Le modèle de données **IMPEx** : un démonstrateur d'accès aux simulations héliosphériques du **CCMC**

(*Community Coordinated Modeling Center*)

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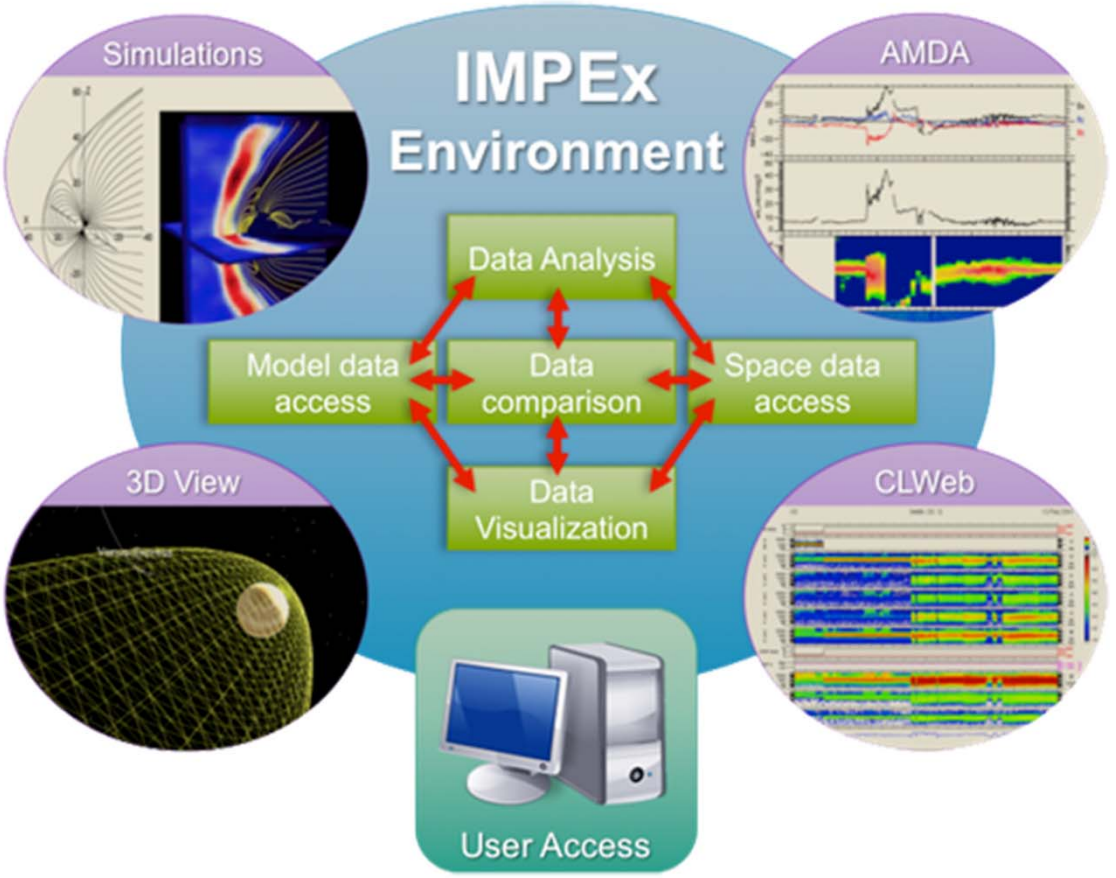
28/01/2014

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

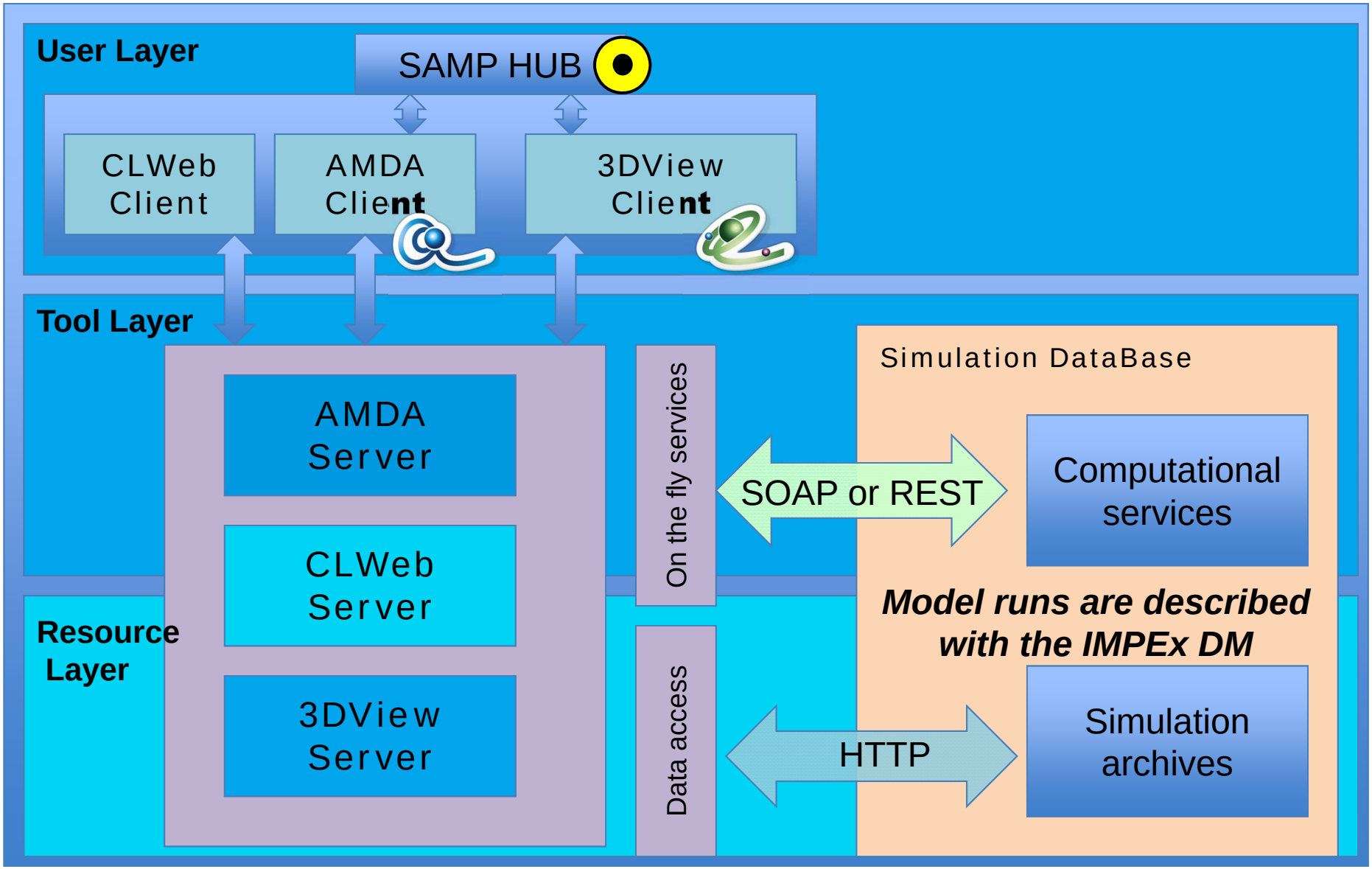


- 4 year project (2011-2015)
- 4 partners :
  - LATMOS, CDPP
  - FMI (Finland)
  - SINP (Russia)
  - IWF (Austria, coordinator)

