JCSDA NOAA CDP

Observation Evaluation and Impact Assessment

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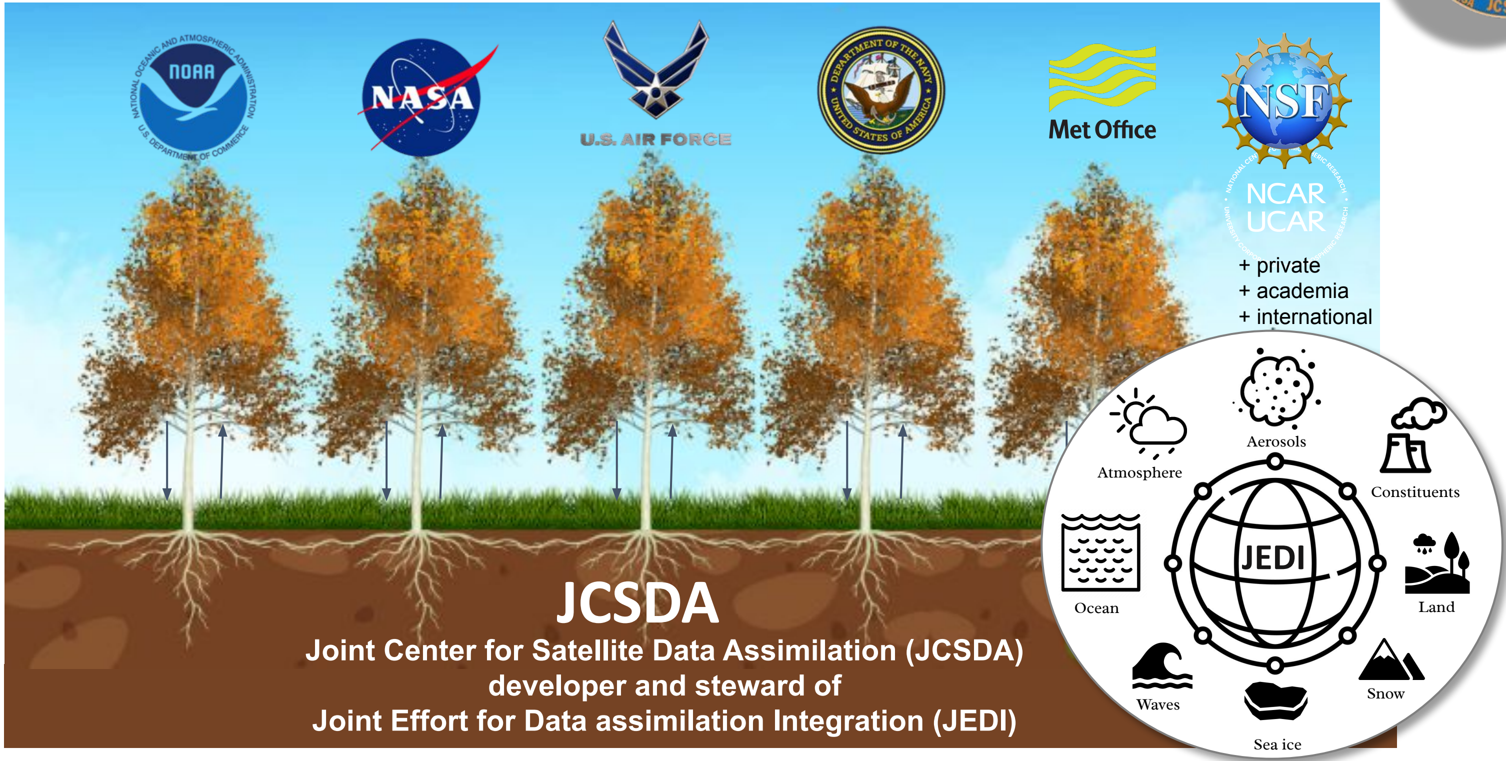
JCSDA – The Force Multiplier Bringing Agencies Together

The "Quiet Revolution"
Agencies converging on next-generation, open-source, unified data assimilation



Consortium of *Jointness* – More science, less redundant work

Overview

The NOAA NESDIS Commercial Data Program (CDP) has enabled access to ***Spire GNSS-R* ocean surface winds (OSW)** data. These are converted to JCSDA JEDI IODA format.

