

Using the MESSy interface for 1- and 2-way online coupling of COSMO/CLM with the global chemistry climate model EMAC

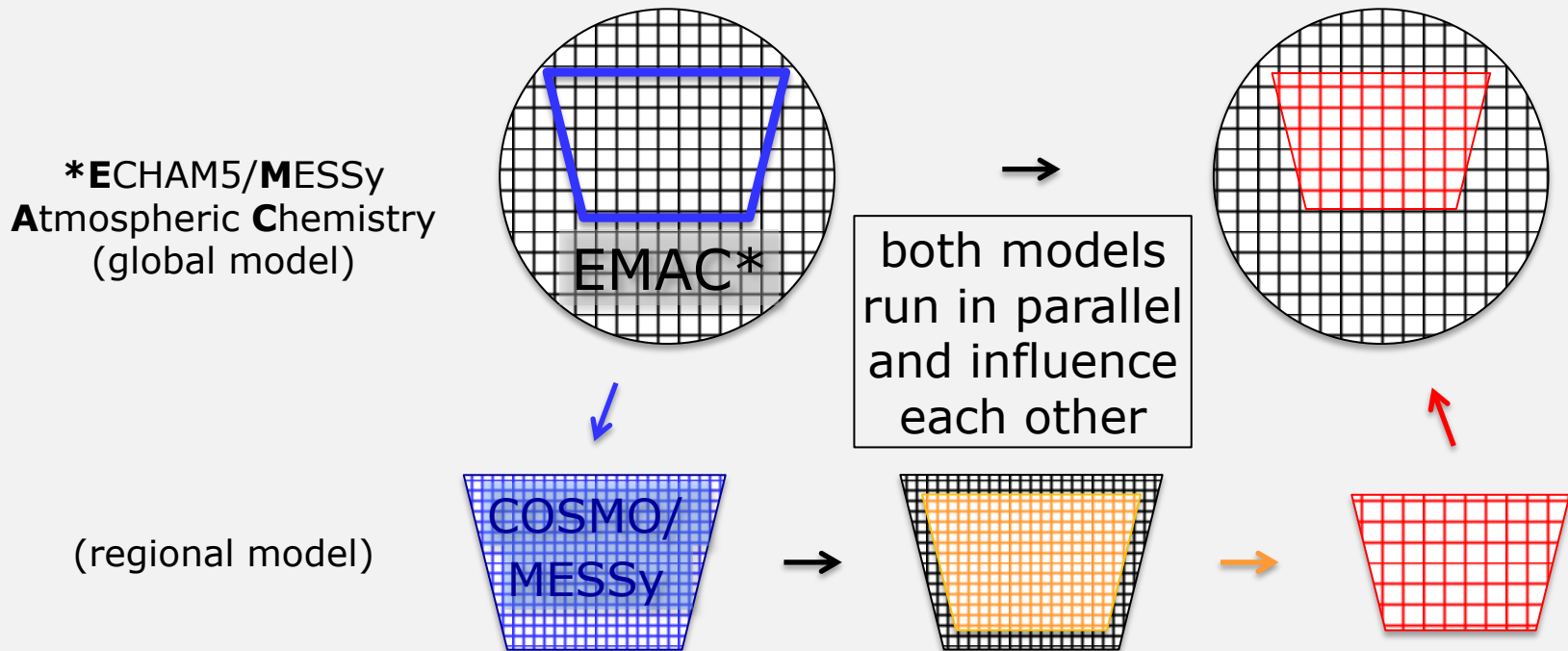
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Patrick Jöckel (IPA, DLR Oberpfaffenhofen)

