

Joint Center for Satellite Data Assimilation

Who we are... What we do... Why it matters...

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To the National Academy of Sciences

Committee on Earth Sciences and Applications from Space (CESAS)

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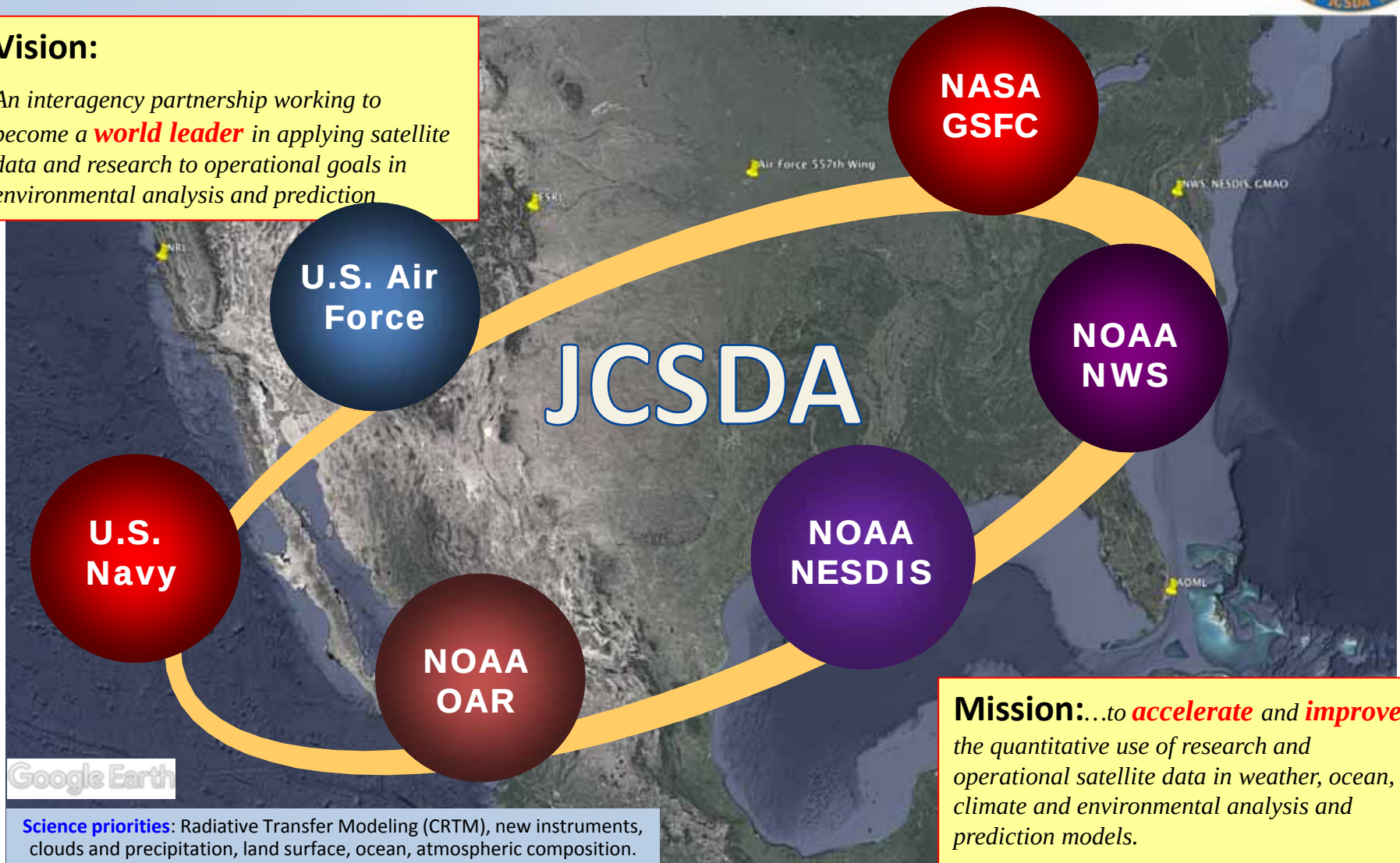


Description of the JCSDA



Vision:

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



Mission:...to **accelerate** and **improve** the quantitative use of research and operational satellite data in weather, ocean, climate and environmental analysis and prediction models.

Science priorities: Radiative Transfer Modeling (CRTM), new instruments, clouds and precipitation, land surface, ocean, atmospheric composition.

