PROGRESS

PRediction Of Geospace Radiation Enviroment and Solar wind parameterS

New EC Horizon 2020 funded project.

PARTICIPANTS

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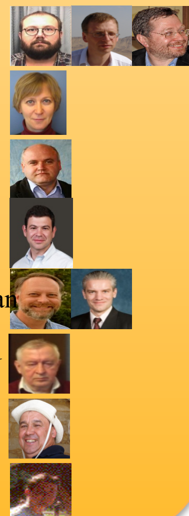
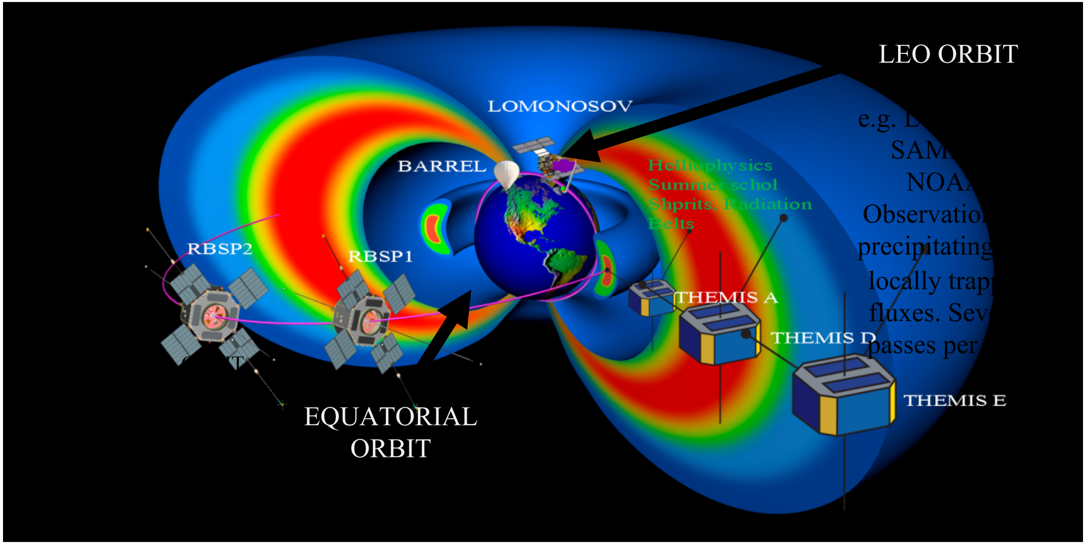


AIMS

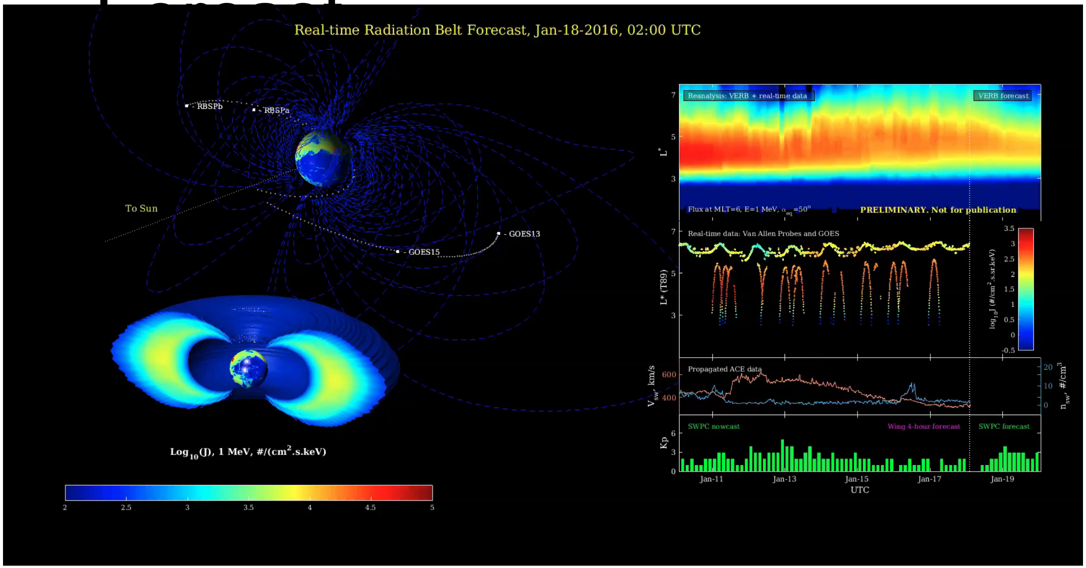
- Development of a European Solar Wind model
- Models for the evolution of geomagnetic indices
- Statistical Wave models of wave activity
- Development and coupling of systems methodologies with physically based models
- Tools for robust, reliable forecasts for
  - geomagnetic indices
  - particle environment of the inner magnetosphere

