



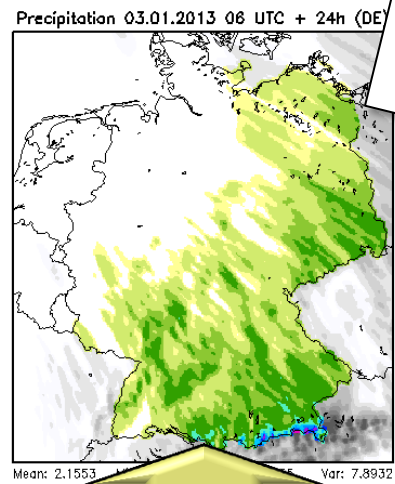
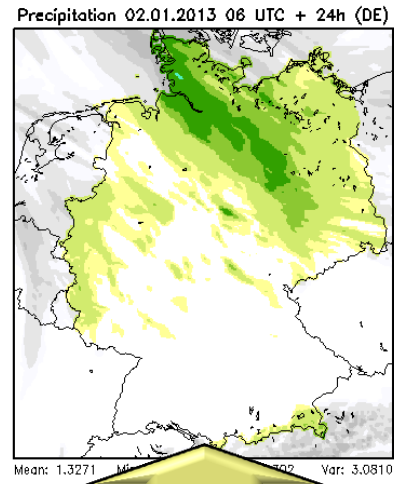
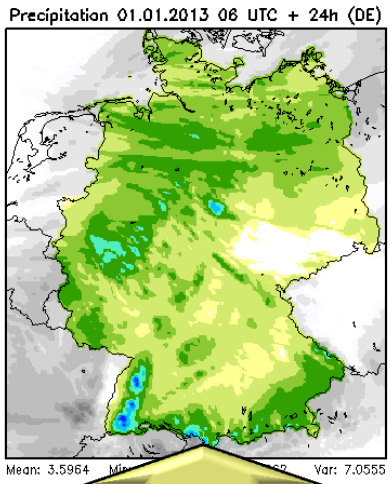
***BACY = Basic Cycling***  
*A COSMO Data Assimilation Testbed  
for Research and Development*

**Roland Potthast, Hendrik Reich, Christoph Schraff,  
Klaus Stephan, Andreas Rhodin, and many more ...**  
*Deutscher Wetterdienst, Offenbach, Germany*

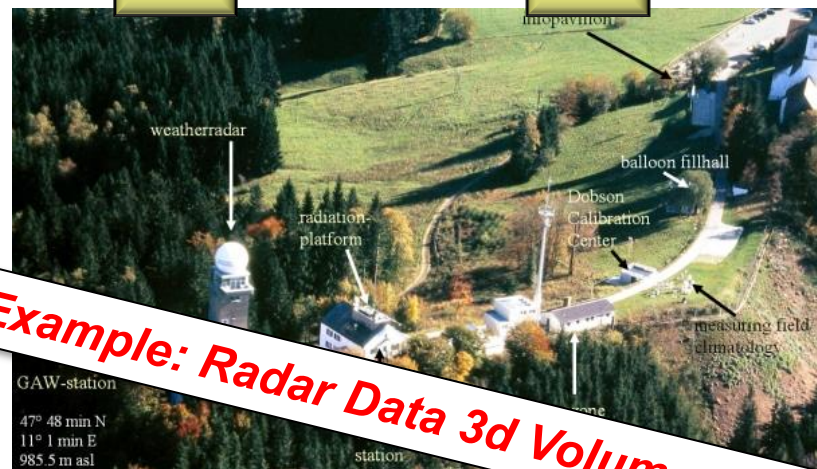
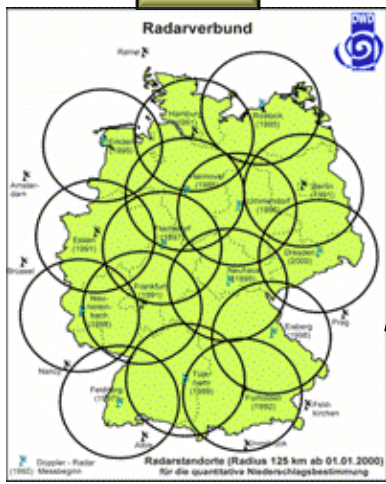
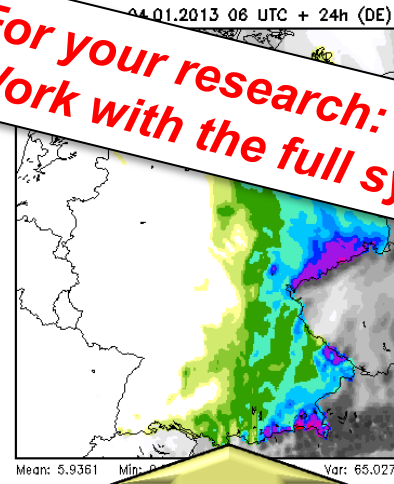
March 17, 2014



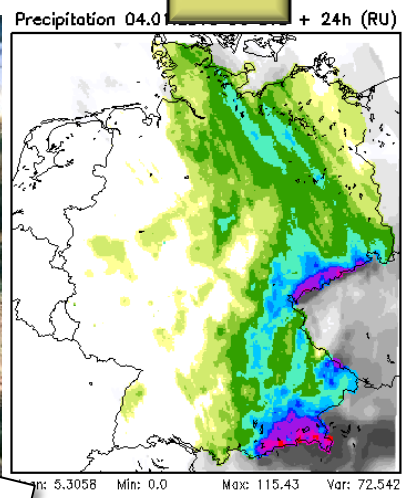
# Full NWP System – Integrates **Cycled** Model and Data Assimilation



