Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Objects, Lightning, Radar, Clouds - Assimilating new Observations within the SINFONY Project

ICCARUS 2018

27. February 2018
DWD, Offenbach am Main

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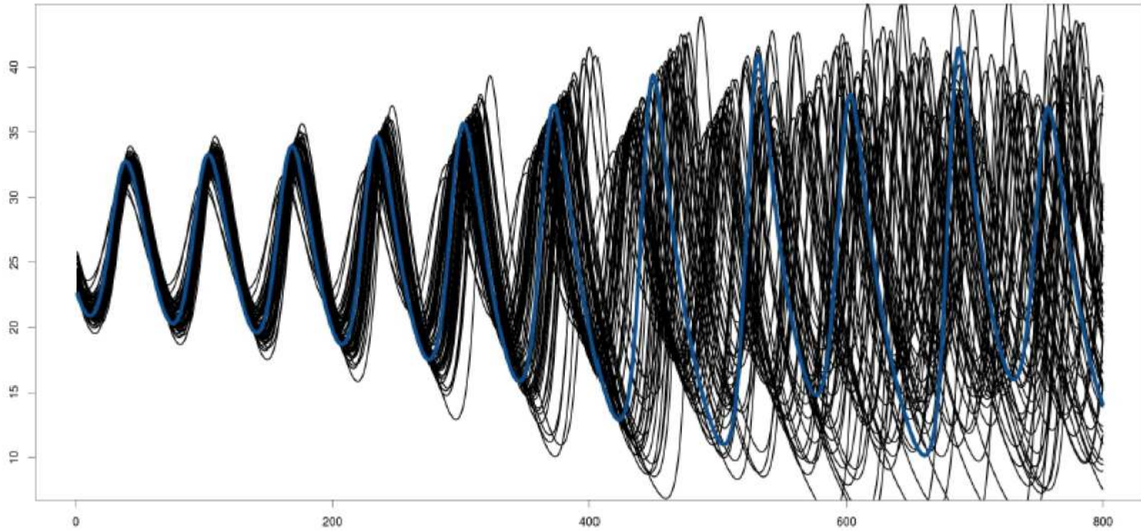
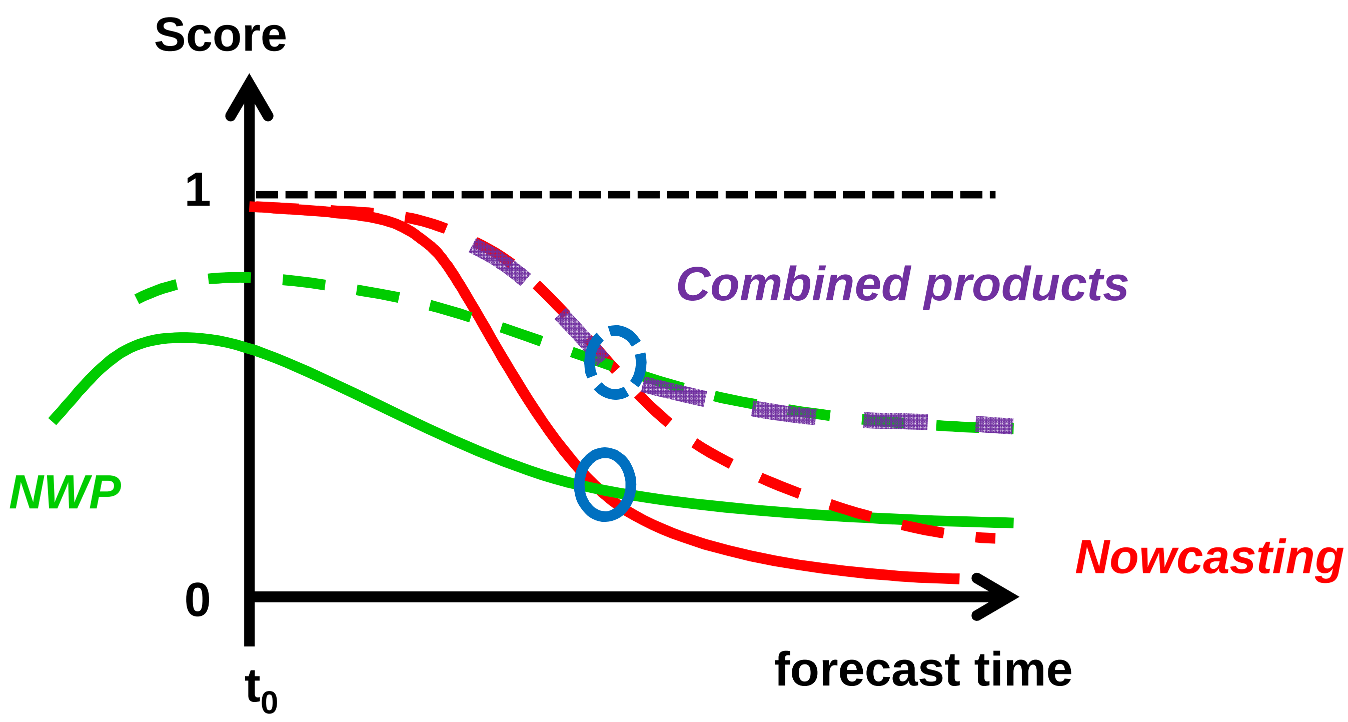
Predictability on the convective scale

The predictability of a flow which possesses many scales of motion (Lorenz, 1969)

- ➔ Cumulus-Scale: 1 hour of predictability
- ➔ Error growth (non-linearities & scale interaction)



What does SINFONY mean?



