Overview of RT2, RT8 and RT11

ACCORD – ASW

Ljubljana, 4-8 April 2022

Presenter:

Erik Gregow (FMI)

Contributors:

Research Team (RT) leaders and RT participants

RT2: Initialisation and spin-up in nowcasting

Co-leaders: Carlos Geijo, Florian Meier and Magnus Lindskog
Wiki-page: https://opensource.umr-cnrm.fr/projects/accord/wiki/RT2

Topics addressed and examples of ongoing work

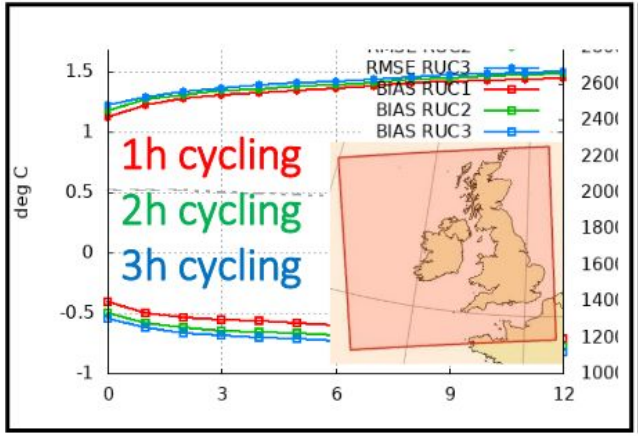
- Studies about cycling strategy with different intervals for nowcasting
- Diagnostics of spin-up using ECHKEVO and DDH, and reduction of spin-up (DFI)
- Observations and products suitable for nowcasting
- Initialisation techniques suitable for nowcasting; Cloud-initialisation, FA and VC

RT2 - Comparing 1h/2h/3h cycling with same resolution (different domains)

- Short range forecasts of dry parameters (such as T2m) generally better with 1h-cycling
  - But this is not the same for moisture variables.
- No benefit for summer period using 1h-cycling UA-DA and 3h-cycling SFC-DA (most right fig.)

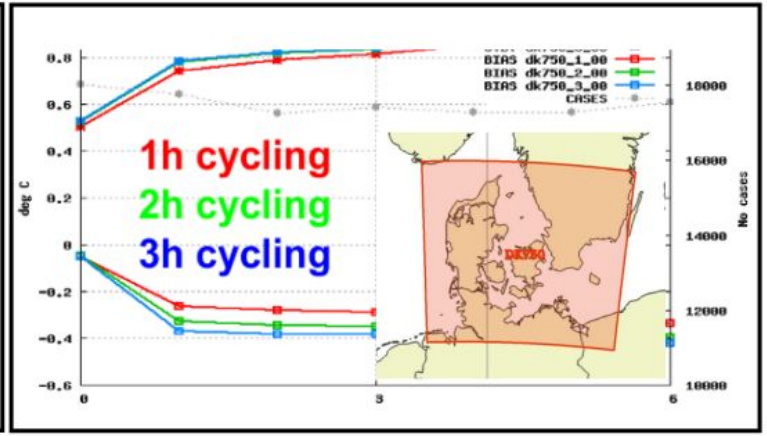
Several 1-2 h cycling setups reported improvements for dry variables (more problems with wet variables)

Spring
T2m (STD & BIAS)



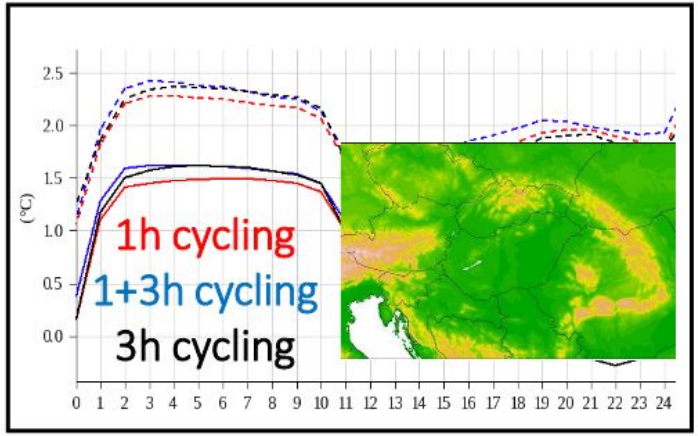
Forecast length (h)

