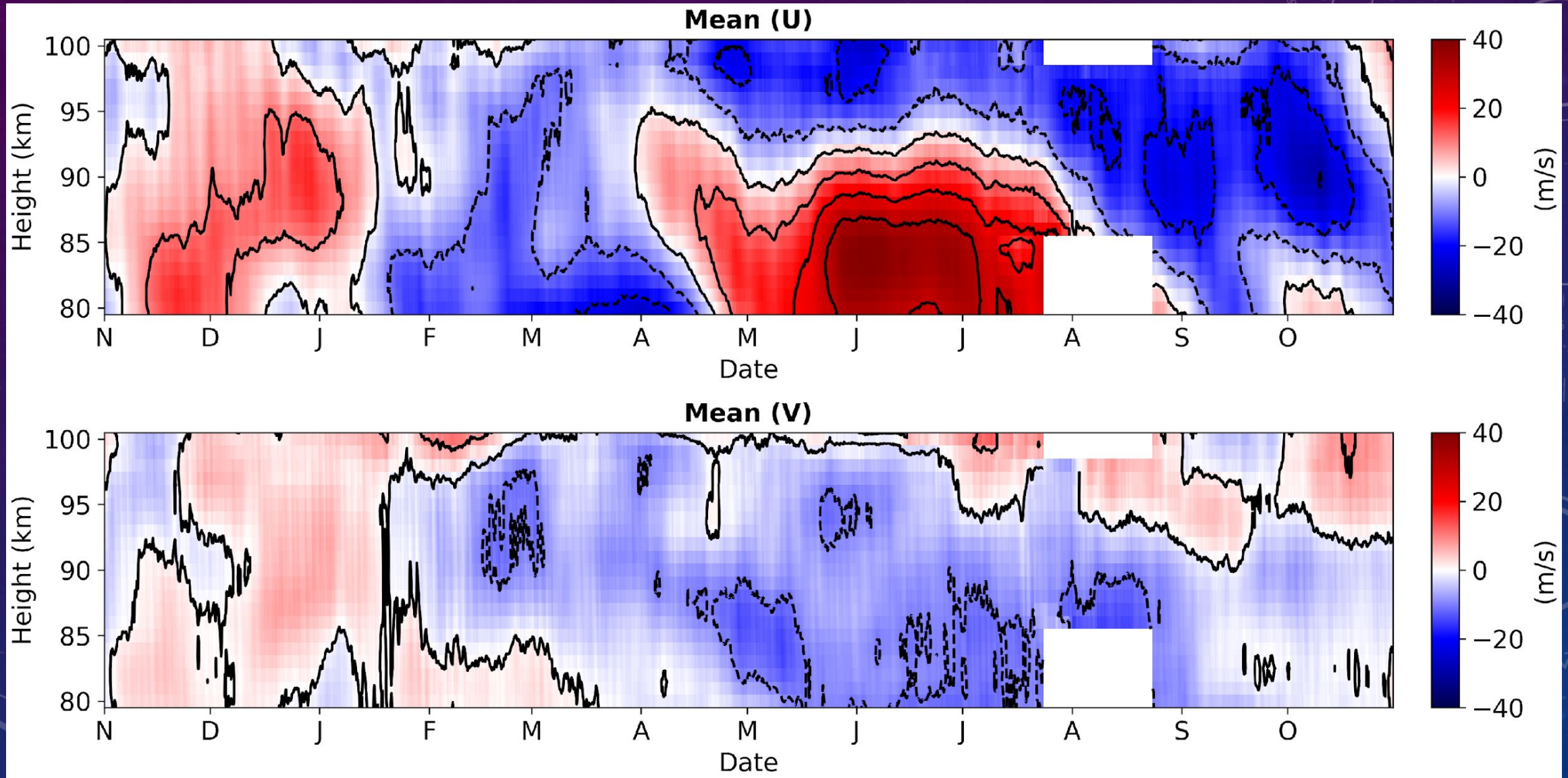
SIMONe Jicamarca

Mag. EQ



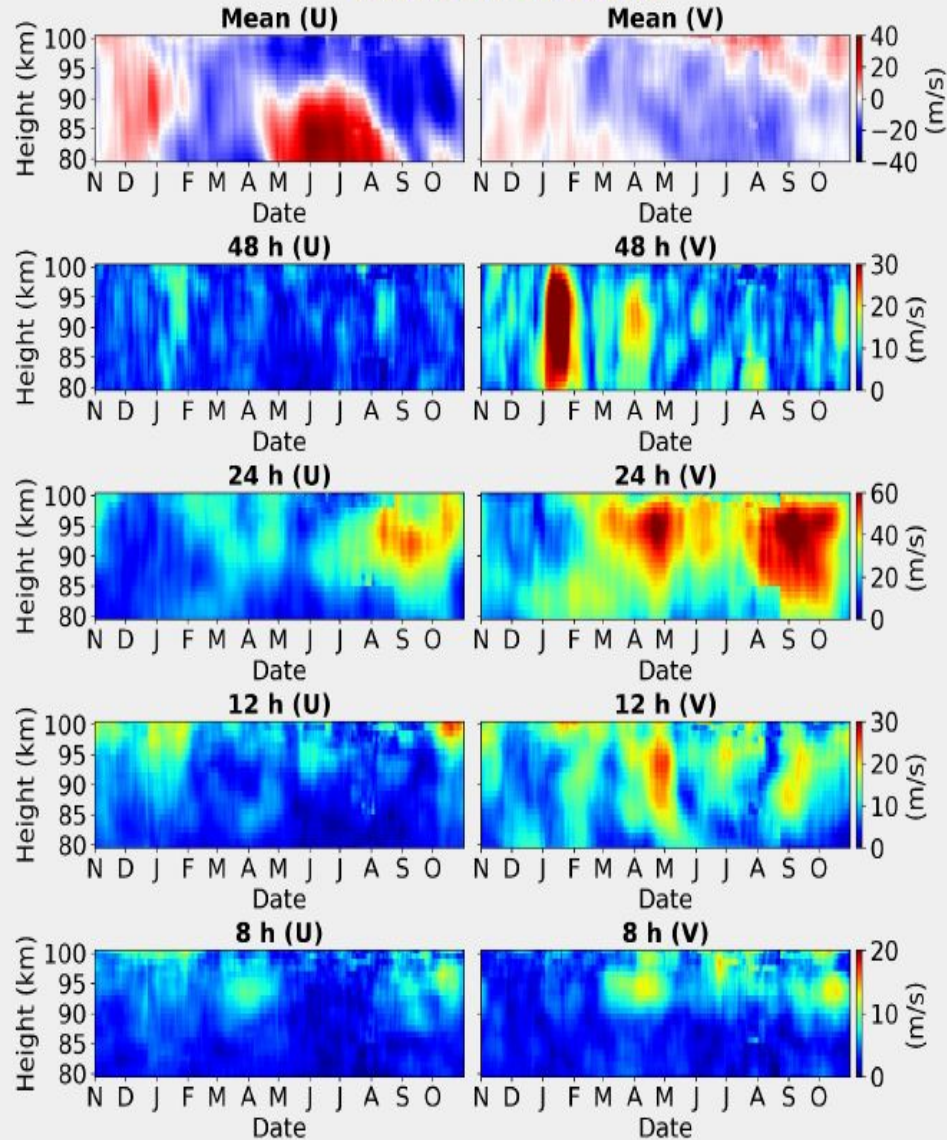


MLT Winds over Jicamarca: Geomagnetic equator

