

# Key Verification Metrics and Graphics

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Water Resources Engineering and Consulting



# Verification Products

- Verification activity has value only if the information generated leads to a decision about the forecast/system being verified
  - User of the information must be identified
  - Purpose of the verification must be known in advance
- No single verification measure provides complete information about the quality of a forecast product
  - Different potential users => different levels of sophistication for verification metrics
- Need to normalize verification results to inter-compare across basins, RFCs etc.

Goal for FY09: for selected users, propose verification standards



# Verification Metrics

CATEGORIES	DETERMINISTIC METRICS	PROBABILISTIC METRICS
<b>1. Categorical</b> <i>(predefined threshold, range of values)</i>	<b>Probability Of Detection (POD),</b> <b>False Alarm Ratio (FAR),</b> <b>Probability of False Detection (POFD)</b> <b>Lead Time of Detection (LTD),</b> Critical Success Index (CSI), Pierce Skill Score (PSS), Gilbert Score (GS)	<b>Brier Score (BS),</b> <b>Rank Probability Score (RPS)</b>
<b>2. Error</b> <i>(accuracy)</i>	<b>Mean Absolute Error (MAE),</b> <b>Root Mean Square Error (RMSE),</b> <b>Mean Error (ME), Bias (%),</b> Linear Error in Probability Space (LEPS)	<b>Continuous Rank Probability Score (CRPS)</b>
<b>3. Correlation</b>	<b>Pearson Correlation Coefficient,</b> Ranked correlation coefficient, scatter plots	
<b>4. Distribution Properties</b>	Mean, variance, higher moments for forecasts/observations	<b>Talagrand Diagram (or Rank Histogram),</b> ensemble spread, Wilson Score (WS), variance of forecasts/observations



# Verification Metrics

CATEGORIES	DETERMINISTIC METRICS	PROBABILISTIC METRICS
<b>5. Skill Scores</b> <i>(relative accuracy over reference forecast)</i>	<b>Root Mean Squared Error Skill Score (SS-RMSE)</b> (with reference to persistence, climatology, lagged persistence), Linear Error in Probability Space Skill Score (SS-LEPS)	<b>Rank Probability Skill Score, Brier Skill Score</b> (with reference to persistence, climatology, lagged persistence)
<b>6. Conditional Statistics</b> <i>(based on occurrence of specific events)</i>	<b>Reliability measures, Relative Operating Characteristic (ROC), ROC Area, discrimination diagram</b> , other discrimination measures	<b>Reliability diagram, ROC and ROC Area, discrimination diagram</b> , other discrimination measures
<b>7. Confidence</b> <i>(metric uncertainty)</i>	<b>Sample size</b> , Confidence Interval (CI)	Ensemble size, <b>sample size</b> , Confidence Interval (CI)



# Verification Graphics

- IVP graphics
- EVS graphics
- WR Water Supply website graphics
- Other graphics: RFCs, academia...



# IVP Chart Capabilities

- ChartDirector wrapped inside a generic chart package
- Chart Director to generate a single plot with fixed labels/axes/position... by calling program
  - + ChartDirector is relatively fast, provides capabilities needed; already license with HydroGen
  - ChartDirector not truly object oriented; access ~ C programming
- Chart wrapper tool to interact with plot and change appearance/data via GUI
  - generic chart package: ~ crude (a few more weeks of coding to truly make it ready for operational use)
  - + gives user ability to modify chart components (e.g. labels, axes) via GUI, zoom in/out, display small navigation version of the chart (e.g. upper right corner of IVP scatter plot), and edit plotted data values

