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# Pushing the Boundary: Solar Energetic Particle Science with an Operational Mission

Mike Marsh

Science from an Operational Mission: An L5 Consortium meeting  
13<sup>th</sup> May 2015



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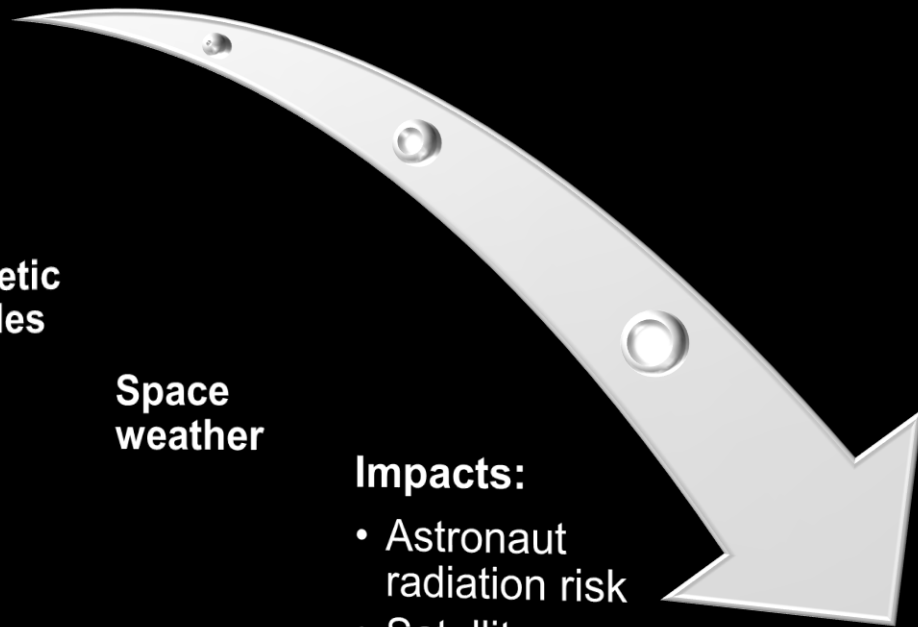


