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Federal Office of Meteorology and Climatology **MeteoSwiss**

Verification of different wind gust parametrizations

Overview of verification results at MeteoSwiss in the year 2012

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MeteoSwiss

COSMO General Meeting 2012
WG5 Parallel Session 10 September 2012



Forecasters feedbacks reports during a 2-year period (10.03.09– 28.02.11)

Top 3 parameters for complaints

- 1. precipitation: 40
- 2. wind: 18 (**12 for gusts**)
- 3. cloudiness: 12 (4 for low clouds/stratus)



Diagnostic calculation of gusts

(A) turbulent part

- based on wind@30m
opr COSMO-7 and COSMO-2 -> namings -2, -7
- based on wind@10m
opr COSMO-EU namings -EU
- based on wind@10m + tuning parameter with wind10m
opr COSMO-DE namings -DE
- physically based (TKE in PBL) after Brasseur
nowhere opr namings BRA



Diagnostic calculation of gusts

(B) convective part (for COSMO-7)

- after Nakamura et.al.: calculation of the gusts considering the buoyancy in the downdrafts of the convection scheme
- other calculation: see paper of Bechtold and Bidlot in ECMWF Newsletter 119, Spring 2009

(C) wind gust = max (turbulent part, convective part)



Diagnosing turbulent gusts

In the COSMO model the maximum gusts at 10 m above the ground are estimated from the absolute speed of the near-surface mean wind V_m and its standard deviation σ :

$$V_{\text{turb}} = V_m + \alpha \cdot \sigma$$

following Panofsky and Dutton (1984)

$$V_{\text{turb}} = V_m + \alpha \cdot 2.4 u_*$$

$$V_{\text{turb}} = V_m + \alpha \cdot 2.4 \sqrt{C_D} V_m'$$

COSMO-EU and COSMO-DE:
 $V_m = V_m' = V @ 10\text{m}$

COSMO-2 and COSM-7:
 $V_m = V @ 30\text{m}; V_m' = V @ k_e (\sim 10\text{m})$

$\alpha = 3$: Tuning parameter

u_* : Friction velocity

C_D : Drag coefficient for momentum



Diagnosing turbulent gusts

In GME the gust factor is expanded by an extra term which makes it weakly dependent on the mean wind speed at 10 m. This enhances particularly the high gusts.

$$V_{\text{turb}} = V_m + \alpha \cdot 2.4 \sqrt{C_D} V_m$$

opr COSMO-EU

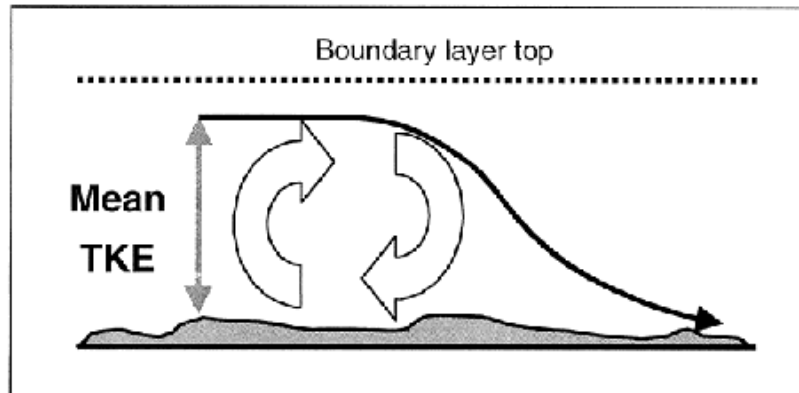
$$V_{\text{turb}} = V_m + (\alpha \cdot 2.4 + \beta \cdot V_m) \sqrt{C_D} V_m$$

opr GME, COSMO-DE

$\beta = 0.09$: Tuning parameter for the COSMO model



Calculation of turbulent part of wind gusts @10m after the approach of Brasseur



Brasseur (Mon. Wea. Rev. **129**, 5-25)

deflection by turbulence of air parcel from the boundary layer to the ground

Fig. 4. Determination of the wind gust estimate based on turbulent kinetic energy averaged over a ven depth (from the surface) in the boundary layer.

necessary condition for the gust:

TKE associated to the thickness of the turbulent layer > buoyancy

$$\frac{1}{z_p - z_{p'}} \int_{z'}^{z_p} TKE(z) dz \geq g \int_{z'}^{z_p} \frac{\Delta\theta_v}{\Theta_v}(z) dz$$



Testchain for the calculation of the four diagnostic turbulent parts of wind gusts

Two test period

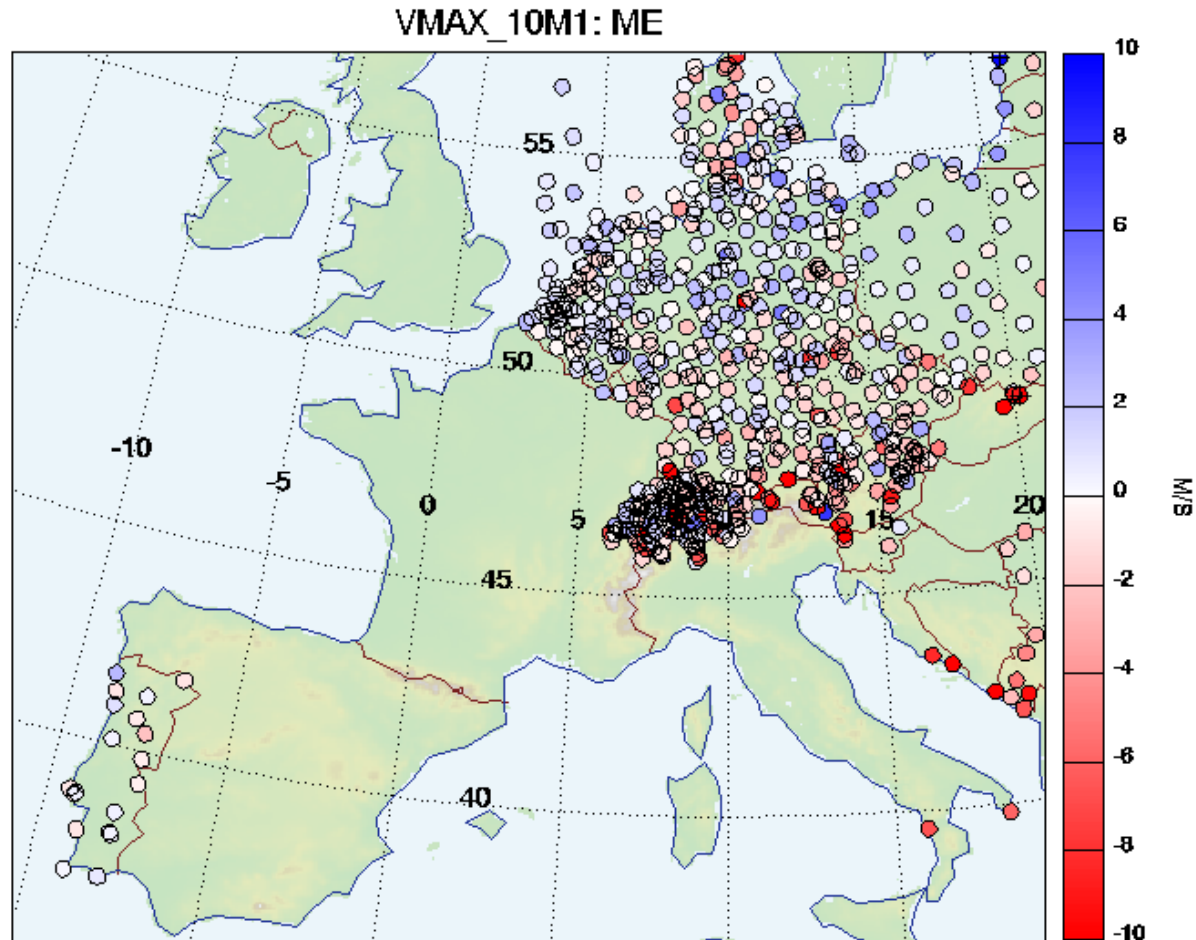
- winter: 03.12.2011 00 UTC – 06.01.2012 12 UTC
- summer: 01.06.2012 00 UTC – 30.06.2012 12 UTC

- namings **-2, -7** based on wind@30m
- namings **-EU** based on wind@10m
- namings **-DE** based on wind@10m + tuning
- namings **-BRA** physically based after Brasseur



bias wind gust after –EU

03.12.11 – 06.01.12 COSMO-7



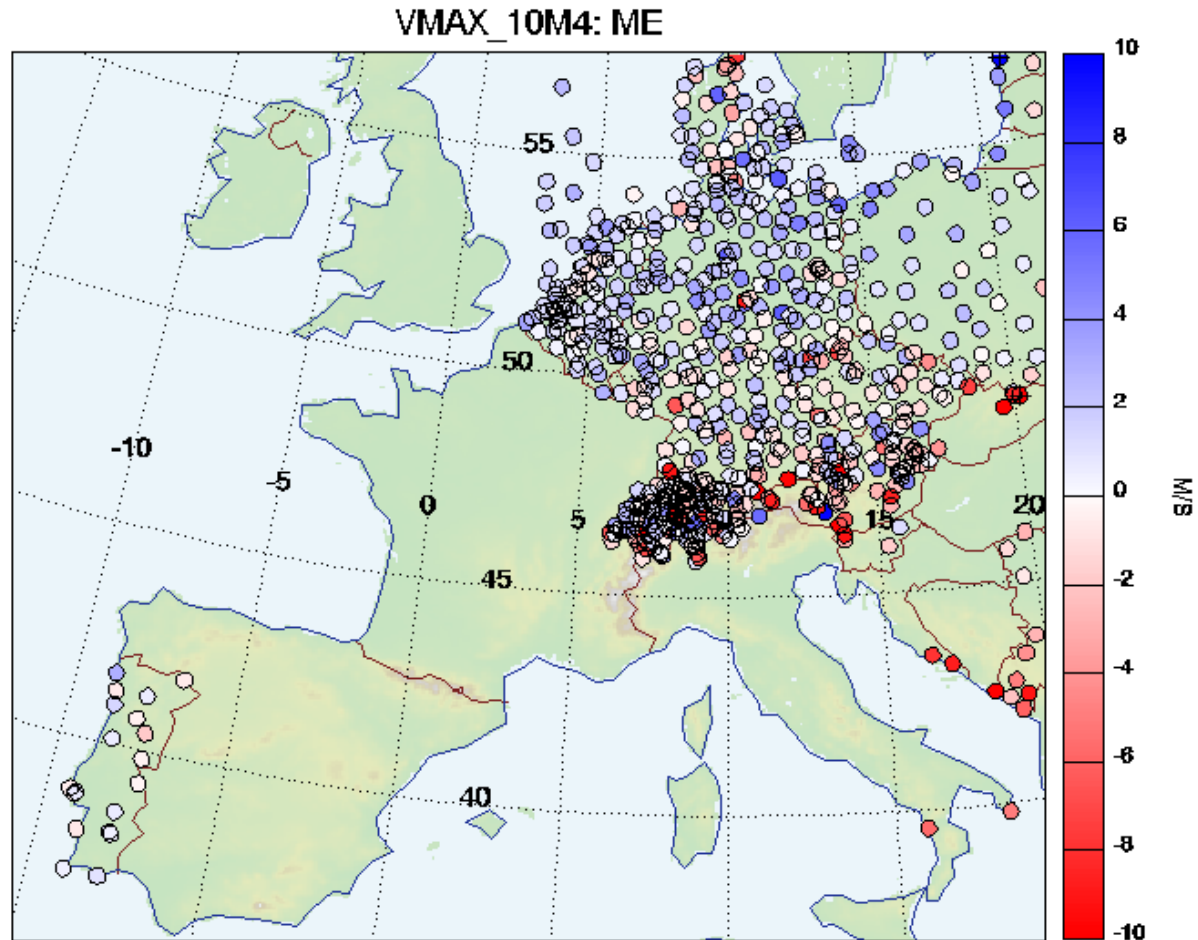
Verification wind gust / Overview of verification at MeteoSwiss in 2012

COSMO GM / WG5 Parallel Session, 10.09.2012

P. Kaufmann



bias wind gust after **-DE** 03.12.11 – 06.01.12 COSMO-7



Verification wind gust / Overview of verification at MeteoSwiss in 2012

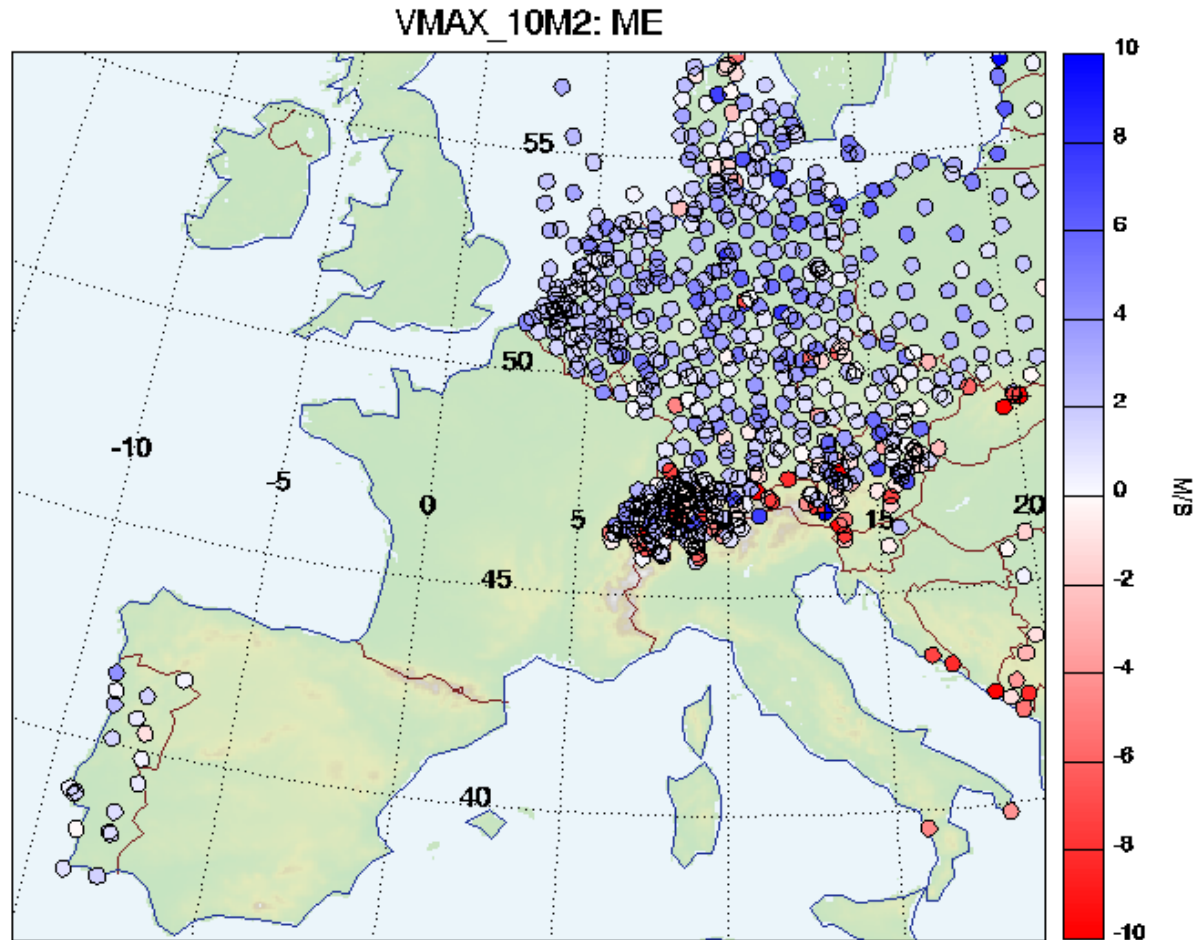
COSMO GM / WG5 Parallel Session, 10.09.2012

P. Kaufmann

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bias wind gust after **-2, -7** 03.12.11 – 06.01.12 COSMO-7



