A Comparison of Air Traffic Management Decision Aids and Meteorological Tools

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Abstract

In this modern age where technology can generate high-resolution meteorological models and user-friendly graphics at real-time speeds, the understanding becomes lost that these products in themselves are simply meteorological tools and do not constitute a comprehensive weather forecast. Like a hammer still requires a carpenter to build a house, current day meteorological models still require a meteorologist to interpret all the pertinent models and assimilate other meteorological products to produce a more accurate and complete forecast. Only when a forecast has reached its most accurate potential, should it be delivered in multi-dimensional color graphics and Tactical Decision Aids (TDAs).

Meteorological decision aids traditionally fall into two categories within the Federal Aviation Administration, (1) model-derived probabilistic products that describe the chances of a weather phenomena, and (2) deterministic products that forecast a "go/no go" of a specific airport runway or air route program. Deterministic product development often requires knowledge of not only the meteorological situation, but aircraft limits and the limits and capability of the specific airport or route for which the forecast tactical decision aid is developed. This study shows through qualitative means that although model-derived probabilistic products seem to be helpful in traffic management decisions, accurate deterministic products and consultations by meteorologists result in a large reduction in aircraft holding and diversions which increase safety and reduce airline costs.

1. INTRODUCTION

Meteorological models are becoming more advanced, however most may still require the skills of meteorologists to utilize all available tools for the best forecast. Pure model data are needed where the decisions are automatically being made by computer algorithms, no human interaction is possible or practical. This is the case with the advancement of the Next Generation Air Traffic Transportation System (NEXTGEN) into air traffic decision making. Graphical interfaces of the information may help with the situation awareness, or a meteorologist may act as an interpreter to the user of the model derived product. This was found to be the case at the

Atlanta ARTCC the majority of the time. When the meteorologist was not consulted, the decision maker had an additional briefing or a decision aid to help with the understanding of the model data.

Tactical Decision Aids (TDAs) utilize graphics and color coding to help visualize the end product for the user. Users of the data are not requiring an in depth knowledge of meteorology, but rather a range of capabilities that the forecasted weather will allow. Tactical decision aids can depict either probabilities of a phenomenon, a "go" or "no go" color coding, or a combination of both (fig. 1.1) to help in the air traffic management decision process. Tactical Decision Aids may be derived by both modeled meteorological information, and "human in the loop" forecasts. Both are used at the Atlanta Air Route Traffic Control Center in Hampton Georgia for making safety and flow control decisions

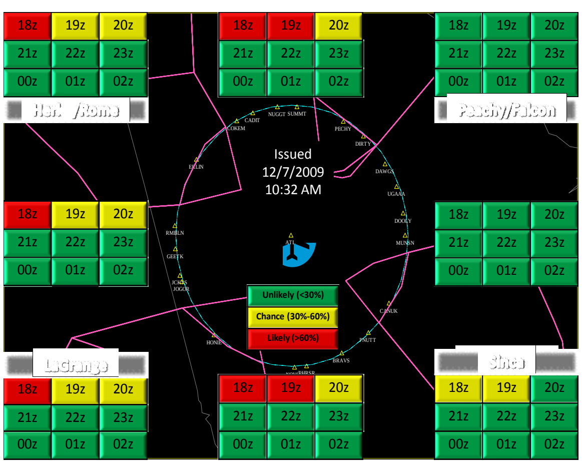

Figure 1.1. Thunderstorm TDA utilizing forecaster derived information color coded for ease of interpretation of the probabilistic chances of thunderstorms at the arrival and departure gates.

for the busiest airport in the world, Atlanta Hartsfield-Jackson International.

Model data, rather in its pure form, automated in air traffic tools, in a graphic, or TDAs are not independent of each other, but rather will complement each other exponentially. Graphically indicated in figure 1.2, both model data and meteorologist derived forecasts have limited benefit in data form. Similarly, meteorological models alone in a TDA are also limited in their ability to transfer vital information to the decision maker because most are derived from a single model which may not be the best for that daily situation.