So what does SINFONY mean?

➔ Seamless integration of nowcasting and numerical weather prediction

➔ Enhanced predictability on the convective scale

Nowcasting

- ➔ Uncertainty estimation by ensemble generation
- ➔ Konrad3D

Numerical weather prediction

- ➔ Modell error reduction by improved model physics
- ➔ Initial condition error reduction by improved data assimilation

Data assimilation in SINFONY

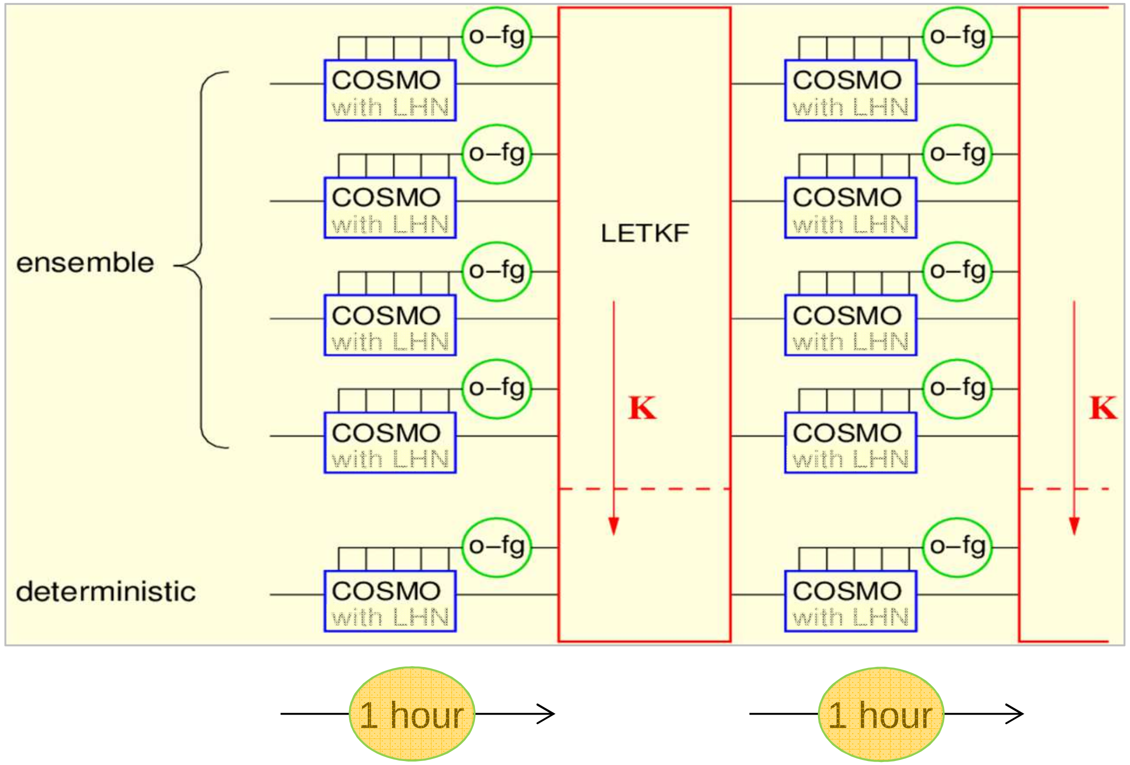
How do we enhance the initial conditions?

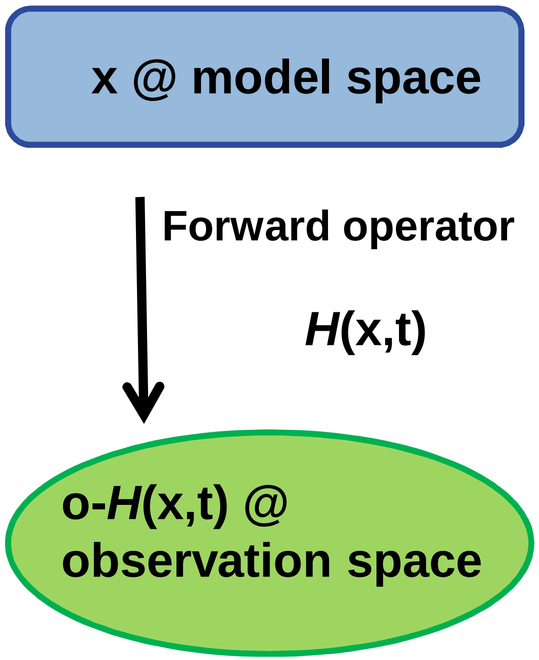
→ Rapid update cycling

→ New observations targeted at convection

KENDA-LETKF

KENDA: 4D-LETKF + LHN (latent heat nudging for assimilation of precipitation, derived from radar reflectivities)





K: Kalman gain for ensemble mean

Assimilating observations to improve convection

SINFONY

Preconvective environment

➔ Conventional observations

Convective initiation

➔ SEVIRI-VIS

Active convection

➔ Radar reflectivities and radial winds

➔ Lightning observations

➔ (Radar-) Objects

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Why assimilate SEVIRI-VIS?

