Multi-Site and Multi-Objective Evaluation of CMORPH and TRMM-3B42 High-Resolution Satellite-Rainfall Products

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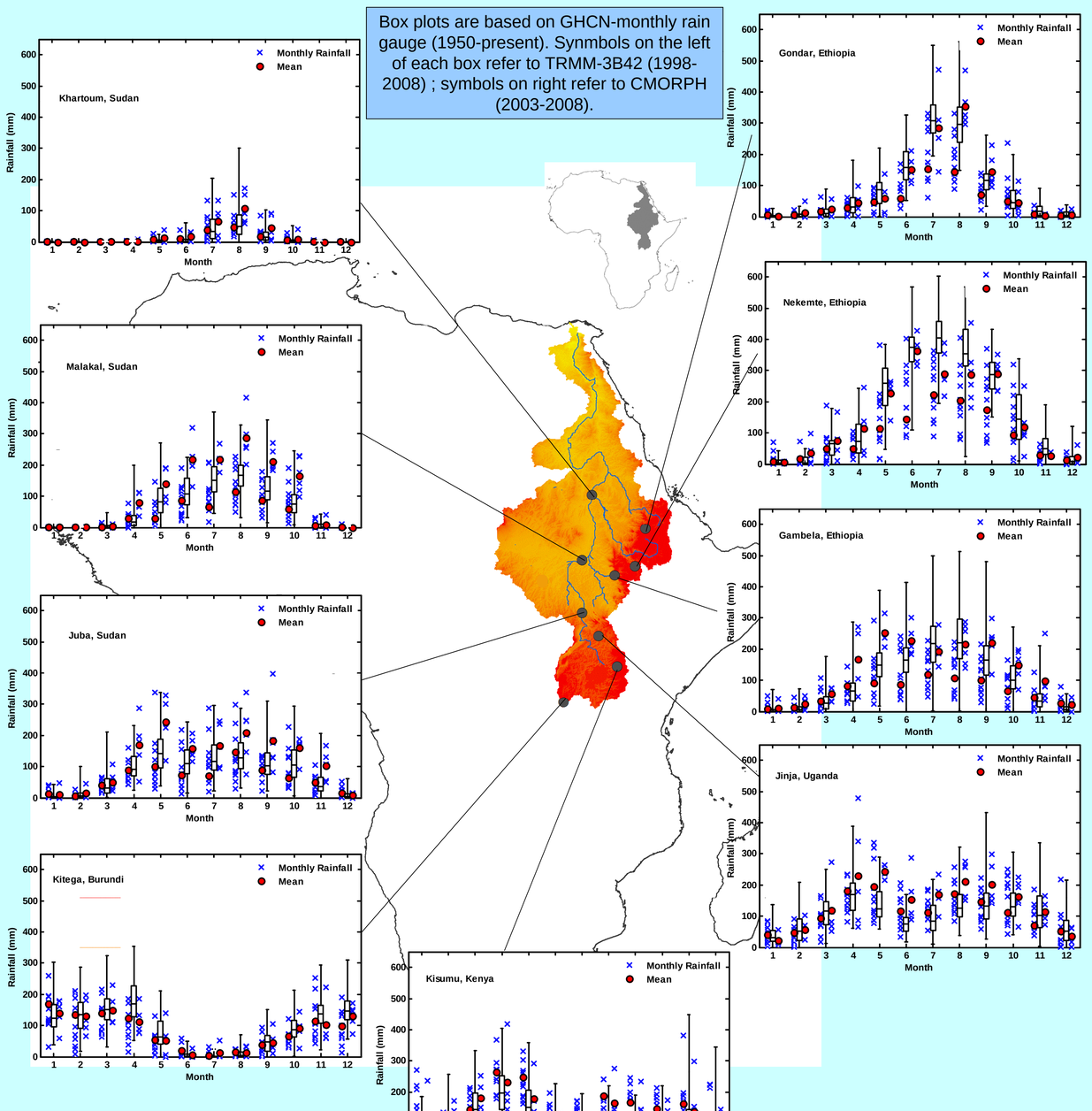
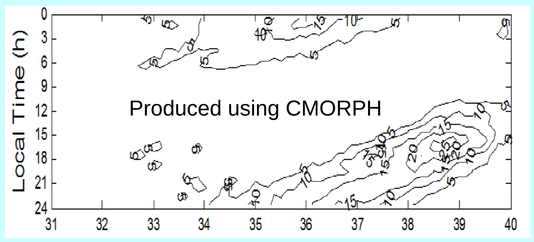
- **This study reports on validation of two high-resolution satellite rainfall products: TRMM 3B42 3-hourly 0.25° product, and CMORPH 8-km 30-minute product.**
- **The two products are assessed in terms of their ability to re-produce spatial variability in monthly and diurnal rainfall cycles across the full Nile Basin domain in Africa.**
- **The CMORPH product is also used to drive a basin-wide hydrological forecasting model (Nile Forecasting System) and compared to simulations based on IR-only rainfall product operationally used by the Nile Forecasting Center in Egypt.**
- **Finally, the CMORPH product is evaluated at its finest resolution using a dense independent rain gauge network in south Louisiana in the US, focusing on hydrologically-relevant validation attributes.**

