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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

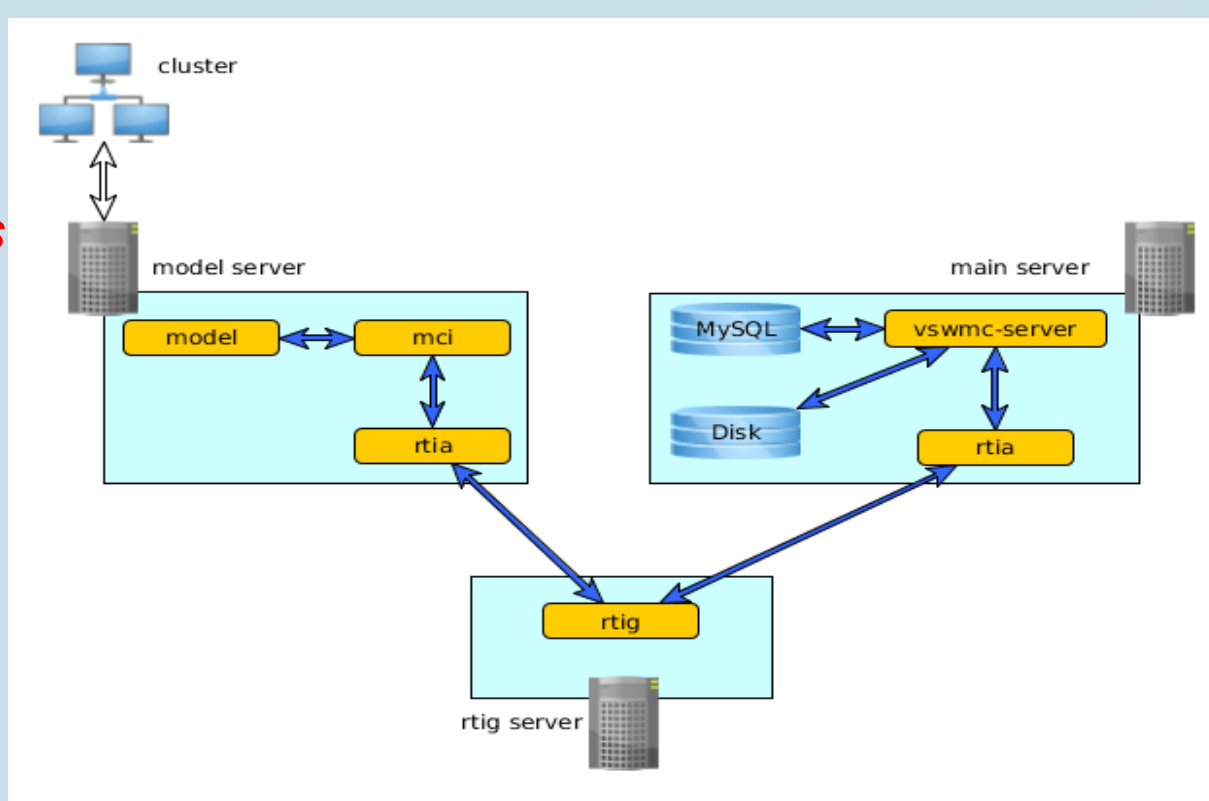
**Part 2C:** Utilities federates (for visualization, validation, demonstration, etc.) in order to showcase the functionality of the system, to verify and to validate the Part 2 Prototype

