



Verification of COSMO-EU and COSMO-DE using RADAR and SYNOP data

Ulrich Damrath





Outline

- ➔ **Basic data**
- ➔ ***Traditional verification***
 - ▶ *Diurnal cycles (observation, forecasts of GME, COSMO-EU and COSMO-DE) starting at different forecast times*
 - ▶ *Contingency tables*
- ➔ **„Fuzzy“-type verification**
 - ▶ **Application of B. Eberts package**
 - ▶ **Coupling intensity scale method and fraction skill score**
- ➔ **Some problems with the radar data**
- ➔ **Verification against SYNOP-observations**





Basic data

- ➔ **Data of GME (resolution 192f ~ 40 km), COSMO-EU and COSMO-DE on the grid of COSMO-DE**

- ➔ **Method of „interpolation“:
using the data to the nearest gridpoint of COSMO-DE**

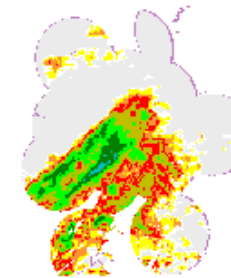
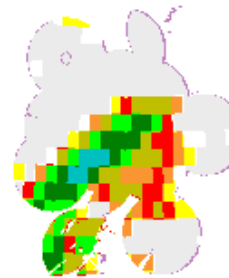
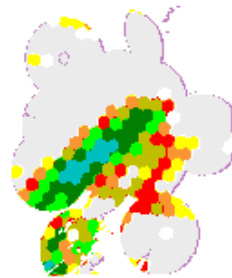


Basic data (example with some missing observations)

GME/I192F AV: 0.72 MA: 32.0 STD: 1.18

GME/R192F AV: 0.72 MA: 25.4 STD: 1.22

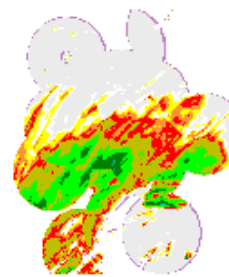
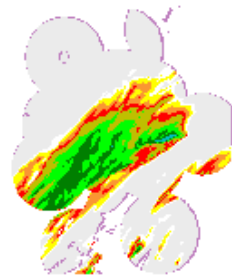
COSMO/LME AV: 0.44 MA: 30.6 STD: 1.07



0.2
0.5
1.0
2.0
5.0
10.0
20.0
50.0
75.0
400.0

COSMO/LMK AV: 0.48 MA: 31.0 STD: 1.07

RADAR AV: 0.54 MA: 38.8 STD: 1.19



	Thr/Mod	I192F	R192F	LME	LMK
FBI	0.0	0.80	0.92	0.90	0.77
	0.5	0.75	0.87	0.80	0.68
	1.0	0.74	0.85	0.74	0.65
	2.0	0.78	0.90	0.71	0.68
	5.0	1.14	1.18	0.74	0.97
	10.0	3.35	3.14	1.24	1.96
	20.0	33.80	25.44	3.96	2.06
	50.0	---	---	---	---
	100.0	---	---	---	---
	ETS	0.0	34.83	38.89	28.31
0.5		43.19	47.87	40.83	36.13
1.0		38.22	43.07	38.90	32.57
2.0		31.13	34.04	32.45	28.55
5.0		21.92	22.42	19.24	30.06
10.0		9.05	11.47	6.46	13.71
20.0		-0.07	-0.07	-0.06	-0.05
50.0		---	---	---	---
100.0		---	---	---	---

Forecasts of precipitation Start: 19.07.2007 00 UTC W=18-06

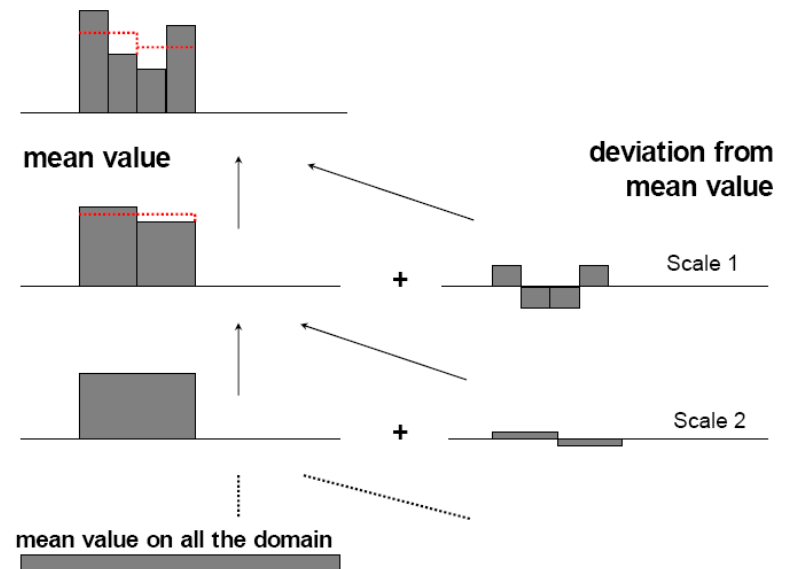


Basic fuzzy scores

N. Roberts
(summing up over all scales)

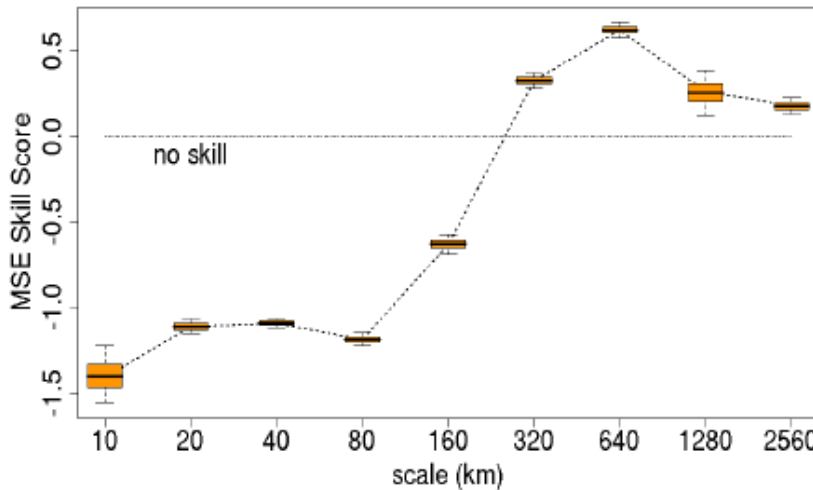
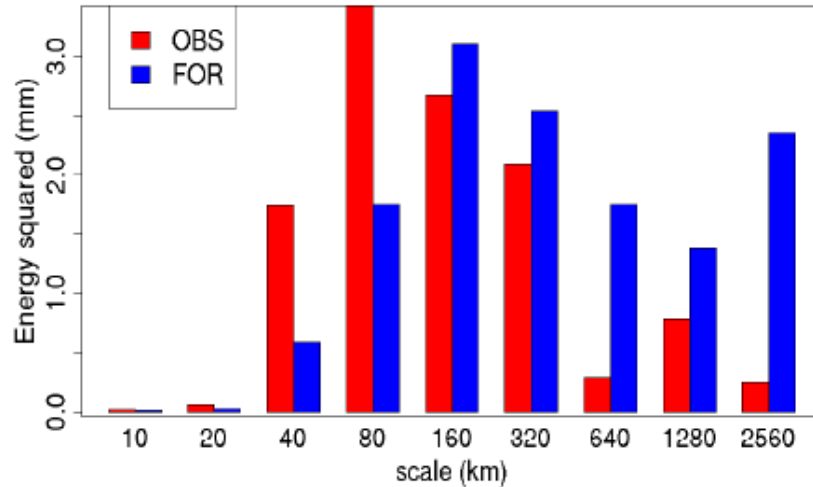
$$FSS = 1 - \frac{FBS}{\frac{1}{N} \left[\sum_{j=1}^N (p_j)^2 + \sum_{j=1}^N (o_j)^2 \right]^{1/2}}$$

B. Casati
(real scale separation)



... yet another score

B. Casati
 energy squared
 Skill Score



Verification

on different scales, but only where obs are available

1. Energy squared:

$$En^2(X) = \overline{X^2}$$

Measures the quantity of events and their intensity at each scale => BIAS, scale structure

2. MSE Skill Score:

$$1 - \frac{MSE(Y, X)}{En^2(X) + En^2(Y)}$$

Modification by U. Damrath in order to have the same structure as the FSS



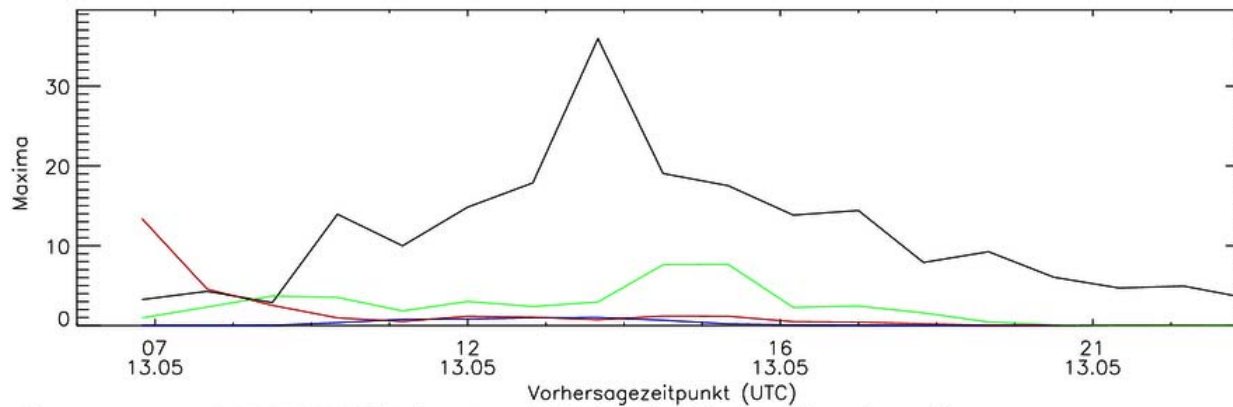
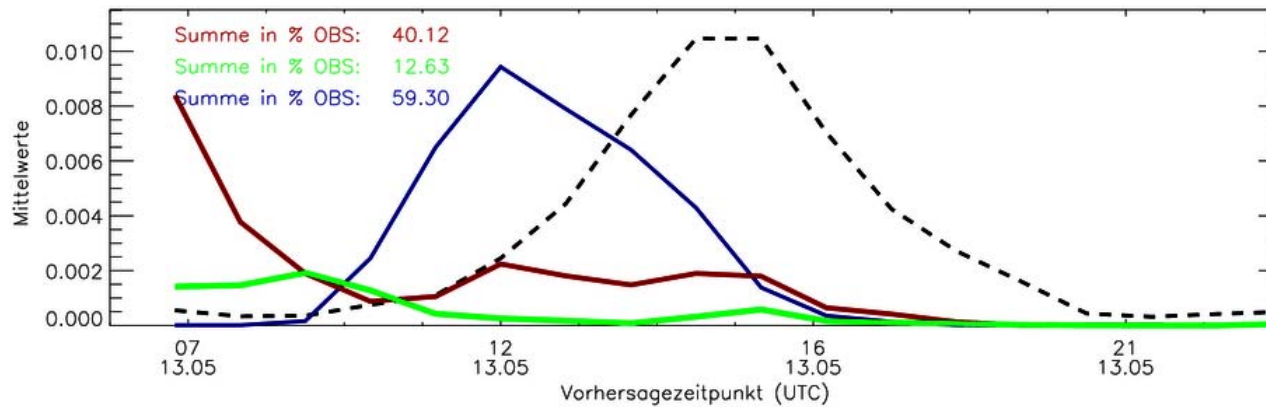


Nearly operational programme:

- ➔ **Getting data from data base**
- ➔ **Interpolation to the grid of COSMO-DE**
- ➔ **Calculation of traditional scores like FBI and ETS**
- ➔ **Calculation of daily and monthly cycles over 18 hours starting from 00, 03 , ... 21 UTC**
- ➔ **Calculation of different „Fuzzy“-scores for each day and different months based on forecasts starting at 00 UTC**
- ➔ **Creating web pages for the local Intranet**
- ➔ **Data available starting July 2007**
- ➔ **Special investigations to prepare meetings**



Diurnal cycle (example)

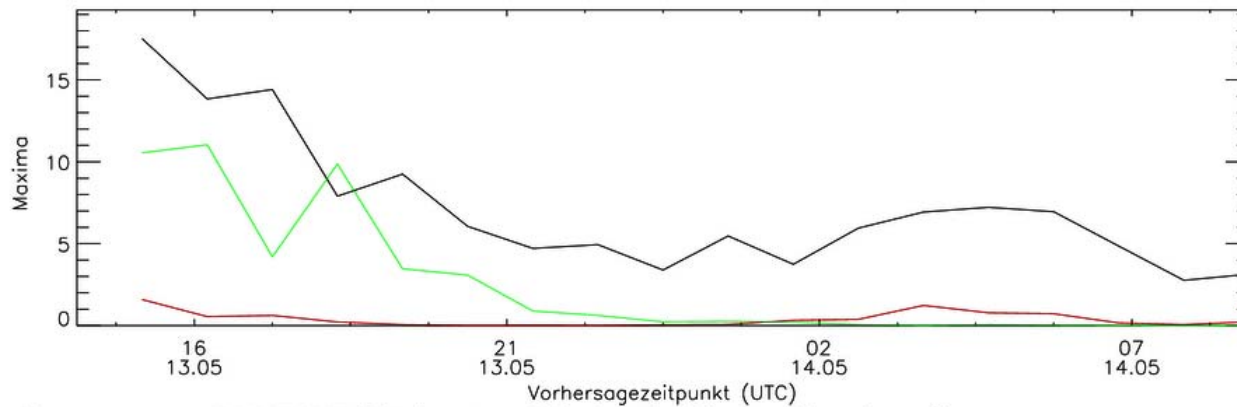
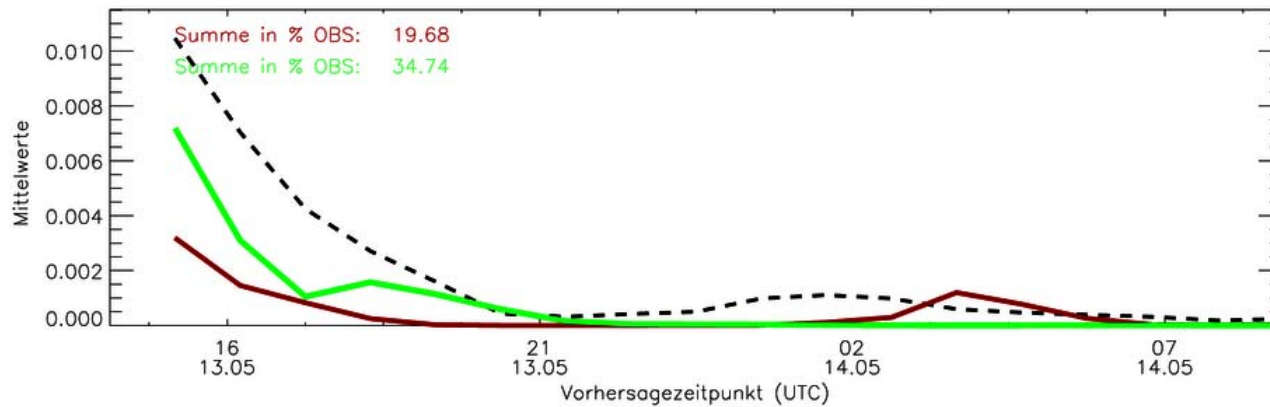


Prognosen vom 2008051306: Mittelwerte und Maxima des Niederschlags in mm/h

COSMO-EU COSMO-DE GME Beobachtung



Diurnal cycle (example)

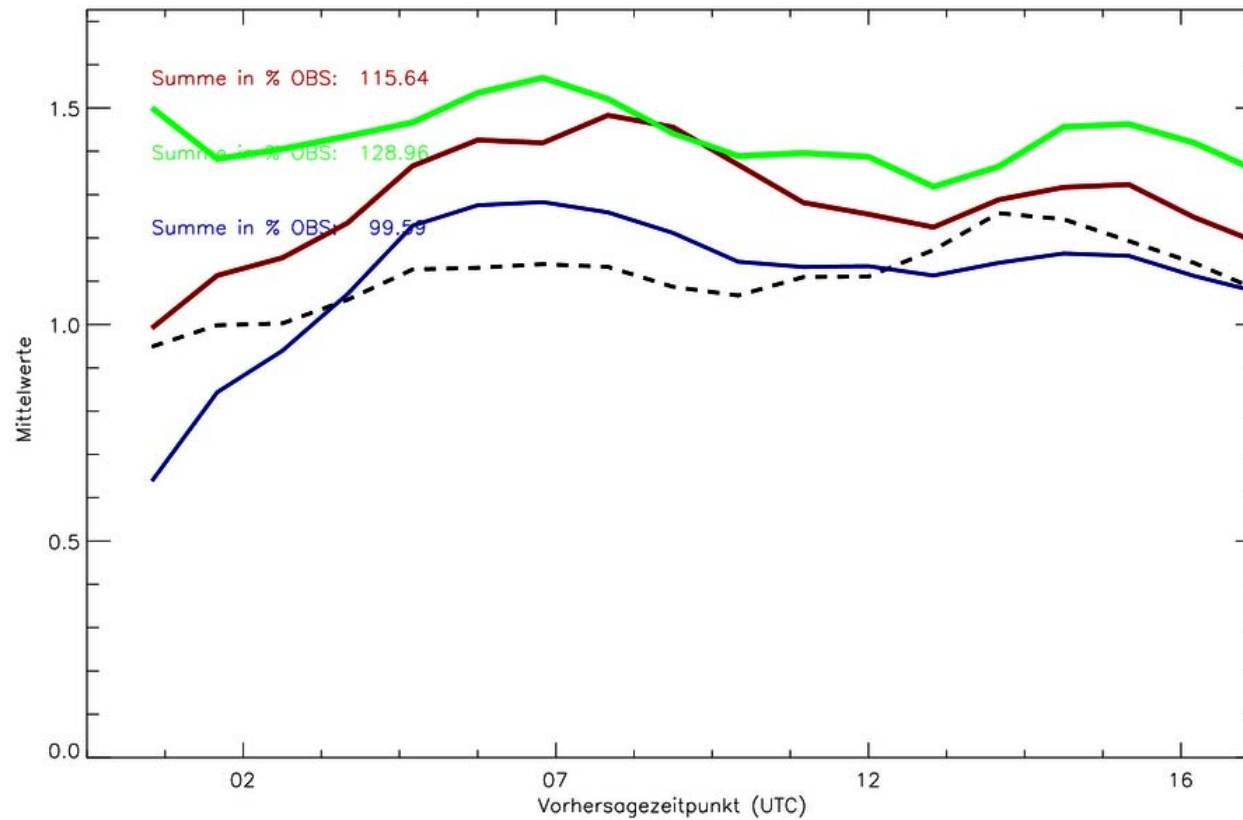


Prognosen vom 2008051315: Mittelwerte und Maxima des Niederschlags in mm/h
COSMO-EU COSMO-DE Beobachtung





Mean diurnal cycles during September 2007

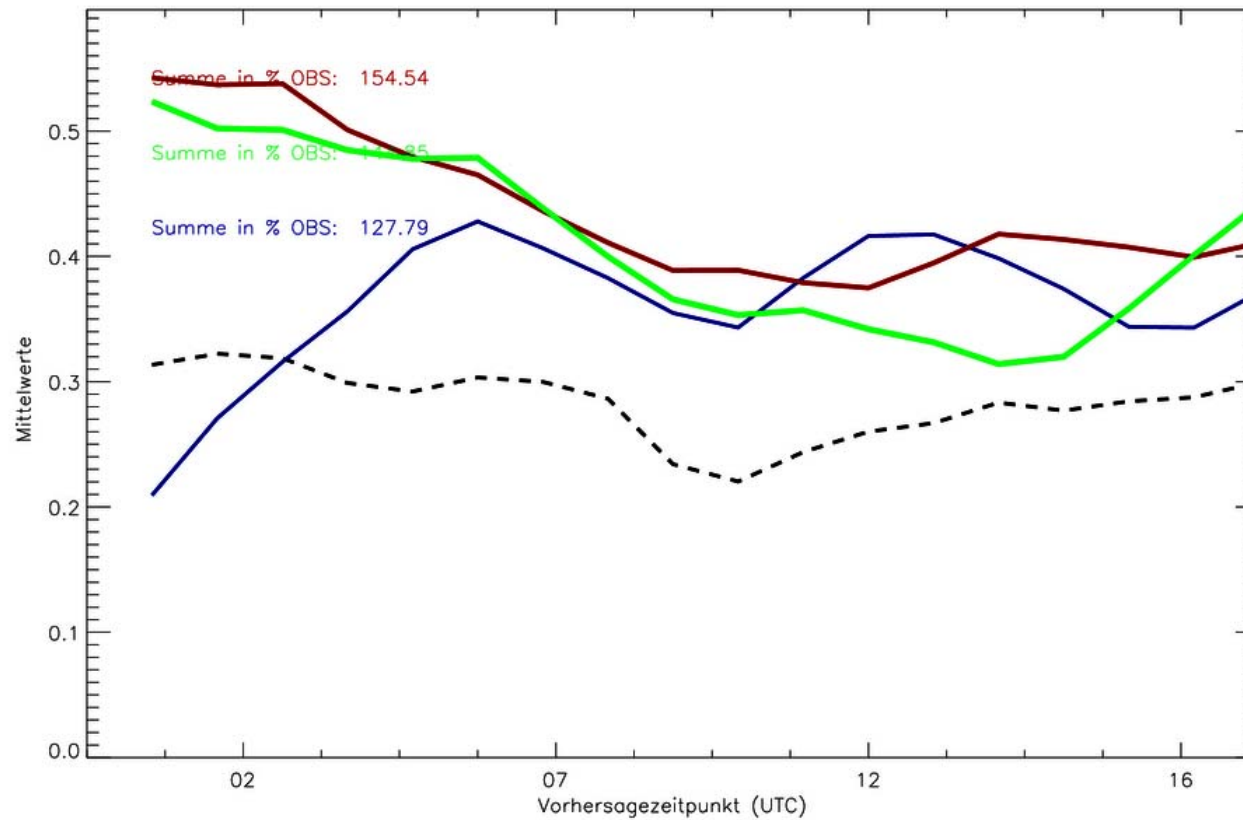


Prognosen im Monat 09/2007 Startzeit: 00 UTC: Mittelwerte des Niederschlags in mm/h (30 Faelle)
COSMO-EU COSMO-DE GME Beobachtung





Mean diurnal cycles during October 2007

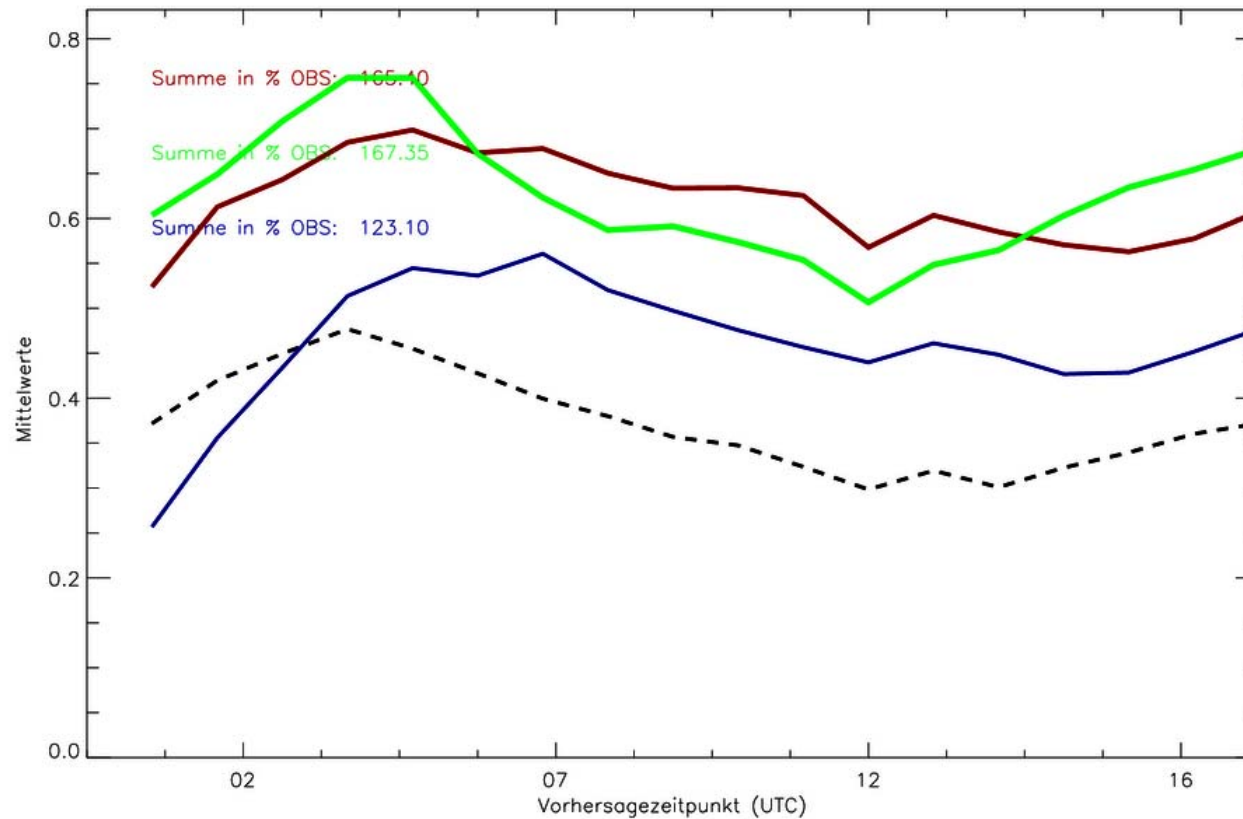


Prognosen im Monat 10/2007 Startzeit: 00 UTC: Mittelwerte des Niederschlags in mm/h (28 Faelle)
COSMO-EU COSMO-DE GME Beobachtung





Mean diurnal cycles during February 2008



Prognosen im Monat 02/2008 Startzeit: 00 UTC: Mittelwerte des Niederschlags in mm/h (26 Faelle)
COSMO-EU COSMO-DE GME Beobachtung



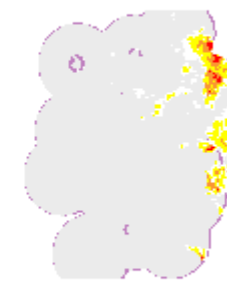
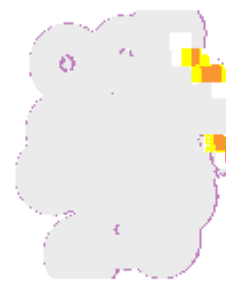
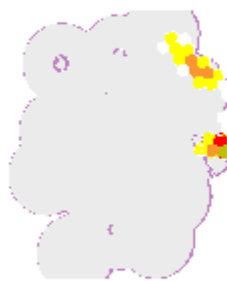


Basic set of „Fuzzy“-scores, case 03.05.2008

GME/I192F
AV: 0.01 MA: 4.3 STD: 0.23

GME/R192F
AV: 0.01 MA: 2.4 STD: 0.23

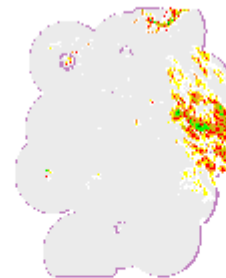
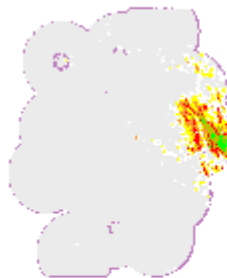
COSMO-EU
AV: 0.01 MA: 4.0 STD: 0.28



