Western Water Verification

www.nwrfc.noaa.gov/westernwater/beta

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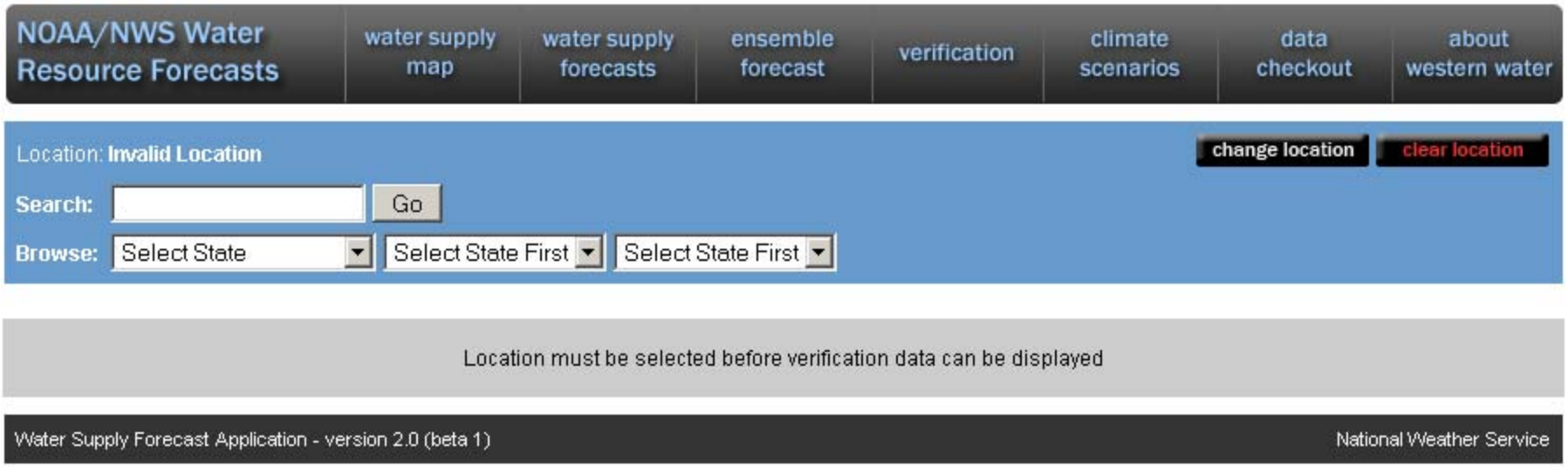
Outline

- Verification capabilities
- Graphing capabilities
- Example

Motivations

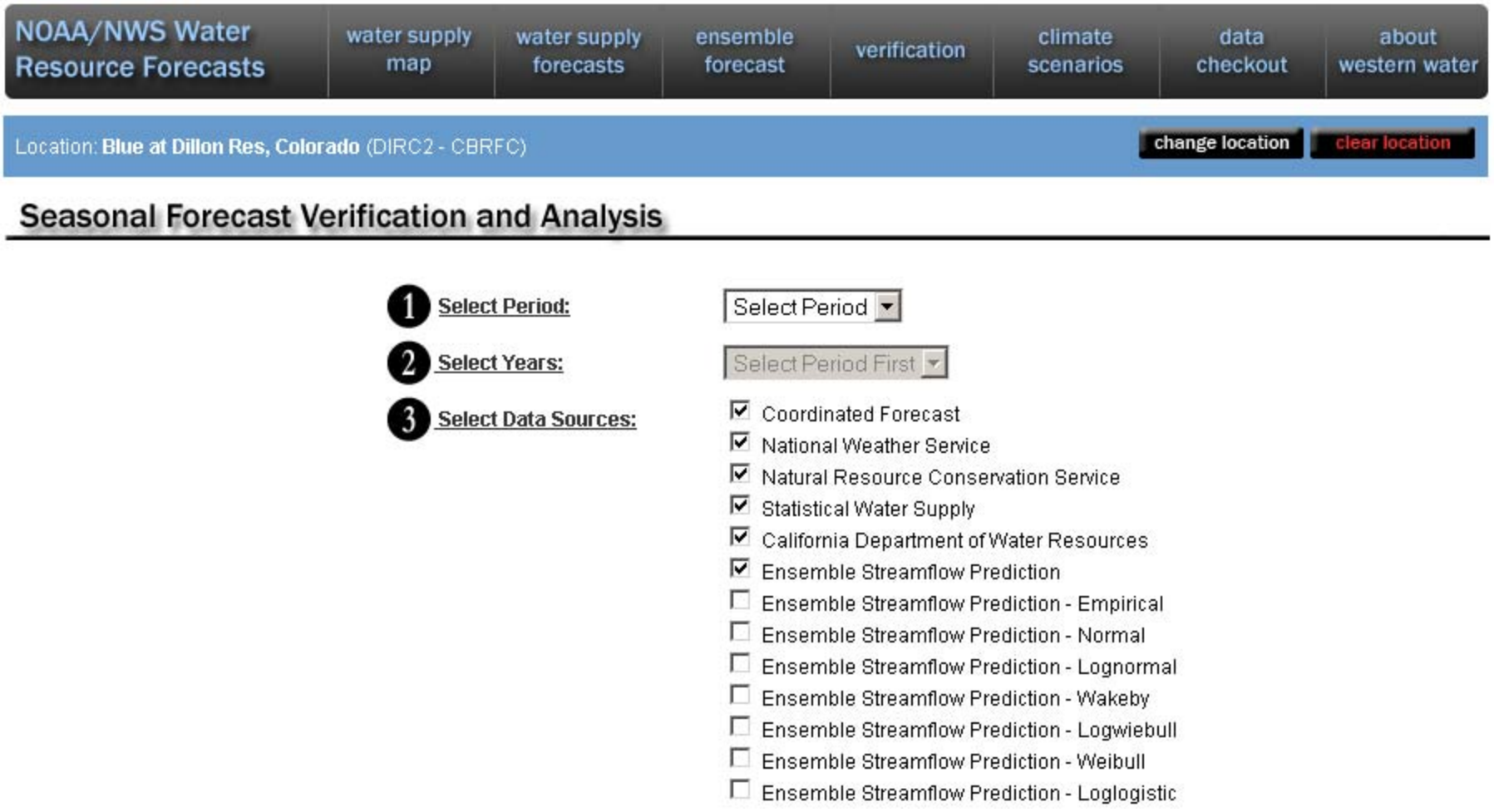
- Improve understanding of uncertainty from forecast tools
  - How good are our forecasts?
  - How much value do human forecasters add?
  - Is one tool better than another?
  - How do the above questions depend on lead time? Amount of runoff?
- Can we use what we learn to:
  - Improve forecasts?
  - Make forecast process more efficient?
  - Improve collaboration?
  - Convey uncertainty to our users?

Verification Capabilities

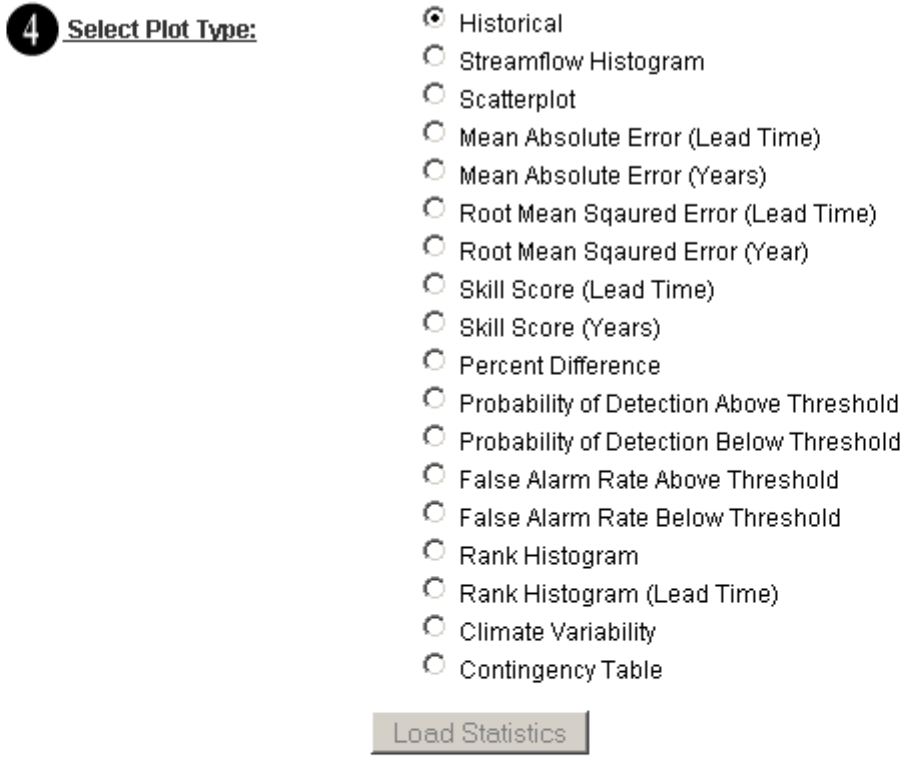


- Search By
  - Station ID
  - State, River, Location
- Location
  - Change
  - Clear
  - Return to main menu

Verification Capabilities



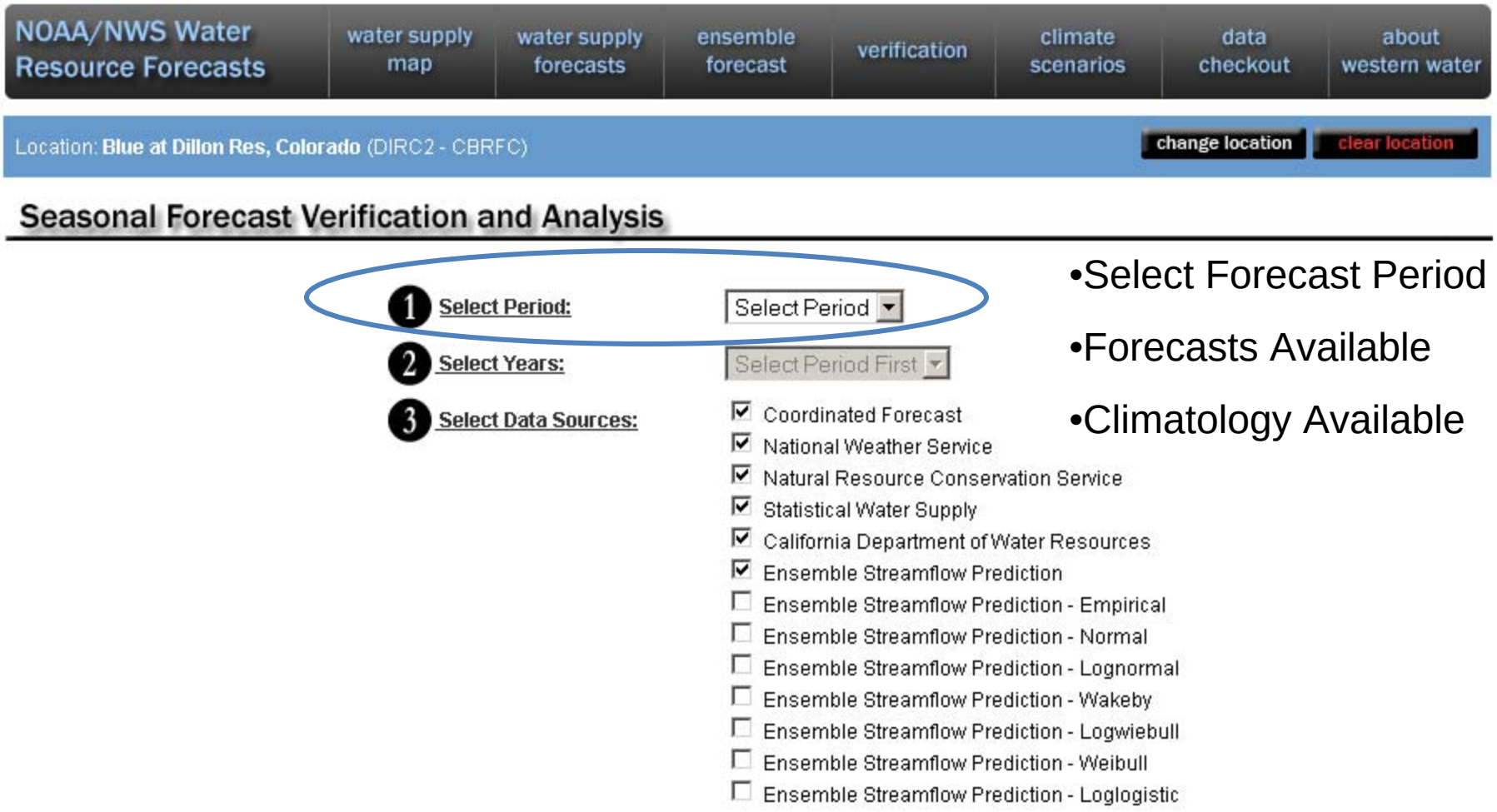
Verification Capabilities



About Forecast Verification

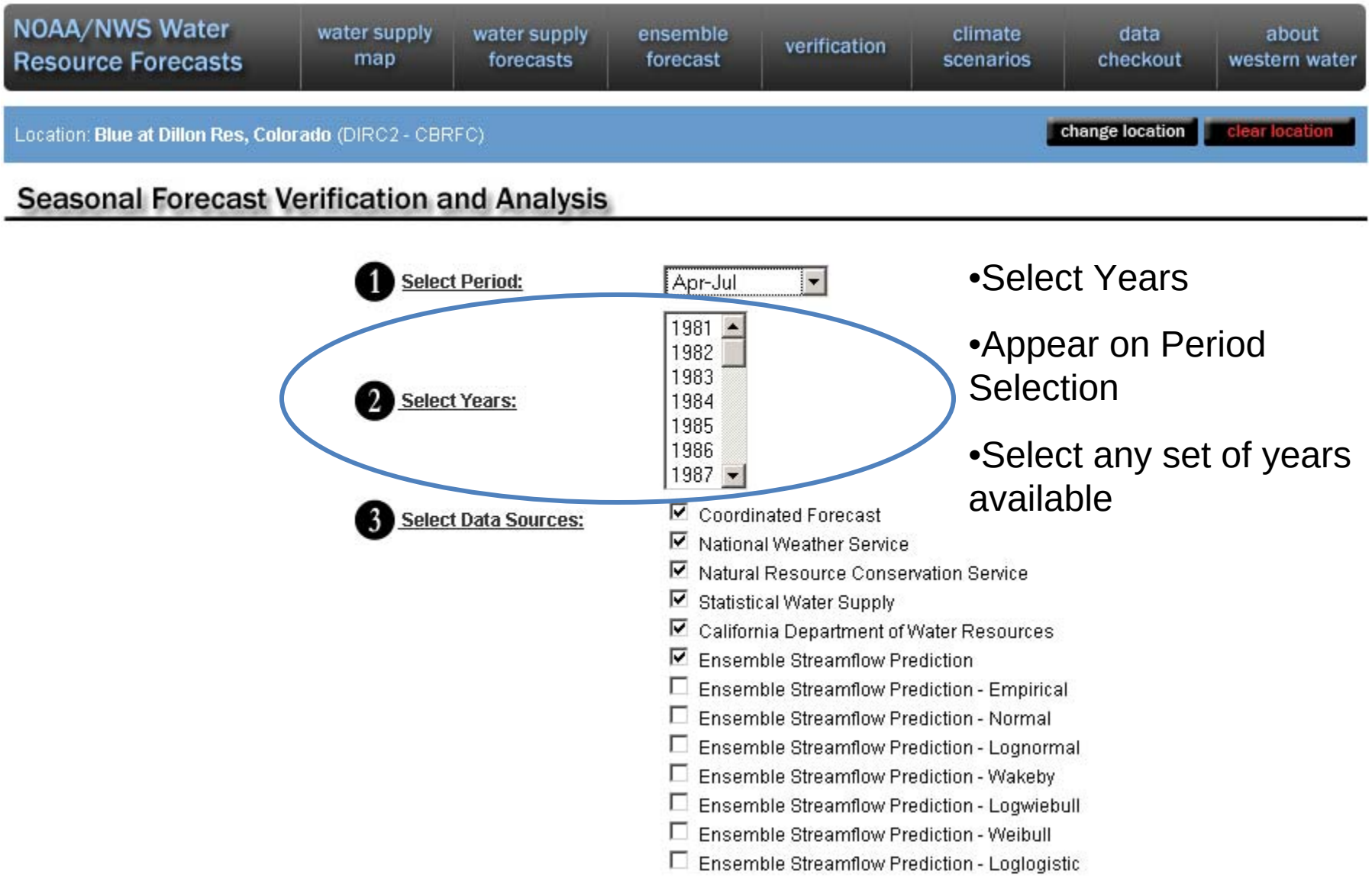
Forecast verification provides meaningful information about the quality of forecasts. Verification is an important for assessing past forecast performance and providing information about current forecast confidence. The seasonal forecast verification application allows users to obtain relatively simple plots and statistics explaining past performance. The application allows the user to choose (1) a forecast period (season), (2) the forecast years, (3) forecast types, and (4) verification metric. All data supporting the plots are archived in a database and may be accessed separately through the data checkout application as well.

