

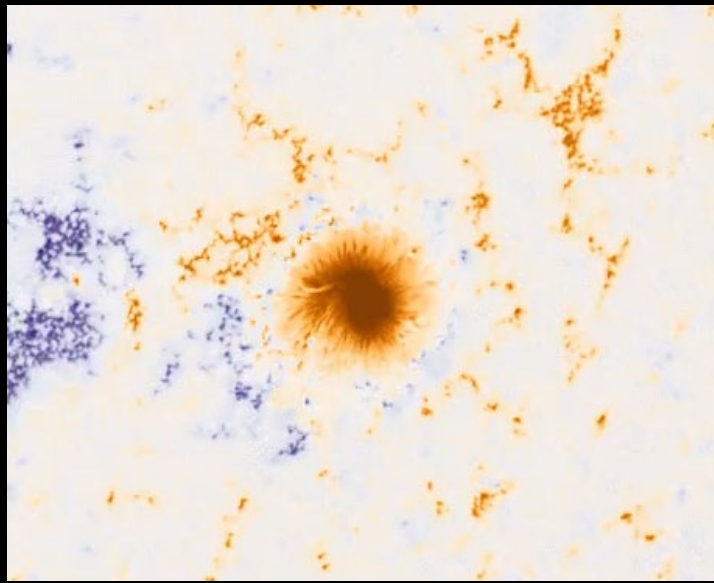
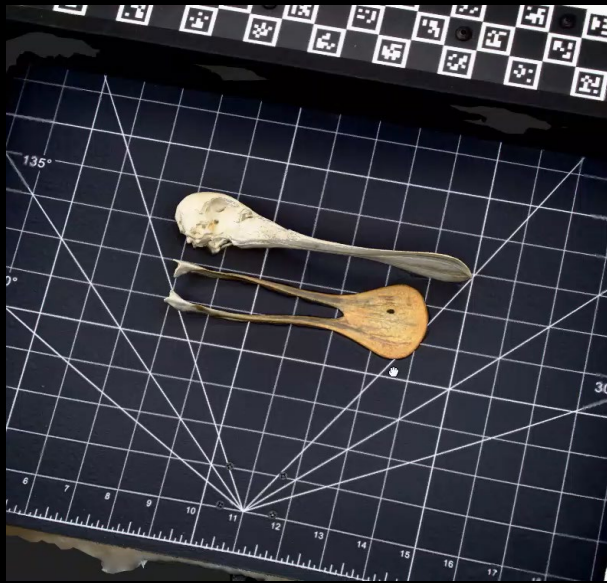
NASEM Panel Discussion