Verification wind gust / Overview of verification at MeteoSwiss in 2012

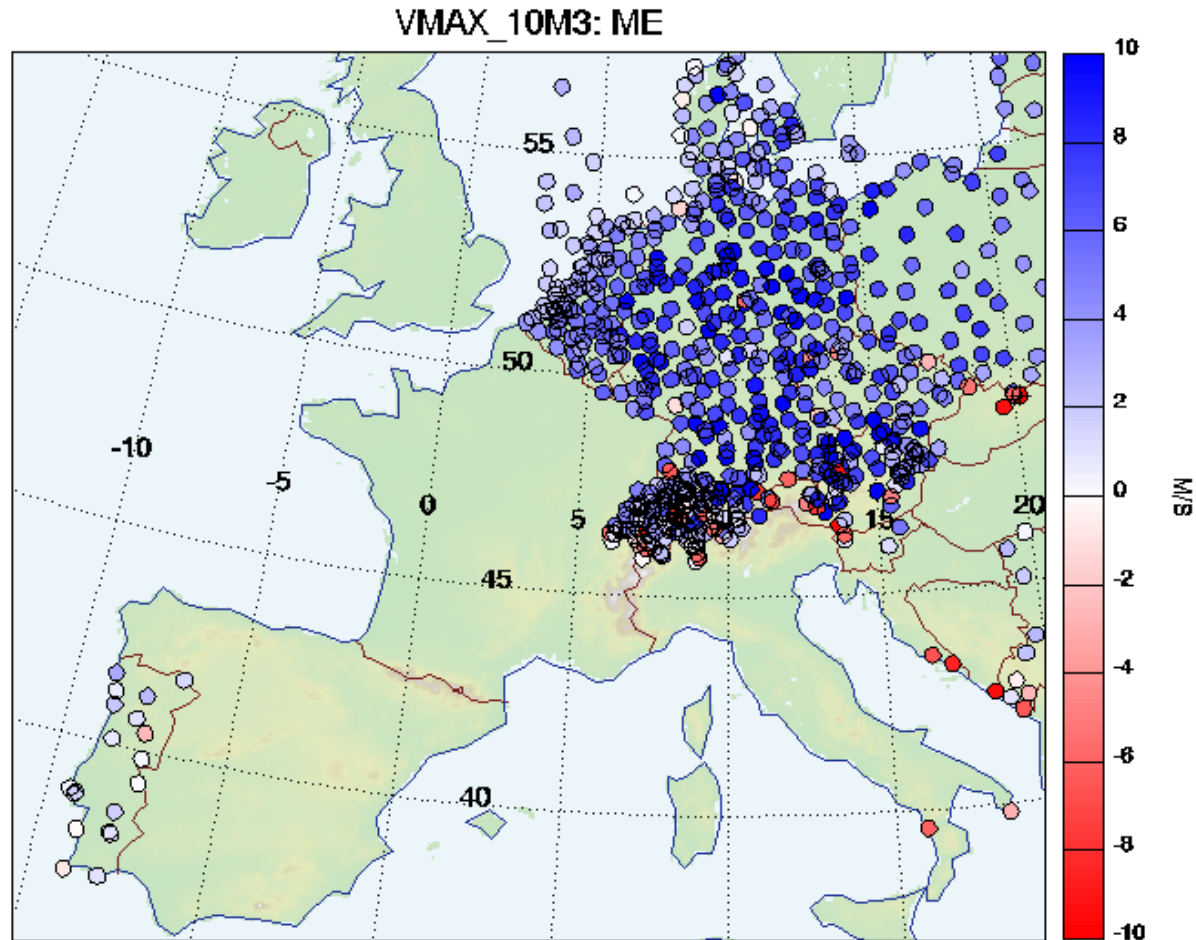
COSMO GM / WG5 Parallel Session, 10.09.2012

P. Kaufmann

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bias wind gust after **-BRA** 03.12.11 – 06.01.12 COSMO-7