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)*

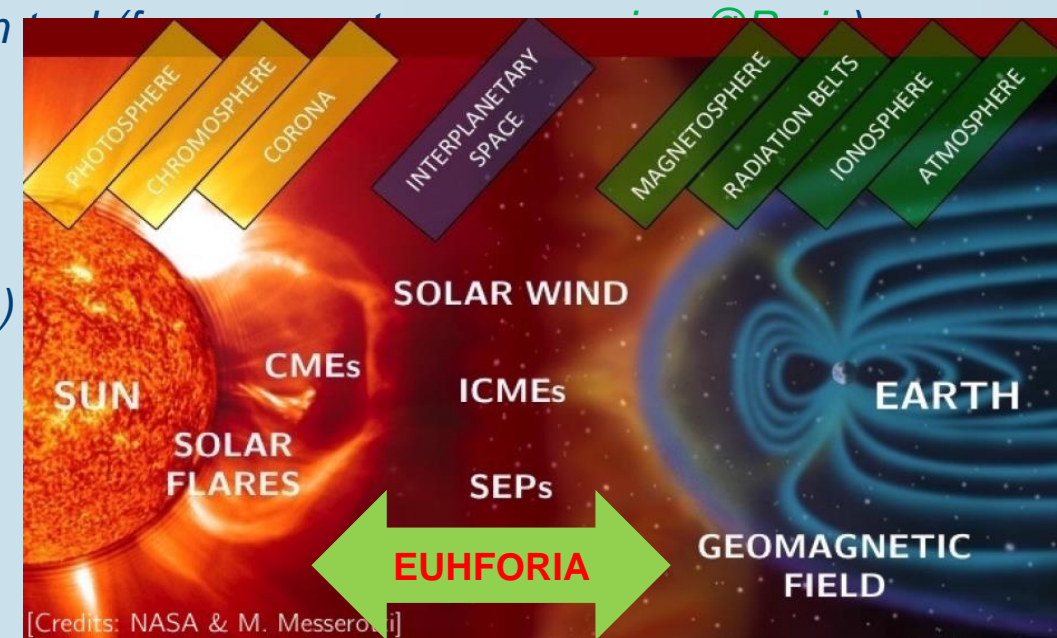
**BAS-RBM\***: *Radiation Belt Model (@ Cambridge)*

**CTIP/CMAT2\***: *ionosphere*

**GUMICS-4\***: *3D MHD magneto-ionosphere*

**EUHFORIA\***: *3D solar wind model + CMEs*

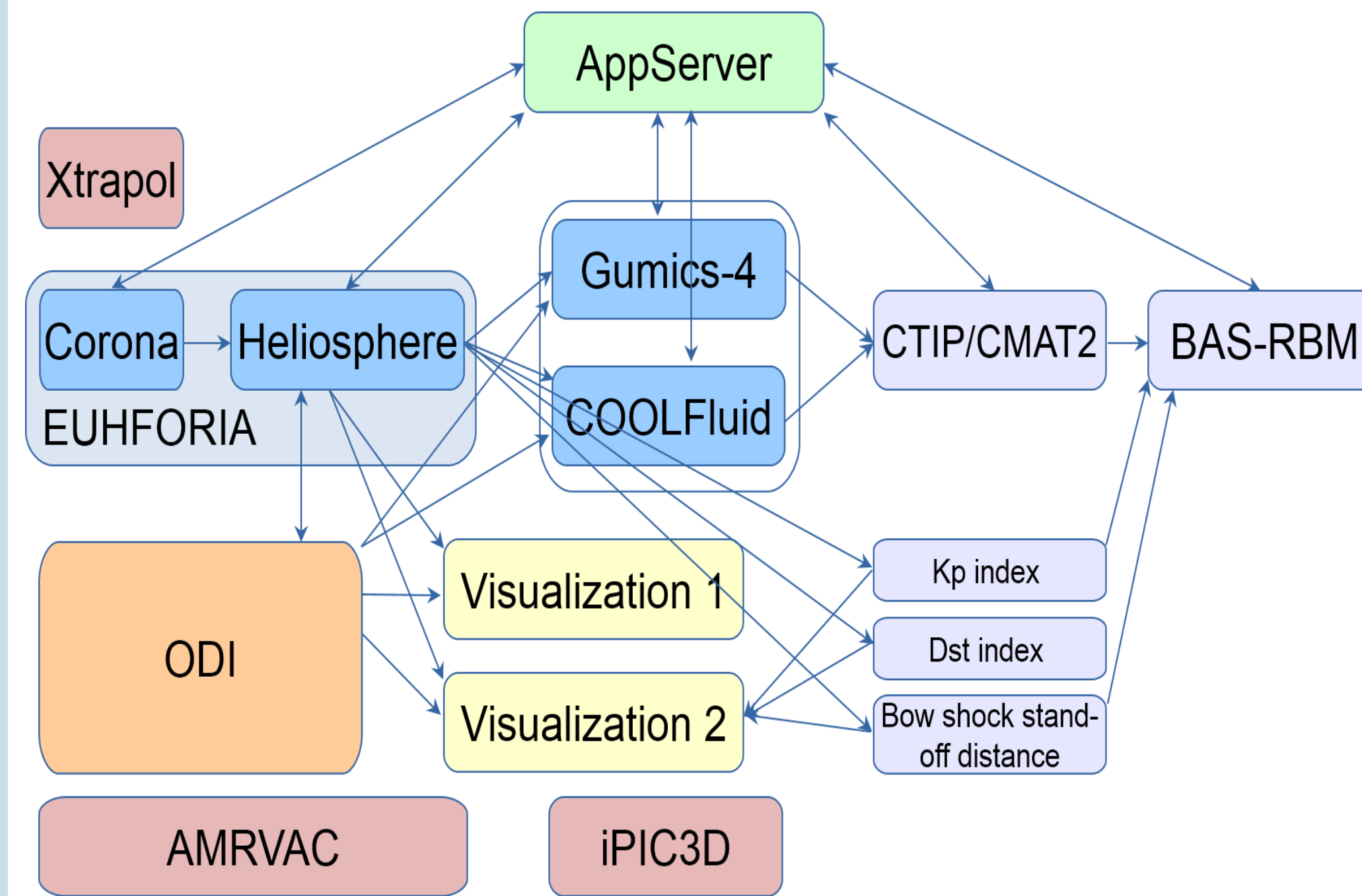
**Effects models:** *Dst and Kp indices, bow shock stand-off model*



