

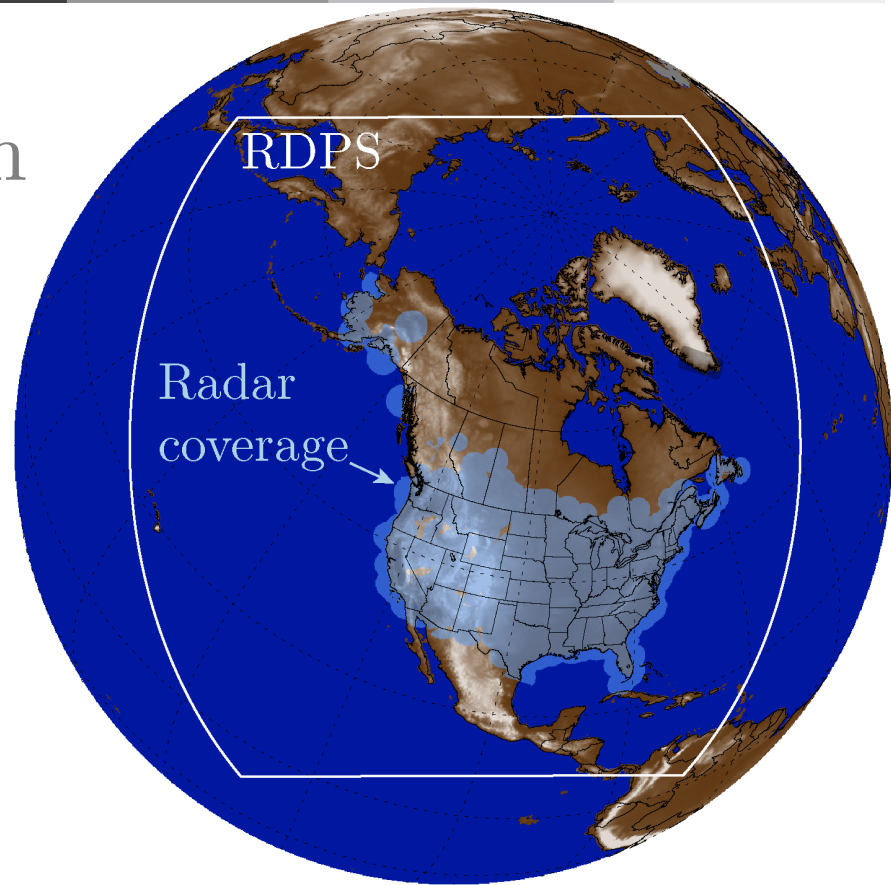


Latent Heat Nudging in the Canadian Regional Deterministic Prediction System

Dominik Jacques

Daniel Michelson

Jean-François Caron



Regional Deterministic Prediction System (RDPS)

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4DEnVAR assimilation system

Atmospheric model (GEM)

Regional Deterministic Prediction System (RDPS)

4DEnVAR assimilation system

Atmospheric model (GEM)

Continuous cycle
with a 6h window

10 km resolution

80 vertical levels
up to 0.1 hPa

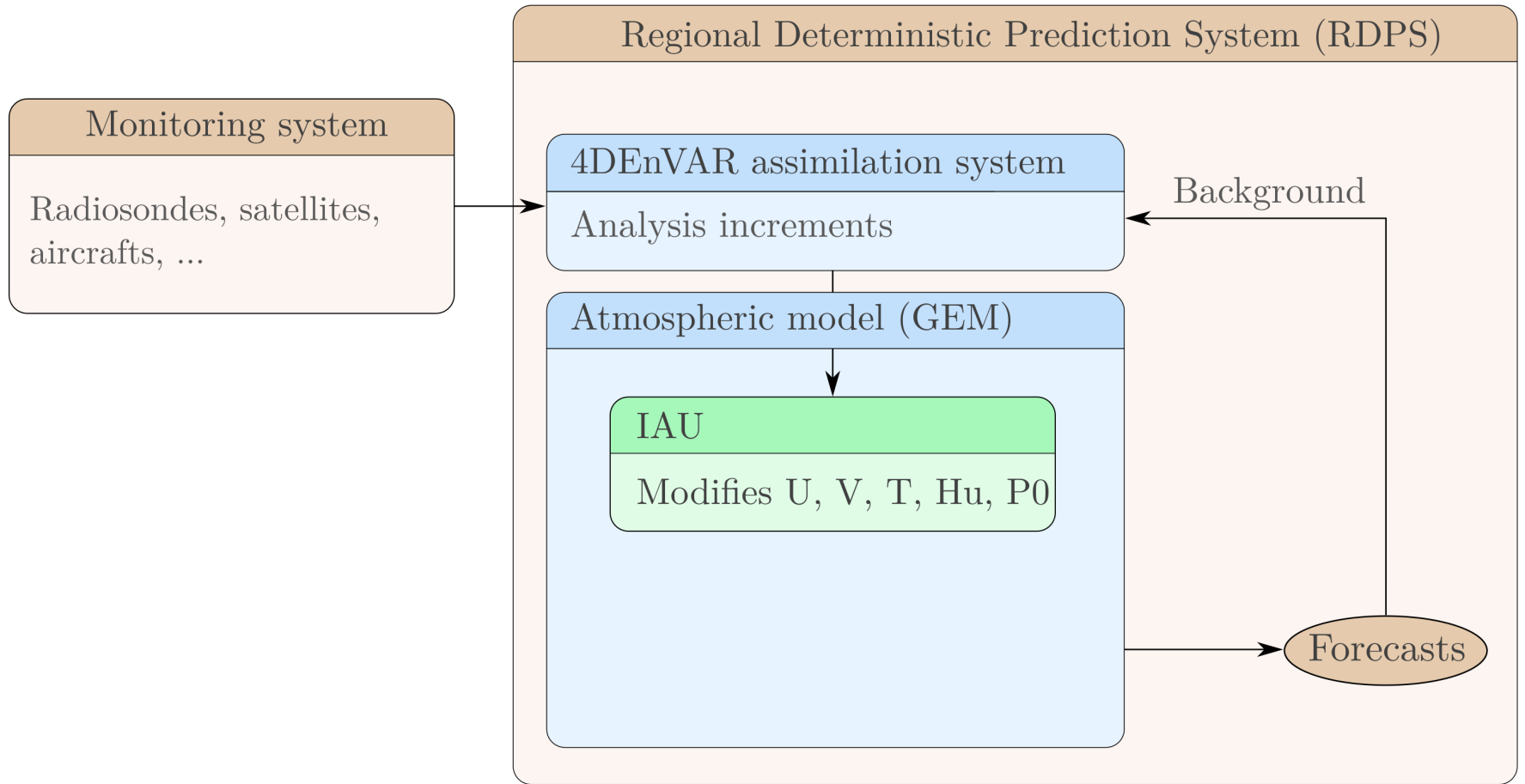
BC's from the 25 km
Global system

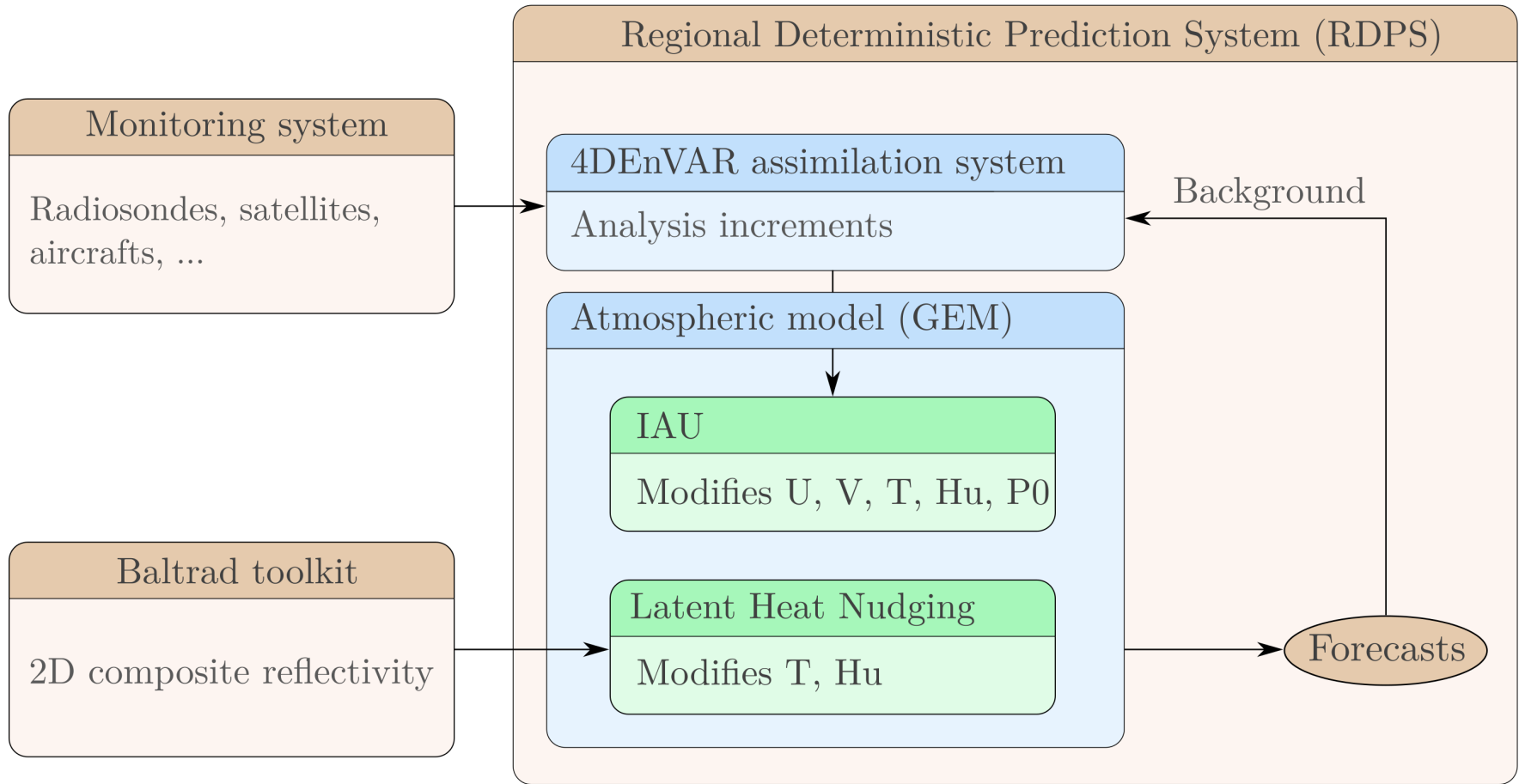
Parametrisations:

Kain and Fritsch (1990,1993)

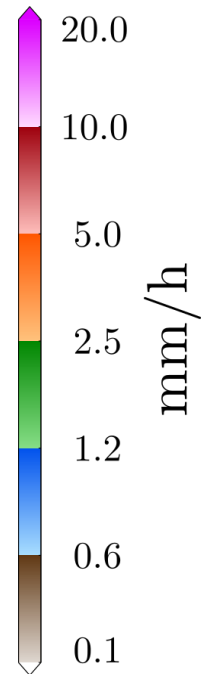
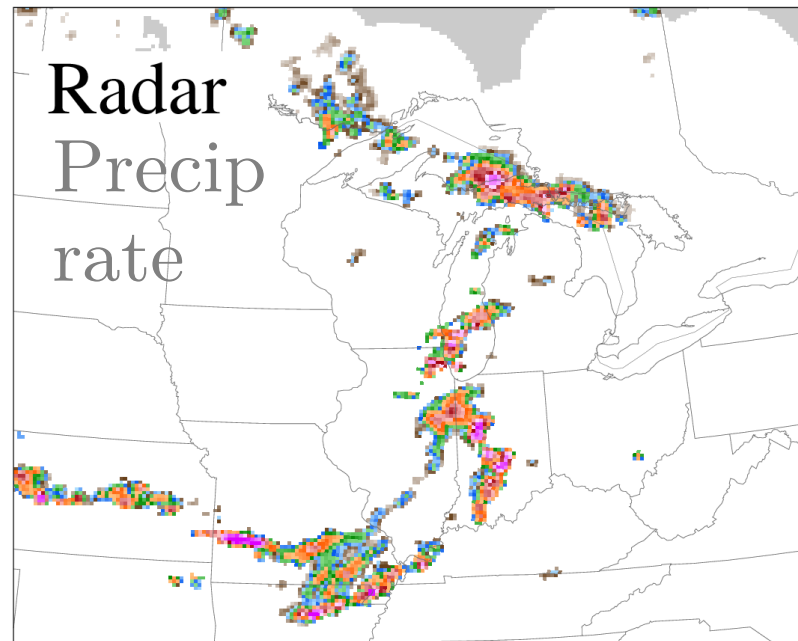
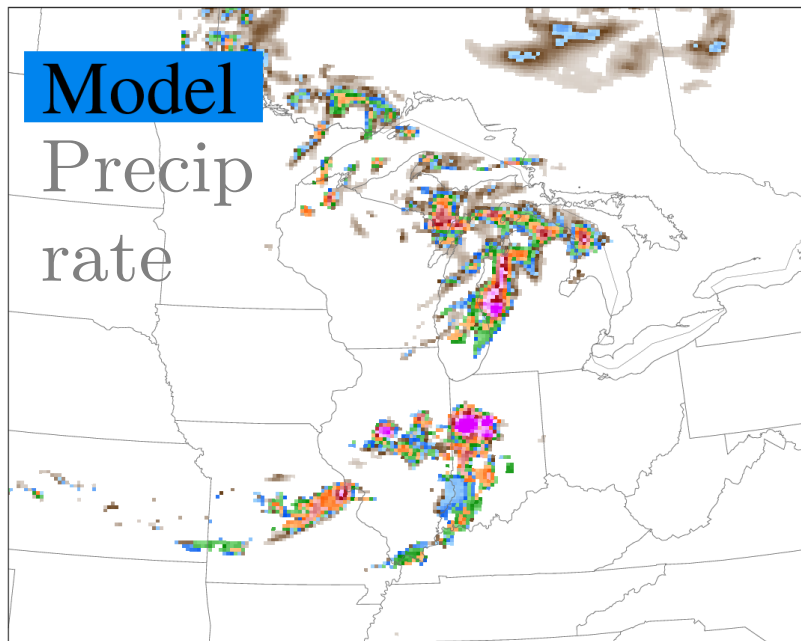
Kuo Transient (Bélair et al. 2005)

Sundqvist (1978)

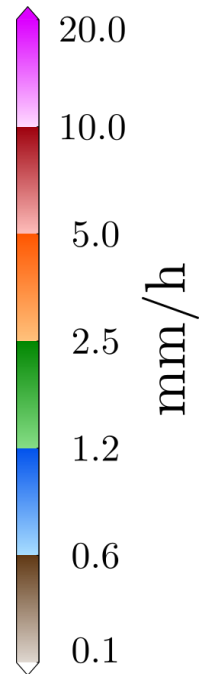
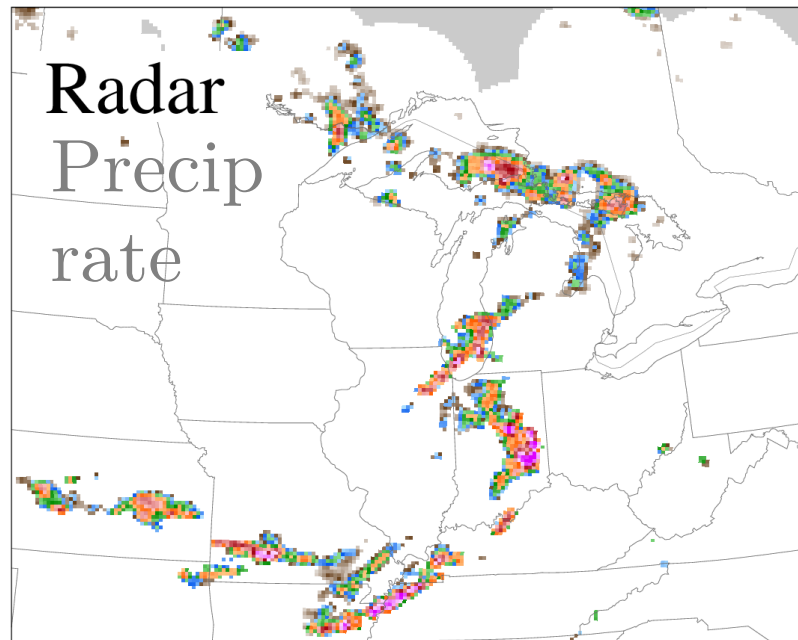
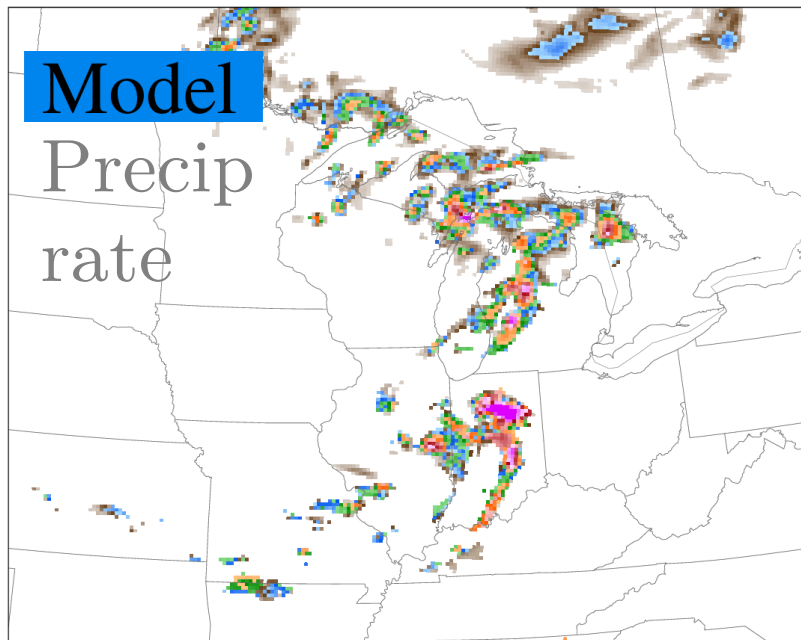




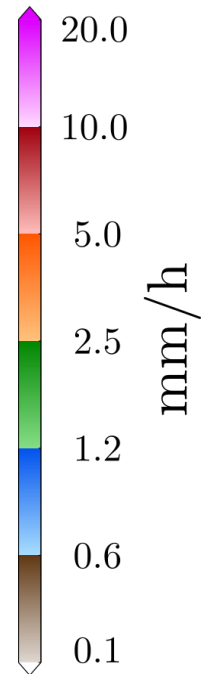
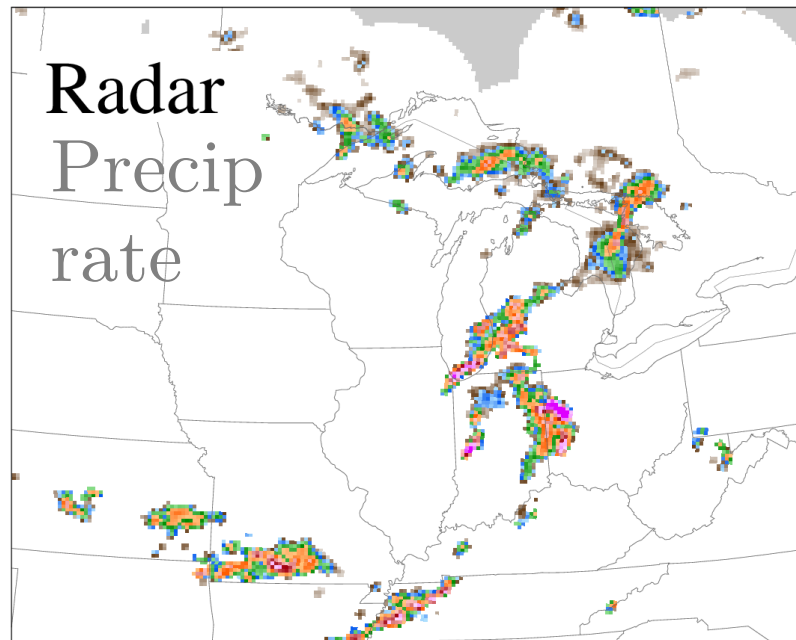
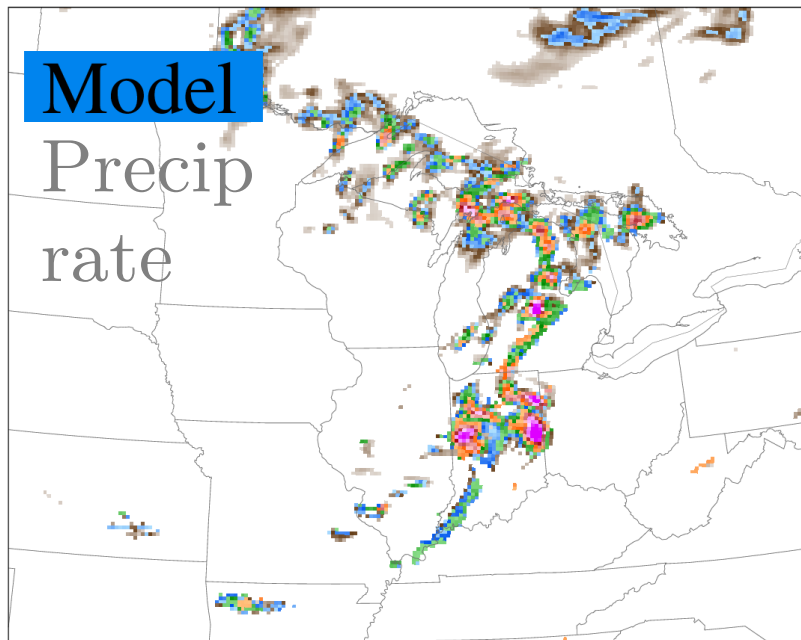
Motivation 1



Motivation 1



Motivation 1



Motivation 2

- Regional Deterministic Prediction System (RDPS)

