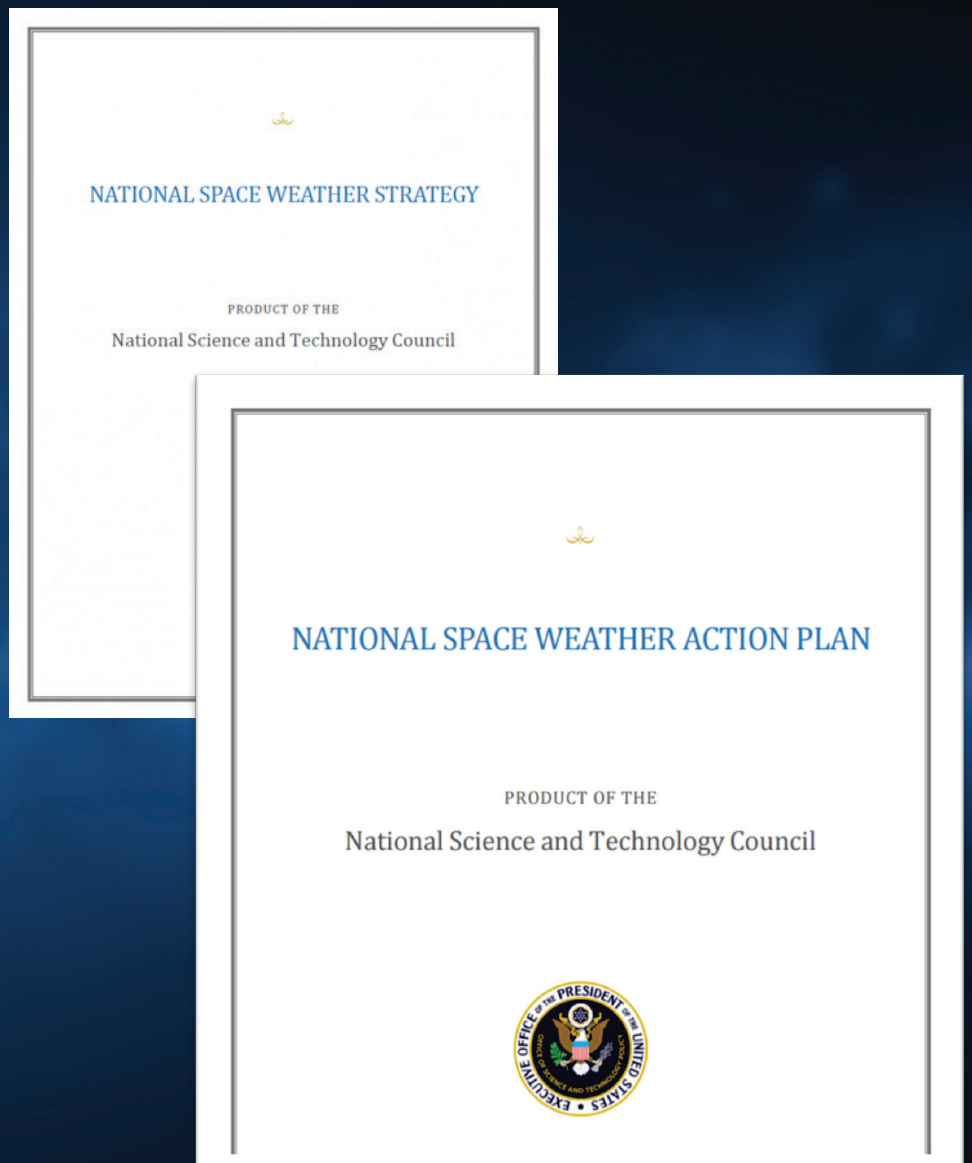
National Aeronautics and
Space Administration

SCIENCE MISSION DIRECTORATE

Thomas H. Zurbuchen
Associate Administrator
Science Mission Directorate
@Dr_ThomasZ

