Verification Overview

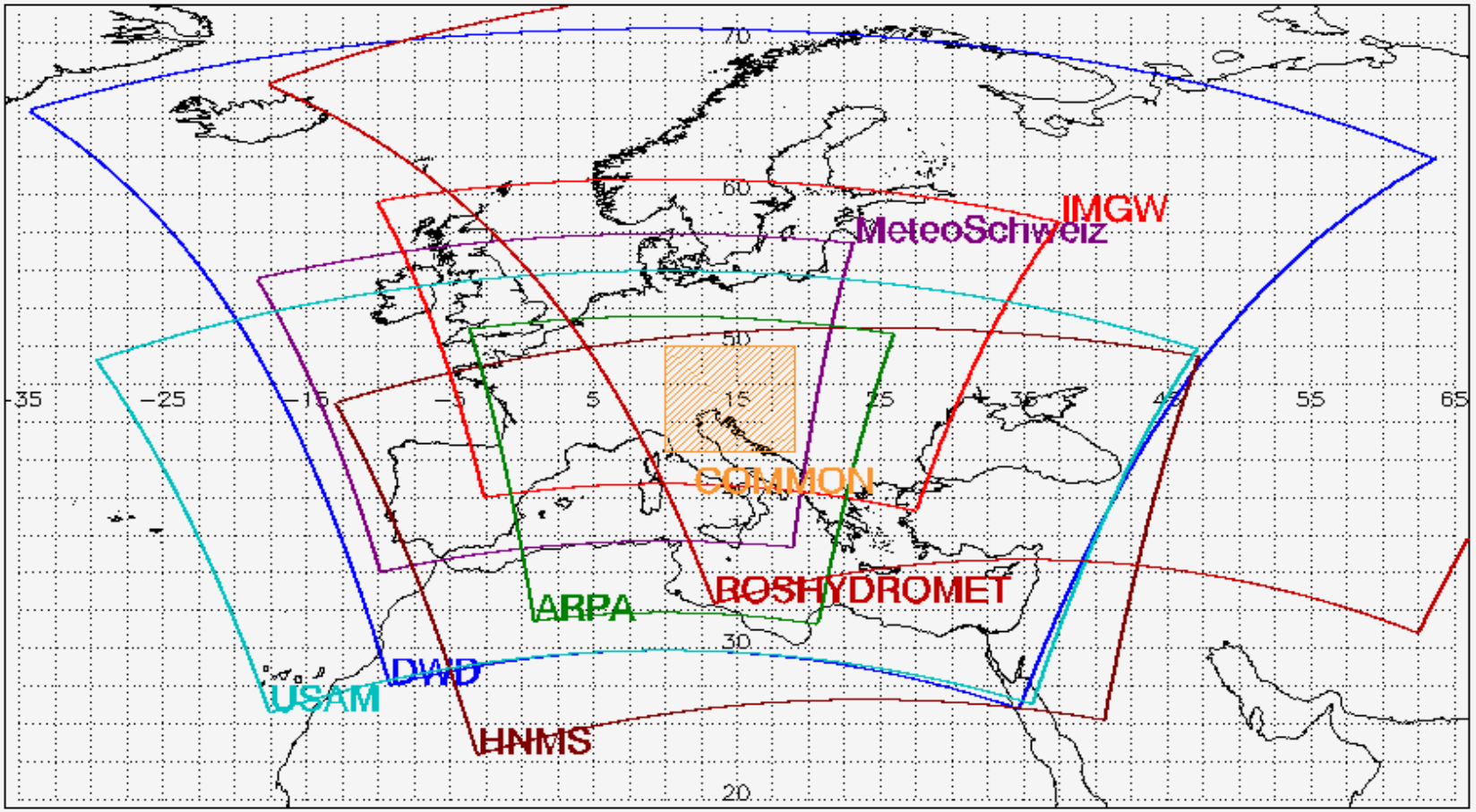
(based on CP activity)

Dimitra Boucouvala & WG5

CONSORTIUM FOR SMALL SCALE MODELING

COSMO

Standard Verification on Common Area- 7km COSMO models and IFS-ECMWF, ICON and ICON-EU



Standard Verification on Common Area

- **Period: JJA 2015, SON 2015, DJF 2015/2016, MAM 2016**
- **Run: 00 UTC run**
- **Continuous parameters - T2m, Td2m, Mslp, Wspeed, TCC**
  - Scores : ME, RMSE
  - Forecasts Step: every 3 hours
- **Dichotomous parameters – Precipitation (15km radius method):**
  - Scores: FBI-POD-FAR-TS with Performance Diagram
  - Cumulating: 6h and 24h
  - Thresholds: 0.2, 2, 5, 10

Weather elements for ComA

June 2015-May2016

JJA : above average warm and dry- some convective precipitation

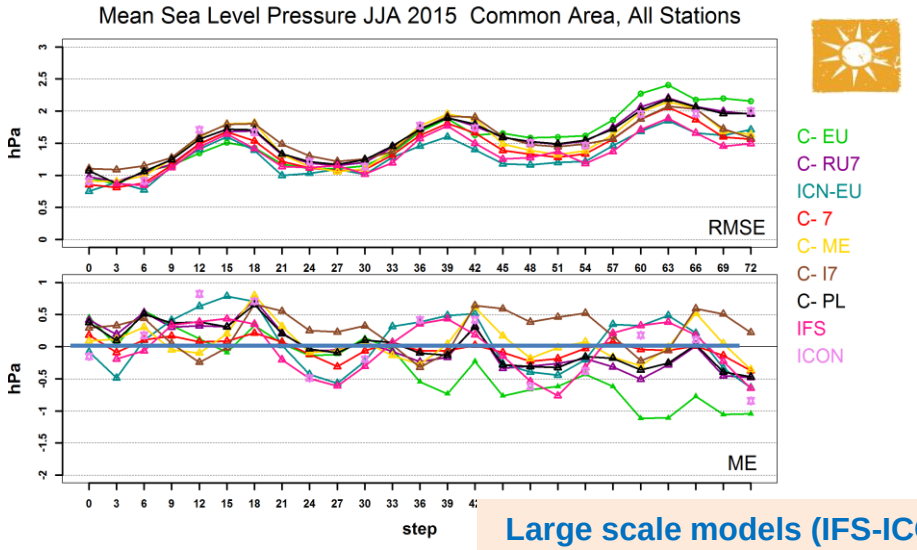
SON: alteration of warm and dry regime- days with rainfall

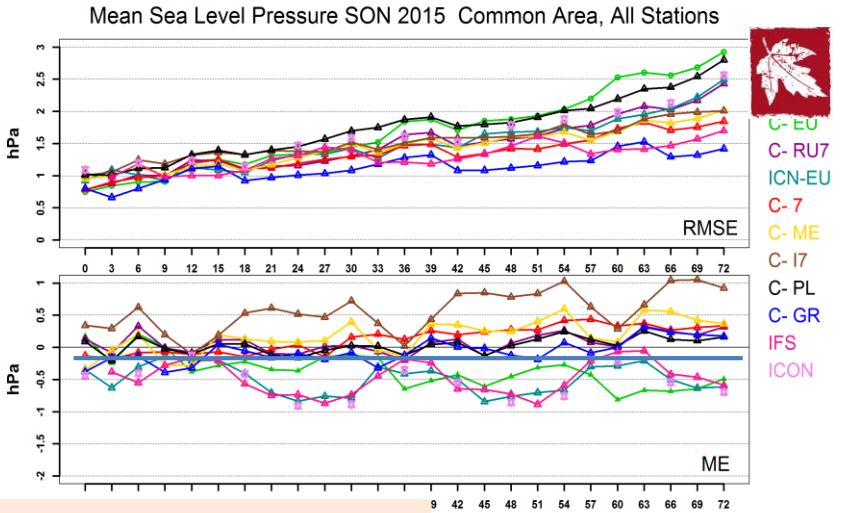
DJF : Mild winter with cooler days and rain the second half

MAM: alteration of warm and dry regime- days with rainfall

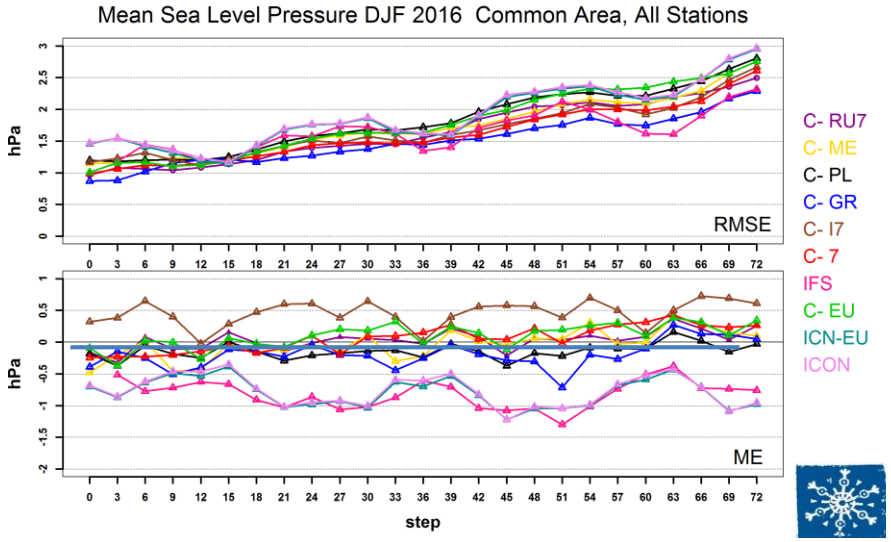
Generally temperatures above average.

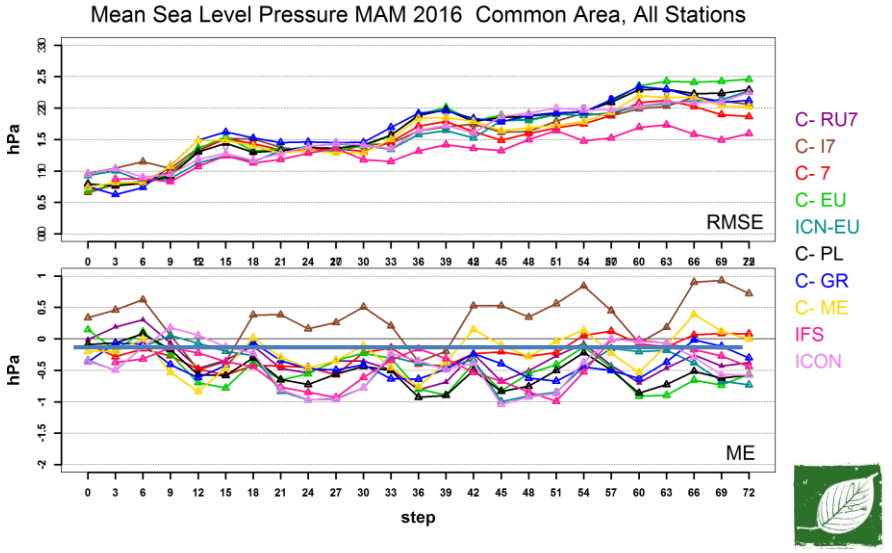
MSLP



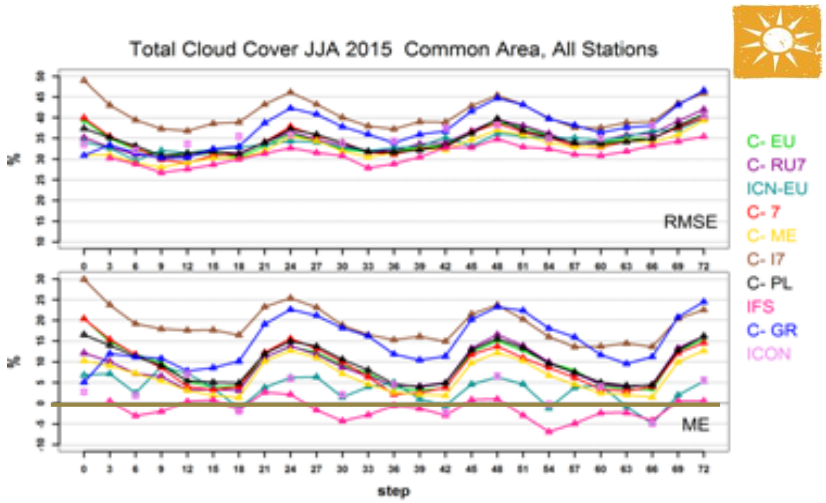


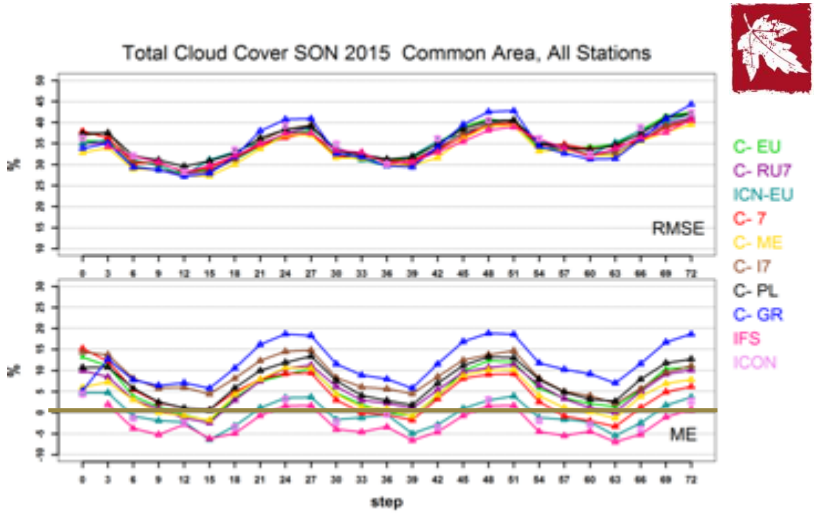
Large scale models (IFS-ICON) and ICON-EU tendency of underestimation almost identical bias values, but IFS lower RMSE. JJA RMSE diurnal cycle. RMSE increases with time lead.



