



National Aeronautics and
Space Administration

Earth Science Modeling Strategy

Earth Modeling Nexus

September 2, 2026

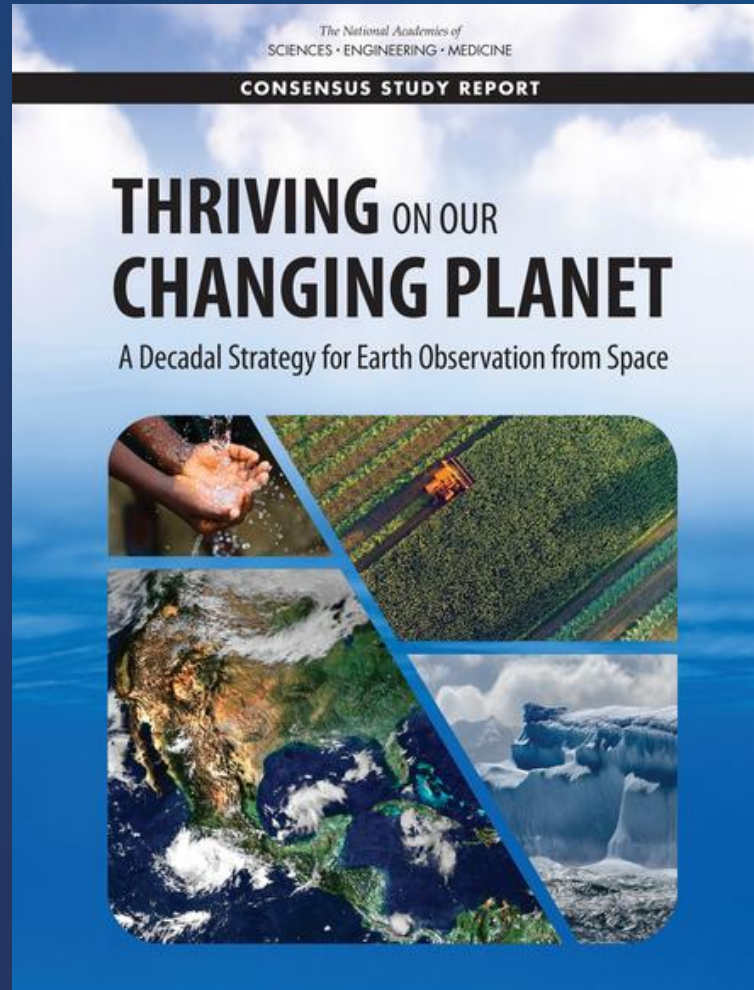
Argyro Kavvada, Program Manager, Earth Modeling Nexus



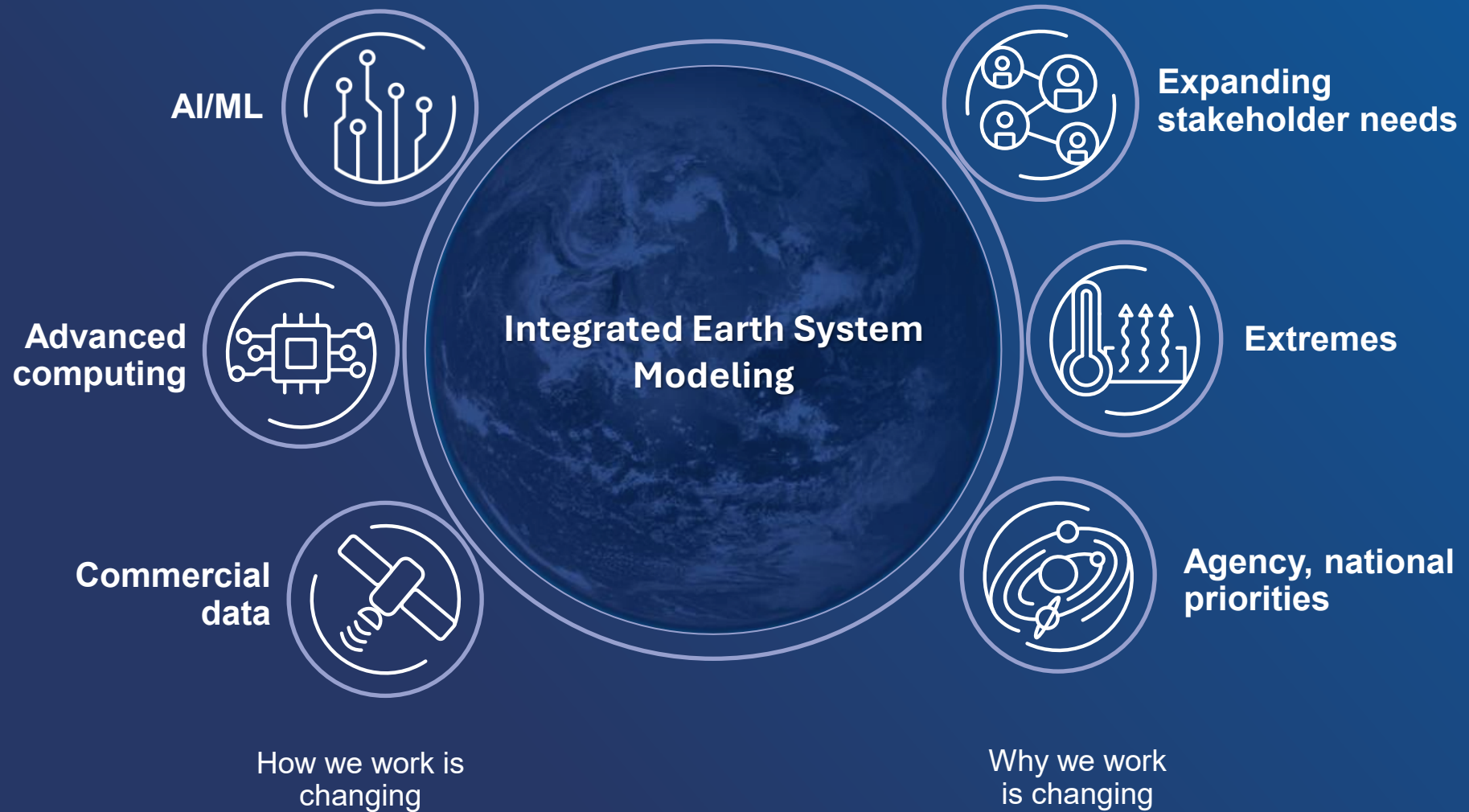
Key Guidance for Earth Science Modeling Strategy

“Pursue increasingly ambitious objectives and innovative solutions that enhance and accelerate the science/applications value of space-based Earth observations and analysis to the nation and the world in a way that delivers great value, even when resources are constrained, and ensures that further investment will pay substantial dividends.”

