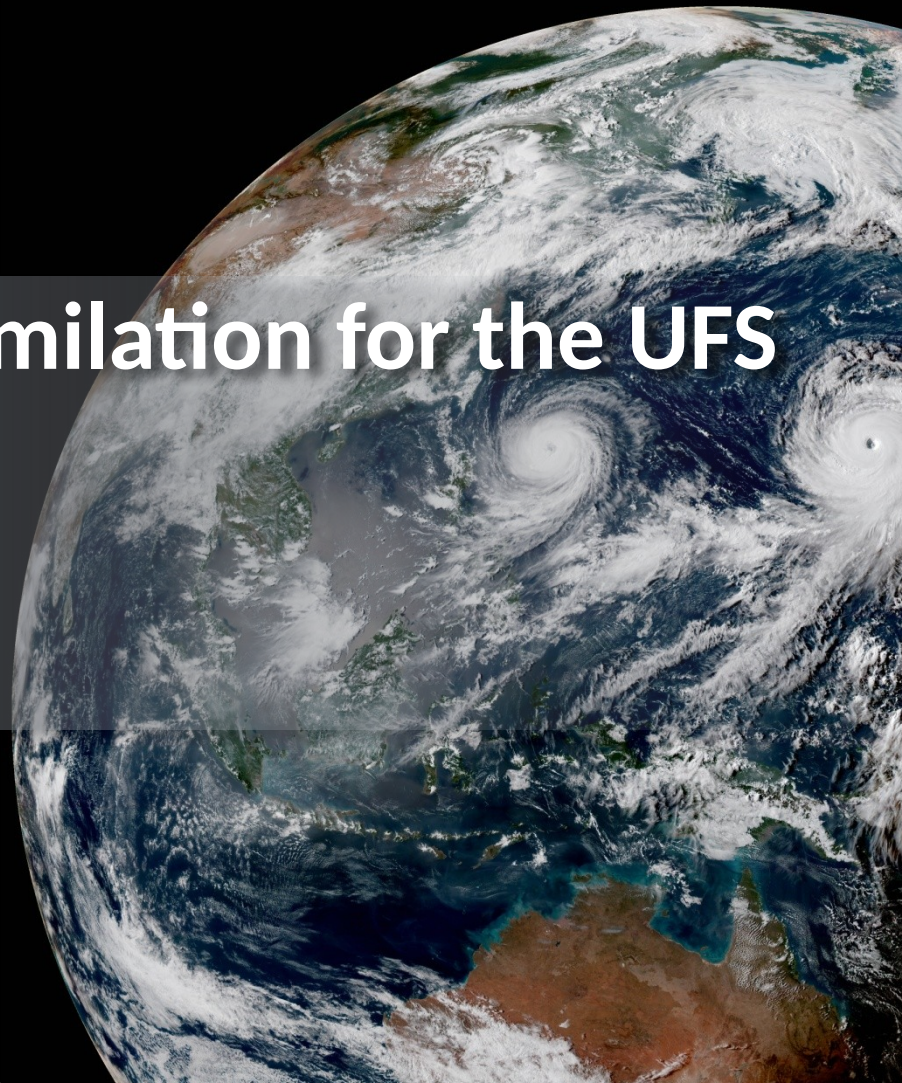
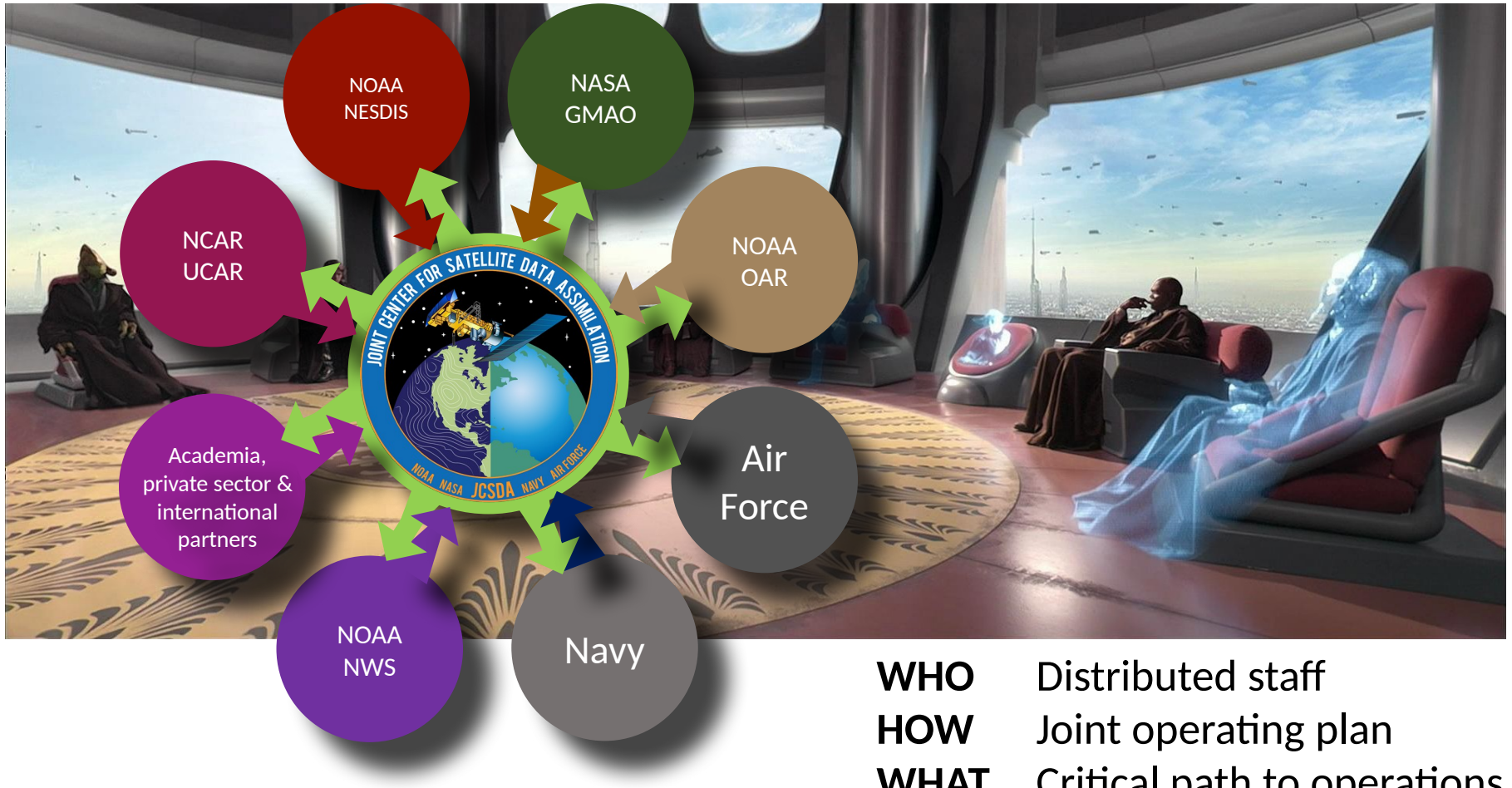
Next Generation Earth System Data Assimilation for the UFS

