Long term analysis of high-resolution E-region neutral wind estimations over Jicamarca: First results

R. Flores [1], M. Milla [2] and D. L. Hysell [3]

[1] Jicamarca Radio Observatory, Instituto Geofísico del Perú, Lima, Perú
[2] Instituto de Radioastronomía, Pontificia Universidad Católica del Perú, Lima, Perú
[3] Department of Earth and Atmospheric Sciences, Cornell University, Ithaca, New York, USA

Abstract

Ground based techniques can be used to measure neutral zonal winds, such as the ISR technique which is usually performed to estimate zonal wind profiles from measured ion drifts at mid- and high-latitude but cannot be used at low-latitudes due to clutter from coherent echoes at E-layer (EEJ). Additionally, the Spread Spectrum Interferometric Multistatic meteor radar Observing Network (SIMONe) system, deployed in September 2019, can estimate neutral winds from specular meteor trail echoes in the mesosphere and lower thermosphere (MLT) region (70 - 110 km) which includes the EEJ layer, however the time resolution is 1 hour and it probes a larger volume than our oblique radar, then estimated winds will be a result of a contribution from different regions. Space-based missions have also been used to measure these winds such as the Michelson Interferometer for Global High-Resolution Thermospheric Imaging (MIGHTI) on board the ICON satellite, the Wind Imaging Interferometer (WINDII) on the Upper Atmosphere Research Satellite (UARS) among others, but their measurements are not continuous over a specific latitude and longitude as they orbit around the planet. On the other hand, a technique to estimate zonal neutral winds from oblique EEJ type II Doppler shifts, sampled every minute approximately, was proposed by Shume et al. [2005]. This method predicts Doppler shifts from neutral winds, compares the Doppler with the measured ones and updates the winds until the best data-model agreement of the Doppler shift (RMSE≤2.0). Although wind estimations are limited to the EEJ echoes detection and SNR intensity, this method provides high time resolution wind profiles from 97 to 107 km approximately and might be complemented by other techniques. This work presents the first results of neutral wind estimations over the Jicamarca Radio Observatory (JRO), a facility of Instituto Geofísico del Perú (IGP), at the EEJ region with a resolution of 5 minutes and 700 meters using oblique spectra data fitted by a skewed Gaussian distribution.

1. Introduction

Coherent echoes from the equatorial electrojet (EEJ) region was routinely detected at IGP-JRO, using an array of 16 Yagi antennas pointing obliquely to the west with an elevation angle of 35 degrees. The spectra of these observations are composed of two types of echoes (Type I and Type II). Spectral parameters can be independently estimated for each type by a fitting procedure. Due to the asymmetric shape of the measured EEJ Type II spectra (Figure 1), a skew Gaussian distribution had to be proposed to fit the data rather than the usual Gaussian model (Figure 2). It was also demonstrated that the shift of the new approach is the parameter that is a better proxy of the Doppler of the echoes instead of the spectral peak.

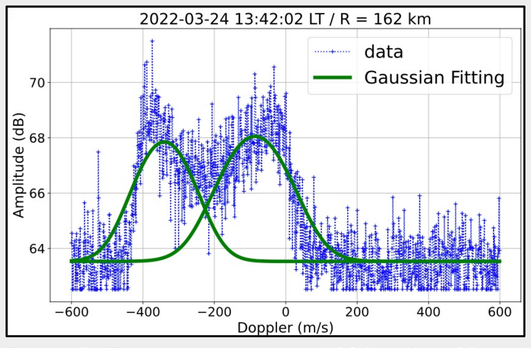

Figure 1. EEJ spectrum at R = 162 km fitted by a Gaussian distribution.

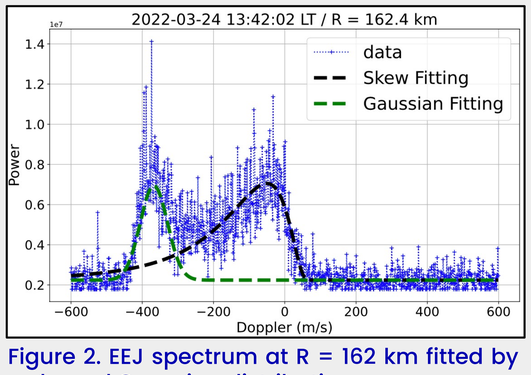

Figure 2. EEJ spectrum at R = 162 km fitted by a skewed Gaussian distribution.