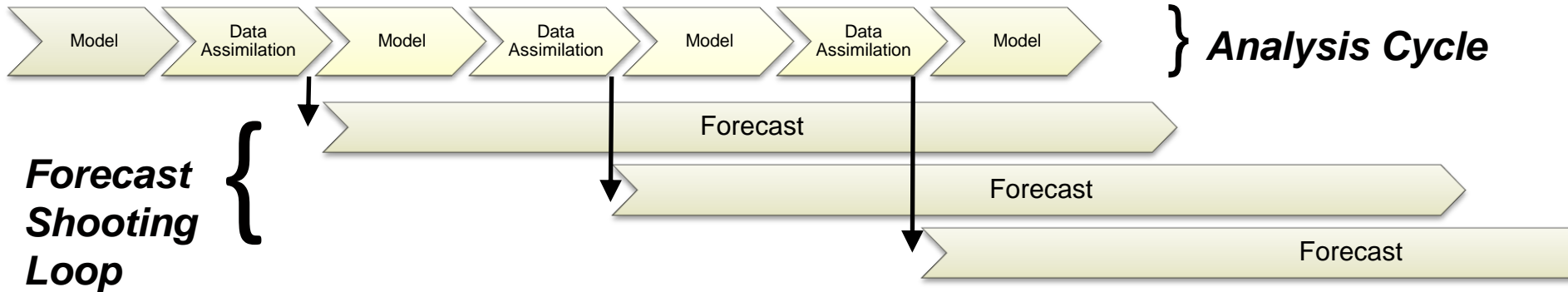
**For your research:  
Work with the full system!**



**Example: Radar Data 3d Volume Scan**



# Full NWP System – Integrates Cycled Model and Data Assimilation

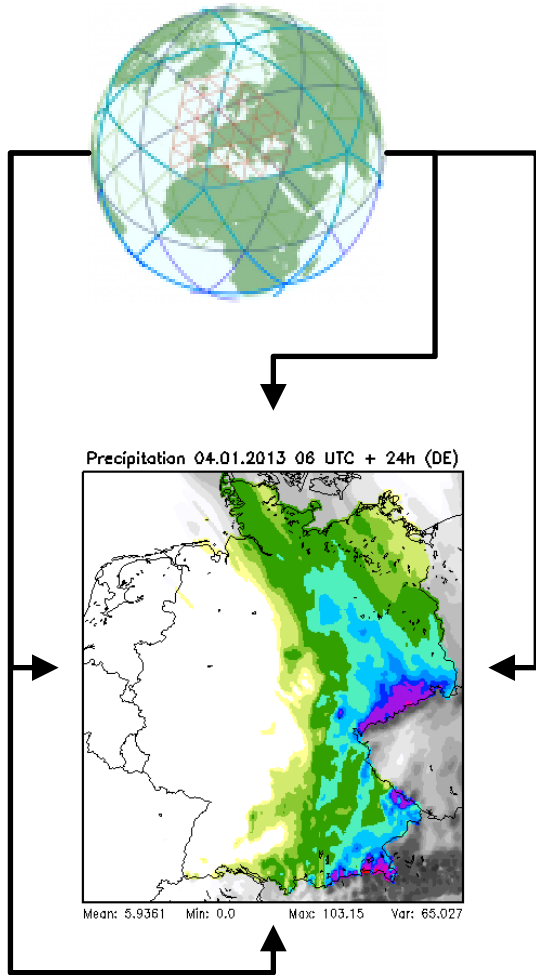


## Some Arguments:

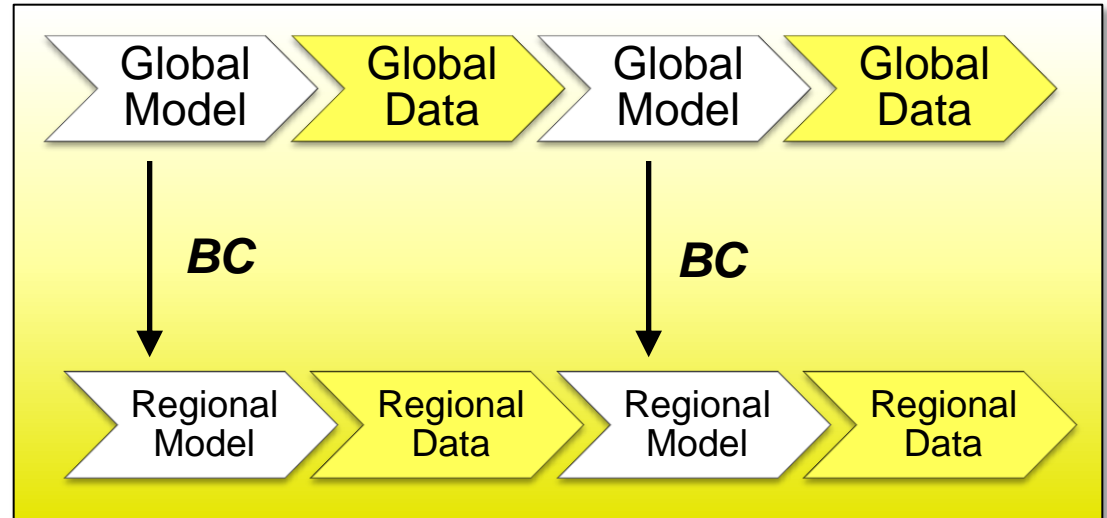
- Test model developments and forecasts in a realistic „small“ or „baby“-cycling environment (BACY)
- Model developments will strongly influence the behaviour of the cycled system and the corresponding forecasts (feedback loops!)
- *Just testing changes of forecasts when model developments are carried out is only a part of what really happens*
- Observe and treat realistic development of biases which often arises by multiplier effect of cycling
- Test the influence of new observations and rather easily integrate them into an NWP environment (without running the whole DB System)



