Heliophysics models beyond Earth and the Solar System - CCMC’s role   
*LIVE PUBLIC NOTES*

[[discussion folder](https://drive.google.com/drive/folders/1RyQOienp3T6ZkQmXEupvIef7HHaUa3rL)]

**Instructions for note takers:** Please record the main points of the discussion under the relevant question. We especially request the action items suggested in the discussion to be recorded here and highlighted in some manner (bold, yellow, etc). Finally, keep all contributions to this document to a professional standard. Thank you!

Theme: Heliophysics models applied to planets beyond earth and systems beyond the solar system. How can CCMC support these applications?

**Question 1:** What are the highest-priority planetary/exoplanetary-related needs for modeling services?

* Requires collaborations
* How applicable are solar system models to other exoplanetary systems?
* Are the current Earth models correct sufficient to other regimes?
  + Easy: change input parameters that are already coded in - orbital distance, gravity, stellar driving, etc.
  + Hard: modeling processes that are not relevant to Earth, e.g. CO2 cooling on Mars, infrared heating in Venus with observations
* Anything missing?
  + **We learn something new with each new planetary example in the solar system alone - exoplanets may have different physical processes than Earth**
* Is it better to run with what we have or should bring new ones?
  + Code up different physics, for example, CO2 cooling on Mars, infrared heating in Venus with observations, take longer
  + Adapting models e.g. building Venus GITM is time-intensive
* **Action item:** (sample action item…)

Targeted questions?

Identify questions

Heliophysics vs. Astronomy

Validation is difficult/impossible in astro

**Use CCMC as a search tool for parameter space rather than for specific star-planet systems with little observational info**

**Use competing models to test robustness**

Choose a target that astro community can benefit

Pick a baseline with data and highly validated

Treat exoplanetary as extreme space weather conditions

Expand CCMC to planetary magnetosphere-atmosphere is a natural next step

Are there enough resources at CCMC to host exoplanet modeling tools?

No scientist in exoplanetary sciences at the CCMC

Computing resources needed may expand dramatically.

Partner with other divisions and teams, e.g. SEEC/EMAC

Work with existing capabilities

**What phenomena and/or systems are should be the highest priorities for inclusion?**

Early Earth

Early Sun

Atmospheric escape

Stellar corona

Stellar winds

Mars (CO2 atmosphere)

Titan (Nitrogen atmosphere)

Jupiter

Saturn

Exo-magnetospheres

Exo-atmosphere/ionospheres

**Question 2:** How does modeling beyond Earth and the solar system compare to “core” heliophysics modeling?

* (type live notes here…)
* MACH center: atmosphere escape from any planets
* CCMC hosts results
* Validation effort, use multiple models to test
* Identification of model parameters
* Understanding Long term consequences of star-planet interactions instead of short term for solar system
* Require different approaches
* Vary applications between different planets
* Data format same or different?
* Different space and time scales
* Different parameters
* Evolution of both Mars and Sun
* Exoplanet very large time scale
* Exoplanet conditions outside of established model input parameter range for Earth or solar system planets.
  + Run ‘competing’ models for input parameters outside of range and compare / establish/show stability as a validation step.
* Young Earth and earlier Sun, many details to pull, big effort
  + Young Earth and Sun were different than present Earth/Sun - “you may as well be talking about an exoplanet”
* **Action item:** (sample action item…)
* It is not possible for the CCMC to cover all the bases
* How can CCMC enable model development and validation at Mars?
* Perform parameter coverage with simple simulations using constant stellar wind and planetary conditions (magnetic moment, mass, orbit parameters) and provide interpolation for any combination in multi-dimensional parameter space.
* If planetary model has the same data format, then can plug into CCMC tools
  + Challenges in formatting planetary mission data (e.g., MAVEN) into usable format for CCMC

**Several of the models at CCMC have been run for other planets/stars than the Earth/Sun. Should CCMC be open to hosting model results run outside of CCMC for these systems for analysis and visualization? Should CCMC be open to hosting the models for run requests?**

**Question 3:** What links can be built to show the value of heliophysics to other science communities?

* (type live notes here…)
* To study the sun’s interaction with planets in the solar system, including space weather
* To understand starts and interactions with exoplanets, including space weather
* Value to other
* Take advantage of magnetosphere ionosphere thermosphere models
* **Action item:** (sample action item…)

Chuanfei: Include exoplanetary models to CCMC and collaborate with exoplanetary modeling and analytic center (EMAC), Mars Climate Modeling Center

Organize Interdisciplinary workshops

Carrie: NSF astronomy covers three NASA divisions

HQ presentation: Exo proposals/programs awarded in Helio

Utilize CCMC resources for exoplanetary research

PI self identified cross-interdisciplinary

**These model results are of interest across multiple communities. Should there be links to EMAC, Mars Climate Modeling Center?**