Met Office AMV processing in JEDI: Next Generation Processing and Assimilation of Observations

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Introduction to NG-PAO

The Next-Generation Processing and Assimilation of Observations (NG-PAO) is a component of the Met Office's Next Generation Modelling Systems (NGMS) Programme.

The project will replace our current Observation Processing System (OPS) and Variational Assimilation System (VAR) used by our global and regional atmospheric data assimilation (DA).

JEDI-Based Observation Processing Application
Replicate OPS, our current observation processing for atmosphere and ocean DA

JEDI Application for Data Assimilation
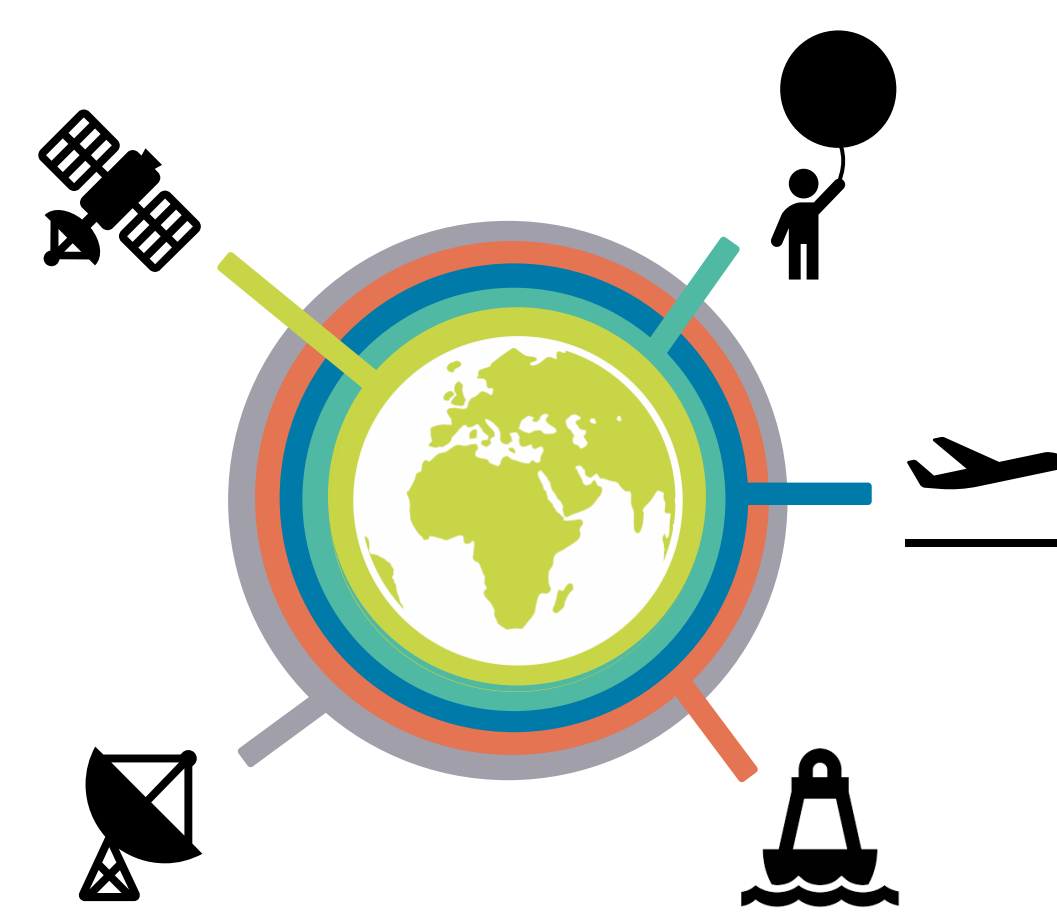Develop new science and code to redesign our DA capabilities

OPS carries out data selection, quality control, error assignments, bias correction, 1D-Var, thinning, and the application of the observation operator.

21 atmospheric observation types
- Satellite radiances
- Satellite winds and active sensors
- Conventional and radar data
- Level 2 products (cloud, aerosol optical depth)

6 marine observation types
- Sea surface temperature (SST)
- Sea ice
- Ocean sounding and colour
- Altimeter

AMV processing in JOPA

In order to port the AMV processing, several new filters have been implemented. The remaining processing is implemented via configuration files (yaml) and the use of existing filters. Component testing has demonstrated that the AMV processing is largely reproduced exactly in JOPA.