# Regional Model needs Boundary Conditions from Global Model



## Global Model provides Boundary Conditions



## Efficient Treatment of Boundary Data



gme\_sub  
icon\_sub

...

int21m



## NWP Development

ICON DA

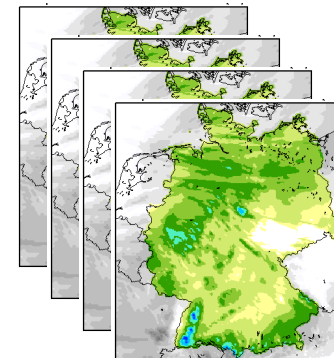


COSMO DA

ICON  
Bacy

ICON VarEnKF  
Bacy

KENDA  
Bacy



**Kilometer  
Scale  
Ensemble  
Data  
Assimilation**

Hendrik Reich

**Variational (3dVar)  
Deterministic  
Data Assimilation  
for ICON**

**Hybrid Variational  
Ensemble Kalman  
Filter (VarEnKF)  
for ICON**

**Boundary  
conditions  
(repository)**

Harald Anlauf

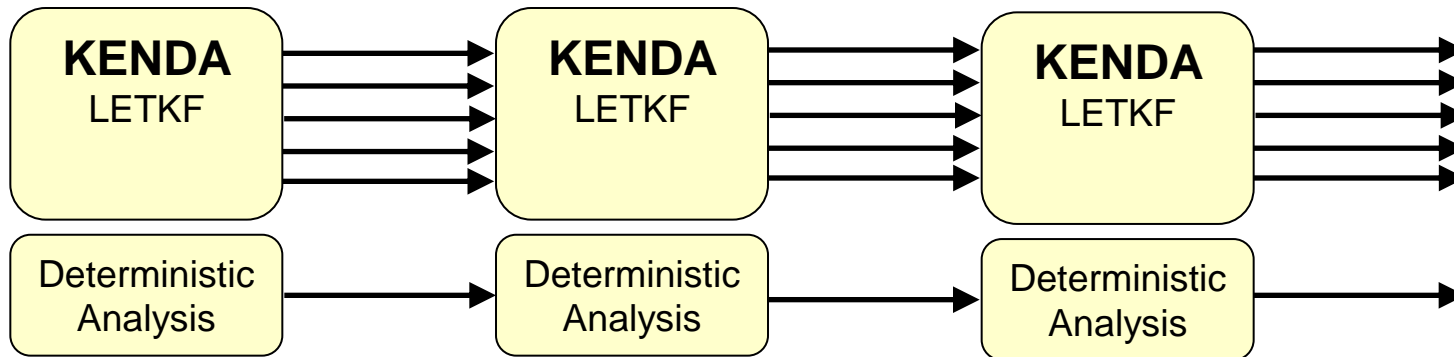
Ana Fernandez, Alex Cress



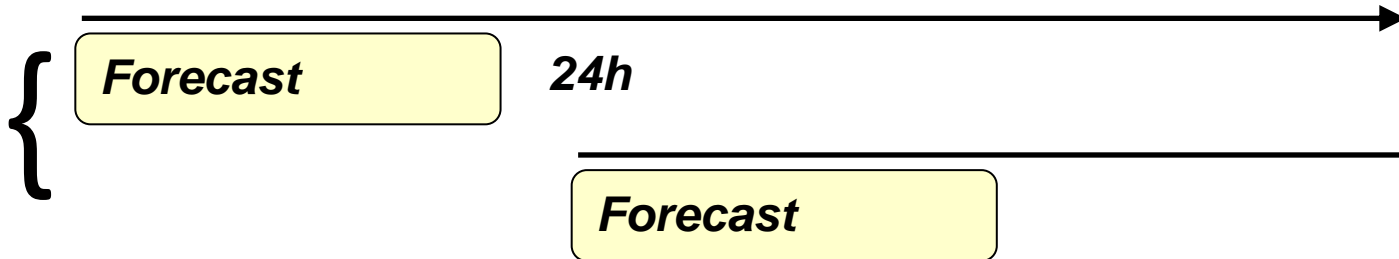
# BACY Experiments: KENDA versus Nudging



Experiments carried out by Hendrik Reich



**Forecast  
Shooting  
Loop**



- COSMO-DE Domain, 2.8km resolution
- Standard operational configuration of DWD
- Bacy Speed 1.2 i.e. 1.2 simulations days per day  
(6 Days Experiment in 5 days)
- Four Experiments with different Setup carried out (adaptivity)





