Data-Optimized Coronal Field Model (DOC-FM)

An HAO-CISL collaboration

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NCAR　　　UCAR　　　NSF

222b Baker Street

From *The Adventure of the Speckled Band*

"Good-morning, madam," said Holmes cheerily. *"My name is Sherlock Holmes.*

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Her features and figure were those of a woman of thirty, but her hair was shot with premature grey, and her expression was weary and haggard.

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"We shall soon set matters right, I have no doubt. You have come in by train this morning, I see. ...
and yet you had a good drive in a dog-cart, along heavy roads, before you reached the station.
..."

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"The left arm of your jacket is spattered with mud in no less than seven places. The marks are perfectly fresh.

There is no vehicle save a dog-cart which throws up mud in that way, and then only when you sit on the left-hand side of the driver."

Holmes' Calculation

Before meeting Ms. Helen Stoner:

- A PRIOR probability of type of **vehicle**

Knowledge of vehicles effects:
- LIKELIHOOD of **observation** *given* type of **vehicle**

Combine prior with observation:
- POSTERIOR is a product:

Likelihood of **mud stains** *given* type of **vehicle**

$\times$ Probability of type of **vehicle**

Maximize over **vehicle**

Holmes' Conclusion: highest probability - vehicle = dog cart

Space weather alerts: A 21st century necessity

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Back-to-back solar flares prompt strong geomagnetic storm watch
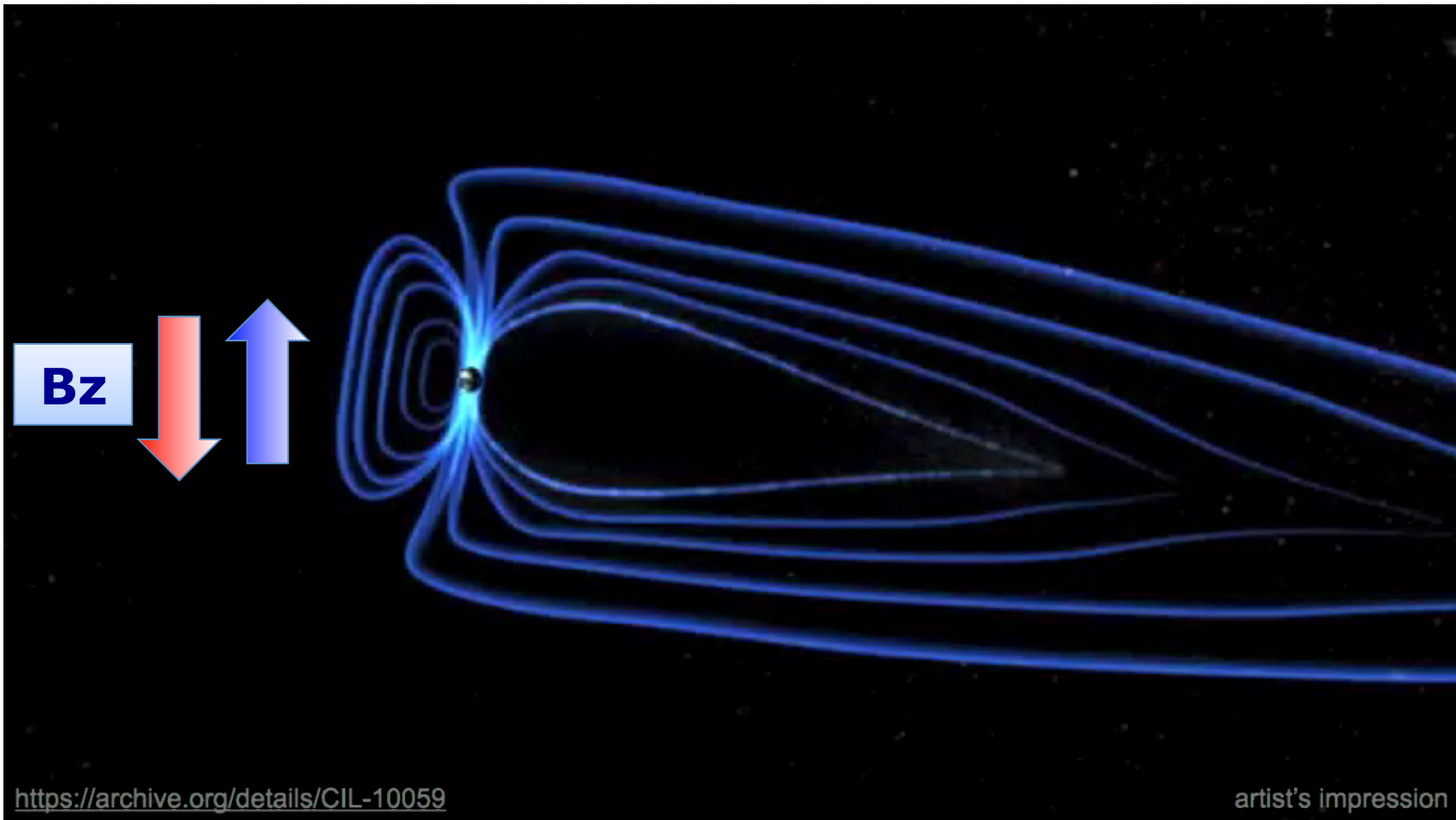
BY **ANGELA FRITZ** ✉ September 11 at 11:34 am

