CBRFC Developments

HEPEX
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Outline

- Introduction and motivation
- Methodology for real time implementation
- Verification
- Results
- Future direction

CBRFC AHPS PROJECT 2002-2004

A cooperative effort between:

Motivation

Improve Ensemble Streamflow Prediction (ESP) forecasts during the first 3 – 4 weeks for fisheries and reservoir management in the Upper Colorado River Basin.

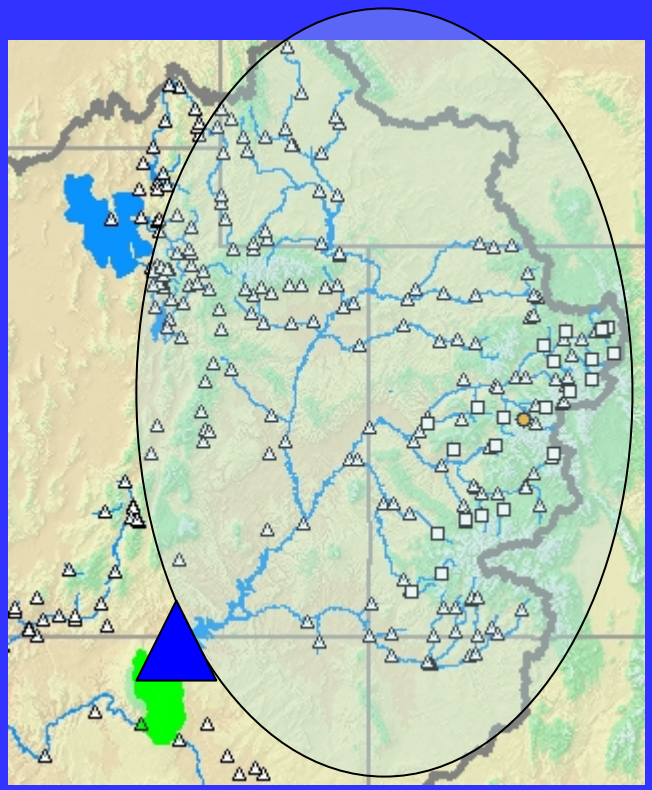
Goals

Introduce probabilistic 14 day meteorological forecasts (ensembles) into a river forecast system.

Capture and display the uncertainty.

Verify the process.

Study Area



-Originally study area was the Colorado River above Grand Junction, CO.

- Currently implemented for the Colorado River above Lake Powell

Method

Medium Range Forecast Model

Downscale to Model Variables

Mean Areal Temperature and Precipitation Ensembles

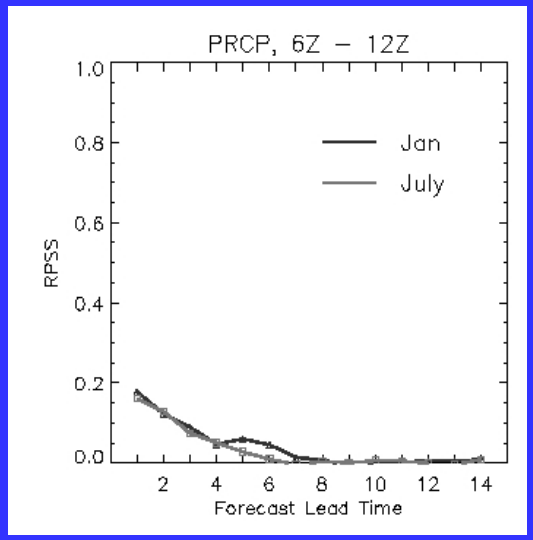
ESP Model

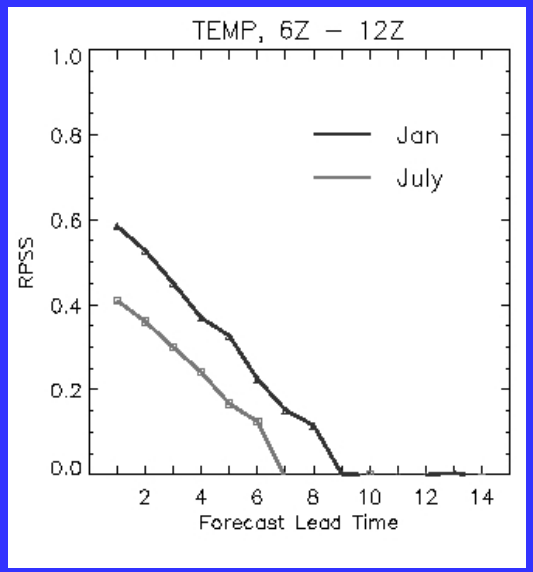
Probabilistic River Forecasts

Medium Range Forecast (MRF) Model

- Following Hamill et al, 2004
- Global Meteorological Model
- Many Atmospheric Variables
- 1998 Frozen Version
- Run Daily at NCEP (still get data through CDC)
- ~150km Spatial Resolution