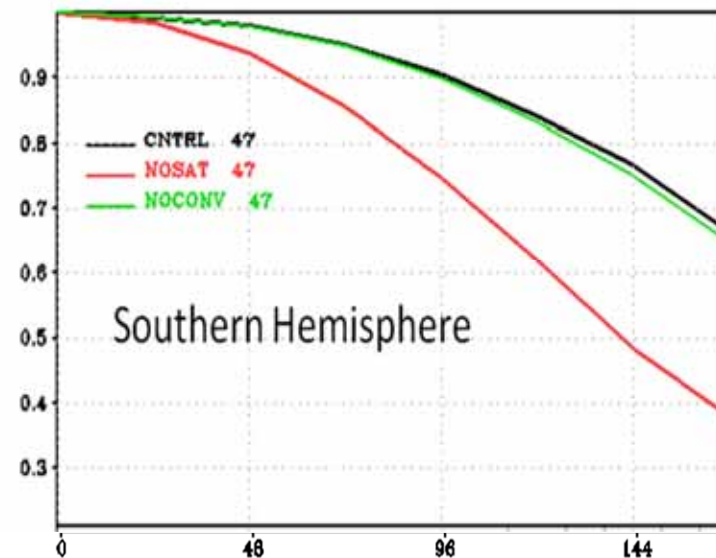
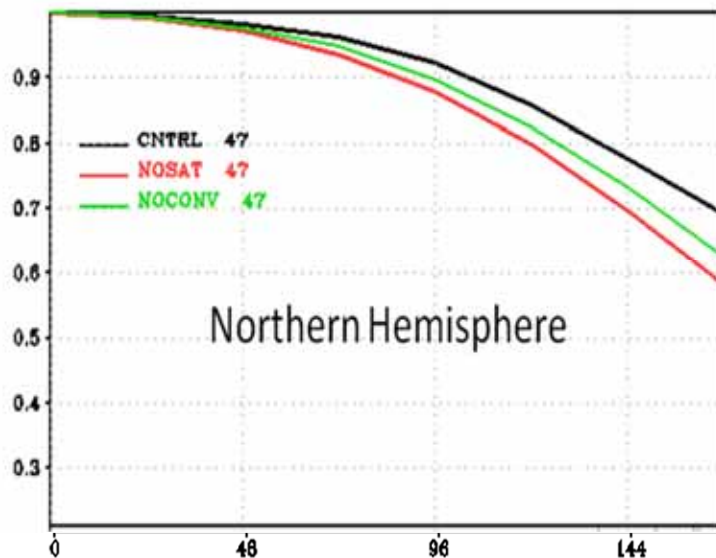
Improve Satellite Data Assimilation



Socio-economic benefit of NWP forecast: estim. \$100B-\$1T per year *(Riishojgaard, 2014)*

Contributions to NWP forecast: Initial Conditions = Model *(Magnusson and Källen, 2013)*

