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Verification of precipitation forecasts of the MAP D-PHASE data set with fuzzy methods

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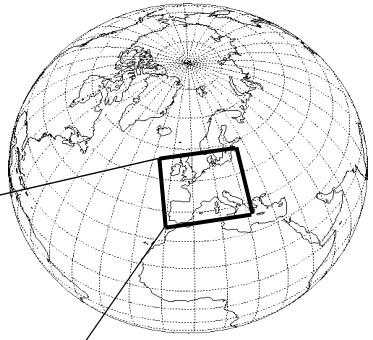
MAP D-PHASE

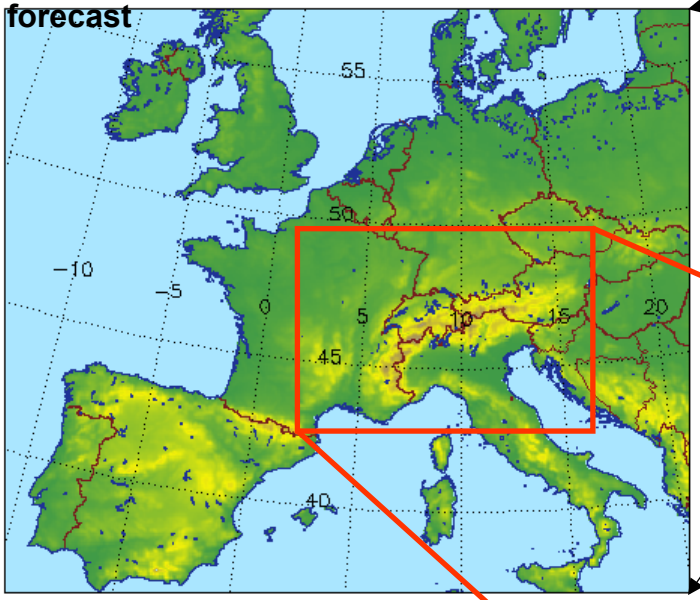
- Forecast Demonstration Project for MAP (Mesoscale Alpine Programme, WWRP RDP, 1999)
- 2nd WWRP Forecast Demonstration Project (FDP)
- Focus on heavy precipitation and flood forecasting
- **D-PHASE: *Demonstration of Probabilistic Hydrological and Atmospheric Simulation of flood Events in the Alpine region***
- D-PHASE Operations Period (DOP):
  June to November 2007 (COPS & “MAP season”)
- 9 countries involved
- 30 atmospheric models / 7 hydrological models in over 40 catchments