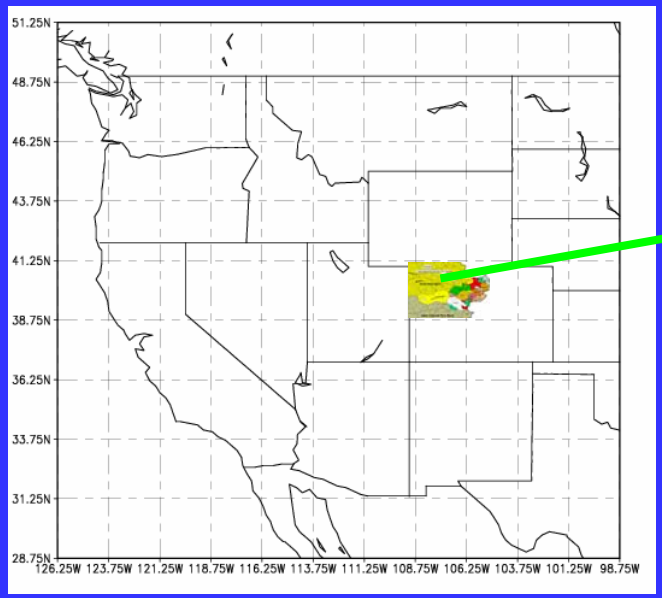
Medium Range Forecast (MRF) Model

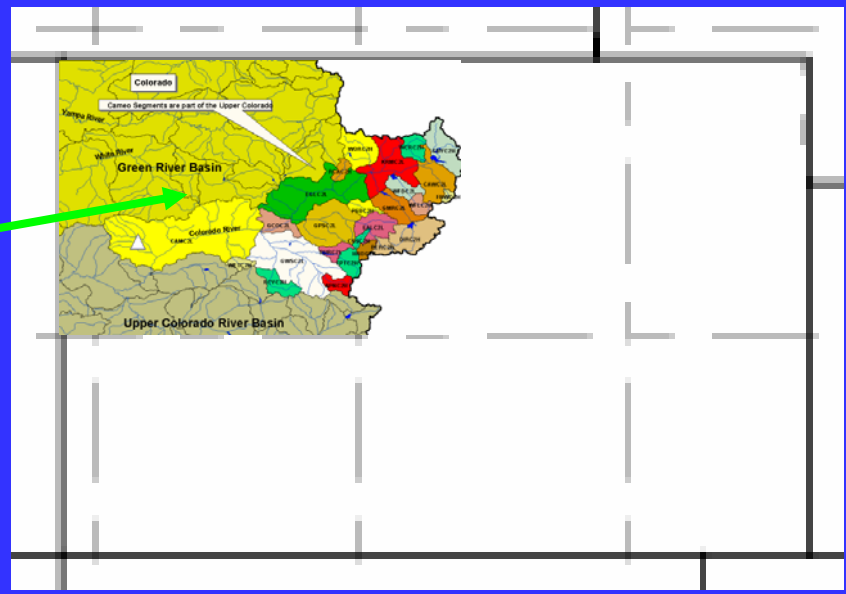




- *Marginal skill in precipitation for first ~5 days. No skill after that.*
- *Good skill in temperature for first week; marginal skill into second week.*
- *Spring snow melt period is the ideal situation to leverage the temperature skill. Snow model (SNOW 17) used by NWSRFS uses temperature forecasts to determine run-off.*

MRF Spatial Resolution

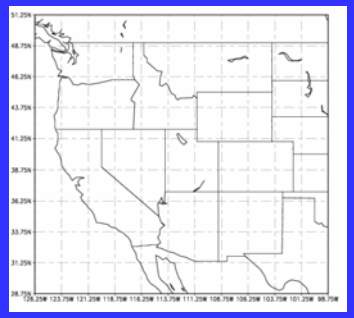


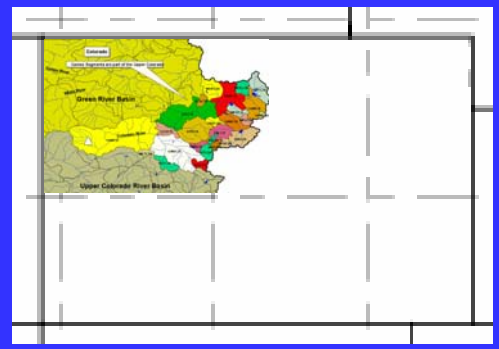


WAY TOO LARGE!

