# Highlights from ESA's Solar-Terrestrial Missions


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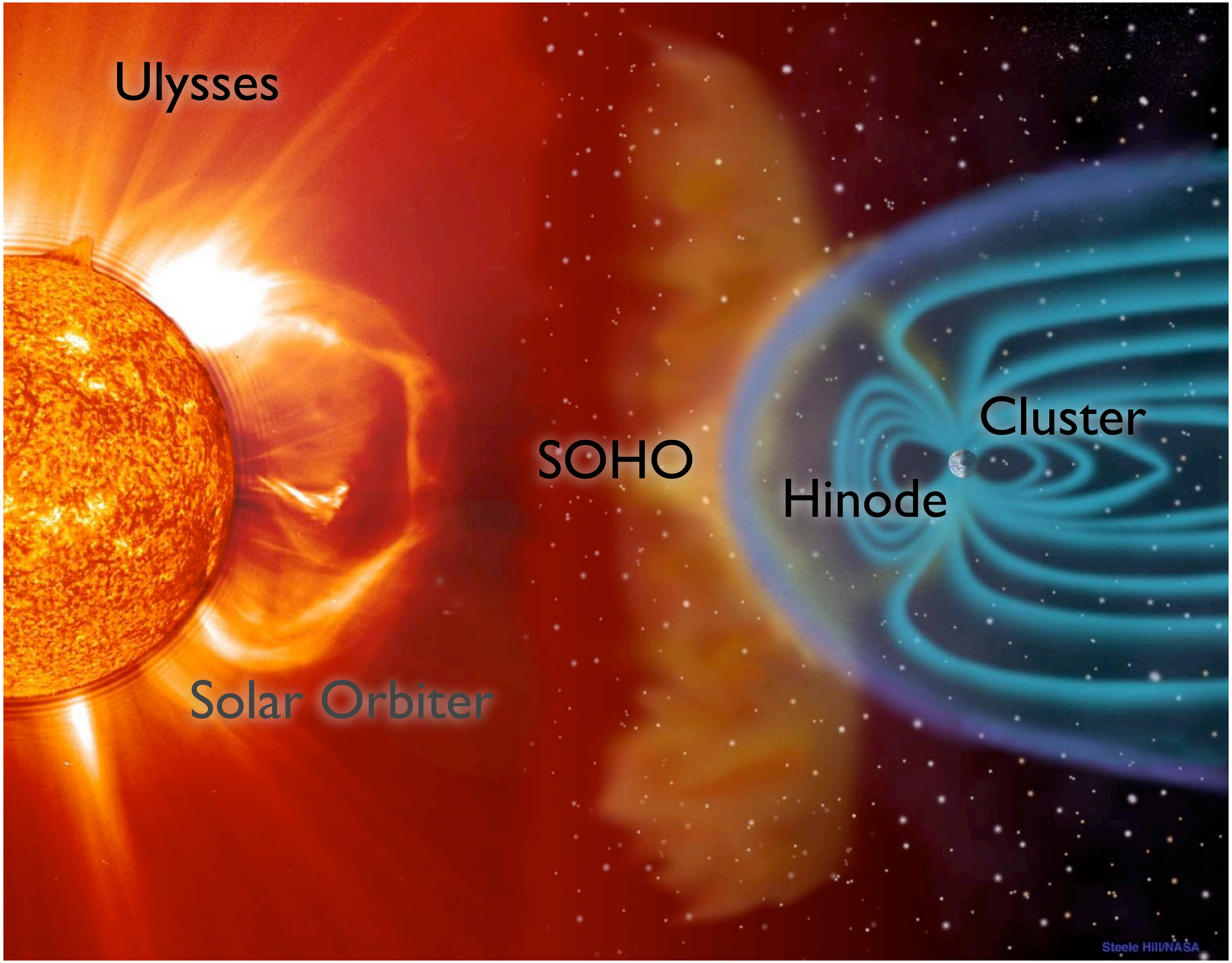
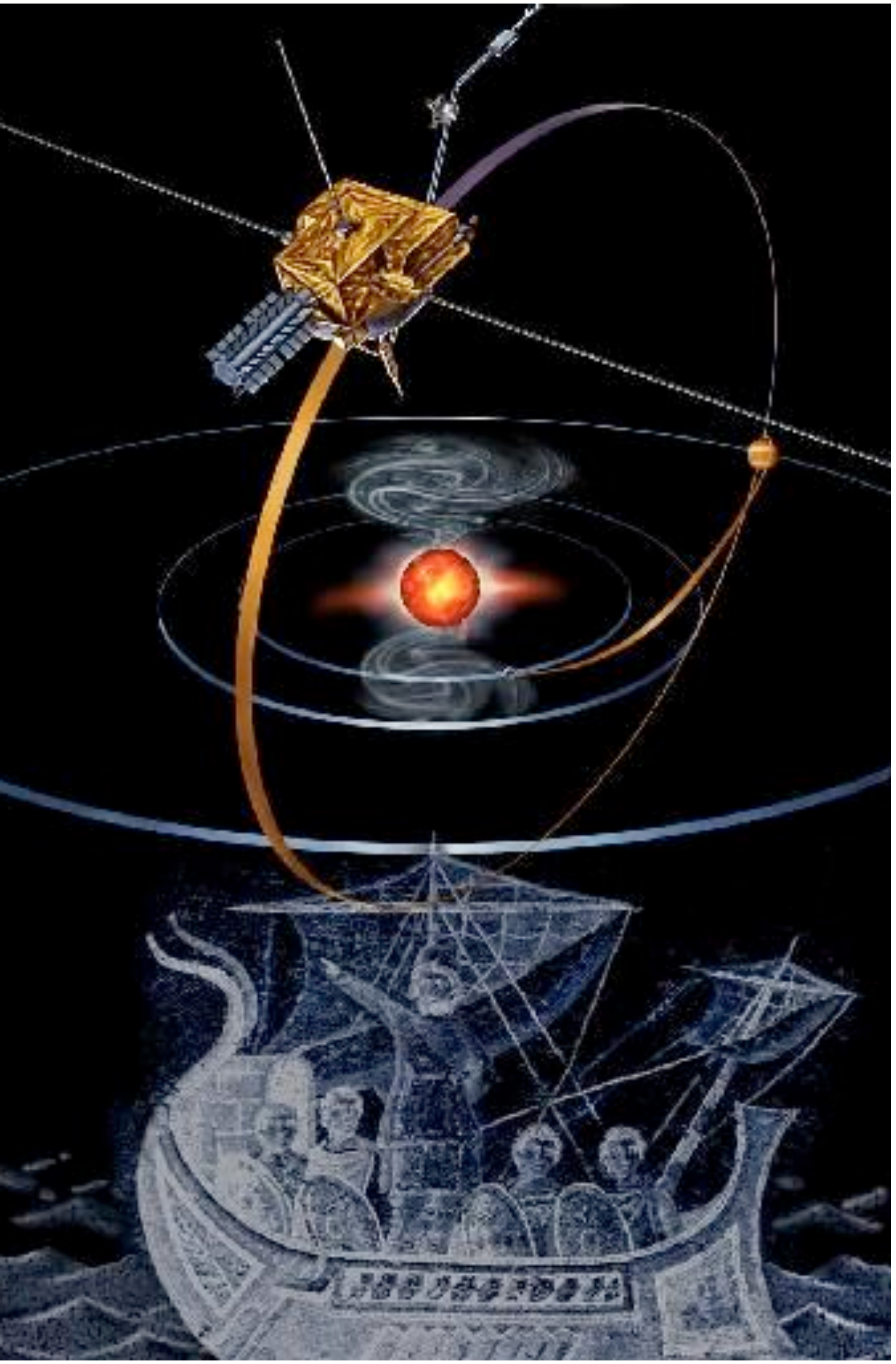
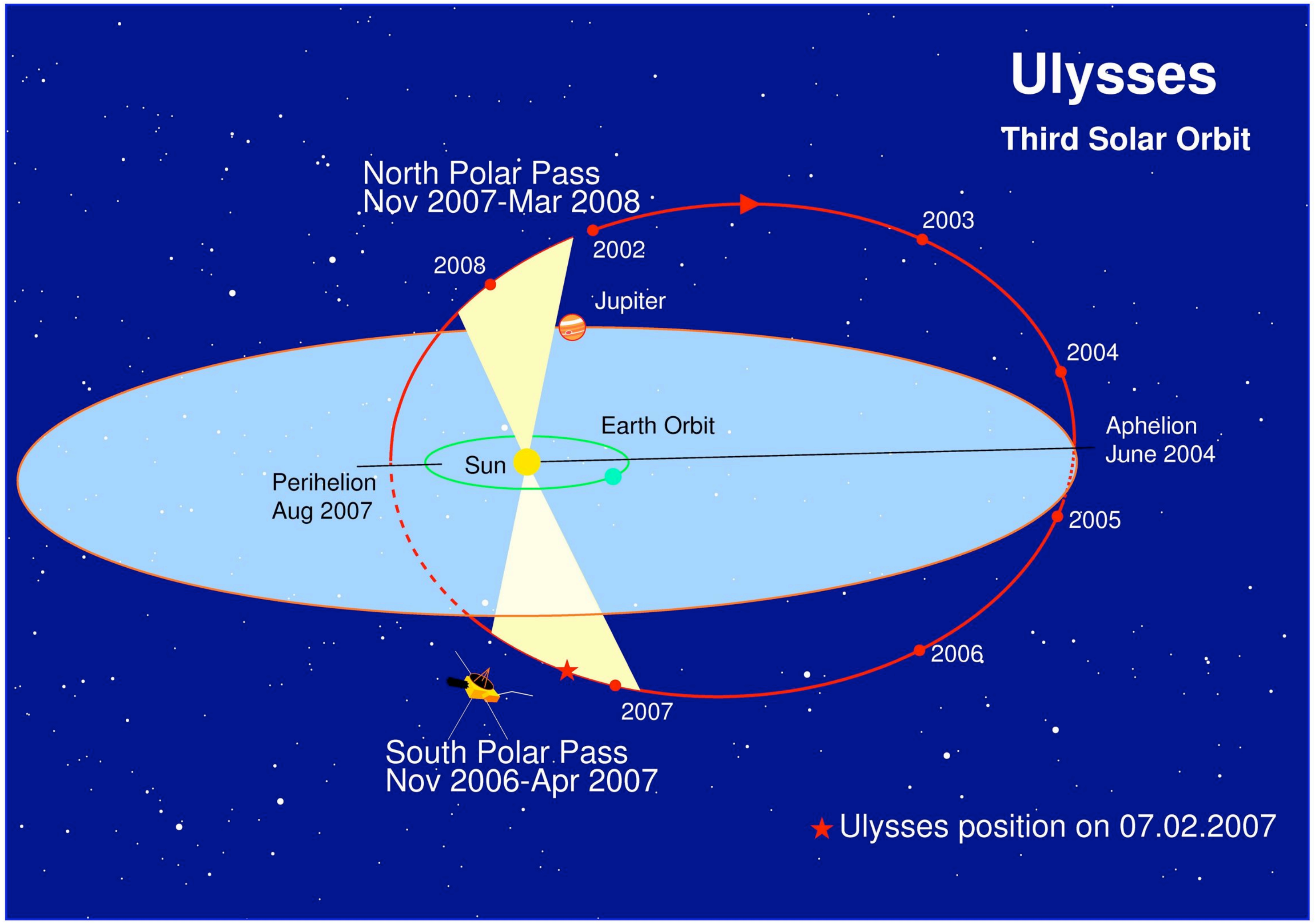
# ESA's Fleet of Solar-Terrestrial Missions



