ASSESSING THE IMPACT OF THE ASSIMILATION OF SATELLITE-RETRIEVED PRECIPITATION AND HUMIDITY PRODUCTS INTO THE HYDROSTATIC BOLAM: TWO ITALIAN CASE STUDIES

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The starting point of this work…

- Satellite-borne instruments represent an additional and useful sources of hydro-met data.
- The use of satellite estimations can have a high impact in flood risk management (e.g. flood forecasting, early warming systems).
- LAM performance in terms of QPFs can improve by assimilating satellite-retrieved product.

➔ goals of a pilot research project **PROSA** – *Progetto Pilota "Protezione Civile dalle Alluvioni: il Nowcasting"* – funded by the Italian Space Agency (ASI), as part of its Earth Observation Program

http://www.prosaproject.it/ Oct.2007-Feb.2011

Satellite products (three releases/versions) validated/verified during PROSA

- ✓ Instantaneous and accumulated hydro-met satellite products: V1 – V2 – V3
- ✓ Hourly and accumulated BOLAM QPFs (without any assimilation): V2 – V3
- ✓ Hourly and accumulated BOLAM QPFs obtained by assimilating EPP e EPS: V3
- ✓ Accumulated MOLOCH QPFs: V3

The hydrostatic BOLAM model

prognostic variable; vertical level	U, V, q, θ, p_s + 5 hydrometers; hybrid levels
advection scheme	Weighted Average Flux
Parameterizations:	
Convection	Kain-Fritsch
Large scale precipit.	Schultz microphysics
Radiation	Geleyn + Morcrette
Surface layer	Monin-Obukhov
Vertical diffusion	E-*l* (*O(1.5)*)
Soil	FAO landuse, icing (3 levels +1)

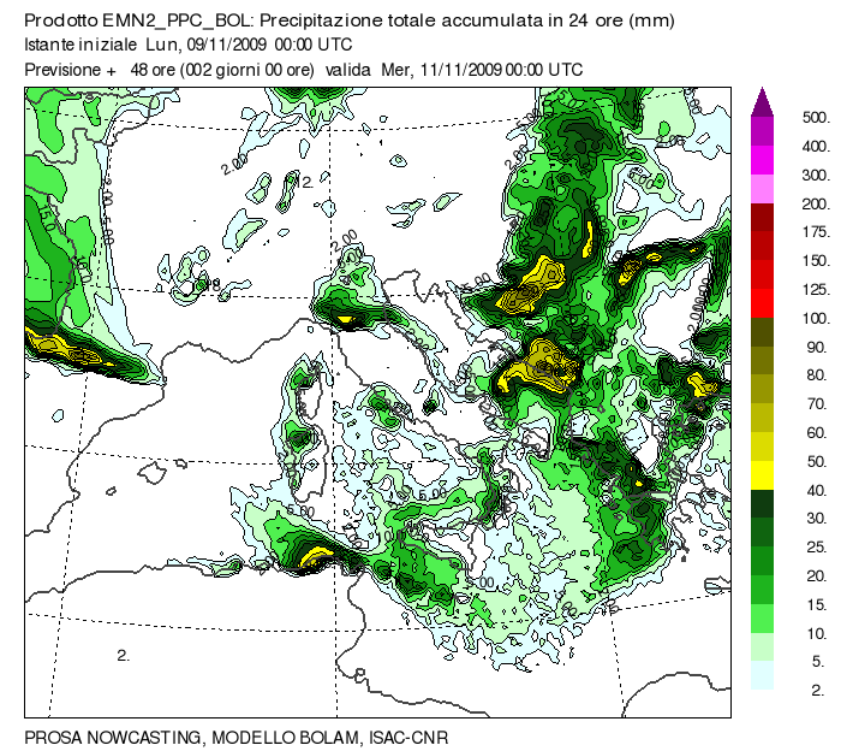
Developed at ISAC-CNR (http://www.isac.cnr.it/dinamica/projects/forecasts/) and operational in several regional and national agencies, including ISPRA (http://www.isprambiente.gov.it/pre_meteo/ - within **SIMM** forecasting chain)

