ENLIL Modeling Support to the HELCATS Project

Dusan Odstrcil

George Mason University & NASA/GSFC Space Weather Lab (Code 674)

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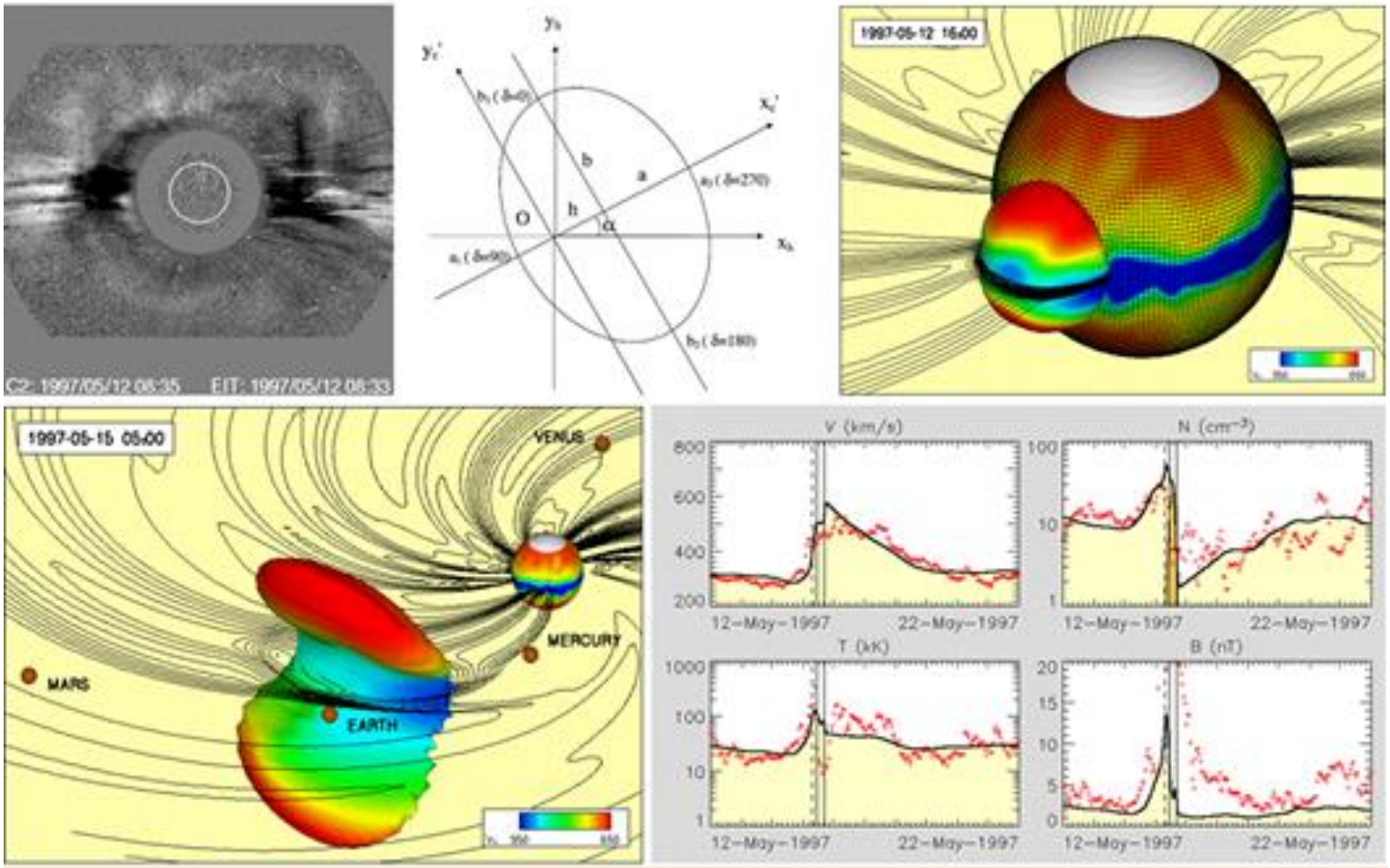
Outline

- WSA-ENLIL-Cone modeling system
- Evolving background solar wind
- Using heliospheric imaging – IPS
- Using heliospheric imaging – white-light
- SEP events – Shock detection
- Heliospheric missions support

WSA-ENLIL-Cone Modeling System



- Observationally driven, near-real time modeling system
- Routine simulation of corotating streams and CMEs, event-by event
- Much faster than real-time

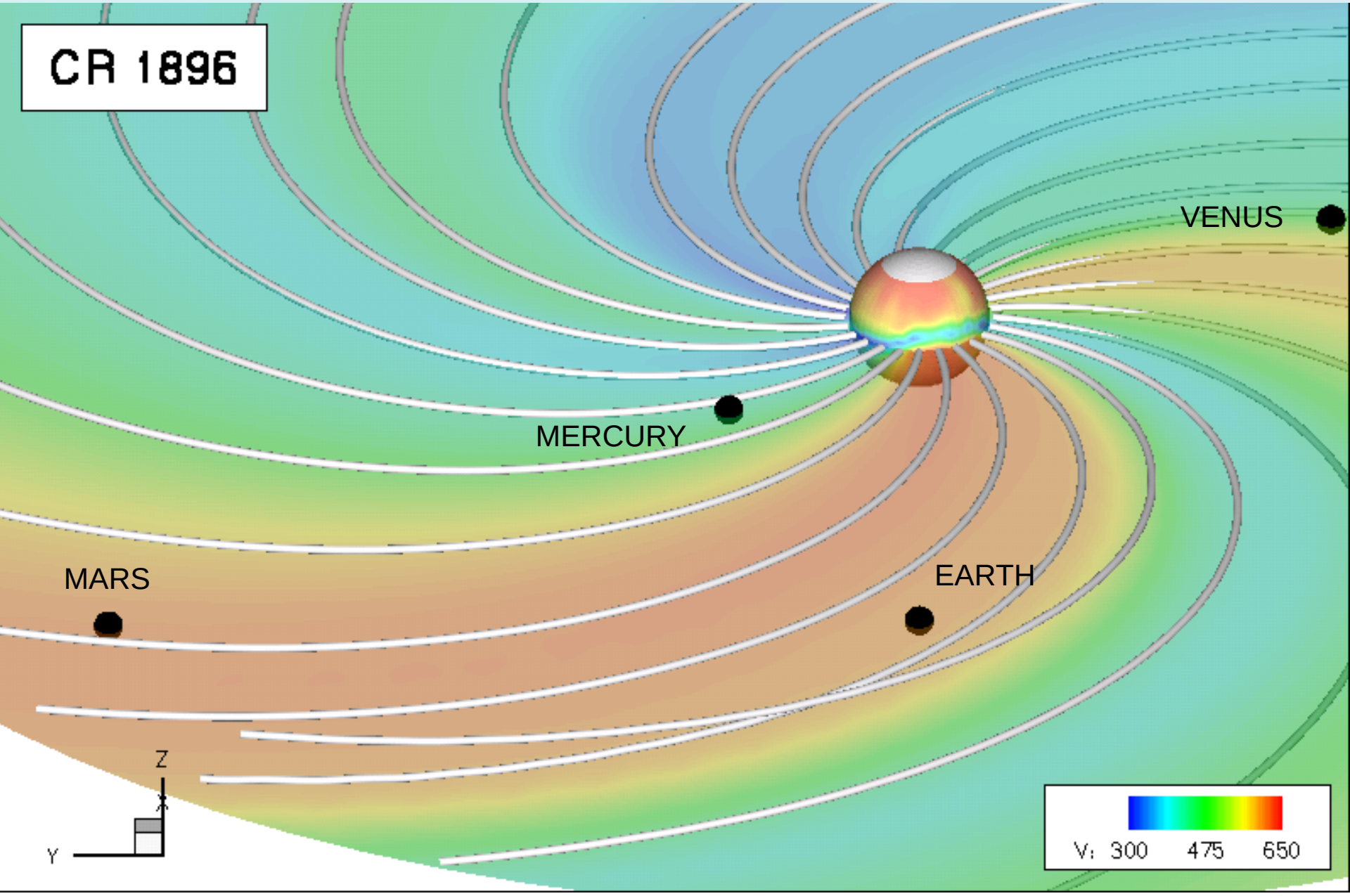
NASA+NSF Partnership for Collaborative Space Weather Modeling (PCSWM)

