Virtual Space Weather Modelling Centre

S. Poedts *(KU Leuven), A. Lani & H. Deconinck (VKI), N.-D. Ho & F. Diet (SAS), D. Heynderickx (DH Consultancy), J. De Keyser, E. De Donder, N.B. Crosby & M. Echim (BISA), L. Rodriguez, A. Devos, F. Verstringe & B. Mampaey (ROB), R. Horne, S. Glauert & J. Isles (BAS), P. Jiggens, R. Keil, A. Glover, A. Hilgers & J.-P. Luntama (ESA)*

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.
- 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 Part 2 prototype based on the to-be-performed requirements analysis

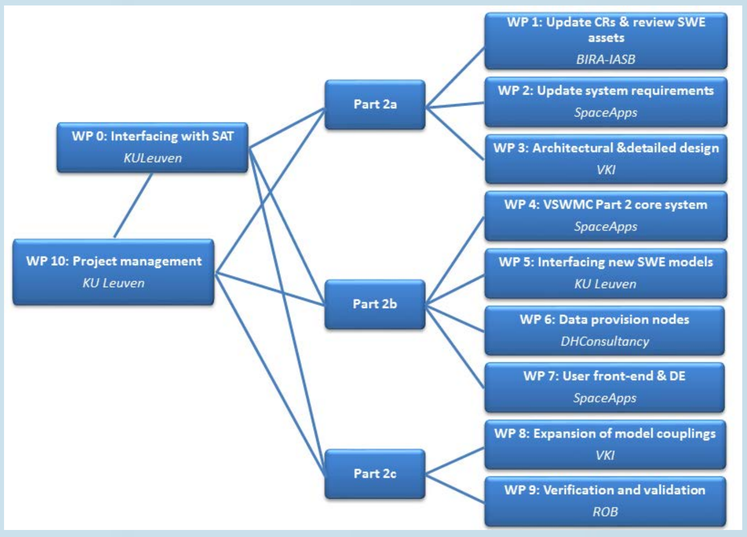
Part 2B: Part 2 prototype of the VSWMC, developed based on the outcomes of the Part 2a

Part 2C: Utilities federates (for visualisation, 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

Tasks



High-Level Architecture

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.*

Interaction between simulations is *managed by a Run-Time Infrastructure*.

The interoperability standard (IEEE 1516-2000) for distributed simulation used to support analysis, engineering and training in a number of different domains such as: Defense, Space, Air Traffic Management, Energy, Off-shore, Railway, etc.

HLA components

A high-level architecture (HLA, used here) consists of the following **components:**

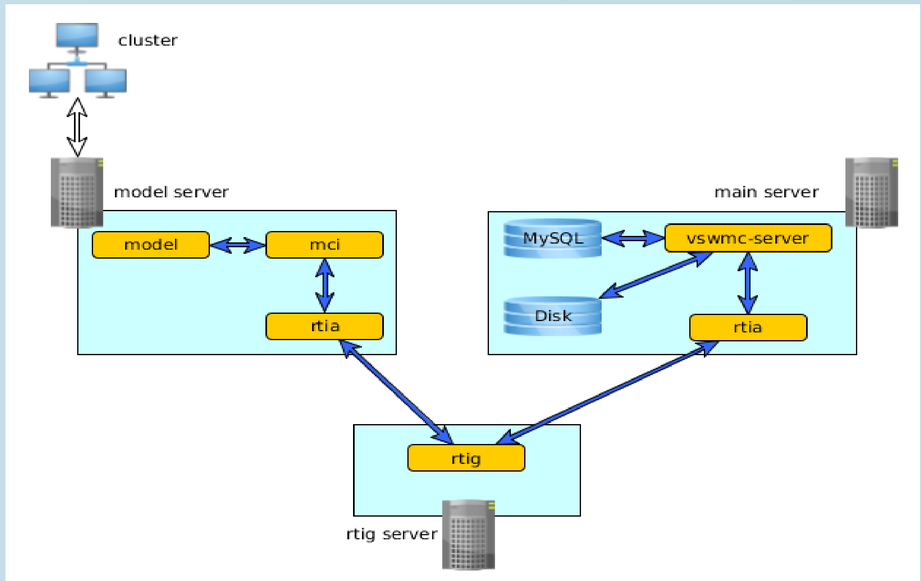
- **Interface specification**, that defines how HLA compliant simulators interact with the Run-Time Infrastructure (RTI). The RTI provides a programming library and an application programming interface (API) compliant to the interface specification.
- **Object model template (OMT)**, that specifies what information is communicated between simulations, and how it is documented.
- **Rules**, that simulations must obey in order to be compliant to the standard.

HLA terminology

- **Federate**: an application which supports the HLA and is capable of participating in a simulation.
- **Federation**: a declaration between federates describing how and what will be simulated, i.e. multiple simulation entities connected via the RTI using a common OMT.
- **Federation Execution**: a run-time instantiation of a Federation; i.e. an actual simulation execution.

