

Implementation of ECMWF-IFS (Tiedtke-Bechtold) Cumulus Convection Scheme into COSMO

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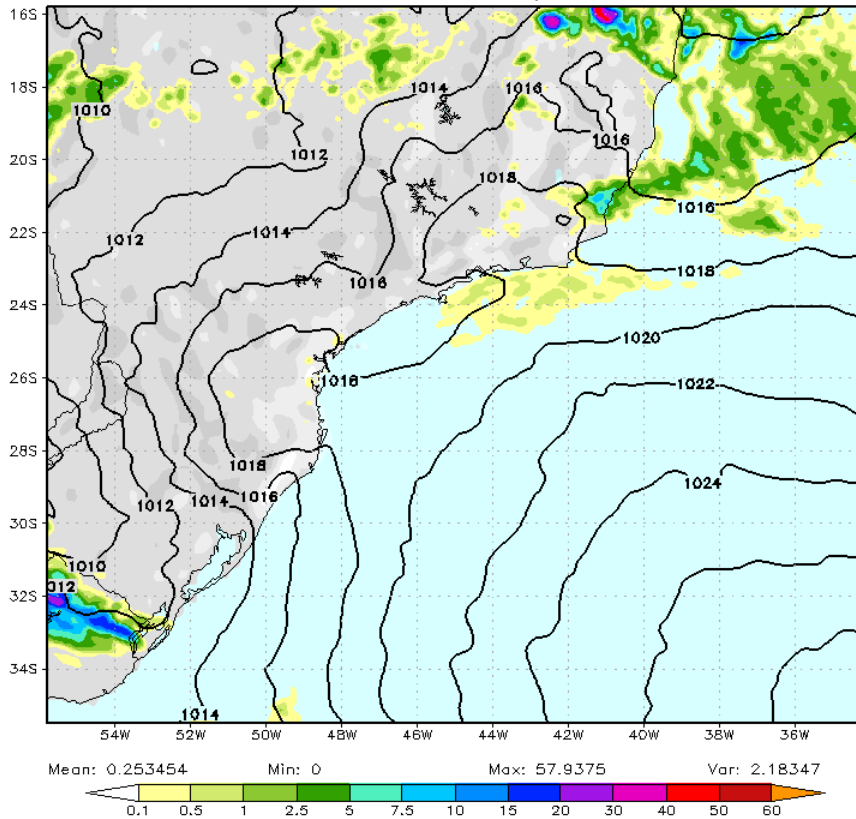
Outline

- Implementation of IFS cumulus convection scheme (ICON version) into COSMO
- Experiments for August 2015 (COSMO-EU, COSMO-DE)
- Verification results (upper air, near surface)
- Conclusions and outlook



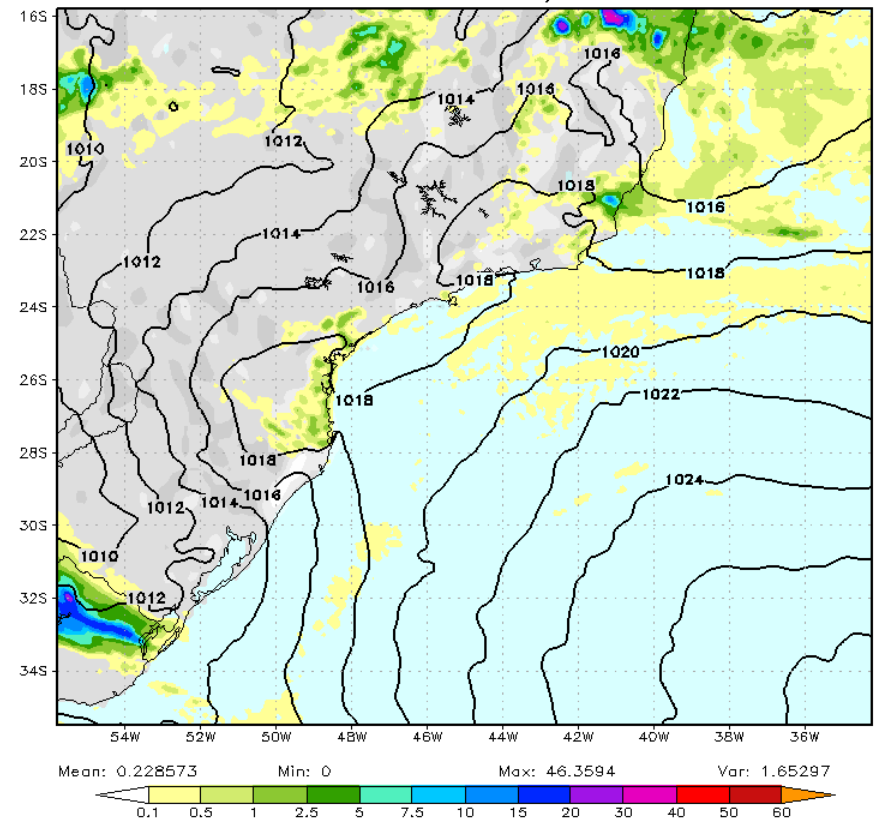
Tiedtke

COSMO (2015 - control) - Acc. Total Precip. (3h) / PMSL
Ref: 30OCT00UTC + PROG06h / Val: 30OCT06UTC



Bechtold

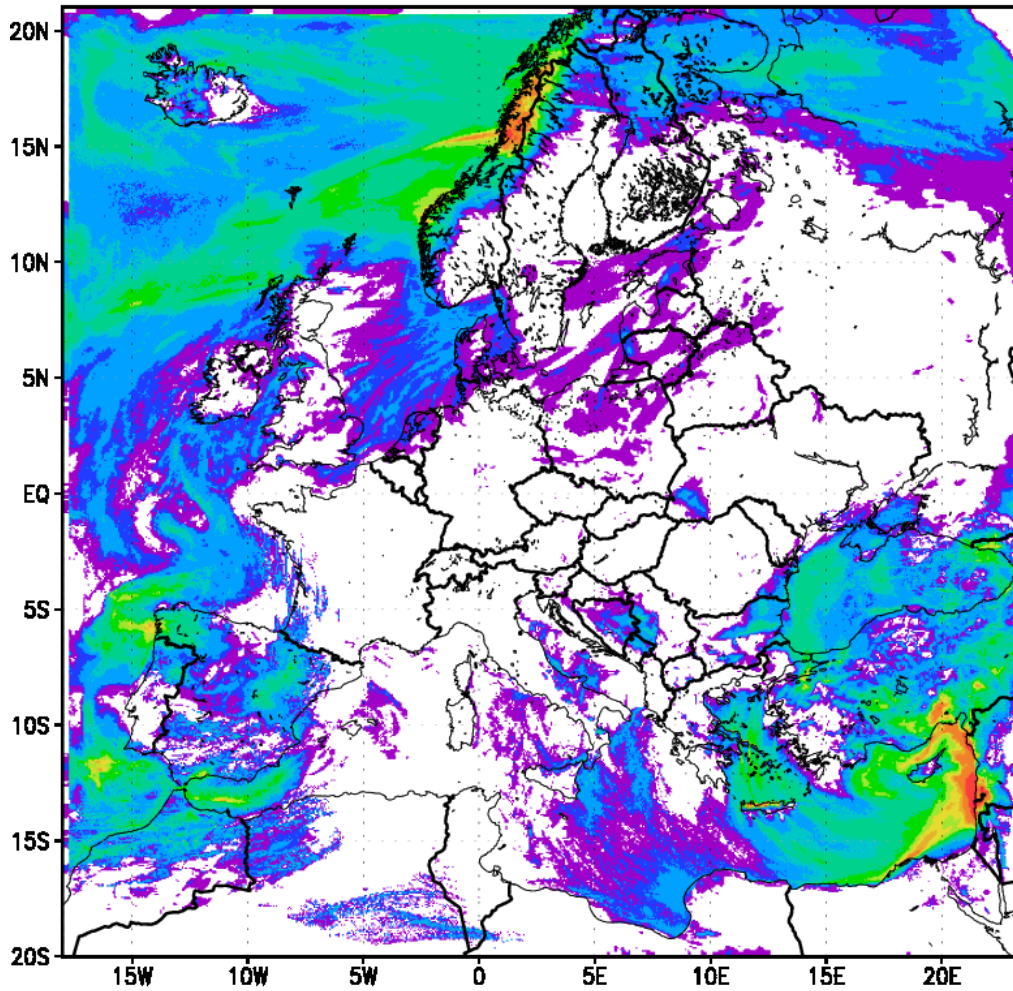
COSMO (2015 - bechtold_icapdeyal_3_icpl_aero_1) - Acc. Total Precip. (3h) / PMSL
Ref: 30OCT00UTC + PROG06h / Val: 30OCT06UTC



valid: 12 FEB 2015 12 UTC k-index: 40
... after 24h forecast time - Bechtold.resolution-bugfix_mtnmask

