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THE NECESSITY OF A COHERENT, AND CONSISTENT FORECAST METHODOLOGY IN THE IFPS/GFE ERA

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ABSTRACT

Historically variation among National Weather Service forecaster methodologies has not been a mission-critical issue. This was largely due to the fact that the end product - a textual forecast product – was subjective in nature. The choice of conceptual model, or even the interpretation of the conceptual model (what we term the translational process) was obscured by semantics (e.g., “occasional rain” v. “showers”, or “partly cloudy” v. “partly sunny”).

However, within the IFPS/GFE system the methodology is a defining and essential characteristic. Forecast offices with mature GFE/IFPS implementations indicate that the approach one uses in GFE will make, or break the forecast process. Thus developing a correct approach is vital to the forecaster in the quest for an internally consistent suite of sensible weather element grids.

There are innumerable IFPS/GFE methodologies currently in vogue across the NWS: some systematic, and some not. The software design allows the forecaster to manipulate the grids in an infinite number of way. With an unlimited number of degrees of freedom, the forecaster is free to define a preferred mode of operation.

During the exploration and development phase this was a good thing. However, IFPS/GFE is now approaching “adulthood” (ORD/IOC), and the lack of a consistent methodology is becoming an impediment to the maturation of IFPS/GFE. It is suggested that a standard methodology should at minimum attempt to address at least three significant issues: the lack of a consistent approach to grid production; the number of independent grids required of the forecaster; and the physical inconsistencies among grids.

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DISCUSSION

Considerable effort has been directed over the years to forecast formulation (e.g., the forecast funnel, development of a mental conceptual model, etc.). However, less effort has been directed toward the forecast production paradigm: the systematic translation of a conceptual model to the construction of an effective operational forecast (figure 1). There are likely a number of reasons for this void. Arguably one reason is that the translational process tends to be highly subjective.

Conceptual model –> translational process –> textual products

Figure 1. Forecast Production Paradigm

Since the translational process is very subjective and difficult to quantify, forecasters tend to gravitate to a process that best suits their personality (left-brain or right-brain dominant, mood, forecast biases, time of day, etc.). Somewhat unexpected is the fact that the current forecast production paradigm does not demand a forecaster follow any particular conceptual model, translational model, or forecast process. In addition the current forecast paradigm requires the operational meteorologist to maintain temporal and internal consistency of an entire product suite. Mental consistency checks are applied at all phases of the composition process as the forecaster refines and corrects the textual products.

Fortunately, variations in forecast production methodologies has not been a mission-critical issue. The subjective textual products – the only means a forecaster has had for conveying the science and the sensible weather information to the customer – were sufficiently vague as to blur the differences among the forecaster methodologies.

However, with the advent of IFPS/GFE the translation model (grid production methodology) is a defining characteristic. The strategy the forecaster uses to adjust the sensible weather element grids is a very close second in importance to the formal knowledge of how to modify the grids (the so-called knobology). Forecast offices with mature GFE/IFPS implementations indicate that the approach one uses in GFE will make, or break the forecast. Thus developing a coherent approach is vital to the forecaster in his quest for an internally consistent suite of sensible weather element grids.

That being said there are innumerable forecast methodologies currently in vogue across the NWS: some systematic, and some not. The myriad of forecast methodologies is due, in large part, to the IFPS/GFE software design. The software does not inherently impose a philosophy, or constrain the forecaster in any fashion. The forecaster is completely free to manipulate the grids in an infinite number of ways. From an IFPS/GFE software perspective, the underlying assumption by the software engineers and programmers is that there should be no constraint imposed on the meteorologist. The forecaster is free to define the preferred mode of operation.

During the exploration and development phase of IFPS/GFE this was a good thing. Forecasters and applications programmers have been allowed to investigate numerous strategies and determine which work, and which do not work. The rapid growth of the GFE Smart Tool Repository is a testimony to this prolific process. However, IFPS/GFE is now approaching “adulthood” (ORD/IOC), and the lack of a consistent methodology is becoming an impediment to the maturation of IFPS/GFE. In other words the lack of any constraint has actually become a “two-edge, GFE/IFPS sword”: too many degrees of freedom within the IFPS/GFE software structure.

With this point in mind consider the following simple scenario extracted from the Anchorage Long Term Forecast Methodology Web Page. Figure 2 represents a forecaster grid production strategy where the forecaster creates all grids for a particular day before moving on to the next. Not shown, but implied, in the grid production process are the Smart Tools and Procedures used by the forecaster to derive or modify additional (e.g., T) fields, and specific anchor and interpolated grids for a given methodology.

