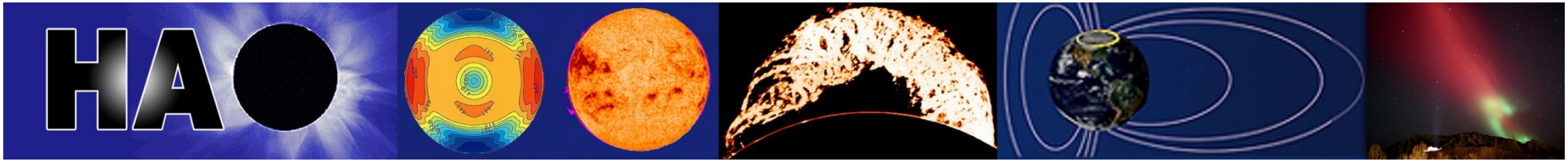


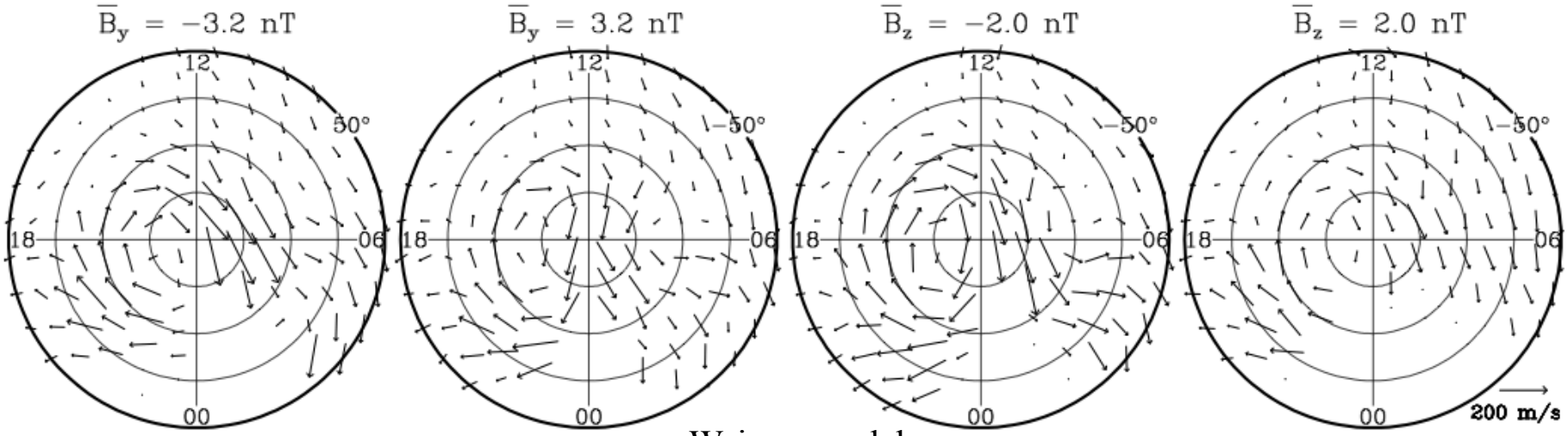
Importance of Winds on High-Latitude Ionospheric Electrodynamics

