Evaluation of TerrSysMP with Radar Polarimetry – Bonn Radar Domain

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About ILACPR

Investigating the impact of **L**and-use and land-cover change on **A**erosol-**C**loud-precipitation interactions using **P**olarimetric **R**adar retrievals

- Project ILACPR contributes to objective one of SPP2115
  - the exploitation of radar polarimetry for quantitative process and model evaluation

- Focus on the impact of anthropogenic land-use and land-cover changes on cloud microphysical and macrophysical (dynamical) mechanisms.
  - Preliminary study show that "Response of the system in terms of surface precipitation for the forcing is weak – however – pathways of microphysical/macrophysical processes reflecting the polarimetric radar signatures vary"

- First year focus mainly on evaluation of simulated and measured radar polarimetric signatures
  - Bonn Radar Domain
  - mainly BoxPol measurements
  - Polarimteric Forward Operator applied to TerrSysMP outputs
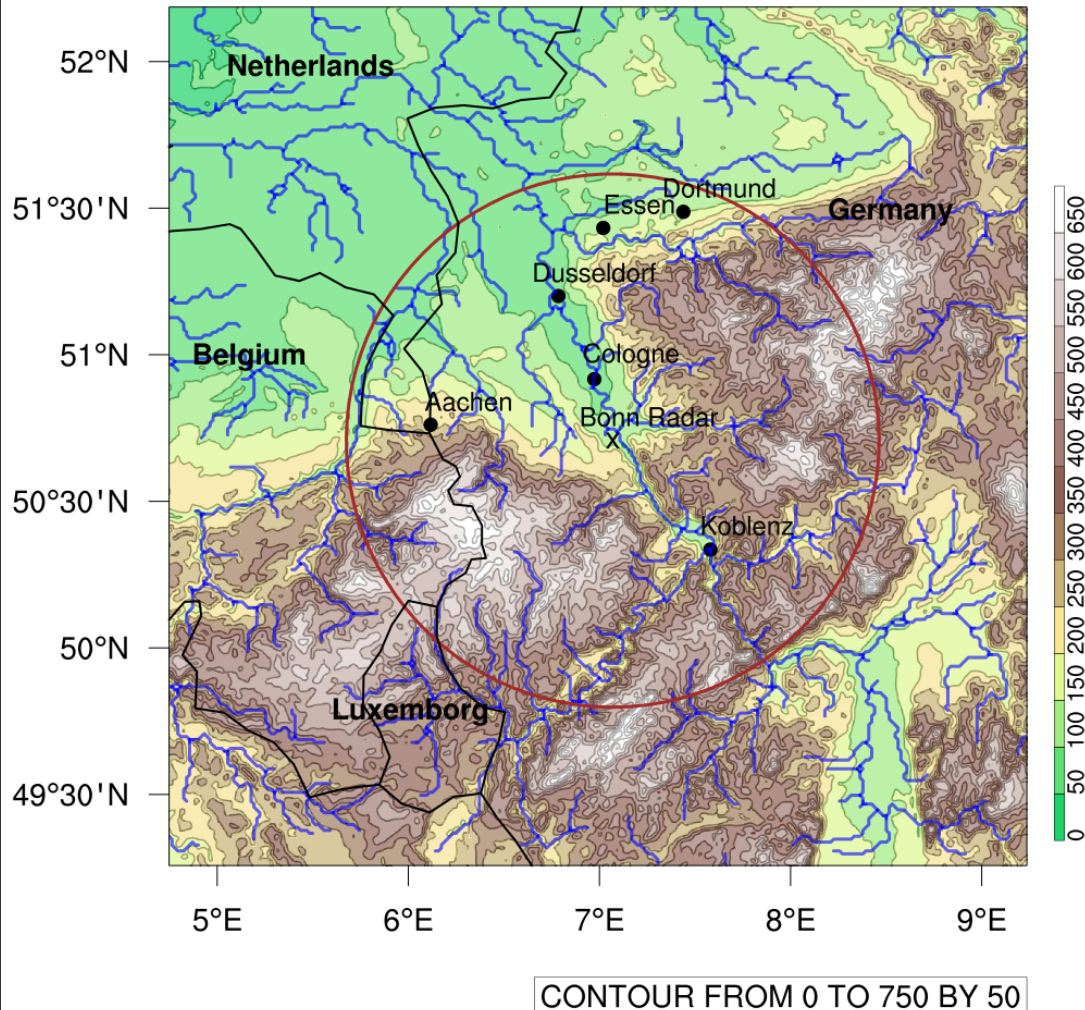
Bonn Radar Domain

