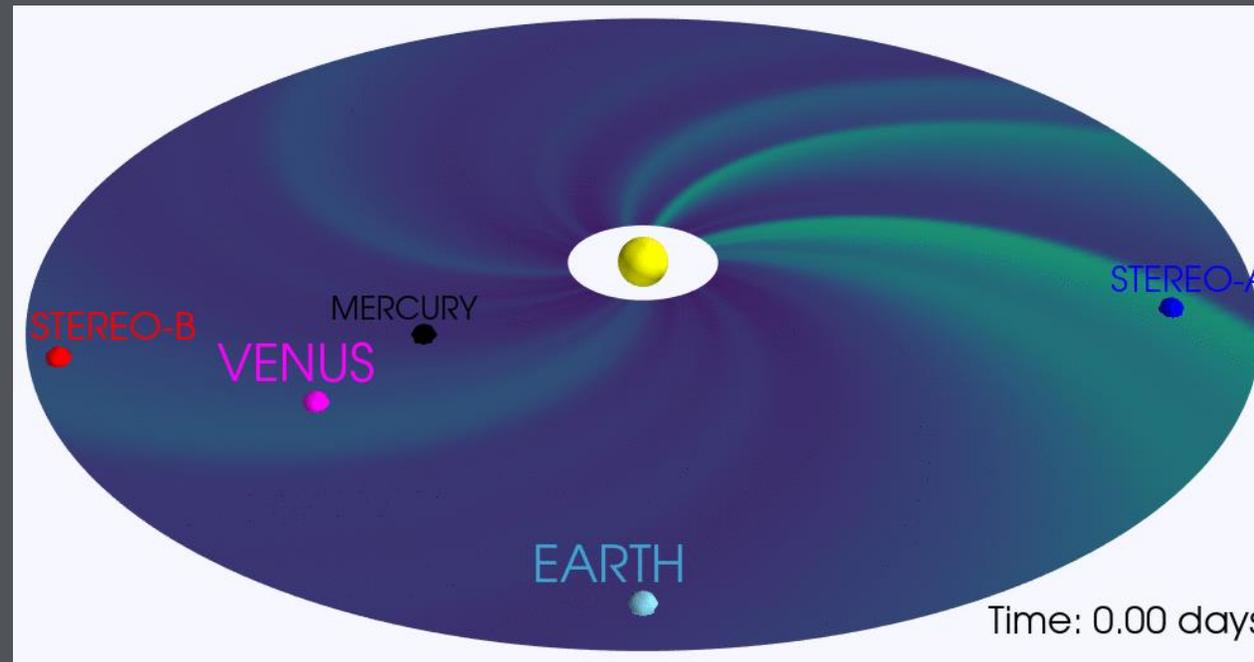
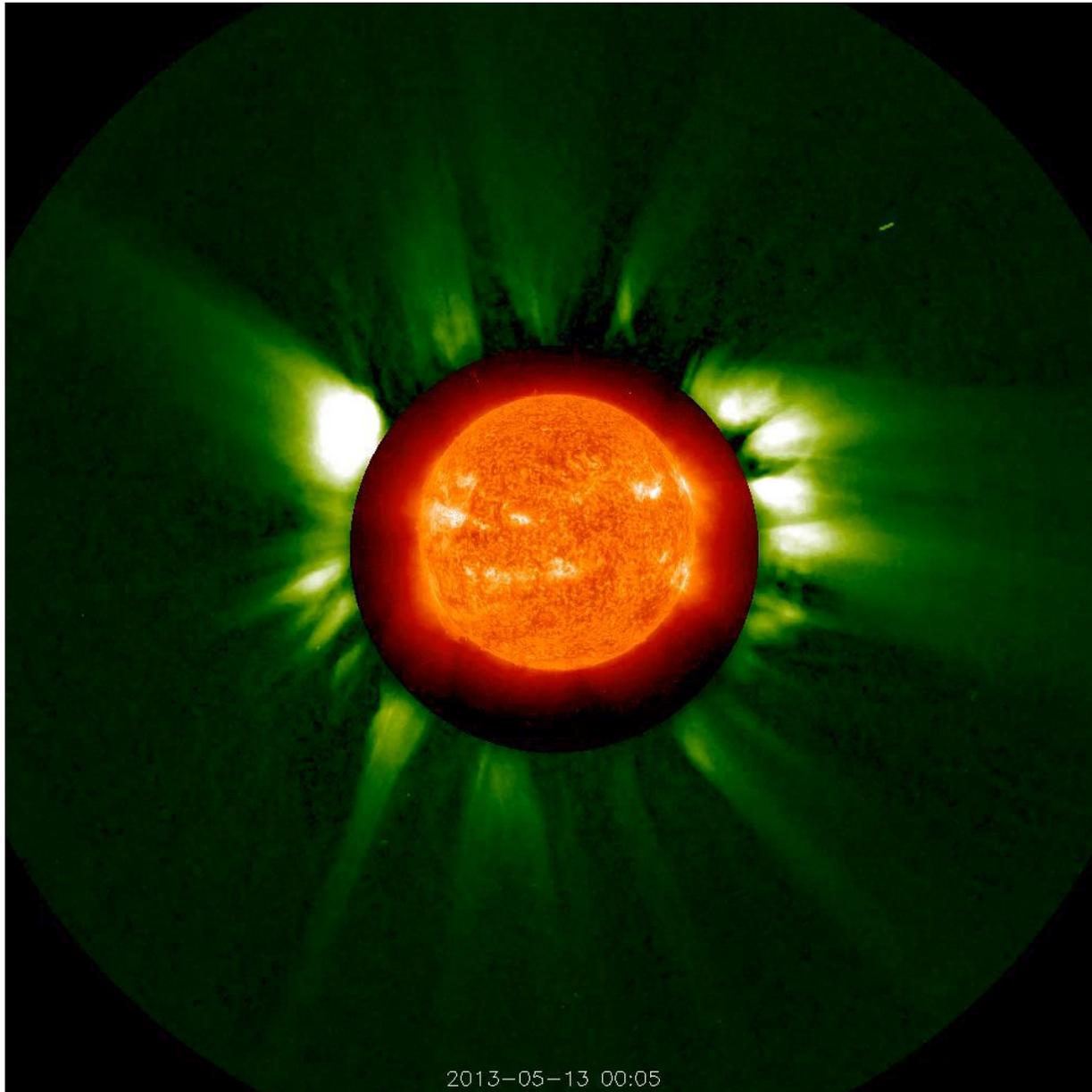