JCSDA will use **JEDI Skylab** testbed with the JEDI MPAS and JEDI FV3 configurations for end-to-end experimentation.

JCSDA has specifically designed for GNSS-R OSW, JEDI configuration files (YAML format).

These provide a user-friendly way to customize quality control procedures and observation error assignments, independently of the JEDI source code.

Code baseline and code updates will be **publicly accessible** via the open source version of JEDI on JCSDA GitHub repository.

JEDI Github - jedi-bundle
JEDI Documentation - readthedocs

Recent news (20Mar2025): Weather Company adopts JEDI to improve everyday forecasts

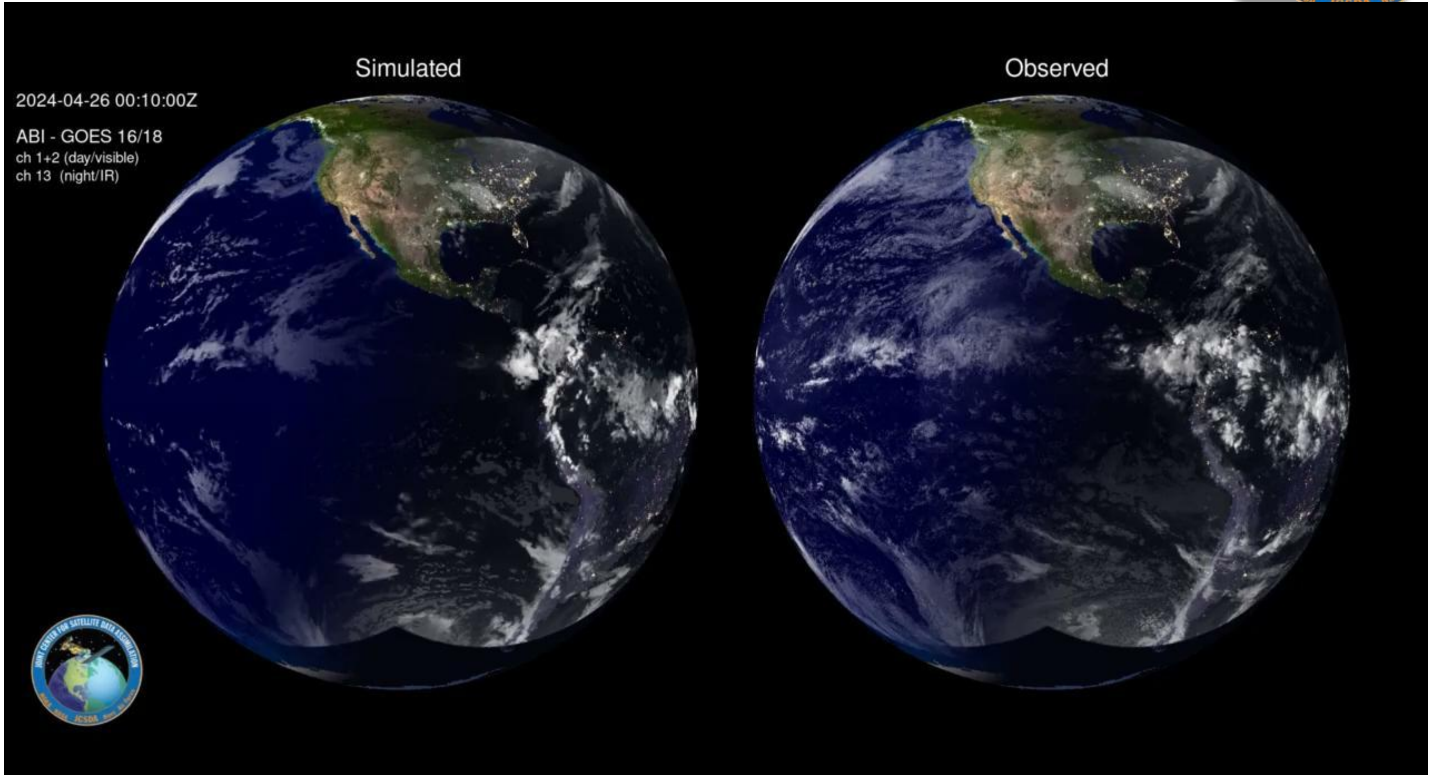
Observation Impact Assessment

Data Assimilation is used to evaluate impact of observations on environmental model(s).

