Deutscher Wetterdienst

Assimilation of Radar Derived Rain Rates into the Convective Scale Model COSMO-DE at DWD

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Outline

- **Looking back**:
  good performance of **latent heat nudging** when applying a **diagnostic precipitation** scheme, esp. during assimilation

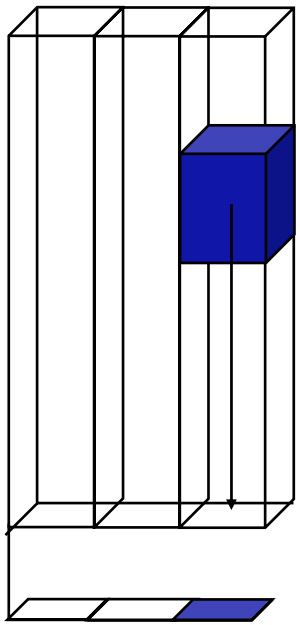
- **Looking today**:
  adaptation the **latent heat nudging** scheme to the requirements of the **prognostic precipitation** scheme to get even better results

- **Looking out**:
  further improvements of **latent heat nudging** are ongoing for both the data and the assimilation scheme

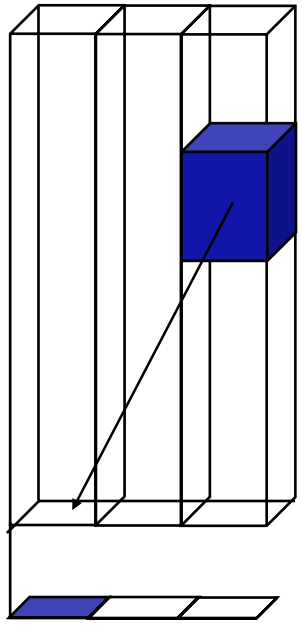
Diagnostic precipitation

Prognostic precipitation

Scheme to describe the path of precipitation particles



Cloud



Precipitation at the ground

$$t_{Ground} = t_{Cloud}$$
$$x_{Ground} = x_{Cloud}$$

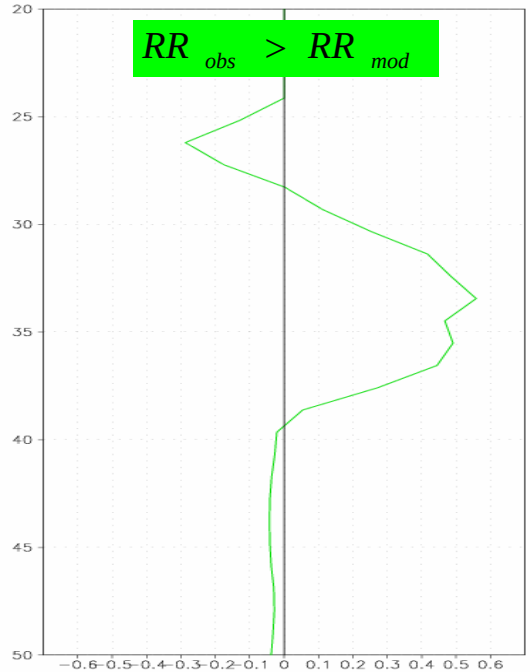
$$t_{Ground} = t_{Cloud} + \Delta t$$
$$x_{Ground} = x_{Cloud} + \Delta x$$

How does it influence the latent heat nudging?

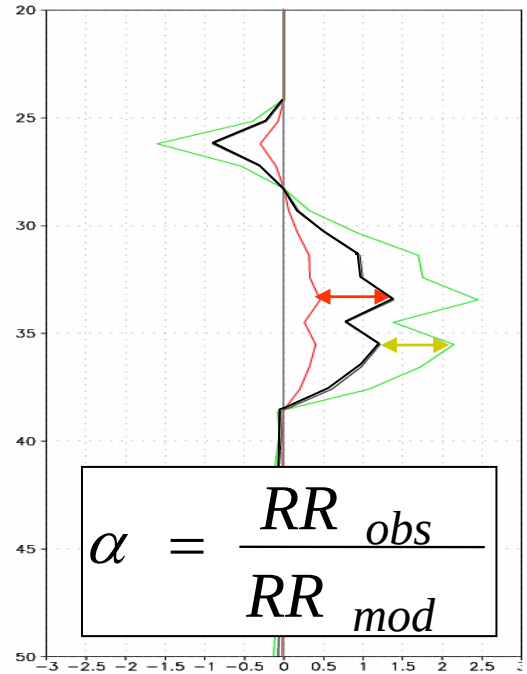
Brief Introduction of Latent Heat Nudging (LHN):

- Approach to assimilate rain rates derived from radar measurements
- Adding of temperature and moisture increments

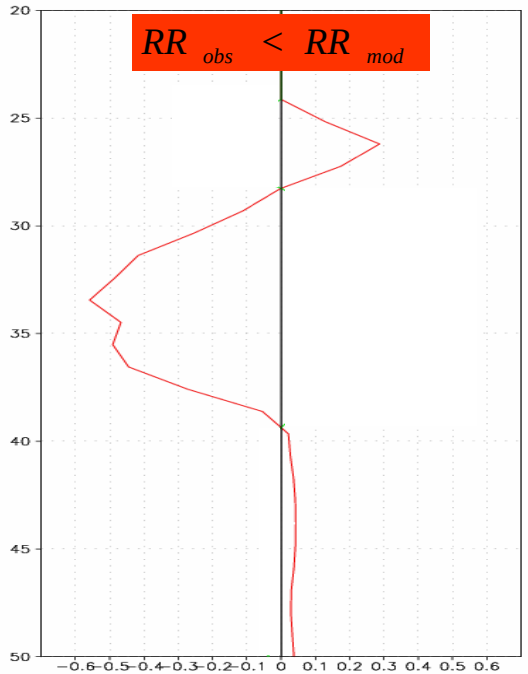
temperature increment



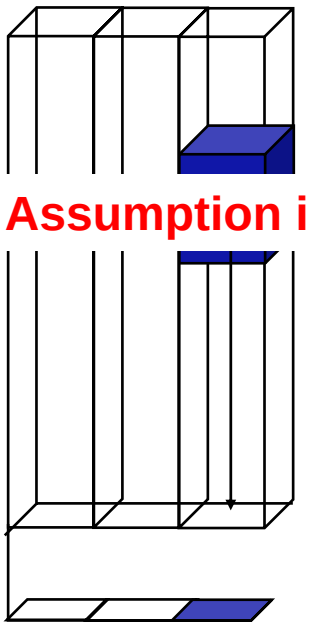
latent heat release



temperatur increment (K/h)