Open source modelling of space weather



Dr Luke Barnard and Professor Mathew Owens

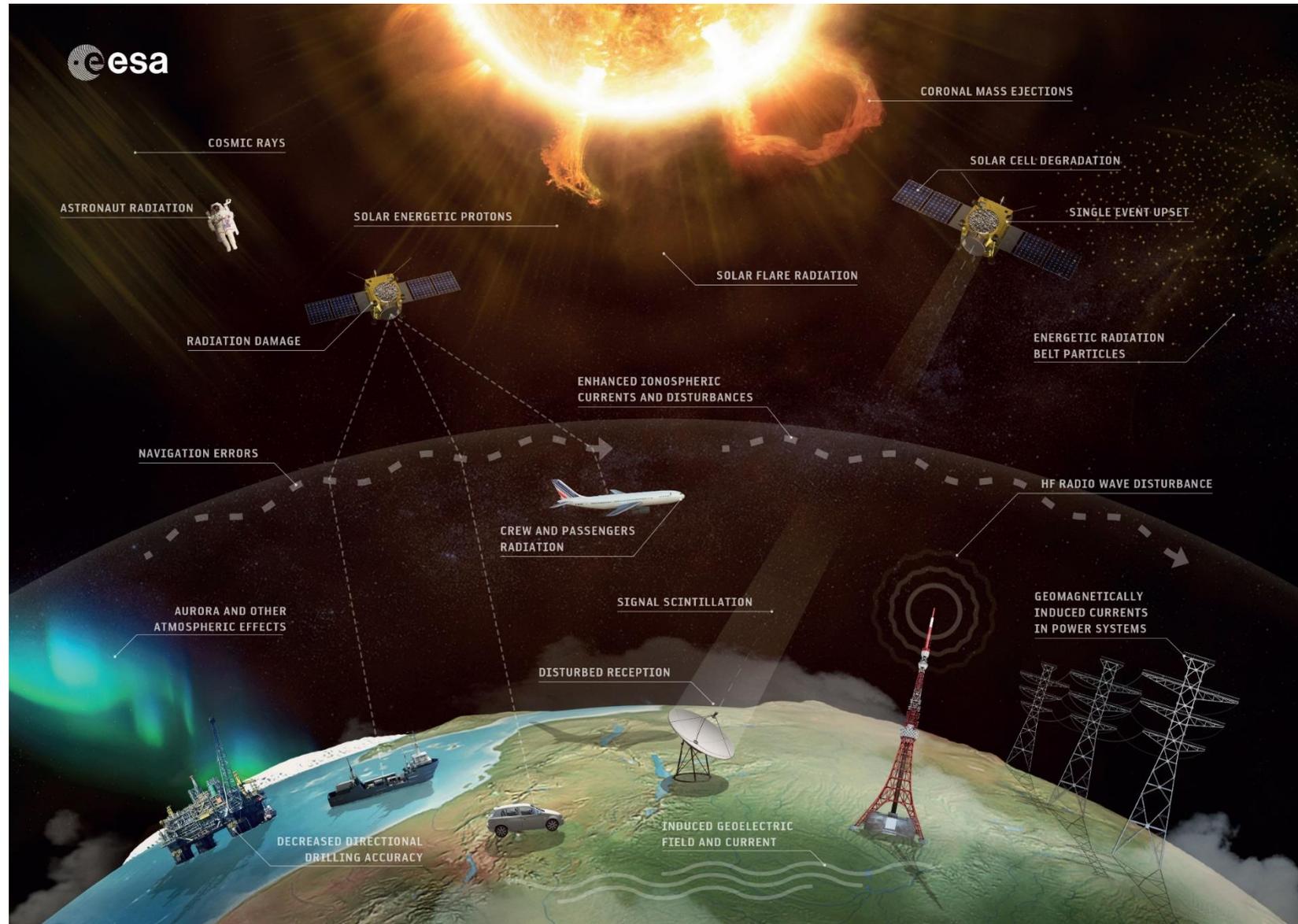
Coronal Mass Ejections



A movie of the Sun in extreme ultra-violet (inner, orange) and visible light (outer, green)

