CHAMP Plasma Measurements

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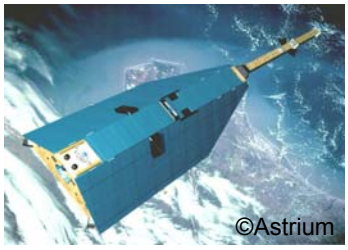
ESTEC

Introduction

- CHAllenging Mini-satellite Payload for geoscience and application. Launched in July 15, 2000 into an almost circular, near polar (i = 87°) orbit with an initial altitude of 454 km.
- Mission to provide accurate measurements of Earth's gravitational field
- Digital ion drift meter (DIDM) to make in-situ measurements of the ion distribution
- Langmuir Probe situated with the DIDM
- CHAMP should tell us how SWARM should behave



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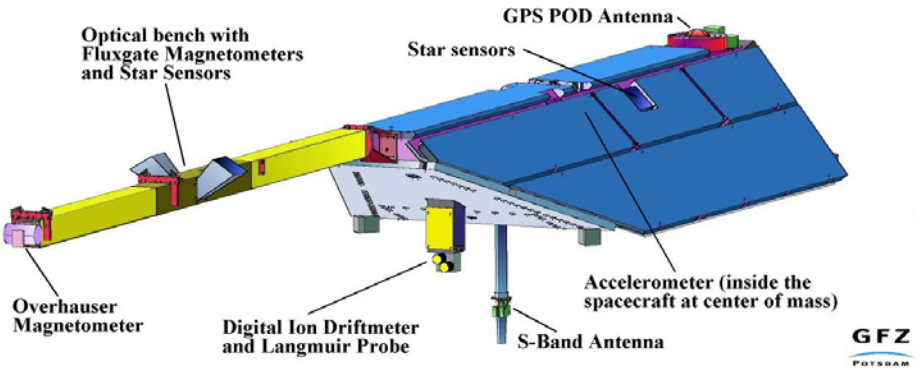
CHAMP



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DIDM and PLP

Planar Langmuir Probe

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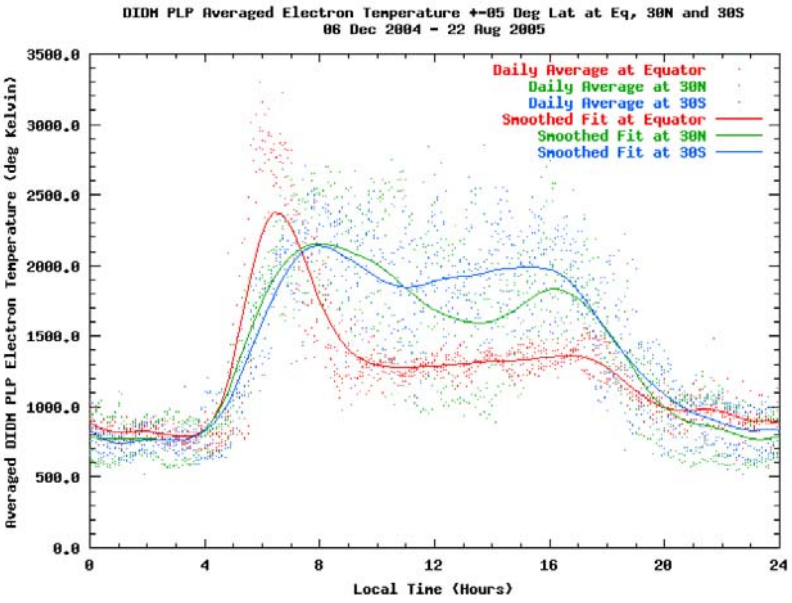

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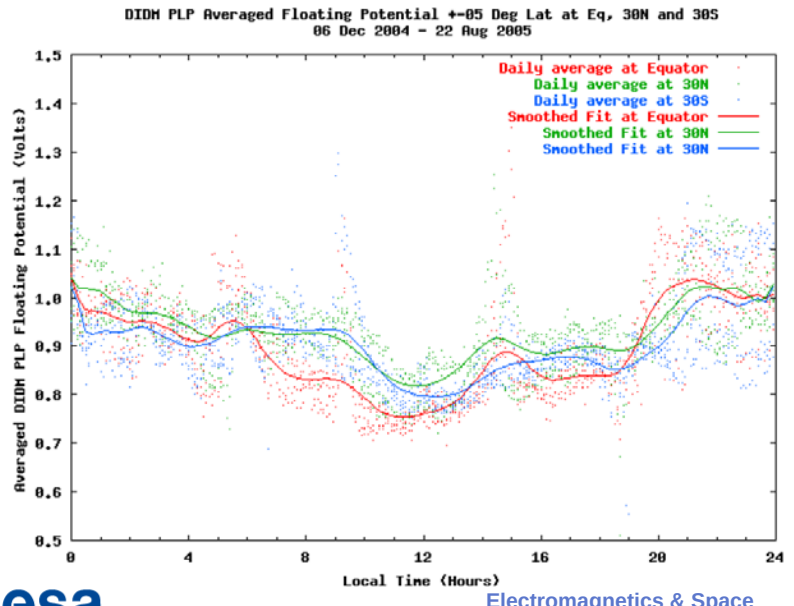

