The Digital Forecast Process: A field discussion on critical DFP issues.

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NWS IFPS Science Steering Team (ISST)

Background and Overview: The IFPS Science Steering Team (ISST) has always made efforts to solicit and gather feedback on critical science issues from its constituents in the field. Last year, in line with its charter (http://www.nws.noaa.gov/ost/ifps_sst/ISST_Charter.htm), the ISST set out to encourage a field discussion on several overarching issues impacting the developing digital forecast process (DFP). Early on in the process, we drafted a "one-pager" documenting (at the time) outstanding issues and concerns related to the digital forecast system. To review this document and others related to this effort, please see the ISST's DFP web page at: http://www.nws.noaa.gov/ost/ifps_sst/dfp/dfp.html

You may recall the next step was to encourage and facilitate field discussion on these issues. Initially we did this through the use of an online forum, which contributed limited, but very helpful insights into the issues. To encourage further discussion we then used the forum material and the ISST's original documents to extract three key questions, which are stated here for quick reference:

Question #1: Within the limits of predictability, what is the optimal spatial and temporal resolution needed to provide a useful and versatile digital service while maintaining scientific validity?

Question #2: What is the best way to minimize discrepancies and produce a near seamless NDFD while not sacrificing accuracy or efficiency?

Question #3: How should each NCEP centers support the WFO's contribution to the digital forecast process?

Dave Sharp (then SR member of the ISST) very effectively organized the SR SOOs into focus groups to consider individually each of the three key questions. The SR responses were thorough, well thought out, and well written. Trying to build upon this success, we then used the SR responses to guide the other Regions through a similar process.

Over the course of this past year each Regional SOO focus group worked hard to provide specific input into the ongoing discussion. Each focus group was charged to produce a consensus Region response to their respective overarching question. The response could take any form -- from an addendum to the matching SR document or an entirely separate stand-alone response. We instructed the focus groups to seek additional input if they felt they needed it. Further we encouraged the groups to think "outside the box" and not

ignore possible solutions some might consider unattainable (while recognizing current resource constraints).

We want to extend our appreciation and thanks to all of the individuals who gave so generously of their ideas and time to prepare the Regional responses. All of the responses can be viewed on our DFP website.

Future ISST Plans Regarding the DFP Input: The ISST will provide additional comment to the questions, using the Regional findings, over the next several months in an effort to provide greater definition to the forecast process within the gridded paradigm. In addition, findings from the Concept of Operations Tiger Team will certainly have a role in this dialogue. We will thoroughly vet the complete set of recommendations and ideas. At this time we anticipate creating an ISST position paper on these critical DFP questions that will contain specific prioritized recommendations.

Content of Regional DFP material: Our intent in tasking the regional SOO focus groups was, again, to aid the ISST in collecting consensus field input. We are pleased to report that the input from the regional teams has been compiled and summarized. Our initial attempt was to identify similarities in thought – as well as differences. Below are brief summary statements regarding these initial findings; a summary of which will be presented to the field at the ISST Forum on the 8th of November. It is important to point out that the ISST has not yet vetted the various recommendations and their presentation below does not represent ISST endorsement, agreement or priority.

Question #1: Within the limits of predictability, what is the optimal spatial and temporal resolution needed to provide a useful and versatile digital service while maintaining scientific validity?

GENERAL COMMENTS: Although differences existed in the responses, there were also many commonalities. Discussion seemed to focus on two common themes: (1) public grid consumption and (2) grid verification (i.e., remaining scientifically valid, but, yet performing the job) in relation to the above stated question. In addition, it was pointed out that we must not be too quick to conclude, generalize, and/or project the future of digital services.

WR advocated NDFD should provide nearly seamless grids at several spatial and temporal resolutions to meet a diversity of user needs. This voice was echoed by both SR and CR. For example, CR stated, “Give customers what they want. If we do not, someone else will.”

ER stated, “NWS forecasting culture must evolve from product centric (deterministic) to a probabilistic system that provides decision support data.” Along that note, ER and SR encouraged an acceleration of the existing ensemble data into AWIPS; and to develop EPS post-processing methods enabling the delivery to forecasters via AWIPS of highly detailed grids of sensible weather elements of which the resolution should match the NDFD. Similarly, SR stated that output grids should never be of higher resolution than

the input grids. ER also advocated the continued investment into local high-resolution EPS projects and the development of procedures to move successful systems to national operational production at NCEP. In further support of probabilistic forecast expression, SR also explicitly stated that an ensemble approach should be employed beyond 72 h and that producing more grids than can reasonably be quality controlled is not the best approach in any system.

The level of effort brought by the ER team was exemplary. It should be noted that their report provides a creative and scientifically valid approach to expressions of uncertainty in the digital forecast process era.

