Some challenges in high-resolution latent heat nudging

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Motivation

- QPF poorest performance area of NWP, especially in summer (convection)
- Rainfall assimilation to mitigate spinup effect
- Radar observations for high-resolution NWP models
- Characteristics of LHN
  - Buoyancy driven
  - Computational efficiency
  - 4DDA, timely assimilation of high-frequency observations
- This study: reevaluation of Latent Heat Nudging (LHN) within high-res model using idealised and real radar data

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Idealised Experiments: Setup and Strategy

- Model: Local Model in idealised configuration
- Unstable environment supportive for supercell storms
- Reference simulation
  - Surface precipitation for assimilation
  - 4D fields for validation
- Assimilation simulations
  - Proof of concept with identical twin simulation (CTRL)
- Sensitivity to uncertainty in observations and environment

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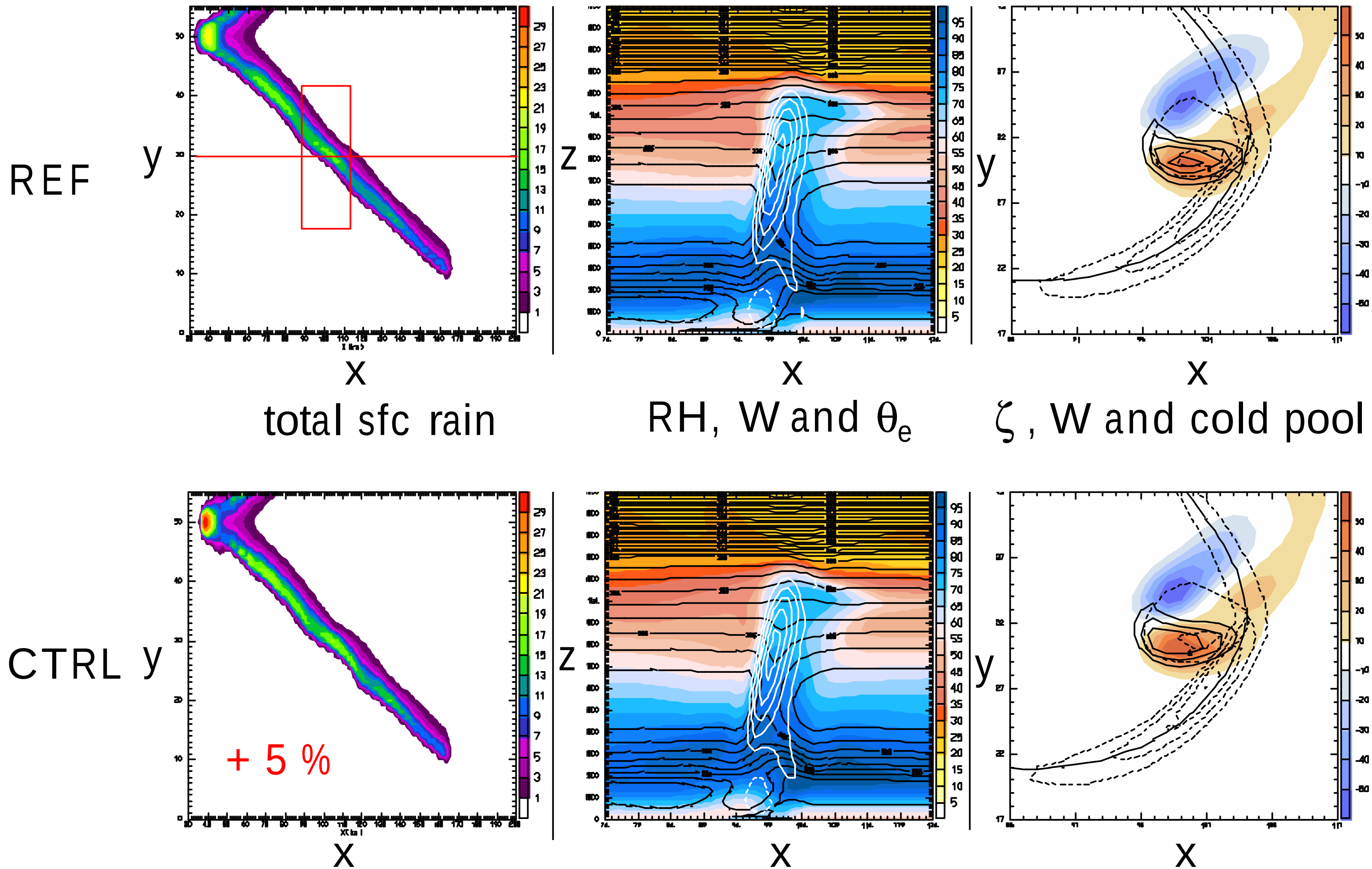
Reference and CTRL simulation