JEDI:
Configurable model-agnostic observation operators

right figure:
JEDI trial at high-spatial and temporal resolution

demonstration of:
GOES visible & IR, and ground-based RADAR



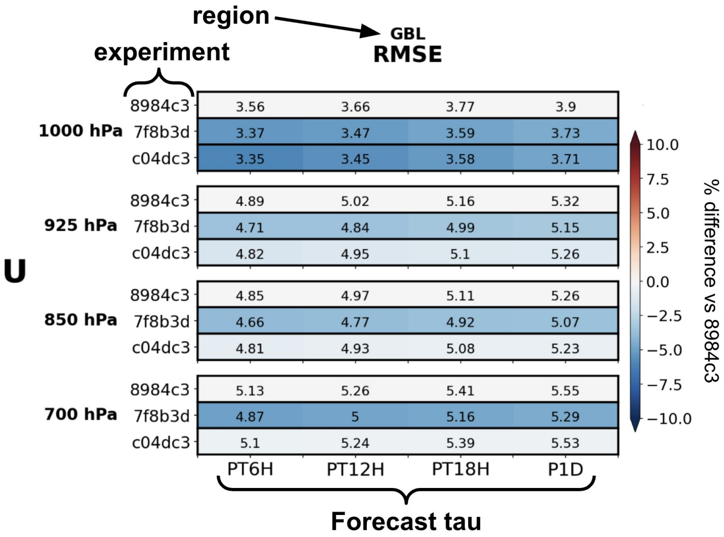
SkyLab Experimental Testbed Environment

JCSDA JEDI SkyLab is an **end-to-end workflow** for a cycling data assimilation system.

SkyLab brings **multiple model interfaces** that are abstracted allowing for **generic observation operators** and solving methods.

JCSDA Skylab diagnostics include the ability to use an **external analysis as verification**. We routinely use the ECMWF ERA-5.

Shown to the right is a verification of a Skylab run with JEDI-MPAS, demonstrating GNSS-R OSW data.



