

Land DA System Training

Running the Containerized Land DA System

By: Gillian Petro, Chan-Hoo Jeon, Edward Snyder

(Key stakeholder groups: NOAA/EMC, PSL, GSL, NESDIS ; NCAR ; JCSDA)



How to Get Help!

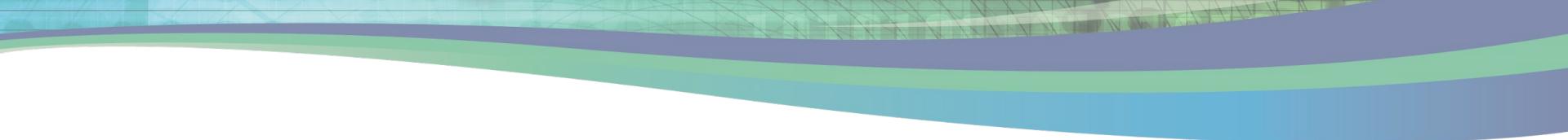
- Raise your hand! :)
- Slack Channel: [#cadre-epic-data-assimilation-training](#)
 - For real-time assistance during the CADRE-EPIC DA Training
- [Land DA GitHub Discussions forum](#)
 - For more in-depth inquiries about the science behind the Land DA workflow
 - For post-training assistance using the Land DA System



Preliminary Steps

- SSH to your instance:
 - `ssh student(#}@jump.epic.noaa.gov`
 - OR
 - `ssh student(#}@137.75.93.46`
- Run `ls` to see what is there. You should see:

```
[ubuntu@ip-10-29-93-178:~$ ls
Land-DA_v2.1_inputs.tar.gz  land-DA_workflow      ubuntu22.04-intel-landda-cadre25.img
inputs                      rocoto
jedi-bundle                  setup_container.sh
```



Raise your hand if:

1. You have NOT ssh'd to the system or
2. You do NOT see the expected files

Overview

- Six (6) available cases
 - Will cover 2-3 cases:

Filename prefix	App	DATM forcing	JEDI algorithm	Observation	Cold/Warm start	Number of cycles	Note
cadre1	LND	ERA5	3D-Var	IMS + SFCSNO	Warm start	7	Benchmark case
cadre2	LND	GSPWP3	LETKF	GHCN	Warm start	2	Different forcing and observation options
cadre3	ATML	N/A	3D-Var	GHCN	Cold start	2	Option 2: Noah-MP + FV3ATM

Documentation Resources

- Follow along in the [documentation](#)
- [Prerequisites](#): preinstalled
- [Data](#): prestaged
- [Container](#): predownloaded
- [Container setup](#): Performed yesterday in Edward Snyder's container presentation

Repositories:

- CADRE-DA-training: <https://github.com/NOAA-EPIC/CADRE-DA-training>
- land-DA_workflow: https://github.com/ufs-community/land-DA_workflow

cadre1: Gulf Coast Blizzard



cadre1: Gulf Coast Blizzard

- Polar vortex stretched far south
- Unusually warm gulf waters
- Result: Unprecedented snowfall across Gulf Coast
- National Weather Service (NWS):
 - Winter Storm Warning
 - Extreme Cold Warning
 - First ever blizzard warning in Lake Charles, LA area

NWS Lake Charles has issued its first ever Blizzard Warning for Jefferson and Orange counties as well as Cameron, Calcasieu, Jeff Davis, Acadia, Vermilion and Lafayette parishes until noon today.

Blizzard Warning
Until Noon Today
January 21, 2025
4:36 AM

A Blizzard Warning means that frequent wind gusts to 35 MPH and snow reducing visibilities to 1/4 mile or less is expected.

Roads, especially bridges and overpasses, will likely become slick and hazardous.

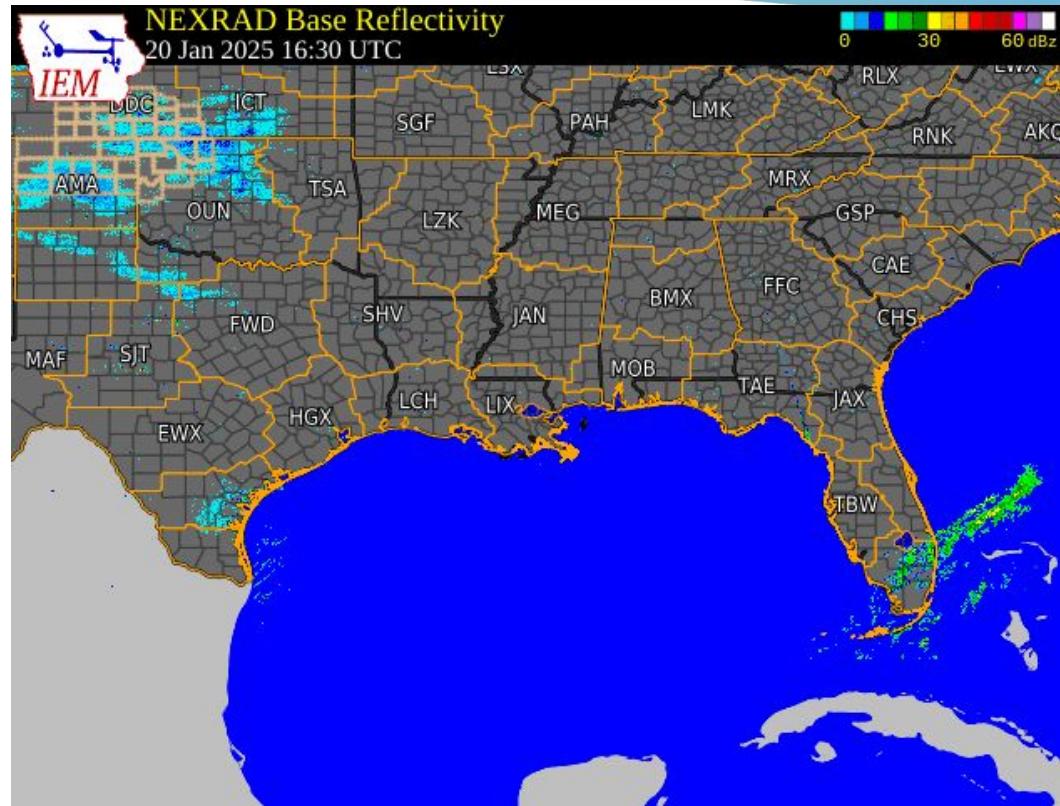
Delay travel if possible. Motorists should use extreme caution if travel becomes necessary.



National Oceanic and Atmospheric Administration
U.S. Department of Commerce

5:45 AM · Jan 21, 2025 · 397K Views

<https://epic.noaa.gov/>



[Iowa State University Iowa Environmental Mesonet](#)

<https://epic.noaa.gov/>

cadre1 configuration

- 2025-01-19 0z to 2025-01-26 0z
 - 24-hour forecasts starting Jan. 19, 2025
 - Data assimilation every 24 hours
 - Relevant variables:
 - DATE_CYCLE_FREQ_HR: 24
 - DATE_FIRST_CYCLE: 2025011900
 - DATE_LAST_CYCLE: 2025012500
 - FCSTHR: 24
- NOTE: Storm hit the Gulf Coast late Jan. 20 and left land by Jan. 23



ufs-community / land-DA_workflow

Type / to search

Code Issues 1 Pull requests Discussions Actions

develop land-DA_workflow / parm / config_samples / samples_cadre / cadre1_config.LND.era5.3dvar.ims.warmstart.yaml

chan-hoo Add sample configs for CADRE training (#227) ✓

Name Last commit message

..

cadre0_config.LND.era5.letkf.ghcn.coldstart.yaml Add sample configs

cadre1_config.LND.era5.3dvar.ims.warmstart.yaml Add sample configs

cadre2_config.LND.gswp3.letkf.ghcn.warmstart.yaml Add sample configs

cadre3_config.ATML.3dvar.ghcn.coldstart.yaml Add sample configs

cadre4_config.LND.era5.3dvar.ghcn.warmstart.yaml Add sample configs

cadre5_config.LND.era5.3dvar.ims_alone.warmstart.... Add sample configs

Code Blame Raw

```
1 ACCOUNT: epic
2 APP: LND
3 ATMOS_FORC: era5
4 COLDSTART: 'NO'
5 COUPLER_CALENDAR: 2
6 DATE_CYCLE_FREQ_HR: 24
7 DATE_FIRST_CYCLE: 2025011900
8 DATE_LAST_CYCLE: 2025012500
9 DT_ATMOS: 900
10 DT_RUNSEQ: 3600
11 envir: test_cadre1
12 EXP_CASE_NAME: cadre1_lnd_era5_ims
13 FCSTHR: 24
14 JEDI_ALGORITHM: 3dvar
15 LND_CALC_SNET: .true.
16 LND_IC_TYPE: custom
```

