



High resolution modeling of wind fields for optimization of empirical storm flood predictions

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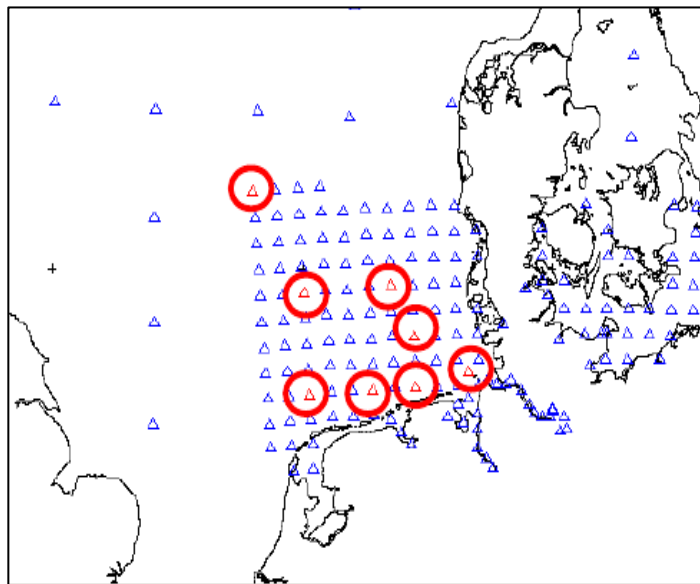


- NLWKN: Empirical storm prediction system for barrage management, scheduling of maintenance or construction work, early warning
 - improve old storm flood prediction: Usage of new and more data, improved tuning of empirical water level model
 - some detailed modeling to study overlay effects
 - need highly resolved wind fields of strong storms
- DWD tasks:
 - provide highly resolved wind fields for 39 storms
 - verification of the wind fields
 - sensitivity analysis of the wind fields to the parameterization of the turbulent flow
- KFKI project (Kuratorium für Forschung im Küsteningenieurwesen, Research in Coastal Engineering) OptempS-MohoWif

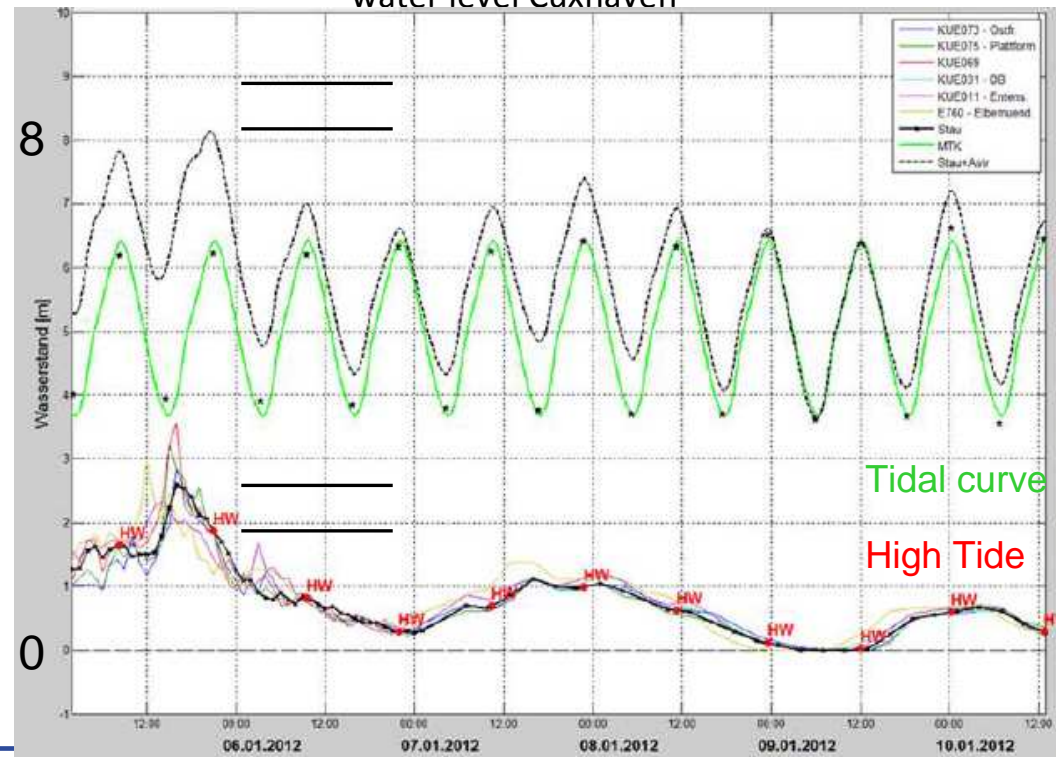
Motivation

- Calculate 4 – 5 days for one storm (2 - 3 days before arriving and the occurrence)
- storm flood simulations cover a period from 1962 till 2011 (> 2/3 of the storms since 1990)
- NLWKN: calculating water level raised by wind with an empirical model which is based on 8 discrete points in the north sea => this should be improved
- Precise timing important for storm surges because of interaction with tides