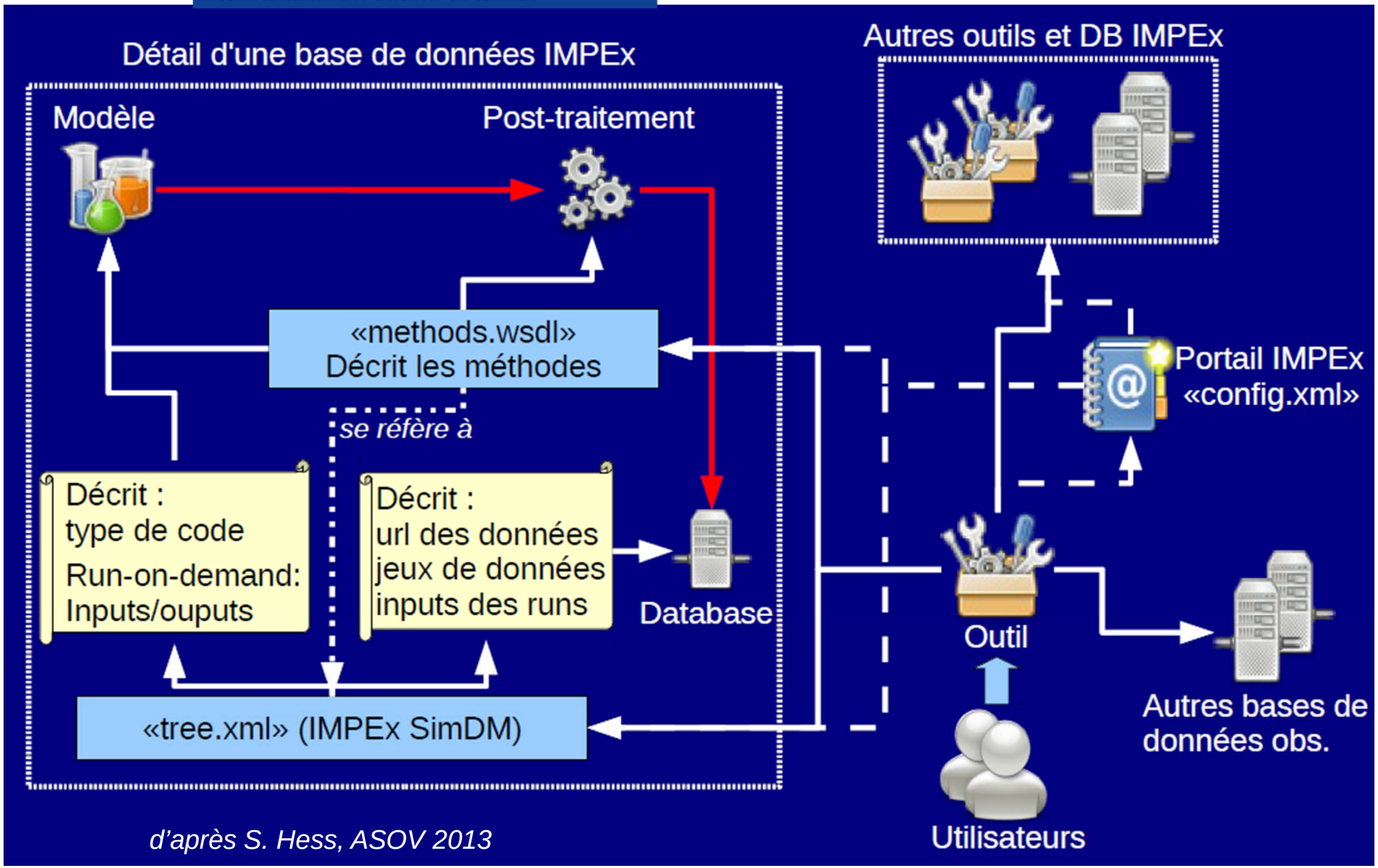
Key IMPEx features

-Goal : Observations / Models data comparison for planetary sciences
-Mean : 2D and 3D visualisations
-Analysis tools : data mining, statistics, event lists
-Access : large databases (CDAWeb, AMDA, models)
-Commonality : all models are described with a datamodel based on SPASE

Architecture 1/2



Architecture 2/2



d'après S. Hess, ASOV 2013

IMPEx DataModel

Basé sur SPASE http://spase-group.org/
modèle pour les données en physique spatiale

SPASE DM fournit des ressources

- Pour décrire les données et leur accès:
  - NumericalData,
  - DisplayData,
  - Granule
- Des métadata pour l'esploitation des données :
  - Catalog,
  - Observatory,...
- Pour décrire la structure de la base de données :
  - Repository,
  - Service, …

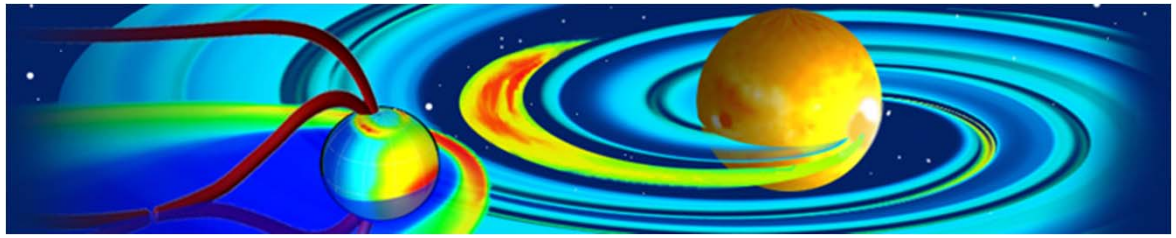
IMPEx Simulation DM ajoute :

- NumericalOuput, DisplayOuput
  clone Spase+ description domaine spatial
  et propriétés liées au post-traitement
- Granule (overrides Spase's)
  ajoute la description du domaine spatial
- SimulationModel
  Infos générales sur le modèle
  (pas sur les algoritmes)
  + liste entrées/sorties pour les RODs
- SimulationRun
  Décrit les paramètres des simulations
  à l'origine des données diffusées

Infos @ http://impex.latmos.ipsl.fr/tools/DataModel.htm

d'après S. Hess, ASOV 2013

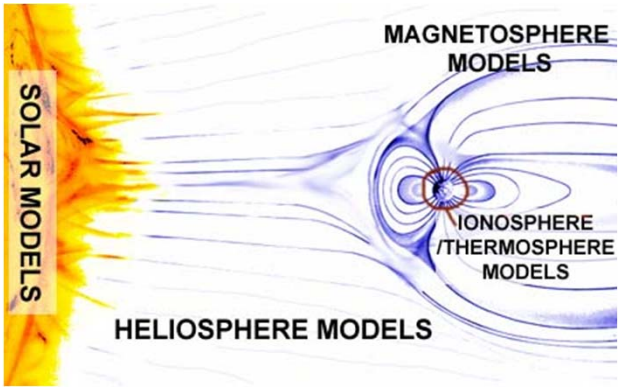
COMMUNITY COORDINATED MODELING CENTER



http://ccmc.gsfc.nasa.gov/

What is CCMC ?