- *Thriving on Our Changing Planet: A Decadal Survey for Earth Observations from Space*, 2017



The Earth system modeling landscape is rapidly changing



Sustained leadership requires agility, innovation, and integration

Integrated Earth Science Modeling Strategy

Models underpin state-of-the-art prediction and risk assessment to support economic growth, national priorities and national security

STREAMLINE



Involve the best experts where they are and consolidate workflows for greater effectiveness

PRIORITIZE



Align investments around advanced technologies and techniques

FLEXIBLE & SCALABLE



Link models to supporting scientific computing systems



Gaps & Opportunities

Identified across multiple surveys, workshops, and community feedback



Sustained Capability

Advance integrated modeling systems and build continuity through long-term investment



Clear Transition Pathways

Establish consistent mechanisms to accelerate evolution from innovation to system capabilities



Consistent Evaluation

Develop shared benchmarking and standards to enable community-wide model assessment



Technology Integration

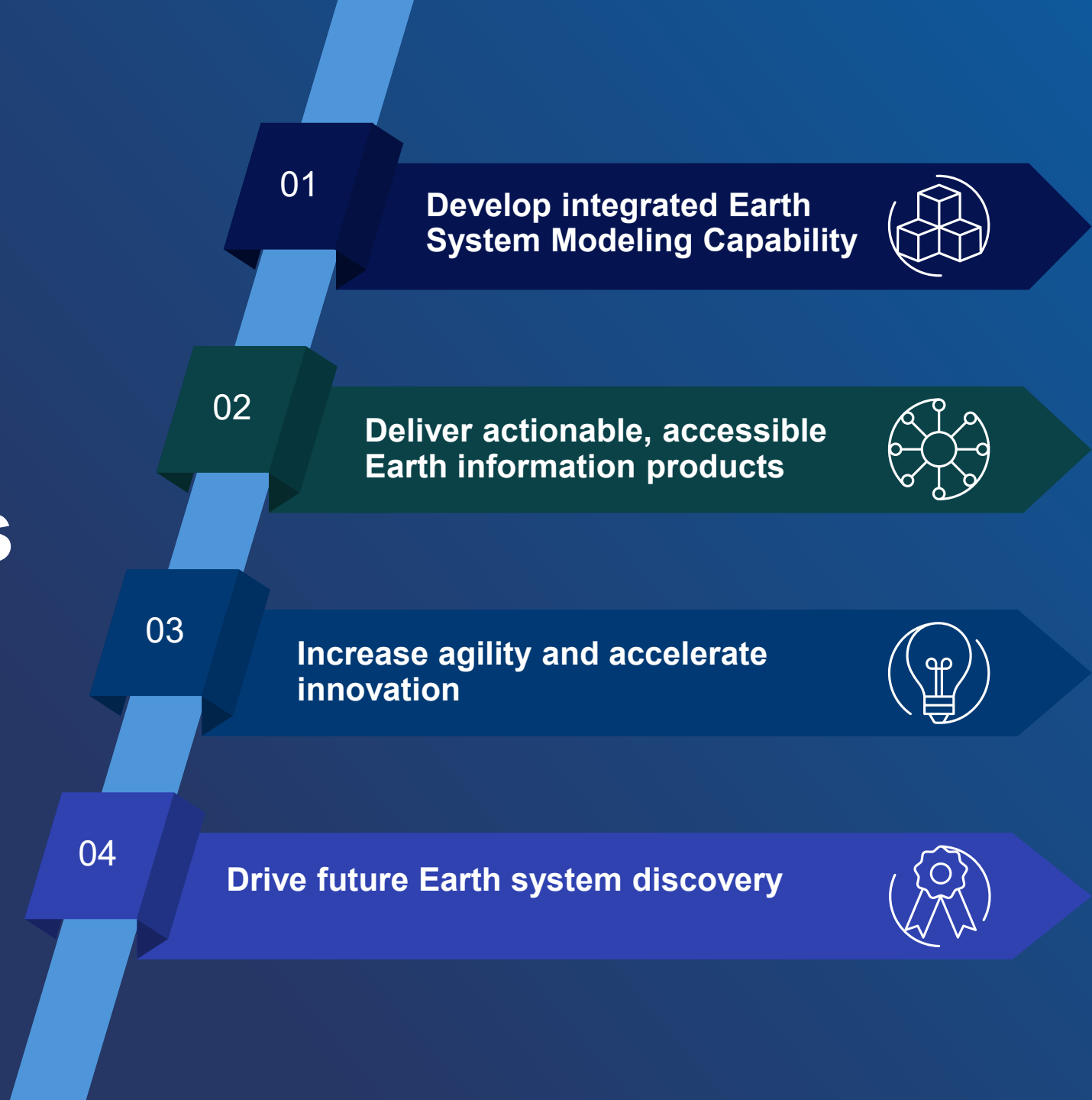
Define clear targets for integrating AI/ML and advanced computing into shared systems



User-Centered Development

Align priorities and product development systematically with end user and application needs