NORAA
NOAA National Centers for Environmental Prediction

Configure the experiment

- NOTE: Container setup performed yesterday in Edward Snyder's container presentation
- Load the workflow environment:
 - `cd land-DA_workflow`
 - `module use modulefiles`
 - `module load wflow_singularity`
- Copy the sample configuration file into `config.yaml`:
 - `cd parm`
 - `cp config_samples/samples_cadre/cadre1_config.LND.era5.3dvar.ims.warmstart.yaml config.yaml`

Configure the experiment cont'd

- Open config.yaml
 - `vim config.yaml`
- Edit (use `i` key to enter insert mode):
 - `DATE_LAST_CYCLE: 2025012200`
 - Change DATE_LAST_CYCLE
- Generate the experiment directory by running:
 - `./setup_wflow_env.py -p=singularity`

```
ACCOUNT: epic
APP: lnd
ATMOS_FORC: era5
COLDSTART: 'NO'
COUPLER_CALENDAR: 2
DATE_CYCLE_FREQ_HR: 24
DATE_FIRST_CYCLE: 2025011900
DATE_LAST_CYCLE: 2025012500
DT_ATMOS: 900
DT_RUNSEQ: 3600
envir: test_cadre1
EXP_CASE_NAME: cadre1_lnd_era5_ims
FCSTHR: 24
JEDI_ALGORITHM: 3dvar
LND_CALC_SNTE: .true.
LND_IC_TYPE: custom
LND_INITIAL_ALBEDO: 0.25
LND_LAYOUT_X: 1
LND_LAYOUT_Y: 2
LND_OUTPUT_FREQ_SEC: 21600
MED_COUPLING_MODE: ufs.nfrac.aoflux
model_ver: v2.1.0
net: landda
NPROCS_ANALYSIS: 6
NPZ: 127
OBS_GHCN_SNOW: 'NO'
OBS_IMS_SNOW: 'YES'
OBS_SFCSNO: 'YES'
RES: 96
RUN: landda
WE2E_TEST: 'NO'
```



setup_wflow_env.py Output (excerpt)

```
ubuntu@ip-10-29-93-226:~/land-DA_workflow/parm$ ./setup_wflow_env.py -p=singularity
Python Log Level= str: INFO, attr: 20
INFO:::/home/ubuntu/land-DA_workflow/parm/../setup_wflow_env.py::L34:: Current directory (PARMdir): /home/ubuntu/land-DA_workflow/parm
INFO:::/home/ubuntu/land-DA_workflow/parm/../setup_wflow_env.py::L36:: Home directory (HOMEdir): /home/ubuntu/land-DA_workflow
INFO:::/home/ubuntu/land-DA_workflow/parm/../setup_wflow_env.py::L38:: Experimental base directory (exp_basedir): /home/ubuntu
INFO:::/home/ubuntu/land-DA_workflow/parm/../setup_wflow_env.py::L168:: Experimental case directory /home/ubuntu/exp_case/cadre1_lnd_era5_ims has been created
INFO:::/home/ubuntu/land-DA_workflow/parm/../setup_wflow_env.py::L175:: Rocoto YAML template: /home/ubuntu/land-DA_workflow/parm/templates/template.land_da.yaml
*****
Overriding      ACCOUNT = epic
Overriding      APP = LND
Overriding      ATMOS_FORC = era5
...
Overriding      queue_default = batch
Overriding      res_p1 = 97
*****
KEEPDATA: YES
      RUN: landda
nprocs_forecast_lnd: 36
MED_COUPLING_MODE: ufs.nfrac.aoflux
EXP_CASE_NAME: cadre1_lnd_era5_ims
NPZ: 127
...
      exp_basedir: /home/ubuntu
      RES: 96
      ATM_LAYOUT_X: 3
native_default: None
      ATM_LAYOUT_Y: 8
DATM_STREAM_FN_LAST_DATE:
      LND_LAYOUT_Y: 3
LND_OUTPUT_FREQ_SEC: 21600
INFO:::/home/ubuntu/land-DA_workflow/sorc/conda/envs/land_da/lib/python3.12/site-packages/uwtools/config/validator.py::L76::0 schema-validation errors found
INFO:::/home/ubuntu/land-DA_workflow/sorc/conda/envs/land_da/lib/python3.12/site-packages/uwtools/rocoto.py::L66::0 Rocoto XML validation errors found
ubuntu@ip-10-29-93-226:~/land-DA_workflow/parm$
```



Questions?



The Experiment Directory

- Navigate to the experiment directory:
 - `cd ../../exp_case/cadre1_lnd_era5_ims/`
- Run the workflow launch command:
 - `rocotorun -w land_analysis.xml -d land_analysis.db`
- To see jobs that are in progress:
 - `squeue -u $USER`
- Check progress with `rocotostat`:
 - `rocotostat -w land_analysis.xml -d land_analysis.db`
 - STATE could be QUEUED, SUBMITTING, RUNNING, SUCCEEDED, DEAD, UNAVAILABLE
 - Let us know if a task goes DEAD or UNAVAILABLE!!!

CYCLE	TASK	JOBID	STATE	EXIT STATUS	TRIES	DURATION
=====						
202501200000	jcb	4	QUEUED	-	0	0.0
202501200000	prep_data	14	QUEUED	-	0	0.0
202501200000	pre_anal	15	QUEUED	-	0	0.0
202501200000	analysis	-	-	-	-	-
202501200000	post_anal	-	-	-	-	-
202501200000	forecast	-	-	-	-	-
202501200000	plot_stats	-	-	-	-	-
=====						
202501210000	jcb	5	QUEUED	-	0	0.0
202501210000	prep_data	-	-	-	-	-
202501210000	pre_anal	-	-	-	-	-
202501210000	analysis	-	-	-	-	-
202501210000	post_anal	-	-	-	-	-
202501210000	forecast	-	-	-	-	-
202501210000	plot_stats	-	-	-	-	-
=====						
202501220000	jcb	6	QUEUED	-	0	0.0
202501220000	prep_data	-	-	-	-	-
202501220000	pre_anal	-	-	-	-	-
202501220000	analysis	-	-	-	-	-
202501220000	post_anal	-	-	-	-	-
202501220000	forecast	-	-	-	-	-
202501220000	plot_stats	-	-	-	-	-



Running the Experiment

- Normally, users need to issue the `rocotorun` command multiple times.
 - `rocotorun` initiates the next task once its dependencies have completed successfully.
 - `rocotostat` will only show updates after a `rocotorun` command is issued.
- Automate the workflow using the `run_expt.sh` script:
 - `wget`
`https://raw.githubusercontent.com/NOAA-EPIC/CADRE-DA-training/refs/heads/main/Day2/run_expt.sh`
`/home/ubuntu/exp_case/cadre1_lnd_era5_ims`
 - `chmod 755 run_expt.sh`
 - `./run_expt.sh`

Directory Structure

```
$LANDDAROOT (<exp_basedir>): Base directory
    └── land-DA_workflow (<HOMElandda> or <CYCLEDIR>): Home directory of the land DA workflow
        ├── jobs
        ├── modulefiles
        ├── parm
        ├── scripts
        ├── sorc
        └── ush
    └── exp_case
        └── EXP_CASE_NAME
            ├── com_dir --> symlinked to ptmp/test_*/com/landda/v2.1.0
            ├── land_analysis.yaml
            ├── land_analysis.xml
            ├── launch_rocoto_wflow.sh
            ├── log_dir --> symlinked to ptmp/test_*/com/output/logs
            └── tmp_dir --> symlinked to ptmp/test_*/com/tmp
    └── ptmp (<PTMP>)
        └── test_* (<envir> or <OPSR00T>)
            └── com (<COMR00T>)
                ├── landda (<NET>)
                │   └── vX.Y.Z (<model_ver>)
                │       └── landda.YYYYMMDD (<RUN>.<PDY>): Directory containing the output files
                │           ├── hofx
                │           └── plot
                └── output
                    └── logs (<LOGDIR>): Directory containing the log files for the Rocoto workflow
    └── tmp (<DATAR00T>)
        ├── <jobid> (<DATA>): Working directory
        └── DATA_SHARE
            ├── YYYYMMDD (<PDY>): Directory containing the intermediate or temporary files
            ├── hofx: Directory containing the soft links to the results of the analysis task for plotting
            └── DATA_RESTART: Directory containing the soft links to the restart files for the next cycles
```