- largest run-on-demand centre in heliophysics
- wide variety of models (MHD, kinetic, …)
- test runs / event runs
- all runs are accessible to everyone, forever



CCMC in the VO context

- no data model, no web services, no IVOA connexion
- IDL visualisations on their web interface only
- difficulty to retrieve data files
- *… not really interested by VO issues … but they're changing*

A prototype to access CCMC simulations

Goals:

- To render CCMC results more easily exploitable by the wider community
- To provide access, visualisation and analysis via CDPP tools (AMDA, 3DView)
- To propose distribution via SAMP to all IVOA tools
- To test the IMPEx SimDM in another context

The prototype *currently* :

- Is limited to one type of simulation :
  - BATSRUS (MHD) code
  - One run with available interpolations along magnetospheric S/C
- Focuses mainly on access (non optimized visualisation)
  - From AMDA
  - From 3DView

CCMC run database

Let's have a look at CCMC runs …
Here's the result of a search with *keyword = genot*

▸Runs on Request: Simulations Results

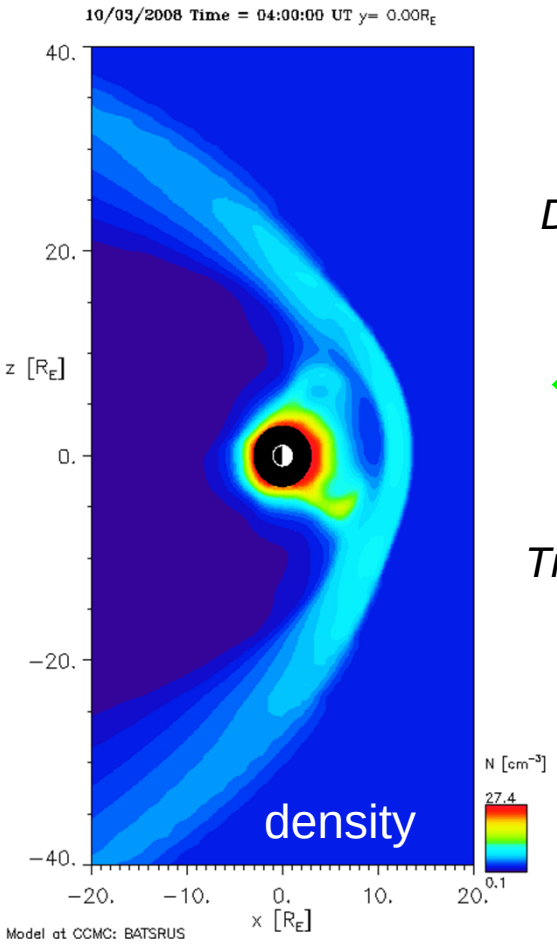
Total Number of Runs in the Database: 3548
Total Number of Search Results in this Database: 5

Run Number	Key Words	Model	Model Version	Grid	Validation Level	Run Type	SW Input Type	Coordinate System for Input	Coordinate System for Output	Dipole Tilt (in the X-Z Plane) at Start	Dipole Tilt in Y-Z GSE plane)	Update Dipole Orientation with Time
Vincent_Genot_012610_1	geo orbit	BATSRUS with RCM	v8.01	2M cells	--	event	var	GSM	GSM	-15.70	-21.50	yes
Vincent_Genot_033011_1	asym1	BATSRUS	v8.01	700K cells	--	model	fix	GSM	GSM	0.00	0.00	no
Vincent_Genot_033011_2	asym2	BATSRUS	v8.01	700K cells	--	model	fix	GSM	GSM	0.00	0.00	no
Vincent_Genot_043009_1	magnetosheath	BATSRUS	v8.01	2M cells	--	event	var	GSM	GSM	16.40	8.90	yes
vincent_genot_051209_1	magnetosheath ; themis	BATSRUS	v8.01	2M cells	--	event	var	GSM	GSM	24.70	-24.10	yes

▸Runs on Request: IT Simulations Results

Simulation run : 2008/10/02 04:00 +24h

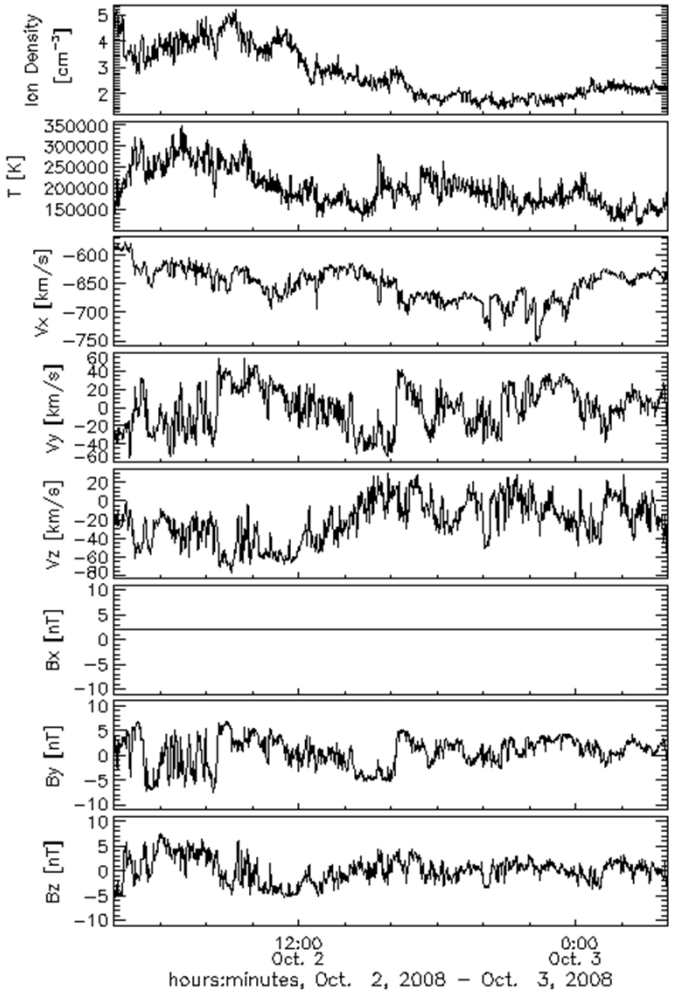
Magnetospheric response in a 288X96X96 R_E^3 box