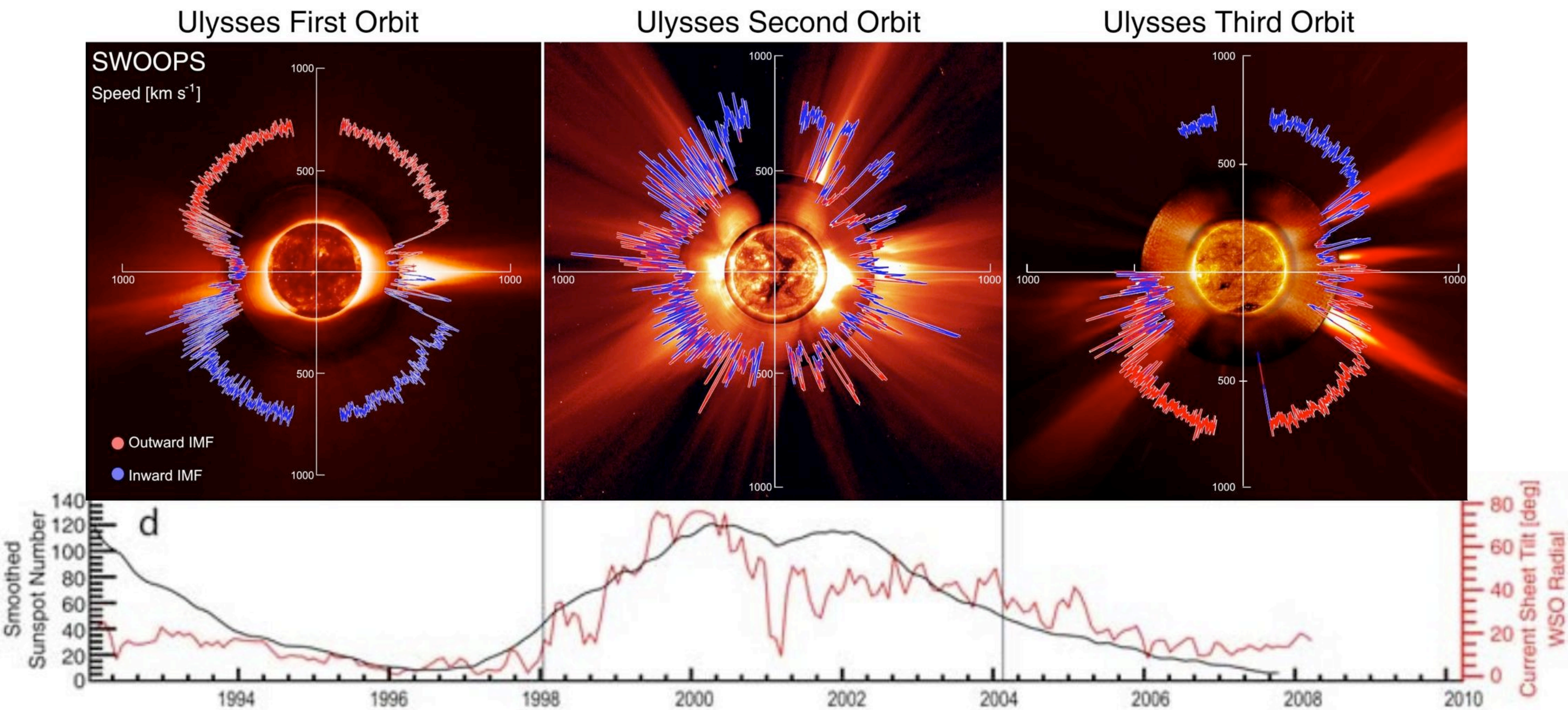
# Ulysses - An Odyssey Through the Heliosphere



- Launched in 10/1990
- Jupiter gravity assist to reach latitude > 80°
- End-of-mission: 07/2008, but still operating



# Ulysses - Solar Wind at its Weakest Since the Start of the Space Age




*McComas et al., GRL 2008*

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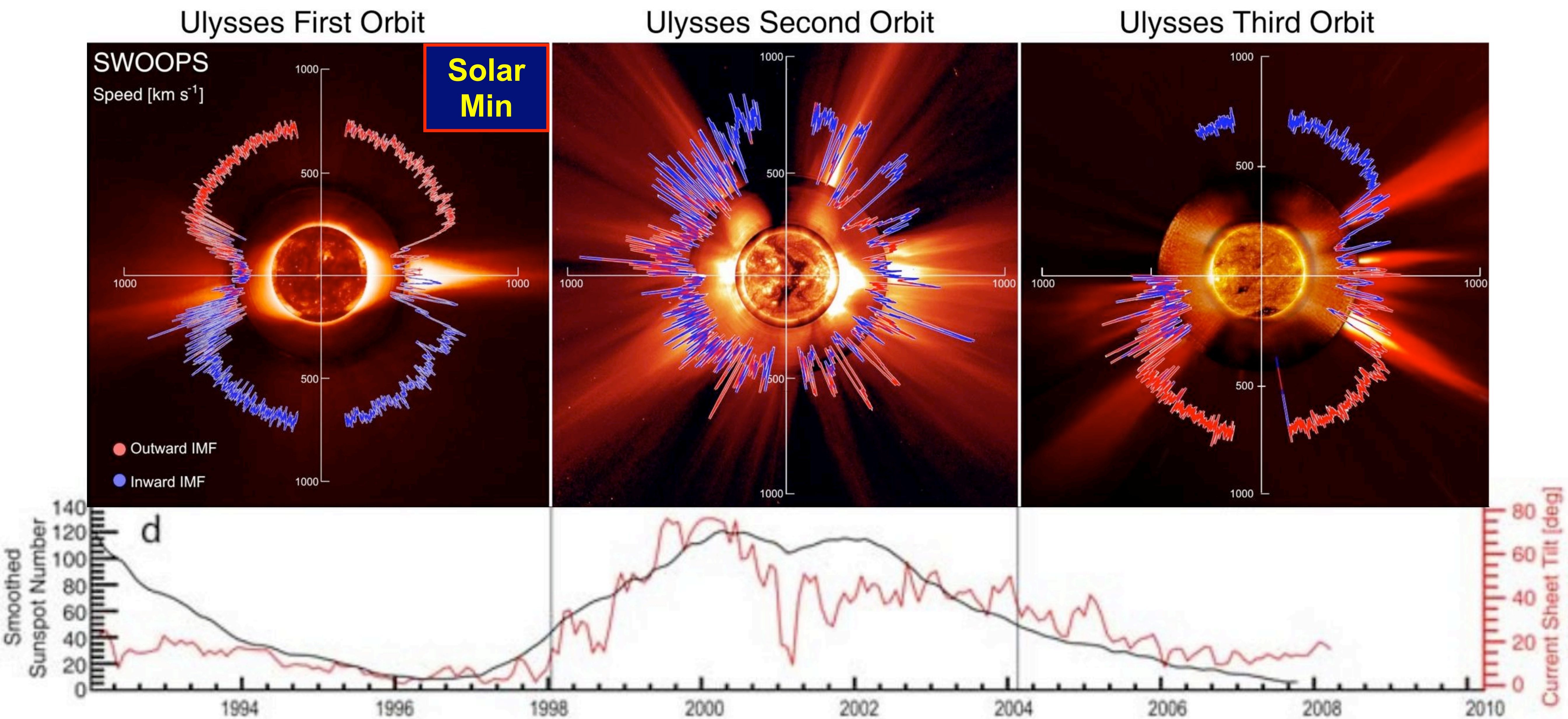


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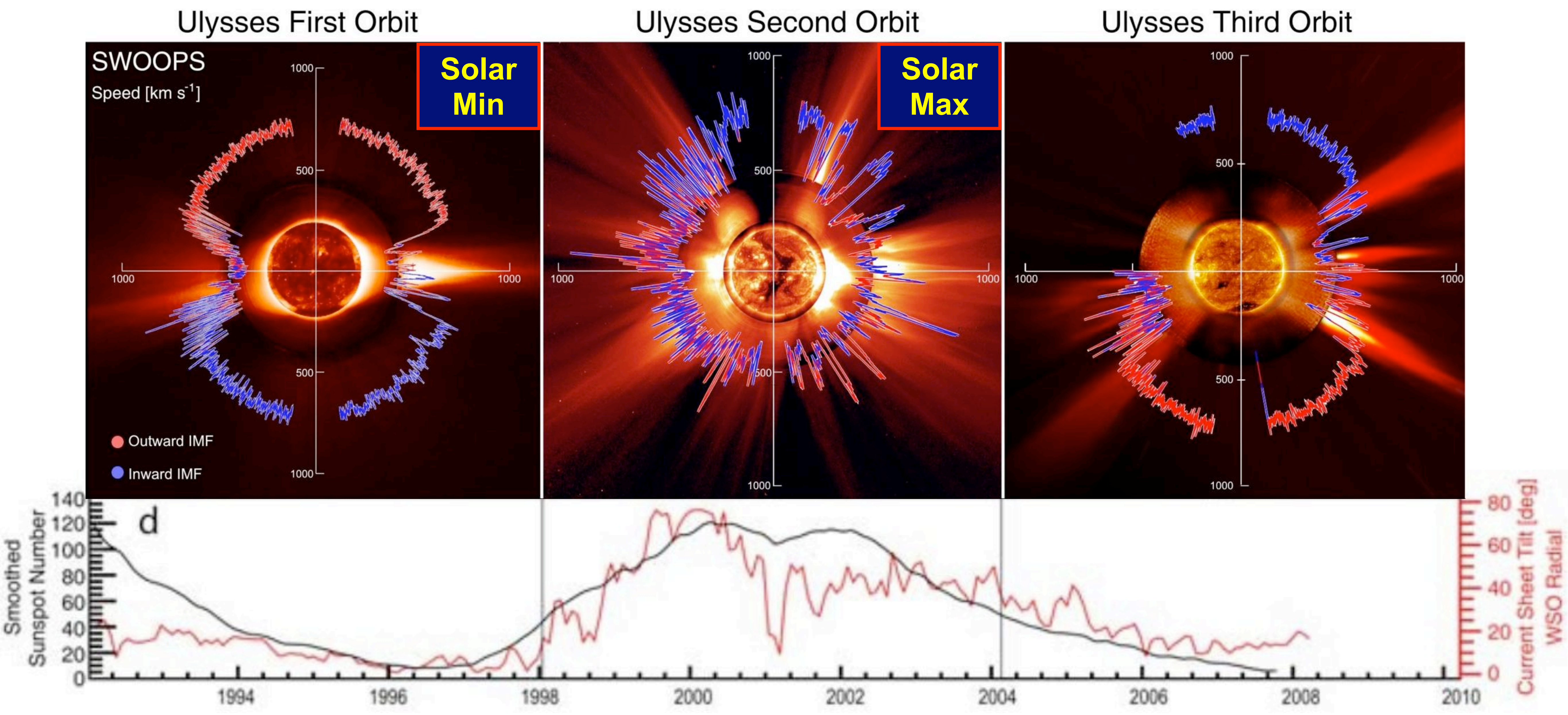


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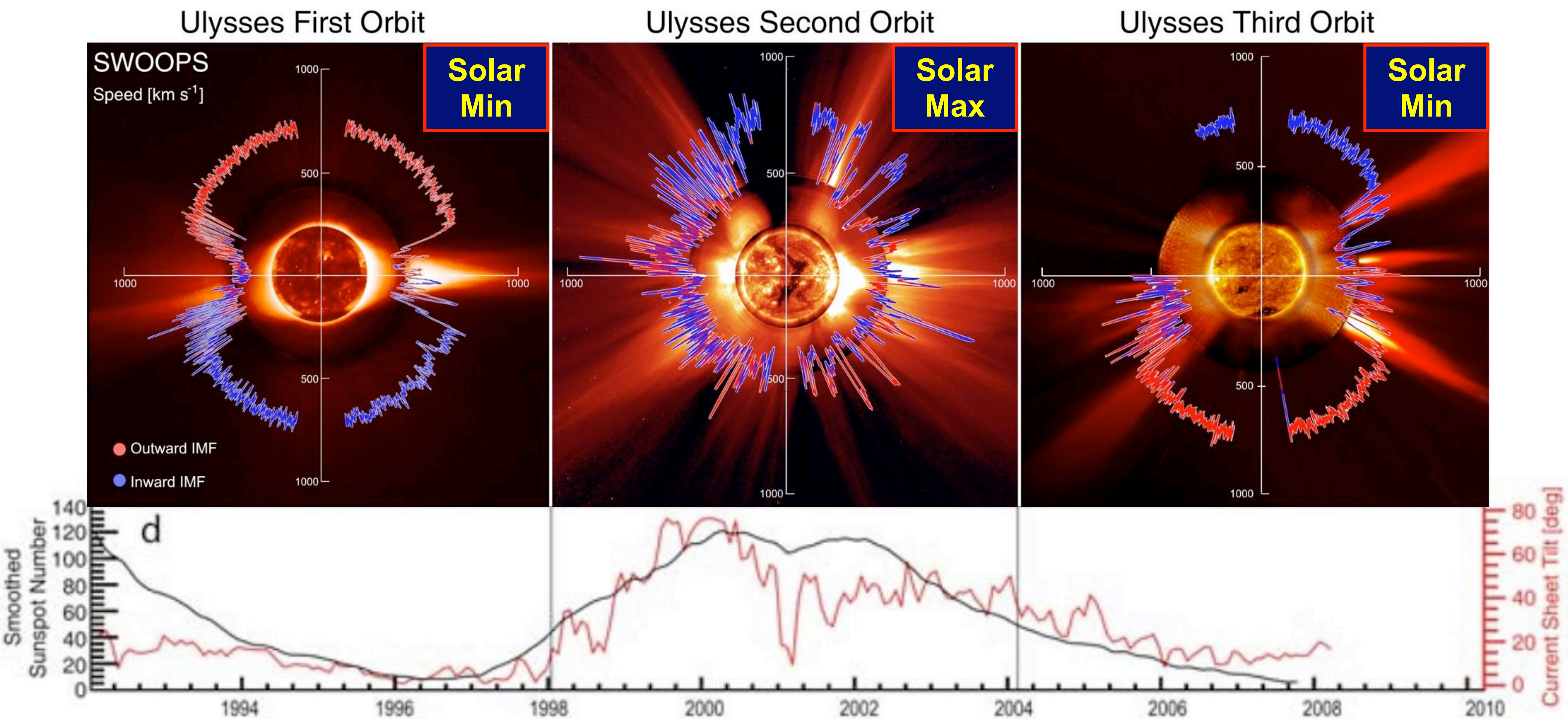