BASIC ASSUMPTION of LHN:
Integral over latent heat release in a column is proportional to precipitation rate at ground

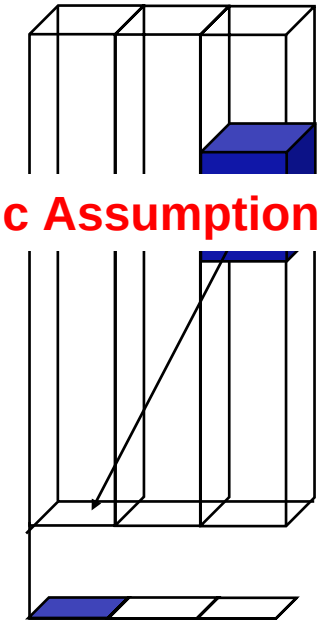


Basic Assumption is true

Cloud

Precipitation at the ground

$$t_{Ground} = t_{Cloud}$$
$$x_{Ground} = x_{Cloud}$$

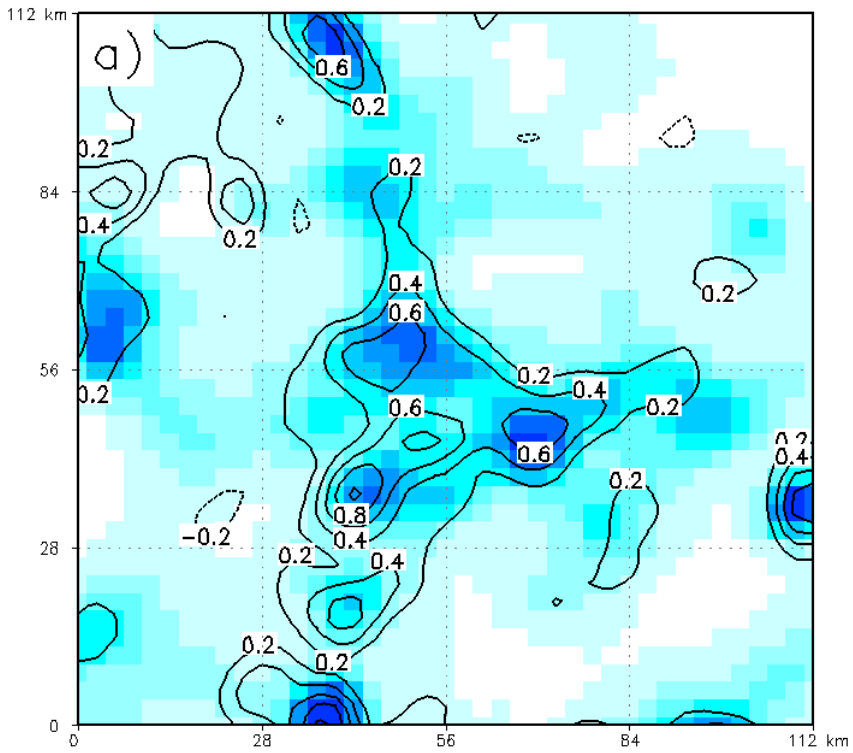


Basic Assumption is false

$$t_{Ground} = t_{Cloud} + \Delta t$$
$$x_{Ground} = x_{Cloud} + \Delta x$$

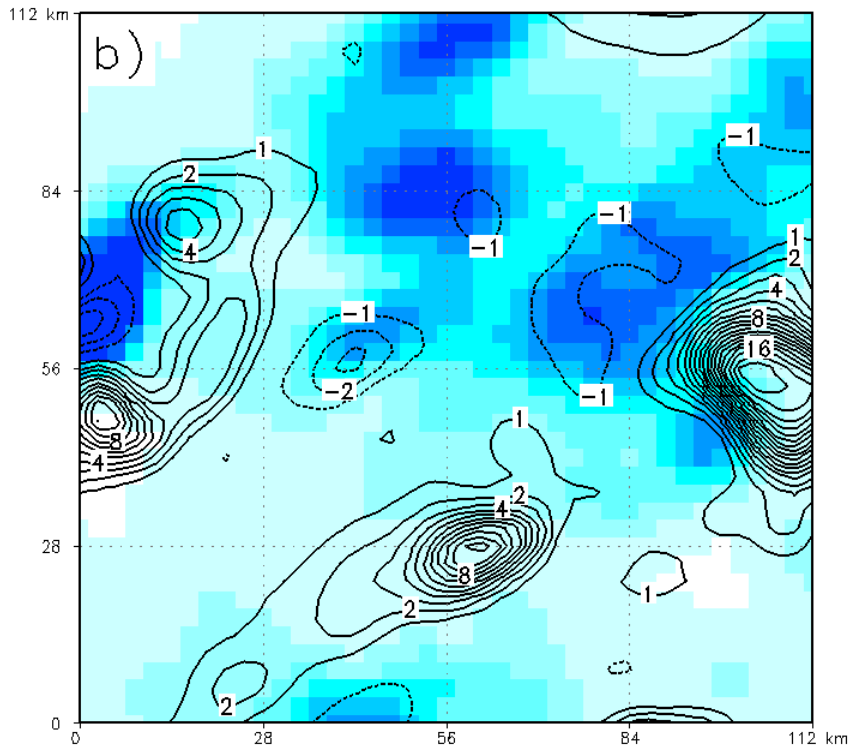
Correlation between model latent heat release (lines) and precipitation rate