Günther Zängl: modified treatment of QI_conv

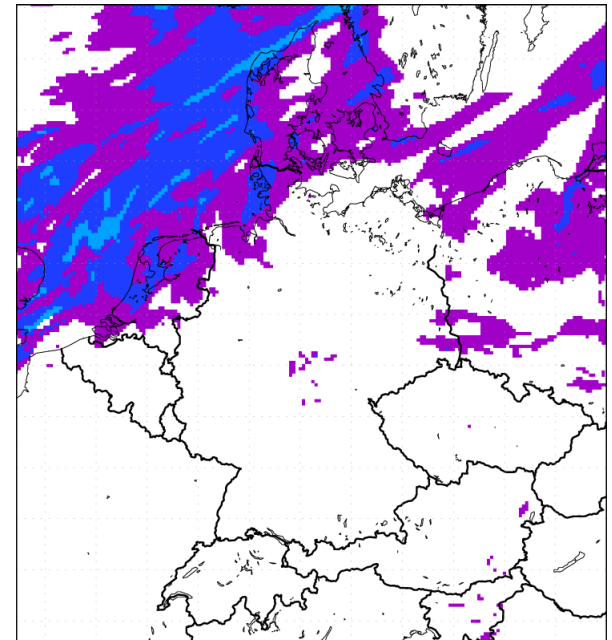
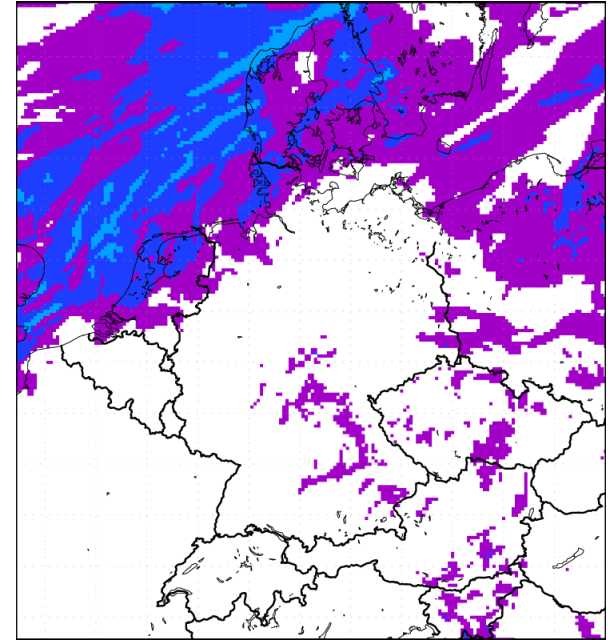
TOT_PREC



Mean: 1.80318 Min: 0 Max: 89.2422 Var: 16.3894



Grid Scale Precipitation



Implementation of ECMWF-IFS Scheme into COSMO

- ECMWF-IFS scheme was implemented into COSMO-NWP version 5.03
- The scheme is now in the official COSMO code (version 5.05/5.04b); the COSMO code includes latest changes made for ICON (treatment of updraft vs. downdraft water-ice mixed phase; treatment of snow melting; interaction with the microphysics scheme as to the detrained rain and snow; diurnal cycle correction in mid-latitudes, not only in the tropics)
- Namelist setting: `itype_conv=2`
(plus: `icapdcycl=3`, `icpl_aero_conv=1`)

Main differences between ICON and COSMO implementation:

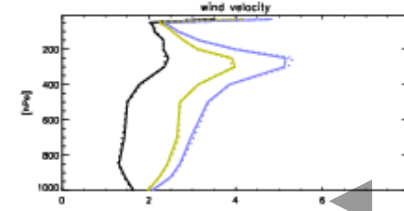
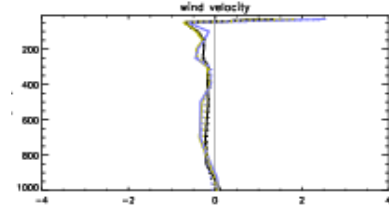
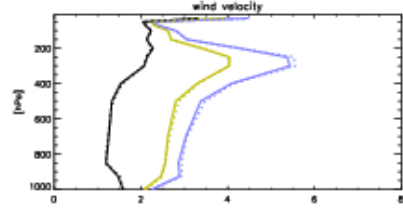
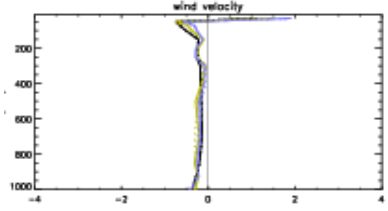
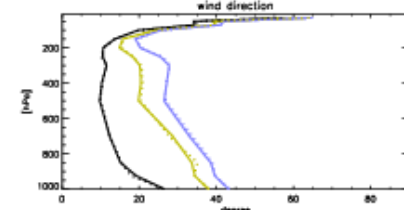
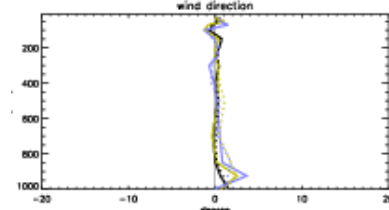
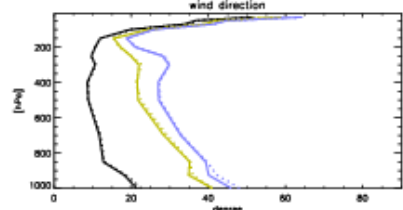
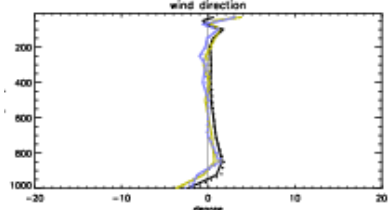
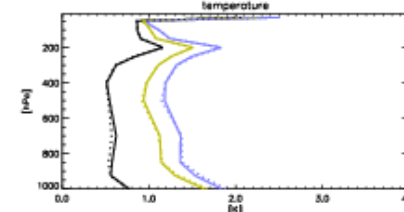
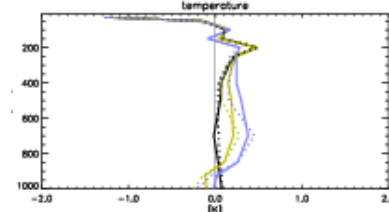
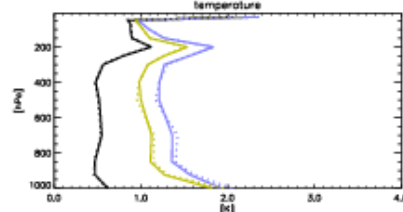
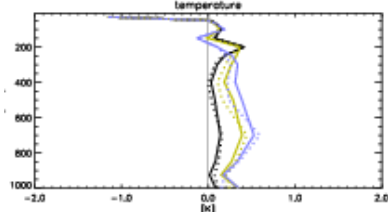
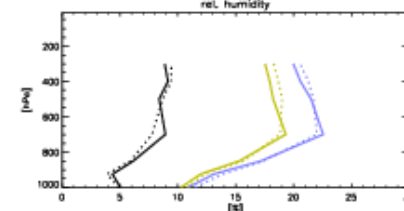
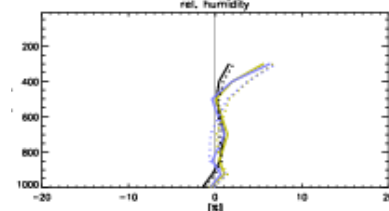
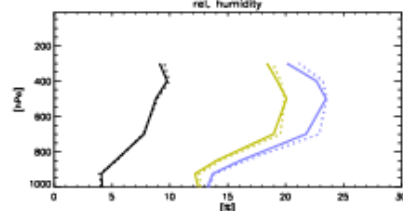
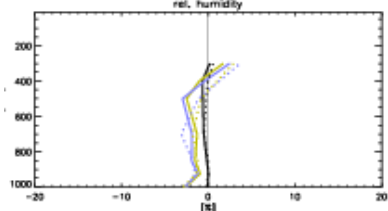
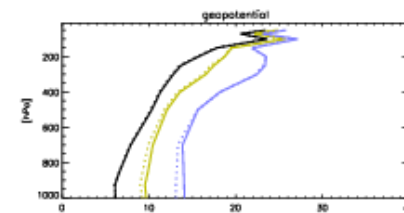
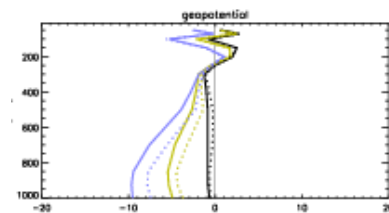
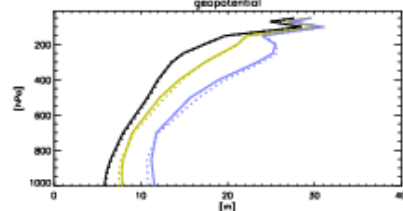
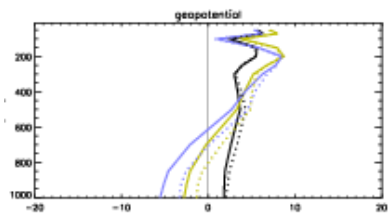
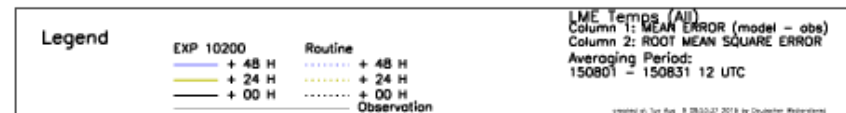
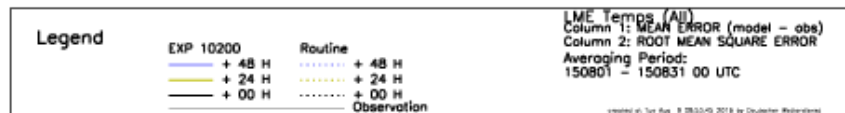
- Simplified treatment of aerosol number concentration:
COSMO: two values – land: 200 cm^{-3} / sea: 50 cm^{-3}
ICON: based on Tegen climatologies
- Convective transport of additional tracers is not yet implemented for COSMO (missing : copy to and from block layout for tracers)