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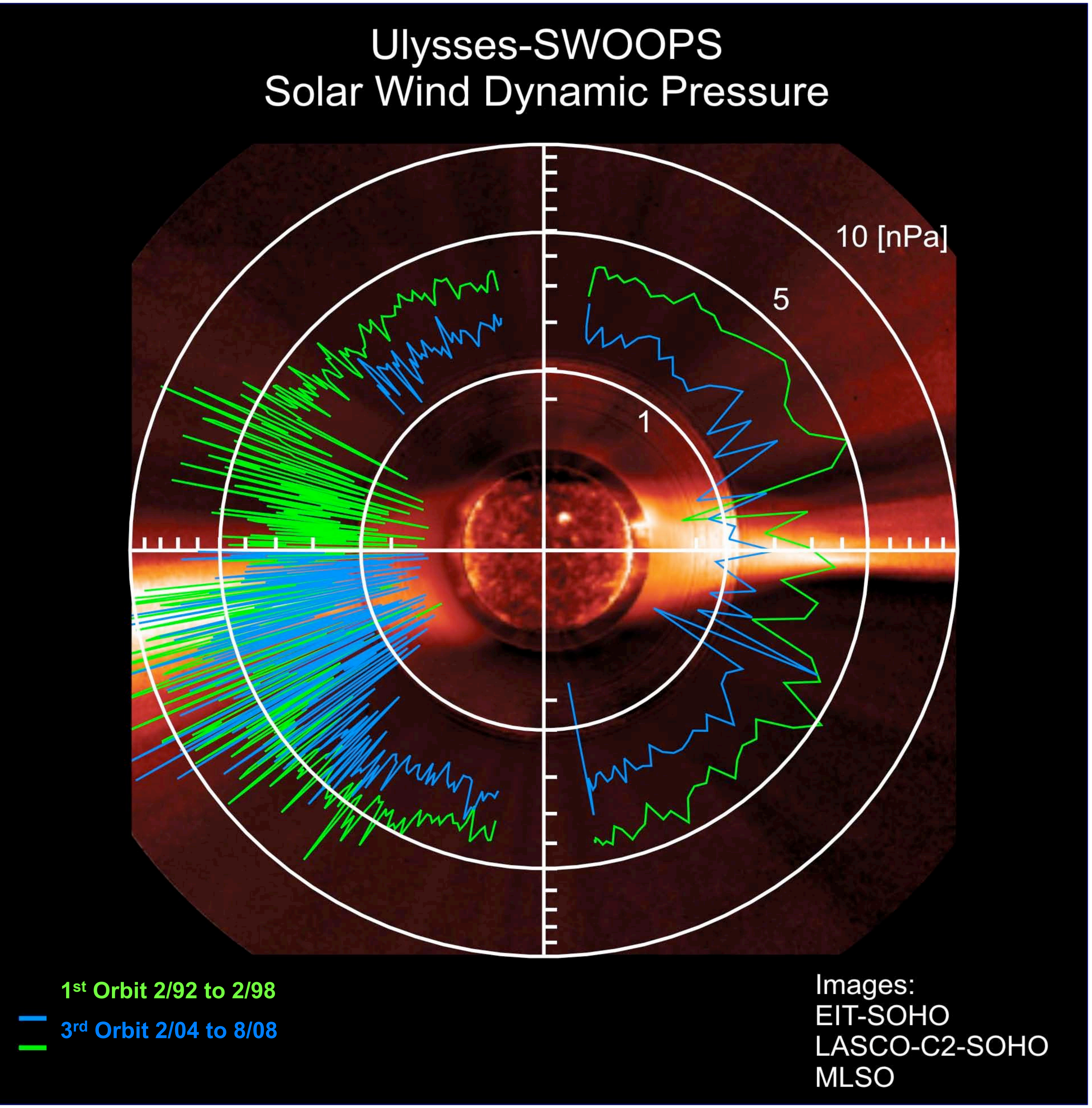


Compared with previous solar minimum:

- Solar wind pressure reduced by ~20%
- Magnetic field ~35% weaker

Possible consequences:

- Boundary of the heliosphere moves inwards (Voyagers 1 & 2 may reach interstellar space sooner than expected, i.e. within 5 years)
- Increase in cosmic ray flux in inner heliosphere

# SOHO - Solar Guardian since 1995

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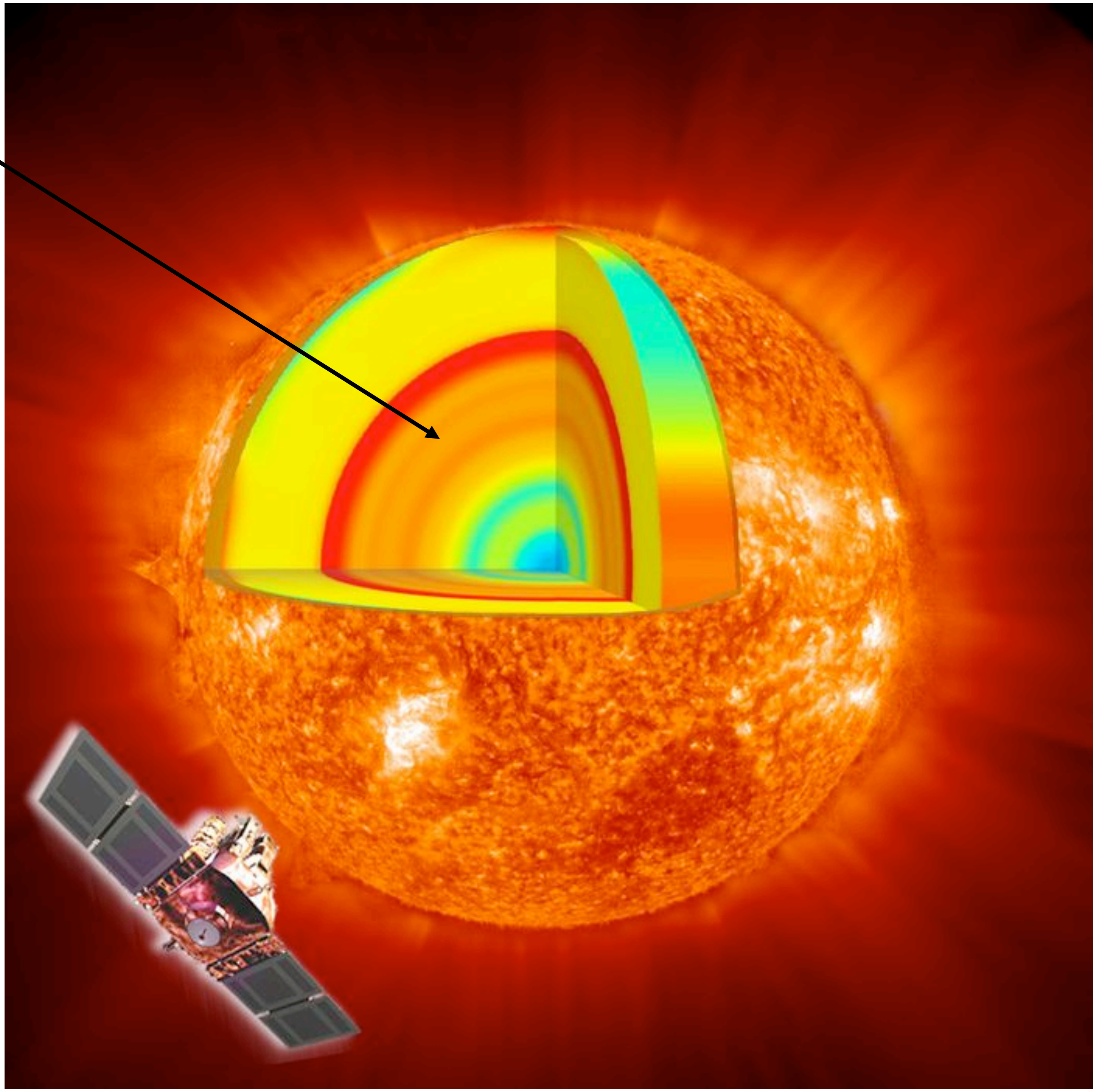
# SOHO - Science Goals

## A) Solar Interior

What are its structure and dynamics?



# SOHO - Science Goals

## A) Solar Interior
What are its structure and dynamics?

## B) Solar Corona
Why does it exist and how
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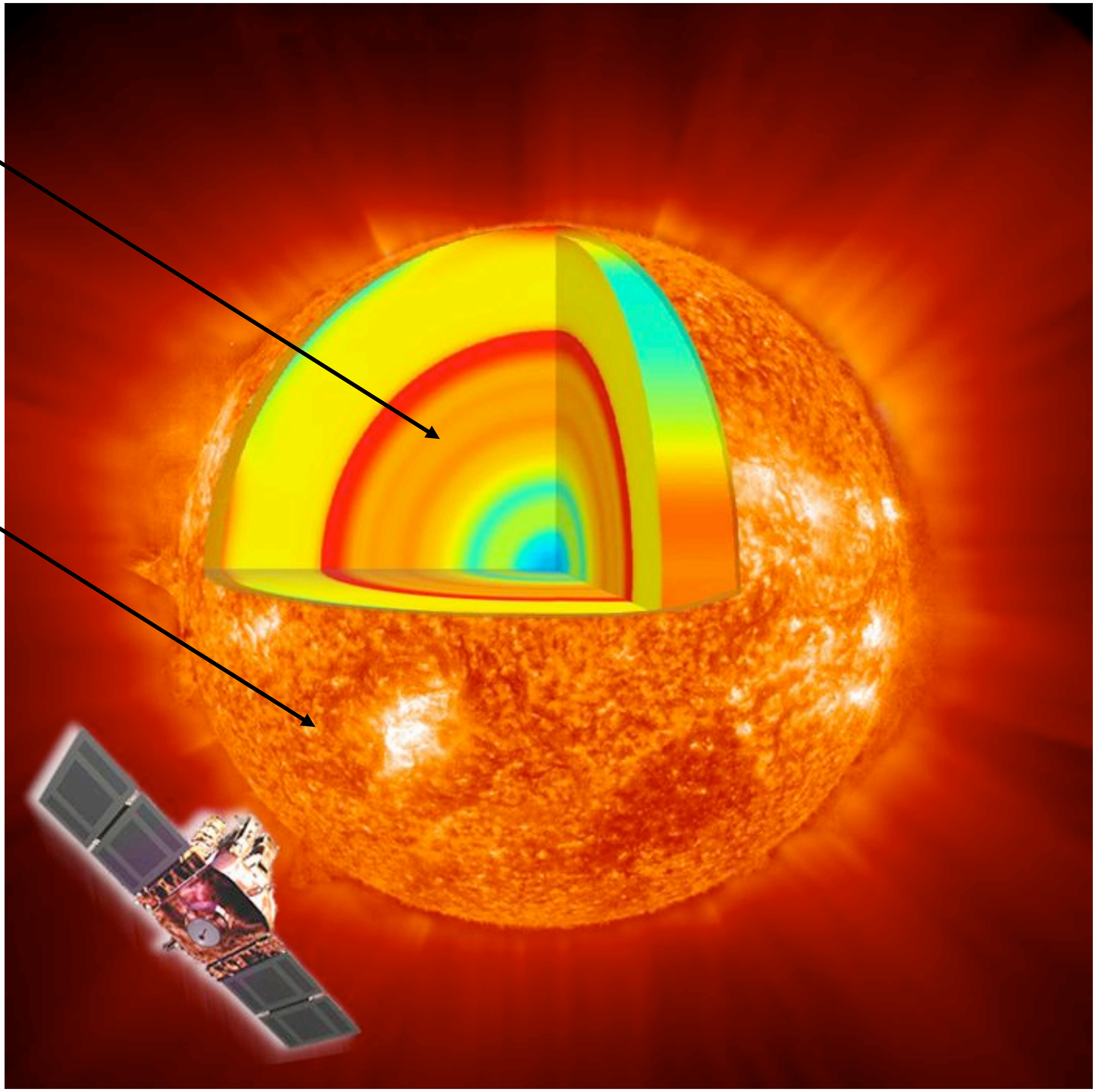
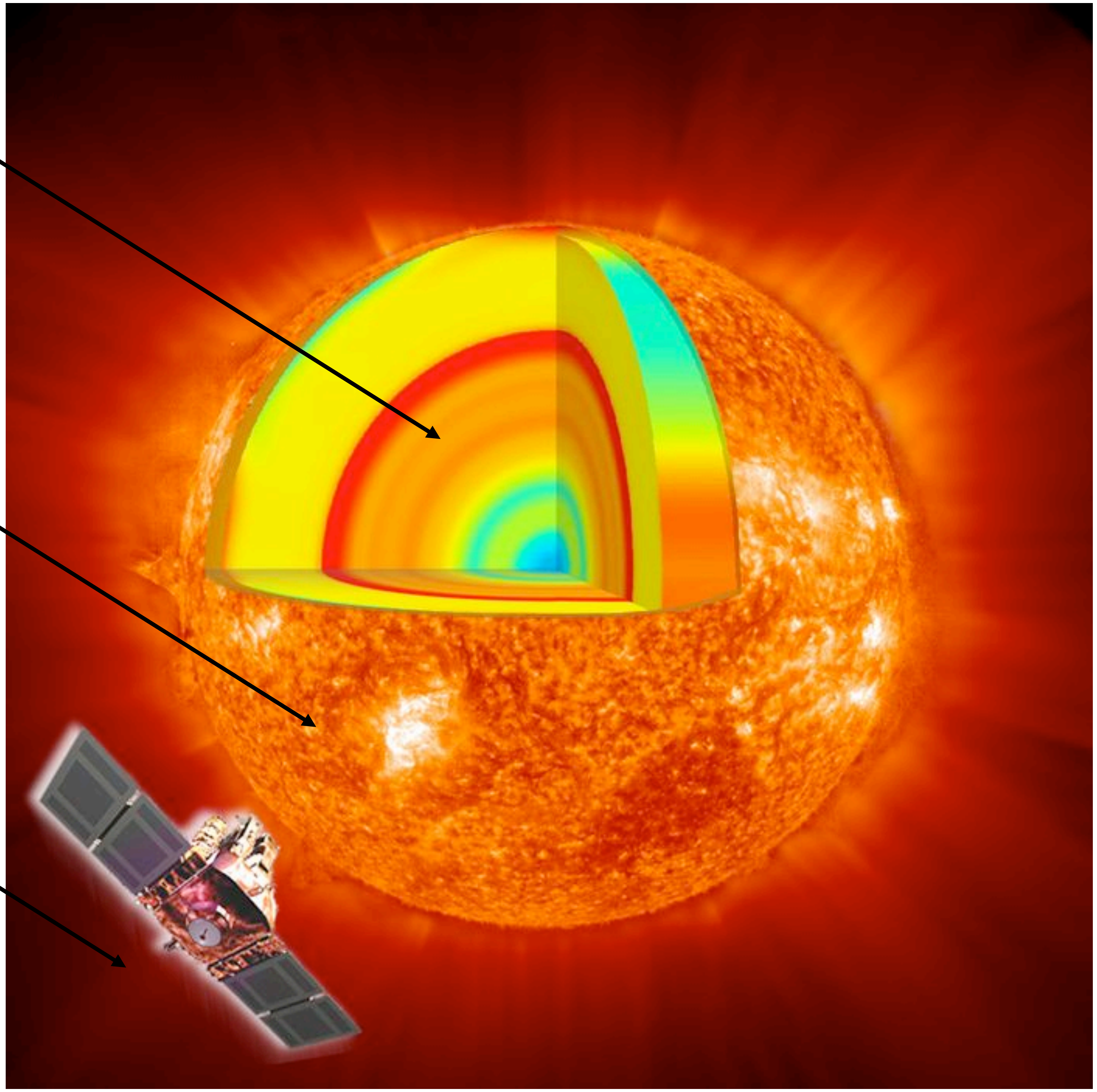