Autumn
T2m (STD & BIAS)



Forecast length (h)

Summer
T2m (RMSE & BIAS)



Forecast length (h)

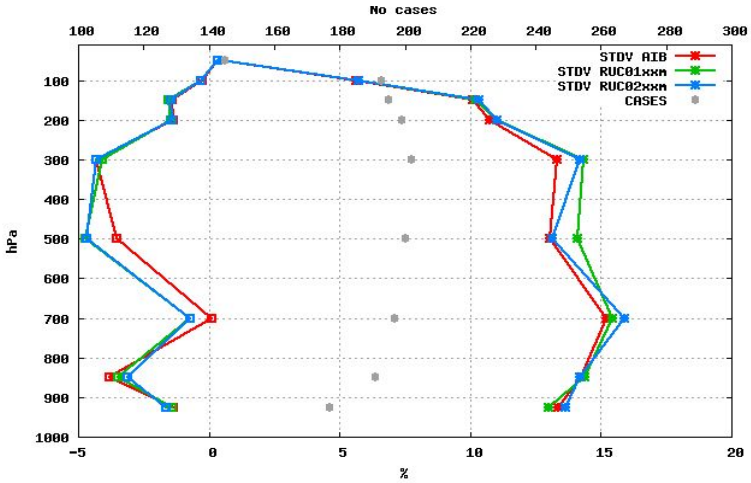
E. Harney, X. Yang, K. Szanyi et al. *(Met Eireann, DMI, OMSZ)*

RT2 - Cycling strategies - 1h and 2h cycling

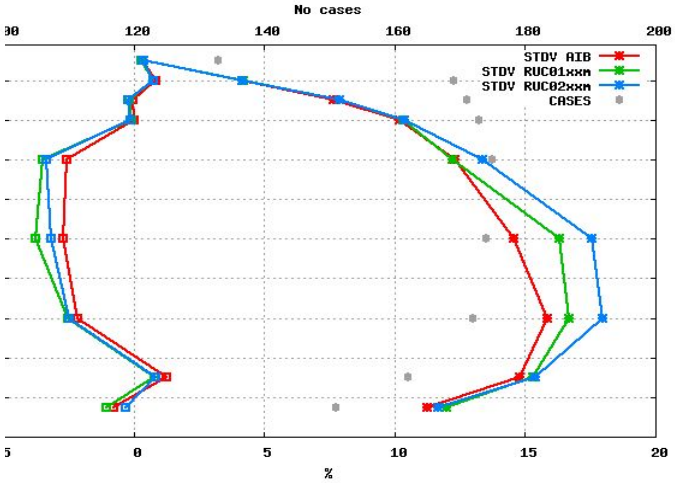
- Important effect on humidity profiles (see differences 00Z and 12Z)
  - There are less radiosonde data at 00h (Lisbon not available)
  - Investigate why 2h cycling is worse
  - Use of radar did not improve
- Wind speed scores also worsen
- We do not expect great improvements with respect to Ref because we are assimilating less upper air information.

Ref - 3h cycling
Exp - 1h cycling
Exp - 2h cycling

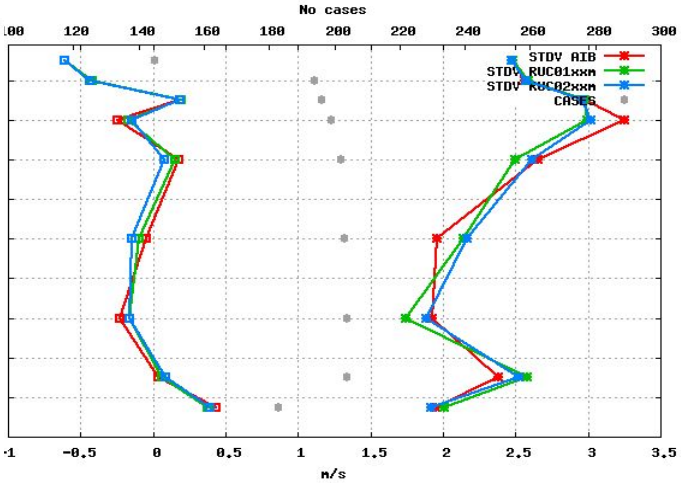
Relative hum. 00Z



Relative hum. 12Z



Wind speed



Javier Calvo, María Díez, Jana Sánchez, Jose Pérez de Gracia

RT2 - Spin-up and initialisation

Spin-up defines the model "noise" at the beginning of forecast, due to the dynamics and physics

