P46W

Verification of COSMO and WRF models for hydrological applications in the South region of Brazil

Reinaldo B. Silveira[1], M.V. Sorribas[1], J.E. Gonçalves[1], A. Breda[1], A. N. Araujo[2], L. Calvetti[3], G. R. Bonatti[4] and R.R. Santos[4]

1: Sistema Meteorológico do Paraná (reinaldo.silveira@simepar.br), Curitiba, PR, Brazil; 2:Copel Geração e Transmissão, Curitiba, PR, Brazil; 3: Universidade Federal de Pelotas, 4: Instituto Nacional de Meteorologia, Brasília-DF, Brazil.

ICCARUS Seminar, DWD, Offenbach, 26th of February to 02nd of March, 2018

Abstract

A hydrological system is in operation in the Meteorological System of Parana State, SIMEPAR, in the South of Brazil. It computes runoff at Iguaçu river basin in the hydroelectric power stations of the COPEL energy company of Parana. The joint research project PD-6491-0333-2013, between SIMEPAR and the Parana's electrical company COPEL-GeT, granted by the Brazilian Electricity Regulatory Agency, ANEEL, was settled to verify the results of COSMO and WRF NWP, as well as the hydrological applications.

The hydrological application

The COPEL GeT electrical company monitor reservoirs in the Iguaçu river in the state of Paraná, as show in Figure 1.

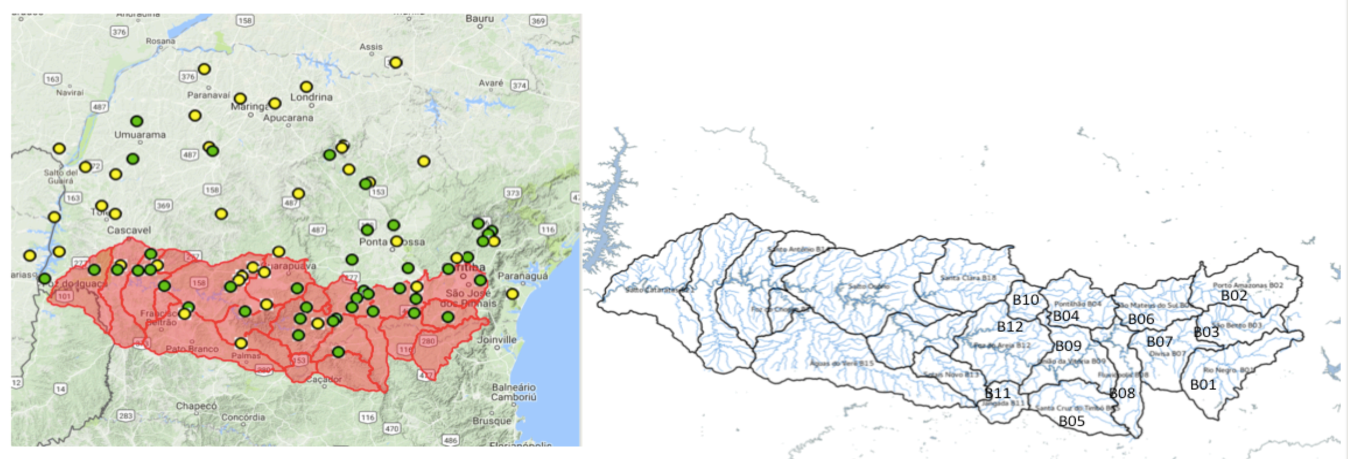

Figure 1: Iguaçu river basin and the observation locations (left) and the sub basin organization (right), from Basin 01 to 12.

The Simepar hydrological system, SISPSHI, comprises a semi-distributed approach, with a Sacramento model as a core system and a local adaptation to take care of the water propagation through large basin channels. Thus the system is so-called **3R**, which extends for **R**ainfall, **R**unoff and **R**outing. It performs the water balance in the soil and in the basin channel, taken into account all the processes in Figure 2.

