

How to advance data assimilation through community engagement and support?

CADRE's perspectives

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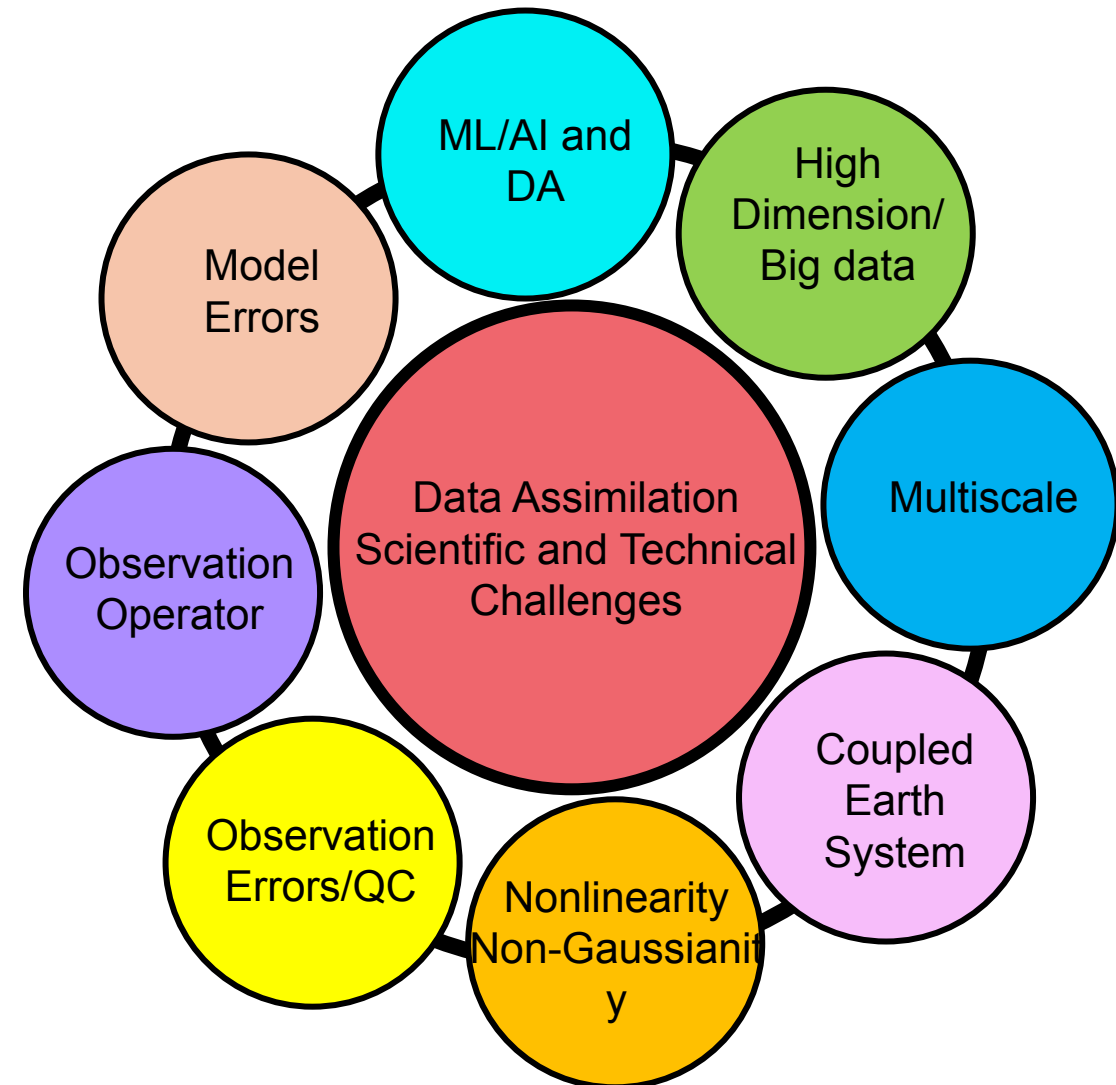
² Consortium for Advanced Data Assimilation Research and Education (CADRE)



CADRE's role

- CADRE is an end-to-end academic–agency partnership (6 universities, ~14 faculty and support scientists, 17 students/postdocs, 26+ CADRE-NOAA forum collaborators).
- Consortium university partners collaborate directly with NOAA and other collaborators under a single umbrella charter to advance DA research, develop DA workforce, build the DA community and facilitate O2R2O (CADRE BAMS paper, 2025)