<u>Studies with ECHKEVO (model dynamics)</u>

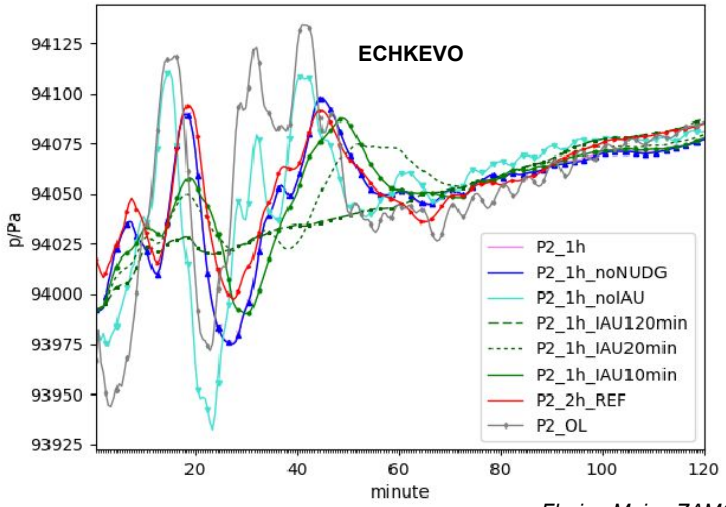
- Use of different IAU settings to reduce spin-up
- On-going work on centered IAU

<u>The use of DDH (model physics) tool is to be tested</u>

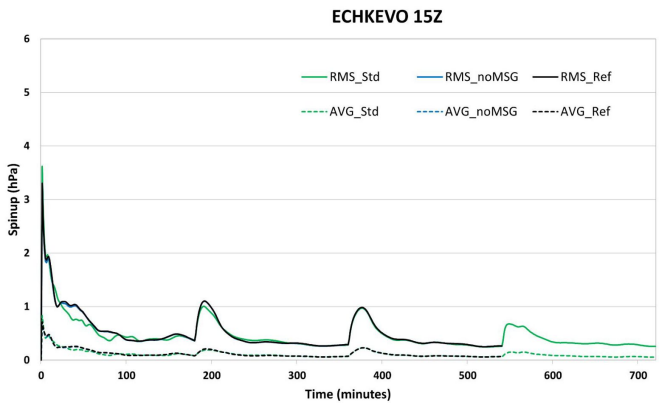
<u>Digital Filter Initialisation (DFI)</u>

- In the blending procedure to produce initial conditions
- Extract the larger scales from the host model fields

Work related to RT8



Florian Meier, ZAMG

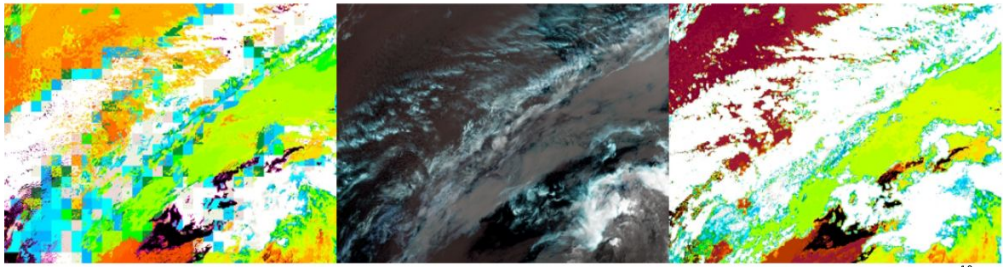


Alina Lerner, ESTEA and Erik Gregow, FMI

RT2 - A selection of observations and products looked into

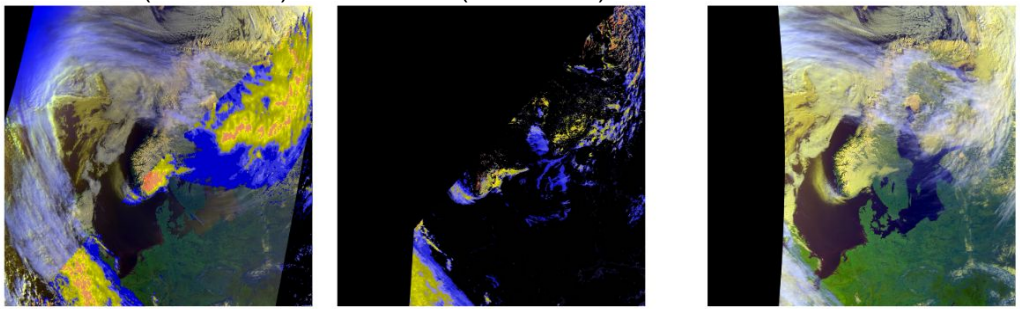
Machine Learning (ML) enhanced cloud-top products
Potential to improve many cloud products

