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Effects of Graphical Weather Information versus Textual Weather Information on Situation Awareness in Meteorology

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EFFECTS OF GRAPHICAL WEATHER INFORMATION VERSUS TEXTUAL WEATHER INFORMATION ON SITUATION AWARENESS IN METEOROLOGY

by

Stefan Melendez

A Thesis Project Submitted to the College of Aviation,
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EFFECTS OF GRAPHICAL WEATHER INFORMATION VERSUS TEXTUAL WEATHER INFORMATION ON SITUATION AWARENESS FOR METEOROLOGY

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This Thesis was prepared under the direction of the candidate's Thesis Committee Chair, Dr. Andrew Dattel, Assistant Professor, Daytona Beach Campus, and Thesis Committee Members Debbie Schaum, Associate Professor, Daytona Beach Campus, and Dr. Christopher Herbster, Associate Professor, Daytona Beach Campus, and has been approved by the Thesis Committee. It was submitted to the Department of Graduate Studies in partial fulfillment of the requirements for the degree of Master of Science in Aeronautics

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Abstract

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Prior to a flight, pilots gather meteorological information to assess the weather conditions pertaining to their flight and to make decisions based on it. This information can come in various formats, such as text and graphical weather information. Research has shown that people have varying learning preferences and that most people prefer visual learning to verbal learning (i.e., graphical over text). It is hypothesized that this difference in learning preference can affect the way pilots interpret and apply the information they obtain prior to their flight. The researcher hypothesizes that graphical weather information has a greater, more positive impact on a pilot's situation awareness in meteorology than textual weather information. For this study, 20 participants were recruited and presented with two sets of weather information and were then asked to fly two different cross-country flights using the weather information provided. While flying, participants were asked SPAM questions to assess their situation awareness in meteorology. The results showed graphical weather information to be better than textual weather information for the participants' situation awareness in meteorology. Additional correlations showed evidence that people with both a high preference for visual learning and verbal learning can benefit from graphical weather information over textual weather information. Finally, the data collected indicated that the lack of meteorology training could be a factor in the misinterpretation of weather information. The implications for the findings of this study as well as opportunities for future research are discussed.

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Chapter I

Introduction

Before conducting a flight, most pilots gather meteorological information to assess the weather conditions that pertain to their flight; pilots can gather their own data or contact a professional weather briefer. Casner, Murphy, Neville, and Neville (2012) found some pilots skip the weather briefer altogether. The main, government-run, portal for obtaining this information codes a large portion of weather information in text form, and, the pilot is required to read and interpret it in form a mental picture of the meteorological conditions pertaining to their flight. In order to interpret the weather information, pilots need to know what certain abbreviations mean and should have basic knowledge in meteorology; for instance, a pilot should know what a thunderstorm is, how it is represented on a weather display, and what sort of hazards are associated with it.

Kharb, Samanta, Jindal, and Singh (2013) found that people prefer visual learning (i.e. pictures and graphics) to verbal learning (i.e. text) and retain visual information more efficiently. It is possible to present most of the textual, coded weather information in graphical form, which could help improve pilots' mental images of the relevant meteorological conditions, and, therefore improve their situation awareness in meteorology (SAM).

Significance of the Study

The significance of the study is to examine if there is an increase in SAM, when using graphical weather information (GWI) over textual weather information (TWI) and, therefore, help pilots more efficiently interpret weather charts. This study may benefit the pilot community by helping shed light on new ways to teach and/or learn aviation meteorology. Additionally, this study will contribute to the existing body of knowledge by adding findings on SAM and the effects that pre-flight weather information have on SA and performance.

For this study, GWI is weather information presented in graphical format. Figure 1 shows an example of a GWI chart. While TWI is weather information presented in the form of text. Figure 2 shows an example of METARS presented in text form.

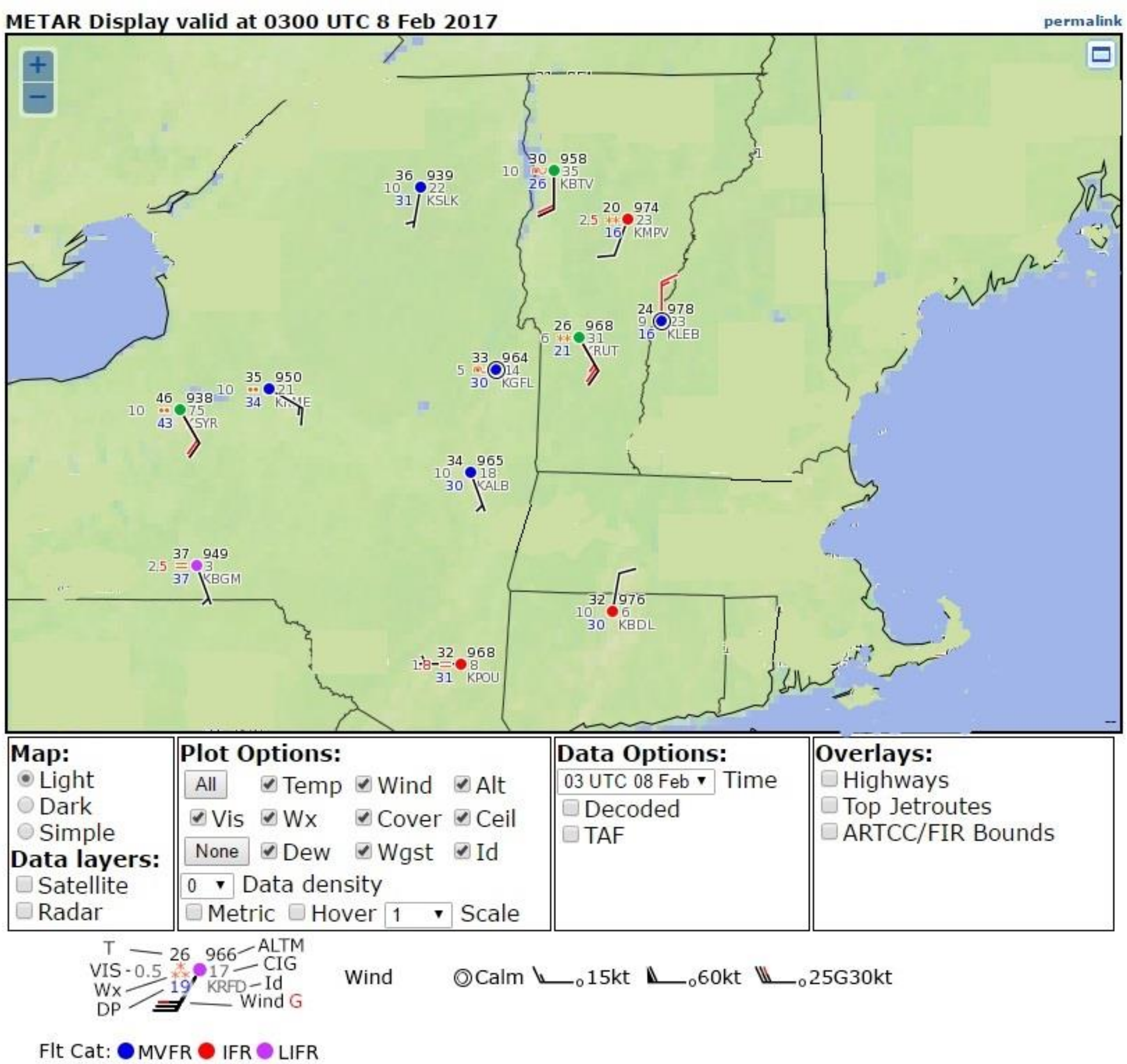

Figure 1. METARS in graphical format. Adapted from “ADDS METARs”, by Aviation Weather Center. Retrieved February 8, 2017 from https://www.aviationweather.gov/metar. In the public domain.

KRUT 150256Z 15010G25KT 6SM -SN OVC030 M03/M06 A2968
KLEB 080235Z 36000G15KT 9SM OVC023 M04/M08 A2978
KGFL 080253Z 00000KT 5SM -FZRA BKN014 01/M01 A2964
KALB 080251Z 16005KT 10SM OVC018 01/M01 A2965
KRME 080253Z 12015KT 10SM -RA BKN021 02/01 A2950
KSYR 080254Z 15010G20KT 10SM -RA OVC075 08/06 A2938
KBGM 080253Z 16005KT 2 1/2SM OVC003 03/03 A2949
KPOU 080253Z 27005KT 1 3/4SM OVC008 00/M01 A2968
KBDL 080251Z 01008KT 10SM BKN006 00/M01 A2976
KMPV 080251Z 20010KT 2 1/2SM -SN OVC023 M07/M09 A29[illegible]
KBTV 080254Z 18010G20KT 10SM -FZRA OVC035 M01/M03 A2958
KSLK 080251Z 19005KT 10SM UP OVC022 02/M01 A2939

Figure 2. METARS in textual format.

Statement of the Problem

The aviation industry is always striving for new ways to improve safety and save lives. Millions of lives pass through the hands of the aviation industry every day so having an excellent safety culture is critical for the industry. Most major airline accidents (i.e., 88%) involved problems with lack of SA (Endsley, 1995); therefore, safety improvements in this area are vital. Some pilots may not be developing an adequate level of SAM based on the way they obtain and interpret weather information and on the format presented. This is why identifying ways to increase pilots' SA could lead to better pilot decision-making and increased flight performance, therefore, leading to fewer accidents.

Purpose Statement

The purpose of this study is to test if there is any difference in a pilot's SA when he or she uses GWI versus TWI. Additionally, to see which of the two, if any, is better.

Hypotheses

The researcher tested the following null hypotheses:

H1: Participants who review GWI will not have better SAM than participants who review TWI.

H2: Participants who review GWI will not have better reaction times for SAM questions than participants who review TWI.

H3: Participants who review GWI will not declare more no-go decisions than participants who review TWI.

H4: Participants with two to three weather courses will not declare more no-go decisions than participants with zero to one weather course.

H5: Participants who are instrument-rater will not declare more no-go decisions than participants who are not instrument-rated.

Delimitations

For the purposes of this study, only pilots holding a private pilots or instrument-rated private pilots are eligible to participate. The reason for this is that these pilots would represent the target population for this research. Additionally, in order to conduct the experiments properly, the researcher needs to sample a population of pilots who have received adequate flight training, who can fly solo, and make the final decisions pertaining to a flight. Finally, due to the time and logistical constraints, the researcher was limited to sampling 20 pilots from Embry-Riddle Aeronautical University (ERAU).

Limitations and Assumptions

The funding resources available for this study are limited to participant remuneration. In addition, the researcher is limited to selecting pilots from ERAU due to geographical constraints and the population available locally. Furthermore, the researcher assumes that participants will follow the directions provided to them, have all received similar training, possess knowledge in line with the ratings they hold, and know how to operate and are familiar with a flight simulator.

Definitions of Terms

Congruency	The level to which pilots are used to seeing and reading a weather product.
Situation awareness	The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.
Situation awareness in meteorology	The meteorological component of Situation Awareness.

List of Acronyms

CFIT	Controlled flight into terrain
CWI	Congruent weather information
ERAU	Embry-Riddle Aeronautical University
FSX	Flight Simulator X
GWI	Graphical weather information

IFR	Instrument flight rules
IWI	Incongruent weather information
KBUF	Buffalo Niagara International Airport
KRME	Griffiss International Airport
KRUT	Rutland–Southern Vermont Regional Airport
KSYR	Syracuse Hancock International Airport
SAM	Situation awareness in meteorology
MO	Mountain obscurations
NTSB	National Transportation Safety Board
SA	Situation awareness
TWI	Textual weather information

Chapter II

Review of Relevant Literature

Situation Awareness

Pilots are required to maintain a level of awareness for the ever-changing and dynamic environment they operate in to conduct flights safely and to prevent problems from developing or getting worse. Not having this SA can cause the pilot to make wrong choices, not know what to do, not know what is going on around them, or get into an accident. According to Bailey (2008), loss of SA is the most common human error in air traffic control operations. Additionally, a study found that 88% of major airline accidents involved problems with lack of SA (Endsley, 1995). In order to maintain a safety culture, it is important to identify the elements that affect the level of awareness pilots have of their dynamic environment. Endsley (1988) defines SA as the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.

In aviation, SA consists of different elements that comprise the dynamic environment pilots operate. These elements include, but are not limited to, weather conditions, traffic, flight conditions, location for a potential emergency landing, and navigation aids. In order for a pilot to have good SA, the pilot needs to be aware and comprehend these elements as they pertain to their flight. Being aware of most, but not all, conditions is not good enough. For instance, a pilot may be aware of all the traffic in their airspace, their flight attitude, and their fuel quantity but may not be aware that ten miles ahead of their flight path are instrument flight rules (IFR) conditions. Wandering into unexpected IFR conditions could lead an unexperienced pilot into being spatially disoriented or in an accident. This is why pilots must be aware of all the relevant elements in their dynamic environment, comprehend their meaning, and project their status in the future, which are the three levels cited by Endsley (1995). For the purpose of this study, the researcher will focus on the meteorological aspect of SA, or, Situation Awareness in Meteorology (SAM).

Meteorological Situation Awareness

Overview and significance. For this study, the researcher defines SAM as the meteorological component of SA. Weather information is important to pilots because it can aid in making decisions pertaining to their flight. Weather conditions affect how an aircraft performs. For instance, warm temperatures increase takeoff distance, and upper level winds affect the aircraft's groundspeed. Additionally, pilots can use current weather conditions to create a flight plan that will consider weather information for flight performance. Adverse weather conditions, such as icing, thunderstorms, wind shear, and fog, can create hazardous conditions for a flight, and pilots should be aware of these to avoid them. Finally, it is important for pilots to understand atmospheric morphology, which is how the weather changes over time. For example, weather conditions may look clear in the morning and good to fly, but if weather forecasts indicate that the temperatures will increase and the air is humid, the pilot should expect the possibility of thunderstorms.

Pilots can obtain weather information required for good SAM before and during a flight. Before a flight, pilots can obtain this information online and through a professional weather briefer (Federal Aviation Administration [FAA], 2008). The pilot can use the information to form an overall mental image of the current meteorological conditions and to create an adequate flight plan. During the flight, pilots can obtain a standard weather briefing or update a previous briefing by contacting Flight Service (FAA, 2008). Additionally, depending on the resources available (i.e. a tablet computer) to pilots in-flight, they can obtain other types of weather data, such as weather radar, wind information, and temperature.

A large portion of the weather information provided by aviationweather.gov, the official website for aviation weather, is in textual format (e.g., METARS, TAFS, and area forecasts, etc.); the pilot is supposed to read and decode this information and make decisions based on it. The website also provides GWI in the form of surface analyses or weather radar, among other charts. All of this weather information requires a level of knowledge in meteorology to understand it enough to create a mental image of what the weather is outside and form good SAM.

Importance of Studying SAM

Accident and incident statistics. Improvements in safety and SA are top priorities in both general aviation and commercial aviation. Finding ways to improve SA is critical to the industry because improving SA may help reduce accidents in aviation. According to Airbus (2007), the Australian Transportation Safety Board conducted research showing that human factors is a contributing cause in around 70% of all aviation incidents and accidents; additionally, in approximately 85% incident reports, there is a mention of loss of situation awareness. Endsley (1995) also highlights the criticality of the problem: 88% of all major airline accidents included some sort of problem with lack of SA.

Research on the meteorological aspect of SA also shows how critical it is to improve SAM, and therefore, SA. Continued visual flight rules (VFR) flight into instrument meteorological conditions (IMC) is one leading causes of fatal accidents in the general aviation (GA) industry (Goh & Wiegmann, 2002). In addition, between 1983 and 1992, general aviation weather accidents constituted 27% of the fatalities among all accidents (Aircraft Owners and Pilots Association, 1996). Furthermore, according to the FAA (2003), 17% of all general aviation accidents are caused by controlled flight into terrain (CFIT); half of these occurred in IMC conditions. Finally, the National Transportation Safety Board (NTSB) mentioned "Identifying and Communicating Hazardous Weather" in their 2014 Most Wanted List for transportation safety improvements (NTSB, 2014).

Target population. The goal of this study was to sample a population that most closely represents GA pilots using the time and resources available to the researcher. The reason for this is that they are the population of pilots who rely on themselves for weather briefings; for instance, airline pilots are provided a flight plan by a dispatcher while a private pilot is responsible for making their own flight decisions. Additionally, with continued VFR flight into IMC being one leading causes of fatal accidents in the GA industry (Goh & Wiegmann, 2002), there is more motive to investigate a population representative of the GA industry.

According to the Aircraft Owners and Pilots Association (2011), about half of all certified pilots are either student pilots or private pilots. The researcher argues that the relatively young and inexperienced population sample, with a mean age of 22 and a mean flight time of 151 hours closely represents what can be reasonably expected from the GA industry.

Potential deterrents for SAM. The lack of an adequate weather briefing could be the cause of improper SAM for a relatively large number of pilots. A significant population of pilots (i.e., approximately 25%) briefed themselves on weather rather than contacting a professional weather briefer (Casner, Murphy, Neville, & Neville, 2012). Additionally, Casner, et al. (2012) found that self-briefing pilots preferred simple weather information rather than more-complex forecasts; this invites questions about the thoroughness of the weather information these groups of pilots are obtaining. These pilots may be missing some very important weather information that the professional weather briefer may explain or important weather information depicted on more-complex weather forecasts. For example, pilots briefing themselves may miss and/or not comprehend a piece of critical weather information that a professional weather briefer would be able to explain. This is important because a large portion of the weather information obtained by self-briefing pilots is in abbreviated text form, and this could be more difficult for less-experienced pilots to comprehend.

Another factor that can come into play to deter SAM is lack of flight experience. Inexperience could cause pilots to misjudge or misunderstand the current weather conditions, and therefore, unintentionally fly into hazardous weather, such as IMC. Pilots flying into IMC, for instance, without experience in IFR could become lost and/or disoriented, which could lead into an accident. Johnson and Wiegmann (2015) showed that pilots with actual instrument weather experience were more likely to avoid IMC conditions. Additionally, Detwiler, Holcomb, Boquet, Wiegmann, and Shappell (2005) showed that VFR flight into IMC conditions primarily involved inexperienced pilots.

SA Demons. In order to understand how GWI versus TWI can affect SAM, it is important to understand some SA demons. SA demons are elements that can negatively affect SA, or enemies to SA (Endsley & Jones, 2011). The following SA demons may play a part in affecting SAM when comparing GWI versus TWI: errant mental models, data overload, and attentional tunneling. Errant mental models could cause pilots to misinterpret a piece of meteorological information. Data overload could overwhelm pilots by the amount of data presented and, therefore, not form a complete picture of the weather conditions. Finally, attentional tunneling could cause pilots to fixate on a particular piece of weather information and/or product and dismiss the rest of the information.

Congruency

For this study, a confound variable may present itself in the form of the congruency of the weather products. In other words, this could happen if pilots obtain weather information in a format that they are not used to seeing versus in a format that they are used to seeing. The incongruence of the information may affect the interpretation of the weather information. For the purpose of the study, the researcher defines congruency as the level to which pilots are used to seeing and reading a weather product. In other words, congruent information is in line with the pilots' expectancies of the weather information format and presentation, while incongruent information violates this expectancy. An example for this could be that since METARS are normally presented in textual form this would classify a textual METAR under congruent for most people, while a graphical METAR would be incongruent.

Previous studies in the field of social psychology have shown that people are likely to spend more time processing information that violates their expectancy than information that does not (Sherman, Lee, Bessenoff, & Frost, 1998; Sherman, 1996; Stangor & McMillan, 1992; Stangor & Ruble, 1989). This suggests that pilots may spend more time examining and studying incongruent weather charts than congruent ones. Furthermore, another study showed that people interpret information better when displayed congruently than when displayed incongruently (Eshet-Alkalai & Geri, 2009); this study examined the effects of tasking high-school students with reading text that authors designed to be displayed in either digital or printed form. The experimenters for classified text that authors designed to be displayed in digital form but shown in print form as incongruent and congruent for text that authors designed to be displayed in the format shown. Participants performed better with the congruent text than with the incongruent text.

Based on the literature, incongruent weather products (e.g. a METAR displayed in graphical form) may have impacts on the participants' SAM. Participants may spend more time examining incongruent information, and therefore, perform worse at interpreting the information.

Learning Styles

The different ways people learn is called "learning style", which is an individual's preferred method of gathering, processing, interpreting, organizing, and analyzing information (Kharb, Samanta, Jindal, & Singh, 2013).One motivation for comparing

GWI to TWI is that the learning styles vary from person to person. Some people may comprehend textual information (i.e., verbal) better than pictures (i.e., visual), while others may comprehend pictures better. This is important because, for instance, people who are better at verbal learning will likely perform better in reading and comprehending textual weather information.

In order to provide learners with a profile of their learning styles, Fleming and Mills (1992) developed the VARK model. VARK stands for Visual, Auditory, Read/write, and Kinesthetic sensory modalities. Fleming and Mills (1992) showed that visual learners will process information better if they can see it, auditory learners will do better if they can hear it, read/write learners like to see the written words, and the kinesthetic learners prefer to acquire information through experience and practice.

Kharb et al. (2013) examined the learning styles of first-year medical students. The study showed that 61% of medical students had multimodal preferences, in other words, they preferred more than one learning style. This study found the following unimodal preferences amongst participants: 39% preferred kinesthetic learning, 32% preferred visual learning, 18% preferred auditory, and 11% preferred read and write. This gap in the percentage of people who prefer visual to textual learning (i.e., 32% to 11%) indicates that participants may prefer GWI to TWI. Other studies can also help confirm that visual information may be beneficial to most people (Kraut, Fussell, & Siegel, 2003; Gergle, Kraut, & Fussell, 2013; Fussell, Setlock, Kraut, 2003).

Considering the different types of learning styles and people's individual differences, another element that could influence SAM and play a role in this study is the type of weather product and the way the product presents the information. Some weather products may be more user-friendly than others may and could contain information that is easier to understand. For instance, color-coded weather radar is simple to understand because of people's high exposure to it (it is shown frequently on the news), but black-and-white charts with large amounts of symbology could be more difficult to understand because it may overwhelm the interpreter and cause data overload. Figure 3 shows an example of a black-and-white weather depiction chart with increased use of symbology. Figure 4 shows an example of color-coded weather radar.

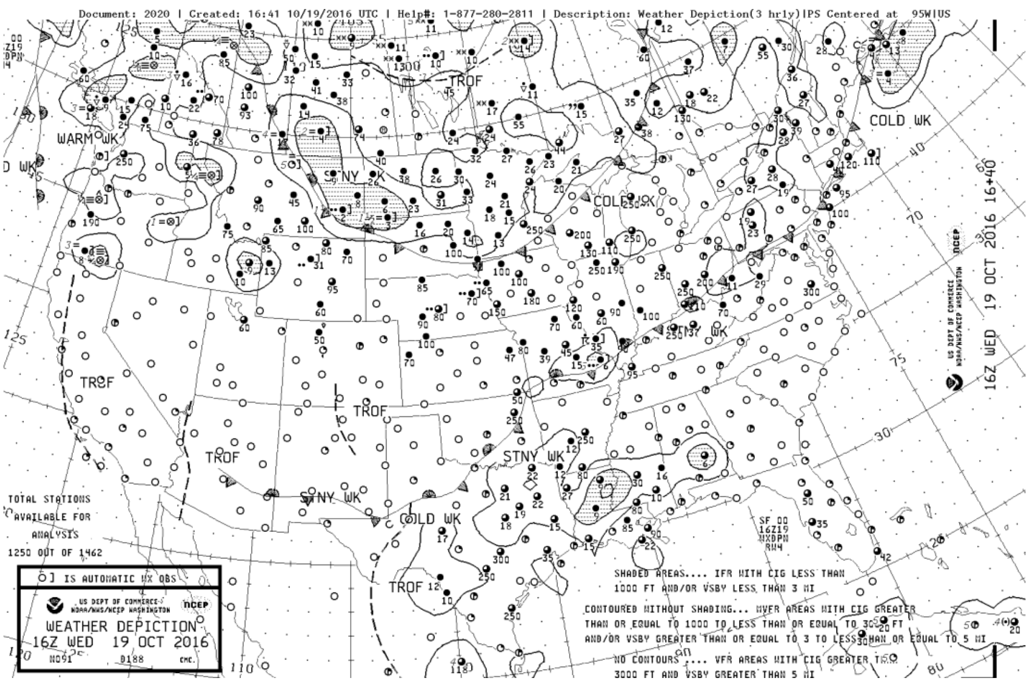

Figure 3. Black-and white Weather Depiction Chart for the United States. *Note*: this chart contains more information than the weather RADAR chart shown in Figure 2. Adapted from "International Flight Folder Program", by Aviation Weather Center. Retrieved October 19, 2016 from https://www.aviationweather.gov/flightfolder/products?type=radar. In the public domain.

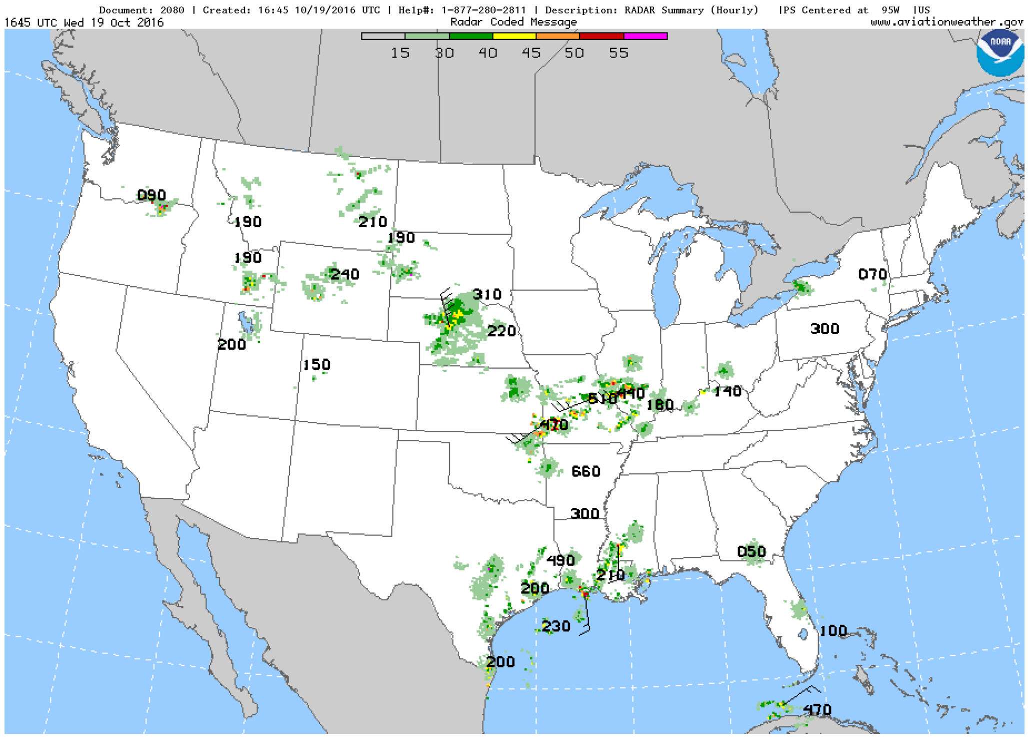

Figure 4. Color-coded weather RADAR Summary chart for the United States. Adapted from "Radar", by Aviation Weather Center. Retrieved October 19, 2016 from http://www.aviationweather.gov/radar. In the public domain.

Summary

In order to improve safety and reduce the number of accidents and fatalities in aviation, it is important to research ways to improve SA. One way to improve SA is by improving one of the most critical elements of it: SAM. Pilots are responsible for obtaining most of the information required to form good SAM. This information is available online and from professional weather briefers. It is critical for pilots to be able to gather, process, interpret, and analyze this information adequately. People have different learning styles and research has shown that most people prefer visual to verbal learning, so, perhaps, presenting meteorological information visually can help increase pilots' SAM. This study will be comparing the effects if GWI to TWI.

Chapter III

Methodology

Overview of the Study

This study examined the effects of GWI versus TWI on a pilot's SAM and determined which of the two sources of information, if any, was better for SAM. Additionally, using the participants' flight planning data, answers to the SPAM questions, and go/no-go decisions, the study examined the possibility that lack of weather training could be an issue for attaining good SAM. This study was a within-subjects (TWI versus GWI) quantitative experiment.

Sample

The researcher recruited 20 participants by posting flyers around ERAU, sending recruitment e-mails to pilots holding private pilot or private pilot with instrument-rating certificates, and by posting a message on ERAU's Human Factors Research Participation System page. This website allows researchers to post their study and for participants to volunteer for participation. The population in this study was generalized to pilots in the GA industry.

Materials

For meteorological information, the researcher presented the participants with binders containing the weather information (shown in Appendix A). For the flight scenario, the researcher used the Cognitive Engineering Research and Transportation Systems (CERTS) Lab located in the Canaveral Hall building at ERAU, its advanced flight simulator (running Microsoft Flight Simulator X [FSX]), and its computers. Additionally, the researcher used the VARK questionnaire (Fleming, 2017) to determine the participants' preferred learning style. Finally, the researcher used the questions in Appendix C along with a modified version of SPAM (Durso & Dattel, 2004) to assess the participants' SAM. For audio recording purposes, the researcher used a headset with a microphone and Audacity as the audio recording software.

Tests, questionnaires, and stimuli. The following are the different tests and questionnaires that participants had to complete and a brief description of what they are and their purpose. Additionally, the stimuli that the researcher used in the study is also described.

Demographics questionnaire. The demographics questionnaire, shown in Appendix E, fulfilled the purpose of collecting background information for each participant. The researcher used this information to describe the population sample, their number of flight hours, their ratings held, and the weather courses they had taken.

VARK questionnaire. This questionnaire consisted of a battery of questions that, when scored, provided participants with a profile of their most likely preferred learning styles. For the purpose of this study, the researcher collected their visual and their read/write results. The purpose of this information was to make correlations between the participants' graphical and textual scores and their preferred learning style.

Flight planning forms. The forms shown in Appendix F provided the participants with instructions on what to do for each flight, information for each cross country flight (e.g., departure time and estimated time enroute), and fields for them to fill in their selected cruising altitude and any other notes they would like to add (such as if the flight was a no-go). Additionally, a snippet from a VFR sectional map containing the departure and arrival airports was included with the flight planning form; the participants used this map to plot their selected flight route. The purpose of this information was for the researcher to cross check the flight plan with each participant's SPAM question answers to assess the accuracy of the answers.

SPAM questions. Each cross-country flight in the study featured eight different questions (shown in Appendix C) that played over a headset while participants flew the flight. A short beeping sound consisting of three short beeps played one second before each question was presented to alert the participant that there was a question coming so that they could pay attention. The purpose of these questions were to test the participants' SAM while flying.

Cross-country flight descriptions and development. This study featured two different VFR cross-country flights. These flights were simulated for 20 minutes in FSX in a Cessna G-1000 aircraft. The two flights featured similar hazards and similar complexities with different origin and departure airports. One flight had the origin airport being Syracuse Hancock International Airport (KSYR) and destination airport being Buffalo Niagara International Airport (KBUF); this flight mainly featured approaching IFR conditions, icing above 8,000 feet (initially), lowering cloud ceilings, turbulence and low-level wind shear, gusty winds and IFR conditions at the destination airport, and strong upper-level winds. The other flight was from Rutland–Southern Vermont Regional Airport (KRUT) to Griffiss International Airport (KRME); this flight mainly featured enroute mountain obscurations and IFR conditions, low cloud ceilings, frozen precipitation and icing, turbulence and low-level wind shear, IFR conditions at the destination airport, and strong upper-level winds. While some of these hazards were not targeted specifically by the SPAM questions, participants could have considered them when making flight decisions ultimately leading to a go or no-go decision. Each flight had the departure weather conditions loaded into them. Because participants would only simulate the first 20 minutes of each cross-country, they would not encounter any weather hazard, even if they failed to plan to avoid them (unless they flew into clouds after being instructed to remain in VFR conditions).

The researcher prepared both GWI and TWI for each flight; therefore, there were four separate stimuli conditions in total: KSYR to KBUF with TWI, KSYR to KBUF with GWI, KRUT to KRME with TWI, and KRUT to KRME with GWI. The two conditions that each participant ultimately received depended on counter-balancing.

Stimuli description and development. The researcher designed the stimuli so that no condition presented any advantages or disadvantages over the other. In order to make an accurate comparison between the two formats, the researcher selected weather products that were available in both graphical and textual formats. Selecting different products could have produced results that are due to the difference in weather information rather than the difference in format). The researcher consulted with Debbie Schaum, aviation weather expert and professor of meteorology at ERAU, to select as many products as possible to allow participants to form a three-dimensional mental picture of the weather information for each flight. The results of this selection process yielded the weather products shown in Figure 5. After selecting the weather products, the researcher looked for weather information and cross-country flights for which a direct flight between the two airports would be a no-go for VFR. After downloading the weather information, the researcher re-formatted it to make sure that one weather information format did not contain information that the other one did not. The reformatting process involved removing pieces of data from one format if the other format did not contain it. For instance, graphical METARS did not contain a “remarks” section so the researcher removed the “remarks” sections from the textual METARS. For any weather information not that was re-formatted, the participants were not tested on it. The TWI and GWI for each flight is shown in Appendix A.

Textual Weather Information	**Graphical Weather Information**
METARS TAFS AIRMETS/SIGMETS Winds/Temps Aloft Forecast Area Forecast	Graphical METARS TAFS AIRMETS/SIGMETS Wind Streamlines / Temps Flight Category Chart

Figure 5. Distribution of weather products between the two within-subjects groups.