Verification Capabilities



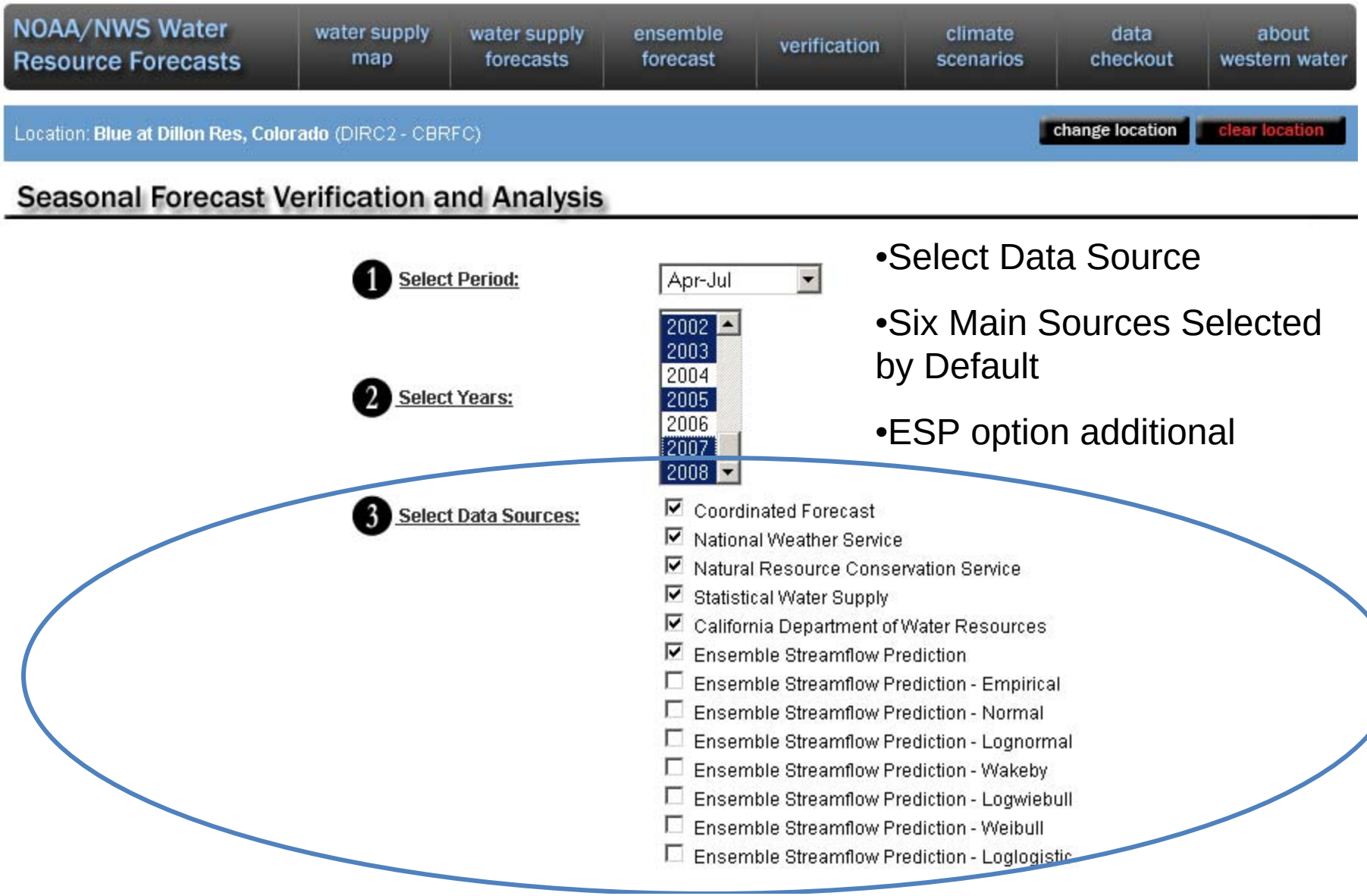
- Select Forecast Period
- Forecasts Available
- Climatology Available

Verification Capabilities



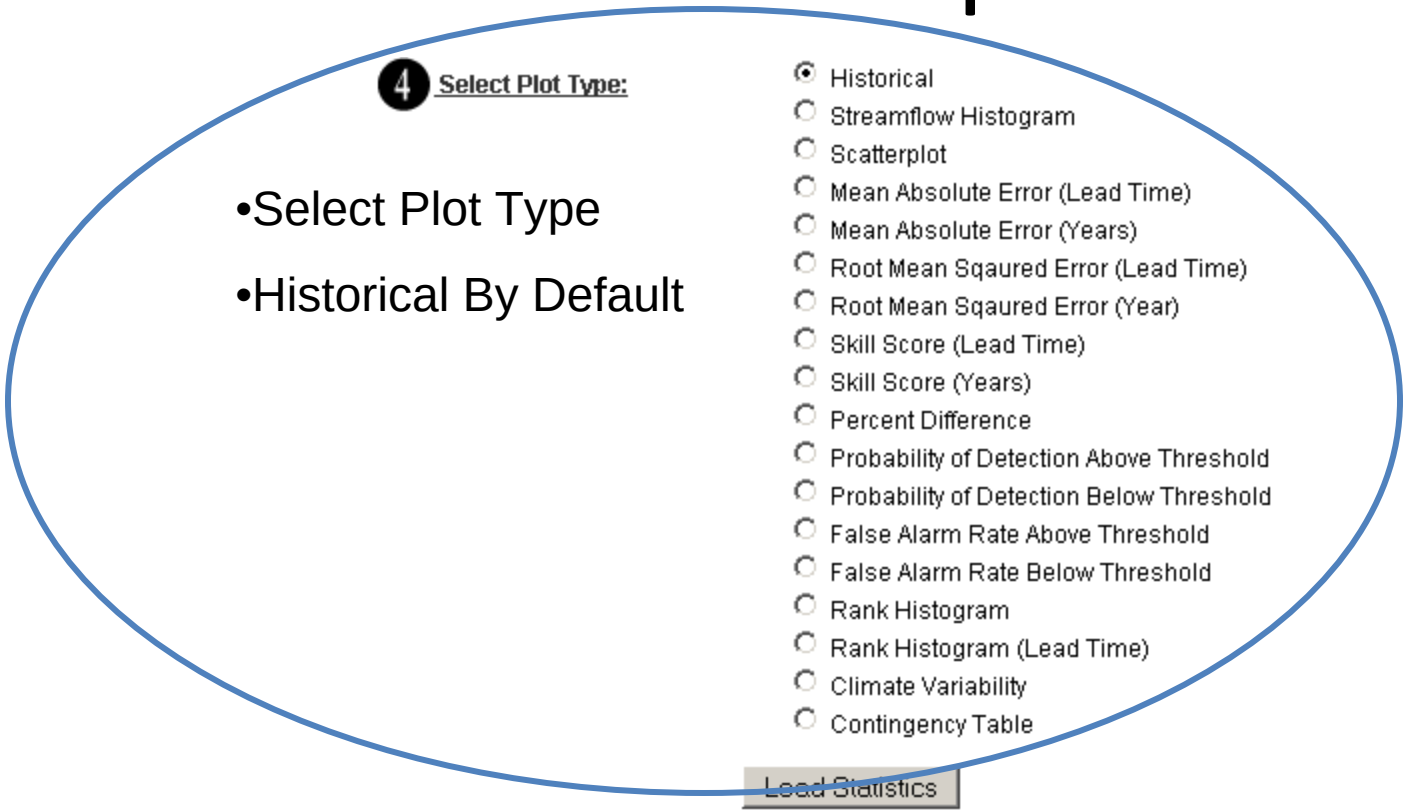
- Select Years
- Appear on Period Selection
- Select any set of years available

Verification Capabilities



- Select Data Source
- Six Main Sources Selected by Default
- ESP option additional

Verification Capabilities



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Site Options

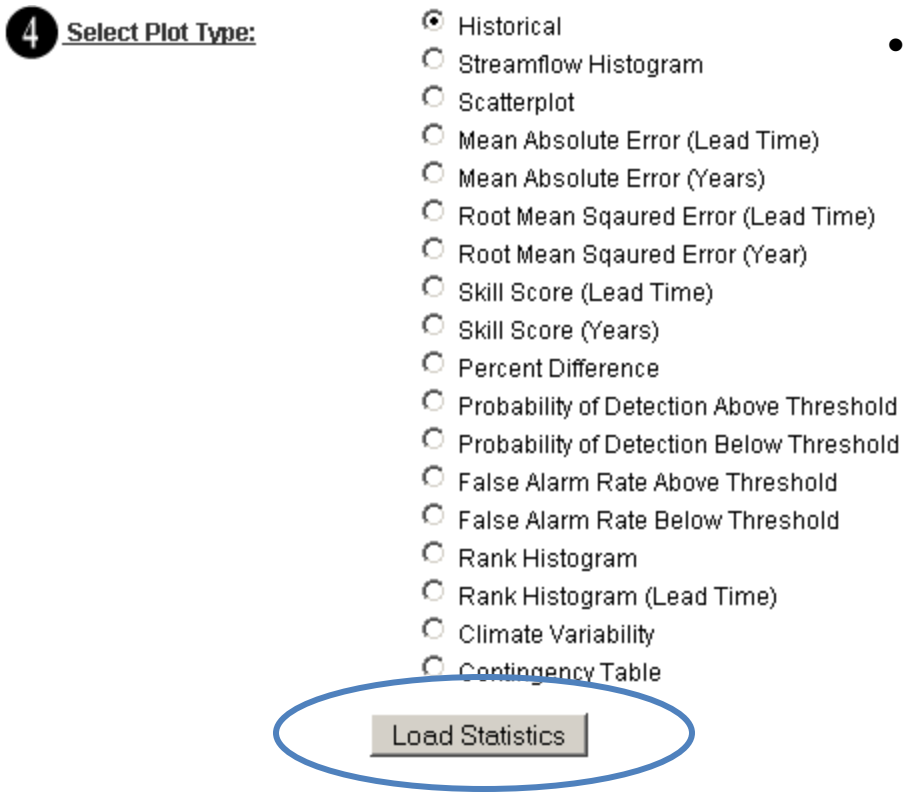
Previous 5 Locations Viewed

GBYC2

Print Graph | Display Raw Data

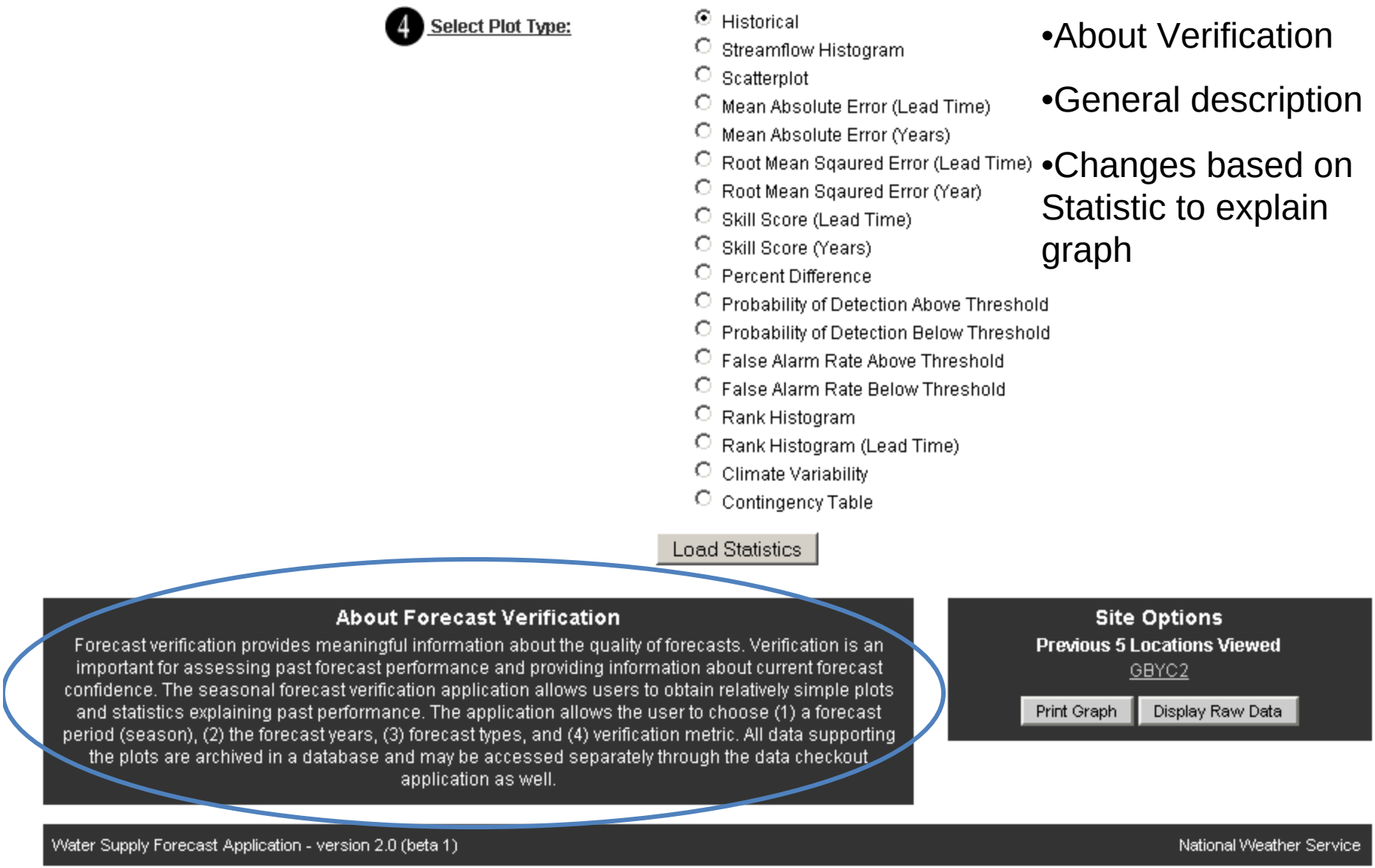
Water Supply Forecast Application - version 2.0 (beta 1) National Weather Service

Verification Capabilities



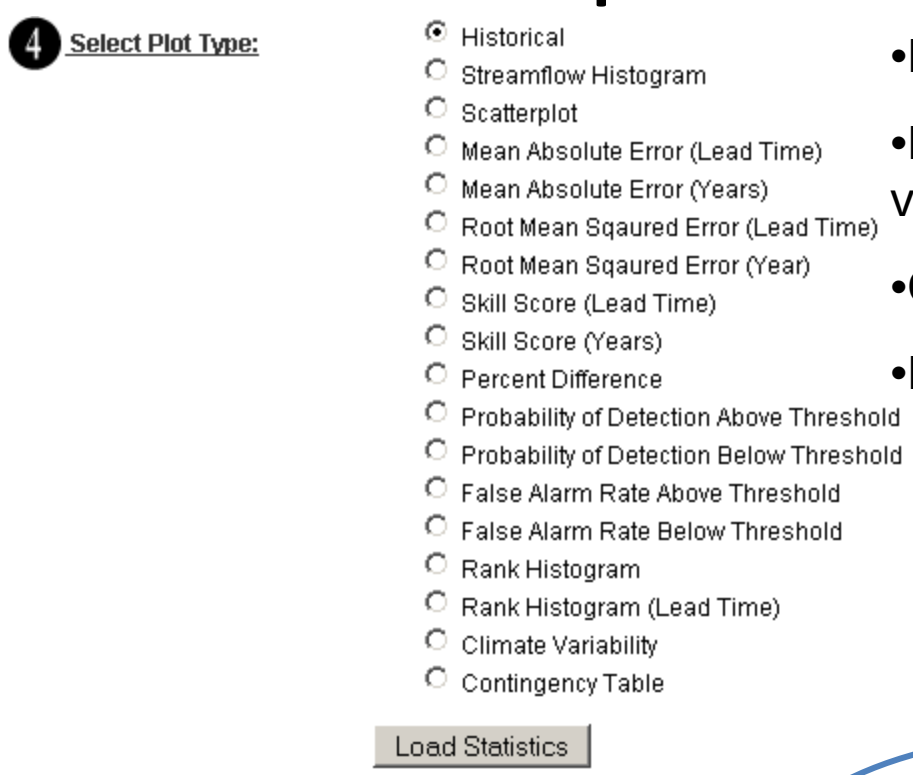
- Load Statistics

Verification Capabilities

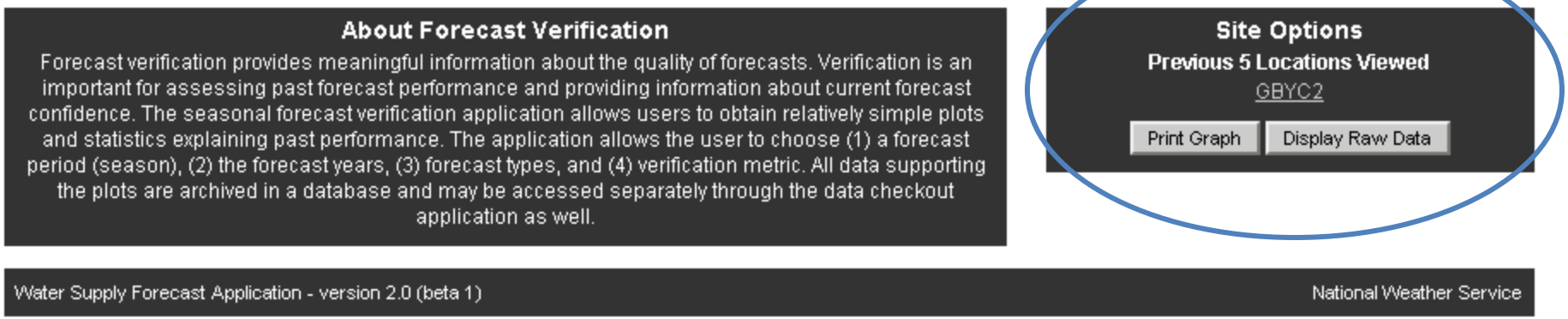


- About Verification
- General description
- Changes based on Statistic to explain graph

