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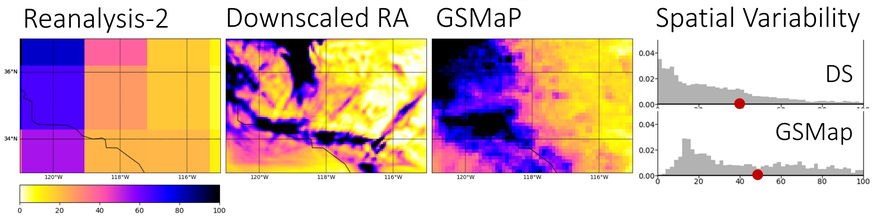
Precipitation Measurement Mission for Improved Forcing in Hyper-Resolution Land Surface Models

[1,2,3] Hyungjun Kim, [4] Yuta Ishitsuka, [3] Gavin D. Madakumbura, [1,3] Nobuyuki Utsumi, [3] John T. Reager and [5] James F. Famiglietti *[1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, United States; [2]JIFRESSE, University of California, Los Angeles, CA, United States; [3]Institute of Industrial Science, The University of Tokyo, Tokyo, Japan; [4]Dept. of XXXXXXXXXXX, University of Massassets, Amherst, MA???; [5]Global Institute for Water Security, University of Saskatchewan, AL??, Canada*

0. Objectives

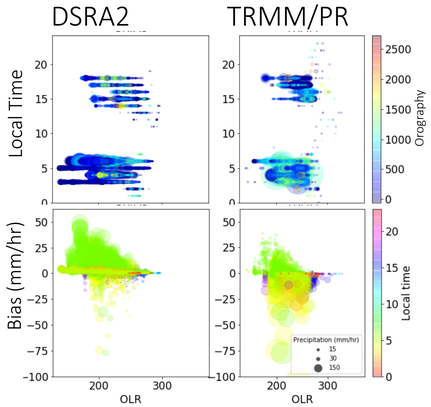
In this research, we aim to supplement the next generation of land surface models, at 'hyper-resolution', by creating and demonstrating the next generation high-resolution precipitation forcing combining dynamically downscaled reanalysis data and PMM observations.

2. Dynamical Downscaling



Using ***Spectral Nudging*** technique, NCEP-DOE Reanalysis-2 (RA2) has been downscaled from 2-degree & 6-hour original resolutions to 0.05 degree & 1-hour spatiotemporal resolution. Downscaling has been tested over Southern California regions for 2-year period (2013-2014). In analysis, only a wet season precipitation has been taken.

3. Statistical Bias Correction

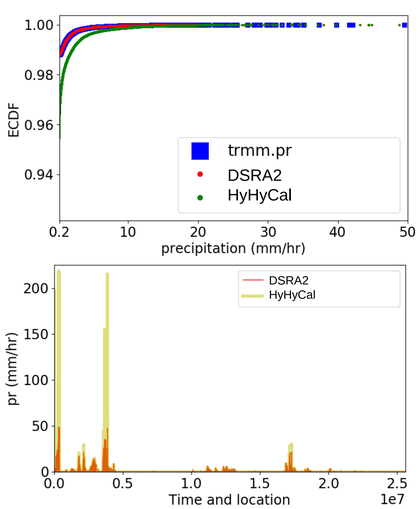


DSRA2 properly captures the diurnal cycle of precipitation over the target domain and shows relation between precipitation intensity (and DSRA2 bias against TRMM/PR) and OLR (Outgoing Longwave Radiation). OLR based spatial precipitation classification for classes 150-200, 200-250, 250-300, 300-350 Wm^2, and BC was done for each group separately.

Quantile Mapping method correct the errors in the shape of the distribution of the variable by matching the intensity of the distribution of the simulated values with that of the observations. If the hourly observed and simulated precipitation of a certain location is Po and Pm respectively, the QM transformation is defined as,

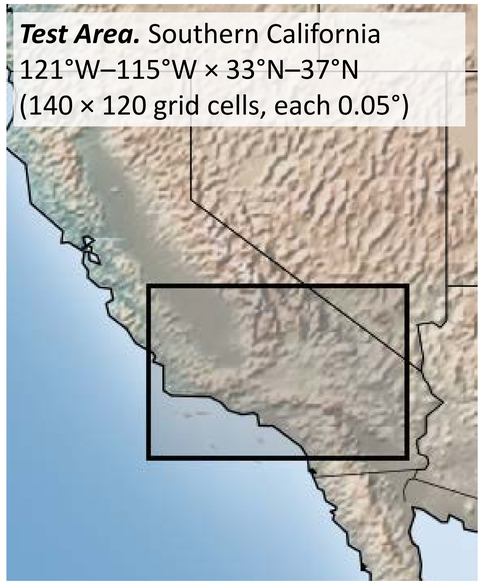
$$P_{obs} = F_{obs}^{-1}(F_{sim}(P_{sim}))$$

where F_m is the cumulative distribution function (CDF) of P_m and F_o^{-1} is the corresponding inverse CDF of P_o.