0.2
0.5
1.0
2.0
5.0
10.0
20.0
50.0
75.0
400.0

COSMO-DE
AV: 0.03 MA: 9.8 STD: 0.34

RADAR
AV: 0.04 MA: 23.3 STD: 0.42



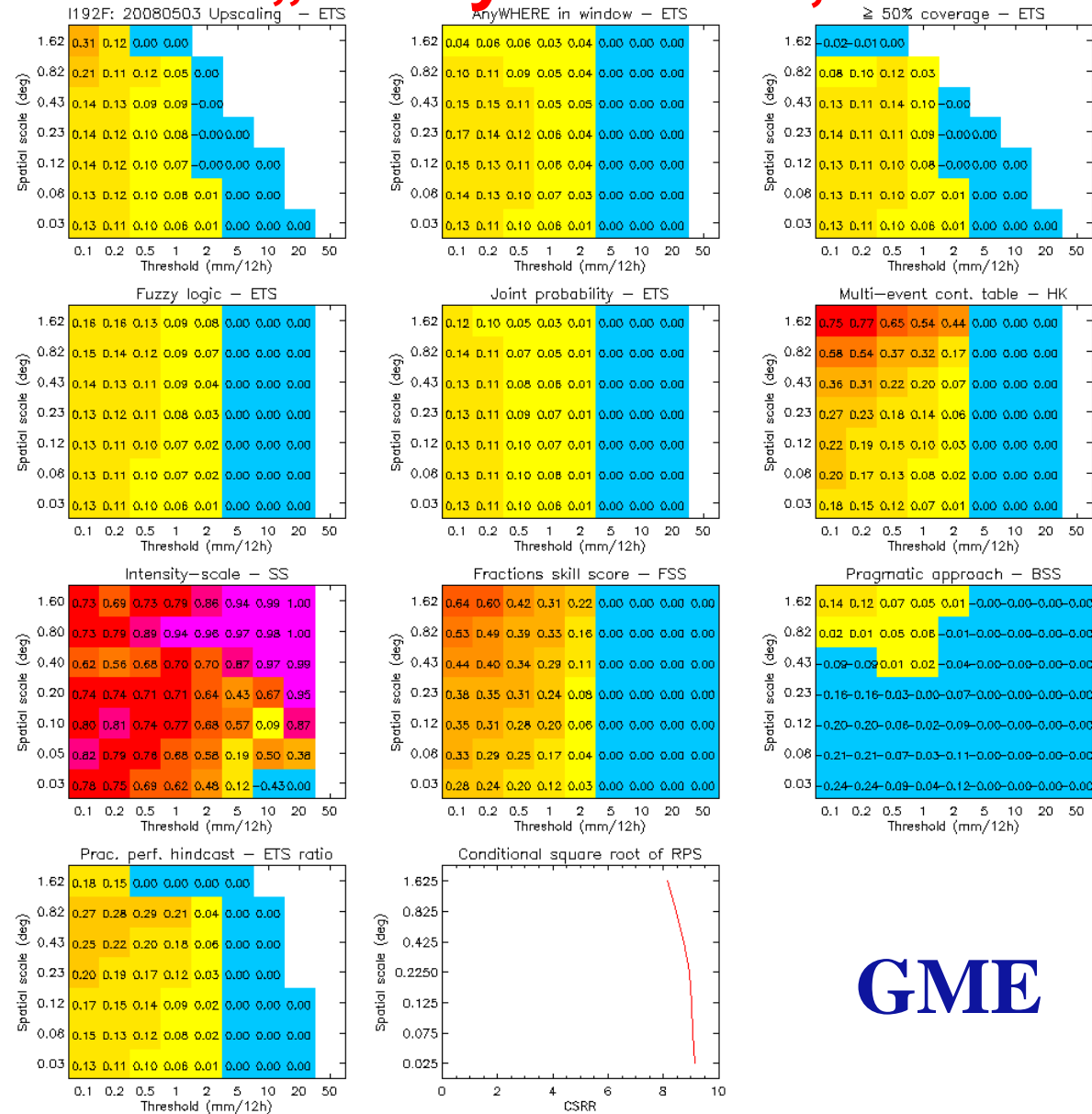
	Thr/Mod	I192F	R192F	COSMO-EU	COSMO-DE
FBI	0.0	1.07	1.28	1.11	0.99
	0.5	0.29	0.36	0.46	0.60
	1.0	0.15	0.16	0.17	0.57
	2.0	0.13	0.16	0.03	0.61
	5.0	0	0	0	0.68
	10.0	0	0	0	0
	20.0	0	0	0	0
	50.0	---	---	---	---
	100.0	---	---	---	---
	ETS	0.0	9.16	12.64	33.70
0.5		9.65	8.98	9.91	26.54
1.0		6.17	4.71	3.76	17.65
2.0		1.12	1.83	0.39	6.27
5.0		0.00	0.00	0.00	0.05
10.0		0.00	0.00	0.00	0.00
20.0		0.00	0.00	0.00	0.00
50.0		---	---	---	---
100.0		---	---	---	---

Forecasts of precipitation Start: 03.05.2008 00 UTC W=18-06





Basic set of „Fuzzy“-scores, case 03.05.2008

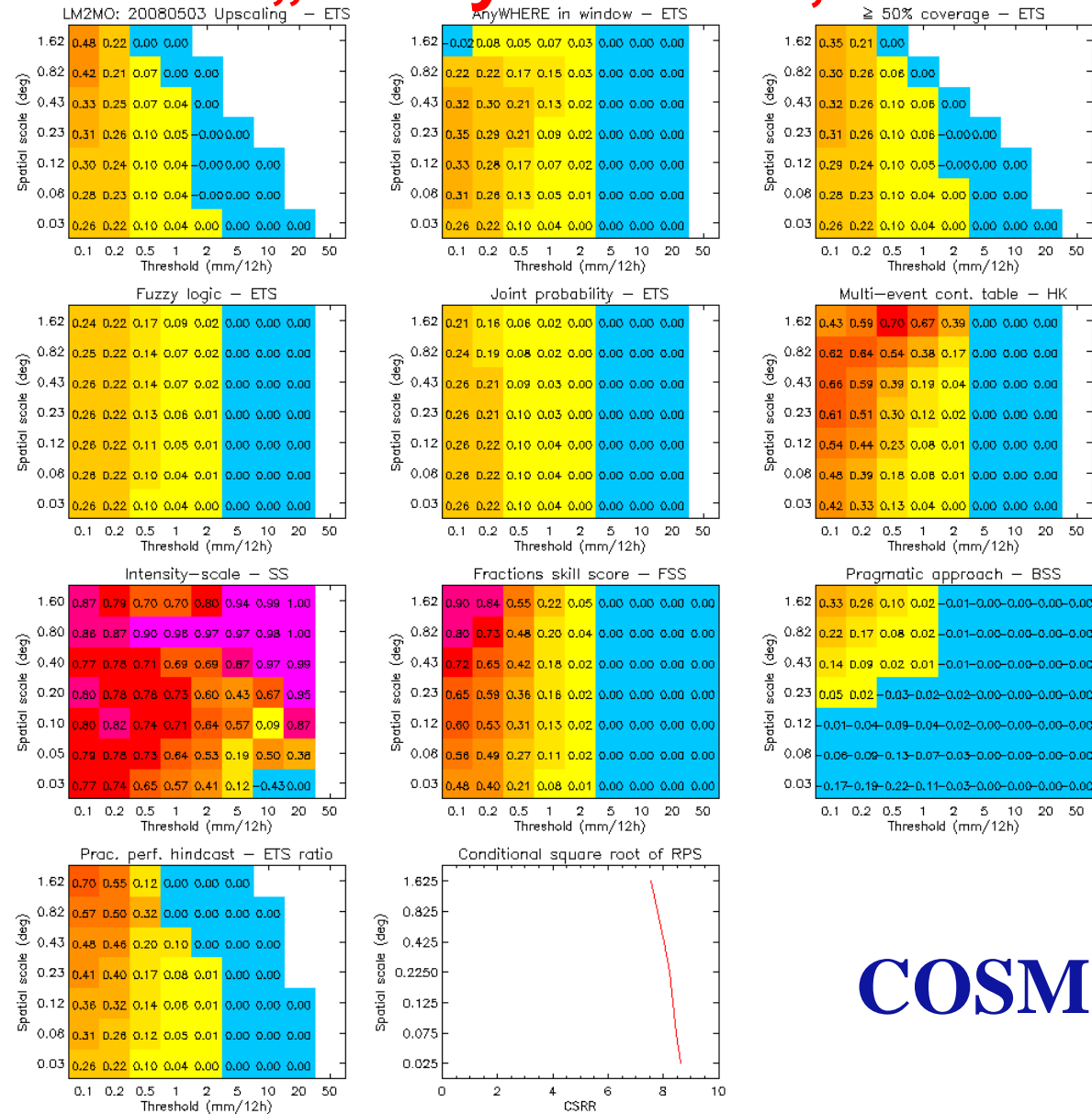


GME





Basic set of „Fuzzy“-scores, case 03.05.2008

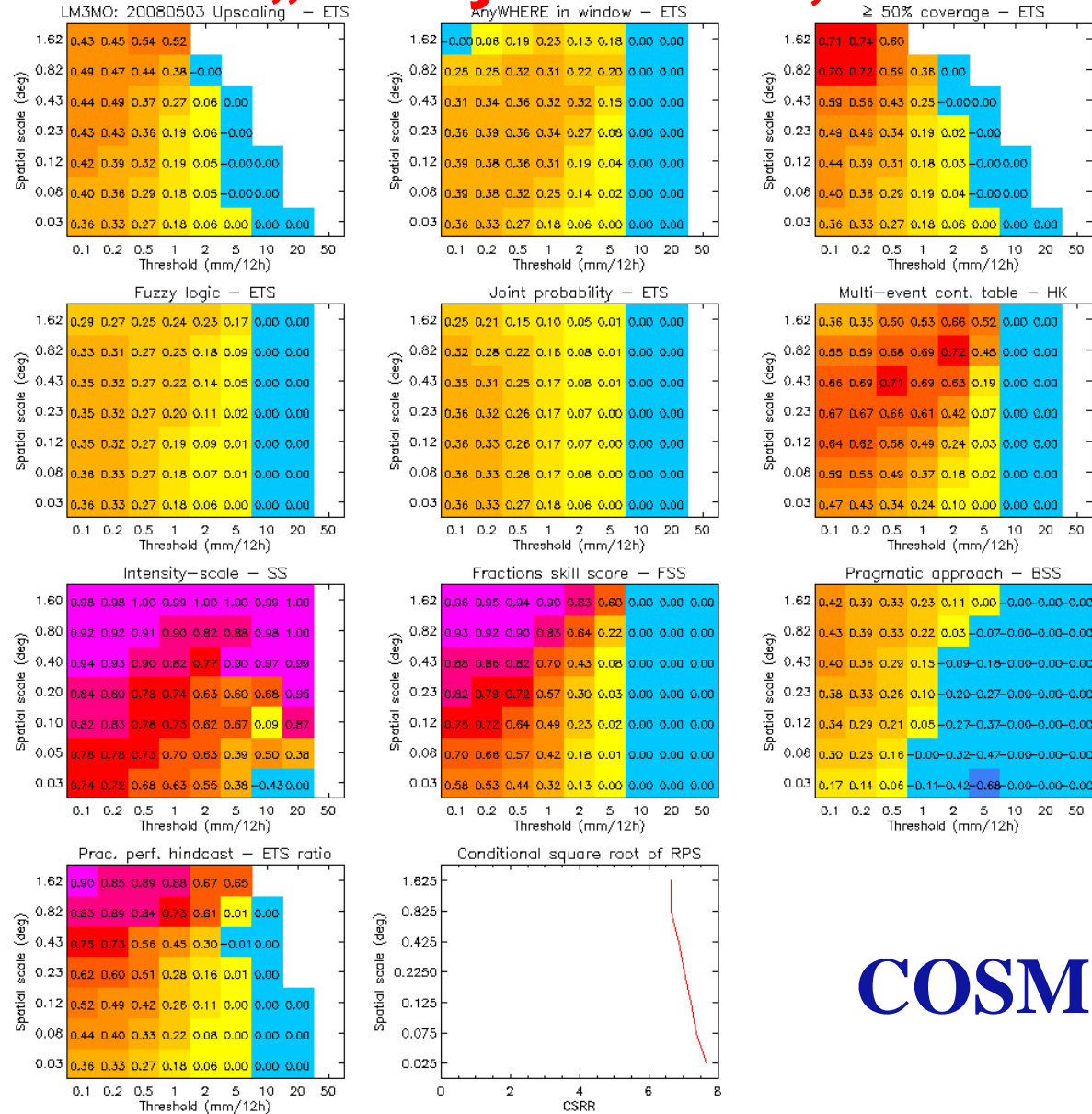


COSMO-EU





Basic set of „Fuzzy“-scores, case 03.05.2008



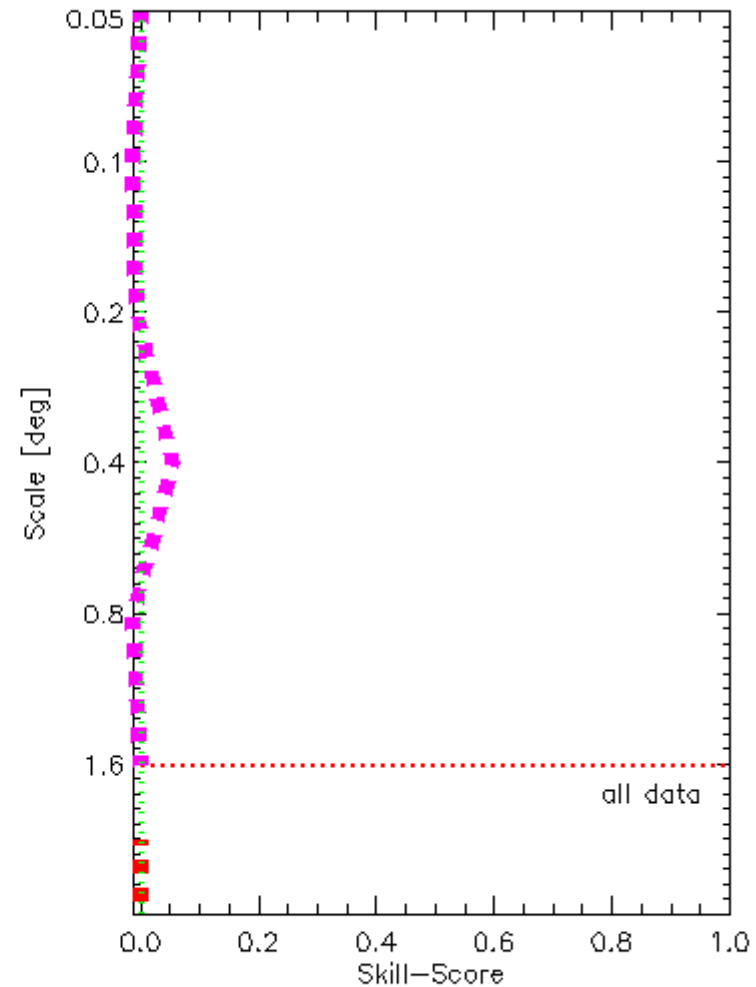
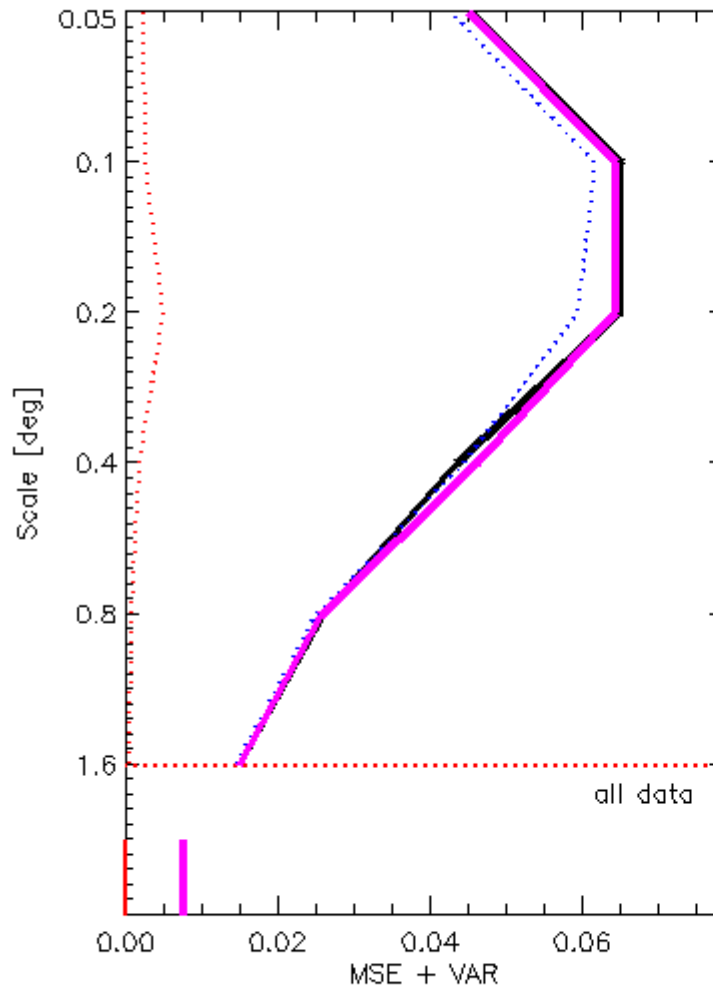
COSMO-DE





Basic set of „Fuzzy“-scores, case 03.05.2008

Precipitation forecast from 20080503 06–18 (MSE and skill scores)



MSE VAR & SKILL OBS VAR & SKILL FCT VAR & SKILL (OBS+FCT), 1192F

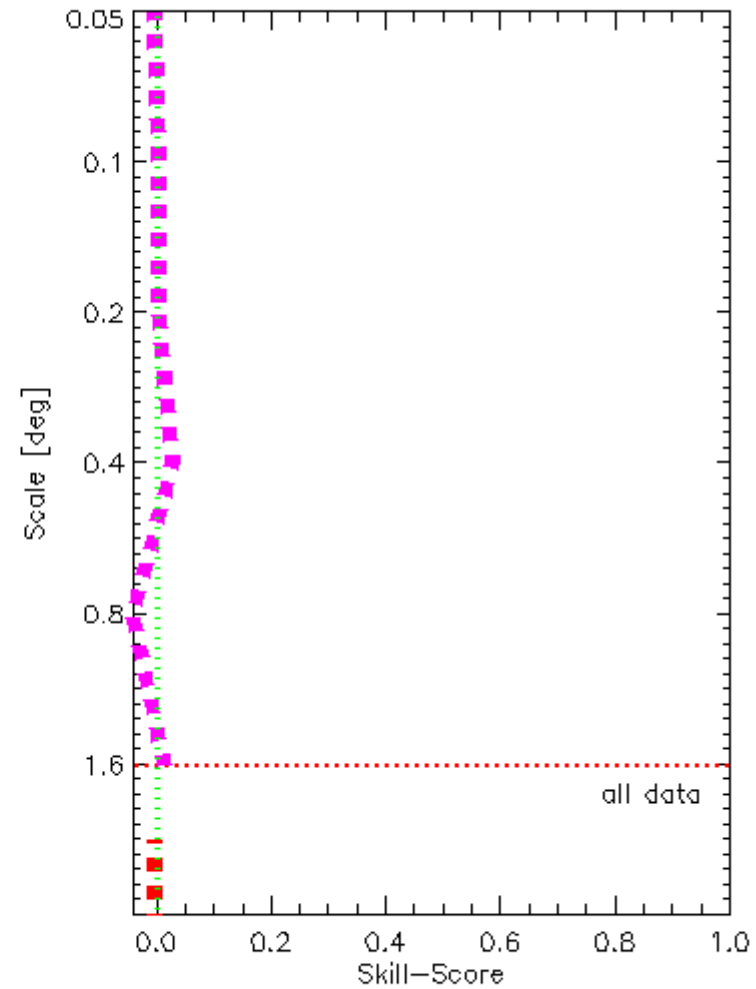
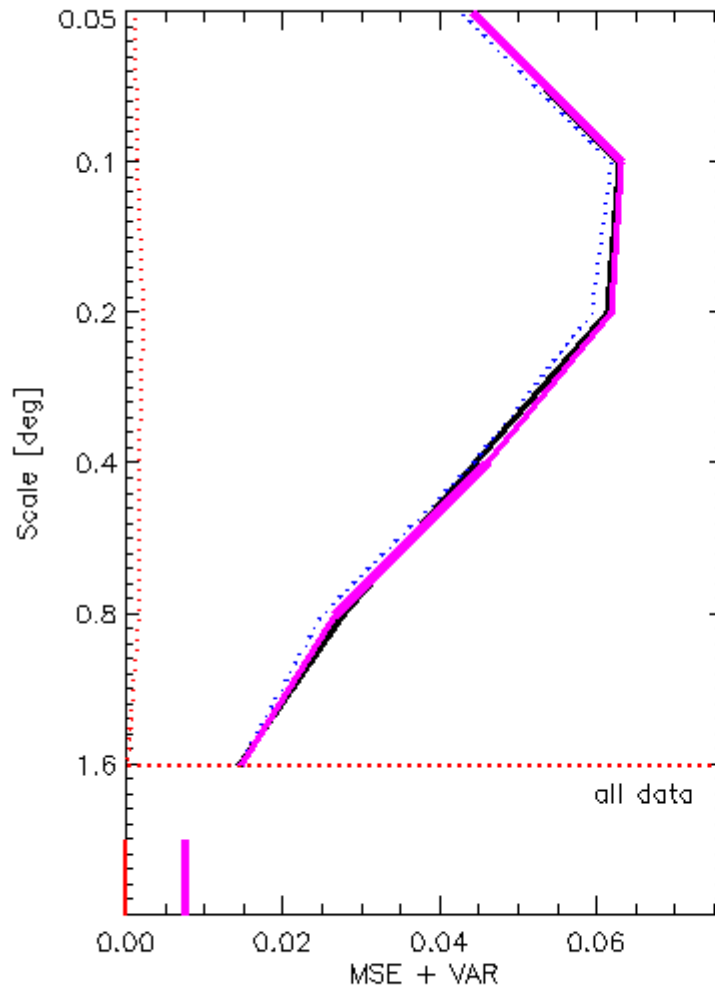
GME





Basic set of „Fuzzy“-scores, case 03.05.2008

Precipitation forecast from 20080503 06–18 (MSE and skill scores)



MSE VAR & SKILL OBS VAR & SKILL FCT VAR & SKILL (OBS+FCT), LM2MO

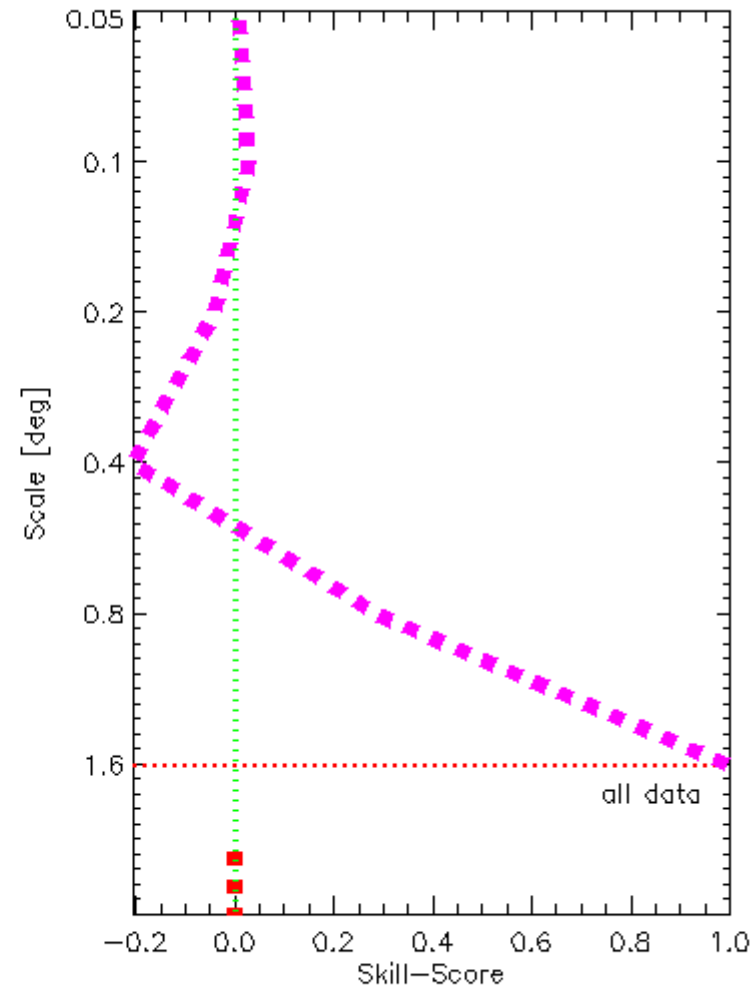
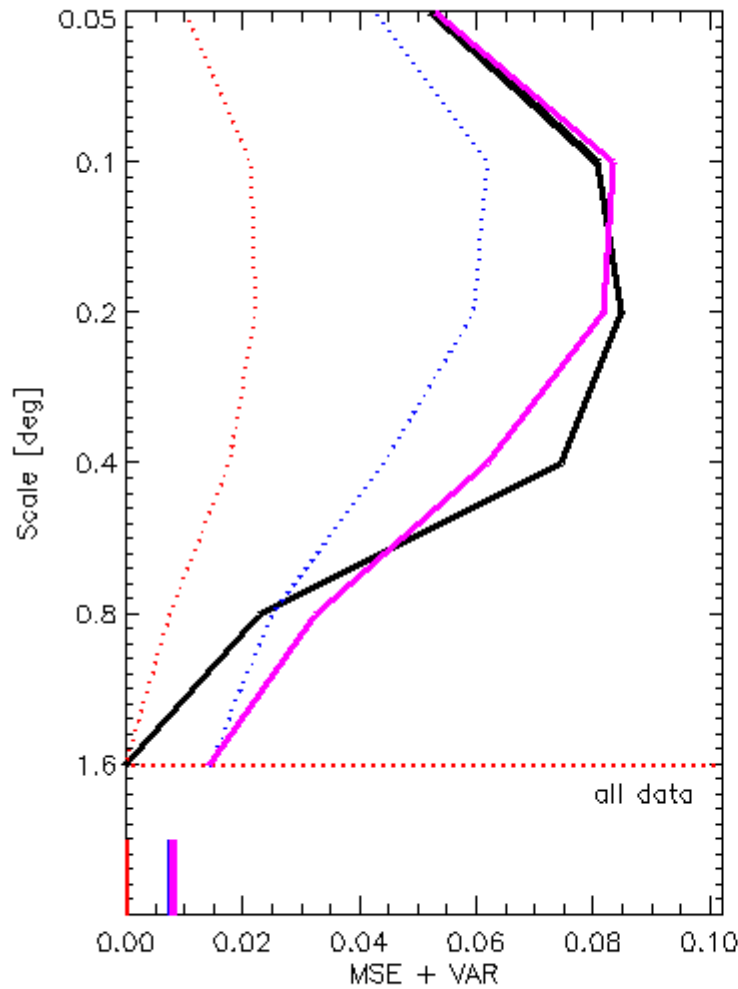
COSMO-EU