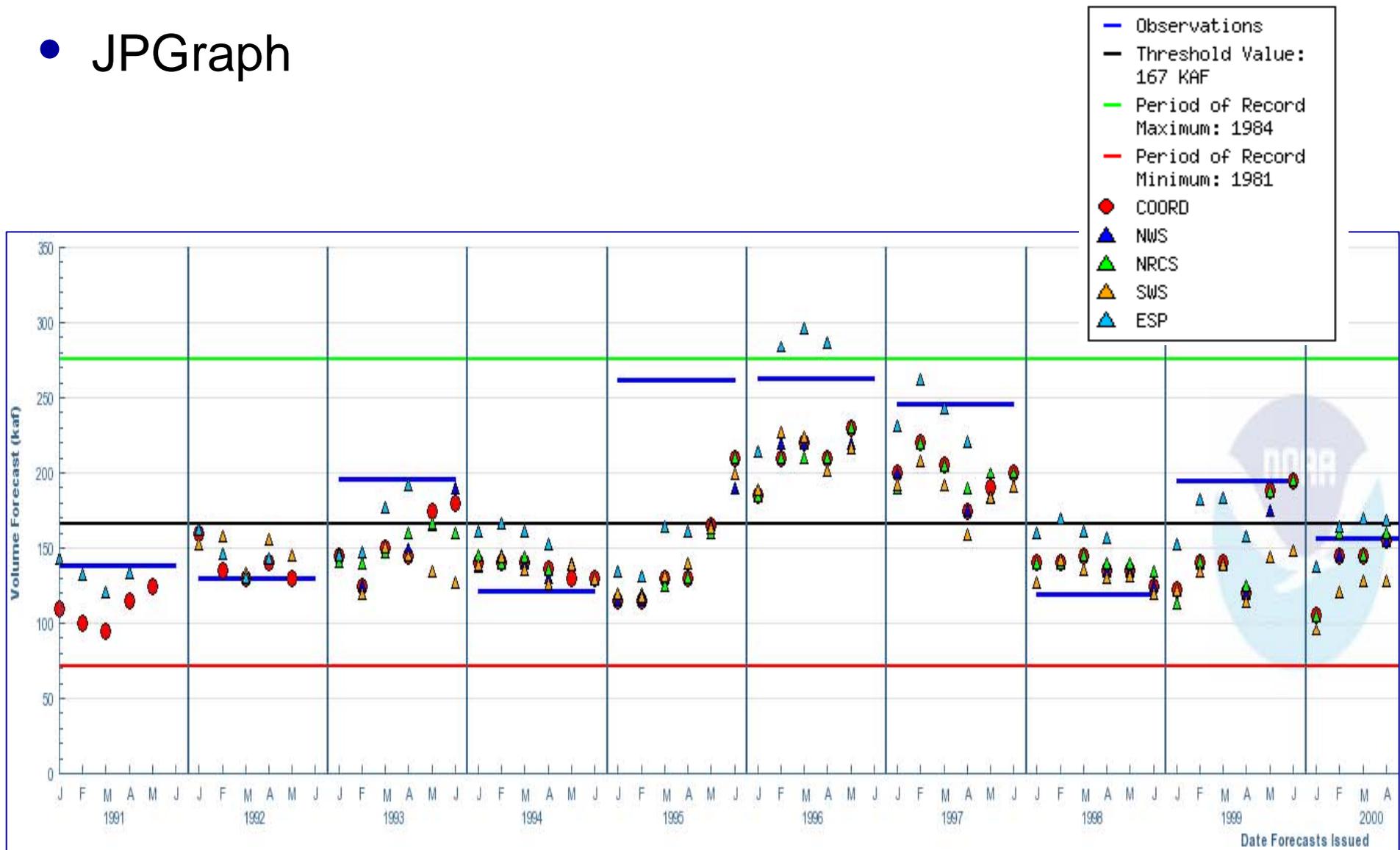


# EVS Chart Capabilities

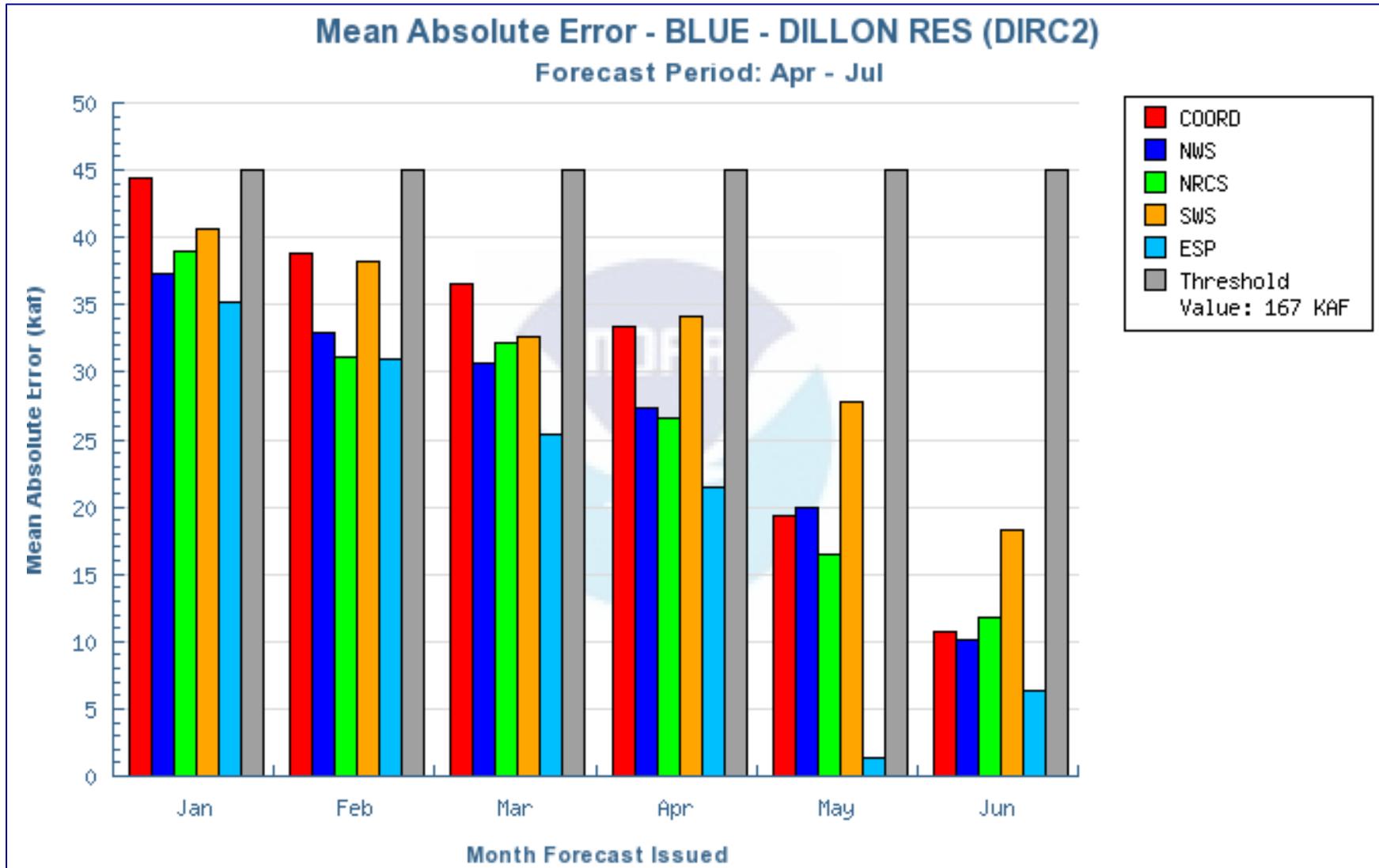
- JFreeChart ([www.jfree.org/\\*jfreechart\\*/](http://www.jfree.org/*jfreechart*/))
  - + Free and easy to adapt for a specific purpose (open source)
  - + Well structured (object-oriented)
  - + Many chart types
  - Appears slow at plotting for some charts (although no formal comparison made with other tools)
  - Can only write charts in a few graphical formats
  - Quality of charts could be improved (e.g. not as sharp as Matlab or R)

