

NUMEX

Numerical Experiments and NWP-development at DWD

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NWP models at DWD in 2013

The way to GME 20km

Idea / Scientific plan

...

Development

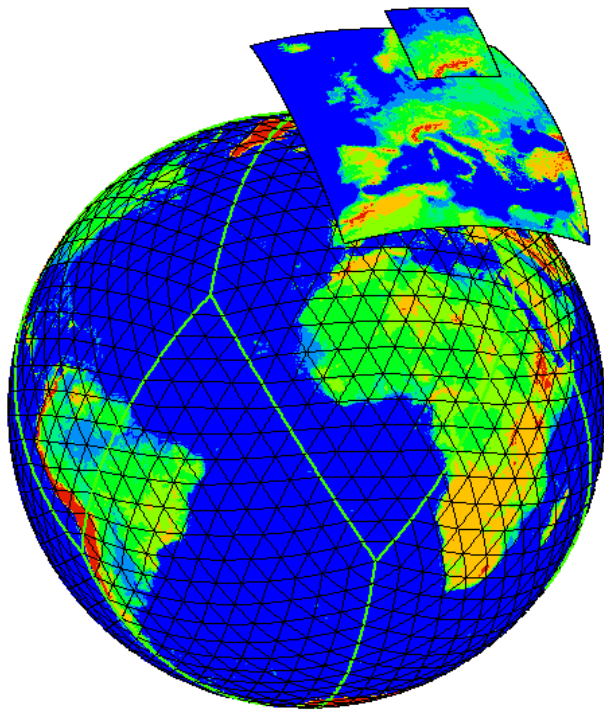
...

New operational NWP model

NUMEX

NWP models at DWD in 2015

Numerical Weather Prediction at DWD in 2013



COSMO-DE $\Delta x = 2.8$ km



COSMO-EU $\Delta x = 7$ km

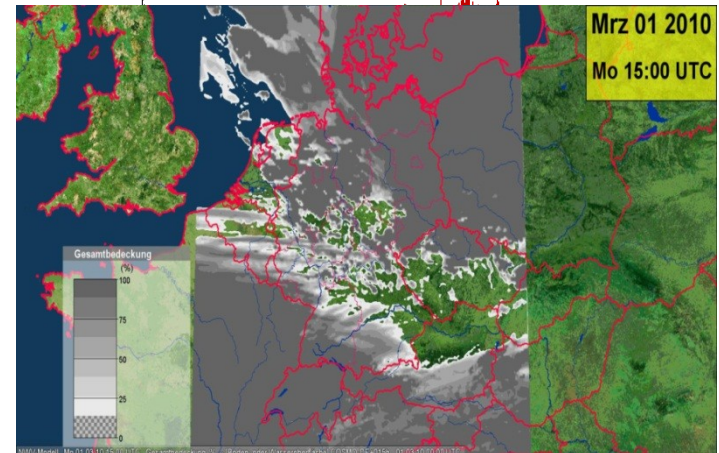
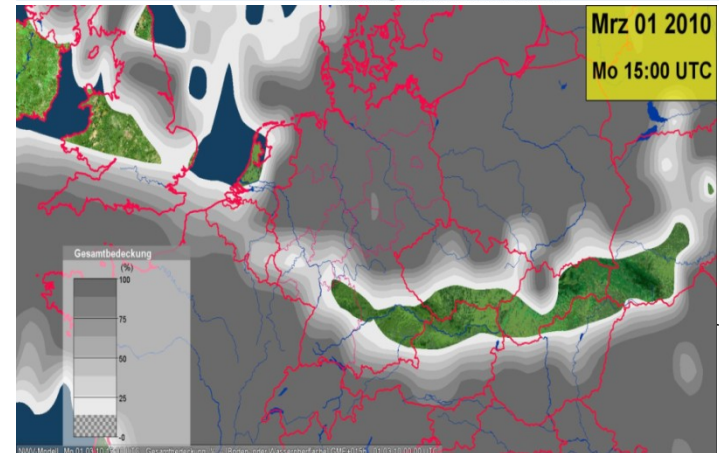


GME $\Delta x = 20$ km

Forecast of Total Cloud Cover:

GME (above)

COSMO-DE (below)



Numerical Weather Prediction at DWD in 2013

Ensemble forecast system COSMO-DE-EPS with 20 members

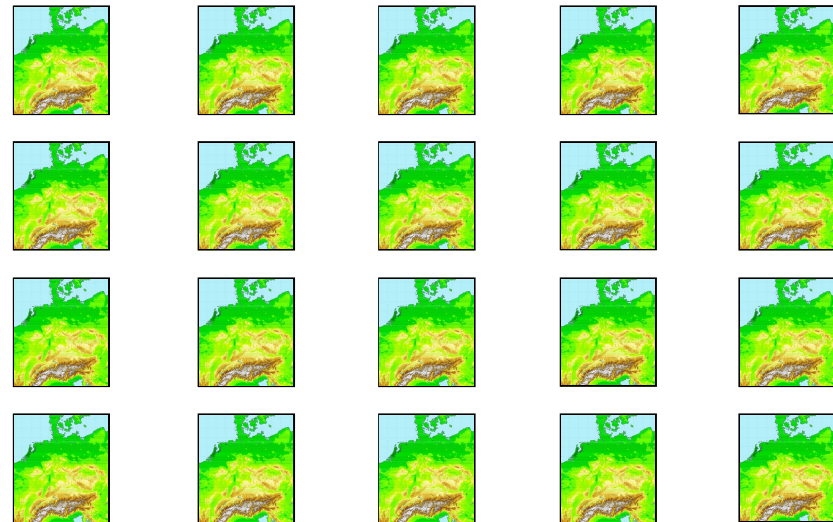
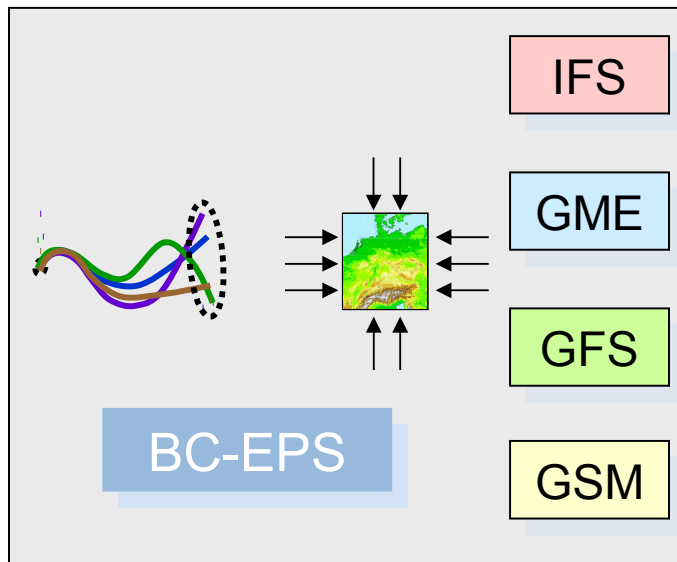
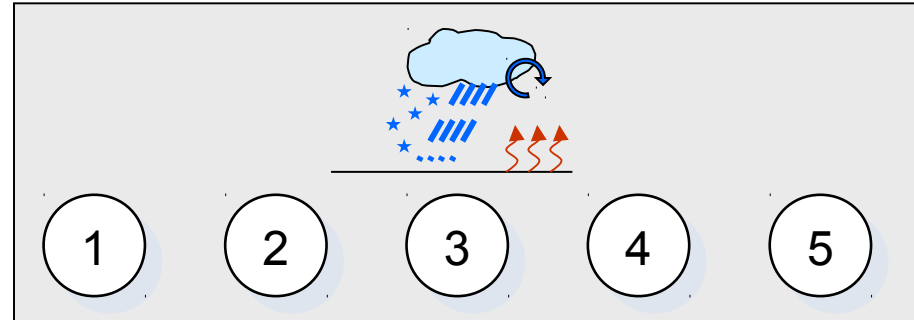
$\Delta x = 2.8 \text{ km}$