Why did we get this forecast wrong?

We are living in the outer atmosphere of the Sun
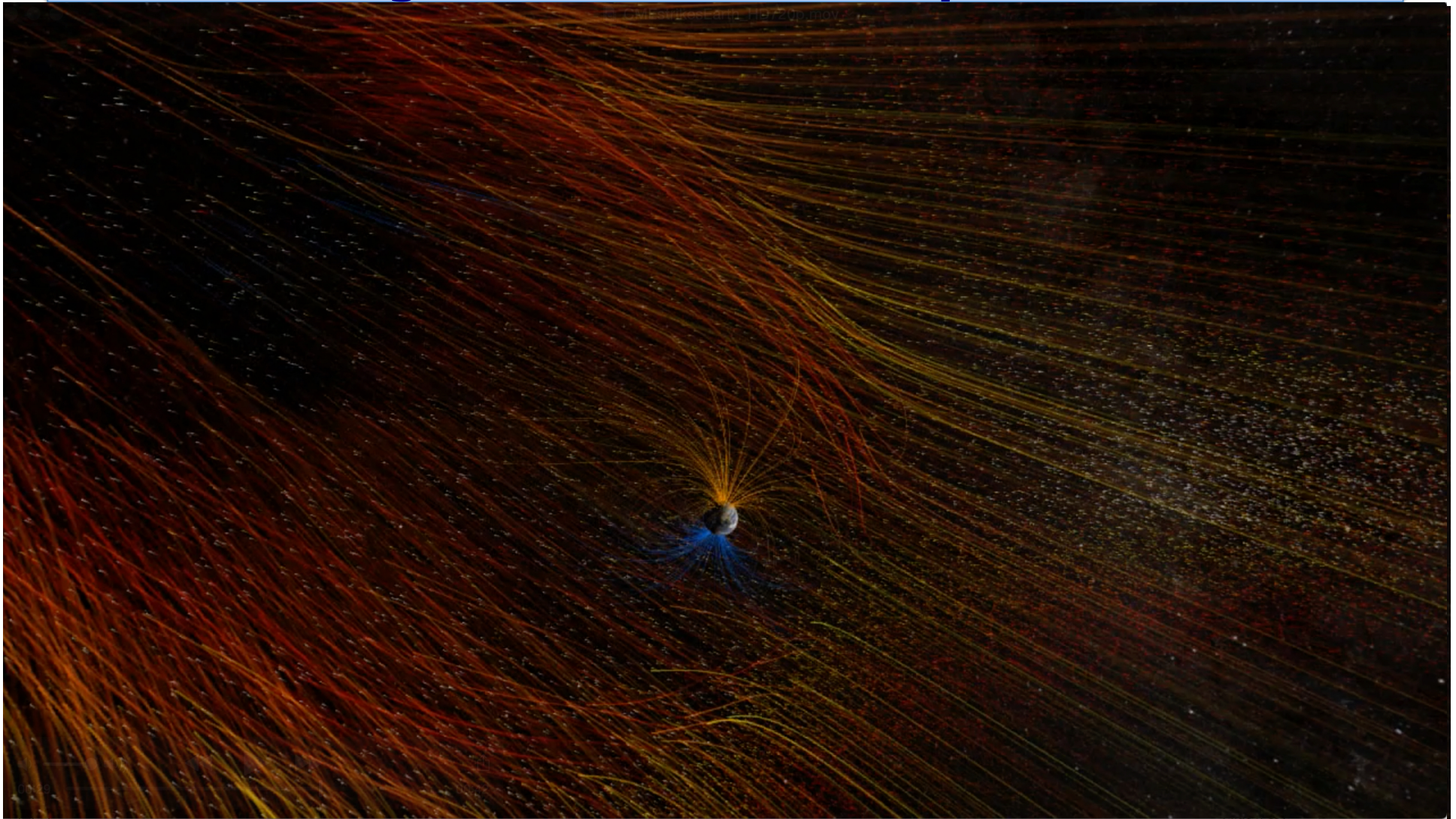
Earth's magnetic field acts as a shield