David Fouhey

New York University: Associate Professor, CS & EE

Polymathic AI: Research Scientist & Solar Lead

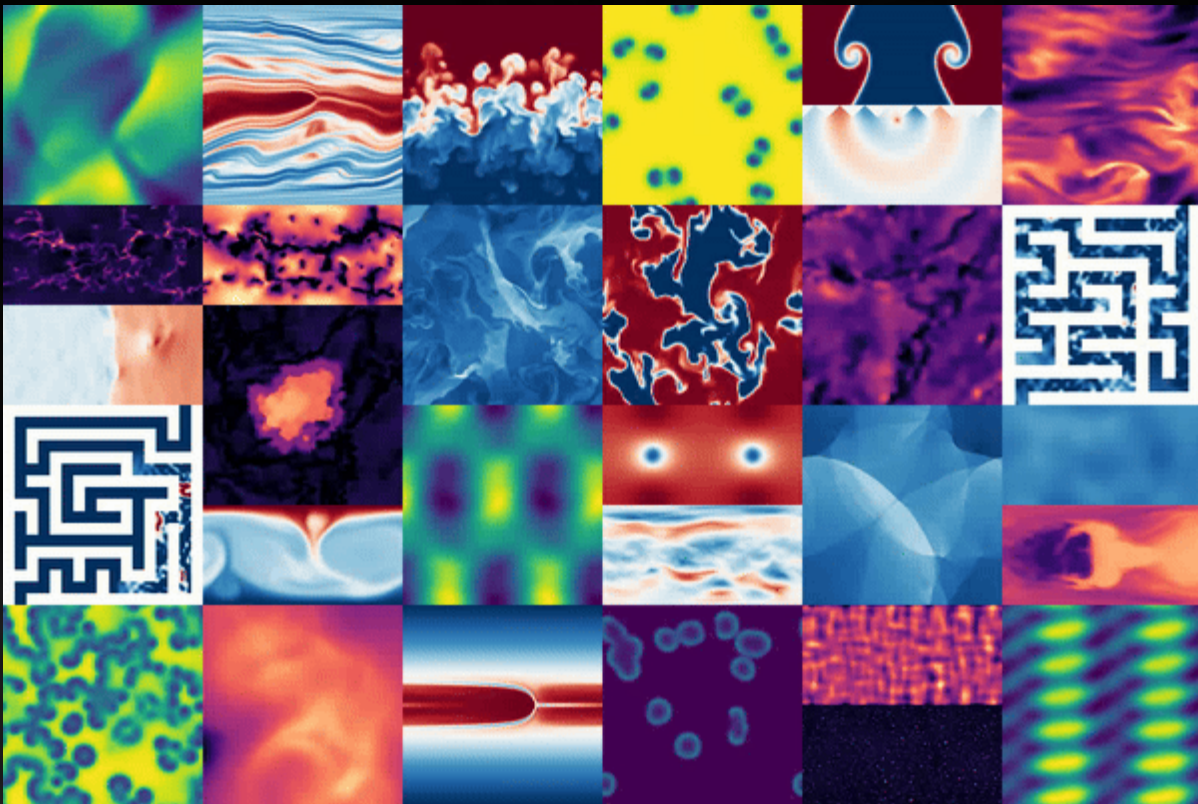
My Background



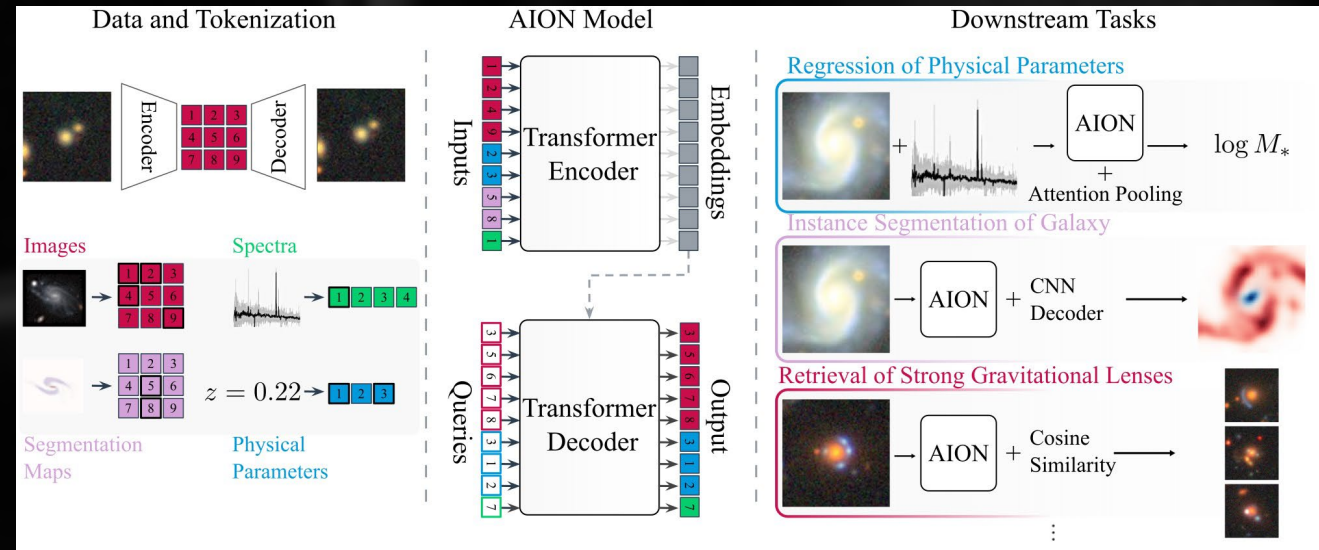
Past 7 Years:
How do we work together
