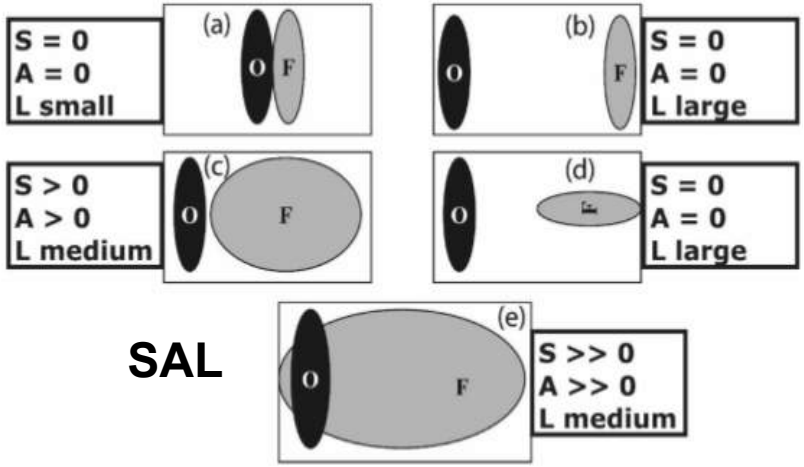
Spatial Verifications vs. Point Verifications Applied to Clouds and Precipitation

Categorical Scores

Contingency Table

		Observed		
Forecast		Yes	No	Total
	Yes	a	b	a+b
	No	c	d	c+d
	Total	a+c	b+d	n



SAL

1.) Motivation

2.) Point Scores

3.) VERA Analyses

4.) SAL Verification

5.) Case Applications

6.) Summary and Conclusions

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UBIMET

Acknowledgements to Heini Wernli (ETH Zurich)

Motivation

Point Scores ←→ Spatial Scores

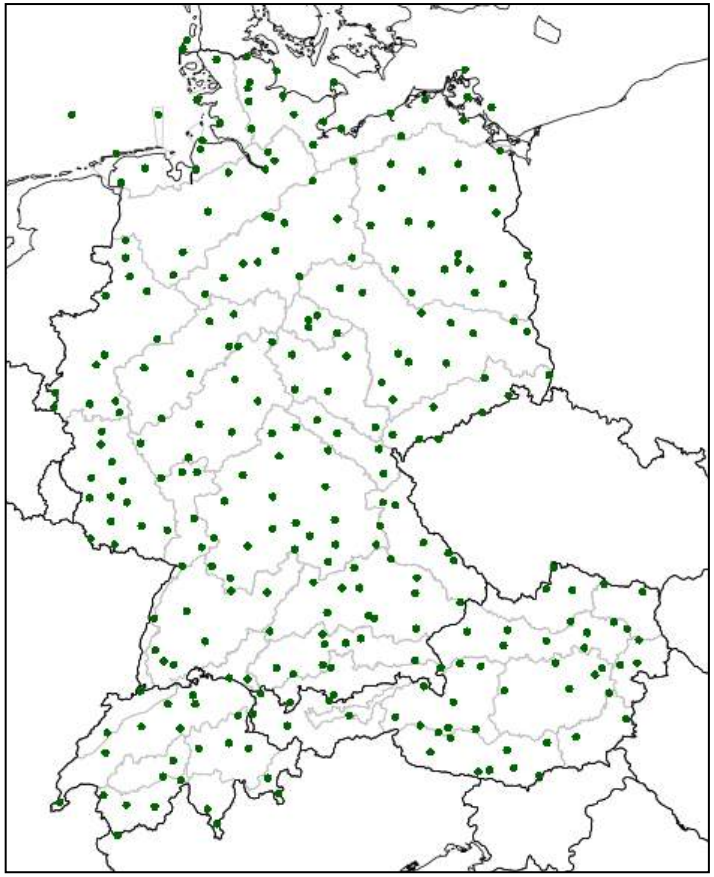
Categorical Scores ←→ SAL-Verification

Goal	Point Scores	SAL
Meaningful **aggregate results**	?	?
Results **representative** of domain	?	?
Scores are **sensitive to forecast attributes**	✔	?
Scores are **proper**	✖	?
Identification of **underlying model errors**	✔	?
Unequivocal **ranking** of forecast models	?	?

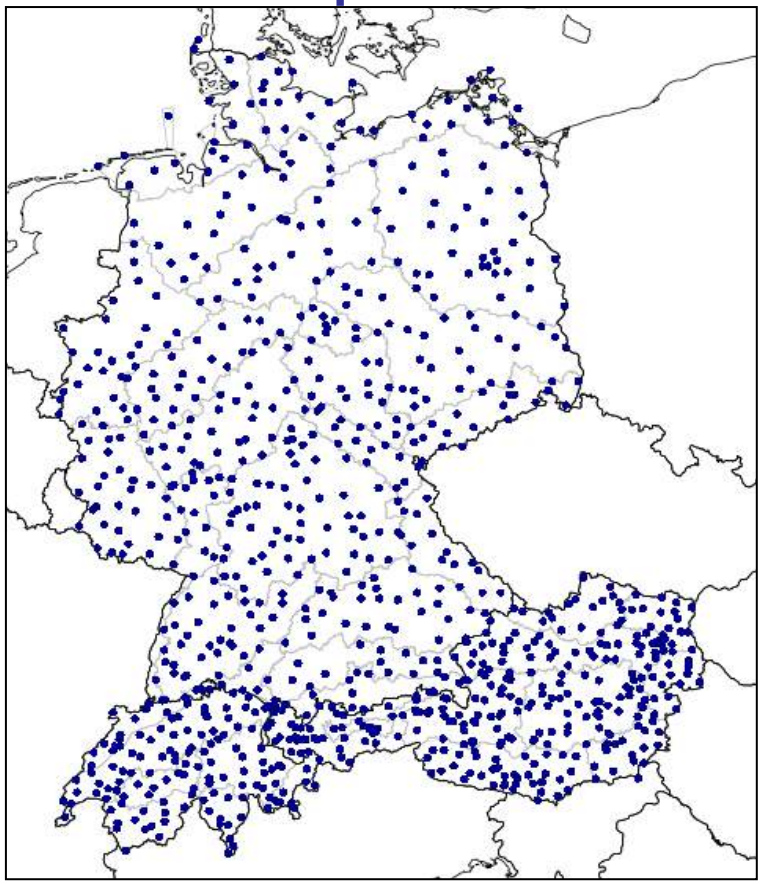
Point Scores

Station Locations

Clouds



Precipitation



a) Verification at each station location (nearest model gridpoint)

b) 0.04°x 0.04° verification grid obtained from VERA analysis

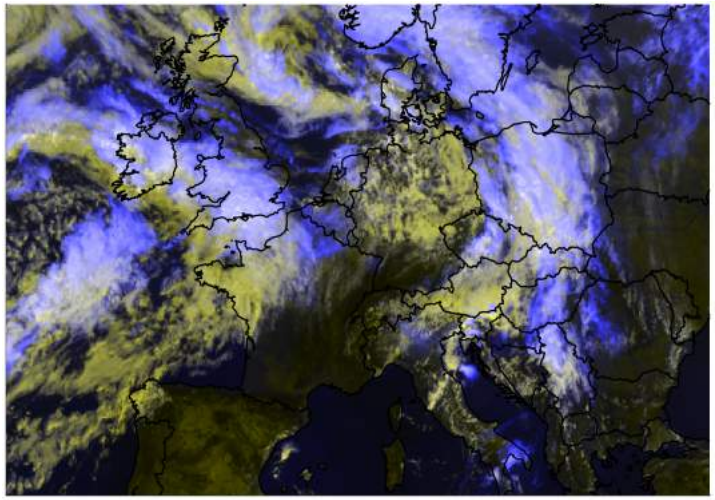
VERA Analyses

Combination of multiple input parameters and data sources

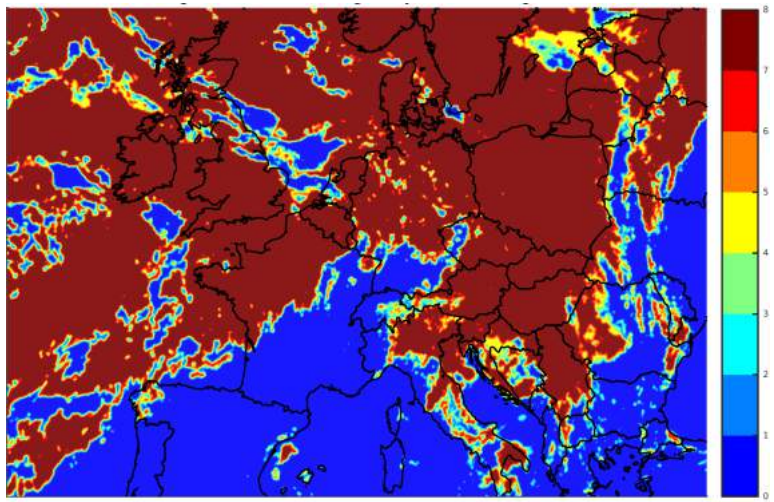
Cloud Cover

- Blending of satellite channels (VIS+IR) with analyzed surface temperature
- Computation of channel differences and comparison with predefined thresholds
- Aggregation of low, medium and high clouds