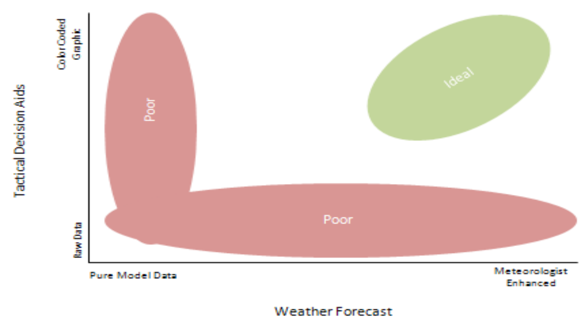

Figure 1.2. Weather forecast type against TDA display type.

2. MODEL DATA USED FOR FAA DECISION MAKING WITHOUT METEOROLOGIST INPUT

Model data without forecaster interaction is becoming more common within the FAA as we approach the NEXTGEN. Because of the sheer volume of weather information that is required by the controller and the traffic management specialist at any given location and time, traditional forecasts become impractical, and in most cases, impossible. Usually this model information is raw model data, and in some cases it may be Model Output Statistics (MOS) data, acquired by the automated FAA equipment. In most cases this data will be inaccessible or unclear by a non meteorologist (fig. 2.1).

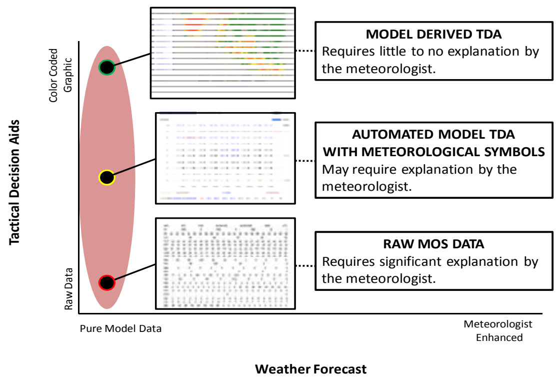

Figure 2.1. MOS guidance against other graphical forms of TDAs.

With the advancing automation of air traffic control system, model data is being used by air traffic control systems to help separate aircraft without human interaction. RUC derived wind data, for example, is assimilated into the calculations of aircraft movement through an airspace sector, and for calculation of optimal aircraft releases to increase the efficiency and safety of an airspace sector or an airport. In some cases this information is transparent to the controller, and in others it can be referenced by the user. In those cases where the data cannot be referenced, supplemental TDAs (fig. 2.2) utilizing the same RUC data can be provided to enhance situational awareness of the controller or traffic management specialist. This level of TDA may still require some interpretation on the behalf of a meteorologist due to its use of meteorological symbology.

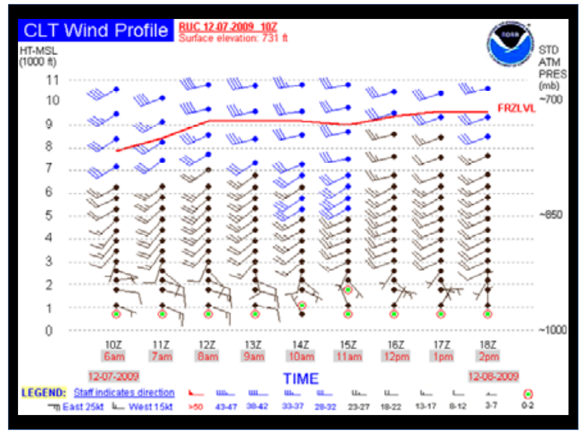

Figure 2.2. An example Vertical Wind Profiles derived from RUC model data that allows the user to visualize the automated data that is calculating aircraft compression on final approach.