Verification wind gust / Overview of verification at MeteoSwiss in 2012

COSMO GM / WG5 Parallel Session, 10.09.2012

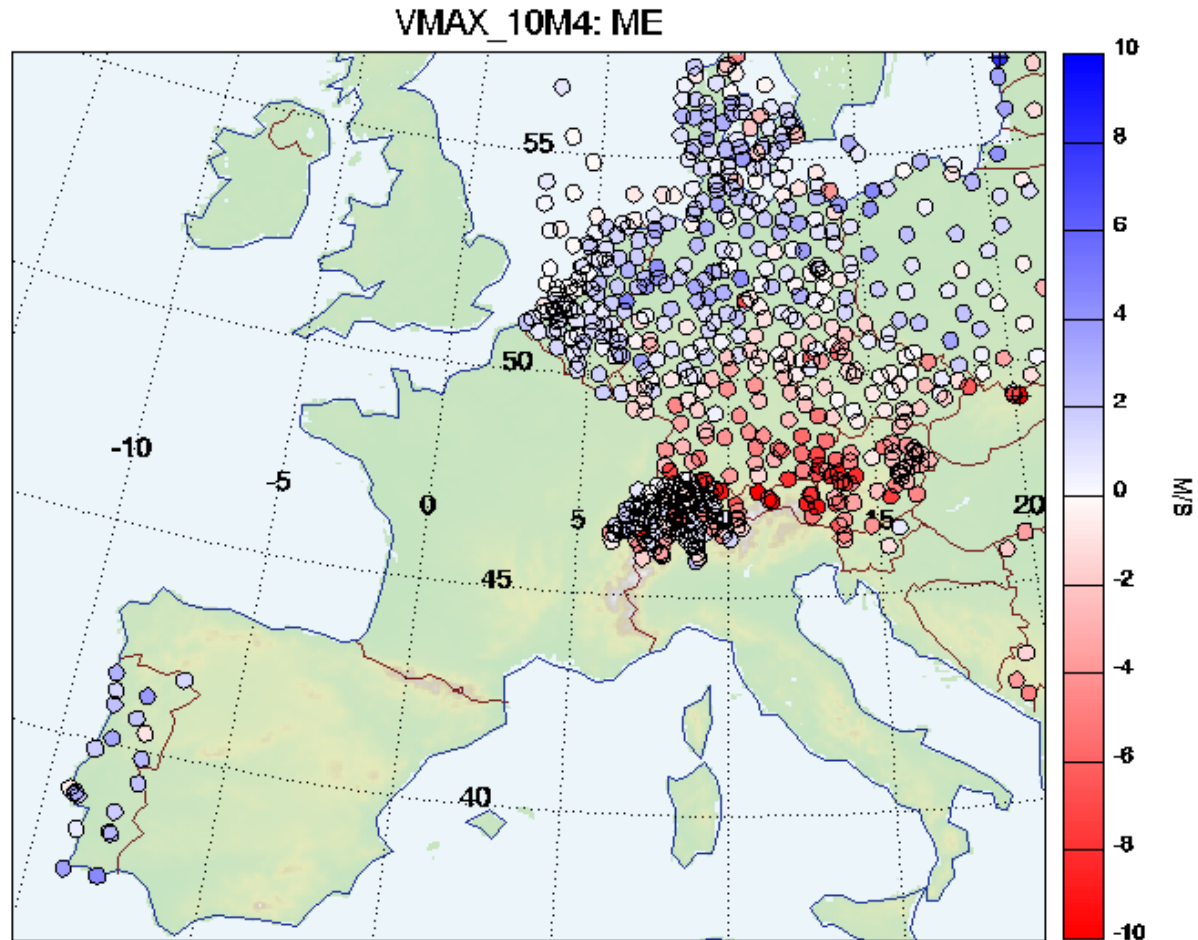
P. Kaufmann

12



bias wind gust after -DE

01.06.12 – 30.06.12 COSMO-7



Verification wind gust / Overview of verification at MeteoSwiss in 2012

COSMO GM / WG5 Parallel Session, 10.09.2012

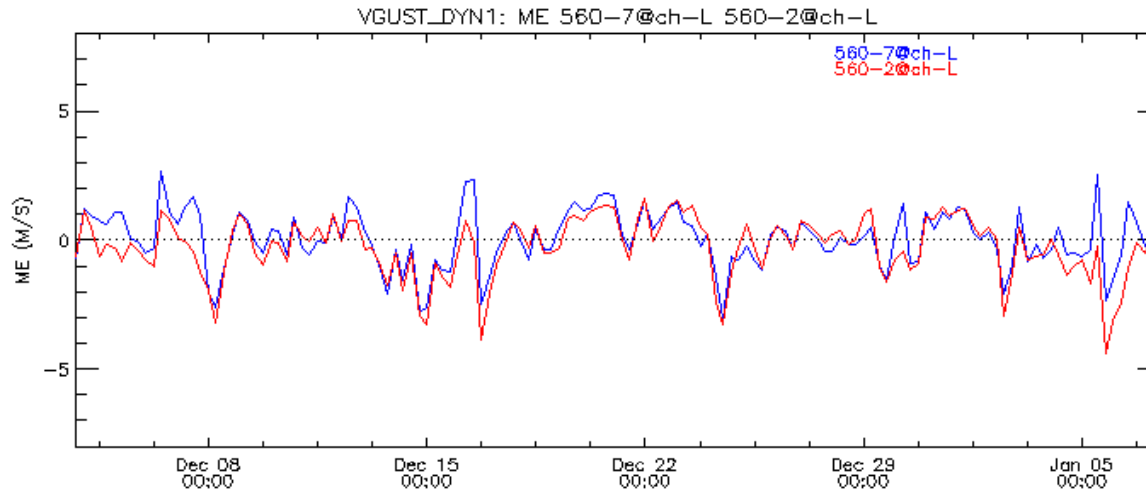
P. Kaufmann

13



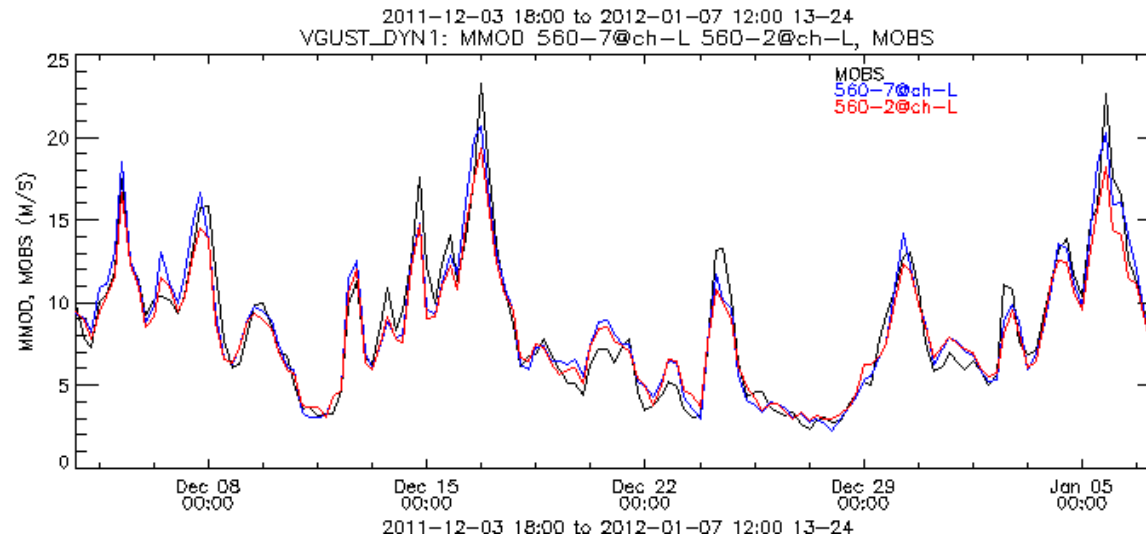
Wind gust (+12..+24h) after -EU

03.12.11 – 06.01.12



bias

COSMO-2
COSMO-7



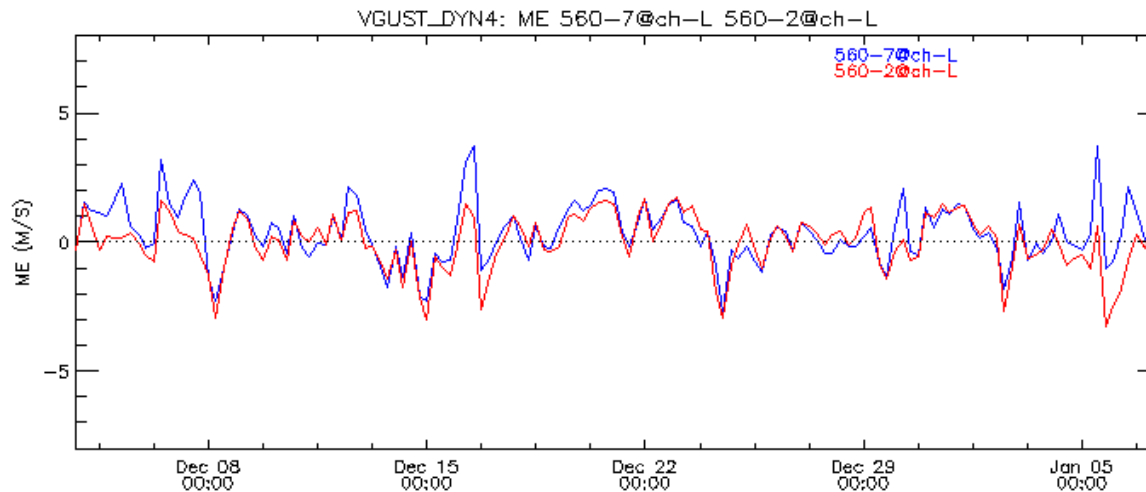
values

OBS
COSMO-2
COSMO-7



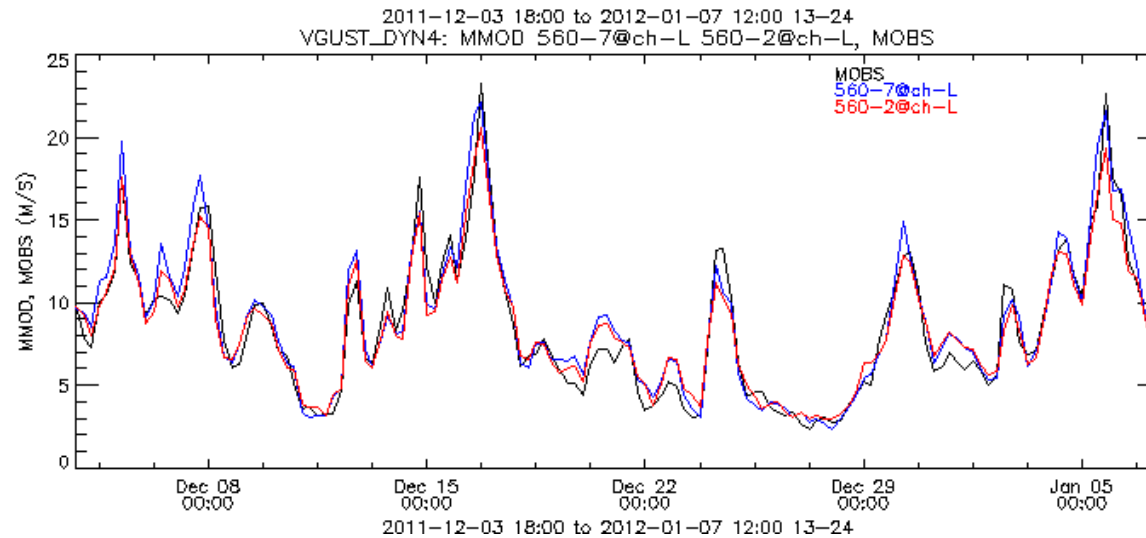
Wind gust (+12..+24h) after **-DE**

03.12.11 – 06.01.12



bias

COSMO-2
COSMO-7

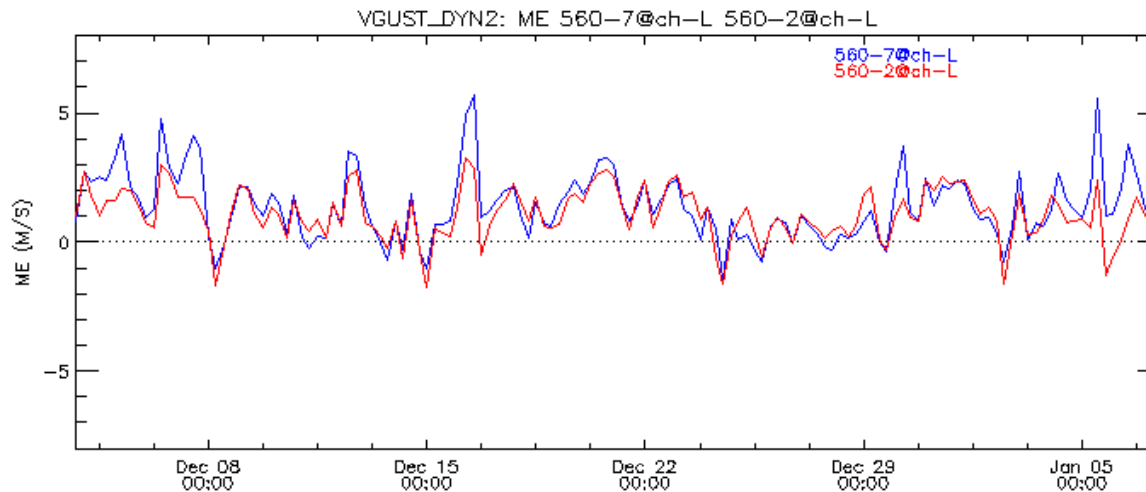


values

OBS
COSMO-2
COSMO-7

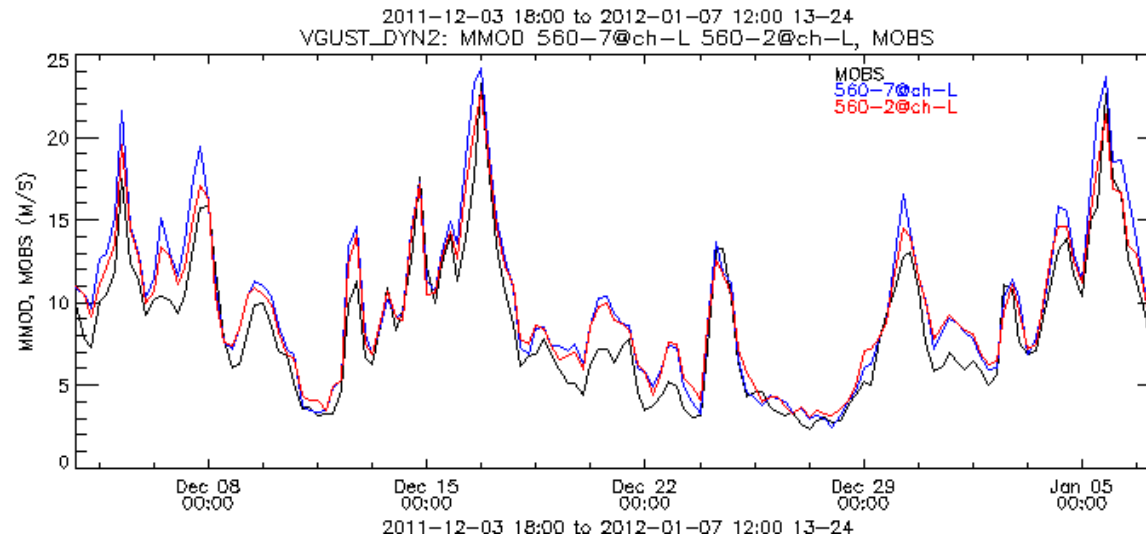


Wind gust (+12..+24h) after **-2, -7** 03.12.11 – 06.01.12



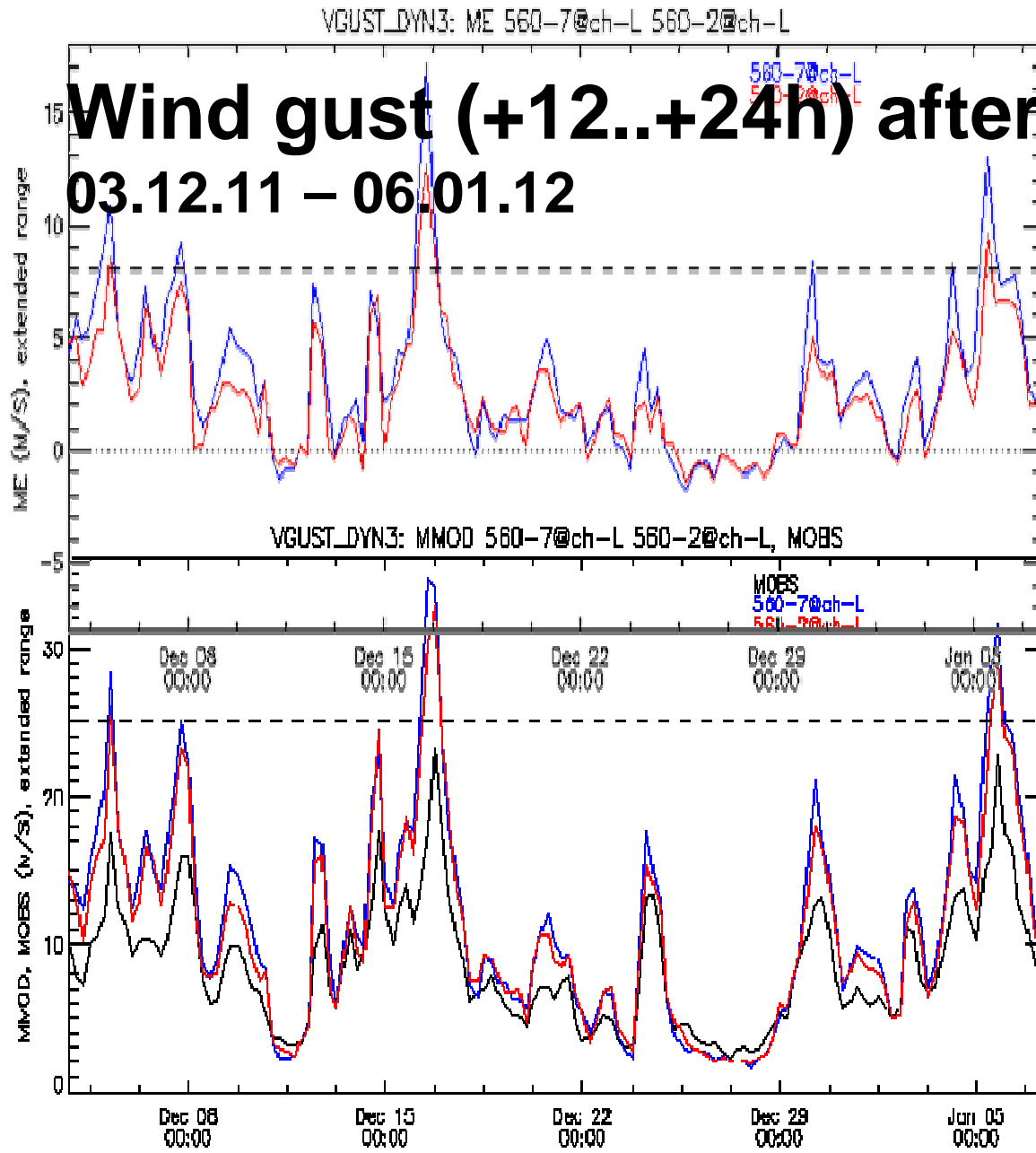
bias

COSMO-2
COSMO-7



values

OBS
COSMO-2
COSMO-7



-BRA

bias

COSMO-2

COSMO-7

values

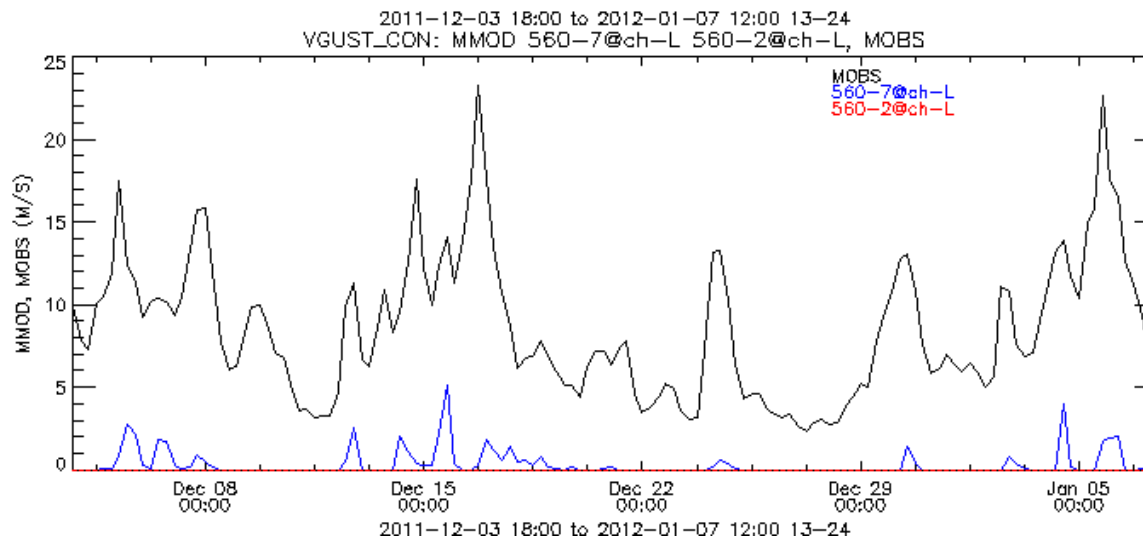
OBS

COSMO-2

COSMO-7



Wind gust only convective part in COSMO-7 03.12.11 – 06.01.12



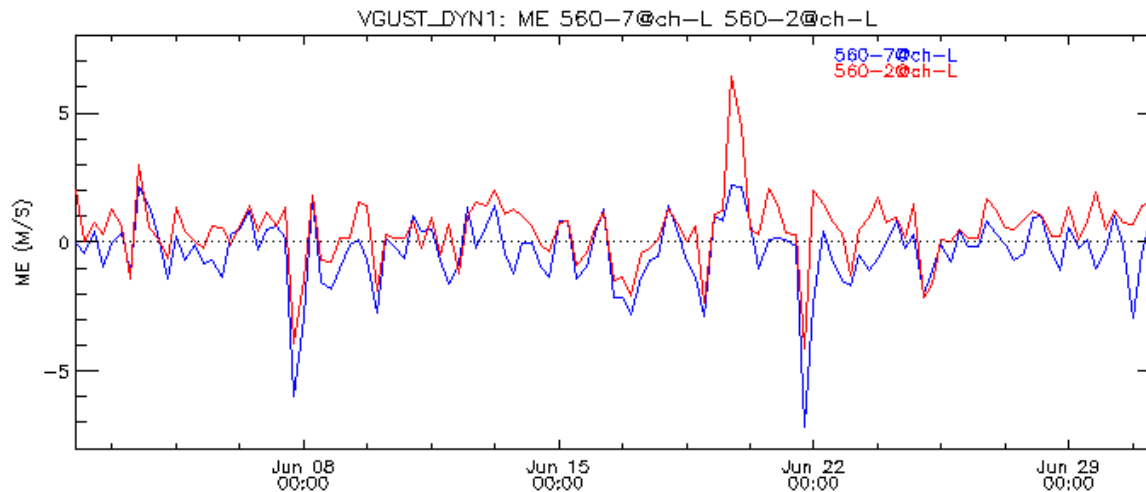
values

OBS
COSMO-7
(+12..+24)