# BACY Experiment 4: KENDA versus Nudging

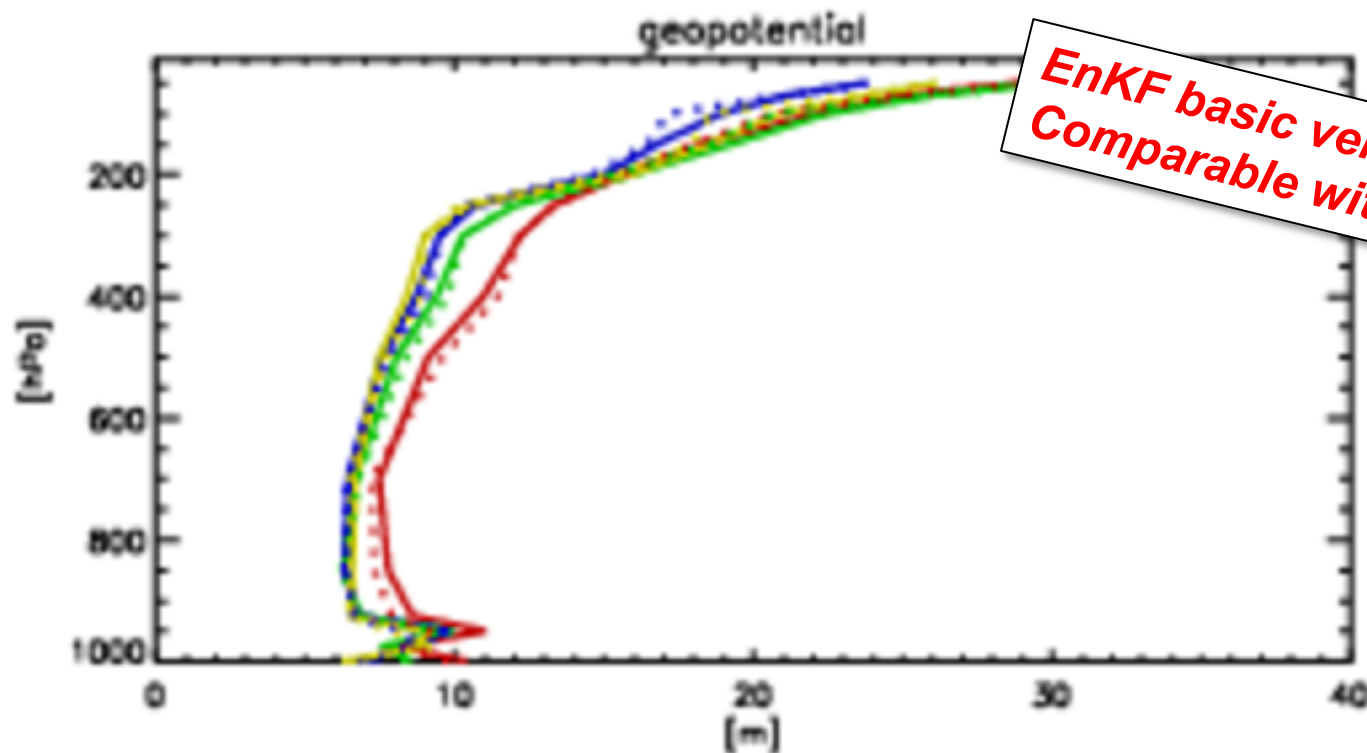


## Legend

LMK All 110606 (det)	LMK All 110606 (nudg)
+ 06 H	+ 06 H
+ 12 H	+ 12 H
+ 18 H	+ 18 H
+ 24 H	+ 24 H
—	Observation

MEAN ERROR (model - obs)  
ROOT MEAN SQUARE ERROR  
1106 UTC

created at Fri Mar 14 08:45:43 2014 by Deutscher Wetterdienst



**EnKF basic version  
Comparable with Nudging**



# BACY Experiment 4: KENDA versus Nudging

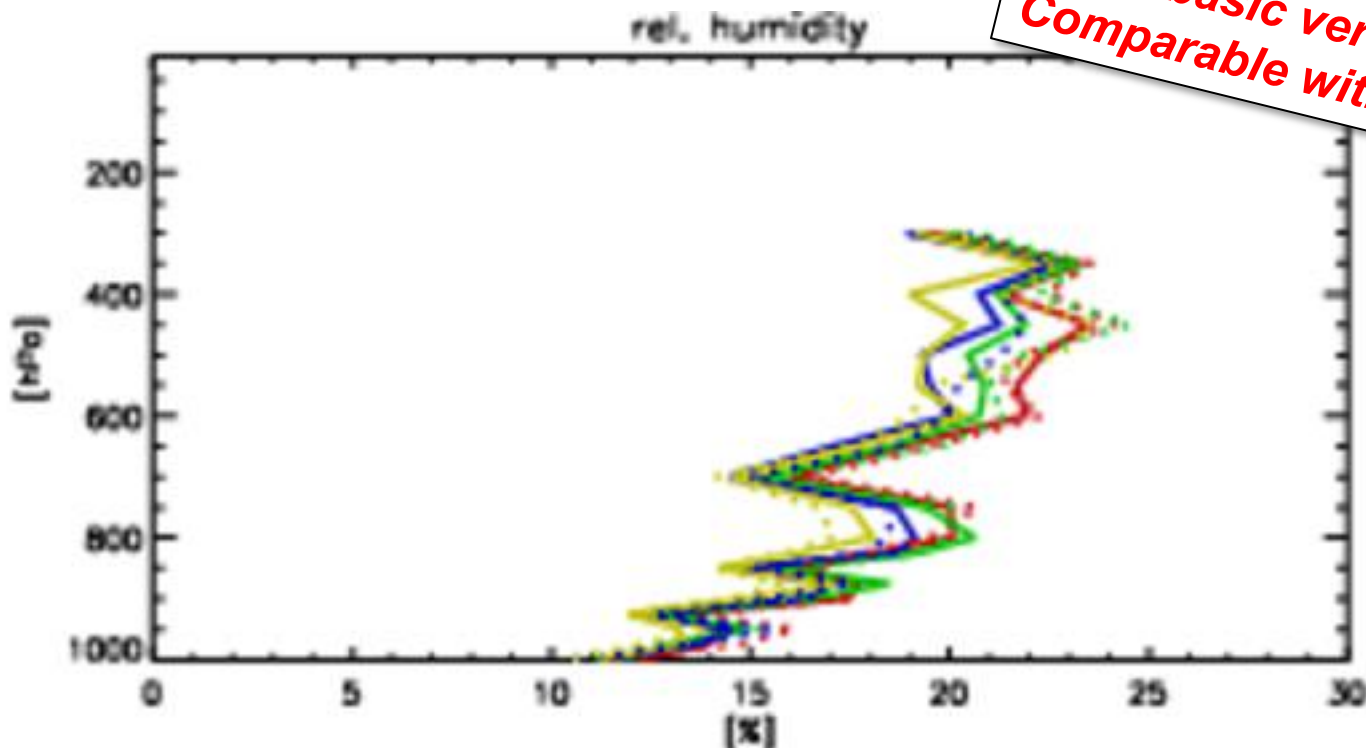


## Legend

LMK All 110606 (del)	LMK All 110606 (nudg)
— + 06 H	— + 06 H
— + 12 H	— + 12 H
— + 18 H	— + 18 H
— + 24 H	— + 24 H
— Observation	