Basic set of „Fuzzy“-scores, case 03.05.2008

Precipitation forecast from 20080503 06–18 (MSE and skill scores)

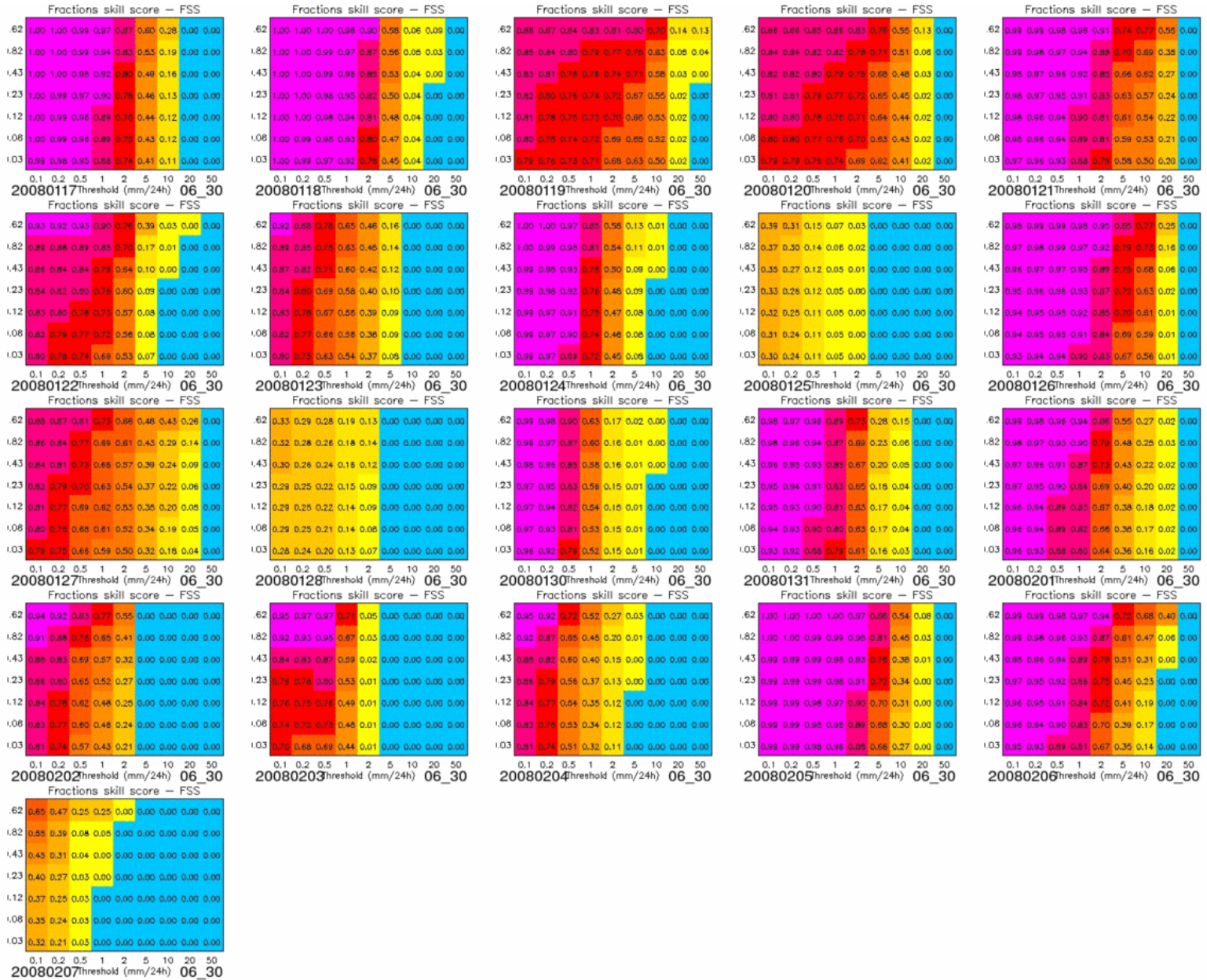


MSE VAR & SKILL OBS VAR & SKILL FCT VAR & SKILL (OBS+FCT), LM3MO

COSMO-DE

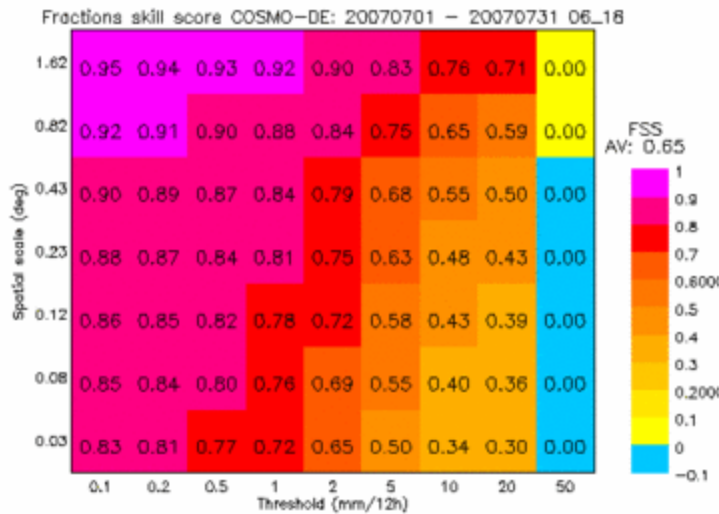
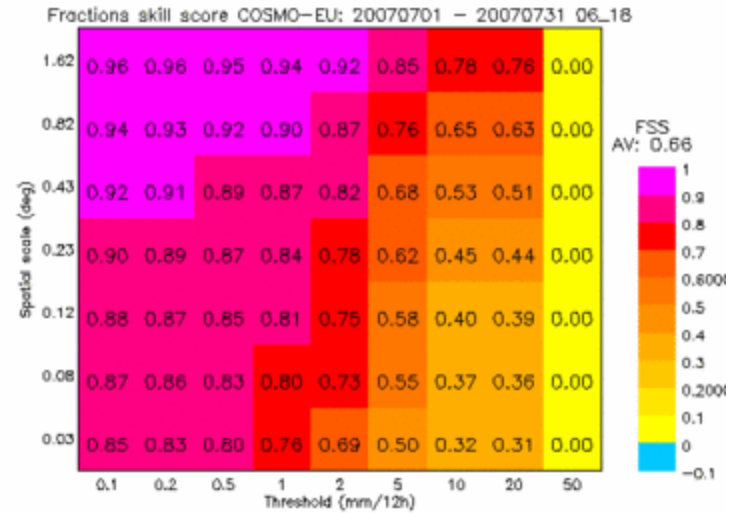
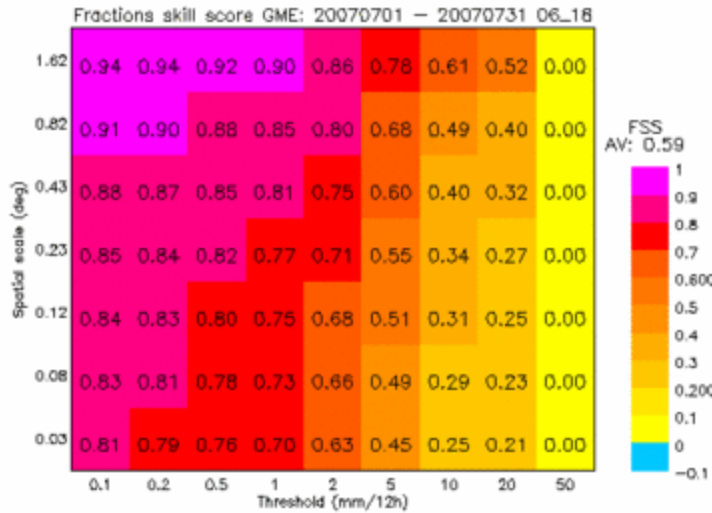


Fraction skill score 17.01.2008 - 07.02.2008





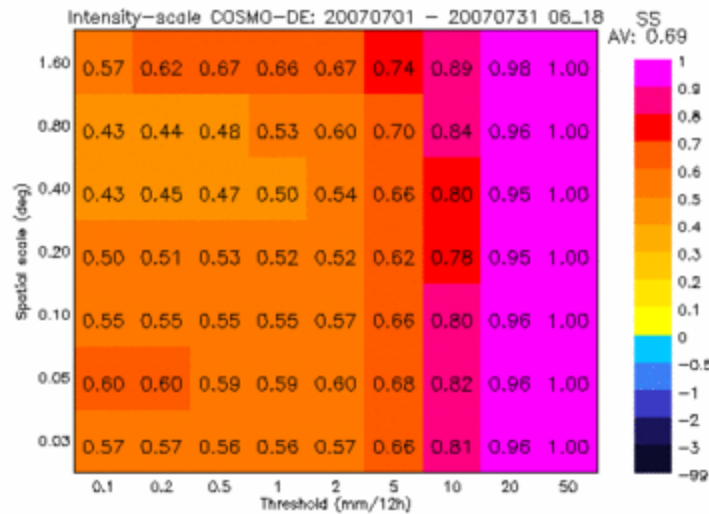
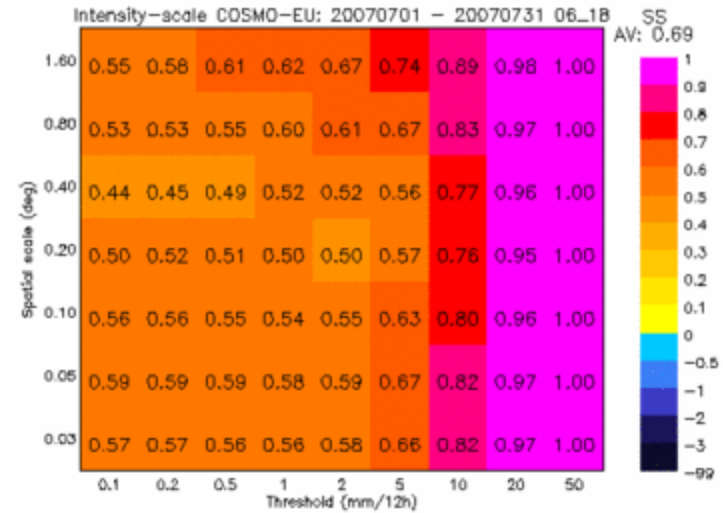
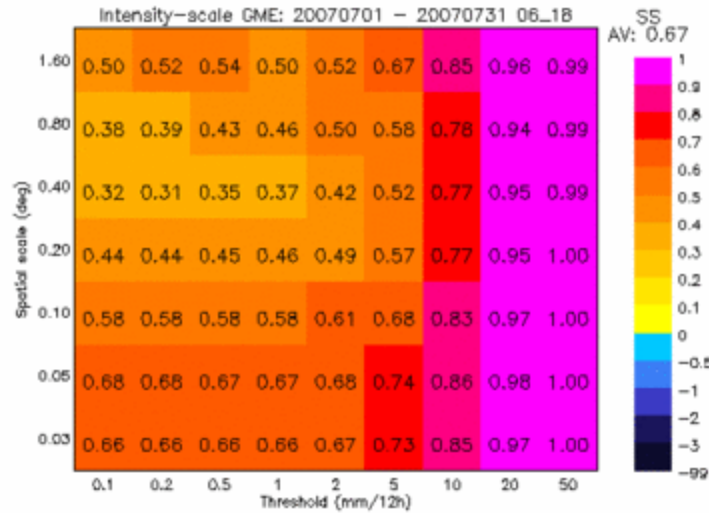
Monthly summaries of „Fuzzy“-scores



FSS July 2007



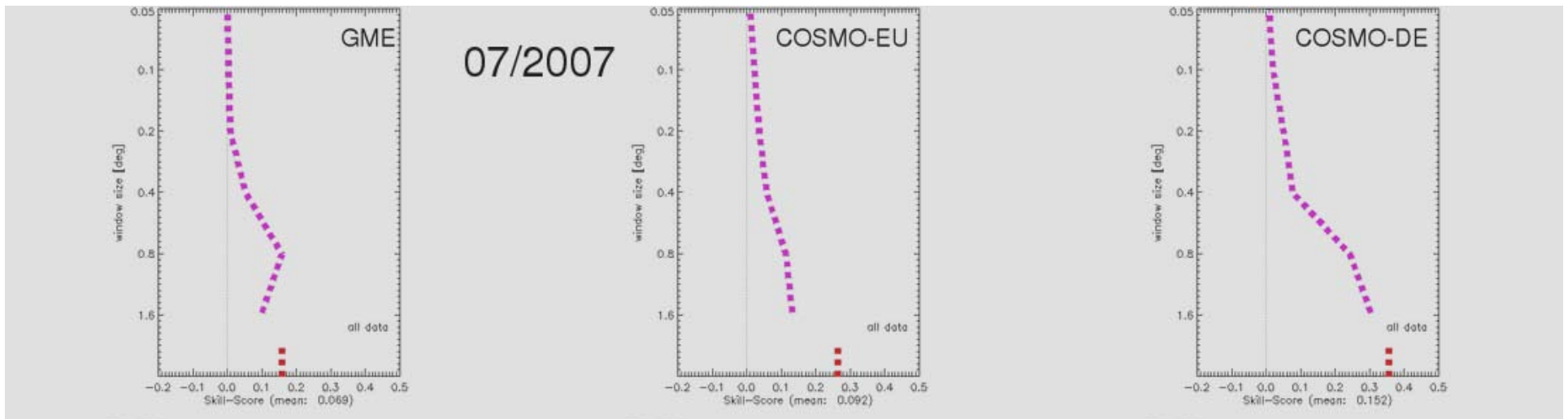
Monthly summaries of „Fuzzy“-scores



ISS July 2007



Monthly summaries of „Fuzzy“-scores

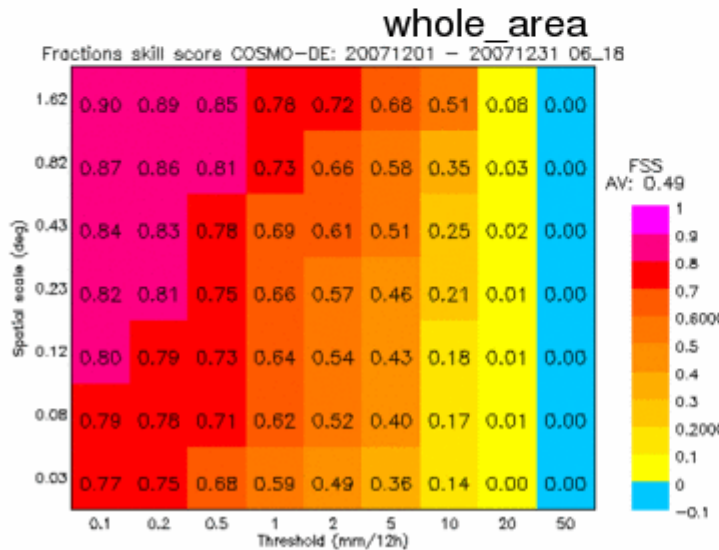
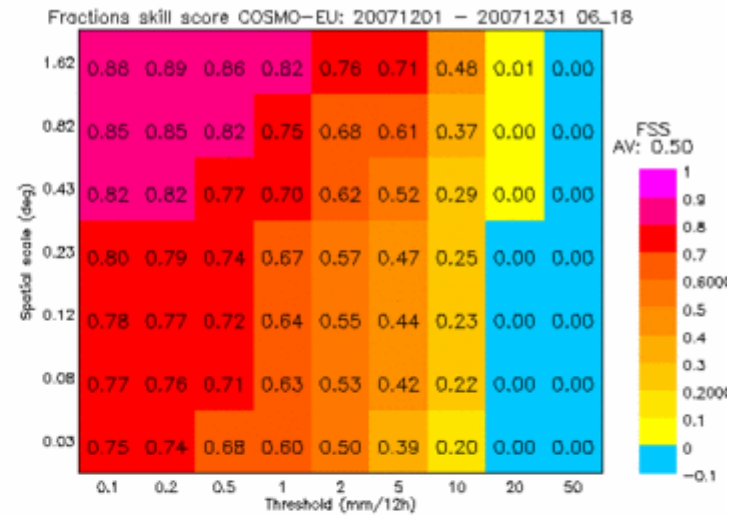
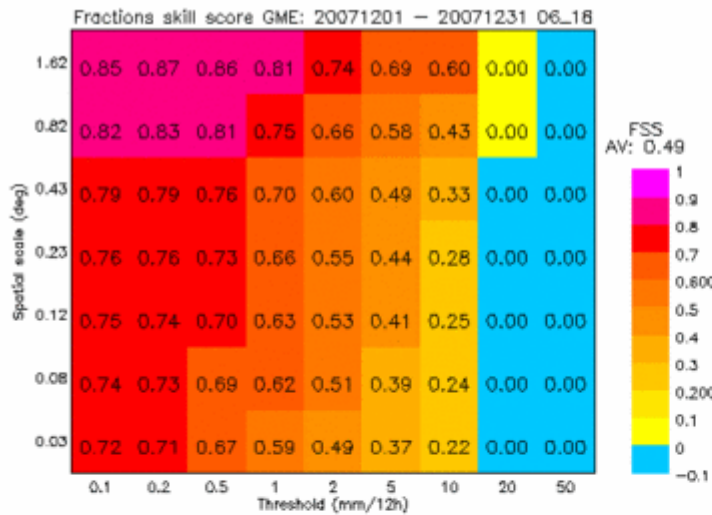


Energy squared skill score July 2007





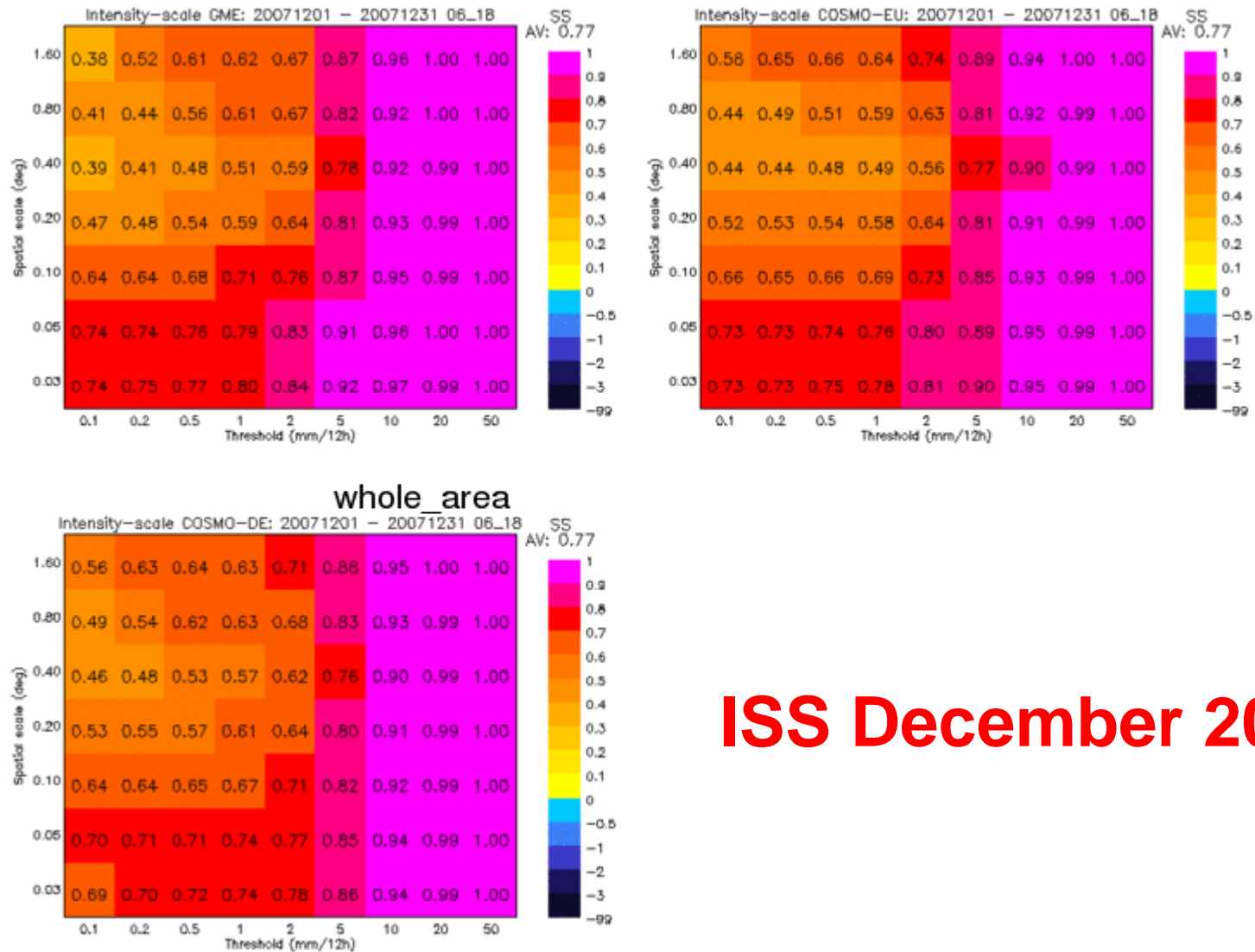
Monthly summaries of „Fuzzy“-scores



FSS December 2007



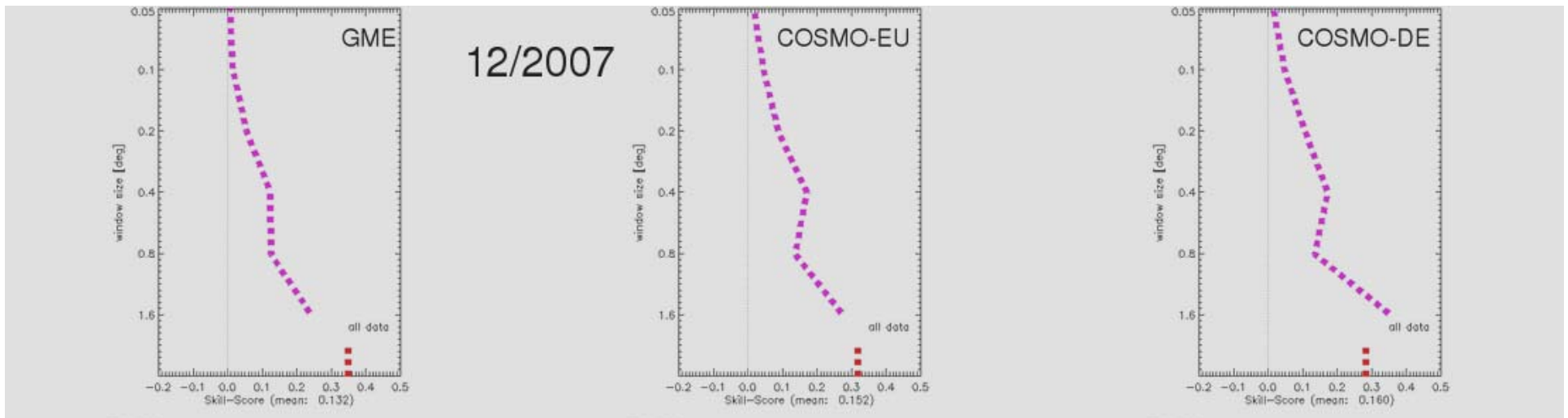
Monthly summaries of „Fuzzy“-scores



ISS December 2007



Monthly summaries of „Fuzzy“-scores

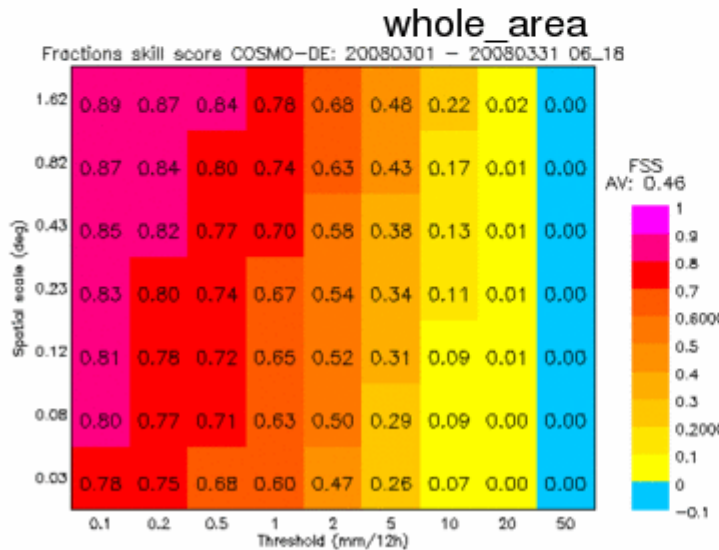
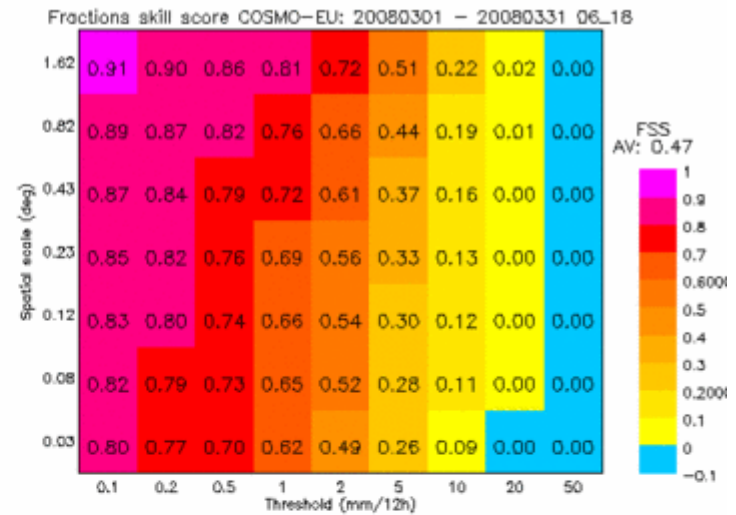
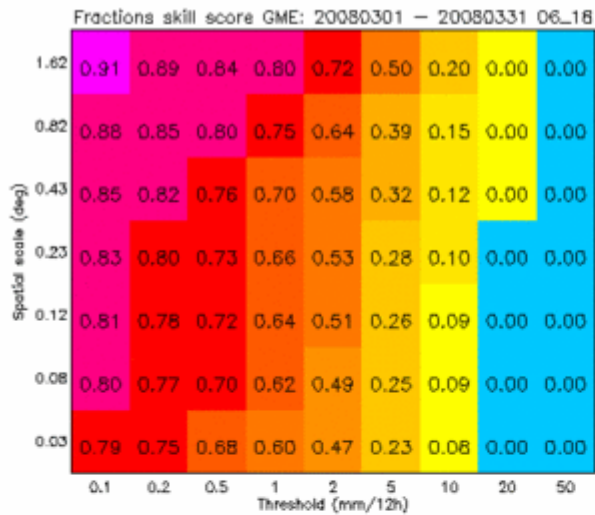