with scientists to solve
challenging problems

Source data: NASA SDO/HMI,
Field Museum of Natural History

Polymathic



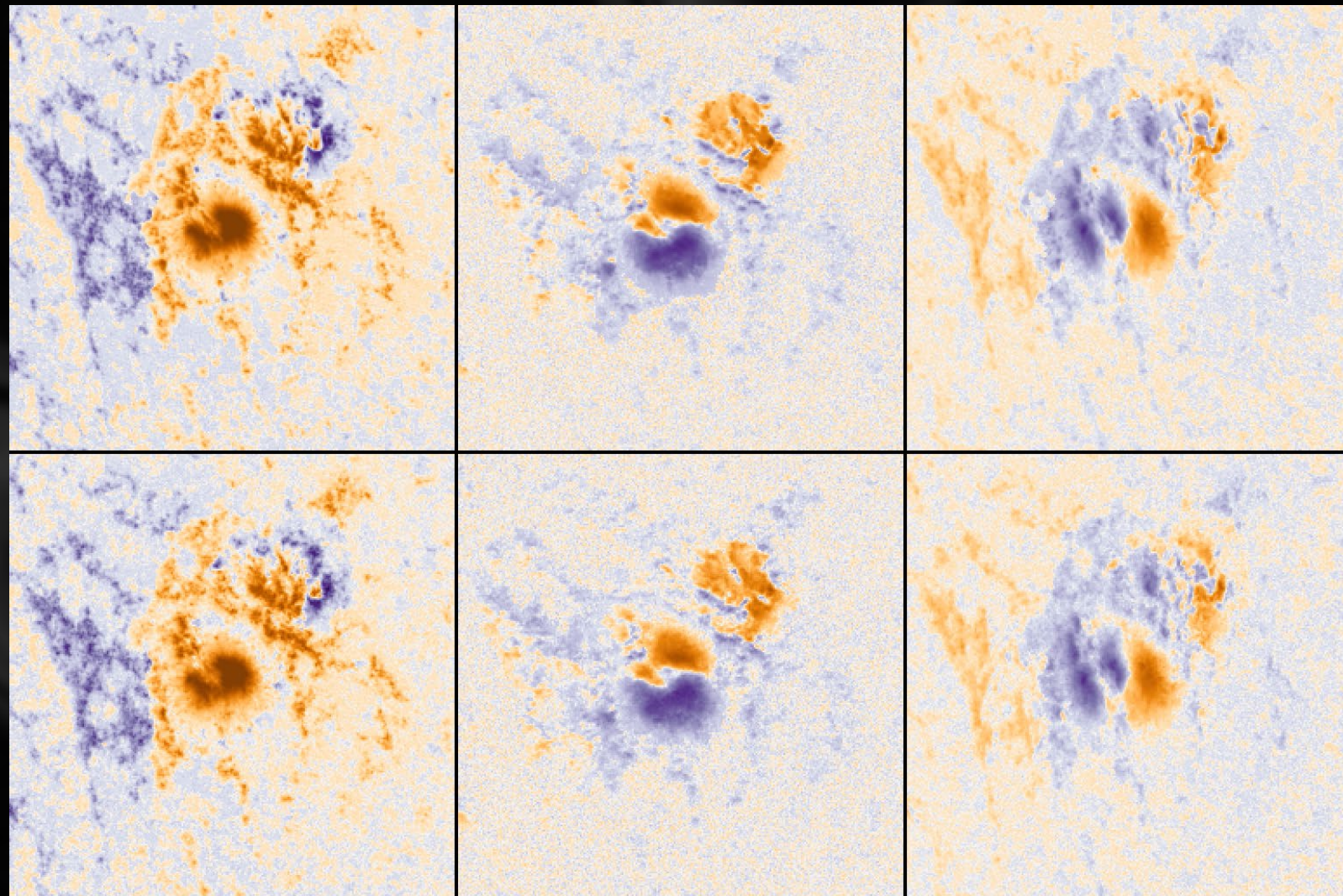
The Well, Ohana, McCabe et al.
Bridging Gaps Across Multiple Problems