Under certain conditions, the shield can break

Bz

https://archive.org/details/CIL-10059

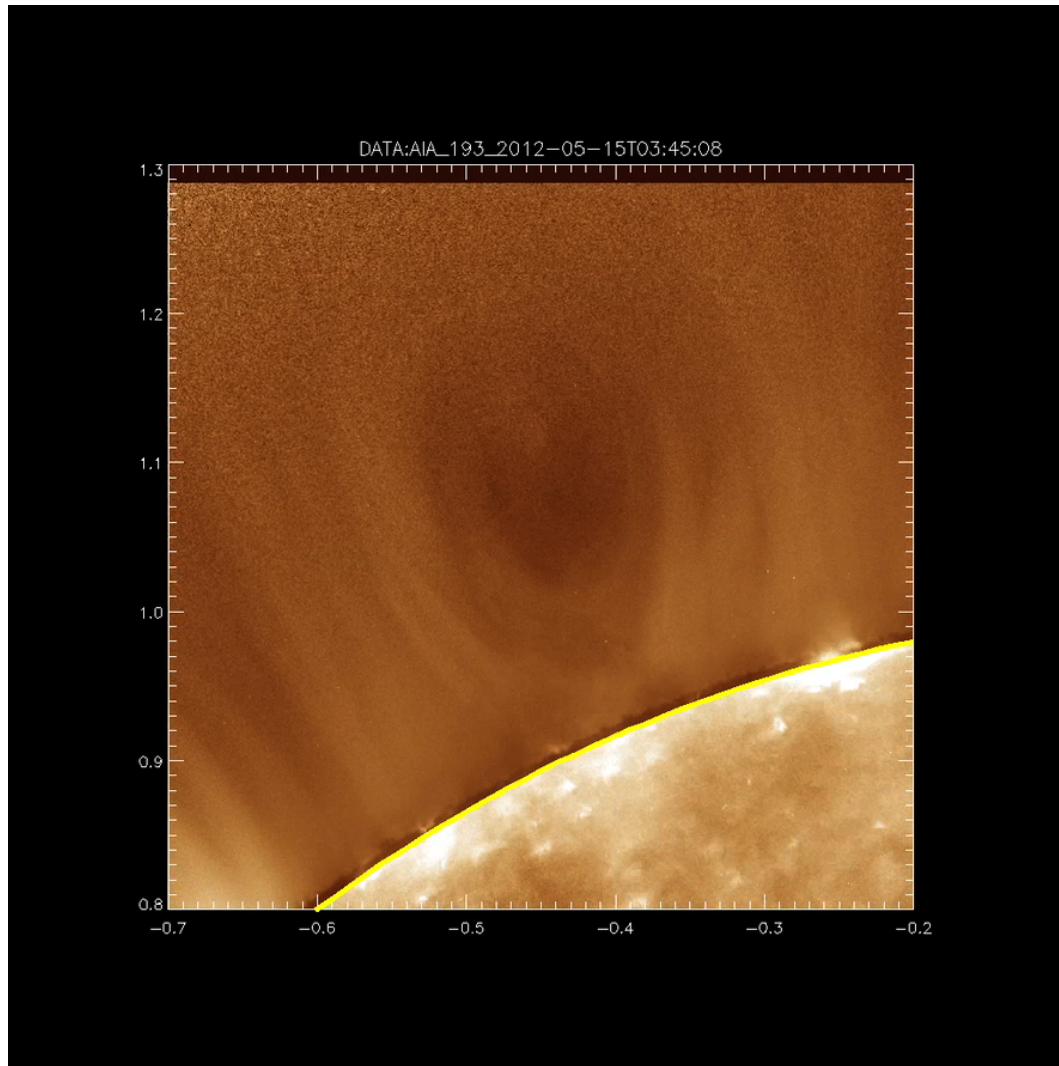artist's impression

Direction of magnetic field matters (southward Bz)