NRW Domain
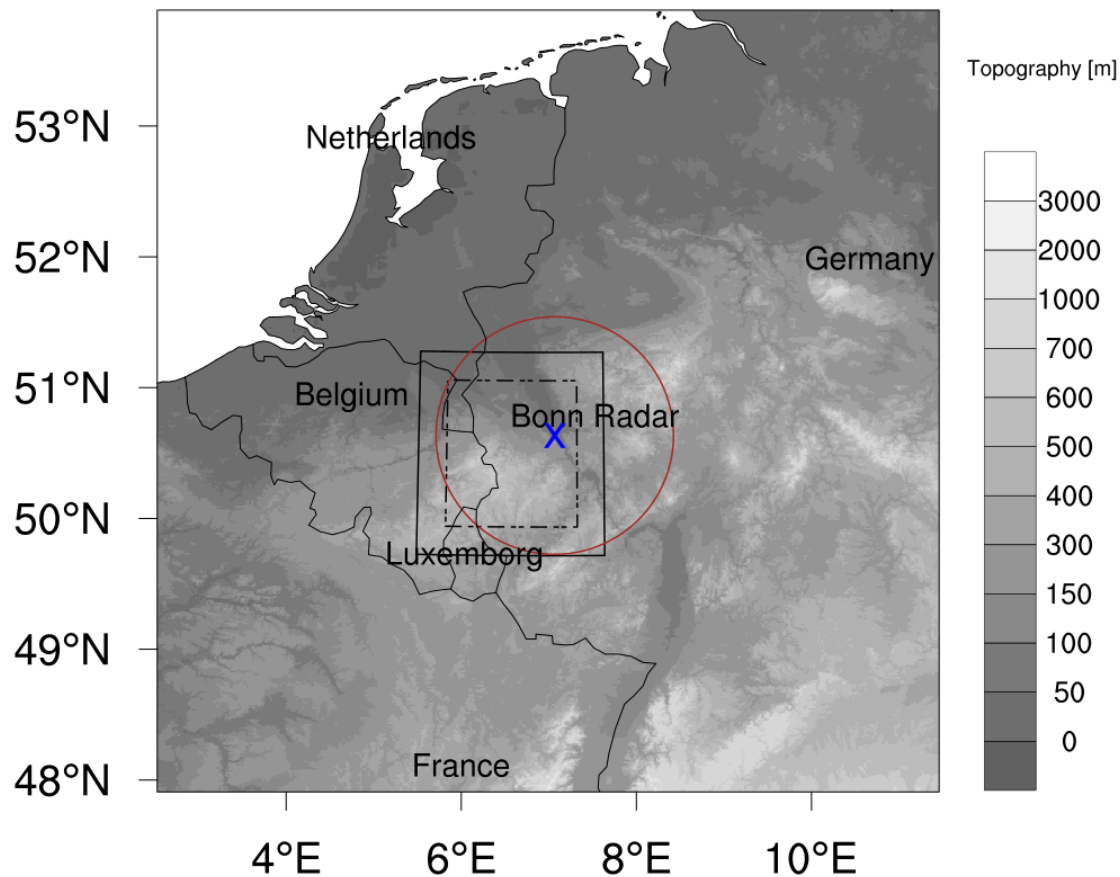
Grid Description

- Δ_x ~ 1.132 km (0.1°)
- Horizontal Extent ~ 332 x 332 km
- Encompasses the Bonn Radar extent excluding the relaxation zone
- Double the extent of NRW domain (Shrestha et al. 2014)

# Bonn Radar Domain – Input Data Preparation

Hydrologic Component

- PFT - MODIS/Terra+Aqua Land Cover Type Yearly L3 Global 500m SIN Grid V006 (MCD12Q1, 2015), water bodies converted to bare soil
- LAI – MODIS Combined Terra and Aqua Leaf Area Index - Fraction of Photosynthetically Active Radiation 8-Day L4 Global 1km (MCD15A2, 2011)
- Soil Texture
    - Vadose Zone (FAO ~ COSMO specification)
    - Subsurface (IHME1500 aquifer data)
- D4 Slopes – COSMO topography and D4 Stream Maps (SRTM topography at $\Delta_x/20$ resolution) with slope smoothing algorithm