Verification Capabilities

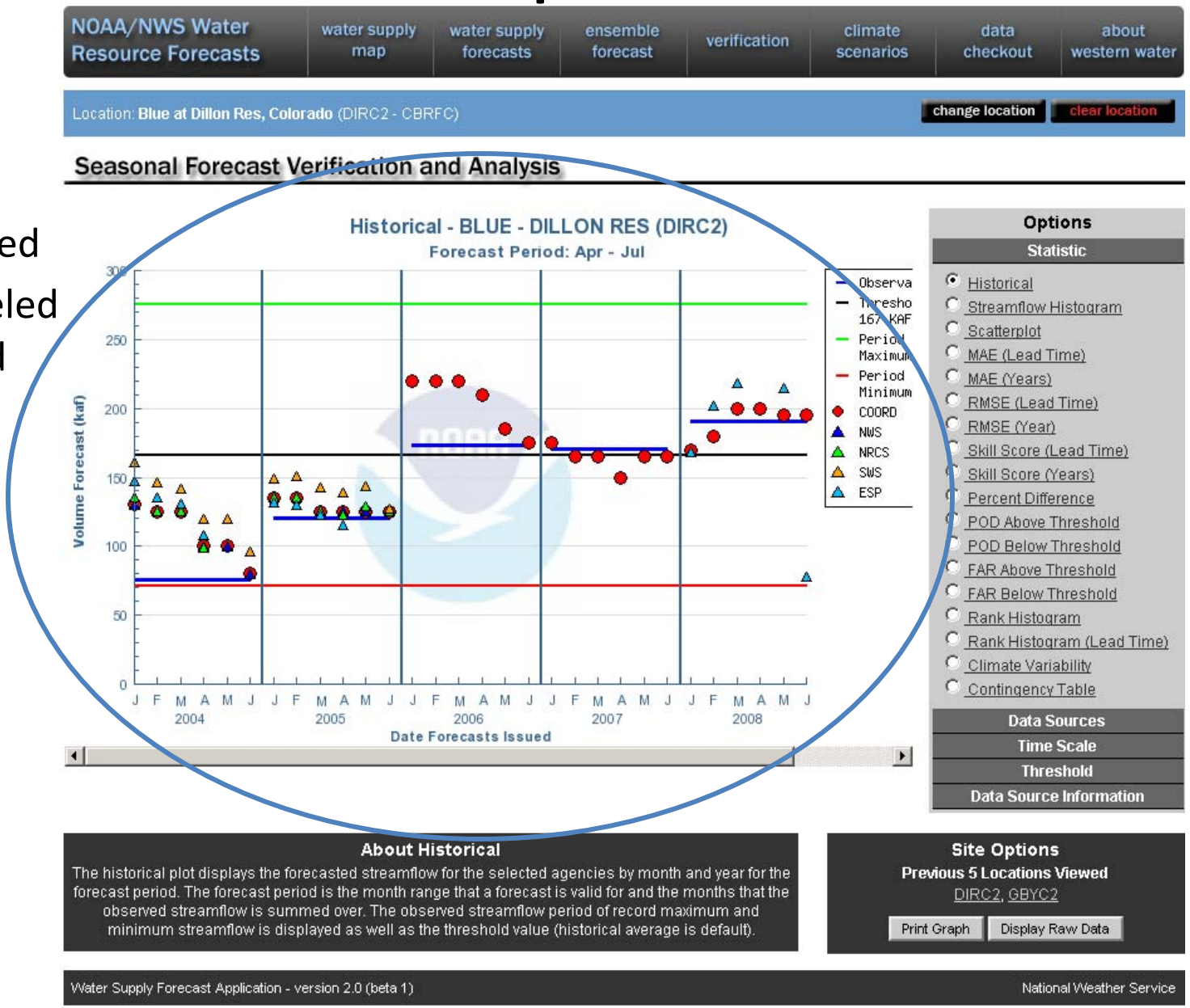


- Previous Sites
- Remembers last 5 visited
- Go to Data Checkout
- Print Graph



Verification Capabilities

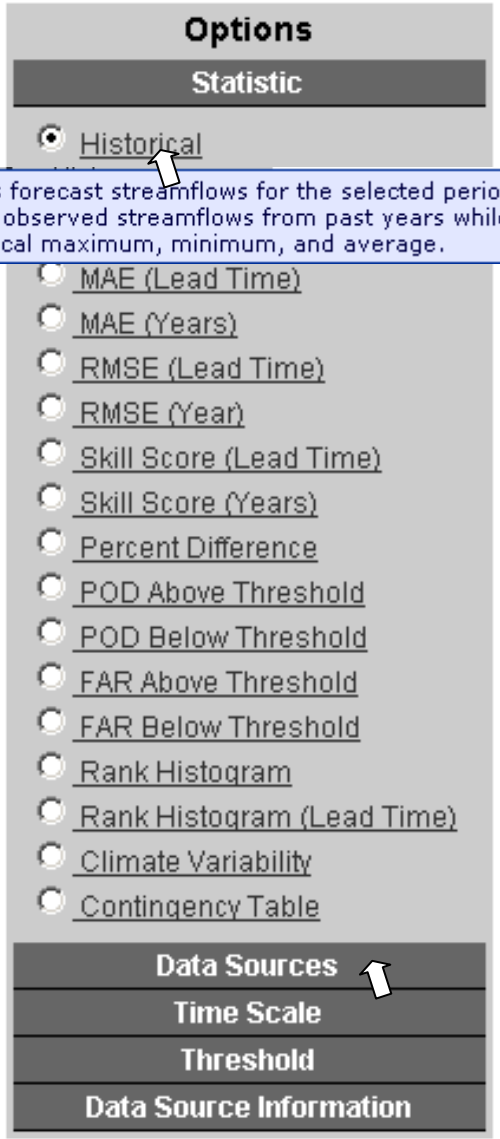
- **Plot Area**
  - Auto scroll when needed
  - Clearly labeled with legend



Verification Capabilities

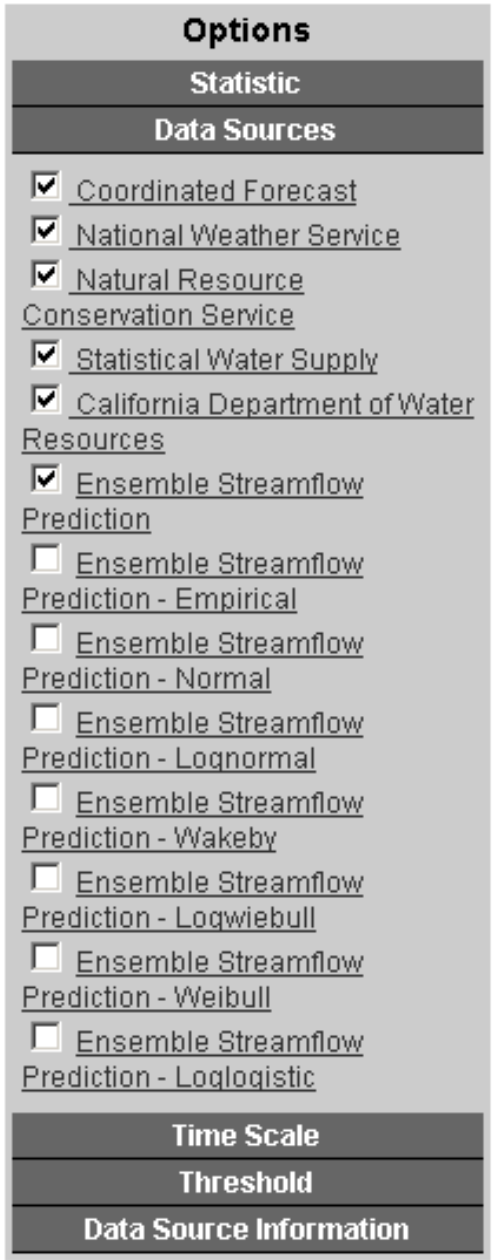
- **Side Options**
  - Statistic
  - Forecast Type/Data Source
  - Time Scale
  - Threshold
  - Data Source Information
  - Graph Options

Verification Capabilities



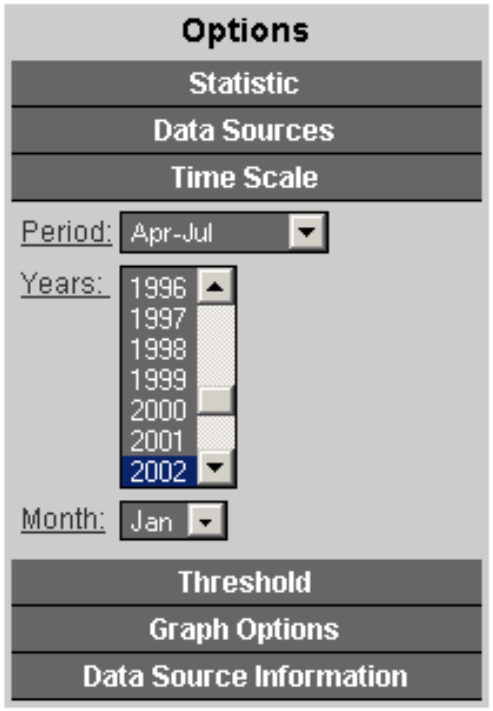
- **Statistic**
  - 18 Statistic choices
  - Graph change on click
  - Mouse-over displays info about graph
- **Group Titles**
  - Mouse and click to display other options

Verification Capabilities



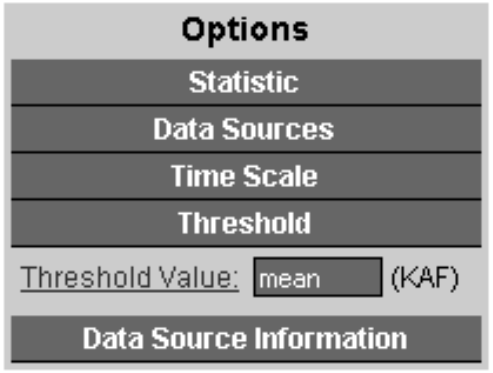
- **Forecast Type**
  - Change Data Sources to be displayed
  - Graph change on click

Verification Capabilities



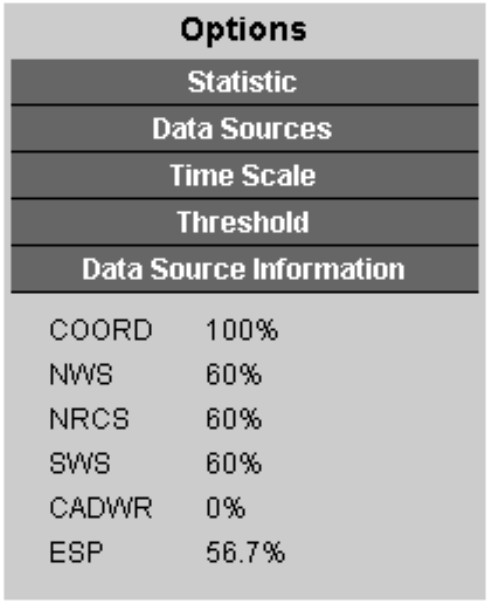
- **Time Scale**
  - Change Period
  - Modify Years
  - Graph change on click
  - Month
    - Only displayed when Contingency Table Statistic is chosen
    - Change the month the table displays

Verification Capabilities



- **Threshold**
  - Default is Climatology / Historical Average
  - Enter value in KAF and press enter
  - Type ‘mean’ to return to default
  - Valid option for all but Rank Histogram statistic options.
  - Graph change on ‘Enter’

Verification Capabilities

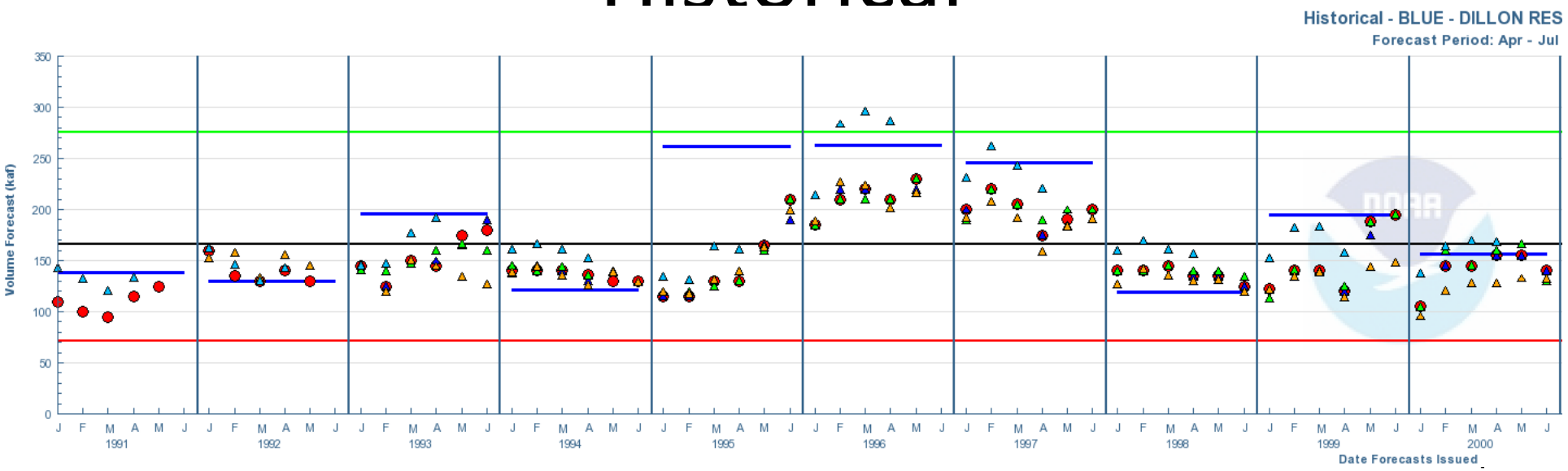


- **Data Source Information**
  - Calculated the percent of forecasts available
  - Keep in mind; can skew thoughts about statistics