8 points are used for actual forecast



water level Cuxhaven



1. General view

- model chain / driving data
- Domain / mesh width

2. Procedure

- Forecast / Nudgecast
- Status / Volume / Problems

3. First results

4. Outlook

Model chain / driving data



COSMO 2.2 km mesh width, 65 vertical level



EU2DE

COSMO 7 km mesh width, 40 vertical level



GME2EU

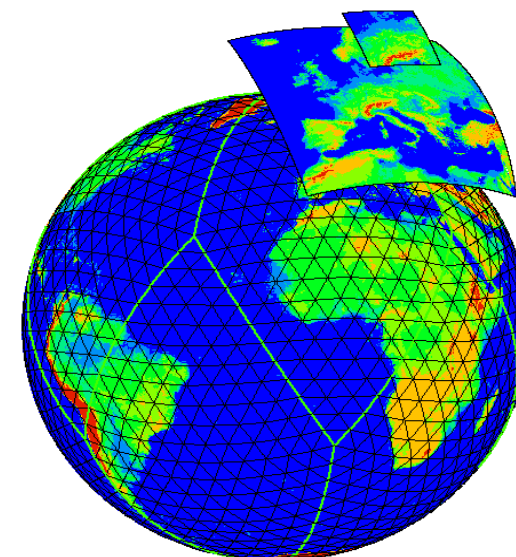
GME 30 km mesh width, 60 vertical level



IFS2GME

ERAInterim/ERA-40

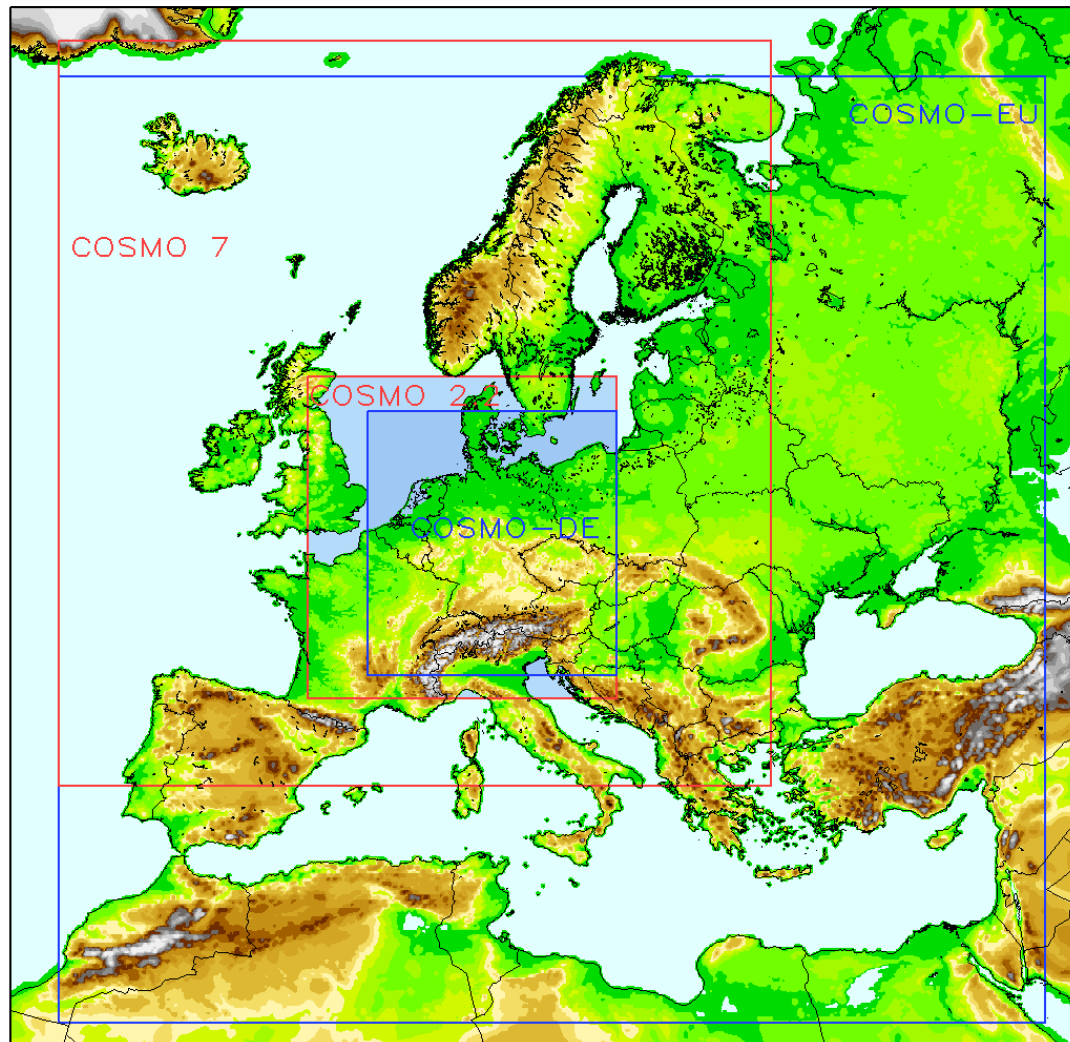
ERAInterim (since 1979)	ERA-40 (till 1979)
60 level	60 level
reduced gaussian grid T255 ≈ 80 km resolution	reduced gaussian grid T159 ≈ 125 km resolution
12 hourly 4D-Var	3D-Var



Model domain / mesh width



Domains COSMO-EU and COSMO-DE



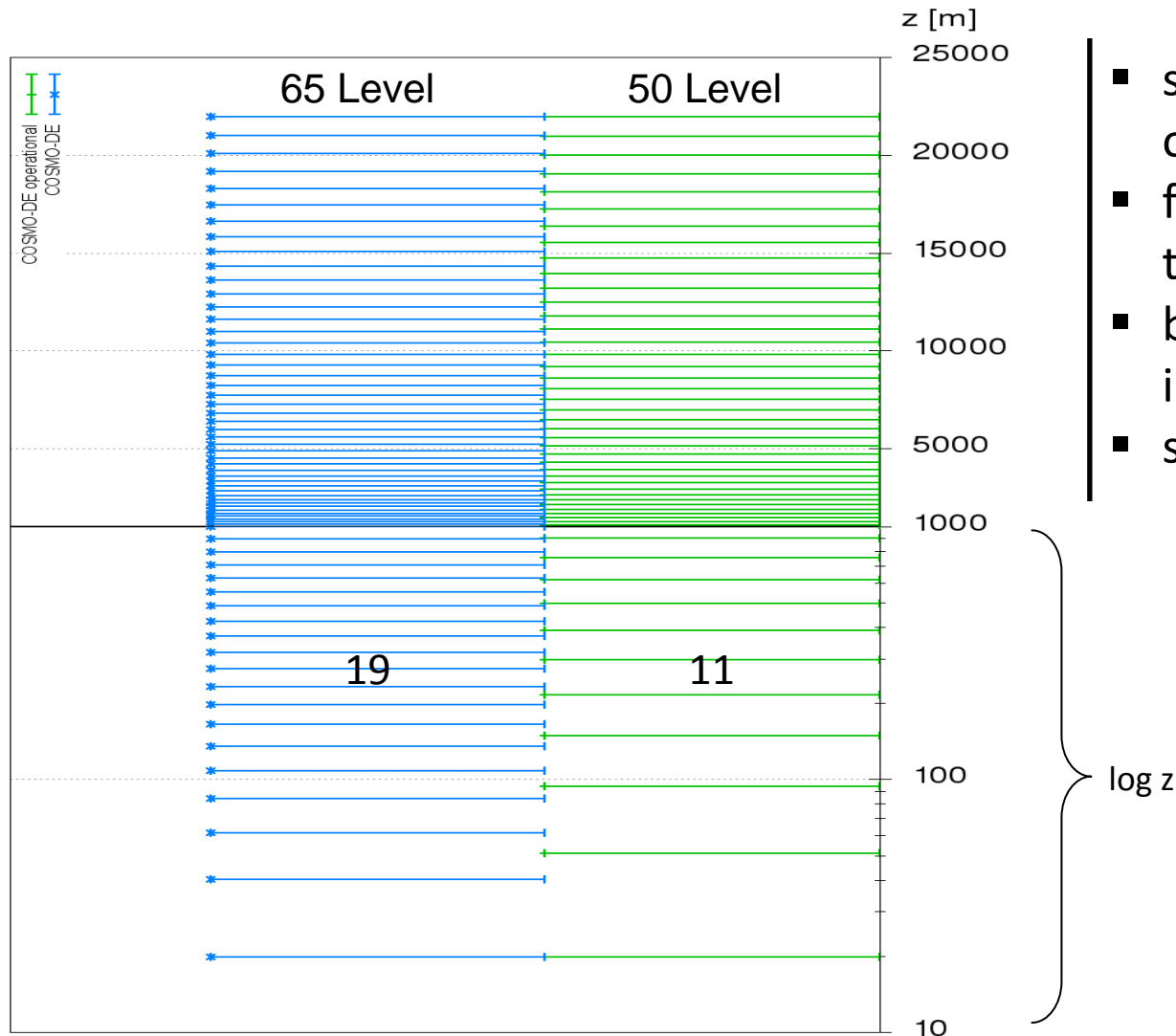
Domain sizes

- COSMO-EU:
665x657 grid points with
0.0625° mesh width
- COSMO 7 km:
480x518 grid points with
0.0625° mesh width
- COSMO 2.2 km:
650x700 grid points with
0.02° mesh width
- COSMO-DE (2.8 km)
421x461 grid points with
0.025° mesh width



Model domain / mesh width

Vertical level in COSMO-DE 2.2 and COSMO-DE

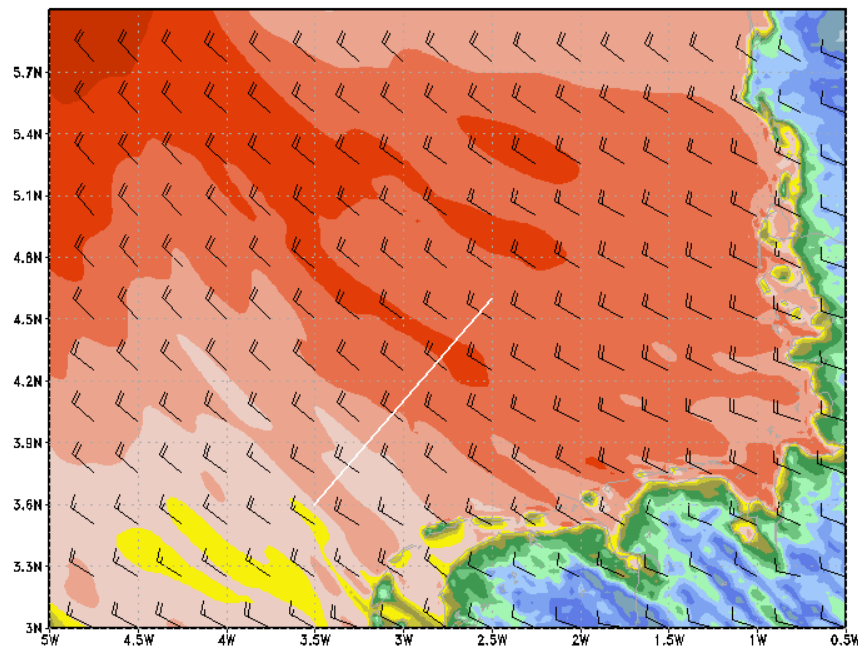


- shall be established in the operational forecast
- from 50 to 65 perhaps up to 80 level
- better triggering / initialization of convection
- serves also as test case

