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High-Fidelity Weather Data Makes a Difference Calculating Environmental Consequences with FAA's Aviation Environmental Design Tool

Michael J. Yaworski & Eric P. Dinges
ATAC Corporation
Sunnyvale, CA, United States

Ralph J. Iovinelli
Office of Environment and Energy
Federal Aviation Administration
Washington, D.C., United States

***Abstract*— High-fidelity atmospheric weather conditions used in FAA's Aviation Environmental Design Tool (AEDT) directly affect aircraft speed, location and engine thrust during flight, which drives the fuel burn, emissions, and noise consequences. Current environmental models use static, geographically invariant atmospheric data. Modifying current modeling methods to be capable of using varying weather inputs, and also implementing methods for obtaining and utilizing high fidelity weather has the potential to make the outputs of environmental models much more realistic. Such improvements can directly enhance the utility of simulation-based air traffic planning and management tools, whether driven by measured aircraft position data or by standard flight procedures. This paper presents an examination of using a high-fidelity weather data to model aircraft performance for the purpose of quantifying environmental consequences in FAA's Aviation Environmental Design Tool.**

Keywords-weather; performance modeling; environmental impacts; noise; emissions; fuel burn; AEDT

I. INTRODUCTION

Detailed high-fidelity weather data can have significant impacts on environmental modeling results. Headwinds, for example, play a critical role in performance calculations. One analysis of a global emissions inventory showed that, in cruise, headwinds can cause equivalent still air flight distance to vary by as much as 20% [1]. This, in turn, can significantly affect fuel burn. Fig. 1 illustrates the sensitivity of fuel burn calculations to headwind, based on flight data recorder information.

A robust aircraft performance model must include a description of the atmosphere through which an aircraft is flying. The accuracy of a performance calculation is limited by the realism of the weather model on which it is based. This paper discusses the implications of incorporating a high-fidelity weather specification into present standard environmental models, and their underlying algorithms. The possible impacts of different weather inputs on performance results are explored. The significance of such impacts, along with the resulting impacts on noise and emissions results, is illustrated in the context of the change from current standard weather treatments to a high-fidelity weather model

II. BACKGROUND

A. Standard Environmental Models

Existing aviation environmental models typically utilize one of two specifications for calculating aircraft flight performance: European Civil Aviation Conference (ECAC) Doc 29 [2] (quite similar to the Society of Automotive Engineers (SAE) Aerospace Information Report (AIR) No. 1845 [3]), or the EUROCONTROL Base of Aircraft Data (BADA) [4]. The first, commonly abbreviated to 1845/Doc29, is intended for use only within the terminal area, or at altitudes below 3048 meters (10,000 feet) Above Field Elevation (AFE). Therefore it is primarily used by airport and regional models such as the FAA's Integrated Noise Model (INM), Emissions and Dispersion Modeling System (EDMS), Noise Integrated Routing System (NIRS), and terminal area calculations within the Aviation Environmental Design Tool (AEDT) as well as the UK Department for Transport's Aircraft Noise Contour Model (ANCON). BADA is applicable throughout all phases of flight, but is primarily applied for en-route portions, above

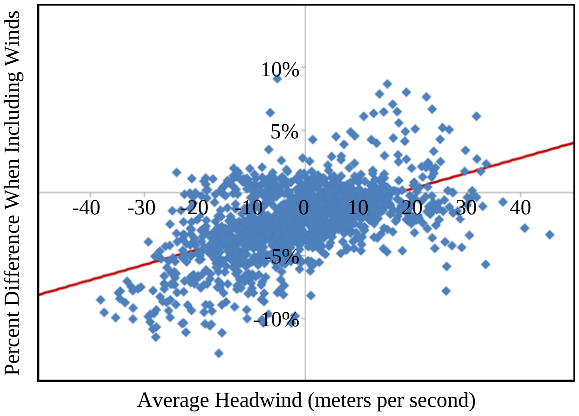

Figure 1 - Changes in fuel burn due to the effect of headwind; fuel burn calculations based on flight data recorder information for a collection of Swiss Air flights.

3048 meters (10,000 feet) AFE, in global models such as FAA's AEDT and EUROCONTROL's Aviation Environmental Model (AEM). These specifications make many simplifying assumptions about atmospheric conditions, which are based on reference conditions at a single location and time.

Each of the performance models incorporated into these standard environmental models includes a portion that addresses the governing physics of the model, and a portion that enumerates standard procedure steps that an aircraft is likely to follow. These procedure steps assign values to enough degrees of freedom featured in the physics specification to allow determination of the remaining degrees of freedom for the associated portion of the flight path. An acceleration step, for instance, might specify thrust, flap configuration, climb rate and final speed, from which the distance traveled and change in altitude can be determined for a given initial state. As an alternative to the use of these procedures, known flight data can be provided, and the governing physics can be used to determine the values of the remaining unknown quantities. For example, flight path information from a flight data recorder can be specified in order to determine what thrust would have been used by the performance model to fit those constraints.

