H-SAF GV network systems

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outline

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Support to Operational Hydrology and Water Management

ground validation networks: raingauges

- general characteristics,
- cumulation interval,
- interpolation,

application to H-SAF precipitation products,

- sensitivity (to gauge density, rainfall intensity…),
- product intercomparison,

validation of early GPM products,

- monthly statistics,
- case studies.

raingauge networks: people

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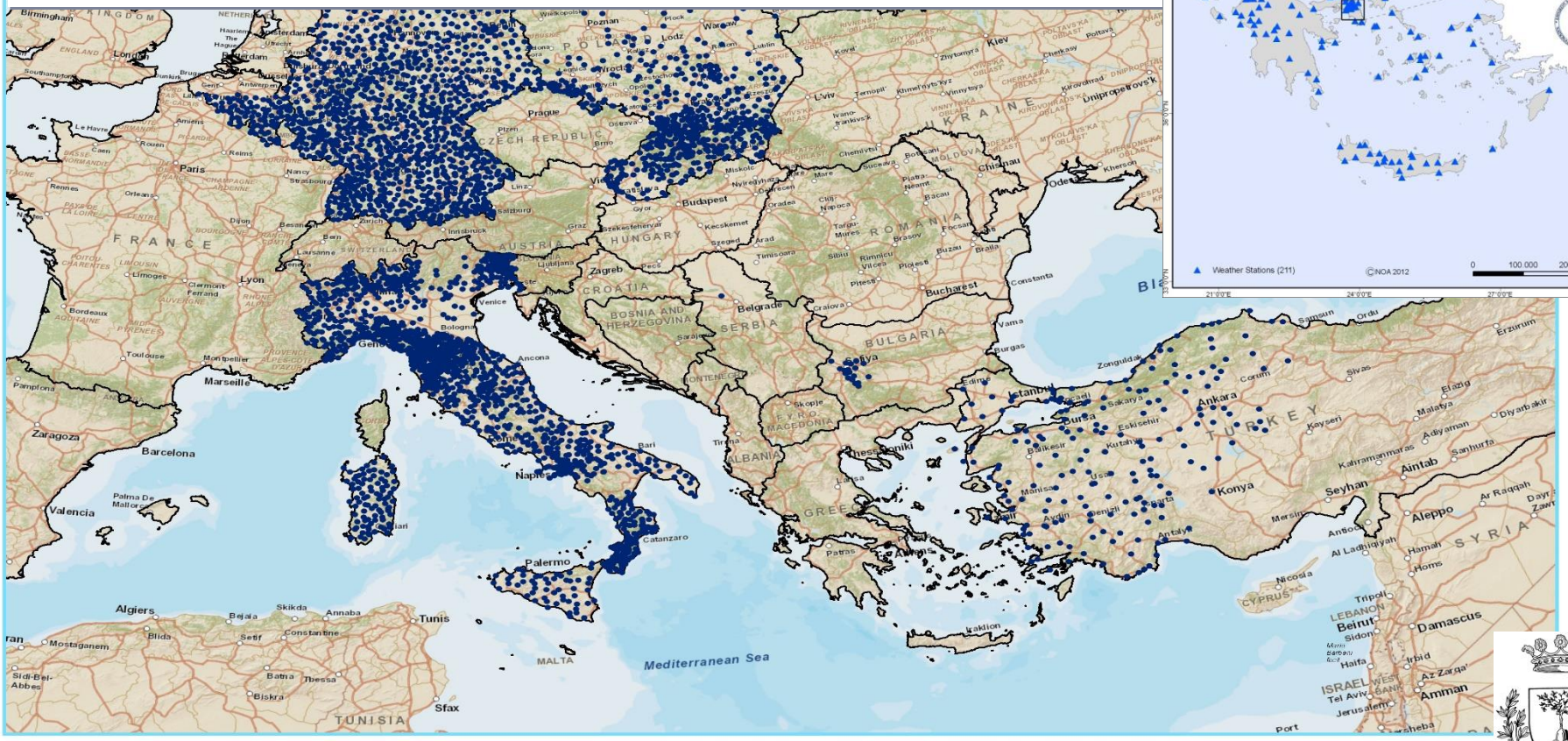
S. Puca, P. Baguis, E. Campione, A. Ertürk, S. Gabellani, P. Helmke, R. Iwański, M. Jurašek, J. Kaňák, J. Kerényi, G. Koshinchanov, G. Kozinarova, P. Krahe, B. Łapeta, E. Lábó, L. Milani, Ľ. Okon, A. Öztopal, P. Pagliara, M. Petracca, F. Pignone, C. Rachimow, N. Rebora, A. Rinollo, E. Roulin, İ. Sönmez, A. Toniazzo

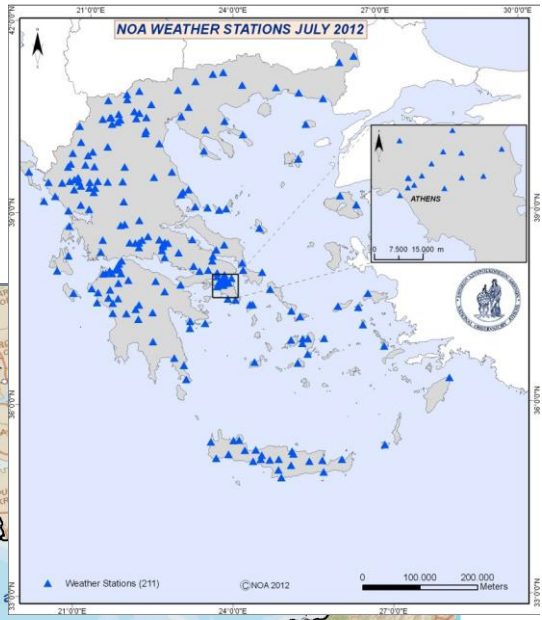
Italian Civil Protection Department, Italy
University of Ferrara (Department of Physics and Earth Sciences), Italy
Royal Meteorological Institute of Belgium, Belgium
Turkish State Meteorological Service, Turkey
CIMA Research Foundation (Satellite Research Department), Italy
Institute of Meteorology and Water Management (Slovak Hydrometeorological Institute), Slovakia
OMSZ-Hungarian Meteorological Service, Hungary
National Institute of Meteorology and Hydrology Bulgarian Academy of Sciences, Bulgaria
Federal Institute of Hydrology (BfG), Germany
Istanbul Technical University, Meteorology Department, Turkey
Istituto di Scienze dell'Atmosfera e del Clima (ISAC) – CNR, Italy

raingauge networks: coverage

The H-SAF PPV Raingauge network 4100 stations

VS '**Validation of the H-SAF precipitation products over Greece using rain gauge data**', **Haralambos Feidas**, Aristotle University of Thessaloniki, Department of Meteorology and Climatology.





raingauge networks: instruments

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Averaged Minimum Distance

Country	Rain gauge type (TB/W)	Minimum detectable rain rate (mm h^{-1})	Maximum detectable rain rate (mm h^{-1})	Heating system (Y/N)	Cumulation interval (min)	AMD (km)
Belgium	TB	0.1 mm	N/A	N	60	11.2
Bulgaria	TB/W	0.1 mm	2000	Y	60, 120	7
Germany	W	0.05 mm	3000	Y	60	17
Italy	TB	0.2 mm	N/A	Y (16%)	10 - 60	9.5
Poland	TB	0.1 mm	N/A	Y	10	13.3
Turkey	TB	0.2 mm	720	Y	1	27

raingauge networks: spatial variability

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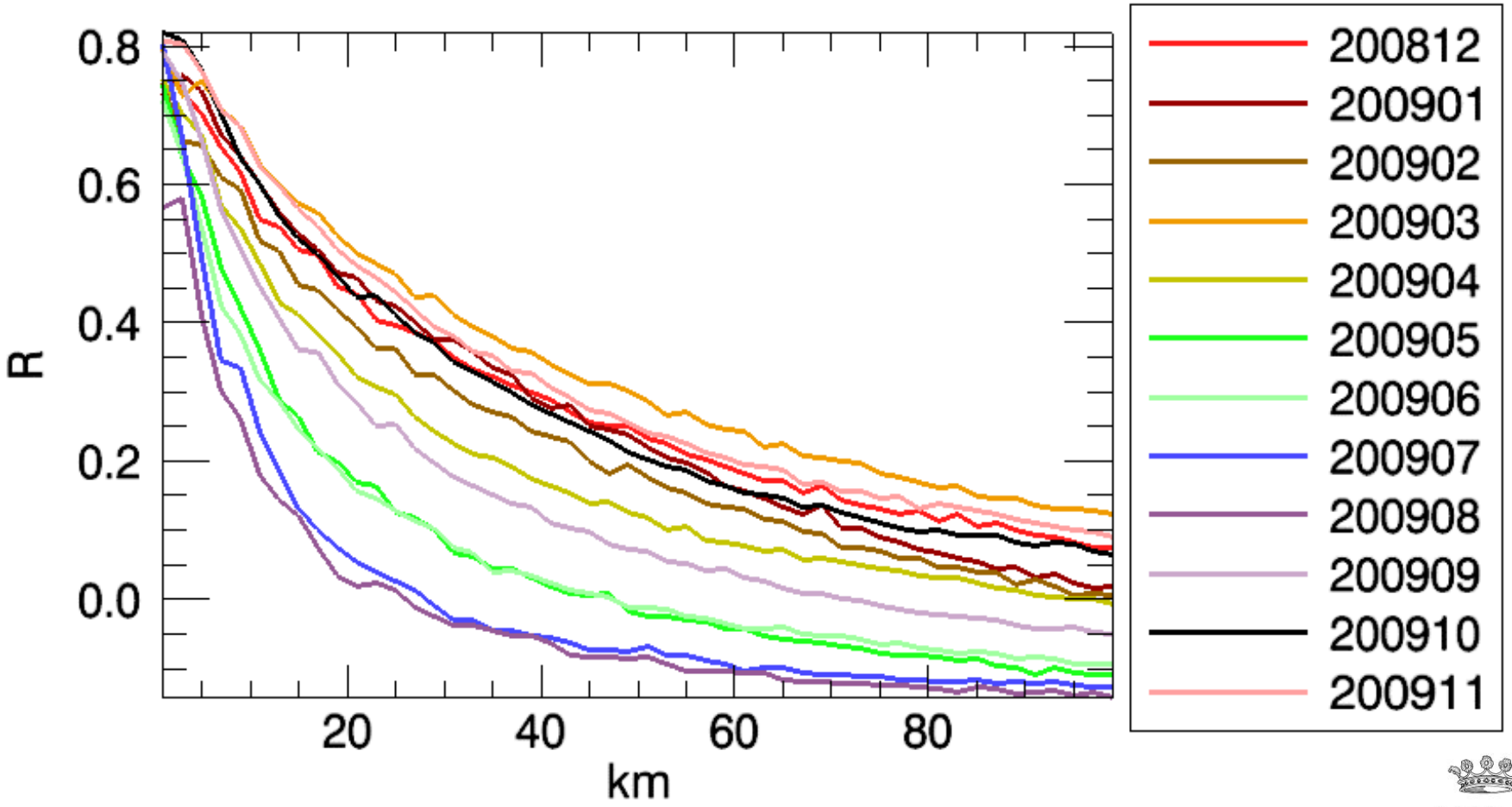
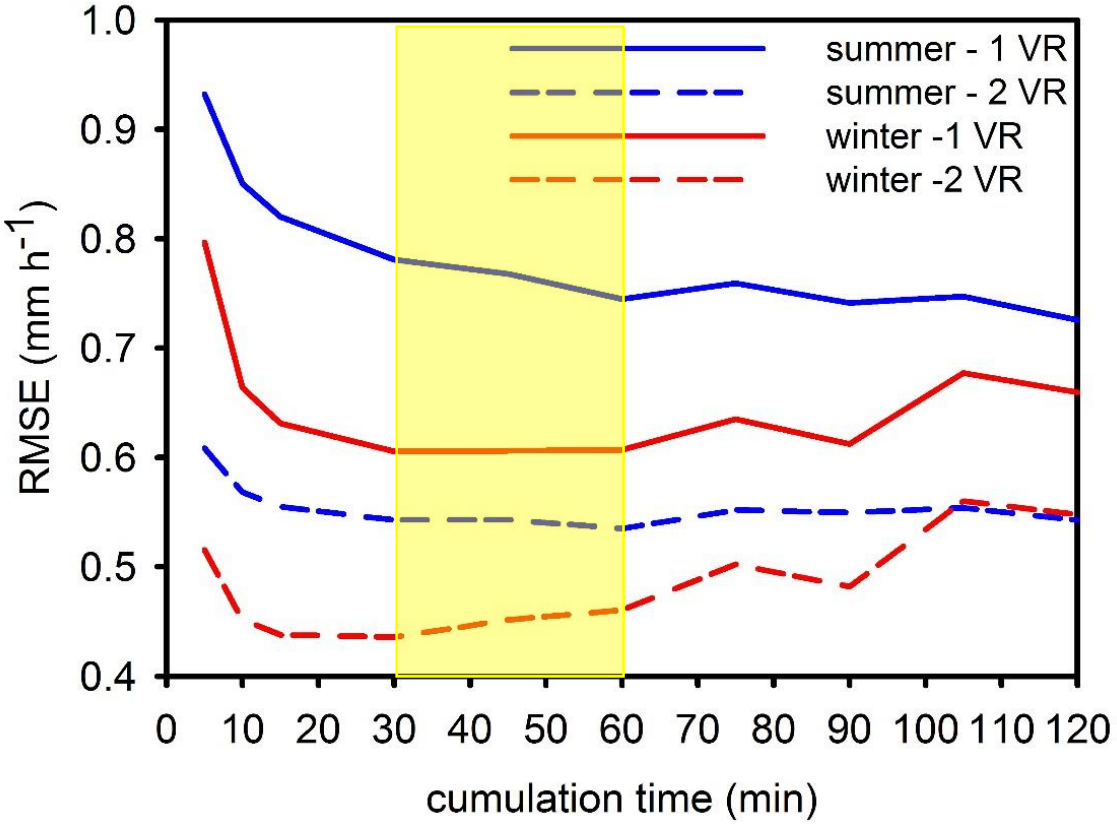
correlation between 2 points in the network as function of their distance