Old cloud height | Satellite image | ML cloud height



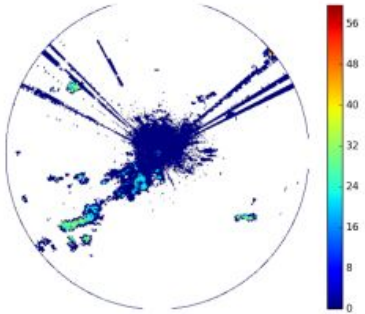
Use of optical thickness to identify multilayer clouds
Also during night-time (planned work)

GEO (09:00 UTC) | PPS (08:54 UTC)

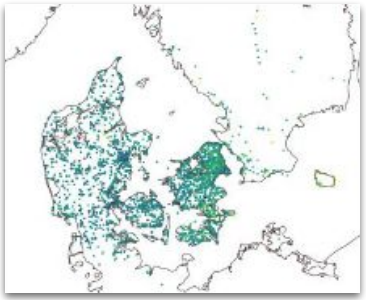


Nina Håkansson, SMHI

Initialisation from radar derived hydrometeors and precipitation etc.
(Overlap with ST4; moving platforms)



Mobile-phone observations including QC
(Related to RT8)



Kasper Hintz, DMI

RT2 - Optimise the 3D construction of clouds, for ingest in Harmonie

Developments with focus on liquid water clouds *(Sibbo van der Veen, KNMI)*

a) Use cloud top heights (Machine learning, trained with Calipso) and cloud geometrical thickness; both are products from SAF CLAAS-3

b) Compute cloud base heights from synop by Kriging per Cloud Type (SAF product) area

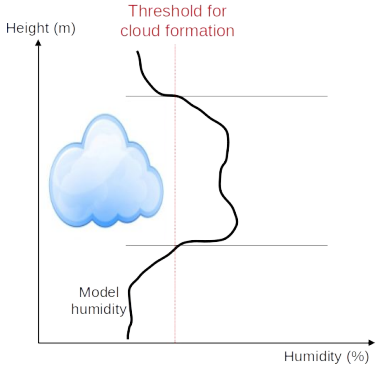
c) Compare cloud top height from a) minus cloud base height from b) with geometrical thickness from a)

d) If difference in c) is small: We have 1 layer
If geometrical thickness << cloud top minus cloud base: We have multi layers

e) Check if assumptions in d) are correct by verification with CloudNet data

Use of cloud initialisation (earlier developments)

- Implemented in MetCoOp-Nowcasting (MNWC)
- Modifications to humidity profiles, after analysis
- MNWC to become operational (summer 2022)