MEAN ERROR (model - obs)  
ROOT MEAN SQUARE ERROR  
1106 UTC

01. Mai 14 08:45:43 2014 by Deutscher Wetterdienst

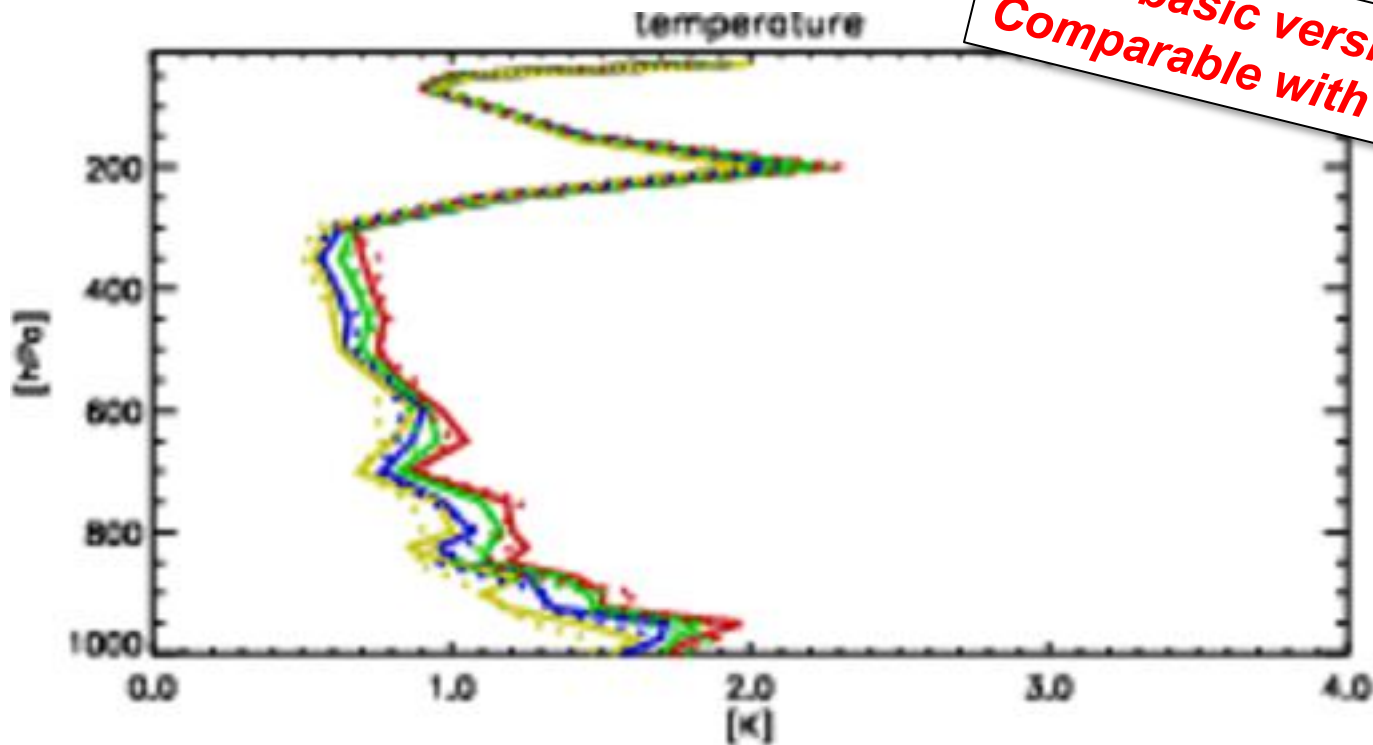
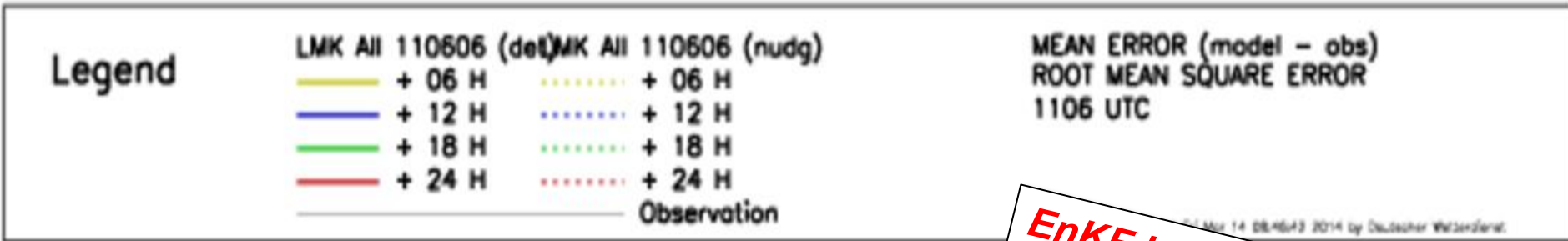


**EnKF basic version  
Comparable with Nudging**





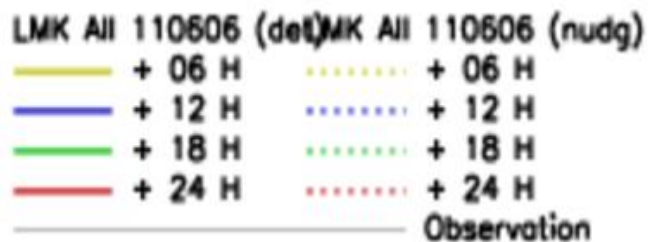
# BACY Experiment 4: KENDA versus Nudging



