A Framework for Automated Forecast Verification and Dissemination of Performance Information

Paul Hamer[1], Melissa Petty[1], and Jennifer Mahoney
NOAA Research – Earth System Research Lab, Boulder, CO

[1]Cooperative Institute for Research in the Atmosphere (CIRA), Ft. Collins, CO

Sponsors: FAA AWRP, ESRL GSD, NWS NextGen, NWS ASB

Framework Requirements

- An extensible, scalable framework to support verification in various roles:
  - Assessments of forecast quality
  - Baseline monitoring
  - Near-real-time verification services in decision support
- The capability to integrate verification information into NextGen processes using NNEW standards for discovery and dissemination
- Flexible configuration using open source tools when possible

Framework decomposition

The forecast verification framework has been decomposed into three primary areas, or layers, of responsibility consistent with the general verification problem:

Production
Production of intermediate verification results

- Raw data ingest and management
- Event-driven processing
- Pluggable verification components

Integration
Management of intermediate verification data

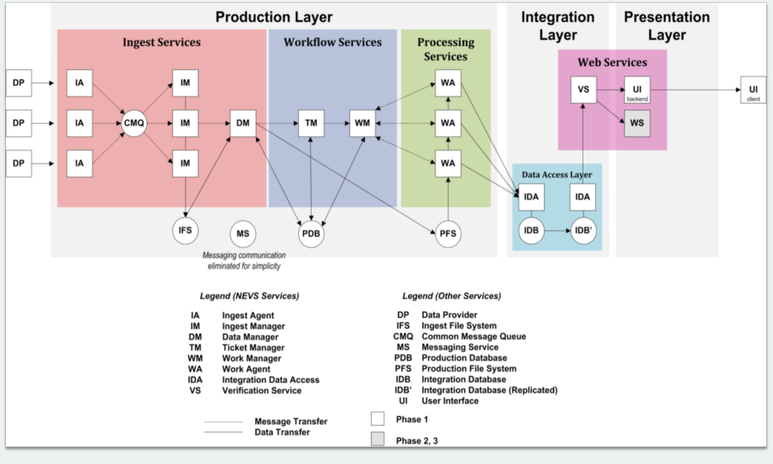
- Storage of verification data and associated metadata
- Services for data insertion and retrieval

Presentation
Utilities to support data analysis

- Data querying capabilities
- Summarization via statistical measures
- Plotting capabilities
- Data dissemination

Framework Detail

The figure below provides further detail on the decomposition of the three primary layers. A messaging system will be used for communication between components. Individual "Agents" serve as workers within the components and can be scaled as needed.



Open Source Technologies

- Fuse Source Enterprise Service Bus, to align with NextGen Technologies, such as:
  - ActiveMQ messaging to support communication within and across layers in the framework
  - Apache Camel framework to support the use of Enterprise Integration Patterns
- Open source RDBMS (PostgreSQL and MySQL) for the Intermediate Data Store and Process Message Persistence

Verification as a Service

A goal of the framework development is to work towards the concept of verification as a service for use within NextGen and elsewhere.

It was decided to try and develop a web service that could be used in the same fashion as other weather data, providing services to support applications that incorporate verification.

Currently, using the 'describe' and 'get' calls to the service returns data as JavaScript Object Notation (JSON) that can easily be handled by a browser client or other software. It is hoped to continue development toward a standard verification service that maps to Open Geospatial Consortium web services that are in use by the NWS and FAA.

***Describe* Parameters to Retrieve Dichotomous Stats**

http://.../vrmc.turbulence.servlet/nevs/question/0.0/describe


```
{
  "questionMetadata": {
    "synopsis": {
      "name": "verification_service.0-
gtg2_5_pireps_grouped_fo_pairs_pdt_thresholds_mean_dichotomous_stats",
      "description": "Grouped mean dichotomous stats from pairs of GTG 2.5 verified against
Pireps using PDT thresholds.",
      "id": "000000000.000000000"
    },
    "properties": {
      "granularity": "foPairs",
      "productDomain": "turbulence"
    }
  },
  "questionParameterization": {
    "parameters": [
      {
        "start": "2010-12-01",
        "end": "2011-03-31",
        "name": "date",
        "selection": "RANGE",
        "type": "Date"
      },
      {
        "valuesAsStrings": [
          "High",
          "Middle",
          "Low"
        ],
        "name": "layer",
        "selection": "SINGLE_OR_ALL",
        "type": "String"
      },
      {
        "valuesAsStrings": [
          "West",
          "Central",
          "East",
          "Other"
        ],
        "name": "region",
        "selection": "SINGLE_OR_ALL",
        "type": "String"
      },
      {
        "valuesAsStrings": [
          "00:00:00",
          "01:00:00",
          "02:00:00",
          ...
          "22:00:00",
          "23:00:00"
        ],
```


***Get* Dichotomous Stats Data**

http://.../vrmc.turbulence.servlet/nevs/question/0.0/get?region=all&issue=all&layer=all&lead=all&date={start:'20101201',end:'20110331'}&severity=Mod/Mod&groupByParameter=region&metric=PODy


```
{
  "name": "Unnamed",
  "columns": [
    {
      "name": "region",
      "type": "String",
      "values": [
        "West",
        "Central",
        "East",
        "Other"
      ]
    },
    {
      "name": "yy",
      "type": "Long",
      "values": [
        75155,
        48619,
        44197,
        5608
      ]
    },
    {
      "name": "yn",
      "type": "Long",
      "values": [
        60288,
        42016,
        37764,
        12141
      ]
    },
    {
      "name": "ny",
      "type": "Long",
      "values": [
        44952,
        50171,
        27867,
        5589
      ]
    },
    {
```


Verification, Requirements, and Monitoring Capability

The VRMC deployment supports assessments of new forecast products and continued monitoring of product performance after the assessment has been completed.