Diagnostic precipitation



0.69

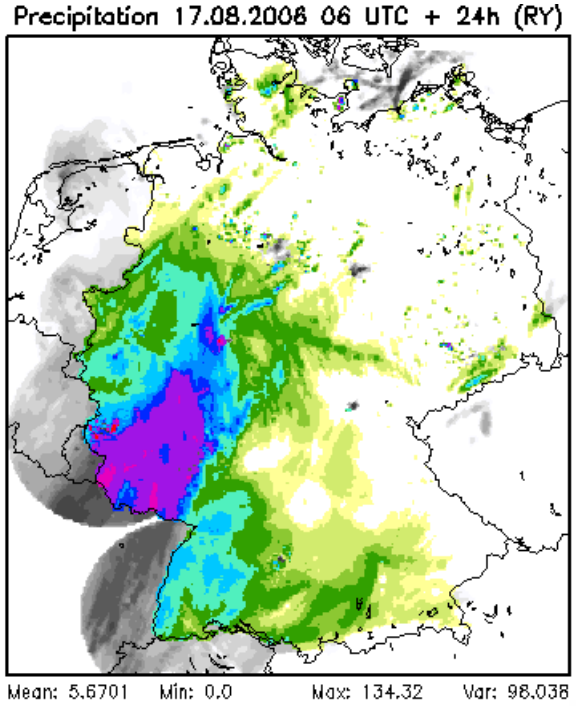
Prognostic precipitation



-0.25

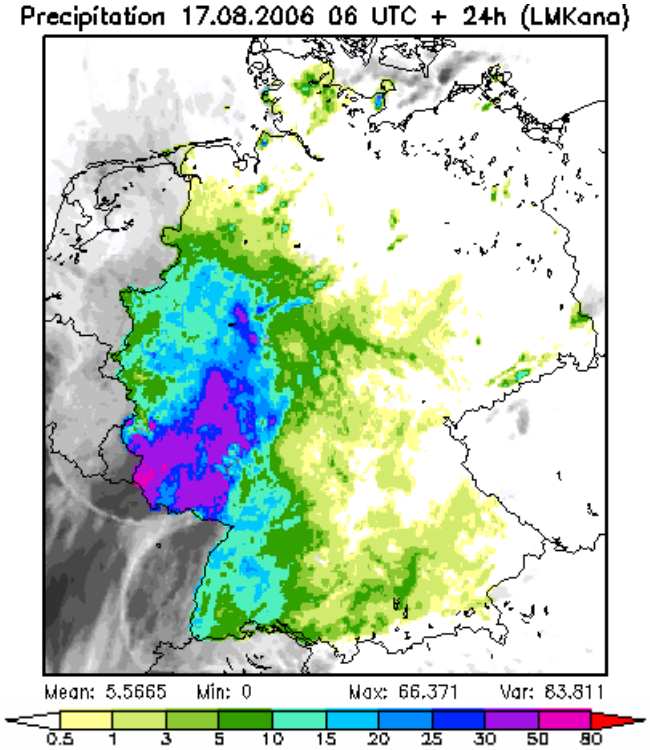
24h precipitation sum for 17.08.2006

Radar



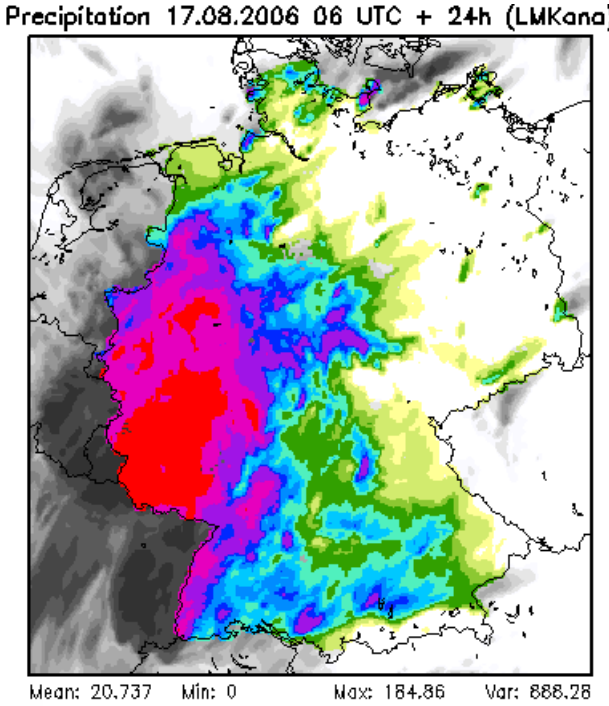
Mean: 5.7 mm

Diagn. Precipitation



Mean: 5.6 mm

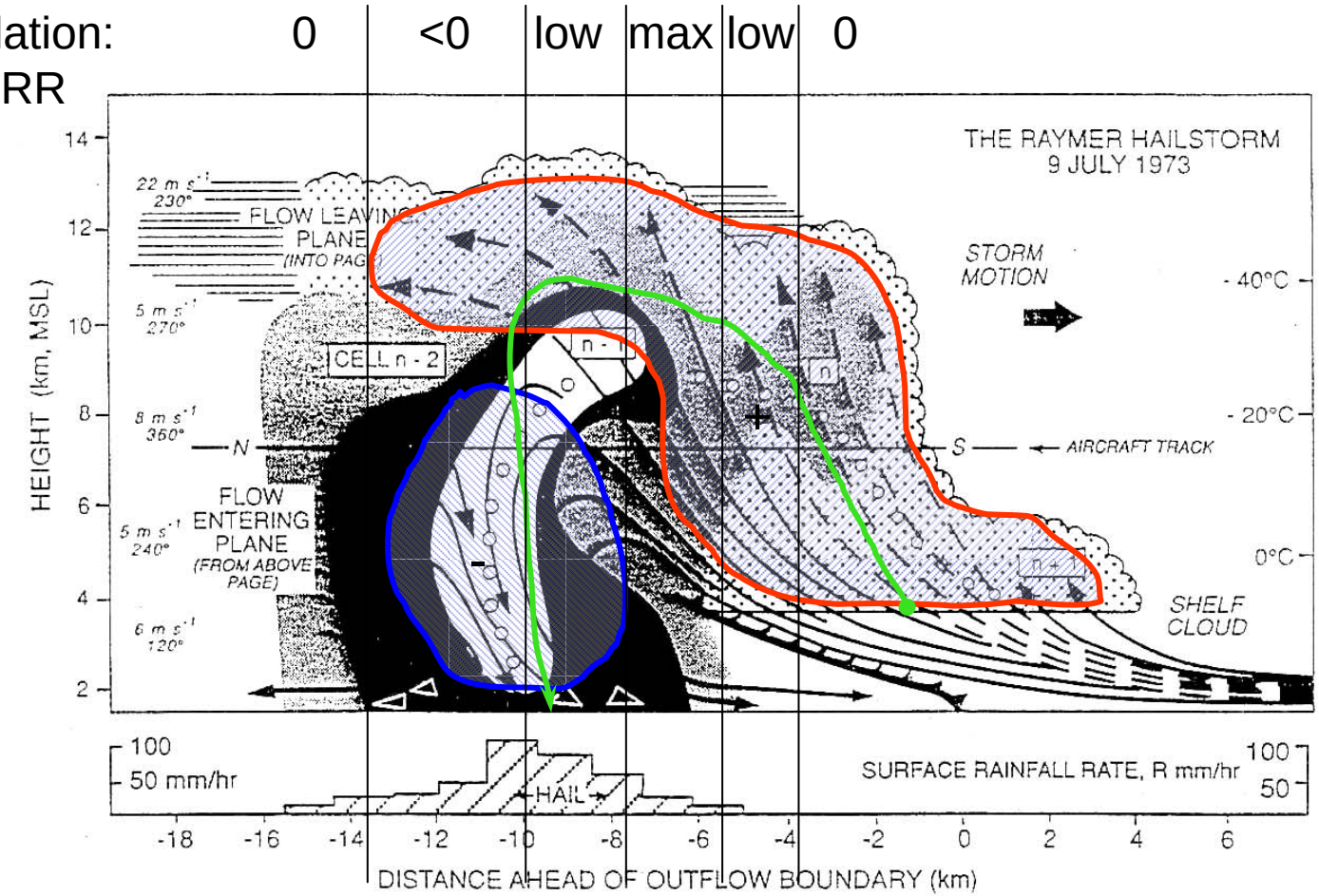
