Report for 2004ID38B: Improved Short-term Operational Streamflow Forecasting for Snow-melt Dominated Basins (Request for Year 2 funding)

- Conference Proceedings:
  - Harshburger, B.J., T.R. Blandford, B.C. Moore, K.S. Humes, V.P. Walden, R.J. Qualls, and W. Zhao, 2004: Improved Short-term Operational Streamflow Forecasting for Snow-melt Dominated Basins in Idaho, Proceedings of the 2004 meeting of the Association of American Geographers, Philadelphia, PA, 14-19 March 2004.
  - Harshburger, B.J., T.R. Blandford, K.S. Humes, V.P. Walden, and B.C. Moore, 2005: Evaluation of Enhancements to the Snowmelt Runoff Model, Proceedings of the 2005 Western Snow Conference, Great Falls, Montana, 11-15 April 2005 , in press.
  - Blandford, T.R., B.J. Harshburger, B.C. Moore, K.S. Humes, and V.P. Walden, 2005: Interpolating surface air temperature for use in a semi-distributed snowmelt runoff model, Proceedings of the 2005 Western Snow Conference, Great Falls, Montana, 11-15 April 2005, in press.
- Articles in Refereed Scientific Journals:
  - Blandford, T.J, and K.S. Humes, 2005: Approximating the daily temperature lapse rate using the synoptic weather type, in preparation for Journal of Hydrometeorology.
  - Blandford, T.J, and K.S. Humes, 2005: Complex versus simple methods for interpolating surface air temperature: Application to conceptual semi-distributed snowmelt runoff models, in preparation for Water Resources Research.
  - Moore, B.C., and V.P. Walden, 2005: Evaluation of NCEP downscaled and NDFD temperature forecasts over the intermountain West region, in preparation for Weather and Forecasting.
- unclassified:
  - Harshburger, B.J., T.R. Blandford, B.C. Moore, K.S. Humes, and V.P. Walden, 2004: Towards improved short-term operational streamflow forecasting for snow-melt dominated basins, Proceedings of the 2004 meeting of the American Geophysical Union, San Francisco, California, 6-10 December 2004.

Report Follows

Title: Improved Short-term Operational Streamflow Forecasting for Snow-melt Dominated Basins (Request for Year 2 funding)

Project Number: 2004ID38B

Start Date: 3/1/2004

End Date: 2/28/2005

Funding Source: 104B

Research Category: Climate and Hydrologic Properties

Focus Categories: Surface Water, Models, Water Quantity

Descriptors:

Primary PI: Von P. Walden

Other PIs: Karen S. Humes

Project Class: Research

Our USGS 104(b) grant was used to initiate a project to provide hydrometeorological tools for streamflow forecasting. Through this funding, our group at the University of Idaho was able to secure additional funding from the Pacific Northwest Research Collaboratory (PNWRC) and, thus, was able to expand the original project. Below are the primary tasks that our group has accomplished.

(1) Evaluation and validation of meteorological forecasts of near-surface variables used by snowmelt models.

We have made significant progress in generating meteorological forecasts for use in our version of the Snowmelt Runoff Model (SRM). We ultimately focused on two different forecasting approaches. First, we continued our work on "downscaling" the global forecasts supplied by the National Center for Environmental Prediction (NCEP) at NOAA. As suggested by Clark et al. (2004; J. Hydrometeor., 5, 243-262), we implemented the technique of regression with forward selection for all SNOTEL and COOP meteorological stations within Idaho and northwest Montana. Regression coefficients were generated for each of these stations for each of the 14 days of forecasts. We have now automated the process of retrieving the daily 14-day forecasts from NCEP's ftp site and then "downscaling" the forecasts to the locations of the SNOTEL and COOP stations.

Our downscaled forecasts are generated automatically each day, and the resulting forecast data are then emailed to various group members that use the data.

Secondly, we have automated the task of retrieving 7-day forecasts from the National Digital Forecast Database (NDFD) from the National Weather Service. Each day, we retrieve the NDFD forecasts, then select the particular grid cells that contain the temperature data for each of the SNOTEL and COOP stations. These data are tabulated and emailed to the group members that use the data.

We are in the process of verifying the results from both the NCEP and NDFD forecasts for the snowmelt period March through July 2005. (Data for June and July will be verified as they become available.) Our verification process compares the forecasted data with the actual measured values from each of the SNOTEL and COOP stations as they become available. We plan to submit a manuscript describing these comparisons (see reference below).

(2a) Validation of SRM on representative sub-basins using actual surface and streamflow observations.

We have provided two major enhancements to SRM: a) a new technique to assign model parameters (i.e. degree-day factor, runoff coefficients) that make use of data from SNOTEL sites located within the basin and; b) the incorporation of relative humidity and wind speed data into a new (optional) model module designed to improve model performance during rain-on-snow events. These enhancements are currently being evaluated.

Using snow-cover images from the Moderate-resolution Infrared Sounder and our meteorological forecasts of temperature, we began to forecast streamflow in the Big Wood Basin in Idaho in March 2005. This has proved to be a interesting year for hydrological forecasting with SRM because of the low amount of snowpack in the Big Wood Basin and the large amount of precipitation that occurred during the spring and early summer. We are currently evaluating SRM's performance in predicting streamflow at the Hailey, Idaho stream gauge for the snowmelt season beginning in March 2005.