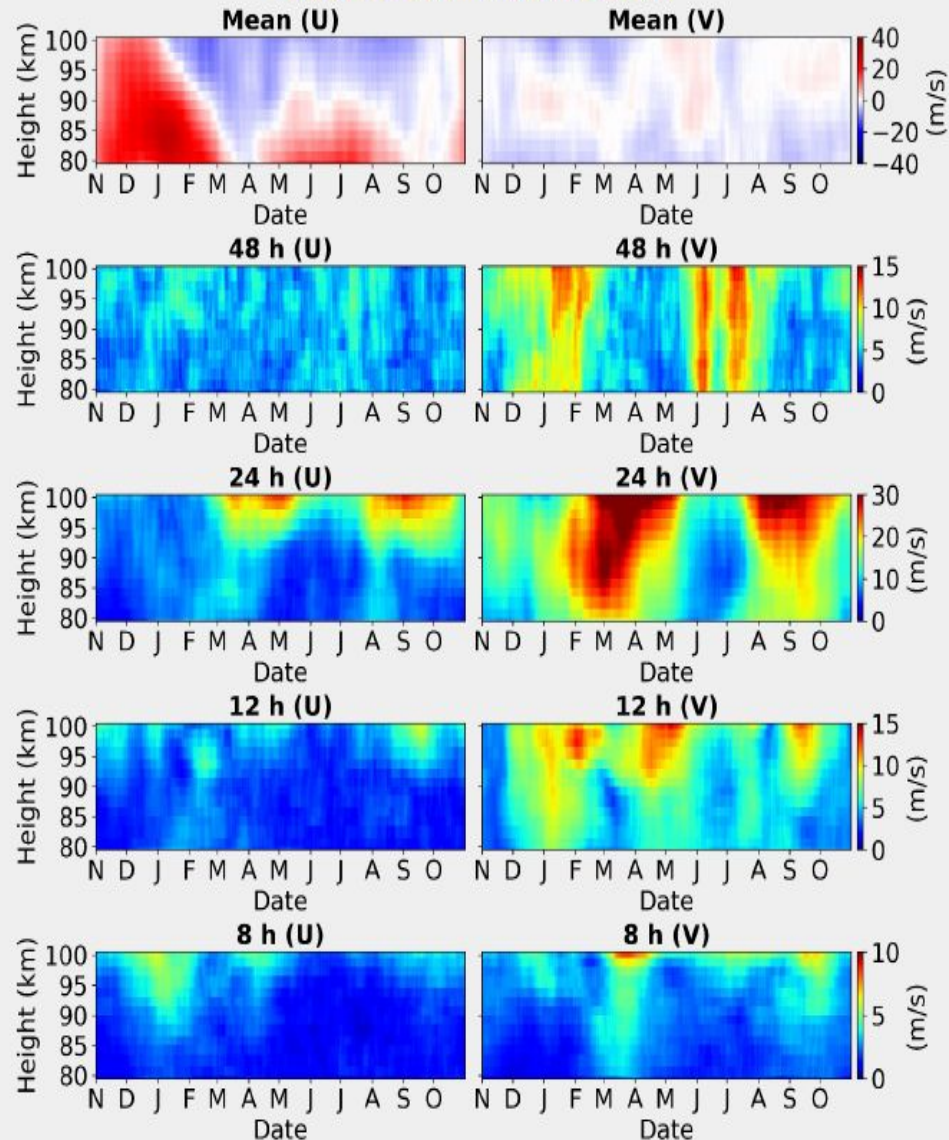


MLT dynamics over Jicamarca: SIMONe vs WACCM-X

SIMONe radar



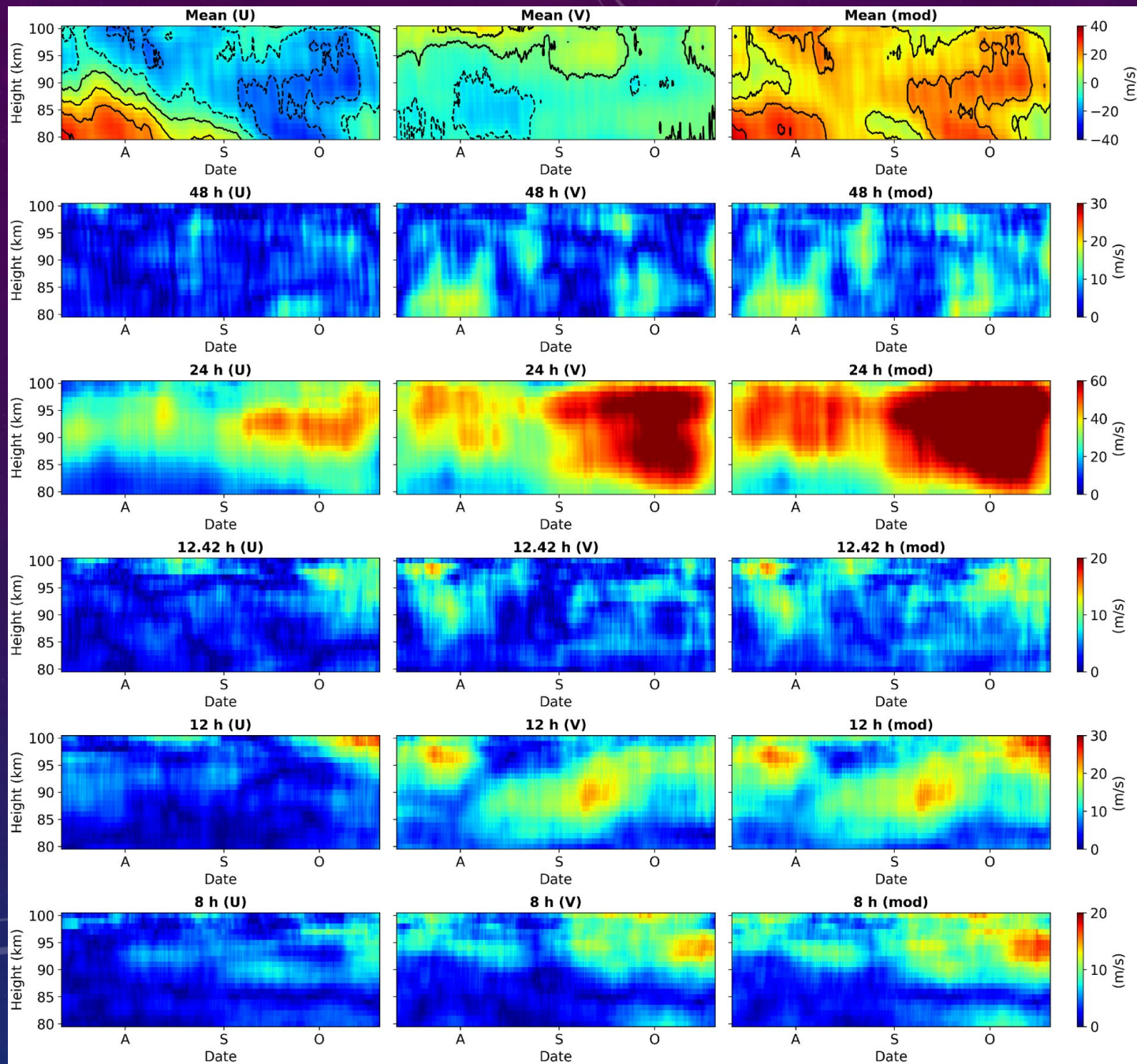
WACCM-X model



(J. Suclupe, MSc. Thesis, 2022)