Multi-Point Observations



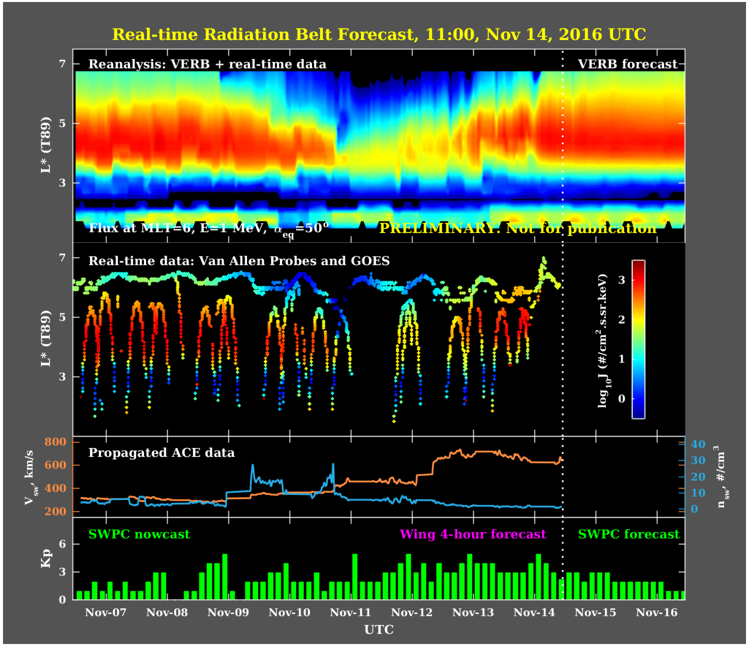
Radiation Belts Assimilative Forecast

Data from different satellites is blended with a physics-based model

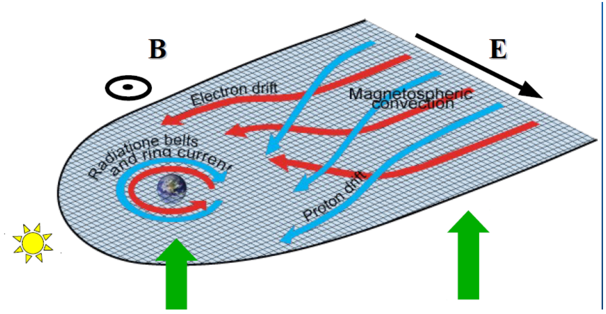


Radiation Belts Assimilative Forcast

http://rbm.epss.ucla.edu/realtime-forecast/



Particle Trajectories of Ring Current and Radiation Belt Particles



Stably trapped particles

Convection of the seed population of energetic electrons

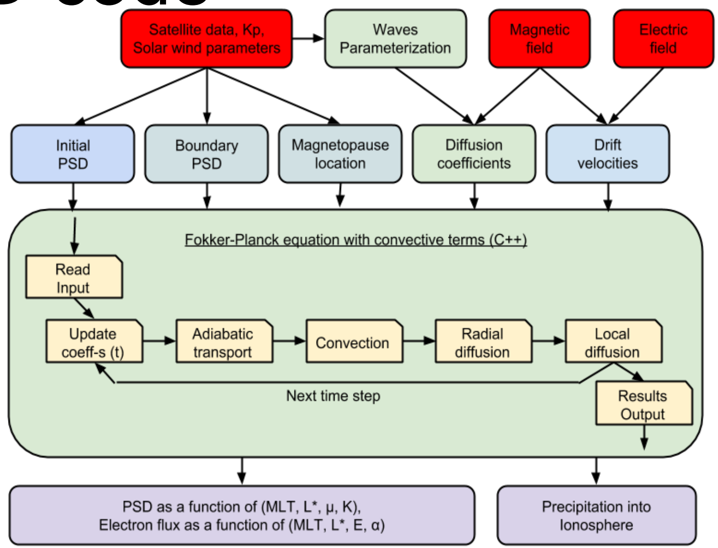