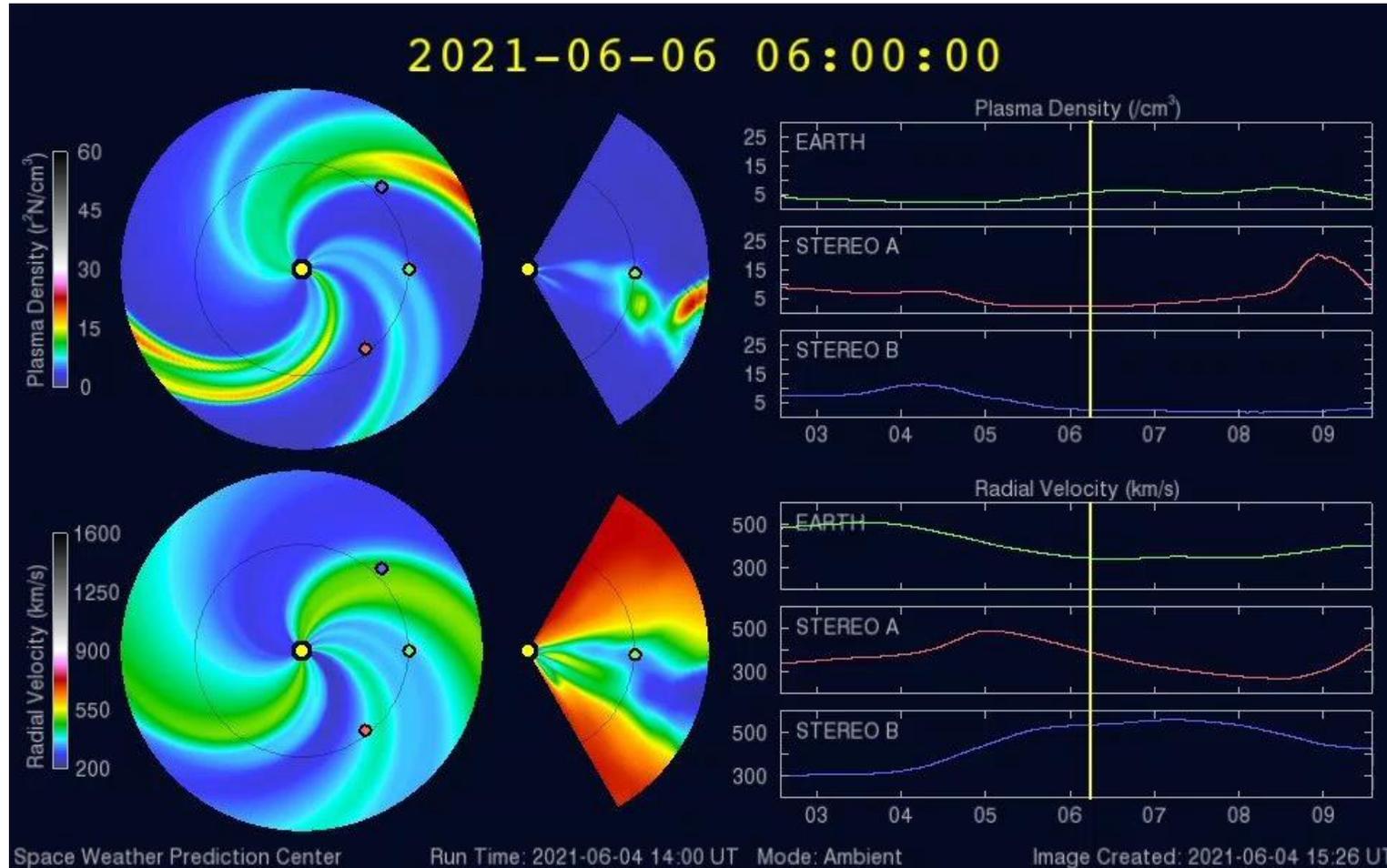
This shows the eruption of CMEs low in the Sun's atmosphere.

Space Weather at Earth



Credit: ESA, [CC BY-SA 3.0 IGO](https://creativecommons.org/licenses/by-sa/3.0/)

