# The Joint Effort for Data assimilation Integration (JEDI)


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Joint Center for Satellite Data Assimilation (JCSDA)


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(Presented by Jim Yoe)

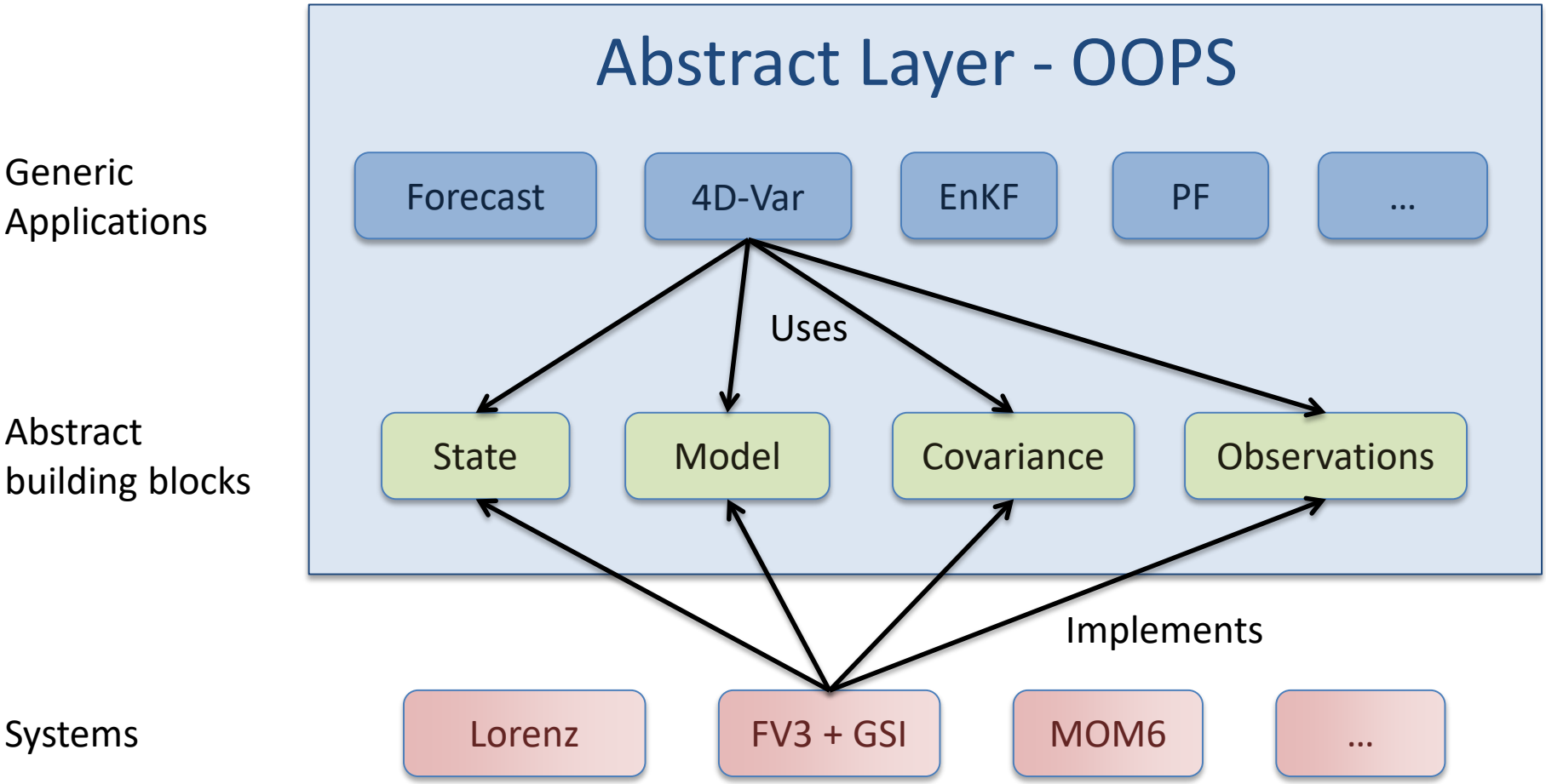
# JEDI: Motivations and Objectives

The Joint Effort for Data assimilation Integration (JEDI) is a collaborative development between JCSDA partners.

