

# SEVEM Meeting

## Organisation, Modelling & Validation strategies

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Minutes prepared by Fabien Darrouzet

Actions at the end of the minutes.

### **Monday 9<sup>th</sup> July 2001:**

#### **Afternoon session: AM: 13:30 – 17:30**

**J. Lemaire:** Welcome to the participants & changes of agenda (10 minutes)

Welcome to the participants, and especially to François Lefeuvre and Andy Smith.  
No changes in the agenda; end around 17h00.

**J. Lemaire:** Introduction to the project SEVEM (20 minutes)

*Needs for statistical elmg wave environment models*  
*History, Description and Aims of the project*  
*Documents and codes available*  
*Existing statistical elmg wave environmental models,...*

1) Different projects at IASB:

\* TREND (Trapped Radiation Environment Model Development):

<http://www.magnet.oma.be/trend4/public/home.html>

Recommendation about existing radiation belts particle models (AE8, AP8).

\* SPENVIS (Space Environment Information System):

<http://www.spervis.oma.be/spervis/>

Tools for analysis of the space environment.

\* SEVEM (Survey of ELF and VLF Experiments in the Magnetosphere):  
<http://www.magnet.oma.be/sevem/>  
Something is missing at all World Data Centres and in Environment Databases  
models: statistical models for waves in the magnetosphere.

2) The SEVEM project:

- \* Very difficult project because there is a high variability on the data, and because lots of parameters should be modelled (amplitude, power, polarisation,...).
- \* The idea was to start with ELF and VLF because these waves are interacting with particles in the radiation belts, one of our major points of interest at IASB-BIRA and SPENVIS.
- \* Interest of J. Lemaire for possible ELF electrostatic potential variations produced by passing by dust grains or debris.

3) The different steps of the project:

- \* First step: produce a catalogue of missions and wave experiments: the SEVEM Web site (<http://www.magnet.oma.be/sevem/>)
- \* Second step: URSI Recommendation about the SEVEM initiative (<http://www.magnet.oma.be/sevem/URSI-Recommendation.html>)
- \* Third step: selection of the first data set for the study (Viking mission)
- \* Fourth step: analyse of the Viking data (with help of C. Hann and C. Dyck)
- \* Fifth step: modelling of these data (by I. Nanobashvili and W. Spjeldvik)
- \* ... Next steps: new missions (Cluster, Demeter, ... ???)

4) Presentation of some works made by other people:

- \* Study with Hawkeye data by Green et al.  
⇒ Necessity that several groups work on different spacecraft and different antennas to compare results.

5) The output of this study should be statistical models (or empirical model in the “old” meaning).

6) The work on Viking:

- \* VLF spectrum and ELF waveform transformed in spectrum; identify specific events and classified these events.
- \* G. Gustafsson (PI of the ELF experiment on Viking – V4L) is enthusiastic with the work on his data going on at IASB-BIRA.

**F. Darrouzet:** The SEVEM WEB site (15 min.)

*Selection of first data set; why VIKING?*

*Utilisation of Cluster measurement (WHISPER & STAFF) and other old and future data sets (Demeter)*

- 1) Demonstration of the SEVEM Web site
  - \* List of the satellites by several criteria (type of experiment, range of frequency, period of time of the measurements, selection by the type of orbit, institutes or countries involved in the missions).
  - \* List of the acronyms used in the Web site.
  - \* Page on the futures missions.
  - \* Examples of the information available for one spacecraft.
  - \* Information about existing statistical waves models.
- 2) Arguments for the selection of the Viking data set (availability of the data in a French data centre [CDPP at <http://cdpp.cesr.fr>], frequency range of the instruments, duration of the mission, type of orbit).
- 3) Plans for the utilisation in the future of the Cluster and Demeter missions.

**F. Lefeuvre:** The statistical wave distribution derived from Dynamic Explorer measurements (30 minutes)

- 1) Contacts of CEA and LPCE since 1994 about ELF wave modelling.
- 2) 1996: contract to develop wave models for the radiation belts:
  - ⇒ Research of spacecraft's data (magnetic field data) in equatorial regions:
    - Dynamic Explorer 1 to make the model
    - ISEE1 and GEOS1 to test the model
- 3) Rq.: No authorisation to publish the model (perhaps unclassified in 1 or 2 years?).
  - Authorisation to publish scientific results obtained with the model.
- 4) Presentation of a paper from R. Andre:
  - \* DE1 data: above 100 Hz, spectra and but 100 Hz, bad resolution.
  - \* For low Kp, very weak emissions below 100 Hz
    - For Kp>4, emissions of higher intensity.
  - \* List of emissions observed and used in the model:
    - equatorial hiss: below 200 Hz
    - plasmaspheric hiss: 100 Hz – 3 kHz (in plasmasphere)
    - chorus: 3 kHz – Fce/2 (exterior of the plasmopause)
    - TBF emitters: 17 – 23 kHz
  - \* The model:
    - empirical model
    - 1 model for each type of waves (4 models)
  - \* Good results and correspondence between the model (obtained with DE1 data) and data from ISEE1 and GEOS1.
  - \* 1 important conclusion: with 3 years of data, we don't have enough points to make a statistic.

- \* Presentation of statistical histograms of the number of data in function of the “binning”. There are 2 pics, instead of 1 for a usual distribution: it is an inhomogeneous sampling.