# SOHO - Science Goals

## A) Solar Interior
What are its structure and dynamics?

## B) Solar Corona
Why does it exist and how
is it heated?

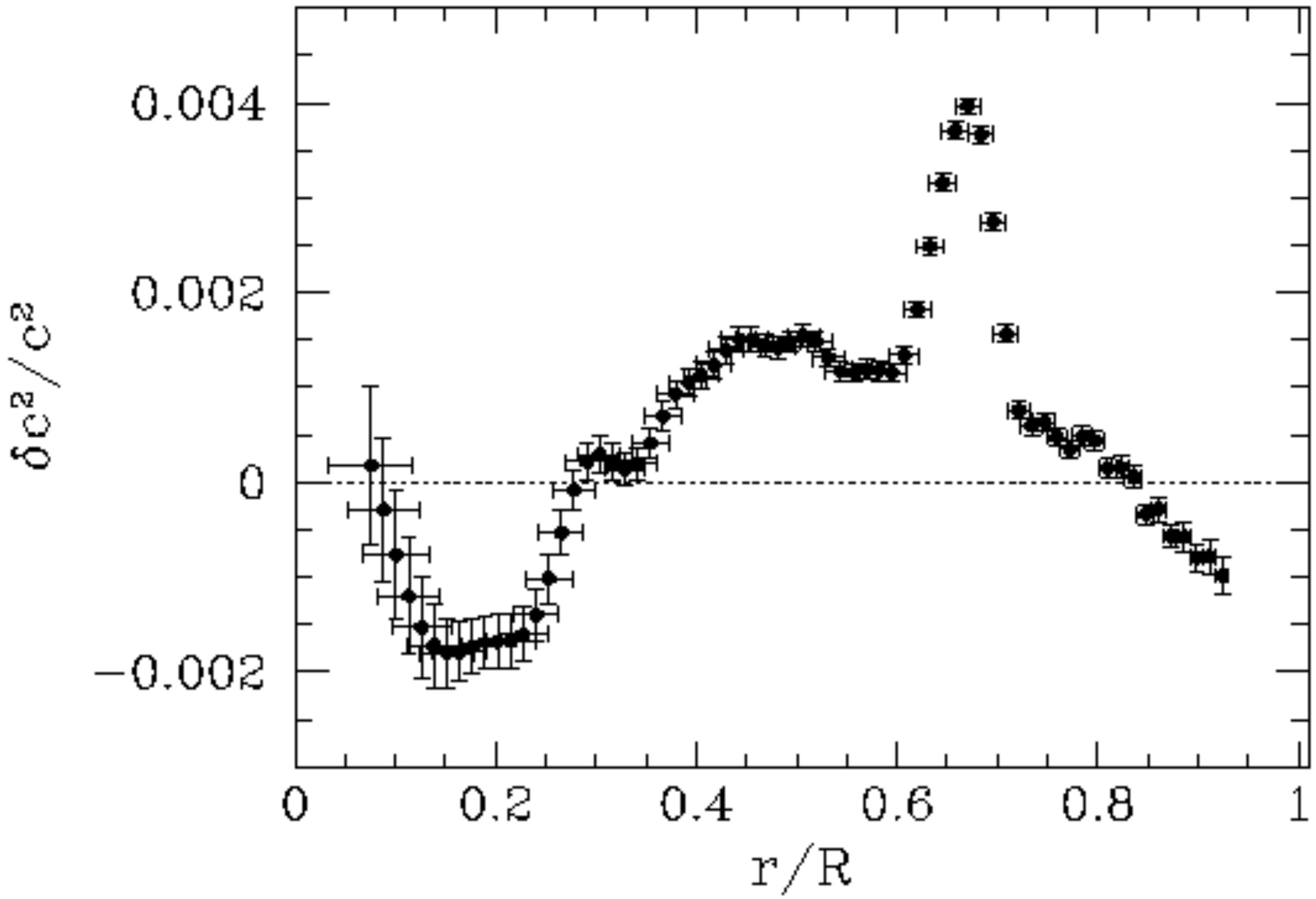
## C) Solar Wind
Where is it accelerated
and how?

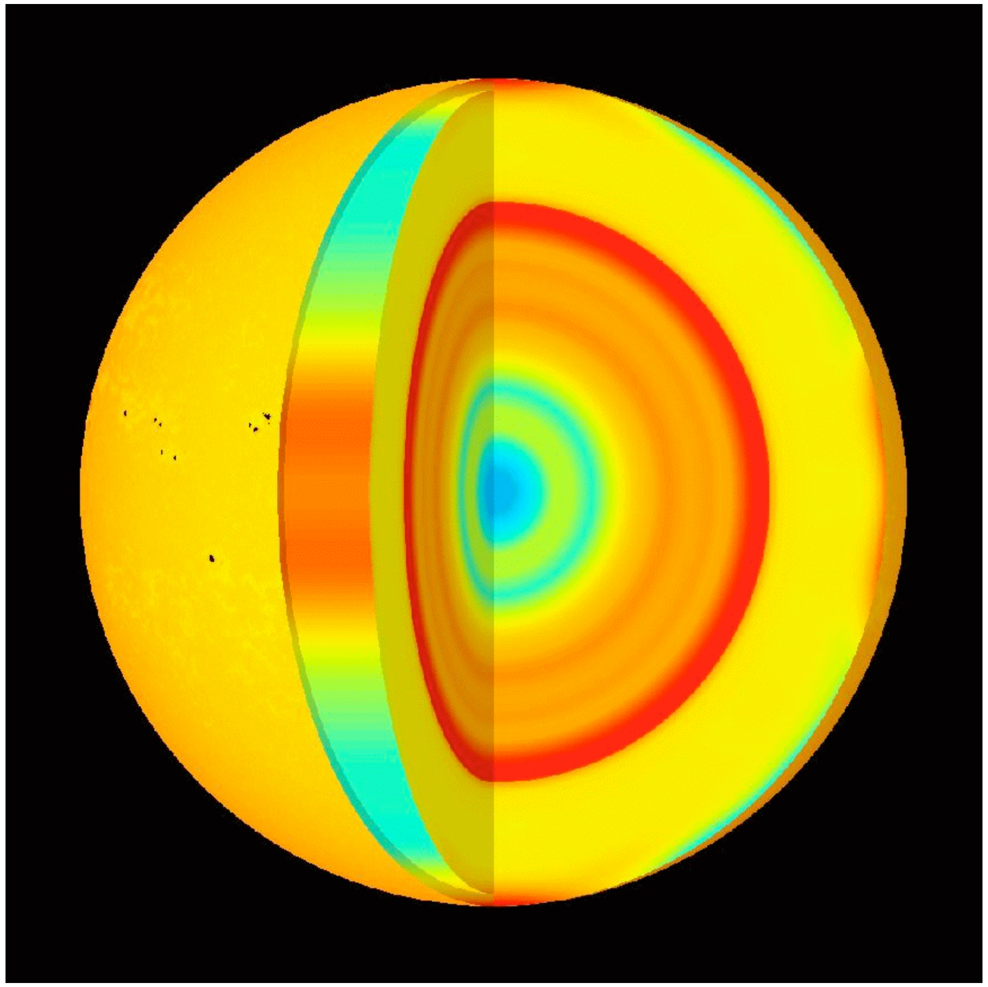


# SOHO - Structure of the Solar Interior

Measured sound speed vs. solar model:

Agreement better than 0.5 %

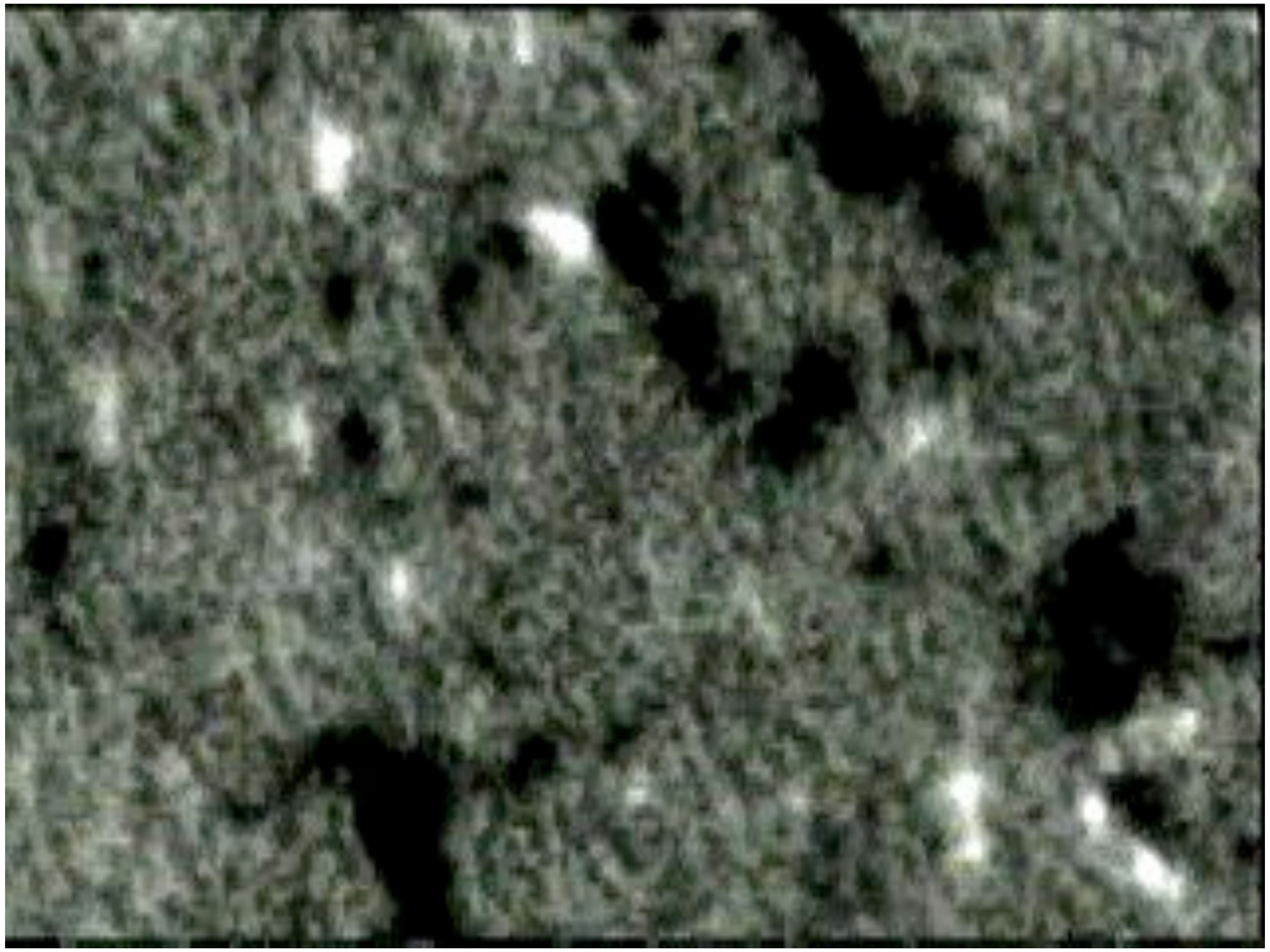


*Kosovichev et al., Solar Physics 1997*

# Heating of the Corona: The Magnetic Carpet

- Constant magnetic flux emergence, fragmentation and disappearance, timescale ~ 40 hours
- Energy supply through "braiding" of large-scale coronal field by small-scale flux replacement is sufficient to heat corona