The NWP system COSMO at MeteoSwiss

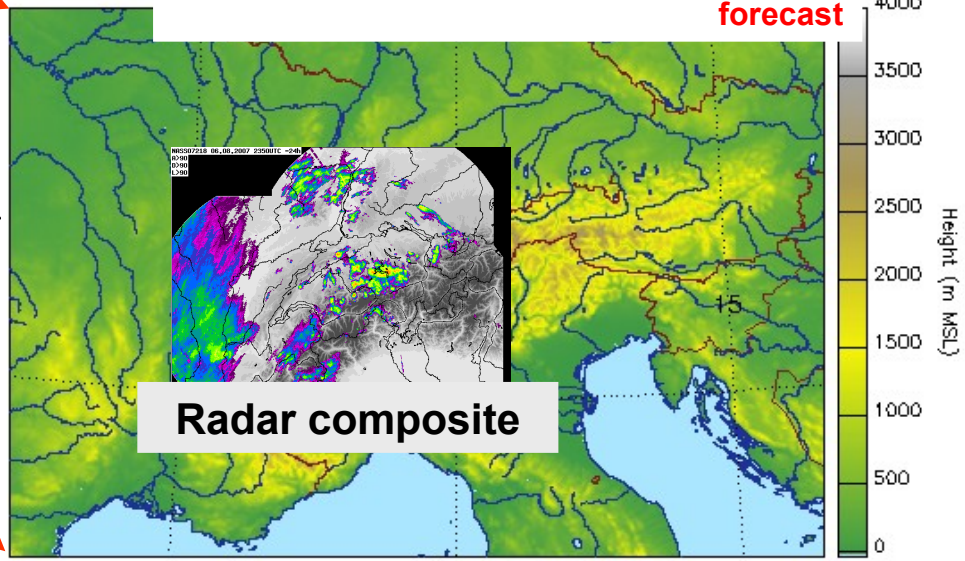


IFS / ECMWF
25km mesh size
synoptic scale

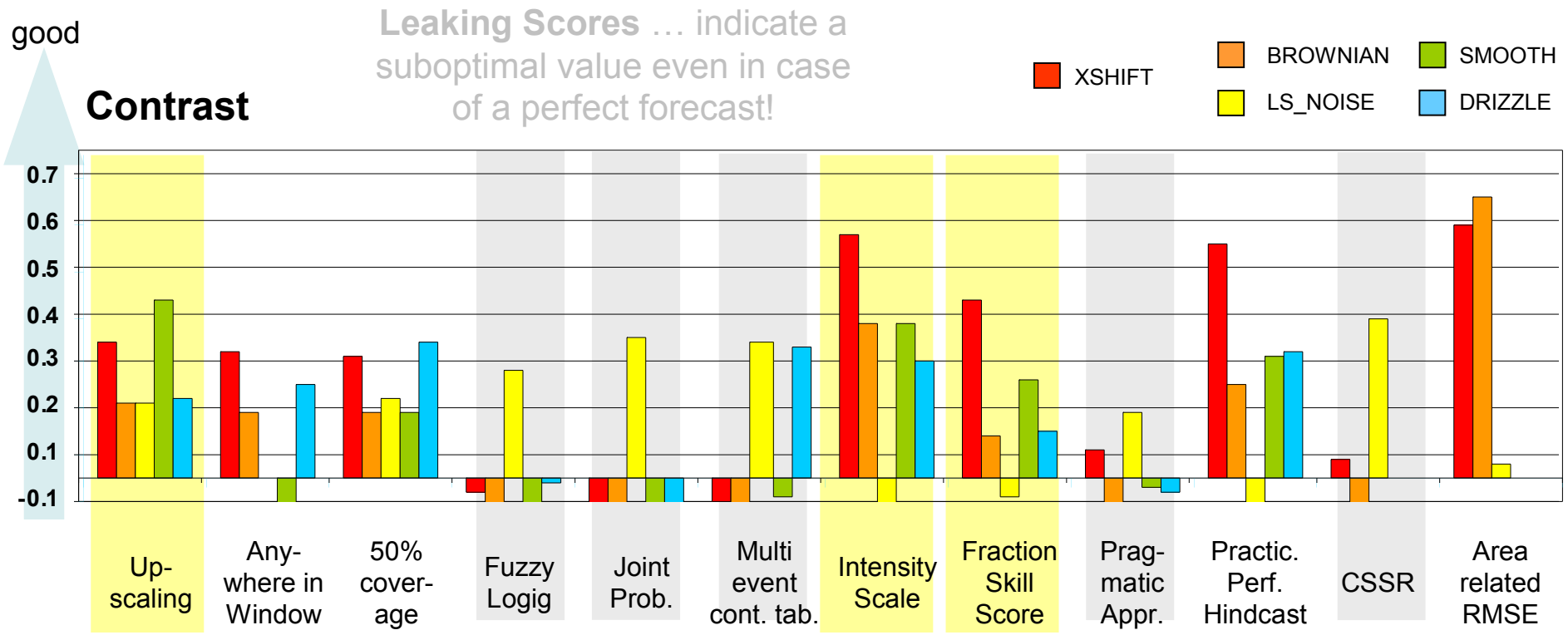
COSMO-7: 6.6 km mesh size, 60 levels own assimilation cycle, 2 daily 72h forecast



COSMO-2: 2.2 km mesh size, 60 levels own assimilation cycle, 8 daily 24h forecast



Fuzzy Verification: choice of the methods



→ **Fractions Skill Score (FSS): shows good results, is widely used**

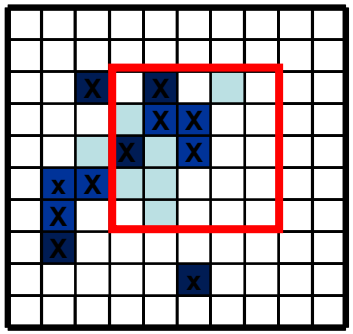
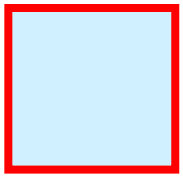
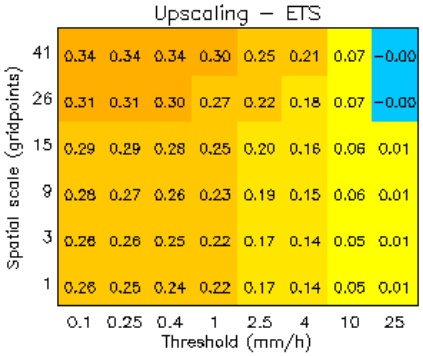
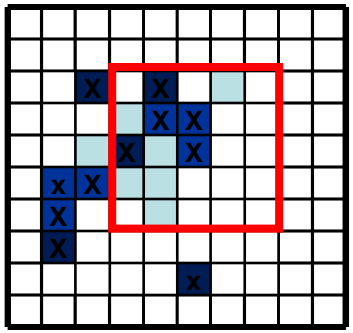
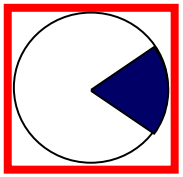
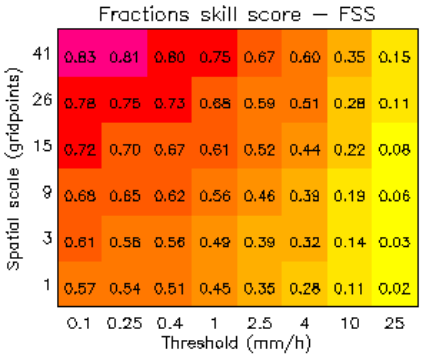
→ **Upscaling (UP): is sensitive to large-scale sample errors**

→ **Intensity scale (IS): promising method – fast and able to detect the scales of spatially errors**

T. Bähler and F. Ament

Fuzzy Verification: choice of the methods (2)

Verification on coarser scales than model scale:
“Do not require a point wise match!“

