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Sub-km nowcasting ensemble with use of overlapping windows

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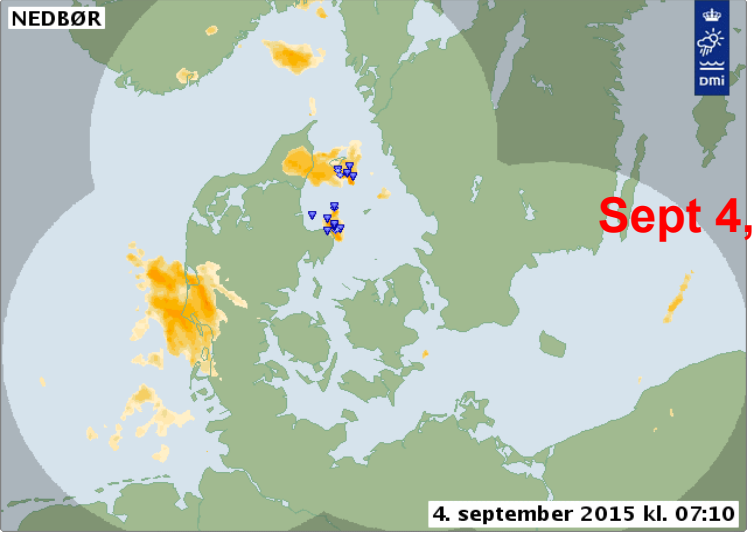
Outlines

Motivation: A forecast capability to warn rapidly developing and extreme convection weather.

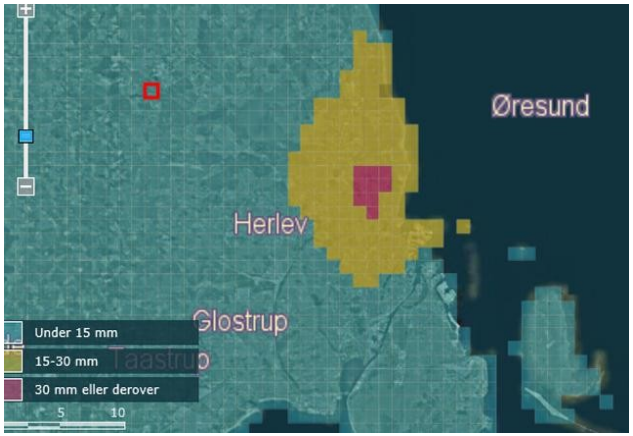
- very short life cycle (1-2 h)
- small scales (few km).

System approach for building sub-km nowcasting ensemble

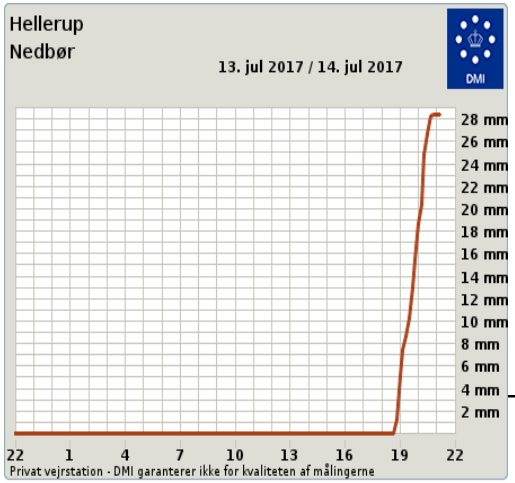
- COMEPS approach: time lagged assimilation cycling with overlapping windows
- Bridging overlapped windows by separation of BG from FG