Control

Counter-balancing. In order to minimize the possibilities of confound variables affecting the results and to account for testing effects, the researcher counter-balanced the groups. Half of the participants received GWI first, while the other half received TWI first. In addition, half of the participants flew the KSYR to KBUF flight first, while the other half flew KRUT to KRME first. Figure 6 shows the participant distribution and how they were counter-balanced. In order to account for testing effects, the researcher also created the scenarios being slightly different but similar in complexity with each flight containing various weather hazards with different parameters. For instance, one flight featured mountain obscurations in the route of flight, while the other flight featured approaching IFR weather.

No.	Flight 1	Flight 2	No.	Flight 1	Flight 2
1	KSYR - KBUF T	KRUT - KRME G	11	KRUT - KRME T	KSYR - KBUF G
2	KSYR - KBUF T	KRUT - KRME G	12	KRUT - KRME T	KSYR - KBUF G
3	KSYR - KBUF T	KRUT - KRME G	13	KRUT - KRME T	KSYR - KBUF G
4	KSYR - KBUF T	KRUT - KRME G	14	KRUT - KRME T	KSYR - KBUF G
5	KSYR - KBUF T	KRUT - KRME G	15	KRUT - KRME T	KSYR - KBUF G
6	KSYR - KBUF G	KRUT - KRME T	16	KRUT - KRME G	KSYR - KBUF T
7	KSYR - KBUF G	KRUT - KRME T	17	KRUT - KRME G	KSYR - KBUF T
8	KSYR - KBUF G	KRUT - KRME T	18	KRUT - KRME G	KSYR - KBUF T
9	KSYR - KBUF G	KRUT - KRME T	19	KRUT - KRME G	KSYR - KBUF T
10	KSYR - KBUF G	KRUT - KRME T	20	KRUT - KRME G	KSYR - KBUF T

Figure 6. Participant distribution and counter-balancing. The “No.” column is the participant number, Flight 1 and Flight 2 show the order that the participants received the flights, while the “T” and “G” labels represent whether the weather information the participants received was textual or graphical respectively.

Stimuli control. In addition to providing similar weather information between the two flights and the same weather information across the TWI and GWI groups of the same flight, the researcher also provided map legends for the GWI group and reference maps for the TWI group. Additionally, a tablet with SkyVector was accessible to each participant for any flight; every participants was able to use SkyVector to search for stations or areas of interest. The researcher instructed the participants not to use the tablet for anything else other than referencing locations. The reason for providing participants with these resources was to minimize any other disadvantages across the groups. Participants may not have been familiar with the area they conducted the flights in, therefore, participants receiving TWI could have had difficulties locating METAR stations among other stations or locations, or forming a mental picture of where the weather was. Furthermore, participants looking at GWI may not have been aware of the meaning of the different symbols presented in the charts. Appendix C shows the legends and maps provided for stimuli control. In Appendix C, Maps 1a and 2a show the locations of the METARS and TAFS stations referenced in the weather information along with the departure and arrival airports shown in red and linked with a straight line. Maps 1b and 2b show a snippet from a VFR sectional chart with a direct flight route plotted between the departure and arrival airports. Maps 1c and 2c show the locations of the stations referenced in the Winds and Temperatures aloft forecasts. These maps were provided to every group regardless of whether the participant received TWI or GWI.

Congruency. In order to minimize the potential effects of the congruency confound variable, the researcher allowed participants enough time to review all weather information and provided them with the maps and legends previously mentioned. More time would have allowed participants a chance to review any incongruent information, while maps and legends would have helped them interpret it. Moreover, to test the Congruency independent variable, as illustrated in Figure 7, each cross-country flight would feature half of the weather information as congruent weather information (CWI) and the other half as Incongruent Weather Information (IWI). In order to verify the classifications for CWI and IWI, the researcher administered a survey to subject matter experts; this survey revealed that the area forecast and flight category chart products were incorrectly classified. Due to this misclassification, the researcher did not conduct any statistical tests on the Congruency variable.

	Textual (XC1)	Graphical (XC2)
Congruent	Textual METAR/TAF Winds Aloft Forecast	AIRMETS/SIGMETS Flight Category Chart
Non-Congruent	AIRMETS/SIGMETS Area Forecast	Graphical METAR/TAF Wind Streamlines

Figure 7. Distribution of weather products between the two within-subjects groups. For each flight, participants would receive two congruent products and two non-congruent products. The green and red items represent the products that participants would receive for cross-country flight one (XC1) and cross-country flight two (XC2) respectively.

Procedure

Study description. The researcher scheduled each participant for two hours in the CERTS lab. Before starting the study, participants were showed the consent form shown in Appendix D and asked them to read and sign it. Afterwards, the researcher gave participants a brief overview of the study and asked them to complete the demographics questionnaire. Following the demographics questionnaire, participants then completed the VARK questionnaire that was loaded into one of the computers. Afterwards, each participant was given an overview of the flight simulator's flight controls and features so they could then practice flying it until they got used to the controls. Following the practice flight, the researcher presented the participants with the appropriate weather information for the first flight; for instance, referring to Figure 5, the first participant received the TWI for the KSYR to KBUF flight and a briefing of the instructions shown in the flight planning forms. These instructions told the participants to treat each flight as if it were a real flight, that they had 20 minutes to review the weather information, and to make any changes and deviations to the flight plan as they saw adequate.

After the flight planning stage concluded, the experiment proceeded to the flight simulation stage. For this part, participants flew the cross-country for which they reviewed the weather information. Before starting the flight, the researcher briefed each participant with the instructions for the flight: “Put on the headset and listen for a beeping sound then pay attention to and answer each question given. You are sitting on runway (15 for KSYR and 13 for KRUT). Take off and climb to 1,000 feet, intercept and fly the GPS course on the aircraft’s GPS, then climb to your selected cruising altitude as long as you can remain in VFR conditions.” After the participants declared they were ready, the researcher started a 20-minute timer, initiated the corresponding Audacity project containing the flight’s SPAM questions, and recorded the participants’ responses using the headset’s microphone.

After the 20-minute timer expired and all SPAM questions played, the researcher terminated the simulated flight and prepared the participant for the second simulated cross-country flight.

For the second flight, participants received a different weather information format and simulated the next flight; for instance, if the first flight was KSYR to KBUF, the second was from KRUT to KRME, and if the first flight received TWI, the second received GWI. The process for weather information review and flight simulation would then be iterated but with different conditions for the participant (different flight, different weather information, and different weather information format).

Variables. For this study, the independent variables were the type of weather information format, which features two levels: GWI vs TWI and Congruent vs

Incongruent Weather Information; while the dependent variables were the accuracy of SAM question responses and response times for SAM.

Treatment of data

The researcher analyzed all of the data and conducted all of the statistical tests using the SPSS Statistics software from IBM.

Descriptive statistics. Descriptive statistics were obtained from the demographics questionnaire and the flight plan forms. These demographics questionnaire had information about age, gender, flight hours, ratings held, and weather courses they have completed. The flight plan helped gather information as the participants' go or no-go decisions and the hazards they would have encountered based on their flight route and cruising altitude.

Go or no-go decisions. The researcher used the answers in the "notes" section of the flight plan to determine whether the flight is a go or a no-go. If the participant planned an alternate airport in their flight plan or simply wrote "no-go," the researcher counted the flight as a no-go; otherwise, it was counted as a "go". The researcher then used this information to describe whether TWI or GWI resulted in more no-go decisions and to show whether the amount of training had an impact on the decisions. In order to test whether or not TWI and GWI had an effect on go/no-go decisions, a chi square-test of independence was conducted. Additional chi-squares were conducted to test go/no-go decisions based on weather courses taken and flight ratings held.

Hazard encounters. The researcher used the cruising altitude information to determine whether each participant would have encountered IFR or icing conditions for the KSYR to KBUF flight and IFR, icing, or mountain obscurations (MO) for the KRUT to KRME flight.

Effects of TWI versus GWI on SAM. The researcher scored each correct answer for a SPAM question as one point, for a maximum eight points per flight. The scores were then sorted into scores for TWI and scores for GWI, with higher scores meaning higher SAM. For each correct answer, the researcher measured the time it took the participant to answer a question correctly and then calculated the average response time.

SPAM question scores. The researcher conducted a related-samples *t*-test to compare the means of the scores for TWI and GWI and to test the null hypothesis.

SPAM reaction times. The researcher sorted participants' average response times into response times for TWI and response times for GWI and then conducted a related-samples *t*-test to compare the two means.

Learning Styles and SPAM Scores Correlations

The researcher used the visual and verbal scores for each participants' VARK questionnaire results in addition to their SPAM scores for TWI and GWI to correlate whether SAM relates to participants' learning styles.

A two-tailed Pearson correlation was conducted to test which of the variables relate to the other. The researcher reported only the correlations that were statistically significant. Six correlations were conducted: (a) VARK visual score and SAM GWI score, (b) VARK visual score and SAM TWI Score, (c) VARK verbal score and SAM GWI score, (d) VARK verbal score and SAM TWI score, (e) VARK visual score and VARK verbal score, (f) SAM TWI score and SAM GWI score.

Chapter IV

Results

Descriptive Statistics

The following information describes the population sampled in this study, their go or no-go decisions for each flight, and which hazards they would have encountered based on their flight planning information.

Demographics. Twenty participants, enrolled as college students, volunteered to participate in the study. Nineteen of the students were enrolled in the flight program at ERAU, while one student was enrolled in a flight program not affiliated with ERAU. The following results describe the population sample in terms of their gender and age, as well as the amount of formal training they have received.

Of the 20 participants sampled, 16 (80%) were male and 4 (20%) were female. The sample mean for age was ($M = 22$, $SD = 6.46$) with a range of 18 years old to 48 years old. Eight participants (40%) were private pilots, and 12 (60%) were instrument-rated private pilots. The mean for total flight hours for the sample population was ($M = 150.55$, $SD = 53.16$), with a range of 78 hours to 315 hours. In terms of weather courses taken at the time of the study, two participants had not taken any weather courses, six participants had taken one, 11 participants had taken two, and one participant had taken three.

Frequency data. Go/no-go decisions based on GWI versus TWI, weather courses taken, flight rating held, and route flown were analyzed and described. Additionally, hazard encounters were analyzed based on flight and the type of hazard participants would have encountered.

Go/no-go decisions. Table 1 shows the number of go/no-go decisions based on the type of weather information received and this serves as the most direct comparison between TWI and GWI for Go/No-go decisions. A chi square test for independence, $\chi^2(1) = 0.102$, $p = 0.749$, showed no difference between TWI and GWI when considering Go/No-go decisions.

Table 1

Total Go/No-go Decisions Based on Stimuli

Stimuli	No-Go	*Go*
GWI	8	12
TWI	9	11

Table 2 shows the total go/no-go decisions based on the flight conducted. Table 3 shows the combination of go/no-go decisions based on both the flight conducted and the stimuli received. Finally, Table 4 shows the go/no-go decisions based on the flight order. Table 5 shows go/no-go decisions based on the number of meteorology courses taken. Table 6 shows go/no-go decisions based on the ratings held. The chi-square tests for go/no-go decisions based on flight order and ratings held were not significant.

Table 2

Total Go/No-go Decisions Based on Flight

Flight	Decision	*n*
KSYR	Go	12
	No-go	8
KRUT	Go	11
	No-go	9

Table 3

Go/No-go Decisions Based on Flight and Stimuli

Flight	Stimuli	Decision	*n*
KSYR	GWI	Go	6
		No-go	4
	TWI	Go	6
		No-go	4
KRUT	GWI	Go	6
		No-go	4
	TWI	Go	5
		No-go	5

Table 4

Go/No-go Decisions Based on Flight Order

Flight	Decision	*n*
First	Go	9
	No-go	11
Second	Go	14
	No-go	6

Table 5

Go/No-go Decisions Based on Meteorology Courses Taken

Courses	Decision	*n*
0-1	Go	8
	No-go	8
2-3	Go	15
	No-go	9

Table 6

Go/No-go Decisions Based on Rating Held

Rating	Decision	*n*
Private	Go	12
	No-go	4
Instrument	Go	11
	No-go	13

Hazard encounters. Table 7 shows the number of participants who would have encountered each hazard for each flight based on their selected route and cruising altitude. The mountain obscuration hazard does not apply to the KSYR to KBUF flight, as the hazard was not present.

Table 7

Hazards Encountered Based on Flight

Flight	Icing	*IFR*	*MO*
KSYR	$n = 1$	$n = 12$	-
KRUT	$n = 11$	$n = 11$	$n = 5$

Note. MO = Mountain Obscuration.

Effects of TWI versus GWI on SAM

Accuracy of SAM question scores. A related-samples *t*-test was conducted to test the difference between the TWI group ($M = 3.25$, $SD = 1.54$) and the GWI group ($M = 4.70$, $SD = 1.72$). Those in the GWI group answered significantly more SAM questions correctly than those in the TWI group. The *t*-test was significant, $t(19) = -2.33$, $p = 0.03$), Cohen's $d = 0.52$.

SPAM reaction times. A related-samples *t*-test was conducted to test whether there is a difference in reaction times between TWI and GWI. The mean reaction time for TWI (*M* = 2.56, *SD* = 1.39) was not statistically different from the mean reaction time for GWI (*M* = 3.05, *SD* = 1.90); *t*(19) = -0.76, *p* = 0.46.

Learning Styles and SPAM Scores Correlations

Six two-tailed Pearson's product-moment correlation coefficients were computed to assess the relationships between participants' learning styles and the SPAM scores. Table 8 shows the significant correlations between the variables. Figures 7, 8, and 9 show scatterplots for the three significant correlations; these figures show that the data points were reasonably well distributed along the regression line, indicating a linear relationship and homoscedasticity.

Table 8

Correlations

	GWI Score	Verbal Score	TWI Score
Visual Score	0.34	0.24	-0.46*
GWI Score		0.47*	-.54*
Verbal Score			-0.15

*Correlation is significant (two-tailed)

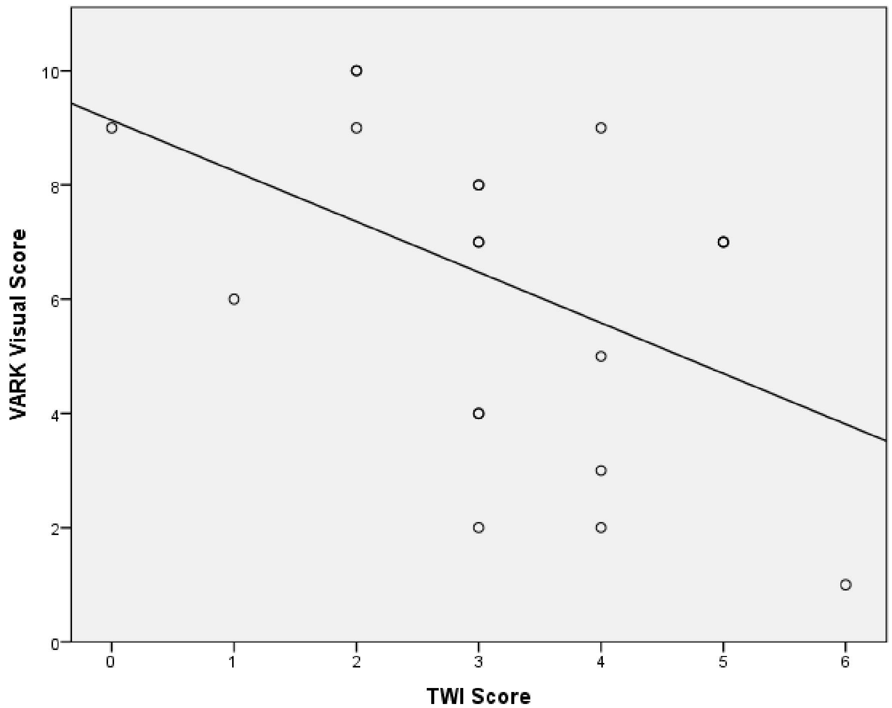

Figure 8. Scatterplot and Regression Line for VARK Visual Scores and TWI Scores.

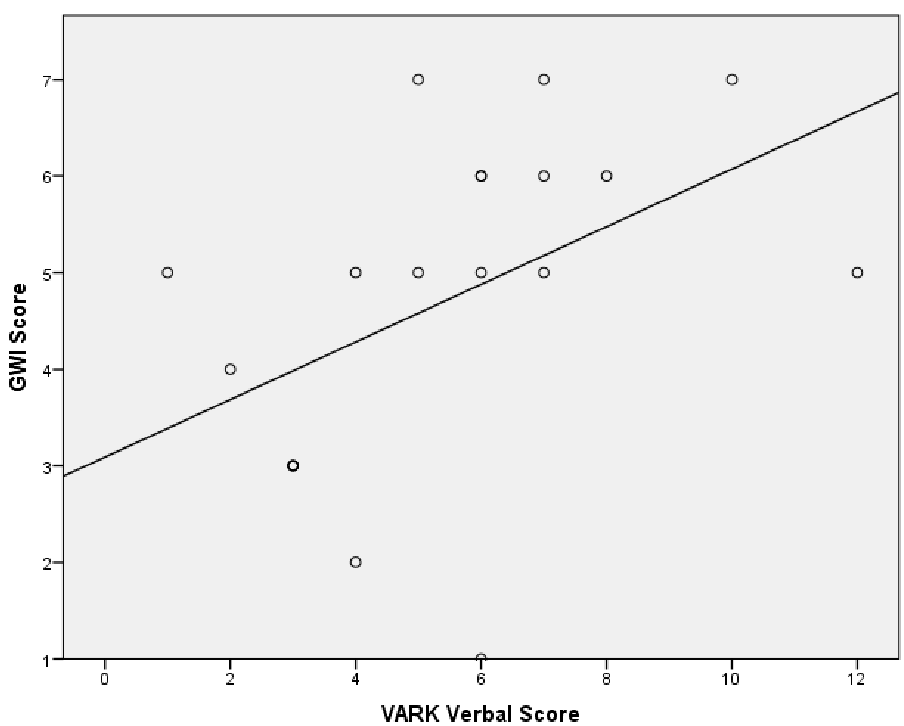

Figure 9. Scatterplot and Regression Line for GWI Scores and VARK Verbal Scores.

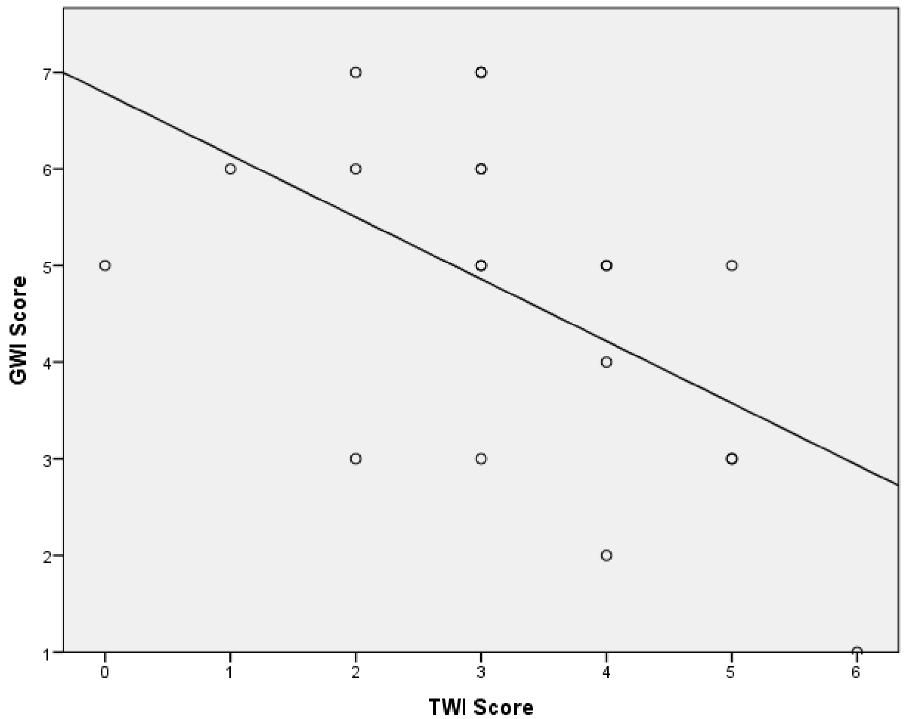

Figure 10. Scatterplot and Regression Line for GWI Scores and TWI Scores.

Chapter V

Discussion, Conclusions, and Recommendations

Discussion

Go/no-go decisions. For the most-direct comparison between TWI and GWI for Go/No-go decisions, there was no statistical difference between the two factors. This finding suggests that the type of weather display had no influence in participants' no-go decisions for this study. Furthermore, there were no significant differences when comparing go/no-go decisions based on meteorology courses taken and ratings held.

Frequency data. For the KSYR to KBUF flight, which featured deteriorating conditions (lowering ceilings and icing conditions, forecasted hazardous weather conditions at the destination airport, and turbulence), 40% of participants' flight plans were declared as a "no-go." While for the KRUT to KRME flight, which featured enroute and destination hazardous conditions (IFR conditions, icing, MO conditions, and a forecasted-IFR destination airport), 45% of participants' flight plans were declared as a "no-go".

Hazard encounters. For the KSYR to KBUF and KRUT-KRME flights, 60% and 55% of participants would have encountered some type of hazard respectively. If the results accurately represent a real-world flight with real pilots, most of the pilots would have encountered IFR conditions while one would have encountered icing for the KSYR to KBUF flight, and five would have encountered MO conditions for the KRUT to KRME flights.

SAM question scores. The related-samples *t*-test showed GWI to be better than TWI for SAM. These results were the most critical for the study because they showed that participants do better in maintaining awareness of the weather while flying when presented GWI over TWI. This means that, if pilots are exposed to graphical and visual charts, they may have higher SAM than if they are exposed to textual information.

SPAM reaction times. The results indicate no statistical difference in the time it took each participant to answer a SPAM question when they were presented with TWI versus GWI. This means that when participants reviewed GWI, they did not react any faster in answering SAM questions than when participants reviewed TWI.

Learning styles and SPAM scores correlations. Of the six correlations conducted, three were significant, and the other three were not significant. The non-significant scores could be due to confound variables or that the variables do not correlate in reality.

For this study, only the visual and verbal (i.e., read/write) scores of the VARK questionnaire were considered. This means that a higher score in visual versus verbal does not mean that a person's preference in learning style lies in that category (it could lie in aural or kinesthetic). For instance, someone with a high visual score prefers visual learning to someone with a lower visual score. This does not rule out that the person could have a higher score on any of the other three categories. Therefore, the correlations conducted in this study do not reflect relationships between visual versus verbal learners. They do, however, show relationships between how much they prefer the learning style in question and how well they performed with textual versus graphical in terms of SAM. The results showed that participants benefited from GWI over TWI in their SAM, but it is important to note that the correlations do not show whether verbal learners benefited from TWI over GWI or whether visual learners benefited from GWI over TWI. The results, however, can provide some evidence that, in general, most people can benefit from GWI over TWI.

VARK visual score and TWI score. There was a significant negative correlation between participants' visual scores in the VARK questionnaire and their TWI scores for SPAM. In other words, participants with higher scores in textual information had lower visual scores, which means that participants with higher preference in visual learning had lower performance with the textual stimuli.

VARK verbal score and GWI score. There was a significant positive correlation between participants' verbal scores in the VARK questionnaire and their GWI scores for SPAM. In other words, participants with higher scores in graphical information also had higher scores for their verbal preference. While this positive correlation may seem counter-intuitive at first, it just shows that people with higher preference in verbal learning performed better on SAM questions that were related to GWI.

TWI score and GWI score. There was a significant negative correlation between participants' TWI scores for SPAM and their GWI scores for SPAM. In other words, participants with higher scores in graphical information had lower scores for textual information. This correlation shows that people who performed better with the graphical stimuli performed worse with the textual stimuli. This could be because people with higher scores in GWI were visual learners and, therefore, performed worse with TWI.

Final thoughts on the correlations. These correlations showed some interesting results: The significant correlations favor GWI and show that people with high verbal affinity can perform well with it. Additionally, there are no significant correlations to show that people with high verbal affinity can benefit from textual information. Based on the results, the most logical conclusion could be that people with high verbal affinity can perform well with GWI, and that most people, including people with high verbal affinity, can perform better with GWI than with TWI.

Conclusions

As shown by previous research and literature, there is a problem that pilots may not be getting adequate meteorological information from the resources available to them, and this could be leading to accidents and safety concerns. This why it is important to make changes in any area that could help improve safety in the aviation industry

This research study served the purpose of making an initial effort to improve the aviation weather products available to pilots. While this study alone does not supply enough evidence, data, and information to initiate widespread changes into the available weather products, it opens the door to many potential follow-up studies and some small changes to be made. The results indicate that GWI information helps SAM over TWI.

TWI versus GWI. GWI was shown to be better than TWI for SAM. Participants answered significantly more question correctly when presented with GWI than with TWI. Additionally, considering the results from the correlations, the results showed some evidence that most people, including those with high preference for verbal learning, could benefit from GWI over TWI.

Training. Based on the overall performance of the participants, the results and descriptive statistics show that most participants would have encountered some sort of hazard in each flight. This shows that participants were likely unable to interpret and, therefore, identify all of the hazards for the respective flights. This could be due to several reasons, participants may have assumed that the weather would improve or perhaps they had a lack of adequate training in reading the charts and/or understanding meteorology. For instance, some participants answered that, for the KSYR to KBUF flight, KBUF would be under marginal VFR conditions while, in reality, it was forecast to be in IFR conditions. They may have missed this piece of information due to numerous factors that could point back to lack of training. Perhaps they did not interpret the information correctly or they did not know which product to look at. Perhaps some participants lack understanding of atmospheric morphology and, therefore, did not expect the IFR weather to be moving toward them. Alternatively, maybe they just did not know which forecast time to look at. Furthermore, although not statistically significant, instrument-rated private pilots declared no-go decisions more often than private pilots did. This finding is in line with the results of the study by Johnson and Wiegmann (2015) which found no statistical difference between instrument-rated private pilots and private pilots. As discussed in the literature review, however, the study did find that actual experience in IMC was a better predictor for safe performance. What this could mean for this study is that the difference in no-go decisions for ratings held could be due to actual experience in IMC rather than the rating held.

Recommendations

Future direction. The researcher recommends follow-up studies to determine which type of weather display is best for SAM with the overall goal of improving the quality of the weather products available to pilots. First, additional research is recommended that could show further evidence that GWI is better than TWI in increasing SAM and improving decision-making. One idea could be to test GWI versus TWI and measure the different SA levels through various questionnaires and/or SPAM questions.

Second, research to show that pilots can get all (or most) of the relevant information visually rather than verbally would help with any doubts that pilots may not get essential information if textual information is minimized or removed. When future studies show additional concrete evidence that GWI is better than TWI, research and development can commence into innovative weather products. Next, after prototypes are developed, future studies can test which of these prototypes are better and whether they are better than the current charts and displays.

Some visual products are already available to certain users in the form of computer model forecasts or to the public in the form of unofficial, non-aviation weather products. Figure 11 shows an example of an existing graphical weather product developed by The Weather Company, LLC (2017) that can provide relatively large amounts of weather information is just one display. With that display, the interpreter can get various surface weather conditions such as winds, temperature, and precipitation. This display can be animated with the colored arrows representing winds and temperatures moving at a speed relative to the wind speed magnitude, and the weather RADAR animation showing where the precipitation is moving in relation to the surface. The animation feature can help the interpreter understand the depicted atmospheric morphology by understanding where and how fast the weather is moving.

Figure 11. Graphical representation of winds, temperature and weather RADAR.

While a display like the one shown in Figure 11 may seem adequate as explained, future research and development are needed to validate a final product. One problem this current display might have is that, while the arrows show wind speeds and temperature, it does not depict the exact values for them and a pilot may have difficulty using the weather information for weather planning. Perhaps a new study comparing current weather charts versus experimental weather charts representing information in various, innovative, ways such as animated or three-dimensional weather products, such as the one shown in Figure 11, can help in the research and development of new weather products.

The researcher also recommends future research to verify which type of training in meteorology results in better SA and performance. This study did not find any statistical differences between any of the training factors, but that could be because the tests were between-subjects rather than within-subjects like the researcher designed this study. What this means is that it is possible that the statistical tests for go/no-go decisions based on ratings held and metrology courses taken did not have enough power. Future researchers could design a between-subjects study to test these variables with more power.

Furthermore, the researcher recommends any future studies to sample pilots from varying regions to minimize the possibility that the sample lacks experience with certain types of weather hazards. For instance, the participants for this study were recruited locally in Florida; these participants completed most of their flight training in an area with infrequent icing conditions. This lack of experience with certain weather hazards could potentially manifest itself as a confound variable.

Vision for future product. The researcher envisions an interactive, three-dimensional flight-planning tool that contains all of the essential weather information required for good decision-making and SAM. This product could feature different layers, animations, and forecasts for which the user can interact. For instance, one feature could include an animation of forecast temperatures with altitude filters; this tool could color-code temperatures with freezing temperatures standing out. Another function could be a click-to-reveal feature that shows additional weather information upon users' requests.

Another alternative could be for pilots to look initially at GWI, like the display in Figure 11, as a way to create an overall mental picture of the weather. Once this mental picture is established, pilots can then proceed to request traditional weather information (such as METARS or Winds-Aloft Forecasts) for flight planning purposes. It is possible that using GWI in synergy with traditional weather information could not only increase SAM but also result in better flight planning.

It is worth noting that effort is already being made into increasing the availability of GWI. Aviationweather.gov has some products similar to what was previously described. An example of this is shown in figure 12. This tool features meteorological information displayed in graphical format with different layers and forecast points. While this tool is a step to GWI, the researcher recommends more research and development into tools that can show animations and three-dimensional information.

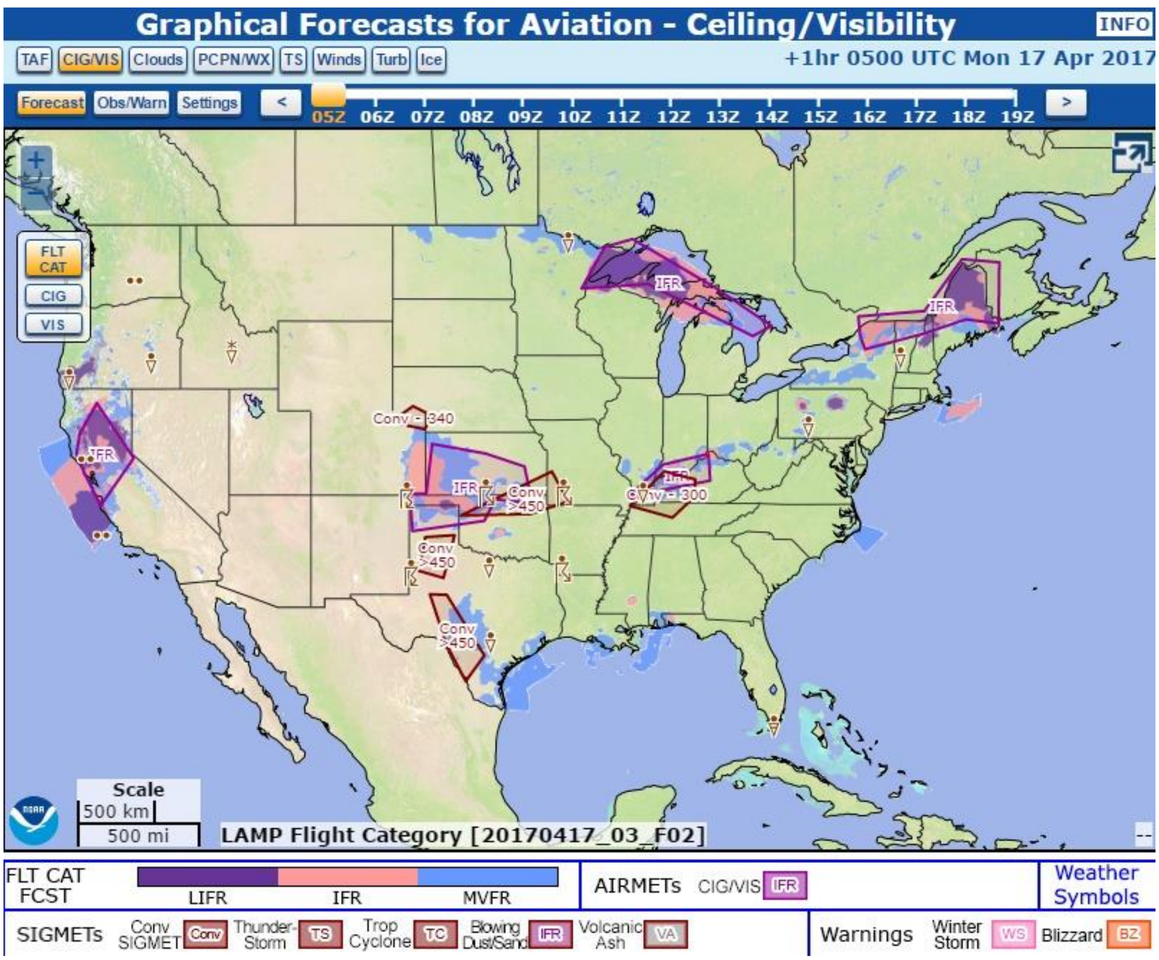

Figure 12. Graphical weather tool. Adapted from “Graphical Forecasts for Aviation”, by Aviation Weather Center, 2017 (http://www.aviationweather.gov/gfa). In the public domain.

Lessons learned. Throughout the process of developing the study, the researcher encountered several issues and obstacles. First, the congruency survey uncovered one weather product that was incorrectly misclassified. Additional time, brainstorming, and consultation would have likely mitigated this issue. Next, more-appropriate SAM questions along several pilot studies (to test the questions) would have helped measure the different SA levels for the participants and, therefore, allowed the researcher to conduct other tests or comparisons. For example, does GWI help attain all three levels of SAM more effectively than TWI?