8 times a day

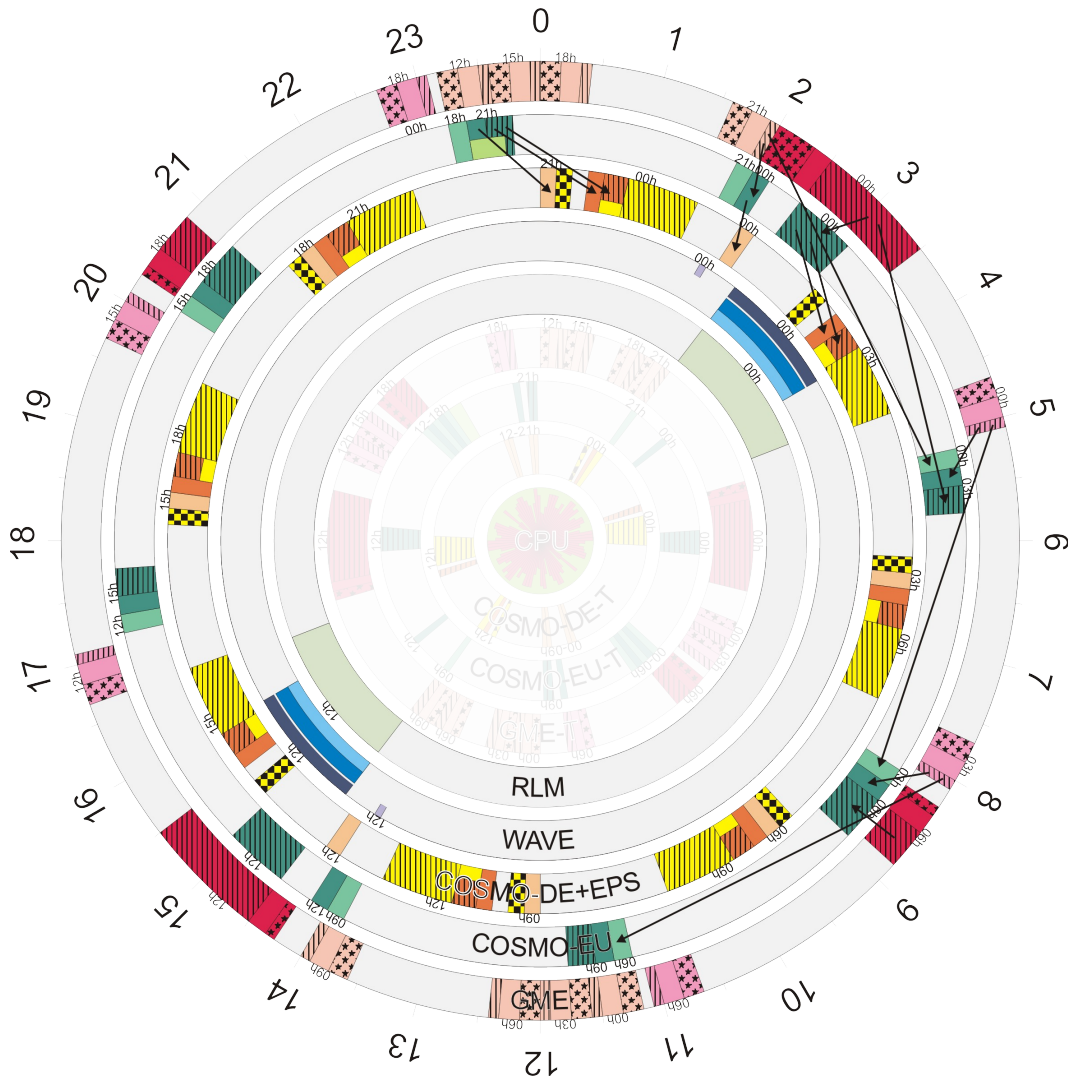
Forecast time: 27h

Available: 2h after observation time

'physics' perturbations



Numerical Weather Prediction at DWD in 2013



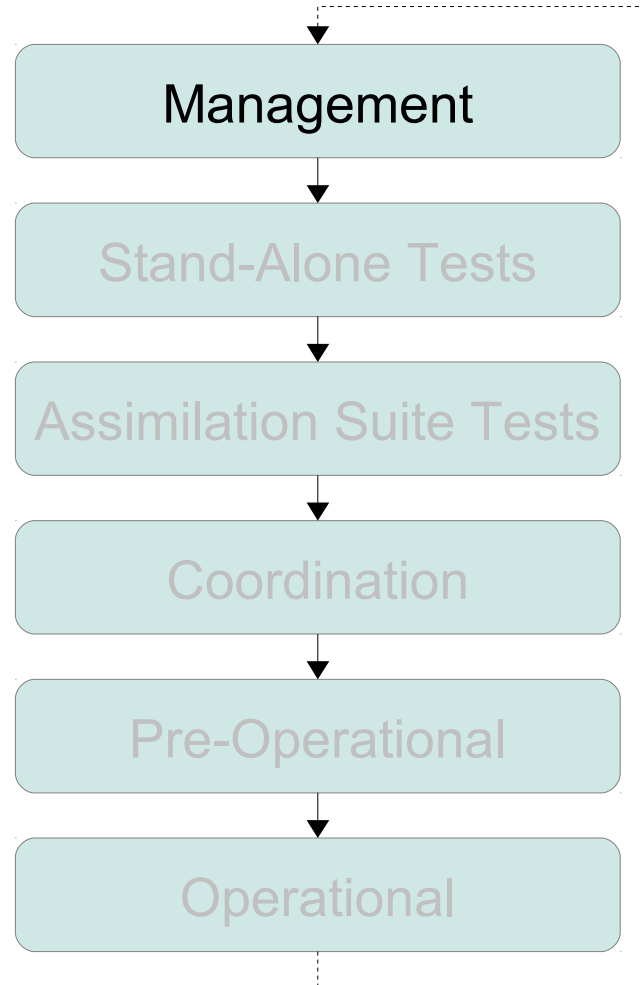
Operational timetable of the DWD model suite with dataflow

- GME, COSMO: Analysis / Nudging
- ⊠ GME Analysis: serial part
- ▨ GME, COSMO: Forecast
- ⊞ COSMO-DE-EPS: Interpolation
- WAVE (GSM, LSM, MSM)
- COSMO-EU: Surface moisture analysis
- Main run
- Pre-Assimilation
- Assimilation
- 00..23 real time [UTC]
- 00h, 03h, .. model time [UTC]
- T Testsuite



The way to the new GME version - 20km

From Decision to Operational Reality



The way to the new GME version - 20km

Management Tasks

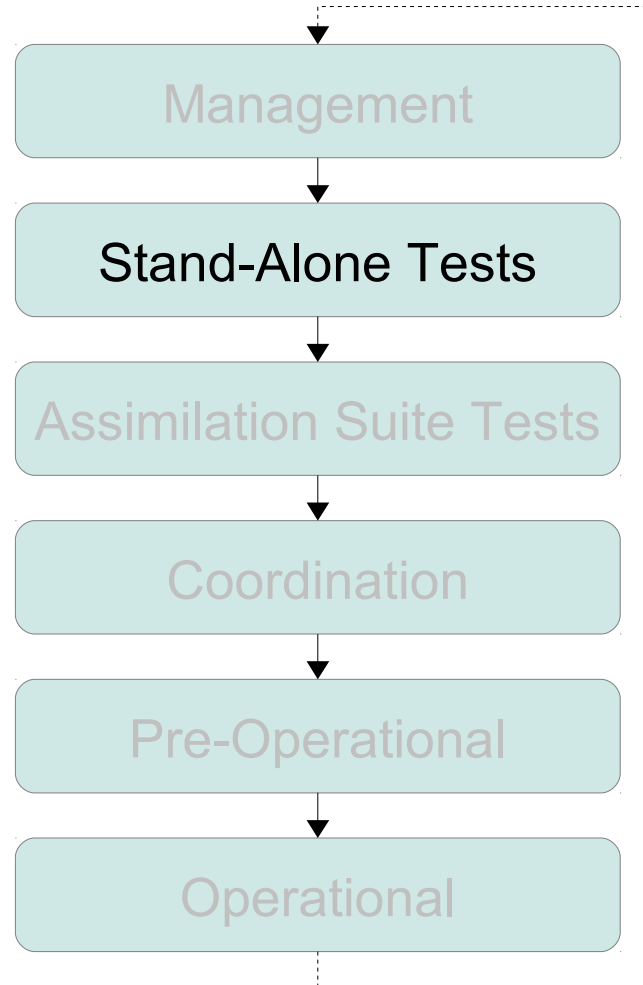
Coordination Group NWP (KG-NWV)

- defines tasks of NWP development