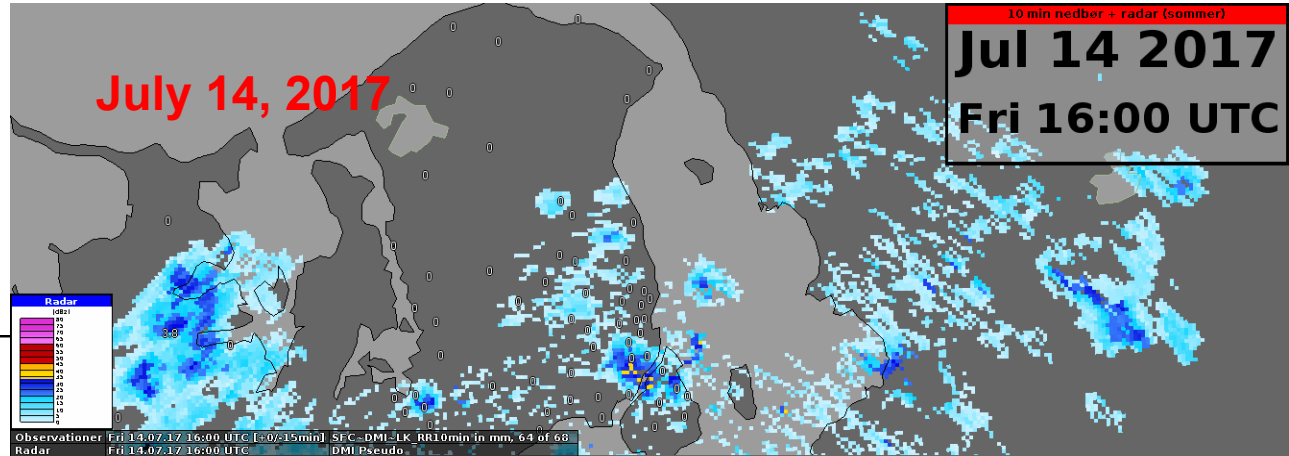
Sept 4, 2015



Some of the cloudburst events in summer Denmark looks extreme... (intensity. duration, horizontal scale)



July 14, 2017



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Nowcasting @DMI: System Targets

- NWP based nowcasting with high resolution that resolves convection
  - (+ radar advection for first 1h)
- Frequent update to assimilate radar and other observation
- With uncertainty information

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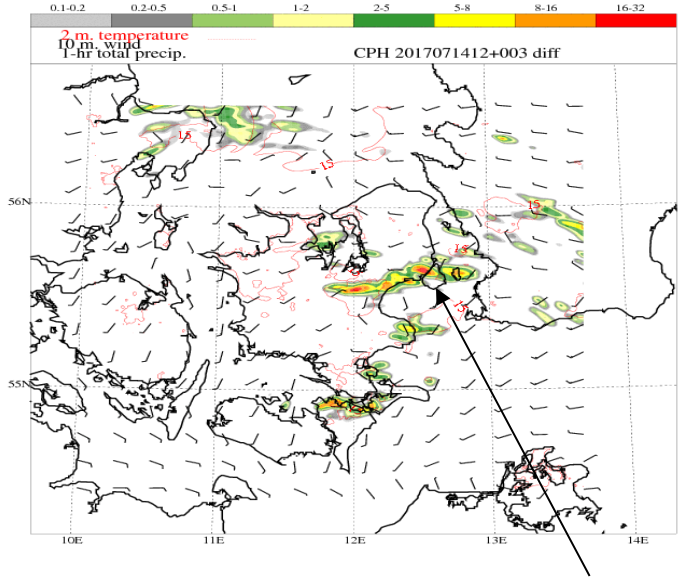
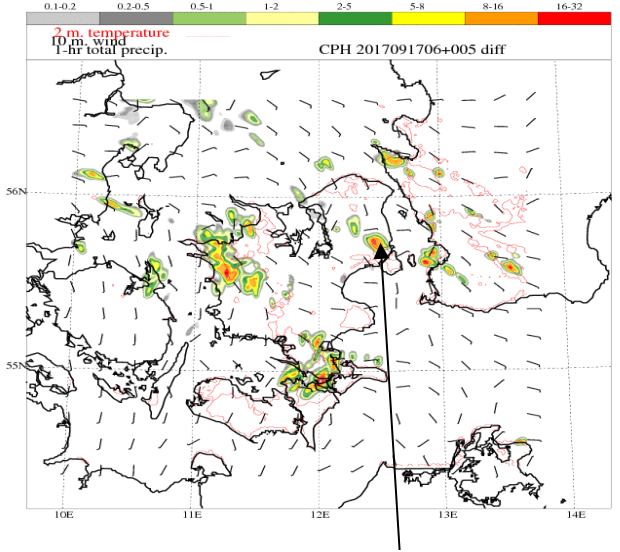
Sub-km Harmonie has potential to model the features!



