ECMWF update

ECMWF | EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

ECMWF

2021 At a glance

- Implementation of two cycle upgrades
- Formal opening of Bologna data centre and Bonn offices
- Start of the Atos acceptance process
- Renewal of ECMWF Copernicus activities
- Renewal of EFAS computational centre activities
- Council approval on Destination Earth
- Virtual training courses, workshops and seminars
- Return to site and teleworking policy
- Georgia joined as Co-operating State on 1 December

ECMWF cycles

	Spring 2021	Autumn 2021	Autumn 2022
47r2	Single precision (HRES fc, ENS, extended-range) Unified vertical resolution (ENS, extended-range to L137)		
47r3		Moist physics upgrade Observation use and DA changes	
48r1			ENS horizontal resolution increase: **9 km** Daily extended-range ensembles (100 members) Multi-layer snow scheme OOPS (multi-executable) operational implementation

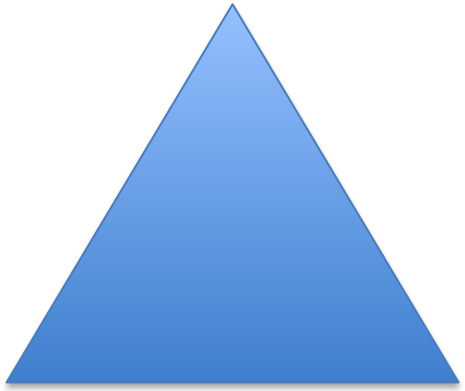
Cycle 47r2

Neutral impact

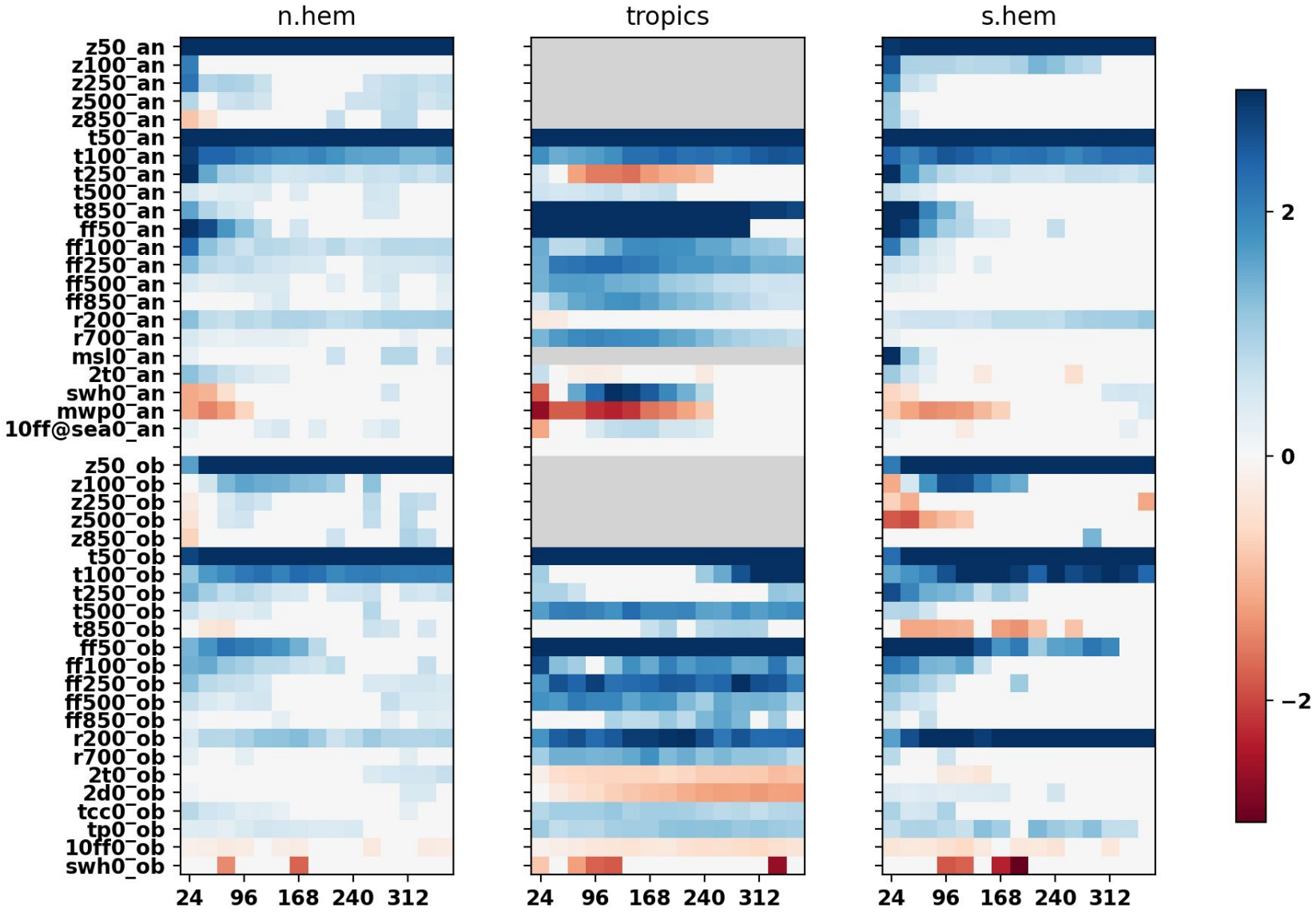
Saving of computational cost through implementation of single precision

Positive impact

Investment to take ENS (medium and extended-range) from L91 to L137



47r2, TCo639L137SP vs 47r1, TCo639L91DP

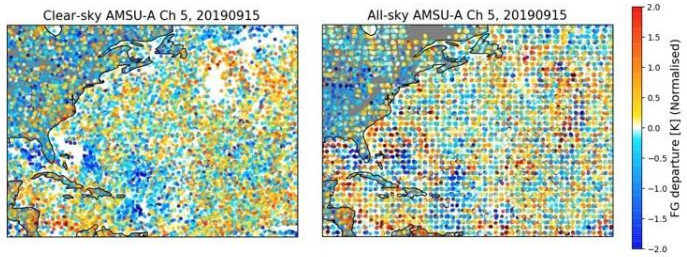


Scorecard, 95% sig. level.