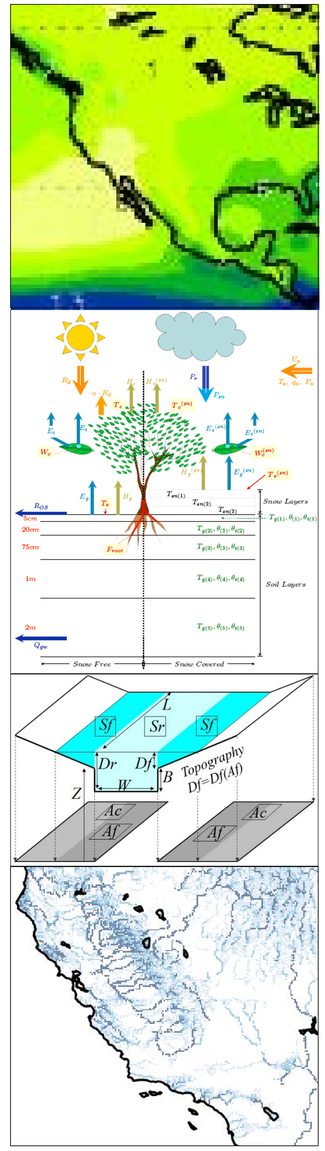


1. Test-bed Design

TRMM/PR L2 retrieval has been tested to provide information of high spatiotemporal variability for regional 1km hydrological simulation. NCEP-DOE Reanalysis-2 (RA2) has been downscaled to be merged with satellite instantaneous scans, and quantile mapping method has been applied to correct the bias of the downscaled RA2 (DSRA2). Land surface simulations have performed using NLDAS forcing data switching precipitation with a newly generated regional hyper-res. Precipitation. Discharge has been simulated by routing calculated runoffs and validated against USGS in-situ observations.



Forcing data generation

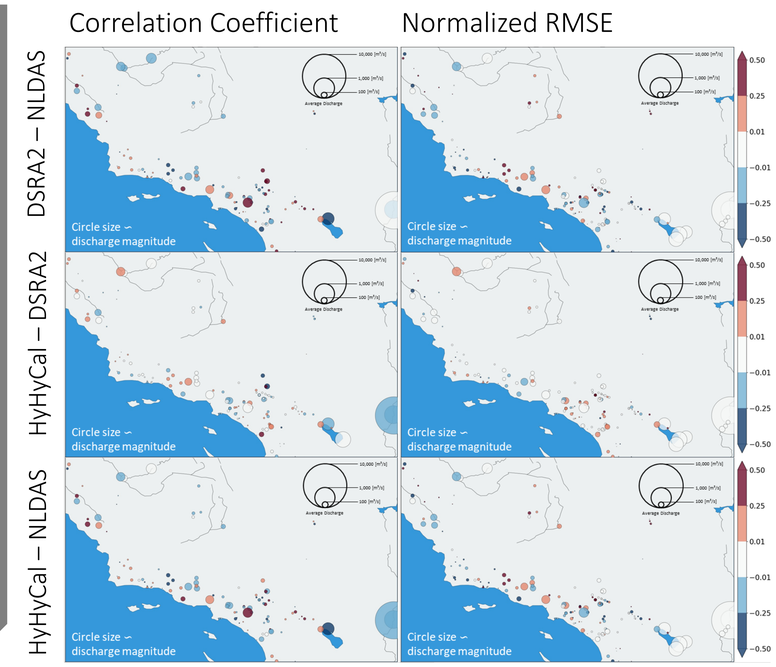


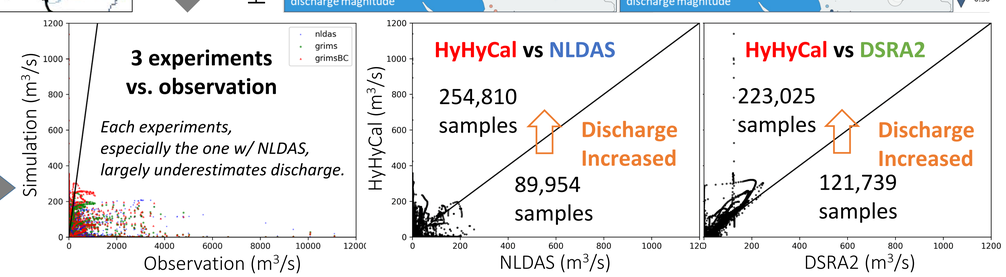
Forcing Dataset	Spatial Res. Temporal Res.	Original Reanalysis	Spatial Res. Temporal Res.
NLDAS (Xia et al., 2012)	0.125 deg. 1-h	NARR (Mesinger et al., 2006)	32km 3-h
DSRA2 (Downscaled RA2)	0.05 deg. 1-h	RA2 (Kalnay et al., 1996)	2.5 deg. 6-h
HyHyCal (Bias corrected DSRA2)	0.05 deg. 1-h	DSRA2 (This study)	0.05 deg. 1-h

Hyper-resolution Hydrologic Modeling

5. Hyper-res. Hydrologic Modeling over California (HyHyCal)

MATSIRO land surface model (Takata et al. 2003) and CaMa-Flood river model (Yamazaki et al. 2011) have been used to calculated runoff and discharge at 5km and 1km grids, respectively. Simulated discharge has been validated against 166 selected USGS in-situ discharge observations for 2014/01/01 – 2014/04/01. Basins transboundary or with strong tide effects have been excluded.



HyHyCal experiment generally performs slightly better than NLDAS and DSRA2 experiment, since QM bias correction efficiently alleviate overall underestimation observed in all three experiments. It is speculated that known shortcoming, groundwater and baseflow, in the modeling framework would be significant, because those processes are relatively more critical in (semi-) arid region whereas the target domain. However, it can be claimed that the proposed methodology successfully showed a potential of PMM L2 retrieval to improve the performance of regional hyper-resolution modeling.

Validation