Observing SAIDs with the Wallops Radar

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This photo on 3 December 2004 shows fully erected poles, partially tensioned kevlar support lines for antennas and partially tensioned guy lines.
Sub-Auroral Ion Drifts (SAID)

- SAIDs were first identified by Galperin et al. [1974], who gave them the name Polarization Streams.
  - The name SAID was given to them by Smiddy et al. [1977].
- Most observations of SAIDs have been made from low-altitude spacecraft.
  - One-dimensional profiles of plasma drift obtained every ~100 minutes.
- SAIDs exhibit latitudinally narrow, ~1°, regions of high-velocity westward flow with speeds reaching more than 2 km/s.
- SAIDs are observed to lie equatorward of the auroral precipitation zone in the pre-midnight local time sector and have been associated with the ionospheric trough.
- The lifetime of SAIDs is typically less than a few hours.
The primary theoretical explanation for the occurrence of SAIDs has been provided by Southwood and Wolf [1978].

They attributed SAIDs to pre-midnight plasma injections, presumably related to substorms, for which the inner edge of the ion plasma sheet is displaced earthward of the inner edge of plasma sheet electrons.

The resulting polarization electric field tends to grow and become more spatially confined with time.

This growth is partially due to plasma processes that deplete the electron density in the lower ionosphere at the foot of the SAID field line.
Examples of SAID Events Observed with the Wallops Radar

- Plots to the left are Doppler velocity time series along one beam of the Wallops radar.
- Positive Doppler velocities are toward the radar (westward flow), negative Dopplers are away (eastward flow)
- Local midnight: ~4 UT
- Dominant blue Doppler regions are sunward flow in dusk convection cell.
- Narrow light-blue/white channels are SAIDs.
- Red/orange Doppler regions are sunward flow in dawn cell.
SAID Activity on August 6, 2005

- This period displays multiple SAID onsets.
- Each event begins with a 2°-3° wide flow burst, which coalesces to a 1° channel at the equatorward edge of the enhancement.
- There is evidence that SAID onsets are associated with enhancements of both dawn and dusk convection cells, possible related to substorm injections.
Observations from Stokkseryi, Iceland (SD) and Narsarsuaq, Greenland (Mag)

Station: Stokkseryi (sto)
Operated by: CNRS/LPCE

Beam 01
06, August 2005 (20050806)
Program ID: 150

Revision: 1.0

Narsarsuaq 1-minute preliminary data August 6, 2005

INTERMAGNET
Preliminary Kp values for August 4-6, 2005

Estimated Planetary K index (3 hour data)

Begin: 2005 Aug 4 0000 UTC

Updated 2005 Aug 7 02:45:03 UTC

NOAA/SEC Boulder, CO USA
Z-Component of Geomagnetic Field at Geostationary Orbit (Note Dipolarizations)
Energetic Electrons at Geostationary Orbit
(Note Injections of Energetic Electrons)
Time Series of SAID Onset

- Times series to the left shows one SAID onset for the time interval 0246-0303 UT on 6 August 2005.
- Each scan is one minute and every second scan is shown.
- Note that the high velocity region initially covers several degrees of latitude and is followed by a coalescence of flow to a narrow channel.
Relationship of SAID to Auroral Precipitation

SuperDARN Wallops: 2005-08-06, 03:41:00-03:41:49 UT

TIMED GUVI: 2005-08-06, 03:33:39-03:56:54 UT
Summary

- The SuperDARN-Wallops radar has provided the first two-dimensional temporally-resolved measurements of the dynamics of SAID flow channels.

- The channels form as a consequence of substorm injections into the inner magnetosphere.

- Initially the flow channels are broad, but they quickly coalesce into narrow flow channels at the equatorward edge of the original broad flow region and equatorward of auroral precipitation.

- The broad flow regions appear to be substorm-related convection enhancements during the substorm expansion phase.

- Overall, these temporally resolved measurements of SAID dynamics appear to be fairly consistent with the predictions of the Wolf and Southwood [1978] model.
GOES Satellite Environment Data