Yellow: VIS portion, Blue: IR portion



Final cloud product

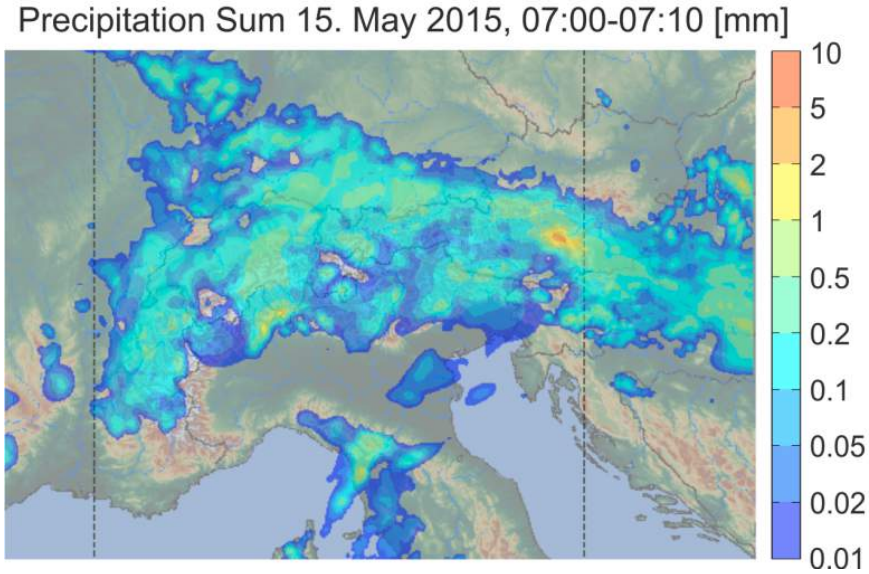


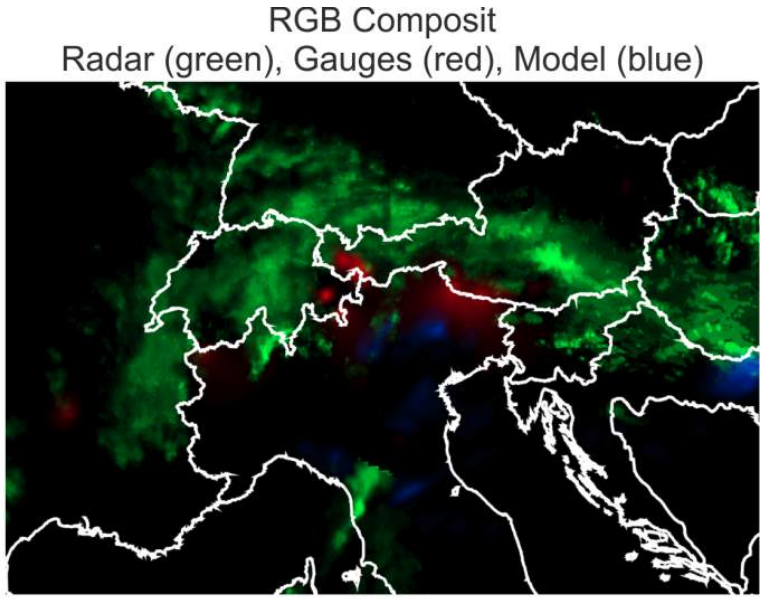
VERA Analyses

Minimization of spatial curvature by thin-plate spline interpolation

Precipitation

- Blending of station reports with RADAR data
- NWP estimates step in over areas without station data
- VERA-type interpolation of quotient between RADAR and station data

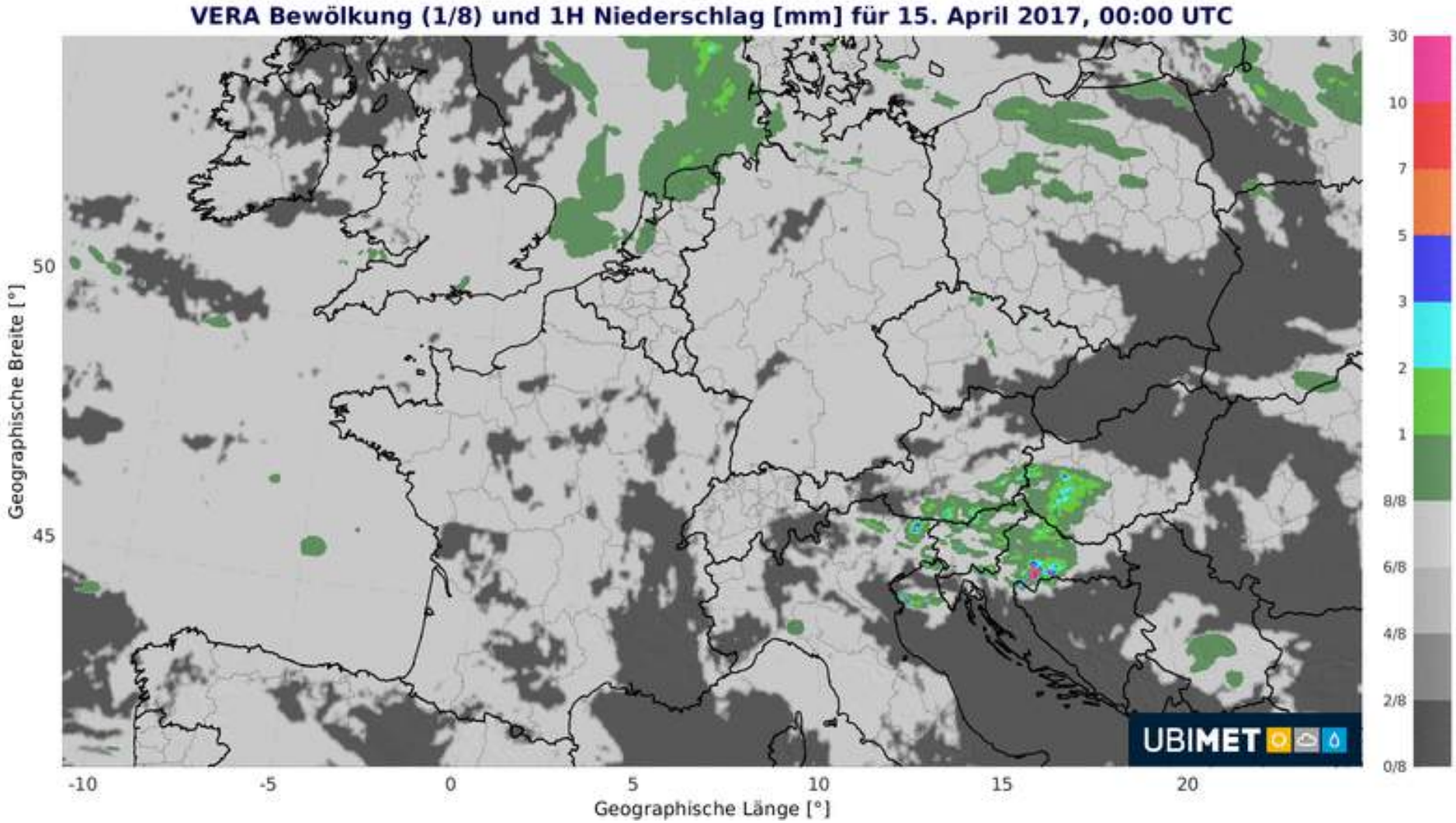




Case Application 1

Two Lows Travelling from the North Sea to the East/Southeast

2017-04-15 00 UTC until 2017-04-20 00 UTC

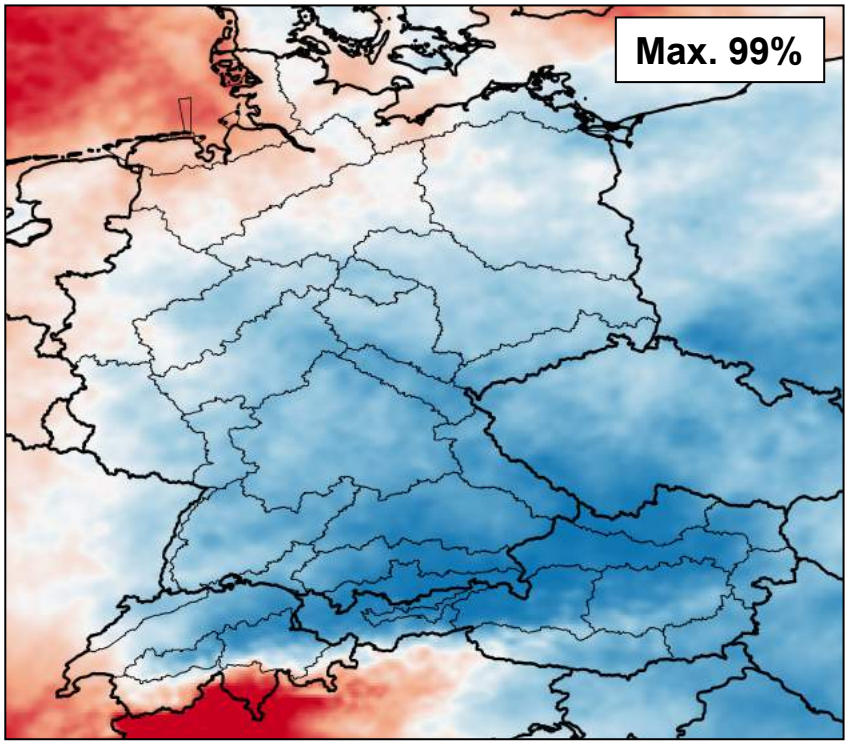


Case Application 1

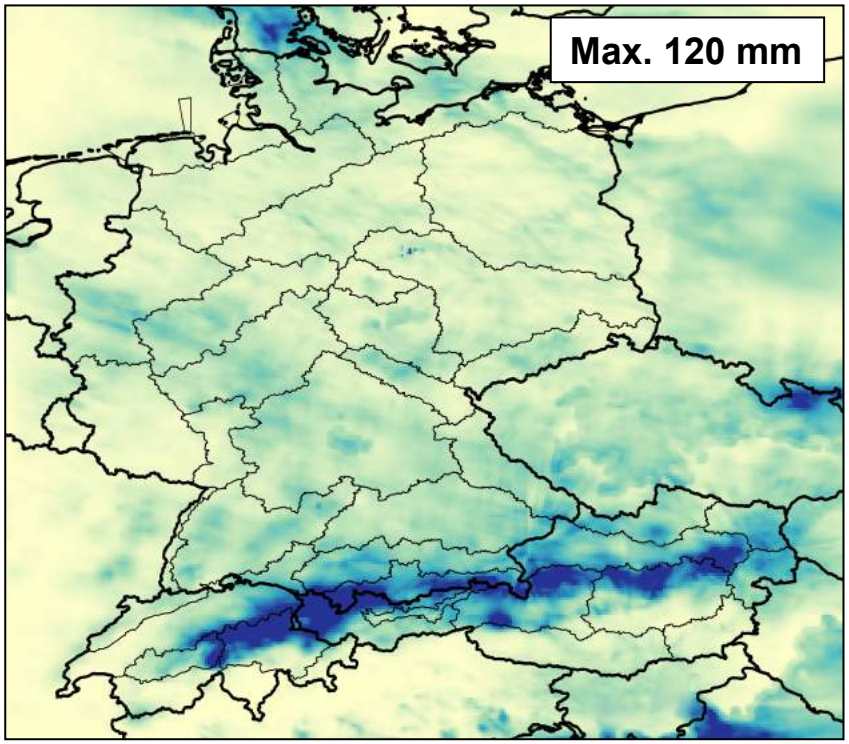
Two Lows Travelling from the North Sea to the East/Southeast

