National River Forecast Verification Plan

System Requirements & Recommendations

Hydrologic Verification System Requirements Team

RFC Short-Term Ensemble Workshop, November 28, 2006

Overview

- Forecast Verification Needs
- Verification Team
- Description of Forecast Verification System
- Verification Projects and Activities
- Recommendations

Forecast Verification

- Needs:
  - In 1996 the NRC stated the verification of hydrologic forecasts are inadequate
  - As a result of the 2005 NOAA Audit Plan – "The Assistant Administrator for Weather Services should develop, document and implement a timeline and action plan for completing a comprehensive river forecast verification program as soon as practicable"
  - Report published by Board on Atmospheric Sciences and Climate in 2006: "Completing the Forecast, Characterizing and Communicating Uncertainty for Better Decisions Using Weather and Climate Forecasts"

Recommendation 6: NWS should expand verification of its uncertainty products and make this information easily available to all users in near real time

Forecast Verification

- Recommendation 6 from BASC Report

  NWS should expand verification of its uncertainty products and make this information easily available to all users in near real time

✓ A variety of verification measures and approaches
  => appropriately represent complexity and dimensionality of verification problem

✓ Verification statistics computed for subsets of forecasts (e.g., by season, region) and presented in formats understandable by forecast users

✓ Archived verification information on probabilistic forecasts (including forecasts and observations) accessible
  => users can produce their own forecast evaluation

Verification Team (Nov 05- Nov 06)

Team Charter

- **Vision:** Provide easy access to enhanced river forecast verification data which will be used to improve our scientific and operational techniques and services.

- **Mission:** Assess forecaster, program management and user needs for verification data. Inventory current national and regional verification practices and identify unmet needs. Establish requirements for a comprehensive national system to verify hydrologic forecasts and guidance products which satisfy these needs. This system should identify sources of error and skill in the forecasts across the entire forecast process.

- **Success Criteria/Deliverables:** Deliver a NWS river forecast verification plan which includes conceptualized solution and a definition of operational requirements

  => **final report delivered on 11/09/2006**

RFC River Forecast Verification System

- **Description**
  - Quantify quality of RFC forecasts and quality of forecast services
  - Monitor forecast quality over time
  - Monitor quality at various steps in the forecast process
  - Improve forecast quality
  - Assist prioritization of forecast system enhancements

- **Uses**
  - Operational
  - Experimental/Research

- **Customers**
  - Hydrologic forecasters
  - Scientists/Researchers
  - Hydrologic program managers
  - Emergency managers
  - Public

RFC River Forecast Verification System

- **Components**:
  - Logistical verification (quality of forecast services)
  - Deterministic verification (quality of deterministic forecasts)
  - Probabilistic verification (quality of ensemble and statistical forecasts)

- **Verification System Capabilities:**
  1. Data Archiving
  2. Computing Metrics
  3. Displaying Metrics
  4. Disseminating Metrics and Data
  5. Real Time Access to Metrics
  6. Error Analysis
  7. Performance Measure Tracking

Verification System Capabilities

1. **Data Archiving**
   - Time attributes (days, months, years, seasons)
   - Service attributes (national, regional, RFCs, forecaster, groups, locations)
   - Basin attributes (response time, size, slope, aspect, elevation)
   - Forecast or observed events (crest timing, raising and falling hydrographs)

Verification System Capabilities

2. Metrics

CATEGORIES	DETERMINISTIC FORECAST VERIFICATION METRICS	PROBABILISTIC FORECAST VERIFICATION METRICS
1. Categorical *(predefined threshold, range of values)*	**Probability Of Detection (POD),** **False Alarm Rate (FAR)**, **Lead Time of Detection (LTD)**, Critical Success Index (CSI), Pierce Skill Score (PSS), Gerrity Score (GS)	**Brier Score (BS),** **Rank Probability Score (RPS)**
2. Error *(accuracy)*	**Root Mean Square Error (RMSE),** **Mean Absolute Error (MAE),** **Mean Error (ME), Bias (%)**, Linear Error in Probability Space (LEPS)	Continuous RPS
3. Correlation	**Pearson Correlation Coefficient**, Ranked correlation coefficient, scatter plots	
4. Distribution Properties	Mean, variance, higher moments for observation and forecasts	Wilcoxon rank sum test, variance of forecasts, variance of observations, ensemble spread, Talagrand Diagram (or Rank Histogram)

Verification System Capabilities

2. Metrics

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

Verification System Capabilities

3. **Displaying Metrics:** examine metrics with graphics and reports
4. **Disseminating Metrics and Data:** understand quality & usefulness of forecasts and for collaborative verification analysis
5. **Real Time Access to Metrics:** understand errors in recent forecasts and over long term
6. **Error Analysis:** identify error sources by analyzing both inputs and outputs (including hindcast experiments)
7. **Performance Measure Tracking:** show level of success of RFC forecasting

HOSIP Verification Projects

- **Logistical Hydrologic Verification Measures**
  - G1 & G2 approved
- **Hydrologic Deterministic Verification**
  - G1, G2, & G3 approved; next phase of G3 to be scheduled
- **Hydrologic Ensemble Hindcaster**
  - G1 & G2 approved; G3 to be scheduled
- **Hydrologic Ensemble Verification and Validation**
  - G1 & G2 approved; G3 to be scheduled

Verification Activities: FY06 Status

	Logistical	Deterministic	Ensemble	Grid
Data Archiving	Started (point forecasts)	RAX	RAX	n/a
Computing Metrics	n/a	IVP (stage data)	EVS (14 lead days)	n/a
Displaying Metrics	n/a	IVP GUI	EVS UI	n/a
Disseminating Metrics & Data	n/a	National Verification Program	n/a	n/a
Real Time Access	n/a	n/a	n/a	n/a
Error Analysis	n/a	Limited (QPF, raw model)	EVS, Hindcaster	n/a
Performance Tracking	n/a	n/a	n/a	n/a
AHPS funding	$0K	$160K	$196K	$0K

Verification Activities: FY07 Plan

Tasks	FY07 Proposal
Ensemble Verification:	
➢Add metrics (and CI), enhance display capabilities in EVS, release and support EVS prototype	$100K (Q4)
➢Develop error analysis, enhance, release and support ensemble hindcaster prototype	$90K (Q4)
➢Evaluate existing archiving capabilities	$20K (Q3)
Deterministic Verification:	
➢Add metrics (and CI), enhance display capabilities in IVP, release and support IVP GUI for AWIPS ob7.2	$90K (Q3)
➢Develop error analysis, develop prototype for “raw model“ forecasts, develop deterministic hindcaster prototype	$90K (Q4)
➢Define data requirements and hardware for verification and hindcaster	$20K (Q3)
Logistical Verification:	
➢Develop archive plan for logistical measures	$10K (Q3)
➢Develop prototype to compute logistical measures	$20K (Q4)

Recommendations

- Establish:
  - 1 verification focal point at each RFC
  - 1 verification program manager at OHD
  - National team for archiving procedures to support verification system
- Coordinate verification activities with RFCs, contractors, academia:
  - it includes analyzing national hydrologic verification data and producing unbiased verification measures to identify needed areas of improvements in forecast process
- Define national river forecast performance goals
- Develop and deliver verification training
- Publish verification findings
- Participate in verification policy decisions
- Ensure verification of all elements (elements outside of RFC forecaster control, data produced by other agencies)

Thank you