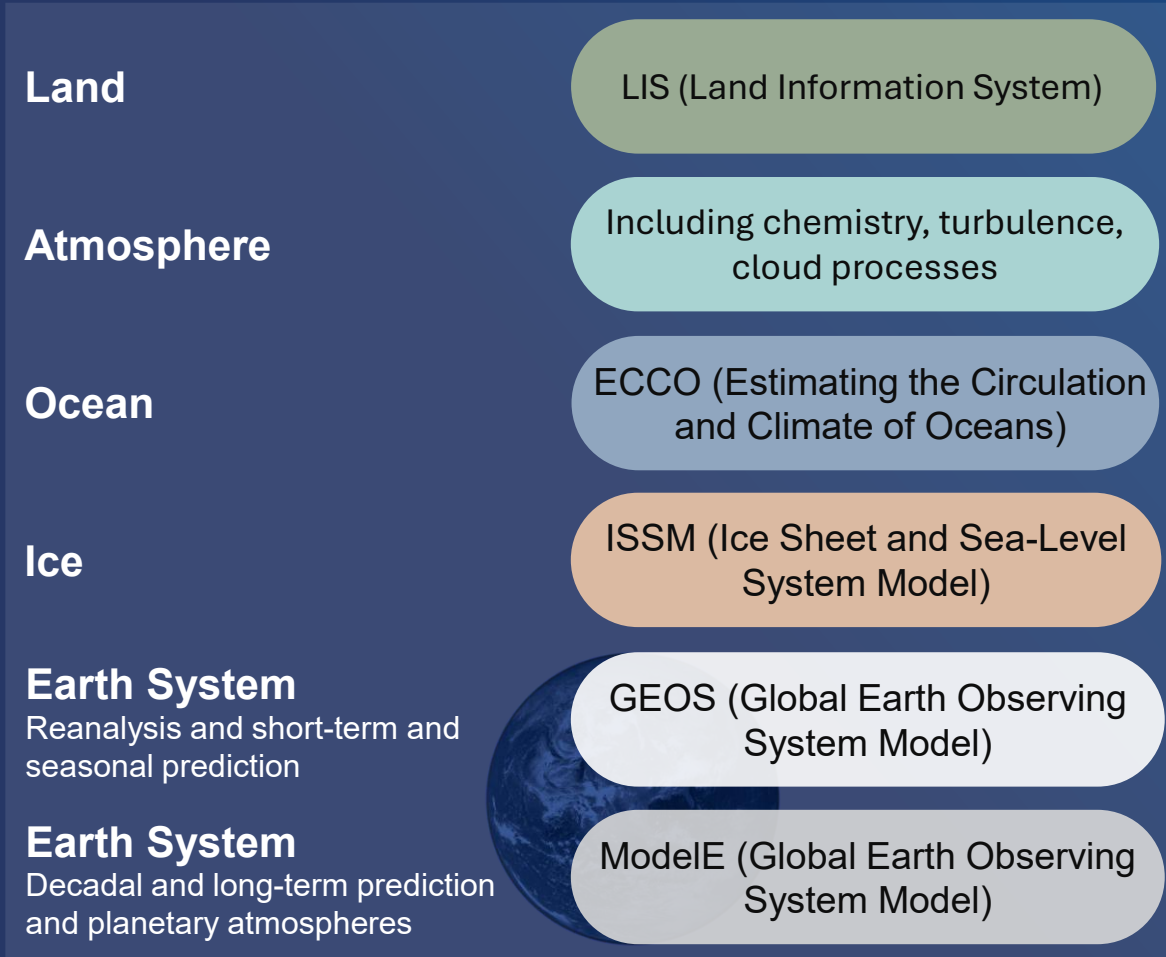
Strategic Objectives



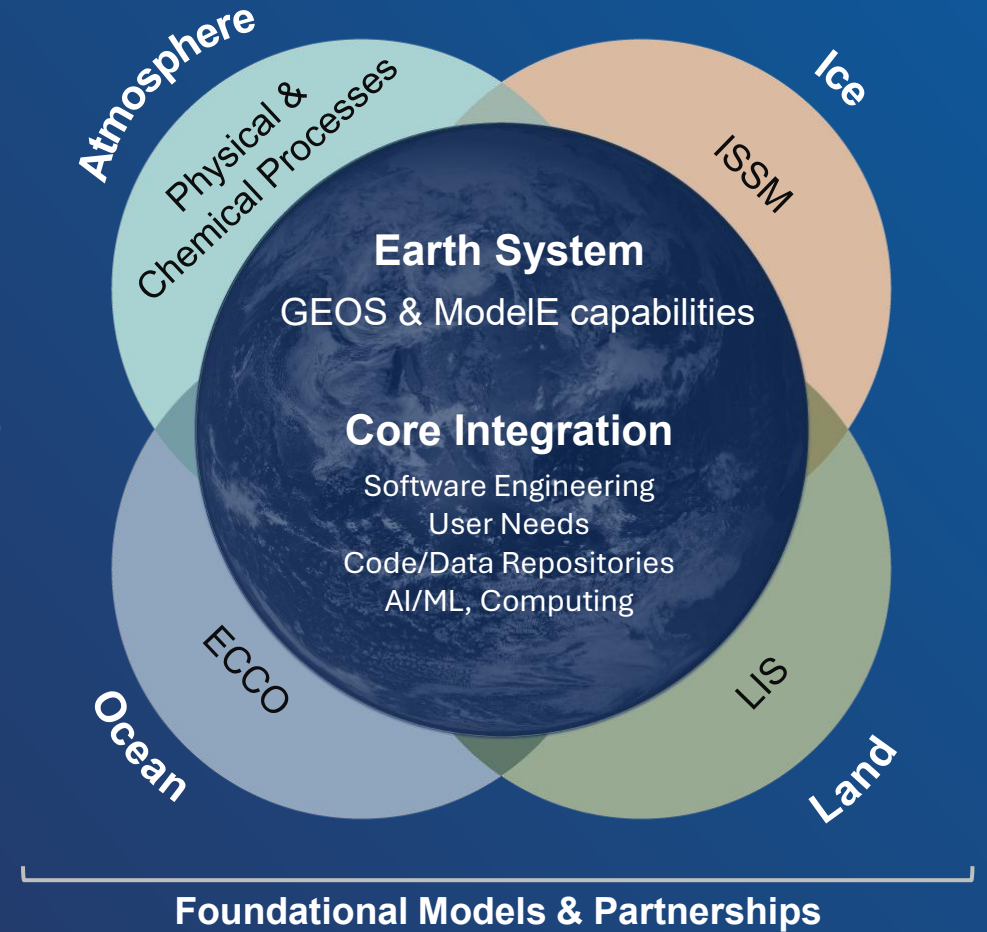
Enabling Foundations

Earth Modeling Nexus (Nexus)

Independent Models Today



Integrated Modeling with Nexus



Earth Modeling Nexus Implementation

CONTINUING

- Sphere-led innovation and exploratory modeling
- HQ authority over solicitations, awards
- Alignment of modeling activities with evolving enterprise systems

BUILDING

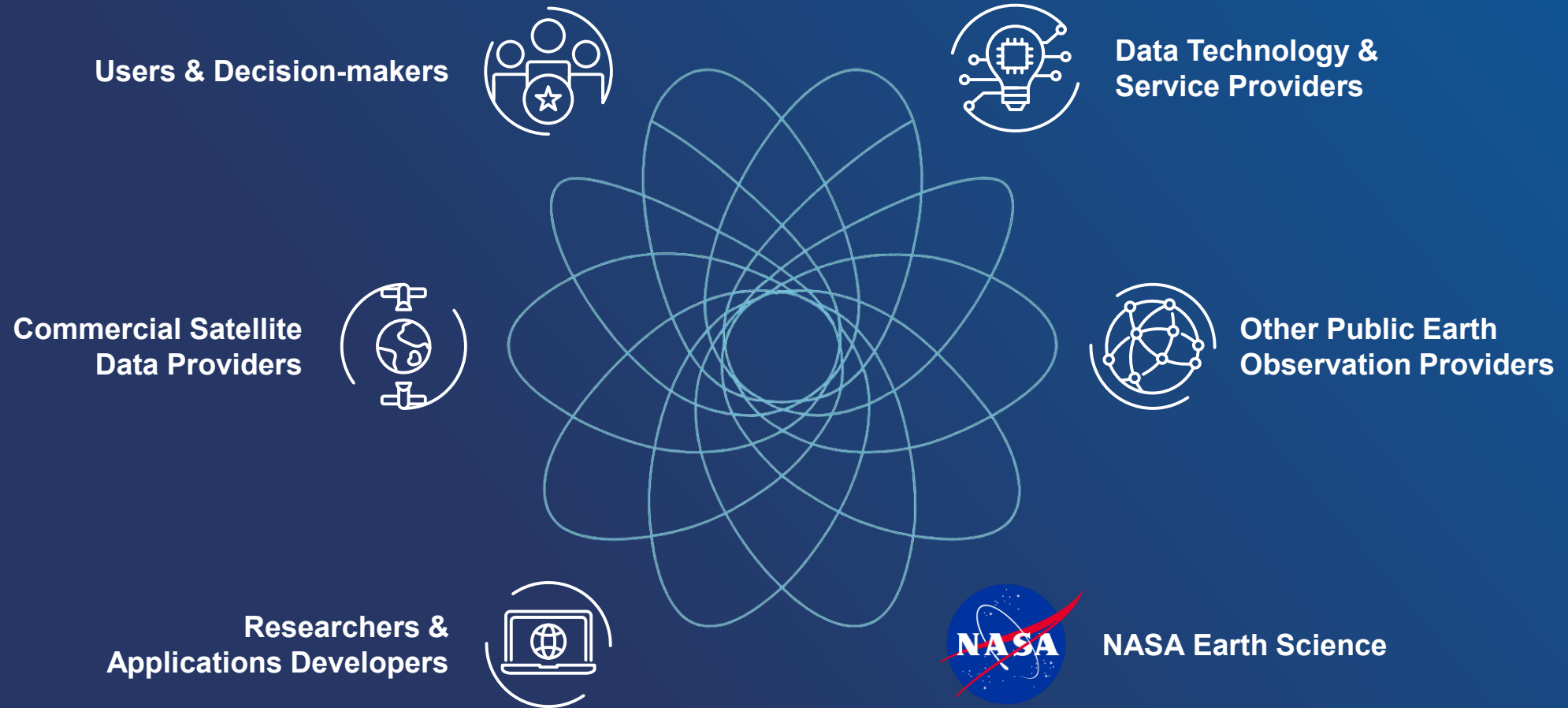
- Clearer transition pathways
- Transparent decision-making
- Sustained enterprise modeling systems
- Greater integration across timescales

