ECMWF research

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ECMWF

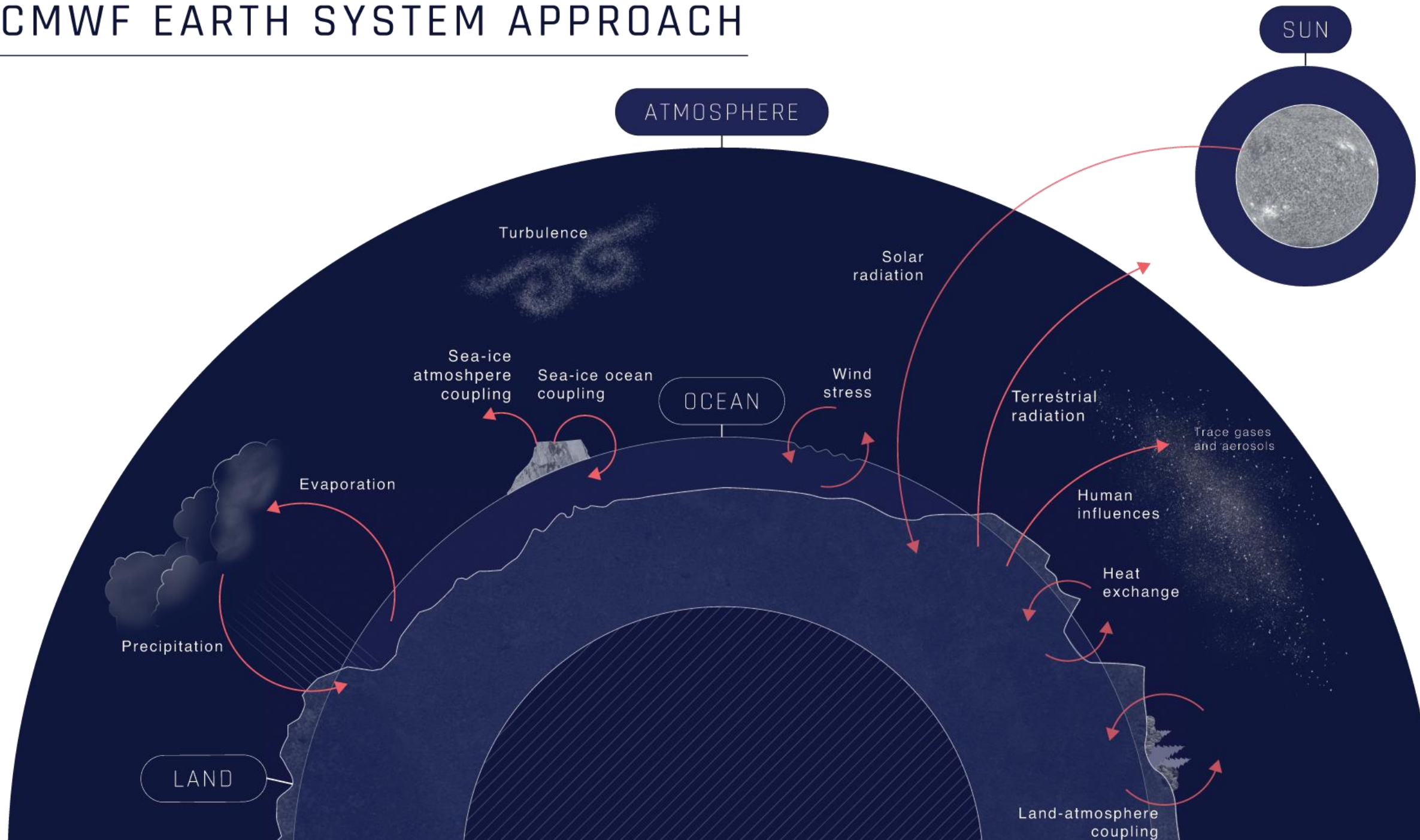
The strength of a common goal:

Strategic Objectives to 2025

Three pillars:

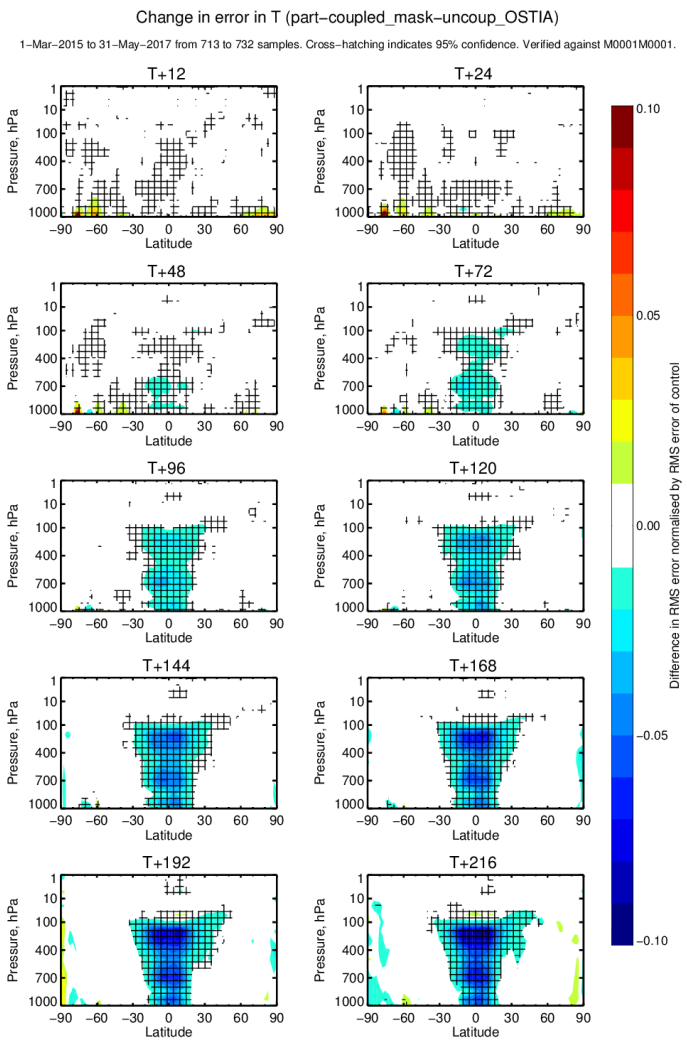
- Seamless earth system approach to modelling and analysing
- Ensemble prediction at 5km
- Scalability across the NWP chain