July 14, 2017, Copenhagen flash flood



Sept 17, 2017, Copenhagen flash flood

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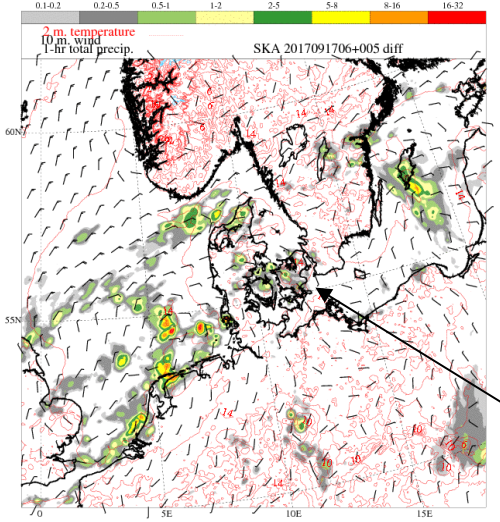
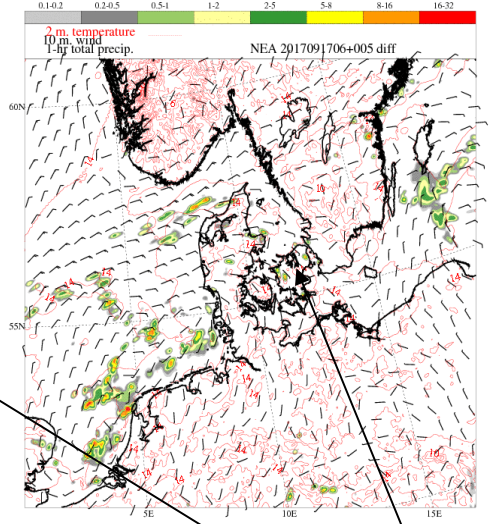
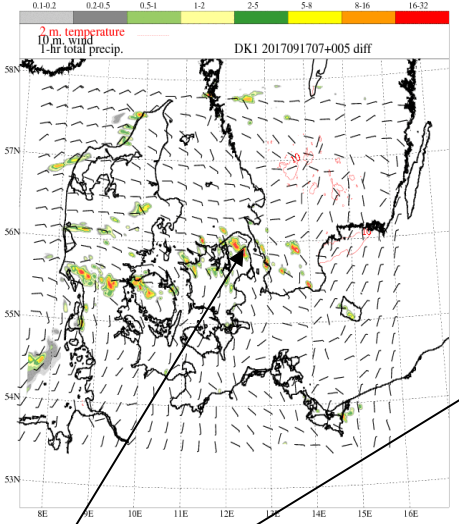
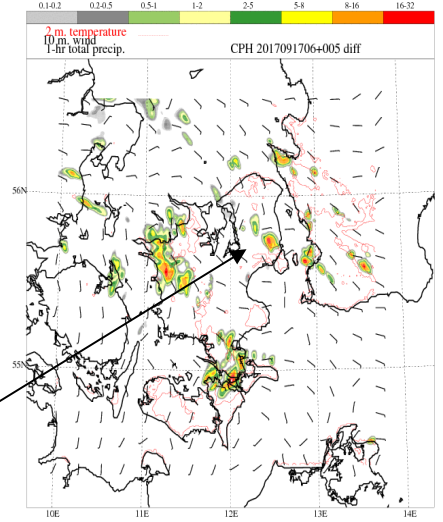
Modeled 1h accumulated precipitation 17 Sept 2017, 11 UTC









SKA-3 km

NEA-2.5 km

DK- 0.75 km

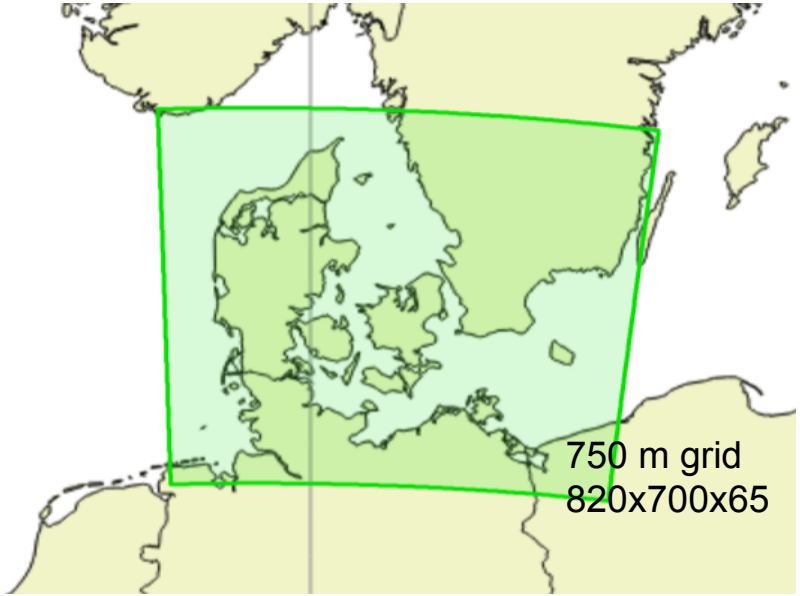
CPH- 0.5 km

Short range forecasts has progressively increased skills in prediction of strong convection... ...

