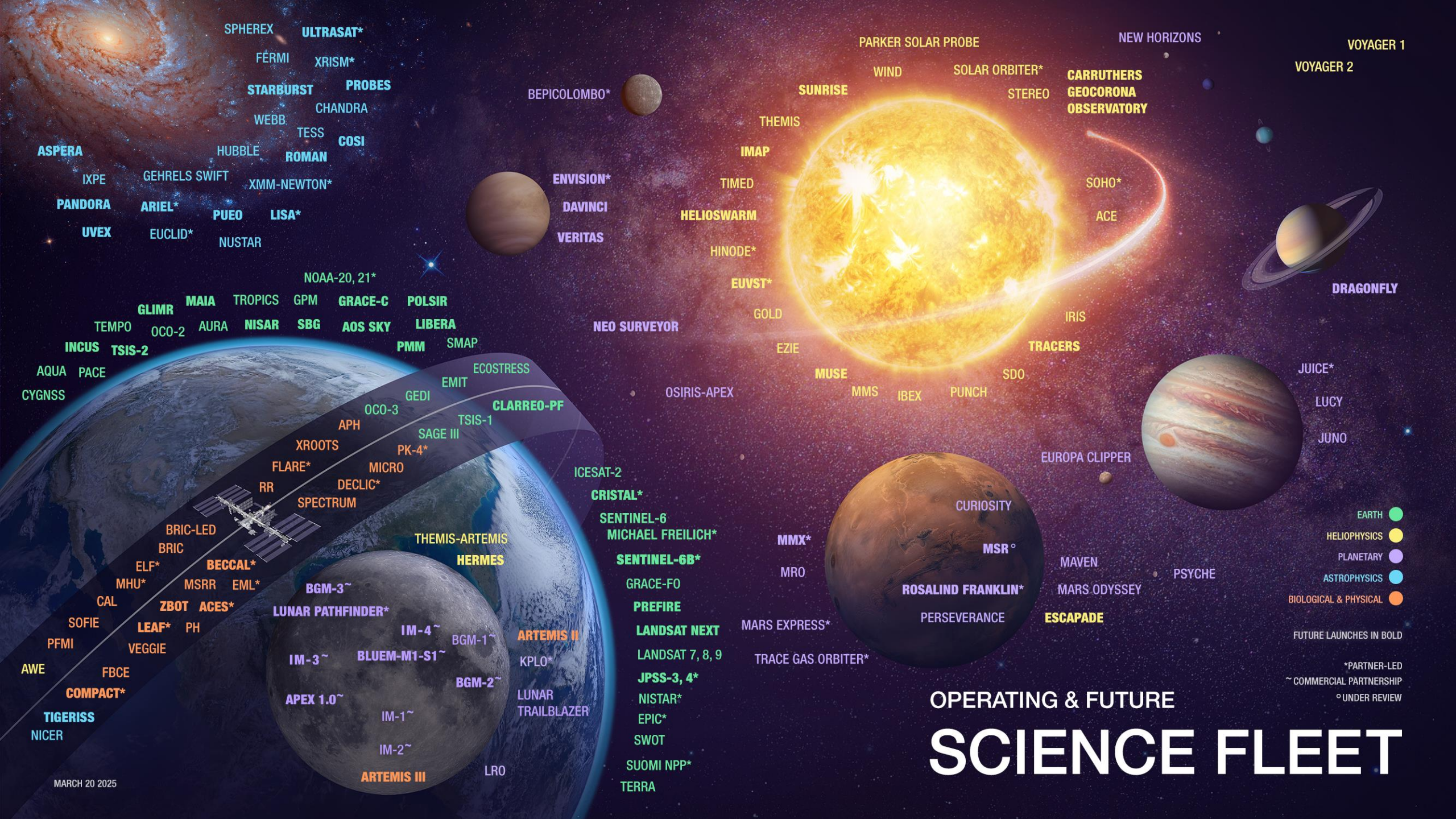
AI for NASA Science

Kevin Murphy,
Chief Science Data Officer

Artificial Intelligence drives how NASA explores our universe, revolutionizes air transportation and sends humans to the Moon, Mars, and beyond.


AI is a
fundamental
part of science.


SPHEREX
ULTRASAT*
FERMI
XRISM*
STARBURST
PROBES
CHANDRA
WEBB
TESS
COSI
ASPERA
HUBBLE
ROMAN
IXPE
GEHRELS SWIFT
XMM-NEWTON*
PANDORA
ARIEL*
PUEO
LISA*
UVEX
EUCLID*
NUSTAR
BEPICOLOMBO*
ENVISION*
DAVINCI
VERITAS
PARKER SOLAR PROBE
NEW HORIZONS
VOYAGER 1
VOYAGER 2
WIND
SOLAR ORBITER*
SUNRISE
STEREO
CARRUTHERS GEOCORONA OBSERVATORY
THEMIS
IMAP
TIMED
HELIOSWARM
HINODE*
EUVST*
SOHO*
ACE
DRAGONFLY
NOAA-20, 21*
GLIMR
MAIA
TROPICS
GPM
GRACE-C
POLSIR
TEMPO
OCO-2
AURA
NISAR
SBG
AOS SKY
LIBERA
INCUS
TSIS-2
PMM
SMAP
AQUA
PACE
CYGNSS
NEO SURVEYOR
GOLD
IRIS
EZIE
TRACERS
MUSE
SDO
OSIRIS-APEX
MMS
IBEX
PUNCH
JUICE*
LUCY
JUNO
ECOSTRESS
EMIT
GEDI
OCO-3
CLARREO-PF
APH
TSIS-1
SAGE III
XROOTS
PK-4*
FLARE*
MICRO
RR
DECLIC*
SPECTRUM
ICESAT-2
CRISTAL*
SENTINEL-6 MICHAEL FREILICH*
SENTINEL-6B*
GRACE-FO
PREFIRE
LANDSAT NEXT
LANDSAT 7, 8, 9
JPSS-3, 4*
NISTAR*
EPIC*
SWOT
SUOMI NPP*
TERRA
EUROPA CLIPPER
CURIOSITY
MMX*
MSR°
MRO
ROSALIND FRANKLIN*
MAVEN
PSYCHE
MARS ODYSSEY
PERSEVERANCE
ESCAPADE
MARS EXPRESS*
TRACE GAS ORBITER*
BRIC-LED
BRIC
ELF*
BECCAL*
MHU*
MSRR
EML*
CAL
ZBOT
ACES*
SOFIE
LEAF*
PH
PFMI
VEGGIE
AWE
FBCE
COMPACT*
TIGERISS
NICER
THEMIS-ARTEMIS
HERMES
BGM-3~
LUNAR PATHFINDER*
IM-4~
BGM-1~
ARTEMIS II
IM-3~
BLUEM-M1-S1~
KPLO*
BGM-2~
APEX 1.0~
LUNAR TRAILBLAZER
IM-1~
IM-2~
ARTEMIS III
LRO
MARCH 20 2025
EARTH
HELIOPHYSICS
PLANETARY
ASTROPHYSICS
BIOLOGICAL & PHYSICAL
FUTURE LAUNCHES IN BOLD
*PARTNER-LED
~ COMMERCIAL PARTNERSHIP
° UNDER REVIEW
OPERATING & FUTURE
SCIENCE FLEET