2. Procedure

According to Shume et al. [2005], zonal neutral winds can be estimated from EEJ type II Doppler shifts following the procedure described in Figure 3.

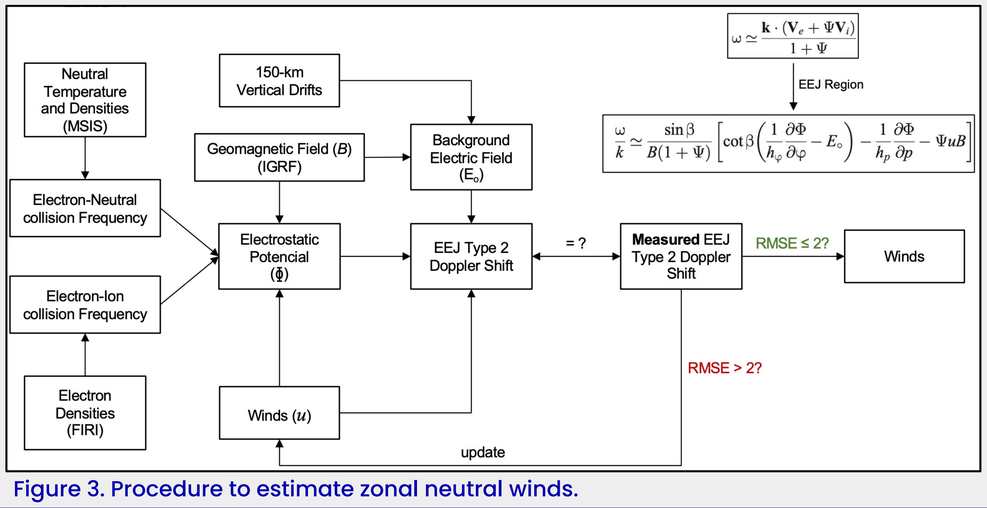

Figure 3. Procedure to estimate zonal neutral winds.

3. Results

Geomagnetically quiet days (Kp<4) were chosen to estimate the zonal neutral winds. In this first attempt, 22 days from months belonging to the local winter solstice between years 2018 and 2020 where used to estimate the winds. The average (Figure 4) shows eastward values up to 200 m/s with the peak around 100 km.

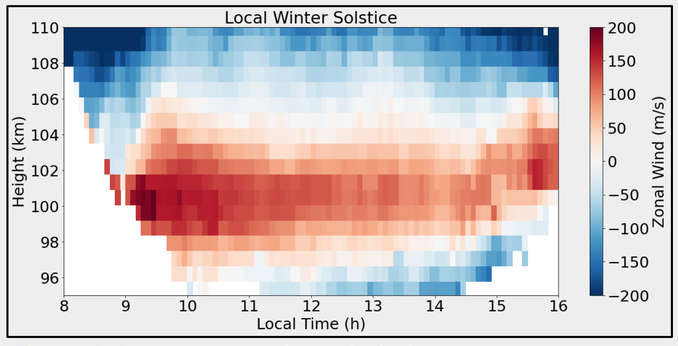

Figure 4. Average neutral zonal winds.

4. Conclusions and Future Work

- ✓ Wind values can be estimated from 8 LT to 16 LT where the EEJ echoes are stronger.
- ✓ For local winter solstice, neutral winds are eastward around 100 km and change direction below and above.
- Implement the method over the 10 year database of EEJ oblique spectra.
- Compare the results with the climatology from SIMONe.

5. Acknowledgments

The Jicamarca Radio Observatory is a facility of the Instituto Geofísico del Perú operated with support from the NSF AGS-2213849 through Cornell University.

6. References

[1] Shume, E. B., Hysell, D. L., & Chau, J. L. (2005). Zonal wind velocity profiles in the equatorial electrojet derived from phase velocities of type II radar echoes. Journal of Geophysical Research: Space Physics, 110(A12).

email: rflores@igp.gob.pe