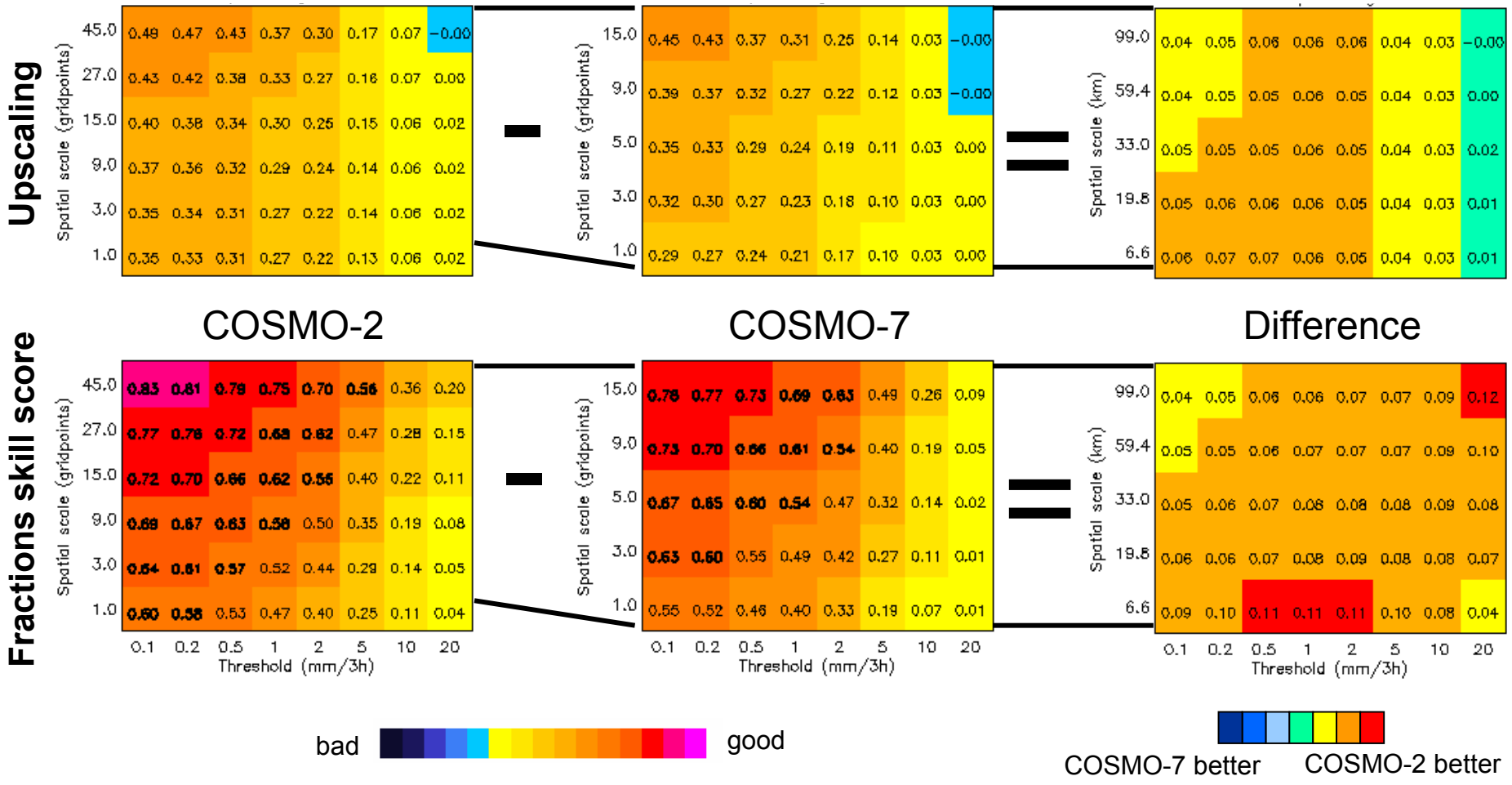
Method	Raw Data	Fuzzyfication	Score	Example result
Upscaling		Average 	Equitable threat score ETS	
Fractions Skill Score (Roberts and Lean, 2005)		Fractional coverage 	Skill score with reference to worst forecast FSS	

Settings for the fuzzy verification for the D-PHASE period: June – November 2007

- **MODEL**: COSMO-2 (2.2km), COSMO-7 (6.6km)
  - 3h accumulations
    - COSMO-2: 8 fcst/day each with 3h-sums from +3 to +6h
    - COSMO-7: 2 fcst/day with four 3h-sums (+3..+6, +6..+9, +9..+12, and +12..+15h)
  - 24h accumulations
    - COSMO-2: 00 UTC runs with 24h-sums from +0 to +24h
    - COSMO-7: 00 UTC runs with 24h-sums from +0 to +24h
- **OBSERVATIONS**: Swiss Radar Composite over Switzerland (3 radars)
- **METHODS**: Upscaling and Fractions Skill Score with bootstrapping