10 km / 6h window \longrightarrow 2.5 km / 1h window

Greater emphasis on short lead times and precipitation

Motivation 2

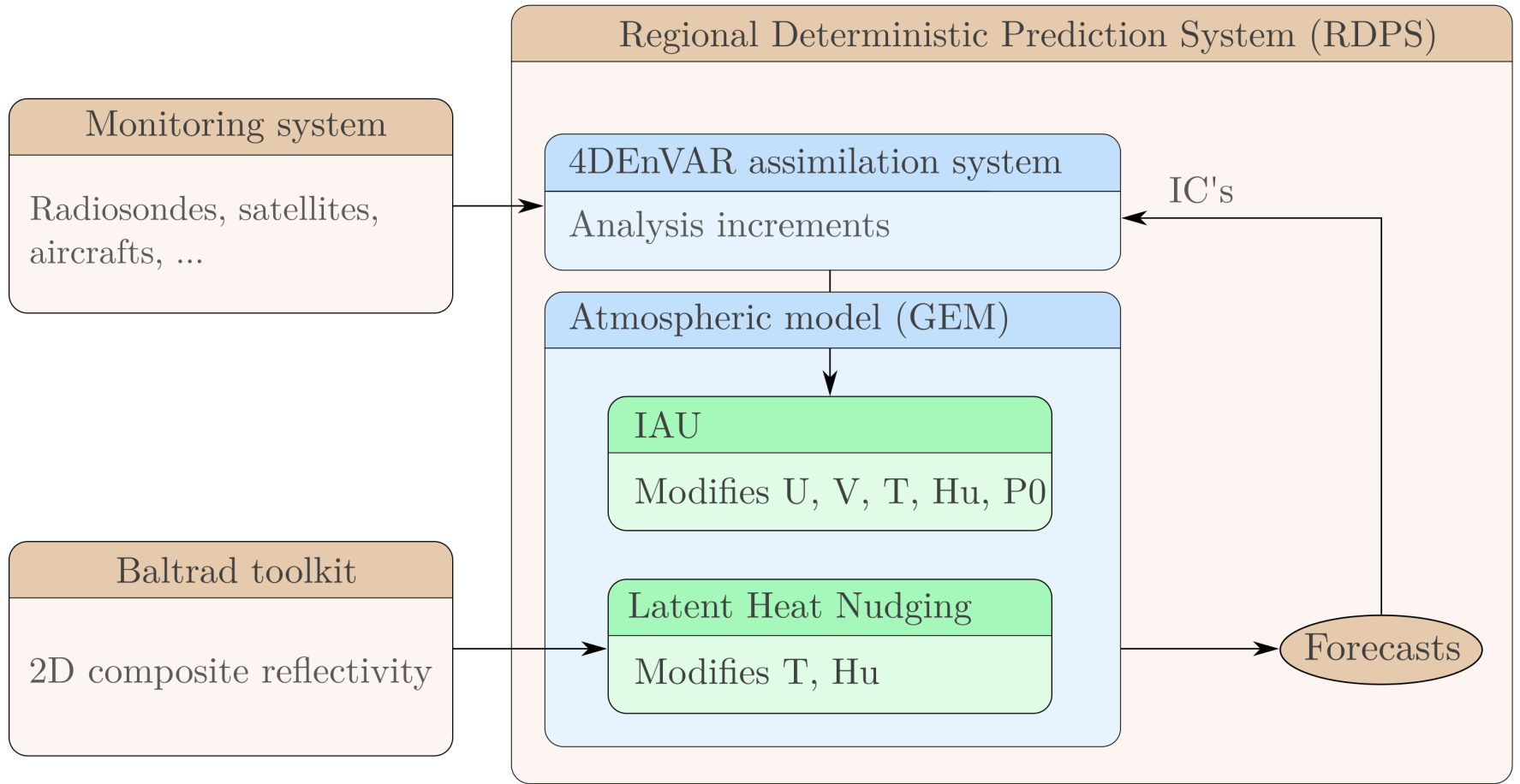
- Regional Deterministic Prediction System (RDPS)

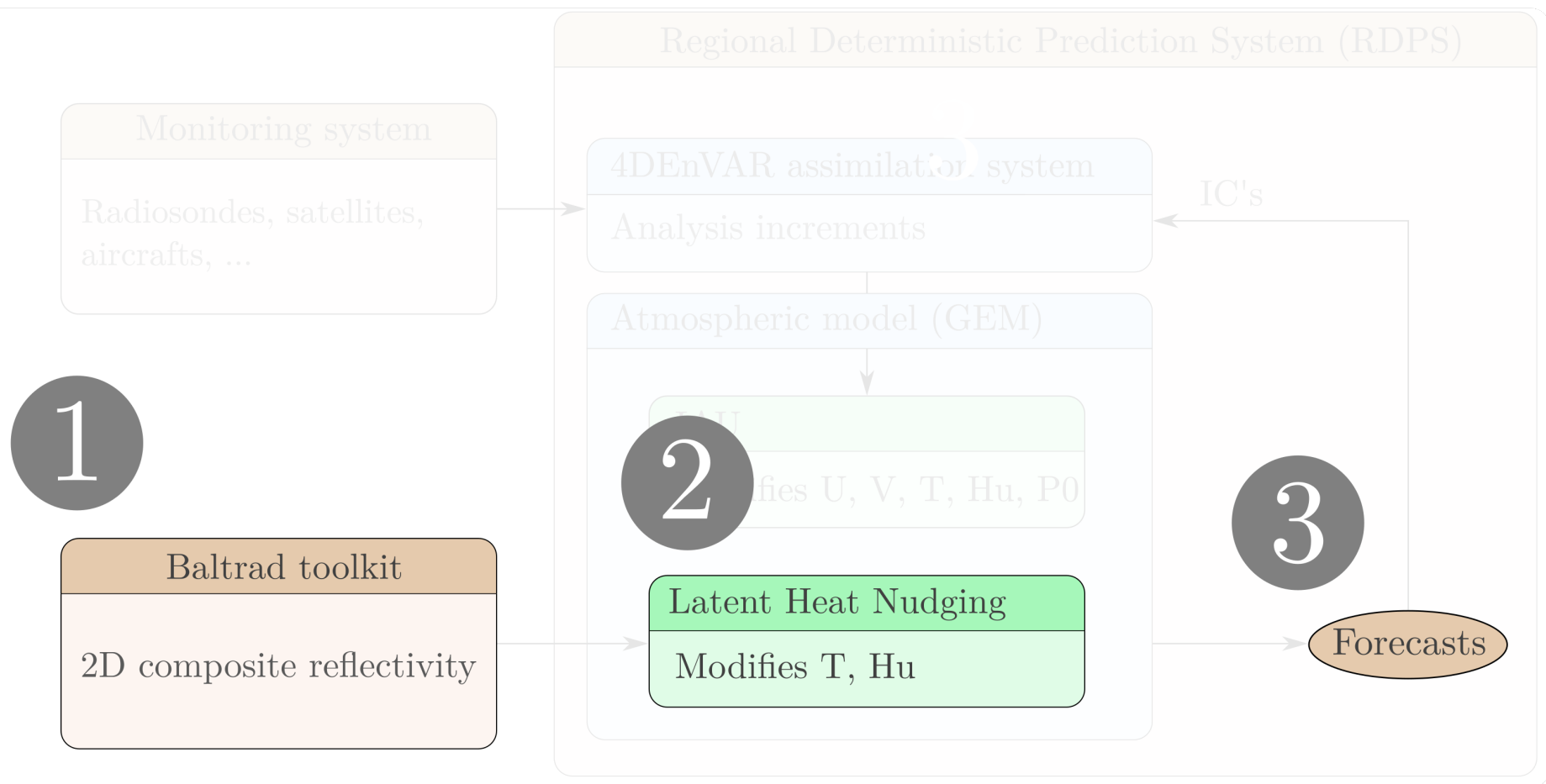
10 km / 6h window \longrightarrow 2.5 km / 1h window

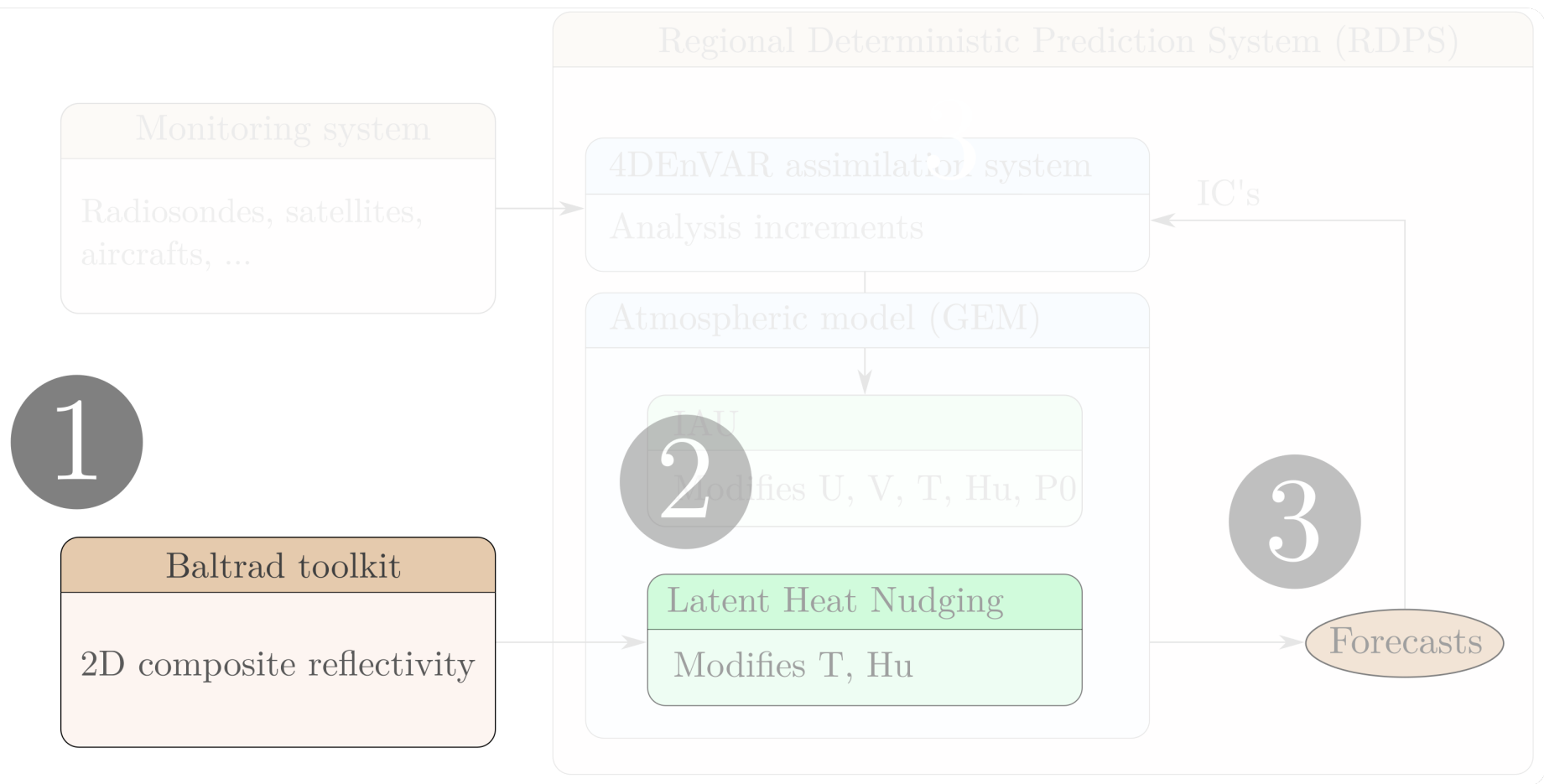
Greater emphasis on short lead times and precipitation

