Advanced Hydrologic Prediction Service

Including an Introduction to Community Hydrologic Prediction System (CHPS)

Gregg Waller: Hydrologist
West Gulf River Forecast Center
Overview

- Introduction to NWS Hydrologic Services
- Background on Advanced Hydrologic Prediction Service (AHPS)
  - Ensemble Modeling
  - Probabilistic Forecasts
- Finally…introduce Community Hydrologic Prediction System (CHPS)
- But first…a little background…
Structure of the NWS

Department of Commerce

National Oceanic and Atmospheric Association

National Weather Service

Weather Forecast Offices (120+)
Flood Time Scales

- 1 – 12 hours
  - Flash Flood Guidance and Warnings

- 1 – 5 days
  - Deterministic forecasts
  - Warnings/Statements/Outlooks

- > 5 days
  - Probabilistic forecasts
  - Water Supply products
Deterministic Forecast Process

River Forecast Centers
- Precipitation data & forecasts
- River forecasts issued to WFOs

Weather Forecast Offices
- River forecasts ingested
- Public products/warnings issued

Precipitation estimates and forecasts merged into continuous dataset

Precipitation dataset ingested into hydrologic model
Advances in science to improve river forecasting

BACKGROUND ON AHPS
Goals of AHPS

- Provide emergency and water resource managers information …
  - To make informed risk-based decisions
  - To optimize the use of resources

- Better meet the hydrologic needs of the country …
  - Plan with confidence and efficiency
  - Stay out of harms way
  - Provide valuable water supply information

- Enable the NWS to increase forecast skill and warning lead time
Advanced Hydrologic Prediction Service

- State of the science forecasting
  - Short and long term probabilistic forecasts
  - Water supply forecasts
  - Inundation mapping

- Innovation at all timescales
  - Flash flood modeling
  - Distributed modeling
  - Ensemble modeling
Advantages of AHPS Probabilistic Products

- Longer lead times
- Range of potential flows
- Information on relative risk to water managers
- Contingency forecasts
  - Low/high flow scenarios
  - Worst case scenarios
Ensemble Modeling

- Ensemble Models
  - Produces long-term probabilistic forecasts
    - Utilizes historical precipitation inputs
    - Current soil moisture conditions
    - Creates simulations based on each year of historical precipitation (ensembles)
  - Performs statistical analysis

Probabilistic Forecasts

Ensemble Simulations
Ensemble Model Outputs - Conditional / Historical Simulations

- **Conditional simulation**
  - Sets the model to the current model states
  - Inputs one year of historical precipitation (i.e., 1960)
  - Creates model simulation
  - Repeat until all years of historical precipitation has been simulated

- **Historical simulation**
  - Sets the model to the current model states initially
  - Input entire historical precipitation time series
  - Model runs nonstop
  - The model is allowed to become “wetter” or “drier” than current conditions prior to the run interval simulated.
Conditional / Historical Simulations

Conditional Simulation

Historical Simulation
Conditional vs. Historical Simulations

Wet Conditions

Dry Conditions
Exceedance Probability Example

- This example is designed to help you understand how the 90 Day Exceedance Probability products are calculated.

- **Steps:**
  1. Extract *maximum flows* from the ESP traces for the forecast period.
  2. Sort maximum flows in descending order.
  3. Apply a rank for each flow value.
  4. Determine probability.
  5. Plot probability.
ESP Trace Ensemble of AUGUSTA 1WW
Latitude: 37.7  Longitude: 97.1
Forecast for the period 8/25/2004 12h - 11/24/2004 12h
This is a conditional simulation based on the current conditions as of 8/25/2004

Trace Start Date
6294 1965
1815 1967
4987 1968
758 1969
1410 1970
1678 1971
50 1972
13760 1973
1609 1974
# Exceedance Plotting

<table>
<thead>
<tr>
<th>Peak</th>
<th>Sorted Peak</th>
<th>Rank</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>1973</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>1967</td>
<td>1965</td>
<td>2</td>
<td>0.2</td>
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<tr>
<td>1968</td>
<td>1968</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>1969</td>
<td>1967</td>
<td>4</td>
<td>0.4</td>
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<tr>
<td>1970</td>
<td>1971</td>
<td>5</td>
<td>0.5</td>
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<tr>
<td>1971</td>
<td>1974</td>
<td>6</td>
<td>0.6</td>
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<tr>
<td>1972</td>
<td>1970</td>
<td>7</td>
<td>0.7</td>
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<tr>
<td>1973</td>
<td>1969</td>
<td>8</td>
<td>0.8</td>
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<tr>
<td>1974</td>
<td>1972</td>
<td>9</td>
<td>0.9</td>
</tr>
</tbody>
</table>

\[ m = \frac{m}{n+1} \]

\[ n = 9 \]
Exceedance Plotting

Flood Stage

1950 cfs

20%
Exceedance Example

Chances of Exceeding River Levels on the Trinity River nr Long Lake
Latitude: 31.7  Longitude: 95.8
This is a conditional simulation based on the current conditions as of 2/14/2007