SPARKING



New opportunities for transition of mature capabilities

Enabling Foundations Partnerships





National Aeronautics and
Space Administration

Building an Enterprise Modeling Capability for NASA Earth Science

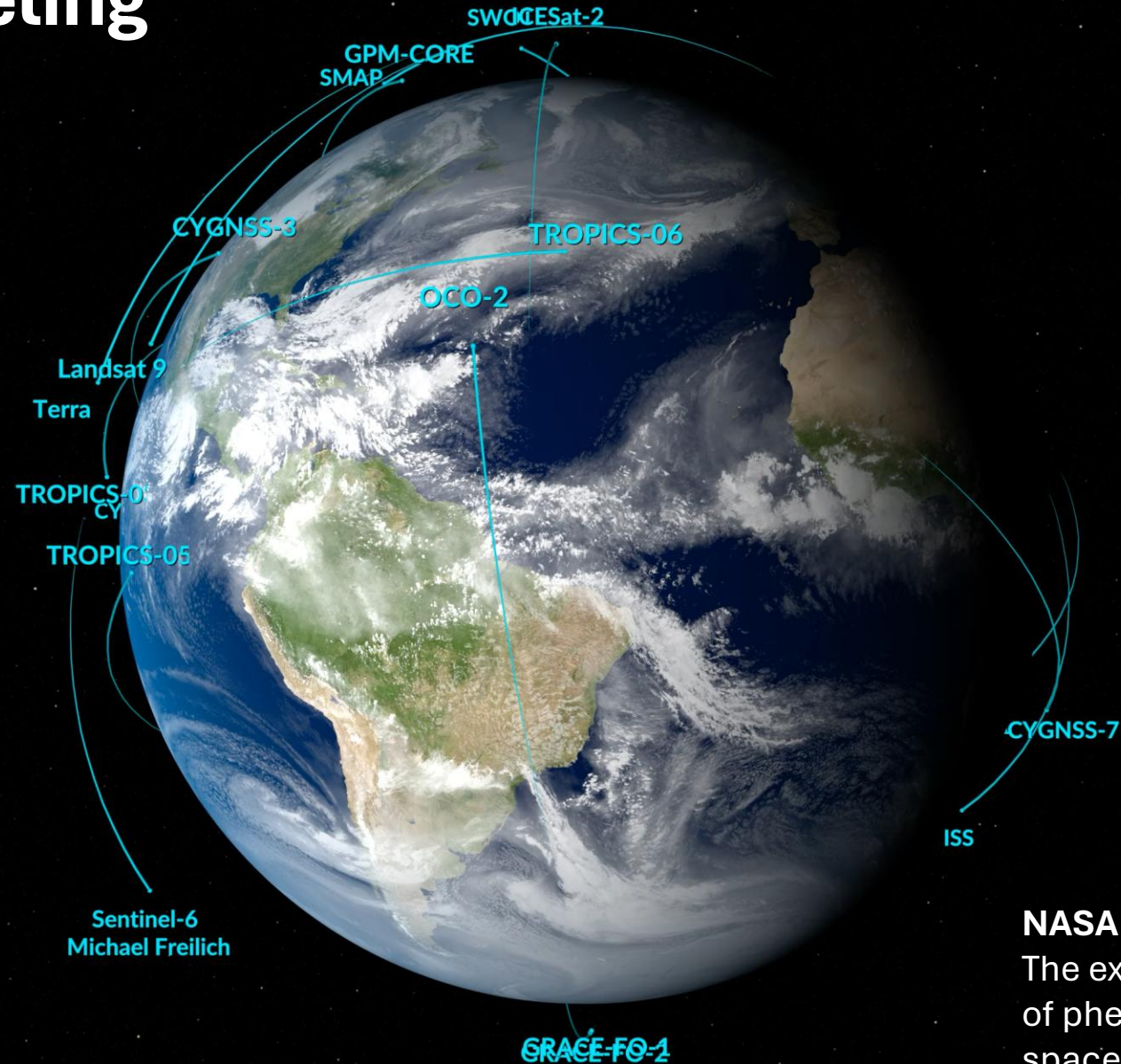
*Implementation within the Earth Science Modeling
Strategy*

