

# **Observations and their importance in the verification process: view of the Joint Working Group on Forecast Verification Research (JWGFVR)**

**Anna Ghelli**

**Thanks to: Simon Mason, Laurie Wilson, Barbara Casati, Barbara Brown, Beth Ebert, Joel Stein, Pertti Nurmi**



## Vision:

To promote best practices and understanding of verification methods

## Activities:

- Verification guidance and support for WMO Forecast Demonstration Projects
- Participation in activities of other WMO groups
- Documentation of recommended methods for specific application
- Education

## Who are we?

Barbara **Brown** (NCAR)

Beth **Ebert** (BOM)

Anna **Ghelli** (ECMWF)

Marion **Mittermaier** (UK MetOffice)

Joel **Stein** (Meteo France)

Clive **Wilson** (UK MetOffice)

Barbara **Casati** (Ouranos)

Harold **Brooks** (NOAA)

Martin **Goeber** (DWD)

Pertti **Nurmi** (FMI)

David **Stephenson** (Uni. Exeter)

Laurie **Wilson** (Env. Canada)





# Where in WMO?

[http://www.wmo.int/pages/prog/arep/wwrp/new/Forecast\\_Verification.html](http://www.wmo.int/pages/prog/arep/wwrp/new/Forecast_Verification.html)

World Meteorological Organization  
Working together in weather, climate and water

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**Atmospheric Research and Environment Programme (AREP)**

The Atmospheric Research and Environment Programme co-ordinates and stimulates research on the composition of the atmosphere and weather forecasting, focusing on extreme weather events and socio-economic impacts. AREP supports global research initiatives under programmatic guidance from the **Commission for Atmospheric Sciences (CAS)**. It does this through two programmes: **Global Atmosphere Watch (GAW)** and the **World Weather Research Programme (WWRP)** including **THORPEX**. See an **overview** of AREP.

**Commission for Atmospheric Sciences (CAS)**

- Message from the President of CAS
- CAS Vision (by the President of CAS)
- CAS Management Group
- CAS structure
- Terms of reference AREP
- Terms of reference OPAG-Environmental Pollution and Atmospheric Chemistry

**World Weather Research Programme (WWRP)**

- Mesoscale Forecasting
- Nowcasting
- Sand & Dust Storms
- THORPEX
- Tropical Meteorology
- Forecast Verification
- Weather & Health
- Weather Modification
- Weather & Society

**Global Atmosphere Watch Programme (GAW)**

- Aerosols
- Greenhouse gases
- Reactive gases
- Atmospheric deposition
- Ozone
- Sand & Dust Storms
- UV radiation
- GURME
- GESAMP

**AREP Overview**

Commission for Atmospheric Sciences  
GAW Programme

GURME  
Greenhouse Gases  
Ozone  
Reactive Gases  
Precipitation Chemistry  
GESAMP  
Calibration Centres  
SAGs & ETs

**WWRP Programme**

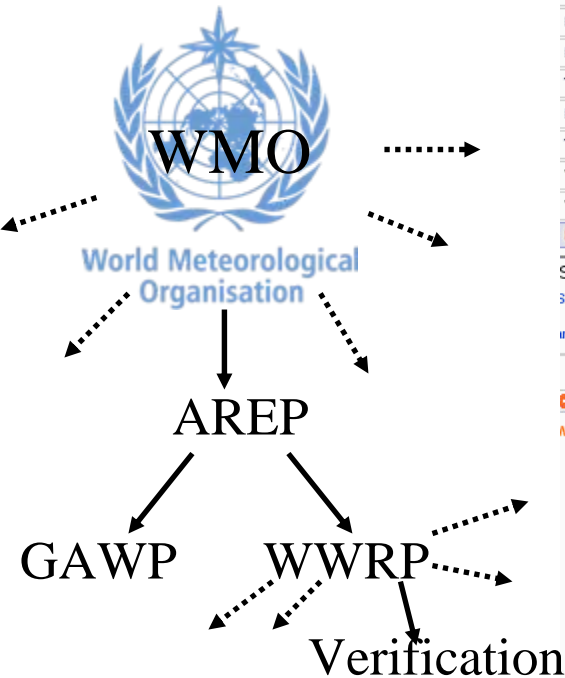
Mesoscale Forecasting  
Nowcasting  
Sand and Dust Storms  
THORPEX  
Tropical Meteorology  
Forecast Verification  
Weather and Health  
Expert Team Weather Modification  
Weather and Society

**Crosscutting Projects**

Research at WMO

**Publications & Bulletins**

GAW Reports  
WWRP Publications  
THORPEX Publications  
Ozone Bulletins  
Greenhouse Gas Bulletin  
Glossary on QA/QC terms  
Statement on Tropical Cyclones and Climate Changes



## History and achievements:

**2002** Birth

**2002** 1st workshop (Boulder, Colorado, USA)

**2004** 2nd workshop (Montreal, Canada)

**2007** 3rd workshop (ECMWF, Reading, UK)  
the workshop included for the first time  
tutorials

**2008** Special issue of Meteorological  
Applications vol. 15 no. 1 with  
papers from the 3rd international  
workshop.

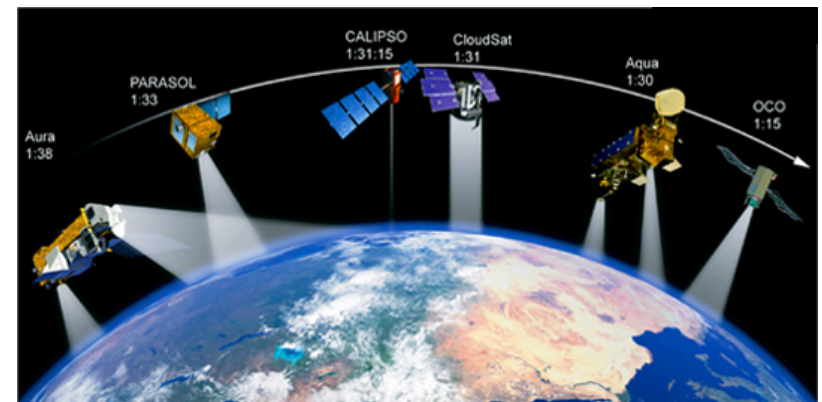
**2009** Publication WMO/TD-No. 1485  
“Recommendations for verification  
of QPF”

**2009** 4th workshop (FMI, Helsinki,  
Finland), tutorials were run as  
integral part of the workshop

**3rd International Workshop on  
Verification Methods, ECMWF,  
Reading, January 2007**



- **Quality control**
- **Observation uncertainty: how to account for it**
- **Observation dataset independency**
- **The role of analyses in verification**
- **Conclusions**