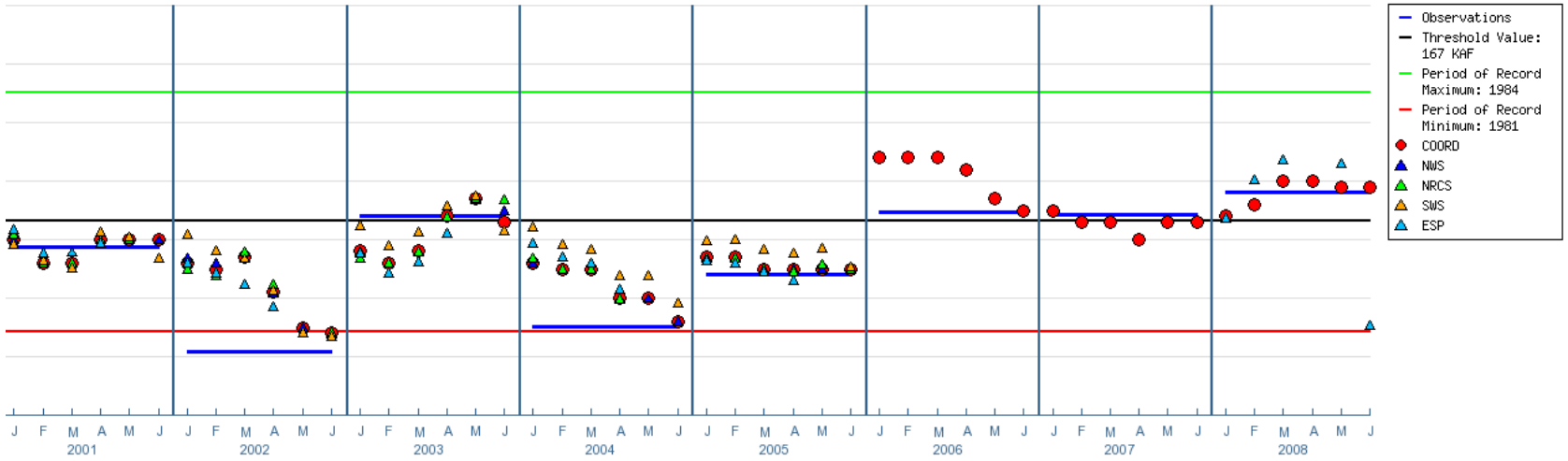
Example

DIRC2
1991 – 2008 Forecast Available

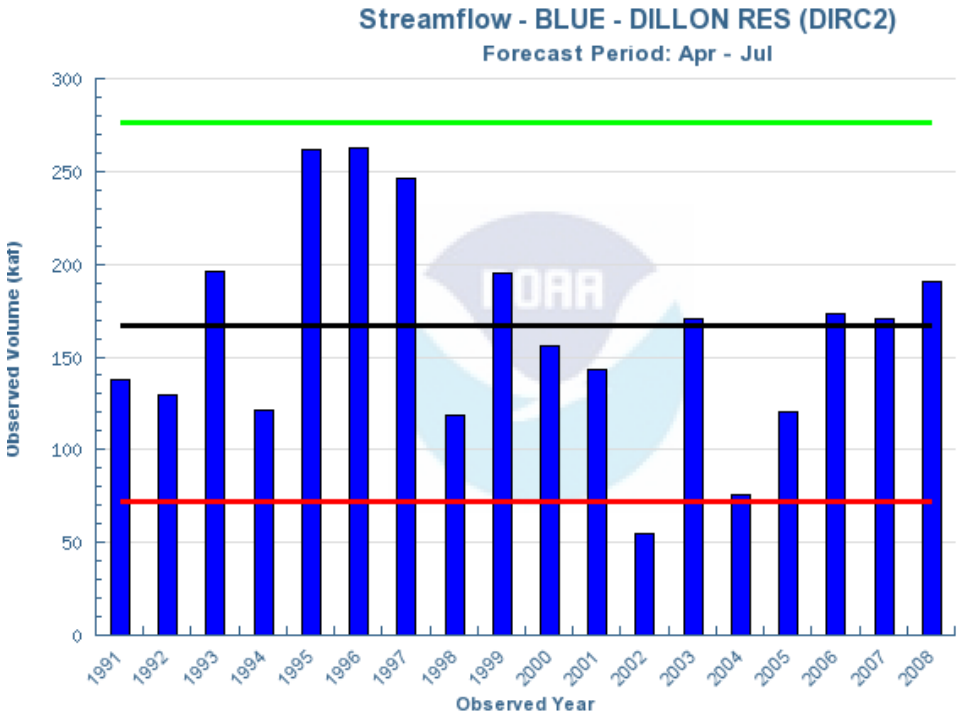
Historical

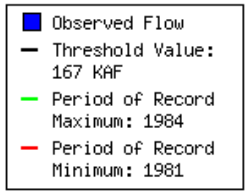


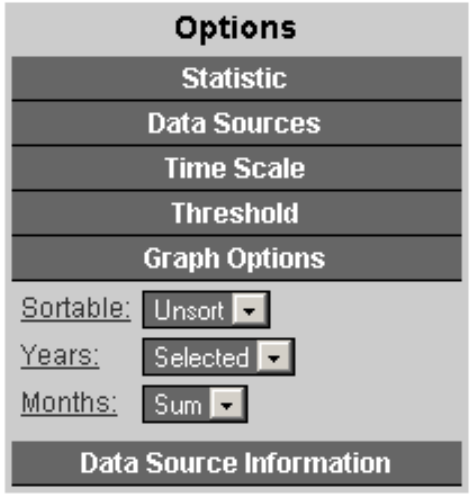
(DIRC2)



Streamflow Histogram

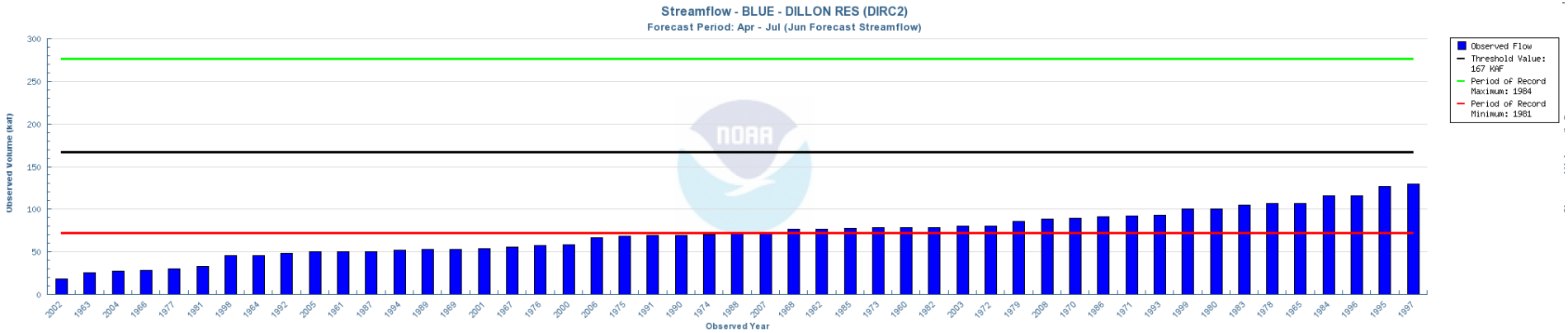


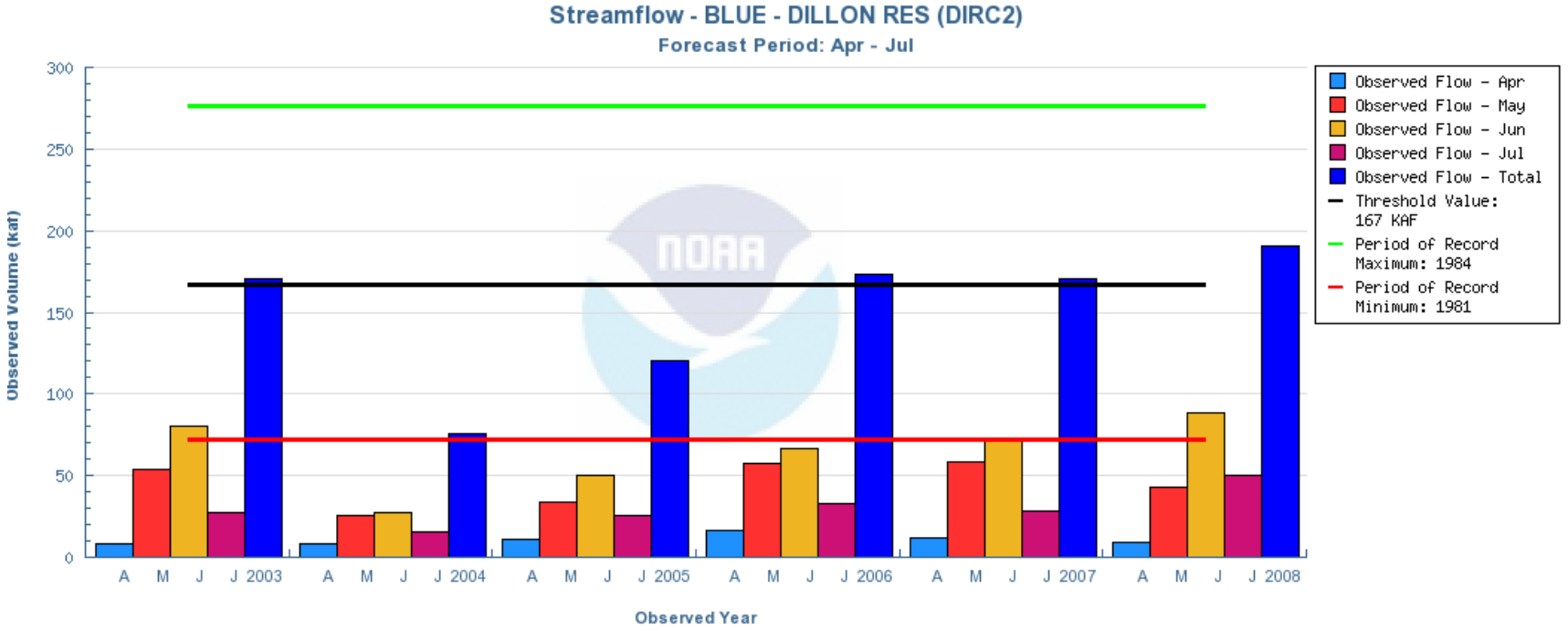




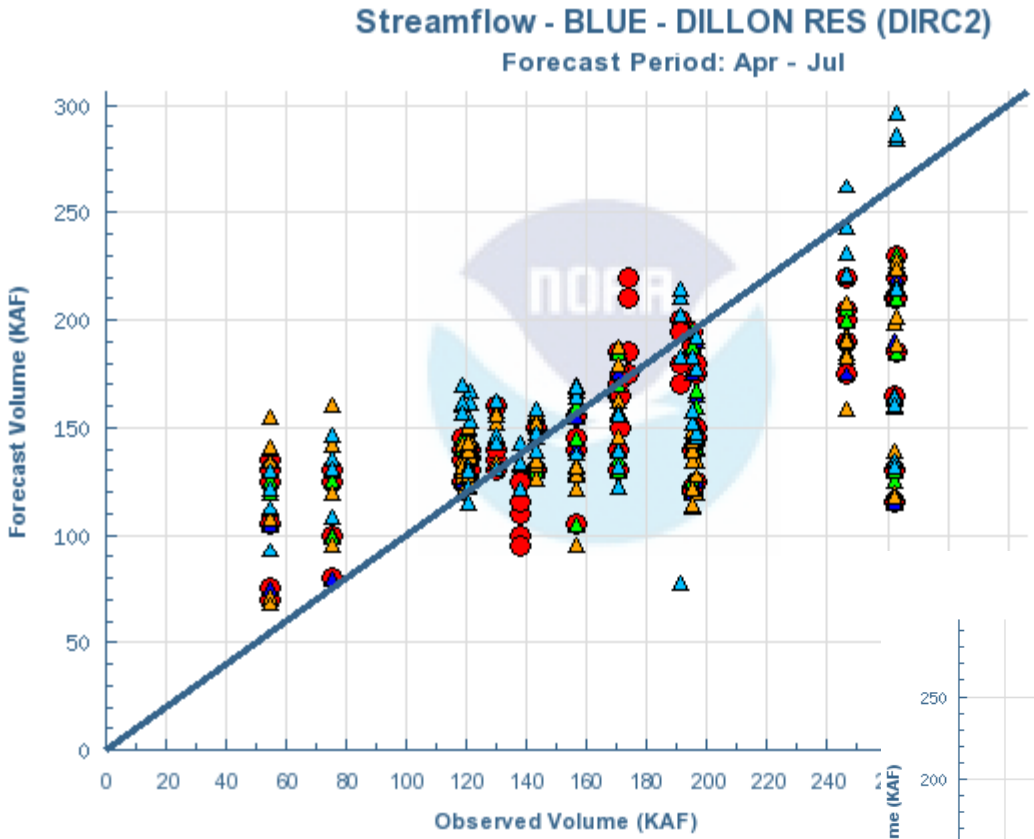
- **Graph Options**
  - Any Combination of Options
  - Sort/Unsort Years
  - Display selected Years or All Observed Years
  - Display Summed Months
  - Individual Months
  - Each Month and Summed

