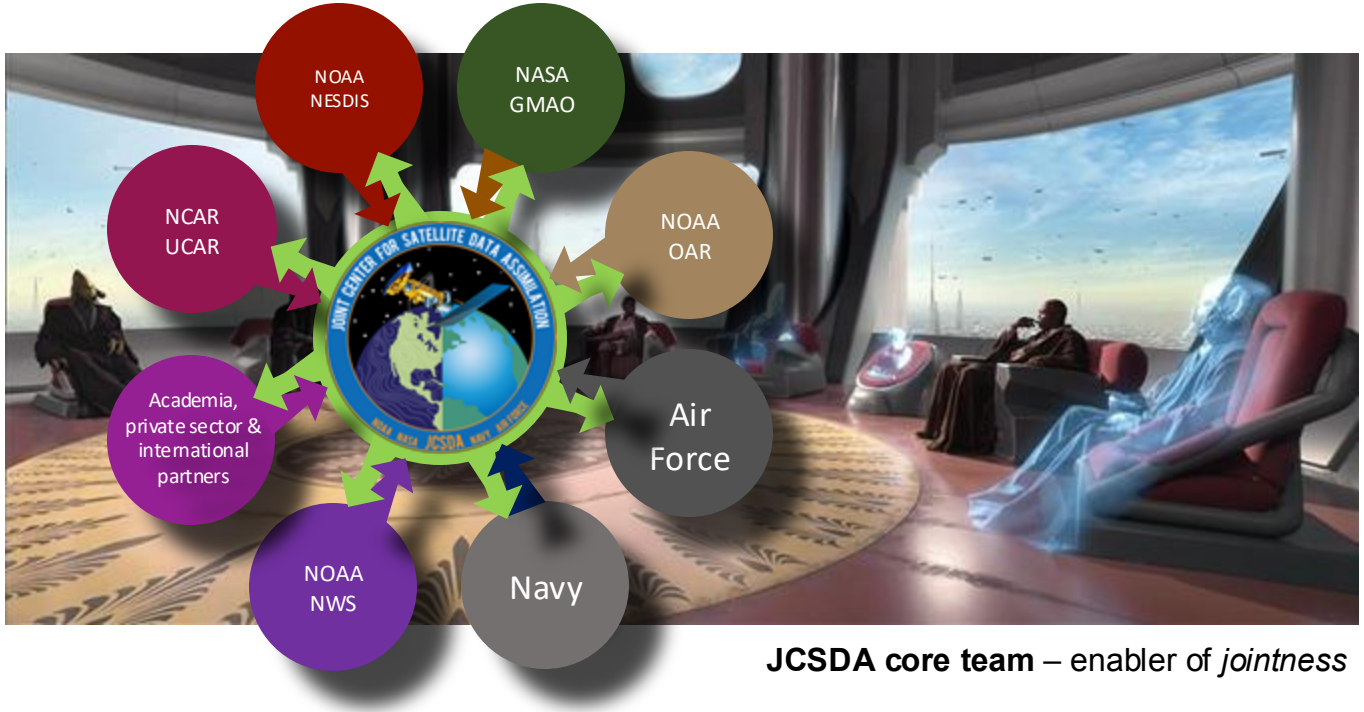
The Joint Effort for Data assimilation Integration (JEDI)

Yannick Trémolet
Joint Center for Satellite Data Assimilation (JCSDA)

ISDA, Kobe, Japan
21-25 October 2024

Joint Center for Satellite Data Assimilation (JCSDA)

Interagency partnership to *accelerate* and *improve* the quantitative use of research and operational satellite data in weather, ocean, climate and environmental analysis and prediction models.



JCSDA core team – enabler of *jointness*

JEDI - Objectives

The Joint Effort for Data assimilation Integration (JEDI) is a collaborative development, lead and coordinated by the JCSDA core team, and involving all the partners.