Motivation 3

- Canadian radar network is being renewed





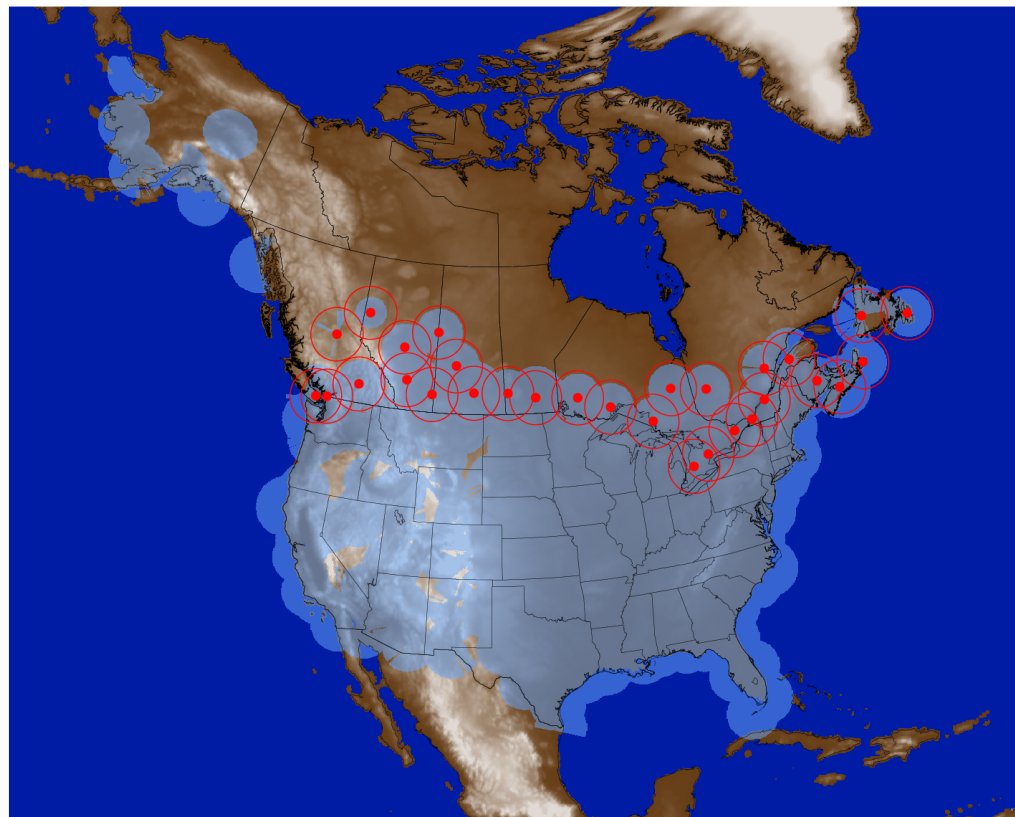


Input radar data

Canadian network

30 C-band Doppler radars

10 minute acquisition cycle



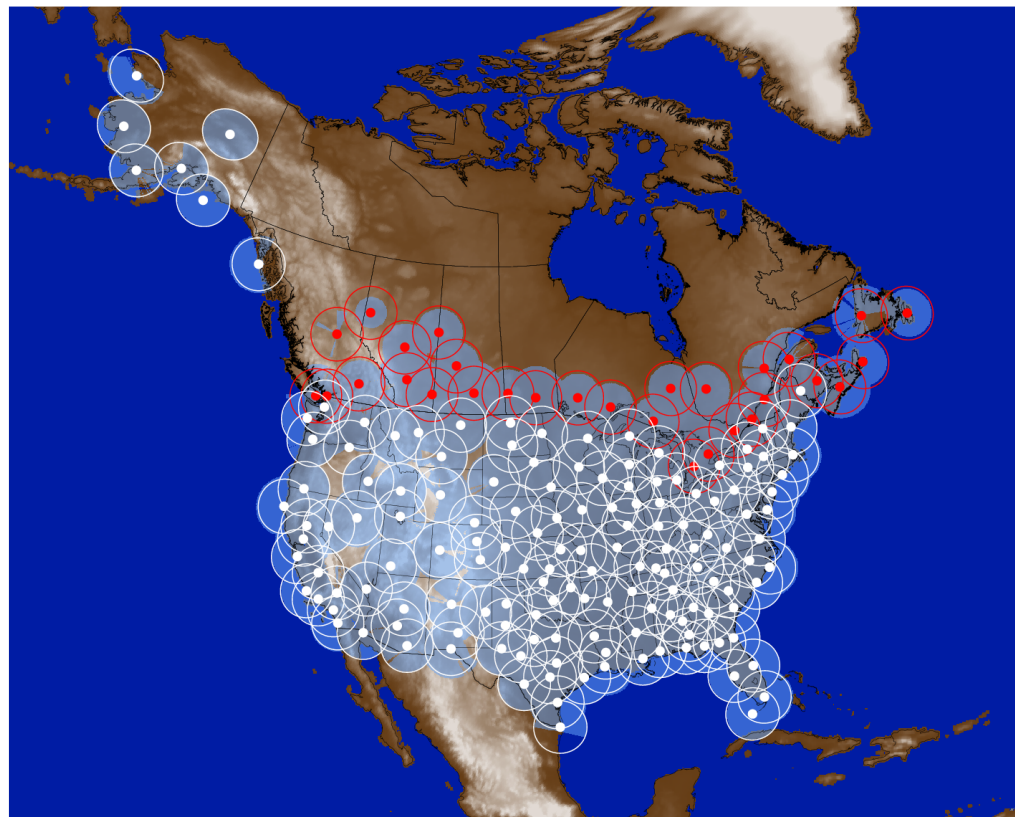
Input radar data

Canadian network

30 C-band Doppler radars
10 minute acquisition cycle

US network

NEXRAD Level II
~5 minute acquisition cycle
CONUS + Alaska



Input radar data

Canadian network

30 C-band Doppler radars
10 minute acquisition cycle

US network

NEXRAD Level II
~5 minute acquisition cycle
CONUS + Alaska

Baltrad toolbox deployed at ECCC

2.5 km reflectivity composites

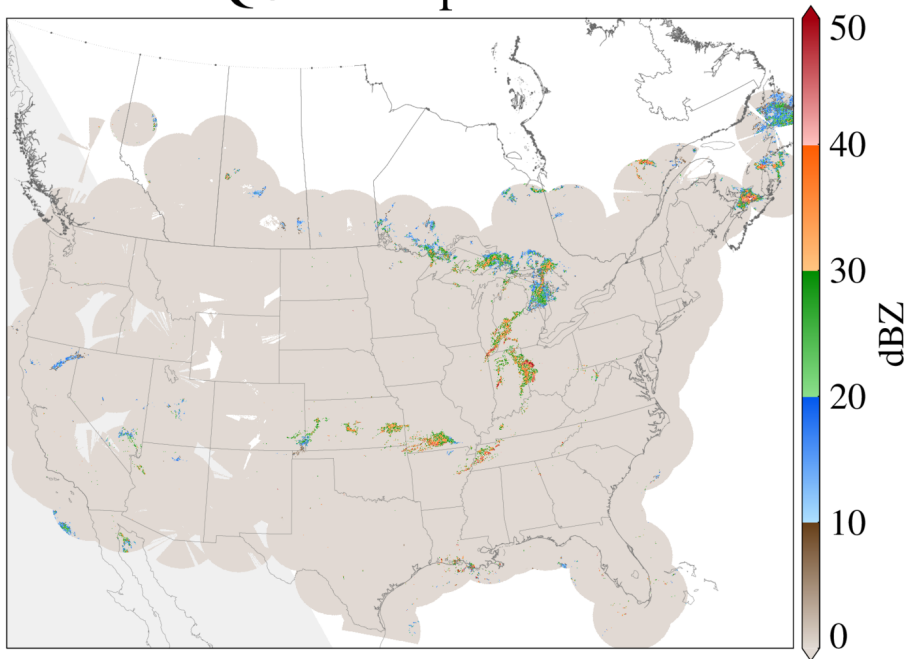
1 km pseudo-CAPPI

Selection criterion: data quality

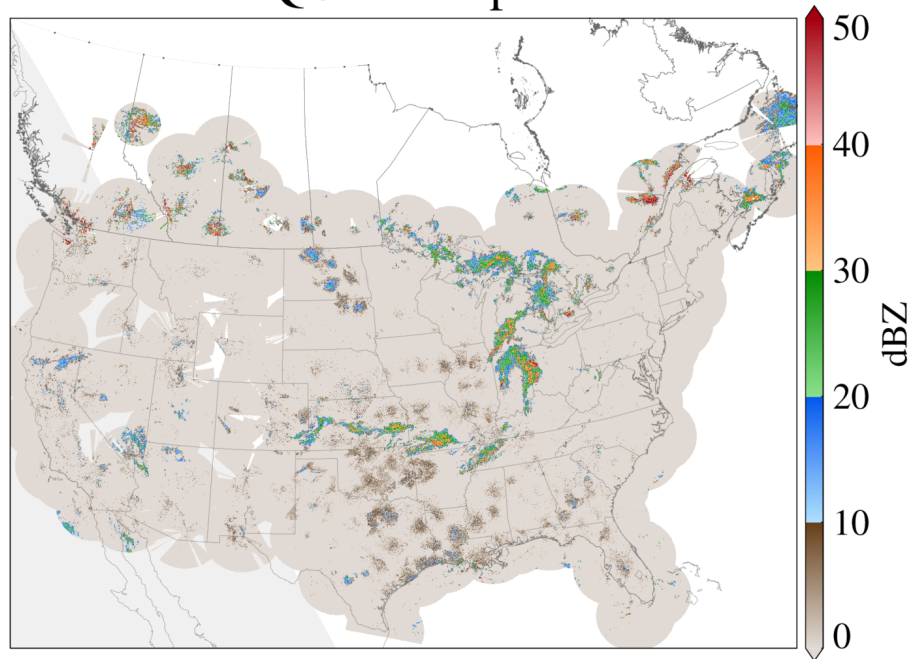
2014-07-08 12:00 UTC

day night

QCed composites



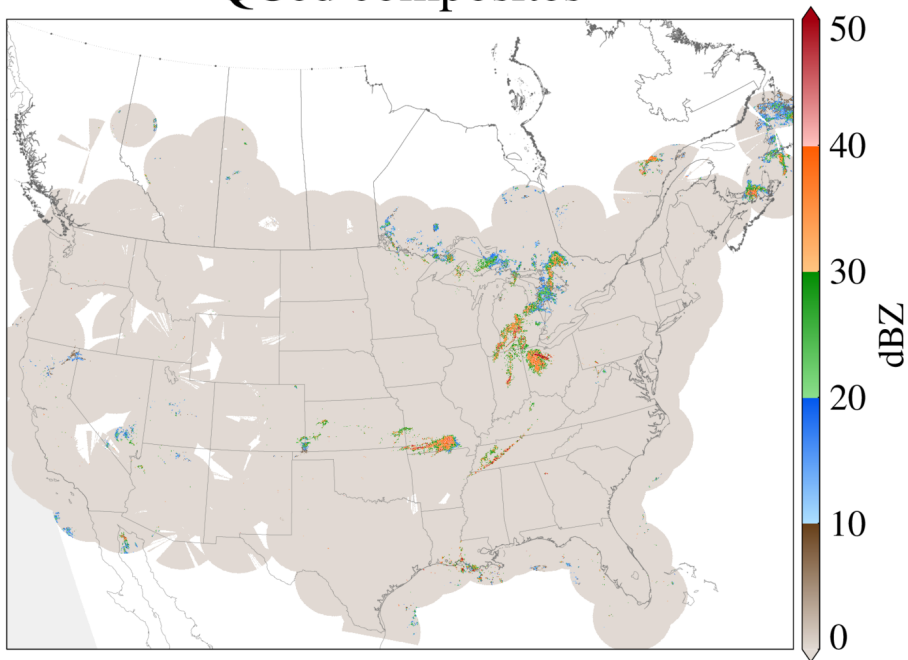
non QCed composites



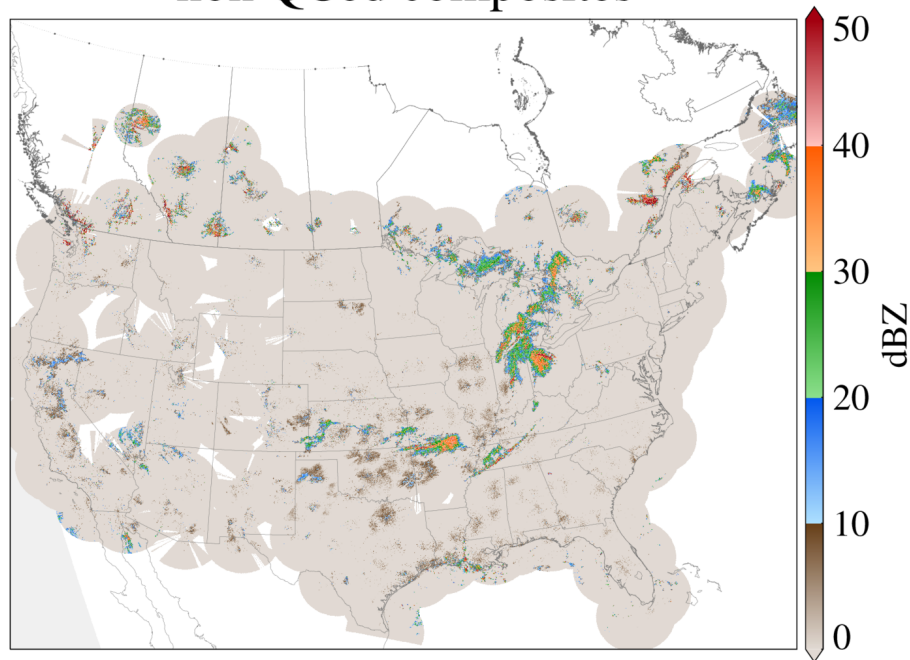
2014-07-08 13:00 UTC

day night

QCed composites



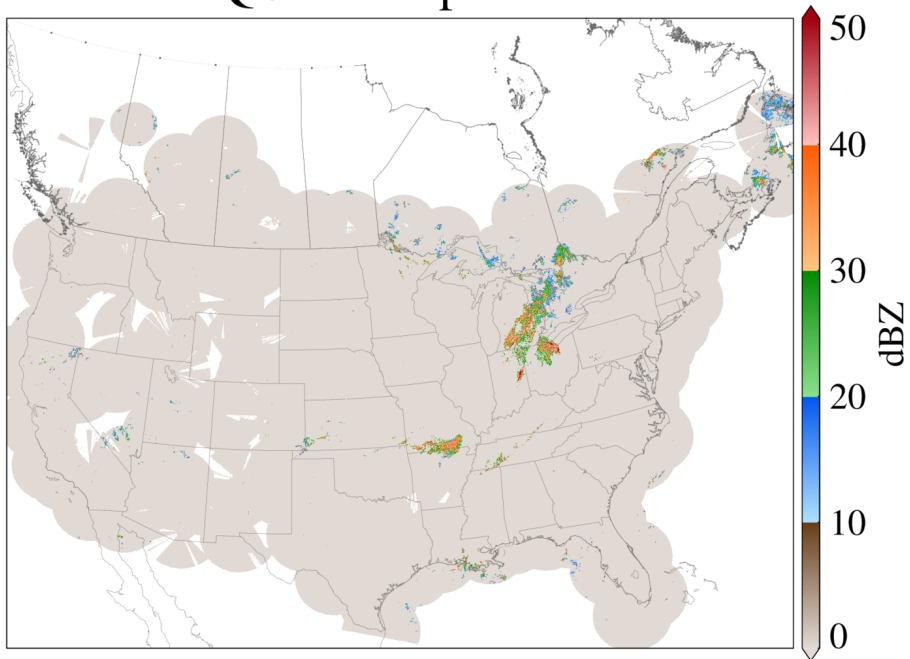
non QCed composites



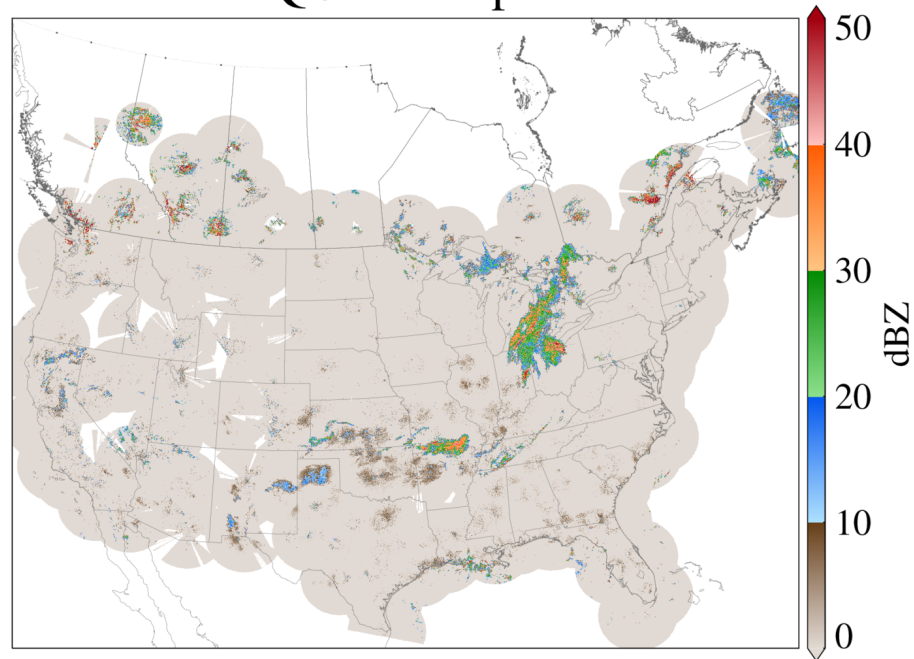
2014-07-08 14:00 UTC

day night

QCed composites



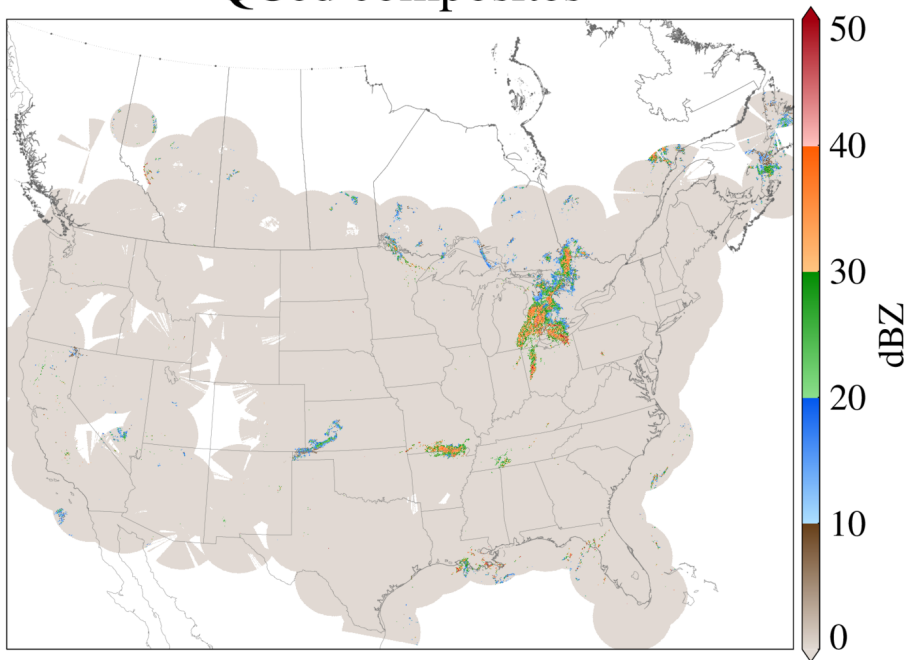
non QCed composites



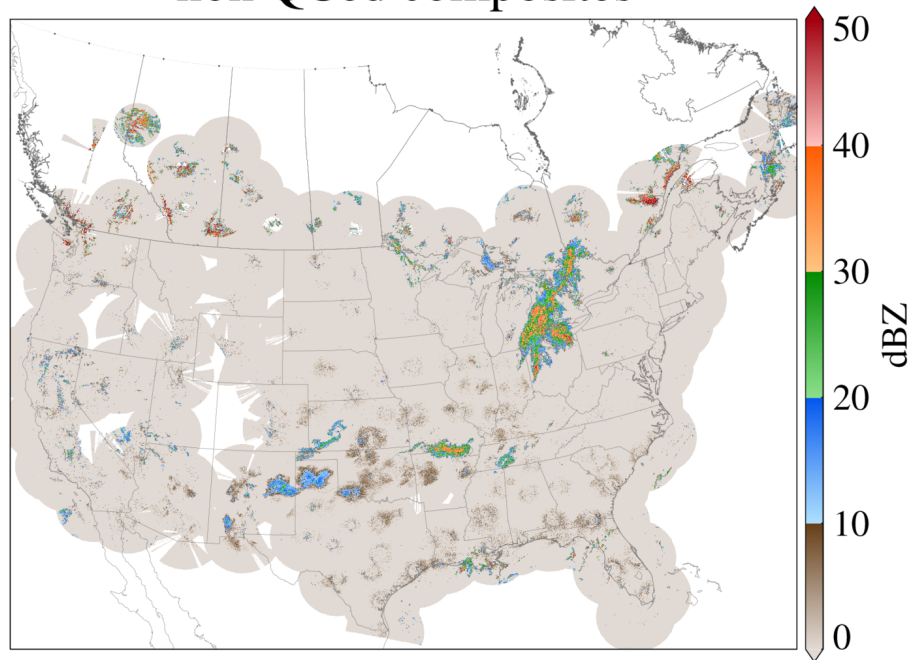
2014-07-08 15:00 UTC

day night

QCed composites



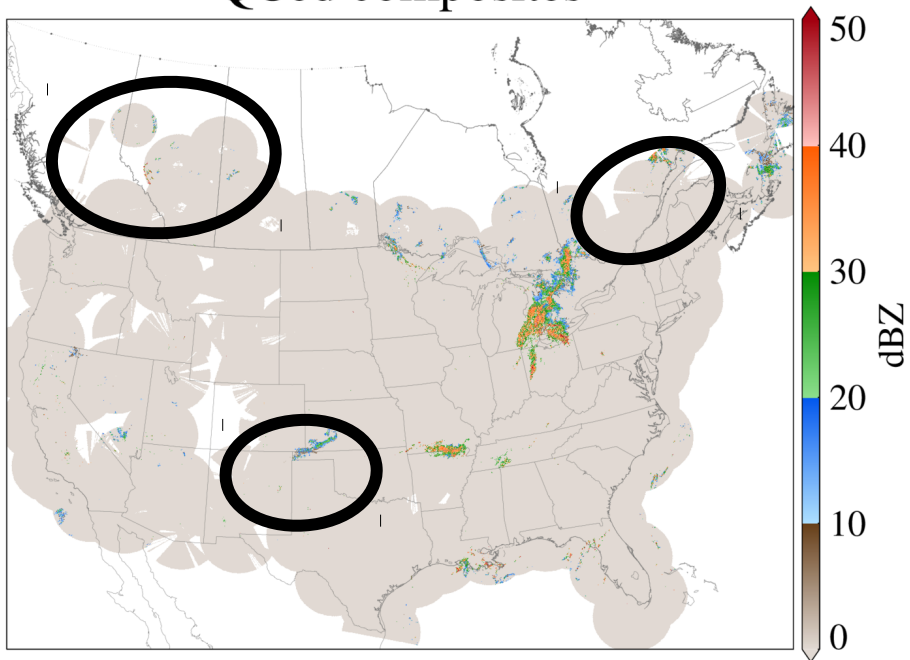
non QCed composites



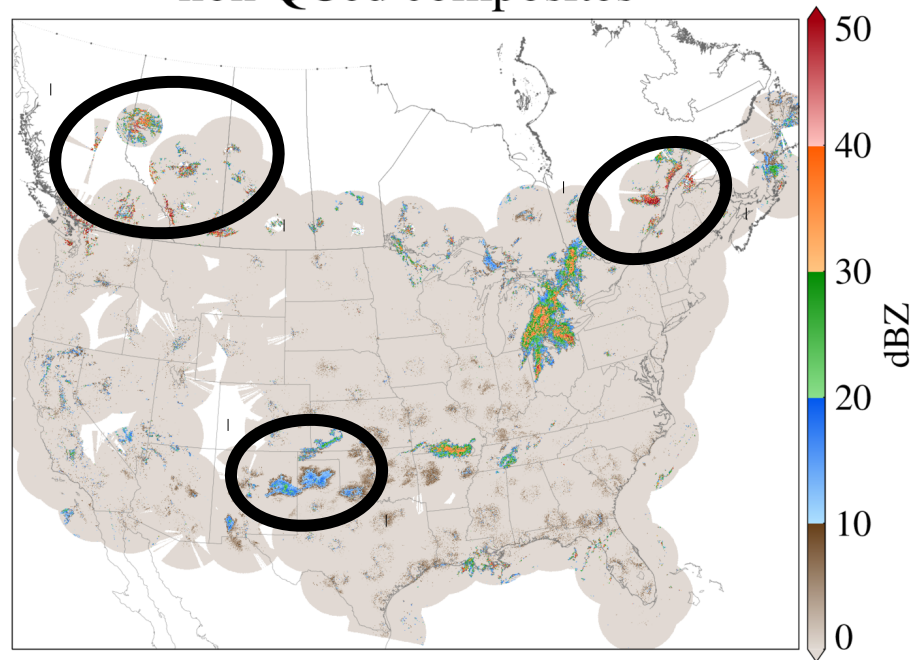
2014-07-08 15:00 UTC

day night

QCed composites



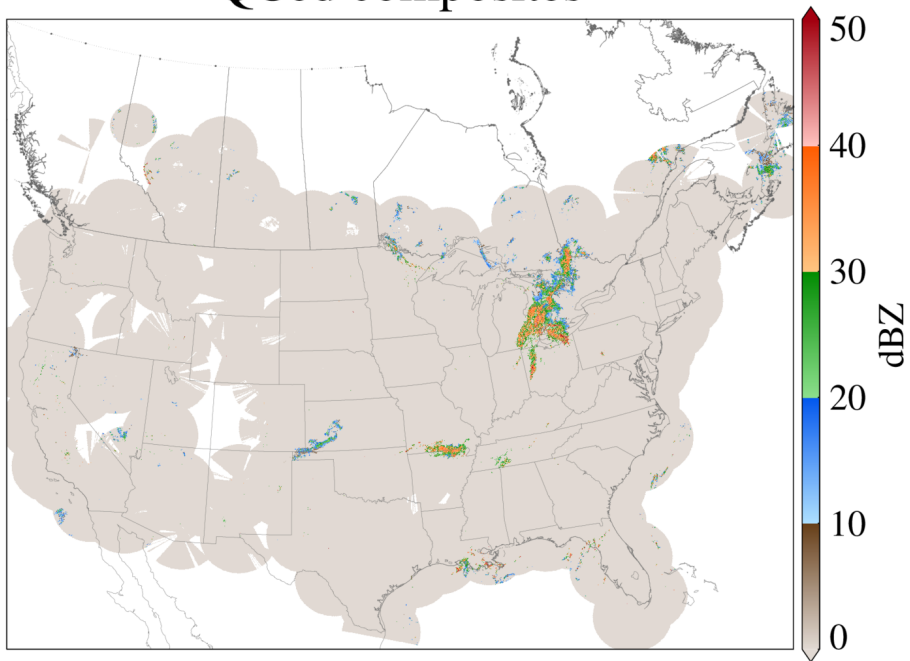
non QCed composites



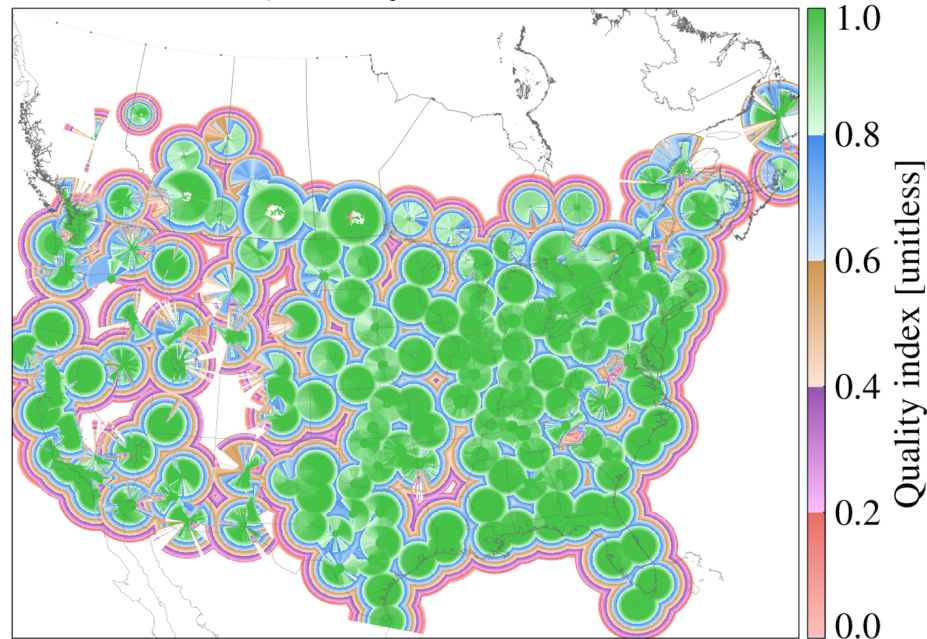
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day night