# WR Website Chart Capabilities

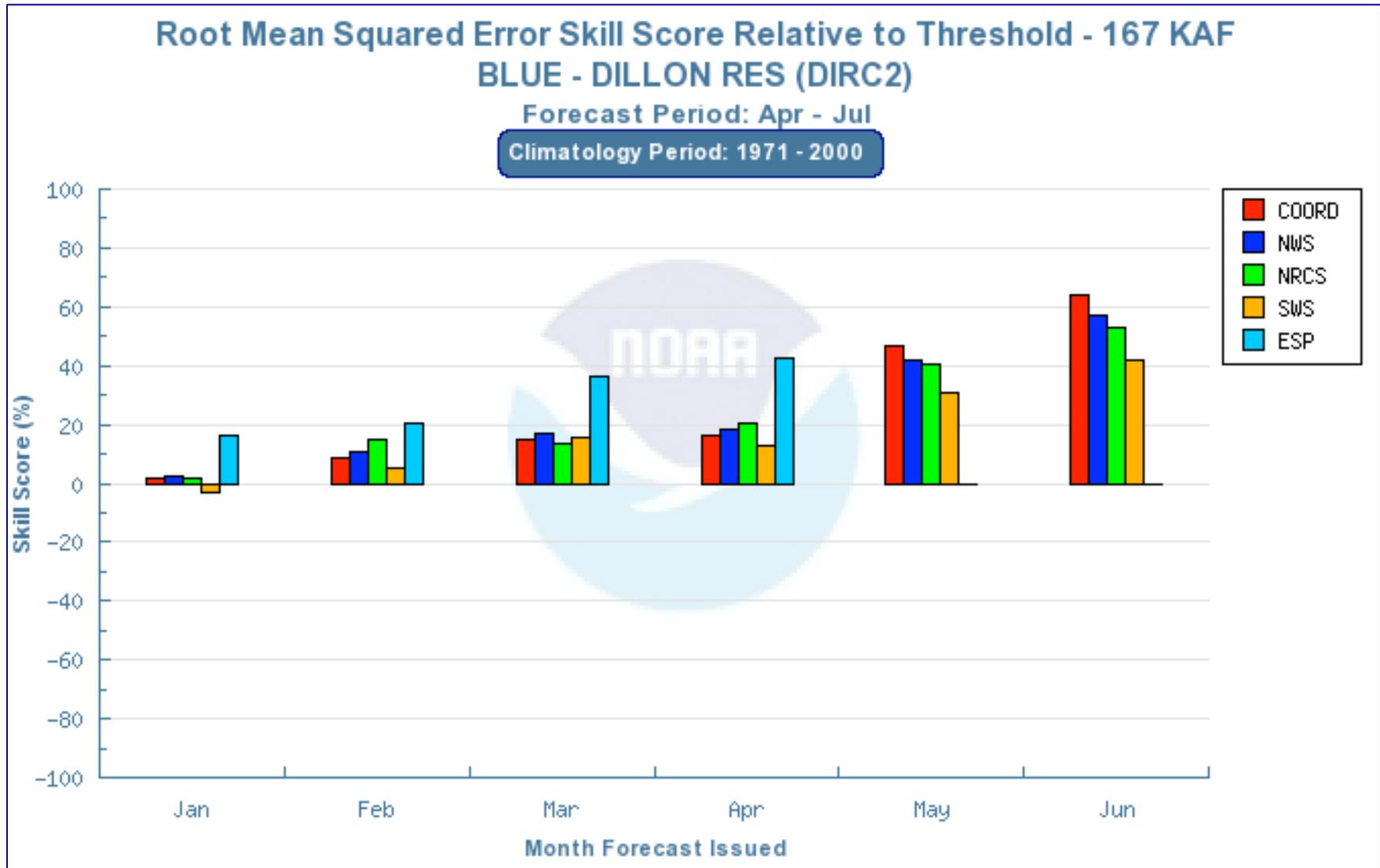
- JPGraph



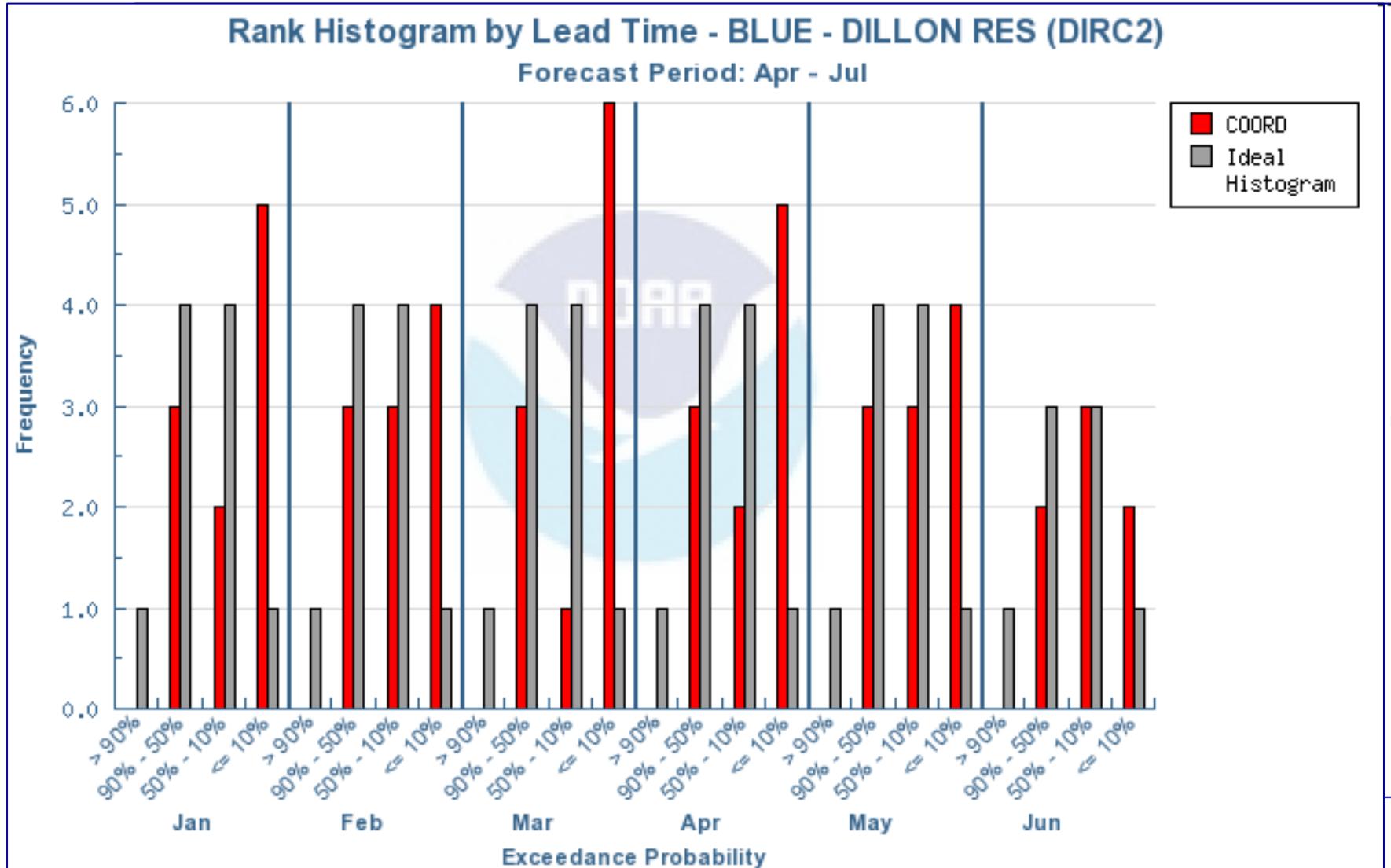
# WR Website Chart Capabilities



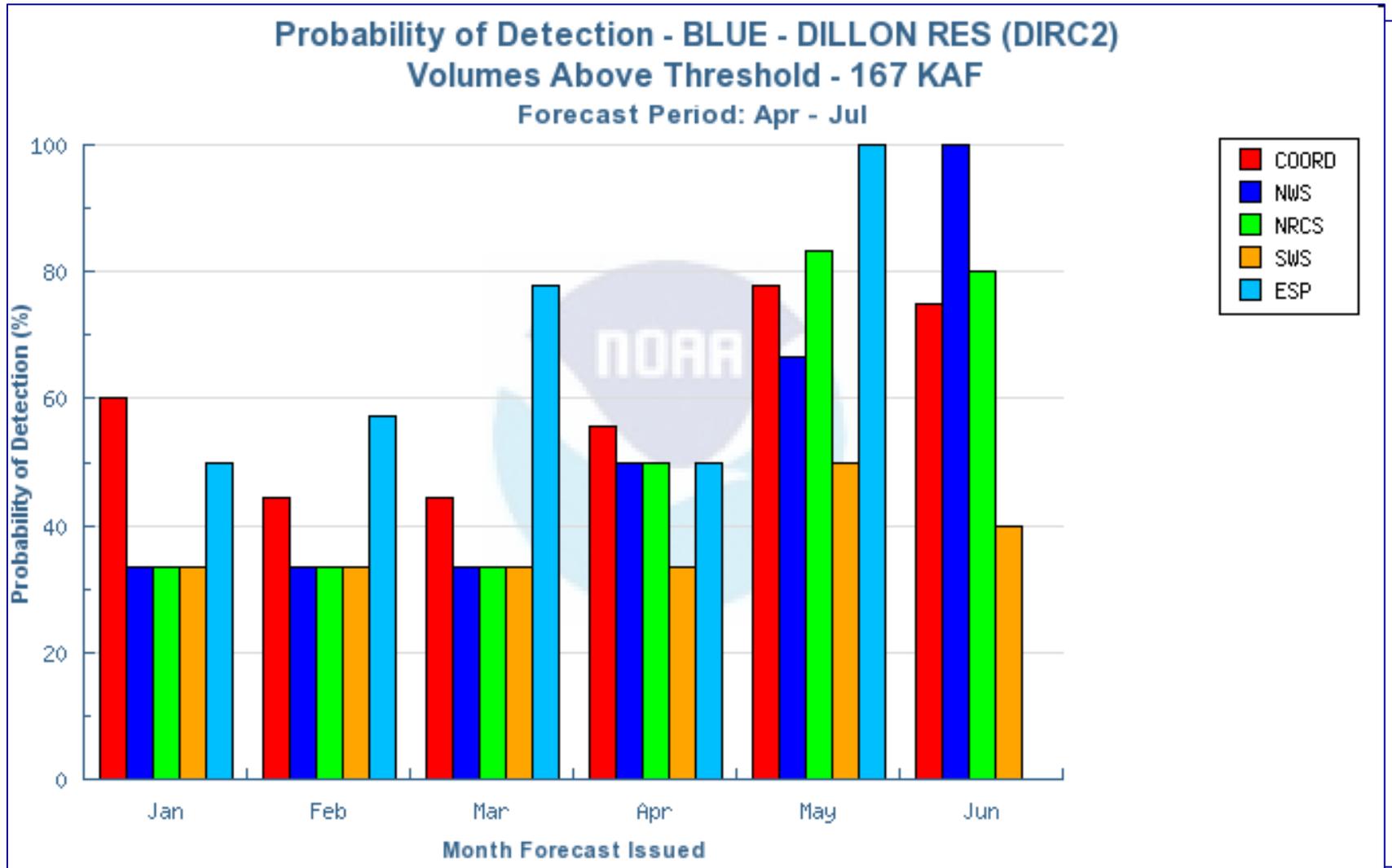
# WR Website Chart Capabilities



# WR Website Chart Capabilities

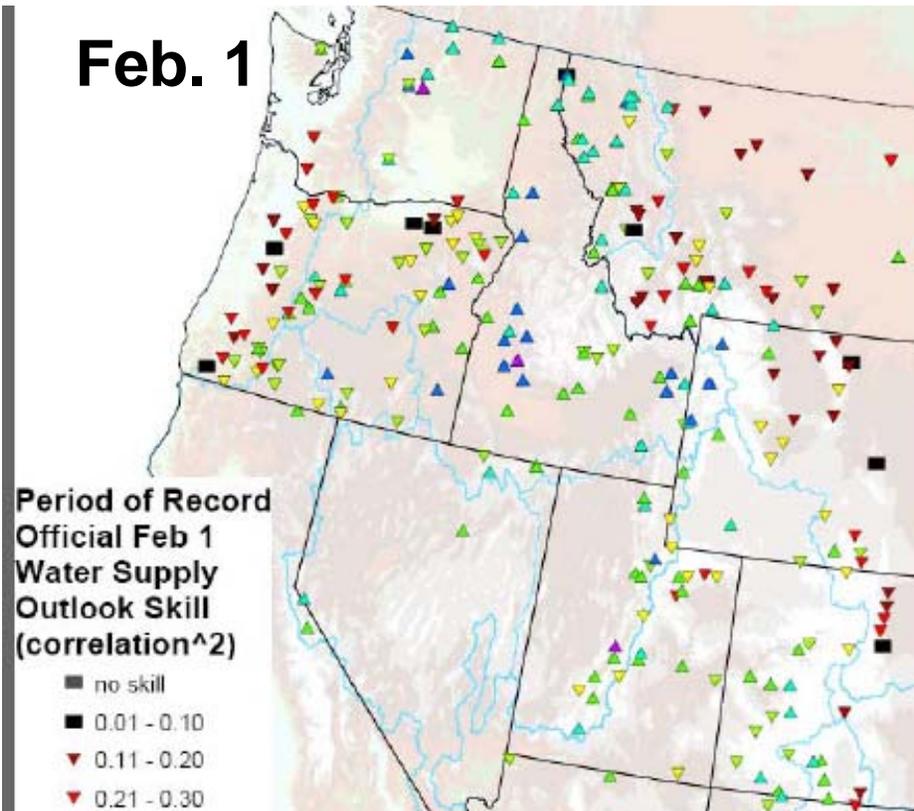


# WR Website Chart Capabilities

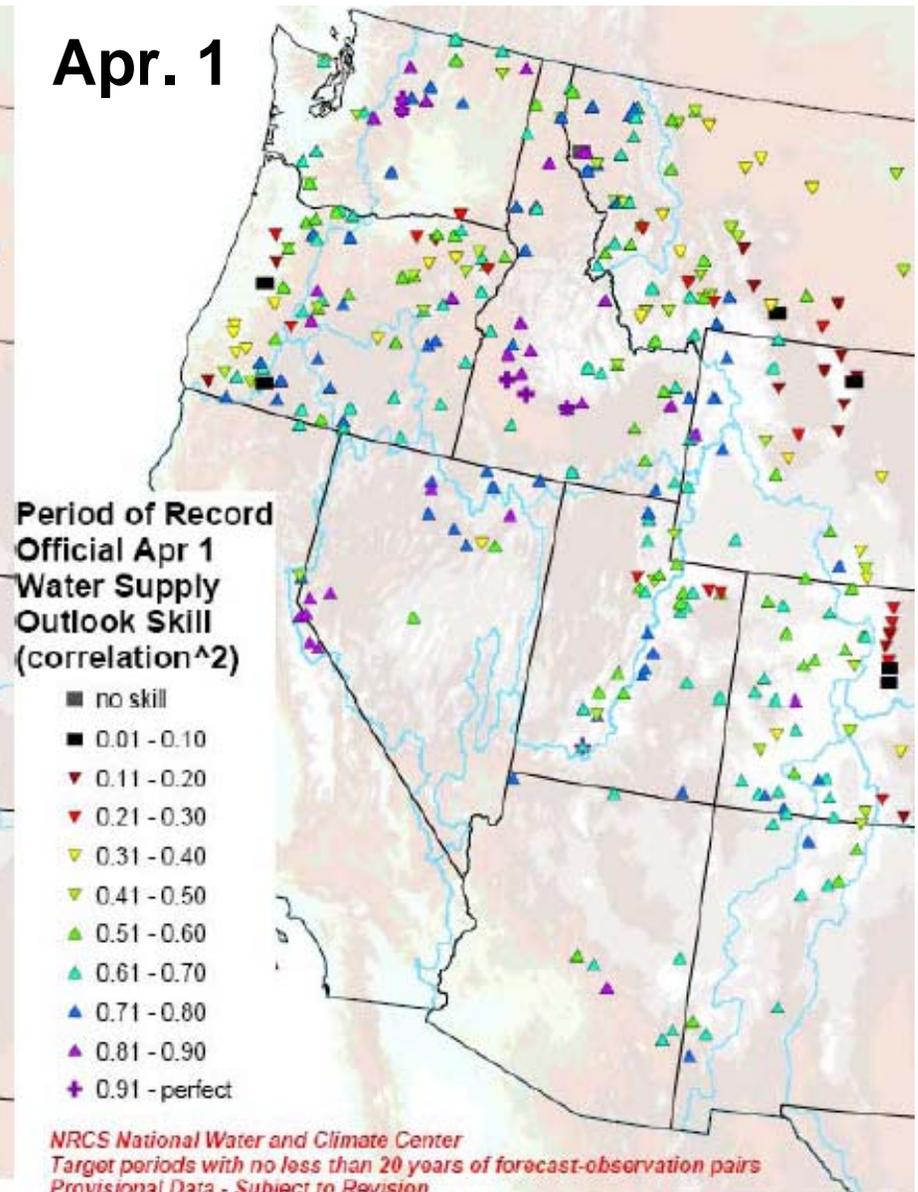


# NRCS (Tom Pagano) Capabilities

Feb. 1



Apr. 1



Basic patterns:  
 Snowmelt-dominated areas do best  
 Forecasts improve with lead time  
 Spring rainfall areas do poorly  
 Complex geology an issue  
 Unaccounted diversions a pain  
 Some places just a data mess

# GoogleMotionChart at OHRFC

- Google Gadget

<http://www.google.com/ig/directory?url=www.google.com/ig/modules/motionchart.xml>

- Derived from Gapminder <http://www.gapminder.org/>

Gapminder is a non-profit venture promoting sustainable global development and achievement of the United Nations Millennium Development Goals by increased use and understanding of statistics and other information about social, economic and environmental development at local, national and global levels.