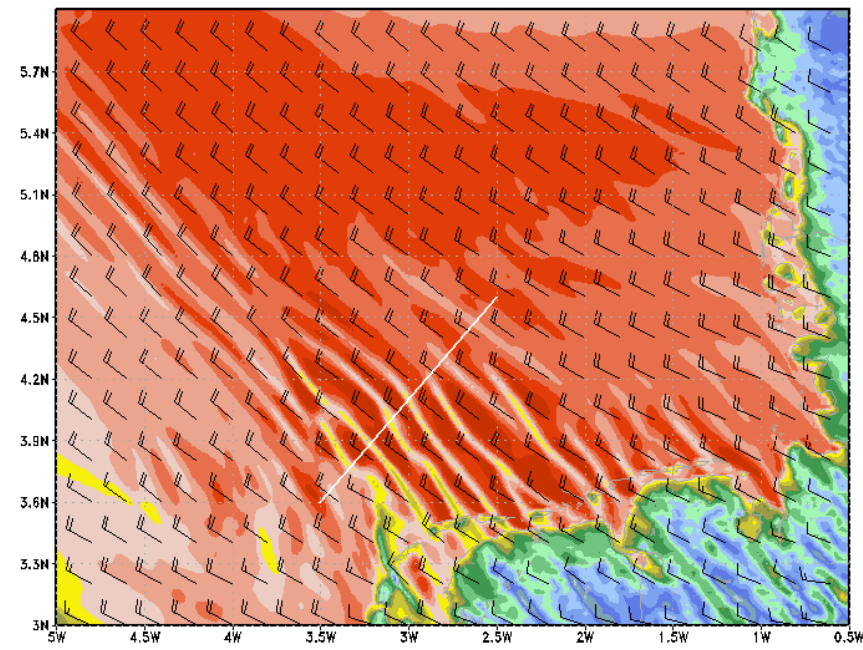


COSMO DE with 2.8 km and 2.2 km

1999020506 FF [m/s] at 10 m
FF in CDE28



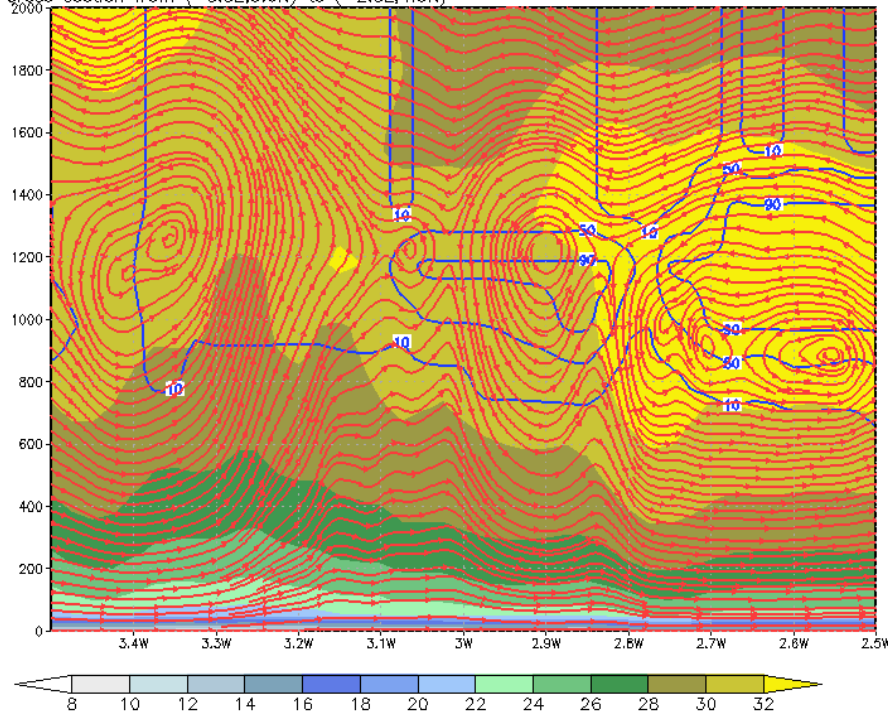
1999020506 FF [m/s] at 10 m
FF in CDE22



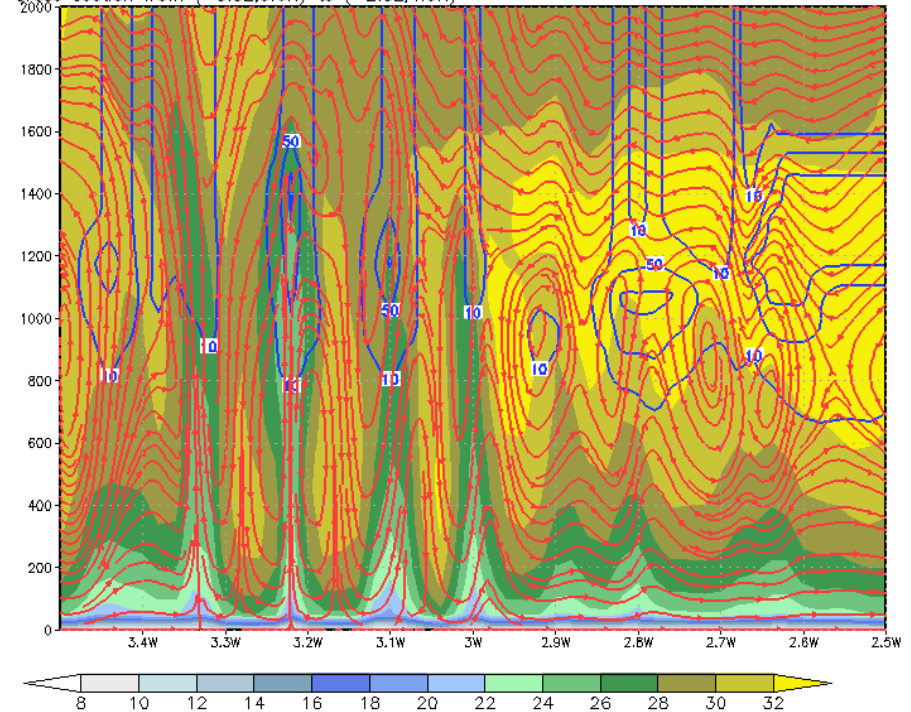
Cross section COSMO-DE 2.8 km and 2.2 km

Wind speed, Stream function of transverse circulation, CLC

COSMO 2.8 km 1999020506: FF [m/s], Stream function (U,100*W) in red, CLC in blue
Cross section from (-3.5E,3.6N) to (-2.5E,4.6N)



