

Atmospheric Data Assimilation

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Objective

- Create best possible (operational) atmospheric DA system for the NGGPS era.

Deliverables

- Completed - None
- Mark Potts – code optimization
 - Began Nov. 18, 2015
 - Computer accounts
 - No WCOSS computer account yet.
 - Theia account – 2 weeks ago
 - S4 (Through JCSDA)
 - Modifications for making gsi work properly for gfortran
 - Unified make system for community gsi
 - Profiling the code on S4 and Theia
 - Learning GSI system.
 - JEDAI
- Rahul Majahan – advance DA techniques
 - Partially transitioned from SS project around end of Nov. 2015 (now completely NGGPS)
 - Involved in Q3FY16 global implementation – (especially the 4d – enVar)
 - Testing enhancements to 4d-hybrid system
 - Transition DA and GFS to cray system

Future Deliverables

- DA team NGGPS work just beginning. Transition from SS to NGGPS through rest of FY16
- Focus of DA work has been on development and implementation of 4d-EnVar and use of all-sky radiances
 - Global – May 17, 2016
 - Also, inclusion of SS aircraft data, aircraft bias correction and additional AMV winds
- Developed inclusion of NSST and FSO capability for future

Future Deliverables

- Project and employees for future
 - Upgrade and maintain use of current observations
 - Illiana Genkova – AMVs
 - Haixia Liu - IR radiances (this month)
 - David Groff - FSO
 - Xu Li – NSST
 - Rosalyn McCracken - aircraft data
 - Continue to develop GSI Hybrid
 - (Rahul Mahajan)
 - Cathy Thomas (this month)
 - Enhance use of cloud-impacted (“all sky”) radiances
 - Yanqiu Zhu (this month)
 - Li Bi (this month)
 - Emily Liu (HFIP)

Future Deliverables

- Employees and projects for future
 - Improve specification of observation errors
 - Kristen Bathmann
 - Improve stochastic physics in ensemble members
 - ESRL
 - Improve quality control and bias correction of conventional data
 - Xiujuan Su
 - Improve scalability and efficiency of GSI code
 - (Mark Potts)

Future Deliverables

- Employees and projects for future
 - Improve hydrological and dynamical balance in analysis increments
 - Enhanced variational quality control for all observations
 - Bias correction of background field
 - Assimilation of aerosol and trace gas information through CRTM
 - Add new satellite instruments, particularly hyperspectral IR instruments

Future Deliverables

- Employees and projects for future
 - Improve static background error in GSI hybrid
 - Increase resolution for data assimilation ensemble members
 - Modification of GSI for new dynamic core
 - ~~– Participate in evaluation of dynamic cores (Phase II)~~