Modular Earth Submodel System

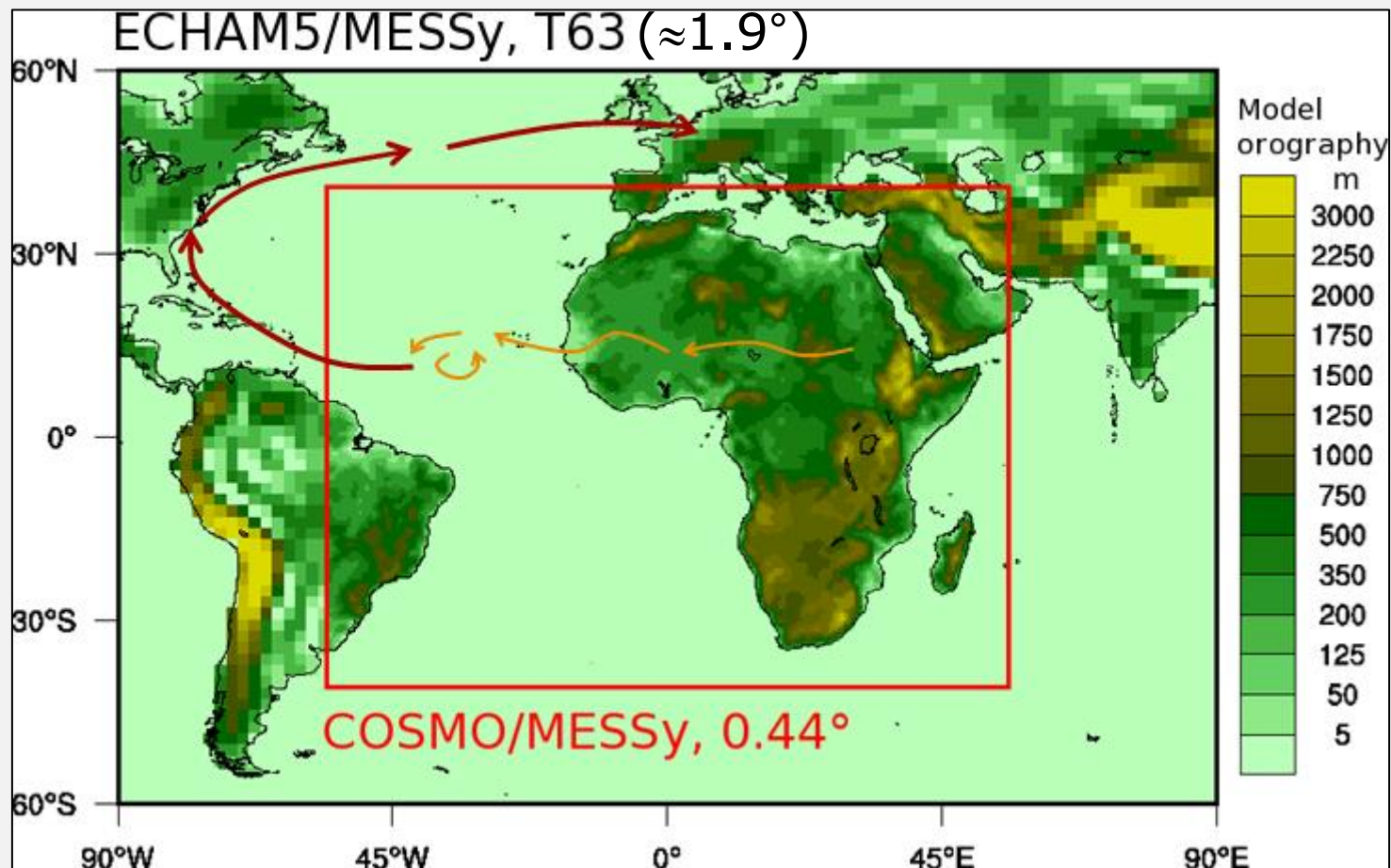
- Interface to MESSy is part of COSMO 5.0
- Poster: Astrid Kerkweg et al. in "Model Developments: Dynamics and Numerics"

- The idea behind “2-way coupling”
- Case studies with the 2-way coupled system
 - Saharan dust outbreak in March 2004 (dust tracers)
 - The Elbe flood in August 2002 (moisture variables)
- Moisture and precipitation dynamics in the 2-way coupled system
- Summary & Outlook

Feedback of a **limited area** model to the **global** scale implemented for decadal **hind-casts** and **projections**



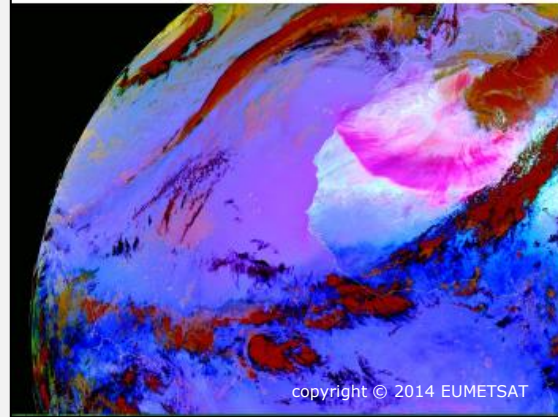
One idea behind FLAGSHIP



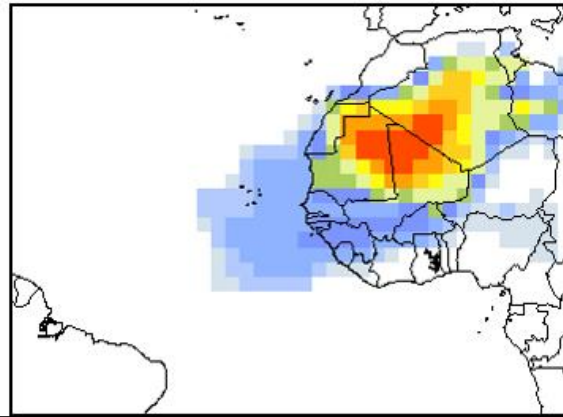
- Better representation of African easterly jet and waves, mesoscale convective systems, and tropical cyclones in COSMO
- Improve the representation of cyclones inside the COSMO-domain in the ECHAM by 2-way coupling
- Improve the further development of cyclones outside of the COSMO-domain in ECHAM

Saharan dust outbreak in March 2004

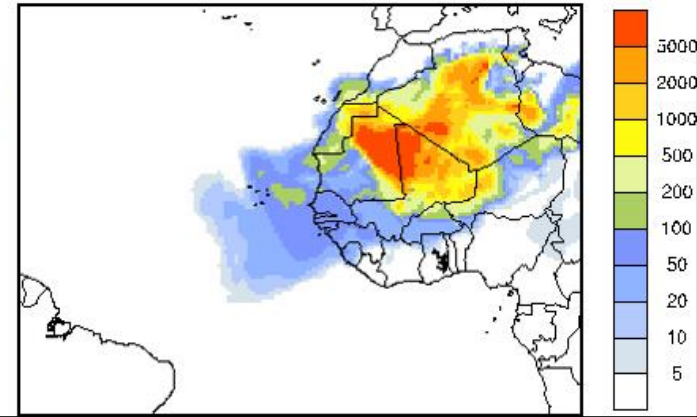
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ECHAM

