ICON Ionospheric Connection Explorer

Virginia Tech

Upcoming Missions: The Importance of Electrodynamics

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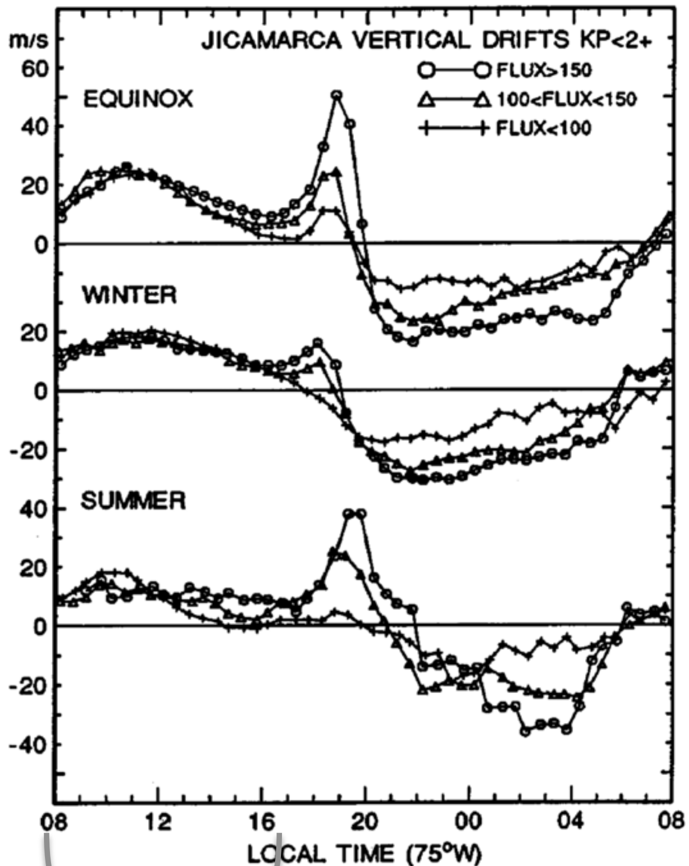
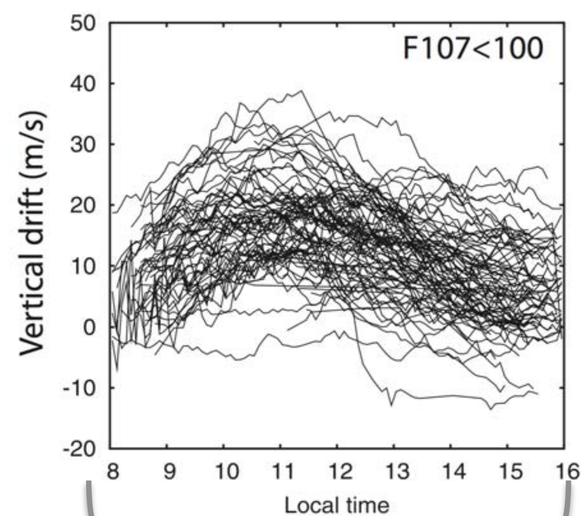
Understanding ExB vertical drifts



- Daytime uplift at the equator − driven by the E-region dynamo.
- Lots of variability, even at quiet times.
- Many shorter-term / smaller-scale gradients than we may expect.