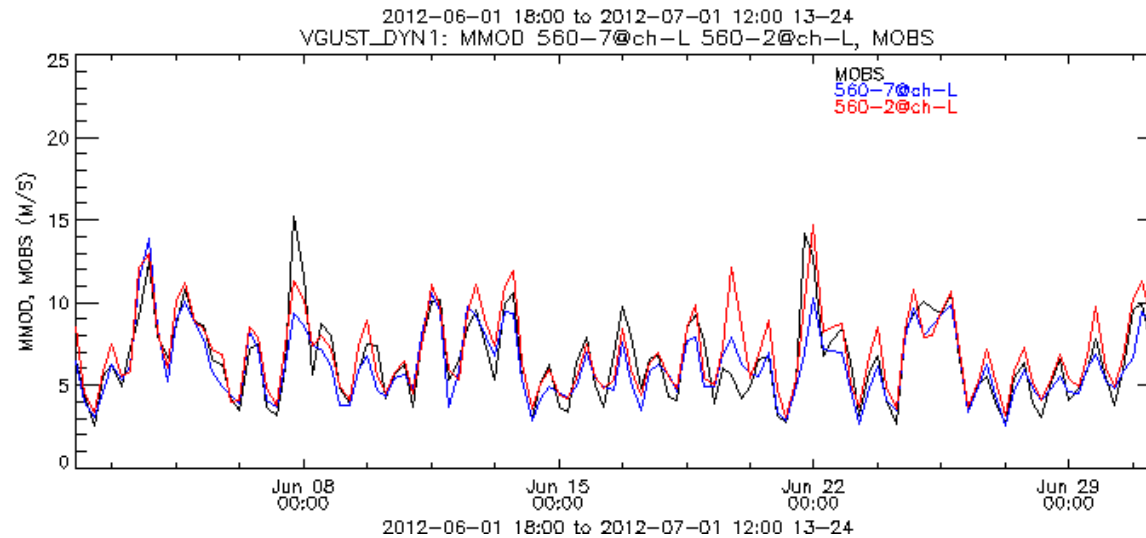
Wind gust turb. part after -EU

01.06.12 – 30.06.12



bias

COSMO-2
COSMO-7



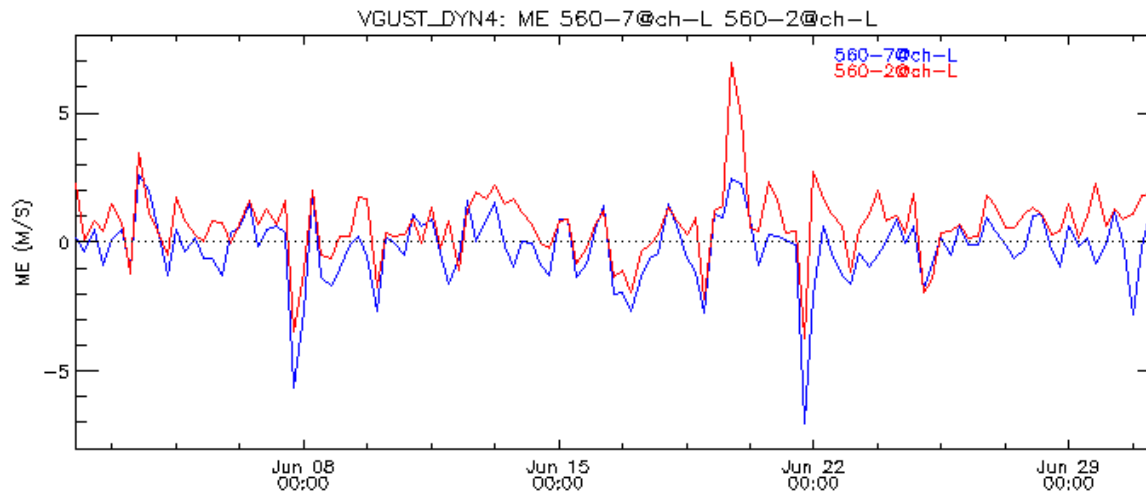
values

OBS
COSMO-2
COSMO-7



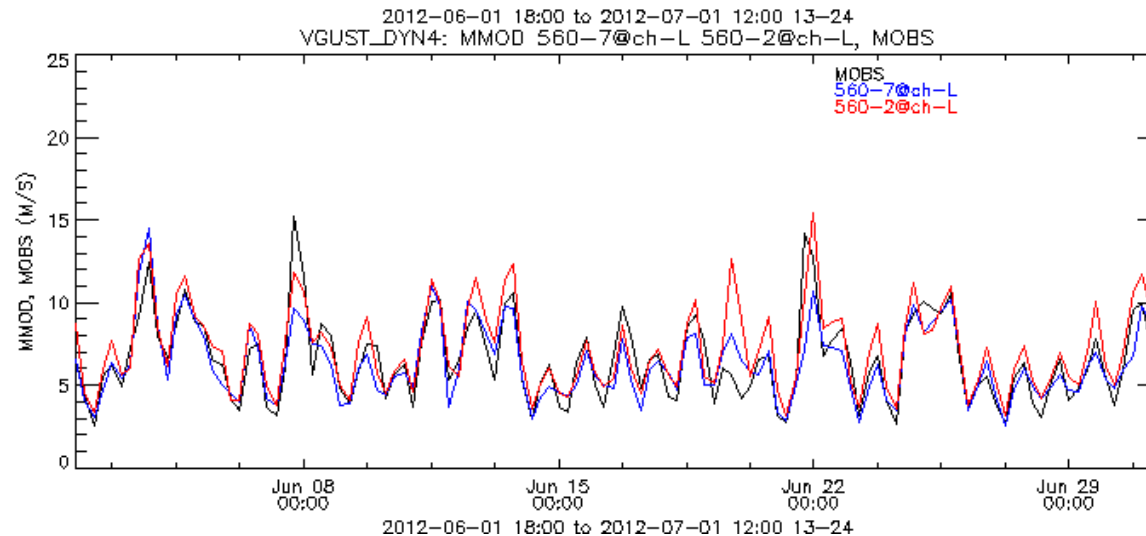
Wind gust turb. part after -DE

01.06.12 – 30.06.12



bias

COSMO-2
COSMO-7



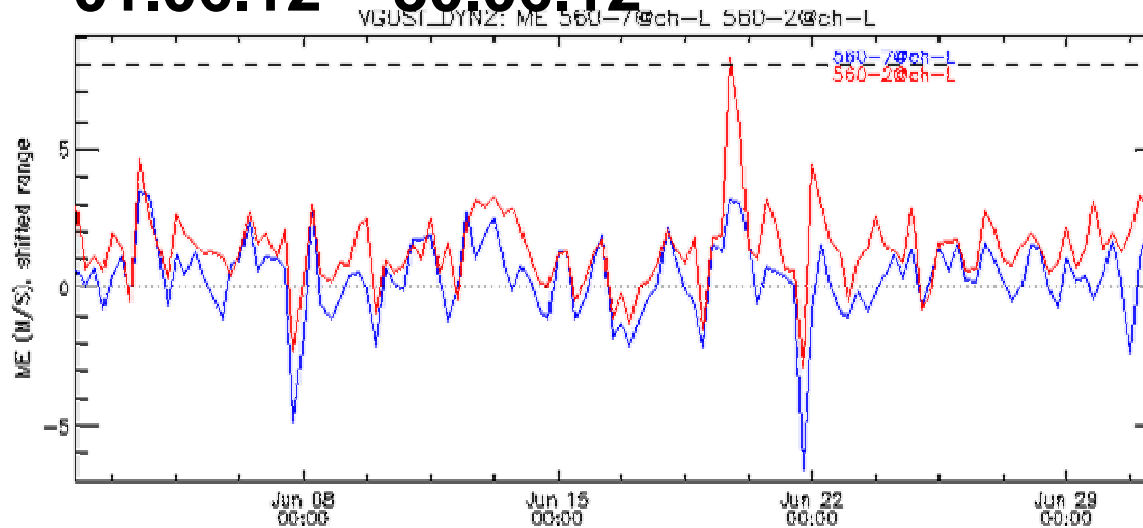
values

OBS
COSMO-2
COSMO-7



Wind gust turb. part after **-2, -7**

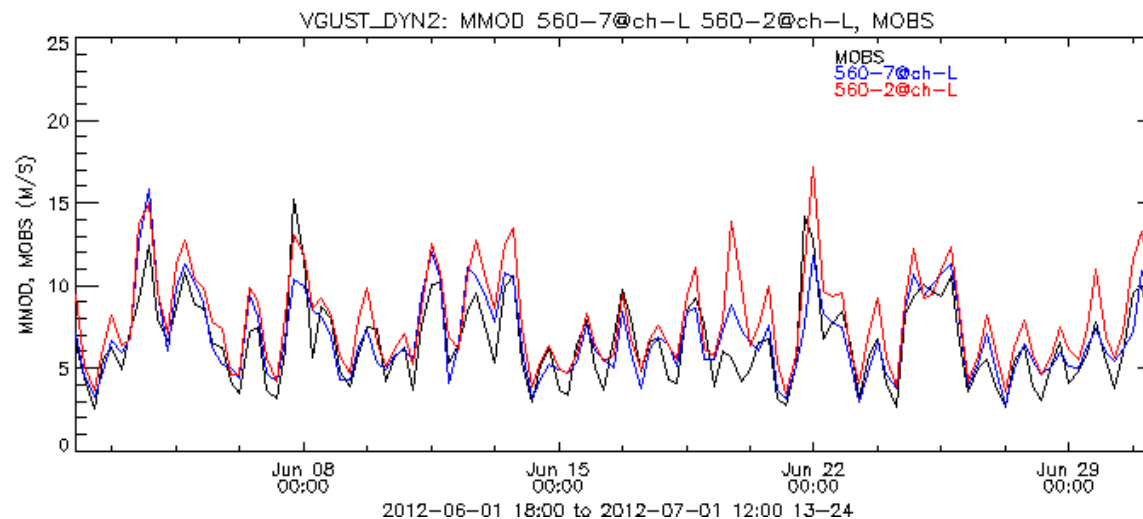
01.06.12 – 30.06.12



bias

COSMO-2

COSMO-7



values

OBS

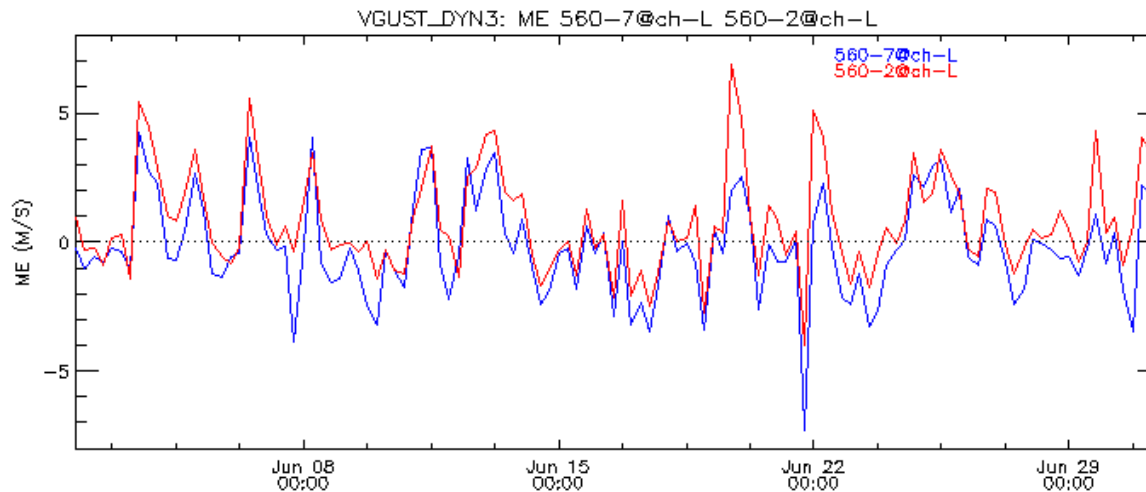
COSMO-2

COSMO-7



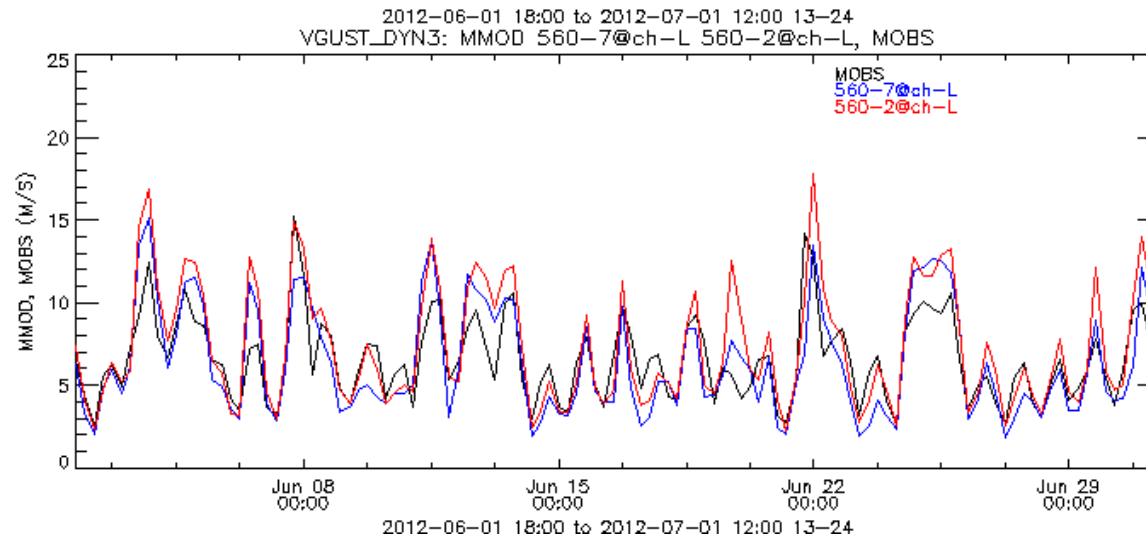
Wind gust turb. part after **-BRA**

01.06.12 – 30.06.12



bias

COSMO-2
COSMO-7

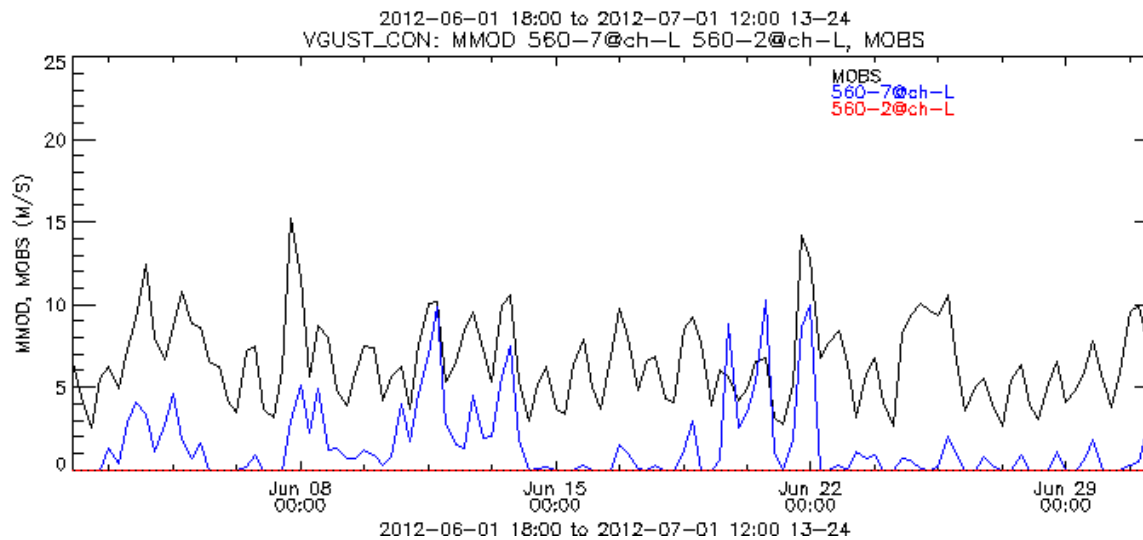


values

OBS
COSMO-2
COSMO-7



Wind gust only convective part in COSMO-7 01.06.12 – 30.06.12



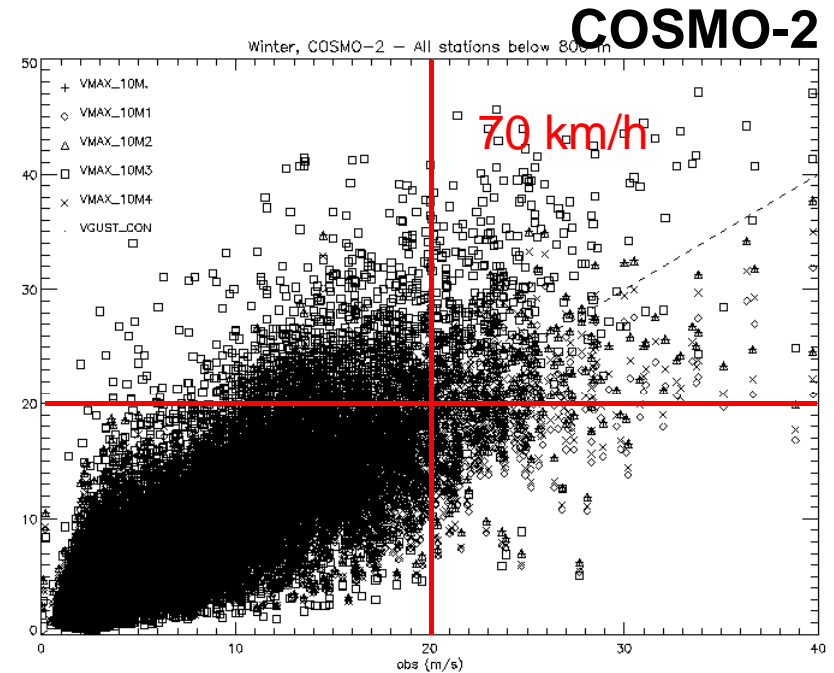
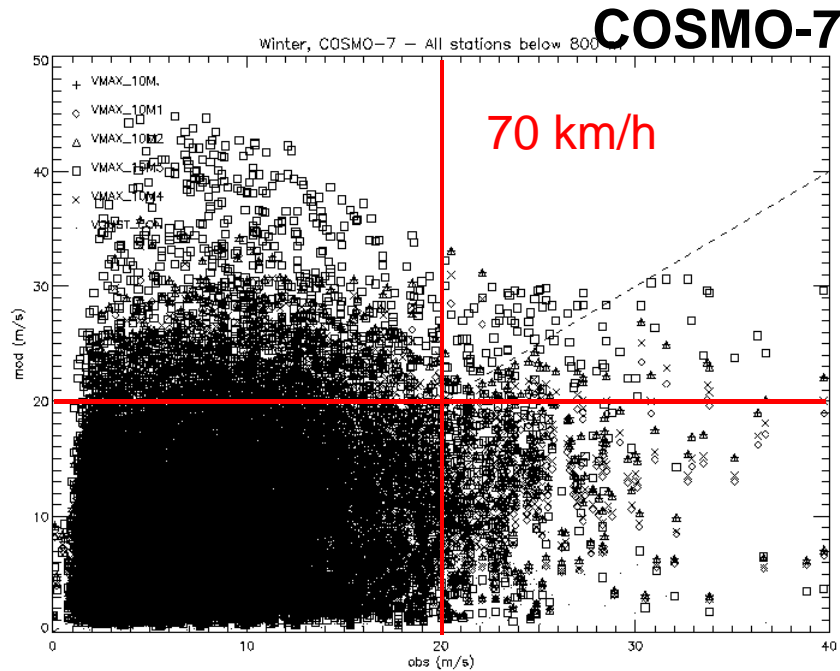
values

OBS

COSMO-7



wind gust (all 4 parametrizations) 03.12.11 – 06.01.12

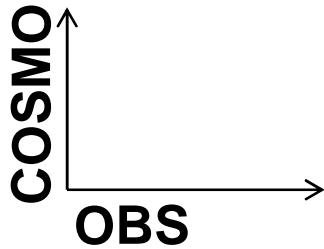
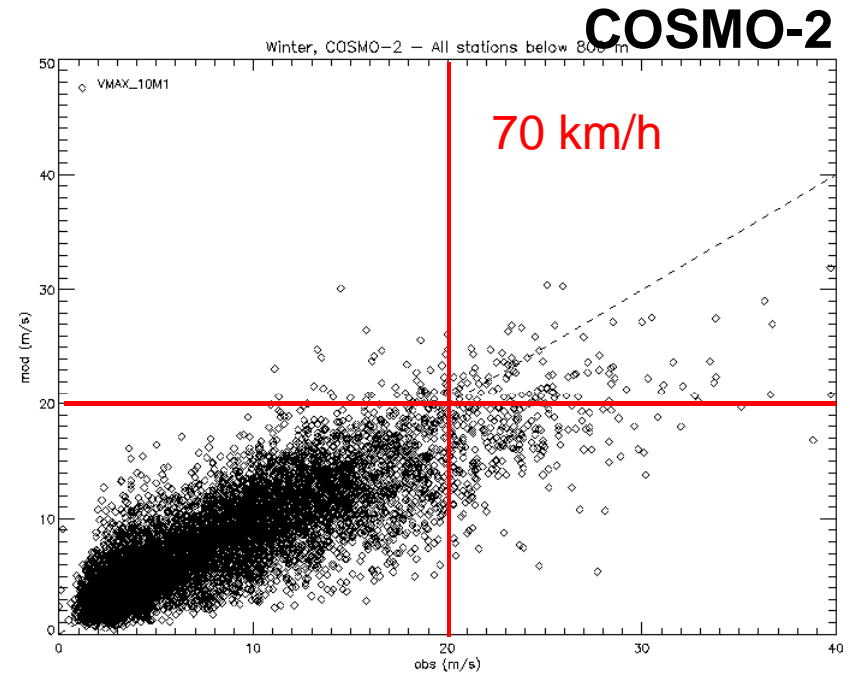
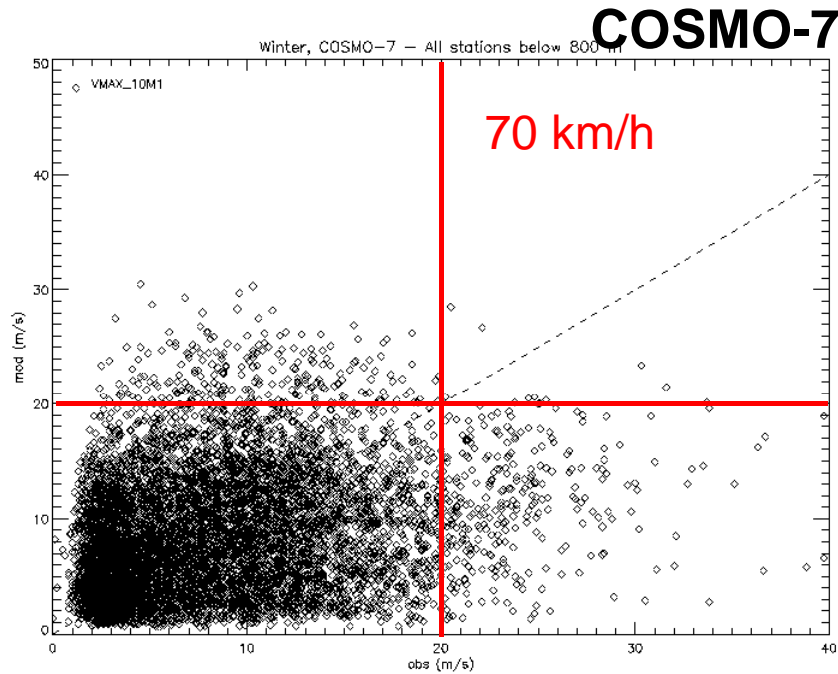