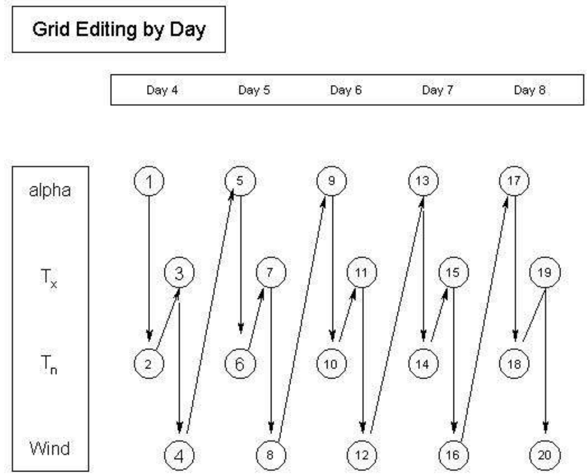

Figure 2. Grid Editing by Day

Now consider an alternative approach to the long term forecast methodology (Figure 3). In this case the forecaster completes, in serial fashion, all grids for a particular sensible weather element type (e.g., Tx and Tn) for all forecast periods before moving on to the next sensible weather element type (e.g., Wind).

To illustrate the potential impact of differing strategies on the internal consistency of the sensible weather element grids, consider the following scenario: Assume two meteorologists (A and B) with identical conceptual models are forecasting for the same CWA, each using a different grid editing strategy. For the sake of argument assume each of the above described grid editing strategies are equally valid for the weather pattern. Because the paths the meteorologists navigate (e.g., Smart Tools used, which grids are anchor grids, and which grids are interpolated, etc.) differ, suite of grids will not be identical.