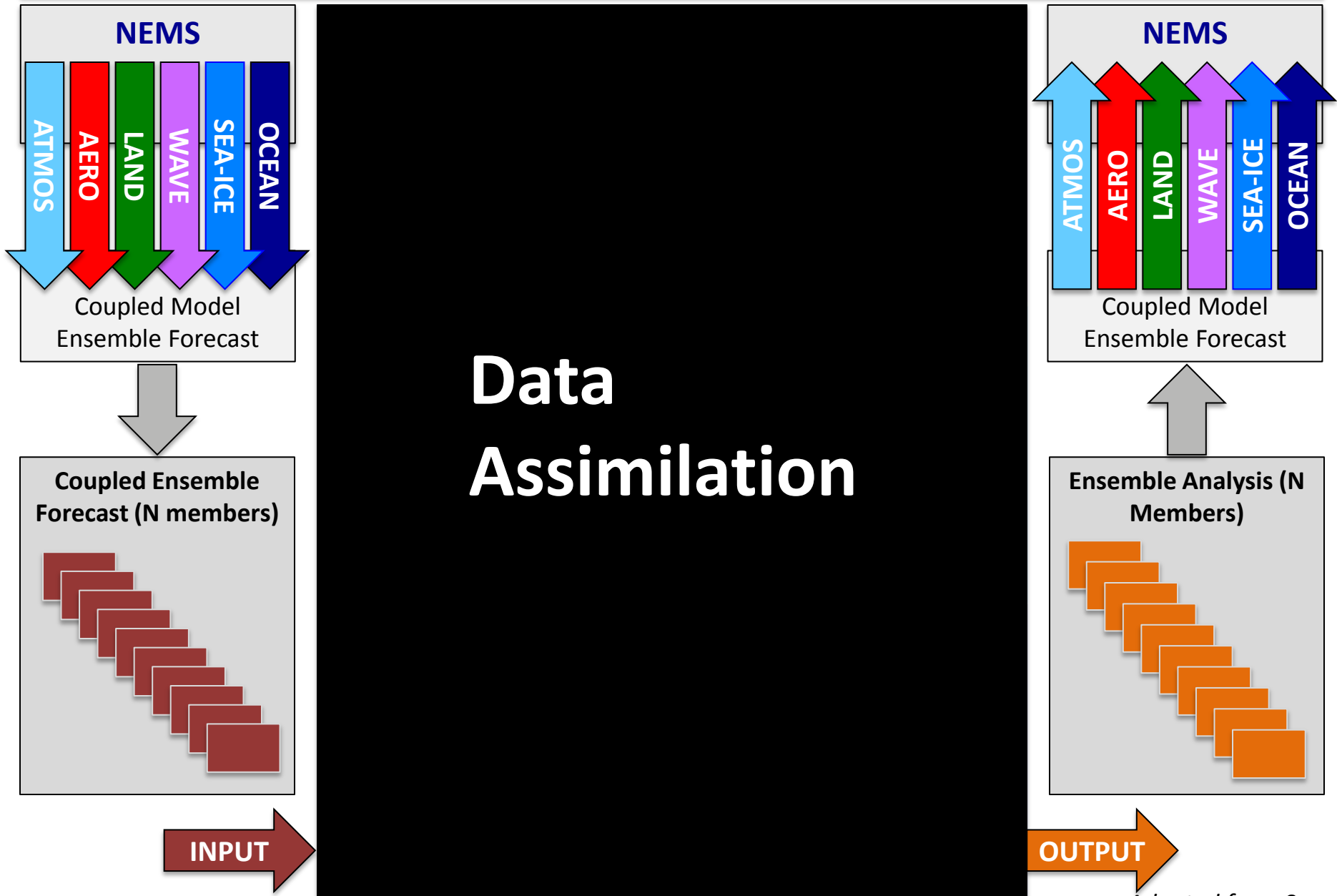
Joint Effort for Data Assimilation Integration (JEDAI)

from the perspective of NGGPS

Tom Auligné , John Derber



NCEP Coupled Hybrid Data Assimilation and Forecast System





Myriad of DA-related Initiatives

- NWP → Earth System Modeling (Ocean, Waves, Cryosphere, Land, Hydrology, Aerosols, Atmospheric composition, Whole Atmosphere)
- Weakly/Strongly Coupled Reanalyses for reforecast & climate
- Operational/Research, Global/Regional models
- Situational awareness, Nowcasting
- Observation impact assessment and OSSEs



Myriad of DA-related Initiatives

“Software is like entropy. It is difficult to grasp, weighs nothing, and obeys the second law of thermodynamics; i.e. it always increases. “

Norman Ralph Augustine

entropy



JEDAI: Stretch goals

1. Nation **unified next-generation DA** system
 - Across JCSDA partners (NCEP, NESDIS, OAR, NASA, Navy, USAF)
 - Standardize + mutualize DA effort, leveraging current projects (NEMS/ESMF, ESPC, NUOPC, ...)
2. Leverage capability of the academic community. Considerably **increase R2O** transition rate.
3. **Increase science productivity** and improve code performance, maintenance, and scalability.