- Presentation by Hans Rosling

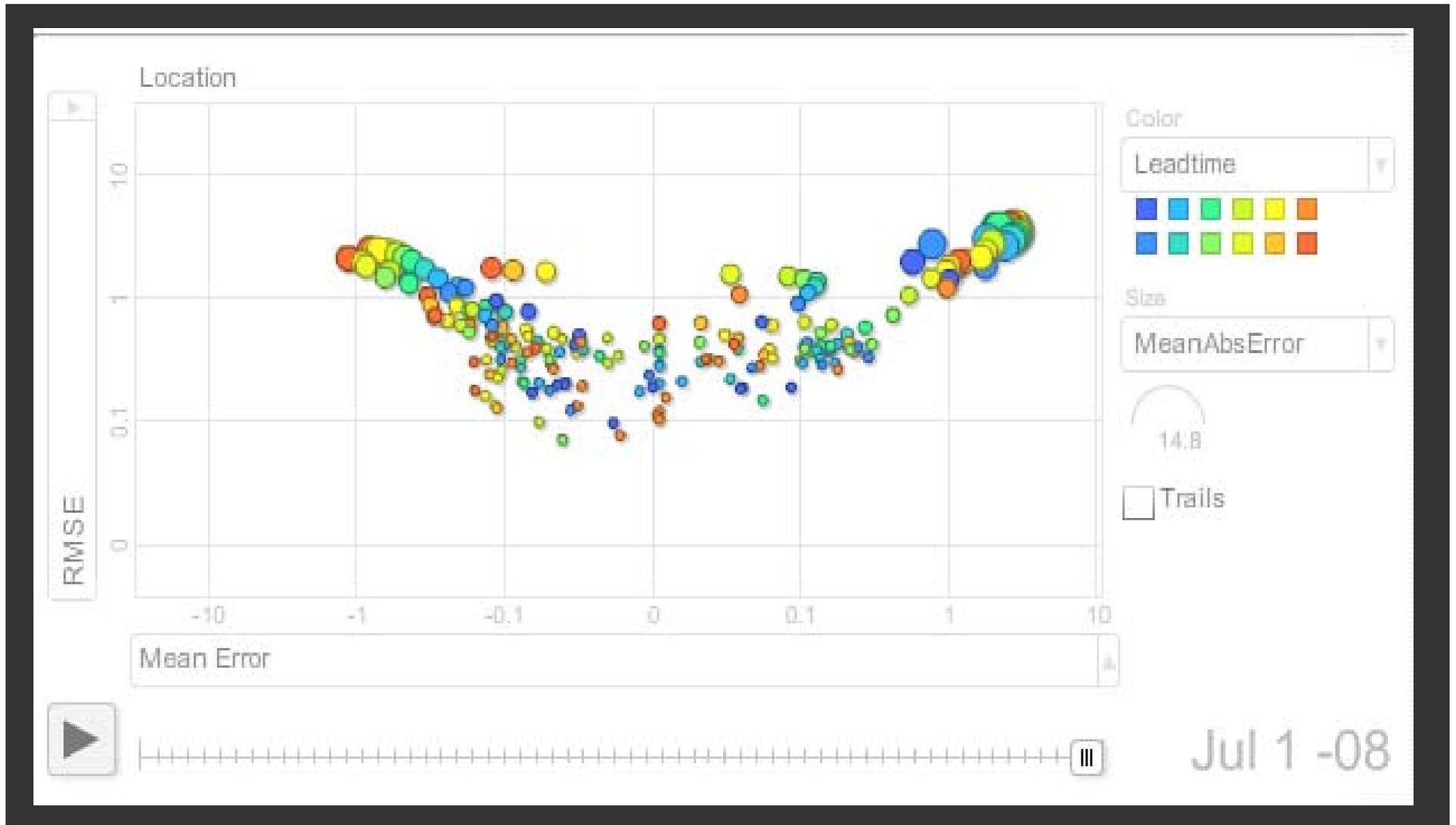
- *Myths about the developing world* —

- <http://video.google.com/videoplay?docid=4237353244338529080&sourceid=search>

- TED Lecture — <http://www.ted.com/>



# Example applied to OHRFC Verification Data



# OHRFC website

The screenshot shows a web browser window with the URL <http://www.erh.noaa.gov/ohrfc/bubbles.php>. The page header includes the NOAA logo and the text "National Weather Service Ohio River Forecast Center". A navigation bar contains "News", "Organization", and "Search". A sidebar on the left lists various services like "Local weather forecast by City, ST" and "Rivers & Hydrology". The main content area features a "Significant River Flood Outlook" and a text box stating "The graphic below is a new product as of August 2008". The central figure is a bubble plot with "Location" on the x-axis and "RMSE" on the y-axis. The plot shows a distribution of data points, with a color legend for "Leadtime" and a size legend for "MeanAbsError". A "Trails" checkbox is also present. The date "Jul 1 -08" is displayed at the bottom right of the plot area.

