**TWINS Ion Temperature Analysis**

TWINS energetic neutral atom (ENA) data are used to measure the ion temperature. The instrument detects ion fluxes from 0.5 to 1.0 A, photons in the Lyman-α (121.6 nm) line, and neutral atoms in the ionospheric extent. The data are collected using a spatial bin size of 0.5 x 0.5 A, pixels in the ionosphere (SGM coordinate) using a fractional field of view algorithm described by Keesee et al. (2011, 2012). This algorithm is designed because the fixed angular relationship of the instrument probe a FOV that increases as a function of distance from the Earth. If the instrument has a fixed angle, the results from different spacecraft will not be consistent. The simulations are calculated by dividing the total flux by the number of lines of sight FOV pixels averaged over a particular spatial bin.

The effective ion temperature in each spatial bin is calculated by assuming the spectrum is dominated by electrons from the hot dayside along the LOS and a Maxwellian distribution for the proton. Thus:

\[
T_{\text{eff}} = \frac{1}{x} \ln \left( \frac{\sigma v^2}{2 \pi k_B T_p} \right)
\]

In Equation 1, \(x\) is the location of the hot point along the LOS, \(T_p\), the energy-dependent change, exchange cross-section (Franklin and Fraser, 1972), \(\sigma\), is the neutral density, \(v\) is the ion velocity, and \(k_B\) is the Maxwell-Boltzmann constant. The region within 3 km of the Earth's surface is excluded from our analysis for reasons of accuracy.

**Ion Temperature Comparison between TWINS and SWMF**

![Image of ion temperature comparison between TWINS and SWMF](image)

**Discussion**

- In the following interval, Figure (b), the region of increase ion temperature extends toward the dusk, although this appears to be more continuous spatially in the simulations than in the data. In addition, a new energized region is observed in the magnetotail in the TWINS data that is not observed in the simulation.
- In Figure (c), the high temperatures are observed to have moved across the magnitude in MLT range in both the data and simulations. This continues and is intensified into the interval in Figure (d). There is also significant heating across the dusk and MLT.
- As the peak of the storm, in Figure (e), a significant region of heating is observed on the nightside and the dawn flank in the TWINS data. It appears that the simulations observe a region of relatively cooler temperatures in that area. However, the minute resolution images demonstrate a "broad" moving earthward from the dawn side of the magnetotail that could be the cause for the observed heating.
- In the early recovery phase, Figure (f), two regions of high ion temperatures are observed within geomagnetic oval, a large one centered near midnight-MLT that extends dawn and dusk, and a more localized region in the post-midnight sector. While the spatial extent and intensity of these regions in the simulations are not the same, the peaks occur in similar locations.