SkyLab Experimental Testbed Steps

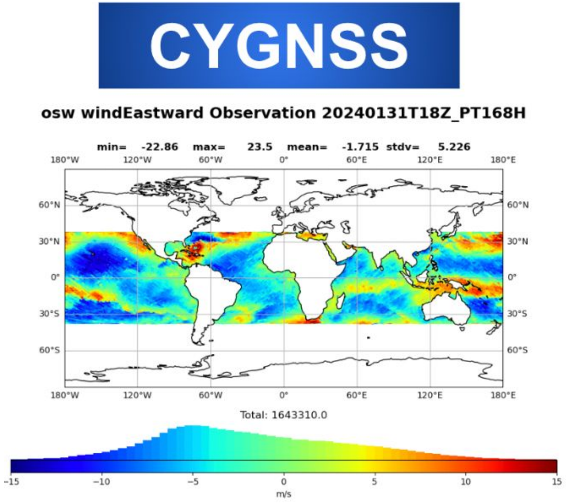
1. Observation data ingest & processing

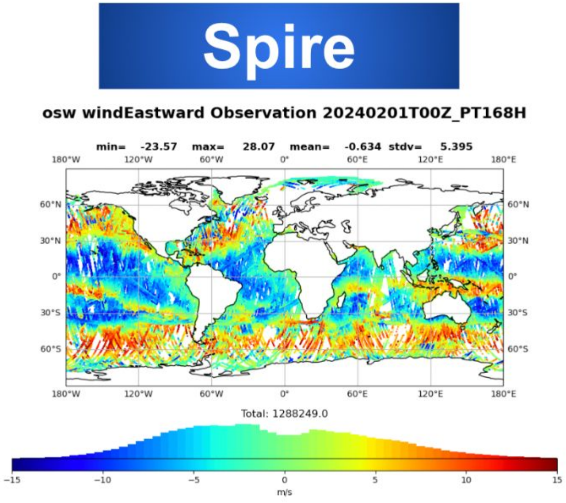
2. Compute Observed minus Simulated (OmB) departures

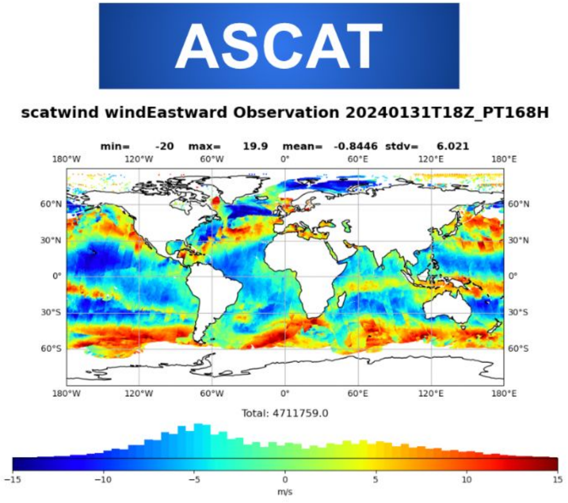
3. Compute DA increment + forecast + observation impact

SkyLab Step 1: Observation Ingest and Processing

JCSDA examined the NOAA purchased Spire OSW dataset (about 6 mos), it was ingested alongside the NASA CyGNSS data and other ocean winds such as the EUMETSAT ASCAT scatterometer.





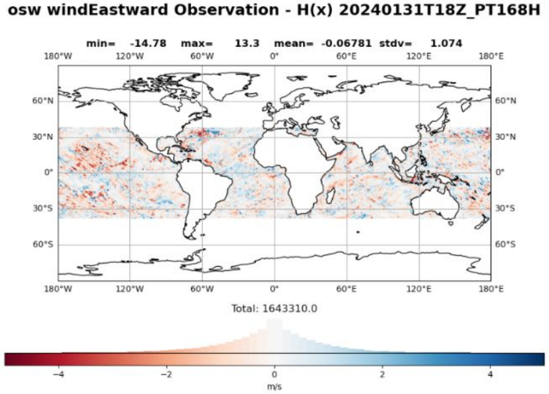


Data ingest enabled from NOAA, python-based decoder established for JEDI IODA file creation from GNSS-R OSW from CyGNSS, Spire and Muon. Decoders in-place for other NOAA operational observations.

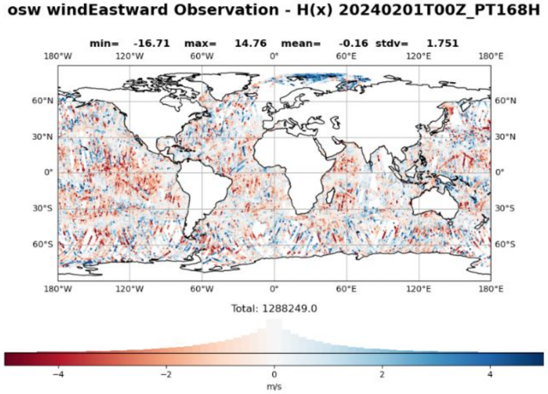
SkyLab Step 2: Compute Observed minus Simulated

JCSDA created a new JEDI observation function allowing the use of the wind direction from the model to separate the OSW speed into zonal and meridional components. This provided an end-to-end ability to perform the forward operator and adjoints (assuming identity) necessary for variational data assimilation.