Progn. Precipitation



Mean: 20.7 mm

LHN in combination with a prognostic precipitation scheme does overestimate the precipitation amount. Adaptations to the new requirements are necessary.

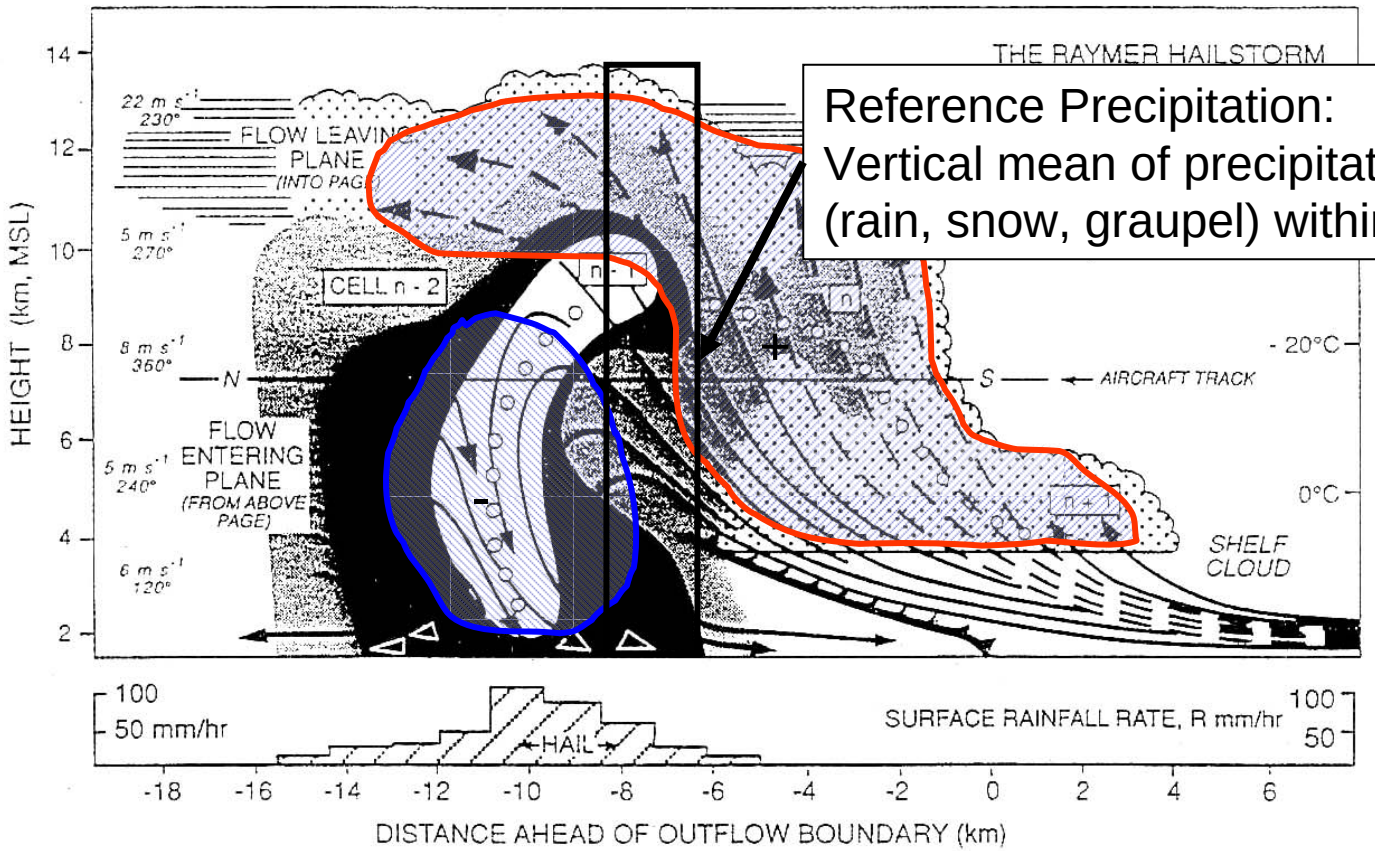
Correlation: 0 <0 low max low 0
LH to RR



(R. A. Houze, Jr.: Cloud Dynamics, International Geophysics Series Vol. 53)