Source Codes :
https://git2.meteo.uni-bonn.de/git/tps

Bonn Radar Domain – Initial Conditions
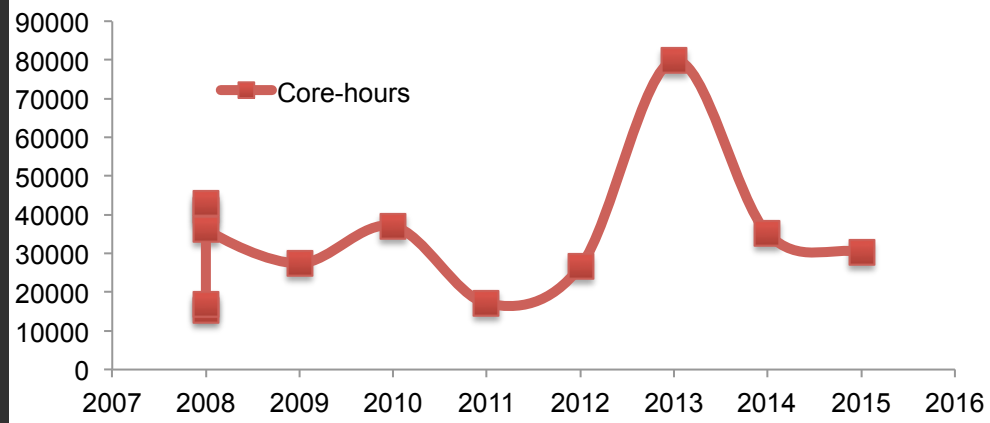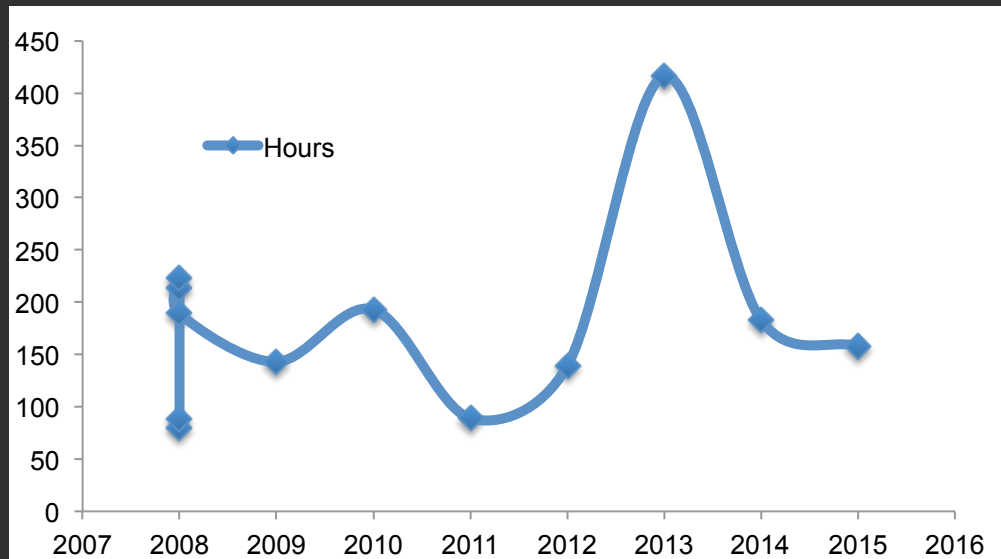
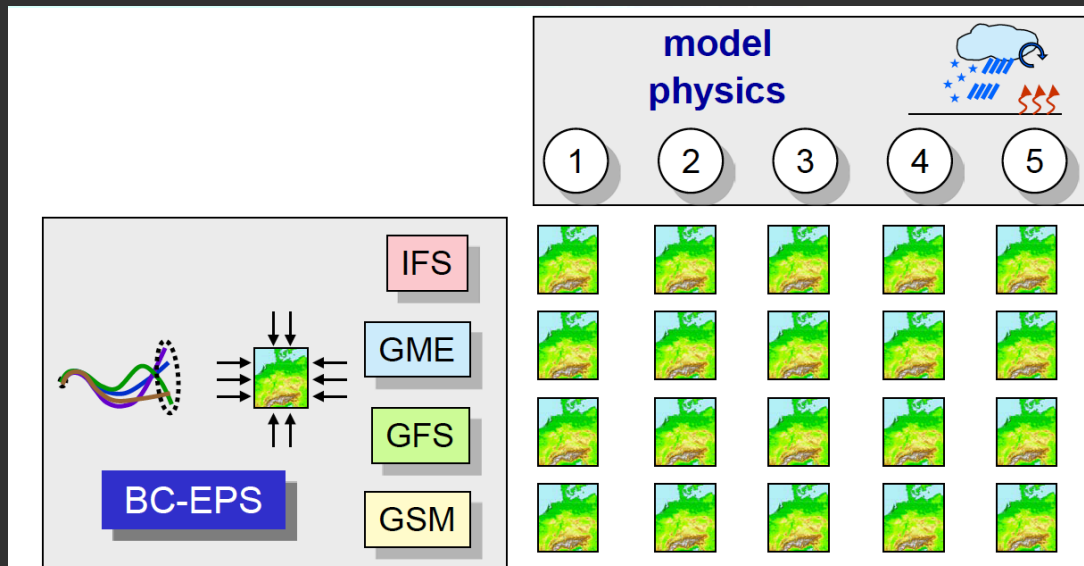## Hydrologic Component