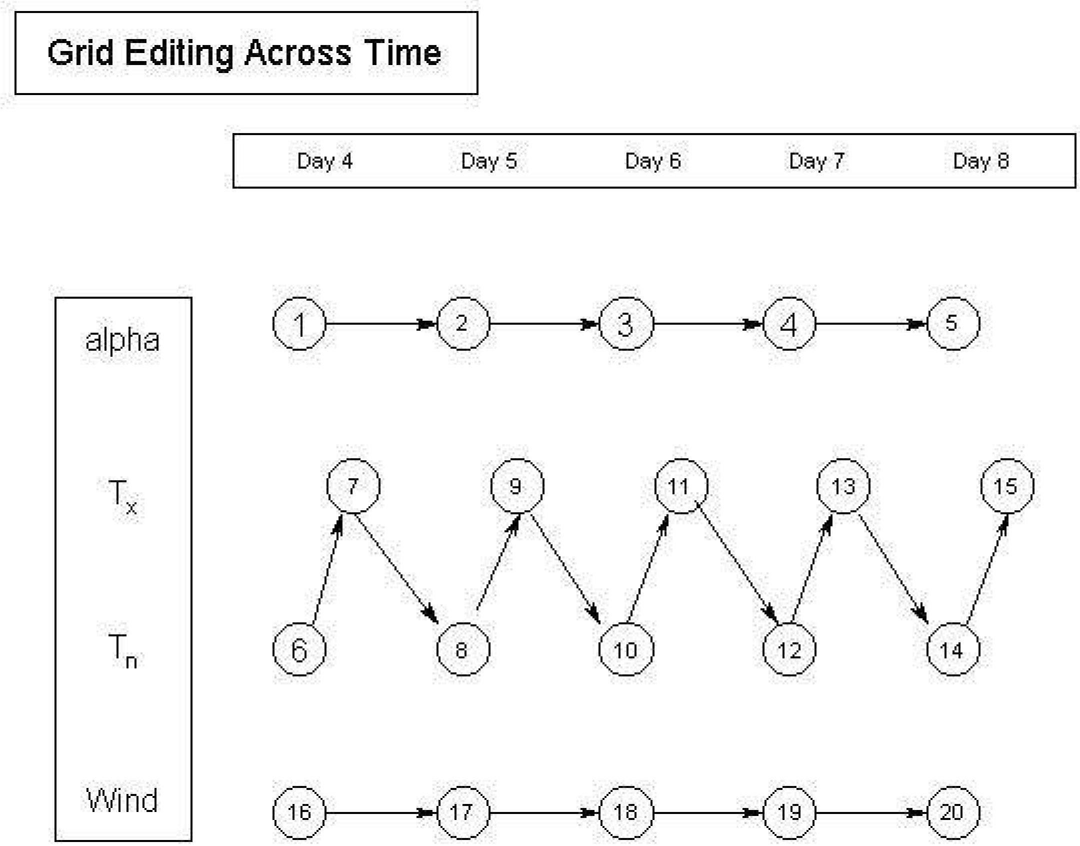

Figure 3. Grid Editing Across Time

Roll forward 12 hours in time and consider the following situation: Meteorologists A and B swap positions. In effect now, each forecaster “inherits” the other forecaster’s grid set from the previous forecast period. However, forecasters A and B use their preferred grid editing strategy to perform the assigned shift duties. Since each forecaster utilizes a different strategy (e.g., Smart Tools used, which grids are anchor grids, and which grids are interpolated, etc.), the two grid sets can be demonstrated to diverge even further simply to dissimilar GFE methodologies.

Complications begin to emerge beyond this very simple scenario when one realizes that forecasters seldom agree 100% on any meteorological topic. For instance if one monitors a timeslice in the sensible weather element matrix through its 7-8 day life cycle, one will likely find that the timeslice is the “victim” of any number of conceptual models and grid editing strategies by several meteorologists. Therefore it should not be a surprise when there are internal inconsistencies in the sensible weather element matrices from shift to shift, and inconsistencies in the NDFD among adjacent forecast offices?

Armed now with this information, we would ask you to switch modes and consider the methodology issue from the perspective of an individual forecaster. As stated previously there are literally no limitations imposed on the forecaster within GFE/IFPS. For example, an approach often taken by the forecaster is to “create” an anchor grid such as probability of precipitation (POP) and derive other forecast grids such as Weather (Wx) and Sky Cover (Sky). In simple terms, what the forecaster is attempting to accomplish is to leverage one set of sensible weather element grids to systematically extract additional grids via algorithms embedded in Smart Tools. As valid as this concept is, the result is often a series “stovepiped” solutions. In other words each grid-to-grid derivation tends to be independent of the other meteorologically. This allows internal inconsistencies to arise in the forecast sensible weather element grids. The forecaster then is forced to spend valuable analysis, diagnosis and forecast time attempting to remedy the discrepancies.

Along the same lines consistency and discrepancy checks presently tend also to be fairly simple minded. For example there are Smart Tools that ensure that T>=Td, and that the Wx grid is consistent with the probability of precipitation (PoP) grid. However, the checks are almost exclusively mathematical rather than physical such that "corrected" grids are often drawn away from internal meteorological consistency with other contemporaneous grids.

For example consider the following scenario: A forecaster decides that the temperature in a particular area is too high. The forecaster adjusts the temperature in that area with a Smart Tool to reduce the temperature appropriately. However, upon reducing the temperature, the forecaster now realizes that dew point temperatures across a percentage of the modified grid points in that affected area exceed their respective temperatures. The forecaster decides to run a discrepancy check tool to correct the problem so that there are no grid points where T>Td. Though the "problem" is corrected, the Smart Tool has now introduced a fundamental physical inconsistency into the sensible weather element grids (i.e., the dew point depression is disconnected from the state of the atmosphere).

With the current state of IFPS/GFE methodology in mind, it is apparent that a more holistic approach is necessary. To improve upon current practices, it is proposed that the "new" methodology should at minimum attempt to address at least three significant issues:

1. the lack of a consistent approach to grid production;

2. the number of independent grids required of the forecaster;

3. the physical inconsistencies among grids.

In searching for a more efficient grid manipulation strategy, it became readily apparent that at least a portion of the answer lay in the minimization of the number of "degrees of freedom" available to the forecaster during the grid production process. "Degrees of freedom" (DF) as most will recall relates the number of independent pieces of information required to define a specific parameter. Relating this specifically to GFE methodology we have to ask the question, "What are the (minimum number of) input grids required to derive all the required sensible weather element grids for any given timeslice?" Figure 4 describes in graphical form the abstract fundamental question.