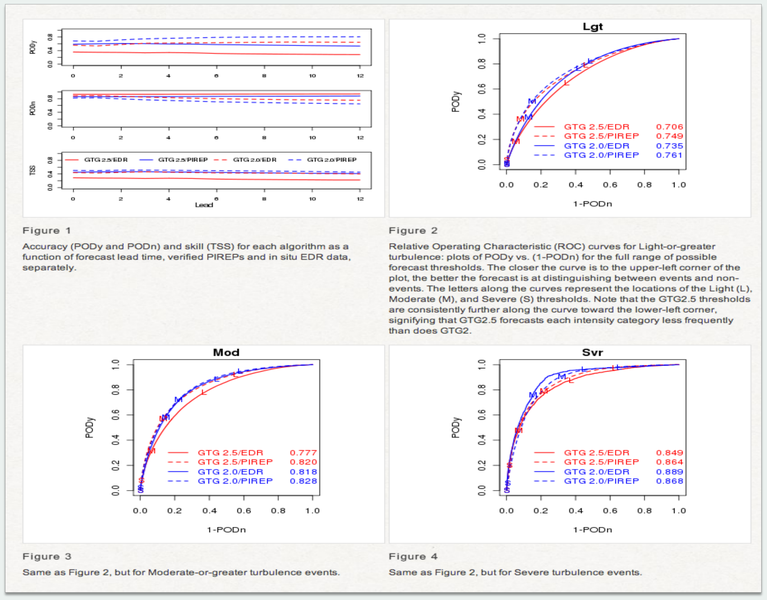


Figure 1
Accuracy (PODy and PODn) and skill (TSS) for each algorithm as a function of forecast lead time, verified PIREPs and in situ EDR data, separately.

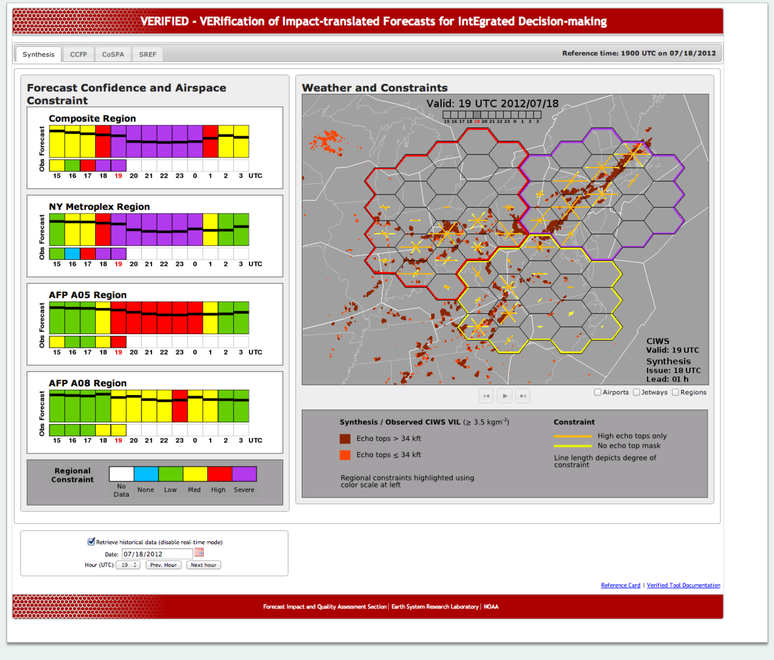
Figure 2
Relative Operating Characteristic (ROC) curves for Light-or-greater turbulence: plots of PODy vs. (1-PODn) for the full range of possible forecast thresholds. The closer the curve is to the upper-left corner of the plot, the better the forecast is at distinguishing between events and non-events. The letters along the curves represent the locations of the Light (L), Moderate (M), and Severe (S) thresholds. Note that the GTG2.5 thresholds are consistently further along the curve toward the lower-left corner, signifying that GTG2.5 forecasts each intensity category less frequently than does GTG2.

Figure 3
Same as Figure 2, but for Moderate-or-greater turbulence events.

Figure 4
Same as Figure 2, but for Severe turbulence events.

VERification of Impact-translated Forecasts for IntEgrated Decision-making (VERIFIED)

The VERIFIED deployment is targeted toward decision support, providing translated weather, measures of constraint and associated confidence, and near-real-time verification.



More Information

For links to other projects and additional information, see the FIQAS homepage: http://esrl.noaa.gov/fiqas/