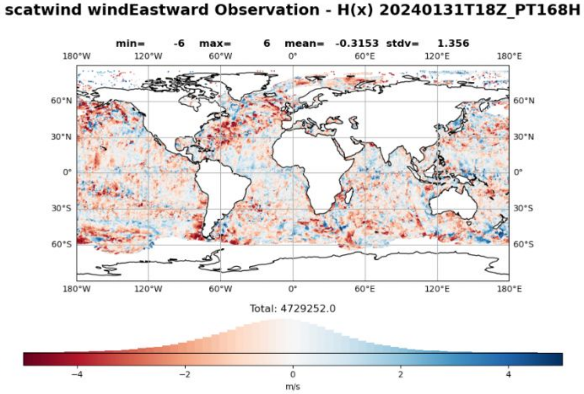
CYGNSS



Spire



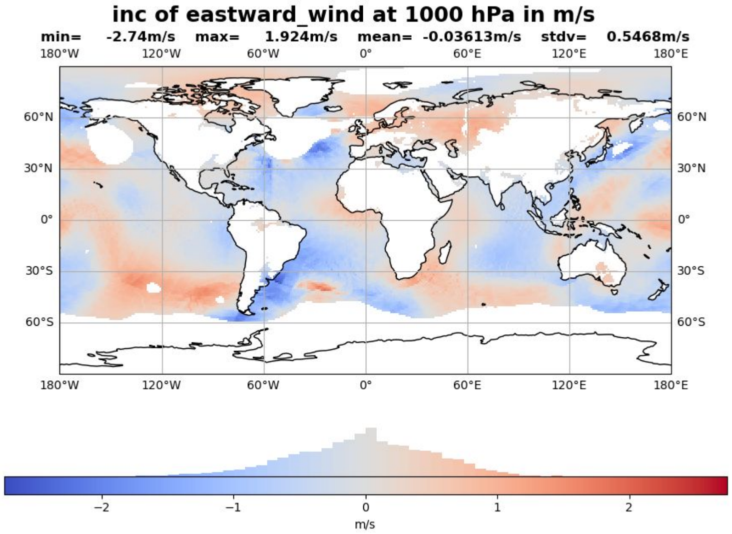
ASCAT

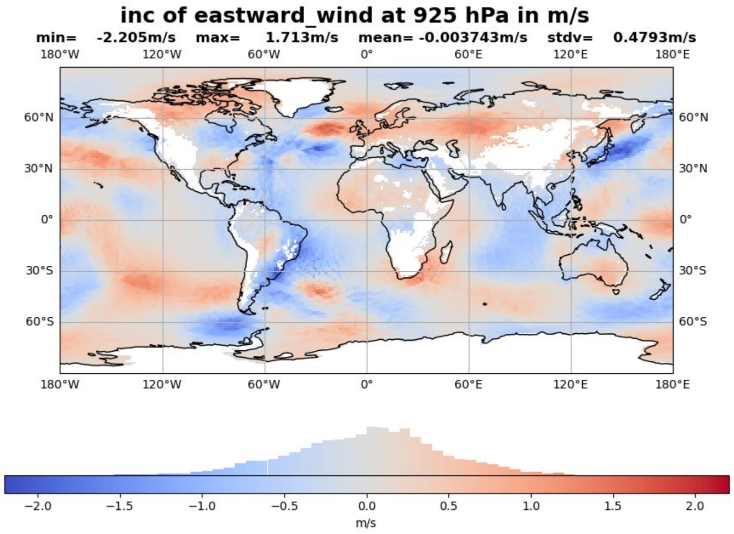


A combination of passive runs and non-cycling DA (re-initialized for each time) were run over the entire dataset. These helped to establish quality control methods and observation error determination.

SkyLab Step 3: Compute DA increment

In-depth examination of the analysis response, and increments (inc) were undertaken to ensure system performance. The final impact system was a 30 km global 3DEnVar using the JEDI-MPAS interface.

