CADRE DA Training: UFS Land-DA Workflow

- **Day 1:**
  - Part 1: Brief Land DA Session Background and Intro [15min; Jong]
  - Part 2: Access to NOAA IT Sandbox system and basic info [45min; Kris]
  - Part 3: Containerization (set-up of spack-stack, python environment, JEDI-bundle) [60min; Eddie]
- **Day 2:**
  - Part 1: Structure and features of UFS land-DA workflow [30min; Chan-Hoo]
  - Part 2: Interactive session with three sample configurations [90min; Gillian]
- **Day 3:**
  - Pre/post-processing, next steps, and Q/A [60min; Jong/Chan-Hoo]

UFS Land-DA Workflow

- Day 1: Quick Land DA Session Intro -

Jong Kim, Chan-Hoo Jeon, Gillian Petro, Eddie Snyder, Kris Booker

Key Stakeholder Groups: NOAA EMC, PSL, GSL, NESDIS, NCAR, JCSDA

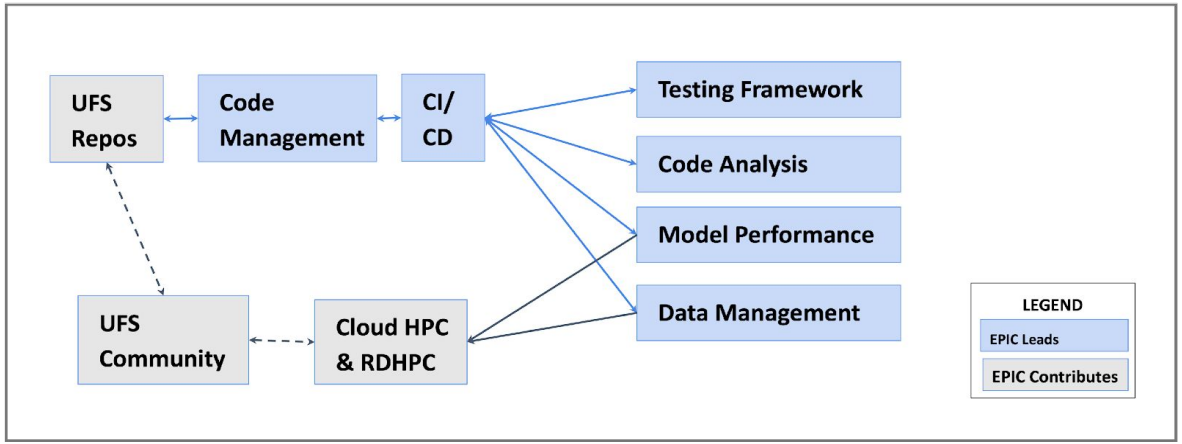
NOAA Earth Prediction Innovation Center (NOAA/EPIC)

Outlines

- NOAA EPIC mission activities and Land DA motivation
- UFS (United Forecast System) Weather Model and Standalone JEDI-based NOAH-MP Land Data Assimilation Application
- Data Assimilation workflow component and structure
  - Model configuration and data assimilation workflow tasks
  - Consistency of workflow structure across UFS DA Applications: Land DA, SRW, etc.
    - File naming convention, environment variables and parameters, vertical workflow directory structure
  - Workflow management system and configuration tools: Rocoto, JEDI configuration Builder (JCB), Unified Workflow (UW) tools
- Analysis output and log files: CADRE DA sample configurations with choice of model and DA configuration options
  - Snow depth analysis: GHCN/IMS/GTS data sets, focus on 2025 January case for IMS data set with 3DVar with ERA5 forcing

EPIC's Keymission Activities

- NOAA created the Earth Prediction Innovation Center (EPIC) to improve operational weather forecast systems through scientific and technical innovation via model co-development with the Weather Enterprise — government, industry and academia.



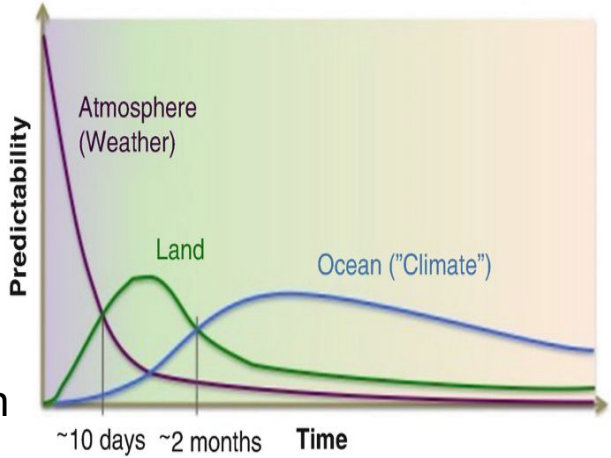
EPIC Infrastructure Focuses on:

- Develop/provide necessary Software Infrastructure;
- Manage, maintain, test, and evaluate the UFS WM and Apps source code;
- Develop and maintain the appropriate frameworks;
- Support the transition of the UFS WM to Cloud-based HPC

https://epic.noaa.gov/

Land Data Assimilation Motivation

- **Operational forecast models increasingly involve with coupled Earth modeling and data assimilation system**
- **Quantification and prediction of land surface state variability:**
  - Critical for initialization of weather and climate forecasts
  - Hydrological community applications include agricultural forecasting, drought and flood risk assessments, etc.
  - Land states can provide predictability in subseasonal-to-seasonal time scale: soil temperature and moisture, snow temperature, etc.
  - Strong influence of land surface flux and moisture partition on the atmospheric boundary layer
  - NWP model constraint: soil moisture, soil temperature, and snowpack