<Spinup>
- COSMO-DE analysis data for atmospheric forcing
- Recycling 2008 for 4 years
- Continuous runs from 2008 to 2015
- **4 years spinup and 8 years of transient run**
  - Started: Feb 26 2019
  - JUWELS (192 cores)
  - 2115 hours of simulation
  - 0.41 million core-hours
  - Slow convergence
  - Insufficient resource allocation
  - Processor and numerical solver optimization
  - Job Queue/ Maintenance

Bonn Radar Domain – Forcing Data Preparation

Atmospheric Component

COSMO-DE EPS hourly forecast data with 20 ensemble members
- Ensemble members are generated by randomly perturbing model parameters and lateral forcing using GME, IFS, GFS and GSM
- Lead forecast upto 27 hours
- Lead forecast upto 45 hours for simulation starting at 0300 hours
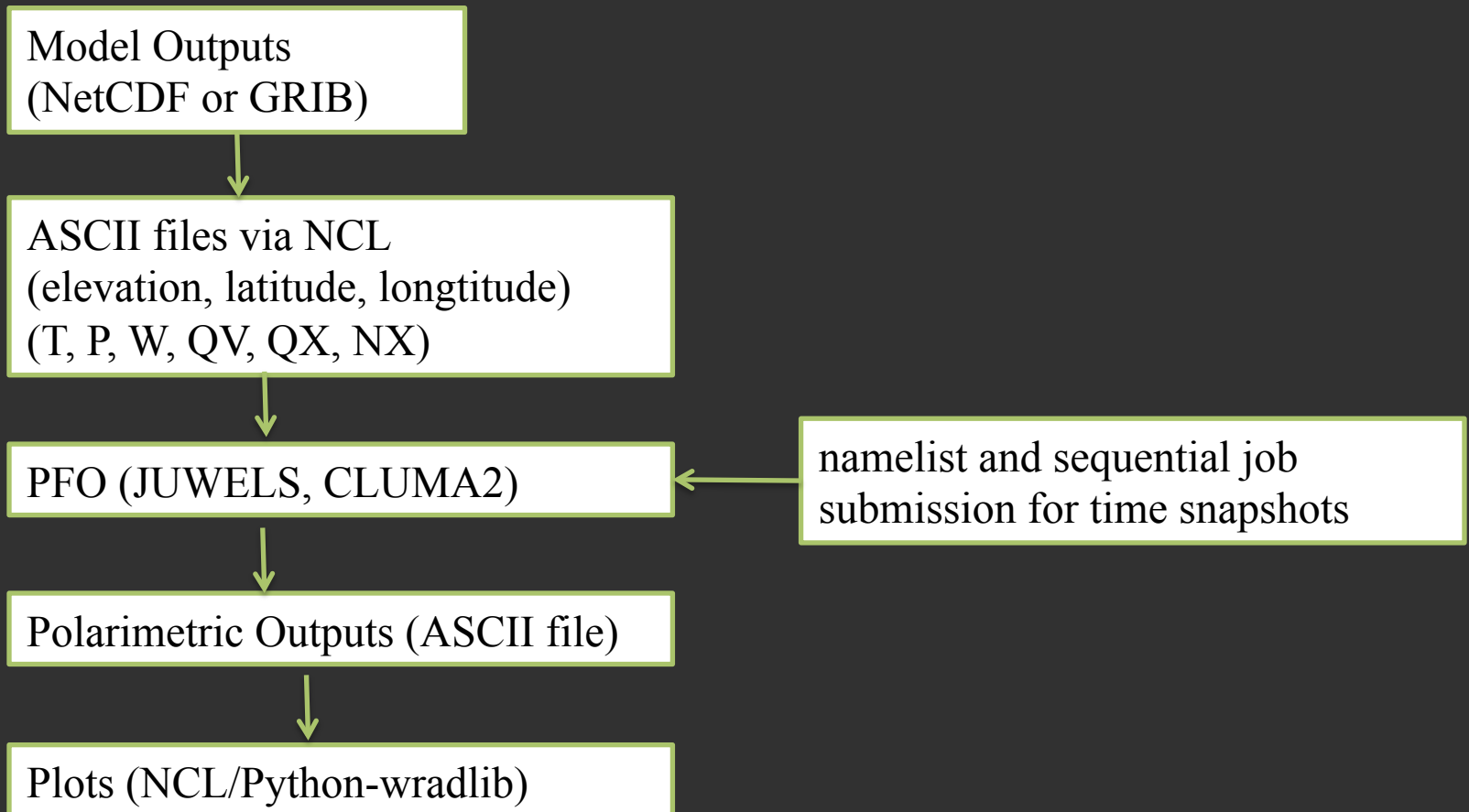- Int2lm2.00.2 used to generate initial and boundary condition files