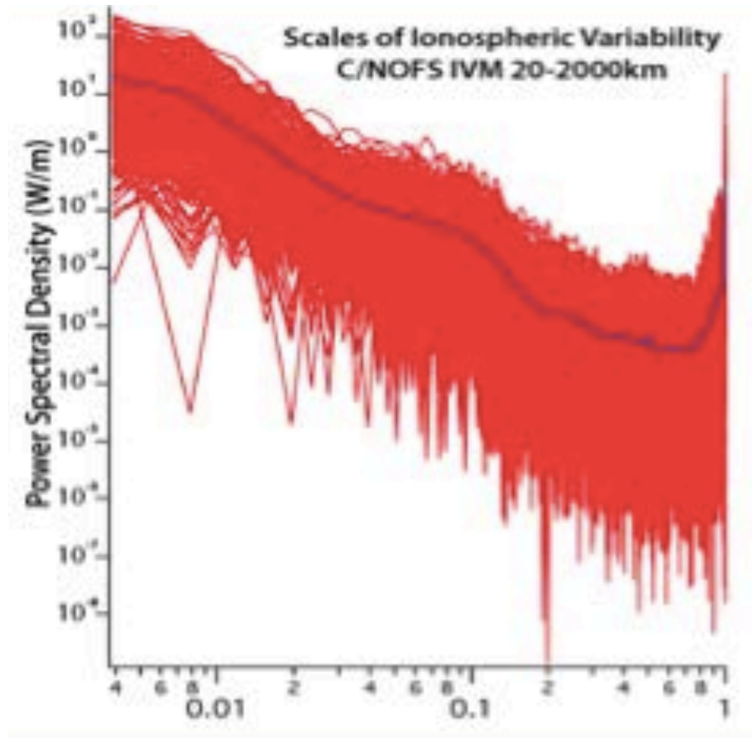


Alken *et al.* 2009

Fejer *et al.*, 1995

Wave-like signatures

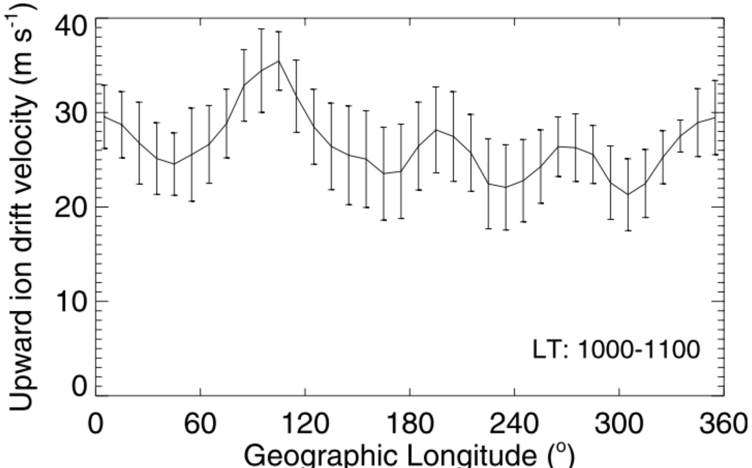
- Examining *in situ* data reveals that some of the variability appears at particular spatial scales.
- In this example, we see 'bumps' at different spatial scales when analyzing 1 year of data.
- How often are these present?
- What fraction of the variability is periodic?
- Can we use this to untangle what's going on & improve predictions?