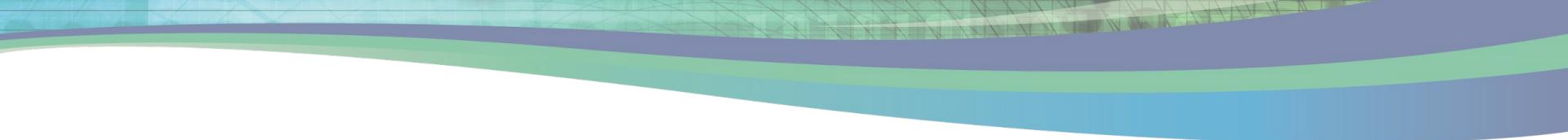


Troubleshooting

- Navigate to the log directory:
 - `cd log_dir`

```
ubuntu@ip-10-29-93-209:~/exp_case/cadre1_lnd_era5_ims/log_dir$ ls
analysis_2025011900.log  forecast_2025012100.log  plot_stats_2025011900.log  post_anal_2025012100.log  prep_data_2025011900.log
analysis_2025012000.log  forecast_2025012200.log  plot_stats_2025012000.log  post_anal_2025012200.log  prep_data_2025012000.log
analysis_2025012100.log  jcb_2025011900.log      plot_stats_2025012100.log  pre_anal_2025011900.log   prep_data_2025012100.log
analysis_2025012200.log  jcb_2025012000.log      plot_stats_2025012200.log  pre_anal_2025012000.log   prep_data_2025012200.log
forecast_2025011900.log  jcb_2025012100.log      post_anal_2025011900.log  pre_anal_2025012100.log   workflow.log
forecast_2025012000.log  jcb_2025012200.log      post_anal_2025012000.log  pre_anal_2025012200.log
```

- View the log file for the tasks that went DEAD
 - `vim prep_data_2025012000.log`
 - Scroll to the bottom for the last output
 - Search for error or failure messages
- Rewind a task using Rocoto (see [reference guide](#))



Is anyone seeing DEAD tasks?



Compare Plots



Plots

- Navigate to the plots directory:
 - `cd ../com_dir/landda.202501##/plot`
 - One directory per cycle
- Each directory will contain several plots:

```
ubuntu@ip-10-29-93-226:~/exp_case/cadre1_lnd_era5_ims/com_dir/landda.20250120/plot$ ls
hofx_omb_ims_snow_20250120_histogram.png      landda_out_restart_2025-01-21_00_snwdph_alltiles.png
hofx_omb_ims_snow_20250120_scatter.png        landda_out_restart_2025-01-21_00_snwdph_tile1.png
hofx_omb_sfcsno_20250120_histogram.png        landda_out_restart_2025-01-21_00_snwdph_tile2.png
hofx_omb_sfcsno_20250120_scatter.png          landda_out_restart_2025-01-21_00_snwdph_tile3.png
landda_comp_sfc_20250120_snwdph_after.png    landda_out_restart_2025-01-21_00_snwdph_tile4.png
landda_comp_sfc_20250120_snwdph_before.png    landda_out_restart_2025-01-21_00_snwdph_tile5.png
landda_comp_sfc_20250120_snwdph_diff_sfc.png landda_out_restart_2025-01-21_00_snwdph_tile6.png
landda_comp_sfc_20250120_snwdph_inc.png       landda_timehistory_omb_totalSnowDepth_ims_snow.png
landda_obs_ims_20250120_SnowDepth.png         landda_timehistory_omb_totalSnowDepth_sfcsno.png
landda_out_combined_2025-01-21_00_snwdph.png
```

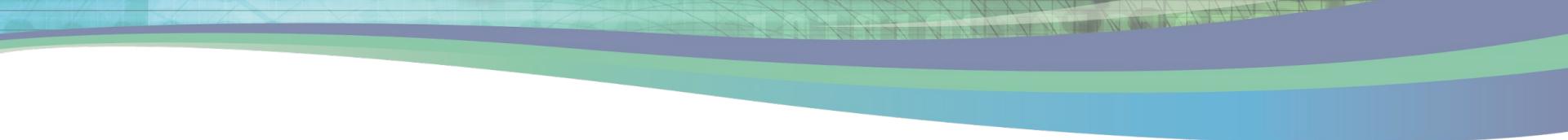


Downloading Plots

- Open a new terminal window.
- Type **bash** to ensure a bash shell.
- Add your private key (e.g., **ssh-add ~/.ssh/id_ed25519_student1**).
- For each directory of plots, run:
 - ```
rsync -v --rsh "ssh student#@jump.epic.noaa.gov ssh"
ubuntu@controller:/home/ubuntu/exp_case/cadre1_lnd_era5_ims/
com_dir/landda.202501##/plot/* ./plots/cadre1/202501##
```
- In the command, replace:
  - **student#** with your actual student number,
  - **landda.202501##** with the cycle date, and
  - **./plots/202501##/** with the cycle date.

# Questions?





# cadre2



# cadre2

- 2000-02-02 0z - 2000-02-03 0z
  - 24-hour forecasts starting Feb. 2, 2000
  - Data assimilation every 24 hours
  - Relevant variables:
    - DATE\_CYCLE\_FREQ\_HR: 24
    - DATE\_FIRST\_CYCLE: 2000020200
    - DATE\_LAST\_CYCLE: 2000020300
    - FCSTHR: 24
  - **GSPW3 forcing data:** Daily-resolution observed climate data on a global (land and ocean)  $0.5^\circ \times 0.5^\circ$  lat-lon grid from the Global Soil Wetness Project Phase 3 (GSPW3). The data set covers the period 1901-2010.
- [https://github.com/ufs-community/ufs-weather-model/blob/develop/tests/test/datm\\_cdeps\\_lnd\\_gswp3](https://github.com/ufs-community/ufs-weather-model/blob/develop/tests/test/datm_cdeps_lnd_gswp3)



# cadre2

Before continuing previously started work:

- Open a new terminal window and ssh to system:
  - `ssh student(#}@jump.epic.noaa.gov / ssh student(#}@137.75.93.46`
- Load the workflow environment:
  - `cd land-DA_workflow`
  - `module use modulefiles`
  - `module load wflow_singularity`

# Configure cadre2

- Navigate to the `parm` directory to configure the new experiment:
  - `cd parm`
- Copy the new experiment configuration into `config.yaml`:
  - `cp config_samples/samples_cadre/cadre2_config.LND.gswp3.letkf.g  
hcn.warmstart.yaml config.yaml`
- Generate the experiment directory by running:
  - `./setup_wflow_env.py -p=singularity`

```
ubuntu@ip-10-29-93-178:~/land-DA_workflow/parm$./setup_wflow_env.py -p=singularity
 Python Log Level= str: INFO, attr: 20
INFO:::/home/ubuntu/land-DA_workflow/parm././setup_wflow_env.py::L34:: Current directory (PARMdir): /home/ubuntu/land-DA_workflow/parm
INFO:::/home/ubuntu/land-DA_workflow/parm././setup_wflow_env.py::L36:: Home directory (HOMEdir): /home/ubuntu/land-DA_workflow
INFO:::/home/ubuntu/land-DA_workflow/parm././setup_wflow_env.py::L38:: Experimental base directory (exp_basedir): /home/ubuntu
INFO:::/home/ubuntu/land-DA_workflow/parm././setup_wflow_env.py::L168:: Experimental case directory /home/ubuntu/exp_case/cadre2_lnd_gswp3_ghcn has been created.
INFO:::/home/ubuntu/land-DA_workflow/parm././setup_wflow_env.py::L175:: Rocoto YAML template: /home/ubuntu/land-DA_workflow/parm/templates/template.land_analyses.yaml

Overriding ACCOUNT = epic
Overriding APP = LND
Overriding ATMOS_FORC = gswp3
Overriding queue_default = batch
Overriding res_p1 = 97

WE2E_TEST: NO
JEDI_PATH: /home/ubuntu
ATM_LAYOUT_Y: 8
FCSTHR: 24
MED_COUPLING_MODE: ufs.nfrac.aoflux
 APP: LND
CCPP_SUITE: FV3_GFS_v17_p8_ugwpv1
 envir: test_cadre2
 KEEPDATA: YES
JEDI_PY_VER: python3.10
DT_RUNSEQ: 3600
nprocs_forecast_lnd: 36
JEDI_ALGORITHM: letkf
WRITE_GROUPS: 1
WRITE_TASKS_PER_GROUP: 6
INFO:::/home/ubuntu/land-DA_workflow/sorc/conda/envs/land_da/lib/python3.12/site-packages/uwtools/config/validator.py::L76::0 schema-validation errors found in Rocoto config
INFO:::/home/ubuntu/land-DA_workflow/sorc/conda/envs/land_da/lib/python3.12/site-packages/uwtools/rocoto.py::L66::0 Rocoto XML validation errors found
ubuntu@ip-10-29-93-178:~/land-DA_workflow/parm$
```