**Solar  
Energetic  
Particles**

**Space  
weather**

**Impacts:**

- Astronaut radiation risk
- Satellite anomalies
- Ground Level Enhancements



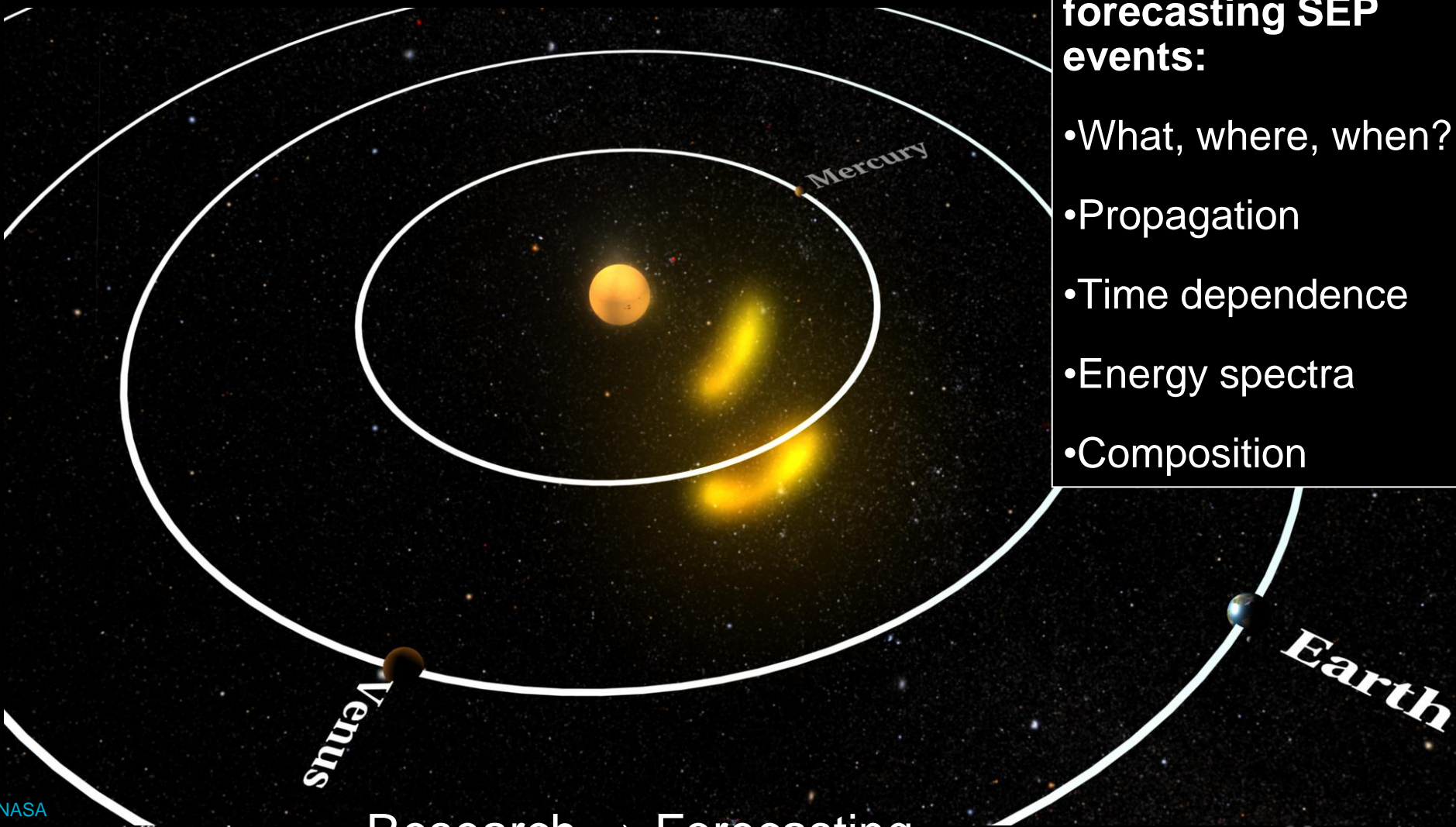
# Challenges



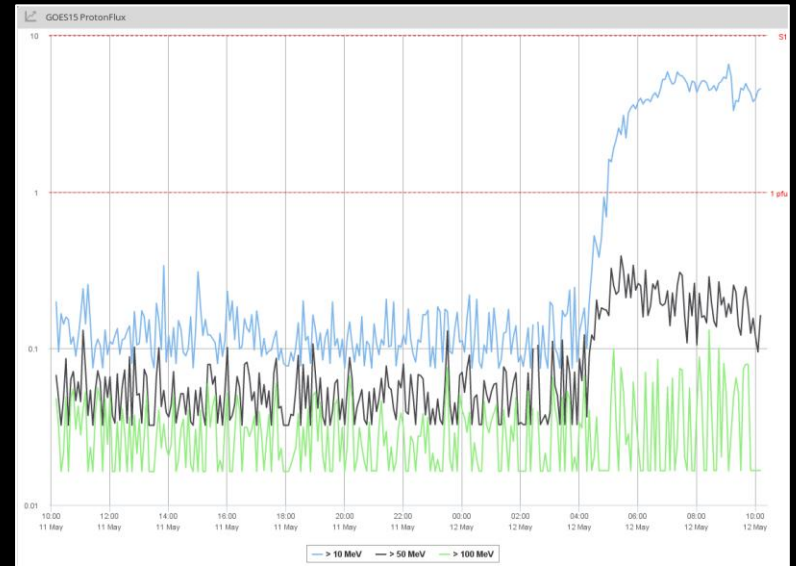
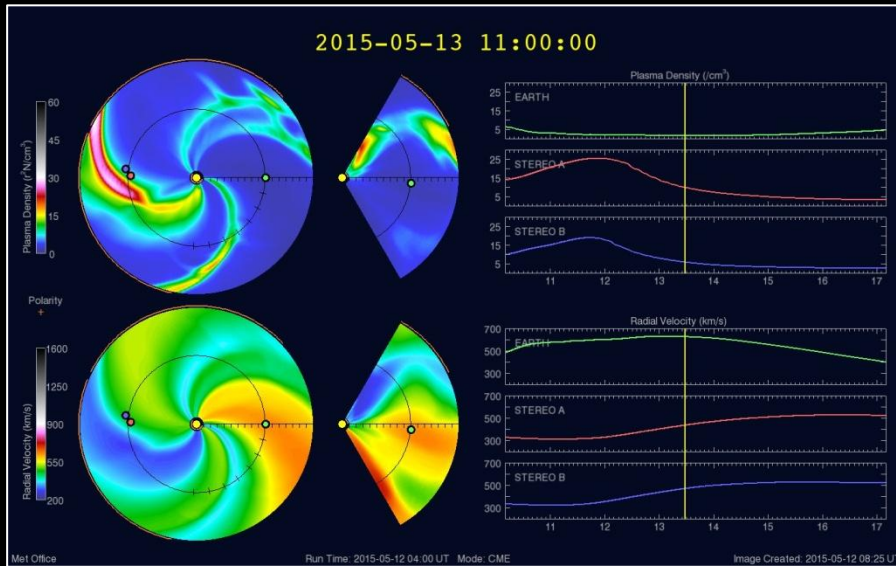
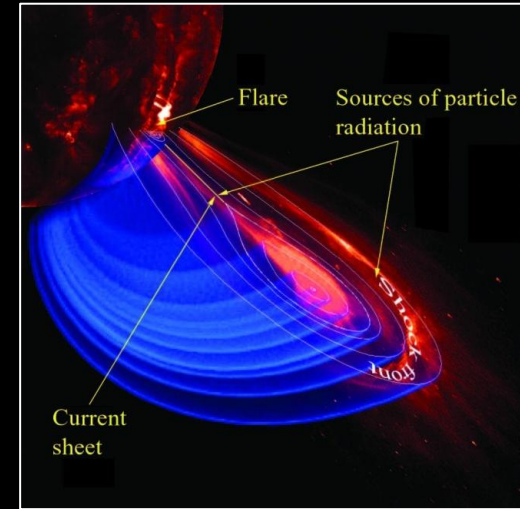
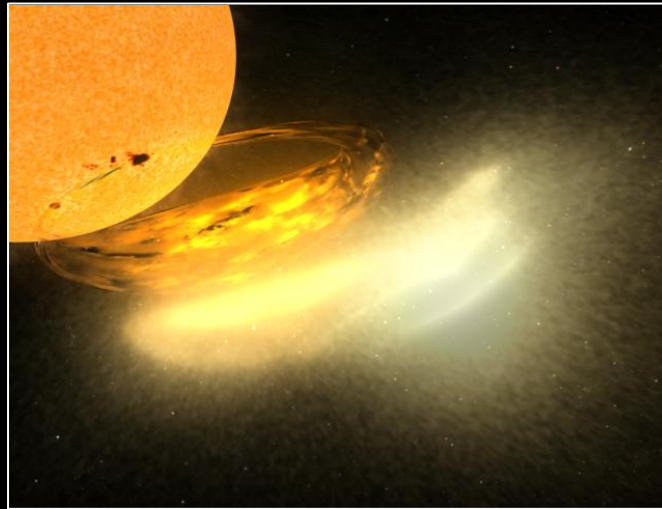
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## Modelling and forecasting SEP events:

- What, where, when?
- Propagation
- Time dependence
- Energy spectra
- Composition



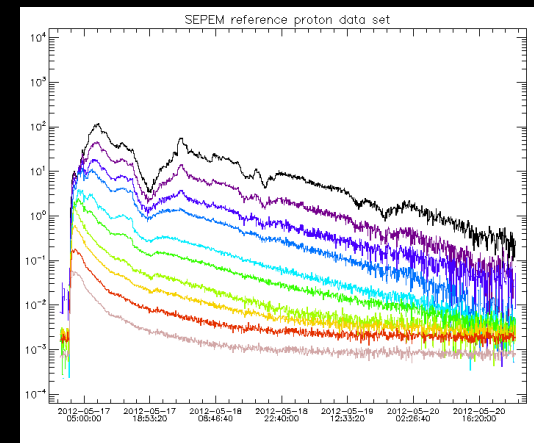
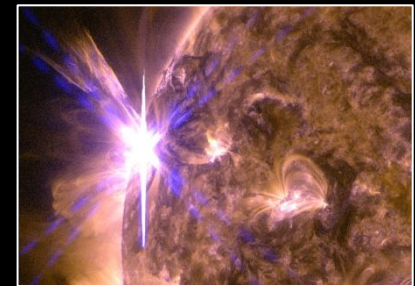
Research → Forecasting



