



**Deutscher Wetterdienst**  
*Wetter und Klima aus einer Hand*



# Assimilation of Radar Volume Data Reflectivity and Radial Velocity

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## Outline

- Motivation
- Radar observation
- Current activities and plans



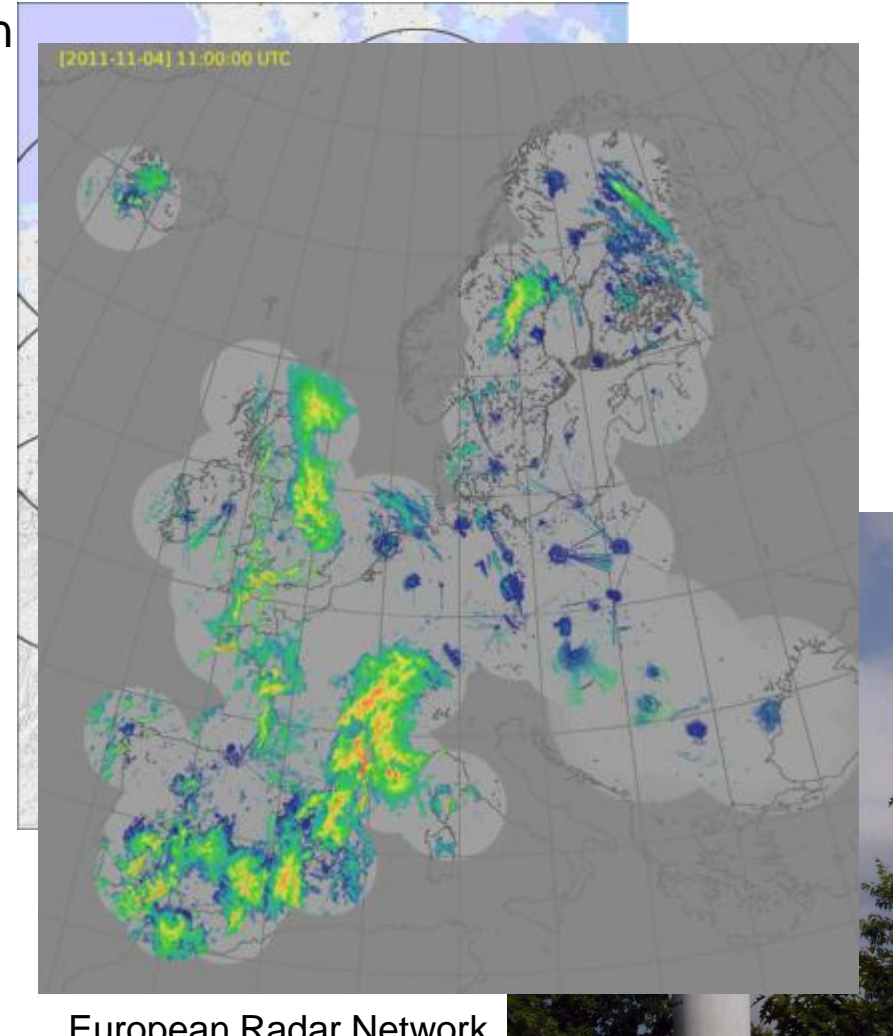
# Motivation



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- High resolution NWP requires observation with a high resolution
- Radar observations will be of great potential for this purpose.
- Current resolution at DWD:
  - 250 m in range (180 km)
  - 1° in azimuth
  - 11 elevation (0.5 – 25° )
  - every 5 min
- Data coverage is very good:
  - 17 Stations in Germany
  - OPERA is currently getting (15 min):
    - 120 Volumes of Reflectivity
    - 30 Volumes of Radial Velocity



European Radar Network  
(OPERA)

Hannover



# Radar Basics



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- **RADAR:** acronym standing for **R**adio **D**etection and **R**anging
- Pulses of electromagnetic waves at radio frequency (2-10 GHz, 15-3 cm, S,C,X-Band) are sent and received (scattered at a target) at the same site.



