New Results on Equatorial Thermospheric Winds and Temperatures from Ethiopia, Africa

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Abstract

We present monthly climatologies (Nov 2015 to April 2016) of equatorial winds and temperatures obtained from Fabry-Perot imaging interferometer measurements of Doppler shift and Doppler broadening for the 630nm redline emission spectral lineshape. The data used (53 nights) in this study were collected by the FPI observatory located at Bahir Dar in the north-western Ethiopia (11.6N, 37.4E, 3.7N magnetic).

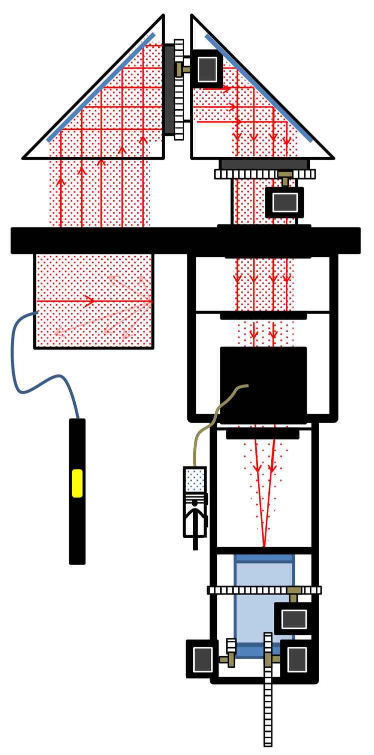

Figure 1: FPI set up

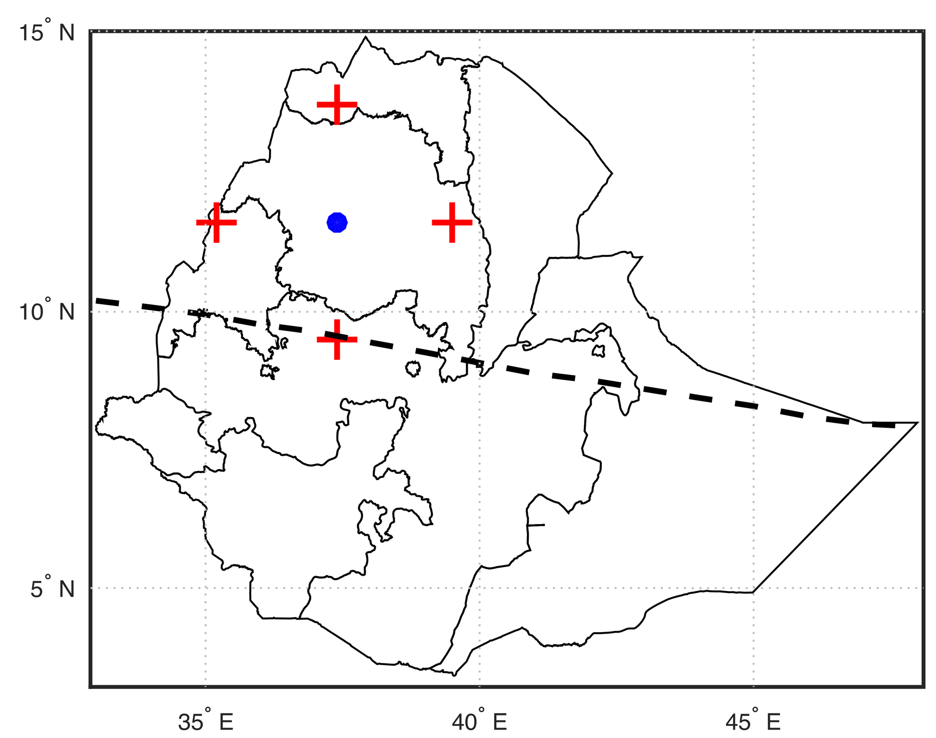

Figure 2: Map of FPI BDR site (blue dot) and look directions (red crosses). The dashed line shows the path of the geomagnetic equator

- Neutral temperature and wind speed & direction are important atmospheric parameters required for the study of the thermosphere-ionosphere coupled system.
- Equatorial latitudes : the formation of F-region dynamo, R-T plasma instability, and development of MTM are mainly driven by the neutral wind.