Duration = 24h

Time resolution = 5min

Time varying Solar Wind input from ACE

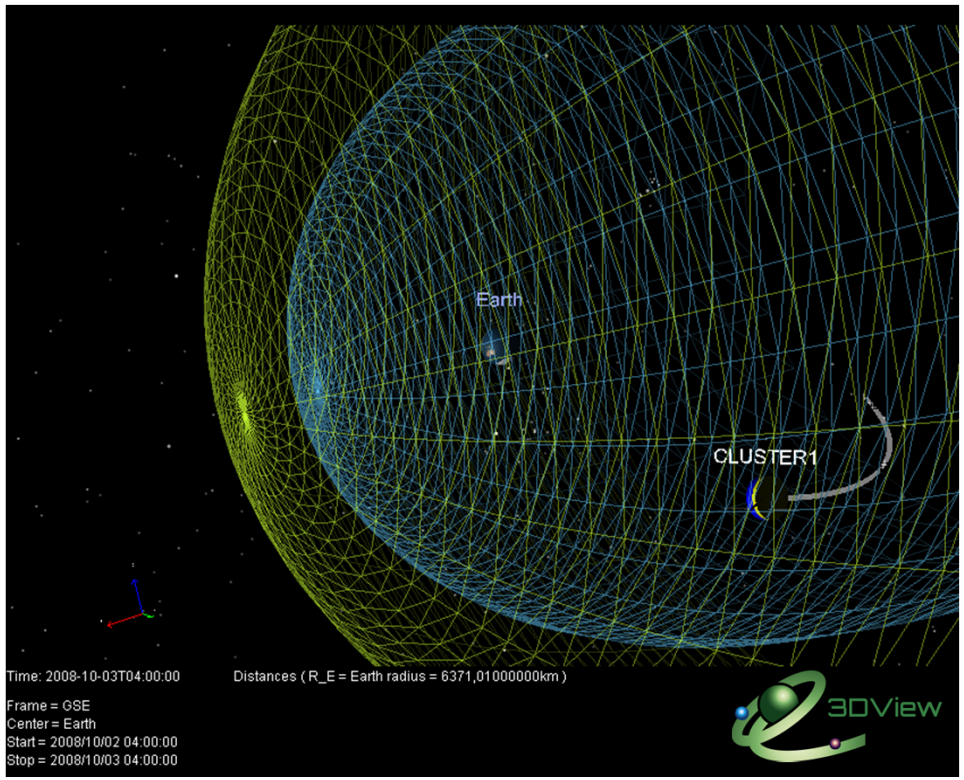


CCMC product description 1/2

- CCMC provides interpolation (in the 3D box) of physical quantities (fields and plasma parameters) along spacecraft trajectory (here Cluster 1) → time series which can be directly compared to in-situ observations

- CCMC files are available in ASCII format at given URL

http://ccmc.gsfc.nasa.gov/RoR_WWW/VMR/3539/Cluster-1/GSM_extract.txt




```
# Data printout from CCMC-simulation: version 1.3
# Data type:   BATSRUS  magnetosphere
# Run name:    Vincent_Genot_012610_1 Missing data:           NaN
# Coordinate System: GSM
# Satellite Track: Cluster-1
# Output data: field with 1x289=289 elements
#
it year mo dy hr mn sc msc X Y Z rho ux uy uz Bx(nT) By(nT) Bz(n
0 2008 10 2 4 0 0 000 -18.0 3.09 -9.31 0.769 -205. -4.52 5.84 -2
1 2008 10 2 4 5 0 000 -18.0 3.07 -9.37 0.716 -202. -5.47 6.83 -2
2 2008 10 2 4 10 0 000 -18.0 3.05 -9.43 0.563 -201. -10.5 10.9 -
3 2008 10 2 4 15 0 000 -18.0 3.02 -9.48 0.458 -213. -13.9 13.1 -
4 2008 10 2 4 20 0 000 -18.0 3.01 -9.52 0.365 -222. -9.32 6.02 -
5 2008 10 2 4 25 0 000 -18.0 2.98 -9.57 0.305 -235. -6.85 4.20 -
6 2008 10 2 4 30 0 000 -18.0 2.96 -9.62 0.281 -245. -9.21 5.76 -
7 2008 10 2 4 35 0 000 -18.0 2.93 -9.68 0.250 -250. -8.48 0.494
8 2008 10 2 4 40 0 000 -18.0 2.91 -9.73 0.218 -257. -15.1 2.95 -
9 2008 10 2 4 45 0 000 -18.0 2.89 -9.77 0.186 -259. -19.2 -11.7
10 2008 10 2 4 50 0 000 -18.0 2.87 -9.82 0.158 -272. -29.2 -21.8
11 2008 10 2 4 55 0 000 -18.0 2.84 -9.88 0.150 -272. -7.29 -24.4
12 2008 10 2 5 0 0 000 -18.0 2.81 -9.93 0.142 -276. 9.63 -26.6 -
13 2008 10 2 5 5 0 000 -18.0 2.79 -9.98 0.162 -264. 5.39 -40.8 -
14 2008 10 2 5 10 0 000 -18.0 2.76 -10.0 0.182 -252. -1.77 -16.0
```

CCMC product description 2/2

- These numerical outputs can be described using the IMPEx DM (see next slides) in a Tree.xml (one Tree exists for each database) – *available at CDPP for the moment*
  - http://apus.cesr.fr/AMDA-IMPEX/public/trees/Tree_CCMC_chablon5.xml

- We developed a service (CDPP, FMI) to access and transform the CCMC files in VOTables (on the fly)
  - http://apus.cesr.fr/AMDA-WS/php/rest/getVotableFromASCII.php?url=http://ccmc.gsfc.nasa.gov/RoR_WWW/VMR/3539/Cluster-1/GSM_extract.txt

- The VOTables are then accessible by all IMPEx tools using the Tree.xml description

```
<?xml version='1.0'?>
<VOTABLE version="1.2"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.2 http://www.ivoa.net/xml/VOTable/v1.2"
 xmlns="http://www.ivoa.net/xml/VOTable/v1.2">
<!--
 ! VOTable written by FMI web service getVOTableURL
 ! 2014-01-26T18:22:02+0000
 !-->
<RESOURCE>
<TABLE name="http://ccmc.gsfc.nasa.gov/RoR_WWW/VMR/3539/Cluster-1/GSM_extract.txt" nrows="289">
<DESCRIPTION>
  # Data printout from CCMC-simulation: version 1.3
# Data type:  BATSRUS  magnetosphere
# Run name:   Vincent_Genot_012610_1 Missing data:          NaN
# Coordinate System: GSM
# Satellite Track: Cluster-1
# Output data: field with 1x289=289 elements
```

IMPEx DM : SimulationModel

```
<?xml version="1.0" encoding="UTF-8" ?>
- <Spase xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://impex-fp7
  fp7.oeaw.ac.at http://impex.latmos.ipsl.fr/doc/impex+spase_latest.xsd">
  <Version>2.2.2</Version>
  - <SimulationModel>
    <ResourceID>impex://CCMC/BATSRUS/</ResourceID>
    - <ResourceHeader>
      <ResourceName>MHD_CCMC</ResourceName>
      <ReleaseDate>2000-01-01T00:00:00.000</ReleaseDate>
      <Description>BATSRUS with RCM v8.01</Description>
      - <Contact>
        <PersonID>CCMC</PersonID>
        <Role>DataProducer</Role>
      </Contact>
      - <InformationURL>
        <URL>http://ccmc.gsfc.nasa.gov/models/modelinfo.php?model=BATS-R-US</URL>
      </InformationURL>
    </ResourceHeader>
    - <Versions>
      - <ModelVersion>
        <VersionID>8.01</VersionID>
        <ReleaseDate>2000-01-01T00:00:00.000</ReleaseDate>
        <Description>First public release</Description>
      </ModelVersion>
    </Versions>
    <SimulationType>MHD</SimulationType>
    <CodeLanguage>Fortran90</CodeLanguage>
  </SimulationModel>
```