Streamflow Histogram





Scatterplot



COORD
NWS
NRCS
SWS
ESP

Options

Statistic

Data Sources

Time Scale

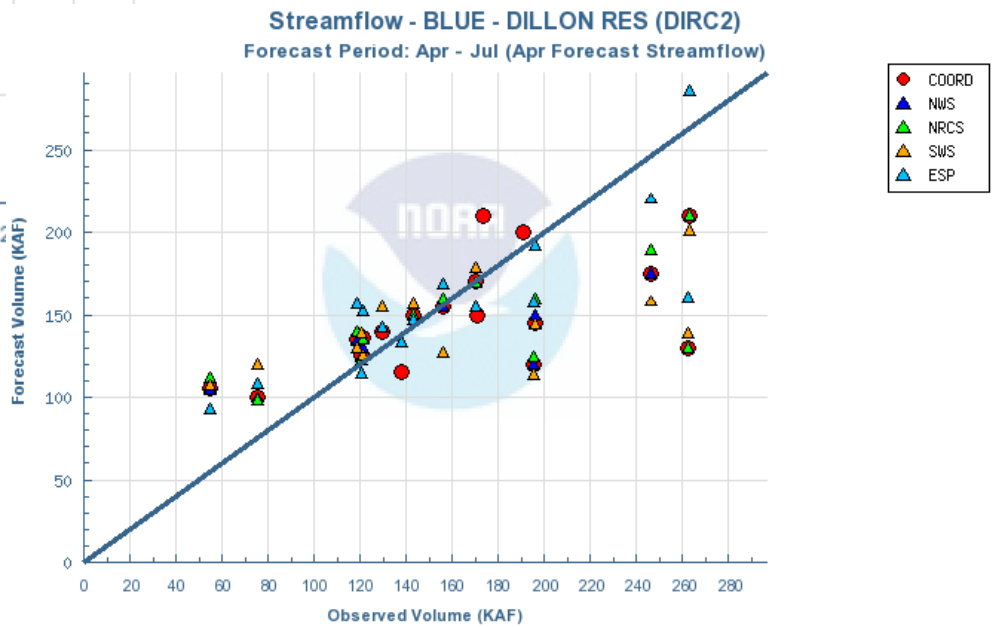
Threshold

Graph Options

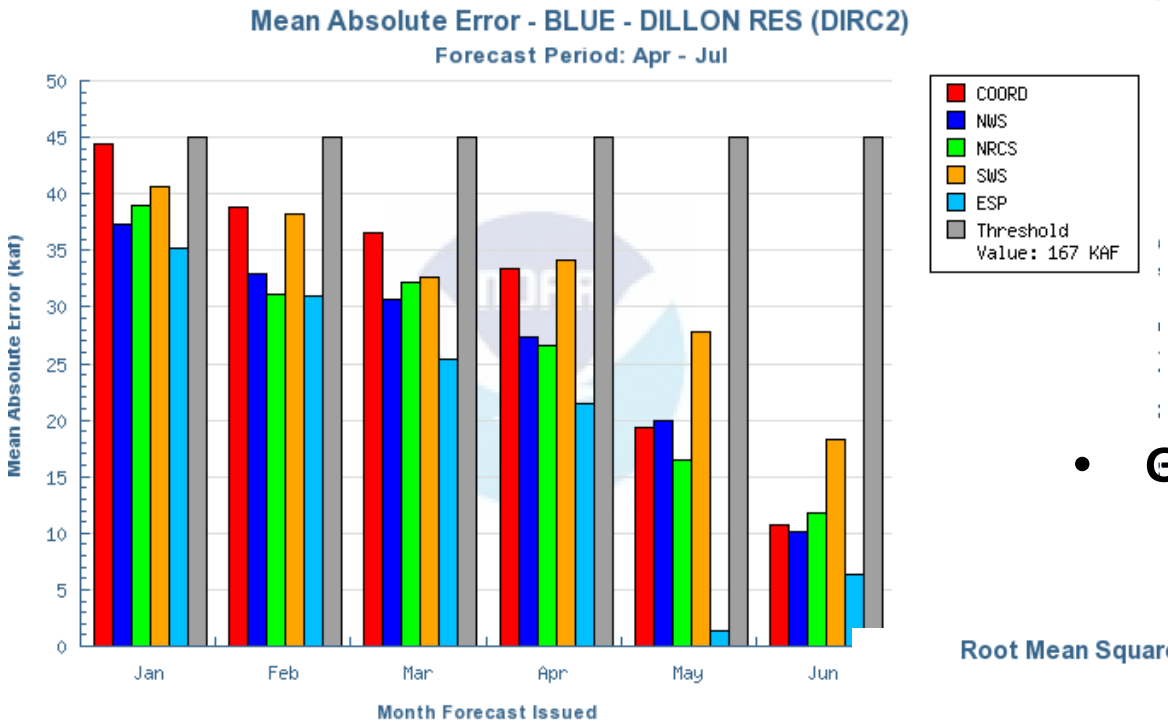
Months: All

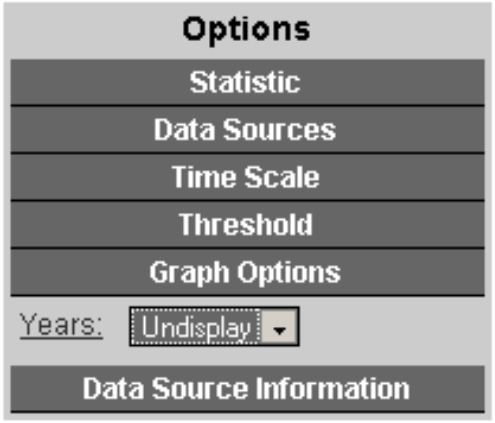
Data Source Information

- **Graph Options**
  - Display All Months or Specific forecast Month



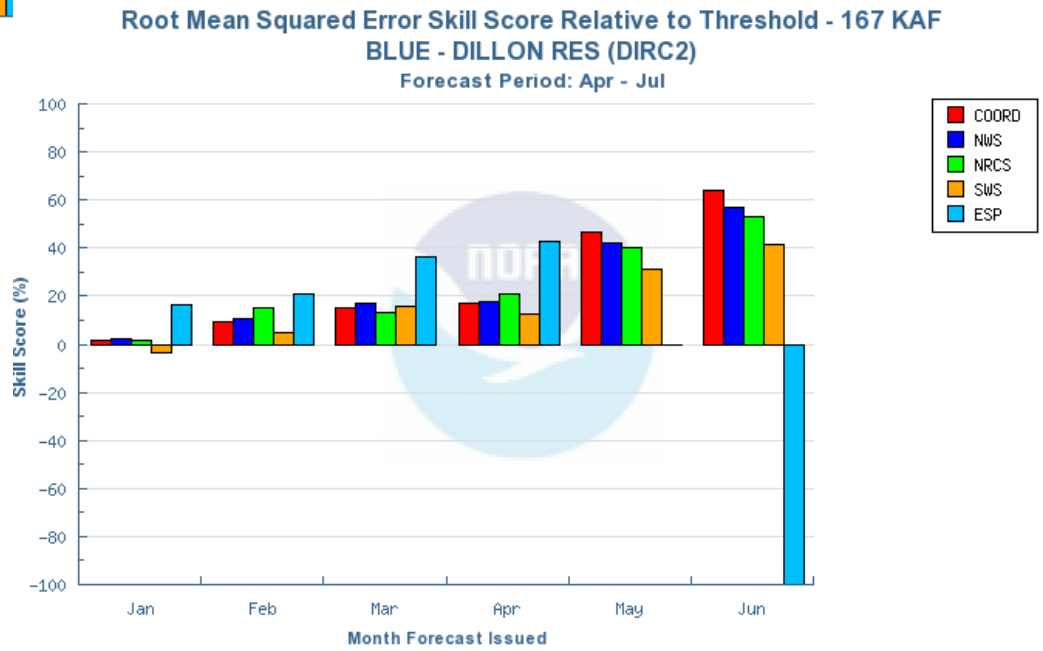
Error and Skill By Lead Time



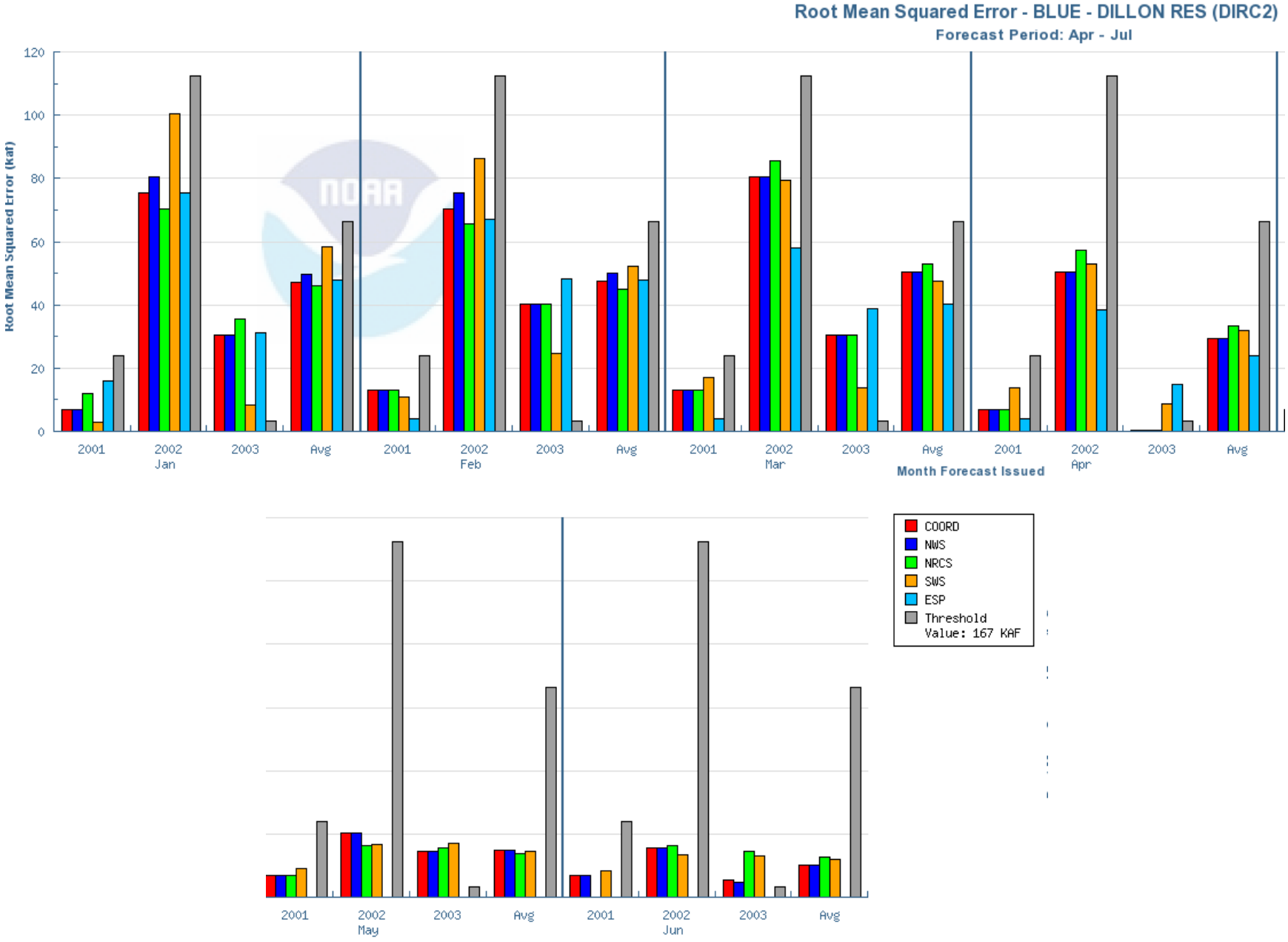


- **Graph Options**
  - Display/Undisplay years within the months

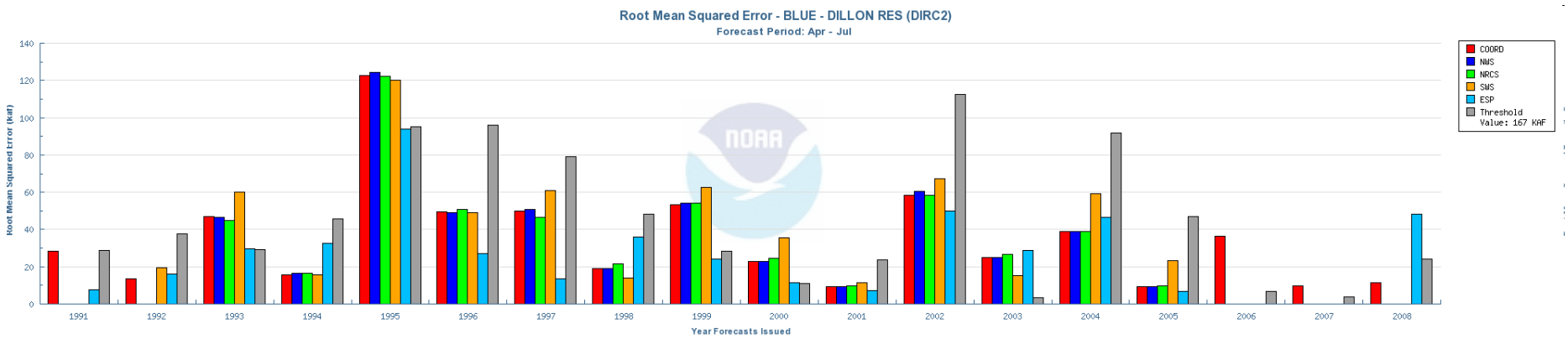
- Comparison of forecast error to "average" error useful diagnostic tool

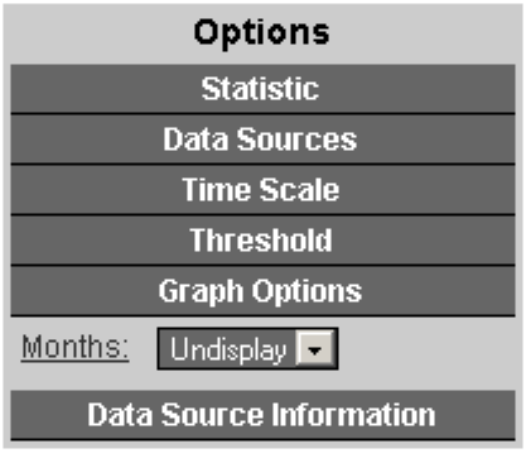


Error and Skill By Lead Time

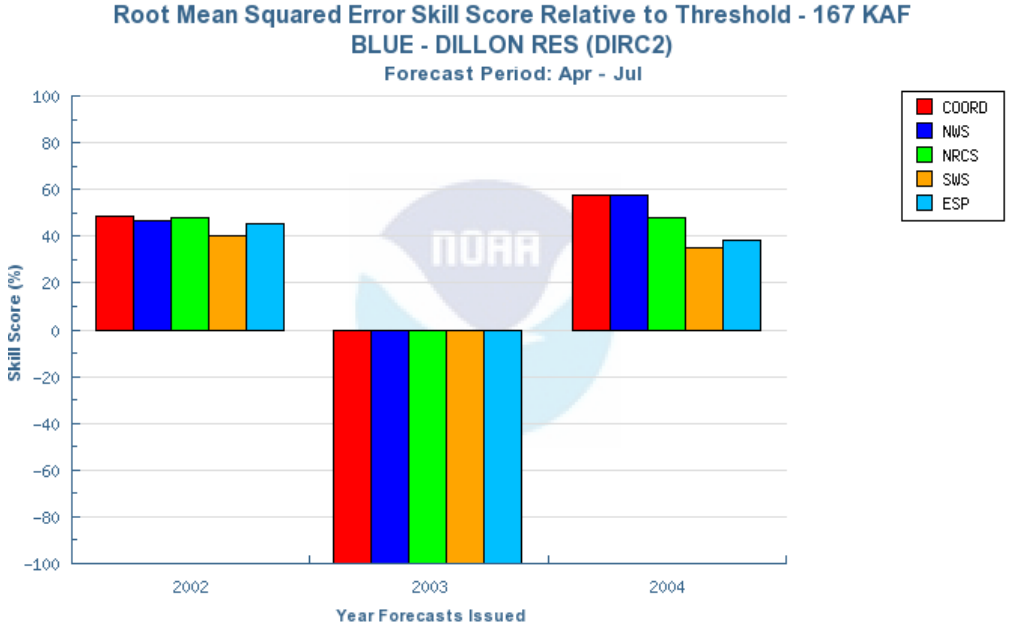


Error and Skill By Year



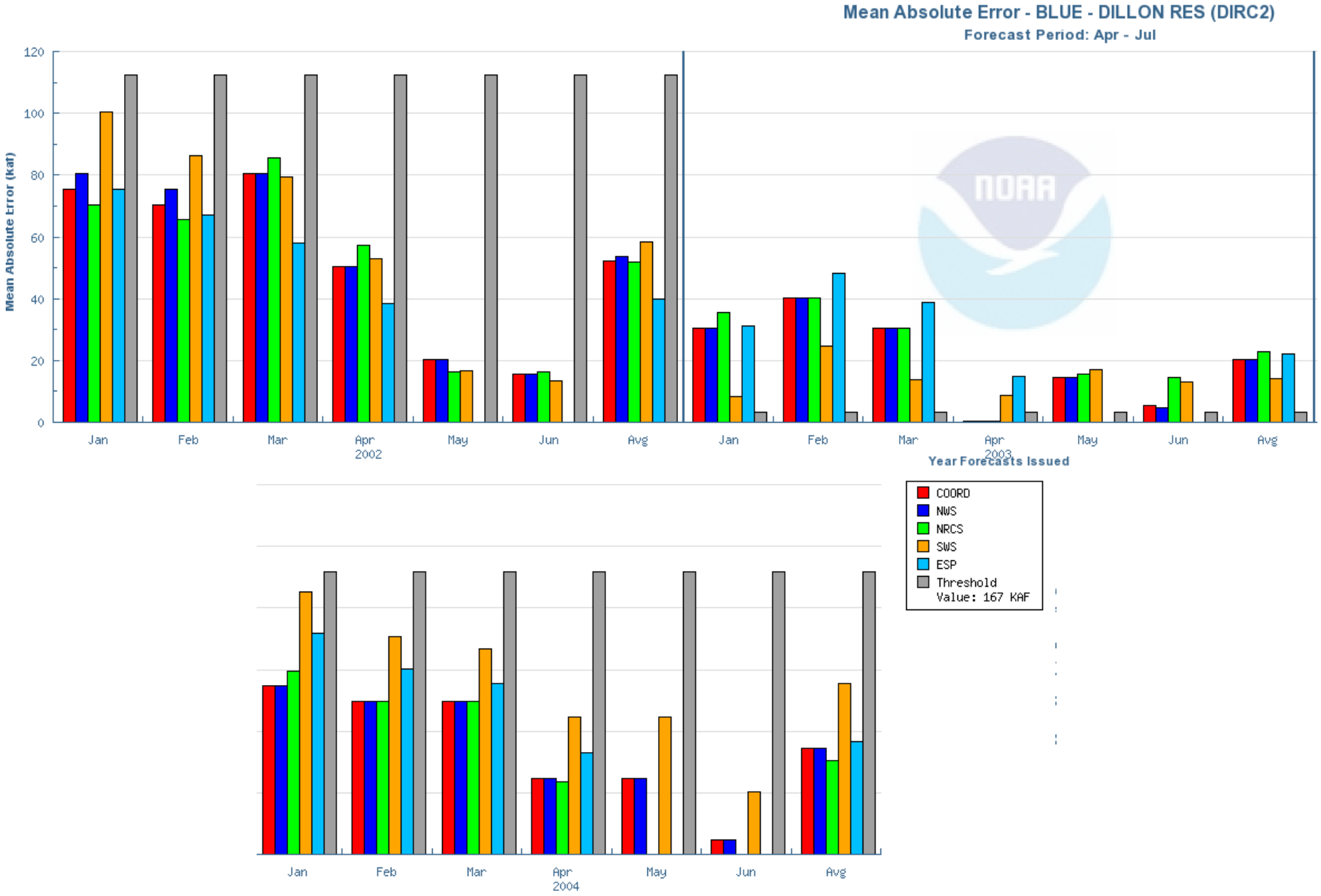


- **Graph Options**
  - Display All Months or Specific forecast Month

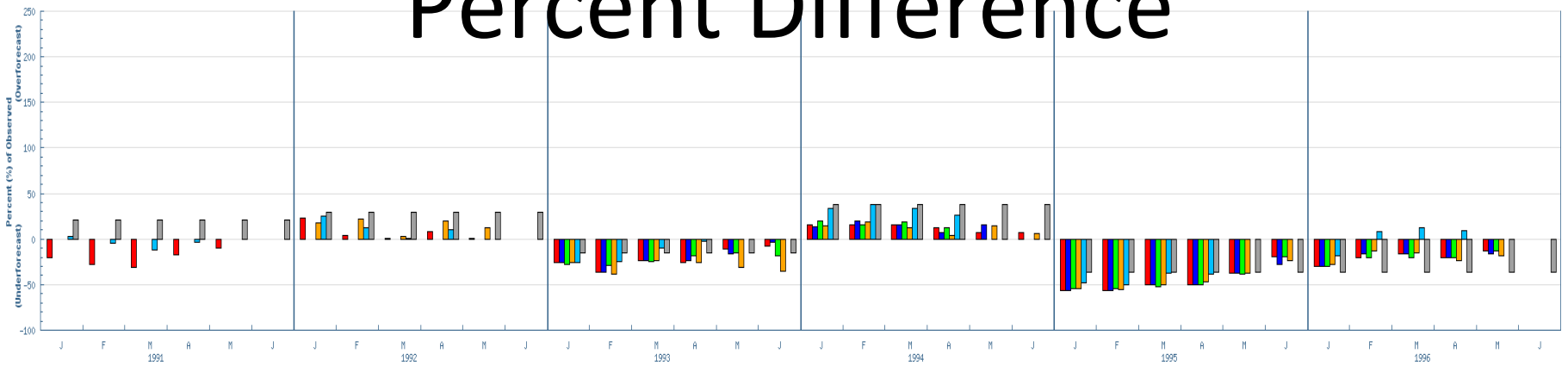


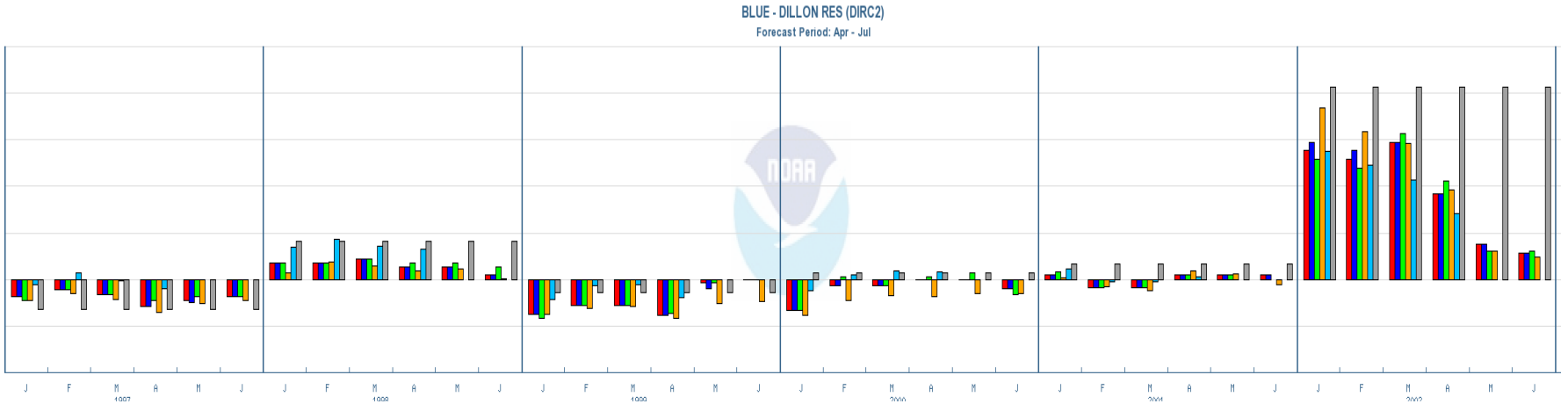
- **Warning**
  - SS can be miss leading when observed close to threshold (2003)