Jicamarca vs Piura (Aug-Oct 2021)

SIMONe Jicamarca (12°S): Mean winds, Q2DW and tides

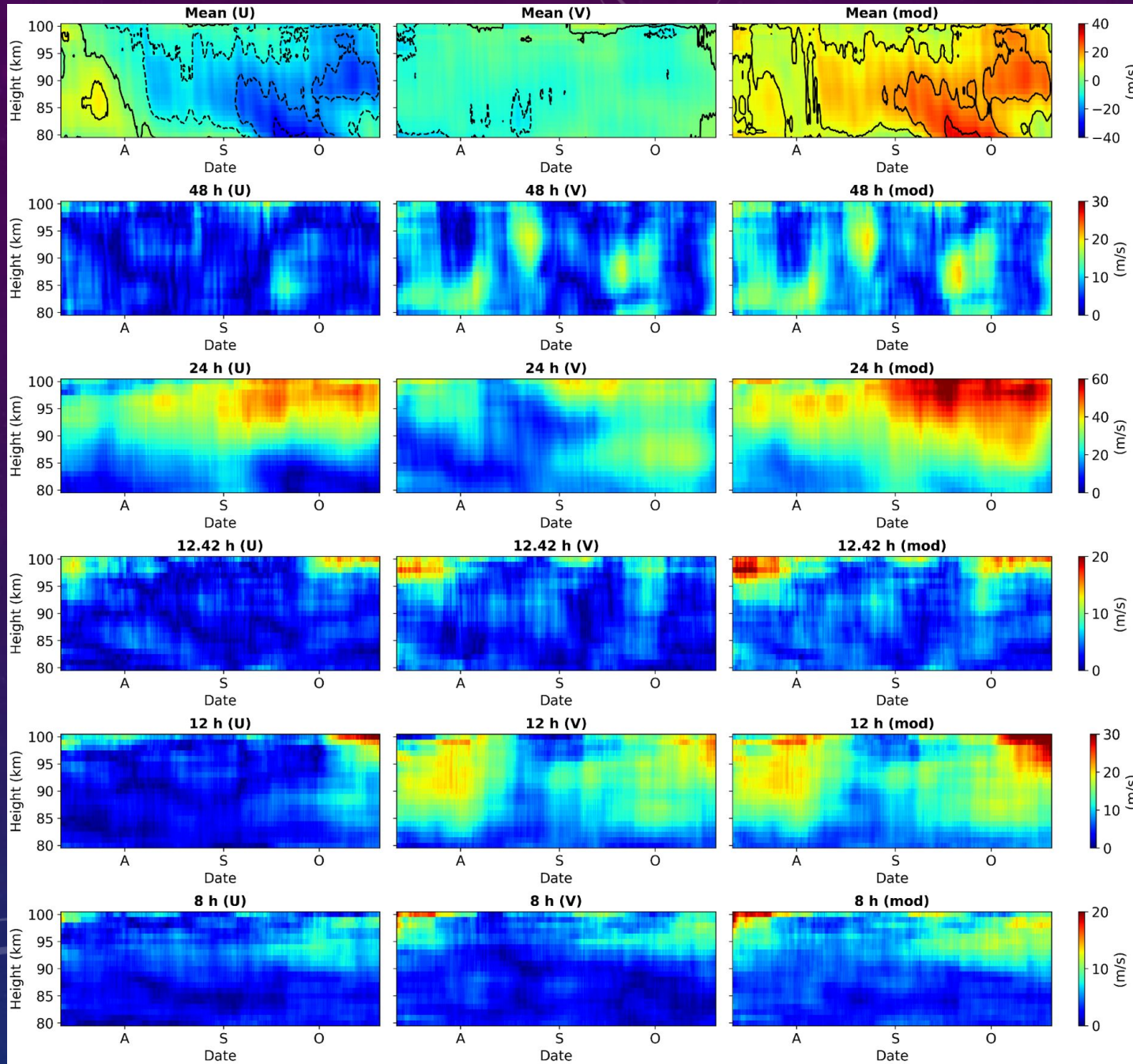


Jicamarca vs Piura (Aug-Oct 2021)

SIMONe Piura (5°S): Mean winds, Q2DW and tides

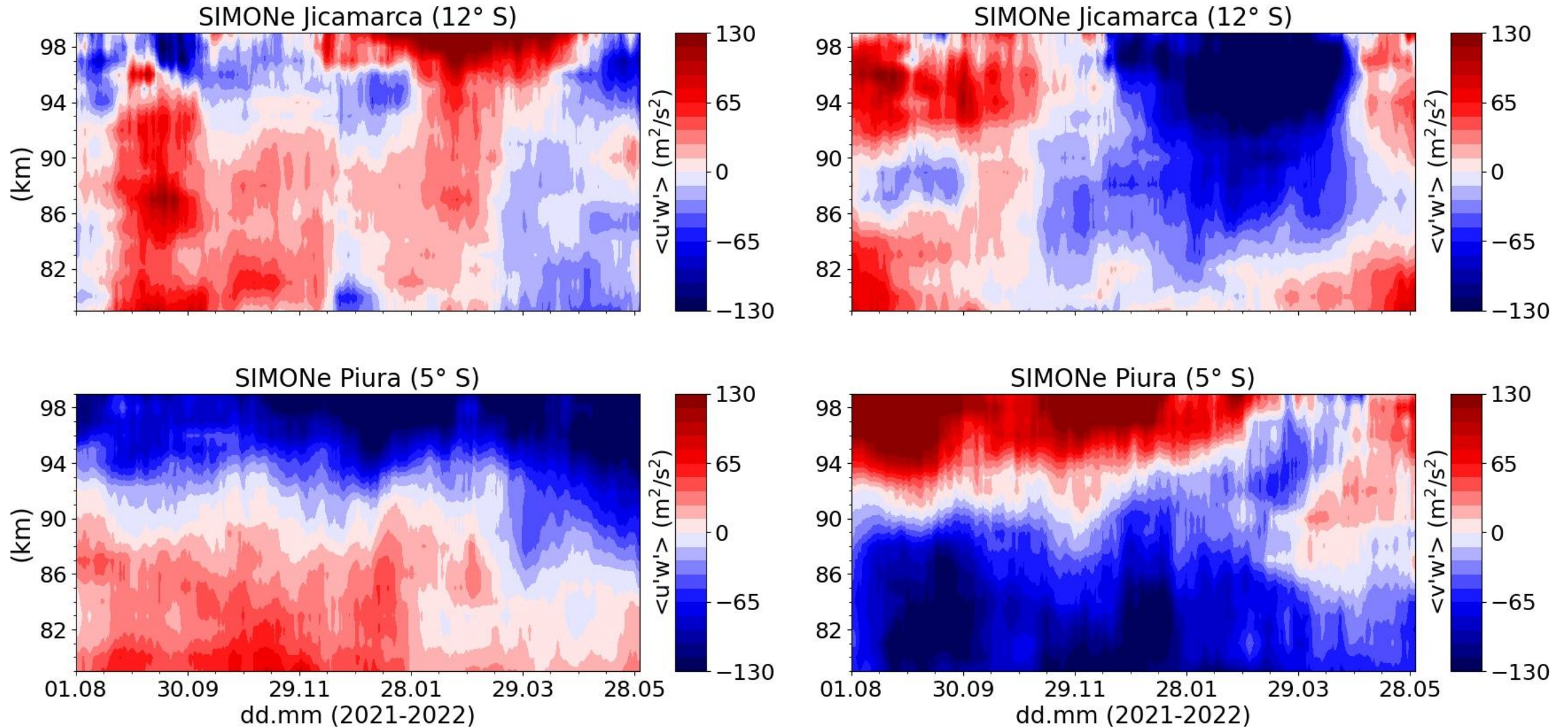
Compared to Jicamarca

- Diurnal tide is stronger in the zonal component and peaks at a higher altitude
- Total diurnal tide is weaker.
- Q2DWs are comparable.
- Terdiurnal tides are weaker.