Experiments

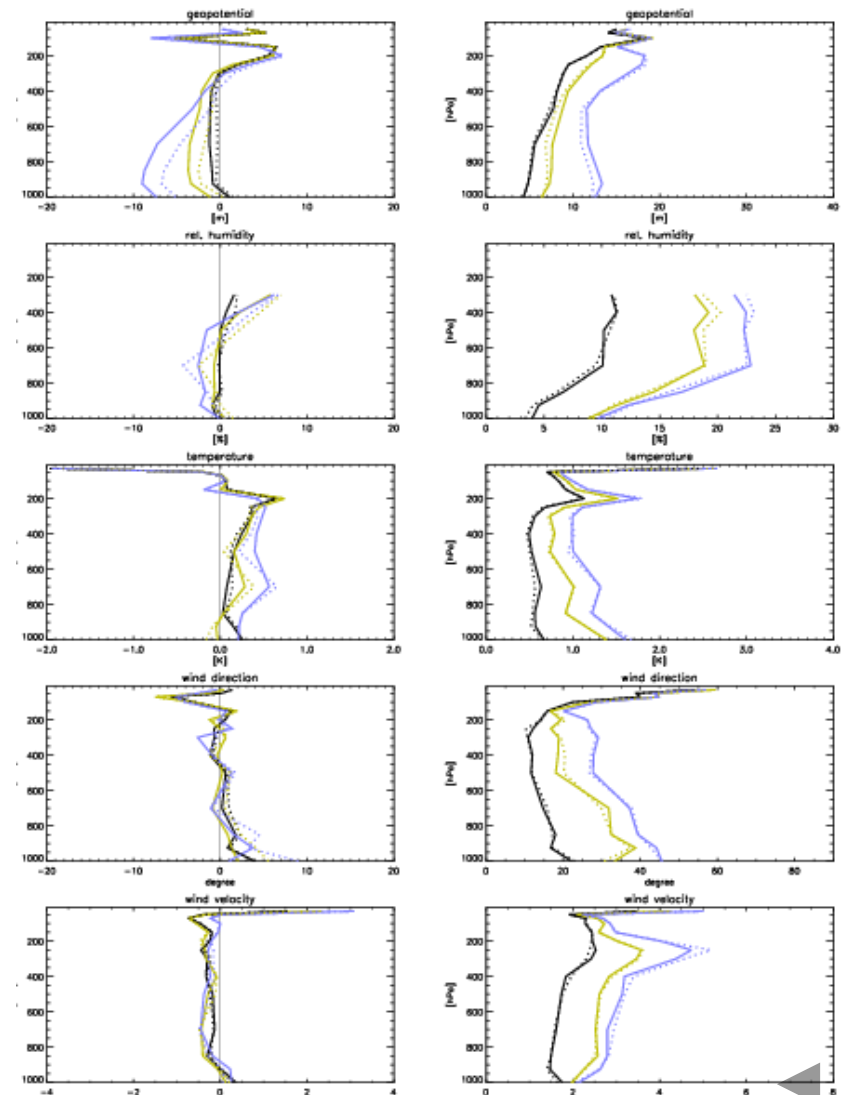
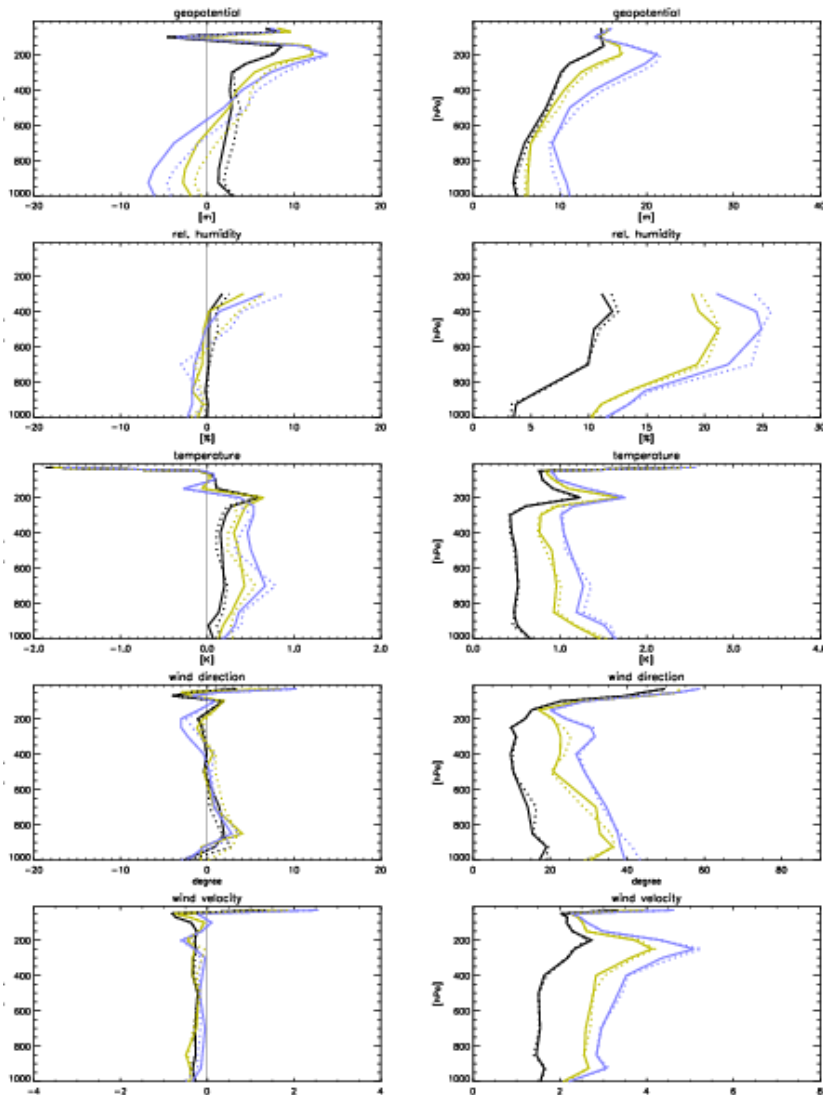
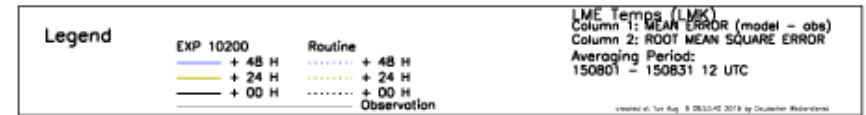
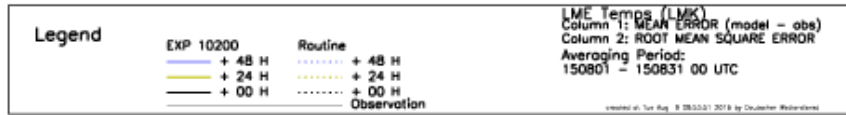
- Run from 25 July through 31 August 2015
(verification over 1-31.08.2015 and 1-10.08.2015)
- B.C. for COSMO-EU from global ICON
- COSMO-EU (Exp_10200) complete assimilation cycle,
00 UTC and 12 UTC forecasts (78 h)
- B.C. for COSMO-DE from COSMO-EU
- COSMO-DE complete assimilation cycle,
00 UTC, 12 UTC forecasts (27 h) and
03 UTC forecast (45 h) for renewable energy projects

- COSMO-EU verification (upper air, near surface)
- COSMO-DE verification (upper air, near surface, precipitation
patterns for particular dates)

COSMO-EU: Upper Air Verification (01-31.08.2015, COSMO-EU Domain)



COSMO-EU: Upper Air Verification (01-31.08.2015, COSMO-DE Domain)



COSMO-EU: Surface Verification

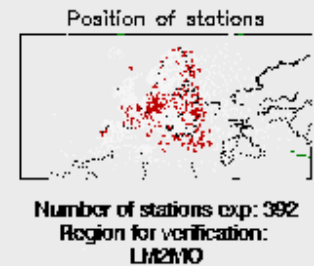
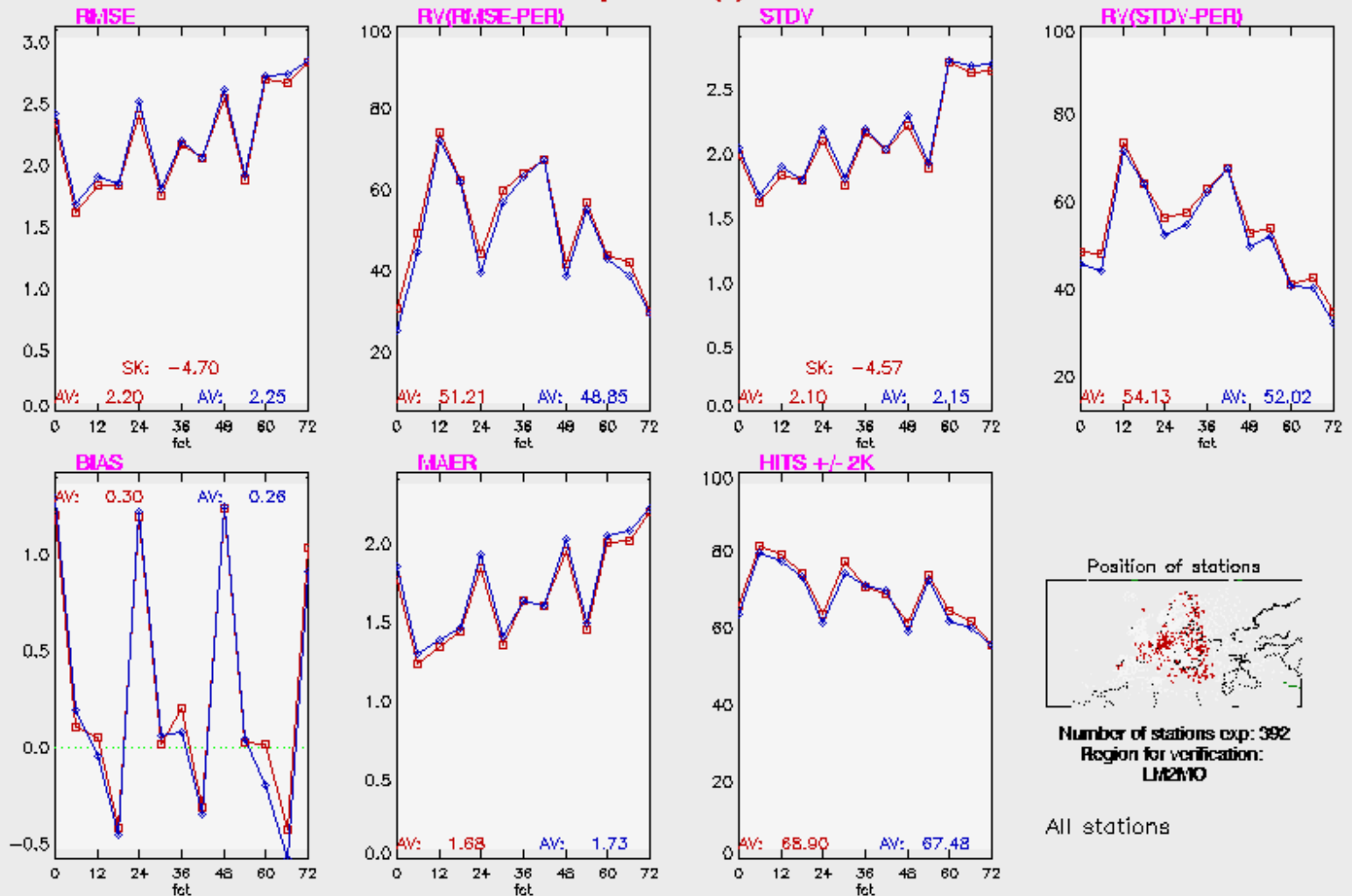
(01-10.08.2015, COSMO-EU Domain, 00 UTC forecasts)