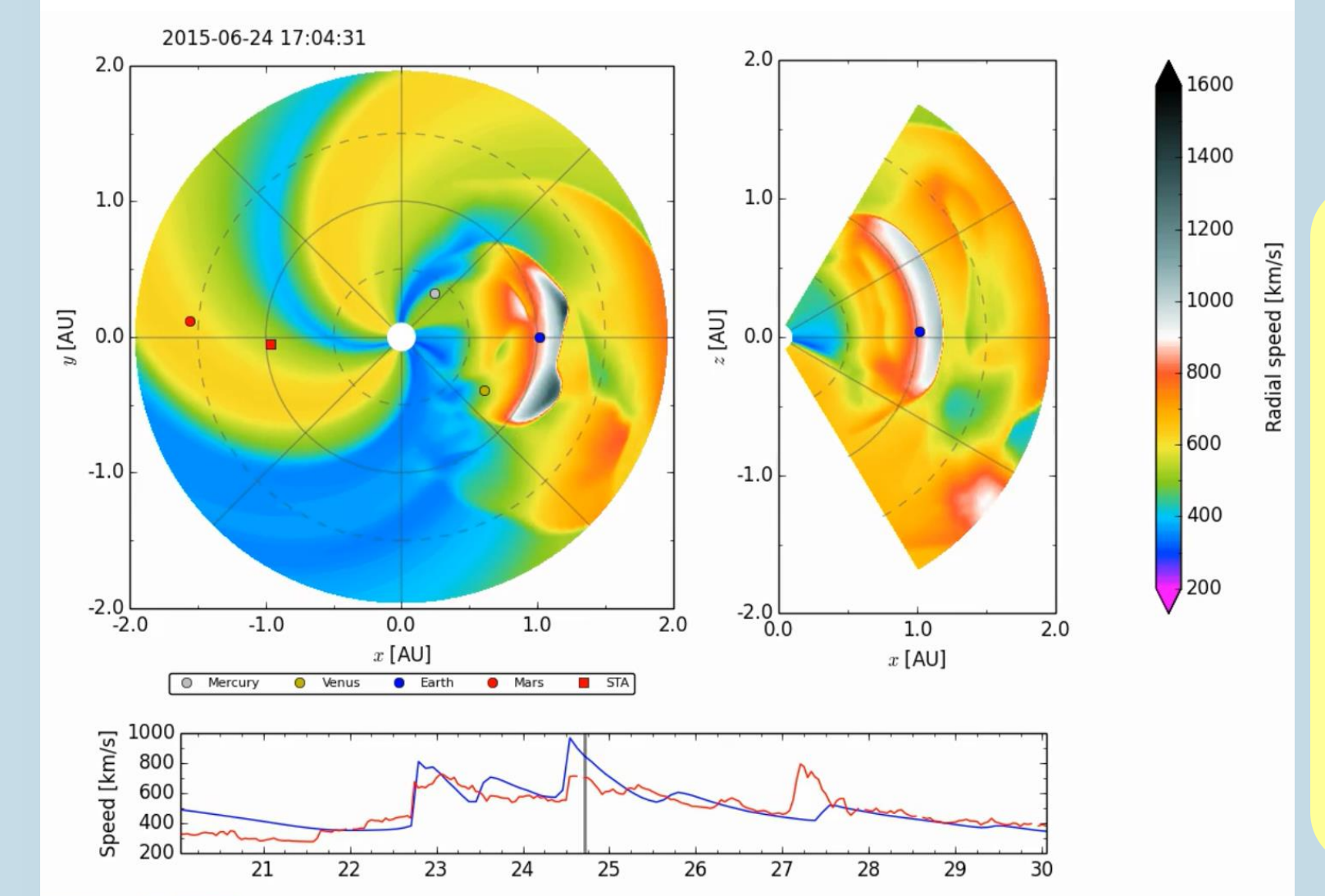
\* Internal consortium models      \* Models from SAT