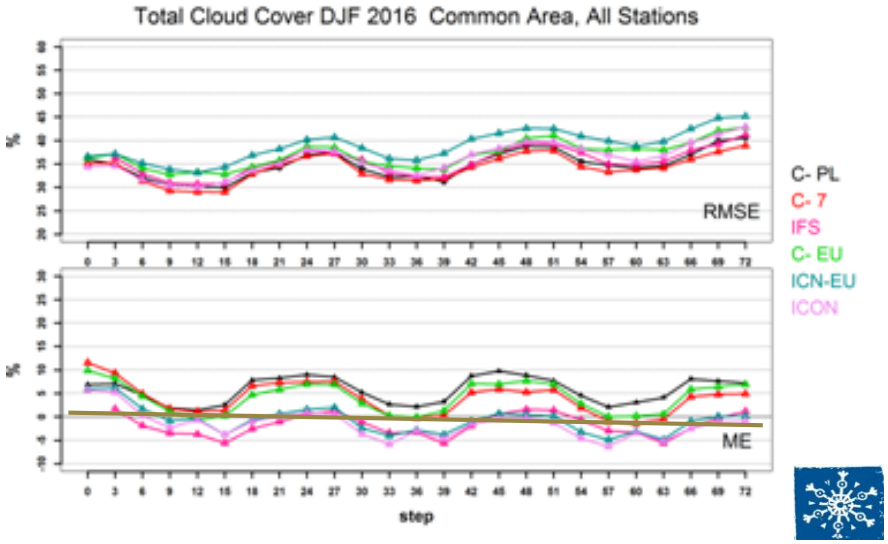


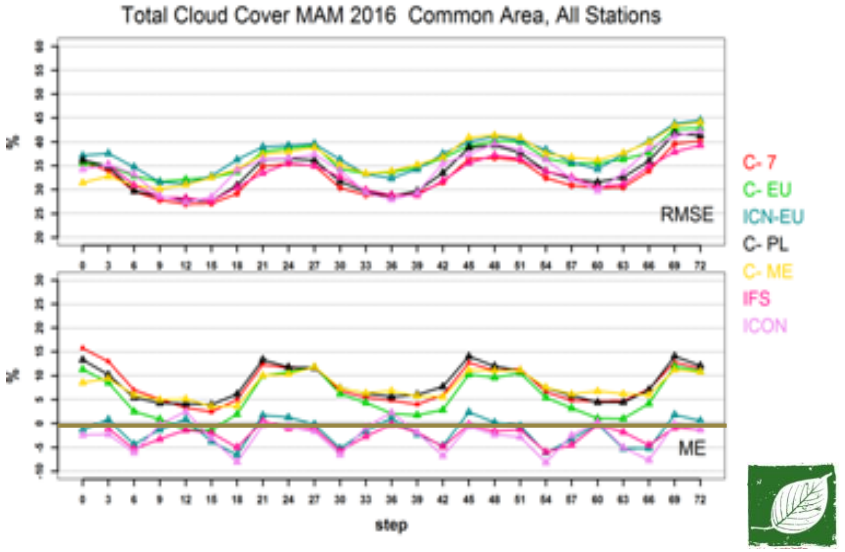
Total Cloud Cover



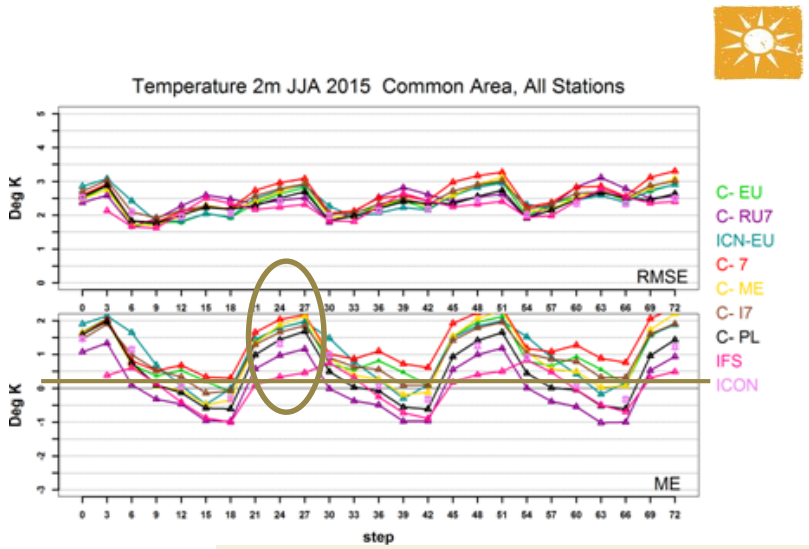


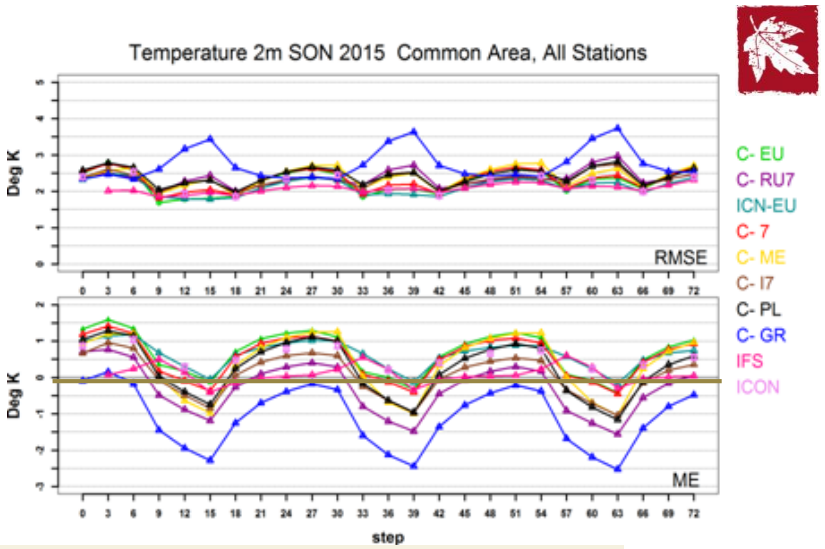
COSMO models follow similar cycle. Overestimation especially at night. IFS, ICON, ICON-EU lower bias



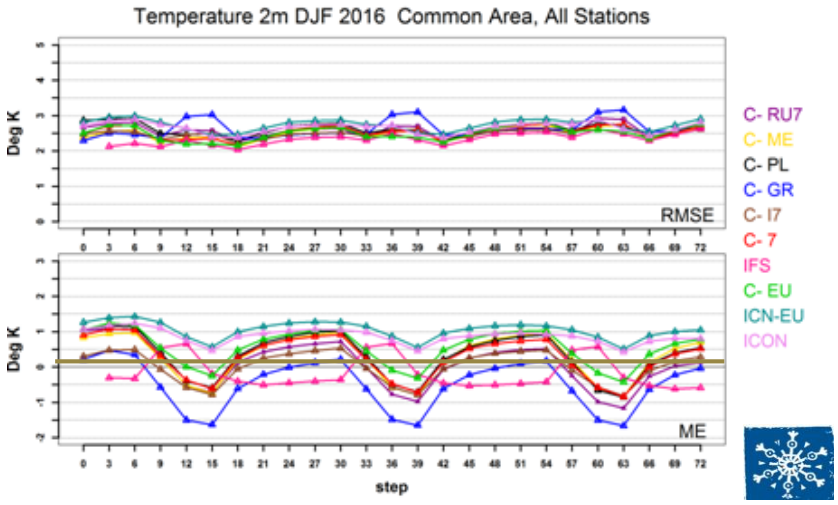


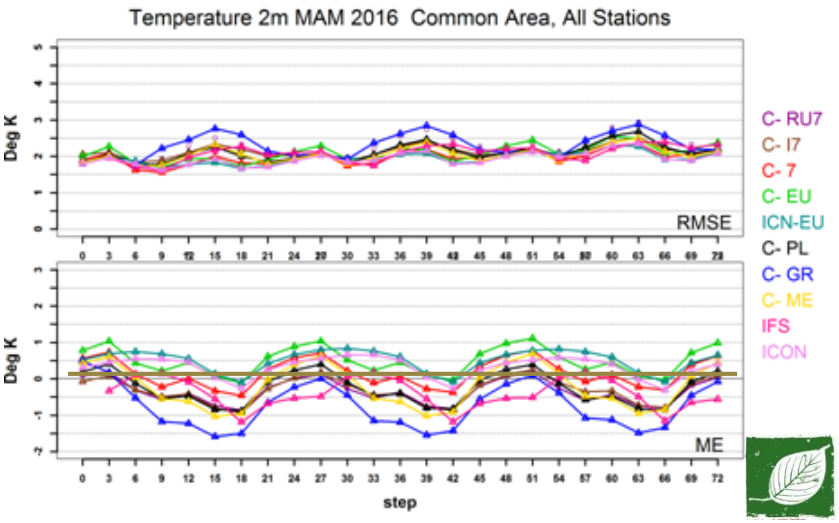
Temperature 2m



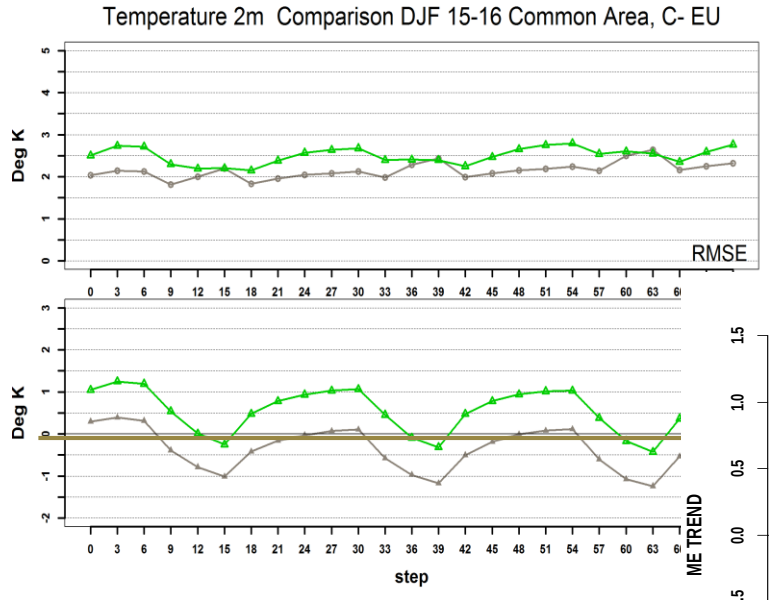


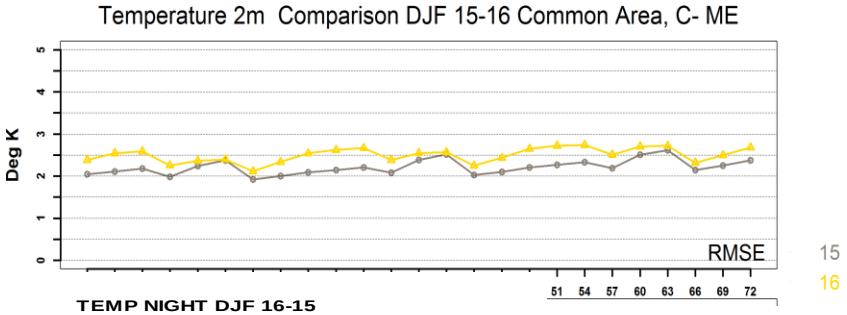
Clear bias diurnal variability with overstimation at night and understimation in the day. JJA high bias at night and less negative in the day. (warm and dry season) .