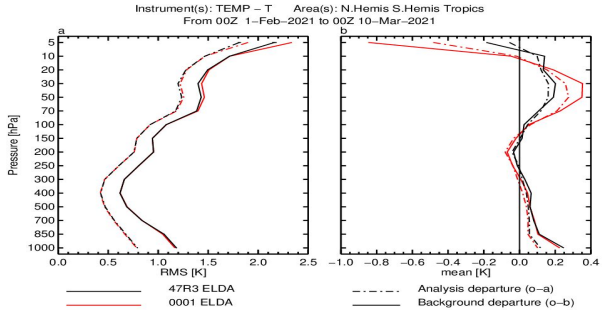
Summer+Winter, 168 ini dates

IFS Cycle 47r3

1. Changes to observation usage in the assimilation
   (infra-red, microwave, atmospheric motion vectors, Aeolus winds)



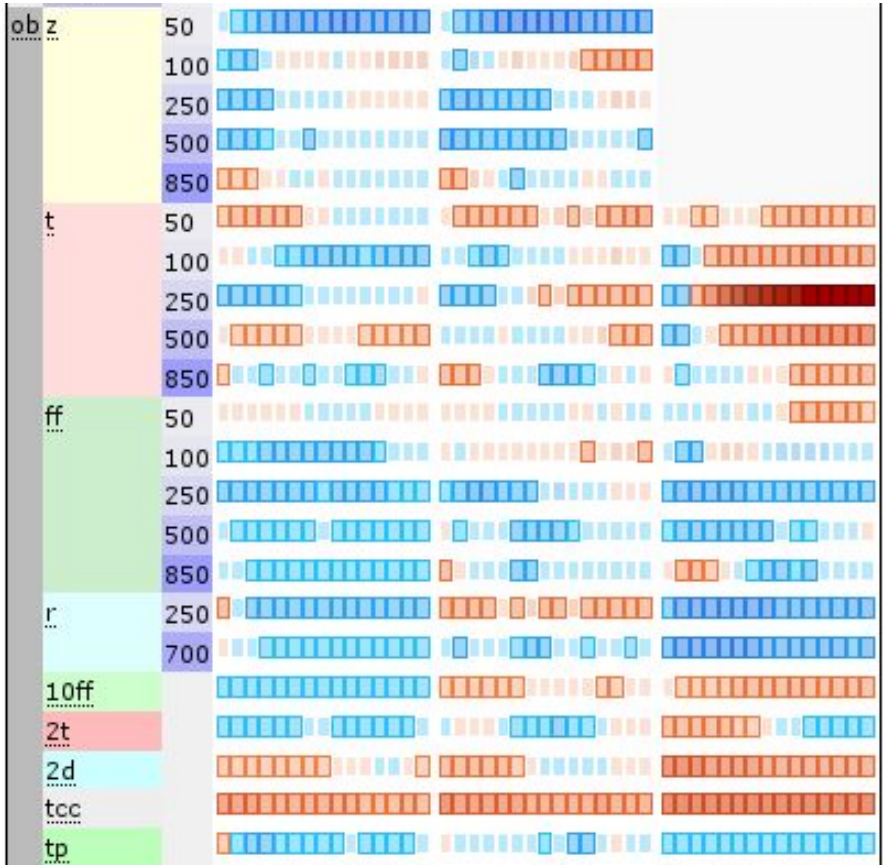
2. Weak constraint 4DVar for stratosphere in EnsembleDA



3. Major revision to improve the physical and numerical basis for moist processes in the IFS

47r3 Impacts

ENS 50m TCo639
Scorecard
CRPS vs observations



(2)

(1)

(3)

(1) Improved geopotential and upper-air winds + 10% reduction in TC track errors

(2) Upper-tropospheric temperature bias issues

(rmsef, CRPS relative differences sensitive to bias)