Results of verification of forecasts for local weather elements at surface stations

LM2MO: 01.08.2015 00 UTC - 10.08.2015 00 UTC (exp. run 10200: Bechthold Schema)

lm2mo: 01.08.2015 00 UTC - 10.08.2015 00 UTC (ope. run LON: -30.00 - 63.47 LAT: 27.70 - 70.00: nearest gridpoint)

Temperature (K)



All stations

COSMO-EU: Surface Verification

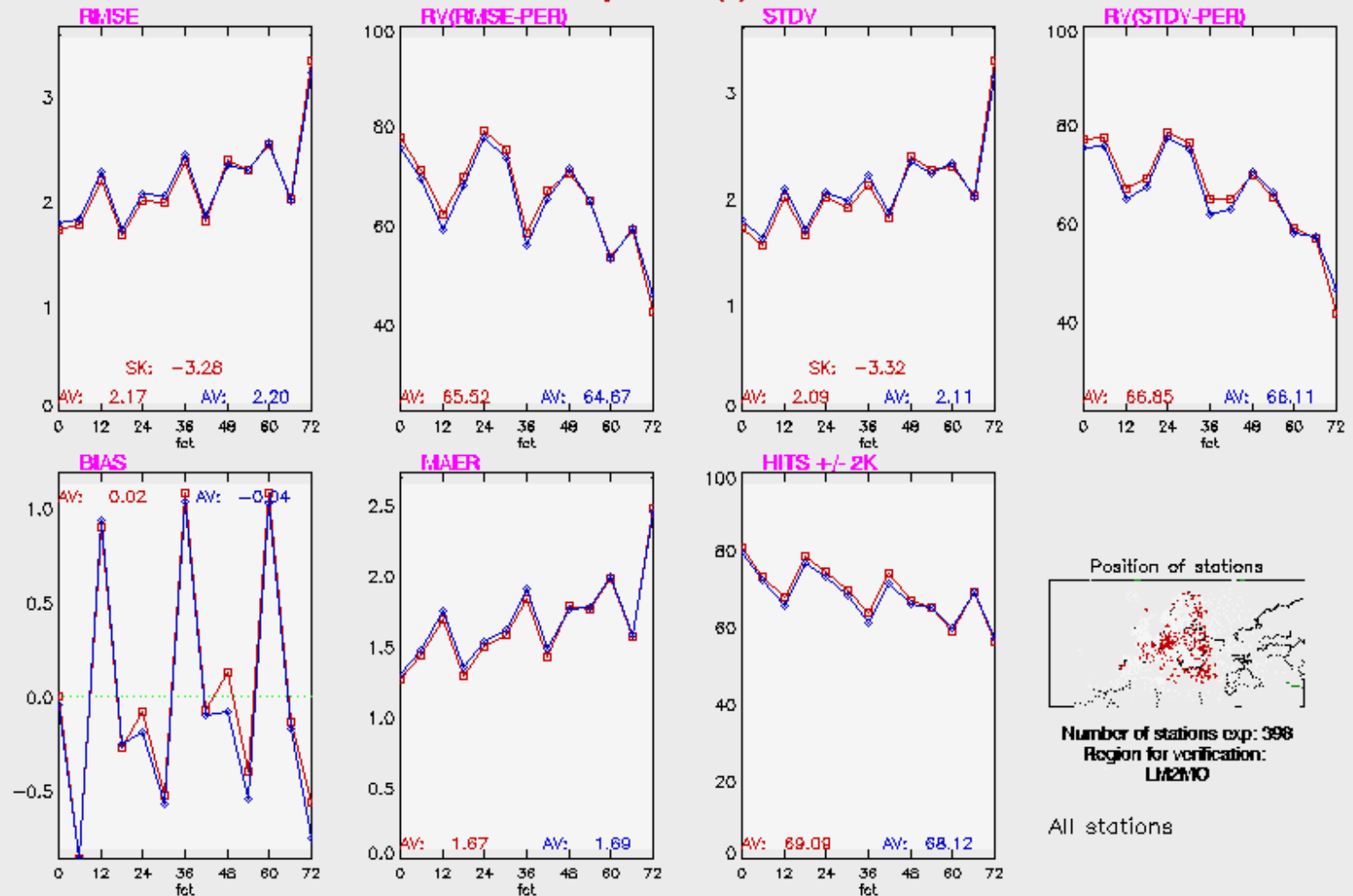
(01-10.08.2015, COSMO-EU Domain, 12 UTC forecasts)

Results of verification of forecasts for local weather elements at surface stations

LM2MO: 01.08.2015 12 UTC – 10.08.2015 12 UTC (exp. run 10200: Bechthold Schema)

lm2mo: 01.08.2015 12 UTC – 10.08.2015 12 UTC (ope. run LON: -30.00 – 63.47 LAT: 27.70 – 70.00: nearest gridpoint)

Temperature (K)



COSMO-EU: Surface Verification

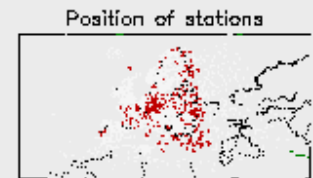
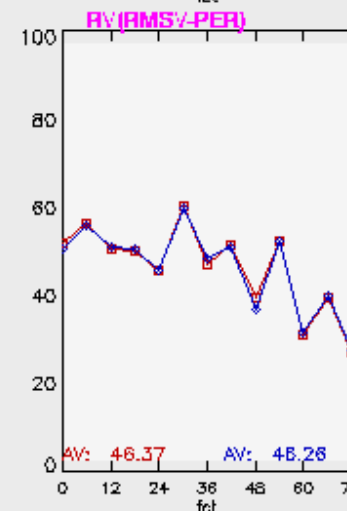
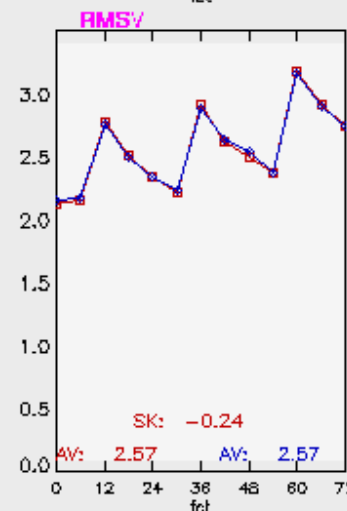
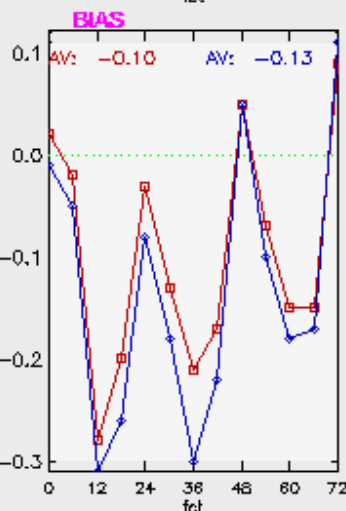
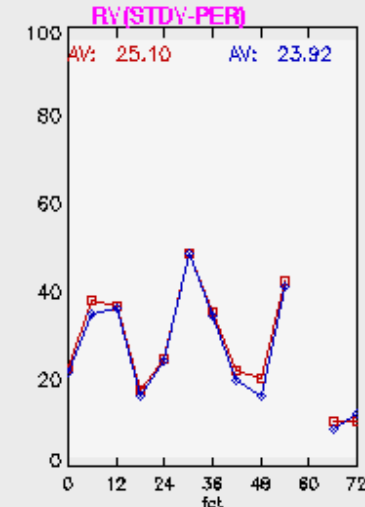
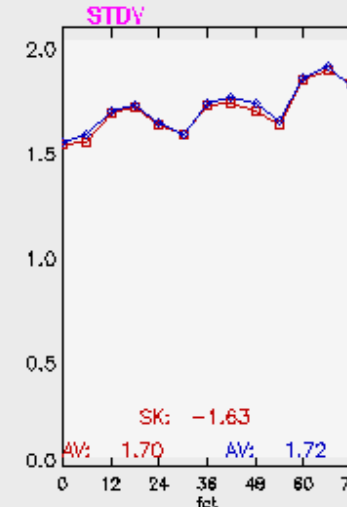
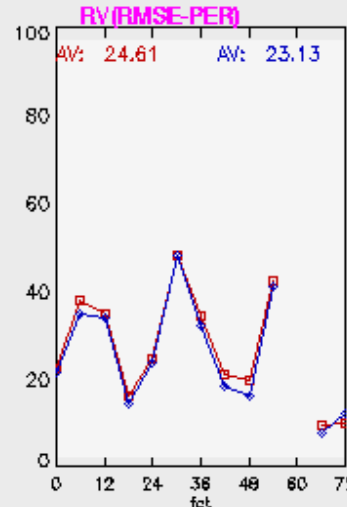
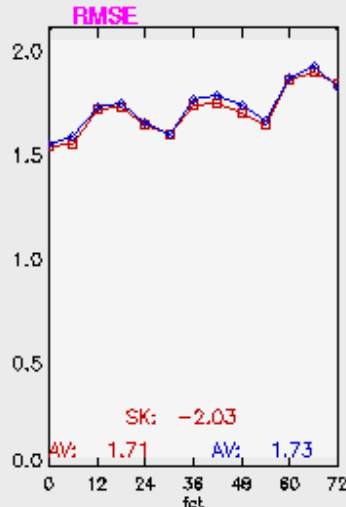
(01-10.08.2015, COSMO-EU Domain, 00 UTC forecasts)