AI for Earth Science

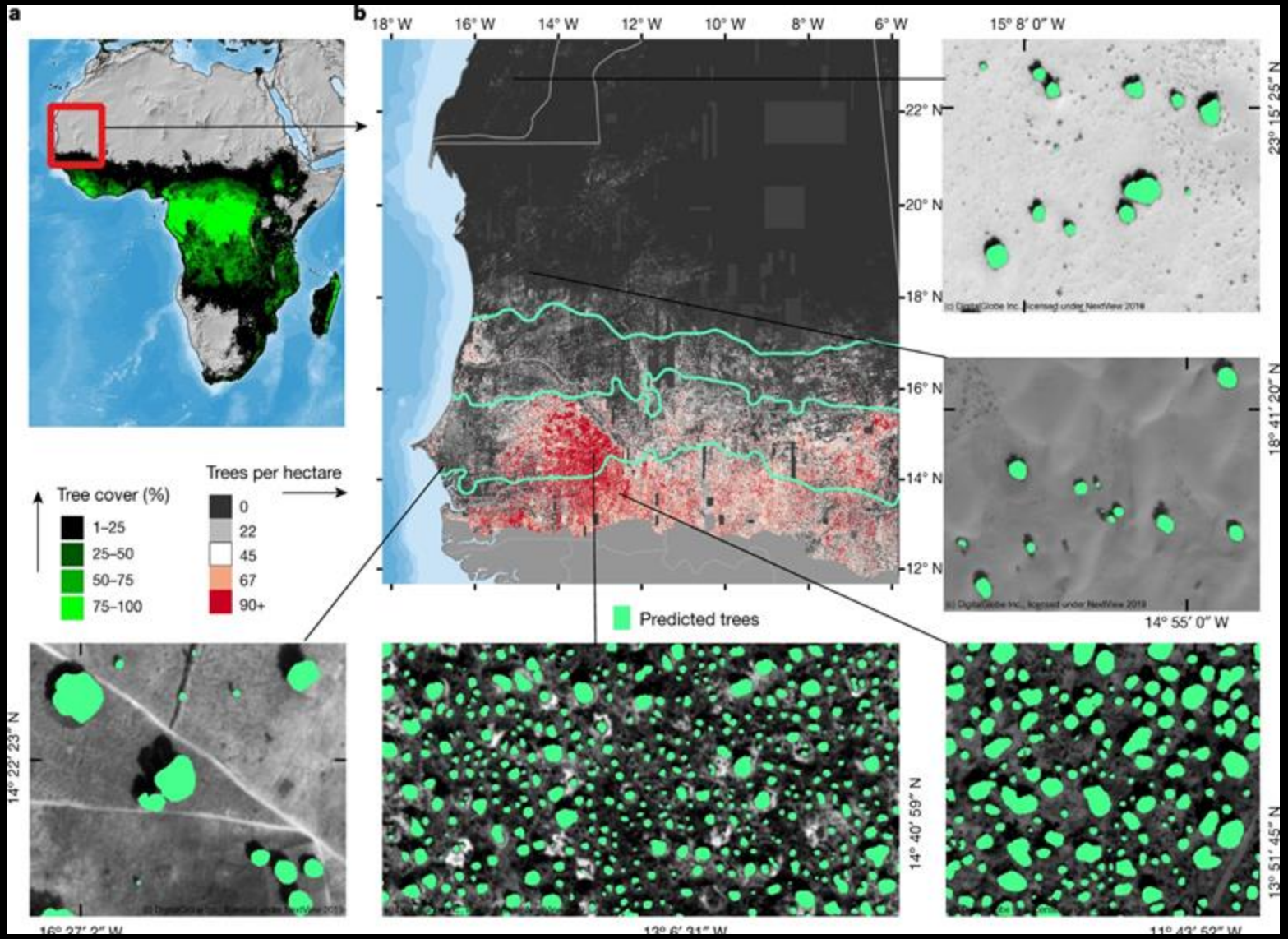
9.9 billion
trees assessed

326,000
satellite images

89,000
hand-labeled tree crowns

10^7 million
sq. km. mapped

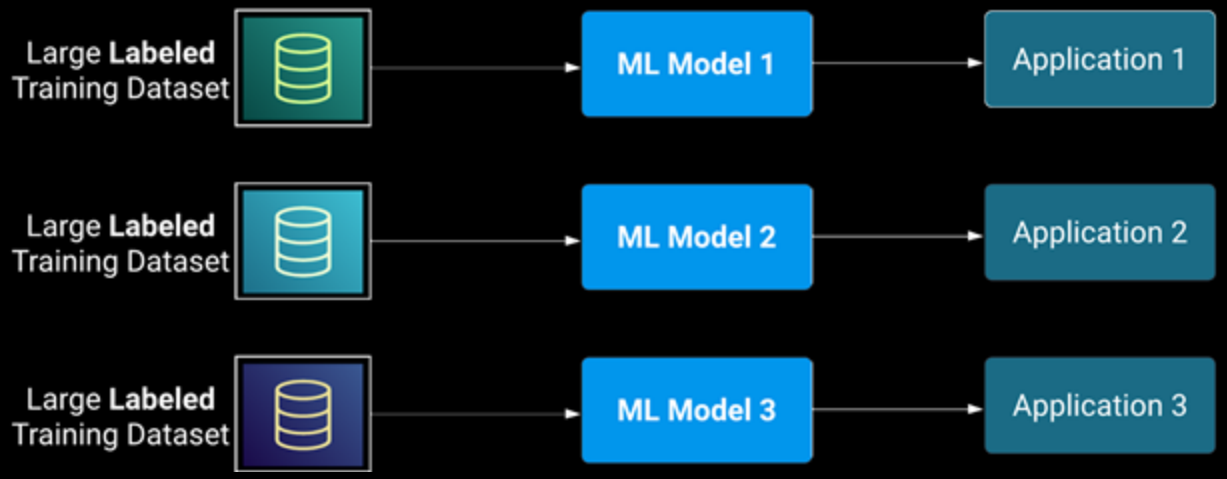
60,000,000
core HPC hours



Brandt, M., Tucker, C.J., Kariryaa, A. et al. An unexpectedly large count of trees in the West African Sahara and Sahel. Nature (2020).

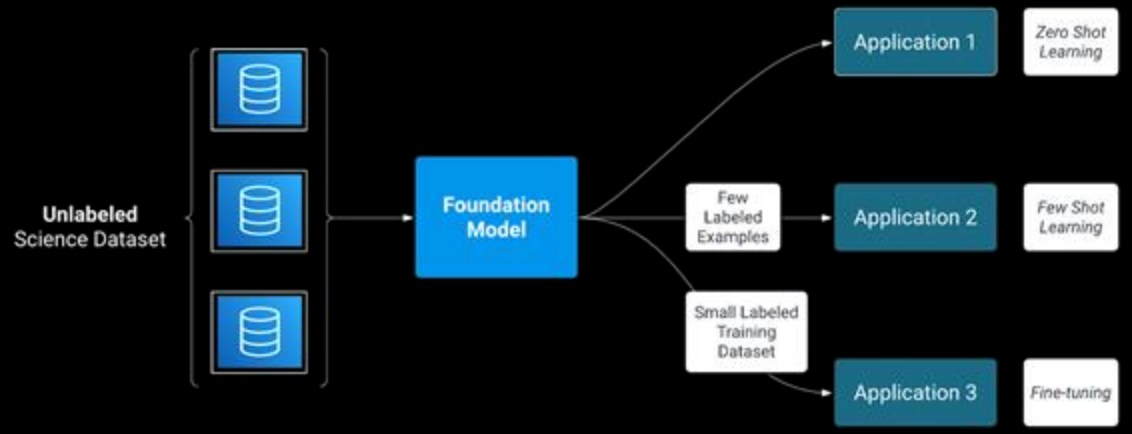
Why AI Foundation Models?

Traditional Supervised Learning Approach



Traditional Learning requires a large amount of labeled data specific to the application. The model's performance is tied to the quality of the labeled data.

