Polar/VIS Science Report

Conjugate Auroral Observations and Implications for Magnetospheric Physics.

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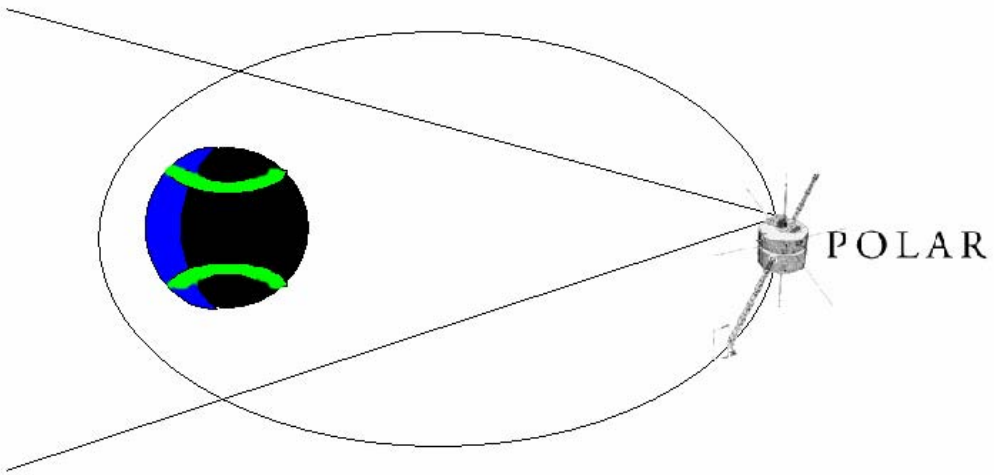
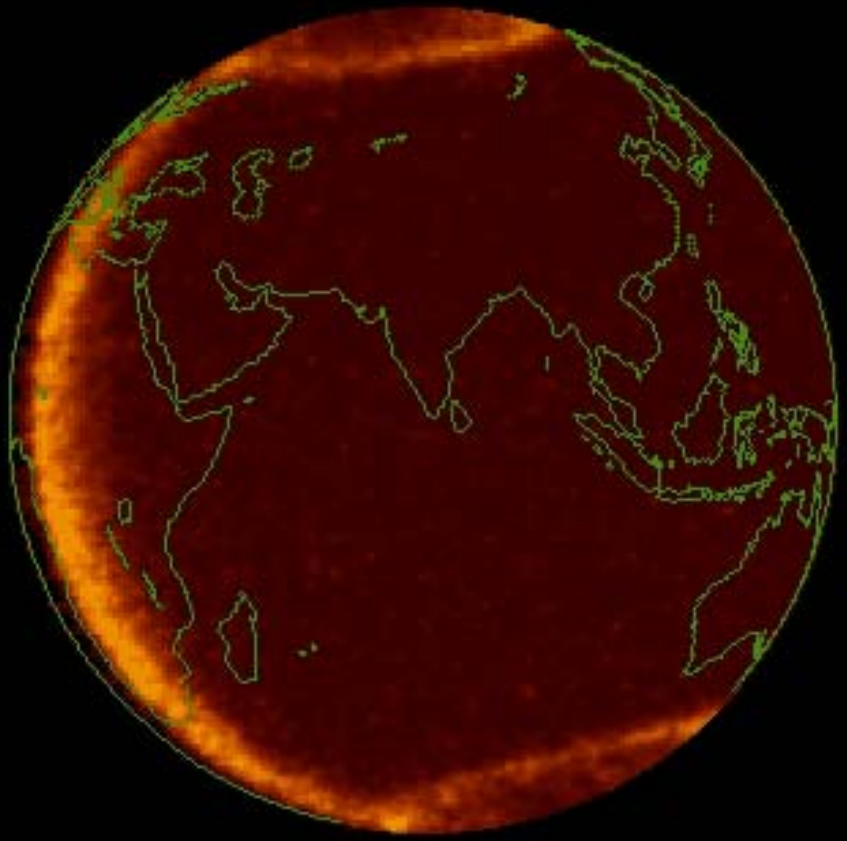
Conjugate Auroral Observations

- Viewing Geometry
- Auroral substorm onsets
- Behavior during storms
- Discussion