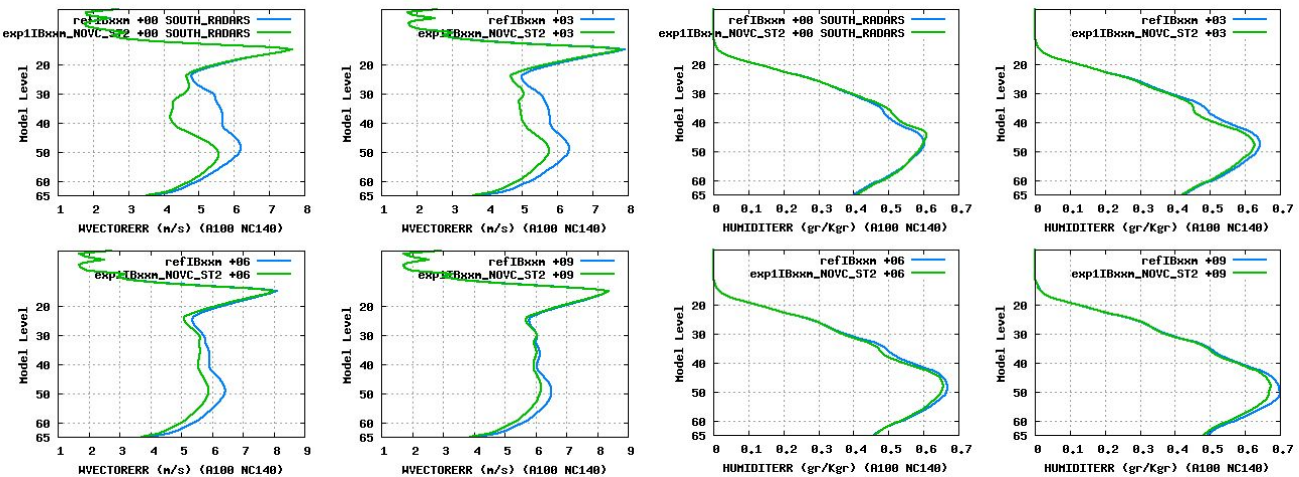
Erik Gregow, FMI

RT2 - Field Alignment (FA) and Variational Constraints (VC)

FA and VC software integrated in cy43h2
Tested with hourly DA and synthetic radar Obs.
FA now available as stand-alone application (easier to use)

FA validation results looks good

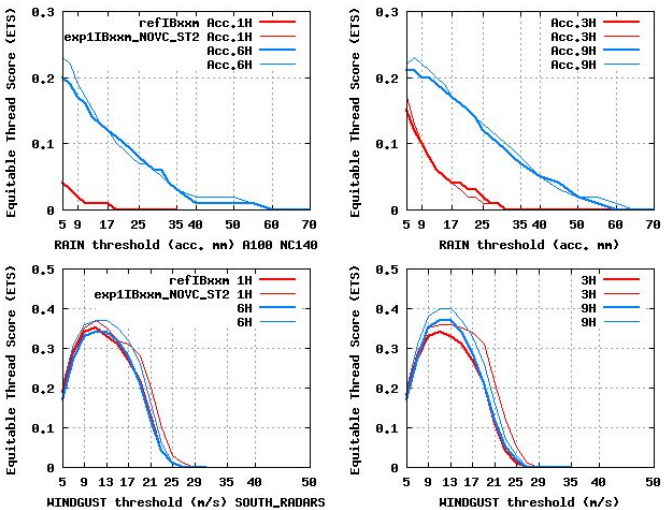
Impact on wind-gust and humidity is positive
Even if humidity is not assimilated in these validation exp.



Wind-gust (MAE)

Relative humidity (MAE)

Clear positive impact on the wind-gust
Less impact on the rain (ETS scores)



Wind-gust (ETS)

Carlos Geijo, AEMET

RT8: Sub-hourly RUC and continuous DA

Co-leaders: Xiaohua Yang, DMI and Erik Gregow, FMI
Wiki-page: https://opensource.umr-cnrm.fr/projects/accord/wiki/RT8

Topics addressed and examples of ongoing actions

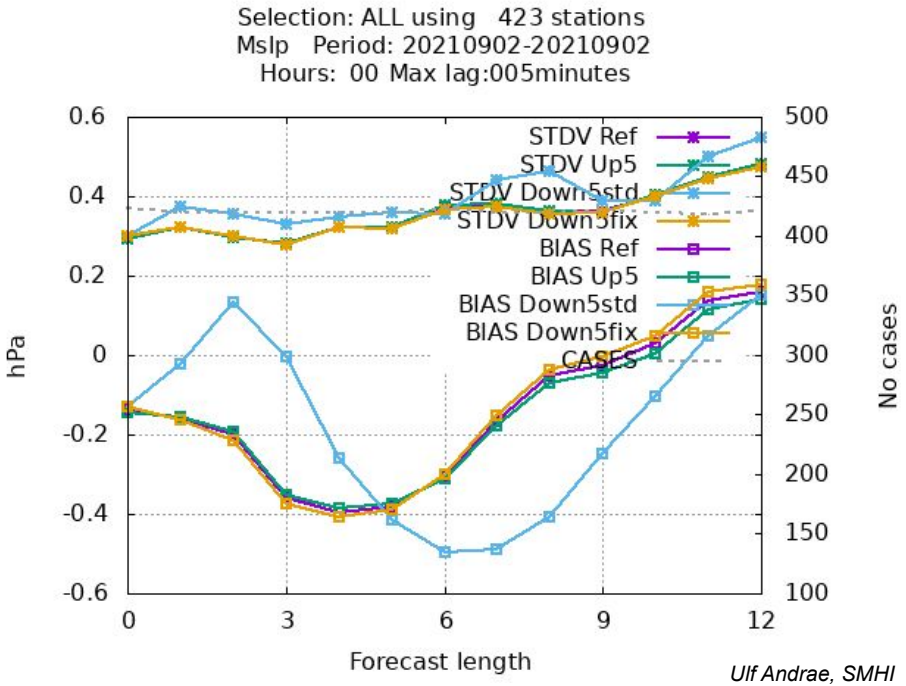
- Sub-hourly launch, with start of cycling window at sub-hour
- Conceptual test of hourly 4DVAR back-to-back with long assimilation window
- Smart-Phone Observations (SPO)