AION-1, Parker et al.
Multimodal, Multi-Instrument Foundation Model

Polymathic

SDO/HMI
Reality



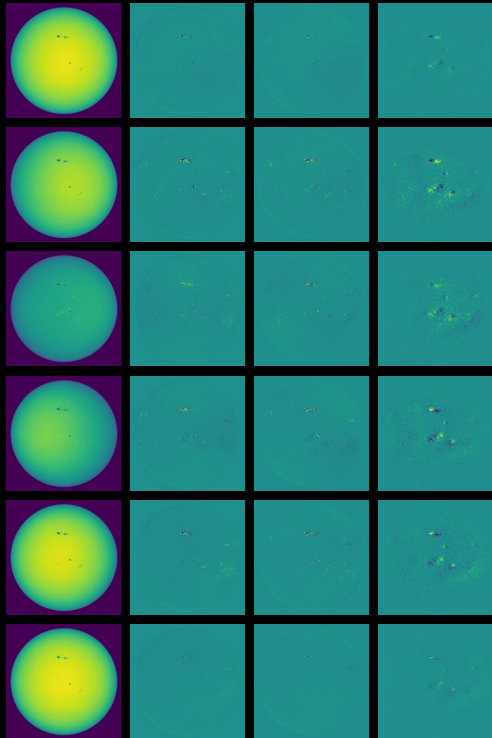
Our
Prediction

Illustrative Example – Space Weather

Illustrative Example – Space Weather

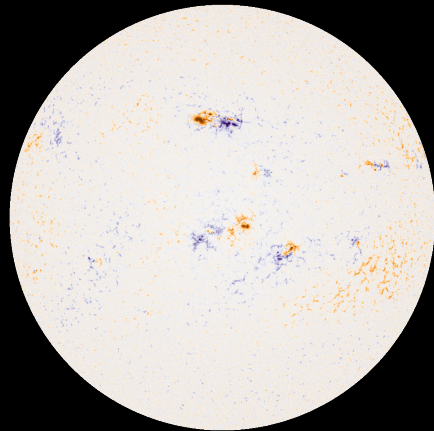
Observations

Stokes Images



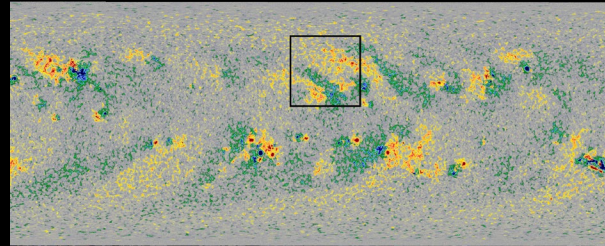
Data Products

Vector Magnetic Field Data



Data Products

e.g., Synoptic Maps



Forecasts

Flares

$P(\text{M Flare}) = 0.7$

$P(\text{X Flare}) = 0.2$

Solar Wind

$v = 500\text{km/s}$

Field = 14 nT



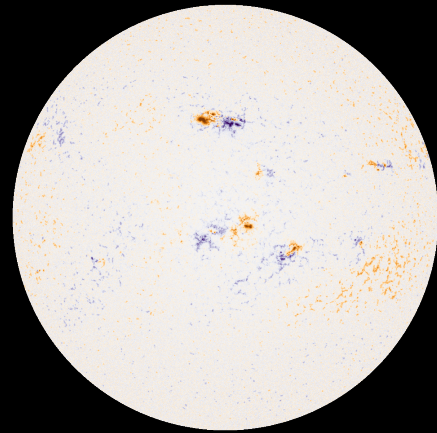
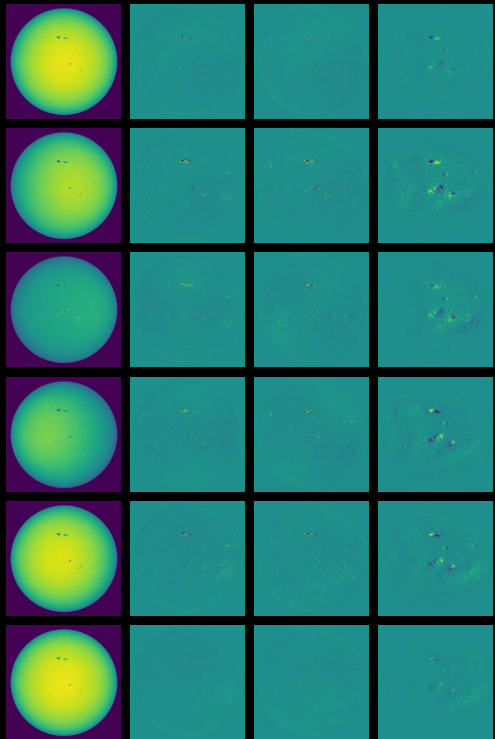
Illustrative Example: AI-Enhanced Data

