**IMPEx = Integrated Medium for Planetary Exploration**

- 4-year EU/FP7 project started on June 2011
- IMPEx is aimed at the creation of an integrated interactive computational framework where data from planetary missions will be interconnected with numerical models providing a possibility...
  1. ...to simulate planetary phenomena and interpret space missions measurements;
  2. ...to test models versus experimental data and perform further improvement of models;
  3. ...to fill gaps in the measurements by appropriate modelling runs;
  4. ...to perform preparation of specific mission operations and solve various technological tasks, including preparation of new missions.

**Simulation tools in IMPEx**

- FMI/HYB: Global hybrid model for planetary plasma interactions
- FMI/GUMICS: Global MHD model of the Earth’s Magnetosphere
- SINP: Paraboloid model of the Earth’s Magnetosphere
- LATMOS: Global hybrid model for planetary plasma interactions

**FMI/HYB: Global hybrid model**

- HYB is a hybrid and kinetic plasma simulation platform for planetary plasma interactions developed at the FMI.
- Originally based on the quasi-neutral hybrid (QNH) description of plasma. Positively charged ions are treated explicitly as kinetic particles and electrons are modelled as a charge-neutralizing, massless MHD fluid. The ions and the electromagnetic fields are self-consistently coupled to each other.

**Equations of the Hybrid model**

\[
\begin{align*}
\text{E} + \text{U}_i \times \text{B} &= \frac{4}{3}\mu_0 \text{J} \times \frac{4}{3}\mu_0 \text{J} \\
\text{H}_e &= n_e \text{m}_e T_e \\
\text{H}_i &= n_i \text{m}_i T_i \\
\text{H} &= \text{H}_e + \text{H}_i \\
\text{E} &= \text{E}_e + \text{E}_i \\
\text{U} &= \text{U}_e + \text{U}_i \\
\text{B} &= \text{B}_e + \text{B}_i \\
\mu_0 \text{J} 	imes \text{B} &= -\text{E} \\
\text{E}_{\text{kin}} &= \frac{1}{2} \text{m}_i \text{v}_i^2 \\
\text{E}_{\text{pot}} &= \text{E}_0 \\
\text{E}_{\text{int}} &= \sum n_i \text{m}_i \text{v}_i^2 \\
\text{SOLAR UV} &\rightarrow \text{ELECTRODYN. IONOSPHERE} \\
\text{MHD MAGNETOSPHERE} &\rightarrow \text{MHD} \\
\text{H} &\rightarrow \text{MAGNETIC FIELD} \\
\text{POTENTIAL} &\rightarrow \text{ELECTRIC FIELD} \\
\text{FAC} &\rightarrow \text{CURRENTS} \\
\text{IONOSPHERE} &\rightarrow \text{IONOSPHERE} \\
\end{align*}
\]

**FMI/GUMICS: Global MHD model**

- Grand Unified Magnetosphere Ionosphere Coupling Simulation is state-of-the-art global MHD code for terrestrial space weather modelling developed at the FMI.
- Based on the ideal conservative MHD description of plasma
- Magnetosphere coupled to electrostatic ionosphere (MHD inner shell at 3.7 R_E)

http://impex-fp7.oeaw.ac.at/

http://hwa.fmi.fi/hyb

http://gumics.fmi.fi