Develop a unified data assimilation system:

- From toy models to Earth system coupled models
- Unified observation (forward) operators (UFO)
- For research and operations (including R2O/O2R)
- Share as much as possible without imposing one approach

# Abstract Design: separation of concerns




Abstract interfaces are the most important aspect of the design

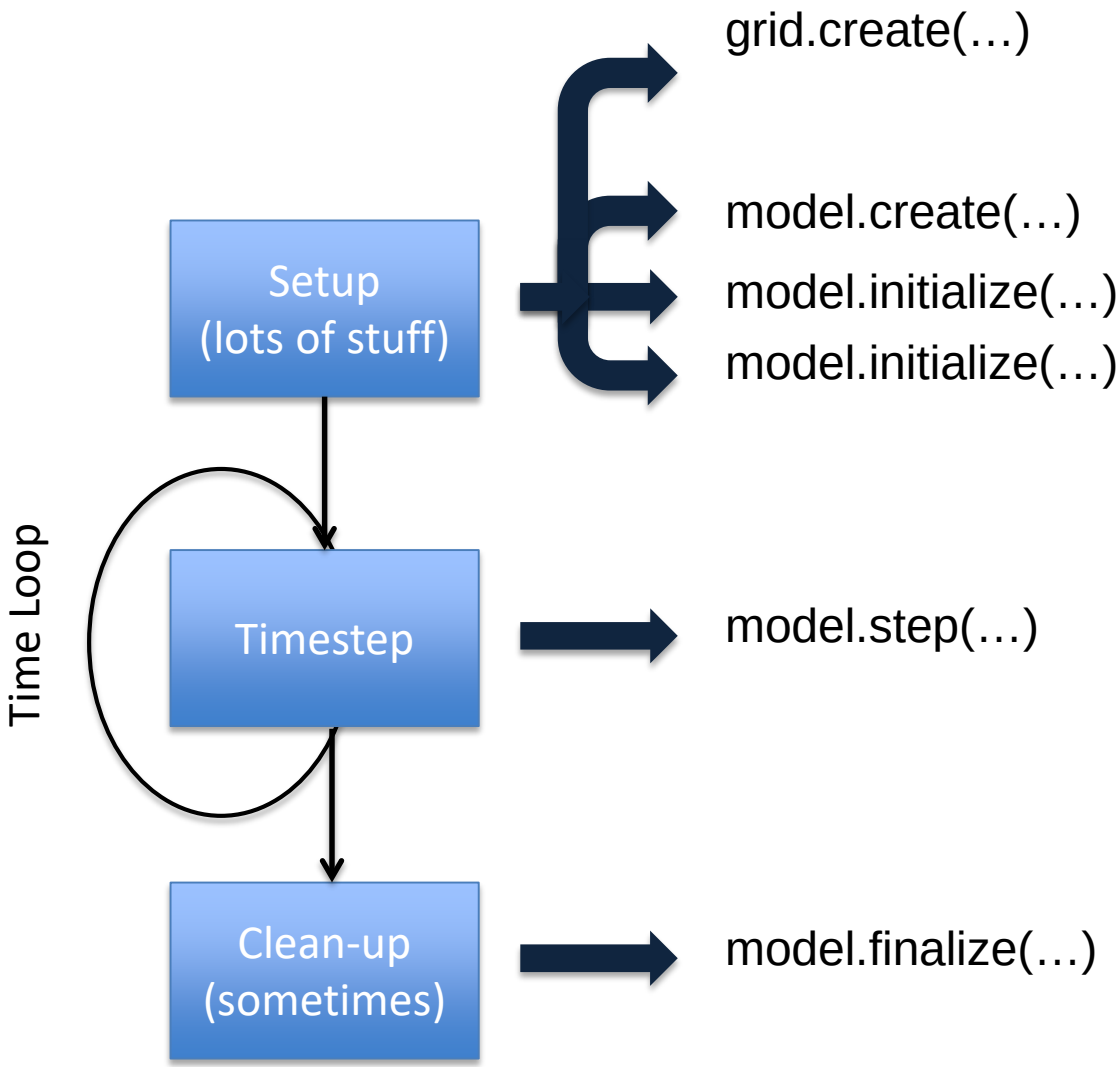
# Joint Effort for Data assimilation Integration

**Model Space Interfaces**

Observation Space Interfaces

Infrastructure and working practices

# Model Design: $x_t=M(x_0)$



# Model Design: Post-processors

- Between model "steps" OOPS calls post-processors
  - OOPS manages when post-processing should be called
  - Post-processing moved away from model code (**separation of concerns**)
  - Adding a post-processor is just adding it to a list