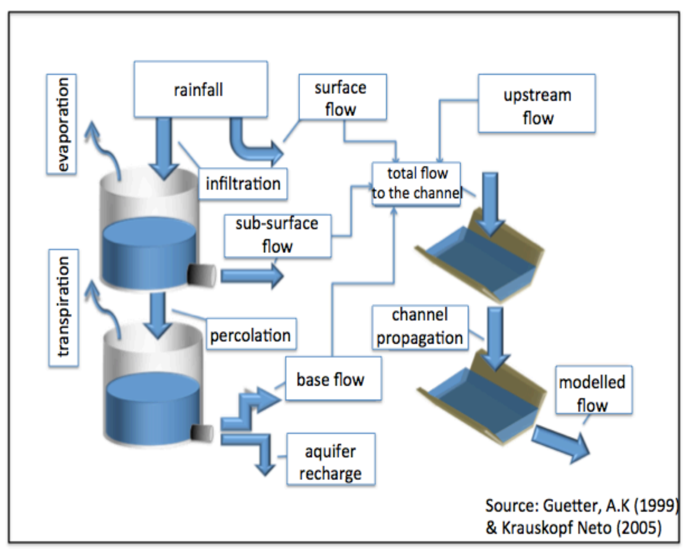

Figure 2: Processes of the 3R-SISPSHI hydrological system which encompass the following tasks:

1. Rainfall data collection and QC;
2. Use of temporal series of rainfall and basin rainfall average;
3. Coupling to COSMO and WRF NWP rainfall forecasting;
4. Compute the basin average forecast rainfall;
5. Perform the hydrological simultation and runoff river flow forecasting.

The runoff was forecasted for twelve cacthments in the Iguaçu River, as depicted in Figure 1, in the hydro-electric power stations and sub-basins numbered from 1 to 12. The SISPSHI output produced hourly runoff forecasting for the period of 120 hours, by using observed and simulated precipitation. The forecast was then verified against observed runoff, computed by using a reference model (based on the accumulated rainfall observations), as shown in Figure 3, for results of simulation for sub-basin 12.