Initial Conditions: Satellites dominate global impact of observations



Accelerate Satellite Data Assimilation



Depreciation



Back-of-the-envelope Estimation

Cost = \$11B

Design life = 20 years

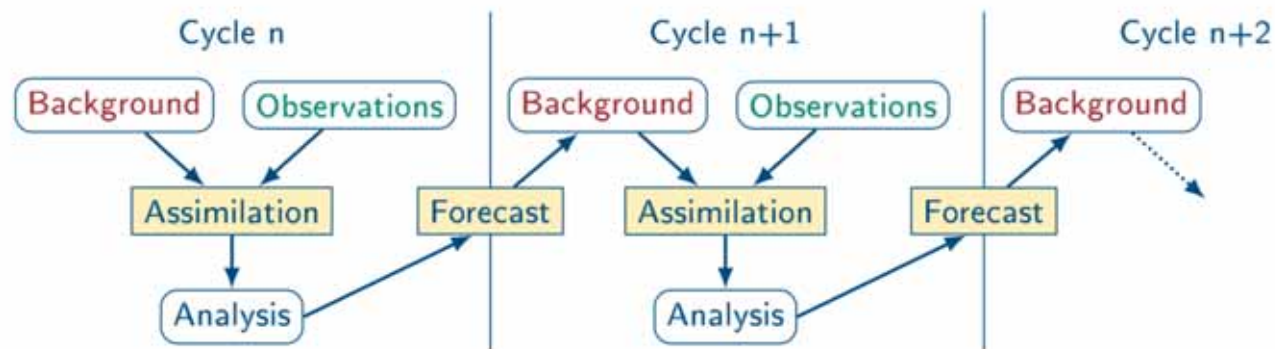
Use for NWP = estim. 50%

Depreciation = \$275M/year

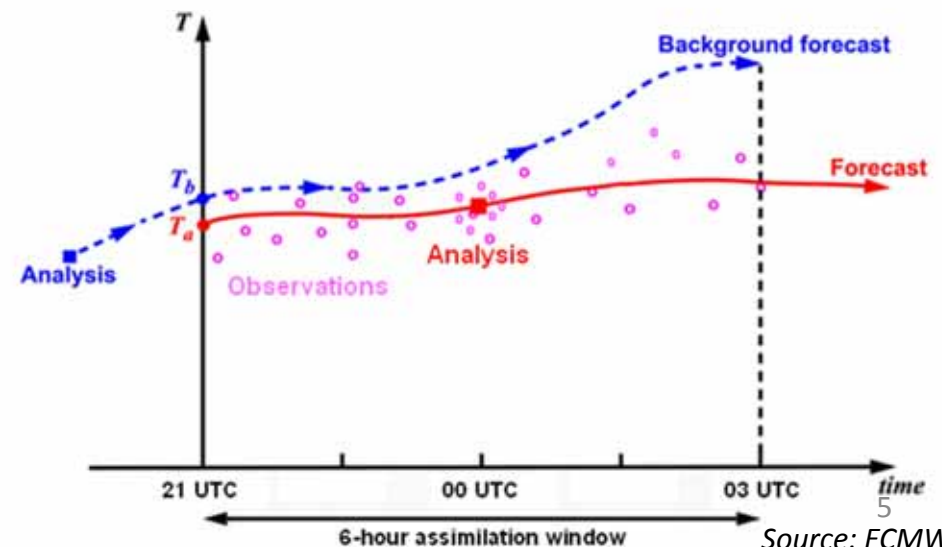


Introduction to Data Assimilation

Data assimilation systems usually combine together information from a set of observations, a short term forecast, and possibly other information to estimate the most probable state of a physical system.



- **Observations** provide information about “reality” but are disparate and irregular in space and time
- **Models** provide regular, physically consistent information about the system, but are prone to systematic errors



Source: ECMWF



Introduction to Data Assimilation

Hypotheses: observation and model background have errors that are uncorrelated, unbiased, normally distributed, with known covariances

Method: Bayesian statistical framework, potentially combined with dynamical constraints

Outcome: “best estimate” of current state
(maximum likelihood, minimum RMSE)

Main Applications:

- Initial conditions for Numerical Prediction
- Calibration and validation
- Observing system design, monitoring and assessment
- Reanalysis (for climate and reforecast)