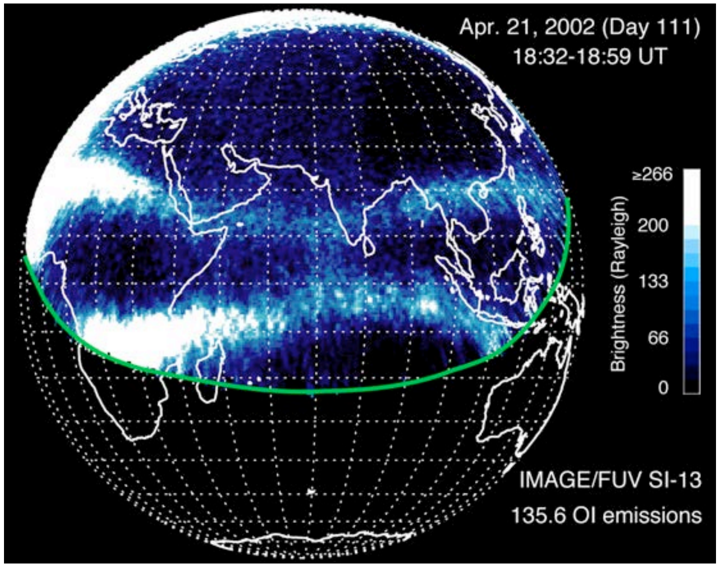
Heelis, private communication

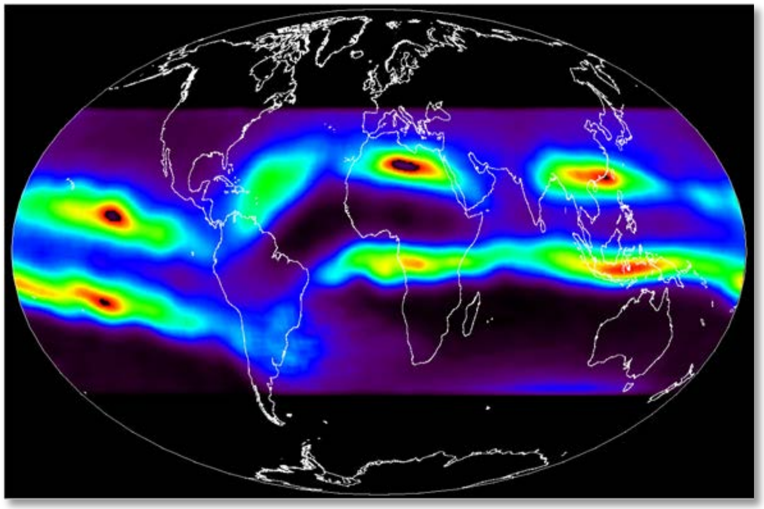
Correlation to known waves

- Some of this can be traced to atmospheric tides.
- The ionospheric signature is reminiscent of the spatial scale of tides.
- A deeper look reveals that these two vary together with season.
- Analysis from multiple datasets points to this being primarily from perturbations to the E-region dynamo, but advection and photochemistry play a role.
- Most of this is a climatological view & things get more complicated on a day-to-day level.