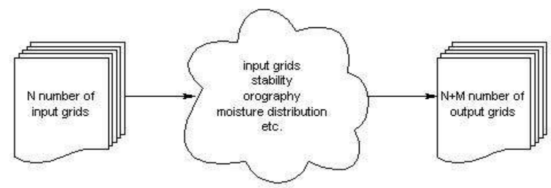

Figure 4. IFPS/GFE Objective Methodology

The devil is in the details, of course, when one attempts to determine a starting point and specify a grid editing flowchart. Sensible weather element grids such as probability of precipitation (PoP), sky, or weather are not ideal candidates as they are either dependent, or derived grids themselves. Therefore it is proposed that for a sensible weather element grid to be considered an effective starting point, the grid must be based on a cardinal, or more fundamental quantity in atmosphere. This independent grid may then be leveraged to systematically derive a multitude of subordinate fields. The IFPS team at AFC has studied this problem at great length over the last few months, and have come up with two possible starting points: QPF, and our so called Master Operation Grid (MOG).

In brief, the QPF approach is fairly straightforward. The forecaster would be expected to use some combination of input (e.g., HPC QPF grids) to draw a limited set of QPF contours. This strategy encourages the forecaster to focus on the non-convective, synoptic scale component to the precipitation field. Using model information and topographic data within the IFPS server along with this QPF field the precipitation type, character, and intensity could be derived as well as a number of other internally consistent fields. The QPF portion of the IFPS/GFE methodology may be viewed in a simple flowchart (Figure 5).

The flowchart is not meant to represent a final state of IFPS/GFE methodology at WFO Anchorage. There are several outstanding issues (e.g., conditional QPF) that need to be addressed. However, the flowchart does express the direction the office is pursuing in order to provide a more consistent environment for grid production.

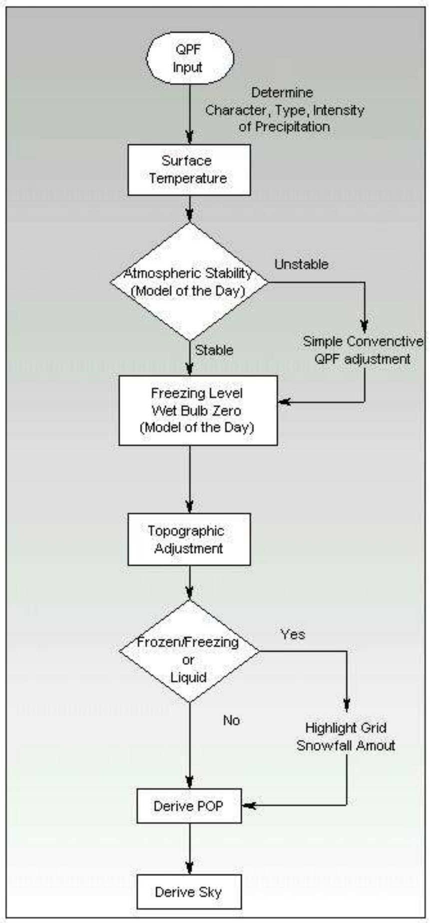

Figure 5. Flowchart of QPF segment of Systematic IFPS/GFE Methodology

Another more controversial approach the office has experimented with is the MOG. The concept of operation for MOG is identical with a QPF approach in that the goal is to minimize the number of input grids a forecaster has to deal with (Figure 6). Instead of focusing on precipitation amounts (QPF) the forecaster is asked to take a step back concentrate on a more abstract quantity that represents synoptic scale forcing. As with the direct QPF approach, model and topographic data within the IFPS server would be used to systematically derive precipitation amount and attributes along with a number of additional fields.

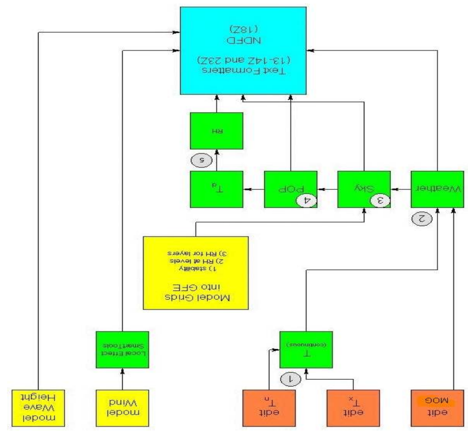

Figure 6. Proposed MOG Approach

CONCLUSION

Regardless of how the systematic IFPS/GFE methodology evolves at WFO Anchorage, the goals remain the same:

- Strive to develop a consistent forecast methodology that will be employed office wide;
- Within that forecast methodology, minimize the number of input, or anchor grids.
- Train the forecasters toward an effective forecast process that has a very specific goal in mind: To produce a set of anchor grids that will be used to objectively drive the grid forecast production within IFPS/GFE.