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3.9 HYDROLOGIC APPLICATION OF GLOBAL ENSEMBLE PRECIPITATION FORECASTS

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1. INTRODUCTION

The National Weather Service (NWS) River Forecast System uses an Ensemble Streamflow Prediction (ESP) technique to create an ensemble of possible streamflow hydrographs that are thenanalyzed statistically to produce probabilistic forecastsof streamflow and streamflow-related variables over a range of forecast periods.

As a result of recent developments in probabilistic weather forecasting, the Office of Hydrology of the NWS is developing methodologies for enhancing the ESP technique by coupling probabilistic quantitative precipitation forecasts (PQPFs) with NWS hydrologic models. The ESP uses a spectrum of operational precipitation forecast products that are produced by all parts of the weather service. At the current stage of development, ESP is capable of ingesting short term PQPF provided by field forecasters through an Ensemble Precipitation Processor (EPP). Long-term PQPF's from the Climate Prediction Center (CPC) of the National Centers for Environmental Prediction (NCEP) are used to re-scale historical precipitation events to produce hydrologically appropriate long range inputs for ESP.

In the intermediate range, PQPFs at hydrologic-relevant space and time scales can be derived from the NCEP Environmental Modeling Center's ensemble-based probabilistic precipitation forecasts. Such forecasts have been made operationally with up to 16 days lead time by NWS global numerical weather prediction models. Our goal is to examine the performance of the NCEP ensemble based probabilistic precipitation forecast product in the context of the NWS hydrologic requirements and objectives. This paper presents preliminary comparisons of the observed and forecast climatological statistics that are important from a hydrological perspective.

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2. ENSEMBLE PRECIPITATION FORECASTS

Since March 1994 the NCEP has operationally run global numerical weather prediction models in the ensemble mode with up to 16 days lead time. The ensemble consists of one control forecast and 10 perturbed forecasts run at 00UTC and 4 forecasts run at 12UTC, all at a T62 resolution. It also includes a T126 (MRF) and a T126 control (AVN) forecast run at 00UTC and 12UTC, respectively. The high resolution forecasts are truncated to T62 after 7 and 3 days respectively.

Precipitation forecast products, based on the ensemble runs, are given in two forms. The first product is a 17-member ensemble of 12-hour precipitation amounts accumulated over 2.5E x 2.5E latitude-longitude grid boxes. The second product contains forecast probabilities of 24-hour precipitation amounts exceeding certain threshold values at the same spatial resolution. Current forecast probabilities are not statistically postproccesed to account for systematic errors, but they are derived simply as the percentage of forecasts (out of seventeen) that exceed selected thresholds.

An archive of these products has been available on a 2.5 degrees grid, globally, beginning in January 1997. For this study, we extracted an area encompassing the conterminous U.S. portion (22.5EN # longitude # 52.5EN; 65EW # latitude#127.5EW; 338 grid points). These data sets are available from our web-page: http://hsp.nws.noaa.gov/oh/hrl/papers/ams00/precip_data/ncep.

3. OBSERVED DAILY PRECIPITATION

Observed daily precipitation data from several different sources are processed in common format and used to create two composite data sets: operational and climatological. Operational data sets are available from http://hsp.nws.noaa.gov/oh/hrl/papers/ams00/precip_data/observed/operational/,and climatological data sets are available from: http://hsp.nws.noaa.gov/

oh/hrl/papers/ams00/precip_data/observed/climate.

The operational data set contains data from the NWS operational network. It also includes snow telemetry (SNOTEL) stations maintained by the US Department of Agriculture (USDA) Natural Resources Conservation Service, as they are becoming available operationally to NCEP. Since currently USDA does not do any data quality control, we applied a very basic one that at least guarantees that accumulated precipitation amounts are non-decreasing numbers.

The climatological data set is based on the National Climatic Data Center climate data archives. SNOTEL data are also included in the data set, since they are the only real source of high elevation data in the west. Climatological daily data were processed through 1997. We plan to update them as soon as they become available.

Both, climatological and operational data sets are used to estimate actual mean areal precipitation for each 2.5 degrees grid element. Climatological monthly precipitation estimates from the Natural Resources Conservation Service PRISM project are used to account for effects of orography and sharp climate gradients within each grid element on mean areal precipitation estimates. Information about the PRISM project is available at: *http://www.ocs.orst.edu/prism/prism_new.html.*

4. STUDY OBJECTIVES

Research into a number of theoretical and experimental issues related to this work is ongoing. Our first objective is to understand the uncertainty issues at the spatial scale at which precipitation forecasts are issued. We evaluate the performance of the ensemble from a hydrologic perspective. To use global ensemble precipitation forecasts as input to hydrologic forecast models requires that the climatology of ensemble forecasts match the climatology of actual precipitation events. We will present comparisons of the forecast and observed climatological statistics at a resolution of 2.5 degrees. Selected statistical summary measures (such as probability of precipitation, conditional mean areal precipitation and conditional coefficient of variation) are shown to condense ensemble information content into a useful form for hydrologic operations and, at the same time, preserve sufficient uncertainty information. We will discuss the approaches used for adjusting the ensemble based precipitation forecast to account for systematic errors resulting from imperfect forecast models and errors in initial perturbations used for generating ensembles. Statistical methodologies for downscaling PQPFs to spatial and temporal scales thatare relevant to NWS hydrologic models, that are already in place, will be outlined. Our final objective is to evaluate the practical aspects of using such downscaled PQPF products for making medium-range probabilistic hydrologic predictions. The results of those studies will be reported in due course.

5. REFERENCES

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