Colorado Basin River Forecast Center

Water Supply Forecasting Tools

Ensemble Streamflow Prediction (ESP) is a modeling component of the National Weather Service Community Hydrologic Forecast System (CHPS). ESP produces long-range probabilistic forecasts of hydrologic variables. ESP utilizes a conceptually based modeling system to simulate soil moisture, snow pack, regulation, and streamflow. This modeling system contains a calibration component and an operational component.

The **calibration component** is where the parameters of the model are determined and where the model stores historical precipitation, temperature and streamflow data. In this system, the hydrologist chooses from a variety of models and processes to model various river segments. The different models and processes will:

- Simulate the snow accumulation and ablation
- Compute runoff using a soil moisture model
- Time the distribution of runoff from the basin to the outlet
- Perform channel routing
- Model reservoir operations

The hydrologist determines the optimal set of parameters for each model to best simulate past flows.

The **operational component** generates the short-term deterministic river forecasts. This is where the model tracks and maintains the current model states, including soil moisture and snowpack.

Inputs are:

- Observed precipitation, temperature, freezing levels, and streamflow (which have all been previously quality controlled by hydrologists and meteorologists)
- Forecast precipitation (up to 7 days depending on the basins) and temperatures and freezing levels (10 days)
- It is important to note that snow and snow water equivalent (SWE) are not direct inputs to the model. The snow model within each segment (or basin) builds and melts its own snowpack based on precipitation and temperature inputs

The states in each segment (or basin) can be adjusted by the forecasters in real time. The operational component is run, at minimum, daily so there is continual quality control, updating and adjusting.

ESP accesses these current hydrologic model states, and the historical precipitation and

temperature time series from each year of the calibration period (currently 1981-2015 for most areas). ESP can also incorporate precipitation and temperature forecasts before blending back to climatology. The CBRFC runs two variations of ESP for each basin: ESP with and without forecast precipitation and temperature.

For ESP runs that include forecast temperature and precipitation, the set up as of water year 2020 is as follows:

- In the Upper Colorado Basin and Great Basin: The ESP runs include 5 days of precipitation and temperature forecasts. Temperature forecasts blend back to climatology days 6 through 10
- In the Lower Colorado Basin, the ESP runs include 7 days of precipitation and temperature forecasts, and temperature forecasts blend back to climatology days 8 through 12

The historical precipitation and temperature time series are used with current hydrologic conditions to generate equally likely sequences of future hydrologic conditions, or an ensemble of forecast flows. Based on statistical distributions applied to these ensembles, ESP derives probabilistic hydrologic forecasts, such as volume, peak, minimum number of days to given flow, etc. The system allows the display of any exceedance levels requested. The ESP output can be post-adjusted based on climate scenarios (typically El Nino and La Nina), and adjusted for model (calibration) bias. Figures 1 through 3 depict the ESP technique.