raingauge networks: selection of cumulation intervals

representativeness error is due to the different temporal and spatial sampling of (areal and instantaneous) satellite estimates and (point-like and cumulated) raingauge measures.



by using a dense 1-min gauge subnetwork, we evaluated the error between the 9-gauges averaged rainrate (within a satellite IFOV) end the 1- and 2-raingauges value, as function of:

1-number of raingauges;

2-raingauges cumulation time;

3-season

raingauge networks: selection of cumulation intervals

errors for 60 minutes raingauge cumulation interval

	RMSE (mmh^{-1})	CC	FAR	POD	ETS	MB
SUM 1 VR	0.74	0.71	0.33	0.86	0.51	1.30
WIN 1 VR	0.61	0.80	0.39	0.81	0.34	1.34
SUM 2 VR	0.53	0.82	0.24	0.88	0.61	1.15
WIN 2 VR	0.46	0.87	0.25	0.82	0.46	1.10

raingauge networks: interpolation

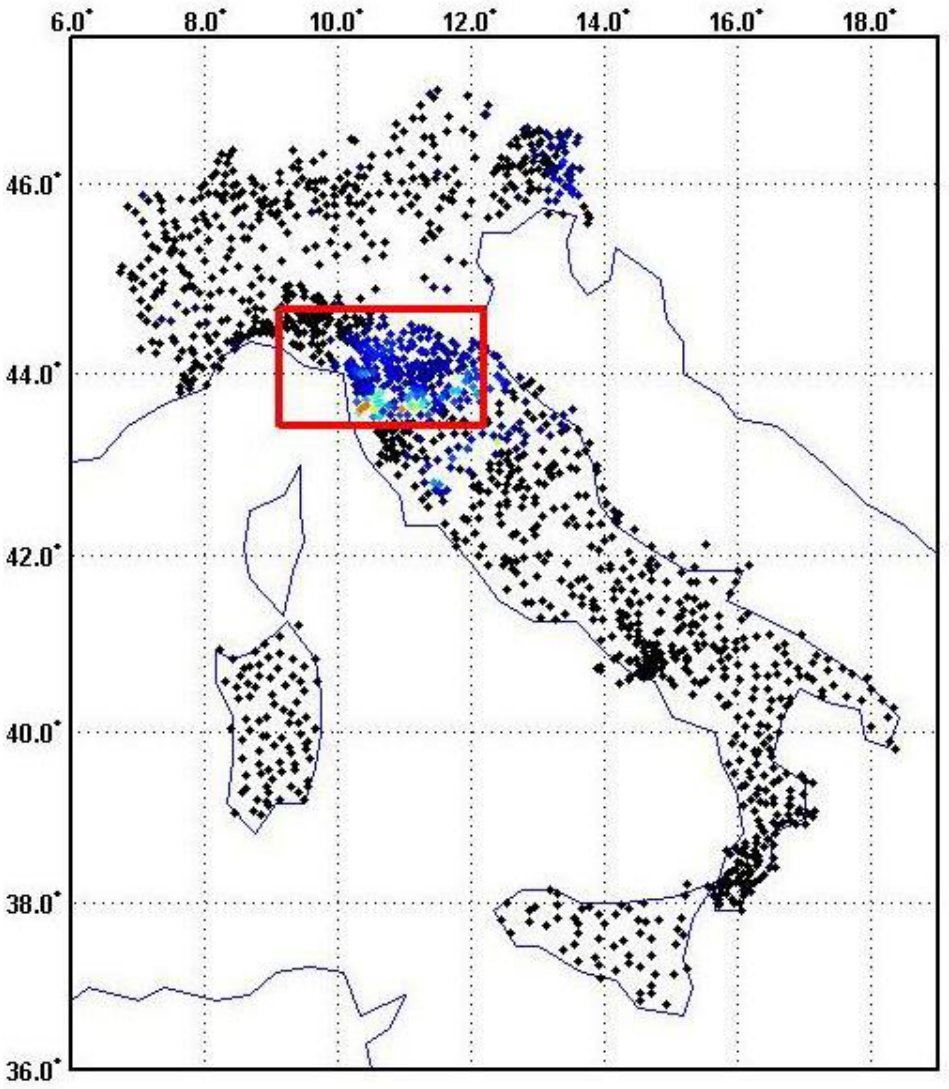
The raingauge networks have highly variable local density (4 km < AMD < 30 km) the application of an interpolation algorithm provides equispaced and homogeneous grid.

Algorithm selection:

- Barnes analysis;
- Ordinary Kriging;
- Random Generator of Spatial Interpolation from uncertain Observations (GRISO) – CIMA Foundation, Savona, Italy;

To test how the interpolated map changes with gauges density

raingauge networks: interpolation

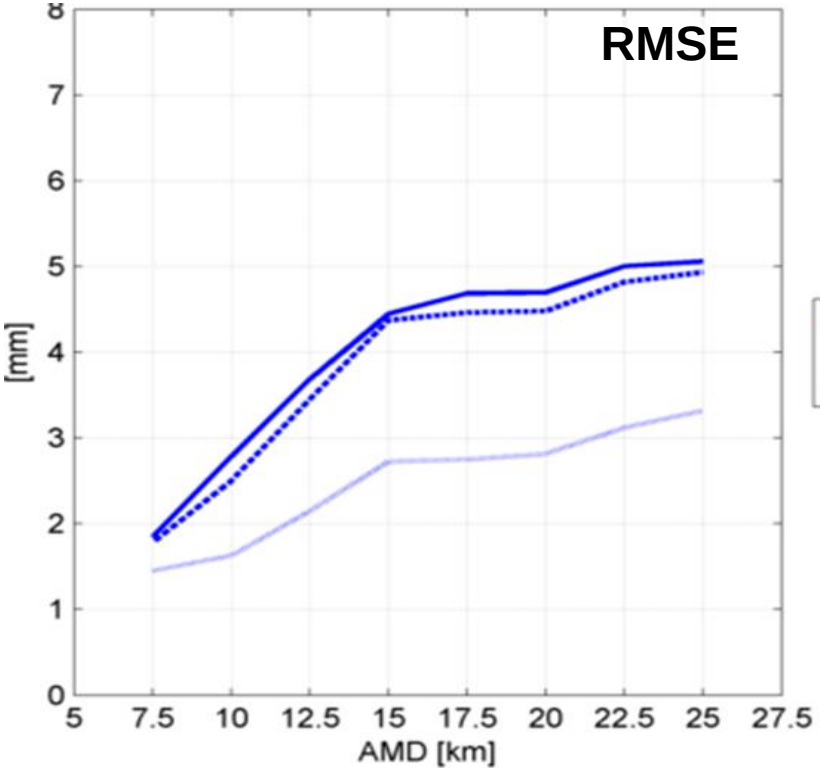


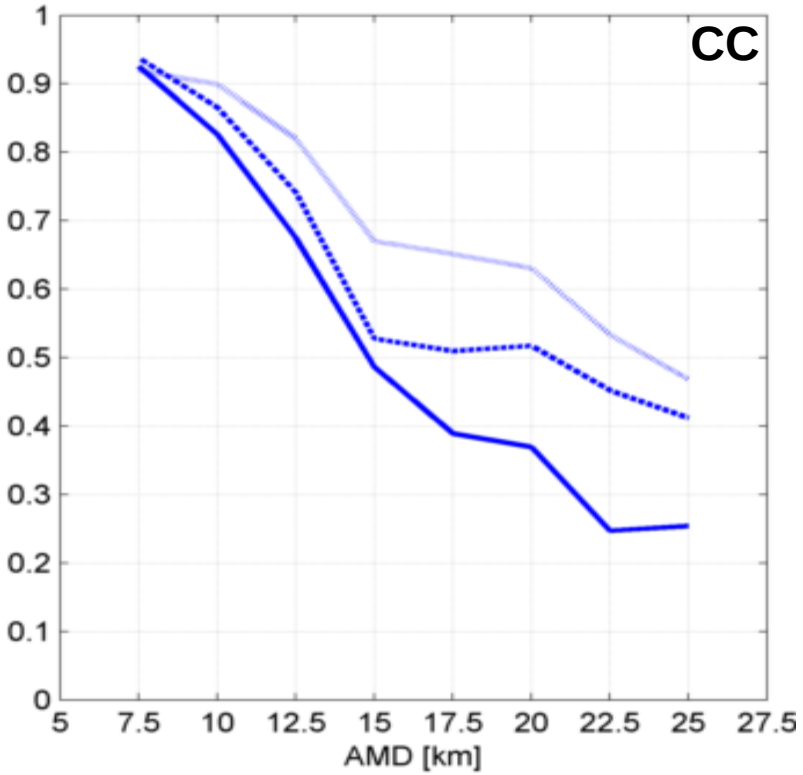
3 techniques are compared;

reference maps are computed with the maximum gauges density (350 raingauges, AMD = 4.5 km);

errors are computed between reference maps and maps obtained with decreasing number of gauges.

raingauge networks: interpolation





raingauge networks: validation flow chart

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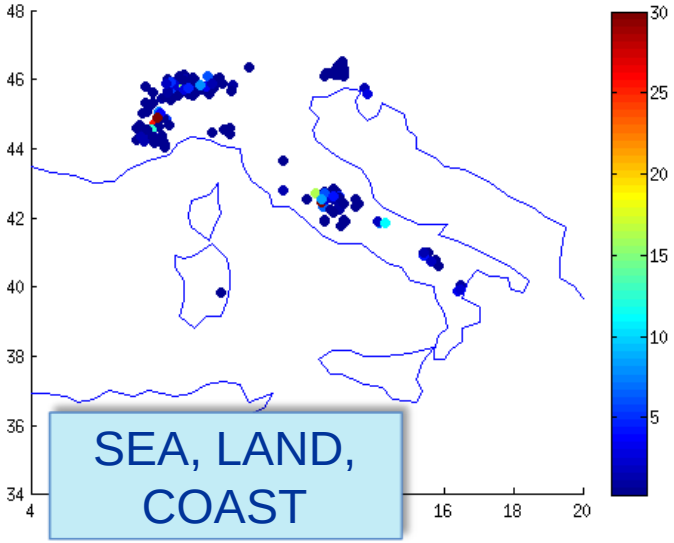
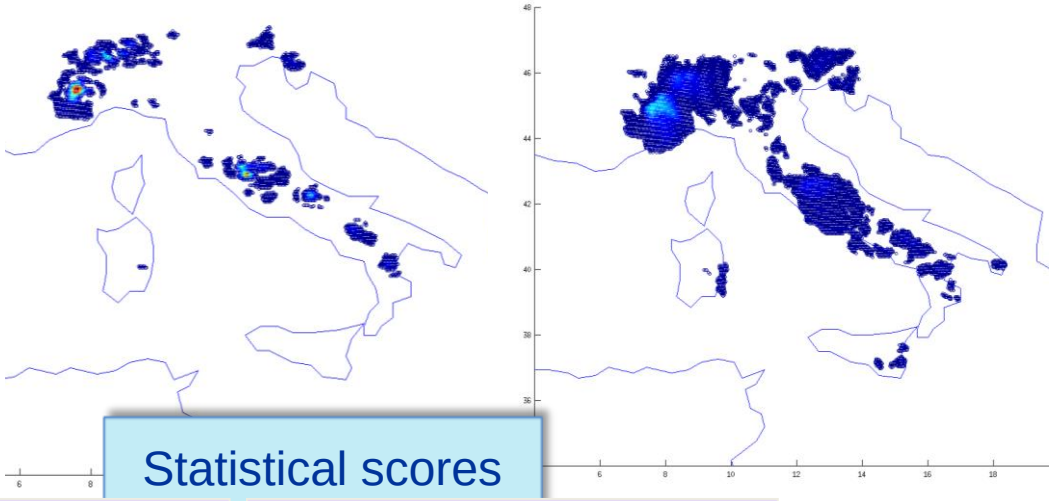
Rain gauge → Quality filter → Interpolation ⇄ Satellite product