2017-04-15 00 UTC until 2017-04-20 00 UTC

Mean Cloud Cover



Precipitation Sum

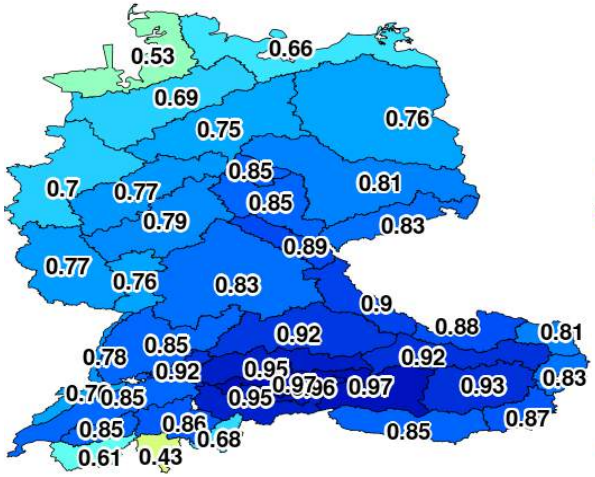


Case Application 1: Cloud Cover

GFS

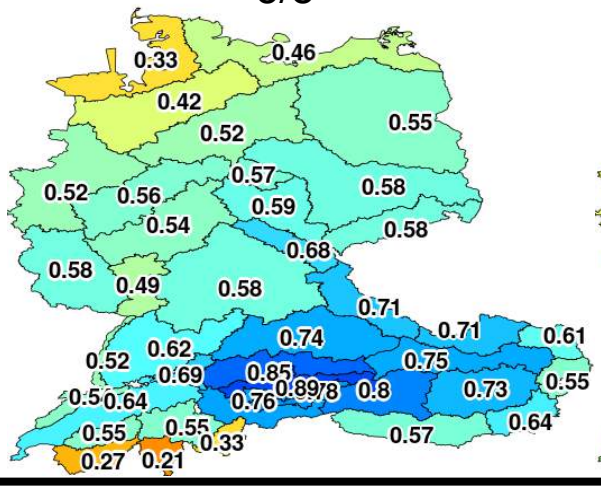
Critical Success Index AVERAGE: 0.81

>= 3/8



Critical Success Index AVERAGE: 0.59

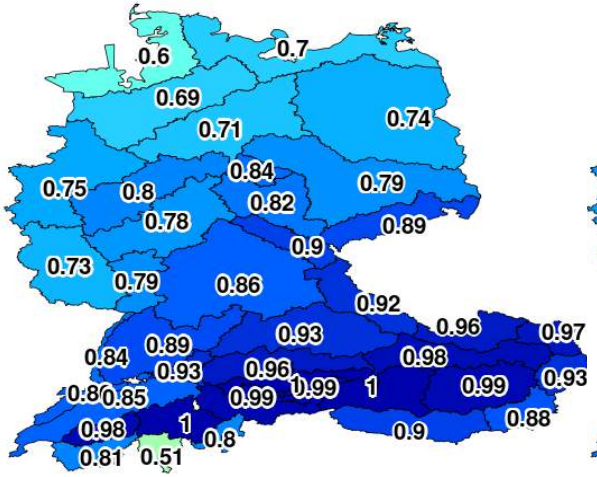
>=5/8



ECMWF

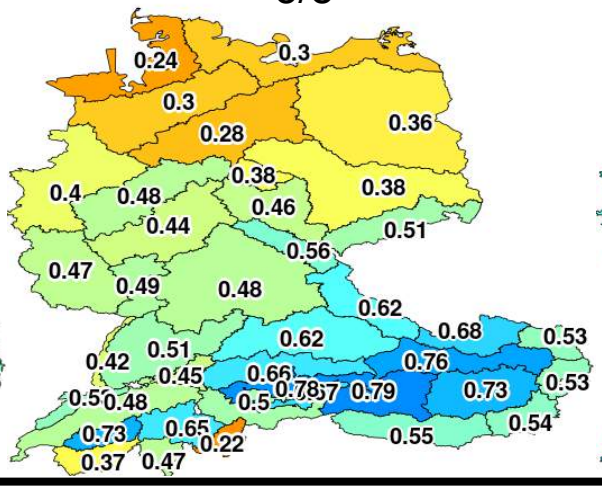
Critical Success Index AVERAGE: 0.86

>=3/8



Critical Success Index AVERAGE: 0.51

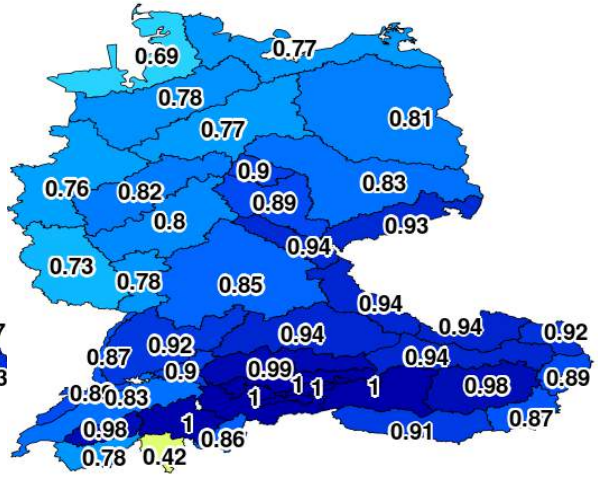
>=5/8



WRF

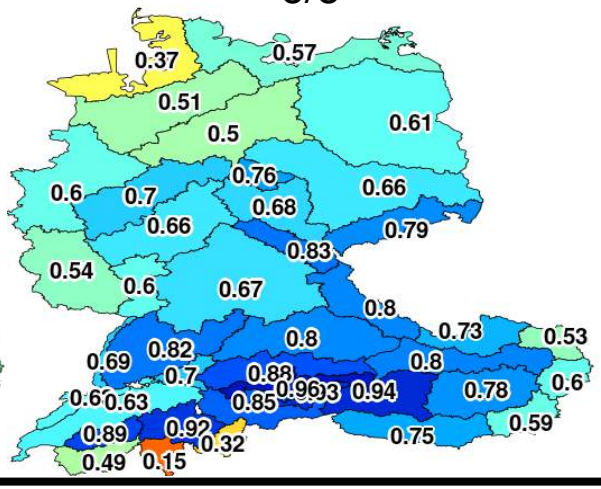
Critical Success Index AVERAGE: 0.87

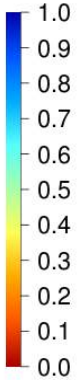
>=3/8

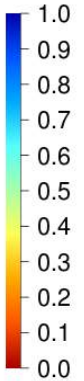


Critical Success Index AVERAGE: 0.68

>=5/8





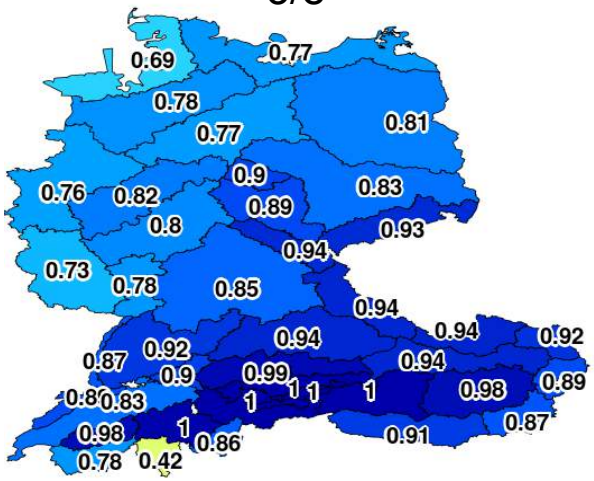


Case Application 1: Cloud Cover

WRF station-based

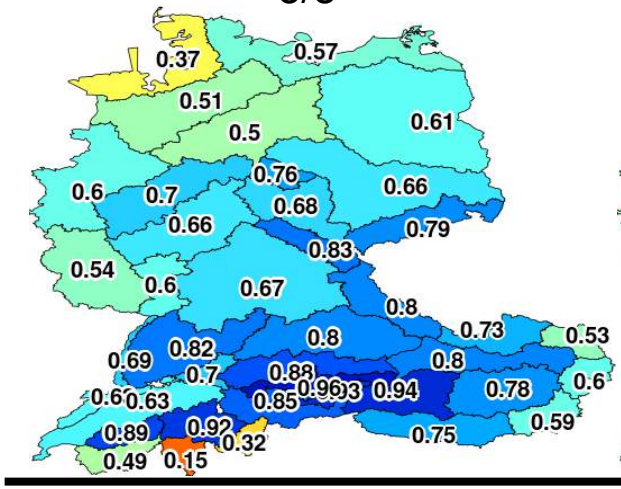
Critical Success Index AVERAGE: 0.87

>= 3/8



Critical Success Index AVERAGE: 0.68

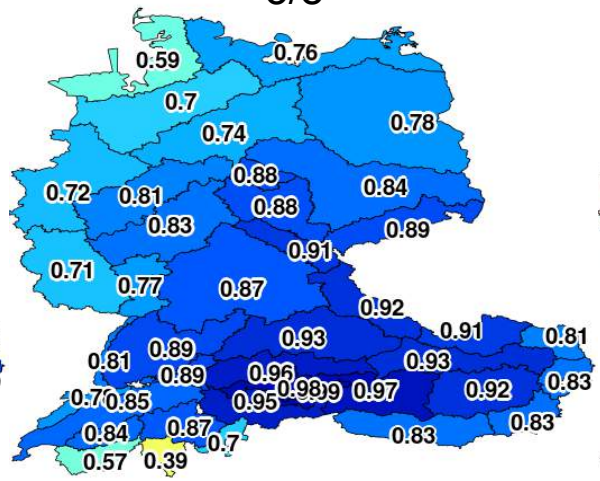
>=5/8



WRF grid-based

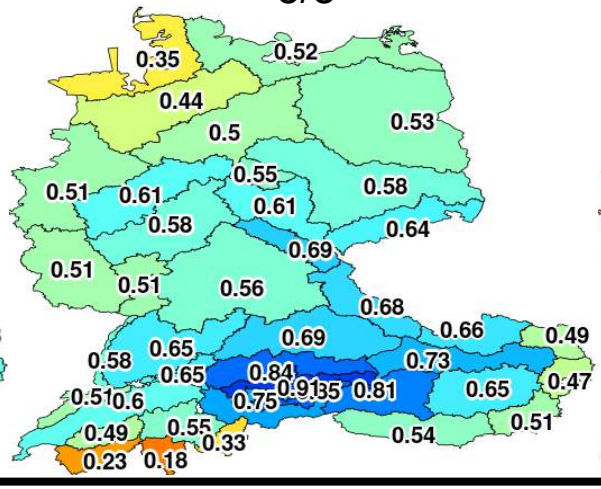
Critical Success Index AVERAGE: 0.83

>=3/8



Critical Success Index AVERAGE: 0.58

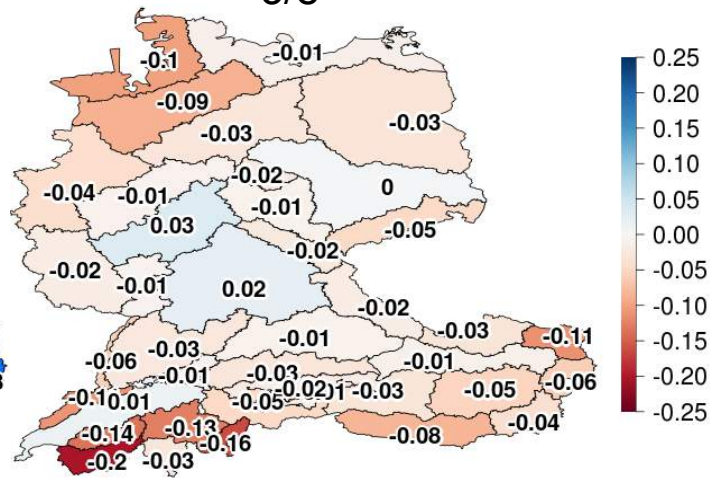
>=5/8



Difference

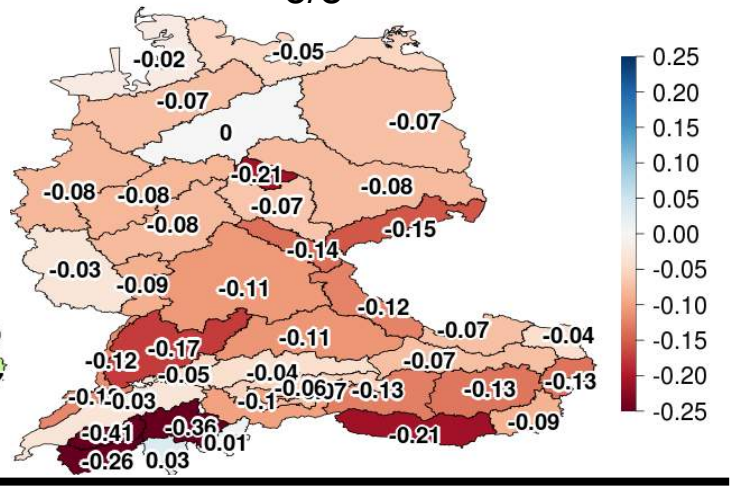
Diff. in Critical Success Index AVERAGE: -0.04

>=3/8



Diff. in Critical Success Index AVERAGE: -0.1

>=5/8

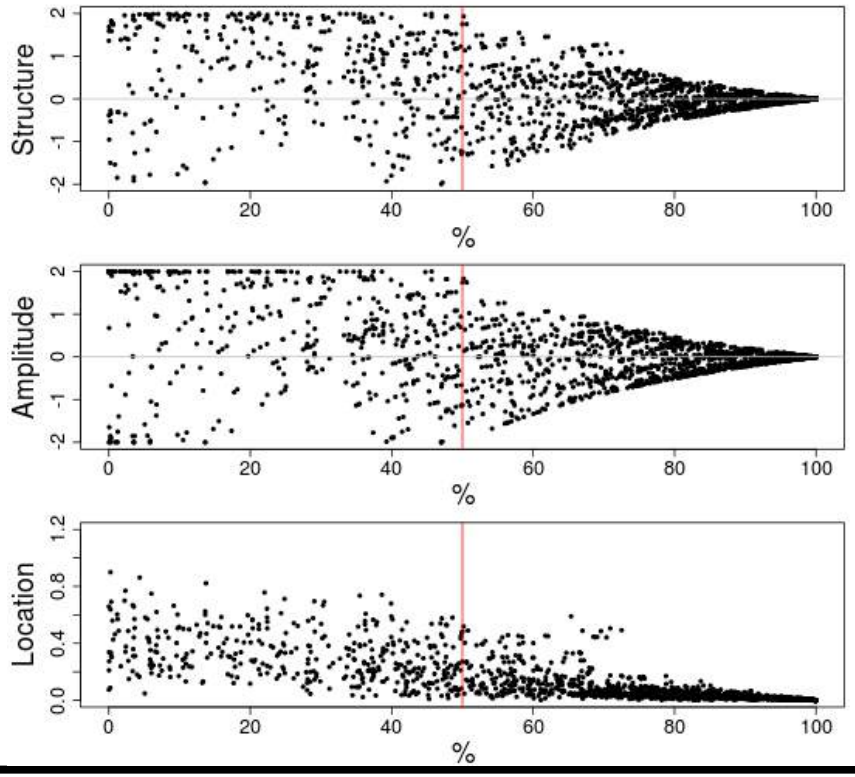


SAL Verification

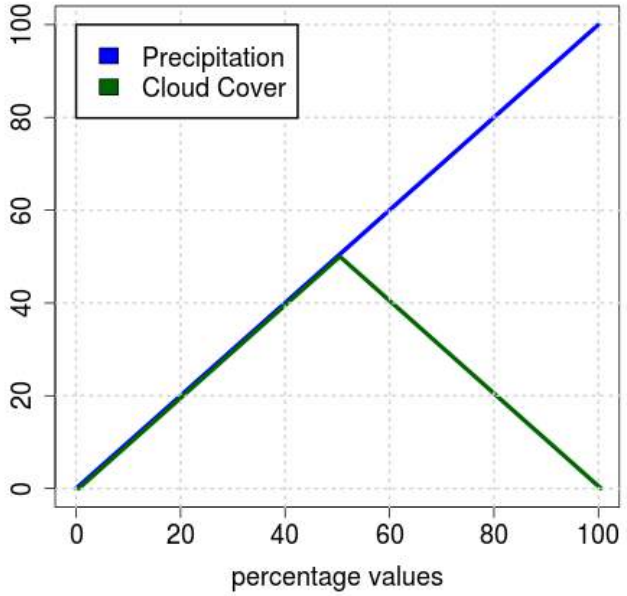
- **Object-based verification over predefined domain**
- Split of total error into components:
  - **Structure** (object too small / large or too peaked / flat)
  - **Amplitude** (rain volume too low / high)
  - **Location** (displacement in object locations)