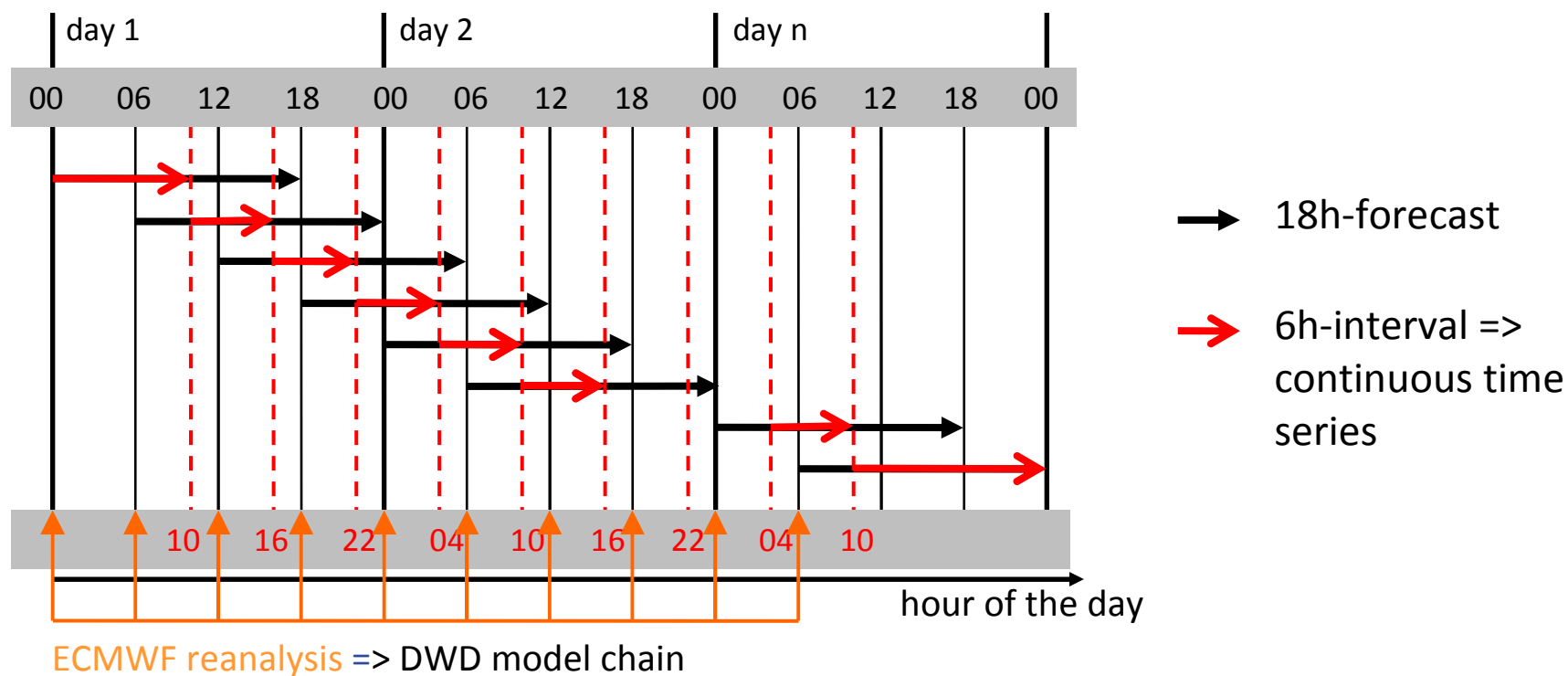
COSMO 2.2 km 1999020506: FF [m/s], Stream function (U,100*W) in red, CLC in blue
Cross section from (-3.5E,3.6N) to (-2.5E,4.6N)



Forecast / Nudgecast



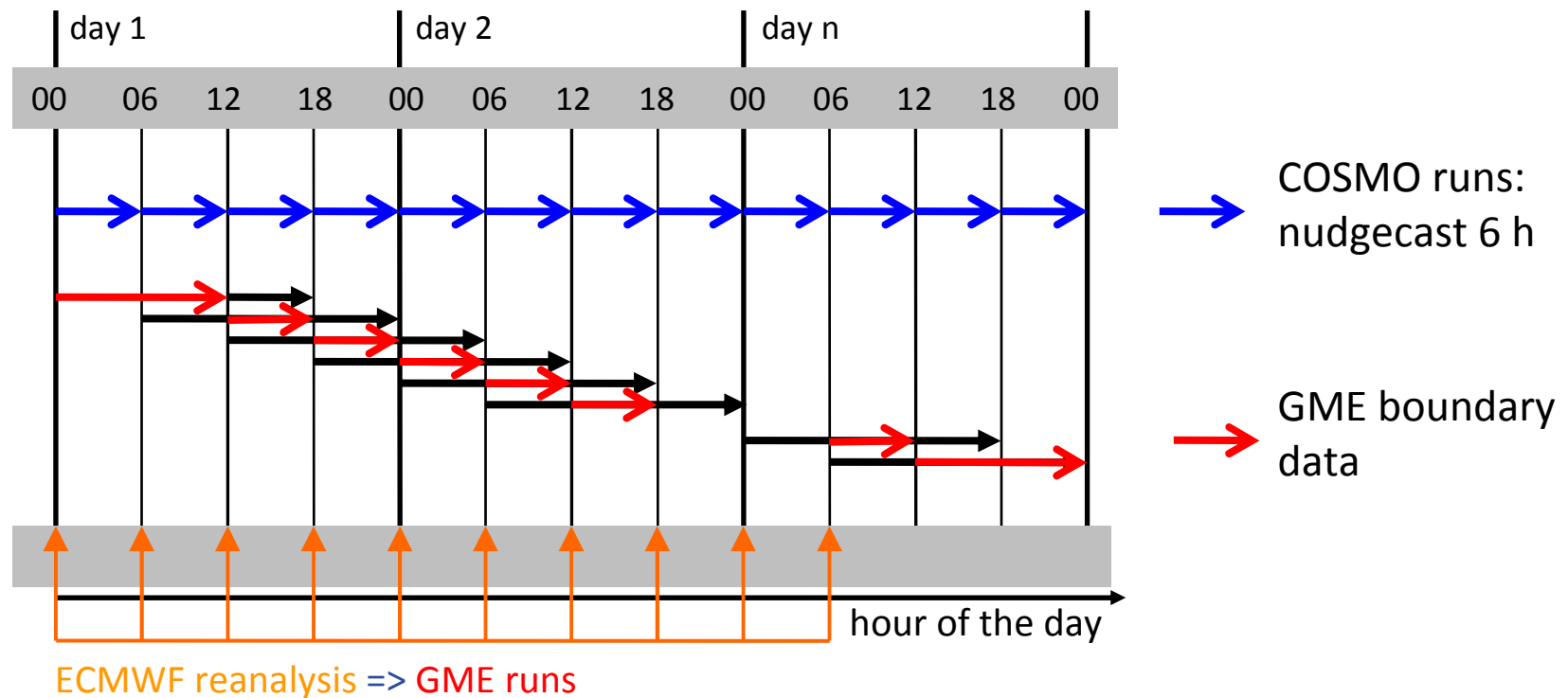
Forecast:



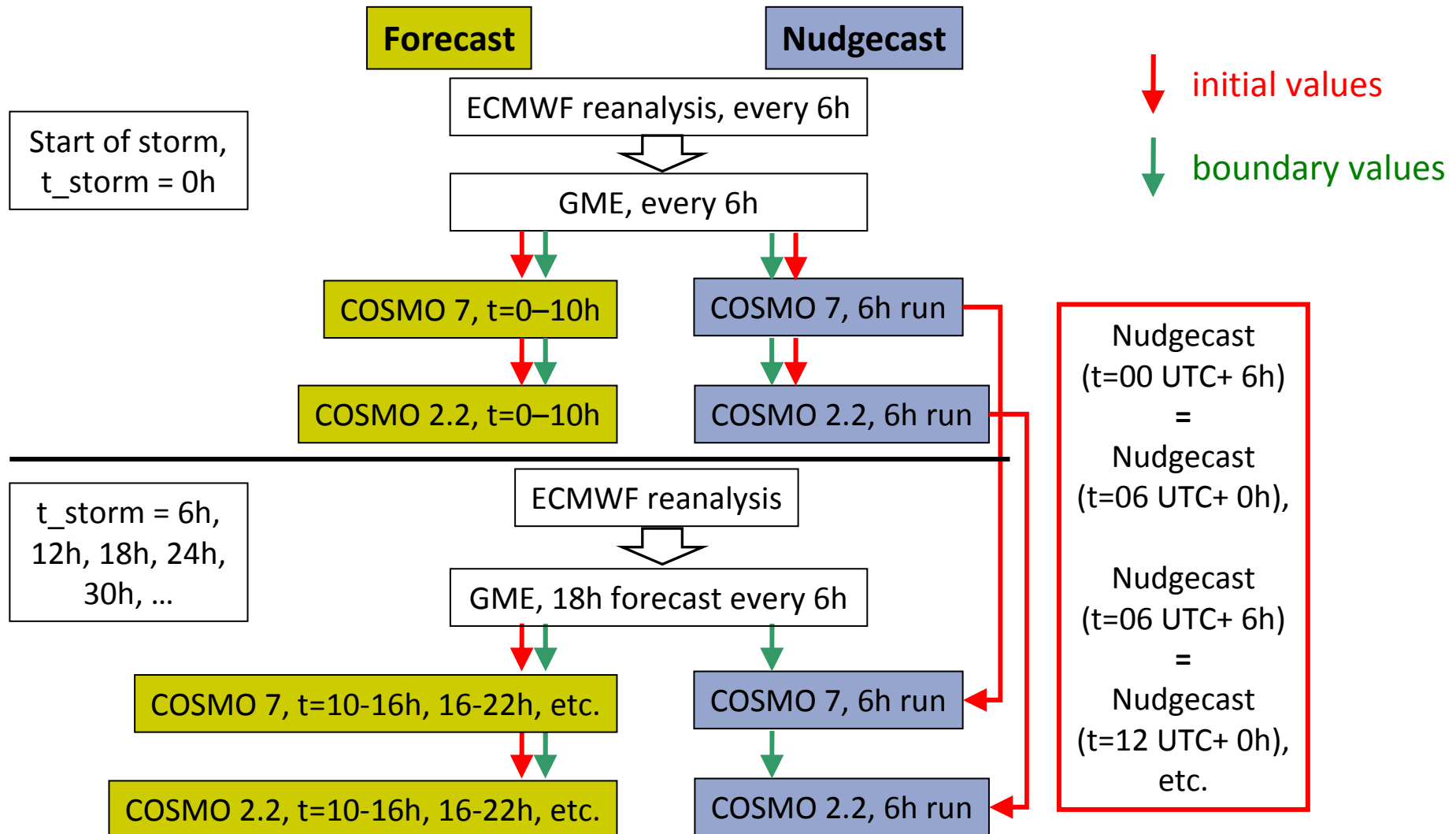
Forecast / Nudgecast



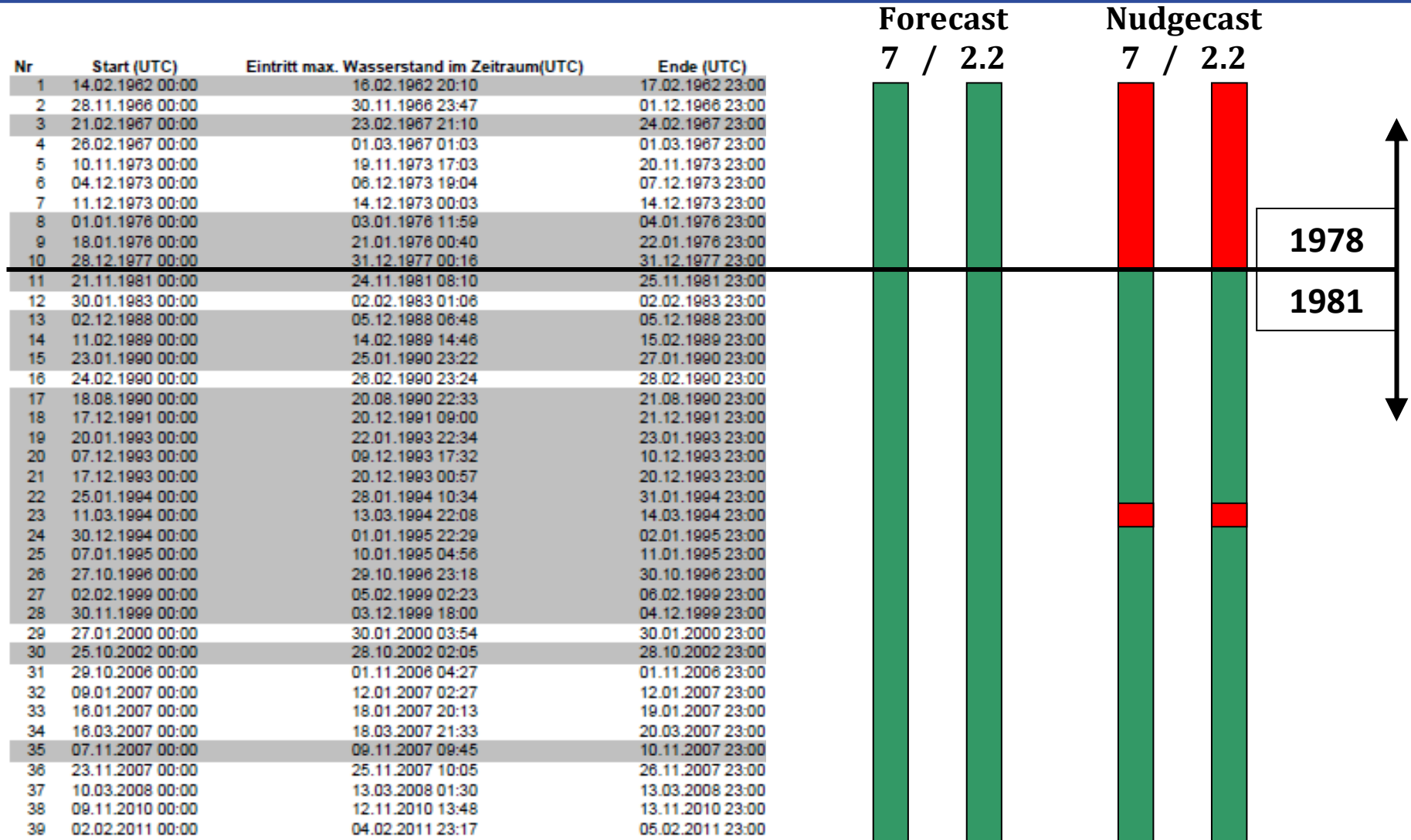
Nudgecast: Series of 6 h nudging runs of COSMO 7km and COSMO 2.2 km



Forecast / Nudgecast



Status / volume / problems



bereits 2005/2006 vom DWD bearbeitet



Status / volume / problems



■ Problems:

- 2 different BUFR formats between 1981 and 1990 => solved
- Observation data incomplete for older storms, i.e. before 1981:
 - => station heights are missing
 - => unsolved yet

■ Data volume:

■ COSMO 7 (output interval 1 hour):

1 storm, 5 days long, all parameter, without nudgecast:	45 GB =>	1,7 TB (39 storms)
1 storm, 5 days long, all parameter, nudgecast:	38 GB =>	1,5 TB (39 storms)
1 storm, 5 days, parameter „u_10m, v_10m, pmsl, z0“:	200 Mb	

■ COSMO 2.2 (output interval 15 minutes):

1 storm, 5 days long, all parameter, without nudgecast:	536 GB =>	20,9 TB (39 storms)
1 storm, 5 days long, all parameter, nudgecast:	456 GB =>	17,8 TB (39 storms)
1 storm, 5 days, parameter „u_10m, v_10m, pmsl, z0“:	2 Gb	



First results: 7 km, Nudgecast



Low pressure system "Tilo": 07.11.2007, 11 UTC – 11.11.2007, 00 UTC
Max. water level at Norderney at 09.11.2007 at 9:45 UTC

Mean sea level pressure [hPa] / 10m wind [kn]

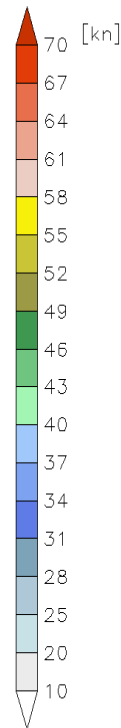
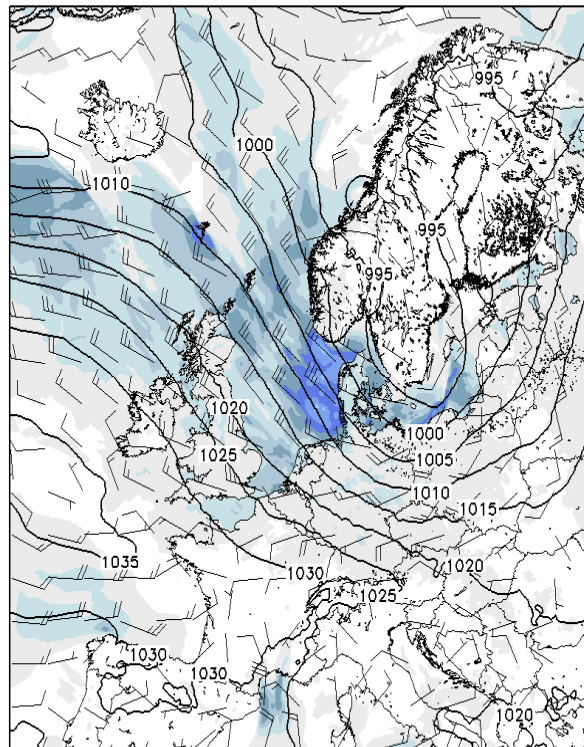
Modell:
COSMO-EU