Observations

Stokes Images

Data Products

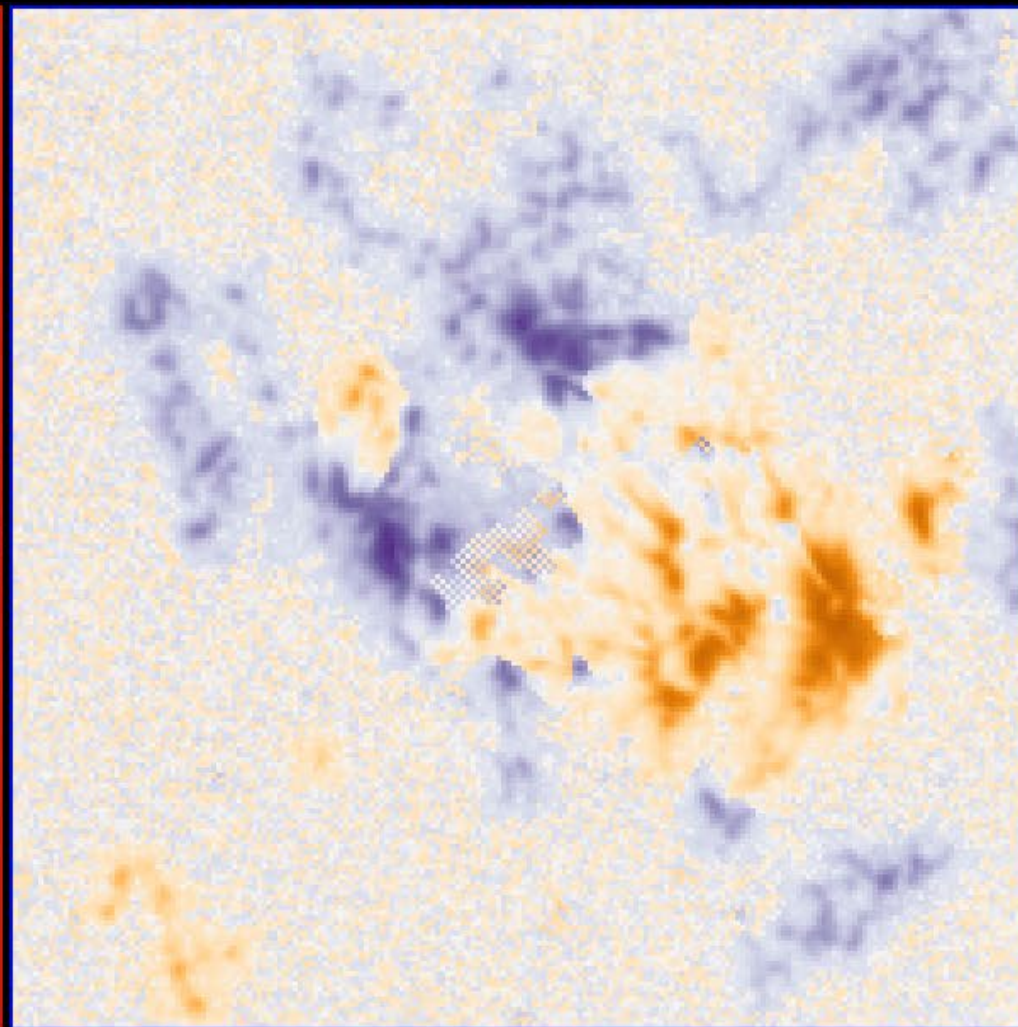
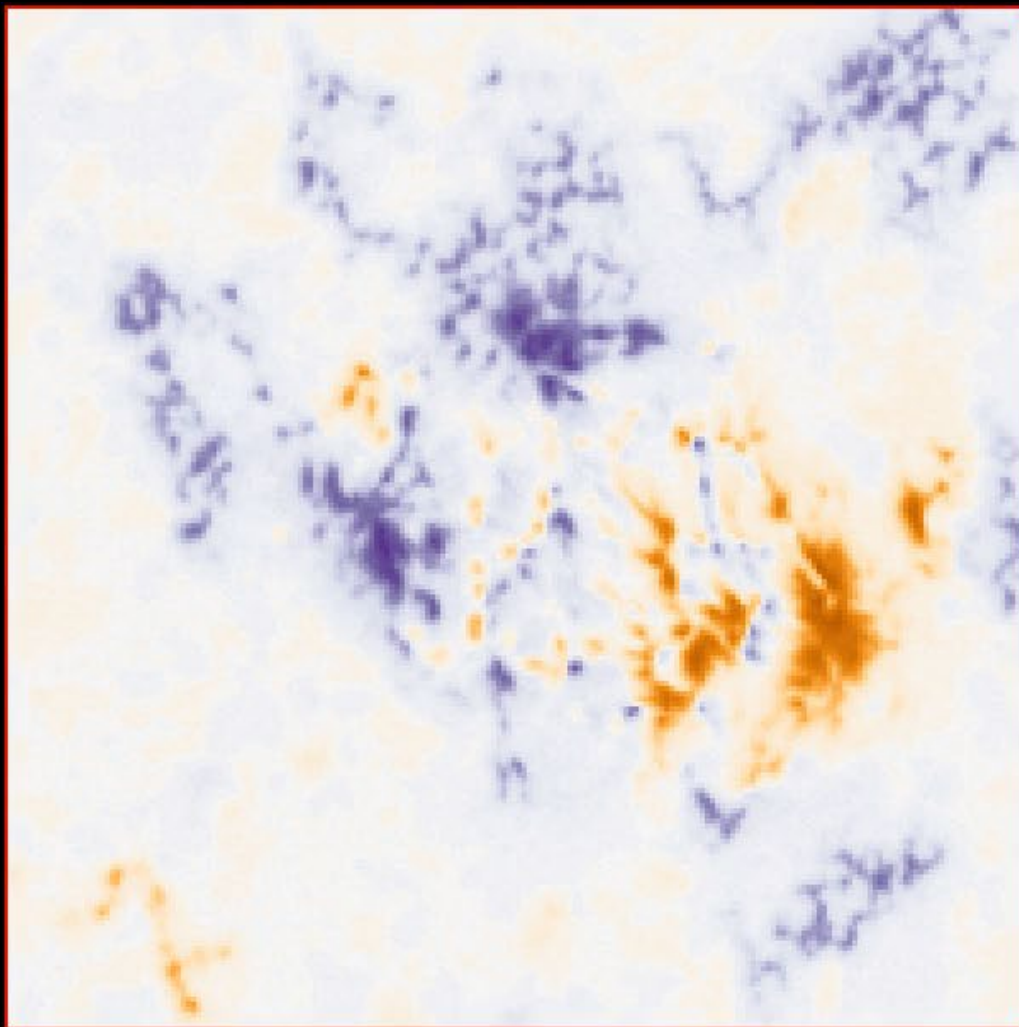
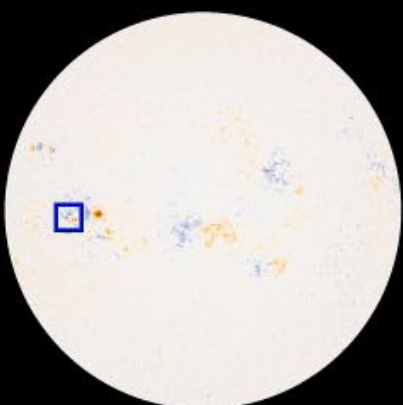
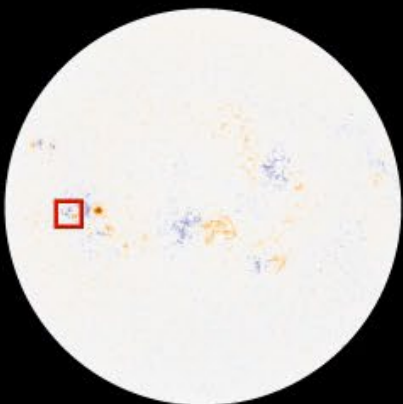
Vector Magnetic Field Data