ECMWF EARTH SYSTEM APPROACH

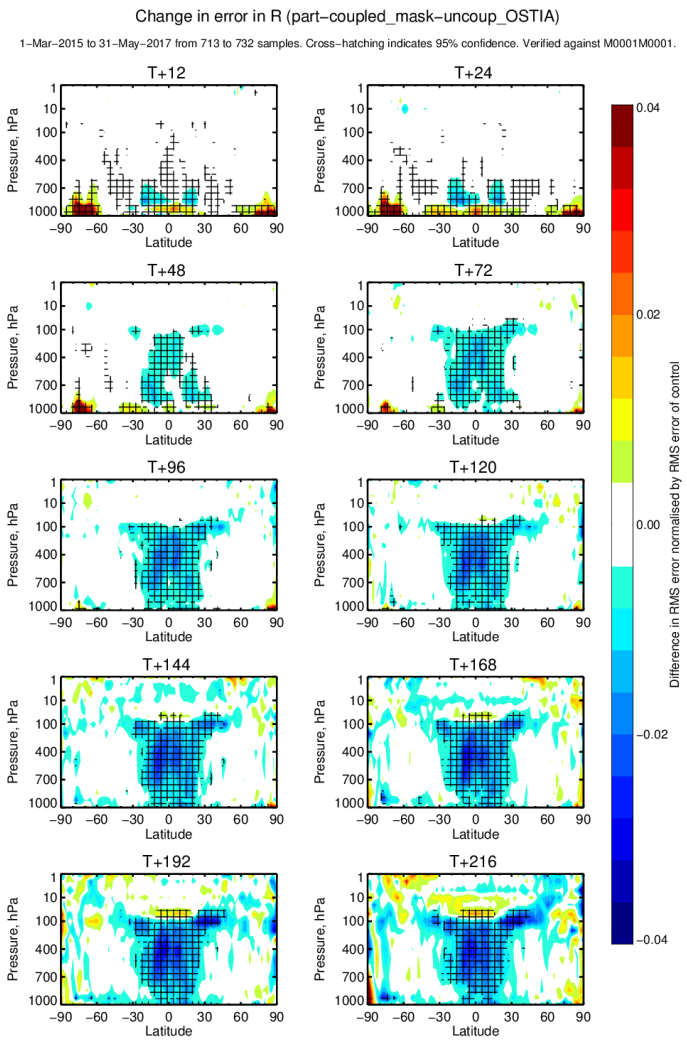


45r1 – June 2018 0.25 degree Ocean coupled to HRES

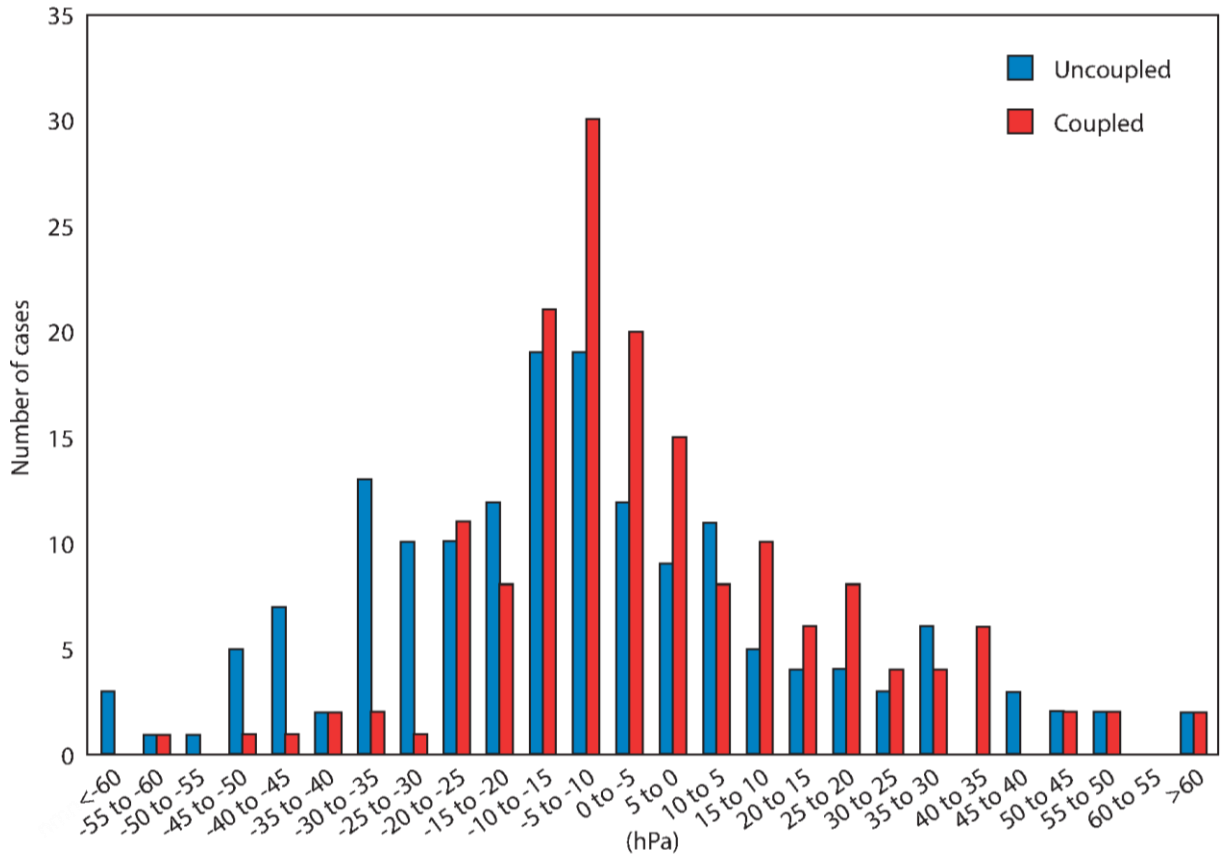
Temperature



Humidity



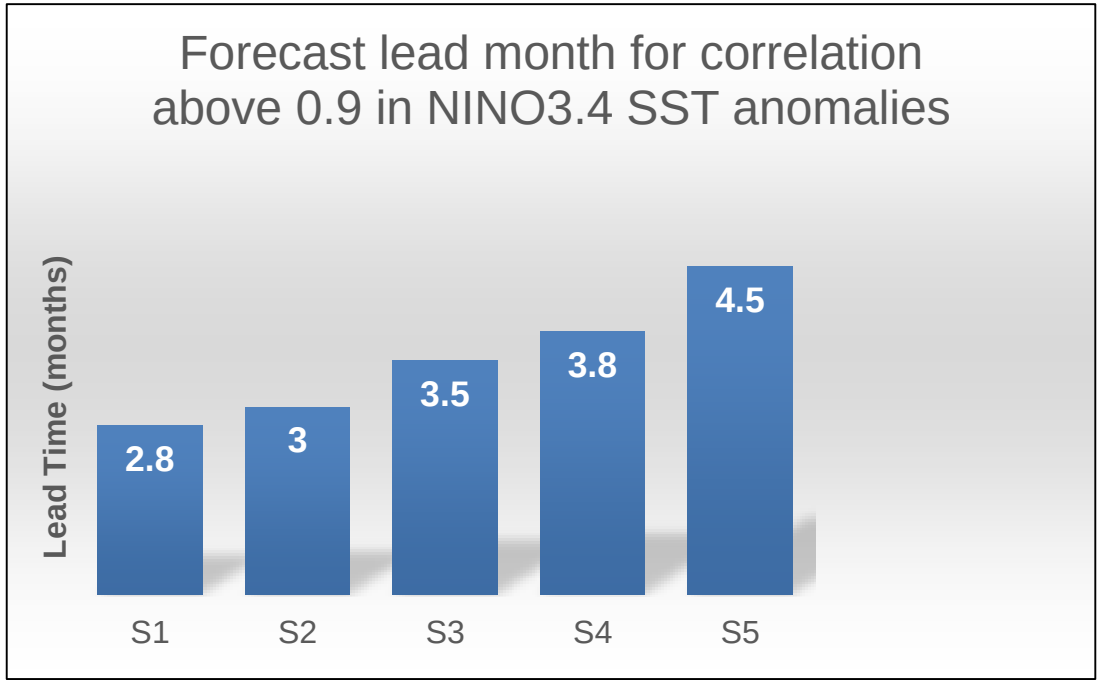
Does the ocean coupling actually matter for a large sample of TC's?



- Distribution of 7-day TC intensity forecast errors for coupled and uncoupled high-resolution forecast experiments.
- The experiments cover the period of March 2015 to June 2017 and were carried out over all basins for a total of 163 TCs.
- The number of over predictions is reduced in the coupled forecasts compared to the uncoupled forecasts.

Seamless modelling: SEAS5

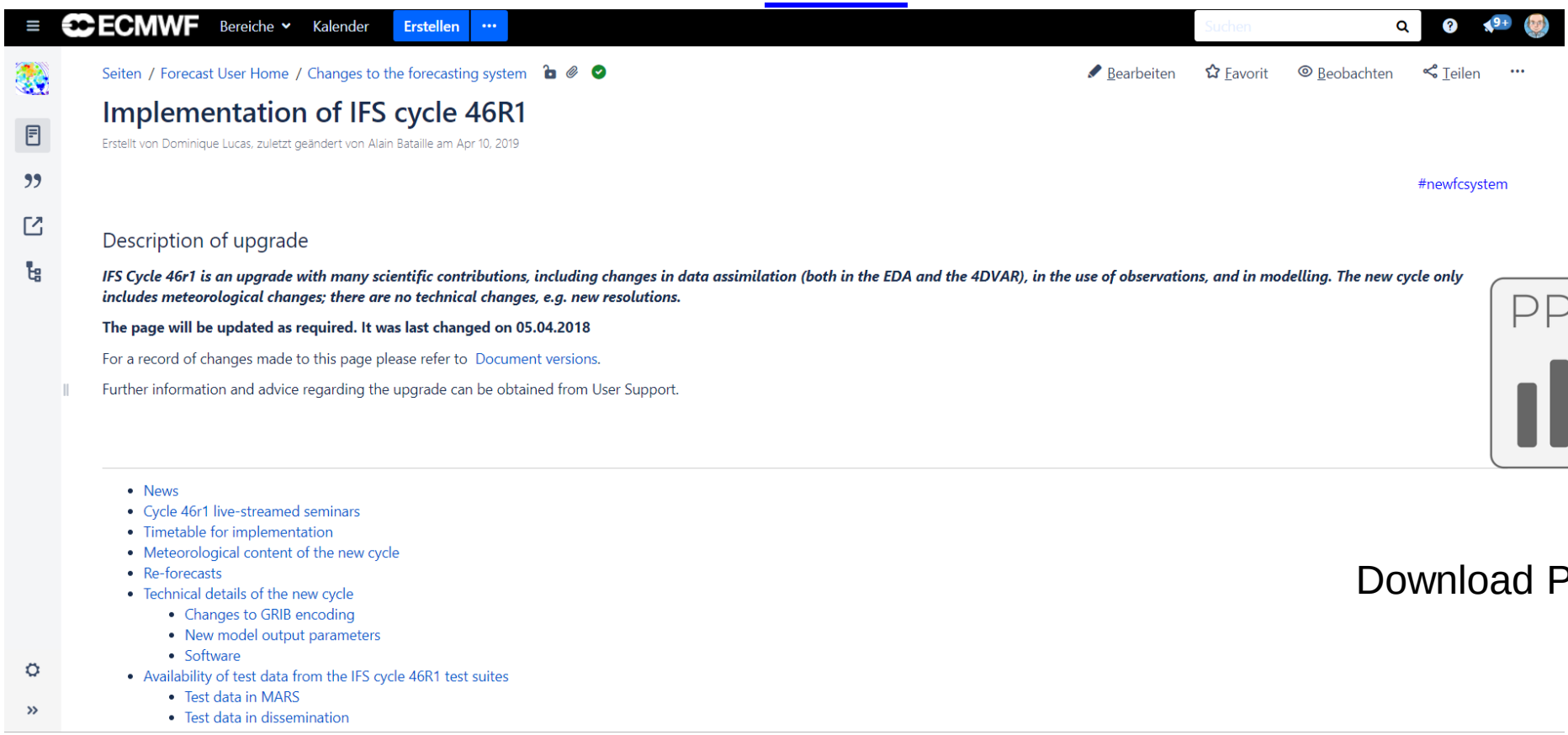
- Most “seamless” system so far
  - Horizontal (Tco319/ORCA25) and vertical resolution (L91/L75) are the same as ENS extended.
  - SEAS5 only differs from the 43r1 ENS extended (monthly) system when testing demonstrated clear improvement in forecast skill or mean state.
    - Different non-orographic gravity wave drag settings (important for QBO) since adopted for all timescales from 45r1
  - Seasonal testing now an integral part of cycle development