## Quality control

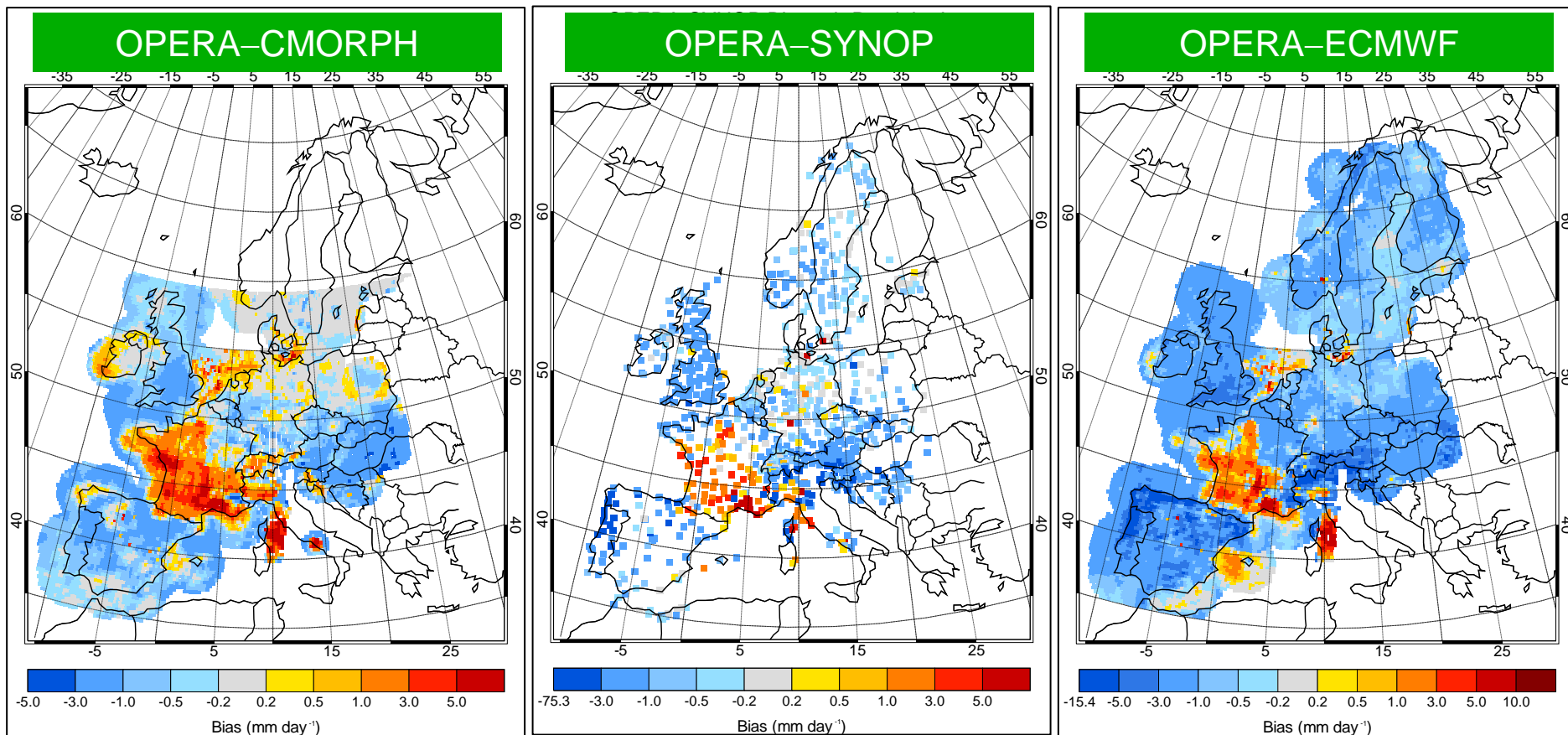
- Remove gross errors
- Remove instruments and reporting errors
- Remove biases

## Properties

- Standardized procedures
- Model independent

(P. Lopez, ECMWF, Tech. Memo. 569, 2008)

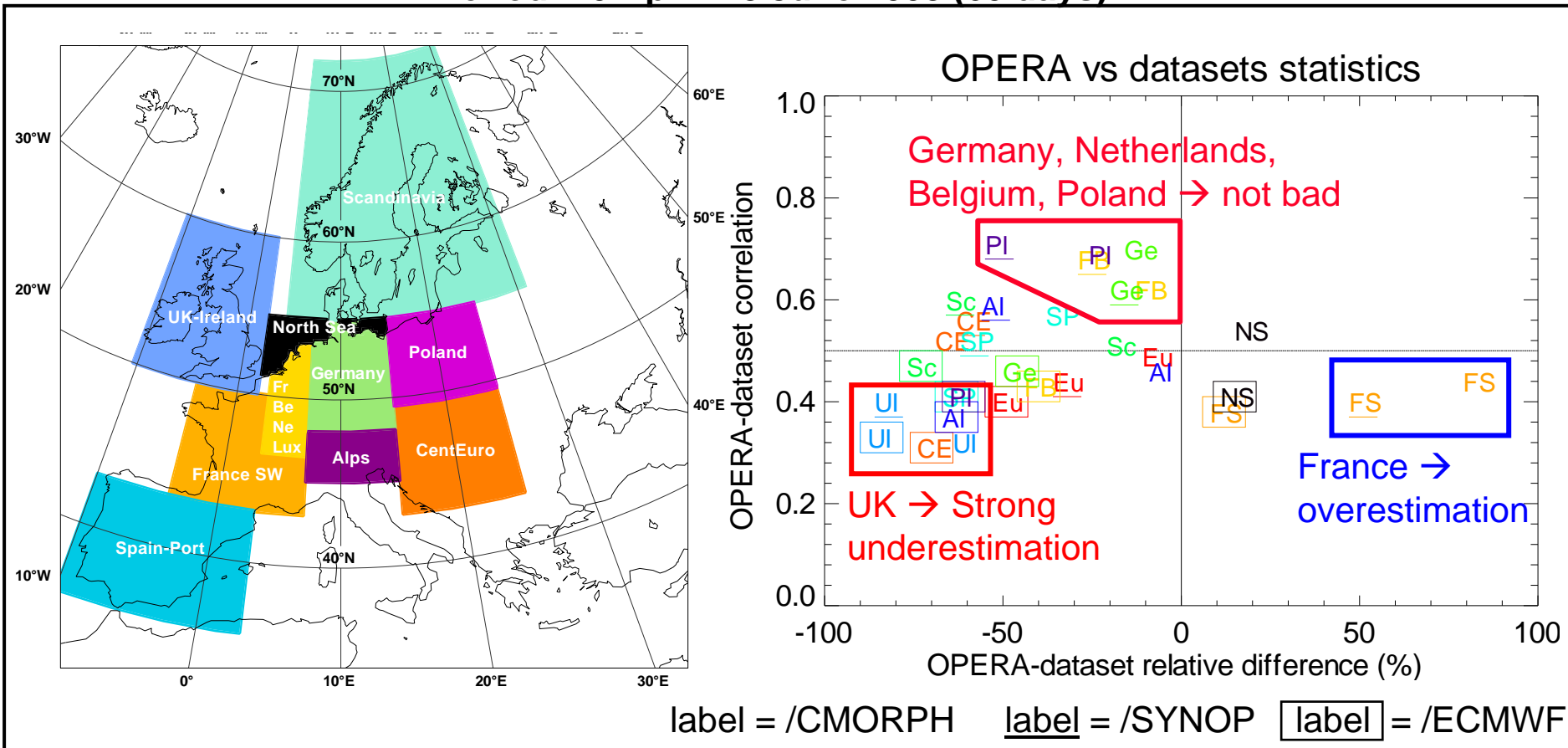
## Mean differences OPERA–dataset (mm day<sup>-1</sup>) Period: 10 April – 8 June 2008 (60 days)