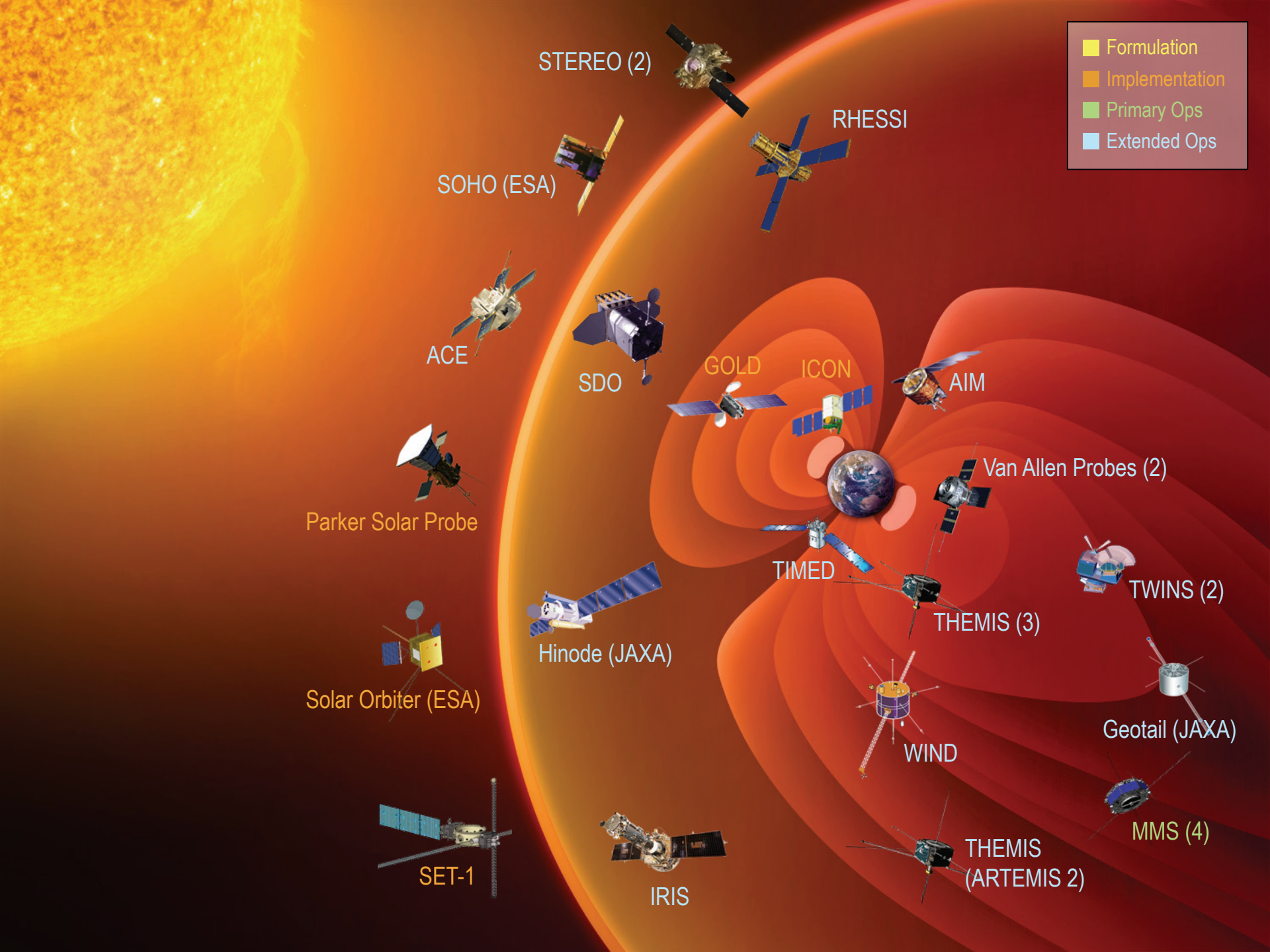
June 27, 2017

SPACE WEATHER ACTION PLAN

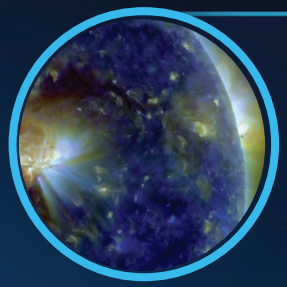


Multi - agency effort to:

- Establish benchmarks for space weather events
- Enhance response and recovery capabilities
- Improve protection and mitigation efforts
- Improve assessment, modeling, and prediction of impacts on critical infrastructure
- Improve space weather services through advancing understanding and forecasting
- Increase international cooperation

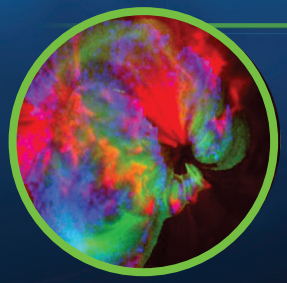

Formulation
Implementation
Primary Ops
Extended Ops
STEREO (2)
RHESSI
SOHO (ESA)
ACE
SDO
GOLD
ICON
AIM
Van Allen Probes (2)
Parker Solar Probe
TIMED
TWINS (2)
THEMIS (3)
Hinode (JAXA)
Solar Orbiter (ESA)
Geotail (JAXA)
WIND
MMS (4)
THEMIS
(ARTEMIS 2)
SET-1
IRIS