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Appendix A

Weather Information

KRUT-KRME Textual Weather Information

AIRMETS

Type: AIRMET Hazard: MTN OBSCN

```
WAUS41 KKCI 072045
BOSS WA 072045
AIRMET SIERRA UPDT 4 FOR IFR AND MTN OBSCN VALID UNTIL 080300
AIRMET MTN OBSCN...ME NH VT MA NY PA WV MD VA
FROM 70NW PQI TO 20SSE MLT TO 20SW CON TO 20N SAX TO EKN TO HMV
TO HNN TO AIR TO JHW TO SYR TO MSS TO YSC TO 70NW PQI
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z...MTN OBSCN ME NH VT MA NY PA WV MD VA
BOUNDED BY 70NW PQI-20SSE MLT-20SSW CON-20NNW SAX-HAR-30N GSO-
HMV-HNN-20ENE AIR-JHW-SYR-MSS-YSC-70NW PQI
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG THRU 09Z.
```

Type: AIRMET Hazard: IFR

```
WAUS41 KKCI 072045
BOSS WA 072045
AIRMET SIERRA UPDT 4 FOR IFR AND MTN OBSCN VALID UNTIL 080300
AIRMET IFR...ME NH VT MA RI CT NY LO NJ PA OH LE AND CSTL WTRS
FROM 40E YQB TO 50SE HUL TO 150ENE ACK TO 30E ACK TO 20NNE CYN
TO 30WSW HAR TO 30S JHW TO 40SW DXO TO 30SE ECK TO YOW TO YSC TO
40E YQB
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z...MTN OBSCN ME NH VT MA NY PA WV MD VA
BOUNDED BY 70NW PQI-20SSE MLT-20SSW CON-20NNW SAX-HAR-30N GSO-
HMV-HNN-20ENE AIR-JHW-SYR-MSS-YSC-70NW PQI
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG THRU 09Z.
```

Type: AIRMET Hazard: TURB

```
WAUS41 KKCI 072045
BOST WA 072045
AIRMET TANGO UPDT 3 FOR TURB STG WNDS AND LLWS VALID UNTIL 080300
AIRMET TURB...LO PA OH LE WV VA NC SC GA FL AND CSTL WTRS
FROM 20N YYZ TO 40S IRQ TO 90WSW PIE TO 170SE LEV TO 130ESE LEV
TO 40W CEW TO 50SW PZD TO GQO TO HMV TO HNN TO CVG TO FWA TO
30SE ECK TO 20N YYZ
MOD TURB BTN FL180 AND FL390. CONDS DVLPG 00-03Z. CONDS CONTG
BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z
AREA 1...TURB NY LO NJ PA OH LE WV MD DC DE VA NC SC GA FL AND
CSTL WTRS
BOUNDED BY YOW-20ESE ALB-30SW PBI-50SSW RSW-SRQ-90WSW PIE-170SE
LEV-130ESE LEV-40W CEW-50SW PZD-GQO-HMV-HNN-CVG-FWA-30SE ECK-YOW
MOD TURB BTN FL180 AND FL390. CONDS CONTG THRU 09Z.
AREA 2...STG SFC WNDS ME NH AND CSTL WTRS
BOUNDED BY 50SW YSJ-150ENE ACK-30SSE ENE-50ENE ENE-50SW YSJ
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS ENDG 06-09Z.
```

Type: AIRMET Hazard: TURB

```
WAUS41 KKCI 072045
BOST WA 072045
AIRMET TANGO UPDT 3 FOR TURB STG WNDS AND LLWS VALID UNTIL 080300
AIRMET TURB...ME NH VT MA NY LO AND CSTL WTRS
FROM 70NW PQI TO 60NE PQI TO 140ENE ACK TO ALB TO 60NE YYZ TO
YOW TO YSC TO 70NW PQI
MOD TURB BLW 080. CONDS CONTG BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z
AREA 1...TURB NY LO NJ PA OH LE WV MD DC DE VA NC SC GA FL AND
CSTL WTRS
BOUNDED BY YOW-20ESE ALB-30SW PBI-50SSW RSW-SRQ-90WSW PIE-170SE
LEV-130ESE LEV-40W CEW-50SW PZD-GQO-HMV-HNN-CVG-FWA-30SE ECK-YOW
MOD TURB BTN FL180 AND FL390. CONDS CONTG THRU 09Z.
AREA 2...STG SFC WNDS ME NH AND CSTL WTRS
BOUNDED BY 50SW YSJ-150ENE ACK-30SSE ENE-50ENE ENE-50SW YSJ
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS ENDG 06-09Z.
```

Type: AIRMET Hazard: TURB

```
WAUS41 KKCI 072045
BOST WA 072045
AIRMET TANGO UPDT 3 FOR TURB STG WNDS AND LLWS VALID UNTIL 080300
AIRMET TURB...ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA
NC SC GA AND CSTL WTRS
FROM 60NE YYZ TO ALB TO 140ENE ACK TO 50S ACK TO 70SSE ECG TO
70SSW ILM TO 30NW CAE TO 30SSE LGC TO GQO TO HMV TO HNN TO 50ESE
ECK TO 60NE YYZ
MOD TURB BLW 100. CONDS CONTG BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z
AREA 1...TURB NY LO NJ PA OH LE WV MD DC DE VA NC SC GA FL AND
CSTL WTRS
BOUNDED BY YOW-20ESE ALB-30SW PBI-50SSW RSW-SRQ-90WSW PIE-170SE
LEV-130ESE LEV-40W CEW-50SW PZD-GQO-HMV-HNN-CVG-FWA-30SE ECK-YOW
MOD TURB BTN FL180 AND FL390. CONDS CONTG THRU 09Z.
AREA 2...STG SFC WNDS ME NH AND CSTL WTRS
BOUNDED BY 50SW YSJ-150ENE ACK-30SSE ENE-50ENE ENE-50SW YSJ
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS ENDG 06-09Z.
```

Type: AIRMET Hazard: TURB

```
WAUS41 KKCI 072045
BOST WA 072045
AIRMET TANGO UPDT 3 FOR TURB STG WNDS AND LLWS VALID UNTIL 080300
AIRMET STG SFC WNDS...ME NH AND CSTL WTRS
FROM 60SW YSJ TO 150ENE ACK TO 30SSE ENE TO 50ENE ENE TO 60SW YSJ
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS DVLPG 00-03Z.
CONDS CONTG BYD 03Z ENDG 06-09Z.
LLWS POTENTIAL...NH VT MA CT NY LO NJ PA OH LE MD DE AND CSTL
WTRS
BOUNDED BY YOW-40NNW MPV-40SE MPV-20W PVD-20SSE CYN-20S SIE-20S
JST-30E EWC-20NW CLE-30SE ECK-40W YYZ-YOW
LLWS EXP. CONDS CONTG BYD 03Z THRU 09Z.
LLWS POTENTIAL...ME NH MA RI CT NY NJ AND CSTL WTRS
BOUNDED BY 140SSE BGR-200SE ACK-110S HTO-20SSE CYN-20W PVD-
140SSE BGR
```

```
LLWS EXP. CONDS CONTG BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z
AREA 1...TURB NY LO NJ PA OH LE WV MD DC DE VA NC SC GA FL AND
CSTL WTRS
BOUNDED BY YOW-20ESE ALB-30SW PBI-50SSW RSW-SRQ-90WSW PIE-170SE
LEV-130ESE LEV-40W CEW-50SW PZD-GQO-HMV-HNN-CVG-FWA-30SE ECK-YOW
MOD TURB BTN FL180 AND FL390. CONDS CONTG THRU 09Z.
AREA 2...STG SFC WNDS ME NH AND CSTL WTRS
BOUNDED BY 50SW YSJ-150ENE ACK-30SSE ENE-50ENE ENE-50SW YSJ
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS ENDG 06-09Z.
```

Type: AIRMET Hazard: ICE

```
WAUS41 KKCI 072045
BOSZ WA 072045
AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 080300
AIRMET ICE...ME NH VT MA NY LO AND CSTL WTRS
FROM 40E YQB TO 30ESE HUL TO 50WSW YSJ TO 140S YSJ TO 50WSW CON
TO 20SW YOW TO YSC TO 40E YQB
MOD ICE BLW 150. CONDS CONTG BYD 03Z THRU 09Z.
FRZLVL...RANGING FROM SFC-105 ACRS AREA
 MULT FRZLVL 020-080 BOUNDED BY YSC-60SW YSJ-140E ACK-40SE BOS-
 20W SAX-20NW HNK-30NE YYZ-YOW-YSC
 SFC ALG 20WNW YYZ-20WSW ALB-130SSE BGR-140SSE BGR
 040 ALG 40WSW YYZ-40WNW SYR-30ENE HNK-30W BDL-BOS-80ENE ACK-
 140ENE ACK
 080 ALG 50WSW ROD-40W ERI-30NE SLT-30SW SAX-50SSE PVD-160ESE
 ACK
```

Type: AIRMET Hazard: ICE

```
WAUS41 KKCI 072045
BOSZ WA 072045
AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 080300
AIRMET ICE...ME NH VT MA RI CT NY LO NJ PA OH LE AND CSTL WTRS
FROM 20SW YOW TO 40ENE ALB TO 140S YSJ TO 170SE ACK TO 50S JHW TO
50SW CLE TO 30SE ECK TO 20SW YOW
MOD ICE BTN 080 AND FL210. CONDS CONTG BYD 03Z ENDG 06-09Z.
FRZLVL...RANGING FROM SFC-105 ACRS AREA
 MULT FRZLVL 020-080 BOUNDED BY YSC-60SW YSJ-140E ACK-40SE BOS-
 20W SAX-20NW HNK-30NE YYZ-YOW-YSC
 SFC ALG 20WNW YYZ-20WSW ALB-130SSE BGR-140SSE BGR
 040 ALG 40WSW YYZ-40WNW SYR-30ENE HNK-30W BDL-BOS-80ENE ACK-
 140ENE ACK
 080 ALG 50WSW ROD-40W ERI-30NE SLT-30SW SAX-50SSE PVD-160ESE
 ACK
```

Area Forecast

```
000
FAUS41 KKCI 080145
FA1W
BOSC FA 080145
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 082000
CLDS/WX VALID UNTIL 081400...OTLK VALID 081400-082000
ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA AND CSTL WTRS
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.
.
SYNOPSIS...02Z LOW 50E YVV WITH CDFNT ALG A 50E YVV-ERI-APE-BWG
LN. WRMFNT ALG A 50E YVV-SYR-ALB-ACK-140E ACK LN. 20Z CDFNT ALG A
60E HUL-ACK-SBY-VXV LN.
.
ME
N HLF...OVC025 LYRD FL300. VIS 3SM -SN BR. BECMG 0912 OVC020. VIS
3SM -FZRAPLSN. OTLK..MVFR CIG FZDZ BR 17Z MVFR CIG.
SW QTR...OVC015 TOPS FL280. VIS 3SM -FZRAPL BR. 08Z OCNL -RA.
OTLK...MVFR CIG SHRA NRN SXNS...VFR SRN SXNS.
SE QTR...OVC015 TOPS FL300. VIS 3SM -FZRAPLSN BR. BECMG 1013
OVC010. VIS 3SM -RA BR. OTLK...IFR CIG RA BR 16Z IFR CIG.
.
NH VT
N HLF...OVC025 TOPS FL250. VIS 3SM -FZRAPLSN BR. OTLK...VFR WRN
SXNS...MVFR CIG ERN SXNS.
S HLF...BKN020 OVC040 TOPS FL280. VIS 3SM -FZRAPL BR. BECMG 1013
BKN050 TOPS 080 BKN CI. OTLK...VFR.
.
MA RI CT
WRN-CNTRL MA...OVC020 TOPS FL270. VIS 4SM -FZRA/-FZDZ BR. BECMG
0609 OVC020. VIS 3SM -RA BR. OTLK...MVFR CIG 17Z VFR.
NANTUCKET ISLAND...BKN010 BKN100 LYRD FL300. VIS 3SM BR. 09Z WND
SW 20G30KT. OTLK...IFR CIG RA BR WND.
RMNDR MA/RI/CT...BKN015 BKN100 LYRD FL300. VIS 3SM BR. OCNL -DZ.
BECMG 0912 OVC015 TOPS 100. VIS 4SM BR. OCNL -RA. OTLK...MVFR CIG
18Z VFR.
.
NY LO
EXTRM SERN NY...BKN010 BKN120 TOPS FL250. VIS 3-5SM -DZ BR. BECMG
0710 OVC015 LYRD FL350. VIS 4SM BR. WDLY SCT -SHRA. OTLK...MVFR
CIG 15Z VFR.
EXTRM NERN NY...OVC030 LYRD FL350. VIS 3SM -FZRAPLSN BR. BECMG
0709 OVC045 TOPS 100. VIS 3SM -RA BR. WND SW G25-30KT. OTLK...VFR
WND.
RMNDR ERN NY...OVC015 TOPS FL350. VIS 3SM -RA BR. OTLK...MVFR CIG
16Z VFR WND.
CNTRL NY...OVC020 TOPS FL350. VIS 4SM IN SCT -SHRA BR. 08Z WND SW
25G35KT NRN SXNS. OTLK...MVFR CIG THRUT...WND NRN SXNS.
WRN NY/LO...OVC020-030 TOPS FL350. VIS 3SM -RA BR. BECMG 0609
WDLY SCT -SHRA. WND SW 20G35KT NRN SXNS. OTLK...MVFR CIG
THRUT..WND NRN SXNS.
.
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```
PA NJ
EXTRM NWRN PA...SCT035 BKN050 TOPS 150. WDLY SCT -SHRA. WND SW
20G30KT. BECMG 0507 BKN020 TOPS 080. OCNL -DZ. WND W G25KT.
OTLK...MVFR CIG.
RMNDR NWRN QTR PA...OVC030-040 TOPS FL250. SCT -SHRA. OTLK...IFR
CIG SHRA 18Z MVFR CIG SHRA.
SW QTR PA...OVC035 TOPS FL220. SCT -SHRA. BECMG 0710 BKN025
BKN060. OTLK...MVFR CIG SHRA WRN SXNS...VFR ERN SXNS.
NERN QTR PA...OVC020 LYRD FL300. TIL 10Z OCNL VIS 3SM -RA BR.
OTLK...MVFR CIG 15Z VFR.
SE QTR PA/NJ...BKN020 BKN100 LYRD FL280. VIS 4SM BR. BECMG 0508
WDLY SCT -SHRA. OTLK...MVFR CIG SHRA BR 15Z VFR.
.
OH LE
W HLF OH...BKN025 TOPS 060. TIL 10Z WND W G25KT NRN SXNS.
OTLK...MVFR CIG THRUT...16Z RASN.
E HLF OH/LE...BKN020-030 TOPS 070. OCNL -DZ NRN SXNS. TIL 06Z
WDLY SCT -SHRA. OTLK...MVFR CIG.
.
WV
NW HLF...OVC040 TOPS 100. WDLY SCT -SHRA MAINLY NRN SXNS.
OTLK...MVFR CIG THRUT...SHRA NRN SXNS.
SE HLF...OVC060 LYRD FL200. TIL 06Z SCT -SHRA. BECMG 0912 OVC035.
OTLK...IFR CIG 17Z VFR.
.
MD DC DE VA
N HLF...SCT030 BKN-SCT100 TOPS 170 BKN CI. WND S G25KT ERN SXNS.
06Z SCT025 BKN-SCT045. OTLK...VFR.
SW QTR...SCT-BKN060 BKN120 TOPS FL200. WDLY SCT -SHRA. BECMG 0710
BKN050. OTLK...VFR.
SE QTR...SCT-BKN CI. BECMG 0609 SCT025 OVC060 LYRD FL220. WDLY
SCT -SHRA. BECMG 1012 OVC015. SCT -SHRA. OTLK...IFR CIG SHRA 17Z
VFR.
.
CSTL WTRS
N OF ACK...OVC010 TOPS FL250. VIS 3SM -RAPLSN BR. WND NELY
25G35KT. BECMG 0609 BKN015 BKN100 LYRD FL250. WDLY SCT -SHRA. WND
S G25KT. OTLK...MVFR CIG SHRA WND.
RMNDR...SCT025 SCT-BKN050 TOPS 150. ISOL -SHRA. BECMG 0912
BKN015-025 LYRD FL350. SCT -SHRA. ISOL -TSRA. CB TOPS FL350. WND
S G25KT. OTLK...MVFR CIG SHRA WND.
....
```

METARS

KRUT 150256Z 15010G25KT 6SM -SN OVC030 M03/M06 A2968
KLEB 080235Z 36000G15KT 9SM OVC023 M04/M08 A2978
KGFL 080253Z 00000KT 5SM -FZRA BKN014 01/M01 A2964
KALB 080251Z 16005KT 10SM OVC018 01/M01 A2965
KRME 080253Z 12015KT 10SM -RA BKN021 02/01 A2950
KSYR 080254Z 15010G20KT 10SM -RA OVC075 08/06 A2938
KBGM 080253Z 16005KT 2 1/2SM OVC003 03/03 A2949
KPOU 080253Z 27005KT 1 3/4SM OVC008 00/M01 A2968
KBDL 080251Z 01008KT 10SM BKN006 00/M01 A2976
KMPV 080251Z 20010KT 2 1/2SM -SN OVC023 M07/M09 A2974
KBTV 080254Z 18010G20KT 10SM -FZRA OVC035 M01/M03 A2958
KSLK 080251Z 19005KT 10SM UP OVC022 02/M01 A2939

TAFS

KRUT 080228Z 0802/0824 16010G25KT 6SM -FZRASNPL OVC035
FM080900 16010KT 3SM -RA OVC045

TAF KLEB 072334Z 080200 VRB03KT 3SM -FZRAPL BR BKN025 OVC040
FM080500 VRB03KT 5SM BR OVC030

KGFL 080212Z 0802/0824 18004KT 6SM -RA OVC015
FM080600 19005KT 3SM -SHRA BR OVC007

KALB 080212Z 0802/0824 18008KT 6SM -RA BR OVC015
FM080600 19010KT 3SM -SHRA BR OVC008

TAF KRME 072342Z 0800/0824 12010KT 5SM –RA OVC015
FM080400 12010KT 2SM -RA OVC008
FM080900 24010KT 5SM –SHRA OVC008

TAF KSYR 072342Z 0800/0824 12010KT 4SM -RA BKN015
FM080500 20010G20KT 5SM –SHRA OVC015
FM080900 25012G20KT 5SM -SHRA BR OVC025

TAF KBGM 072342Z 0800/0824 16010KT 5SM –RA OVC007
FM080400 20010G20KT 5SM -SHRA OVC008
FM080900 24010G20KT 6SM -SHRA OVC008

KPOU 080212Z 0802/0824 VRB03KT 3SM OVC009
FM080500 21005KT 3SMOVC009

KMPV 080228Z 0802/0824 19010G25KT 2SM -FZRA OVC025

KBTV 080201Z 0802/0824 16010KT 6SM -FZRA OVC035
FM080900 18015G25KT 6SM VCSH OVC030

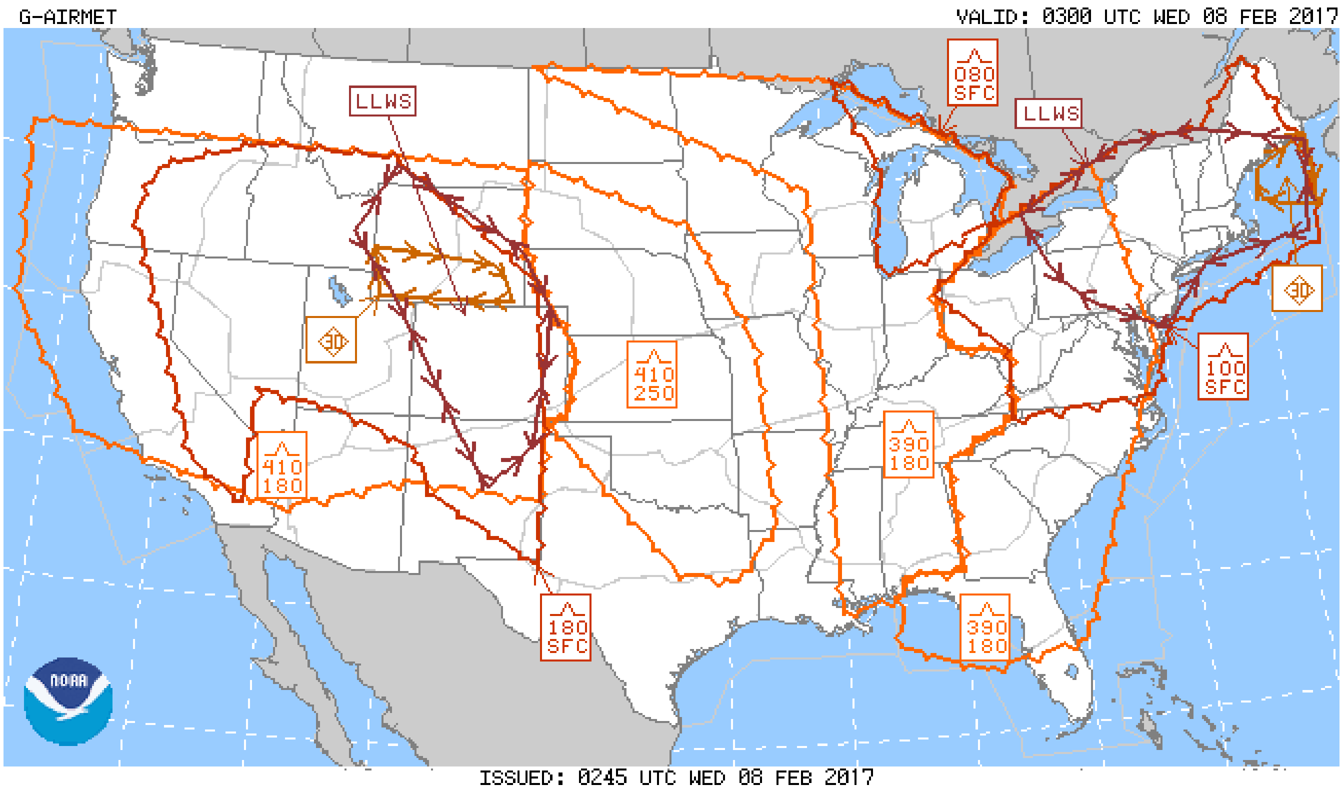
Winds and Temperatures Aloft

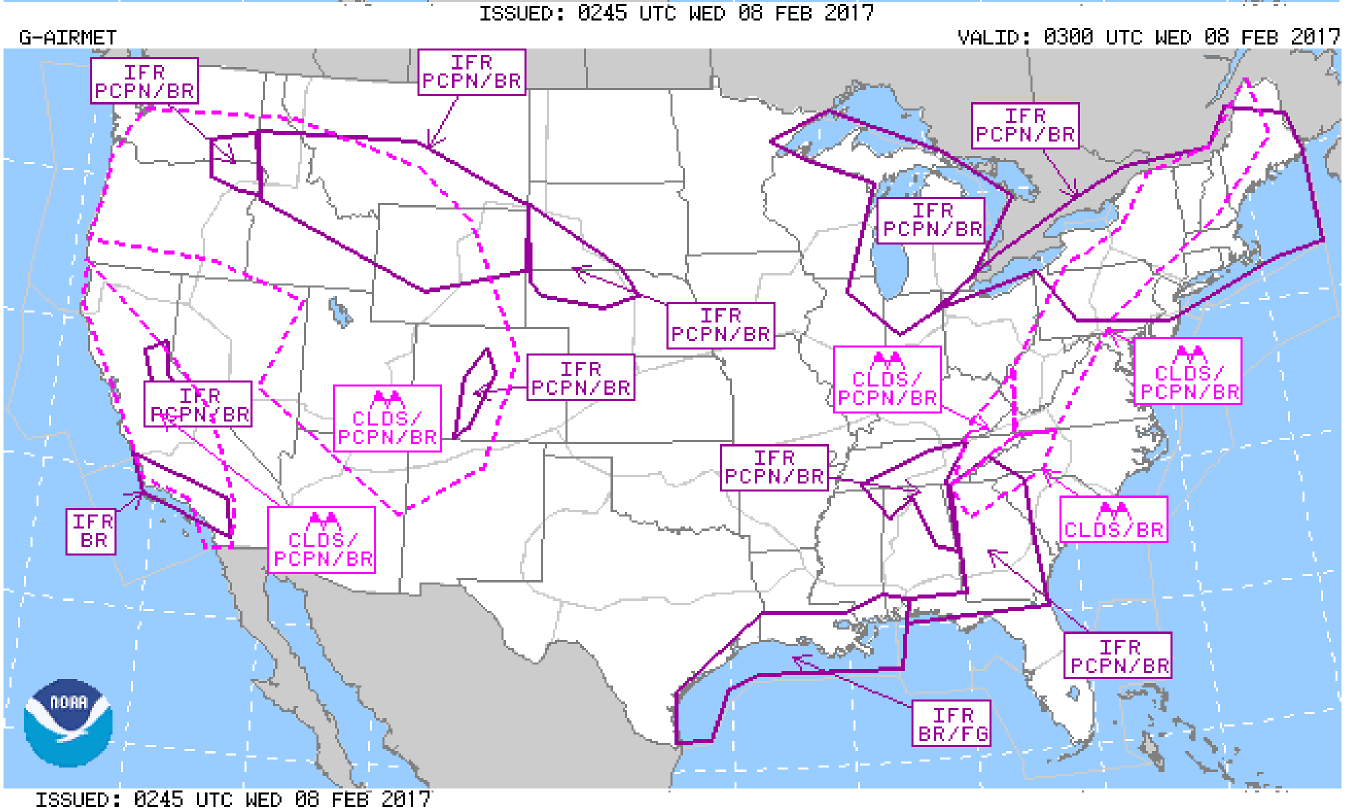
```
(Extracted from FBUS31 KWNO 072002)
FD1US1
DATA BASED ON 071800Z
VALID 080000Z   FOR USE 2000-0300Z. TEMPS NEG ABV 24000

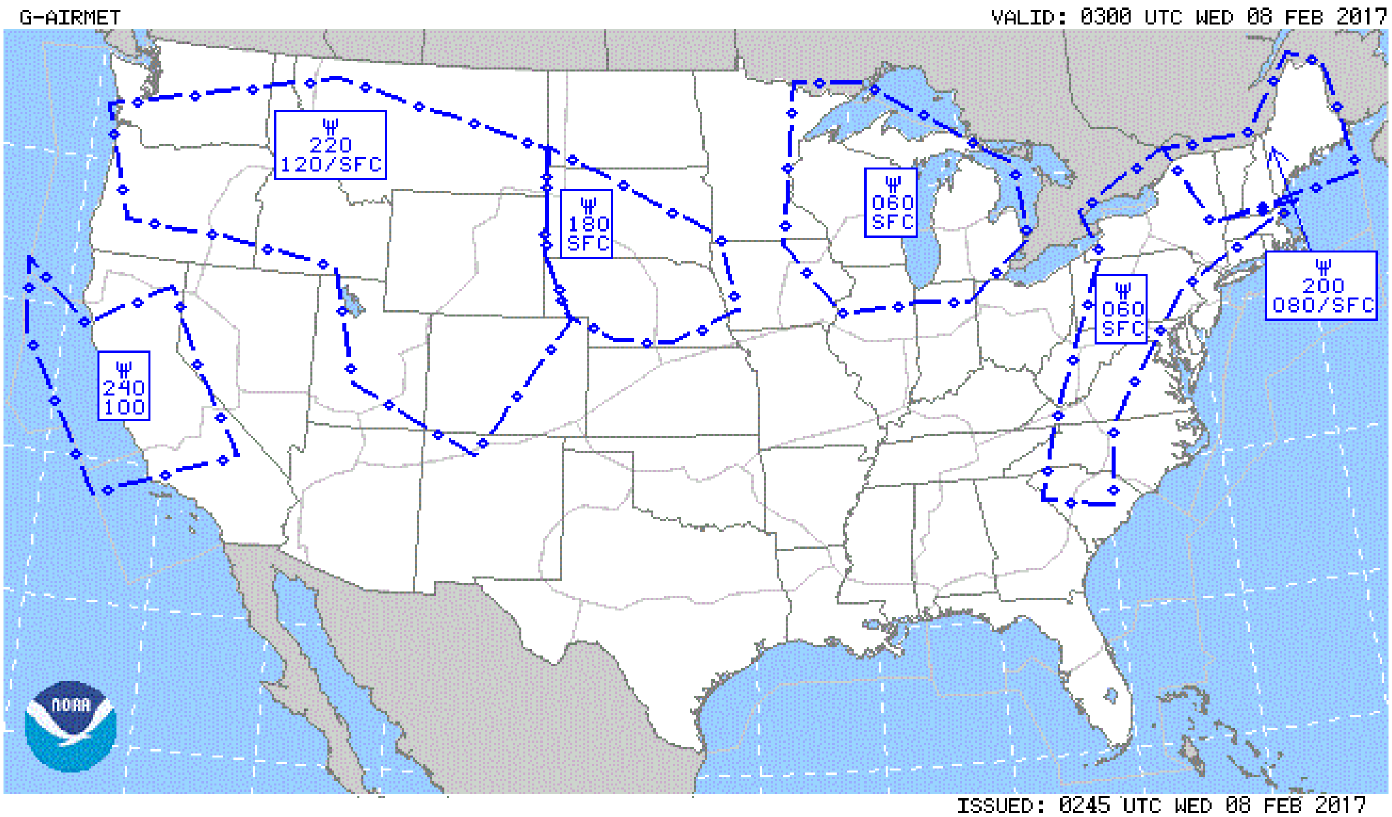
FT  3000    6000    9000   12000   18000   24000  30000  34000  39000
BDL 1919 2448+06 2554+00 2566-04 2555-17 2558-29 266145 256456 257168
BGR 1119 2130-04 2326-05 2535-10 2457-20 2672-31 278947 279957 780468
PWM 1136 2232+00 2445-02 2551-06 2666-18 2568-30 268047 278456 278567
EMI 2149 2452+09 2452+03 2347-04 2448-17 2548-28 235345 245555 247266
ACK 2345 2454+06 2552+01 2659-04 2650-18 2653-29 265546 265756 267667
BOS 1520 2446+04 2456+00 2658-05 2656-17 2560-29 276546 266955 267868
BML 1232 2129+00 2221-04 2230-08 2559-19 2569-30 268647 279257 279668
ACY 2352 2448+11 2448+03 2350-05 2453-17 2450-28 245545 255755 256166
ALB 1737 2350+05 2461+00 2473-05 2571-17 2565-29 267146 267356 258168
BUF 2257 2551+05 2347-01 2458-06 2357-17 2467-29 248145 238655 248265
JFK 2344 2439+09 2450+02 2455-05 2556-18 2548-28 244845 245255 266267
PLB 1653 2134+00 2233-03 2338-07 2560-18 2567-30 268647 269556 269868
SYR 2060 2458+05 2344-01 2456-05 2464-17 2464-28 257146 247756 249067
CLE 2351 2549+04 2451-01 2546-07 2450-19 2358-30 228446 730356 246858
AGC 2344 2457+05 2455-01 2460-05 2362-16 2464-28 236545 247455 247365
AVP 1945 2248+07 2564+02 2361-04 2560-17 2552-28 245945 246255 257368
```