- Each target returns a tiny bit of the transmitted energy
  - Air planes, insects, birds, rain drops, hail ...
- Measuring the elapsed time between sending and receiving the signal



# Radar Basics



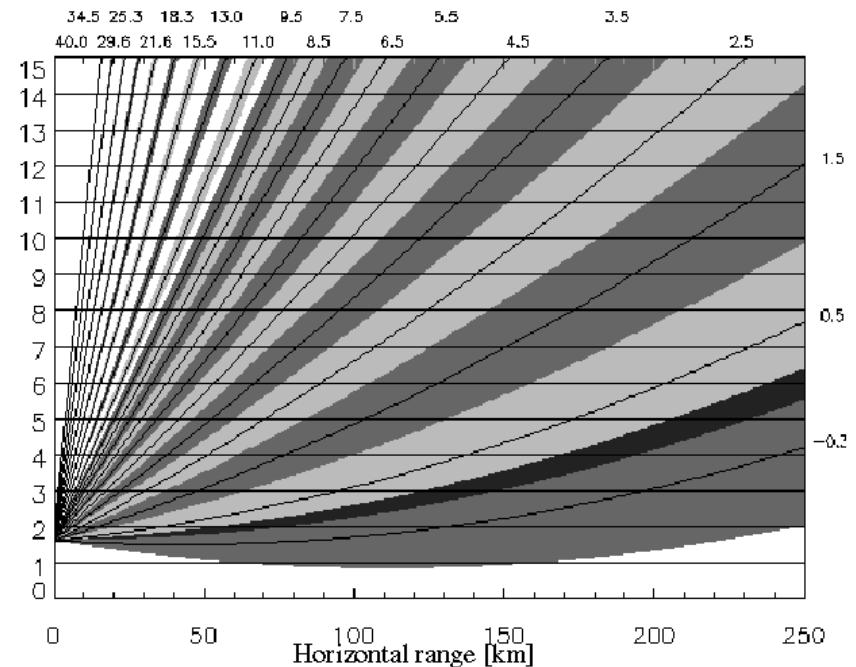
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- Radar Antenna is turning around continuously (1-3 rpm)
- A very short pulse is send ( $\sim 1 \mu\text{s}$ ) and the respond is received ( $\sim 10 \text{ ms}$ )
- After a turn is completed the next elevation is adjusted

## Some facts:

- beam is broadening with distance  
( $\sim 1 \text{ km}^3$  at 100 km)
- bended due to the refractivity of the atmosphere (normally back to the ground)
- resolution decreases with distance  
(vertically and azimuthally)



- elapsed time of the signal, azimuth and elevation of the Radar beam yield the location of a target (air craft, rain droplet, insects, etc..)



# Radar Basics



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- Beside the time delay of the signal Weather Radar measures:
  - **Reflectivity**
    - Estimation of Precipitation Amount (QPE)
  - **Doppler Velocity** (only for Dopplerised Radar)
    - Measurement of radial wind component
    - Estimation of vertical profile of horizontal wind (VAD)
  - **Polarimetric Parameters** (only for polarised Radar)
    - Improvement of QPE
    - Distinction of different precipitation types
- This information can be used for NWP in
  - Data assimilation, verification, validation, process studies
- Requires well equipped Radar and a efficient radar forward operator (RFO)



# Current work



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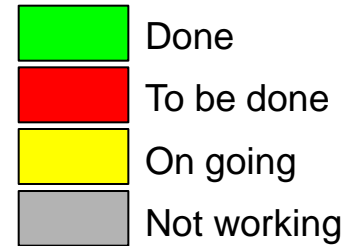