Need to Relate to Basin…

Downscaling





MRF Variables:

- 2m air temp
- Precipitation
- 700mb Relative Humidity
- Sea Level Pressure
- 10m Vector Wind
- Total Column Precipitable Water

Basin Scale Variables:

- Mean Areal Temperature
- Mean Areal Precipitation

Downscaling Method

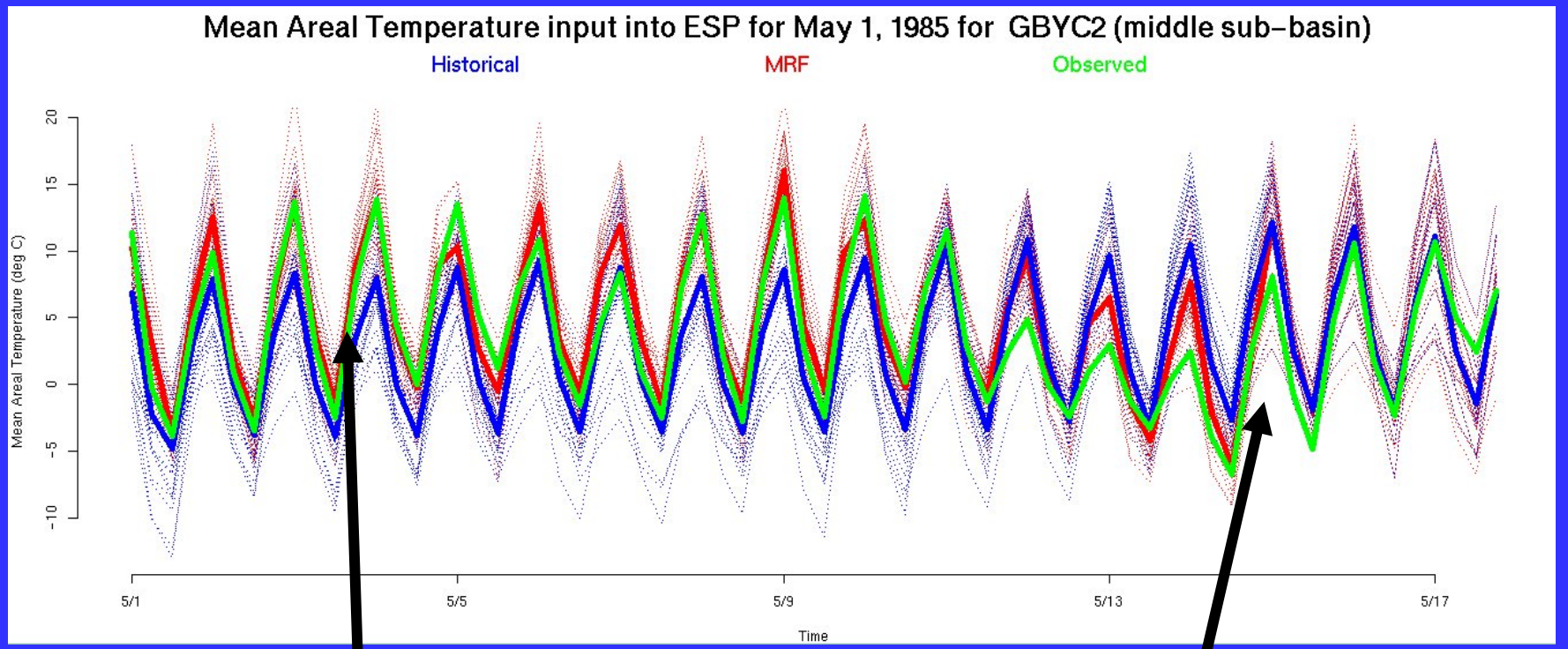
1. Relates historical MRF scale variables to historical basin scale variables through multivariate linear regression equations. For example:

   Basin MAP = a_1(MRF Precipitation) + a_2(MRF wind) + … + (uncertainty term)