- Comparisons with other datasets
- Common procedures

(P. Lopez, ECMWF, Tech. Memo. 569, 2008)

## OPERA-dataset mean correlation vs OPERA-dataset mean difference (various domains) Period: 10 April – 8 June 2008 (60 days)

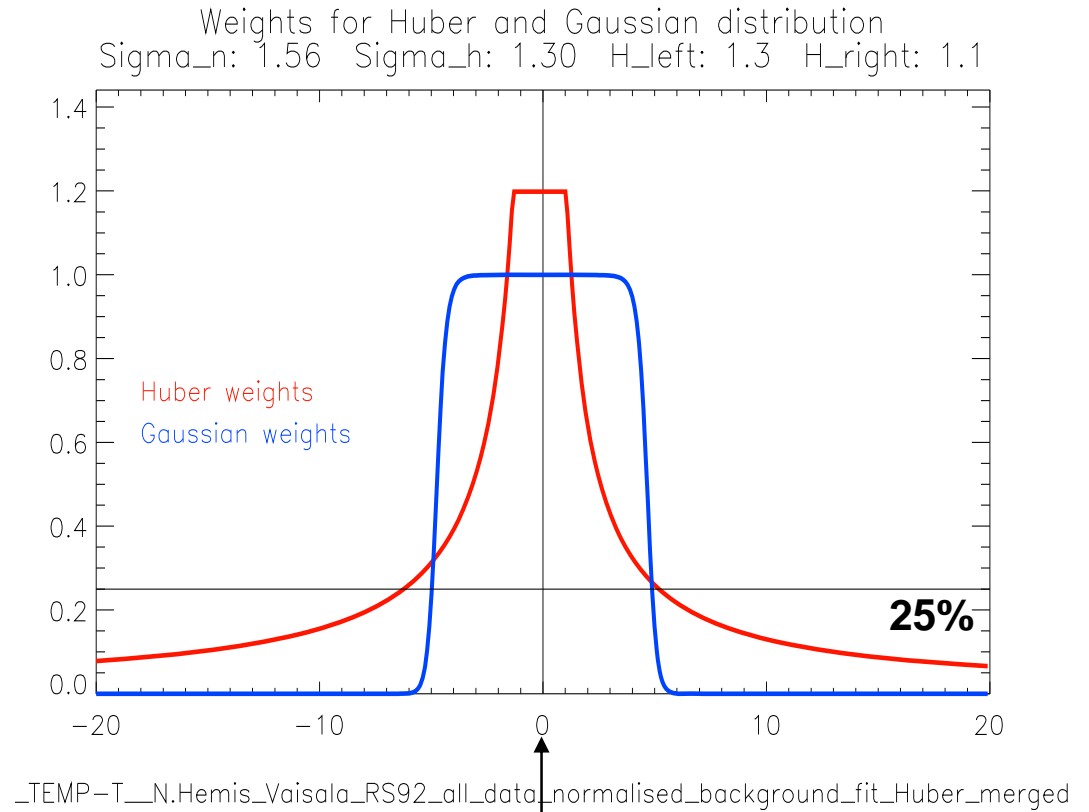




## Comparing two norms: Huber (red) Gaussian (blue)

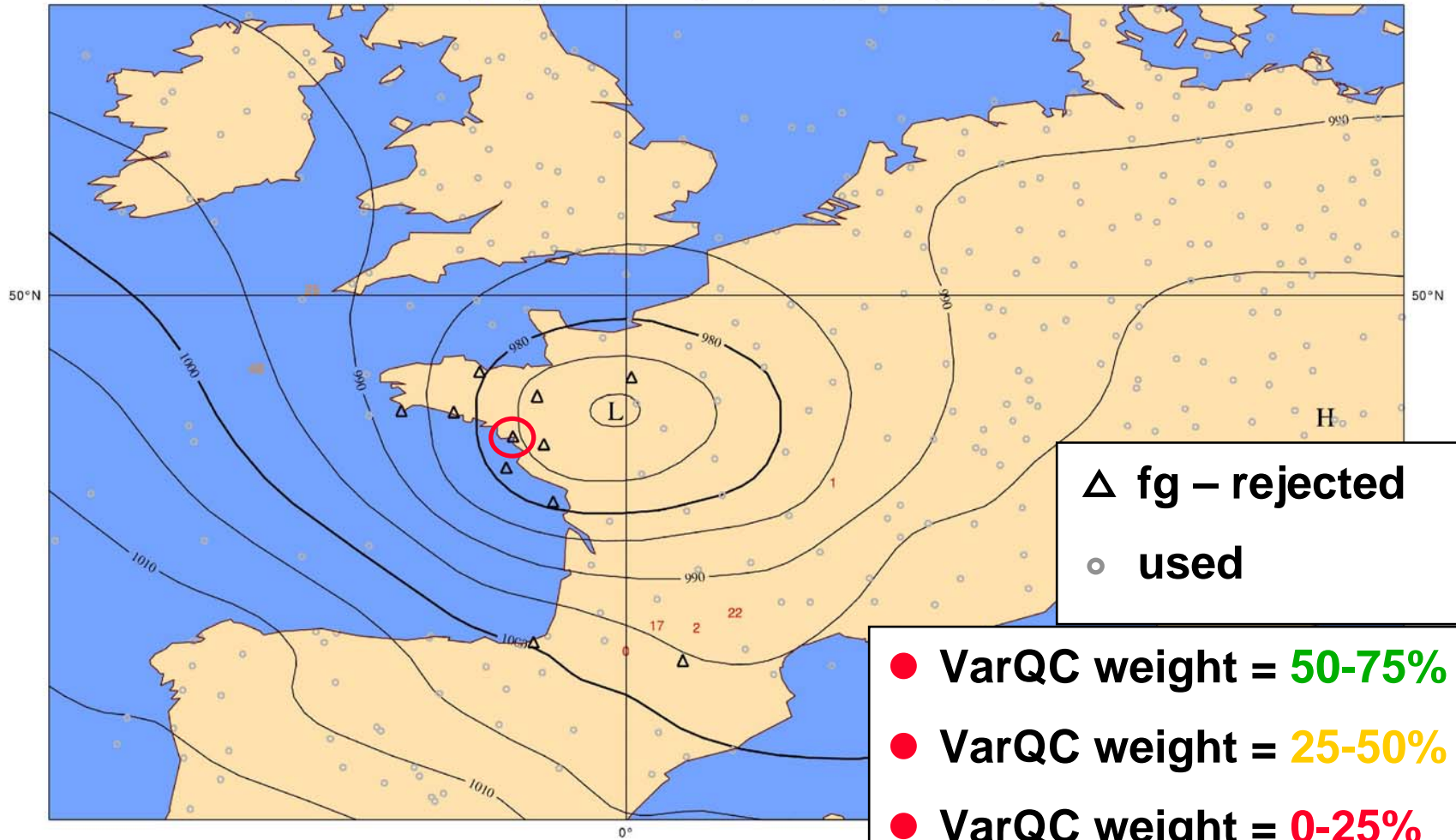
- **More weight in the middle of the distribution**
- **More weight on the edges of the distribution**
- **More influence of data with large departures**