Momentum Fluxes: Jicamarca vs Piura (Aug 2021-May 2022)

Mom. flux (28-day) after removing (4-h, 4-km) mean horizontal winds



(courtesy Fede Conte , 2022)

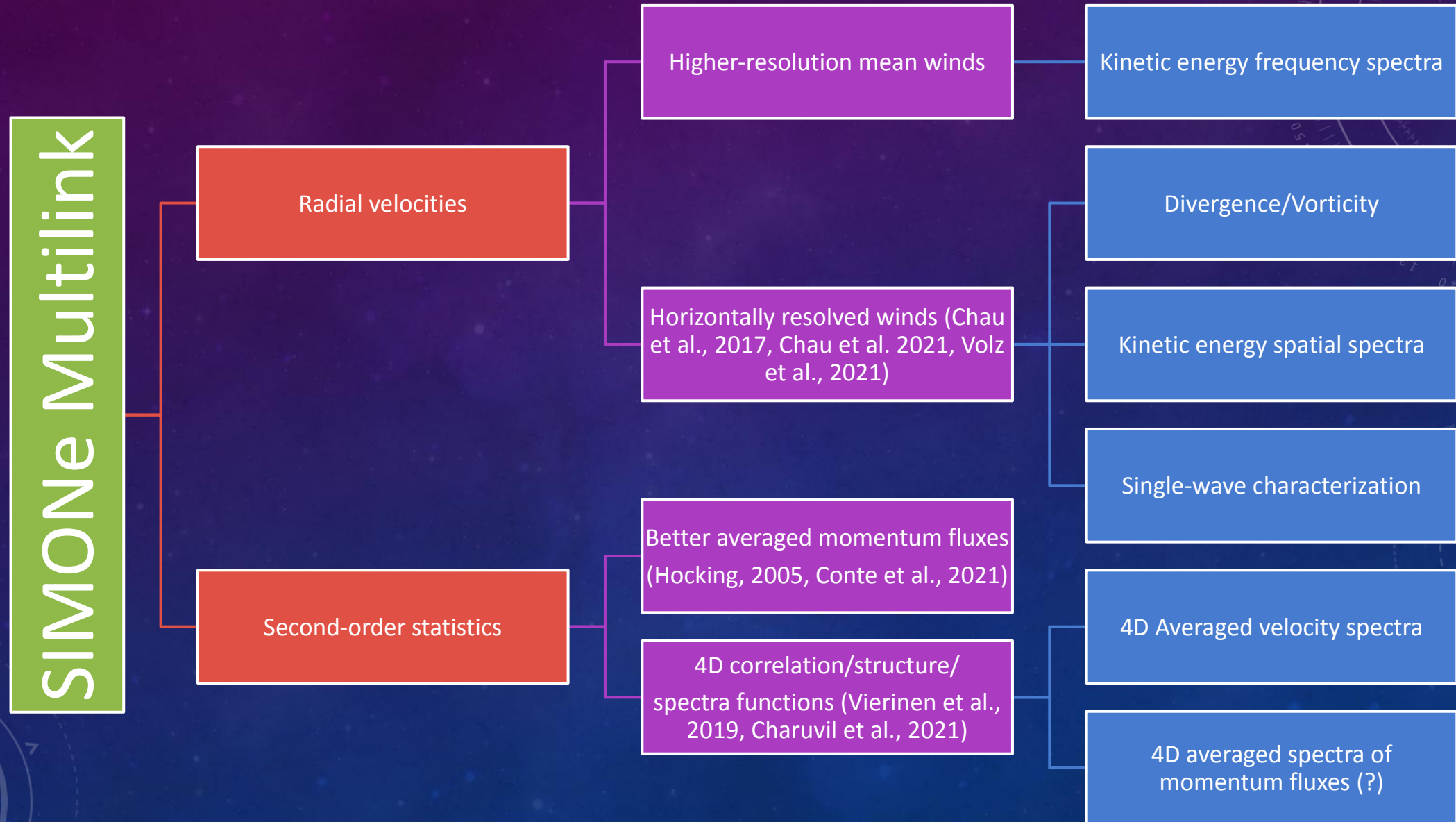
Summary and Outlook

- SIMONE-Peru complements JRO's capabilities covering the large- and meso-scale MLT dynamics.
- The low-latitude valley region shows significant day-to-day as well as minute-to-hour variability that is most likely related to local as well as non-local (MLT) neutral dynamics.
- Jicamarca and Piura, separated by just 7° latitude, present significant differences at mesoscales. At large scales, the differences are less.
- Future work:
 - Correlate equatorial valley –region and EEJ variability observed with Jicamarca clustered (e.g., ISR + LISN) instrumentation with mesoscale variability at different latitudes: (a) case studies and (b) climatology.
 - Work on multi-instrument case studies, e.g., with JRO MLT wind modes, ICON/MIGHTI.

Congratulations!

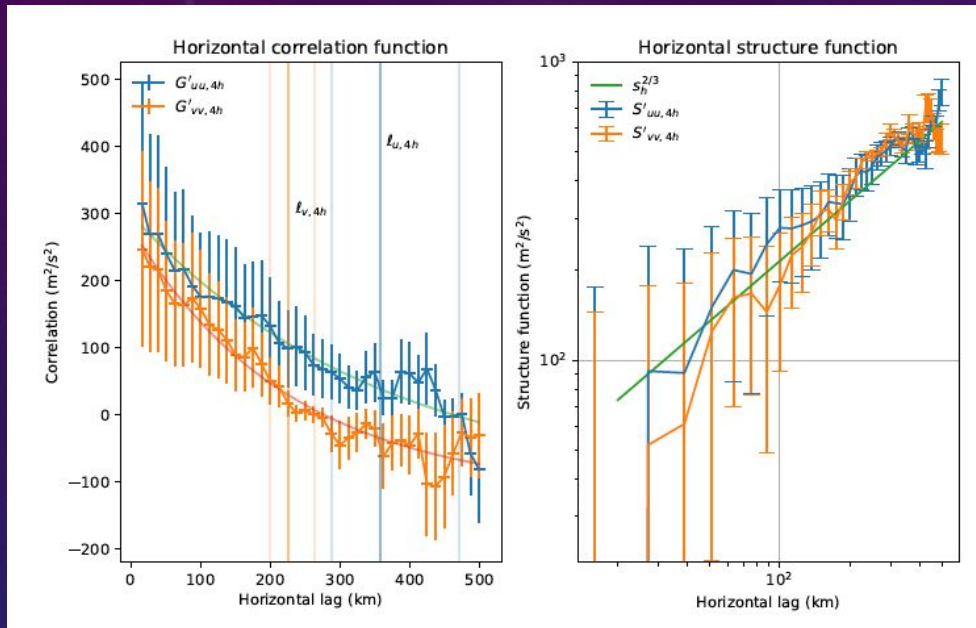


What one can do with SIMONe-Peru?