QPF BOLAM data set: 5 Jul. 2009 & 7-9 Nov. 2009

- without any assimilation, initialized using GFS (NOAA, NCEP, USA) forecast data;
- with the assimilation rainfall estimations obtained by using a blending tech. – Levizzani et al. – which combines IR and MW data;
- with the assimilation For the assimilation of the surface soil water content and snow cover water content which were elaborated at IFAC-CNR (Italy) using data of the MW AMSR-E sensor on board of AQUA polar satellite and of the SSM/I sensor on board of DMSP polar satellites.

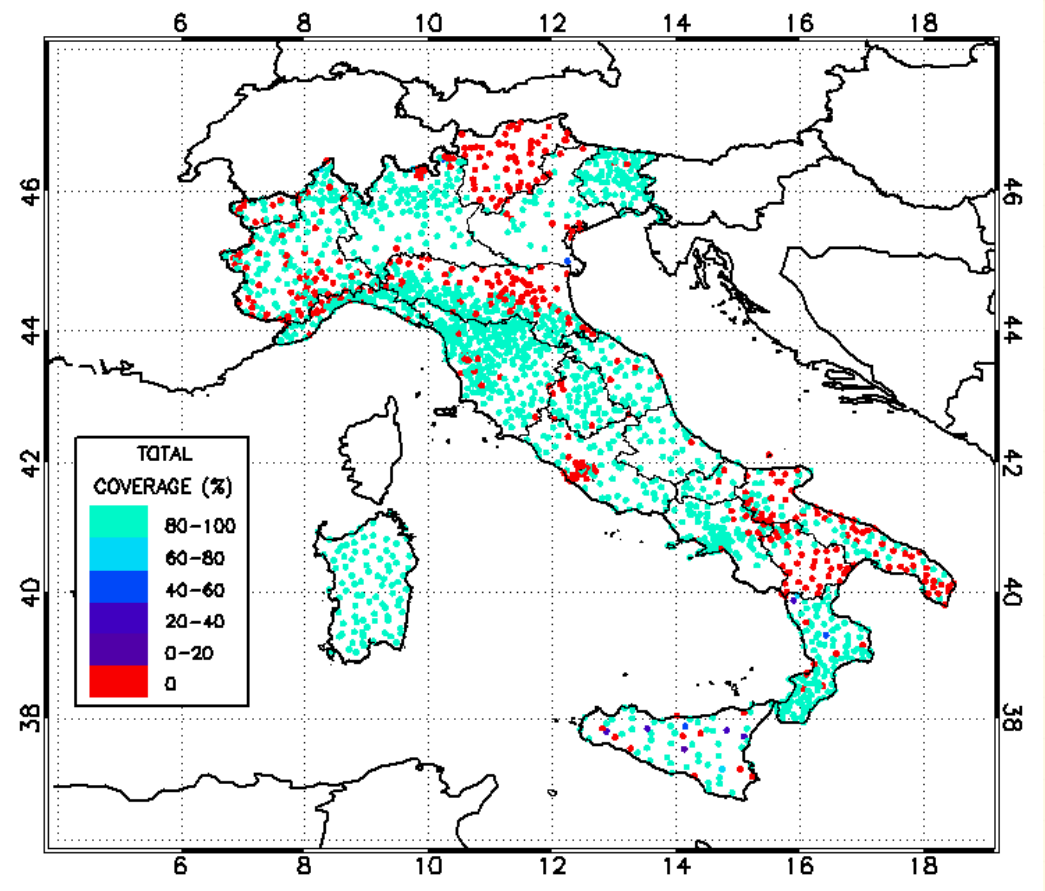
RUNS:

1200 UTC 2009/07/03
0000 UTC 2009/07/04
1200 UTC 2009/07/04
1200 UTC 2009/11/06
0000 UTC 2009/11/07
1200 UTC 2009/11/07
0000 UTC 2009/11/08
1200 UTC 2009/11/08
0000 UTC 2009/11/09



Rain gauge data

- Data collected from 1905 (regional) rain gauge stations through the Italian DPC (→ Network of Functional centres).
- Ca. 1500 daily measures available during the case studies.
- Data missing from some IT areas of interest, which were affected by the 2 events.
- Data not available within the from the other MED regions/ nations.



