What does Incoherent Scatter Radar bring to Conductance Specification?

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Motivation and Limitations

- Incoherent scatter radar is one of few measurements that can simultaneously observe the necessary parameters to determine conductivity without requiring an electron transport model although validity limited to $B_{||}$ look direction
  - Electron density is the prime parameter that is measured by ISR. However, need to have enough SNR.
  - Can calculate conductivity using a neutral atmosphere and magnetic field model
  - Long history of inverting E-region electron density to quantify precipitating flux (assuming or not spectral shape of distribution). Requires particle transport model to do the inversion.
- Unlike satellite measurements, ISR can continuously sample auroral phenomena (does not suffer from a revisit rate issue) and quantify rapid temporal variations (down to 10 seconds, depending on the mode).
- Unlike satellite measurements, ISR is spatially limited to a very small region of space making it difficult to infer a global distribution of conductance. At best you could get a 'ring' of measurements.

What does ISR bring to the table?

- **ISR brings a means by which to update or generate new conductance specification or models over a wide range of geophysical activity.**
- Sondrestrom ISR has 30+ years of irregularly sampled data, PFISR has 9+ years of regularly sampled, continuous data.

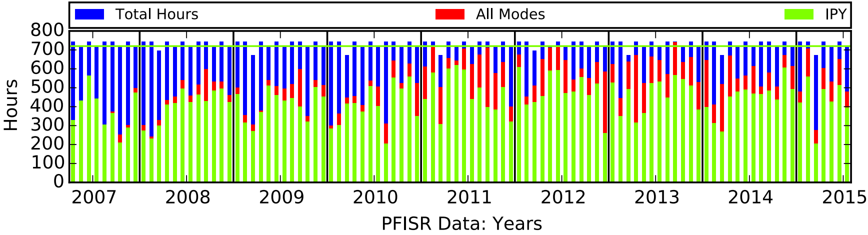
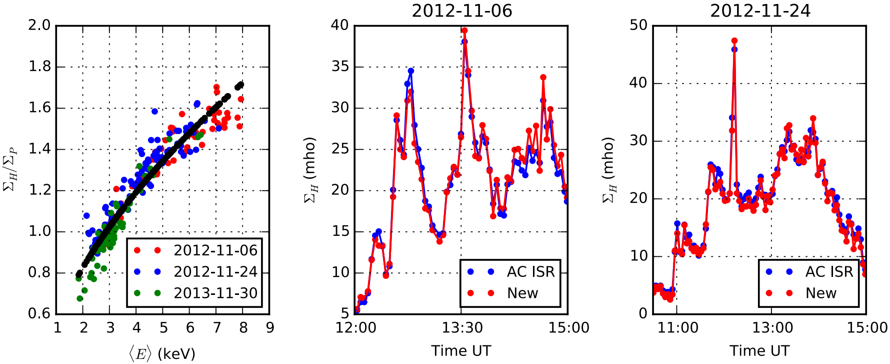


Figure: Data coverage from PFISR with modes suitable for conductance estimation. Note: does not include 2016.

Updating Empirical Conductance Formulas

Original empirical formulas in Robinson et al., 1987, JGR:

$$\Sigma_P = \frac{40\langle E\rangle}{16 + \langle E\rangle^2} Q_0^{1/2} \qquad \frac{\Sigma_H}{\Sigma_P} = 0.45\langle E\rangle^{0.85}$$

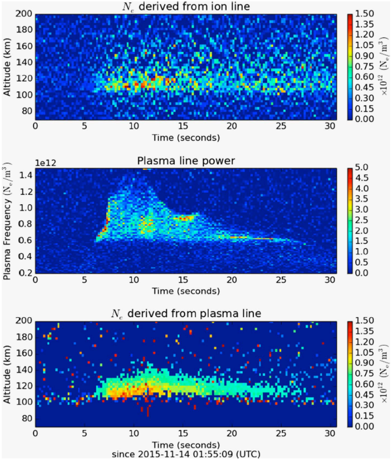


FIRST STEP: Relation derived in study by Kaeppler et al., 2015, JGR using two events from PFISR (2012-11-06 and 2012-11-24) and Sondrestrom (2013-11-30). Fit shown in black.

$$\frac{\Sigma_H}{\Sigma_P} = 0.57\langle E\rangle^{0.53}$$

Very Rapid Temporal Variations from Plasma Lines

Study by Vierinen et al., 2016 GRL using Sondrestrom plasma line - very high temporally resolved electron density structures/derive conductivity.



How do or will models account for rapid temporal variations in auroral structure?

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