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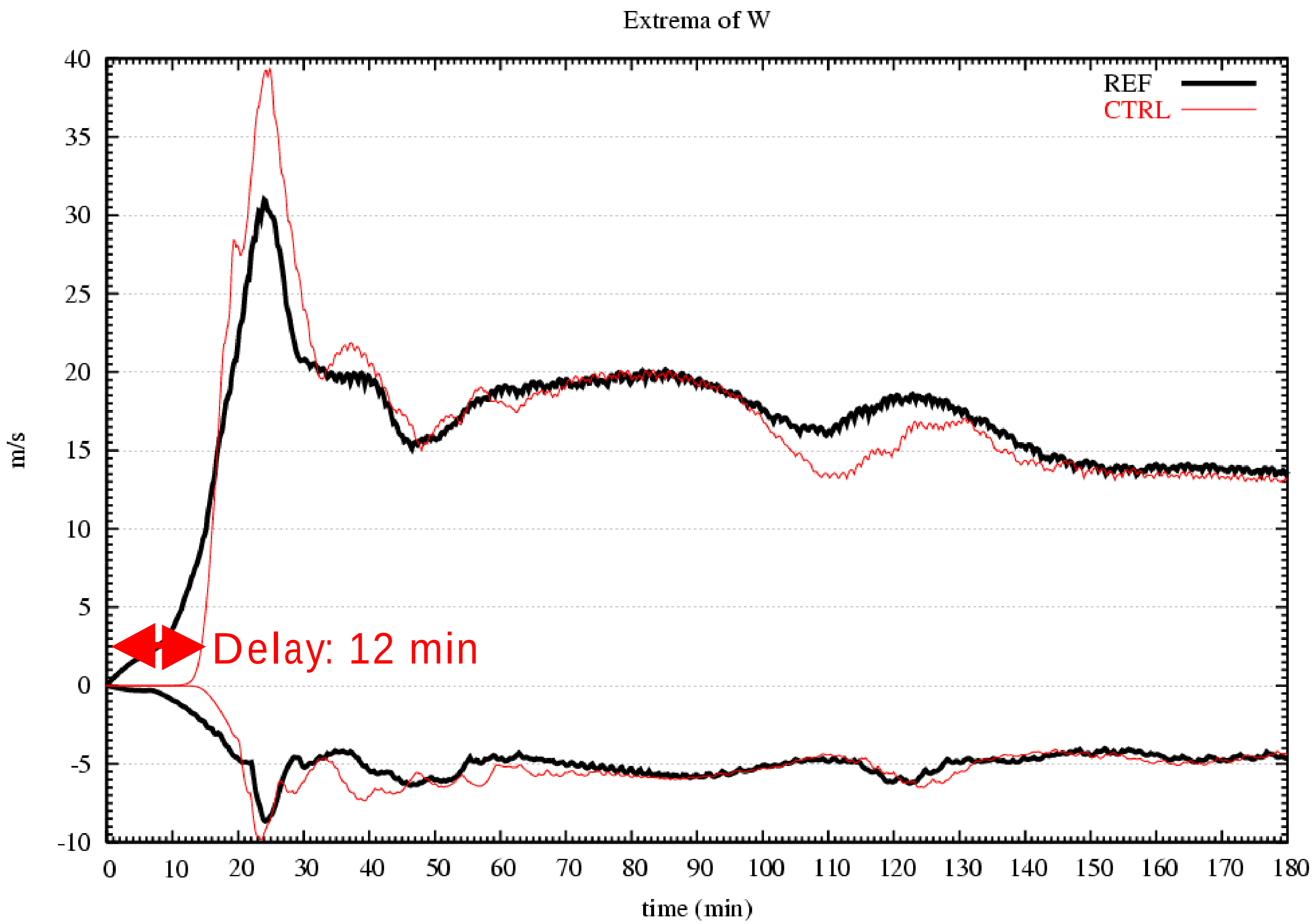
Extrema of w