**A. Smith:** Magnetospheric waves on the ground and in space. (20 minutes)

**1) The VELOX (VLF/ELF Logger eXperiment) network (several ground stations):**

- \* 8 wide-band channels 0.25 – 10 kHz
- \* 22 kHz bandwidth  $\Rightarrow$  40000 samples per second
- \* magnetic field measurements
- \* data available at <http://dabs.nerc-bas.ac.uk>
- \* plots available at <http://www.nerc-bas.ac.uk/public/uasd/intro.html>

**2) Examples of data and waves observed at the Halley station.**

**3) List of statistical requirements suggested by R. Horne**

- \* Peak and time average power spectral density in
  - $\rightarrow$   $nT^2/Hz$  (EM waves) AND  $V^2/m^2/Hz$  (ES waves)
- \* Peak and time average wave amplitude in
  - $\rightarrow$  nT and V/m
- \* Peak frequency and bandwidth for each wave mode
- \* Wave distribution function:
  - $\rightarrow$  Principal direction
  - $\rightarrow$  Bandwidth in polar angle away from B
  - $\rightarrow$  Bandwidth in azimuthal angle around B
- \* Characteristic frequencies essential:
  - $\rightarrow$  fpe and fce
- \* Parameters must be scaled to fce, fpe
- \* Parameters are required for different levels of
  - $\rightarrow$  Kp, AE, Dst, Pc (polar cap index)
- \* Required for different
  - $\rightarrow$  Magnetic local time
  - $\rightarrow$  Latitude
  - $\rightarrow$  L shell
- \* Issues:
  - $\rightarrow$  Some emissions are constant frequency – e.g. hiss
  - $\rightarrow$  Some vary with fce – e.g. chorus
  - $\rightarrow$  Wave modes will be difficult to identify:
    - Hiss, chorus,
    - R-X, L-O, L-X-Z,
    - magnetosonic, lower hybrid, Electrostatic,
    - EMIC.
  - $\rightarrow$  Boundary positions – plasmopause, magnetopause

## **B. Quaghebeur: Demo of SPENVIS (20 min.)**

### **1) 3 parts in SPENVIS:**

- Environment (scientific community)
- Effects (engineering tools)
- Education (other people)

### **2) Demonstration of the SPENVIS Web site:**

- \* List of the users: in USA, Europe and Far East.
- \* Main aim of the site: link all the models.
- \* List of the possibilities:
  - orbital generator
  - geometry of a spacecraft
  - magnetic field models
  - atmosphere and ionosphere models
  - spacecraft charging
  - meteoroids and debris models
  - database queries (several spacecraft and geomagnetic and solar indices).

### **All: Discussion of the SEVEM project (120 minutes)**

- 1. organisation, funding and responsibilities*
- 2. selections of missions & data sets*
- 3. model what physical parameters?*
- 4. development of statistical models*
- 5. formats of models*
- 6. validation of models*
- 7. archiving of models*
- 8. distribution of models & publications*
- 9. access to models*
- 10. scientific returns*

#### **1. Organisation: set up a consortium (with IASB, LPCE, BAS and ...???)**

Funding: ESA, European Community and tender for an action concerning pilot projects about space weather (to be announced in SWEN soon).

Responsibilities: who should be the project scientist?

**[JL]** It should be a young active scientist: a locomotive is needed.

⇒ We should all identify people motivated by this project.

3 steps in this project: - define a topic (already done)

- contact people, to find who is interested in this topic
- write a proposal for a project to get the support/budget

#### **2. Future data sets: we will see later, after analysing Viking data.**

**[AS]** We should think about definitions of new missions, which could fit into in the SEVEM project; what do we need for this kind of modelling; should we push on new projects about wave measurements on spacecraft?

3. Physical parameters modelled: see the requirements by R. Horne (in the [AS] presentation).

4. 5. Which kind of binning? B/L co-ordinates like particle models? It could be interesting because of the interaction wave-particles but this is not sure since the waves don't propagate along (B/L) drift shells, like Van Allen particles.

[FD] One should adapt the same database formats in all SEVEM groups to facilitate comparison between models and results.

[FL] Use of magnetic field data is easier than electric field data (it avoids the problems of calibration, with transfer functions).

6. We should test the model (made with 1 set of data) with another set of data.

7. Archiving of validated ELF-VLF wave models: in SPENVIS.

8. Distribution of models: be careful with the rights on projects and models.

9. Access to the models: through SPENVIS on the Web.

10. [JL] Many other issues should be discussed at SEVEM working group meetings to be convened in the future and possibly linked with VERSIM meetings.

11. [JL] VERSIM should be the co-ordinator of the SEVEM modelling structures.

[AS] But be careful, because VERSIM is an international group, and SEVEM would be a European project...

12. [JL] The validation of the models should be done by an international team of experts designated by IAGA and COSPAR. These international bodies can then recommend these models and propose their adoption by ISO (International Standard Organisation).

### **Actions:**

- 1) Contact J. L. Rauch to have information about neural network on ELF wave recognition. [FD]
- 2) Contact A. Hilgers to have information about the possibilities to obtain a support by ESA. [JL]
- 3) Look for other possible support by the European Community. [FL]
- 4) Think about a young active person to lead and write a joint proposal (technical, administrative, financial) and about any persons motivated and interested by the project. [All]
- 5) Report the results and recommendations of this meeting at the next IAGA meeting in Hanoi. [AS]
- 6) Consider the possibility to organise a session about statistical wave modelling at the next URSI meeting. [AS]