ABSTRACT

This study integrates model with observations in two ways. First, a land surface model (LSM) with a hydrologically-based soil moisture scheme is calibrated to observations across the continental U.S. for large river basins (on the order of USGS hydrologic regions and subregions) as well as for smaller tributary catchments. The observations include stream gauge records, as well as independent remote sensing estimates of evapotranspiration and terrestrial water storage change. This portion of the analysis serves to evaluate the extent to which remote sensing data can improve streamflow prediction and aid in the overall parameter estimation procedure. The second part of the study uses the calibrated model to derive a parameter regionalization framework using various observations as predictors. Predictors include land surface characteristics, geomorphic parameters and meteorological variables from several sources. Principal components analysis is used to establish predictive relationships between predictors and predictands. Predictands are the soil parameters of the Unified Land Model (ULM), which is a merger of the Noah LSM (used in NARR-NCEP) or numerical weather prediction and climate models) and the Sacramento Soil Moisture Accounting Model (used by NWS for operational flood forecasting and seasonal streamflow forecasting). Our major objective is to quantify the potential for the aforementioned predictors to produce parameter sets that are capable of capturing observed patterns of streamflow, and which can be used as a priori estimate of the CONUS domain. Finally, we evaluate the role of scale in model behavior and the observed physical phenomena.

Key scientific questions of this study:
- How can model performance be improved by calibration to multiple observation sources?
- To what extent can calibrated model parameters be regionalized, using land surface characteristics, geomorphic parameters, and hydrometeorological attributes?
- Are flood forecasts better improved by model simulations resulting from regionalization, calibration or statistical bias correction?

Study Domain

Fig. 1: Large-scale study domain, precipitation gauges (black dots), as well as major hydrographic regions that are defined through their drainage stream gage basins (blue lines).

Fig. 2: Catchment-scale study domain, including approximately 500 catchments (yellow shading) with an associated precipitation gauges (black dots). Stations were identified by Schaefer et al. (2004).

Model Validation and Parameter Estimation

Fig. 3: Calibration results from 8 large basins in which ULM was calibrated towards streamflow for a 20 year period (1990 – 2009). For western US basins, naturalized streamflow data were used, while USGS gage data were used for the remainder of basins.

Fig. 4: Mean monthly ET (mm) for the major river basins for the period 2002-2010 including the control and calibrated model simulations; the range of variability for each case is shown accordingly.

Fig. 5: Mean monthly TWSC (mm) for the major river basins for the period 2002-2010 including the control and calibrated model simulations; the range of variability for each case is shown accordingly.

Parameter Regionalization using Principle Components Analysis;

1. Land surface characteristics and geometric variables
2. Historic meteorological information
3. Soil texture information
4. GAGES-2 basin characteristics

References