SEA, LAND, COAST



Statistical scores

Binary scores:	Continuous scores:
POD	Mean absolute error
FAR	Root mean square error
CSI	correlation coefficient
ETS	Standard deviation
HSS	Fractional standard error
BIAS	Nash-Suthcliffe coefficient

H-SAF product validation

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product	sensor	revisiting time	ground resolution	algorithm
H01	SSMI/ SSMIS	≈ 4 hours	16-50 km	CDRD
H02	AMSU/ MHS	≈ 4 hours	30 km	ANN
H03	SEVIRI + h02	15 min	≈4x5 km^2	blending
H04	SEVIRI + h01+h02	30 min	8x8 km^2	morphing

H-SAF product validation: h03 error topography

2 years of data

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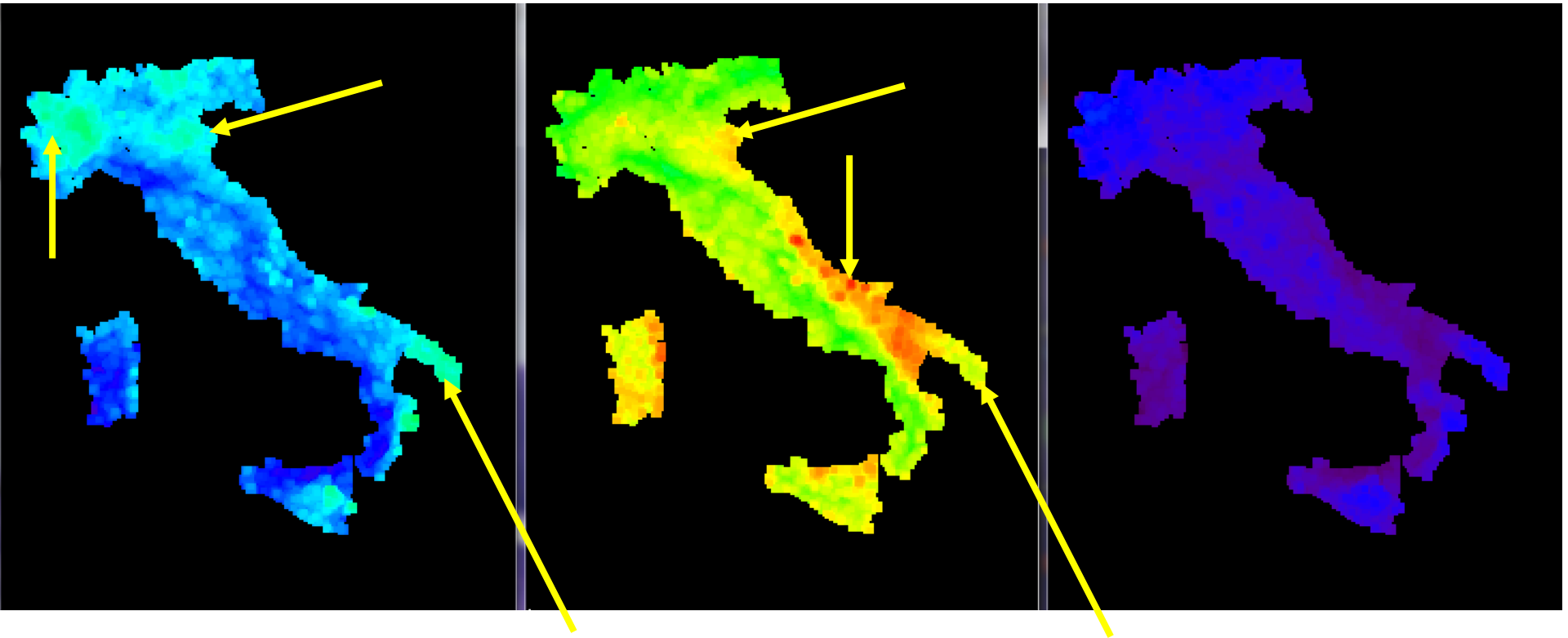
POD

FAR

ETS



H-SAF product validation: h03 error topography

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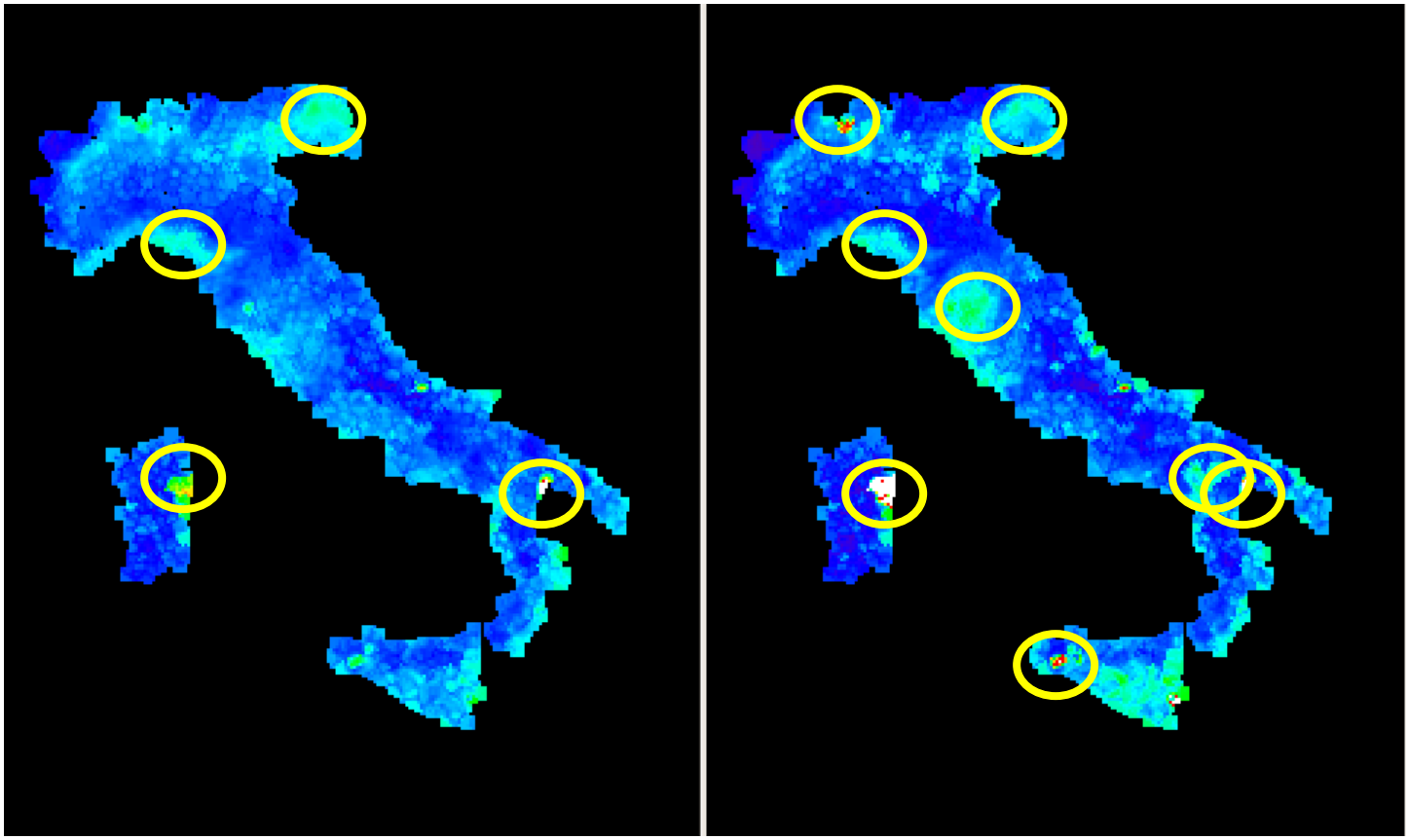
<RR$_{wet}$>

RMSE



0 2.5 5

mmh^{-1}

0 2 4 6 8

mmh^{-1}

H-SAF product validation: sensitivity to gauges density

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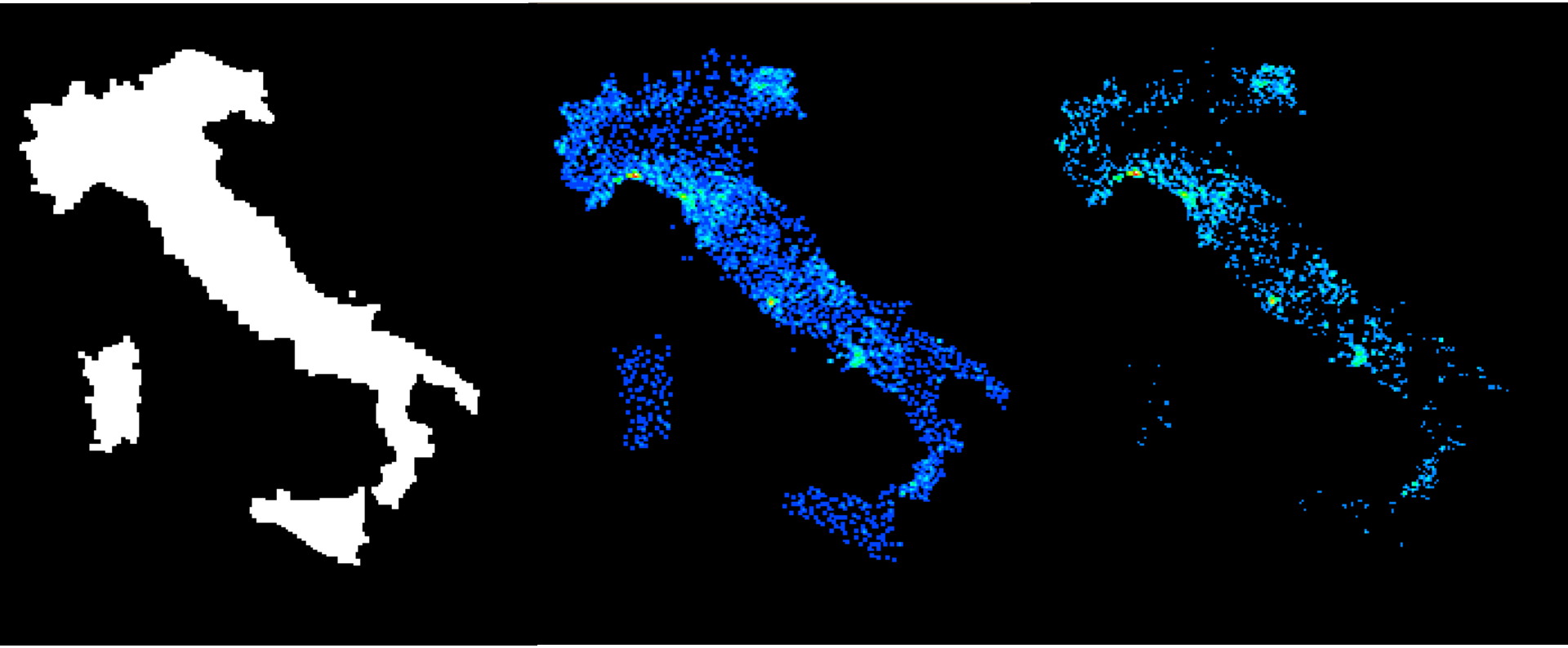
all land | at least 1 RG | at least 2 RG