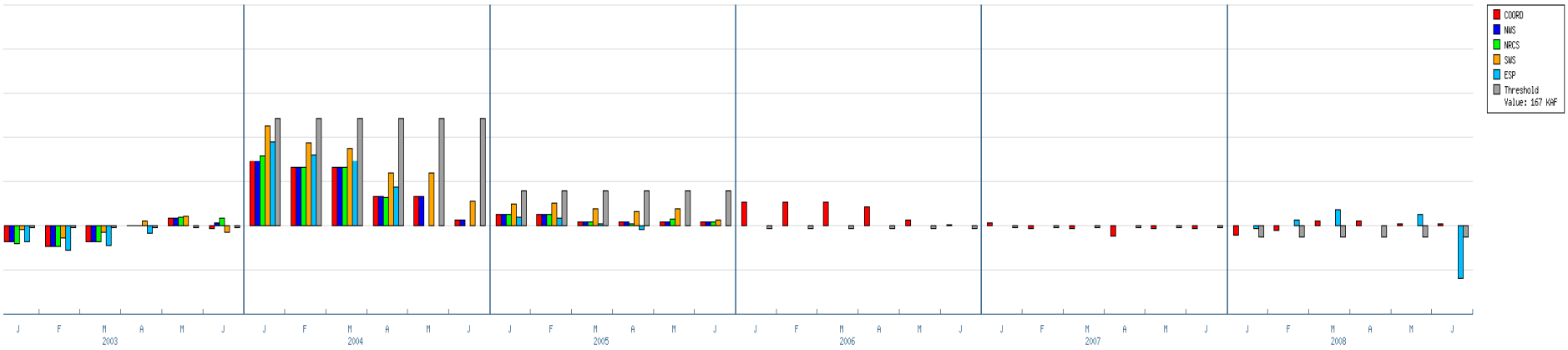
Error and Skill By Year



Percent Difference

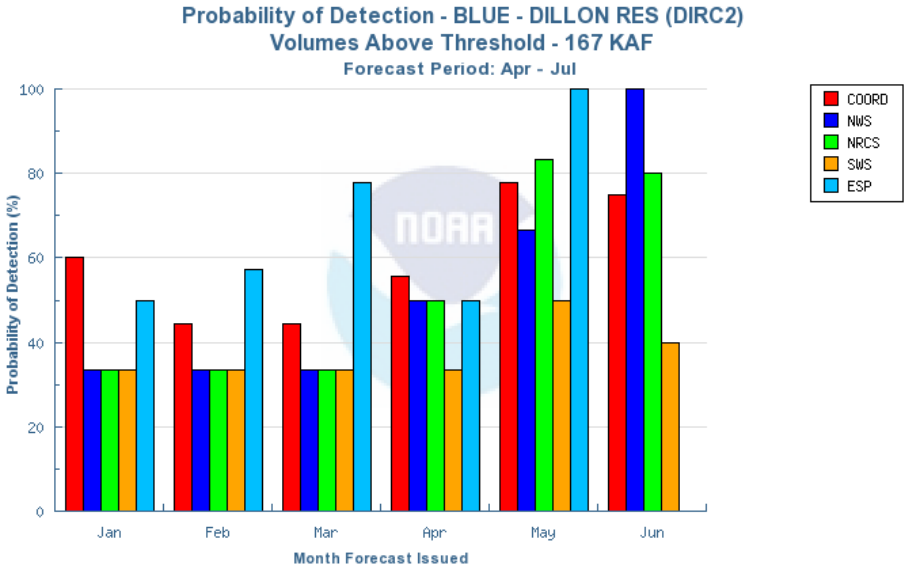


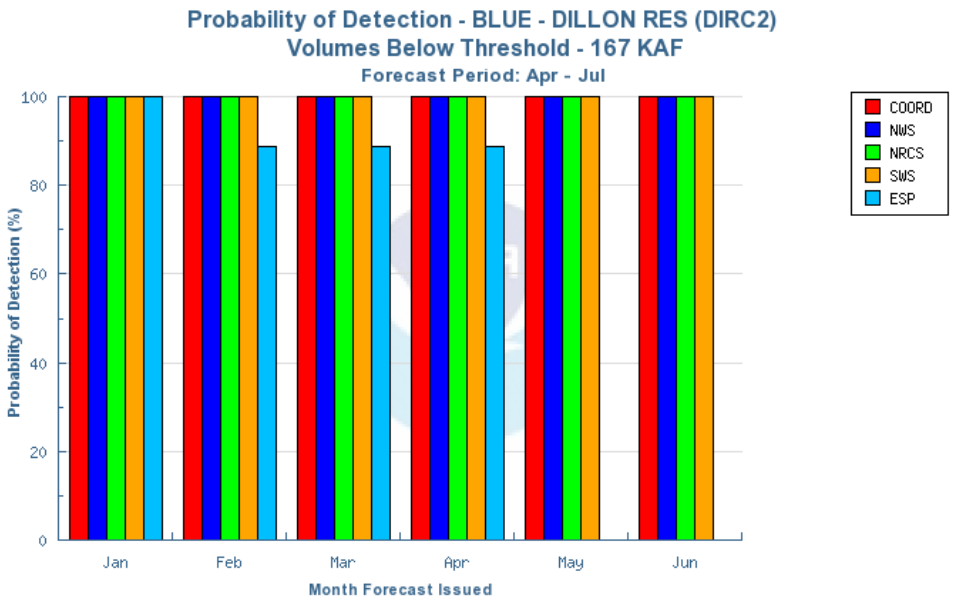




Probability of Detection

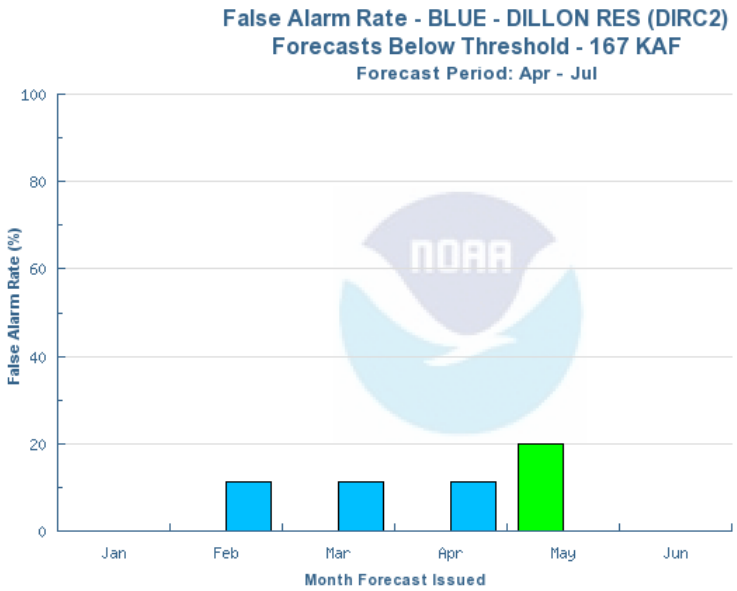
- High years much for difficult to detect in the early season
- All forecasts during low years have been for low volumes