## Possible model couplings

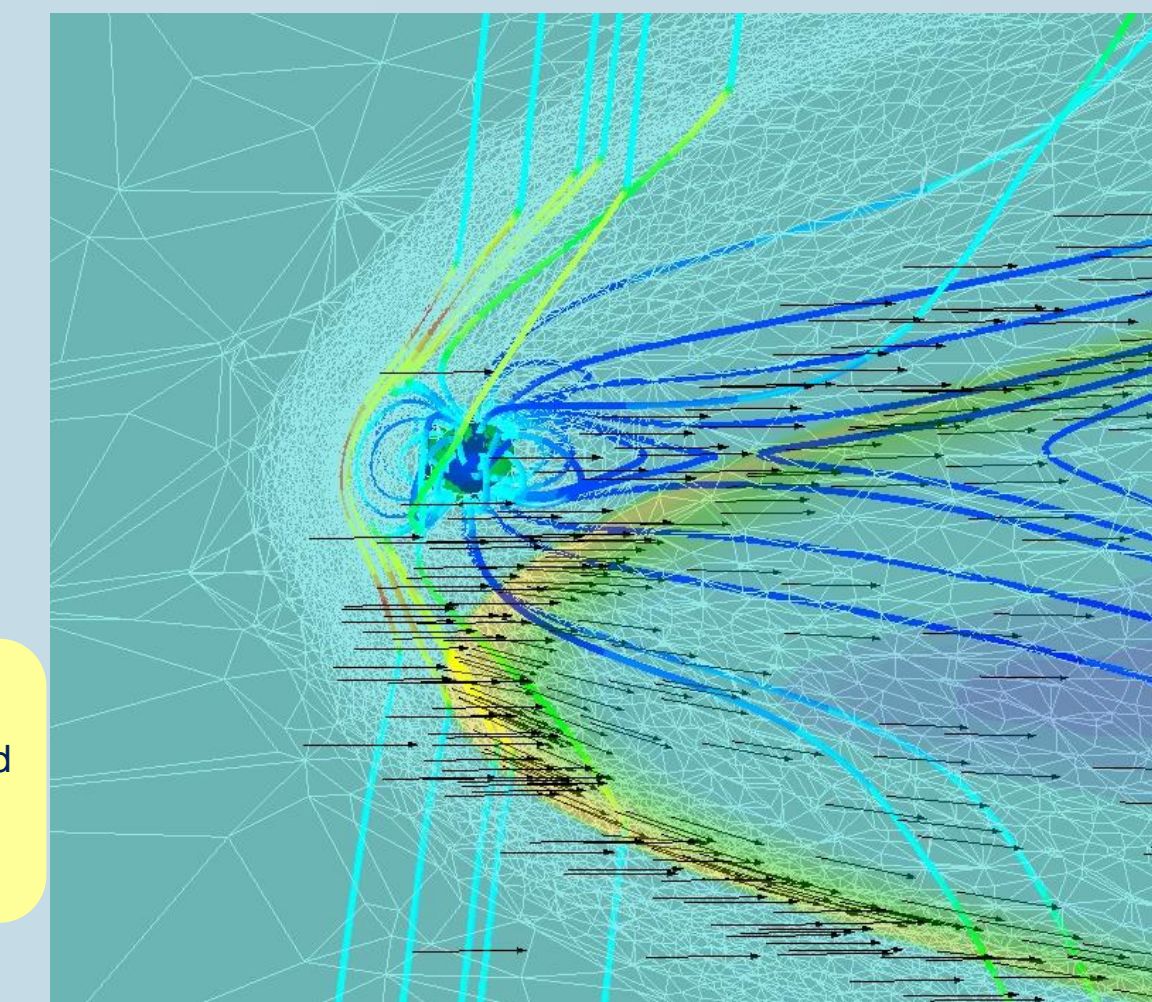
### Framework node communication