Harmonie-Arome Nowcasting @DMI, 2018

Prototype:
2 parallel 3DVAR suites with 2h cycling,
one runs at even hour,
another at odd hour
3DVAR, 6h forecast
Nested to 2.5 km COMEPS control
Launch time point:15min after hour

Target:
Every 10 min
Nested to 2.5 km COMEPS
Lagged ensemble
Delivery time: < 45 min
Update continuously



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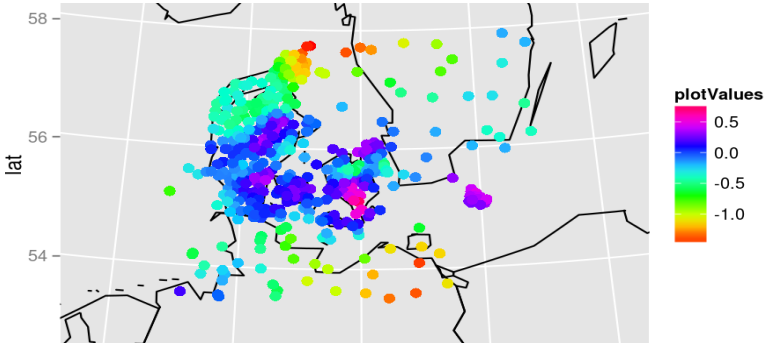
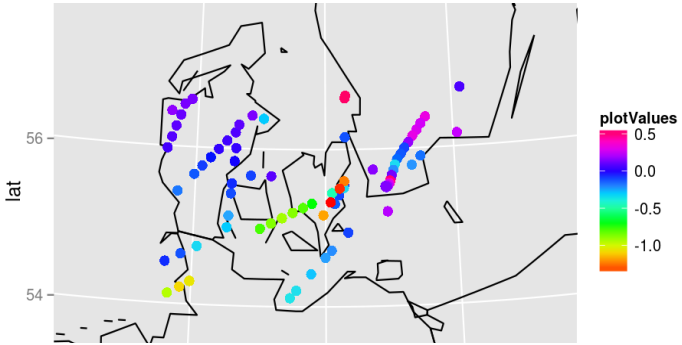
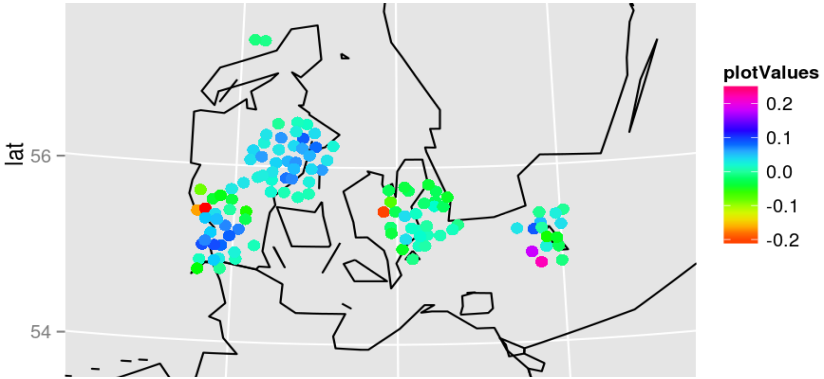
SYNOP, T2M





Aircraft, U



Radar reflectivity, RH

Analysis increment with 3DVAR
17 Z 2 March 2018
Nominal data window 16-18Z, cutoff 17:15Z

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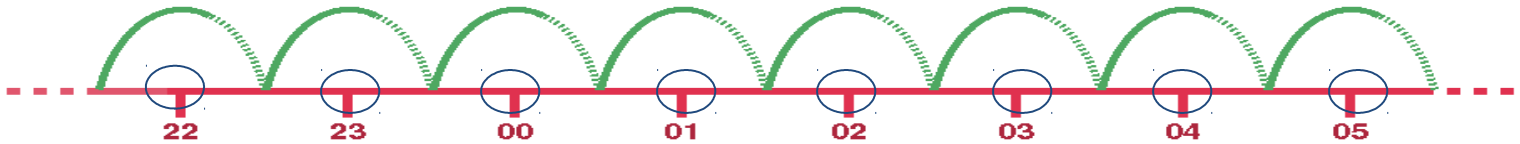
How to achieve frequent analysis update?

Intermittent data assimilation cycling



Assimilation window 1h
Background and first guess from 1h forecast of previous cycle

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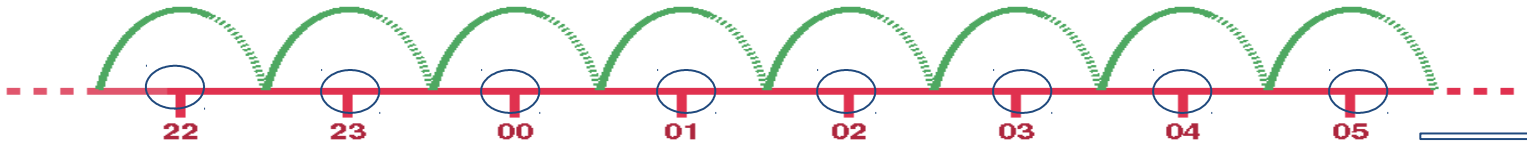
How to achieve frequent analysis update?