- here: increase the resolution of GME from 30 km to 20 km
([GME30L60](#) → [GME20L60](#))
- objective: better forecast results

Research department – requirements for model development

- changes of the dynamics of the NWP-model: advection of QR and QS
- changes of the physical parameterisation
- new invariant / climatological datasets
- changes of the structure of output fields
(size: 2.25, grid point position – land / sea, icosahedral and regular)

From Decision To Operational Reality



The way to the new GME version - 20km

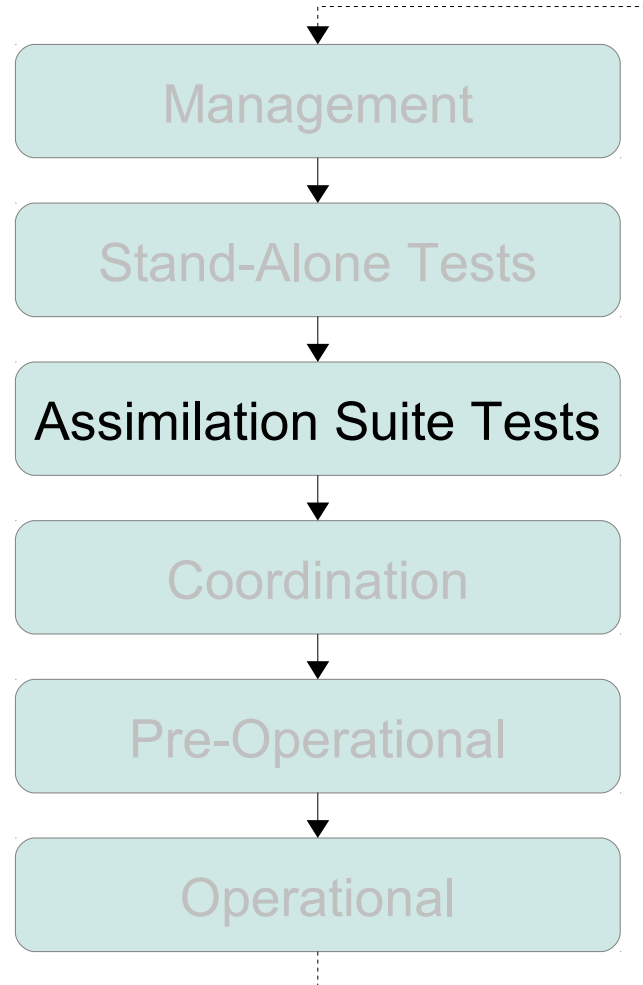
Stand Alone Test

Test cases of the new model version

- idealized test
- start from interpolated analysis
- performance on the compute server
 - full resolution
 - full output
 - full model physics

→ Is it possible to run the new model within the operational schedule ?

