LWS/UCAR 2023 Heliophysics Summer School WSA Activities

This document contains the activities on the WSA model of the corona and solar wind to pose to students at the 2023 Heliophysics summer school, organized by NASA's LWS and UCAR's CPAESS programs. This cohort of 25 students will be a subgroup of that which participated in the

- NASA: National Aeronautics and Space Administration
    - LWS: Living With a Star
- UCAR: University Corporation for Atmospheric Research
    - CPAESS: Cooperative Programs for the Advancement of Earth System Science

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WSA Visualization Notebook

Distribution
- Notebook Steps
  - Access the Google Drive Link:
    https://drive.google.com/drive/folders/1dF7hgm6zFHQ_JsZLteV5SB-liWfXYATM?usp=sharing
  - Sign in to your personal/work google account
  - Right click shared Google Drive Folder > *Organize* > *Add shortcut* > *My Drive*
  - Open `WSA_3D_Interactive_Visualizer.ipynb`
    - If a screen saying "No Preview Available" in Google Drive appears, select the 3 dots in the upper right, select *Open in new window*
  - If the plot does not display, follow the HTML steps
- HTML/Movie Steps
  - Open the "output" folder, then "DefaultGroup"
  - Select the case folder you would like to investigate
  - Download the content you would like to investigate to your computer and open it from there
- Backups: Distribute notebook to students or HTML files and videos for many cases

Duration: 45 min

Rotation Movie Demonstration

Timing: Begin
- Instructor describes visualizations
  - Model input map on the solar surface
  - Colored field line footpoint markers
  - Field line colors
- Instructor
- Global Min R000
- Global Max R005

Instructor Description of Tool Usage

Timing: 5 min elapsed
- Model data and viewing angle configurations

Individual Case Interaction

Timing: 15 min elapsed
- Prompt: Explore the solar minimum and maximum cases in the global magnetic field line view first. Then the magnetic field line view of Earth subsatellite points (locations on the outer boundary incident with the ecliptic plane).

- What differences do you see in the global magnetic field structure during the 2 periods?
    - Open vs closed
    - Differences in activity
- Where is most of the solar wind coming from during solar min vs max?
    - Escaping to the heliosphere
    - Arriving at a spacecraft in the ecliptic plane
- Global Cases
    - Solar_Min_2020 R000
    - Solar_Max_2014
- Subsatellite Cases
    - Solar_Min_2020 R000 (-7 deg latitude)
    - Solar_Max_2014 Subsatellite R005 (35 deg latitude)

Solar Cycle Movie Analysis

Timing: 25 min elapsed
- Prompts
    - What happens to the polar fields over the solar cycle?
    - What happens to the polarity?
    - Is there a relationship between activity and sources of the solar wind?
- Solar_Cycle_24 Movie
    - Global R000

ADAPT Realization Movie Analysis

Timing: 35 min elapsed

- Prompt: Explore the solar minimum and maximum movies where different photospheric magnetic field maps (i.e., realizations) are used in the model.
    - How sensitive are the coronal magnetic field solutions to the different input maps?
    - How do you think this will impact the solar wind solutions?
    - What do you think is needed to reduce the uncertainty?
- Solar_Min_2020 Movies
    - Global R000
    - Subsatellite R000 (-7 deg latitude)
- Solar_Max_2014 Movies
    - Global R005
    - Subsatellite R005 (35 deg latitude)

WSA Dashboard

Link
- https://wsa-dashboard.helioanalytics.io/

Distribution
- Share Dashboard with students

Duration: 45 min

Instructor Description of Visualizations

Timing: Begin
- Plots: Coronal holes, ephemeris, current sheet, wind speed, IMF polarity
- Settings: Fade slider, Realization slider and composite checkbox, date animation button and slider, input map, satellite, date range