Upscaling and Fractions Skill Score

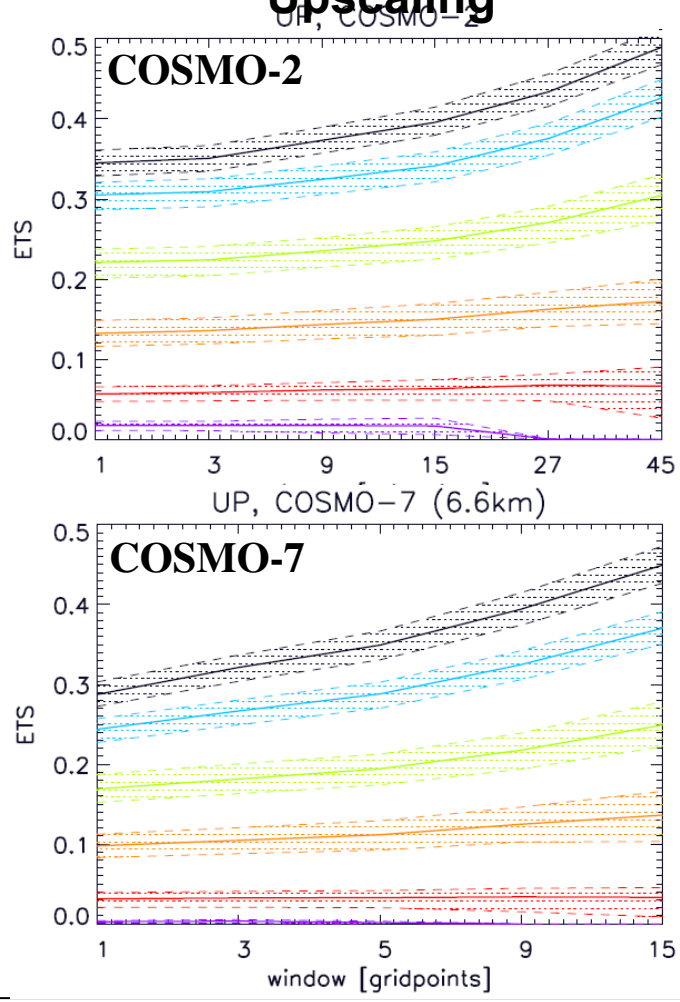
3 hourly accumulations



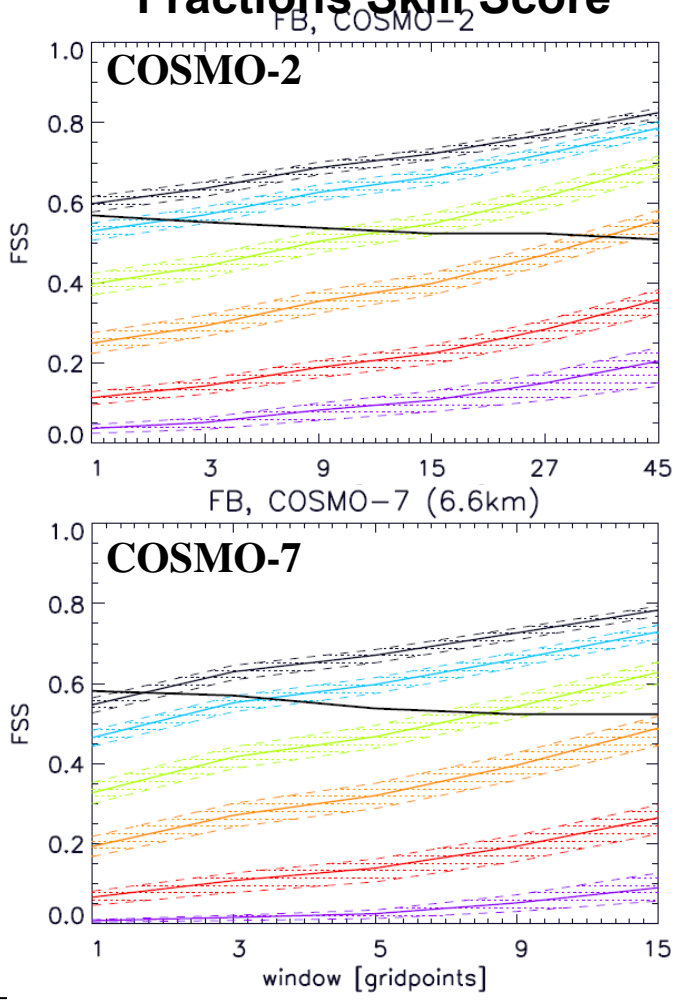
Bootstrapping (nboot =100, [q95–q05] confidence interval)

3 hourly accumulations

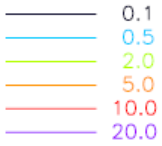
Upscaling



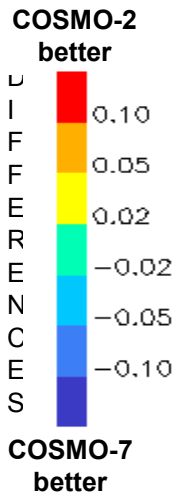
Fractions Skill Score



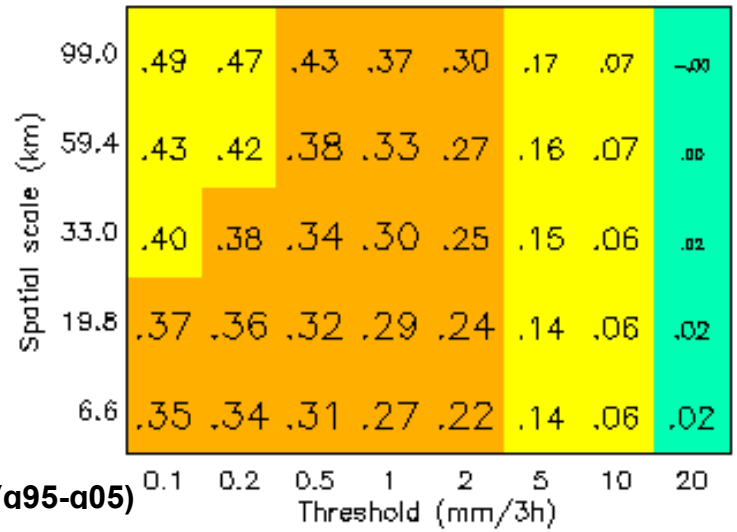
threshold [mm/3h]



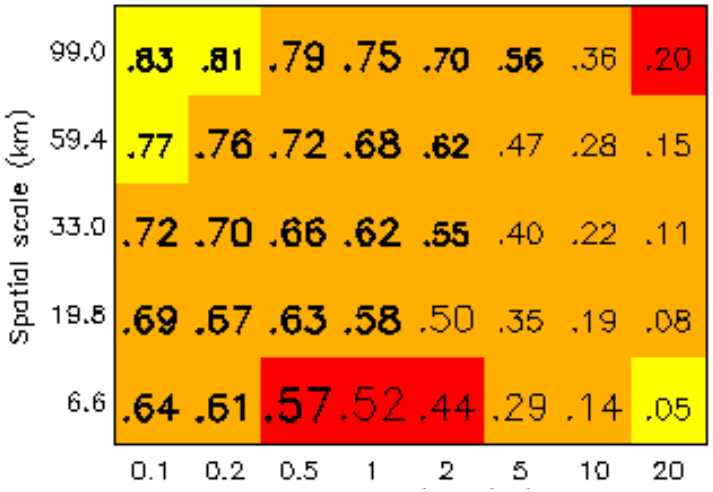
Bootstrapping 3 hourly accumulations
COSMO-2 [values] ; COSMO-2 - COSMO-7 [colors]



Upscaling



Fractions Skill Score



abs(median) / 0.5(q95-q05)

