A Case Study of the Research-to-Operations (R20) Process at HMT-WPC

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HMT-WPC: What do we do?

Accelerate the transfer of scientific and technological innovations into operations to enhance WPC products and services.
R20: How it works

Three-step transition process

1. Development and testing of new datasets, models and techniques
   » Real-time/retrospective forecasting experiments
2. Subjective and objective evaluation
3. Operational training and implementation

Experiments:
Test new models, guidance, tools, products in (pseudo) real time, with real forecasters, in a real operational meteorology setting
I) The Issue: Improve Numerical Model Snowfall Guidance

• Numerical model prediction of snowfall is still an “inexact” science that suffers from several issues:
  – The precipitation-type (p-type) conundrum
    • Instantaneous P-type
  – The snow-to-liquid ratio (SLR) conundrum
    • Snowfall = QPF x SLR
    • How do we get the SLR right?
  – The snowfall vs. snow accumulation conundrum

• Collaboration with EMC/NAM
  – Mike Bodner (HMT-WPC) and Brad Ferrier (EMC)
NAM Rime Factor-Modified Snowfall Accumulation

- **Roebber snowfall (SLR) technique**

- **Modifies Roebber SLR by considering the percentage of frozen precipitation and the rime factor**
  - Percent Frozen QPF (*instantaneous*) – percent of precipitation reaching the ground that is frozen
  - Rime Factor (*instantaneous*) – indicates amount of growth of ice particles by riming and liquid water accretion

  - $1 < RF < \sim 2$: no change to Roebber SLR
  - $\sim 2 < RF < \sim 5$: Roebber SLR reduced by factor of 2
  - $\sim 5 < RF < \sim 20$: Roebber SLR reduced by factor of 4
  - $RF > \sim 20$: Roebber SLR reduced by factor of 6

- **Evaluated during the 2013 Winter Weather Experiment**
  - Probability of exceedance forecasts (e.g. 2”, 4”, 8”)
  - Decision support

Courtesy of Brad Ferrier (EMC) and Faye Barthold
NAM Roebber 24 hour Snowfall
Valid 00Z Jan 18, 2013
NAM Filter Rime Factor
Valid 21Z Jan 17, 2013

(fluffy snow)

(graupe)

(rimed snow)

(fluffy snow)

Courtesy of Brad Ferrier (EMC)
NAM Rime-Factor 24 hour Snowfall
Valid 00Z Jan 18, 2013
Verification: An Example

...in areas of north central North Carolina where the high rime factor/low fraction of frozen precip the latter half of the forecast and short duration of high percent frozen suggest lower amounts will fall.”
A Penny for Your Thoughts?

How accurate was your forecast?

Did the experimental guidance provide any benefit?

Impressions? Feedback? How can we improve it?

2013 WWE Guidance Impressions

Rime Factor Filter

6. What is your overall impression of the rime factor-based snowfall accumulation algorithm? Do you think this concept is an improvement over the current SLR methods? Do you have any suggestions for refining the technique?
WWE Results, and What Now?

- Overall favorable reception
  - Rime factor, Percent frozen precip, SLR modification
  - Helps identify areas where precipitation-type could be a concern

- Main drawbacks:
  - Only applied to the NAM (and its QPF)
  - Resolution differences made comparison to standard NAM Roebber snowfall difficult

- Going forward:
  - Expanding to all forecast cycles (only available at 00Z)
  - Implementation on 32km grid? (currently produced at 12 km)
  - Apply it to SREF or GFS?
  - Combine snowfall forecast with land use parameterization → potentially improve accumulation forecasts(?)
II) The Issue: Improve Predictability of Extreme Precipitation Events along the West Coast

• QPFs are challenging
  – Amounts, location & timing difficult
  – Especially in mid-range timeframe

• Influence of WPC products
  – Excessive rainfall
  – Medium range QPF

• 2012 Atmospheric River Retrospective Forecasting Experiment (ARRFEX)
  – 8 retrospective AR cases
  – Tested experimental data sets in creating 72 hour QPF and probability of exceedance forecasts
ESRL 2\textsuperscript{nd} Generation Reforecast Dataset

• 2\textsuperscript{nd} generation GEFS (version 9.0.1); 1985-2010
• 10 members plus control run; archive 00Z initializations
• Ranked analog method at each grid point to find dates of closest 50 matches
  – NARR precipitation data (32 km)
  – 24 hr PQPF and mean QPF
• Removes model QPF biases; uses observations of past events to make forecasts

http://www.esrl.noaa.gov/psd/forecasts/reforecast2/

Probability of >3” in 24 hours
5-day Forecast
ARRFEX Results, and What Now?

- Forecasters reacted favorably to the reforecast dataset, particularly in its ability to identify areas at risk for heavy precipitation at mid-range lead times.

Reforecast deemed ‘most helpful’ in 6 cases (CMCE: 1, HMT: 2)
ARRFEX Results, and What Now?

- Collaboration between WPC-HMT and ESRL on development of reforecast products:
  - Probability of exceedance
  - Percentiles (climatology)
  - Deterministic (mean QPF)
  - Extreme Forecast Index

- Working on getting WPC direct access to the reforecast dataset for continued in-house development (e.g., dataflow)

Credit: Tom Hamill and Gary Bates, ESRL
What You Should Take Away...

TEST ➔ EVALUATE ➔ TRAIN AND IMPLEMENT

• WPC-HMT continually works with colleagues to investigate ways to improve WPC operations

  A Few Examples:
  - Ensemble Sensitivity Tool (SUNY Stonybrook)
  - SREF parallel (EMC)
  - AFWA High-Resolution Ensemble (AFWA)
  - GEFS 2nd Generation Reforecast Dataset (ESRL)
  - Storm Scale Ensemble of Opportunity (SPC)
  - Ensemble Clustering (EMC)
  - HMT-Ensemble (ESRL/HMT)
  - NAM Rime-Factor Modified Snowfall (EMC)

• For the WPC, testing in the operational setting is imperative
  – Experiments ➔ it’s not just about objective scores

• Implementation can be a big hurdle
  – Proper data formatting and dependable dataflow to meet requirements

Beneficial ➔ Efficient ➔ IT Compatible ➔ Sustainable