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 also contains a calibration component and an operational component.

The **calibration component** is where the parameters of the model are determined. It is also 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 been previously quality controlled by hydrologist and meteorologists).
- Forecast precipitation (5 days) and temperatures and freezing levels (10 days).
- **Note: snow and snow water equivalent (swe) are not a direct input to the model. The snow model within each segment builds and melts its own snowpack based on precipitation and temperature inputs.

The states in each segment 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 then accesses these current hydrologic model states, and can use the precipitation forecast (5 days into the future) and temperature forecast (10 days into the future) as inputs. From that point in time it then uses the historical precipitation and temperature time series from each year of the calibration period (currently 1981-2010).

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 hydrologist can choose different probability distributions such as empirical, log, wakeby, 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.

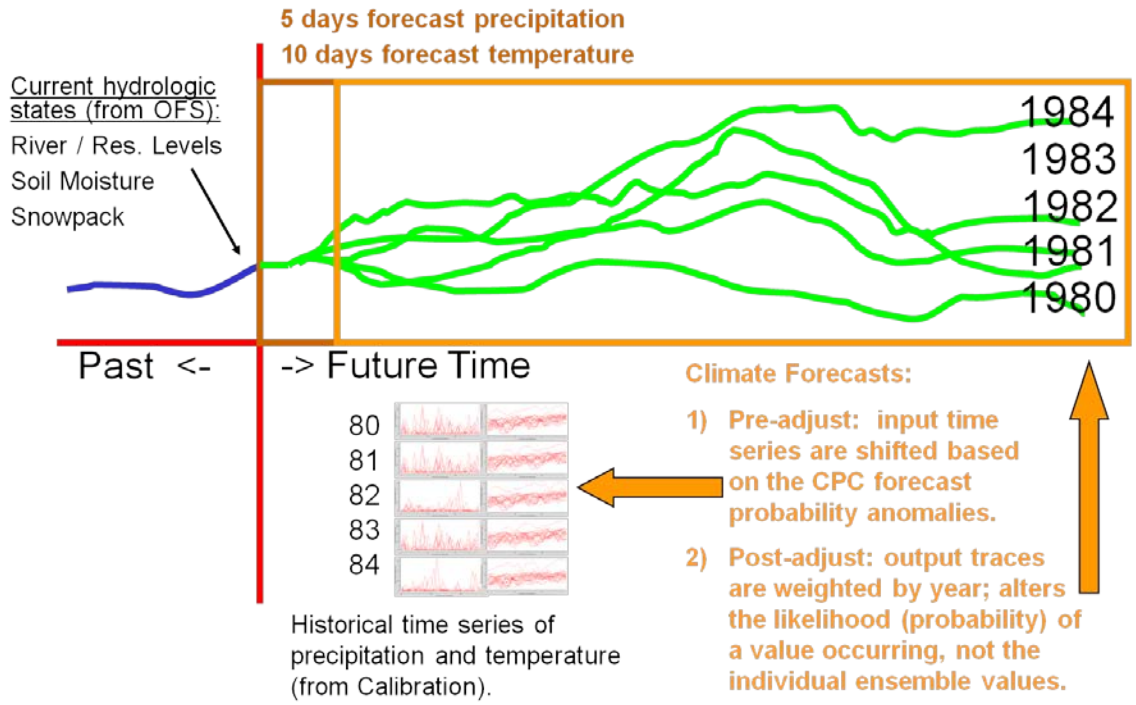


Fig 1 - Depiction of ESP methodology

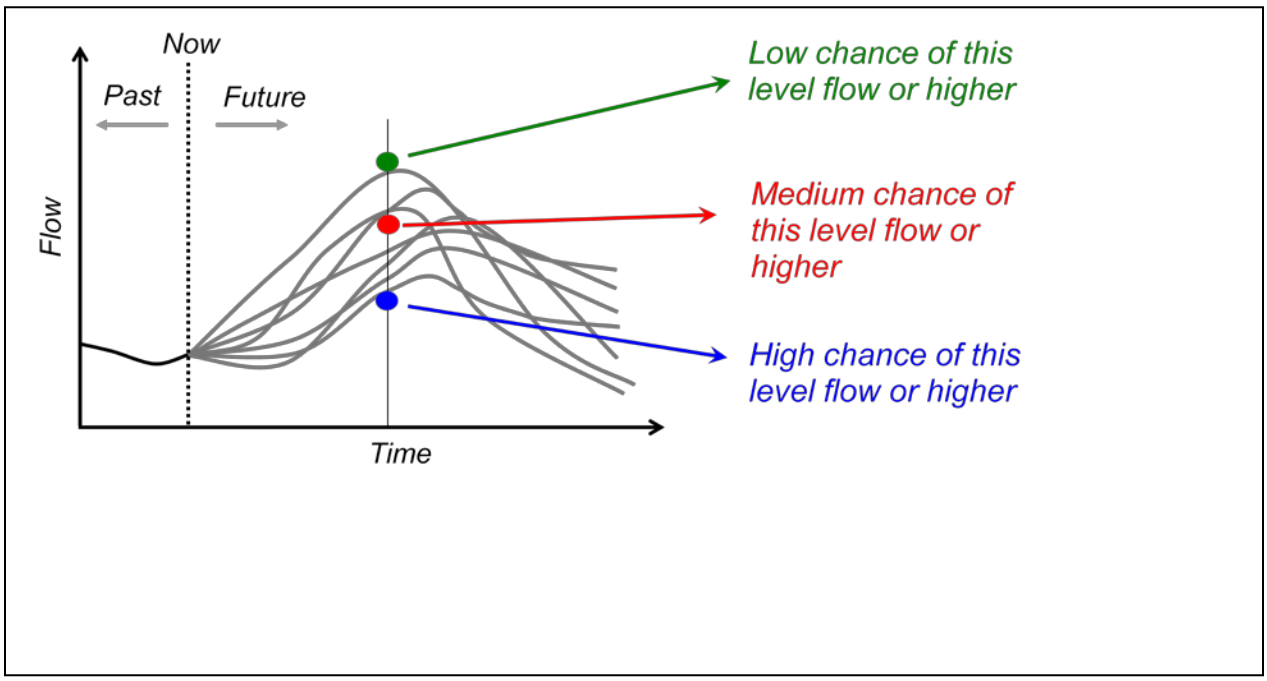
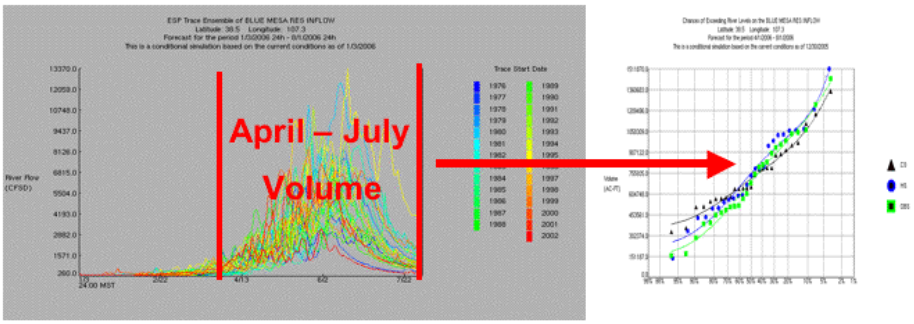


Fig 2 – ESP – Ensembles



1. Select a forecast window
2. Select a forecast variable
3. Model derives a distribution function
4. 50% exceedance value = most probable forecast
5. Correct for model bias

# Exceedance Probabilities	Conditional Simulation	Historical Simulation	Historical Observed
0.900	438320.500	328520.656	262730.375
0.750	552369.562	499977.531	435810.375
0.500	711742.375	751782.938	691946.625
0.250	877104.812	973699.188	935549.938
0.100	1080490.375	1170393.125	1157333.250

Fig 3 – The ESP interface