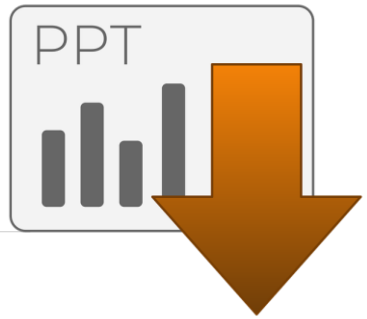


Information to new cycle 46R1

All information is published on the website

https://confluence.ecmwf.int/display/FCST/Implementation+of+IFS+cycle+46R1





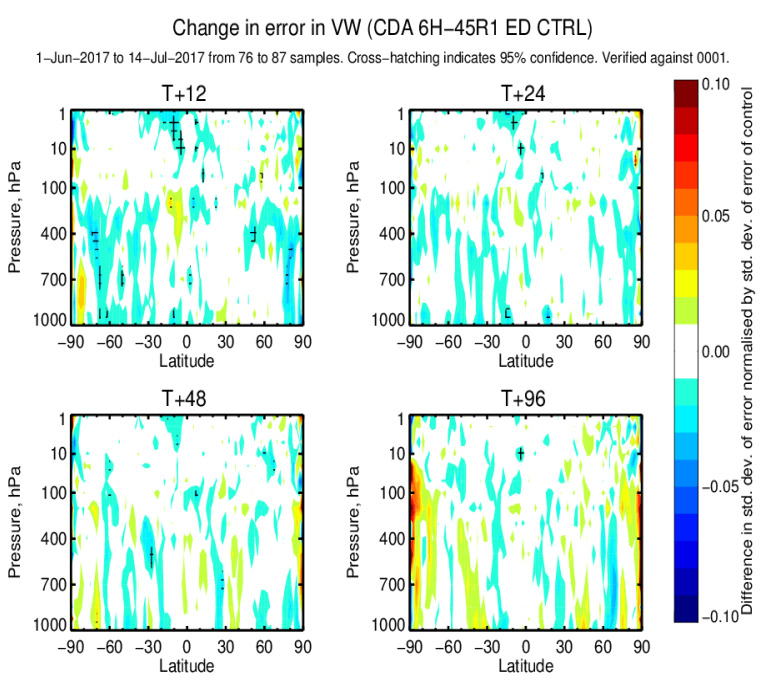
Download Presentations later

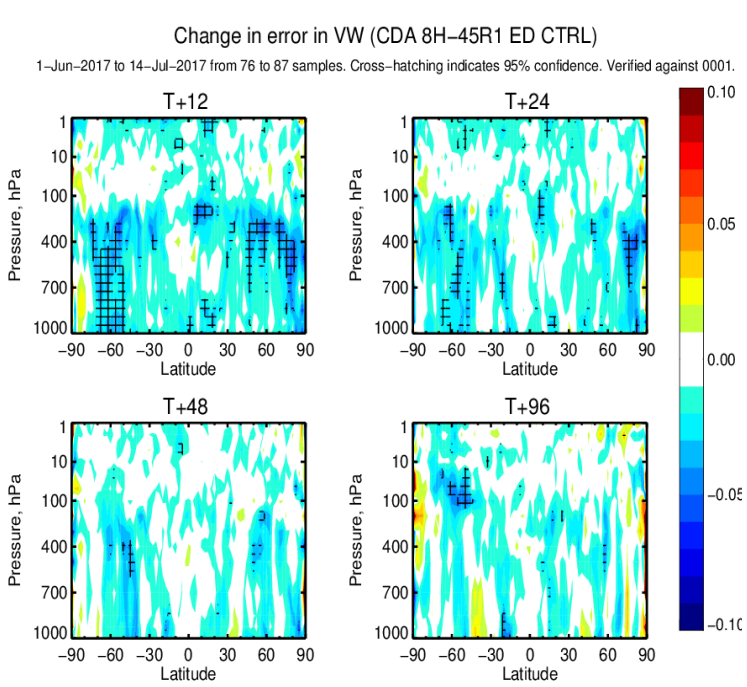
Continuous data assimilation

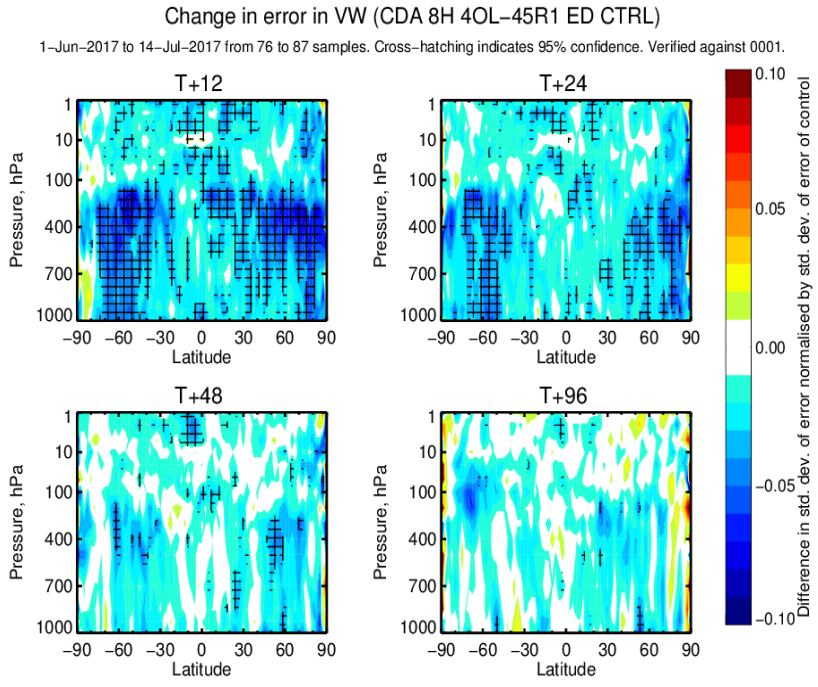
- Key point: Start running data assimilation **before** all of the observations have arrived:
  1. Most of the assimilation is removed from the time critical path
  2. Configurations which were previously unaffordable can now be considered

Continuous DA

- **Preliminary results (Wind Vector error stdev, 1/6/17 – 14/7/17)**







A: Late obs – 6h window

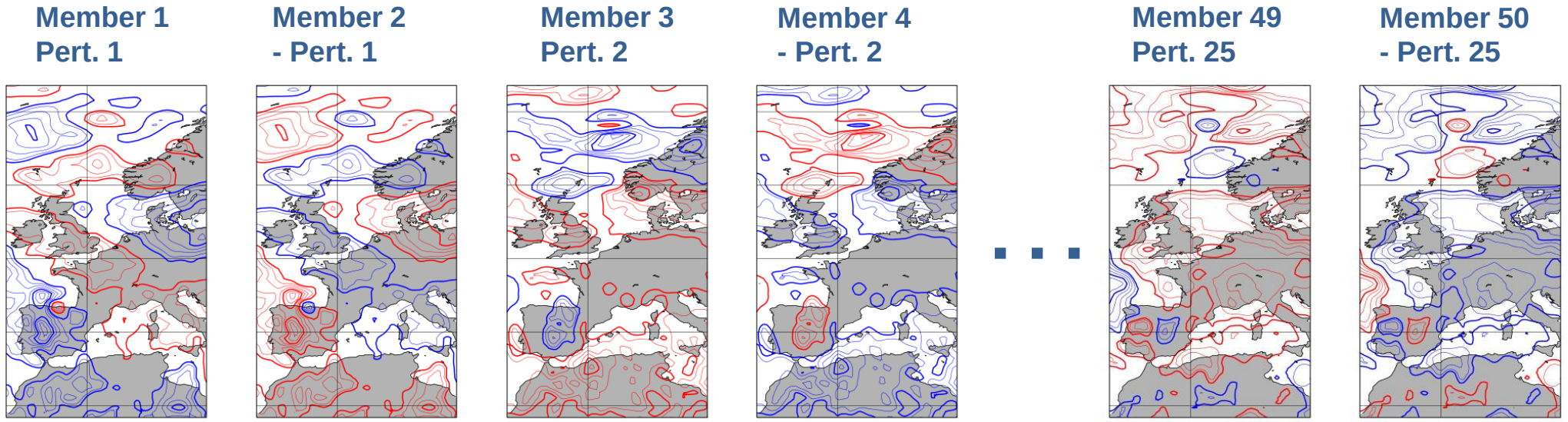
B: Late obs – 8h window

C: B + 4 outer loops

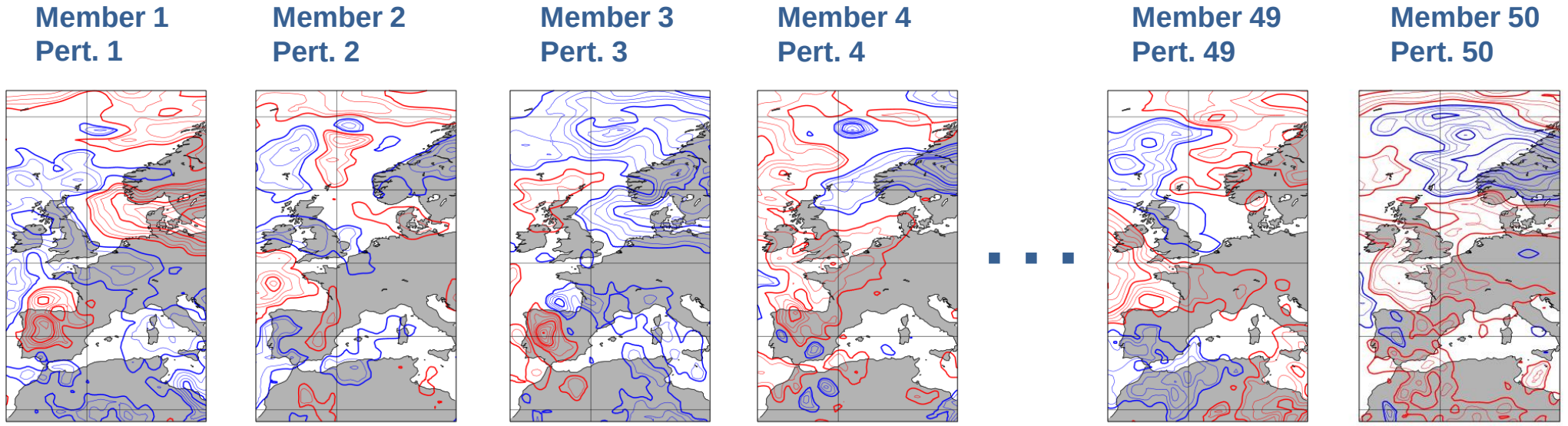
New way to perturb the ensemble initial conditions for 50 Ensemble Members