- A post-processor can be anything that
  - Is called (regularly) during model integration
  - Does not modify the State

- OOPS relies on post-processors for isolating data assimilation from the model (**separation of concerns**)
  - Computing simulated observations H(x)
  - Jc-DFI, …

# Joint Effort for Data assimilation Integration

Model Space Interfaces

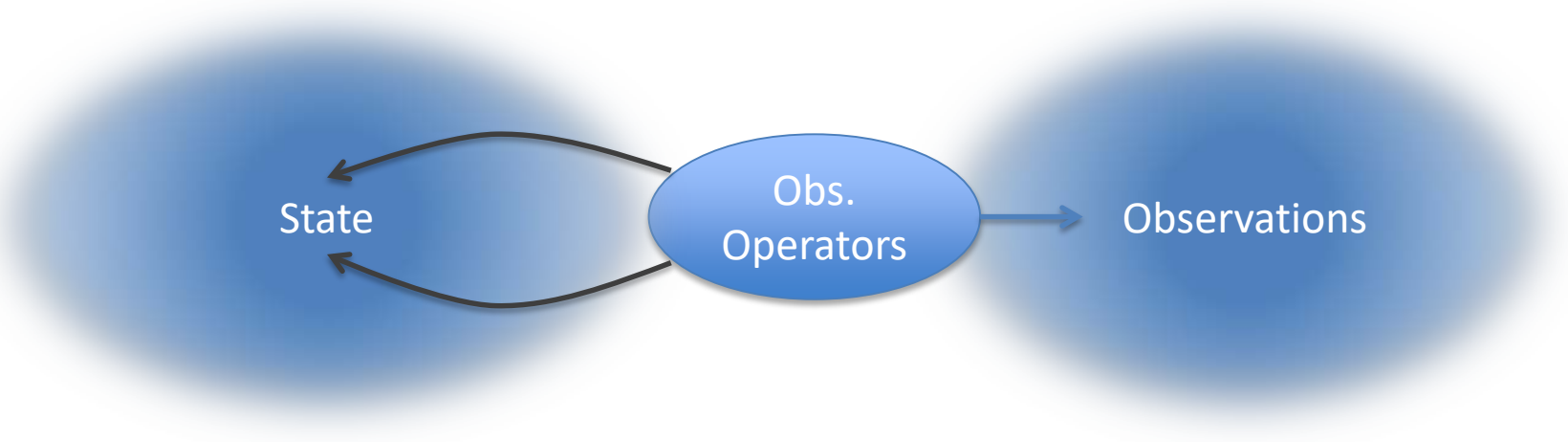
**Observation Space Interfaces**

Infrastructure and working practices

# Observation Space Objectives

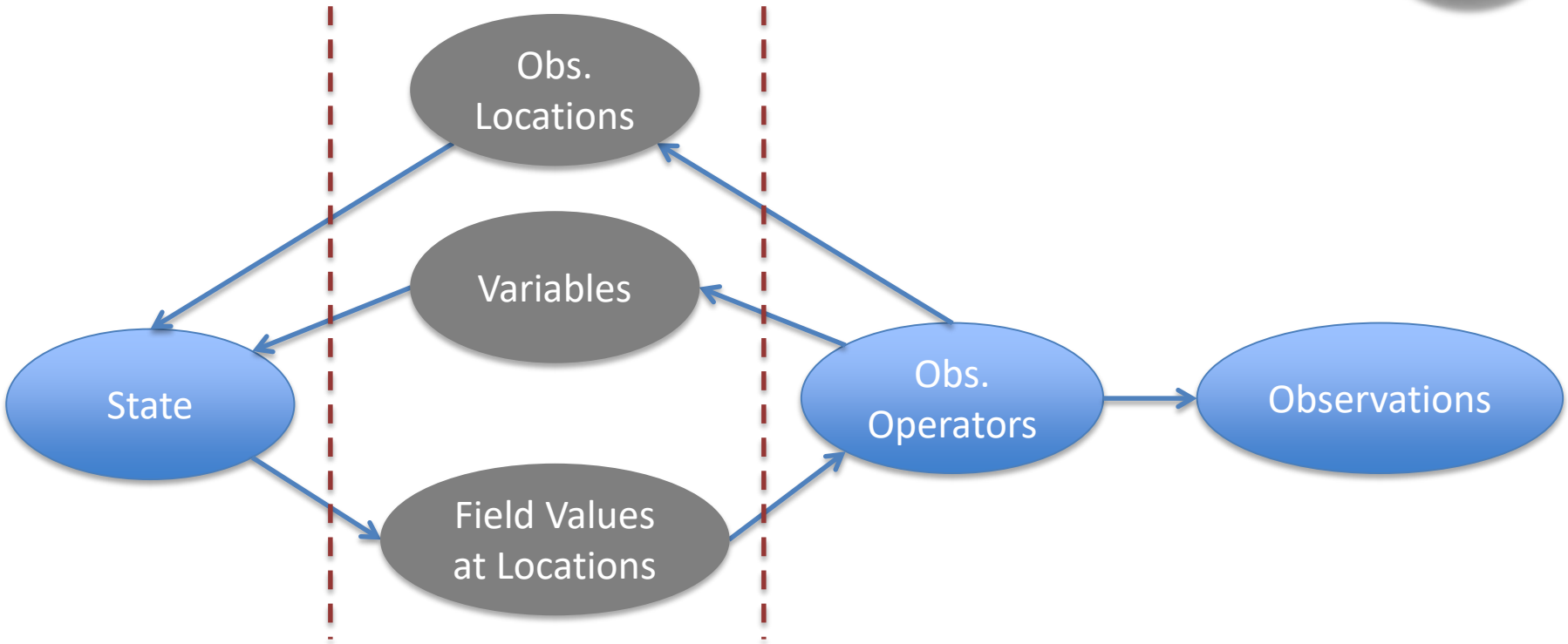
- Share observation operators between JCSDA partners and reduce duplication
  - Include instruments science teams
- Faster use of new observing platforms
  - Regular satellite missions are expensive
  - Cube-sat have short expected life time
- Unified Forward Operator (UFO)
  - Build a community app-store of observation operators (“op-store”)

# Observation Operators




- In most existing systems, observation operators directly access state/model data
- Observation operators, and as a result DA systems, are very model specific

# UFO: the interface advantage




- JEDI/UFO introduces standard interfaces between the model and observation worlds
- Observation operators are independent of the model and can easily be shared, exchanged, compared

# UFO Observation "filters"

- JEDI/UFO calls abstract "observation filters" before and after the actual observation operator
- Filters can be written once and used with many observation types
- Observation filters are generic and have access to
  - Observation values and metadata
  - Simulated observation value (post-filter)
  - Their own private data
- Examples:
  - Quality control (background check, buddy check, cloud detection…)
  - Thinning
  - Saving linearization trajectory or Jacobians

# Interface for Observation Data Access (IODA)

Interface to isolate science code from data storage

Three levels:

- Long term storage (historic database)
- Files on disk (one DA cycle)
- In memory handling of observations (hardware specific?)

Two environments:

- Plotting, analyzing, verifying on workstation
- DA and other HPC applications (MPI, threads, GPUs…)

Goal: one interface, possibly several implementations?