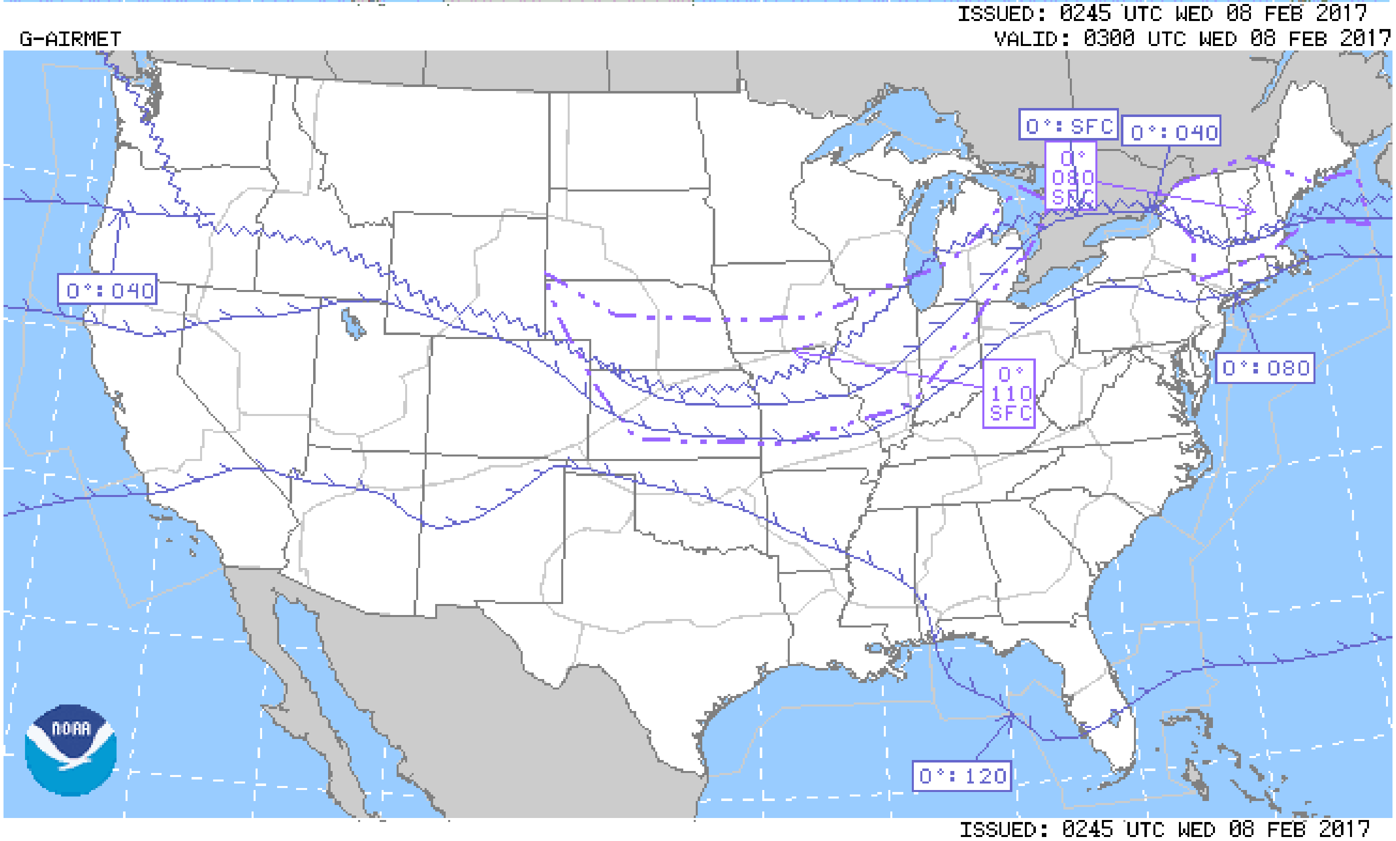
KRUT-KRME Graphical Weather Information

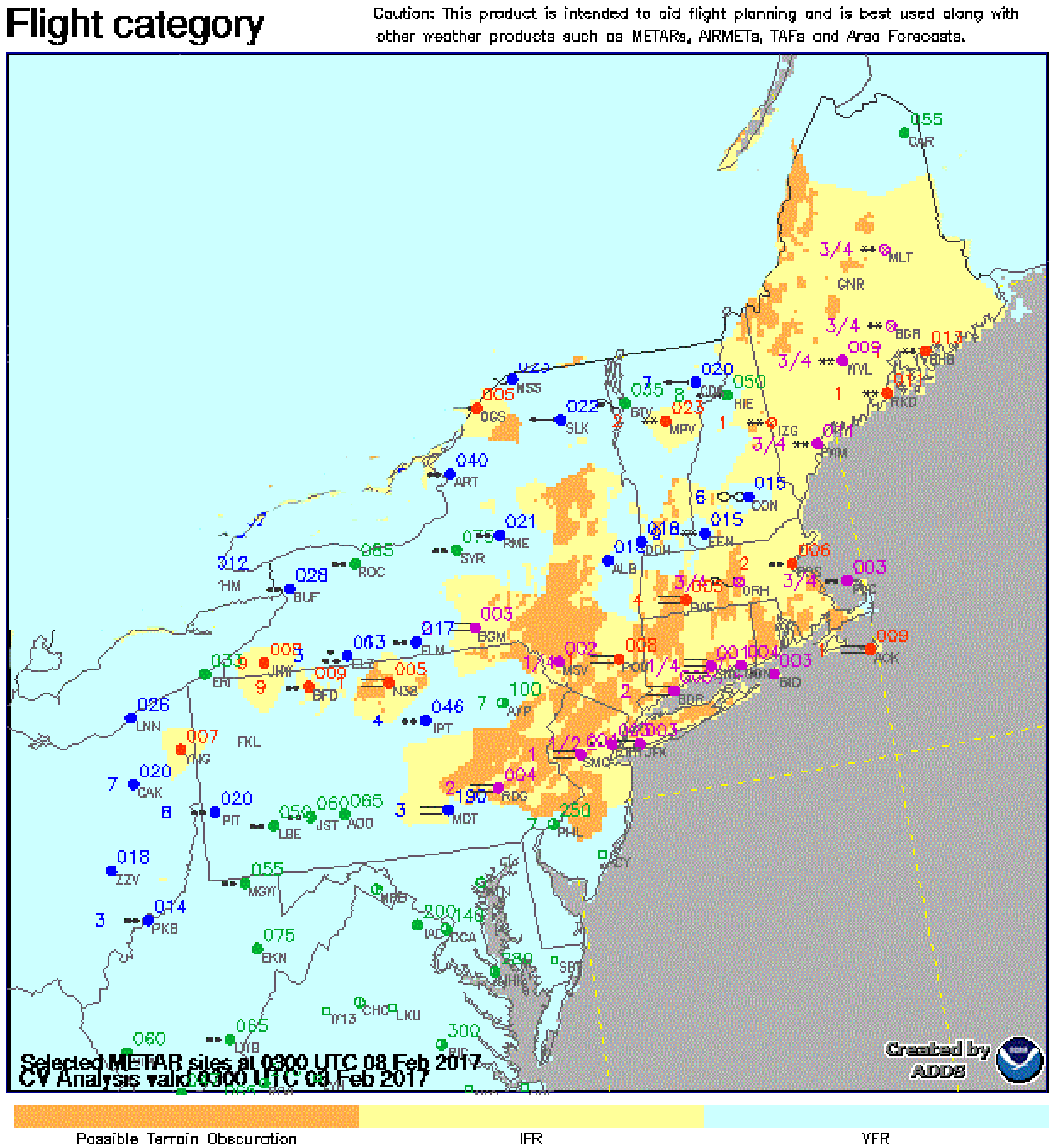
AIRMETS



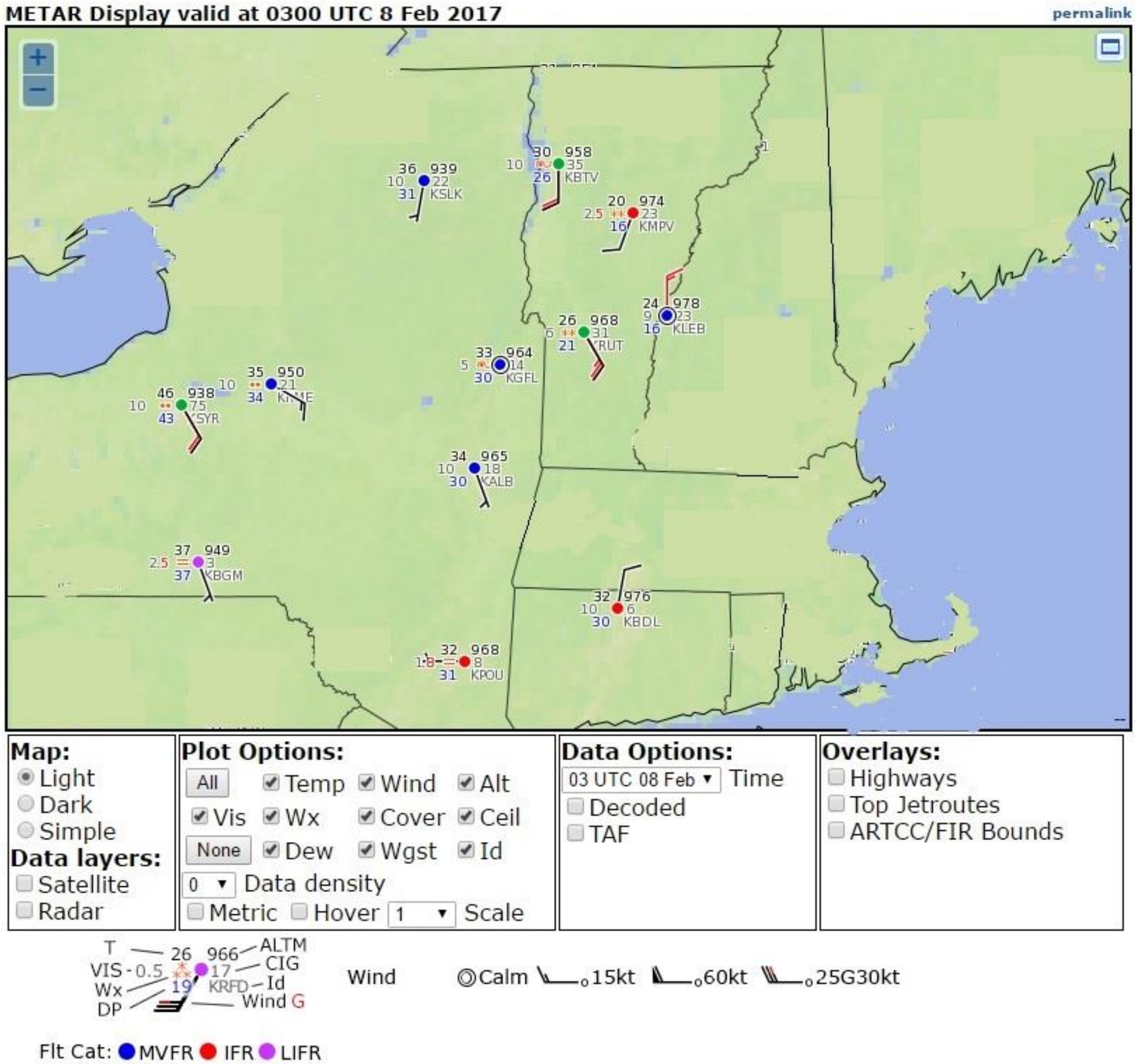



G-AIRMET
VALID: 0300 UTC WED 08 FEB 2017
220
120/SFC
180
SFC
060
SFC
060
SFC
200
080/SFC
240
100
NOAA
ISSUED: 0245 UTC WED 08 FEB 2017


G-AIRMET
VALID: 0300 UTC WED 08 FEB 2017
0°:SFC
0°:040
0°
080
SFC
0°:040
0°
110
SFC
0°:080
0°:120
NOAA
ISSUED: 0245 UTC WED 08 FEB 2017

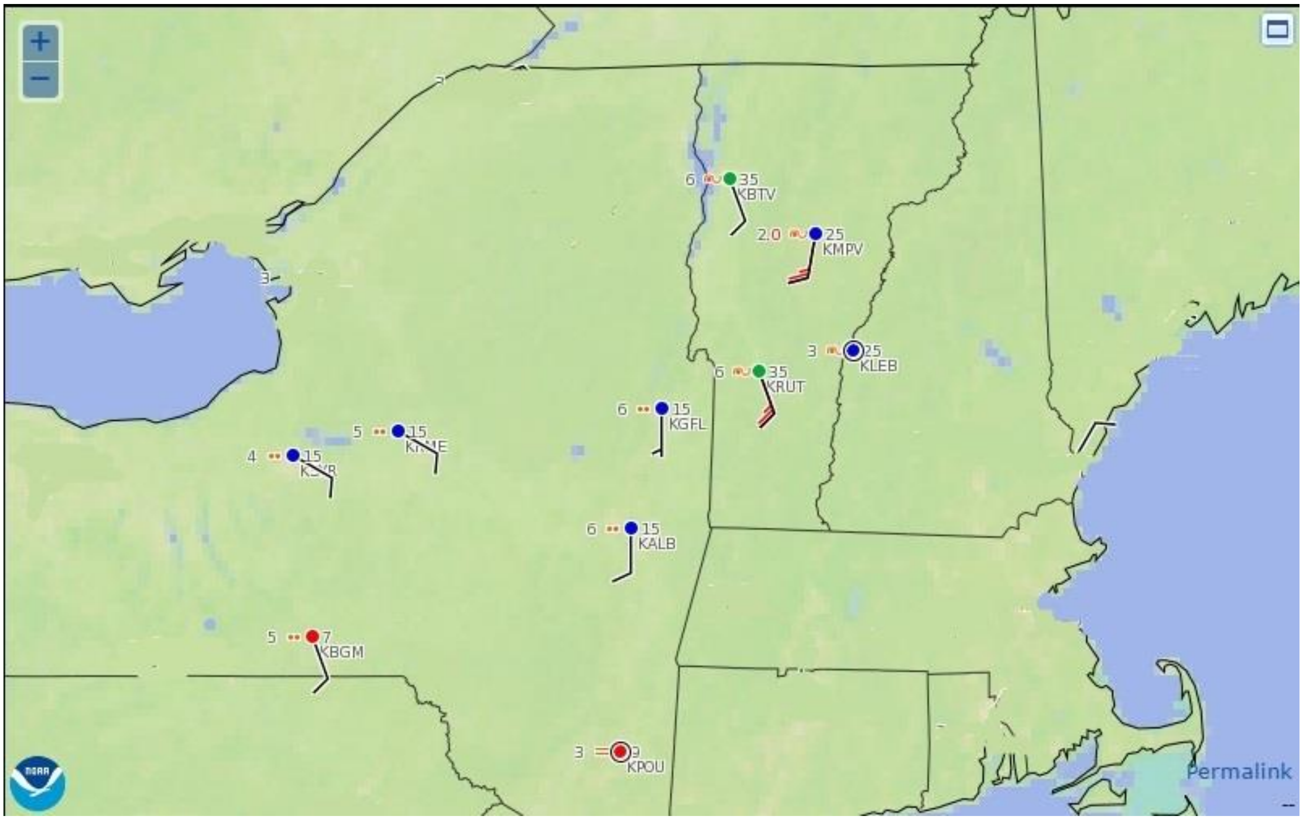

Flight category
Caution: This product is intended to aid flight planning and is best used along with other weather products such as METARs, AIRMETs, TAFs and Area Forecasts.
Selected METAR sites at 0300 UTC 08 Feb 2017
CV Analysis valid 0300 UTC 08 Feb 2017
Created by ADDS
Possible Terrain Obscuration
IFR
VFR

METARS

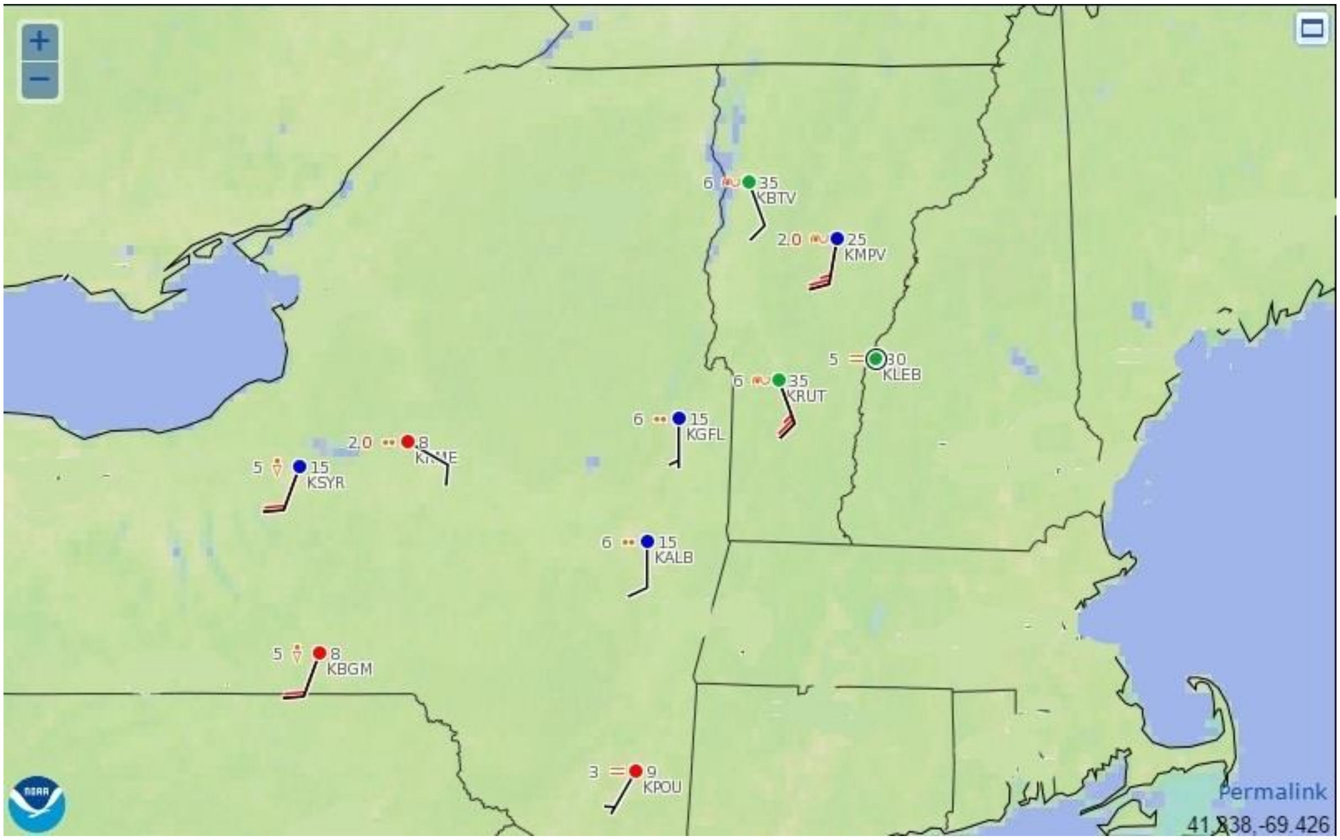

METAR Display valid at 0300 UTC 8 Feb 2017
permalink
36 939 10 22 31 KSLK
30 958 10 35 26 KBTV
20 974 2.5 23 16 KMPV
24 978 9 23 16 KLEB
26 968 6 31 21 RUT
33 964 5 14 30 KGFL
35 950 10 21 34
46 938 10 75 43 SYR
34 965 10 18 30 KALB
37 949 2.5 3 37 KBGM
32 976 10 6 30 KBDL
32 968 8 31 KPOU
Map:
Light
Dark
Simple
Data layers:
Satellite
Radar
Plot Options:
All
Temp
Wind
Alt
Vis
Wx
Cover
Ceil
None
Dew
Wgst
Id
0
Data density
Metric
Hover
1
Scale
Data Options:
03 UTC 08 Feb
Time
Decoded
TAF
Overlays:
Highways
Top Jetroutes
ARTCC/FIR Bounds
T
VIS
Wx
DP
26 966
0.5
17
19
KRFD
ALTM
CIG
Id
Wind G
Wind
Calm
15kt
60kt
25G30kt
Flt Cat:
MVFR
IFR
LIFR