[10 , Inf] .50

[5 , 10 [.50

[2 , 5 [.50

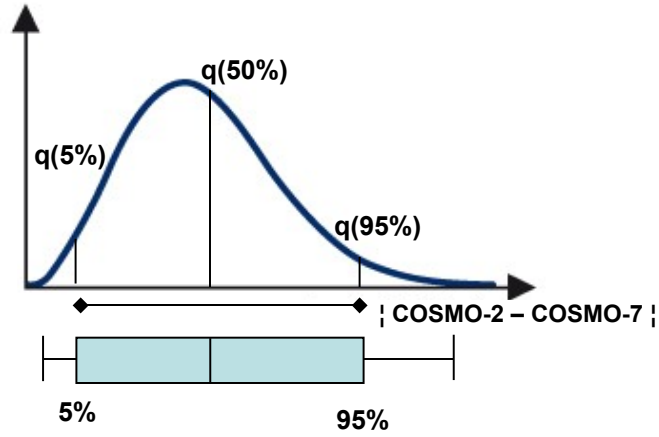
[1 , 2 [.50

[0 , 1 [.50

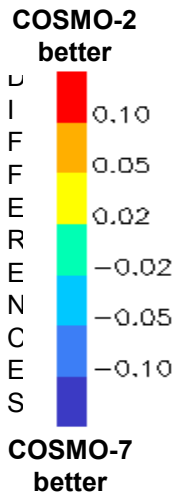
Size of numbers =

abs(Median) / 0.5(q95-q05)

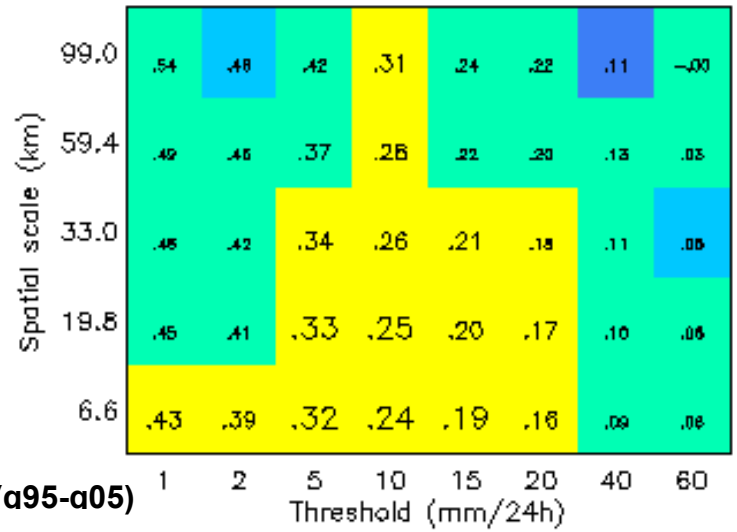
→ measure for significance of differences



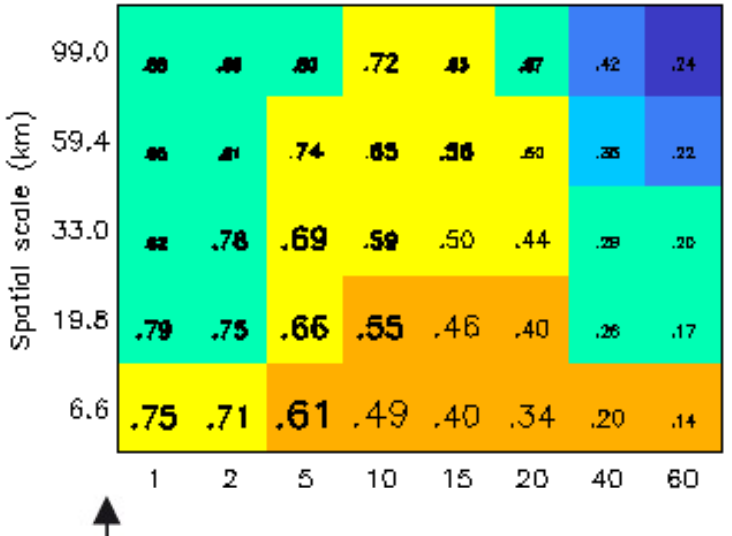
Bootstrapping 24 hourly accumulations
COSMO-2 [values] ; COSMO-2 - COSMO-7 [colors]



Upscaling



Fractions Skill Score



abs(median) / 0.5(q95-q05)

[10 , Inf] .50

[5 , 10 [.50

[2 , 5 [.50

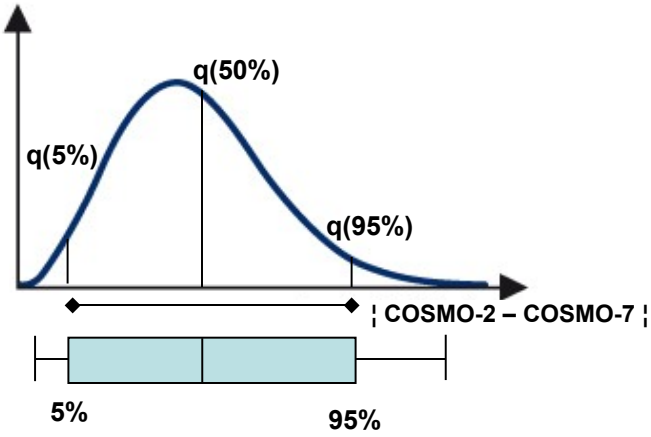
[1 , 2 [.50

[0 , 1 [.50

Size of numbers =

abs(Median) / 0.5(q95-q05)

→ measure for significance of differences



Sensitivities

… model run

- using 00 and 12 UTC runs for both models (instead of 00,03,06,… for COSMO-2 and 00,12 for COSMO-7)
  - → higher update frequency of the COSMO-2 model has a **small impact** on the results: the differences between the models stay the same