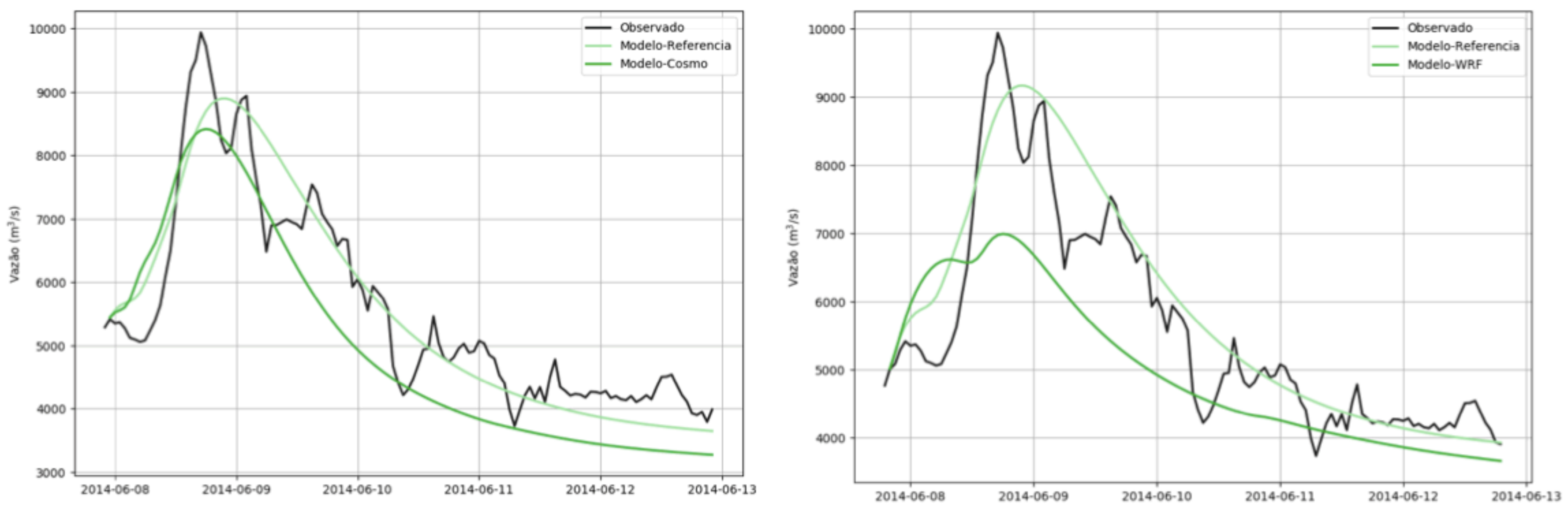

Figure 3: Summary of hdrological simulation of channel runnof for sub basin B12, Foz do Areia, for the period from 08th to 13th of June, 2014, when an event of flood happened in the region of catchments B09 and B12, Uniao da Vitoria and Foz do Areia, respectively. The SISPSHI was forced with COSMO (left) and WRF (right) rainfall outputs.

NWP simulation

The rain-runoff model was forced by using the NWP accumulation precipitation from COSMO-7km and WRF models. The model domains cover South and Central regions of Brazil, including the Parana state, with mesh size of 7km for COSMO e 9km for WRF, respectively, as depicted in Figure 4.

The outputs of GME and ICON global models from DWD were used as boundaries for the COSMO-7km and the NOAA GFS provided boundaries for WRF simulations.

The code of COSMO-7km used in the simulation was from version 5.01 and the int2lm interpolation was from version 2.02. The cumulus scheme was according to Tiedke (1989).

The WRF simulation was of version 3.4 and the mean of ensemble simulations of six different schemas for the microphysis (Morrison, Lin, Ferrier, Tiedke, Thompson and WDM6) was used in this work.