Source: https://www.ecmwf.int/en/elibrary/13851-cosmo-de-eps-new-way-predicting-severe-convection
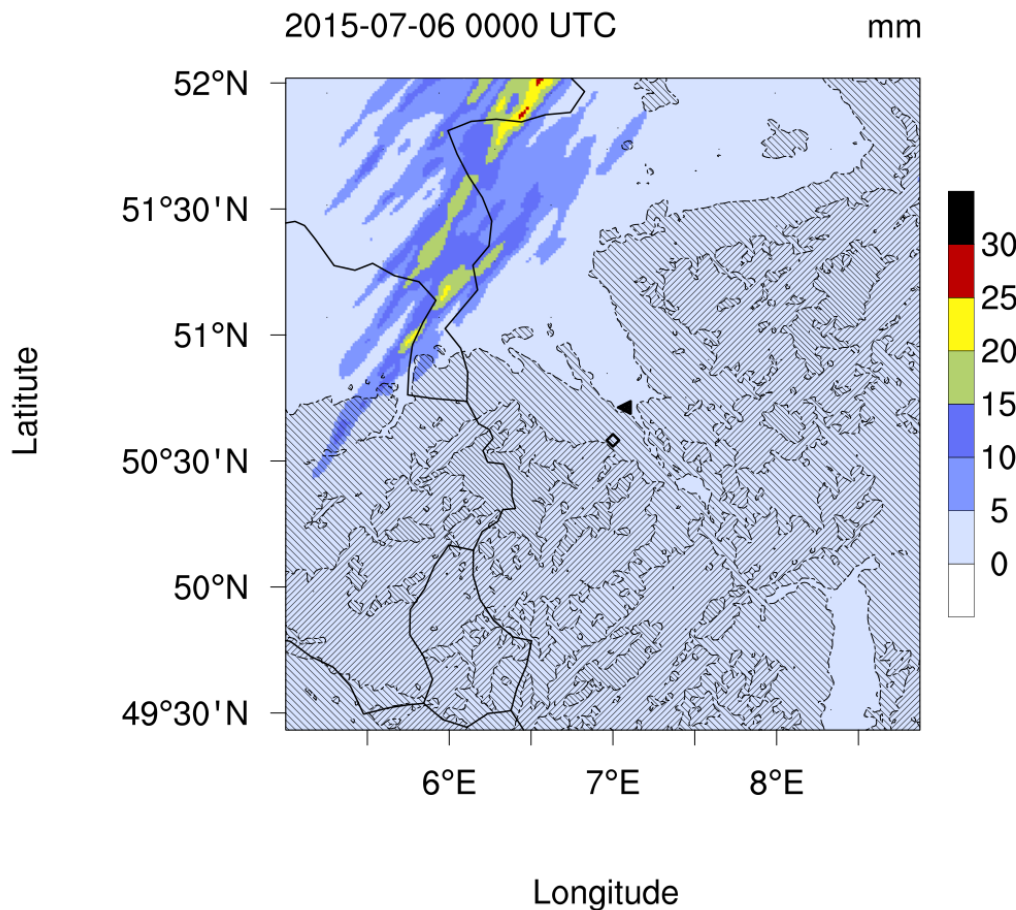
Case Studies