12149 | 7338 | 2517

0 5 10 15 raingauges/gridpoint

H-SAF product validation: sensitivity to gauges density

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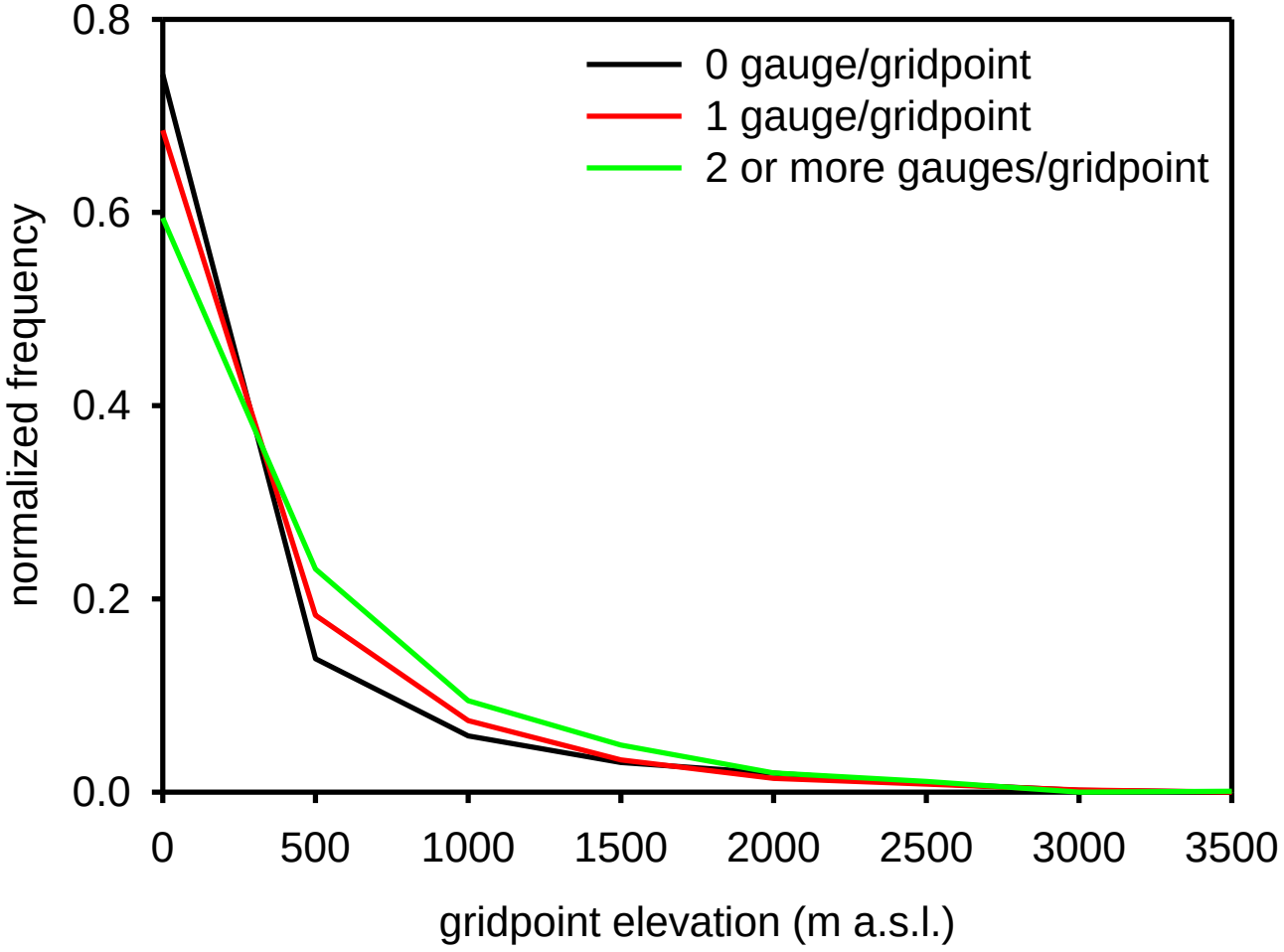
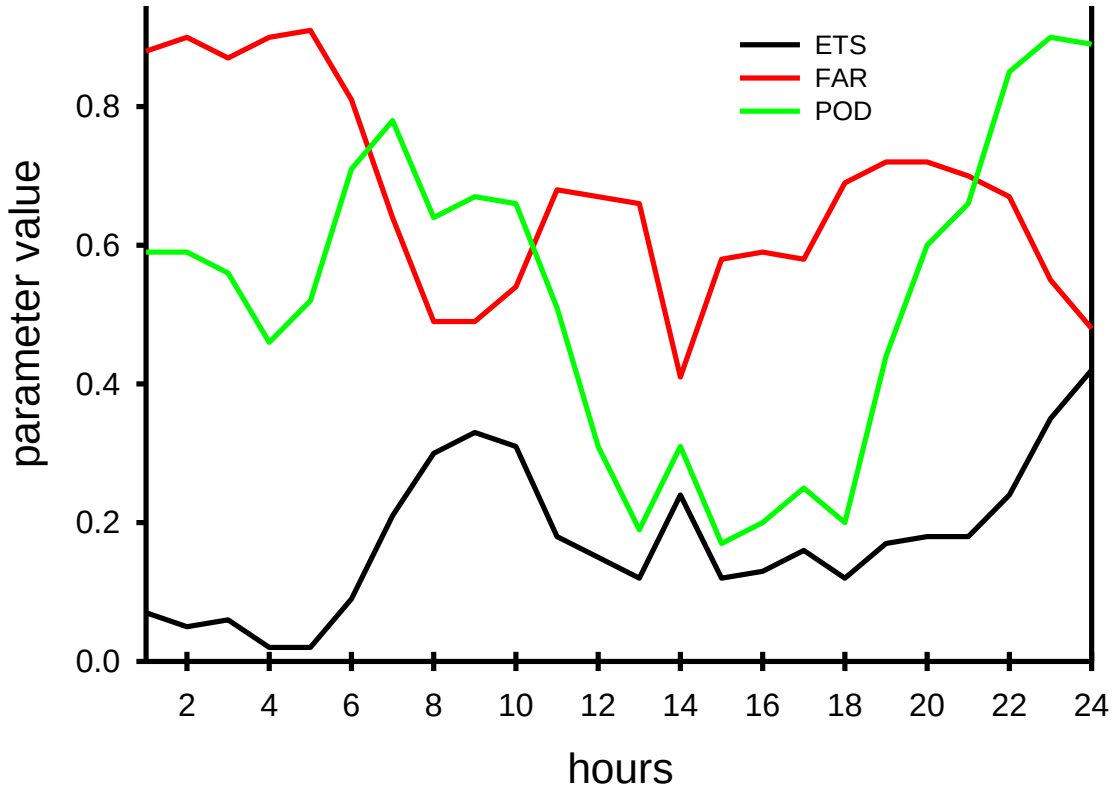
Fraction of gridpoints with 0, 1 or 2 and more raingauges as function of the elevation



H-SAF product validation: sensitivity to gauges density

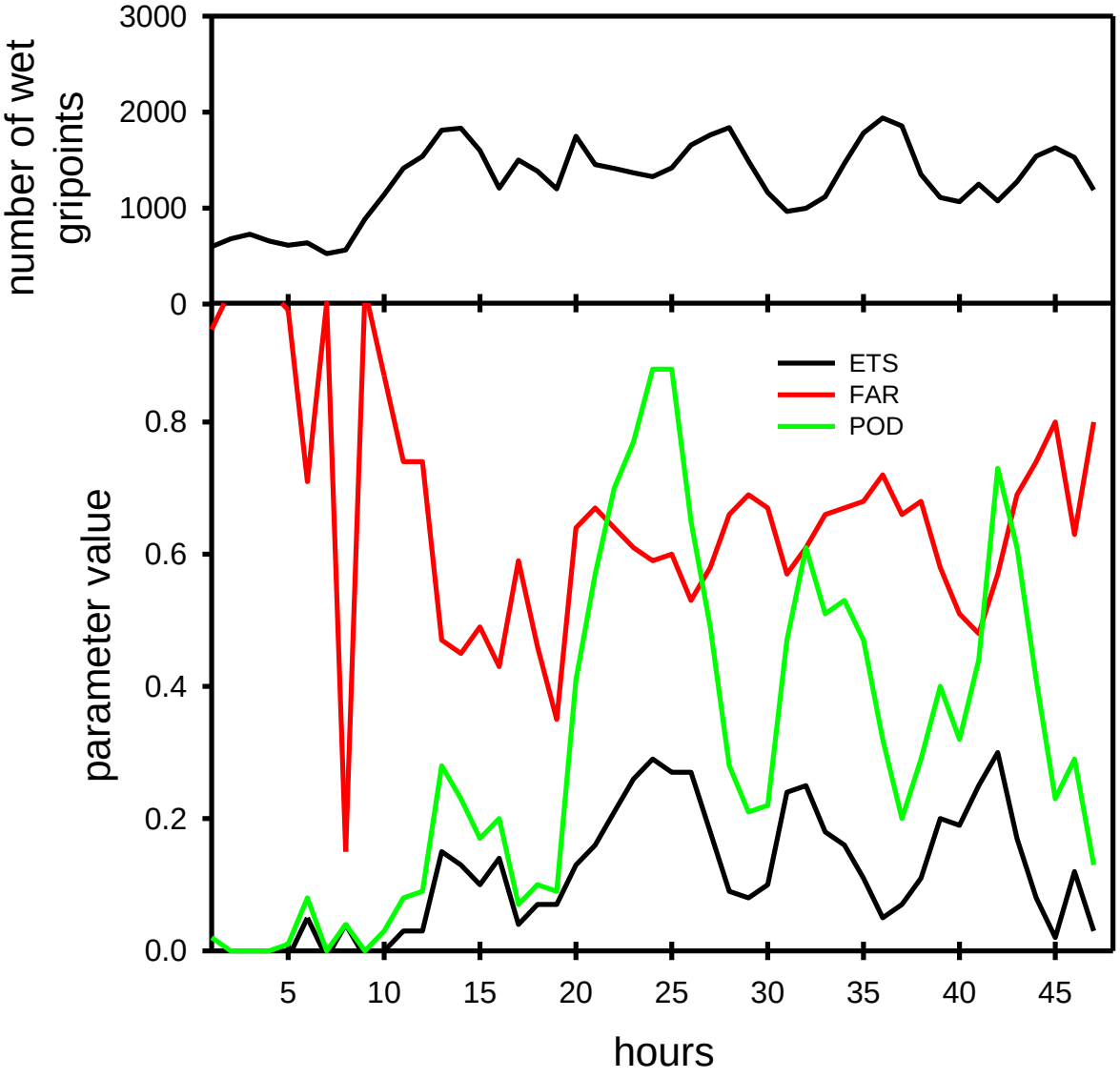
201207			201301	
0-1 RG	2-6 RG	H01	0-1 RG	2-6 RG
2.11	2.10	MAE	0.90	0.90
0.31	0.38	CC	0.40	0.43
3.97	3.81	RMSE	1.36	1.27
4.55	3.51	%RMSE	1.26	1.28
0.25	0.25	ETS	0.25	0.26
0-1 RG	2-6 RG	H03	0-1 RG	2-6 RG
1.98	2.01	MAE	1.10	1.04
0.23	0.32	CC	0.25	0.24
3.54	3.22	RMSE	1.65	1.54
2.43	2.30	%RMSE	1.14	1.05
0.20	0.24	ETS	0.13	0.12