*Schrijver et al., Nature 1998*

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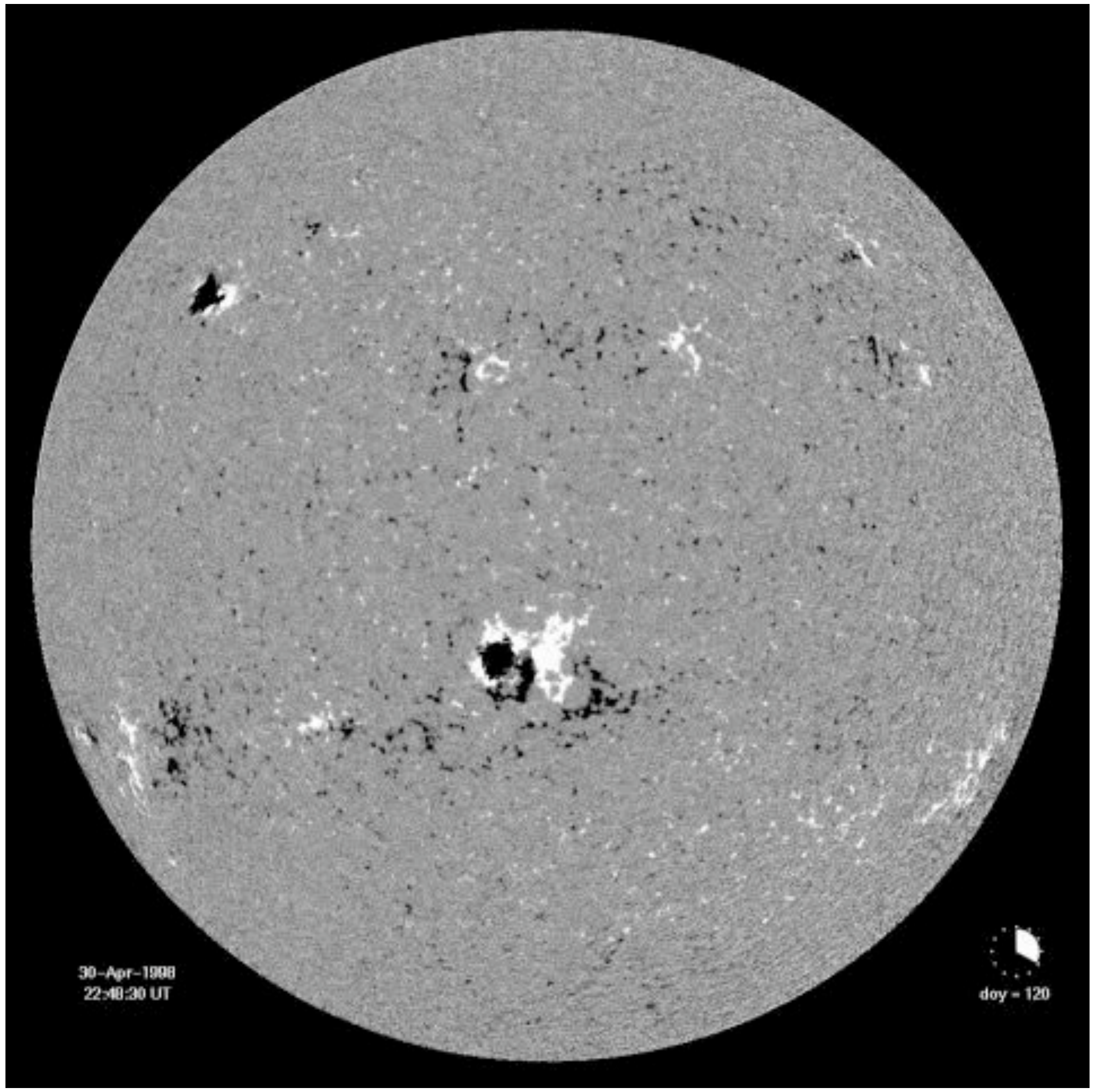


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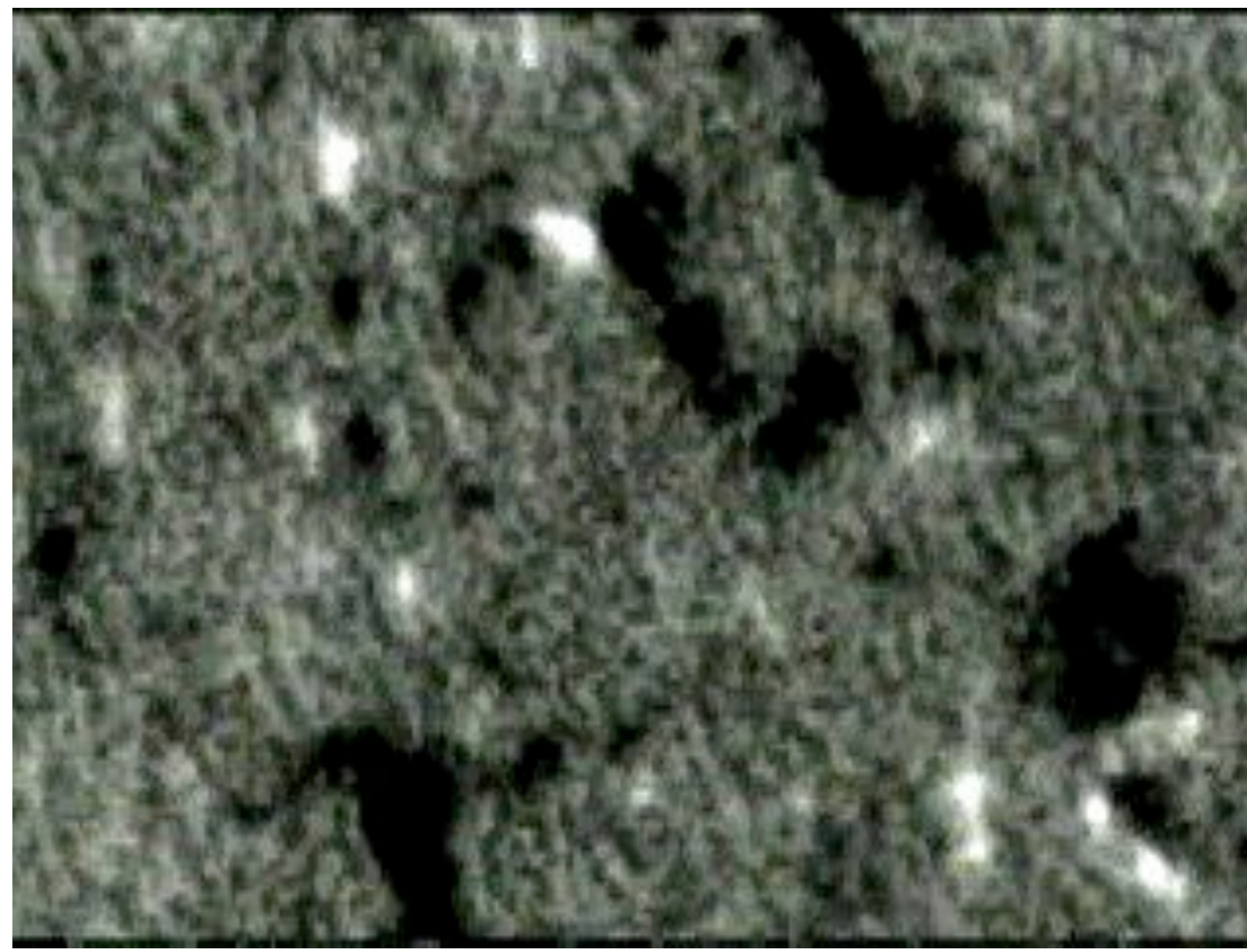

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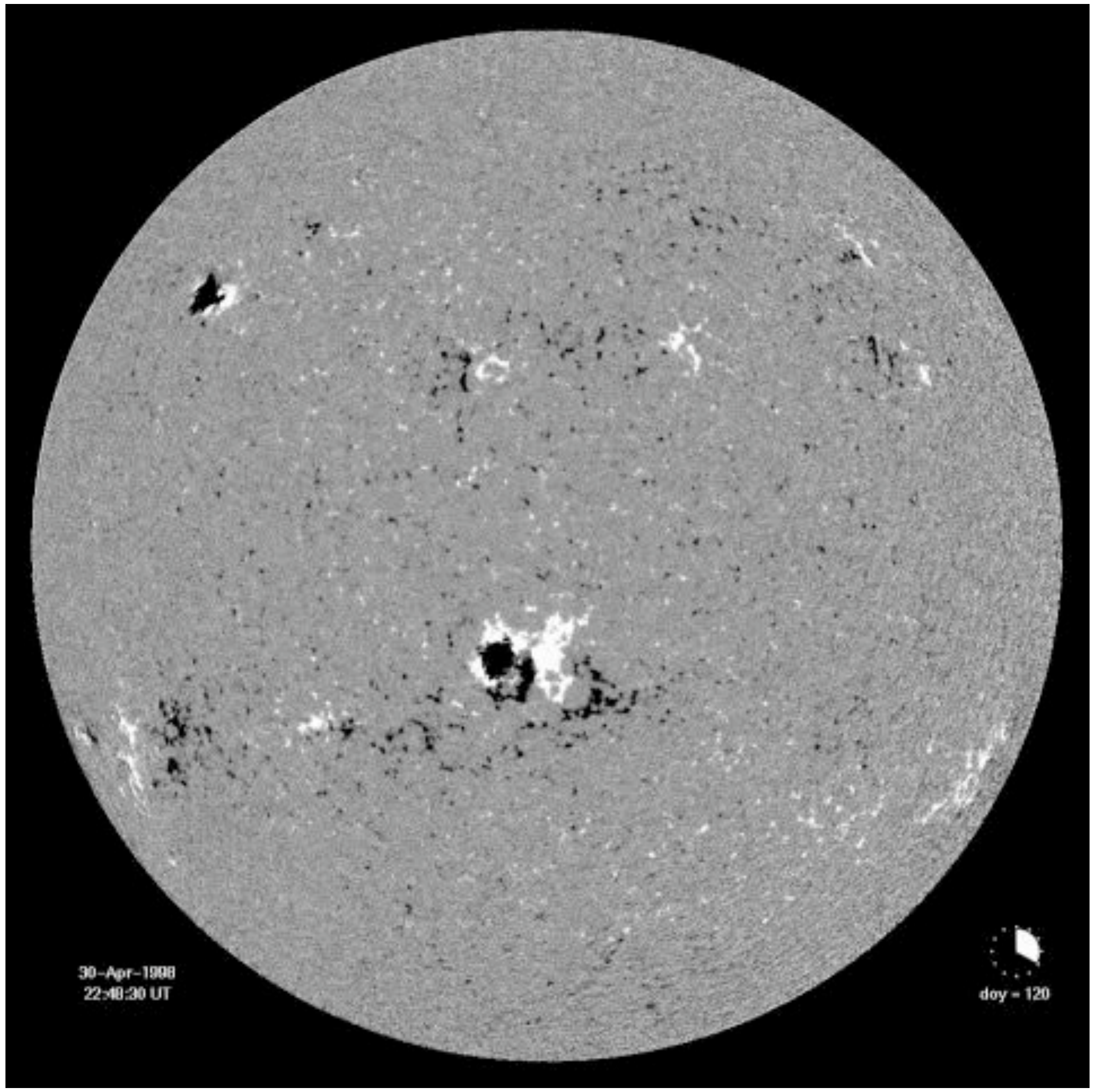