(*NASA Living With a Star (LWS) Strategic Capability Program*)

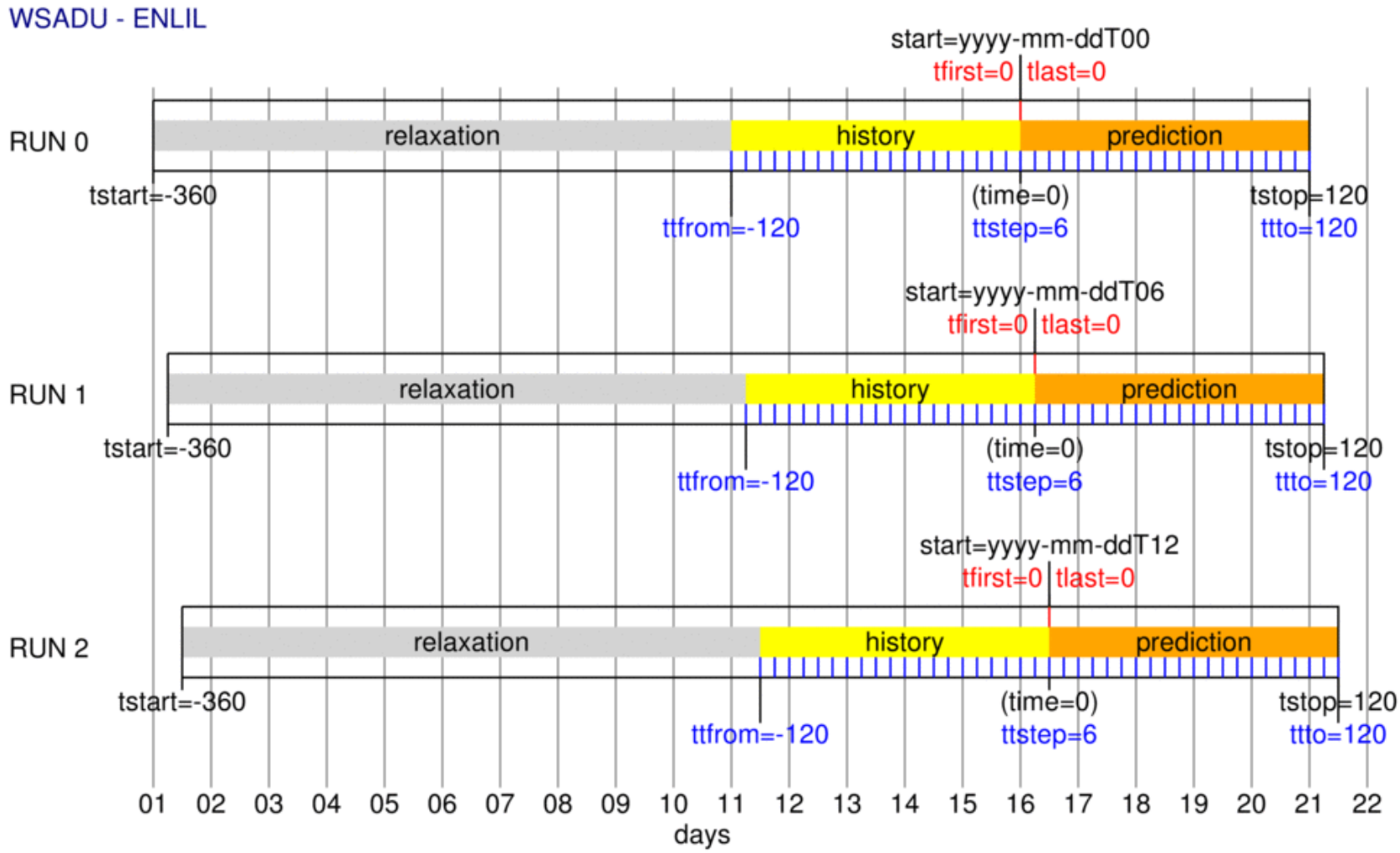
- Medium Range Thermosphere-Ionosphere Forecasts
- A First-Principle-Based Data Assimilation System for Global Ionosphere
- MHD and Kinetic Effects into Global Magnetosphere Models
- Magnetic Flux Emergence and Transport
- Coronal Global Evolutionary Models
- A Modular Community Modeling of Flares, CMEs, and Interplanetary Impacts
- Corona-Solar Wind Energetic Particle Acceleration
- **Integrated Real-Time Modeling System for Heliospheric Space Weather Forecasting**