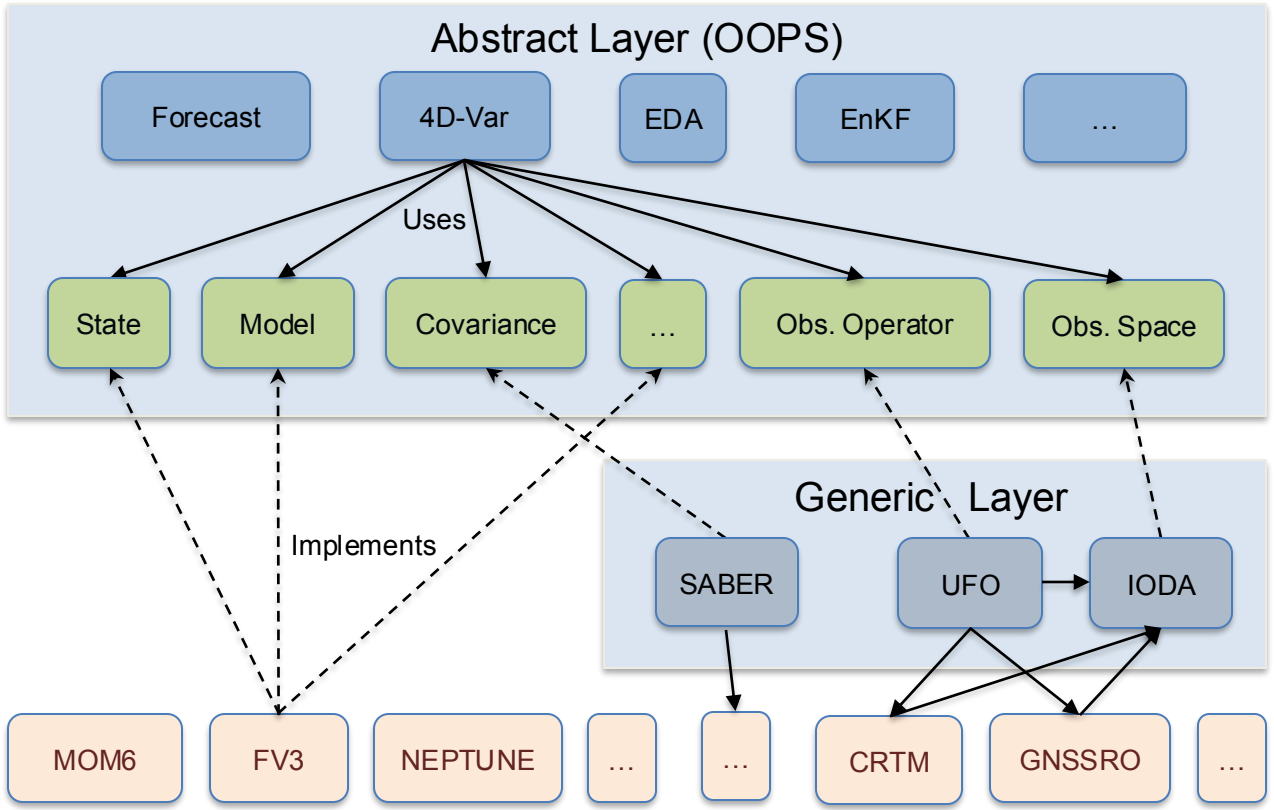
Develop a unified data assimilation system:

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

Design driven by scientific vision for data assimilation

- Not trying to salvage old codes at any cost

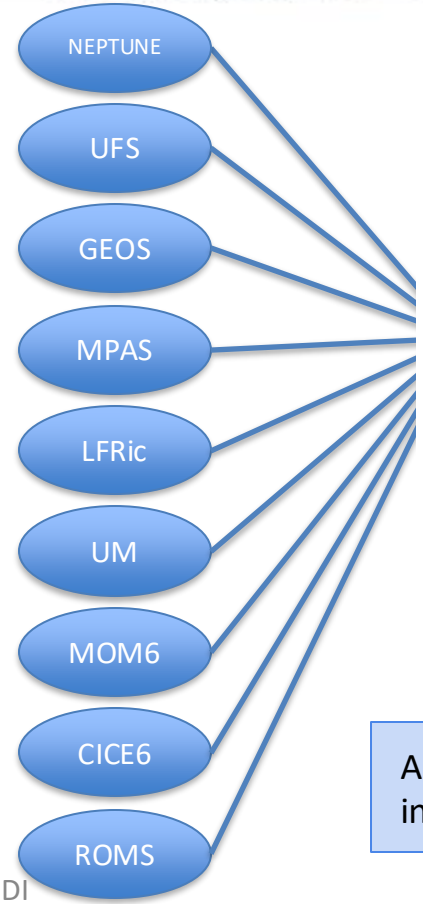
JEDI - Abstraction and Genericity

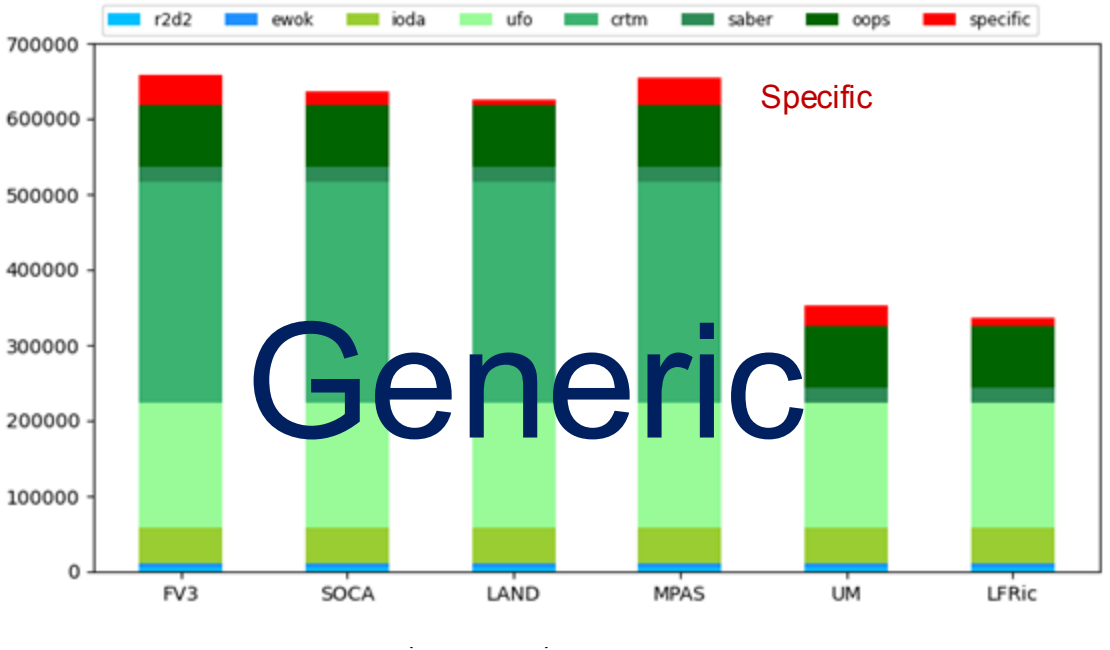


Abstract, model-agnostic DA system

OOPS is complemented by generic (shared) components.

JEDI - Structure





tive

ciently
adiances

ervation

D of the

Abstract interfaces and generic codes eliminate duplication of code and effort, including across Earth-system components.