Description of the JCSDA

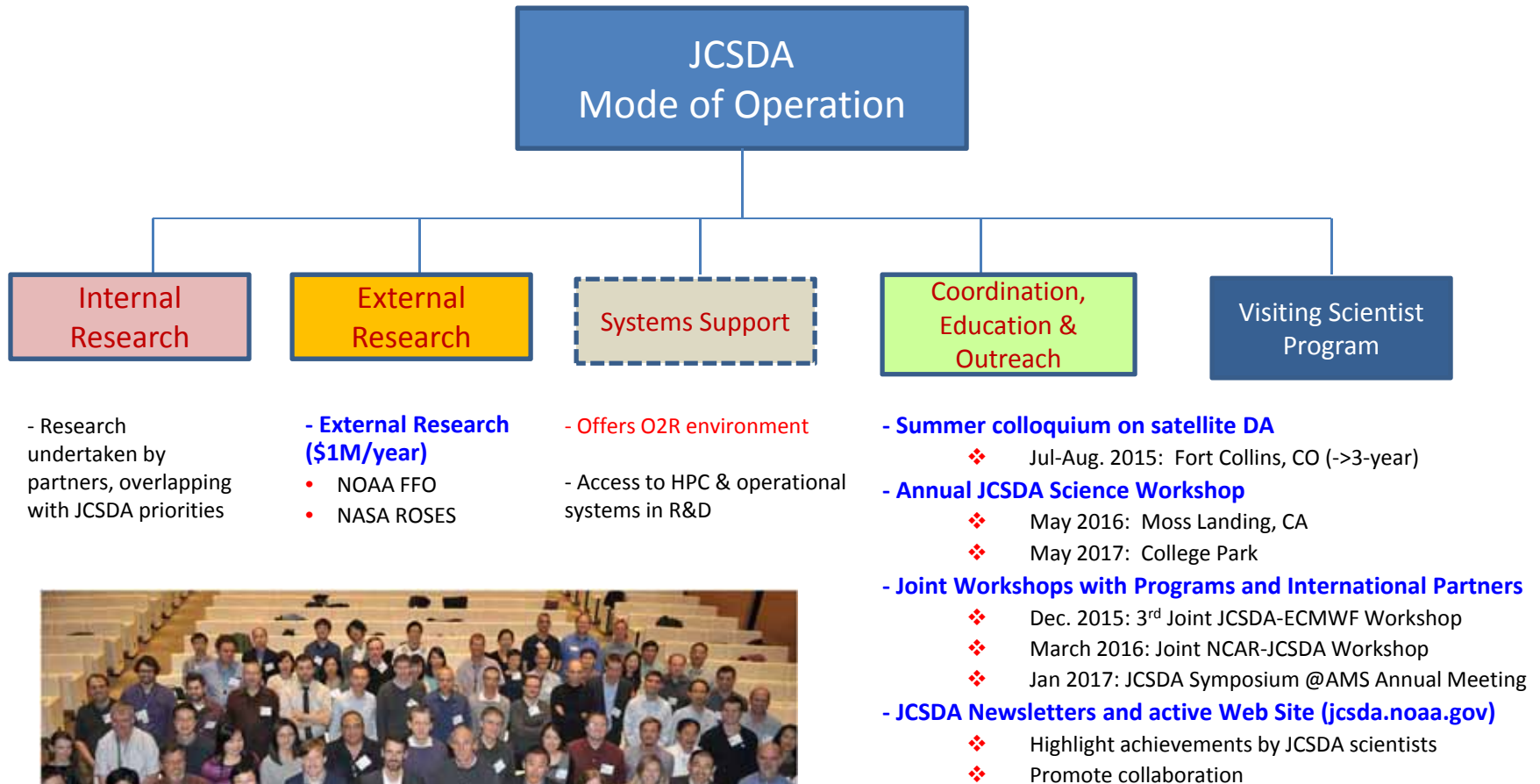


- History
 - 2001: creation (NOAA, NASA)
 - 2005: DoD joining (Air Force, Navy)
 - 2008: Charter (signed by Agency Executives) and Terms of Reference
- JCSDA has enabled (multi-agency) partners to share efforts and results to accelerate, enhance, and expand use of satellite data in operational prediction systems
- Keys to Success
 - Development and adoption of common tools (e.g. CRTM)
 - R2O supported by O2R infrastructure
 - Effective communication b/w Research and Operation communities
- **New**: UCAR CPAESS providing structure and mechanism for JCSDA government agencies to accomplish planning and execution of common mission more effectively.

JCSDA Management Structure



JCSDA Mode of Operation



Strategic Goals



1. Expand capabilities in assimilating satellite sensors
2. Spearhead a community data assimilation initiative
3. Address scientific frontiers to optimize the use of satellite data
4. Deliver new and improved tools to support observing system impact assessments
5. Foster improved organizational management, interagency coordination and outreach strategies

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Satellites

~268 Earth observation satellites

~413 instruments

Tens of millions of observations daily

(not all of them are currently used)

Processing satellite data
requires an army of
specialized scientists

-> incentive to mutualize
efforts



Prioritized New Satellites and Sensors



■ **New Sensors Data Assimilation:**

(new QC, error optimization, impact assessment on NOAA forecast systems)

- **GOES-R – ABI (AMV winds and radiances)** (Launched in Dec 2016)
- **JPSS1 – ATMS and CrIS** (Launch date Q4 FY17)
- **COSMIC 2** (Launch date Q2 FY17)
 - HIMAWARI-8 AHI (Dry run for GOES-R ABI)
 - GPM /GMI
 - Megha-Tropiques SAPHIR (WV Sounder)
 - ISS-RAPIDSCAT (Scatterometer)
 - GCOMW AMSR2
 - SMAP
 - JASON 3

■ **Existing Sensors optimization:**

(QC, Surface-sensitive channels assimilation, pre-processing, dynamic emissivity, etc)

- ATMS, SSMIS, AMSU, MHS

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Joint Effort for Data assimilation Integration (JEDI)