Evolving Background Solar Wind

Near Solar Minimum

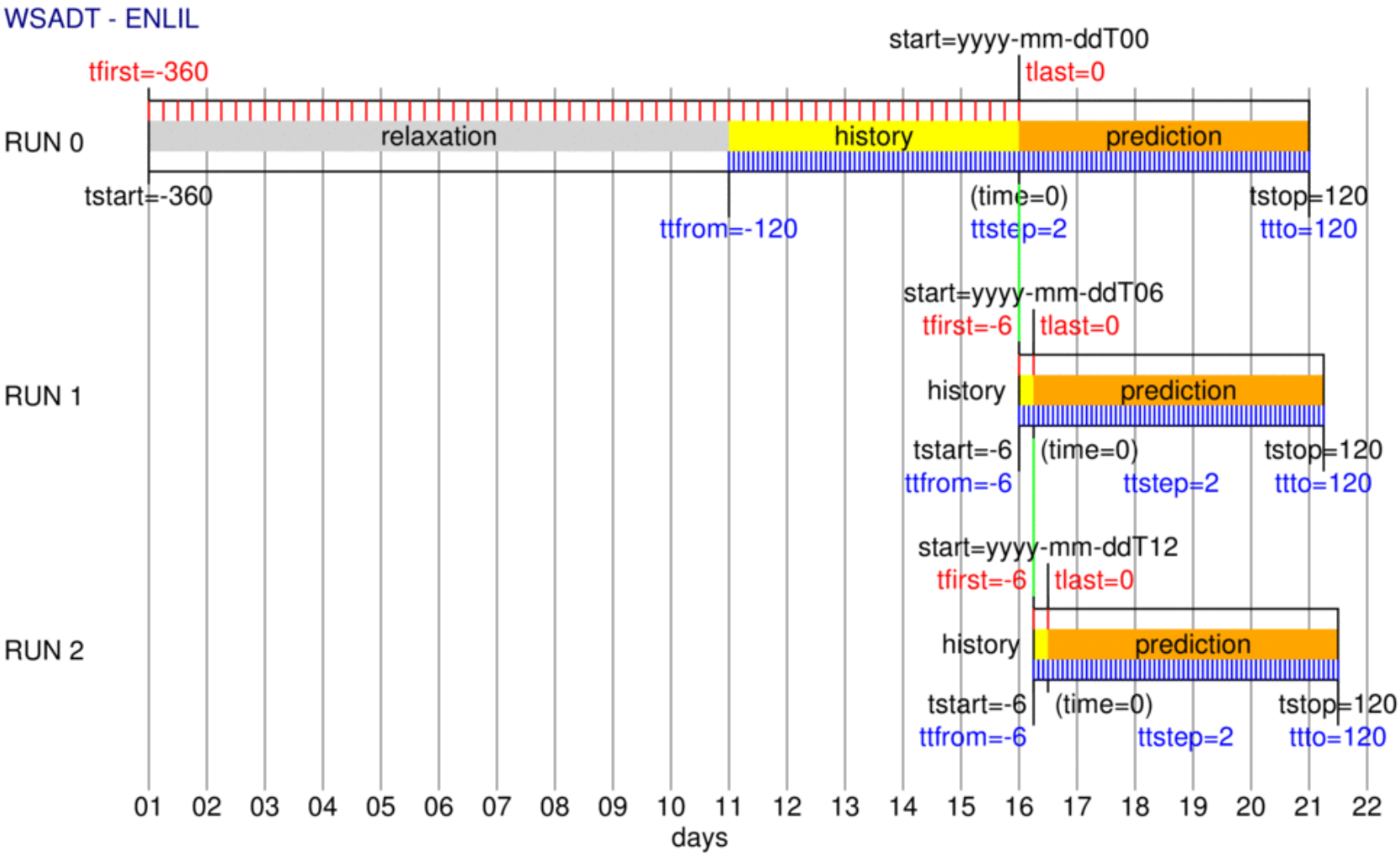


Run Schematic (Old) – “Single-map”, Corotating Background



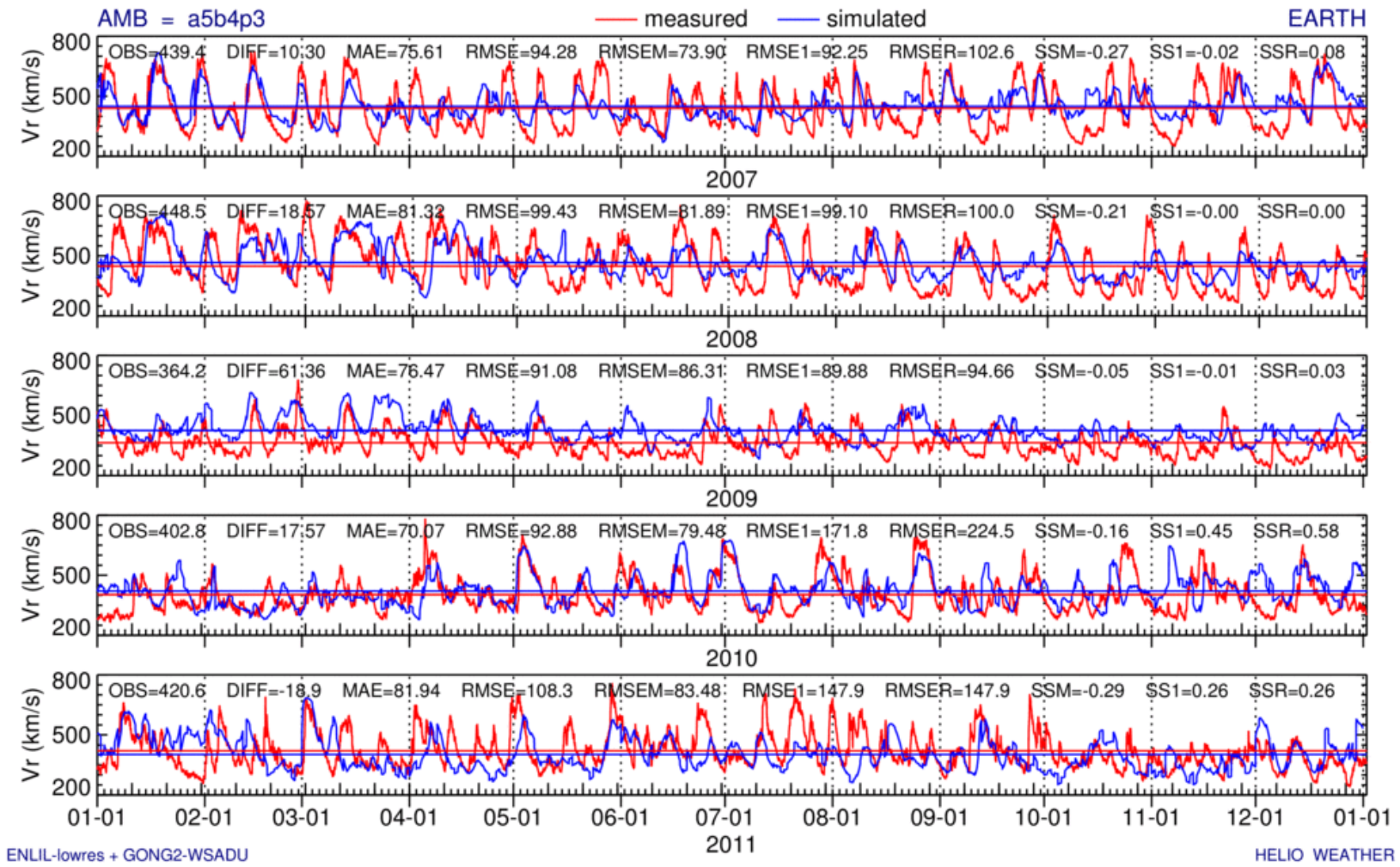
- Numerical relaxation is needed to establish self-consistent background in the computational domain – about 10 days up to Mars
- Numerical relaxation is needed for each prediction

Run Schematic (New) – “Multiple-Maps”, Evolving Background



- Continuously evolving background is achieved be resuming from previous runs
- Significant savings in computational time