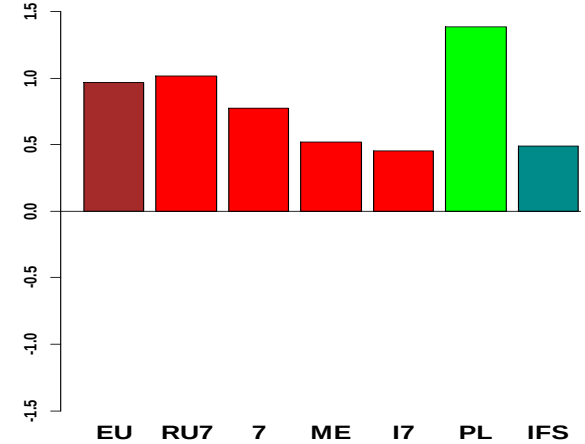


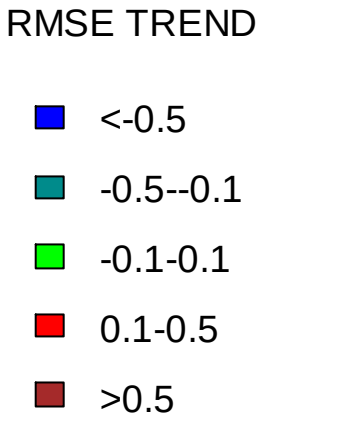


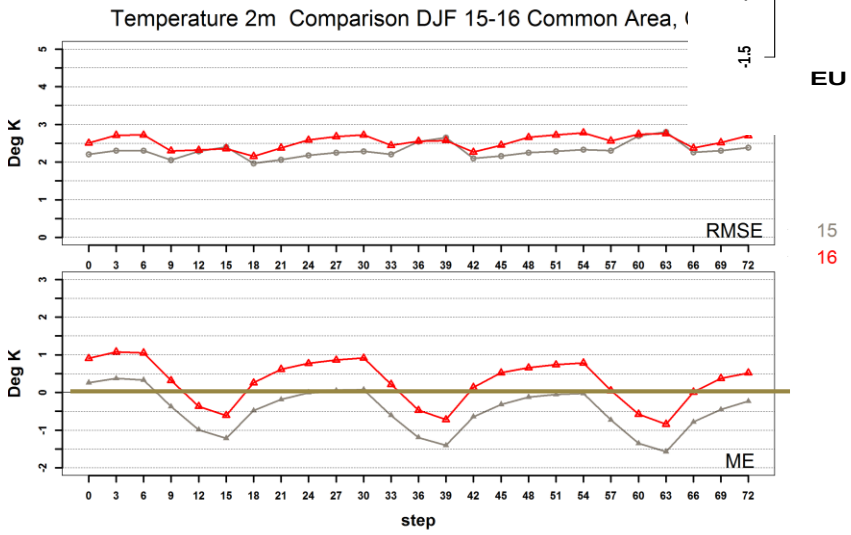
2m Temp DJF 16 and 15

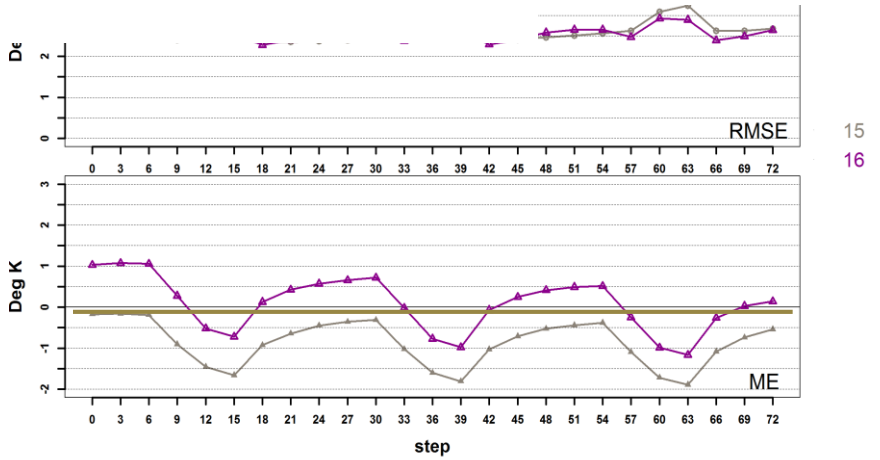




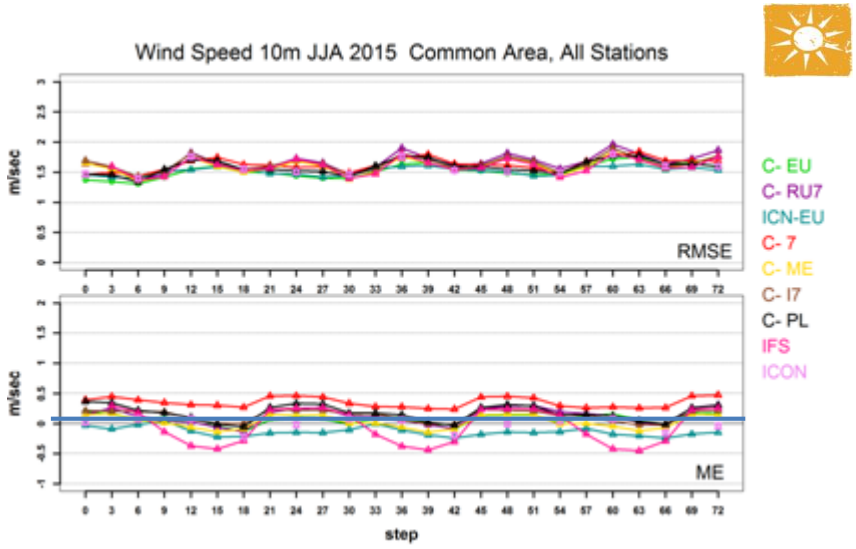


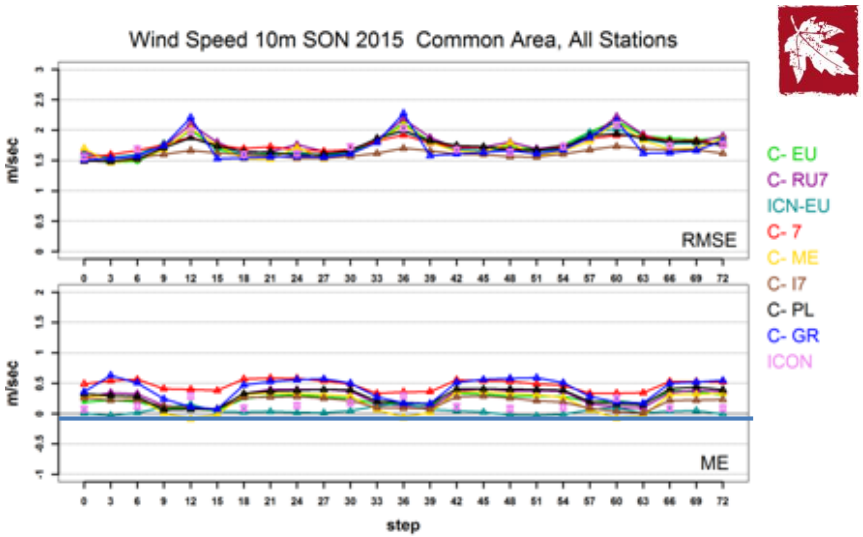




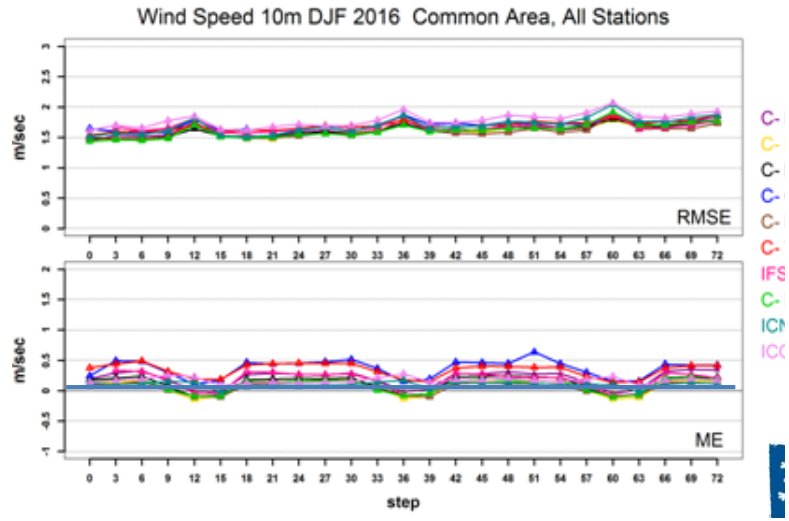


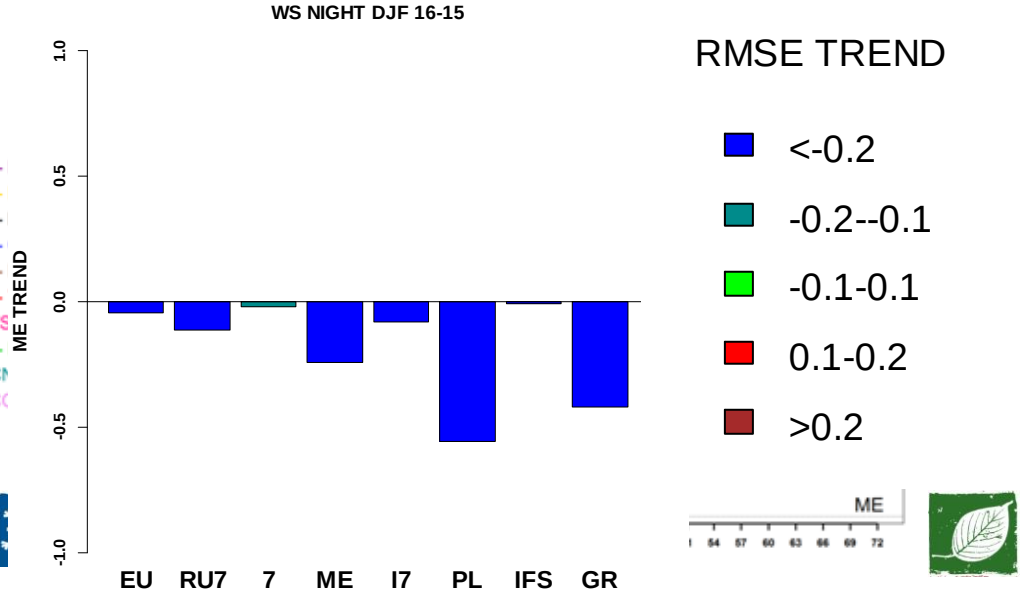
WIND SPEED 10m

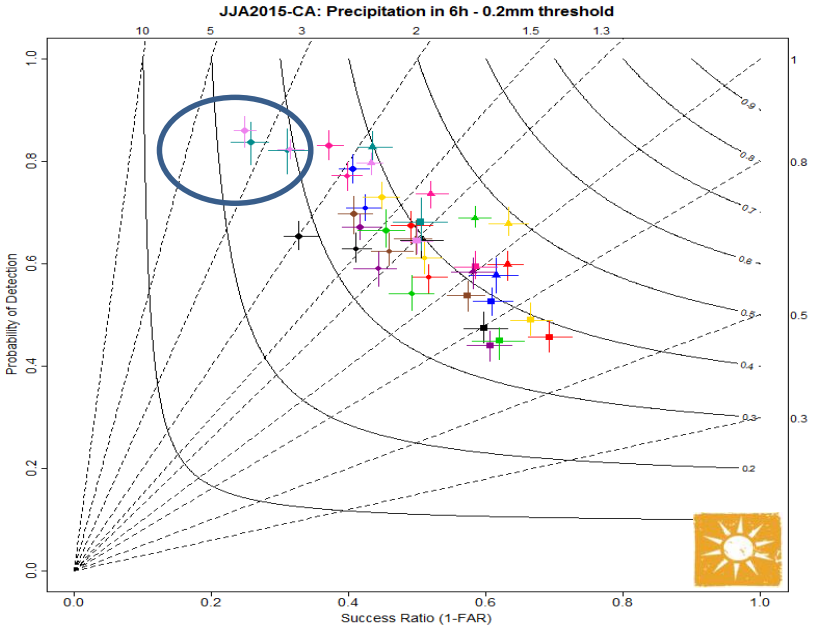


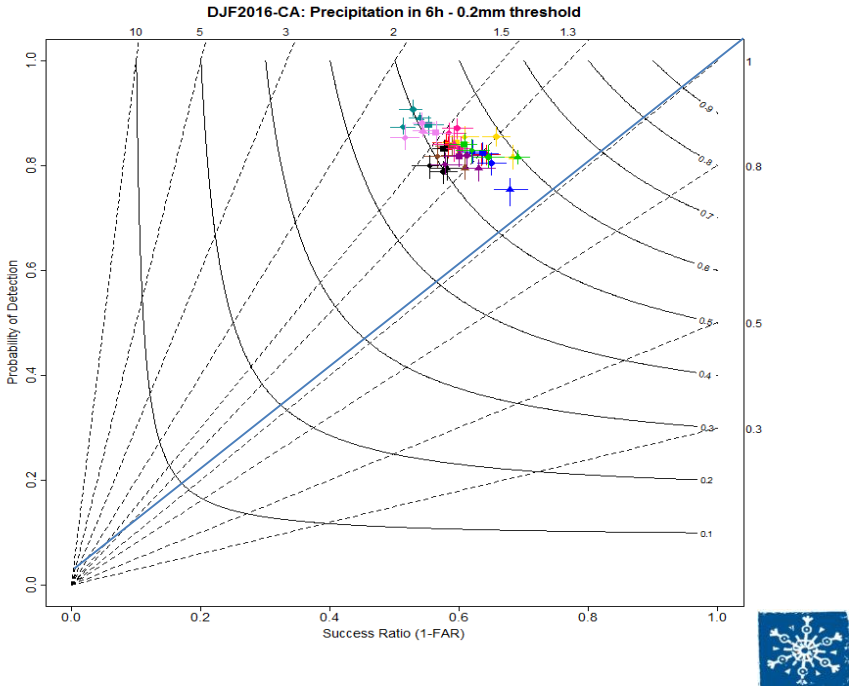


Minimum of diurnal cycle. Tendency of overestimation especially at night







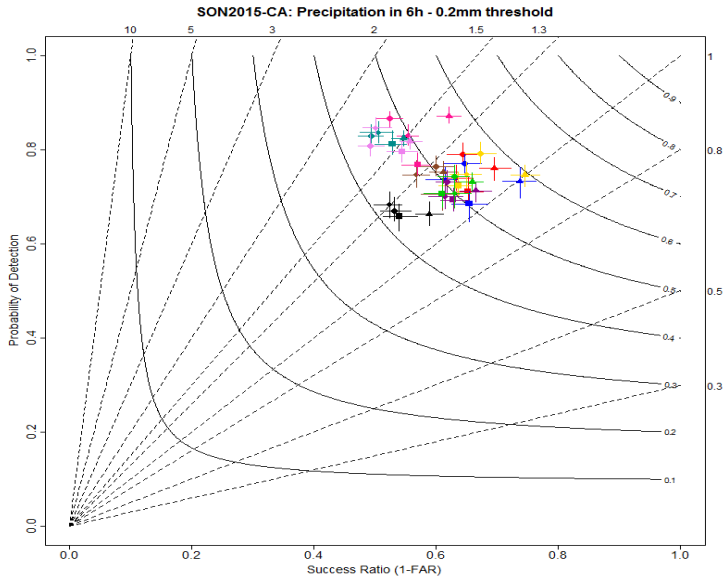


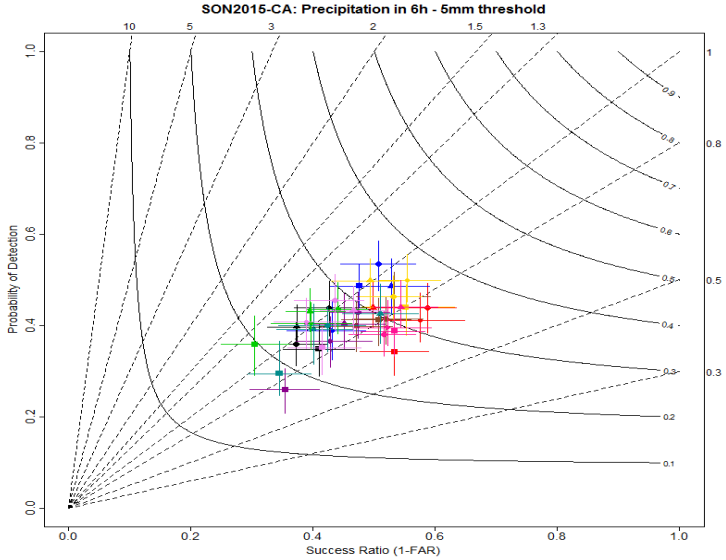
JJA and DJF different : JJA clear FBI diurnal cycle with overestimation especially 12h, but underestimation at 24h. DJF models grouped together with FBI >1. ICON and ICON-EU FBI >>1 POD >>0

6h > 0.2mm

FORECAST DAY 1

- COSMO-7 + 06
- COSMO-7 + 12
- COSMO-7 + 18
- COSMO-7 + 24
- COSMO-GR + 06
- COSMO-GR + 12
- COSMO-GR + 18
- COSMO-GR + 24
- COSMO-I7 + 06
- COSMO-I7 + 12
- COSMO-I7 + 18
- COSMO-I7 + 24
- COSMO-ME + 06
- COSMO-ME + 12
- COSMO-ME + 18
- COSMO-ME + 24
- COSMO-PL + 06
- COSMO-PL + 12
- COSMO-PL + 18
- COSMO-PL + 24
- ECMWF-IFS + 06
- ECMWF-IFS + 12
- ECMWF-IFS + 18
- ECMWF-IFS + 24
- COSMO-RU + 06
- COSMO-RU + 12
- COSMO-RU + 18
- COSMO-RU + 24
- COSMO-EU + 06
- COSMO-EU + 12
- COSMO-EU + 18
- COSMO-EU + 24
- ICN-EU + 06
- ICN-EU + 12
- ICN-EU + 18
- ICN-EU + 24
- ICON + 06
- ICON + 12
- ICON + 18
- ICON + 24





With increasing Threshold, FBI decreases. TS differences among hours increase. IFS, ICON, ICON-EU difference from other models decreases with threshold

6h >0.2mm

6h >5mm

SON

FORECAST DAY 1

- COSMO-7 + 06
- COSMO-7 + 12
- COSMO-7 + 18
- COSMO-7 + 24
- COSMO-GR + 06
- COSMO-GR + 12
- COSMO-GR + 18
- COSMO-GR + 24
- COSMO-I7 + 06
- COSMO-I7 + 12
- COSMO-I7 + 18
- COSMO-I7 + 24
- COSMO-ME + 06
- COSMO-ME + 12
- COSMO-ME + 18
- COSMO-ME + 24
- COSMO-PL + 06
- COSMO-PL + 12
- COSMO-PL + 18
- COSMO-PL + 24
- ECMWF-IFS + 06
- ECMWF-IFS + 12
- ECMWF-IFS + 18
- ECMWF-IFS + 24
- COSMO-RU + 06
- COSMO-RU + 12
- COSMO-RU + 18
- COSMO-RU + 24
- COSMO-EU + 06
- COSMO-EU + 12
- COSMO-EU + 18