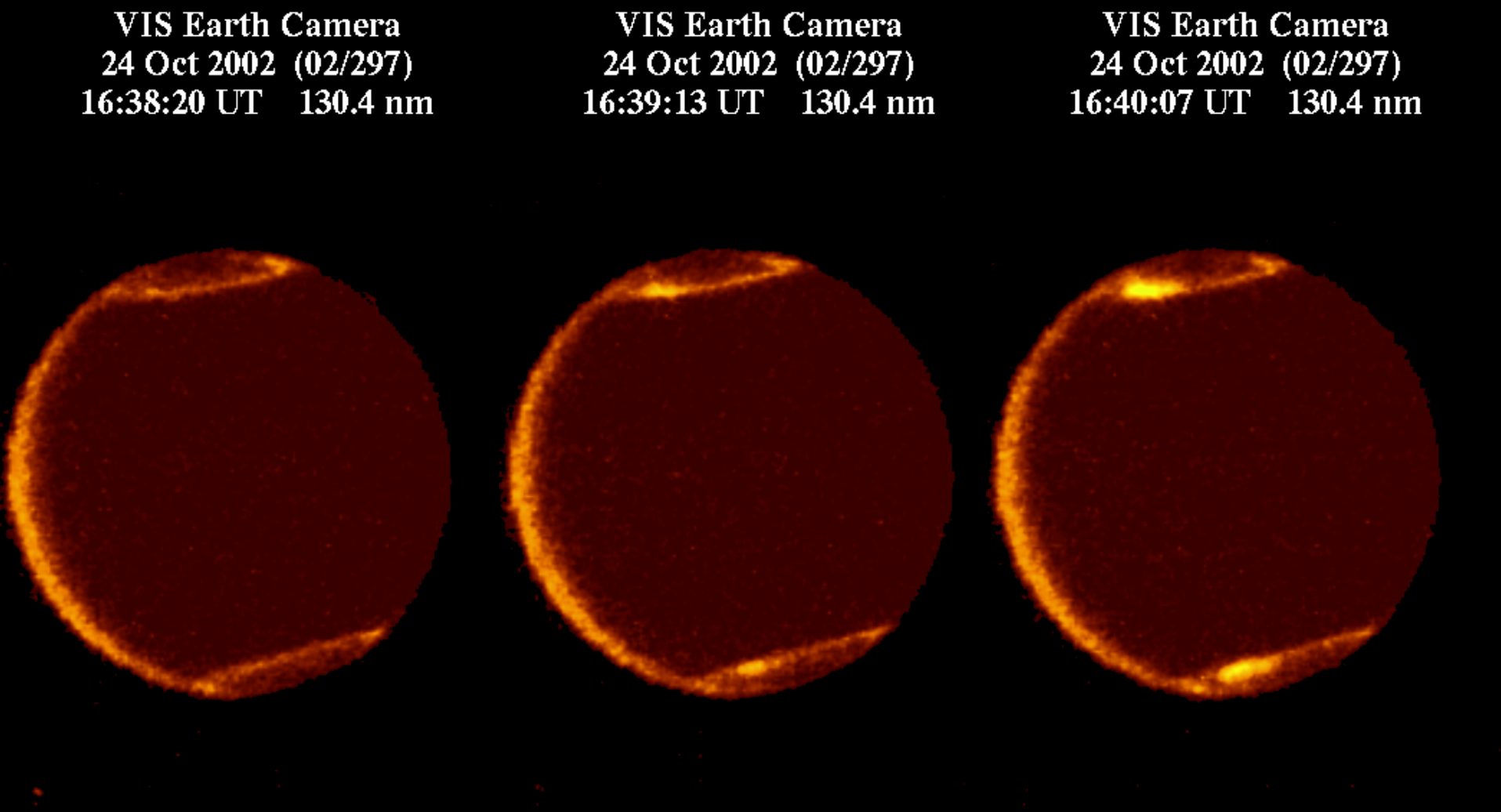
Viewing Geometry

- Polar Spacecraft at 8 R_E apogee altitude near the equator.
- Single Camera.
- Nighttime sectors of the Northern and Southern auroral ovals imaged <u>simultaneously</u> in single frames.
- Eliminates timing, bandpass, and sensitivity issues that have limited other studies

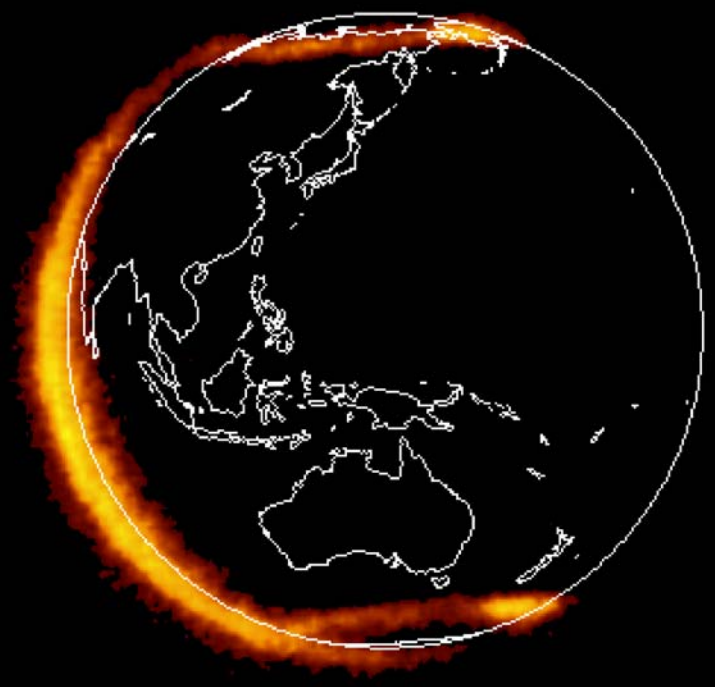




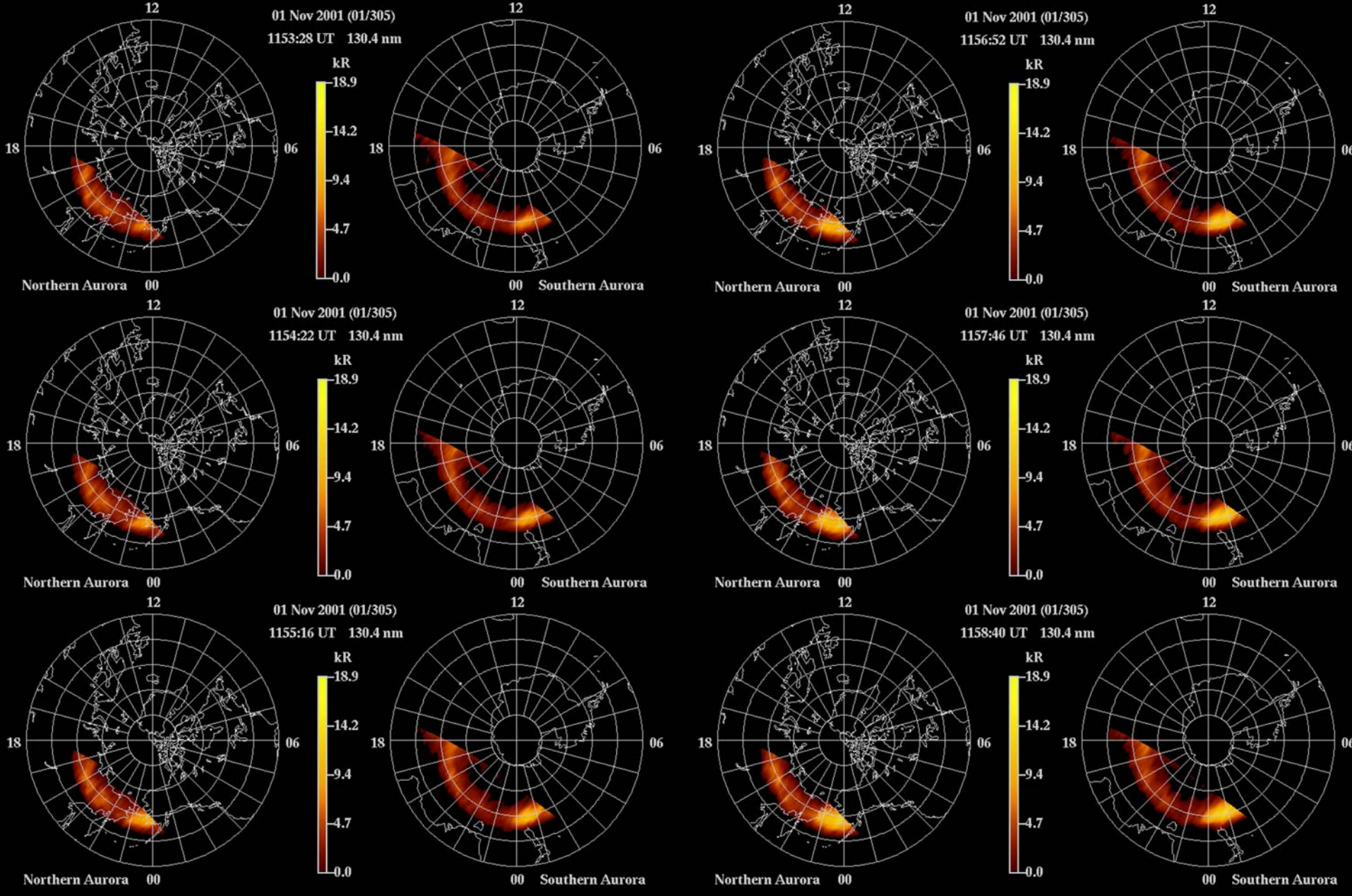
•Classic conjugate aurora



- Onset locations conjugate (within 2°).
- However, the northern hemisphere aurora is ~25% brighter post onset and leads the southern hemisphere by ~ 1 minute.