Intermittent data assimilation cycling



Assimilation window **2h**, allowing more observation data
Background and first guess from **2h** forecast of previous cycle

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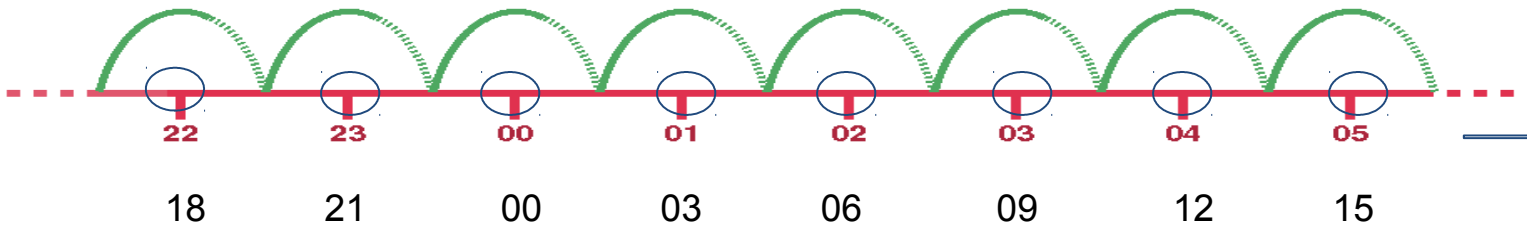
How to achieve frequent analysis update?

Intermittent data assimilation cycling



Assimilation window **3h,** allowing more observation data
Background and first guess from **3h** forecast of previous cycle

Continuous Meso-scale EPS@DMI (COMEPS)
Hourly analysis with 3-h cycling on partially overlapped windows

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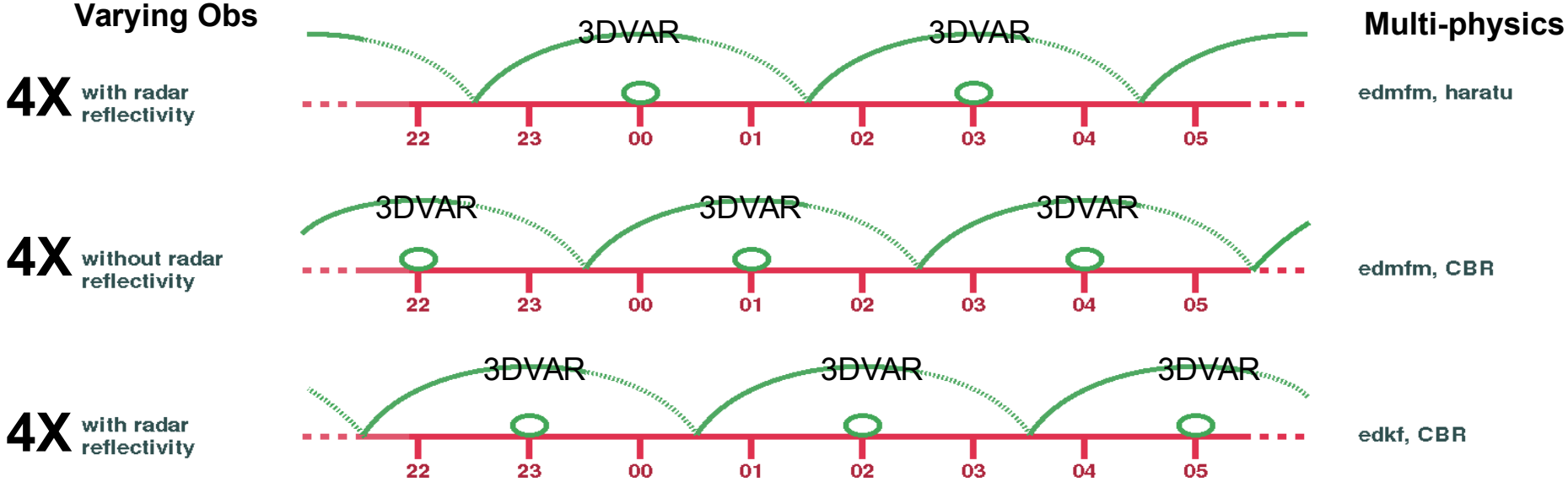
Varying Obs | **Multi-physics**



Use of parallel suites, overlapped windows in COMEPS enables a continuous and even distribution of EDA/EPS runs and to generate larger number of EPS by time lagging. Hourly EPS can be generated around clock.