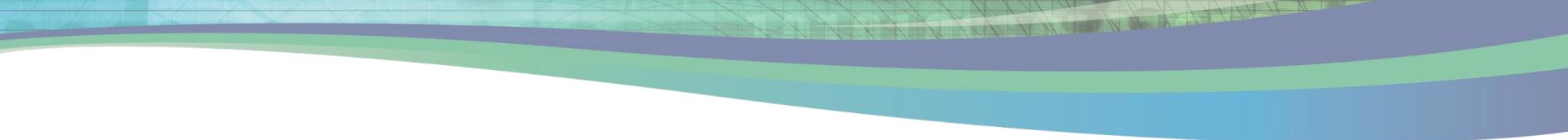
## cadre2: *setup\_wflow\_env.py* output (excerpts)

# The Experiment Directory

- Navigate to the experiment directory:
  - `cd ../../exp_case/cadre2_lnd_gswp3_ghcn/`
- Run the workflow launch command:
  - `rocotorun -w land_analysis.xml -d land_analysis.db`
- To see jobs that are in progress:
  - `squeue -u $USER`
- Check progress with `rocotostat`:
  - `rocotostat -w land_analysis.xml -d land_analysis.db`
  - STATE could be QUEUED, SUBMITTING, RUNNING, SUCCEEDED, DEAD, or UNAVAILABLE
    - Let us know if a task goes DEAD or UNAVAILABLE!!!

# Running the Experiment

- Normally, users need to issue the `rocotorun` command multiple times.
  - `rocotorun` initiates the next task once its dependencies have completed successfully.
  - `rocotostat` will only show updates after a `rocotorun` command is issued.
- Automate the workflow using the `run_expt.sh` script:
  - `wget`  
`https://raw.githubusercontent.com/NOAA-EPIC/CADRE-DA-training/refs/heads/main/Day2/run_expt.sh` .
  - `chmod 755 run_expt.sh`
  - `./run_expt.sh`



# Questions?

# Compare Plots



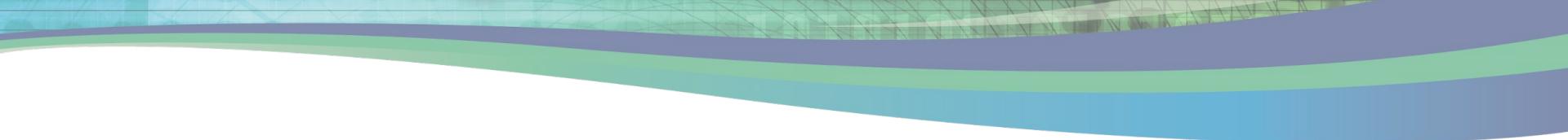
# Plots

- Navigate to the plots directory:
  - `cd com_dir/landda.2000020#/plot`
  - One directory per cycle
- Each directory will contain several plots:

```
[ubuntu@ip-10-29-93-209:~/exp_case/cadre2_1nd_gswp3_ghcn/com_dir/landda.20000202/plot$ ls
hofx_omb_ghcn_snow_20000202_histogram.png landda_out_restart_2000-02-03_00_snwdph_alltiles.png
hofx_omb_ghcn_snow_20000202_scatter.png landda_out_restart_2000-02-03_00_snwdph_tile1.png
landda_comp_sfc_20000202_snwdph_after.png landda_out_restart_2000-02-03_00_snwdph_tile2.png
landda_comp_sfc_20000202_snwdph_before.png landda_out_restart_2000-02-03_00_snwdph_tile3.png
landda_comp_sfc_20000202_snwdph_diff_sfc.png landda_out_restart_2000-02-03_00_snwdph_tile4.png
landda_comp_sfc_20000202_snwdph_inc.png landda_out_restart_2000-02-03_00_snwdph_tile5.png
landda_obs_ghcn_20000202_SnowDepth.png landda_out_restart_2000-02-03_00_snwdph_tile6.png
landda_out_combined_2000-02-03_00_snwdph.png landda_timehistory_omb_totalSnowDepth_ghcn_snow.png
```

# Downloading Plots

- Open a new terminal window.
- Type **bash** to ensure a bash shell.
- Add your private key (e.g., **ssh-add ~/.ssh/id\_ed25519\_student1**).
- For each directory of plots, run:
  - ```
rsync -v --rsh "ssh student#@jump.epic.noaa.gov ssh"
ubuntu@controller:/home/ubuntu/exp_case/cadre2_1nd_gswp3_ghc
n/com_dir/landda.2000020#/plot/* ./plots/cadre2/2000020#
```
- In the command, replace:
 - **student#** with your actual student number
 - **landda.2000020#** with the cycle date
 - **./plots/2000020#** with the cycle date



Questions?

cadre3: Building ATML executables



cadre3

- 2022-12-21 0z - 2022-12-22 0z
 - 24-hour forecasts starting Dec. 21, 2022
 - Data assimilation every 24 hours
 - Relevant variables:
 - DATE_CYCLE_FREQ_HR: 24
 - DATE_FIRST_CYCLE: 2022122100
 - DATE_LAST_CYCLE: 2022122200
 - FCSTHR: 24
- Same date as the sample configuration of the global workflow.

cadre3

- Open a new terminal window and ssh to system:
 - `ssh student(#}@jump.epic.noaa.gov / ssh student(#}@137.75.93.46`
 - (If continuing in same terminal window, navigate to `/home/ubuntu` instead.)



Build ATML executables for cadre3

- Shell into the container:
 - `singularity shell -B /home:/home /home/ubuntu/ubuntu22.04-intel-landda-cadre25.img`
- Go to the `land-DA_workflow/sorc` directory that was copied out of the container.
 - `cd /home/ubuntu/land-DA_workflow/sorc`
- Set up the environment
 - `source /opt/spack-stack/spack-stack-1.6.0/envs/fms-2024.01/.bashenv -fms`
 - `module use ../modulefiles`
 - `module load build_singularity_intel`



Build ATML executables for cadre3

- Build the model using `app_build.sh`.
 - Options:
 - ATML Configuration:
 - `./app_build.sh -p=singularity -a=ATML --conda=off --build`
 - LND (default) Configuration:
 - `./app_build.sh -p=singularity --conda=off --build`
- NOTES:
 - `-p=singularity` indicates that the platform uses a container build
 - `--conda=off` prevents rebuilding conda, which was pre-built in previous steps.
 - `--build` keeps the executables in the `build` directory under `bin`.