Results of verification of forecasts for local weather elements at surface stations

LM2MO: 01.08.2015 00 UTC - 10.08.2015 00 UTC (exp. run 10200: Bechthold Schema)

lm2mo: 01.08.2015 00 UTC - 10.08.2015 00 UTC (ope. run LDN: -30.00 - 63.47 LAT: 27.70 - 70.00: nearest gridpoint)

Wind speed and RMSV (m s^{-1})



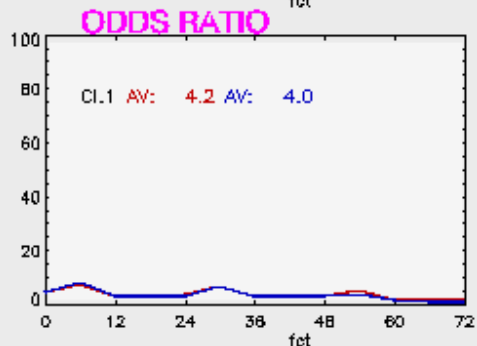
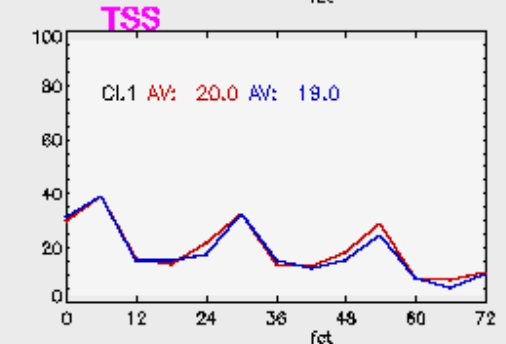
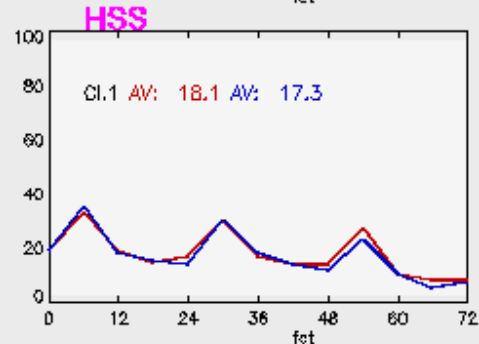
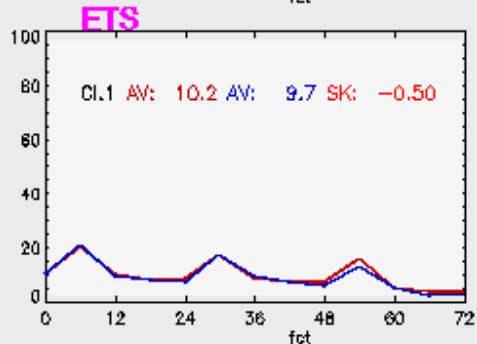
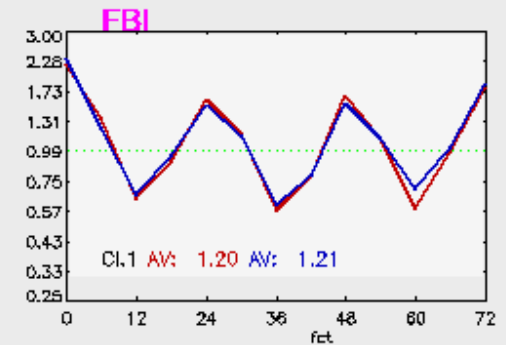
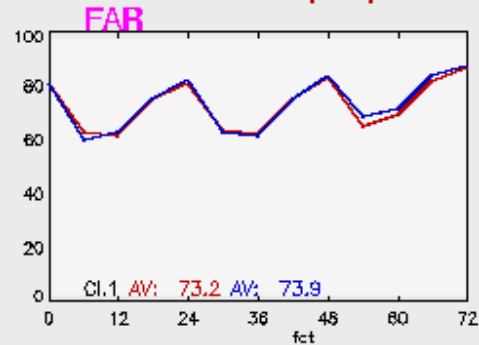
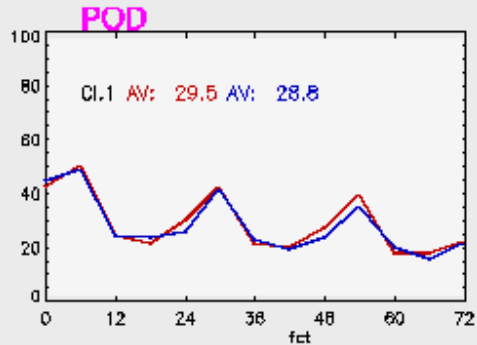
All stations

COSMO-EU: Surface Verification

(01-10.08.2015, COSMO-EU Domain, 00 UTC forecasts)

Results of verification of forecasts for local weather elements at surface stations

Element: **Cloud cover of low clouds (Octa)** All stations



cloud cover above 2 Octa

LM2MO: 01.08.2015 00 UTC - 10.08.2015 00 UTC (exp. run 10200: Bechthold Schema)

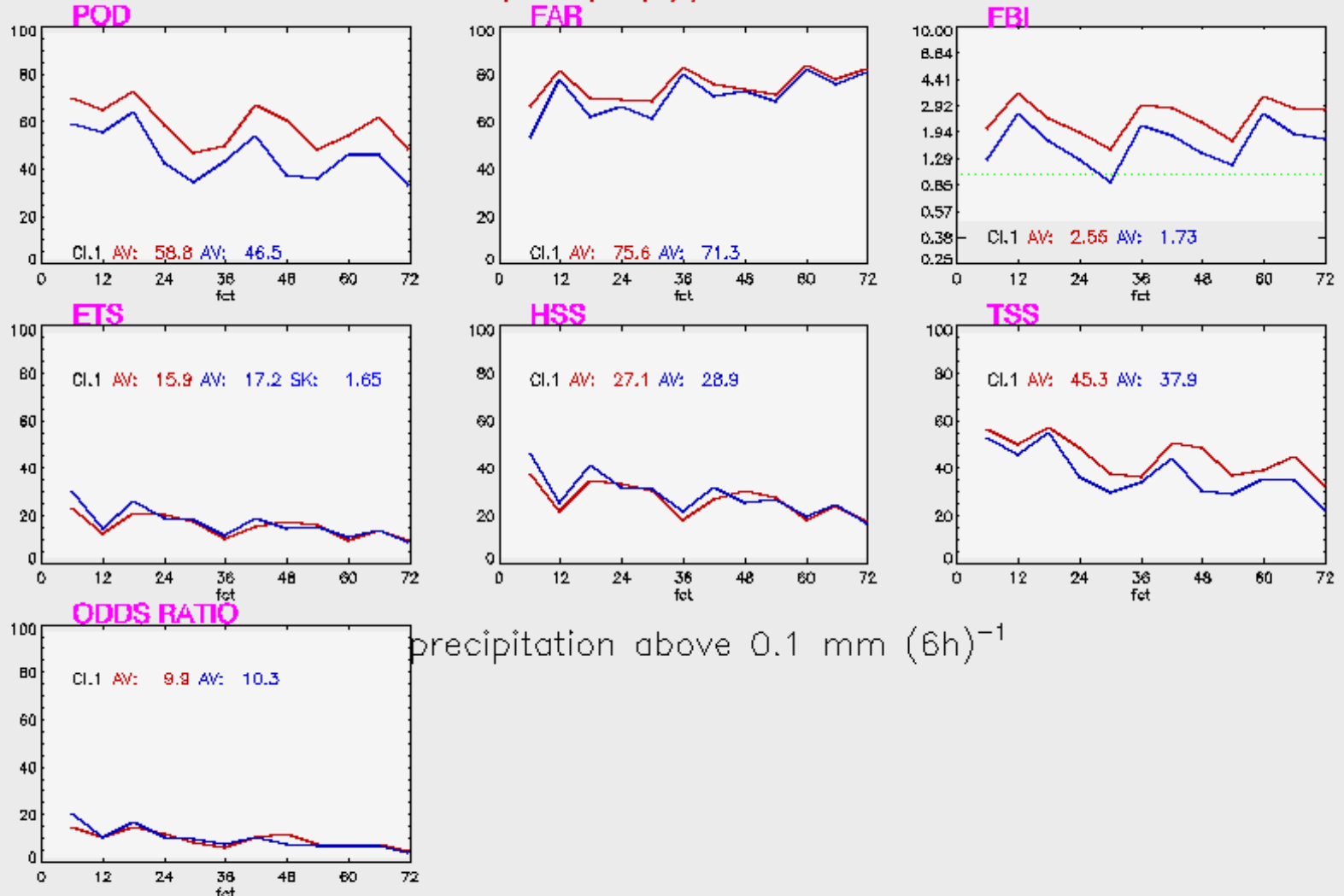
lm2mo: 01.08.2015 00 UTC - 10.08.2015 00 UTC (ope. run LON: -30.00 - 63.47 LAT: 27.70 - 70.00: nearest gridpoint)

COSMO-EU: Surface Verification

(01-10.08.2015, COSMO-EU Domain, 00 UTC forecasts)

Results of verification of forecasts for local weather elements at surface stations