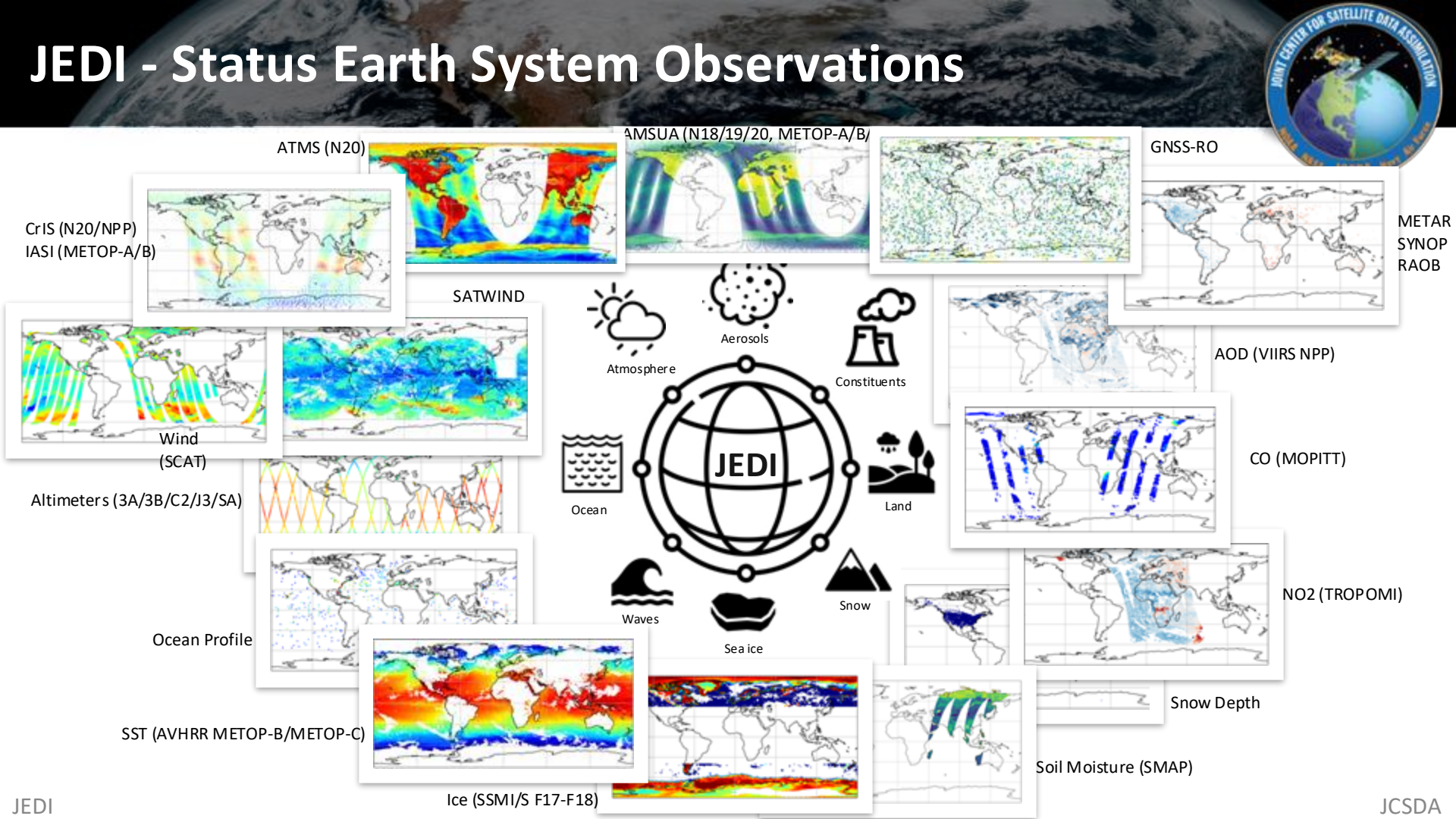
JEDI and AI Models

AI models are becoming more and more common, several JCSDA partners are preparing their own AI models.

JEDI is generic w.r.t. models, including AI-based (and space weather).

We are defining a strategy for interfacing JEDI with AI-based models, through a more streamlined interface.

JEDI - Status Earth System Observations



JEDI - Generic Observation Operators

Marine

Microwave	Satellite
Aquarius L-band	SAC-D
AMSR-2	GCOM-W
GMI	GPM
SAR L-band	SMAP
MIRAS	SMOS
SSMI	F14-F15
SSMI/S	F16-F17-F18
WINDSAT	Coriolis

Infrared	Satellite
ABI	GOES-16-17
AHI	Himawari-8
AVHRR	NOAA-18-19 METOP-A-C
VIIRS	SNPP NOAA-20

Insitu platform	
Moorings	TAO, PIRATA, RAMA
Profiling floats	Argo
gliders	
saildrone	
Ships	
drifters	

HF Radar	
US East-West coast	
Gulf of Mexico	

Altimeter	Satellite
SIRAL	Cryosat-2
RA Ku band	ERS-1
RA Ku band	ERS-2
ASAR	Envisat
RA	Geosat
GLAS	ICESat
ATLAS	ICESat-2
Poseidon-2	Jason-1
Poseidon-3	Jason-2
Poseidon-3B	Jason-3
ALtiKa	Saral
SRAL	Sentinel-3A
Topex/Poseidon	Topex/Poseidon

Land

Observation
Conventional
Snow depth (SYNOP)
Snow depth (GHCN)
Snow water equivalent (from OWP - AWIPSSBN, MADIS)
Snow Retrievals
IMS snow cover fraction
AFWA snow depth
Soil Moisture Retrievals
SMAP
SMOS
ASCAT