NASA'S SPACE WEATHER APPROACH



Fundamental Research

Innovative Architecture

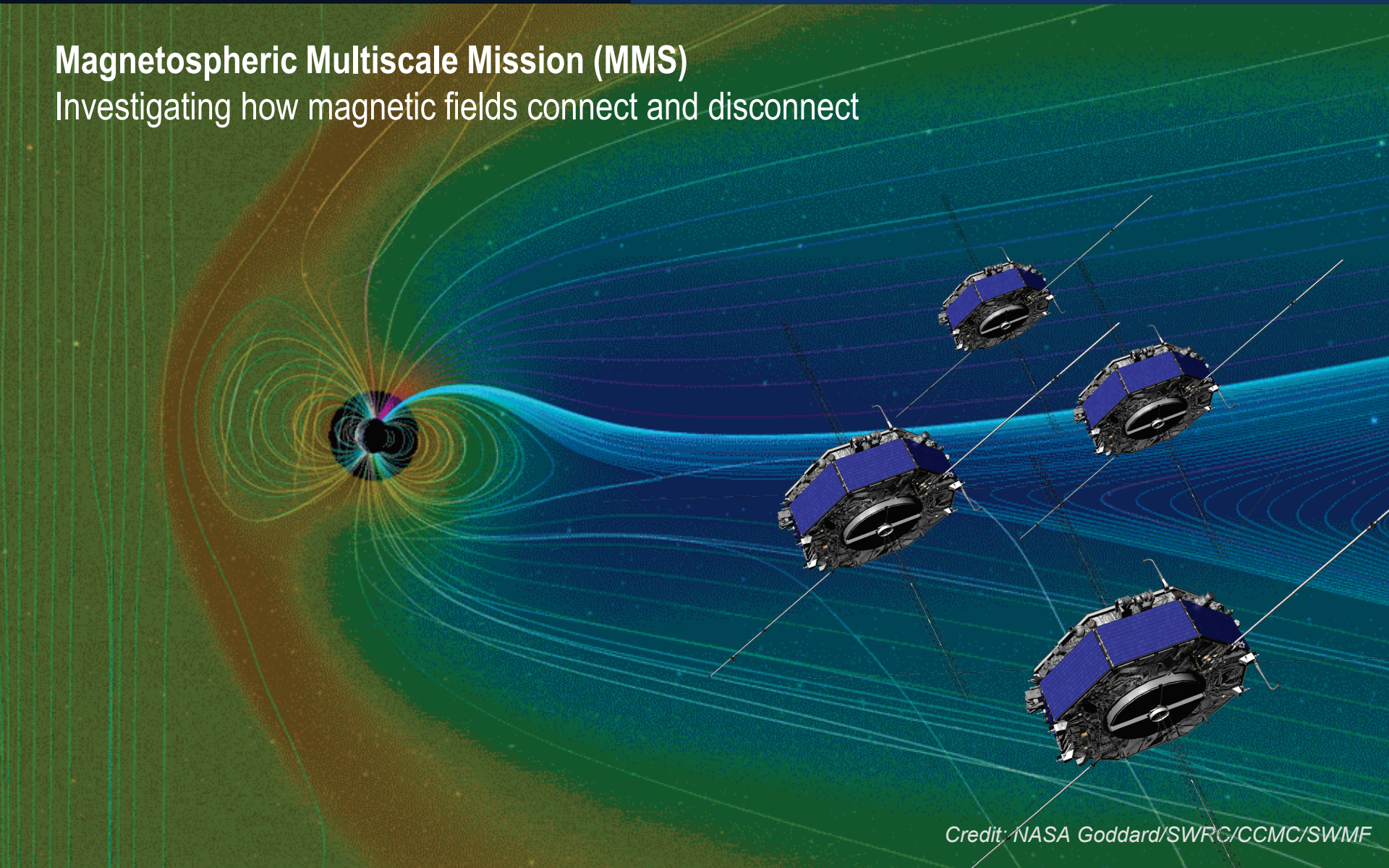


Integrated Models

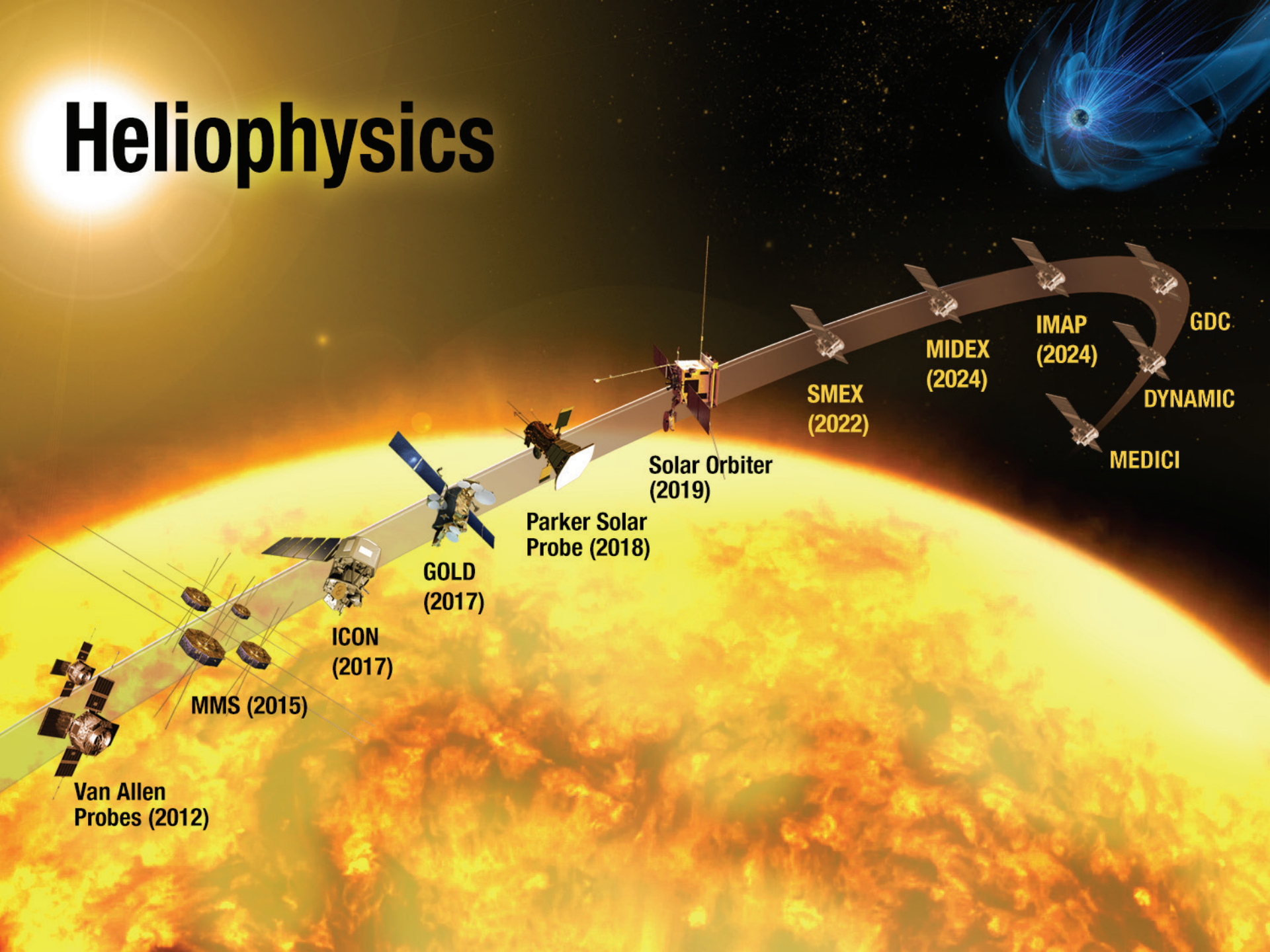
FUNDAMENTAL RESEARCH

Magnetospheric Multiscale Mission (MMS)

Investigating how magnetic fields connect and disconnect

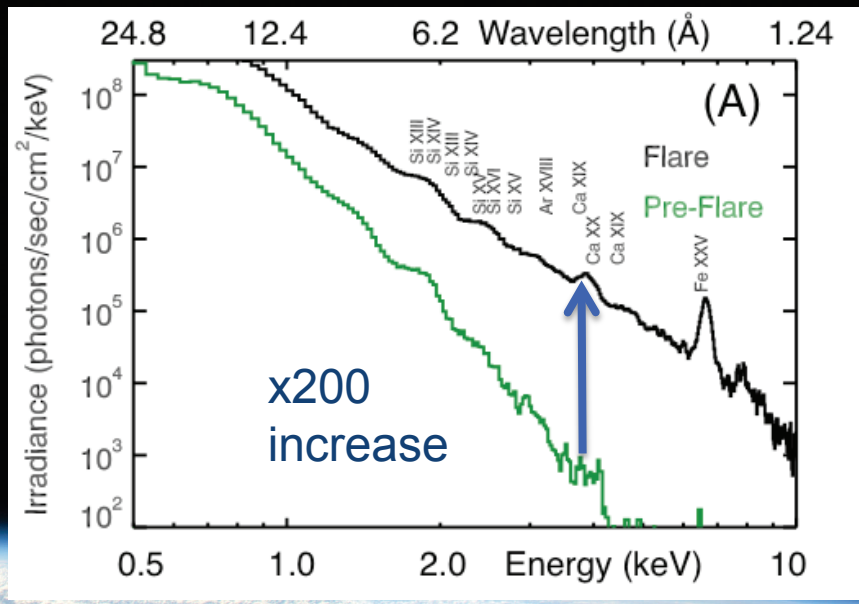


Credit: NASA Goddard/SWRC/CCMC/SWMF


Heliophysics
Van Allen Probes (2012)
MMS (2015)
ICON (2017)
GOLD (2017)
Parker Solar Probe (2018)
Solar Orbiter (2019)
SMEX (2022)
MIDEX (2024)
IMAP (2024)
GDC
DYNAMIC
MEDICI

INNOVATIVE ARCHITECTURE

- MinXSS-1 CubeSat observations focus on flare energetics
- Soft x-ray irradiance increases during the M5.0 flare on July 23, 2016 by a factor of ~200
- Corona temperature increases from 2 MK to 15 MK at flare peak