Space Weather Forecasting

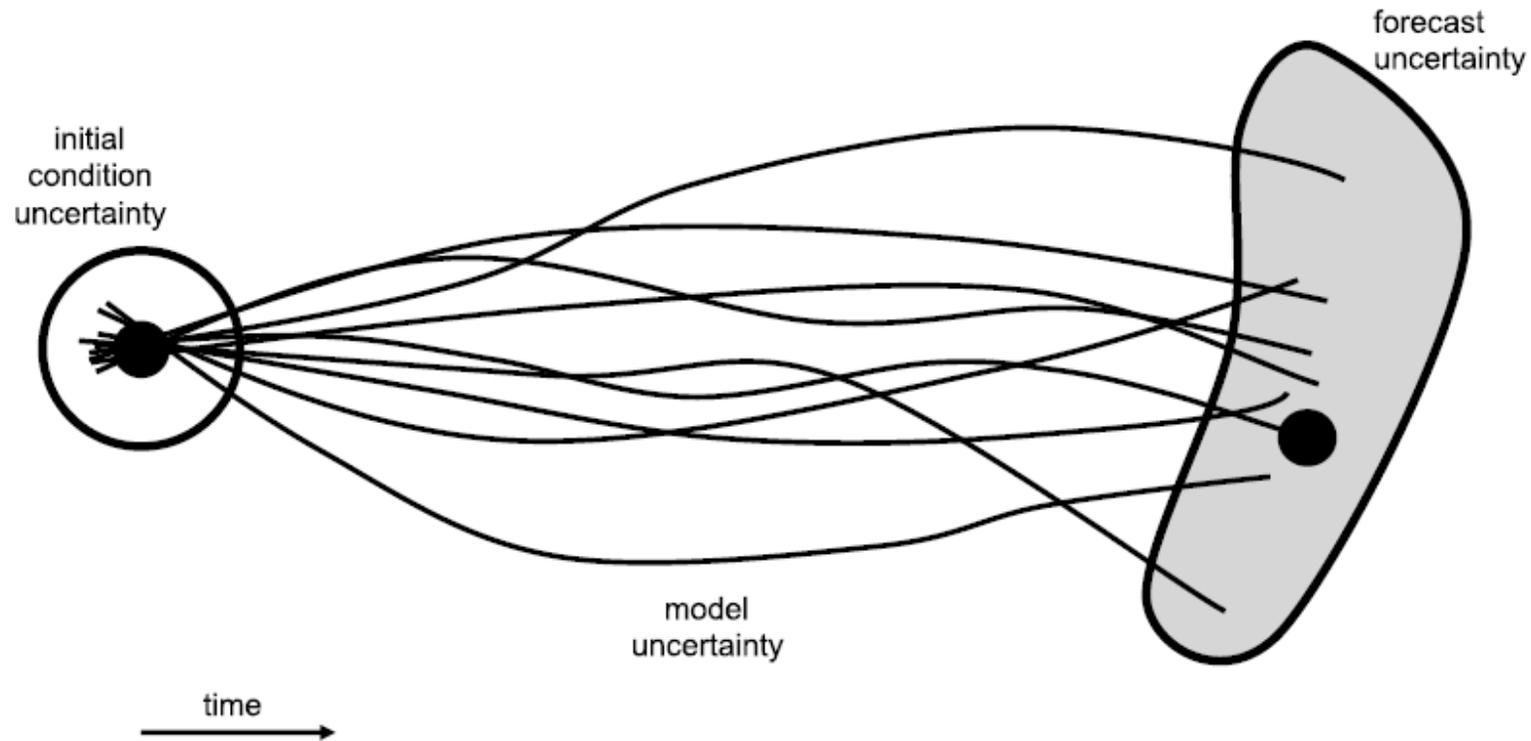


A recent forecast from the Space Weather Prediction Center in the US

Uses an numerical model with many physical processes and parameters.