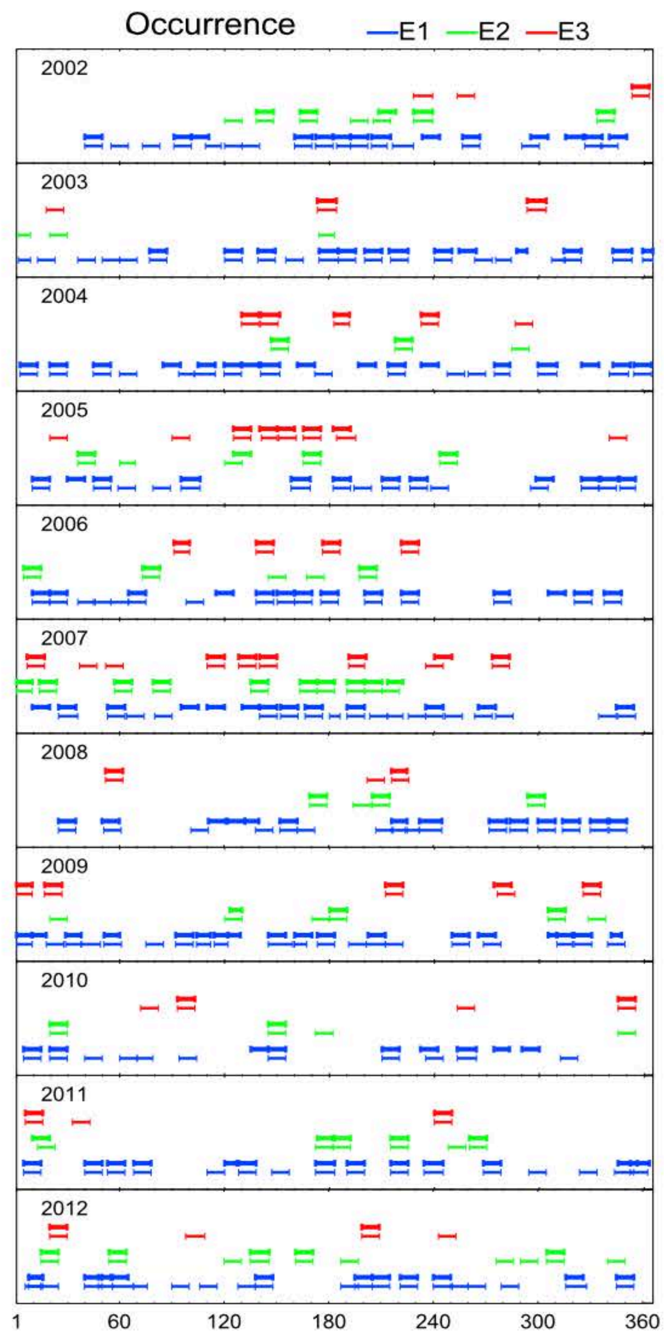
Kil *et al.*, 2007





Event-by-event studies

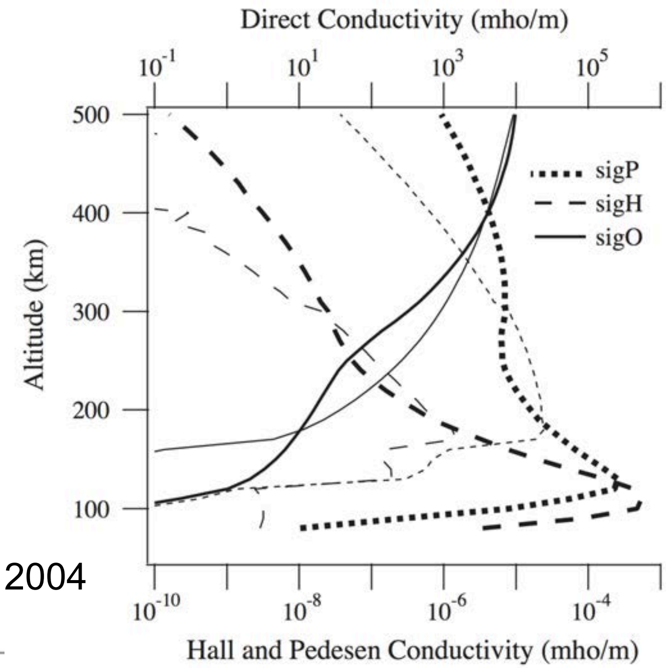
- Looking at more intermittent waves & shorter time-scales, we can see some of the variability is related to Kelvin, Rossby waves etc.
- As these are sporadic & their periods vary, this requires an event-type study.
- Such a study reveals that over 10 years, we see many such events.
- This looks promising for understanding & eventually predicting ionospheric variability.
- We don’t have the observations of winds at E- and F-region altitudes, conductivity (or proxies thereof), to really test how models reproduce these effects.



