Soil Erosion and Conservation Research Group (CEBAS-CSIC) & IMIDA. *3/06/2010*

An (efficient) algorithm to estimate rainfall from radar data

The research group is involved in land degradation, restoration and management of dry ecosystems and its relation to water and carbon cycles.

Water

Soil ⟷ Vegetation

The paper

First author is just now in the UK

WATER RESOURCES RESEARCH, VOL. 45, W01415, doi:10.1029/2008WR007011, 2009

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Rainfall estimation by rain gauge-radar combination: A concurrent multiplicative-additive approach

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Our primary motivation was improving hydrological modelling on semiarid catchments.

Runoff is highly sensitive to spatial distribution of rainfall.

We detected some problems on existing multisensor (radar-rain gauges) algorithms

Both radar and rain gauges are subjected to problems

Radar: orographic blocking, overshooting, attenuation

Rain gauges: wind, bad for spatial pattern description (convective storms), etc..

Data merging is also problematic

Support scale: Radar 2 km, rain gauge 17 cm.

Spacing: radar 2 km, rain gauge highly variable and usually >> 2km

Some available methods

Weighted interpolation: e.g. cokriging. Problem: extreme values tend to be lost.

Multiplicative bias adjustment: g/r generally for field bias adjustment. Problem: if r=0 it is assumed no rain, that not always is true.

The radar bias is spatiotemporally variable and may include bias in partial coverage detection

General view

Phase I

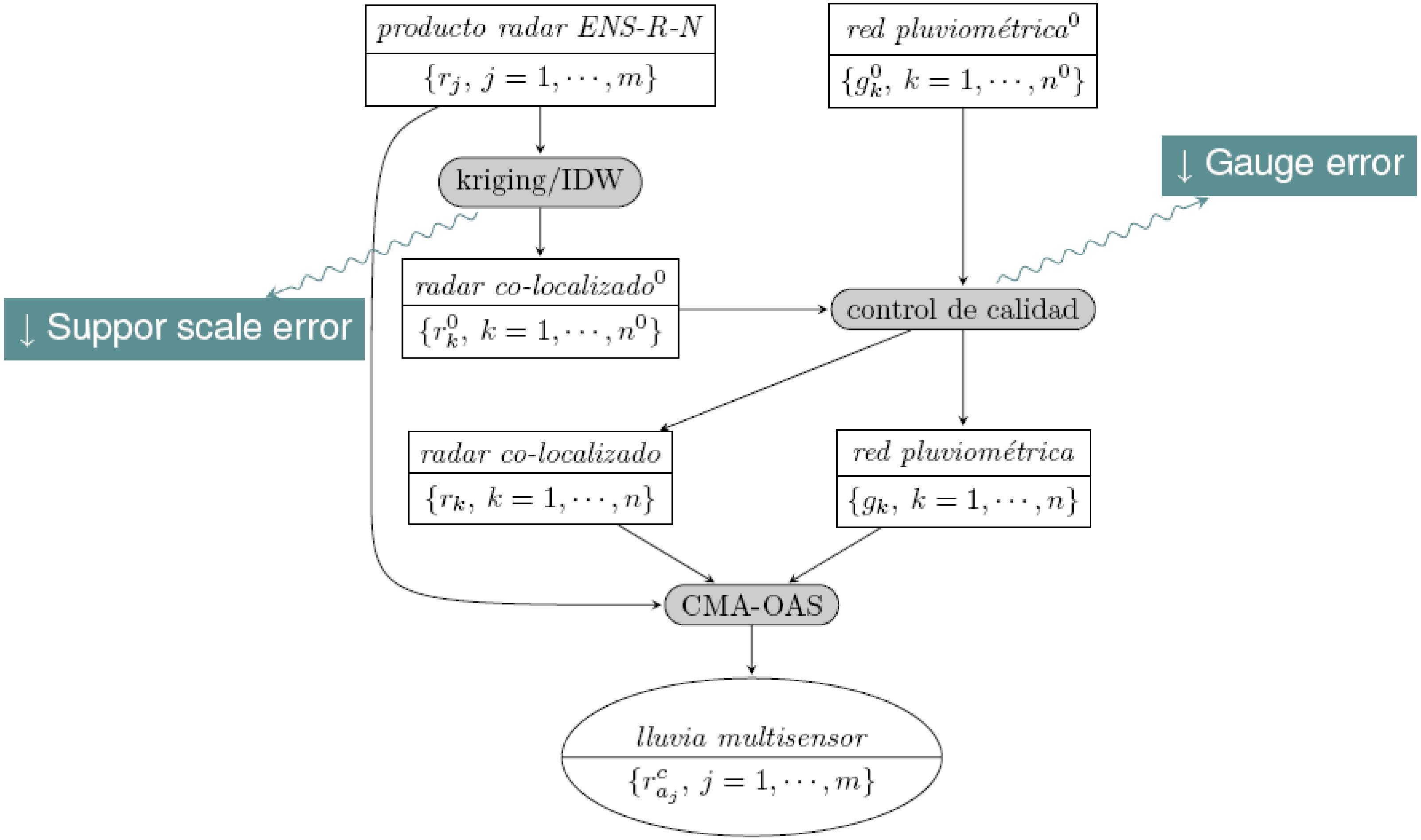
Pre-process to obtain adequate radar-gauge pairs