Tom Auligné, Joint Center for Satellite Data Assimilation (JCSDA)



Joint Center for Satellite Data Assimilation (JCSDA)

Vision: An interagency partnership working to become a **world leader** in applying satellite data and research to operational goals in environmental analysis and prediction.



WHO Distributed staff
HOW Joint operating plan
WHAT Critical path to operations

U.S. AIR FORCE

NCAR

Met Office

UCAR COMMUNITY PROGRAMS

JCSDA - Trailblazer in Community Development

Collaborative working practices

- ✓ Lean project management
- ✓ Agile/SCRUM methodology
- ✓ Champion of Open Science
- ✓ Leader in automated testing, CI/CD
- ✓ Pathfinder in cloud HPC and containers
- ✓ Shift in software portability
- ✓ Community training

Success Metrics

176 current contributors (60+ FTEs)

1,000+ PRs/commits/comments per week

1,000,000+ lines of open-source code (github.com/jcsda)

Quarterly roll-up releases (24 repositories + 479 packages)

1,800+ automated unit, function, integration tests

1st to port FV3-GFS pre-operational model to AWS (2018)

1st to demonstrate value of super-containers

12 different HPC configurations supported (23 tested)

Porting time from several months to few days

500+ padawans (7 JEDI Academies, online tutorials)

Public Releases

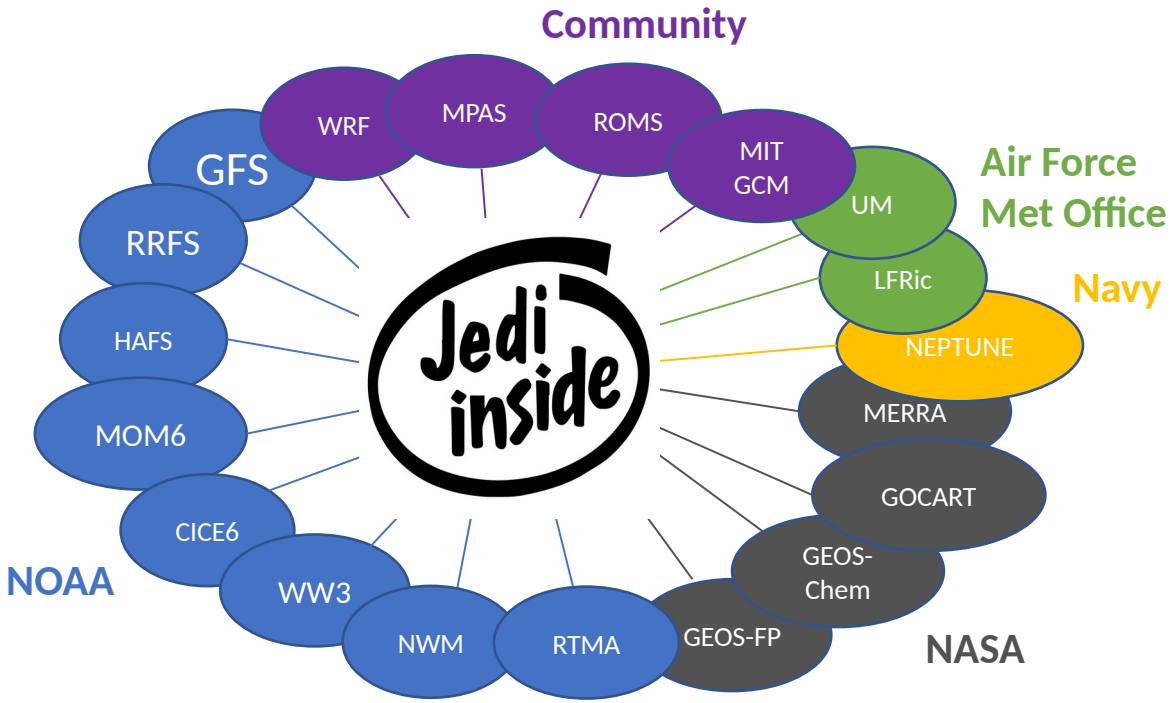
2022-07-18	JEDI-SKYLAB v1
2022-10-11	JEDI-SKYLAB v2
2023-01-09	JEDI-SKYLAB v3
2023-04-17	JEDI-SKYLAB v4
2023-07-17	JEDI-SKYLAB v5