The good news: we usually know when something is coming!
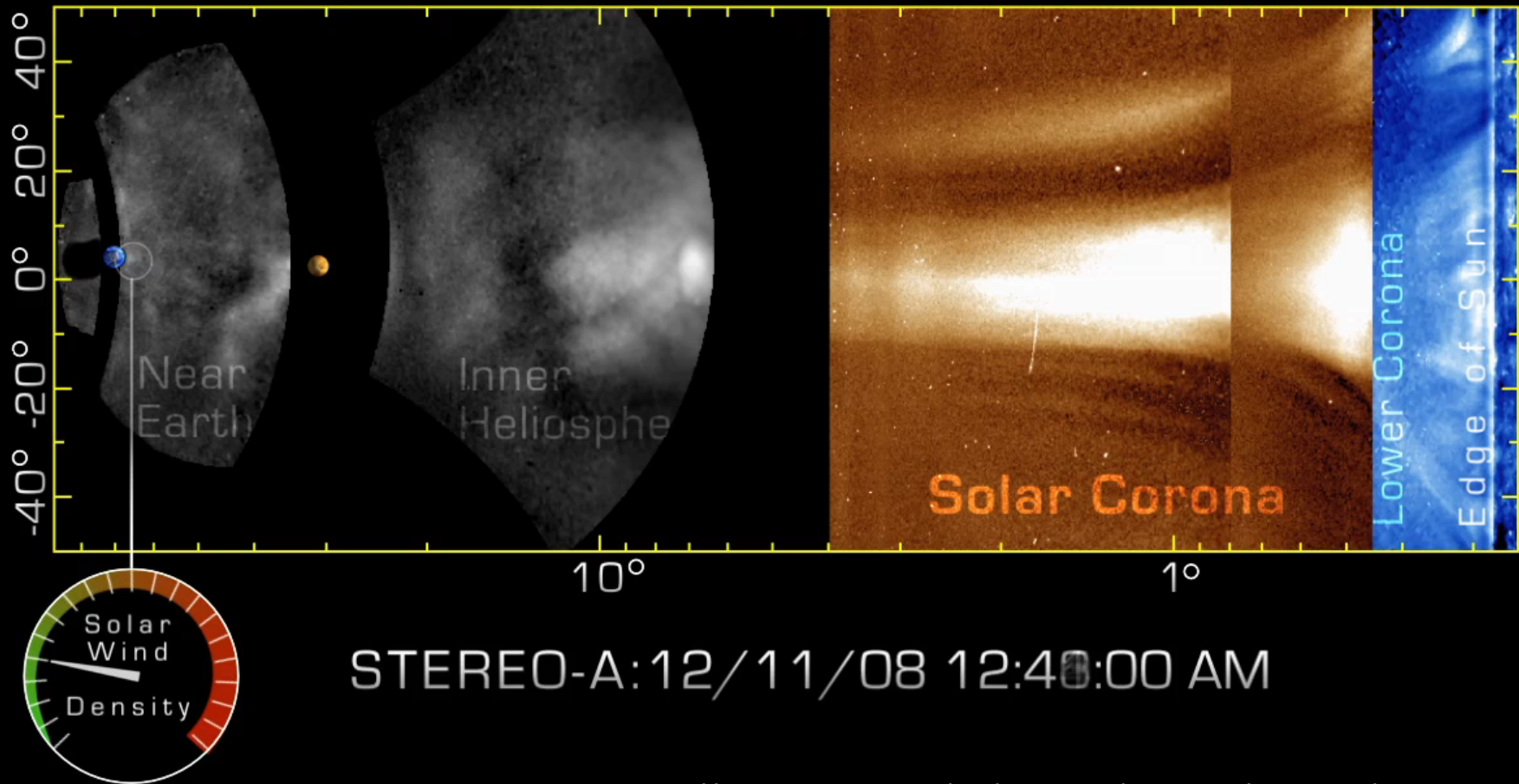
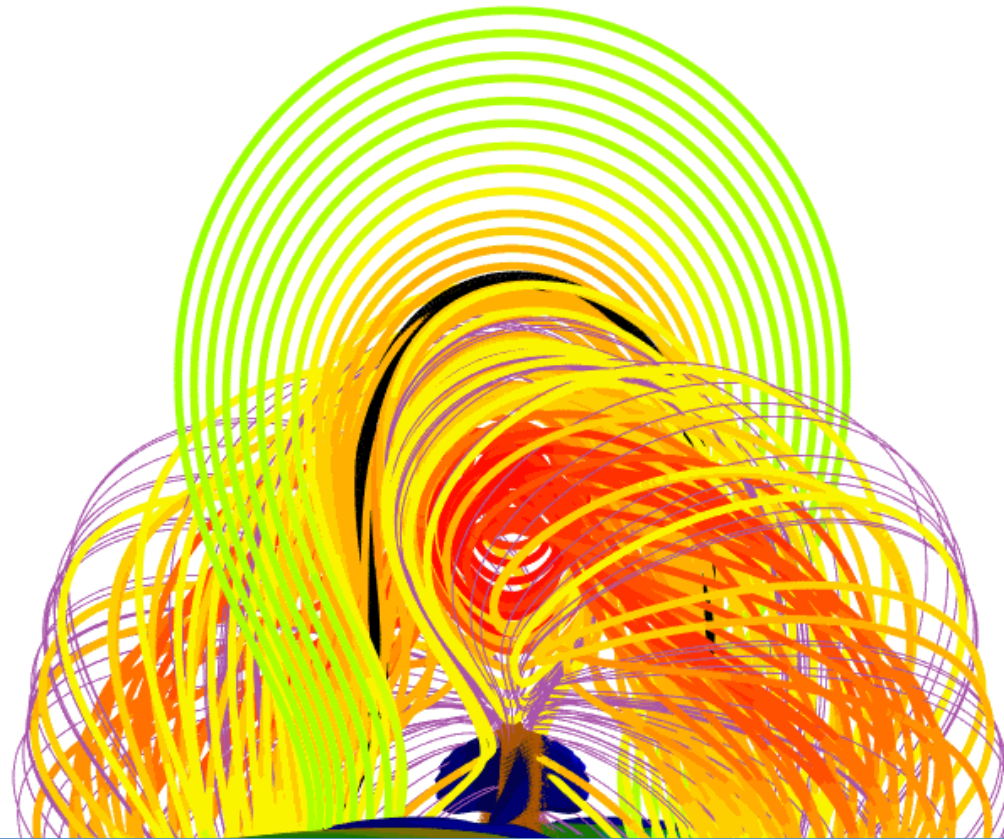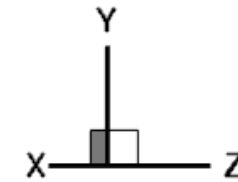**The bad news: we generally don't know its magnetic orientation.**