Cycling approach for COMEPS (hourly analysis, 24 member ensemble)

- Hourly analysis with 3h assimilation cycling over partially overlapped windows
- Control: EDA along time
  - Varying observation data stream: (radar reflectivity, radiance... ...)
  - Model perturbation
  - Combination of comparable physics option
    - Turbulence, microphysics, radiation, diffusion, ...
  - Dynamic options (horizontal diffusion,...)
  - Surface perturbation
- 4 perturbed members each hour; SLAF for lateral boundaries
- Time lagging using model data in the latest 6 h
- 3 parallel suites running on partially overlapped windos, mutually independent

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COMEPS cycling approach applied to nowcasting

Frequent analysis & Long assimilation window

- Utilizing frequent radar observation (10 min update) to follow evolution of convection, such as on convergence zones, open/closed cell convection, sea breeze fronts etc.
- Long observation window to enable better use of longer delivery data such as satellite obs, sonding, aircraft

Better room for 'expensive schemes' such as 4DVAR

Evenly distributed computation tasks

Continuous generation of forecast products

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COMEPS, hourly analysis

Hourly suite
3-h window
Control EDA
Perturbed runs
3 independent
parallel suites
with hourly
shifted basetime

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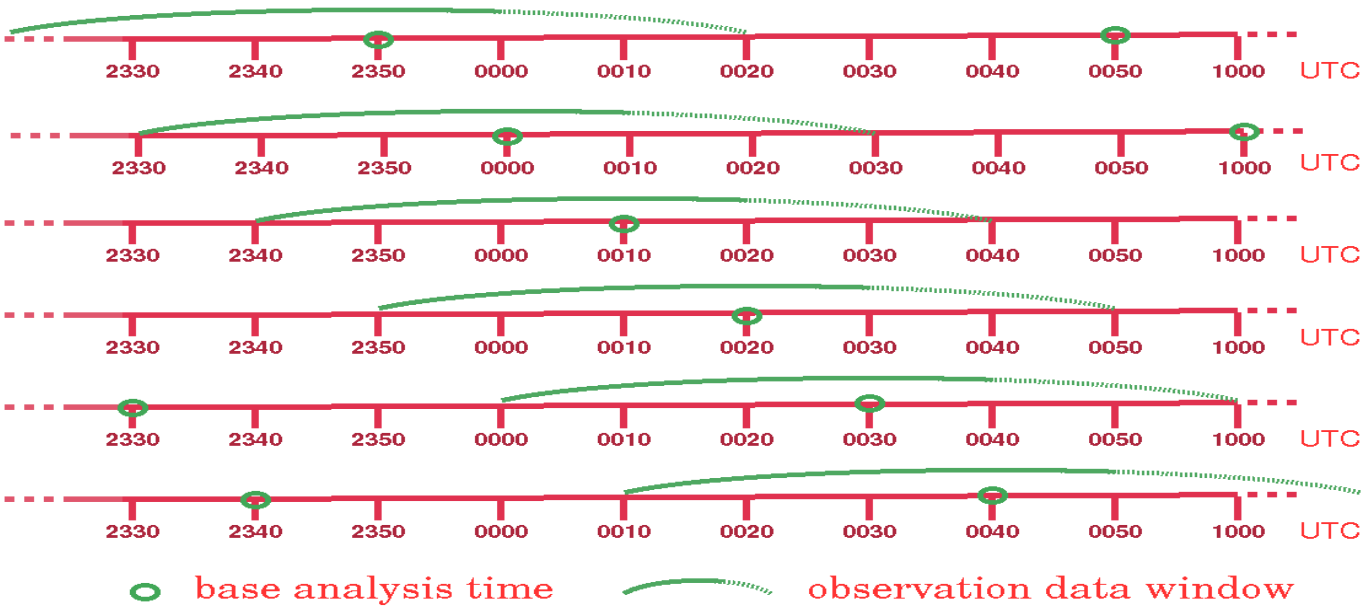
Nowcasting, sub-hourly analysis



Sub-hourly suite
1h to 2h window
Control EDA??
Perturbed runs ??