Art Richmond
NCAR High Altitude Observatory

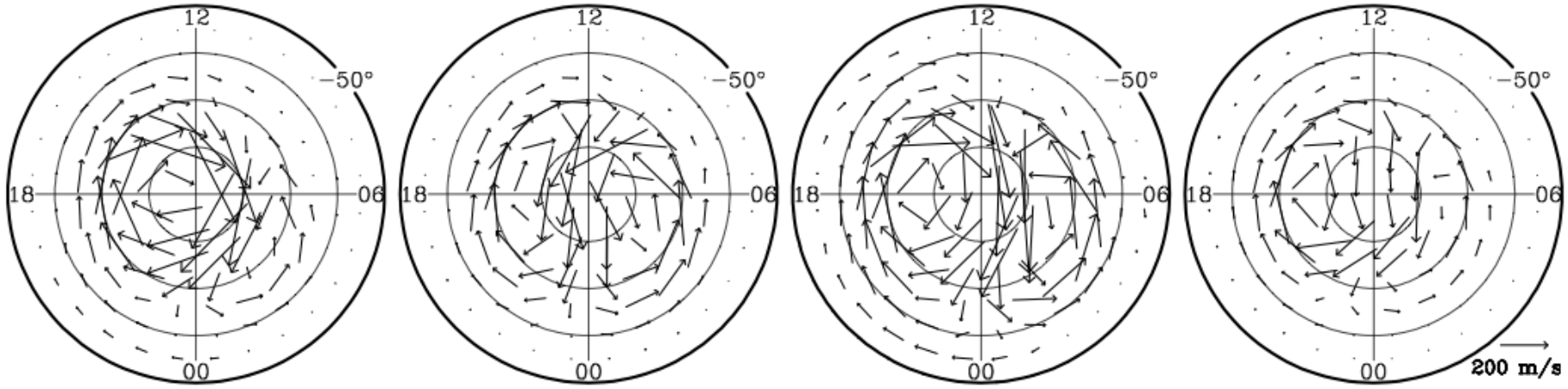
- Lower-thermosphere wind driven by high-latitude ion convection
- Wind contribution to electrodynamics
- Forces determining wind and its vorticity
- Suggested approach to account for wind effects