Version:
4.22

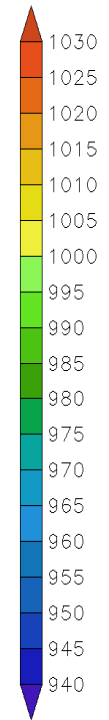
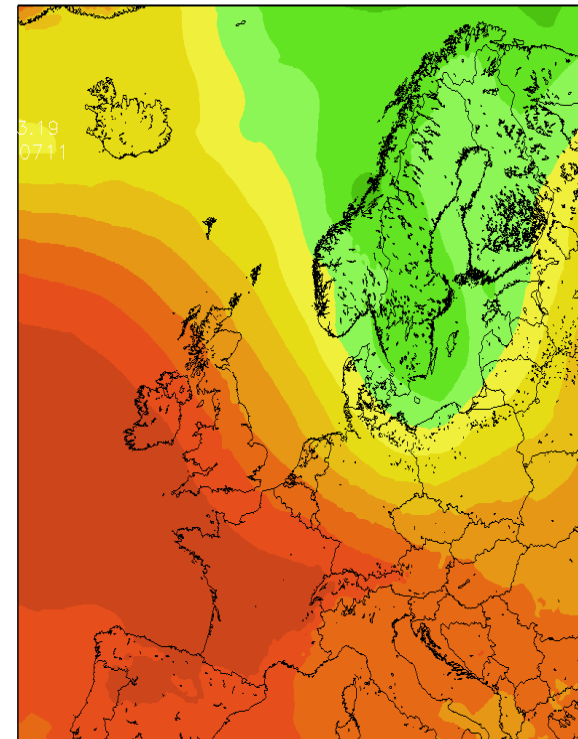
Nudgecast?
yes

valid time:
07.11.2007 11:00 UTC

vmax:
37.7414 kn
69.8971 km/h



MSLP[hPa]_COSMO-EU_2007110711



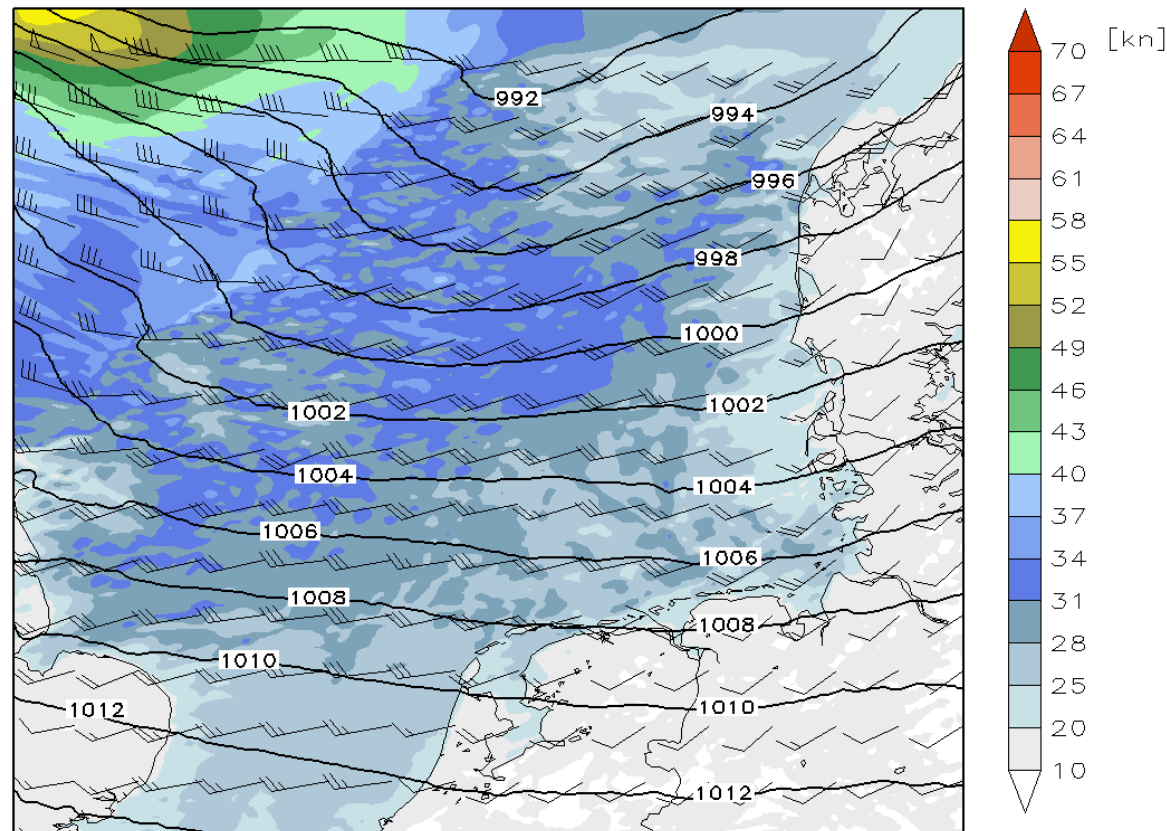
First results: COSMO 2.2 km



Low pressure system "Tilo": 08.11.2007, 12 UTC – 09.11.2007, 10 UTC
Max. water level at Norderney at 09.11.2007 at 9:45 UTC

Mean sea level pressure [hPa] / 10m wind [kn]

Modell:
COSMO-DE
Version:
4.25.1.1
Nudgecast?
yes
valid time:
08.11.2007 12:00 UTC
vmax:
57.2655 kn
106.056 km/h



First results



Mean sea level pressure [hPa] / 10m wind [kn]