Reasons and Revisions

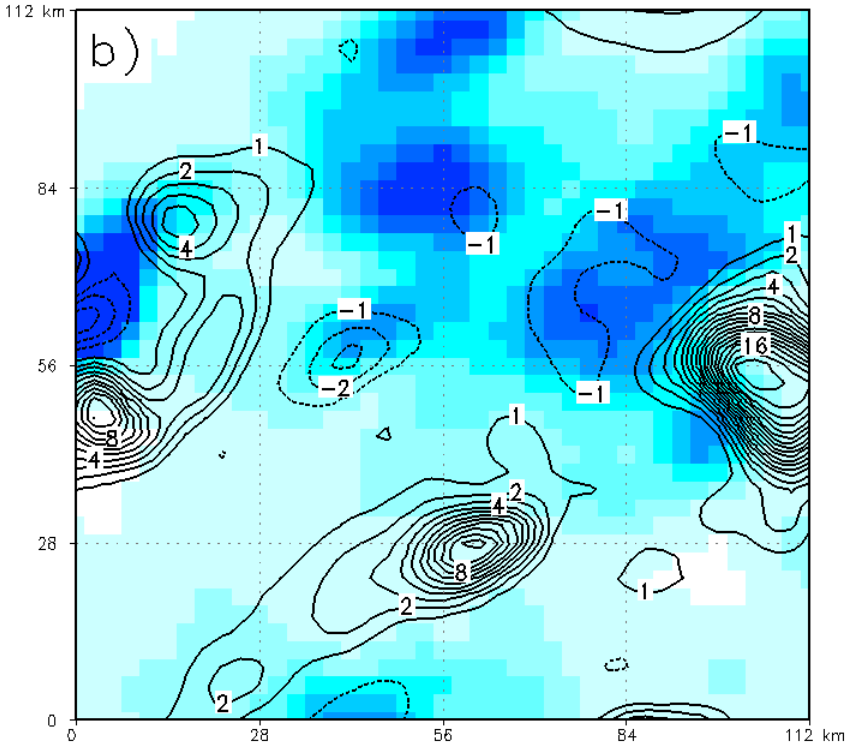
- ➔ Correlation is lower and can be even negative
  - ➢ Use a Reference Precipitation
  - ➢ Treat only layers with positive latent heat rates
- ➔ Time of precipitation formation and outfall are different (no feedback to LHN)
  - ➢ Use a Reference Precipitation
  - ➢ Revision of all LHN modules (i.e. grid point searching)
- ➔ Latent heat rates are much higher than for diagn. precipitation scheme
  - ➢ Reduce intensity of LHN (control parameters)



(R. A. Houze, Jr.: Cloud Dynamics, International Geophysics Series Vol. 53)

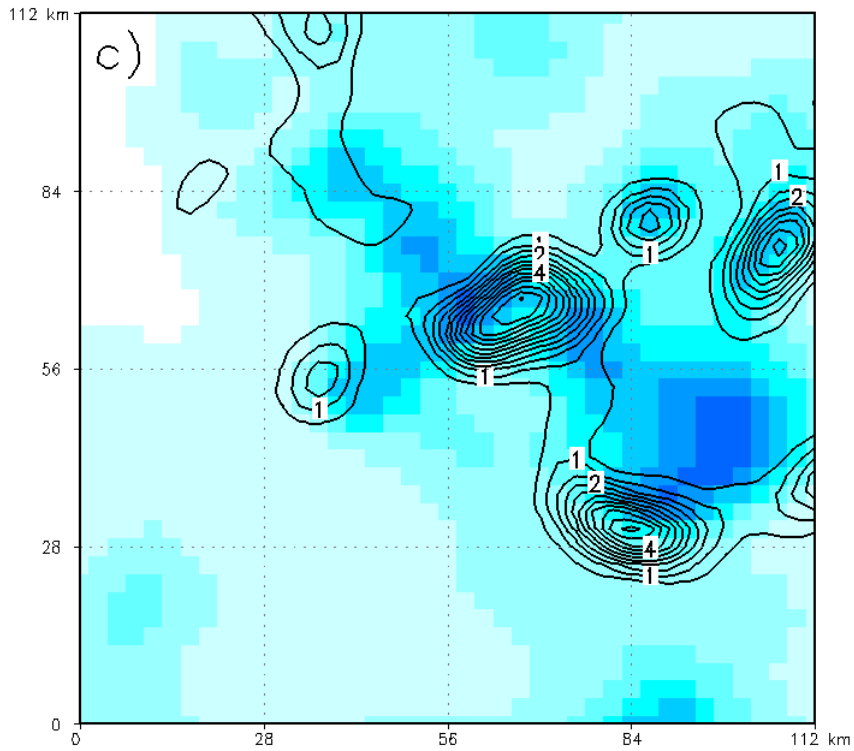
Correlation between model latent heat release and reference precipitation

Prognostic precipitation (original LHN scheme)



-0.25

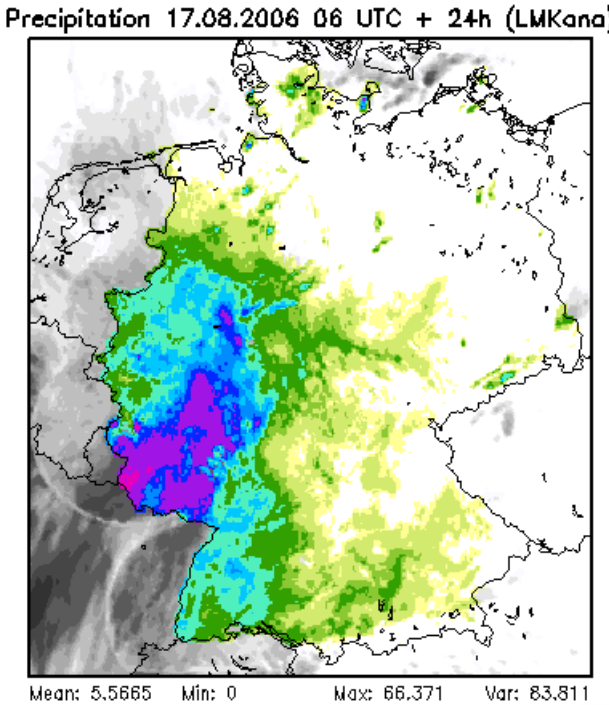
Prognostic precipitation (revised LHN scheme)