Atmosphere

Infrared	Satellite
ABI (IR)	GOES-16, GOES-17
AHI (IR)	Himawari-8
AIRS (IR)	AQUA
AVHRR-3	NOAA-18-19, Metop-A-C
CrIS	SNPP NOAA-20
GIIRS (IR)	FY-4A
GOES Imager (IR)	GOES-11-15
GOES Sounder	GOES-11-15
HIRS-3	NOAA-15-17
HIRS-4	NOAA-15-19, MetOp-A-B
IASI	MetOp-A-C
IASI-NG	MetOp-SG-A
SEVIRI (IR)	MeteoSat-8-11
VIIRS (IR)	SNPP NOAA-20
ABI (IR)	GOES-T

Microwave	Satellite
AMSR-2	GCOM-W
AMSR-E	AQUA
AMSU-A	NOAA 15-19, Aqua, MetOp A-C
AMSU-B	NOAA-15-17
ATMS	SNPP, NOAA-20
ATMS-NG	N/A
GEMS-1	OMS-1
GEMS-2	OMS-2
GMI	GPM
MHS	NOAA-18-19, MetOp-A-C
SAPHIR	Megha-Tropiques
SSMI	DMSP-F14-F15
SSMI/S	DMSP-F16-F17-F19
TROPICS	Pathfinder
AMR-C	Sentinel-6A

Visible	Satellite
ABI	GOES-16-18
AHI	Himawari-8
GIIRS	FY-4A
GOES Imager	GOES-11-15
SEVIRI	MeteoSat-8-11
AIRS	AQUA
VIIRS	JPSS-1, JPSS-2

Ozone	Satellite
GOME	MetOp-A-C
MLS	AURA
OMI	AURA
OMPS-nadir (OMPSNP)	Suomi NPP (SNPP)
OMPS-limb (OMPSTC8)	Suomi NPP (SNPP)
SBUV	NOAA-16-19

GNSS Radio Occultation	Satellite
GRAS	MetOp-A-C
IGOR	TerraSAR-X
IGOR	TanDEM-X
IGOR	COSMIC-1
AOPOD	KOMPSAT-5
TGRS	COSMIC-2
ROHPP	PAZ
GPSRO	Sentinel-6A

Conventional Data	
Aircraft	ACARs, MDCRS, AIREPs
Sonde	+dropsonde
Surface (land)	SYNOP, METAR
Surface (marine)	Buoy, ship, CMAN
VAD-wind	Not used in GDAS
RASS-temp	Not used in GDAS

Satwind/ Scatt. wind	Satellite
Feature tracked wind	
ABI	GOES-16, GOES-17
AHI	Himawari-8
MODIS	AQUA, TERRA
AVHRR	NOAA 15-19, Metop A-C
VIIRS	SNPP, NOAA-20
SEVIRI	MeteoSat 8-11
GOES Img/Snd	GOES-11-15
INSAT	INSAT, KALPANA

Scatterometer	
ASCAT	Metop-Series
OSCAT WindSat, ..	various

GNSS Ground	
IGS	GNSS

completed | in progress | upcoming

Progressing toward initial goal to match skills of operational systems

JCSDA

JEDI - Observations and Generic QC

Generic Quality Control: No Coding!

```yaml
ObsTypes:
- ObsOperator:
    name: GnssroBndGSI
  ObsFilters:
  - Filter: Domain Check
    where:
    - variable:  impact_height
      minvalue: 0
      maxvalue: 50000
  - Filter: Background Check
    variables: [bending_angle]
    threshold: 3.0
```

```yaml
ObsFilters:
- Filter: Domain Check
  variable: ascending_flag
  is_not_in: 1
  where:
  - variable: occulting_sat_id
    is_in: 825
```