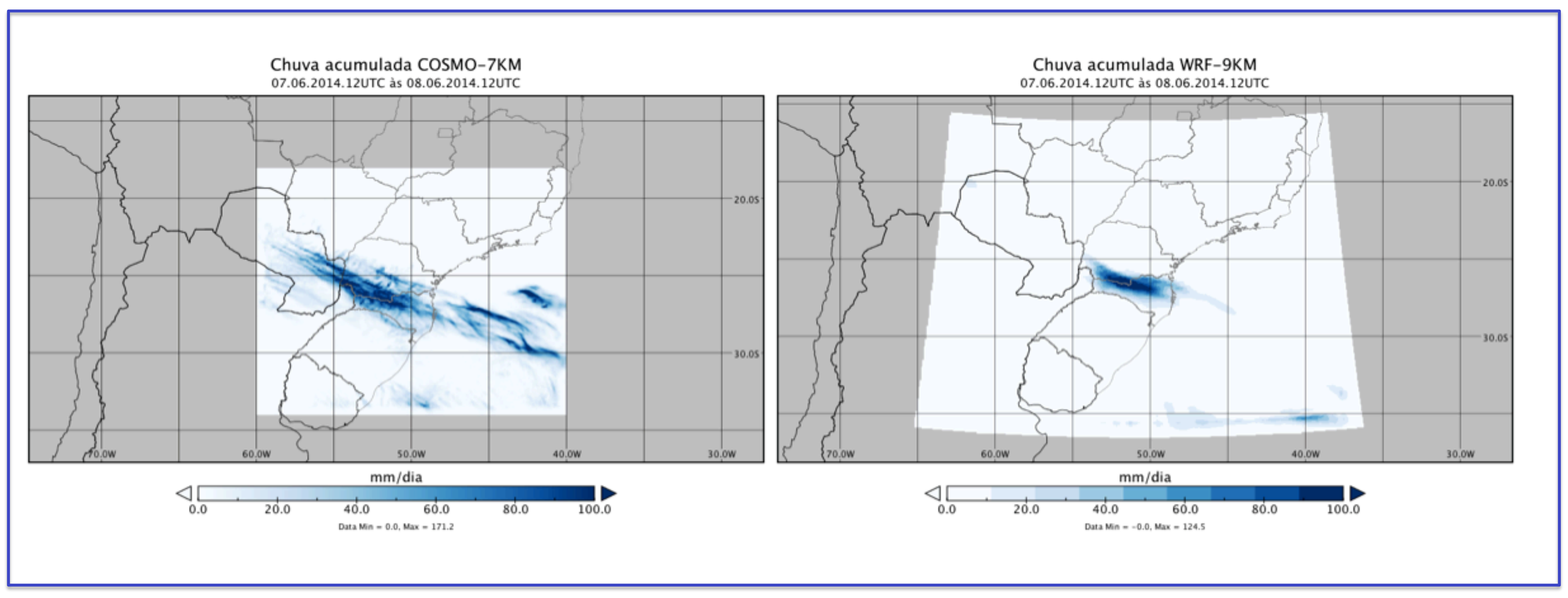

Figure 4: configuration domain of COSMO-7km (left) and WRF-9km, covering South and Central region of Brazil, including the state of Paraná, where the Iguaçu river flows.

Verification procedures

The rainfall accumulation outputed from NWP models were verified against the spatial average of observations over the Iguaçu river sub basins, computed for observing stations in the catchment regions, for the period from 2013 to 2017. A result of the comparison is shown in the time series of Figure 5, for sub basin 12 (Foz do Areia), for 24hrs and 48hrs of rainfall accumulation. It is also noted that the models understimated the extreme event of June, 2014, that occurred in the region.