COSMO
OBS

Scatter plot for obs with
all swiss stations < 800m



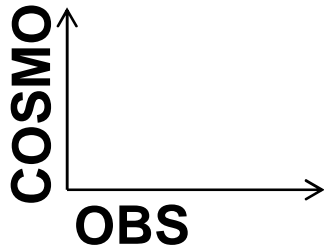
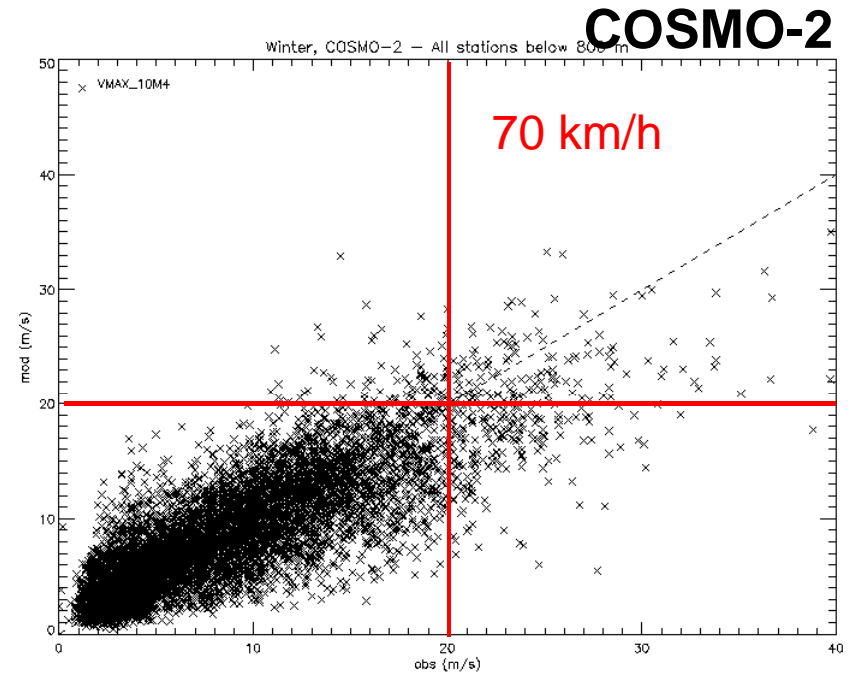
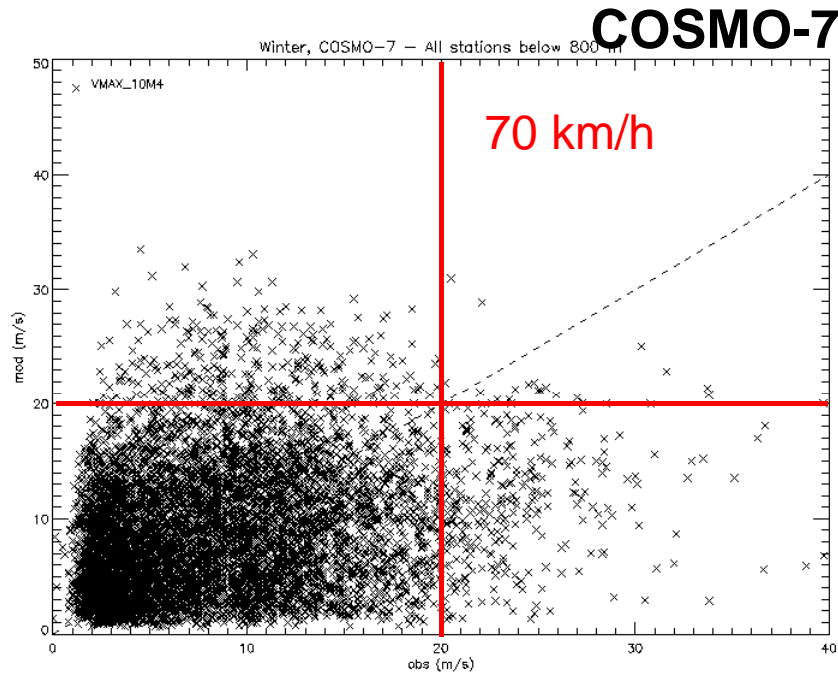
wind gust after –EU 03.12.11 – 06.01.12



Scatter plot for obs with
all swiss stations < 800m



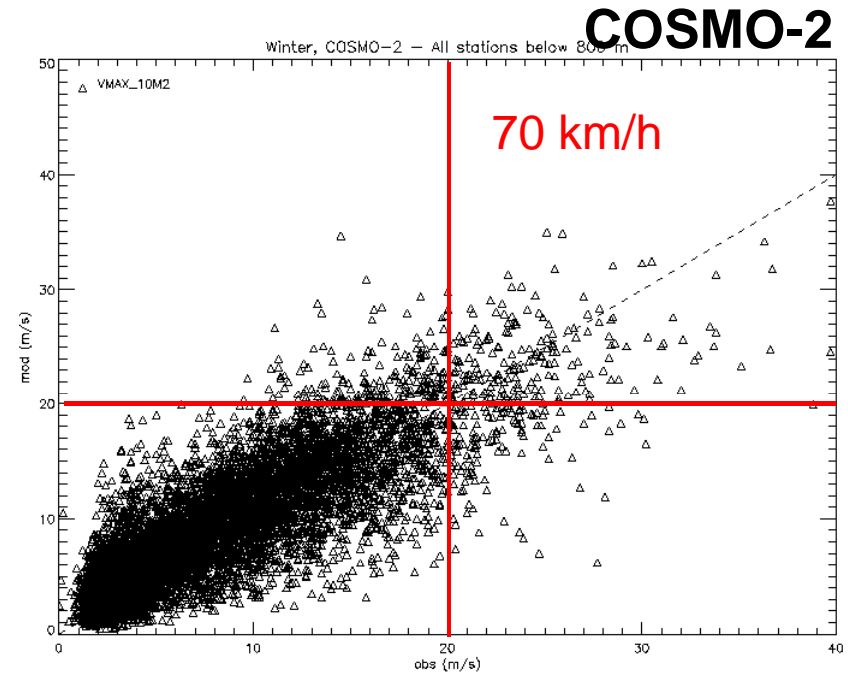
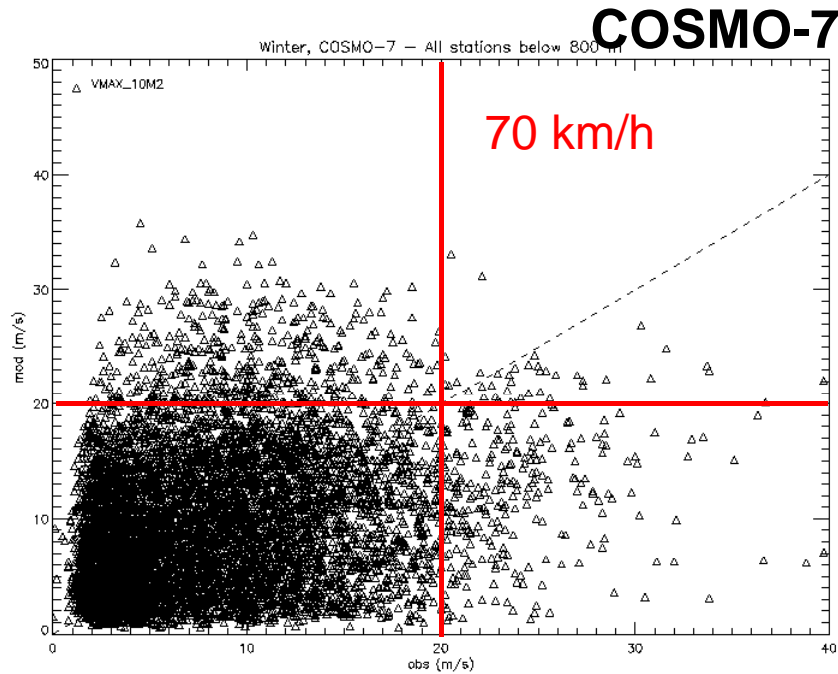
wind gust after **-DE** 03.12.11 – 06.01.12



Scatter plot for obs with
all swiss stations < 800m



wind gust after -2, -7 03.12.11 – 06.01.12

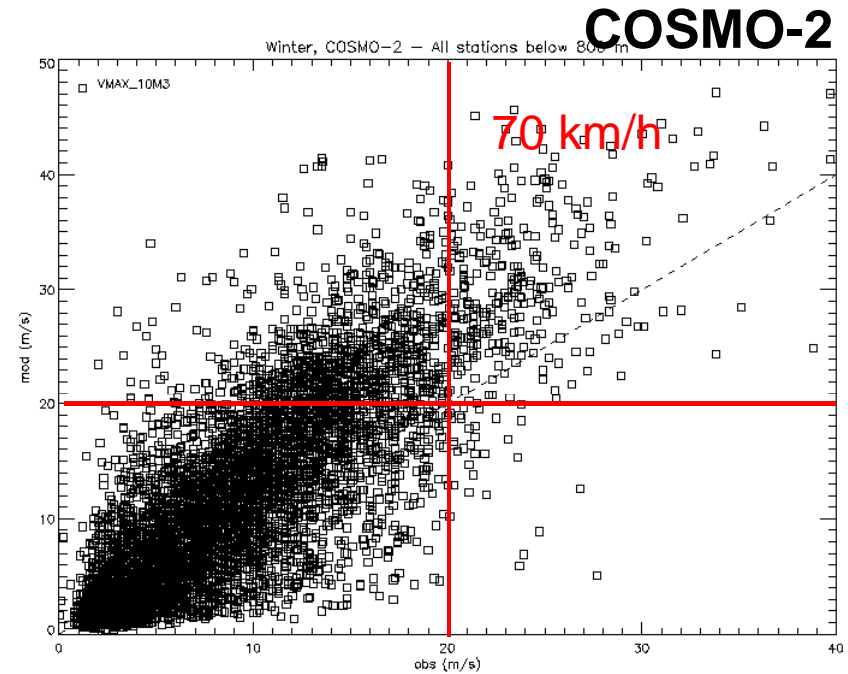
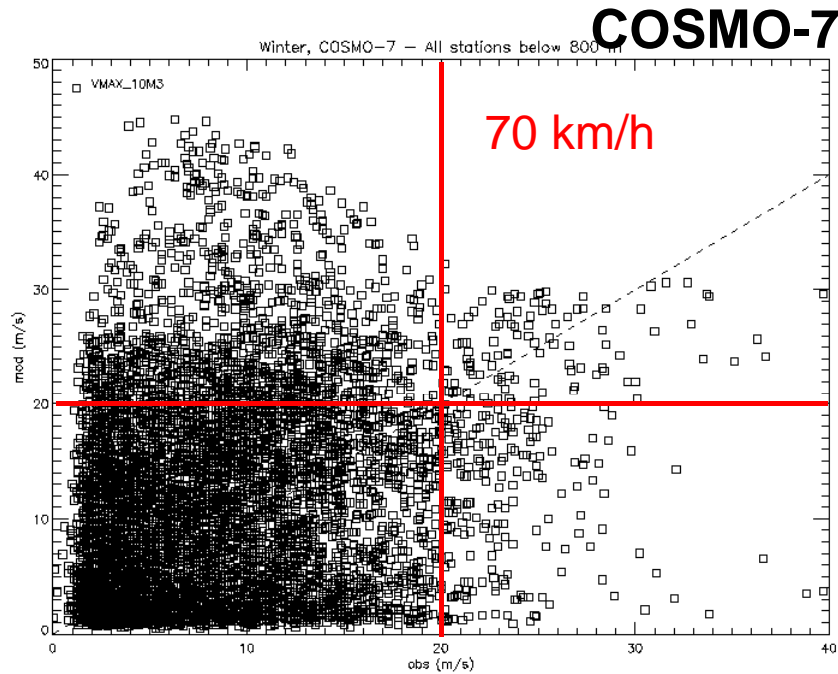


COSMO ↑
OBS →

Scatter plot for obs with
all swiss stations < 800m



Wind gust after **-BRA** 03.12.11 – 06.01.12

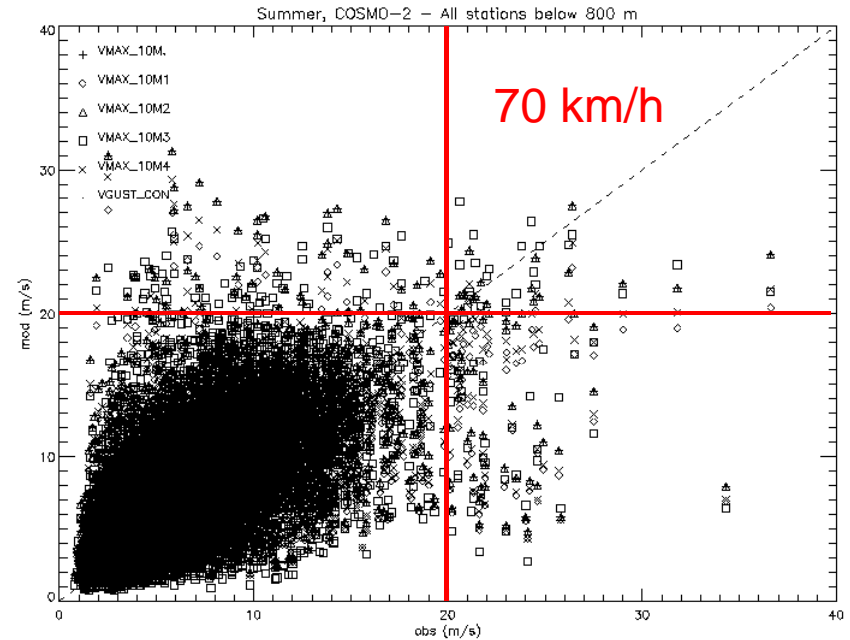
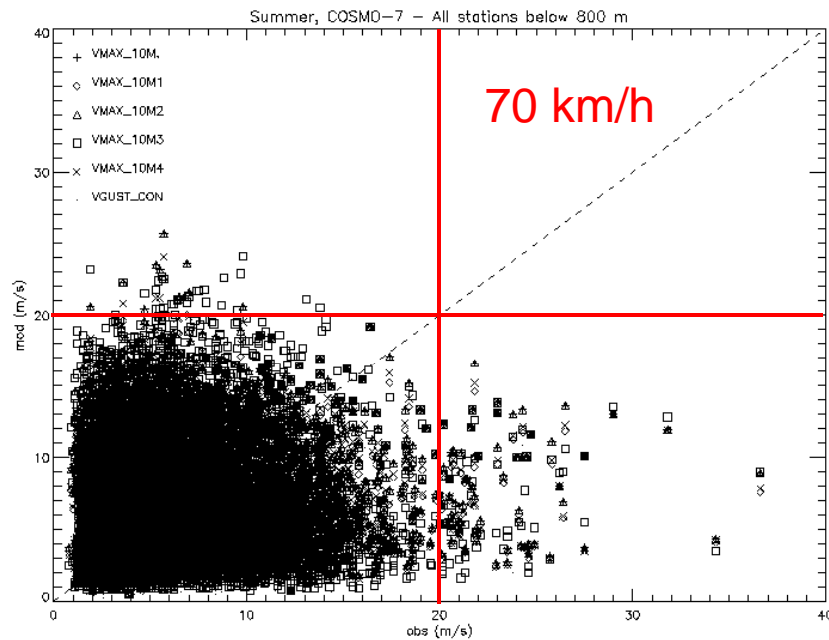


COSMO ↑
OBS →

Scatter plot for obs with
all swiss stations < 800m



wind gust (all 4 parametrizations) 01.06.12 – 30.06.12



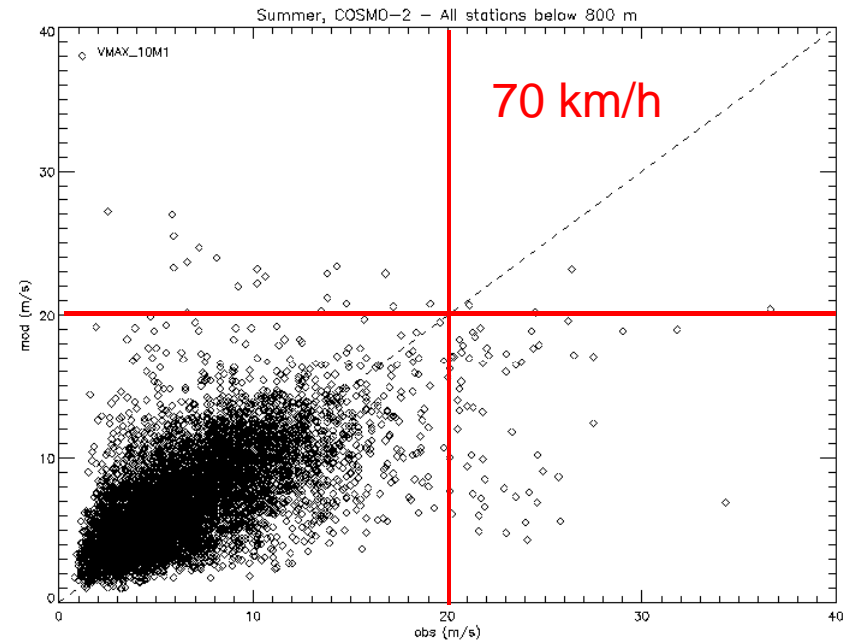
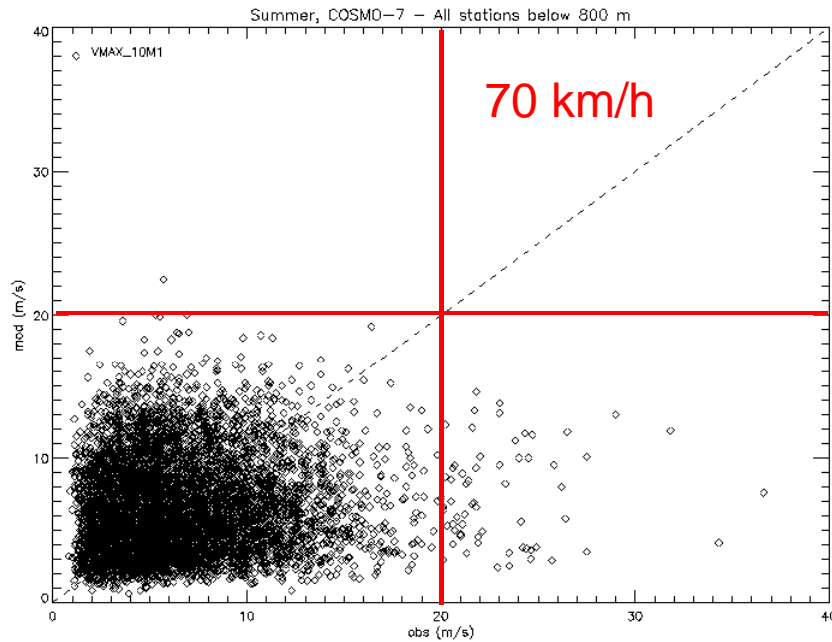
COSMO ↑
→ **OBS**