Old:
Plus-Minus
Symmetry with
Perturbations from
25-Member EDA

z 500hPa



New:
Perturbations
from new
50-Member EDA

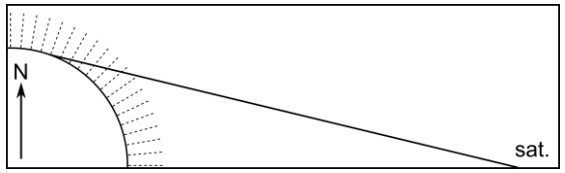


Geostationary radiances

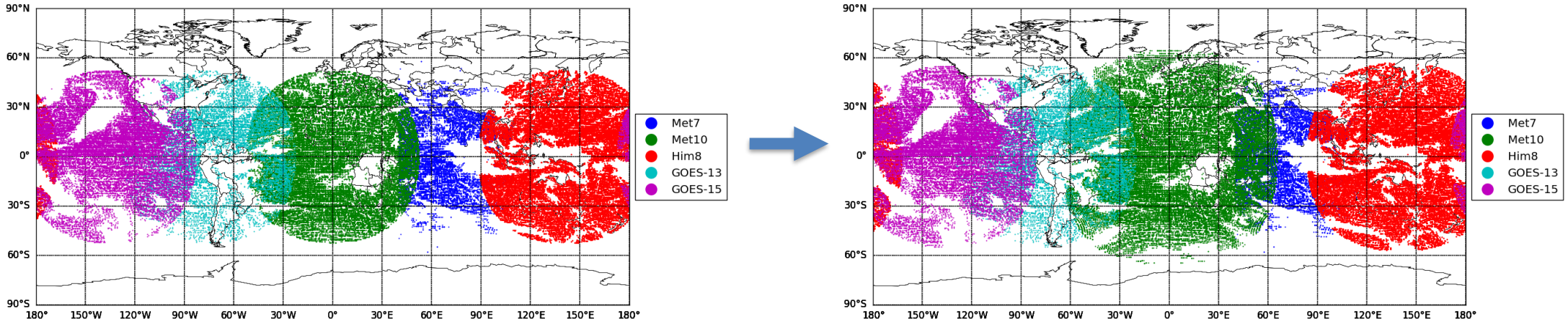
Diagnosed inter-channel error correlations for the water vapour channels on SEVIRI, AHI and ABI. E.g.

$$\mathbf{R}_{SEVIRI} = \begin{pmatrix} 0.46 & 0.20 \\ 0.20 & 0.30 \end{pmatrix} \qquad \mathbf{R}_{AHI} = \begin{pmatrix} 0.55 & 0.43 & 0.22 \\ 0.43 & 0.46 & 0.31 \\ 0.22 & 0.31 & 0.35 \end{pmatrix}$$

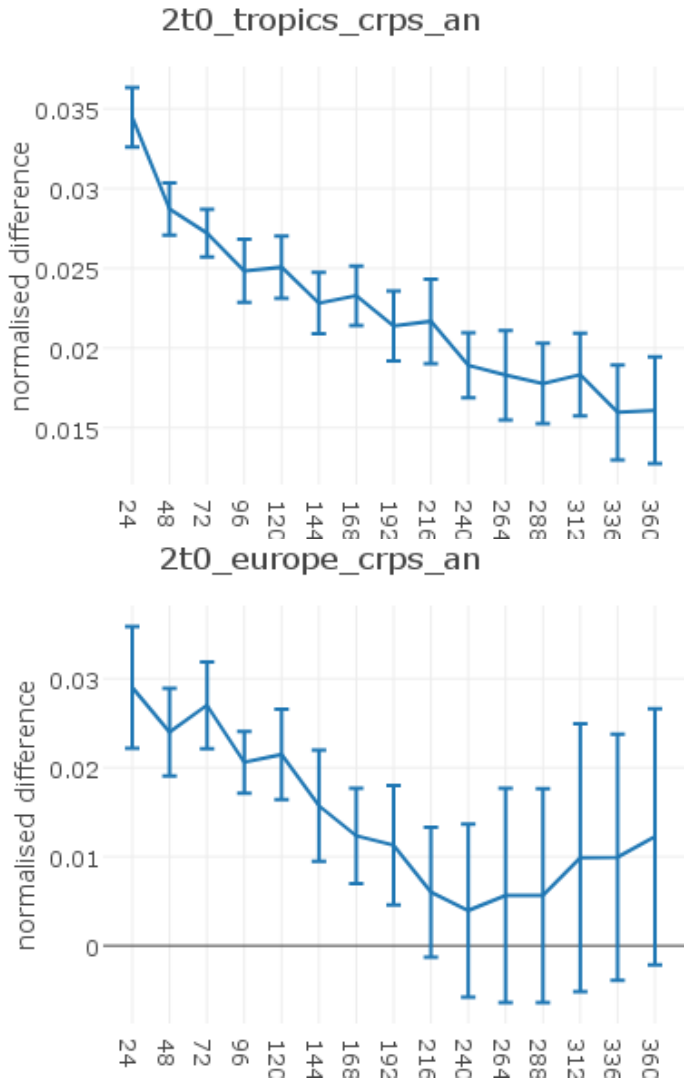
Slant path radiative transfer – this improves forward-modelling at high zenith angles:



Increased use of data at high zenith angles beyond 60° (assisted by the slant path processing):