TAFS

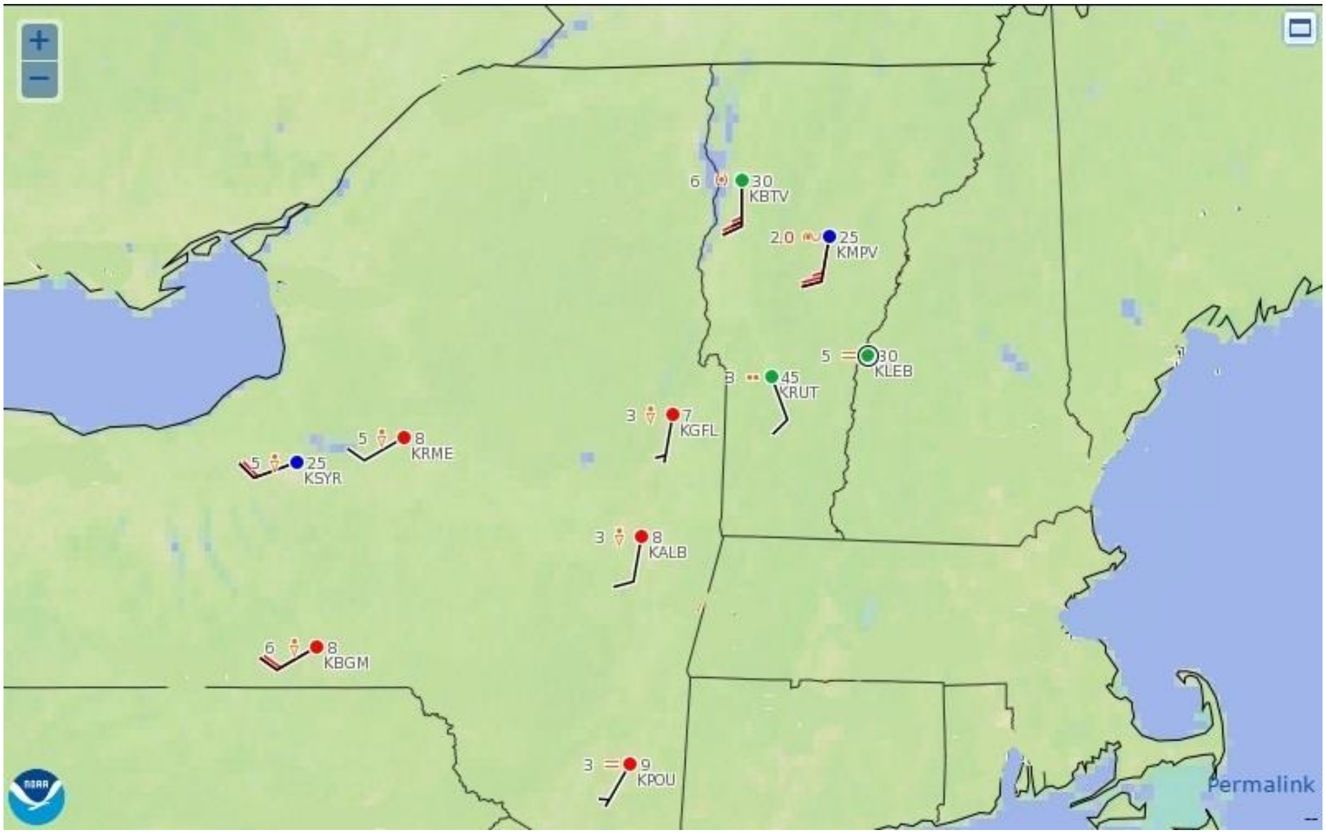
03Z



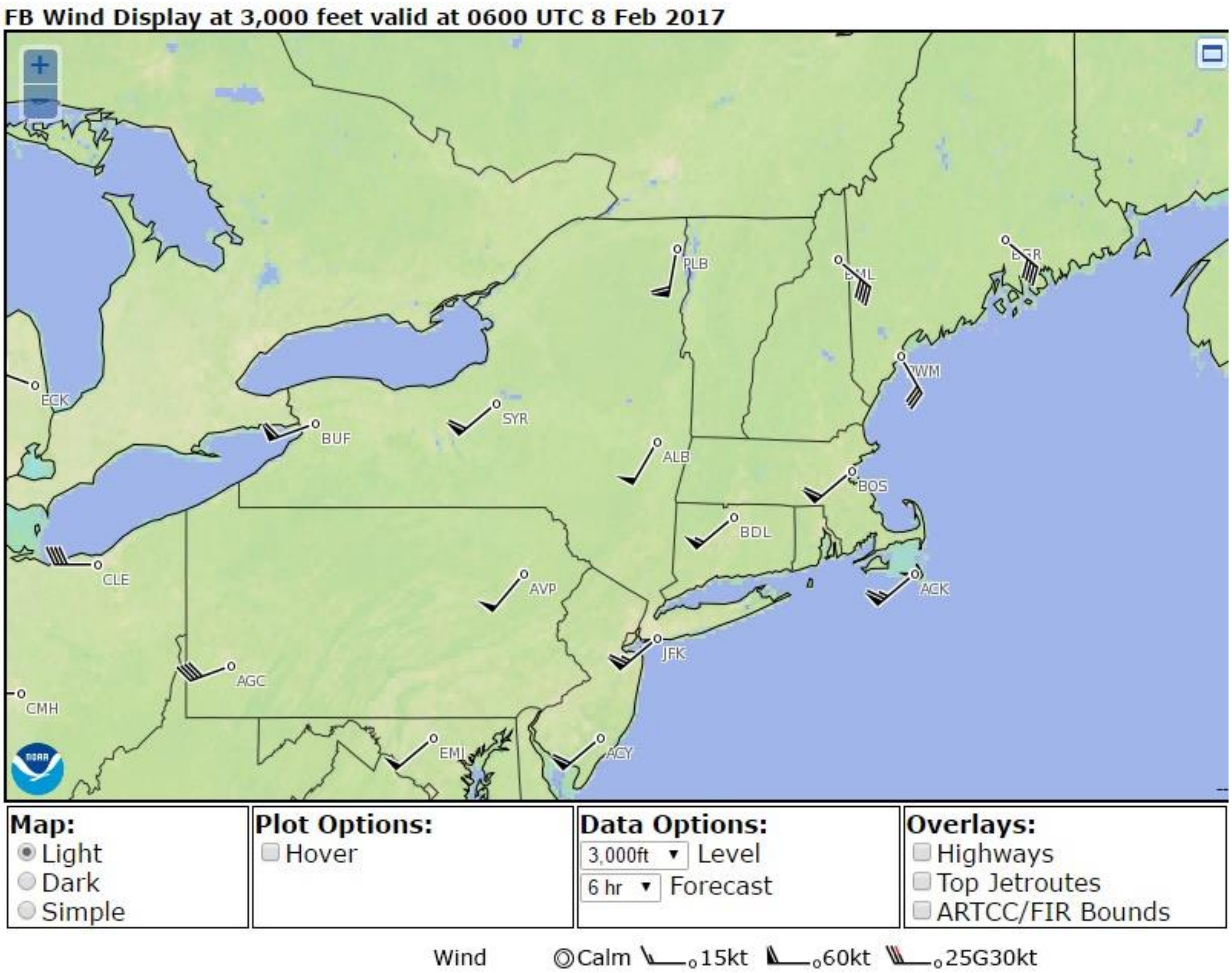
05Z


6
35
KBTV
2.0
25
KMPV
5
30
KLEB
6
35
KRUT
6
15
KGFL
2.0
8
5
15
KSYR
6
15
KALB
5
8
KBGM
3
9
KPOU
Permalink
41.838,-69.426

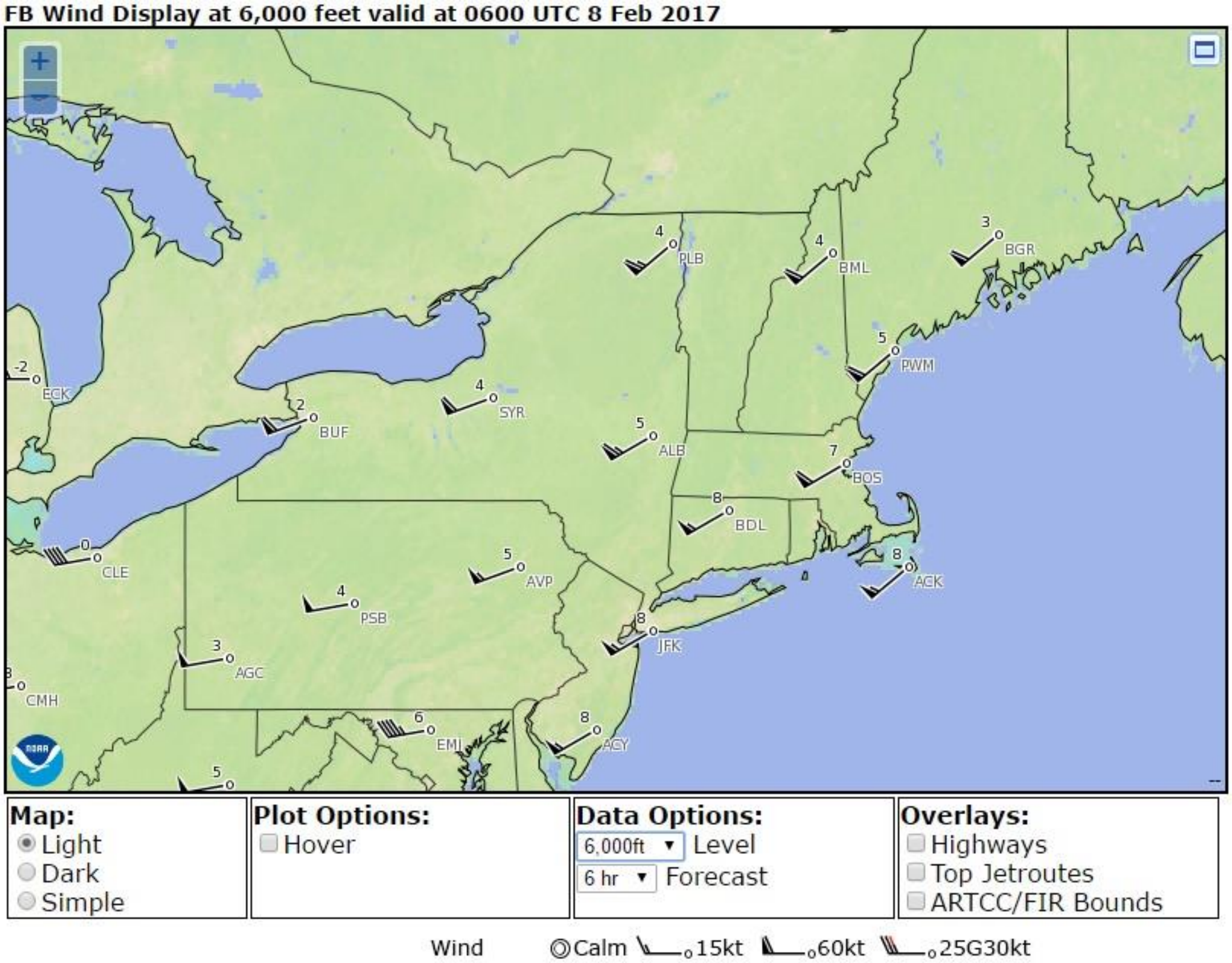
09Z

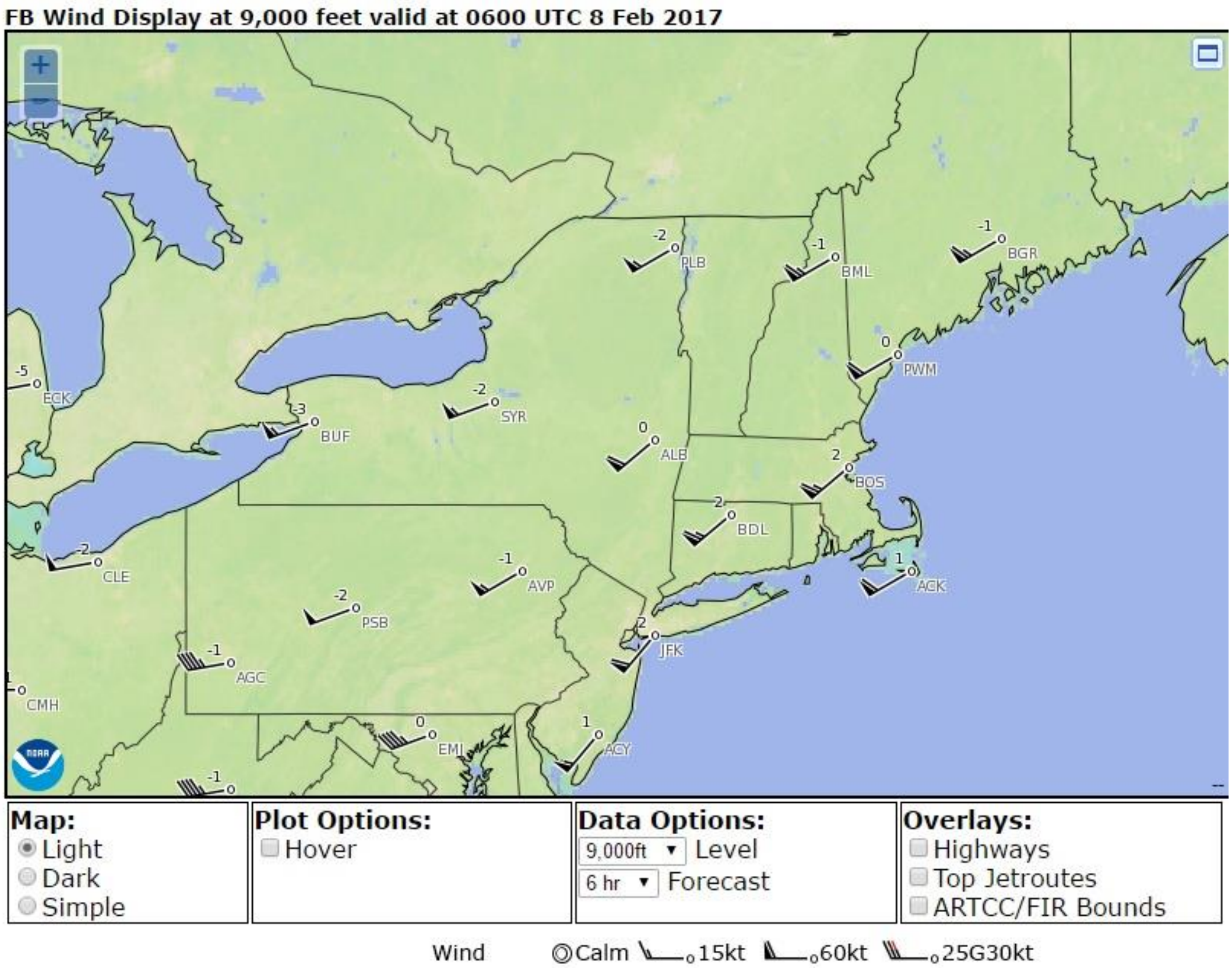

6
30
KBTV
2.0
25
KMPV
5
30
KLEB
3
45
KRUT
3
7
KGFL
5
8
KRME
5
25
KSYR
3
8
KALB
6
8
KBGM
3
9
KPOU
Permalink

Winds and Temperatures Aloft

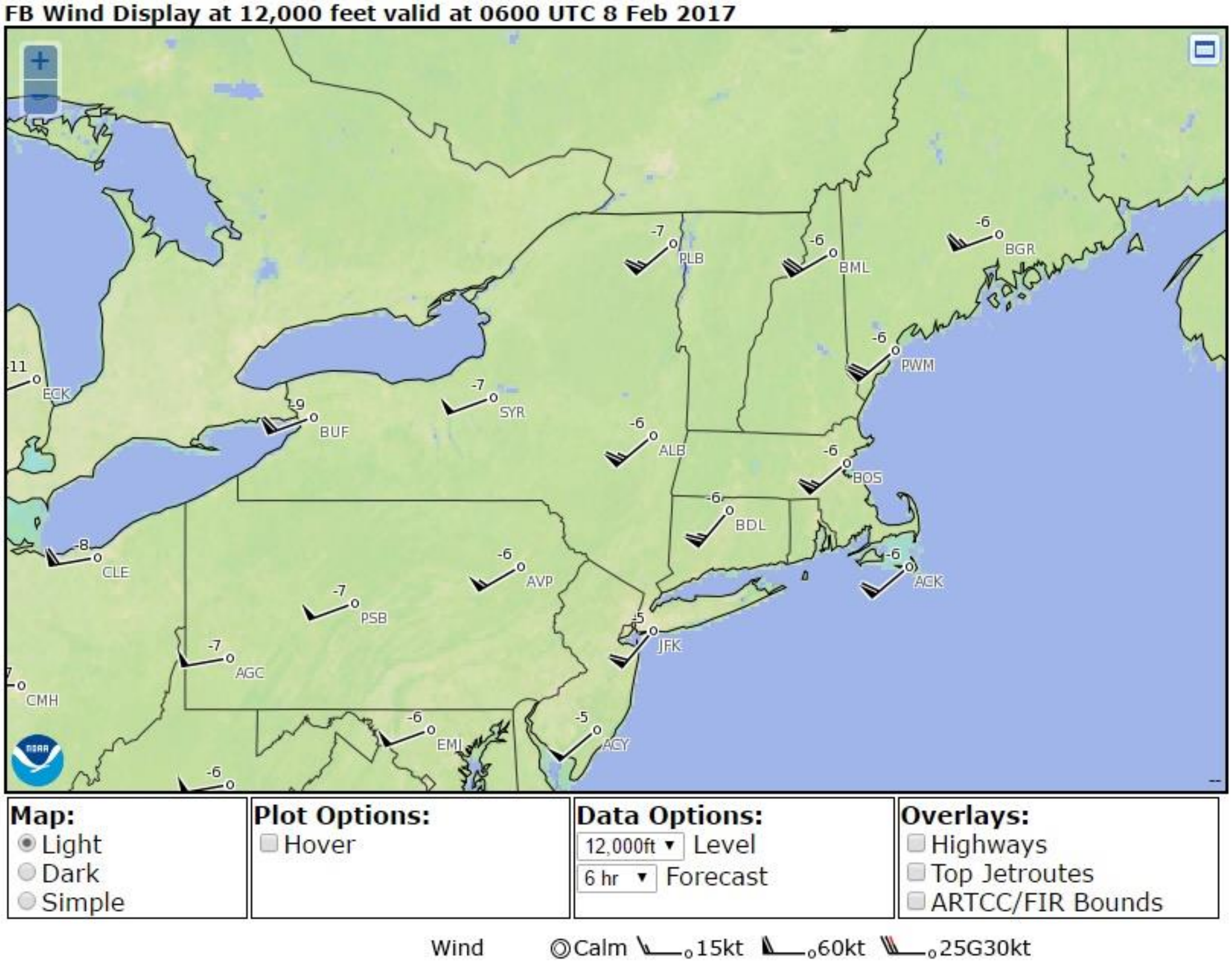


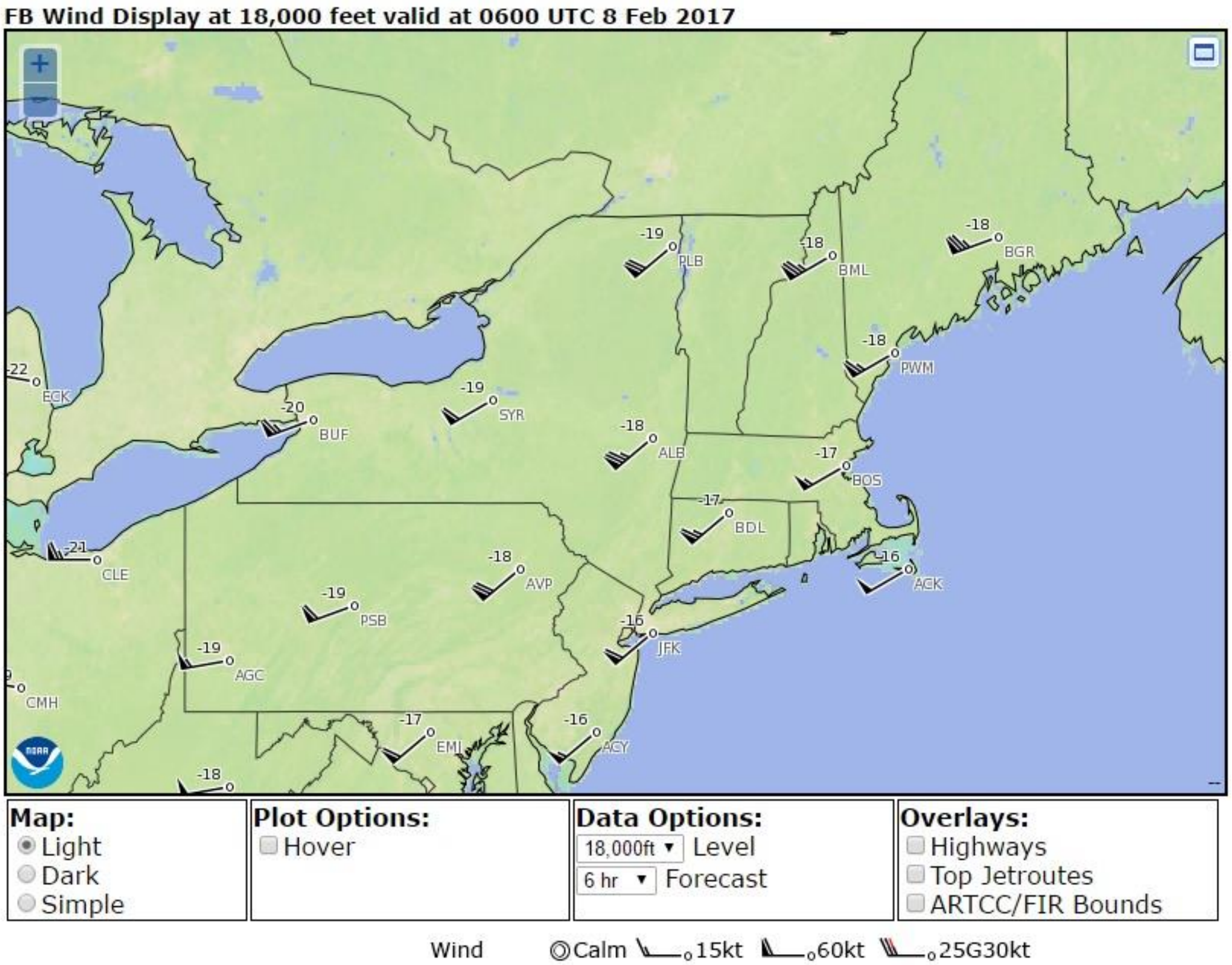
FB Wind Display at 6,000 feet valid at 0600 UTC 8 Feb 2017

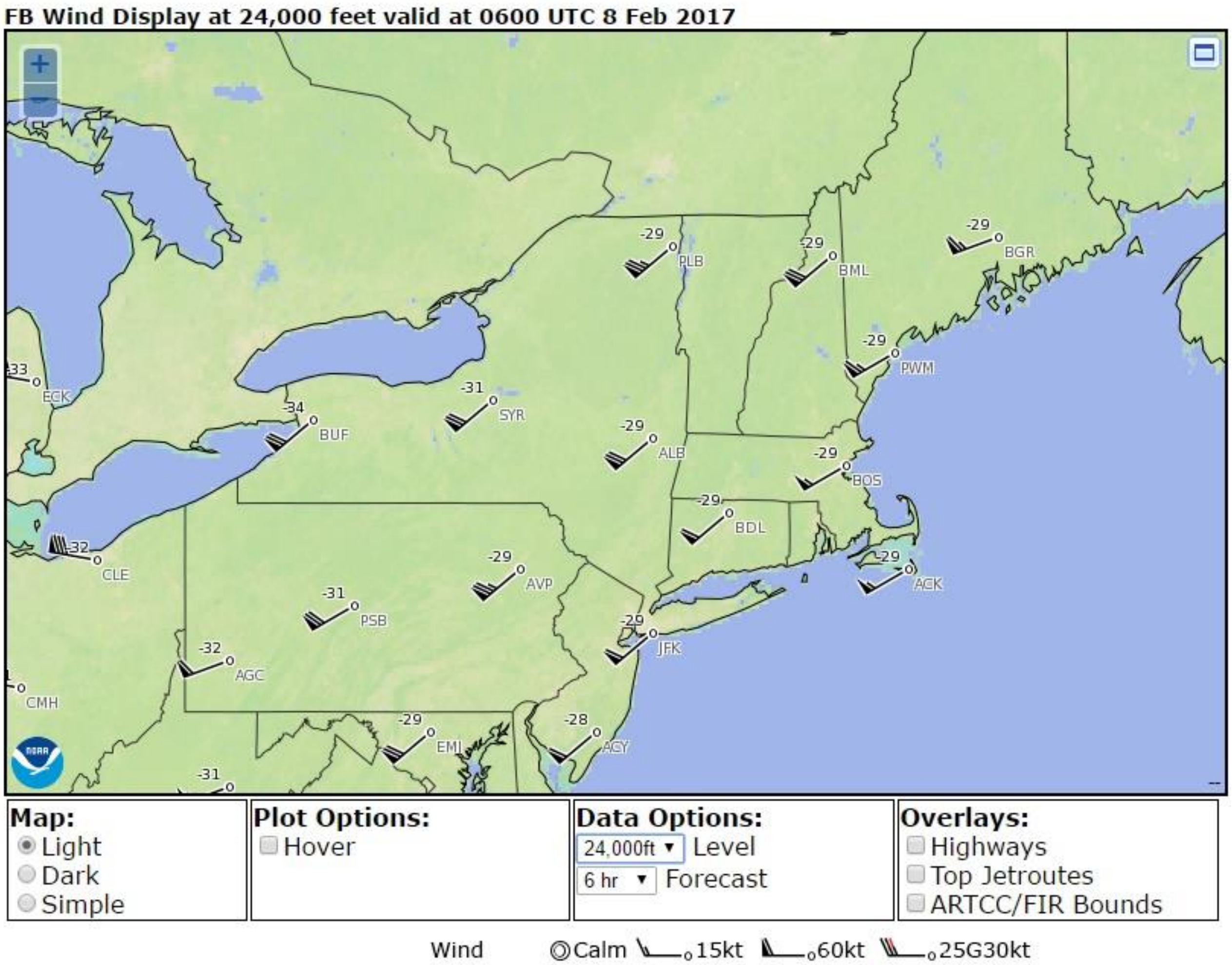


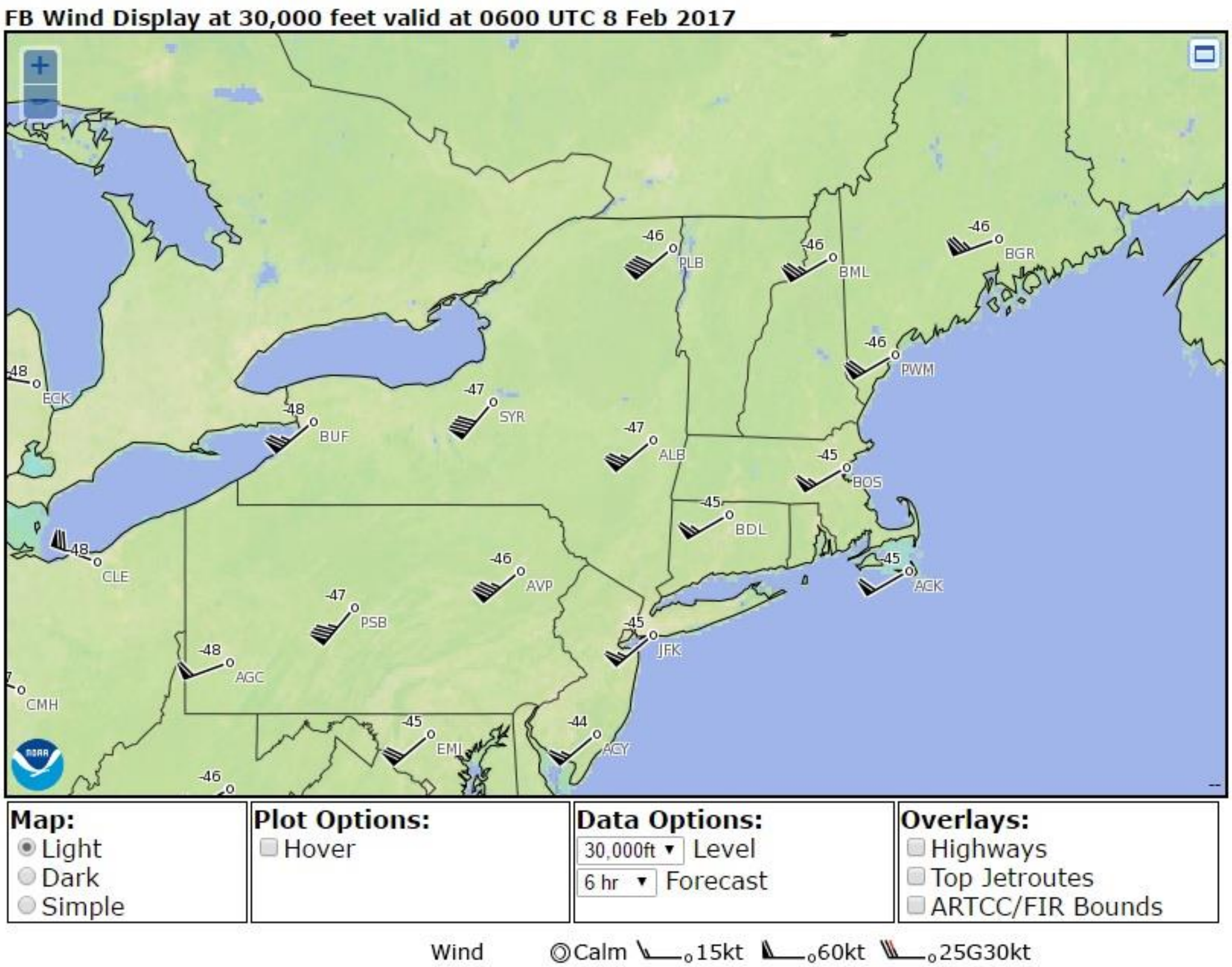

FB Wind Display at 9,000 feet valid at 0600 UTC 8 Feb 2017
PLB
BML
BGR
PWM
ECK
SYR
BUF
ALB
BOS
BDL
CLE
AVP
ACK
PSB
JFK
AGC
CMH
EMI
ACY
Map:
Light
Dark
Simple
Plot Options:
Hover
Data Options:
9,000ft Level
6 hr Forecast
Overlays:
Highways
Top Jetroutes
ARTCC/FIR Bounds
Wind
Calm
15kt
60kt
25G30kt

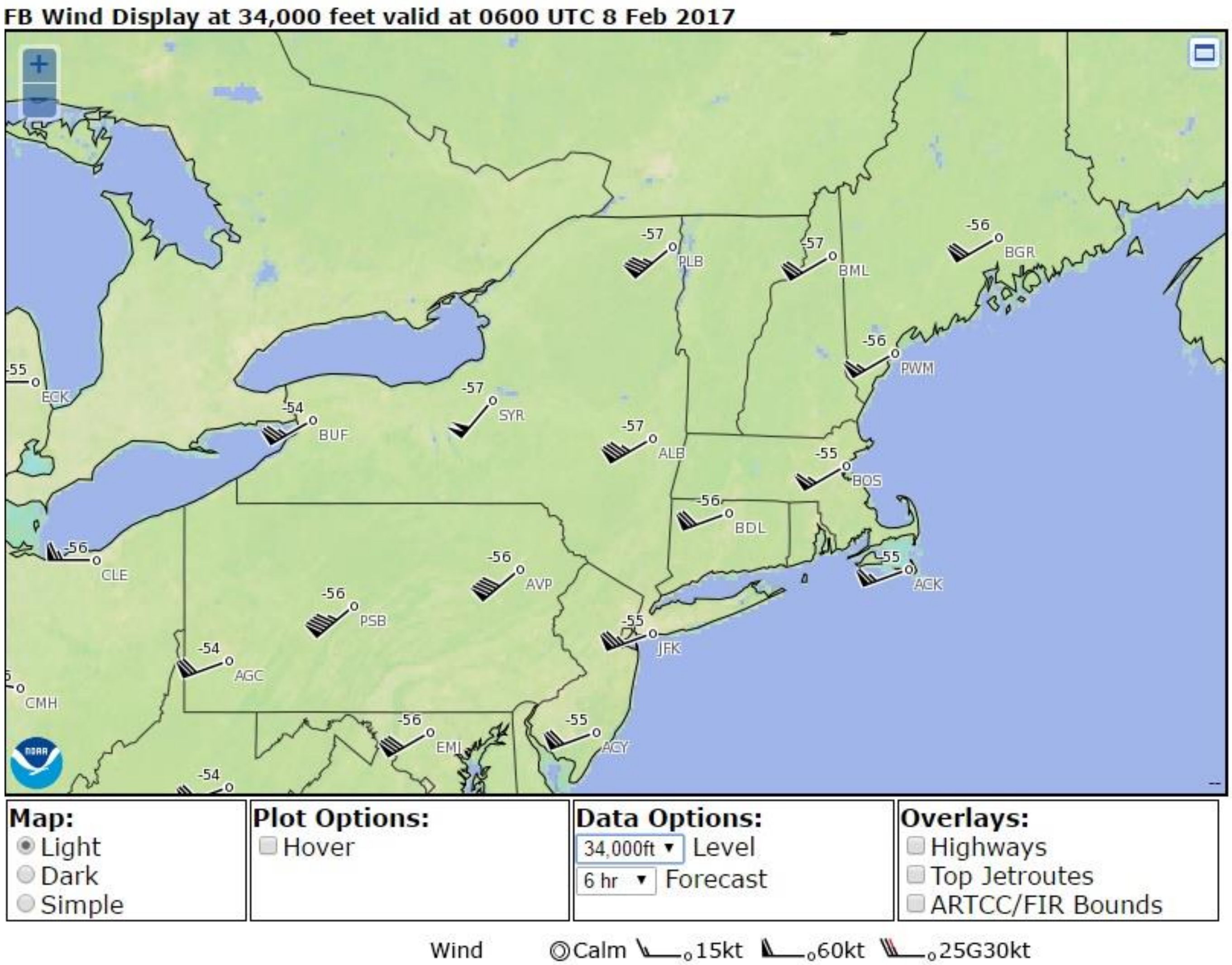
FB Wind Display at 12,000 feet valid at 0600 UTC 8 Feb 2017



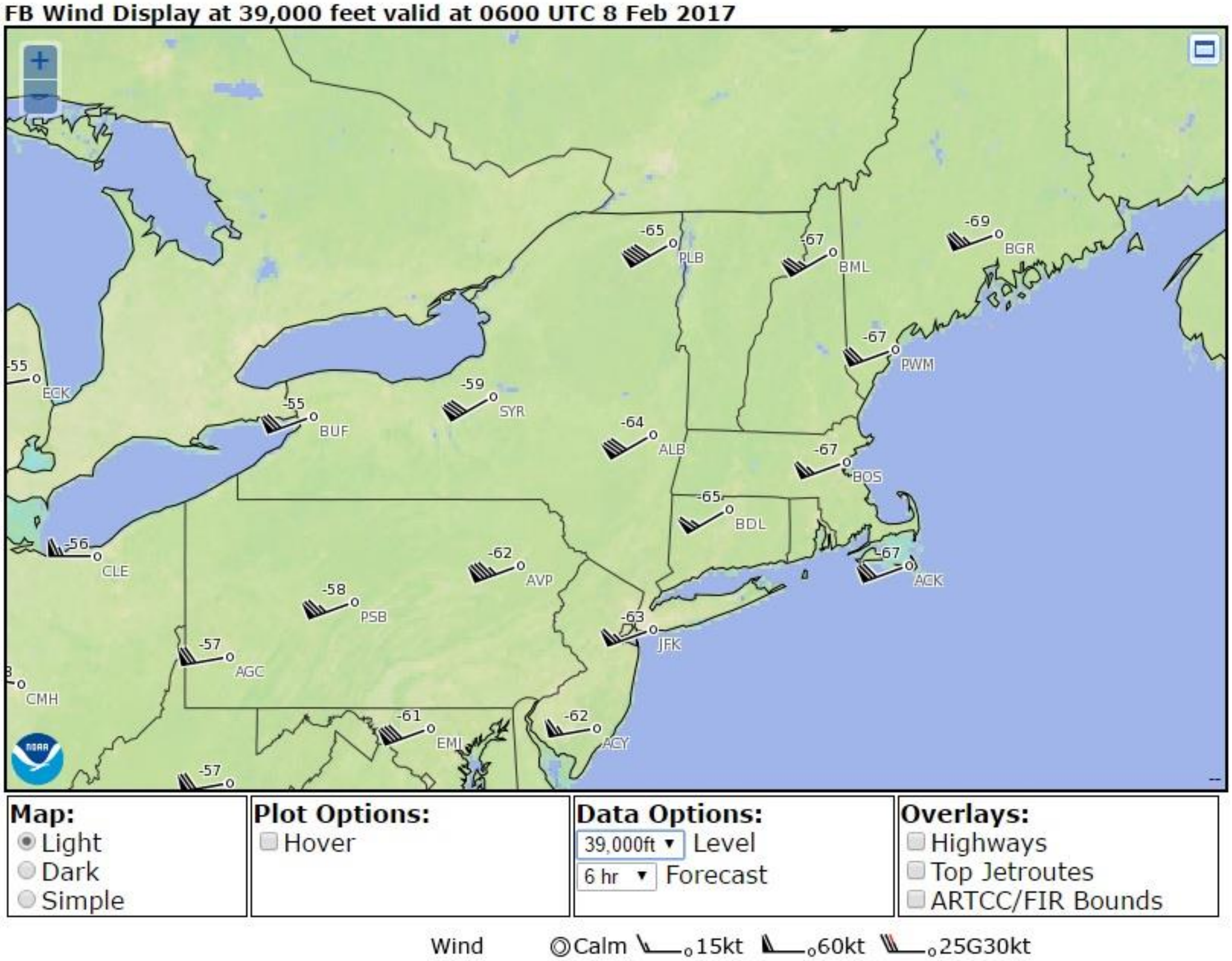

FB Wind Display at 18,000 feet valid at 0600 UTC 8 Feb 2017
PLB
BML
BGR
PWM
ECK
BUF
SYR
ALB
BOS
BDL
CLE
AVP
ACK
PSB
JFK
AGC
CMH
EMI
ACY
Map:
Light
Dark
Simple
Plot Options:
Hover
Data Options:
18,000ft Level
6 hr Forecast
Overlays:
Highways
Top Jetroutes
ARTCC/FIR Bounds
Wind
Calm
15kt
60kt
25G30kt


FB Wind Display at 24,000 feet valid at 0600 UTC 8 Feb 2017
-29 PLB
-29 BML
-29 BGR
-29 PWM
33 ECK
-34 BUF
-31 SYR
-29 ALB
-29 BOS
-29 BDL
-32 CLE
-29 AVP
-29 ACK
-31 PSB
-29 JFK
-32 AGC
CMH
-29 EMI
-28 ACY
-31
Map:
Light
Dark
Simple
Plot Options:
Hover
Data Options:
24,000ft Level
6 hr Forecast
Overlays:
Highways
Top Jetroutes
ARTCC/FIR Bounds
Wind
Calm
15kt
60kt
25G30kt


FB Wind Display at 30,000 feet valid at 0600 UTC 8 Feb 2017
-46 PLB
-46 BML
-46 BGR
-46 PWM
-48 ECK
-48 BUF
-47 SYR
-47 ALB
-45 BOS
-45 BDL
-45 ACK
-48 CLE
-46 AVP
-47 PSB
-45 JFK
-48 AGC
CMH
-45 EMI
-44 ACY
-46
Map:
Light
Dark
Simple
Plot Options:
Hover
Data Options:
30,000ft Level
6 hr Forecast
Overlays:
Highways
Top Jetroutes
ARTCC/FIR Bounds
Wind
Calm
15kt
60kt
25G30kt


FB Wind Display at 34,000 feet valid at 0600 UTC 8 Feb 2017
-57 PLB
-57 BML
-56 BGR
-56 PWM
-55 ECK
-54 BUF
-57 SYR
-57 ALB
-55 BOS
-56 BDL
-56 CLE
-56 AVP
-55 ACK
-56 PSB
-55 JFK
-54 AGC
CMH
-56 EMI
-55 ACY
-54
Map:
Light
Dark
Simple
Plot Options:
Hover
Data Options:
34,000ft Level
6 hr Forecast
Overlays:
Highways
Top Jetroutes
ARTCC/FIR Bounds
Wind
Calm
15kt
60kt
25G30kt

FB Wind Display at 39,000 feet valid at 0600 UTC 8 Feb 2017



KSYR-KBUF Textual Weather Information

AIRMETS

Type: AIRMET Hazard: MTN OBSCN

```
WAUS41 KKCI 072045
BOSS WA 072045
AIRMET SIERRA UPDT 4 FOR IFR AND MTN OBSCN VALID UNTIL 080300
AIRMET MTN OBSCN...ME NH VT MA NY PA WV MD VA
FROM 70NW PQI TO 20SSE MLT TO 20SW CON TO 20N SAX TO EKN TO HMV
TO HNN TO AIR TO JHW TO SYR TO MSS TO YSC TO 70NW PQI
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z...MTN OBSCN ME NH VT MA NY PA WV MD VA
BOUNDED BY 70NW PQI-20SSE MLT-20SSW CON-20NNW SAX-HAR-30N GSO-
HMV-HNN-20ENE AIR-JHW-SYR-MSS-YSC-70NW PQI
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG THRU 09Z.
```

Type: AIRMET Hazard: IFR

```
WAUS41 KKCI 072045
BOSS WA 072045
AIRMET SIERRA UPDT 4 FOR IFR AND MTN OBSCN VALID UNTIL 080300
AIRMET IFR...ME NH VT MA RI CT NY LO NJ PA OH LE AND CSTL WTRS
FROM 40E YQB TO 50SE HUL TO 150ENE ACK TO 30E ACK TO 20NNE CYN
TO 30WSW HAR TO 30S JHW TO 40SW DXO TO 30SE ECK TO YOW TO YSC TO
40E YQB
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z...MTN OBSCN ME NH VT MA NY PA WV MD VA
BOUNDED BY 70NW PQI-20SSE MLT-20SSW CON-20NNW SAX-HAR-30N GSO-
HMV-HNN-20ENE AIR-JHW-SYR-MSS-YSC-70NW PQI
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG THRU 09Z.
```

Type: AIRMET Hazard: TURB

```
WAUS41 KKCI 072045
BOST WA 072045
AIRMET TANGO UPDT 3 FOR TURB STG WNDS AND LLWS VALID UNTIL 080300
AIRMET TURB...LO PA OH LE WV VA NC SC GA FL AND CSTL WTRS
FROM 20N YYZ TO 40S IRQ TO 90WSW PIE TO 170SE LEV TO 130ESE LEV
TO 40W CEW TO 50SW PZD TO GQO TO HMV TO HNN TO CVG TO FWA TO
30SE ECK TO 20N YYZ
MOD TURB BTN FL180 AND FL390. CONDS DVLPG 00-03Z. CONDS CONTG
BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z
AREA 1...TURB NY LO NJ PA OH LE WV MD DC DE VA NC SC GA FL AND
CSTL WTRS
BOUNDED BY YOW-20ESE ALB-30SW PBI-50SSW RSW-SRQ-90WSW PIE-170SE
LEV-130ESE LEV-40W CEW-50SW PZD-GQO-HMV-HNN-CVG-FWA-30SE ECK-YOW
MOD TURB BTN FL180 AND FL390. CONDS CONTG THRU 09Z.
AREA 2...STG SFC WNDS ME NH AND CSTL WTRS
BOUNDED BY 50SW YSJ-150ENE ACK-30SSE ENE-50ENE ENE-50SW YSJ
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS ENDG 06-09Z.
```

Type: AIRMET Hazard: TURB

```
WAUS41 KKCI 072045
BOST WA 072045
AIRMET TANGO UPDT 3 FOR TURB STG WNDS AND LLWS VALID UNTIL 080300
AIRMET TURB...ME NH VT MA NY LO AND CSTL WTRS
FROM 70NW PQI TO 60NE PQI TO 140ENE ACK TO ALB TO 60NE YYZ TO
YOW TO YSC TO 70NW PQI
MOD TURB BLW 080. CONDS CONTG BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z
AREA 1...TURB NY LO NJ PA OH LE WV MD DC DE VA NC SC GA FL AND
CSTL WTRS
BOUNDED BY YOW-20ESE ALB-30SW PBI-50SSW RSW-SRQ-90WSW PIE-170SE
LEV-130ESE LEV-40W CEW-50SW PZD-GQO-HMV-HNN-CVG-FWA-30SE ECK-YOW
MOD TURB BTN FL180 AND FL390. CONDS CONTG THRU 09Z.
AREA 2...STG SFC WNDS ME NH AND CSTL WTRS
BOUNDED BY 50SW YSJ-150ENE ACK-30SSE ENE-50ENE ENE-50SW YSJ
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS ENDG 06-09Z.
```

Type: AIRMET Hazard: TURB

```
WAUS41 KKCI 072045
BOST WA 072045
AIRMET TANGO UPDT 3 FOR TURB STG WNDS AND LLWS VALID UNTIL 080300
AIRMET TURB...ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA
NC SC GA AND CSTL WTRS
FROM 60NE YYZ TO ALB TO 140ENE ACK TO 50S ACK TO 70SSE ECG TO
70SSW ILM TO 30NW CAE TO 30SSE LGC TO GQO TO HMV TO HNN TO 50ESE
ECK TO 60NE YYZ
MOD TURB BLW 100. CONDS CONTG BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z
AREA 1...TURB NY LO NJ PA OH LE WV MD DC DE VA NC SC GA FL AND
CSTL WTRS
BOUNDED BY YOW-20ESE ALB-30SW PBI-50SSW RSW-SRQ-90WSW PIE-170SE
LEV-130ESE LEV-40W CEW-50SW PZD-GQO-HMV-HNN-CVG-FWA-30SE ECK-YOW
MOD TURB BTN FL180 AND FL390. CONDS CONTG THRU 09Z.
AREA 2...STG SFC WNDS ME NH AND CSTL WTRS
BOUNDED BY 50SW YSJ-150ENE ACK-30SSE ENE-50ENE ENE-50SW YSJ
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS ENDG 06-09Z.
```

Type: AIRMET Hazard: TURB

```
WAUS41 KKCI 072045
BOST WA 072045
AIRMET TANGO UPDT 3 FOR TURB STG WNDS AND LLWS VALID UNTIL 080300
AIRMET STG SFC WNDS...ME NH AND CSTL WTRS
FROM 60SW YSJ TO 150ENE ACK TO 30SSE ENE TO 50ENE ENE TO 60SW YSJ
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS DVLPG 00-03Z.
CONDS CONTG BYD 03Z ENDG 06-09Z.
LLWS POTENTIAL...NH VT MA CT NY LO NJ PA OH LE MD DE AND CSTL
WTRS
BOUNDED BY YOW-40NNW MPV-40SE MPV-20W PVD-20SSE CYN-20S SIE-20S
JST-30E EWC-20NW CLE-30SE ECK-40W YYZ-YOW
LLWS EXP. CONDS CONTG BYD 03Z THRU 09Z.
LLWS POTENTIAL...ME NH MA RI CT NY NJ AND CSTL WTRS
BOUNDED BY 140SSE BGR-200SE ACK-110S HTO-20SSE CYN-20W PVD-
140SSE BGR
```

```
LLWS EXP. CONDS CONTG BYD 03Z THRU 09Z.
OTLK VALID 0300-0900Z
AREA 1...TURB NY LO NJ PA OH LE WV MD DC DE VA NC SC GA FL AND
CSTL WTRS
BOUNDED BY YOW-20ESE ALB-30SW PBI-50SSW RSW-SRQ-90WSW PIE-170SE
LEV-130ESE LEV-40W CEW-50SW PZD-GQO-HMV-HNN-CVG-FWA-30SE ECK-YOW
MOD TURB BTN FL180 AND FL390. CONDS CONTG THRU 09Z.
AREA 2...STG SFC WNDS ME NH AND CSTL WTRS
BOUNDED BY 50SW YSJ-150ENE ACK-30SSE ENE-50ENE ENE-50SW YSJ
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS ENDG 06-09Z.
```

Type: AIRMET Hazard: ICE

```
WAUS41 KKCI 072045
BOSZ WA 072045
AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 080300
AIRMET ICE...ME NH VT MA NY LO AND CSTL WTRS
FROM 40E YQB TO 30ESE HUL TO 50WSW YSJ TO 140S YSJ TO 50WSW CON
TO 20SW YOW TO YSC TO 40E YQB
MOD ICE BLW 150. CONDS CONTG BYD 03Z THRU 09Z.
FRZLVL...RANGING FROM SFC-105 ACRS AREA
 MULT FRZLVL 020-080 BOUNDED BY YSC-60SW YSJ-140E ACK-40SE BOS-
 20W SAX-20NW HNK-30NE YYZ-YOW-YSC
 SFC ALG 20WNW YYZ-20WSW ALB-130SSE BGR-140SSE BGR
 040 ALG 40WSW YYZ-40WNW SYR-30ENE HNK-30W BDL-BOS-80ENE ACK-
 140ENE ACK
 080 ALG 50WSW ROD-40W ERI-30NE SLT-30SW SAX-50SSE PVD-160ESE
 ACK
```