Courtesy of Ek and Dirmeyer

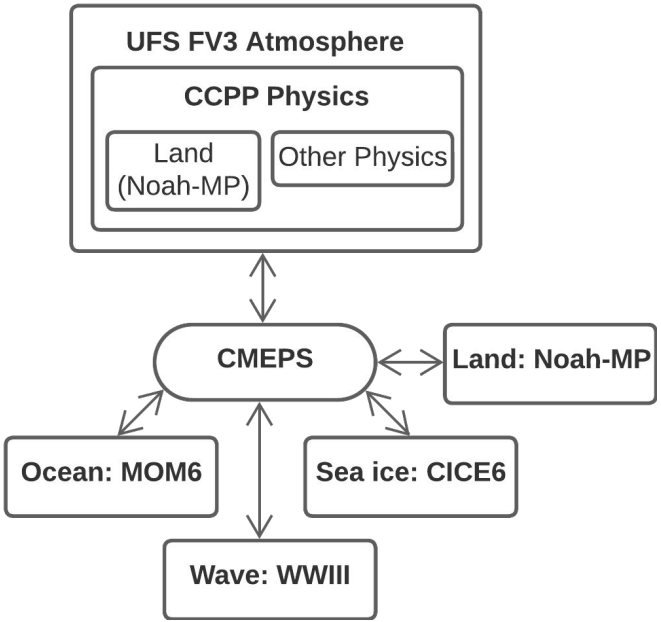
UFS Weather Model Coupling Options

- **Current coupling options: 11 components for 14 coupling applications**
  - **Noah-MP coupling options: DATM (ERA5 and GWSP3 atmospheric forcings) and FV3-LND**

UFS Build Configurations	FV3: Atmosphere	☑ DATM: Aata Atmosphere	MOM6 or HYCOM: Ocean	DOCN: Data Ocean	CICE6: Sea Ice	☑ WW3: Wave	GOCART: Aerosol	AQM: Air Qaulity	Noah-MP or LM4: Land Component	☑ Fire Behavior
Global S2SWA	☑	☐	☑	☐	☑	☑	☑	☐	☐	☐
Global S2SW	☑	☐	☑	☐	☑	☑	☐	☐	☐	☐
Global S2S	☑	☐	☑	☐	☑	☐	☐	☐	☐	☐
Global or regional ATM	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Global or regional ATMW	☑	☐	☐	☐	☐	☑	☐	☐	☐	☐
Global or regional ATMAERO	☑	☐	☐	☐	☐	☐	☑	☐	☐	☐
Global or regional ATMAQ	☑	☐	☐	☐	☐	☐	☐	☑	☐	☐
Global ATMF	☑	☐	☐	☐	☐	☐	☐	☐	☐	☑
Global or regional HAFS-ALL	☑	☐	☑	☑	☐	☐	☐	☐	☐	☐
Global or regional HAFS-MOM6W or HAFSW	☑	☐	☑	☐	☐	☑	☐	☐	☐	☐
Global NG-GODAS	☐	☑	☑	☐	☑	☐	☐	☐	☐	☐
Global LND	☐	☑	☐	☐	☐	☐	☐	☐	☑	☐
Global ATML	☑	☐	☐	☐	☐	☐	☐	☐	☑	☐

Noah-MP Component Model: UFS Weather Model

- **Supported Coupling Configurations**
  - DATM+LND (incl. restart capability)
    - Tested with GSWP3 and ERA5 input provided by CDEPS data components
  - FV3+LND side-by-side configuration (no feedback from land)
    - FV3/CCPP/Noah-MP also runs
    - Aims to compare the results coming from component model and CCPP
  - FV3+LND fully coupled (incl. restart capability)
    - Fully active atmosphere coupled two-way with land component
    - Supports also running land component in high resolution



The Joint Effort for Data assimilation Integration (JEDI)

- Collaborative development led by the Joint Center for Satellite Data Assimilation (JCSDA)
- JEDI provides a software infrastructure for data assimilation software infrastructure
- Key points:
  - Model agnostic, generic and portable from toy models to operational Earth system coupled models
  - Data assimilation on the model native grid
  - No restriction with one specific DA methodology or algorithm
  - Framework for generic observation handling capability and model-independent observation operators
  - Unified observation data process: Interface for Observation Data Access (IODA)
- FV3-JEDI: interfaces between the generic JEDI components and UFS
  - Noah-MP snow data assimilation: file-based pseudo model approach to read the state of a forecast from FV3 restart files

JEDI Core Components and Application Interfaces

- Oriented Prediction System (OOPS) – the operating system for JEDI. Provides wholly generic algorithms for running data assimilation and forecast models.
- Unified Forward Operator (UFO) – an 'app-store' of observation operators.
- Integrated Observation Data Access (IODA) – generic handling of observations.
- System Agnostic Background Error Representation (SABER) – gathering of all the state of the art B matrix methods in a generic fashion.