- Major Flooding: Above 45.0 Feet.
- Moderate Flooding: 40.0-45.0 Feet.
- Minor Flooding: 35.0-40.0 Feet.

Maximum Stage (FT)

Regulated Flow
Flood Stage = 35.0 Feet

32.5 ft
39%
Weekly Exceedance Example

- This example is designed to help you understand how the Weekly Exceedance Probability products are calculated.

- **Steps:**
  1. Extract *maximum flows* from the ESP traces for each week throughout the forecast period.
  2. Sort maximum flows in descending order.
  3. Apply a rank for each flow value.
  4. Determine probability.
  5. Plot desired probability levels.
Weekly Interval Analysis

ESP Trace Ensemble of Trinity River nr Long Lake
Latitude:31.7  Longitude:95.8
Forecast for the period 2/14/2007 12h - 5/16/2007 6h
This is a conditional simulation based on the current conditions as of 2/14/2007

ESP Window

Trace Start Date
- 1954
- 1955
- 1956
- 1957
- 1958
- 1959
- 1960
- 1961
- 1962
- 1963
- 1964
- 1965
- 1966
- 1967
- 1968
- 1969
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2003
Weekly Exceedance Probabilities
90 Day Window

1 Week Chances of Exceeding River Levels on the Trinity River nr Long Lake
Latitude: 31.7  Longitude: 95.8
This is a conditional simulation based on the current conditions as of 2/14/2007

Exceedance Probability
- 10 – 25%
- 25 – 50%
- 50 – 75%
- 75 – 90%
- >= 90%

Weekly Maximum Stage (FT)
Regulated Flow
Flood Stage = 35.0 Feet
Flood Inundation Mapping

- Utilizes high resolution Digital Elevation Maps (DEM)
- Utilizes hydraulics modeling at numerous river cross sections
- Model output fed into Geographical Information System (GIS) for map display
Flood Inundation Mapping

- Map types
  - Predefined Levels
  - Flood Categories
  - Current Forecast

- Overlays
  - Street maps
  - Aerial photos

- Map Tools
  - Zoom
  - Mouse over for water depth
  - Export to multiple formats (including shapefiles)

- Current forecast zoomed to forecast point

Full map with aerial photo and predefined height displayed

Flood categories zoomed to nearby neighborhood
Who benefits from AHPS?

America Benefits

- Dam Operators
- Farmers/Irrigators
- Emergency Managers
- Municipal Water Suppliers
- Riverboat Pilots
- Recreationists
How can you get the river and rainfall information you need?

PUBLIC PRODUCTS AND SERVICES
AHPS on the Internet

- [http://www.nws.noaa.gov/ahps/](http://www.nws.noaa.gov/ahps/)
  - All encompassing
  - One-stop shopping

- Products/Services available
  - Deterministic River Forecasts
  - Probabilistic River Forecasts
  - Inundation Mapping
  - Precipitation Graphics
What is CHPS…?

COMMUNITY HYDROLOGIC PREDICTION SYSTEM
What is CHPS?

- CHPS is built on a modular operating platform, which builds on the Advanced Hydrologic Prediction Service (AHPS), and has the capability of infusing cutting edge hydrologic models and new technologies into the system.

- CHPS will allow for improved cooperation and coordination within NOAA, as well as with other federal, state, municipal, academic and private institutions.
CHPS

- The “C” in CHPS is an important distinction - use the “Community” to help meet the needs of our customers.
  - Better coordination among all water agencies
  - CHPS allows for the rapid transfer of collaborative research into NWS operations.
    - Models from the research community, other federal agencies (i.e. U.S. Army Corps of Engineers), and test beds within the National Weather Service can be quickly incorporated into the CHPS environment.

- This is a “quantum leap” in modeling technology for the National Weather Service.
CHPS

- It will be a two year process, with parallel operations of both systems (NWSRFS and CHPS) before switching over.
- WGRFC goal for CHPS – parallel operations by October 2010
- Some examples…
Display Concepts

Windows can be “undock”ed and can be repositioned anywhere.