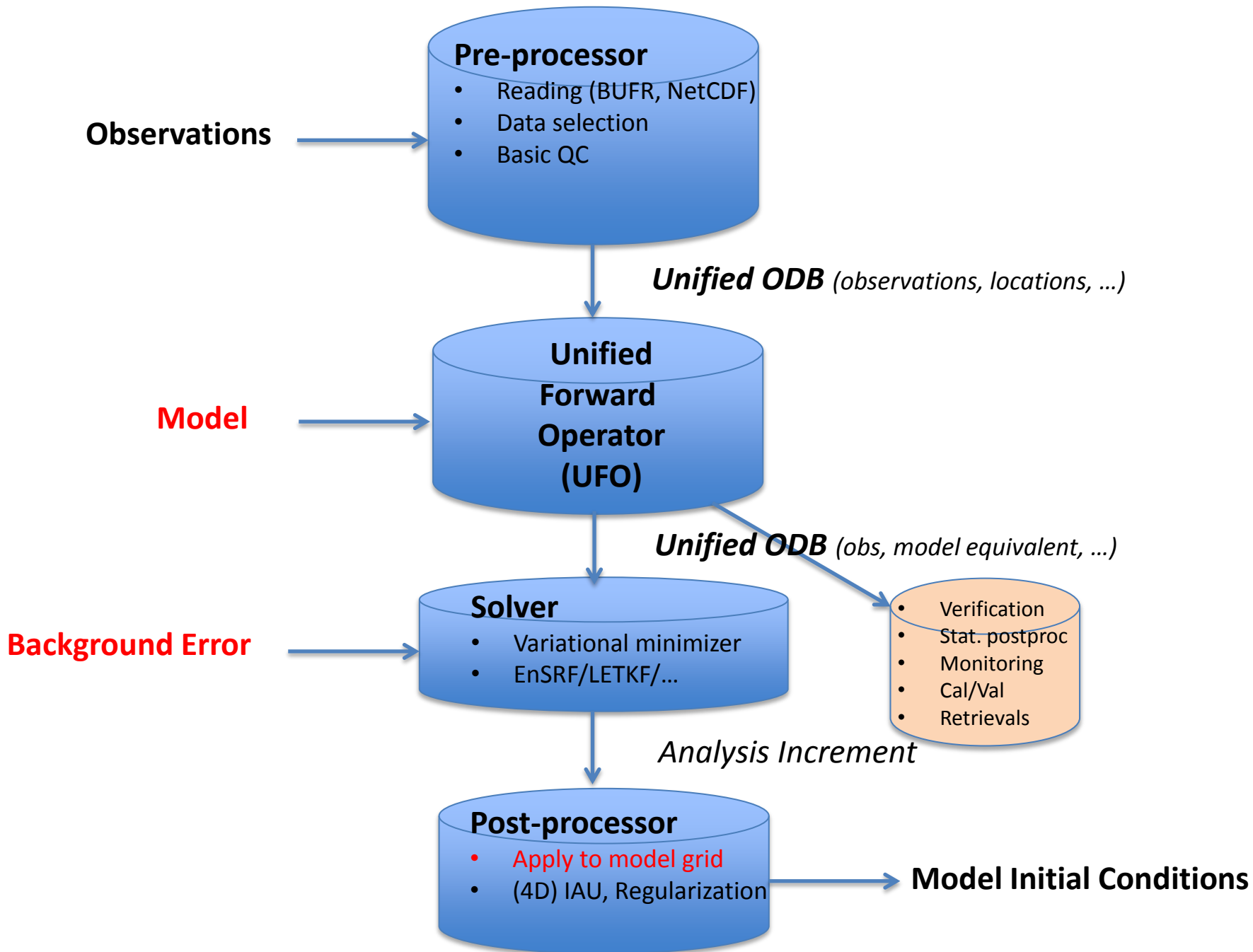
JEDAI: Strategy

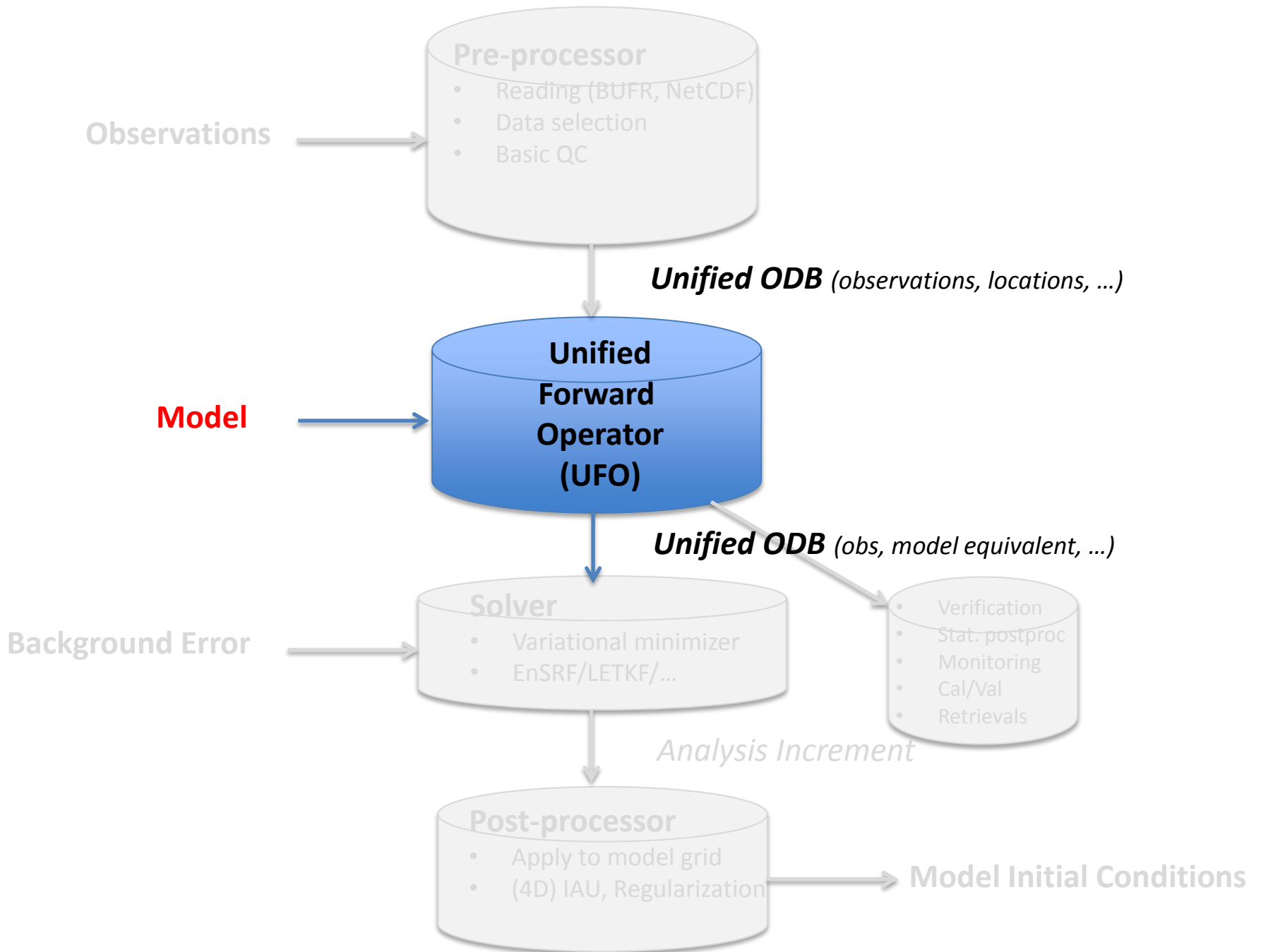
- Build **model-agnostic** DA components
- **Mutualize** redundant “plumbing” to focus on science
- Use **Object-Oriented Design** + modern coding standards
 - Flexibility
 - Portability
 - Exchangeability
 - Maintainability
 - Scalability
 - Readability
 - Reusability
 - Testability