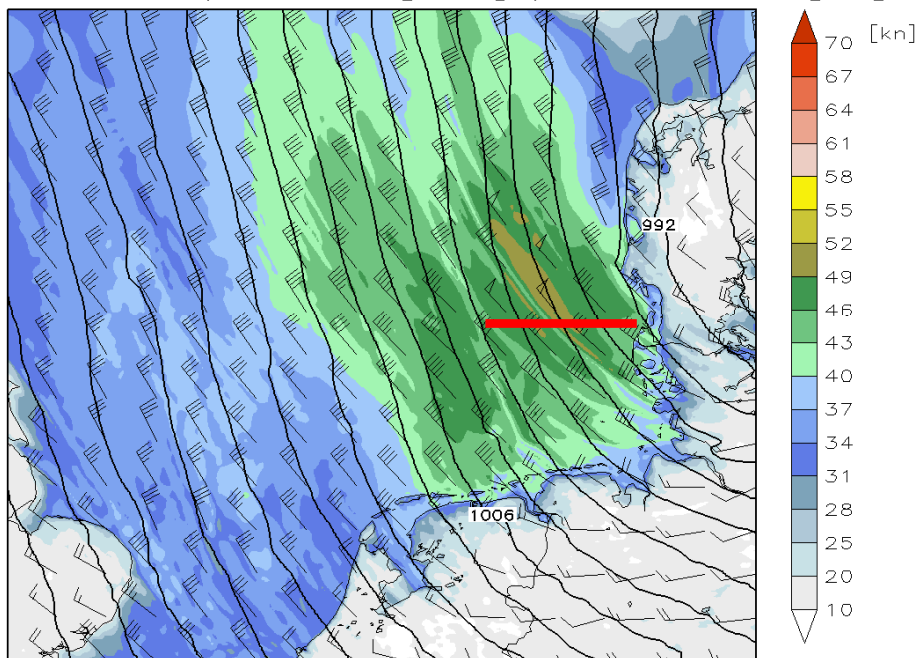
Modell:
COSMO-DE

Version:
4.25.1.1

Nudgecast?
yes

valid time:
09.11.2007 08:45 UTC

vmax:
50.5856 kn
93.6845 km/h



Cross section at lat 4.8
Lon -2.5 -1
T=228



Tilo: Difference sea level pressure



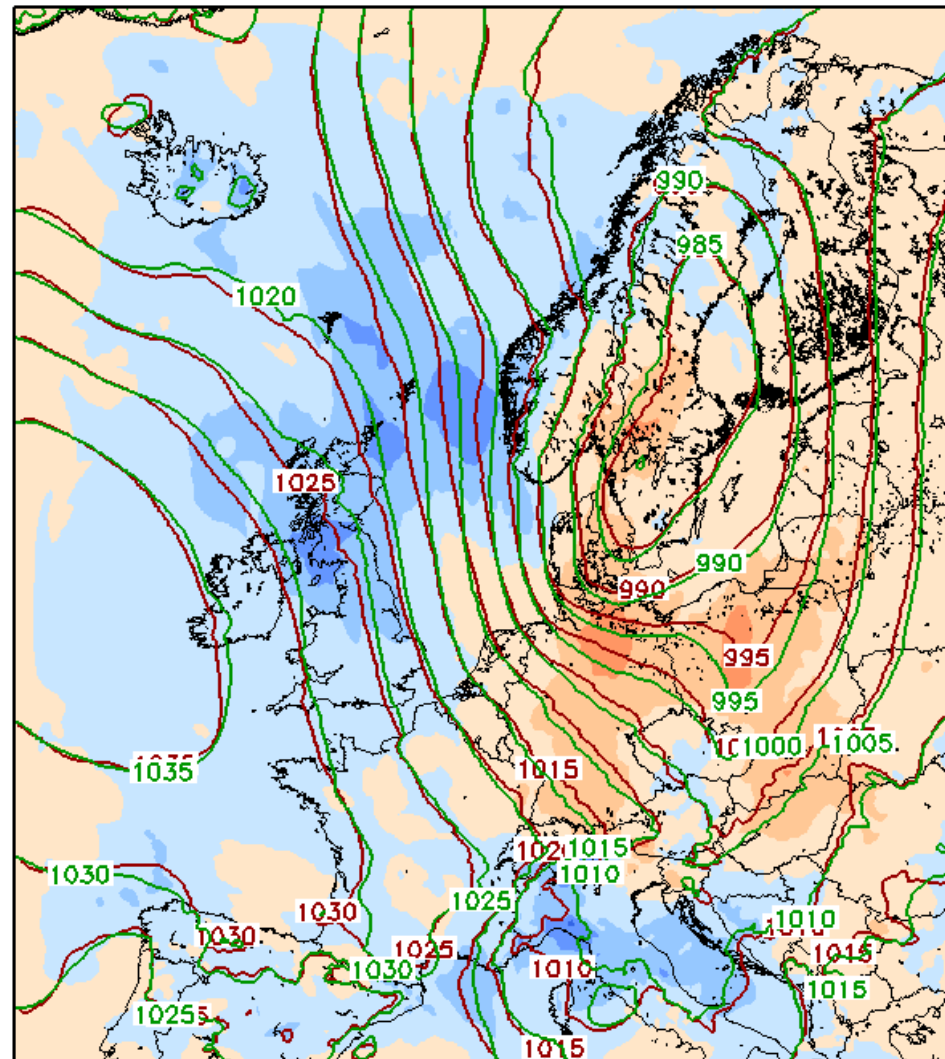
MSLP (Nudgecast) – MSLP (Forecast) [hPa]

model:
COSMO-EU

Version:
4.22

valid time:
09.11.2007
09:00 UTC

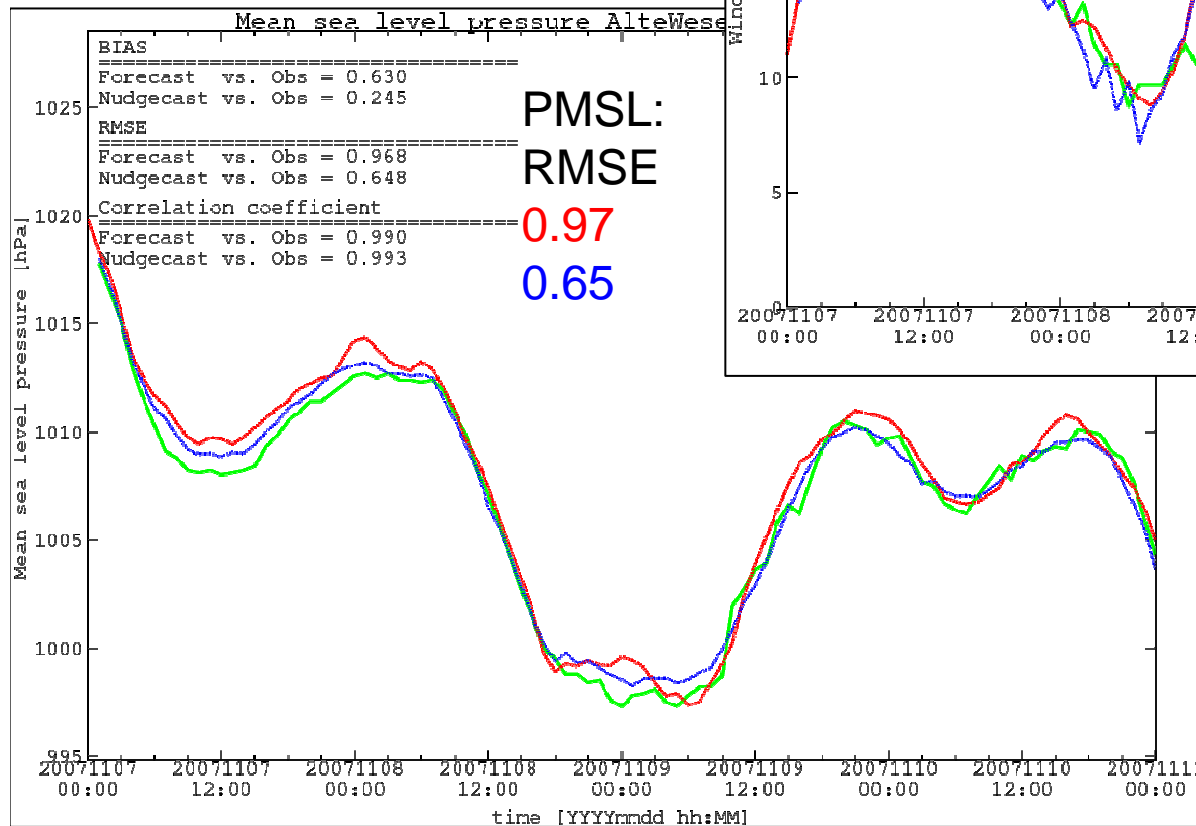
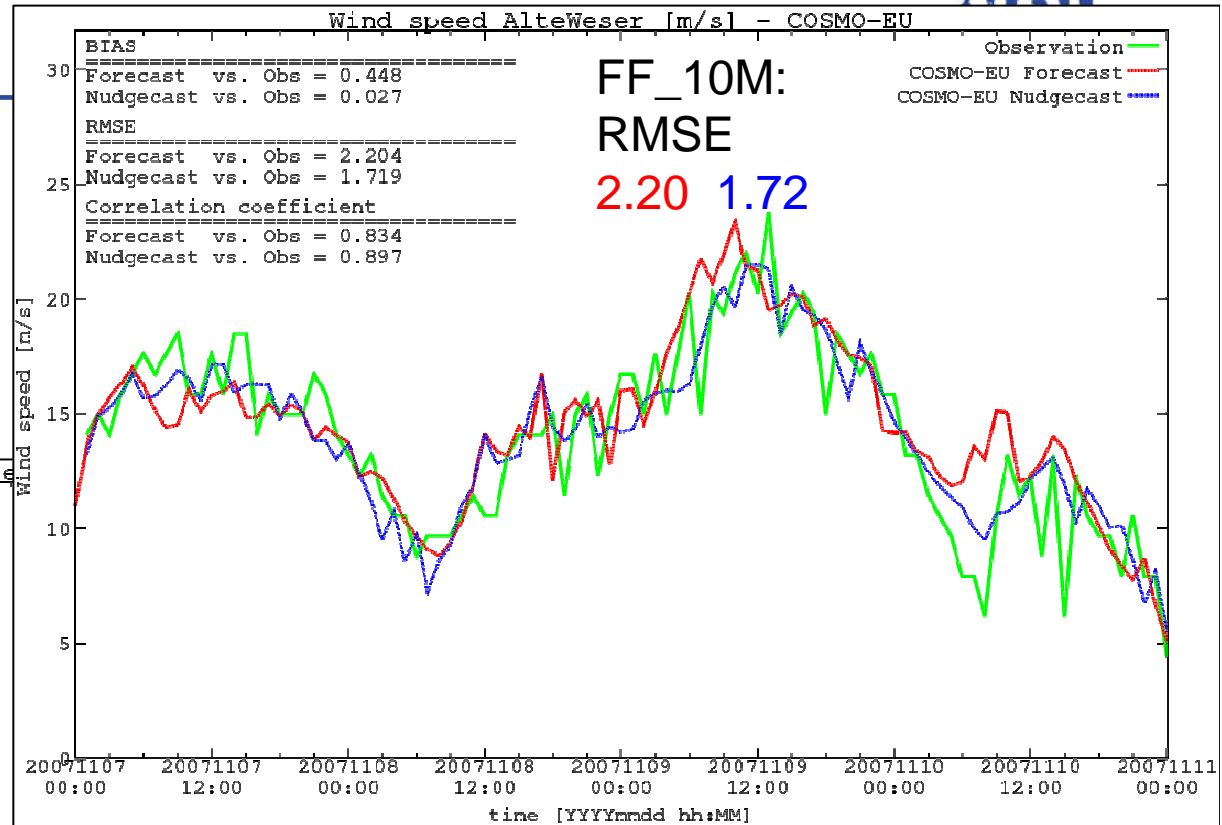
Nudgecast
Forecast