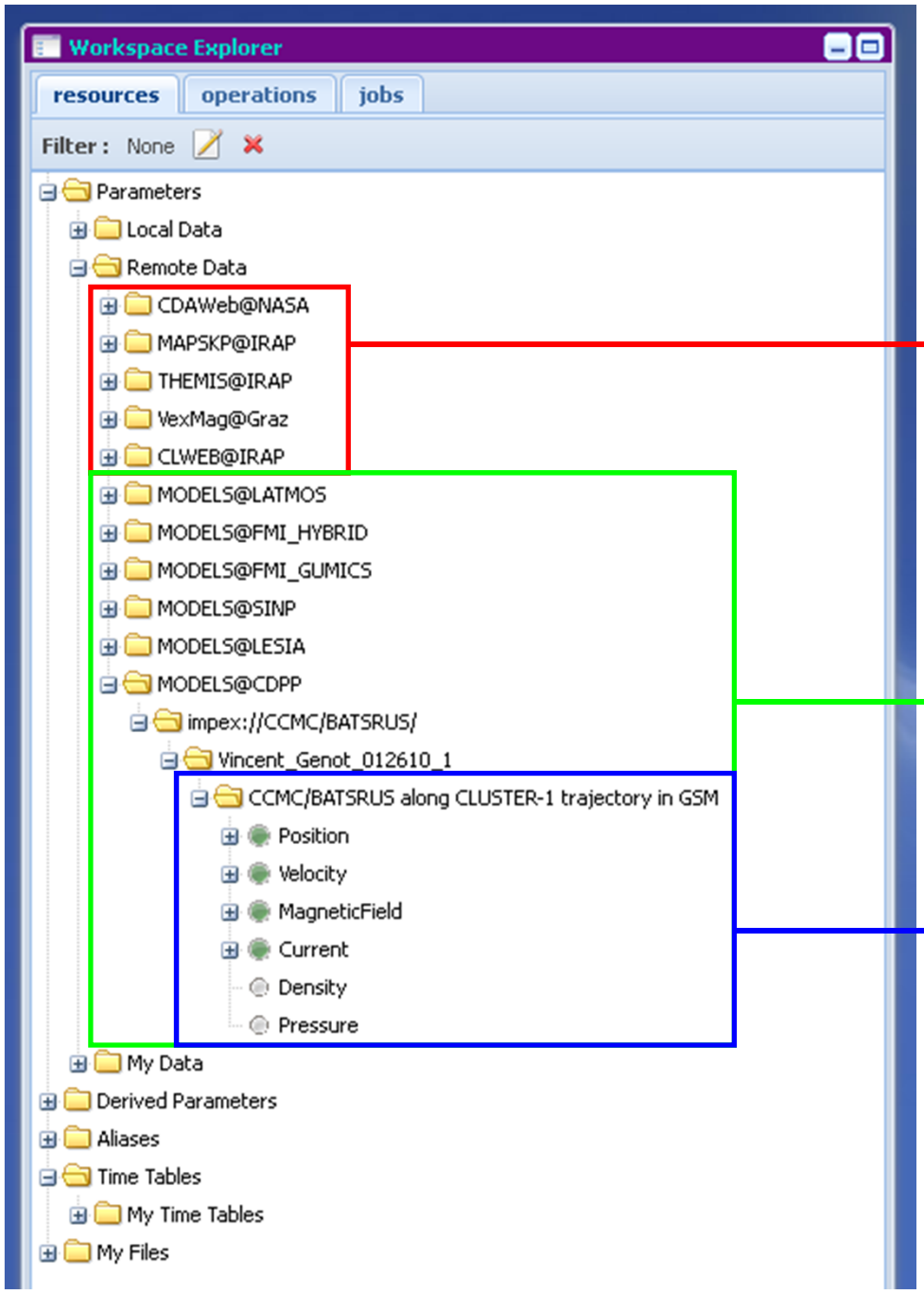
Part of Tree.xml

IMPEx DM : NumericalOutput

```
- <NumericalOutput>
    <ResourceID>impex://CCMC/BATSRUS/Vincent_Genot_012610_1/Cluster-1/GSM</ResourceID>
  - <ResourceHeader>
      <ResourceName>CCMC/BATSRUS along CLUSTER-1 trajectory in GSM</ResourceName>
      <ReleaseDate>2010-01-26T00:00:00.000</ReleaseDate>
      <Description>BATSRUS event run from CCMC interpolated along CLUSTER-1 trajectory in GSM</Description>
    - <Contact>
        <PersonID>Vincent Génot</PersonID>
        <Role>DataProducer</Role>
      </Contact>
    </ResourceHeader>
  - <AccessInformation>
      <RepositoryID>impex://CCMC</RepositoryID>
    - <AccessURL>
        <URL>http://apus.cesr.fr/AMDA-WS/php/rest/getVotableFromASCII.php?
          url=http://ccmc.gsfc.nasa.gov/RoR_WWW/VMR/3539/Cluster-1/GSE_extract.txt</URL>
      </AccessURL>
      <Format>VOTable</Format>
    </AccessInformation>
    <MeasurementType>ElectricField</MeasurementType>
  - <TemporalDescription>
    - <TimeSpan>
        <StartDate>2008-10-02T04:00:00.000</StartDate>
        <StopDate>2008-10-03T04:00:00.000</StopDate>
      </TimeSpan>
    </TemporalDescription>
    <SimulatedRegion>Earth</SimulatedRegion>
    <InputResourceID>impex://CCMC/BATSRUS/Vincent_Genot_012610_1</InputResourceID>
  - <Parameter>
      <Name>Position</Name>
      <ParameterKey>X,Y,Z</ParameterKey>
      <Units>R_E</Units>
      <UnitsConversion>6371200 > m</UnitsConversion>
    - <CoordinateSystem>
        <CoordinateRepresentation>Cartesian</CoordinateRepresentation>
        <CoordinateSystemName>GSM</CoordinateSystemName>
      </CoordinateSystem>
    - <Support>
        <SupportQuantity>Positional</SupportQuantity>
      </Support>
    </Parameter>
```