Element: **Precipitation (mm (6h)⁻¹)** All stations



precipitation above 0.1 mm (6h)⁻¹

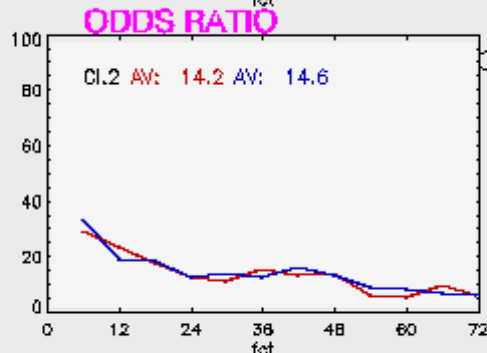
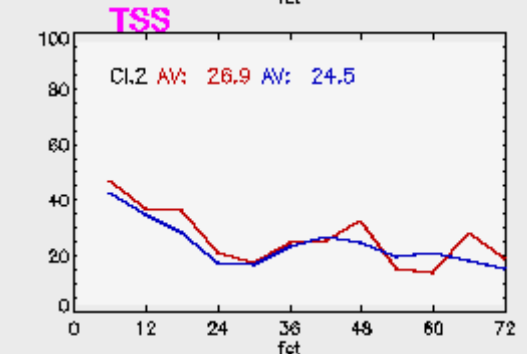
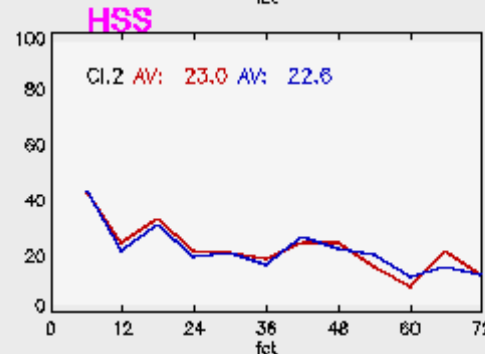
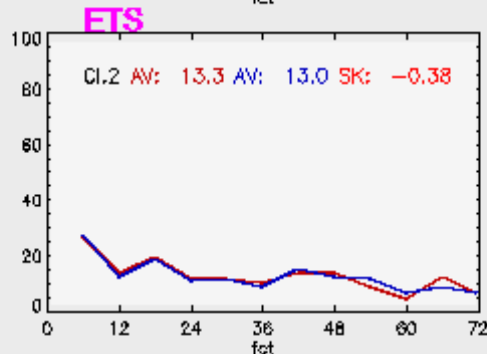
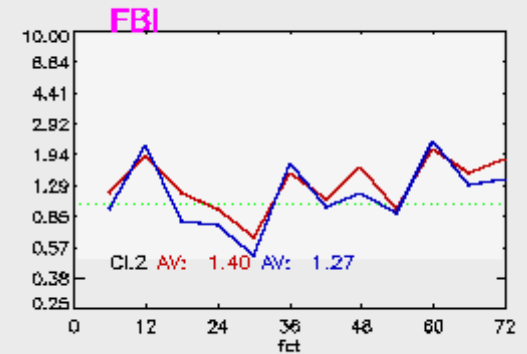
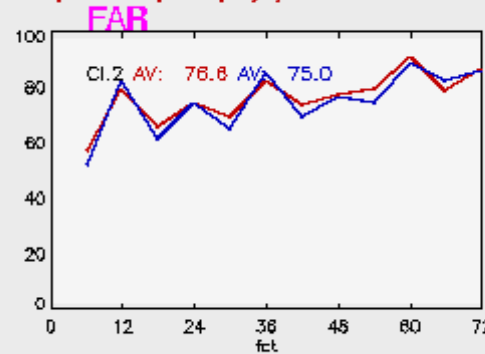
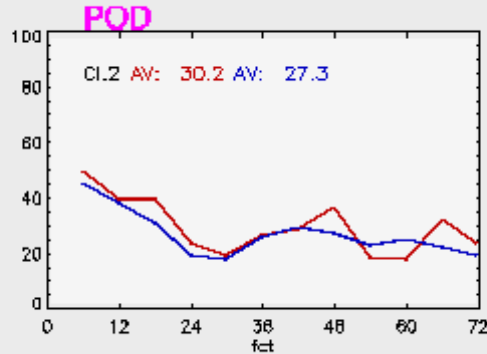
LM2MO: 01.08.2015 00 UTC – 10.08.2015 00 UTC (exp. run 10200: Bechthold Schema)

lm2mo: 01.08.2015 00 UTC – 10.08.2015 00 UTC (ope. run LON: -30.00 – 63.47 LAT: 27.70 – 70.00: nearest gridpoint)

COSMO-EU: Surface Verification

(01-10.08.2015, COSMO-EU Domain, 00 UTC forecasts)

Results of verification of forecasts for local weather elements at surface stations
 Element: **Precipitation (mm (6h)⁻¹)** All stations



precipitation above 2 mm (6h)⁻¹

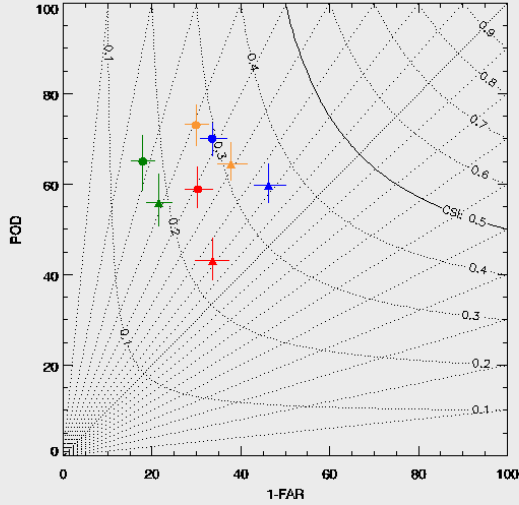
LM2MO: 01.08.2015 00 UTC – 10.08.2015 00 UTC (exp. run 10200: Bechthold Schema)

lm2mo: 01.08.2015 00 UTC – 10.08.2015 00 UTC (ope. run LON: -30.00 – 63.47 LAT: 27.70 – 70.00: nearest gridpoint)

COSMO-EU: Surface Verification

(01-10.08.2015, COSMO-EU Domain, 00 UTC forecasts)

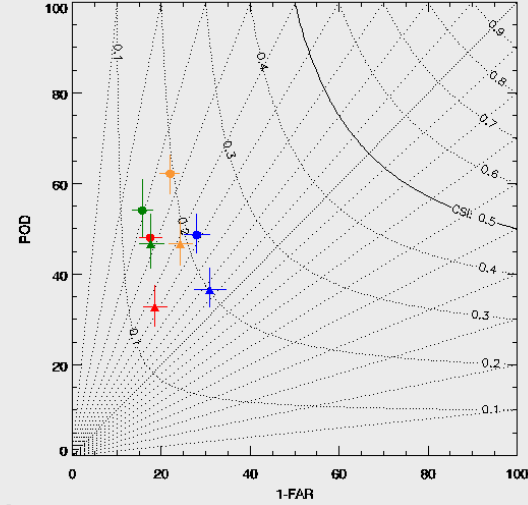
Precipitation (precipitation above 0.1 mm (6h)⁻¹) [6.4% of all cases]



Forecast time: 006 hours
 Forecast time: 012 hours
 Forecast time: 018 hours
 Forecast time: 024 hours

● Model: LM2M0: 01.08.2015 00 UTC - 10.08.2015 00 UTC (exp. run 10200; Bechthold Schema)
 ▲ Model: Im2mo: 01.08.2015 00 UTC - 10.08.2015 00 UTC (ope. run L0N: -30.00 - 63.47 LAT: 27.70 - 70.00; nearest gridpoint)
 All stations

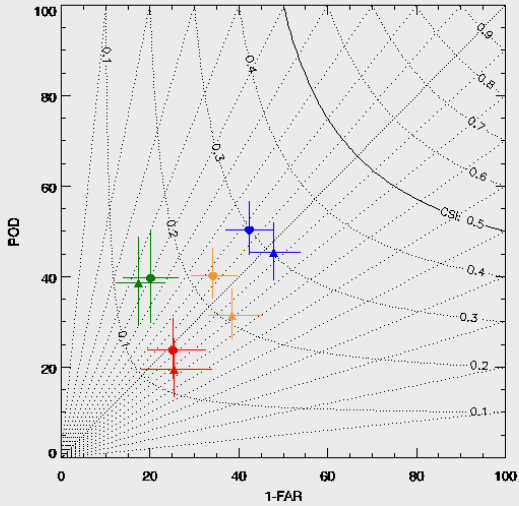
Precipitation (precipitation above 0.1 mm (6h)⁻¹) [6.4% of all cases]



Forecast time: 054 hours
 Forecast time: 060 hours
 Forecast time: 066 hours
 Forecast time: 072 hours

● Model: LM2M0: 01.08.2015 00 UTC - 10.08.2015 00 UTC (exp. run 10200; Bechthold Schema)
 ▲ Model: Im2mo: 01.08.2015 00 UTC - 10.08.2015 00 UTC (ope. run L0N: -30.00 - 63.47 LAT: 27.70 - 70.00; nearest gridpoint)
 All stations

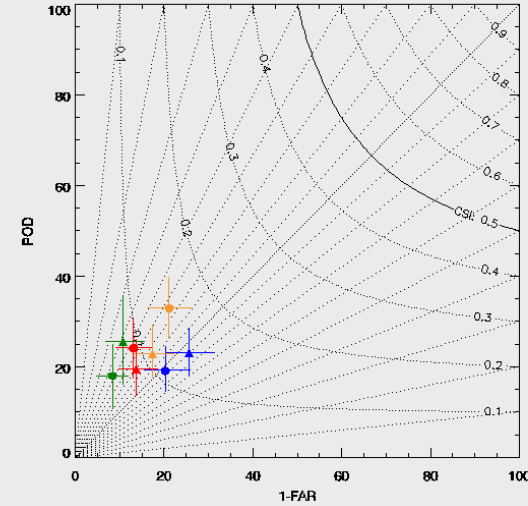
Precipitation (precipitation above 2 mm (6h)⁻¹) [3.0% of all cases]



Forecast time: 006 hours
 Forecast time: 012 hours
 Forecast time: 018 hours
 Forecast time: 024 hours

● Model: LM2M0: 01.08.2015 00 UTC - 10.08.2015 00 UTC (exp. run 10200; Bechthold Schema)
 ▲ Model: Im2mo: 01.08.2015 00 UTC - 10.08.2015 00 UTC (ope. run L0N: -30.00 - 63.47 LAT: 27.70 - 70.00; nearest gridpoint)
 All stations