Nation Unified Next-generation Data Assimilation

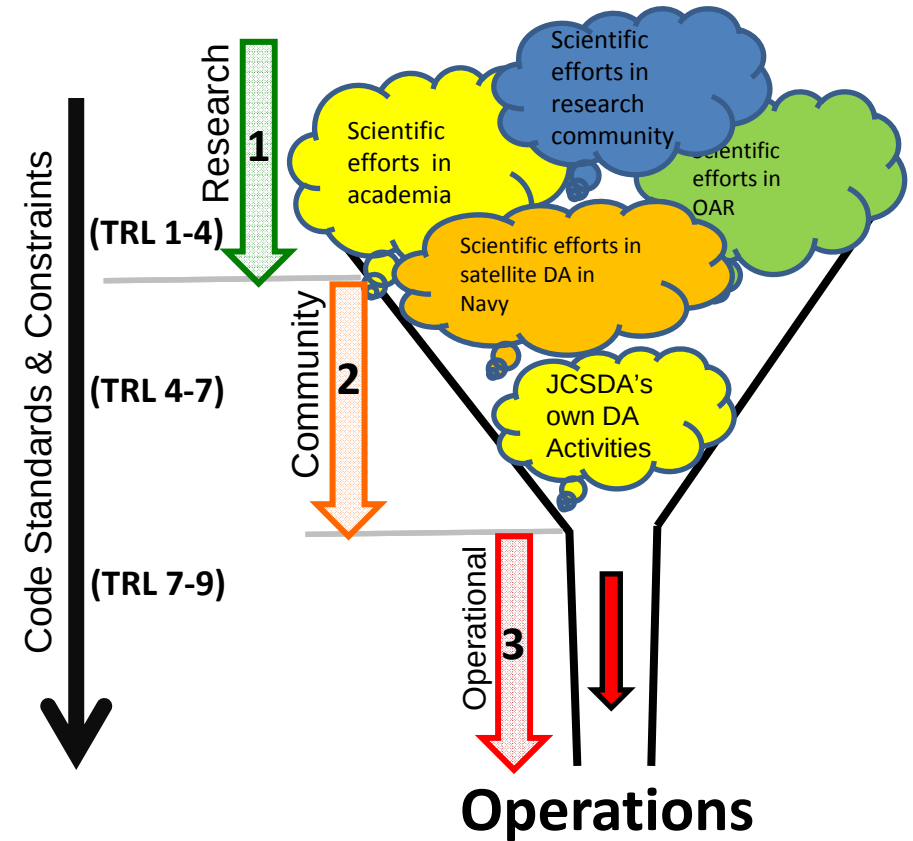
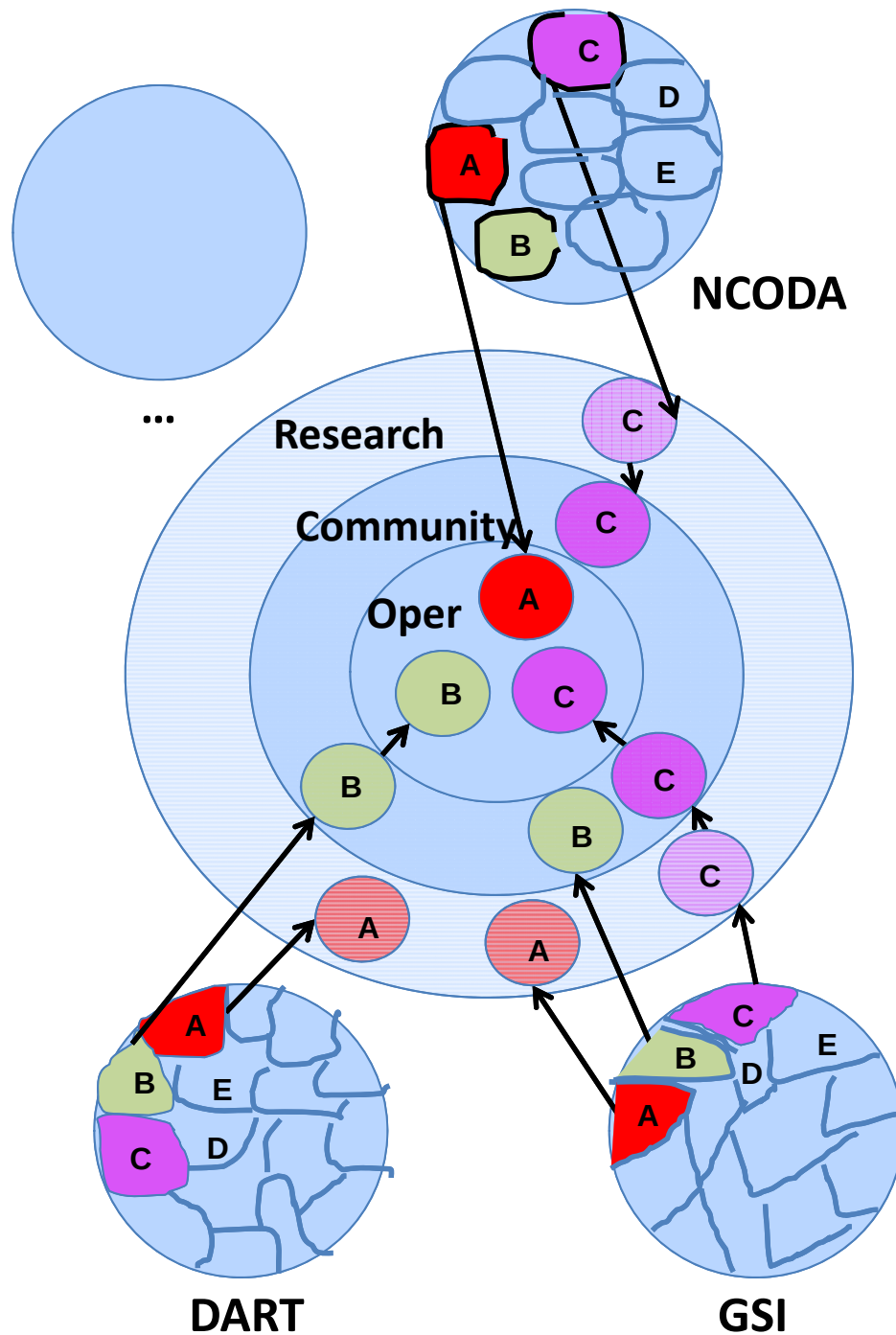
OBJECTIVES

1. Facilitate innovative developments to address DA grand challenges
2. Increase **R2O** transition rate from community
3. Increase **science productivity** and **code performance**