0.04° x 0.04°
Verification Grid

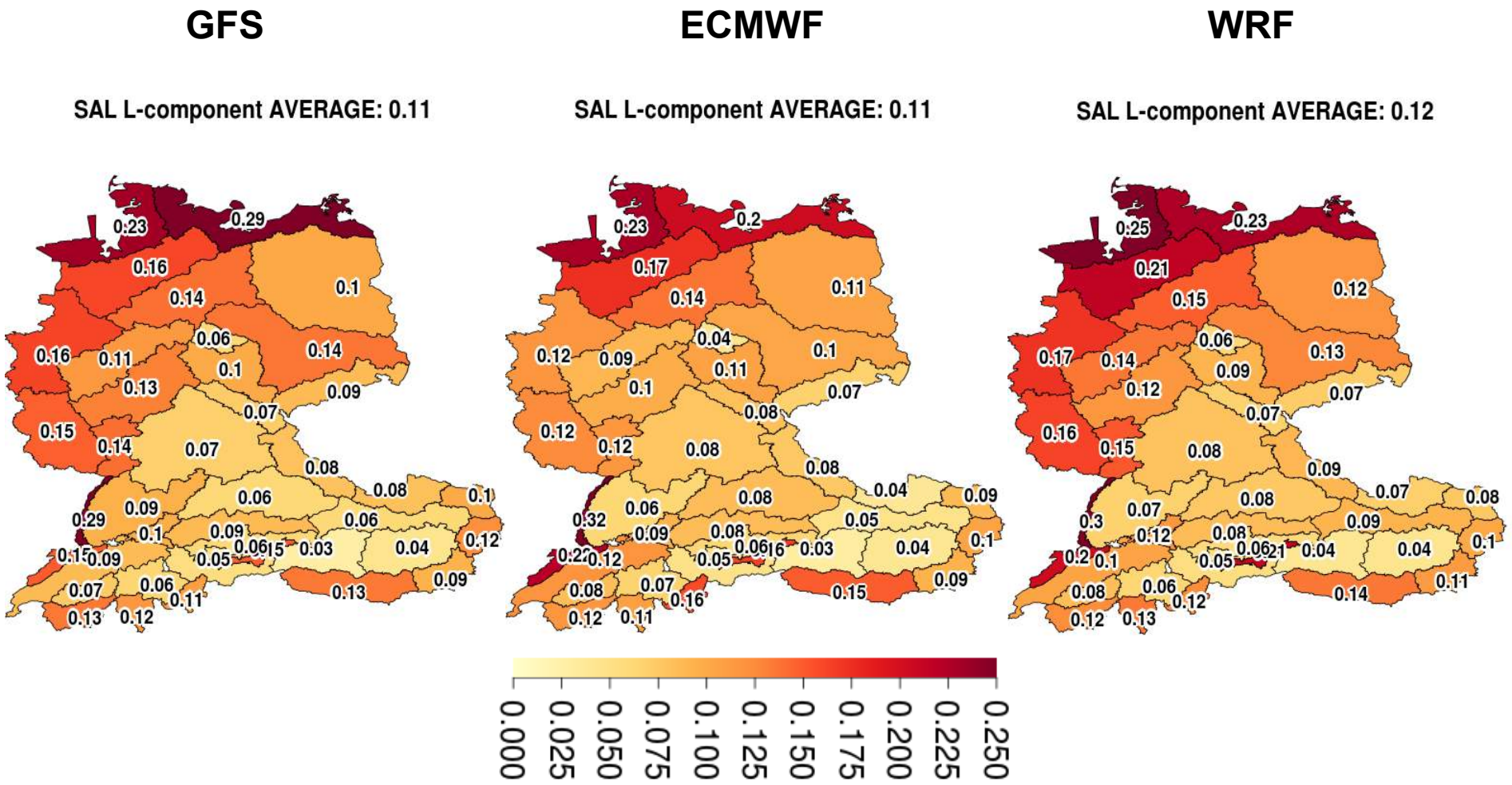
Typical SAL values for clouds



Weighted aggregation with intensity threshold: (fcst.+vera)/2

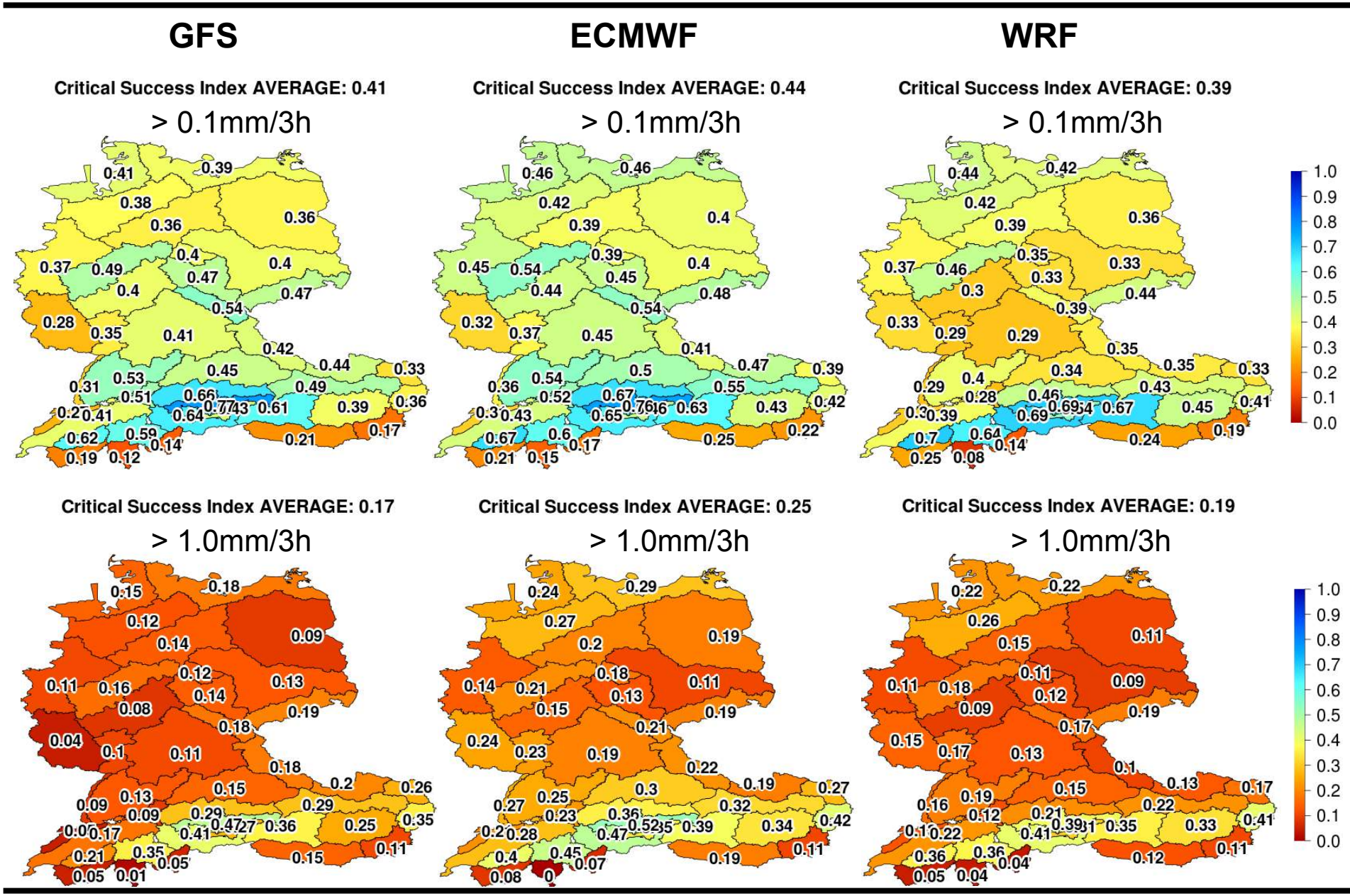


Case Application 1: Cloud Cover



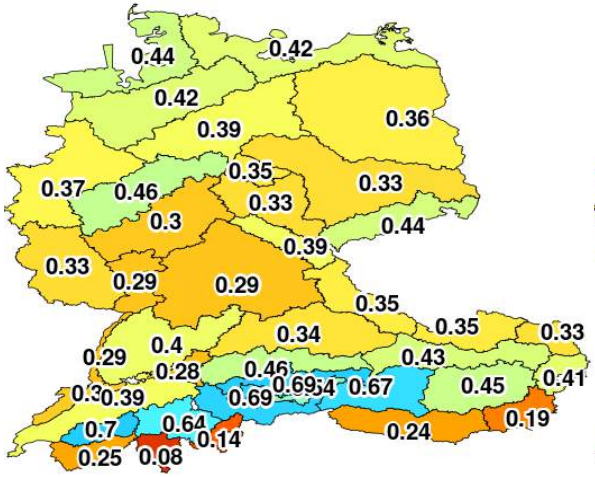
(Object locations match) **0 < L < 2** (Object locations totally displaced)