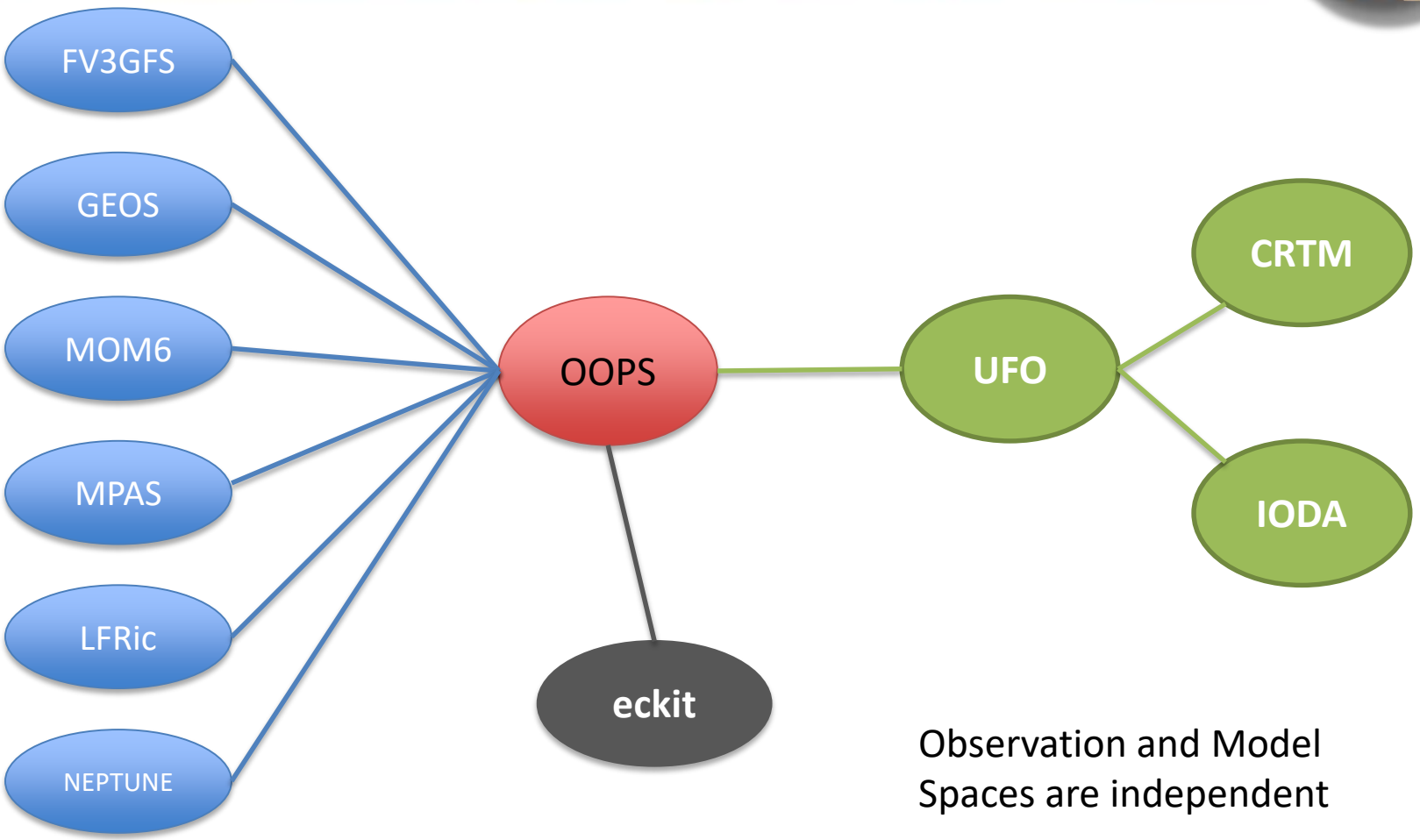
# Joint Effort for Data assimilation Integration

Model Space Interfaces