H-SAF product validation: sensitivity to rain rate and area



H03 *01:00-24:00 UTC - 23/07/2011*

H-SAF product validation: sensitivity to rain rate and area



H03 01:00 - 02/02/2012 to 24:00 - 03/02/2012

H-SAF product validation: sensitivity to rain rate and area

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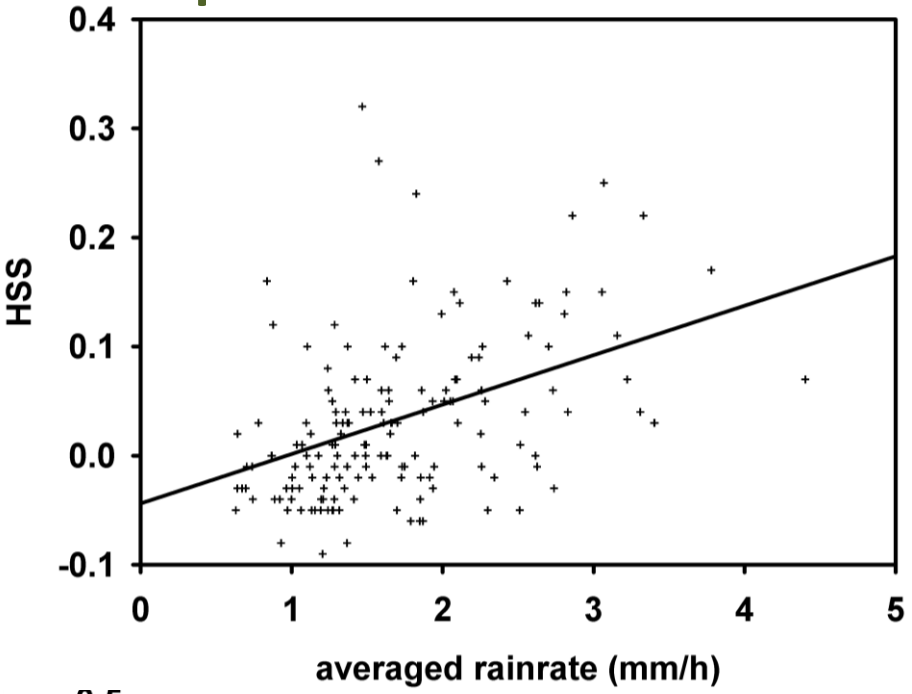
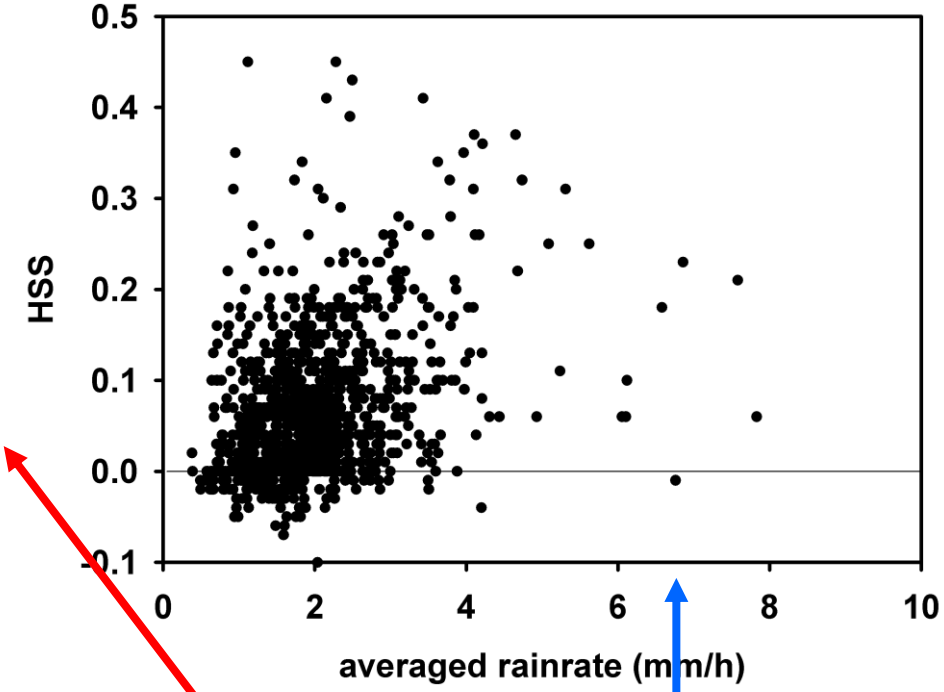
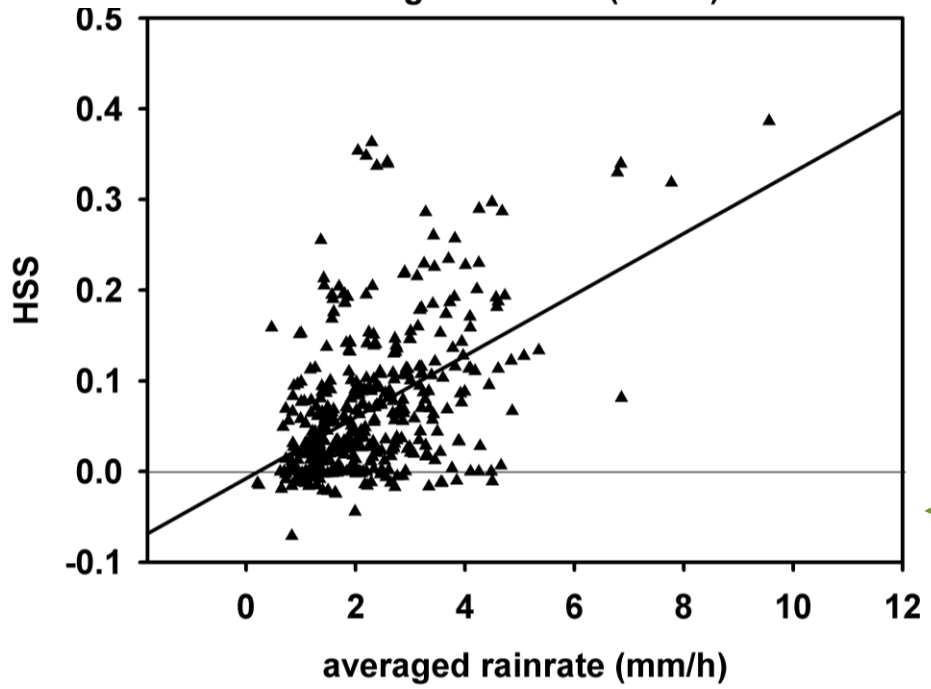






h01

h03

September 2013

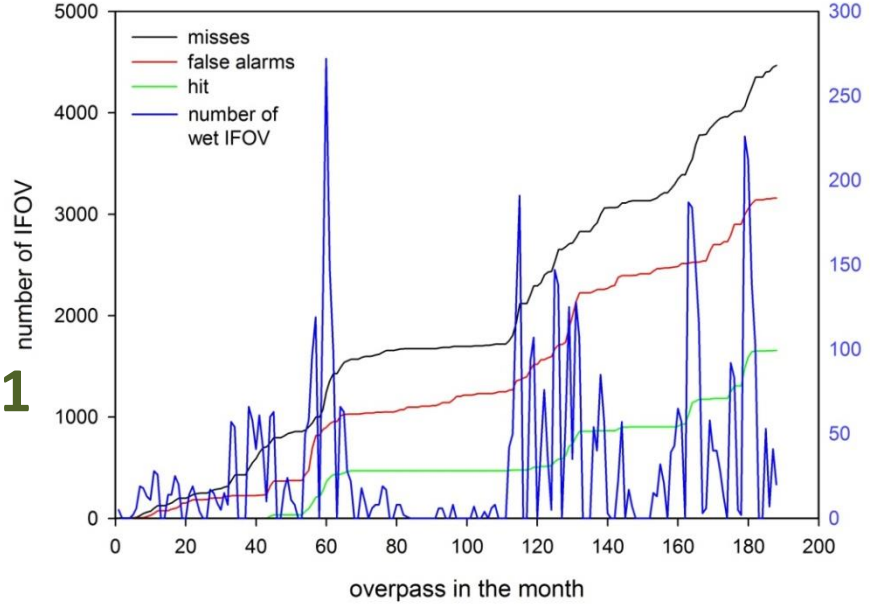
h02

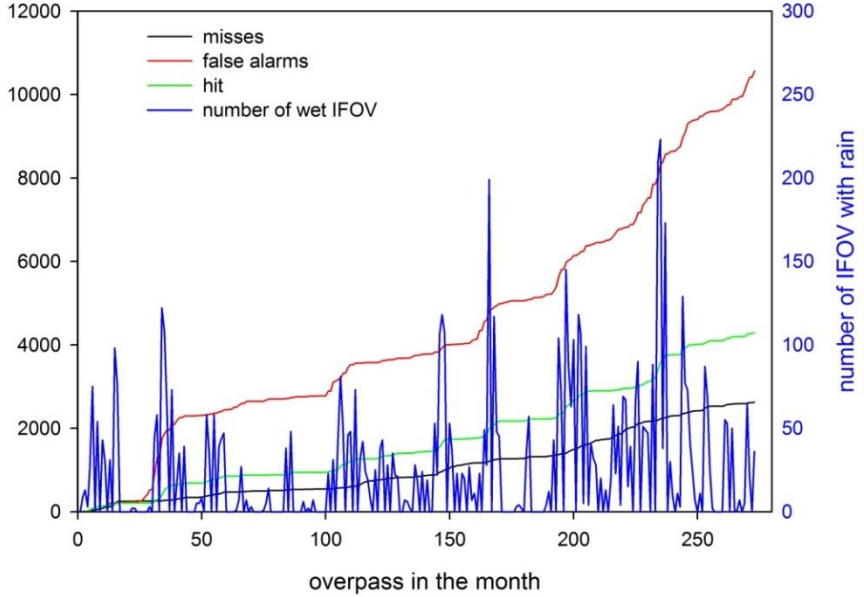
H-SAF product validation: intercomparison h01 vs. h02