Scatter plot for obs with
all swiss stations < 800m



wind gust after –EU

01.06.12 – 30.06.12

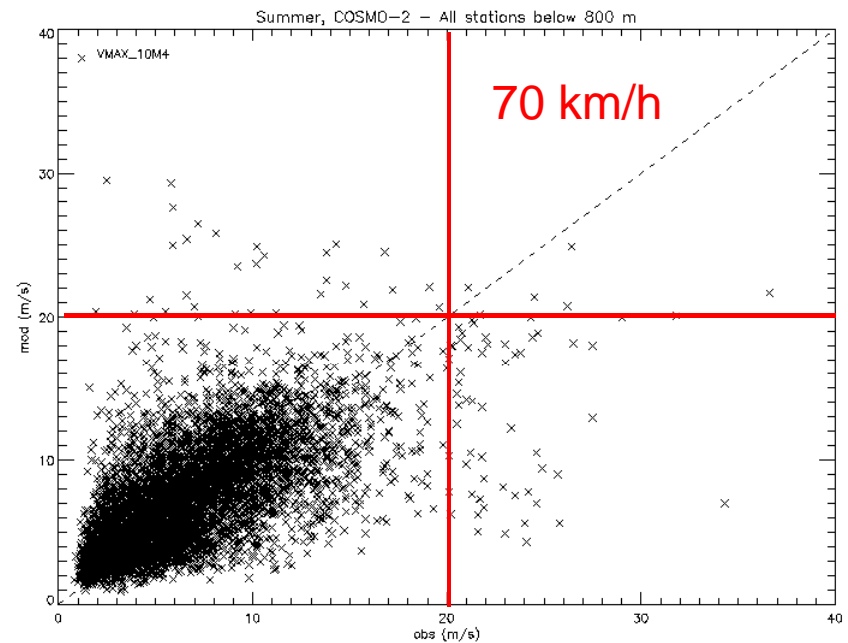
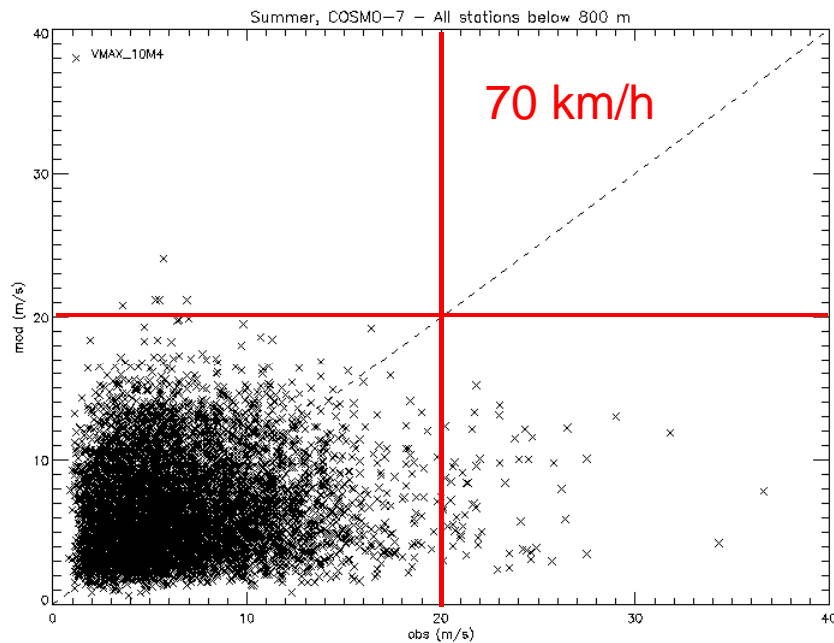


COSMO ↑
→ **OBS**

Scatter plot for obs with
all swiss stations < 800m



wind gust after **-DE** 01.06.12 – 30.06.12

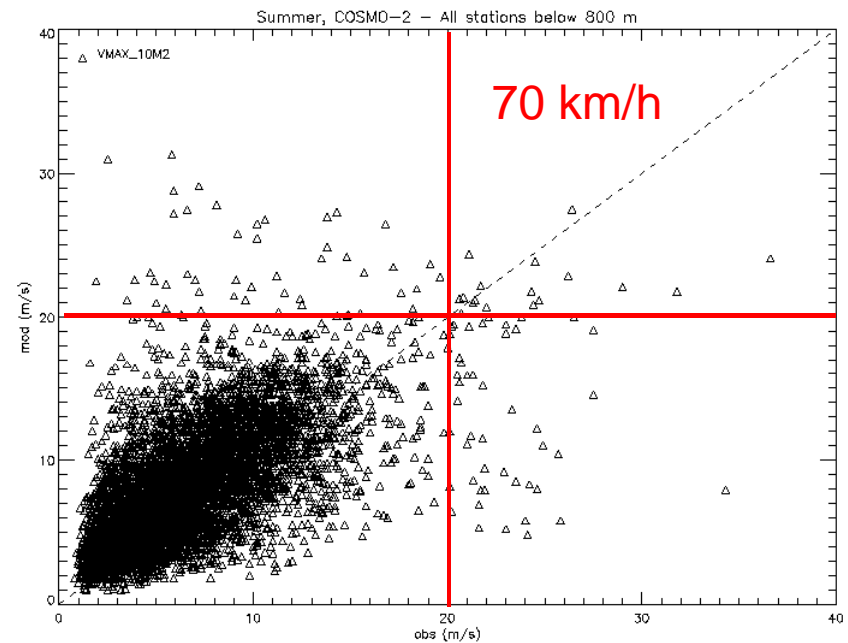
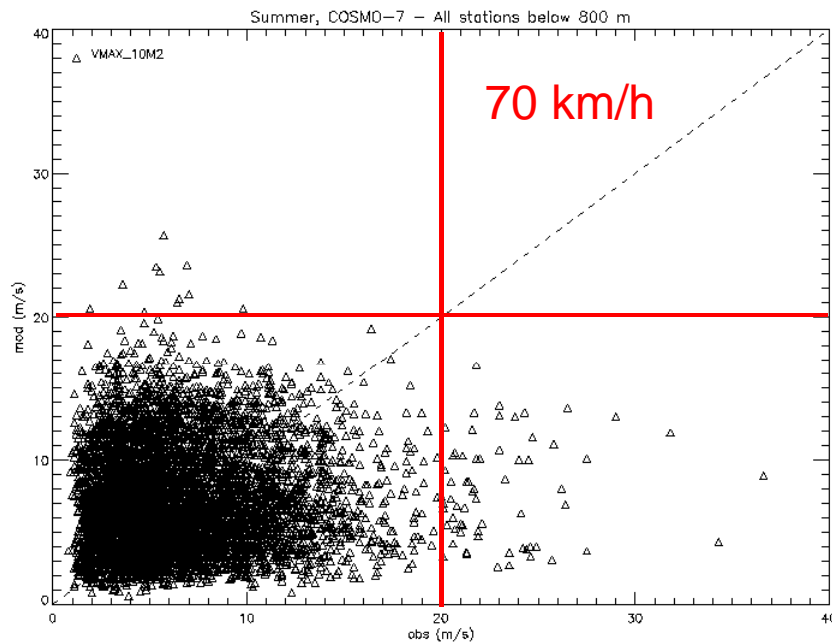


COSMO ↑
→ **OBS**

Scatter plot for obs with
all swiss stations < 800m



wind gust after **-2, -7** 01.06.12 – 30.06.12

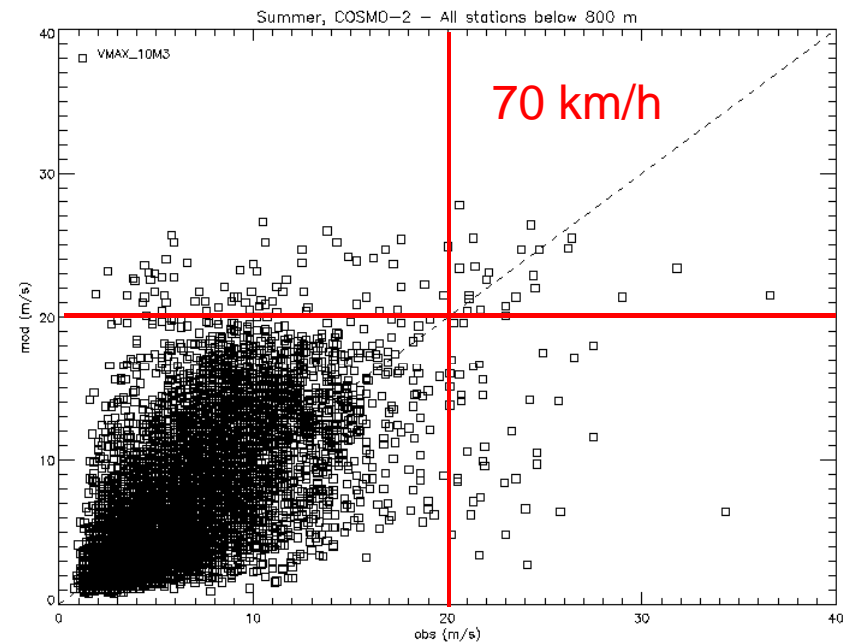
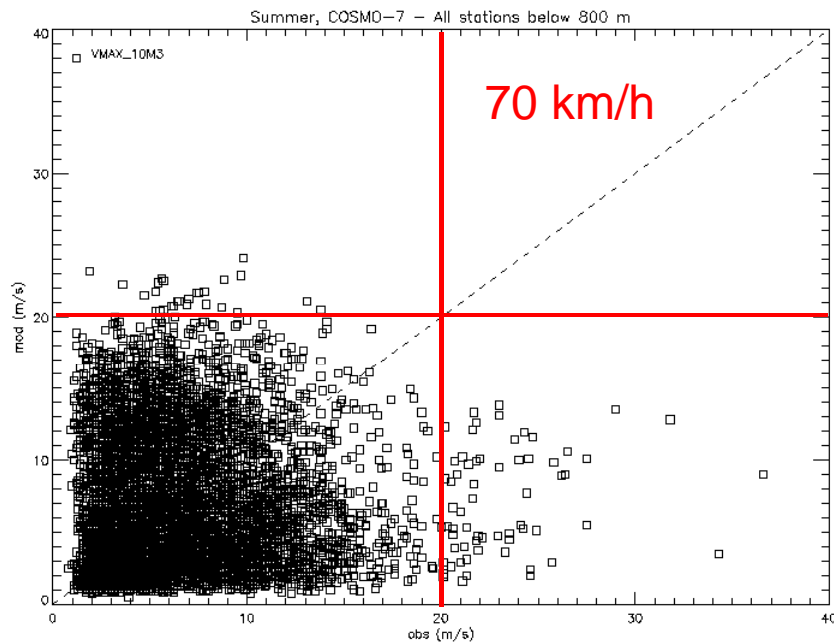


COSMO ↑
→ **OBS**

Scatter plot for obs with
all swiss stations < 800m



Wind gust after **-BRA** 01.06.12 – 30.06.12



COSMO ↑
→ **OBS**

Scatter plot for obs with
all swiss stations < 800m



Frequency bias (%) of the 4 windgust parametrizations over Switzerland (stations < 800m)

W: 03.12.11-06.01.12 / S: 01.06.12-30.06.12

param		- EU		- DE		-2,-7		BRA	
		W	S	W	S	W	S	W	S
20 m/s	CO-2	46	38	65	64	121	116	367	145
	CO-7	76	5	101	8	160	17	415	45
25 m/s	CO-2	21	27	52	72	107	136	643	100
	CO-7	47	0	101	0	189	9	717	0
30 m/s	CO-2	17	0	25	0	63	67	1083	0
	CO-7	8	0	38	0	96	0	1217	0



Summary of wind gust verification with four parametrizations for turbulent part

- Much better forecast of wind gust in COSMO-2 than in COSMO-7 (for all 4 parametrization schemes)
- The original scheme based on 10m wind underestimates gusts $> 20\text{m/s}$ in COSMO-7 and also COSMO-2 (especially in Winter)
- The new scheme based on 10m wind with a weak dependance on the wind@10m gives higher values, i.e. better scores for gusts $> 20\text{m/s}$
- The old scheme based on 30m gives even higher values with more cases for gust $> 20\text{m/s}$ observed and forecasted
- Brasseur gives strong overestimation
- In the summer period for COSMO-7 none of the schemes shows cases with gust $> 20\text{ m/s}$ in both model and obs (i.e. strong underestimation)

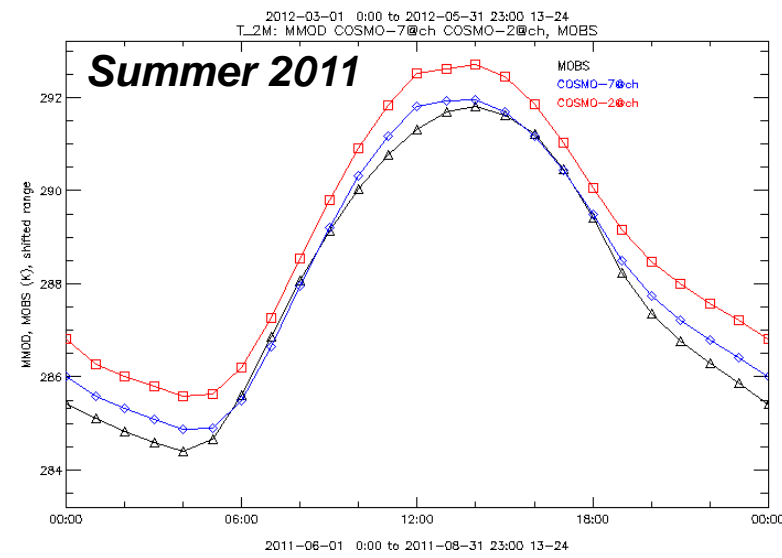
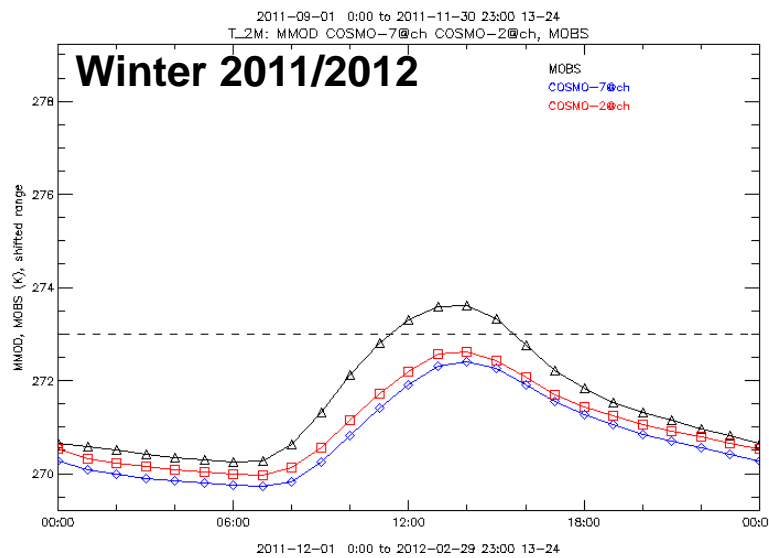
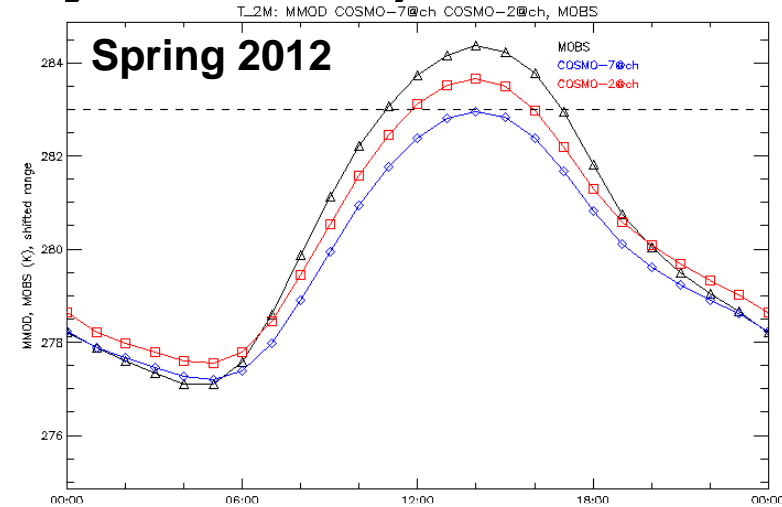
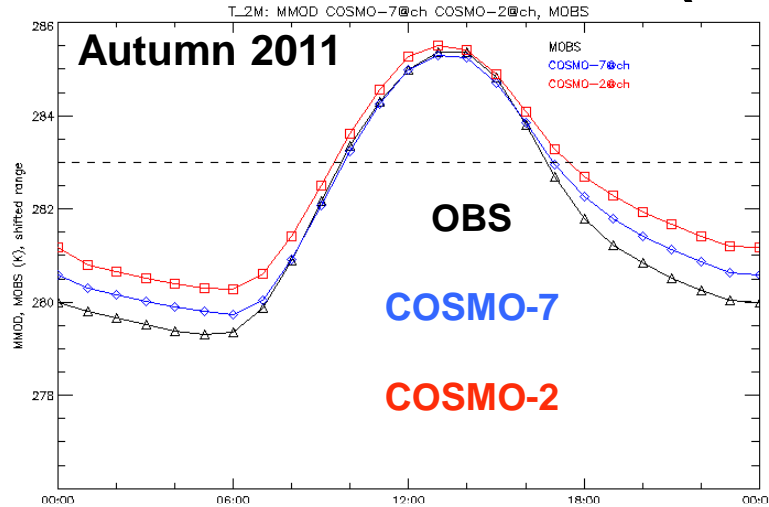