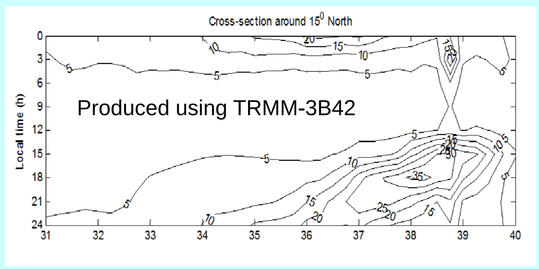
Seasonal cycle of rainfall across the Nile basin: comparison against long-term rainfall climatology

Box plots are based on GHCN-monthly rain gauge (1950-present). Synmbols on the left of each box refer to TRMM-3B42 (1998-2008) ; symbols on right refer to CMORPH (2003-2008).

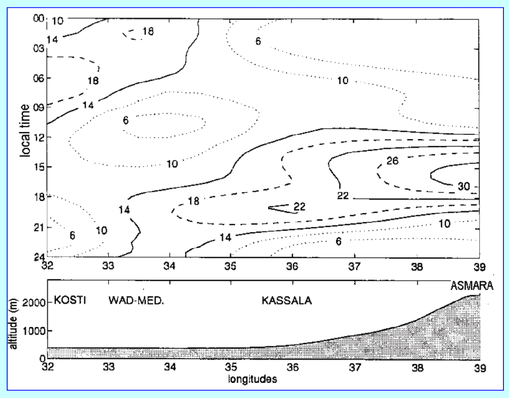


Diurnal cycle along a latitudinal cross section (15° N)