winter

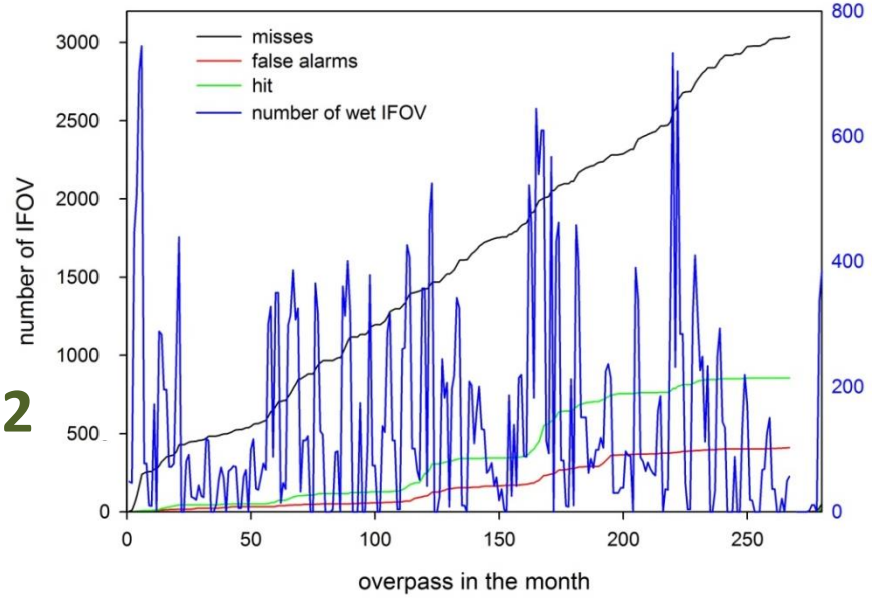
summer

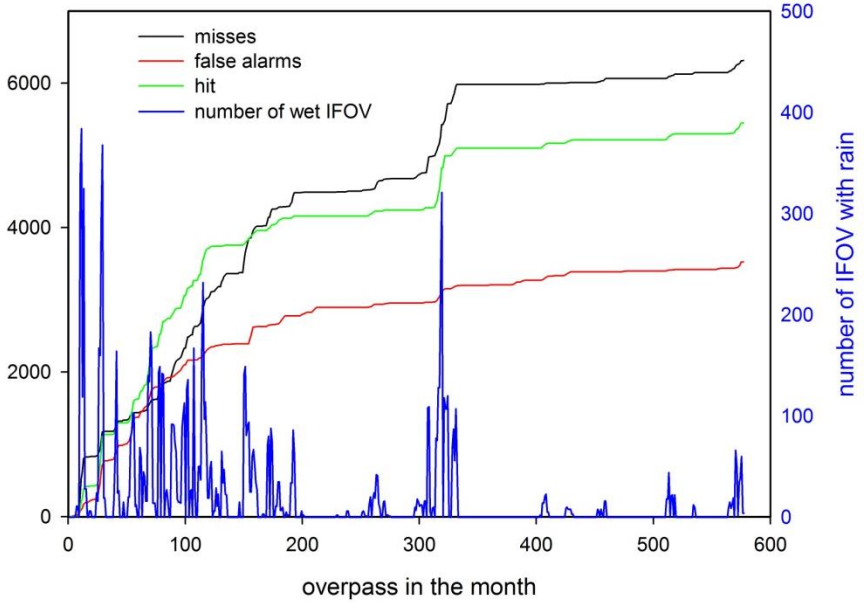
h01





h02





H-SAF product validation: intercomparison h01 vs. h02

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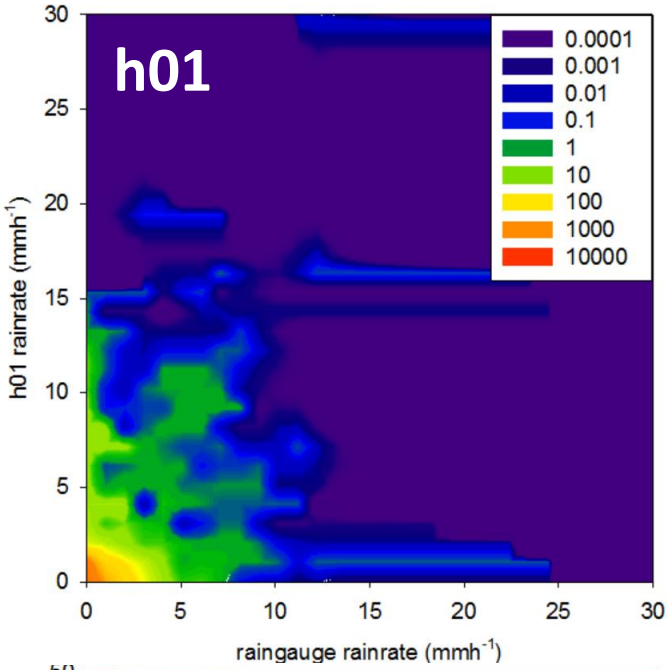
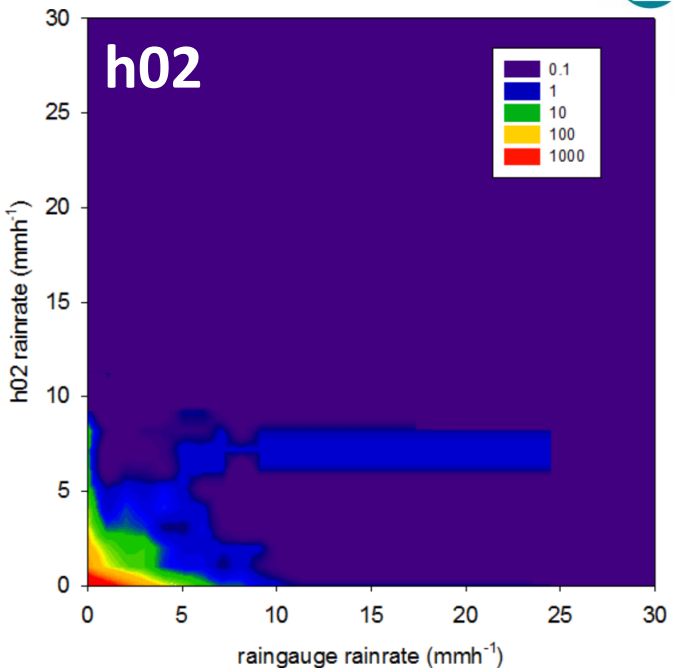
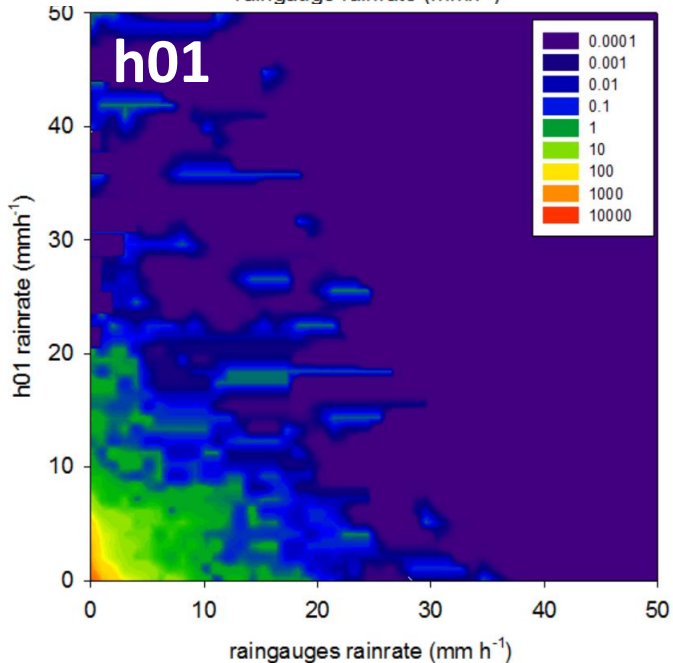
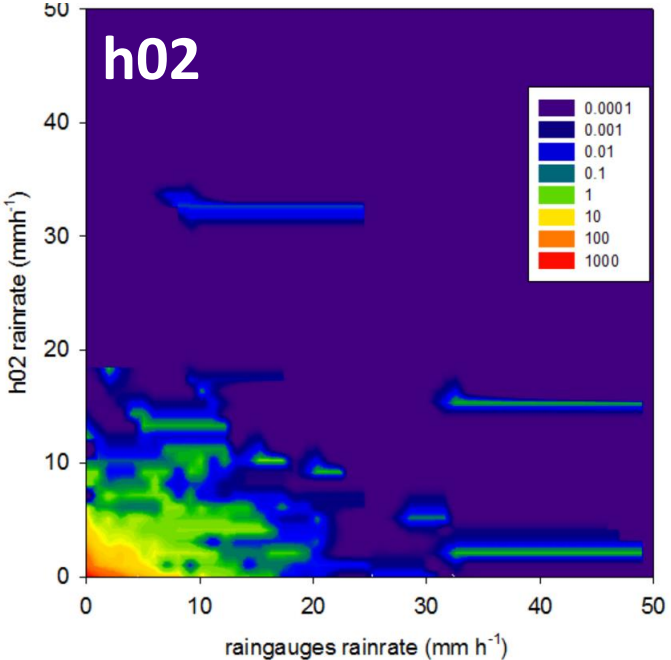