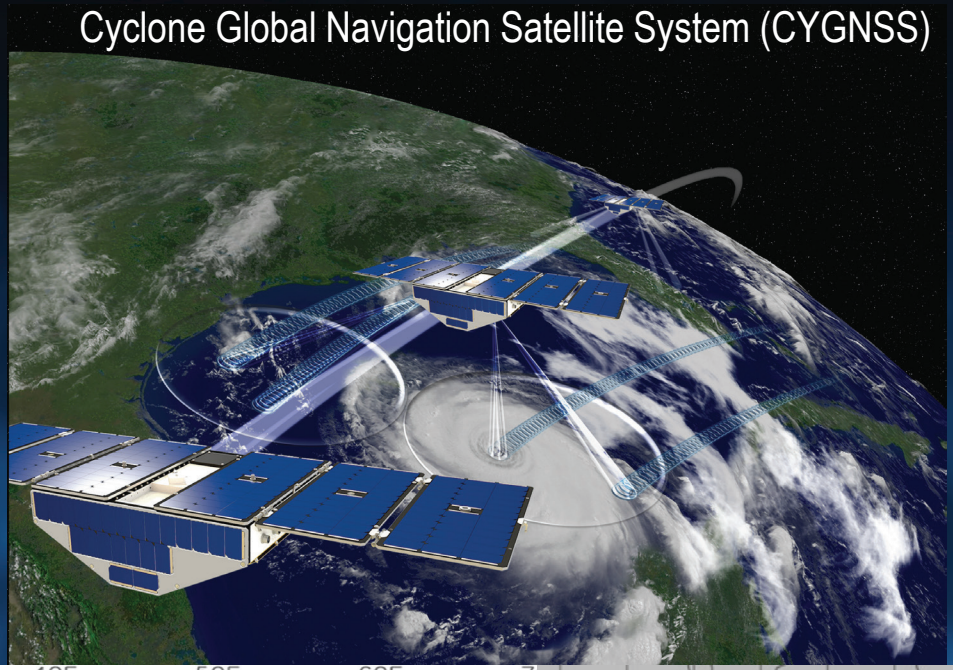


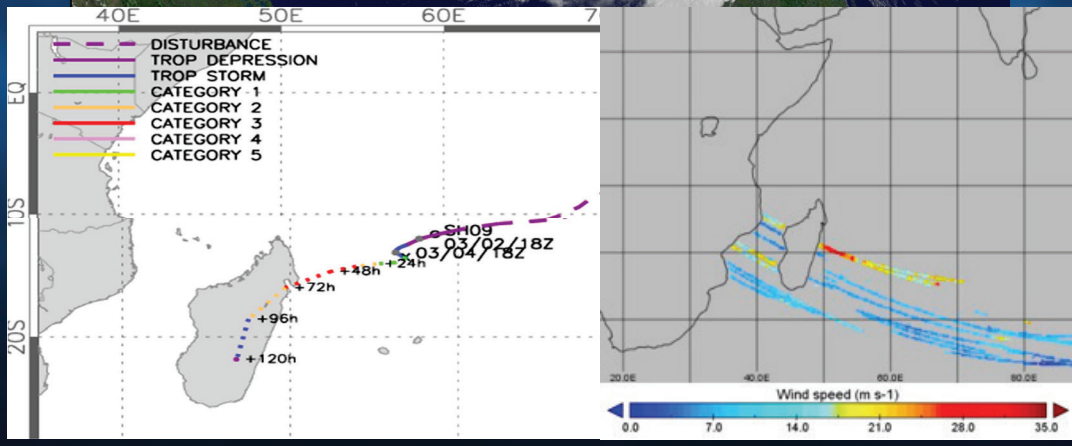
Miniature X-ray Solar Spectrometer (MinXSS)

Photo by Astronaut Tim Peake

CUBESATS/SMALLSATS INITIATIVE

- The FY 2018 budget includes SMD-wide initiative to use small satellites to advance selected high-priority science objectives in a cost-effective manner
- Implementing recommendations from the National Academy of Sciences conclusions that small satellites are suitable to address science goals
- All four science divisions will focus technology development on CubeSats/SmallSats and targeted science missions to exploit this value
- Multi-disciplinary approach will leverage and partner with a growing commercial sector to collaboratively drive instrument and sensor innovation