March 5, 2026

Lesley Ott, Project Scientist, Earth Modeling Nexus

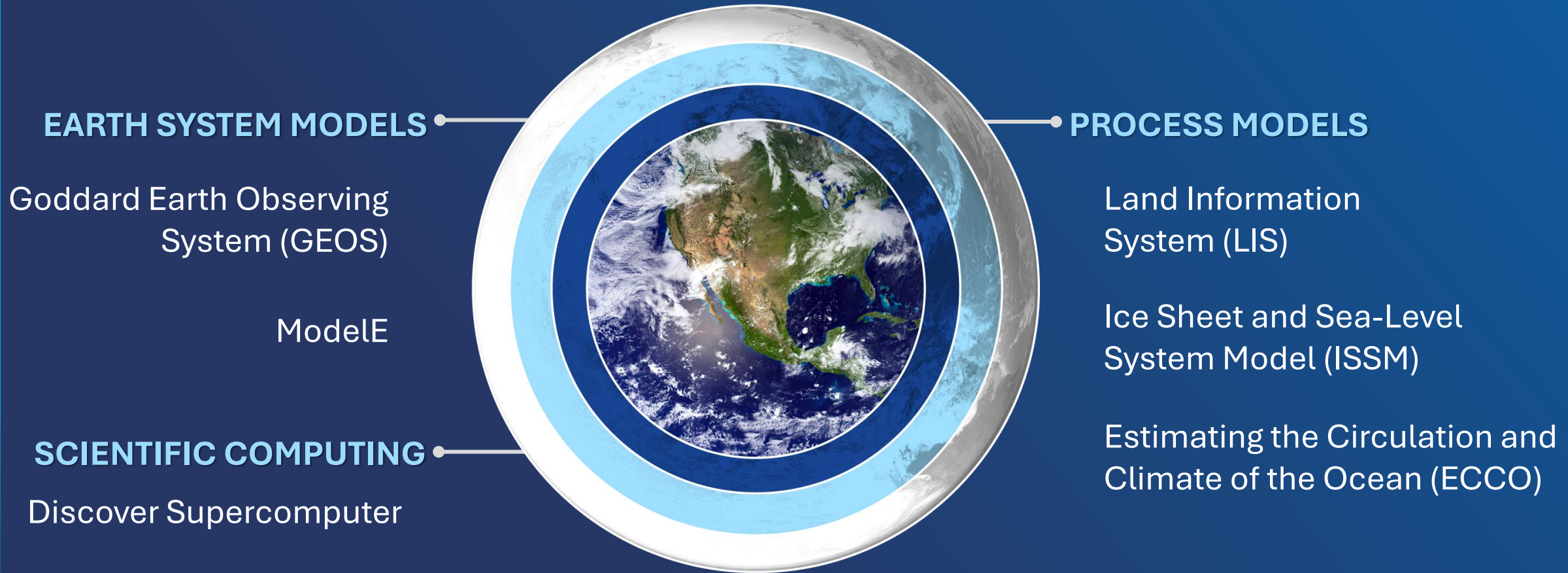


Treating Modeling as Mission Critical

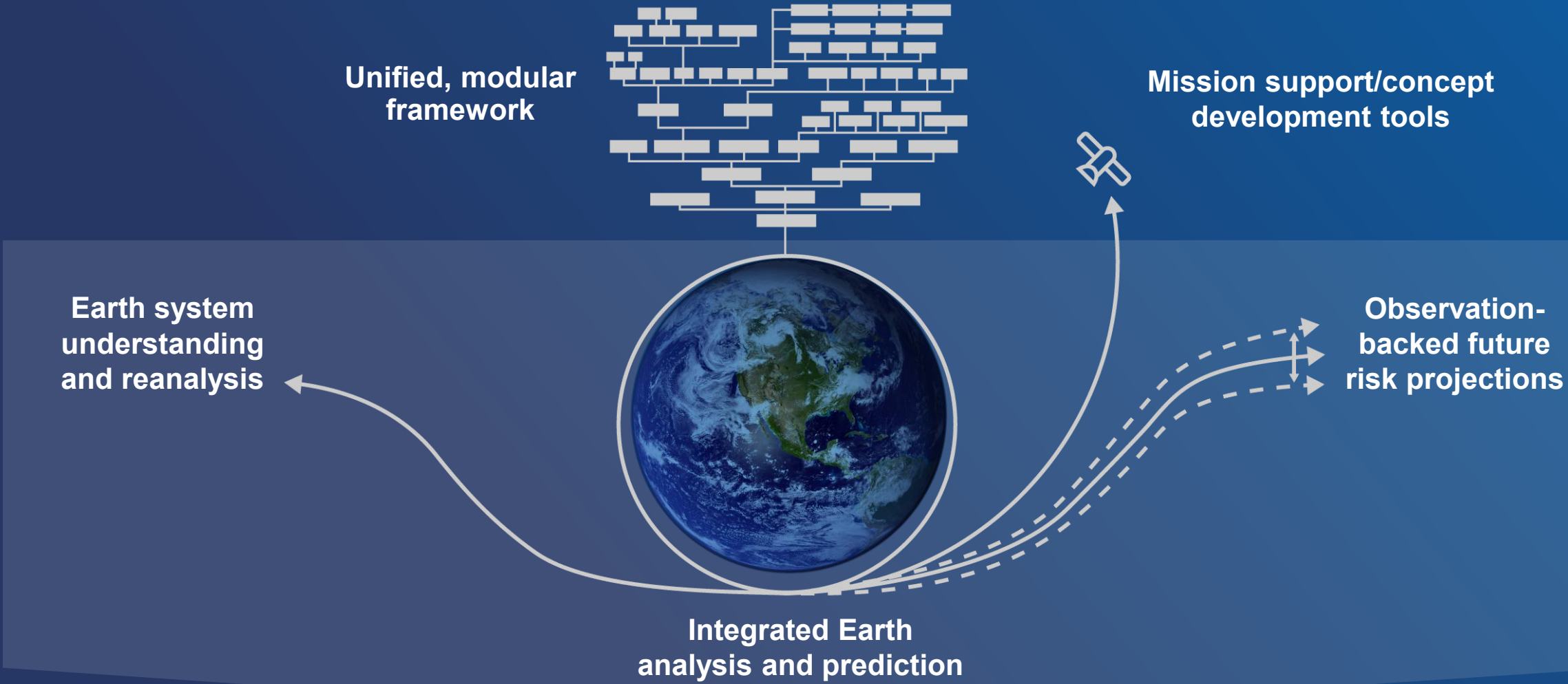


NASA Mission Statement (1958):
The expansion of human knowledge
of phenomena in the atmosphere and
space

Nexus: Leveraging Complementary Strengths



NASA Integrated Modeling



Best estimates of Earth's past, present, and future based on all available observations