QCed composites



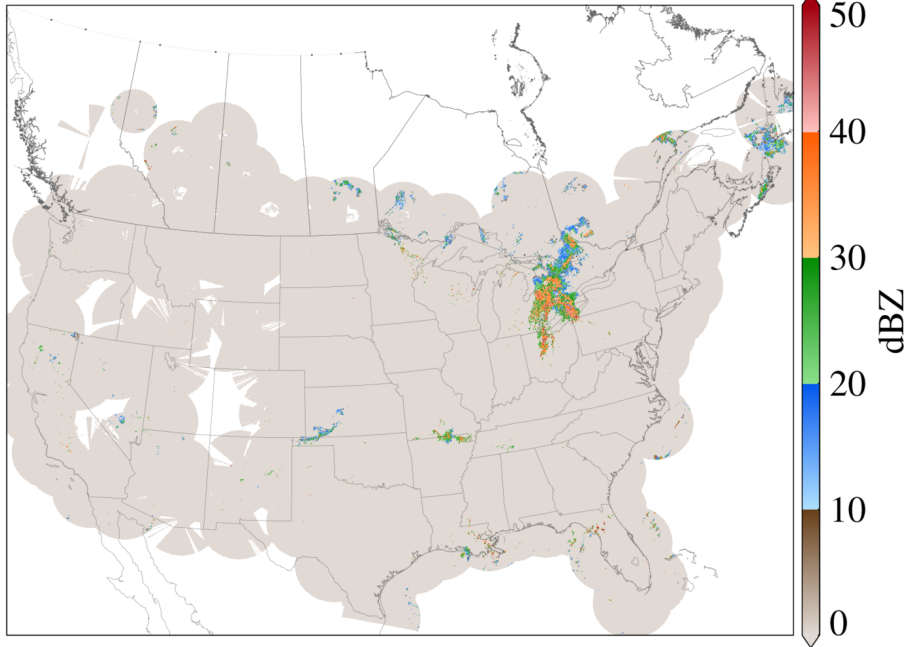
Quality index



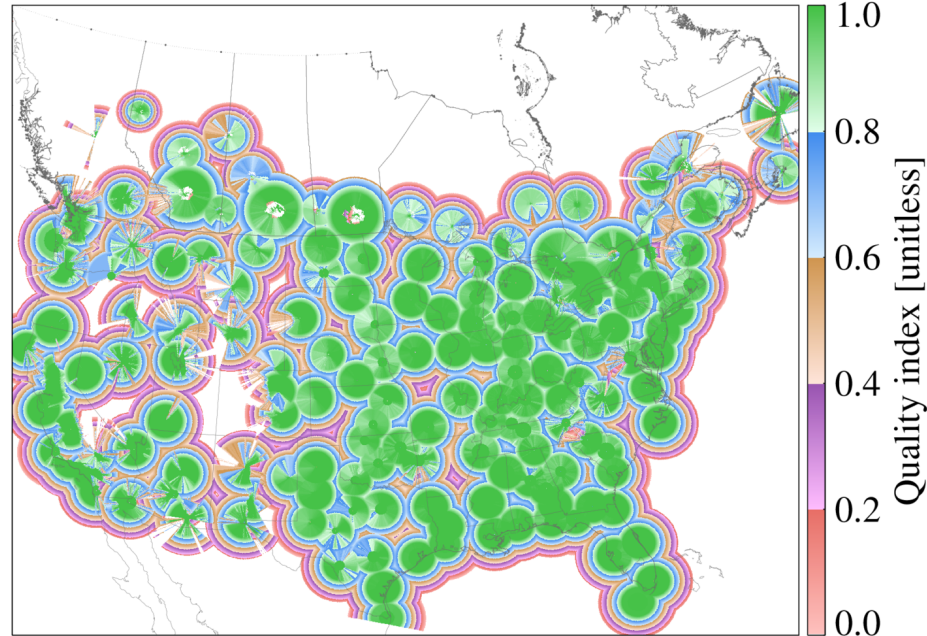
2014-07-08 16:00 UTC

day night

QCed composites



Quality index

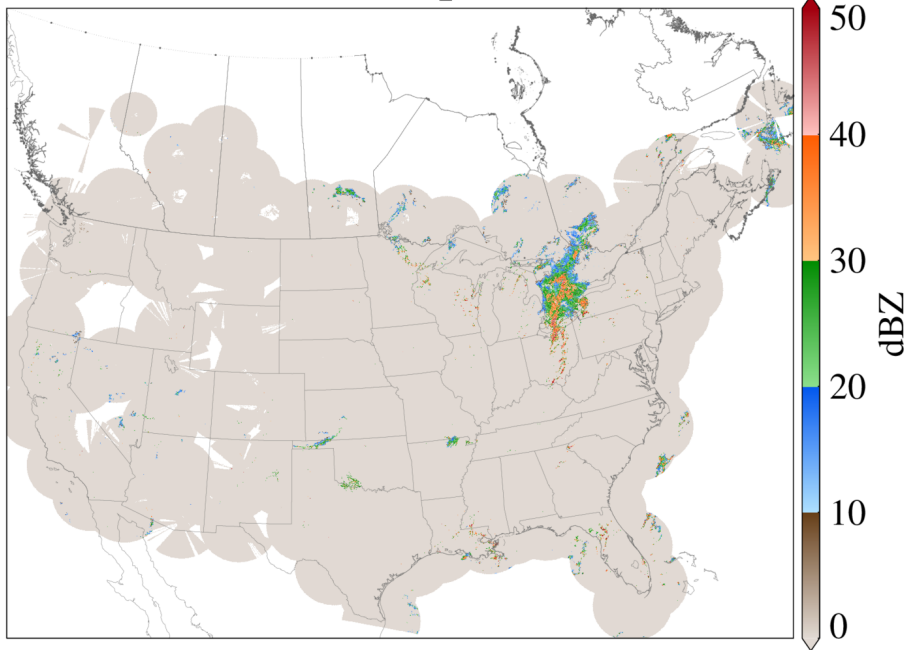


2014-07-08 17:00 UTC

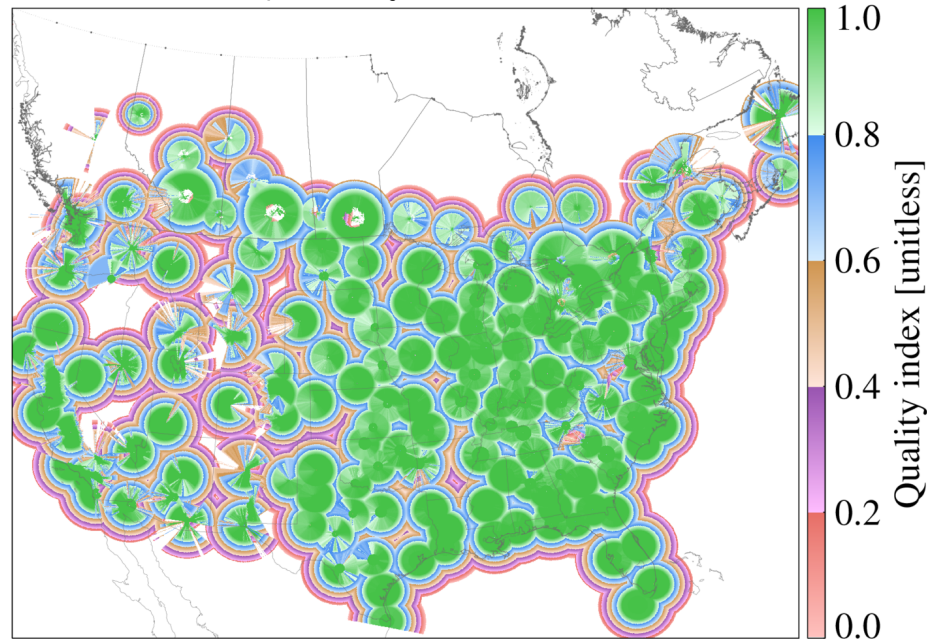
day

night

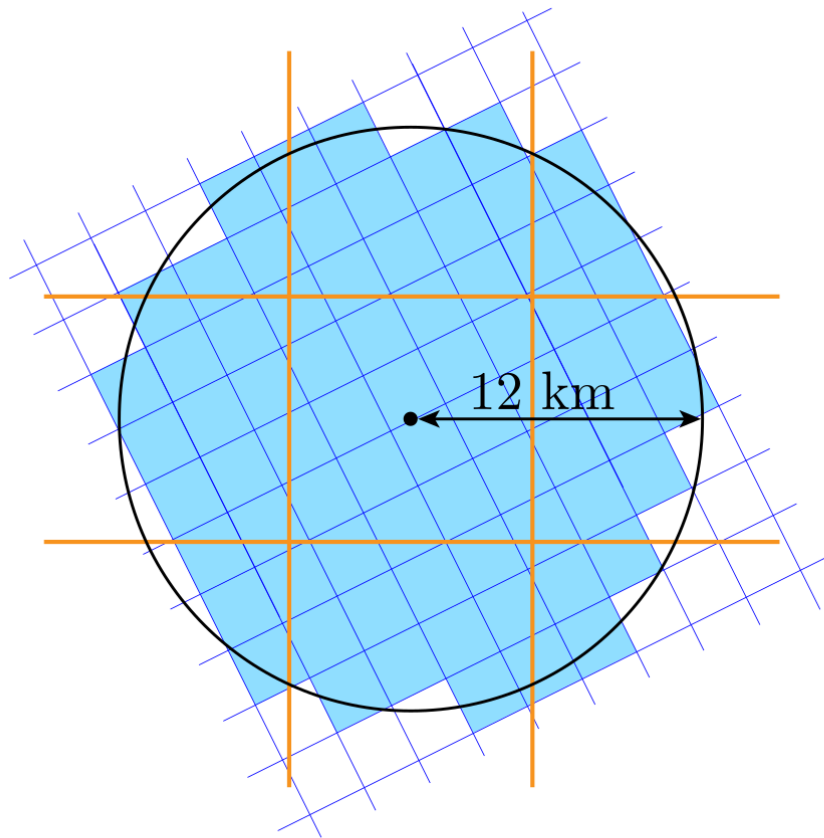
QCed composites



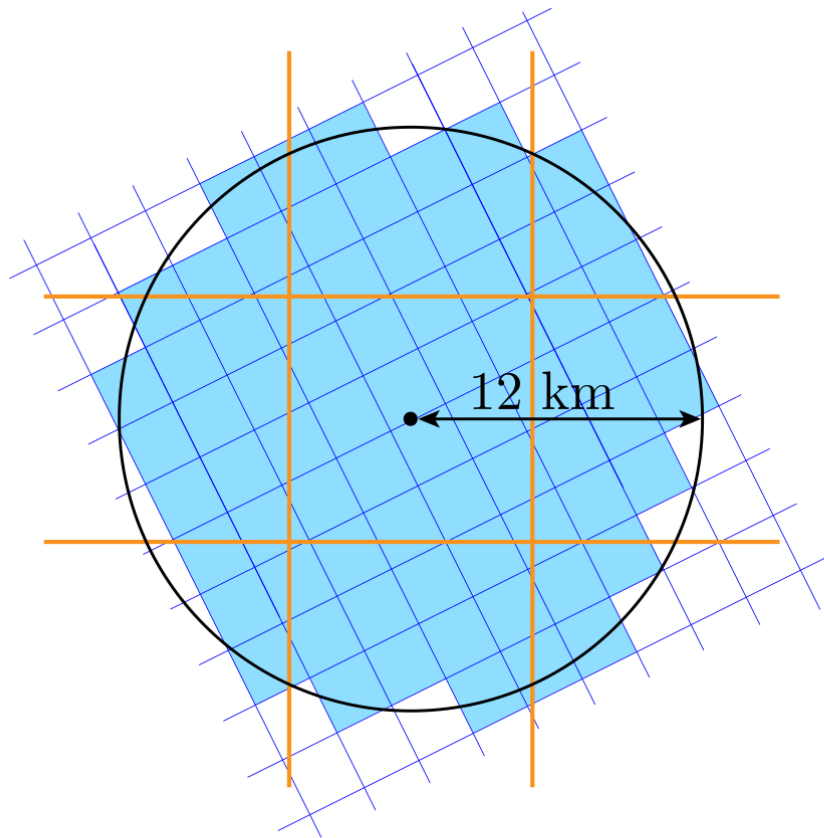
Quality index



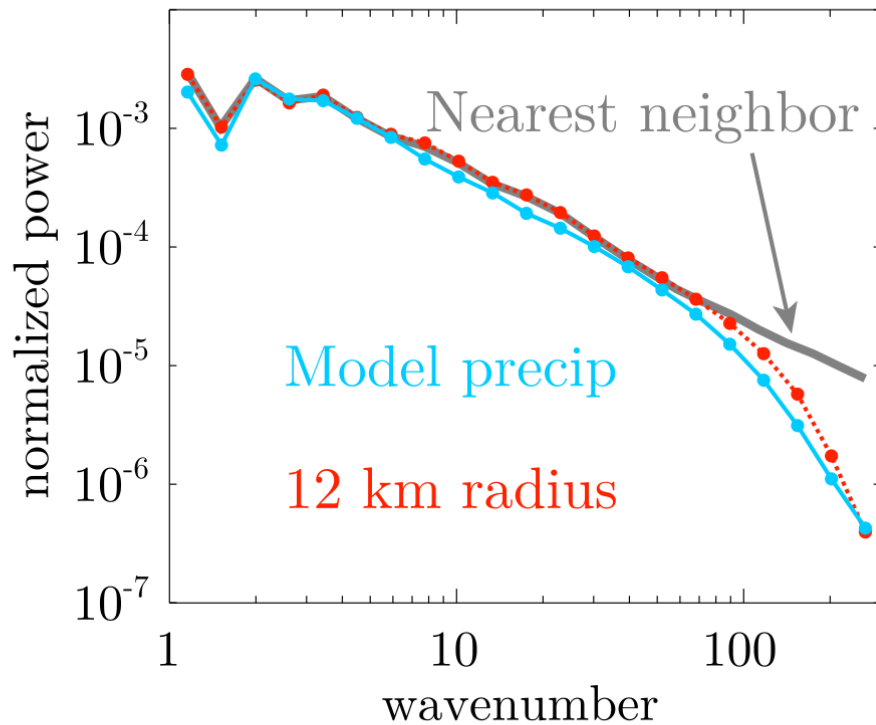
2.5 km composites -> 10 km precip rates



2.5 km composites \rightarrow 10 km precip rates

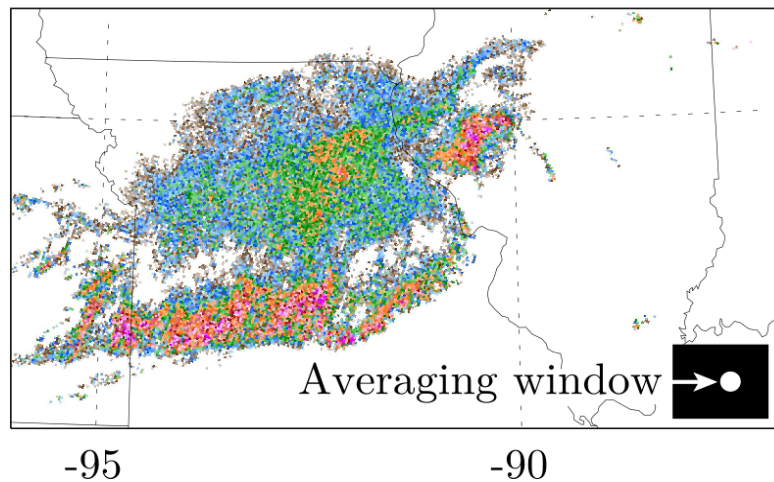


2D spectral density

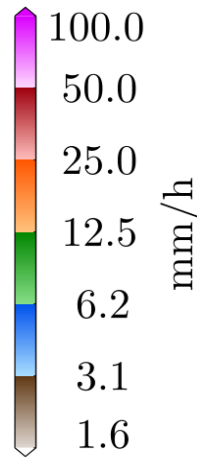
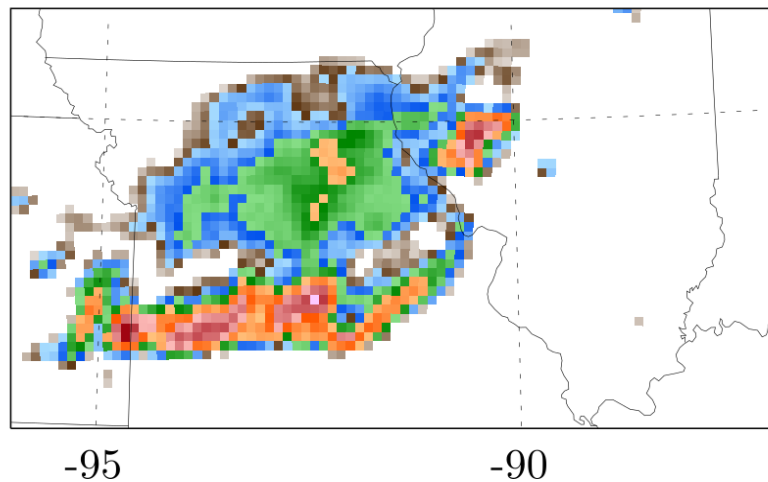


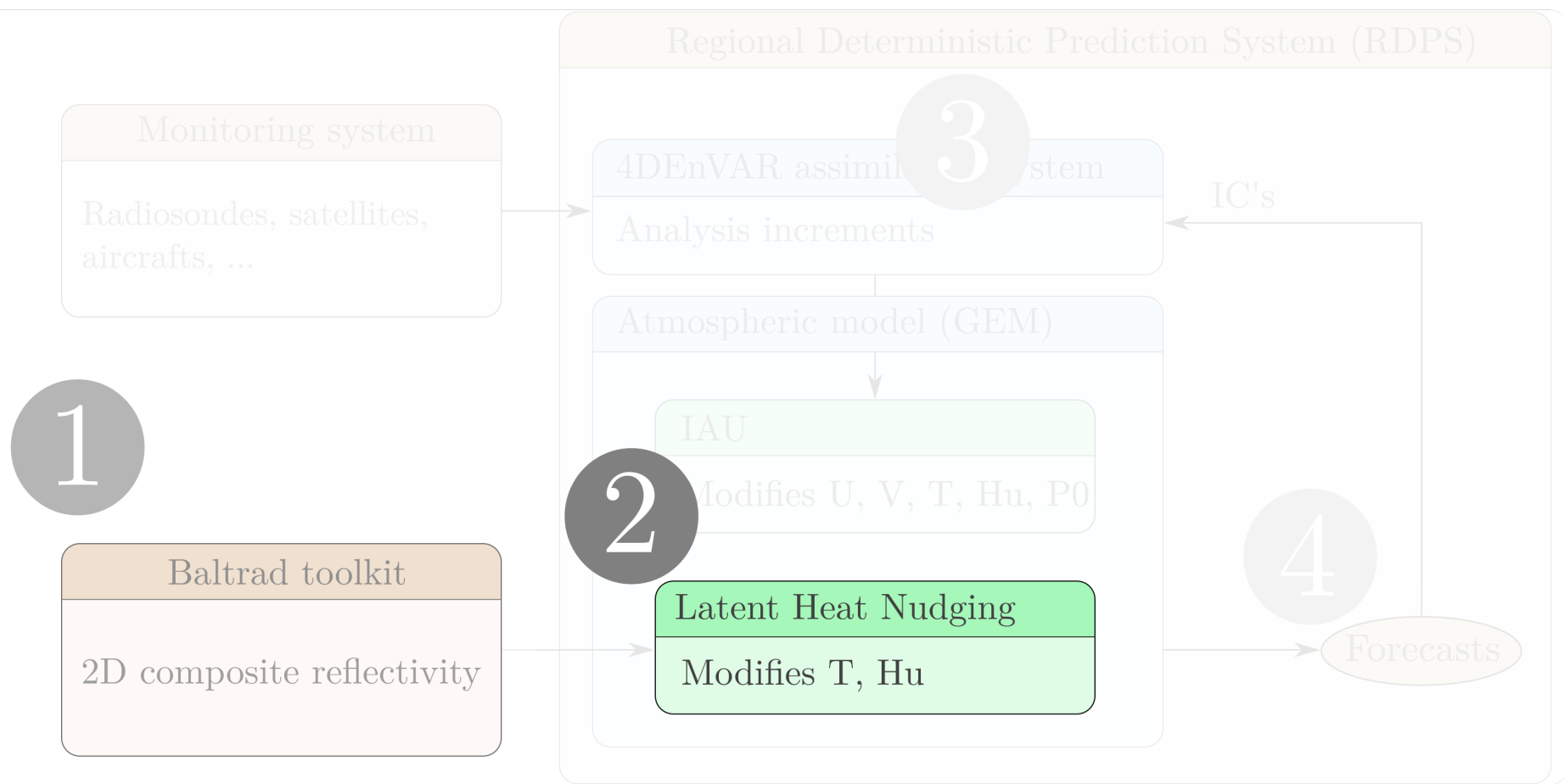
2.5 km composites \rightarrow 10 km precip rates

BALTRAD 2.5 km $R=f(\text{dBZ})$

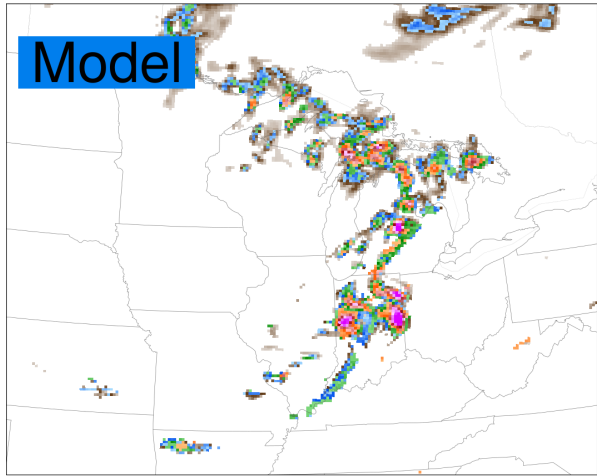


smoothed 10km R

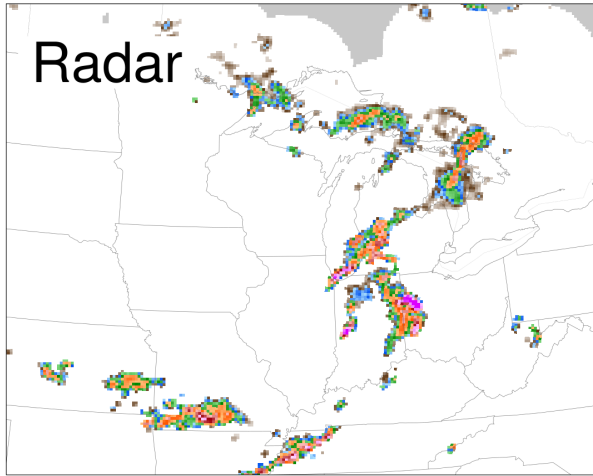




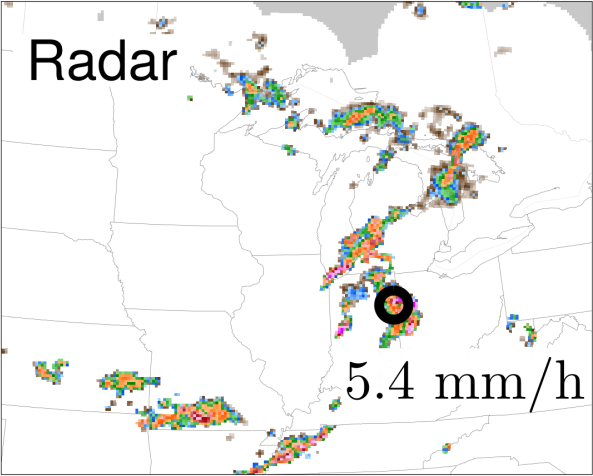
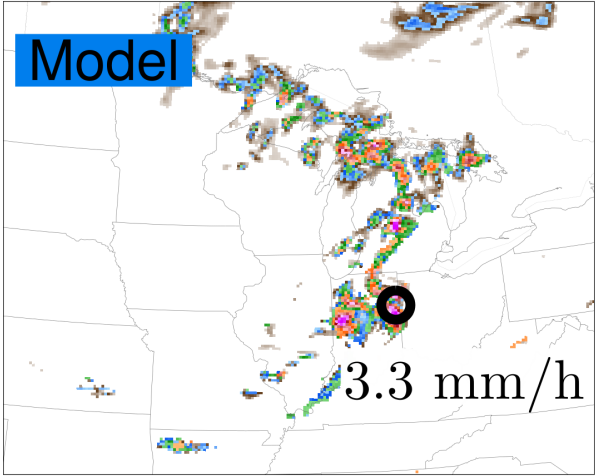
Model



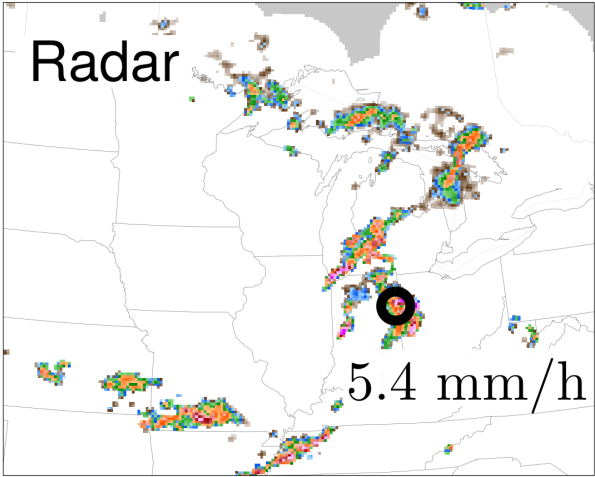
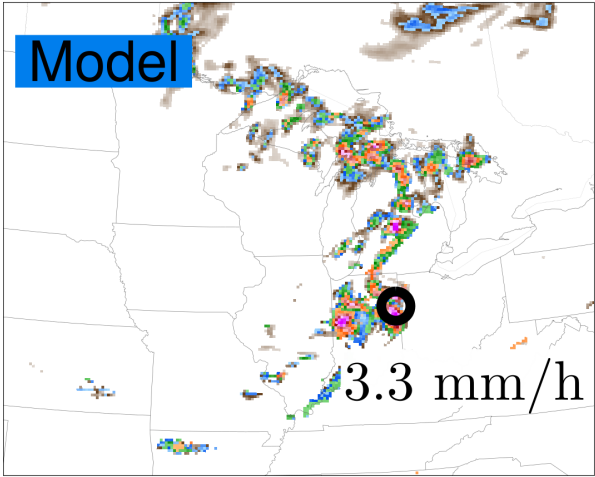
Radar



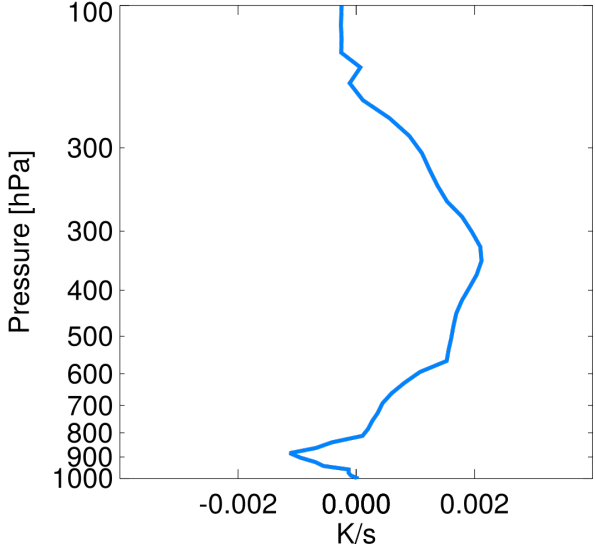
Rain-Rain



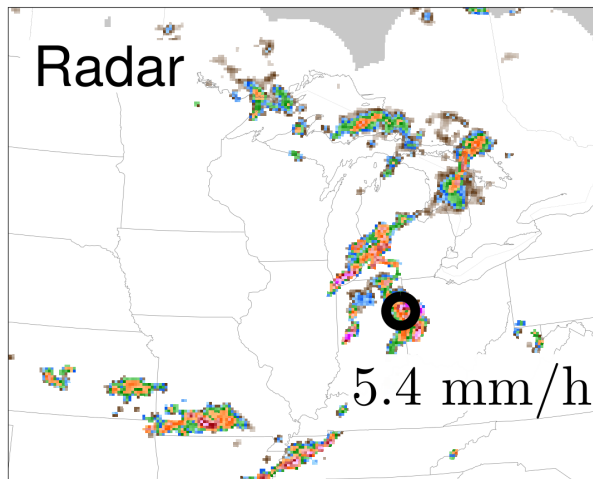
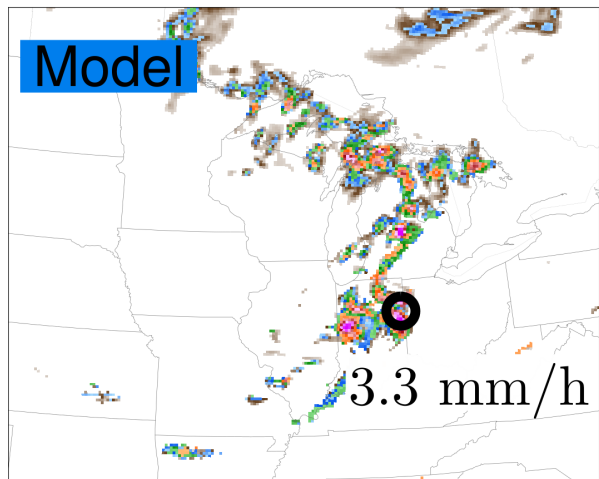
Rain-Rain