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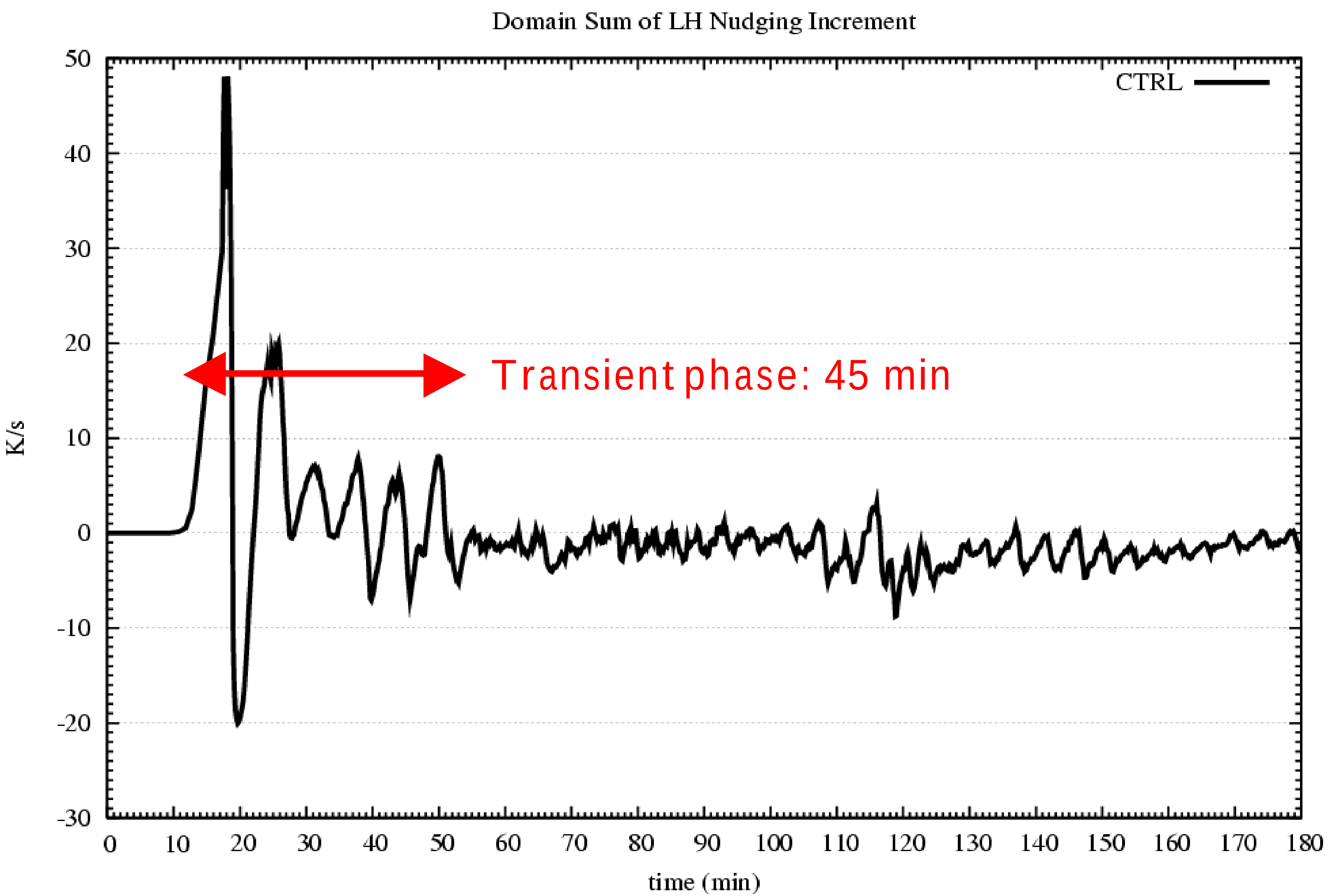
Assimilation increments



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Observation Uncertainty

- Amplitude Error
  - Factor 0.5 (2) results in 88% (133%) of total precipitation
  - Environment and model dynamics damps error
- Temporal resolution
  - Combined amplitude and structure error
  - Strong sensitivity
- Non-Rain Echoes
  - Potential strong sensitivity