Ensemble modelling

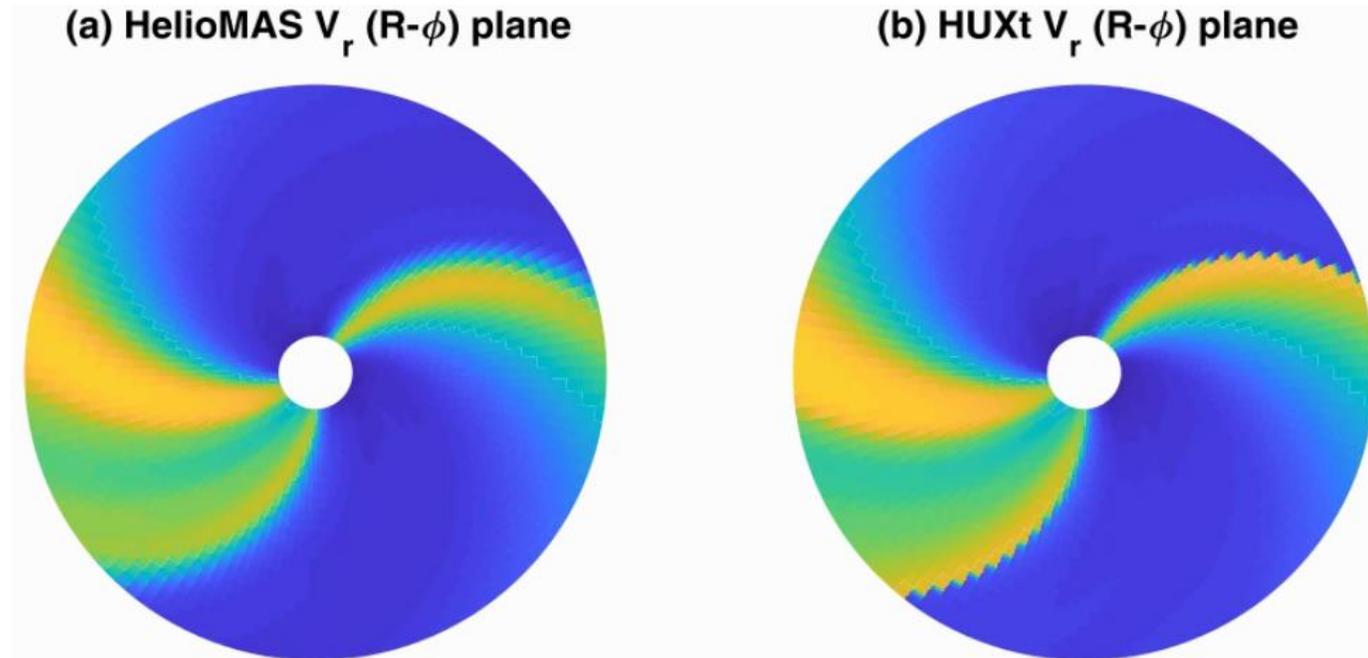
- Ensemble modelling helps us understand and quantify the uncertainty in a space weather forecast due to our limited knowledge of the conditions near the Sun.
- This requires running the model many times.



Credit: Murray, 2018, doi:10.1029/2018SW001861

HUXt

- An open source model of the solar wind.
- Written in Python.
- Uses some approximations to reduce the model complexity.
- This makes the model much faster to run, with only a small reduction in accuracy.
- This also makes the model accessible to anyone with modest computing resources



Owens et al., 2020, <https://doi.org/10.1007/s11207-020-01605-3>

Open Source in Space Weather

- There is growing environment of open source software in Space Weather research.
- This is mostly based in the Python language.
- These provide tools that we increasingly depend upon to analyse observations and develop space weather models.



Making HUXt Open Source



- HUXt is hosted on both GitHub and zenodo under the MIT license.
- Working this way made it simple for researchers outside our group to review the code and suggest improvements.

zenodo Search Upload Communities

June 1, 2021 Software Open Access

University-of-Reading-Space-Science/HUXt: HUXt

Luke Barnard; Mathew Owens

Release of HUXt version used to generate figures for "Improving Solar Wind Forecasts Using Data Assimilation". Minting DOI from Zenodo for publication.

Preview

HUXt-v3.0-zenodo.zip

- University-of-Reading-Space-Science-HUXt-Of5ad68
 - .gitignore 385 Bytes
 - ipynb_checkpoints
 - README-checkpoint.md 2.3 kB
 - environment-checkpoint.yml 338 Bytes
 - requirements-checkpoint.txt 200 Bytes

University of Reading Space Science Research Group

Research outputs from the University of Reading Space Science Group

Reading, UK

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HIEnsembleHindcast

Constraining HUXt ensembles with heliospheric imager data.

Python MIT 1 star 0 forks 2 issues Updated 5 days ago

HUXt

HUXt - a lightweight solar wind model.