B. Standard Weather Models

1) Terminal-Area Atmosphere

The weather model used in conjunction with the 1845/Doc29 performance model is based on static weather data. Reference values for thermodynamic properties (temperature and pressure) are given at the airport, and atmospheric profiles are constructed to fit those data in a physically realistic manner, similar to the manner in which the International Standard Atmosphere (ISA) [5] was derived. These quantities are a function of altitude only, with no variation with respect to surface coordinate or time.

2) BADA Atmosphere

The weather model and corresponding performance model outlined in the BADA user manual is partially based on annual average weather data, and partially based on the ISA. In this model, the temperature at the ground is unconstrained, but the remaining temperature profile decreases with altitude at the same lapse rate as used in the ISA. The pressure at sea level is taken to be equal to the ISA sea-level pressure, but the rest of the pressure profile is adjusted to account for the non-ISA temperature profile.

The BADA model of the atmosphere changes above the tropopause altitude, which the model defines as the altitude at which temperature equals 216.65 degrees (Kelvin). The temperature profile above this altitude is constant, maintaining the tropopause value. The pressure (and therefore density) profile exhibits exponential decay from its tropopause value as the altitude increases beyond the tropopause altitude.

3) Wind Models

For wind, one value for headwind was assigned to an airport, with an optional scaling factor per runway end. This (possibly scaled) value of headwind would apply throughout a flight, without regard to altitude, latitude, longitude, time, or direction of travel. This could be viewed as equivalent to model where wind has constant speed and varies such that it is always blowing into the direction opposite the aircraft's course.

C. Weather Effects on Other Models

Performance models are used to determine aircraft position, groundspeed and thrust for use in noise and emissions calculations. The inputs to these models can take many forms, but most can ultimately be interpreted as a set of procedures that the aircraft is expected to follow. Each step of these procedures could have any of several combinations of constraints and degrees of freedom. There are therefore many ways in which changes in weather conditions might affect modeled results. Some performance results may be less intuitive in the face of changing weather inputs. Altitude and speed profiles from procedural arrivals also tend to be insensitive to weather, due to the inherent nature of the 1845/Doc29 methods used to calculate them. When driven by altitude controls, as previously found in FAA's NIRS tool [6] to specify airspace restrictions, flight profiles obey a calibrated airspeed schedule that varies with altitude, based on the standard speed profile.

1) Speeds

There are many speed-related opportunities for weather to affect performance. Although speed in performance can be specified relative to the ground frame of reference, it is rare for a procedure to do so. There are two possible layers of abstraction between groundspeed and the speed specified in a procedure. The first lies between groundspeed and true airspeed. The second is between true airspeed and either calibrated airspeed or Mach number

The groundspeed corresponding to a given airspeed is directly related to the headwind. Greater headwinds dictate smaller groundspeeds for a given true airspeed. The BADA model does not explicitly reference headwind, but implementations such as that in AEDT rely partially on aspects of the Doc29 model that are sensitive to headwind.

Standard flight procedures in 1845/Doc29, as well as some in BADA, are specified in terms of calibrated airspeed. In the 1845/Doc29 model, calibrated airspeed is related to true airspeed through atmospheric density alone. The relationship is specified more accurately by the BADA model through both density and pressure. For a given calibrated airspeed, the corresponding true airspeed increases with decreasing density.

There are some BADA procedure steps for which speed is specified as a Mach number. Since the speed of sound is a direct function of temperature, true airspeed for a given Mach number is also temperature dependent. For a given Mach number, the corresponding true airspeed increases with decreasing temperature.

Some modifications to the 1845/Doc29 model of descent steps essentially convert the speed specification from a calibrated airspeed to a true airspeed. The true airspeed calculation depends on headwind, among other non-weather quantities.

2) Thrusts

For many procedure steps for aircraft with jet engines in the 1845/Doc29 model, the thrust is specified as a function of pressure, temperature, and calibrated airspeed, along with a set of craft-specific coefficients. Calibrated airspeed is not a degree of freedom in these steps, so it is unaffected by weather. However, changes in pressure and temperature can cause thrust to grow or diminish. Since the coefficients vary by aircraft, and per procedure step, there are no general expected correlations between these weather changes and the corresponding thrust; the only reliable expectation is that thrust will usually change in response to weather conditions.

The 1845/Doc29 model also includes procedure steps for propeller-driven aircraft in which thrust is a function of pressure and true airspeed. Since calibrated airspeed is fixed for such steps, this comprises an indirect dependence on density. Increases in pressure and density lead to gains in thrust.