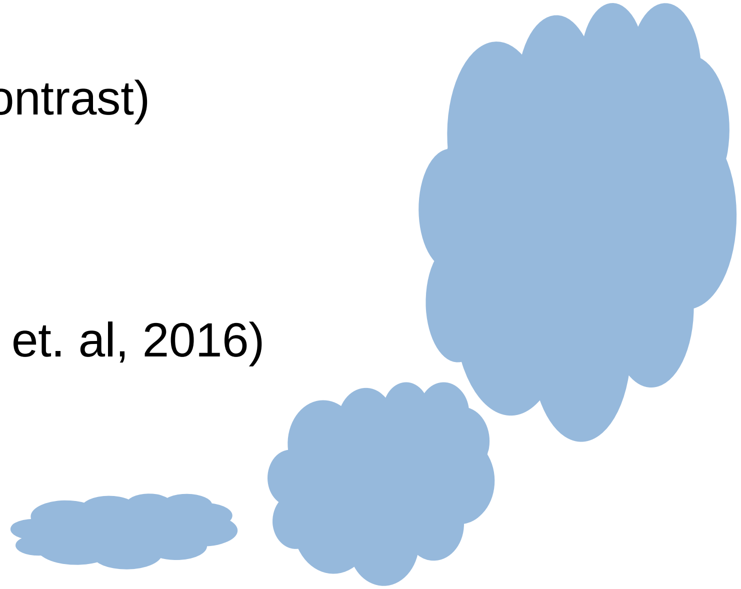
- ➔ SEVIRI channel in the visible spectral range (0.6 µm)
- ➔ On Meteosat Second Generation (geostationary)

- ➔ Information on cloud cover
- ➔ Complementary to IR channels (brightness contrast)

Newly possible due to

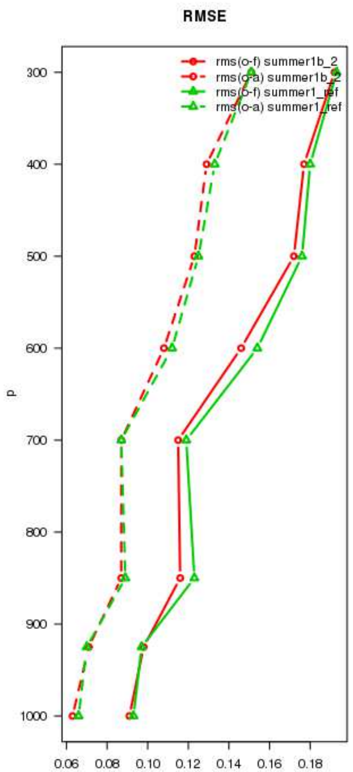
- ➔ Fast & accurate obs operator Mfasis (Scheck et. al, 2016)

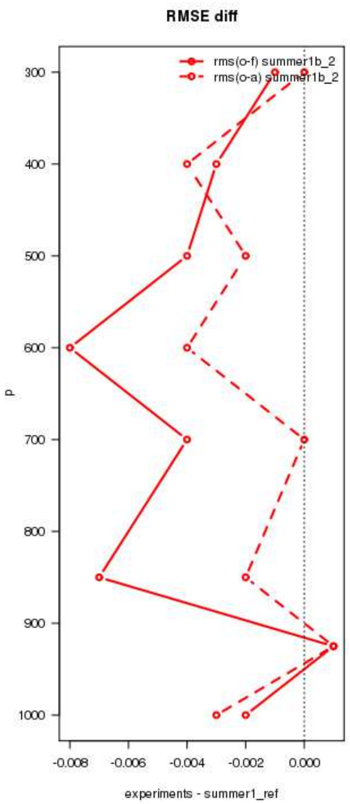
Low stratus



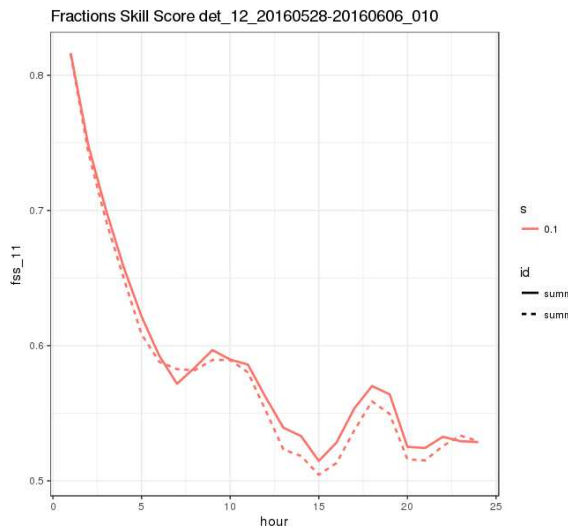
Convective initiation

Results SEVIRI-VIS

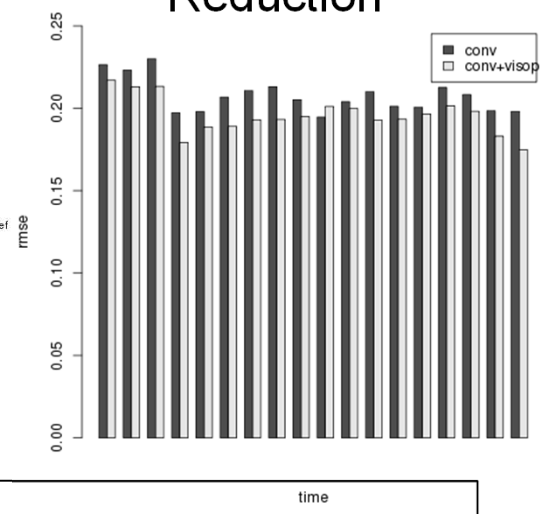




FSS



Reflectance RMSE Reduction



Positive impact

- RMSE relative humidity (1h-FG), temp, wind
- RMSE reflectance (1h-FG)
- FSS (forecasts)