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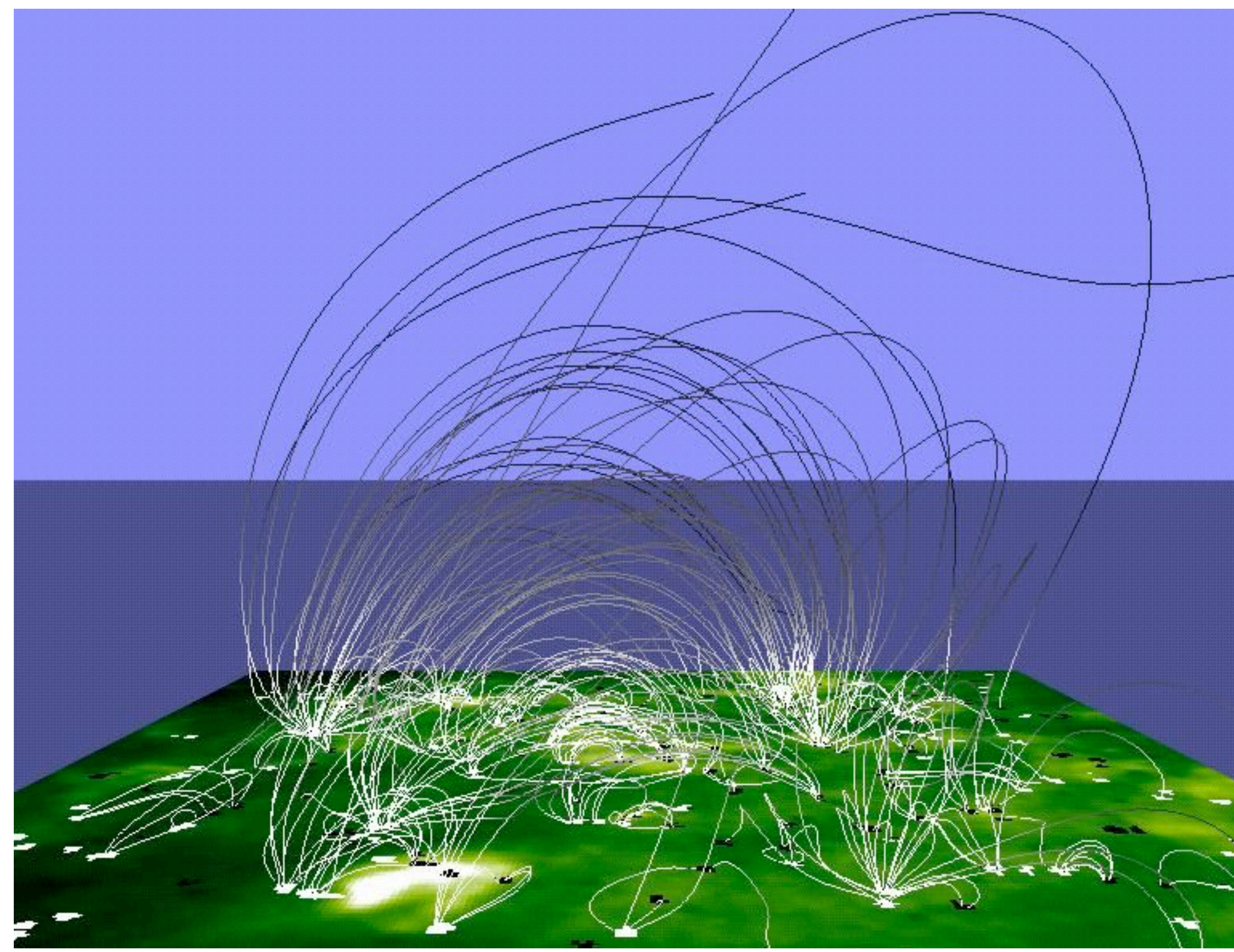
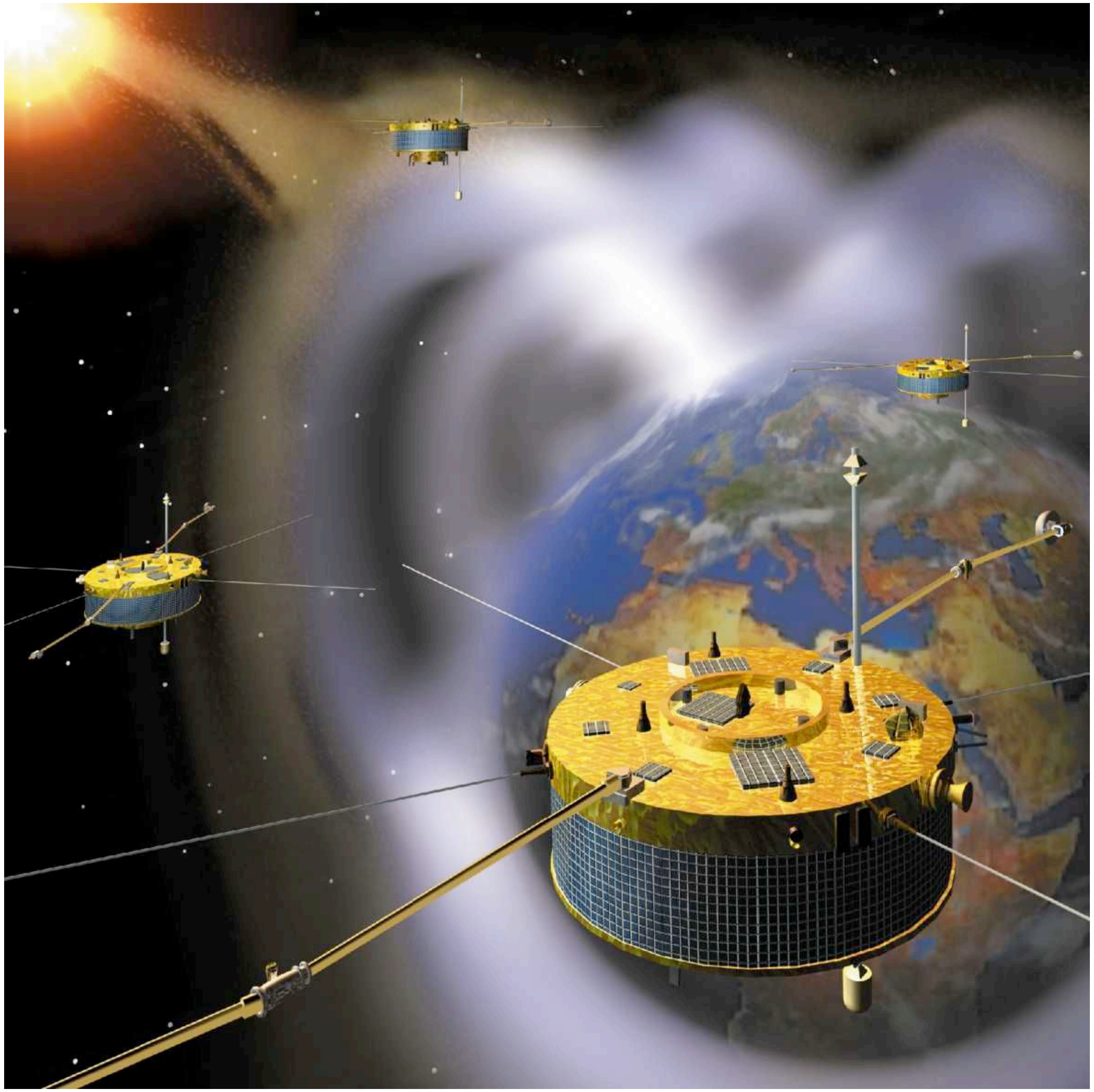


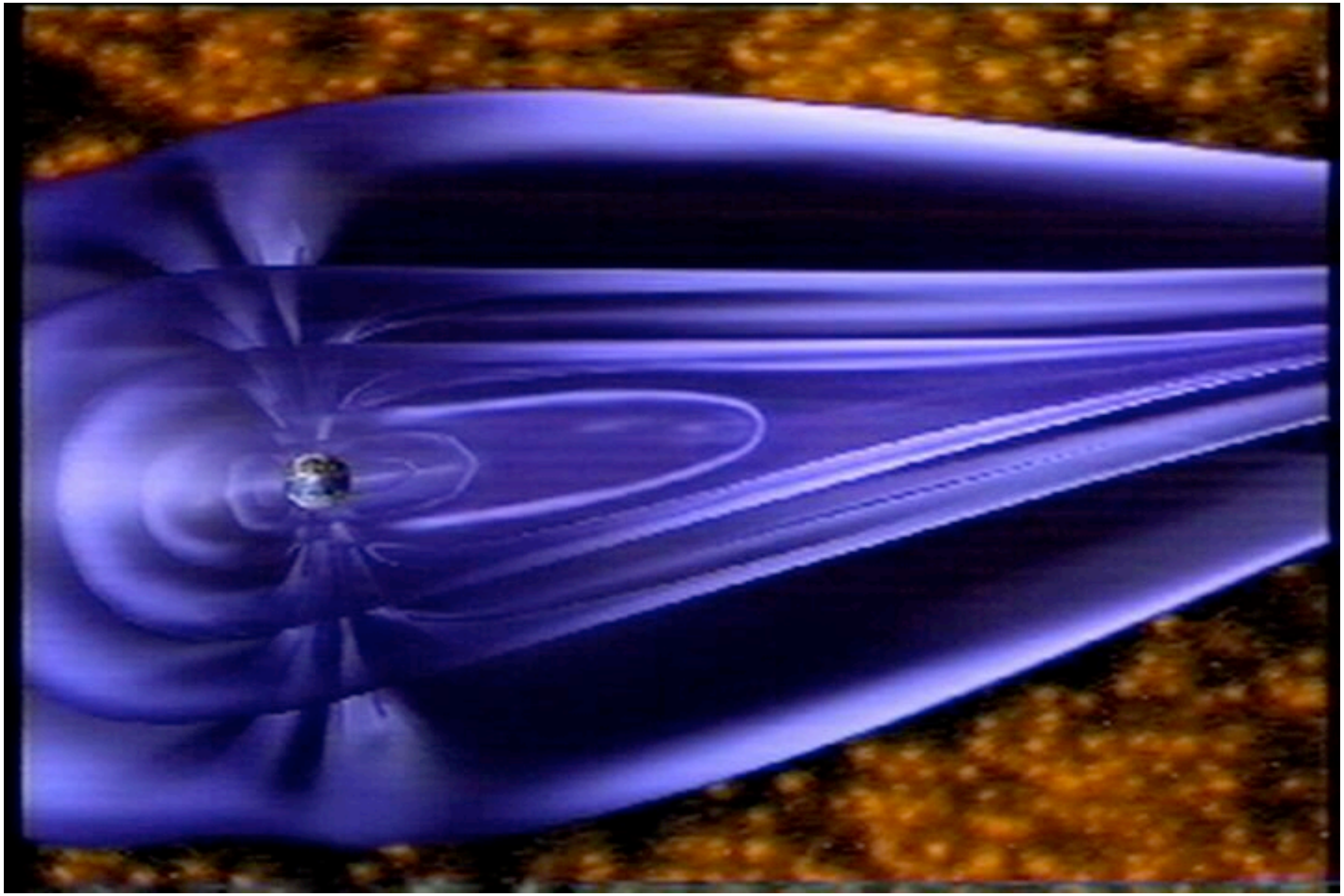
*Schrijver et al., Nature 1998*

# Cluster - The Magnetosphere in 3D



- 4 spacecraft to study plasma processes in the Earth's magnetosphere in 3 D
- Launched in 07-08/2000 into an elliptical polar orbit