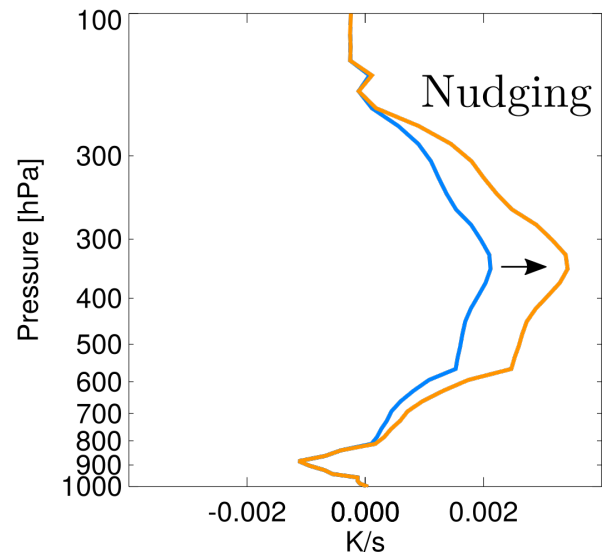
T tendency
due to latent heat release



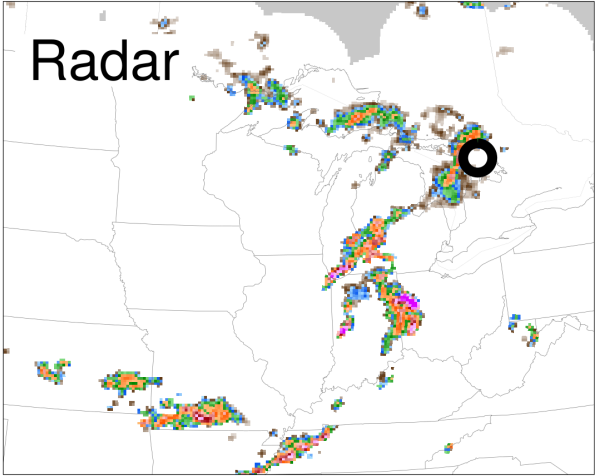
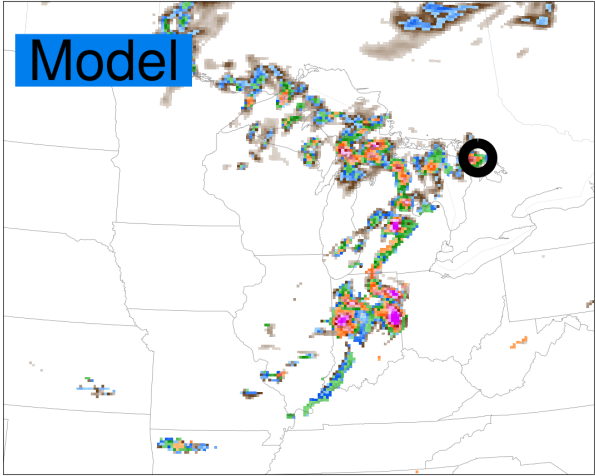
Rain-Rain



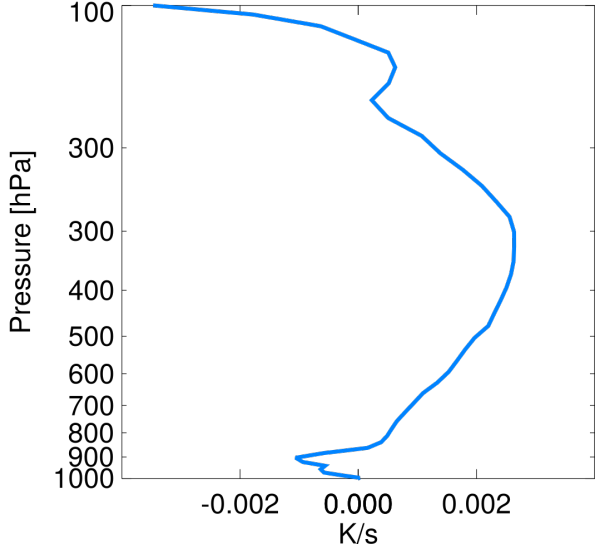
T tendency
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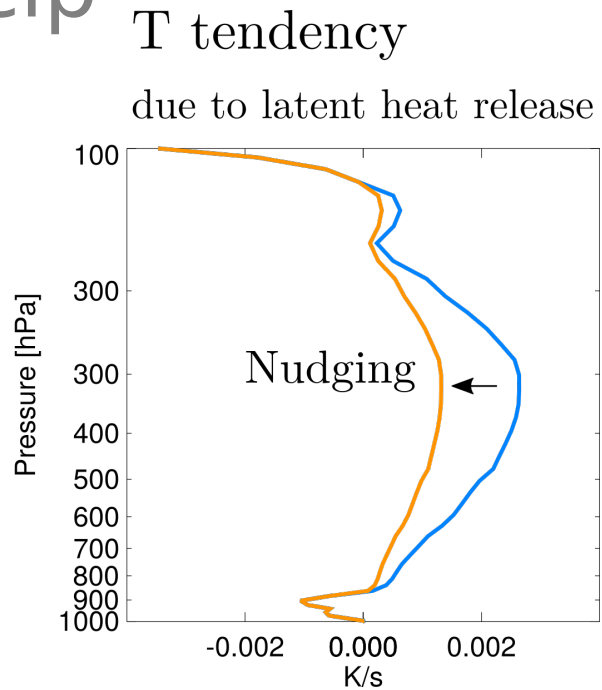
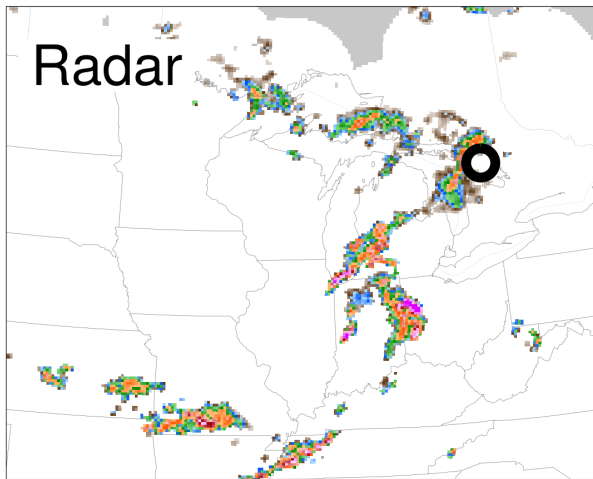
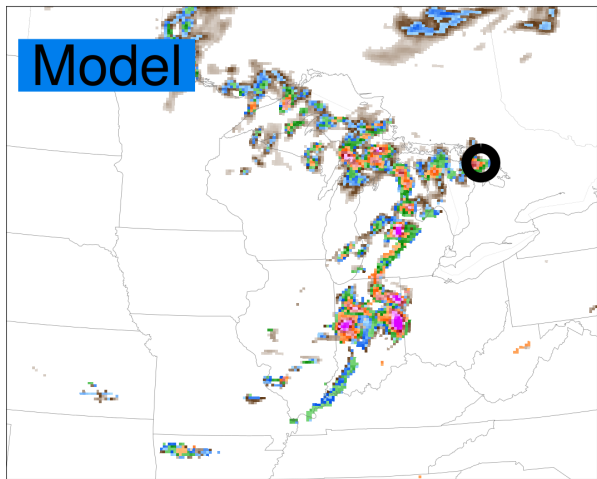
Model precip – Radar no precip



T tendency
due to latent heat release

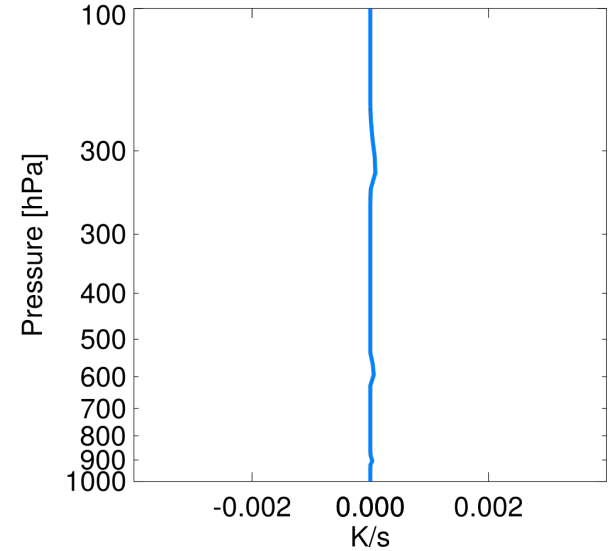
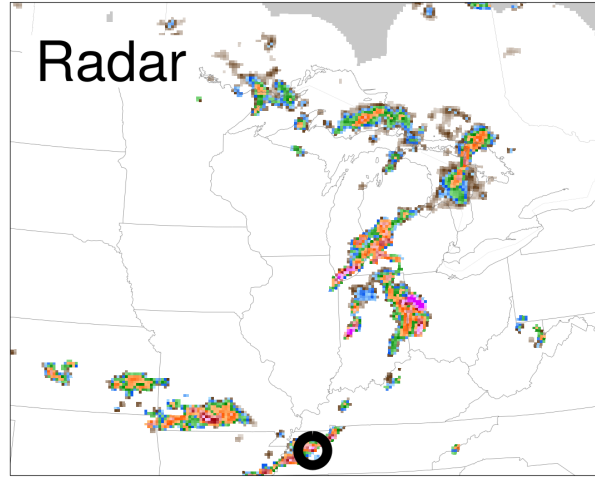
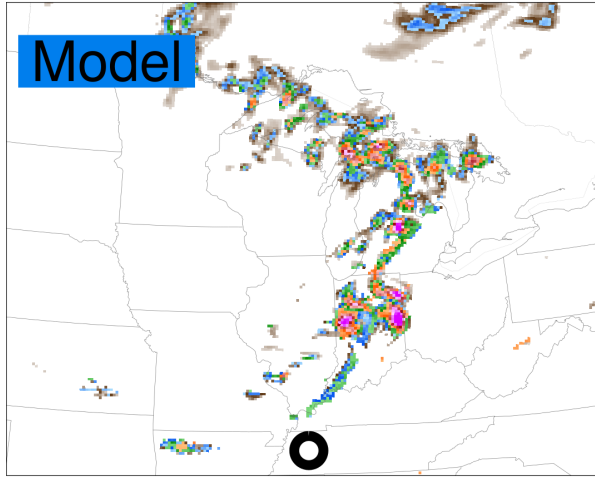


Model precip – Radar no precip



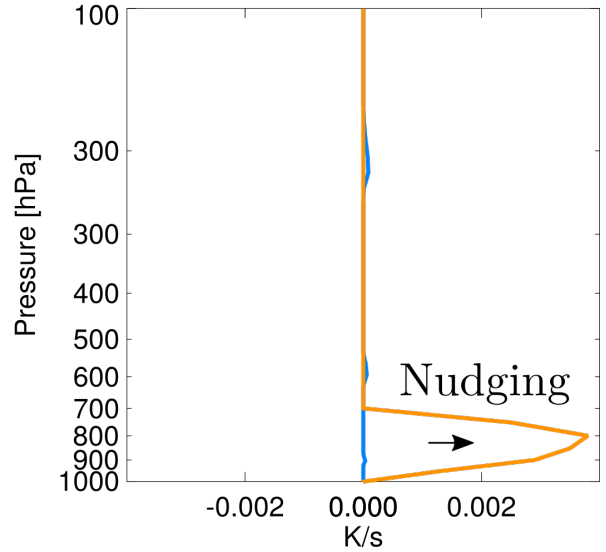
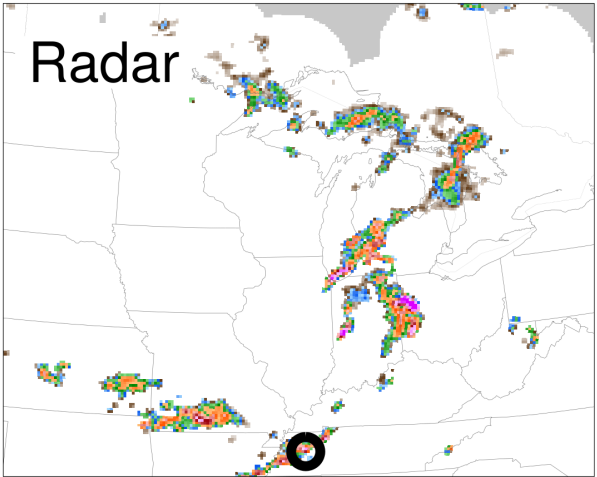
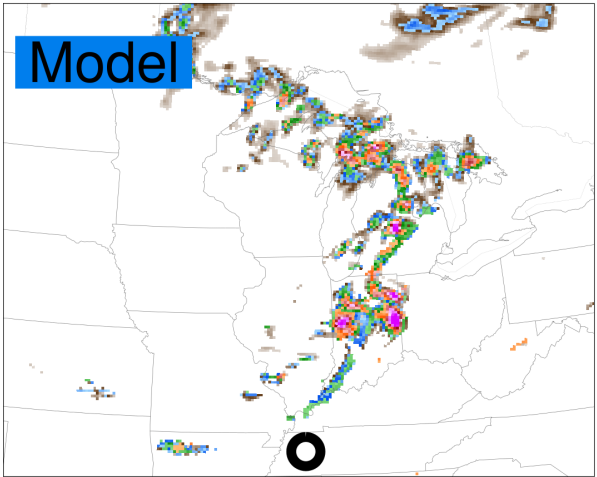
Radar precip - Model no precip

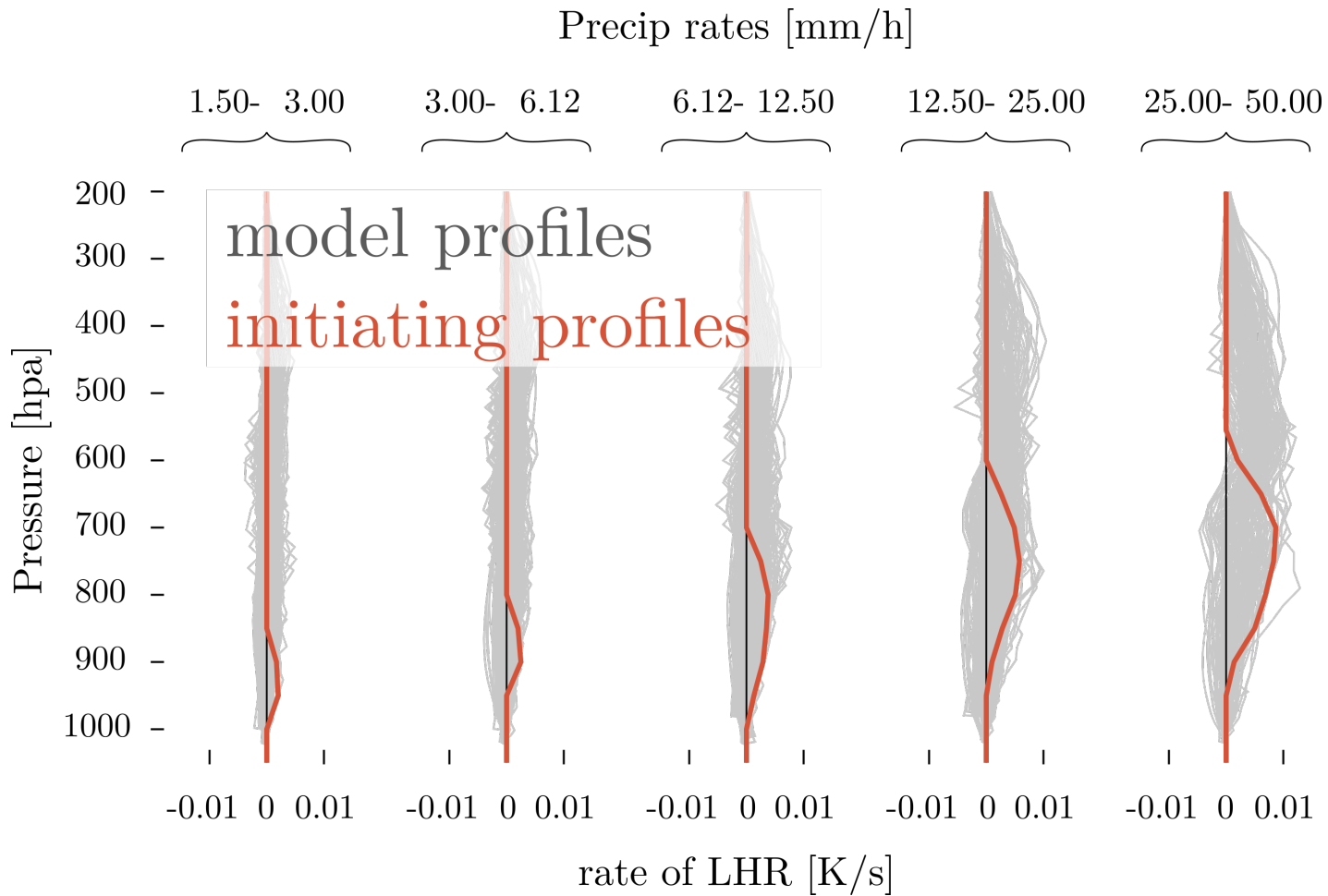
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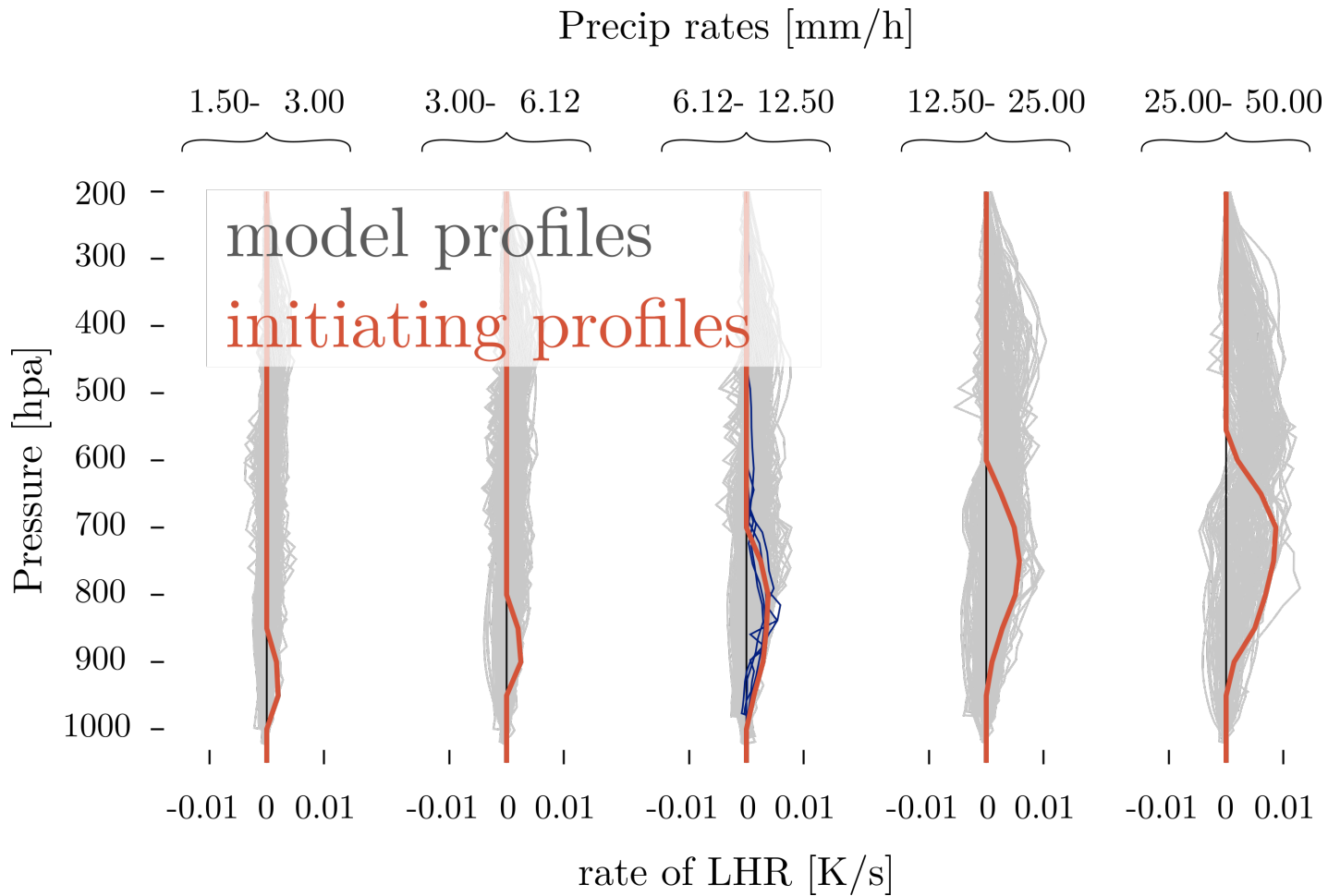