- COSMO-EU + 24
- ICN-EU + 06
- ICN-EU + 12
- ICN-EU + 18
- ICN-EU + 24
- ICON + 06
- ICON + 12
- ICON + 18
- ICON + 24

Conditional Verification tests 2015-2016 (T2m Td2m)

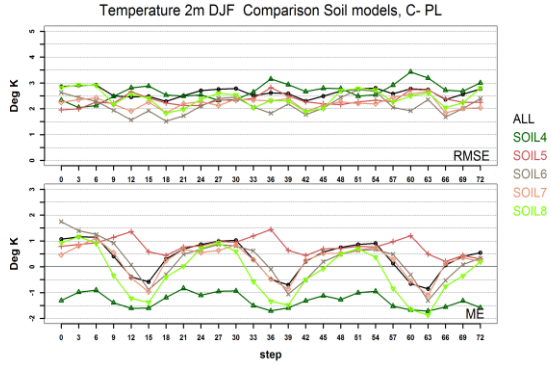
Reasoning: The soil representation in the model involves the fluxes of energy and water at the surface and **determines the exchange of heat, moisture and momentum between the surface and the atmosphere**. Study th

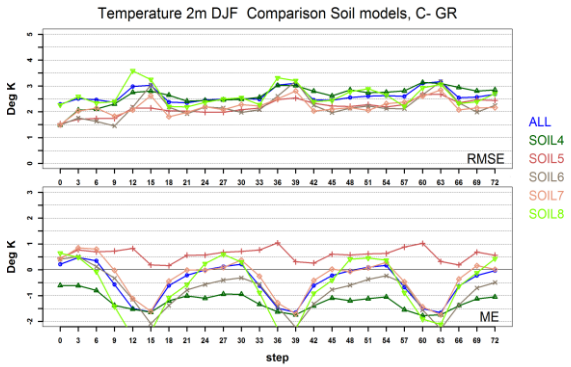
Soil Types (used in COSMO model)	
Soil Type 1	Ice
Soil Type 2	Rock
Soil Type 3	Sand
Soil Type 4	Sandy Loam
Soil Type 5	Loam
Soil Type 6	Clay loam
Soil Type 7	Clay
Soil Type 8	Peat
Soil Type 9	Sea water
Soil Type 10	Sea Ice

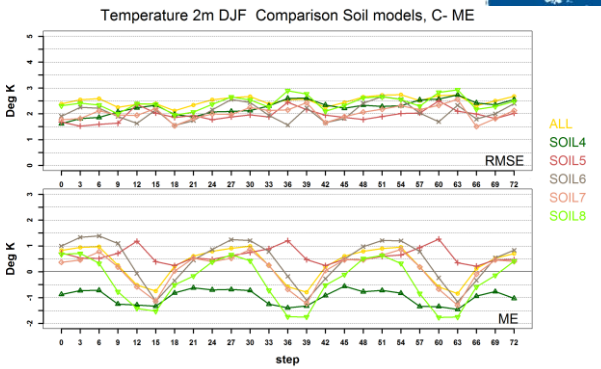
soil type	1 ice	2 rock	3 sand	4 sandy loam	5 loam	6 loamy clay	7 clay	8 peat
volume of voids w_{PV} [1]	-	-	0.364	0.445	0.455	0.475	0.507	0.863
field capacity w_{FC} [1]	-	-	0.196	0.260	0.340	0.370	0.463	0.763
permanent wilting point w_{PWP} [1]	-	-	0.042	0.100	0.110	0.185	0.257	0.265
air dryness point w_{ADP} [1]	-	-	0.012	0.030	0.035	0.060	0.065	0.098
minimum infiltration rate I_{K2} [kg/(m^2 s)]	-	-	0.0035	0.0023	0.0010	0.0006	0.0001	0.0002
hydraulic diffusivity parameter D_0 [10^{-9} m^2/s]	-	-	18400	3460	3570	1180	442	106
hydraulic diffusivity parameter D_1 [1]	-	-	-8.45	-9.47	-7.44	-7.76	-6.74	-5.97
hydraulic conductivity parameter K_0 [10^{-9} m/s]	-	-	47900	9430	5310	764	17	58
hydraulic conductivity parameter K_1 [1]	-	-	-19.27	-20.86	-19.66	-18.52	-16.32	-16.48
heat capacity $\rho_0 c_0$ [10^6 J/(m^3 K)]	1.92	2.10	1.28	1.35	1.42	1.50	1.63	0.58
heat conductivity								
λ_0 [W/(K m)]	2.26	2.41	0.30	0.28	0.25	0.21	0.18	0.06
$\Delta\lambda$ [W/(K m)]	0.0	0.0	2.40	2.40	1.58	1.55	1.50	0.50
exponent B [1]	1.0	1.0	3.5	4.8	6.1	8.6	10.0	9.0

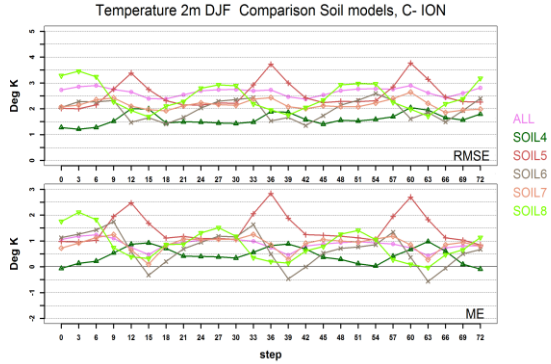
- After a preliminary analysis, it represented from the 97 Com
- For the purpose of this experiment, one only station was chosen to represent each category.(station with same soil type for all participating models)
- For Soil Type 5 that is the most populated, a stratification based on the station height (<200m, >800m) is applied.