TEMPORAL RESOLUTION: Of those NWS Regions that provided 'specific' answers, the following conclusions were drawn:

0-6 hours	minute → hourly
0-24 hours	hourly
25-72 hours	three hourly
73-184 hours	six or 12 hourly

Some regions proposed that somewhere between Days 3 and 4, the forecast should be expressed probabilistically – in contrast to the currently employed deterministic expressions. WR and SR both advocated decreasing temporal resolution as forecast lead time increased only on the LDFD scale. Also noted as potentially useful (particularly in days 1 to 3) was the use of probabilistic expressions of exceeding critical thresholds for specific weather elements (e.g., risk of exceeding 33 kt over marine waters).

SPATIAL RESOLUTION: Some Regions felt that there was either no limit, or that resolutions <5 km could be used in a separate 'native WFO grid' (i.e., different from NDFD; perhaps a formalized LDFD) to resolve terrain and\or mesoscale processes vital to expressing any deterministic portion of the forecast – most logically in the very shortest timescales. Other NWS Regions felt that 5 km was optimum given both current tools and the state of the applied science. SR stated that within the LDFD, offices could decide for themselves a scientifically valid spatial horizontal resolution given the need to represent terrain and\or mesoscale features within each county warning area and discontinue the one size fits all method.

It is important to note that both SR and WR recognized there could be a place for two separate grid resolution structures; an LDFD and the NDFD. SR felt the LDFD could be used for verification purposes while WR advocated verification across all scales. Specifically, WR advocated that the LDFD (1-2.5 km) should float while the NDFD (5 km) should not float. SR stated that depending upon the forecast element, the resolution could change.

AR and WR stated that by no means should spatial resolution decrease with increasing forecast lead time due to the need to represent complex geoclimatic signatures imposed by coastlines and terrain. ER and SR advised that spatial scales should decrease with increasing forecast error (i.e., SR suggested the establishment of some sort of regional

error baseline, and the ER focused on the deterioration (or not) of the flow regime stability).

MISCELLANEOUS: WR and ER added that either ISST (or an ISST-like team) be tasked with discovering and understanding NDFD enhancements that would robustly support risk-based management systems. Specifically, ER advised that producing a CONOPS that would detail a 'shared vision' between all elements of the NWS (e.g., NWSHQ, NCEP, WFOs) would be a good approach.

Question #2: What is the best way to minimize discrepancies and produce a near seamless NDFD while not sacrificing accuracy or efficiency?

GENERAL COMMENTS: The main message in the regional team responses to this question was to improve both collaboration and grid editing techniques. There were quite a few specific suggestions on how to achieve this, some of which were common to more than one of the teams. These common suggestions will be the primary focus of this brief summary. However, many specific suggestions unique to only one team's response are also worth further exploration, and these will be listed as well.

COMMON SUGGESTIONS: The ideas that showed up more than once in the regional responses represent a strong message from the field on how best to achieve a solution to the question posed above. They are not prioritized or listed in any particular order, and also, on a few, include some preliminary input from the ISST:

- Better leadership is needed at all levels, and especially a stronger, more authoritative voice from the national level (which argues the need for a dedicated DSPO);

- Standardization of best practices for methodologies and tools (but with some local flexibility still allowed), also avoid mandating one model solution as a starting point for the entire US since that would rarely be appropriate). The ISST would like to emphasize more standardization of the overall forecast process relative to the national standardization of tools;

- Better overall communication between offices (forecaster exchange, sub-regional workshops, inter-office team building exercises, understanding neighboring office local shift schedules, etc);

- Better collaboration software/methods (graphical sharing, conference calls or audio/video conferencing, etc);

- LDFD vs. NDFD concept, which might even include a three-tiered approach with an RDFD as well). A relaxed inter-site collaboration policy for an LDFD would allow specific event-driven forecasting and customization for local weather information users;

- Emphasize forecast accuracy as a way of improving collaboration, or tying in accuracy incentives with collaboration "smiley faces"; using gridded verification (especially real-time feedback) will not only help with the accuracy issue, but also improve collaboration (this was a strong message);

- Collaborate earlier in the process on the large scale; edit in ISC mode and send ISC grids frequently (with some caveats and system performance issues, although we support improving system performance to handle collaboration needs);

- Enforce use of consistency checks and better define collaboration thresholds based on science. The ISST would add better definitions of the elements themselves are very important.

OTHER SUGGESTIONS: The recommendations below generally only appeared in one Region's response. Again here there has not been an attempt to prioritize the list.

- Create standardized sets of tools for certain weather situations;

- Better use of bias-corrected grids, model blends, and ensembles;

- Temporal resolution and start/stop times of grids should be consistent (i.e., UTC);

- Improved conceptual models, especially on the mesoscale (development of best practices to depict these processes in the grids, and regional or regime-based gridded climatologies would help);

- Deadlines to have preliminary grids sent (challenge is doing this nationally vs. in small clusters);

- Routine times for collaboration for forecast hours beyond 36, but as needed in the short term;

- More positive incentives or rewards for improved accuracy and collaboration (some ISST concerns about details of this idea);

- Local managers and forecasters need more awareness of regional/national customers (and national leaders and program managers need better understanding of local customers too);

- Idea of HPC providing fields (maybe dynamic fields) such as MSLP, from which the sensible weather grids are derived locally, which would assure the same starting point (this obviously ties in very much with Question 3, on the role of the national centers).