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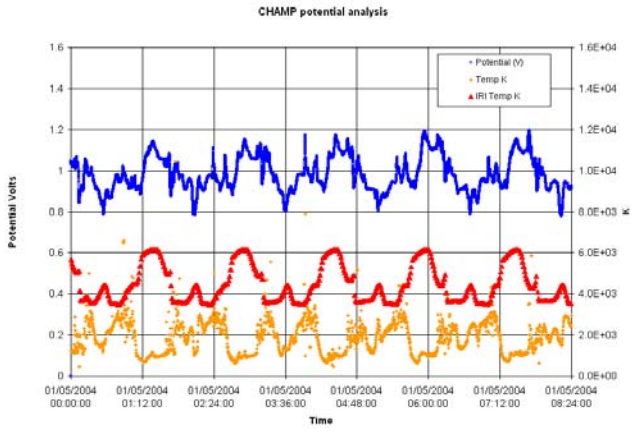
CHAMP measurements



Potential (blue) expected to rise and fall in phase with electron temp (yellow)

Floating potential

$J = J_{ions} + J_{electrons}$

J_{photo} is unimportant , J_{ions} is due to spacecraft velocity

$$\Psi_{eq} = -\frac{kT_e}{e} \ln \frac{A_e}{A_i} \left[\frac{kT_e}{2\pi m_e v_{sc}^2} \right]^{\frac{1}{2}}$$

A_e/A_i ratio of the electron and ion current collection areas,
v_{sc} spacecraft velocity

[1] Anderson PC, WB Hanson WR Coley and WR Hoegy, Spacecraft potential effects on the Dynamics Explorer 2 satellite, JGR Vol.90, A3, pp.3985-3997, 1994

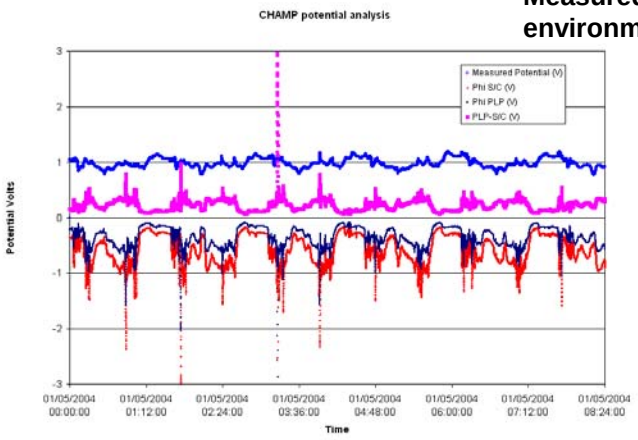
Potential measurement

$$\Psi_{obs} = \Psi_{PLP} - \Psi_{s/c}$$

PLP $A_e/A_i = 1$

Spacecraft $A_e/A_i \approx 3.97$

Measured environment



Potential measurement

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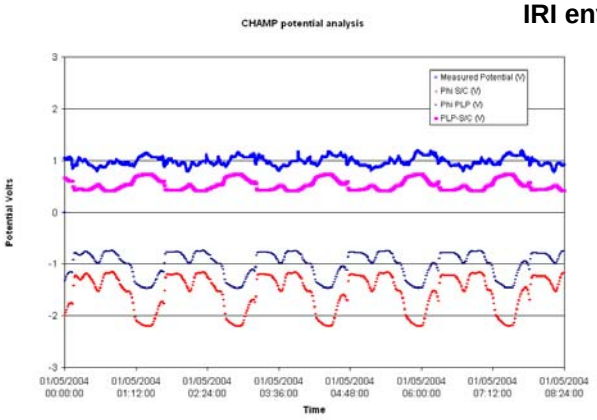
IRI environment



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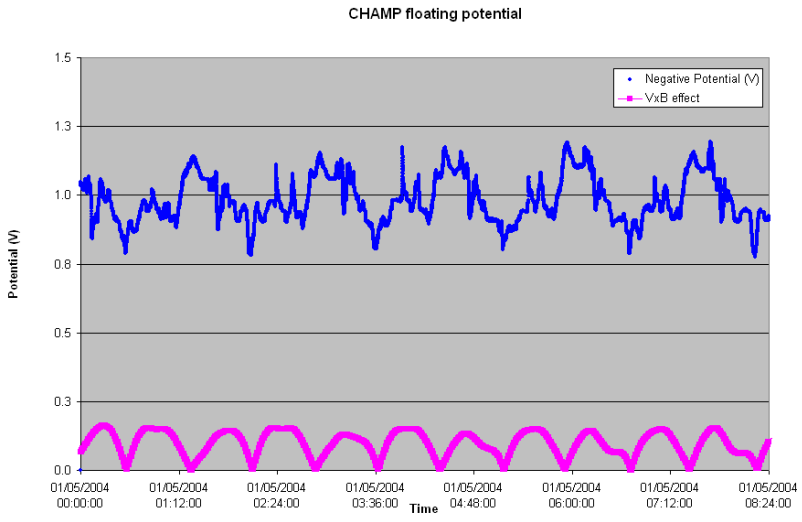
VxB effect

- Due to the high orbital velocity, CHAMP will also experience an induced electric field from the VxB effect.
- This VxB E-field will vary, with a maximum at the poles and a minimum at the equator
- The direction of the induced field is perpendicular to the direction of motion and the magnetic field line i.e. s/c ±y direction .
  - Maximum width 0.8m in y direction
- Maximum effect can be estimated using orbit calculation and a realistic magnetic field model



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Conclusions

- Measured potential cannot be explained in terms of measured temperature
- Comparison of potential with expectations from IRI environment has qualitative agreement but an offset remains.
- VxB effect and magnetic field restriction on current collection may play a role.
- Modelling of current collection to s/c and PLP in LEO environment should lead to better interpretation of the data.
- More complex LPs, e.g gridded probes are being developed. These need careful simulation if we are to interpret them correctly.

THE END

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