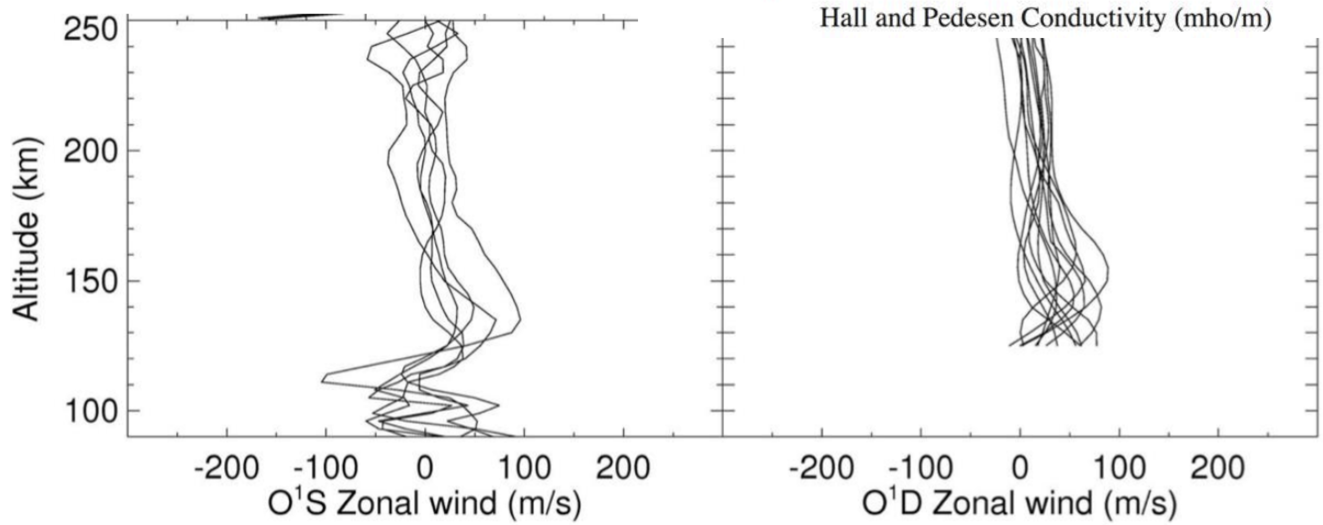
Liu *et al.*, 2015

What we'd like to observe

- Conductivity at E- and F-region altitudes depends on ion-neutral collisions.
- We'd like to have observations to constrain this − ion density, neutral density & composition.
- In addition, we need to know the neutral wind motion − at both E- and F-region altitudes.
- WINDII did this, using O^1S and O^1D.
- With both of these, we want to look at their variability − spatially & temporally − so we need systematic observations of them.