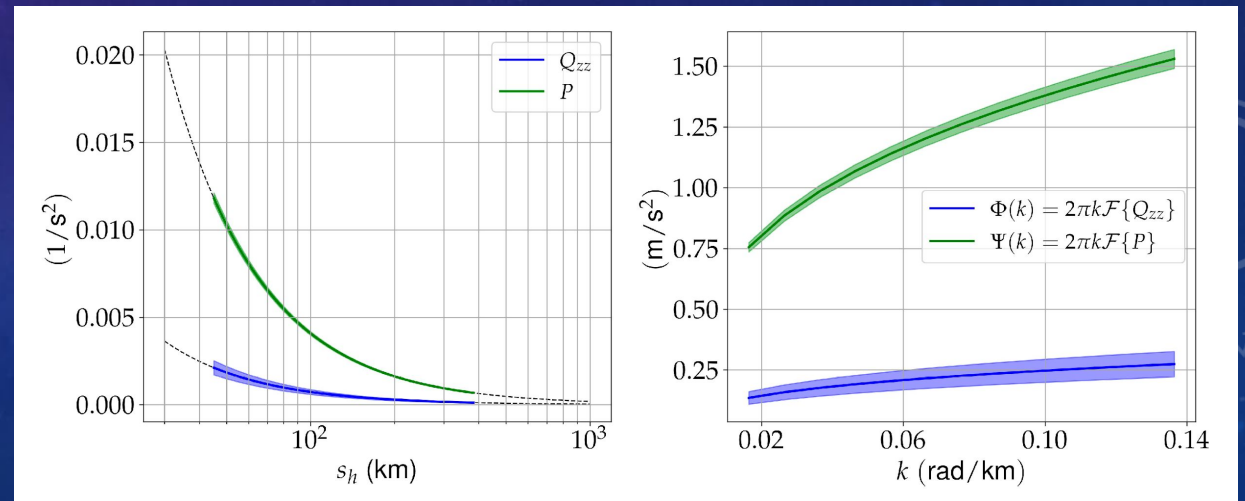
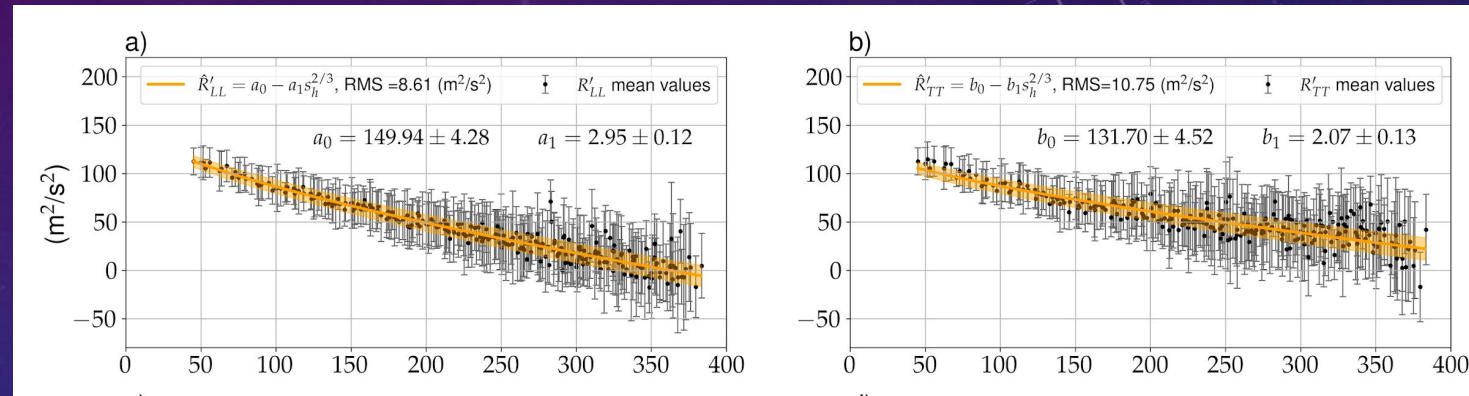
MLT mesoscales (10s to 100s km): Second-order statistics

Temporal and Spatial correlation frequency and structure functions of horizontal winds



(Vierinen et al., 2019)

Spatial correlation and wavenumber spectra of Horizontal Divergence and Vertical vorticity

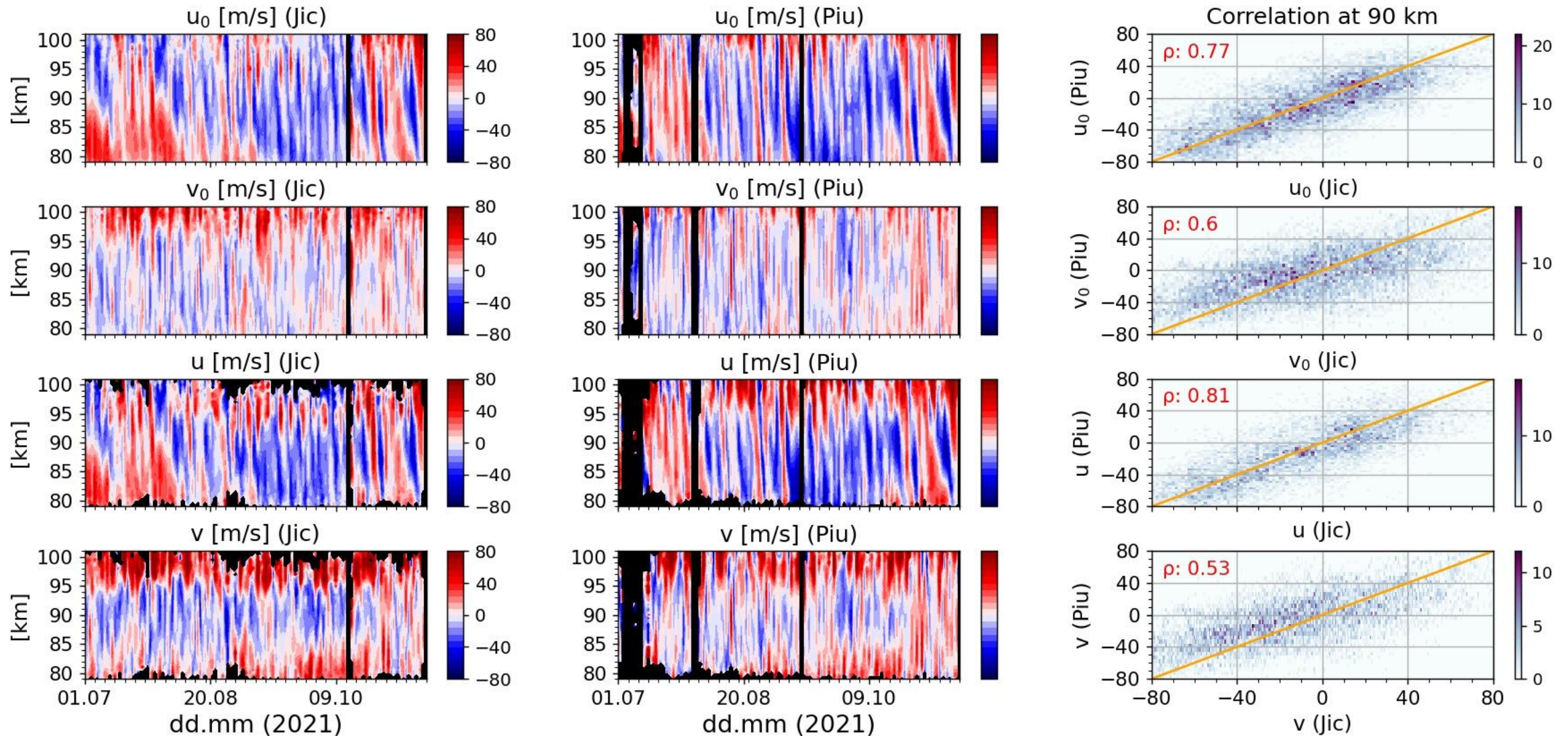


(Poblet et al., in revision, 2022)