-Weights: 0 – 25%



(Lars Isaksen and Cristina Tavolato, ECMWF)

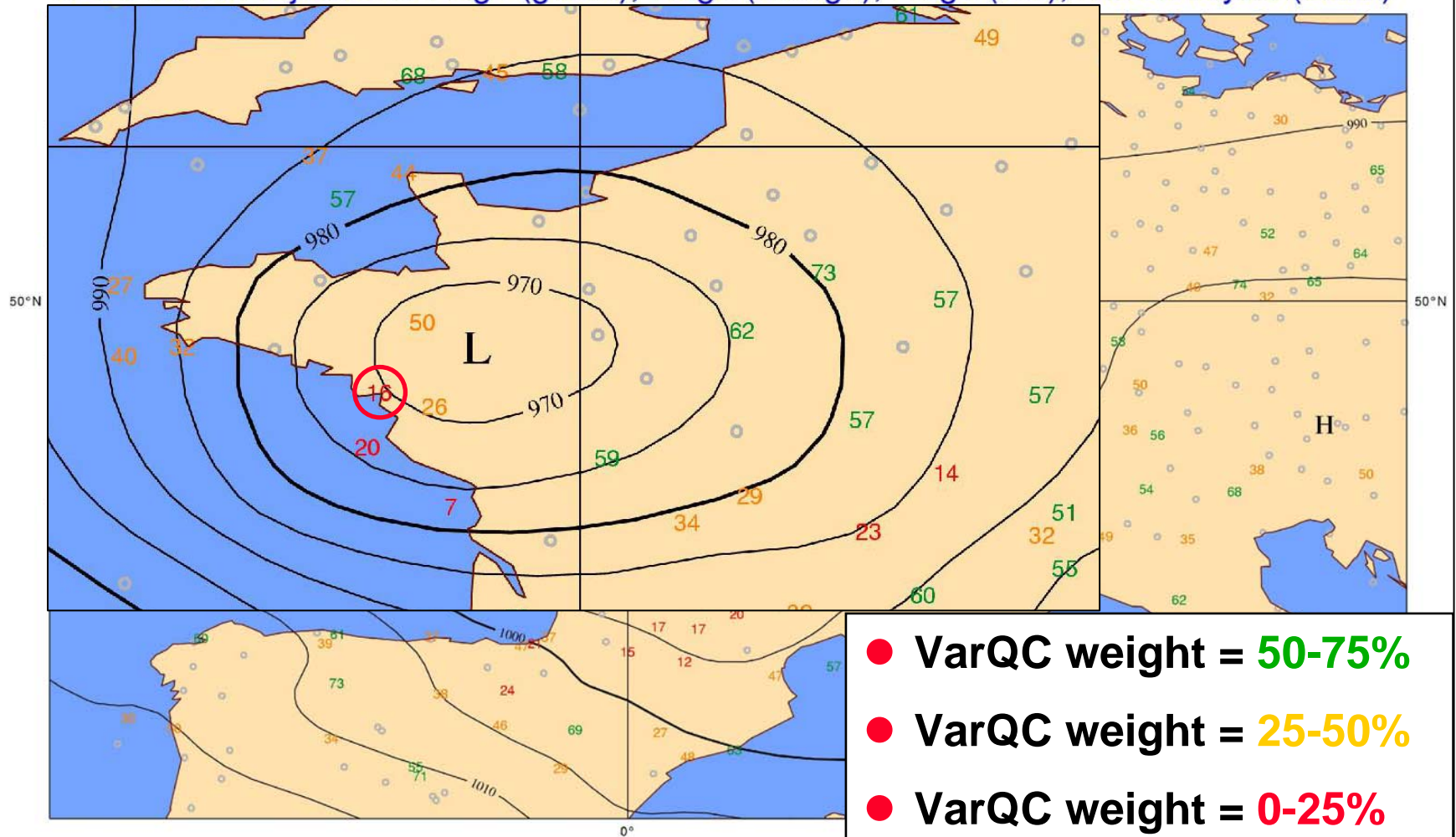
1112: VarQC-rejections: Flag1 (green), Flag2 (orange), Flag3 (red), MSL analysis (black)



# JWGFVR French Storm

-- not model independent

1362: VarQC-rejections: Flag1 (green), Flag2 (orange), Flag3 (red), MSL analysis (black)



## Sources of Uncertainty

- ◆ Observation error
- ◆ “Under-sampling” of station data
- ◆ Interpolation (time and space)
- ◆ Analysis errors
- ◆ .....