2. Equations developed in (1) are applied to real-time MRF forecasts to produce forecasts of basin scale variables.

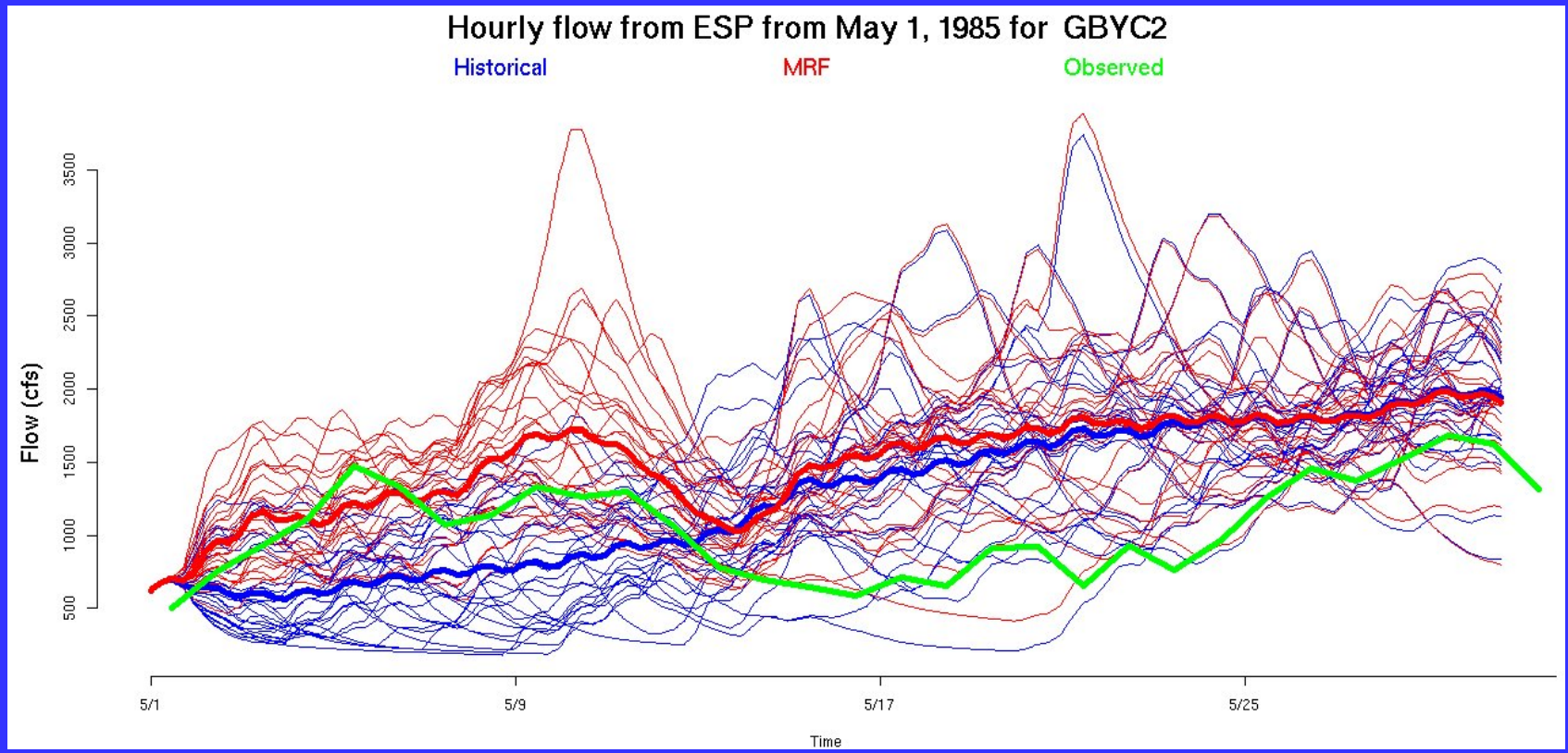
3. Multiple values at a particular time step and basin by using a random number multiplied by the uncertainty term. "Schaake Shuffle" used to restore observed space-time co-variability.