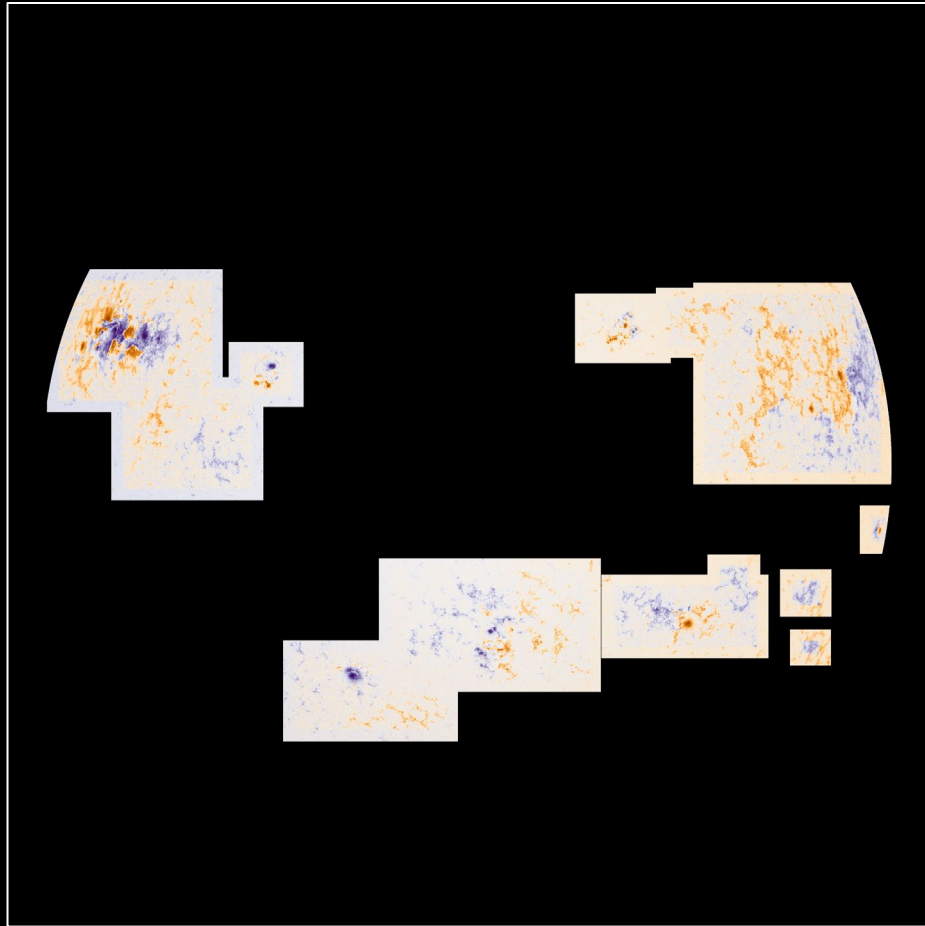
Can we create AI-enhanced
foundational data products
that unlock new
capabilities?