Distribution of (regional) rain gages, with time coverage indication for the two case studies

Categorical score approach

Contingency table of possible events for a selected threshold.

		Rain observed	
		Yes	No
Rain forecast	Yes	*a*	*b*
	No	*c*	*d*

Contingency Table

$$\mathbf{BIAS} = \frac{a+b}{a+c}$$

$$\mathbf{ETS} = \frac{a-a_r}{a+b+c-a_r} \quad \mathbf{with} \quad a_r = \frac{(a+b)(a+c)}{a+b+c+d}$$

$$\mathbf{HK} = \frac{(ad-bc)}{(a+c)(b+d)} = \mathbf{POD} - \mathbf{F} = \frac{a}{a+c} - \frac{b}{b+d}$$

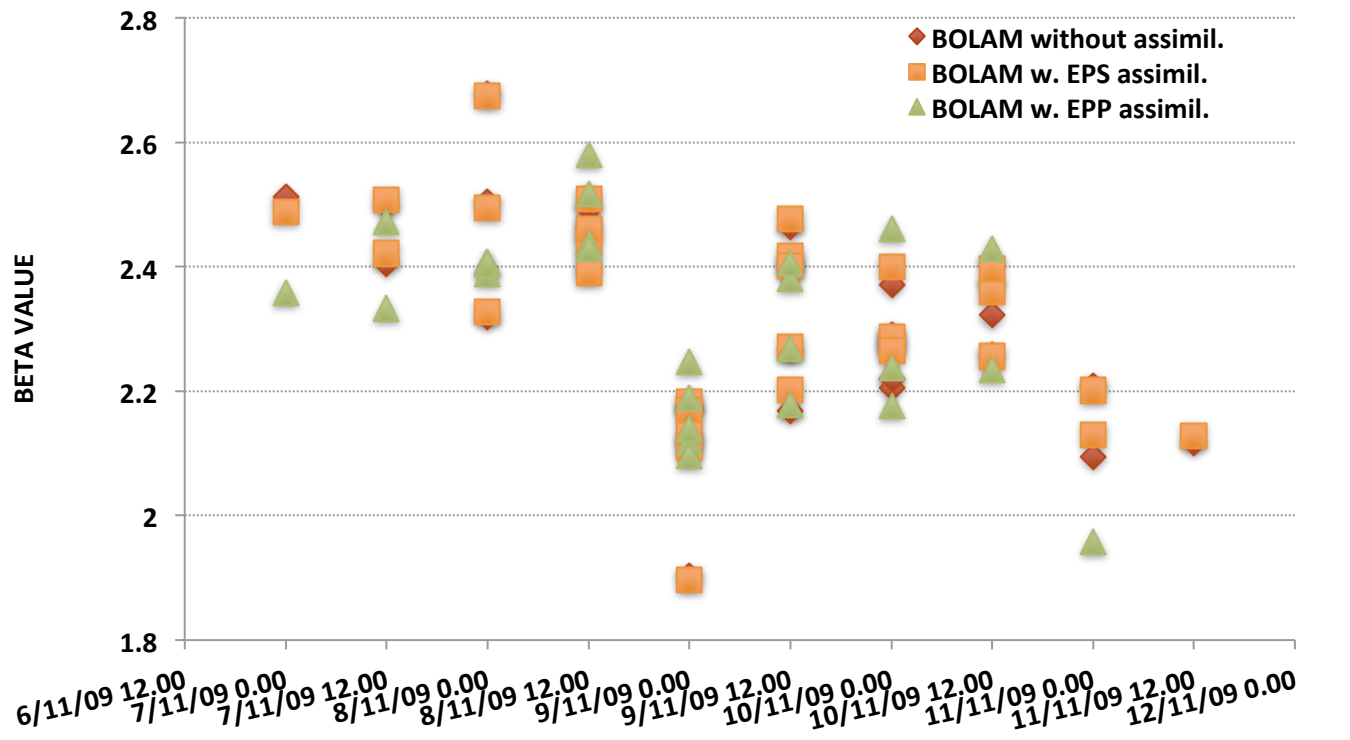
$$\mathbf{ORSS} = \frac{\mathbf{ODDS}-1}{\mathbf{ODDS}+1} = \frac{ad-bc}{ad+bc} \quad \mathbf{where} \quad \mathbf{ODDS} = \frac{ad}{bc}$$