Configure cadre3

- Type `exit` to exit the container.
- Load the workflow environment:
 - `cd land-DA_workflow`
 - `module use modulefiles`
 - `module load wflow_singularity`
- Navigate to the `parm` directory to configure the new experiment:
 - `cd /home/ubuntu/land-DA_workflow/parm`
- Copy the new experiment configuration into `config.yaml`:
 - `cp config_samples/samples_cadre/cadre3_config.ATML.3dvar.ghcn.oldstart.yaml config.yaml`
- Generate the experiment directory by running:
 - `./setup_wflow_env.py -p=singularity`



Point to ATML Executables

- For ATML configurations, users must modify `run_container_executable.sh`.
For example:
 - `vim run_container_executable.sh`
- Uncomment the second-to-last line of the script:
 - `#export SINGULARITYENV_PREPEND_PATH=/home/ubuntu/land-DA_workflow/src/build/bin:$SINGULARITYENV_PREPEND_PATH`
- This line adds the ATML executables to the container by exporting the `SINGULARITYENV_PREPEND_PATH` variable.

setup_wflow_env.py Output (excerpt)

```
Python Log Level= str: INFO, attr: 20
INFO:::/home/ubuntu/land-DA_workflow/parm./setup_wflow_env.py::L34:: Current directory (PARMdir): /home/ubuntu/land-DA_workflow/parm
INFO:::/home/ubuntu/land-DA_workflow/parm./setup_wflow_env.py::L36:: Home directory (HOMEdir): /home/ubuntu/land-DA_workflow
INFO:::/home/ubuntu/land-DA_workflow/parm./setup_wflow_env.py::L38:: Experimental base directory (exp_basedir): /home/ubuntu
INFO:::/home/ubuntu/land-DA_workflow/parm./setup_wflow_env.py::L168:: Experimental case directory /home/ubuntu/exp_case/cadre3_atml has been
created.
INFO:::/home/ubuntu/land-DA_workflow/parm./setup_wflow_env.py::L175:: Rocoto YAML template:
/home/ubuntu/land-DA_workflow/parm/templates/template.land_analysis.yaml
*****
Overriding           ACCOUNT = epic
Overriding           APP = ATML
Overriding           ATMOS_FORC = gswp3
...
Overriding           queue_default = batch
Overriding           res_p1 = 97
*****
DATE_CYCLE_FREQ_HR: 24
DATM_STREAM_FN_LAST_DATE:
nprocs_forecast_atm: 54
APP: ATML
LND_CALC_SNET: .false.
...
ATM_LAYOUT_Y: 4
MACHINE: singularity
INFO:::/home/ubuntu/land-DA_workflow/sorc/conda/envs/land_da/lib/python3.12/site-packages/uwtools/config/validator.py::L76::0 schema-validation
errors found in Rocoto config
INFO:::/home/ubuntu/land-DA_workflow/sorc/conda/envs/land_da/lib/python3.12/site-packages/uwtools/rocoto.py::L66::0 Rocoto XML validation errors
found
```



The Experiment Directory

- Navigate to the experiment directory:
 - `cd ../../exp_case/cadre3_atml/`
- Run the workflow launch command:
 - `rocotorun -w land_analysis.xml -d land_analysis.db`
- To see jobs that are in progress:
 - `squeue -u $USER`
- Check progress with `rocotostat`:
 - `rocotostat -w land_analysis.xml -d land_analysis.db`
 - STATE could be QUEUED, SUBMITTING, RUNNING, SUCCEEDED, DEAD, or UNAVAILABLE
 - Let us know if a task goes DEAD or UNAVAILABLE!!!

Running the Experiment

- Normally, users need to issue the `rocotorun` command multiple times.
 - `rocotorun` initiates the next task once its dependencies have completed successfully.
 - `rocotostat` will only show updates after a `rocotorun` command is issued.
- Automate the workflow using the `run_expt.sh` script:
 - `wget`
`https://raw.githubusercontent.com/NOAA-EPIC/CADRE-DA-training/refs/heads/main/Day2/run_expt.sh` .
 - `chmod 755 run_expt.sh`
 - `./run_expt.sh`

Questions?

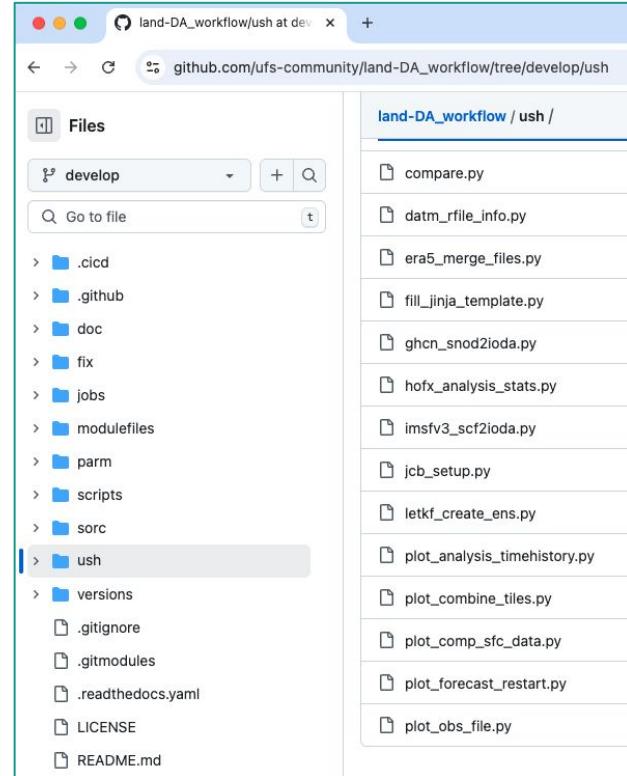
Downloading cadre3 Plots

- Open a new terminal window.
- Type **bash** to ensure a bash shell.
- Add your private key (e.g., **ssh-add ~/.ssh/id_ed25519_student1**).
- For each directory of plots, run:
 - ```
rsync -v --rsh "ssh student#@137.75.93.46 ssh"
ubuntu@controller:/home/ubuntu/exp_case/cadre3_atml/com_dir/
landda.20221222/plot/* plots/cadre3/20221222
```
- In the command, replace:
  - **student#** with your actual student number
- Only one cycle has plots

# Questions?

# Post-Processing: cadre1 case

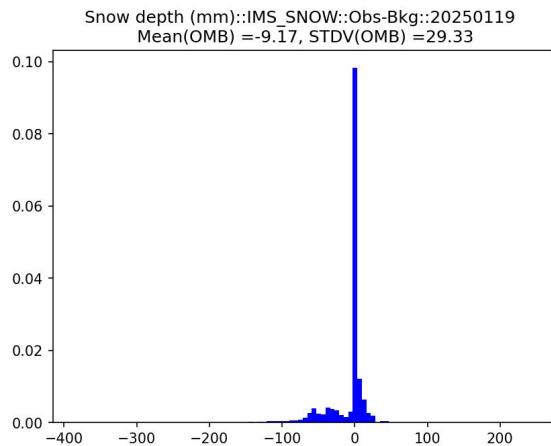
- The `plot_stats` task plots output from the experiment, including:
  - Scatter plots and histograms ([`hofx\_analysis\_stats.py`](#))
  - Restart output files ([`plot\_forecast\_restart.py`](#))
  - Time history of analysis output  
([`plot\_analysis\_timehistory.py`](#))
  - Comparison of `sfc_data` files by analysis task  
([`plot\_comp\_sfc\_data.py`](#))
  - Plot observation data files ([`plot\_obs\_file.py`](#))



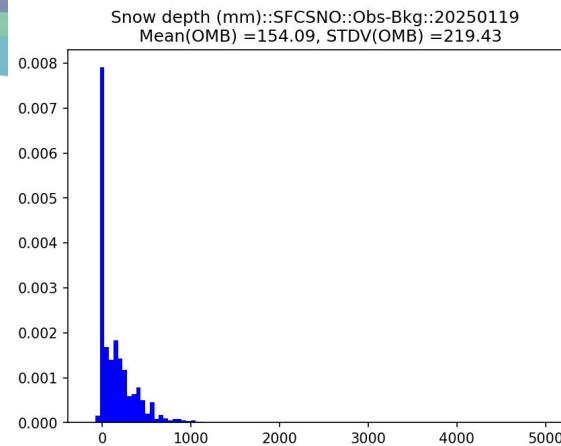
# Histograms

- Histograms show Observation Minus Background (OMB) from JEDI output
  - OMB values on the x-axis
  - Frequency density values on the y-axis
  - Title lists real value of OMB mean and standard deviation
- OMB values are skewed:
  - Left for IMS data
  - Right for SFCSNO data
- Indicates a bias/issue in the data