From Decision To Operational Reality



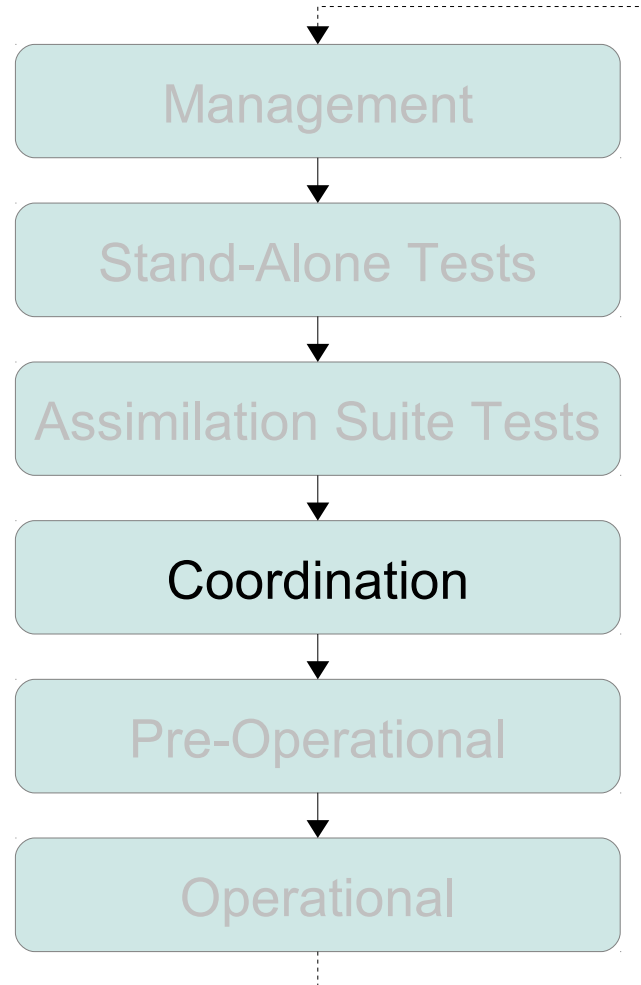
Assimilation Suite Tests

NUMEX: run the complete data assimilation cycle with forecasts

- add the new resolution to:
 - scripts (backward compatibility to old model resolutions)
- data handling within databases (new data types)
 - timings of storing and reading the data (← size = factor 2.25)
- forecast runs with postprocessing and verification
- **pay attention to cutoff times of operations**
- influence on the regional models COSMO-EU and COSMO-DE
 - forecast quality

The way to the new GME version - 20km

From Decision To Operational Reality



Coordination Tasks

Working group NWP (AG-NWV)

- presentation of the new development to potential users

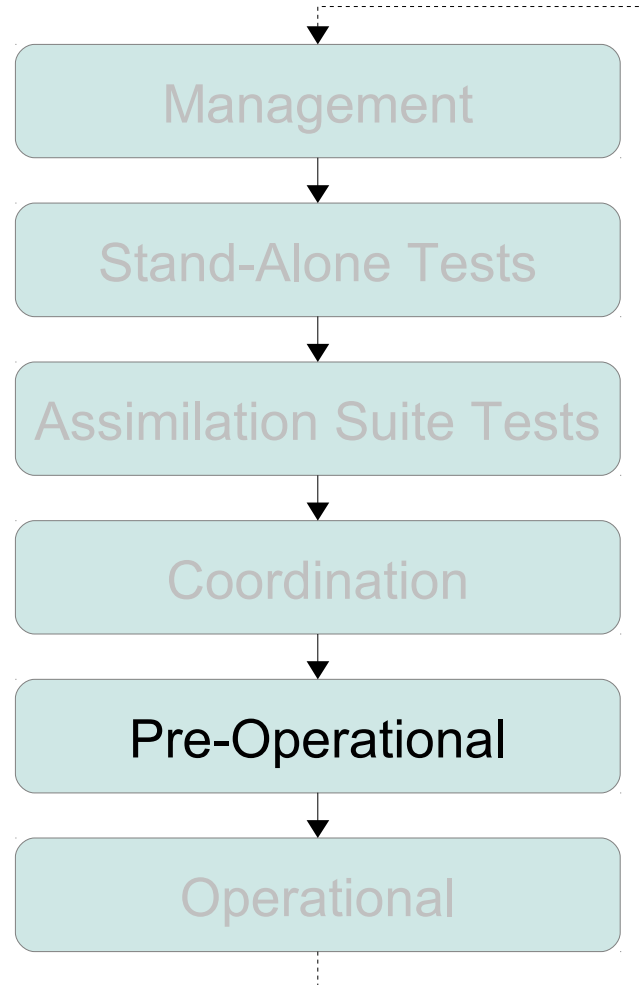
Migration Workgroup

- all business units (leadership: operations & research department)
- meetings with increasing frequency (monthly → weekly)
- determine all tasks influenced by the model change (migration list)
- regular reports on progress

- define migration dates
 - pre-operational run = Parallel Suite
 - operational run (proposal - management of DWD has to agree)