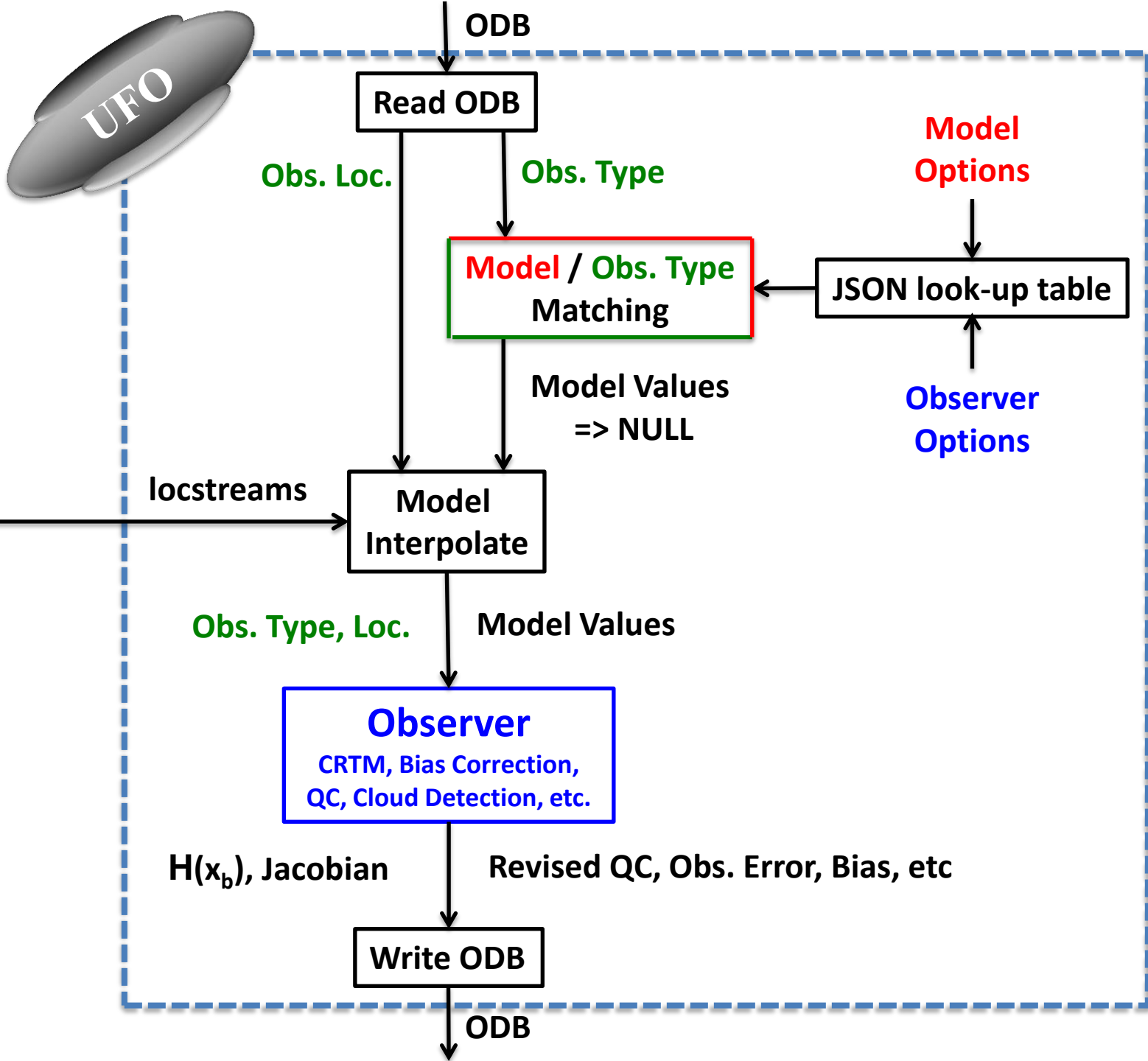
JEDAI: Approach

- Simultaneous **top-down** and **bottom-up** approach
- **Top-down approach**
 - start with a clean slate,
 - redesign entire architecture (ECMWF, Met Office, NCAR)
- **Bottom-up approach**
 - start from existing codes,
 - incremental modularization (NCEP GSI refactoring, Navy)
- Roadmap gradually connecting the two approaches.