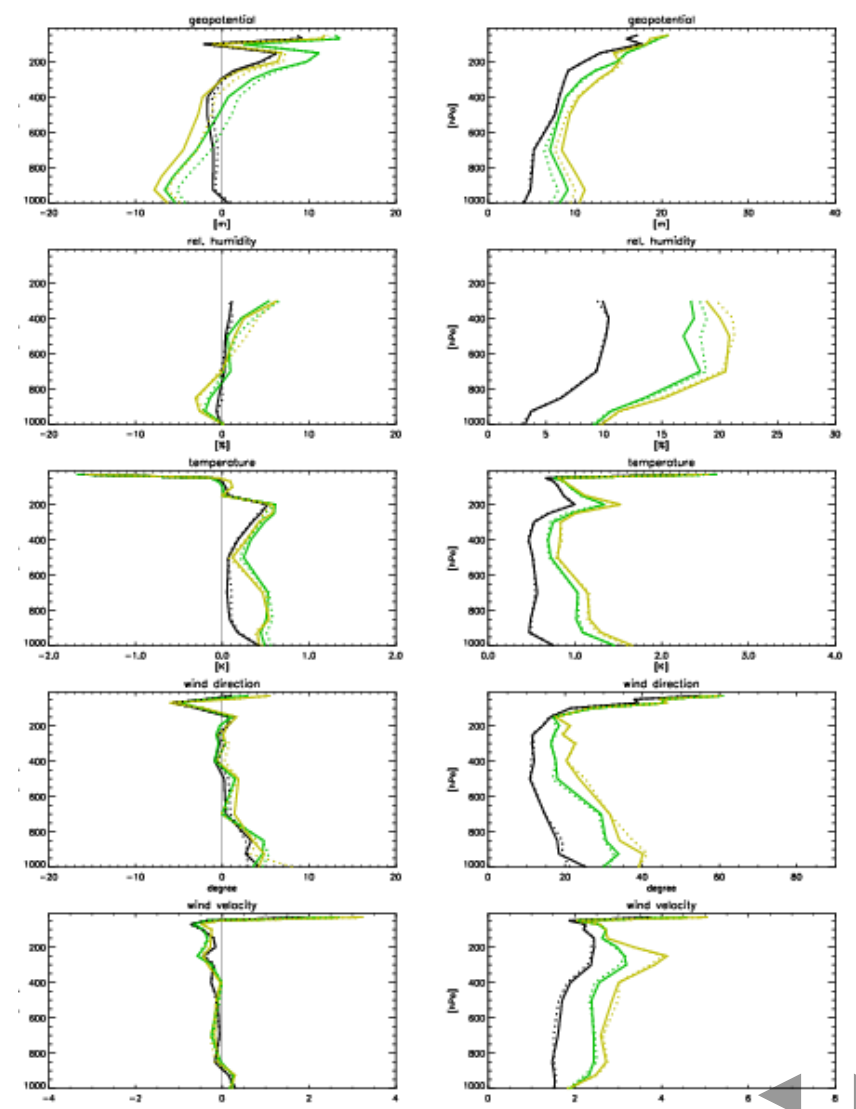
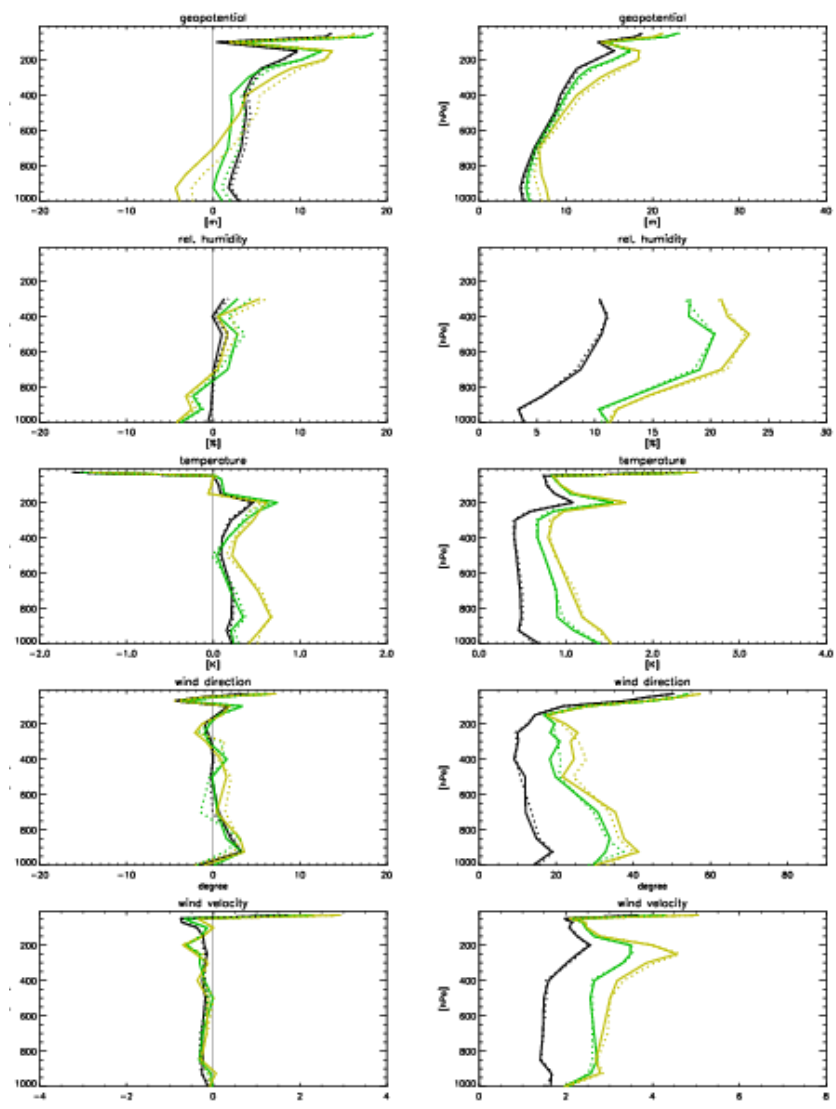
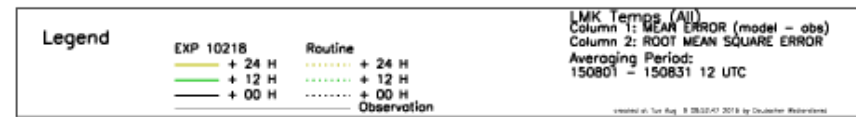
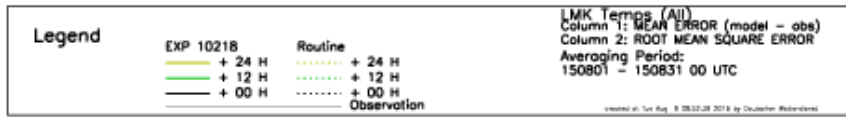
Precipitation (precipitation above 2 mm (6h)⁻¹) [3.0% of all cases]