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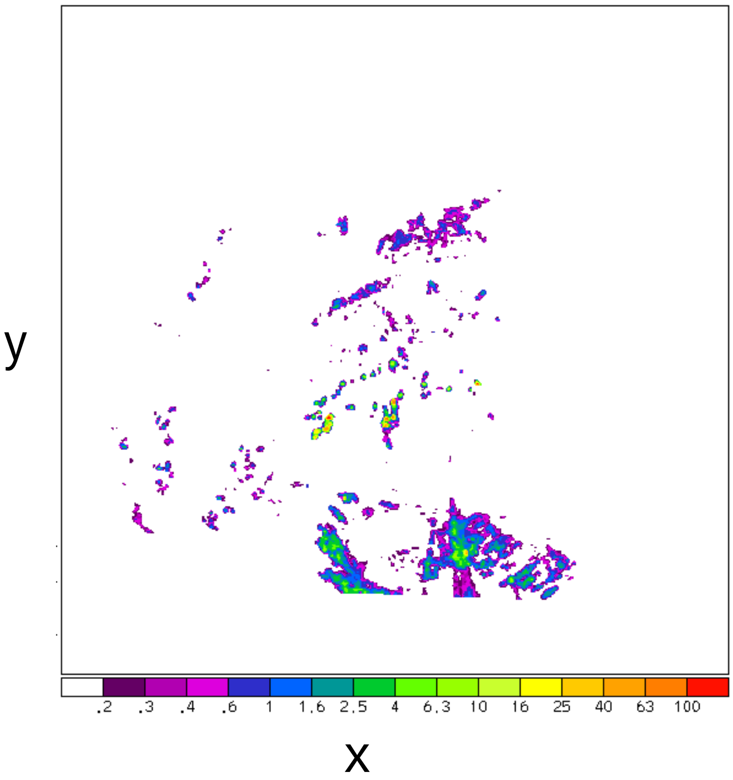
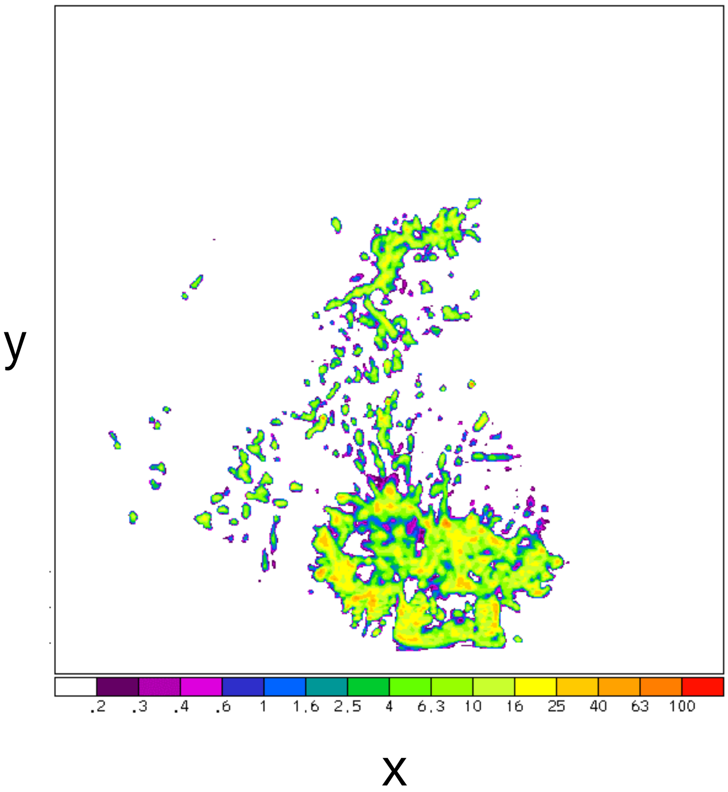
Non-Rain Echoes

6h Sum of Radar



6h Sum of Model Precipitation



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Environment Uncertainty

- Perfect observations, degraded environment
- Low-level Humidity
  - -4% (4%) error in PBL humidity → -14% (11%) precip. deviation
- Environmental Wind
  - Can lead to distorted system dynamics