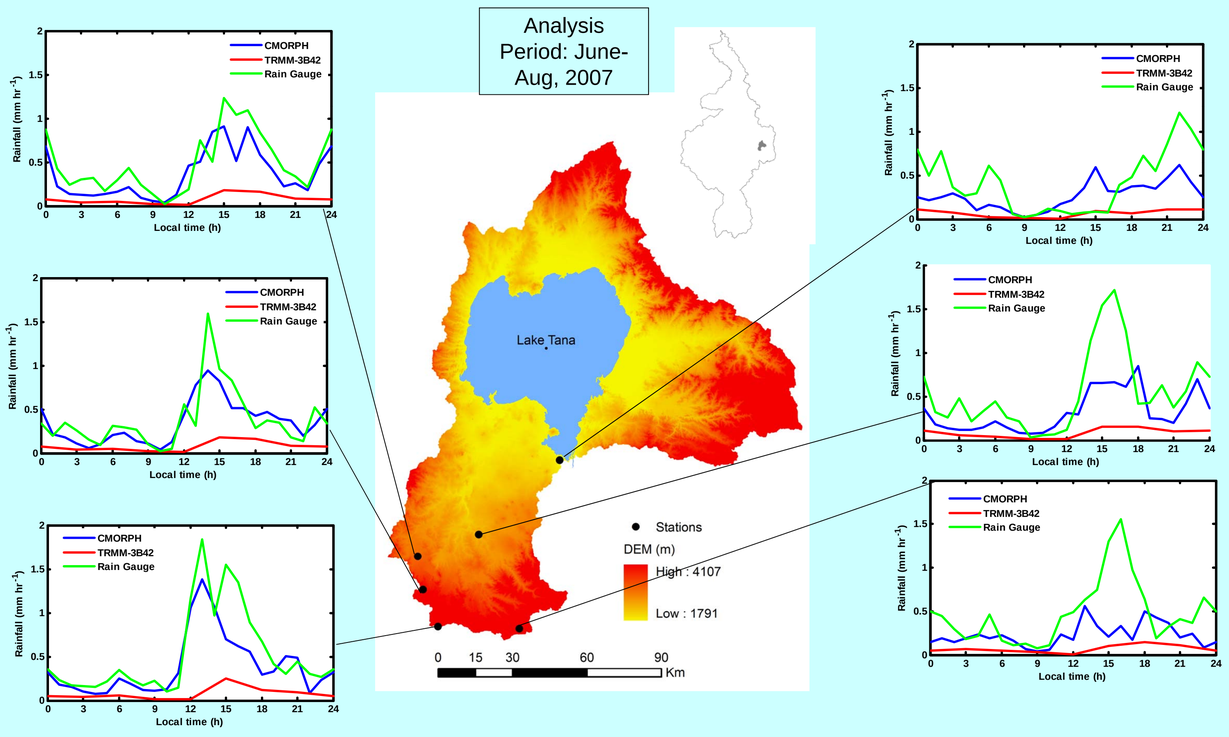




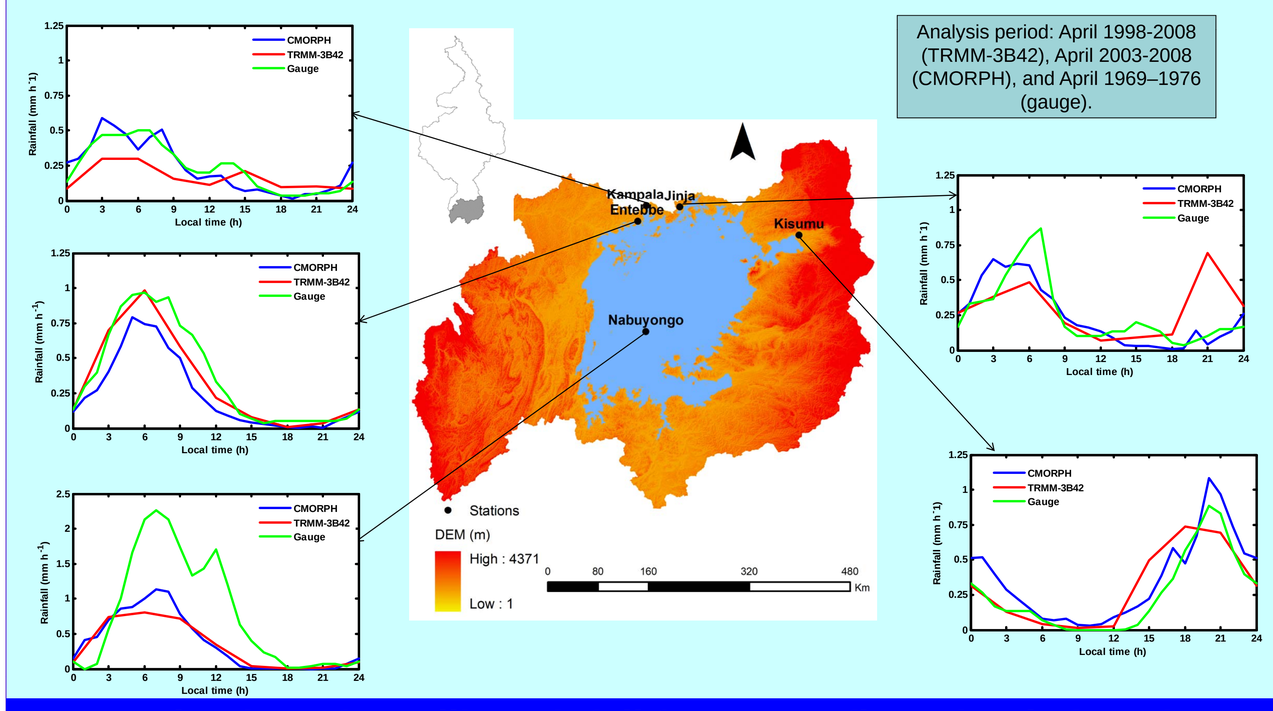
Based on historical Gauge (Camberlin, 2009)