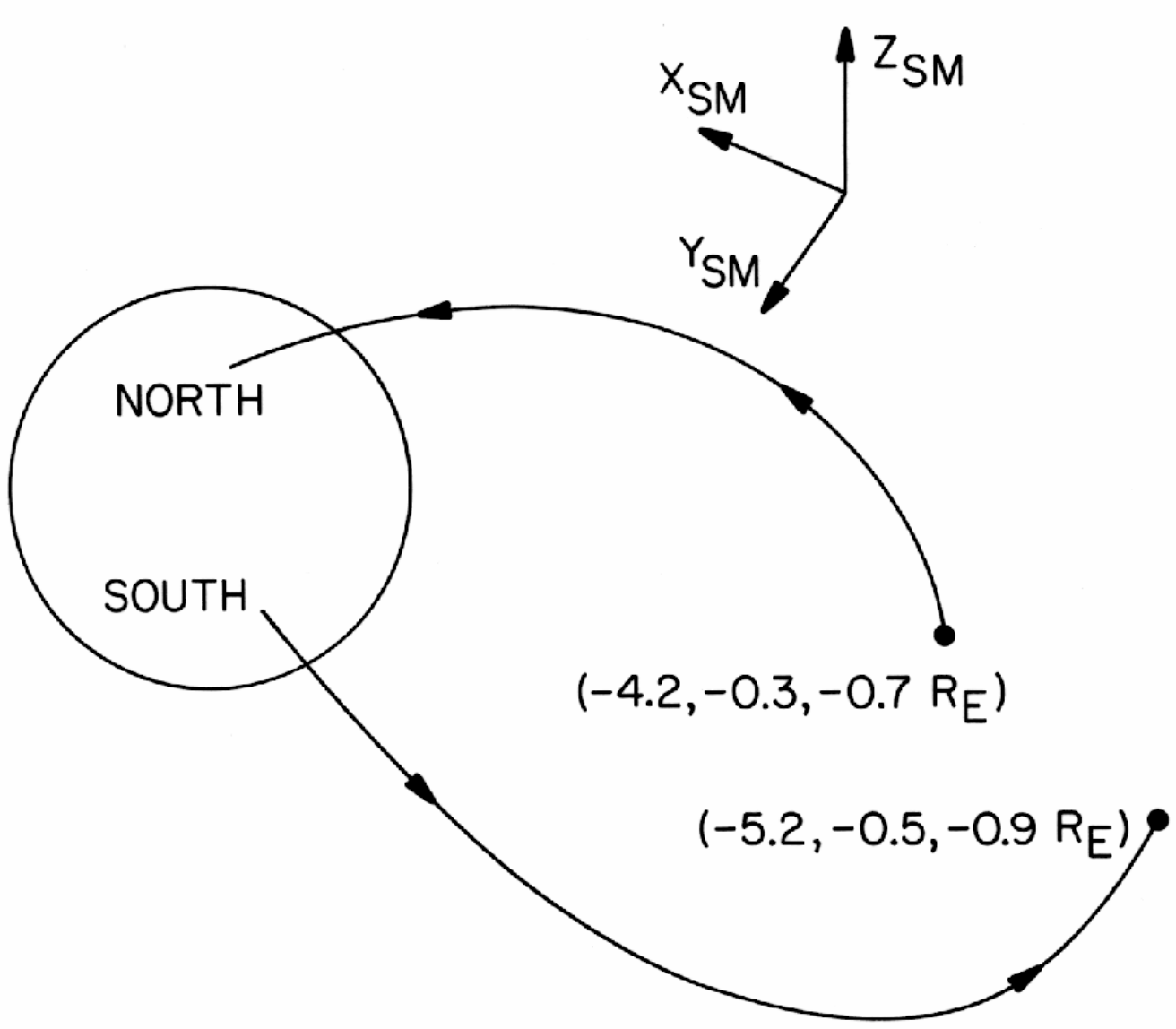


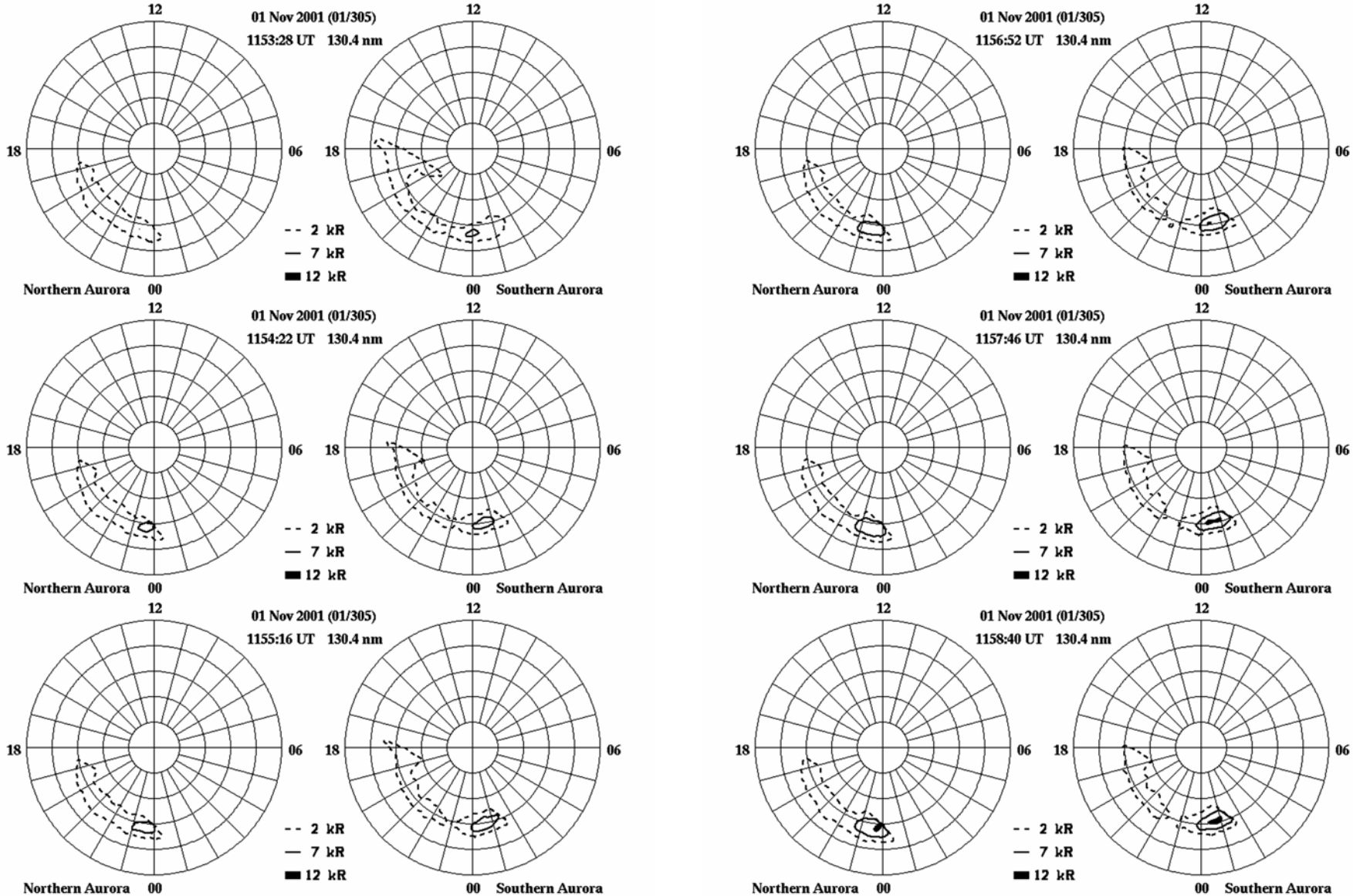
•Frank and Sigwarth, 2003