Type: AIRMET Hazard: ICE

```
WAUS41 KKCI 072045
BOSZ WA 072045
AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 080300
AIRMET ICE...ME NH VT MA RI CT NY LO NJ PA OH LE AND CSTL WTRS
FROM 20SW YOW TO 40ENE ALB TO 140S YSJ TO 170SE ACK TO 50S JHW TO
50SW CLE TO 30SE ECK TO 20SW YOW
MOD ICE BTN 080 AND FL210. CONDS CONTG BYD 03Z ENDG 06-09Z.
FRZLVL...RANGING FROM SFC-105 ACRS AREA
 MULT FRZLVL 020-080 BOUNDED BY YSC-60SW YSJ-140E ACK-40SE BOS-
 20W SAX-20NW HNK-30NE YYZ-YOW-YSC
 SFC ALG 20WNW YYZ-20WSW ALB-130SSE BGR-140SSE BGR
 040 ALG 40WSW YYZ-40WNW SYR-30ENE HNK-30W BDL-BOS-80ENE ACK-
 140ENE ACK
 080 ALG 50WSW ROD-40W ERI-30NE SLT-30SW SAX-50SSE PVD-160ESE
 ACK
```

Area Forecast

```
000
FAUS41 KKCI 080145
FA1W
BOSC FA 080145
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 082000
CLDS/WX VALID UNTIL 081400...OTLK VALID 081400-082000
ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA AND CSTL WTRS
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.
.
SYNOPSIS...02Z LOW 50E YVV WITH CDFNT ALG A 50E YVV-ERI-APE-BWG
LN. WRMFNT ALG A 50E YVV-SYR-ALB-ACK-140E ACK LN. 20Z CDFNT ALG A
60E HUL-ACK-SBY-VXV LN.
.
ME
N HLF...OVC025 LYRD FL300. VIS 3SM -SN BR. BECMG 0912 OVC020. VIS
3SM -FZRAPLSN. OTLK..MVFR CIG FZDZ BR 17Z MVFR CIG.
SW QTR...OVC015 TOPS FL280. VIS 3SM -FZRAPL BR. 08Z OCNL -RA.
OTLK...MVFR CIG SHRA NRN SXNS...VFR SRN SXNS.
SE QTR...OVC015 TOPS FL300. VIS 3SM -FZRAPLSN BR. BECMG 1013
OVC010. VIS 3SM -RA BR. OTLK...IFR CIG RA BR 16Z IFR CIG.
.
NH VT
N HLF...OVC025 TOPS FL250. VIS 3SM -FZRAPLSN BR. OTLK...VFR WRN
SXNS...MVFR CIG ERN SXNS.
S HLF...BKN020 OVC040 TOPS FL280. VIS 3SM -FZRAPL BR. BECMG 1013
BKN050 TOPS 080 BKN CI. OTLK...VFR.
.
MA RI CT
WRN-CNTRL MA...OVC020 TOPS FL270. VIS 4SM -FZRA/-FZDZ BR. BECMG
0609 OVC020. VIS 3SM -RA BR. OTLK...MVFR CIG 17Z VFR.
NANTUCKET ISLAND...BKN010 BKN100 LYRD FL300. VIS 3SM BR. 09Z WND
SW 20G30KT. OTLK...IFR CIG RA BR WND.
RMNDR MA/RI/CT...BKN015 BKN100 LYRD FL300. VIS 3SM BR. OCNL -DZ.
BECMG 0912 OVC015 TOPS 100. VIS 4SM BR. OCNL -RA. OTLK...MVFR CIG
18Z VFR.
.
NY LO
EXTRM SERN NY...BKN010 BKN120 TOPS FL250. VIS 3-5SM -DZ BR. BECMG
0710 OVC015 LYRD FL350. VIS 4SM BR. WDLY SCT -SHRA. OTLK...MVFR
CIG 15Z VFR.
EXTRM NERN NY...OVC030 LYRD FL350. VIS 3SM -FZRAPLSN BR. BECMG
0709 OVC045 TOPS 100. VIS 3SM -RA BR. WND SW G25-30KT. OTLK...VFR
WND.
RMNDR ERN NY...OVC015 TOPS FL350. VIS 3SM -RA BR. OTLK...MVFR CIG
16Z VFR WND.
CNTRL NY...OVC020 TOPS FL350. VIS 4SM IN SCT -SHRA BR. 08Z WND SW
25G35KT NRN SXNS. OTLK...MVFR CIG THRUT...WND NRN SXNS.
WRN NY/LO...OVC020-030 TOPS FL350. VIS 3SM -RA BR. BECMG 0609
WDLY SCT -SHRA. WND SW 20G35KT NRN SXNS. OTLK...MVFR CIG
THRUT..WND NRN SXNS.
.
```

```
PA NJ
EXTRM NWRN PA...SCT035 BKN050 TOPS 150. WDLY SCT -SHRA. WND SW
20G30KT. BECMG 0507 BKN020 TOPS 080. OCNL -DZ. WND W G25KT.
OTLK...MVFR CIG.
RMNDR NWRN QTR PA...OVC030-040 TOPS FL250. SCT -SHRA. OTLK...IFR
CIG SHRA 18Z MVFR CIG SHRA.
SW QTR PA...OVC035 TOPS FL220. SCT -SHRA. BECMG 0710 BKN025
BKN060. OTLK...MVFR CIG SHRA WRN SXNS...VFR ERN SXNS.
NERN QTR PA...OVC020 LYRD FL300. TIL 10Z OCNL VIS 3SM -RA BR.
OTLK...MVFR CIG 15Z VFR.
SE QTR PA/NJ...BKN020 BKN100 LYRD FL280. VIS 4SM BR. BECMG 0508
WDLY SCT -SHRA. OTLK...MVFR CIG SHRA BR 15Z VFR.
.
OH LE
W HLF OH...BKN025 TOPS 060. TIL 10Z WND W G25KT NRN SXNS.
OTLK...MVFR CIG THRUT...16Z RASN.
E HLF OH/LE...BKN020-030 TOPS 070. OCNL -DZ NRN SXNS. TIL 06Z
WDLY SCT -SHRA. OTLK...MVFR CIG.
.
WV
NW HLF...OVC040 TOPS 100. WDLY SCT -SHRA MAINLY NRN SXNS.
OTLK...MVFR CIG THRUT...SHRA NRN SXNS.
SE HLF...OVC060 LYRD FL200. TIL 06Z SCT -SHRA. BECMG 0912 OVC035.
OTLK...IFR CIG 17Z VFR.
.
MD DC DE VA
N HLF...SCT030 BKN-SCT100 TOPS 170 BKN CI. WND S G25KT ERN SXNS.
06Z SCT025 BKN-SCT045. OTLK...VFR.
SW QTR...SCT-BKN060 BKN120 TOPS FL200. WDLY SCT -SHRA. BECMG 0710
BKN050. OTLK...VFR.
SE QTR...SCT-BKN CI. BECMG 0609 SCT025 OVC060 LYRD FL220. WDLY
SCT -SHRA. BECMG 1012 OVC015. SCT -SHRA. OTLK...IFR CIG SHRA 17Z
VFR.
.
CSTL WTRS
N OF ACK...OVC010 TOPS FL250. VIS 3SM -RAPLSN BR. WND NELY
25G35KT. BECMG 0609 BKN015 BKN100 LYRD FL250. WDLY SCT -SHRA. WND
S G25KT. OTLK...MVFR CIG SHRA WND.
RMNDR...SCT025 SCT-BKN050 TOPS 150. ISOL -SHRA. BECMG 0912
BKN015-025 LYRD FL350. SCT -SHRA. ISOL -TSRA. CB TOPS FL350. WND
S G25KT. OTLK...MVFR CIG SHRA WND.
....
```

METARS

KSYR 130154Z 14010G20KT 10SM –RA OVC075 07/06 A2938

CYPQ 080147Z AUTO 00000KT 5SM -SN OVC005 M02/M03 A2923

CYGK 080100Z 06010KT 5SM -RA OVC006 01/M03 A2930

CYYZ 080129Z 00000KT 4SM -FZRA OVC012 M00/M01 A2921

CYTR 080150Z 08010KT 3SM -FZRA OVC003 M00/M03 A2927

KBUF 080154Z 20020G25KT 10SM -RA BKN028 12/09 A2928

KROC 080154Z 21010KT 10SM -RA OVC085 10/08 A2929

KART 080156Z 17020G35KT 5SM -RA OVC040 08/06 A2928

KRME 080153Z 11015KT 10SM -RA OVC021 02/02 A2950

KJHW 080155Z 21015G25KT 10SM BKN010 OVC018 10/08 A2936

KELM 080153Z 00000KT 6SM -RA OVC017 07/05 A2945

KBGM 080153Z 14005KT 3SM BR OVC003 03/03 A2949

TAFS

TAF CYYZ 072340Z 0800/0906 24020G35KT P6SM OVC015
FM080700 27020G30KT P6SM OVC015
FM081300 29020G30KT P6SM BKN025

TAF CYTR 072332Z 0800/0824 22015KT WS005/24040KT 3SM -DZ OVC007
FM081300 25015G25KT P6SM SCT007 OVC020

KBUF 072322Z 0800/0824 23025G40KT 2SM OVC007
FM080700 24020G35KT 3SM BR OVC007
FM081300 26016G24KT P6SM OVC020

KROC 072322Z 0800/0824 20008KT 3SM -RA OVC025
FM080500 20015G20KT 5SM -RA OVC025
FM080700 25020G35KT P6SM OVC015
FM081300 27020G25KT P6SM OVC025