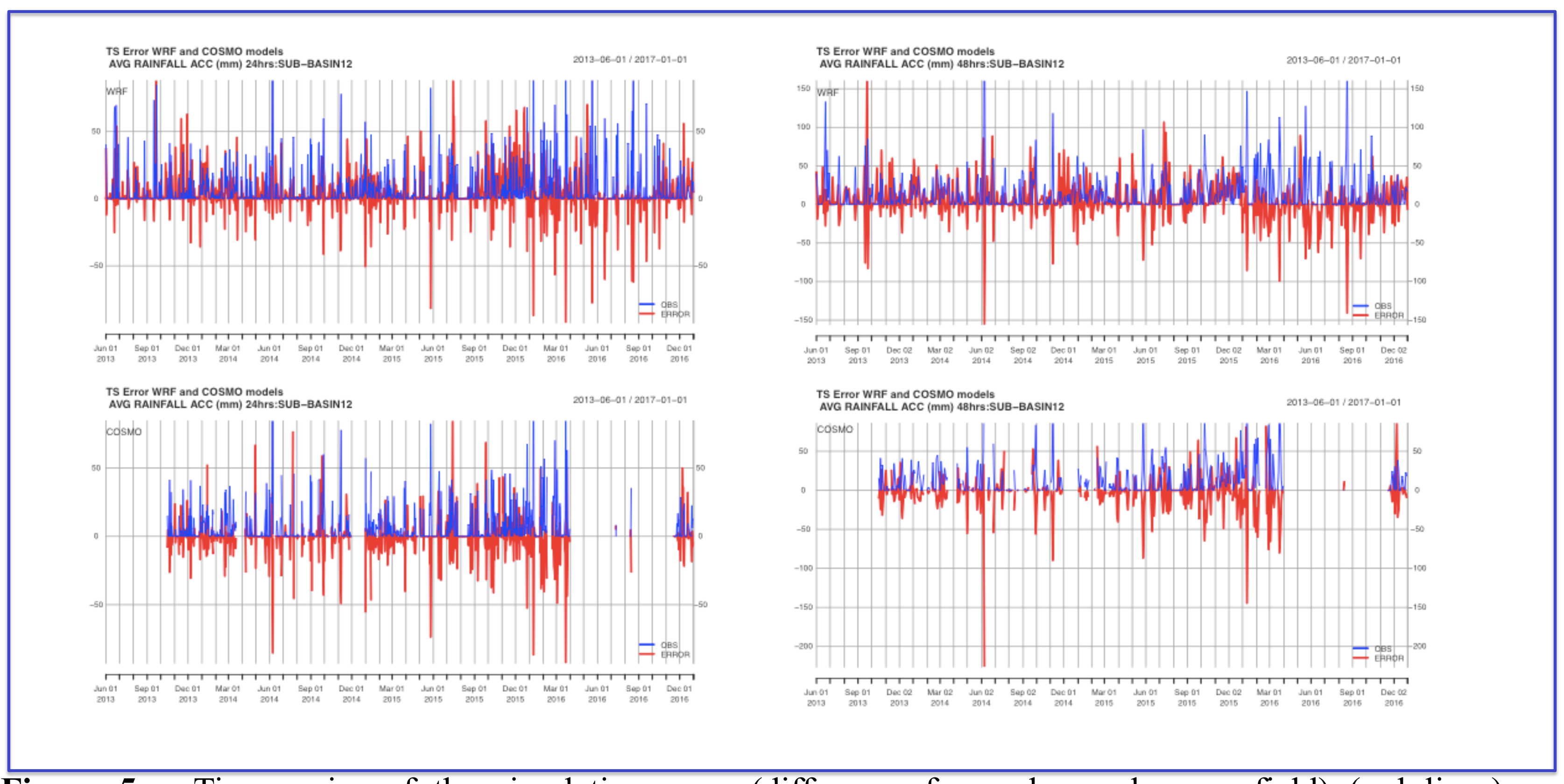

Figure 5: Time series of the simulation error (difference from observed mean field) (red lines) and observation (blue lines), for 24 hours (left) and 48 hours (right). The results for WRF are in the top panels and for COSMO are in bottom panels, respectively.

An overall comparison between simulation and observation of average rainfall was achieved by examining the non-parametric distribution of the parameters, as shown in figure 6, for COSMO model (figura 5(a)) and WRF model (figura 5(b)). As it can be noted from the results, the models are close to the observation to low and middle distribution quantiles. But, both are negatively biased as accumulation of rainfall increases. It can also be observed that the WRF is slightly positively biased for low and middle portions of the distributions.