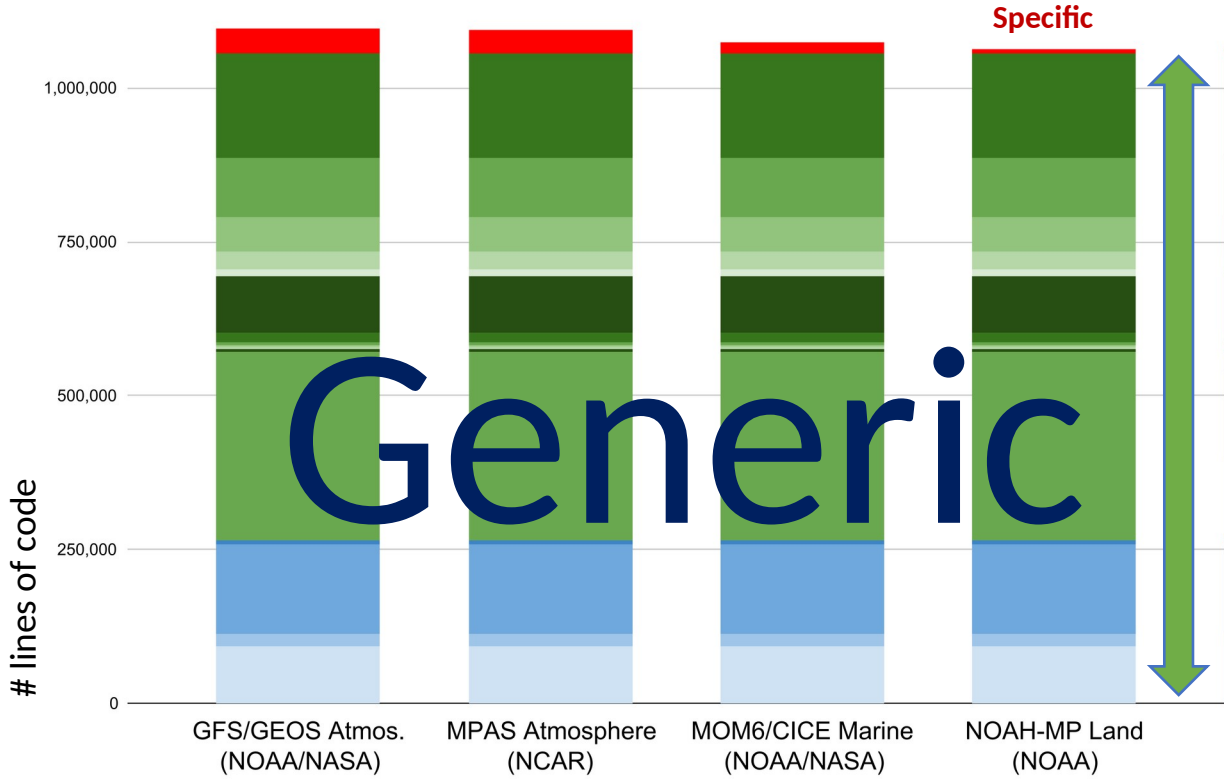
Joint Effort for Data assimilation Integration (JEDI)

Consortium of *Jointness*: Scientific diversity without reinventing the wheel

Goals

- Next-generation **unified** DA for Earth system science
- Increase **R2O/O2R** transition rate
- Improve **science productivity** and **code performance**

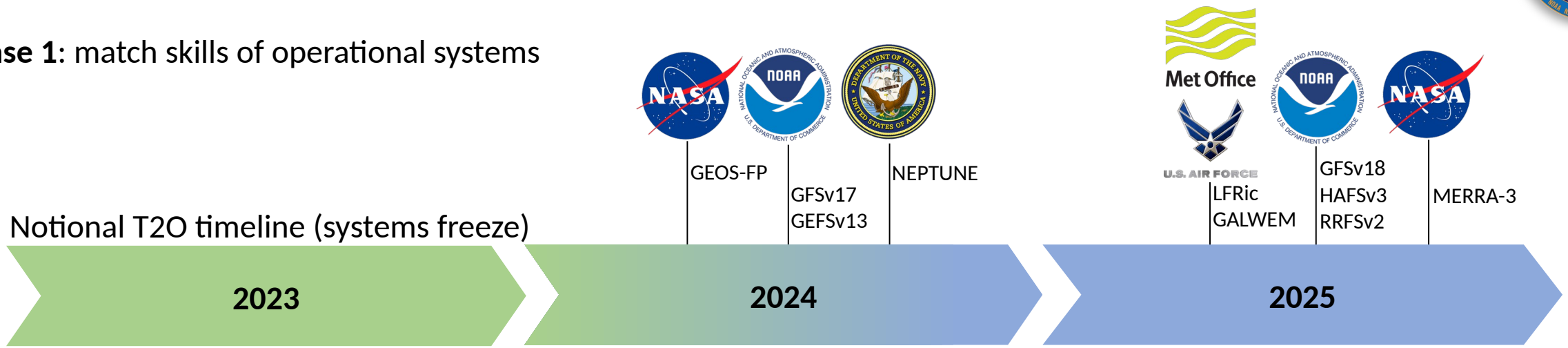




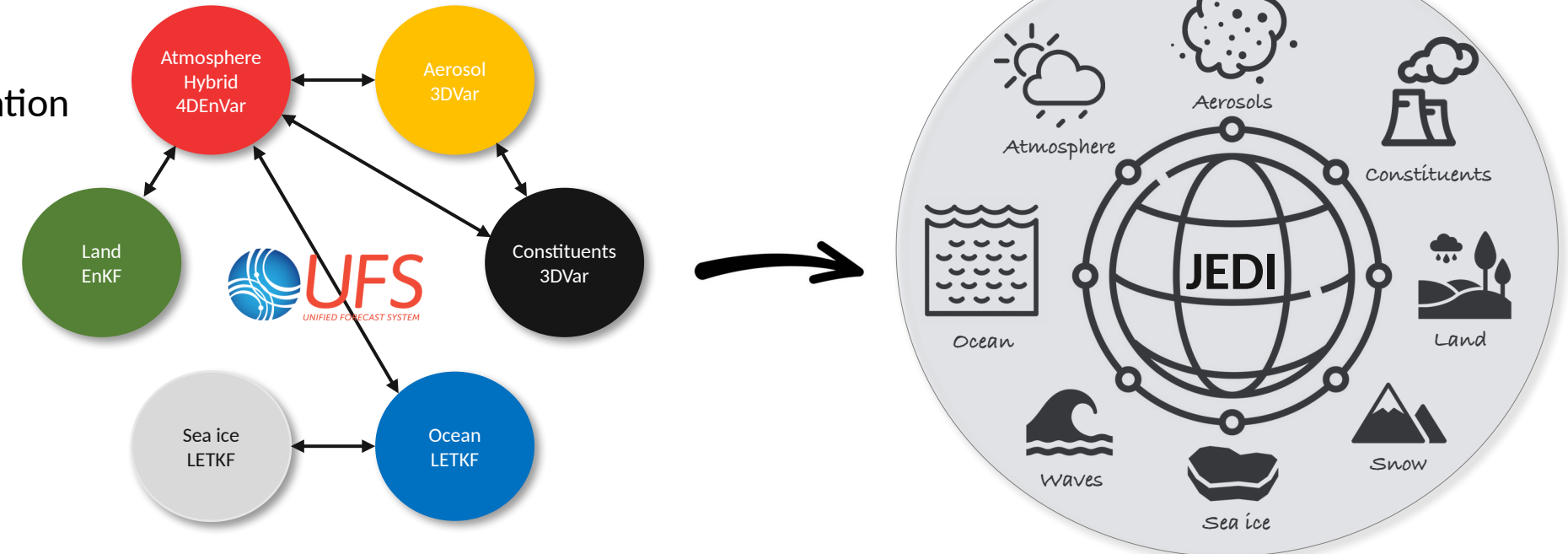
JEDI - A New Dawn (for Earth System DA)