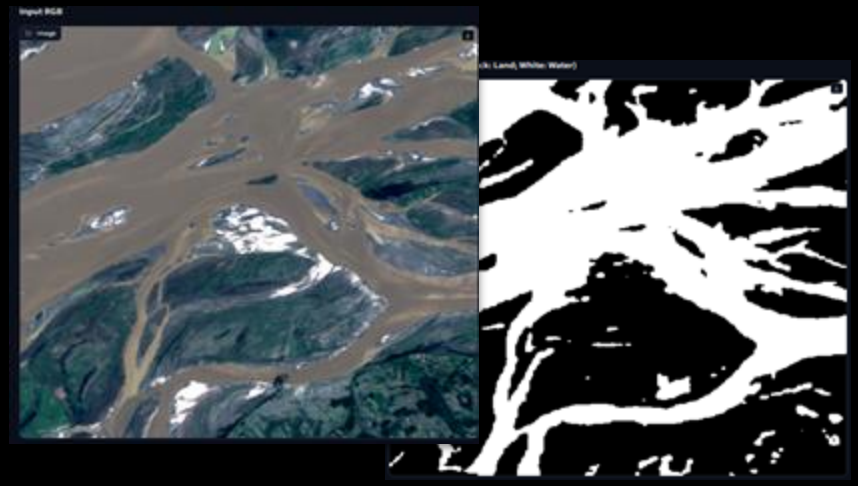
Foundation Model Approach



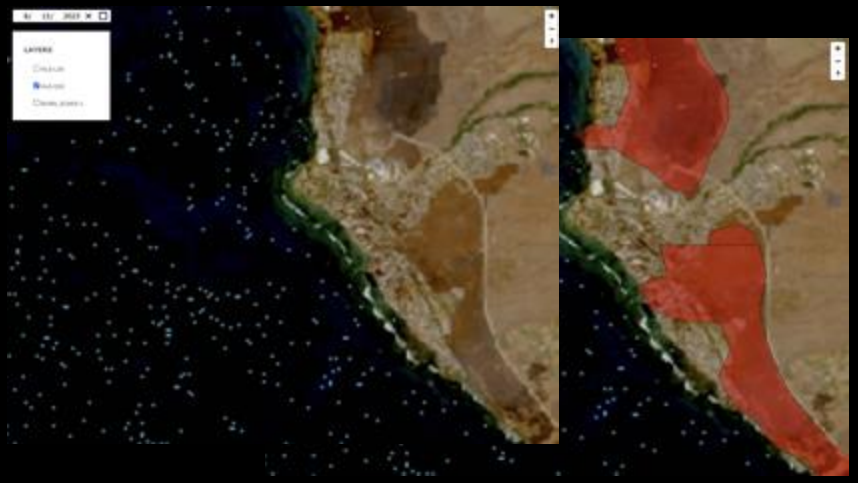
An AI Foundation Model is a large machine learning model pre-trained on a vast amount of data using self supervision, enabling it to perform a wide range of tasks.

5+1 AI for Science Strategy

Prithvi Downstream Applications



Model fine-tuned to segment the extent of floods on Sentinel-2



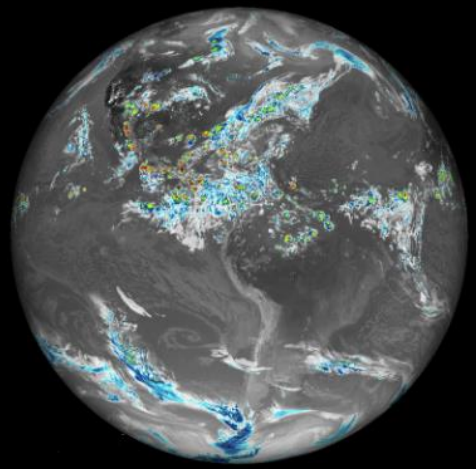
Burn scar mapping: Maui Fire 8.13.2023

HLS FM openly released (August 3, 2023) at Hugging Face: *Models, Datasets, and Code*

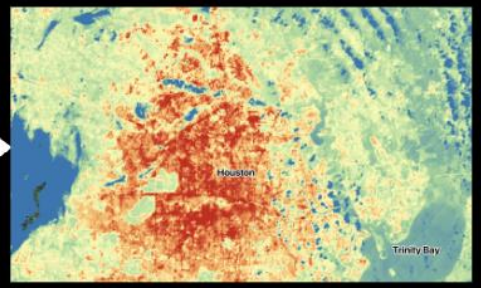
- **80+ downloads**
- **Used in university classroom**
- **Global SpaceApps 2023 GeoAI Challenge**
- **Presented at White House Demo Day (Audience included President Biden)**