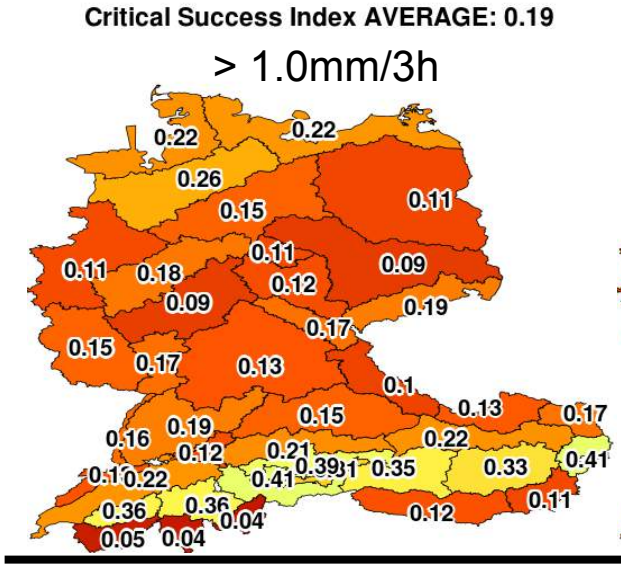
Case Application 1: Precipitation



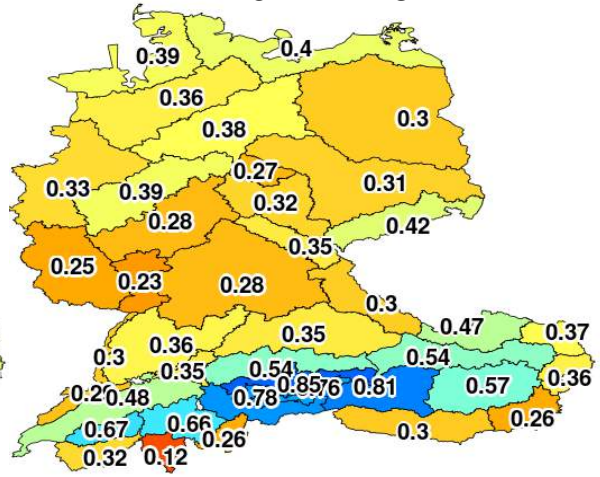
Case Application 1: Precipitation

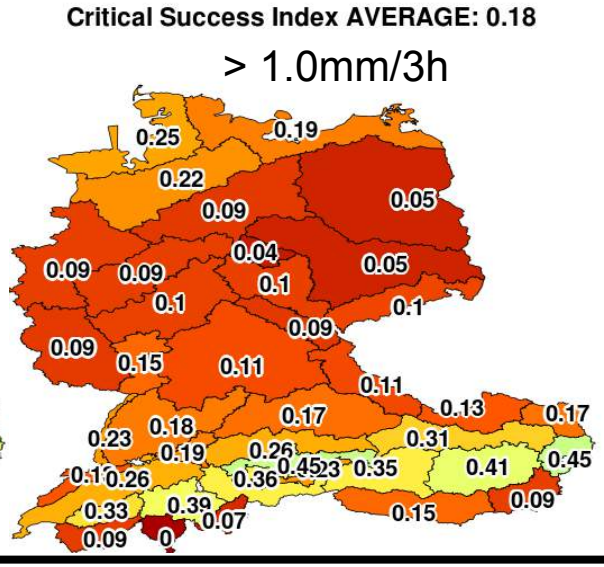
WRF station-based



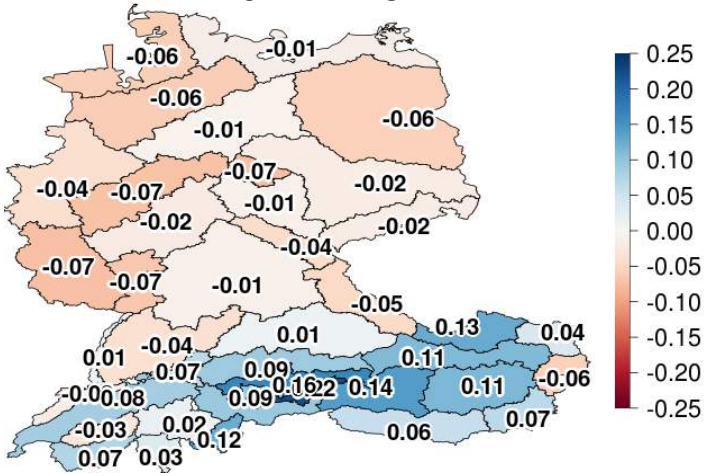


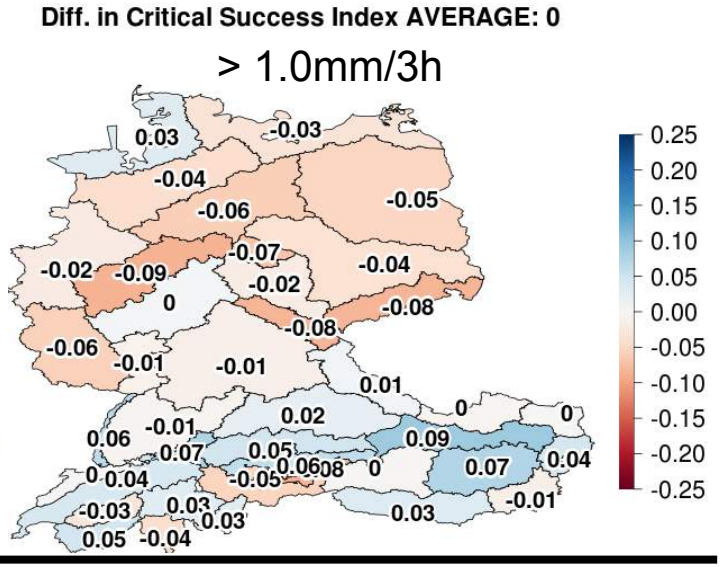
WRF grid-based



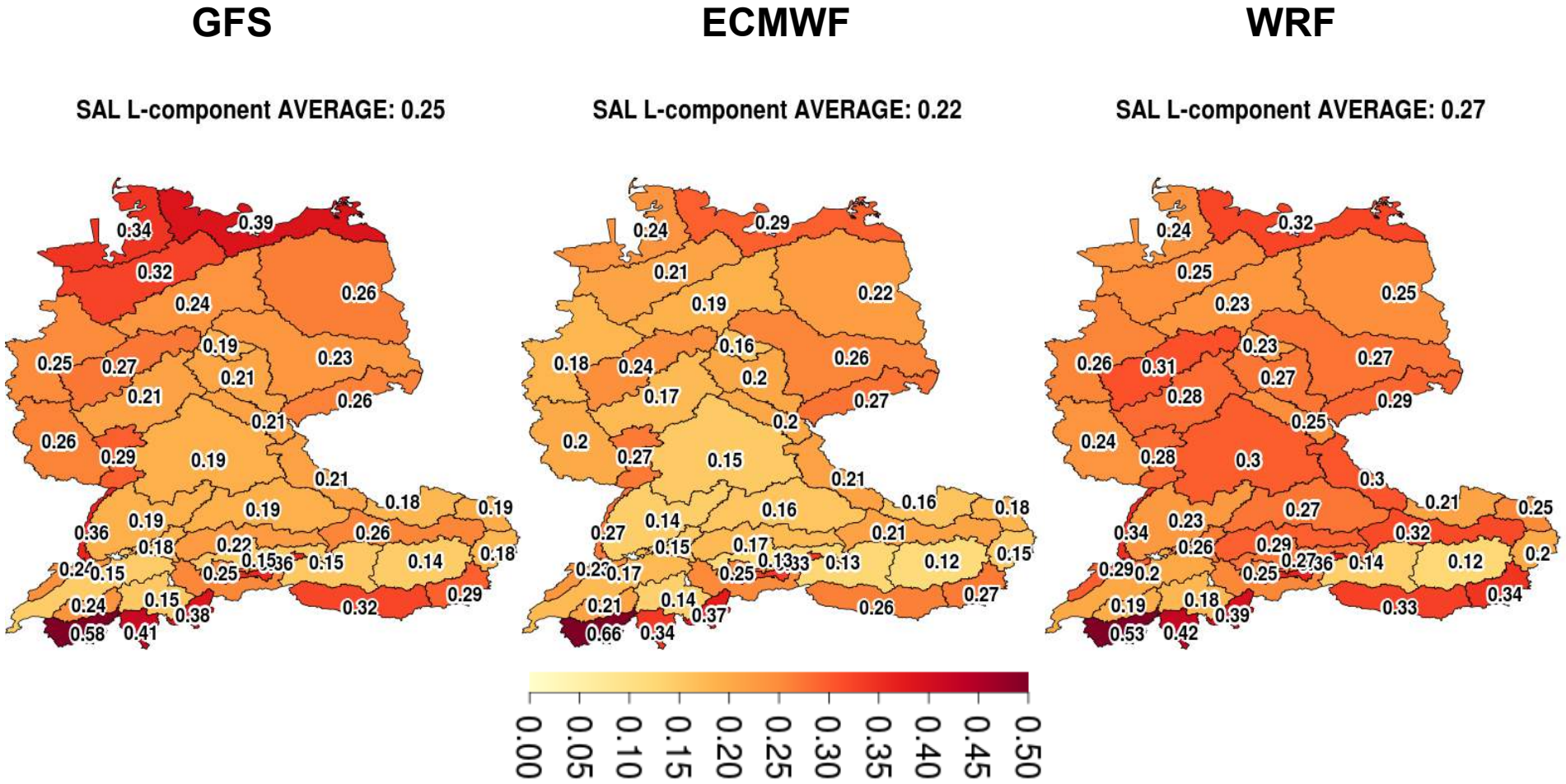


Difference





Case Application 1: Precipitation