STRATEGY

1. Collective path toward unification, allowing multiple levels of engagement
2. Modular, Object-Oriented code for flexibility, robustness and optimization
3. Mutualize **model-agnostic** components across
 - Applications (atmosphere, ocean, land, aerosols, strongly coupled, etc.)
 - Models & Grids (operational/research, regional/global models)
 - Observations (past, current and future)

MULTI-LEVEL COMMUNITY REPOSITORY



Strategic Goals



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Data Assimilation Scientific Frontiers



Immediate priorities

- Improve the Community Radiative Transfer Model (CRTM)
transmittance calculation, cloud and aerosol optical properties, software efficiency
- Assimilation of all-sky satellite radiances
cloud-affected and over land
- Improve balance in analysis
better use of ensemble information

Longer-term

- Multi-scale DA (spatial + temporal)
global to convective scale, “seamless” DA across scales
- Coupled Earth System Model
[Strongly] coupled DA for multiple domains (ocean, atmosphere, land, etc.)
- Non-linear, non-Gaussian DA Algorithms
- Representing model uncertainty & systematic errors

Strategic Goals

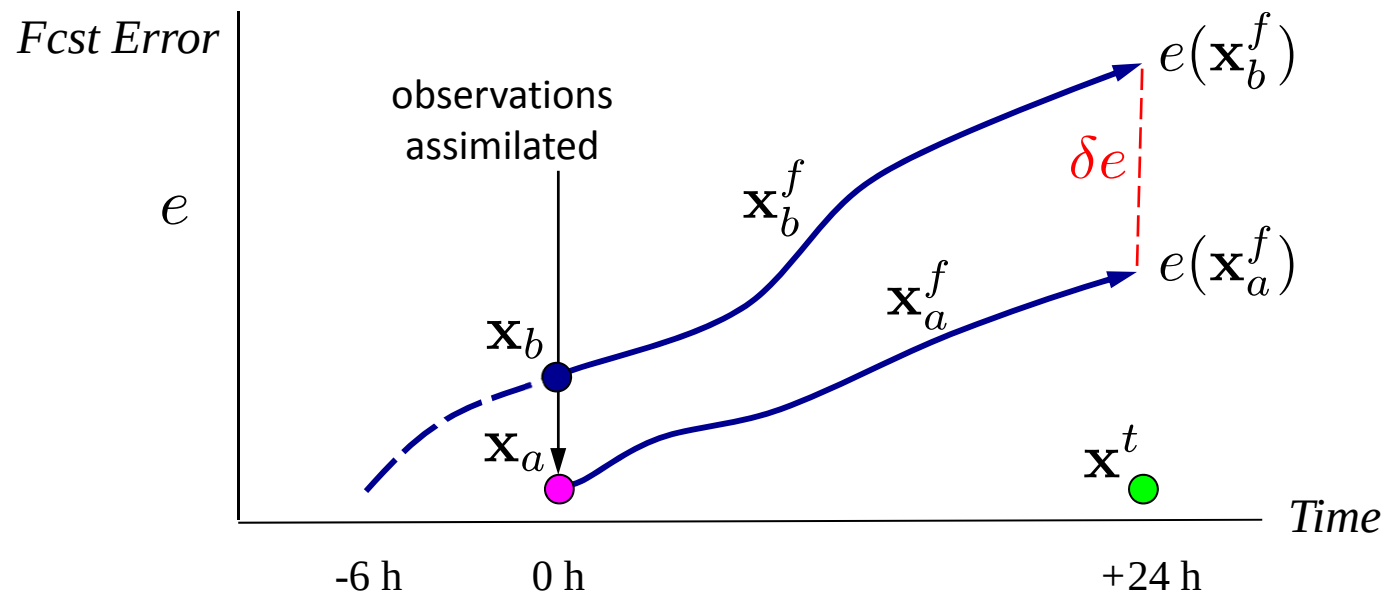


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Observing System Impact Assessment