**How can we cope with observational uncertainty?**



# Verification using RADAR and rain gauges

- QPF in pre-specified area → River / Lake catchment
- Three independent components addressing the quality

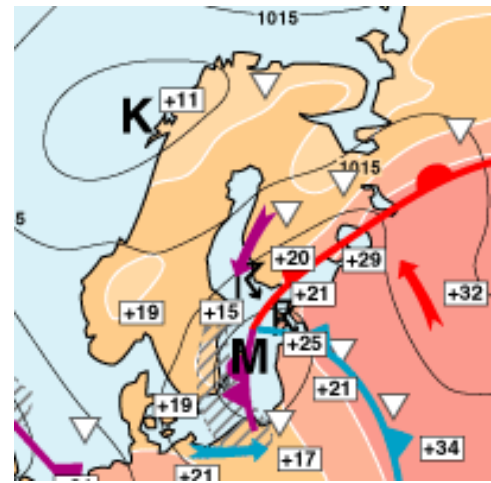
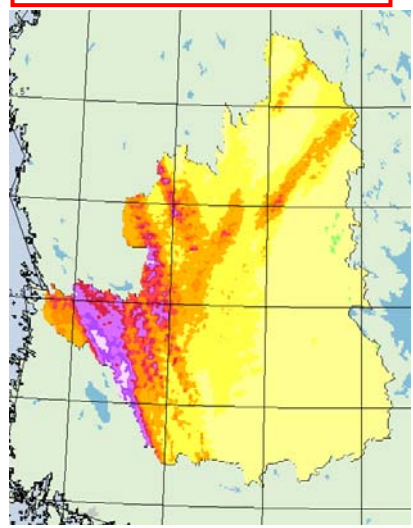
◆ Structure	- S -	-2	...	0	...	+2
		object too small or too peaked		Perfect		objects too large or too flat
◆ Amplitude	- A -	-2	...	0	...	+2
		Averaged QPF underestimated		Perfect		Averaged QPF over-estimated
◆ Location	- L -	-2	...	0	...	+2
				Perfect		wrong location of Total Center of Mass (TCM) and / or of objects relative to TCM

**For a perfect forecast:  $S = A = L = 0$**

*Wernli, Paulat, Hagen, Frei, 2008 (MWR, 136, 4470-4487)*



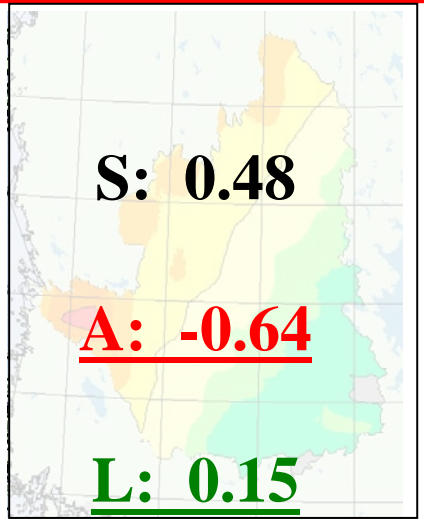
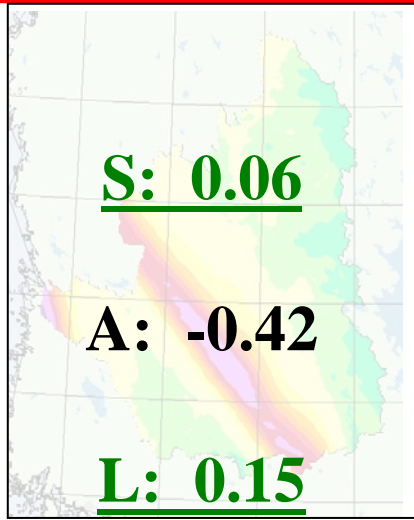
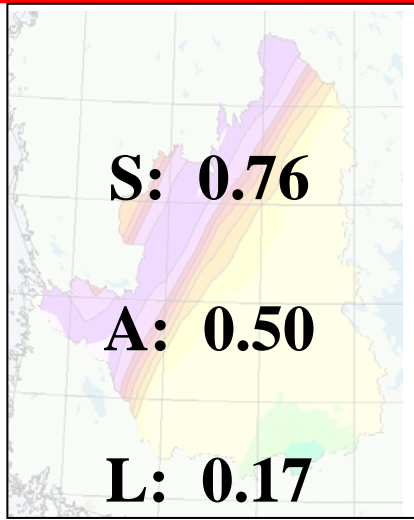
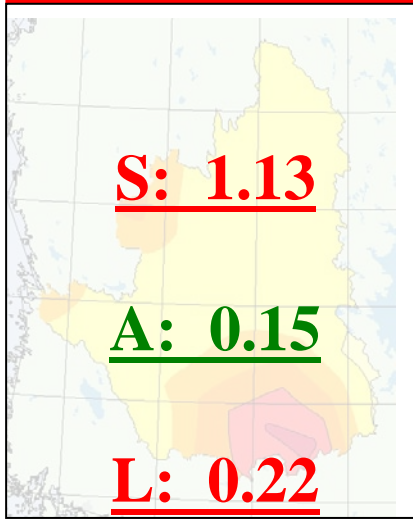
Radar ~ 1 km



# Medium-size catchment

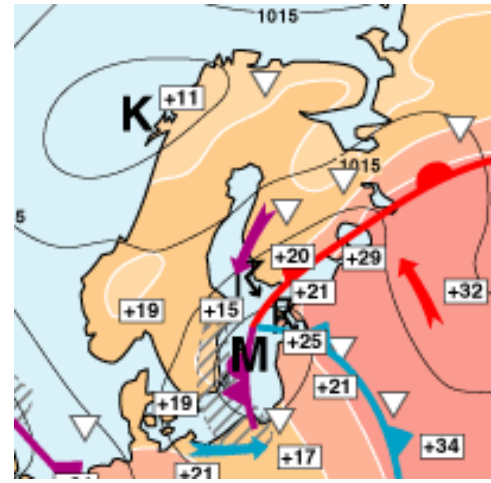
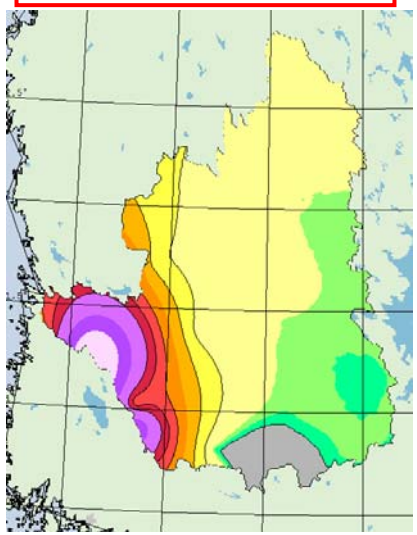
17 August 2008;  
24 hour accumulated precipitation