**Energy squared skill score
December 2007**





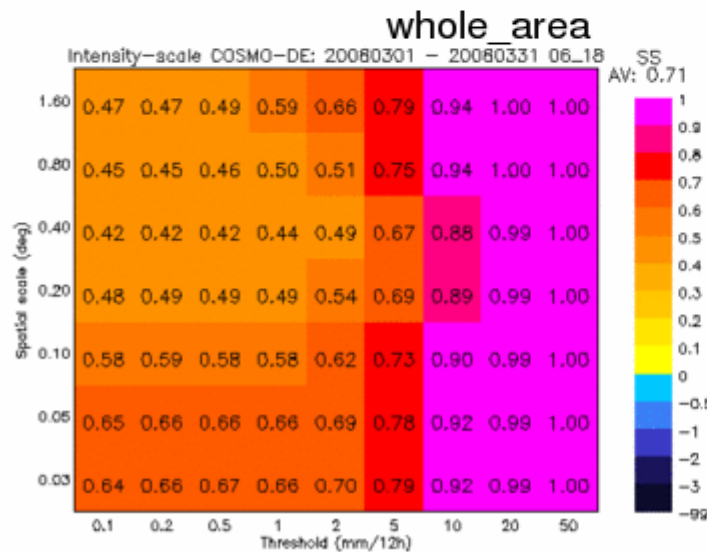
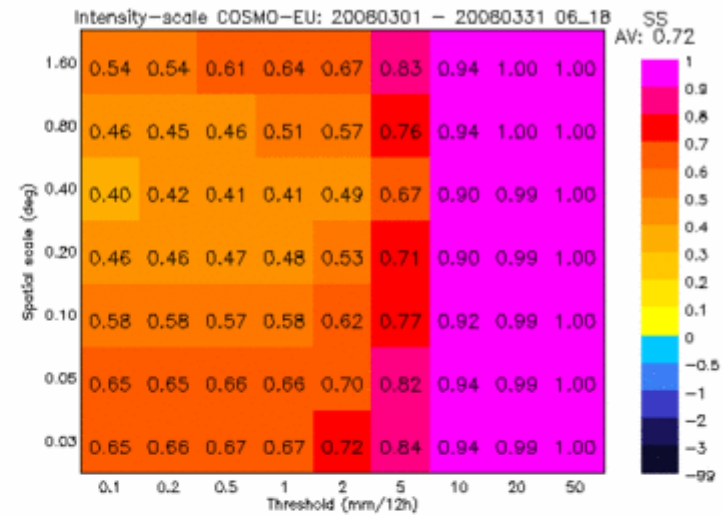
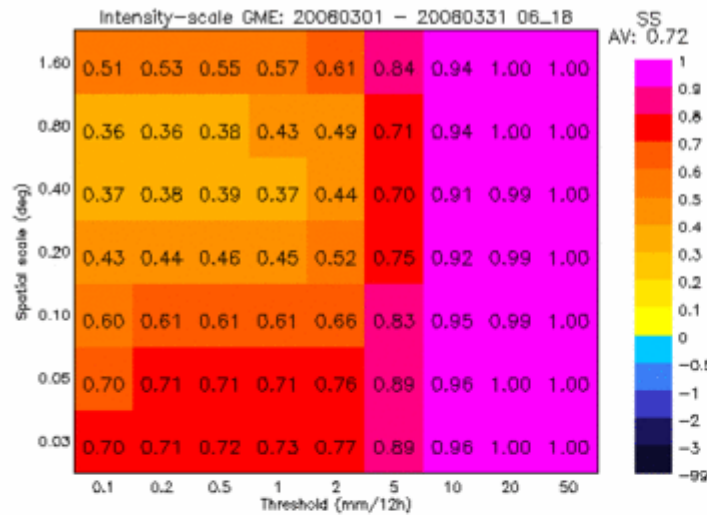
Monthly summaries of „Fuzzy“-scores



FSS March 2008



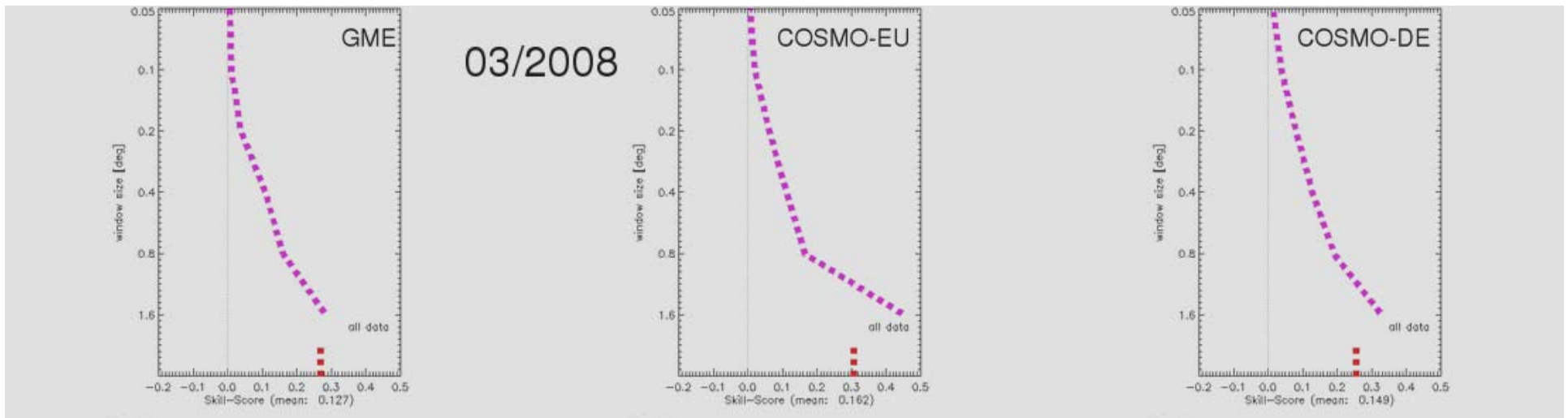
Monthly summaries of „Fuzzy“-scores



ISS March 2008



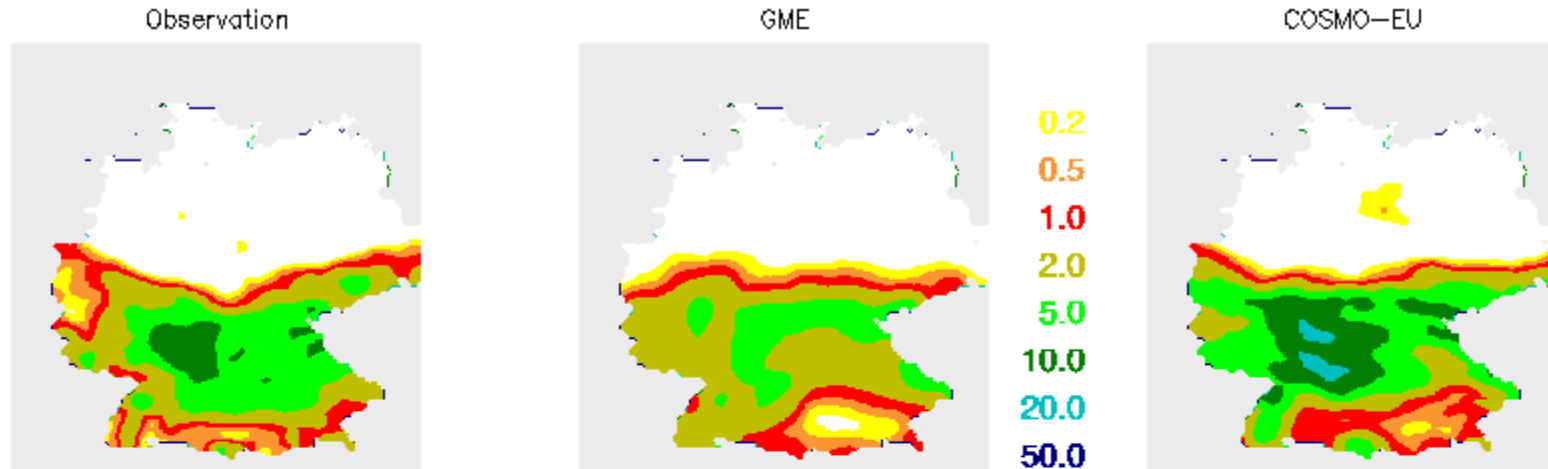
Monthly summaries of „Fuzzy“-scores



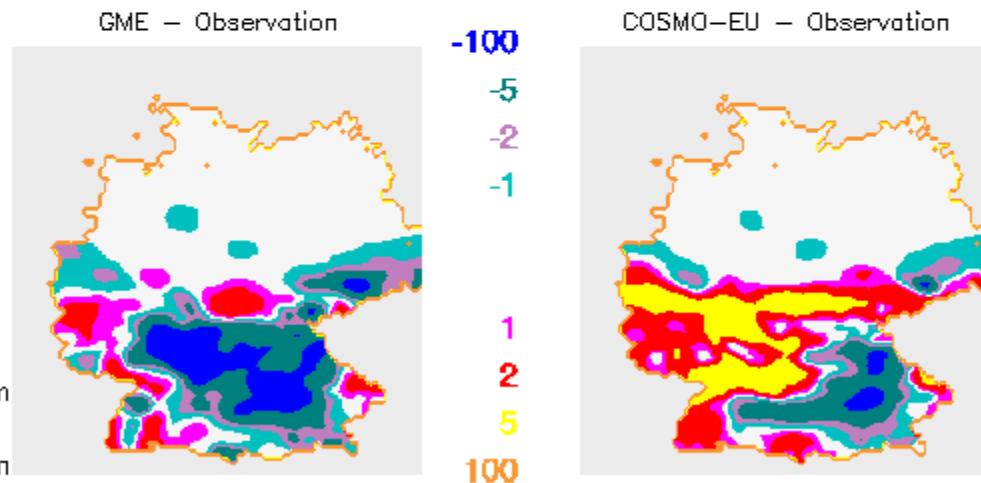
Energy squared skill score March 2008



Basic data (example with some observation problems)



Mean G: 1.8 Mean C: 3.7 Mean O: 2.6
 Max G: 7.3 Max C: 23.4 Max O: 19.6
 BIAS G: -0.88 BIAS C: 1.10
 RMSE G: 2.59 RMSE C: 3.11
 CORR G: 0.767 CORR C: 0.829
 ETS G: 75.0 ETS C: 74.7 Thrs: 0.1 mm
 ETS G: 28.3 ETS C: 36.2 Thrs: 5.0 mm



Observations and forecasts of precipitation over 24 hours, Start: 19.04.2008 06 UTC



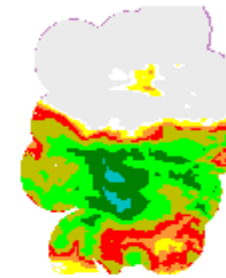
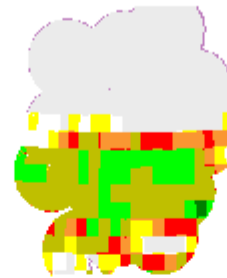
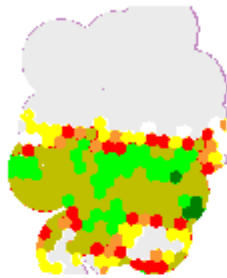
Basic data

(example with some observation problems)

GME/I192F
AV: 0.58 MA: 15.9 STD: 1.26

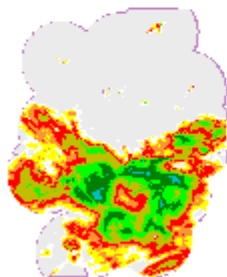
GME/R192F
AV: 0.58 MA: 11.9 STD: 1.27

COSMO-EU
AV: 1.13 MA: 25.5 STD: 1.51

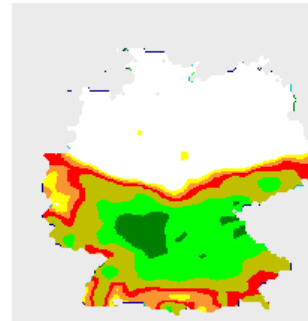


0.2
0.5
1.0
2.0
5.0
10.0
20.0
50.0
75.0
400.0

RADAR
AV: 0.65 MA: 37.1 STD: 1.23



Observation



Thr/Mod	I192F	R192F	COSMO-EU
0.0	1.08	1.20	1.16
0.5	1.02	1.09	1.32
1.0	1.14	1.17	1.49
2.0	1.36	1.42	1.75
5.0	0.93	0.94	2.11
10.0	0.20	0.07	1.70
20.0	0	0	1.97
50.0	---	---	---
100.0	---	---	---
0.0	51.74	49.73	59.43
0.5	45.63	47.53	49.64
1.0	39.64	37.99	37.31
2.0	33.59	32.68	29.00
5.0	18.75	20.92	21.37
10.0	3.34	-0.37	20.15
20.0	0.00	0.00	7.42
50.0	---	---	---
100.0	---	---	---

Forecasts of precipitation Start: 19.04.2008 00 UTC W=30-06



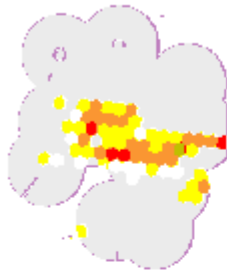


Basic data (different regions for evaluation)

GME/I192F
AV: 0.03 MA: 2.2 STD: 0.42

GME/R192F
AV: 0.03 MA: 1.5 STD: 0.42

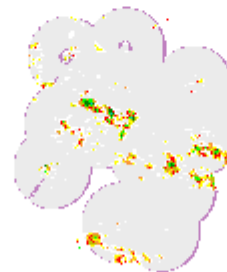
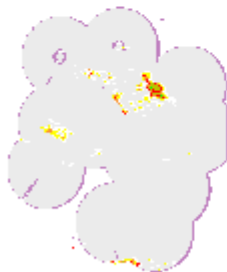
COSMO-EU
AV: 0.00 MA: 1.5 STD: 0.15



0.2
0.5
1.0
2.0
5.0
10.0
20.0
50.0
75.0
400.0

COSMO-DE
AV: 0.01 MA: 10.2 STD: 0.18

RADAR
AV: 0.05 MA: 56.4 STD: 0.38



	Thr/Mod	I192F	R192F	COSMO-EU	COSMO-DE
FBI	0.0	1.97	2.34	0.96	0.48
	0.5	1.80	1.64	0.06	0.26
	1.0	0.52	0.73	0.01	0.21
	2.0	0.18	0	0	0.16
	5.0	0	0	0	0.06
	10.0	0	0	0	0.01
	20.0	0	0	0	0
	50.0	0	0	0	0
	100.0	---	---	---	---
	ETS	0.0	14.59	14.31	10.90
0.5		9.01	8.03	0.74	1.02
1.0		0.55	1.11	0.09	0.38
2.0		-0.02	0.00	0.00	0.00
5.0		0.00	0.00	0.00	-0.04
10.0		0.00	0.00	0.00	-0.00
20.0		0.00	0.00	0.00	0.00
50.0		0.00	0.00	0.00	0.00
100.0		---	---	---	---

Forecasts of precipitation Start: 13.05.2008 00 UTC W=18-06





Basic data (different regions for evaluation)

GME/I192F
AV: 0.02 MA: 2.2 STD: 0.75

GME/R192F
AV: 0.02 MA: 1.5 STD: 0.73

COSMO-EU
AV: 0.00 MA: 0.6 STD: 0.85



0.2
0.5
1.0
2.0
5.0
10.0
20.0
50.0
75.0
400.0

COSMO-DE
AV: 0.00 MA: 1.8 STD: 0.86

RADAR
AV: 0.02 MA: 26.0 STD: 0.84



	Thr/Mod	I192F	R192F	COSMO-EU	COSMO-DE
FBI	0.0	2.75	3.36	0.82	0.25
	0.5	2.43	2.26	0.01	0.04
	1.0	0.79	1.40	0	0.01
	2.0	0.35	0	0	0
	5.0	0	0	0	0
	10.0	0	0	0	0
	20.0	0	0	0	0
	50.0	---	---	---	---
	100.0	---	---	---	---
	ETS	0.0	13.45	13.42	12.62
0.5		6.92	4.87	-0.04	0.86
1.0		1.13	1.50	0.00	0.31
2.0		-0.03	0.00	0.00	0.00
5.0		0.00	0.00	0.00	0.00
10.0		0.00	0.00	0.00	0.00
20.0		0.00	0.00	0.00	0.00
50.0		---	---	---	---
100.0		---	---	---	---

Forecasts of precipitation Start: 13.05.2008 00 UTC W=18-06



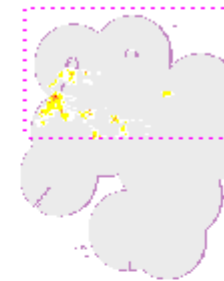
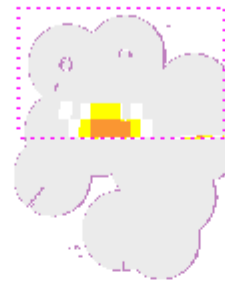


Basic data (different regions for evaluation)

GME/I192F
AV: 0.01 MA: 1.2 STD: 0.88

GME/R192F
AV: 0.01 MA: 0.8 STD: 0.87

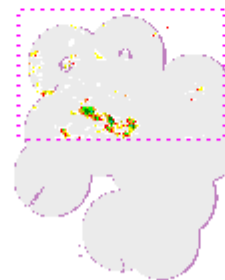
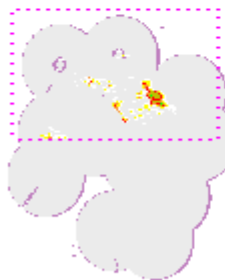
COSMO-EU
AV: 0.00 MA: 1.5 STD: 0.89



0.2
0.5
1.0
2.0
5.0
10.0
20.0
50.0
75.0
400.0

COSMO-DE
AV: 0.01 MA: 10.2 STD: 0.90

RADAR
AV: 0.02 MA: 56.4 STD: 0.90



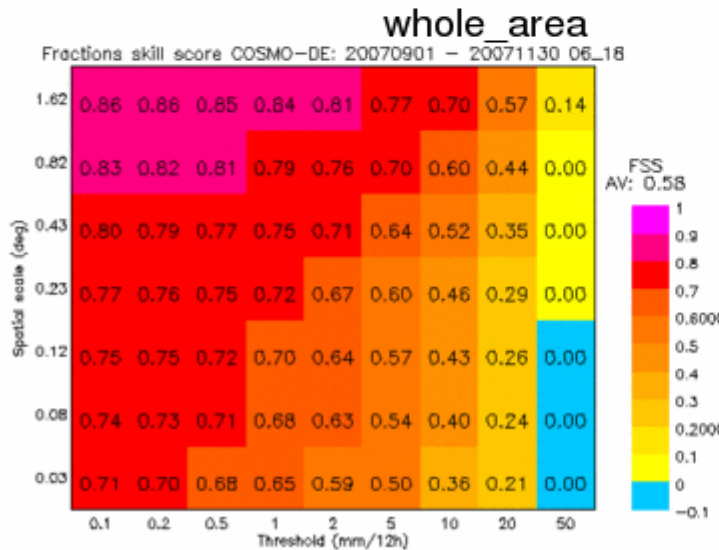
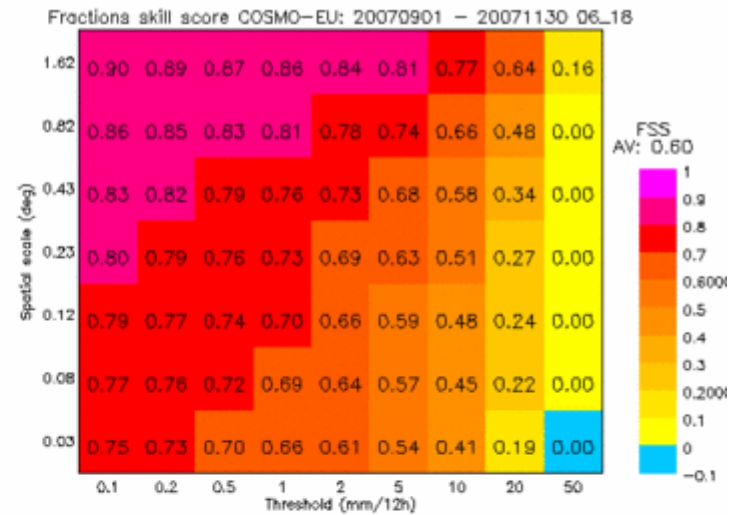
	Thr/Mod	I192F	R192F	COSMO-EU	COSMO-DE
FBI	0.0	1.48	1.59	1.28	0.79
	0.5	1.35	1.14	0.15	0.55
	1.0	0.12	0	0.02	0.47
	2.0	0	0	0	0.36
	5.0	0	0	0	0.10
	10.0	0	0	0	0.01
	20.0	0	0	0	0
	50.0	0	0	0	0
	100.0	---	---	---	---
	ETS	0.0	22.82	21.39	13.32
0.5		16.45	14.84	2.20	-0.08
1.0		-0.19	0.00	0.26	-0.06
2.0		0.00	0.00	0.00	0.16
5.0		0.00	0.00	0.00	-0.06
10.0		0.00	0.00	0.00	-0.00
20.0		0.00	0.00	0.00	0.00
50.0		0.00	0.00	0.00	0.00
100.0		---	---	---	---

Forecasts of precipitation Start: 13.05.2008 00 UTC W=18-06





Quarterly summaries of „Fuzzy“-scores

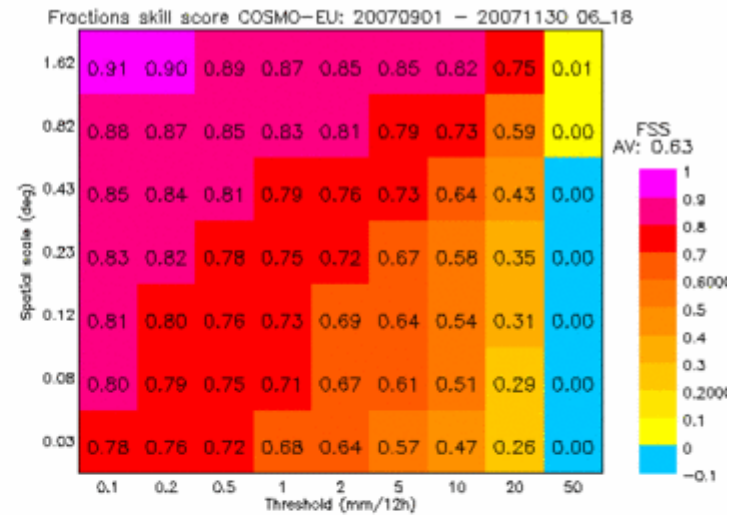
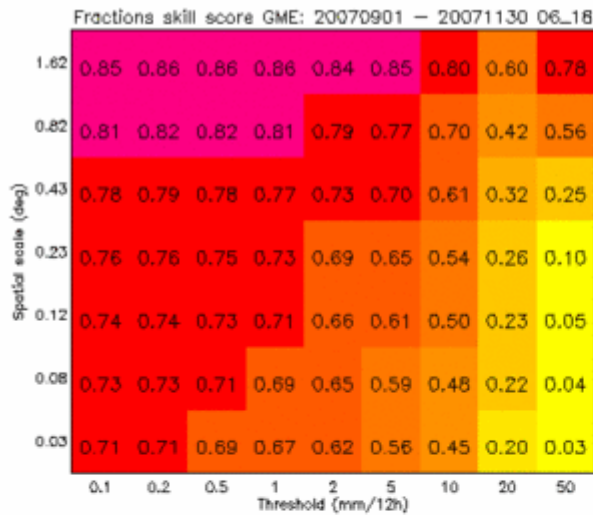


FSS Autumn 2007

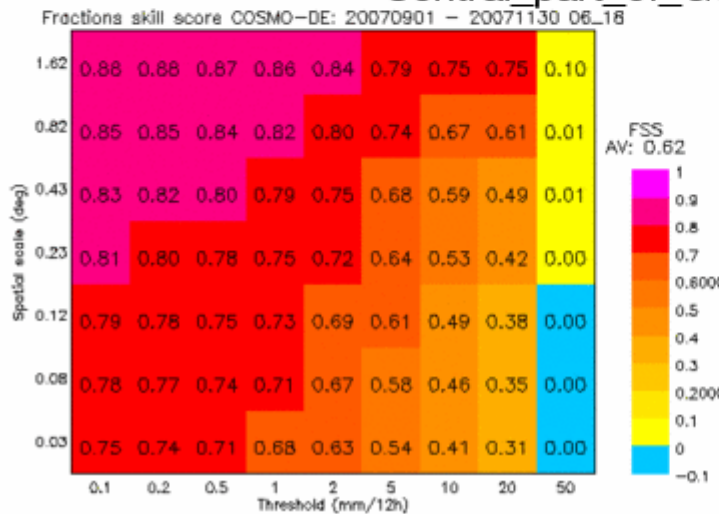




Quarterly summaries of „Fuzzy“-scores



Central part of Germany

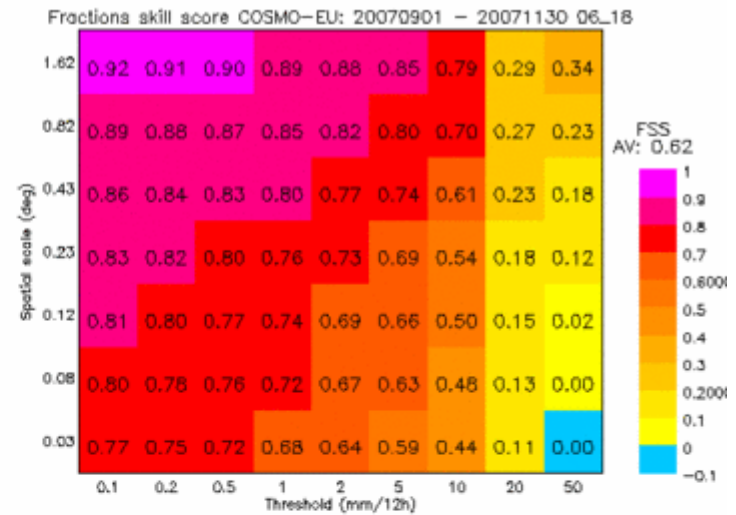
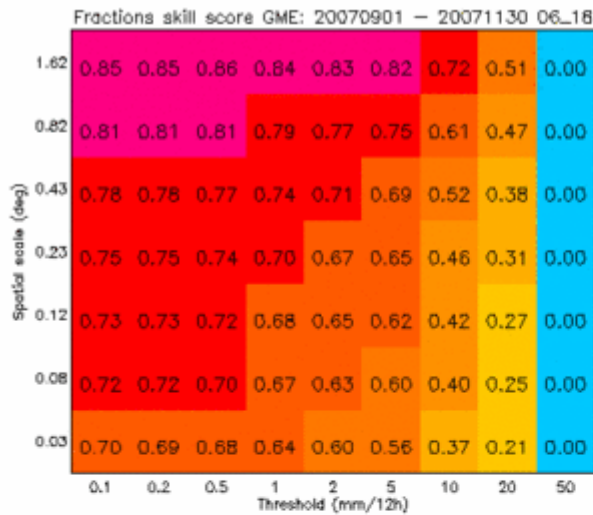