47r3=warmer, higher res=warmer, stochastic pert=warmer

(3) Mixed signals in near-surface variables

partly due to increased variability,

partly due to small changes in bias, to be addressed in future

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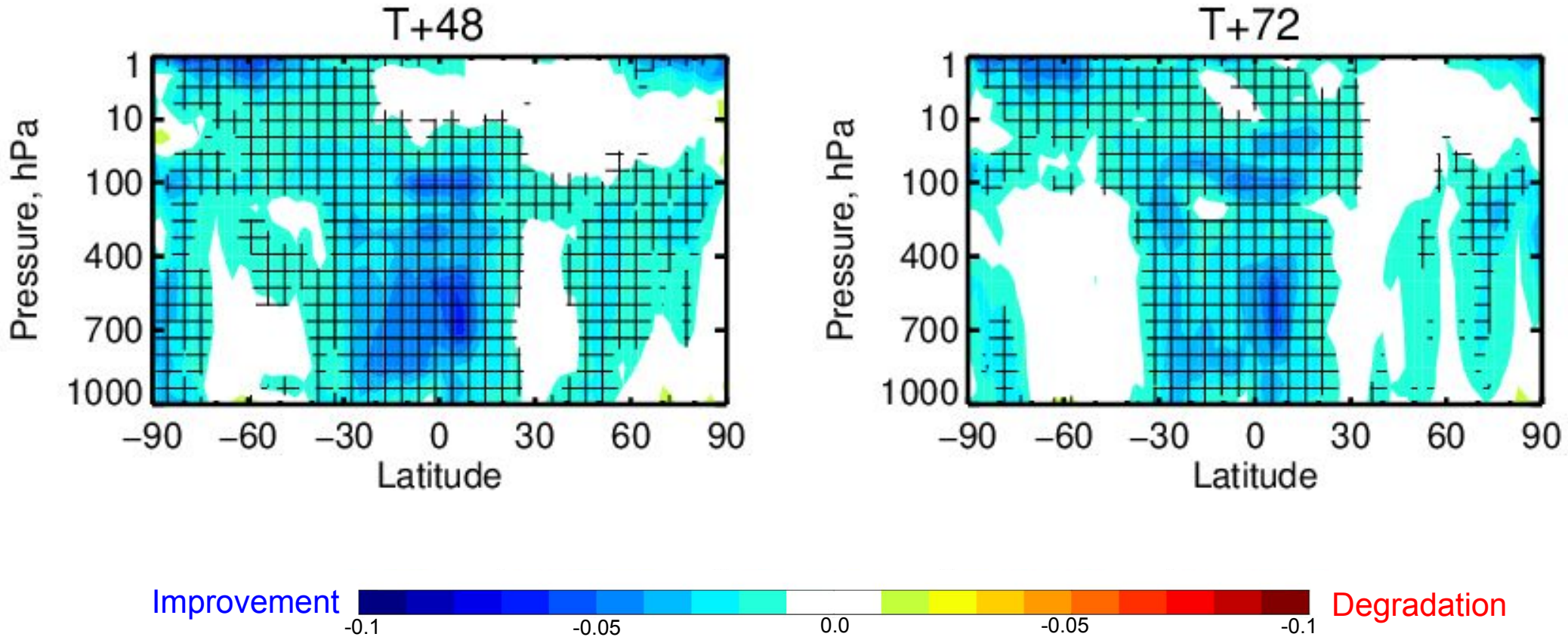
47r3 Impacts: HRES Wind RMSE zonal cross section



Difference in RMS error normalized by RMS error of control

Acceptance of Atos supercomputer

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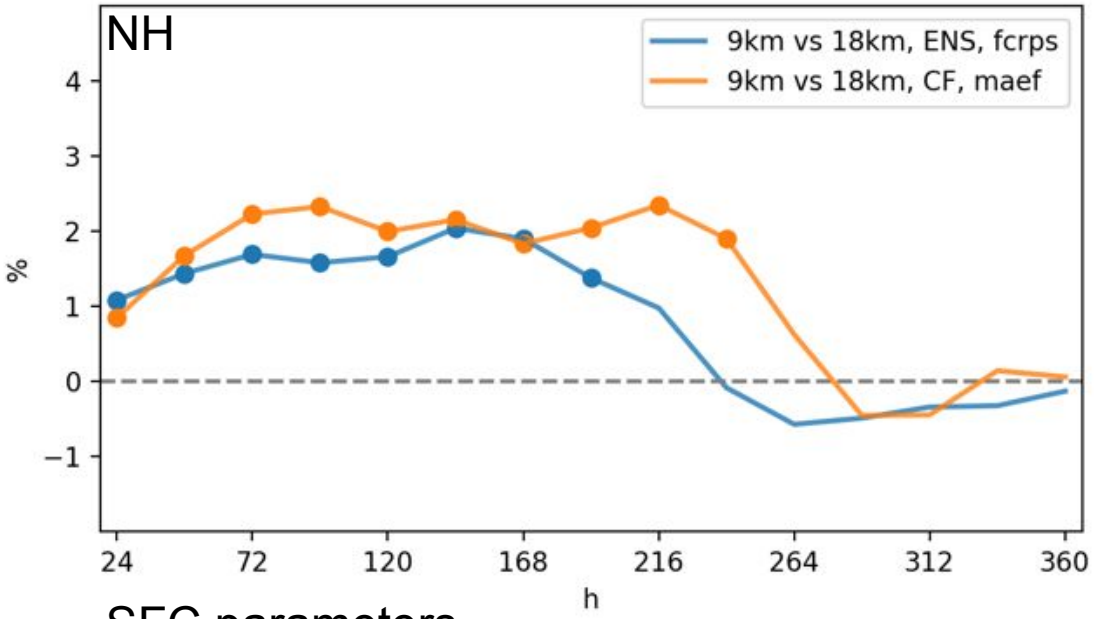
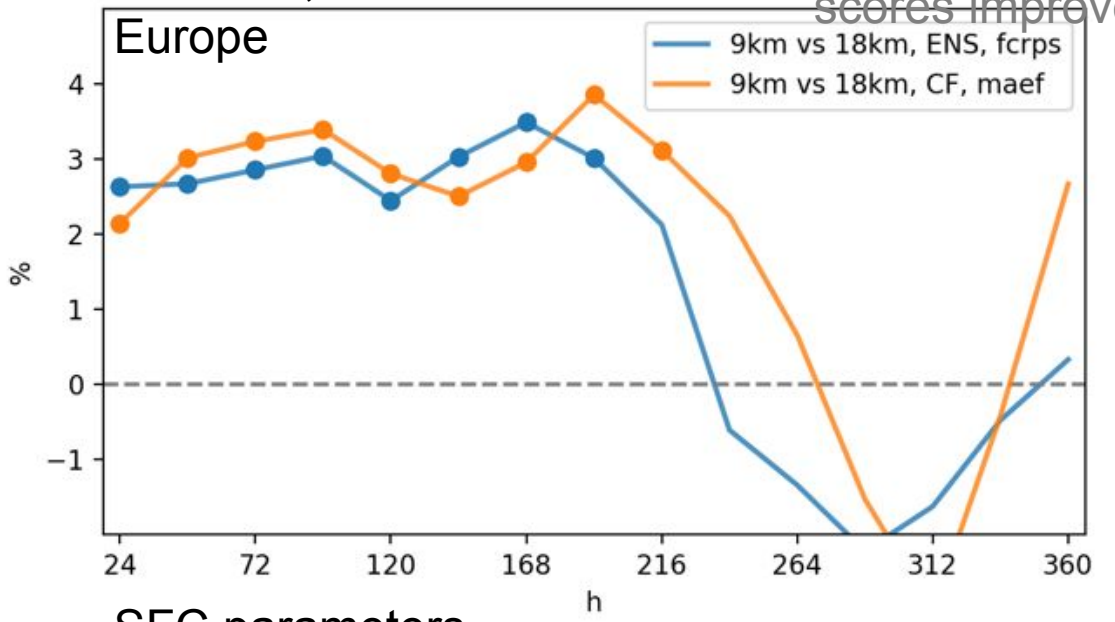
TCo1279L137 vs TCo639L137 (obs), dots indicate stat. signif. (95%)