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Radar

DWD radar network:

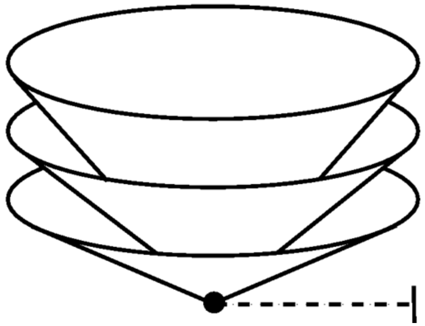
- 17 polarimetric Doppler C-Band radar systems
- Reflectivities and radial winds
- Full scan every 5 minutes

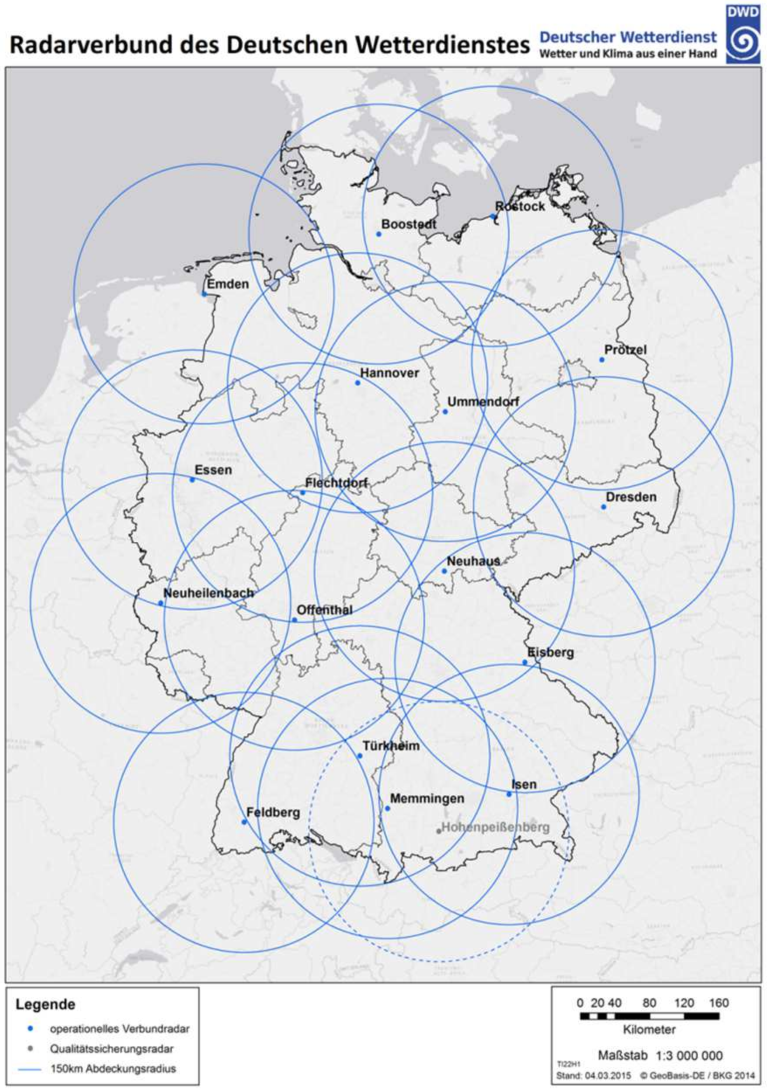
  + terrain-following precipitation-scan
- Spatial resolution:

  1° azimutal angular

  1 km radial (up to 180 km)

  10 elevations (between 0.5° and 25°)





Radar: radial winds

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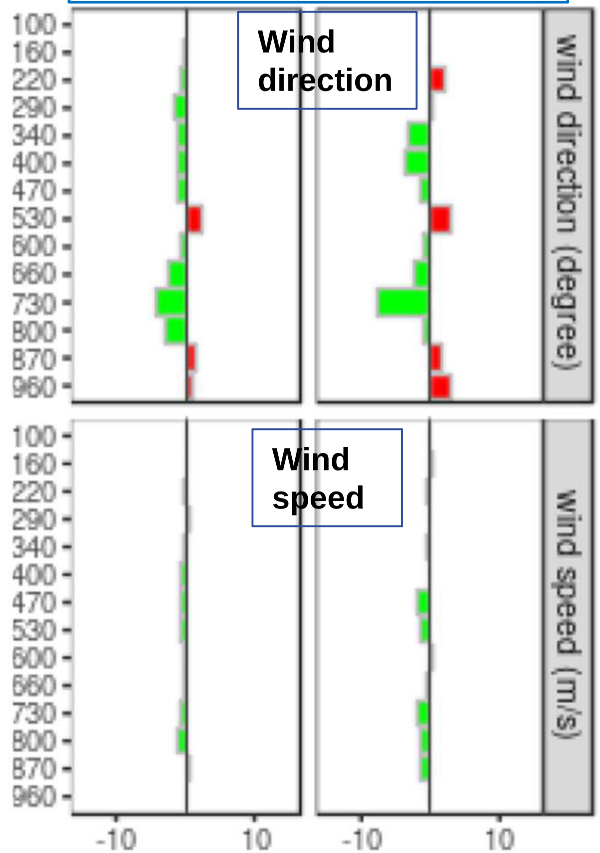
Experiments:

- ➔ Close to operational setup at DWD
- ➔ Radial winds: Temporal thinning, subset of elevations
- ➔ Period: May/June 2016 (5 weeks)
- ➔ 24h-forecasts every 6 hours

  (6, 12, 18, 24 UTC)

Cycling:
Wind statistics with conv. observations

Forecasts:
Upper air verification with radio sondes
(**exp better**)



Radar: reflectivity

Current hot topics for radar reflectivity assimilation:

- Desroziers statistics
- Warm bubbles
- 2-moment physics scheme
- Inflation

More about these topics
in the talk by
A. de Lozar, A. Seifert and U. Blahak
at 5 pm today
and in the
Kenda side meeting

Assimilating observations to improve convection

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➔ **Lightning observations**

➔ (Radar-) Objects

Lightning: the LPI

Possibility of charge separation at maximum for equal mixing ratio of snow, ice, graupel and water

Charge separation happens between 0°C and -20°C

$$\varepsilon = 2\frac{\sqrt{Q_i Q_l}}{Q_i + Q_l}$$

$$\text{LPI} \propto \int_{H_{0^\circ C}}^{H_{-20^\circ C}} \varepsilon w^2 dz$$

Q_i
Fractional cloud ice
(ice, snow, graupel)

Q_l
Super-cooled liquid water

Yair (2009), Lynn & Yari (2010)

Lightning: scaling the LPI

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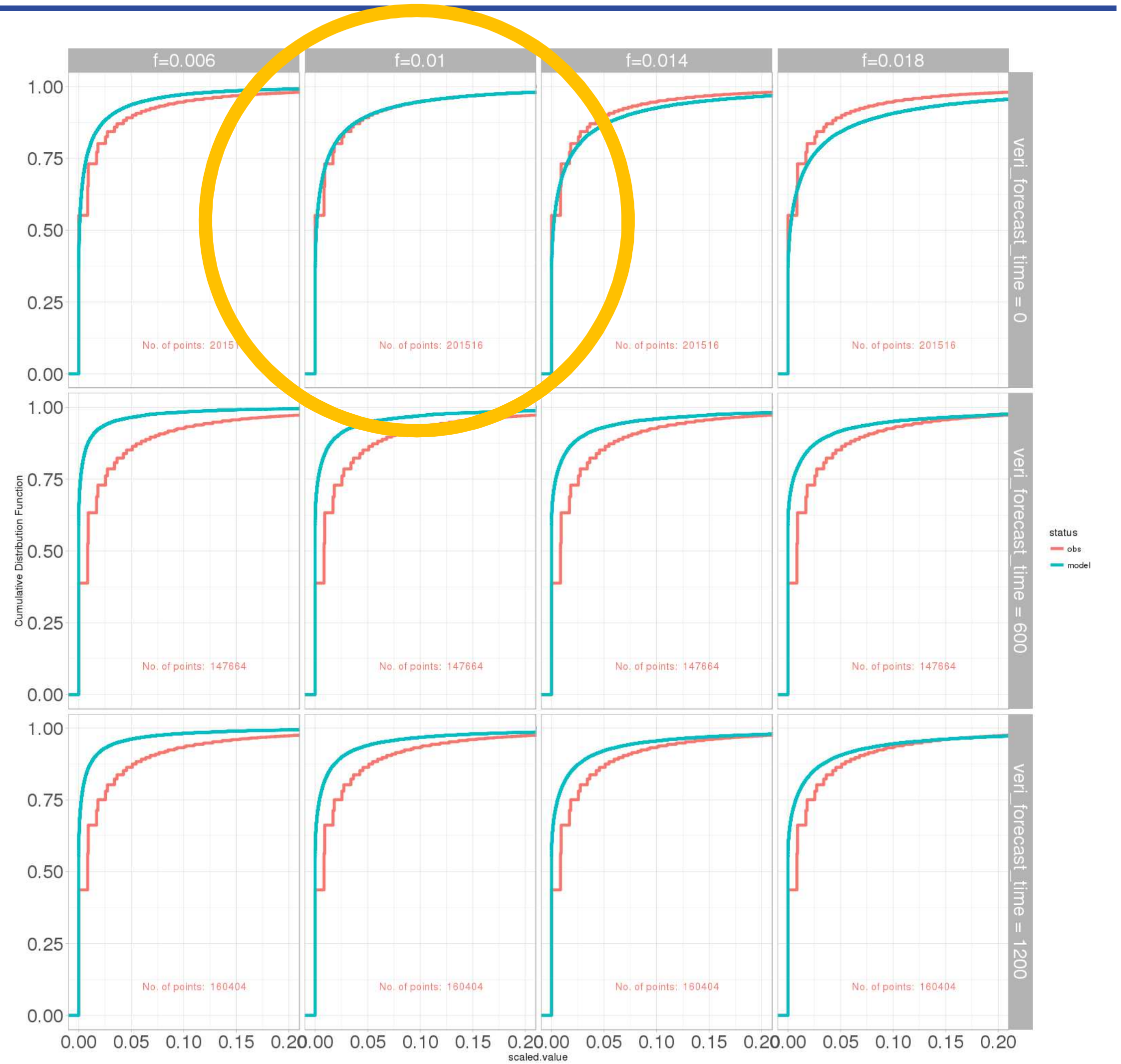
Lead time: 0h