<http://www.erh.noaa.gov/ohrfc/bubbles.php>

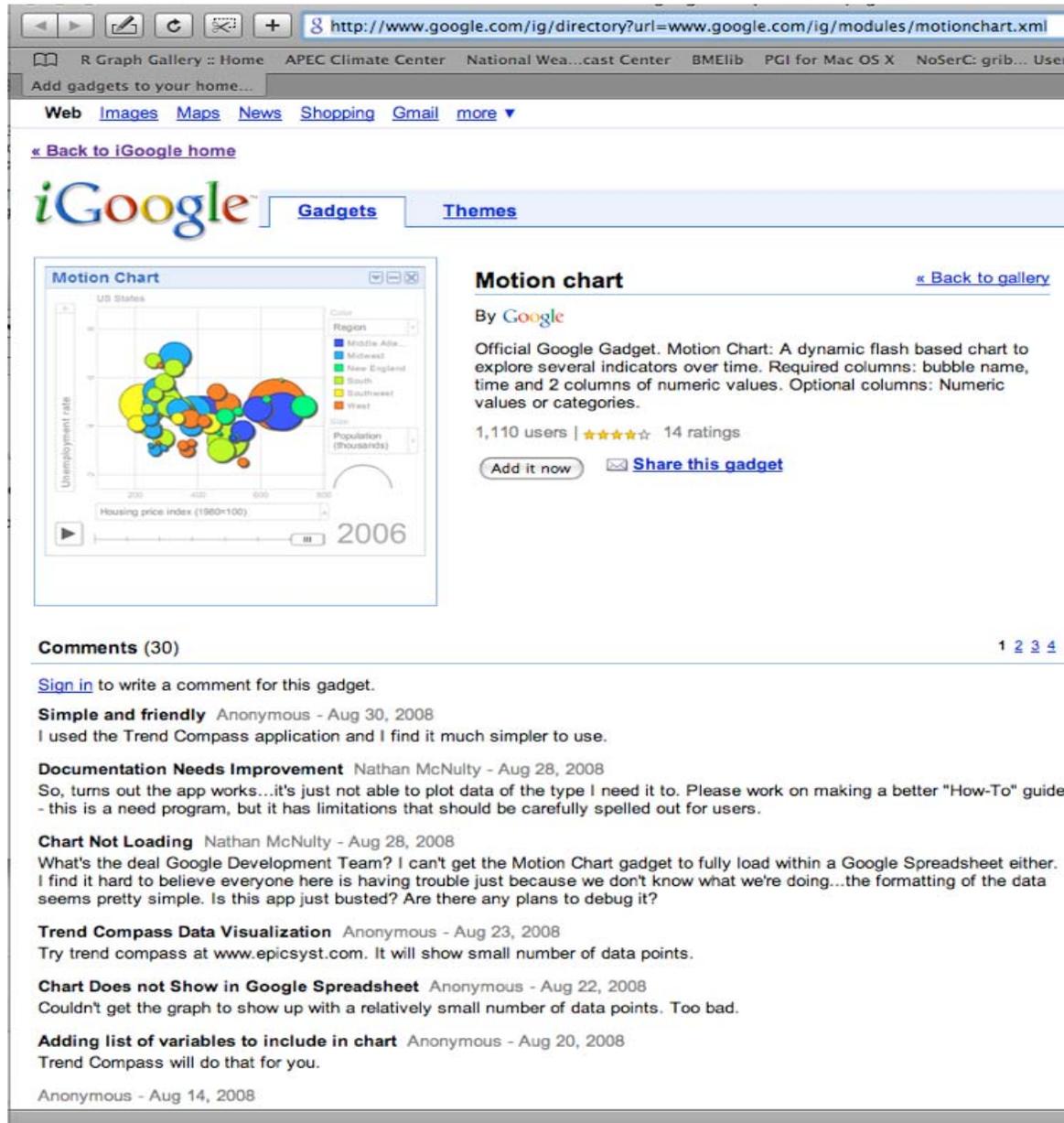


# What's needed?

- Used \*\_tab data from: /rfc\_arc/verify/output/oper/
- Include javascript from Google in OHRFC webpage
- write an awk script to reformat data into javascript code
- OHRFC webpage calls command to include javascript code
- Contact Mark Fenbers, at OHRFC



# What's needed?



[http://www.google.com/ig/directory?url=www.google.com/ig/modules/motionchart.xml](#)

[R Graph Gallery :: Home](#) [APEC Climate Center](#) [National Wea...cast Center](#) [BMElib](#) [PGI for Mac OS X](#) [NoSerC: grib... User](#)

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By **Google**

Official Google Gadget. Motion Chart: A dynamic flash based chart to explore several indicators over time. Required columns: bubble name, time and 2 columns of numeric values. Optional columns: Numeric values or categories.

1,110 users | ★★★★★ 14 ratings

[Add it now](#) [Share this gadget](#)

**Comments (30)** [1](#) [2](#) [3](#) [4](#)

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**Simple and friendly** Anonymous - Aug 30, 2008  
I used the Trend Compass application and I find it much simpler to use.

**Documentation Needs Improvement** Nathan McNulty - Aug 28, 2008  
So, turns out the app works...it's just not able to plot data of the type I need it to. Please work on making a better "How-To" guide - this is a need program, but it has limitations that should be carefully spelled out for users.

**Chart Not Loading** Nathan McNulty - Aug 28, 2008  
What's the deal Google Development Team? I can't get the Motion Chart gadget to fully load within a Google Spreadsheet either. I find it hard to believe everyone here is having trouble just because we don't know what we're doing...the formatting of the data seems pretty simple. Is this app just busted? Are there any plans to debug it?

**Trend Compass Data Visualization** Anonymous - Aug 23, 2008  
Try trend compass at [www.epicsyst.com](http://www.epicsyst.com). It will show small number of data points.

**Chart Does not Show in Google Spreadsheet** Anonymous - Aug 22, 2008  
Couldn't get the graph to show up with a relatively small number of data points. Too bad.

**Adding list of variables to include in chart** Anonymous - Aug 20, 2008  
Trend Compass will do that for you.

Anonymous - Aug 14, 2008



# What's needed?