KSYR 072342Z 0800/0824 12010KT 4SM -RA BR BKN015
FM080500 20010G20KT 5SM -SHRA BR OVC015
FM081300 28015G25KT P6SM BKN025

KART 072322Z 0800/0824 05005KT 3SM -FZRA BR OVC015
FM080500 14015G20KT 3SM -RA BR OVC012
FM081300 25020G25KT P6SM BKN025

KRME 072342Z 0800/0824 12010KT 2SM -RA BR OVC008
FM081200 27010KT P6SM OVC015

KJHW 072322Z 0800/0824 21015G25KT 3SM -RA BR OVC007
FM080700 25015G25KT 3SM -SHRA BR OVC007
FM081300 28012KT P6SM OVC012

KELM 072342Z 0800/0824 23010KT P6SM -SHRA OVC015
FM081300 29010G20KT P6SM BKN035

KBGM 072342Z 0800/0824 20010G20KT 5SM -SHRA OVC008
FM081300 27010G20KT P6SM OVC015

Winds and Temperatures Aloft

```
(Extracted from FBUS31 KWNO 072002)
FD1US1
DATA BASED ON 071800Z
VALID 080000Z   FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT  3000    6000    9000   12000   18000   24000  30000  34000  39000
BDL 1919 2448+06 2554+00 2566-04 2555-17 2558-29 266145 256456 257168
BGR 1119 2130-04 2326-05 2535-10 2457-20 2672-31 278947 279957 780468
PWM 1136 2232+00 2445-02 2551-06 2666-18 2568-30 268047 278456 278567
EMI 2149 2452+09 2452+03 2347-04 2448-17 2548-28 235345 245555 247266
ACK 2345 2454+06 2552+01 2659-04 2650-18 2653-29 265546 265756 267667
BOS 1520 2446+04 2456+00 2658-05 2656-17 2560-29 276546 266955 267868
BML 1232 2129+00 2221-04 2230-08 2559-19 2569-30 268647 279257 279668
ACY 2352 2448+11 2448+03 2350-05 2453-17 2450-28 245545 255755 256166
ALB 1737 2350+05 2461+00 2473-05 2571-17 2565-29 267146 267356 258168
BUF 2257 2551+05 2347-01 2458-06 2357-17 2467-29 248145 238655 248265
JFK 2344 2439+09 2450+02 2455-05 2556-18 2548-28 244845 245255 266267
PLB 1653 2134+00 2233-03 2338-07 2560-18 2567-30 268647 269556 269868
SYR 2060 2458+05 2344-01 2456-05 2464-17 2464-28 257146 247756 249067
CLE 2351 2549+04 2451-01 2546-07 2450-19 2358-30 228446 730356 246858
AGC 2344 2457+05 2455-01 2460-05 2362-16 2464-28 236545 247455 247365
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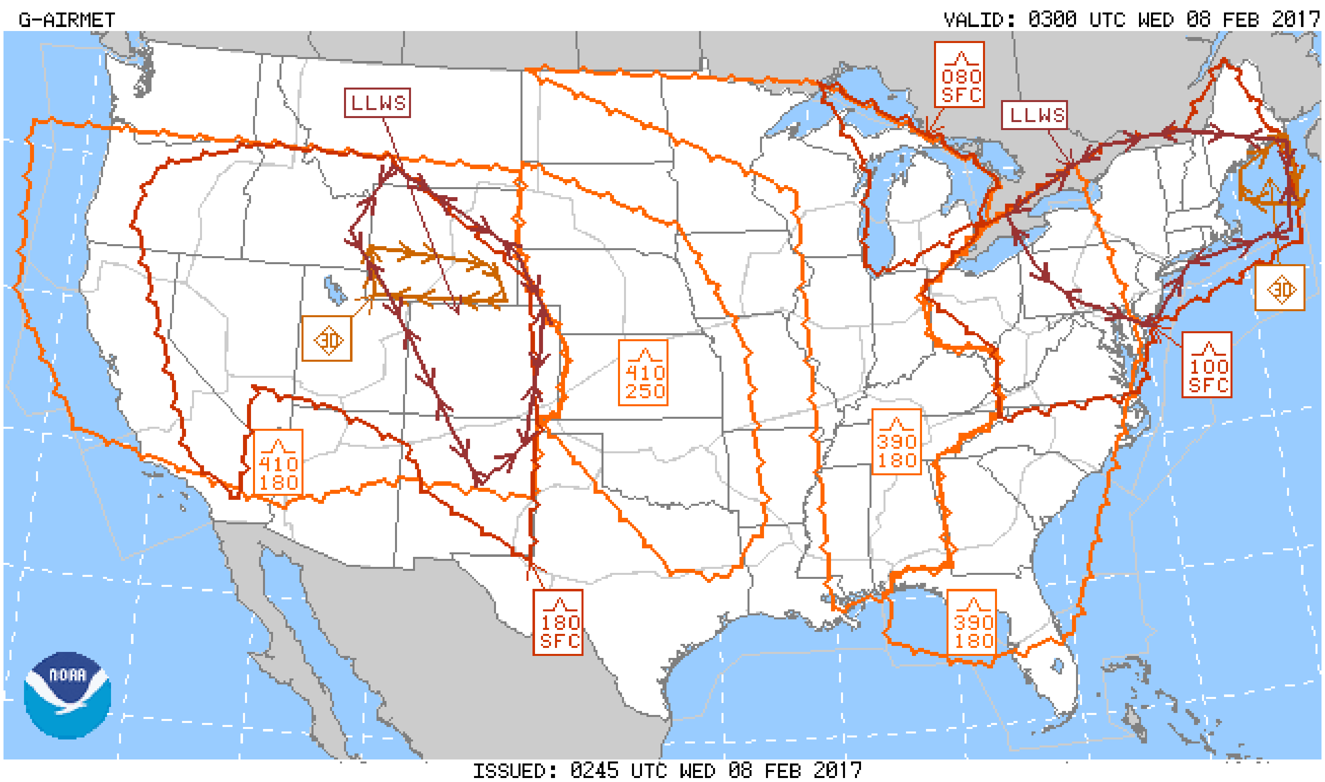
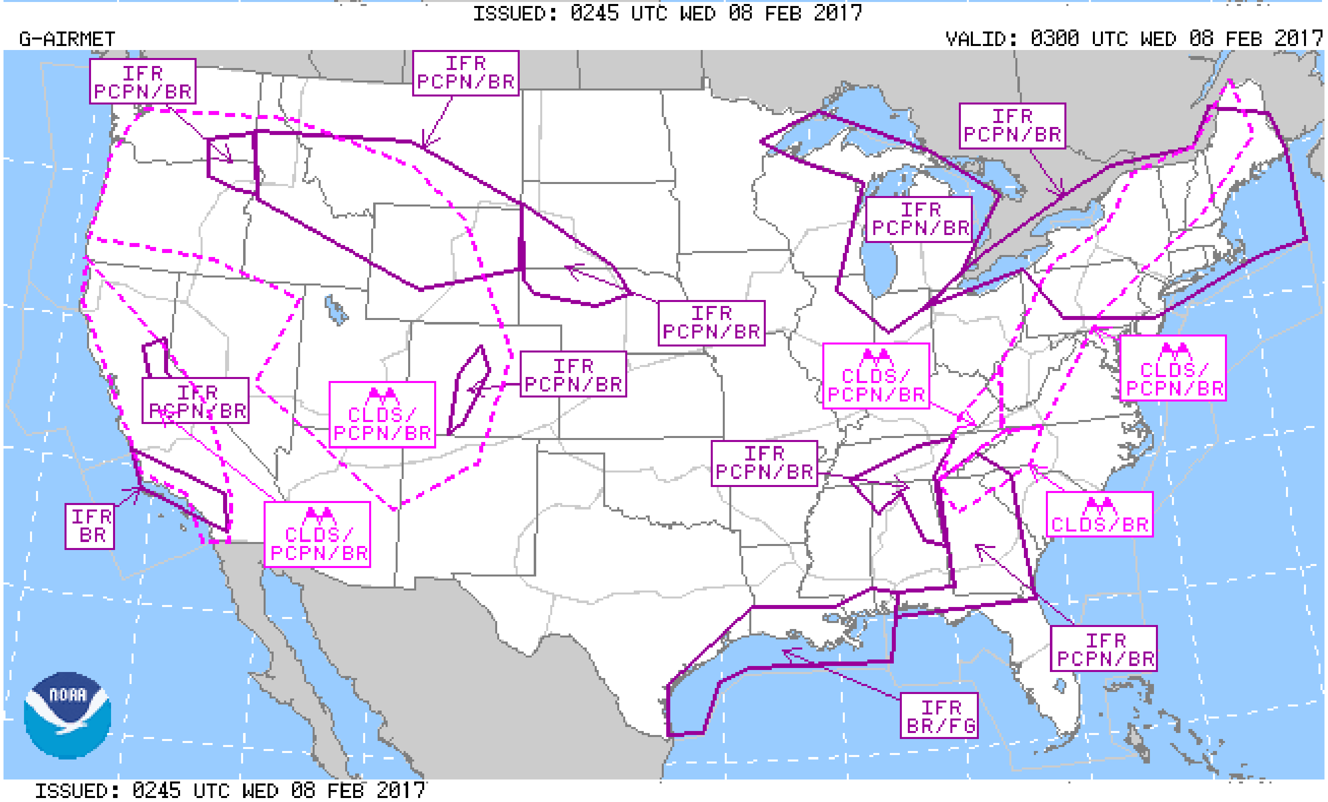
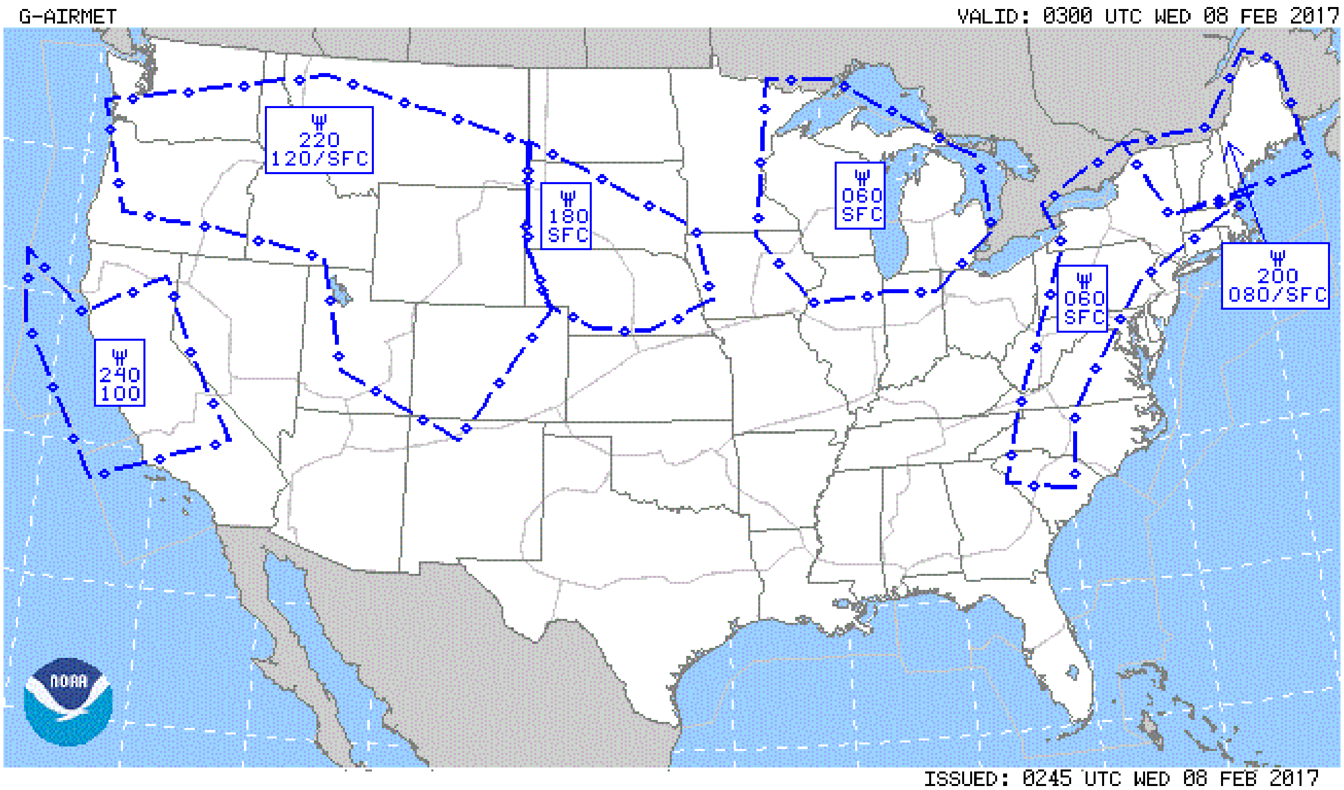
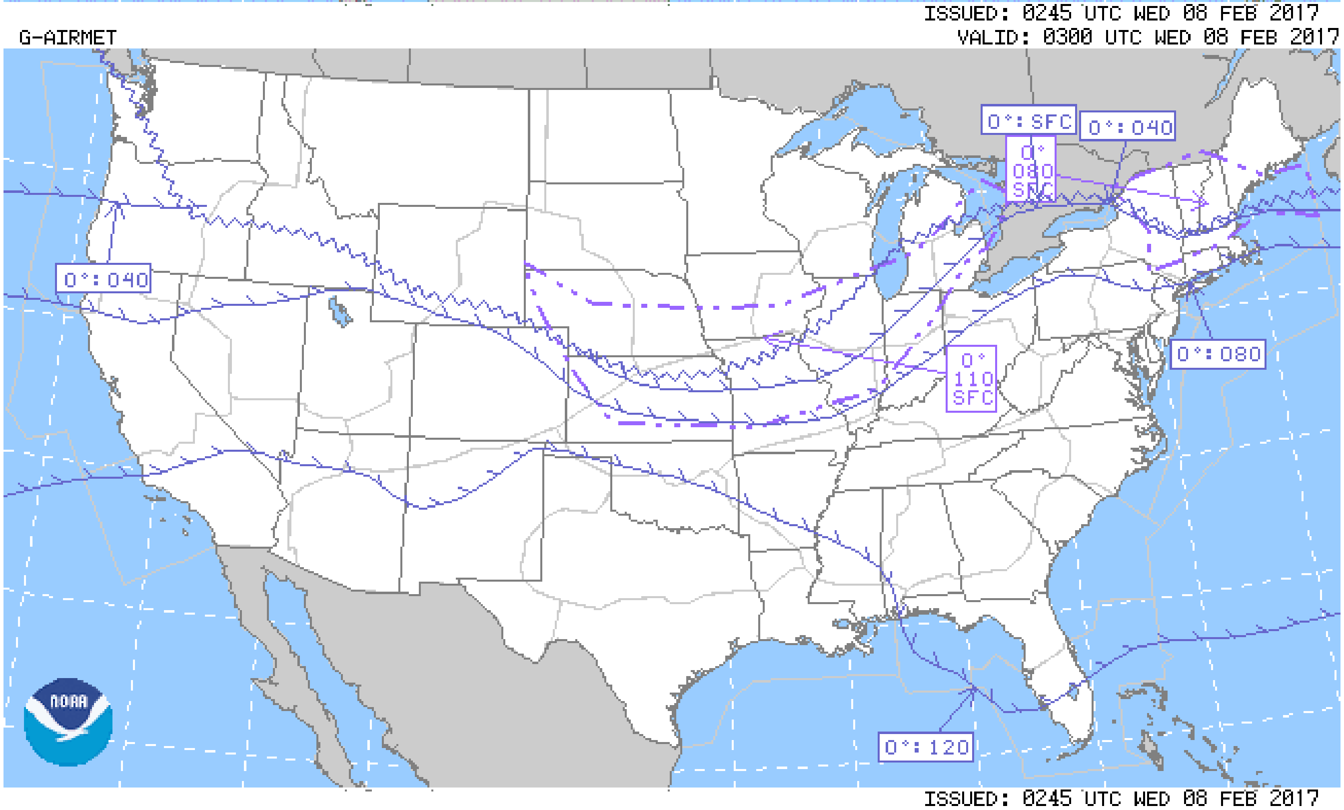
KSYR-KBUF Graphical Weather Information

AIRMETS






G-AIRMET
VALID: 0300 UTC WED 08 FEB 2017
220
120/SFC
180
SFC
060
SFC
240
100
060
SFC
200
080/SFC
ISSUED: 0245 UTC WED 08 FEB 2017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VALID: 0300 UTC WED 08 FEB 2017
0°:SFC
0°:040
0°
080
SFC
0°:040
0°:080
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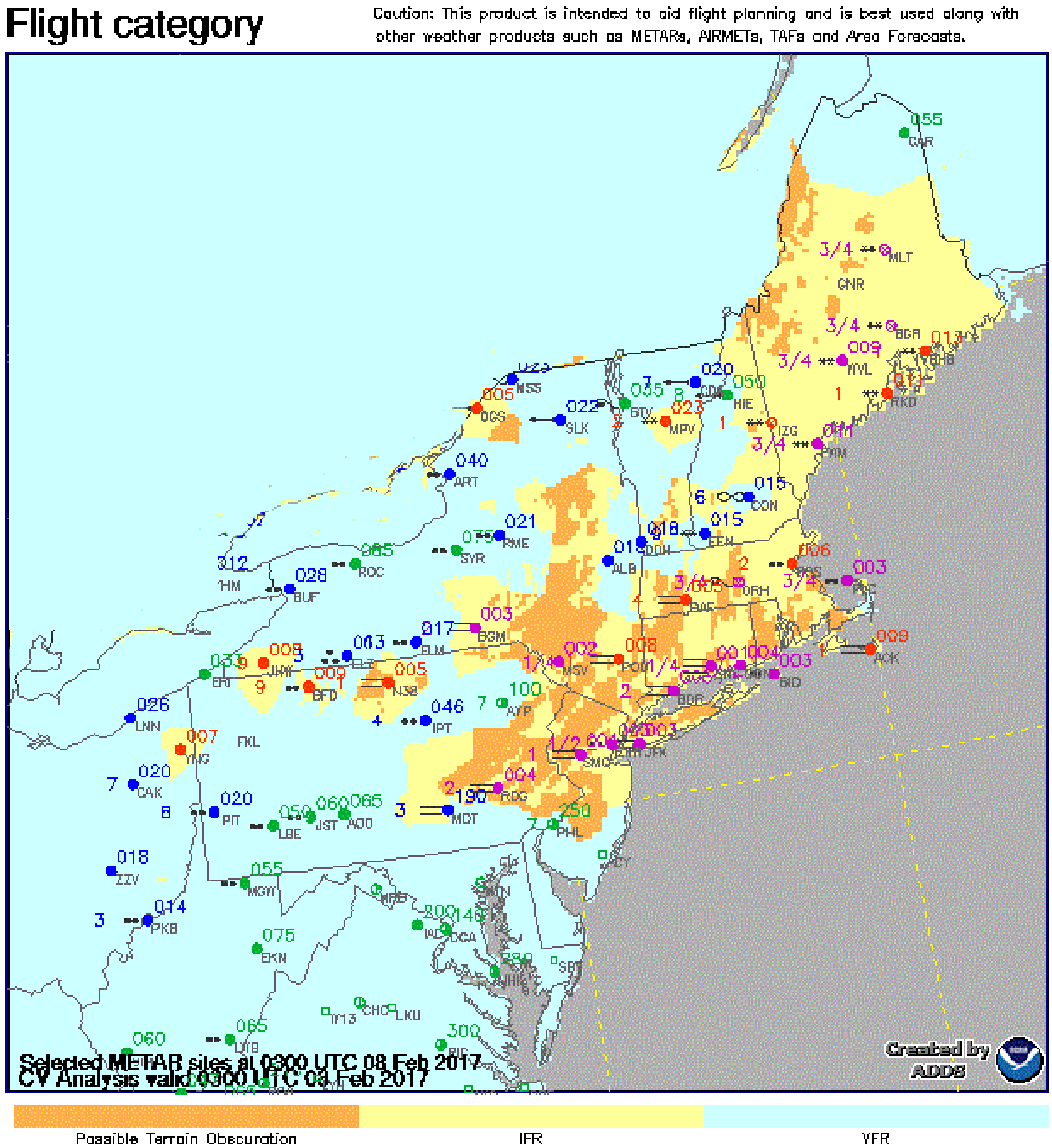
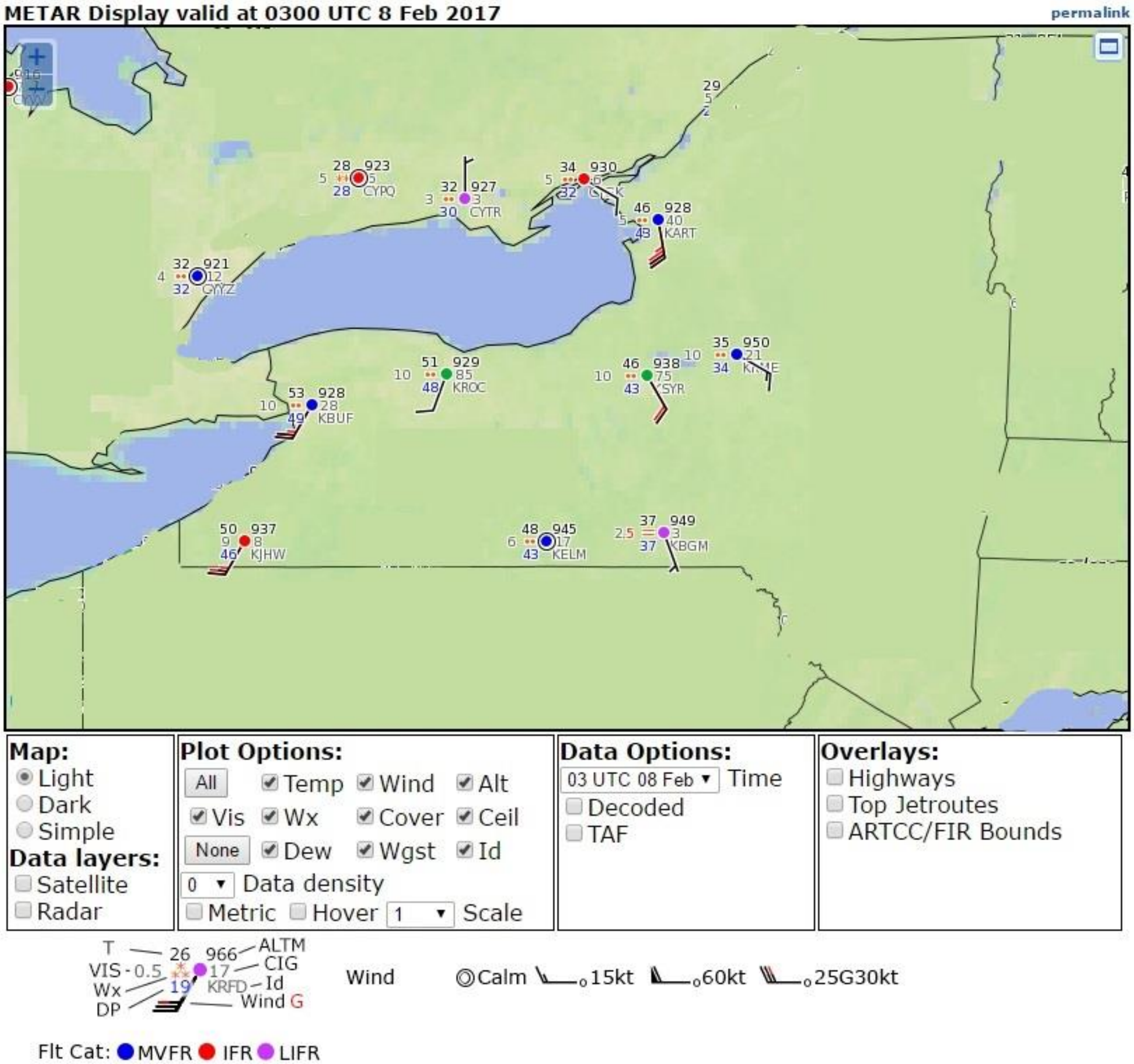
SFC
0°:120
ISSUED: 0245 UTC WED 08 FEB 2017

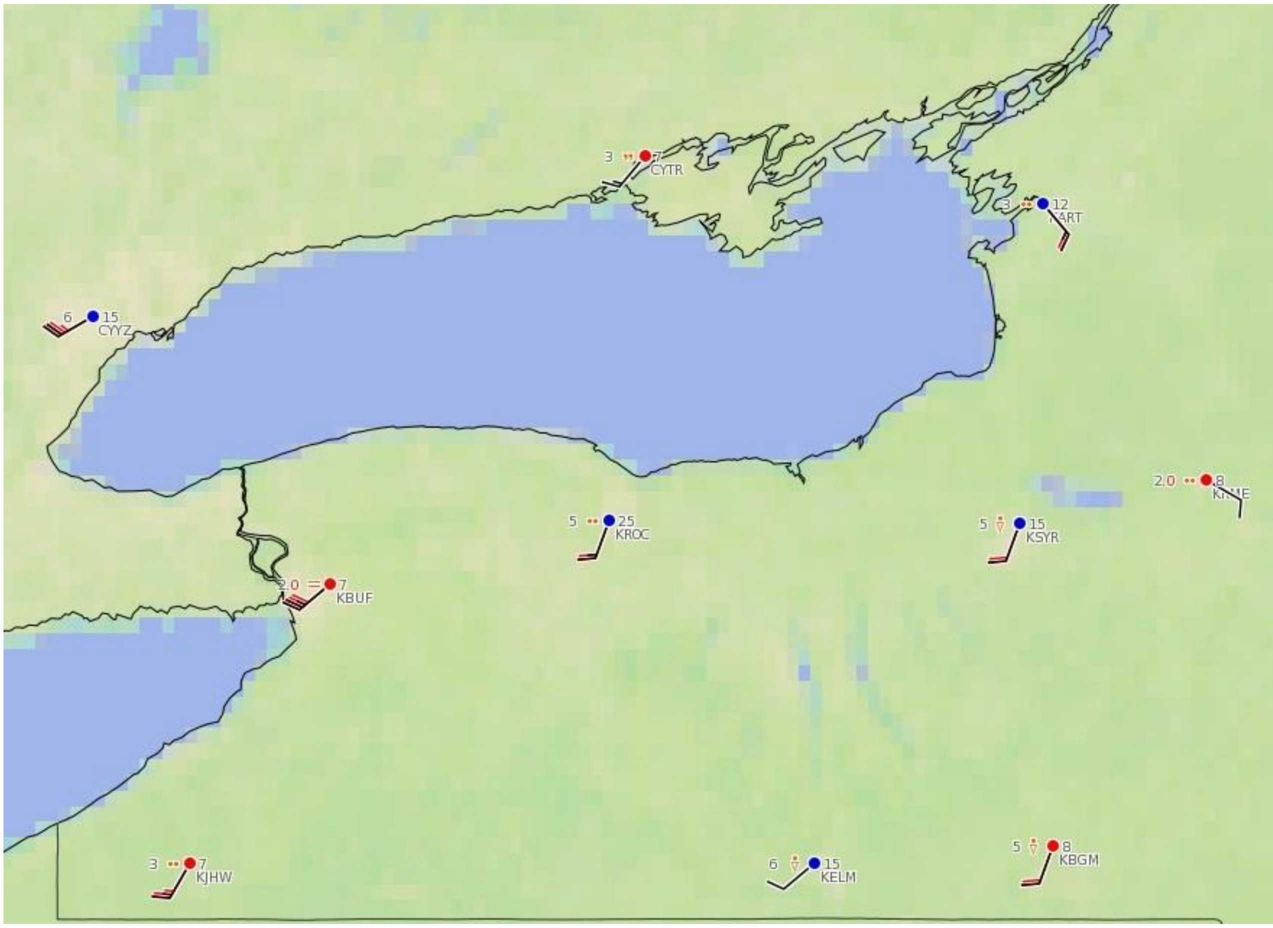

Flight category
Caution: This product is intended to aid flight planning and is best used along with other weather products such as METARs, AIRMETs, TAFs and Area Forecasts.
Selected METAR sites at 0300 UTC 08 Feb 2017
CV Analysis valid 0300 UTC 08 Feb 2017
Created by ADDS
Possible Terrain Obscuration
IFR
VFR

METARS

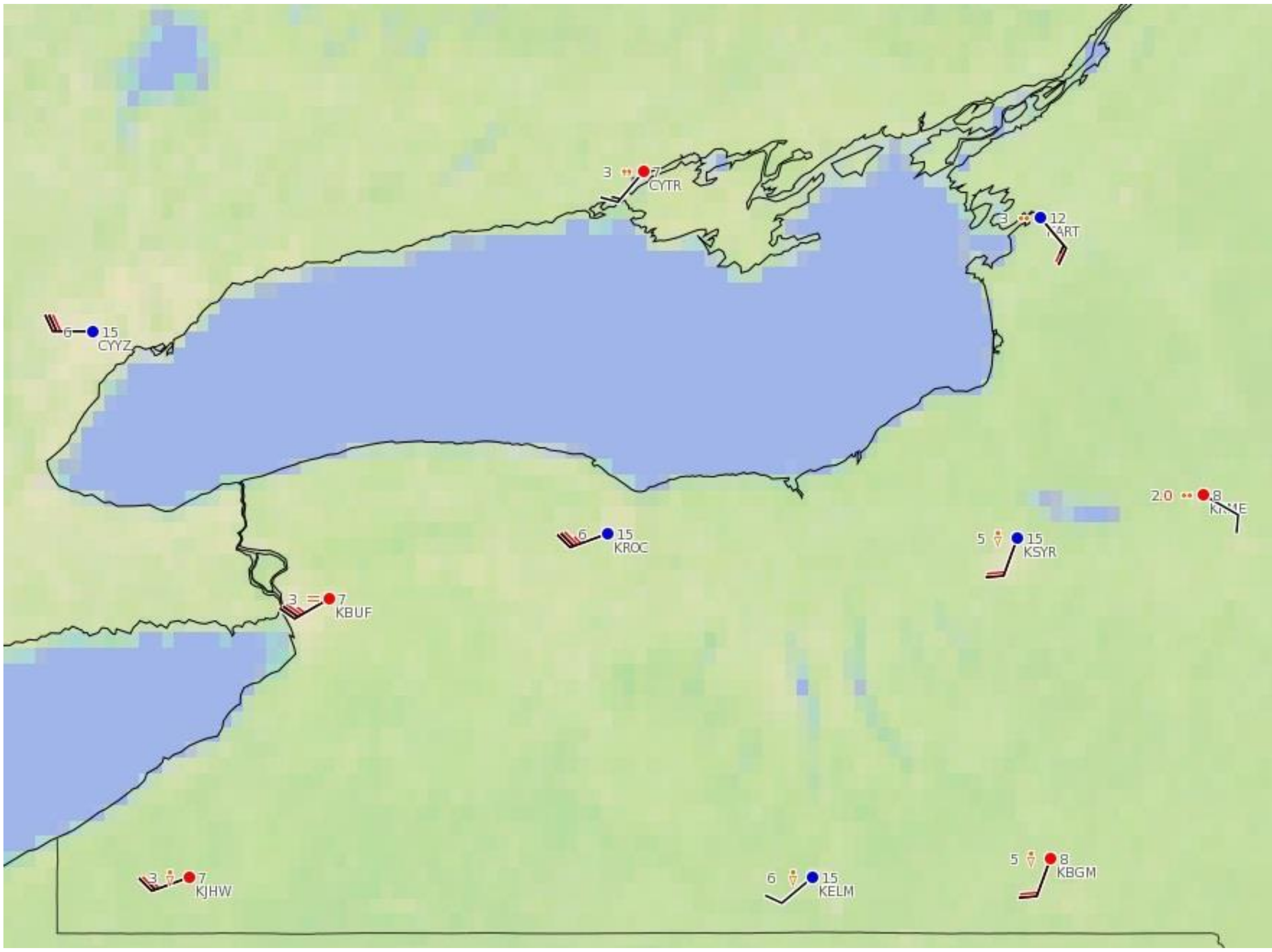

METAR Display valid at 0300 UTC 8 Feb 2017
permalink
CYPQ
CYTR
KART
CYYZ
KROC
KSYR
KBUF
KJHW
KELM
KBGM
Map:
Light
Dark
Simple
Data layers:
Satellite
Radar
Plot Options:
All
Temp
Wind
Alt
Vis
Wx
Cover
Ceil
None
Dew
Wgst
Id
Data density
Metric
Hover
Scale
Data Options:
03 UTC 08 Feb
Time
Decoded
TAF
Overlays:
Highways
Top Jetroutes
ARTCC/FIR Bounds
T
VIS
Wx
DP
ALTM
CIG
Id
Wind G
Wind
Calm
15kt
60kt
25G30kt
Flt Cat:
MVFR
IFR
LIFR

TAFS

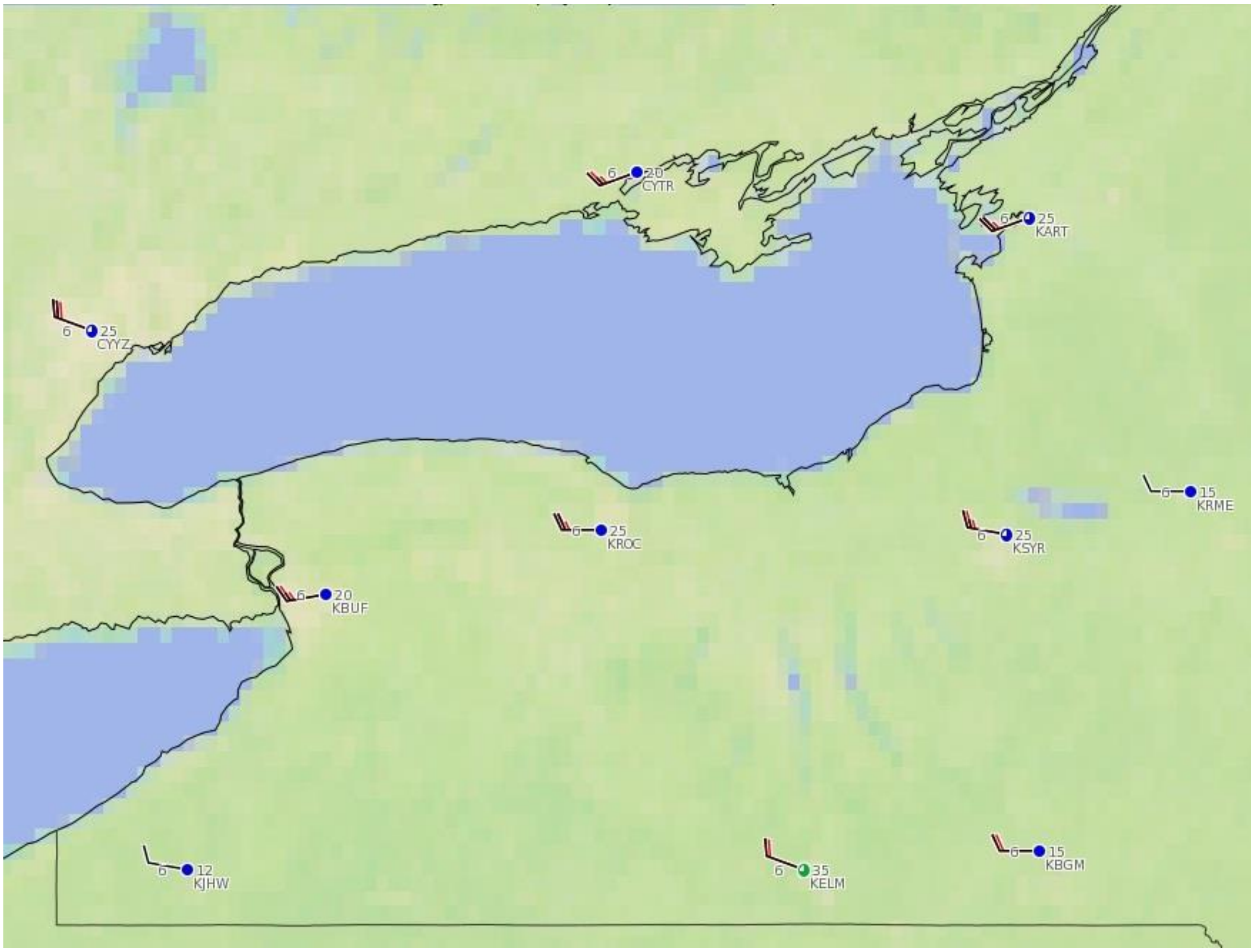
05Z


3
7
CYTR
3
12
KART
6
15
CYYZ
2.0
8
5
25
KROC
5
15
KSYR
2.0
7
KBUF
3
7
KJHW
6
15
KELM
5
8
KBGM

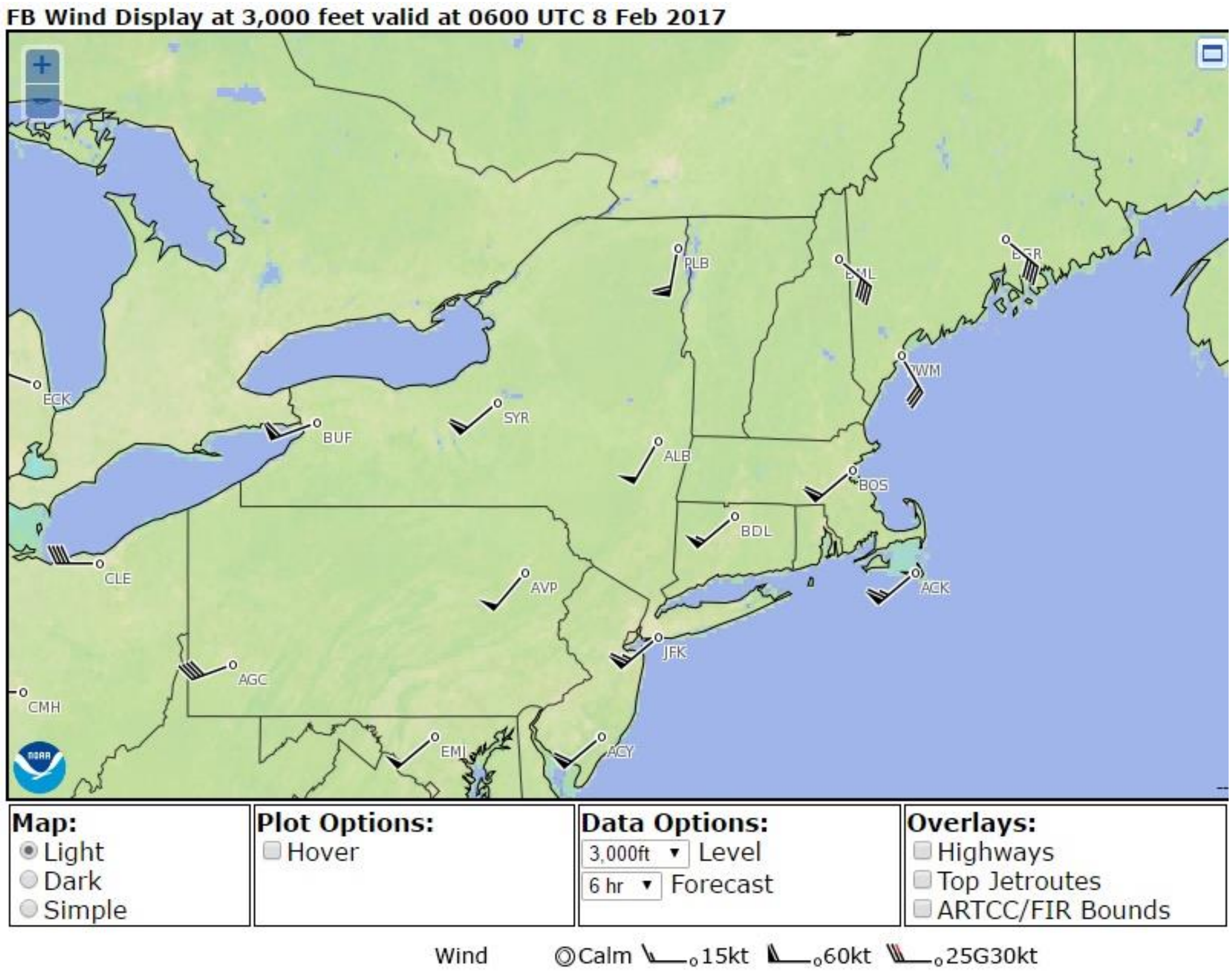
07Z



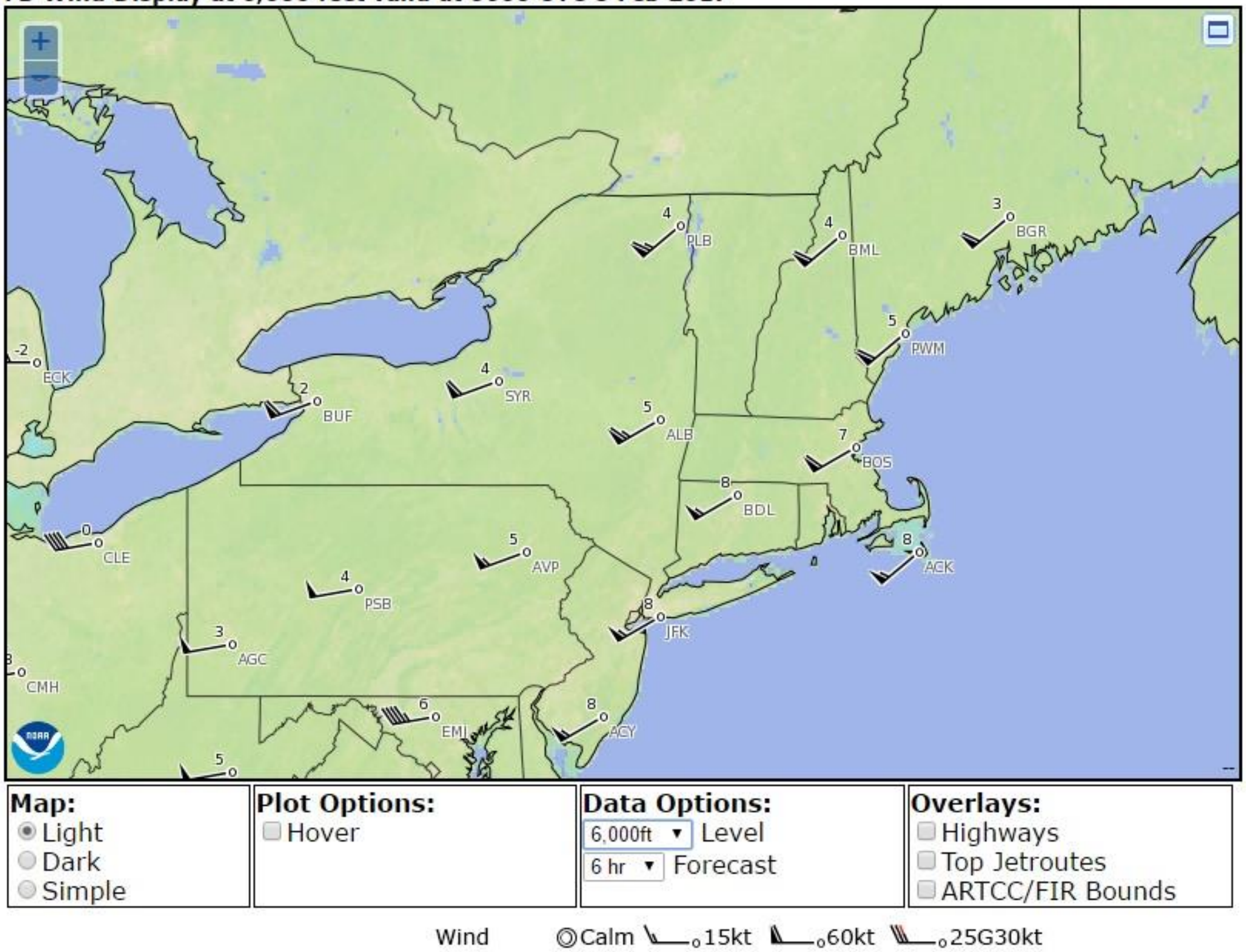
13Z

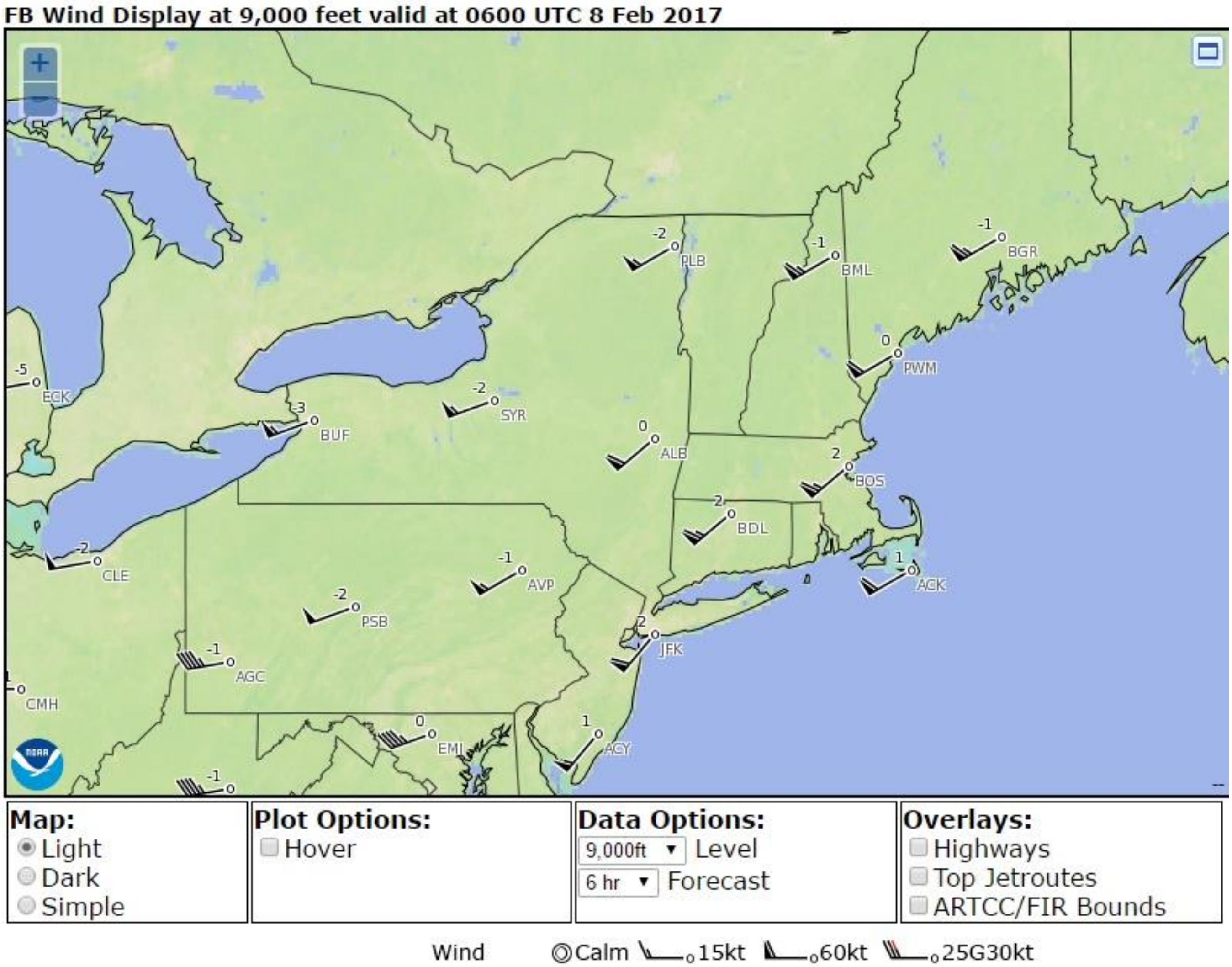

6
20
CYTR
6
25
KART
6
25
CYYZ
6
15
KRME
6
25
KROC
6
25
KSYR
6
20
KBUF
6
12
KJHW
6
35
KELM
6
15
KBGM

Winds and Temperatures Aloft

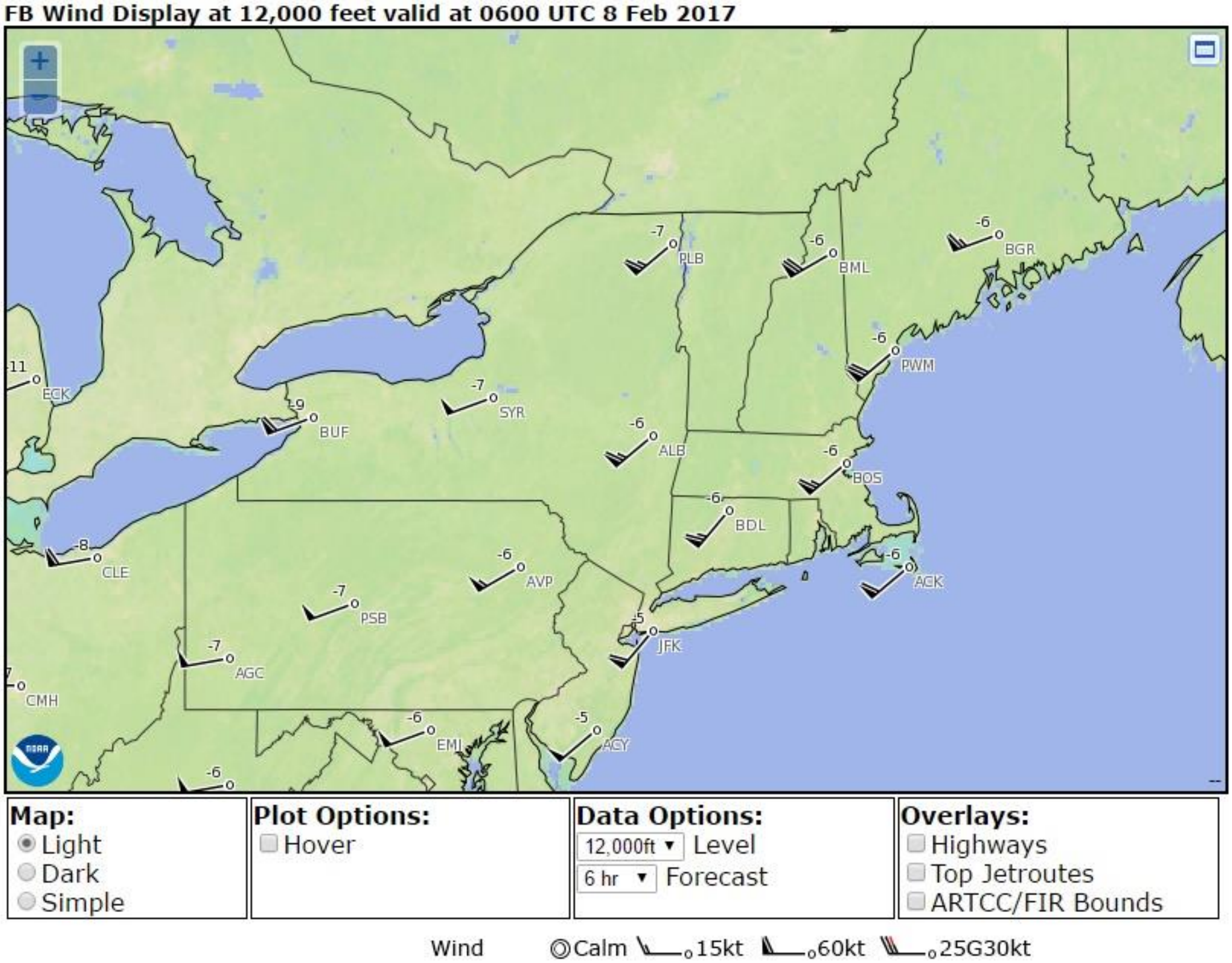


FB Wind Display at 6,000 feet valid at 0600 UTC 8 Feb 2017

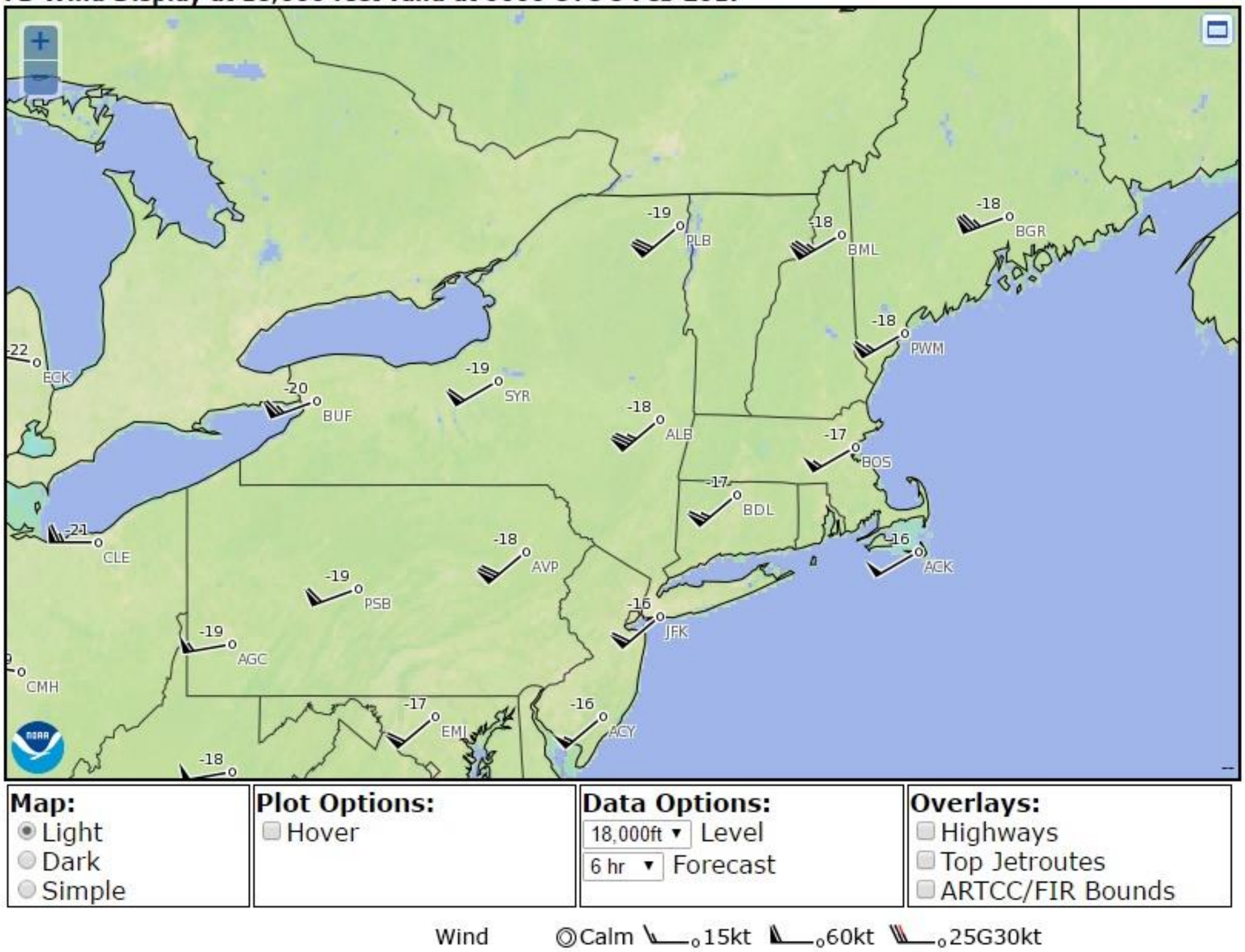



FB Wind Display at 9,000 feet valid at 0600 UTC 8 Feb 2017
PLB
BML
BGR
PWM
ECK
SYR
BUF
ALB
BOS
BDL
CLE
AVP
ACK
PSB
JFK
AGC
CMH
EMI
ACY
Map:
Light
Dark
Simple
Plot Options:
Hover
Data Options:
9,000ft Level
6 hr Forecast
Overlays:
Highways
Top Jetroutes
ARTCC/FIR Bounds
Wind
Calm
15kt
60kt
25G30kt

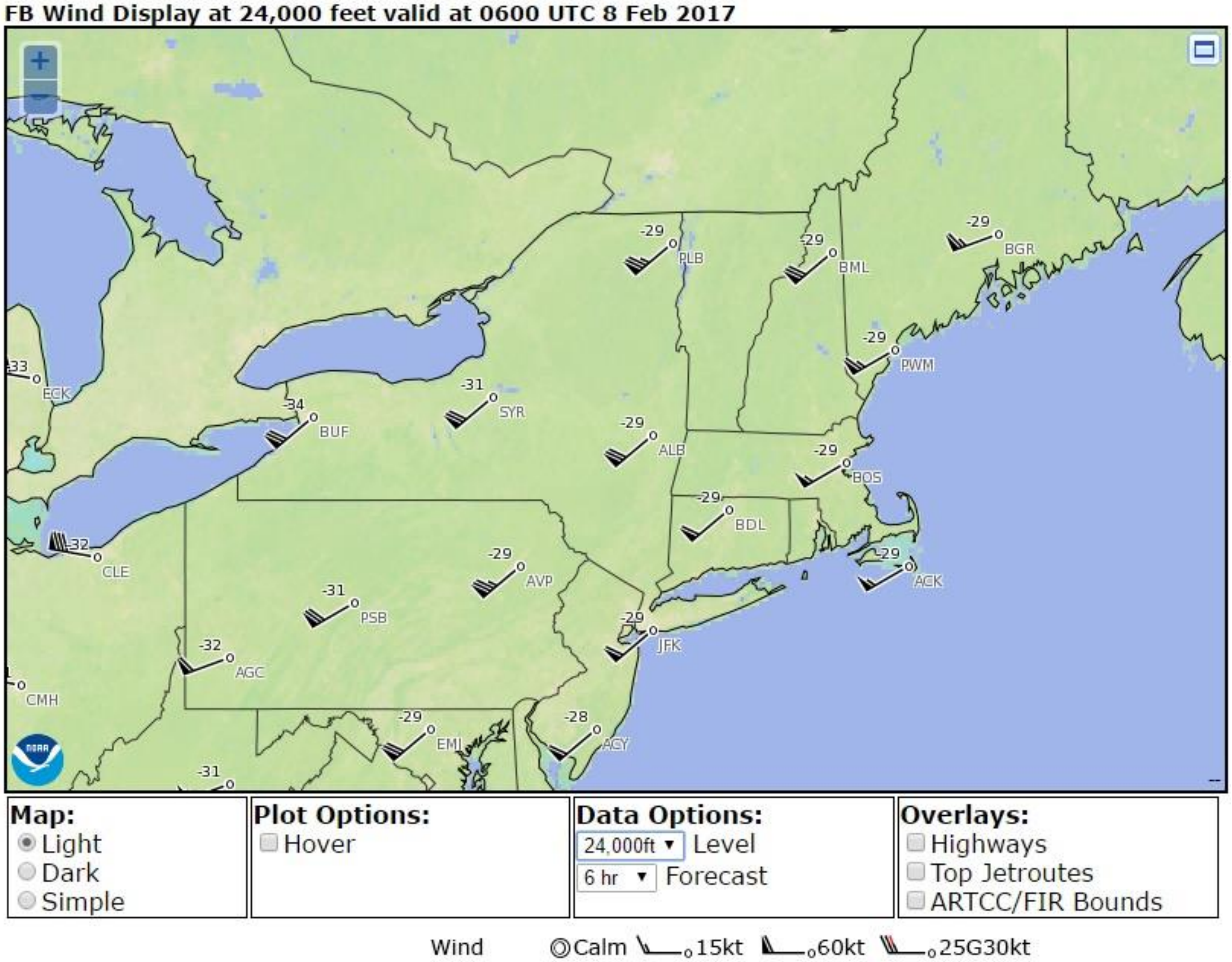
FB Wind Display at 12,000 feet valid at 0600 UTC 8 Feb 2017



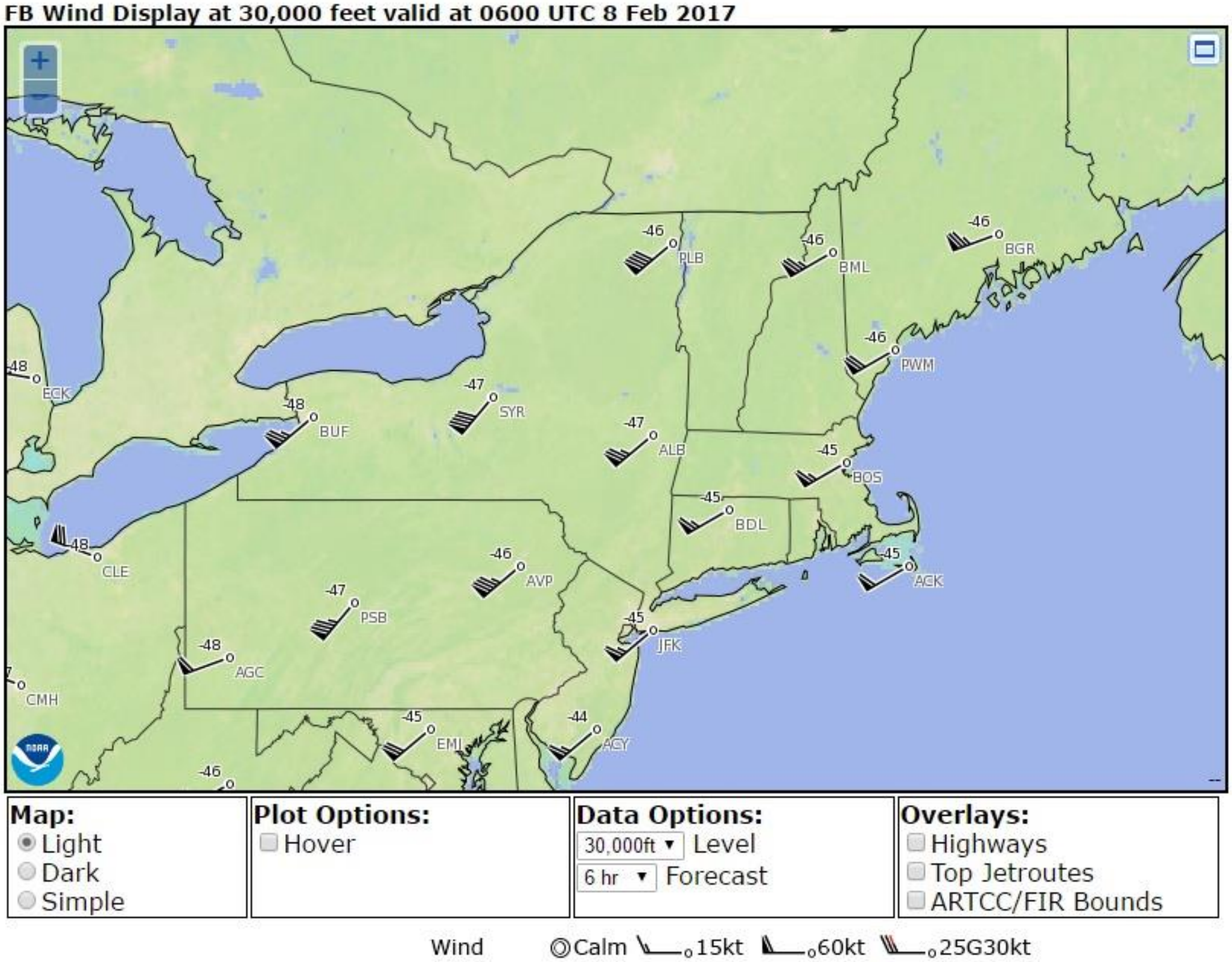
FB Wind Display at 18,000 feet valid at 0600 UTC 8 Feb 2017

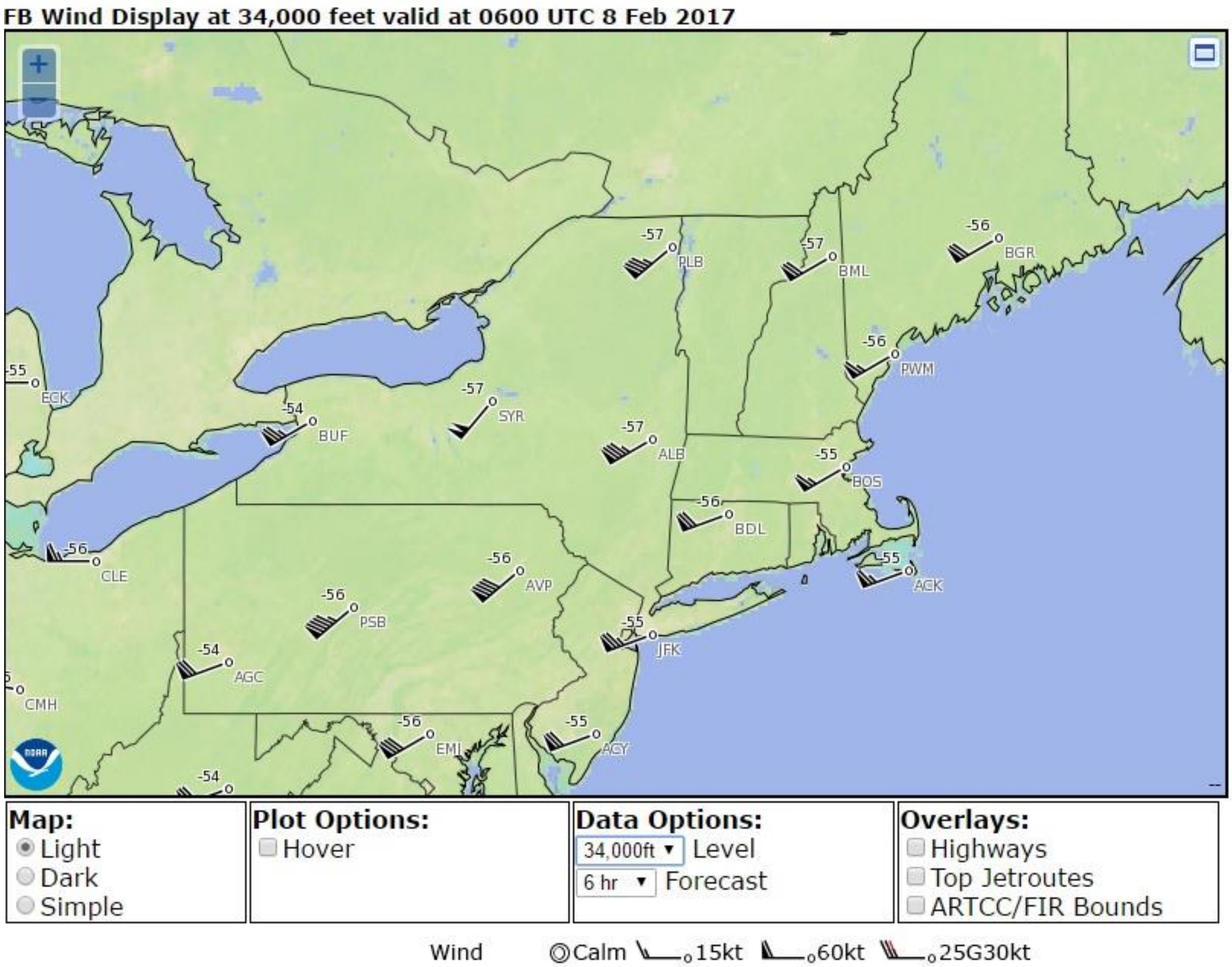


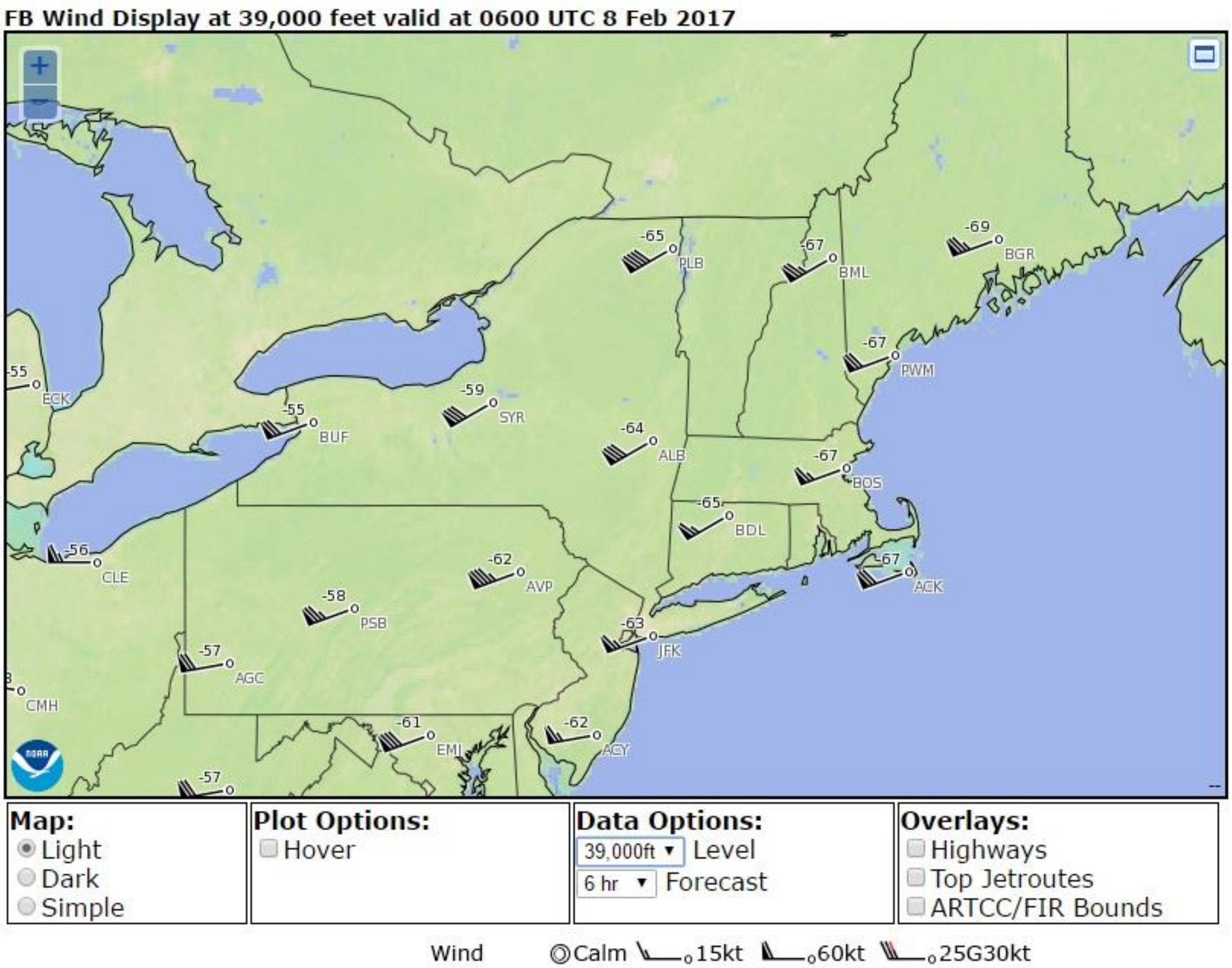
FB Wind Display at 24,000 feet valid at 0600 UTC 8 Feb 2017



FB Wind Display at 30,000 feet valid at 0600 UTC 8 Feb 2017




FB Wind Display at 34,000 feet valid at 0600 UTC 8 Feb 2017
-57 PLB
-57 BML
-56 BGR
-56 PWM
-55 ECK
-54 BUF
-57 SYR
-57 ALB
-55 BOS
-56 BDL
-56 CLE
-56 AVP
-55 ACK
-56 PSB
-55 JFK
-54 AGC
CMH
-56 EMI
-55 ACY
-54
Map:
Light
Dark
Simple
Plot Options:
Hover
Data Options:
34,000ft Level
6 hr Forecast
Overlays:
Highways
Top Jetroutes
ARTCC/FIR Bounds
Wind
Calm 15kt 60kt 25G30kt


FB Wind Display at 39,000 feet valid at 0600 UTC 8 Feb 2017
-65 PLB
-67 BML
-69 BGR
-55 ECK
-59 SYR
-55 BUF
-67 PWM
-64 ALB
-67 BOS
-65 BDL
-56 CLE
-62 AVP
-67 ACK
-58 PSB
-63 JFK
-57 AGC
CMH
-61 EMI
-62 ACY
-57
Map:
Light
Dark
Simple
Plot Options:
Hover
Data Options:
39,000ft Level
6 hr Forecast
Overlays:
Highways
Top Jetroutes
ARTCC/FIR Bounds
Wind
Calm
15kt
60kt
25G30kt

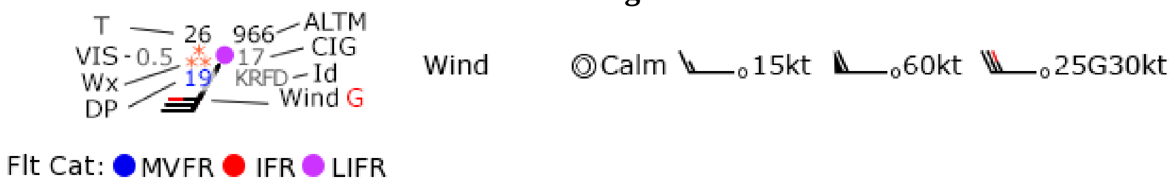
Appendix B

TWI and GWI Legends and Reference Maps

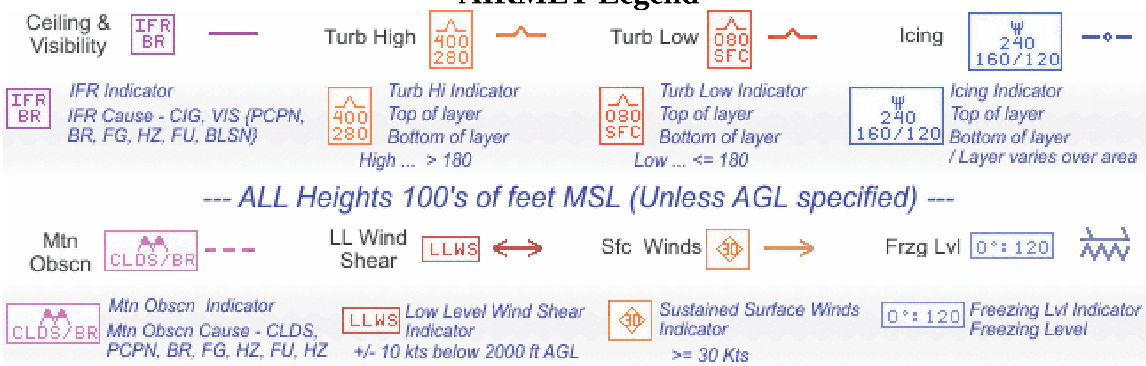
GWI Legends

These legends were provided only to the GWI groups.

METAR/TAF Legend



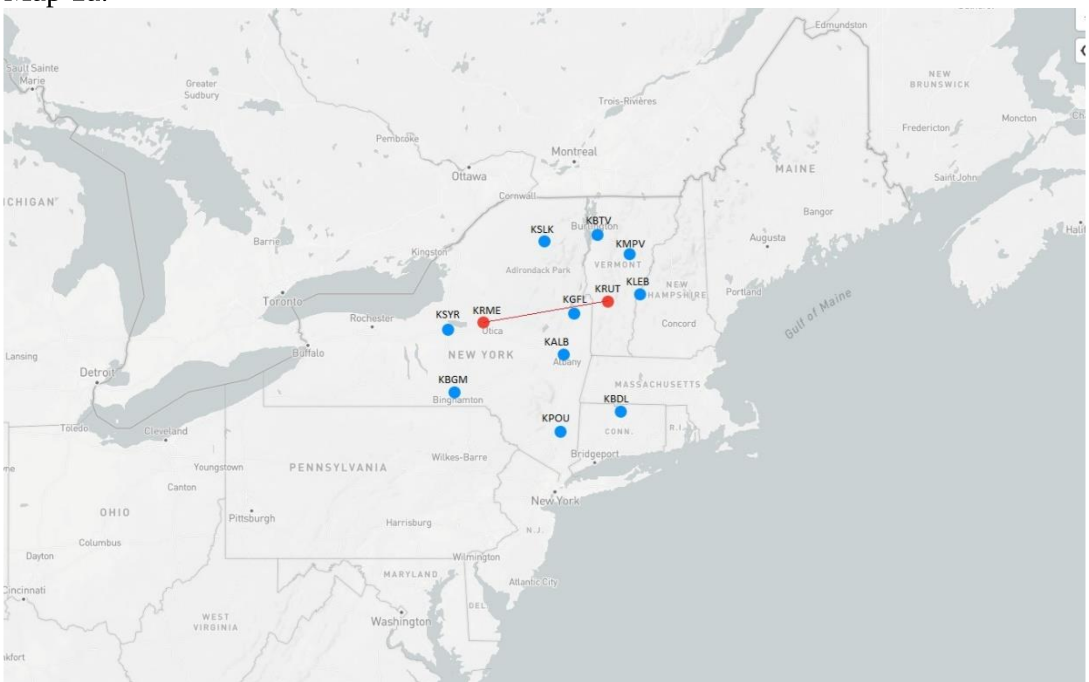
AIRMET Legend



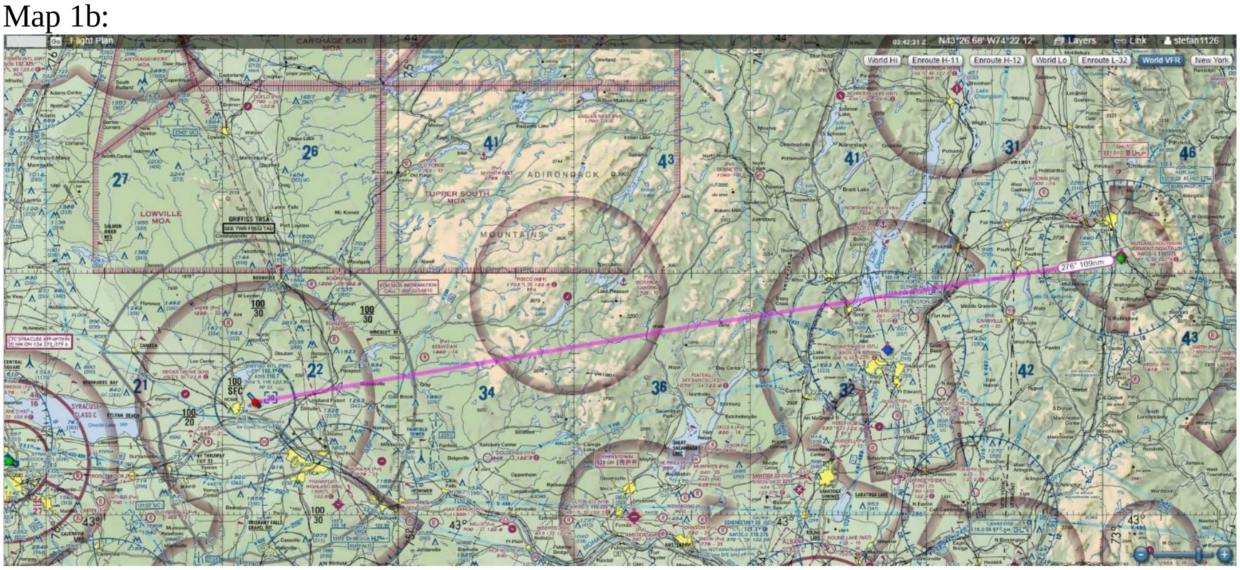
KRUT – KRME Supplements

These supplements were included in both TWI and GWI groups.

Map 1a:



Map 1b:



Map 3a:


BGR
BML
PWM
PLB
ECK
SYR
BUF
ALB
BOS
BDL
CLE
AVP
ACK
JFK
AGC
CMH
EMI
ACY

KSYR – KBUF Supplements

These supplements were included in both TWI and GWI groups.

Map 2a:

Map 2b:

Map 3b:


BGR
BML
PWM
PLB
SYR
BUF
ECK
ALB
BOS
BDL
CLE
AVP
ACK
JFK
AGC
CMH
EMI
ACY

Appendix C

SAM Questions

KSYR - KBUF

1. What are the current surface-level winds
2. What is the current visibility?
3. What is the freezing level?
4. What is the cloud ceiling?
5. Will the destination airport be in VFR, MVFR, or IFR conditions when you arrive?
6. Which direction is the IFR weather moving? (Away or toward you?)
7. What are the winds at your current altitude?
8. What are the surface-level winds at your destination airport?

KRUT – KRME

1. Is the departure temperature above or below freezing?
2. Is there an icing hazard along your route of flight?
3. Will the destination airport be in VFR, MVFR, or IFR conditions when you arrive?
4. Based on the weather information, what is the visibility?
5. Is there any turbulence or low-level wind shear along your route?
6. Are there any IFR weather conditions along your route of flight/?
7. Are there any terrain obscurations along your flight route?
8. How is the wind predominantly affecting you? Do you have a headwind, crosswind, or tailwind component?

Appendix D

Consent Form

AGREEMENT TO PARTICIPATE IN

How Pilots Process Weather Information

STUDY LEADERSHIP. You are invited to participate in a research study that is being conducted by Stefan Melendez, a graduate student in the Masters of Science in Aeronautics (MSA) department at Embry-Riddle Aeronautical University (ERAU).

PURPOSE. The purpose of this study is to determine what effects the flight information available to the pilot has on the pilot's situation awareness.

ELIGIBILITY. To be in this study, you must be 18 years or older and possess at least a Private Pilot certificate issued by the Federal Aviation Administration.

PARTICIPATION. During the study, you will be asked go over and review some flight information provided by the researcher and then to fly a flight simulator. Your involvement in this study will be approximately 2 hours.

