Status Report and Future Directions for Imaging Fabry-Perot Studies

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Inferring Horizontal Wind Vectors

Doppler imaging only directly measures line-of-sight wind components. We infer the underlying vector field by fitting a model of the form:

\[
H_x = u_0 + \frac{u}{x}x + \frac{u}{y}y \\
H_y = v_0 + \frac{v}{x}x + \frac{v}{y}y
\]

To solve for the model coefficients (2 uniform wind terms and 4 gradient terms), we compute the Fourier expansion of the line-of-sight wind in one ring:

\[
H^R Y S_k, d? = \hat{a} a_0 + > \sum_{m=1}^{n=1} Y a_m \sin m S_k + b_m \cos m S_k \hat{a} \sin \hat{c}
\]

The coefficients in the wind model are then related to the DC, fundamental and 1st harmonic Fourier coefficients by:

\[
a_0 = \frac{1}{2} R \left( \frac{u}{x} + \frac{v}{y} \right) \\
a_1 = u_0 \\
b_1 = v_0 \\
a_2 = \frac{1}{2} R \left( \frac{v}{y} - \frac{u}{x} \right) \\
b_2 = \frac{1}{2} R \left( \frac{v}{x} + \frac{u}{y} \right)
\]

But note: There are only five Fourier coefficients, whereas there are six horizontal wind unknowns! (Worse, there's no hope of mapping vertical winds...)
Burnside's Assumption

To obtain the final horizontal constraint, Burnside et al. [1981] assumed:

$$\frac{\partial \psi}{\partial x} p \frac{1}{\partial \psi/\partial t}$$

where epsilon is the tangential velocity due to Earth's rotation.

But this assumes the observatory is moving in time beneath an unchanging meridional wind field. This is, at times, a dreadful assumption in the auroral zone.

In practice, it is usually better simply to assume

$$\frac{\partial \psi}{\partial x} = 0.$$
An array of three all-sky imaging FPS instruments centered around the AMISR site could map unambiguously small-scale features in the 3-component wind field – including vertical wind mapping.

Filter wheels would provide some height resolution, through alternating observations of emissions from mesopause, E-region, and F-region heights.

New etalons & detectors would guarantee time...