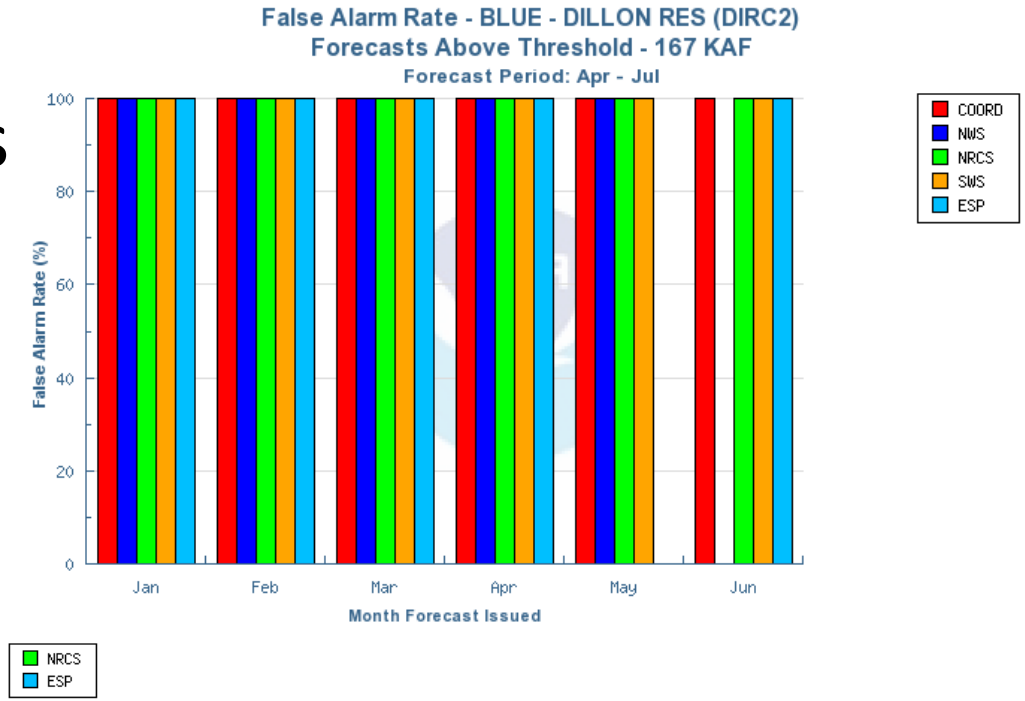




False Alarm Rate

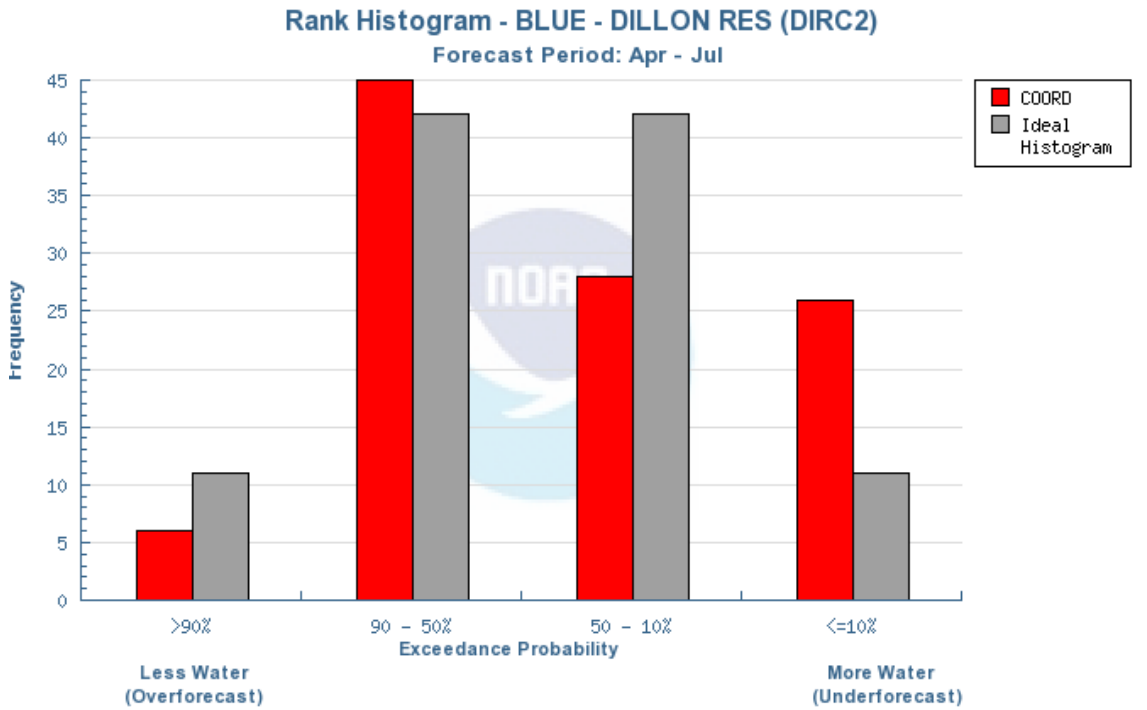
- Similar story here as with POD



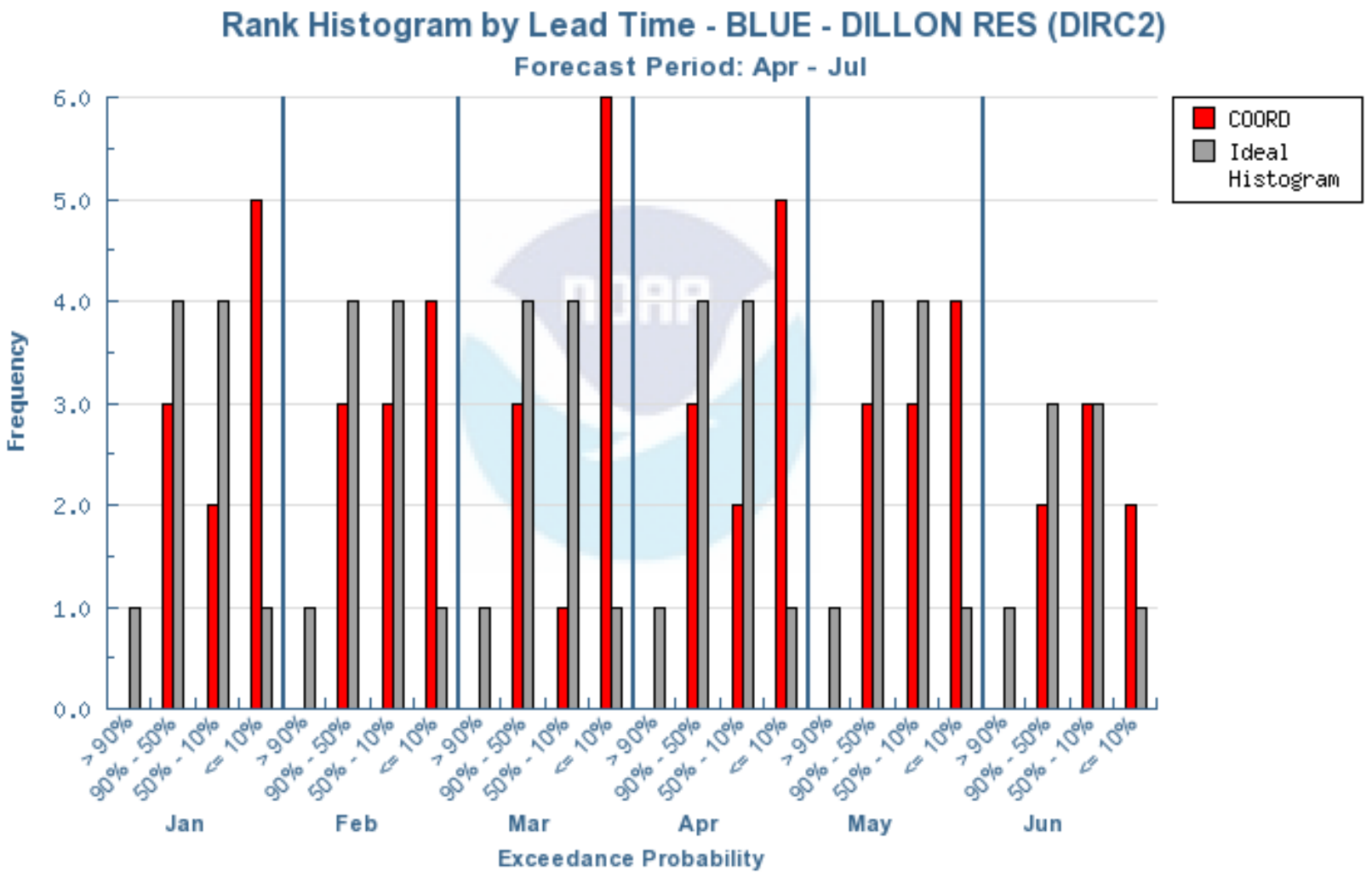


Forecast Distribution

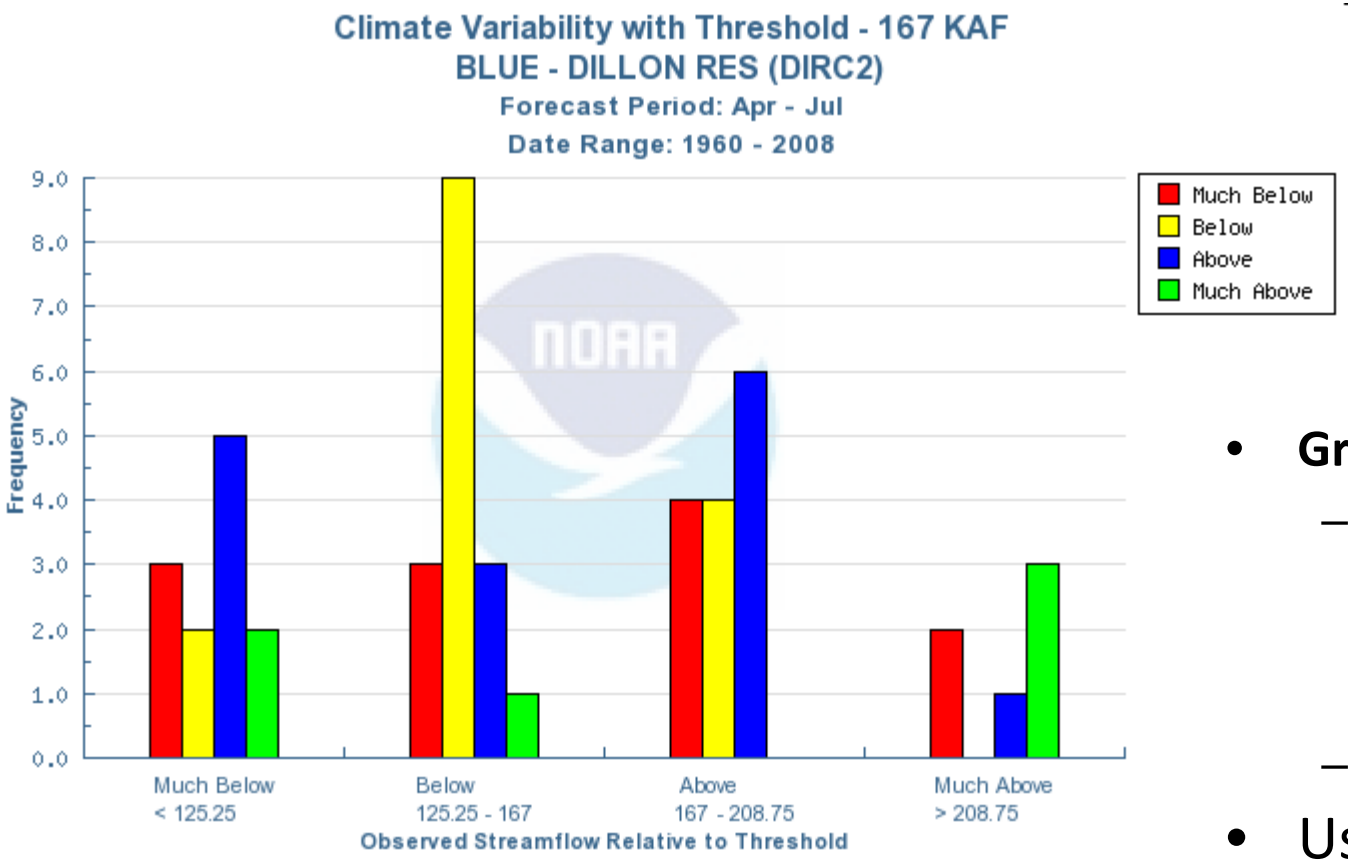
- Some tendency to underforecast
- 26% of observed streamflow falls above the 10% exceedance forecast value
- Reasonable max not so reasonable
- Results very dependent on years selected

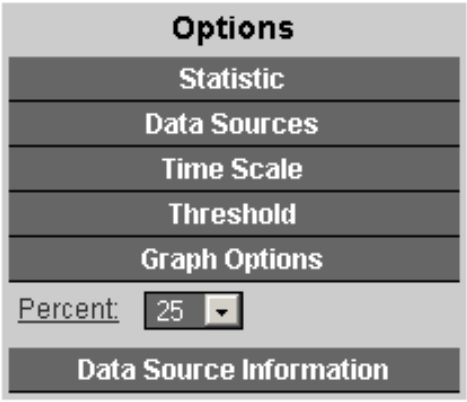


Forecast Uncertainty by month



Observed Lag-1 Analysis
Climate Variability



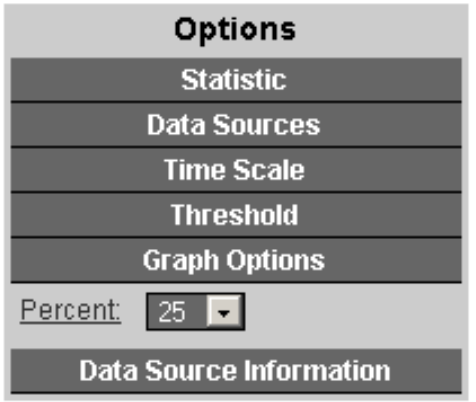


- **Graph Options**
  - Select the percentage to adjust the categories
  - 25% Default
- Uses all observed years in database

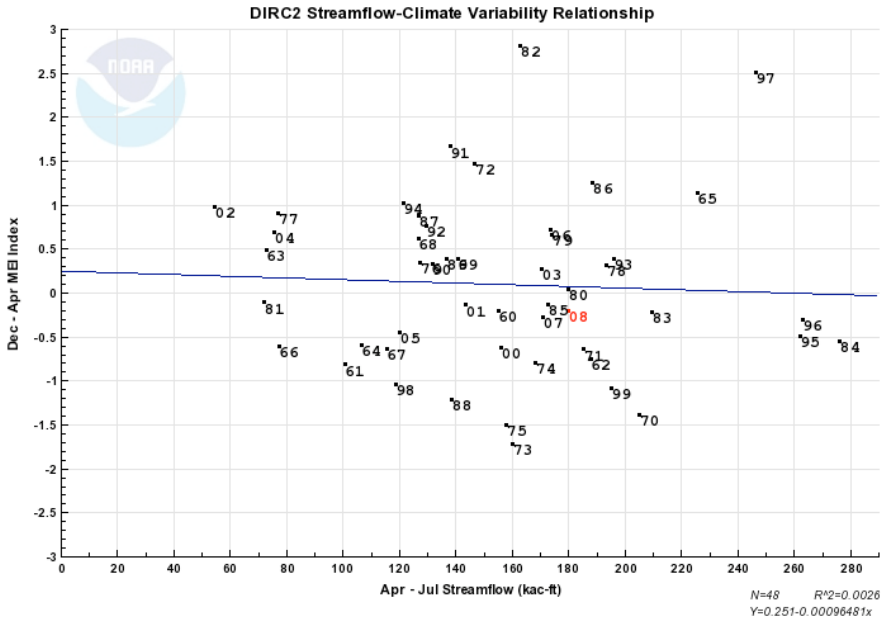
Contingency Table

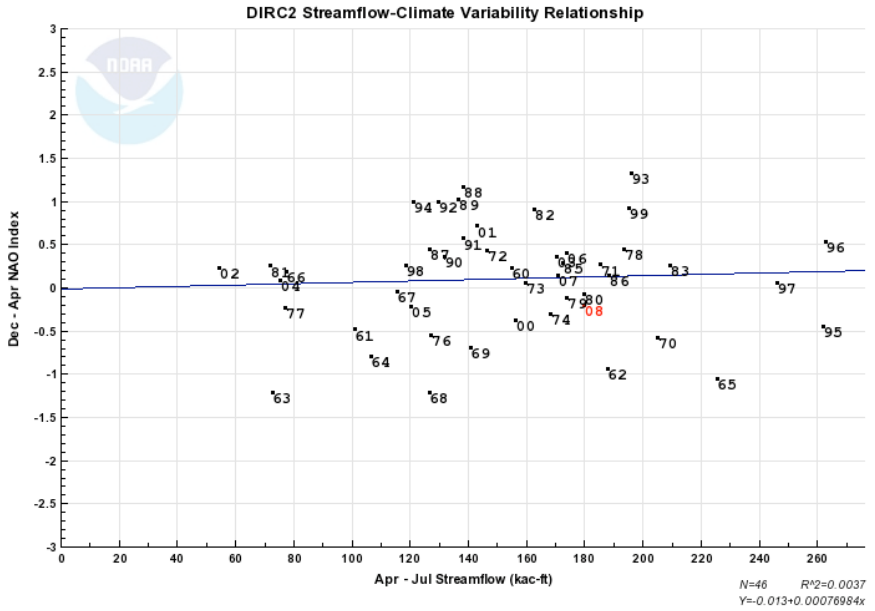
Contingency Table for Jan with Threshold - 167 KAF
BLUE - DILLON RES (DIRC2)

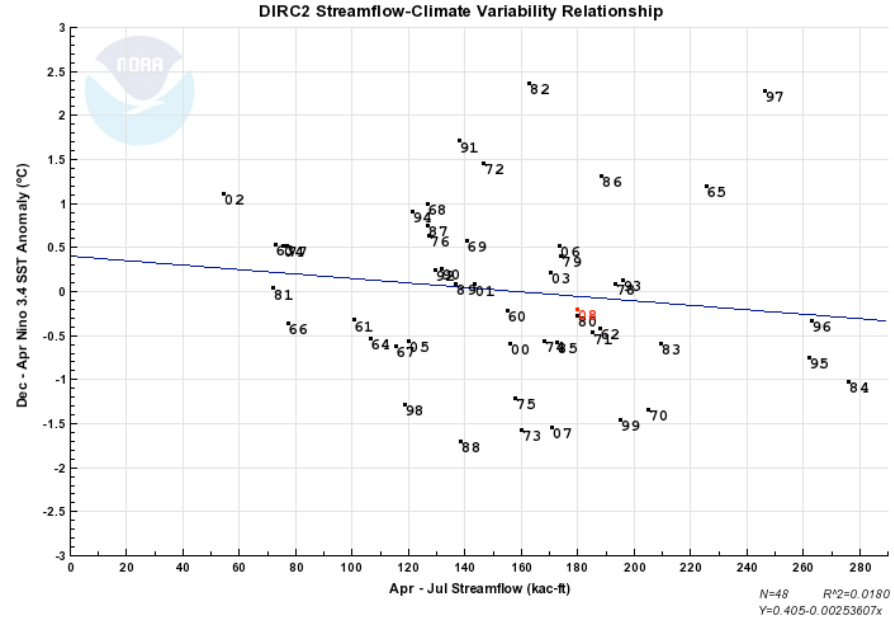
COORD NWS NRCS SWS ESP		Observed Streamflow			
		Much Below < 125.25 KAF	Below 125.25 - 167 KAF	Above 167 - 208.75 KAF	Much Above > 208.75 KAF
Forecast Streamflow	Much Below < 125.25 KAF	2002	1991 2000 2000 2000 2000	1999 1999 1999 1999	1995 1995 1995 1995
	Below 125.25 - 167 KAF	1994 1998 2002 2004 2005 1994 1998 2002 2004 2005 1994 1998 2004 2005 1994 1998 2002 2004 2005 1994 1998 2002 2004 2005	1992 2001 2001 2001 1992 2001 1991 1992 2000 2001	1993 2003 1993 2003 1993 2003 1993 2003 1993 1999 2003	1995
	Above 167 - 208.75 KAF			2007 2008 2008	1996 1997 1996 1997 1996 1997 1996 1997
	Much Above > 208.75 KAF			2006	1996 1997

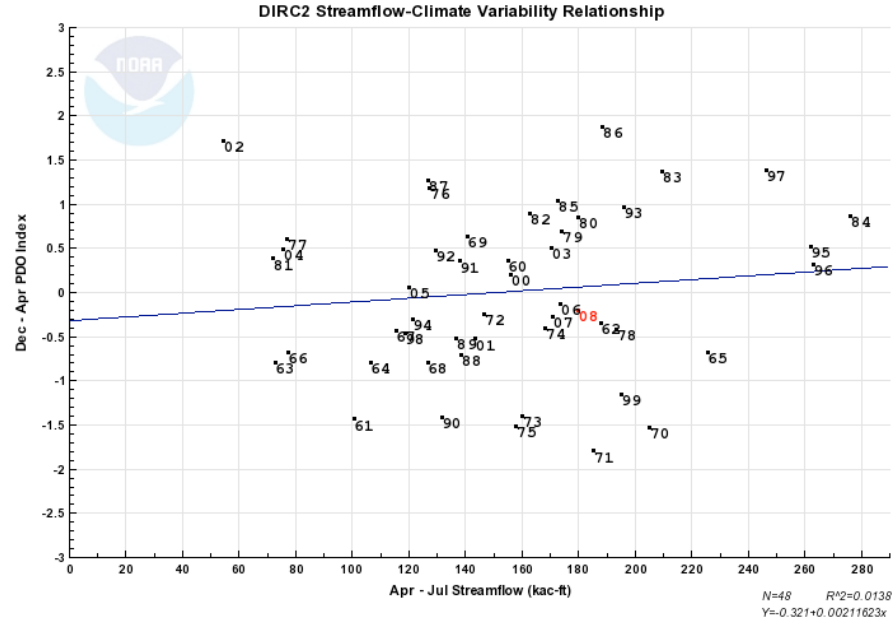


- **Graph Options**
  - Select the percentage to adjust the categories
  - 25% Default
  - Month Displayed January by default


DIRC2 Streamflow-Climate Variability Relationship
Dec - Apr MEI Index
Apr - Jul Streamflow (kac-ft)
N=48 R^2=0.0026
Y=0.251-0.00096481x


DIRC2 Streamflow-Climate Variability Relationship
Dec - Apr NAO Index
Apr - Jul Streamflow (kac-ft)
N=46 R^2=0.0037
Y=-0.013+0.00076984x

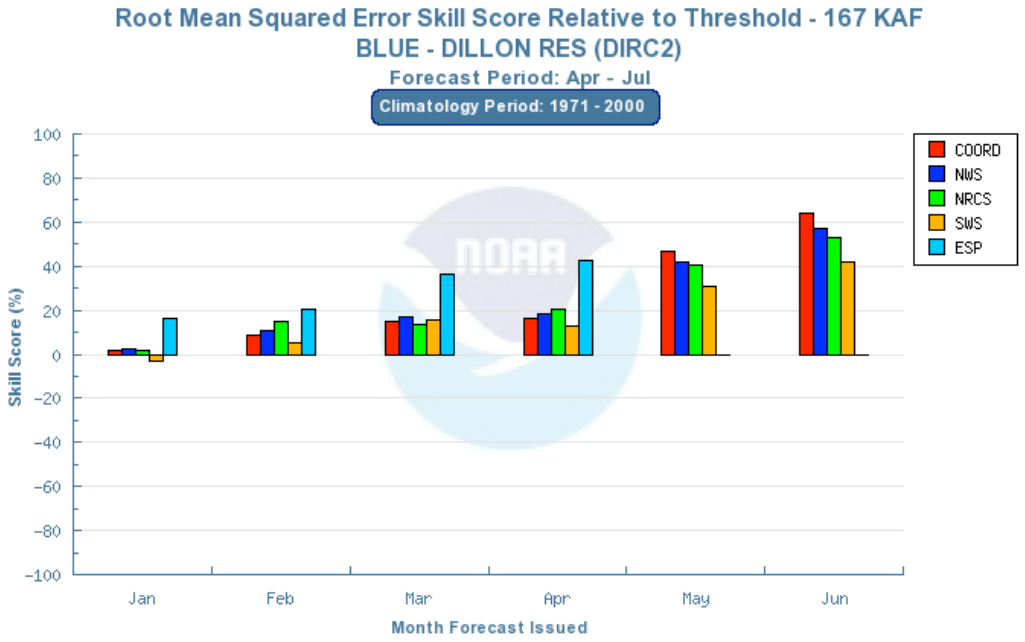

DIRC2 Streamflow-Climate Variability Relationship
Dec - Apr Nino 3.4 SST Anomaly (°C)
Apr - Jul Streamflow (kac-ft)
N=48 R^2=0.0180
Y=0.405-0.00253607x


DIRC2 Streamflow-Climate Variability Relationship
Dec - Apr PDO Index
Apr - Jul Streamflow (kac-ft)
N=48 R^2=0.0138
Y=-0.321+0.00211623x