# BACY Experiment 4: KENDA versus Nudging

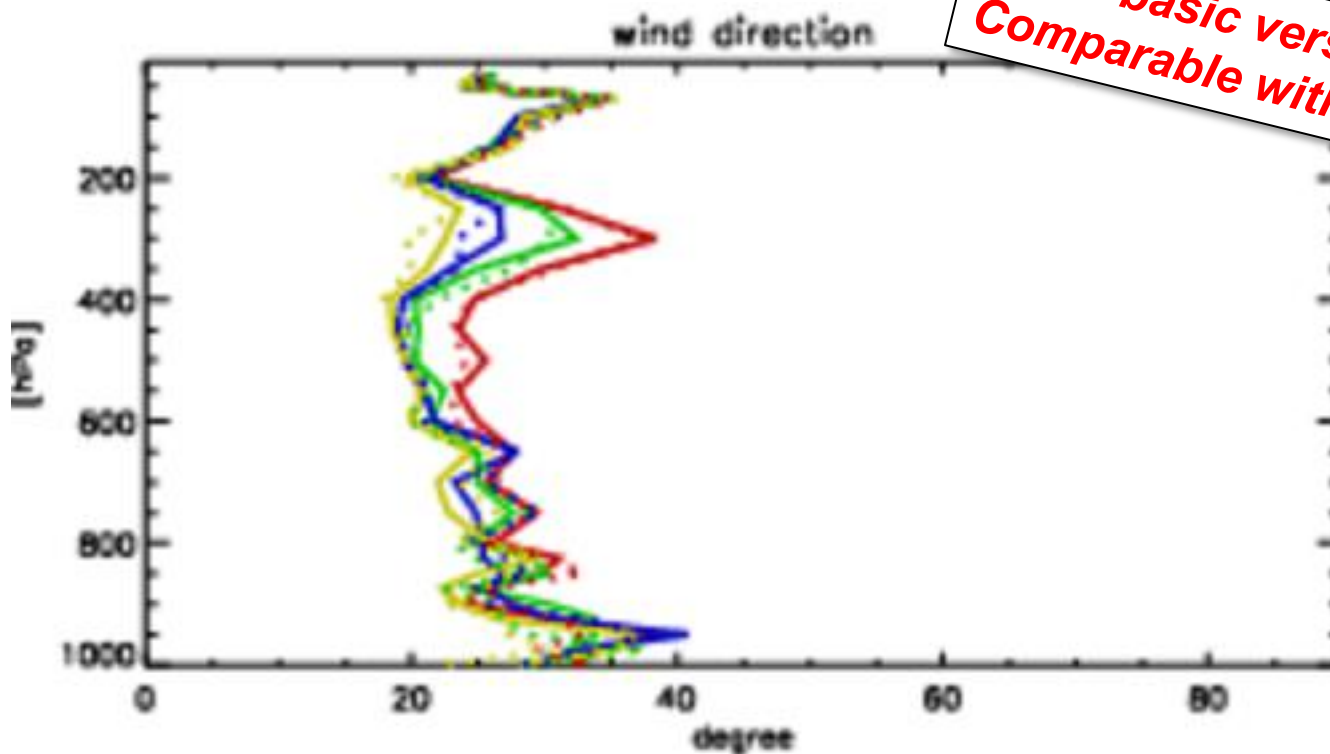


## Legend



MEAN ERROR (model - obs)  
ROOT MEAN SQUARE ERROR  
1106 UTC

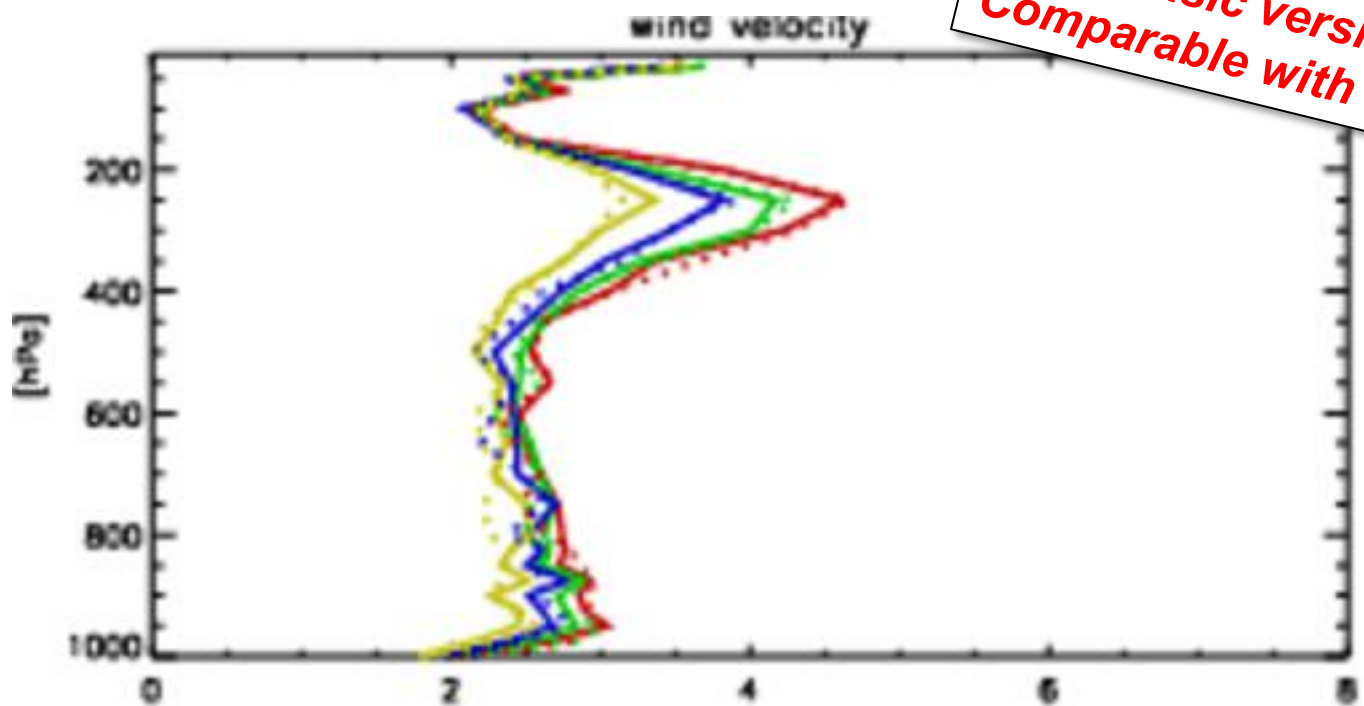
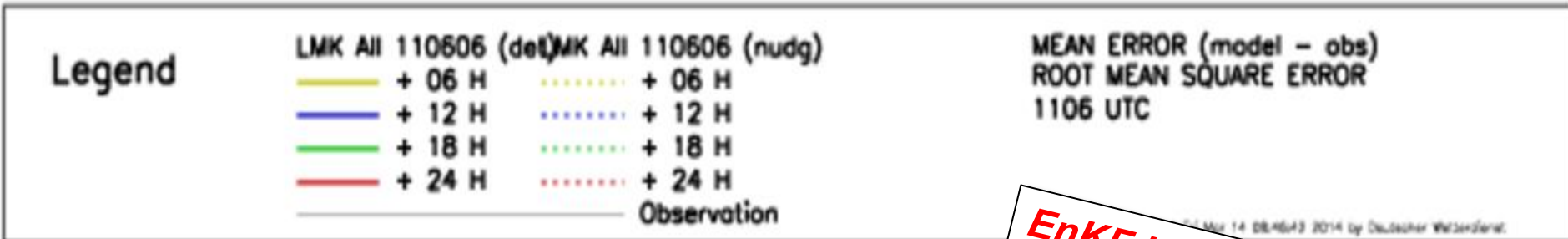
01. Mai 14 08:45:43 2014 by Deutscher Wetterdienst



