Brahmaputra and Ganges Rivers

Test Bed Leaders

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Test Bed Description

The Brahmaputra and Ganges river basins are part of the project Climate Forecasting Applications for Bangladesh (CFAB), which provides operational real-time forecasts of river discharge into Bangladesh at daily, weekly, monthly, and seasonal time-scales. In support of this project, short-term (1 to 10 day) forecasts of severe flood-stage discharges in the catchments of the Ganges and Brahmaputra Basins were developed and began operational dissemination during the monsoon season of 2003, continuing to the present. In order to generate fully automated probabilistic river discharge forecasts, the forecasting scheme utilizes the European Centre for Medium-Range Weather Forecasts (ECMWF) ensemble weather forecasts, near-real-time satellite and rain gauge precipitation estimates, and near-real-time discharge estimates from the Bangladesh Flood Forecasting and Warning Centre (FFWC), in conjunction with statistical dressing and the use of lumped and distributed hydrological models. The spatial scale of the Brahmaputra basin is approximately 1×106 km2 while that of the Ganges basin is approximately 5×105 km2. The temporal scale (response time) of the Brahmaputra and Ganges basins are approximately 10 days and 20 days, respectively.

Key Scientific Questions

- Can data assimilation techniques significant improve in operational discharge forecast performance through improvements in forecast model state estimation?
- What role does data assimilation technique play in provide accurate forecast error estimates, reducing hydrologic model parameter uncertainty, and improving model structural calibration in rain-fed and snow-melt dominated basins?

Key Objectives of the Research Project

The Brahmaputra and Ganges Test Beds will provide an opportunity to compare the performance of a variety of different data assimilation techniques within this data-sparse operational setting. In particular, these two basins are primarily ungauged, except at the forecast location itself, where near-real-time discharge estimates (rating curve derived) are available. As well, the only "observation-based" data inputs are "forcing" precipitation data provided by two semi-independent near-real-time satellite-derived estimates (6 to 12 hour lags) as well as sparse rain gauge estimates (36 hour lag).

As part of the data assimilation technique inter-comparison, the current operational discharge forecast methodology for these basins includes an analogue-based data assimilation and forecast correction technique. This technique was developed to provide real-time estimates of discharge forecast uncertainty by utilizing the near-real-time discharge estimates. This technique has shown good skill, and has its own strengths and weaknesses not inherent in other data-assimilation techniques.

Data Resources

Data Sets

- Daily River Discharge of the Brahmaputra and Ganges Rivers derived from rating curves from the late 1950's to the present.

- ECMWF ensemble forecast weather variables [10U 10V 2D 2T CP LSP SLHF SSHF SSR STR SWVL1 SWVL2 SWVL3 SWVL4] over the region 30E to 160E, 40S to 45N, nominally 1°×1°, but linearly interpolated down to 0.5°×0.5°, 51 members, initialized 12:00 GMT, with forecast interval times every 12 hours out to 10 days from 2003 to the present.
- Satellite observed precipitation from the Global Precipitation Climatology Project (GPCP) and the NOAA CPC Morphing Technique ("CMORPH"), 3 hourly, nominally 1997 to the present.
- Gridded rain gauge data, 1979 to the present, provided by the National Oceanic and Atmospheric Administration's Climate Prediction Center, which were derived from the daily-reporting GTS rain gauge network.
- The satellite and rain gauge estimates are also combined into one product and are interpolated to the same grid (0.5°×0.5°) and time window as the ECMWF forecasts for operational use.
- Digital Elevation Map over the region from the EROS Data Center.

Forecasting Techniques

- A weather forecast correction technique is available for precipitation forecasts to remove model biases and other discrepancies with "observations" (while retaining spatial and temporal covariances). The correction approach is based on a quantile-to-quantile mapping technique.
- A flexible multi-model discharge forecasting approach, which combines a data-based lumped catchment model and a sub-catchment distributed model, has been implemented for real-time forecasting.
- An analogue technique is available to account for all aspects of discharge forecasting error (while simultaneously making a model correction) so that more statistically correct probabilistic discharge forecasts can be made.