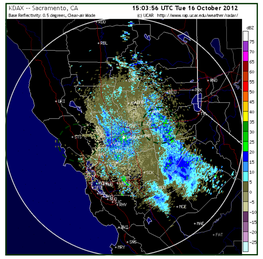
Distributed Hydrologic Modeling Using High Resolution Precipitation Products

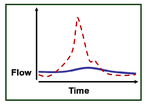
Chengmin Hsu[1], Lynn Johnson[2], Rob Cifelli[3], and Robert Zamora[3]

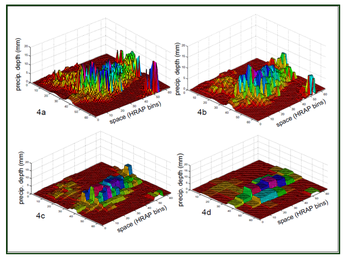
[1]CIRES, University of Colorado at Boulder, E-mail: chengmin.hsu@noaa.gov; [2]University of Colorado Denver; [3]NOAA Earth System Research Laboratory, Boulder, CO 80305

1. Overview

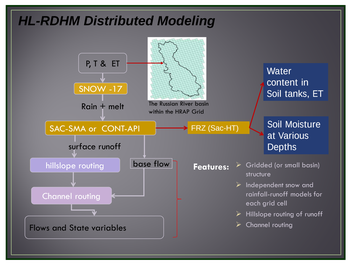
1. Water flows
2. A topographically-based model is the foundation for a more scientifically valid approach to the prediction of flash floods than the current fielded tools.
3. Take advantage of the NEXRAD grid precipitation data to improve forecast accuracy
4. Spatially averaging a typical precipitation field (Lumped Mode) from the NEXRAD radar will result in a smoothed input signal to hydrologic models operating at the scale of averaging.
5. Distributed model is an excellent tool to validate the grid precipitation data (gauge-only, radar only, or integrated gauge and products)

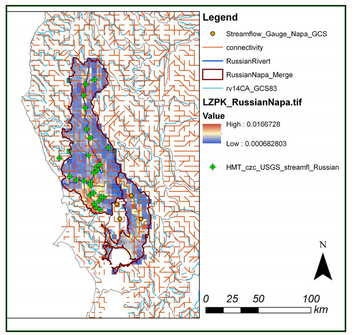


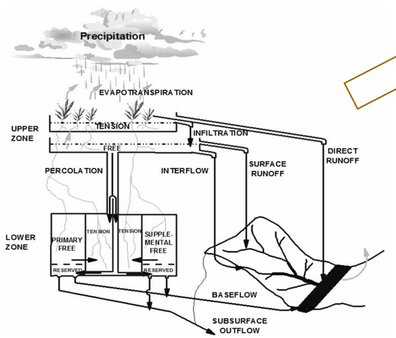




2. The Model Structure of HL-RDHM

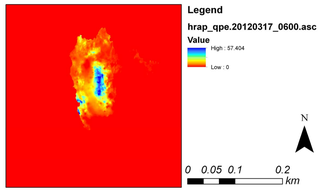




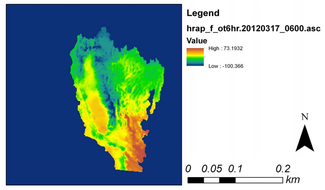


1. *Snow Melt and Rain serves as a input forcing to SACSMA. From SACSMA, surface runoff and base flow are generated and put into "rutpix" model to simulate the flow and various states for each grid.*
2. *Connectivity file is required for calculating distribution of flow*
3. *To control the percolation curve, ZPERC, REXP, and LZFSM need to be observed simultaneously.*
4. *Routing component can be executed in a loop to find the set of scalar multipliers*

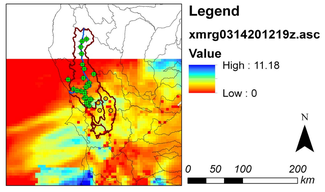
3. Forcing Data and the Priori Parameters



CNRFC QPE

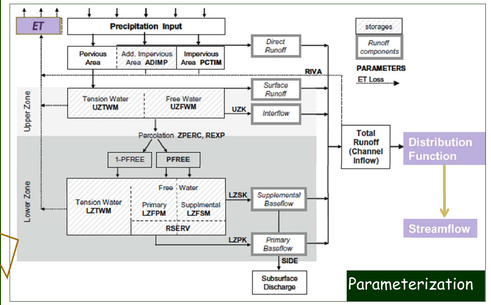


CNRFC Temperature



MTR MPE

One -year CNRFC QPE and temperature data are used for calibrating the model. The model was spun for one year and two months to obtain the model states. Based on these states, the model was then run from Feb. 1, 2011 to Mar. 12, 2012 for calibration and sensitivity test. The validation period is from March 13, 2012 to March 31, 2012.