FSS Autumn 2007

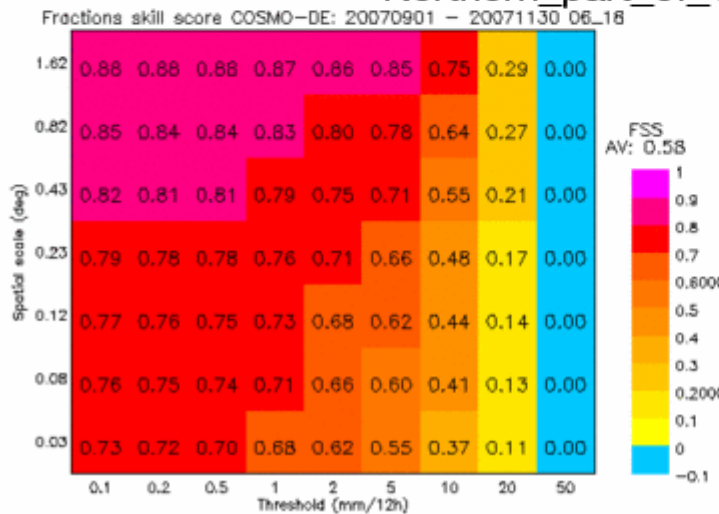




Quarterly summaries of „Fuzzy“-scores



Northern_part_of_Germany

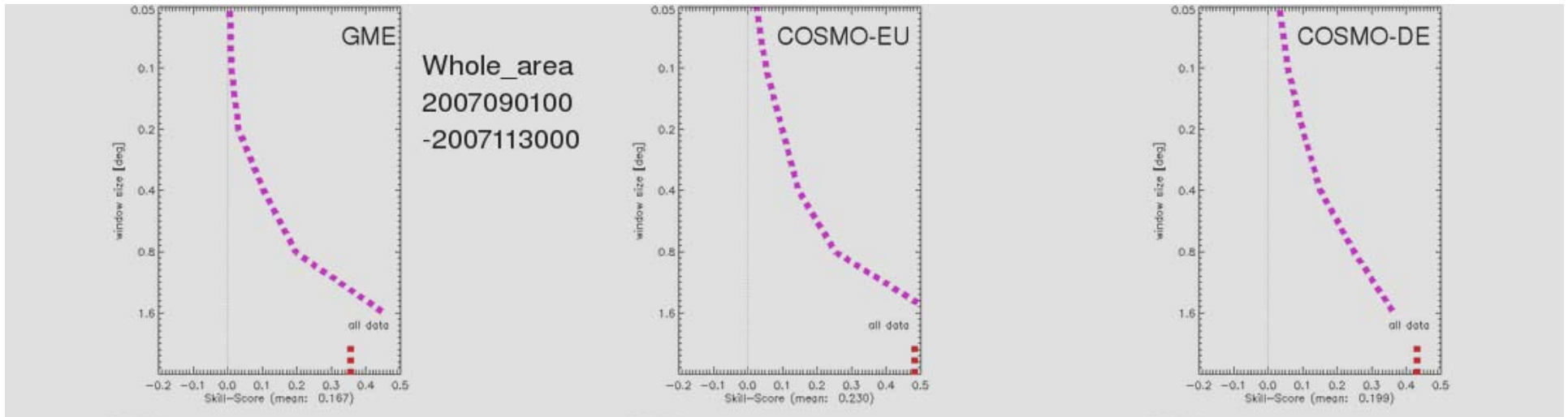


FSS Autumn 2007





Quarterly summaries of „Fuzzy“-scores

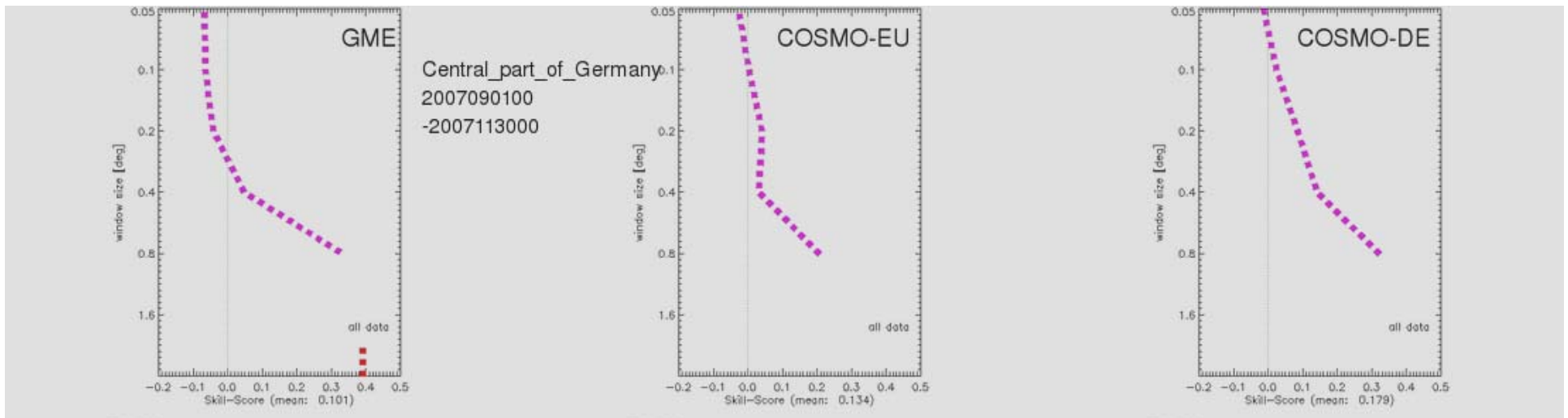


Energy squared skill score Autumn 2007





Quarterly summaries of „Fuzzy“-scores

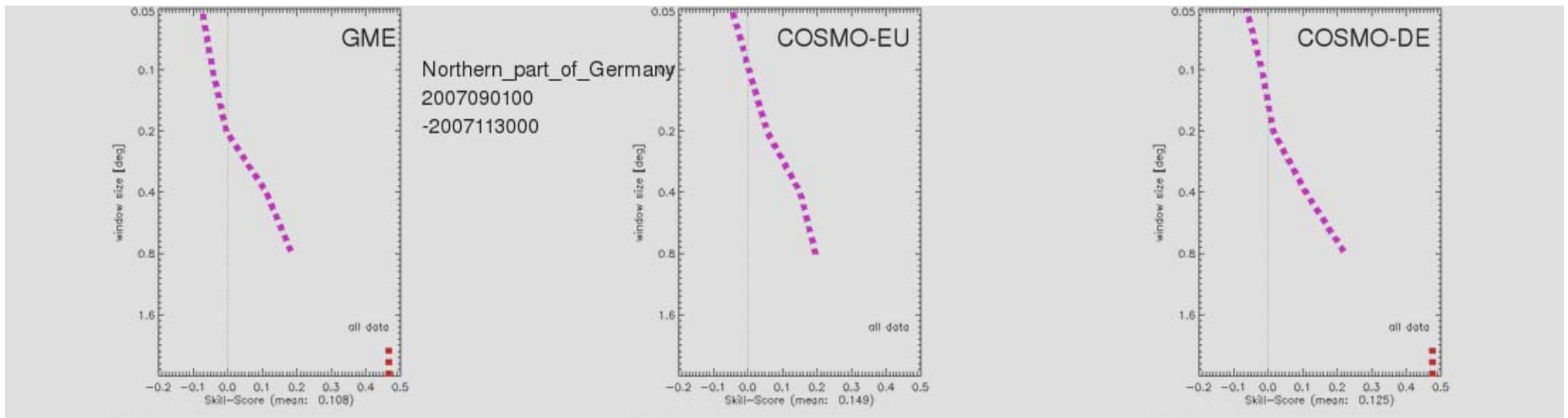


**Energy squared skill score
Autumn 2007**





Monthly summaries of „Fuzzy“-scores

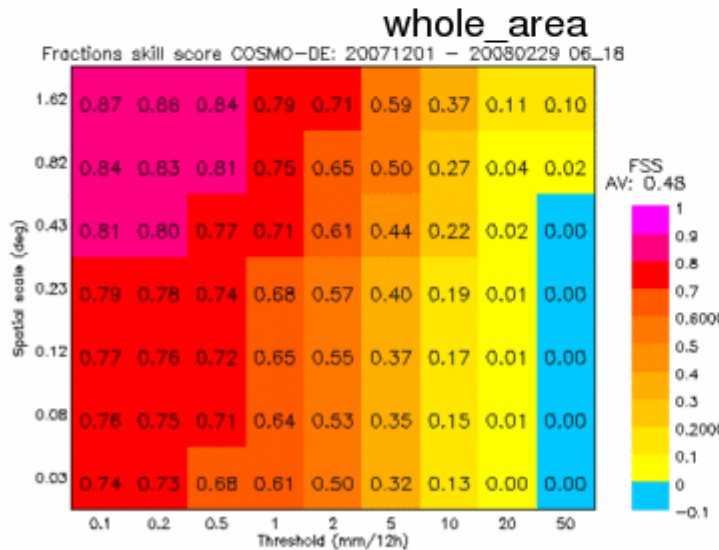
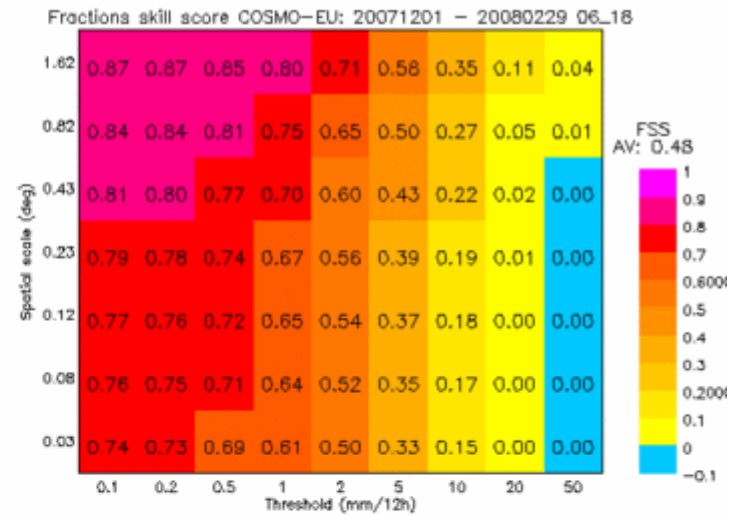
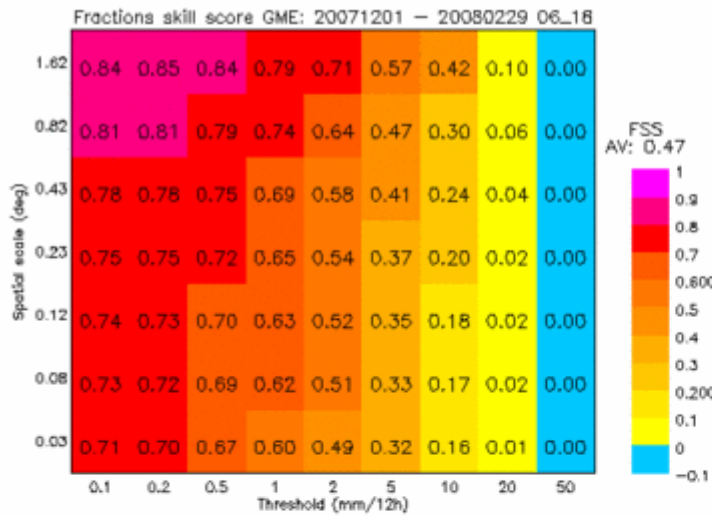


**Energy squared skill score
Autumn 2007**





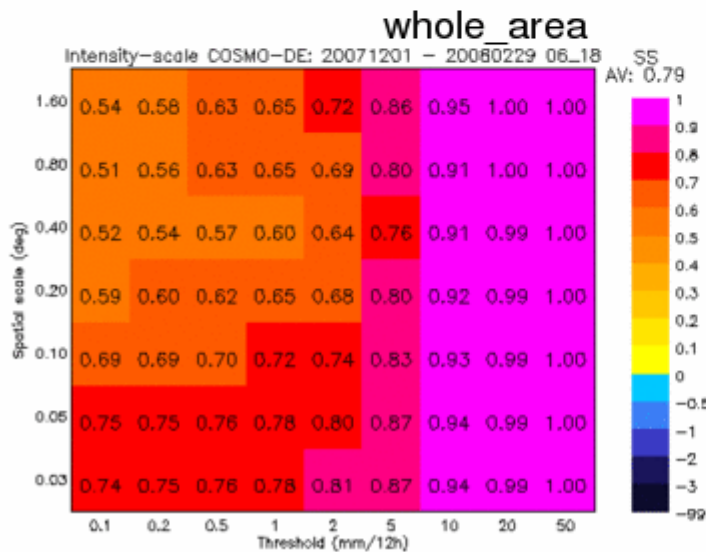
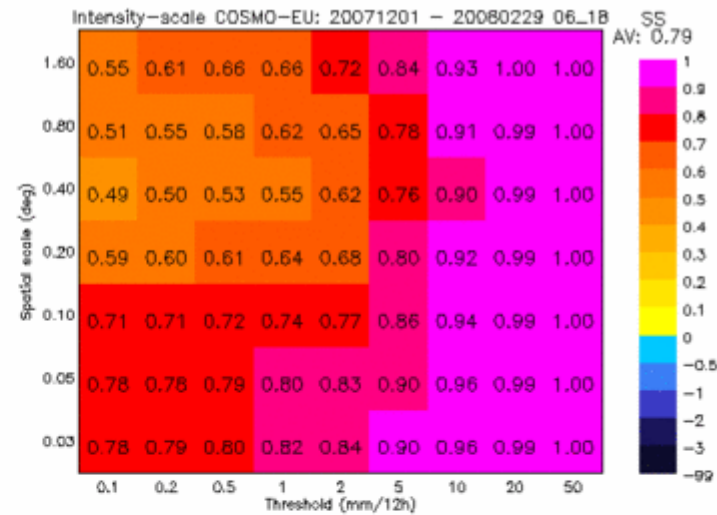
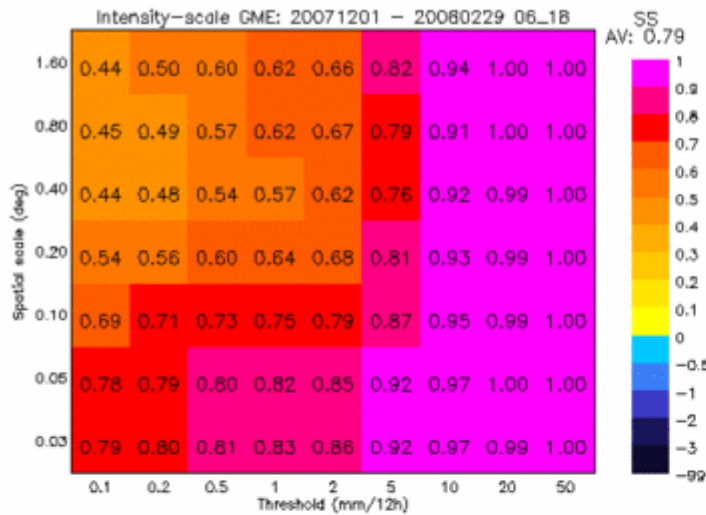
Quarterly summaries of „Fuzzy“-scores



**FSS Winter
2007/2008**



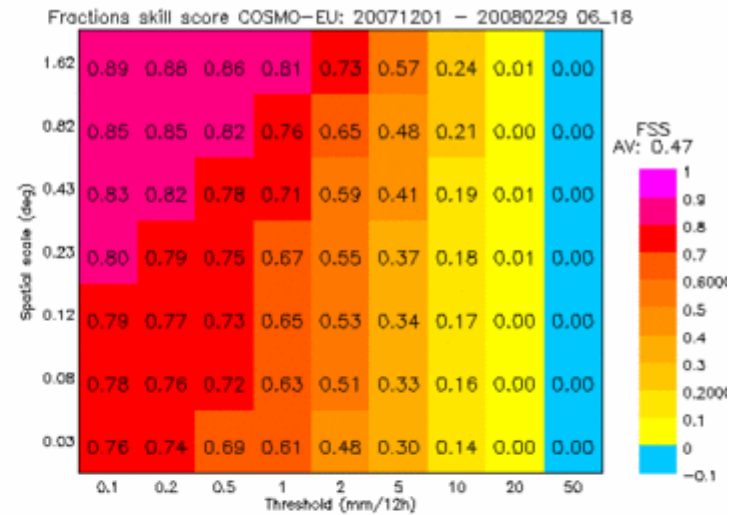
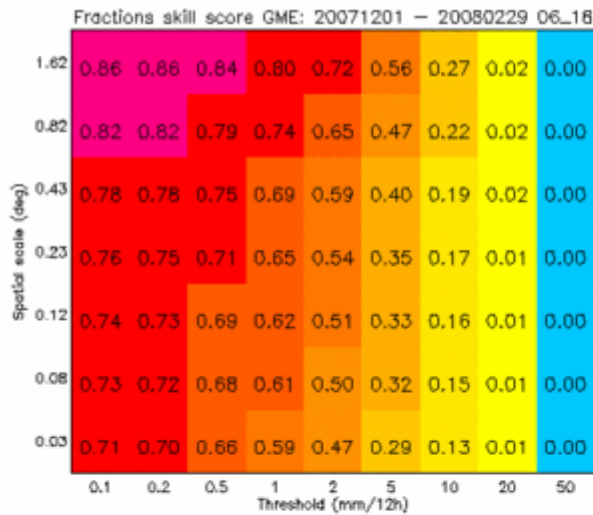
Quarterly summaries of „Fuzzy“-scores



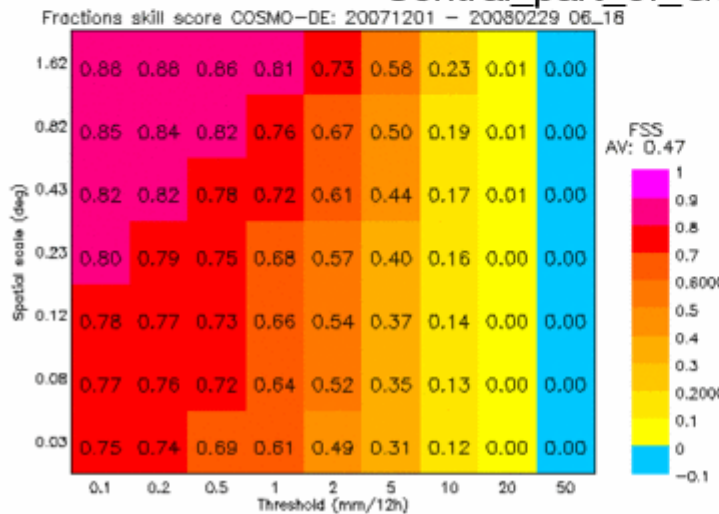
**ISS Winter
2007/2008**



Quarterly summaries of „Fuzzy“-scores



Central part of Germany

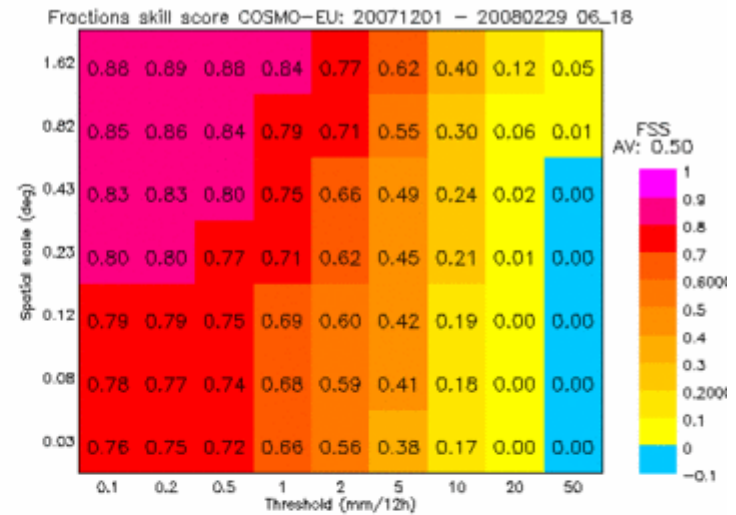
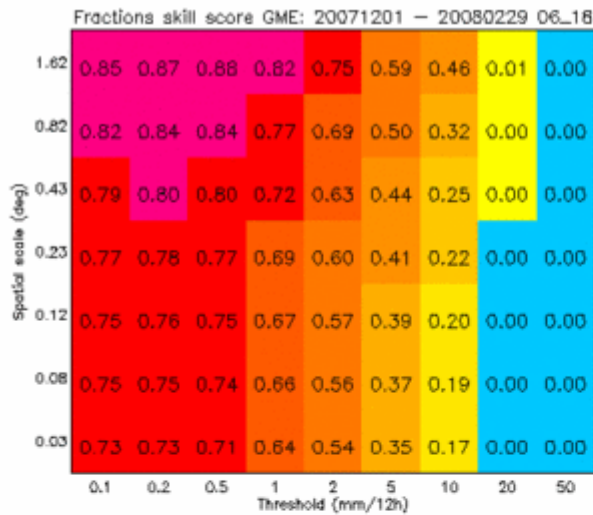


**FSS Winter
2007/2008**

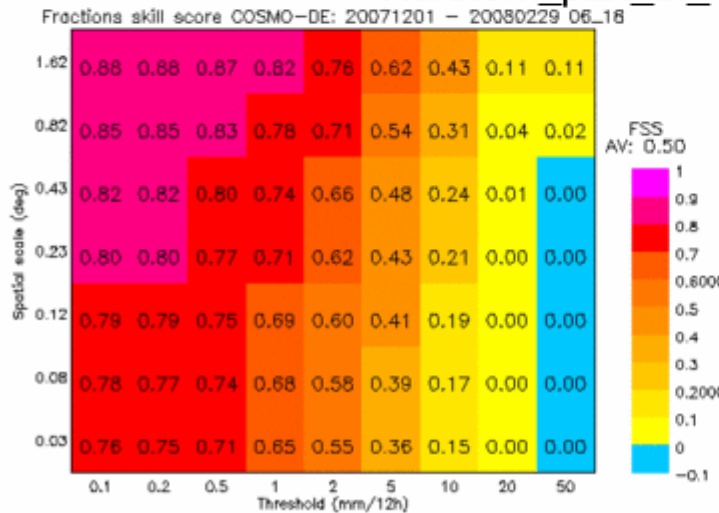




Quarterly summaries of „Fuzzy“-scores



Northern_part_of_Germany



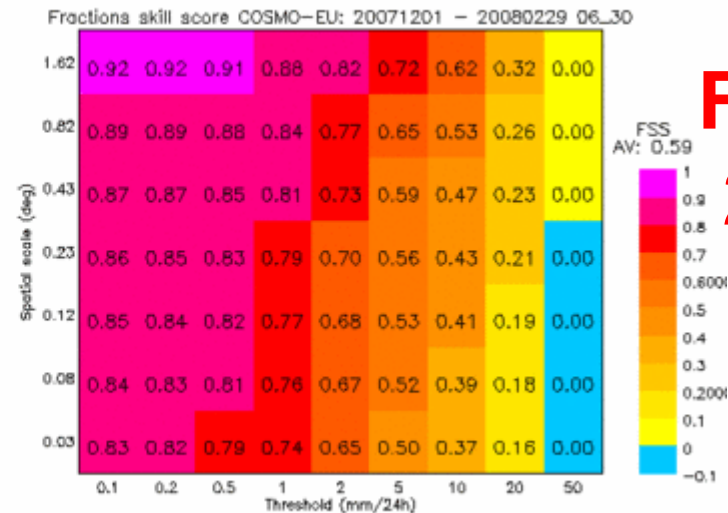
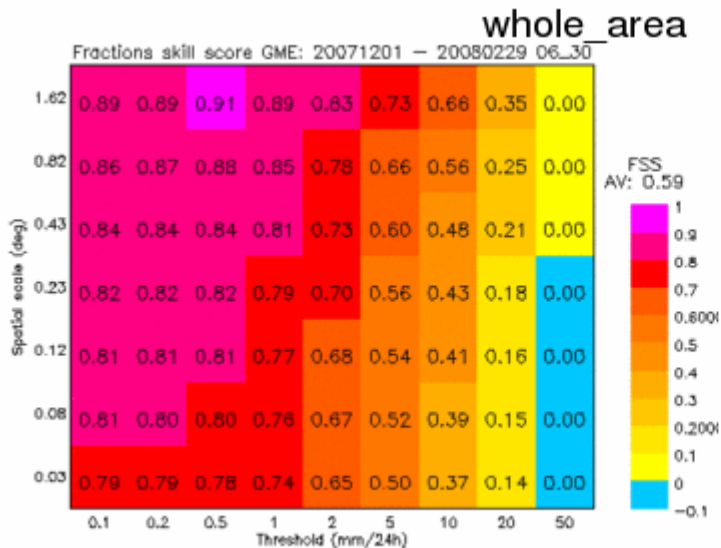
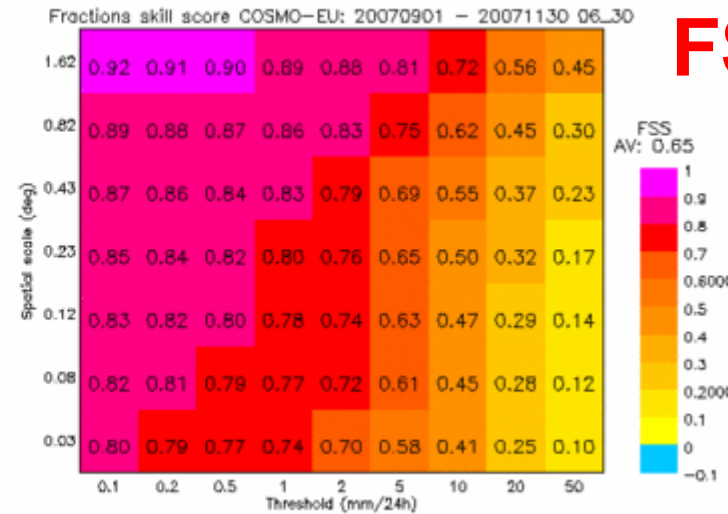
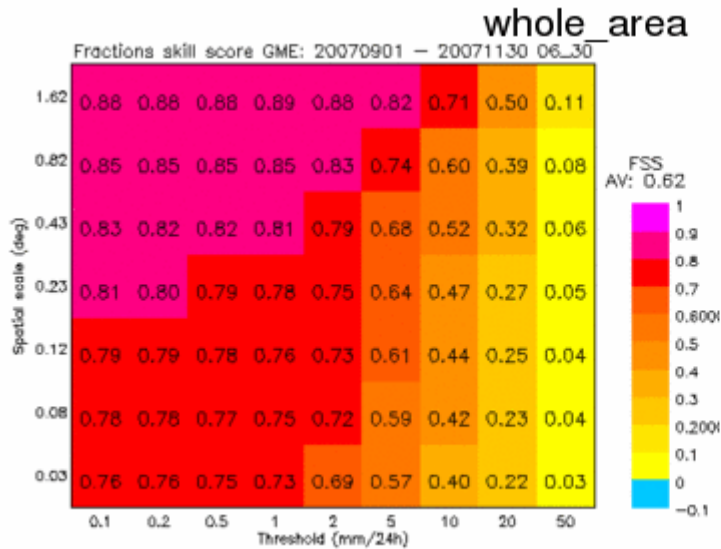
**FSS Winter
2007/2008**