Night to Night variability

There is seen significant night-to-night variability in the temperature, 630nm airglow intensity, and the wind speed/direction. Figure 3 illustrates a typical example.

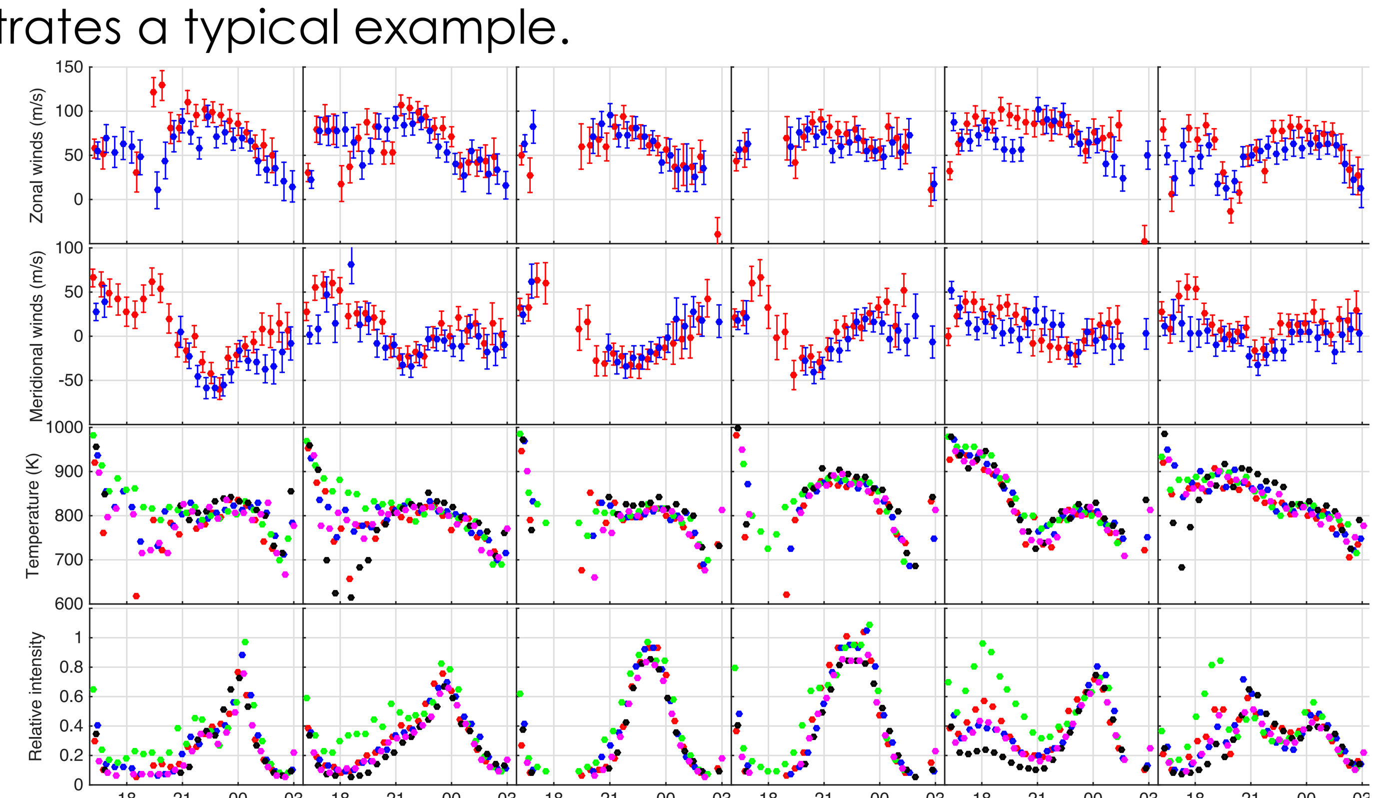

Figure 3: Winds, temperature and intensity data from Feb 04 to 09 2016.

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Thermospheric winds & HWM14 model results

- Figure 4 shows the monthly climatologies of neutral winds from BDR and the HWM14 model results for comparison.
- The maximum zonal wind values are between 70 & 90m/s, this magnitude is smaller compared to other longitudes i.e above 100 m/s (Martinis et al., 2001; Meriwether et al., 2011, 2012).
- Maximum equatorward wind shifts to later time in winter & to earlier time in equinox (black arrows).
- High poleward wind at the beginning of the night in winter months: conclude due to interhemispheric flow.
- Model values show good agreement with some exceptions, overestimating in the winter months for both wind speed components.