# Current state of the art

## Operational empirical tools

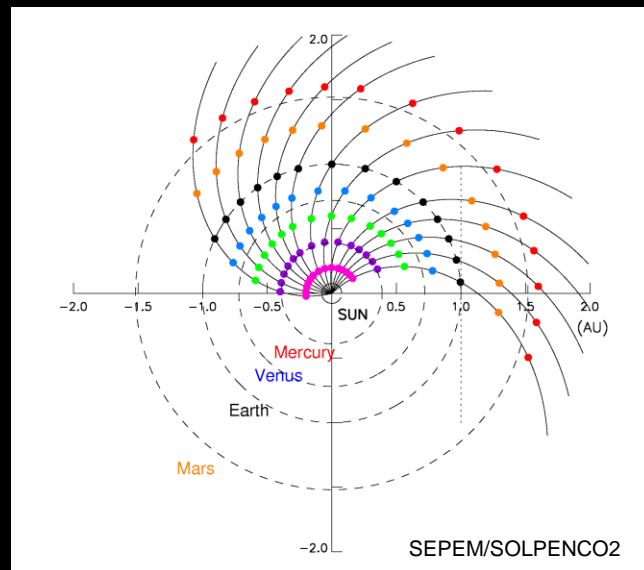
- SWPC SEP tool [Balch, 2008]
- RELEASE Posner [2007]
- MAG4 [Falconer et al., 40 2011]
- UMASEP Nunez [2011]
- Proton Prediction System [Kahler et al., 2007]
- FORSPEF
- COMESSEP SEP Forecast [Dierckxsens, 2014]

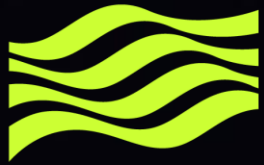


# Current state of the art

## Physics based forecasting models

- SOLPENCO [Aran et al., 2006]
- Cone model shock [Luhmann et al. 2010]
- EMMREM [Schwadron et al., 2010]
- SPARX [Marsh et al., 2015]

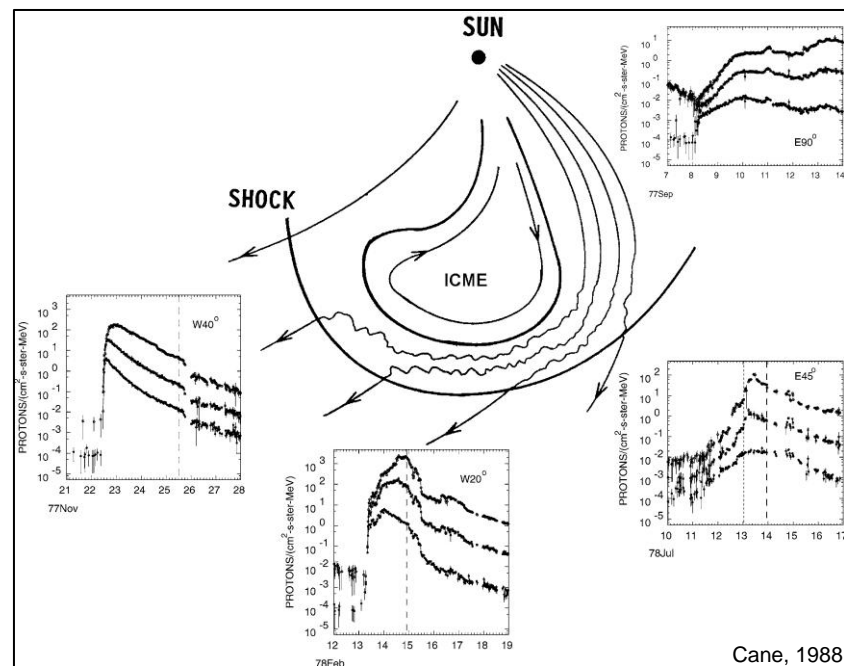
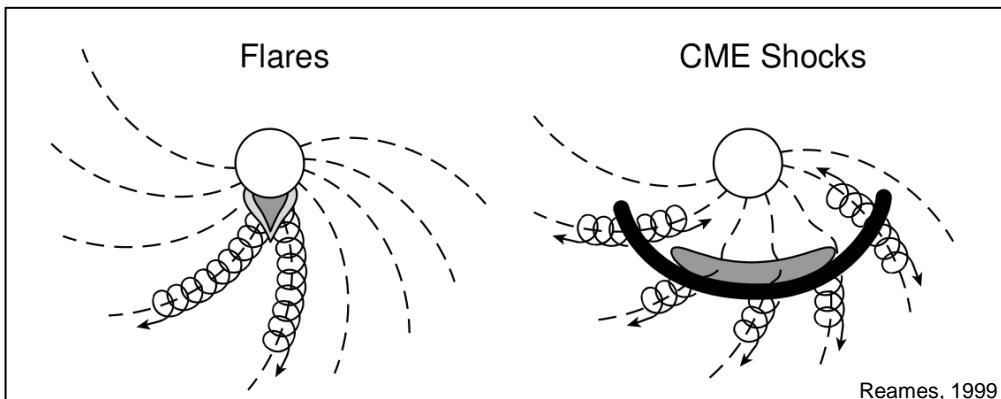