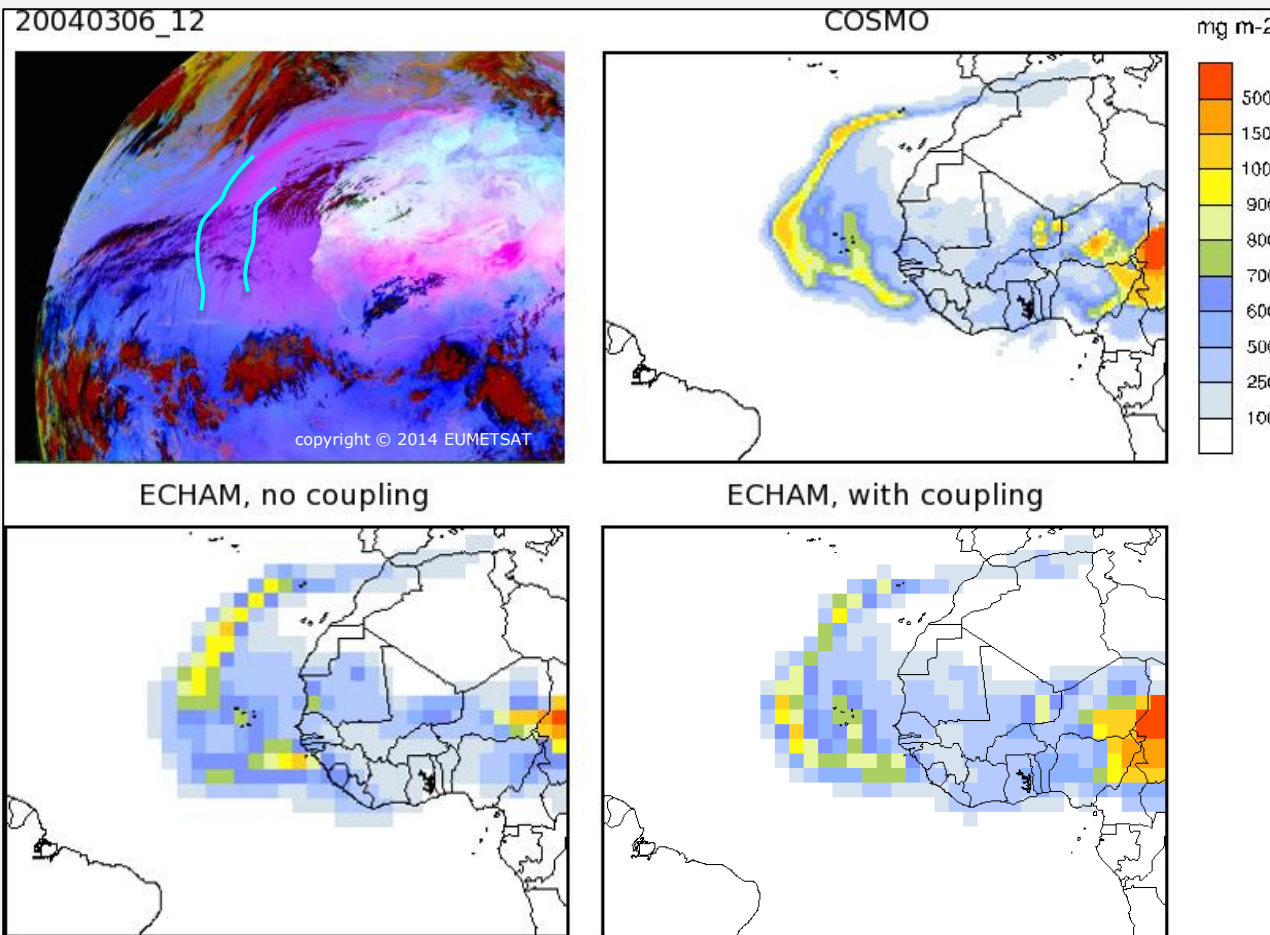


COSMO



- 10-day simulation with chemical processes, e.g., emission, transport, ageing, and deposition of mineral dust
- 1-way coupling (ECHAM → COSMO)
- Both models reproduce the main features during the initial phase of the dust outbreak in a realistic way
- Smaller structures are captured better in COSMO than in ECHAM

Saharan dust outbreak in March 2004



1-way coupling:

- COSMO reproduces the two-fold frontal structure
- ECHAM simulates a more uniform structure behind the first dust front