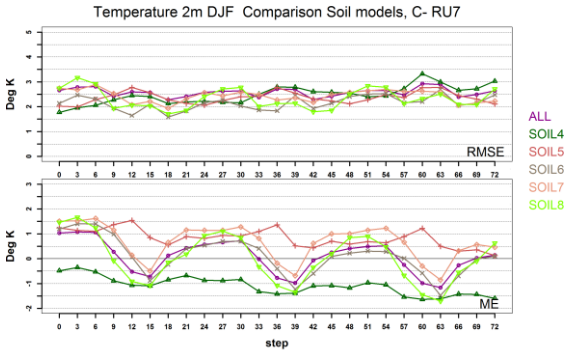
2m T -All models – All Soil Types

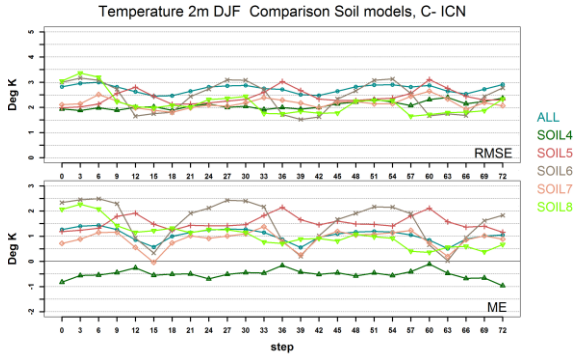


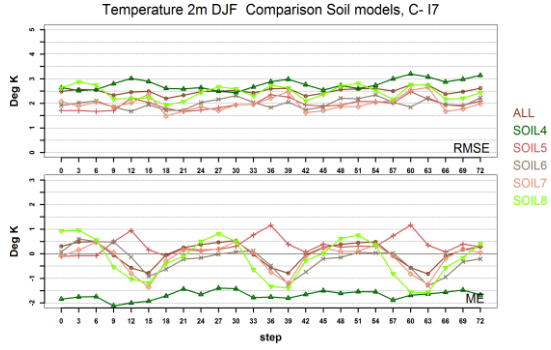


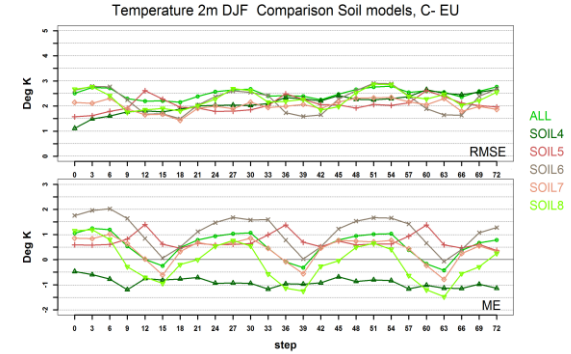


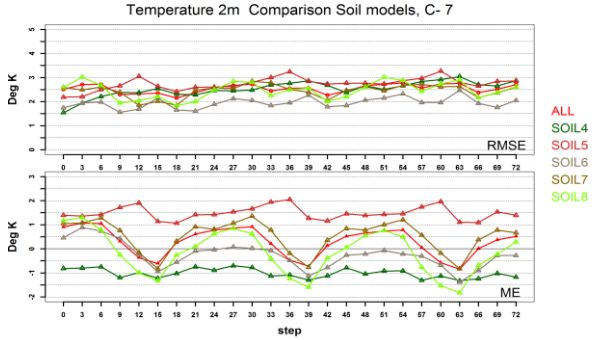




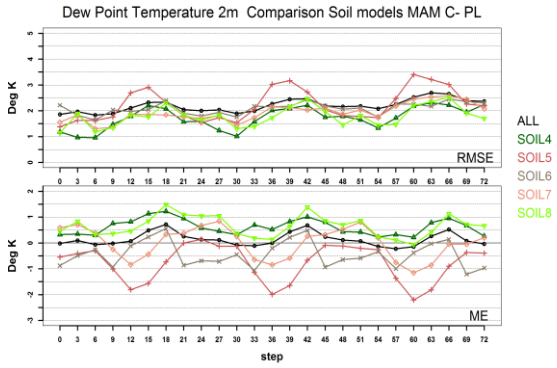


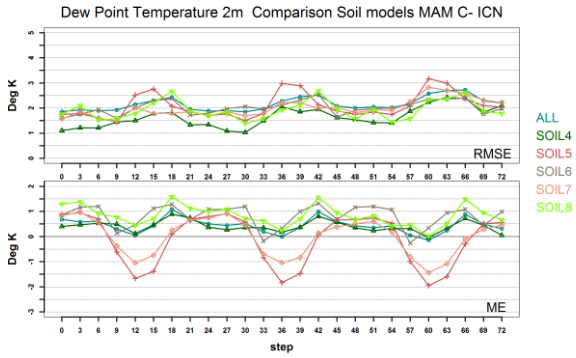


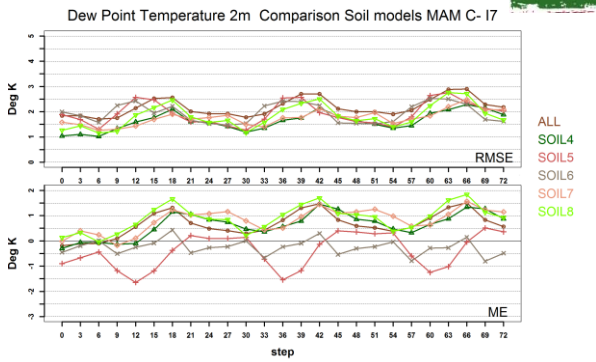


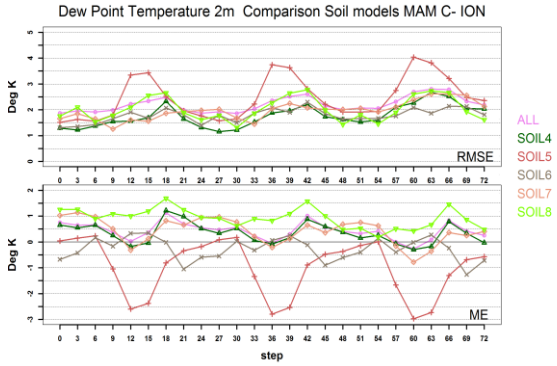


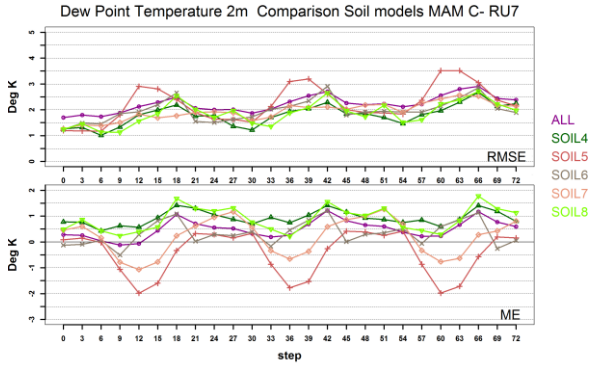
2m Dew T -All models – All Soil Types

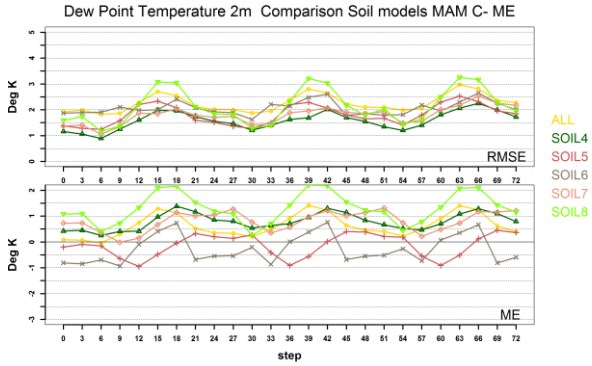


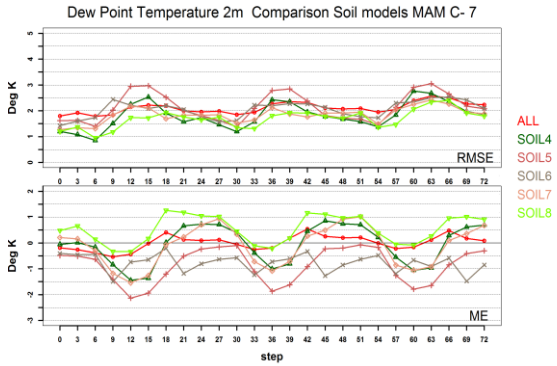


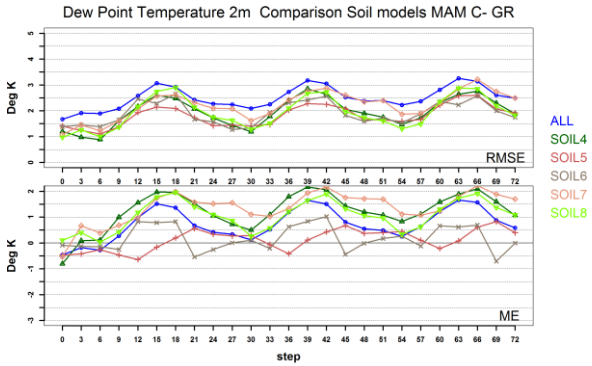


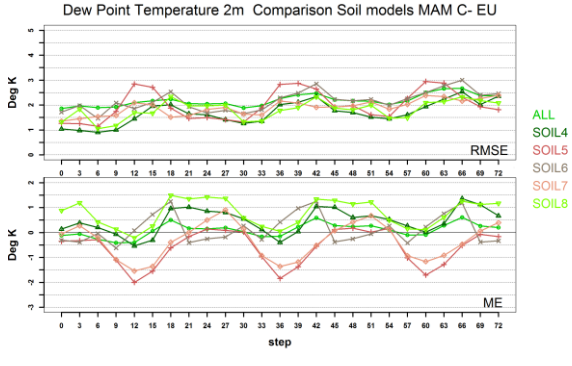












Deutscher Wetterdienst
Wetter und Klima aus einer Hand

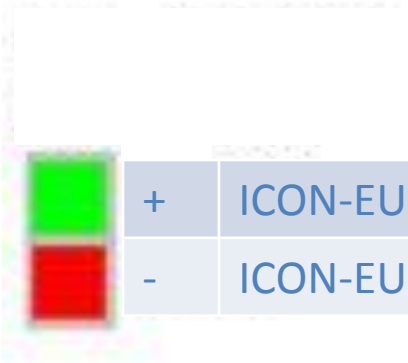
Operational Verification at DWD
Comparison
ICON-EU vs. COSMO-EU

Ulrich Pflüger
Deutscher Wetterdienst

Percentage Difference of RMSE (PD_{RMSE} in [%])

$$PD_{RMSE} = \frac{(RMSE_{COSMO\text{-}EU} - RMSE_{ICON\text{-}EU}) * 100}{(RMSE_{COSMO\text{-}EU} + RMSE_{ICON\text{-}EU}) * 0.5}$$

Model names in some figures		
ieu_icon	=	ICON-EU
lme_icon	=	COSMO-EU



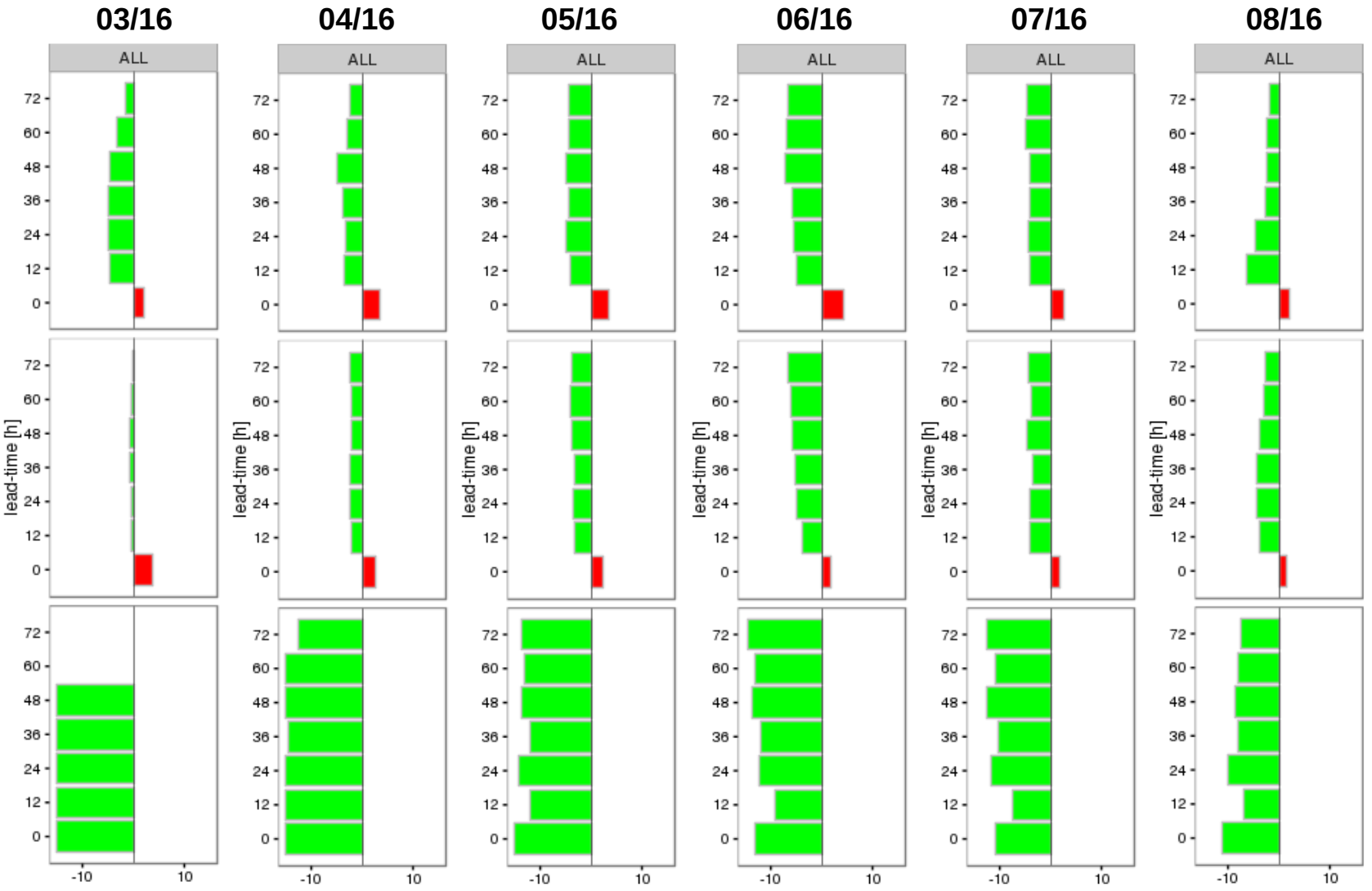
+	ICON-EU	better
-	ICON-EU	worse

Time Series of Percentage Difference of RMSE

Percentage difference RMSE [%]

All common stations

All runs (00 and 12 UTC)

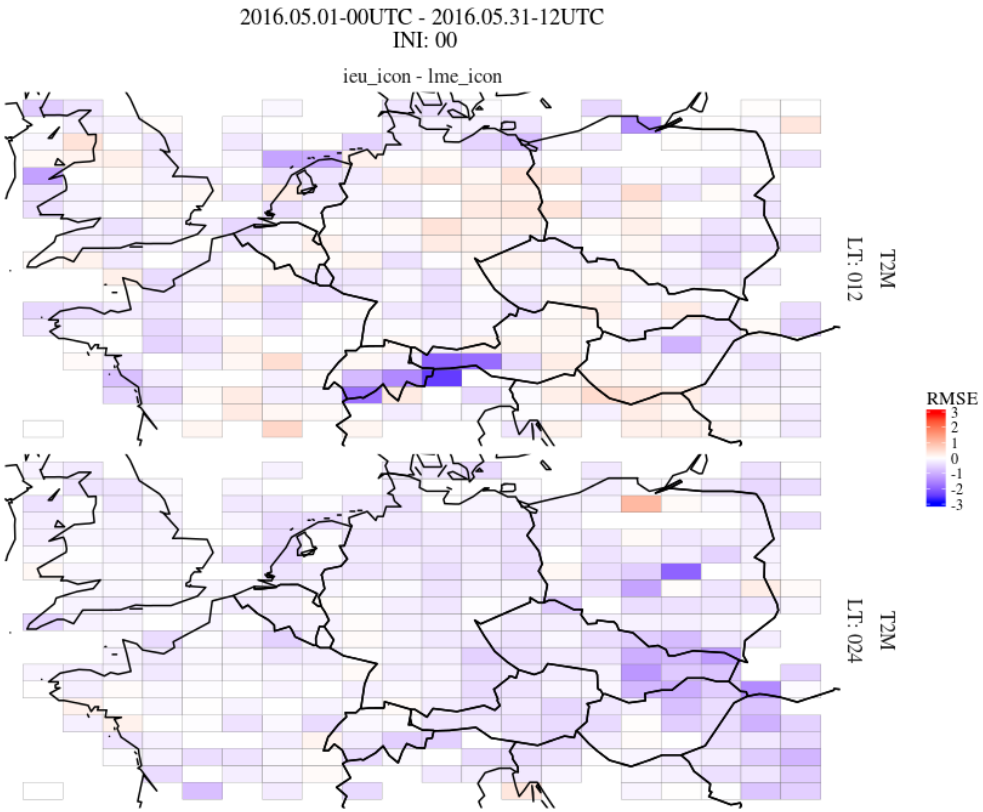


Spatial and day/night variation of ΔRMSE of T_2m (May 2016)