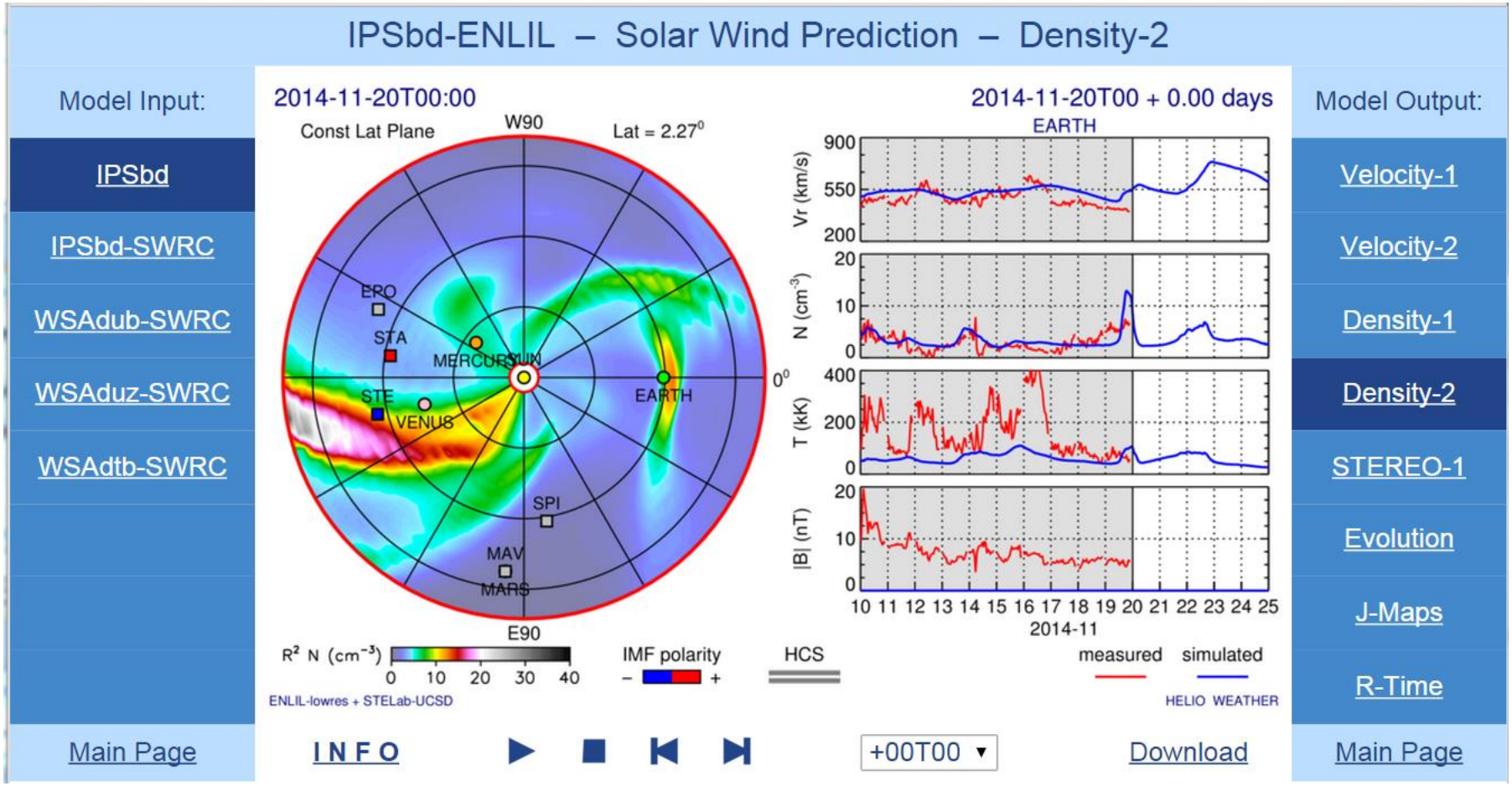
Solar Wind Velocity: GONGz-WSADU: 2007-2011



- Prediction of global solar wind parameters at Earth (blue) depends on the coronal model input and also on the heliospheric model free parameters
- WSA maps based on the NSO/GONG daily-updated magnetograms provide positive skill scores for 1-day persistency (SS1) and 27-day recurrence (SSR)

Using Heliospheric Imaging – IPS

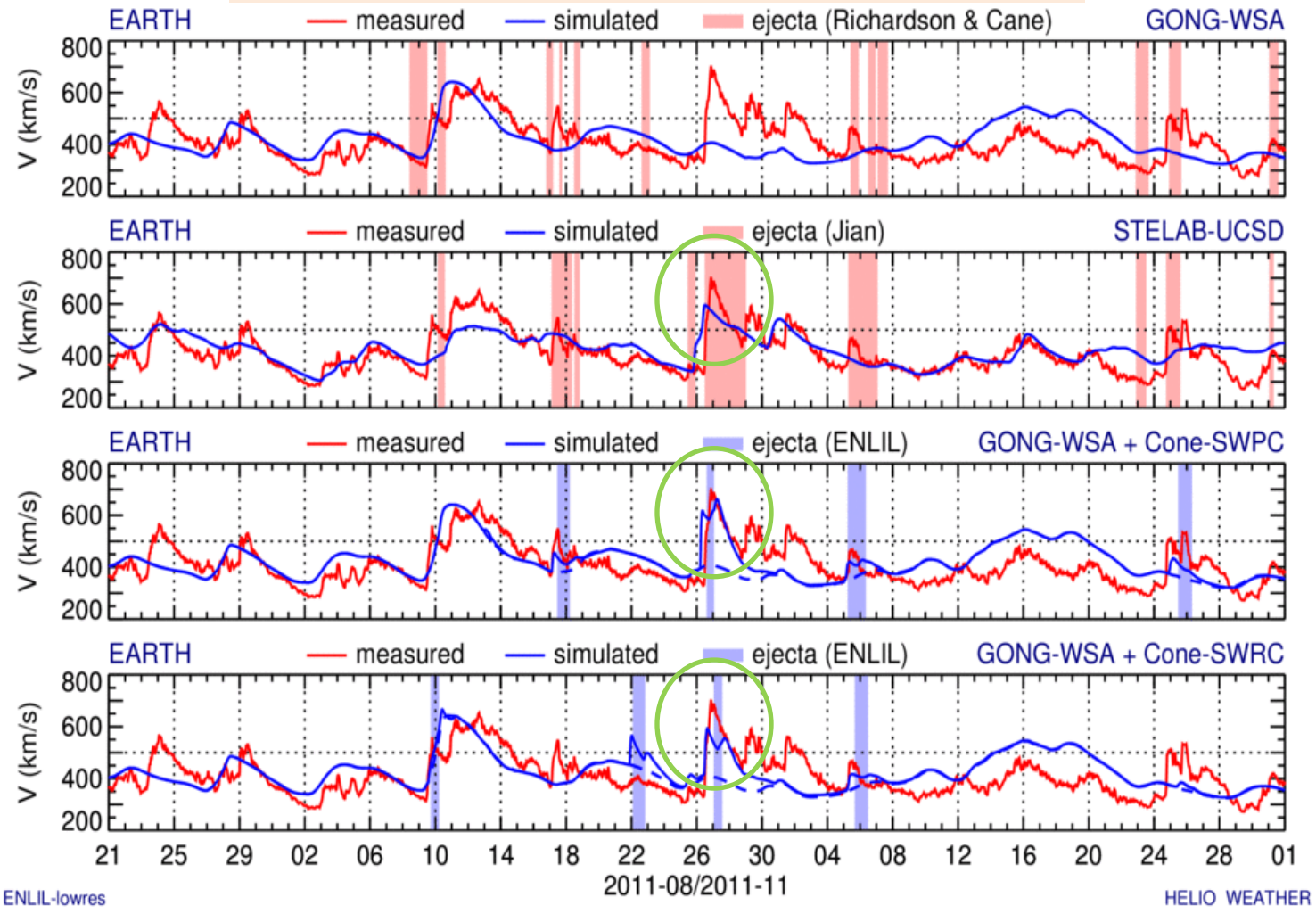
Development/Monitoring of IPSBD-ENLIL



- Main page: http://helioweather.net
- Updated daily around 3 AM (7 AM) for WSA (IPS) based input