Observations
- Wind speed/direction, pressure, Quality Index (QI), MetaData

Model
- Interpolation of model fields to observation horizontal location and time

Prior filters
- Inversion correction
- Reject all data
- Accept sat-channel combinations
- Model humidity check
- Observed wind speed
- QI thresholds
- Zenith angle
- Spatial rejections
- Assign pressure errors

Pre filters
- Transform to u, v components
- Assign channel information
- Process QI

H(x) observation operator
- Vertical interpolation of background and its errors

Post filters
- Background wind speed
- AMV observation error scheme
- Spatial / temporal thinning
- Background check
- Write output for 4d-Var

VAR single cycle tests

- ✓ Final 4D-Var penalties are within 0.25%
- ✓ Mean O-A are the same
- ✓ RMS O-A are within 0.15%
- ✓ Observation counts differ by less than 0.1%

Figure: Wind analysis increments at model level 40 for a single DA cycle: OPS (top), JOPA (middle), and difference (bottom).
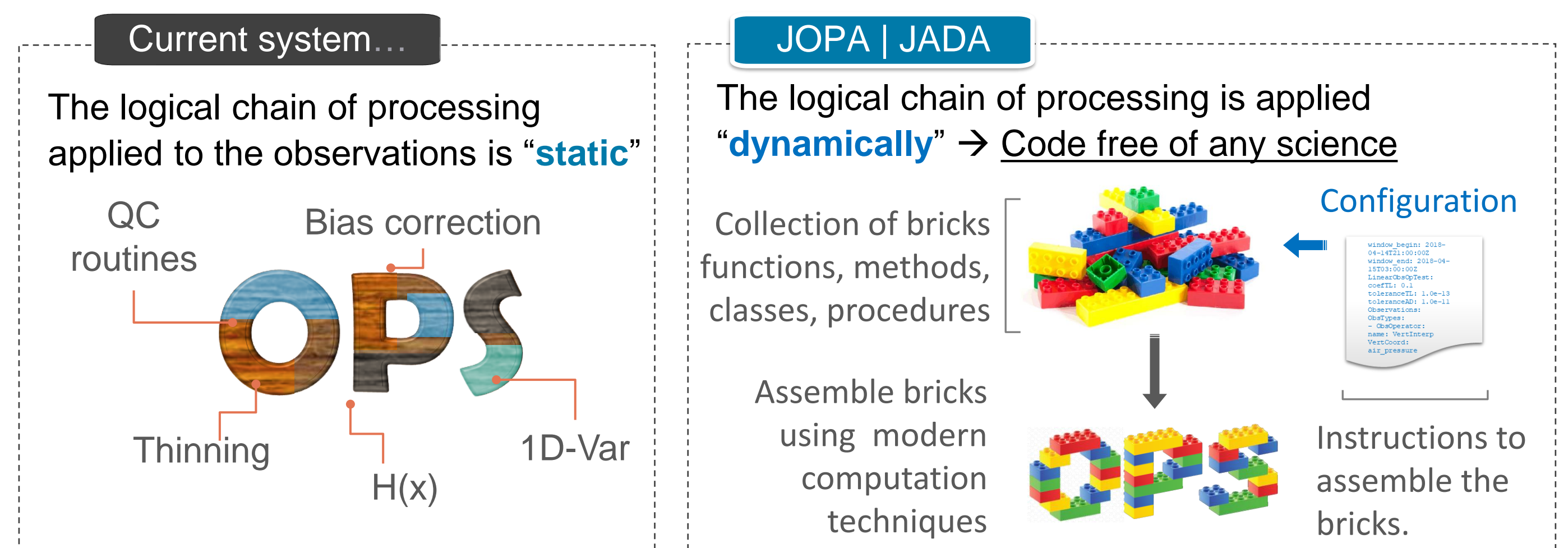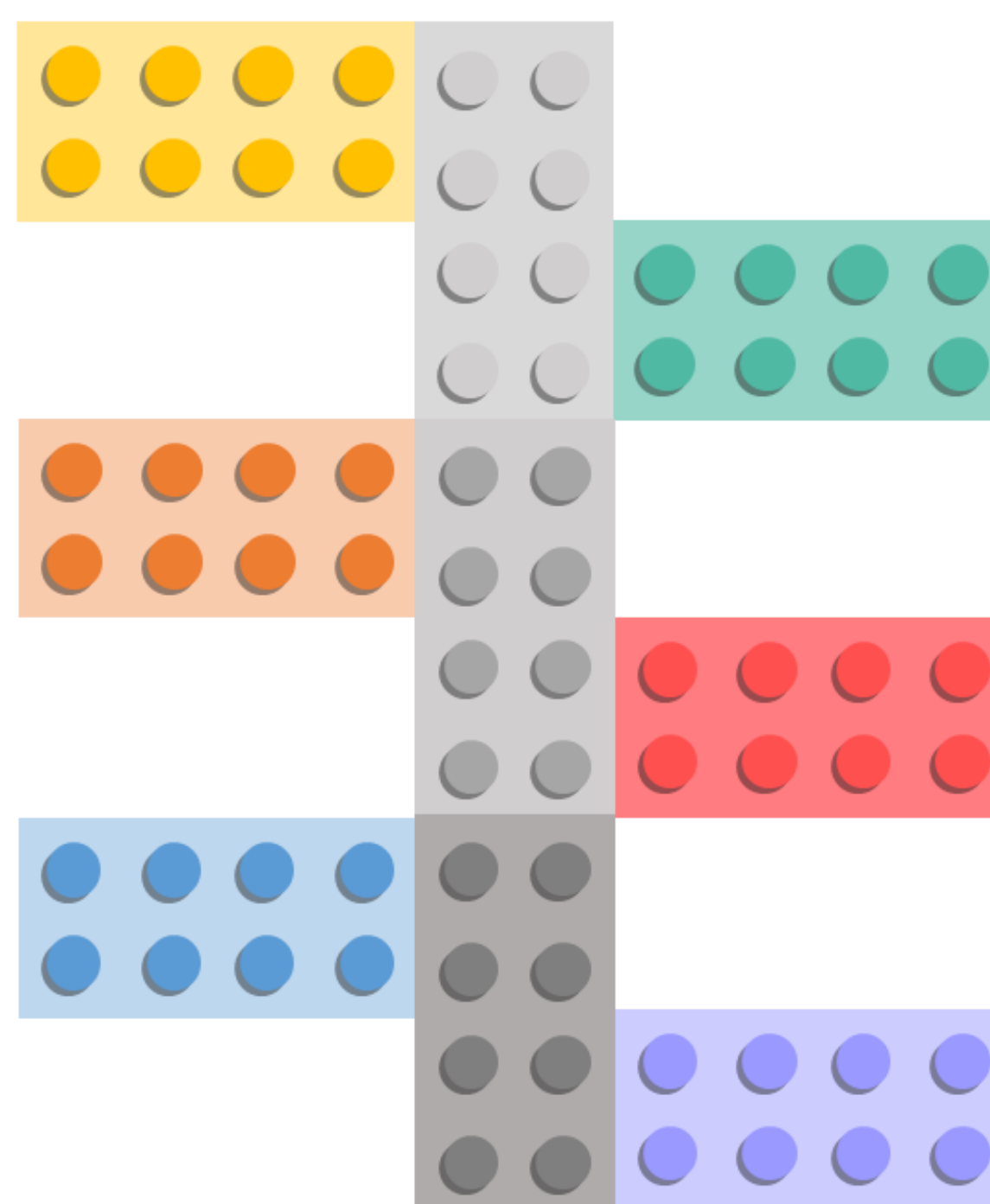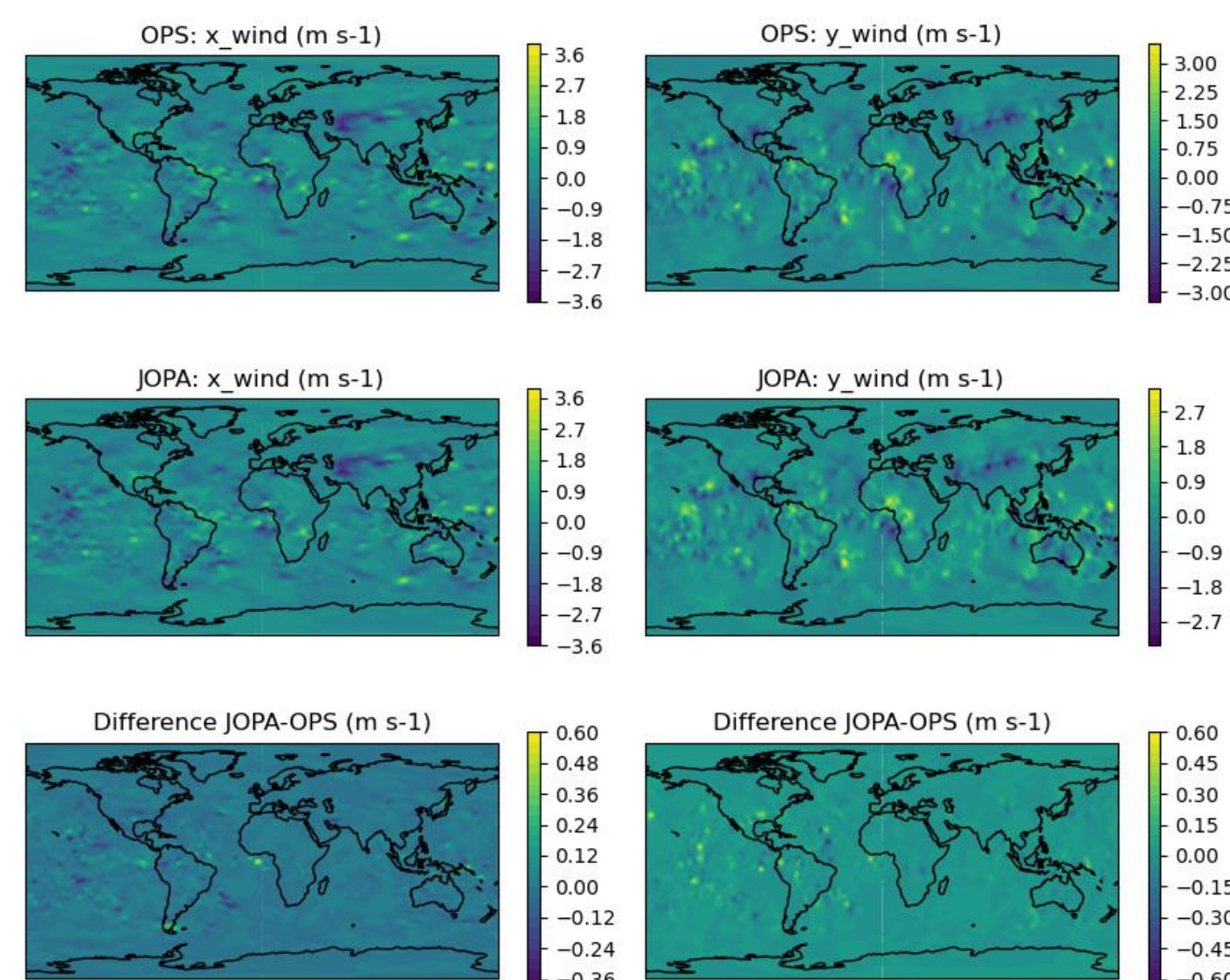
Requirements and JEDI