+ 12 h

day

ΔRMSE (ICON-EU – COSMO-EU)



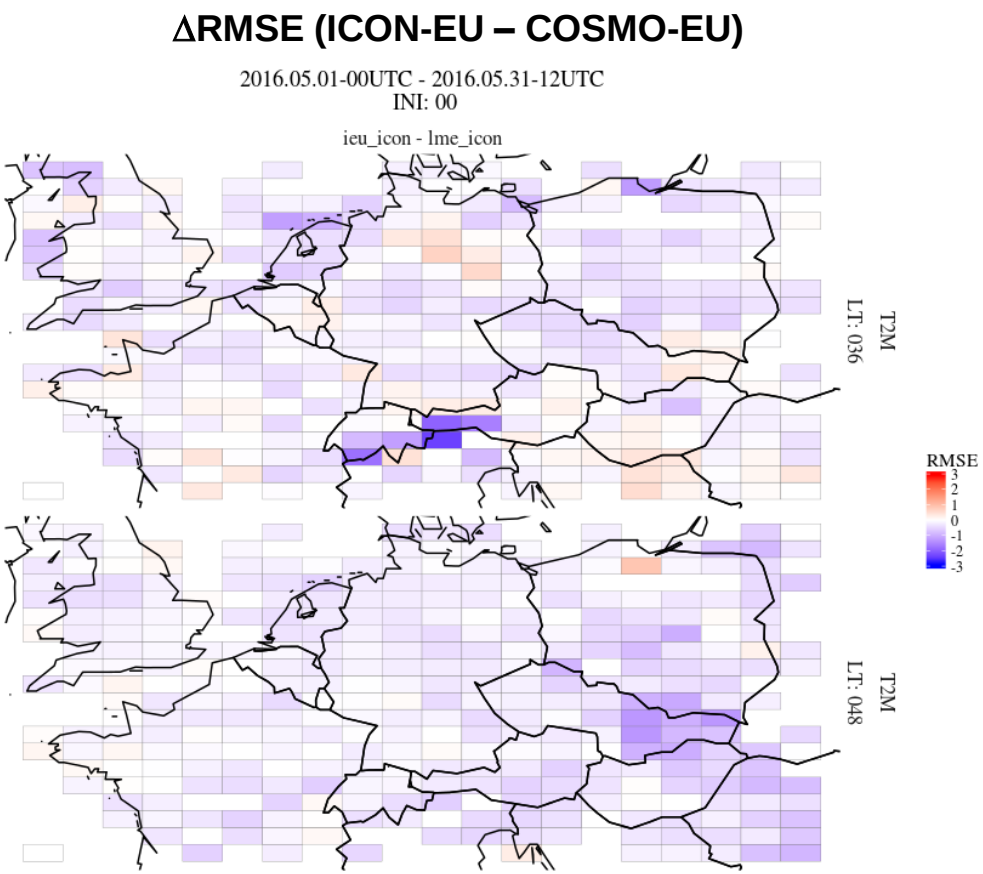
+ 24 h

night

Spatial and day/night variation of ΔRMSE of T_2m (May 2016)

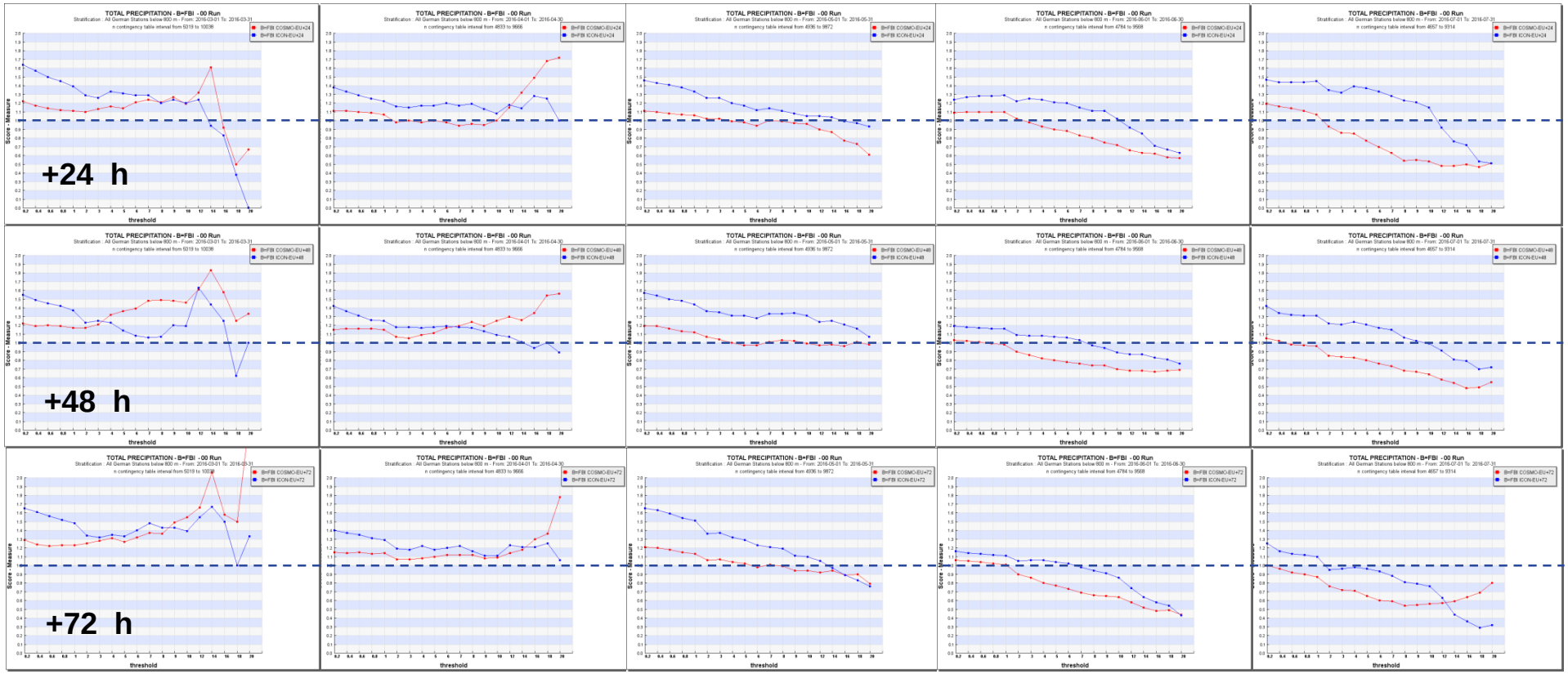
+ 36 h **day**

+ 48 h **night**



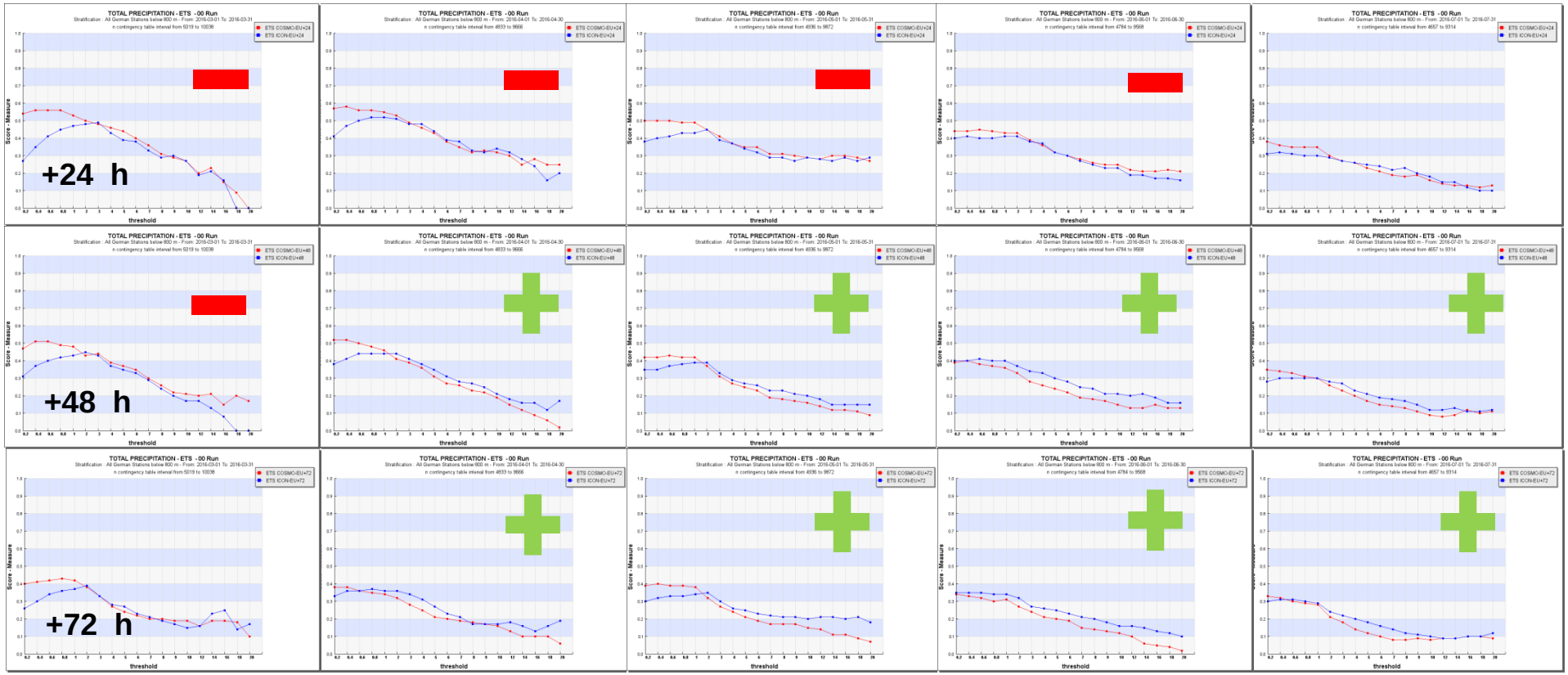
Monthly FBI of rr_24h for different thresholds for day 1, 2 and 3

03/16 04/16 05/16 06/16 07/16



Monthly ETS of rr_24h for different thresholds for day 1, 2 and 3

03/16 04/16 05/16 06/16 07/16



Upper-air Verification

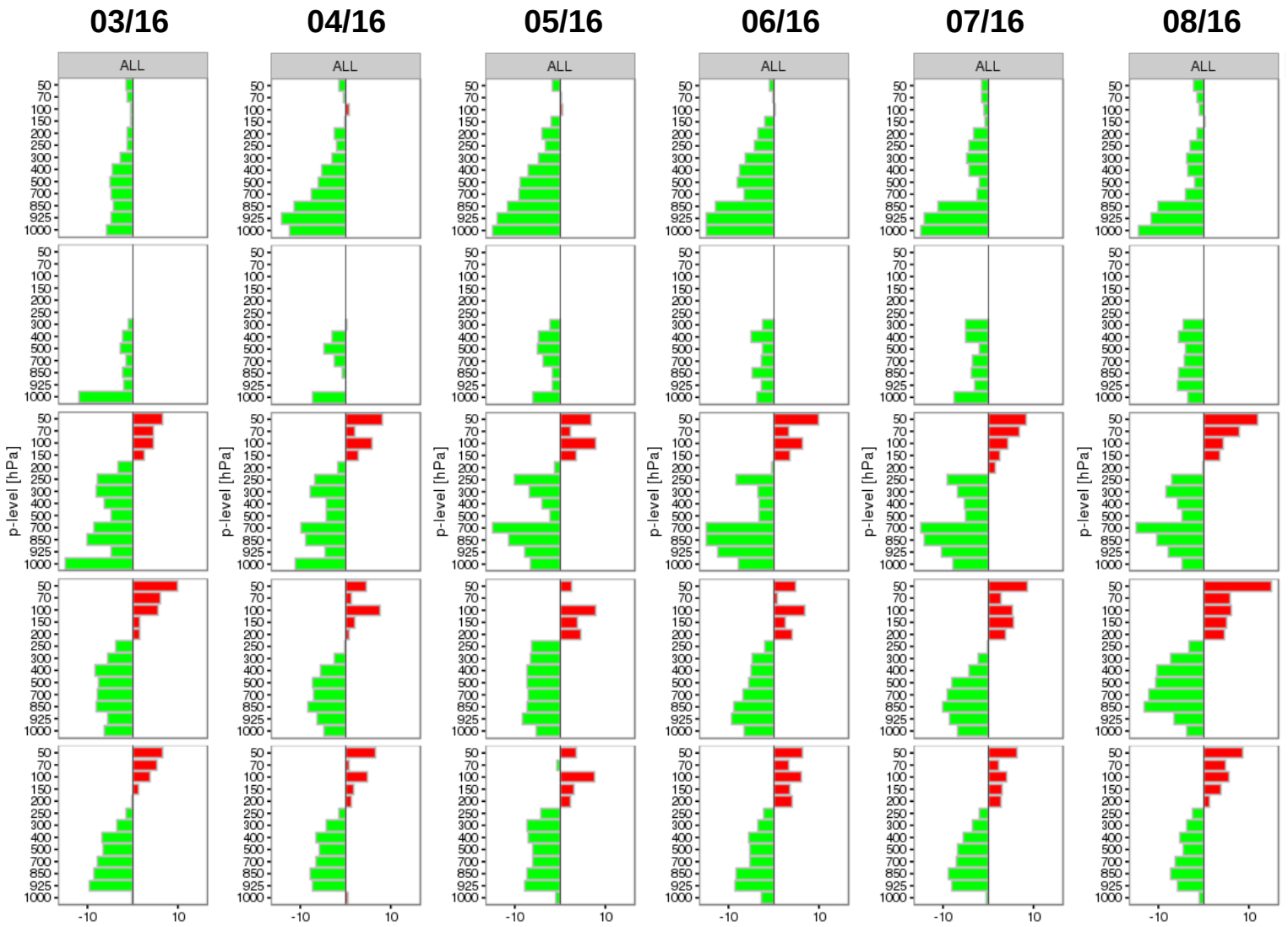
Time Series of Percentage Difference of RMSE

