

Plasmasphere Brainstorm Meeting

ESA, Paris

16 July 2004

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

Participants:

Nicolas André (NA)	Nicolas.Andre@cesr.fr	<i>CESR, Toulouse, France</i>
Sylvie Benck (SB)	sylvie.benck@fyuu.ucl.ac.be	<i>UCL, Louvain-la-Neuve, Belgium</i>
Don Carpenter (DC)	dlc@nova.stanford.edu	<i>STAR, Stanford, CA-USA</i>
Iannis Dandouras (ID)	Iannis.Dandouras@cesr.fr	<i>CESR, Toulouse, France</i>
Fabien Darrouzet (FD)	Fabien.Darrouzet@oma.be	<i>IASB-BIRA, Brussels, Belgium</i>
Pierrette Décreau (PD)	pdecreau@cnrs-orleans.fr	<i>LPCE/CNRS, Orléans, France</i>
Dennis Gallagher (DG)	dennis.l.gallagher@nasa.gov	<i>MSFC/NASA, Huntsville, AL-USA</i>
Jerry Goldstein (JG)	jgoldstein@swri.edu	<i>SWRI, San Antonio, TX-USA</i>
Sandrine Grimald (SG)	grimald@cnrs-orleans.fr	<i>LPCE/CNRS, Orléans, France</i>
Karine Issautier (KI)	Karine.Issautier@obspm.fr	<i>LESIA, Meudon, France</i>
Joseph Lemaire (JL)	jfl@oma.be	<i>IASB-BIRA, Brussels, Belgium</i>
Arnaud Masson (AM)	Arnaud.Masson@esa.int	<i>RSSD/ESA, Noordwijk, The Netherlands</i>
Viviane Pierrard (VP)	Viviane.Pierrard@oma.be	<i>IASB-BIRA, Brussels, Belgium</i>
Ondrej Santolik (OS)	ondrej.santolik@mff.cuni.cz	<i>MFF-IAP/CAS, Prague, Czech Republic</i>
Claire Vallat (CV)	Claire.Vallat@cesr.fr	<i>CESR, Toulouse, France</i>
Hien Vo (HV)	hbv@aber.ac.uk	<i>University of Wales, Aberystwyth, UK</i>

Agenda:

Talks:

DC: Whistler-mode and Z-mode
DC: Plasmasphere Boundary Layer
JG: Global plasmaspheric evolution during erosion
VP: Formation and deformation of the plasmopause
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 plasmopause
OS: Discrete whistler-mode emissions observed close to the plasmopause
JL: Intense VLF emissions observed near the geomagnetic equator
AM: Observations of mid-latitude hiss near the plasmopause
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 plasmopause 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 plasmopause

cf.: 2004July_Paris_Plasmasphere_Pierrard.pdf

- Simulations of plasmopause 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 plasmopause 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 Quanaaq 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 $\sim 90^\circ$ 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 \Rightarrow plasma flow along field lines
 - \Rightarrow ballooning-type instability permitted \Rightarrow detached elements

OS: Equatorial noise emissions observed close to the plasmopause

cf.: 2004July_Paris_Plasmasphere_Santolik_1.pdf

- Equatorial noise emissions observed - below f_{ih}
 - close to the plasmopause
 - in electric and magnetic fields
- * Statistical analysis of these waves
- * Estimation of N_e from from E/B ratio of the equatorial noise, and comparison with N_e from spacecraft potential: good agreement

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

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 plasmopause 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 plasmopause

cf.: 2004July_Paris_Plasmasphere_Masson.pdf

- Mid-latitude hiss observed by WHISPER, STAFF and WBD
 - * Close to the equator
 - * No MLT dependence, but K_p dependence
 - * 2 possible explanations:
 - Hiss generated within a given F/Fce range, and with $K_p \nearrow \rightarrow L \searrow \rightarrow Fce \nearrow \Rightarrow F \nearrow$
 - 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
 - $\Rightarrow F_{c \text{ source}} = 7.5 \text{ kHz}$; and $F_{c \text{ local}} = 8.2 \text{ kHz}$
- 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.