

# Diurnal and semidiurnal tides in the Mesosphere and Lower Thermosphere over the central coast of Peru

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## Abstract

It has been over a year since measurements of mesosphere and lower thermosphere (MLT) winds have been obtained with the SIMONE Peru radar. This modern multistatic specular meteor radar, placed on the central coast of Peru, has its transmitter located at the Jicamarca Radio Observatory (11.95° S, 76.87° W, dip angle 1°). This work will show some results of the climatology of diurnal and semidiurnal tides obtained from the analysis of zonal and meridional mean winds that have been estimated at heights between 80–100 km using one year of data (Nov 2019 – Oct 2020). The monthly and seasonal variation of tide amplitudes will be described. From the results we have seen that diurnal tides are more intense than semidiurnal tides, which is typical at low latitudes and that diurnal tide is more intense in August and September. These and others results will also be described in this work.

## 1. Introduction

- SIMONE Peru is a modern multistatic specular meteor radar (SMR) that allows to measure winds in the mesosphere and lower thermosphere (MLT) between 70 and 110 km altitude [1].
- Operating frequency of SIMONE Peru: 32.55 MHz (CW).
- 1 Transmitter station located at Jicamarca Radio Observatory (JRO, 11.95° S, 76.87° W, dip angle 1°) is shown as a red circle in figure 1, and 5 receiving stations deployment in the Central Coast of Peru (green circles).



Figure 1. Currently Tx and Rxs stations.

## 2. Data and methodology

- One year of data (from November 2019 to October 2020) was analyzed.
- Half-hourly winds in the MLT over Jicamarca:
  - 24-h tides dominates
  - Higher amplitudes generally appears at higher altitudes
  - Sometimes, it can reach values of 120 m/s
- composite days and harmonic analysis methodologies were applied.

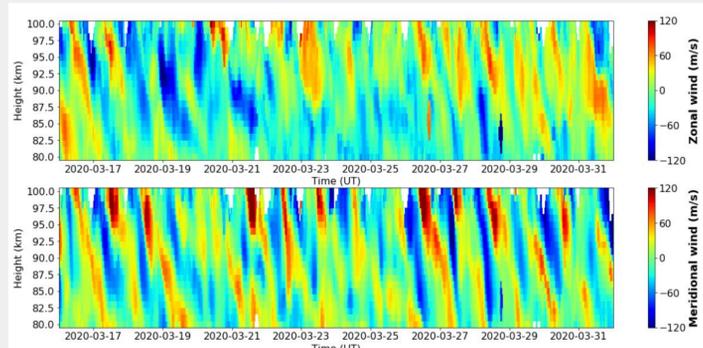


Figure 2. Half-hourly zonal and meridional winds obtained with SIMONE Peru between March 16 and March 31 (2020).

## 3. Results and discussions

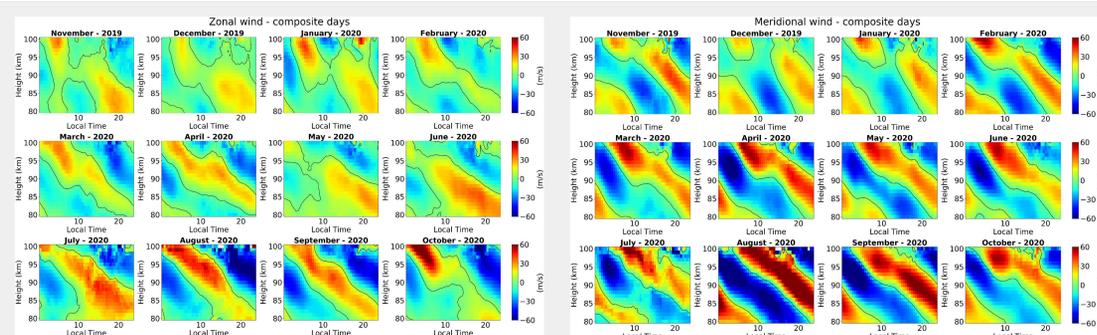


Figure 3.1. Composite days for zonal and meridional winds. This was obtained as the average in time and altitude for each day of the same month. Finally, the mean at each height of the composite day is removed to reveal only the tidal perturbations.

### For zonal and meridional wind - composite days

- 24-hour tides predominate.
- 12-hour tide is also present.
- Discontinuities in the phase front show the presence of planetary waves and tides.
- Meridional winds have more intensity in august and september, while for zonal winds it happens from august to october.
- The negative slope indicates a vertical phase velocity.

## 3. Results and discussions

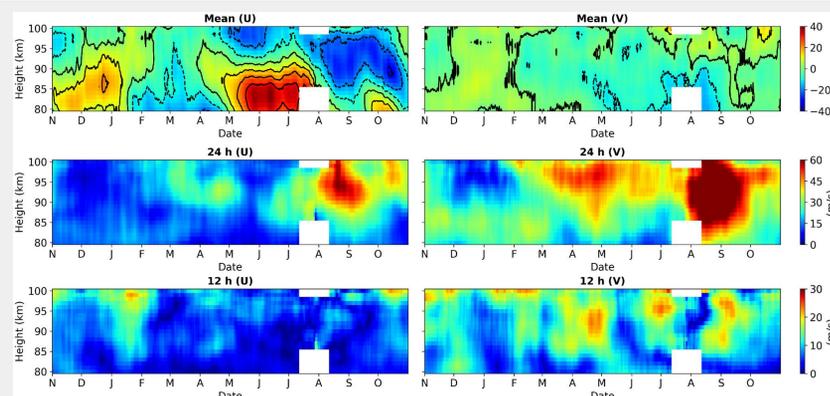


Figure 3.2. Background wind, 24 h and 12 h tides. They were obtained by fitting to specific periods. The window size for the fitting is 30 days.

- **For zonal background winds:**
  - In general, a quasi-semester period is observed below 90 km.
  - The most intense easterly winds (35 m/s) happened between the end of May and the first 15 days of June, possibly related to the winter solstice (June 21). Also, in the same period of time and between 95–100 km an increase in winds towards the west was observed (15–20 m/s).
  - At the end of December, there was an increase in winds towards the east (20 m/s), between 84–88 km, possibly related to the summer solstice (December 21).
  - From the beginning of August to the end of October, between 85–97 km, intense winds were observed towards the west, between 20–30 m/s.
- **For meridional background winds:**
  - In general, a quasi-annual period is observed.
  - Greater intensity was observed towards the south in July and August (15–20 m/s) below 90 km.
  - An increase of the winds towards the north was observed in October (15–20 m/s, between 95–100 km).
  - For December 2019 and January 2020, mostly for all altitudes between 80–100 km, the winds were towards the north.
- **For 12 h and 24 h tides:**
  - The 24 h tides were more intense than 12 h tides.
  - For 24 h tide:
    - it had the maximum intensity in August and September.
    - It was observed that the meridional component was more intense than the zonal component.
    - In mid October, there was an increase in amplitude above 90 km. Another increase happened in March, April and May above 90 km.
    - For 24 h meridional tide, in December and January, the amplitudes above 90 km were less intense than below 90 km.
  - For the 12 h tide:
    - Usually, it was observed that the meridional component was more intense than the zonal component (it was not case for January).

## 4. Future Work

- Comparison with GCMs (e.g., WACCM-X).
- Statistics of quasi-two day waves, that are also strong at low latitudes.

## 5. Acknowledgments

- Thanks to Leibniz-Institute of Atmospheric Physics and Instituto Geofísico del Perú staff.

## 6. References

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