Land mask

Reject ADT obs if SST<5°C

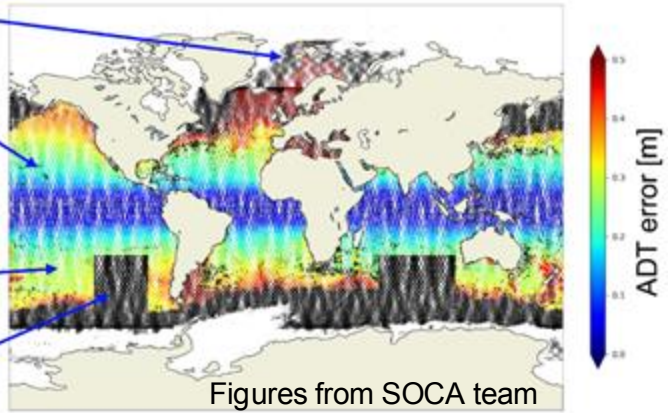
Reject ADT obs if |Obs-Bkg|<0.2 m

Reject ADT obs outside of [-2.0m, 2.0m]

Assign ADT obs error [m]

Reject ADT obs in specific region

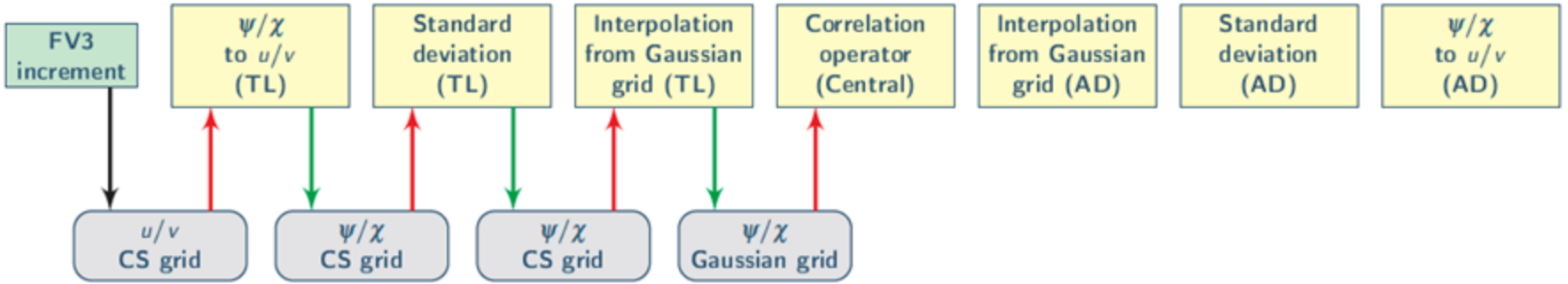
- Rejected observations



Figures from SOCA team

JEDI - Generic Background Error Covariances

System Agnostic Background Error Representation (SABER)



Background Error Covariances represented as a series of generic blocks:

- Change of Geometry (resolution, grid…)
- Change of variables (winds, temperature, balanced/unbalanced…)
- Central correlation operator (BUMP, Spectral…)

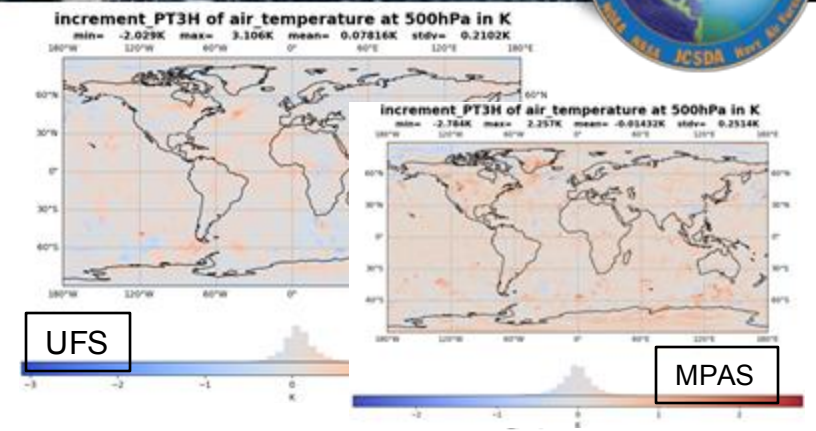
JEDI - Release SkyLab v7 (weather)