- ✓ **Categorical scores & skill scores: Wilks, 1995; Schaefer, 1990; Stephenson, 2000; Hanssen and Kuipers, 1965; and Murphy, 1990 (→ Dimensionality)**

- ✓ **ROC curves**
- ✓ **Spatial distribution of Contingency Table elements**

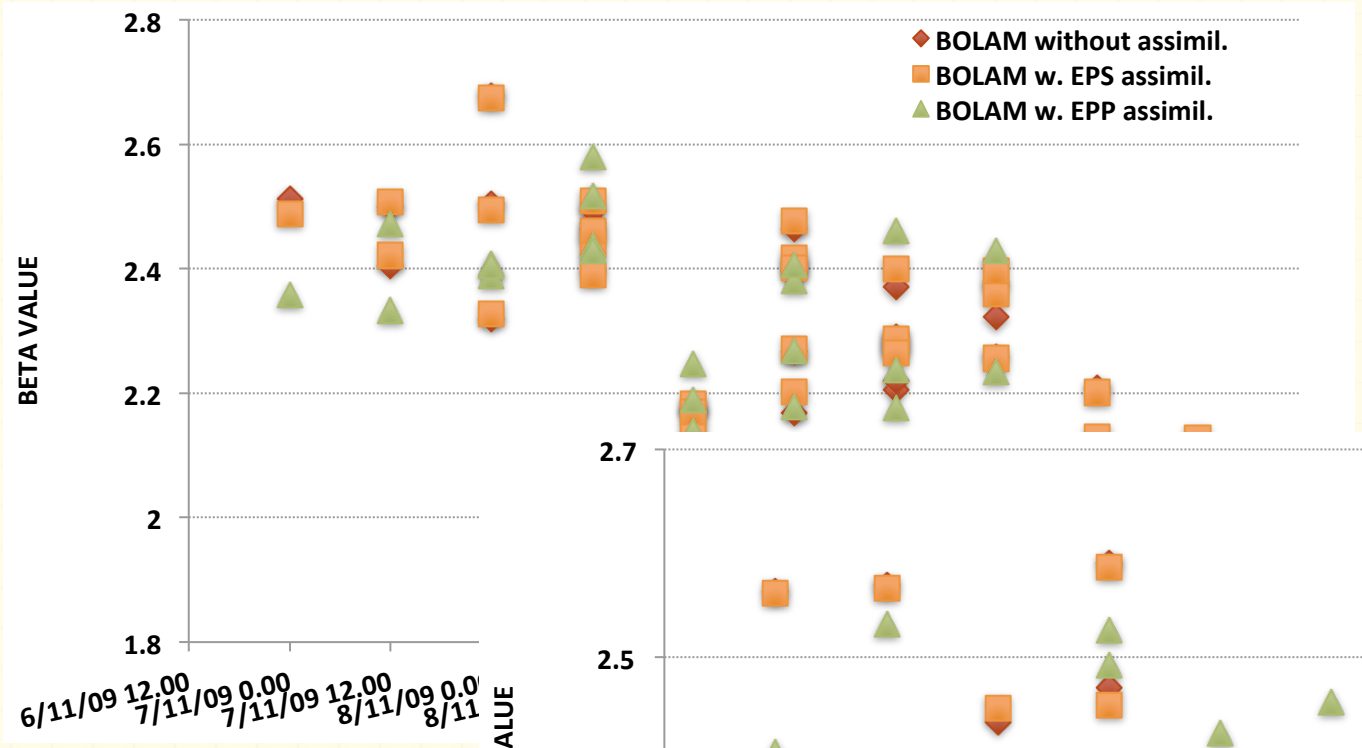
- ✓ **(Small-)Scale analysis through power spectra:**
  Point-to-point matching is sensitive to small displacement errors (→ double penalty effect). Power spectrum analysis is studied to assess if the fields being compared are defined on grids with the same resolution and if they have the same amount of small scale detail.
  The 2-D spectra were averaged angularly to give an isotropic power spectrum E(k), where k = $(k_x^2 + k_y^2)^{1/2}$ (k_x & k_y wavenumbers). Scaling occurs when $E(k) \sim k^{-\beta}$. The higher β the smoother is the structure.

