Plasmasphere Brainstorm Meeting
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Minutes (F. Darrouzet, with input from S. Benck)

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Agenda:

Talks:

- DC: Whistler-mode and Z-mode
- DC: Plasmasphere Boundary Layer
- JG: Global plasmaspheric evolution during erosion
- VP: Formation and deformation of the plasmapause
- FD: Cluster and Image observations of plasmaspheric plumes
- HV: Possible ionospheric signature of plasmaspheric plumes
- ID: Ion distributions in the plasmasphere with Cluster-CIS data
- NA: Convective instabilities in the plasmasphere
- OS: Equatorial noise emissions observed close to the plasmapause
- OS: Discrete whistler-mode emissions observed close to the plasmapause
- JL: Intense VLF emissions observed near the geomagnetic equator
- AM: Observations of mid-latitude hiss near the plasmapause
- SG: Spatio-temporal observations of non-thermal continuum
- PD: L-shell – frequency Whisper spectrograms

Presentations:

DC: Whistler-mode and Z-mode

cf.: 2004July_Paris_Plasmasphere_Carpenter_1.pdf

● RPI sounder onboard IMAGE satellite (1000km * $7R_E$)
  ∗ sounding in - whistler mode ($f<f_{ce}$)
  - Z-mode ($f_{pe}<f<f_{uh}$) → Z mode dependence upon f_{pe}/f_{ce} ($f_{pe}>f_{ce}$ in plasmasphere)
  ∗ 4 possibilities of sounding to study whistler and Z-mode.

● Dependence of the Z-mode cutoff (f_Z) on the ratio f_{pe}/f_{ce}
  ∗ existence of a minimum of f_Z
  ⇒ different echoes if the spacecraft is below or above this minimum

● Examples with IMAGE/RPI
  ∗ Sounding echo pattern from a location - below a trough minimum
  - above a trough minimum

● Summary:
  ∗ A Z-mode propagation cavity exists essentially at all times over a wide range of latitudes, such that echoes can return to IMAGE from both directions along geomagnetic field line paths
  ∗ An inversion process has been developed, permitting determination of the field line distribution of ionization several thousand km from IMAGE in the direction of the magnetic equator

DC: Plasmasphere Boundary Layer

cf.: 2004July_Paris_Plasmasphere_Carpenter_2.pdf

● PBL = Plasmasphere Boundary Layer
  ∗ New concept (like LLBL)
  ∗ Recently introduced in URSI Bulletin (March2004)

● Processes involved in the formation of new boundary layers following quiet periods:
  ∗ Hot/cold plasma interface
  ∗ SAID

● Evolution of boundary layers in the aftermath of PBL formation
● Variation in a boundary layer with distance along the geomagnetic field lines and with time
  ∗ density structure in the plasmapause profile
  ∗ particle precipitation
  ∗ VLF wave bursts

JG: Global plasmaspheric evolution during erosion

cf.: 2004July_Paris_Plasmasphere_Goldstein.pdf

● Quiet time study are very interesting also (not only storm events).

● 18 June 2001
  ∗ PP - not regular in dayside
        - regular and smooth in nightside
  ∗ Erosion of PLS: - motion of PP towards Earth in nightside
                    - motion of PP outward Earth in dayside
              + azimuthal motion of the boundary
  ∗ Formation of a plume, and then "double-plume"
  ∗ Nightside held steady, but dayside co-rotates

● 17 April 2002
  ∗ Global PP motion starts in pre-midnight sector
  ∗ Impulse front

⇒ PLS becomes very structured, even during quiet time.

VP: Formation and deformation of the plasmapause

cf.: 2004July_Paris_Plasmasphere_Pierrard.pdf

● Simulations of plasmapause formation based on:
  - the mechanism of plasma instability
  - the E5D electric field model

● 9-10 June 2001
  ∗ ZPF (Zero Parallel Force surface) closer to Earth in post-midnight sector
  ∗ plume created when Kp increases (and erosion of PLS)
  ∗ shoulder created when Kp decreases (and PP going further)

● 25-26 June 2000
  ∗ creation of a plume (same local time sector between simulation and IMAGE/EUV)

● 1-3 May 2001
  ∗ very quiet time event, PP very extended

● 2 June 2002
  ∗ formation of a plume (seen also on IMAGE/EUV images)

● Kp-L relation for the PP position
  ∗ rather good correspondence between simulation and EUV

FD: Cluster and Image observations of plasmaspheric plumes

cf.: 2004July_Paris_Plasmasphere_Darrouzet.pdf

● Cluster (WHISPER, EFW, CIS) and IMAGE (EUV) general context

● 27 June 2001
∗ Very structured plume in the inbound pass, plume seen by C3 35 minutes later
∗ Plume observed by EUV 4UT before, in same MLT
∗ Simulation OK: plume in same MLT

● 11 April 2002
∗ Large plume in the inbound and outbound passes observed on 4 spacecraft at the same time
∗ Azimuthal motion of plume = 50% of co-rotation (3.2km/s): plume convected away from Earth
∗ Plume observed on both spacecraft in both passes by CIS data (but much less He^+ and no O^+)
∗ Plume seen by IMAGE/EUV, and PP position OK between Cluster and IMAGE
∗ Rotation of the plume between 2 Cluster passes, and between EUV corresponding images

● 7 May 2002
∗ Plume observed in the inbound pass on 4 s/c at the same time (almost not seen in outbound pass)
∗ Plume seen also by EUV in same MLT sector (Cluster in the tail of the plume)
∗ Comparison OK with simulation
∗ Plume seen by CIS on C1 (but no O^+)