For descending steps of 1845/Doc29, the thrust depends directly on headwind and calibrated airspeed. Again, calibrated airspeed is fixed without regard to weather, so there is no indirect dependency. However, the dependence on headwind is direct; increased headwinds require greater thrust.

Thrust for a turboprop or propeller-driven aircraft under the BADA model is specified as a function of altitude, true airspeed, and temperature. A different expression is used for each engine type, and a different set of modeling coefficients is used per-aircraft. As with the case of parametric thrust calculations under the 1845/Doc29 model, the a priori unknown coefficients leave no general rules regarding the response of these thrusts with respect to weather conditions, but there is a sensitivity to weather through its dependence on true airspeed.

3) *Distances*

In the case of procedure steps for which track distance is not specified directly, distance calculations depend on weather conditions. In the 1845/Doc29 model, force balances and geometric constraints are used such that distance traveled can be a function of thrust and/or true airspeed, each of which has its own dependence on weather. In addition to this indirect interaction, some weather parameters appear independently of thrust and speed in some 1845/Doc29 distance calculations, most notably the headwind in takeoff and climbing steps, but also temperature in the case of takeoff. In general, increased headwinds lead to reductions in the distances required to reach target speeds and altitudes; takeoff lengths are shorter, and climb angles are steeper.

4) *Noise*

The noise analysis that follows performance calculations is heavily dependent on corrected net thrust. This is the net thrust produced by the aircraft engines, scaled by the pressure ratio in which the thrust was generated. For those procedure steps of the 1845/Doc29 model that do not specify a parametric thrust, and for the BADA model, net thrust is calculated, without this scaling, because it is involved in a force balance (sometimes the balance is how the thrust is calculated). Although this net thrust generally already has a dependence on weather, through the various possible couplings enumerated in the discussion of thrusts, the use of corrected net thrust for noise calculations adds to noise results an additional layer of weather-sensitivity. Decreasing pressure augments corrected net thrust, for a given net thrust.

5) *Fuel Burn*

The BADA model of fuel burn rate for propeller-driven aircraft has no dependence on weather. However, for jets and turboprops, it specifies fuel burn rate as the product of net thrust with a thrust-specific fuel consumption (TSFC) rate. This immediately introduces an indirect dependence on weather as described in the discussion of thrust response to weather changes. Each type of engine has its own expression to evaluate TSFC as a function of true airspeed and aircraft-specific modeling coefficients. BADA fuel burn rate for jets and turboprops therefore inherits further weather-sensitivity from true airspeed, but the effect cannot be qualitatively predicted because the values of the TSFC coefficients are not constrained.

The AEDT terminal-area fuel consumption model [7][8] is used for fuel burn calculations in the terminal area phase of flight. This model has separate treatments for arrivals and departures, but both depend on temperature, Mach number, and thrust for TSFC rates, all of which have their own weather dependencies. Arrival TSFC rates have an additional sensitivity to weather through pressure.

III. IMPROVED WEATHER TREATMENT

A. *Improved Weather Model*

The improvement under consideration is the introduction of a high-fidelity model of weather that supports variation of all atmospheric properties (temperature, pressure, wind, etc.) along all three spatial dimensions, as well as in time. This is done by reading and interpolating weather data defined on 4D grids. These grids are supplied by the user as files, and they can be retrieved in supported formats from the historical datasets of the NCEP/NCAR Reanalysis Project [9][10], from the predictive datasets of NOAA/NCEP's Rapid Update Cycle (RUC) [11][12], or from NASA's Goddard Earth Observing System (GEOS) [13]. The data supplied in these sets are defined on grids that are regularly spaced in time and along geographic coordinate systems, but irregularly spaced along the direction in which altitude is measured.

The implementation of this model requires a decision of how atmospheric quantities should vary between grid points. Perhaps the simplest treatments to implement involve piecewise constant variation, where properties remain constant throughout a piece of space or time adjacent to a grid point (the most common example of this is "nearest neighbor" interpolation, but temporal interpolation might favor a "most recent sample" approach). A more complex, but arguably more intuitive treatment is to use linear interpolation of atmospheric properties between grid points. Fig. 2 illustrates these approaches in one dimension, for clarity.