Phase 1: match skills of operational systems

Notional T2O timeline (systems freeze)



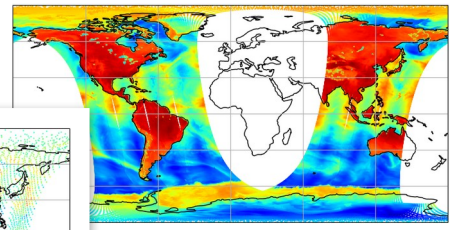
Phase 2: foster scientific innovation



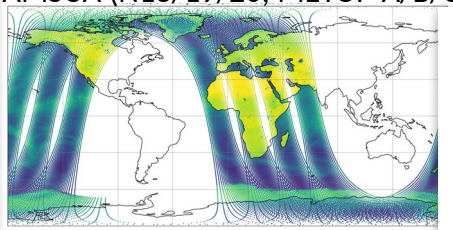
JEDI - A New Dawn (for Earth System DA)

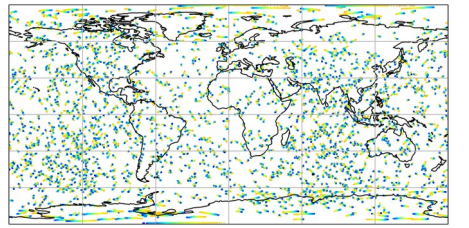
https://skylab.jcsda.org

ATMS (N20)



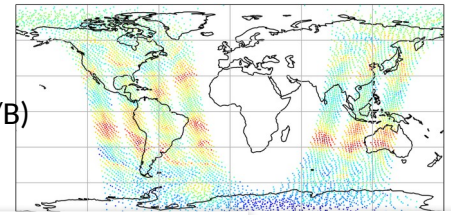
AMSUA (N18/19/20, METOP-A/B/C)

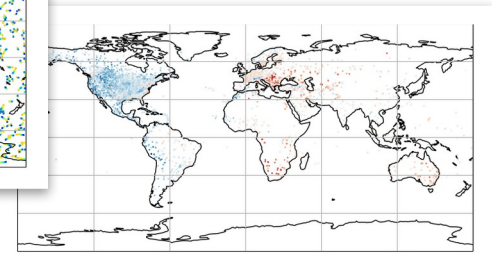




GNSS-RO

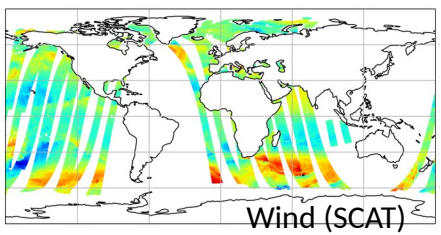
CrIS (N20/NPP)
IASI (METOP-A/B)

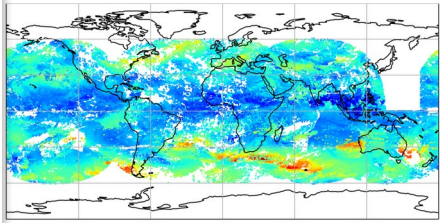


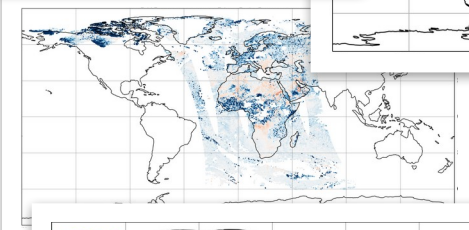


METAR
SYNOP
RAOB

SATWIND

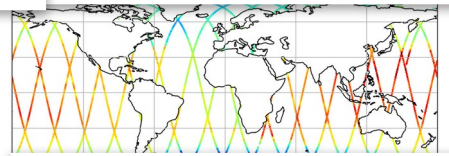


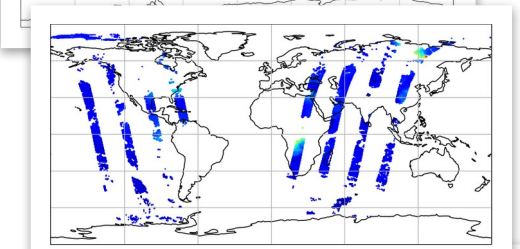




AOD (VIIRS NPP)

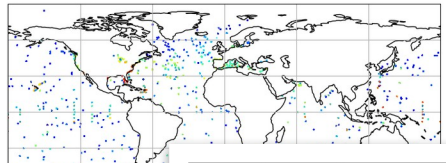
Wind (SCAT)

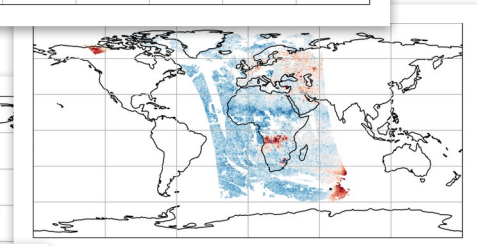




CO (MOPITT)

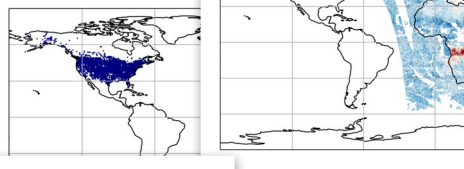
Altimeters (3A/3B/C2/J3/SA)



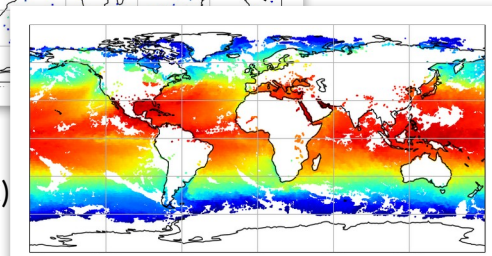


NO2 (TROPOMI)

