# Comparison of modeled meridional neutral winds using changes in $h_mF_2$ with neutral wind observations and other models.

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## Introduction

A new empirical model of winds in the mid-latitude thermosphere is being developed. Magnetic meridional neutral winds have been derived using the ionospheric $F_2$ layer heights ($h_mF_2$) from ionosonde observations using a global ionosonde database of mid-latitude ionosonde measurements that spans 30 years. The database consists of nearly 80 mid-latitude ionosonde sites and the derived wind values at each site have a one hour time resolution. The neutral winds have been termed 'equivalent' (EQ) winds due to the fact that they are obtained from $h_mF_2$ that may be driven by both neutral winds and/or a vertical drift due to horizontal electric fields. This work presents a comparison of these new equivalent winds with other modeled winds and wind observations in the thermosphere. Understanding the behavior of horizontal meridional neutral winds in the thermosphere is critical to ionospheric modeling.

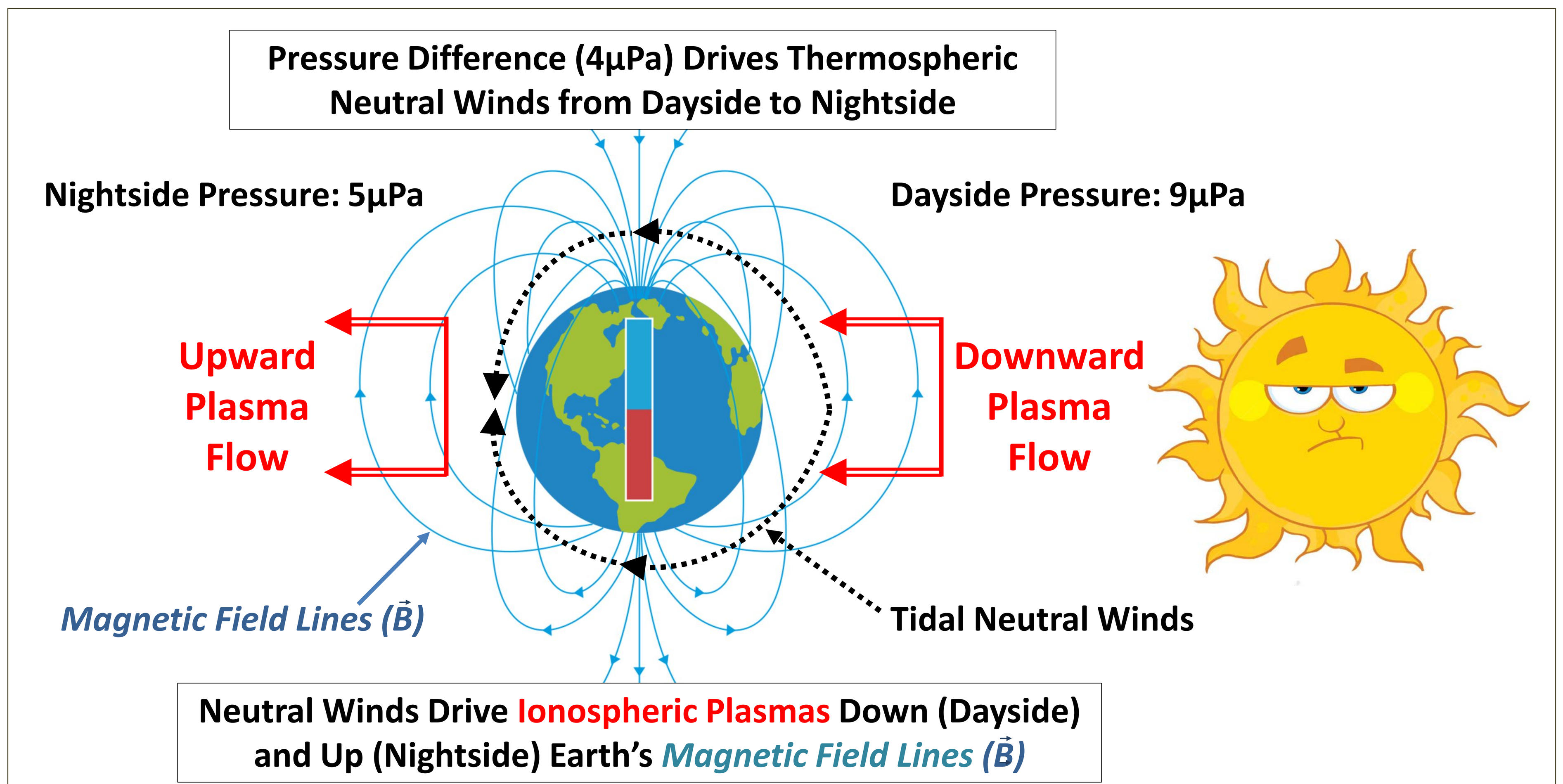


**Figure 1. Physics of thermospheric tidal winds and how they affect ionospheric F2 layer height ($h_mF_2$).**

## Comparison with HWM14 empirical winds

A comparison of the derived equivalent (EQ) neutral winds with HWM14 empirical winds is shown in Figure 2 below at Townsville, Australia. Ionosonde observations of the F2 layer height ($h_mF_2$) in (b) are used to constrain the first-principles Field Line Interhemispheric Plasma (FLIP) model in order to derive the peak electron densities ($N_mF_2$) in (c) and the hourly equivalent meridional neutral winds in (d). The general diurnal behavior of the HWM14 winds is comparable to the EQ winds, but the EQ winds display the frequent surges and abatements that are required for the model $h_mF_2$ to track the observed $h_mF_2$ shown in (b).

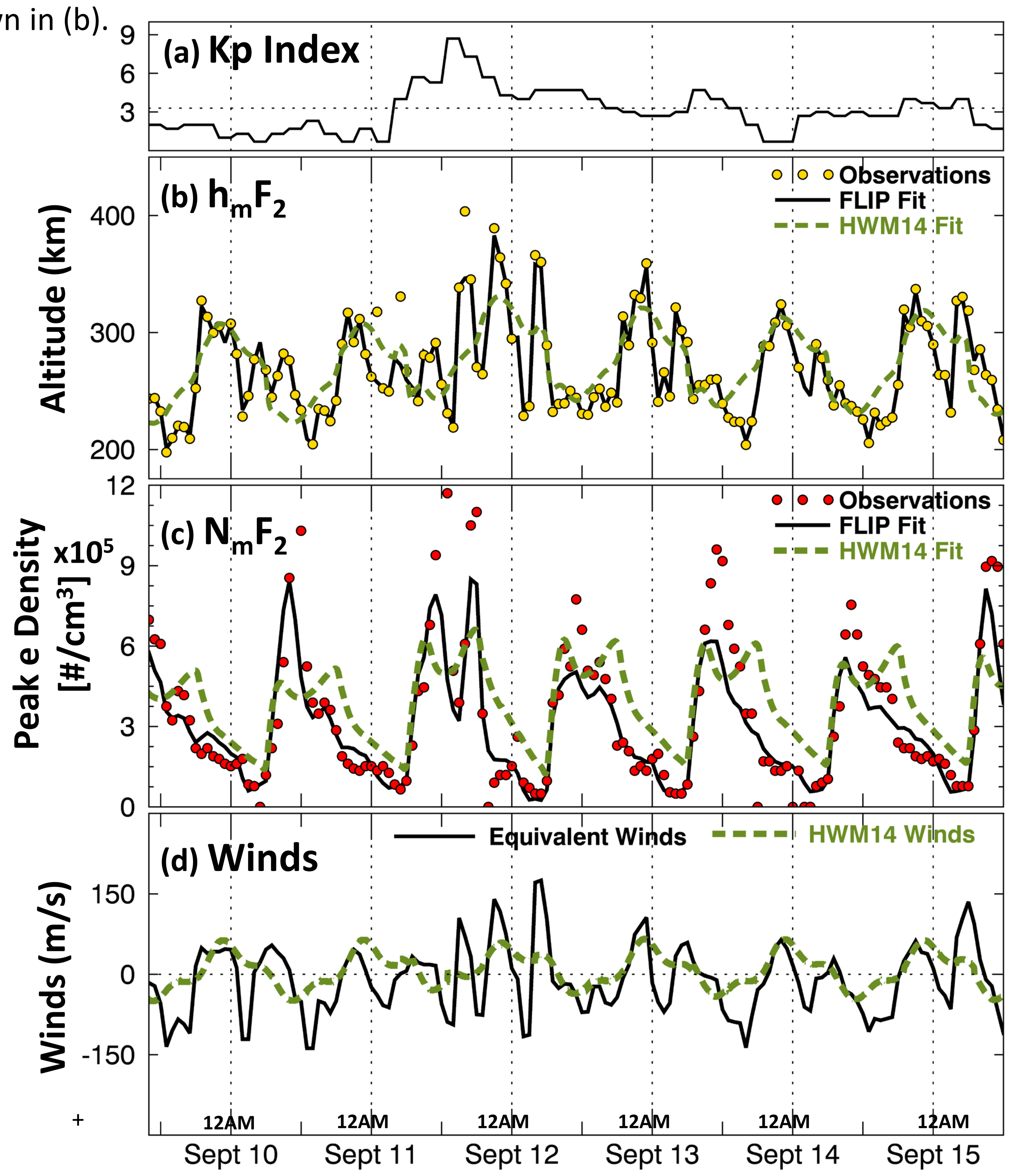


**Figure 2. $h_mF_2$, $N_mF_2$ and northward meridional neutral winds at Townsville, AU (-28° MagLat) during 1986 (solar minimum).**