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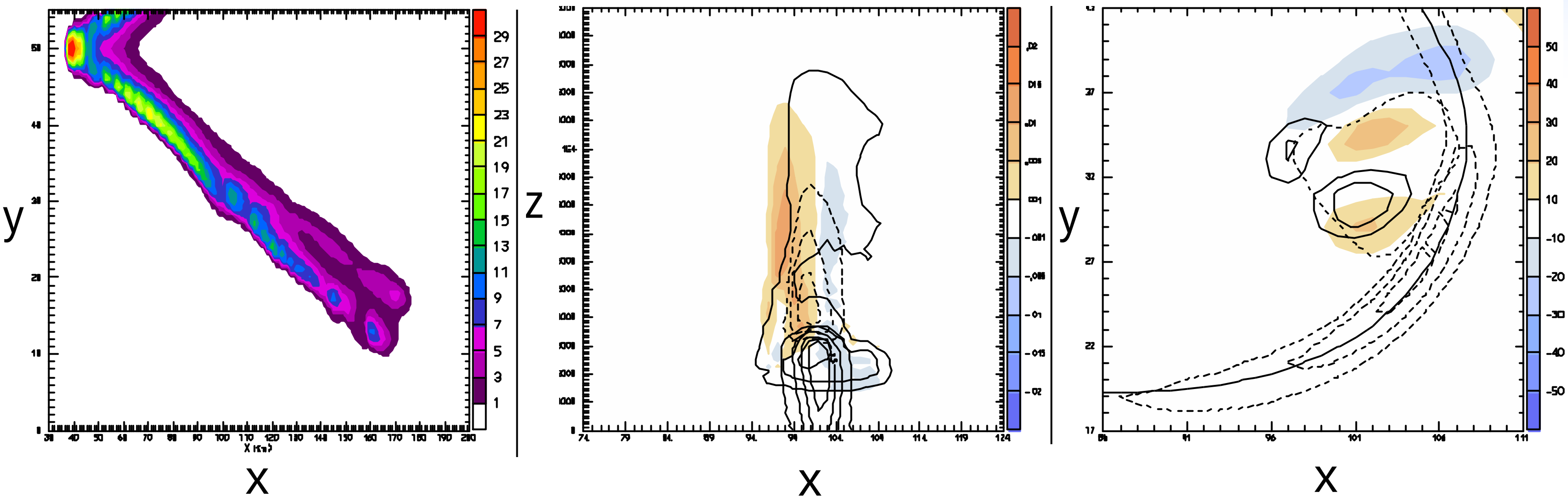
Uncertainty in the Environment: Error in Wind