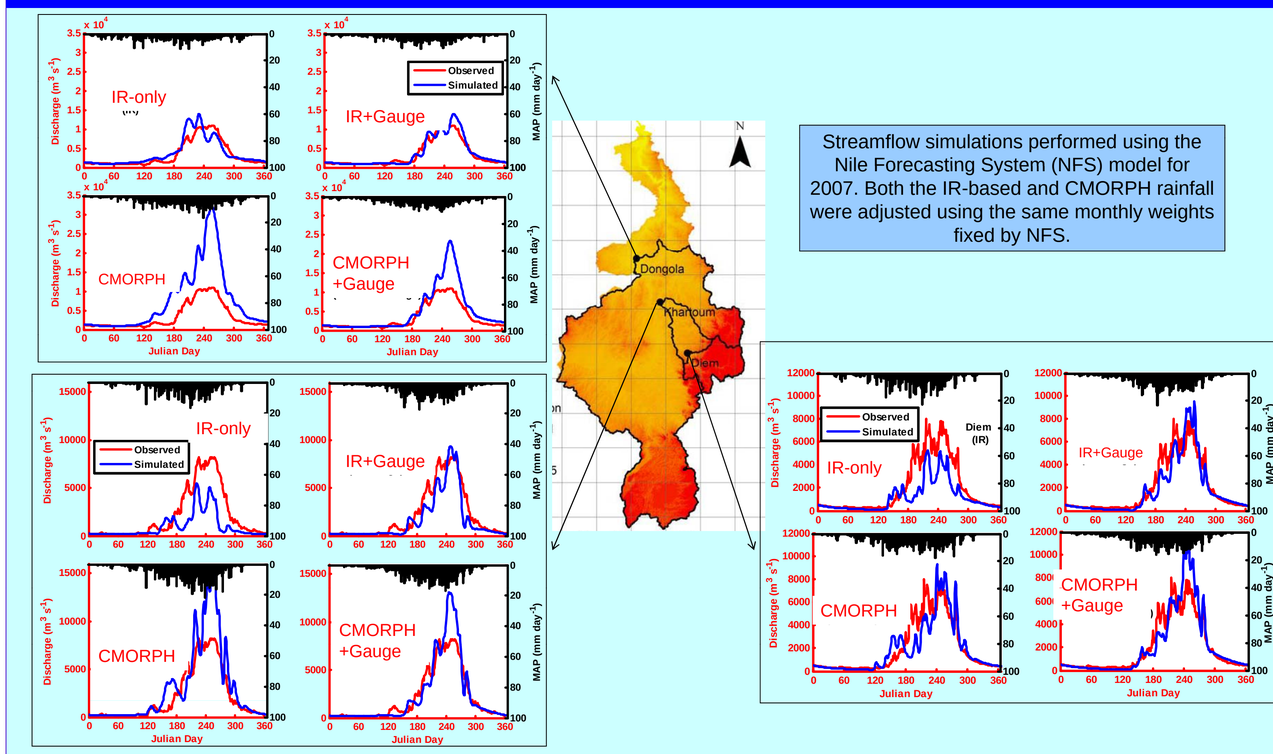
Diurnal cycle of rainfall in Lake Tana basin, source of Upper Blue Nile