## Thermospheric Meridional Wind Patterns

Thermospheric winds tend to blow away from the hot (high pressure) near the subsolar point on the dayside toward the cold (low pressure) location on the nightside. If there is not much auroral activity, the winds blow over the poles from dayside to nightside, gaining momentum. Nightside winds may pick up momentum from mild auroral activity. Stronger auroral activity will oppose Northward dayside winds and enhance Southward nightside winds. In the mid-latitudes, nightside winds may be larger than dayside winds due to lower nightside ion production and subsequent lower ion drag.

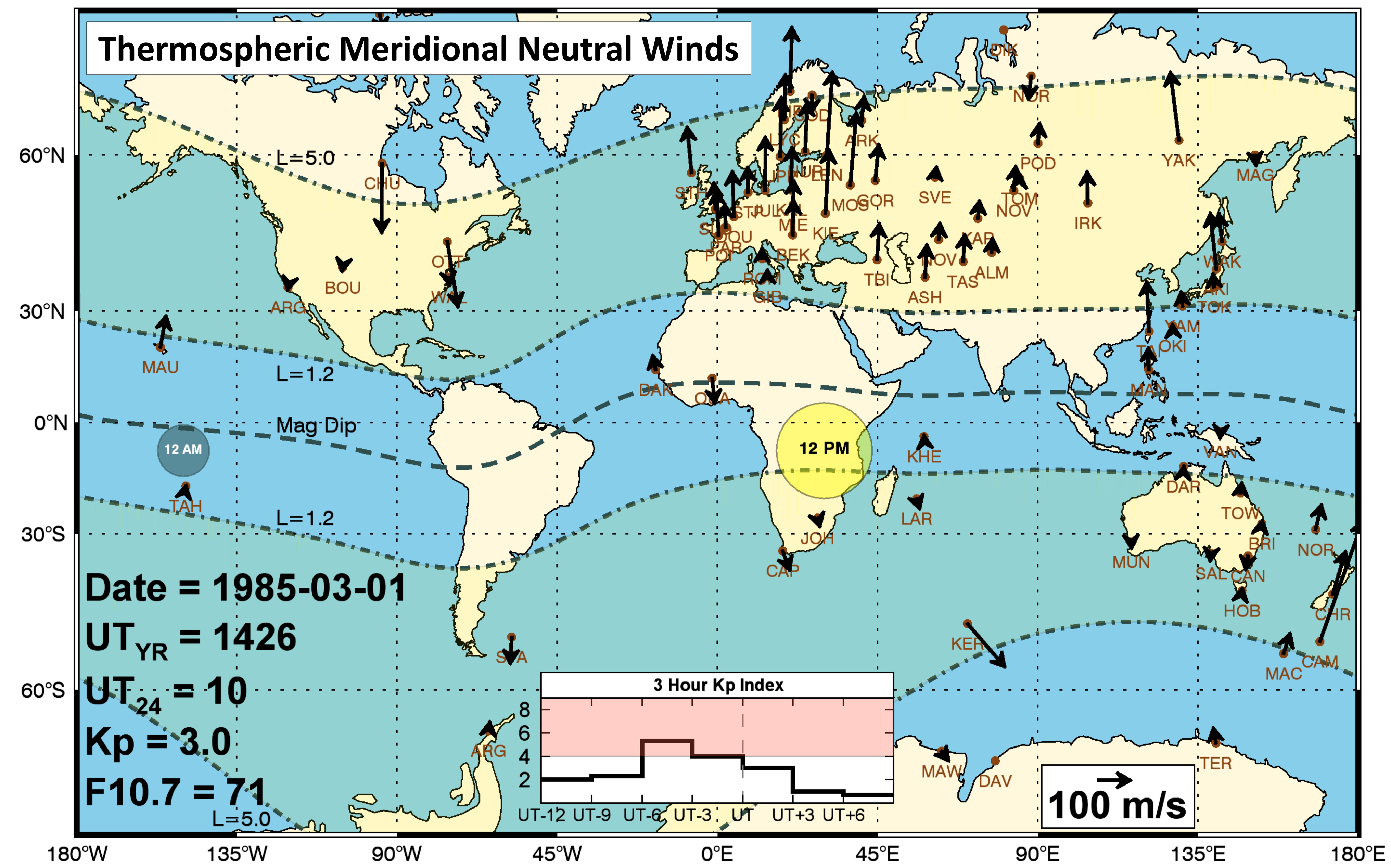


**Figure 3. Hourly meridional neutral wind vectors. The magnetic mid-latitude regions (±24° to ±63° MagLat, or L-shell from 1.2 to 5.0) are shaded in light green.**

## Validation: Comparison with Wind Observations

A comparison of Fabry-Perot Interferometer (FPI) thermospheric wind observations with derived equivalent winds and HWM14 empirical winds is shown in Figure 4 below. In this case, the International Reference Ionosphere (IRI) model provided the $h_mF_2$ layer heights for the equivalent winds. All of the winds are southward meridional.

