EUHFORIA in the ESA *Virtual Space Weather Modelling Centre*

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Objective and scope

- The **further development of the VSWMC** building on the Phase 1 prototype system and focusing on the interaction with the SSA SWE system.
- Models are geographically distributed (Leuven, Brussels, Cambridge, Paris,…)
- Efficient integration of **new models and new model couplings**, including a first demonstration of an *end-to-end simulation capability*.
- Further development and wider use of the **coupling toolkit** and the **front-end GUI** which will be designed to be accessible via the SWE Portal.
- Availability of more **accessible input and output data** on the system and development of **integrated visualization tool** modules.

Work breakdown

Part 2A: Updated architectural design of the full VSWMC system of the future and the detailed design of the P2 prototype based on the requirements analysis

Part 2B: Prototype of the VSWMC, developed based on the outcomes of the Part 2a

Part 2C: Utilities federates (for visualization, validation, demonstration, etc.) in order to showcase the functionality of the system, to verify and to validate the Part 2 Prototype

VSWMC aims to combine **three roles**:
- Repository for models and data
- A facility offering a model coupling infrastructure
- A facility that executes coupled model simulations

Typical prototype setup

The VSWMC prototype uses **high-level architecture (HLA)**, a general purpose architecture for *distributed computer simulation systems (across heterogeneous hardware and software platforms)*. HLA enables computer simulations *to interact* (to communicate data and to synchronize actions) with other computer simulations *regardless of the computing platforms: reuse without significant code change or development cost.*
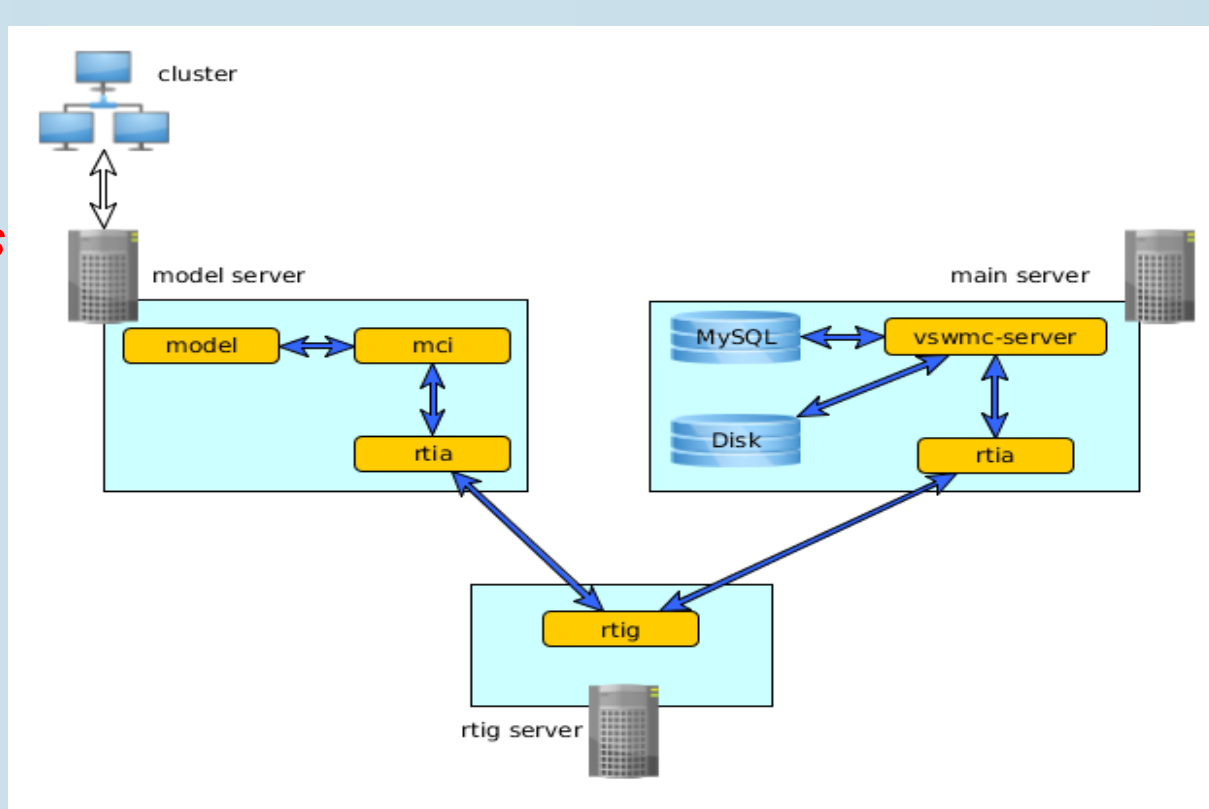