Open Exploration

Timing: 10 min elapsed

ADAPT Realization Interaction

Timing: 20 min elapsed
- Prompt: Why do you think the different ADAPT realizations produce different solutions?
  - How well do the model coronal holes agree with observations?
- Settings
  - Date Range Setting: 05/10/2023 - 06/10/2023
    - Date to Select: 06/01 16:00
    - Observe overprediction on 06/04
  - Input Map: AGONG
  - Realization: Vary selection
 - Satellite: ACE
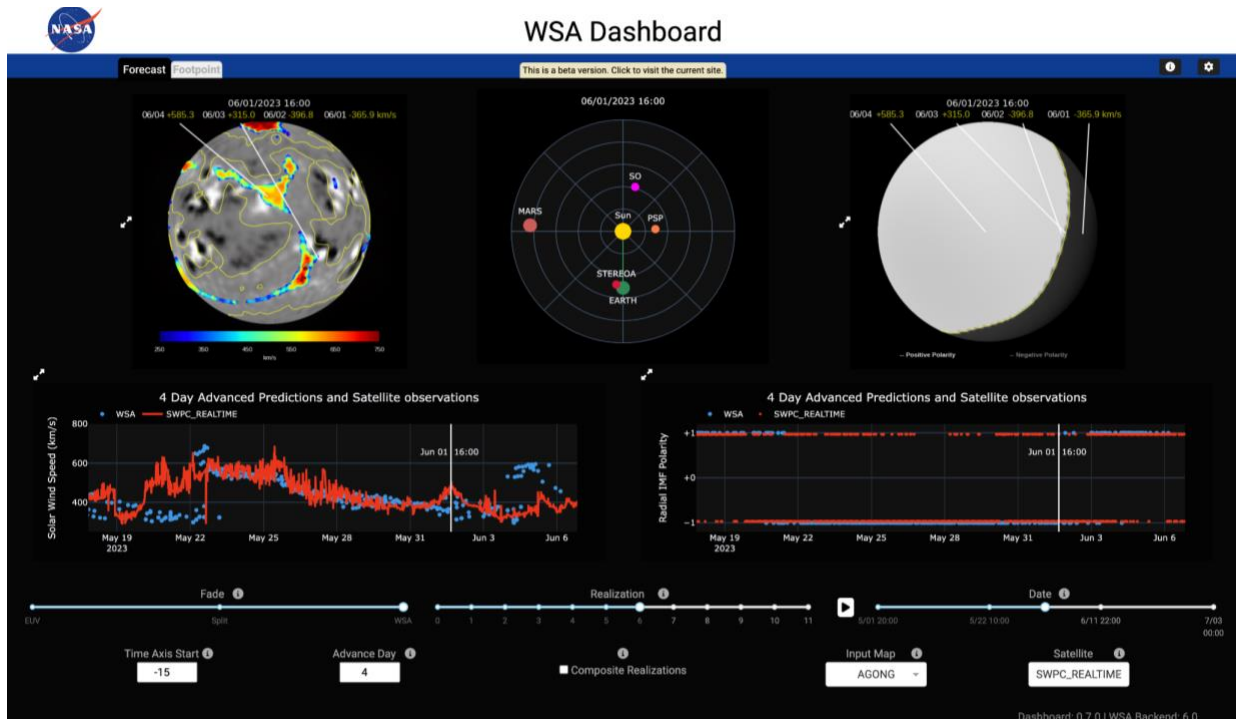
AGONG Realization 6

Ensemble vs Single Input Map Comparison

Timing: 25 min elapsed
- Prompt: Discuss possible reasons as to why GONG_Z provides a better solution for this period.
    - Compare modeled coronal holes with observations
    - Identify where in the coronal hole the solar wind emerges from
- Settings
    - Date Range: 05/10/2023 - Real Time
        - Date to Select: 06/01 15:04
        - Observe lack of over prediction on 06/04
   - Input Map: AGONG vs GONG_Z
    - Realization: 0
    - Satellite: ACE
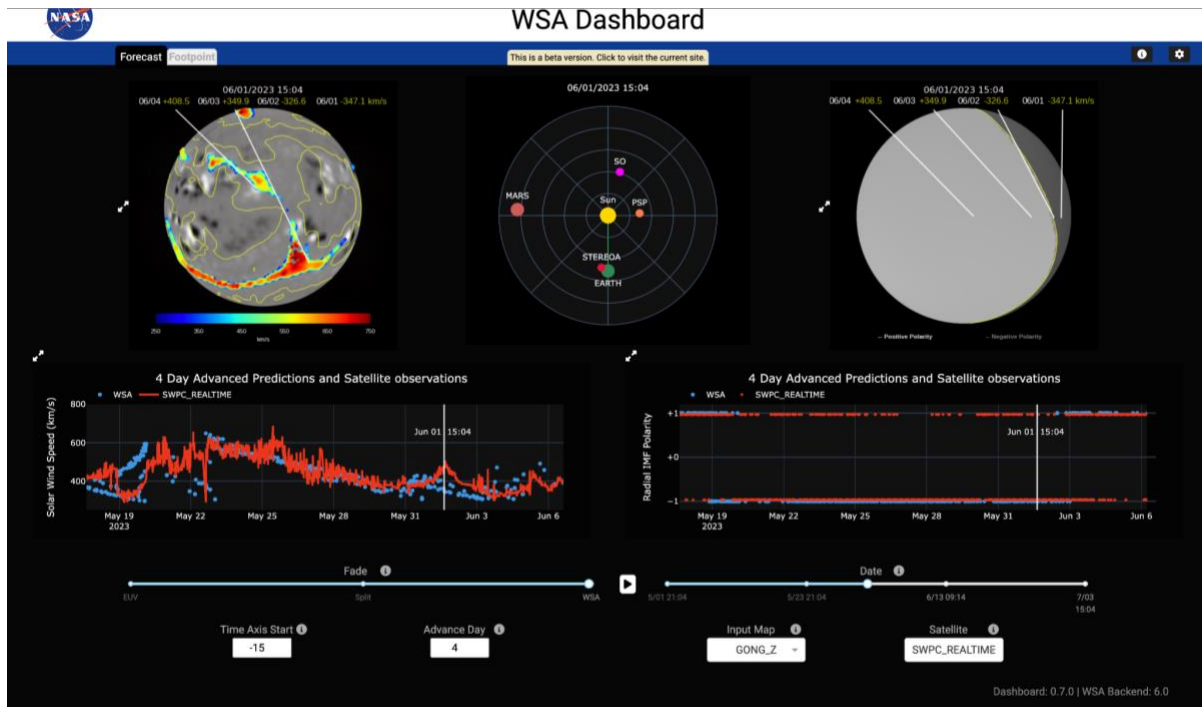
GONG_Z