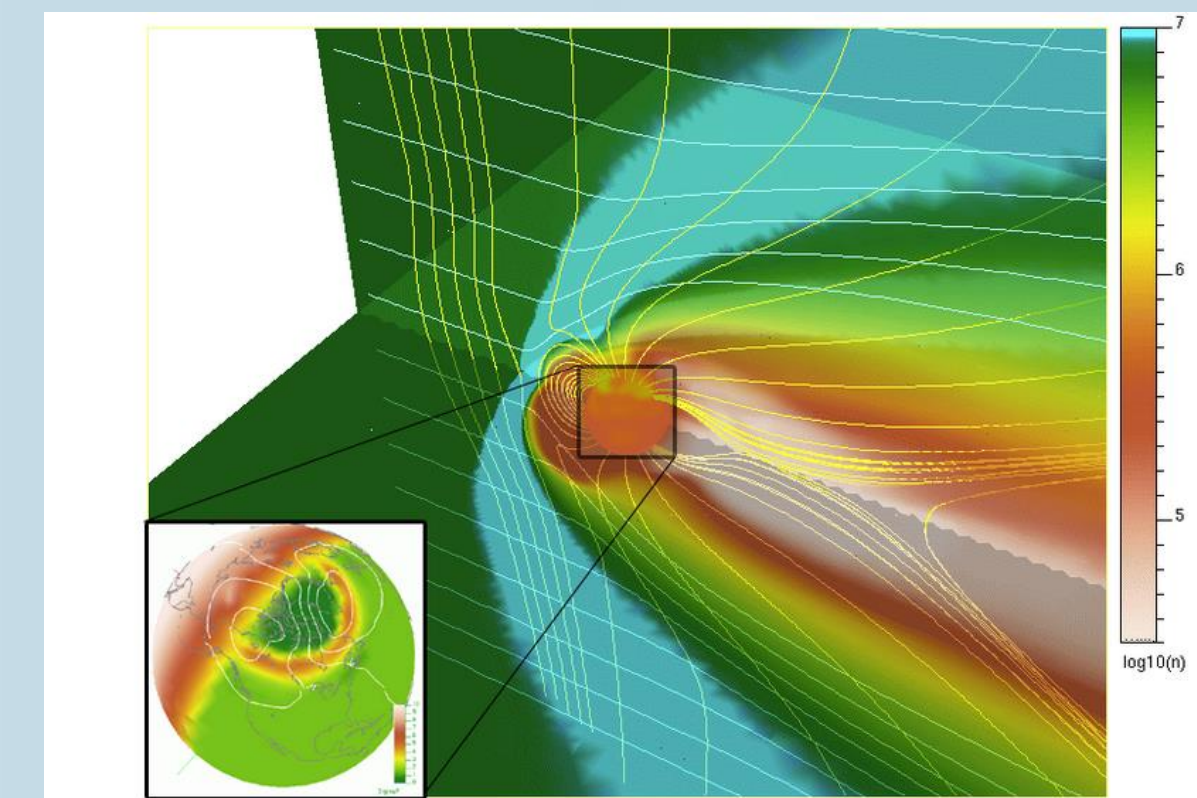
## Output Examples



**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]