RISKS OF PARTICIPATION. The risks of participating in this study are minimal. The simulators being used are desktop simulators. There is a small possibility that you may experience slight dizziness associated with the use of the simulator, resulting from interacting with a video game interface. If you have used a desktop flight simulator or gaming device previously, and have not experienced motion sickness, it is unlikely that you will experience any motion sickness or dizziness in this study. Otherwise, your experience in this study should not exceed normal levels of stress during similar everyday situations. If you feel psychologically or physically uncomfortable during any phase of the experiment, you can request to terminate the session. You may withdraw from the study at any time with no penalty. If you feel any negative side effects from stress and motion sickness, campus health services can be contacted at (386) 226-7917.

BENEFITS OF PARTICIPATION. Your participation will help us better understand what factors can predict situation awareness in a dynamic environment.

VOLUNTARY PARTICIPATION. Your participation in this study is voluntary. You may stop or withdraw from the study at any time or refuse to answer any question that you are uncomfortable answering without penalty. Your decision whether or not to participate will have no effect on your current or future connection with anyone at ERAU or the Federal Aviation Administration. If you decide to opt-out, your data will be deleted, shredded, and/or destroyed.

RESPONDENT PRIVACY. Your responses in this study will be confidential. Only myself and other researchers directly involved in this study will have access to the data. In order to protect the confidentiality of your responses, I will provide each participant with a random ID for the study. Any collected data or personal information will be entered and stored in a password protected file on a password-protected computer or in a locked file cabinet. The data will be stored for 3 years after any publication, and then will be shredded.

FURTHER INFORMATION. If you have any questions or would like additional information about this study, please contact Stefan Melendez at (305) 608-0819 or melendes@my.erau.edu. You can also contact my advisor, Dr. Andy Dattel at (386) 226-7795 or andy.dattel@erau.edu.

The ERAU Institutional Review Board (IRB) has approved this project. You may contact the ERAU IRB with any questions or issues at (386) 226-7179 or teri.gabriel@erau.edu. ERAU's IRB is registered with the Department of Health & Human Services – Number – IORG0004370.

CONSENT. Your signature below means that you understand the information on this form, that any and all questions you may have about this study have been answered, and you voluntarily agree to participate in it. A copy of this form can also be requested from the researcher.

Signature of Participant: ______________________ Date: ____________

Print Name of Participant: ______________________

Signature of Researcher: _______________________ Date: ___________

Print Name of Researcher: _______________________

Appendix E

Demographics Questionnaire

Participant Number: _____

Demographic Questionnaire

Please answer the following questions:

1. What is your gender? _______

2. What is your age? ______

3. How many total flight hours do you have? ______

4. Which pilot rating(s) do you hold? ____

5. List all weather/meteorology coursework you have taken either at ERAU or at another college/university (eg. WX 201)
   ____
   ____

6. Did you complete your flight training at Embry-Riddle? ________

7. Have you completed any flight training outside of ERAU, if so, where?
   ____
   ____

8. If applicable, estimate what percentage of your flight training was done outside of ERAU.
   ____

Appendix F

Flight Plan Forms and Instructions

KSYR-KBUF

Participant Number: ______

T/G: ______

Review the provided weather and map information to plan the flight and make decisions as if it were a real flight. You have 20 minutes to review the information and make your plans, so take your time. You are flying direct from KSYR to KBUF. Your departure time is 3PM and you will be arriving roughly two hours later. The chart times show Zulu time, so just pretend they show local time in PM. For example, the 05Z TAFS would translate to 5PM time. Your departure runway will be 15. This is a VFR flight, so you are allowed to make any deviations and changes to the flight plan to stay safe and compliant. And remember, review the information and fly this as if it were an actual flight.

Departure: 3PM

Cruising speed: 95 KIAS

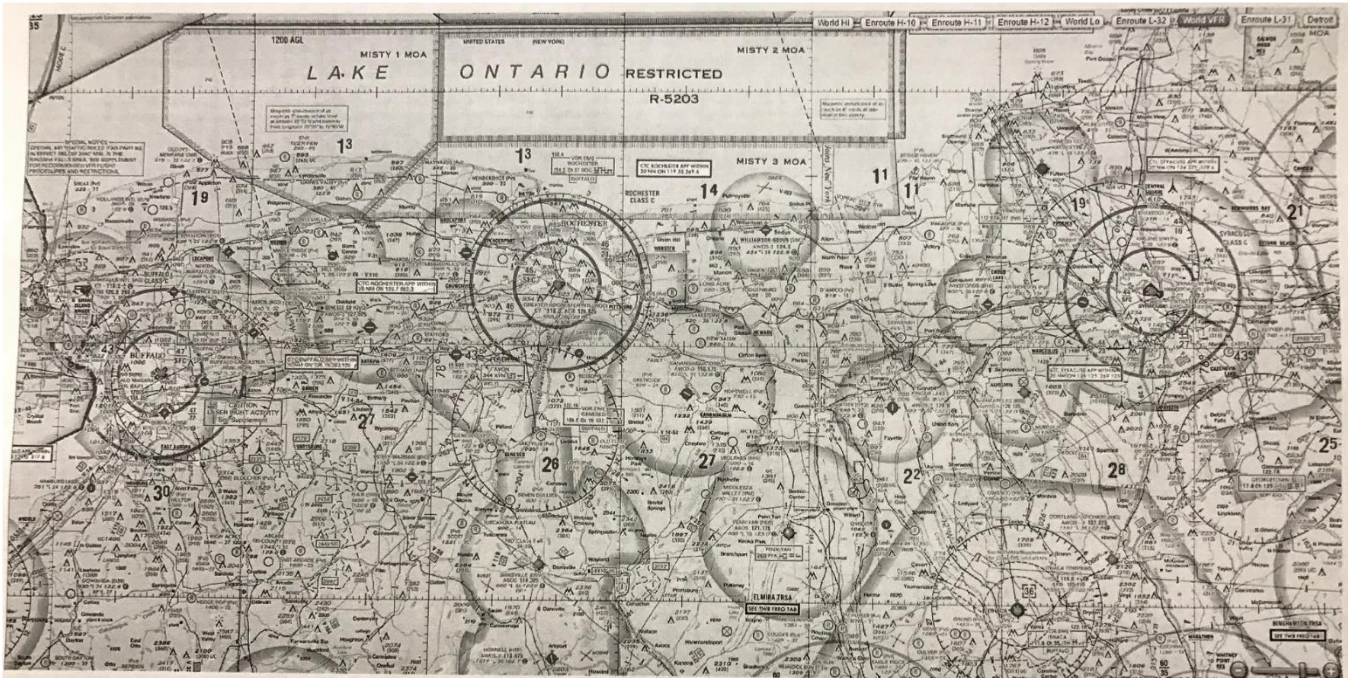
KSYR to KBUF Distance: 116NM

Cruising altitude: _______

Optional: note any other changes/deviations to the flight plan you would like to make:

____

____


World Hi
Enroute H-10
Enroute H-11
Enroute H-12
World Lo
Enroute L-32
World VFR
Enroute L-31
Detroit
1200 AGL
MISTY 1 MOA
LAKE
ONTARIO
RESTRICTED
R-5203
MISTY 2 MOA
MISTY 3 MOA
ROCHESTER
CLASS C
BUFFALO
ELMIRA TRSA

KRUT-KRME

Participant Number: ______

T/G: ______

Review the provided weather and map information to plan the flight and make decisions as if it were a real flight. You have 20 minutes to review the information and make your plans, so take your time. You are flying direct from KRUT to KRME. Your departure time is 3PM and you will be arriving roughly two hours later. The chart times show Zulu time, so just pretend they show local time in PM. For example, the 05Z TAFS would translate to 5PM time. Your departure runway will be 13. This is a VFR flight, so you are allowed to make any deviations and changes to the flight plan to stay safe and compliant. And remember, review the information and fly this as if it were an actual flight.

Departure: 3PM

Cruising speed: 95 KIAS

KRUT to KRME Distance: 109NM

Cruising altitude: _______

Optional: note any other changes/deviations to the flight plan you would like to make:

____

____


World Hi
Enroute H-11
Enroute H-12
World Lo
Enroute L-32
New York
ADIRONDACK
MOUNTAINS
LOWVILLE MOA

Appendix G

Permission to Conduct Research

Embry-Riddle Aeronautical University
Application for IRB Approval
Expedited Determination

Principle Investigator: Stefen Melendez **Other Investigators:** Andrew Dattel **Role:** Student **Campus:** Daytona Beach **College:** COA

Project Title: ***How Pilots Process Weather Information***

Submission Date: 2/21/2017 **Determination Date:** 3/17/2017

Review Board Use Only

Exempt: No

Approved:

David Ison	M.B. McLatchey	February 28, 2017 Expires: February 27, 2018
Pre-Reviewer Signature	Chair of the IRB Signature	Date of Approval / Expiration Date

Brief Description: The purpose of this study is to test whether there is any difference in a pilot's situation awareness when they use Graphical Weather Information (visual) versus Textual Weather information (verbal) and to see whether any of these differences impact situation awareness and flight performance. Flight Simulation will be used as well as audio recording of the participants conducting the flight and answering questions will be used.

This research falls under the **expedited** category as per 45 CFR 46.110 (b) because one or both of the following apply:

(1) ☒ some or all of the research appearing on the list below are found by the reviewer(s) to involve no more than minimal risk,

(2) ☐ minor changes in previously approved research during the period (of one year or less) for which approval is authorized.

Research activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the following categories. The activities listed should not be deemed to be of minimal risk simply because they are included on this list. Inclusion on this

Bankert, E. A., Amdur, R. J., (2006) *Institutional Review Board Management and Function, Second Edition*, pp. 517-518.

list merely means that the activity is eligible for review through the expedited review procedure when the specific circumstances of the proposed research involve no more than minimal risk to human subjects. (Bankert & Amdur 2006)

1. ☐ Prospective collection of biological specimens for research purposes by noninvasive means.

2. ☒ Collection of data from voice, video, digital, or image recordings made for research purposes.

3. ☐ Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.) [This means research that presents ***more than minimal risk to human subjects***.]