Part of Tree.xml

Remote data in AMDA



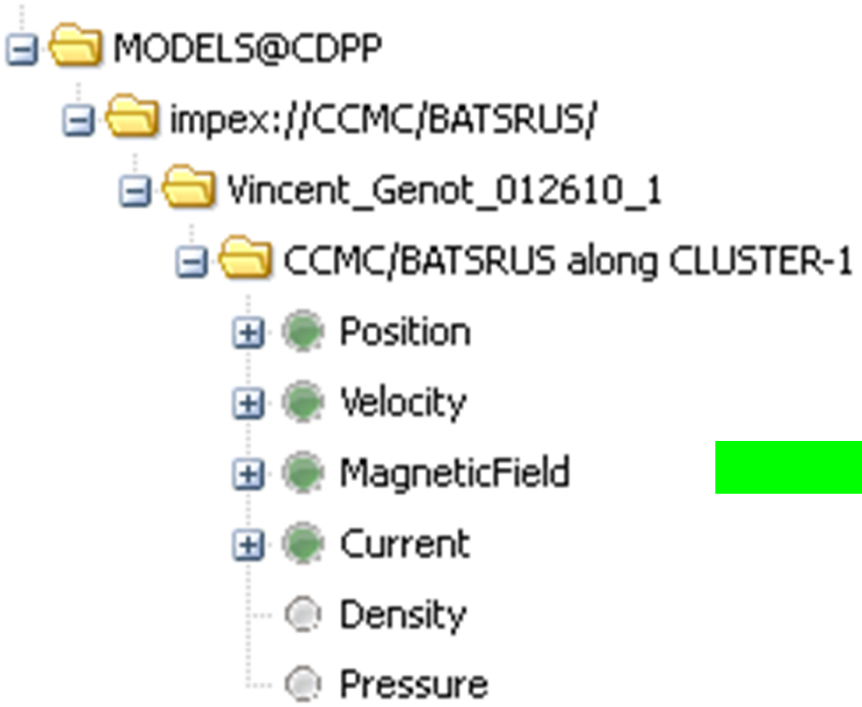
Observational data

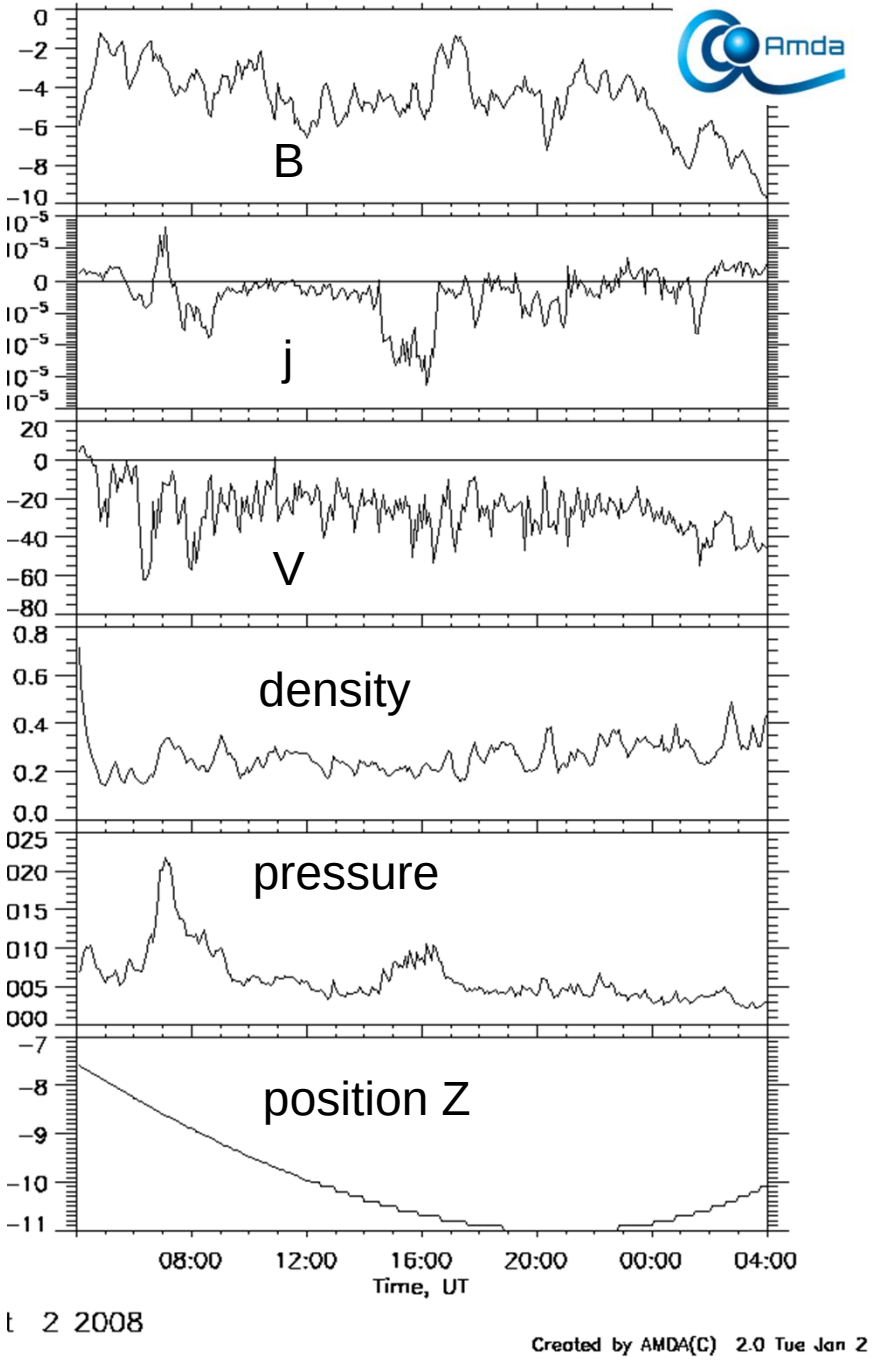
Simulation Trees

CCMC Simulation run

- *BATSRUS run*
- *interpolation along Cluster 1 in GSM*

CCMC run visualisation in AMDA

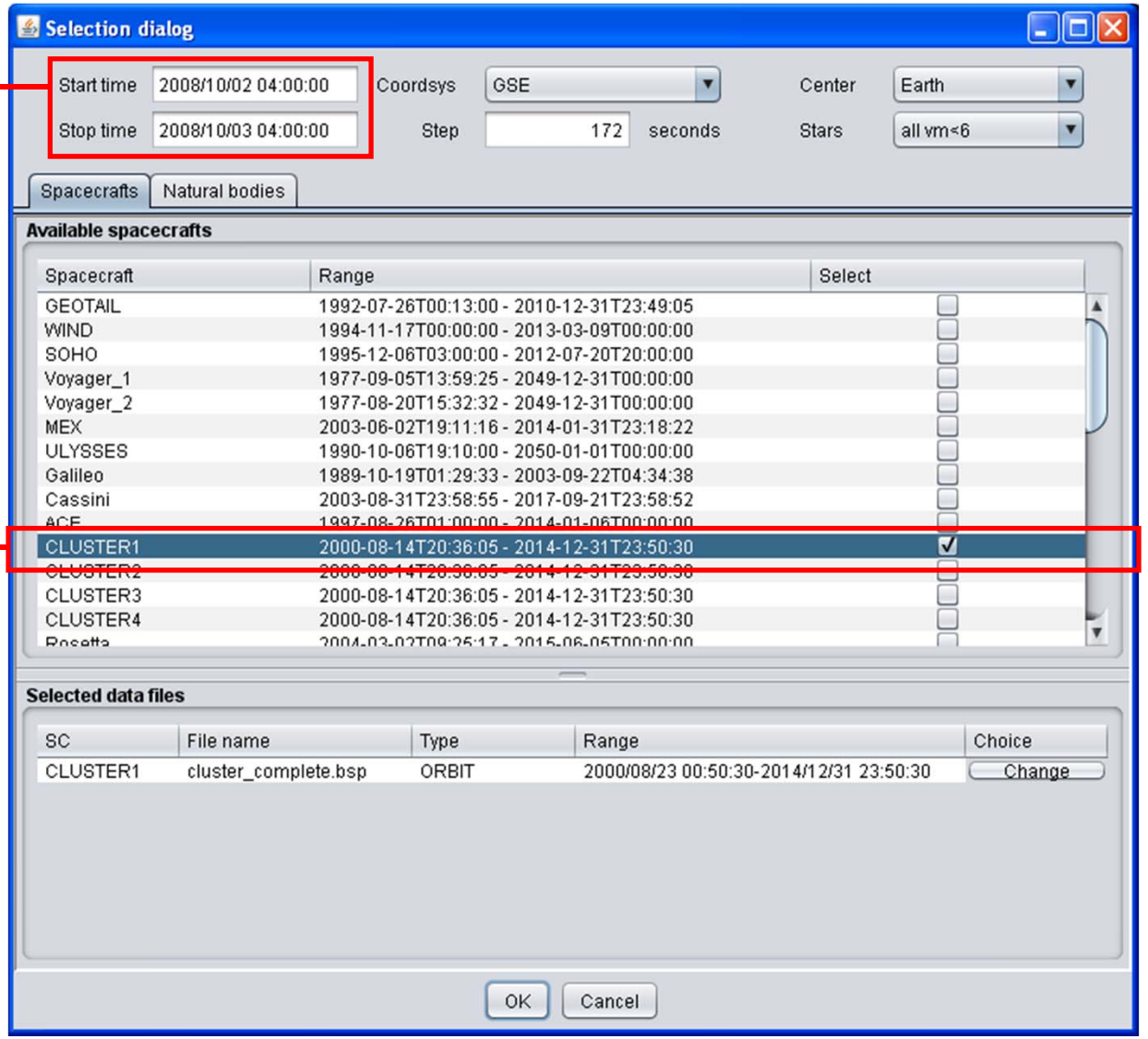




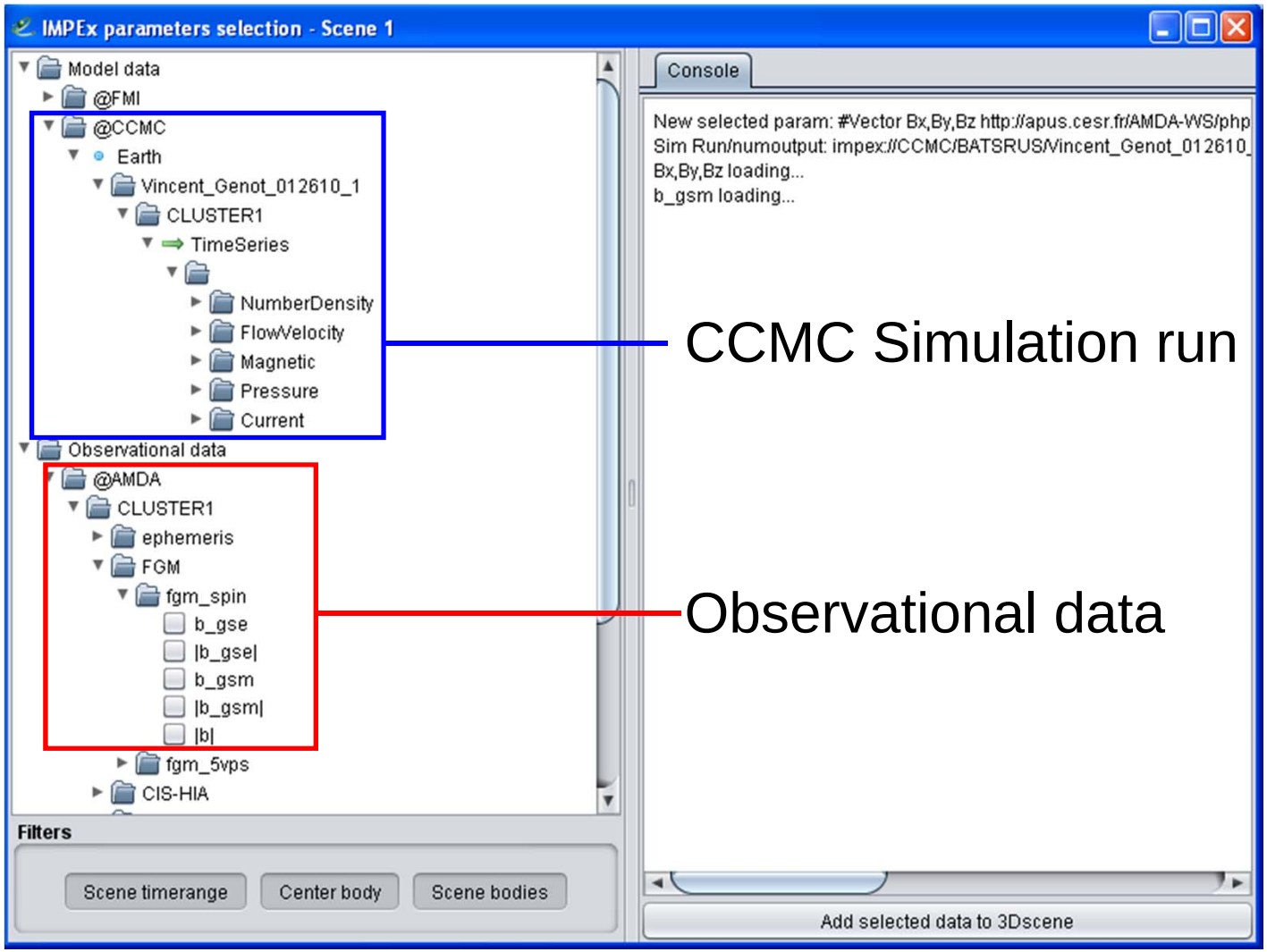
Scene setup in 3DView : Cluster 1

Simulation interval

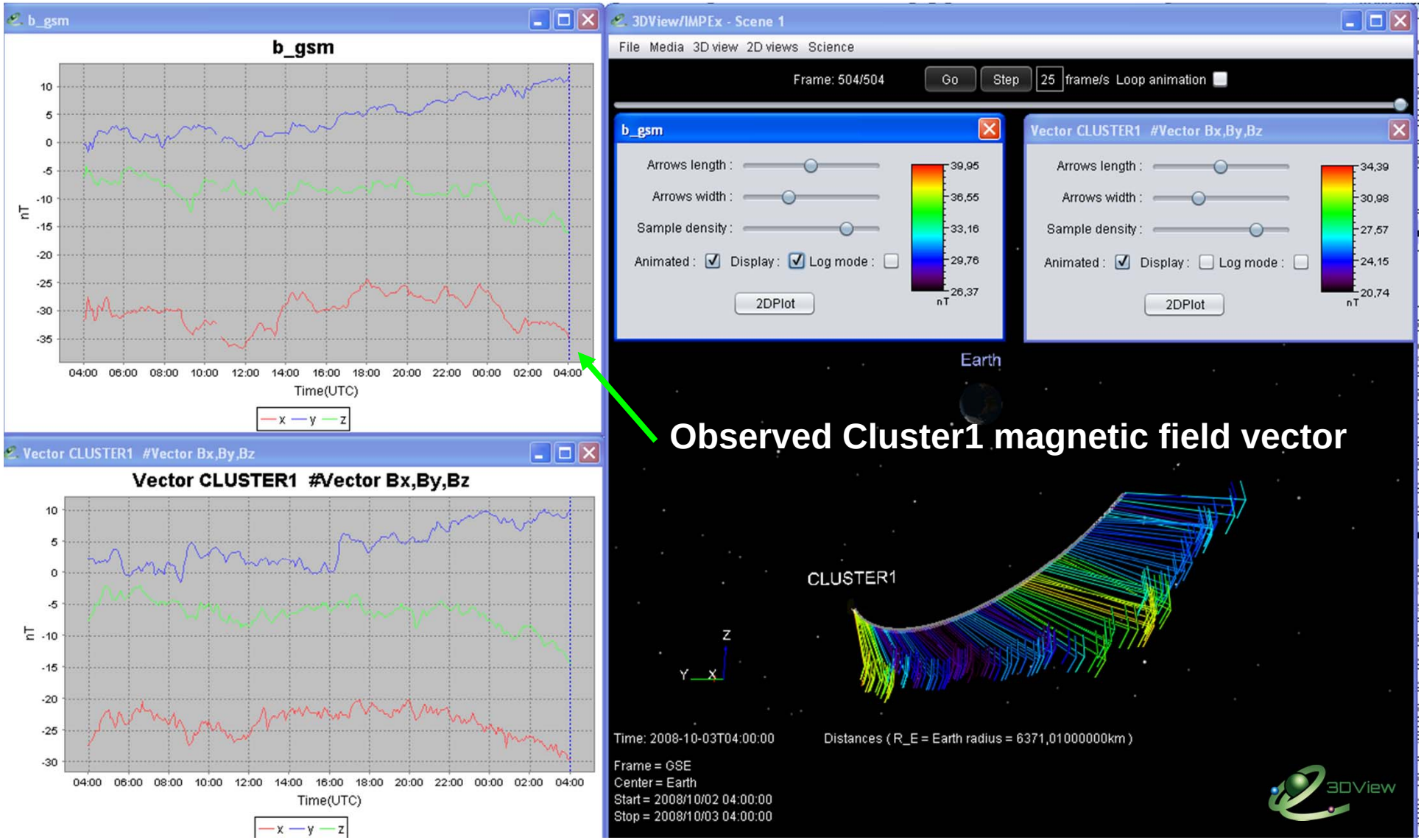