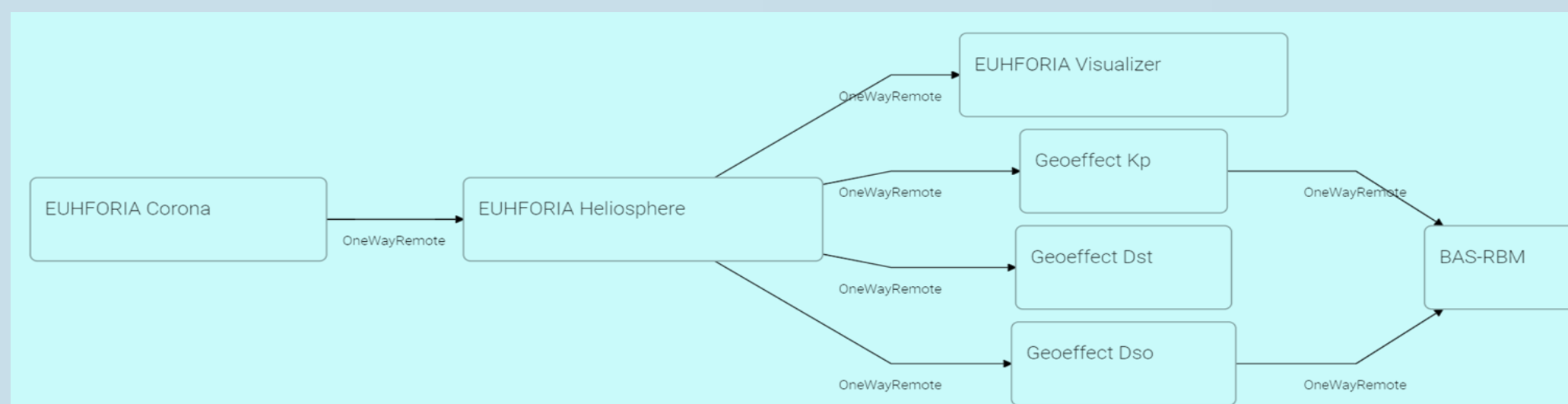
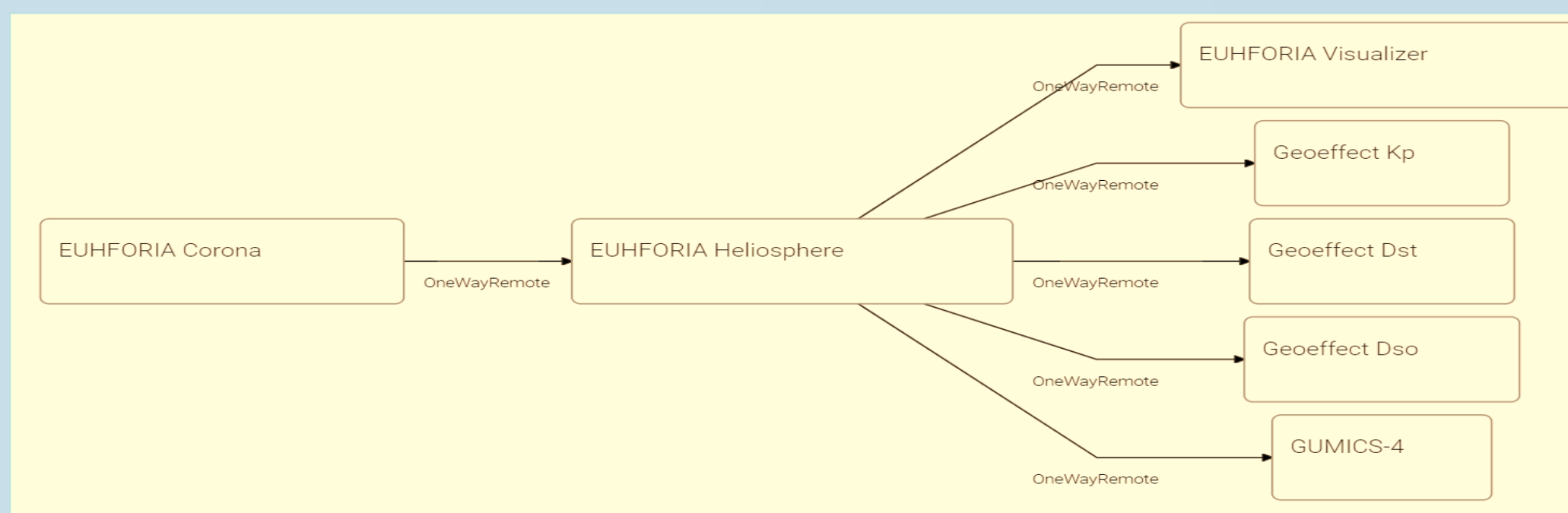
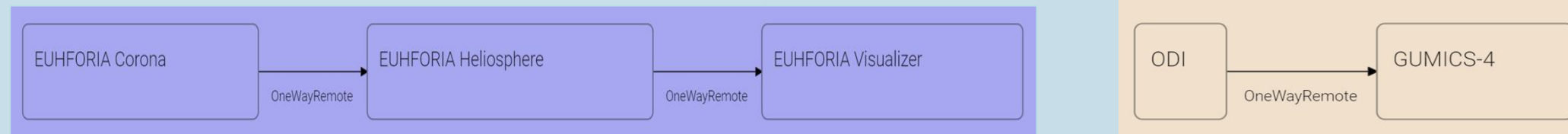