ECMWF ~ 25 km    HIR\_RCR ~ 16 km    HIR\_MB71 ~ 7.5 km    MET\_Edit ~ 15 km





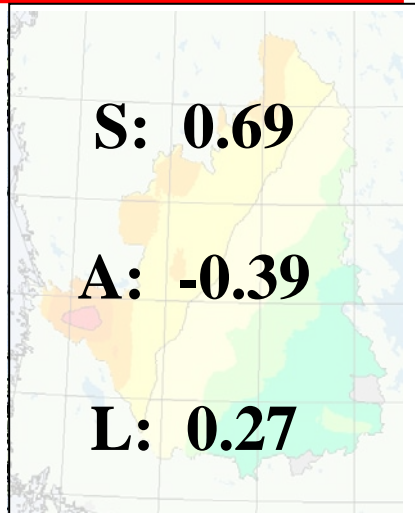
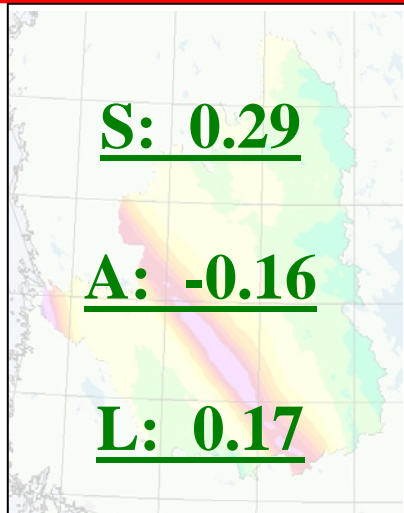
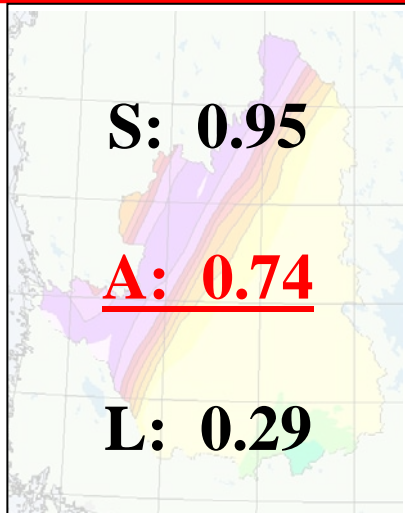
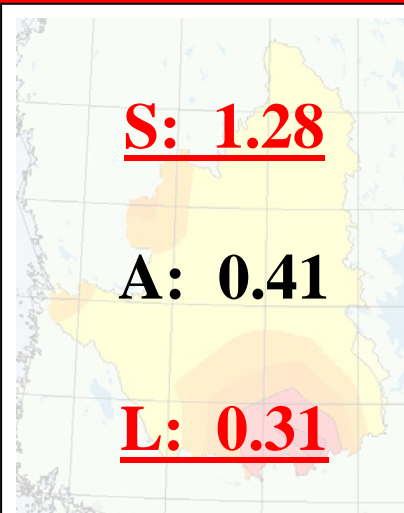
**Gauge**



# Medium-size catchment

17 August 2008  
24 hour accumulated precipitation

**ECMWF ~ 25 km    HIR\_RCR ~ 16 km    HIR\_MB71 ~ 7.5 km    MET\_Edit ~ 15 km**





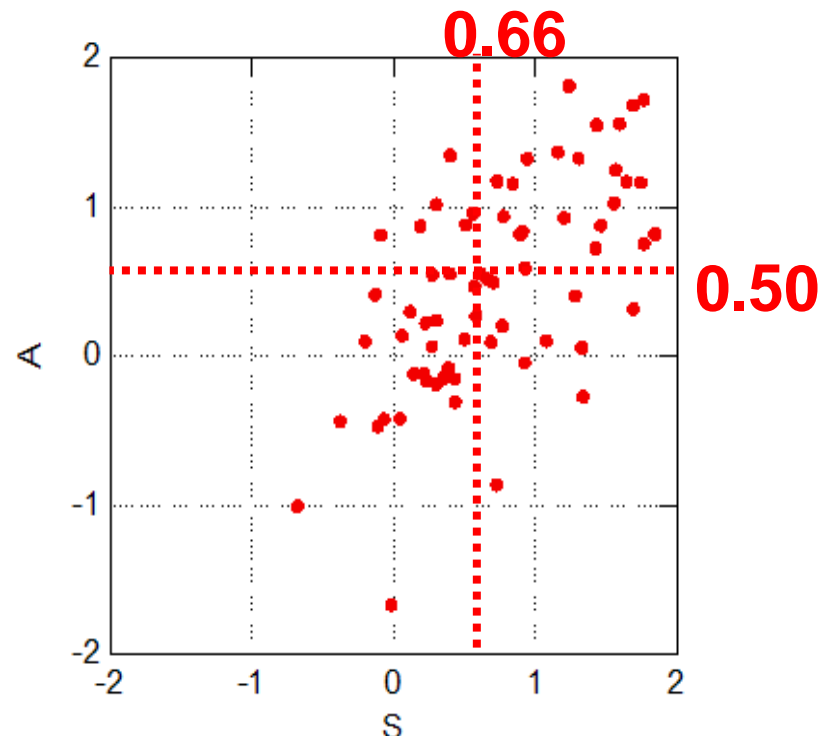
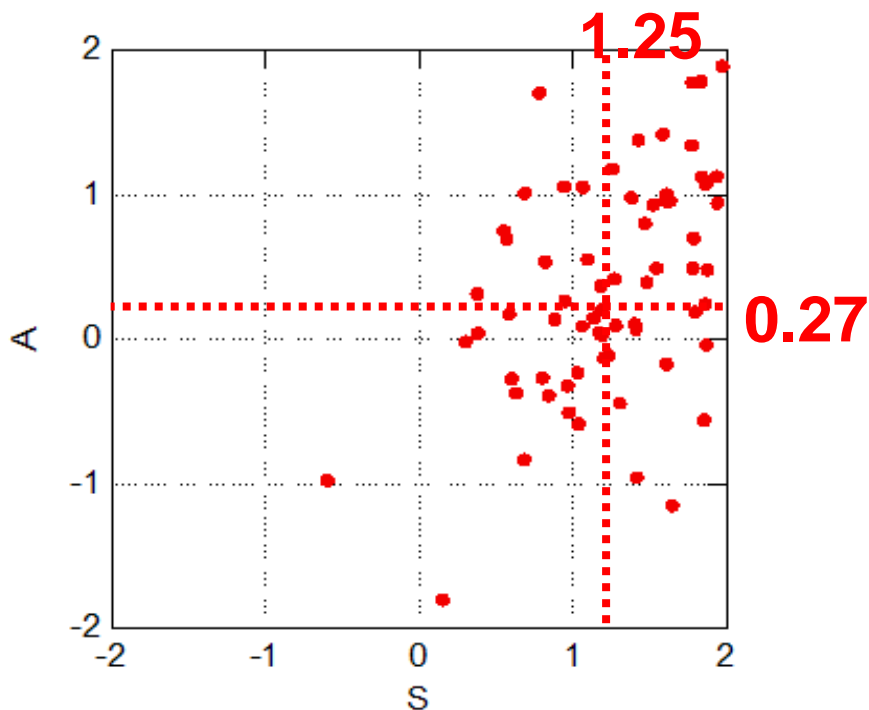
- Which is the truth?
- Observation uncertainty