B. *Implications for Performance Models*

1) *1845/Doc29 Performance Model*

Atmospheric thermodynamics and wind are only referenced as point-wise values in the 1845/Doc29 model, and there is no dependence on how any of these values changes between

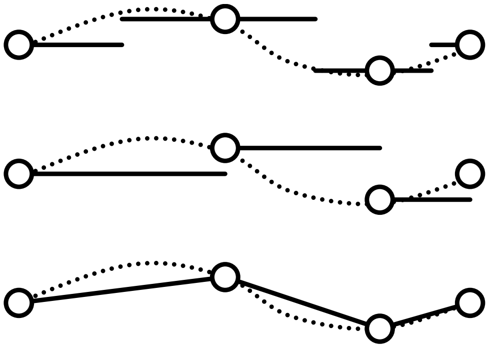

Figure 2 - Data samples (circles) from continuous functions (dashed curves) can be interpolated (solid lines) using nearest neighbor (top), most recent (middle), or piecewise linear (bottom) approaches.

locations and times. Therefore, the only changes to the performance model itself would be explicit acknowledgement that atmospheric quantities have 4-dimensional variation, and that headwind depends on the orientation of the aircraft. Although this is logistically simple, the introduction of such potentially rich behavior is transformative.

2) *BADA Performance Model*

It is less straightforward to incorporate high-fidelity weather into the BADA performance model. Several aspects of the BADA model are predicated on the assumption that temperature varies according to certain features of the BADA temperature model. These include the thrust correction due to temperature deviation, the maximum altitude, the constant-speed energy share factors, and the Mach transition altitude.

The thrust correction due to temperature deviation is based on the deviation of the temperature profile from the ISA temperature profile. There is ambiguity surrounding whether or not it should refer to the value of the deviation at sea-level or at the altitude for which thrust is being evaluated. Favoring the use of at-altitude temperature deviation is the fact that the thrust to which the correction is applied is based on local altitude and speed, and also that using the sea-level deviation would introduce non-local effects. The latter reasoning is less compelling when considering that the BADA performance model, when using the BADA atmosphere, does introduce non-local effects for altitudes above tropopause, for which the local temperature deviation from ISA is zero.

The interpretation of temperature deviation also figures prominently in the dependence of maximum altitude on a BADA temperature profile. Again, the BADA performance model defines this quantity, for a given aircraft mass, in terms of the temperature deviation from an ISA temperature profile, and it is not clear whether sea-level deviation or at-altitude deviation is appropriate in conjunction with a high-fidelity weather model. The altitude maximum models the variation in "altitude capability", as provided by aircraft manufacturers [14]. In the case where BADA temperature is used, the maximum altitude parameter defines a surface of spatially constant altitude, above which an aircraft cannot fly because its altitude exceeds its maximum altitude; the altitude of this surface increases as the weight of the aircraft diminishes. One might argue that, in the context of a 4D temperature field, the sea-level temperature deviation is the preferred basis for maximum altitude. This would mean that the maximum altitude defines one surface entirely at or below a spatially constant altitude (increasing as aircraft weight diminishes) through which the aircraft cannot fly because altitude exceeds maximum altitude on the other side. The surface would change in time in response to changes in the temperature field, but at any given time the surface would be single-valued for every ground coordinate. Alternatively, one might argue that, since the maximum altitude is a function of aircraft capabilities, it should be calculated from conditions local to the aircraft, including the at-altitude temperature deviation. In this case, maximum altitude defines at least one surface similar to the surface described for the sea-level deviation case, except without the "single-valued" criterion. It could also define any number of additional moving closed surfaces below this surface, each separating accessible regions from inaccessible regions.

The energy share factor for constant-speed procedure steps, derived from the BADA total-energy model, has complicated interactions with weather conditions. The BADA model presents simplifications of the energy share that are valid for constant-Mach or constant-CAS conditions (typical of BADA procedure steps), but the simplified expressions are partially based on the BADA pressure, density, and temperature profiles. Without the assumed behavior, there is an additional dependence on density, and on the derivative of pressure and temperature with respect to altitude.

The Mach transition altitude marks the transition between a constant-CAS procedure step and a constant-Mach step in standard BADA procedure steps. In the BADA model, the transition altitude for a given calibrated airspeed and Mach number defines a surface of constant altitude. Although the transition altitude presented in the BADA model is predicated on the BADA temperature and pressure profiles, the transition pressure ratio included in the model can be shown to hold for any spatially continuous atmospheric conditions. Thus, the transition altitude in the context of high-fidelity weather is a (single-valued) function of surface coordinate that also changes with time.

C. *Implications for Performance Algorithms*

One beneficial feature of the improved weather model is that it includes wind direction information. However, it introduces complexity to performance calculations, as the headwind is no longer explicitly provided. Instead, it must be calculated from the local 3D wind vector and the course of travel.

In current environmental models, flight profiles are calculated independently of the flight track. The two are then combined to complete the flight path. With the introduction of 4D weather, this is no longer possible, as the location and heading of the aircraft must be known to determine the weather for profile calculations. The algorithm must therefore track the surface coordinate while calculating the flight profile.

Present performance models and algorithms have the advantage of operating with the certainty that temperature, pressure, and density are monotonically decreasing with altitude. High-fidelity weather eliminates this guarantee. Furthermore, the implementation of the weather model may introduce spatial and/or temporal discontinuities in these properties. Some iterative solvers used in procedure step calculations will need to become more robust in response to these changes in conditioning.