'Federates' (models) included

ODI (Open Data Interface): *MySQL database system (used for input data and validation)*
XTRAPOL*: *NLFF Magnetic Field Reconstruction*
AMRVAC*: *2.5D solar wind model + CMEs*
iPIC-3D*: *3D kinetic (PIC) magnetosphere*
COOLFluiD*: *MHD magnetosphere (@ VKI)*
BAS-RBM*: *Radiation Belt Model (@ Cambridge)*
CTIP/CMAT2*: *ionosphere*
GUMICS-4*: *3D MHD magneto-/ionosphere*
EUHFORIA*: *3D solar wind model + CMEs*
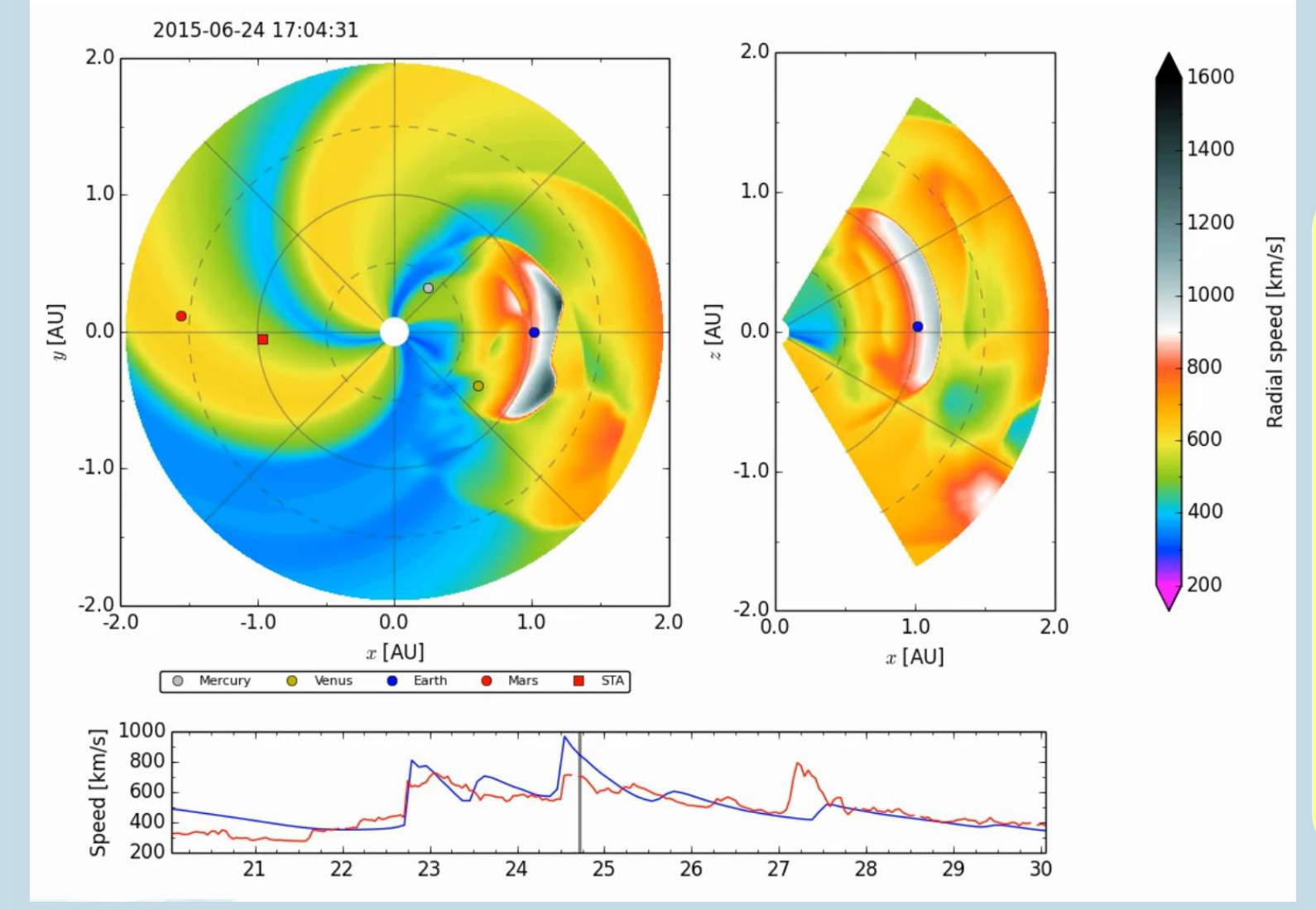**Effects models:** *Dst and Kp indices, bow shock stand-off model*
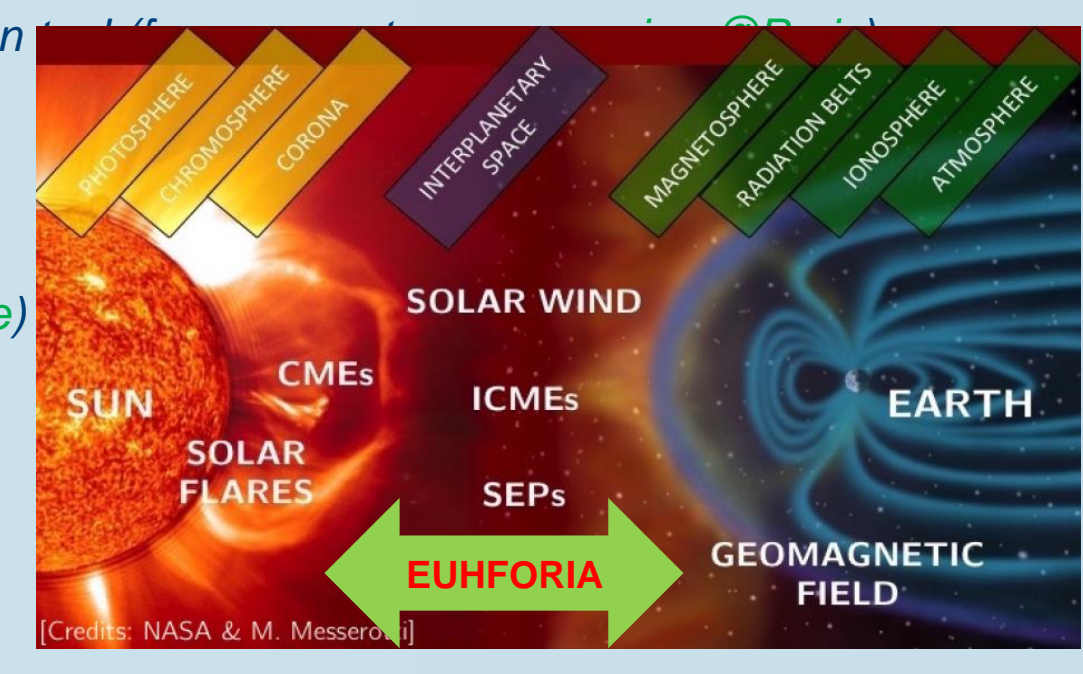
* Internal consortium models   * Models from SAT