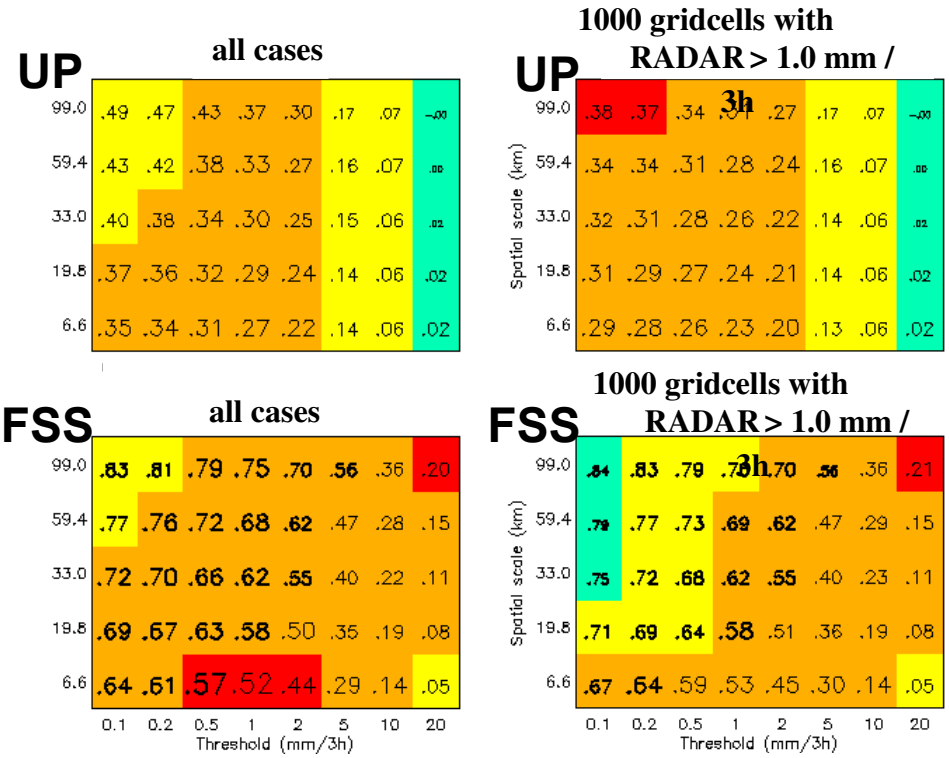
… rain amount

- rainy cases = cases with at least 1000 gridpoints with R_{obs} > 1.0mm / 3h

→ similar changes in skill for both models, mainly for low thresholds and large windows:

Upscaling (UP): decrease in skill
larger for COSMO-7
→ more pronounced differences

Fractions Skill Score (FSS): increase in skill
stronger for COSMO-7
→ differences become smaller