D. Present Implementation

The present work is based on the implementation of a high-fidelity weather model in an early version of AEDT. Here, weather quantities are interpolated linearly in space, and are considered constant in time, according to the most recent sample of weather data. Headwind is derived from interpolated 3D wind vectors by taking the component that is opposite to an aircraft's direction of travel. Dependence on the BADA atmospheric model is intact, with high-fidelity weather data used only to determine the reference state. . Calculations for procedure steps are performed on the assumption that the atmospheric profiles at the beginning of each step remain the same throughout the length and duration of the step.

IV. SAMPLE PERFORMANCE IMPACT

In order to provide a more concrete idea of how variations in weather can affect performance results, we have included results from a series of five flight calculations differing only in the weather model applied. The control result used the legacy-style ("lapsed") weather treatment. The remaining four calculations were performed using high-fidelity ("interpolated") weather data, each taken from NCAR files describing a distinct time window (a morning in June, the evening of that same day, a November morning, and the corresponding evening). All flights are departures from Denver International Airport, in a Boeing 747-200. The ground track used for these flights includes altitude controls, as found in the Noise Integrated Routing System tool. Results presented here are restricted to those for which performance was calculated from the 1845/Doc29 specification.

The differences between weather inputs for each case can be examined from plots in Fig. 3. These feature samples of weather properties gathered at the midpoint of each segment of the calculated flight paths. Differences between pressure profiles are subtle, but the largest differences are between interpolated and lapsed pressure profiles. Temperature profile differences are most pronounced between interpolated and lapsed cases, and differences among interpolated temperature profiles are larger between seasons than between times of day. The most dramatic variation in inputs is found in headwind; interpolated headwind profiles are substantially different from the constant airport headwind used in the lapsed treatment. Interpolated headwind profiles for a given month are again qualitatively similar to each other, but differences between night and day become more pronounced at higher altitudes. Also, the difference between night and day headwinds is greater in winter than summer.

Performance results exhibit sensitivity to these changes in weather inputs, as seen in Fig. 4. As the effects of headwind and each thermodynamic property reinforce and counteract each other in complex ways, it is not straightforward to discuss specific variations of results in response to specific changes in weather conditions. Generally, differences in weather conditions affect the distance required to reach the target speeds and altitudes specified by procedure steps. Weather