System requirements:
- To fully exploit future generations of supercomputer (portability, scalability).
- To ease new scientific developments with improved modularity and flexibility
- Unified system suitable for global and regional NWP.

NG-PAO has adopted the Joint Effort for Data assimilation Integration (**JEDI**) code framework developed by the Joint Center for Satellite Data Assimilation (JCSDA)
- Generic object-oriented programming approach
- Standard interface between models, observation and DA (model agnostic)

Current system...

The logical chain of processing applied to the observations is "**static**"

QC routines | Bias correction | Thinning | 1D-Var | H(x)

JOPA | JADA

The logical chain of processing is applied "**dynamically**" → Code free of any science

Collection of bricks functions, methods, classes, procedures

Assemble bricks using modern computation techniques

Configuration

Instructions to assemble the bricks.

Global model trialling

Once an observation type has been replicated in JOPA, it is fully tested by running a cycling data assimilation experiment over a period of several months. The first season covers 1 June 2021 - 19 Sept 2021.

Control — An uncoupled, low resolution (N320) experiment based on PS45 science. Uses **OPS** for the processing of all observations

Trial — For each component trial, we change the processing for a single observation type from OPS to **JOPA**

ATMS / Satwind / Scatterometer — We then build up a series of packages, adding groups of observations until we have tested the full system using JOPA

AMV trial evaluation

If the observation processing has been replicated correctly then we should see a **neutral forecast impact** when comparing errors between the trial and the control.

AMV trial scorecards: forecasts verified against observations (left) and ECMWF analyses (right).

Normally we would look for beneficial impacts, but in this case, white is good!