1/19

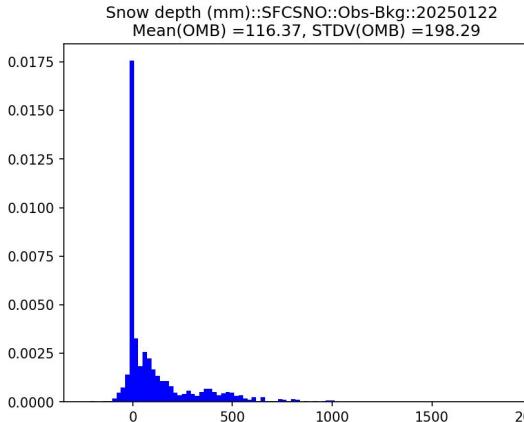
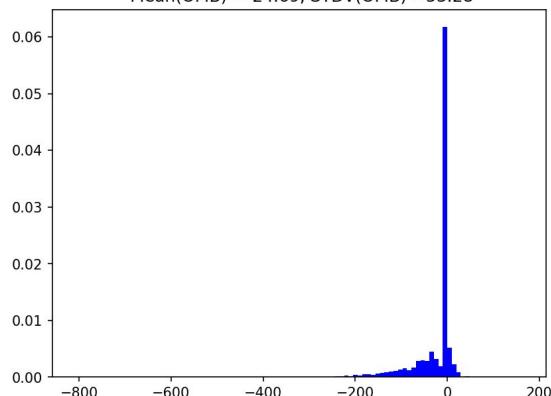


IMS



SFCSNO

1/22

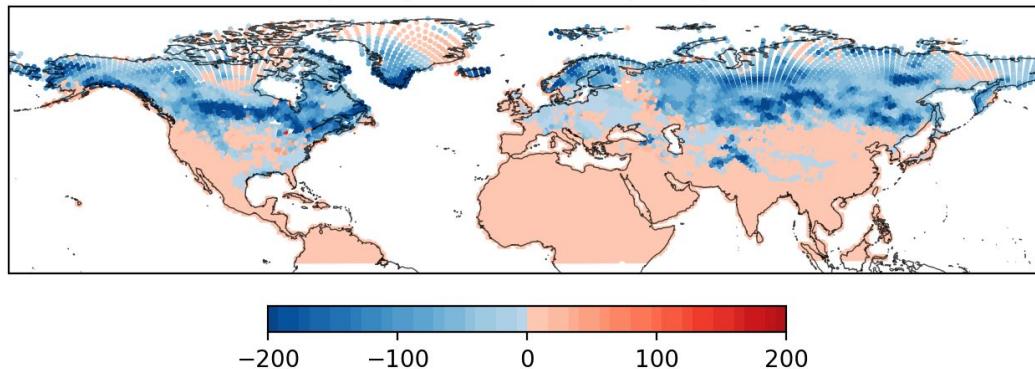


# Scatterplots

- Scatter plots show Observation Minus Background (OMB) from JEDI output
  - Blue points: Observed values are less than the background values
  - Red points: Observed values are greater than the background values.
  - Title indicates mean and standard deviation of absolute value of OMB.
- Bias:
  - **IMS:** Preponderance of blue
  - **SFCNSNO:** Preponderance of red
- Both shifting more blue over time

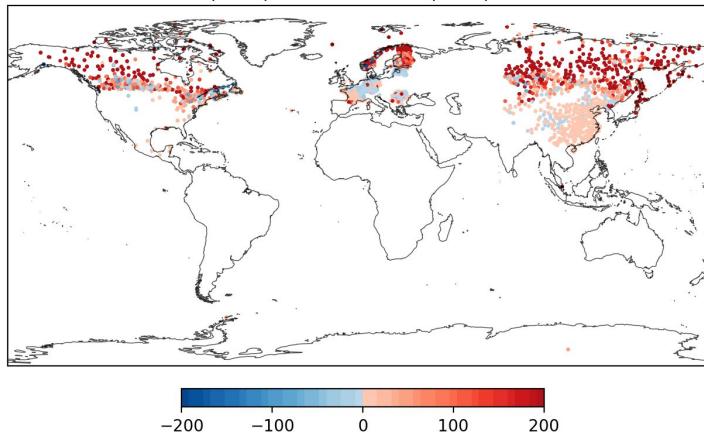
Snow depth (mm)::IMS\_SNOW::Obs-Bkg::20250122

Mean |OMB| =26.45, STDV |OMB| =52.43



Snow depth (mm)::SFCSNO::Obs-Bkg::20250122

Mean |OMB| =124.63, STDV |OMB| =193.21

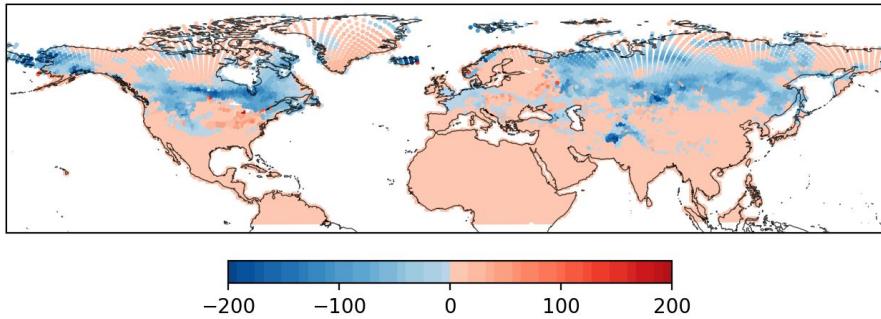


IMS observed snow depth is less than the background; the model therefore seems to be overforecasting snow depth.

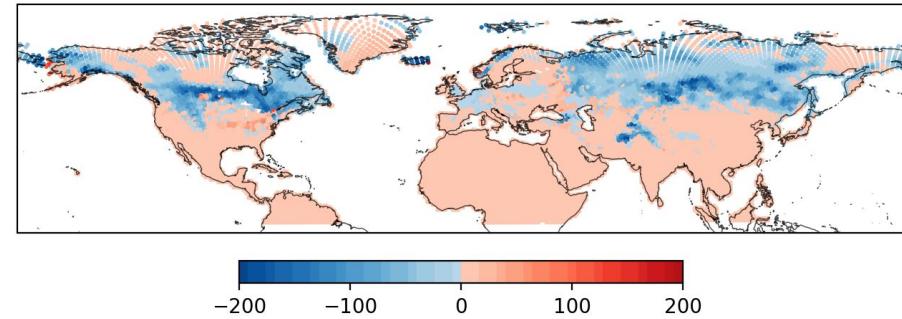
SFCSNO observed snow depth is greater than the background; the model seems to be underforecasting snow depth.

# Analysis Increment Over Time: IMS

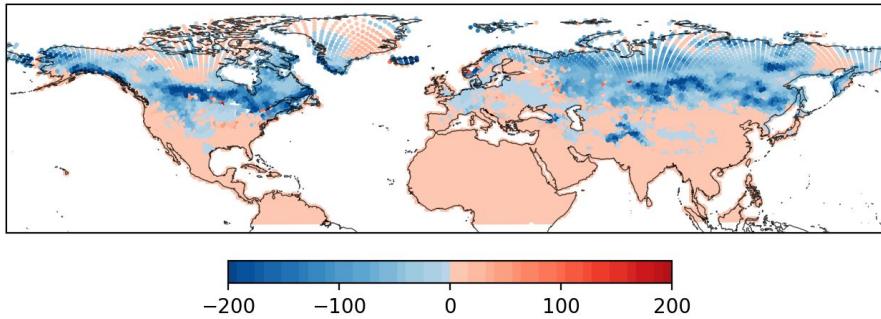
Snow depth (mm)::IMS\_SNOW::Obs-Bkg::20250119  
Mean |OMB| =13.62, STDV |OMB| =27.55



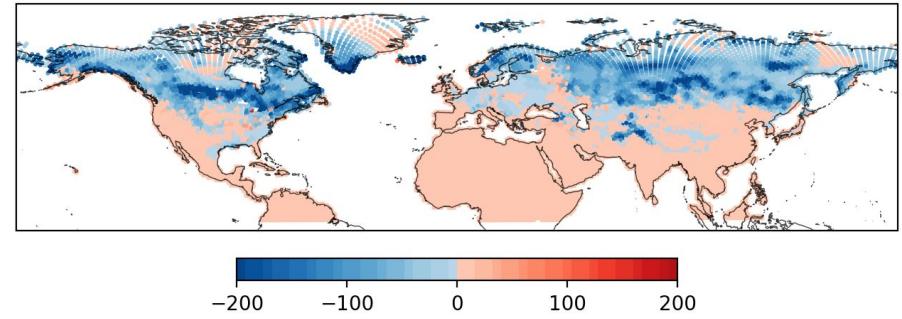
Snow depth (mm)::IMS\_SNOW::Obs-Bkg::20250120  
Mean |OMB| =16.22, STDV |OMB| =32.17