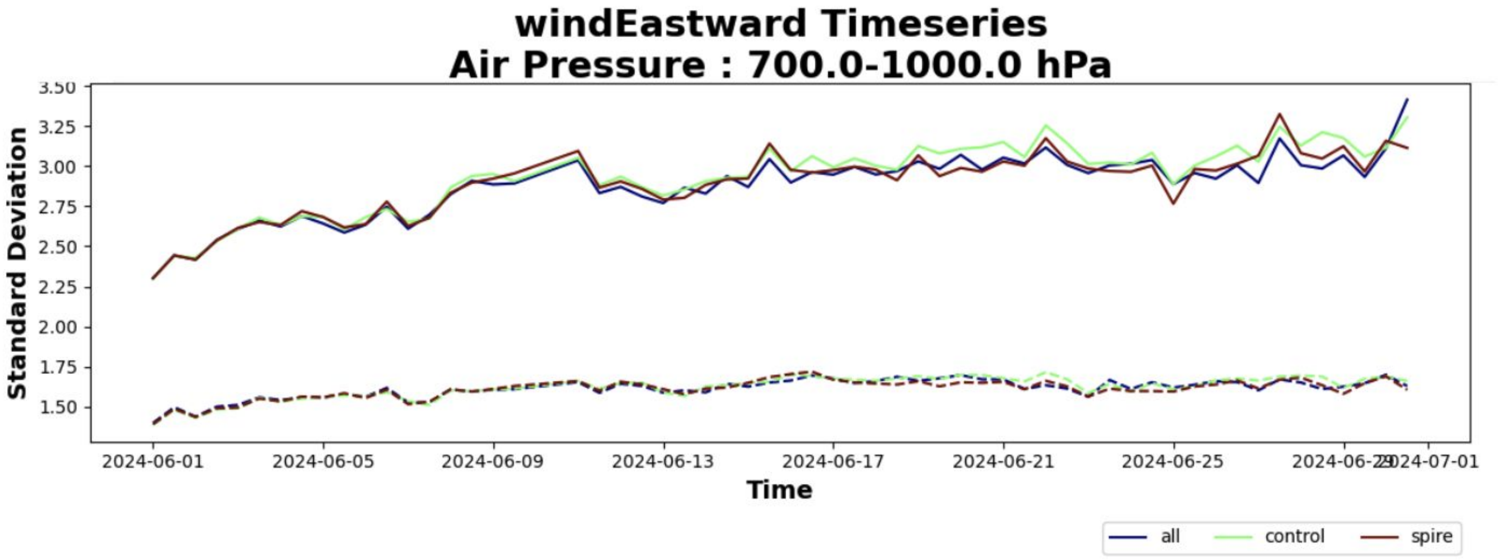




A single snapshot of increments from Feb 16, 2024, at 00 UTC for the zonal or eastward wind.

SkyLab Step 3: Observation Impact

The change in fit of other observations in JEDI Skylab can help determine value to system.



The fit of radiosonde by the cycling system as it evolves shows differing response to the additional data. Trials for June 2024 shown above for: control (no GNSS-R OSW), Spire, and Spire+CyGNSS+Muon.

SkyLab Step 3: Forecast Impact

Forecast impacts to 24-hours for JEDI-MPAS system using ERA-5 as verification baseline.

T (RMSE; colour scale: % difference vs 8984c3, −10.0 to 10.0)

		GBL PT6H	GBL PT12H	GBL PT18H	GBL P1D	TRP PT6H	TRP PT12H	TRP PT18H	TRP P1D
1000 hPa	8984c3	2.02	2.04	2.07	2.1	1.12	1.13	1.14	1.15
	7f8b3d	1.96	1.98	2.01	2.04	1.1	1.11	1.12	1.13
	c04dc3	1.95	1.98	2.01	2.04	1.12	1.13	1.13	1.15
925 hPa	8984c3	3.04	3.1	3.15	3.21	1.19	1.2	1.22	1.24
	7f8b3d	2.94	2.99	3.05	3.11	1.18	1.2	1.22	1.24
	c04dc3	3	3.05	3.1	3.17	1.19	1.21	1.23	1.25
850 hPa	8984c3	2.75	2.8	2.86	2.92	1.35	1.36	1.38	1.4
	7f8b3d	2.65	2.7	2.75	2.81	1.33	1.35	1.36	1.38
	c04dc3	2.73	2.78	2.84	2.9	1.34	1.36	1.37	1.39
700 hPa	8984c3	2.49	2.53	2.58	2.64	1.44	1.46	1.47	1.5
	7f8b3d	2.39	2.44	2.48	2.53	1.42	1.43	1.45	1.47
	c04dc3	2.46	2.5	2.55	2.6	1.43	1.44	1.46	1.48