Observation Space Interfaces

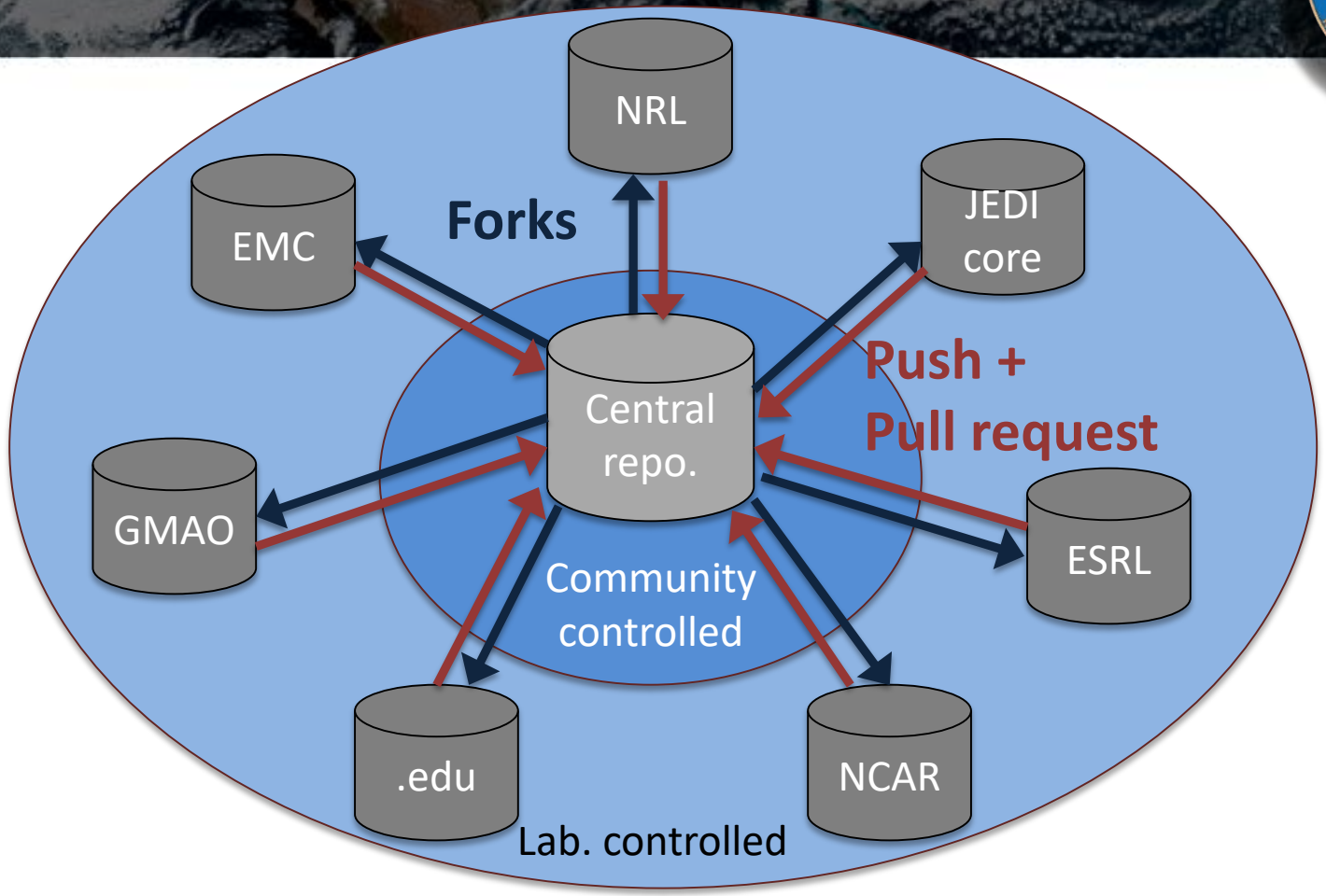
**Infrastructure and working practices**