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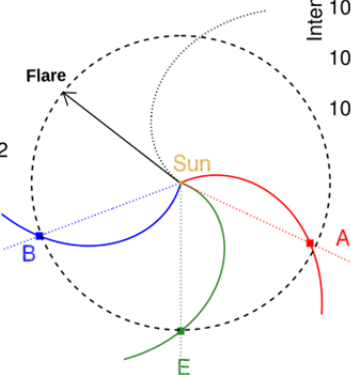
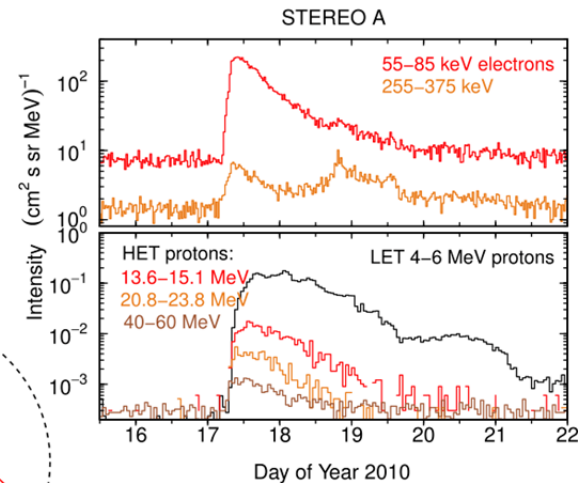
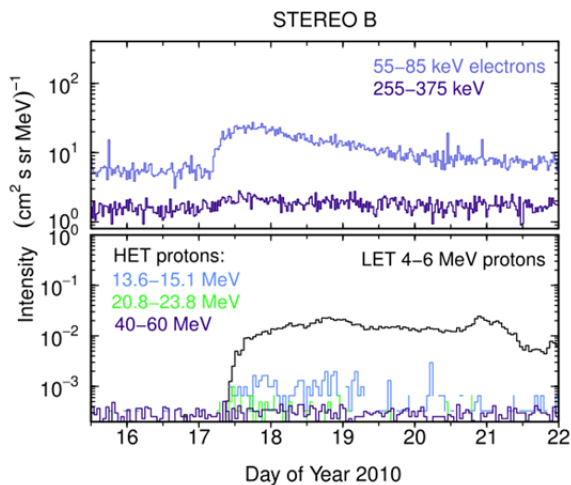
# The unknown