The way to the new GME version - 20km

From Decision To Operational Reality

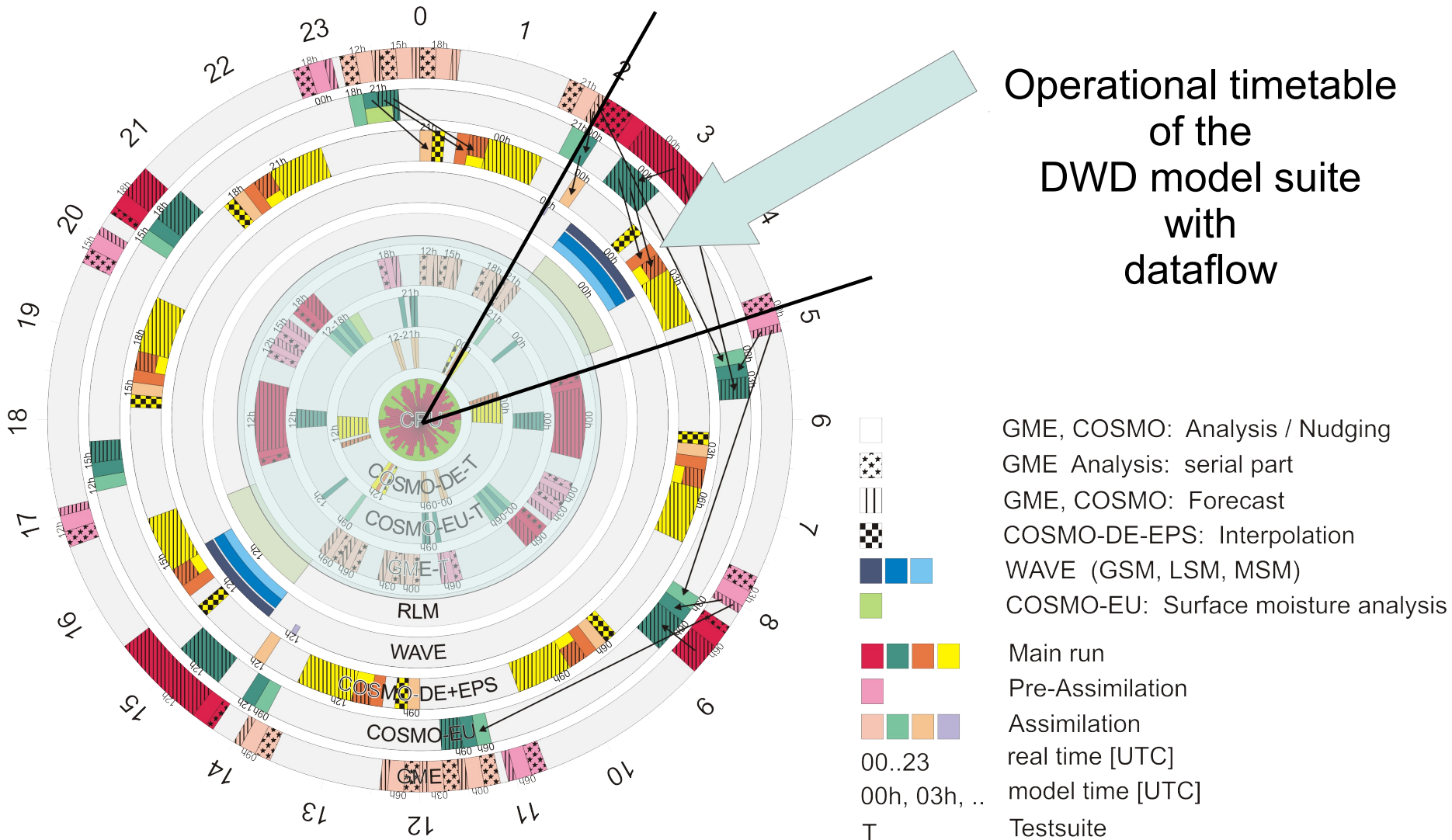


Pre-Operational Tasks

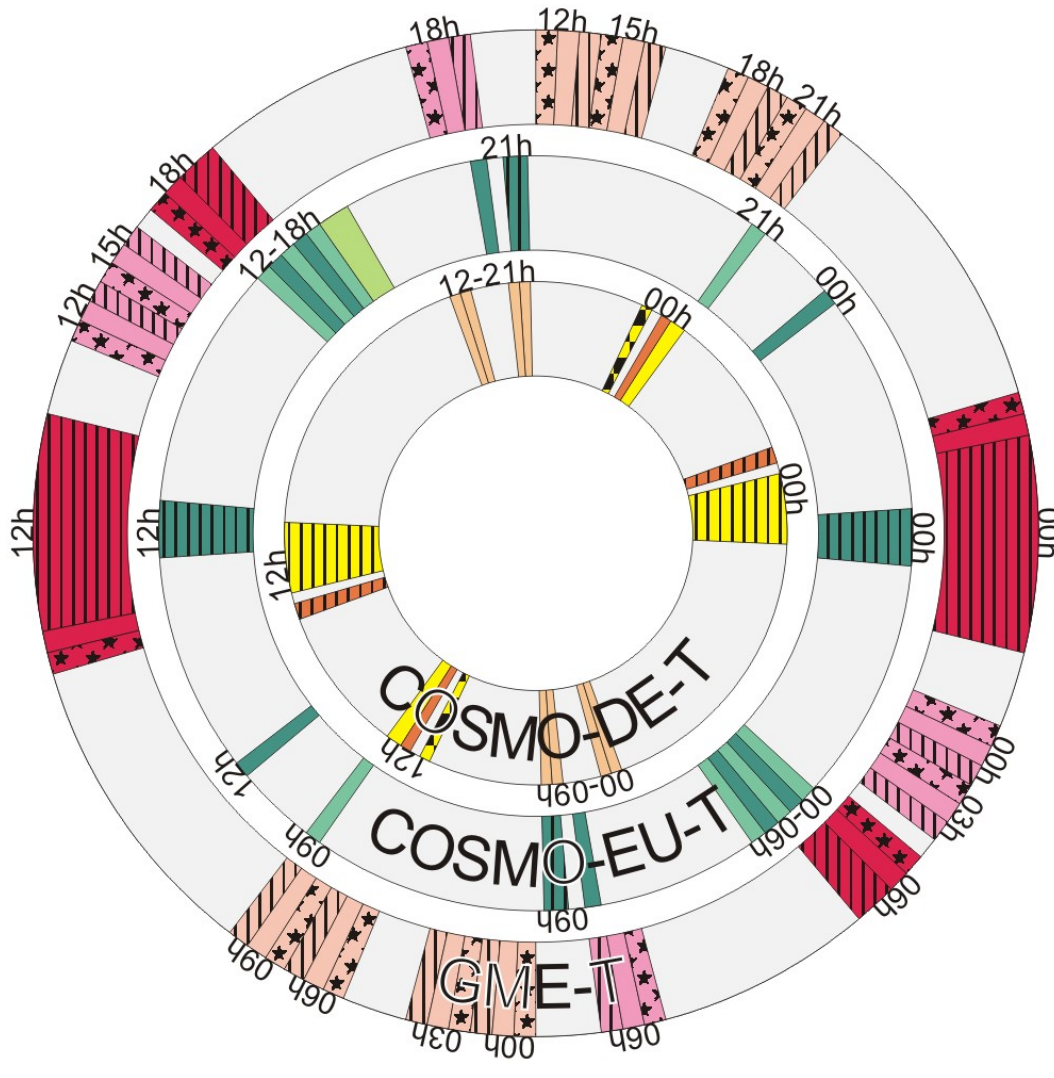
Parallel Suite

- complete data assimilation cycle of GME, COSMO-EU, COSMO-DE, COSMO-DE-EPS and WAVE
- forecasts of all NWP models starting at 00 and 12 UTC
- complete set of databases
- operational environment (SMS, time critical, ...)
- all data are available for users to run extended tests with postprocessing routines
- test data can be delivered to customers automatically










The way to the new GME version - 20km