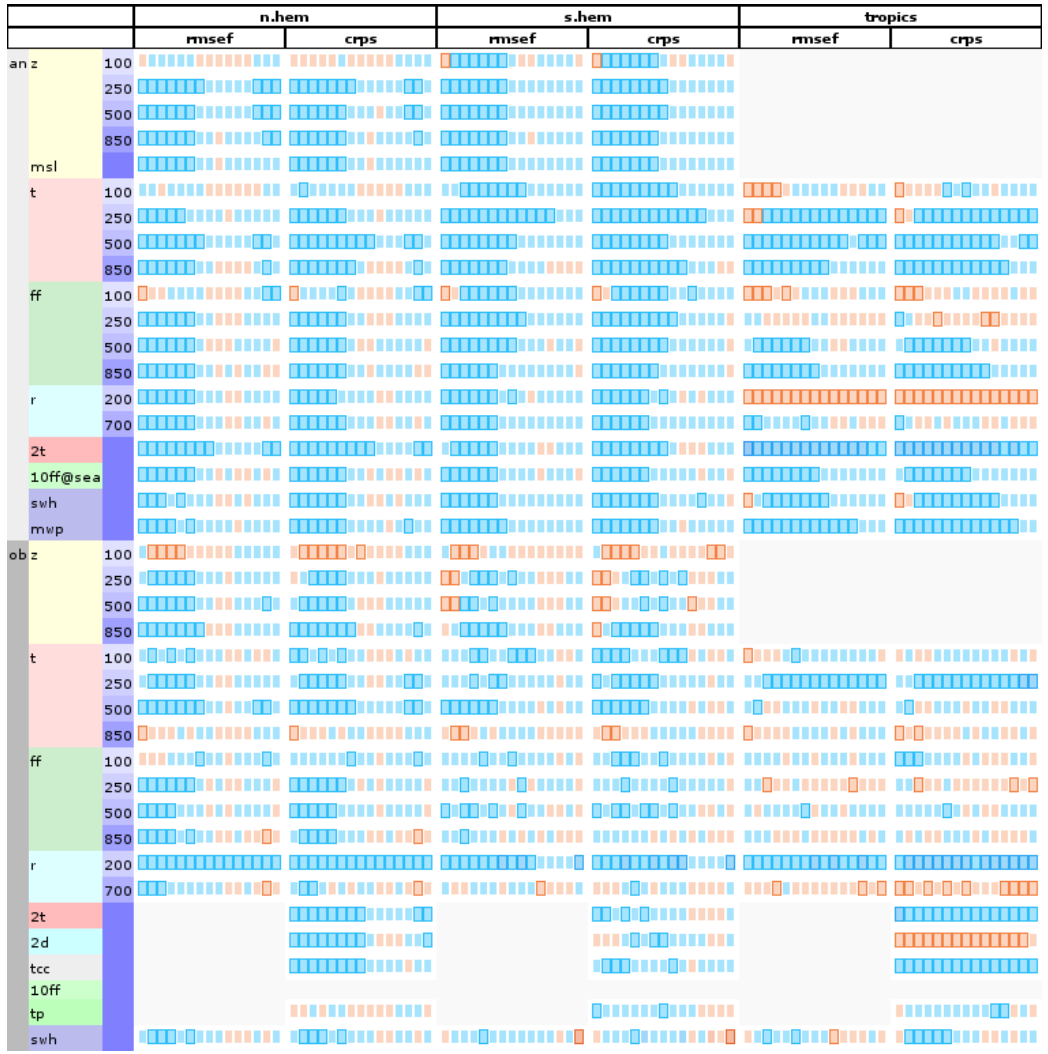


Impact of 1 hourly radiation on ENS



1 hourly radiation is better

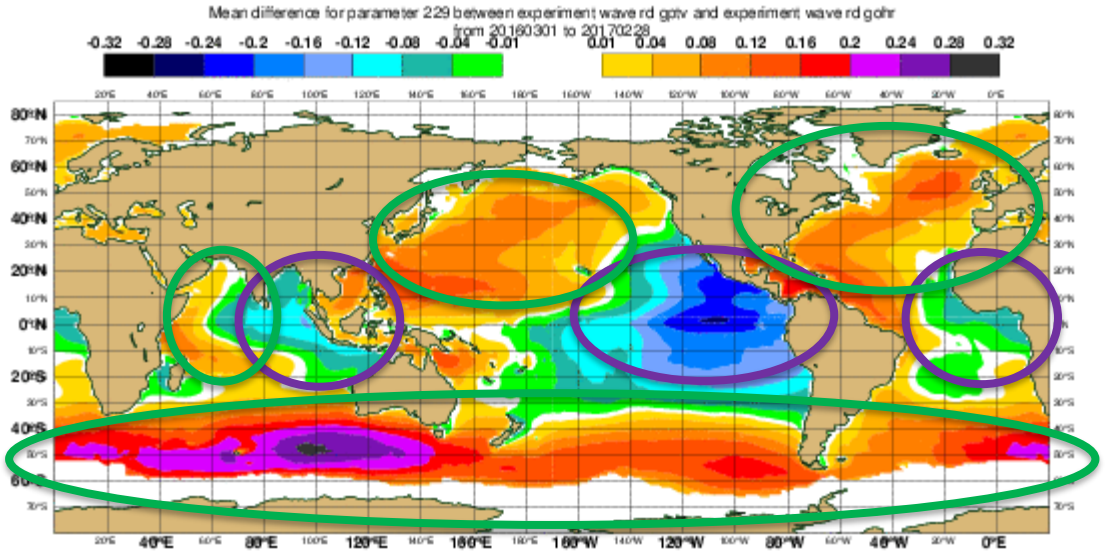
1 hourly radiation is worse



Modified wave physics

The wave model has the tendency to produce
- too much swell in the deep **Tropics**
- too little waves in the **stormy/windy areas**.

The modified wave physics, based on the work of Ardhuin et al. 2010 generally addresses this issue:



new – default

<u>Stand alone hindcast</u> for 1 year, forced by ECMWF analysis winds:
Mean Significant wave height difference (m)

46r1 ENS scorecard

https://confluence.ecmwf.int/display/FCST/Implementation+of+IFS+cycle+46R1

Based on about 240 model runs for verification against analysis and about 290 model runs for verification against observations

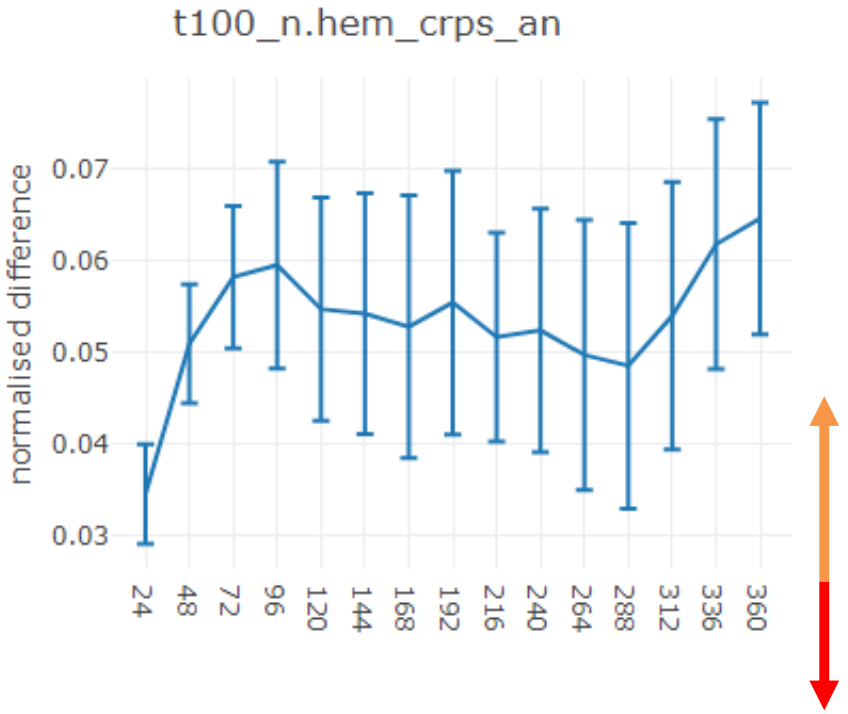
Improvements of 0.5-4% for most parameters, levels, and forecast lead times

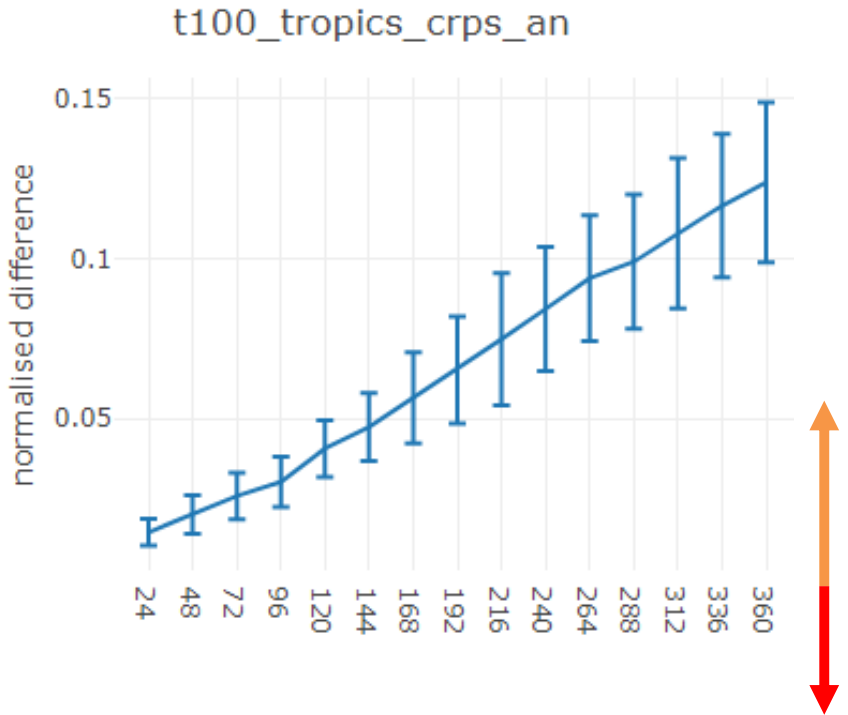
Further ahead

- 47r1
- Suites for Bologna
- Exploitation of existing and new observations
- Coupled modelling and DA
- Scalability and taking advantage of new technology

137 levels vs 91 levels ENS scores

Experiments: TCo639, 10 members, 91 levels, June-August, 44 inidates

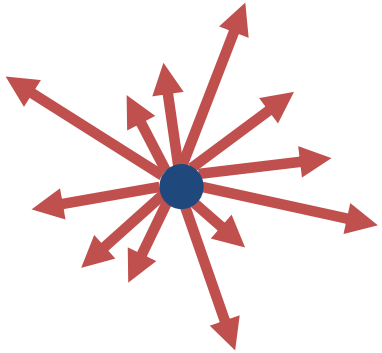




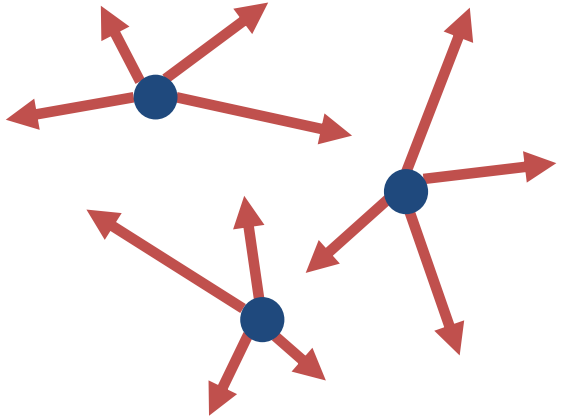
Re-centring with multiple centre analyses

Here: centre on a small number of HRES like analyses with different satellite obs selection for thinning. No model unc. representation and obs perturbations in the centre analyses to limit sampling uncertainty (see Hólm, 2018 for details).