Question #3: How should each NCEP centers support the WFO's contribution to the digital forecast process?

GENERAL COMMENTS: Due to the large number of centers and their individual focus it would be hard to ever have a commonality for this particular question. In combination, the Regional teams identified support roles for seven different centers: Aviation Weather Center (AWC), Climate Prediction Center (CPC), Environmental Modeling Center (EMC), Hydrometeorological Prediction Center (HPC), Ocean Prediction Center (OPC), Storm Prediction Center (SPC) and the Tropical Prediction Center (TPC). The two centers that were identified as playing the most significant role were, not surprisingly, EMC and HPC. The two most discussed topics that emerged from the responses were HPC Day 4-7 grids and model data available to the WFOs at native resolution. Verification was also mentioned – specifically as it relates to the Analysis of Record (AoR), which needs to be produced to aid in verification of all gridded forecasts including EMC and HPC products.

GENERAL REQUESTS:

All NCEP guidance/forecasts that have benefit to the DFP need to be in gridded form and as close to NDFD resolution as possible for use in IFPS. For example, there are current products that cannot be used effectively in IFPS because they are either graphics or text products. This greatly compromises their value to the field. These include: MOS, weather outlooks and medium range guidance.

Probabilistic guidance grids need to be generated for certain parameters (at parameter dependant thresholds) and ensemble output needs to be provided in gridded format (means and members).

Research needs to be done to aid regions that have mountainous terrain generate better wind forecasts at higher elevations.

Climatology grids need to be produced at the highest possible temporal and spatial resolution with the aid of NCEP. These grids could become part of the GFE baseline for each verification element. In addition to this, local/regional libraries could be created to aid in seasonal variations.

REQUESTS SPECIFIC TO EMC:

EMC should produce the best possible AOR grids using all available, quality observational data sets. They should also support the production of an Analysis of the Moment (AOM) to continually validate and update the first period of the forecast.

Model output should be provided to WFOs at native resolution in a timelier manner to support the first period and to support local models.

Non-NCEP model guidance (e.g., ECMWF, UKMET, etc.) output in the operational data stream to WFOs is needed to help in modifying the days 4-7 grids.

REQUESTS SPECIFIC TO HPC:

HPC should produce high-quality Day 4-7 grids and make them available in a timely manner such that they can be directly ingested (with very little editing) to meet WFO deadlines during high workload demand. HPC must conduct robust verification of these grids.

HPC should provide the best possible guidance/forecasts in the medium and extended range such that the WFO can focus their attention on the first three days. To insert a specific quote: "Focusing on the short term (days 1-3) is not a form of relinquishing our duties, it is a redistribution of duties: the same workload, just more concentration on the short term. – John Distefano, WFO Wilmington, OH"

All snow and QPF data should be produced by HPC in a gridded format. Two regions requested that HPC produce gridded data with a resolution down to 2.5km.

REQUESTS SPECIFIC TO OPC:

OPC needs to produce offshore element grids (wind/wave) at 60 to 250 nm in a gridded format that would go over the SBN and into AWIPS for ingestion into GFE. If OPC is unable to produce these grids then support should be made available to local WFOs such that they are able to run locally developed model data.

OPC should create and provide a climatology analysis of wind and wave conditions in coastal waters, probabilistic forecast guidance, statistical wave guidance and a high resolution Great Lakes wave model.

OPC should incorporate TPC guidance into their products for better overall wind, wave height and surge guidance.

REQUESTS SPECIFIC TO TPC:

Timeliness of TCM grids from TPC is very important to the WFO because of the discontinuities it can create between WFOs. NCEP should use the TPC positions from the TCM as input into model data and incorporate the radius of cyclone winds. This information would result in better wind and wave forecasts in the near shore.

REQUESTS SPECIFIC TO SPC:

Products produced by SPC need to be in a gridded format. These products should be limited to days 1-3 for the present time. Other products of value from SPC should be a gridded CAPE product and fire weather grids.

REQUESTS SPECIFIC TO AWC:

AWC needs to provide gridded guidance on ceiling and visibility as well as the CCFP and other aviation fields in gridded format for use by WFOs and CWSUs.

ADDITIONAL NOTES: There were a few requests or overarching comments that seem to identify critical areas or premises: native center resolution, higher center resolution (NDFD scale), better timeliness of the centers' products, incorporation of additional data and that the onus should be on the WFO for days 1-3 and on the centers for the medium and extended range.

The additional data products and native center resolution are problems that are inherent of AWIPS and not the centers. It should also be noted that additional products will also have a two-fold problem, bandwidth and performance issues. Timeliness or availability of products is also a bandwidth issue.

Work should be done to ensure all of the NWS is on an even playing field. The OCONUS still requires a lot of work in this regard specifically relating to NCEP guidance and products.

The WFO should have the best guidance possible for the medium and extended range forecast periods. This will allow the WFO more time to work on the days 1-3 grids and better collaborate with neighboring offices. There is still a great deal of work required in that arena.