- Investigations are split in two groups:
  - **Reflectivity**
    - Theresa, Virginia, Heiner, Klaus
  - **Doppler Velocity** (only for Dopplerised Radar)
    - Yuefei, Heiner, Klaus
- Main issues:
  - Suberobbing and Data thinning
  - Localization
  - Combination with less frequent and sparse data
  - Model error with respect to reflectivity and observation error
- First steps:
  - Getting started LETKF + RFO
  - Getting used to RFO, monitoring of RFO

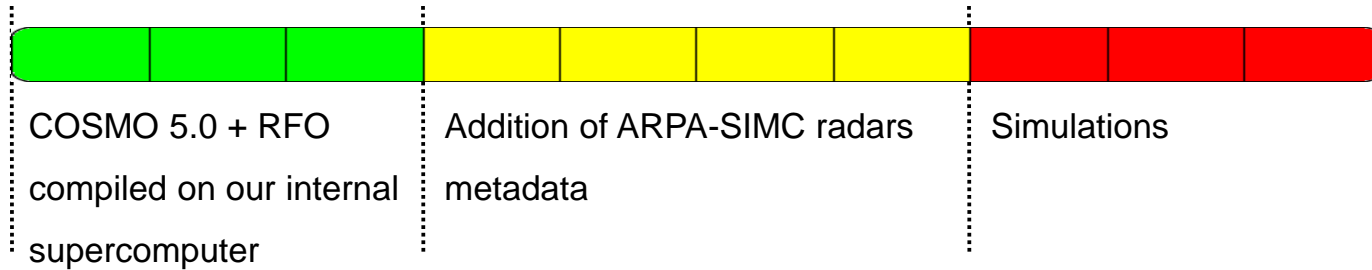




## ARPA-SIMC plans



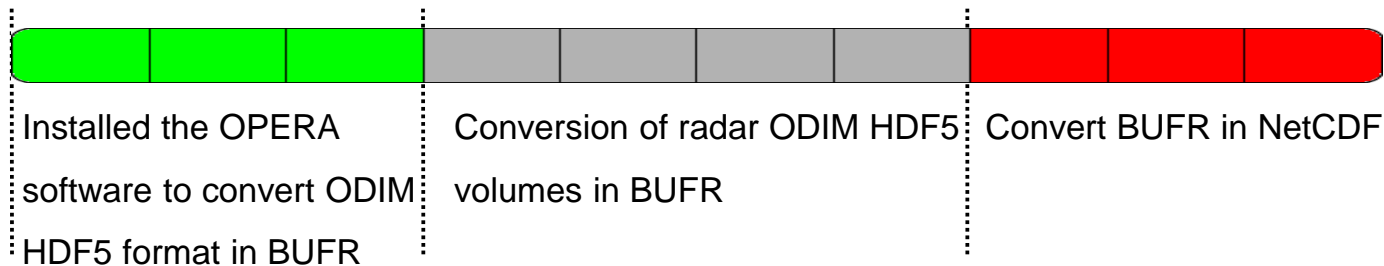
### 1) Simulation with ARPA-SIMC radars



### 2) Verification of simulations vs. observations



### 3) Radar volume: file format adaptation



### 4) KENDA runs on the ECMWF supercomputer





# Current work - Reflectivity

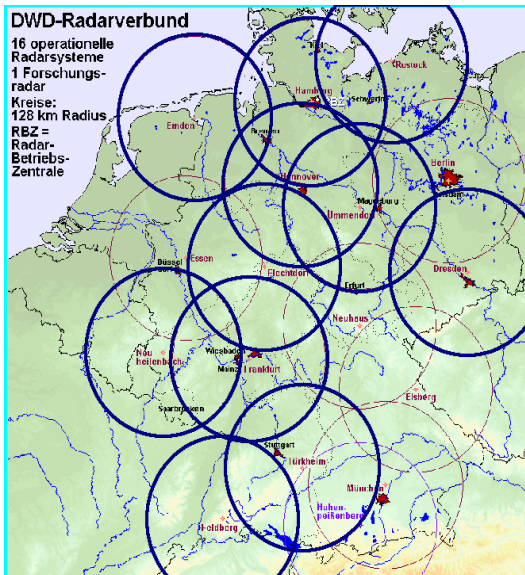


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- **(Very) first trial:** Assimilation of Z and Vr on June 6th, 2011, 6h cycling