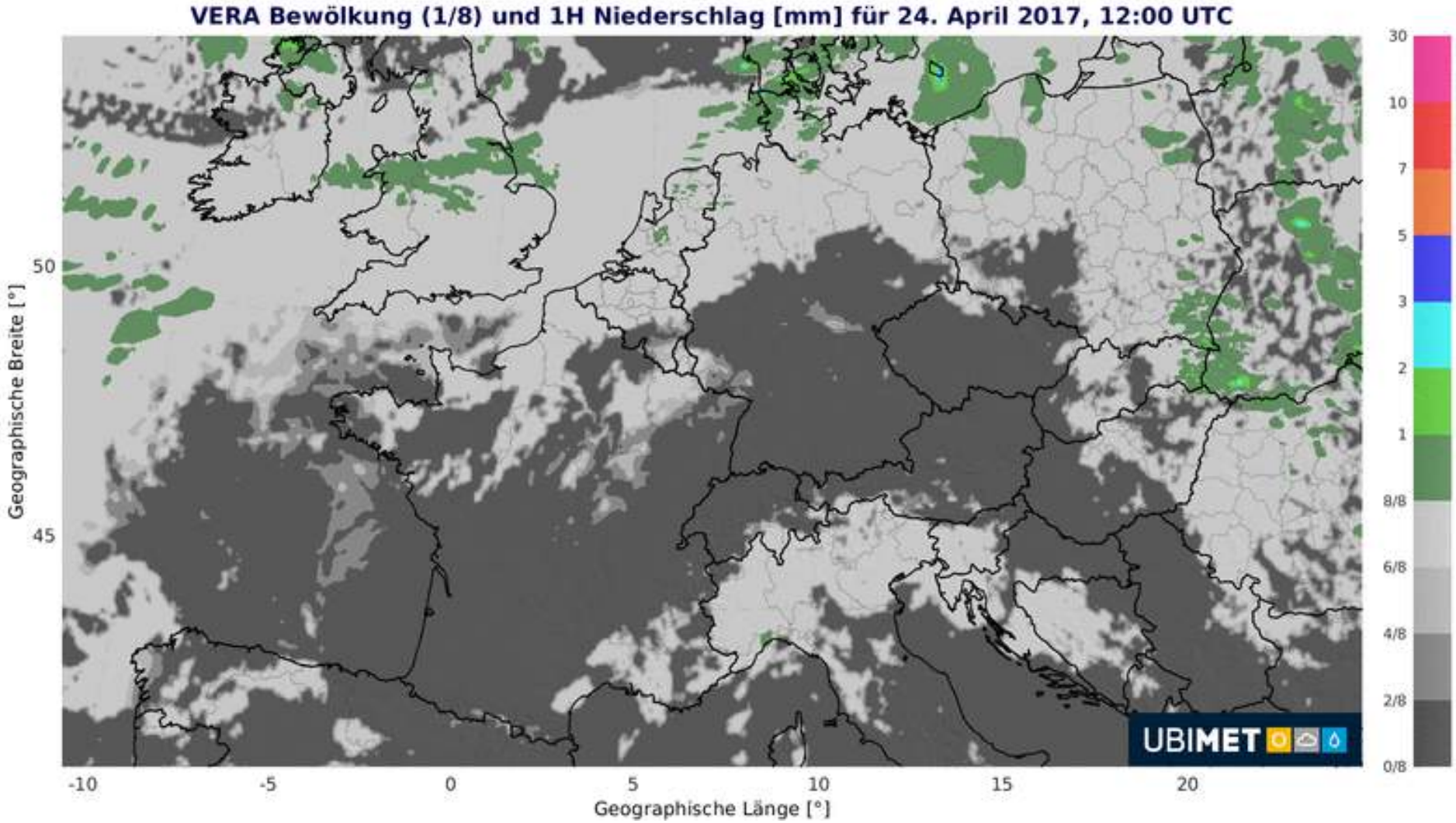


(Object locations match) **0 < L < 2** (Object locations totally displaced)

Case Application 2

Steering Low over the Baltic Sea and Lee Cyclogenesis south of the Alps

2017-04-24 12 UTC until 2017-04-29 12 UTC

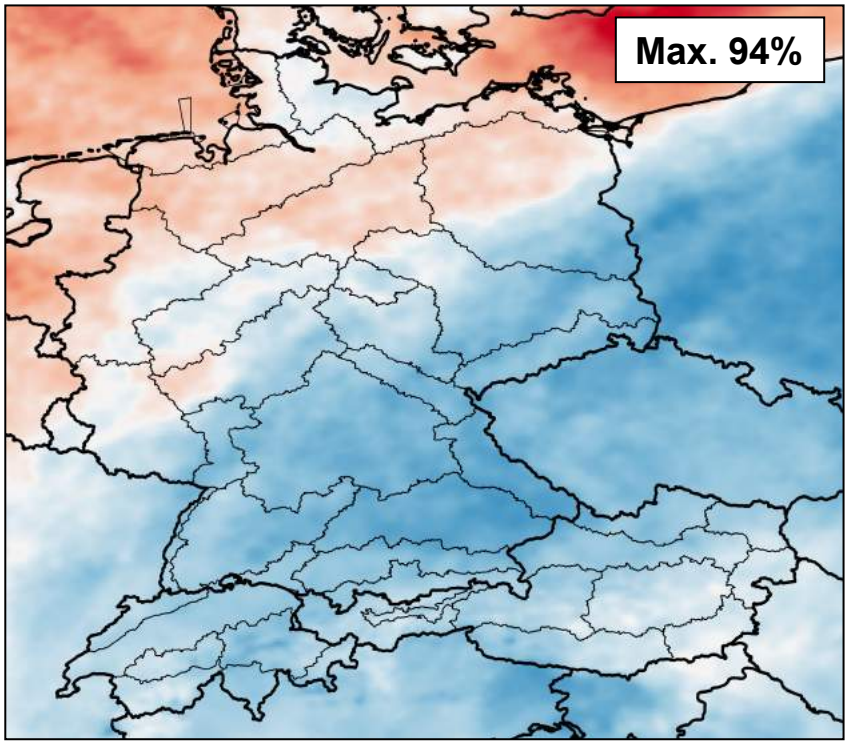


Case Application 2

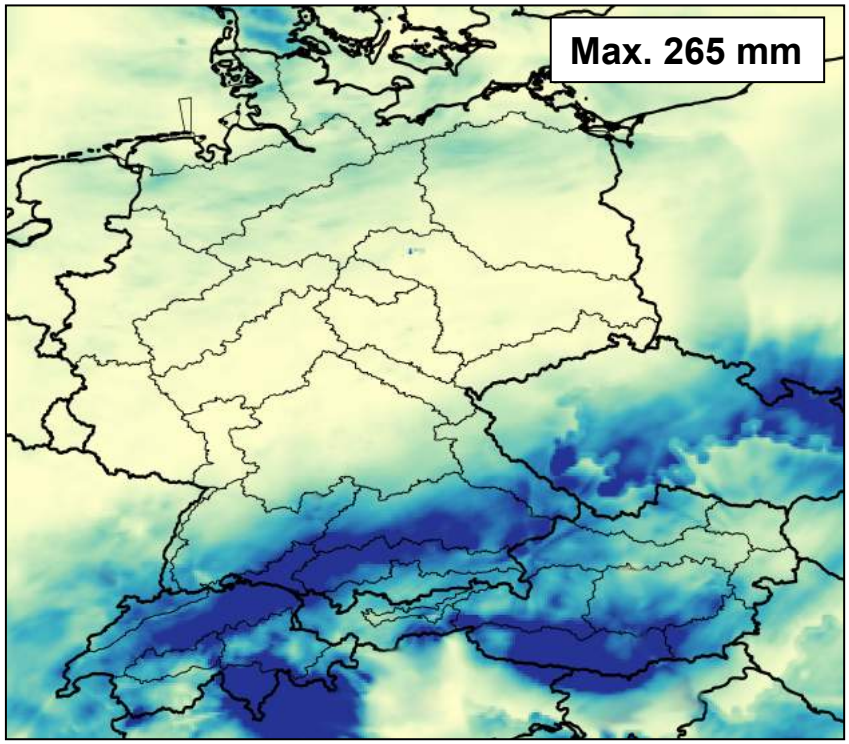
Steering Low over the Baltic Sea and Lee Cyclogenesis south of the Alps