Quarterly summaries of „Fuzzy“-scores

FSS Autumn 2007



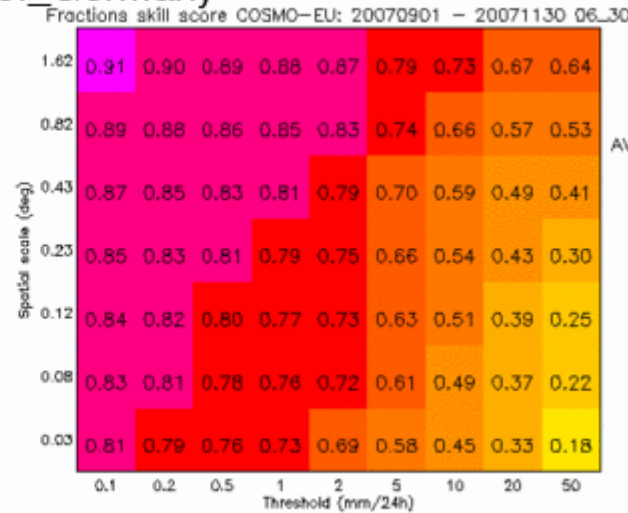
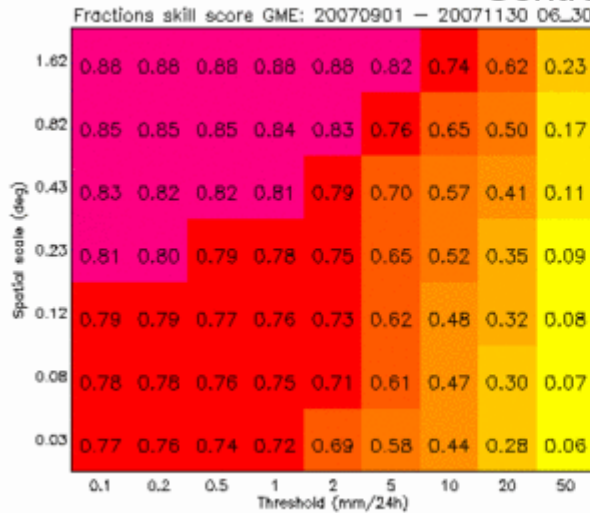
FSS Winter 2007/2008





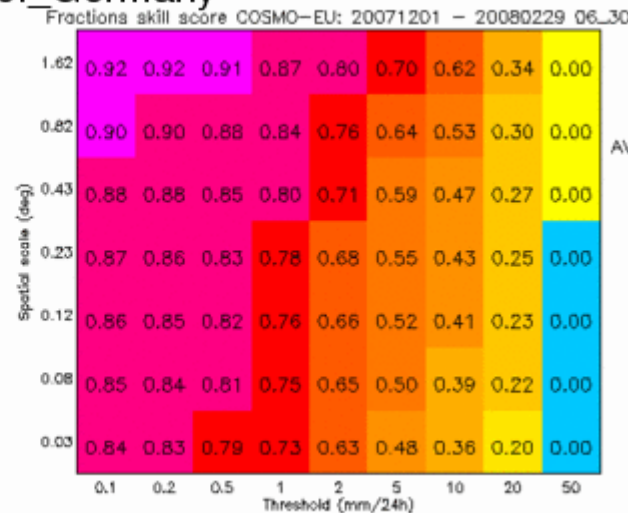
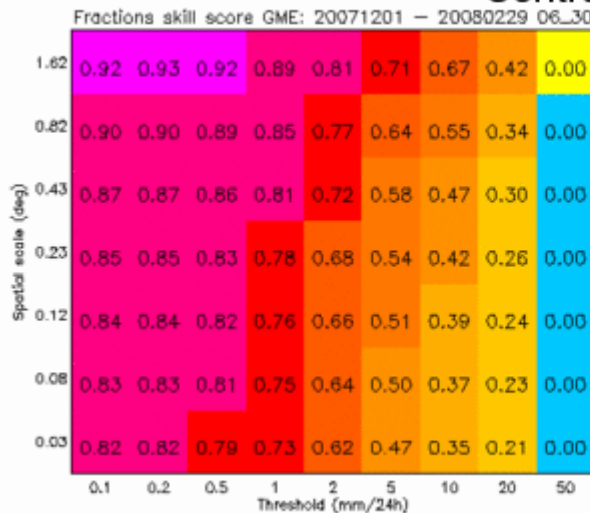
Quarterly summaries of „Fuzzy“-scores

Central_part_of_Germany



**FSS Autumn
2007**

Central_part_of_Germany



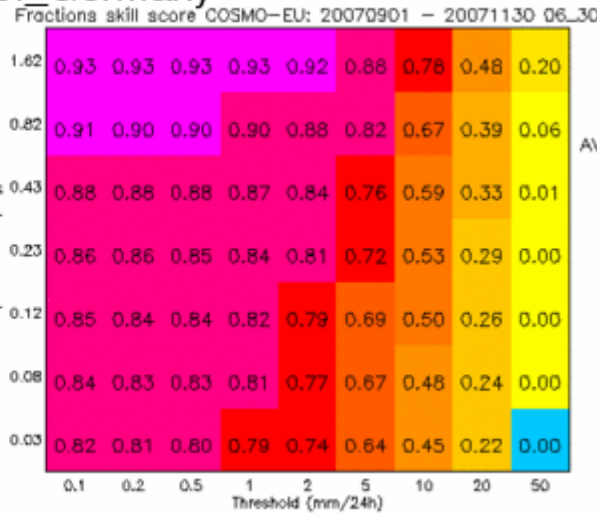
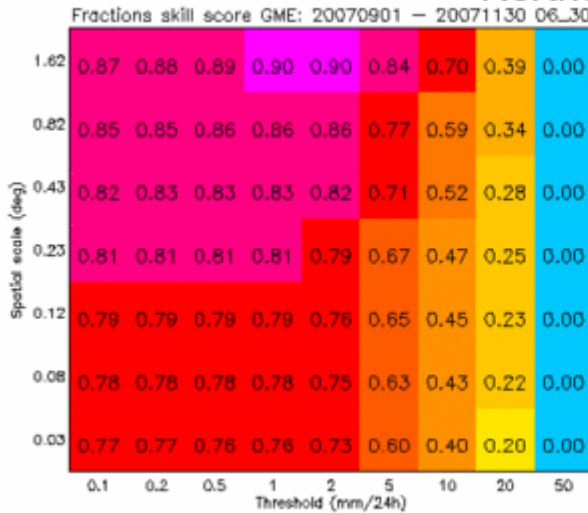
**FSS Winter
2007/2008**





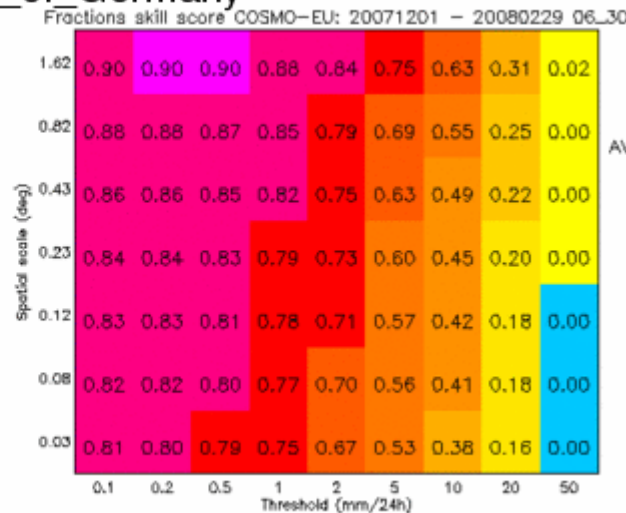
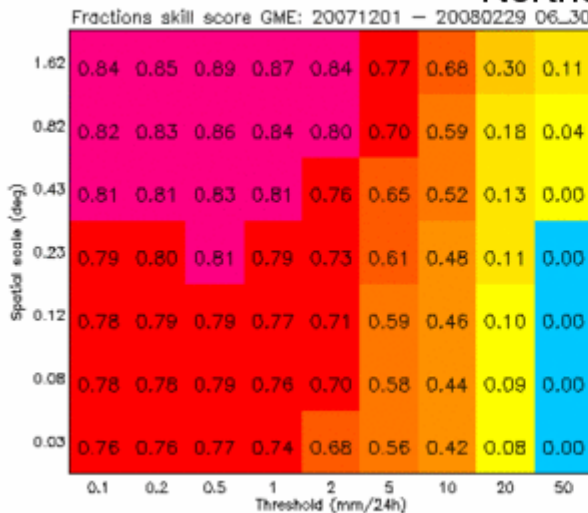
Quarterly summaries of „Fuzzy“-scores