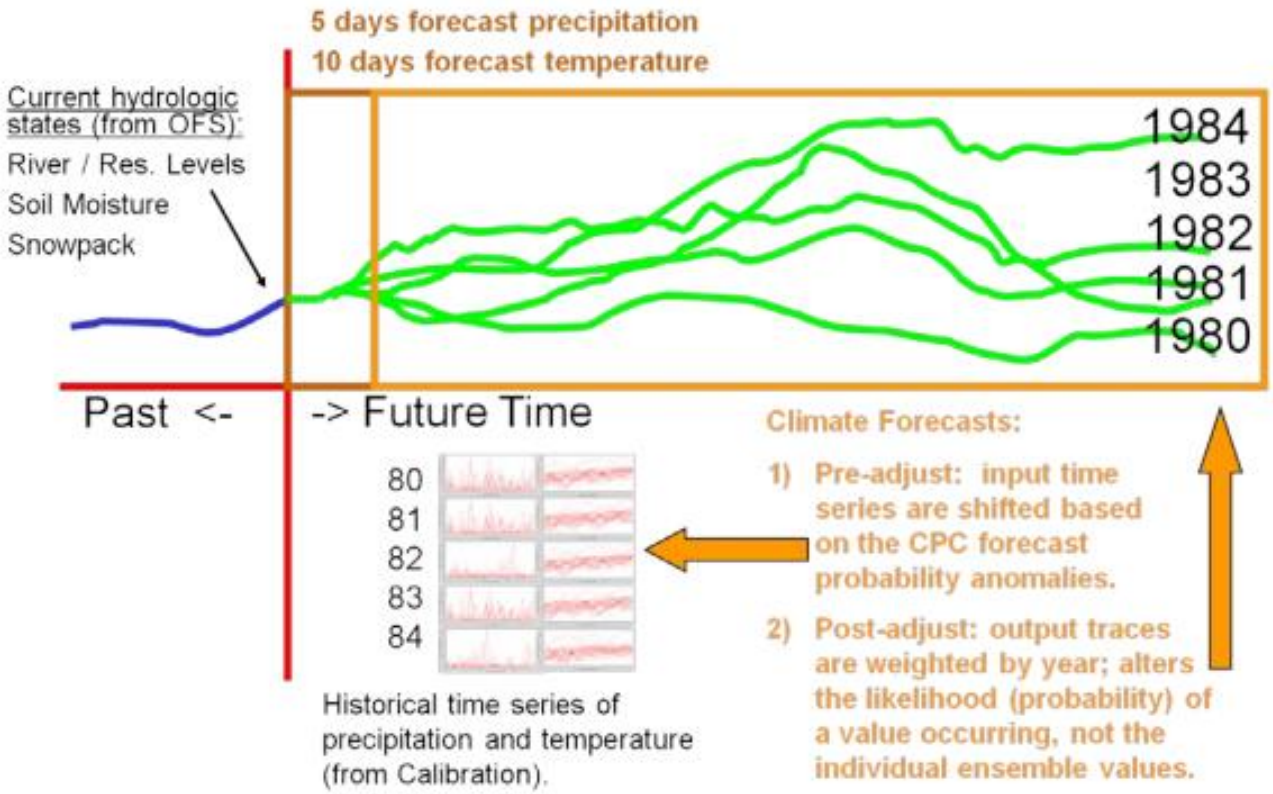

Figure 1: Depiction of ESP Methodology

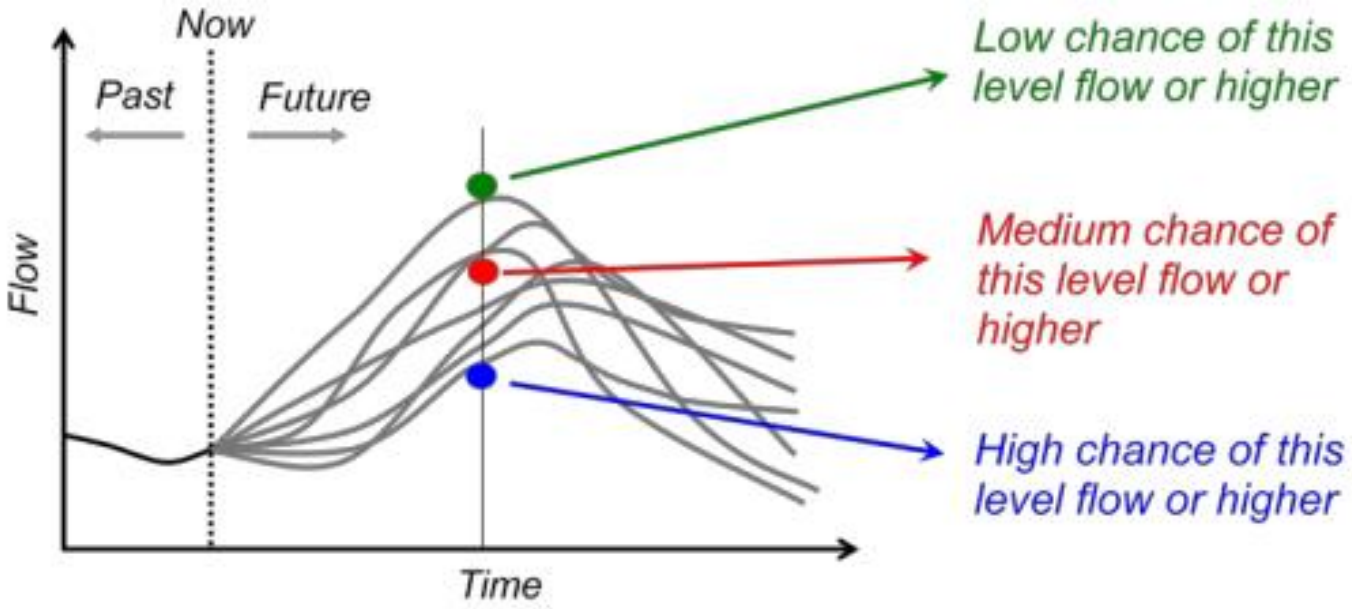