Percentage difference RMSE [%]

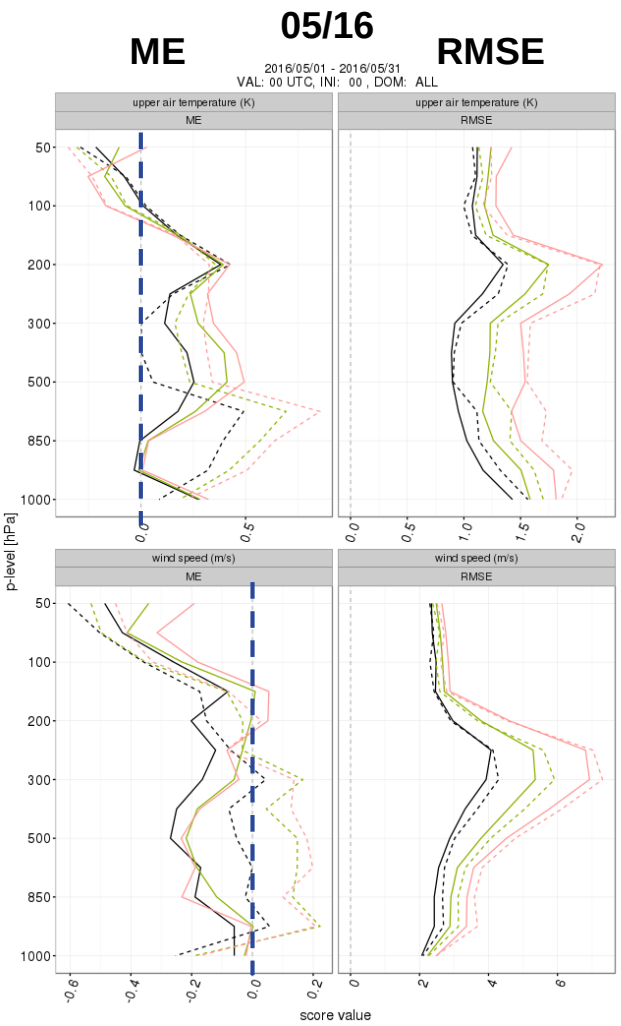
All common radiosondes

All runs (00 and 12 UTC)

All lead times



Monthly Upper-air Verification



TEMPERATURE

lead-time [h]
- 024
- 048
- 072

Exp.
- ieu_icon
- lme_icon

WIND SPEED

above 200 hPa:

- Raleigh damping at the model top of COSMO-EU causes smoother wind and temperature fields
- gravity waves are damped in COSMO-EU
- =>less variance => smaller RMSE

Summary of results I

- **Total cloud cover:**
  - ***Positive BIAS especially at night. IFS, ICON, ICON-EU similar behavior with weaker variability and small negative values.***
- **Temperature 2m:**
  - ***Clear diurnal cycle of BIAS with higher values during night . JJA overestimation greater than other seasons. In DJF nightime overestimation (in contrast to underestimation of last year). ICON and ICON-EU weaker variability.***
- **Dew point temperature 2m:**
  - ***Weaker variability in SON and DJF. Overestimation for ICON and ICON-EU.***

Summary of results II

- **Mean surface level pressure:**
  - ***Large Scale models have similar BIAS diurnal variability with tendency of underestimation, but RMSE lower for IFS.***
  - ***All models (also IFS, ICON, ICON-EU) show a maximum of RMSE during summer at late afternoon.***
- **Wind speed 10m:**
  - ***Positive BIAS and diurnal cycle with low amplitude and minimal values during late afternoon***
  - ***Lower BIAS amplitudes for ICON, ICON-EU.***
  - ***Improvement of wind scores from last year.***
- **Precipitation:**
  - ***Summer: Overestimation for occurences of low precipitation amounts during day especially for 06 - 12 UTC,– Underestimation for 18 – 24 UTC. (FBI decreases for higher precipitation amounts) .***
  - ***Winter: Overestimation for occurences of low precipitation during the whole day. For higher precipitation amounts frequency bias is slightly greater than 1 with worse quality compared to low precipitation amounts***
  - ***Overestimation for ICON, ICON-EU, IFS for low precipitation amounts.***

Summary of results III

- **ICON-EU-COSMO-EU Comparison**
  - ***Δ(RMSE) percentage difference time series showed that ICON-EU performed better except for initial time steps for wind parameters***
  - ***COSMO-EU performed better over 200hPa for wind and Tempetrature due to gravity wave damping.***
  - ***ICON-EU FBI is high (overestimation of cases) especially for low thresholds , ETS ICON-EU score improves with higher thresholds and forecast day.***

Common Plots for COSMO year 2015-2016

CONSORTIUM FOR SMALL SCALE MODELING

Continuous line plots

	MSLP	TCC	TEMP	TD	WS
JJA	see	see	see	see	see
SON	see	see	see	see	see
DJF	see	see	see	see	see
MAM	see	see	see	see	see

Precipitation performance diagrams 6h

	0.2		2		5		10	
	day-1	day-2	day-1	day-2	day-1	day-2	day-1	day-2
JJA	see	see	see	see	see	see	see	see
SON	see	see	see	see	see	see	see	see
DJF	see	see	see	see	see	see	see	see
MAM	see	see	see	see	see	see	see	see

Precipitation performance diagrams 24h

	0.2	2	5	10
JJA	see	see	see	see
SON	see	see	see	see
DJF	see	see	see	see
MAM	see	see	see	see

Conditional Soil Type Plots for T and Td

		SOIL						
		4	5	5< 200m	5> 800m	6	7	8
SON	T	see	see	see	see	see	see	see
	Td	see	see	see	see	see	see	see
DJF	T	see	see	see	see	see	see	see
	Td	see	see	see	see	see	see	see
MAM	T	see	see	see	see	see	see	see
	Td	see	see	see	see	see	see	see

CONSORTIUM FOR SMALL SCALE MODELING

COSMO

http://www2.cosmo-model.org/content/tasks/verification.priv/common/analytics/2015-2016/default.htm

Common soil conditional scores comparison

Note: images show conditional scores for all soil types for each model

		MODEL								
		C-7	C-EU	C-PL	C-RU	C-GR	C-ME	C-I7	ICON-EU	ICON
SON	T	see	see	see	see	see	see	see	see	N/A
	TD	see	see	see	see	see	see	see	see	N/A
DJF	T	see	see	see	see	see	see	see	see	see
	TD	see	see	see	see	see	see	see	see	see
MAM	T	see	see	see	see	see	see	see	see	see
	TD	see	see	see	see	see	see	see	see	see

Local domain HR line plots

	MSLP	TCC	TEMP	TD	WS	PRECI 6h	PRECI 24h
JJA	see	see	see	see	see	see	see
SON	see	see	see	see	see	see	see
DJF	see	see	see	see	see	see	see
MAM	see	see	see	see	see	see	see

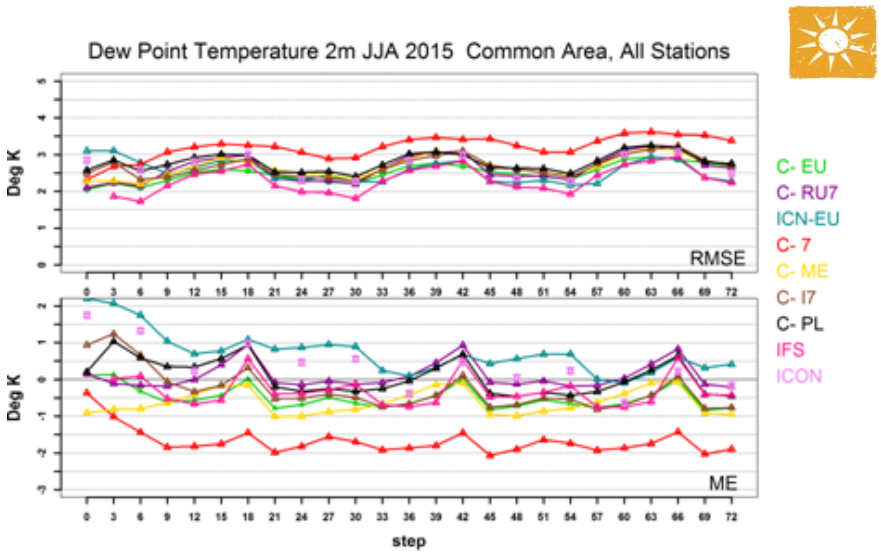
Common area scores comparison

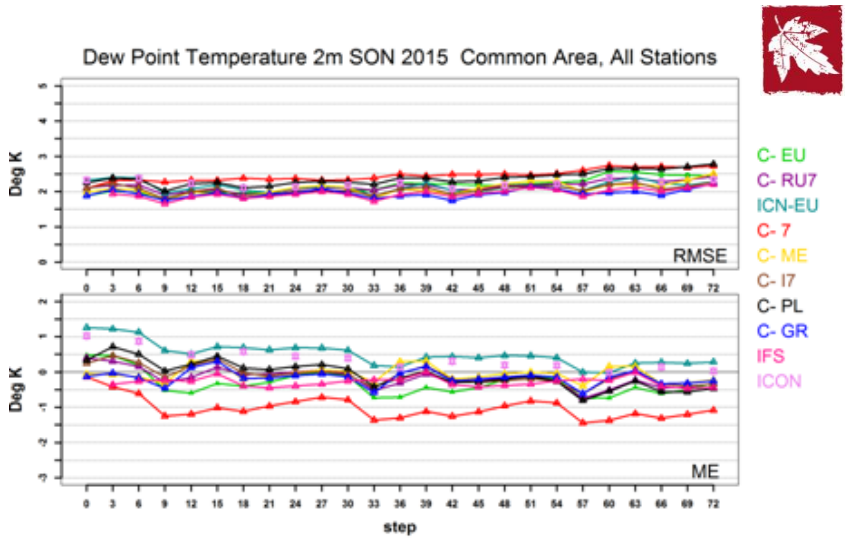
Note: images show the differences from last year (2014/2015) for each model

		MODEL							
		C-7	C-EU	C-PL	C-RU	C-GR	C-ME	C-I7	IFS
MSLP	JJA	see	see	see	see	N/A	see	see	see
	SON	see	see	see	see	N/A	see	see	see
	DJF	see	see	see	see	see	see	see	see
	MAM	see	see	see	see	see	see	see	see
TCC	JJA	see	see	see	see	N/A	see	see	see
	SON	see	see	see	see	N/A	see	see	see
	DJF	see	see	see	N/A	N/A	N/A	N/A	see
	MAM	see	see	see	N/A	N/A	N/A	N/A	see
TEMP	JJA	see	see	see	see	N/A	see	see	see
	SON	see	see	see	see	N/A	see	see	see
	DJF	see	see	see	see	see	see	see	see
	MAM	see	see	see	see	see	see	see	see
TDEW	JJA	see	see	see	see	N/A	see	see	see
	SON	see	see	see	see	N/A	see	see	see
	DJF	see	see	see	see	see	see	see	see
	MAM	see	see	see	see	see	see	see	see
WS	JJA	see	see	see	see	N/A	see	see	see
	SON	see	see	see	see	N/A	see	see	N/A
	DJF	see	see	see	see	see	see	see	see
	MAM	see	see	see	see	see	see	see	see
PRECI 6h (0.2mm day1)	JJA	see	see	see	see	see	see	see	see
	SON	see	see	see	see	see	see	see	see
	DJF	see	see	see	see	see	see	see	see
	MAM	see	see	see	see	see	see	see	see