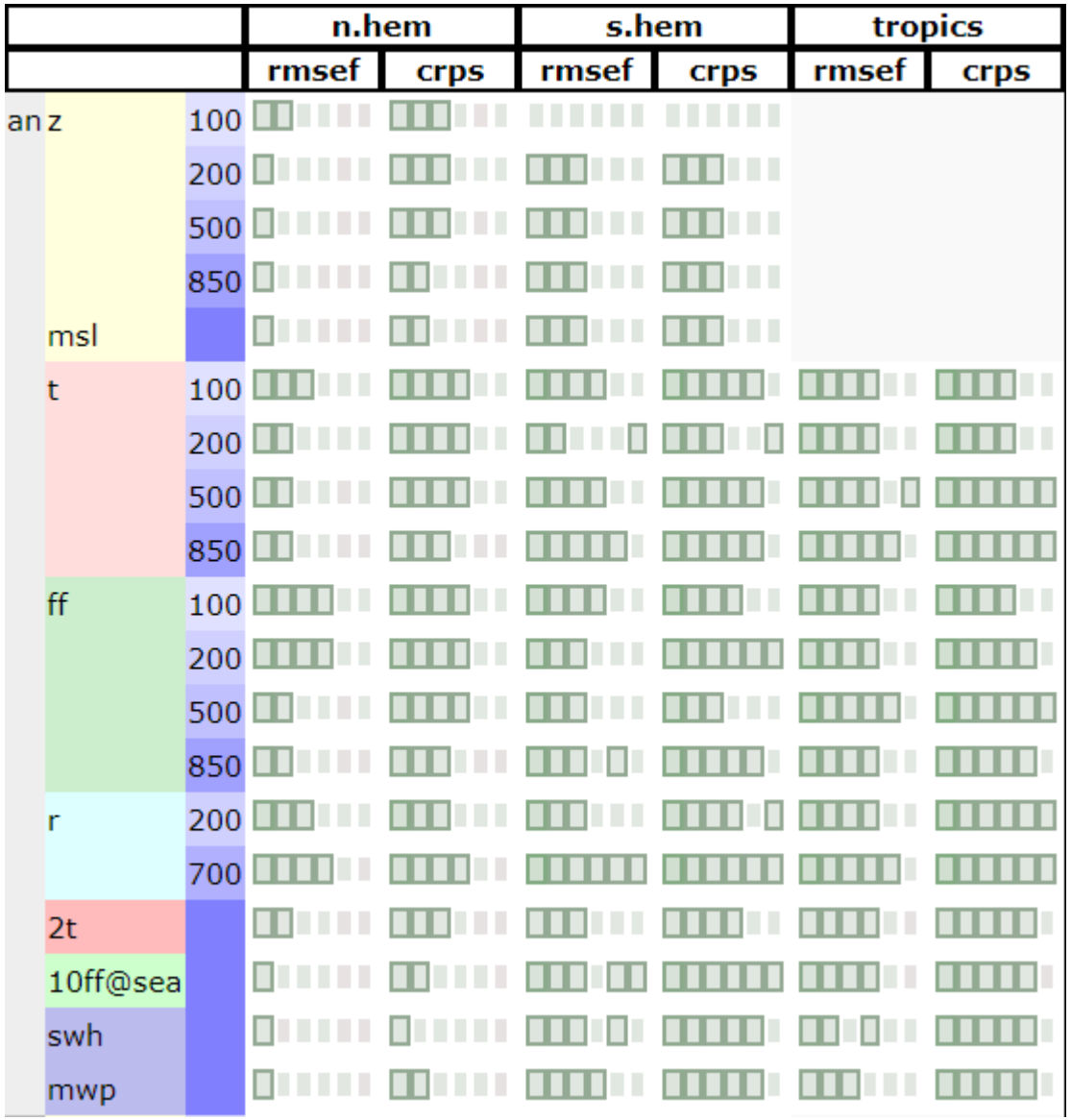
Re-centre perturbations on single Analysis



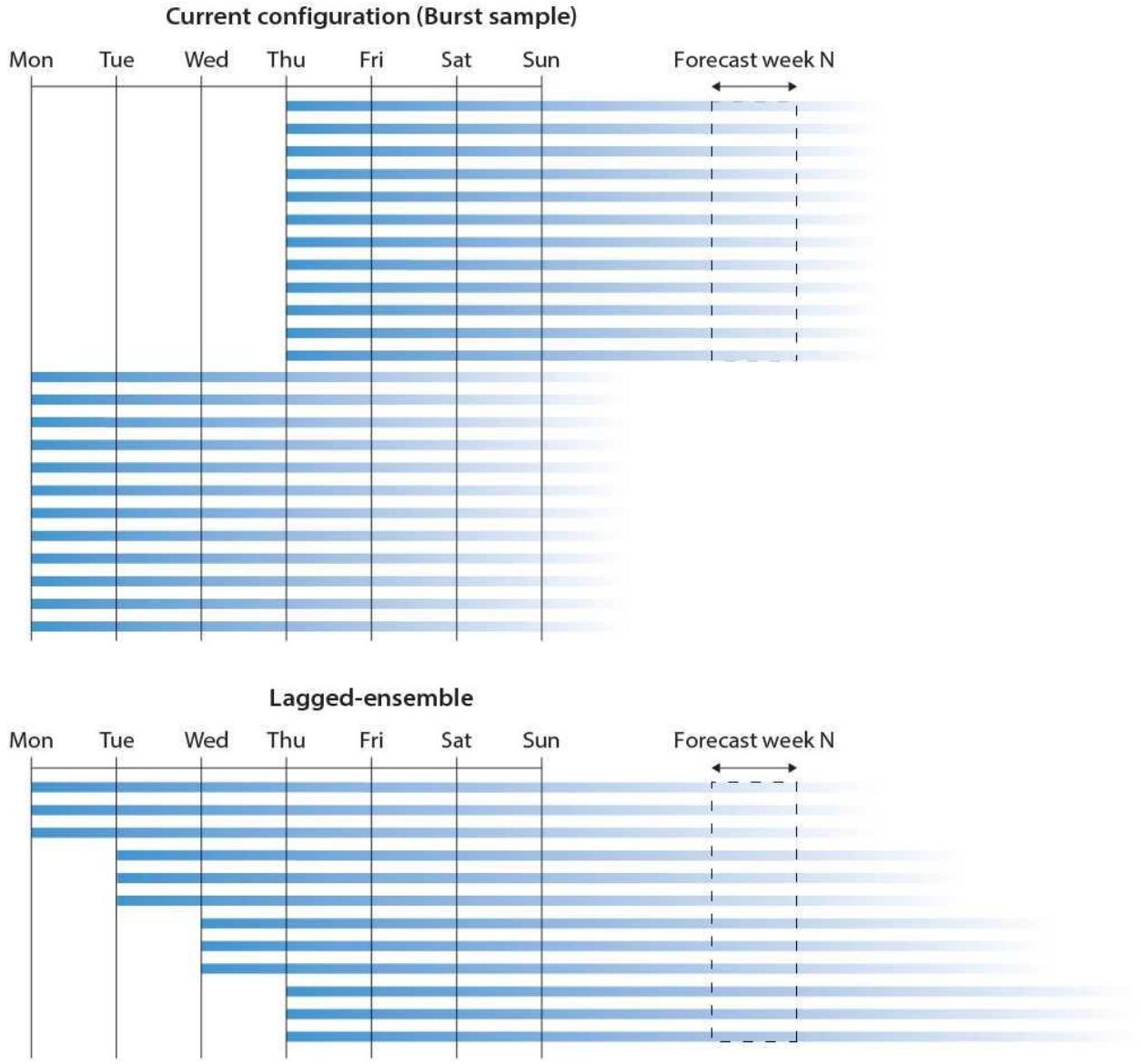
Re-centre perturbations on multiple Analyses



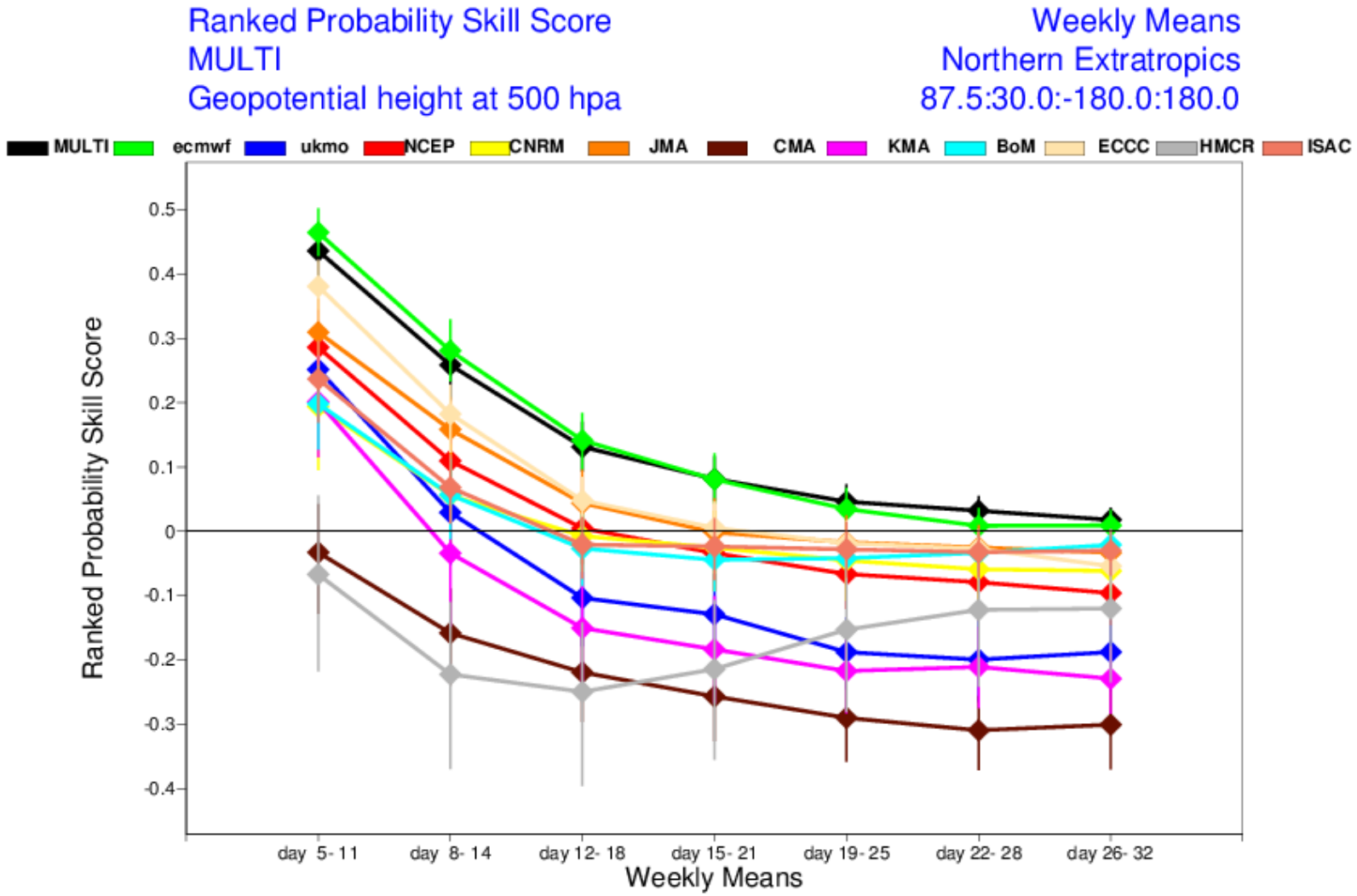
TCo639 experiments Analysis + ENS, verified against Oper