RT8: Sub-hourly cycling developments

- Option to start, cycle & output on the accuracy of minutes in CY46 branch
- Tested on ECMWF HPC in standard AROME with 3DVAR, CANARI (oi_main) using conventional observations forced with ECMWF HRES data
- Some problems discovered; investigate if related to data-assimilation (DA) or lateral boundary conditions (LBC)

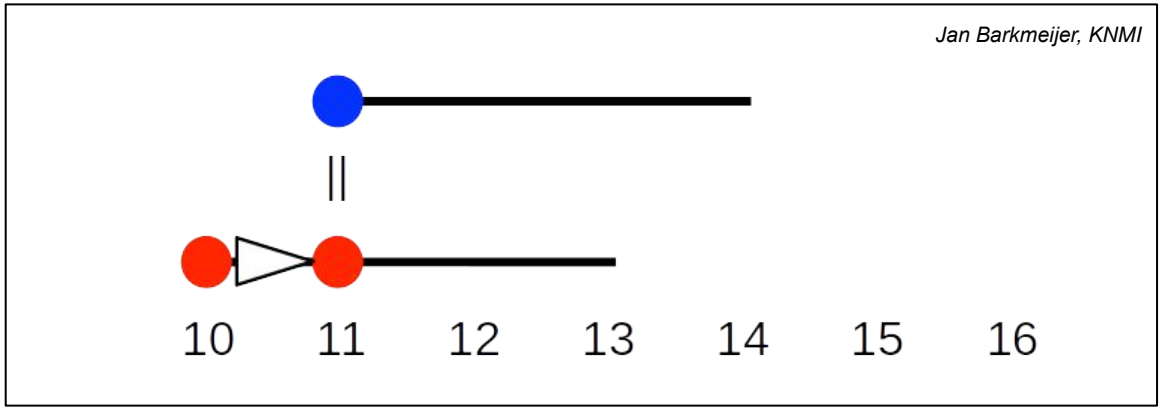
First tests indicate that DA works correctly and LBC handling needs further investigation

Ref - Reference
Up5 - DA shift +5min
Down5std - DA shift -5min, LBC early
Down5fix - DA shift -5min, LBC later



Ulf Andrae, SMHI

RT8: Hourly cycling with default 4DVAR set-up



- Analysis at beginning of the 3h observation window is propagated for 1h
- Provides first guess for next cycle
- Two strategies have been tried to prevent double use of observations in subsequent cycles:

  i) no obs in the ‘middle hour’, or ii) only recent obs from the final hour

⇨ Further work is required to study properties (e.g. convergence)

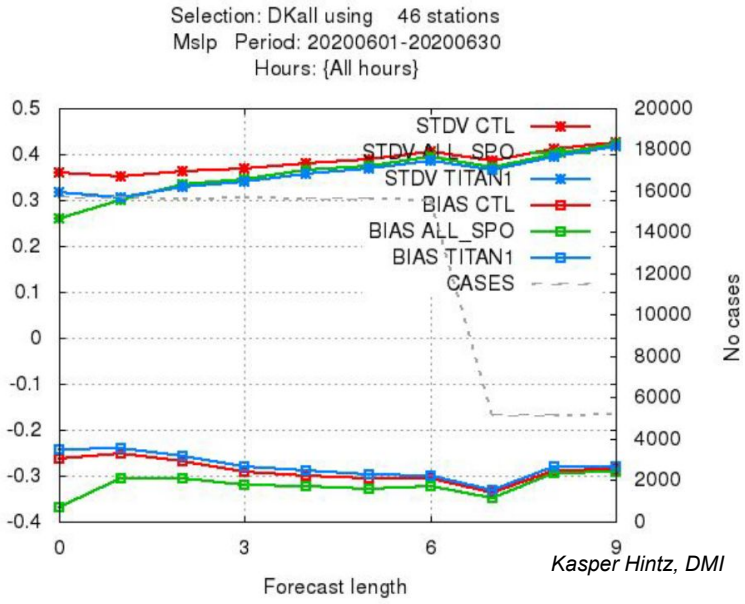
RT8: High resolution and crowd-sourced observations