2017-04-24 12 UTC until 2017-04-29 12 UTC

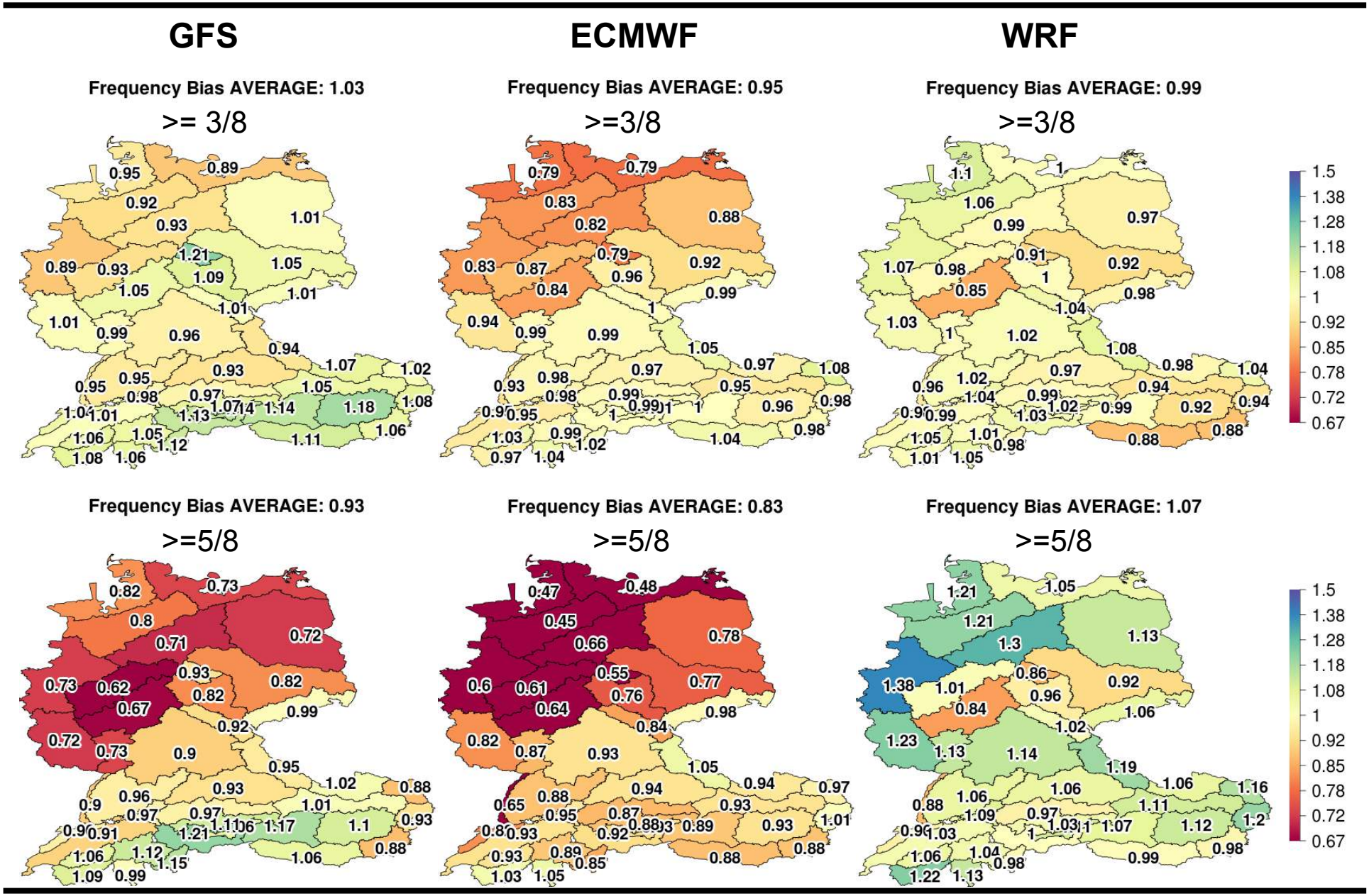
Mean Cloud Cover



Precipitation Sum

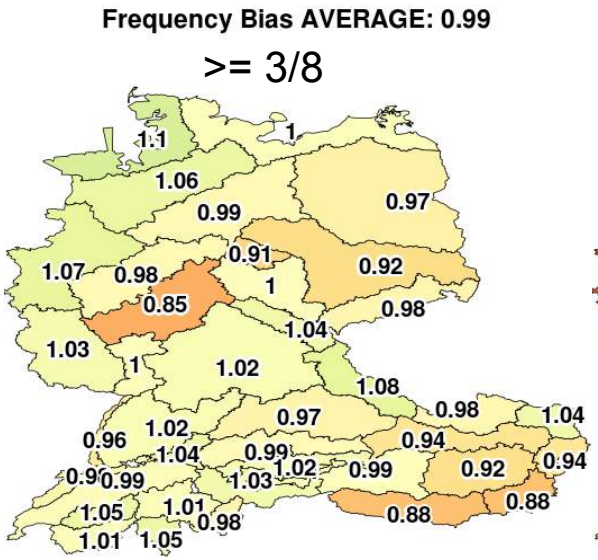


Case Application 2: Cloud Cover

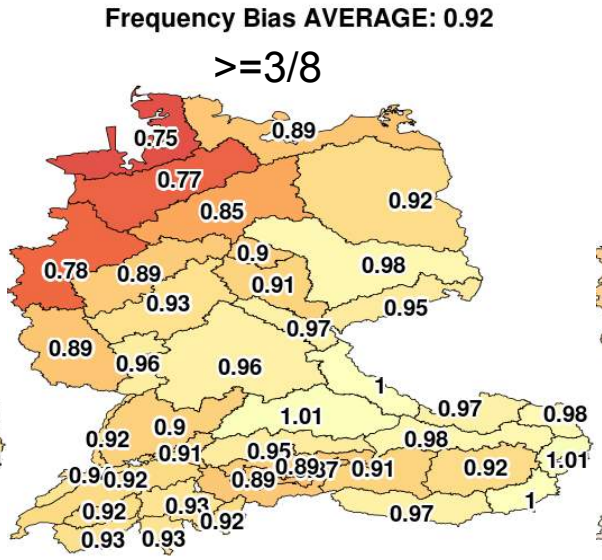


Case Application 2: Cloud Cover

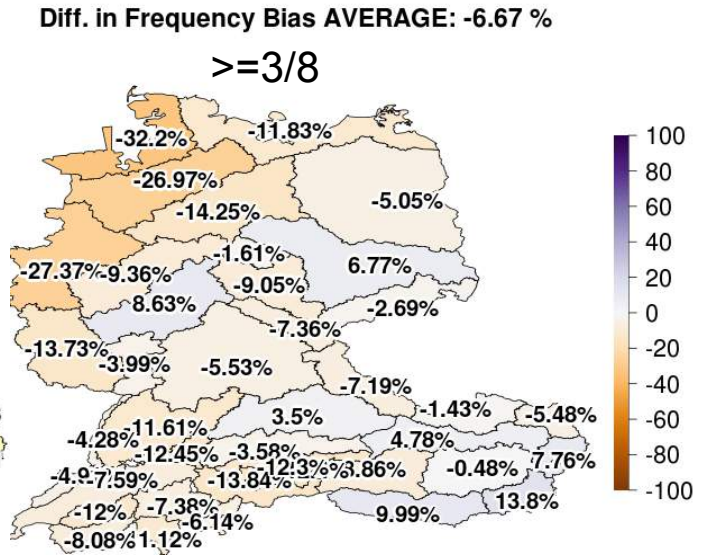
WRF station-based

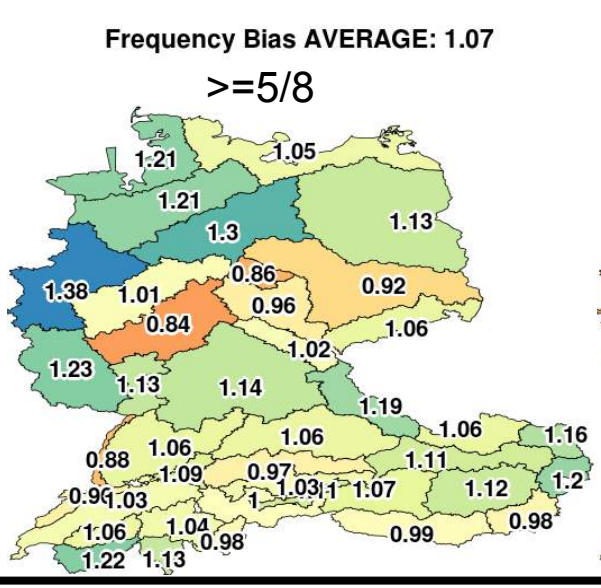


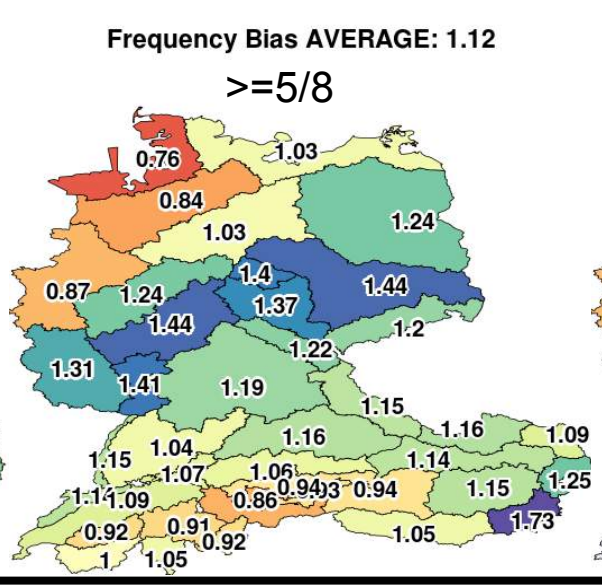
WRF grid-based

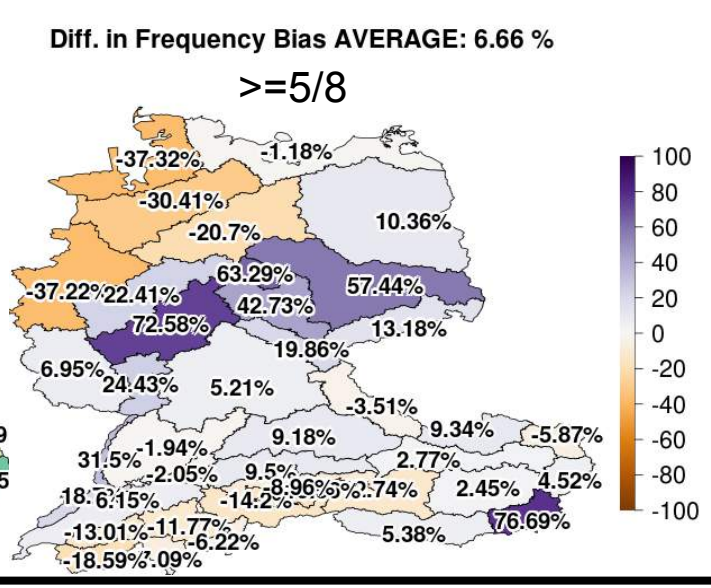


Difference



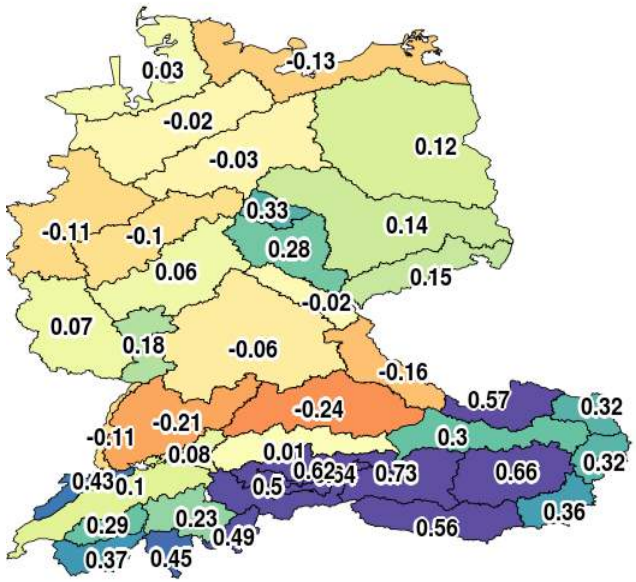




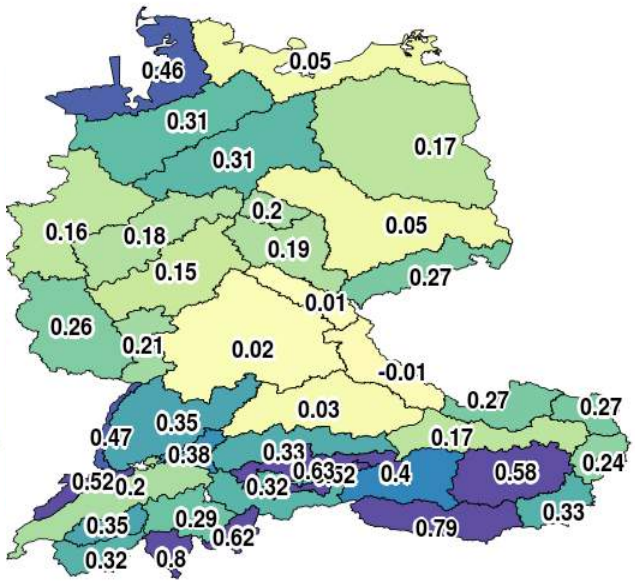


Case Application 2: Cloud Cover

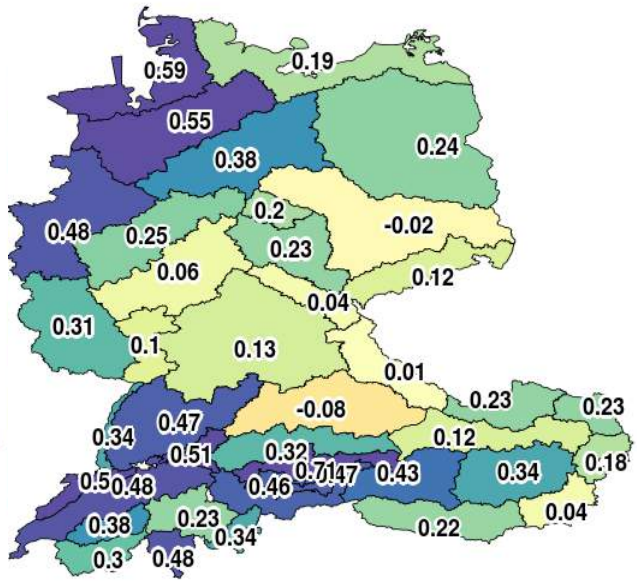
GFS

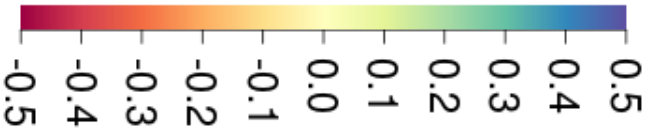


ECMWF



WRF



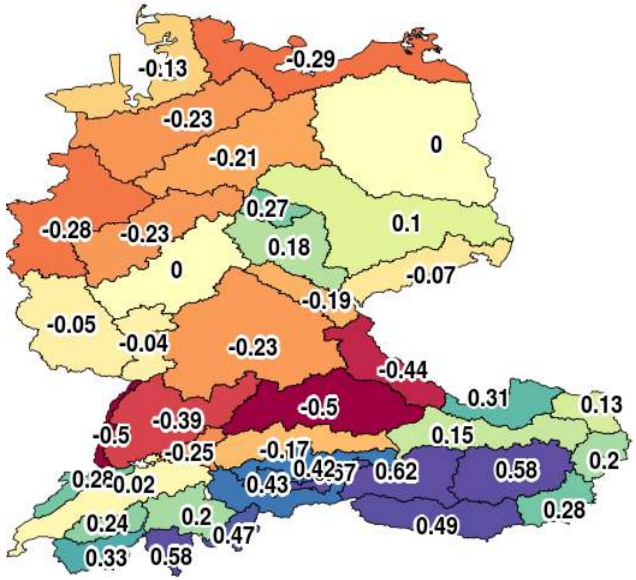