Forecast Example



MRF derived MATs used to force ESP. Note MRF is warmer in first week

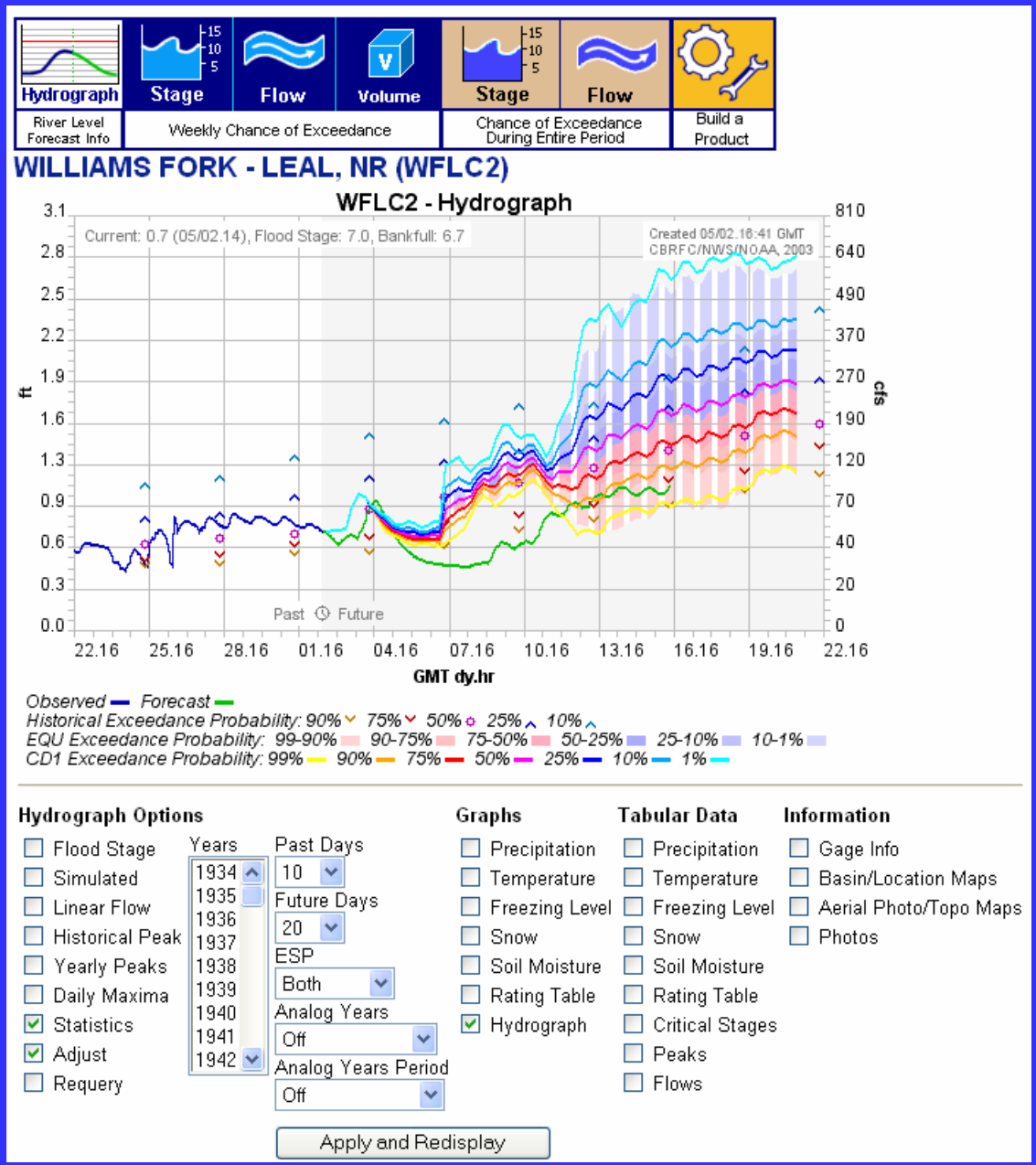
Example ESP Output



Hourly instantaneous flow ensembles are created by ESP and saved. MRF forced ESP shows higher flows from snow melt than historical during the first week (e.g. where MRF is warmer).

Web Page Example

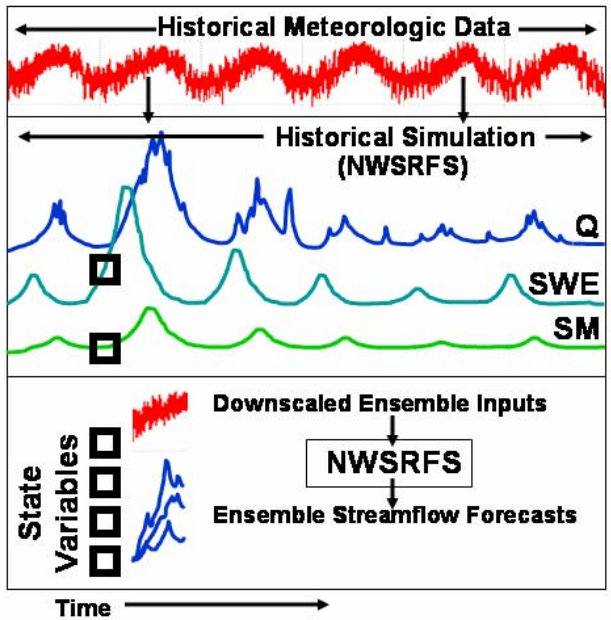
Probabilities from ESP (shaded) Using Historical MAPs and MAPs Equally Weighted and ESP (lines) Using Maps And Mats Derived from The MRF Ensembles Plotted with Deterministic Forecast and Historical Exceedance Values

