Satellite-derived potential evapotranspiration for distributed hydrologic runoff modeling

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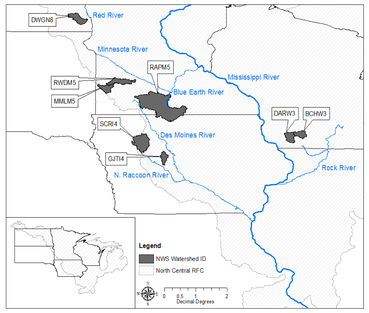
Introduction

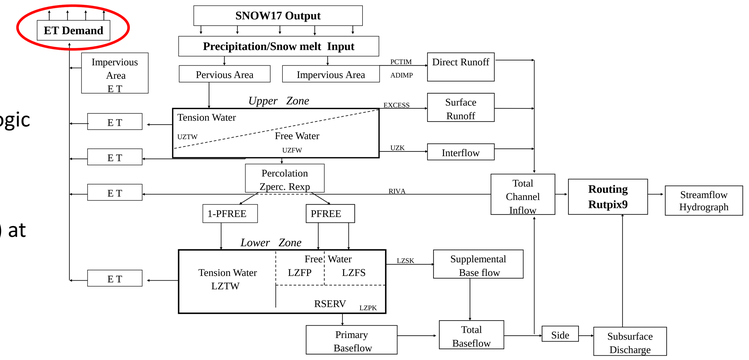
- Operational streamflow forecasting primarily relies on watershed-scale models driven by ground-based (commonly point-scale) observations of precipitation, temperature and climatological , pan-based potential evapotranspiration (PET) estimates.
- Advances in satellite and radar remote sensing of hydrologic variables have made the application of distributed models feasible.
- This study examines the potential benefits of a satellite-derived PET product (UCLA MODIS-PET; Kim and Hogue., 2008) for use in the HL-RDHM.
- **The objective of this study is to improve operational hydrologic forecasts through the application of advanced spatially and temporally distributed satellite data products**.

Study Sites

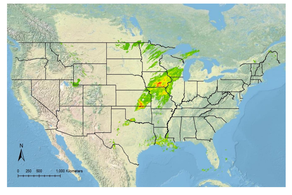


HL-RDHM

- The National Weather Service Hydrology Laboratory – Research Distributed Hydrologic Model V. 3.2.0
- Components: SNOW17, SACSMA-HT, Overland and Channel Routing (rutpix9)
- Model is run at the HRAP resolution (4km) at a 6hr time step
- A-priori CONUS gridded parameters developed by the Hydrology Lab

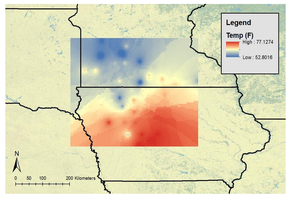


Model Inputs



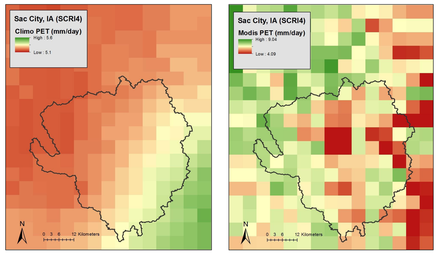
Precipitation

- Climatology-Calibrated Precipitation Analysis (CPPA) provides quality controlled precipitation estimate at 4 km resolution.
- Combines CPC Unified Global Daily Gauge Analysis and Stage IV dataset.



Temperature

- Gridded temperature dataset was developed using inverse distance weighting interpolation on ASOS and AWOS point scale station data.