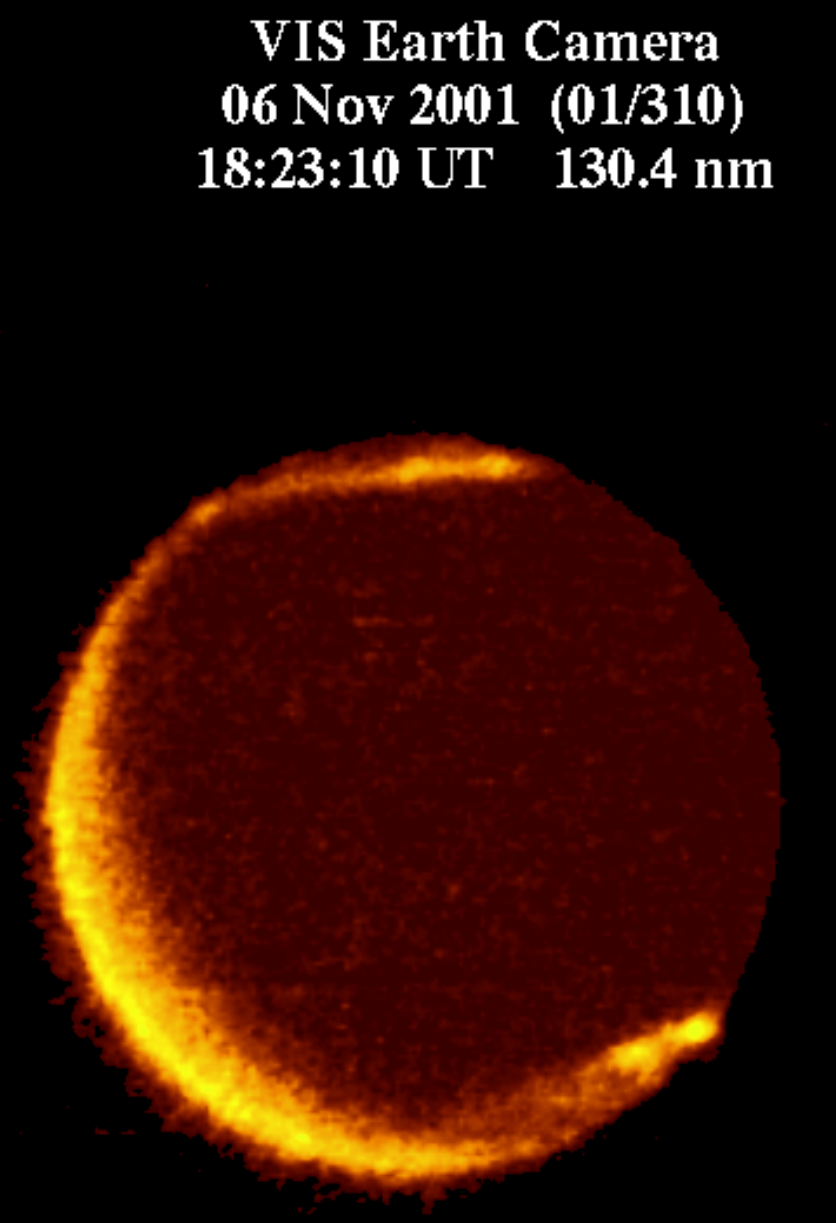
•Southern auroral onset is offset 3° east of the northern conjugate point.