Positive values -> scores improved

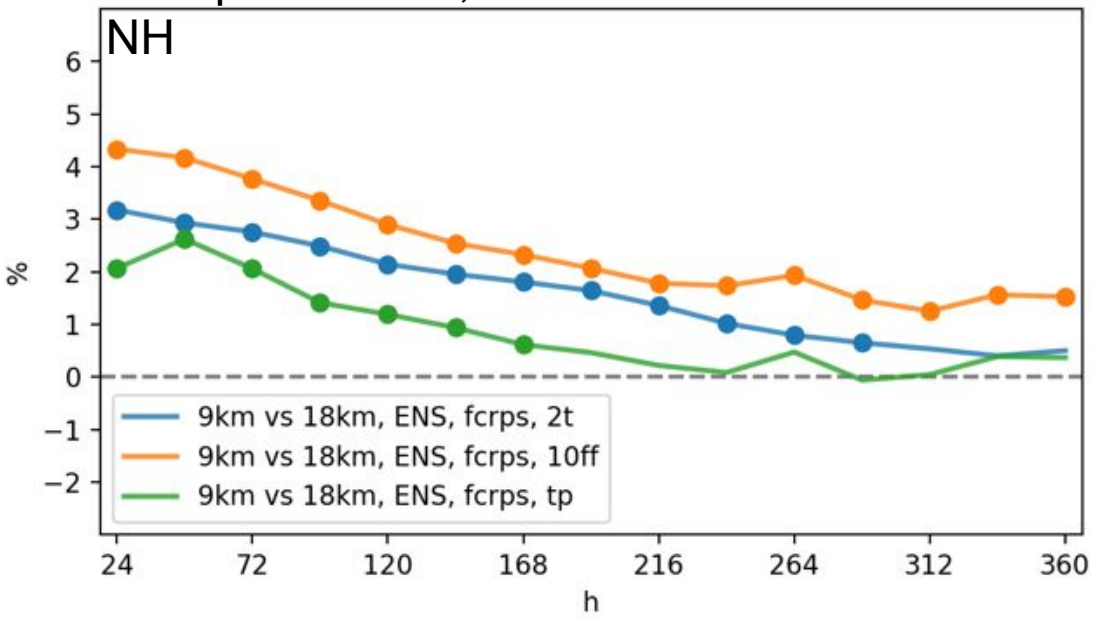
z500hPa, NH



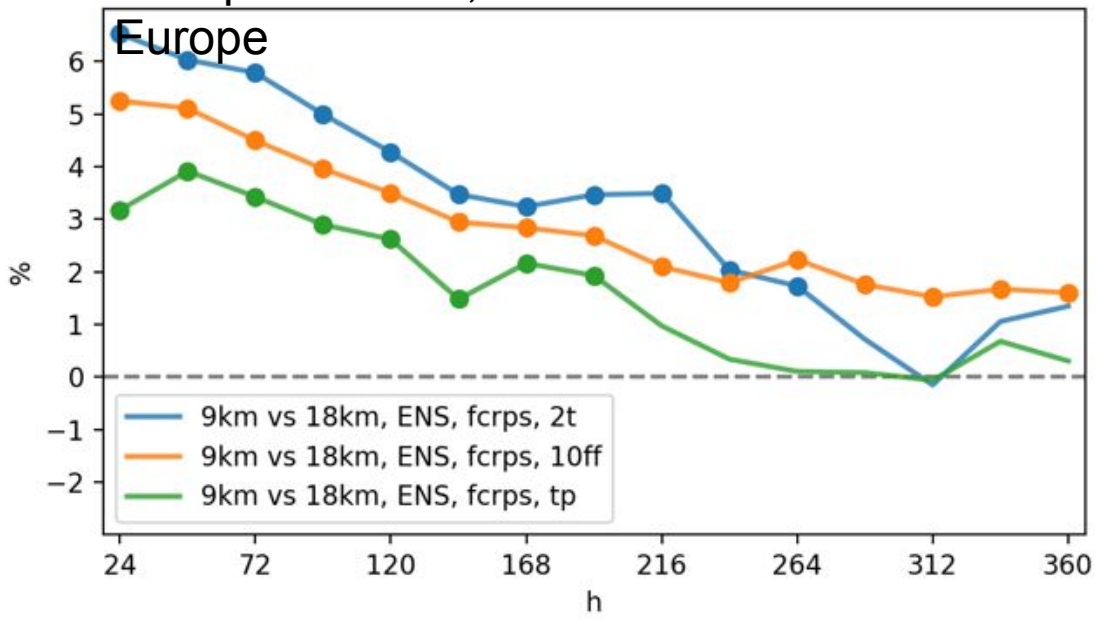
z500hPa, Europe



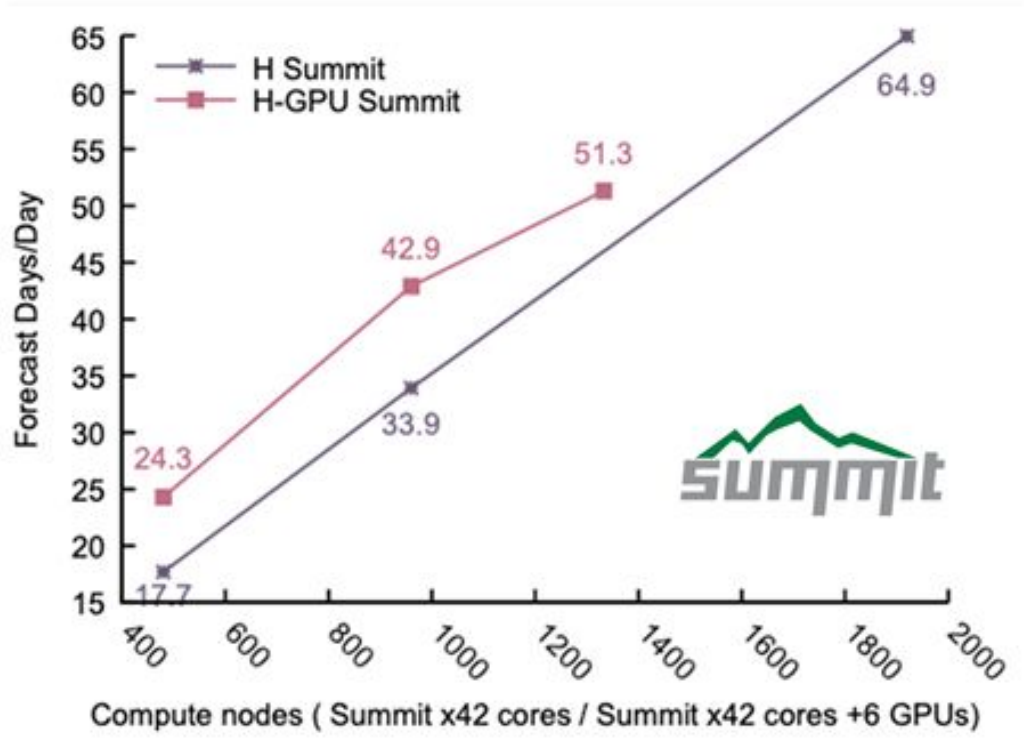
SFC parameters, NH

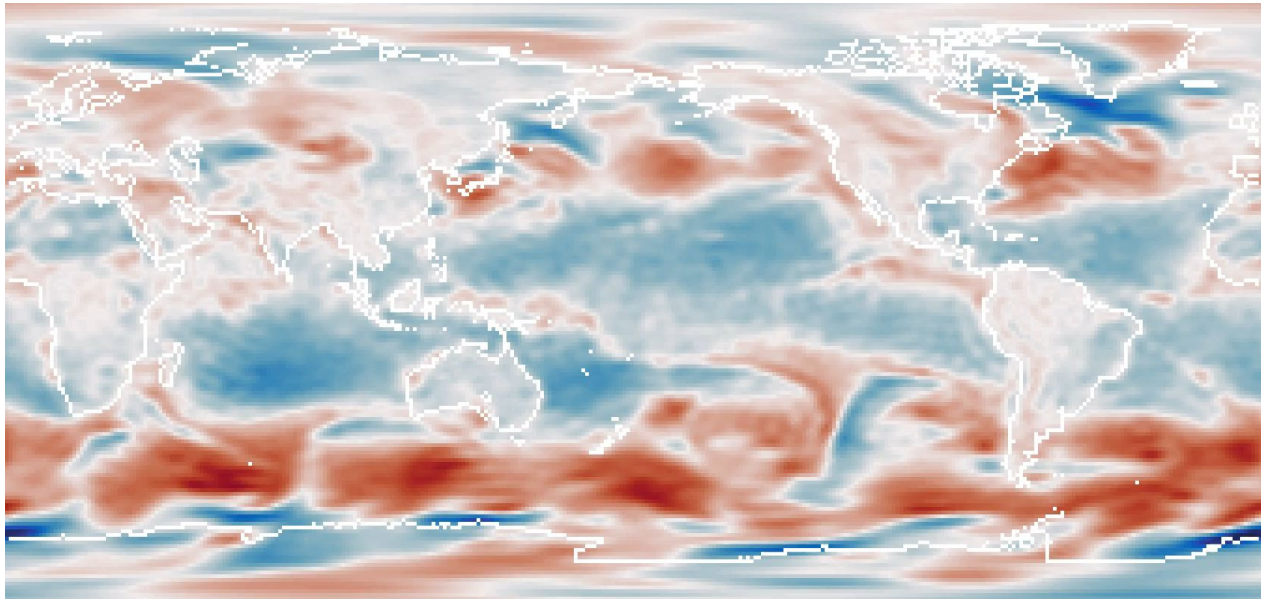


SFC parameters, Europe



Performance of IFS at 1 km on Summit and first tests on Fugaku

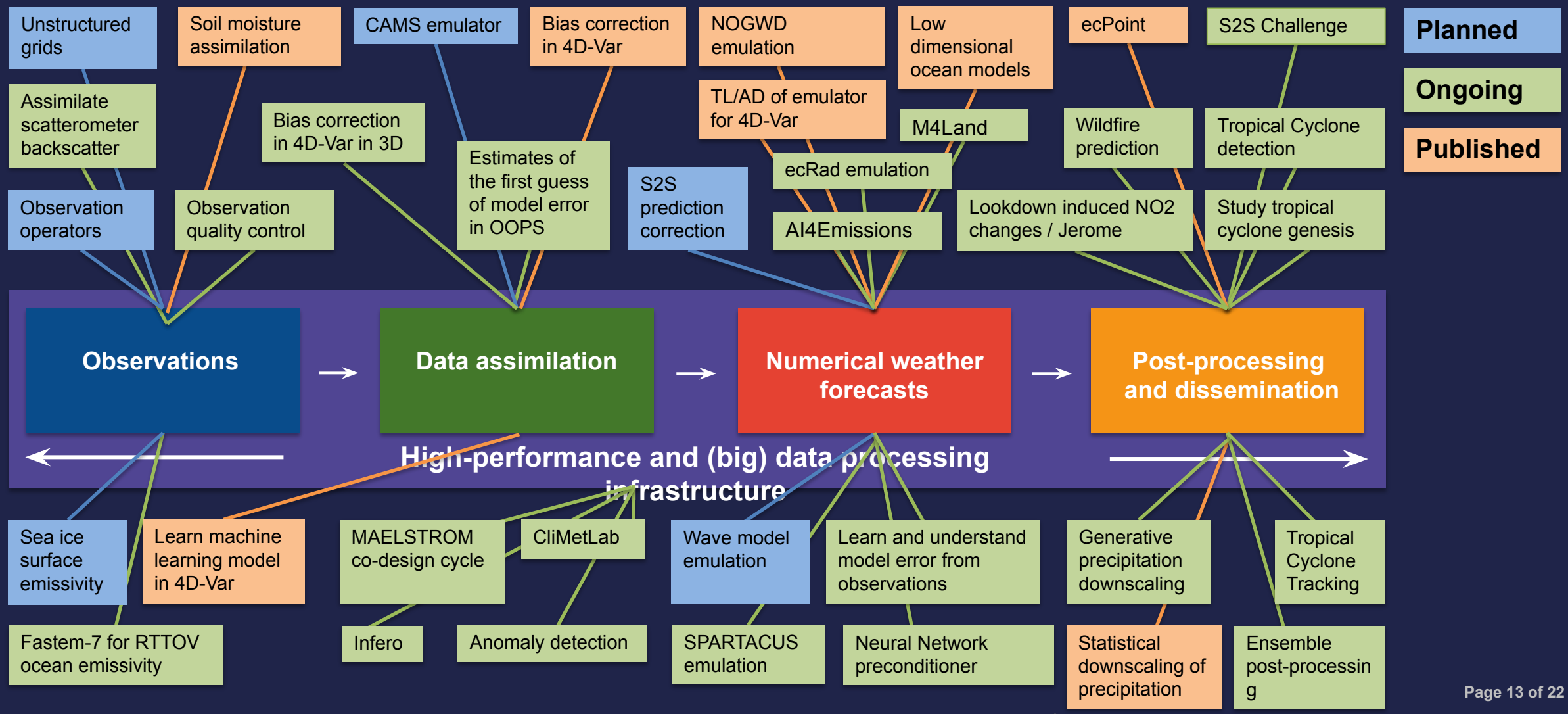




Fugaku, RIKEN Center for Computational Science

Hybrid2024 project. Delivering capability for DestinE and for next ECMWF procurement