Spectra anlysis

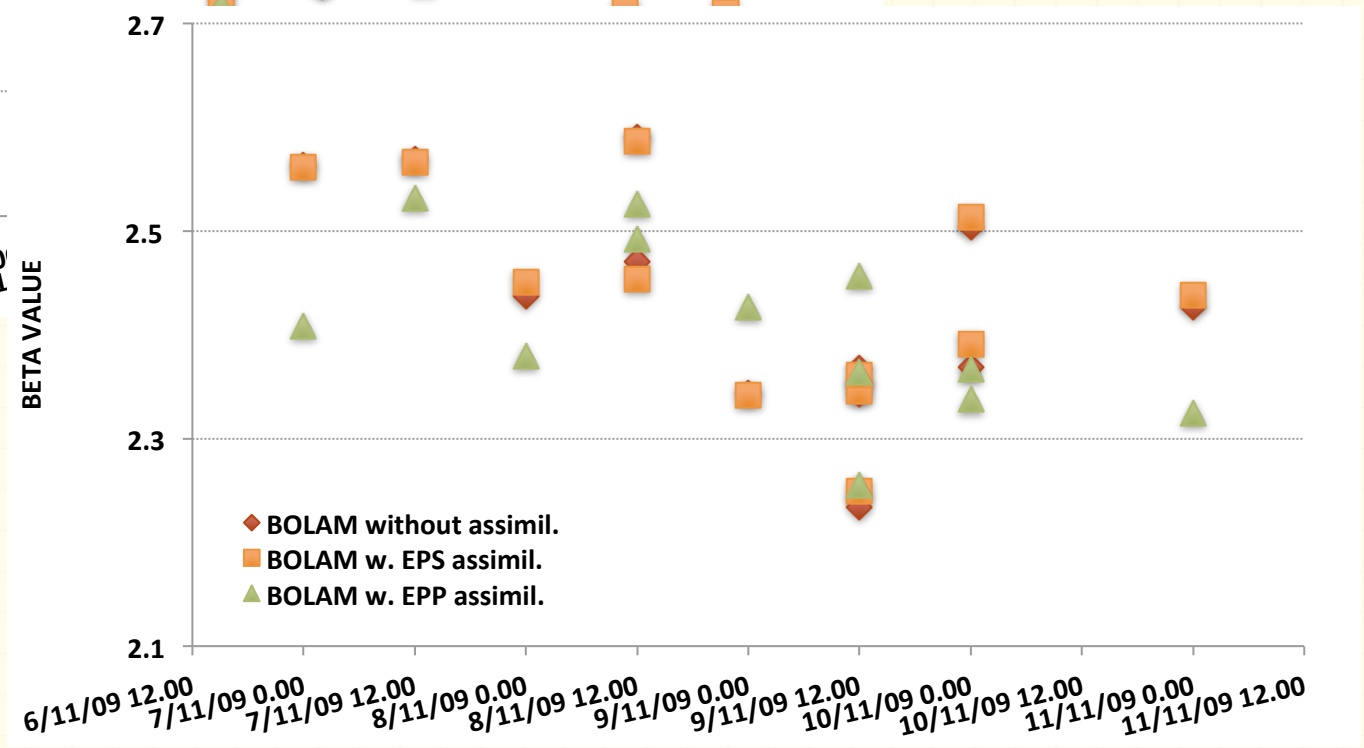


Nov. case study
12-h QPF

Spectra analysis

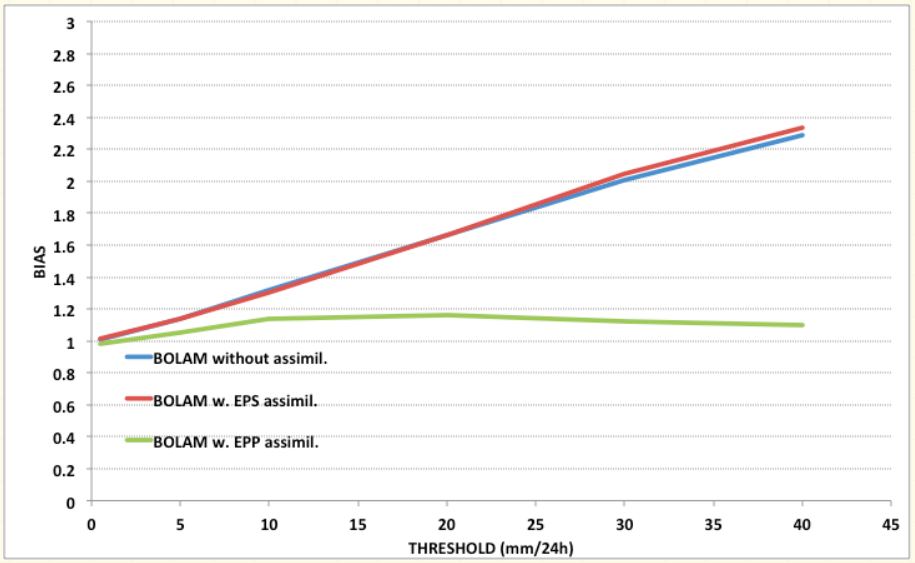


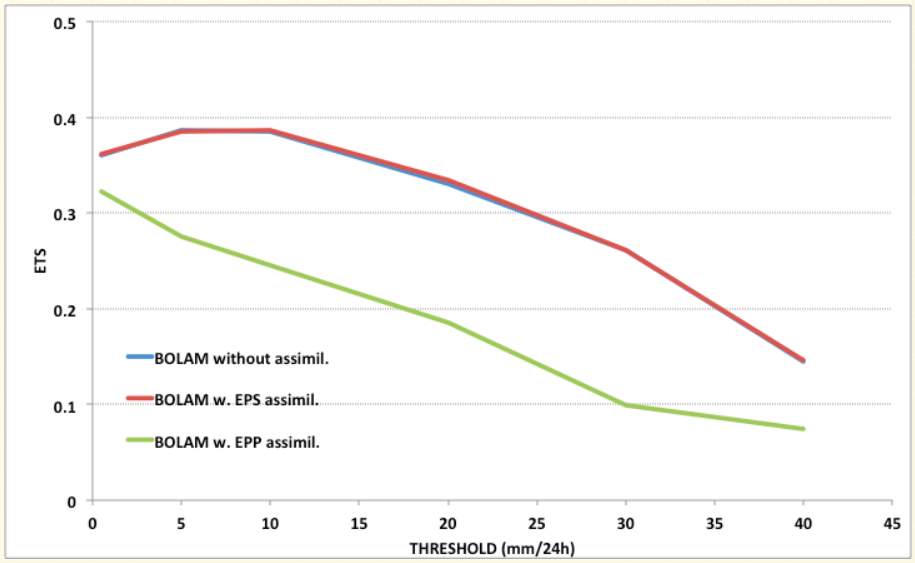
Nov. case study
12-h QPF

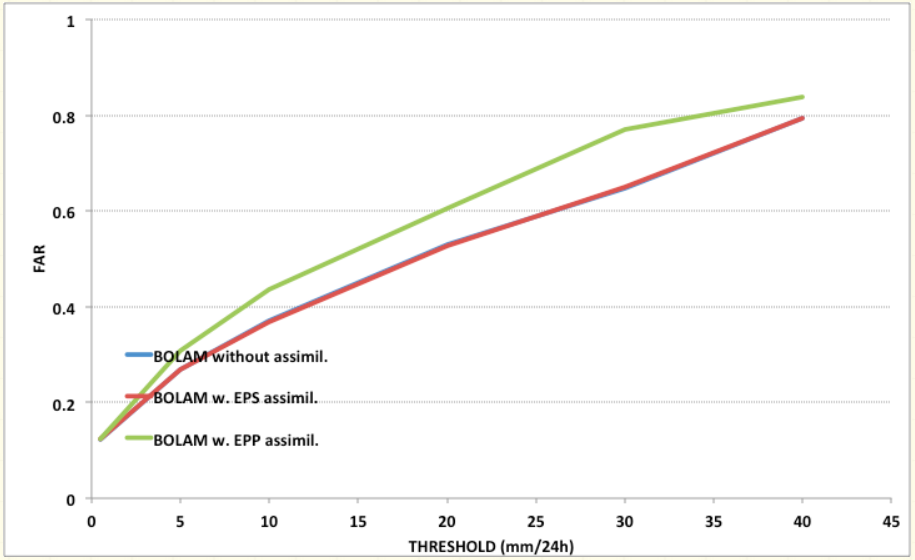


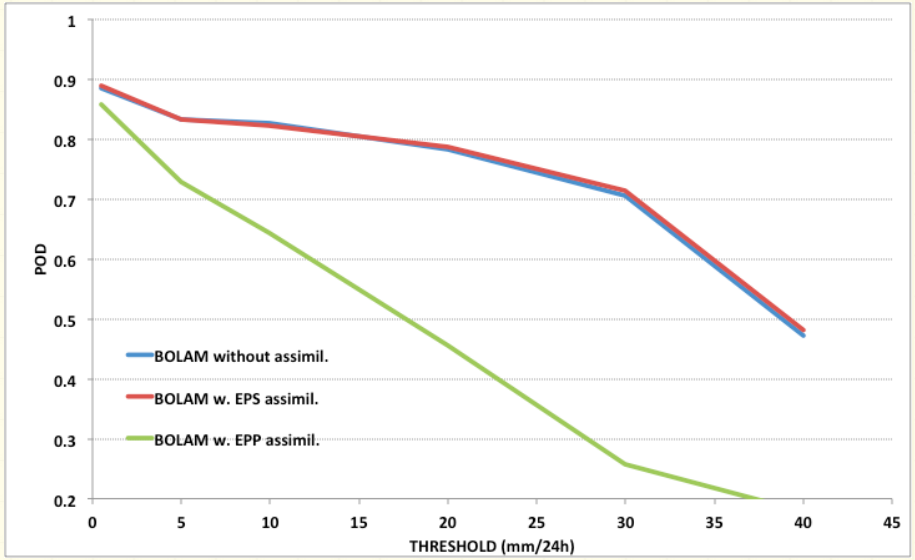
Nov. case study
24-h QPF

Scores and skill scores

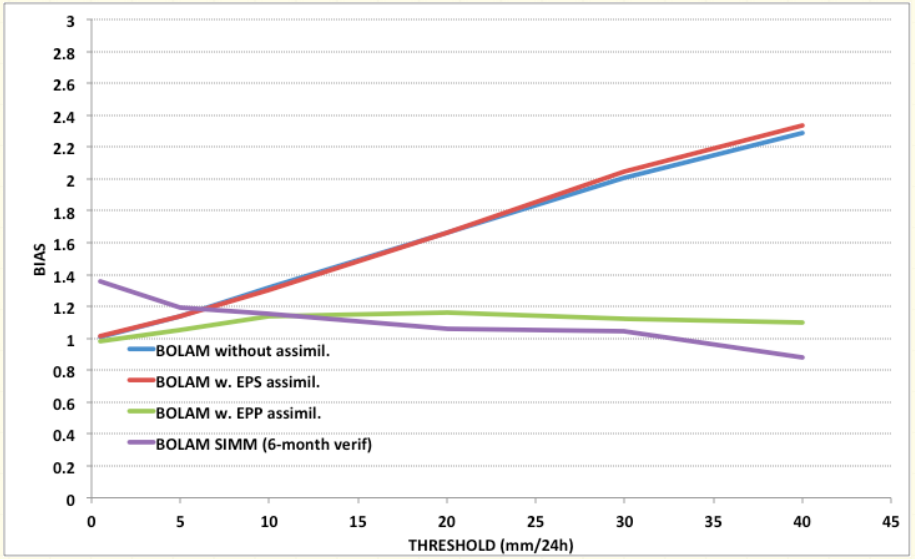


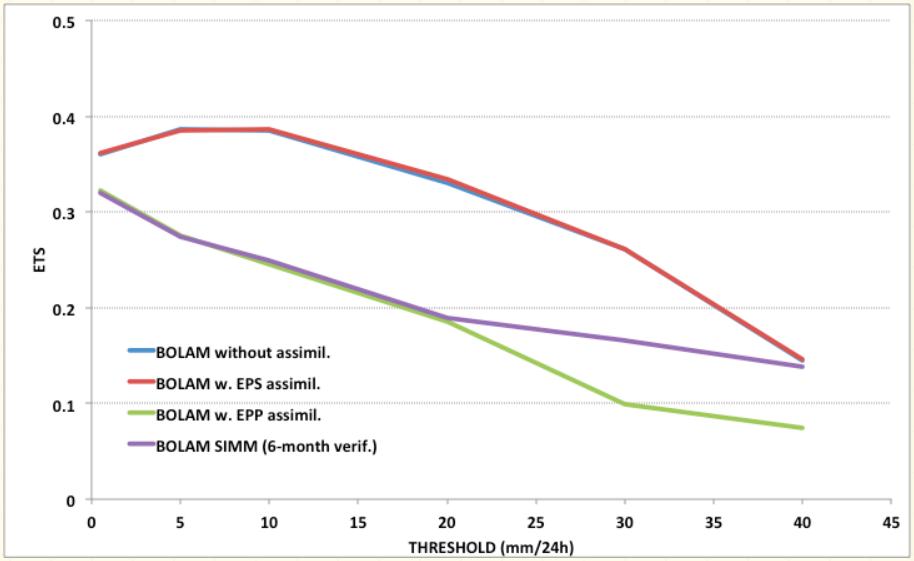






Scores and skill scores + CTRL





- CTRL obtained using reforecast QPFs from '09 version of BOLAM for the period Apr.-Sept. 2001 and verified over an observational dataset covering the entire Italy.

Conclusions

- The impact of the assimilation of satellite-retrieved data has been analysed in the framework of the PROSA project over two case studies.
- Despites the size of the samples (which is not optimal for a statistical robust verification of a model performance), it is obtained that:
  - EPS-assimilated BOLAM QPFs perform similarly to BOLAM QPFs;
  - EPP-assimilated BOLAM QPFs seem to perform worse; however BIAS ≈1 for all threshold and the structure is lesser smoother than those of the other QPFs;
  - In terms of skill scores, EPP-assimilated BOLAM QPFs perform similarly to the BOLAM ('09 version) QPFs over a 6-month different period.
- However, a more extensive database (in time & space) is needed to clearly (and **in a statistically significant way**) identify the improvement in terms of QPFs provided by the assimilation in BOLAM of satellite estimates

→ PROSA 6-month pre-operational phase ←

That's all folks!

Thanks for your kind attention.

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