Tsyganenko 96 mapping

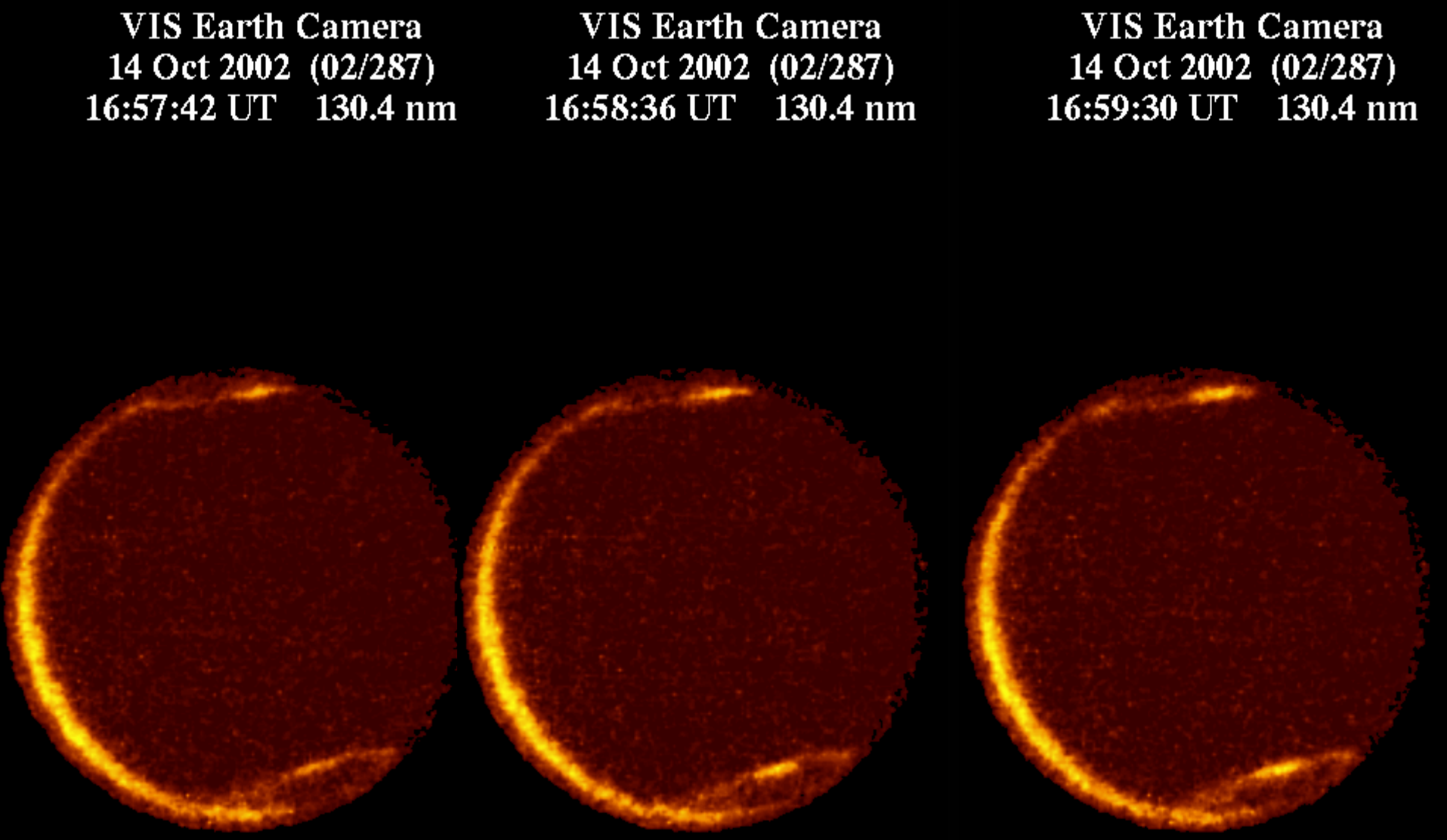




- The southern hemisphere aurora is brighter.
- The southern aurora leads the northern aurora by 1-2 minutes.
- The southern aurora is 7.4° east of the northern conjugate point.

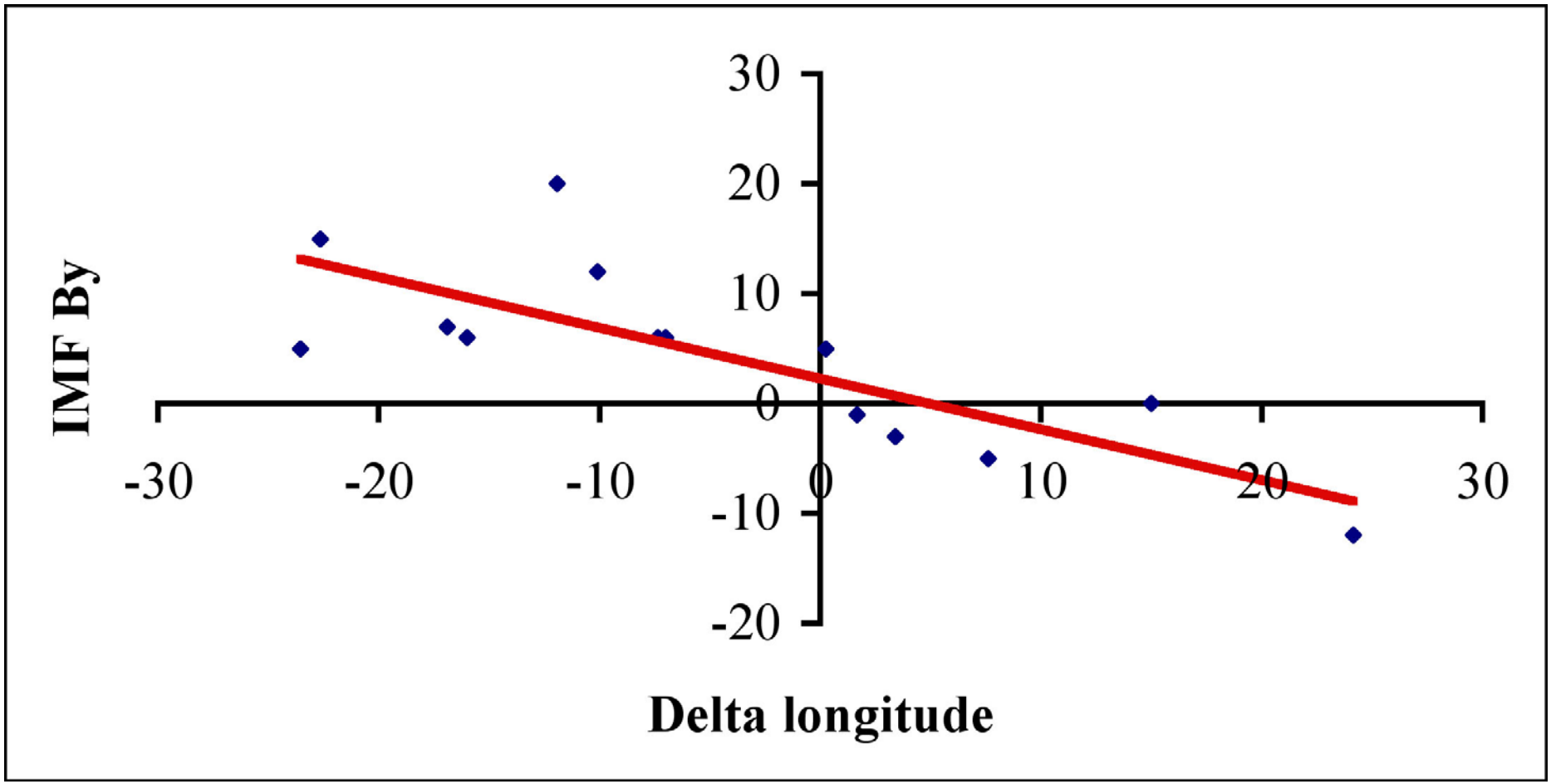


- Southern onset is 12° east of the northern conjugate point.
- Northern aurora is 18% dimmer post onset.