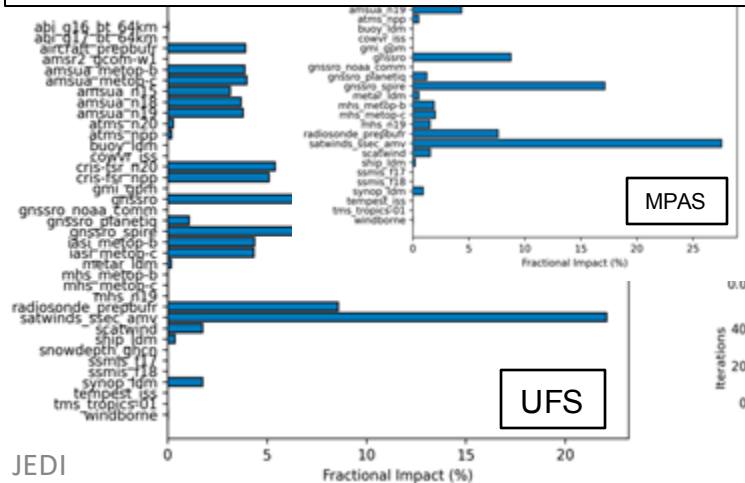
UFS:

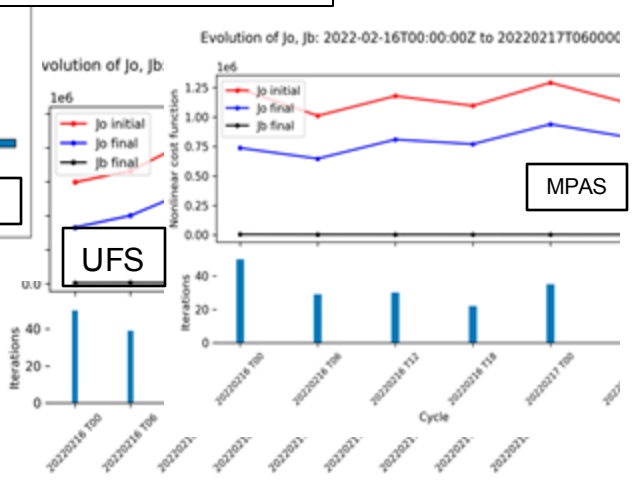
- Fully cycled c768
- High-res: 4D-En-Var with 1hr sub-window
- Ensemble: 80 members 3D-Var EDA, c384

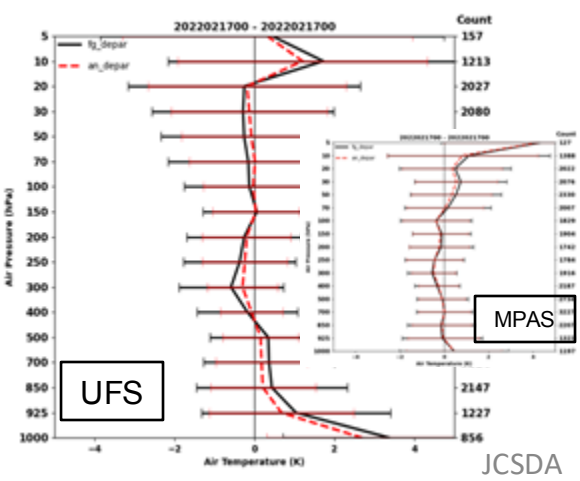
MPAS:

- Fully cycled variable mesh (15-3km)
- High-res: 4D-En-Var with 3hr sub-window
- Ensemble: 30 members 3D-Var EDA, 30km