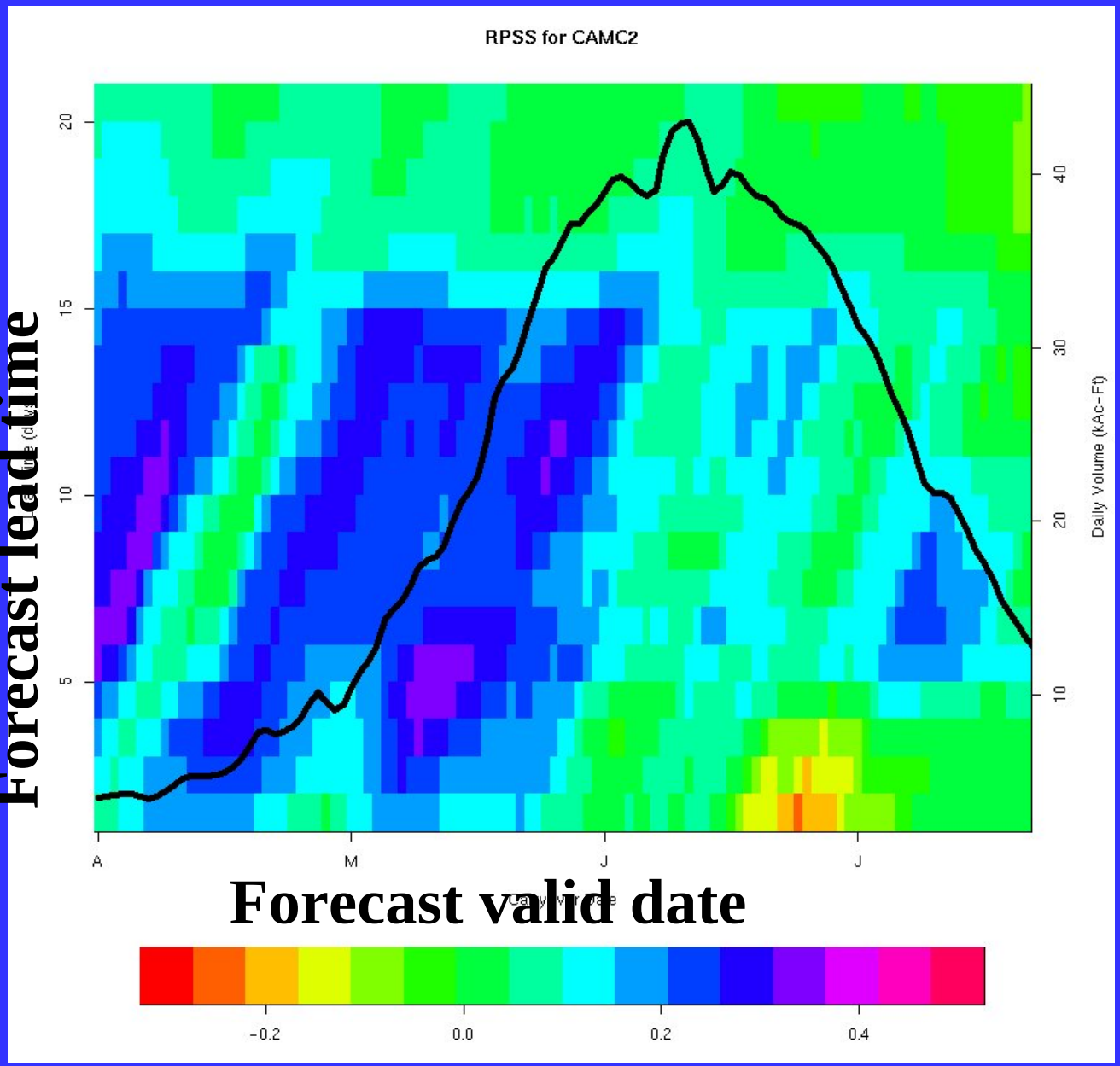


ESP Reforecasts

To assess improvement from realized from MRF model, a retrospective verification study was conducted:

- MRF forced ESP ensembles compared to climatology forced ESP ensembles
- Reforecasts conducted over 1980-2000 time frame