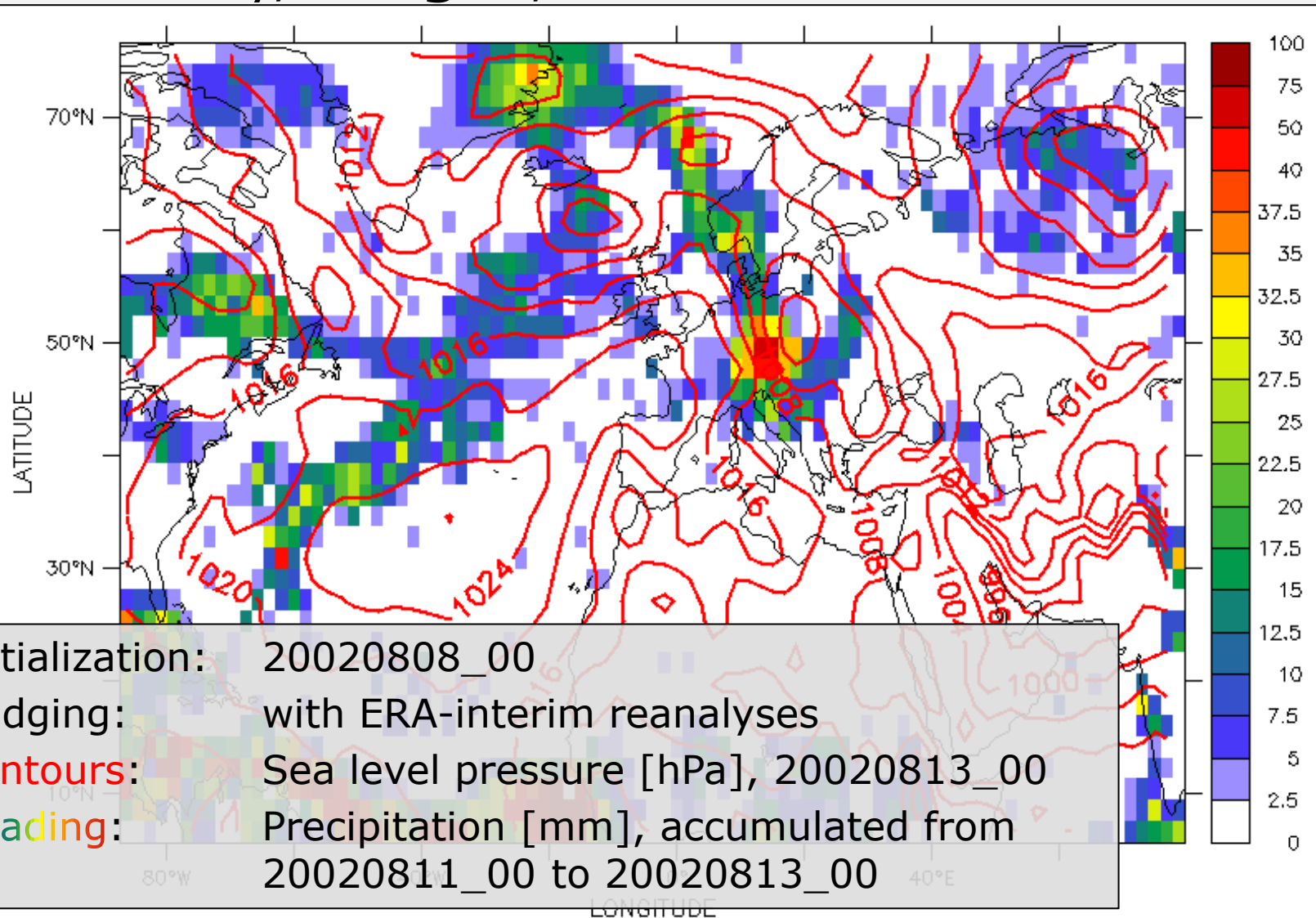
2-way coupling of dust tracers:

- ⇒ Second front is also visible in ECHAM

- This is just one case study
- Quantitative analysis of dust is challenging
- But, the 2-way coupling technically works and we see the potential for improved global results