AI-Based

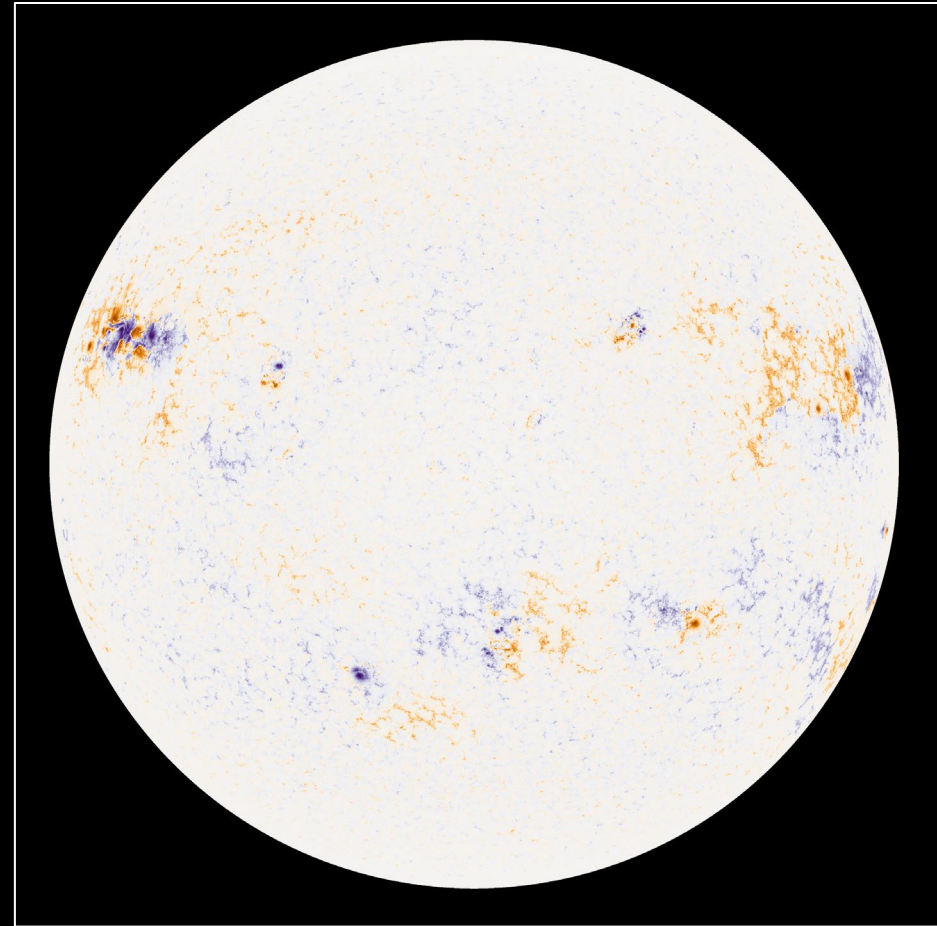
Traditional Pipeline



Applications



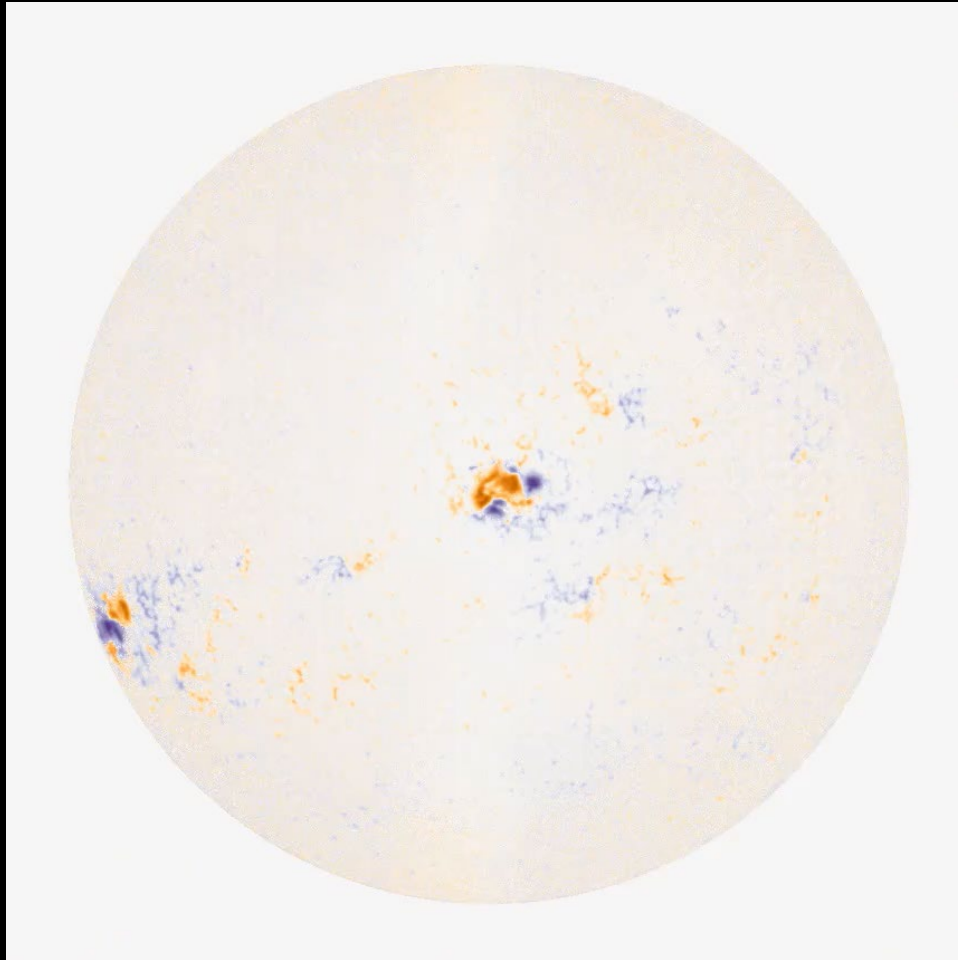
Existing Near-Real Time



AI-Based: ~2 minutes



Applications



Halloween 2003 Storm
X40+ Solar Flare

Never recorded in full
vector data, now restored

-3000 G

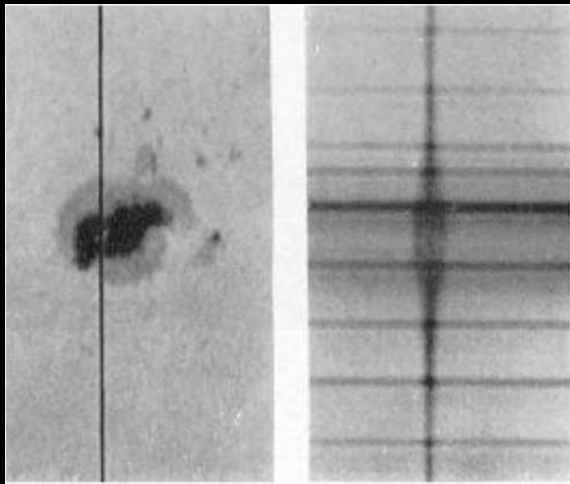


3000 G

Lessons Learned: It takes time

Classic methods developed over *decades*

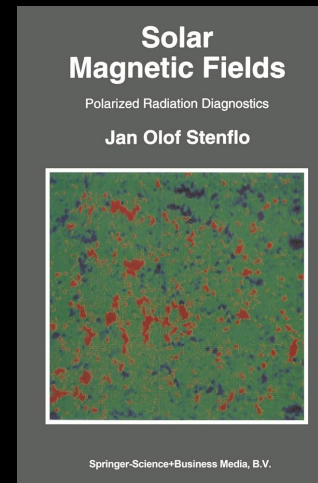
100 years from Hale's discovery to Solar Dynamics Observatory