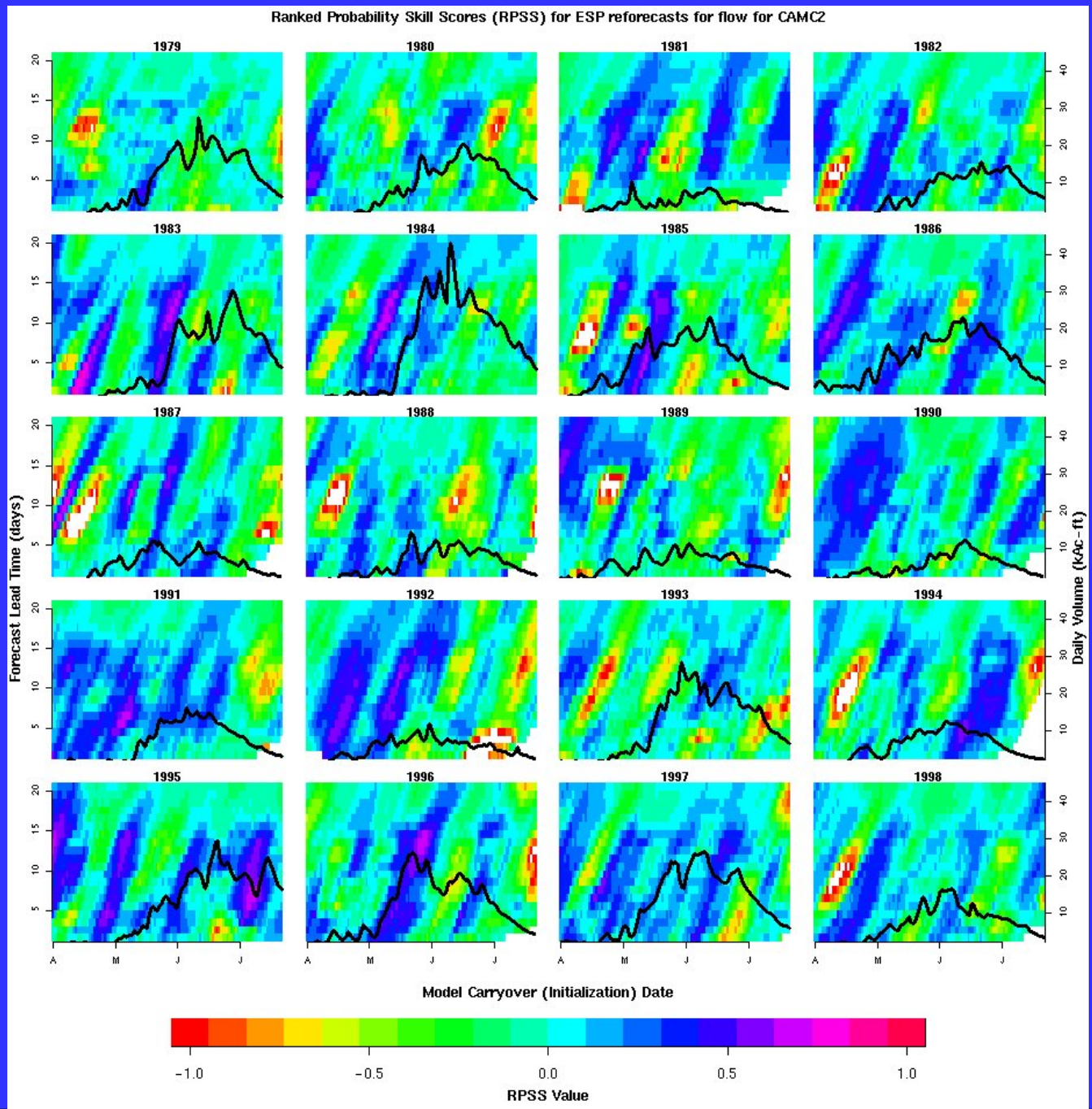


ESP Forecast Verification

Mean hydrograph and RPSS values…

Good forecast skill improvements during rising limb of hydrograph.

ESP Forecast Verification



Summary

- Added significant skill during rising limb of hydrograph when snow melt is important.
- MRF skill mostly in temperature in the medium range; precipitation skill low beyond day 1 or 2.
- Useful tool for conveying meteorological forcing uncertainty into ESP.
- MRF methodology fully implemented this year (3rd year for some parts of basin).

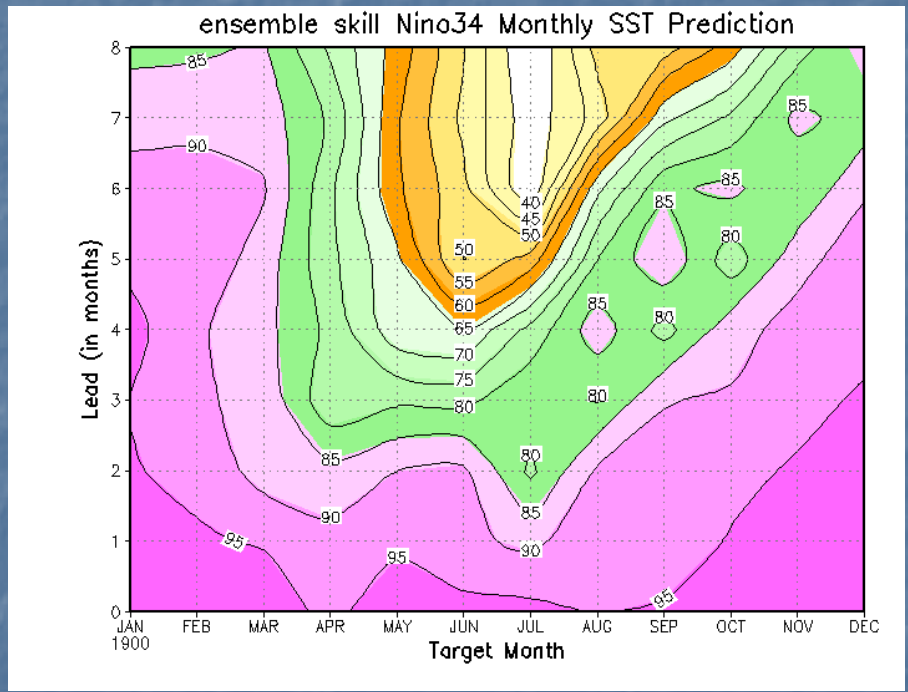
Summary (con't)