Bias in environmental wind: +2m/s



Surface precipitation

ΔT_{LHN}, cloud, precip

ζ , W and cold pool

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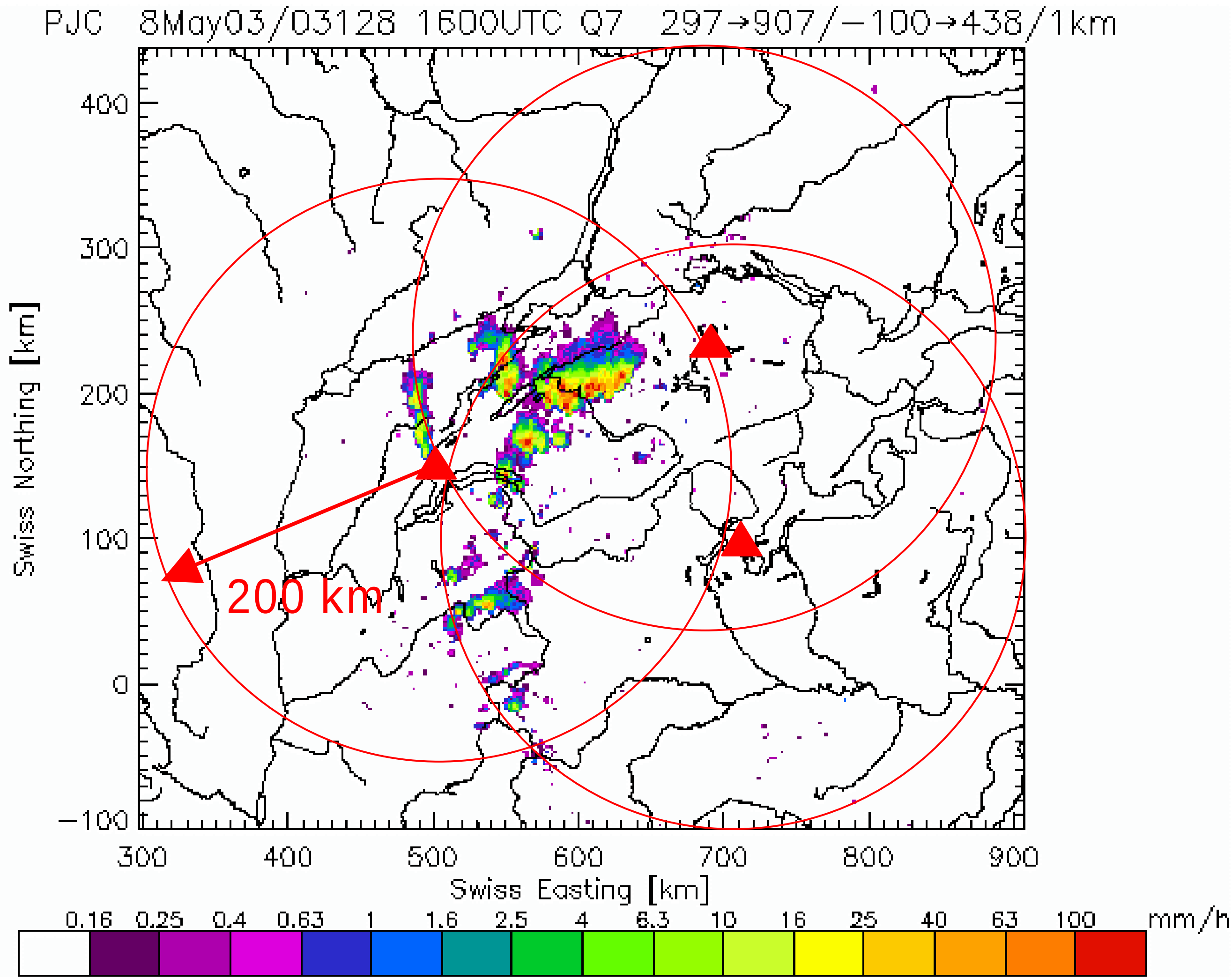
Case study of 8. May 2003 21 UTC



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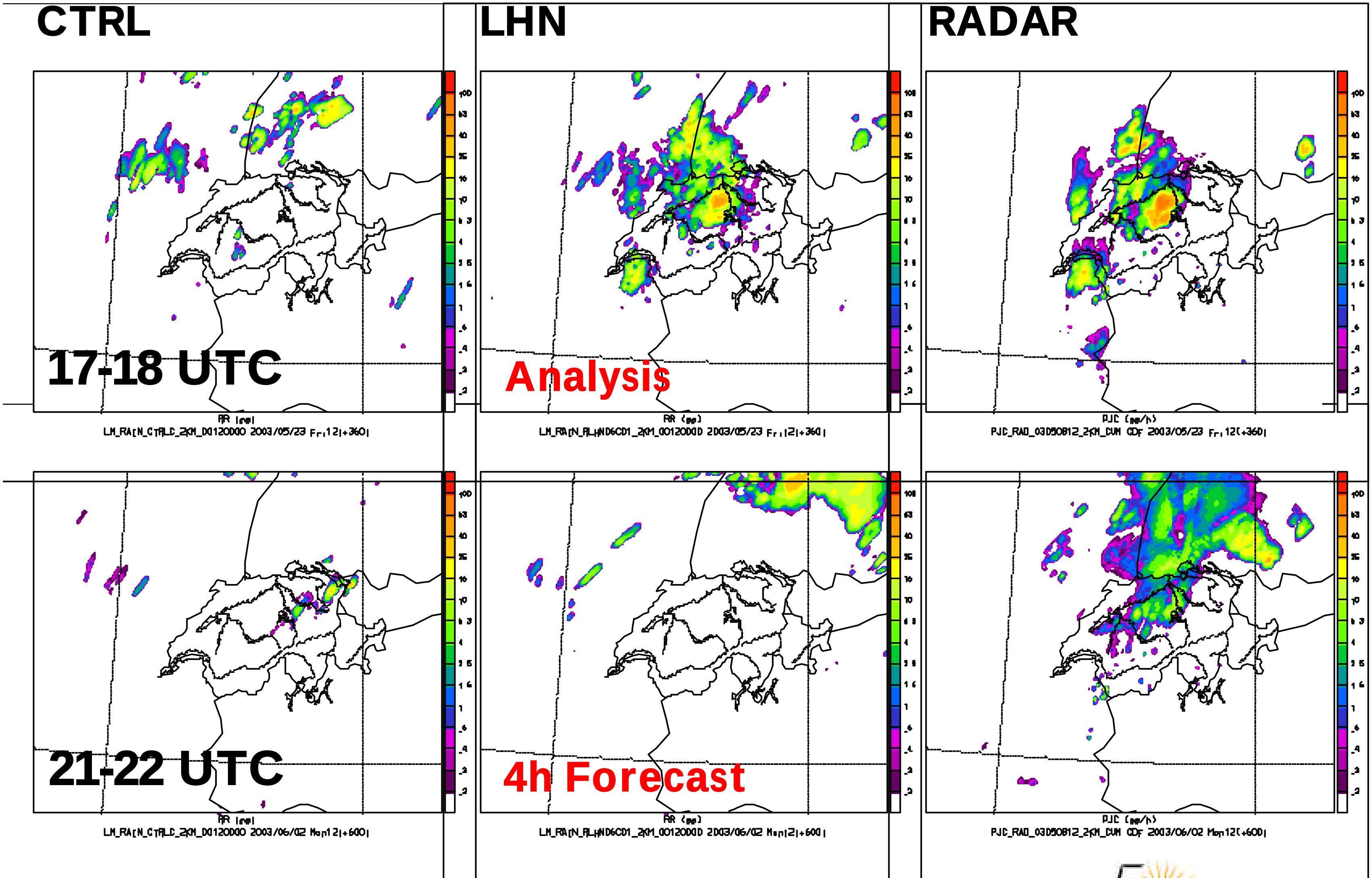
Simulations with Δx = 2.2km, no CPS