Verification outside VERSUS of COSMO-2, COSMO-7, COSMO-LEPS and IFS

- **Operational (COSMO-2, COSMO-7, COSMO-LEPS [mean], IFS):**
 - Surface (3h-steps SYNOP and 1h-steps SMN [Swiss Met Net])
 - psred, ps, T2m, Td2m, RH2m, 10m-wind, cloud cover, gusts, precipitation (1h, 12h)
 - Upper-air (TEMP)
 - T, RH, wind, Φ
- **Quasi-operational (COSMO-2, COSMO-7, IFS):**
 - **not updated in 2012:** precipitation with RADAR (neighborhood/fuzzy verification, Ebert's package) also weather-type dependant
- **Monitoring: SMN (swiss SYNOPs) , RADAR**
- **Ongoing in experimental modus:**
 - windprofiler over Switzerland
 - fluxes at Payerne



T2m: mean diurnal cycle (first 24h forecasts) domain Switzerland (hourly SYNOP's)

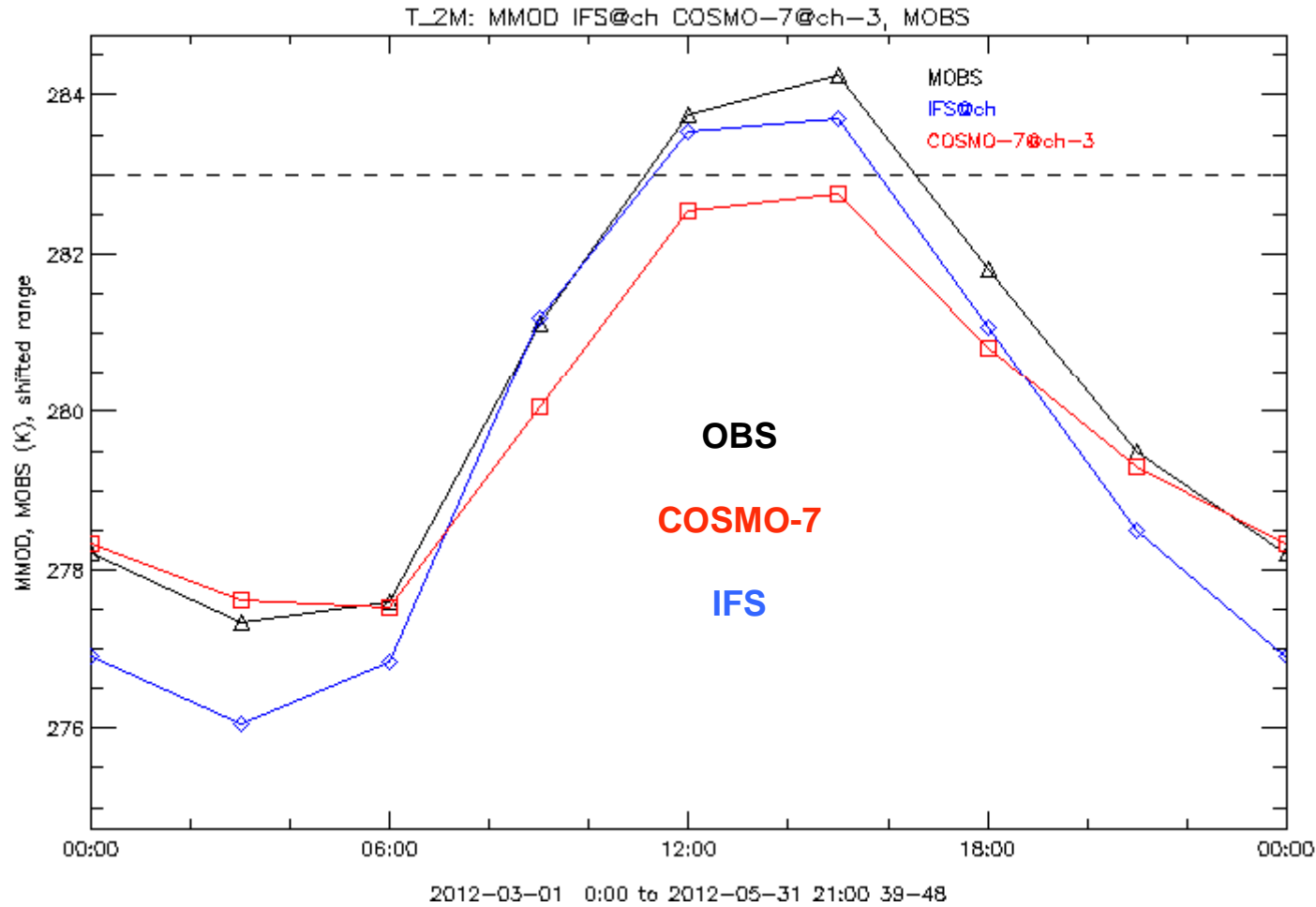




T2m: mean diurnal cycle Spring 2012

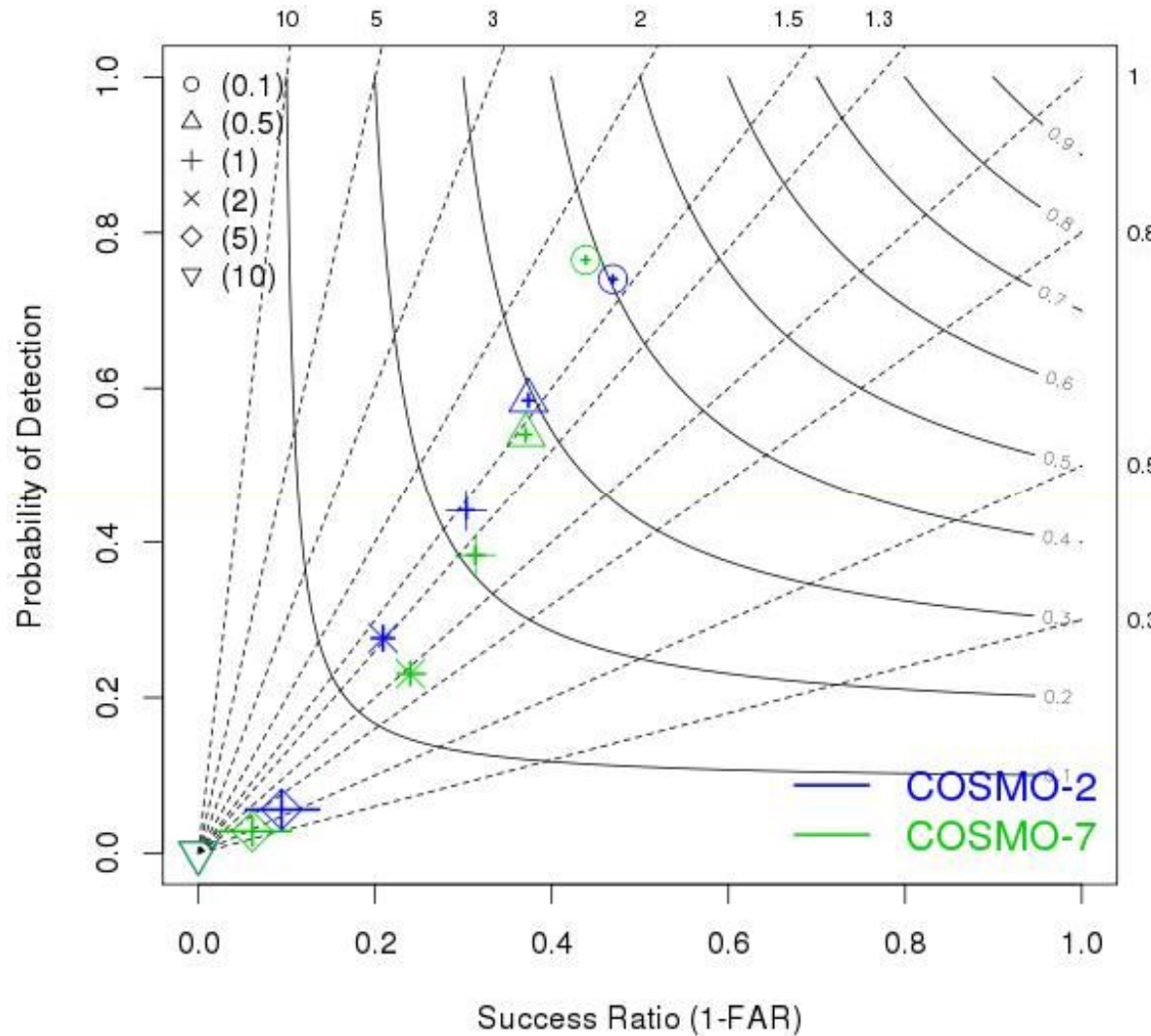
COSMO-7 vs IFS

SYNOP's over COSMO-7 domain





Precipitation: Spring 2012



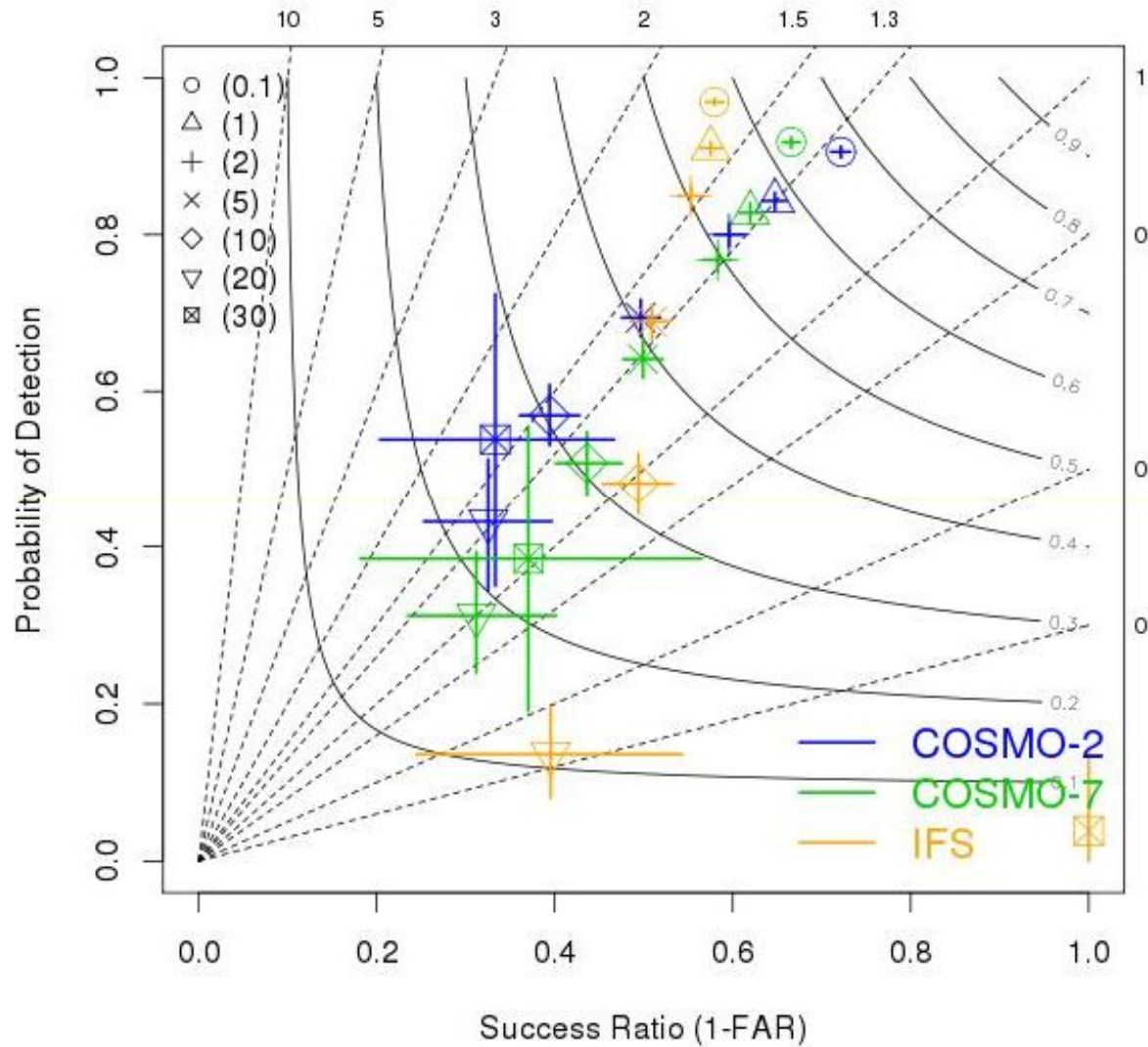
Performance diagram for the swiss stations for **all 1h accumulated precipitation (+12-+24h)**

COSMO-2
COSMO-7

after [Roebber, 2009]



Precipitation: Spring 2012



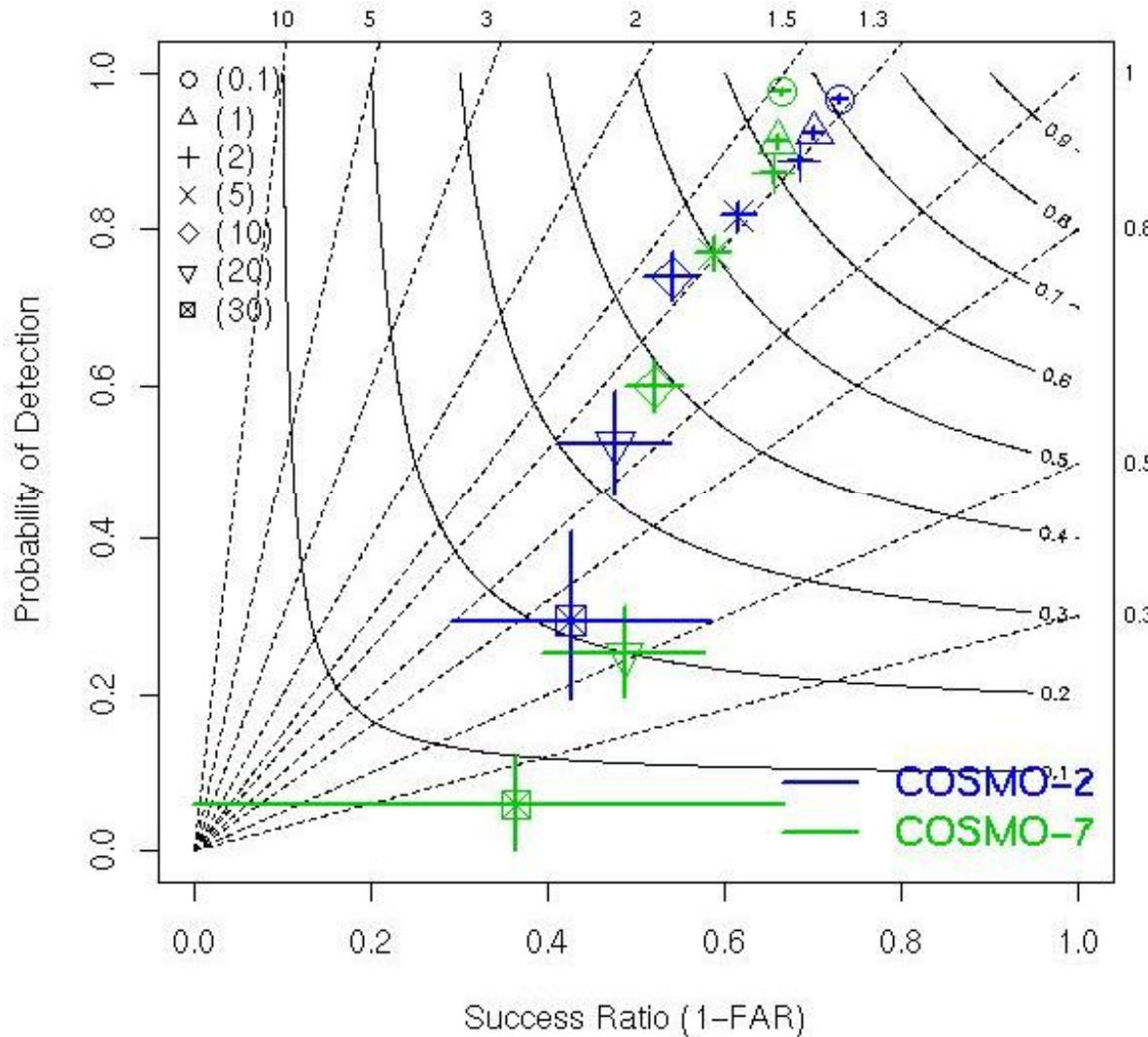
Performance diagram for the swiss stations for 12h accumulated precipitation (+12-+24h)