winter

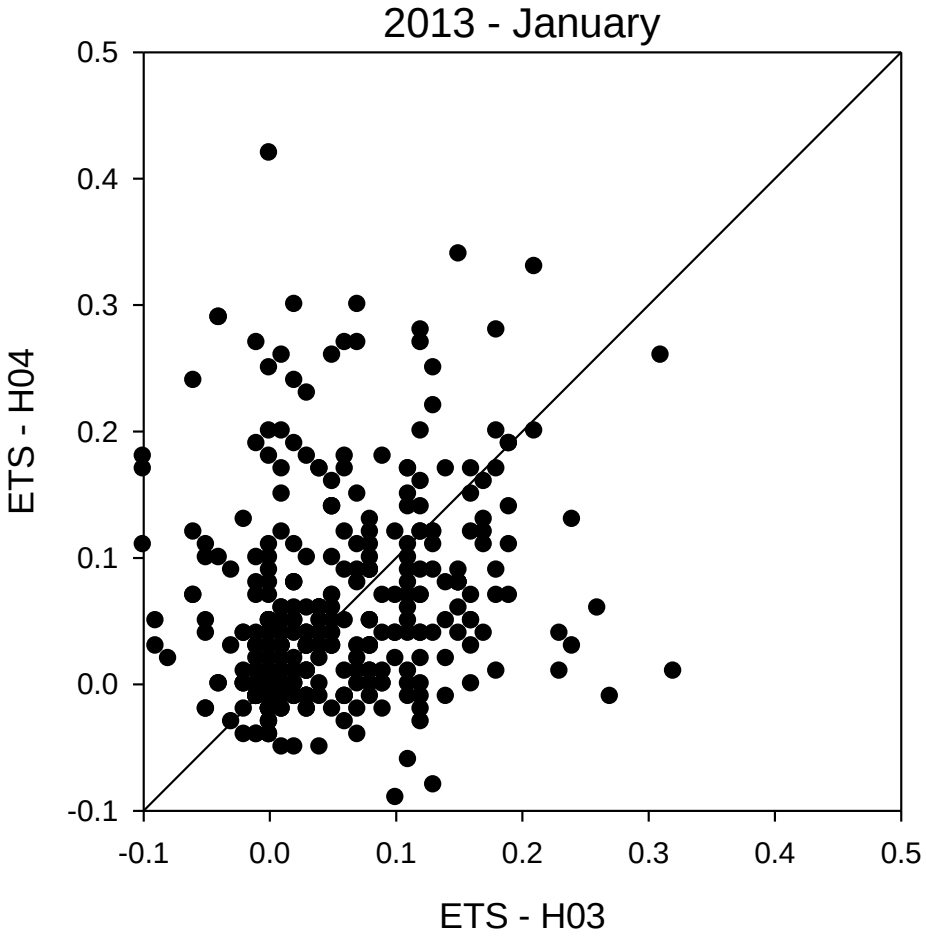


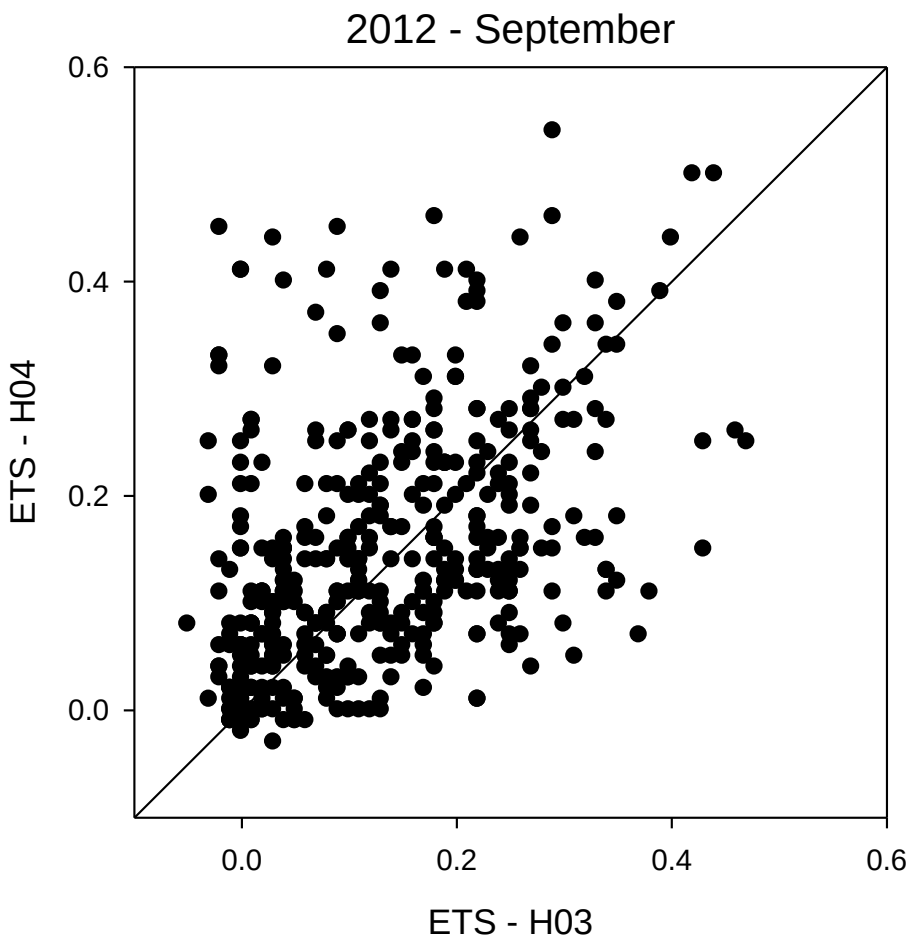


summer

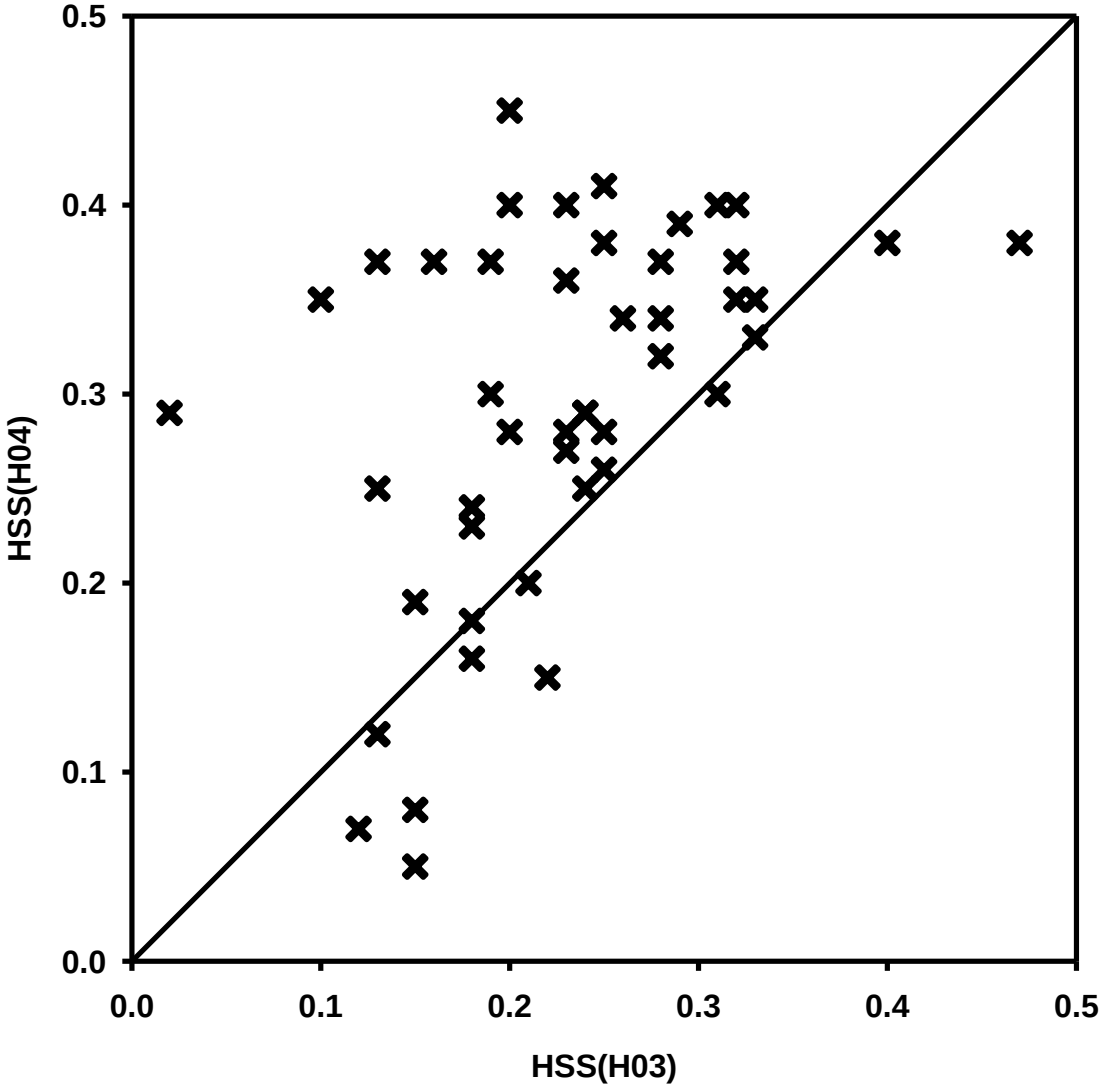


H-SAF product validation: intercomparison h03 vs. h04





H-SAF product validation: intercomparison h03 vs. h04



H03 & H04 01:00 - 05/11/2011 to 24:00 - 06/11/2011

H-SAF product validation: intercomparison h03 vs. h04

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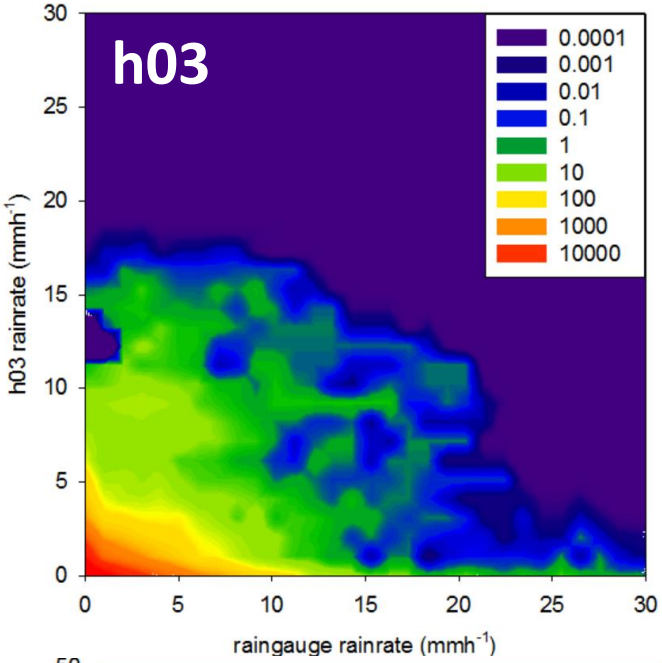
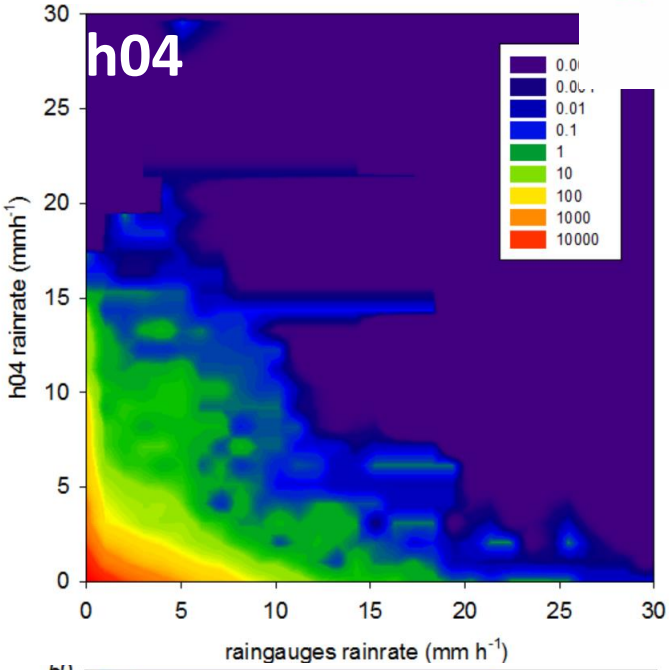
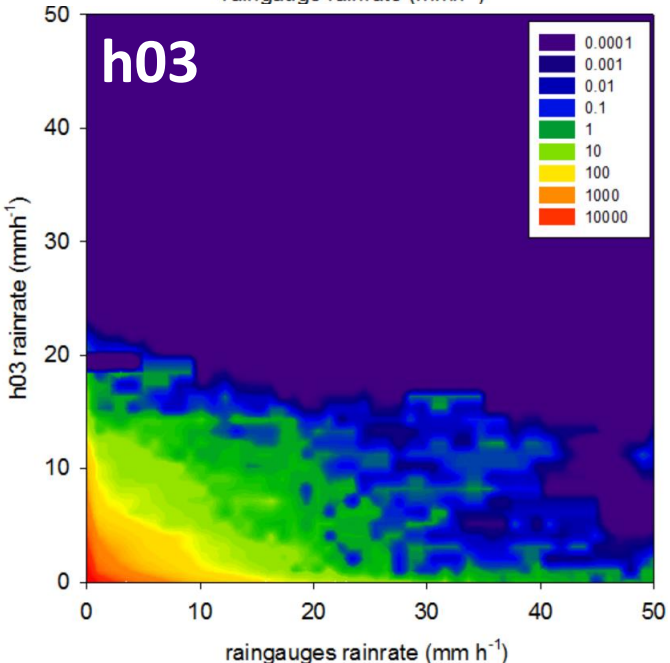
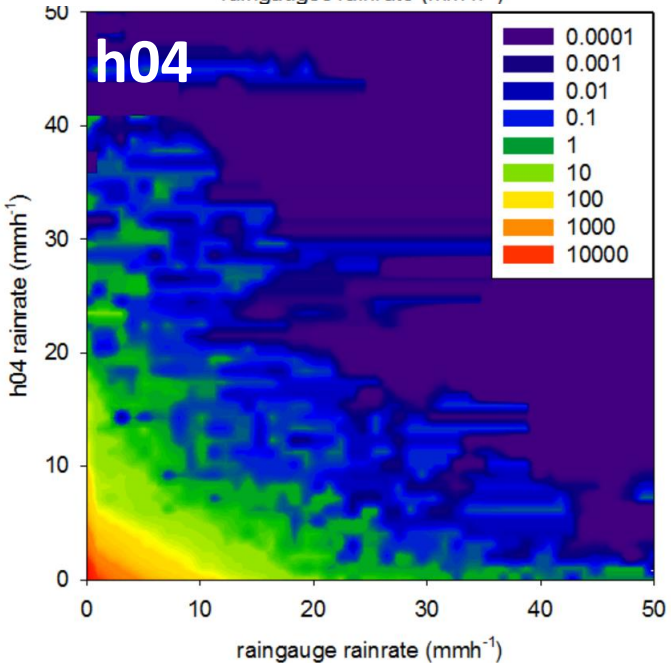


winter





summer



GPM product validation: approch

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product: GMI GPROF V03 ***period: March-June 2014***

- COMMON VALIDATION:

  Satellite product (GPROF V03) averaged on a 0.5° x 0.5° grid;

  Rain gauge masurements: spatial interpolation and remapped to same grid;

  Radar estimates: up-scaling to match the 0.5° x 0.5° grid;

  Statistical scores evaluation (continuous and multi-categorical);

- CASE STUDY ANALYSIS

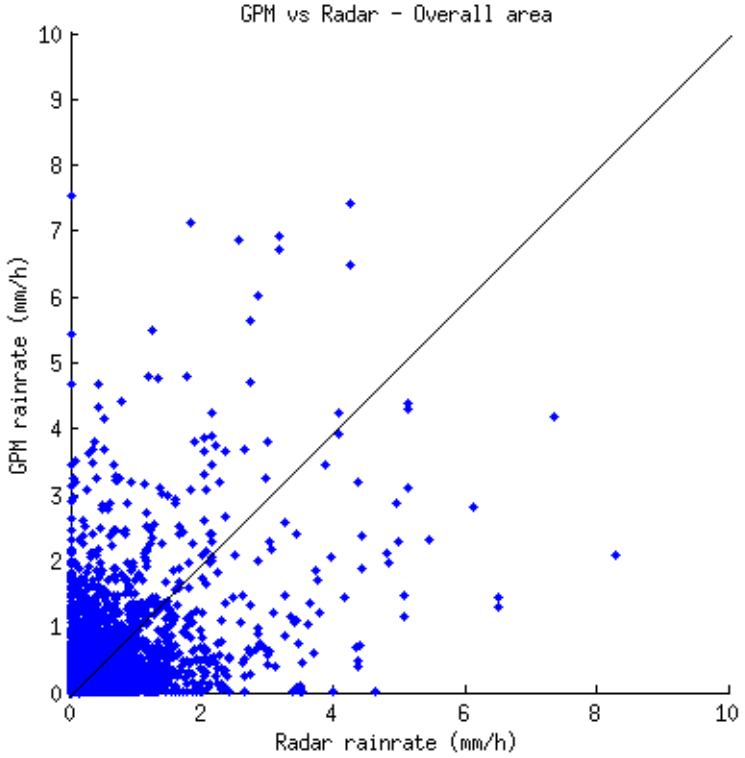
  are carried out indipendently by each Institute: ancillary data such as lightning, MSG SEVIRI images, NWP models, nowcasting products might be used.