Possible model couplings

Framework node communication
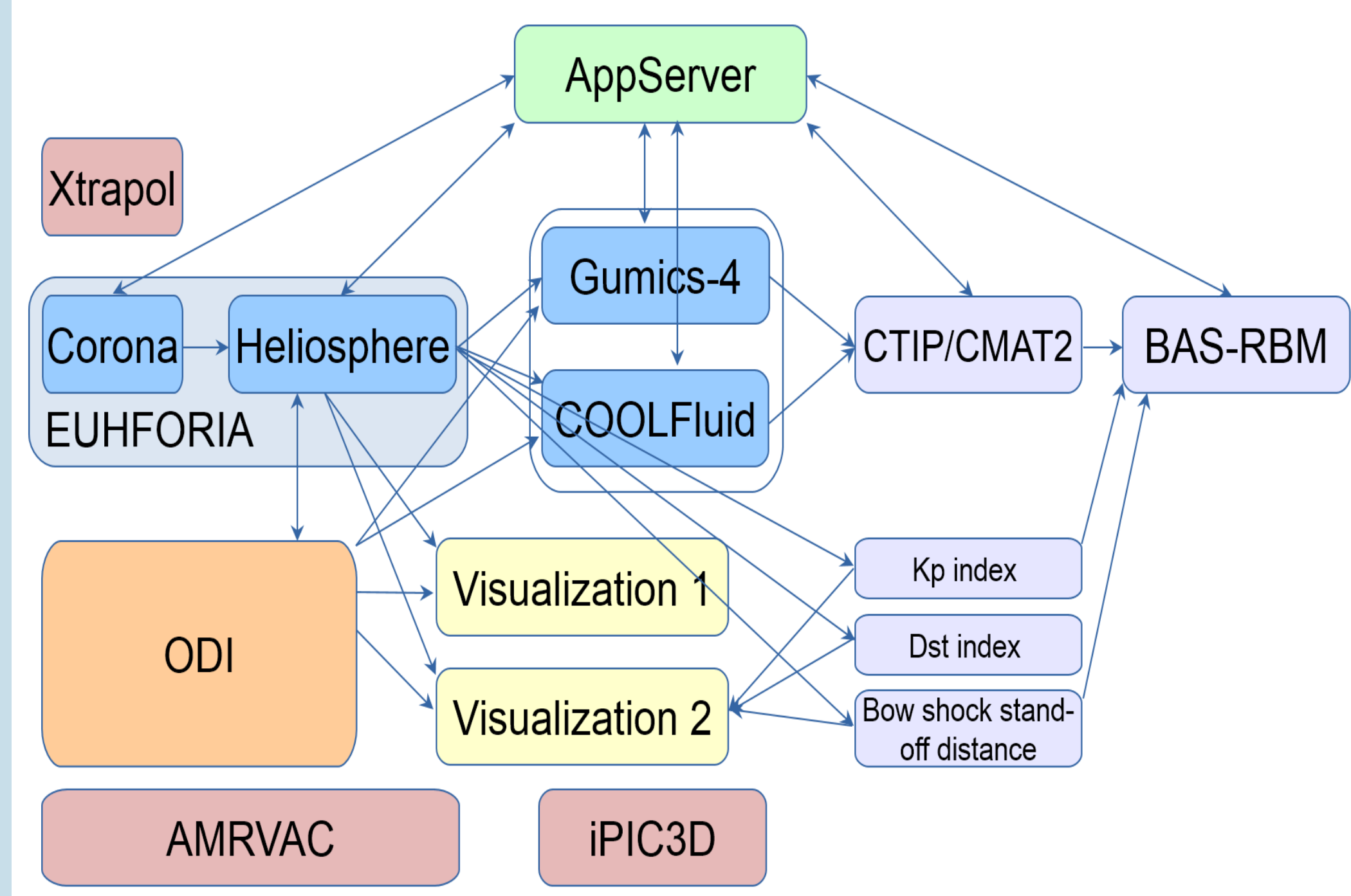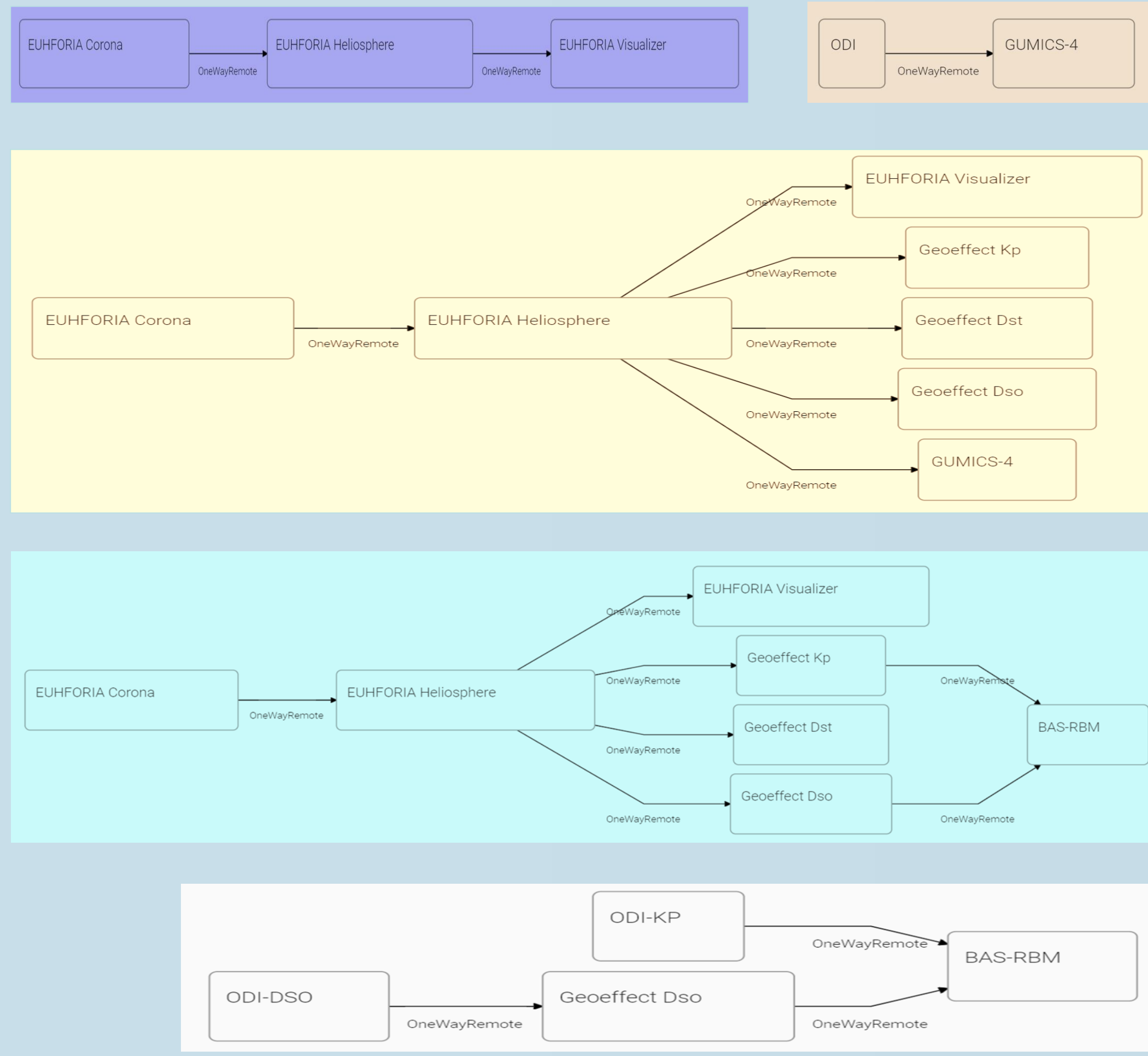