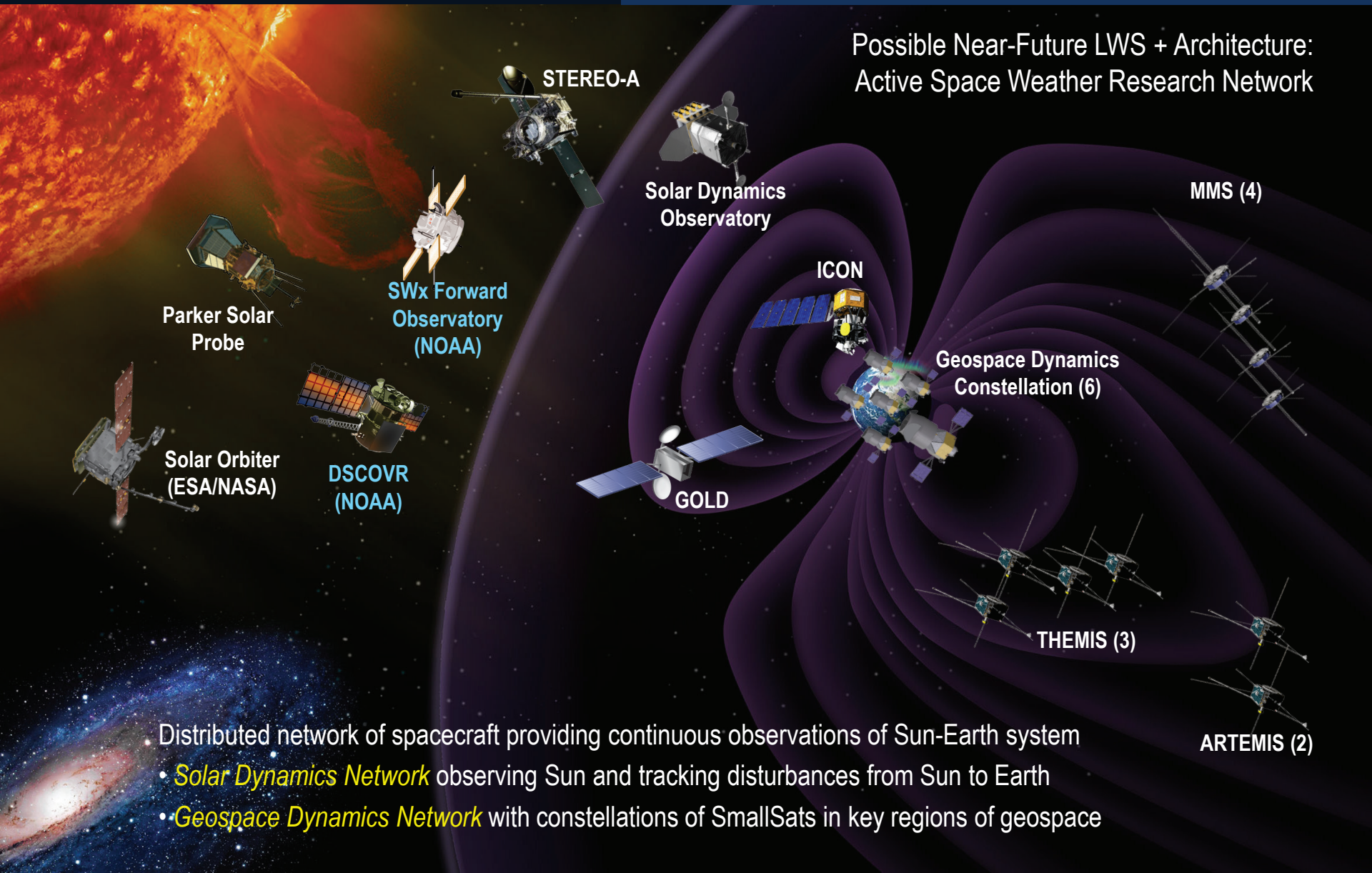




Storm Track and CYGNSS Wind speed measurements from overpasses of Tropical Cyclone Enawo, March 2017