Northern_part_of_Germany



**FSS Autumn
2007**

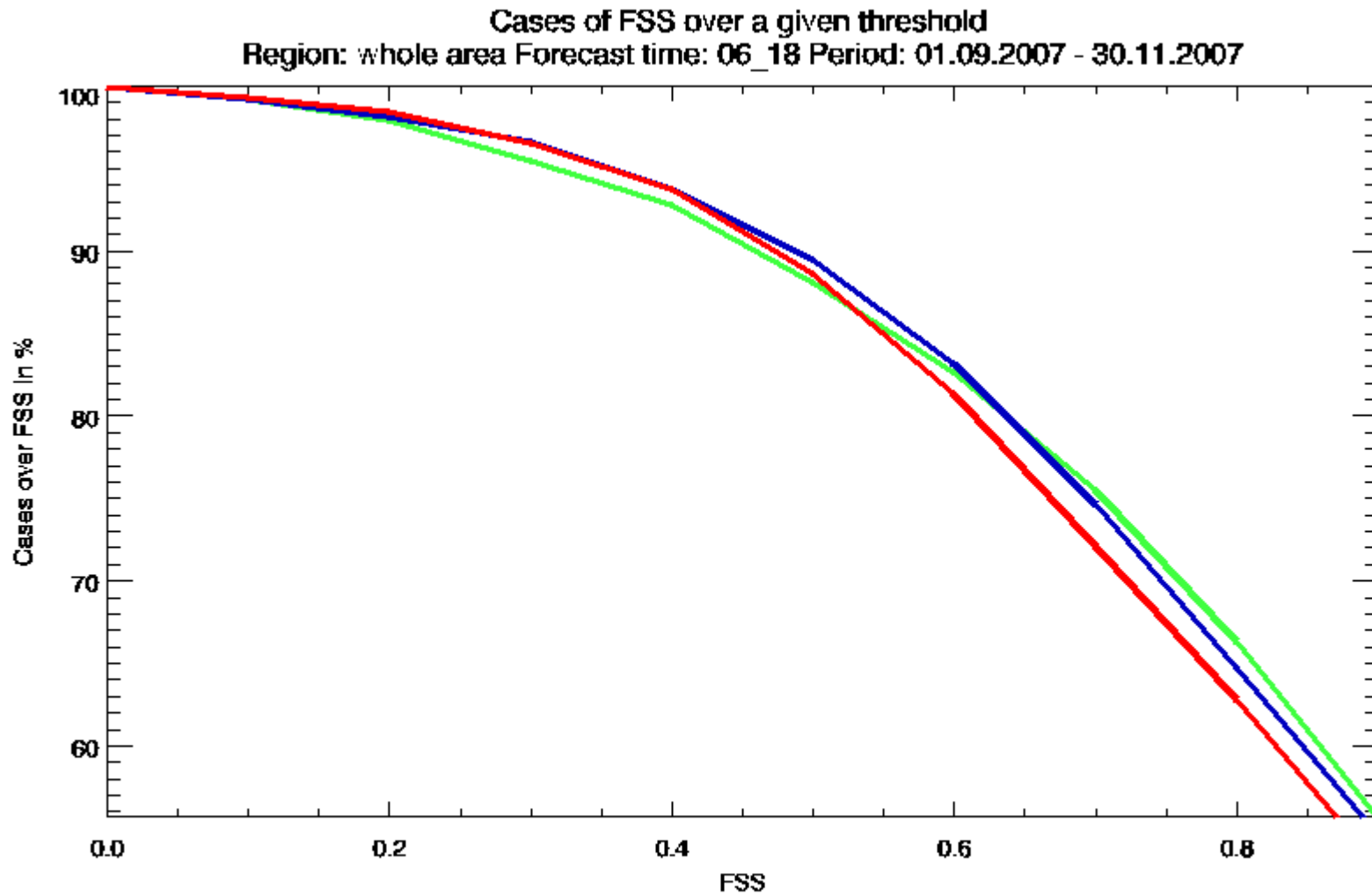
Northern_part_of_Germany



**FSS Winter
2007/2008**

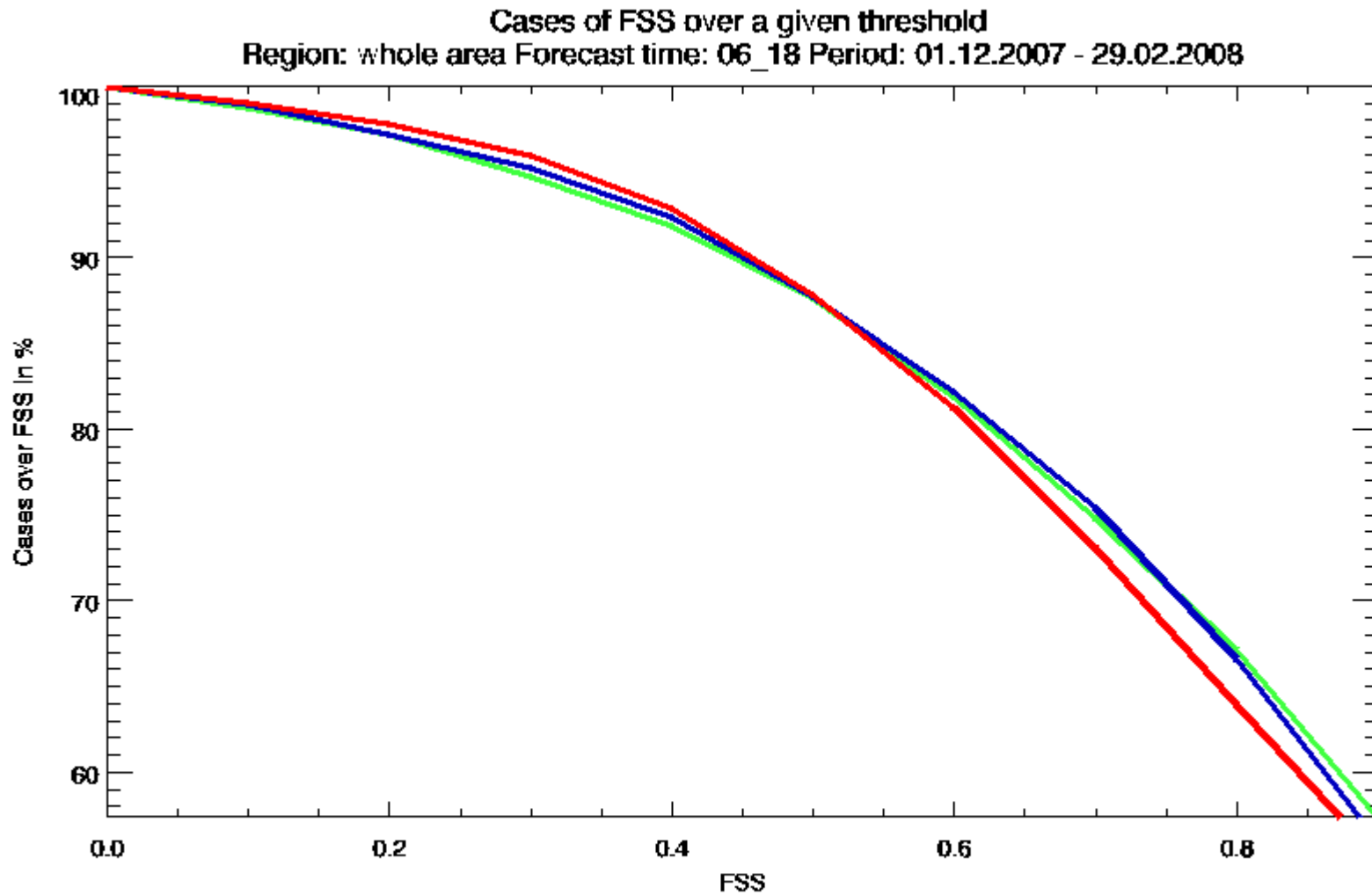


Quarterly summaries of „Fuzzy“-scores



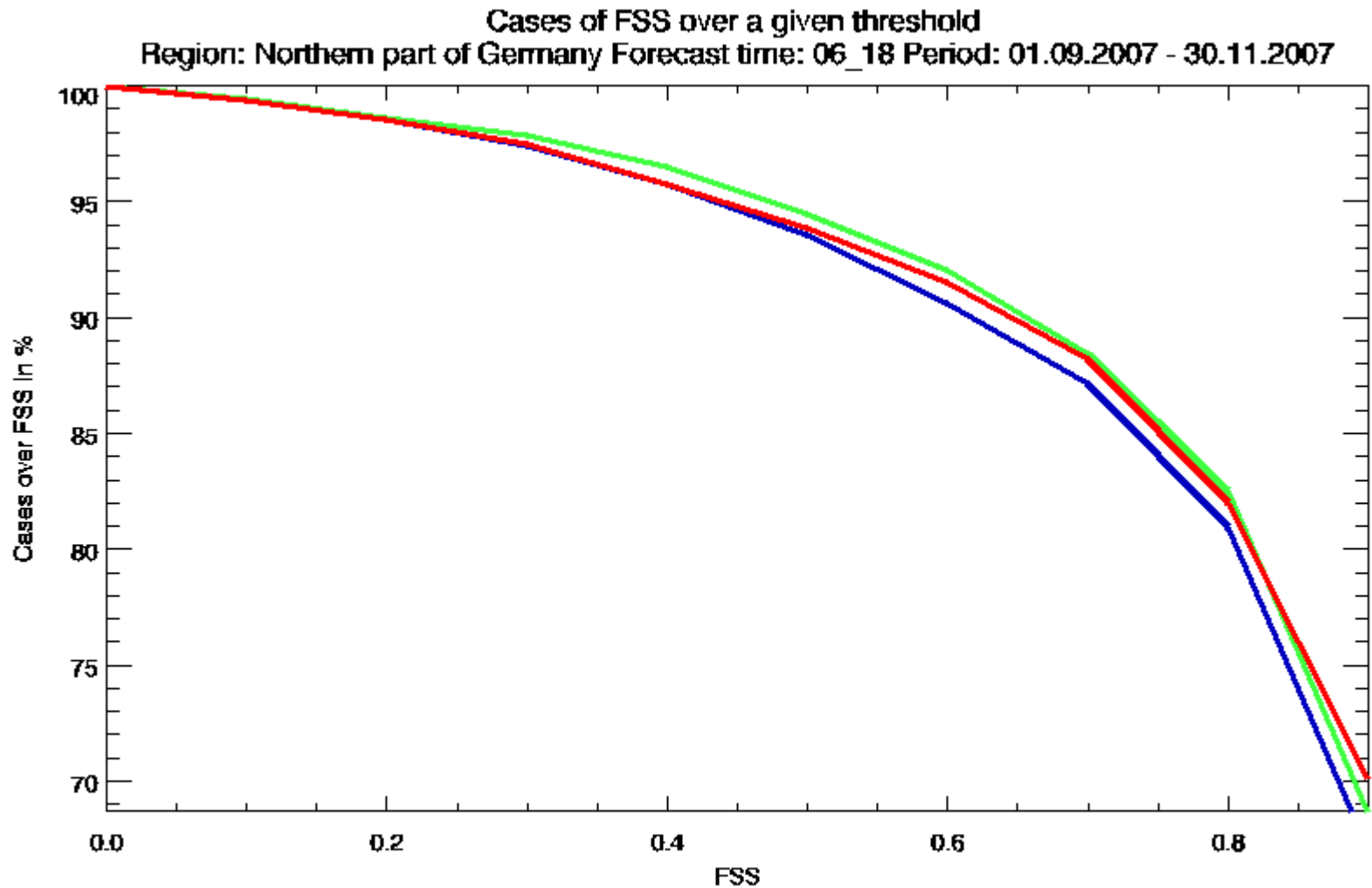
I192F 06_18 LM2MO 06_18 LM3MO 06_18

Quarterly summaries of „Fuzzy“-scores



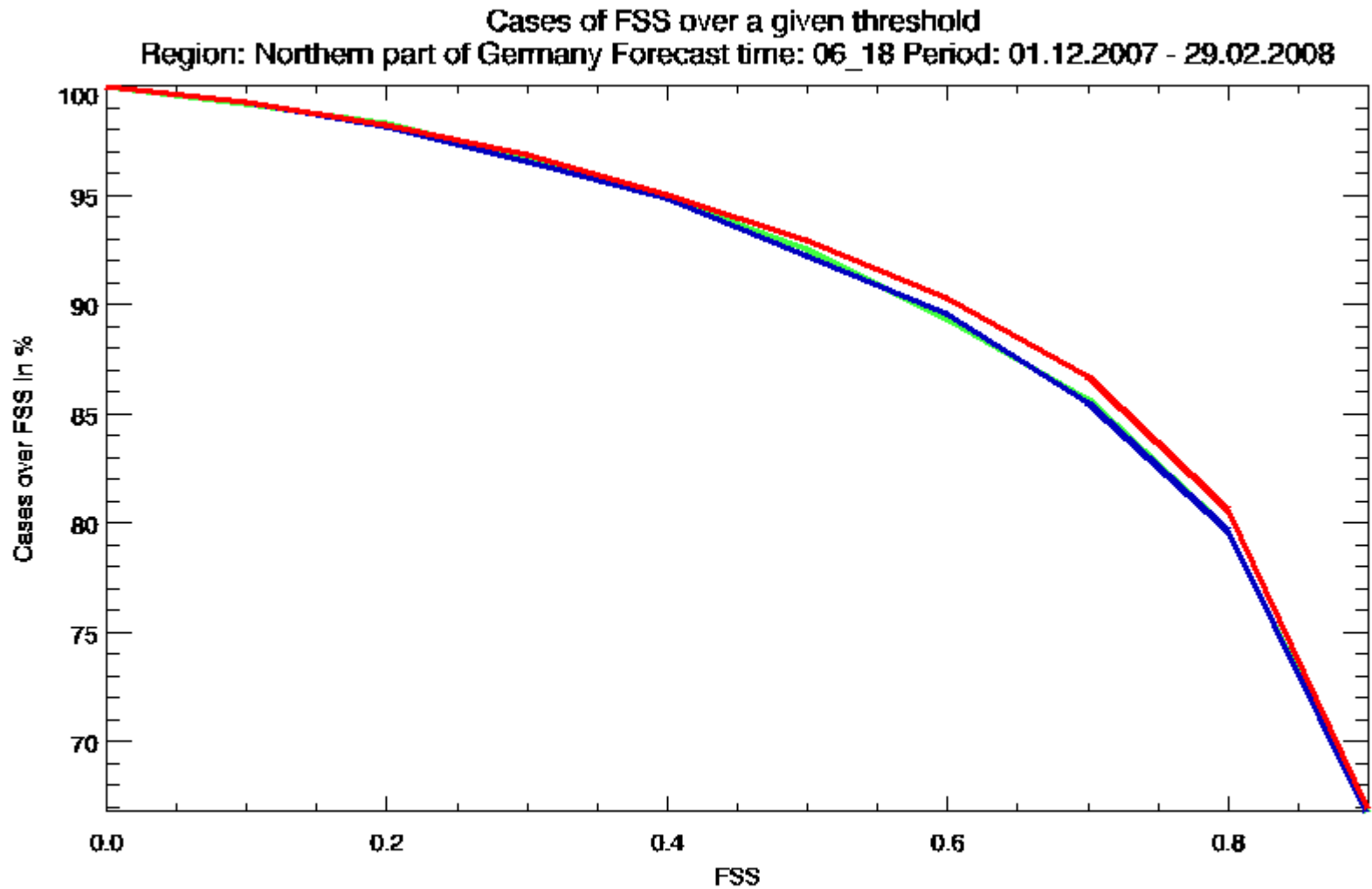
I192F 06_18 LM2MO 06_18 LM3MO 06_18

Quarterly summaries of „Fuzzy“-scores



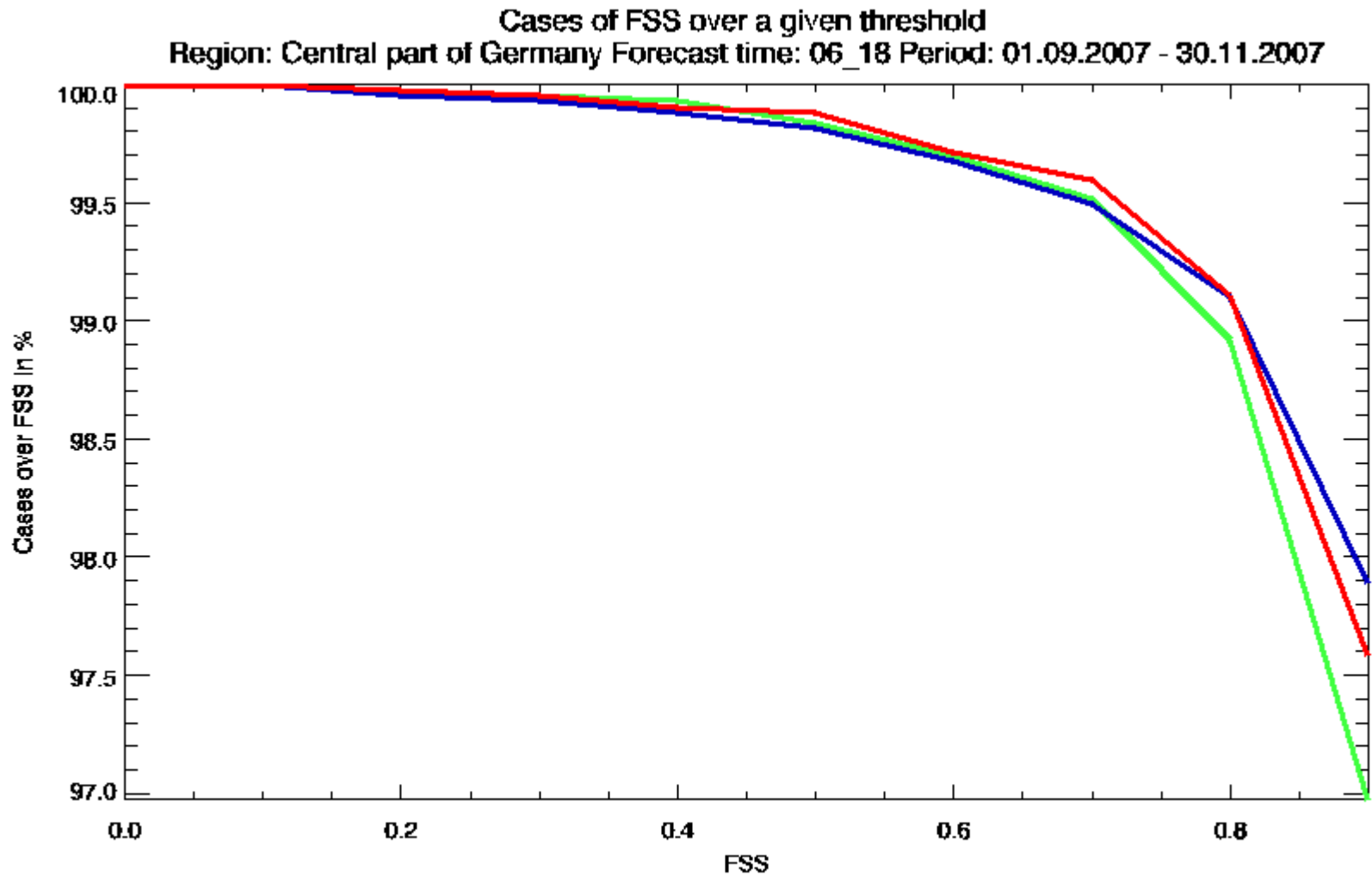
I192F 06_18 LM2MO 06_18 LM3MO 06_18

Quarterly summaries of „Fuzzy“-scores



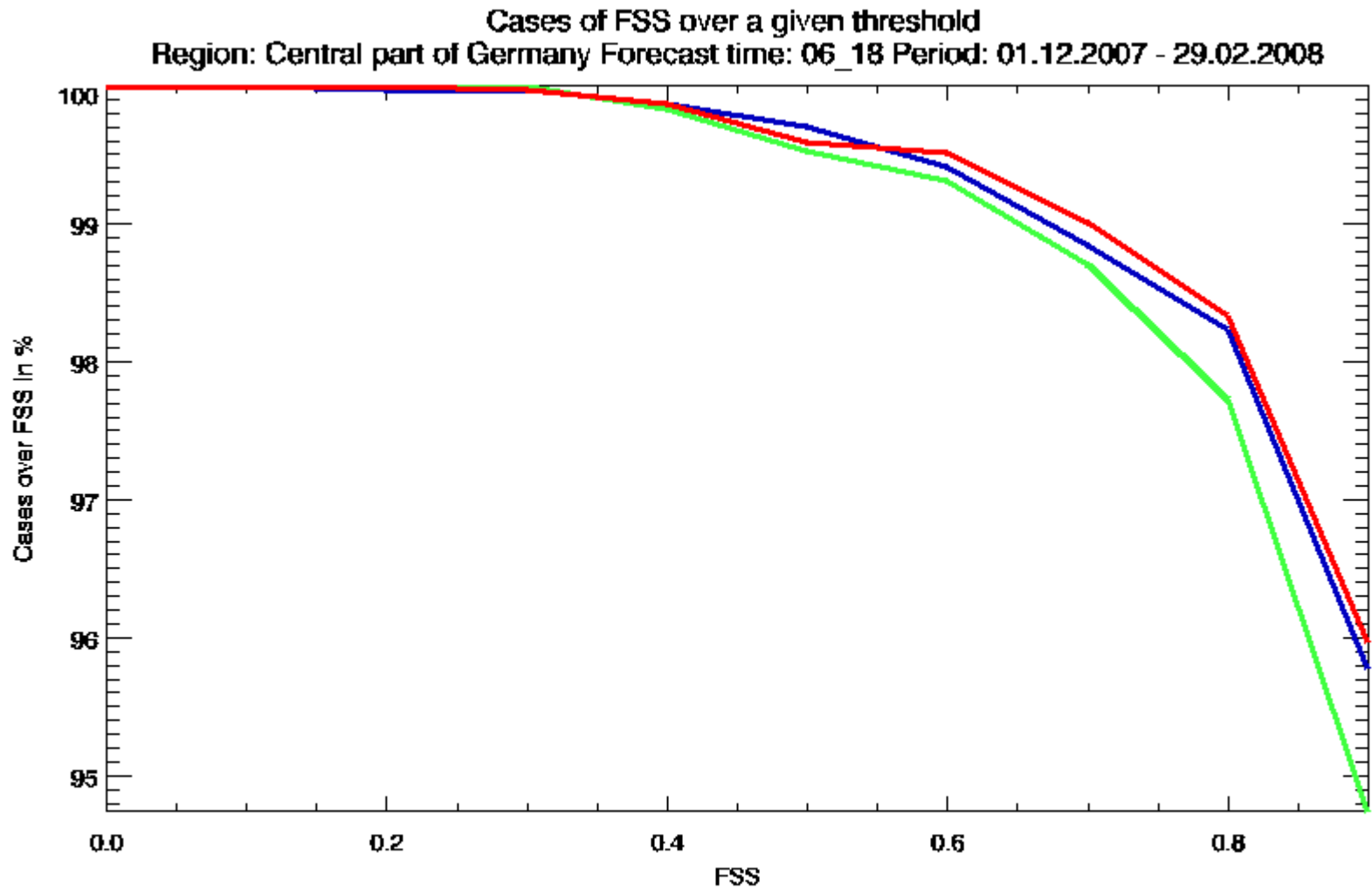
I192F 06_18 LM2MO 06_18 LM3MO 06_18

Quarterly summaries of „Fuzzy“-scores



I192F 06_18 LM2MO 06_18 LM3MO 06_18

Quarterly summaries of „Fuzzy“-scores



I192F 06_18 LM2MO 06_18 LM3MO 06_18



(Sub)Summary concerning verification against radar observations

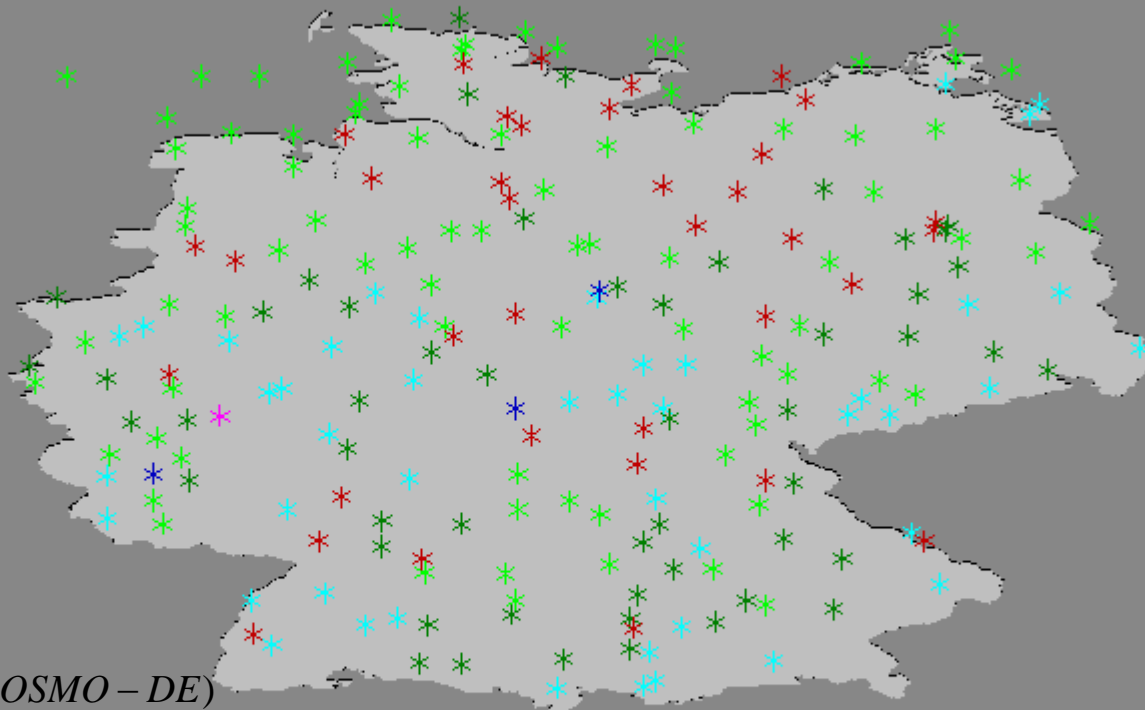
- Verification against radar observations show slight signals that favorites COSMO-DE against COSMO-EU**
- But: The judgement is a bit dependent on the score under consideration and the type of building an integral score**
- And: It is clearly demonstrated that high resolution models are able to produce more reliable precipitation patterns and amounts than the GME**
- And: Over regions with moderate heights of orography (Central parts of Germany) COSMO-DE did a better job than COSMO-EU when looking on the frequency of exceeding some thresholds of FSS**





Quarterly summaries of results for verification against SYNOP stations

RV Temperature COSMO-DE vs COSMO-EU
March till May 2007



$$RV = 1 - \frac{RMSE^2(COSMO - DE)}{RMSE^2(COSMO - EU)}$$

RMSE < 1.8 (37.4%)

RMSE > 1.8: RV < -0.5 (0.5%)

RMSE > 1.8: 0.1 < RV < 0.5 (20.5%)

-0.1 < RV < +0.1 (23.7%)

-0.5 < RV < -0.1 (16.4%)

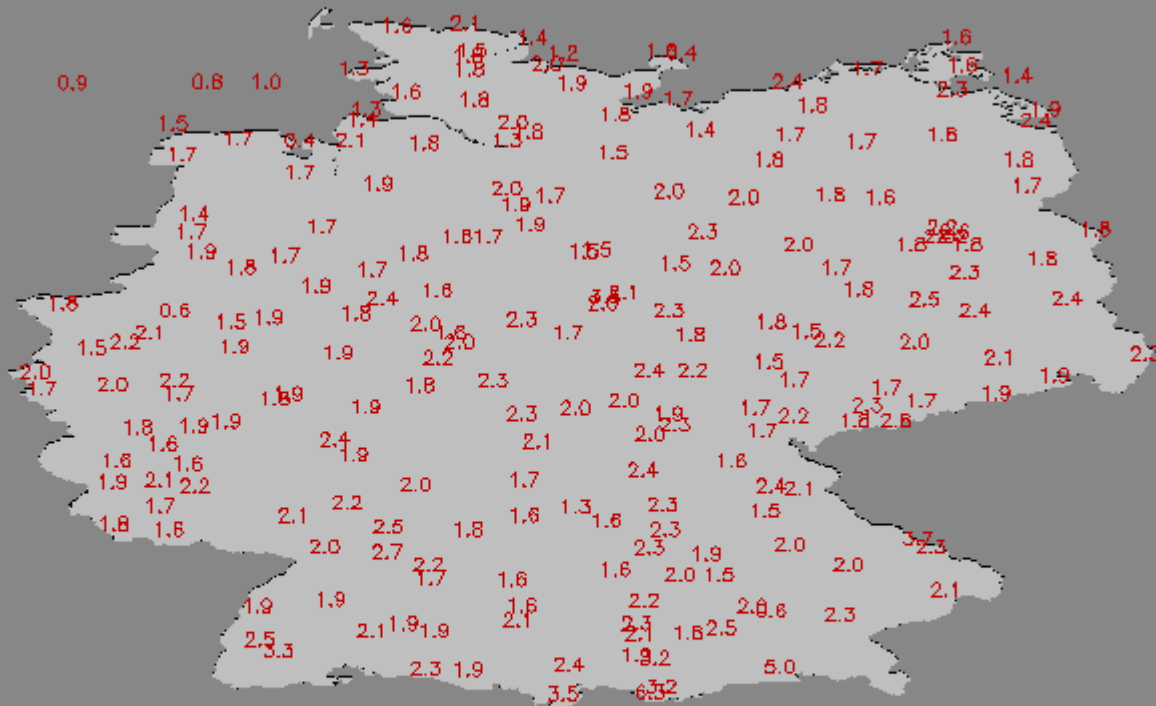
RV > 0.5 (1.4%)





Quarterly summaries of results for verification against SYNOP stations

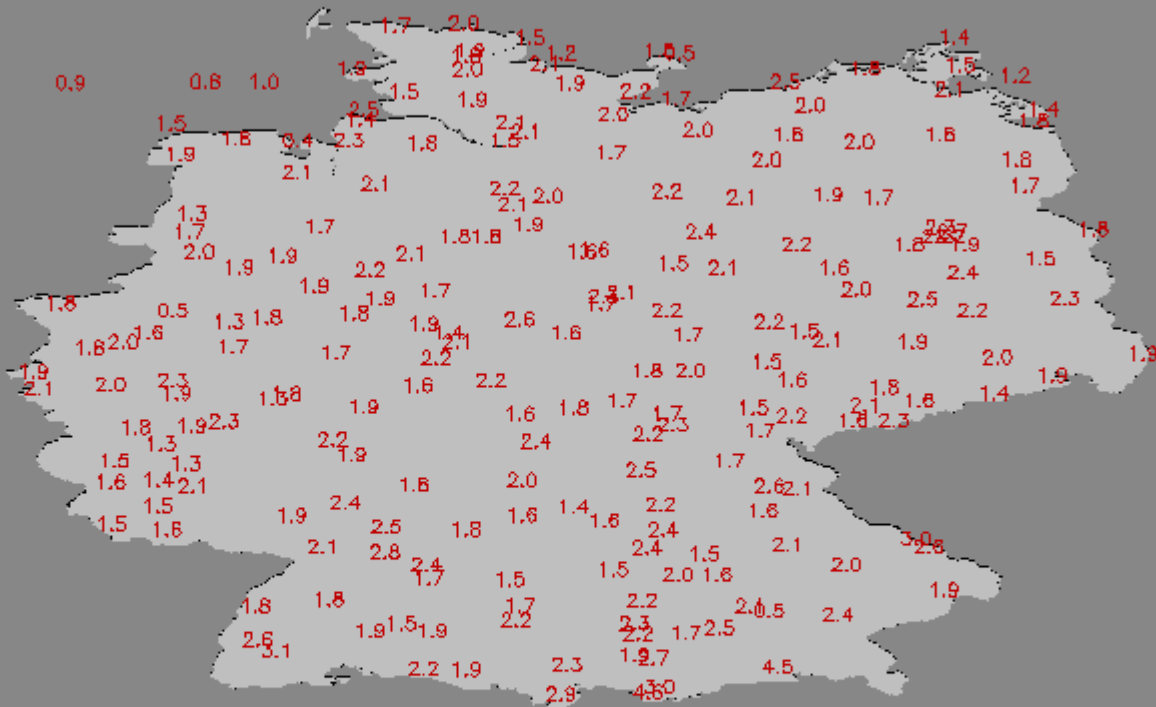
RMSE Temperature (K) COSMO-EU
March till May 2007





Quarterly summaries of results for verification against SYNOP stations

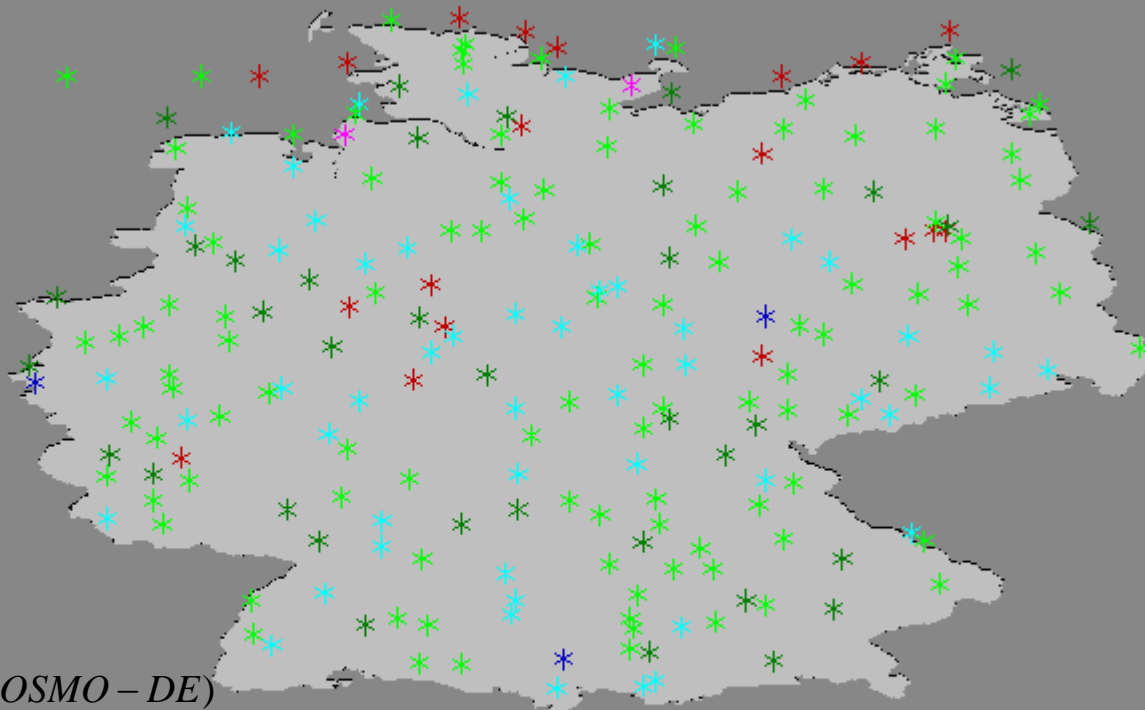
RMSE Temperature (K) COSMO-DE
March till May 2007





Quarterly summaries of results for verification against SYNOP stations

RV Windspeed COSMO-DE vs COSMO-EU
March till May 2007



$$RV = 1 - \frac{RMSE^2(COSMO - DE)}{RMSE^2(COSMO - EU)}$$

RMSE < 1.5 (48.6%)

RMSE > 1.5: RV < -0.5 (0.9%)

RMSE > 1.5: 0.1 < RV < 0.5 (23.6%)

-0.1 < RV < +0.1 (16.8%)

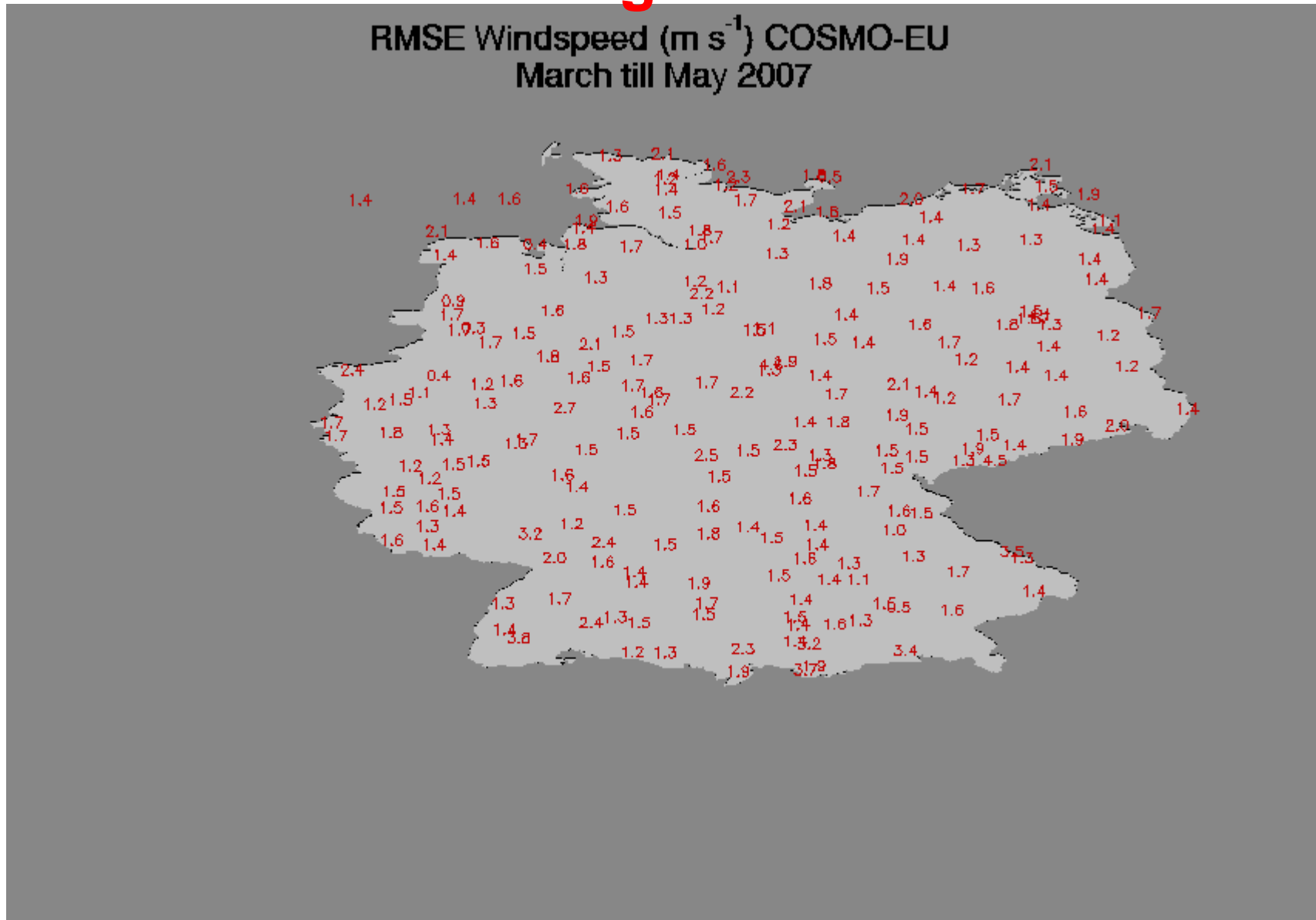
-0.5 < RV < -0.1 (8.6%)

RV > 0.5 (1.4%)



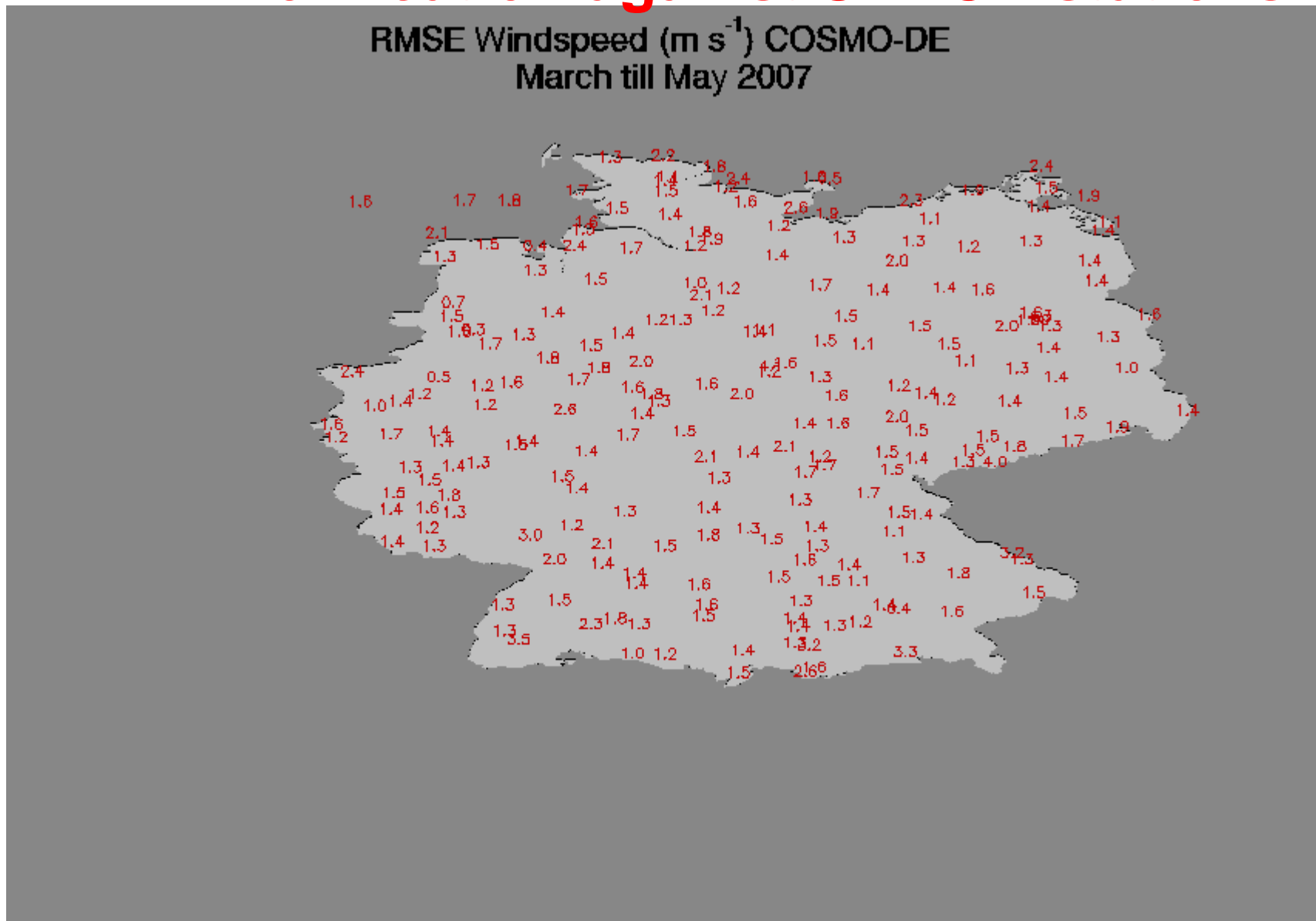


Quarterly summaries of results for verification against SYNOP stations





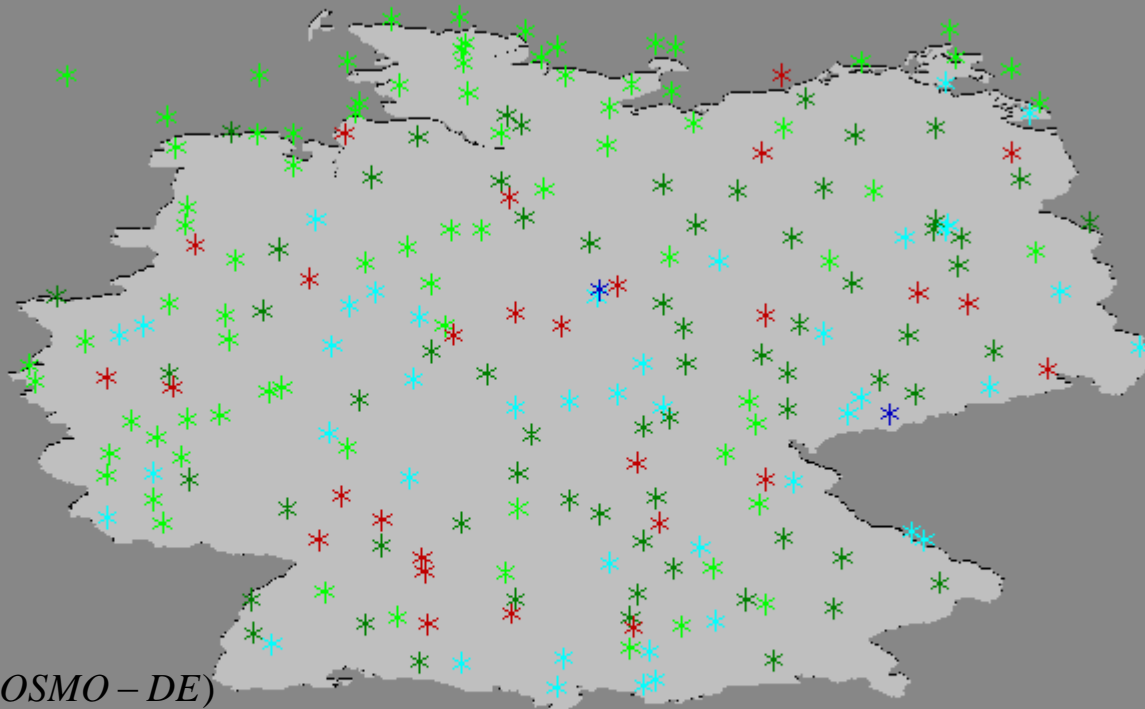
Quarterly summaries of results for verification against SYNOP stations





Quarterly summaries of results for verification against SYNOP stations

RV Temperature COSMO-DE vs COSMO-EU
June till August 2007



$$RV = 1 - \frac{RMSE^2(COSMO - DE)}{RMSE^2(COSMO - EU)}$$

RMSE < 1.6 (36.1%)

RMSE > 1.6: RV < -0.5 (0.0%)

RMSE > 1.6: 0.1 < RV < 0.5 (19.6%)

-0.1 < RV < +0.1 (30.6%)

-0.5 < RV < -0.1 (12.8%)