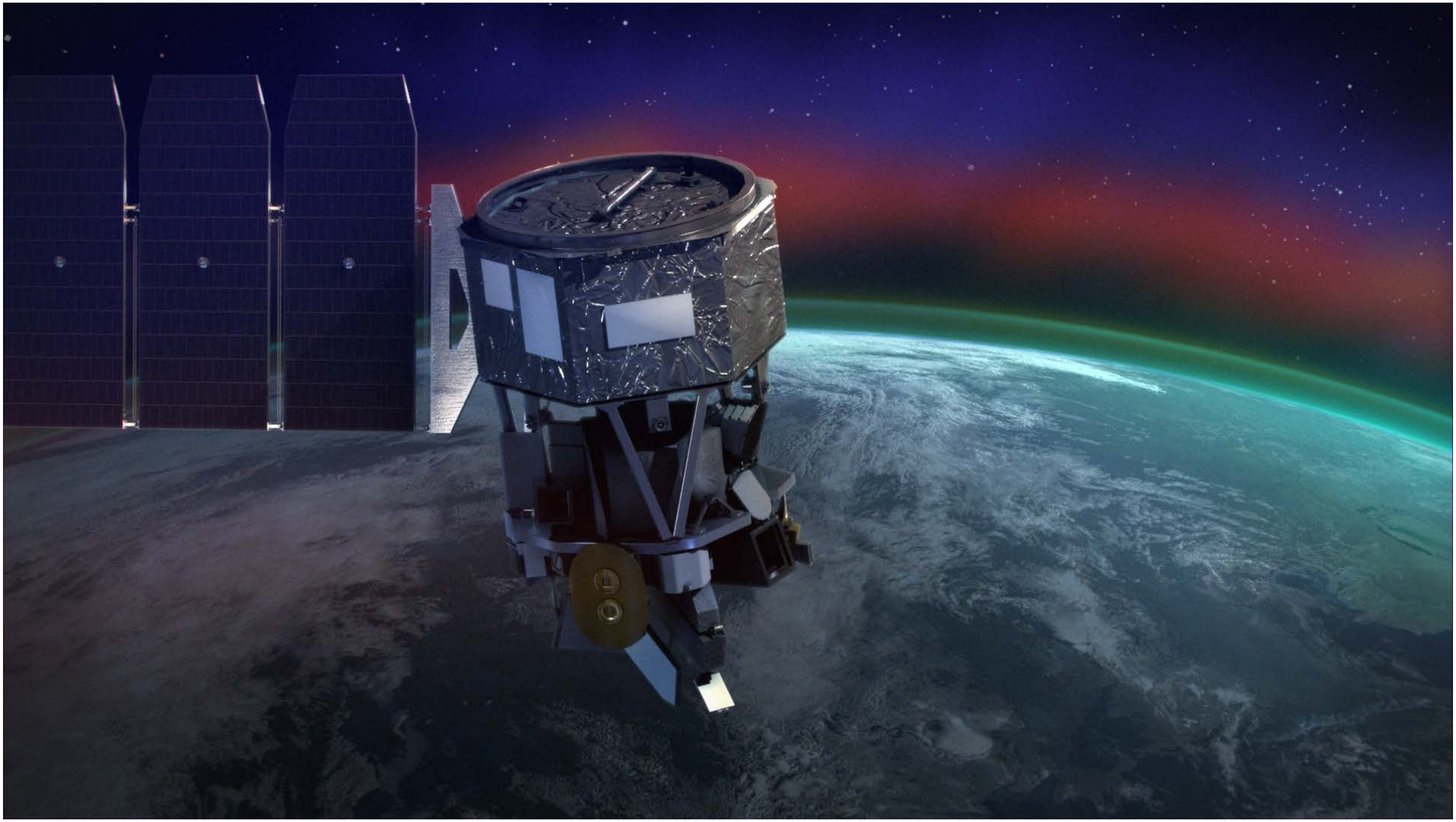


Heelis, 2004

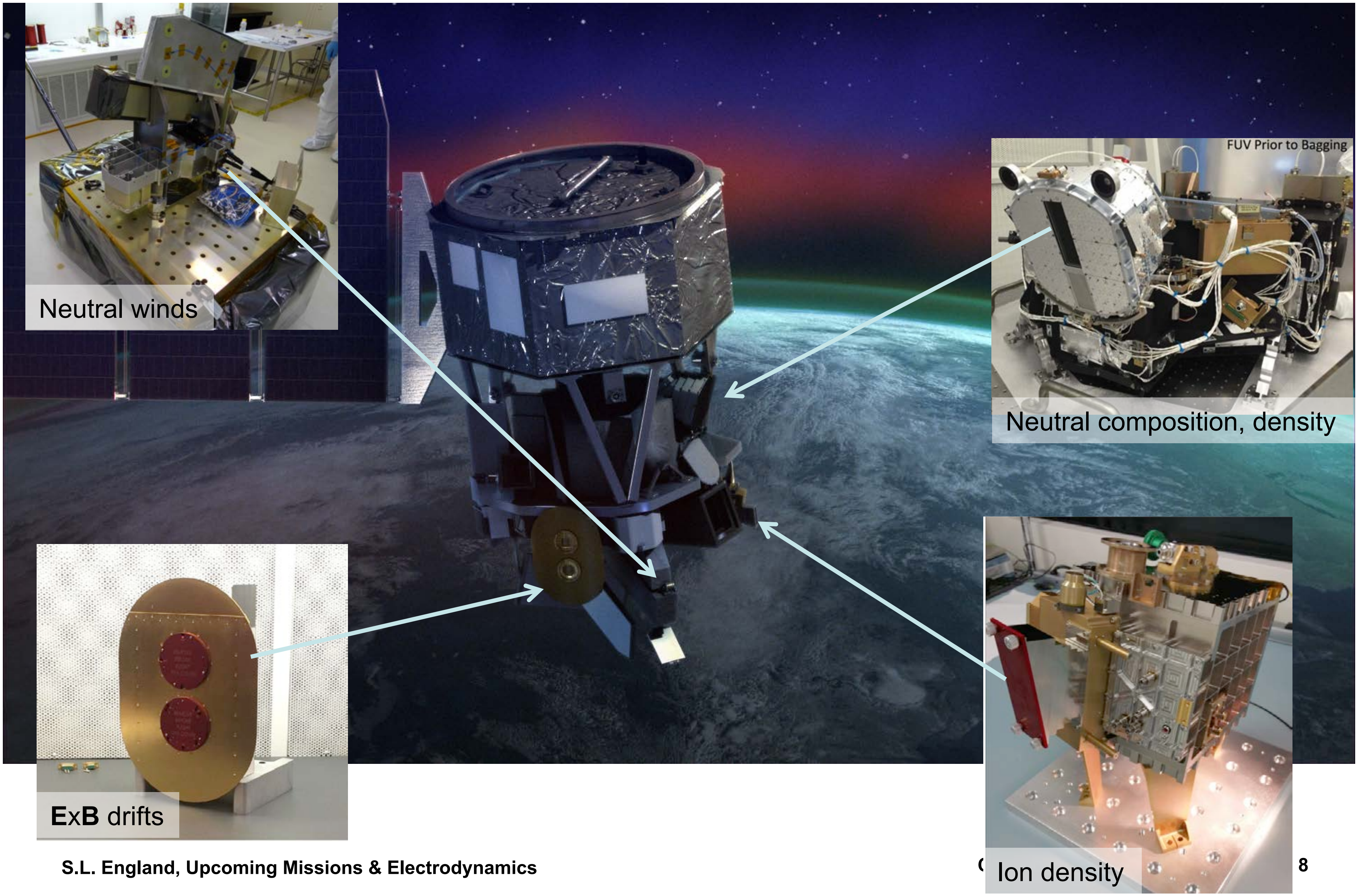


Shepherd *et al.* 2012

ICON Observations

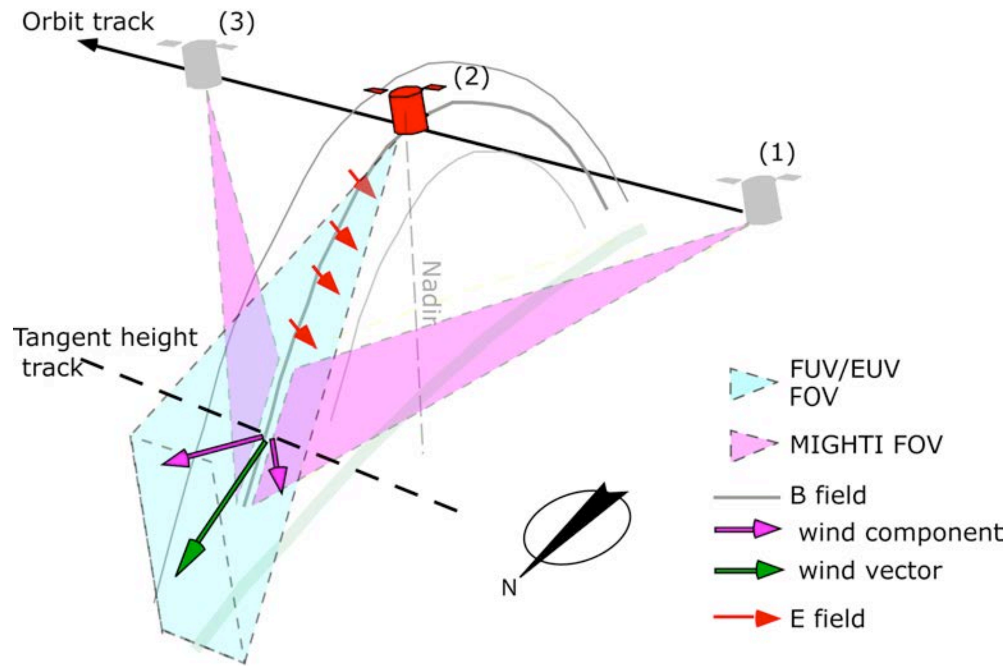


ICON Instruments

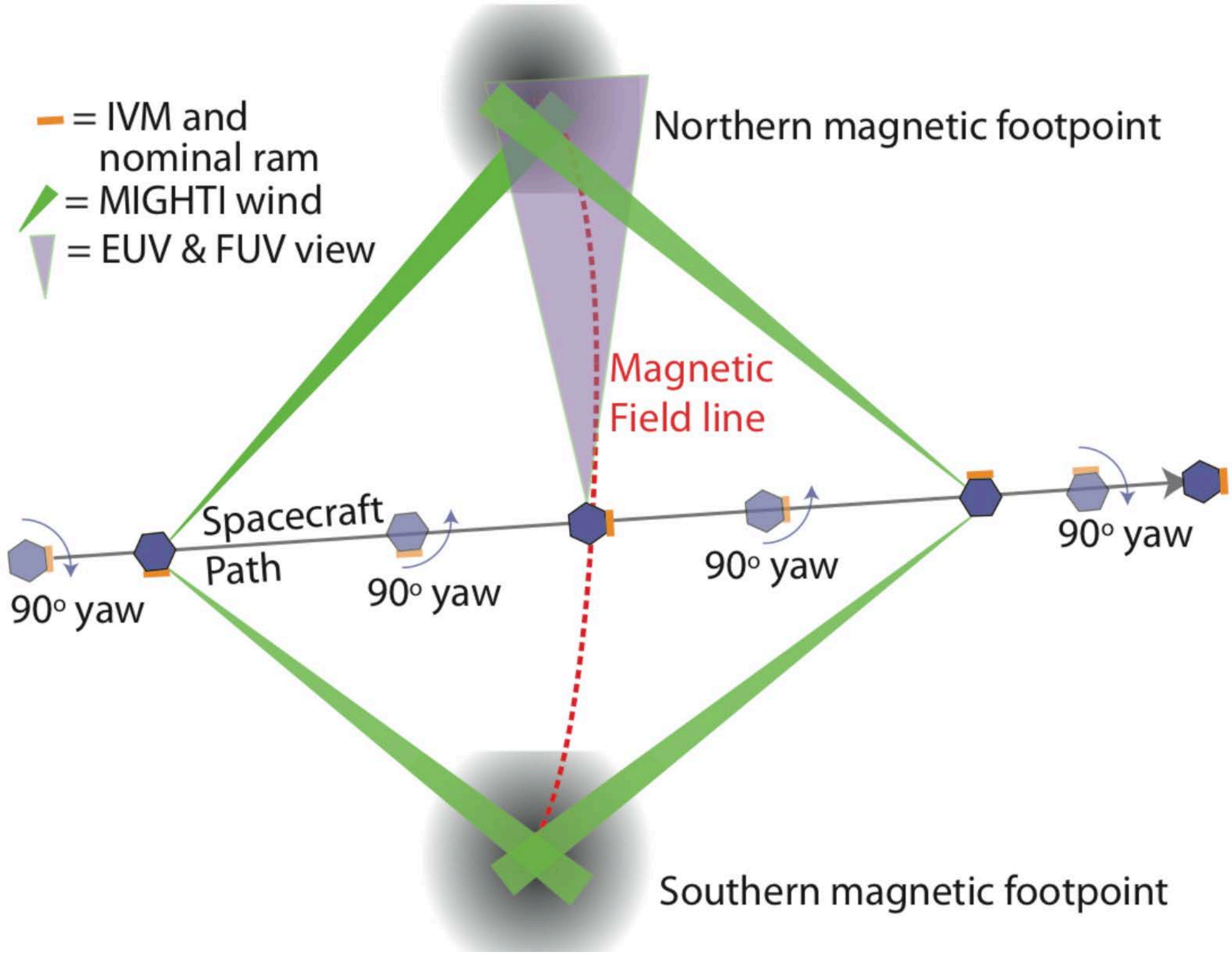


ICON Observations & Electrodynamics

- ICON will make measurements *in situ* and remotely (on the limb).
- Winds, composition and ion density are measured on the limb, perpendicular to the S/C velocity track, and the resultant ExB drift is measured *in situ*.