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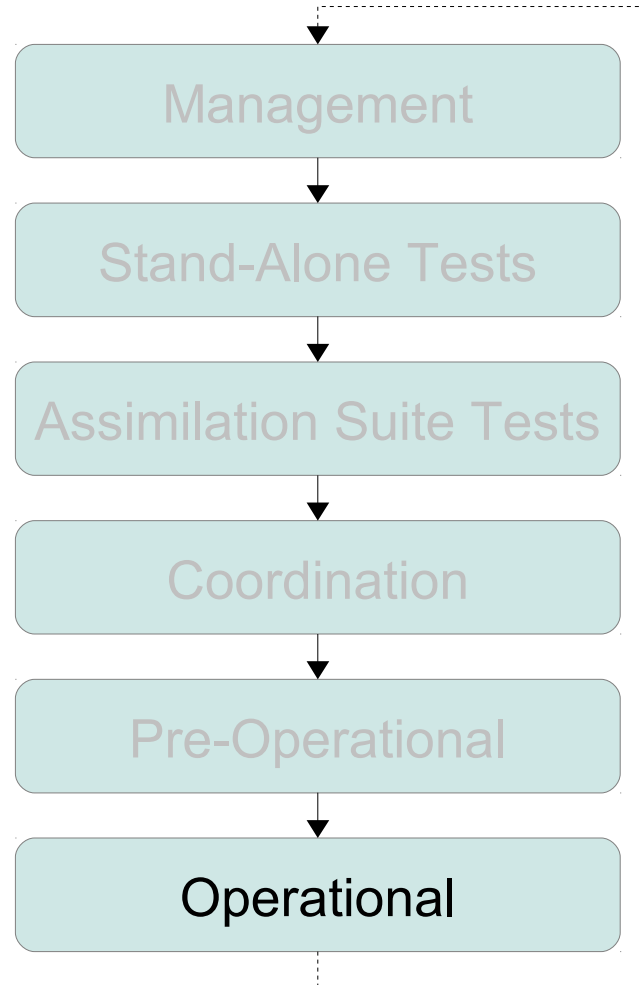


Parallel suite of the DWD NWP models

-  GME, COSMO: Analysis / Nudging
-  GME Analysis: serial part
-  GME, COSMO: Forecast
-  COSMO-DE-EPS: Interpolation
-  WAVE (GSM, LSM, MSM)
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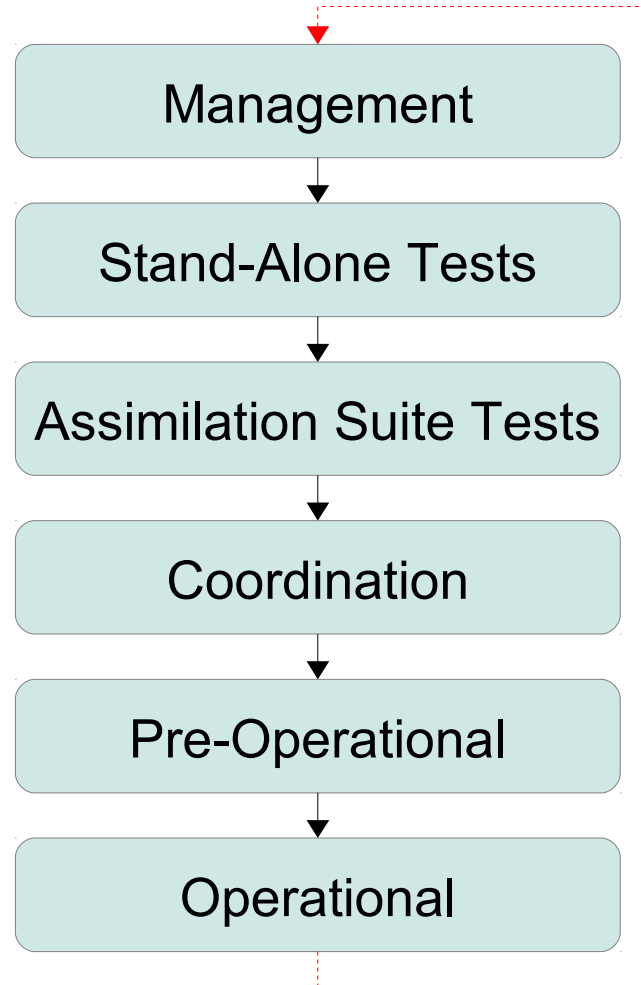
Operational Tasks

Operational run

- switch the operational suite to GME20L60
 - now fitted into the operational timetable (no delay compared to GME30L60)
- old version GME30L60 switched to parallel suite
 - parallel run of both systems for one month
 - products delayed compared to the operational products