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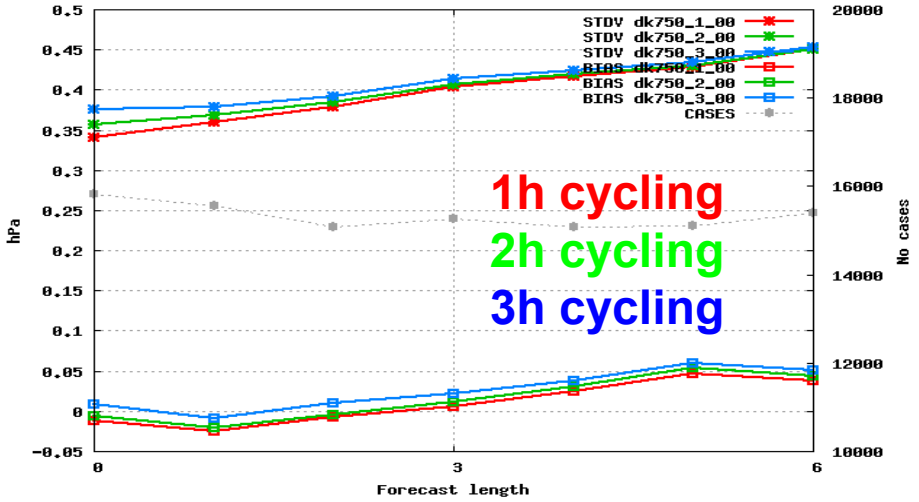
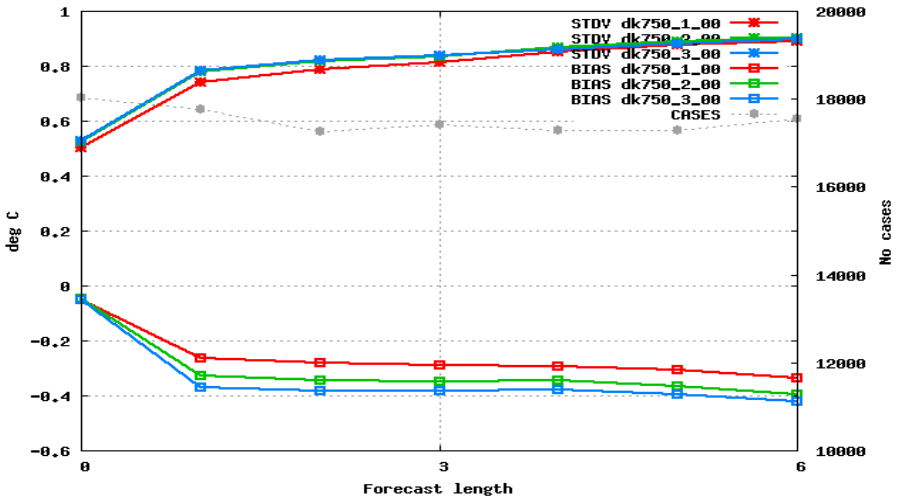
What is the optimal assimilation window length?