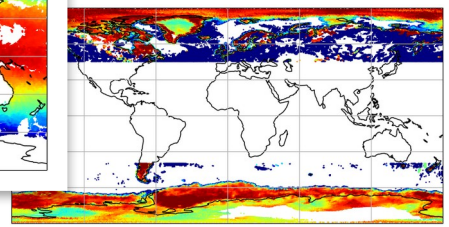
Ocean Profile

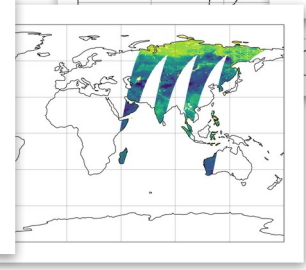


Snow Depth



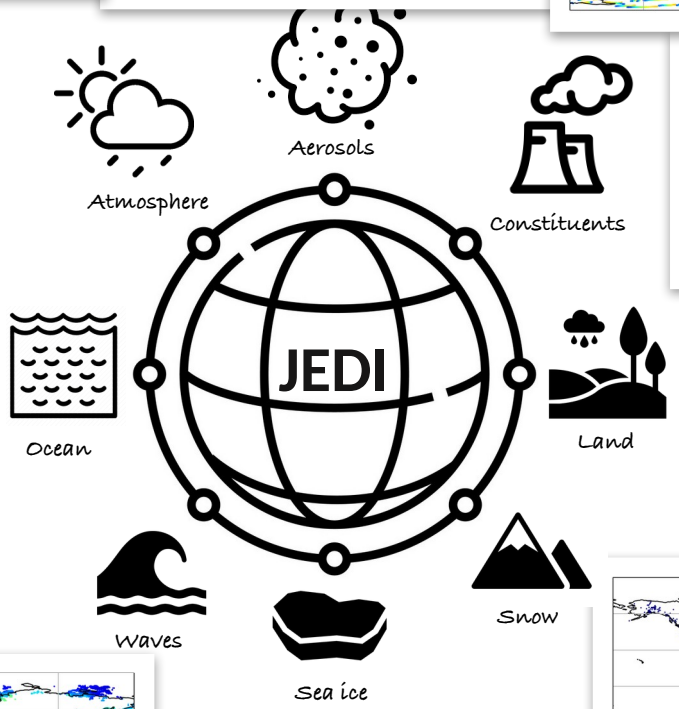
SST (AVHRR METOP-B/METOP-C)





Soil Moisture (SMAP)

Ice (SSMI/S F17-F18)



JCSDA SkyLab Testbed

Observations

Ingest

Use

Evaluate

BUFR Tanks

Data Lake

CDAAC

ODB

FTP

LDM

SKYLAB TESTBED

Interface for Observation Data Access (IODA)

Research Repository for Data and Diagnostics (R2D2)

Diagnostics

Experiment Workflow and Orchestration Kit (EWOK)