# Cluster - Observing Magnetic Reconnection in 3D



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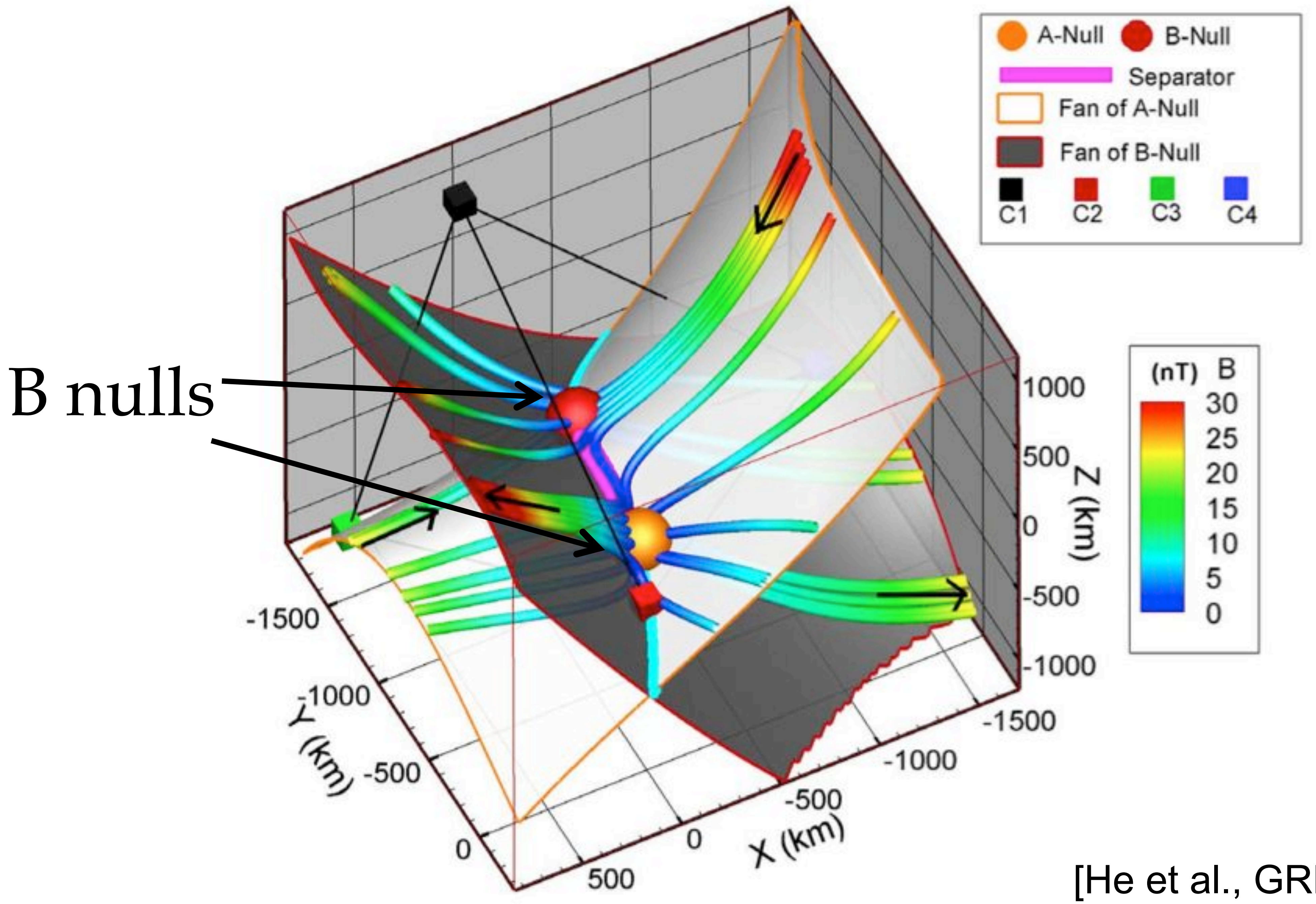
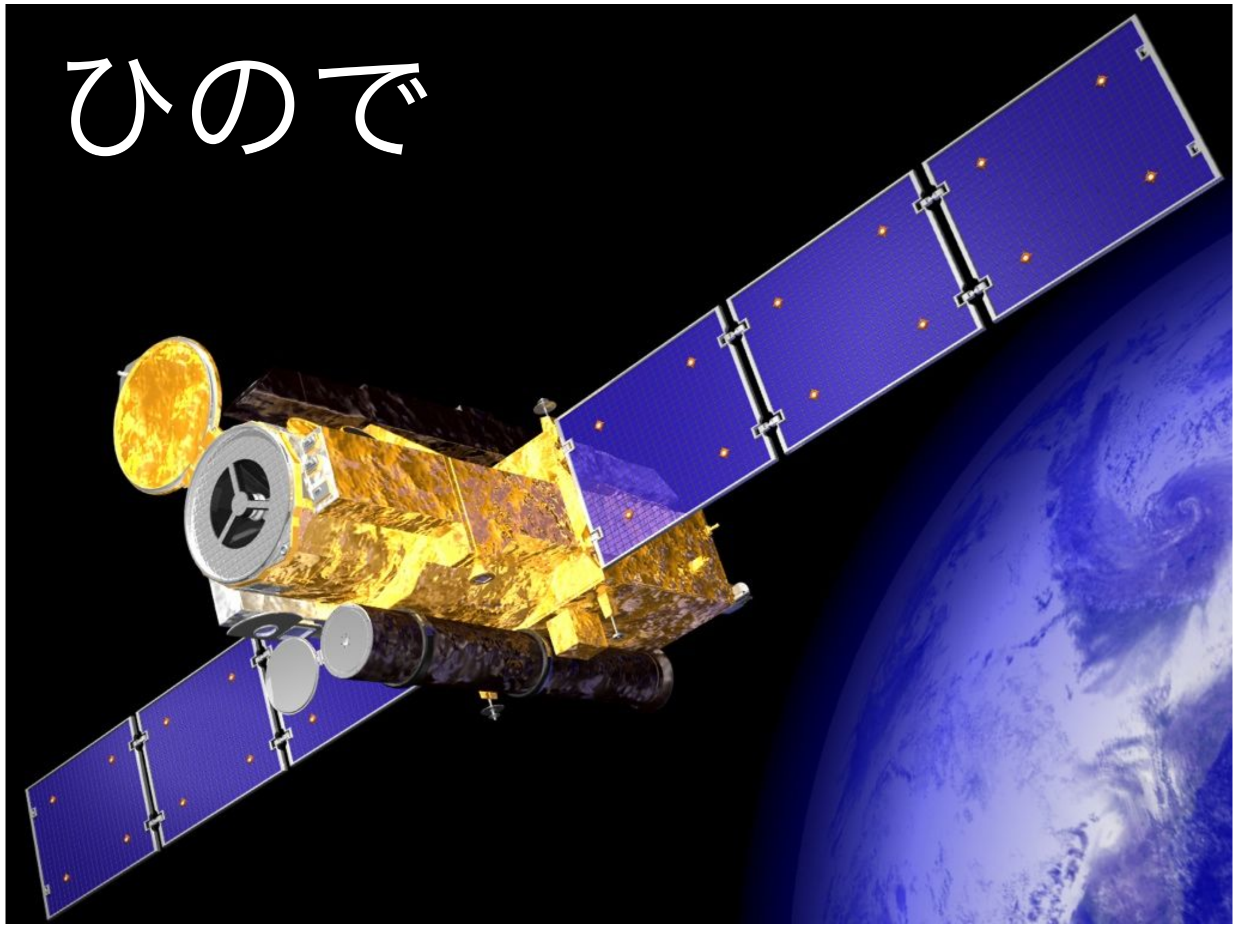


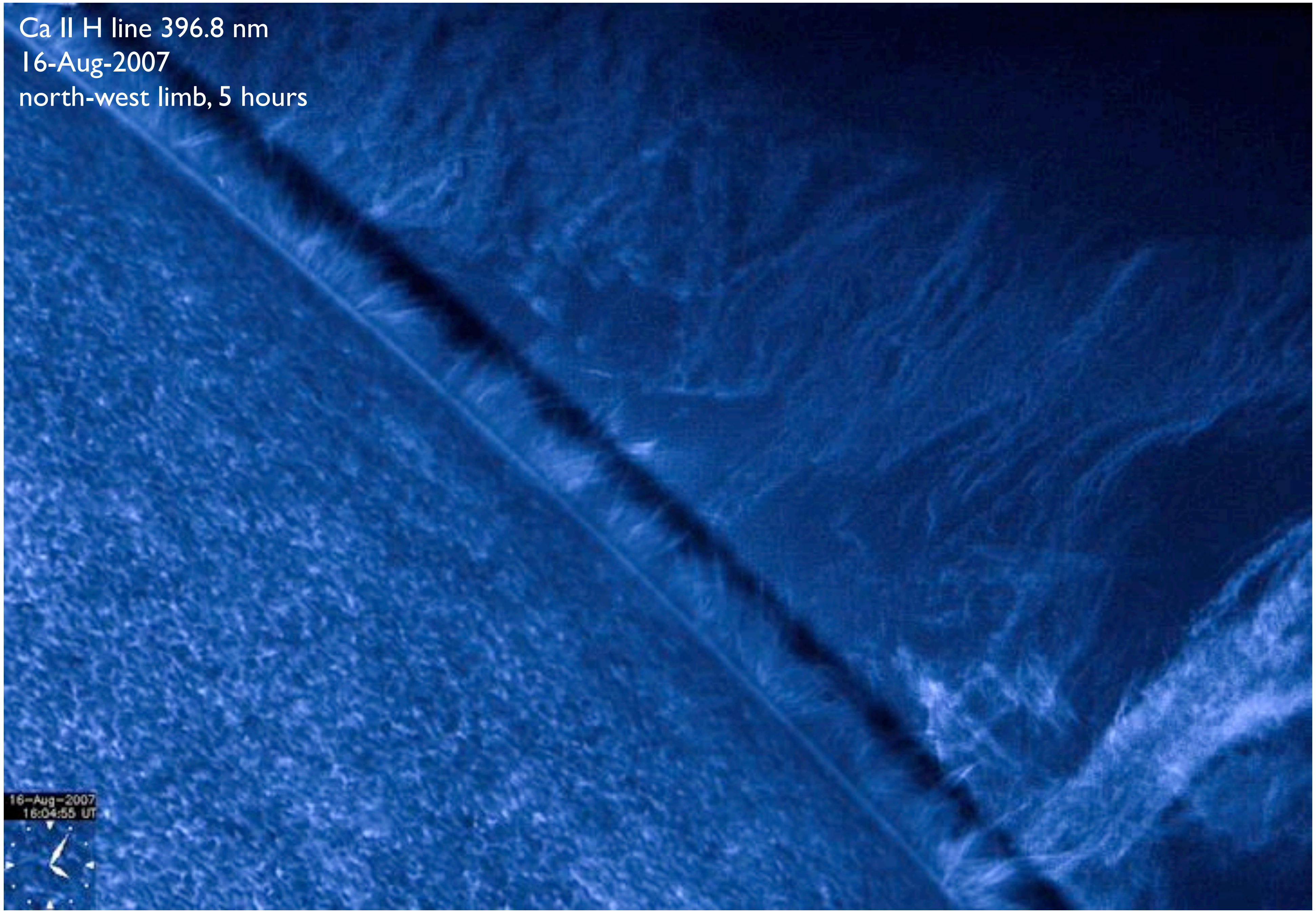

[He et al., GRL, 2008]

# Hinode - Here Comes The Sun [G. Harrison]

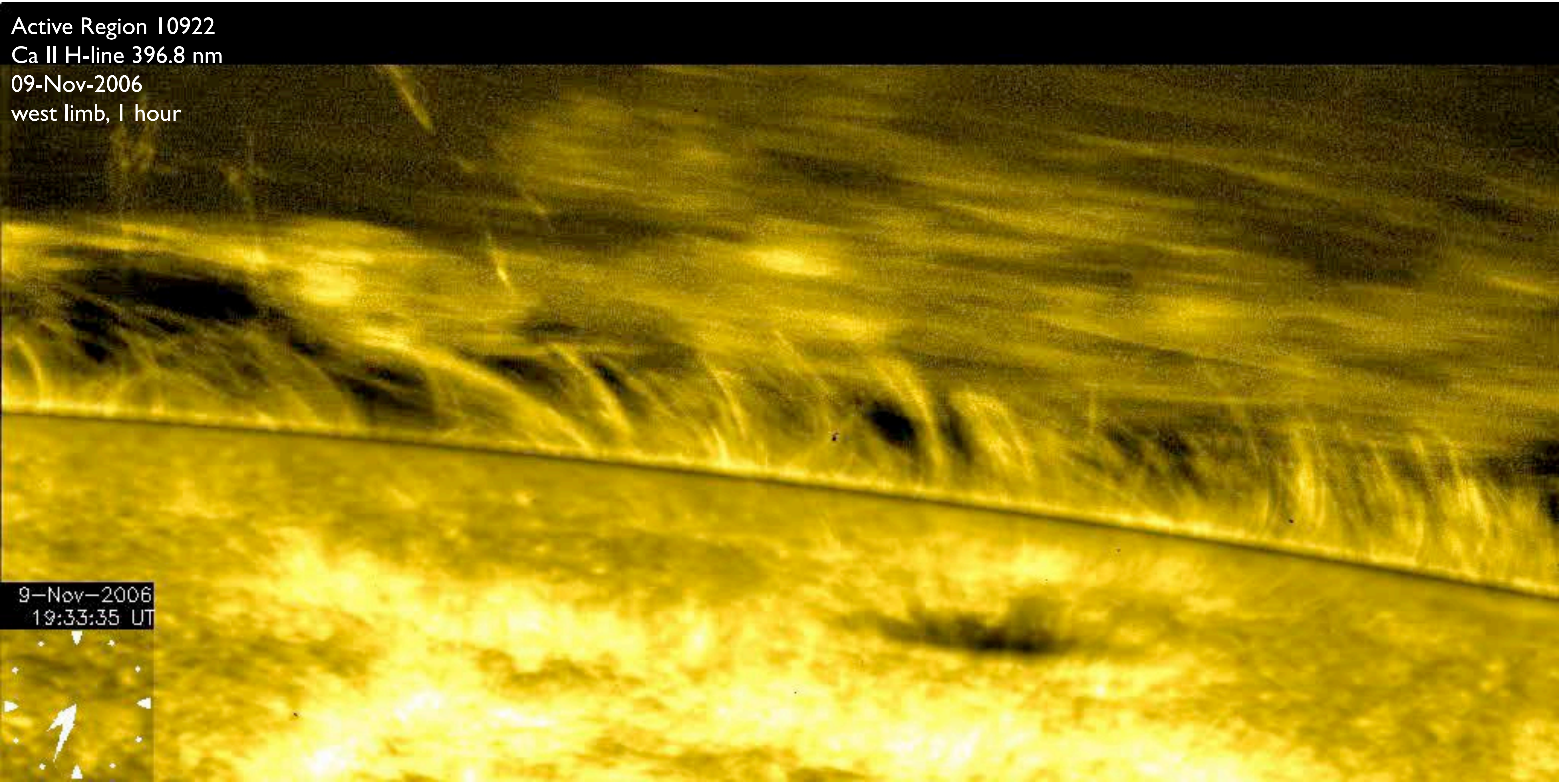



- Japanese mission with international partners (NASA/UK/ESA), launched in 09/2006
- 3 instruments:
  - Solar X-ray telescope (XRT)
  - EUV imaging spectrometer (EIS)
  - Solar Optical Telescope (SOT) with 0.2” resolution and full Stokes polarimeter