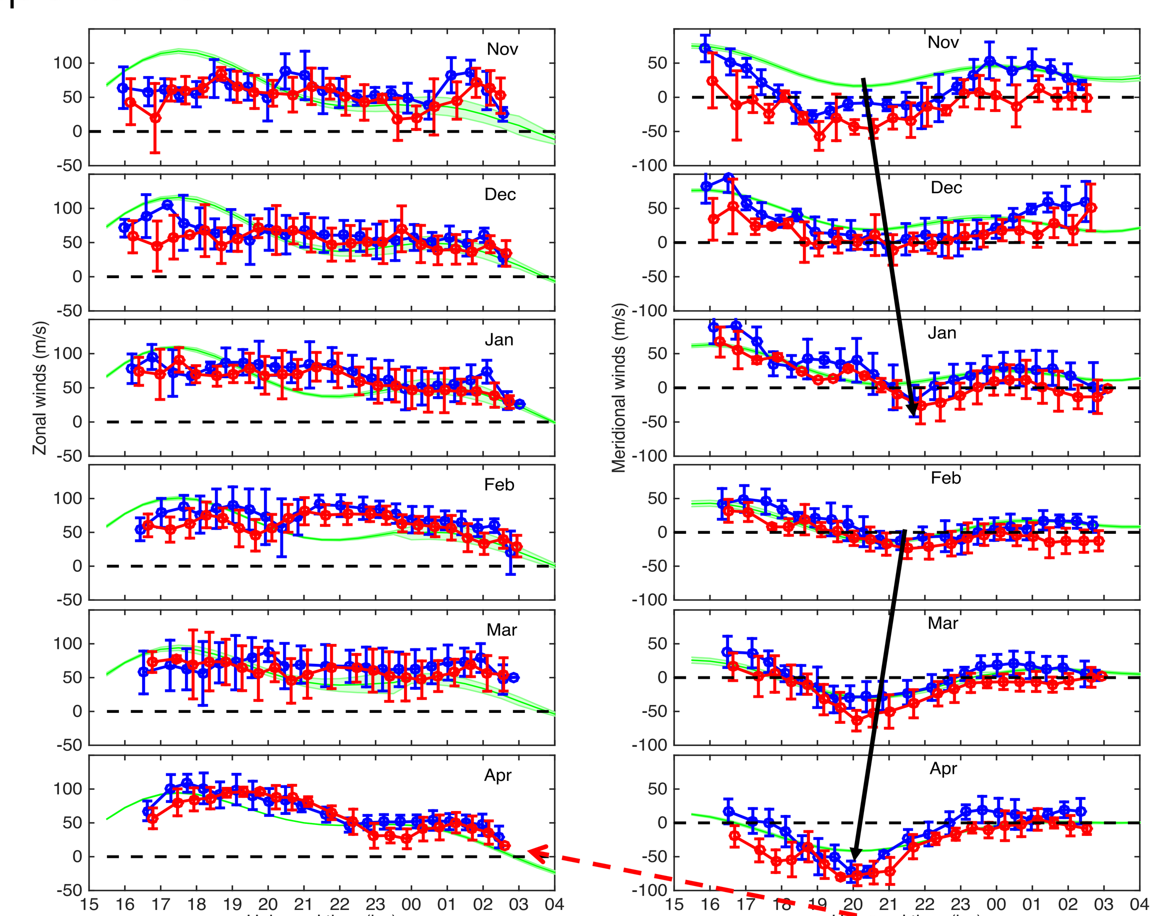

Figure 4: Monthly climatology wind (red (West and South) and blue (East and North)) & model results (green)..

Temperature and MSIS-00 model results

- Figure 5 shows monthly climatologies of BDR temperatures and MSIS-00 model results for comparison
- MTM signatures were evident in these observations (50-110K).
- The MTM was observed after 1 to 2 hrs of equatorward wind.
- The MTM signatures are associated with the abatement and/or reversal of meridional winds.
- MSIS fail to reproduce temp behavior for the early evening winter months.