0.42

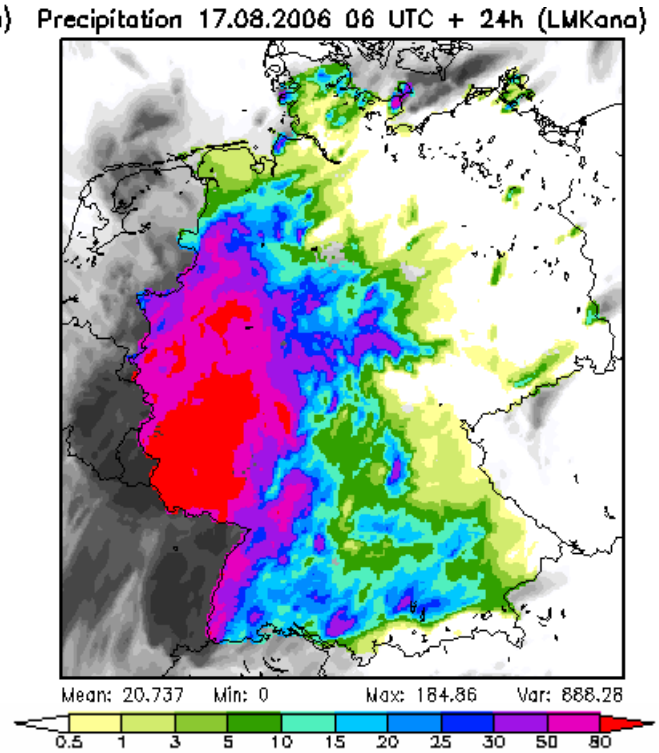
24h precipitation sum for 17.08.2006

Diagn. Precipitation



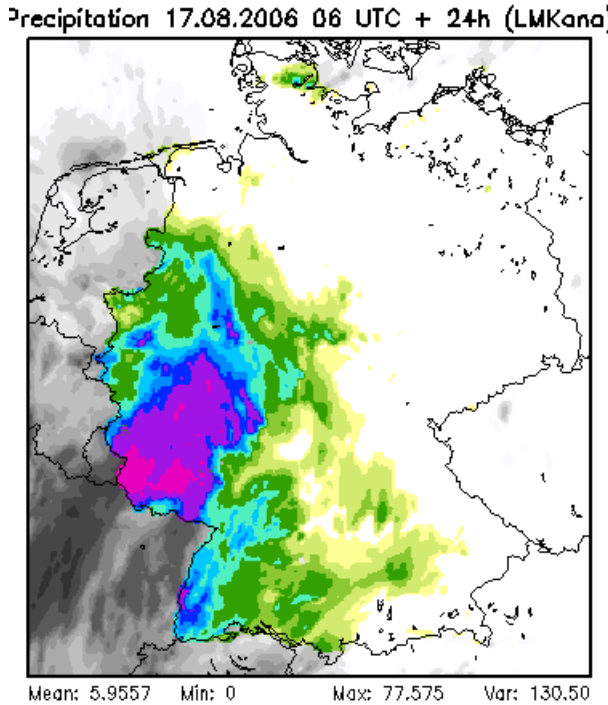
Mean: 5.6 mm

Progn. Precipitation (orig. LHN-scheme)