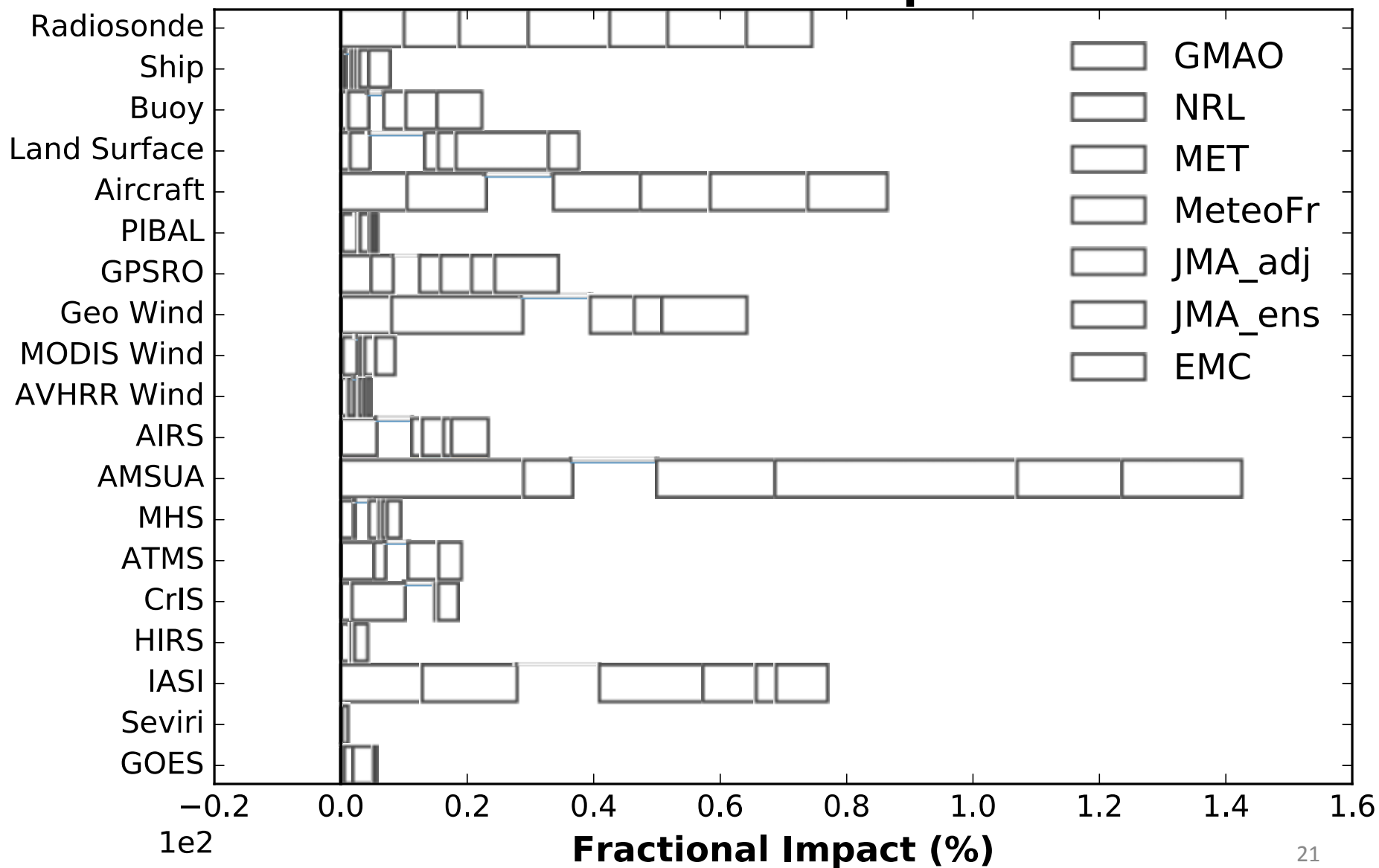
- Global Forecast Dropout Tool (GFDPT)
- JCSDA Observing System Assessment Standing Capability (JOSASC)
- Forecast Sensitivity - Observation Impact (FSOI)



24-h Observation Impact Summary

Global Domain, 00Z 06Z 12Z 18Z DJF 2014-15

Fractional Impact



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Supporting External Research



❖ External Research (\$1M/year)

- ❖ NOAA FFO
- ❖ NASA ROSES

❖ Visiting Scientist Program

- ❖ Jun-Aug 2016: Sayed Bateni (U. Hawaii)

❖ Summer colloquium on satellite DA

- ❖ Jul-Aug. 2015: Fort Collins, CO (->3-year)

❖ Annual JCSDA Science Workshop

- ❖ May 2016: Moss Landing, CA
- ❖ May 2017: College Park

❖ Joint Workshops with Programs and International Partners

- ❖ Dec. 2015: 3rd Joint JCSDA-ECMWF Workshop: "Cloud&Precip Radiance DA"
- ❖ March 2016: Joint NCAR-JCSDA Workshop: "Blueprints for Next-Gen DA"
- ❖ Jan 2017: JCSDA Symposium Joint Session @AMS Annual Meeting

❖ JCSDA Newsletters and active Web Site (jcsda.noaa.gov)

- ❖ Highlight achievements by JCSDA scientists, and promote collaboration
- ❖ Open positions at JCSDA, Visiting Scientist Program, projects, etc



Components of O2R/R2O Infrastructure



- **What Money can Buy....**

- Supercomputer (Hardware, basic software, and IT) (almost the easiest part!)
- Scientific Software Integration (this is the hardest part: keep in sync with operational models)
- User Support & Documentation
- Management of resources to allow R2O and O2R to be sustained
- Documented Utilities to help scientists (CRTM, assessment, formatting tools)
- Constant engagement between Research and Operations
- Rigorous software configuration system to track changes
- Rigorous (and independent) testing mechanism to demonstrate added value