Phase II

At each pair

(i)decomposition on additive and multiplicative local bias and a measure for spatial extrapolation
(ii)integration of bias and extrapolations measures in a Gaussian kernel smoother to obtain bias fields
(iii)the additive (AF) and multiplicative (MF) bias fields are combined to obtain the multisensor estimate r = AF + MF

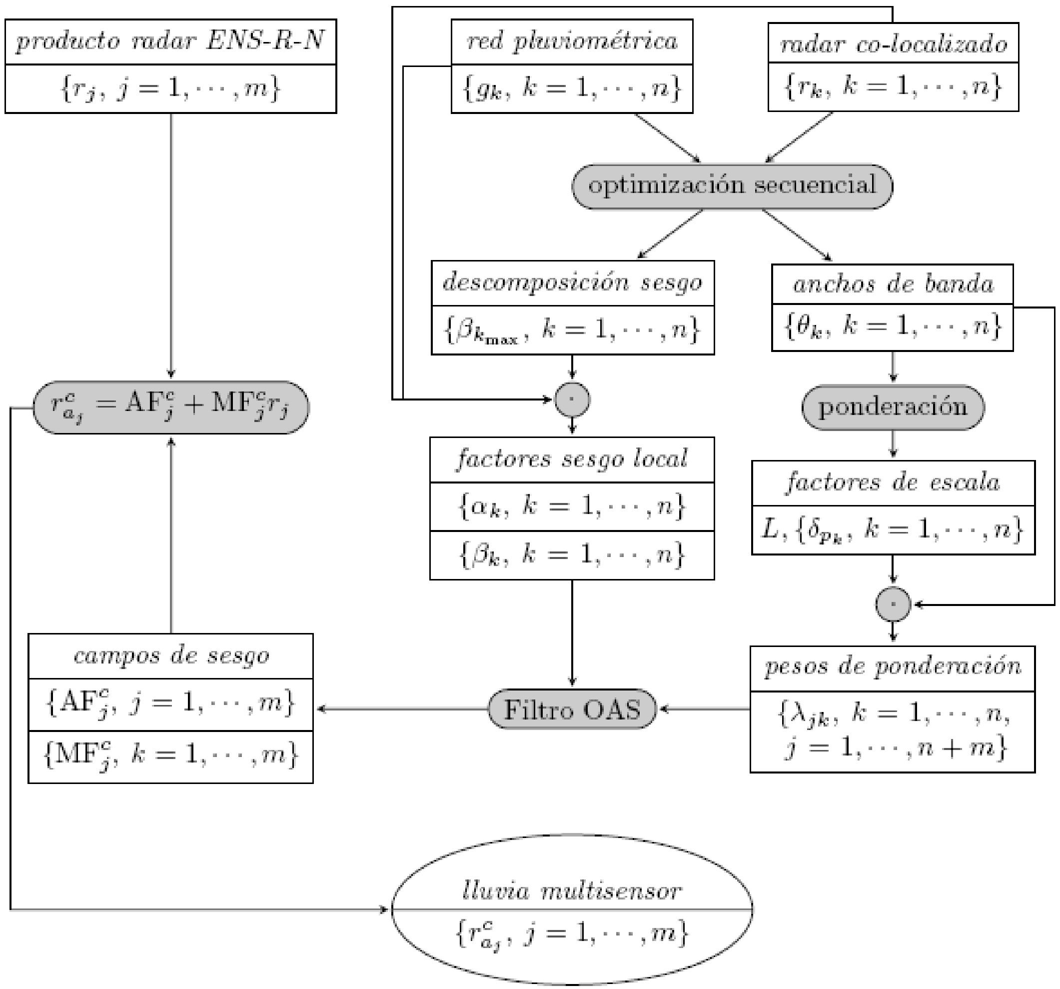