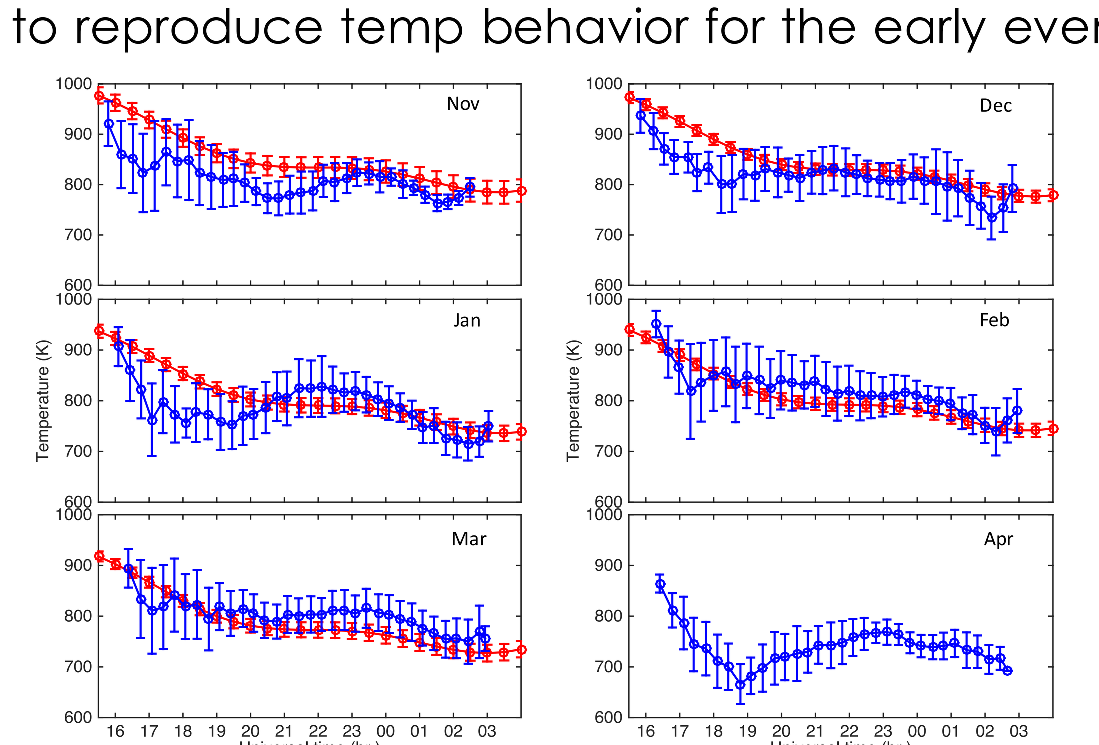

Figure 5: Monthly climatology (blue) plots of Temperature and MSIS-00 model results (red).

Intensity and vertical winds

- 630-nm Intensity shows a major decrease in the post sunset hours due to the vertical **E**x**B** drift elevating the plasma, lowering the recombination rate; Conversely, post midnight, the intensity increase significantly due to the now downward **E**x**B** drift.
- The vertical winds show significant variations from month to month before midnight and often just before dawn.