Using IPSBD – Near the Sun-Earth Line

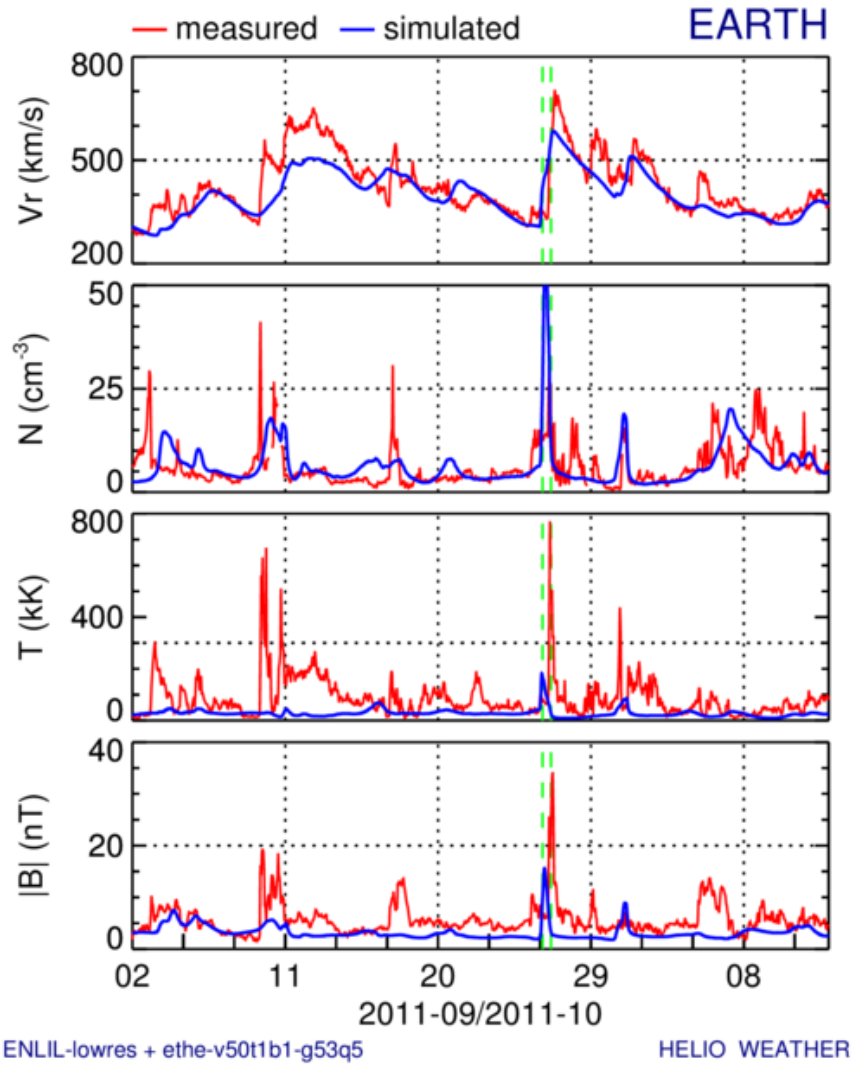
Solar Wind Velocity at Earth by 4 Models



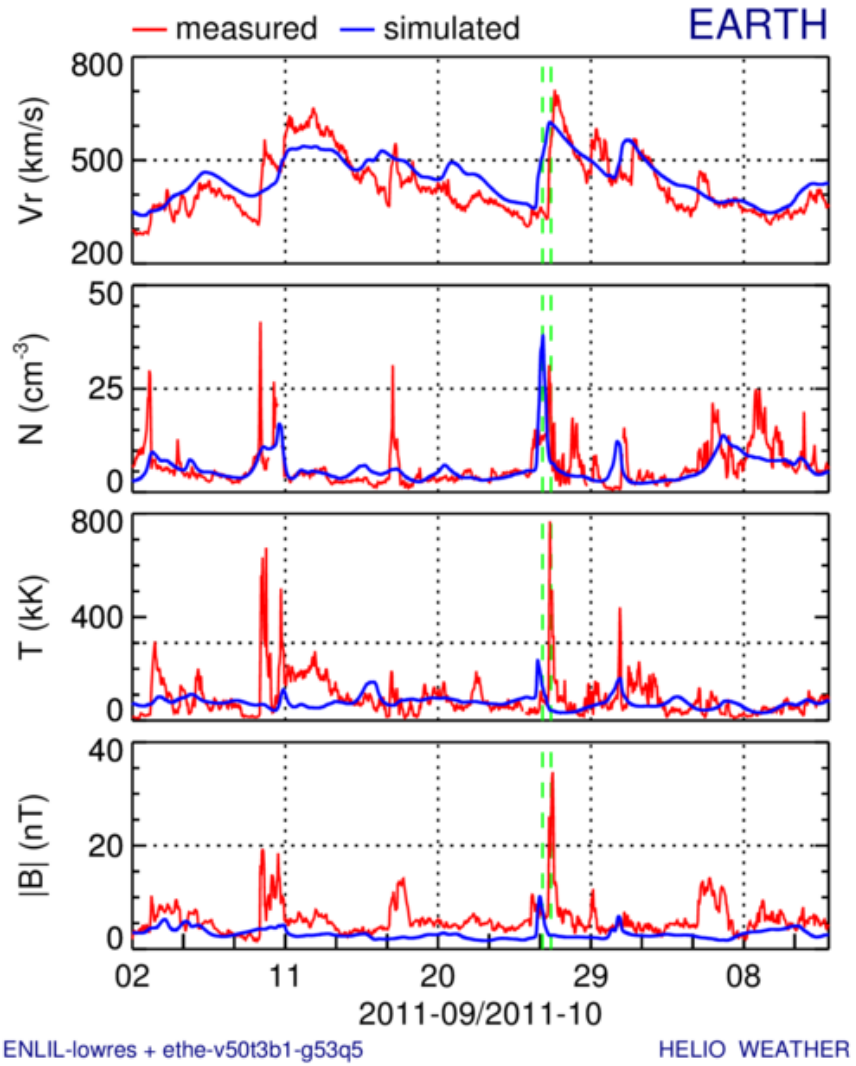
- No ICME on 2011-09-27 in Richardson & Cane caused by poor ACE data
- The 2011-09-24 CME arrives at Earth similarly on 09-27 for all cases