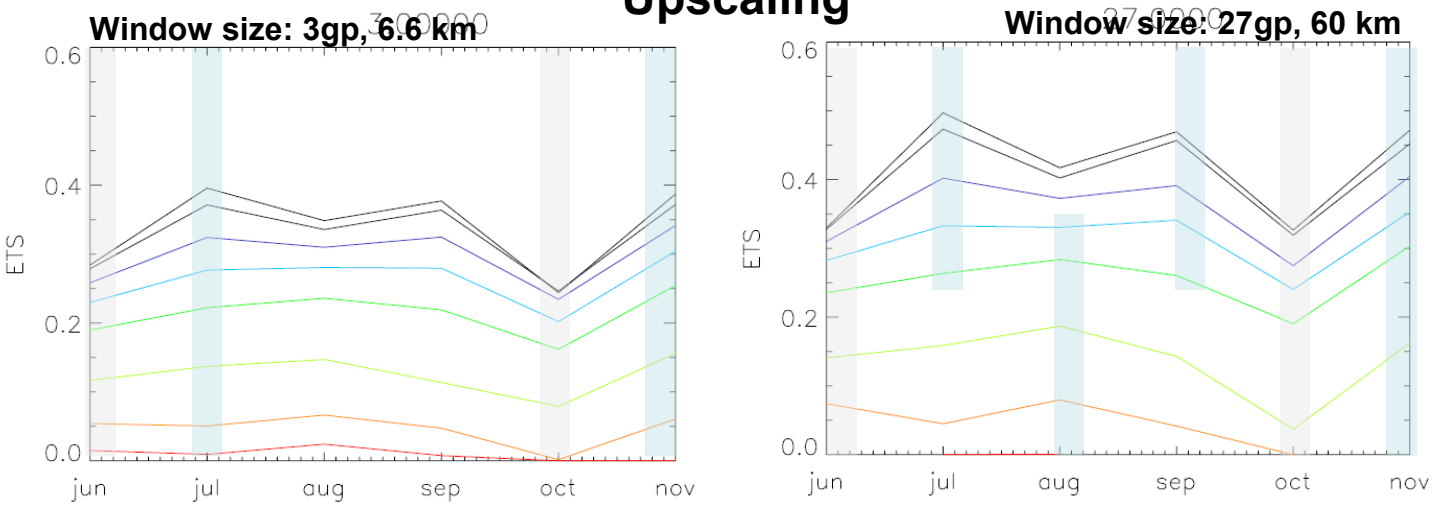


- 0.10 COSMO-7 better — **0.10** COSMO-2 better

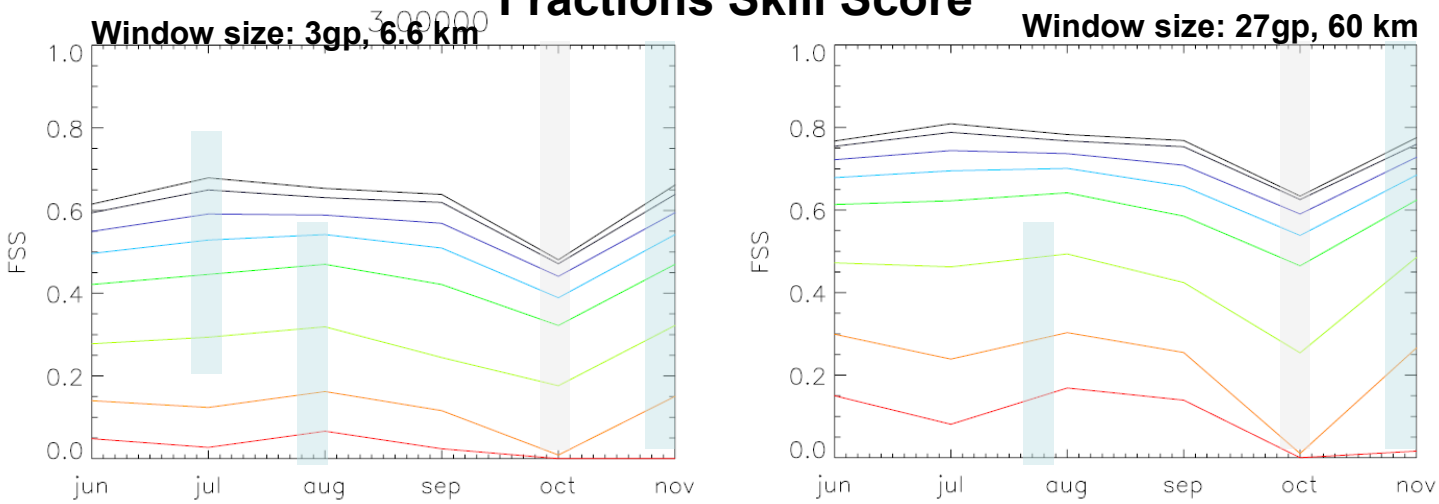
Monthly values for COSMO-2

3 hourly accumulations

Upscaling



Fractions Skill Score

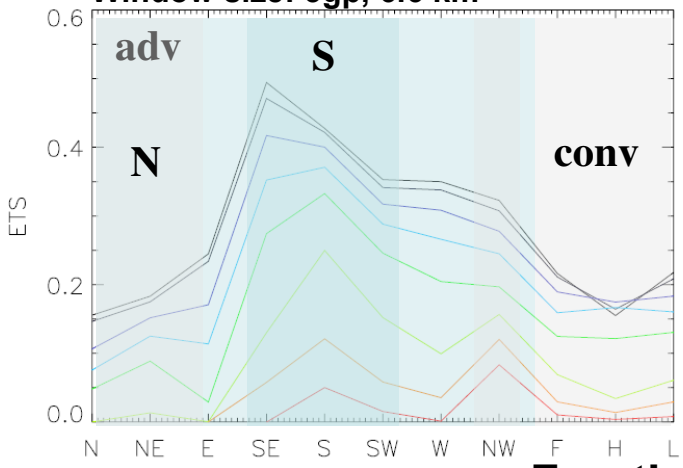


Weather type verification (11 classes): COSMO-2

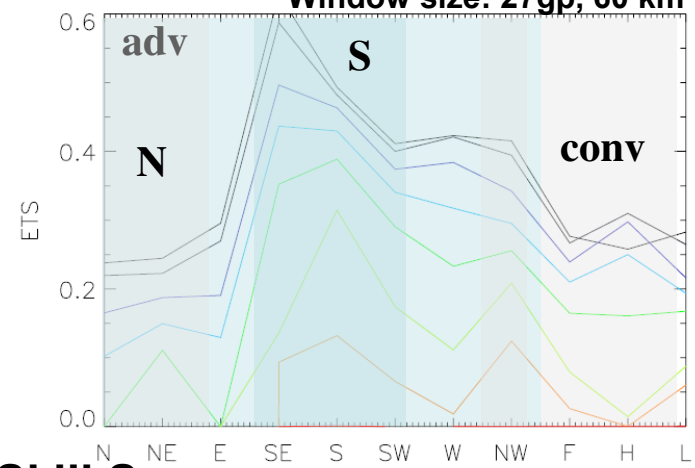
3 hourly accumulations

Upscaling

Window size: 3gp, 6.6 km

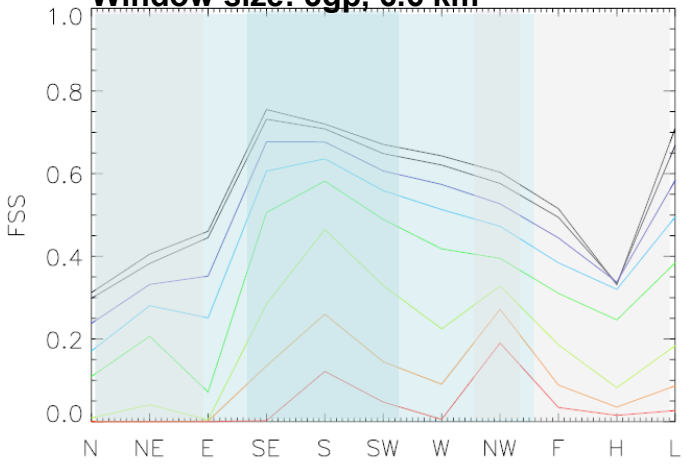


Window size: 27gp, 60 km

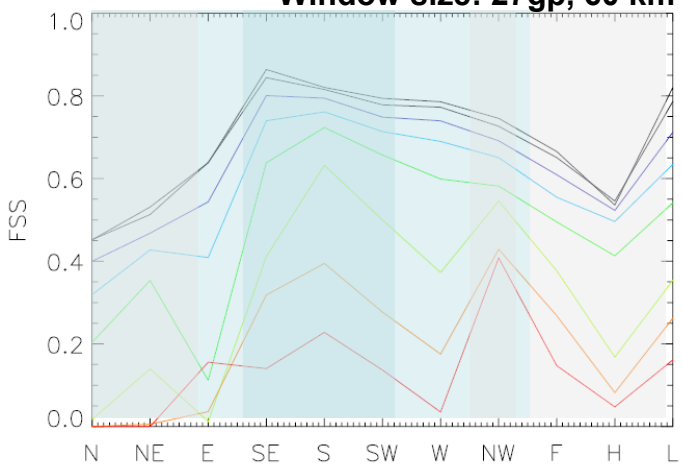


Fractions Skill Score

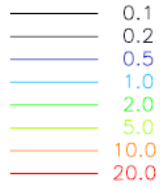
Window size: 3gp, 6.6 km



Window size: 27gp, 60 km

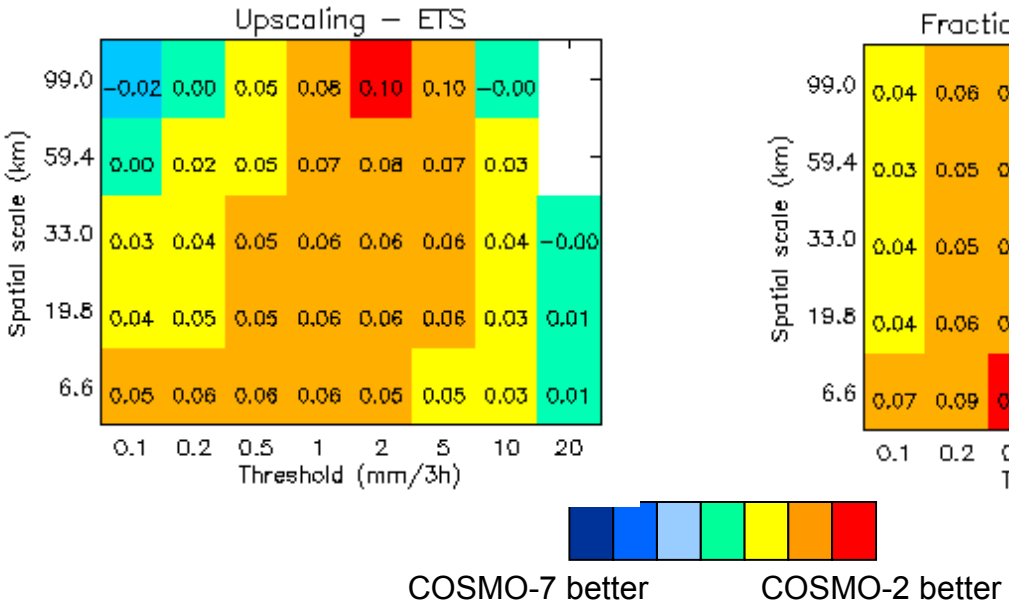


Threshold [mm/3h]



# cases	4	7	5	5	7	45	31	23	15	34	7

Weather type verification: Flat situations (15 cases) COSMO-2 – COSMO-7 for 3 hourly accumulations



- COSMO-2 has a clearly better skill (FSS) for large thresholds and large catchments
- airmass convection apparently quite well represented in COSMO-2

Summary fuzzy verification (precipitation)
for the D-PHASE period (June – November 2007)

- for **3 h accumulations:**