Composite Ensemble Interaction

Timing: 35 min elapsed
- Prompt: Observe the photospheric field as viewed from Earth and from Solar Orbiter.
  - Does it look different? Why?
- Settings
  - Date Range: 05/10/2023 - Real Time
    - Dates to Investigate: 5/28 - 6/5
  - Input Map: AGONG
  - Realization: Select composite realizations checkbox
  - Satellite: SO (May click on pink marker in center ephemeris plot)
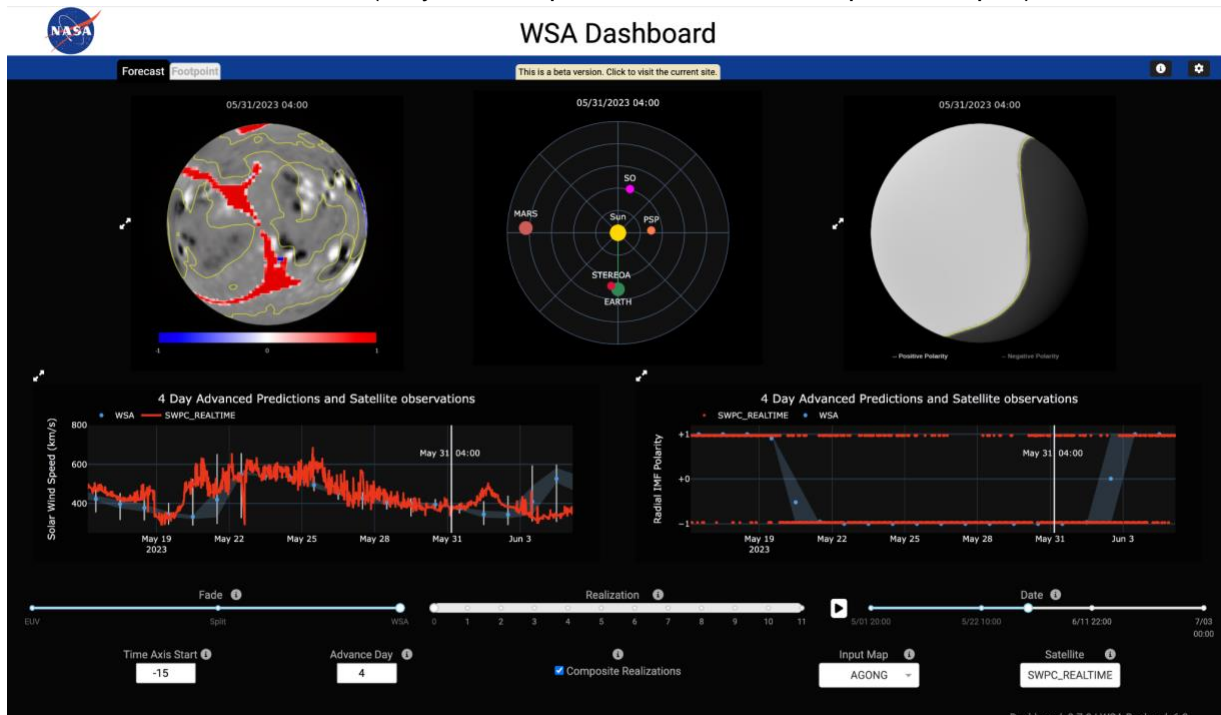
AGONG composite realizations as seen from Earth

Open Exploration

Timing: 40 min elapsed
- Prompts
  - Now explore the Dashboard on your own for whichever periods you like.
  - Come up with a question that you would like answered (you can think of answers too!).
  - Think of one or two ways that the tool could be improved.
- Class discussion on the questions and possible explanations.