Status of machine learning at ECMWF



Code Licensing Options (as presented to council)

- Option 1: Status quo → Not recommended

- Option 2: Selected model components to open source → Recommended

  ✔ Enables enhanced collaboration on specific parts of model code, with no significant downside

- Option 3: Whole model to open source → Worthy of further Investigation

  ✔ Further enhanced collaboration

  ✔ Internal efficiency (reduced time spent on licencing, and on stripping out parts of code for different purposes)

  X Potential loss of competitive advantage (although DA still protected)

- Option 4: Whole IFS to open source → Not recommended

  X Significant resource implications, with little further incremental benefit for collaboration

  X Larger potential loss of competitive advantage

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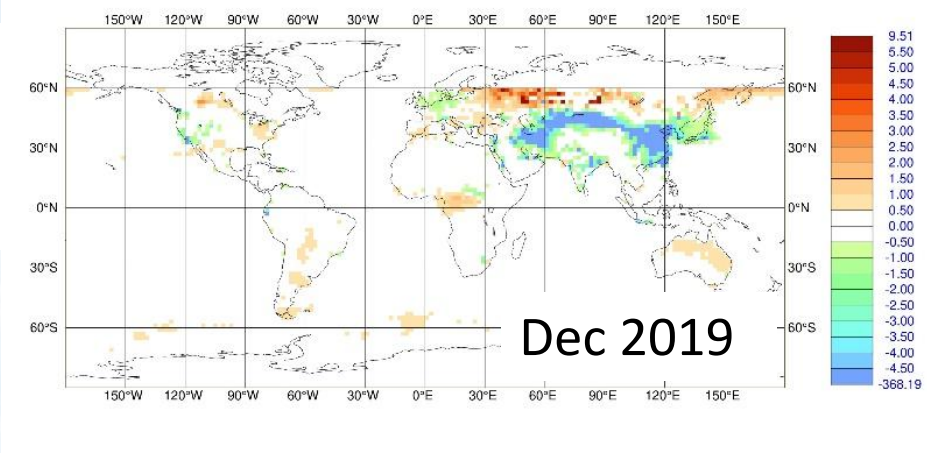
TROPOMI NO2 assimilation

Atmosphere Monitoring

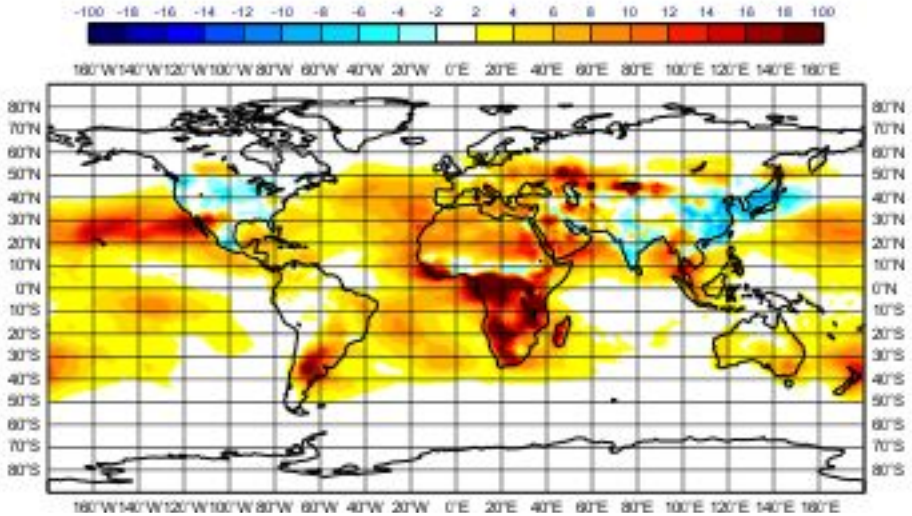
TROPOMI NO2 fg-dep from CTRL (obs-fg)