➢ HLA provides the **Federation** formalism by which **Federates** can be modelled such that the framework can support **Federation Execution**

Typical prototype setup



‘Federates’ (models) included

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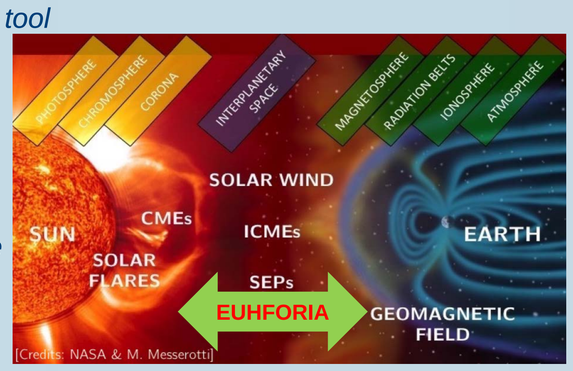
- **ODI** (Open Data Interface): MySQL database system
- **XTRAPOL***: *NLFF Magnetic Field Reconstruction tool*
- **AMRVAC***: *2.5D solar wind model + CMEs*
- **iPIC-3D***: *3D kinetic (PIC) magnetosphere*
- **COOLFluiD***: *3D MHD magnetosphere*
- **GUMICS-4***: *3D MHD magnetosphere/ionosphere*
- **EUHFORIA***: *2.5D solar wind model + CMEs*
- *Internal consortium models* * *Models from SAT*



Euhforia

‘European heliospheric forecasting information asset’

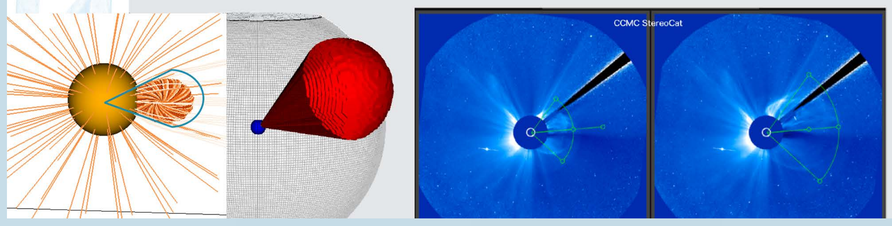
Heliosphere model with cone & Flux-ROPE CMEs

AIM: Compute time dependent evolution of MHD variables from 0.1 AU to 1 AU and beyond (up to a few AU)

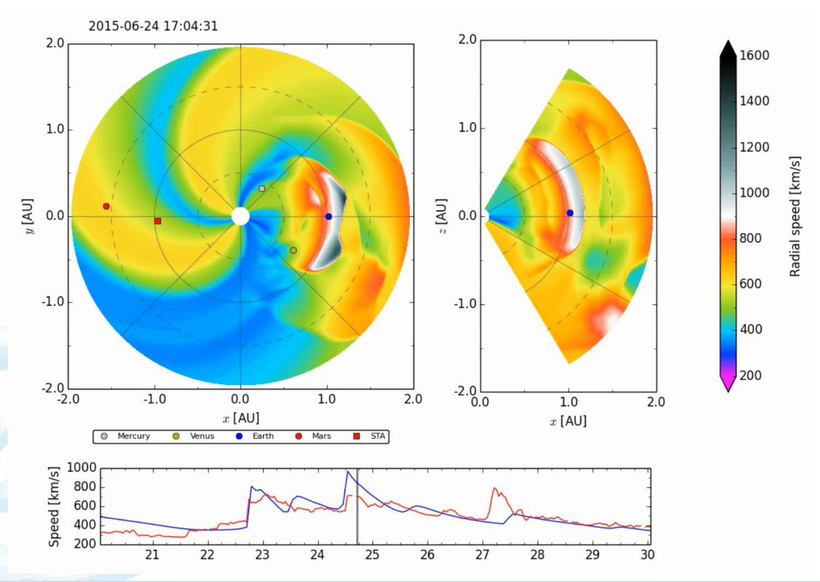
INPUT: Plasma properties at 0.1 AU from coronal model, self-similar **G-L flux-rope or cone model** CME parameters from fits to observations

METHOD: Second order finite volume MHD scheme

CMEs inserted at 21.5 AU as time-dependent boundary condition



Euhforia: *radial velocity V_r vs ACE data*



Project milestones

Milestone ID	Purpose	Date
KOM Part 2	Kick-Off Meeting Part 2	17/02/2016
M1	Completion and approval of Critical Design Review	17/08/2016
M2	Completion and approval of TRR	17/08/2017
Final	Completion of Part 2 and approval of FR	17/02/2018

This work was supported by the ESA VSWMC project under contract 4000116641/16/D/MRP