Spacecraft choice



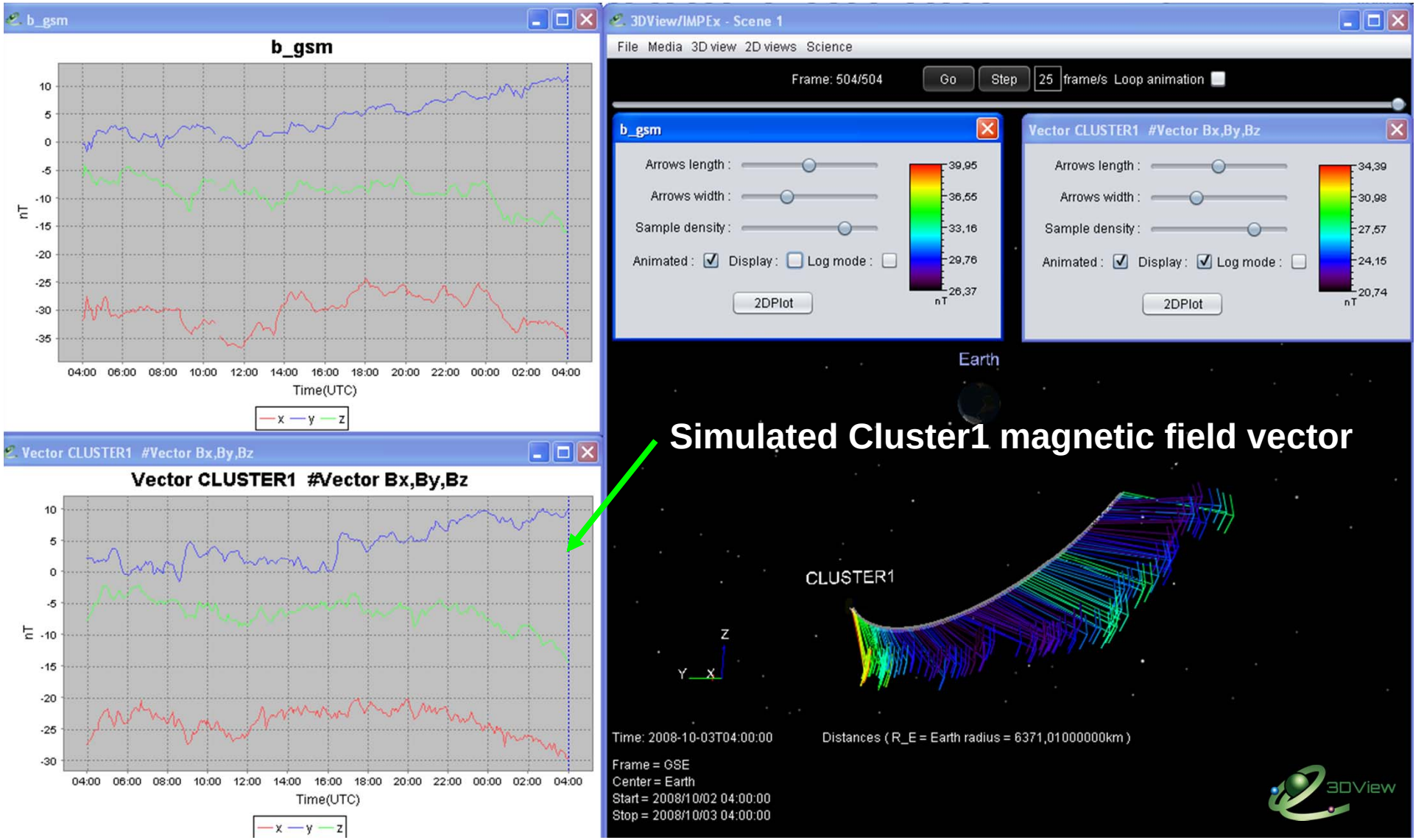
Adding CCMC+in-situ data in 3DView



Observed/simulated time series + observed 3D field



Observed/simulated time series + simulated 3D field



Conclusions / perspectives

- From information available at CCMC, describing a simulation run with the IMPEx DM is relatively easy
- However doing it systematically for the whole CCMC holdings would be very much time consuming
  - 1000's of runs, numerous spacecraft, several coordinate systems
  - Each combination [run+S/C+coord.syst.] is one output file
- Some steps could be simplified (with CCMC help), for instance
  - CCMC could propose VOTable outputs in addition to their ASCII formats
  - CCMC could automatically generate Tree.xml (describing their runs with the IMPEx DM)
- Next steps
  - Describe a few more runs ourselves
  - Get CCMC feedback