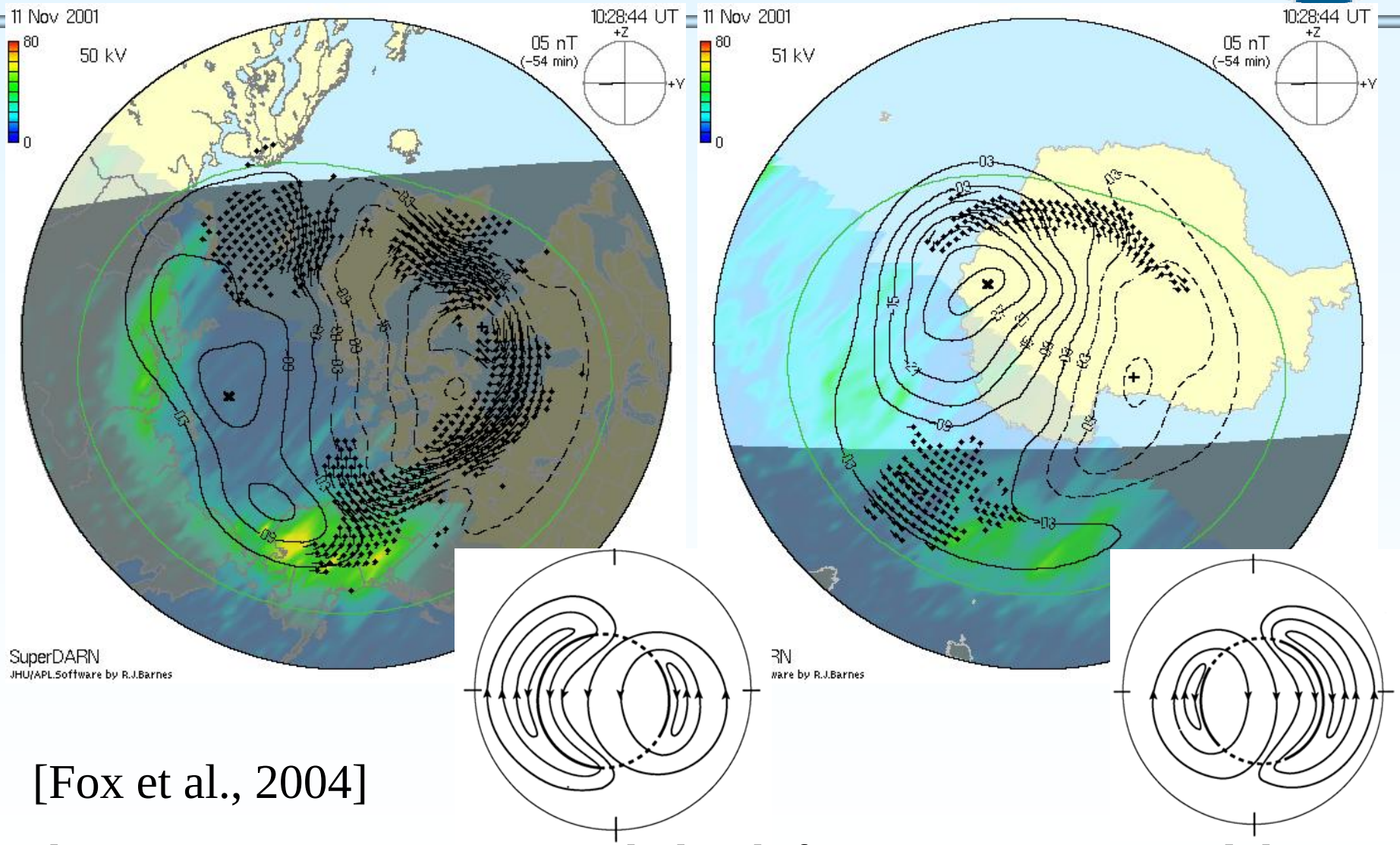
- Southern onset is 24° west of the northern conjugate point.
- Northern aurora is 30% brighter post onset.

Onset “twist” due to IMF B_y



For positive Delta Longitude, the northern conjugate point is east of the southern conjugate point.

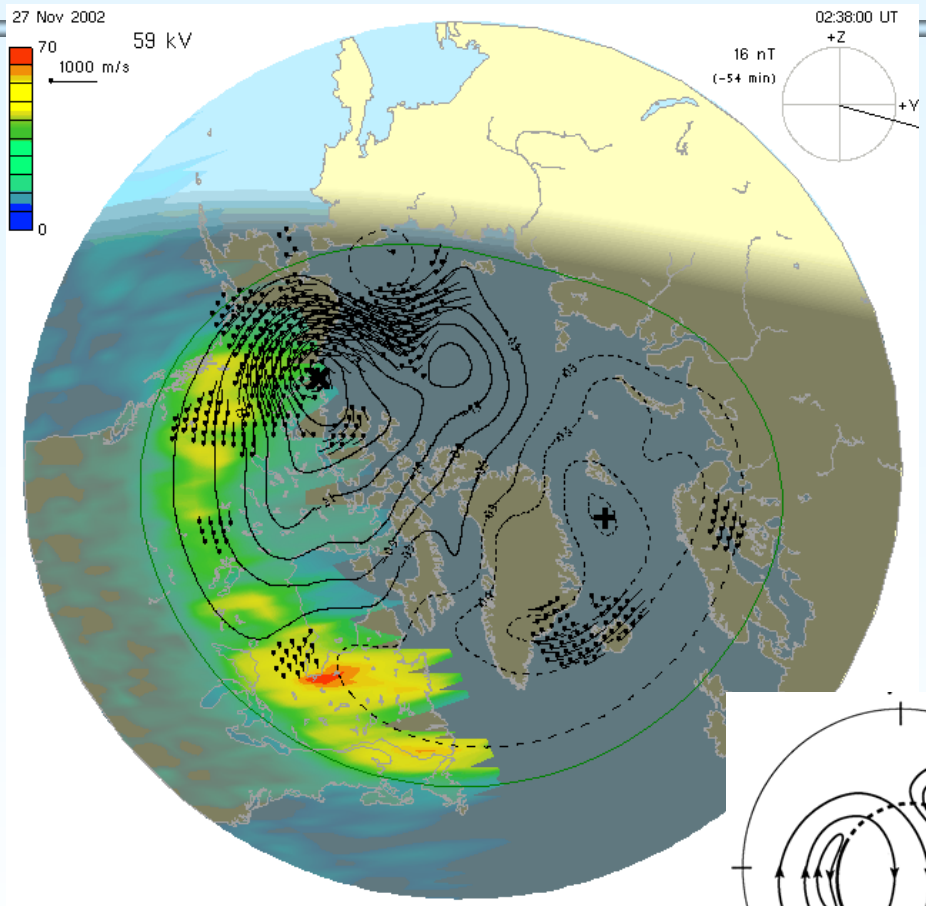
Convection Maps & Aurora Combined

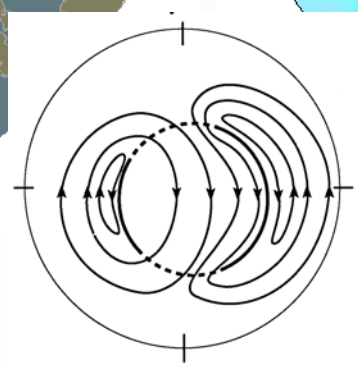


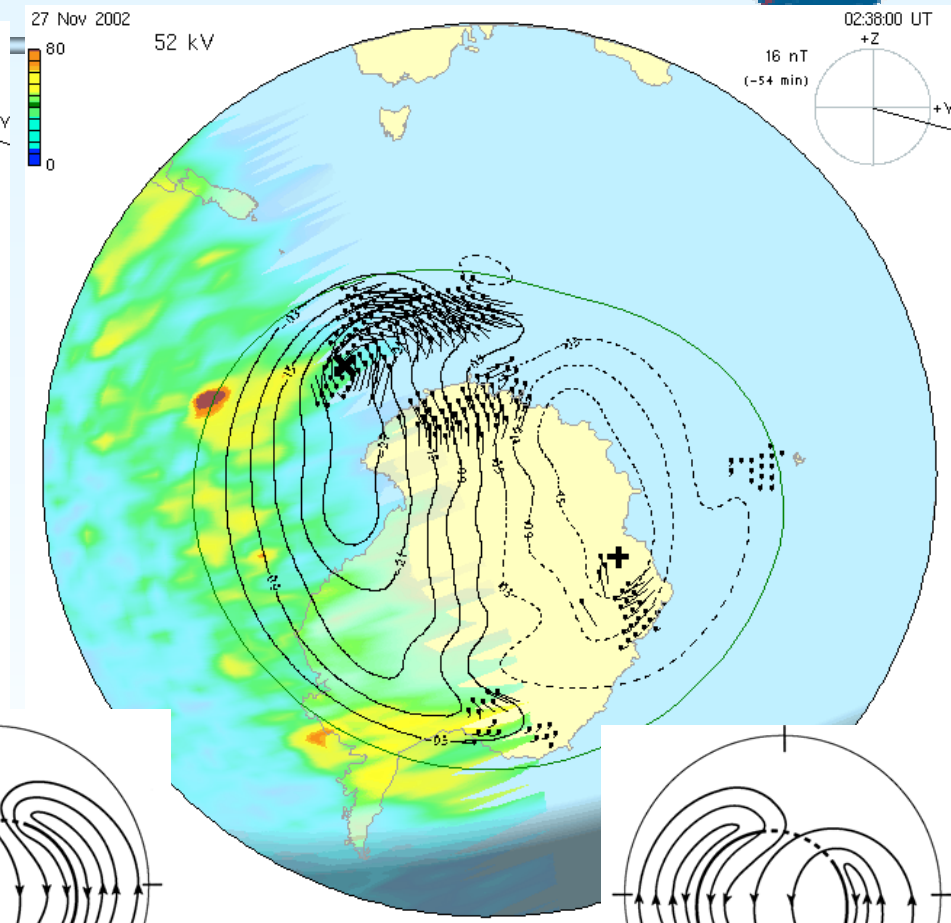
[Fox et al., 2004]