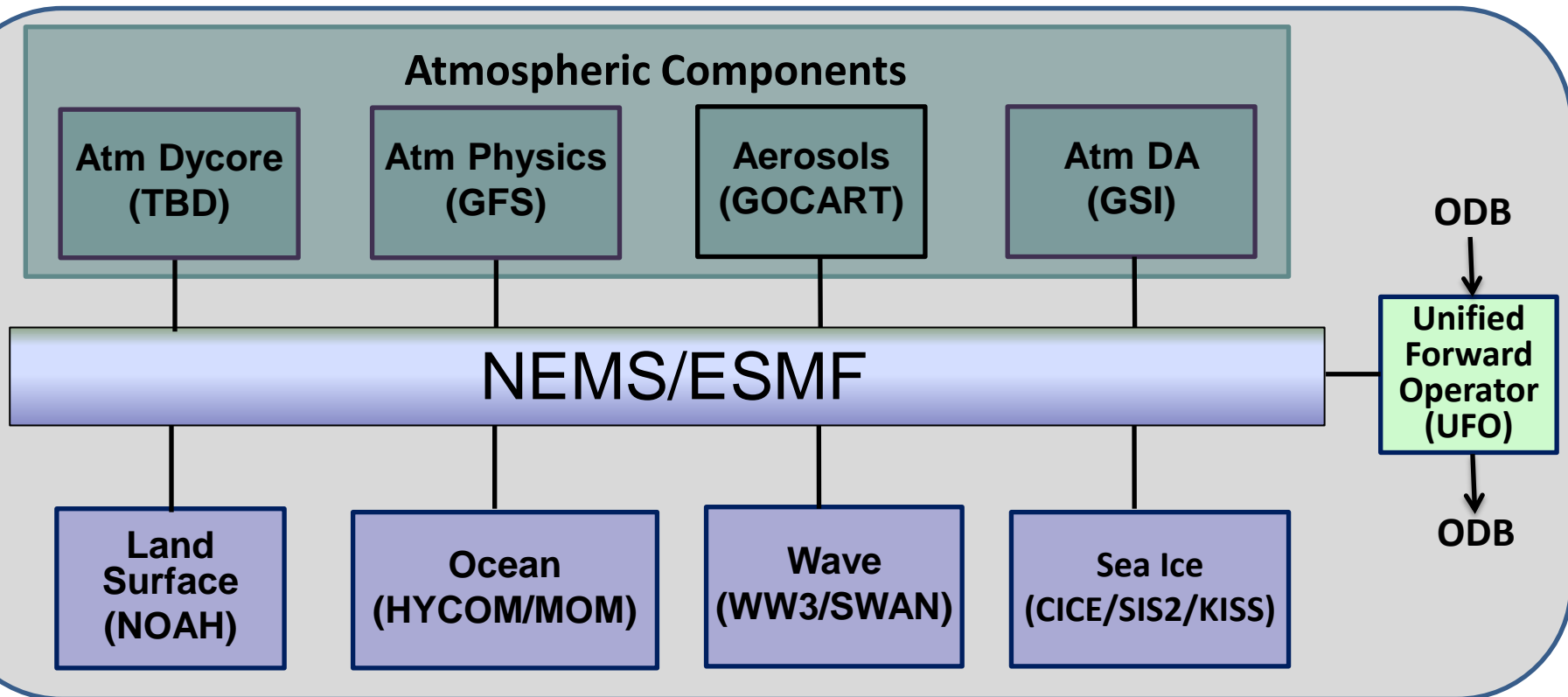




Unified Forward Operator



NGGPS Planned Components





JEDAI: Unified Forward Operator (UFO)



Project Information and Highlights

Lead:

Tom Auligné, Director JCSDA

Scope:

Phase 1: prototype development

Implement improved Observation Data Base, flexible code architecture and coupler to NEMS/ESMF. Test with several models (e.g. atmosphere, ocean, land, wave, sea ice and aerosol) for a limited set of observations.

Phase 2: mature system demonstration

Improve ODB structure based on refined requirements. Expand the list of used observations. Address performance and scalability issues.

Phase 3: transition to operations

Estimated Benefits:

Model-agnostic community capability to simulate observations for verification, model development, data assimilation, inverse problems, statistical post-processing, etc.

Scheduling (Phase 1)

Milestone	Date	Status
Split GSI Observer and Solver	Q2FY2016	In progress.
Connect with improved ODB	Q3FY2016	In progress.
Define Observation Locations and match observation types with model variables	Q4FY2016	Not started.
Object-oriented design for the Observer	Q1FY2016	In progress.
Encapsulate interpolation of model fields to observation locations	Q1FY2017	Not started.
Replace grid-specific interpolation with NEMS/ESMF regridding capabilities	Q2FY2017	Not started.

Issues/Risks

Risks & Issues

- 1) Data assimilation systems for various applications have already diverged significantly.
- 2) Progress contingent on allocated human resources (2 FTE contractors requested) and compute resources.

Mitigation:

- 1) Convergence/Unification will require close working connections with data assimilation experts in each application.
- 2) Funding request in progress.

Finances

Funding Sources:

NCEP/EMC
 NGGPS (2 FTE contractors requested)
 OAR/PSD (1 FTE)
 NASA/GMAO (1 FTE)

Status: **Unfunded**

NCEP/EMC
 NGGPS
 USAF



Management Attention Required



Potential Management Attention Needed



On Target

Conclusions

Joint Effort for Data Assimilation Integration (JEDAI)

Inter-agency force toward unification

- Community system for research & operation
(Joint NCAR/JCSDA workshop)
- Modular, flexible code with improved readability, maintenance, testing and optimization
- Encompass a wide variety of
 - Applications (atmosphere, ocean, land, strongly coupled, etc.)
 - Models & Grids (operational, research, toy)
 - Observations (satellite, radar, conventional, etc.)
 - Solvers (variational, EnKF, in observation/model space, etc.)



Questions?

“Just as the constant increase of entropy is the basic law of the universe, so it is the basic law of life to be ever more highly structured and to struggle against entropy.”

Vaclav Havel