Effect of Temperature

T = 1 MK

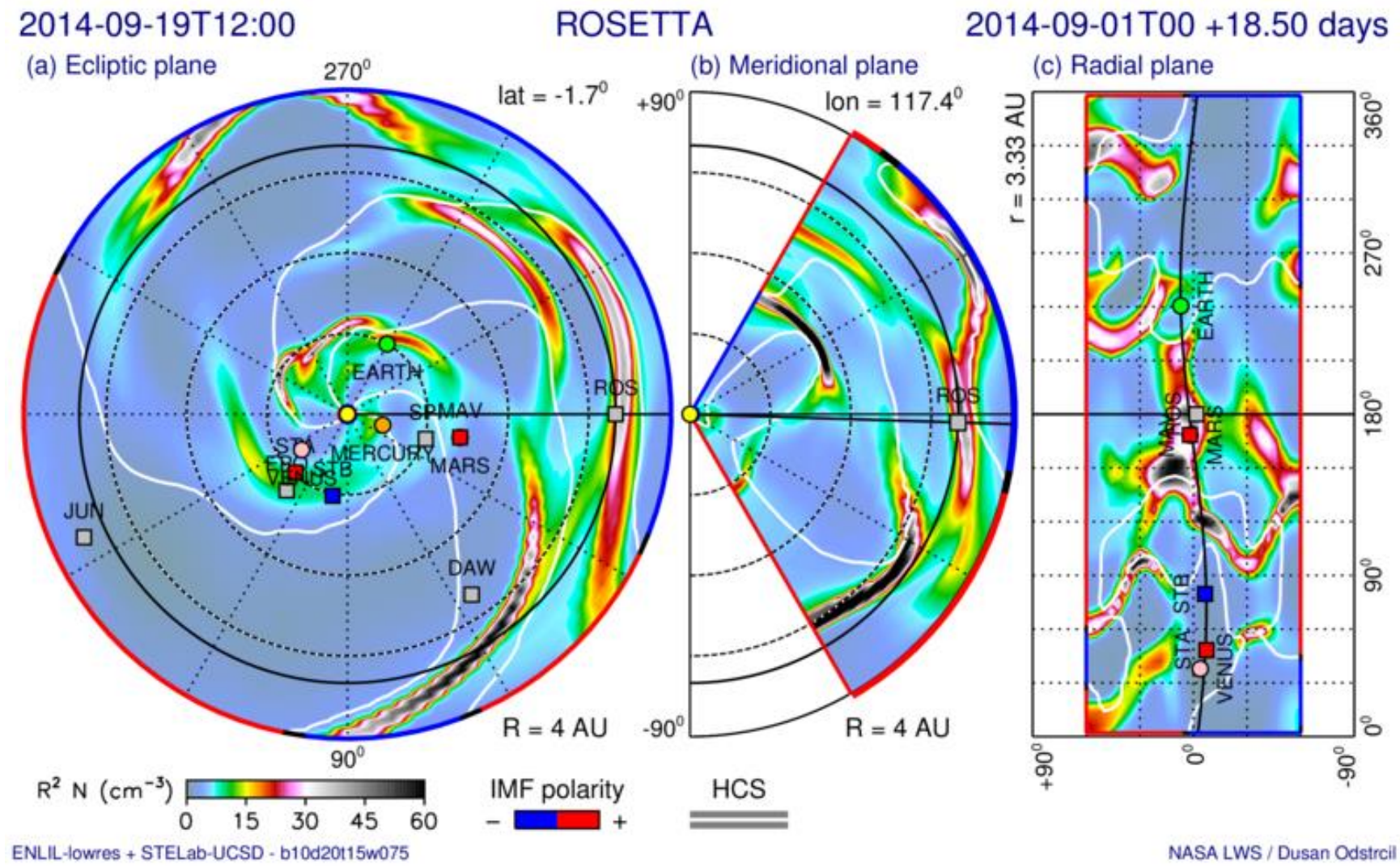


T = 3 MK



- A density structure on 9/26 is “sandwiched” between forward and reverse shocks
- Higher solar wind temperature cases broadening of the structure and smaller density peak

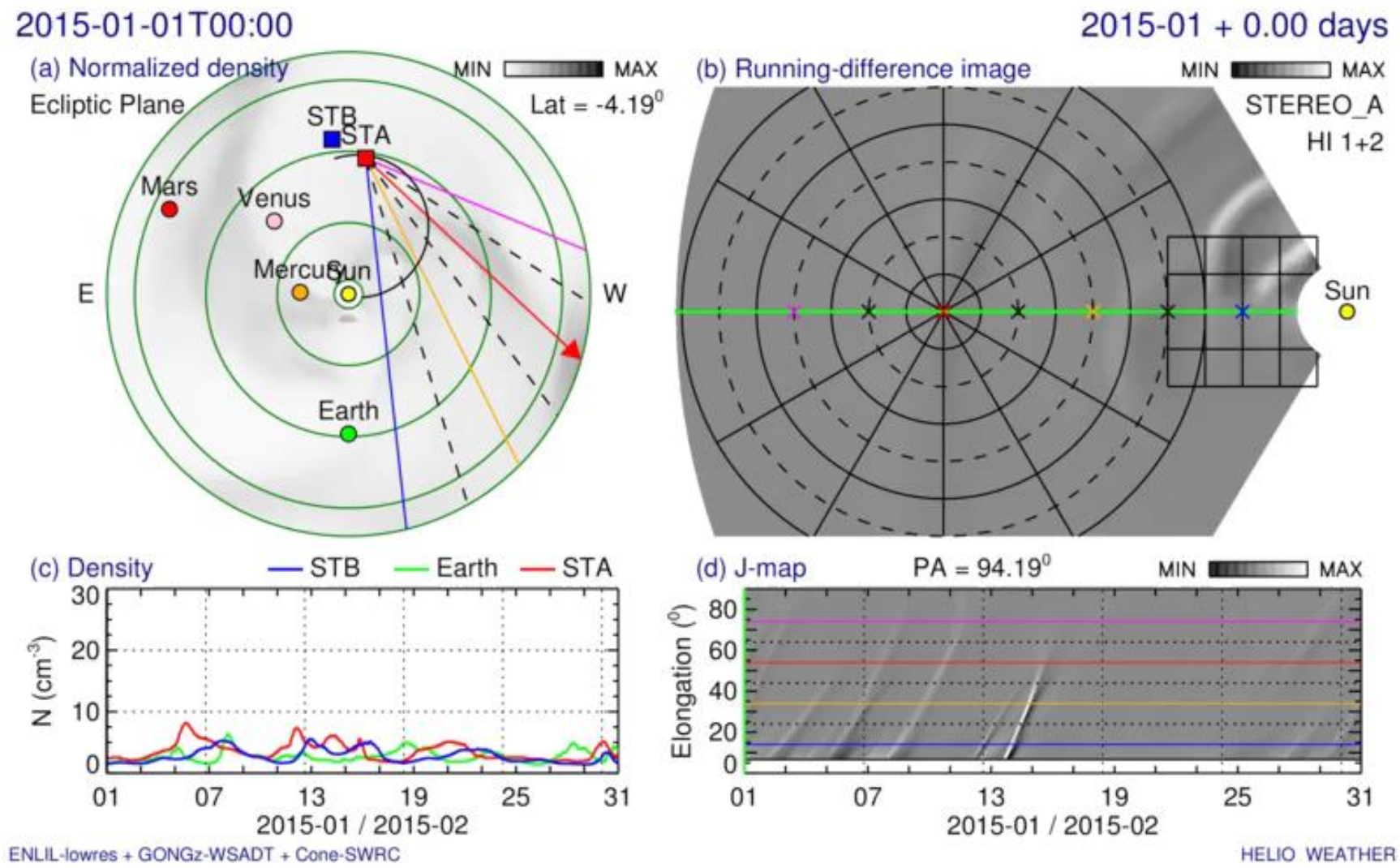
Using IPSBD – Away from the Sun-Earth Line



- ROSETTA 60^0 west from Sun-Earth line; IPS observed – predicts disturbance arrival
- Photospheric field not observed; 23.5-days old data used – WSA maps not accurate