Drift of lower energy particles is dominated by ExB drift.

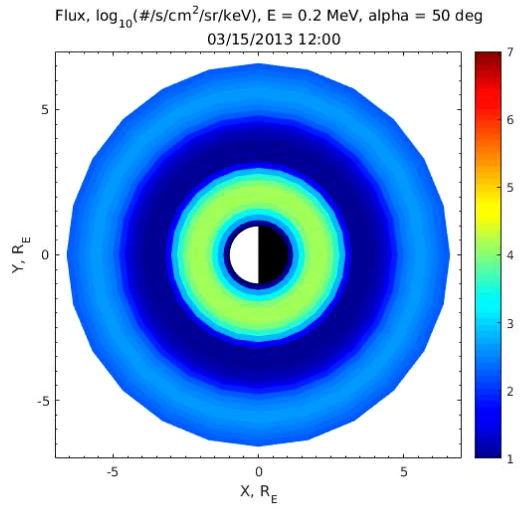
Radiation Belt particles are subject to the gradient and curvature drifts and will drift around the Earth.

Electrons –eastward,

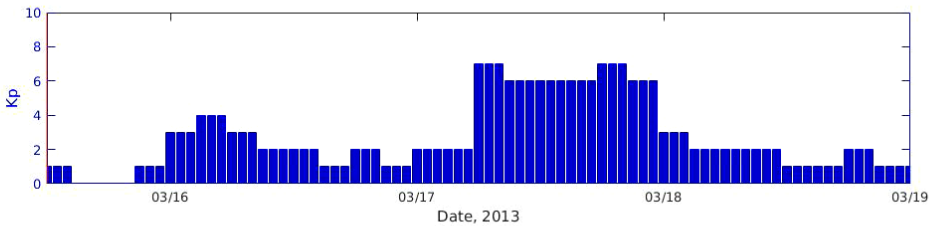
Ions – westward.

Block Diagram Showing Data Exchange between the modules of the VERB 4D code





Flux, $\log_{10}$(#/s/cm^2/sr/keV), E = 0.2 MeV, alpha = 50 deg
03/15/2013 12:00
Y, R_E
X, R_E
5
0
-5
1
2
3
4
5
6
7