(Objects too small or peaked) **-2 < S < 2** (Objects too large or flat)

Case Application 2: Cloud Cover

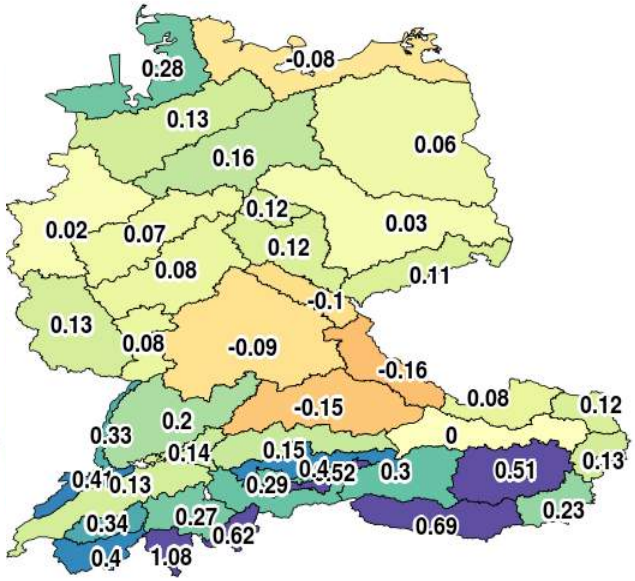
GFS

SAL A-component AVERAGE: 0.07



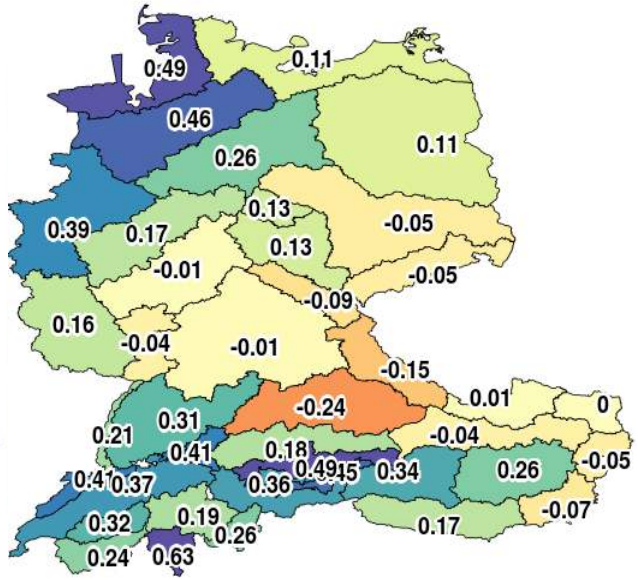
ECMWF

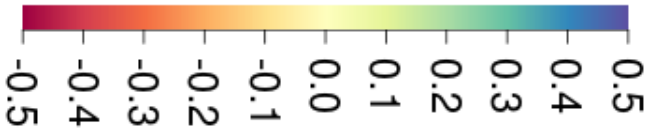
SAL A-component AVERAGE: 0.2



WRF

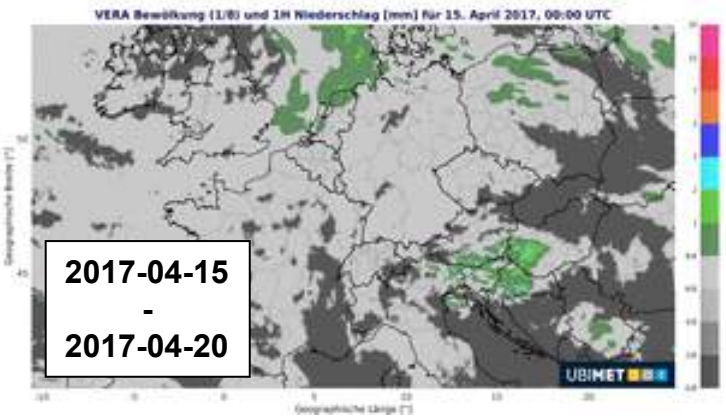
SAL A-component AVERAGE: 0.18

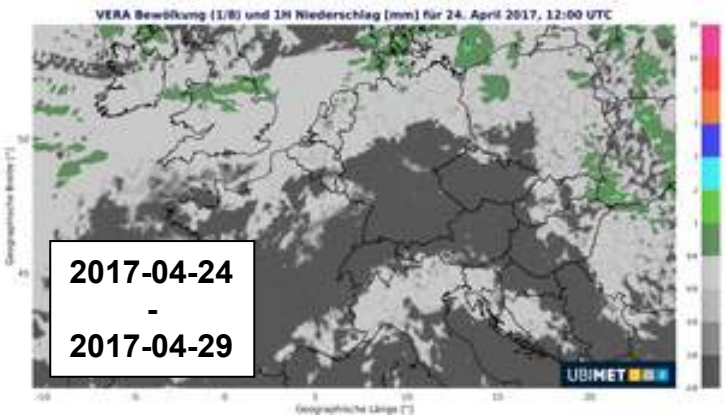




(Volumes too low) **-2 < A < 2** (Volumes too high)

Summary and Interpretation





Goal	Point Scores	SAL
Meaningful **aggregate results**	✖	✔
Results **representative** of domain	✖/✔	✔
Scores are **sensitive to forecast attributes**	✔	✔
Scores are **proper**	✖	✖
Identification of **underlying model errors**	✔	✔
Unequivocal **ranking** of forecast models	?	?