Using Heliospheric Imaging – White-Light

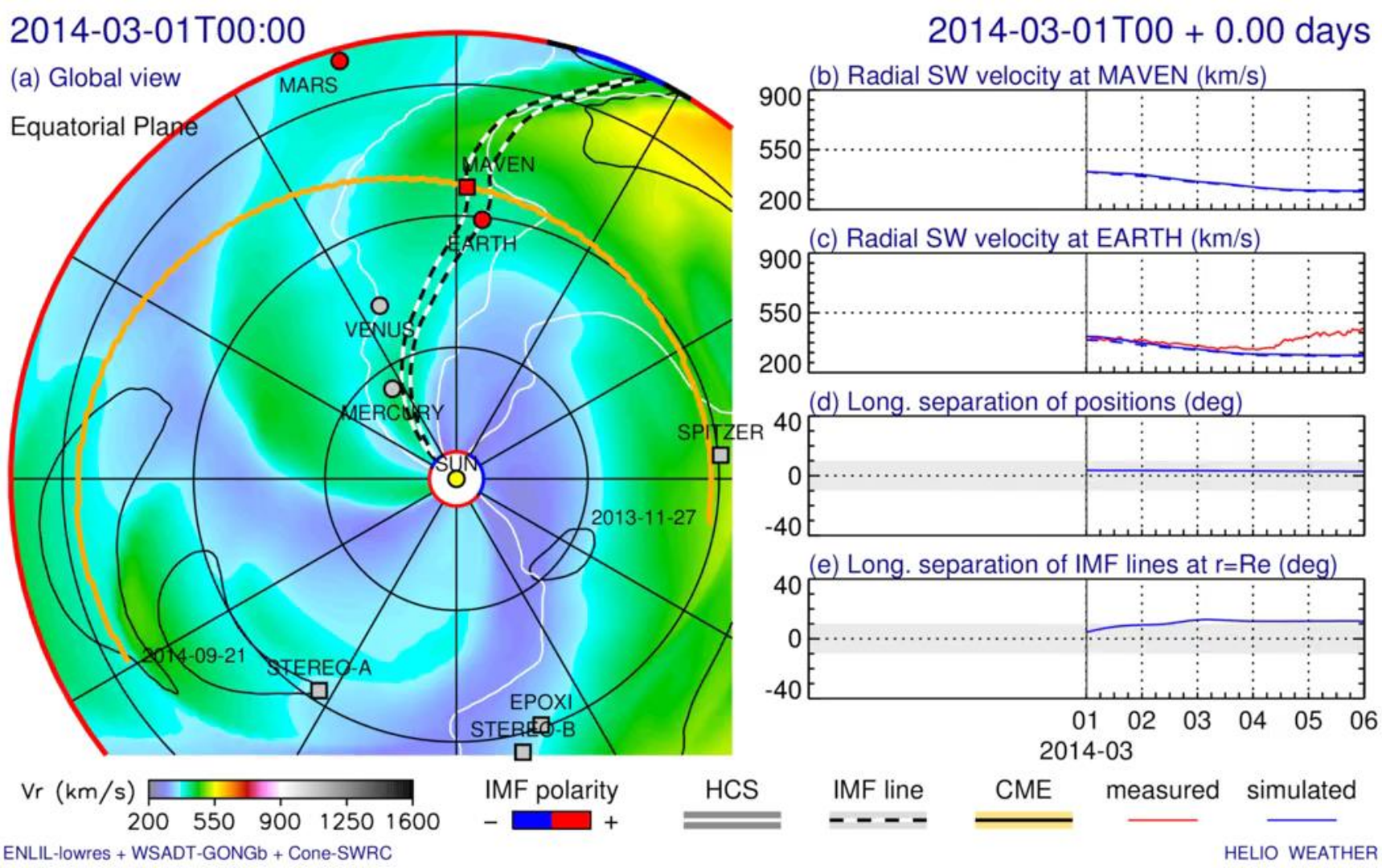
Synthetic White-Light Imaging: 2015 Jan-Apr



- Results for SIRs and CMEs in 2011-2015 are grouped by calendar months

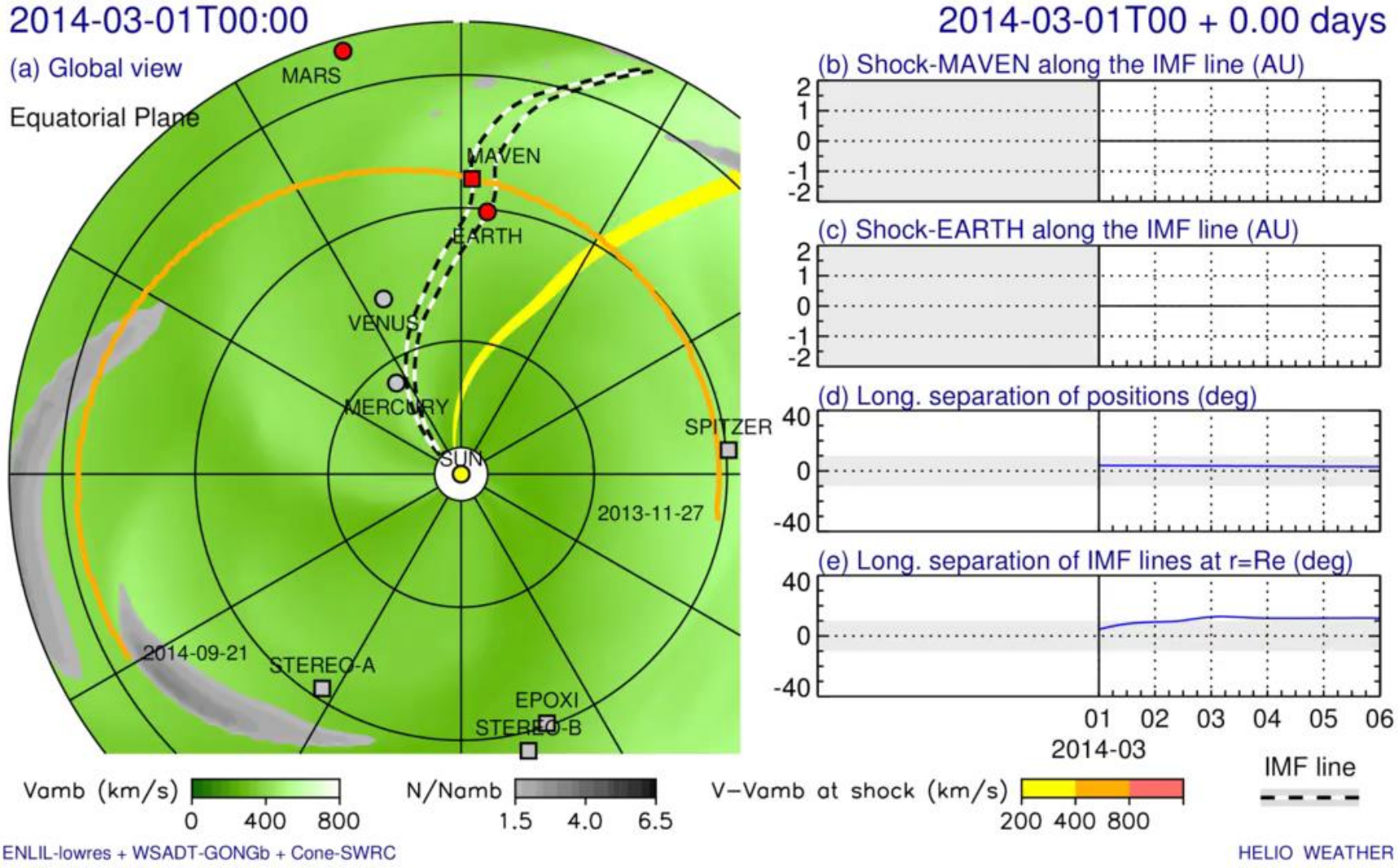
SEP Events – Shock Detection

MAVEN Cruise to Mars – Predicted CMEs



- Earth-MAVEN magnetic connectivity exists for months; but it can be broken by CMEs