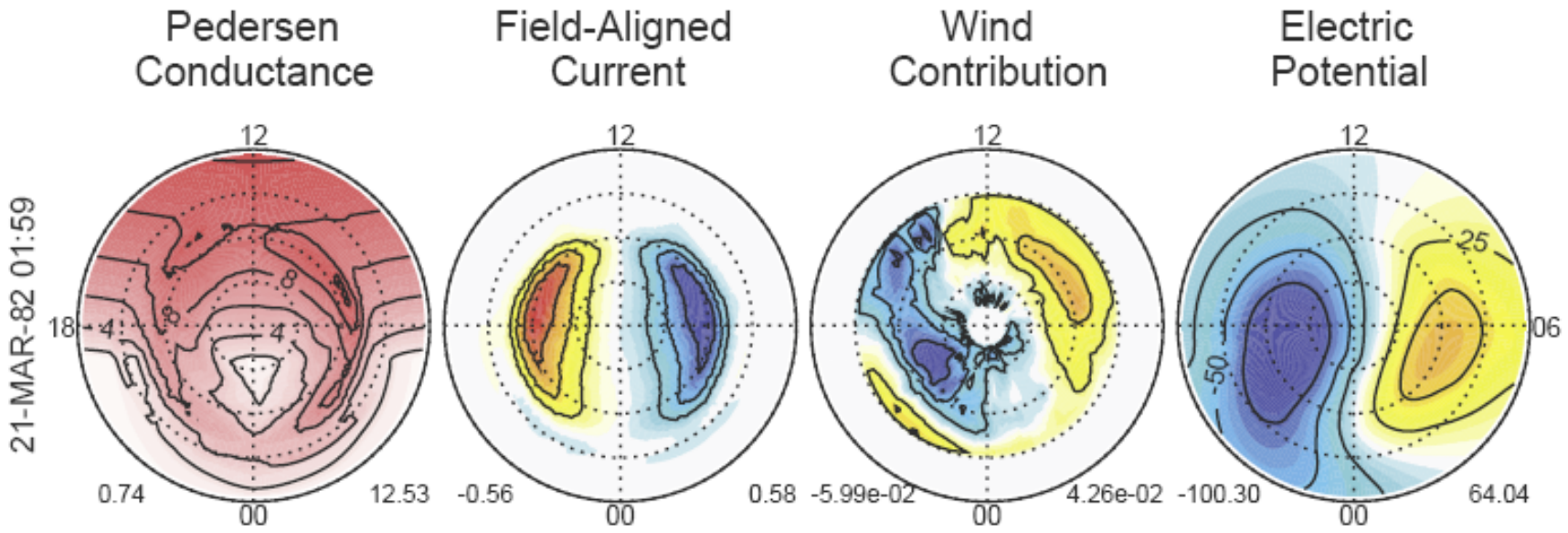
Southern Hemisphere, Summer

WINDII Observations



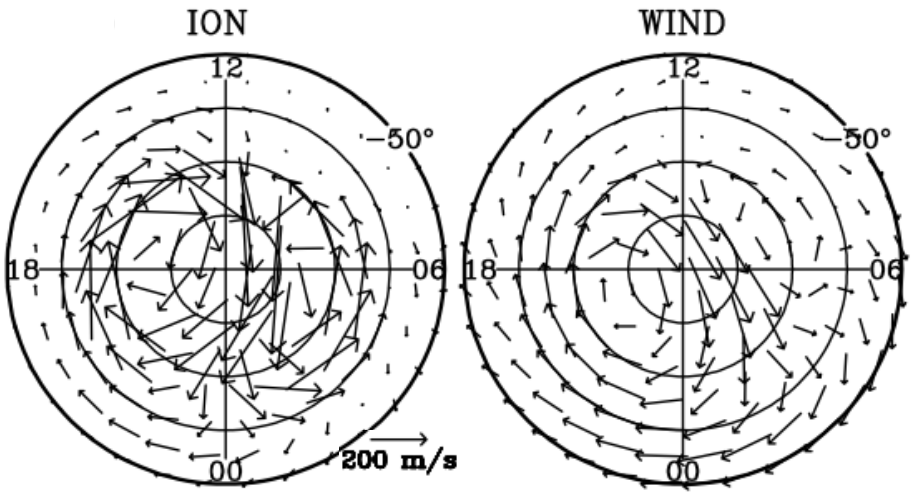
Weimer model





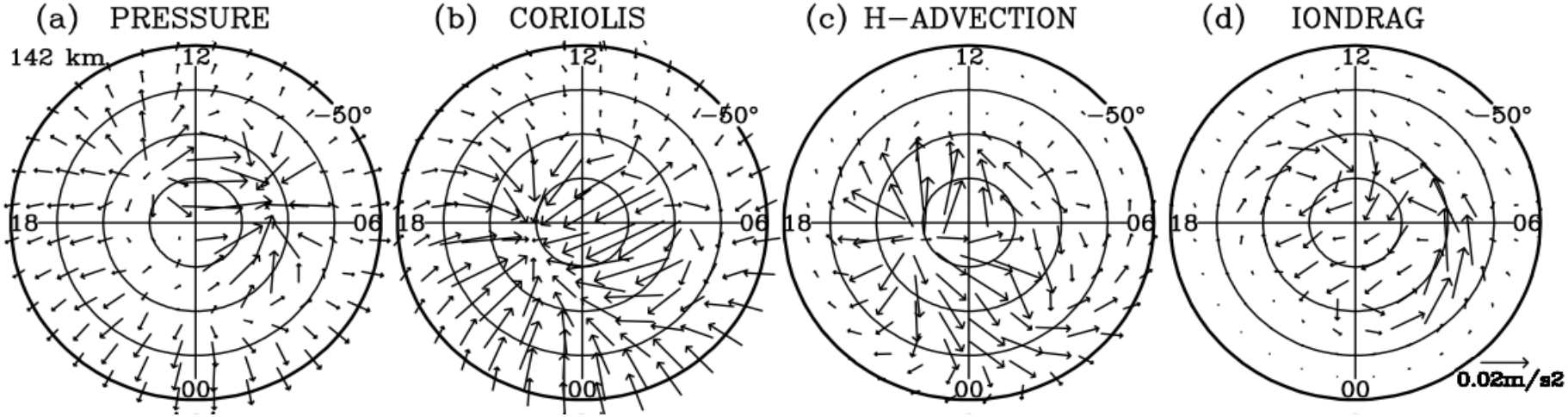
Ridley, A. J., A.D. Richmond, T.I. Gombosi, D.L. De Zeeuw, and C.R.Clauer (2003), Ionospheric control of the magnetospheric configuration: Thermospheric neutral winds, J. Geophys. Res., 108(A8), 1328, doi:10.1029/2002JA009464.