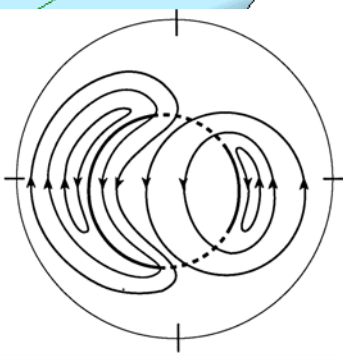
The convection maps agree with the shift in onset position and the convection throat moves eastward with increasing B_y negative.

Convection Maps & Aurora Combined



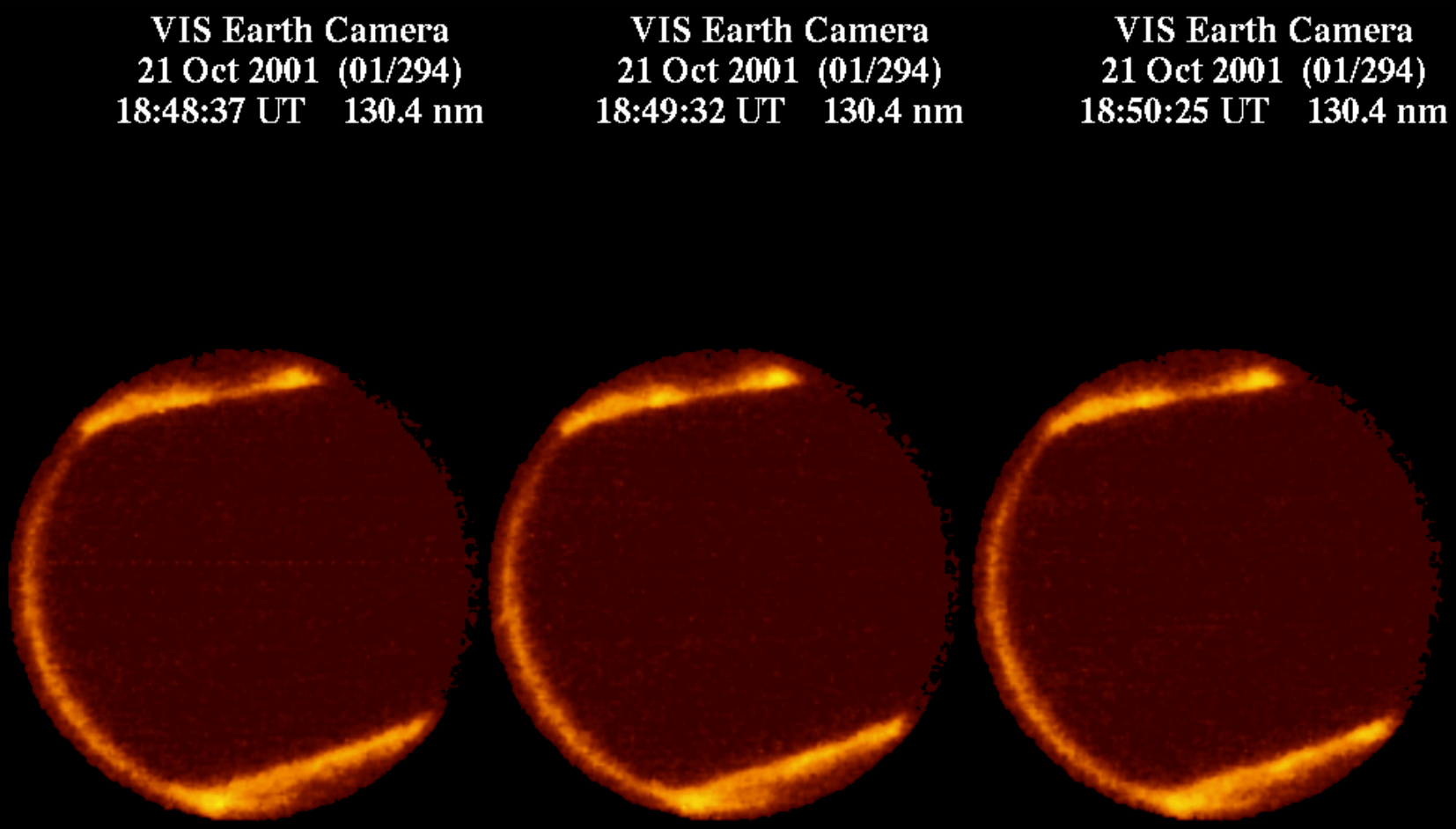




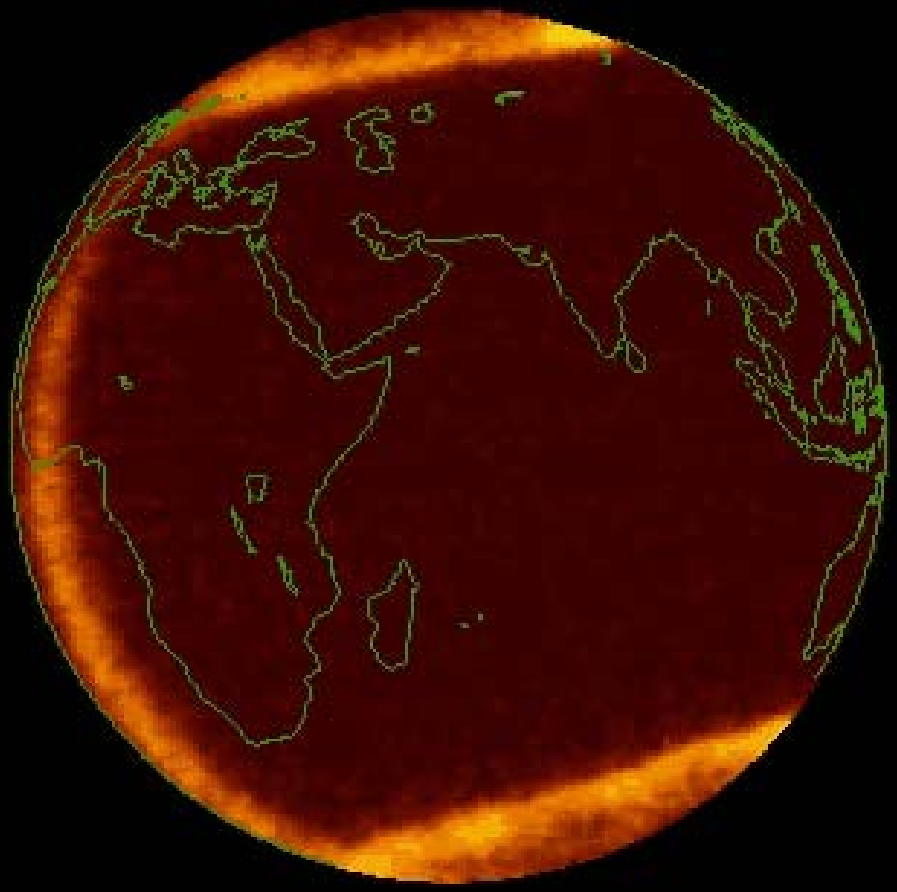


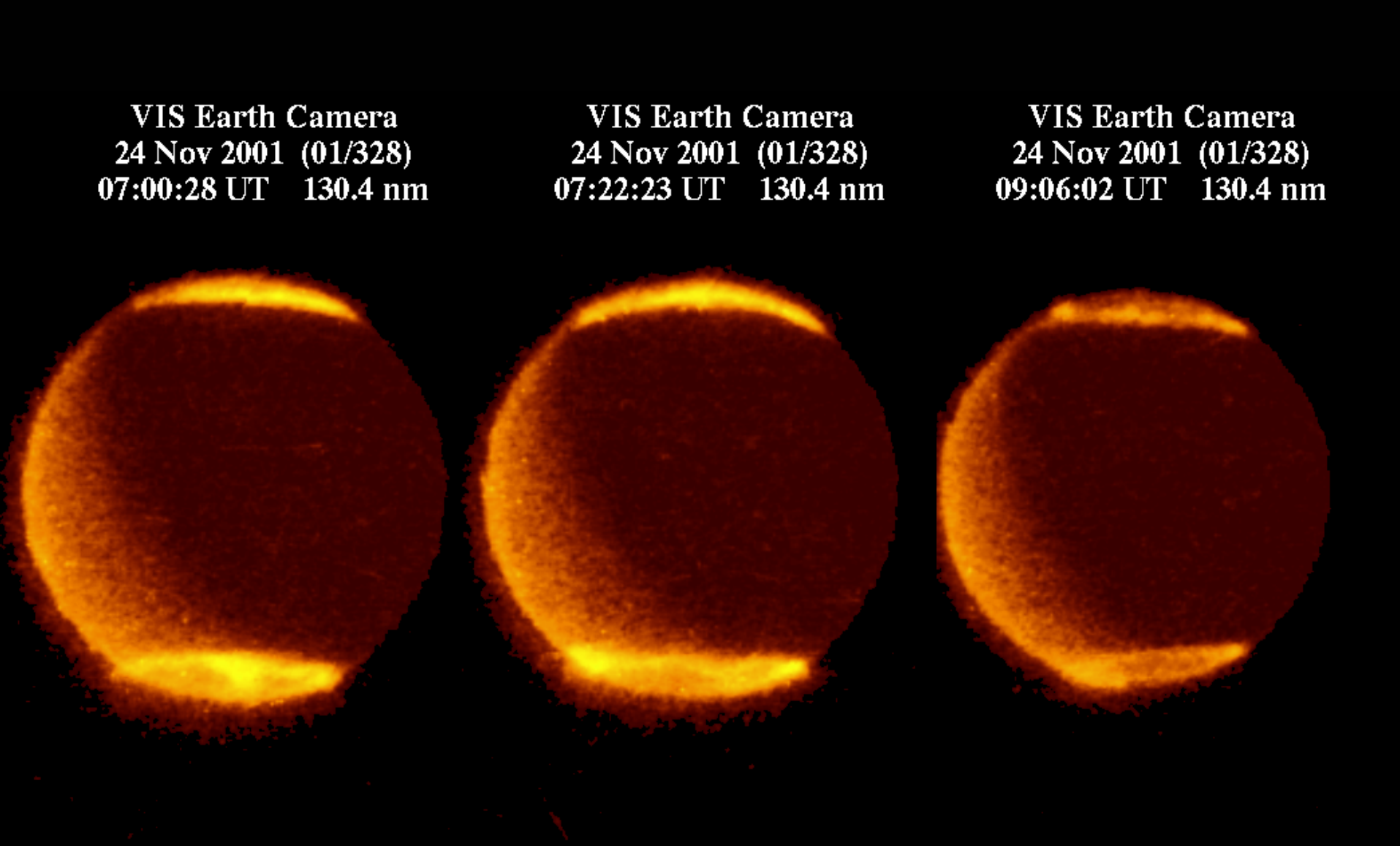
[Fox et al., 2004]

Similar twist in concord with the shift in onset position and the convection throat moves westward to a greater degree due to much larger B_y positive.



•During the storm on 21 October 2001, the northern auroral oval dims and thins while at the conjugate location in the southern hemisphere the aurora remains bright and wide and a section brightens further.





•Several examples of nonconjugate auroral events during the storm on 24 November 2001.

Discussion

- Auroral onset times between hemispheres may differ by ~1-2 minute
- Auroral brightness immediately after onset may be as much as 50% more in one hemisphere with neither hemisphere having preference for brighter emissions
- The lagging hemisphere continues to trail behind in intensity for ~10 or more minutes.

Discussion

- Locations of onset may differ by > 20° in corrected geomagnetic longitude. When mapped along the magnetic field lines to the equator, this leads to “miss” distances of > 1 R_E.
- Auroral formations during storms may be dramatically different. For example a thin, dim section of an oval in one hemisphere contrasted with a wide, bright oval in the conjugate hemisphere.

Discussion

- Hemispheric preferential scattering in the magnetotail could explain the auroral intensity asymmetries.
  - Possible but not probable.
  - Implementation of such a mechanism would be difficult to imagine.
- Hemispheric differences in magnetic field line path lengths from the onset region in the magnetotail could explain the auroral onset timing asymmetries.
  - Timing offsets of 1-2 minutes would imply path length differences of ~ 1 R_E.
  - ~10-20% interhemispherical path length difference for onset regions located at 5—10 R_E in the magnetotail.

Discussion

- Differences in the auroral acceleration regions and MI coupling for the two hemispheres could explain all of the observed non-conjugate features.
  - The bright emissions in the Polar/VIS Earth Camera images are typically associated with discrete auroral arcs.
  - Larger parallel potentials in one hemisphere would result in brighter FUV auroral emissions
  - Differing ramp-up times for the two parallel potential structures would result in timing offsets for substorm onset.
  - During storms, asymmetries in the auroral acceleration regions would result in the very different auroral structures observed in the images.