Results that might be presented …

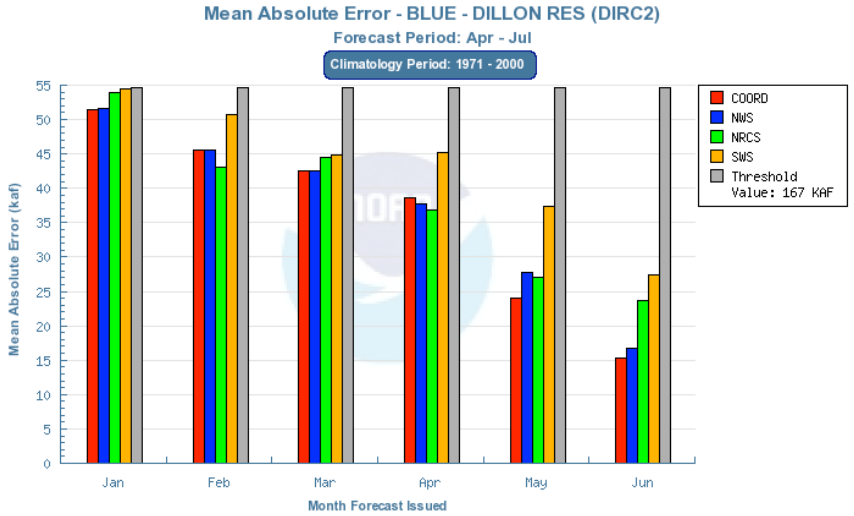
ESP is really, really good

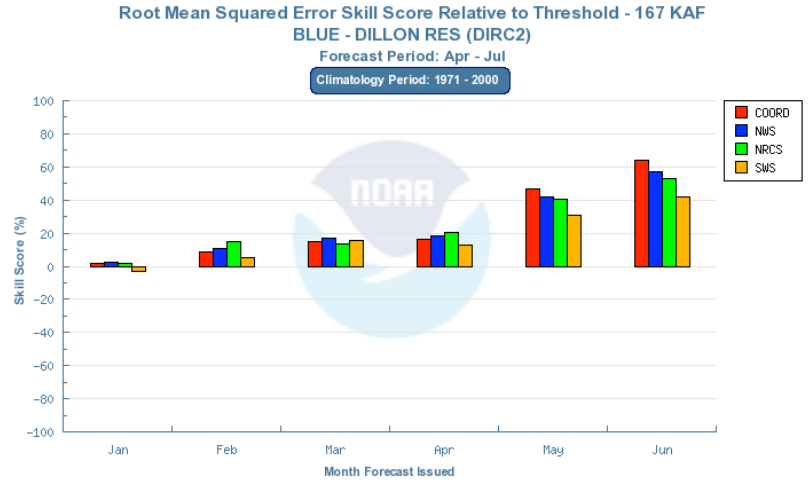
- ESP is much better than any other forecast method particularly in high years
- With “real” ESP as opposed to ESP reforecasts, results should be even better



Forecast Quality

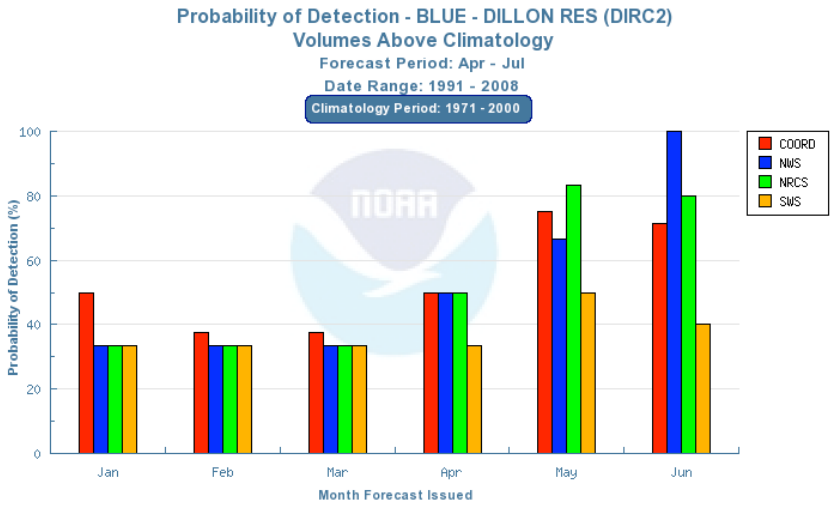
- January forecasts are essentially as good as climatology
- Coordination process appears to add (marginal) value except in April.
- Forecast tweaks much less than the error should not be entertained unless some overriding rational exists to support those tweaks.





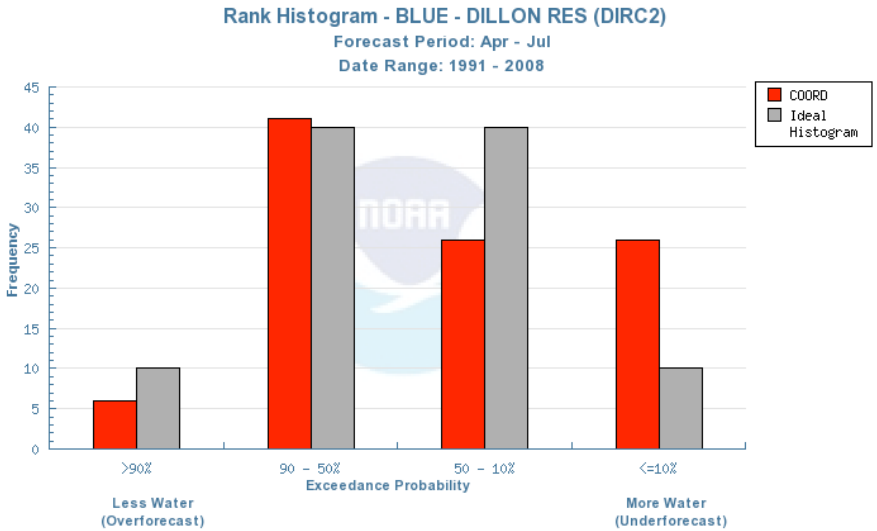
High flows hard
Low flows no so hard

- Forecast system is perfect (POD = 100% in all cases) for detecting below average flows.
- Forecasts struggle with detecting high flows even through May.



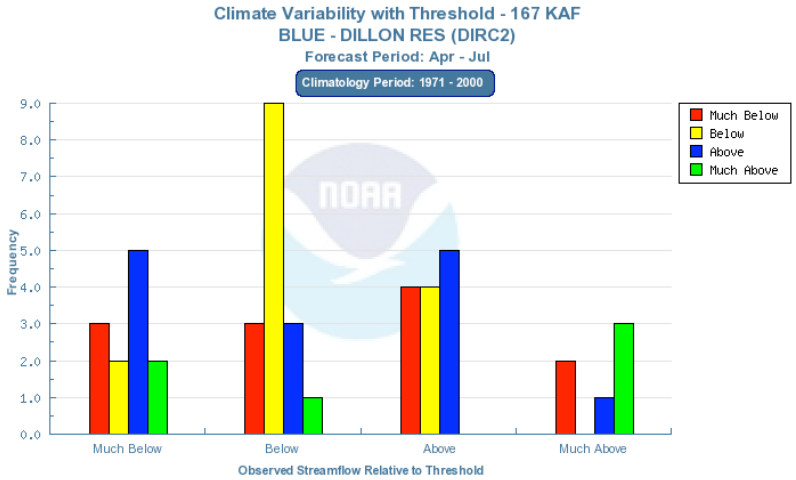
Reasonable max not so reasonable

- Observed streamflow greater than the reasonable max nearly 30% of the time.



Climate variability not much help

- Very low predictability based on prior year hydrology or climate index
- Weak tendency for low years to follow low years

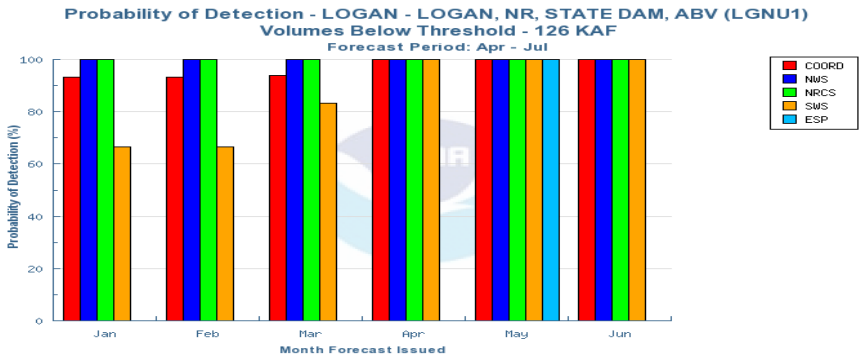


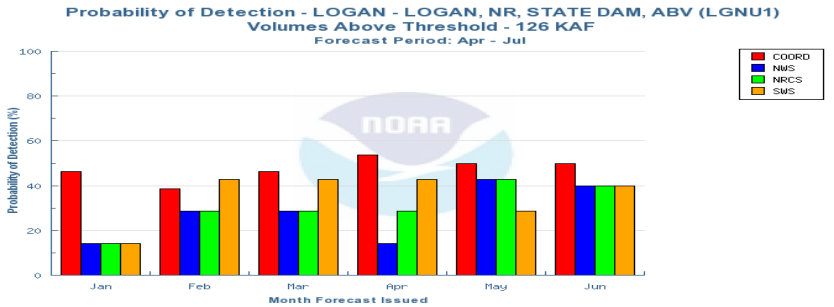
Possible Application (Discussion)

- April DIRC2 forecast is 150kAc-ft. Average error for April is 35kAc-ft. How could you use this information to:
  - Improve your forecast?
  - Improve your forecast process?
  - Improve forecast application?

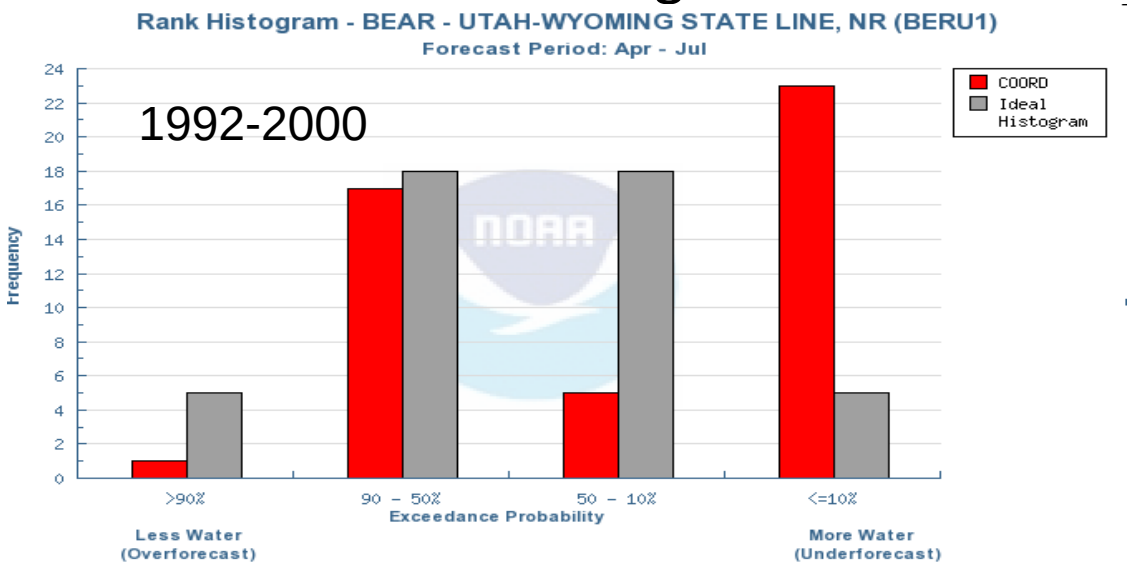
Great Basin Case Study credit: Brent Bernard

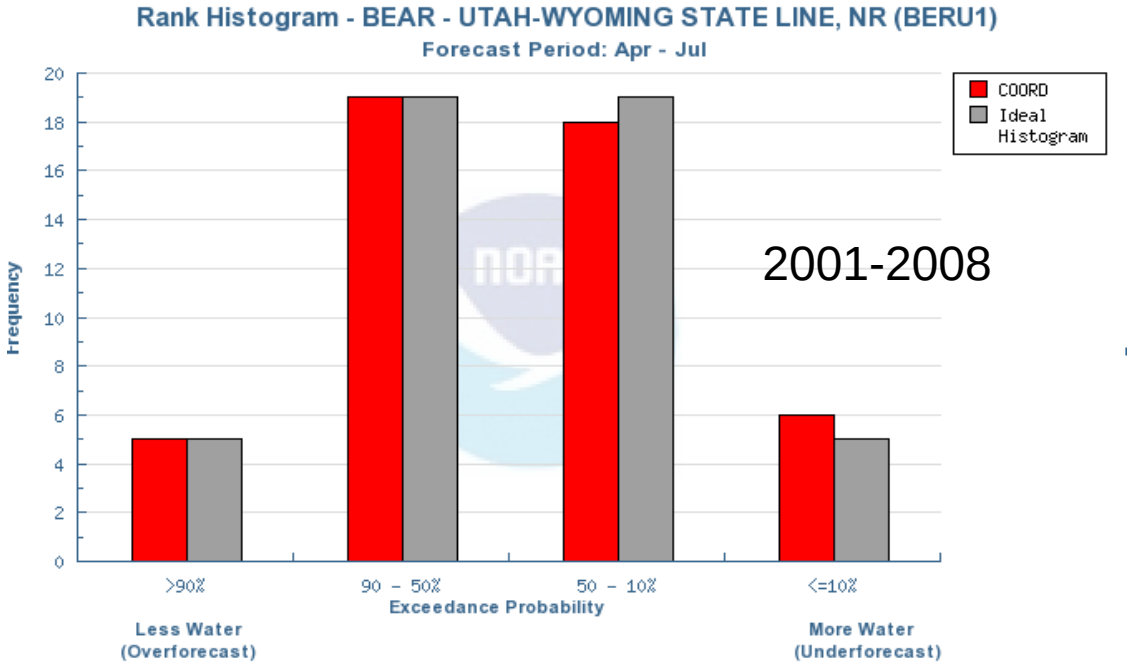
- Findings indicate we detect low flows better than high flows with current and often over forecast the 10% exceedance values.



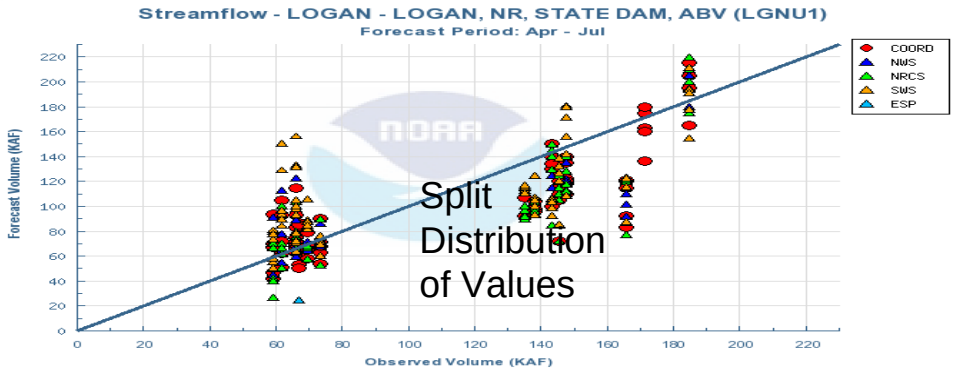


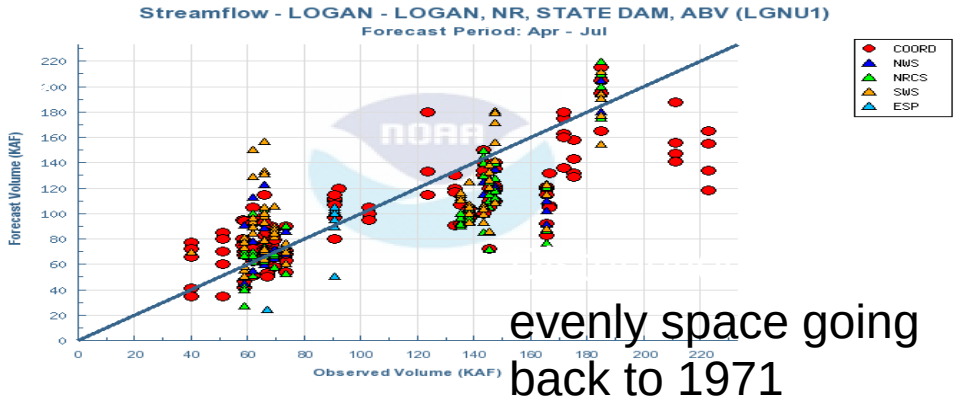
Bear River – Near Utah, Wyoming State Line
Rank Histogram





- That many of the data sets from 1991-2008 have a binary split indicating that more extremes have occurred in observed flow during the last 20 years.





evenly space going back to 1971