**EnKF basic version  
Comparable with Nudging**



# BACY Experiment 4: KENDA versus Nudging



**EnKF basic version  
Comparable with Nudging**

**See more in Hendrik's Talk in the afternoon workshop!**



# Experiment of HErZ LMU: KENDA versus COSMO-DE-EPS



Experiments by Florian Harnisch and Christian Keil, LMU

**(1) 15 UTC 10 June - 00 UTC 12 June 2012: → 21-h fc at 00 UTC 11 / 12 June**

**(2) 06 UTC 18 June – 12 UTC 19 June 2012: → 21-h fc at 12 UTC 18 June**

- KENDA**: - 3-hourly LETKF data assimilation of conventional data
- 3-hourly analysis ensemble with **20** ensemble members
  - 20 member ECMWF EPS lateral boundary conditions (16 km)
  - No physics parametrization perturbations (PPP)
  - Multiplicative adaptive covariance inflation

**KENDAppp**: including 10 physics parametrization perturbations (PPP)

**KENDArtp**: relaxation-to-prior-perturbation inflation ( $\alpha = 0.75$  )

**KENDArtps**: relaxation-to-prior-spread inflation ( $\alpha = 0.95$  )

**KENDArtps40**: 40 ensemble members / relaxation-to-prior-spread



# Experiments: KENDA versus COSMO-DE-EPS



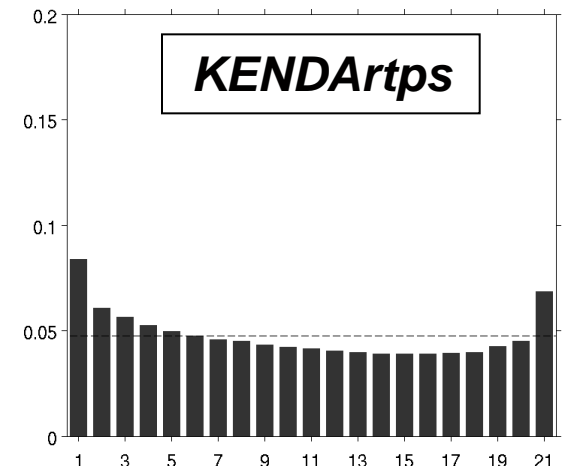
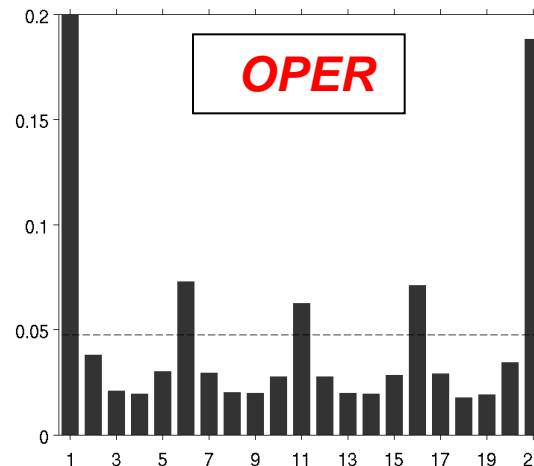
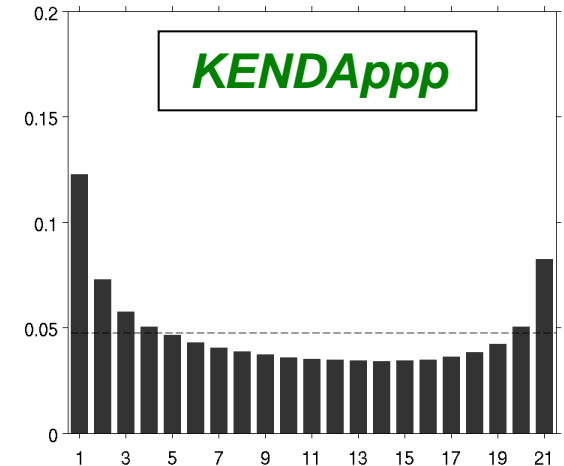
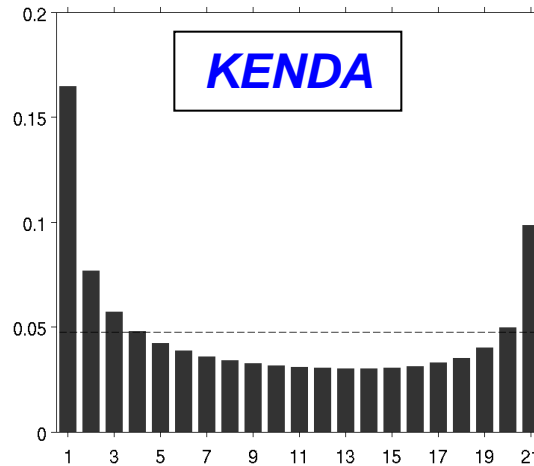
Experiments carried out by  
Florian Harnisch and  
Christian Keil, LMU