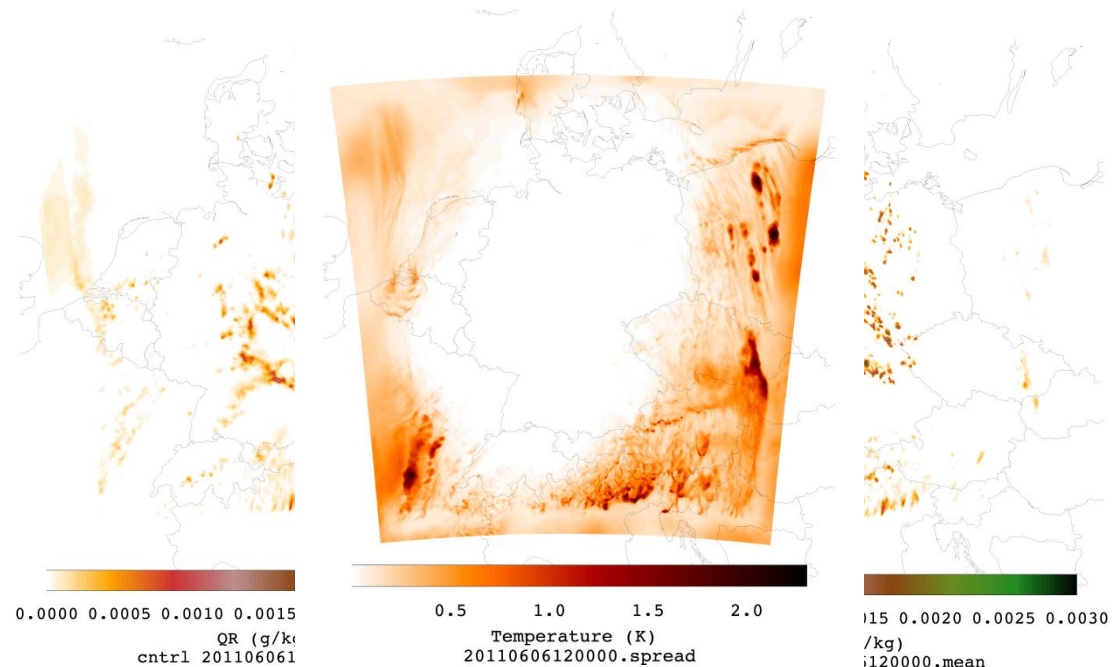
Available stations



Specific rain content, lowest model layer, ensemble mean

Control experiment:

Radar experiment:



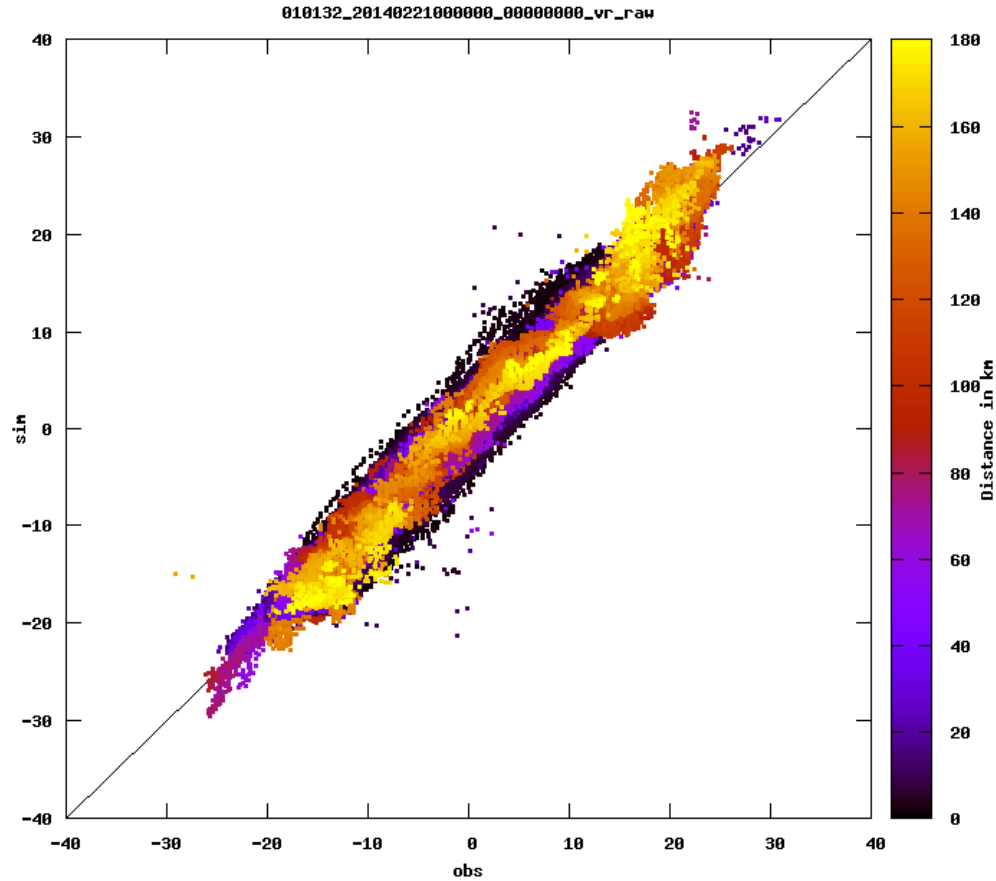
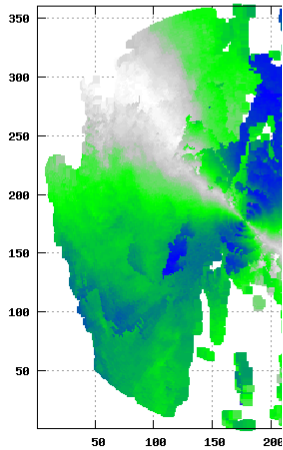
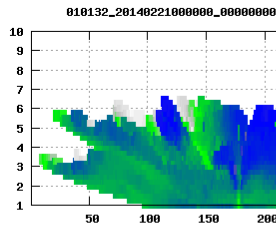
# RFO monitoring Radial Wind



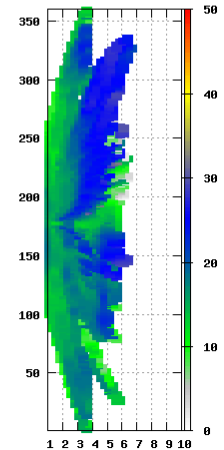
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Observ:



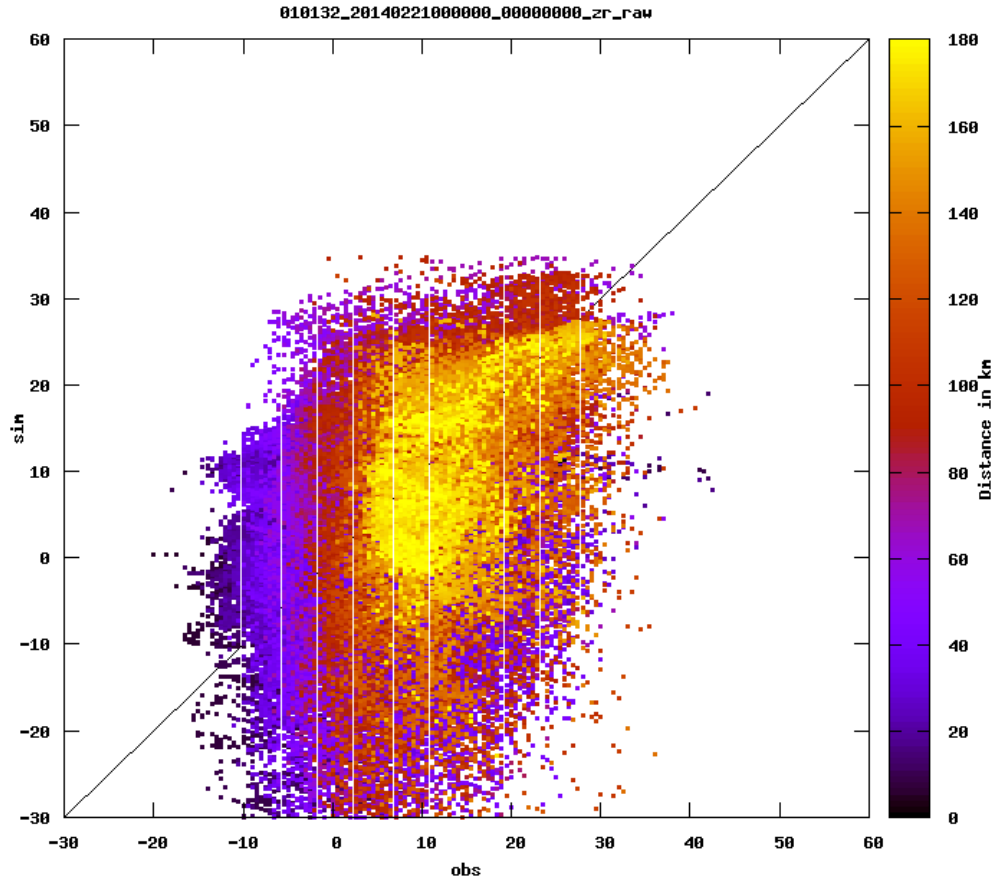
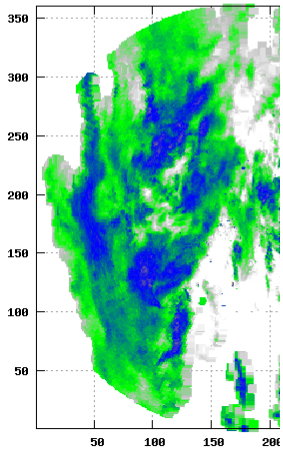
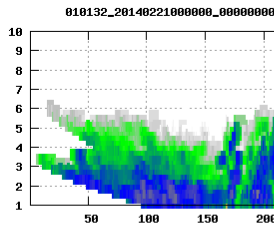
OBS: MEAN: 0.47 VAR: 143.57 NUM: 174861.00  
SIM: MEAN: 0.67 VAR: 146.67 NUM: 174861.00  
BIAS: -0.05 RMSE: 0.97



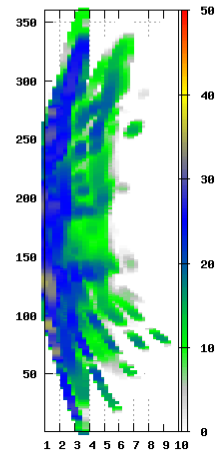
# RFO monitoring Reflectivity



Observ:



OBS: MEAN: 7.41 VAR: 63.07 NUM: 174730.00  
SIM: MEAN: -2.33 VAR: 254.94 NUM: 324889.00  
BIAS: 0.41 RMSE: 6.15



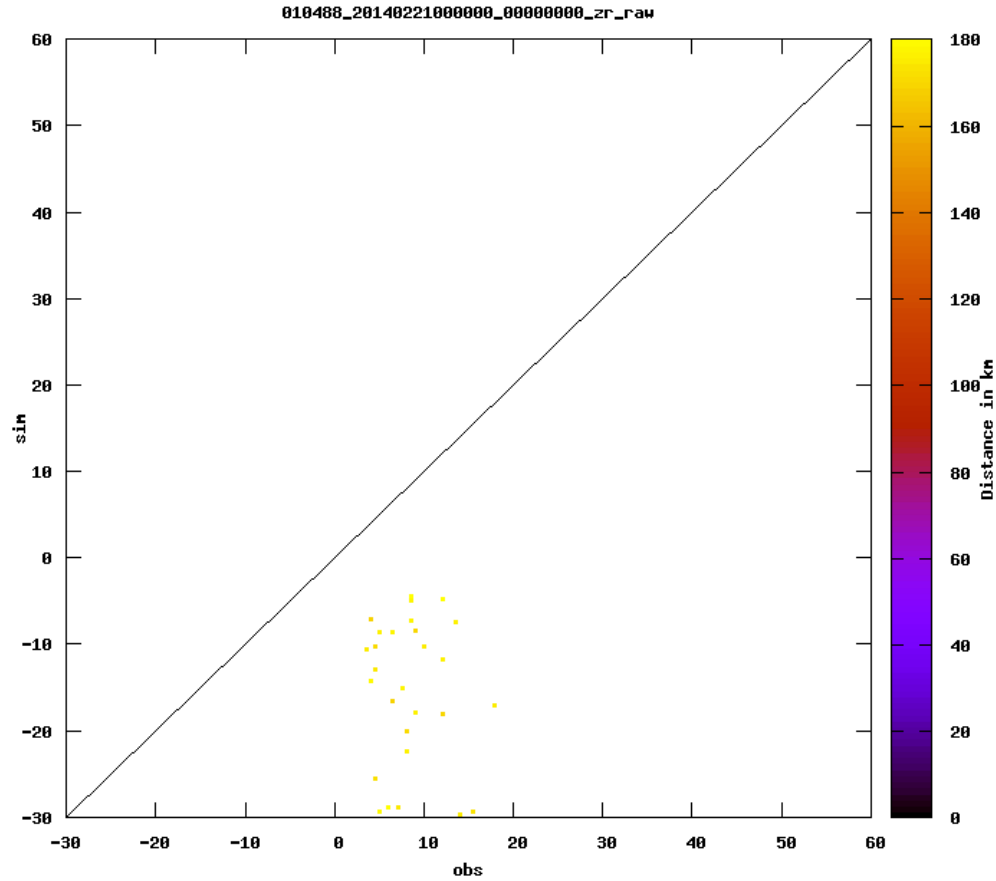
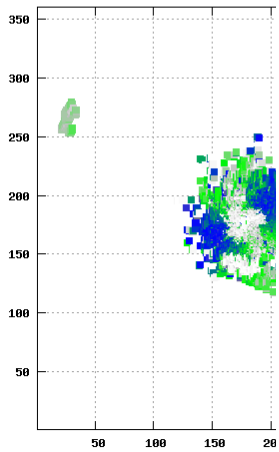
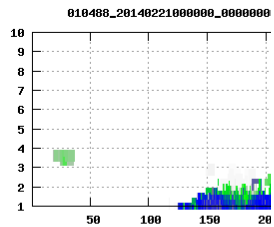
# RFO monitoring Radial Wind



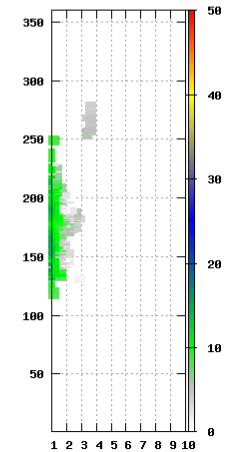
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Observ:



OBS: MEAN: -8.84 VAR: 54.60 NUM: 28567.00  
SIM: MEAN: -32.31 VAR: 224.24 NUM: 3066.00  
BIAS: 0.00 RMSE: 0.24





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**Thank you for your attention**

Remarks?

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Questions?