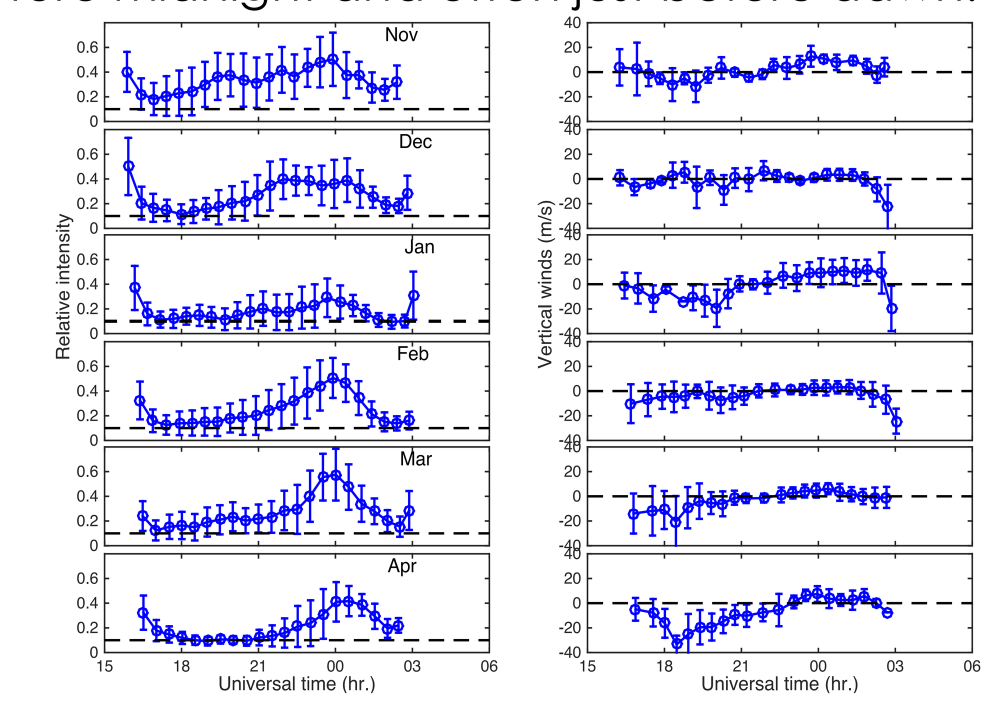

Figure 6: intensity and vertical winds

Pressure Bulge effect

- The westward pressure gradient slows down the eastward wind until the pressure bulge passes overhead.
- The eastward pressure gradient force on the eastward flank of the bulge begins to accelerate the wind in the predawn sector.
- The rediual effect of the pressure bulge on the zonal winds is shown in Figure &, where the bulge abates the zonal wind by 20m/s.

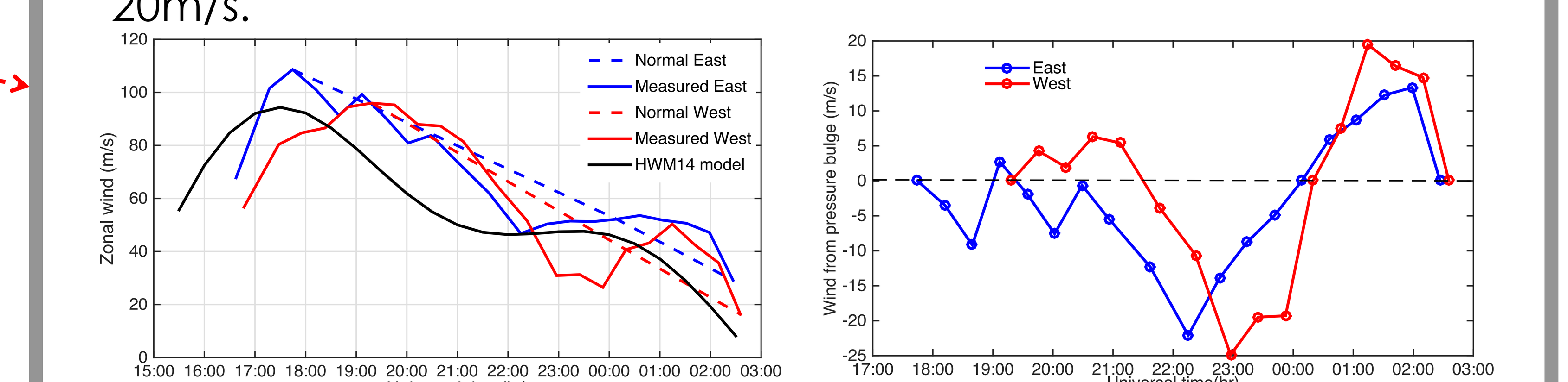

Figure 7: Figure to illustrate back pressure bulge effect on zonal wind (April 2016).

Conclusions

- The maximum magnitude of the zonal wind is found to be weak (b/n 70 to 90m/s) but in agreement with HWM14.
- Meridional winds show seasonal variations in the equatorward surge shifting to later time in winter and earlier time in equinox.
- Significant MTM signatures with values ranging from 50 to 110K.
- Generally HWM14 wind model agreed well with observations.
- The pressure bulge wind is about 20 m/s.

References

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