- Forecasters used on MRF ESP for comparison against traditional forecast methods. Particularly valuable this year due to large snow packs and relatively quick melt.
- BUT… still no direct customer use for medium range hydrologic ensembles.
- Need to convey ensembles to end-user partners to demonstrate value in ensemble forecasting.
- No implementation beyond CBRFC planned.

Future Direction

Investigate CPC's Climate Forecast System (CFS) for use with long range hydrologic forecasts.

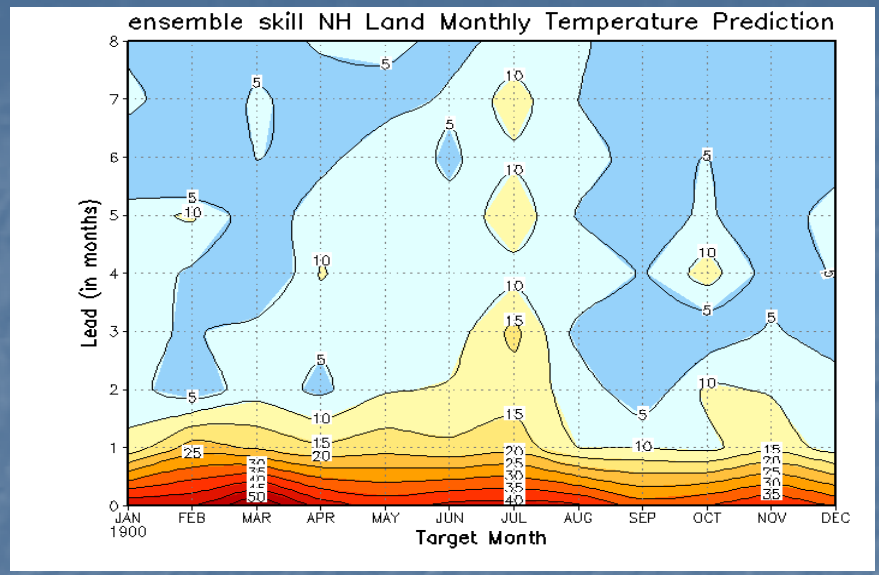
- Archive of retrospective forecasts similar to CDC's MRF archive.
- CFS shows good predictive skill for ENSO events, particularly for NH winter season.

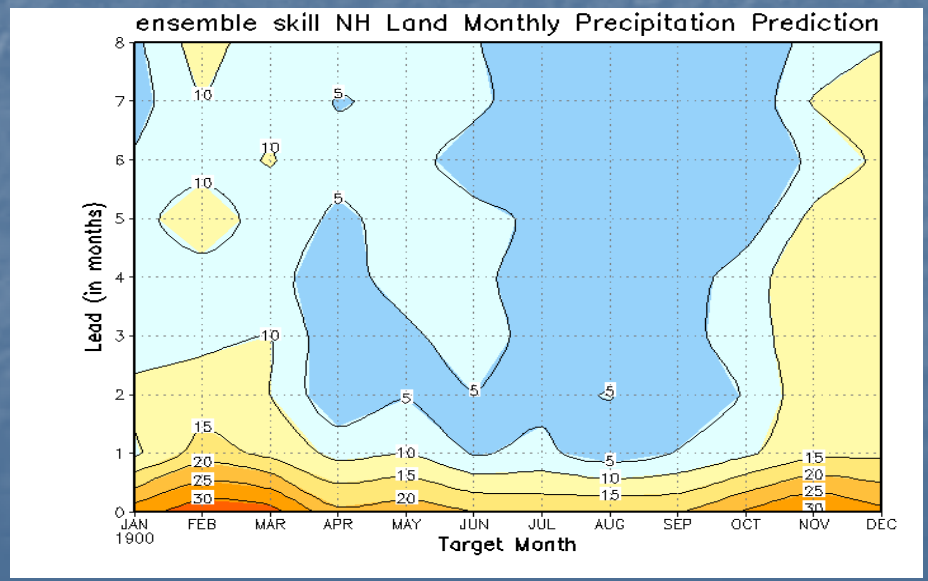


Credit: Saha et al, 2005

Future Direction

Skill for NH land temperature and precipitation is more modest. However, areas with strong ENSO skill such as the SW US show better predictive potential.





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