*Largest/flattest precip objects ref.  
winter/spring*

*Too large/flat precip objects, on  
average*

*Amplitude somewhat overestimated*

*Amplitude strongly overestimated*



**ECMWF vs RADAR**

*Pertti Nurmi, FMI*

**ECMWF vs GAUGES**





## Direct approaches for coping with observational uncertainty

Compare forecast error to known observation error

- If forecast error is smaller, then
  - A good forecast
- If forecast error is larger, then
  - A bad forecast



### ● Bowler (2008)

-Methods for reconstructing contingency table statistics, taking into account errors in classification of observations

### ● Ciach and Krajewski (1999)

-Decomposition of RMSE into components due to “true” forecast errors and observation errors

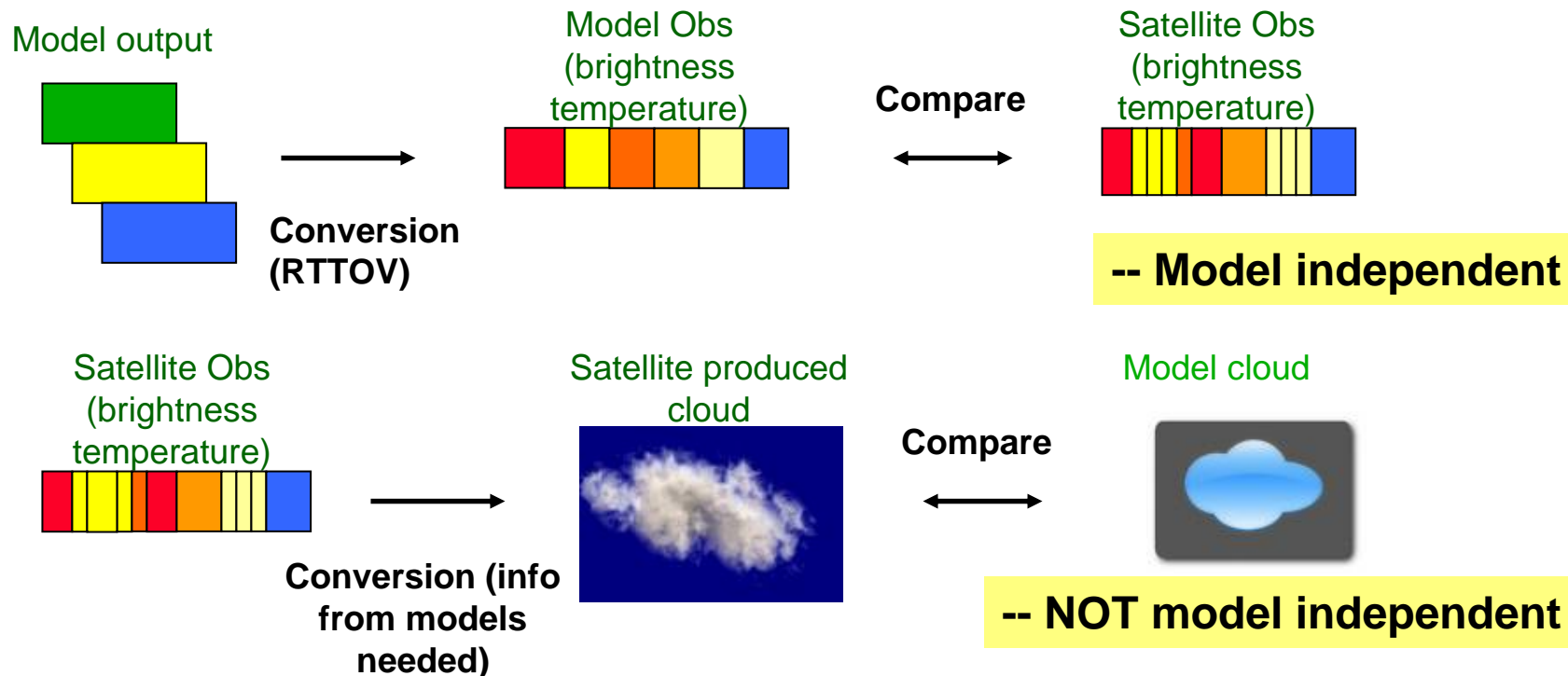
- Candille and Talagrand (2008)
  - Treat observations as probabilities (new Brier score decomposition)
- Briggs et al. (2005)
  - Incorporating mis-classification errors using a “gold standard”
- Casati (2008)
  - Wavelet reconstruction
- Roberts and Lean (2008)
  - Perturb pixels in the observed field to obtain error bars
- Hamill (2001)
  - Rank histogram perturbations
- Mittermaier (2008)
  - Incorporation of uncertainty in radar-rainfall estimates



# The matching game: Strive for an independent dataset

## Approaches:

- Model to observations → model output is manipulated to become comparable to observations
- Observations to model → observations are manipulated to become comparable to model output