The way to the new GME version - 20km

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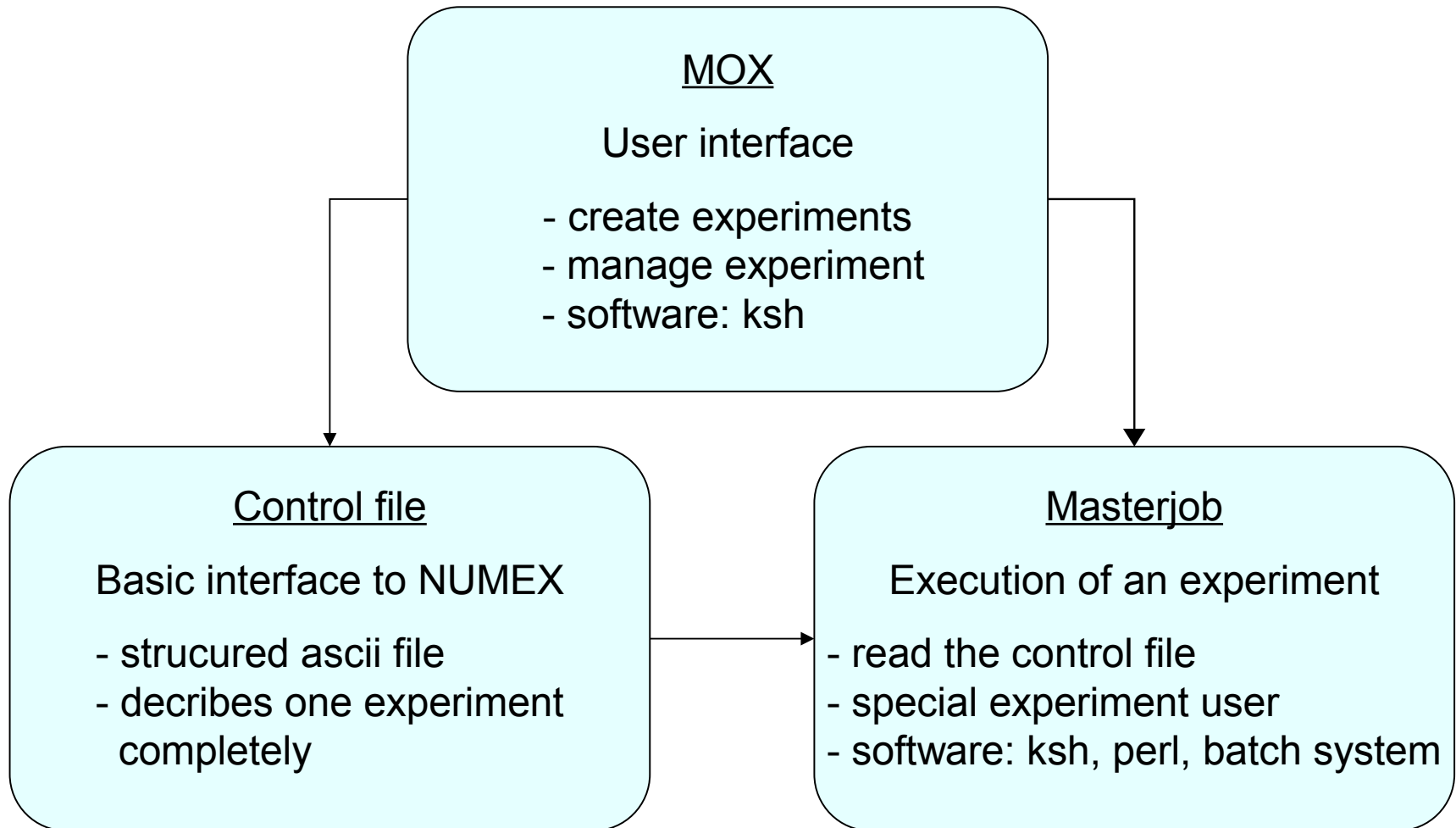
What is NUMEX ?

- testbed for all operational changes of the NWP routine at DWD
- general run-time system for DWD-NWP-models
- runs on different architectures (NEC, IBM, Cray, ...)
- terminal-based interface runs on HPC and workstations
- NUMEX monitor as GUI

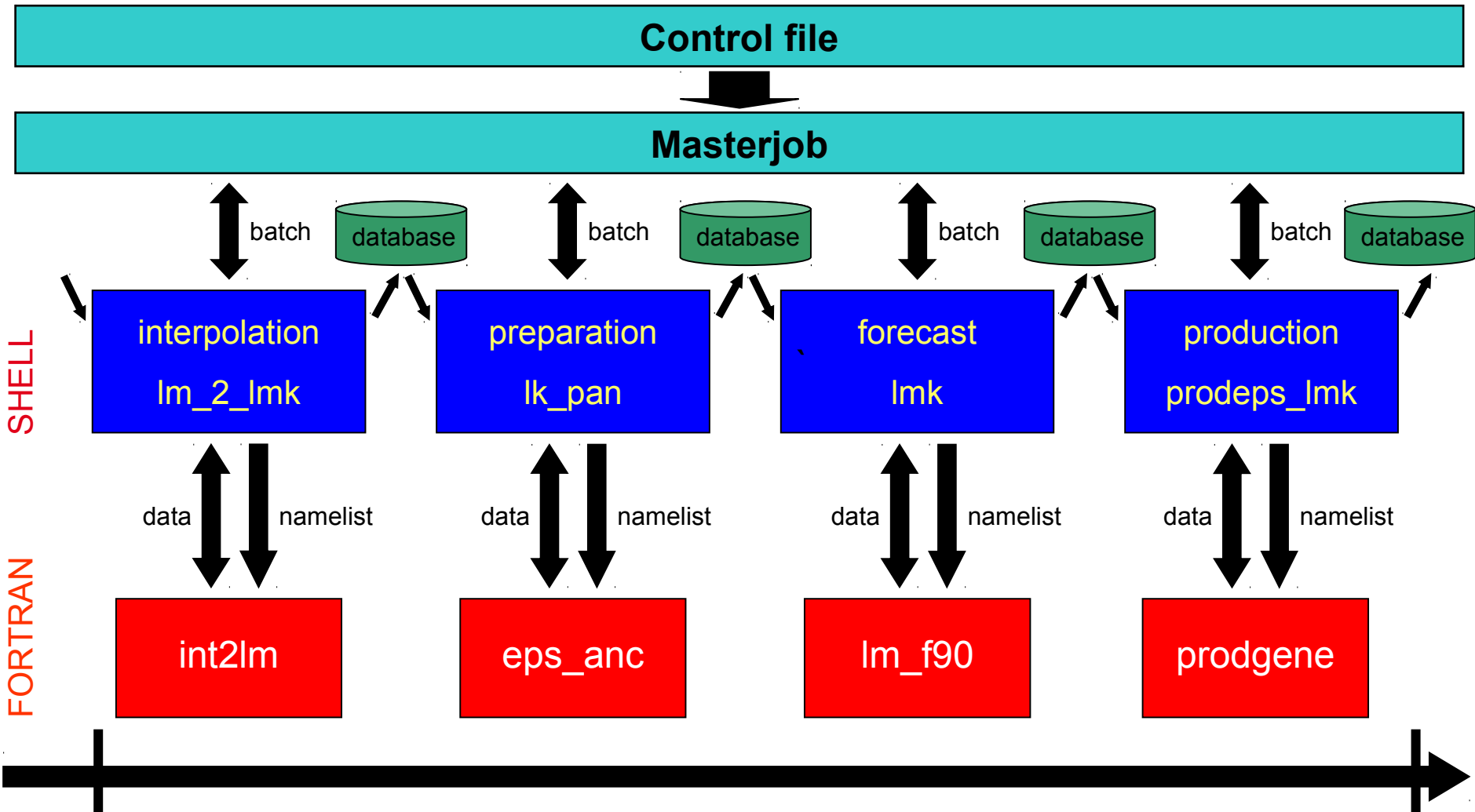
NUMEX – What is it used for ?