INNOVATIVE ARCHITECTURE

Possible Near-Future LWS + Architecture:
Active Space Weather Research Network

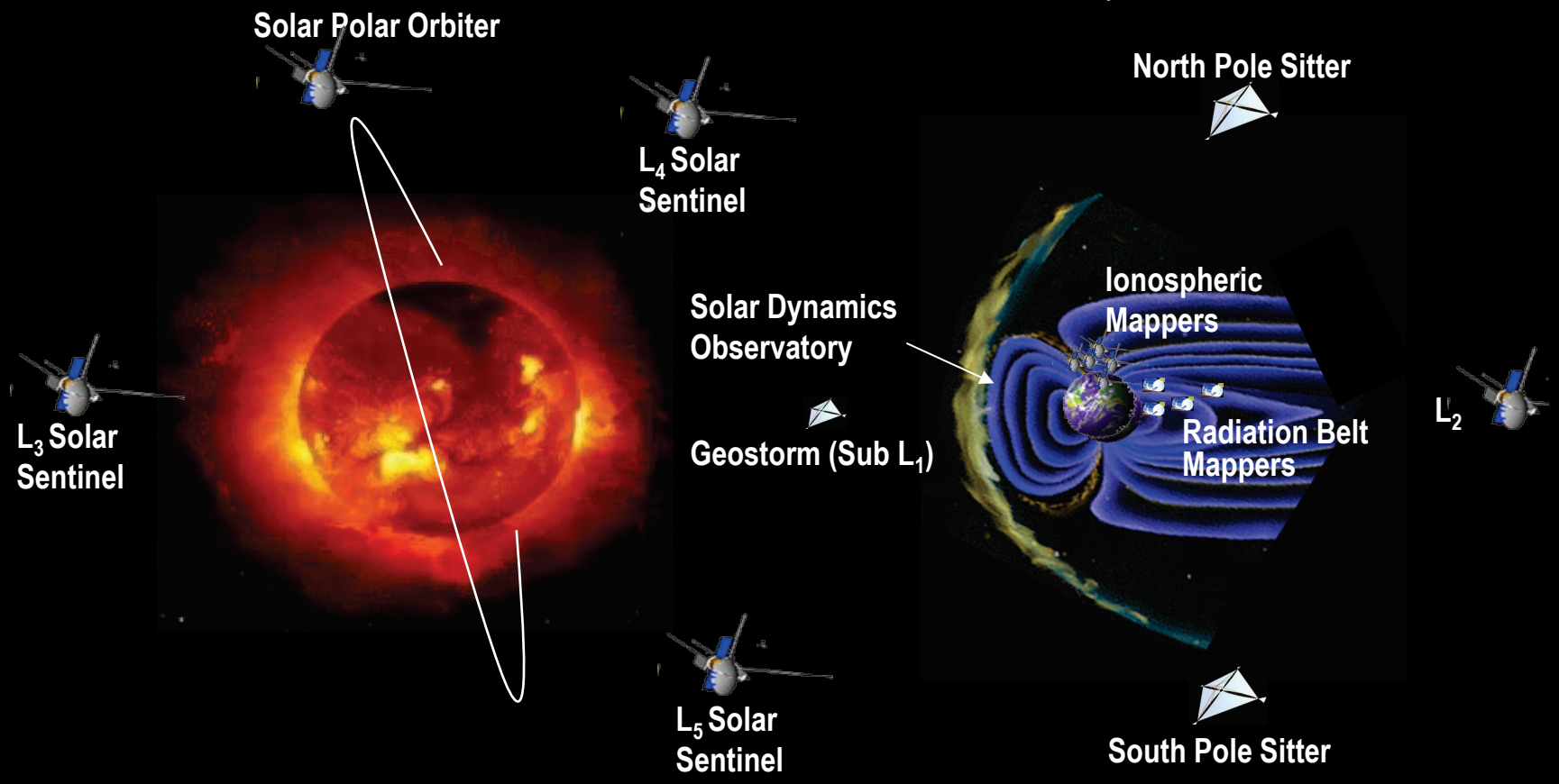


Distributed network of spacecraft providing continuous observations of Sun-Earth system

- *Solar Dynamics Network* observing Sun and tracking disturbances from Sun to Earth
- *Geospace Dynamics Network* with constellations of SmallSats in key regions of geospace

INNOVATIVE ARCHITECTURE

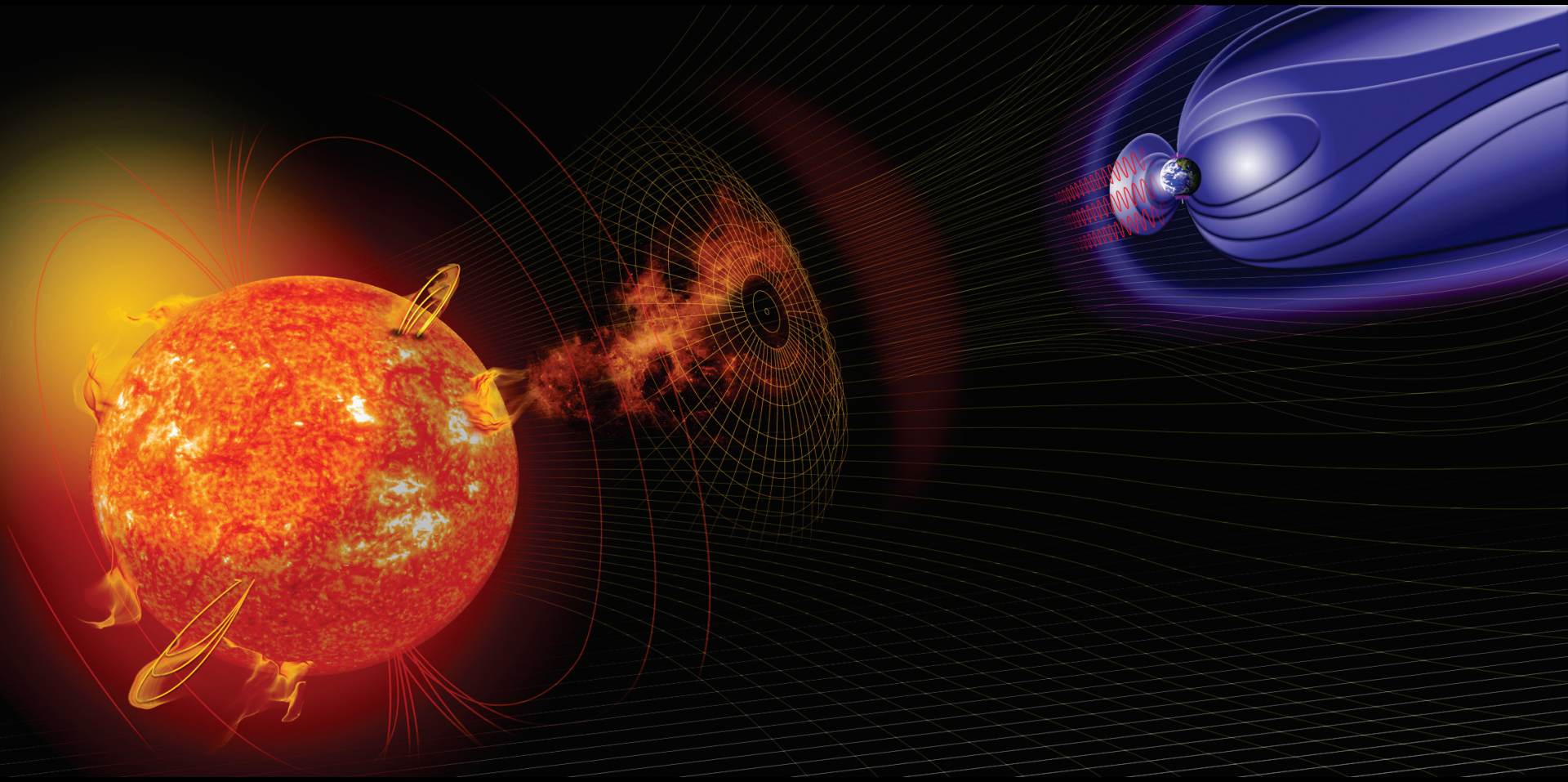
Original LWS Architecture Concept:
Establish Space Weather Research Network