Snow depth (mm)::IMS\_SNOW::Obs-Bkg::20250121  
Mean |OMB| =21.29, STDV |OMB| =42.57

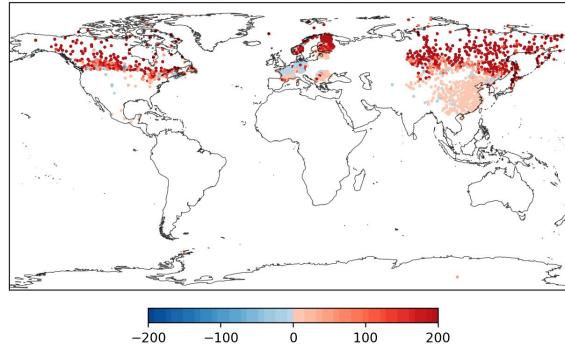


Snow depth (mm)::IMS\_SNOW::Obs-Bkg::20250122  
Mean |OMB| =26.45, STDV |OMB| =52.43

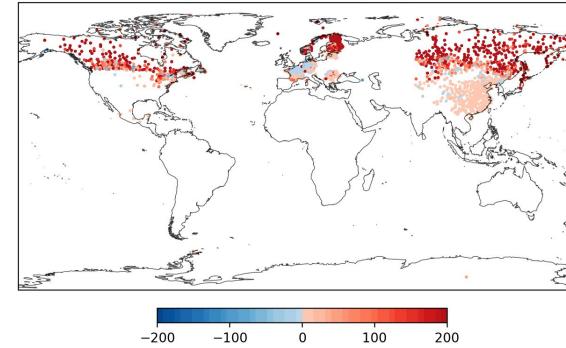


# Analysis Increment Over Time: SFCSNO

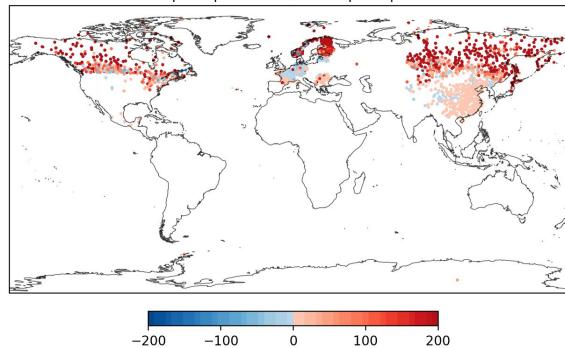
Snow depth (mm)::SFCSNO::Obs-Bkg::20250119  
Mean |OMB| =156.23, STDV |OMB| =217.91



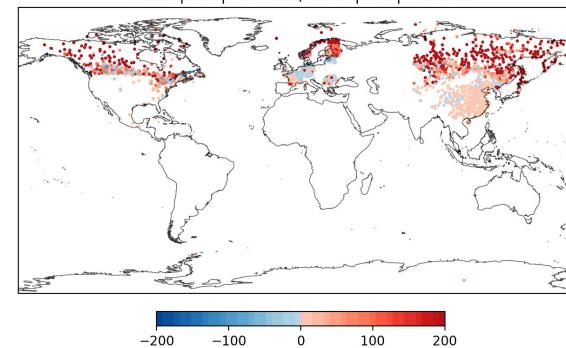
Snow depth (mm)::SFCSNO::Obs-Bkg::20250120  
Mean |OMB| =148.31, STDV |OMB| =212.5



Snow depth (mm)::SFCSNO::Obs-Bkg::20250121  
Mean |OMB| =139.17, STDV |OMB| =195.17



Snow depth (mm)::SFCSNO::Obs-Bkg::20250122  
Mean |OMB| =124.63, STDV |OMB| =193.21



# Time-History Plots

- Time history data: `com_dir/landda.{date}/hofx/{time_history_data}.txt`

```
epic 1652462 Jun 2 16:36 diag.ims_snow_2025012200.nc
epic 988066 Jun 2 16:36 diag.sfcsno_2025012200.nc
epic 148 Jun 2 16:44 hofx_omb_timehis_abs_ims_snow.txt
epic 159 Jun 2 16:44 hofx_omb_timehis_abs_sfcsno.txt
epic 165 Jun 2 16:44 hofx_omb_timehis_ims_snow.txt
epic 174 Jun 2 16:44 hofx_omb_timehis_sfcsno.txt
```

- Date – mean – STD

```
2025-01-19-00 -9.17 29.33 241.9 -384.58
2025-01-20-00 -12.59 33.76 199.67 -392.38
2025-01-21-00 -18.63 43.8 235.18 -586.18
2025-01-22-00 -24.69 53.28 166.54 -809.05
```

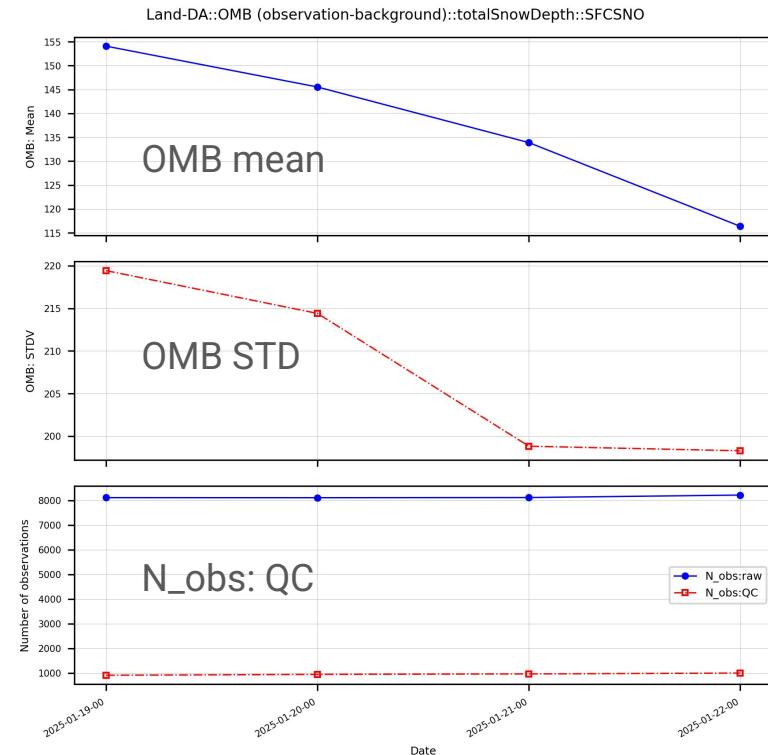
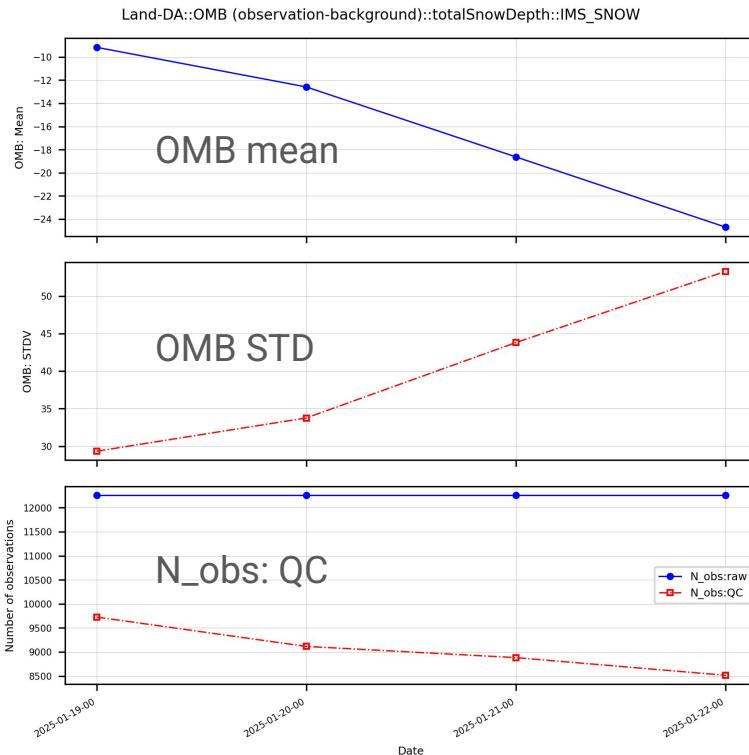
- Analysis task log file: `log_dir/analysis_{date}.log`
  - Contains info on quality control (QC) for observations