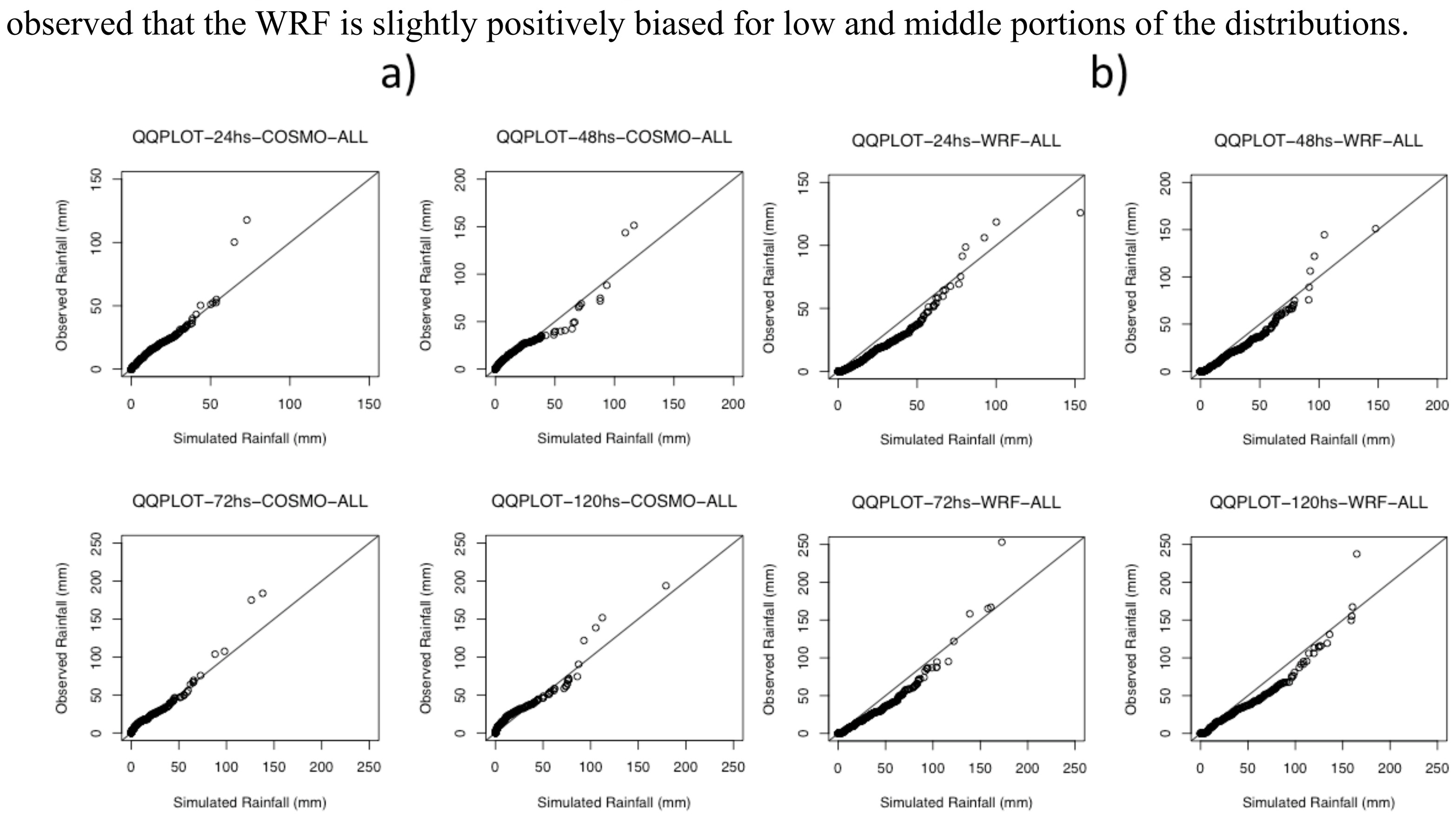

Figura 6: analysis of quantiles of non parametric distribution of (a) COSMO and (b) WRF data.

Measurement of overall performance of COSMO and WRF models were obtained by computing verification indexes as BIAS, standard deviation (SD), RMSE, correlations, contigency tables, HR, FAR and ROC, for individually and for the average ensemble of sub-basin results. Some of this quantities are depicted in figure 7.