Phase I: Pre-process



The most important point in preprocessing is collocate radar and rain gauge estimates.

We prefer an ordinary kriging (or IDW) of radar estimates than a regionalization of rain gauges as it is more reliable.

Phase II: Process



Method is complex

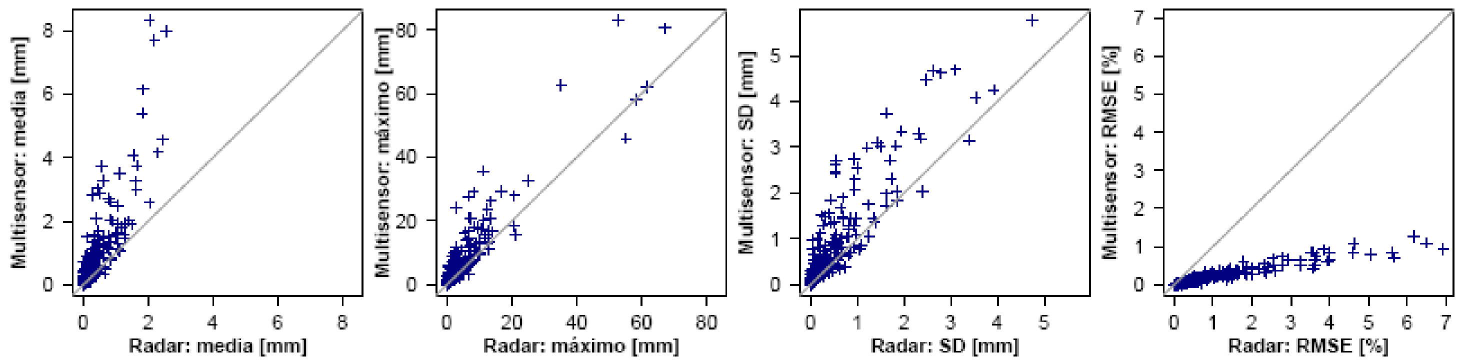
Important (but simplifying) points in processing are:

a)If radar (r)= 0 and gauge (g) > 0 there is only an additive component

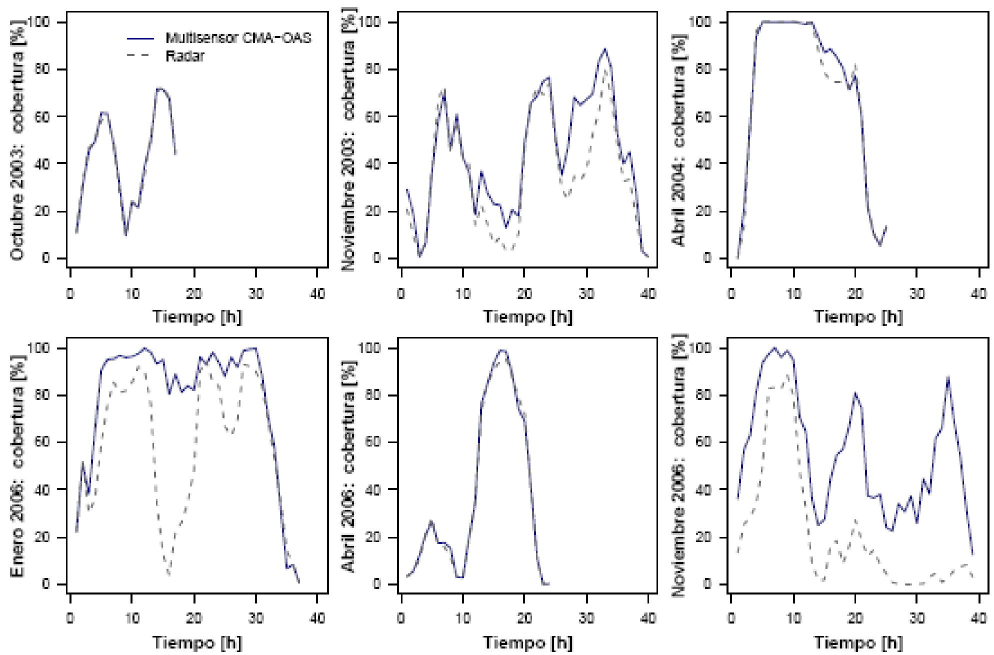
b)If g/r is over a threshold multiplicative factor (MF) is the threshold and we have both additive (AF) and MF, otherwise only there is MF and it is g/r.

c)The threshold is calculated specifically on each step as a minimization problem taking into account an exponential decay parameter that also includes local density of gauges

Nevertheless its apparent and real complexity it can be implemented to work on real-time configuration with no problem



- Radar
  - Subestimate ⇔ intensity
- Multisensor adjustment
  - Light increase in maxima and SD
- Bias in fractional coverage
  - High variability
  - Temporal patterns



Event	n^a	Radar[b]	Multisensor[b]	RC[c]	GRC[d]
October 2003	17	11.7	14.1	99.5	0.5
November 2003	40	15.6	31.2	95.0	5.0
April 2004	25	23.5	61.4	99.5	0.5
January 2006	37	8.4	25.3	85.3	14.7
April 2006	24	9.0	13.6	97.5	2.5
November 2006	39	4.0	28.5	77.6	22.4

[a]Contiguous hours with significant rainfall; [b]Radar rainfall estimates/CMA-OAS [mm]
[c]RC: CMA-OAS rainfall within the radar-detected fractional coverage [%]
[d]GRC: CMA-OAS rainfall where radar == 0 [%]