Jupyter Notebook MIT 7 stars 9 forks 0 issues Updated 6 days ago

HUXt - a lightweight solar wind model

Introduction

This repository provides an implementation of the HUXt model (Heliospheric Upwind Extrapolation with time dependence) in Python, as described by Owens et al. (2020). This is a simple 1D incompressible hydrodynamic model, which essentially solves Burgers equation using the upwind numerical scheme. For more details on the models background, refer to Owens et al. (2020).

Installation

HUXt is written in Python 3.7.3 and has a range of dependencies, which are listed in the requirements.txt and environment.yml files. Because of these dependencies, the simplest way to work with HUXt in conda is to create its own environment. With the anaconda prompt, in the root directory of HUXt, this can be done as:

HUXt impacts - Research

- Since HUXt was published in February 2020:
 - Was central to three of our groups recent research papers.
 - Is being used and developed by 3 PhD students in our group for their research
 - Has led to new international collaborations with teams in the US, Austria, and China. This has produced 1 new submitted publication, with 2 more being written.

HUXt impacts - Research

- We used HUXt to demonstrate a proof-of-concept method for using ensemble modelling with spacecraft observations to improve CME arrival times by up to 20%.
- Published in AGU Advances which had an open peer review process.

Ensemble CME Modeling Constrained by Heliospheric Imager Observations

Overview of attention for article published in AGU Advances, September 2020



About this Attention Score

In the top 5% of all research outputs scored by Altmetric

Mentioned by

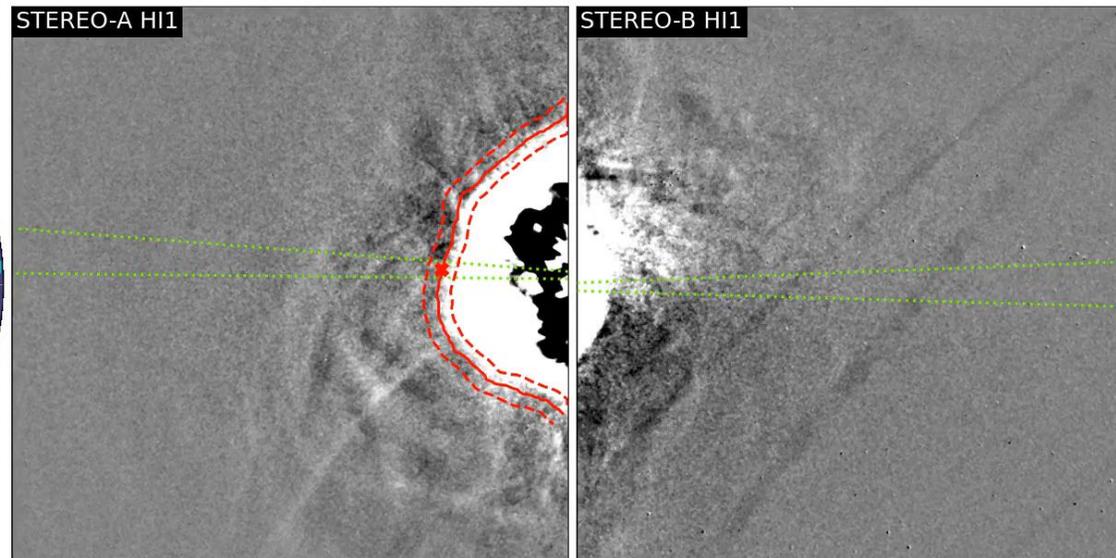
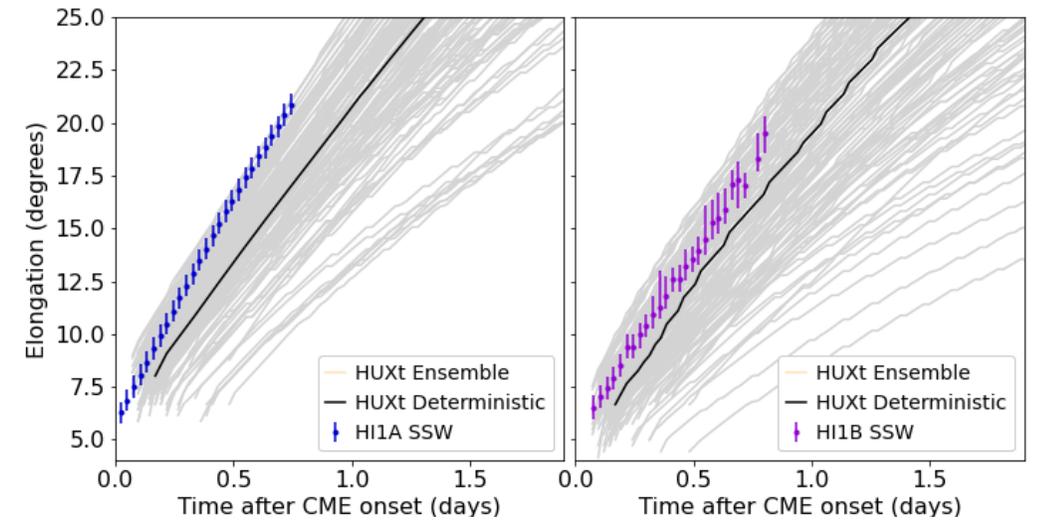
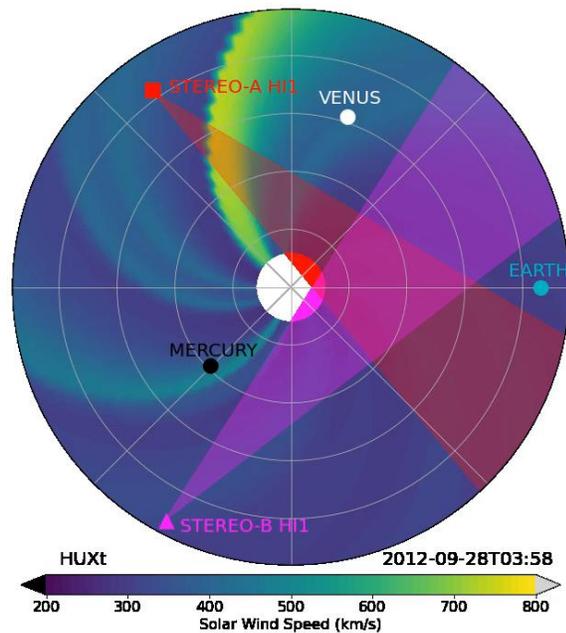
- 108 news outlets
- 2 blogs
- 20 tweeters