Observation type
- Smartphone Pressure Observations (SPO's)

Observation collection
- Software Development Kit (SDK)
- SMAPS - "Not an app", but installs into native apps
    - IOS
    - Android

Observation sources
- DMI Weather App.
- "Weather from DMI & YR, by SFS Development

QC methods used
- Titan
- Machine Learning (ML)



Red - Reference, No SPO
Green - No Screening (inflated obs err)
Blue - QC done with Titan

<u>Configuration:</u>
3DVAR, 750m hor. res., DK domain, SPO's subtype to synop, Obs. err.=160pa

RT11: Assimilation and quality control of observations at appropriate scales

Co-leaders: Máté Mile, Phillip Scheffknecht, Florian Meier

Wiki-page: https://opensource.umr-cnrm.fr/projects/accord/wiki/RT11

Topics addressed and examples of ongoing actions:

- Quality control and background errors in observation space, observation errors
- Spatial representation error (HR obs vs LR model; LR obs vs HR model)
- Diagnostics and verification

RT11 Quality control issues

- For the background check in QC, background errors needs to be represented in observation space. This is specified in Grid-point σ_b maps (named as errgrib file).

- There are issues and questions related to the errgrib (discussion during the 1st video meeting of RT11):
  - Is it appropriate for mesoscale LAM DA?
  - Is there a better representation of mesoscale LAM σ_b maps?
  - How to compute this properly? Using an ensemble? Combination of an EPS and the climatology? Daily update, flow dependency?

- The application of VarQC (ZAMG example) was also discussed during the video meeting and would be interesting to further test in mesoscale DA.

RT11 Correlated observation errors

- The inter-channel error correlations for IASI/CrIS is planned to be studied in Harmonie-Arome DA in the future.

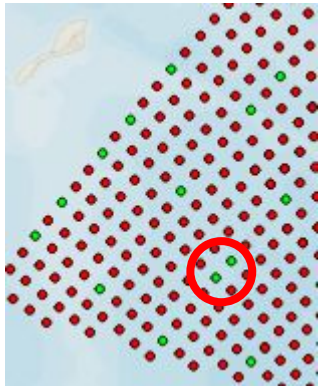
RT11 Spatial representation error in mesoscale DA

1. High-resolution observations in coarser resolution LAM models - *Data thinning, superobbing, observation error inflation*
2. Low-resolution observations in high-resolution LAM models - *Supermodding, footprint operators*

<u>1 - Data thinning:</u>

- Weakness of the original algorithm: radiance, scatterometer, crowd-sourced observations

Example: Scatterometer ASCAT coastal product 12.5 km sampling



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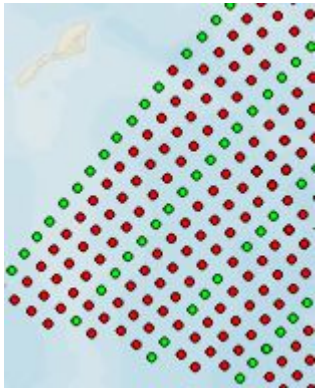
(NTHINSCA = 4)



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(NTHINSCA = 4)

