S2S Climate Forecast Products for the Water Sector

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Motivation

The potential value of the sub-seasonal to seasonal (S2S) prediction has not yet been fully realized by stakeholders in the water management applications sector. Challenges related to fundamental predictability are difficult to surmount, but other hurdles can be readily addressed – eg, products are:

- misaligned with users' space-time needs;
- disseminated in formats not easily processed; and
- biased relative to user climatologies.

More can be done to bridge the gap by enhancing the usability, quality, and relevance of water-oriented S2S climate predictions.

Objectives

1. Implement CONUS-wide S2S precipitation and temperature forecast products for watershed spatial units, eg USGS `HUC4`:
   (a) benchmark raw model forecast precipitation and temperature outputs
   (b) bias-correct and statistically calibrate versus NLDAS reference datasets
2. Develop forecasts of the probability of extreme events within the S2S forecast periods.
3. Verify the prediction skill of products to raise product awareness and enhance users' understanding.
4. Research to operations (R2O) transition of the approaches and results to operational CPC setting.
5. Facilitate data dissemination for the watershed oriented forecast and hindcast products.

Together, the tasks are designed to expand current CONUS-wide climate prediction outputs to connect more effectively with the water management community, and to demonstrate skill enhancements through statistical post-processing.

Data & Methods

Raw Hindcast & Forecast Outputs

NMME-2
- Monthly (by the 8th day)
- Hindcasts: 1982-2010
- Forecasts: 2011-present

CFSv2
- Four initializations daily at 6-hr time steps
- Hindcasts: 1999-2010; 4 traces daily
- Forecasts: 16 traces daily

Spatial & Temporal Processing

NMME-2
- Reproject
- Temporally average to seasonal lead time → ensemble mean
- Spatially average to watersheds

CFSv2
- Reproject
- Temporally average to bi-weekly time periods → ensemble mean
- Spatially average to watersheds

Verification

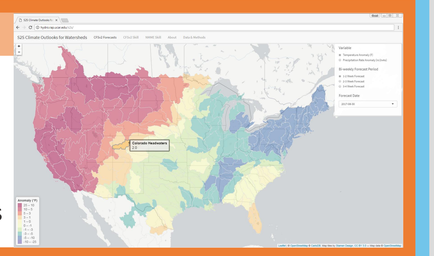
- Anomalies calculated based on climatology
- Forcing Data – NLDAS-2
- Anomaly correlation, bias, and percent bias calculated for each model, lead, and season

Post-Processing

- Bias-correction, calibration of raw data
- Extremes predictions on S2S scale

S2S Products

- Real-time Forecasts
  - ***CFSv2*** – bi-weekly forecast products updated daily
  - ***NMME*** – monthly forecast products updated monthly
- Benchmark Skill of Hindcasts



Refs

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Xia, Y., et al. (2012), Continental-scale water and energy flux analysis and validation for the North American Land Data Assimilation System project phase 2 (NLDAS-2): 1. Intercomparison and application of model products, J. Geophys. Res., 117, D03109, doi:10.1029/2011JD016048.

Water Management Example

Rio Grande Headwaters watershed

- Managed by Bureau of Reclamation
- Potential benefit of S2S predictions to water management decisions:
  - More skillful streamflow forecasts especially during runoff season
  - Anomalous heat waves can help predict peak runoff timing which is important to managing releases from tributaries

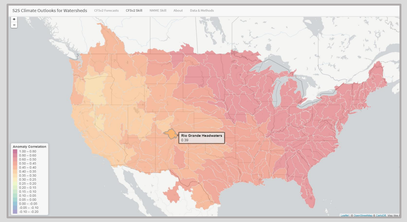

Fig. 1: CFSv2 anomaly correlation for 2-3 bi-weekly period temperature at Rio Grande Headwaters watershed.

Anomaly Correlation for both CFSv2 and NMME temperature and precipitation forecasts varies seasonally and decreases with increasing lead time.

CFSv2 mean forecast skill is high in the first 2 bi-weekly periods over all of the CONUS domain (Fig. 2). Raw overall precipitation forecast skill drops off rapidly after the first bi-weekly period and is unusable by the 3-4 week period.

NMME-2 mean temperature forecast skill is high for the first month, while months 2 and 3 have lower but similar skill patterns (Fig. 3). Mean precipitation forecast skill has skill is some watersheds in the first month, but decreases significantly for months 2 and 3.

Mean forecast skill varies seasonally in each watershed. For CFSv2 mean temperature forecast skill, the southeastern and northwestern watersheds exhibit higher skill, while skill in the central watersheds remains lower through all seasons (Fig. 4).

Results

Raw Anomaly Correlation

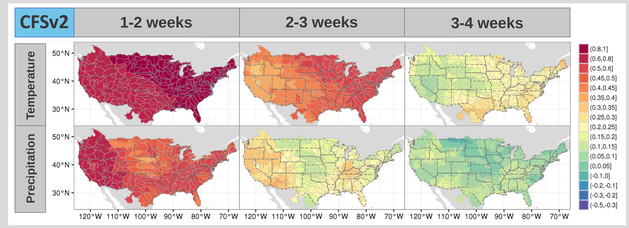

Fig. 2 (top): CFSv2 anomaly correlation at bi-weekly time step for temperature and precipitation rate at a HUC4 watershed scale. **Fig. 3** (bottom): Same as Fig. 1 with NMME anomaly correlation a monthly time step.

Seasonality of Anomaly Correlation Temperature – 3-4 weeks

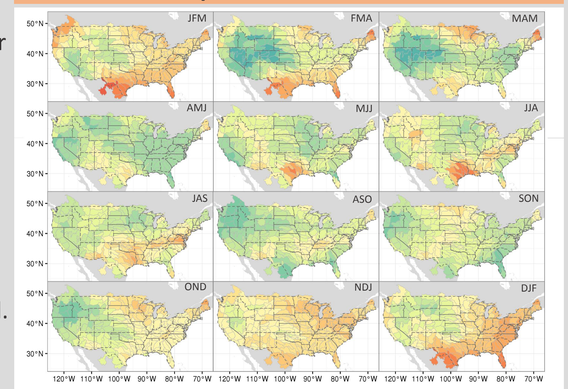

Fig. 4: CFSv2 anomaly correlation of temperature at weeks 3-4 for moving 3 month averages.

Future Directions

- Interact with operational water management offices in Reclamation and US Army Corps of Engineers to gauge interest in products and solicit feedback
- Add links to disseminate hindcasts/forecast data associated with watershed maps
- Train post-processing approaches to enhance skill of raw real-time S2S forecasts, where possible
- Explore opportunities for extremes prediction at S2S time scales

Website: http://hydro.rap.ucar.edu/s2s/