Citations

- 1 Dimensions

Readers on

- 6 Mendeley



HUXt impacts - Teaching

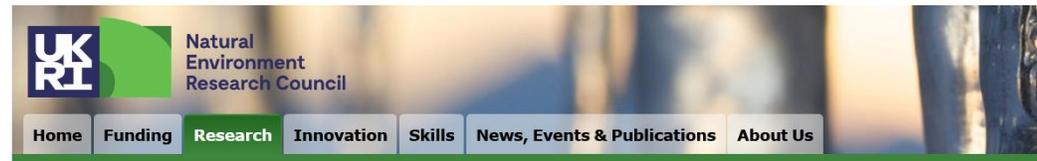
- HUXt is being used by Peking University in the Masters course on Heliophysics.
- We received feedback that the accessibility of the model makes it a good tool for teaching about both the dynamics of the solar wind, and how to model it.

HUXt impacts - Future

- Through the £20M UKRI-STFC SWIMMR Programme, we are now funded to develop HUXt to be an operational model for the UK Met Office.
- The Met Office Space Weather Operations Center are enthusiastic about the benefits that large ensembles from HUXt could offer their forecasters.



SWIMMR (Space Weather Instrumentation, Measurement, Modelling and Risk)



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Space Weather Instrumentation, Measurement, Modelling and Risk (SWIMMR)

- Programme overview

SWIMMR (Space Weather Instrumentation, Measurement, Modelling and Risk) is a £20 million, four-year programme that will improve the UK's capabilities for space weather monitoring and prediction. There will be an emphasis on