CADRE BAMS paper , 2025



- Scope
 - address **multiscale, nonlinear, and coupled** Earth system DA challenges to improve **short-range (sub-hour -) to seasonal** predictions through 12 research thrusts.
- How?
 - **novel** data assimilation **algorithm** development
 - **novel utilization of machine learning (ML)** in DA
 - **optimizing the utilization of** existing and new in-situ and remotely sensed **observations**

CADRE presentations at UIFCW 2025



***Benneh, Michael et al. Advancing aerosol data assimilation with the Unified Forecast System (UFS)-Aerosols/JEDI by assimilating CALIOP aerosol profiles.**

Chen, Zhihong and Xuguang Wang. Investigation of data driven background ensemble covariance from Graphcast toward Hurricane data assimilation and prediction

*Chiao, Sen. Two decades of partnership with NOAA Line Offices: Challenges and Opportunities with the NOAA Center for Atmospheric Sciences and Meteorology (NCAS-M)

***Johnson, Aaron and Xuguang Wang. Understanding sampling error characteristics in ensemble-based estimates of land-atmosphere coupled background error covariances in a dryline CI case study**

Kim, Yushin and Xuguang Wang. Impact of Assimilating Atmospheric Boundary Layer Observations on the Rapid Intensification of Hurricane Idalia (2023) in the HAFS-JEDI Framework

Knisely, Joseph. Obstacles for High-Resolution HAFS over the Entire Atlantic Basin.

***van Leeuwen, Peter Jan. On the efficient implementation of non-Gaussian observation errors in existing DA schemes**

Padmanabhan, Thiruvengadam, Xuguang Wang and Yongming Wang. Improving Background Error Covariance and Square Root Estimation with the Convolution Neural Network (CNN) in the Gain Form Ensemble Transform Kalman filter (GETKF)

Poterjoy, Jonathan. Toward High-Frequency Bayesian Assimilation in the UFS Using Local Particle Filters

***Santer, Henry and Jonathan Poterjoy. Non-parametric Estimates of Sea Ice Concentration Observation Errors using CICE6 and Kernel Embeddings of Conditional Distributions**

*Wang, Xuguang. CADRE progress and plans/data assimilation panel discussion

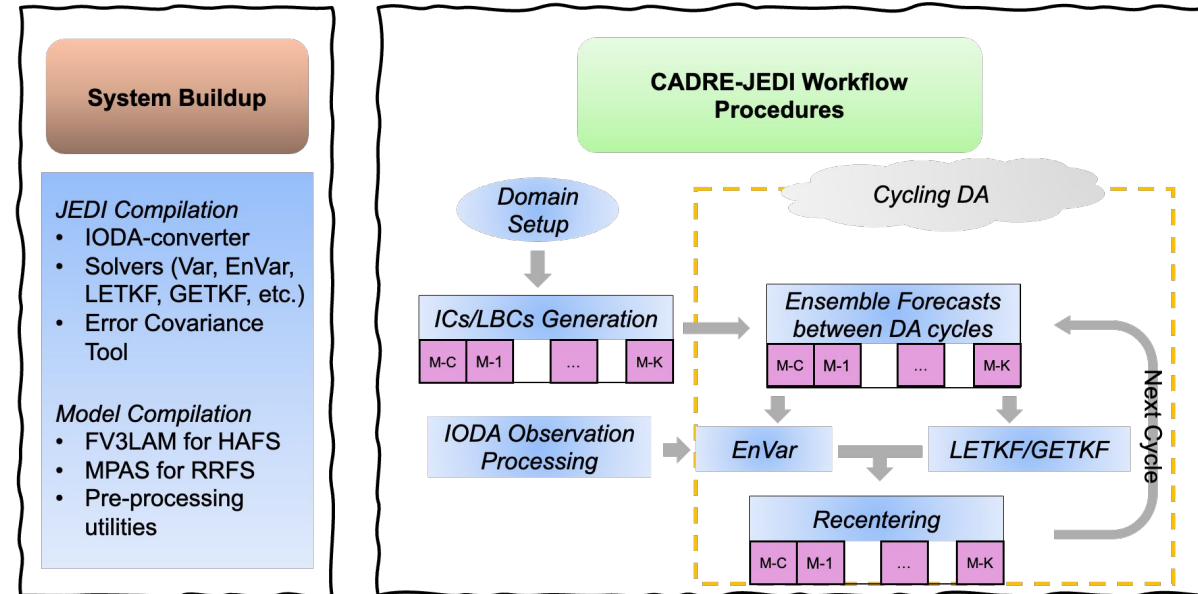
***Wang, Yongming and Xuguang Wang. MAPCast: a convection allowing emulator for multiscale data assimilation**