STEREO-A:12/11/08 12:48:00 AM

http://svs.gsfc.nasa.gov/vis/a010000/a010800/a010809/index.html

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Coronal cavities – a space weather source

DATA:AIA_193_2012-05-15T03:45:08

We would like to be able to deduce their magnetic field

Magnetic flux rope – magnetically-energized model

Likelihood: magnetic flux ropes match observations

Data · Model — Morphology

Data · Model — Structure

Data · Model — Flows

POS-flow (AIA) · LOS-flow (Doppler)
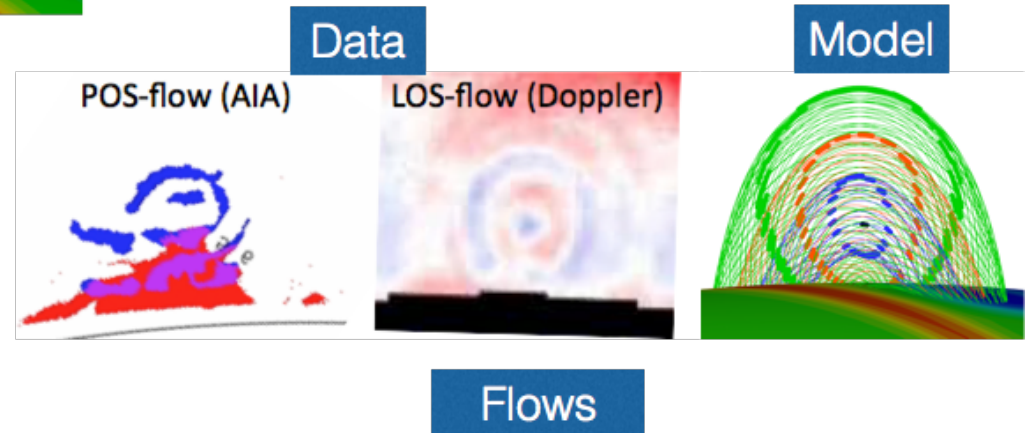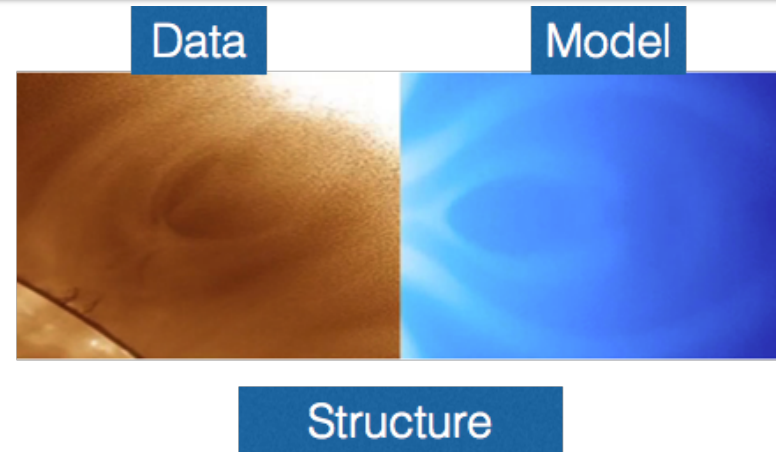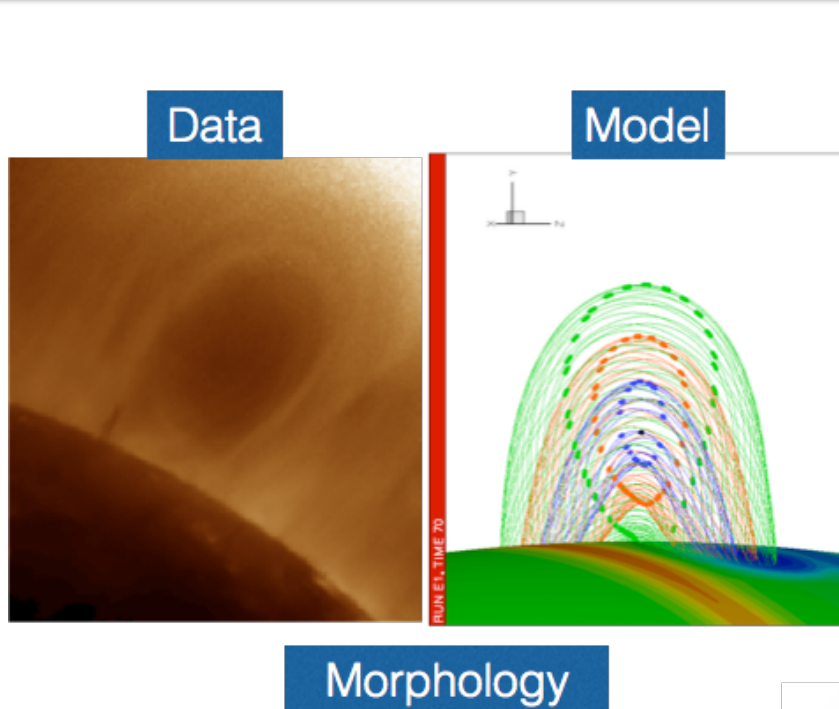
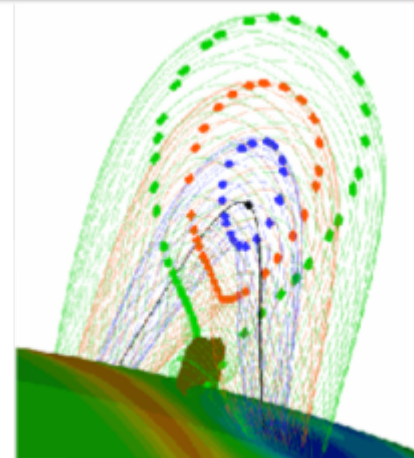## Our Conclusion: highest probability -- cavity = flux rope

Compares well – but how do we translate to a quantified coronal magnetic field distribution?