- By combining limb and *in situ* in this way, we can measure the atmosphere & ionosphere along the local B-field line at E- and F-region altitudes.
- This geometry works best near the magnetic equator, which corresponds to ~17% of the time.

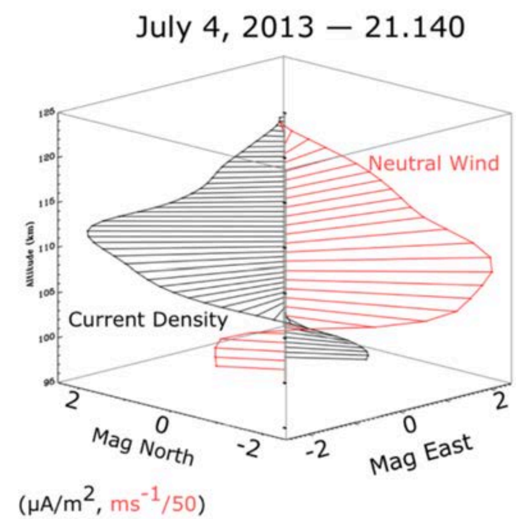


Conjugate Measurements



Local & Global

- ICON will make detailed measurements near the S/C, and in that sense is a bit like rocket experiments that measure local winds and currents.
- For longer-lived features (e.g. tides, planetary waves) we can build up a picture by combining multiple orbits of measurements.
- For others, we can look at the variability in the conductivity, winds and E-fields.
- To go further, we'll use global-scale models:
  - TIEGCM, driven by ICON observations & AMIE
  - SAMI3 driven by TIEGCM winds, composition
  - IDA4D, assimilating ICON data.



R. Pfaff, private communication

Conjugate measurements