Prithvi Geospatial Foundation Model

Foundation model

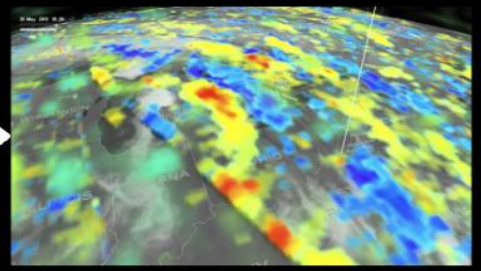


Adaptation with small data and neural network



Weather forecasts

Hurricane prediction

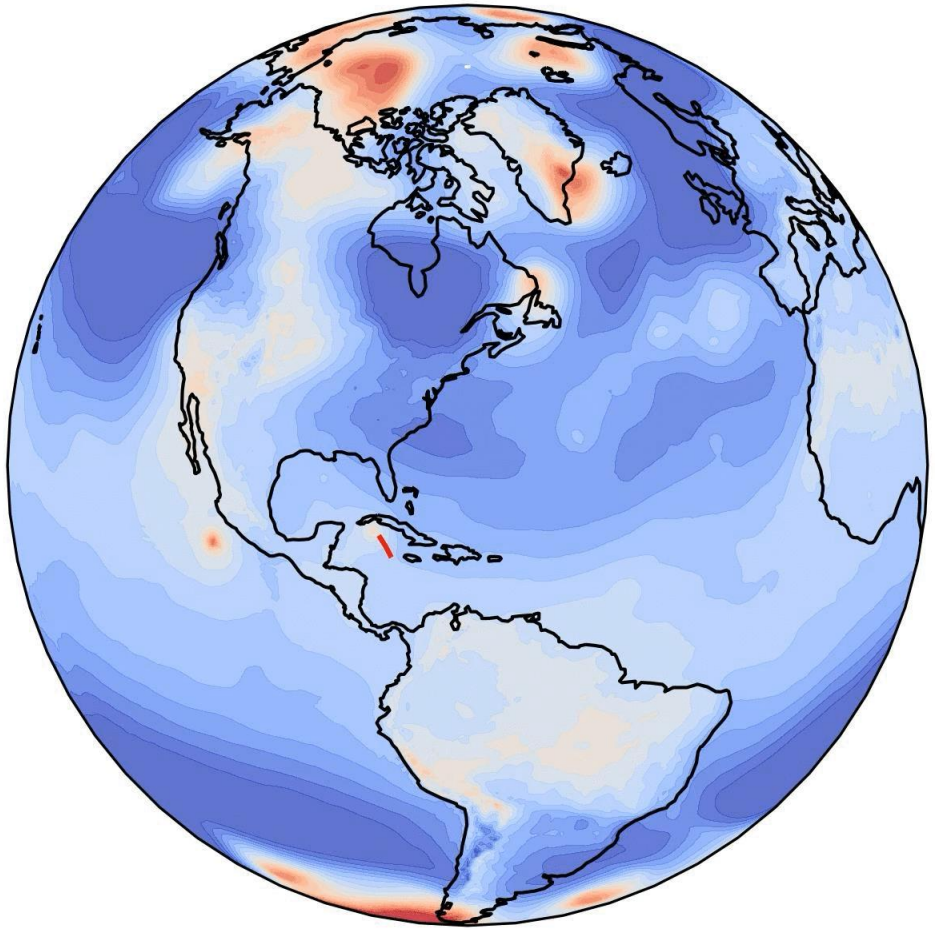


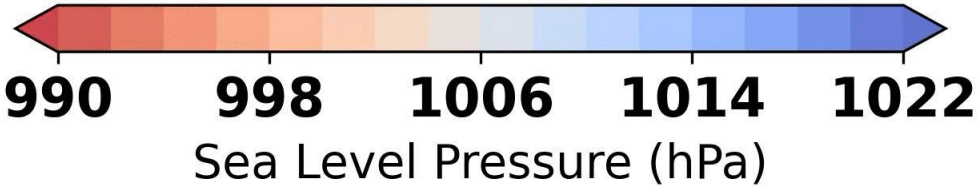
Gravity wave parameterization

Prithvi WxC FM

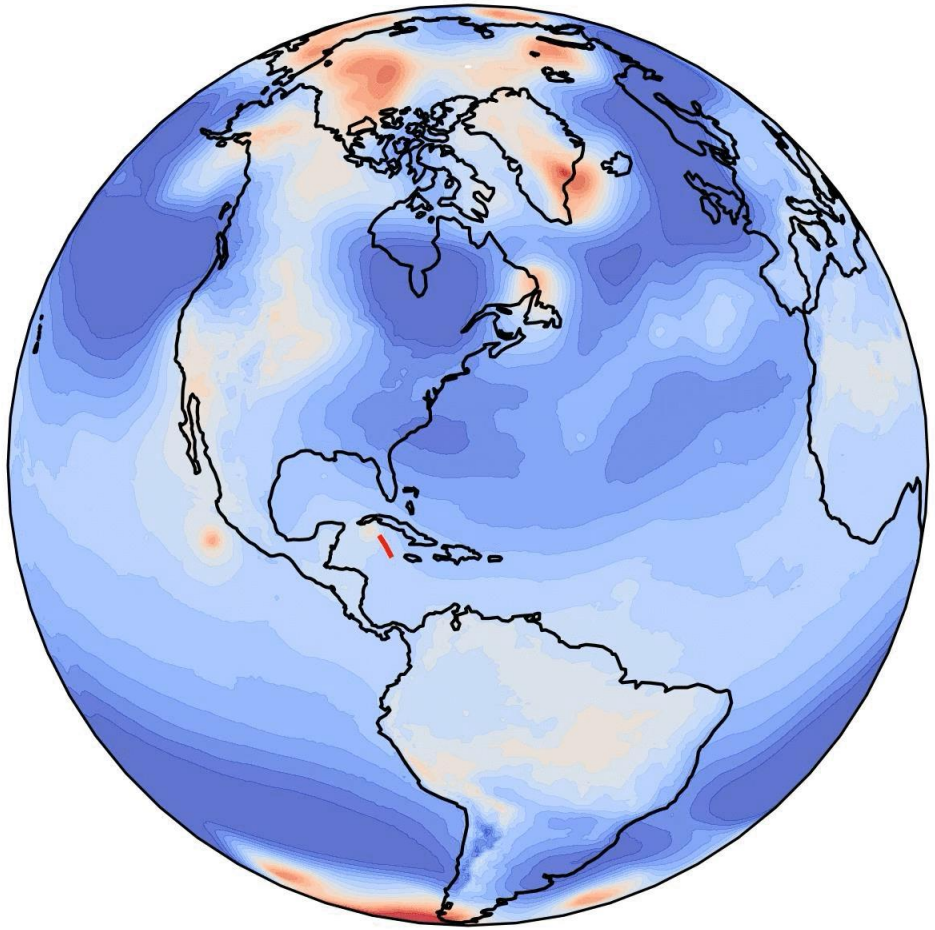
Ida (2021) | C4 | 2021-08-27 00UTC + 006 H Forecast