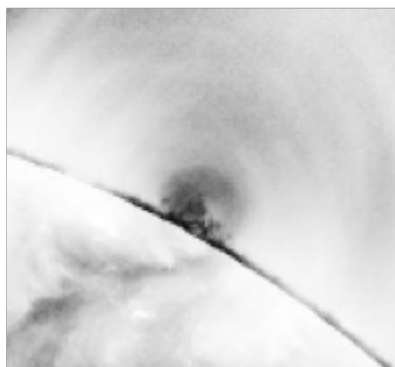Forward-modeled Fan flux rope | CoMP Linear polarization
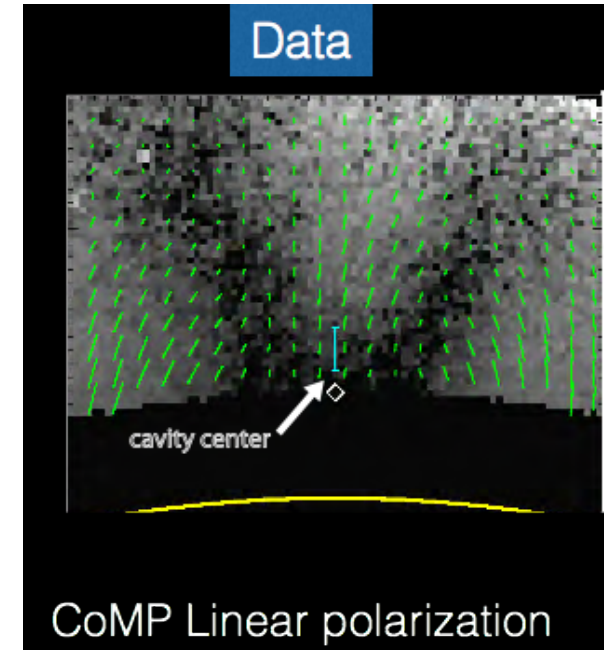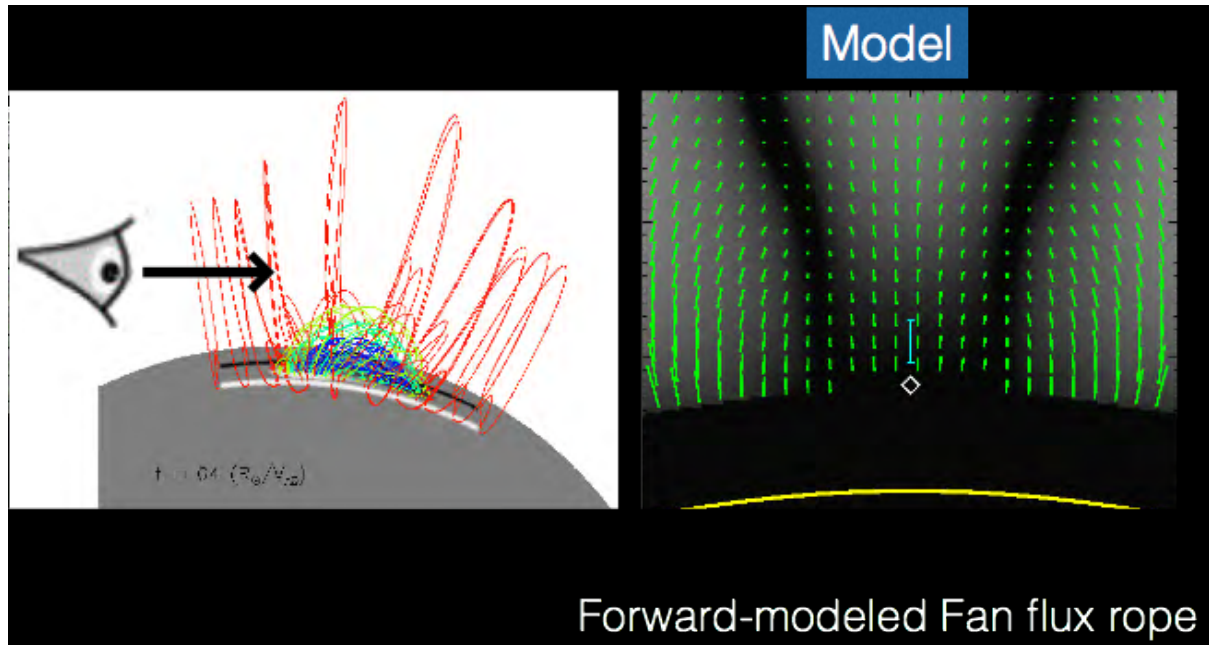
Pick observations that directly constrain magnetism