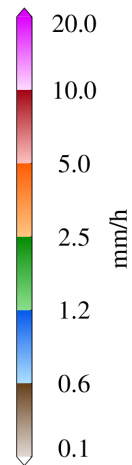
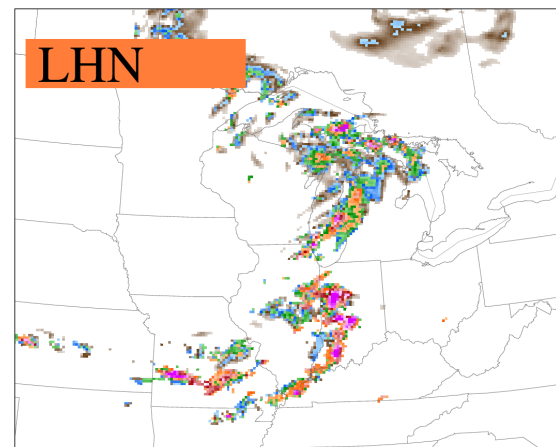
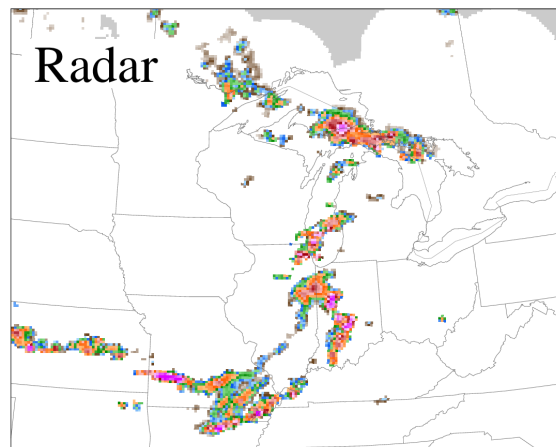
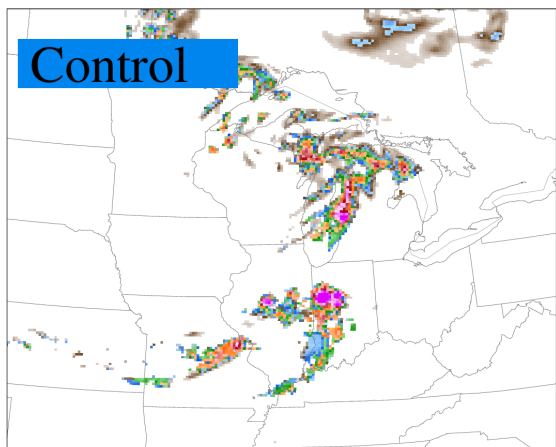
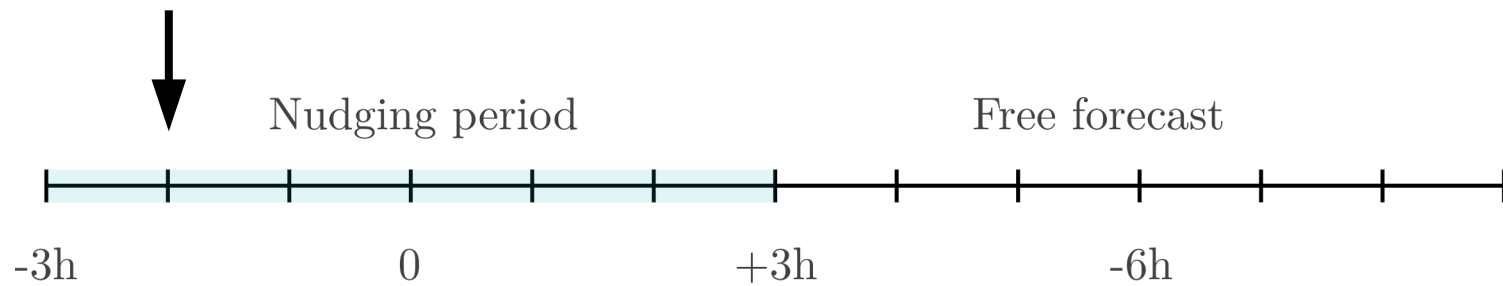
Radar precip - Model no precip

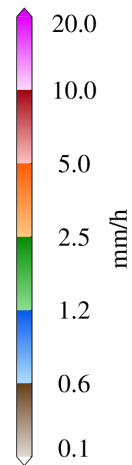
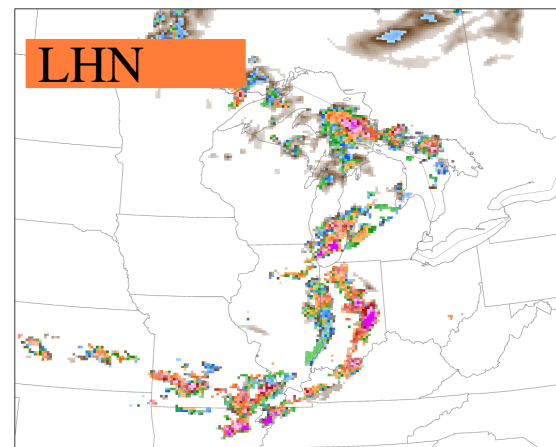
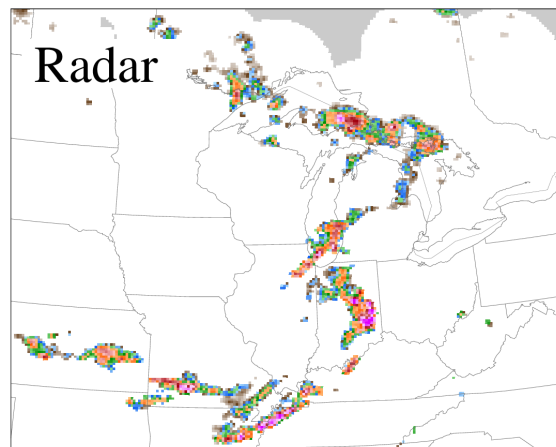
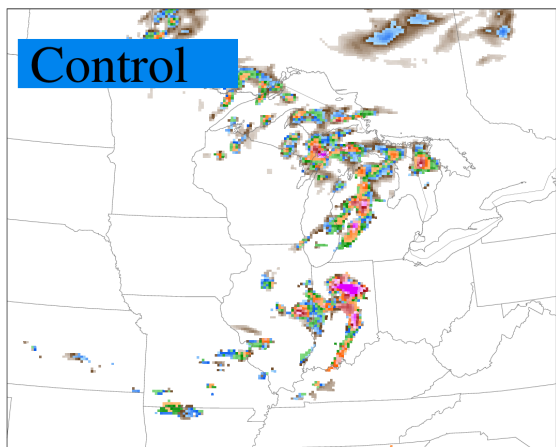
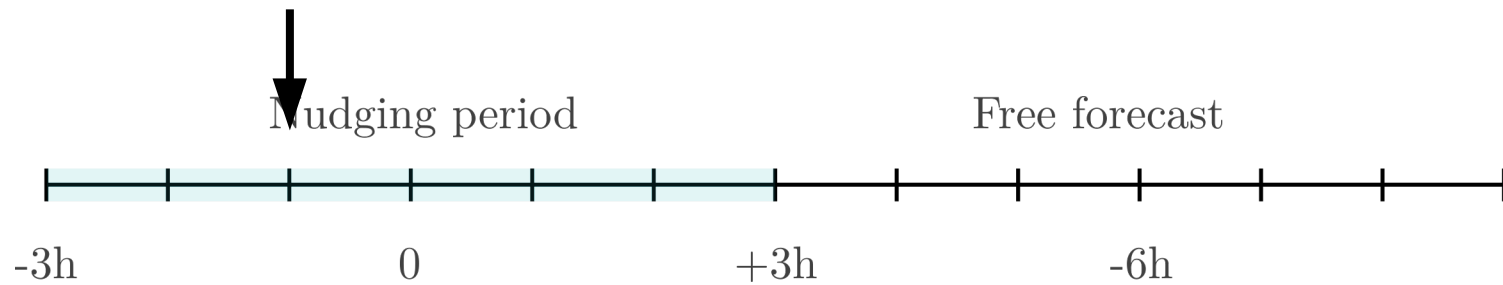
T tendency
due to latent heat release

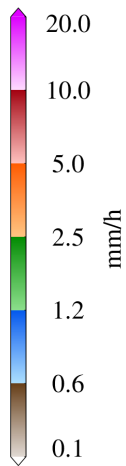
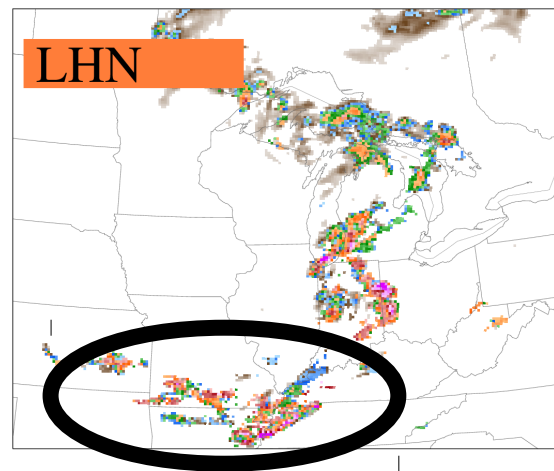
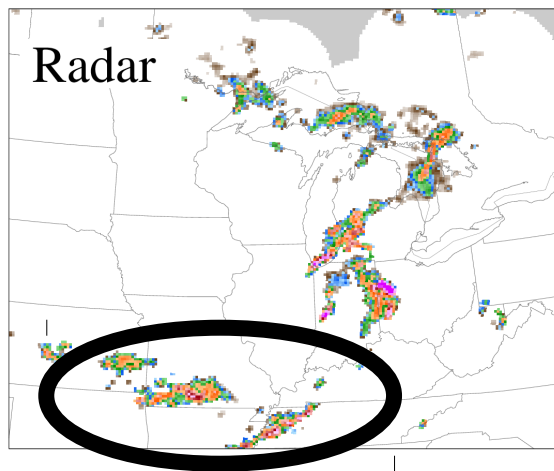
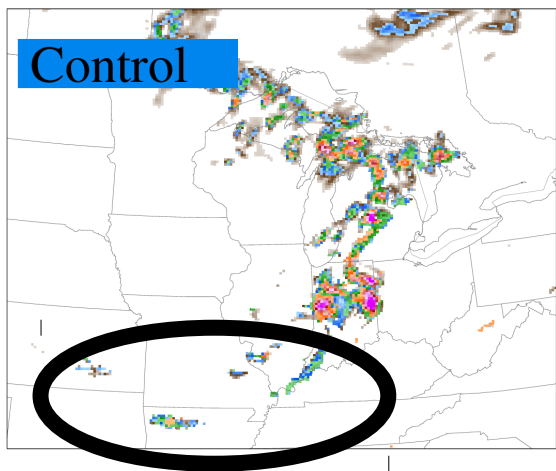
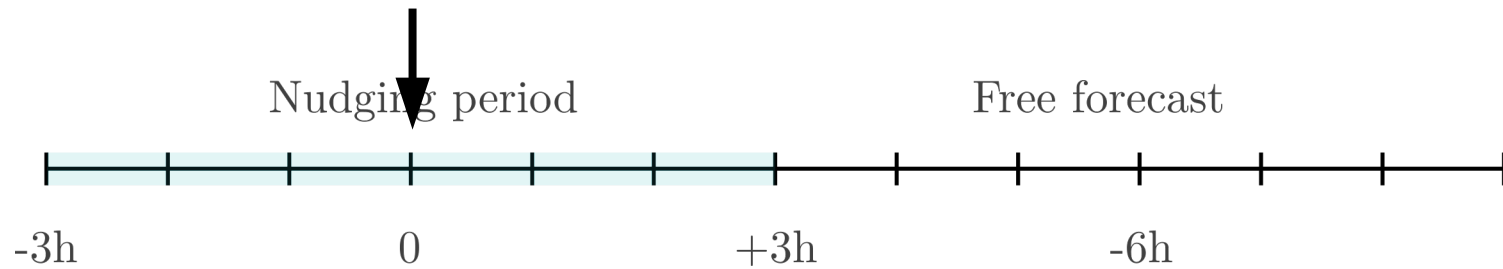


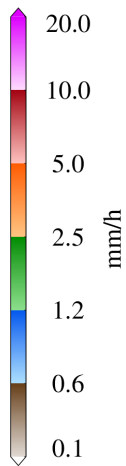
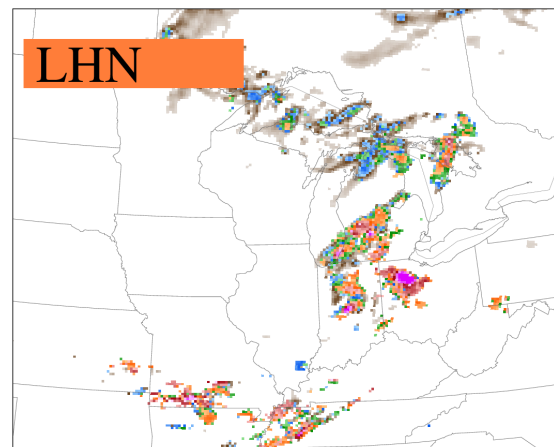
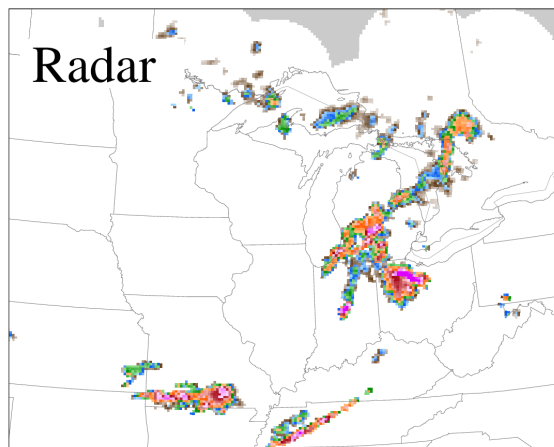
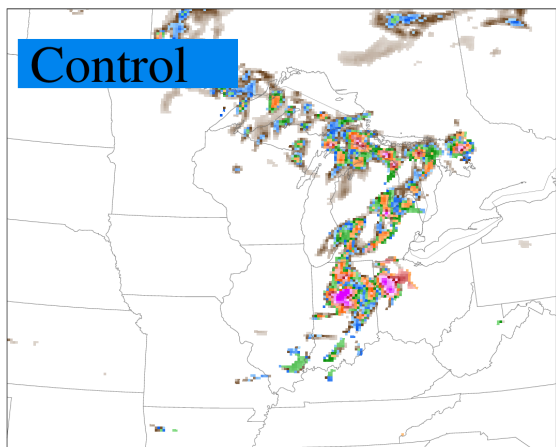
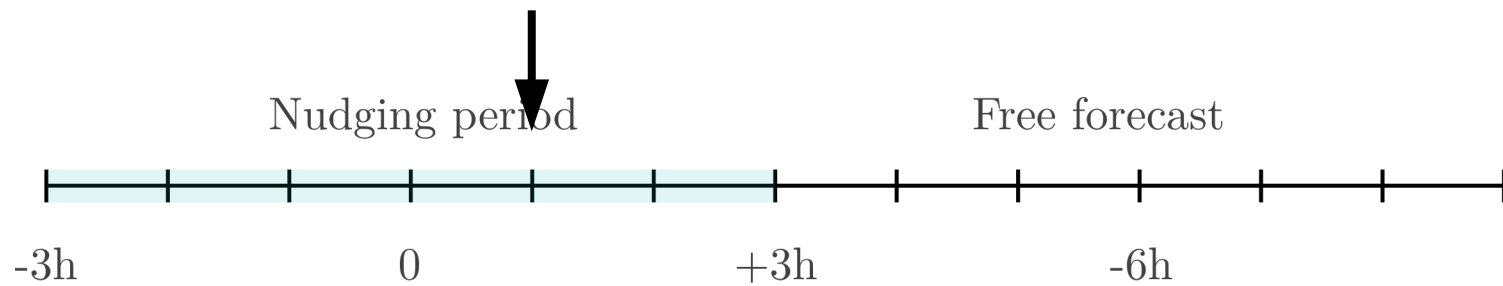








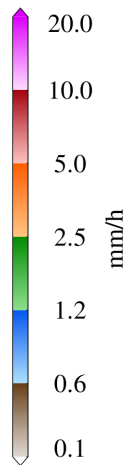
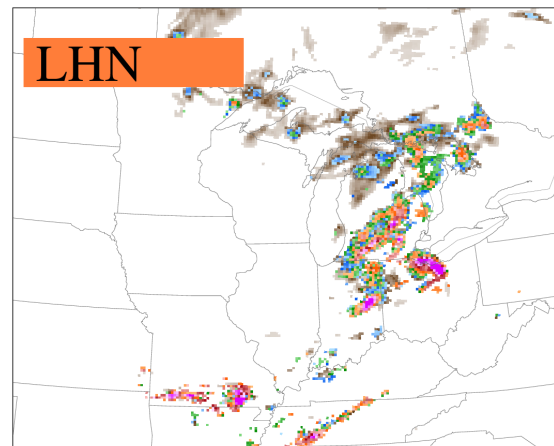
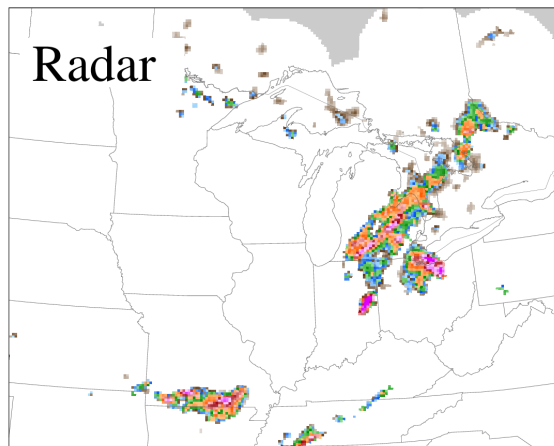
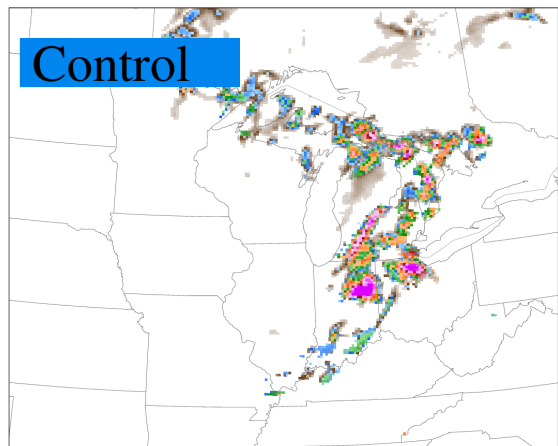
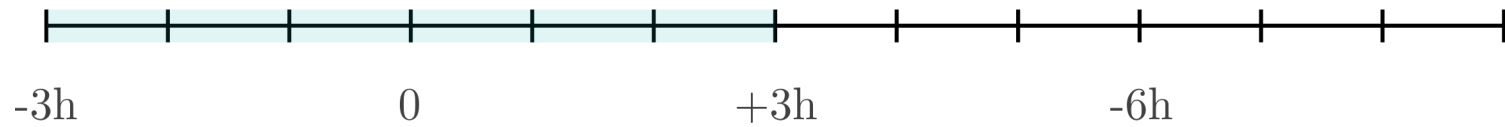


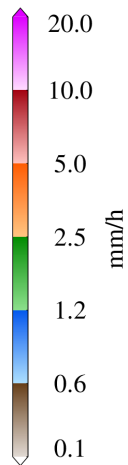
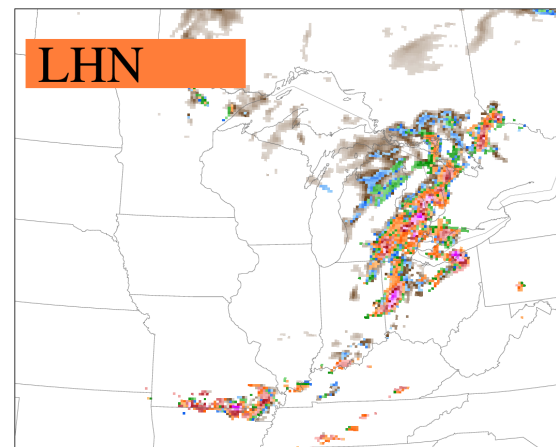
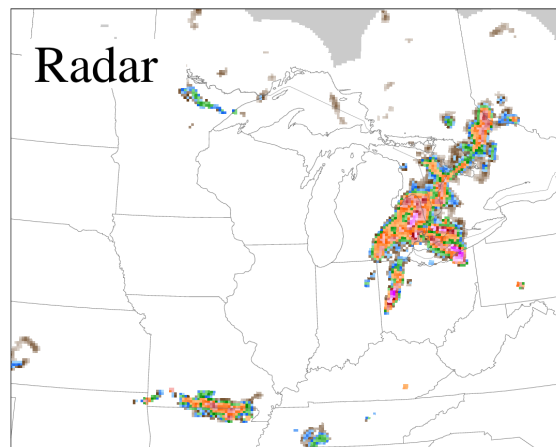
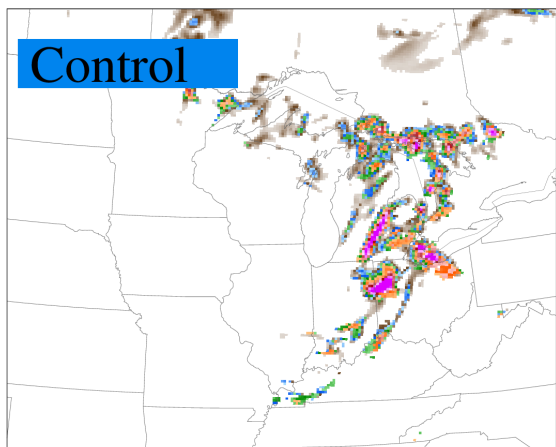
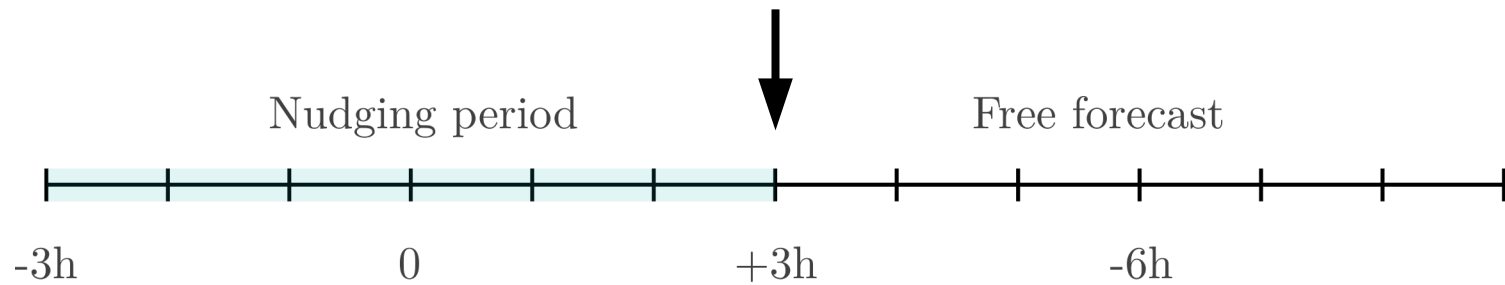