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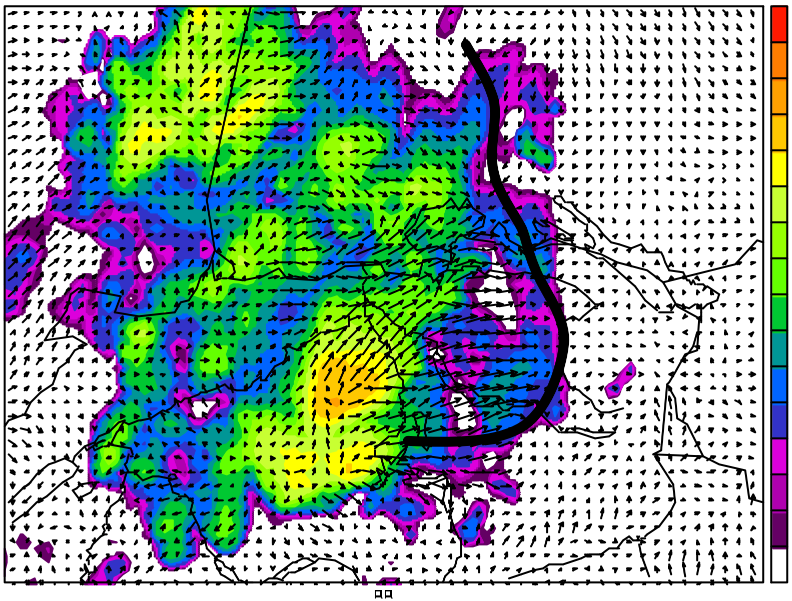
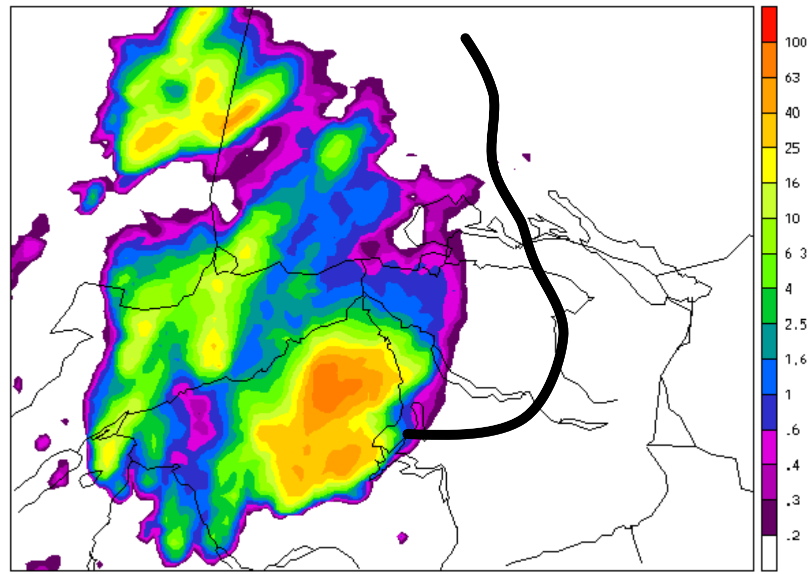
8. May 2003 Storm

