Summary on Session:
"EPP Effects on Thermosphere and Ionosphere"

M. López-Puertas

- 5 oral presentations (1 invited) and 2 posters
- 5 dealing mainly with Ionosphere and 2 with the Thermosphere.

- Large efforts for estimating (deriving) precipitation of energetic particles from ground-based measurements, mainly manifested through their interaction with the ionosphere (EISCAT radar, riometers, communication signals).

- The SABER NO and CO2 coolings constitute the first long-term climate data record in the thermosphere.
  - Exploitation of this dataset will help improving our knowledge of the Thermosphere/Ionosphere.
  - Validating the basic energetics in all upper atmosphere general circulation.

EPP effects on the Thermosphere and Ionosphere(1/7)

- **Statistical comparison of particle precipitation fluxes and the D-region electron density profiles**

Antti Kero et al.

- Finding correlations between the e- density in the D-region and particles precipitation.
- Electron density from EISCAT radar against satellite data of particles precipitation fluxes (POES).
- **Conclusions:**
- Electron densities measured by the VHF and MEPED electron fluxes correlate well at 80-90km but not below and above.
- Can be caused by uncertainties in the spatial and temporal match of the two datasets + general uncertainties of the data.
- **On going work.** Reanalysis of the POES and EISCAT datasets
- More satellites: DMSP, DEMETER.

EPP effects on the Thermosphere and Ionosphere(2/7)

- **Observations of trapped and precipitating electrons in the auroral zone, and related effects in the D-Region (Poster)**

  Hargreaves et al.

  - Finding an empirical relationship between the precipitating particles (flux) (>30keV, >100keV, POES) and the response of the ionosphere (absorption, Riometer imaging).
  - Address the short term (hours) variations.

Conclusions:

- The precipitated e- flux varies more than the trapped e-.
- Flux ~ Absorption^2 holds more for the trapped than for the precipitated e-.
- Empirical formula for the Flux and Absorption. Estimated one form the other and vice-versa within factors of 2-3 and 1.4.
- Can be used to estimate diffusion of >30keV e- in the morning sector.

EPP effects on the Thermosphere and Ionosphere(3/7)

- **Global AARDDVARK Measurements of Energetic Electron Precipitation**

  Mark Clilverd, Craig Rodger, and the AARDDVARK team

  - The AARDDVARK network provide continuous long-range (the 2 hemispheres) observations of the lower ionosphere (30-85 km) and energetic particles prepicitating there.
  - Uses the very low fixed-frequency (VLF) signal of communications transmitters.

  Conclusions:

  - First confirmation that EMIC-waves drive intense relativistic precipitation in the atmosphere.
  - First indication of the size of relativistic electrons microburst precipitation events: can be as large as 90º in longitude.
  - Future: Modelling development to estimate precipitation fluxes from the AARDDVARK observations.

EPP effects on the Thermosphere and Ionosphere(4/7)

- **HF waves observed by DEMETER above the SAA**

  Michel Parrot

  - DEMETER observes a narrow frequency band (660 – 680 kHz) emission over the SAA at an altitude of 660 km. Not observed during SH summer.

Conclusions:

- The fading of the HF emission during SH summer suggests that its generation occurs below the ionospheric levels (~200 km).
- It is suggested that these HF waves are caused by a Z-mode emission originated by the drifting of the energetic particles that are continuously precipitating into the SAA ionosphere.

EPP effects on the Thermosphere and Ionosphere(5/7)

- **Midlatitude nighttime D region variability detected by broadband VLF sferics (Poster)**

  F. Han and S. Cummer

  - Study of the variability of the mid-lat ionospheric D-region by measuring the high power, broadband signals launched by lightning and propagating along the Earth-ionosphere waveguide.
  - Time scales and possible sources of such variability, including the high energy particle precipitation and the direct lightning-ionosphere coupling.

Conclusions:

- Among the first measurements of the night D region on short time scale (minute) over many nights.
- Large variability in many scales (night, hour, minute).
- LEP and EMP are two possible mechanisms causing such variability.
- Future: Quantitative analysis of these mechanisms.

EPP effects on the Thermosphere and Ionosphere(6/7)

- **Energetic particles precipitation effects on the energy balance of the the Thermosphere and Ionosphere**

  M. Mlynczak et al.

  - Infrared cooling measurements from SABER on time scales from a few days to 11-year solar cycle

Conclusions:

- The “natural thermostat” effect of NO is highly efficient in removing energy deposited from solar wind particle events
- Short-term periodic features in radiative cooling are observed and shown to have geomagnetic origins.
- Long-term changes in radiative cooling have both geomagnetic and solar ultraviolet causes
- A strong coupling between both particles and photons from the Sun and long-term changes in thermospheric neutral dynamics.
- The SABER NO and CO2 coolings constitute the first long-term climate data record in the thermosphere and are fundamental for validating the basic energetics in all upper atmosphere general circulation models.

EPP effects on the Thermosphere and Ionosphere(7/7)

- **Recurrent Geomagnetic Activity Driving a Multi-Day Response in the Thermosphere and Ionosphere**

  J. Thayer et al.

  - Recent findings on changes upper atmosphere at periods near 5, 7 and 9 days have attributed to recurrent high speed solar wind stream disturbances and coronal hole distributions on the Sun.
  - Aim at relating these periodicities in geomagnetic activity to global thermosphere and ionosphere responses.

Conclusions:

- Use CHAMP satellite to study this correlation and the thermospheric response.
- Use global temperature variations from TIMED/SABER to study the global thermal response of the mesosphere/lower thermosphere to recurrent geomagnetic activity.