RFIND= 12500; RMIND=7500
NTHINSCA = 1

RT11 Spatial representation error in mesoscale DA

2 - Supermodding, footprint operators

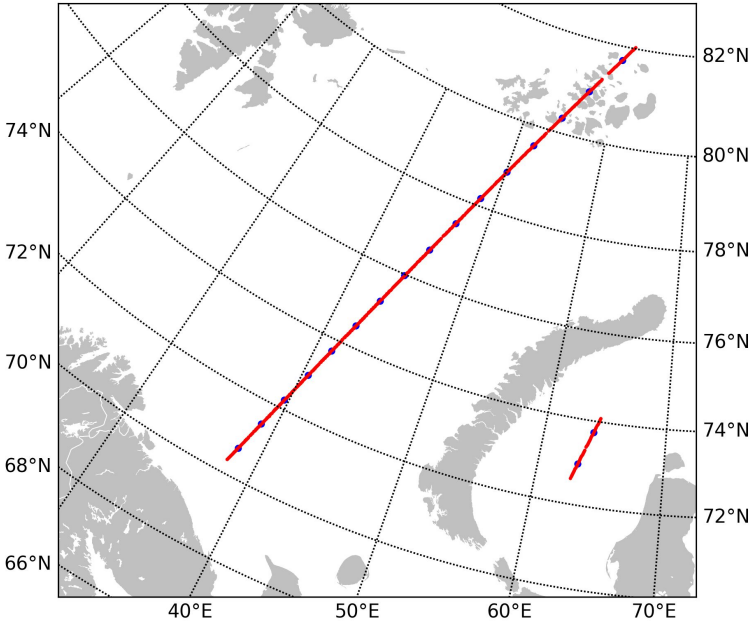
Scatterometer, Aeolus, and radiance data are being tested so far.

- Such operator is efficient when the model variability over the averaging size is comparable or higher than the corresponding observation error.

- Multi-incremental 4D-Var needs different settings in HR trajectory runs and LR minimization.

- The impact on large scales is maximised and so the forecast sensitivity on longer ranges are usually increased. However, the forecast impact is generally small with the current resolution gap between the model and the data.

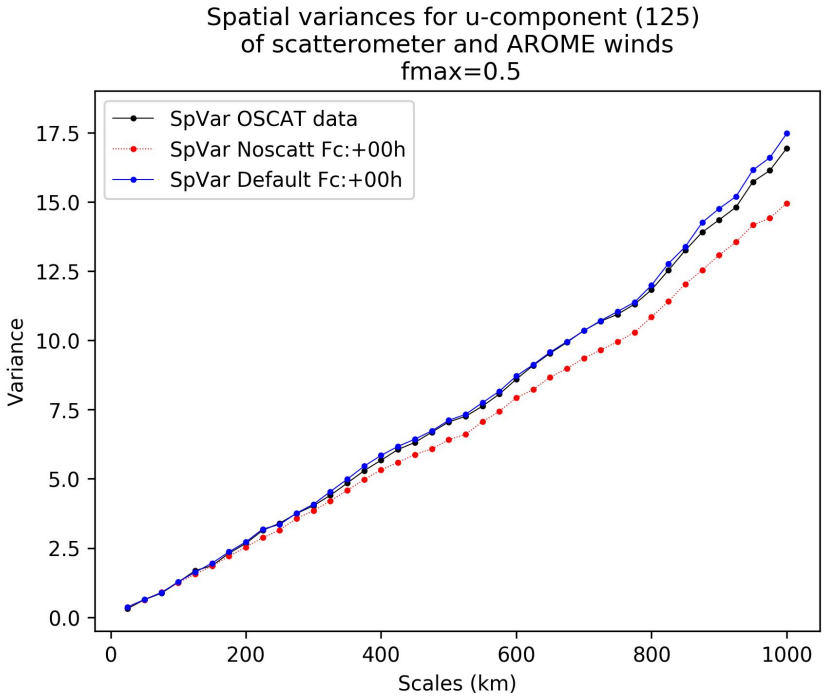
Aeolus Rayleigh-clear observations (blue) and footprint operator model points (red)



RT11 Spatial representation error in mesoscale DA

More diagnostics, verification techniques are needed

- Scale-dependent verification to mitigate double-penalty effects (Mittermaier, 2014. https://doi.org/10.1175/WAF-D-12-00075.1)
- More departure-based diagnostics (e.g., to use supermodding operator for scale-dependent background information)
- Spatial variances (Vogelzang et al. (2015). https://doi.org/10.1002/2014JC010239)
- Distributional analysis, Spectral analysis, Wavelet analysis (e.g., Lilly, J. M. (2022). https://doi.org/10.5281/zenodo.5977995)



Spatial variance - **OSCAT data (25 km sampling)**
Spatial variance - **AROME-Arctic analysis without ASCAT**
Spatial variance - **AROME-Arctic analysis with ASCAT**

Cooperation with RT10 and ST9