**Ex.2:** An illustration of the magnetosphere as simulated by COOLFluid (unstructured mesh with anisotropic AMR).  
[Courtesy: Yalim Mehmet]

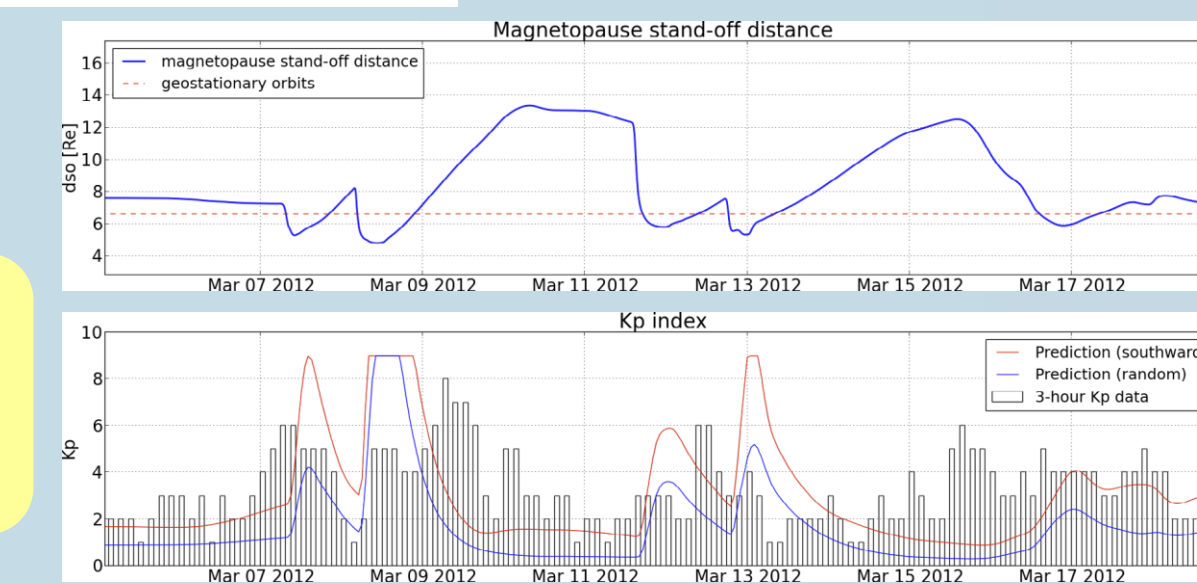


**Ex.3:** An illustration of the magnetosphere as simulated by GUMICS-4 (structured AMR mesh).  
[courtesy: Pekka Janhunen]

## Coupling Examples



**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-vswwmc.eu/>