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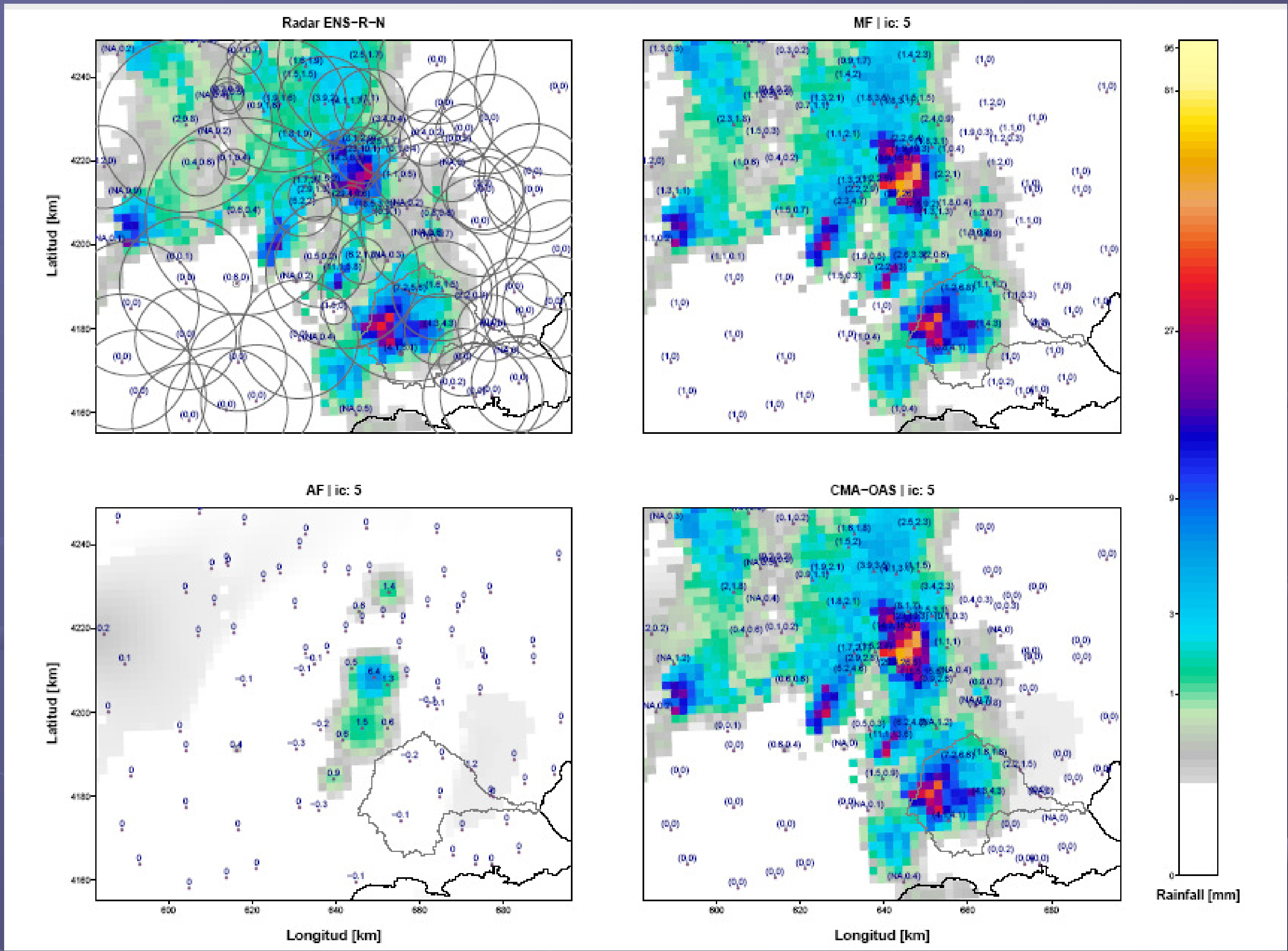

The CMA-OAS works better than other algorithms

Table 4. Summary of Performance Measures in Cross Validation[a]

Adjustment	$\overline{\text{MAE}} \pm$ SD (mm)	$\overline{\text{RMSE}} \pm$ SD (mm)	$\overline{\text{Corr}} \pm$ SD
1-guess[b]	0.34 ± 0.42	0.60 ± 0.70	0.63 ± 0.26
2-guess[b]	0.33 ± 0.41	0.60 ± 0.70	0.64 ± 0.26
3-guess[b]	0.33 ± 0.42	0.60 ± 0.71	0.63 ± 0.26
4-guess[b]	0.34 ± 0.43	0.61 ± 0.72	0.63 ± 0.27
5-guess[b]	0.34 ± 0.44	0.61 ± 0.73	0.62 ± 0.27
Brandes[c]	0.52 ± 0.65	0.93 ± 1.12	0.49 ± 0.27
mba[d]	0.99 ± 1.20	1.37 ± 1.71	0.32 ± 0.38
cok[e]	0.64 ± 0.84	1.02 ± 1.30	0.01 ± 0.17