Modeling foundations to accelerate discovery and impact

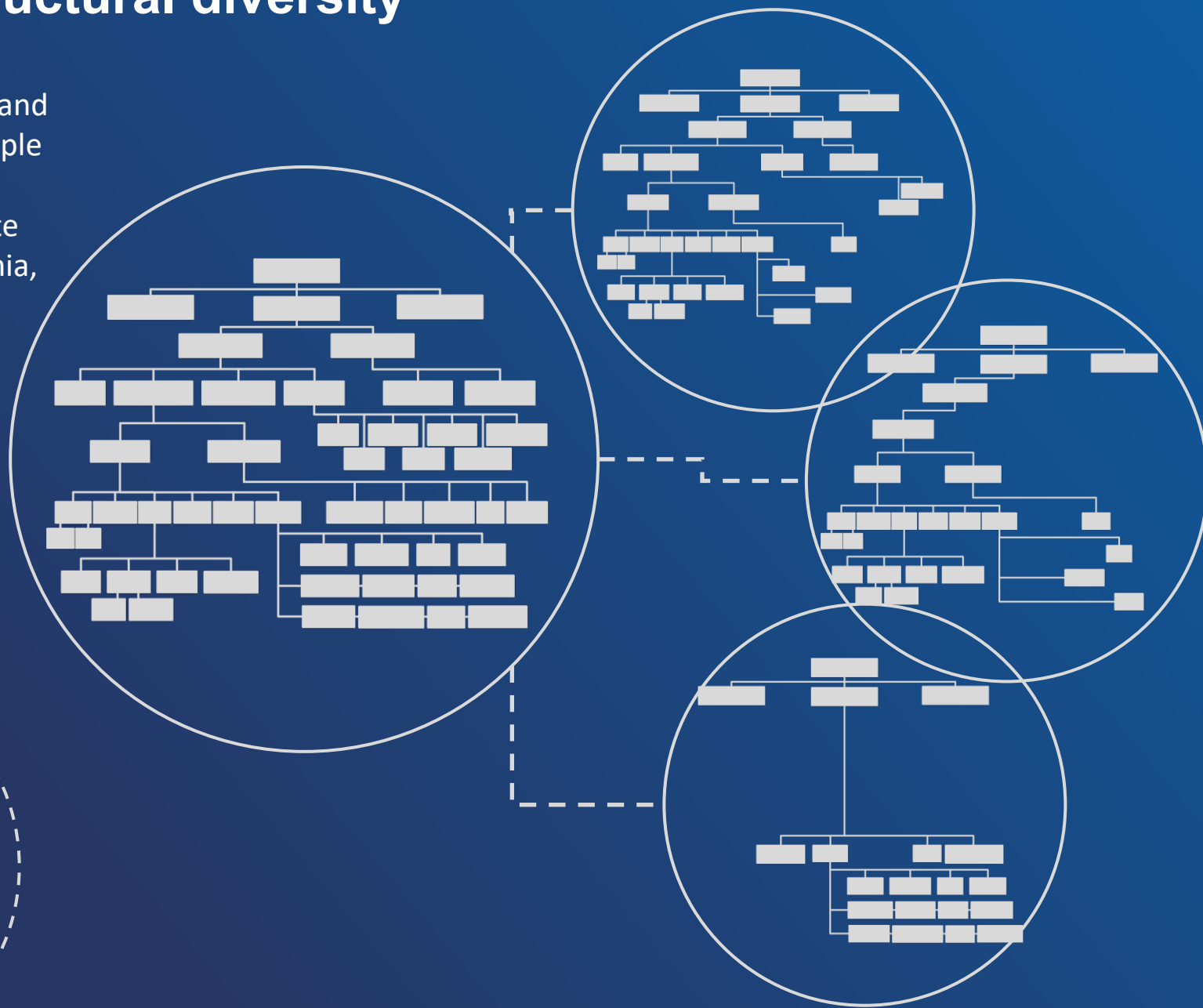


Strategic approach to structural diversity

Leverages flexible infrastructure and modular design to support multiple core configurations.

New opportunity to incorporate scientific advances from academia, partners.

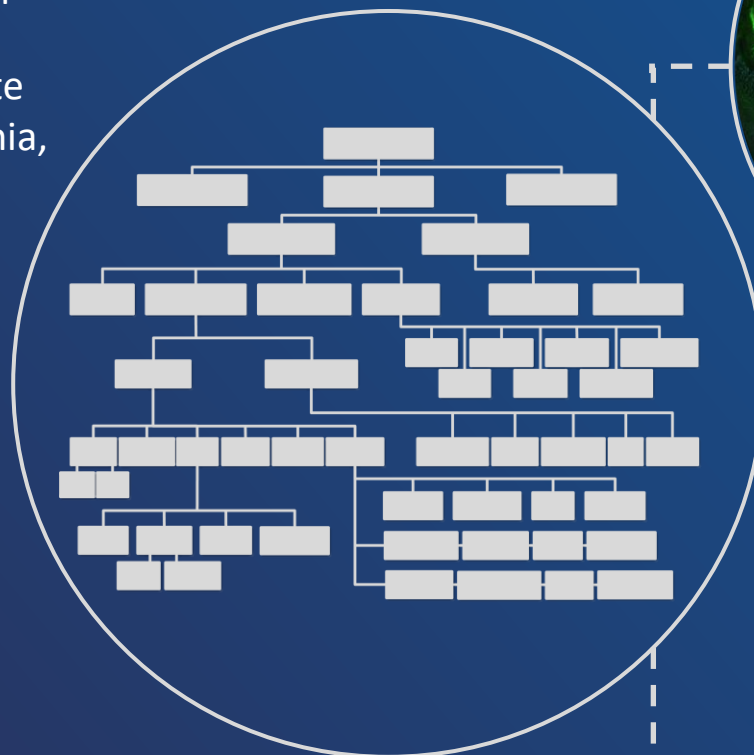
Expanding to new configurations



Strategic approach to structural diversity

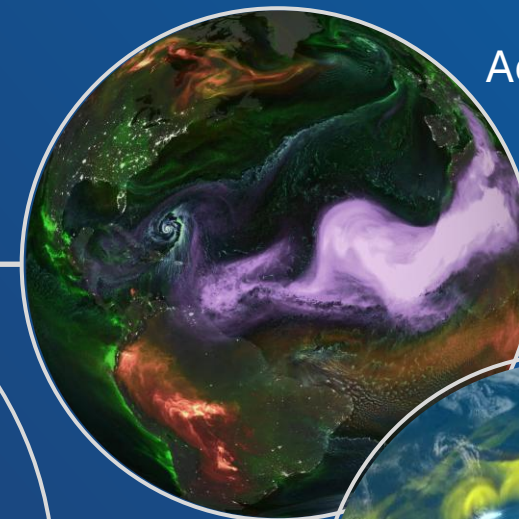
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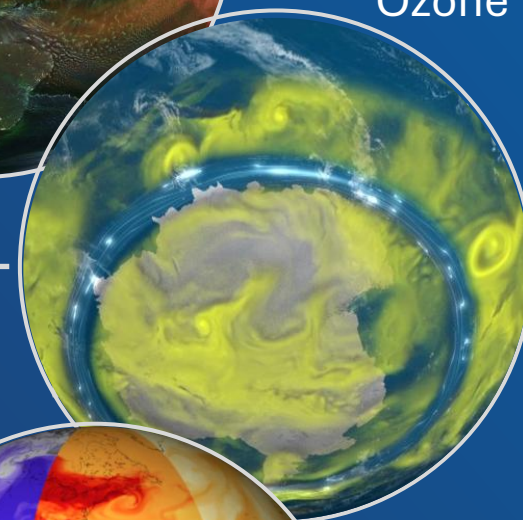


Expanding to new configurations

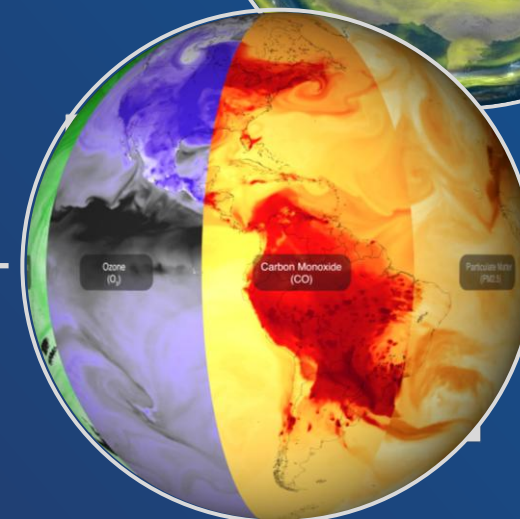
Example:



Aerosols



Ozone



Air quality

Earth Modeling Nexus Scope

Earth Modeling Nexus

- ✓ Unified modeling framework, focus on coupled Earth system modeling, data assim.
- ✓ Core cross-disciplinary product lines – best estimates of past, present, future
- ✓ Multi-purpose tools contribute to agency mission planning
- ✓ Leadership for modeling, evaluation standards