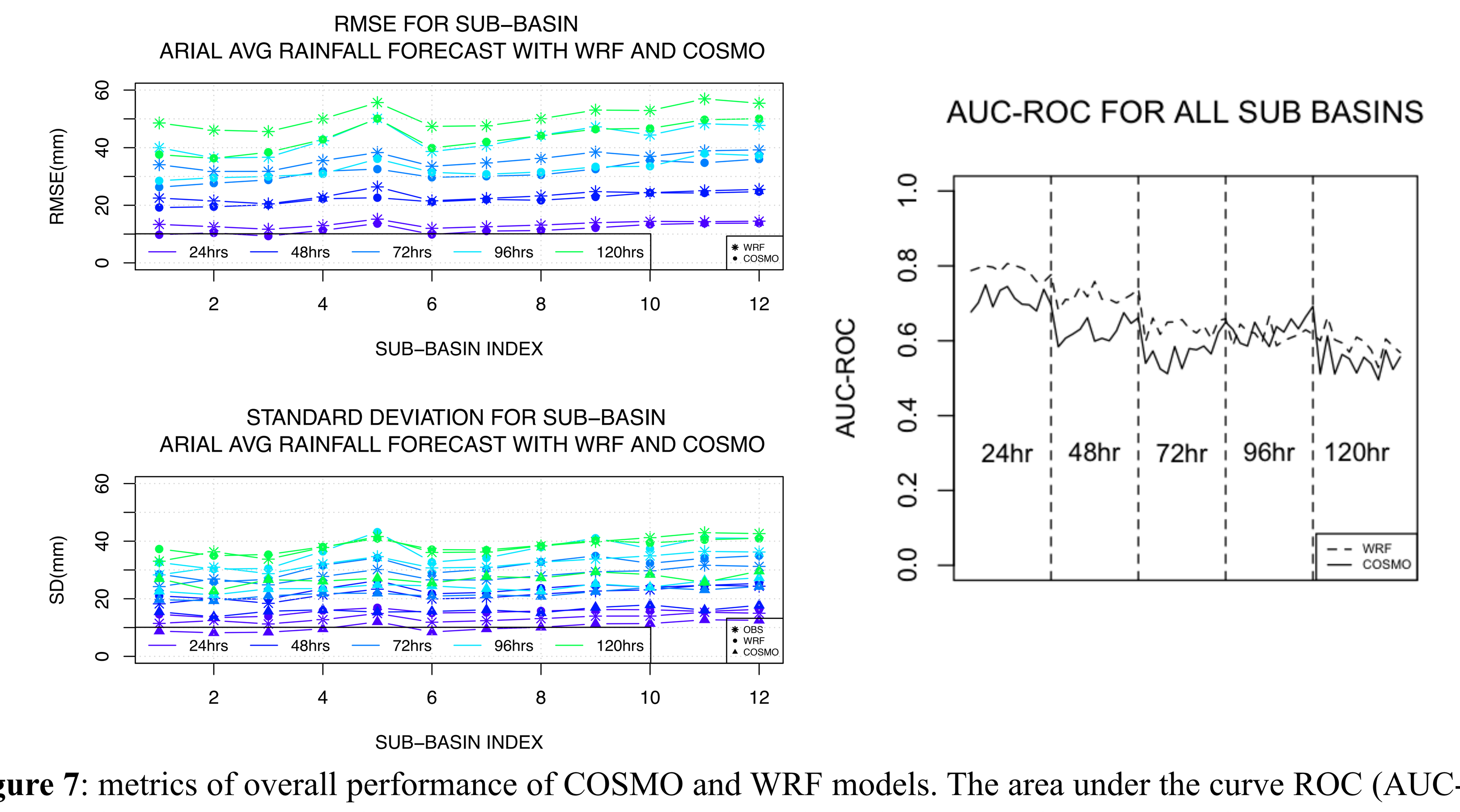

Figure 7: metrics of overall performance of COSMO and WRF models. The area under the curve ROC (AUC-ROC), right side, correspond to the ROC results for the sub basins and each window refers to periods of rainfall accumulation, from 24hrs to 120hrs.

Conclusions

The results indicate that both models performed well for forecasting weak and moderate rainfall accumulation (up to 50mm) and for short periods (up to 48 hours). Also the dispersion of models tend to agree to the observation field and RMSE is close to SD, which is observed to be high for the region. The AUCs are close for both models, decreasing the performance as forecasting time increases. Nevertheless it is important to mention that this verification approach was based on derived observation information and not trully station data, and therefore the results will follow the quality of the arial estimation, which can be a problem in case of lack of observations within sub basins. Besides there are extreme event values that will be set aside on further analysis.