Agile

SkyLab-Atmos

SkyLab-Land

SkyLab-Marine

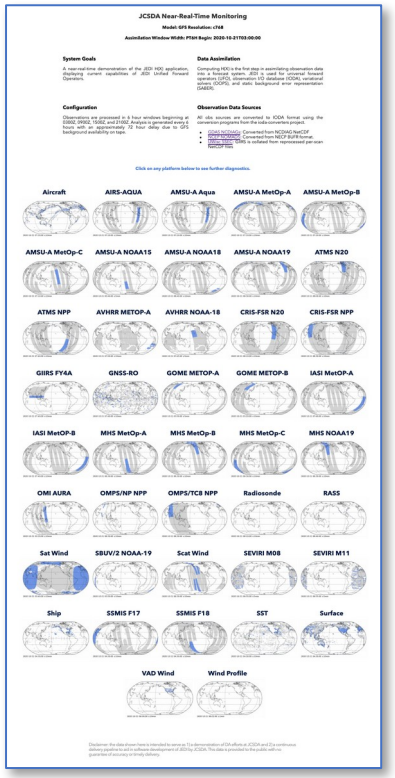
SkyLab-Aerosols

SkyLab-TraceGas

YAML

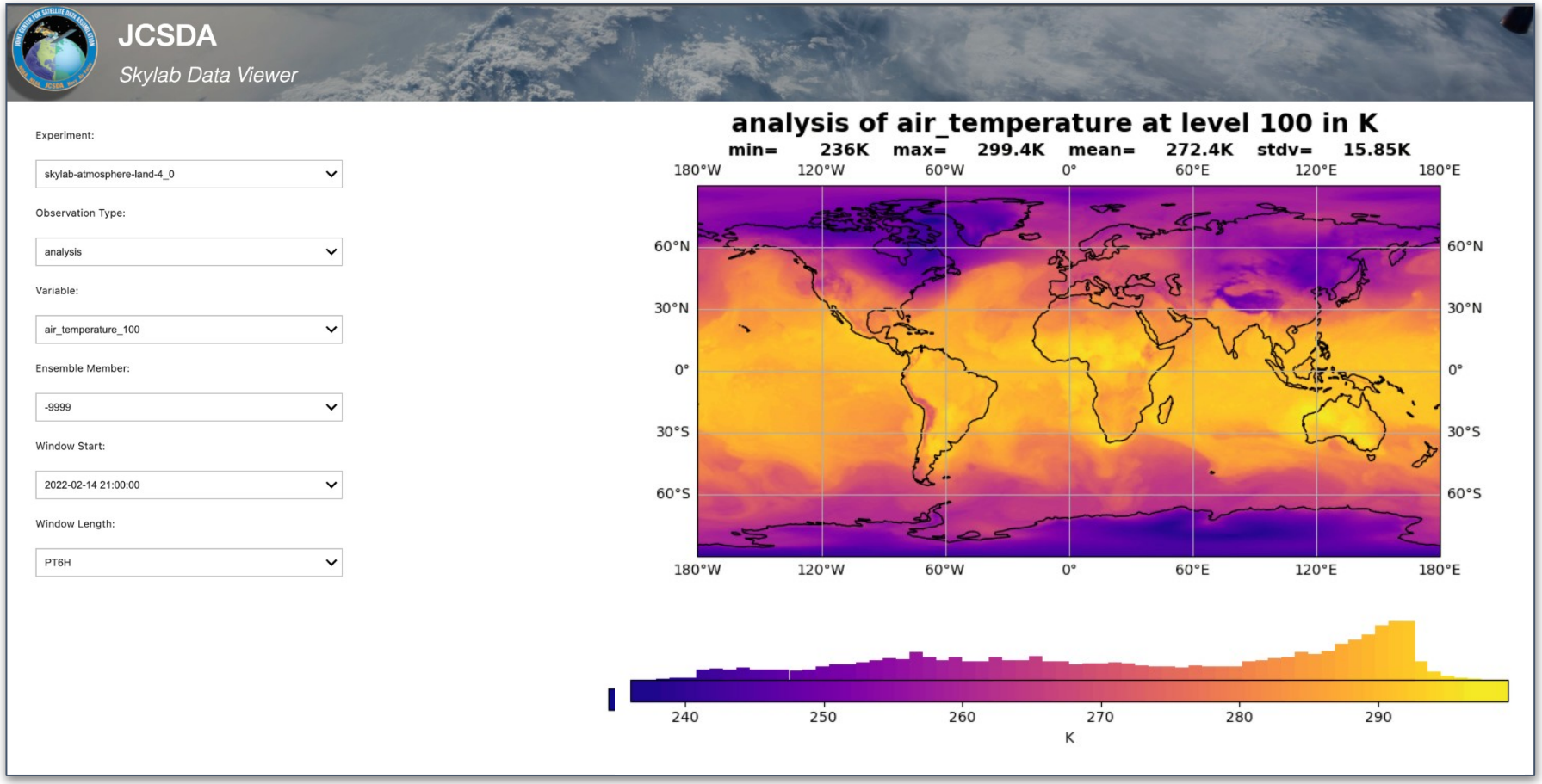
Config

Code



JCSDA SkyLab Testbed

https://skylab.jcsda.org



UFS DA experiments:

- Aerosols (GOCART)
- Marine (MOM6/CICE6)
- Atmosphere / land (FV3ATM, NOAH-MP)

Three Major Goals

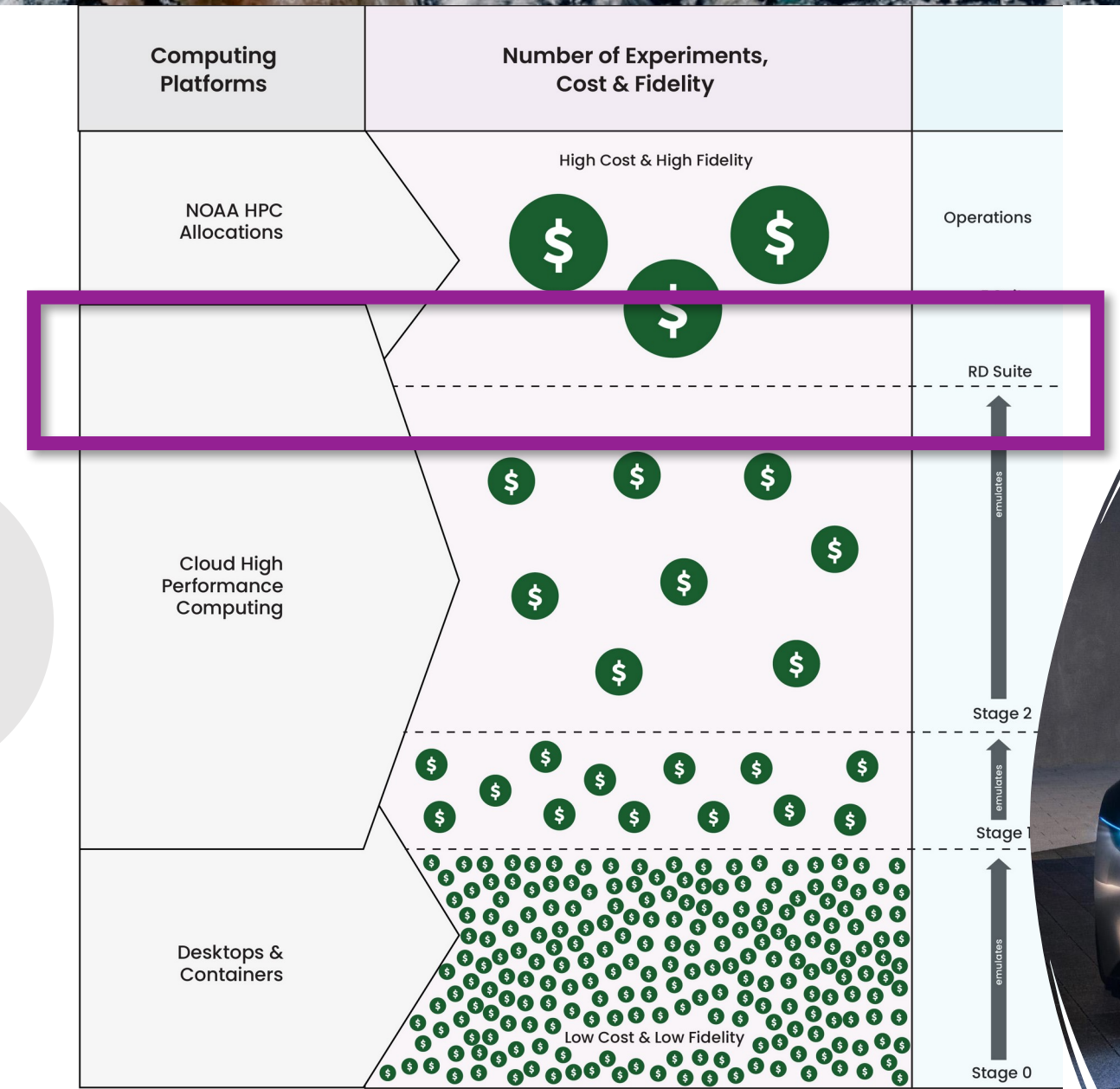
JCSDA Product Management
SKYLAB

- Real-world system hardening
- *Coarse* scientific quality assurance

- Training staff & community
- Open source, agile, CI/CD

- Rapid integration of innovation
- Pathway to next-generation DA

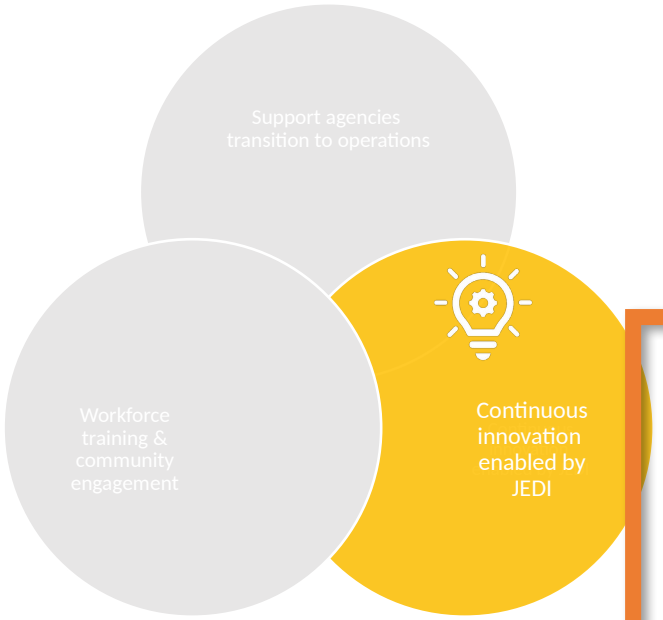
Open-Science Connecting Research and Operations

