IMPEx
Integrated Medium for Planetary Eploration

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General facts

- **Project Title** : IMPEx – Integrated Medium for Planetary Exploration
- **Call identifier** : FP7-SPACE-2010-1
- **Theme** : SPA.2010.2.1-03
  Exploitation of space science and exploration data

Funding scheme : Collaborative project

- **Budget** : 2 M€
- **Submitted :** December 06, 2009
- **Accepted** : June 15, 2010
- **Started** : June 1, 2011

Objectives

Create an interactive framework with data from planetary missions interconnected with numerical models *providing a possibility to*

- Simulate planetary phenomena and interpret space missions measurements
- Test models *vs* observational data
- *Fill gaps in the measurements* by appropriate modelling runs
- Perform preparation of mission operations and solve technological tasks, including preparation of new missions

IMPEx will provide access to space missions *data* and world leading computing *models*, with advanced visualization tools

Audience :

- planetary science community
- data analysts
- mission and instrument designers

Objectives

Primary scientific focus of IMPEx

➔ Plasma and magnetic environments of

- **Mercury** (BepiColombo)
- **Venus** (VenusExpress)
- **Earth** (Cluster, Themis)
- **Mars** (MarsExpress)
- **Jupiter & Ganymede** (Galileo , JGO)
- **Saturn & Titan** (Cassini)
- **Comet 67P** (Rosetta)

In the context of European engagement in corresponding space missions

IMPEx will enable

1. Selection, downloading, visualisation and analysis of data from the modelling runs
2. Superimposing modelling data with spacecraft measurements
3. Request of specific modelling runs
4. Scientific tools and functions for the support of space missions
   - Virtual spacecraft
   - Visualise expected observations from the DB of simulations

Background resources

Data operation of IMPEx

AMDA – Data analysis tool developed and operated by CNRS/IRAP/CDPP

3DView Multimission – visualisation of position and orientation of spacecraft and planetary ephemerides, developed by Akka Technologies under CNES contract

CLWeb – Data analysis tool developed and operated by CNRS/IRAP

Modelling sector of IMPEx

- 3D hybrid modelling platform **HYB** (FMI, Finland)
- **MHD** modelling platform for 3D terrestrial magnetosphere (FMI)
- 3D paraboloid **magnetospheric model** (SINP, Russia)

Hybrid codes

- Provided by FMI and CNRS/LATMOS
- Apply to « small bodies » magnetized or not : Mercury, Venus, Mars, Titan, Ganymede, the Moon, Comets
- Physical formalism: hybrid = electrons as one fluid, ions as individual particles
- Static: the simulation is run until an equilibrium state is reached and considered as the solution for the chosen inputs
- 3D cartesian XYZ: the Central body is in (0,0,0) position and the solar wind comes in the X direction
- **Inputs**
  - Numerical: 3D box size, time steps, spatial resolution, number of particles (ions)
  - Physical (scalar,vectors,3D arrays): density, velocity, temperature for solar wind and magnetospheric populations, IMF, magnetospheric magnetic field if any, parameters for atmospheric/exospheric physics (photoionization frequencies), parameters for physical and chemical processes (charge exchange rates, chemical reactions, electron impact ionization)
- **Outputs** (at all grid points, ie 3D arrays): density, velocity, temperature for all populations, magnetic and electric field, other derived quantities

MHD codes

- Provided by FMI
- Apply to the Earth only
- Physical formalism: MagnetoHydroDynamics = plasma as one fluid
- Dynamic : time dependant
- 3D cartesian XYZ: the Central body is in (0,0,0) position and the solar wind comes in the X direction
- **Inputs**
  - Numerical: 3D box size, time steps, spatial resolution
  - Physical(scalar,vectors,3D arrays): density, velocity, temperature for solar wind plasma and magnetospheric plasma, IMF, magnetospheric magnetic field, other parameters TBD
- **Outputs** (at all grid points, ie 3D arrays): density, velocity, temperature for the plasma, magnetic and electric field, other derived quantities

Magnetic field models

- Provided by SINP (*paraboloid* models)
- Apply to *magnetized* bodies : Earth, Jupiter, Saturn , Mercury
- Physical formalism: Analytic derivation (TBD)
- Dynamic : time dependant
- 3D cartesian XYZ: the Central body is in (0,0,0) position

- **Inputs** (here for the Earth)
  - position, time, AL index, Dst index, solar wind density and velocity, IMF Bz (all time dependant and available in AMDA)

- **Outputs** (at all grid points, ie 3D arrays or magnetic field lines): magnetic field vector, derived quantities(like currents TBD)

Expected results

Bring the data and models outside of the mission teams and modelling groups making them accessible for a broad planetary science community

A working prototype of an infrastructure which will bridge the gap between spacecraft data bases and the scientific modelling tools

A *generic* data-model platform for connection of various data archives and modelling support tools → a perspective of extension