ESD

- ✓ Discipline-focused process modeling (R&A), AI-enabled components (ESTO)
- ✓ Products and services tailored to non-technical users, applied models (Earth Action)
- ✓ Enterprise data services and partnerships (ESDS)
- ✓ Mission-specific planning tools (Flight Programs)

PARTNER- LED

- Community models enabling wide range of approaches (NSF)
- Operational models focused on warnings (NOAA)
- Primary focus on model intercomparisons (international, academia)
- Standalone AI models without traceability to physical foundations (private industry)

Integration Pathways

EXPLORATORY**INTEGRATION****ENTERPRISE****Nexus**

Enterprise system stability
Advancing in step with research



Improved core products
& prediction capabilities

Potential for Model Readiness Levels
to guide transition process
(see: **ECMWF**)



Subset of approaches
Integration
Testing

**Research
Innovation**

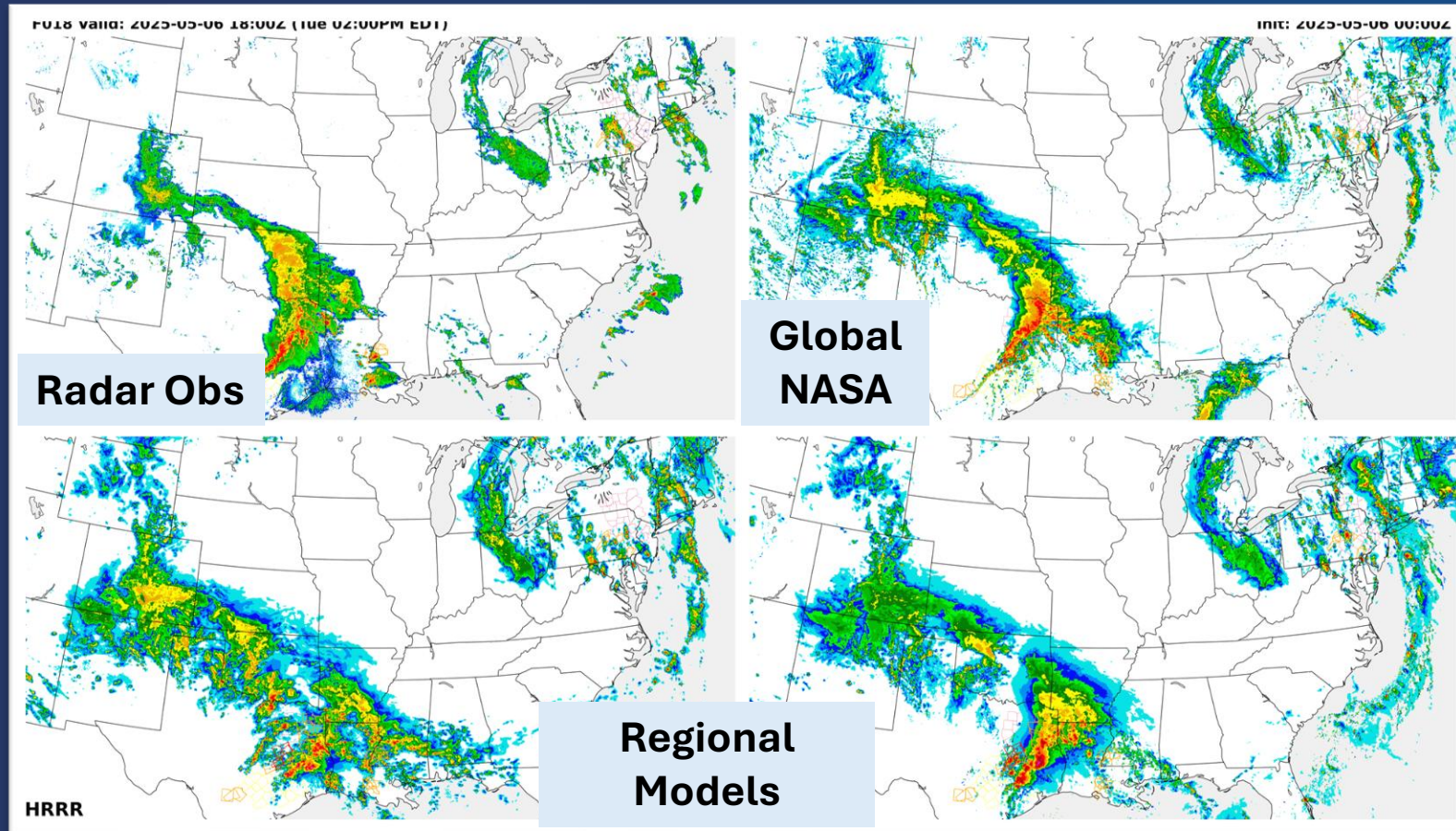
Prototype components
Evaluation & benchmarking



Continued development
Process studies

Nexus Capability Focus: Multi-scale Modeling

Example: 2025 Texas Tornado Outbreak (NASA, NOAA model simulations)



Challenges:

- Regional high-res modeling disconnected from sustained Earth system capability
- Advances from campaigns, process studies do not propagate into reanalysis, prediction systems