Coupling Examples
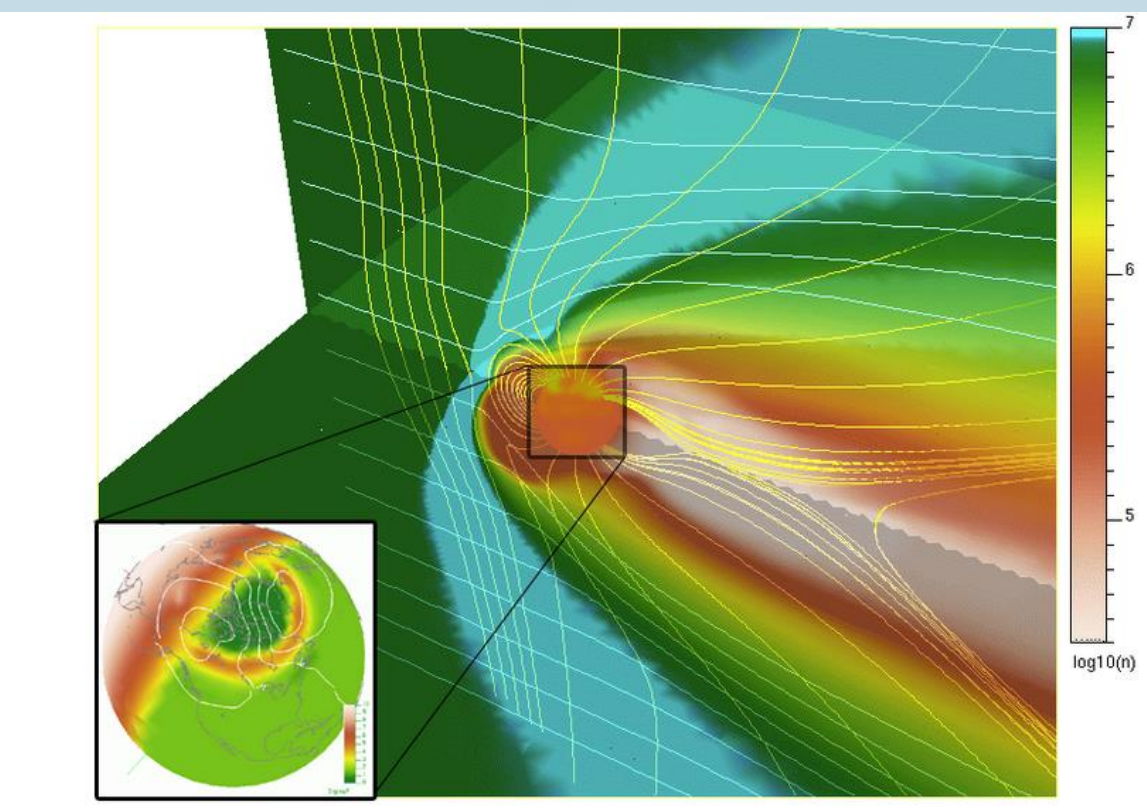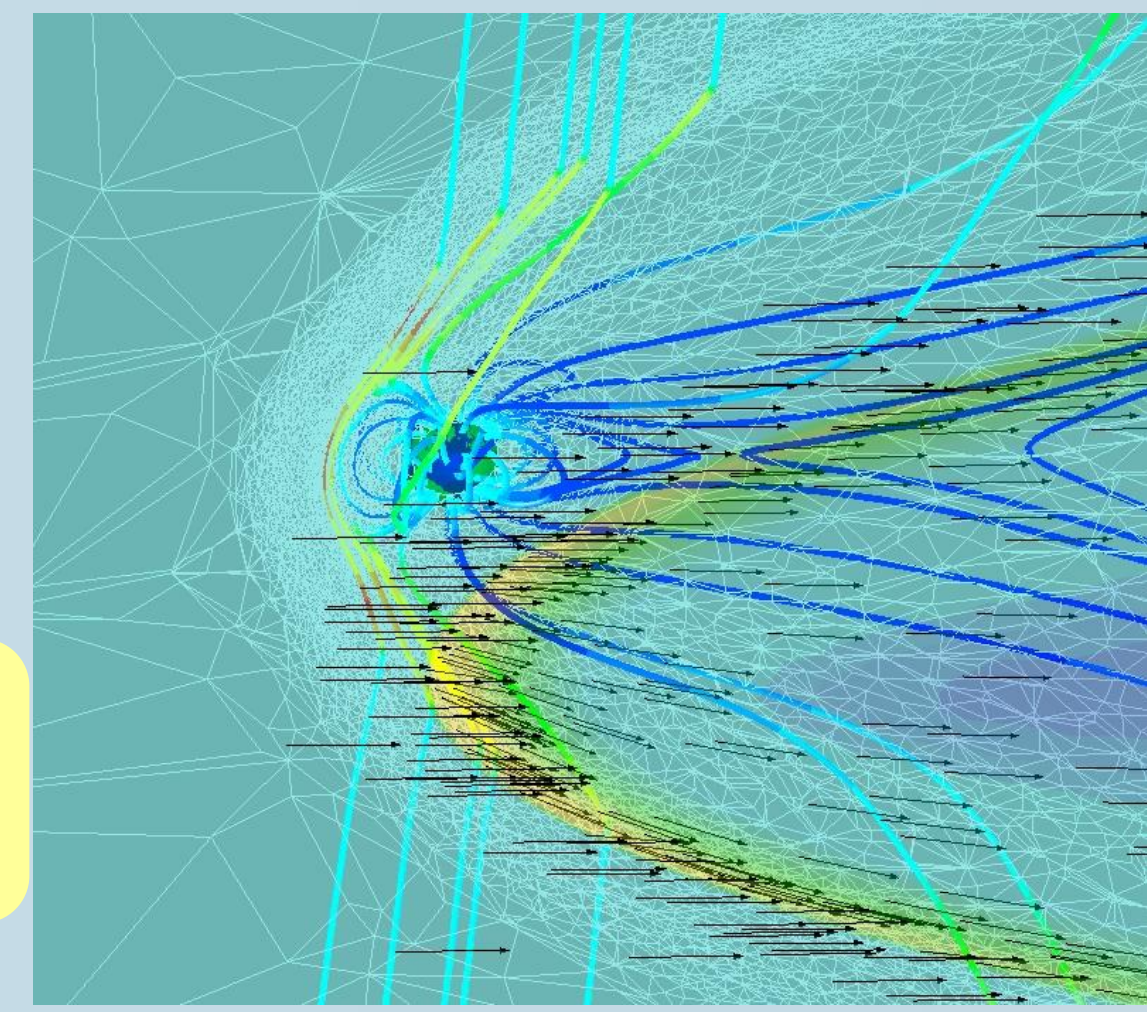