Lead time: 6h

Lead time: 12h



Observations $f \times$ LPI   26.05.2016 - 30.06.2016

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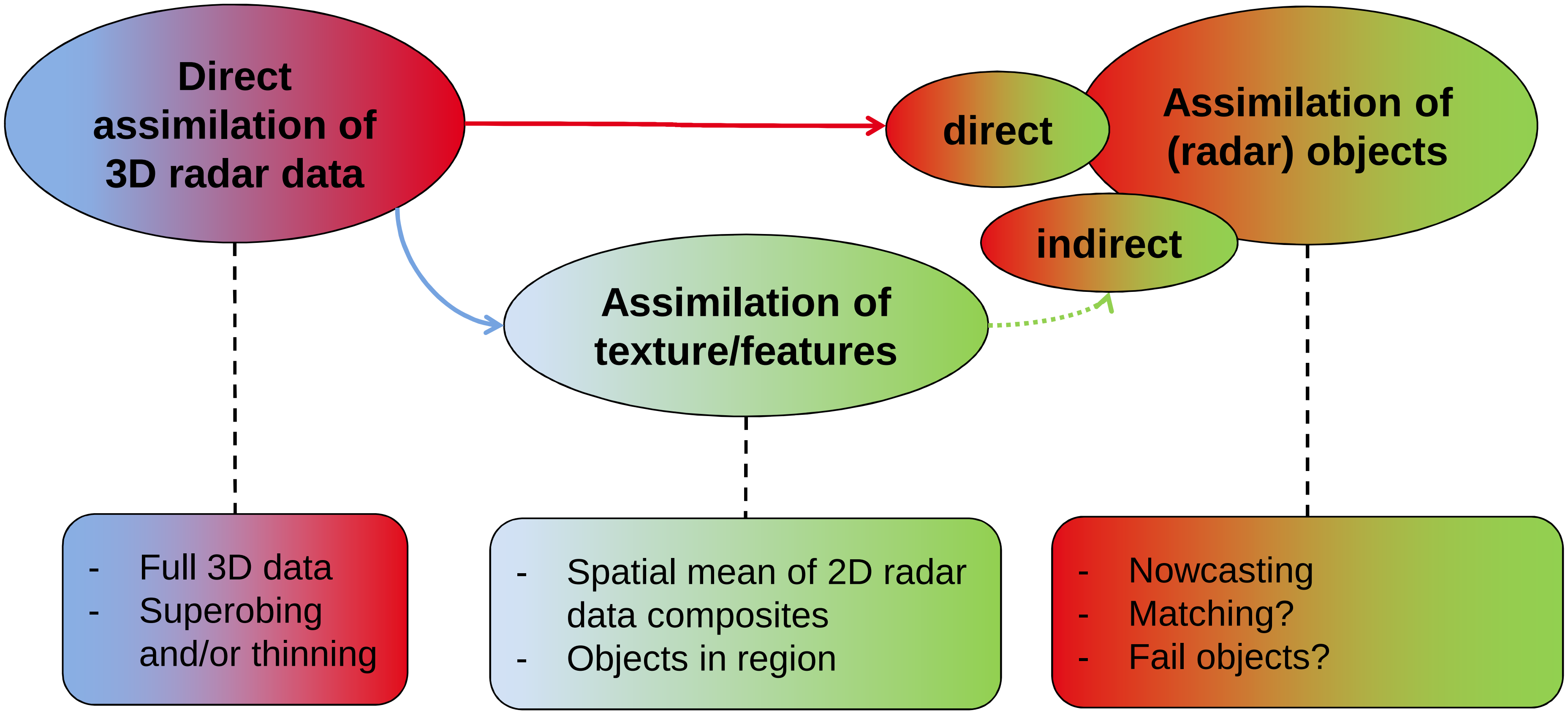
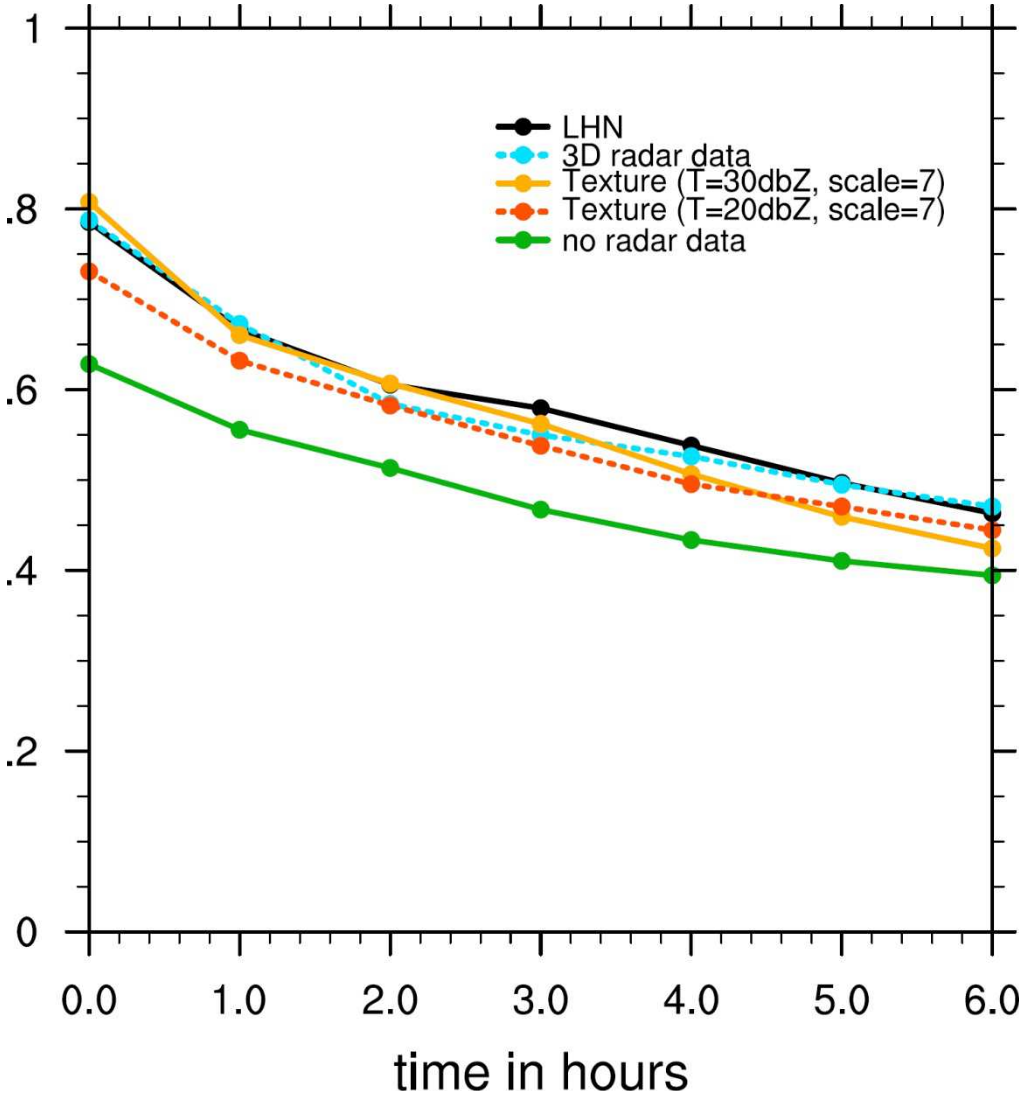
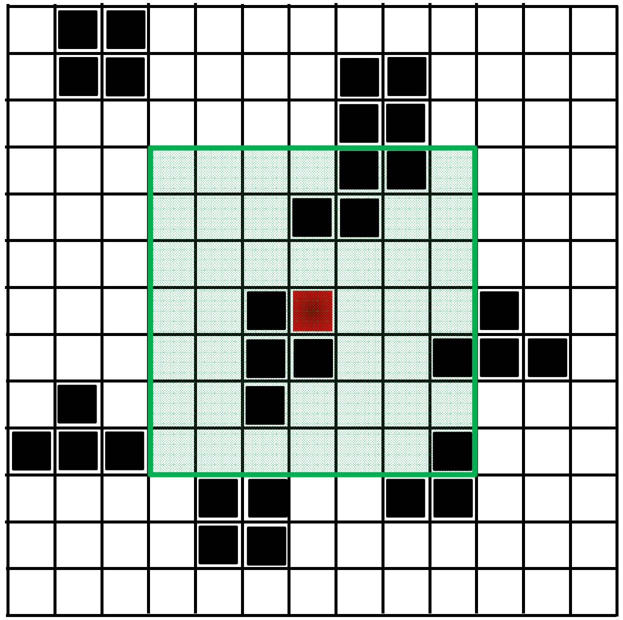
➔ **(Radar-) Objects**

Texture and Objects



Texture and Objects





- *FSS (scale = 21 grid points)*
- *Reflectivity > 30 dbZ*
- *Deterministic forecasts (27.05.-30.05.2016, hourly 10-18 UTC runs)*

Conclusion

- Attempt to assimilate different observations to improve description of convective process
- Promising first results

Outlook

- Improve systems separately and test observations together
- Migrate to ICON-LAM

More about SINFONY :

Project overview: U. Blahak (Poster P38)
Model improvements: A. de Lozar (Talk Tue.)
Verification: M. Hoff (Talk Wed.)