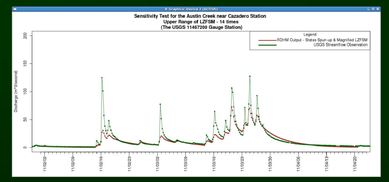
Parameter	Units	Description	Allowable range
UZTWM	mm	Upper zone tension water maximum storage	10 - 300
UZFWM	mm	Upper zone free water maximum storage	10–75
UZK	day^{-1}	Upper zone free water withdrawal rate	0.2–0.5
PCTIM	%/100	% permanent impervious area	0.0–0.05
ADIMP	%/100	% area contributing as impervious when saturated	0.0–0.2
RIVA	%/100	Percent area affected by riparian vegetation	0.0–0.2
ZPERC	none	Maximum percolation rate under dry conditions	20–300
REXP	none	Percolation equation exponent	1.4–3.5
PFREE	%/100	% of perc. going directly to lower zone free water	0–0.5
LZTWM	mm	Lower zone tension water maximum storage	75–300
LZFSM	mm	Lower zone free water supp. maximum storage	15–300
LZFPM	mm	Lower zone free water primary maximum storage	40–600
LZSK	day^{-1}	Lower zone supplementary withdrawal rate	0.03–0.2
LZPK	day^{-1}	Lower zone primary withdrawal rate	0.001–0.015

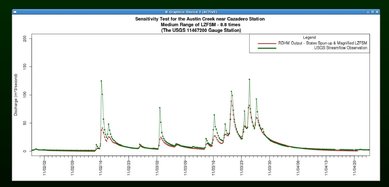
SIDE: the ration of deep recharge to channel baseflow
RSERV: the fraction of lower zone free water not transferable to lower zone tension water

4. Sensitivity Test and Calibration

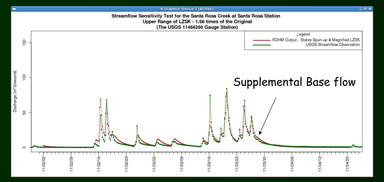
The indices used for calculating accuracy are:

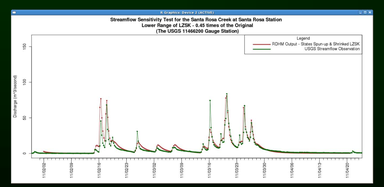
- Nash-Sutcliffe
- Percent Bias
- RSR
- Rmod
- Event Depth Difference



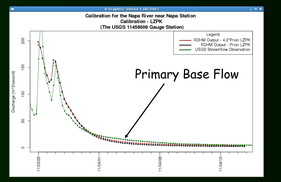


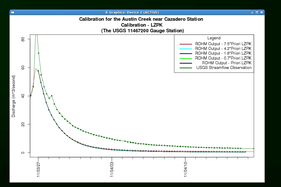
LZFSM controls the amount of supplemental baseflow as well as the percolation rate



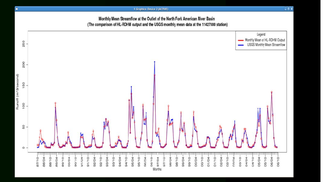


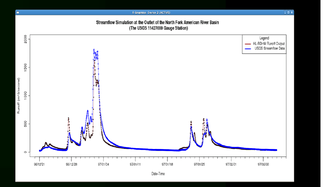
LZSK controls the timing of the supplemental recession





LZPK behaves differently in different watersheds



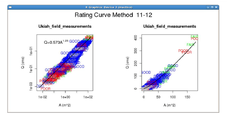


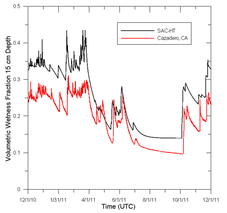
20 Years Simulation for the North Fork American River Basin

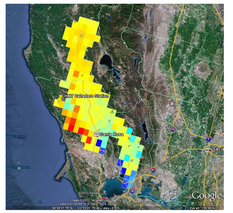
5. Routing Parameters & Soil Moisture

$Q = q_0 * A^{qm}$

q0chn	qmchn	alphac	betac	n
0.264	1.25	1.49	1.72	0.1







Soil Moisture Output at 10 cm depth and Its Validation

6. Conclusion

1. RDHM can simulate streamflow, soil moisture, and many hydrologic states with high accuracy and high resolution.
2. Much local phenology and geomorphology interact with hydrologic dynamics and can be further analyzed in the distribute hydrologic model simulation.