Potential Evapotranspiration

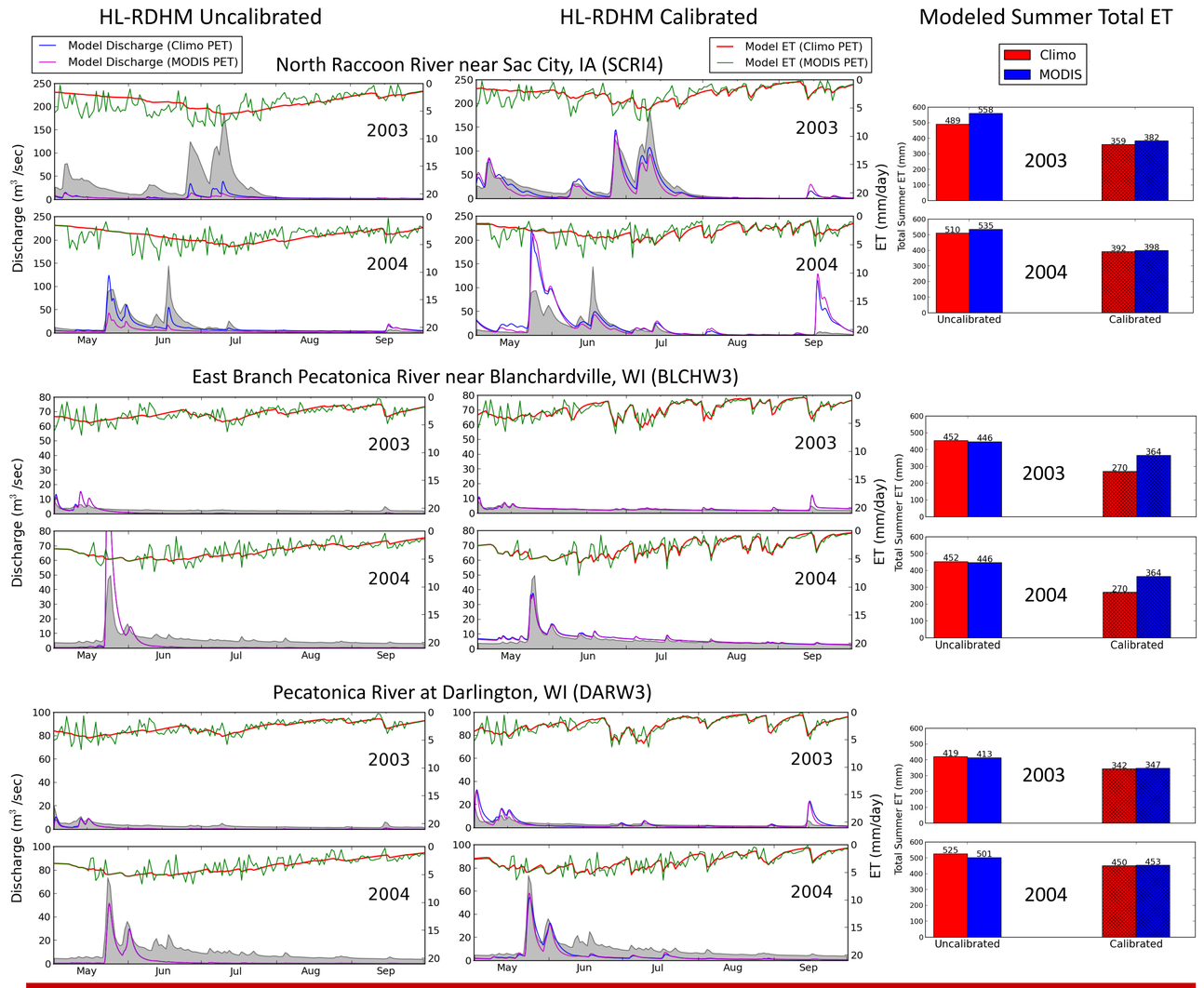
- Daily 1 km resolution UCLA MODIS-based PET product is derived from 13 MODIS products and the Priestly Taylor formula (above right)
- Monthly climatological PET grids are obtained from Hydrology Lab (above left)

Automated Calibration

Selected a-priori model parameters for the SACSMA-HT and SNOW17 were calibrated using an automated Stepwise Line Search (SLS) technique and a Multi-Scale Objective Function.

- Calibration period: 1/1/2007 – 12/31/2010 (contained several wet summers)
- Validation period : 1/1/2003 – 12/31/2006
- A 1 year spin-up period was used to reduce the influence of initial model state conditions

Results



Conclusions and Future Work

SCRI4 2003-2006	*Uncalibrated*		*Calibrated*	
Error	Climo	MODIS	Climo	MODIS
Corr Coef	0.78	0.76	0.85	0.77
% bias	-46.18	-71.68	3.55	-5.8
NS	0.39	0.03	0.66	0.5
MAE (m^3/s)	12.16	15.07	9.02	11.7

- Calibration of the HL-RDHM improved simulations using both climatological PET and MODIS-PET
- MODIS-PET often produced higher ET rates, and therefore a more negative bias in stream discharge
- Evidence of time periods that benefit from the more dynamic daily MODIS PET demand input
- Periods when model performance does not improve and even degrades when compared to climatological PET results
- Calibration of the HL-RDHM is an essential factor in producing accurate discharge values while still maintaining realistic parameter values (changing parameter values is the primary factor in altering the modeled ET output)
- Continuing the study with limited manual calibration
- Addition of more study basins is currently underway to provide a better understanding of how the more realistic daily PET demand affects the distributed SACSMA-HT for Midwest watersheds.

Acknowledgements

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References

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