The National Weather Service’s (NWS) Hydrologic Ensemble Forecast Service (HEFS) is an operational forecasting system that quantifies the total uncertainty in hydrologic forecasts, including the uncertainties contributed by the meteorological forcing and the hydrologic modeling. The HEFS is a modular system that includes software tools for quantifying the different sources of uncertainty and for conducting retrospective forecasting (hindcasting) and verification. The HEFS leverages weather and climate forecasts to produce ensemble forecasts of precipitation, temperature and streamflow (among other variables) at forecast lead times ranging from one hour to one year.

The HEFS is being implemented in two phases, the first of which focused on a limited number of NWS River Forecast Centers (RFCs), together with limited validation of the forcing and streamflow forecasts. The RFCs have: (i) developed a template for hindcast running and conducting basic control checks; (ii) implemented the Hindcasting and Verification System (HVS), which is used to evaluate forcing and streamflow hindcasts; (iii) the Ensemble Verification Service (EVS), which is used to support product development and probably for verification; and (iv) collaborated with the National Weather Service (NWS) Office of Hydrologic Development (OHD) to develop an introduction to the HEFS in both web and seminar formats.

Following the first phase of implementation, the operational version of the HEFS will be provided to the remaining RFCs, informed by the first phase of implementation. The physical rollout of the HEFS (distribution, training and support of the software) will be extended to the remaining (eight) RFCs. The plan is that each RFC will implement the HEFS in a gradual and coordinated way, beginning with a limited number of locations. The vision is for the HEFS to become fully integrated into the routine operations across all RFCs (at limited locations) within the timeframe of the HEFS rollout (CY 2014). This contribution describes the operational implementation of the HEFS, including the main lessons learned from the first phase of implementation and the early use of the HEFS.

First phase of implementation

Since 2011, the HEFS has transitioned from a collection of prototype components into a service integrated into the NWS RFC operational streamflow forecast system, the Community Hydrologic Prediction System (CHPS). Figure 1 shows a schematic of the HEFS components and operational setup (see Brown et al., 2013, Brown et al., 2014a/b/c, and associated reports available at the bottom of this document). The OHD plans to develop an introduction to the HEFS in both web and seminar formats. The OHD will gradually provide tiered support of the HEFS, as their level of experience and knowledge increases. The OHD staff has been working with RFCs to provide technical guidance, and requests for help on HEFS issues to technical experts. The HSB staff are also attending training, and they will provide feedback from the RFCs.

In late 2014, the HEFS will be provided to the remaining NWS RFCs. During this second phase, the strategy is to extend the HEFS to all RFCs and coordinate the way along with training, support, and additional validation. A gradual approach is necessary to monitor the implementation, manage expectations, develop products and services that meet the needs of the RFCs and their customers, and to ensure that the robustness is reinforced by ongoing validation and testing. The initial coverage will focus on headwater locations and then expand, as the RFCs gain experience with the HEFS, including additional validation at newly implemented locations. Meanwhile, NWS will continue to address HEFS issues and constraints, and take steps to make the HEFS forecasts and forecast products more widely available.

At the beginning of the second phase, training and guidance will be provided on the science and use of the HEFS. The HEFS software documentation (user’s manuals and implementation guides) will be provided to the RFCs. The RFCs will begin by implementing the HEFS at two locations on a CHPS RFC local development and test environment. The implementation includes calibration of the CHPS components and adding those component to the RFC automated or semi-automated runs of hydrological models within the CHPS models, which also include the HVS. The CHPS calibration tools are utilizing the HEFS hindcast data to provide better probabilistic estimates of streamflow and other water-related variables (e.g., peak flows) and to provide better probabilistic estimates of streamflow and other water-related variables (e.g., peak flows).

Second phase of implementation

In late 2014, the HEFS will be provided to the remaining NWS RFCs. During this second phase, the strategy is to extend the HEFS to all RFCs and coordinate the way along with training, support, and additional validation. A gradual approach is necessary to monitor the implementation, manage expectations, develop products and services that meet the needs of the RFCs and their customers, and to ensure that the robustness is reinforced by ongoing validation and testing. The initial coverage will focus on headwater locations and then expand, as the RFCs gain experience with the HEFS, including additional validation at newly implemented locations. Meanwhile, NWS will continue to address HEFS issues and constraints, and take steps to make the HEFS forecasts and forecast products more widely available.

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In parallel to these developments in products and services, scientific enhancements will be prioritized and implemented in a research version of the HEFS (for subsequent operational implementation). Several research and development priorities have been identified through the recent validation work and earlier studies. For example, the EnsPost and other statistical calculations are being developed to improve the HEFS analysis and interpretation capabilities, and to generate better validation metrics and understanding of the probabilistic forecasts. Forecasts from the HEFS will be integrated into the warning/hazard services at the RFCs. Forecasts from the HEFS will be integrated into the warning/hazard services at the RFCs. Forecasts from the HEFS will be integrated into the warning/hazard services at the RFCs. Forecasts from the HEFS will be integrated into the warning/hazard services at the RFCs.

The HEFS plans to develop an introduction to the HEFS in both web and seminar formats, together with guidance on the HEFS products. The HEFS products will eventually link to web-based explanations, and the seminars will be available to the RFCs for outreach to the WFOs and other stakeholders.

Eventually, forecasts from the HEFS will be integrated into the warning/hazard services at the RFCs. Forecasts from the HEFS will be integrated into the warning/hazard services at the RFCs. Forecasts from the HEFS will be integrated into the warning/hazard services at the RFCs. Forecasts from the HEFS will be integrated into the warning/hazard services at the RFCs. Forecasts from the HEFS will be integrated into the warning/hazard services at the RFCs. Forecasts from the HEFS will be integrated into the warning/hazard services at the RFCs. Forecasts from the HEFS will be integrated into the warning/hazard services at the RFCs.

The CHPS plans to develop an introduction to the HEFS in both web and seminar formats, together with guidance on the HEFS products. The HEFS products will eventually link to web-based explanations, and the seminars will be available to the RFCs for outreach to the WFOs and other stakeholders.

References