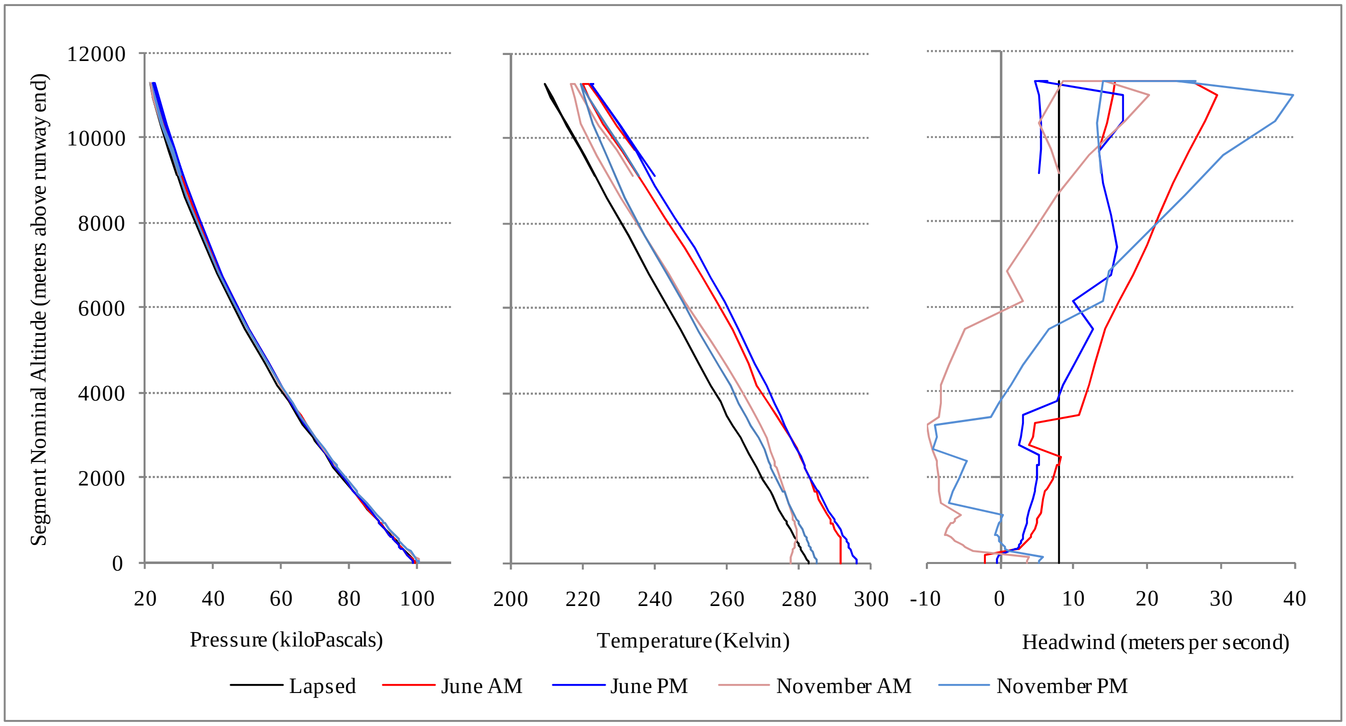

Figure 3 - Pressure, temperature, and headwind experienced by a departure event for 5 different weather specifications.

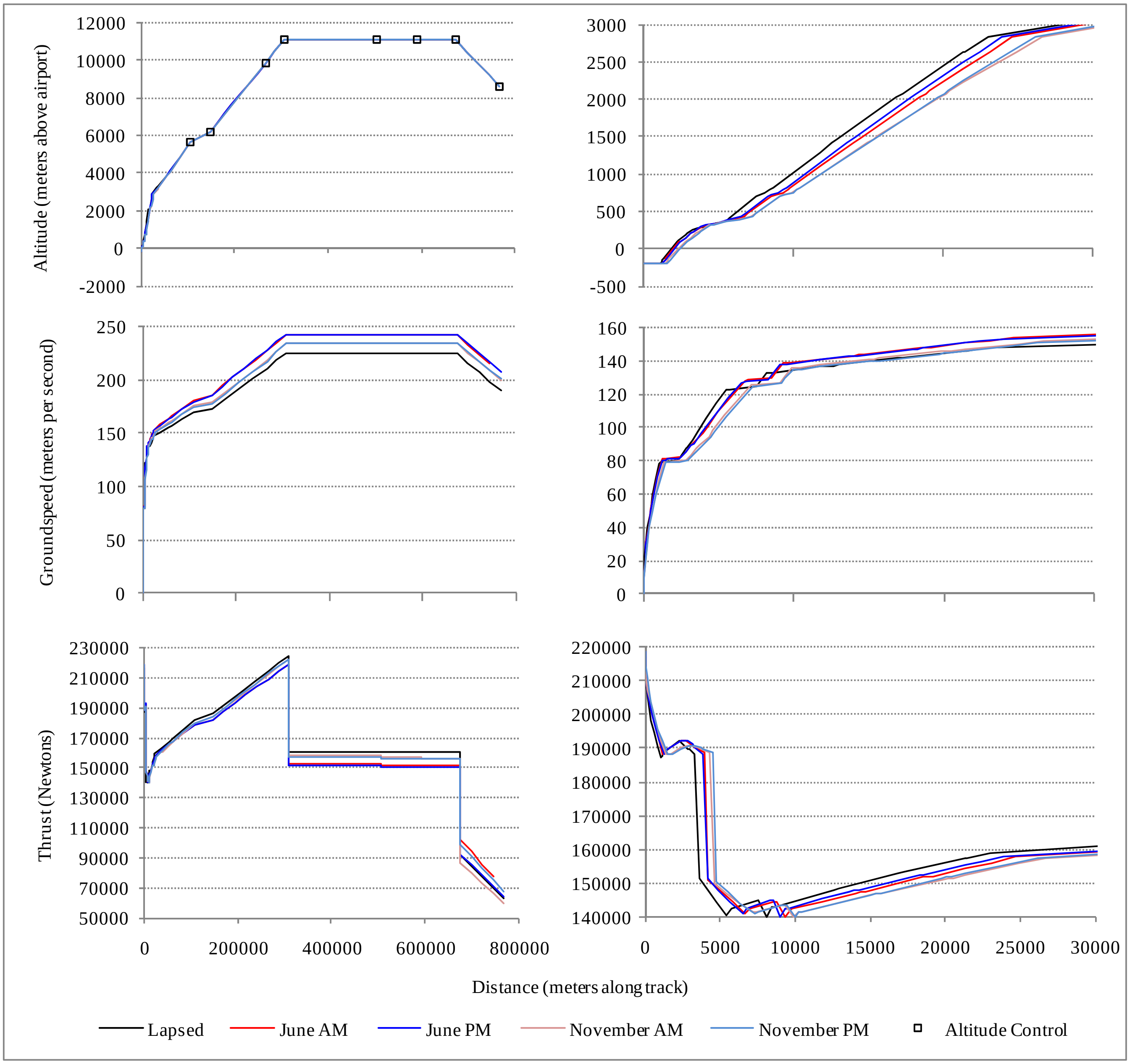

Figure 4 - Altitude, groundspeed, and thrust profiles calculated for a departure for 5 different weather specifications.

conditions affect altitude and speed profiles the most at lower altitudes, where performance is driven by standard procedures. During the latter stages of the flight, aircraft altitude is driven by altitude control constraints associated with the surface coordinate, and speed is driven by a speed schedule established by the standard flight profile, so the effects of weather variation no longer come into play for those quantities. Thrust results are susceptible to changes in weather throughout all flights. Also, for all performance quantities, results from a given month are similar to each other, as expected in light of the corresponding similarity of inputs.