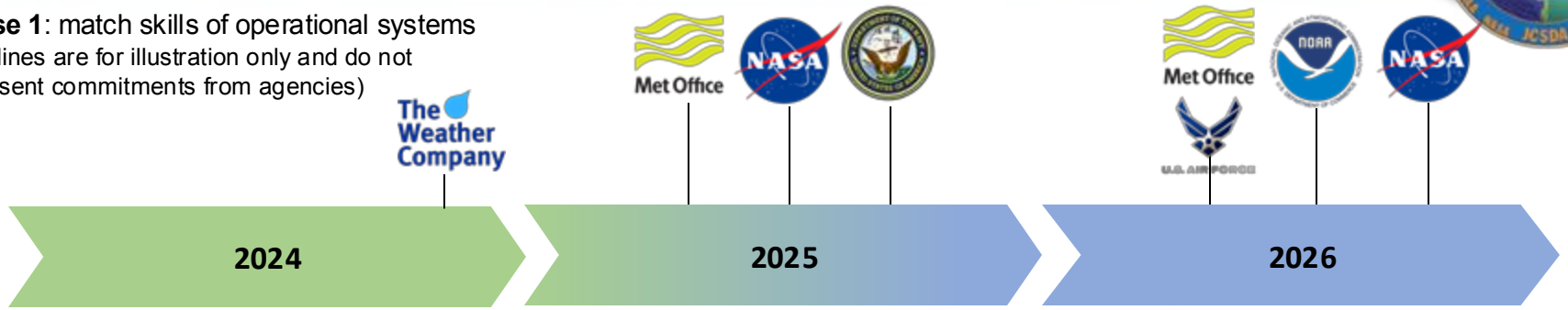




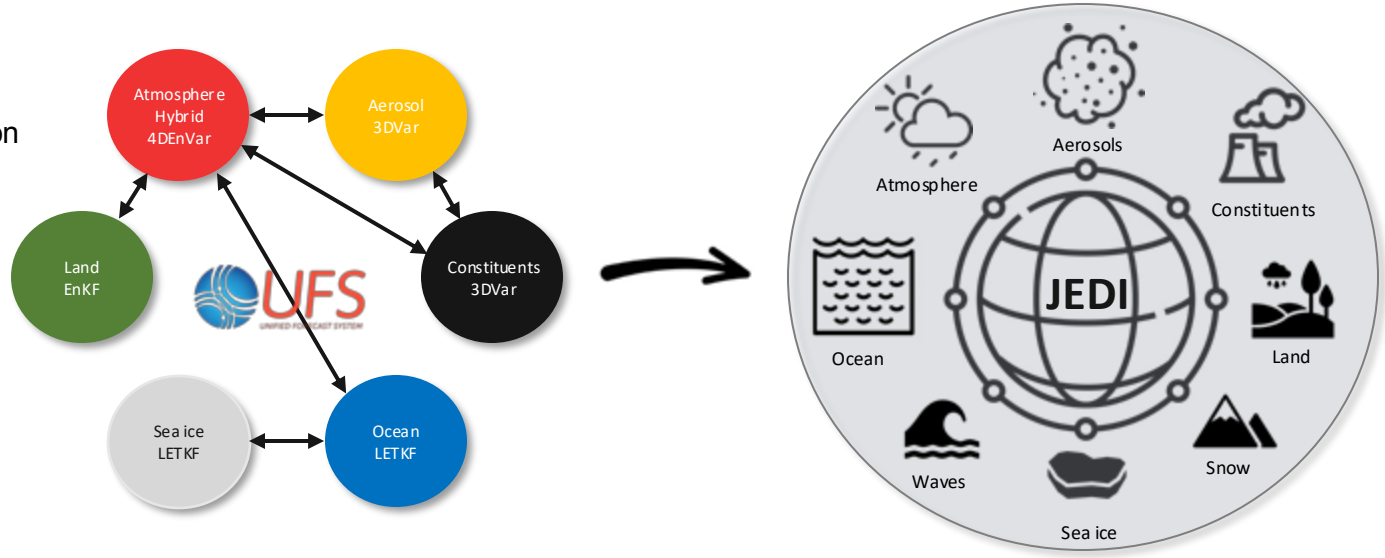


JEDI – Next Steps

Phase 1: match skills of operational systems
(timelines are for illustration only and do not represent commitments from agencies)



Phase 2: foster scientific innovation



JEDI – Next Steps

JEDI is moving towards coupled data assimilation in steps:

- All Earth system components in the same experiment (generic workflow, scripts, data handling) and in the same executable (generic code)
- Coupled H(x), coupled B matrices, coupled solver

No (a lot less) observation data left on the table:

- All-sky/all-surface satellite radiances
- Full spectrum resolution
- Full spatial resolution

Program	Cost (USD billions)	Radiance used in operational DA
GOES-R	11.4	0.02 %
JPSS	12.8	0.06 %

Algorithms:

- Hybrid TLM
- HPC (Cloud computing, GPUs)
- Continuous DA: always use latest observations available
- AI/ML (QC, VarBC, surrogate models…)

JCSDA

Get all the latest JCSDA news, developments, and operations updates on our social channels:

Joint Center for Satellite Data Assimilation

@JCSDA

@JCSDAofficial

and at jcsda.org/news

JEDI is a joint effort involving the JCSDA core team members and many contributors from the JCSDA partner agencies

Thank you to all who contributed

Questions?