COSMO 7 km at Alte Weser



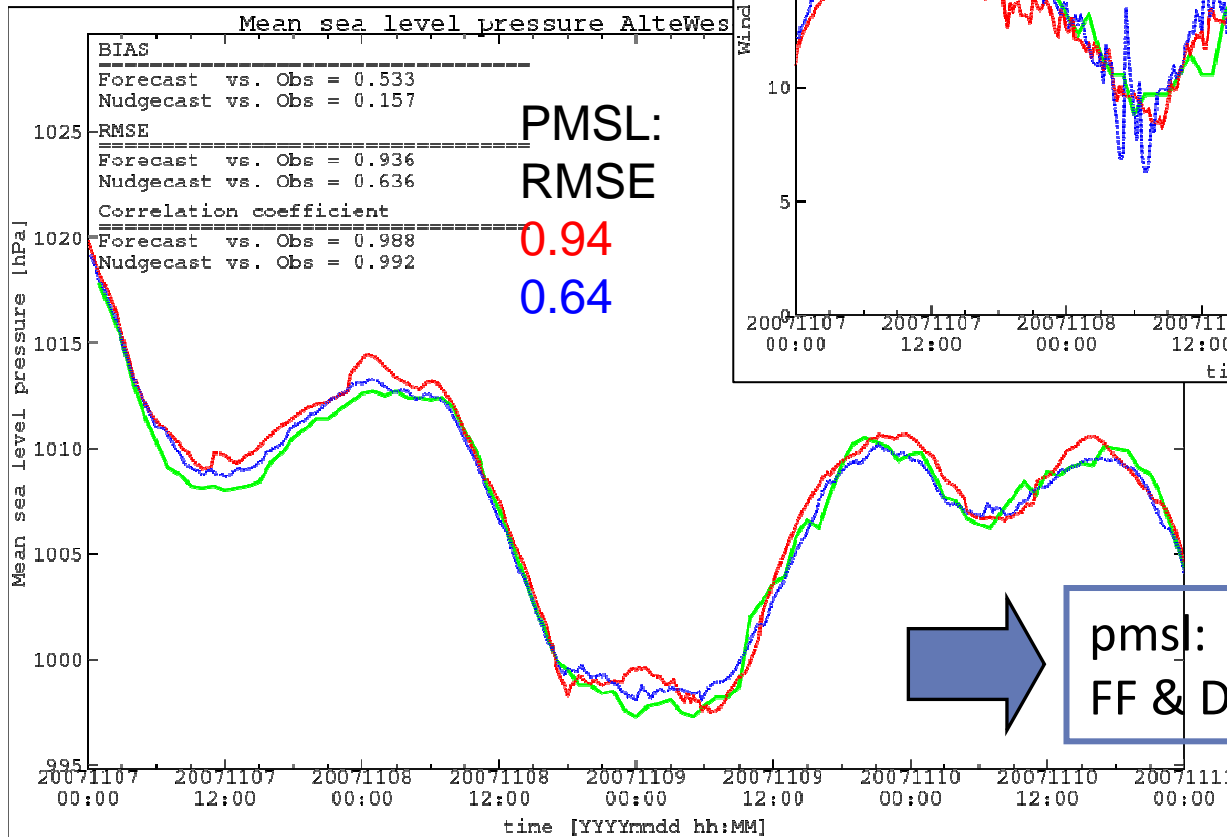
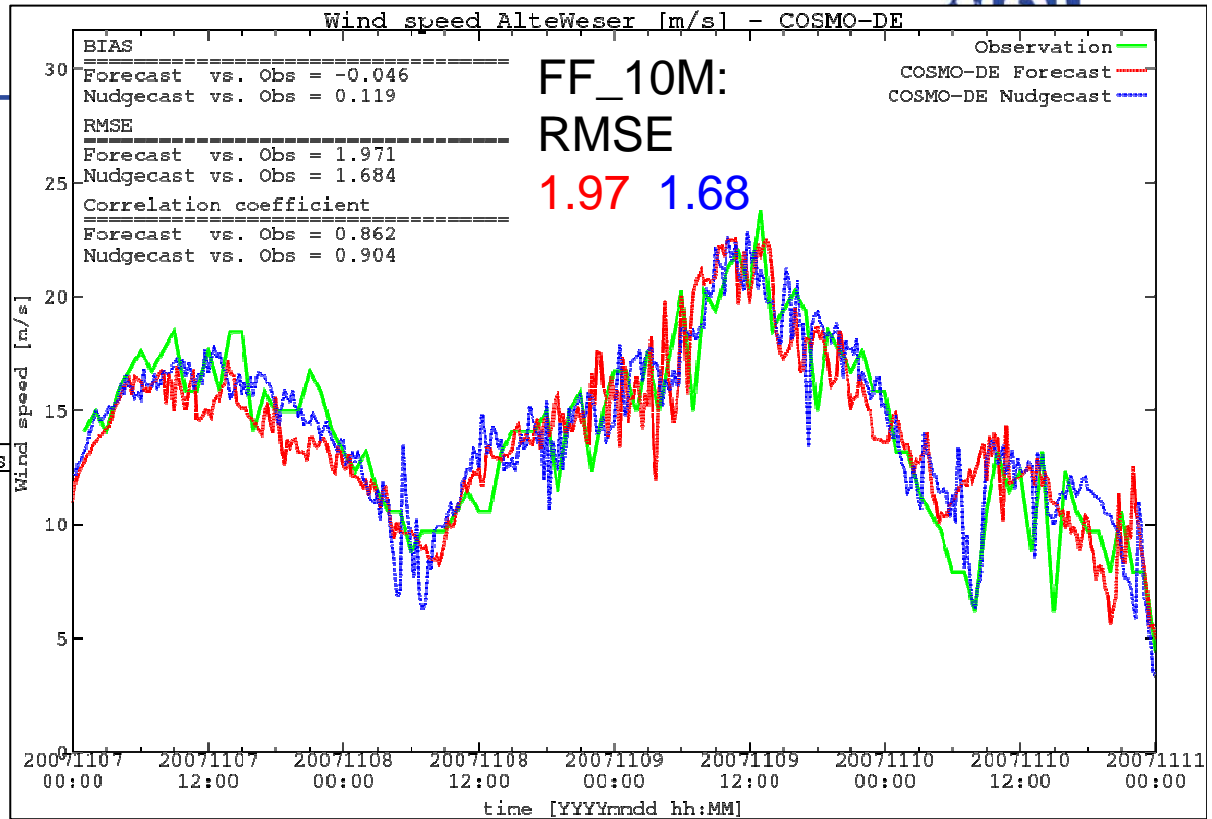
Observation
Forecast
Nudgecast



COSMO 2.2 km at Alte Weser



Observation
Forecast
Nudgecast



→ pmsl: nudgecast better in all cases
FF & DD: nudgecast mostly better





■ To do:

- complete simulations with nudgecast
- compare time series with observation values every 15 minutes
- sensitivity analysis of the wind fields due to the parameterization of the turbulent flow



➤ Parameterization of the sea surface roughness

- Charnock constant
- Fetch dependence
- Other models

➤ change tuning parameters in the turbulence formula of the COSMO model



NLWKN: Run storm surge model and tune their forecast model