Components of O2R/R2O Infrastructure



- **What Money can NOT Buy....**

- **And perhaps more importantly: the right culture.**

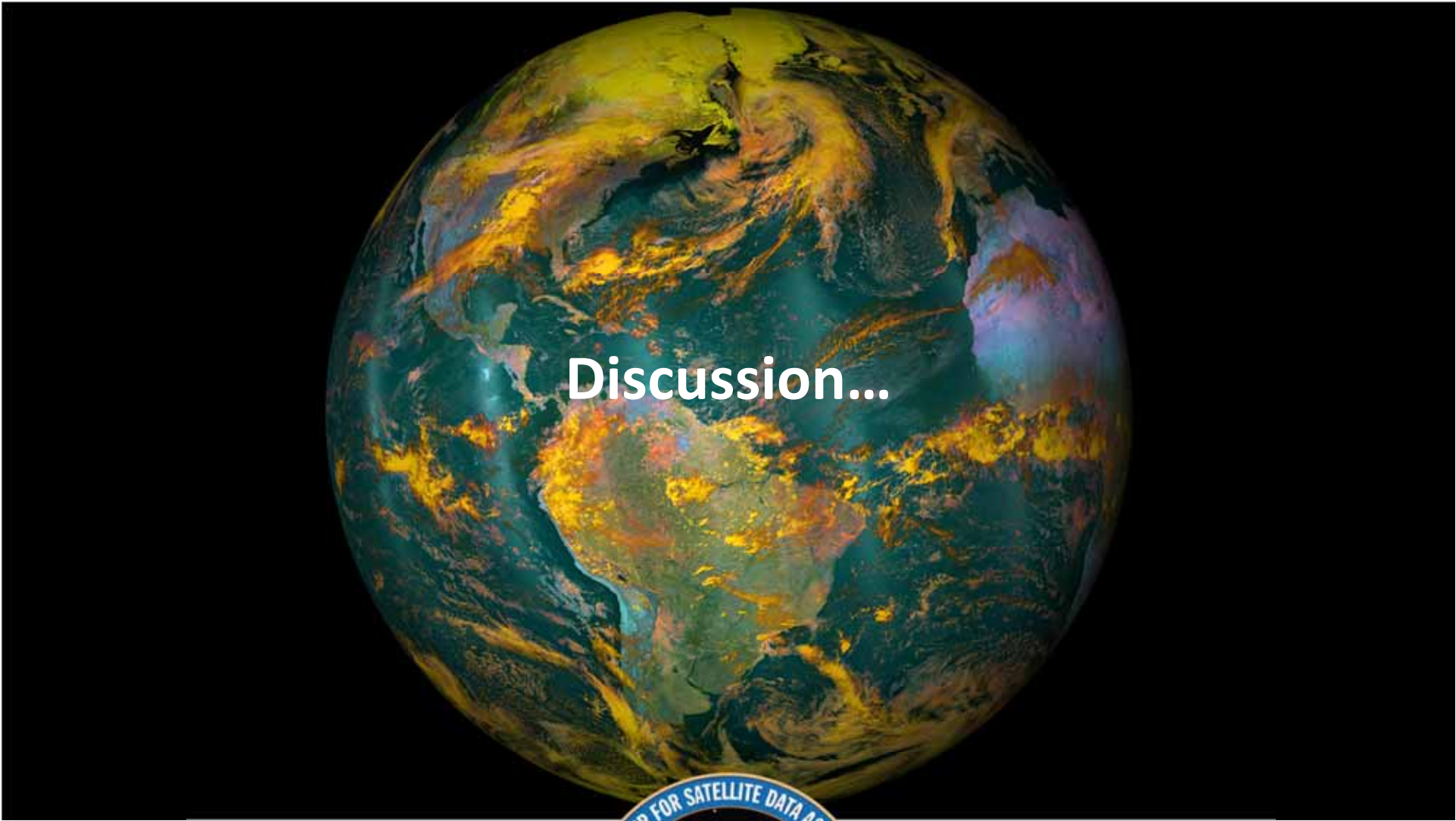
- Transparency of R2O protocols and willingness to accept research performed by researchers & work collaboratively (on the operational partner)
 - Willingness to work/start with operational system and follow protocols and accept constructive feedback (on the research partner)
 - Sense of Mutual respect between Researchers and Operational partners: respect for innovation in research and pragmatism in the operational implementation

Accept that R2O is not for everyone: careful choice of research and operations partners is important

Summary



- JCSDA = multi-agency, distributed center enabling partners to share efforts and results to accelerate, enhance, and expand use of satellite data in operational prediction systems
- Keys to success include
 - Identify community of partners with overlapping interests
 - Nurture communication and incentives b/w Research and Operational Communities
 - R2O supported by O2R infrastructure
 - Development and adoption of Common Tools (e.g. CRTM)
- Future Outlook
 - Exploring means to be more collaborative in planning and execution



Discussion...