V. SAMPLE AIRPORT-WIDE IMPACT

The aggregated effects of high-fidelity weather are also an area of interest. It is possible for weather differences to play a significant role in individual flight calculations while having a negligible effect on overall noise and emissions results. We have analyzed a full airport-wide study in the context of both the standard lapsed weather and a high-fidelity data sample.

Noise contours for the two scenarios are illustrated in Fig. 5. Note that there is no overall trend in the changes; in some locations, noise is greater for the high-fidelity scenario, while other locations exhibit more noise for the lapsed scenario. Trends are also absent in the noise and emissions metrics values provided in Table 1.

VI. FUTURE WORK

The present work represents a small first step into a vast landscape of possibilities to explore regarding high-fidelity weather treatment. There are many improvements that can be made to performance models to take advantage of the expansion in weather realism. The current algorithms are also quite simple, and would benefit greatly from a more robust sampling of richer weather content. As the models and algorithms improve, applications of simulation-driven design will expand, with previously impractical possibilities becoming realities.

A. Model Improvements

The current 1845/Doc29 and BADA performance models are based on the assumption that aircraft heading and aircraft course are equivalent. Now that realistic 3D wind information is available, it is possible to adjust these models to treat the two separately. Thus, the effect of an aircraft "crabbing" into prevailing winds to maintain a desired course can be properly calculated, including directivity effects on noise.

Calculation of arrival procedure steps using the 1845/Doc29 model is somewhat insensitive to weather. There are enhanced models that more realistically capture arrival performance. Procedures can be designed using these enhanced step models to achieve more realistic results.

The model for energy share in BADA constant-speed procedure steps is inadequate in the context of high-fidelity weather. These quantities should be reformulated to include the effect of deviations from the BADA atmospheric model.

B. Algorithm Improvements

The present implementation assumes a locally invariant atmospheric column for the duration of every procedure step. These steps can cover long distances and durations, over which significant changes in weather and aircraft course can take place. A first improvement to this situation would be to break the procedure step calculations into smaller segments, taking new weather and track course readings at the beginning of each segment.

Further improvements might treat the track-wise or temporal variation of weather conditions within a procedure step (or sub-segments thereof). This would likely require a significant amount of additional iteration schemes. It could possibly also require a broader set of information from the weather model than the point-wise data readings provided by the present implementation.

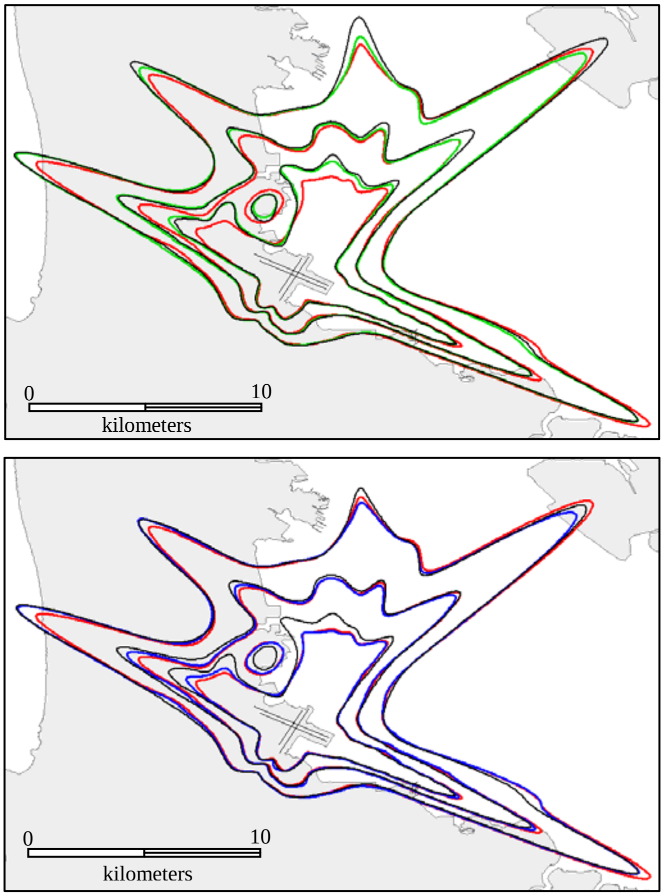

Figure 5 - Noise contours at 55dB, 50dB, 65dB for a full study in the context of a lapsed atmospheric model (red), and high-fidelity datasets from NCAR summer (green), RUC summer (black), and RUC winter (blue)