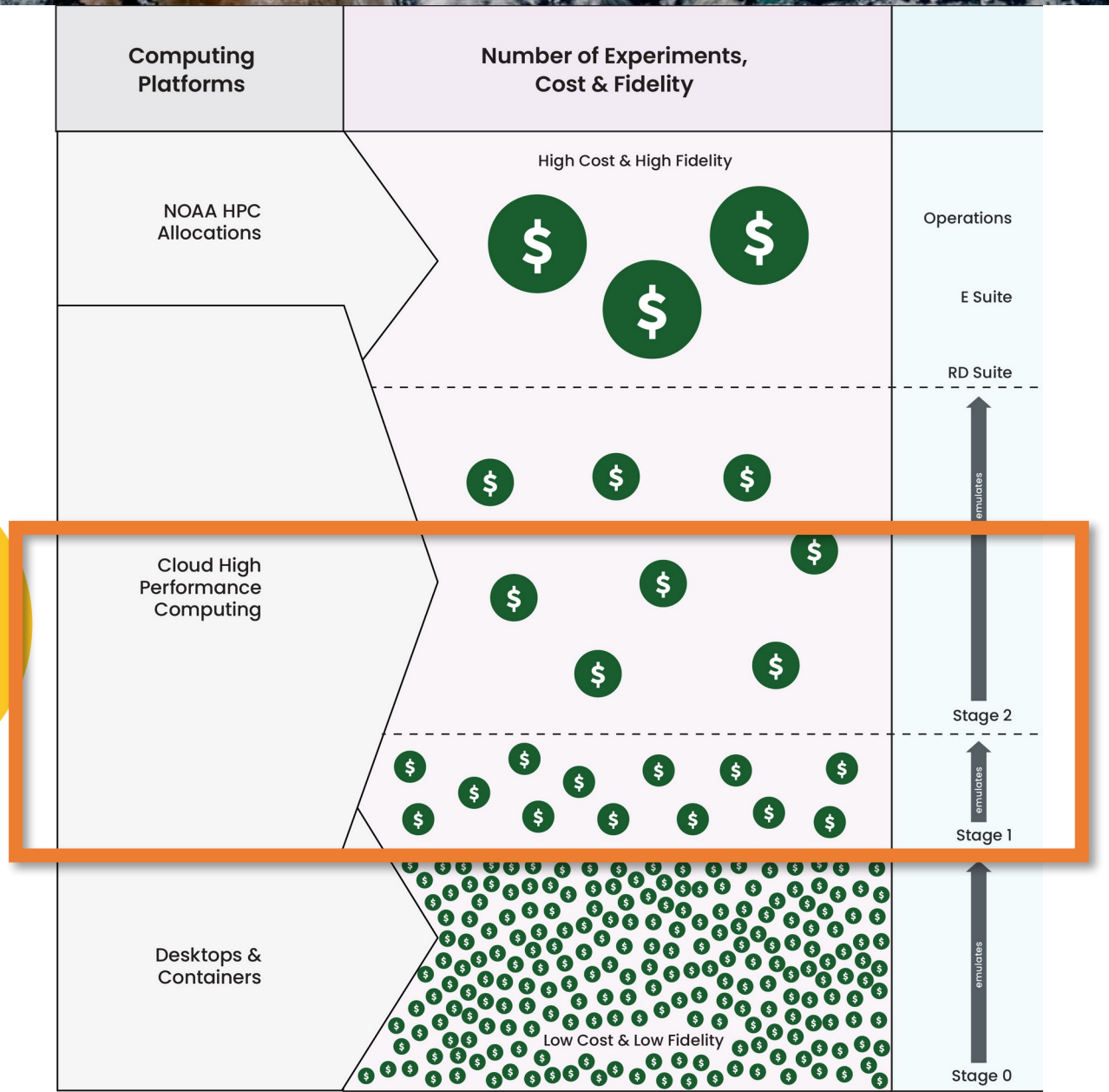


SkyLab (Large)

- Point of convergence for rapid prototyping & validation with quarterly releases (soft + expt)
- Continuous delivery of functional system for downstream operations