# The current paradigm

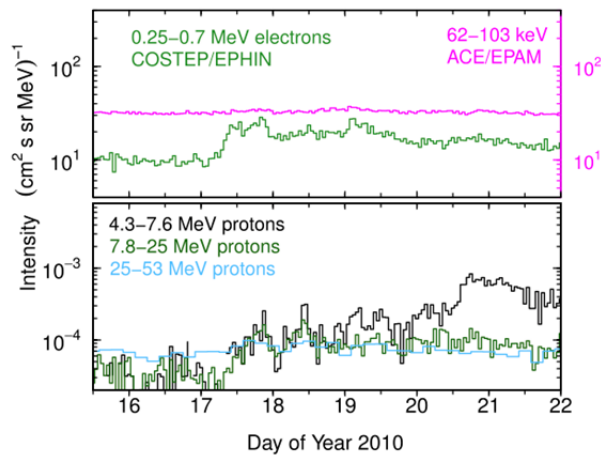




# Multiple viewpoints

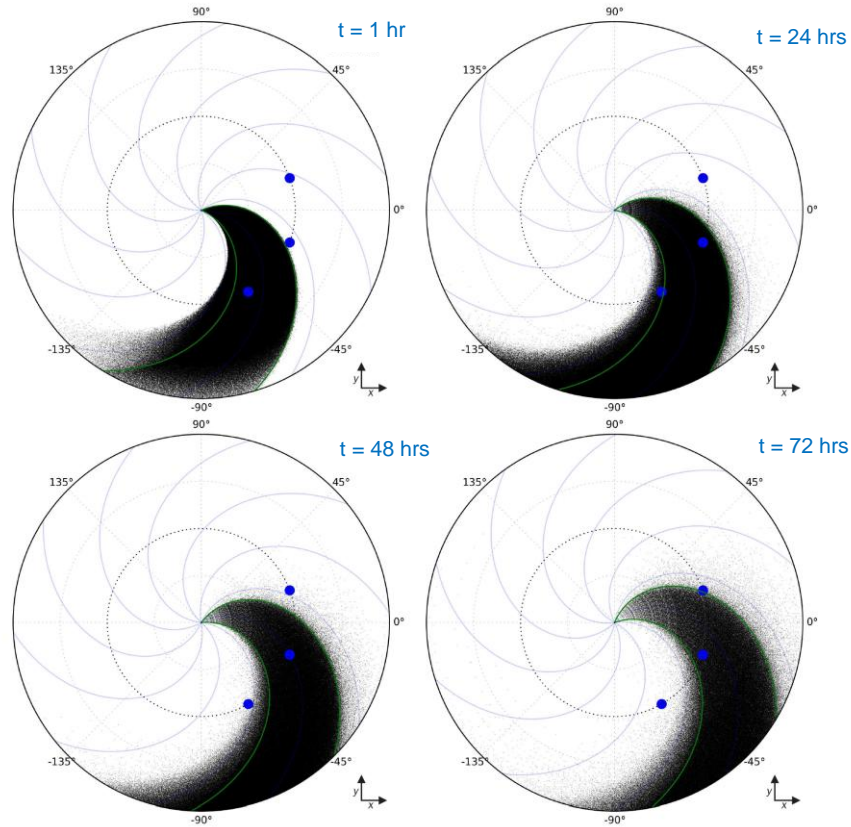


SOHO / ACE

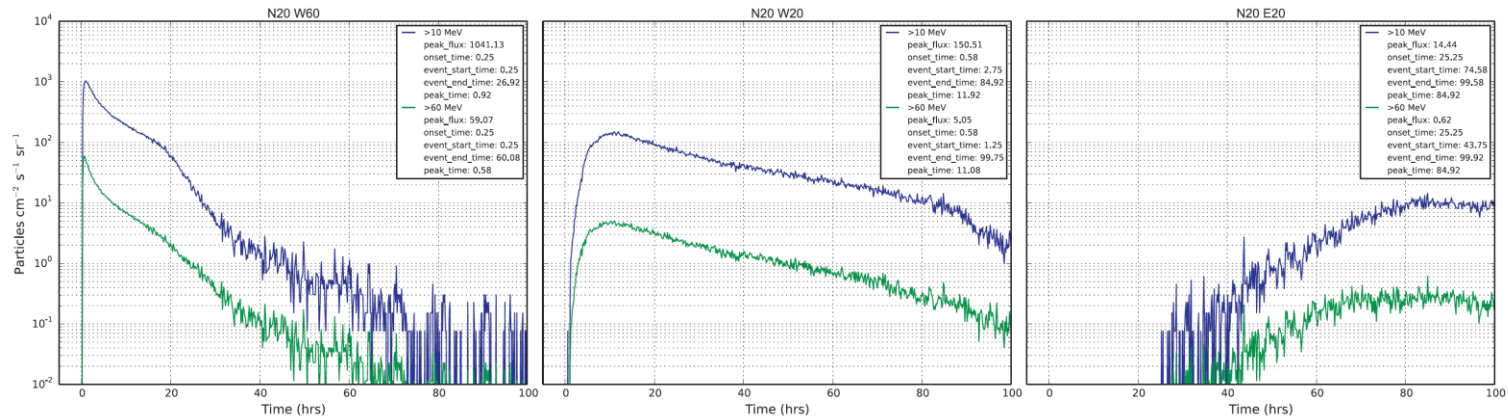


Dresing, 2012

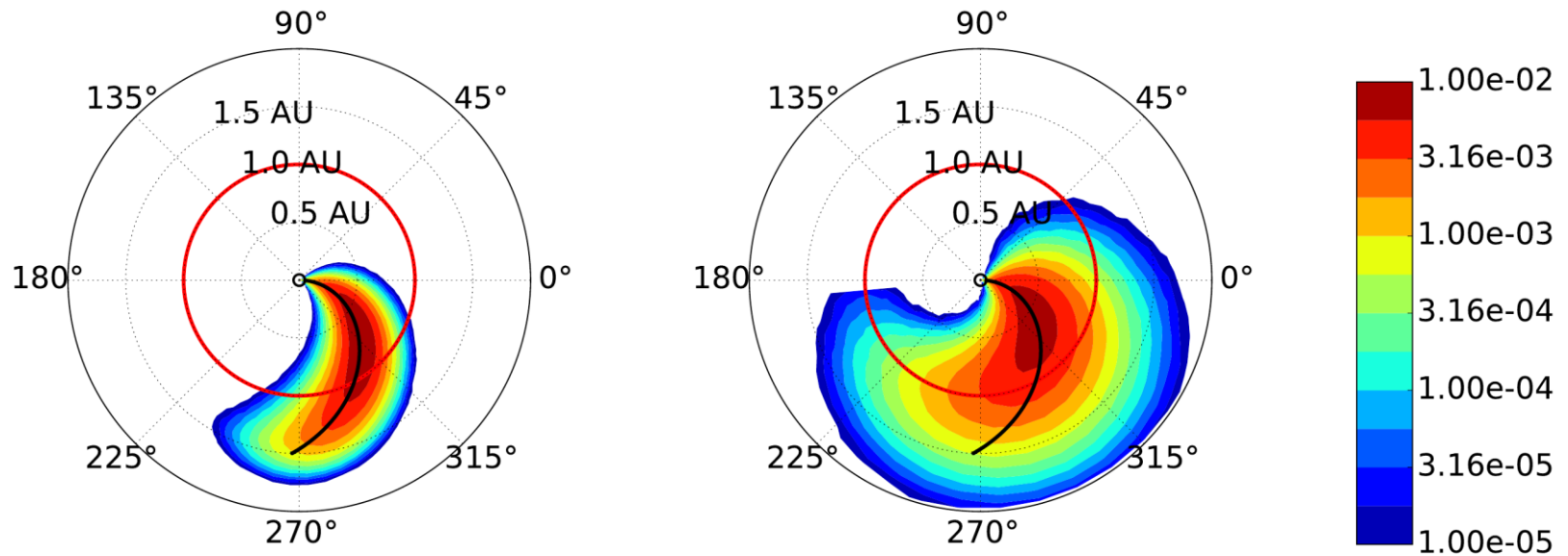
# Physics based models



SPARX (Marsh et al., 2015)