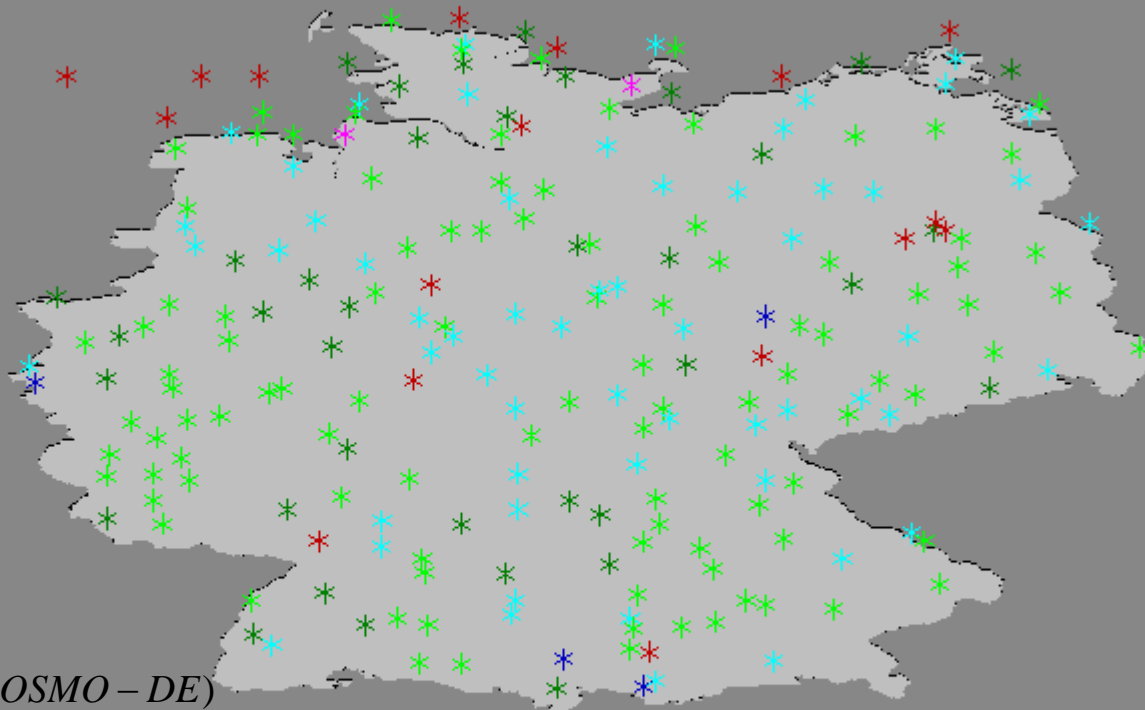
RV > 0.5 (0.9%)





Quarterly summaries of results for verification against SYNOP stations

RV Windspeed COSMO-DE vs COSMO-EU
June till August 2007



$$RV = 1 - \frac{RMSE^2(COSMO - DE)}{RMSE^2(COSMO - EU)}$$

RMSE < 1.5 (46.4%)

RMSE > 1.5: RV < -0.5 (0.9%)

RMSE > 1.5: 0.1 < RV < 0.5 (26.4%)

-0.1 < RV < +0.1 (16.8%)

-0.5 < RV < -0.1 (7.7%)

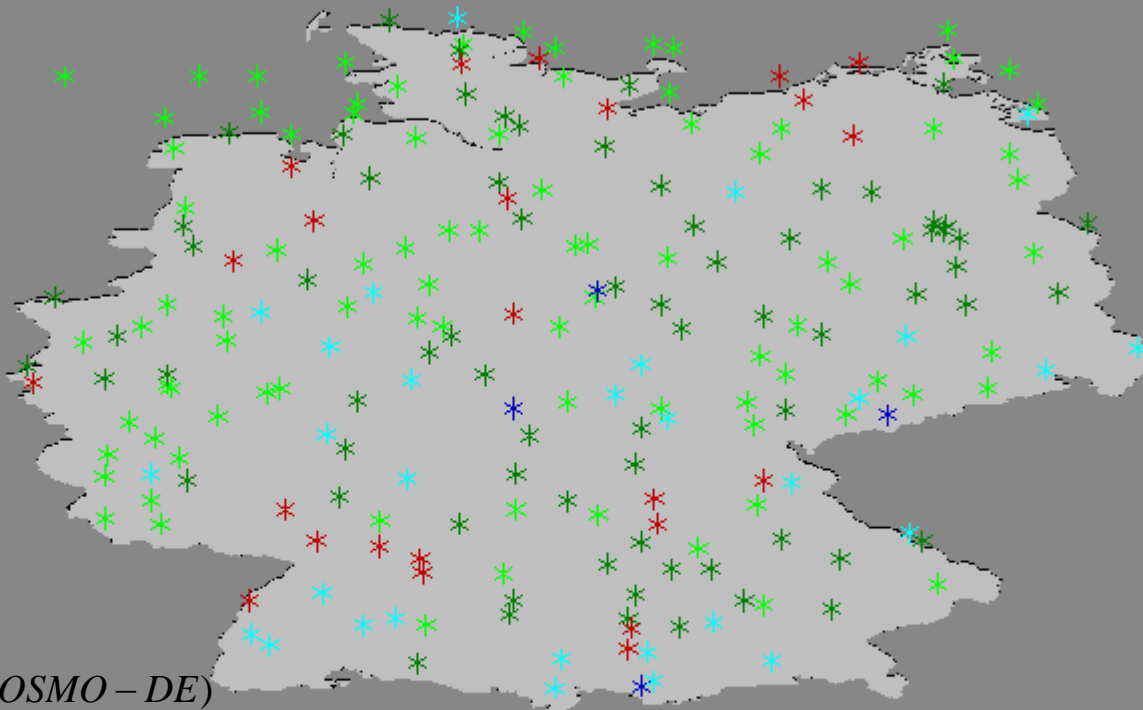
RV > 0.5 (1.8%)





Quarterly summaries of results for verification against SYNOP stations

RV Temperature COSMO-DE vs COSMO-EU
September till November 2007



$$RV = 1 - \frac{RMSE^2(COSMO - DE)}{RMSE^2(COSMO - EU)}$$

RMSE < 1.4 (40.8%)

RMSE > 1.4: RV < -0.5 (0.0%)

RMSE > 1.4: 0.1 < RV < 0.5 (13.8%)

-0.1 < RV < +0.1 (32.6%)

-0.5 < RV < -0.1 (11.0%)

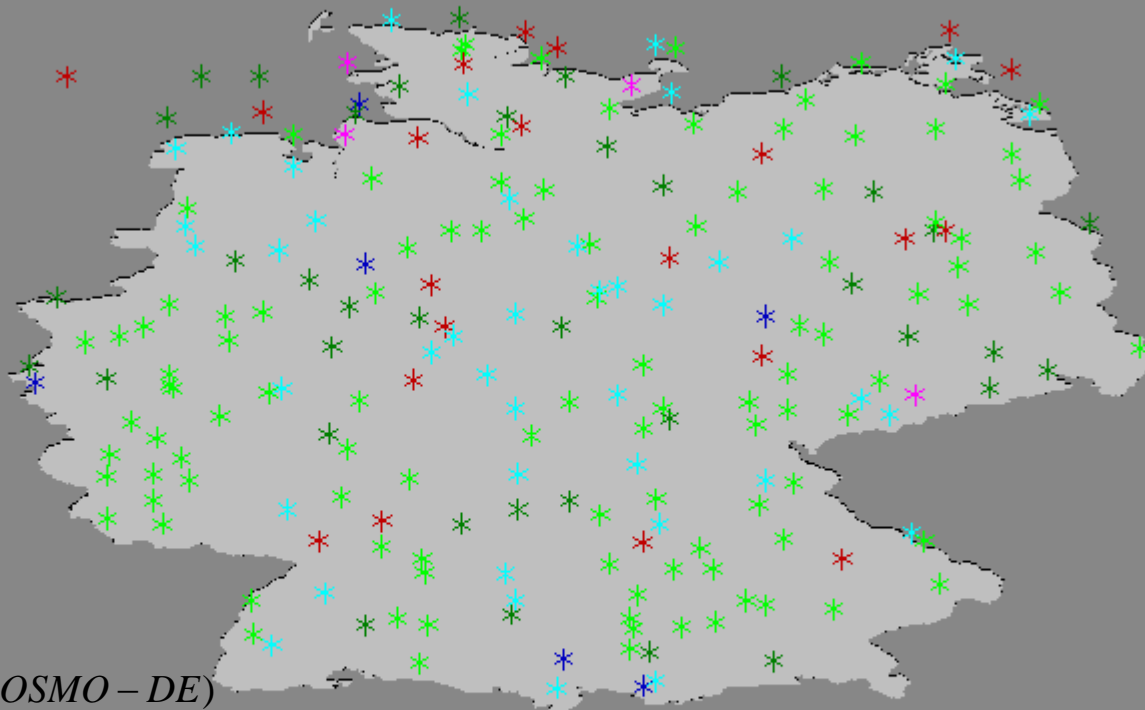
RV > 0.5 (1.8%)





Quarterly summaries of results for verification against SYNOP stations

RV Windspeed COSMO-DE vs COSMO-EU
September till November 2007



$$RV = 1 - \frac{RMSE^2(COSMO - DE)}{RMSE^2(COSMO - EU)}$$

RMSE < 1.4 (49.5%)

RMSE > 1.4: RV < -0.5 (1.9%)

RMSE > 1.4: 0.1 < RV < 0.5 (19.0%)

-0.1 < RV < +0.1 (17.1%)

-0.5 < RV < -0.1 (9.7%)

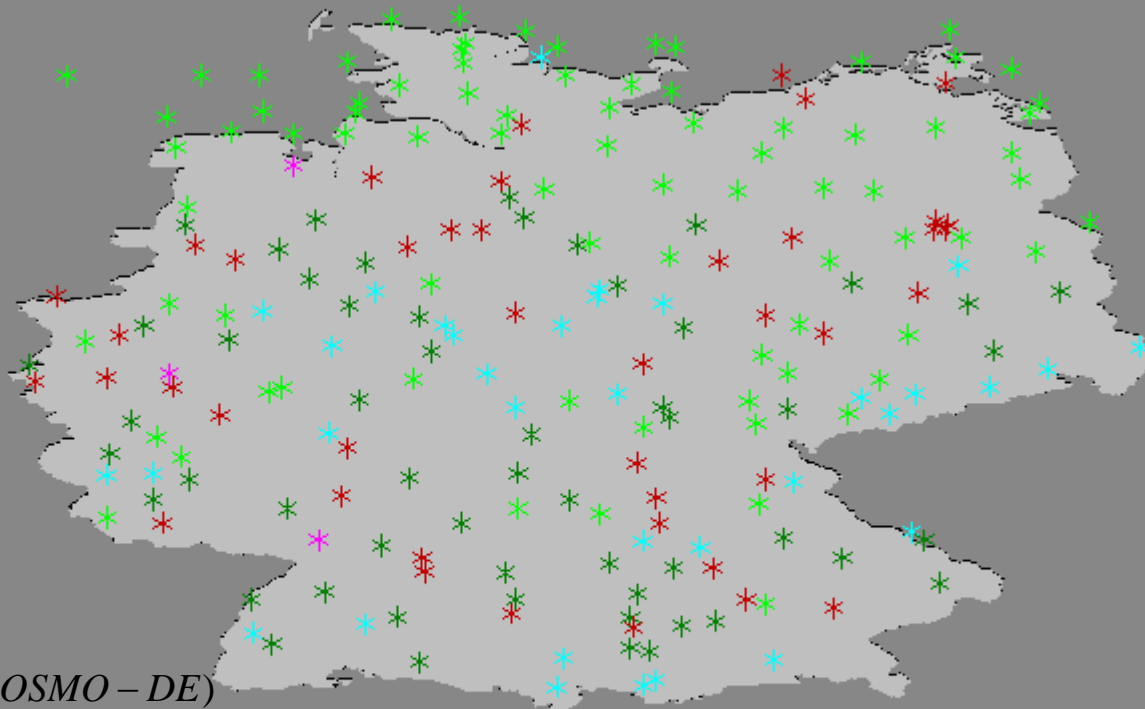
RV > 0.5 (2.8%)





Quarterly summaries of results for verification against SYNOP stations

RV Temperature COSMO-DE vs COSMO-EU
December 2007 till February 2008



$$RV = 1 - \frac{RMSE^2(COSMO - DE)}{RMSE^2(COSMO - EU)}$$

RMSE < 1.5 (37.7%)

RMSE > 1.5: RV < -0.5 (1.4%)

RMSE > 1.5: 0.1 < RV < 0.5 (15.8%)

-0.1 < RV < +0.1 (25.6%)

-0.5 < RV < -0.1 (19.5%)

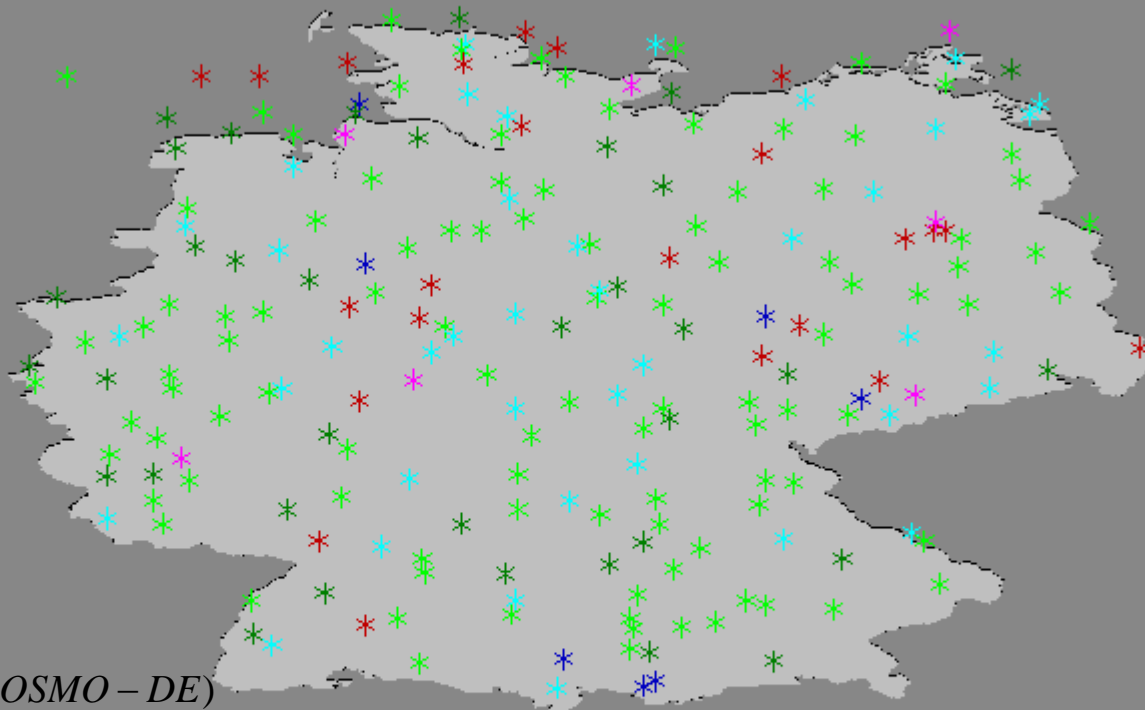
RV > 0.5 (0.0%)





Quarterly summaries of results for verification against SYNOP stations

RV Windspeed COSMO-DE vs COSMO-EU
December 2007 till February 2008



$$RV = 1 - \frac{RMSE^2(COSMO - DE)}{RMSE^2(COSMO - EU)}$$

RMSE < 1.5 (47.4%)

RMSE > 1.5: RV < -0.5 (3.3%)

RMSE > 1.5: 0.1 < RV < 0.5 (18.8%)

-0.1 < RV < +0.1 (16.4%)

-0.5 < RV < -0.1 (10.8%)

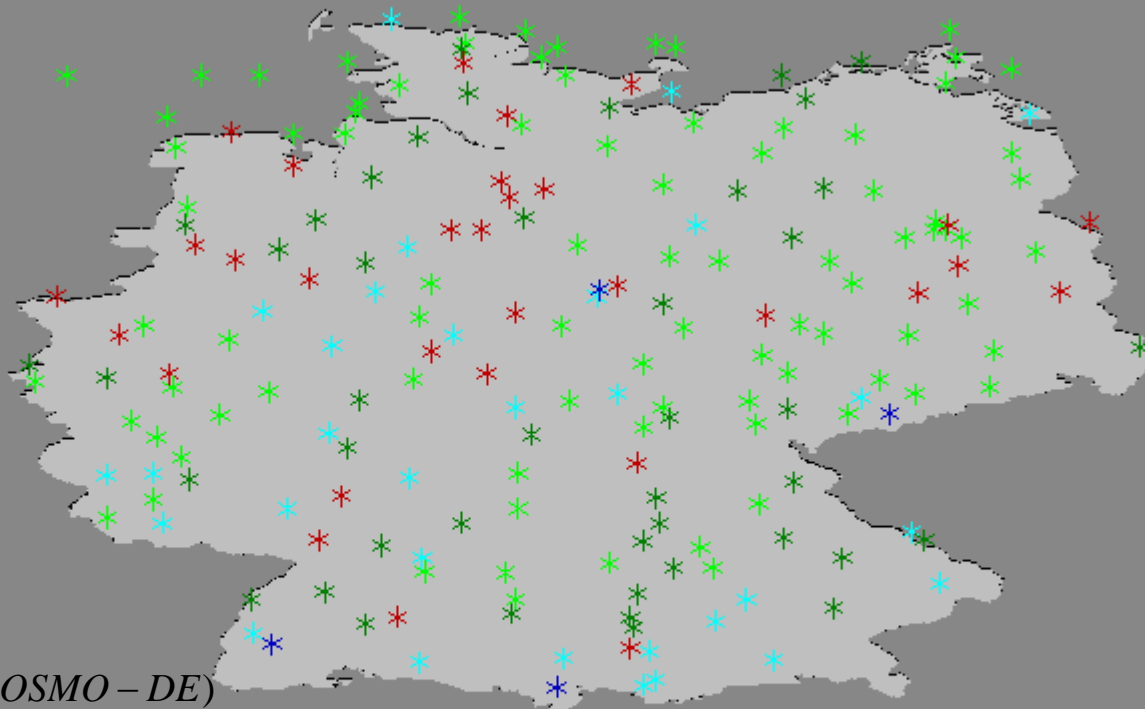
RV > 0.5 (3.3%)





Quarterly summaries of results for verification against SYNOP stations

RV Temperature COSMO-DE vs COSMO-EU
March till April 2008



$$RV = 1 - \frac{RMSE^2(COSMO - DE)}{RMSE^2(COSMO - EU)}$$

RMSE < 1.5 (44.2%)

RMSE > 1.5: RV < -0.5 (0.0%)

RMSE > 1.5: 0.1 < RV < 0.5 (15.7%)

-0.1 < RV < +0.1 (22.3%)

-0.5 < RV < -0.1 (15.7%)

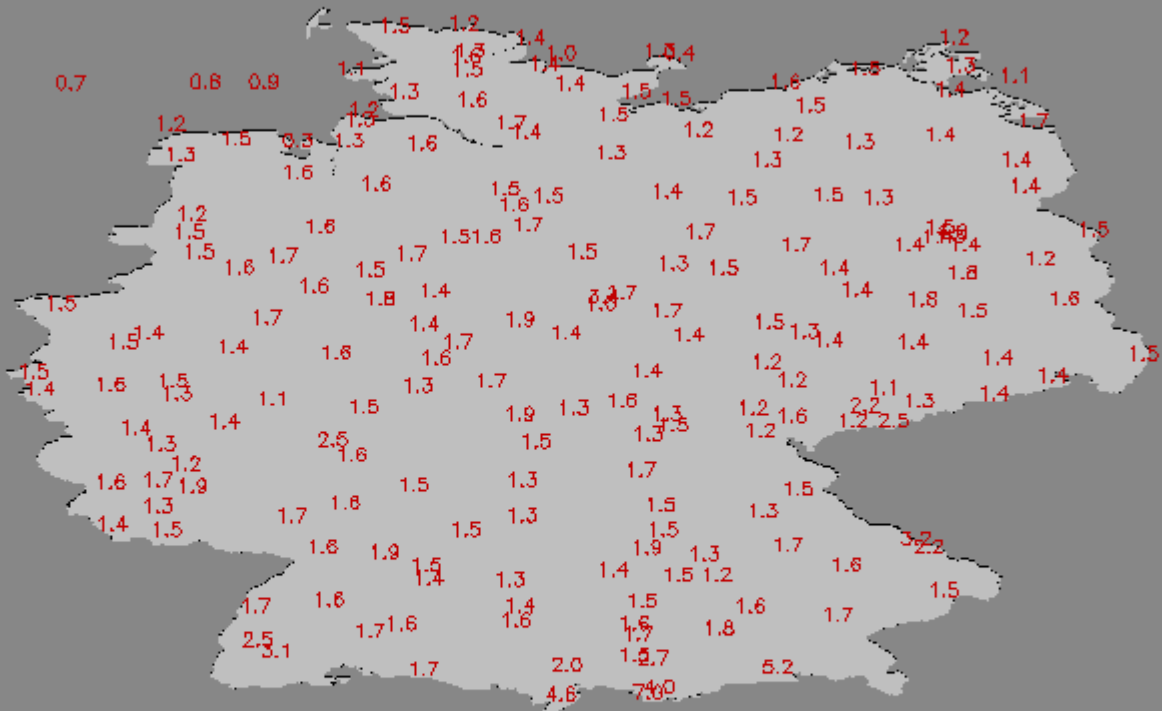
RV > 0.5 (2.0%)





Quarterly summaries of results for verification against SYNOP stations

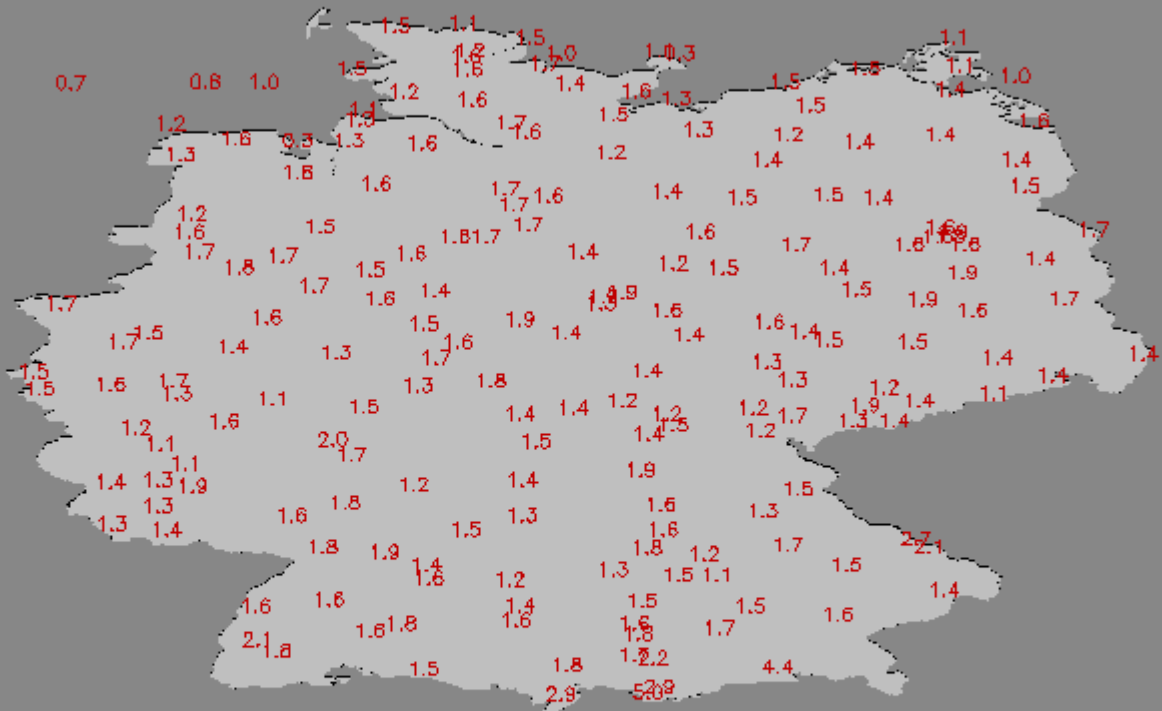
RMSE Temperature (K) COSMO-EU
March till April 2008





Quarterly summaries of results for verification against SYNOP stations

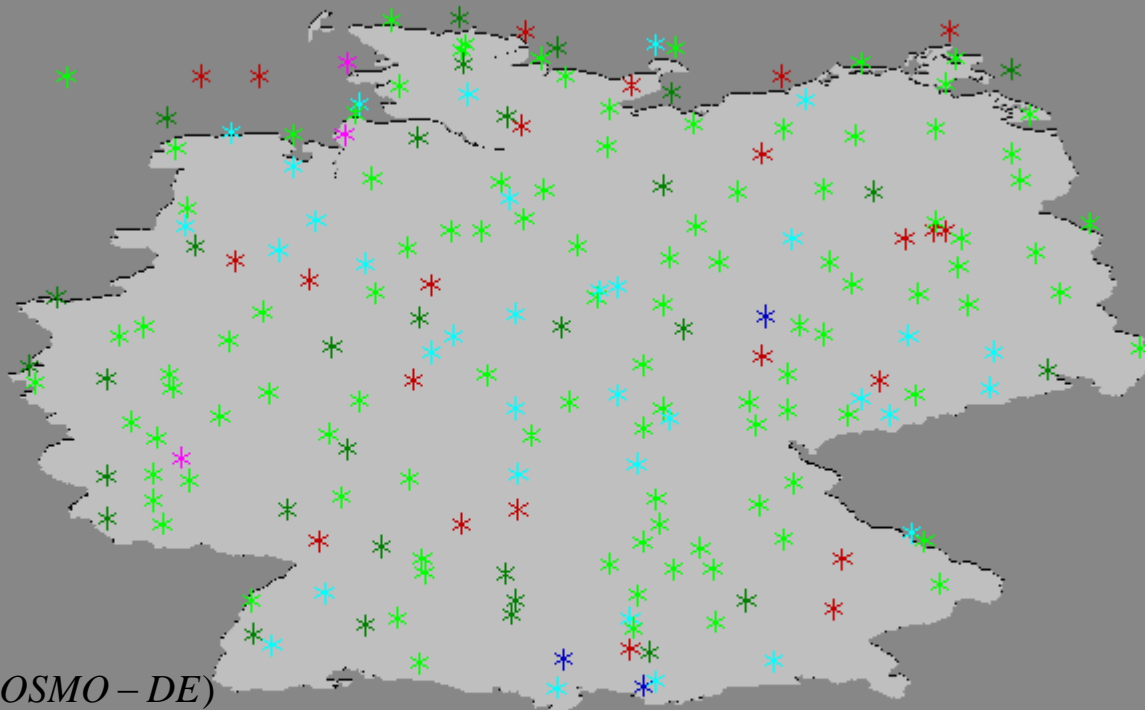
RMSE Temperature (K) COSMO-DE
March till April 2008





Quarterly summaries of results for verification against SYNOP stations

RV Windspeed COSMO-DE vs COSMO-EU
March till April 2008



$$RV = 1 - \frac{RMSE^2(COSMO - DE)}{RMSE^2(COSMO - EU)}$$

RMSE < 1.5 (52.5%)

RMSE > 1.5: RV < -0.5 (1.5%)

RMSE > 1.5: 0.1 < RV < 0.5 (17.2%)

-0.1 < RV < +0.1 (15.7%)

-0.5 < RV < -0.1 (11.6%)

RV > 0.5 (1.5%)





(Sub)Summary concerning verification against SYNOP observations

- Verification against SYNOP observations show in most cases clear signals that favorites COSMO-DE against COSMO-EU.**
- This is especially true for wind.**
- Advantages of COSMO-DE occur in most cases at stations where small scale variabilities are evident in observations.**



An interesting precipitation forecast