1908



1960s



1994



2010

Lessons Learned: Progress Unsteady

Technology develop over *decades*

People tend to

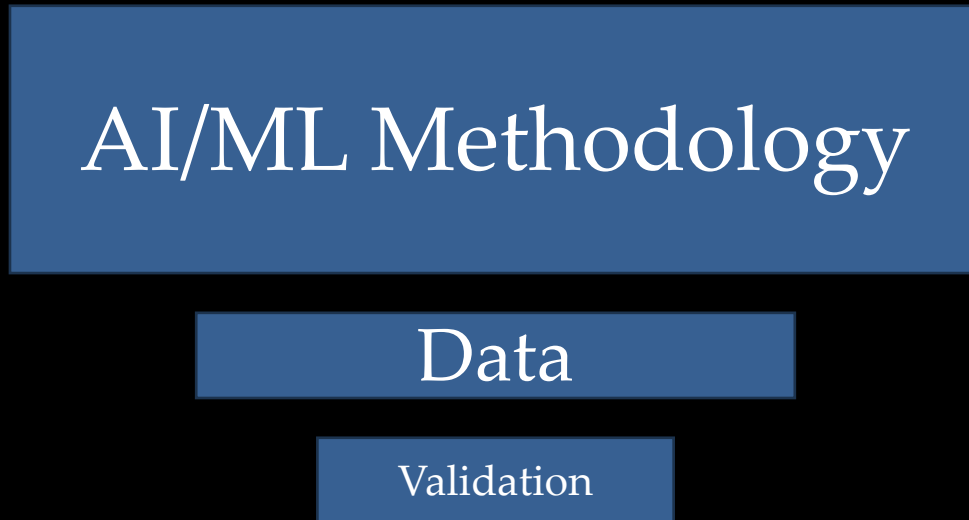
- *Overestimate* progress over 2 years
- *Dismiss* based on early data
- *Underestimate* progress over 20 years



AI is no different!

Lessons Learned: Validate ML Seriously

Perception:

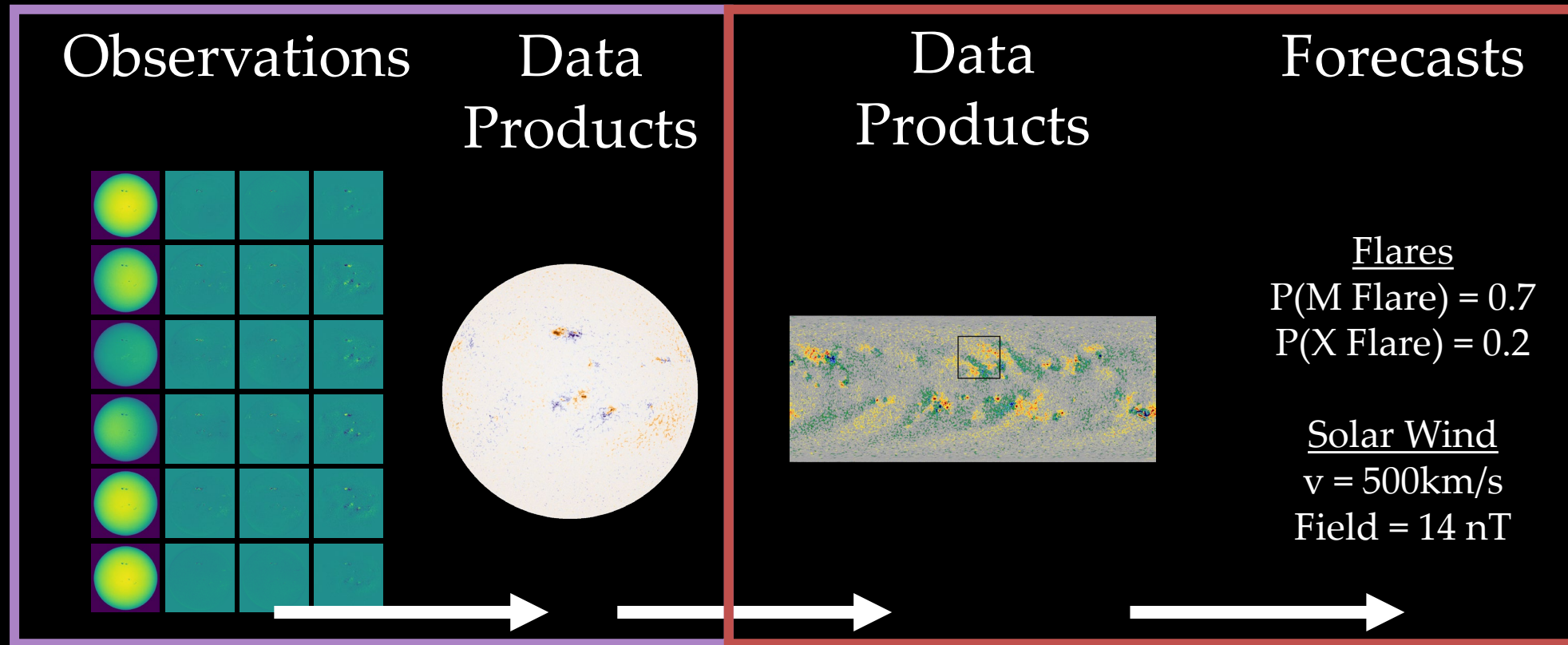


In practice:



- **Data and mission longevity is key**
- **Data and mission longevity is key**
- Need real engagement with serious AI experts
- Need validation beyond mean-square errors and pictures
- AI may work worse at first because of lack of head-start

Lessons Learned: The Bigger Picture



Downstream uses built around *existing* systems and their limitations. Need space to rethink the big picture
Analogy: Electrification required retooling

Summary

Building new AI systems for heliophysics

- Development takes time
- AI depends on high-quality data and we need support for gathering it
- Validation is critical
- Need support for thinking about the big picture