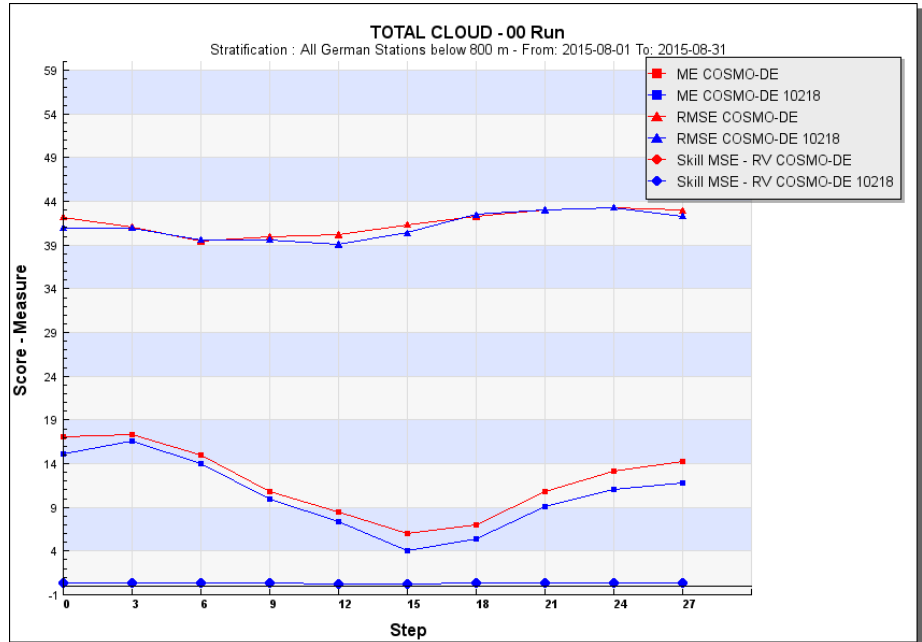
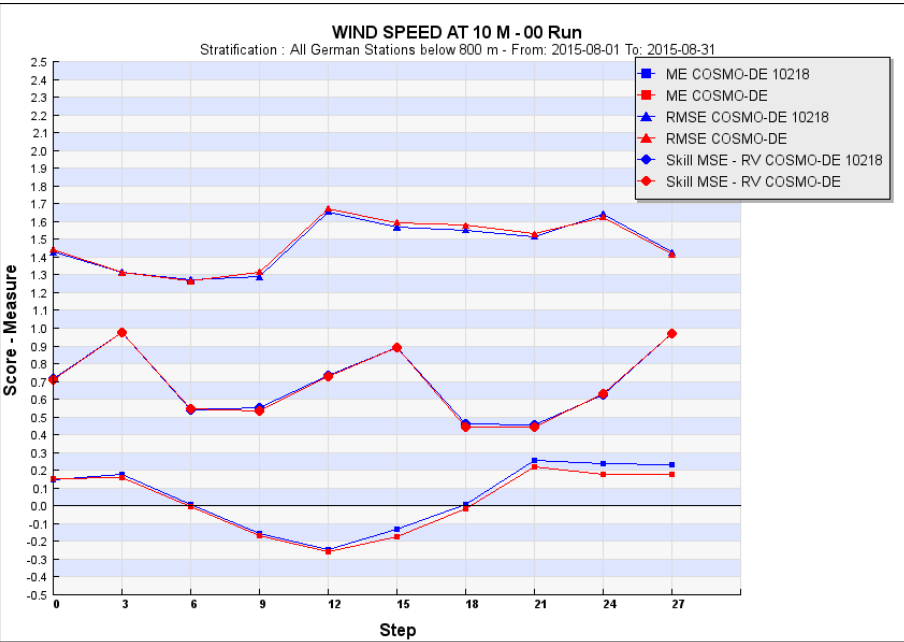
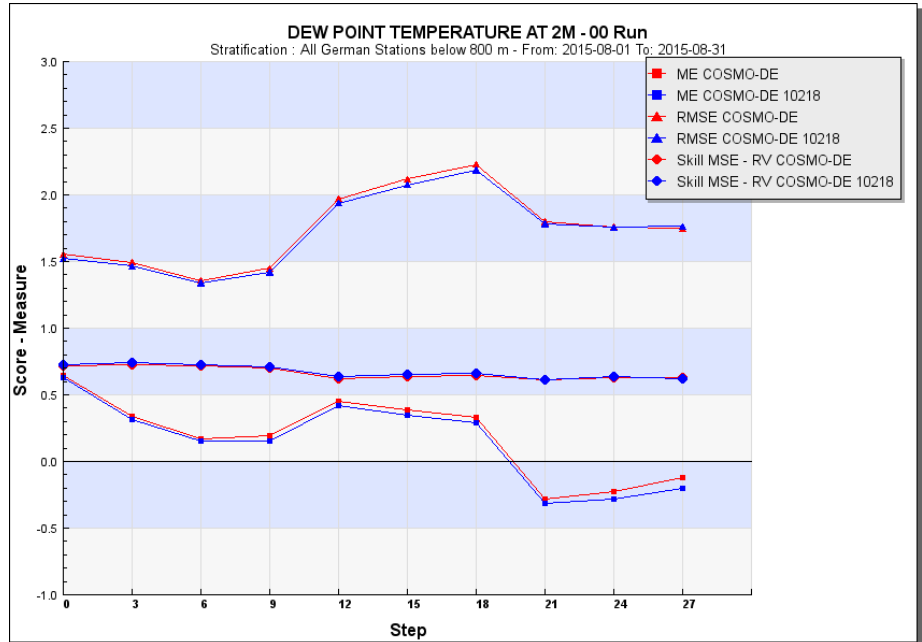
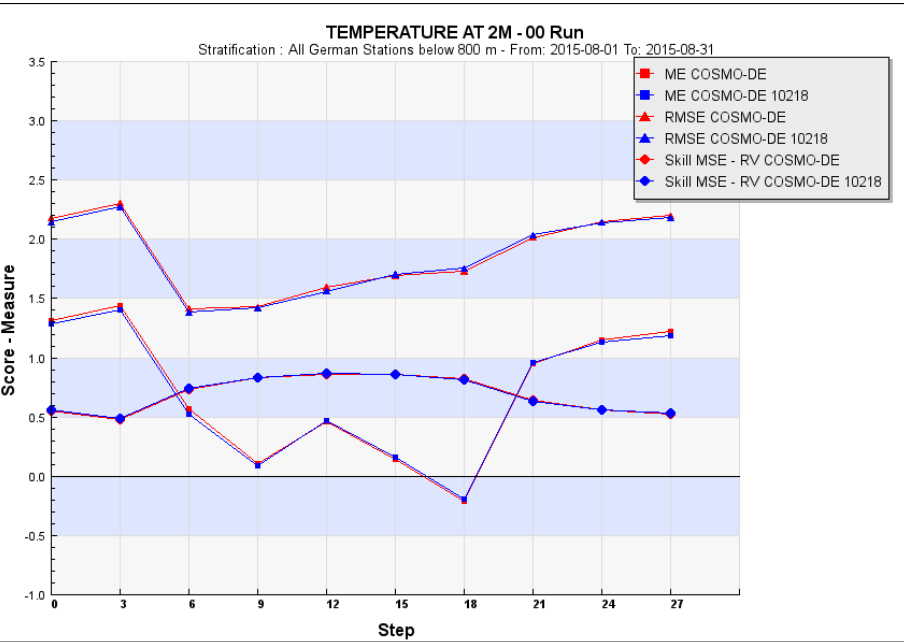
Forecast time: 054 hours
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 Forecast time: 066 hours
 Forecast time: 072 hours

● Model: LM2M0: 01.08.2015 00 UTC - 10.08.2015 00 UTC (exp. run 10200; Bechthold Schema)
 ▲ Model: Im2mo: 01.08.2015 00 UTC - 10.08.2015 00 UTC (ope. run L0N: -30.00 - 63.47 LAT: 27.70 - 70.00; nearest gridpoint)
 All stations

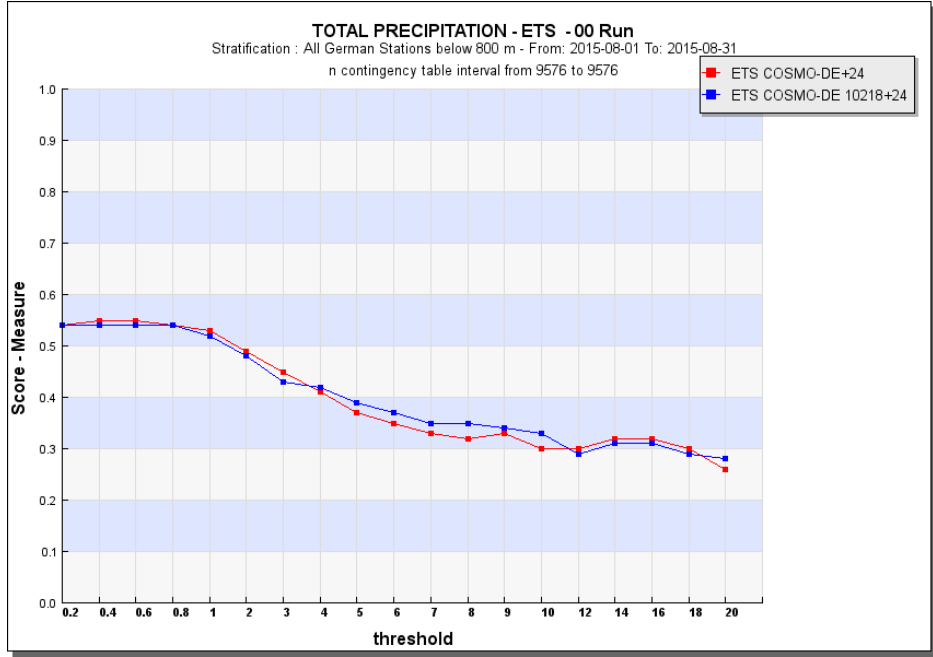
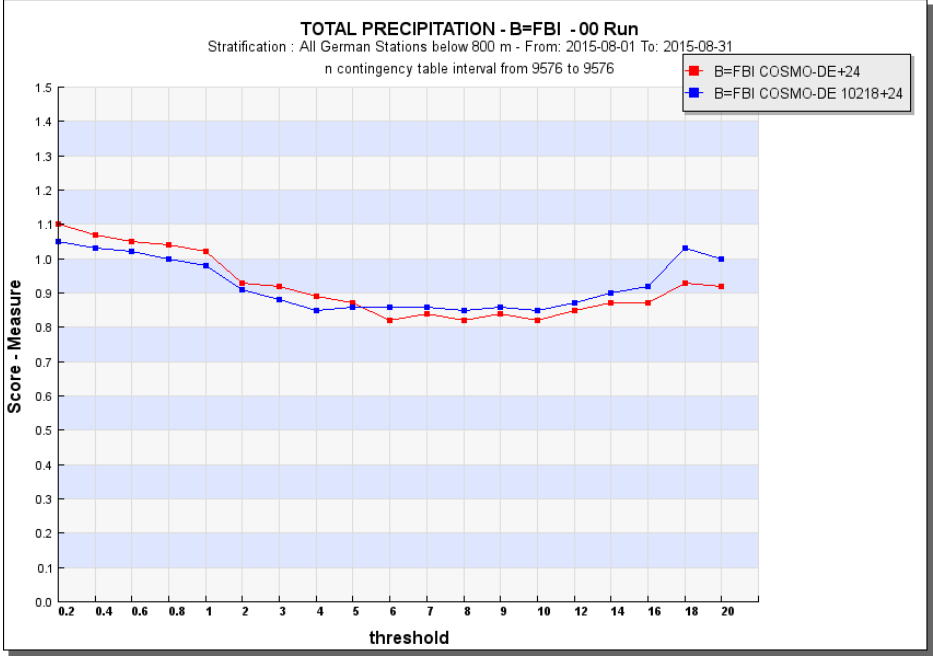
COSMO-DE: Upper Air Verification (01-31.08.2015)



COSMO-DE: Surface Verification (01-31.08.2015, 00 UTC frsts)



COSMO-DE: Surface Verification (01-31.08.2015, 00 UTC frsts)



1 indicates perfect score



COSMO-DE Precipitation

COSMO-DE

driven by COSMO-EU with IFS scheme (Exp_10218)

versus

COSMO-DE Routine (driven by COSMO-EU with Tiedtke scheme),

COSMO-DE driven by ICON-EU (3dVar) (Exp_10076),

COSMO-DE driven by ICON-EU (EDA) (Exp_10168)

- 1 August 2015 (00UTC), [html](#)
- 4 August 2015 (00UTC), [html](#)
- 7 August 2015 (00UTC), [html](#)



Conclusions and Outlook

- ECMWF-IFS (Tiedtke-Bechtold) cumulus convection is implemented into COSMO
- IFS scheme is included into the official COSMO code (version 5.05/5.04b)
- Results from test runs look reasonable; verification scores are neutral to slightly positive
- Drizzle problem (cf. ICON)
- IFS scheme may/should become a default option within COSMO (towards unified COSMO-ICON physics)

Thanks for your attention!

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