Kp
10
8
6
4
2
0
03/16
03/17
03/18
03/19
Date, 2013

Comparison with IMAGE EUV

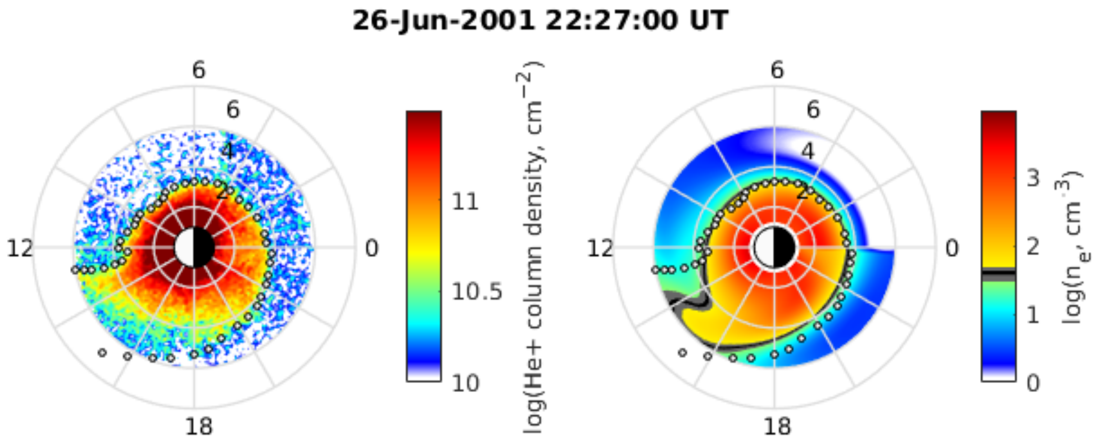
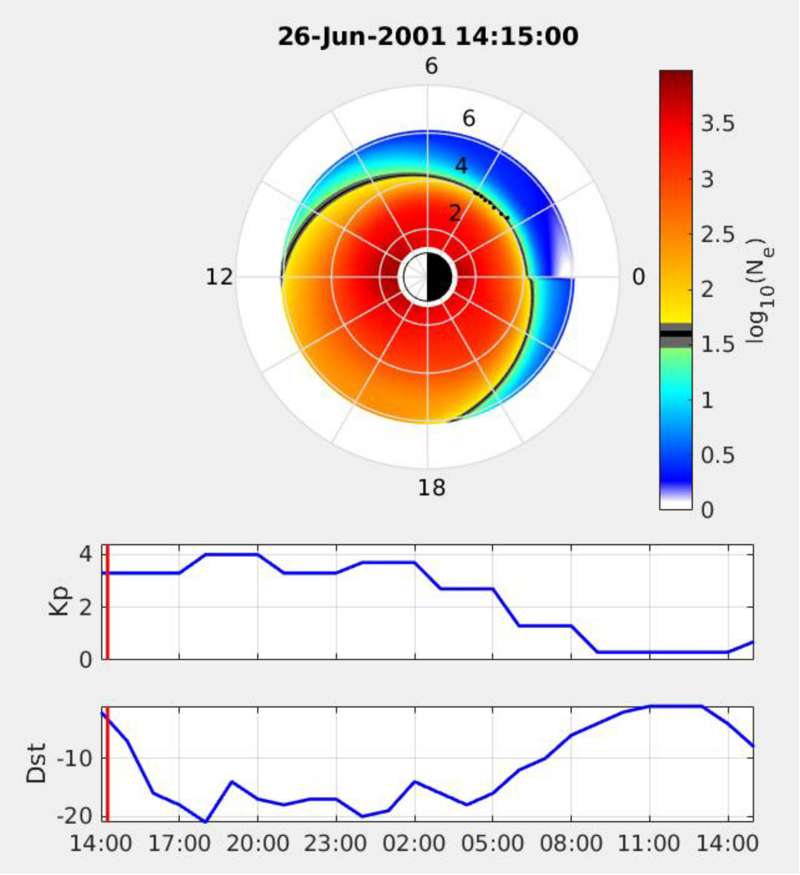


IMAGE EUV

Neural network output

Global density reconstruction



Questions:

Why are we in such a big room?
What do you think we should be doing?
What are other products that may be useful?
Should we focus on predictions or on reanalysis?
How our predictions may help?

VERB-4D code development

Shprits Y., Kellerman A., Drozdov A., Aseev N.

VERB-4D code testing

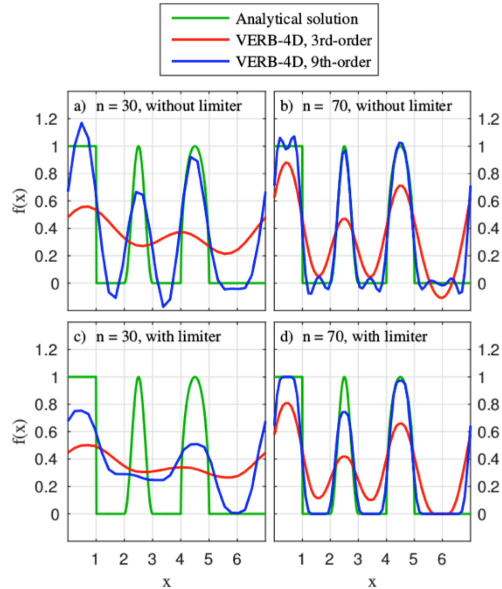
The VERB-4D code was thoroughly validated [Aseev et al., 2016].