**+3 h forecasts of  
10 m wind speed**

**EnKF improved versions  
Can improve EPS**

Verified against  
COSMO-DE  
analysis  
(similar results  
against  
observations)

## Ensemble rank histogram

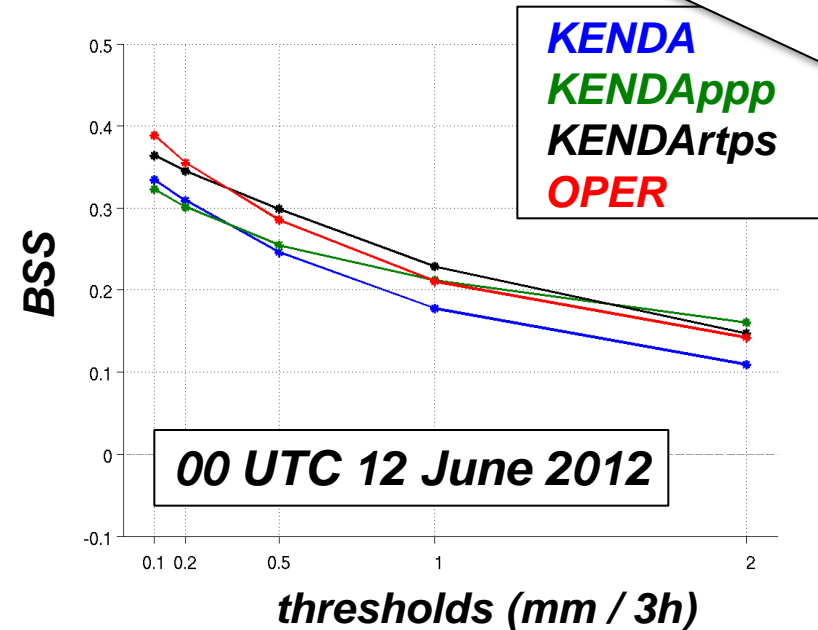
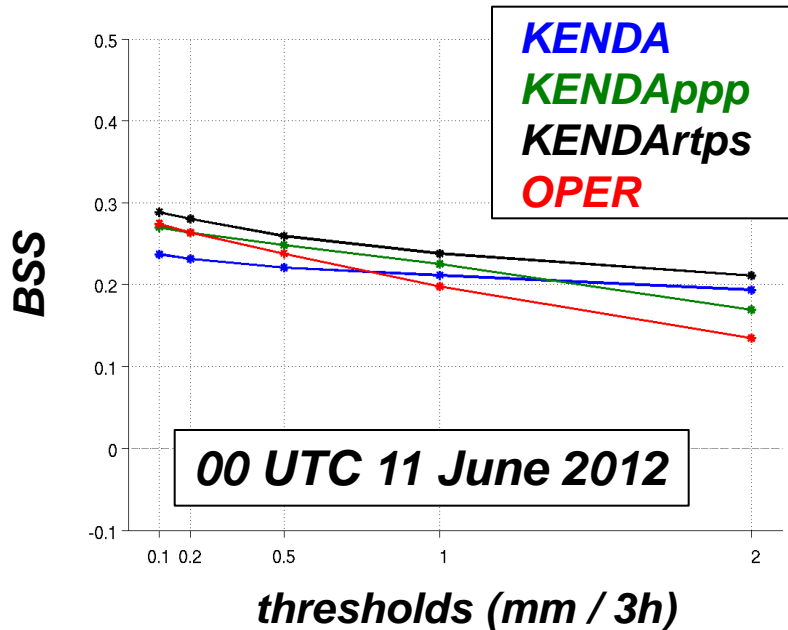


# Experiments: KENDA versus COSMO-DE-EPS

EnKF improved versions  
Can improve EPS

## BSS: 21-h ensemble forecasts of precipitation

3-21 h forecasts averaged over Germany



- Brier Skill Score = [resolution – reliability] / uncertainty
- Accounting for model errors with **PPP** shows positive impact
- Large impact of **inflation** procedure





**Over the past 8 month  
ICON development has  
strongly benefited from  
Basic Cycling (Bacy)**

## Basic Cycle

- Elementary Cycling; principle of simplicity
- File Based for Model Fields
- Flexible DB/Files for Observations
- Useful for Debugging
- Basic speed check for DA components
- Needed for efficient NUMEX implementation and test

## ICON Basic Cycling Environment