(2b) Several schemes for the spatial interpolation of point-based ground temperature measurements will be evaluated.

Surface air temperature is an important meteorological input parameter for snowmelt runoff models, as well as models of other hydrologic processes. In

complex terrain, such as that found throughout much of Idaho, it is necessary for spatial interpolation techniques to specifically account for orographic effects. We have evaluated three different schemes for spatial interpolation of surface temperature in complex terrain, including a simple lapse rate method, elevationally-detrended ordinary kriging, and the use of climate interpolation models (PRISM). Each of these schemes was evaluated on their overall performance, as well as ease-of-use. It was determined that the simple lapse-rate scheme is easy to use, fast computationally, and performs well in complex terrain. Therefore, this scheme will be used to interpolate our meteorological forecasts over mountain basins. We have two papers in preparation on this topic (see references below).

(3) Development of an interface between meteorological forecast model outputs, real-time ground data, operationally available snowcover data (remotely sensed), and SRM.

We have begun to develop an expert system for improving streamflow forecasting in Idaho. We have created an Excel version of SRM that will ultimately be linked to Arc GIS. Using Arc GIS, we have automated the disaggregation of remotely-sensed, snow-cover images into the percentages of snow-covered area, which is one of the primary inputs into SRM. A user's manual has been written for our end-users. As mentioned above, we have also automated the production of temperature forecasts using NCEP and NDFD data.

A. **PUBLICATIONS:** A list of all reports published during the reporting period as a result of projects supported using section 104 and required matching funds, including base grants, and National Competitive Grant Program awards **for which you are the lead institute**, and as a result of supplemental awards. Publications for current projects are to be entered in the "Research Project" section of the report if the publication resulted from a research project and in the Information Transfer section of the report if it resulted from an information transfer project. Publications from prior-year projects should be entered by going to the menu item labeled "Publications from Prior Projects".

Harshburger, B.J., T.R. Blandford, B.C. Moore, K.S. Humes, V.P. Walden, R.J. Qualls, and W. Zhao, 2004: Improved Short-term Operational Streamflow Forecasting for Snow-melt Dominated Basins in Idaho, Proceedings of the 2004 meeting of the Association of American Geographers, Philadelphia, PA, 14-19 March 2004.

Harshburger, B.J., T.R. Blandford, B.C. Moore, K.S. Humes, and V.P. Walden, 2004: Towards improved short-term operational streamflow forecasting for snow-melt dominated basins, Proceedings of the 2004

meeting of the American Geophysical Union, San Francisco, California, 6-10 December 2004.

Harshburger, B.J., T.R. Blandford, K.S. Humes, V.P. Walden, and B.C. Moore, 2005: Evaluation of Enhancements to the Snowmelt Runoff Model, Proceedings of the 2005 Western Snow Conference, Great Falls, Montana, 11-15 April 2005 , in press.

Blandford, T.R., B.J. Harshburger, B.C. Moore, K.S. Humes, and V.P. Walden, 2005: Interpolating surface air temperature for use in a semi-distributed snowmelt runoff model, Proceedings of the 2005 Western Snow Conference, Great Falls, Montana, 11-15 April 2005, in press.

In preparation for peer-reviewed journals:

Blandford, T.J, and K.S. Humes, 2005: Approximating the daily temperature lapse rate using the synoptic weather type, in preparation for *Journal of Hydrometeorology.*

Blandford, T.J, and K.S. Humes, 2005: Complex versus simple methods for interpolating surface air temperature: Application to conceptual semi-distributed snowmelt runoff models, in preparation for *Water Resources Research.*

Moore, B.C., and V.P. Walden, 2005: Evaluation of NCEP downscaled and NDFD temperature forecasts over the intermountain West region, in preparation for *Weather and Forecasting.*

B. **INFORMATION TRANSFER PROGRAM:** A brief description of information transfer activities supported with section 104 and required matching funds during the reporting period.

Not Applicable to this project.

C. **STUDENT SUPPORT:**

	Section 104 Awards		NIWR-USGS Internship	Supplemental Awards	Total
	Base Grants	Competitive Awards			
Undergrad.					
Masters	2				2
PhD.	1				1
Post-Doc.					
Total	3				3

D. **NIWR-USGS STUDENT INTERNSHIP PROGRAM:**

Not Applicable to this project

E. **NOTABLE ACHIEVEMENTS AND AWARDS:**

Graduate Student Awards

- Best Poster at the PhD Level: Brian Harshburger, "*Improved short-term operational streamflow forecasting for snow-melt dominated basins in Idaho*", 2004 Annual Meeting of the Association of American Geographers, Philadelphia, PA.

- Best Poster: Troy Blandford, "*Interpolating Surface Air Temperature and Precipitation for Use in a Semi-distributed Snowmelt Runoff Model*", 2005 Western Snow Conference, Great Falls, MT.

- Runner-up, Student Paper Competition: Brian Harshburger, "*Evaluation of Enhancements to the Snowmelt Runoff Model*", 2005 Western Snow Conference, Great Falls, MT.