- Selected based on
  - BoxPol Z_h animations
  - May-June-July
  - Starting from 2015
  - Convective Storm Events (Spatial Extent and Duration)

- Selected events
  - 5 July 2015 (Deep convective storm with large hail)
  - 4 June 2016 (Small scale rapidly developing convective storms)
  - 19 July 2017 (Heavy rain mixed with moderate hail)

Polarimetric Forward Operator (PFO)

- https://git2.meteo.uni-bonn.de/git/pfo

```
Model Outputs
(NetCDF or GRIB)
        |
        v
ASCII files via NCL
(elevation, latitude, longtitude)
(T, P, W, QV, QX, NX)
        |
        v
PFO (JUWELS, CLUMA2)  <---  namelist and sequential job
        |                    submission for time snapshots
        v
Polarimetric Outputs (ASCII file)
        |
        v
Plots (NCL/Python-wradlib)
```

8

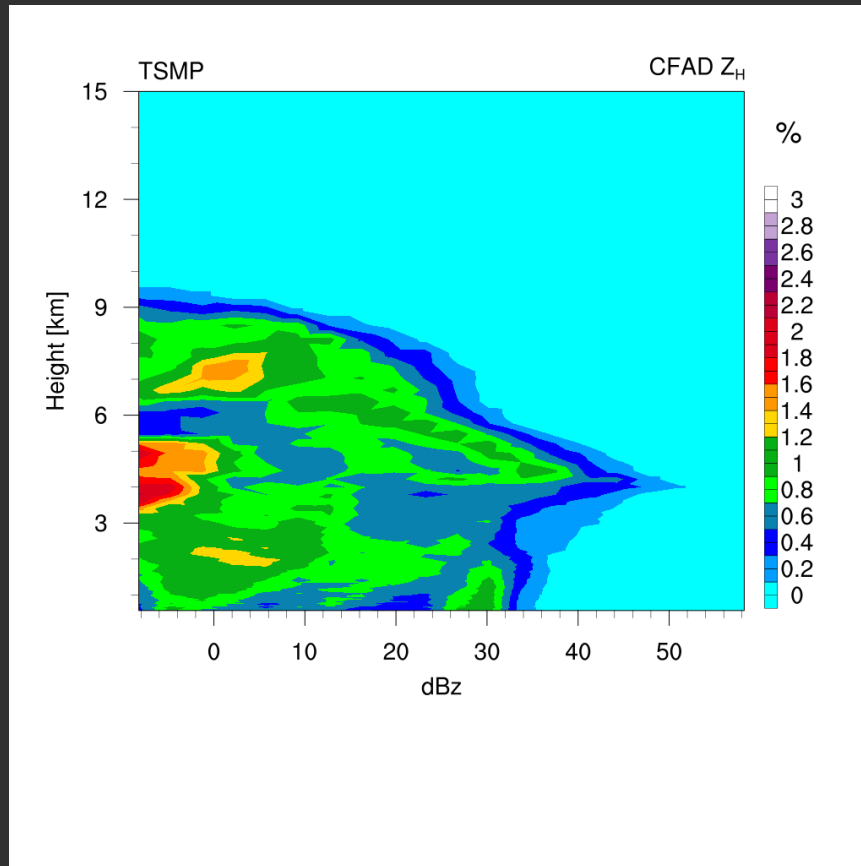# Ensemble Simulation – Total Accumulated Precipitation

2015-07-06 0000 UTC — mm

Model integrated from 2015
4 July 0300 UTC

- Spatial extent and large scale pattern has strong dependence on forcing datasets.

- Variation in magnitudes are dependent on model perturbations used to generate EPS data.

Ensemble Simulation – CFAD

July 5 2015 1540 UTC

- Mismatch in spatial and temporal time-scale of storm evolution.

- Direct comparison with radar measurements becomes challenging.

- Monitor ensemble properties of storm evolution.

CFAD computed over model levels encompassing entire Bonn radar domain excluding relaxation zone.

Summary

- Polarimetric fingerprint comparisons are also ongoing <plotting issues with wradlib library>
- Simulation and analysis are ongoing work with large scale aerosol perturbation and land-use and land-cover change <computational resources and data storage>

- Response of the system to precipitation and ensemble properties of storm is highly sensitive to atmospheric forcing data.

Thank you !

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