The Elbe flood in August 2002

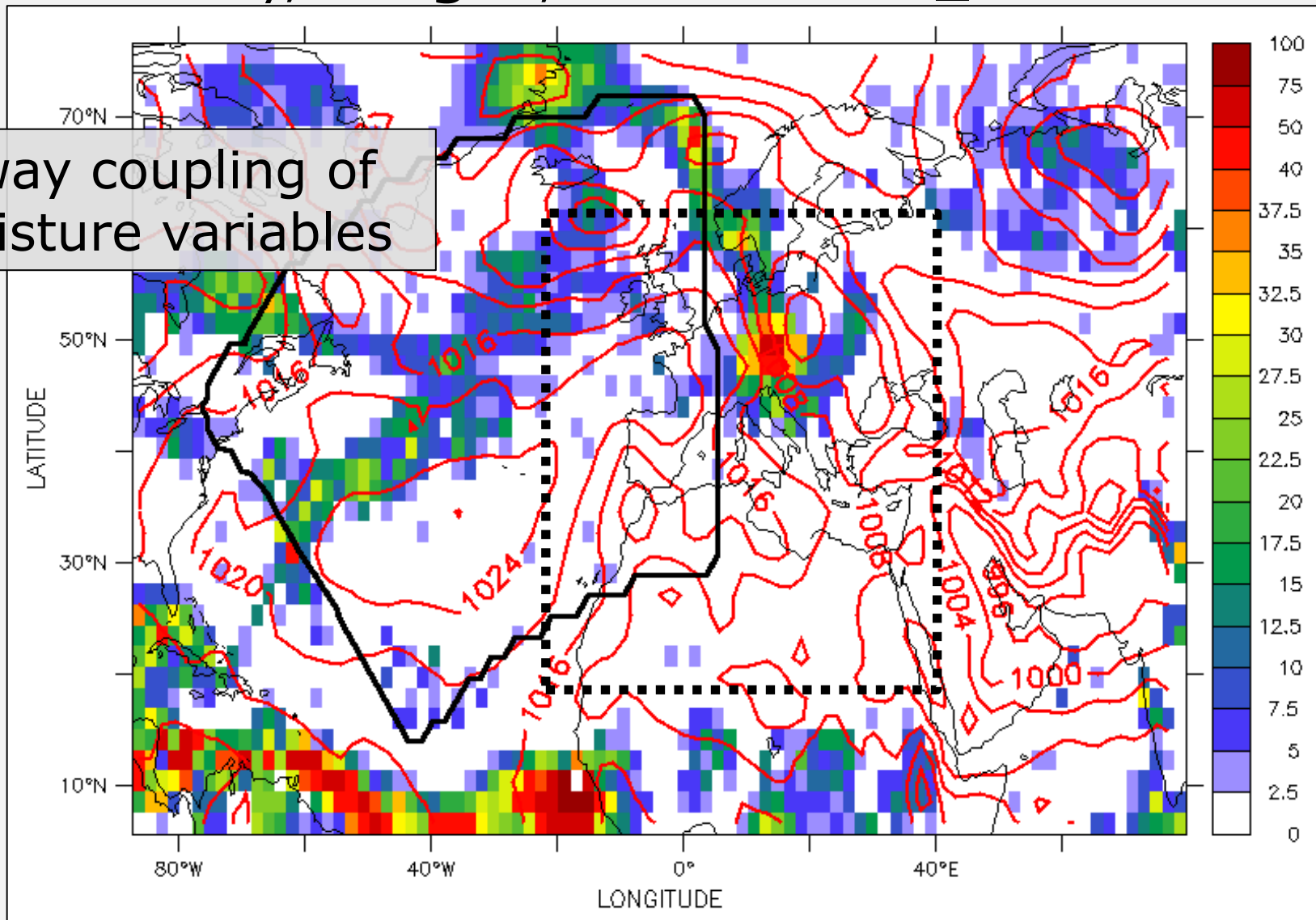
ECHAM only, **nudged**, 20020813_00



The Elbe flood in August 2002

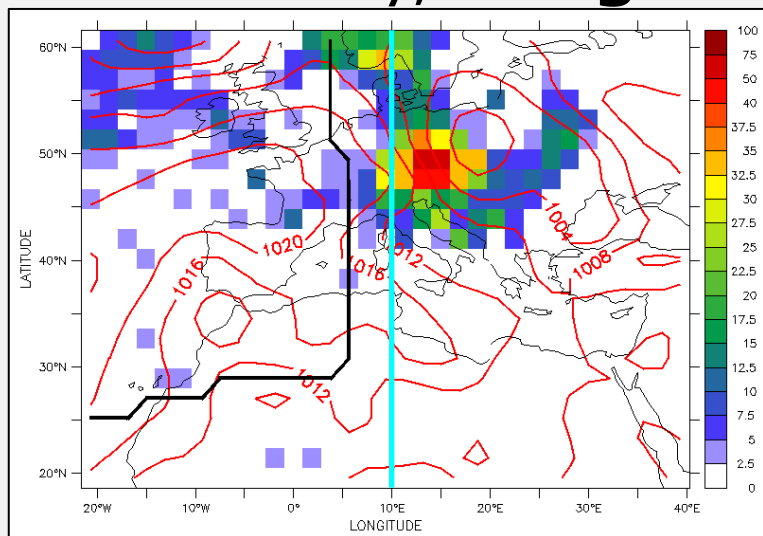
ECHAM only, **nudged**, 20020813_00

2-way coupling of moisture variables

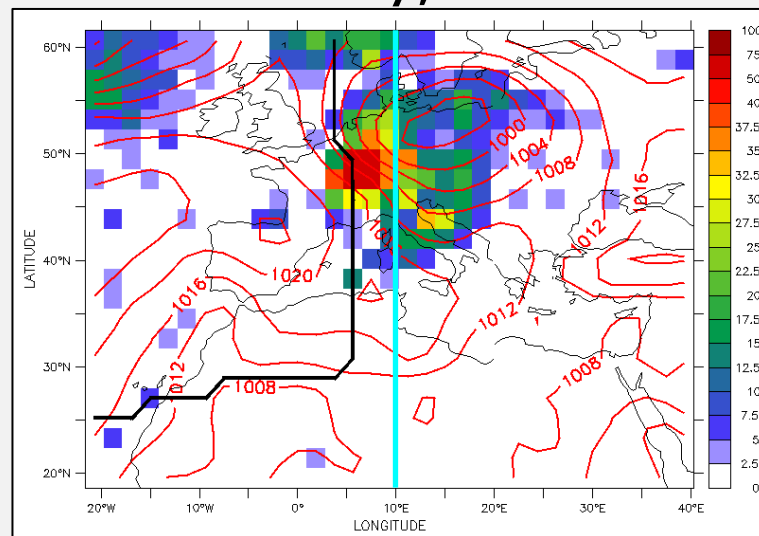


2-way coupling of moisture variables

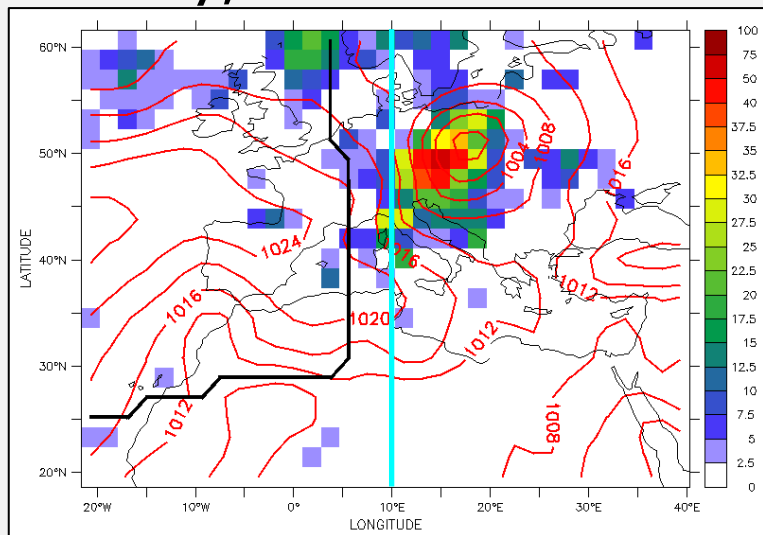
ECHAM only, nudged




ECHAM only, free

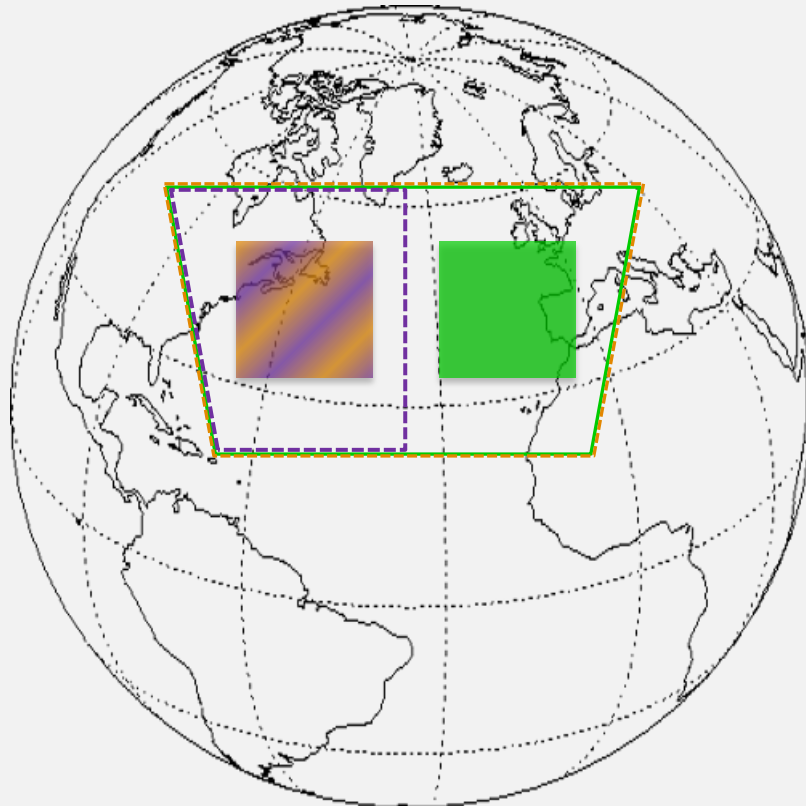




2-way, free






- Westward shift of precipitation in the ECHAM only, **free** simulation