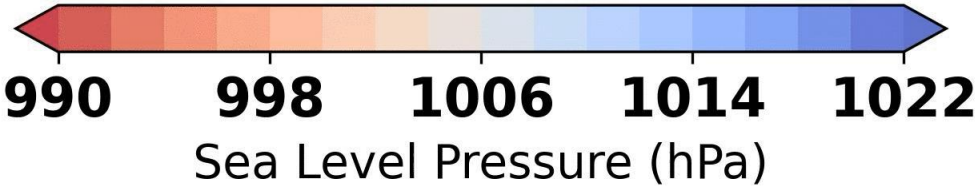
Ground Truth

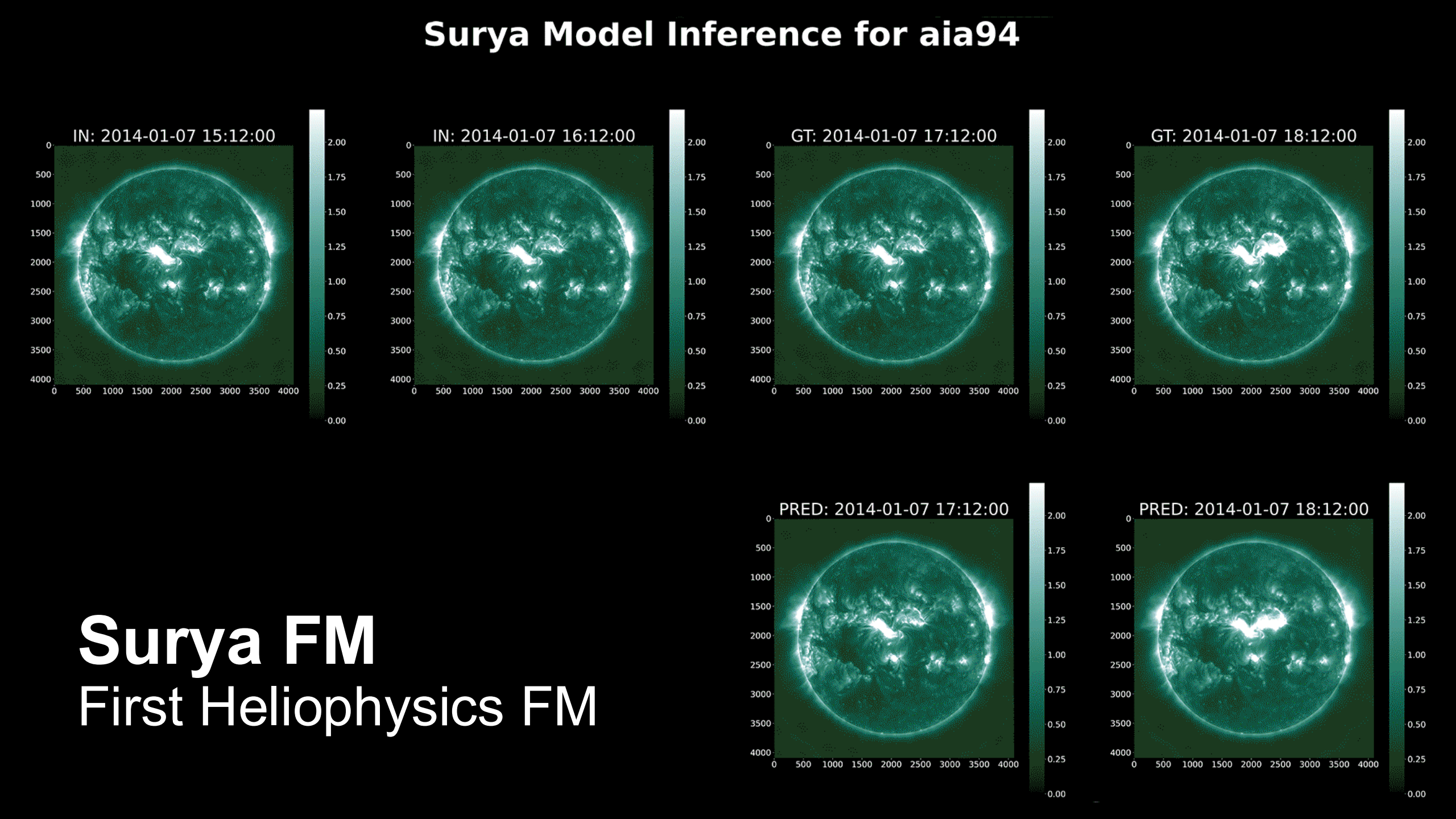




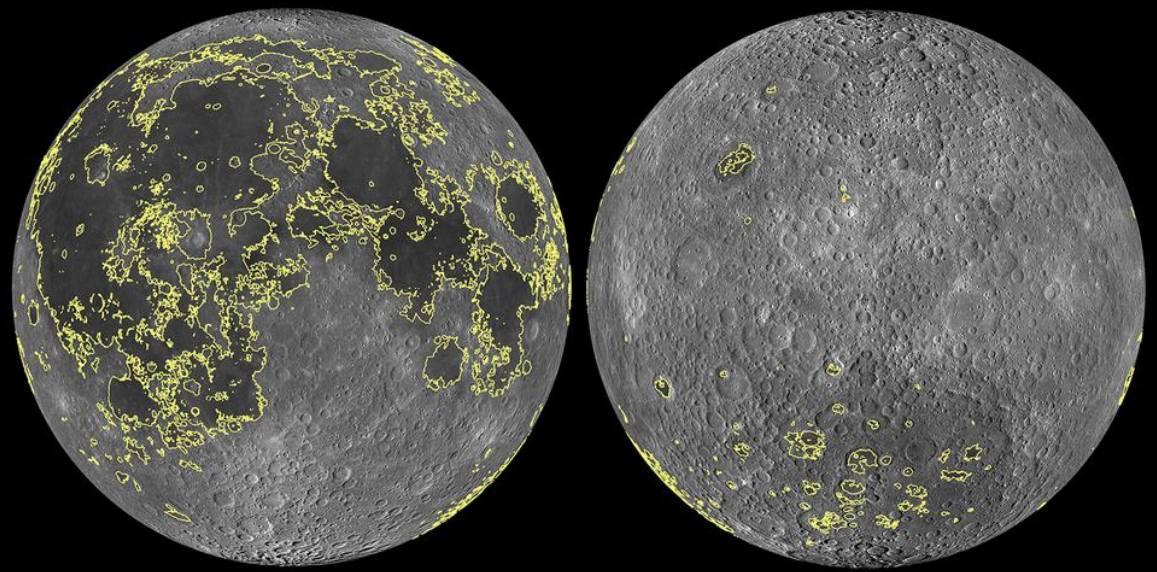
WxC Prediction



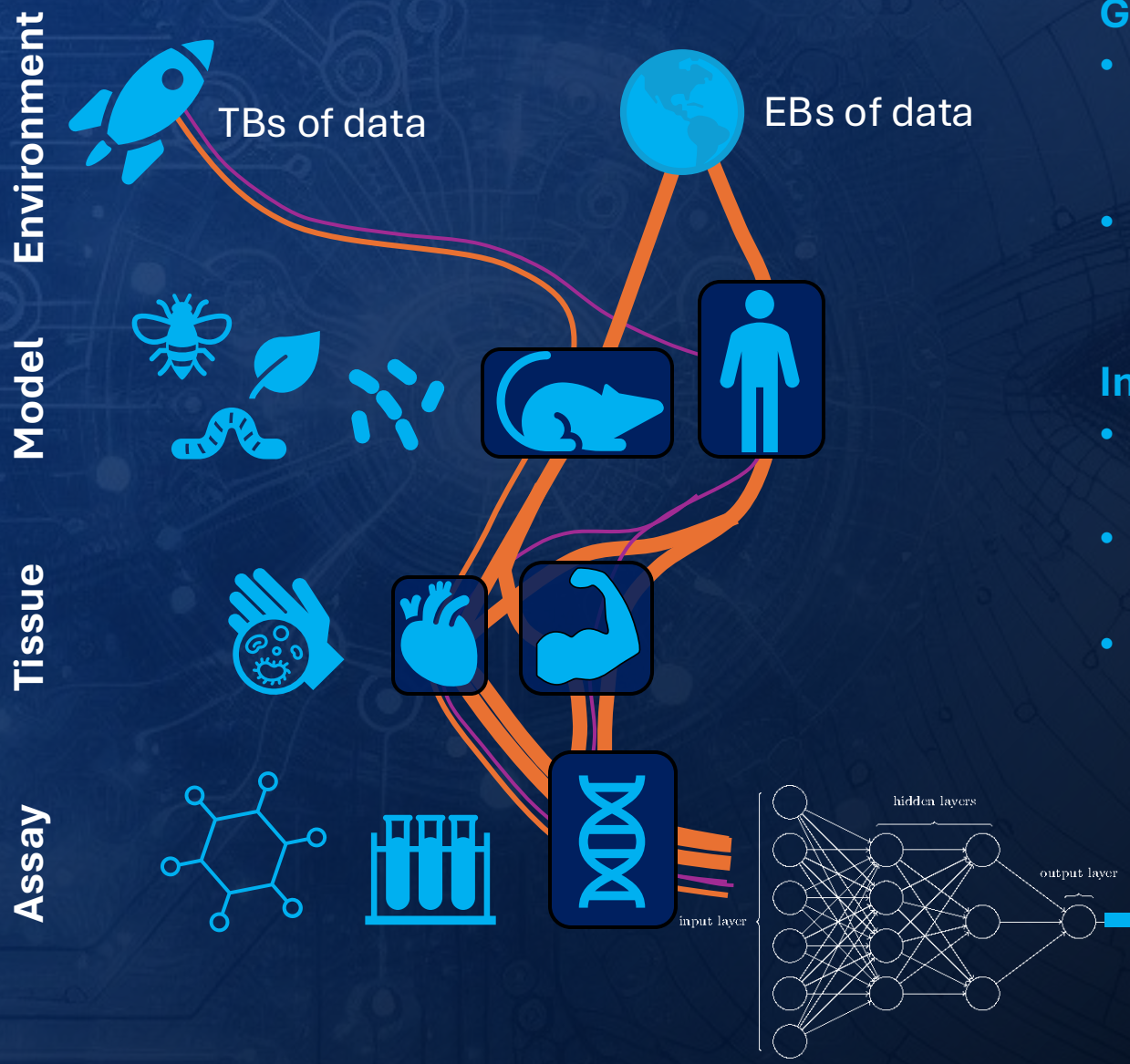



Surya Model Inference for aia94
IN: 2014-01-07 15:12:00