Fg-dep from monitoring exp



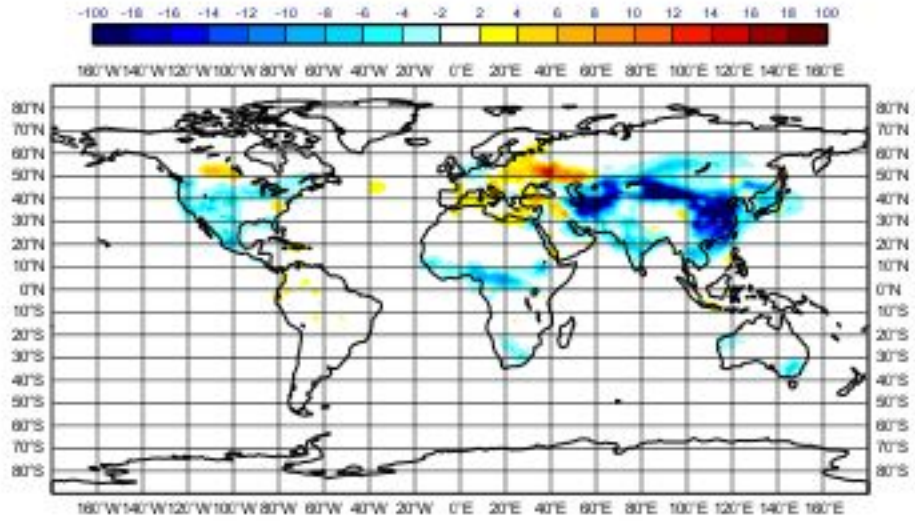
ASSIM noTL/AD - CTRL

Relative diff in %



ASSIM TL/AD - CTRL

Relative diff in %

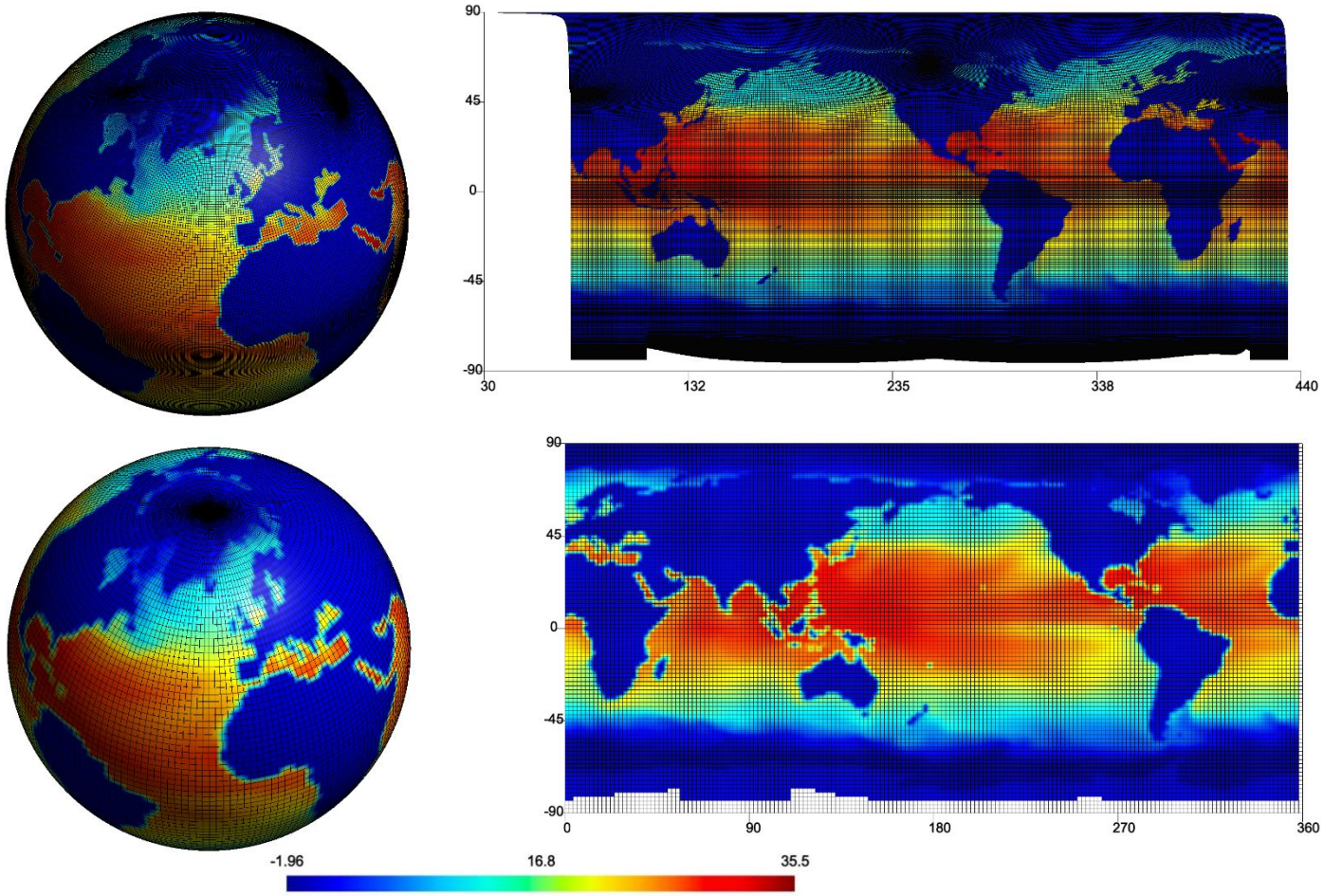


- TL/AD – CTRL differences agree well with TROPOMI NO2 fg-dep from CTRL
- noTL/AD – CTRL differences do not agree with TROPOMI NO2 fg-dep from CTRL