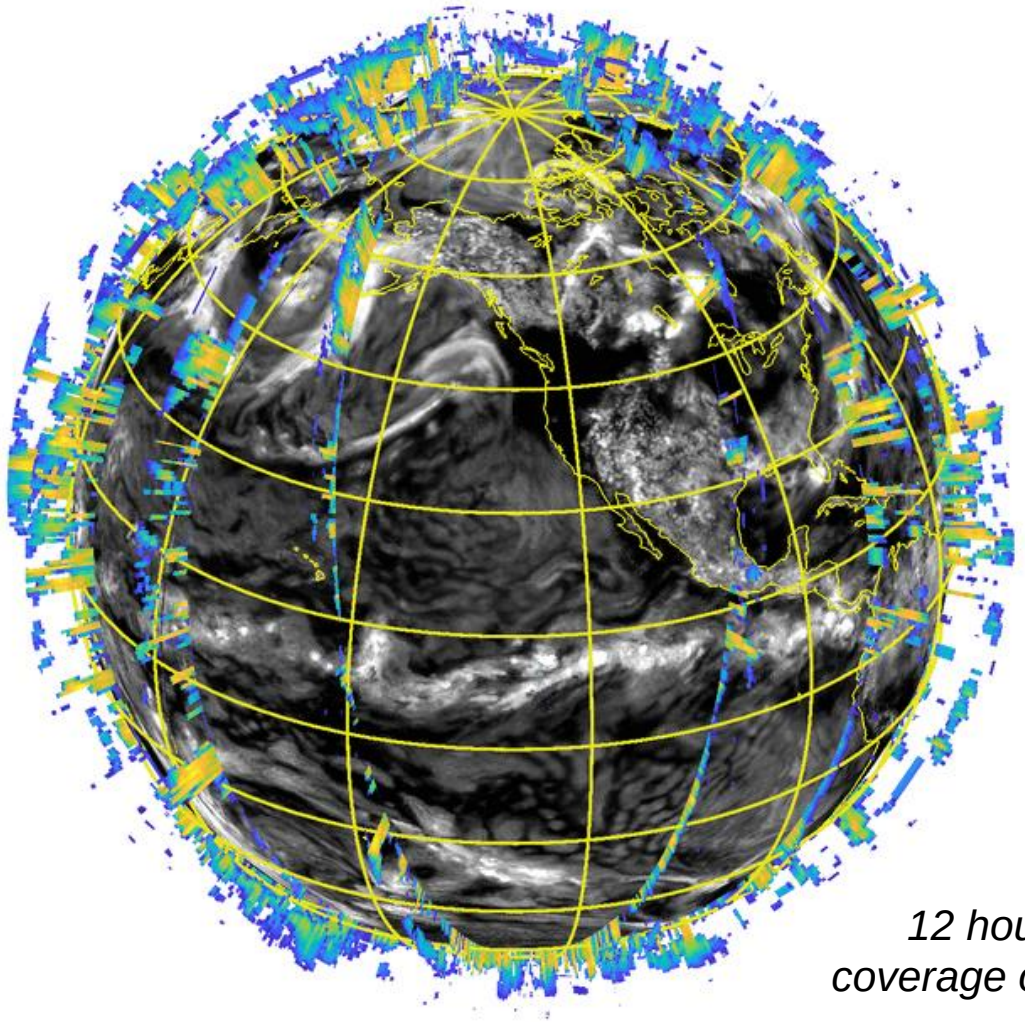
Extended range suite design



Collaborations and serving community: S2S project



First-ever direct 4D-Var assimilation of space-borne cloud radar and lidar in NWP

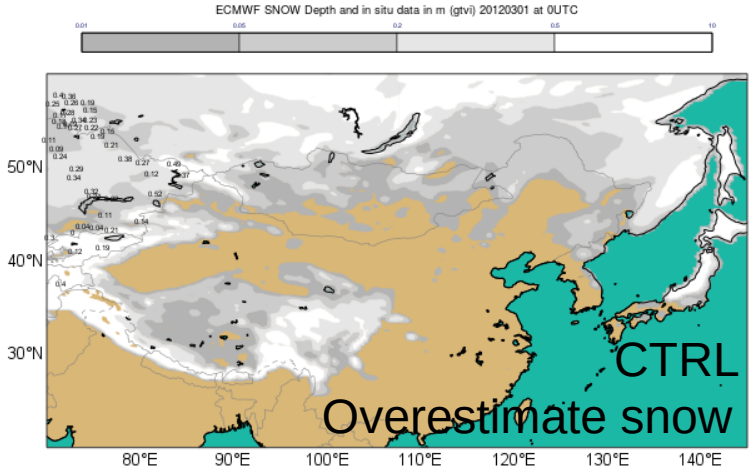


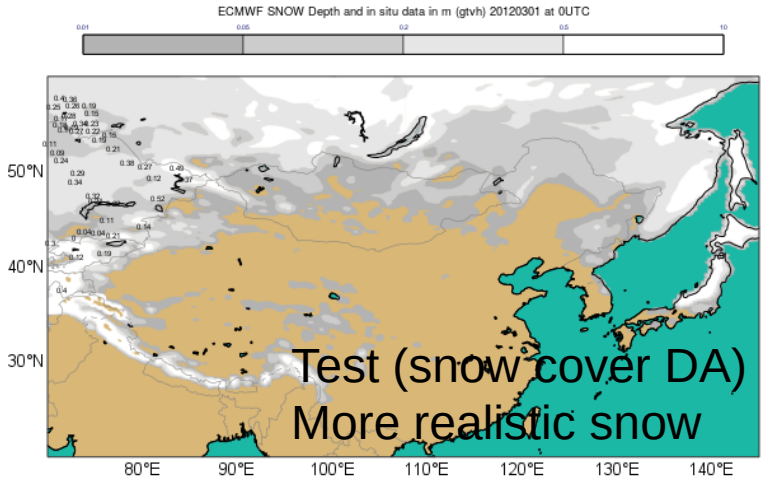
12 hour Cloudsat coverage on model cloud field

- Novel observation type: challenge to implement and for 4D-Var linearized cloud physics, but promising results

- Enables observation monitoring:
  - simplify model evaluation
  - real-time monitoring could help detect instrument issues faster than observations alone

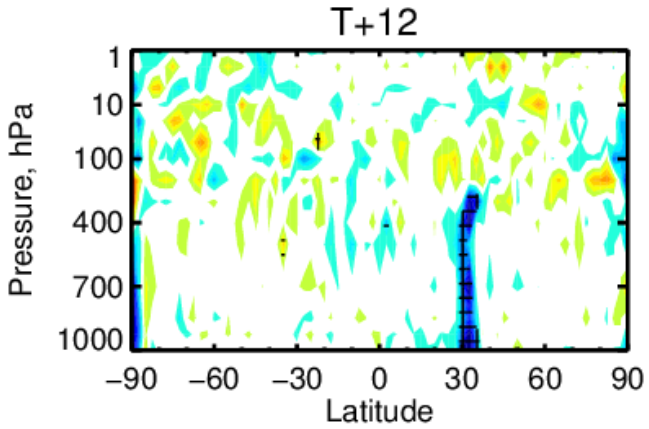
Snow cover data assimilation over the HTP