# Code and repositories




Observation and Model Spaces are independent

# Collaborating: Repositories




Permission to fork repository are very easy to obtain

Contributing code is very controlled:

- Pushing a branch requires write permission on central repository
- Pull request triggers code review and approval for merging to higher level branch

# Governance and code reviews

**Governance** is about management keeping in control and deciding what features should be in the system

**Code reviews** are about quality of the code

Two different levels of control

- Good code can stay outside of central repository (stability of interfaces is important)
- A desired feature that does not satisfy quality requirements cannot be accepted as is

Testing is a pre-requirement for code reviewing

Different people and different pace: **Separation of concerns**…

# Infrastructure, working practices

- Project methodology inspired by Agile/SCRUM
  - Adapted to distributed teams and part time members
- Collaborative environment
  - Easy access to up-to-date source code (github)
  - Easy exchange of information (Confluence, zenhub)
- Flexible build system (ecbuild-based)
- Coding norms
- Documentation, tutorials, JEDI Academy

# Infrastructure, working practices

- Continuous Integration, Testing framework
  - Toolbox for writing tests
  - Automated running of tests (on push to repositories)

- Effort on portability
  - Automatically run tests with several compilers
  - JEDI available in containers (Docker, singularity)

- Enforce software quality (correctness, coding norms, efficiency)

- Change in working practices take time…

# Code Sprints

- Gather 8-10 people in a room for 2 weeks
  - NICAS B Matrix (Aug 2017)
  - Observation Operators (Nov. 2017)
- Efficient use of time, especially for part time contributors
- Involve people from all partner institutions in project
- Very motivating (before, during, after)

# Summary

- JEDI is critical to next-generation DA development (hence to NGGPS)
- Provides scalability/reusability to support multiple applications, users, and contributors
- Builds off successful example (Object Oriented Prediction System – OOPS)
- Coding began in August, 2017
  - Successful components already exist
    - See SOCA example in JCSDA Round-Up Presentation

# Thanks to all involved in JEDI (2017)

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# Joint Center for Satellite Data Assimilation

A multi-agency research center created to improve the use of satellite data for analyzing and predicting the weather, the ocean, the climate and the environment.

Collaborative organization funded by

- NOAA/NWS
- NOAA/NESDIS
- NOAA/OAR
- NASA/GMAO
- US Navy
- US Air Force

Organized by projects:

- CRTM (Community Radiative Transfer Model)
- JEDI (Joint Effort for Data assimilation Integration)
- SOCA (Sea-ice Ocean Coupled Assimilation)
- NIO (New and Improved Observations)
- IOS (Impact of Observing Systems)