Open-Science Connecting Research and Operations

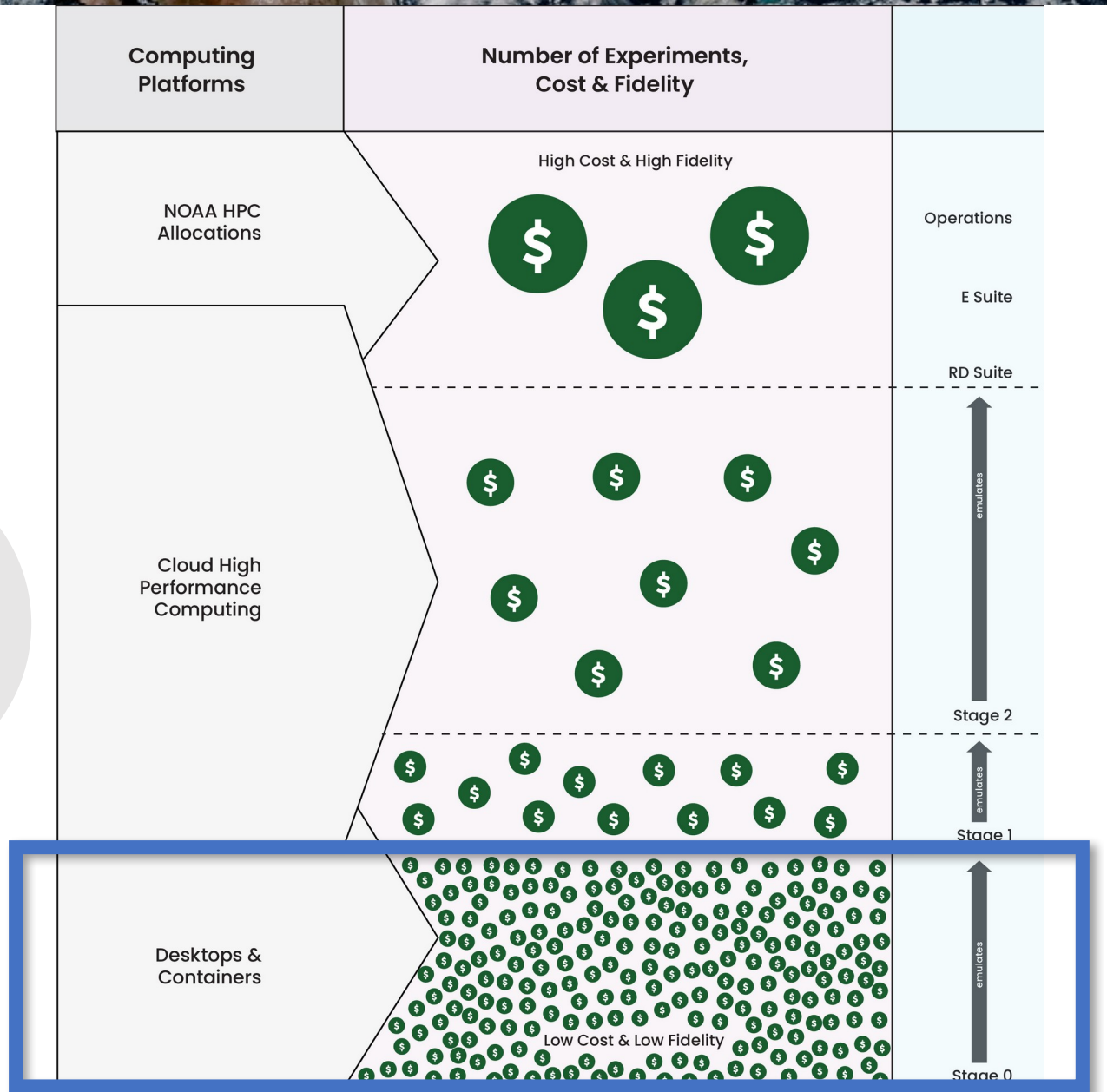




Testbed (SkyLab-Medium)

- Turnkey solution for *real-world* community experimental testbed
- Experiment as a Service
  - Data Store (ingest pipelines)
  - Generic build & workflow
  - Configuration management
  - Diagnostics dashboard
  - Multi-platform

Open-Science Connecting Research and Operations



Online tutorials
7 JEDI Academies
500+ *padawans*
(35 univ. + 11 private + 9 interna.)

JEDI-EDU (SkyLab-Small)

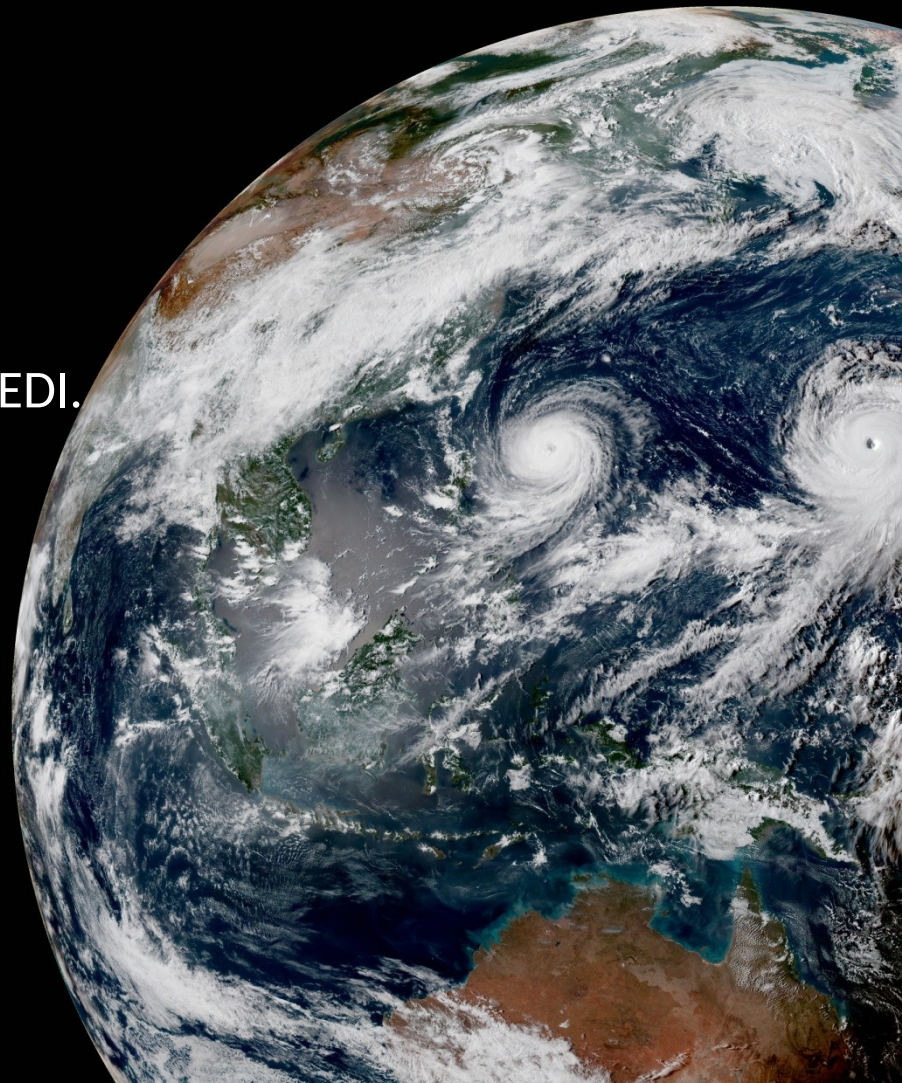
- End-to-end package to download + learn + experiment + evaluate within minutes on laptop
- Integrate in university curriculum

Final Remarks

- JCSDA has found a unique and efficient way to manage jointness and provide demonstrable value to partner agencies.

- NOAA, NASA, USAF, Navy, NCAR, Met Office critically dependent on JEDI. Operational implementation within grasp; will unlock transformative technologies.

- Vision of success
  - World-class use of Earth observations
  - Coupled multiscale Earth system data assimilation
  - Advanced algorithms (hybrid AI/ML) scaling on future HPCs
  - Continuous innovation with rapid transition to operations
  - Community engagement and collective resilience



Discussion


NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
NASA
JOINT CENTER FOR SATELLITE DATA ASSIMILATION
NOAA NASA JCSDA NAVY AIR FORCE
DEPARTMENT OF THE NAVY
UNITED STATES OF AMERICA
U.S. AIR FORCE