# Physics based models



Laitinen et al., 2015



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# SEP Science from L5

# Advantages of an operational L5 mission

A consistent dataset

## Empirical models:

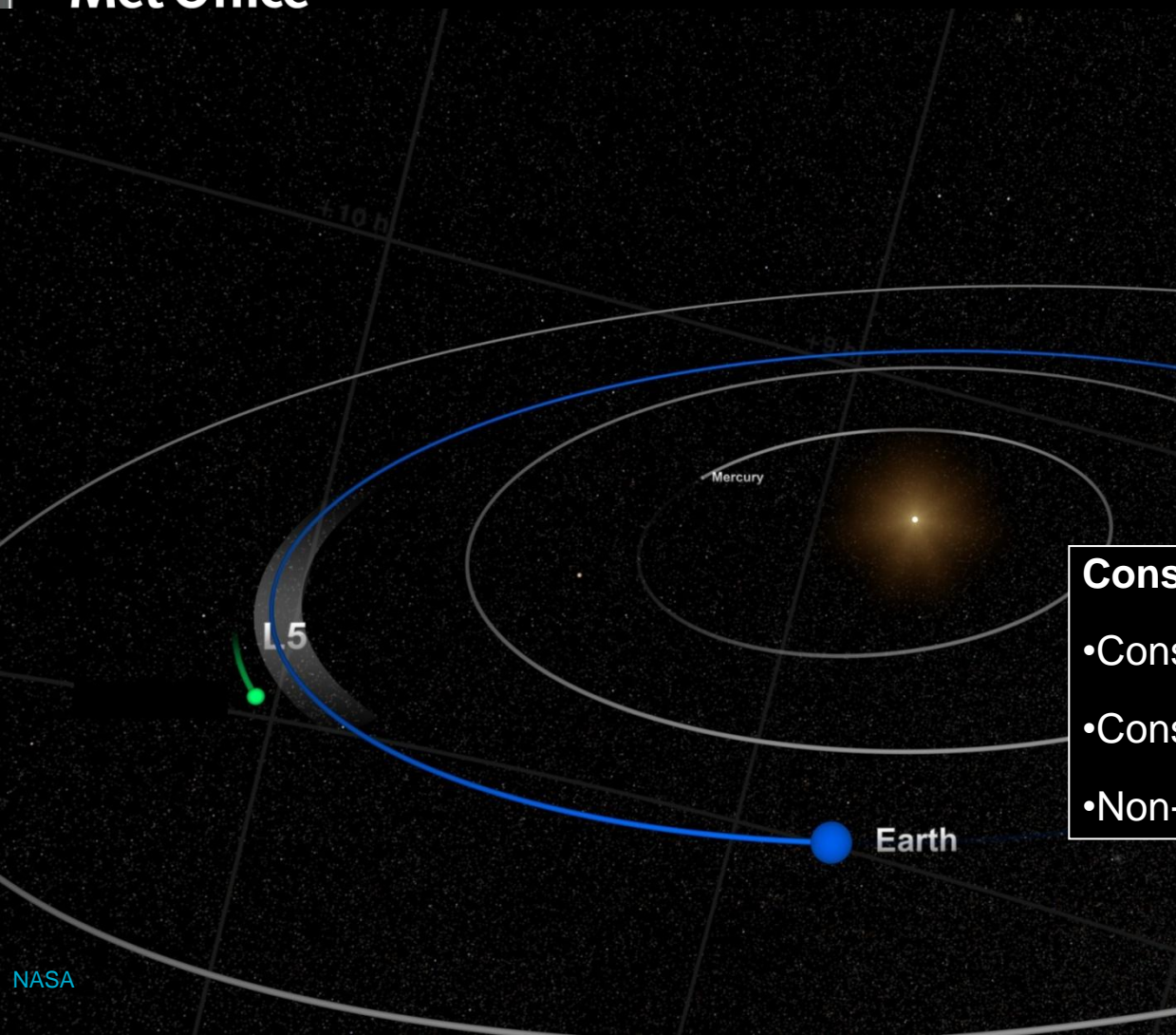
- Establish SEP event statistics in “pure” IMF (c.f. GOES)