New architecture will be spatially distributed, contemporaneous, and evolutionary

INTEGRATED MODELS

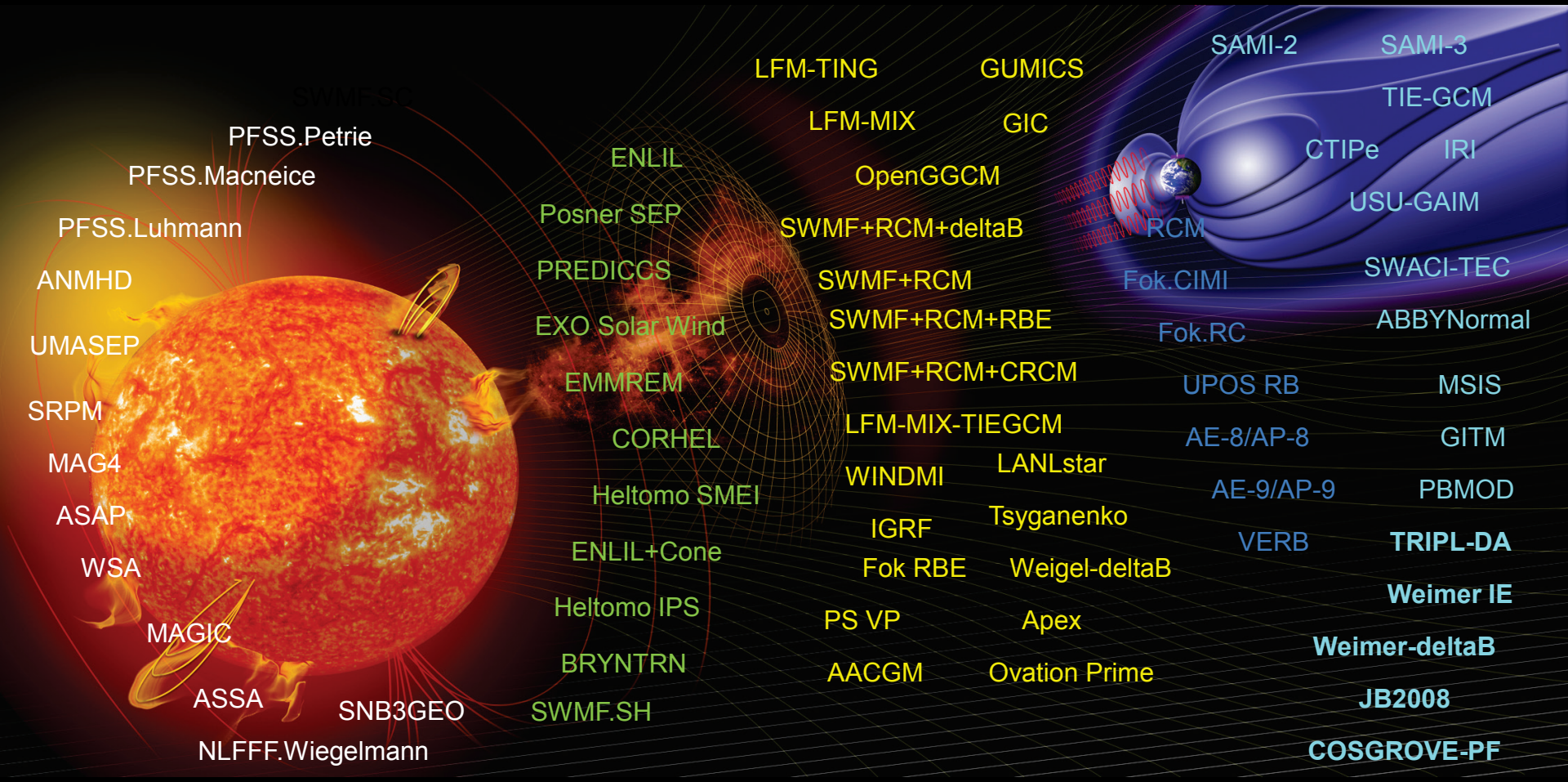
Community Coordinated Modeling Center (CCMC)



INTEGRATED MODELS

Community Coordinated Modeling Center (CCMC)

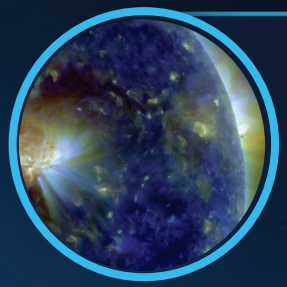
Expanding collection of models to over 80



INTEGRATED MODELS

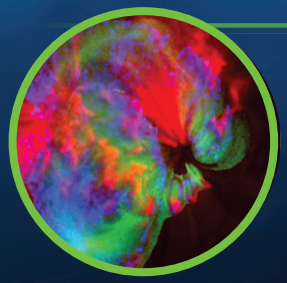
CCMC model of multiple coronal mass ejections (CMEs)

NASA'S SPACE WEATHER APPROACH



Fundamental Research

Innovative Architecture



Integrated Models