Twin view is 2 (or more) monitors configured as a single screen allowing more visual real estate.
Display Concepts

Log messages tab: Contains all logging messages produced by runs or system. May be good idea to split type of messaging into different tabs

Forecast notes tab: Contains hand-over information from forecasters. This information can be edited in the tab.
CHPS System

Main Map Display
Time Series Display
Spatial (Multi-Sensor)
Forecast Topology “Mockup”
Time Series Display
State Modifier Display
Time Series Display (ESP)
Time Series Display

Probabilistic
Time Series Display
Longitudinal Data (Profiles)
Forecast Plots

Log messages tab:
Contains all logging messages produced by runs or system.
May be good idea to split type of messaging into different tabs

Forecast notes tab:
Contains hand-over information from forecasters. This information can be edited in the tab.
TS Modifiers “Mock-up”

A Mod only becomes available in the modifiers table and main window chart after rerun is pressed. This way the Mod is consistent with the forecast data. When editing in the main window, the mod is visible but only becomes persistent after rerun.

This value is fixed depending on Mod type selected.
Log Messages | Forecast Notes
--- | ---
06.08.2008 02:47:30 INFO - Datastore.NewCurrentRun: Taskrun MEHO3_Forecast (TID=2008-08-08 00:00, Dispatch=2008-08-08 00:47, Id=23_2) is made current automatically
06.08.2008 02:47:30 INFO - Workflow.ActivityCompleted: Workflow MEHO3_Forecast completed in 0 minutes and 1 seconds
06.08.2008 02:47:30 INFO - Completed Activity MEHO3_Natural_FlowToLevel_Forecast completed in 0 minutes and 0 seconds
06.08.2008 02:47:30 INFO - Started Activity MEHO3_Natural_FlowToLevel_Forecast
06.08.2008 02:47:30 INFO - Completed Activity Santiam_Calculate_MEHO3N_Forecast completed in 0 minutes and 0 seconds
06.08.2008 02:47:30 INFO - Started Activity Santiam_Calculate_MEHO3N_Forecast
06.08.2008 02:47:30 ERROR - Workflow MEHO3_Forecast failed because activity ROUTE_DETOSN_Forecast failed. (Plugin ROUTE_DETOSN_Forecast failed, message was: 'Tir Module/ConfigFiles/ROUTE_DETOSN_Forecast 1.00 default.xml')
06.08.2008 02:47:30 INFO - Started Activity ROUTE_DETOSN_Forecast
06.08.2008 02:47:30 INFO - Completed Activity MEHO3_FlowToLevel_Forecast completed in 0 minutes and 0 seconds
06.08.2008 02:47:30 INFO - Started Activity MEHO3_FlowToLevel_Forecast
06.08.2008 02:47:30 INFO - Completed Activity MEHO3_Calculate_EffectiveLocal_Forecast completed in 0 minutes and 0 seconds
06.08.2008 02:47:30 INFO - Started Activity MEHO3_Calculate_EffectiveLocal_Forecast
06.08.2008 02:47:30 INFO - Completed Activity YRMA_MEHO3_Forecast completed in 0 minutes and 0 seconds

<table>
<thead>
<tr>
<th>Time</th>
<th>Forecaster</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jun 08 2008 12</td>
<td>Paul</td>
<td></td>
</tr>
<tr>
<td>Jul 10 2008 12</td>
<td>Mike</td>
<td></td>
</tr>
</tbody>
</table>

Question:
- Should we allow images to be inserted here?
- Should we insert new messages to top of list or bottom? In any case new messages should be directly visible.
E-19 Info “Mock-up”

E19 view
Shows all available documentation for the selected forecast group. This view does not require any tool tabs.

All the document types will be opened in the view window with the use of embedded viewer components.
Other Features

- **E-19 Display Section**
  - “Canned” info, Intranet pages, etc.

- **Forecaster “Rules of Thumb”**

- **Crossplots**

- **Historic Event info**

- **And much more….**
Summary

- **NWS Hydrologic Services**
  - River Forecast Centers and Weather Forecast Offices working together

- **Advanced Hydrologic Prediction Service (AHPS)**
  - Science infusion to improve short and long term hydrologic forecasts

- **AHPS Products**
  - Provide partners and customers with information and forecasts to make informed decisions

- **CHPS – Community Hydrologic Prediction System**

**Questions or Comments?**