(Chau et al., 2021)

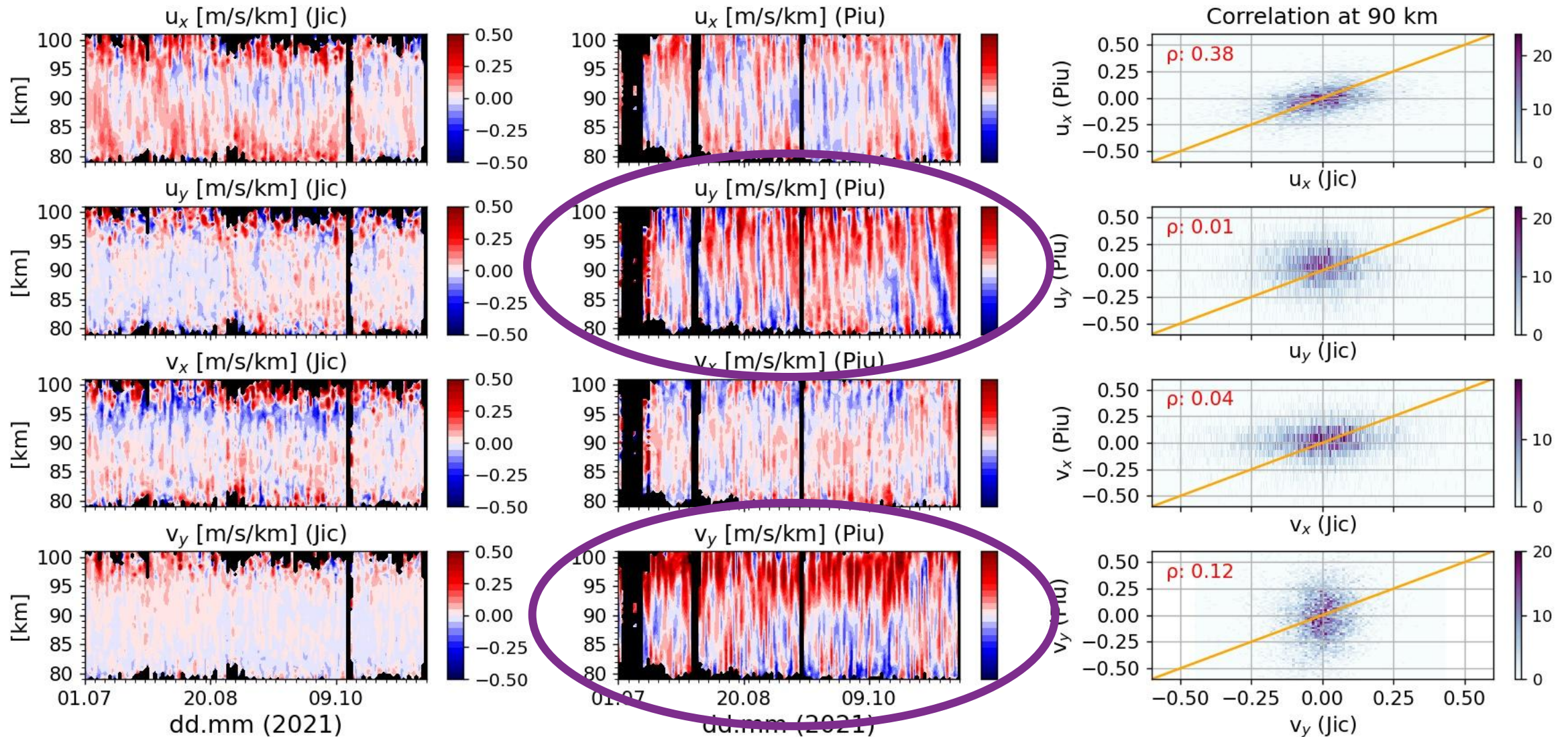
Jicamarca vs Piura (Aug-Oct 2021): Mean winds

Daily parameters & correlation of 1-h values between SIMONE Jicamarca & SIMONE Piura



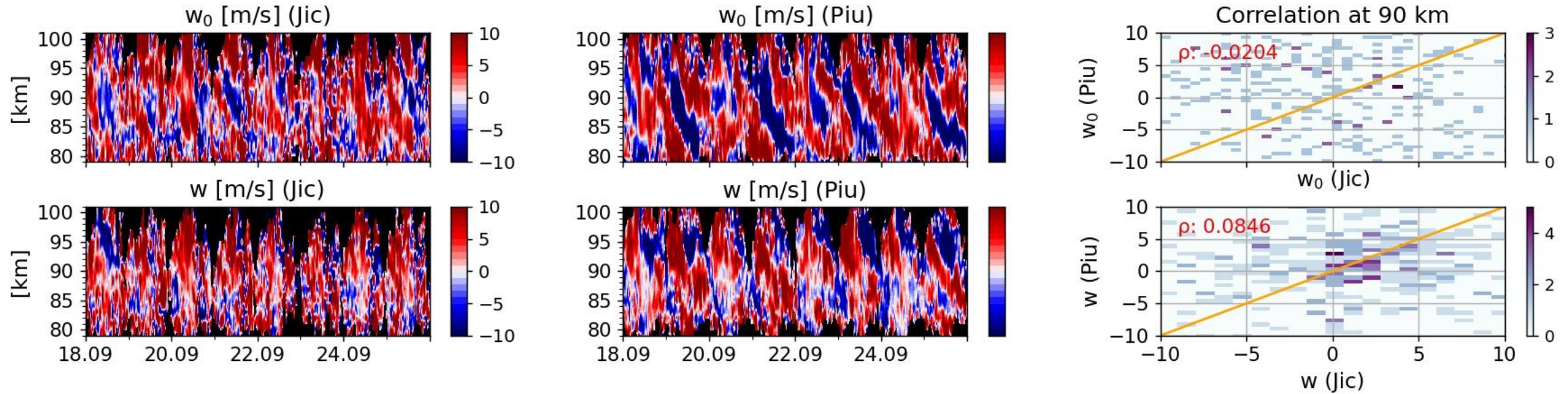
Jicamarca vs Piura (Aug-Oct 2021): Horizontal Gradients

Daily parameters & correlation of 1-h values between SIMONE Jicamarca & SIMONE Piura