Thank you for your attention

Gracias por tu atención

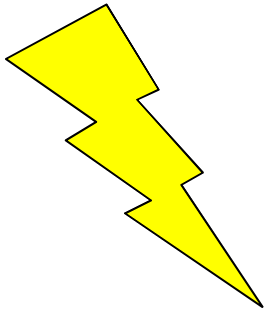
Bedankt voor uw aandacht

Grazie per l'attenzione

Спасибо за внимание

Merci de votre attention

Danke für Ihre Aufmerksamkeit



Wisi enim ad operam

תודה לך על תשומת הלב

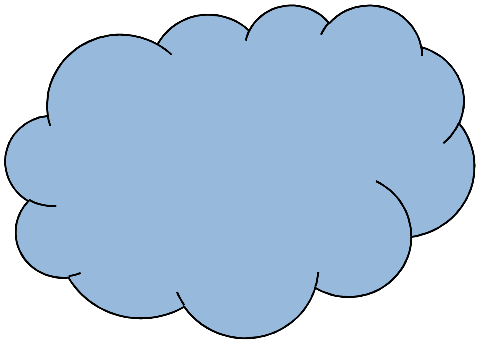
Dankie vir jou aandag

Kiitos huomiostasi

Dziękuję za uwagę

Obrigado pela sua atenção

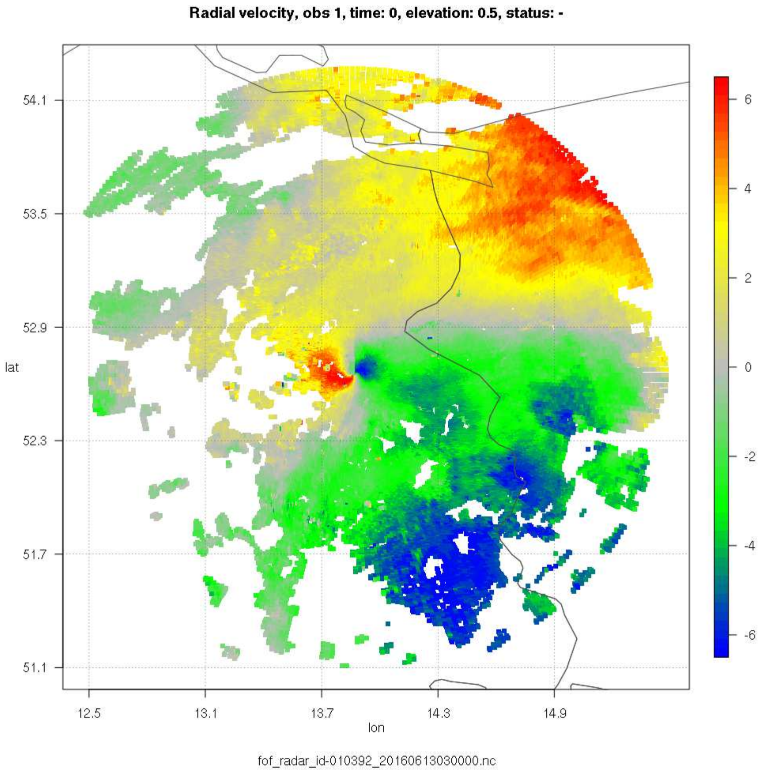
Shnorhakalut’yun ushadrut’yan hamar



Radar

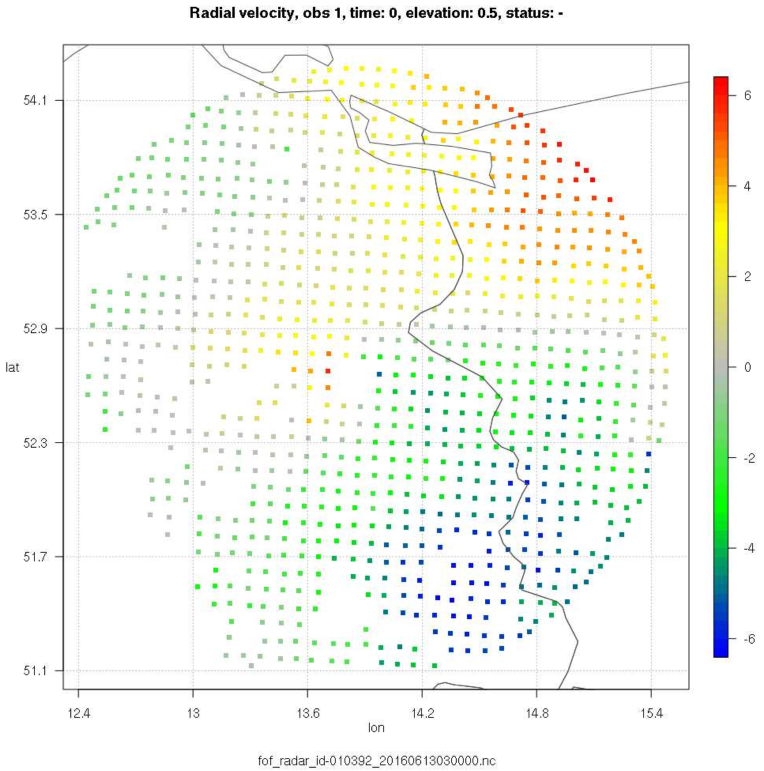
- Radar operator: **EMVORADO** (Efficient Modular VOlume scanning RADar Operator) [Y. Zeng et al., QJRMS 2016]
- Superobing (averaging observation in boxes) for each elevation & radar station

Without superobing



Radial winds

With superobing (here 10 km)



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