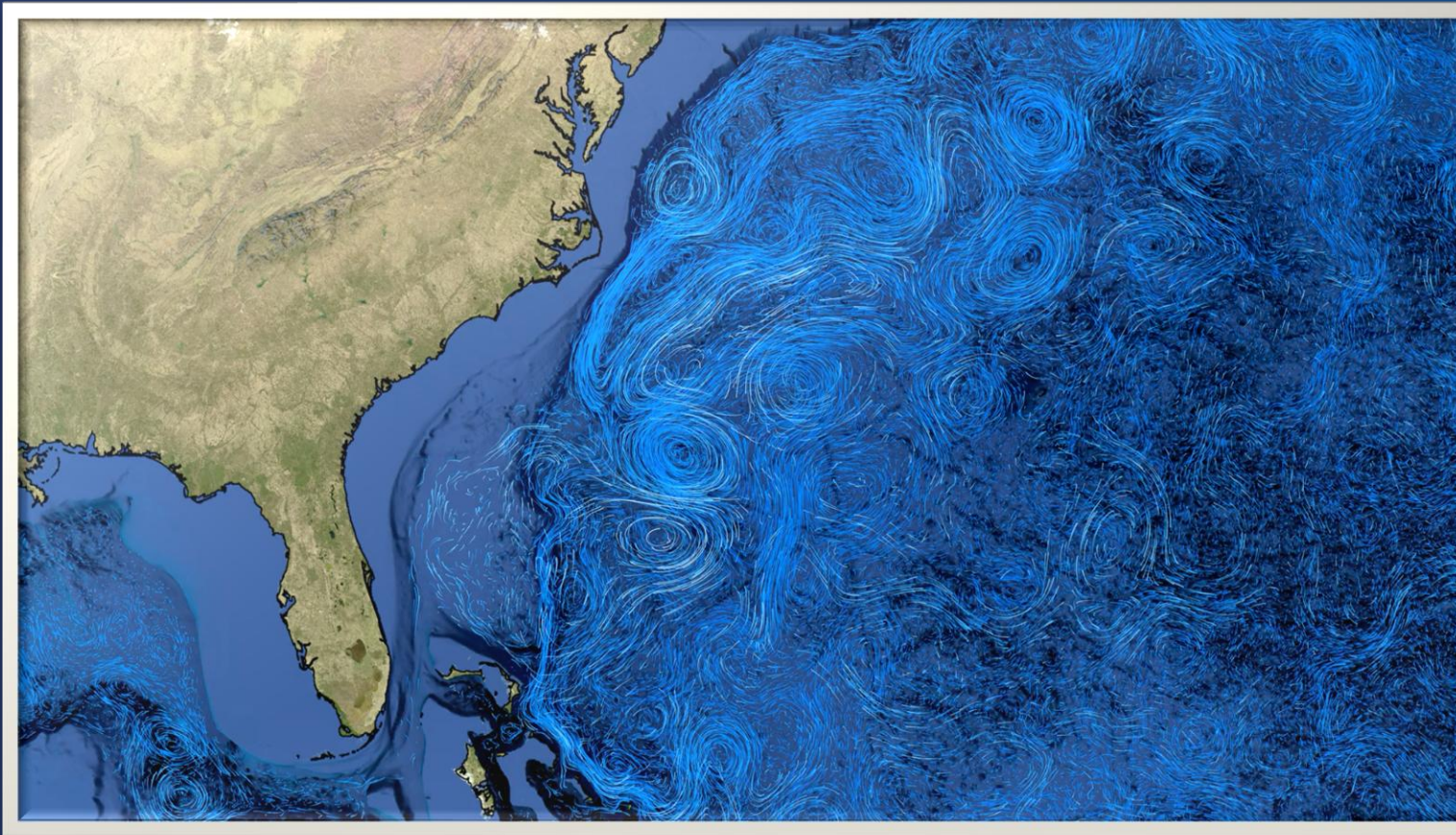
IMVI enables consistent representation of extremes, large scale interactions from weather → climate projection. New opportunities to shape:

- Development and evaluation
- Deployment to support field campaigns
- Observational constraints that can support cross-scale benchmarking

The Nexus connects scales through shared, scale-aware modeling and data assimilation, allowing advances to propagate into sustained system capability

Nexus Capability Focus: Earth System Interactions

Example: ECCO Ocean Currents – Gulf Stream



Challenges:

- Biggest science questions, societally relevant decisions are coupled problems
- Discipline-specific models cannot represent feedbacks, constraints across Earth system

IMVI enables coupled modeling, DA across atmosphere, land, ocean, & ice – and adoption of system –level constraints (water, energy, carbon). New opportunities:

- Land-atmosphere coupling -> extremes, predictability
- Ocean, stratospheric composition -> S2S (science of STRIVE)
- Land/ocean, atmosphere -> carbon cycle constraint on future projections

Flexible modeling framework allows new opportunities for NASA community to investigate coupled questions – and feed back on next generation of reanalysis, long range predictions

Nexus Capability Focus: Coupled Earth System Prediction

Tracking high impact events as they happen

Example: Current ENSO Forecast

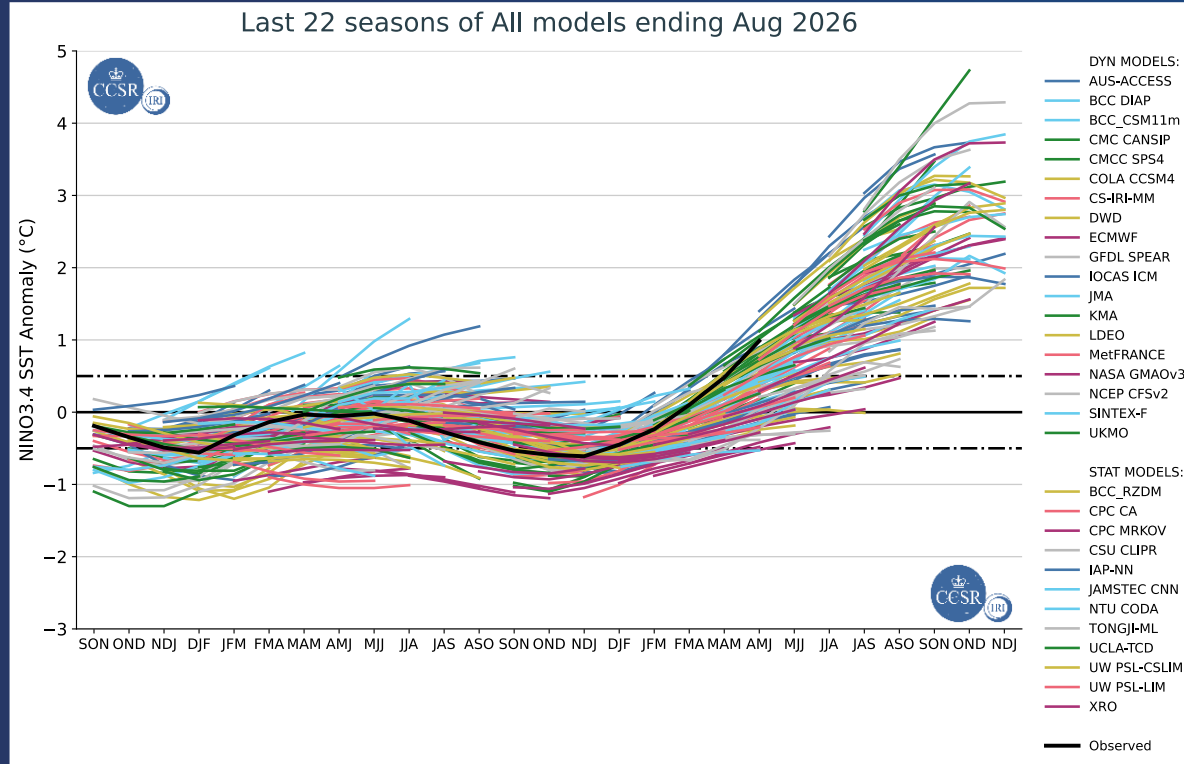


Image credit: IRI, Columbia University

Opportunity: NASA S2S Capability

NASA's unique role in S2S: Advancing novel use of Earth Observations

- Improve initialization – coupling, new constraints
Explore representation of processes (e.g., aerosol-cloud interactions)
- Use of ocean state estimates to improve skill at interannual-decadal timescales

Recent updates to GEOS-S2S3 system:

- Focus on coupled atmosphere-ocean observed precip forcing for initialization
- Reduces shock, improves skill in 2-6 wk range
- Seamless approach users request
- **Pilot:** Used to drive LIS, provide information to US water managers

Value increased by leveraging key development across NASA research, missions, Earth Action

Result: Better Strawberry Forecasts

Nexus: Pathways to advance Earth system modeling capability together