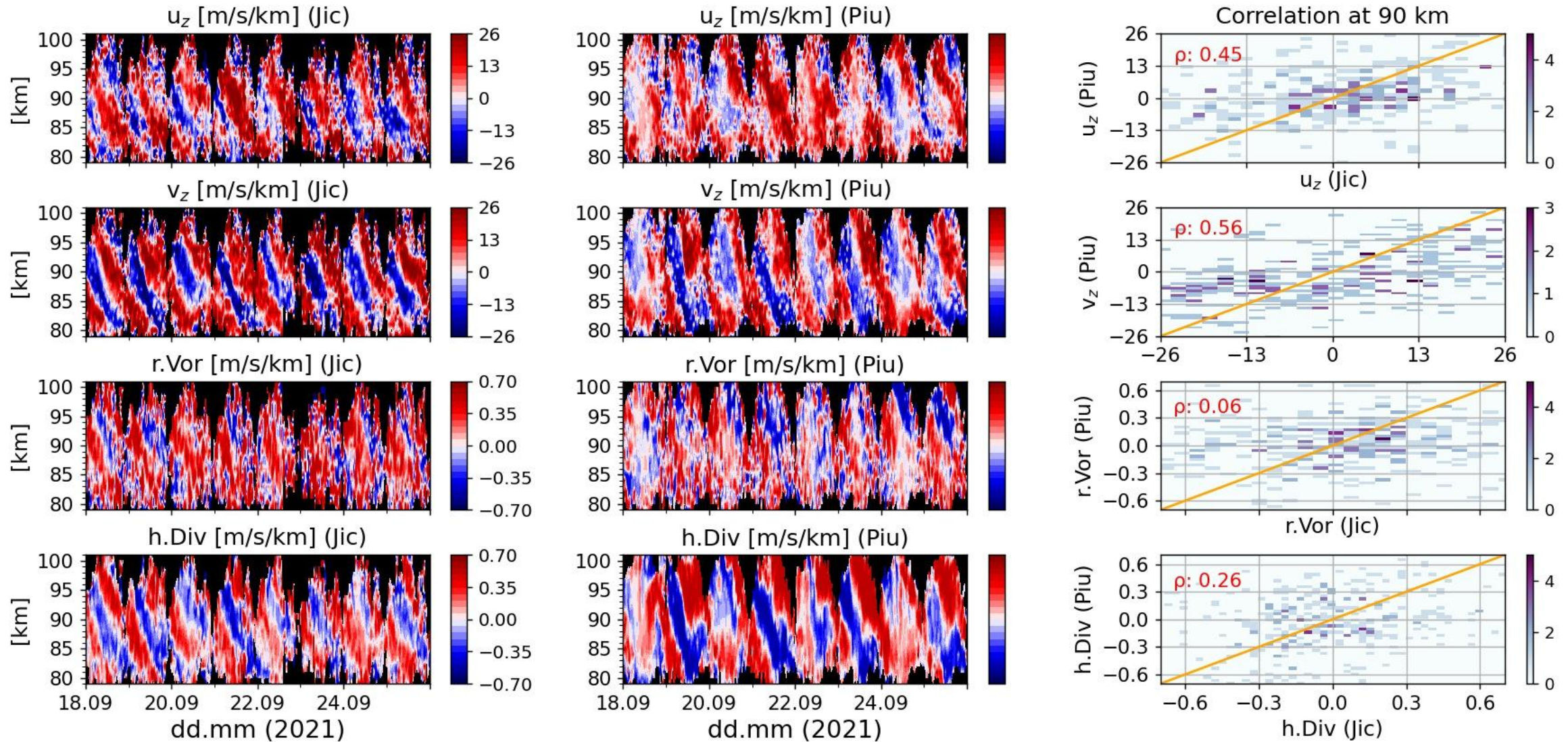
Jicamarca vs Piura (18-25 Sep): Apparent vertical velocities

Parameters & correlation of 1-h values between SIMONE Jicamarca & SIMONE Piura

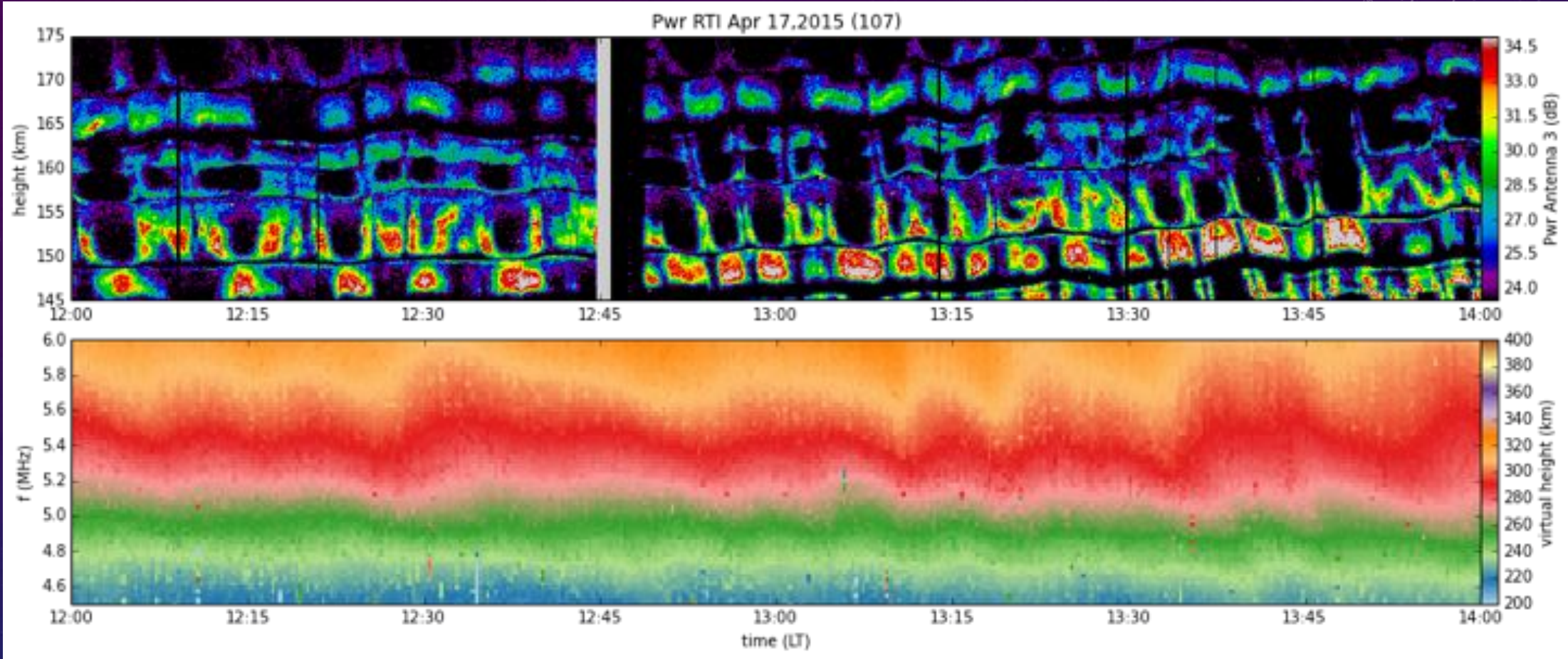


Jicamarca vs Piura (18-25 Sep): Vertical gradient s+ Vort. +Diverg.

Parameters & correlation of 1-h values between SIMONE Jicamarca & SIMONE Piura



DAYTIME VALLEY REGION: OSCILLATIONS (NEUTRAL FORCING?)