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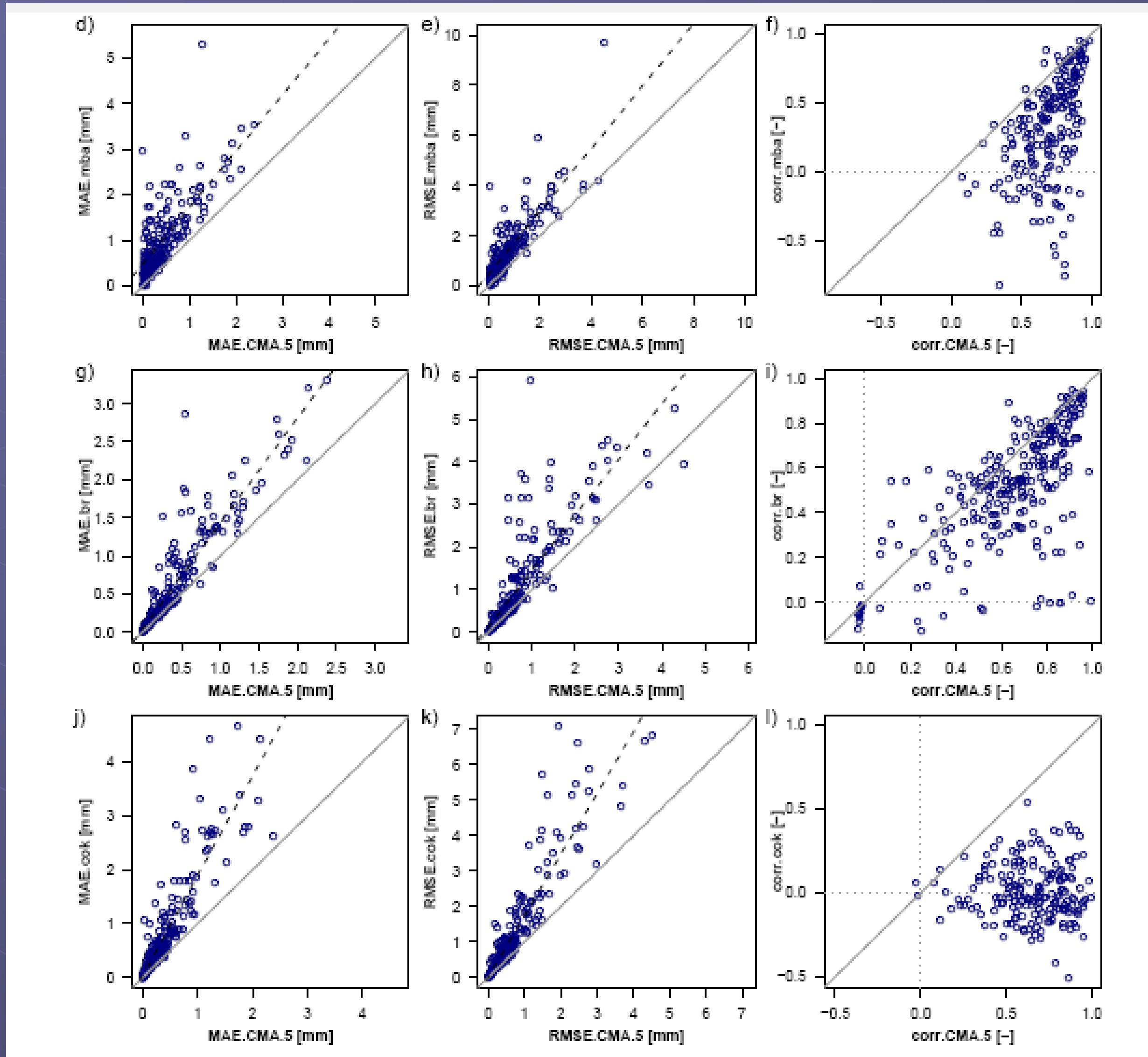

The future

(i)Operational implementation on (quasi) real-time. Flood, irrigation and drought management
(ii)Retrospective analysis of historical radar data. Drought spell studies.
(iii)Combination with ET estimation from remote sensing. Very high spatiotemporal resolution (250-m, 15-d)

Thank you