LHN Analysis



RADAR



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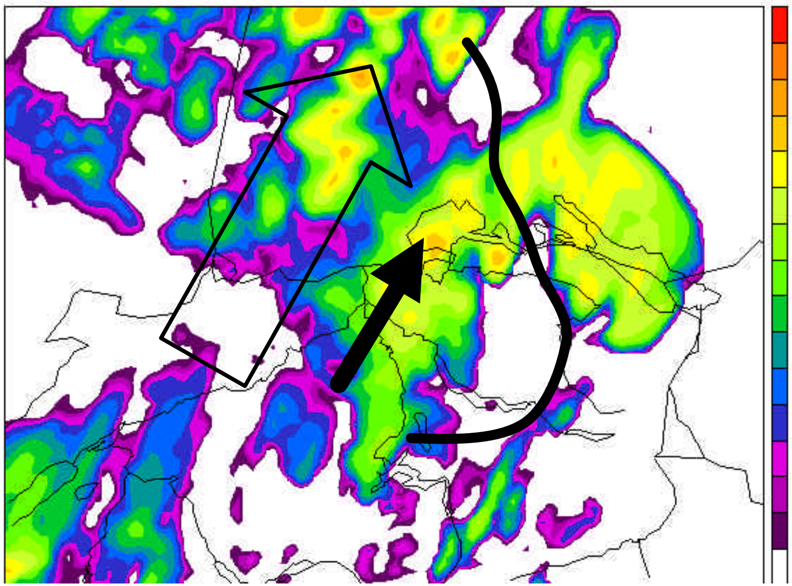
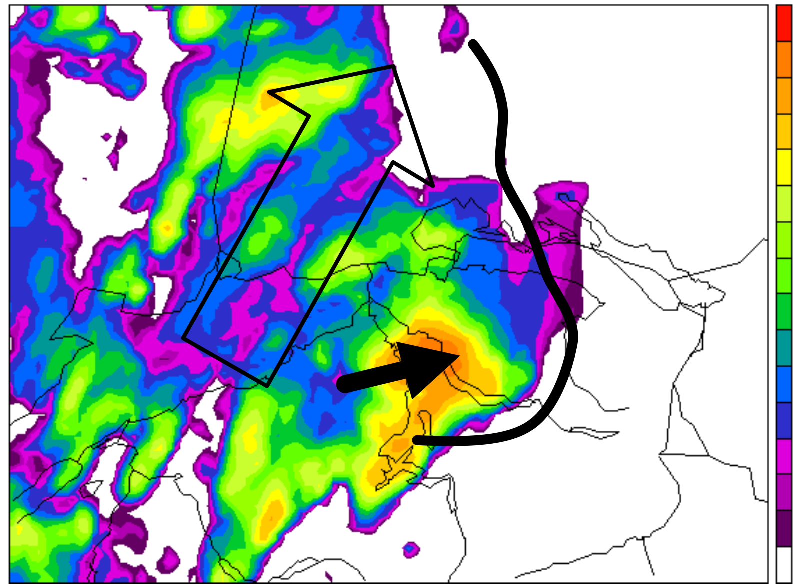
8. May 2003 Storm

1h Forecast



RADAR



Findings

- LHN has potential to work if advection of precip is not considered
- Good results in identical twin simulation
- Scheme sensitive to observation and environment errors
- Non-rain echoes potential problem
- Case study of real storm
  - LHN triggers storm at right location and intensity
  - Radar data clearly improves QPF in the first hours
  - Outflow located too far downstream
  - Storm kept in model for more than 4h
- Storm environment important! Use VAD/radial winds and other remote sensing observations for its specification!

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Thank you for your attention !

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