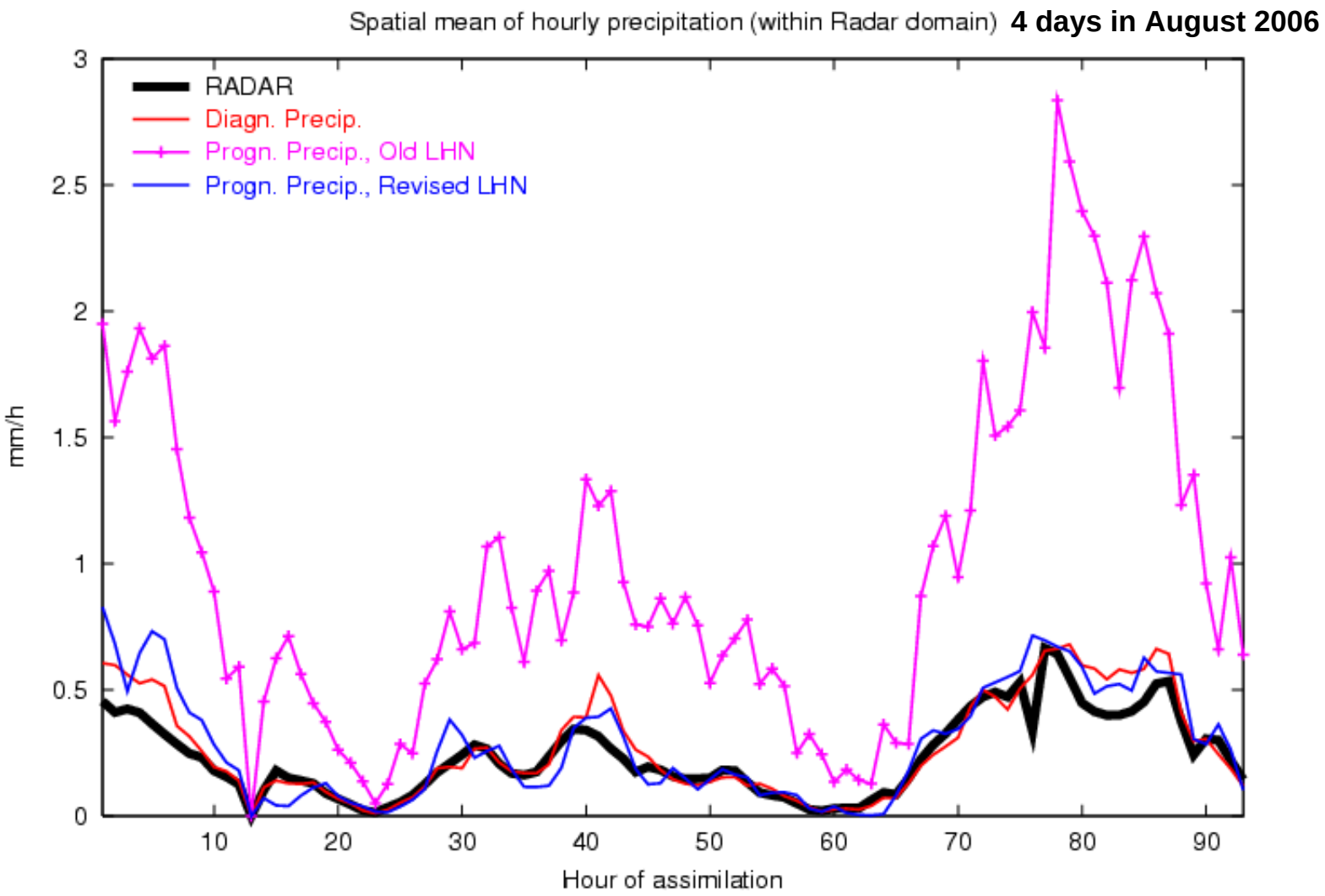


Mean: 20.7 mm

Progn. Precipitation (revised LHN scheme



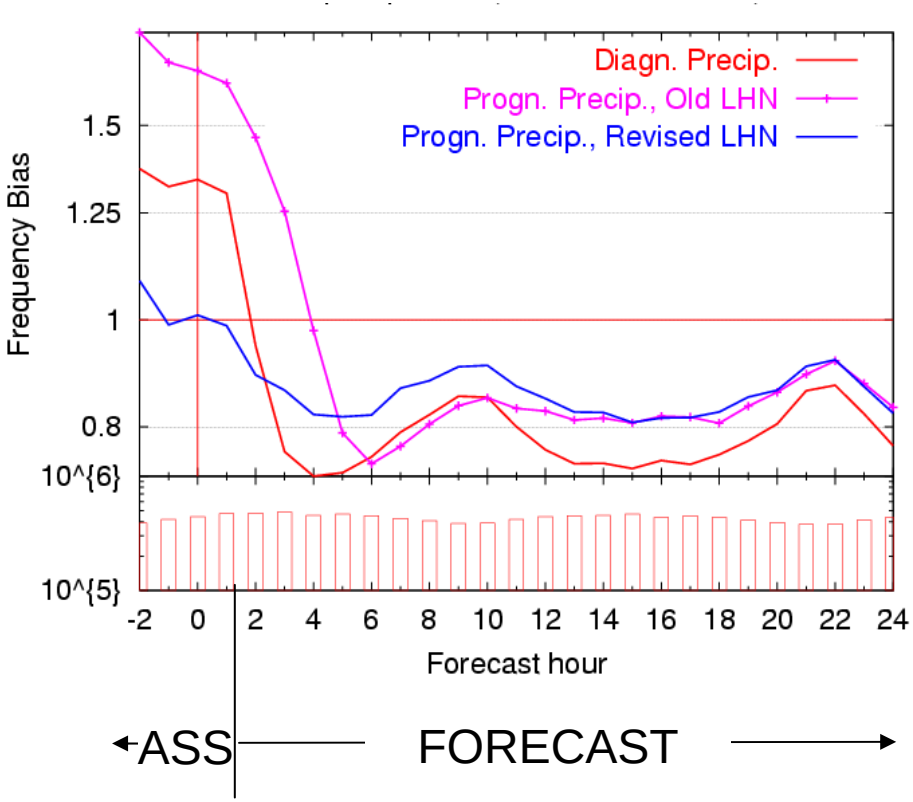
Mean: 6.0 mm


Spatial mean of hourly precipitation (within Radar domain) 4 days in August 2006
RADAR
Diagn. Precip.
Progn. Precip., Old LHN
Progn. Precip., Revised LHN
mm/h
Hour of assimilation
0
0.5
1
1.5
2
2.5
3
10
20
30
40
50
60
70
80
90

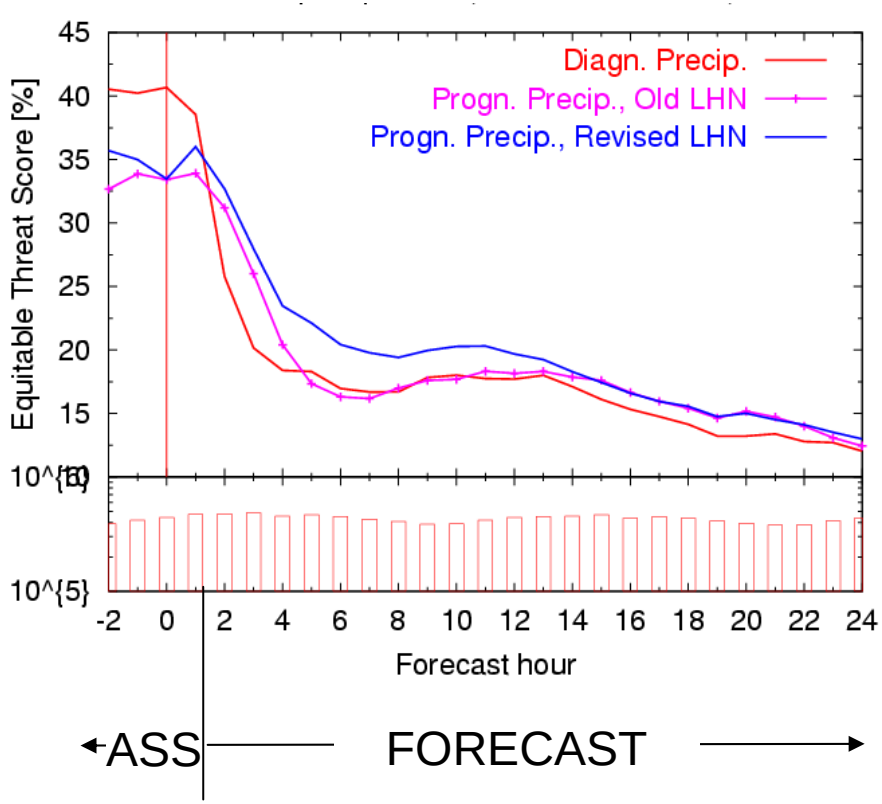
Mean skill scores over 32 forecast (00 and 12 UTC) AUGUST 2006

