Evaluation of the QPE integration by Poisson's Equation using Radar Reflectivity, MPE Eumetsat and Rain Gauge Network on a subtropical basin in Brazil

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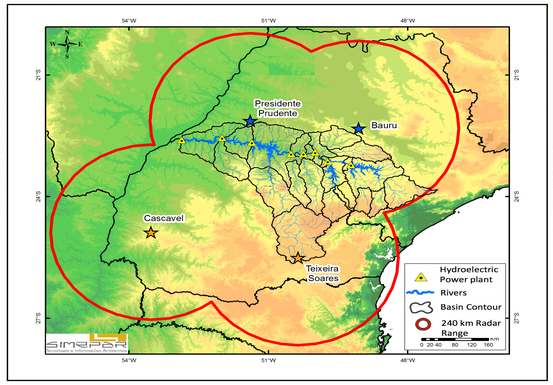
Introduction

The present work aims to evaluate the integration of radar mosaic, satellite QPE and raingauge network, named SIPREC, which uses the Poisson equation and multigrid method to solve the Laplacian. The 1km^2 gridded precipitation field has been used as a input in the SMAP (Soil Moisture Accounting-Procedure) hydrological model (Lopes et al., 1982).

Study Area

Paranapanema basin location and the Radar Mosaic composed by Bauru, Presidente Prudente (IPMet/UnesP), Cascavel and Teixeira Soares (Simepar) S-Band Doppler Radars.



Methodology

The **Siprec** is a multi-sensor QPE that uses radar mosaic, satellite and raingauge network blended by the Poisson's Equation numerically solved by the parallel Multigrid algorithm (Briggs et al., 2000). To blend radar (R), gauge (G) and satellites (S) QPE the algorithm of Reynolds was used (Reynolds, 1988; Xie and Arkin, 1996). Similar to a data assimilation technique, this algorithm uses a boundary condition field as a truth to combine the analysis.

First, the radar mosaic QPE is blended with raingauge network by assuming that the shape satisfies the Poisson's equation:

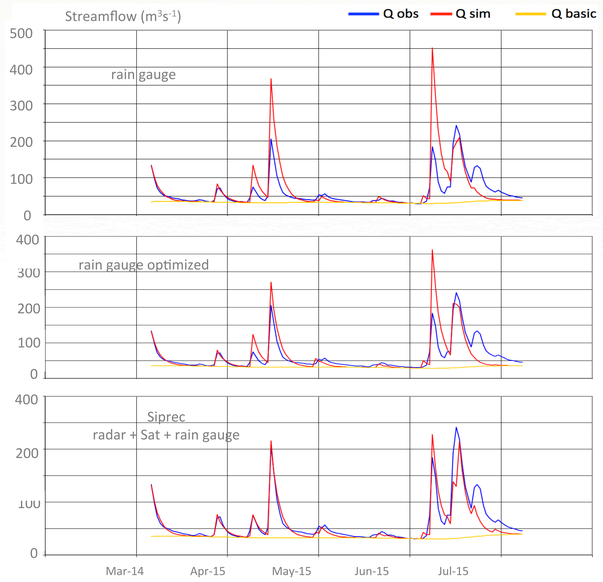
$\nabla^2 B_G = R$ where B_G is the boundary condition, in this case, the hourly precipitation measured by the raingauge network and R is the hourly Radar Mosaic QPE which uses the ZR relationship with parameters a=52 and b= 2.8.

This solution generates a new gridded field PR where radar and rain gauge QPE are combined. Satellite QPE S is added to the PR grid using again the Poisson`s equation:

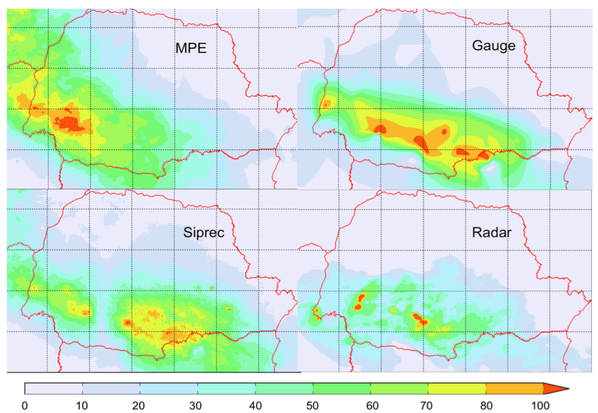
$\nabla^2 B_{PR} = S$ where B_{PR} is the hourly radar-gauge analysis and S is the hourly Satellite QPE that can be any technique. Here it has been used Meteosat MPE (Heinemann et al., 2002).

The idea of this method is to impose a high convergence to the raingauge precipitation amplitude (the rain gauge was used as a boundary condition) and to keep down the mesoscale signature captured by radar and satellite, modifying only the amplitude of the precipitation.

Comparison between streamflow simulations by SMAP hydrological model using rain gauge, rain gauge optimized and Siprec (integration of radar, satellite and rain gauge network) for Paranapanema basin.



Accumulated daily precipitation (mm day^{-1}) from satellite MPE (upper left), rain gauge (upper right), Siprec (bottom left) and radar mosaic (bottom right) for 08 June 2014.



Performance Rating categories used to evaluate the hydrological model (adapted from Moriasi et al., 2007)		
Category	Nash-Sucliffe Efficiency	Percent Bias
Very Good (vg)	> 0.6	< 10
Good (g)	0.4 – 0.6	10 - 15
Acceptable (a)	0.1 – 0.4	15 - 25
Unacceptable (ua)	< 0.1	> 25

Simulations	Watersheds										
	CMA	BUR	FAA	OLP	SCR	FAB	AND	PST	TBO	JAZ	IGE
Rain gauge Operational	a	a	a	a	a	ua	ua	ua	g	ua	ua
Rain gauge Optimized	g	vg	g	vg	g	a	vg	vg	vg	ua	ua
Siprec	ua	g	g	g	g	g	vg	g	ua	vg	g
Siprec with bias correction	vg	vg	g	vg	vg	vg	g	s	s	vg	g

Evaluation of the streamflow simulations using the SMAP hydrological model over 11 watersheds over Paranapanema basin from September 2013 to July 2015. The operational is the hydrological model that runs on the Duke Energy Brazil, the optimized is the same model with adjusted weights in rain gauge data (ideal case), Siprec ad Siprec with bias correction are the same model but using Siprec QPE and Siprec corrected by bias removal.

Conclusions

The Siprec provides high temporal (1h) and spatial (1km^2) QPE integrating radar, raingauge and satellite data by the Poisson's Equation. The solution of the integration was tested on the SMAP hydrological model over Paranapanema basin getting very encouraging results. The streamflow simulations using Siprec as a precipitation input data got better scores than using only rain gauges information because it improved the spatial identification of the rain over the watersheds. But, a correction of the bias is necessary to aims good results.

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