*Directly funded by CADRE

CADRE R20 efforts

- ❑ Software level:
 - Share/release CADRE's JEDI related development with NOAA collaborators and the public through JCSDA JEDI repository
 - CADRE code repositories (MPAS-JEDI and HAFS-JEDI) are periodically synced with JCSDA JEDI repository and NOAA models (e.g. MPAS and HAFS)
 - Plan to include JCB in CADRE workflow code repositories to facilitate test and evaluation among multiple entities

- ❑ Collaboration:
 - CADRE faculty-NOAA scientists co-advised students' thesis/dissertation
 - Co-ordinate with NOAA on the development
 - Assist NOAA scientists closely when NOAA tests CADRE codes

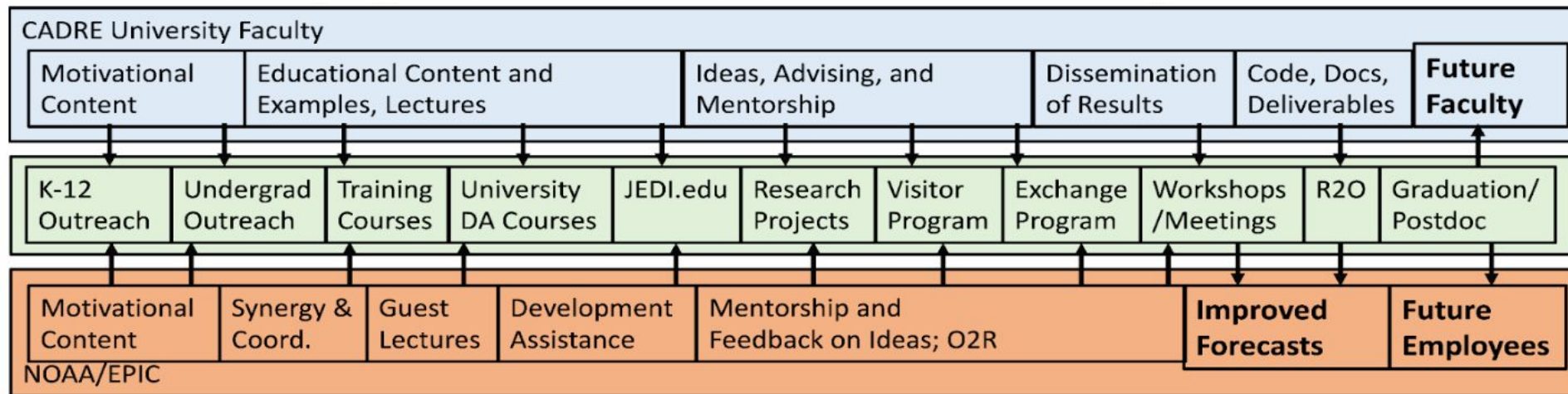


Example of recent CADRE R2O efforts

- ❑ OU MAP lab of CADRE implemented the direct radar reflectivity data assimilation in CADRE's MPAS-JEDI for all three solvers, EnVar, LETKF, LGETKF following the approaches of Wang and Wang (2017) and Johnson et al. (2015).
- ❑ New functionalities/capabilities added
 - Direct radar reflectivity data assimilation
 - Update of vertical velocity
- ❑ Pull requests were made in the JEDI repository hosted by JCSDA to share the code with NOAA labs/centers (GSL, EMC, NSSL) and for public release.
- ❑ Assist EMC and GSL scientists (Sam Degelia, David Dowell, Ming Hu, Shun Liu) to test the codes in RDASapp
- ❑ Created test data sets to allow c-test in JCSDA repository for regional high-resolution DA development, collaborating with GSL scientist (Ming Hu)

CADRE workforce development and community building efforts

- ❑ DA is trans-disciplinary in nature, requiring an understanding of
 - Mathematical/statistical algorithms
 - Physical processes/domain science
 - Observations/measurements
 - Numerical modeling
 - High performance computing
 - Data science/ML/AI





Year 1 training

- Partnered with EPIC
- June 4-6, 2025 at Colorado State University
- Students from 13 states
- Theory, operational application, simple model hands-on, JEDI-UFS-land-DA hands-on on cloud

Year 2 training and science workshop

- National Weather Center, Norman, OK
- Tentatively June 1-5, 2026
- Training + science workshop
- Visit ucadre.org for applications and more details

Year 3 training and science workshop

- College Park, MD

Expansion of partnership

- Addressing the scientific, technical, and human resource challenges of DA requires a holistic approach including close partnership among universities, government agencies, and private sectors, international and trans-disciplinary partnership .
- A natural and necessary next step is to expand CADRE, including bringing additional federal agencies, broadening academic participation, and inclusion of private sectors