Model derived TDAs may also be built without meteorologist input for non automated FAA systems. These TDAs would be referenced by FAA decision makers on how to best utilize airspace and arrival rates based on the forecast weather conditions. An example would be thunderstorm impacts on jet routes (fig. 2.3). Computer models color code jet routes that may be impacted by convections based on preset values of the probability of intensity, altitude and location of the convective cell to each

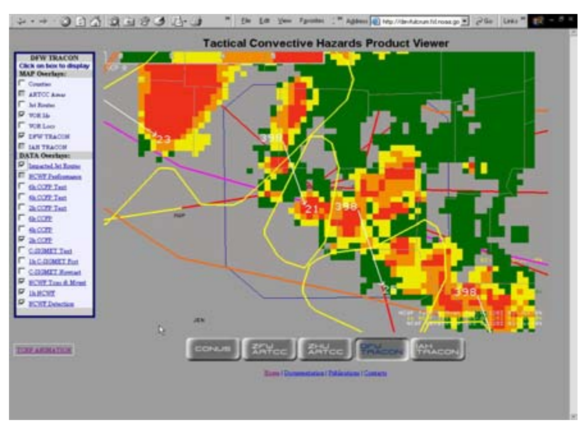

Figure 2.2. Model derived TDA for possible jet route closure without forecaster input.

route. These TDAs are color coded for easy deterministic interpretation of the impact of weather without input or interpretation from a meteorologist.

3. NON TDA FORECAST INFORMATION

Aviation forecast information has traditionally been in the form of written text, which predated teletype communications. The most common of which is the Terminal Aerodrome Forecast (TAF). Meteorologist, utilizing all available tools to include numerical models, construct the TAF for a specific airport for twenty-four to thirty hours. TAFs are provided

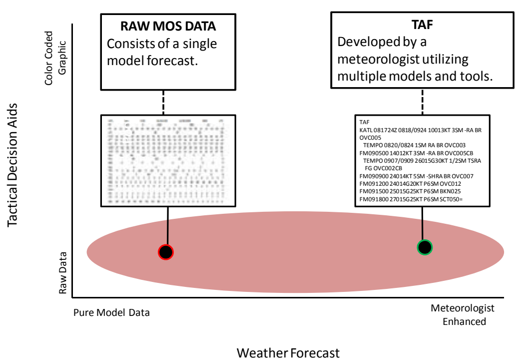

Figure 3.1. Text forecast ranging from numerical guidance to more accurate meteorologist derived forecast.

Meteorologist can improve over guidance because several things to include experience with the local climate and model initialization and selection amongst others. As indicated in the horizontal axis of figure 3.1, forecaster-in-the-loop forecasts like the TAF are better forecast over model data alone (Grumm, 2003), however they lack in communicating that information to the decision maker with the ease of a deterministic TDA.

4. METEOROLOGIST DERIVED TACTICAL DECISION AIDS

Traffic management decision makers need the most accurate forecast, delivered in the most user friendly TDA, when utilizing non automated management systems. Figure 4.1 indicates that weather products that are both good TDA's and the most accurate forecast will plot out in the top right of the graph. Tactical Decision Aids that produce both deterministic and probabilistic information were found to be even better. Products that can fall in this area of the chart will tend to be of the most use to the traffic manager.

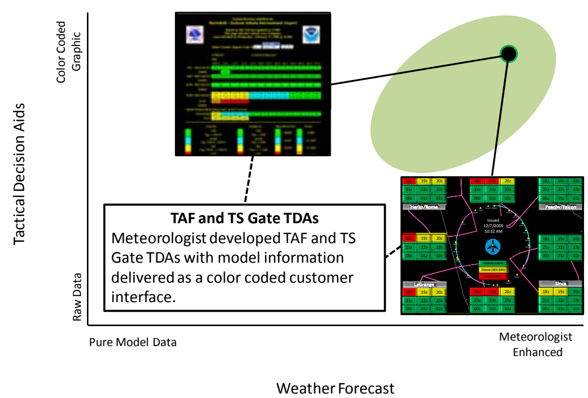

Figure 4.1. Forecaster generated TDAs provide both the most accurate forecast and a easily read color coding scheme.

5. SUMMARY OF FUTURE WORK

Rather it is forecaster in the loop or forecaster over the loop, further research of advanced TDAs that utilize human meteorologist input need to be researched. Great advances in model technologies are being incorporated into traffic management decision tools with little to no forecaster involvement. These products, although efficient and fast, may not be the most accurate. Model generated TDA products would be more accurate if fast and efficient meteorologist input techniques were researched and technologies were developed to allow it.

Further work in product assimilation into automated FAA systems of forecaster produced products is also needed to allow use of these products beyond the simple reference.

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