- 2-way coupling of moisture variables adjusts this shift!

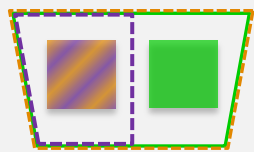
- One 31-day simulation with a **1-way** coupled COSMO nest over the North Atlantic 
- One 31-day simulation with two COSMO nests over the North Atlantic:



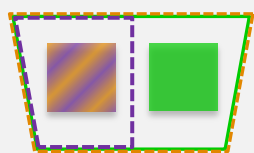
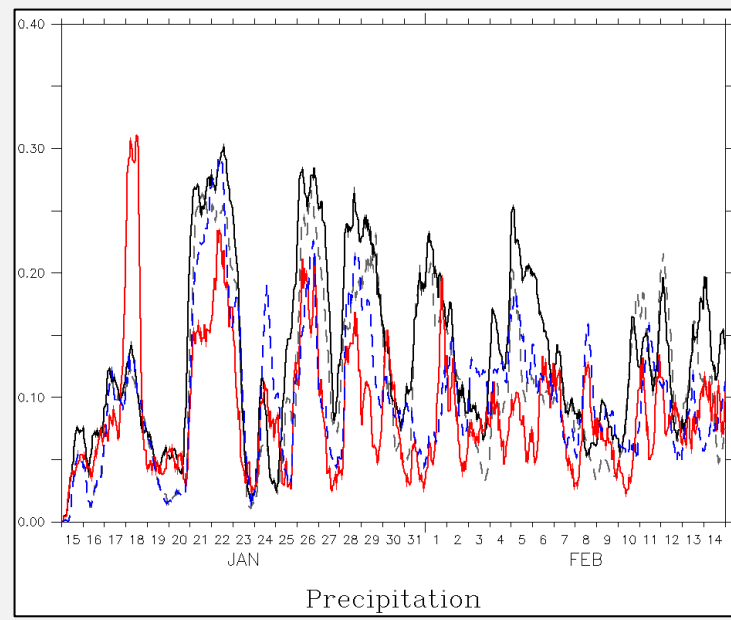
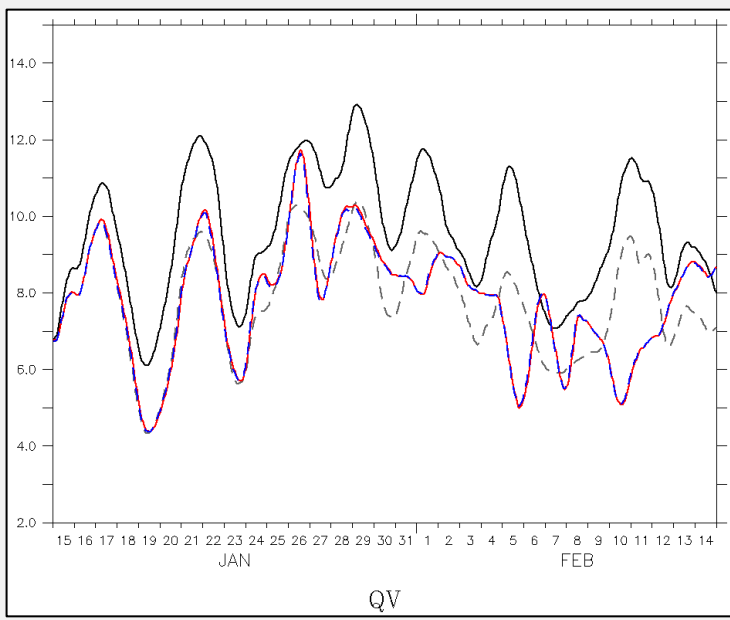
- **1-way** coupling 
- **2-way** coupling 
- Calculate specific humidity (up to 250 hPa) and precipitation