Figure 2: ESP Ensembles

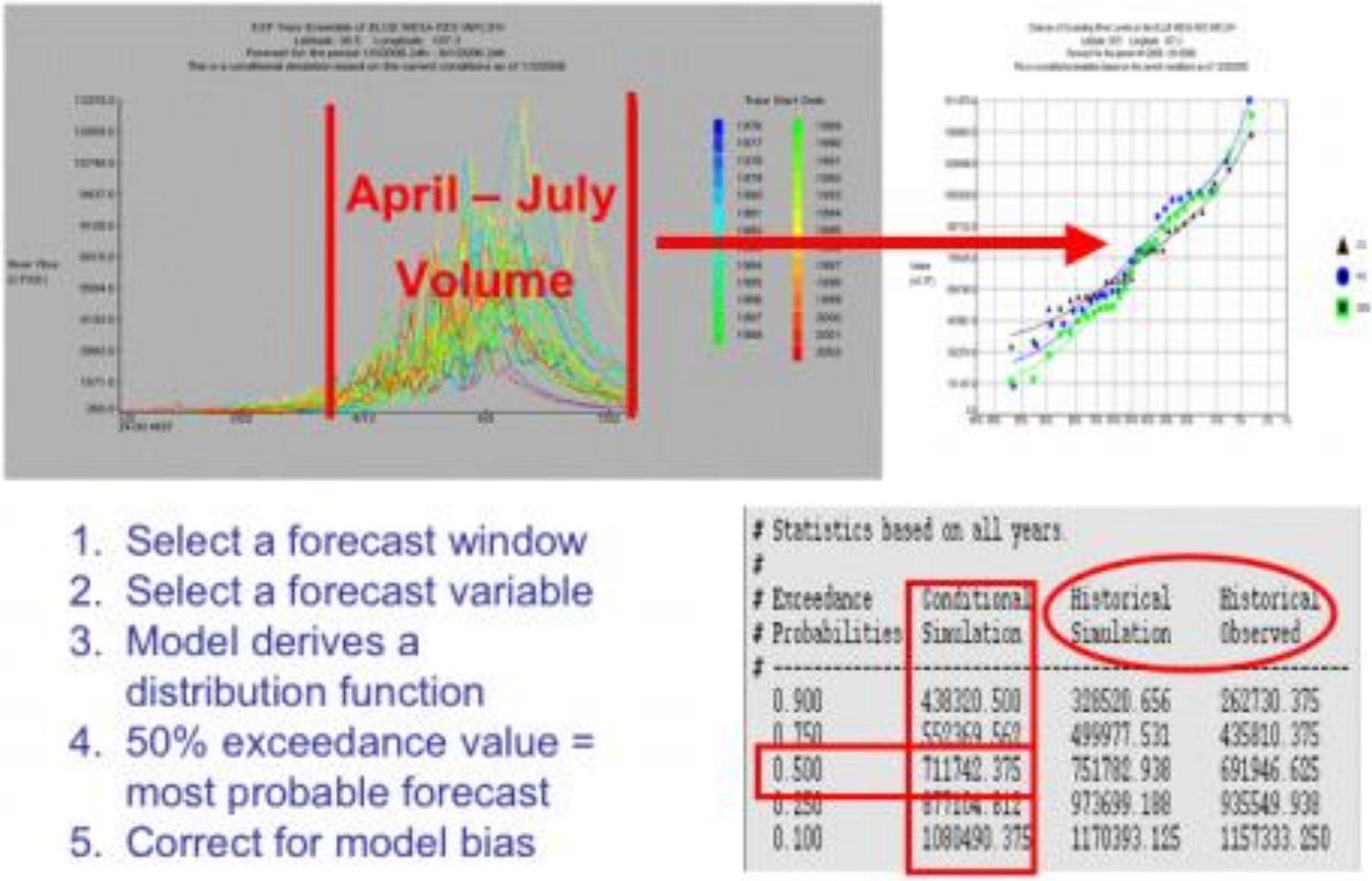

Figure 3: ESP Interface