Estimating 2D neutral wind patterns using line-of-sight data from multiple Scanning Doppler Imagers

*Heikki Vanhamaki[1], Shin-ichiro Oyama[1,2], Mark Conde[3], Anita Aikio[1], Lei Cai[4], Ilkka Virtanen[1]

1. University of Oulu, Finland, 2. Institute for Space-Earth Environmental Research, Nagoya University, Japan, 3. Geophysical Institute, University of Alaska Fairbanks, US, 4. KTH Royal Institute of Technology, Sweden

We present a new analysis technique for estimating 2D neutral wind pattern using data from a single Scanning Doppler Imager (SDI) or a combination of SDIs, incoherent scatter radars (ISR) and Fabry-Perot interferometers (FPI) within overlapping field-of-views. Neutral wind plays an important role in ionospheric electrodynamics and Ionosphere-Thermosphere coupling, by for example affecting the Joule heating rates and plasma transport. However, reliable and extensive measurements of the neutral wind are rather difficult to obtain.

Pointwise measurements can be obtained with ISRs or FPIs, but these measurements can not provide 2D latitude-longitude maps of the neutral wind pattern needed in mesospheric studies. A Scanning Doppler Imager can measure the line-of-sight (LOS) component of the neutral wind in dozens of directions simultaneously. However, further modeling is needed to convert the LOS velocities into 2D velocity maps. Unfortunately these maps are far from unique, as perpendicular velocities (e.g. rotation around the measurement site) are not visible in the LOS data. This can be mitigated by combining data from several nearby SDIs, or a combination of SDIs, FPIs and ISRs.

Our analysis technique is based on fitting the LOS data with special vector basis functions called Spherical Elementary Current Systems (SECS). In this approach the wind is naturally divided into curl-free and divergence-free components, and there is no need to provide any explicit boundary conditions on the wind pattern.

We present several synthetic test scenarios as well as first results using data from SDIs located in Alaska. Using the synthetic test scenarious we further estimate optimal locations for 2 or 3 SDIs that could be located around the future EISCAT_3D radar system in northern Scandinavia.

Keywords: Ionosphere, Thermosphere, Neutral wind

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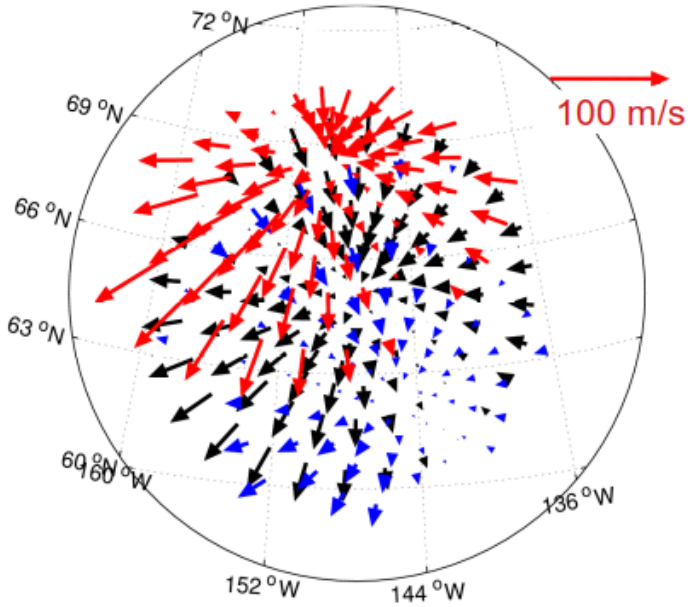
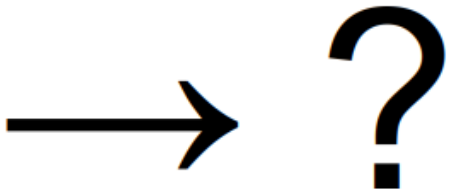
Line-of-sight velocity
from 3 SDIs



Neutral wind pattern



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