 NO2 assimilation requires use of simplified TL/AD of chemistry (N. Bousserez, V. Huijnen)

 Included in CY47R3

Use of Atlas and interpolation

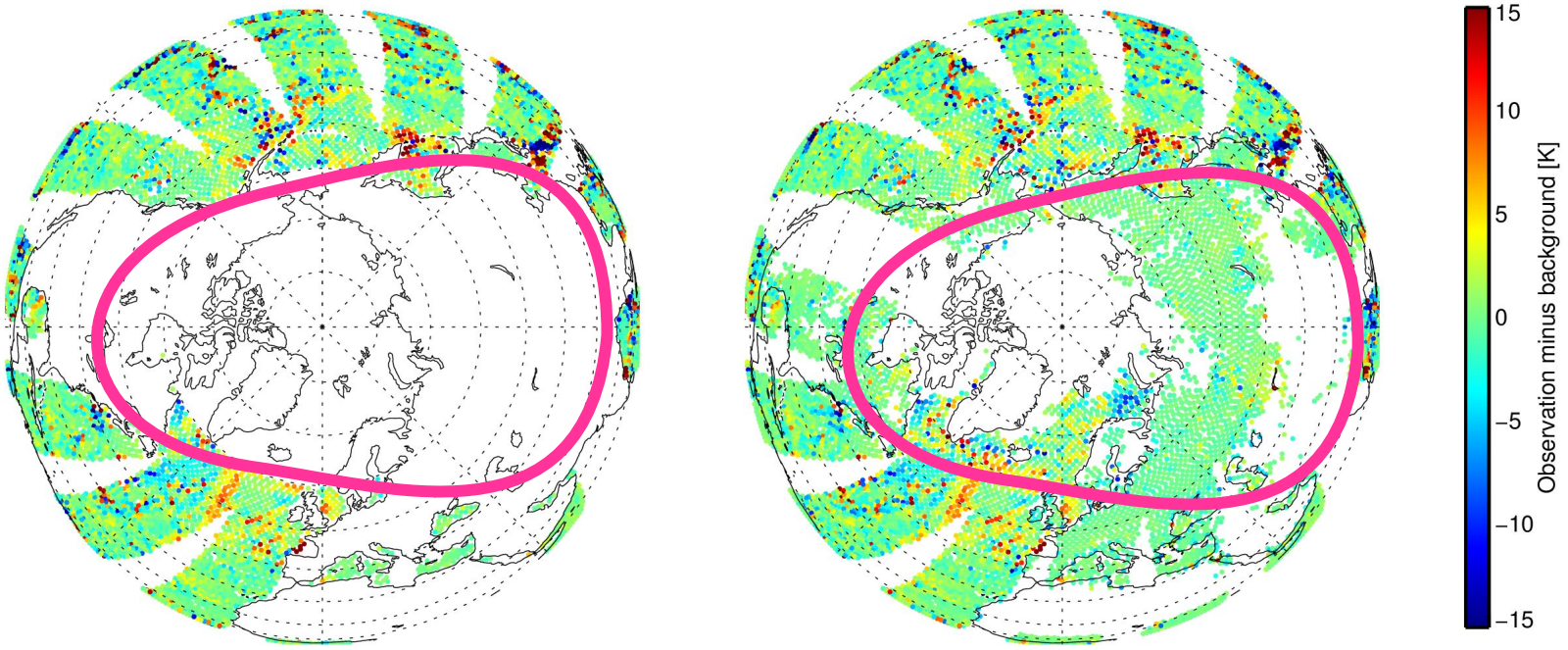


Ongoing developments for surface-sensitive microwave channels

Active channel 10
(36.5 GHz, v-polarised)
observations from AMSR2 during
00 UTC analysis cycle,
26 June 2019

NOW
(all-sky but not all-surface)

UPGRADE



- **Adding higher latitudes, land surfaces, mixed scenes (land – water) (but excluding sea-ice, snow, high altitudes, desert soils)**

ECMWF FOUR-YEAR PROGRAMME: 2022–2025

Destination Earth: Phase 1 Implementation

HPCF
Atos HPCF operational and migration of archive

HPSS market survey

ATLAS

ML integration
Integration of ML applications in operational workflow (physics)

ML tools
Machine learning tools explored further to represent ignition and evolution of wildfires and to predict floods

IFS acceleration
Specialised hardware for machine learning used to accelerate kernels of IFS

2022 | **2023** | **2024** | **2025**

Cloud strategies and options for HPC strategies

JupyterHub and ML libraries: available on European Weather Cloud and HPC

CPU-GPU readiness
Model (IFS and FVM) ready for CPU-GPU architecture

HPC2026
Business case and preparation of ITT for HPC 2026

ECMWF FOUR-YEAR PROGRAMME: 2022–2025

Interactive ozone
Ozone interactive with radiation in NWP (following success of HLO in CAMS)

Cycle 48r1
Increased ENS resolution, enhanced extended range, multi-layer snow, OOPS, increased use of surface-sensitive observations

New stochastic physics

Pilot SST analysis

Multiple grids in CAMS

GloFAS
Prototype km-scale GloFAS

2022	2023	2024	2025

Improve grey zone
Continue to improve representation of physics in grey zone through collaboration (following success of Cycle 47r3)

4D-Var
Weak-constraint 4D-Var extended to troposphere

Continuous data assimilation
Extending assimilation window

Satellite data preparation
Preparation for EPS-SG, MTG, Sentinels, EarthCare, ...