# Time-History Plots

- Example: `log_dir/analysis_20250122.log`

```
OOPS_STATS Variational end - Runtime: 80.86 sec, Local Memory: 2.37 Gb
ims_snow: save database to diags/diag.ims_snow_2025012200.nc (io pool size: 4)
sfcsno: save database to diags/diag.sfcsno_2025012200.nc (io pool size: 4)
QC ims_snow snowCoverFraction: 12254 rejected as processed but not assimilated.
QC ims_snow snowCoverFraction: 0 passed out of 12254 observations.
QC ims_snow totalSnowDepth: 5 missing values.
QC ims_snow totalSnowDepth: 3347 out of bounds.
QC ims_snow totalSnowDepth: 319 black-listed.
QC ims_snow totalSnowDepth: 66 rejected by first-guess check.
QC ims_snow totalSnowDepth: 8517 passed out of 12254 observations.
QC sfcsno totalSnowDepth: 17 out of bounds.
QC sfcsno totalSnowDepth: 71 out of domain of use.
QC sfcsno totalSnowDepth: 16 black-listed.
QC sfcsno totalSnowDepth: 6329 removed by thinning.
QC sfcsno totalSnowDepth: 214 rejected by first-guess check.
QC sfcsno totalSnowDepth: 575 rejected by difference check.
QC sfcsno totalSnowDepth: 998 passed out of 8220 observations.
QC sfcsno totalSnowDepth: 214 assigned the background_check diagnostic flag.
QC sfcsno totalSnowDepth: 0 assigned the buddy_check diagnostic flag.
QC sfcsno totalSnowDepth: 575 assigned the elevation_bkgdiff diagnostic flag.
QC sfcsno totalSnowDepth: 1 assigned the invalid_elevation diagnostic flag.
QC sfcsno totalSnowDepth: 17 assigned the invalid_snowdepth diagnostic flag.
QC sfcsno totalSnowDepth: 27 assigned the land_check diagnostic flag.
QC sfcsno totalSnowDepth: 10 assigned the landice_check diagnostic flag.
QC sfcsno totalSnowDepth: 43 assigned the missing_elevation diagnostic flag.
QC sfcsno totalSnowDepth: 0 assigned the missing_snowdepth diagnostic flag.
QC sfcsno totalSnowDepth: 6 assigned the rejectlist diagnostic flag.
QC sfcsno totalSnowDepth: 6329 assigned the temporal_thinning diagnostic flag.
```

# cadre1: IMS + SFCSNO



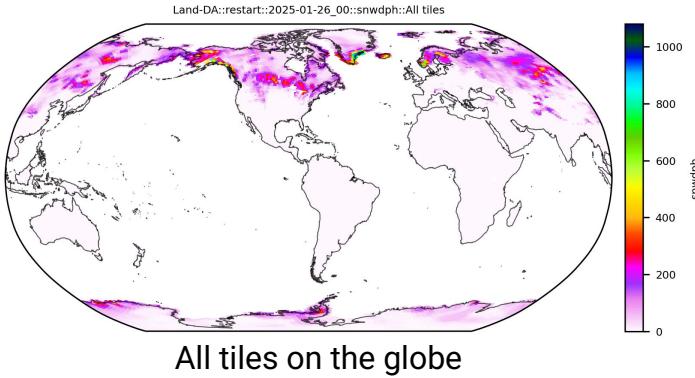
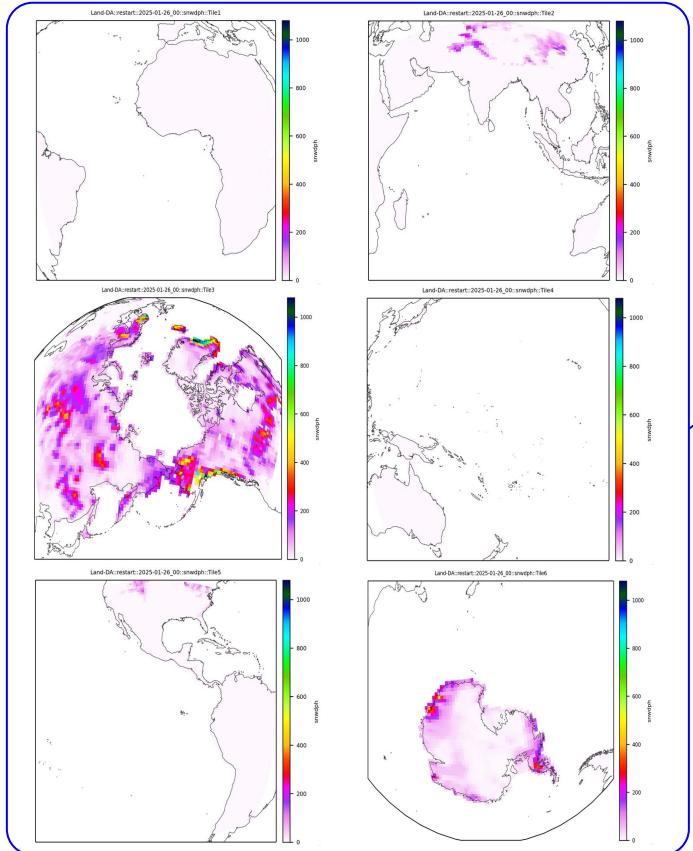
# Post-processing: 'plot\_stats'

- Result file of JEDI: 'diag.{obs\_type}{cycle\_date}.nc'

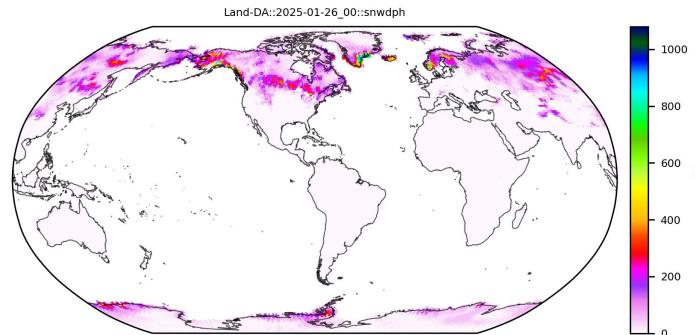
| Group name      | Description                                                      | LETKF                 | 3D-Var                |
|-----------------|------------------------------------------------------------------|-----------------------|-----------------------|
| EffectiveError0 | UFO's computed effective ObsError value                          | <input type="radio"/> | <input type="radio"/> |
| EffectiveQC0    | UFO's final QC value given by 'QCflags.h'                        | <input type="radio"/> | <input type="radio"/> |
| MetaData        | Ancillary data such as stationElevation, longitude, and latitude | <input type="radio"/> | <input type="radio"/> |
| ObsBias0        | Bias correction of observation data                              | <input type="radio"/> | <input type="radio"/> |
| ObsError        | Observation errors from upstream data sources                    | <input type="radio"/> | <input type="radio"/> |
| ObsValue        | Directly measured observation values                             | <input type="radio"/> | <input type="radio"/> |
| hofx0           | End product of the forward operator; H(x)                        |                       | <input type="radio"/> |
| hofx0_1         | H(x) of Ensemble member 1                                        | <input type="radio"/> |                       |
| hofx0_2         | H(x) of Ensemble member 2                                        | <input type="radio"/> |                       |
| hofx_y_mean_xb0 | Mean of H(x)                                                     | <input type="radio"/> |                       |
| ombg            | <b>Observation - H(Background)</b>                               | <input type="radio"/> | <input type="radio"/> |

# Post-processing: Plots of Restart Files

- Task 'plot\_stats': three types of 'snow depth' plots for restart files (result of UFS weather model)



All tiles on the globe



Interpolated onto the coarse grid (400x200)