Threshold 0.1 mm/h

FBI



ETS



Summary of the revisions

- LHN was operating well during assimilation with diagnostic precipitation scheme but went worse when changing to prognostic precipitation scheme
- Reasons: Violation of basic assumption and lack of feedback
- Revision of LHN scheme restores the validity of the basic assumption and does improve the assimilation and free forecast to even better results than before
- The important revisions are:
  - Introduction of a Reverence Precipitation
  - considering of only positive latent heating rates
  - Improvement of grid point search module

Looking Today:

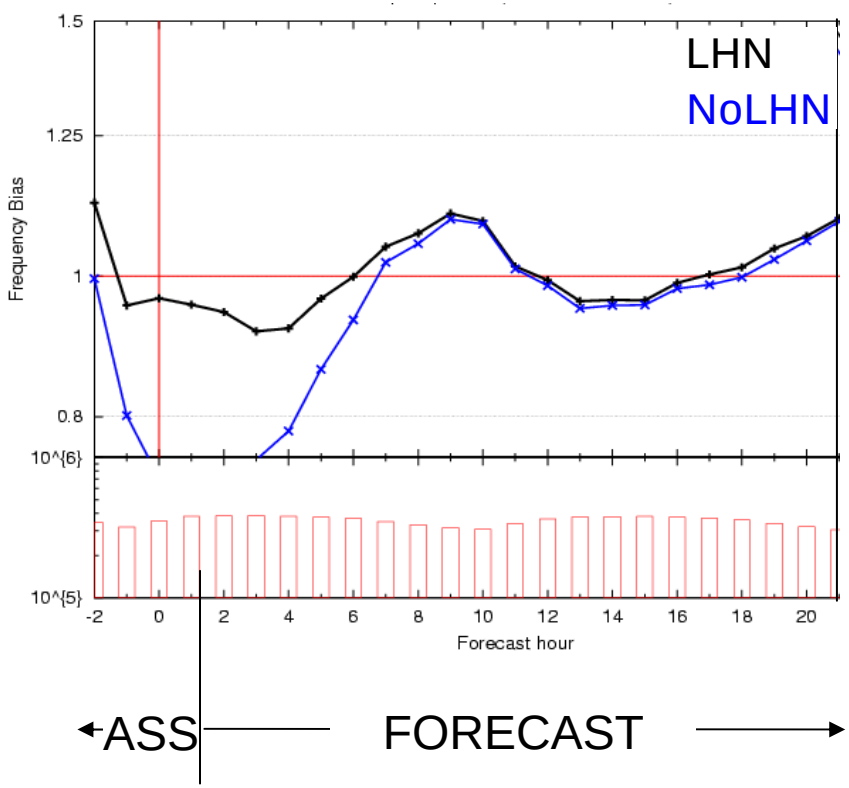
- ➔ Several changes of COMSO-DE took place since start of (pre)operational mode
- ➔ Changes in microphysics required further revisions of the LHN scheme
  - ➔ Refinement of definition the reference precipitation
  - ➔ Improvement of grid point search module

- ➔ What the benefit of LHN in the current setup compared to assimilation without LHN of radar information?

Mean skill scores over 32 forecast (00 and 12 UTC) AUGUST 2006

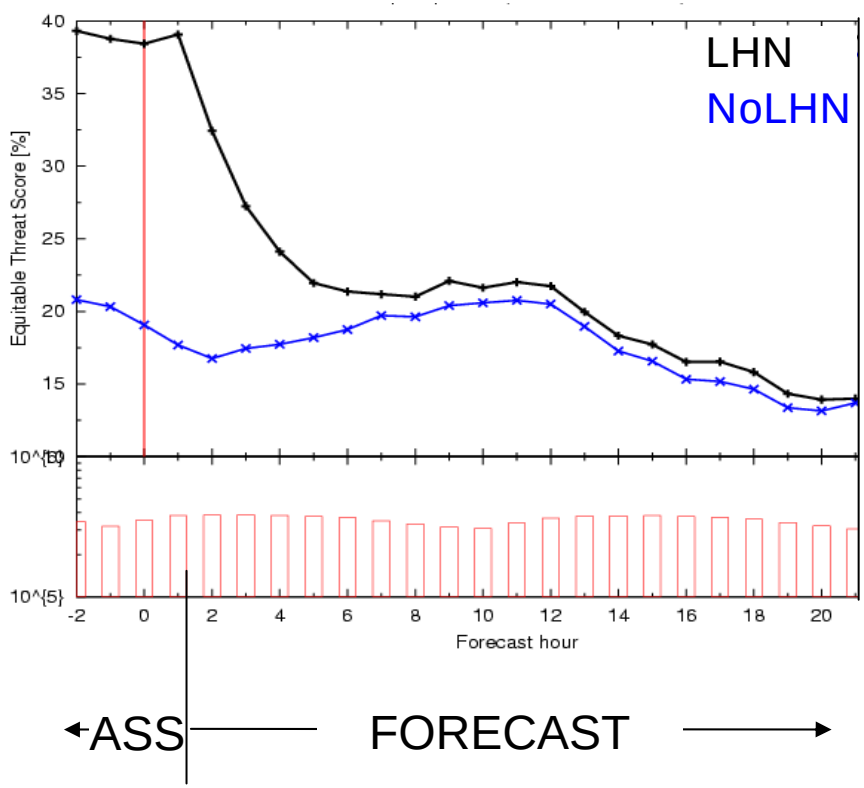
Threshold 0.1 mm/h

FBI



←ASS FORECAST →

ETS



←ASS FORECAST →

Outlook

- Assimilation Scheme:
  - Increasing the duration of forecast benefit
  - Investigation of balances constrains and local environment
  - Inclusion of radar beam height
    - Definition of reference precipitation
    - Vertical distribution of increments
- Data sources
  - Extension the radar domain to the entire model domain
  - Improving quality check, i.e. bright band detection
  - Complete volume scan with quality information
  - Using Radial wind information

Thank you for your attention