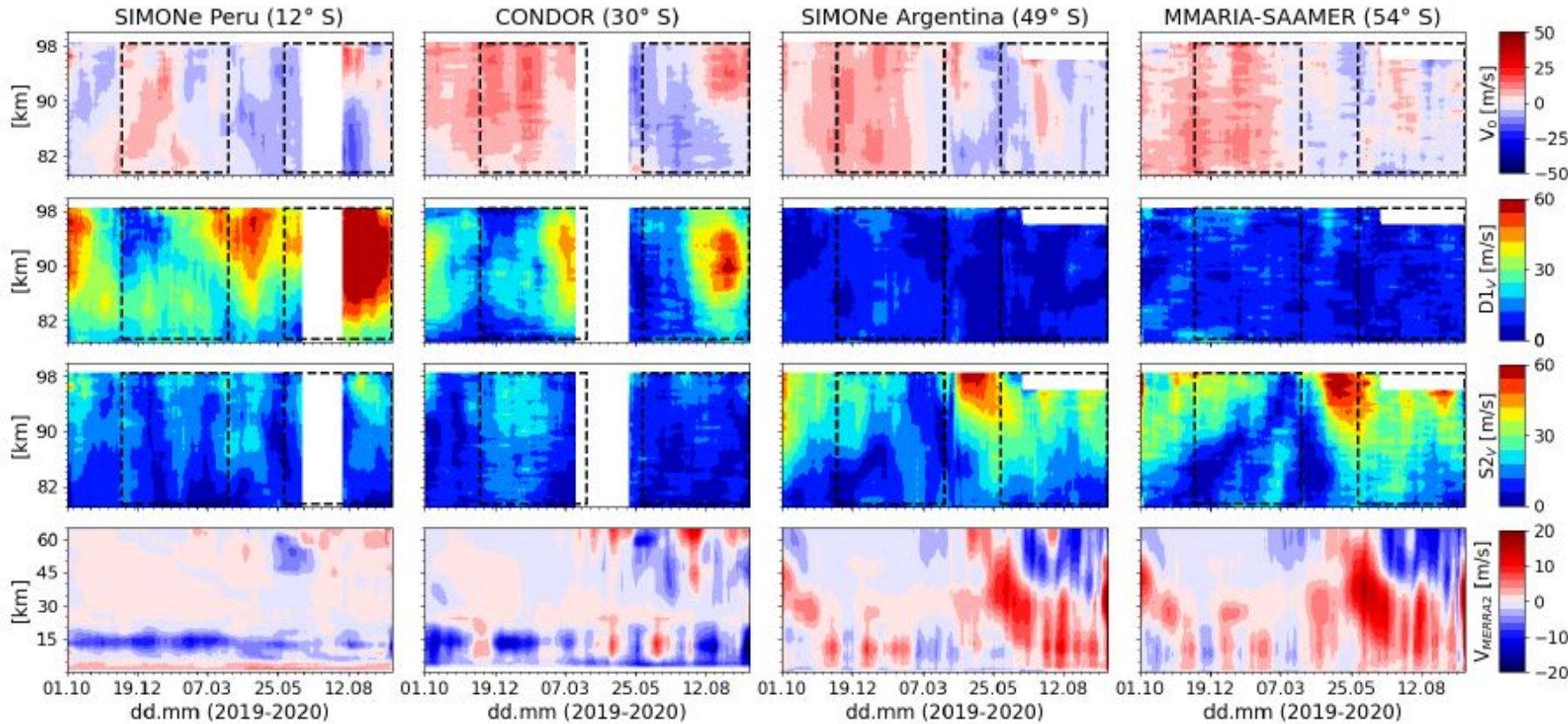


Oscillations of the sheath-like features (forbidden zones) of the 150-km echoes seem to have same periodicities as the VIPIR virtual height fluctuations.

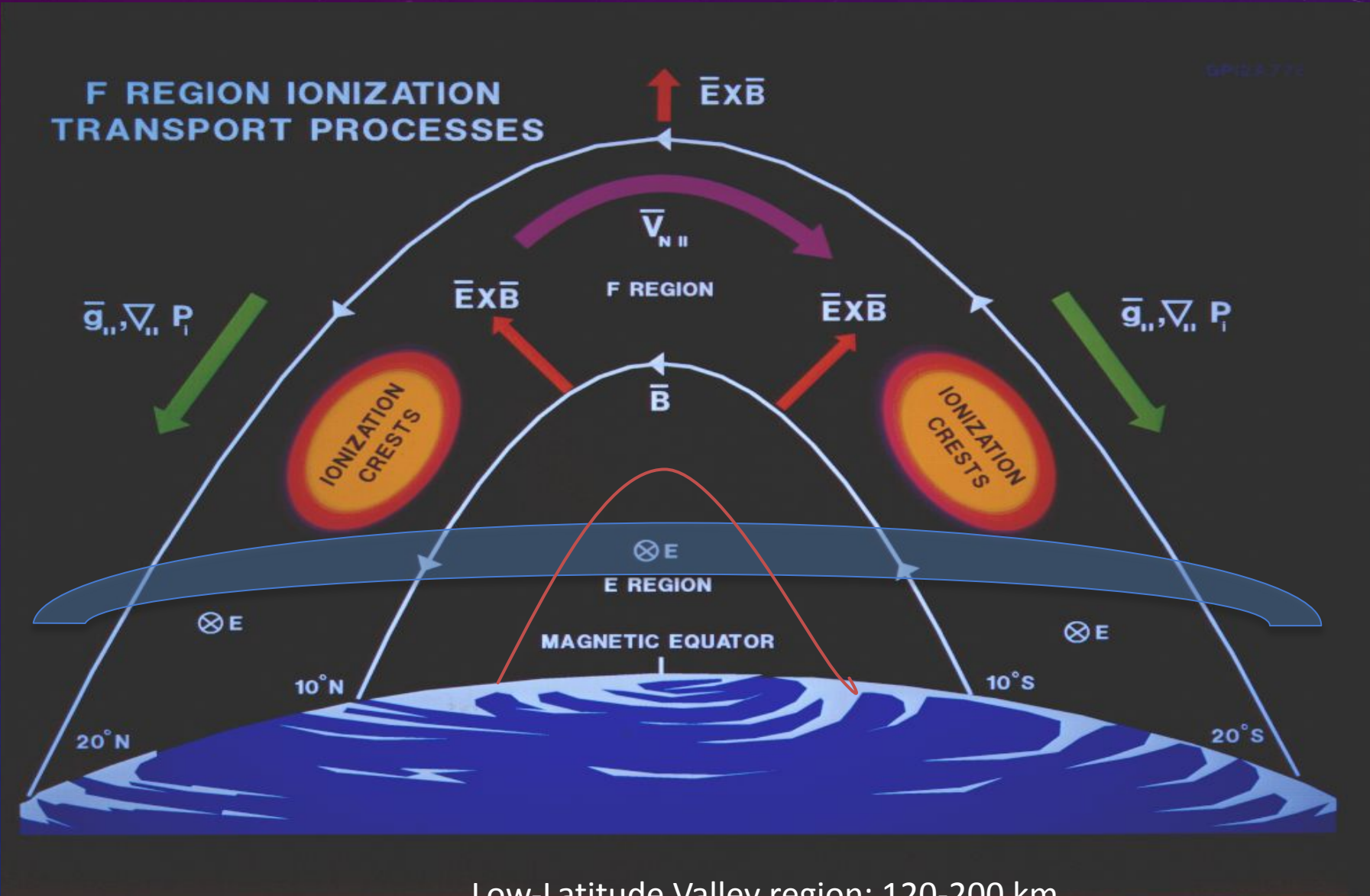
(from P. Reyes, Ph.D. work)

MLT Meridional winds: Mean + Tides

Meridional wind, diurnal and semidiurnal tides (28-day average)



LOW LATITUDE IONOSPHERE VALLEY REGION



Low-Latitude Valley region: 120-200 km,
where **terrestrial** weather meets **space** weather

(adapted from D. Anderson)