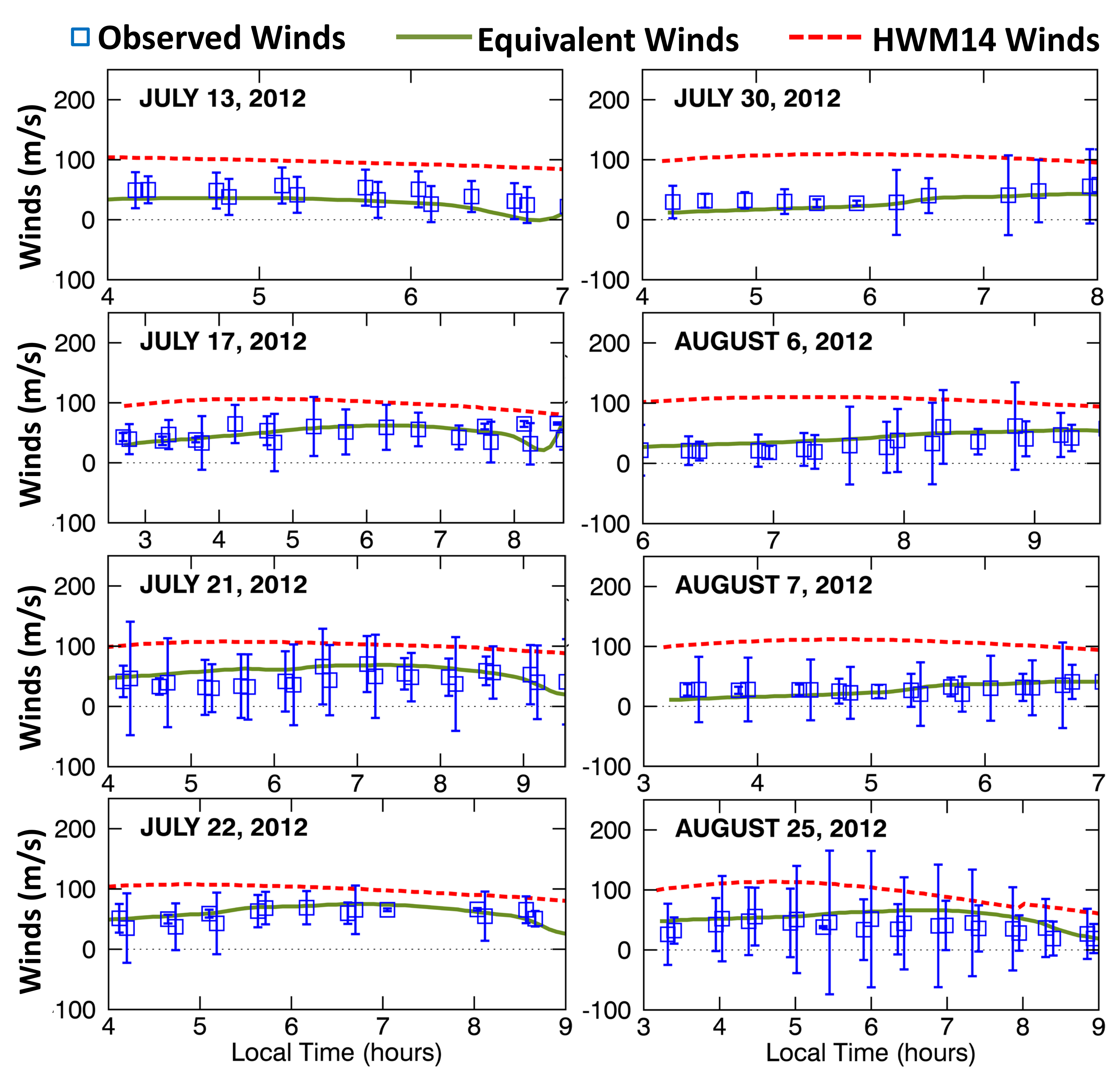


**Figure 4. Modeled winds vs. wind observations at the Richmond, Kentucky FPI site (+38° GeoLat). All winds are southward meridional.**