Implemented numerical schemes are stable regardless time step and computational grid.

Solutions of advection and diffusion equations converge to analytical solutions.

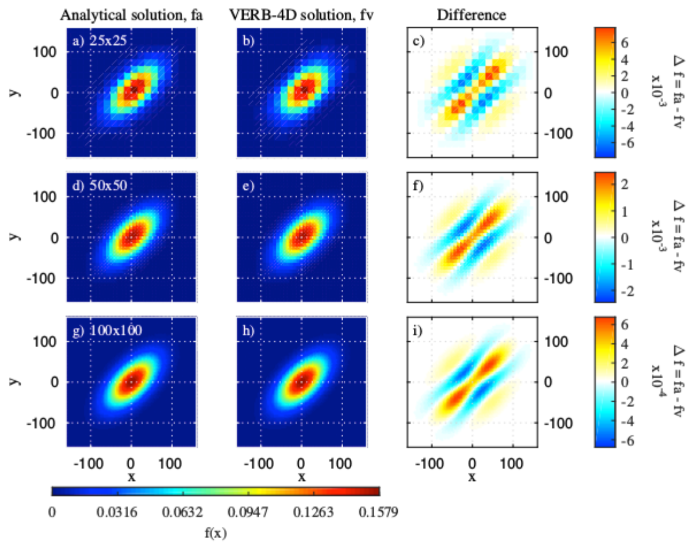
VERB-4D code testing

Implemented 9th-order scheme shows much more accurate results than the 3rd-order one.



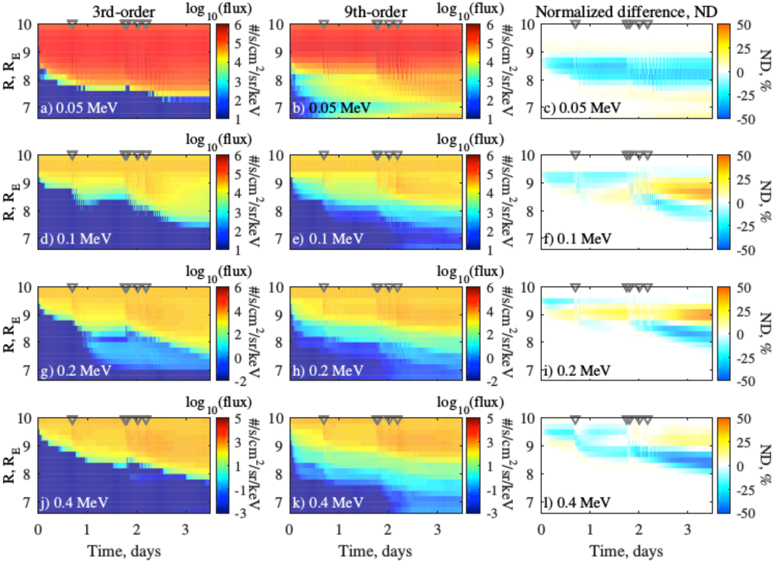
VERB-4D code testing

The solution of diffusion equation with cross-derivative terms converges to the analytical one.



VERB-4D code testing

The order of numerical scheme may significantly affect the results of charged particles advection modeling



Boundary conditions for extended VERB-4D code

VERB-4D code is now being extended up to radial distances R~=10-15 Re.