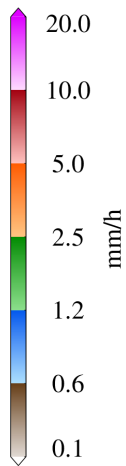
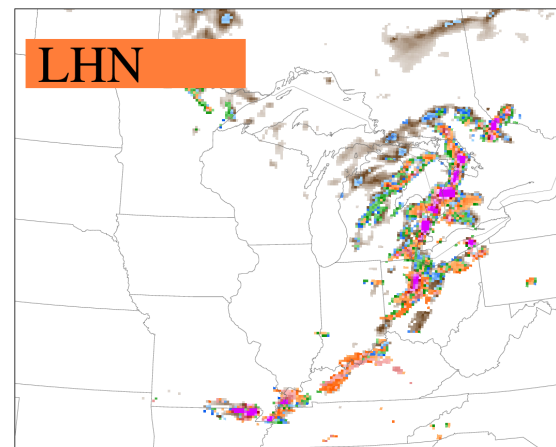
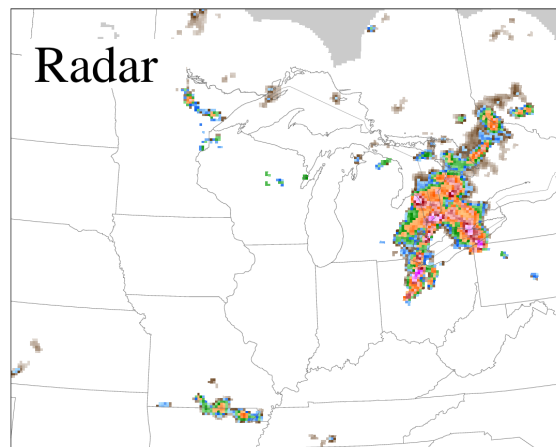
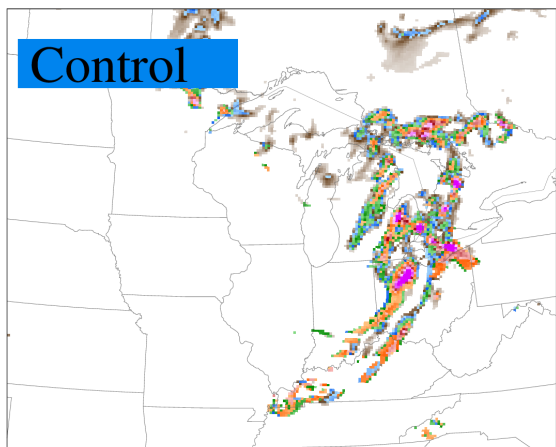
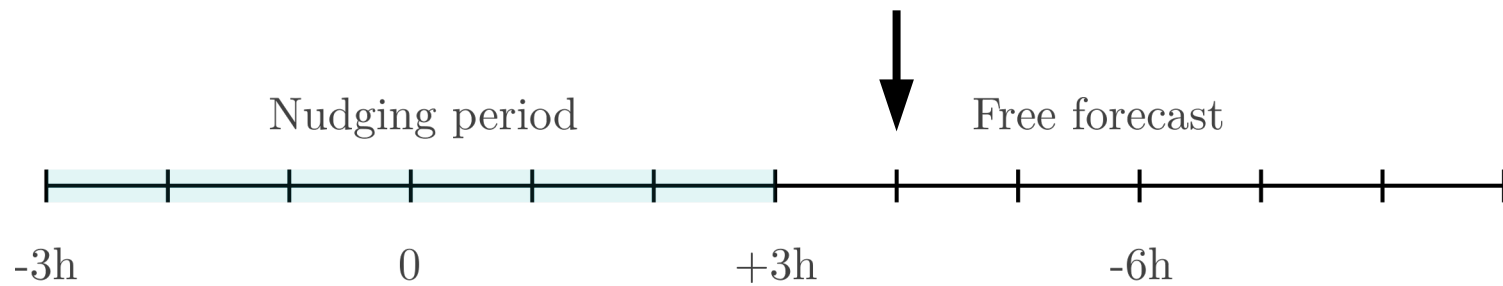
Nudging period

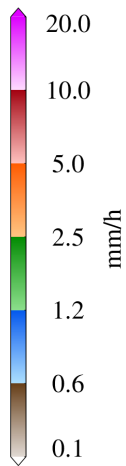
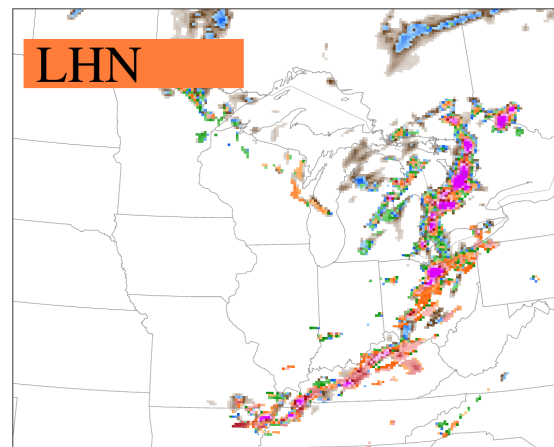
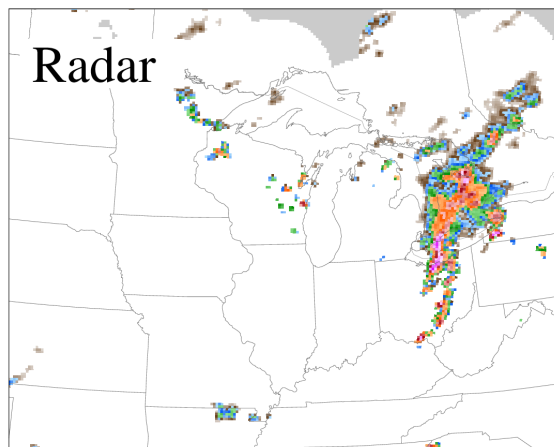
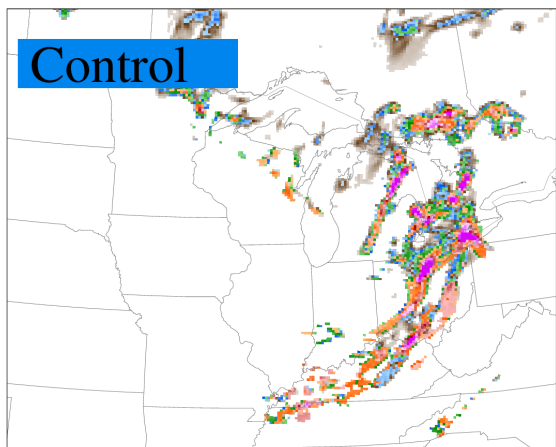
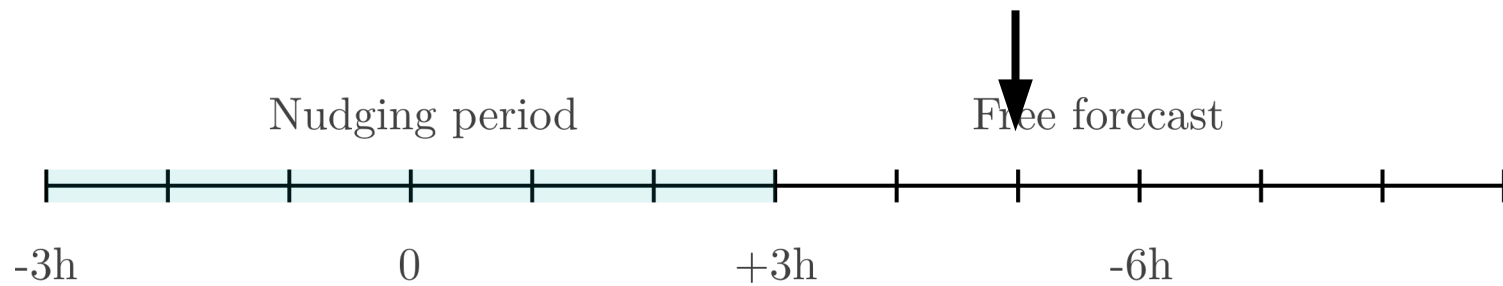


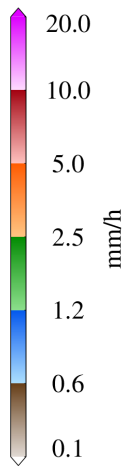
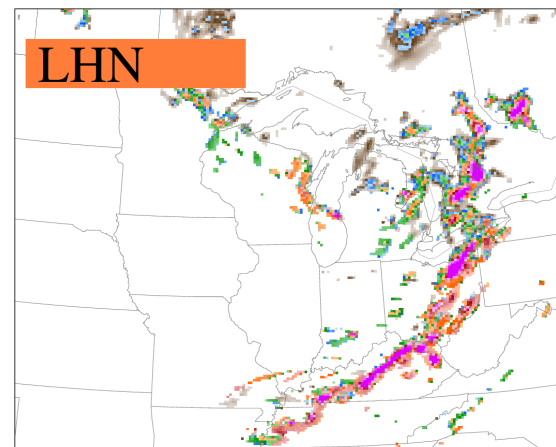
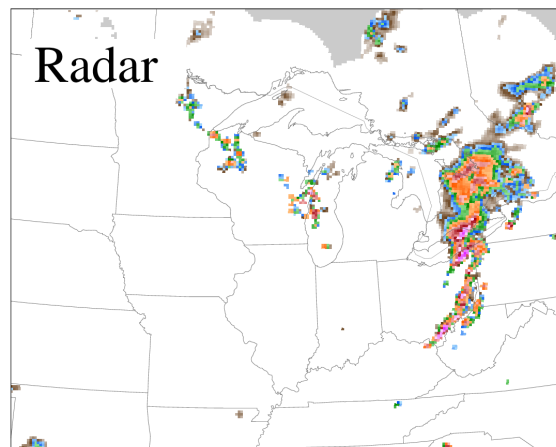
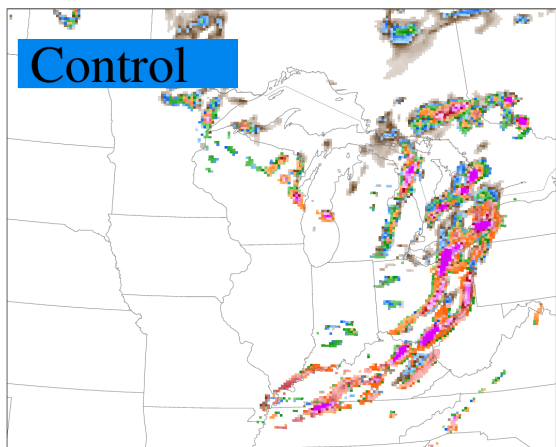
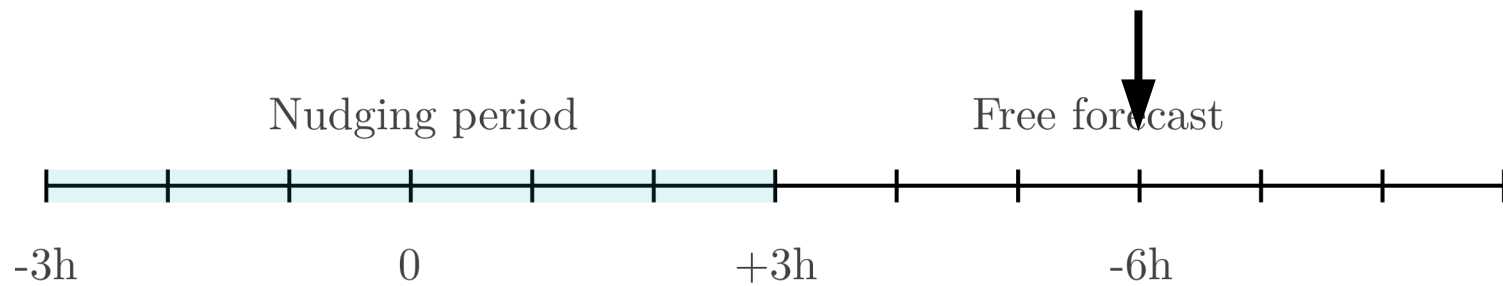
Free forecast

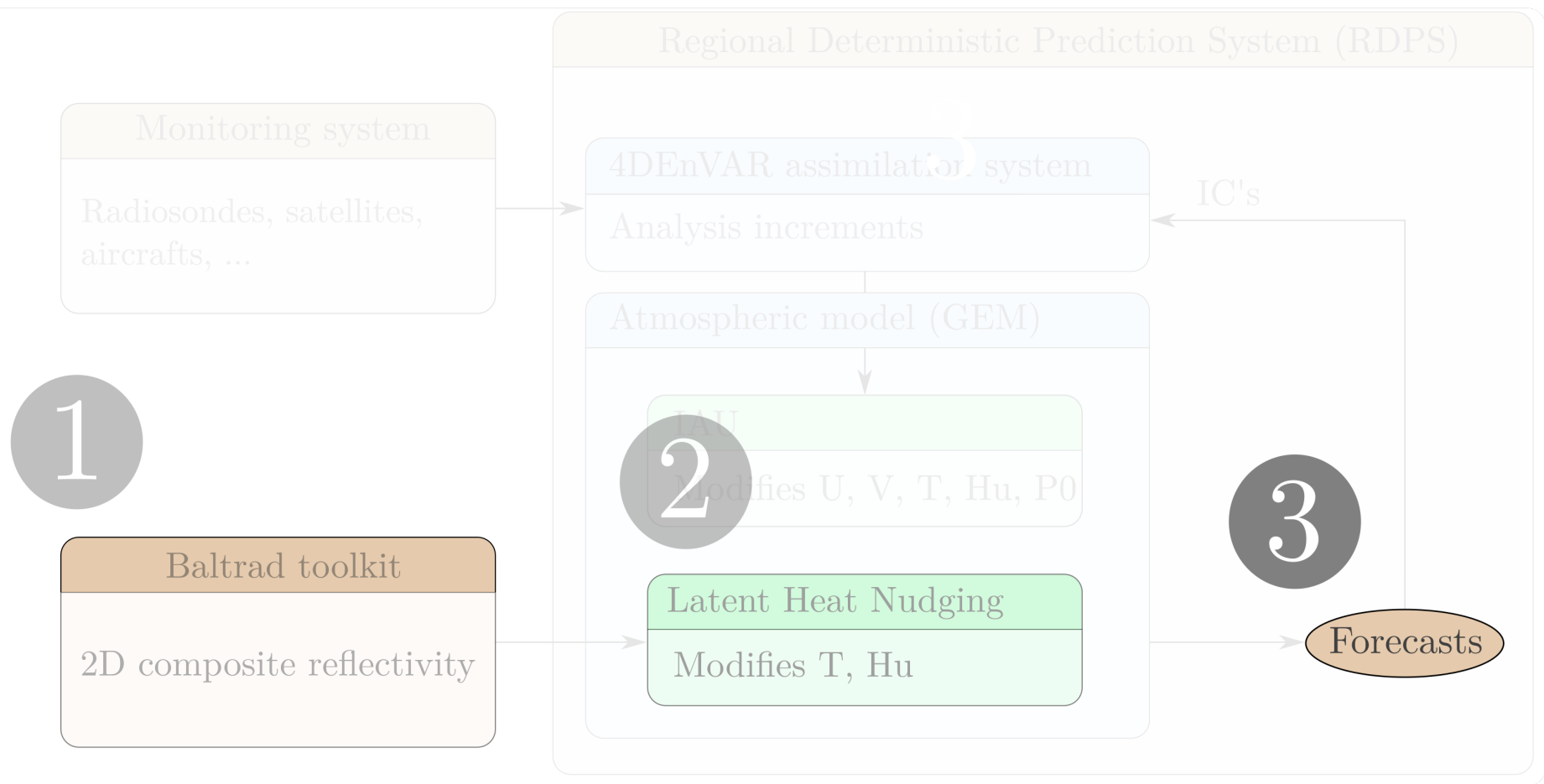












This project:

- The implementation of LHN
- Document the impact of applying LHN in a continuously cycled system

This project:

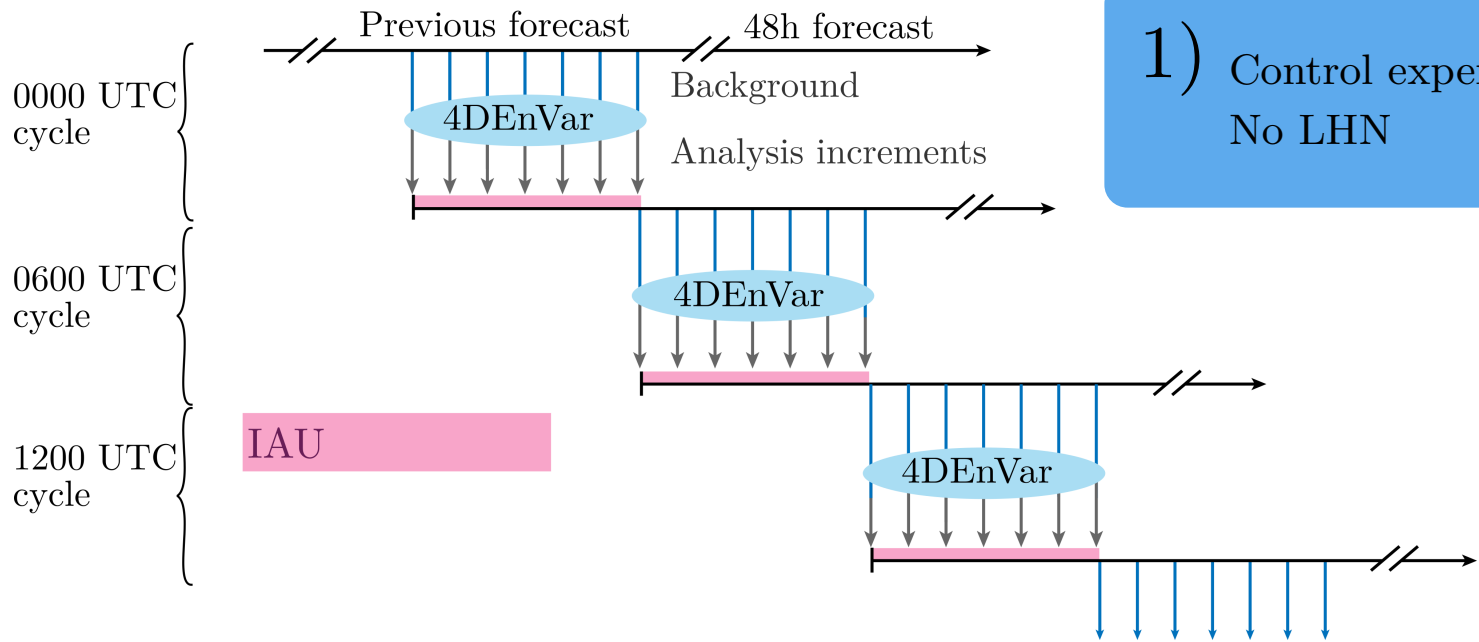
- The implementation of LHN
- Document the impact of applying LHN in a continuously cycled system

Three experiments were conducted

hour of day [UTC]

21 0 3 6 9 12 15 18 21

...



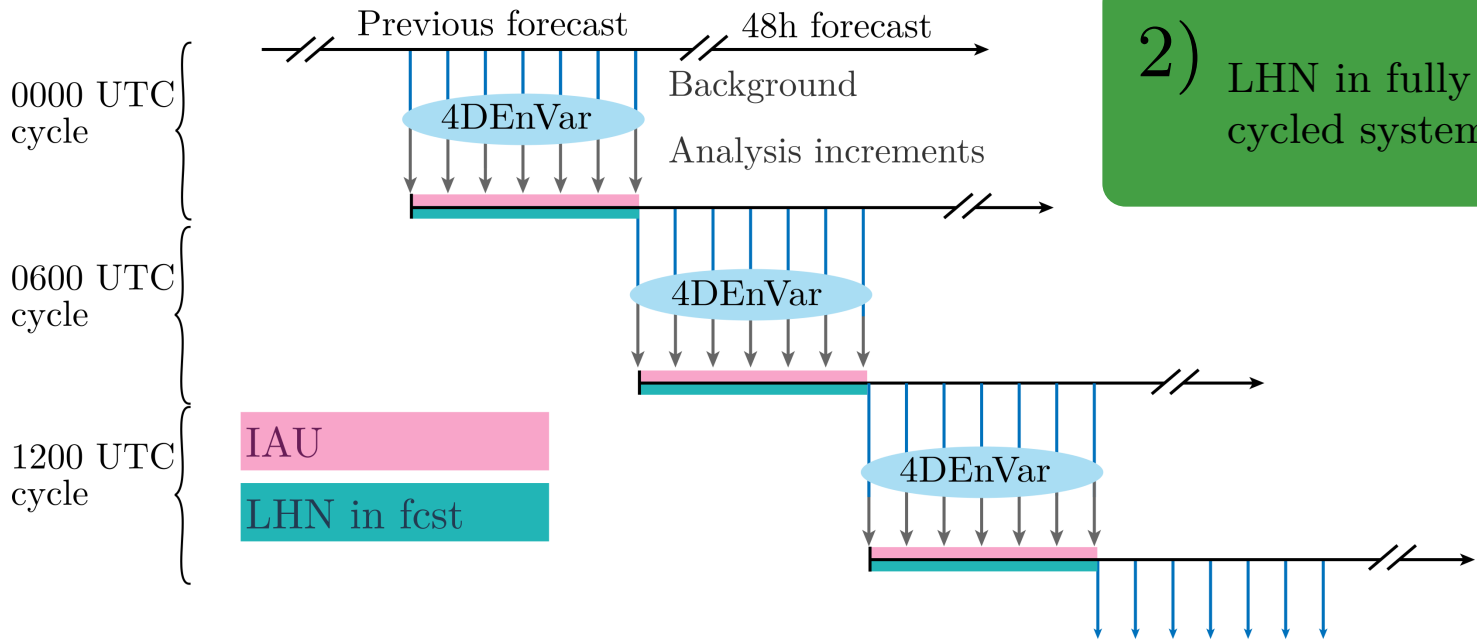
1) Control experiment
No LHN

...

hour of day [UTC]

21 0 3 6 9 12 15 18 21

...



2) LHN in fully cycled system

...

hour of day [UTC]

21 0 3 6 9 12 15 18 21

...

0000 UTC
cycle

Previous forecast // 48h forecast →

Archived Analysis increments



0600 UTC
cycle

Archived Analysis increments



1200 UTC
cycle

IAU

LHN in fcst

Archived Analysis increments



3) LHN in forecast only

...