- ≡
-  in the western part of the large COSMO domain
 -  within the 2-way coupled region
 -  downstream of the 2-way coupled region

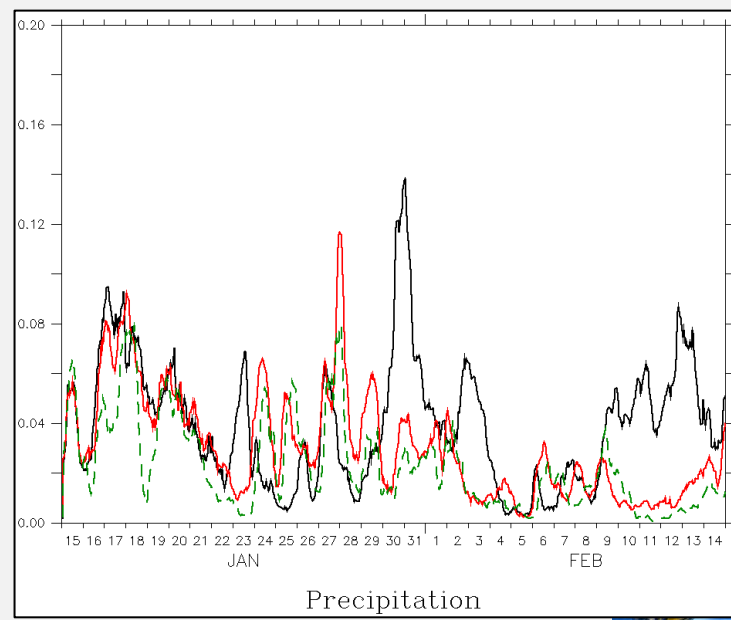
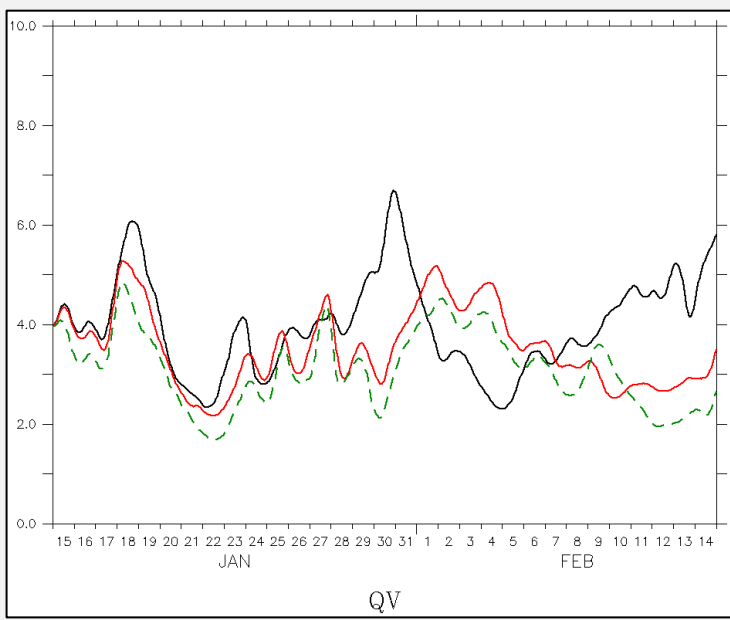
Moisture and precipitation dynamics $E \leftrightarrow C$



- ECHAM-1w** (black solid line)
- COSMO-1w** (grey dashed line)
- ECHAM-2w** (red solid line)
- COSMO-2w** (blue dashed line)

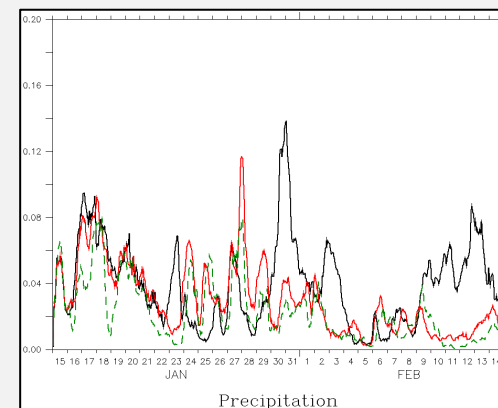
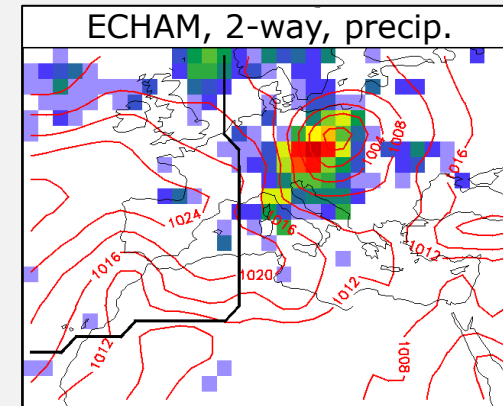
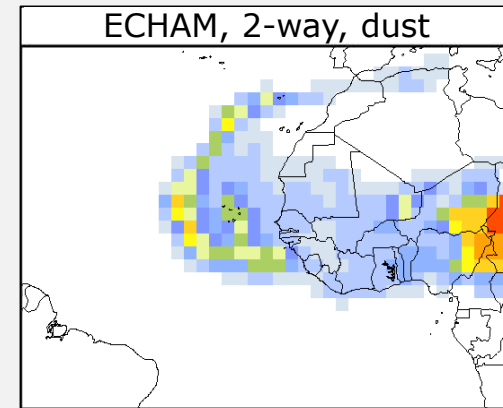