Accurate boundary conditions are required in the inner central plasma sheet region.

$$f = N \left(\frac{M}{2\pi\kappa E_o}\right)^{3/2} \frac{\Gamma(\kappa+1)}{\Gamma(\kappa-\frac{1}{2})} \left[1 + \frac{E^*}{\kappa E_o}\right]^{-\kappa-1}$$

Omnidirectional differential electron flux is fitted with kappa distribution function:

$$E_0 = kT\,\frac{\kappa-3/2}{\kappa}$$

κ

Boundary condition parameterization

Plasma sheet electron density and temperature are taken from [Dubyagin et al., 2016]

$$N_{ps} = A_1 + A_2 R^* + A_3 \phi^{*2} R^* + A_4 \phi^{*2} + A_5 N^*_{sw} + (A_6 + A_7 R^*) B^*_S,$$

$$T_{ps} = \left[A_1 + A_2 \phi^* + A_3 V^*_{sw} + (A_4 + A_5 \phi^{*2} R^*) B_S^{*A_7} + A_6 R^* B_N^{*A_8}\right]^{A_9},$$

$\phi^* = \phi/90°$ $\phi = \arctan(-Y_{GSM}/X_{GSM})$ $R^* = R/10R_E$ N^*_{sw} V^*_{sw} B^*_S B^*_N

, , 1

, and , , and are averaged over preceding time interval (specific for each solar wind parameter).

Boundary condition parameterization

κ = 4.1 is determined by minimization of RMSE between THEMIS fluxes and kappa distribution function

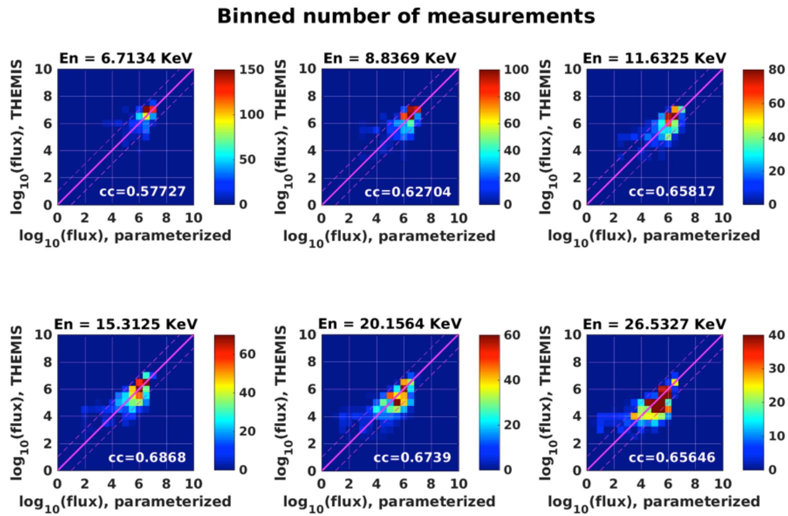


Figure. Predicted plasma sheet electron fluxes versus THEMIS ESA measurements

Boundary condition parameterization

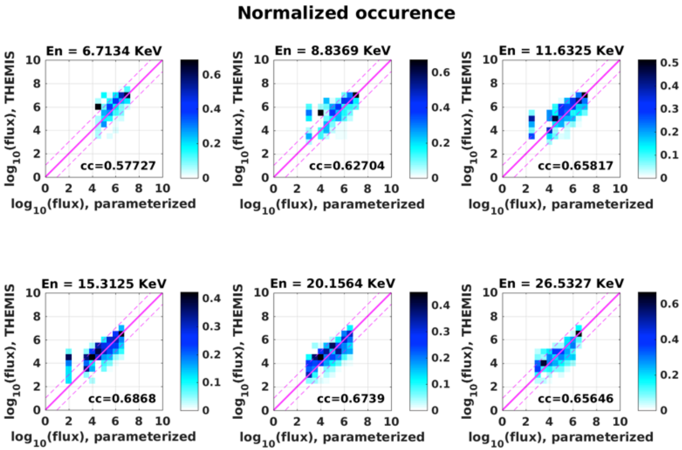


Figure. Conditional probability of predicted flux to be in particular bin of THEMIS data.