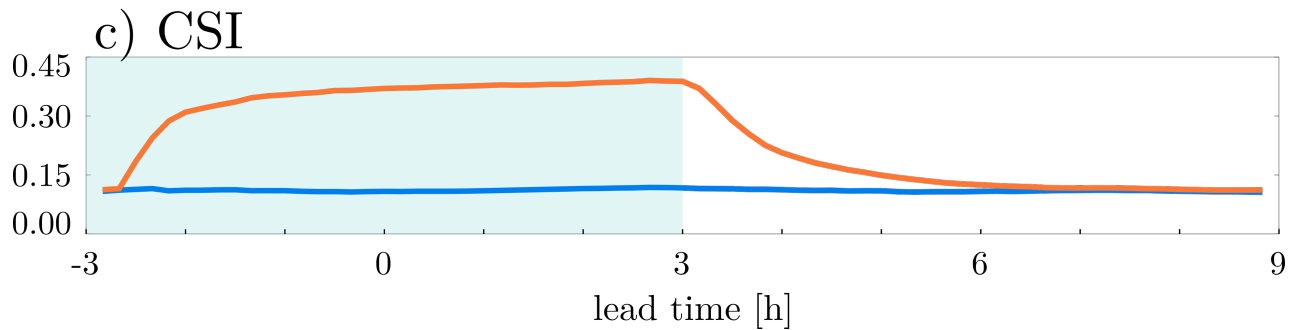
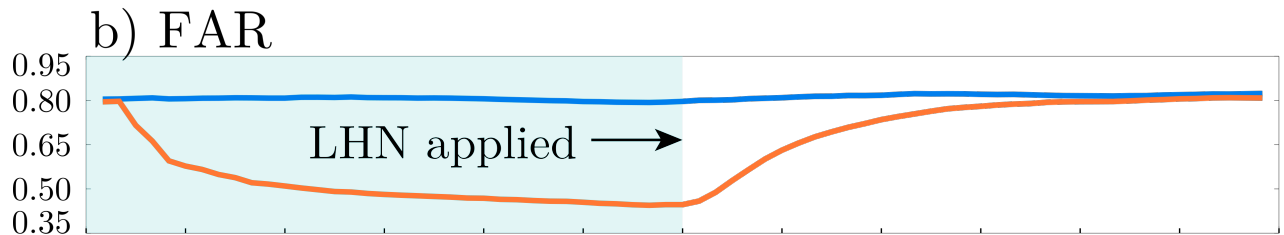
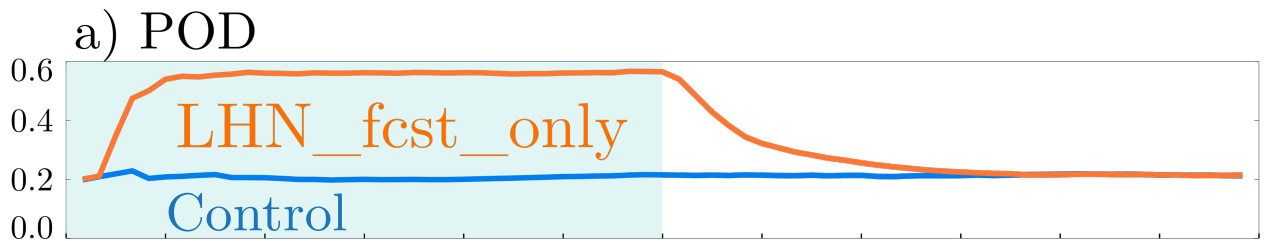
Verification against radar composites

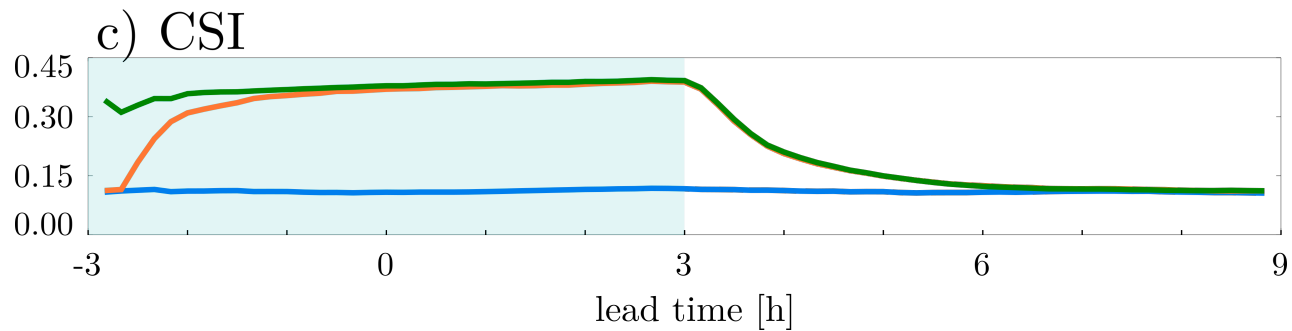
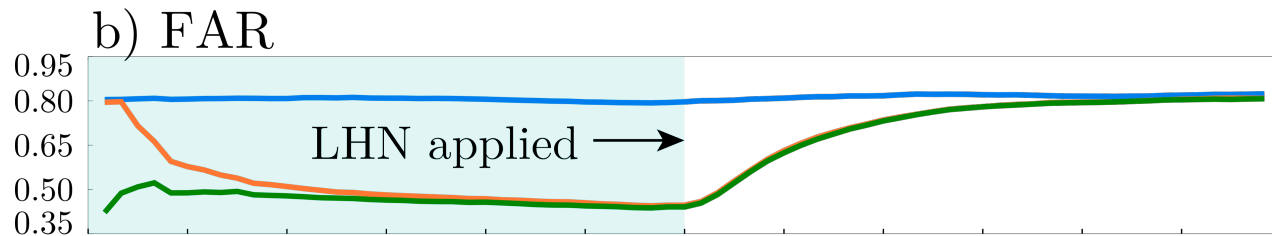
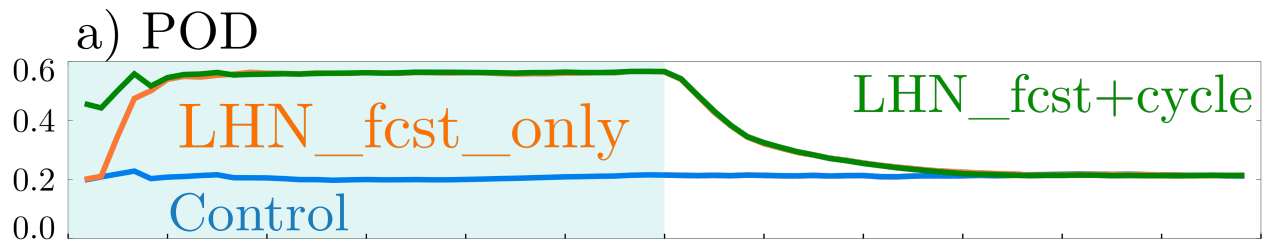
Instantaneous precipitation

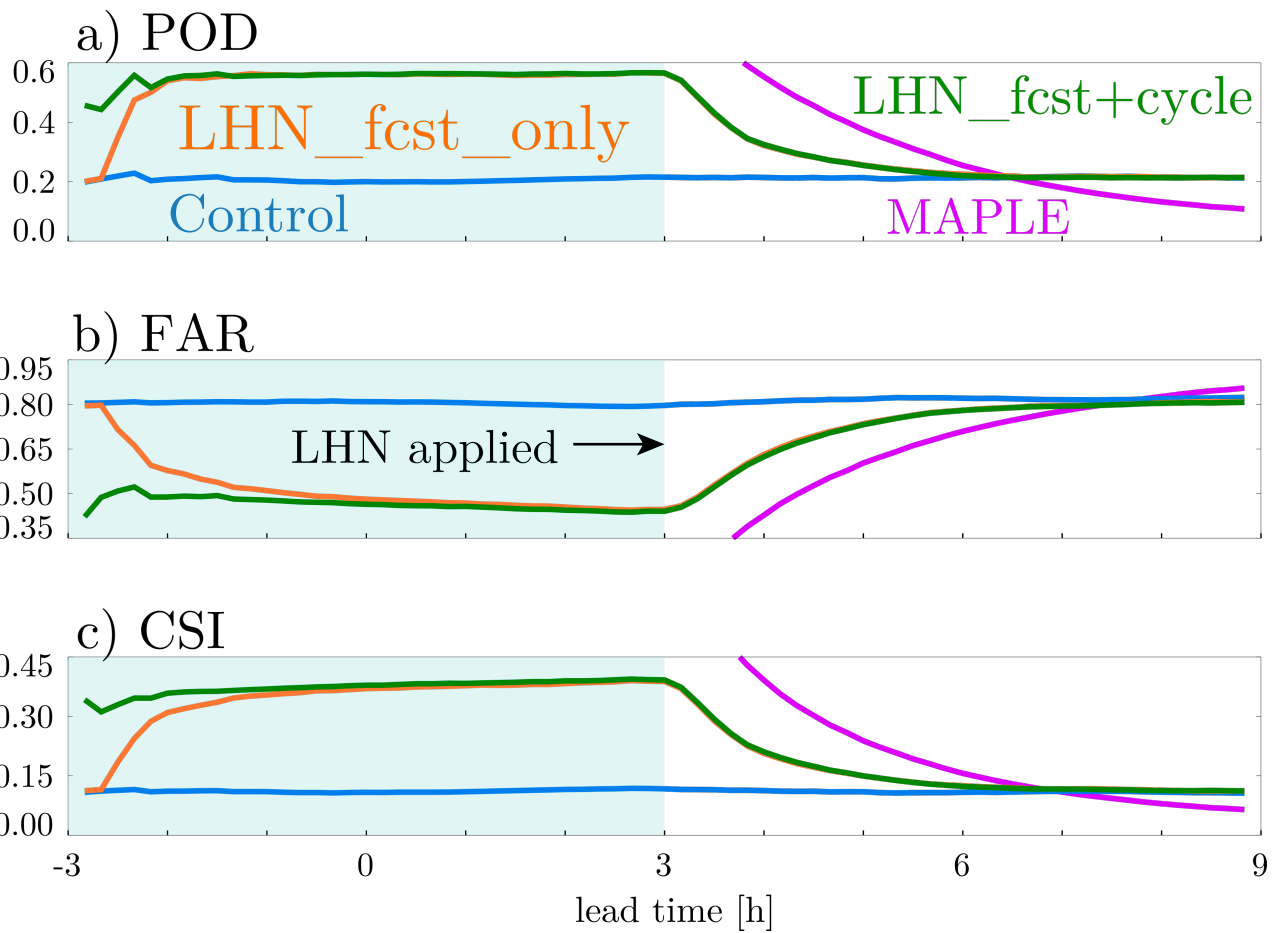
Aggregated scores for August 2016

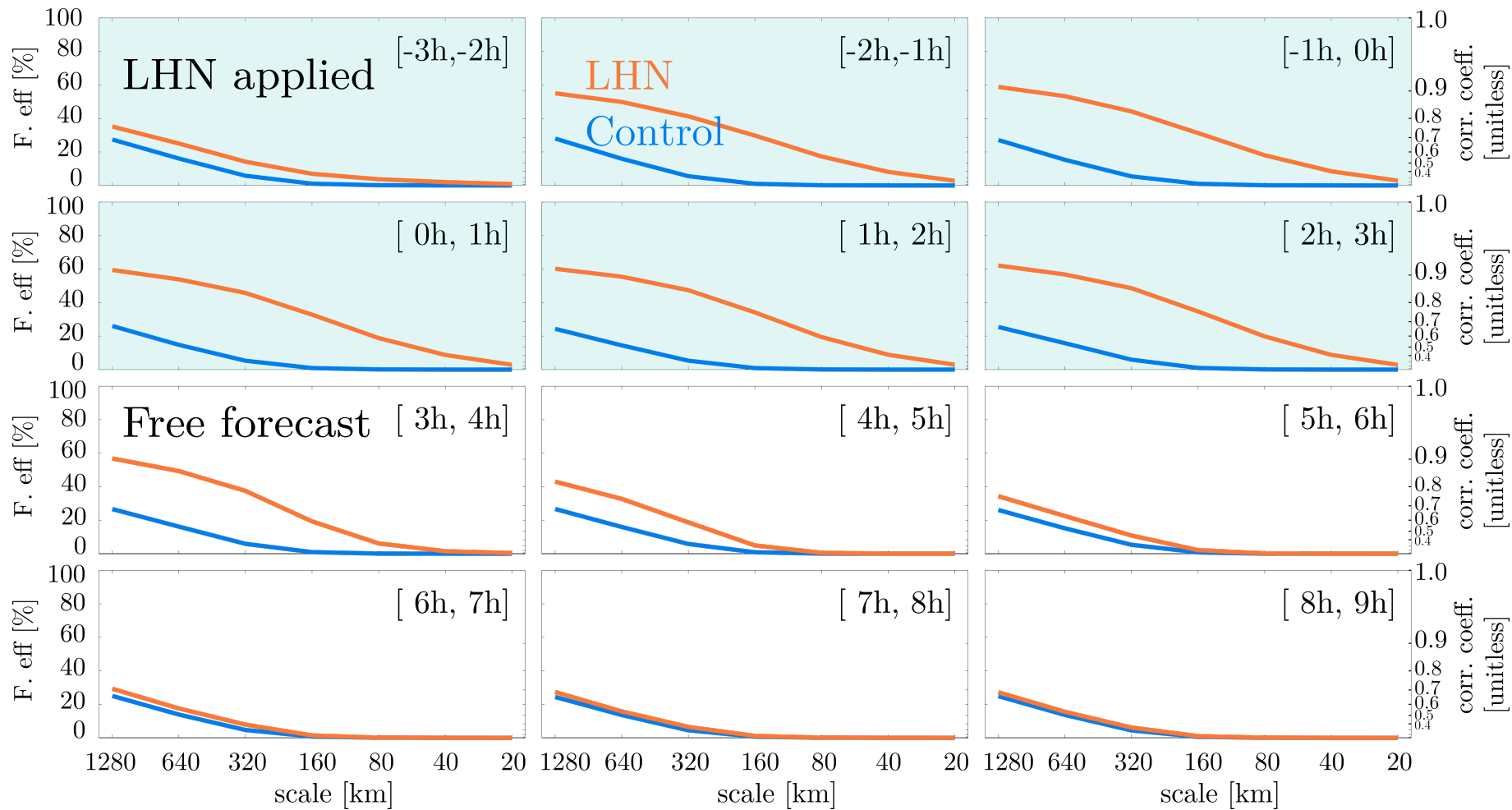
Forecasts at 0000 and 1200 UTC

60 forecasts total









Verification against aircraft measurements

Again for a total of 60 forecasts

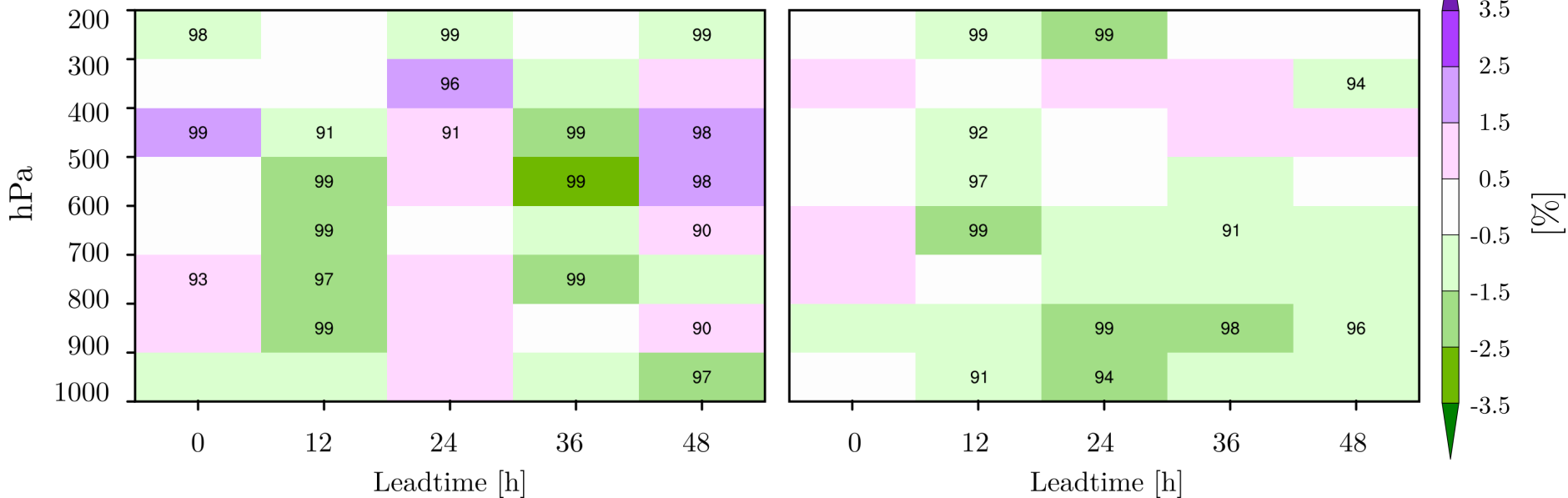
LHN in forecast only

% difference RMSE due to LHN

Worse

U-wind

V-wind



Better

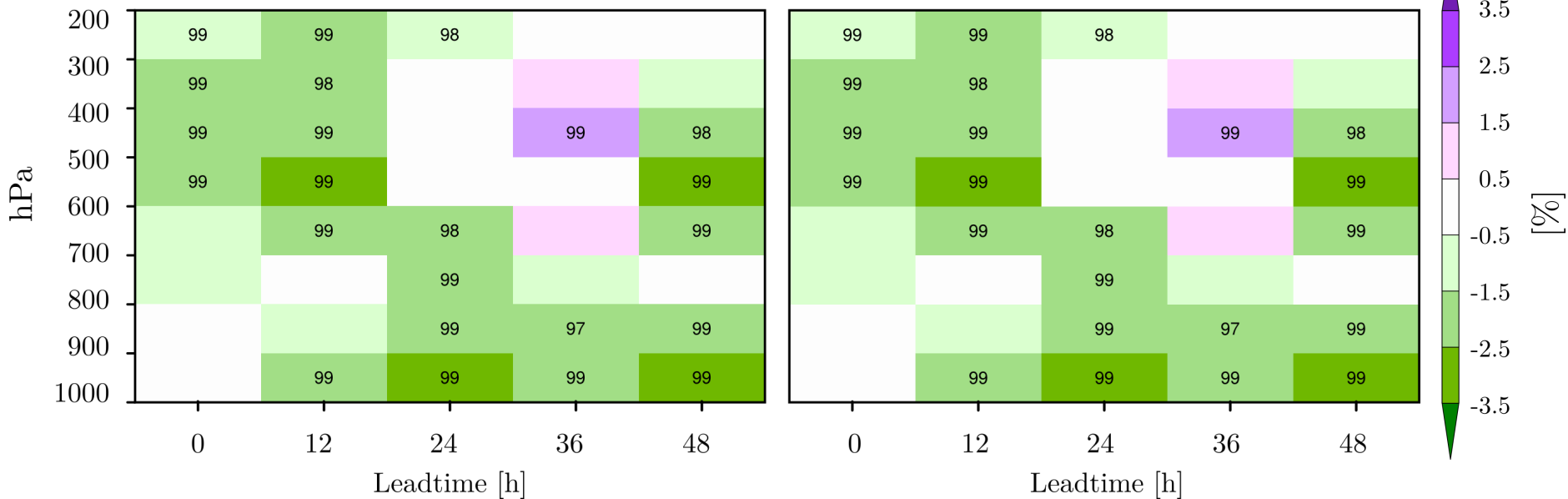
LHN in continuous cycle

% difference RMSE due to LHN

Worse

U-wind

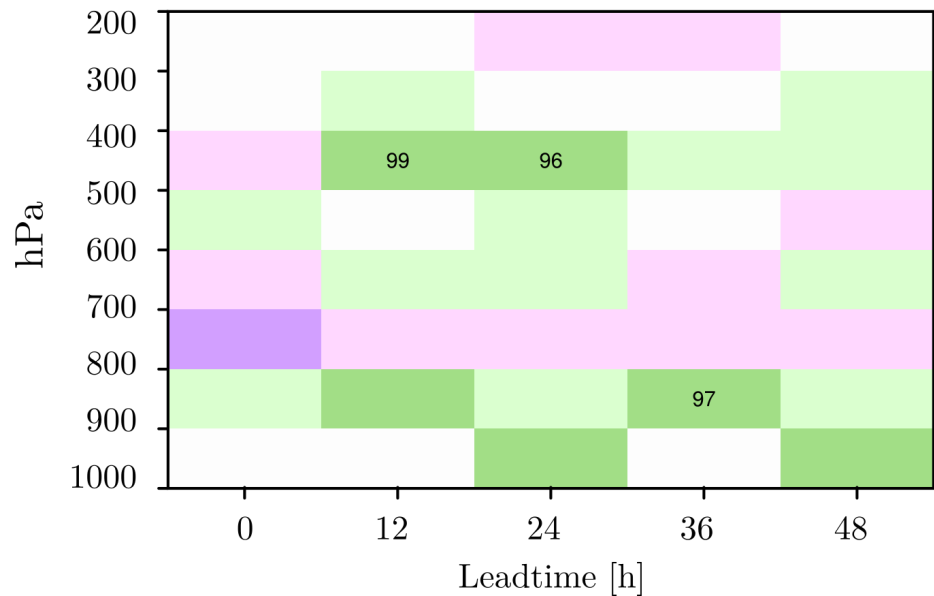
V-wind



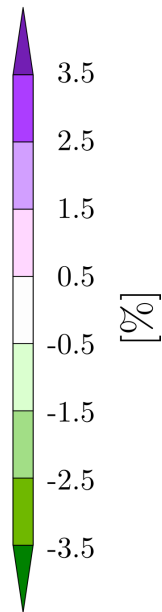
Better

LHN in forecast only

% difference RMSE due to LHN
T-Td



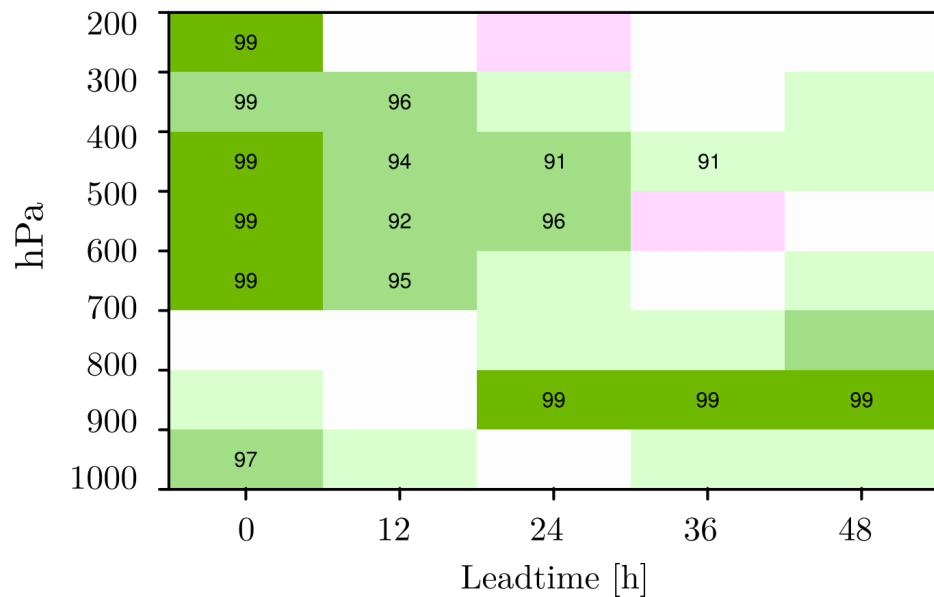
Worse



Better

LHN in continuous cycle

% difference RMSE due to LHN
T-Td



Worse

[%]

3.5

2.5

1.5

0.5

-0.5

-1.5

-2.5

-3.5

Better

Conclusions

- LHN improves instantaneous precipitation rates for ~ 3 h
- Cycling has no impact on precipitation
- However, applying LHN in the continuous cycle significantly improves winds and moisture