MSLP



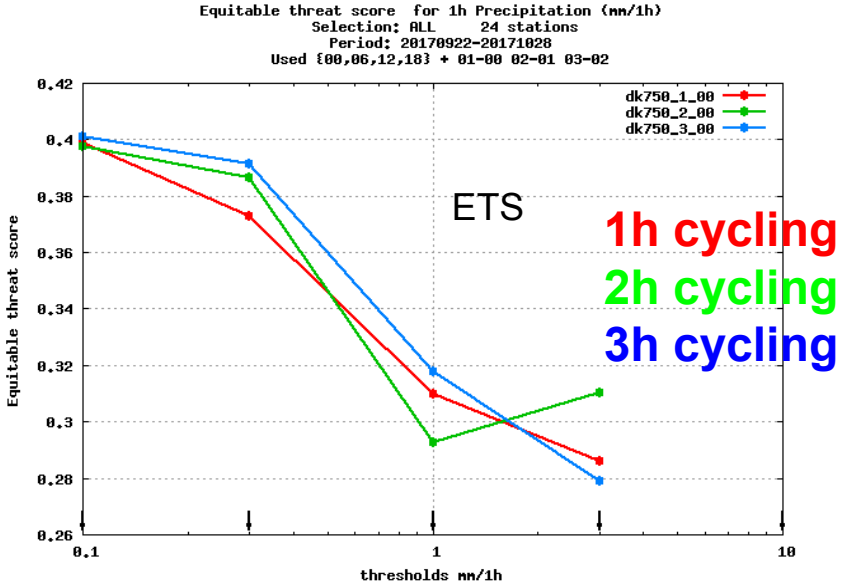
Std & bias

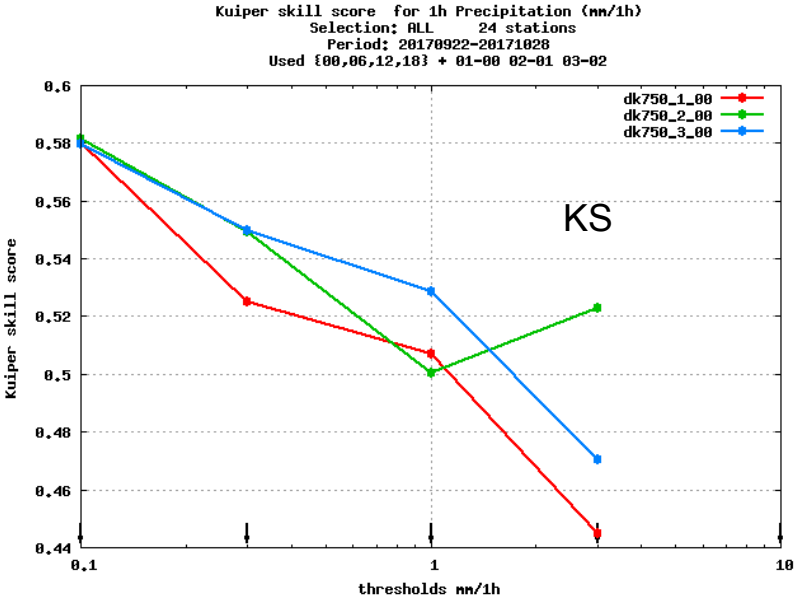
T2m



Cycling frequency & observation data window: DK750-3DVAR

1h cycling clearly advantageous for dry surface parameters MSLP/T2m



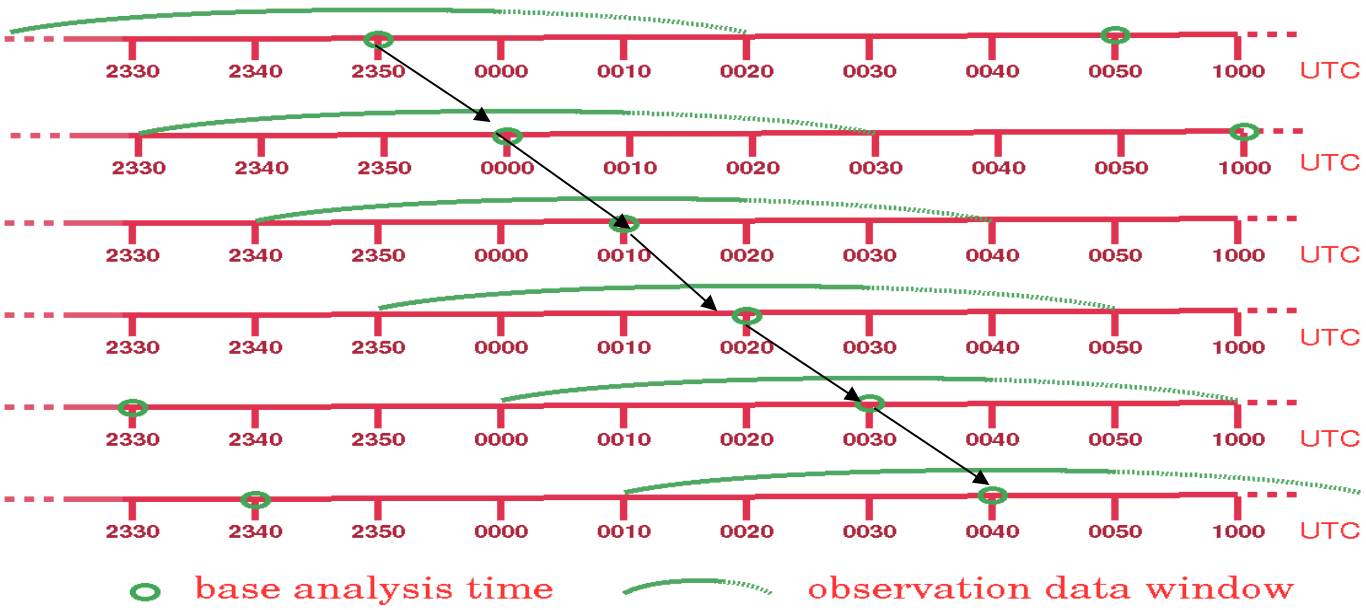


Cycling frequency & observation data window: DK750-3DVAR

1h cycling clearly advantageous for dry surface parameters MSLP/T2m
But for cloud and precipitation, 1h cycling may not be optimal

Note that the situation may depend on obs data, analysis schemes, ...

Nowcasting: connected neighbouring suites



Sub-hourly suite
1h to 2h window
Control EDA??
Perturbed runs ??
Separation of FG/BG

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T2M, std&bias

1 hour cycling
2 hour cycling, parallel
2 hour cycling, connected

Cloud, ETS

1h Precipitation, ETS

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Summary

- **Small convective temporal/spatial scales** require rapid update & high resolution
- Radar observation provides data for RUC system, but a too short **observation cutoff and assimilation window** affects utilisation of observation in intermittent DA
- Moisture **spin-up** a major concern in design of assimilation cycling strategy
- RUC with overlapping windows address some of the challenges
  - Sufficiently long assimilation window good for data use and spin-up
  - Separation of FG from BG beneficial
- Construction of ensemble perturbation remain to be done