- ECHAM-1w** (black solid line)
- COSMO-1w** (green dashed line)
- ECHAM-2w** (red solid line)

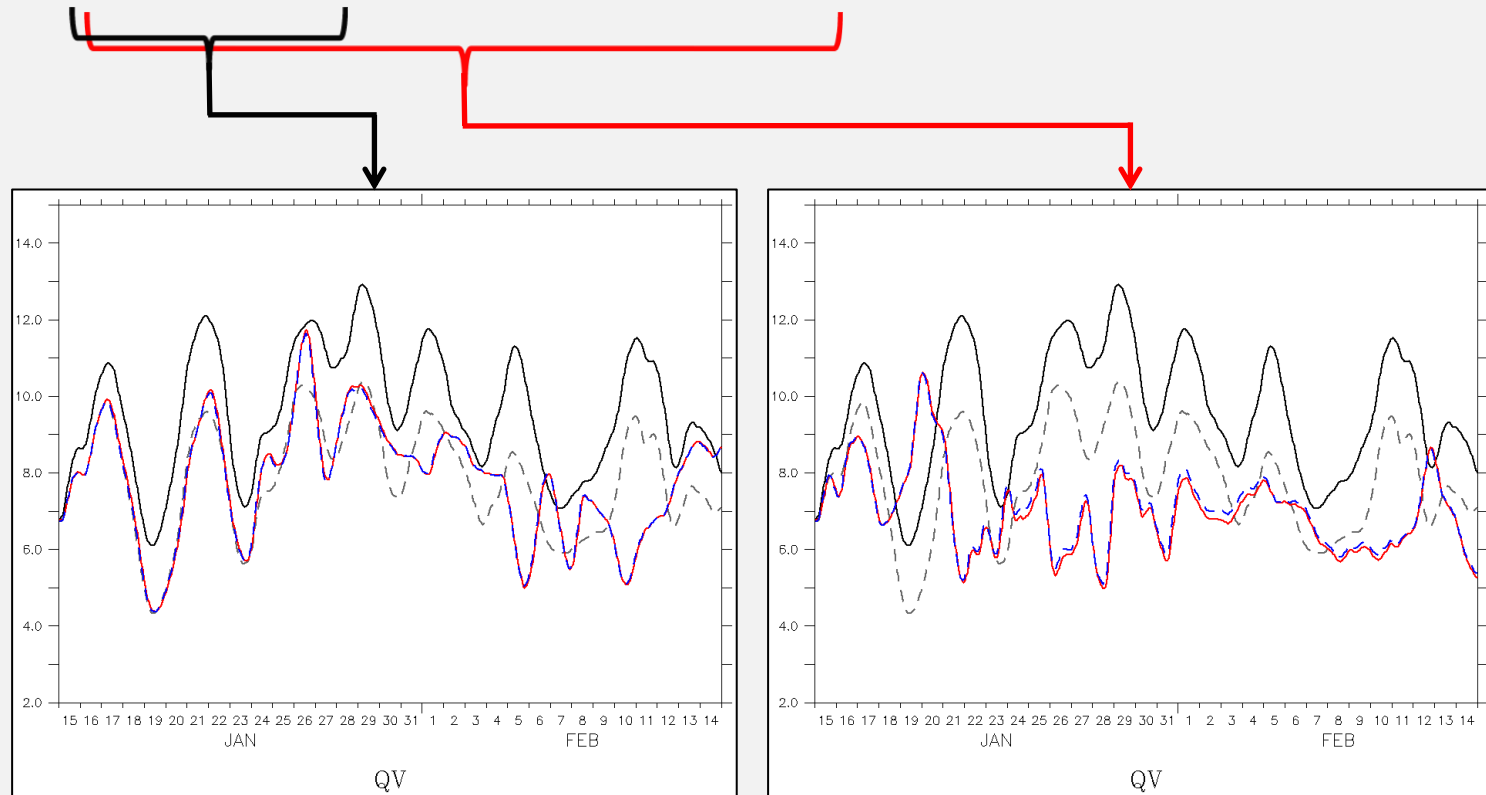


Summary

- The MESSy interface enables the **2-way coupling** of COSMO/MESSy and the GCCM EMAC
- Single episodes show the potential for **improved global results**
 - Saharan dust outbreak, March 2004
 - Elbe Flood, August 2002
- **Physical response** of EMAC to the 2-way coupling
 - ⇒ EMAC precipitation is pushed towards the COSMO results **inside and outside of the coupling region**



- Further tests with full 2-way coupling of moisture **and dynamical** variables



- Further tests with full 2-way coupling of moisture **and dynamical** variables
- **Long-term/decadal simulations** with and without 2-way coupling of moisture and dynamical variables with COSMO nests over...
 - ... the CANA domain (comparison with MesoTel, another MiKlip project)
 - ... the DEPARTURE domain
- Simulations with **feedback of aerosols** on radiation and dynamics
 - West African monsoon
 - African easterly waves
 - tropical cyclones