- **all new NWP-developments** have to be implemented into NUMEX before becoming operational
 - GME20L60, COSMO-DE-EPS, GME-SMA, ICON, KENDA, ...
- new HPC-system → NWP system will be migrated via NUMEX
- many internal and external projects
 - ICON, COSMO development, EweLINE, ORKA, AirPort, ...
- dissertations
- special non-operational, but nearly real-time running NWP-models
 - COSMO-ART (volcanic ash runs during Eyjafjallajökull eruption)
 - Fukushima Daiichio nuclear disaster
 - Olympic games

NUMEX – Main Parts



A NUMEX Job



Global model ICON

Grid spacing: 13 km

Layers: 90

Forecast range:

174 h at 00 and 12 UTC

78 h at 06 and 18 UTC

1 grid element: 173 km²

ICON zooming area Europe

Grid spacing: 6.5 km

Layers: 54

Forecast range:

78 h at 00, 06, 12 and 18 UTC

1 grid element: 43 km²

plus one zooming area (military use)

COSMO-DE (-EPS 40)

Grid spacing: 2.2 km

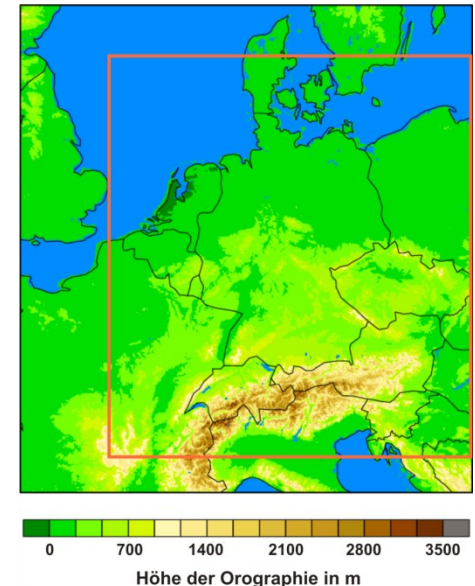
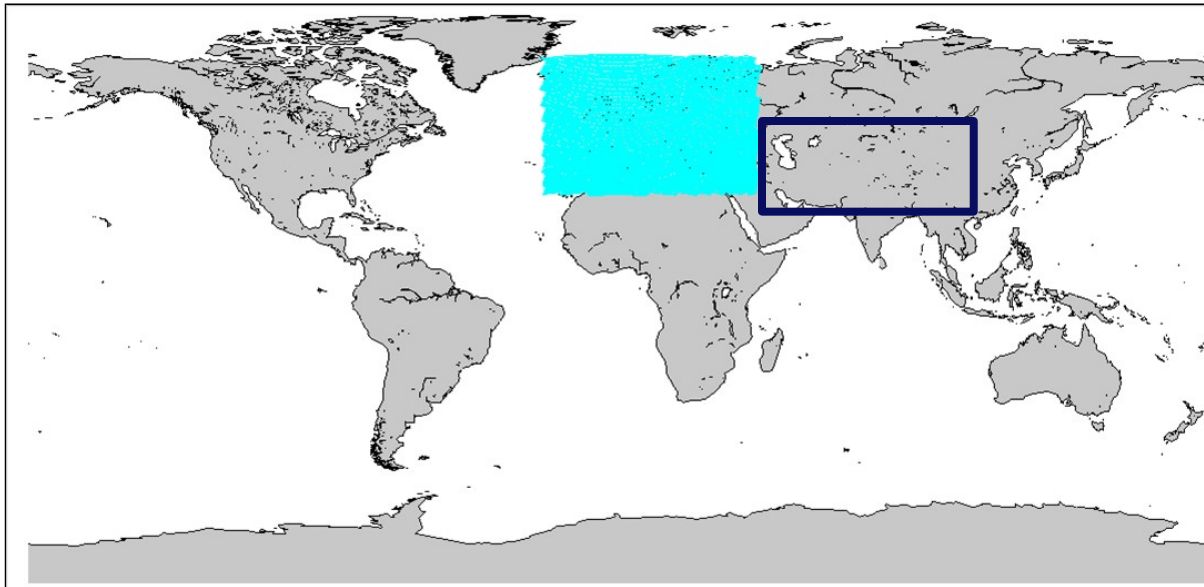
Layers: ~ 80

Forecast range:

27 h at 00, 03, 06, 09,

12, 15, 18, 21 UTC

1 grid element: 5 km²



Summary

- ICON global: 13km
- ICON Europe (zooming area): 6.5km
- COSMO-DE and COSMO-DE-EPS: 2.2km, 40 members
- KENDA - Ensemble Data Assimilation (COSMO-DE): 2.2km
- VarEnKF – Ensemble Data Assimilation (ICON): 13km

- New HPC system
 - Cray XC30
 - Megware Linux Cluster



**Thank you for your
attention!**

Any questions?