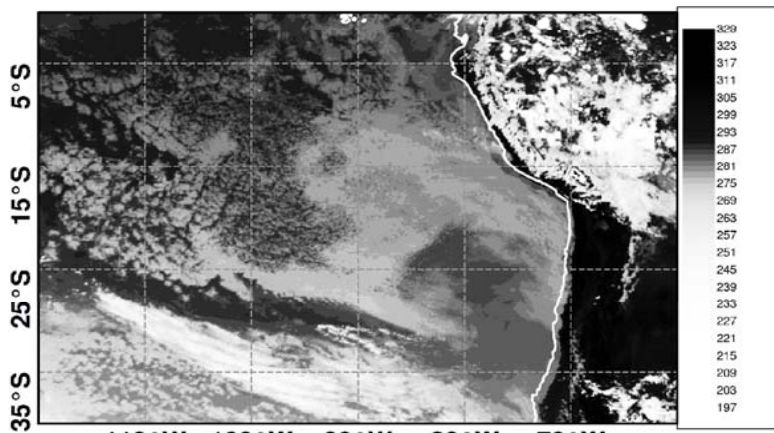


# The matching game

VOCALS field experiment off Chile

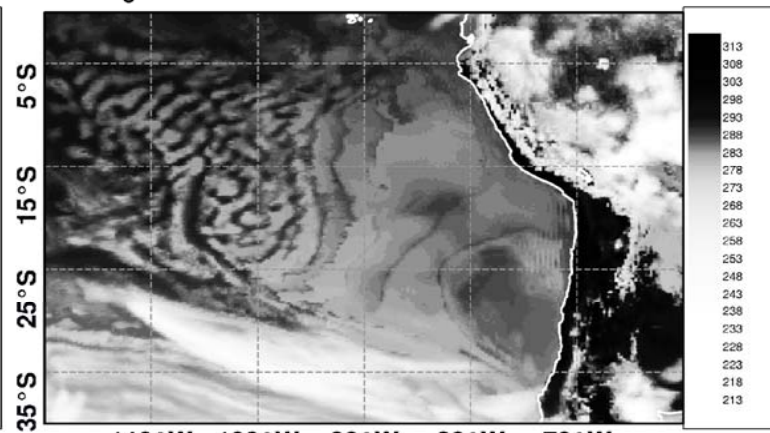
GOES12 10.8 $\mu$ m

GOES12IR10.8 20081018 18 UTC

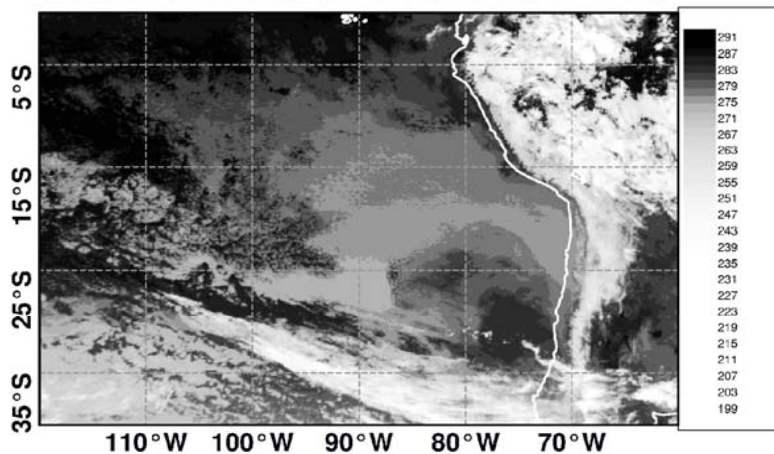


ECMWF 10.8 $\mu$ m

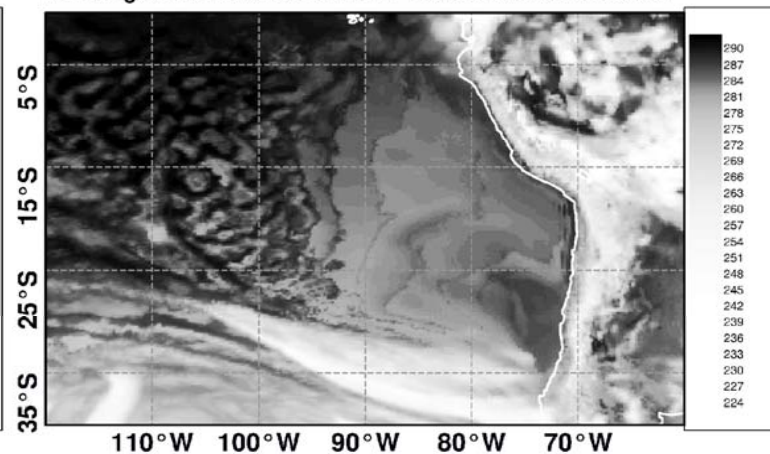
RTTOV gen. GOES12IR10.8 ECMWF Fc 20081018 00 UTC+18h:



GOES12IR10.8 20081019 6 UTC



RTTOV gen. GOES12IR10.8 ECMWF Fc 20081018 00 UTC+30h:

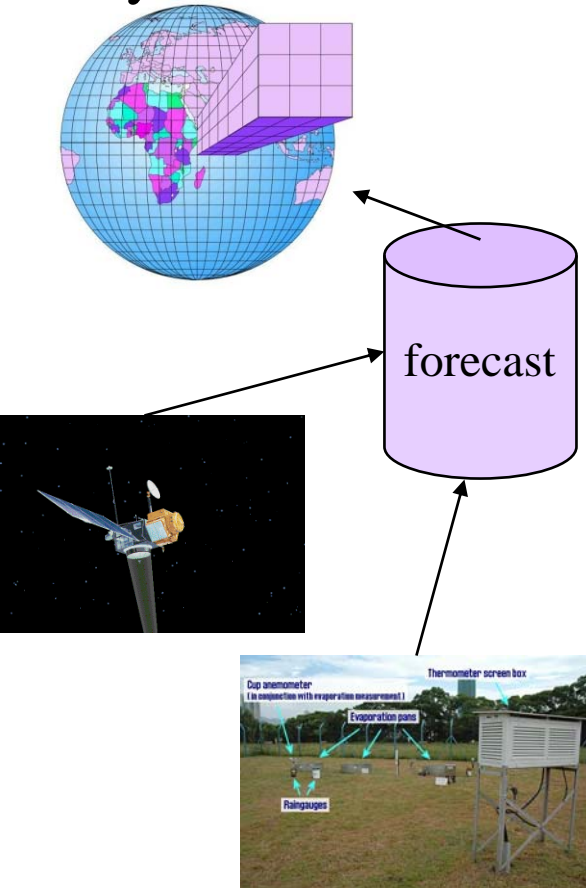




# The role of the analysis in verification

- **Analyses are model dependent**

analysis



- Allows to use a **number of different type of sensors** to provide a coherent analysis for the model → this out-weights the drawback of model contamination
- Good if used for specific purposes e.g. when performance needs to be assessed for **scales that the model can resolve** and for comparison of same model (operational vs. experimental suite)
- **Multi-analysis** against observations scores better than single analysis
- Use of **randomly drawn** analyses for comparative verification of multiple models.



# What do we need for verification purposes?