U (RMSE; colour scale: % difference vs 8984c3, −10.0 to 10.0)

		GBL PT6H	GBL PT12H	GBL PT18H	GBL P1D	TRP PT6H	TRP PT12H	TRP PT18H	TRP P1D
1000 hPa	8984c3	3.56	3.66	3.77	3.9	1.85	1.9	1.94	1.99
	7f8b3d	3.37	3.47	3.59	3.73	1.8	1.85	1.9	1.95
	c04dc3	3.35	3.45	3.58	3.71	1.83	1.89	1.94	1.99
925 hPa	8984c3	4.89	5.02	5.16	5.32	2.3	2.39	2.46	2.51
	7f8b3d	4.71	4.84	4.99	5.15	2.26	2.34	2.41	2.47
	c04dc3	4.82	4.95	5.1	5.26	2.29	2.38	2.45	2.51
850 hPa	8984c3	4.85	4.97	5.11	5.26	2.68	2.8	2.9	2.98
	7f8b3d	4.66	4.77	4.92	5.07	2.63	2.75	2.84	2.93
	c04dc3	4.81	4.93	5.08	5.23	2.68	2.8	2.9	2.99
700 hPa	8984c3	5.13	5.26	5.41	5.55	3.13	3.2	3.28	3.36
	7f8b3d	4.87	5	5.16	5.29	3.09	3.16	3.24	3.32
	c04dc3	5.1	5.24	5.39	5.53	3.12	3.2	3.28	3.37

Q (RMSE; colour scale: % difference vs 8984c3, −10.0 to 10.0)

		GBL PT6H	GBL PT12H	GBL PT18H	GBL P1D	TRP PT6H	TRP PT12H	TRP PT18H	TRP P1D
1000 hPa	8984c3	0.0011	0.00112	0.00113	0.00116	0.00119	0.00119	0.0012	0.00122
	7f8b3d	0.00108	0.00109	0.00111	0.00113	0.00119	0.00119	0.0012	0.00121
	c04dc3	0.00109	0.00111	0.00113	0.00115	0.00119	0.0012	0.00121	0.00122
925 hPa	8984c3	0.00139	0.00141	0.00144	0.00147	0.00161	0.00162	0.00164	0.00166
	7f8b3d	0.00138	0.0014	0.00143	0.00146	0.0016	0.00162	0.00164	0.00166
	c04dc3	0.00138	0.0014	0.00143	0.00146	0.0016	0.00162	0.00164	0.00166
850 hPa	8984c3	0.00173	0.00176	0.00179	0.00183	0.0023	0.00233	0.00235	0.00239
	7f8b3d	0.00171	0.00173	0.00177	0.0018	0.00229	0.00231	0.00233	0.00237
	c04dc3	0.00171	0.00174	0.00177	0.00181	0.0023	0.00232	0.00235	0.00238
700 hPa	8984c3	0.00139	0.00141	0.00144	0.00147	0.00198	0.002	0.00202	0.00204
	7f8b3d	0.00136	0.00138	0.00141	0.00145	0.00195	0.00197	0.00199	0.00202
	c04dc3	0.00137	0.00139	0.00142	0.00145	0.00195	0.00197	0.002	0.00202

V (RMSE; colour scale: % difference vs 8984c3, −10.0 to 10.0)