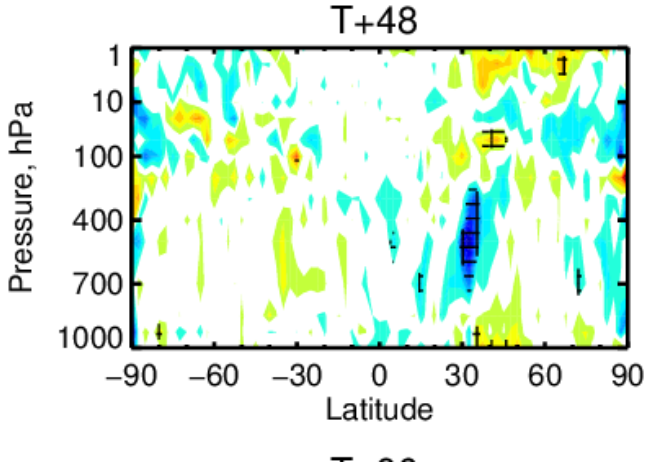




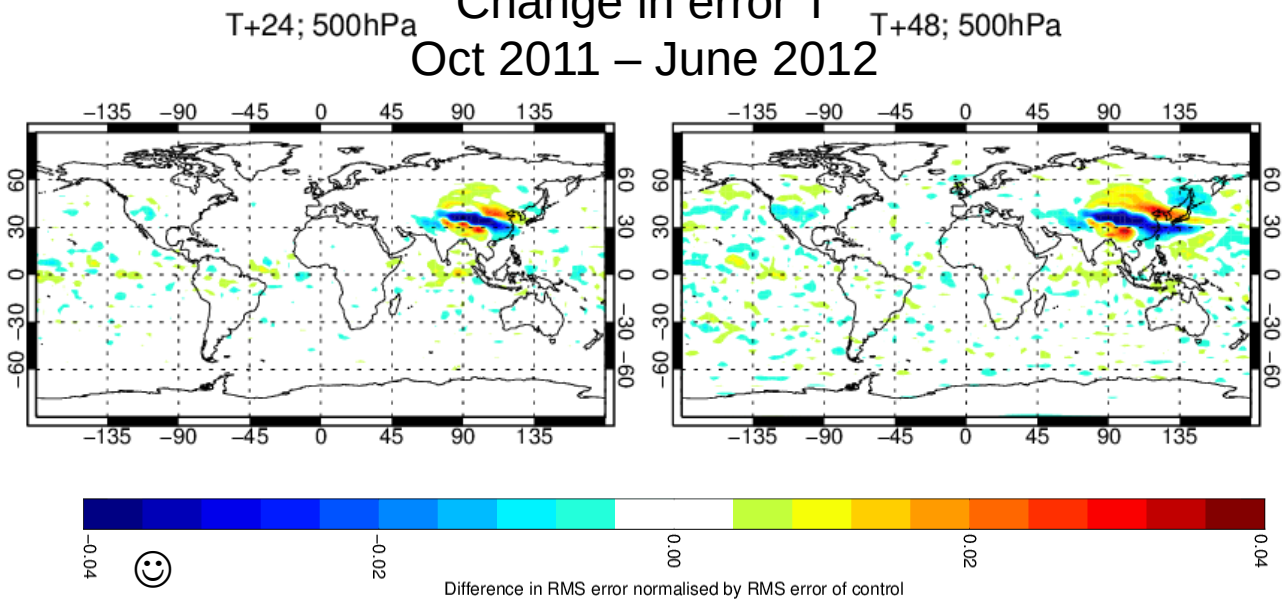
Impact on albedo and momentum
→ Modifies the jet circulation

Change in error R
Oct 2011 – June 2012

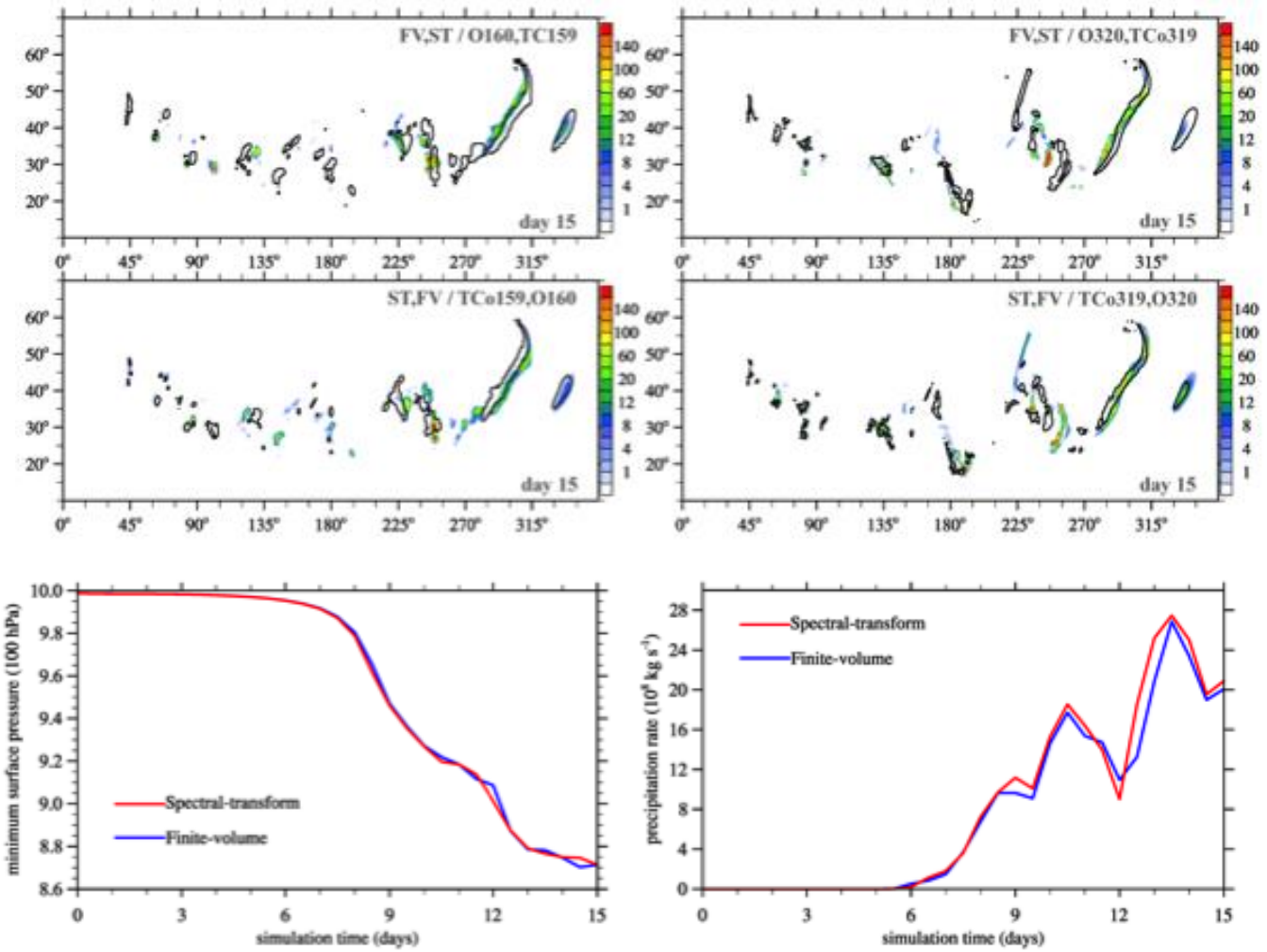


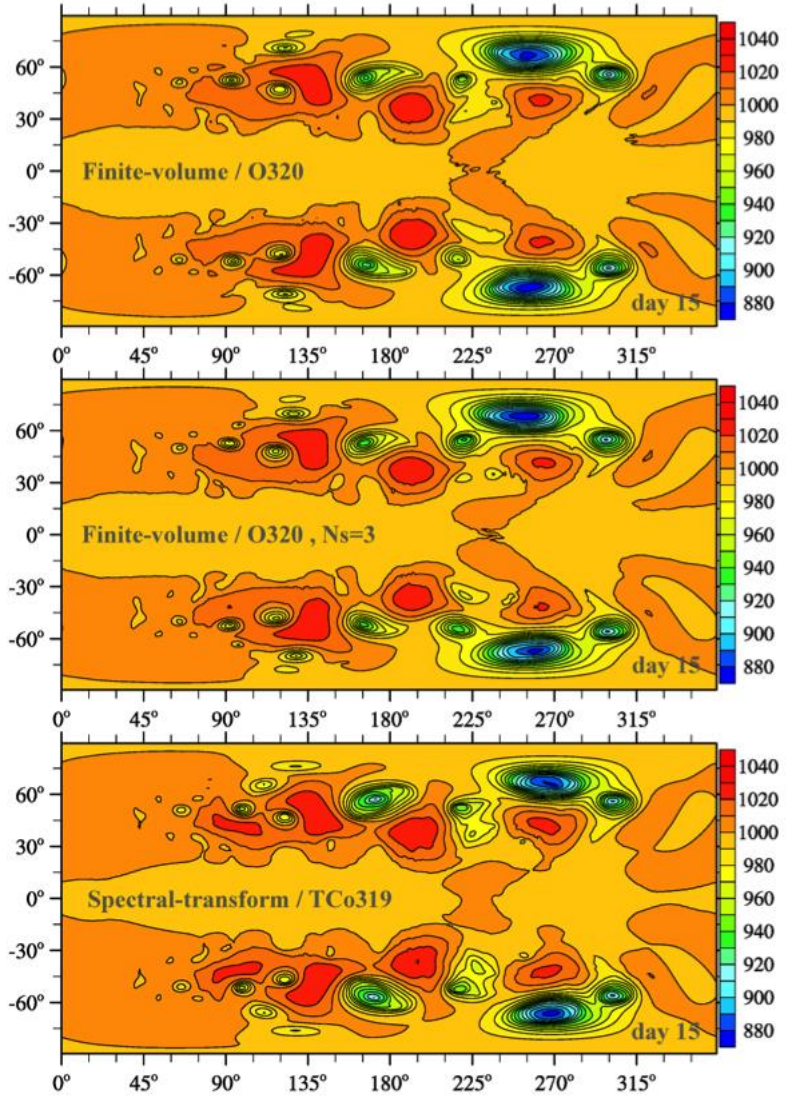


Change in error T
Oct 2011 – June 2012



Finite-Volume Module of IFS: moist-precipitating dynamics and coupling to IFS physical parametrisations





Results for IFS-FVM coupled to IFS cloud parametrisation

Investigating the potential of machine learning

Data acquisition

Forecast run

Product generation

Dissemination

RMDCN

Internet

Web services

Internet

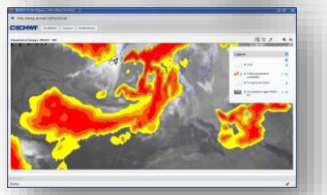
Archive

Data Handling System

- quality control
- adaptive thinning
- adaptive bias correction

- surrogate model components
- tangent-linear/adjoint models
- error covariance statistics

- adaptive information extraction (resolution, ensembles, features)
- data compression
- integration of downstream applications



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- Seamless earth system approach to modelling and analysing
- Ensemble prediction at 5km
- Scalability across the NWP chain

- Good progress against strategy
- Prediction quality improving
- More to come!

ECMWF