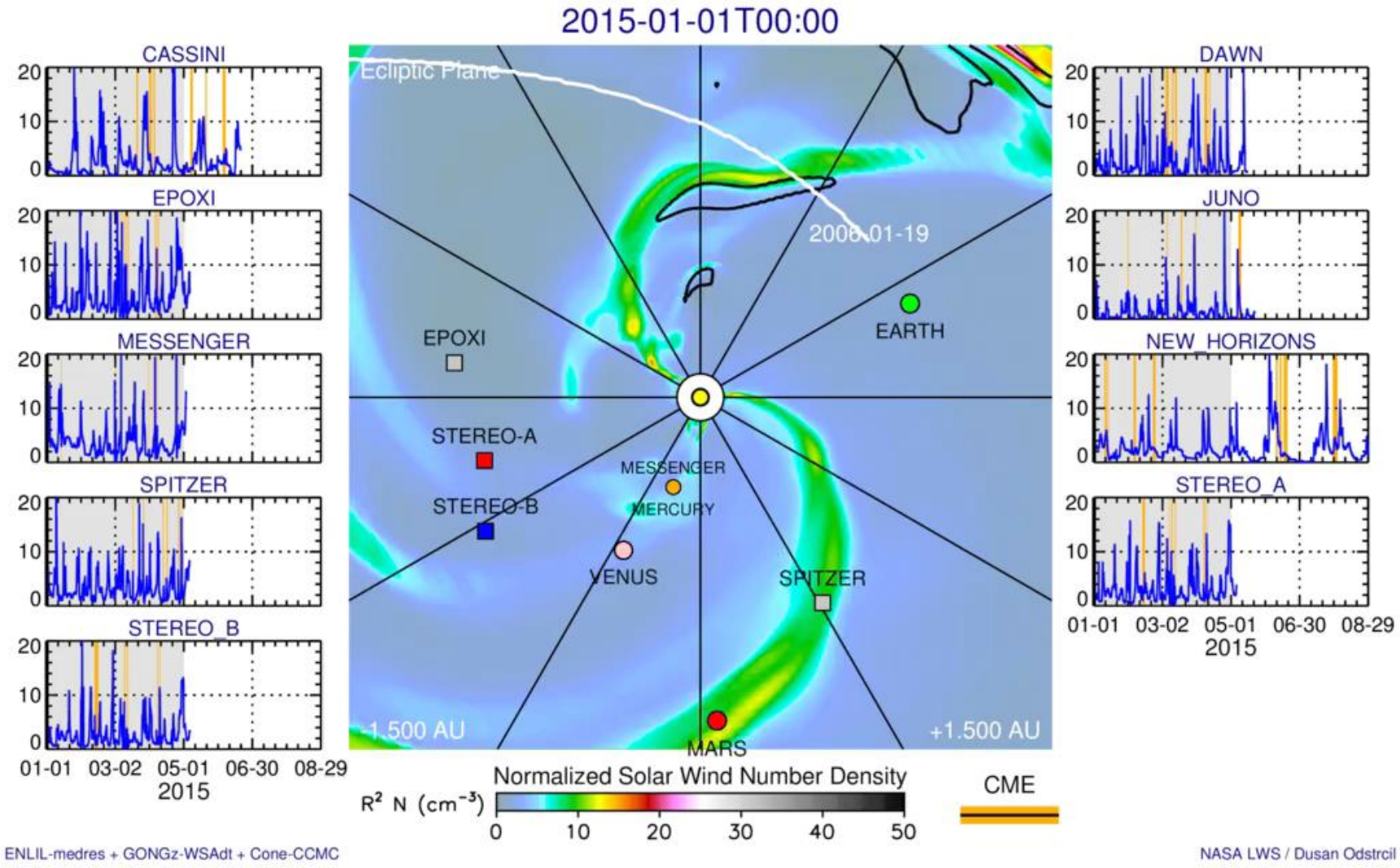
MAVEN Cruise to Mars – Predicted SEPs Alerts



- Visualization of “all-clear” and “alerts” for SEPs accelerated by heliospheric shocks

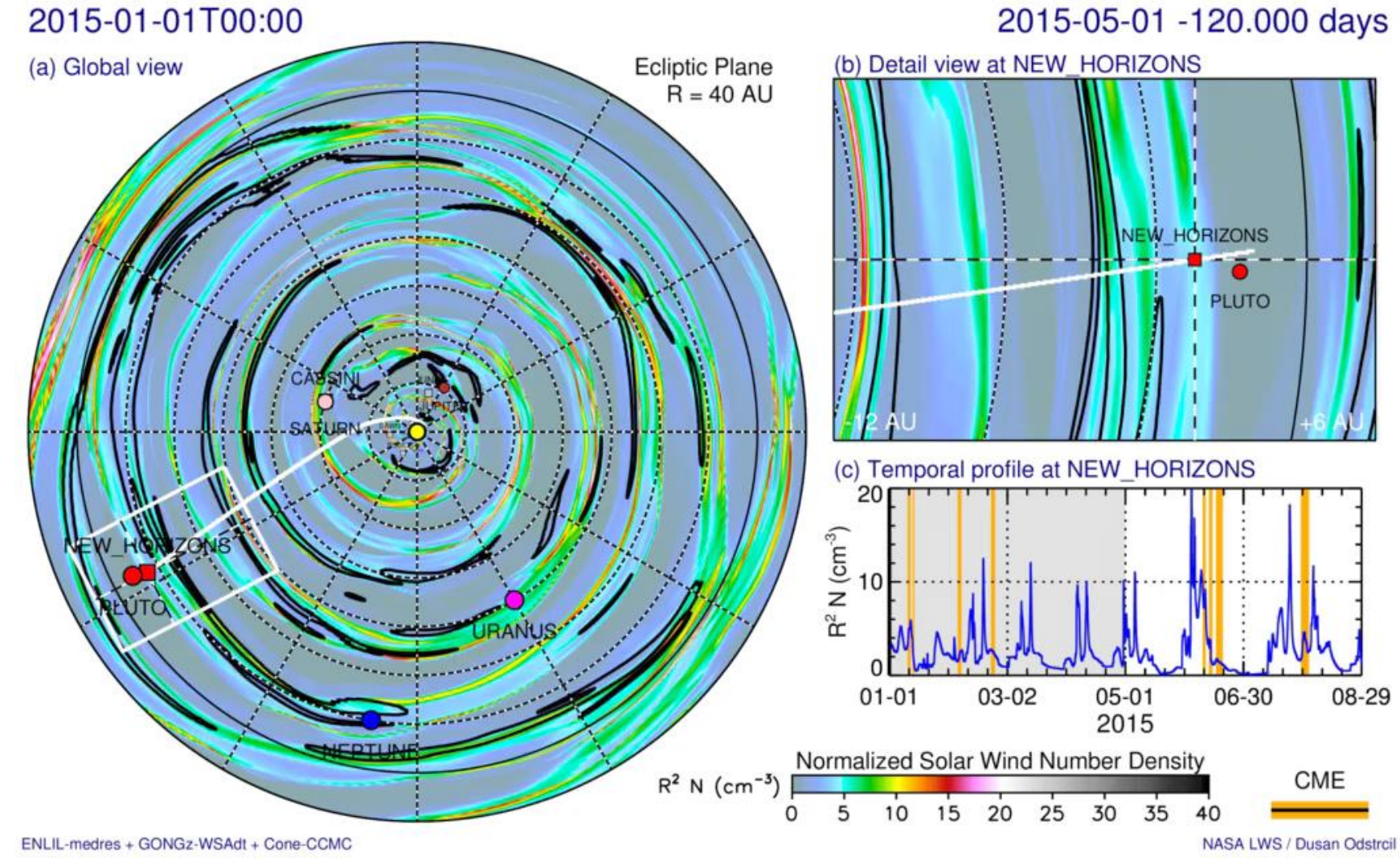
Heliospheric Missions Support

NEW HORIZONS – Concept for Space Weather Prediction



- All CMEs (>500 km/s) fitted by CCMC in past 8 months are used for 4-months fcst

NEW HORIZONS – Concept for Space Weather Prediction



- Pluto's atmosphere may be immersed in low-density rarefaction followed by GMIR

Conclusions

- Improvements of the heliospheric modeling system are under development
- Evolving solar wind:
  - more realistic background
  - extended runs
- Using IPSBD maps:
  - alternative to coronagraph observations
  - promising approach with upcoming more data
- Using heliospheric imaging – white-light
  - interpretation of 3D density structures
  - “mid-course” correction
- Predicting SEP events associated with IP shocks
  - IMF topology and shock parameters
  - “alert/all-clear” plots

THANK YOU

Questions, Comments, Suggestions