△ Reduction in forecast error

▽ Increase in forecast error
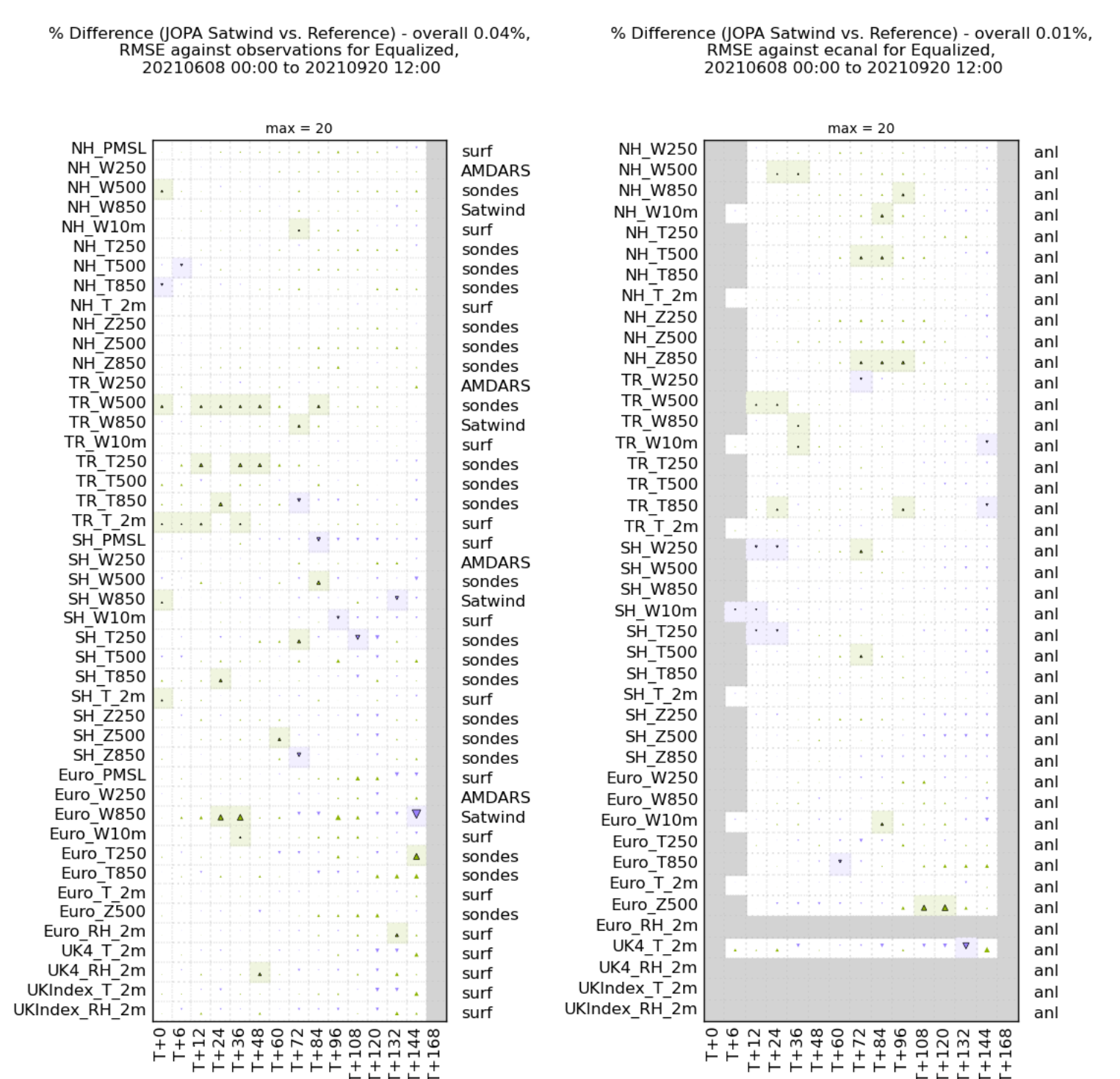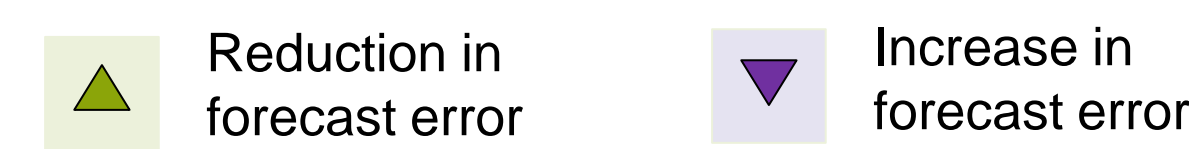
Operational timeline

JOPA is anticipated to replace the current OPS used by the global atmospheric data assimilation systems in PS47, around Summer 2024. Regional model implementation will occur in the following parallel suite, PS48, around Summer 2025. Initially JOPA will be interfaced with the current UM model and VAR data assimilation system.

Obs. Proc. Sys.	DA	Model	
OPS	VAR	UM	Current system
JOPA (JEDI)	VAR	UM	Summer 2024 (GL, PS47) Summer 2025 (UKV, PS48)
JOPA (JEDI)	VAR	LFRIC	Summer 2026 (GL, PS49) Summer 2027 (UKV, PS50)
JOPA (JEDI)	JADA (JEDI)	LFRIC	Summer 2027 (PS50)