## Physical models:

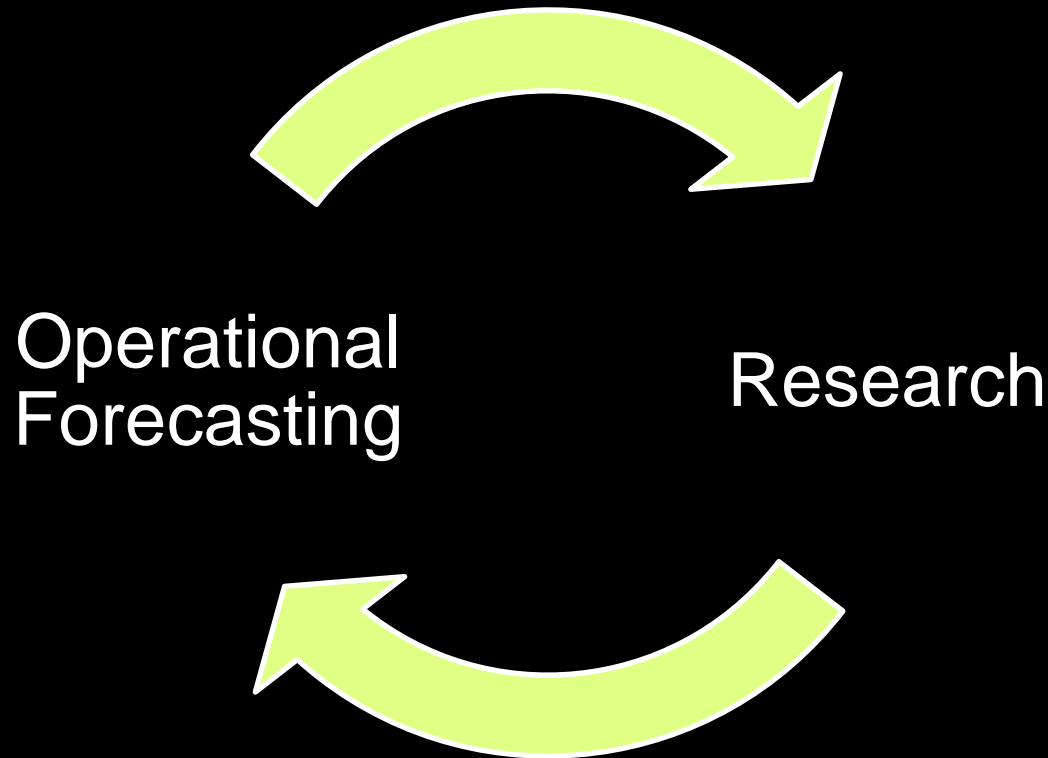
- Probe of longitudinal structure (L1 & L5)

## Construction of reference dataset:

- Constant radius
- Constant longitude separation
- Non-changing viewpoint c.f. STEREO



# Conclusion - L5 Synergy



*An operational L5 mission provides a platform to dissect the structure and dynamics of SEP events, building a systematic statistical sample of observations that are essential to future physical and empirical operational forecast models.*