IN: 2014-01-07 16:12:00
GT: 2014-01-07 17:12:00
GT: 2014-01-07 18:12:00
PRED: 2014-01-07 17:12:00
PRED: 2014-01-07 18:12:00
Surya FM
First Heliophysics FM

In Development: Lunar FM



Foundation Model for the Biological and Physical Sciences Division



Architecture

Goal

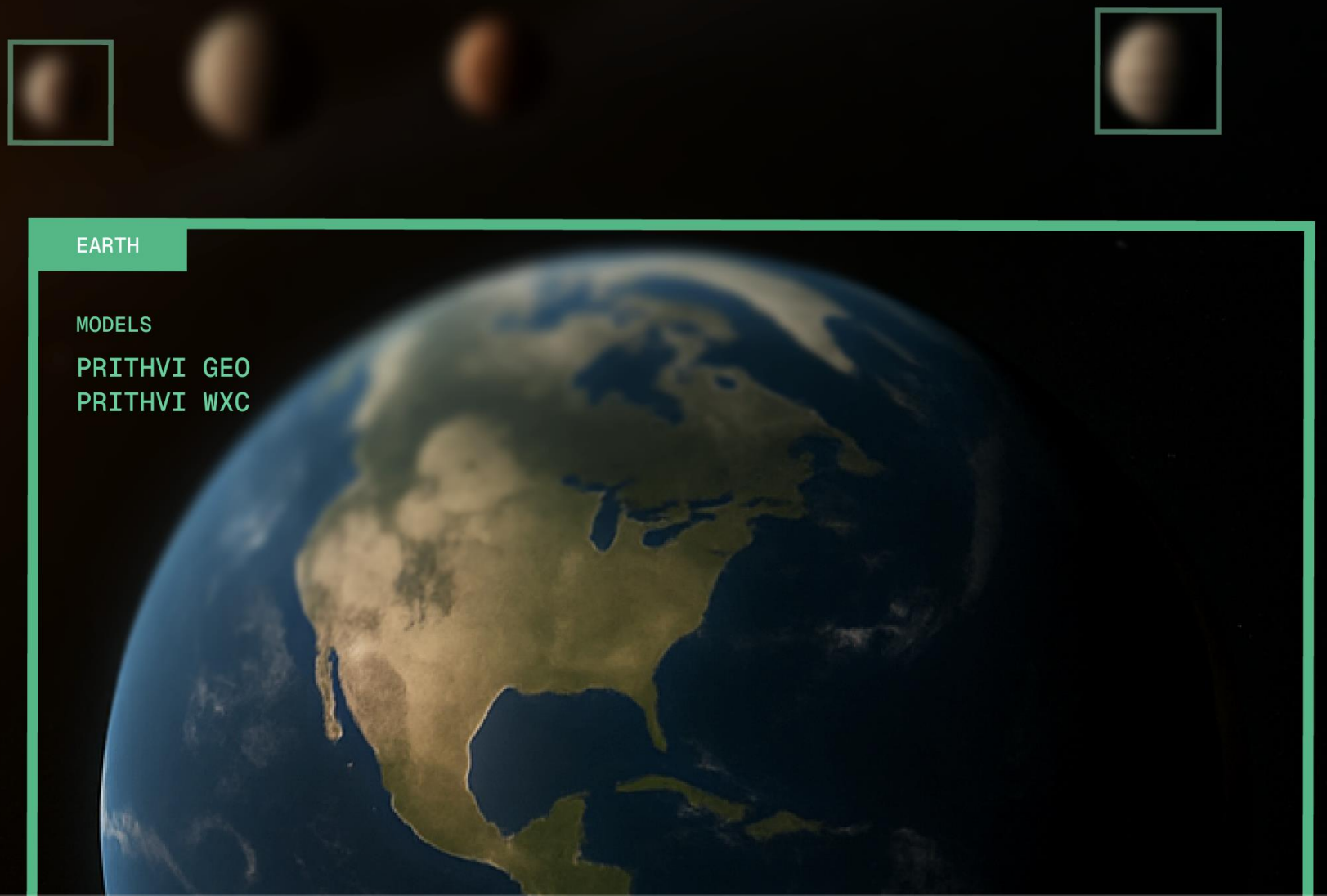
- Integrate TBs of spaceflight and EBs of terrestrial biomedical data, spanning various models and assays
- Create a a single modular, multi-modal architecture to support multiple capabilities