● 2 June 2002
∗ Very big plume seen in the inbound and outbound passes on 4 s/c at the same time
∗ Very extended plume observed by EUV between 18 and 23 MLT
∗ Plume seen by CIS onboard both spacecraft in both populations H^+ and He^+

● Summary
∗ Plasmaspheric plumes have different characteristics (position, size, duration, ...)
∗ Comparison between Cluster and IMAGE very useful
∗ Simulation does not need very high Kp to create a plume

HV: Possible ionospheric signature of plasmaspheric plumes

cf.: 2004July_Paris_Plasmasphere_Vo.pdf

● Observation of plume signatures in ionosphere by ground-based data
∗ plume observed above US and moving towards Europe (never in the other way round)

● PLS coupling with the mid-latitude ionosphere: identification of mid-latitude ionospheric 'footprint' of plasmaspheric drainage plumes over the European sector
∗ use TEC measurements

● Relationship between equatorial plasmapause to the mid-latitude trough
∗ OK for nightside, not so good for dayside

● High latitude ionospheric signatures of plasmasphere drainage plumes
∗ 02/02/2002: TEC enhancements seen in Scandinavian and Quaanaaq data at MLT and UT corresponding to the plume base

ID: Ion distributions in the plasmasphere with Cluster-CIS data

cf.: 2004July_Paris_Plasmasphere_Dandouras.pdf

● Ion distribution with CIS experiment (0.7-25 eV in RPA mode) onboard Cluster

● 04 July 2001
 * 100 cm^{-3} of H^+ and 10 cm^{-3} He^+ in PLS: typical ratio
 * Co-rotation inside PLS

● 31 October 2001
 * Pitch angle ~ 90 ° in PLS, but isotropic in plume
 * No O^+ in plume
 * Co-rotation in PLS, but expansion in plume

● 12 November 2001
 * Inbound plume uni-directional, but outbound plume bi-directional
 * Up-welling H^+ and O^+ in plume

● 17 February 2002
 * No PLS on C4, but detached structure observed only on C4, with up-welling H^+ and He^+
 * Simulation explains why only C1 and C3 go in PLS (all s/c on the edge of PP)

● Statistic on PP position, as a function of L and Kp
 * Shoulder in dawn, plume in dusk

● Summary
 * Co-rotation inside PLS
 * Outwards expansion of detached elements

NA: Convective instabilities in the plasmasphere

cf.: 2004July_Paris_Plasmasphere_Andre.pdf

● Existence of plasmaspheric wind??

● MHD modes influenced by gravitation
 → Quasi-interchange → Type1 = Interchange
 → Type2 = Translation
 + Stability Criteria

● MHD modes influenced by stratification (gravity + curvature)
 → Quasi-interchange → Type1 = Interchange
 → Type2 = Translation
 + New Stability Criteria

● Profiles stable against Type1, but unstable against Type2 ⇒ plasma flow along field lines
 ⇒ ballooning-type instability permitted ⇒ detached elements

OS: Equatorial noise emissions observed close to the plasmapause

cf.: 2004July_Paris_Plasmasphere_Santolik_1.pdf

● Equatorial noise emissions observed - below f_{lh}
- close to the plasmapause
- in electric and magnetic fields

∗ Statistical analysis of these waves
∗ Estimation of Ne from from E/B ratio of the equatorial noise, and comparison with Ne from spacecraft potential: good agreement

OS: Discrete whistler-mode emissions observed close to the plasmapause

cf.: 2004July_Paris_Plasmasphere_Santolik_2.pdf

● 18 March 2002
∗ Quiet period before
∗ Small structures seen at the same time by the 4 s/c, but global structure shifted in time between 4 s/c.
⇒ why localized in time??
∗ WHISPER N_e, compared with EFW V_{sc}
∗ STAFF: high waves in PP: slow mode, chorus-like…
∗ Ray-tracing to fit the plasmapause position

JL: Intense VLF emissions observed near the geomagnetic equator

cf.: 2004July_Paris_Plasmasphere_Lemaire.pdf

● Intense emissions when s/c outside PLS, close to geomagnetic equator.
∗ Why??
- position dependant?
- some waves at f_{uh} in ELF range?
- anti-correlation with flux of electrons with E<100 MeV?

● Need: - a statistic of these waves
- to study the dispersion relation with non-uniform plasma along field lines.

AM: Observations of mid-latitude hiss near the plasmapause

cf.: 2004July_Paris_Plasmasphere_Masson.pdf

● Mid-latitude hiss observed by WHISPER, STAFF and WBD
∗ Close to the equator
∗ No MLT dependence, but Kp dependence
∗ 2 possible explanations:
- Hiss generated within a given F/Fce range, and with Kp ↗ → L↘ → Fce ↗ => F ↗
- Doppler shift between a moving source and the spacecraft
∗ Observed when Cluster are in a notch (observed by IMAGE/EUV)

SG: Spatio-temporal observations of non-thermal continuum

cf.: 2004July_Paris_Plasmasphere_Grimald.pdf

- 26 September 2003
  - ∗ Continuum radiations observed outside PLS
    - ⇒ $F_{c\ source}$ = 7.5 kHz; and $F_{c\ local}$ = 8.2 kHz

- 30 December 2003
  - ∗ Continuum radiations observed at PP, with F decreasing along trajectory
  - ∗ Waves shifted in time, but not shifted in magnetic latitude

- 8 November 2003
  - ∗ Case much more complex, with F increases, then decreases, then increases.
  - ∗ Waves not shifted in time, but shifted in magnetic latitude

PD: L-shell – frequency Whisper spectrograms

cf.: 2004July_Paris_Plasmasphere_Decreau.pdf

- New WHISPER tool:
  L-frequency spectrograms, instead of time-frequency spectrograms.