Diurnal cycle of rainfall in Lake Victoria basin, source of White Nile

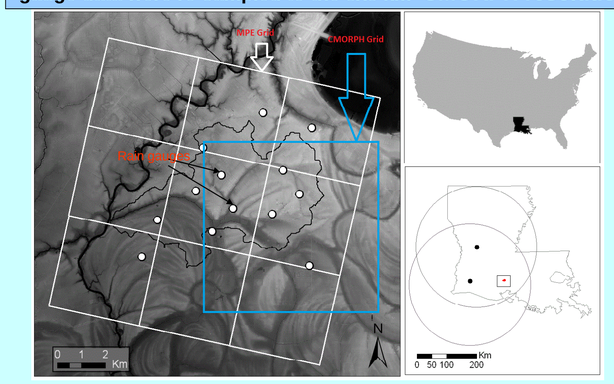


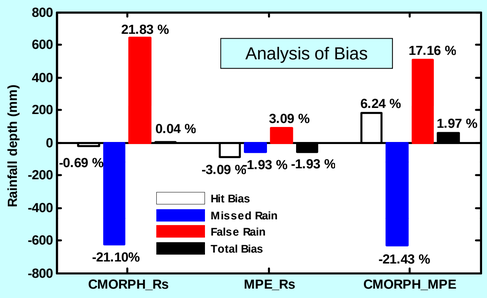
Evaluation of satellite rainfall for streamflow simulations in the Nile Basin

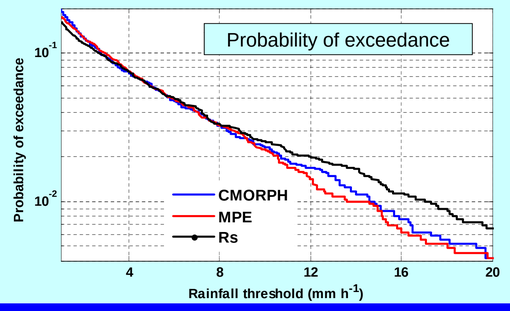


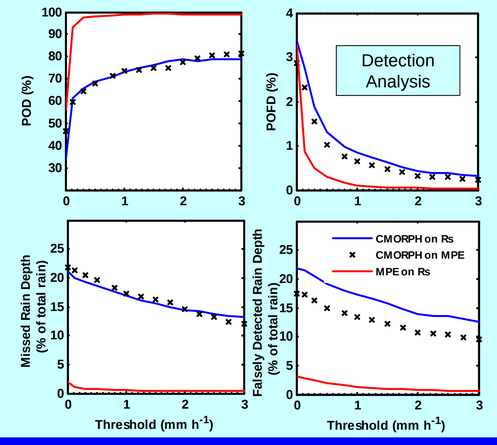
Evaluation at fine time-space resolution using dense gauge network and MPE radar-based product in Louisiana, US

Analysis period: (Aug 2004 – Dec. 2006). The 4x4 km² MPE and the gauge data were re-sampled to the 8x8 km² CMORPH resolution









Conclusions

- **Both products capture the overall patterns of rainfall climatology over the Nile Basin. Over basin areas north of the equator, monthly rainfall amounts are mostly overestimated by CMORPH and underestimated by TRMM-3B42. The agreement is better around the equator.**
- **CMORPH performed better than TRMM-3B42 in terms of capturing diurnal cycle of rain rate over Lake Tana basin (source of Blue Nile). The major limitation is over the mountains and the Lake shore. TRMM-3B42 extremely underestimated rain rates in this basin.**
- **Over Lake Victoria basin, both products successfully identified regions that have morning rain rate maxima and those that receive their maximum in late-evening to mid-night local times. However, products significantly underestimated the rain rate at the middle of the lake.**
- **CMORPH and an operational IR-only product resulted in relatively poor performance of the NFS rainfall-runoff model. Significant improvements in model performance were gained by adjusting satellite-rainfall inputs using gauge data. In Blue Nile basin, the relative volume error of simulated flow decreased from -40% when using CMORPH instead of IR-estimates as a model input. However, merging either product with real-time gauge data resulted in nearly equivalent performance.**
- **Evaluation of CMORPH at fine space-time scales showed that: CMORPH has very negligible total bias (0.04%) but its missed-rain and false-rain biases are significantly large (-21.10 and 21.83 %). CMORPH has poor rainfall detection capability in the study area particularly for light rain rates (< 2 mm h^{-1}). Correlation between CMORPH estimates and gauge data increased from 0.4 at hourly scale to 0.6 at a daily scale. Similarly, the relative RMSE decreased from 840 % of mean rain rate at hourly scale to ~200% at 2-days time scale. Using radar based MPE as reference results in favorable accuracy of CMORPH than its actual accuracy in terms of POFD and falsely detected rain depth. It results in less favorable accuracy in terms of total bias and hit bias**

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