In Progress (~18-Month Effort)

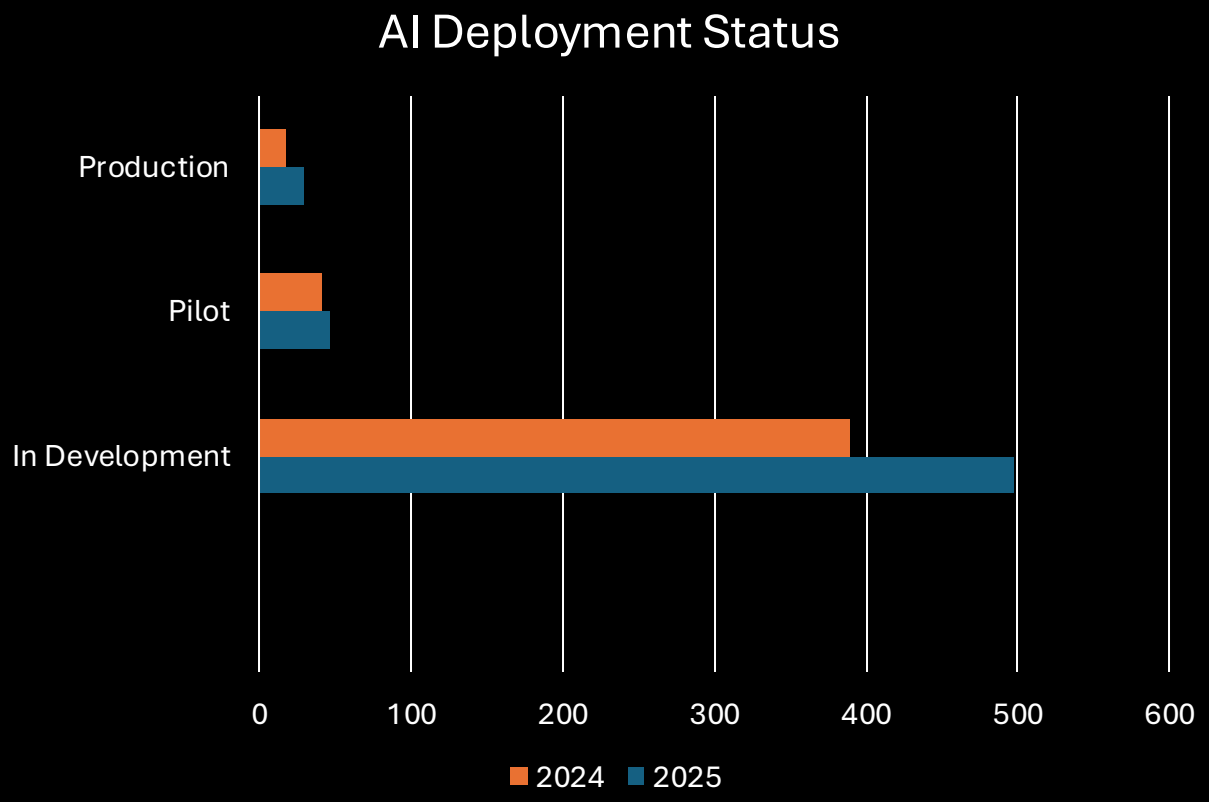
- Gene expression model in pretraining for classification and prediction
- Astronaut health benchmark dataset under development for health outcome prediction
- Knowledge graph connector in development to enable natural language access to biological data;

- Predict phenotypes from molecular data
- Fill gaps in molecular data
- Predict outcomes of radiation damage
- Translate results between model species and astronauts
- Aid in astronaut risk modeling
- Etc.

+1 Large Language Model, Uniting Research



AI Inventory: Transparency in Motion



- A dynamic inventory of the real-time state of AI at NASA.
- Currently 427 use cases
- Provides a clear look at the progress of AI from pilots to production.

PUBLIC INVENTORY

www.nasa.gov/ai-inventory/

Q&A

OCSDO

OFFICE OF THE CHIEF
SCIENCE DATA OFFICER