Output Examples

Ex.1: An illustration of an EUHFORIA run, incl. radial velocity component in the equatorial plane and the meridional plane and a comparison of synthetic velocity data at L1 with ACE data at L1.
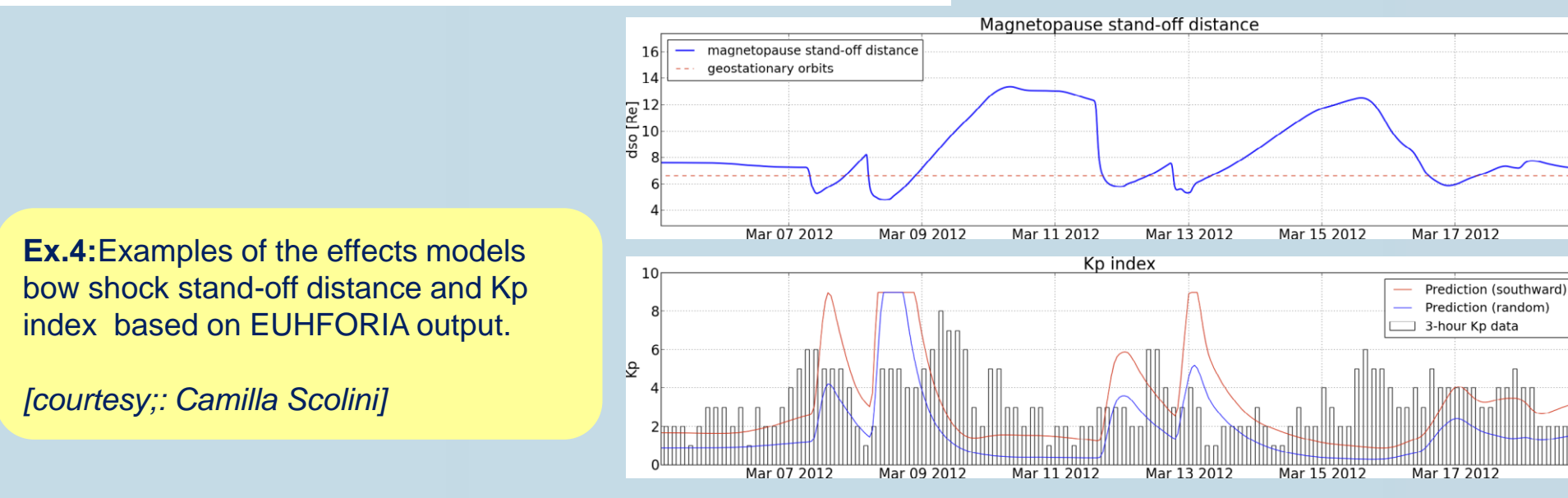
[courtesy: J. Pomoell]

Ex.2: An illustration of the magnetosphere as simulated by COOLFluiD (unstructured mesh with anisotropic AMR).

[Courtesy: Yalim Mehmet]

Ex.3: An illustration of the magnetosphere as simulated by GUMICS-4 (structured AMR mesh).

[courtesy: Pekka Janhunen]

Ex.4: Examples of the effects models bow shock stand-off distance and Kp index based on EUHFORIA output.

[courtesy;: Camilla Scolini]

More info on **https://esa-vswmc.eu/** *and this* **JSWSC PAPER**