Pick parameters that best match observations and prior knowledge
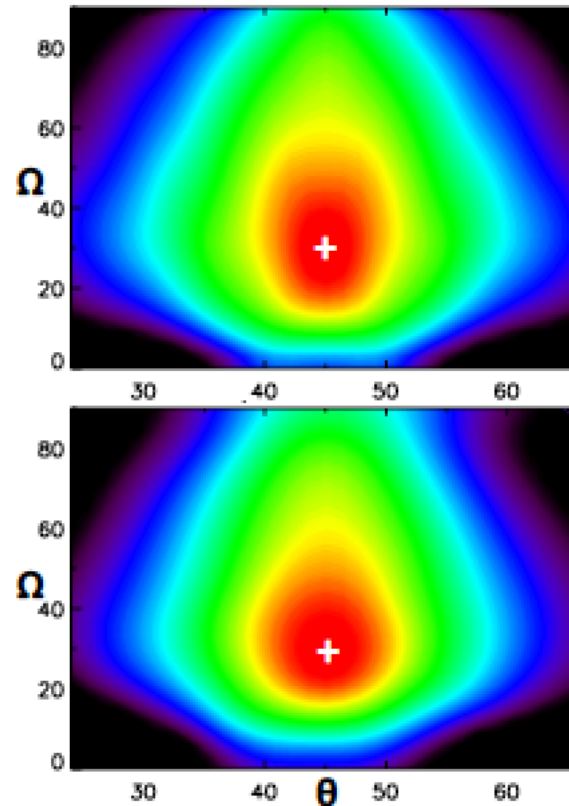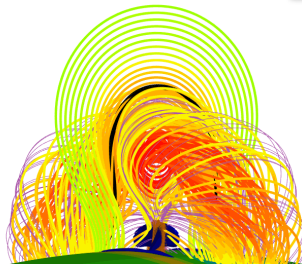

Model
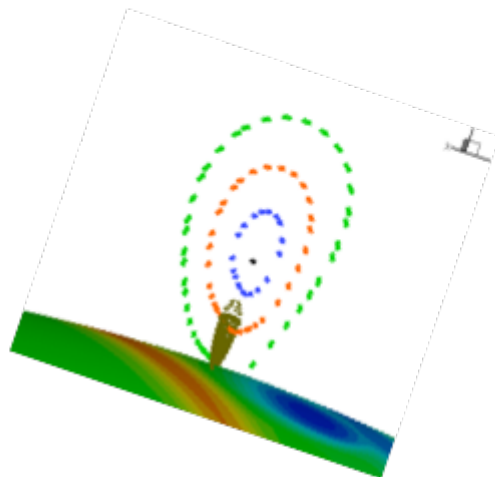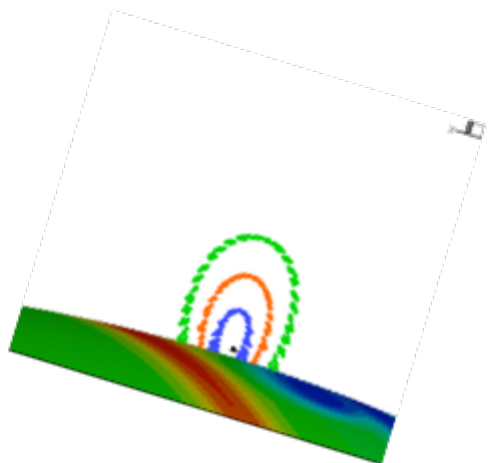
Data

Maximize the posterior

Pick parameters that best match observations and prior knowledge
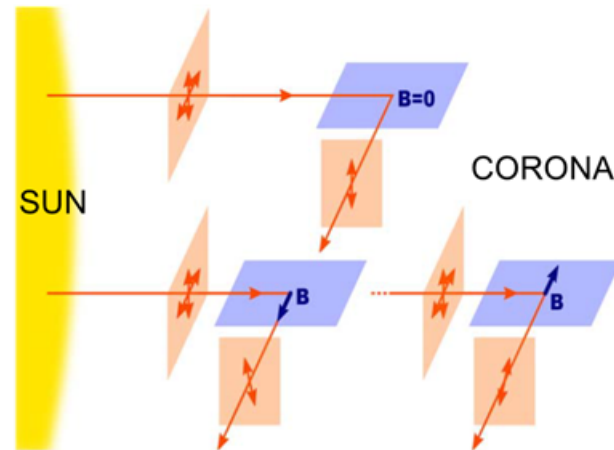

Maximize the posterior

Data-Optimized Coronal Field Model (DOC-FM)

Model of the solar coronal *physical state* (magnetic field, density, temperature..)
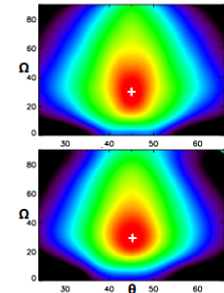Use priors!

Maximize posterior

Forward operation of magnetically-sensitive *physical processes* on the physical state, resulting in synthetic observations

Calculation of likelihood comparing synthetic vs. measured observations

Modify model