COSMO-2
COSMO-7
IFS

after [Roebber, 2009]



Precipitation: Winter 2011/2012



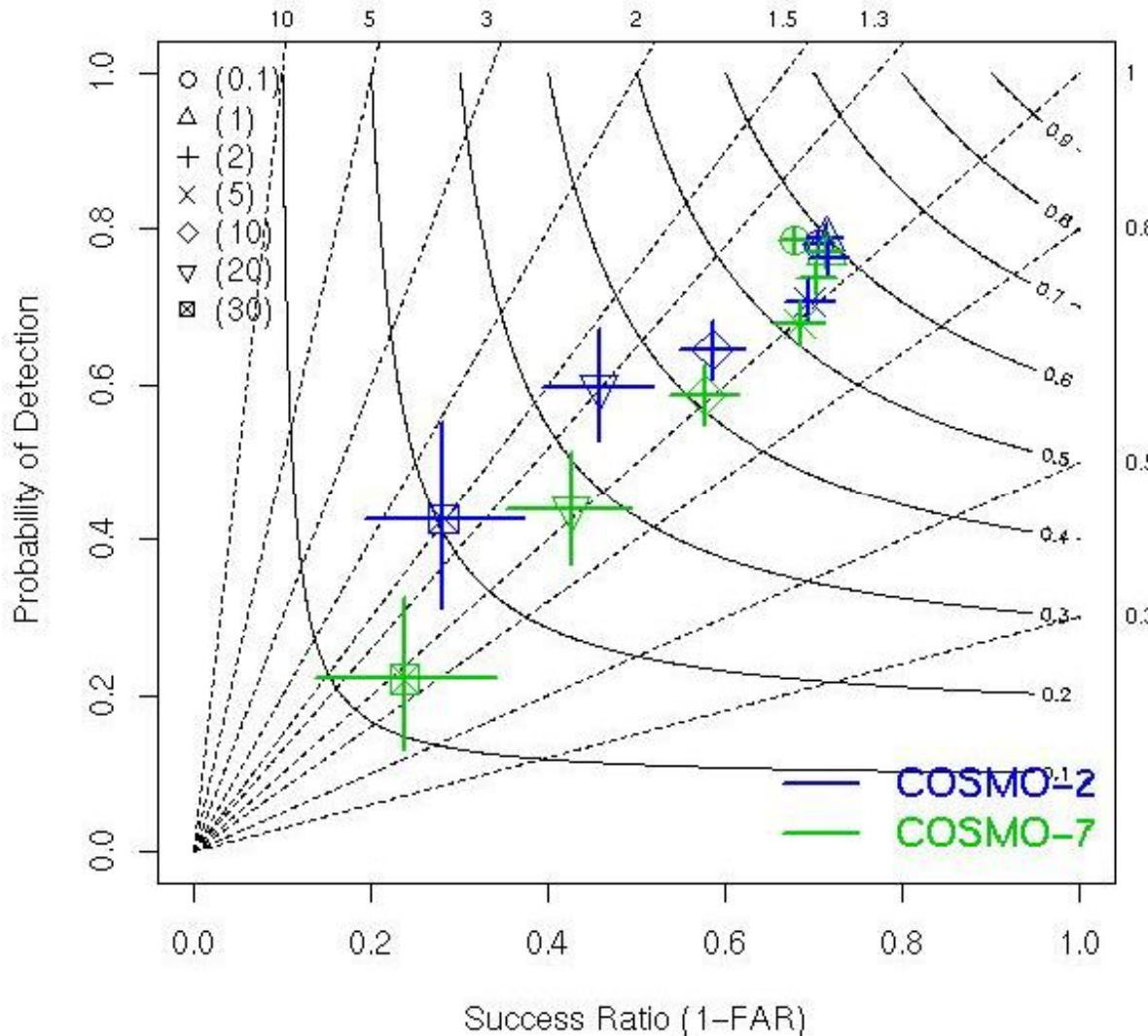
Performance diagram for the swiss stations for 12h accumulated precipitation (+12-+24h)

COSMO-2
COSMO-7

after [Roebber, 2009]



Precipitation: Autumn 2011



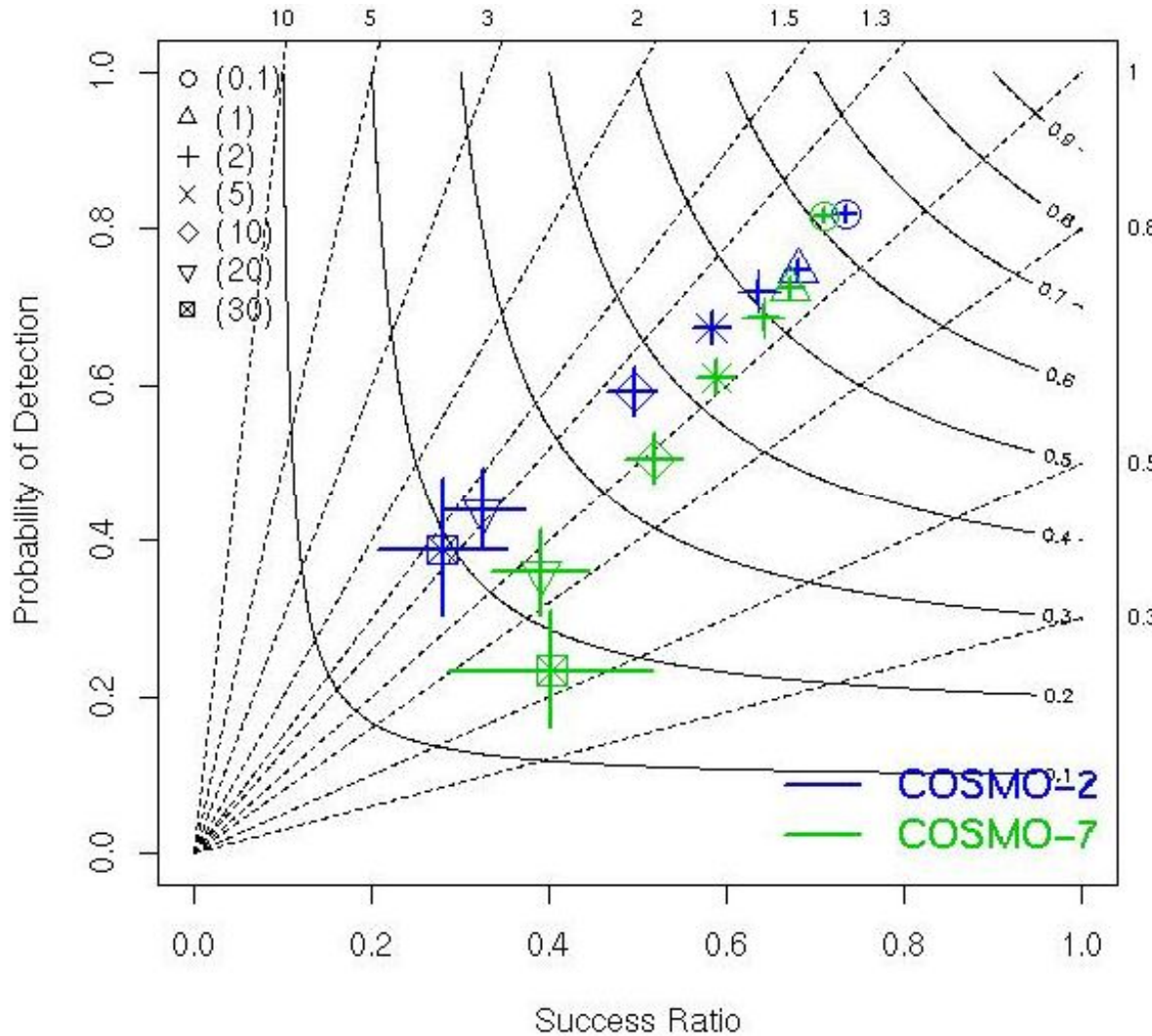
Performance diagram for the swiss stations for 12h accumulated precipitation (+12-+24h)

COSMO-2
COSMO-7

after [Roebber, 2009]



Precipitation: Summer 2011



Performance diagram for the swiss stations for 12h accumulated precipitation (+12-+24h)

COSMO-2
COSMO-7

after [Roebber, 2009]



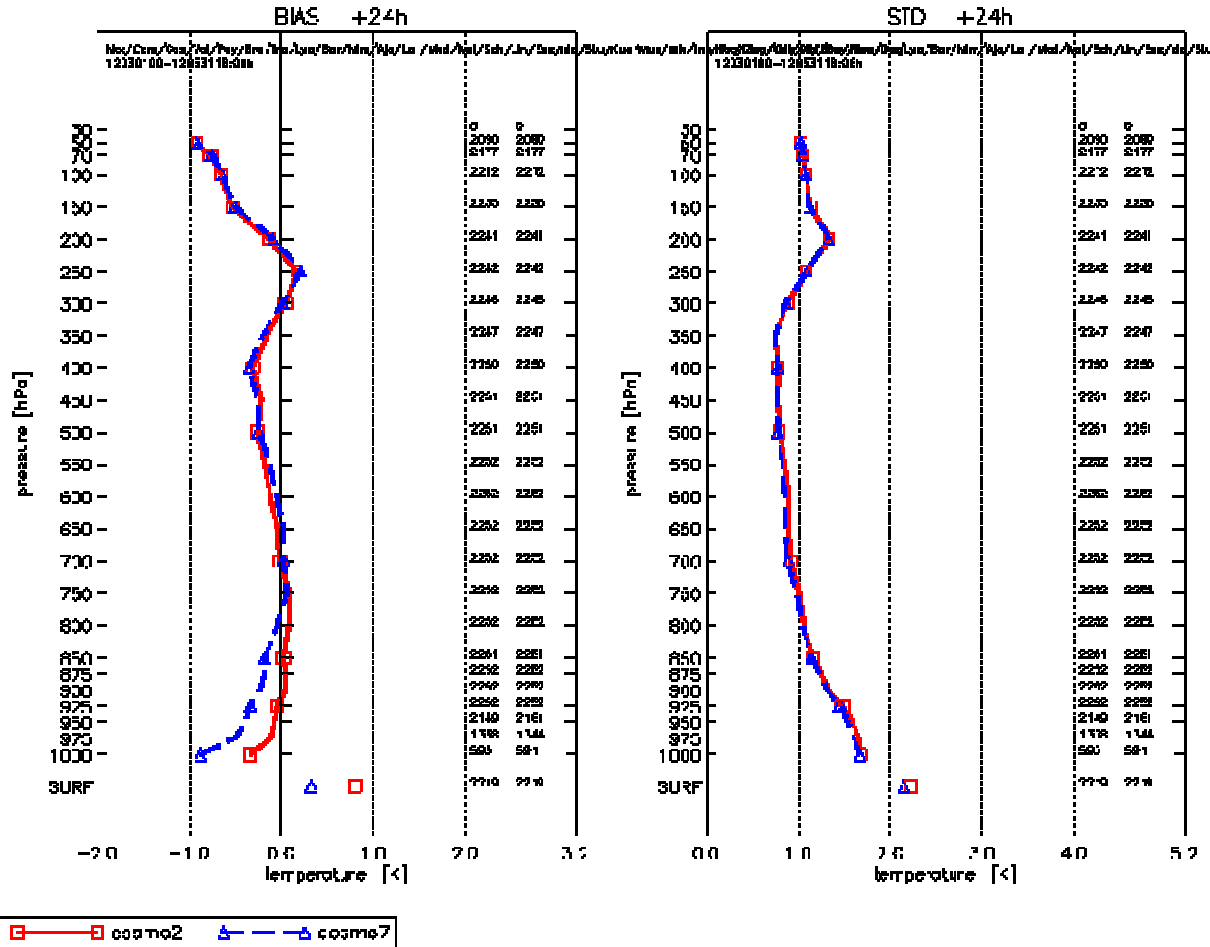
Verification of surface weather parameters

- **2m-temperature:**
 - cold bias in winter and warm bias in summer and autumn
 - positive bias more pronounced during nighttime
 - COSMO-2 ~0.5 K warmer (higher values) than COSMO-7
- **2m-dewpoint:**
 - negative bias (~1 K) especially in the summer and autumn period, more pronounced during the night
- **10m-windspeed:**
 - negative bias along the coast and on mountains, positive bias inland
- **total cloudiness:**
 - mean daily cycle not well represented (mainly overestimation during night and underestimation during day)
- **precipitation:**
 - higher amounts in COSMO-2 / higher amounts over Alpine area
 - low amounts (0.1 mm/12h): overestimated, more pronounced in COSMO-7



TEMPS verification: temperature +24h Spring 2012

JA verification: COSMO-2 vs. COSMO-7 operational set for Mar/Apr/May 2012 (yyyyss = 2012s?)
file included: verif-2-for/cosmo2-0006-cosmo2012s2-tdk-verif-2-for/cosmo2-0006-cosmo7012s2-tdk



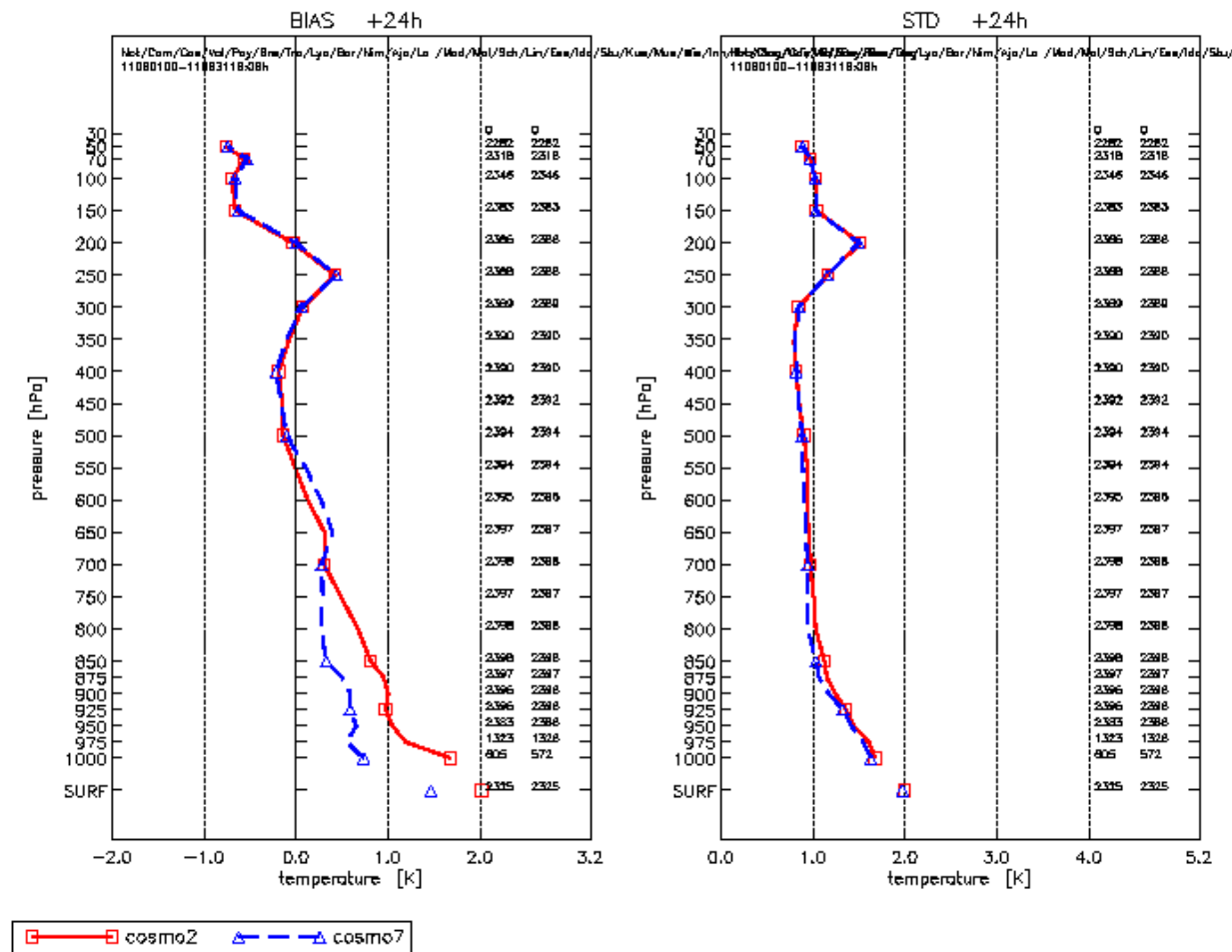
all TEMPs
COSMO-2
domain

— COSMO-7
— COSMO-2



TEMPS verification: temperature +24h Summer 2011

UA verification: COSMO-2 vs. COSMO-7 operational set for Jun/Jul/Aug 2011 (yyyyss = 2011s3)



all TEMPs
COSMO-2
domain

— COSMO-7
— COSMO-2



Verification with vertical profiles: main results

- temperature: cold bias (~ 0.5 K) in winter and warm bias (~ 0.5 K) in summer from ground to 600 hPa
- windspeed: positive bias in PBL (up to $+1.5$ m/s) and slight negative bias above 400 hPa