GPM product validation: approch

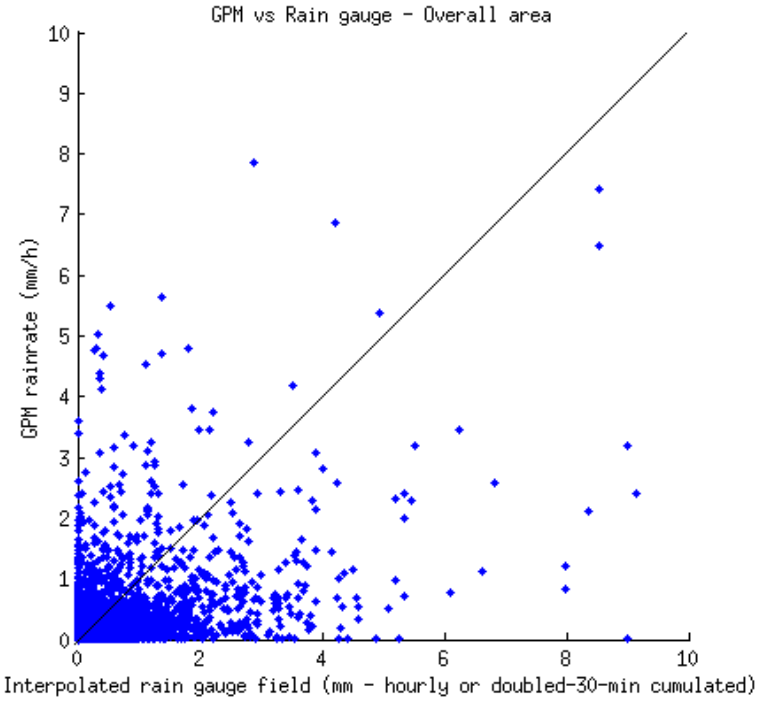
- Evaluated **on monthly basis;**
- Statistics are calculated **over each country** and then **over the whole area;**
- Three different statistics for **Land**, **Coast** and **Sea**;
- **Rain/no rain threshold** (0.20 mm/h for the GPM products);
- Statistics evaluated for different **precipitation classes**:
  - -Class 1 (no rain): 0.00 – 0.20 mm/h
  - -Class 2: 0.20 – 110 mm/h
  - -Class 3: 1.00 – 110 mm/h
  - -Class 4: all events above 0.20 mm/h
  - -Class 5: all events above 1.00 mm/h

- Radar data: **Italy, Hungary, Slovakia (Poland for case studies)**
- Raingauge data: **Italy** (30 min), **Bulgaria** (60 min, very limited area) (**Poland for case studies**)

GPM product validation: monthly values



GMI vs Radar – All areas



GMI vs RG – All areas

GPM product validation: monthly values

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RADAR		Land	Coast	Sea
rr>0.20 mm/h	NS	1428	380	227
	NR	2159	334	134
	Mean Error	-0.38	0.12	0.48
	Std. Dev.	0.73	0.84	1.05
	MAE	0.54	0.50	0.75
	Bias	0.49	1.19	1.73
	RMSE	0.82	0.85	1.15

RAIN GAUGE		Land	Coast
rr>0.20 mm/h	NS	1117	101
	NR	1796	110
	Mean Error	-0.60	-0.48
	Std. Dev.	1.05	0.82
	MAE	0.76	0.61
	Bias	0.39	0.40
	RMSE	1.21	0.95

GPM product validation: case studies

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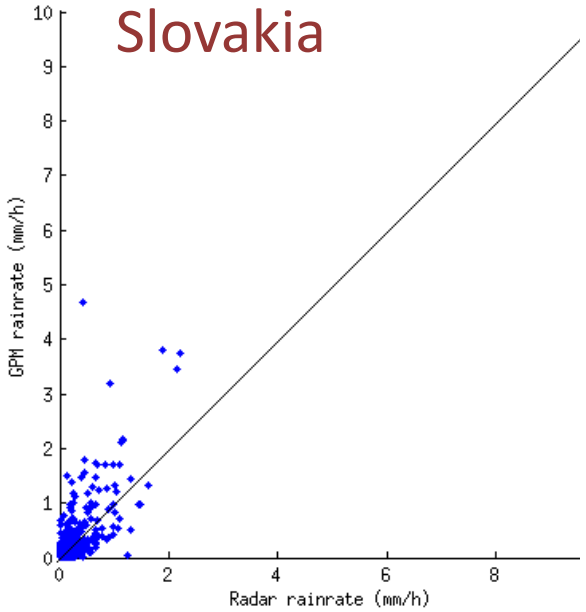
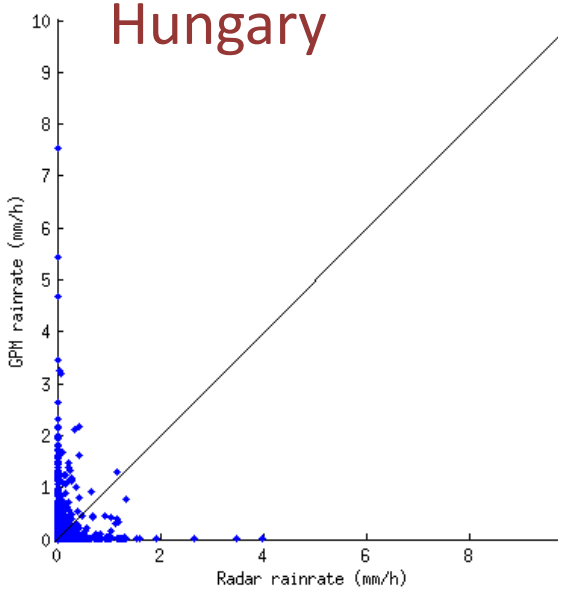
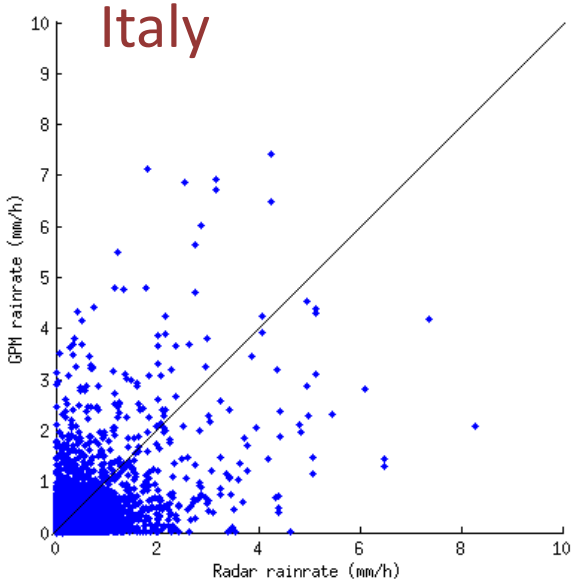
GMI vs Radar Slovakia



GMI vs Radar Hungary



GMI vs Radar Italy



Good results in Slovakia (land only), where **stratiform precipitations** occurred during the validation period (**GPROF overestimation**), and **quite good in Italy (land, coast, and sea) where also convective precipitation** has been registered, and **bad results in Hungary**. The difference between the scatterplots are mainly due to the different precipitation regimes.

GPM product validation: case study

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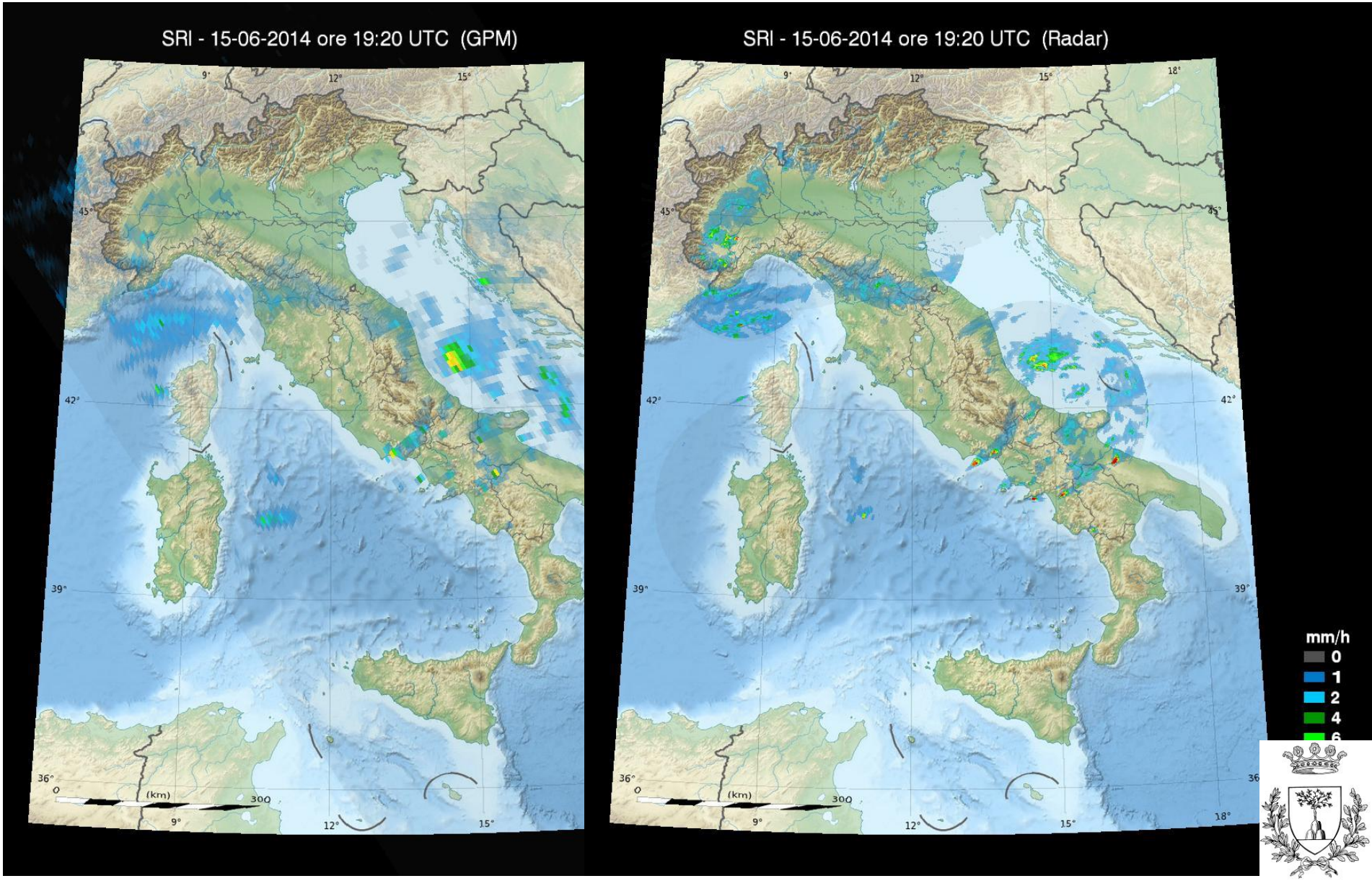
GMI

Radar



GPM product validation: case study

H SAF
Support to Operational Hydrology and Water Management

Score	Rain gauges	Radar (Land)	Radar (Sea)
NSat	62	45	15
NGround	94	79	11
Mean Error	-0.51	-0.40	0.42
Bias	0.31	0.37	1.41
MAE	0.55	0.42	0.45
CC	0.33	0.36	0.77
RMSE	0.81	0.60	1.17

	RG	RD (land)	RD (sea)
POD	0.49	0.49	1.00
FAR	0.26	0.13	0.26
CSI	0.42	0.46	0.73

threshold:
0.20 mm/h

raingauge networks: summary

Sensitivity studies indicates 30-60 minutes as raingauges cumulation time to minimize some errors.

GRISO is the interpolator with lower sensitivity to changes in raingauge network AMD.

A significant part of the error is due to inherent inaccuracies in the validation procedure: their impact could mitigated but not eliminated.

H-SAF product validation: summary

The increase of ground truth quality results in an improvement of the matching with satellite products.

A priori statements (gauge density, orography) have variable impact: correlated effects (low local gauge density, parallax error, high representativeness errors and products uncertainties) can mask the impact.

Take advantage of the product variety, according to season, precipitating system, use of the product.

GPM product validation: summary

High % of missed light precipitation (0.2 mm/h – 1.00 mm/h) compared to both radar and rain gauges.

Good performances have been evaluated in term of continuous statistical scores (Mean error from -0.38 mm/h (over land) to 0.48 mm/h (over sea)) and Root Mean Squared Error from 0.82 mm/h to 1.15 mm/h) using as reference the radar data.

Good results have been obtained generally for the stratiform precipitation occurred in Slovakia (with some overestimation), and for Italy (overall better with respect to radar than to raingauges).

references

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Porcù F., L. Milani and M. Petracca, 2014: On the uncertainties in validating satellite instantaneous rainfall estimates with raingauge operational network, *Atmos. Res.*, **144**, 73-81.