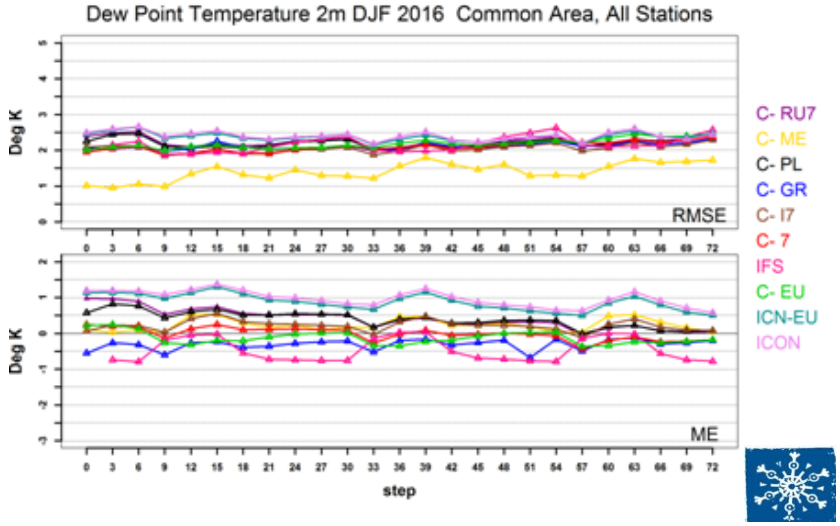
Thank you for your attention

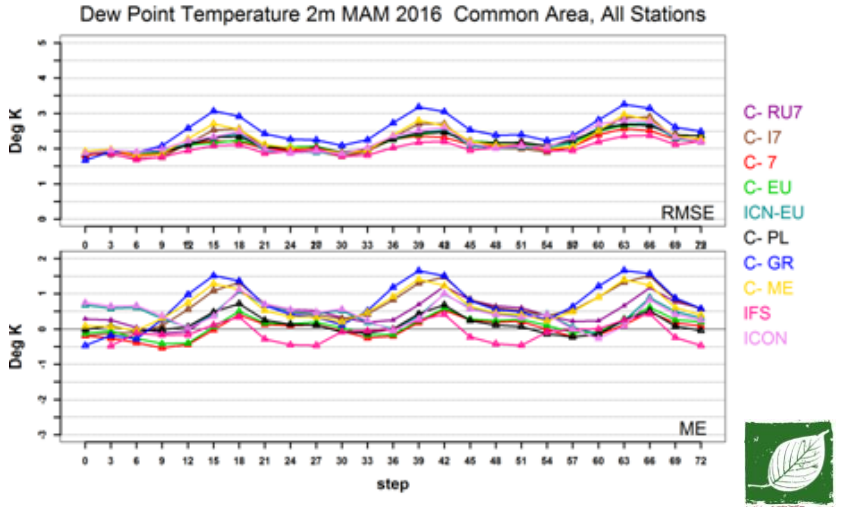
T DEW 2m



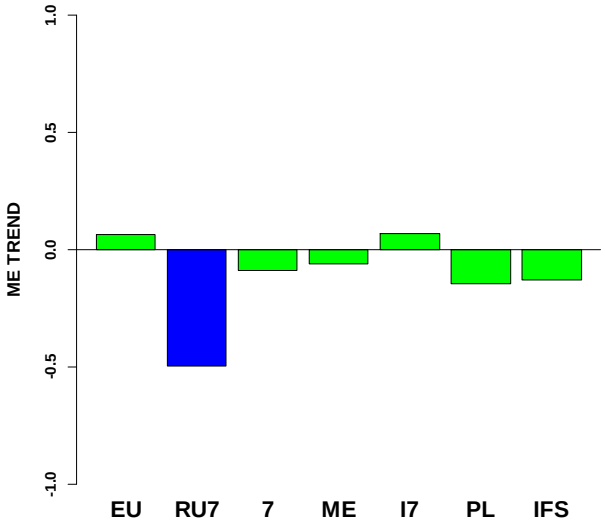


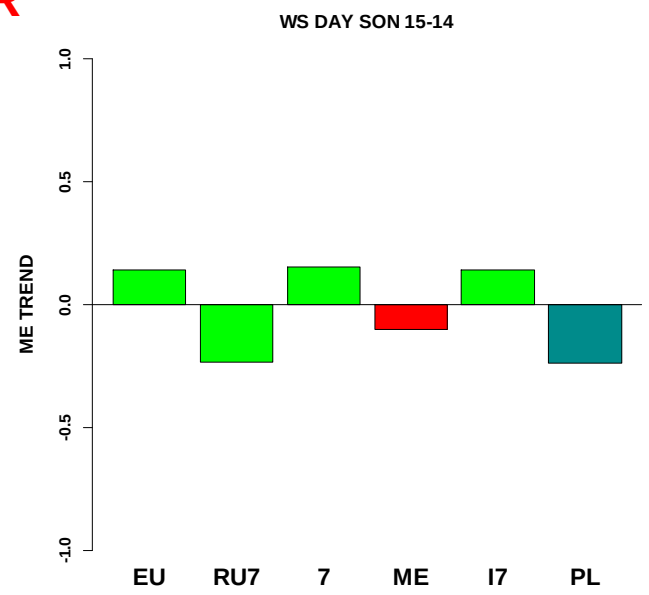
JJA , MAM ME RMSE diurnal cycle. ICON, ICON-EU bias >0

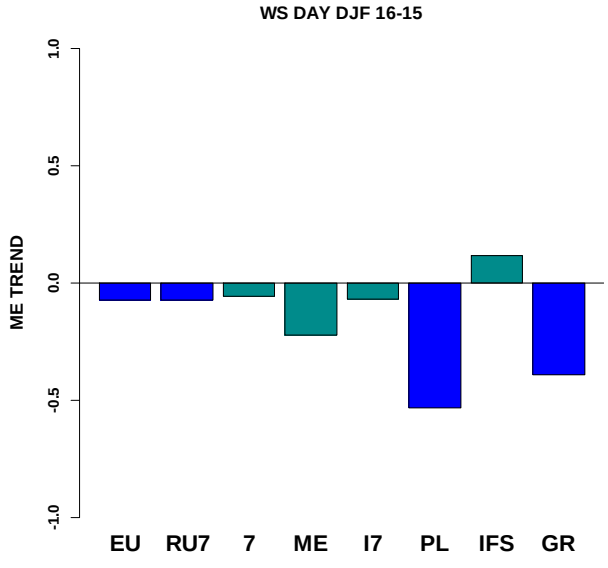


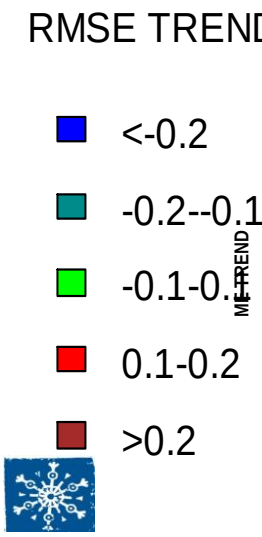


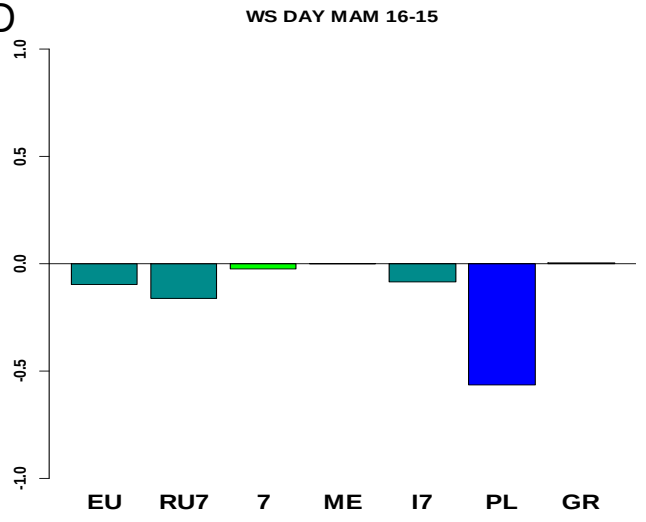
WS DAYTIME SCORE TRENDS vs LAST YEAR

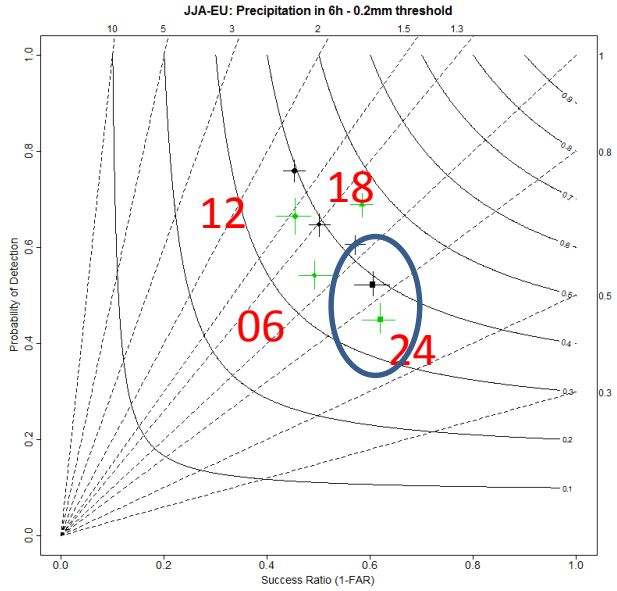




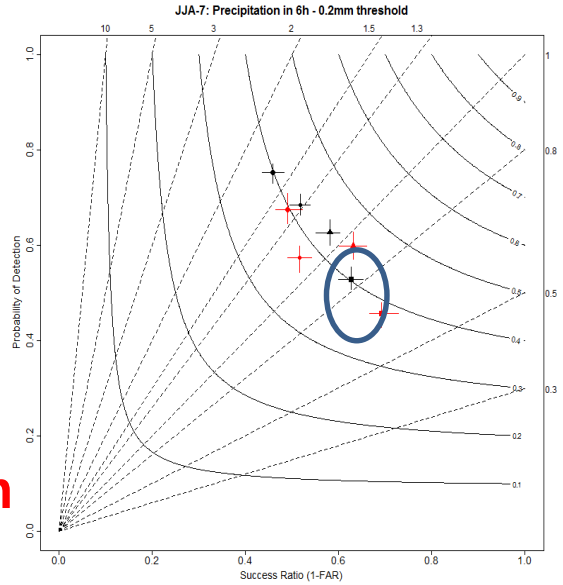






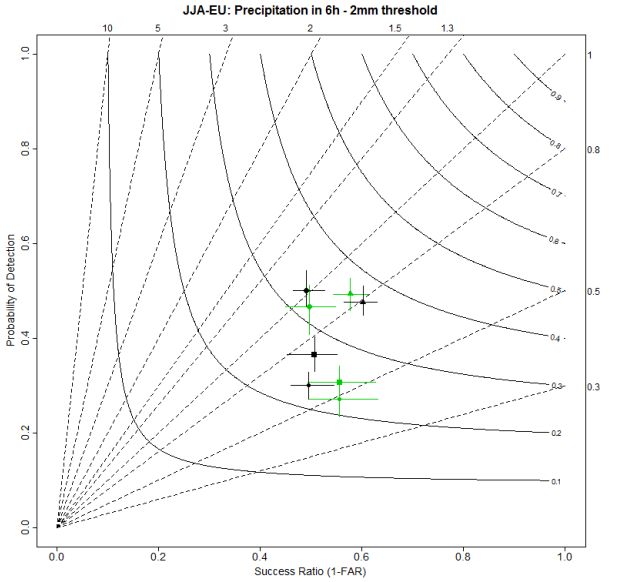


FORECAST DAY 1
- COSMOEU-15 + 06
- COSMOEU-15 + 12
- COSMOEU-15 + 18
- COSMOEU-15 + 24
- COSMOEU-14 + 06
- COSMOEU-14 + 12
- COSMOEU-14 + 18
- COSMOEU-14 + 24



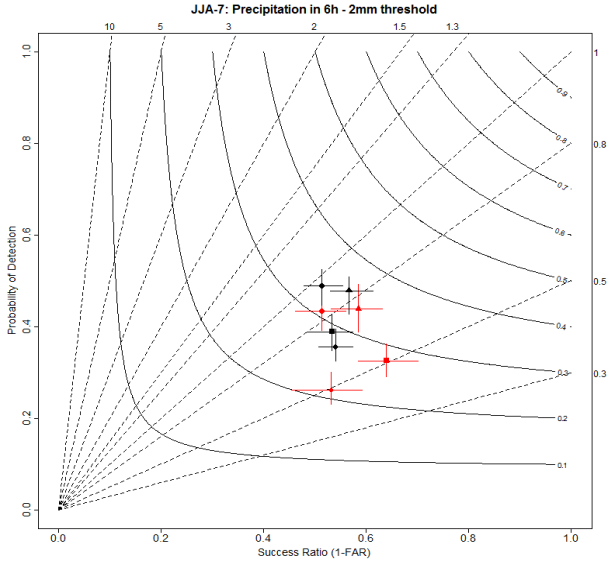
FORECAST DAY 1
- COSMO7-15 + 06
- COSMO7-15 + 12
- COSMO7-15 + 18
- COSMO7-15 + 24
- COSMO7-14 + 06
- COSMO7-14 + 12
- COSMO7-14 + 18
- COSMO7-14 + 24

6h >0.2mm



FORECAST DAY 1
- COSMOEU-15 + 06
- COSMOEU-15 + 12
- COSMOEU-15 + 18
- COSMOEU-15 + 24
- COSMOEU-14 + 06
- COSMOEU-14 + 12
- COSMOEU-14 + 18
- COSMOEU-14 + 24

6h > 2mm



FORECAST DAY 1
- COSMO7-15 + 06
- COSMO7-15 + 12
- COSMO7-15 + 18
- COSMO7-15 + 24
- COSMO7-14 + 06
- COSMO7-14 + 12
- COSMO7-14 + 18
- COSMO7-14 + 24