  COSMO-2 has better skill on nearly all scales

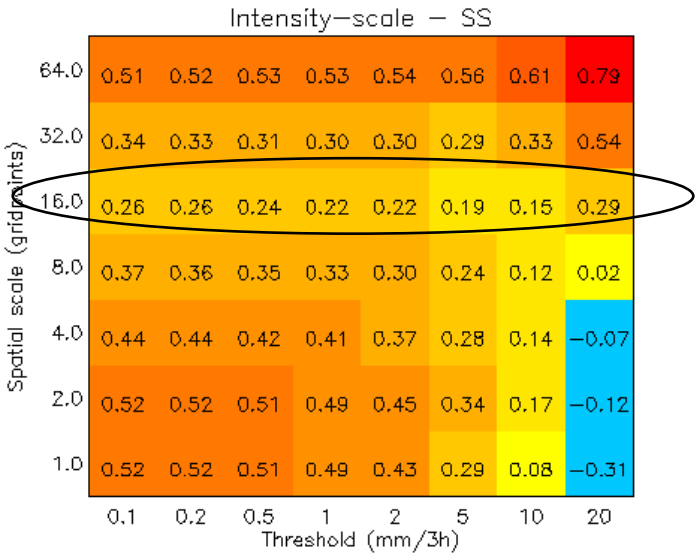
- the results are **robust** and the differences between the models are **significant on most scales**

- the **conditional verification** reveals differences between the weather types, skill relatively good for advective cases and southerly wind

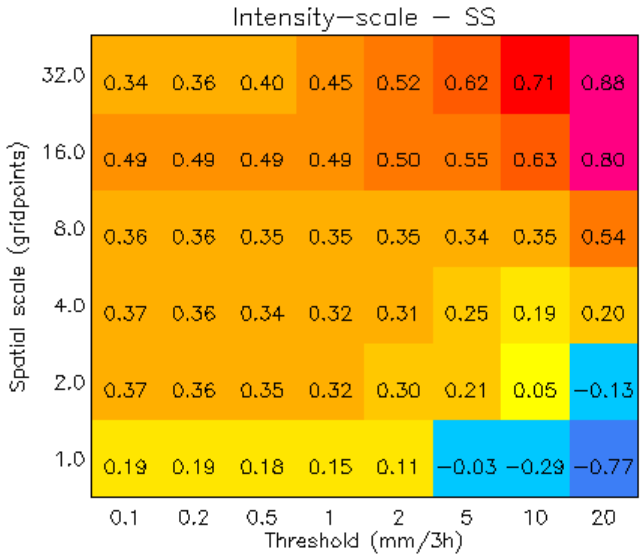
Intensity Scale

3 hourly accumulations

COSMO-2



COSMO-7



In COSMO-2 it seems to be a shift of about 16 gridpoints (?)

Outlook fuzzy verification at MeteoSwiss

- Precipitation with the Swiss Radar Composite over Switzerland
  - Operational implementation for COSMO-2 and COSMO-7 in Autumn 2009 for:
    - Upscaling (with the scores: ETS and also FBI,FAR, POD)
    - Fractions Skill Score
    - Intensity Scale
  - Fuzzy verification with time windows
  - SAL(T) approach for river catchment verification
- Extension to other data sources:
  - Precipitation, mixing ratio, Θ , Θ_e, … with VERA (**V**ienna **E**nhanced **R**esolution **A**nalysis) for the D-PHASE/COPS dataset
  - Global radiation and cloudiness with EUMETSAT CM-SAF

Thank you!