# Prominence Observations: Large-Scale Bubbles



# Counter-streaming Flows and Alfvén Waves



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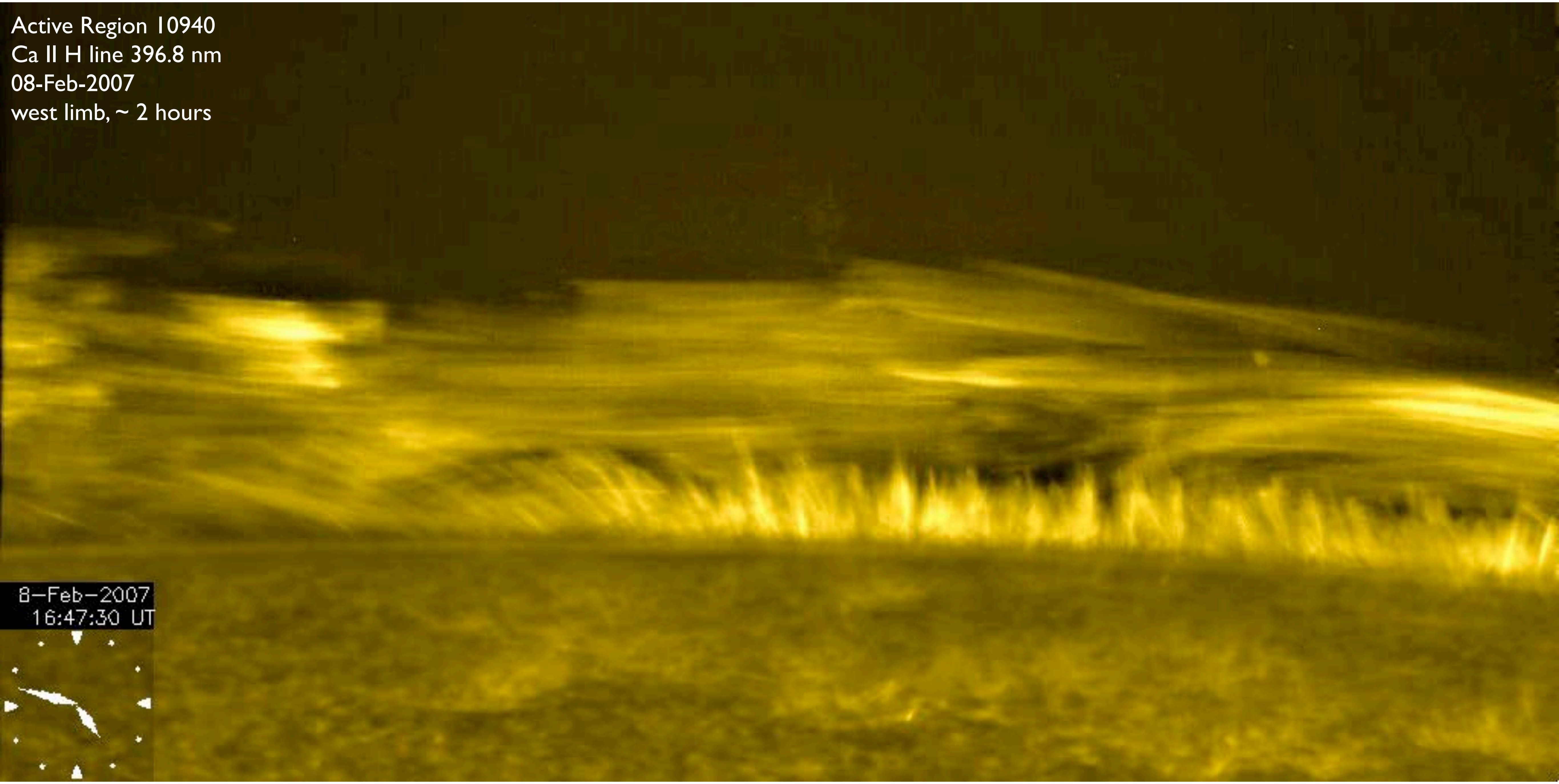
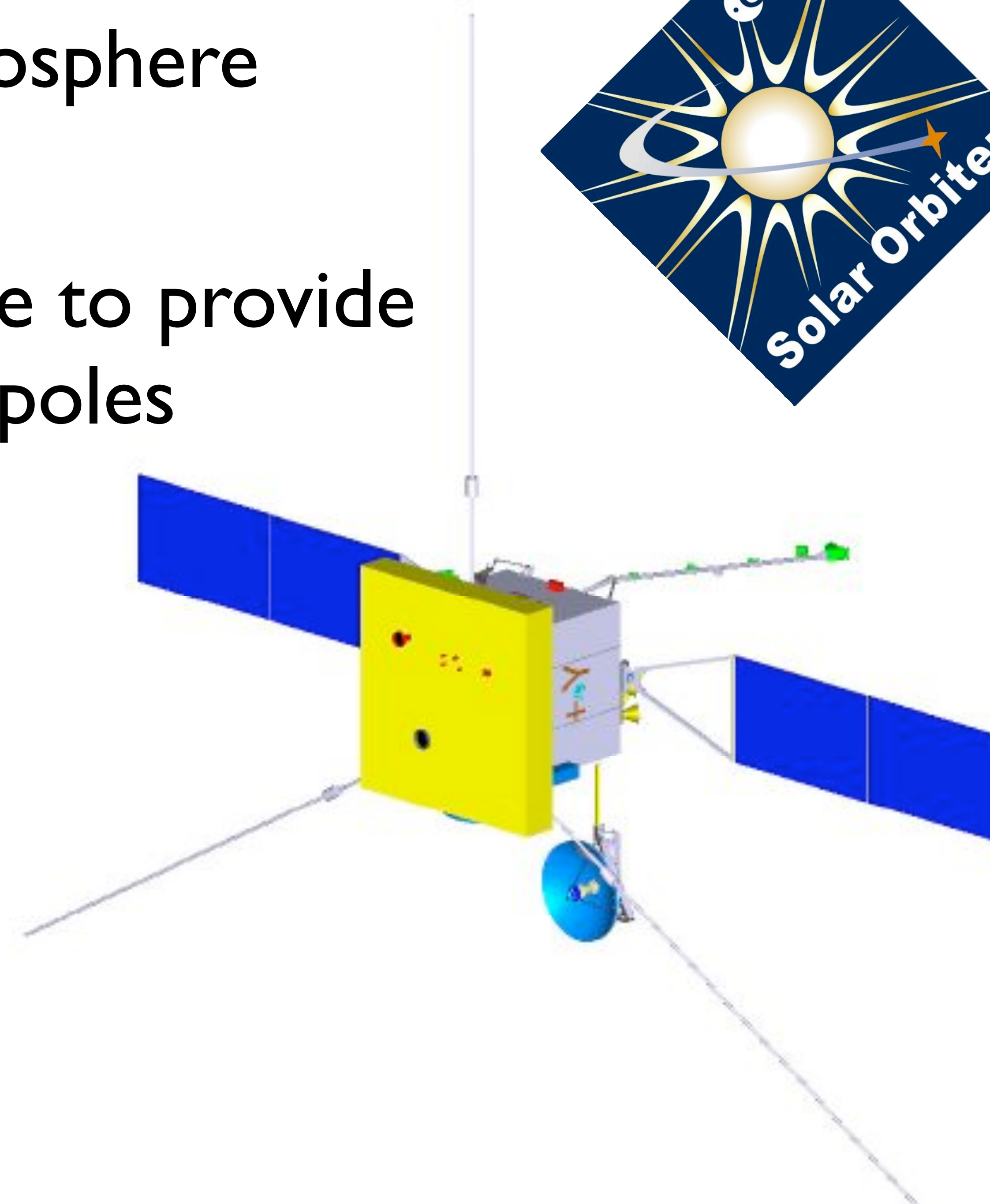
# Counter-streaming Flows and Alfvén Waves II



# Solar Orbiter - Letters From High Latitudes

- Goal: Linking the Sun and inner heliosphere
- Final perihelion of 0.2 AU
- Will reach >30° heliographic latitude to provide first ever detailed view of the Sun’s poles



# Solar Orbiter - Science Goals

1. Determine the properties, dynamics and interactions of plasma, fields and particles in the near-Sun heliosphere
2. Investigate the links between the solar surface, corona and inner heliosphere
3. Explore, at all latitudes, the energetics, dynamics and fine-scale structure of the Sun's magnetized atmosphere
4. Probe the solar dynamo by observing the Sun's high-latitude field, flows and seismic waves

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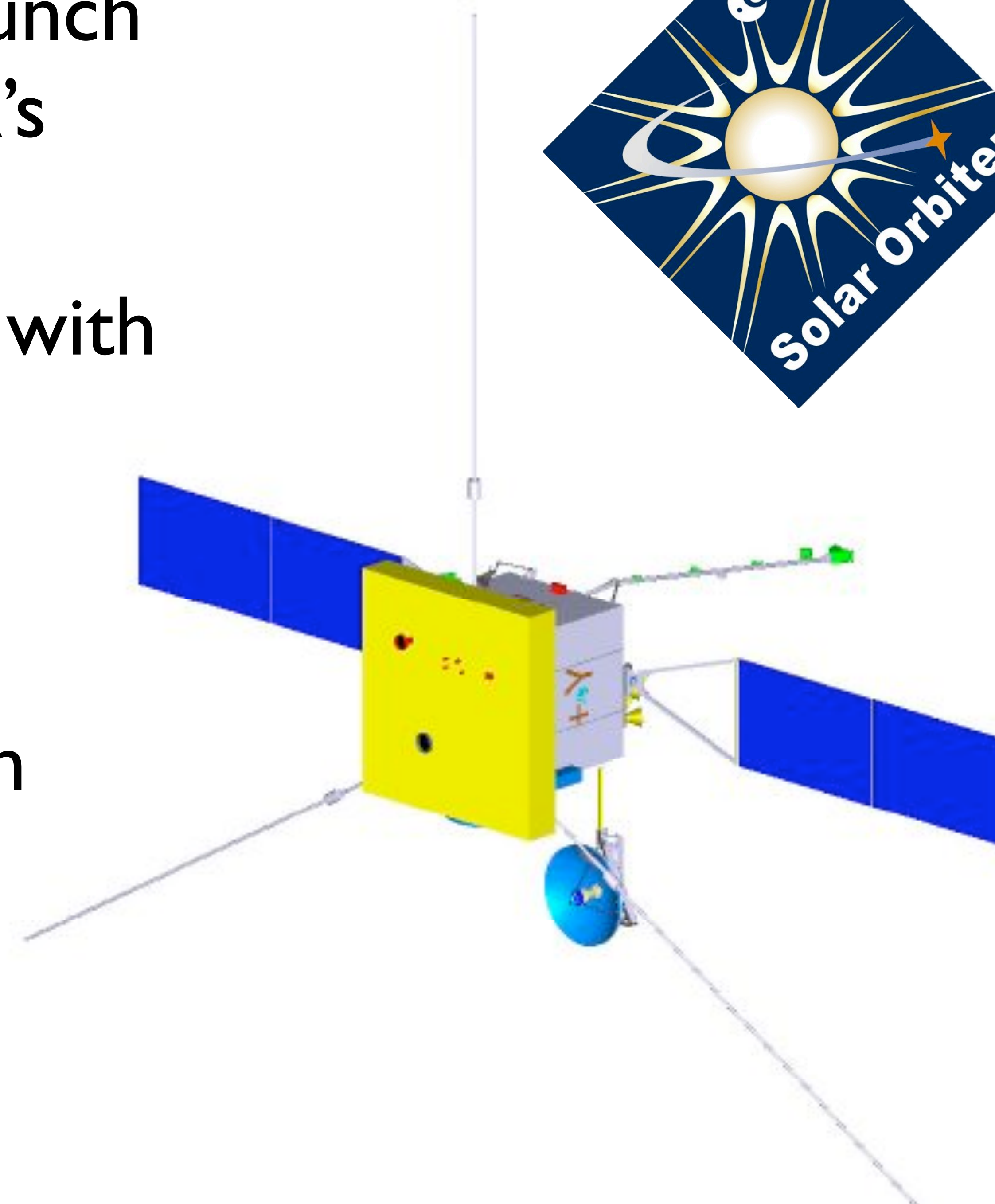
**Combination of remote sensing + in-situ science**

# Solar Orbiter - Current Status

- Solar Orbiter is competing for a launch in 2017 as a M-class mission in ESA's Cosmic Vision Programme
- Joint ESA/NASA mission, synergies with NASA's Solar Probe+
- Preliminary payload selection announced on March 20, 2009
- Decision on next phase expected in early 2010



# The End

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