		GBL PT6H	GBL PT12H	GBL PT18H	GBL P1D	TRP PT6H	TRP PT12H	TRP PT18H	TRP P1D
1000 hPa	8984c3	3.62	3.74	3.86	3.99	1.95	1.98	2.02	2.06
	7f8b3d	3.46	3.59	3.71	3.85	1.91	1.94	1.99	2.02
	c04dc3	3.53	3.66	3.8	3.94	1.94	1.97	2.01	2.05
925 hPa	8984c3	4.81	4.96	5.11	5.27	2.2	2.25	2.3	2.34
	7f8b3d	4.67	4.82	4.97	5.13	2.17	2.22	2.27	2.31
	c04dc3	4.8	4.95	5.11	5.28	2.19	2.25	2.29	2.34
850 hPa	8984c3	4.72	4.84	4.98	5.13	2.28	2.35	2.41	2.47
	7f8b3d	4.55	4.67	4.81	4.96	2.25	2.31	2.37	2.42
	c04dc3	4.69	4.82	4.96	5.12	2.28	2.34	2.4	2.46
700 hPa	8984c3	5.06	5.22	5.37	5.52	2.68	2.73	2.78	2.84
	7f8b3d	4.8	4.95	5.1	5.24	2.65	2.7	2.75	2.8
	c04dc3	5.02	5.17	5.33	5.47	2.67	2.72	2.77	2.83

Forecast impact for June 2025 is shown for three trials with RMSE difference again ERA-5 shown in cell. Control (8984c3), Spire OSW (7f8b3d) and NOAA L2 Spire (c04dc3).

Summary and Conclusions

JCSDA is developing JEDI, a broad **cross-functional configurable assimilation system** for partner applications.

JEDI SkyLab is used by JCSDA to **demonstrate observation behavior and establish pathways** for current and emerging data to be assimilation (e.g. error estimation methodology and quality control approaches).

JCSDA has created ingest pathways for GNSS-R Ocean Surface Wind (OSW) from multiple sources the NASA CyGNSS, Spire and Muon Space.

JCSDA has exercised the JEDI-FV3 and JEDI-MPAS interfaces with SkyLab, to develop configurations that **display positive impact from GNSS-R OSW** on environmental forecasts.

The highly customizable JEDI system as demonstrated with Skylab is being used for a wide-range of applications, and provides a **user-friendly way to customize** quality control procedures and observation error assignments, independently of the JEDI source code.

Questions

SkyLab Step 3: System Configuration

This YAML is the JCSDA JEDI Skylab working configuration for Spire OSW assimilation.

ufo — vi osw_spire.yaml — 110×72


```yaml
obs space:
  name: osw_spire
  _source: testing
  obsdatain:
    engine:
      type: H5File
      missing file action: error
  obsdataout:
    engine:
      type: H5File
      allow overwrite: true
  io pool:
    write multiple files: true
  simulated variables: [windEastward, windNorthward]
  observed variables: [windSpeed]
  derived variables: [windEastward, windNorthward]
obs operator:
  name: VertInterp
  vertical coordinate: height_above_mean_sea_level
  observation vertical coordinate: height
  interpolation method: linear
obs filters:
- filter: Variable Assignment
  assignments:
  - name: DerivedObsValue/windDirection
    type: float
    function:
      name: ObsFunction/WindUVfromObsSpdHofxDir
      options:
        hofx_group: HofX
# Assign obsError
- filter: Perform Action
  filter variables:
  - name: windEastward
  - name: windNorthward
  action:
    name: assign error
    error parameter: 3.5
# PreQC
- filter: PreQC
  filter variables:
  - name: windSpeed
  maxvalue: 0
  action:
    name: reject
# Apply quality control filters
- filter: Background Check
  filter variables:
  - name: windEastward
  - name: windNorthward
  threshold: 3.0
  action:
    name: reject
  defer to post: true
# Reject eastward wind where northward wind was rejected and vice versa.
- filter: RejectList
  filter variables:
  - name: windNorthward
  where:
  - variable: QCflagsData/windEastward
    minvalue: 1
  defer to post: true
- filter: RejectList
  filter variables:
  - name: windEastward
  where:
  - variable: QCflagsData/windNorthward
    minvalue: 1
  defer to post: true
~
~
```


2,1 All