Velocities

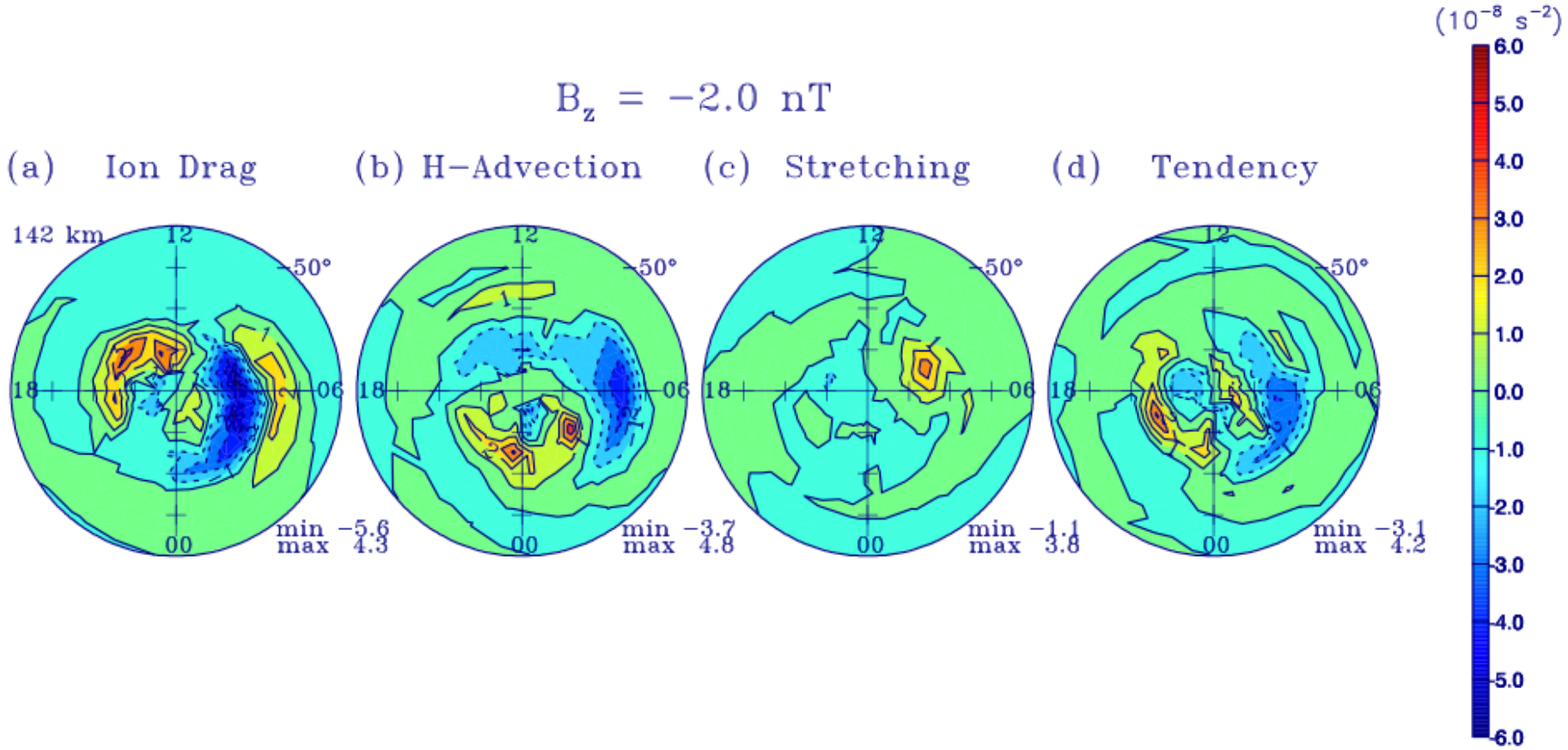


TIEGCM
summer
B_z = -2 nT
142 km

Acceleration terms

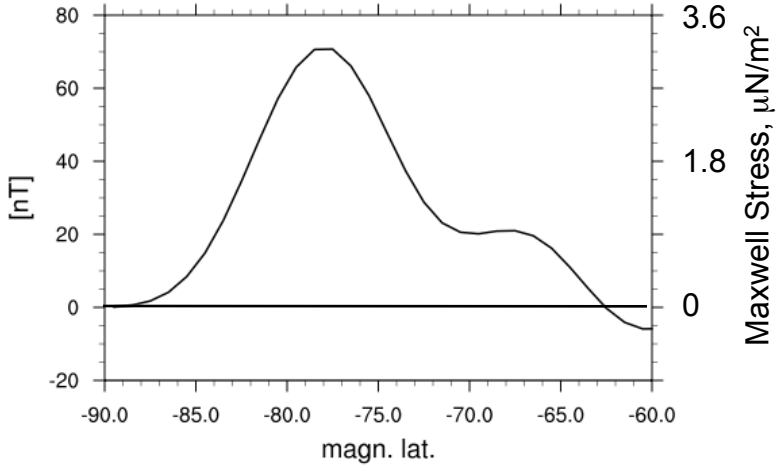


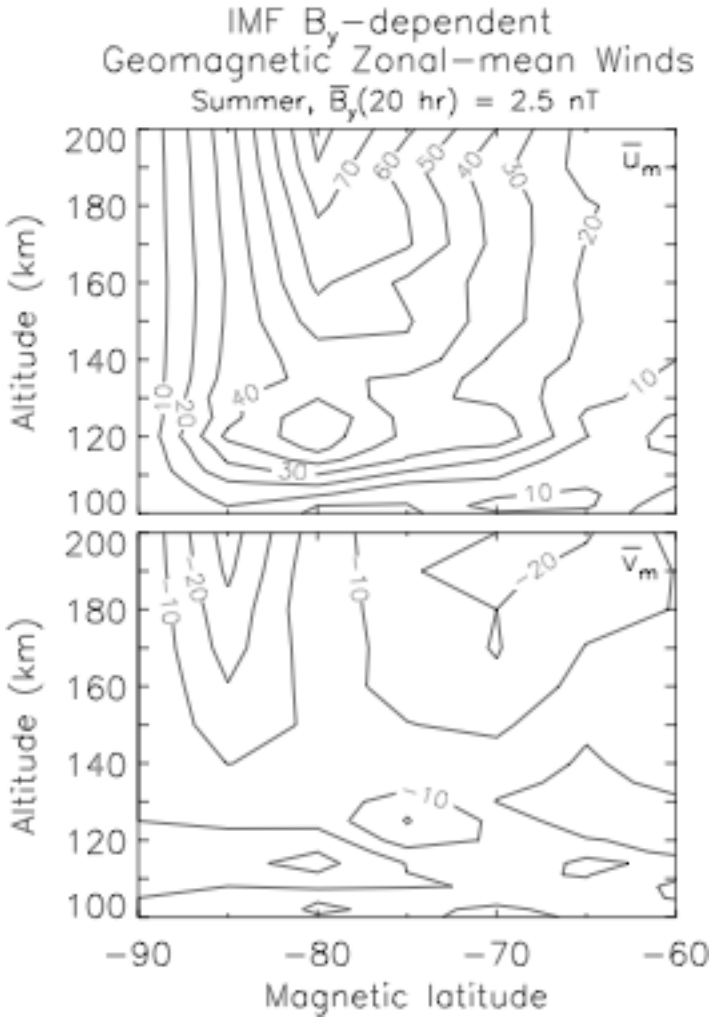
Kwak, Y.-S., and A.D. Richmond (2007), An analysis of the momentum forcing in the high-latitude lower thermosphere, J. Geophys. Res., 112, A01306, doi:10.1029/2006JA011910.



Kwak, Y.-S., and A.D. Richmond (2014), Dependence of the high-latitude lower thermospheric wind vertical vorticity and horizontal divergence on the interplanetary magnetic field, J. Geophys. Res., 119, 1356-1368, doi:10.1002/2013JA019589.

Zonal Mean Eastward Magnetic Perturbation Above Ionosphere (Summer, IMF B_y = 2.5 nT)





Atmospheric mass ~ 10^{-3} kg/m^2 above 110 km

$2x10^{-6}$ N/m^2 causes $2x10^{-3}$ m/s^2 acceleration,
which produces 40 m/s wind after $2x10^4$ s (~ 6 hours).

Richmond et al. [2003]

Summary

- The wind contributing to electrodynamics is largely rotational, and has similarities to the ion convection.
- On short (< 1 hour) time scales the wind cannot respond well to changes in ion convection, but on longer times scales it can build up to ~40% of the climatological ion velocity.
- The wind above 110 km responds closely to the Maxwell stress, such that the vertical vorticity is closely related to the time-averaged field-aligned current density above the ionosphere.
- A simplified estimate of the wind might be possible using time-integrated Maxwell stresses.