There are also opportunities to address the dependence of the BADA performance model on the BADA weather profiles. The present implementation does not address these issues. There are many simple options outlined in the previous discussion that could be easily implemented. Improvements presented to address Mach transition are less simple, but crucial to finding results that better reflect reality. The other more

TABLE I. ENVIRONMENTAL IMPACTS FOR A FULL STUDY UNDER VARYING WEATHER CONDITIONS; AREA OF NOISE CONTOURS AND EMISSIONS OF CARBON DIOXISE (CO_2), MONO-NITROGEN OXIDES (NO_X), TOTAL PARTICULATE MATTER (PM), VOLATILE FUEL ORGANICS PARTICULATE MATTER (PMFO), NON-VOLATILE PARTICULATE MATTER (PMNV), VOLATILE SULFUR PARTICULATE MATTER (PMSO), SULFUR OXIDES (SO_X), AND FUEL BURN

Weather Data Type	**Contour Area (km^2)**			**CO$_2$ (10^{9}g)**	**NO$_x$ (10^{7}g)**	**PM (10^{5}g)**	**PMFO (10^{5}g)**	**PMNV (10^{4}g)**	**PMSO (10^{4}g)**	**SO$_x$ (10^{5}g)**	**Fuel (10^{5}kg)**
	55 dB	***60 dB***	***65 dB***								
Lapsed	171.8	77.0	31.4	1.87	1.67	1.54	2.17	3.21	3.25	6.93	5.92
NCAR Summer	179.3	83.5	37.5	2.02	1.85	1.67	2.31	3.47	3.51	7.50	6.40
RUC Summer	172.8	82.2	37.1	2.00	1.84	1.67	2.32	3.46	3.49	7.43	6.34
RUC Winter	172.3	78.5	32.0	1.91	1.73	1.64	2.31	3.38	3.36	7.10	6.07

complex treatments presented, may have less promise from a cost-benefit perspective.

C. Applications

There are immediate applications for this new realism in coupling weather with performance models. Past weather conditions in aggregate are fair indicators of what to expect in the future. Using datasets covering past conditions, simulations can be used to predict what impacts would have resulted from a given procedure and track. This can be used to analyze existing practices, or to design new practices, in the context of real weather conditions. Such analyses and designs will have benefitted from the increased realism of individual flight results.

Over the long term, high-fidelity weather treatment in performance simulation has the potential to enable very useful technologies. As predictive weather data sets become more reliable, and computing power becomes more accessible, simulations could be performed within an optimization framework to choose flight paths, on the fly, such that environmental impacts are minimized.

VII. CONCLUSION

For the first time, AEDT users can now have greater control over the weather data used in the aircraft performance models. It is clear from the included results that, as in reality, the atmospheric weather conditions have a real impact on aircraft performance. From this heightened accuracy in weather modeling, one can expect more realistic results for predicting aircraft positioning, fuel consumption, acoustics, and emissions.

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AUTHOR BIOGRAPHIES

Michael J. Yaworski is an Aviation Environmental Analyst at ATAC Corporation, located in Sunnyvale, CA. He holds a B.S. in Physics and an M.S. in Aeronautical Engineering from Rensselaer Polytechnic Institute, with a primary focus on modeling turbulence using finite element methods. He has been the lead developer for the aircraft performance module of the FAA's Aviation Environmental Design Tool since 2009.

Eric P. Dinges is the Director of Environmental Programs at ATAC Corporation located in Sunnyvale, CA. He has been involved in acoustic modeling since 1997, and has been a member of the FAA’s Integrated Noise Model (INM) development team since 2001. He is also currently serving as ATAC’s lead on the FAA’s Aviation Environmental Design Tool (AEDT) development team. He received a B.S. in Mechanical Engineering from Rensselaer Polytechnic Institute in 1997 and has also pursued graduate studies in Mechanical Engineering and Acoustics from Rensselaer at Hartford and The Pennsylvania State University.

Ralph J. Iovinelli is the Aviation Environmental Design Tool (AEDT) Program Manager for the U.S. Federal Aviation Administration's Office of Environment and Energy in Washington, DC. He obtained his M.S. in environmental engineering from the University of Illinois at Urbana-Champaign. He is an active member of the ICAO Committee of Aviation Environmental Protection's (CAEP) technical emissions Working Group 3 (WG3). Mr. Iovinelli is also a participant in the SAE A-21 aircraft noise and emissions subcommittee.