Introduction

For the past two years, the Global Weather Hazards (GWH) Project has demonstrated that today’s technology allows the upload of operational weather products into the cockpit of commercial aircraft flying transoceanic routes. During the GWH Project, two convective products have been shown on a supplementary basis over a global domain and at an update rate of 15 min. The two products, the Cloud Top Height (CTH) and the Convective Diagnosis Oceanic (CDO), are plotted over the navigational maps on the Electronic Flight Bag (EFB) within the flight route, thus allowing the pilot to better understand and anticipate the weather situation that is beyond the range of onboard radar. In addition, standard products such as Significant Meteorological Information (SIGMETs) and Aviation Meteorological Information (AIRMETs) were displayed on the EFB that resides on a Microsoft Surface Pro 3 and uses the Lido EFBInFlight Manual (EMR).

Now that the capability has been proven to upload and display weather products that are accurate, timely and useful for strategic decision-making by pilots, the next steps in the display evolution are shown. Combining the onboard radar display with the satellite-based convective products is discussed and examples shown. Also, global turbulence intensity maps, Radar Based 3D Composite Refractivity, and Echo Top Products have been devised for the EFB and are described and shown. Unlinking additional weather products to the EFB display gives pilots more complete situational awareness of potential hazards and enhances safety and efficiency.

This poster, describes the overall improvements that will be added to the cockpit by augmenting the onboard cockpit radar with products that provide global situational awareness to avoid the “flying into the box” condition that is a risk with a cockpit weather radar alone.

Better Decisions for Safety and Flight Efficiency achieved by augmenting the Cockpit WxRadar with Global/Regional Wx Products

Conventional Cockpit Based Radar Display

Weather Phenomena limited to line of site

Real-time Data Display

Limited Lateral Awareness

125 NM Look Ahead

120 Degree CTA

Limited Range

125 NM Look Ahead

Lacks global awareness

Best tool for flying through Wx

Trans-Oceanic Flight Routes demand Regional to Global Weather Products

An example is shown of a flight route made to avoid severe convective storms on a flight from Orlando, Florida to Frankfurt, Germany on 29 April 2016 (Keenwave et al. 2017). In Figure 3, the CTH and CDO polygons are displayed on the eRM at 1014 UTC, about 3 hrs prior to take-off at 0428 UTC. In Figure 2, the eRM shown at 0152 UTC shortly before the pilot received an amended flight route from the New York Operations Center. Convective SIGMETs are indicated by tan polygons under the CTH and CDO shaded polygons. In Figure 3, the pilot photographed the onboard radar display as the GOUGH waypoint was passed on the amended flight route. The approximate area of the radar scan is displayed over the eRM for comparison of the CTH and CDO polygons to the radar reflectivity.

Figure 1

Figure 2

Flight Cross Section is available for specific weather products. MeteoStar’s Global Composite Turbulence Guidance (GCTG), with a nested GTO 3.0, is one turbulence product available that has a 100-km vertical interval, generated hourly with FVComcast hours (Figure 4, left). NCEP and NSSL developed the next phase of the NEXRAD processing within the Multi-Radar Multi-Sensor product (Smith et al. 2016; Zhang et al. 2016). The MMIRS product is a much more sophisticated Composite Refractivity Product (Figure 4 and 5, right). Figure 6 while preserving the Base Reflectivity scans to present a detection based vertical product (Figure 5, left). When used in-flight, pilots can make subtle changes earlier to flight paths and avoid flying into a box. The vertical cross-section also assists in identifying the pertinent weather.

Figure 3

Figure 4

Figure 5

Figure 6

Radar Based Echo Tops versus Satellite Based Cloud Top Heights is a subject of continued investigation. The MMIRS 3D reflectivity product essentially delivers the Advanced Echo Top product. The Cloud Top Height (CTH) product delivers a complete picture of radar structures above 25kft as seen by geostationary satellite. The left panel of Figure 5 (above) and Figure 6 (below) shows the vertical cross-section of the MMIRS 3D reflectivity with the highest points indicating the “Echo Top” product shown in Figure 7. Limitations of this or any Radar product include line of sight and coverage termination due to scheduled and unscheduled outages. In these situations, there is no clear indication for the user to discern between “good weather” and “no coverage”. The corresponding CTH product, taken at about the same time (Figure 8) shows that the satellite indicates much larger clouds with higher heights, when compared to the radar-based echo top heights, as is expected.

Figure 7

Figure 8

Figure 9

Wx Product Improvements and their positive impact with Flight Safety

BCT’s work with Lufthansa Airlines entailed the use of data from five primary geostationary satellites, plus others for backup, to construct a global mosaic. The original set included GOES-13 (East), Meteosat-10, Meteosat-7, and MTSAT-2. The MTSAT-2 and GOES-13 have been replaced with Himawari-8 and GOES-16, respectively. In both cases, coverage, resolution and update rates have been greatly improved. In the case of GOES-16, some areas located in South America with previous update rates of 1 to 2 hours are now 15 minutes. These improvements, along with others, allow the use of satellite data in circumstances previously reserved for radar.

Acknowledgements

Donovan et al., 2009: An evaluation of a Convection Diagnosis Algorithm over the Gulf of Mexico using NASA TRMM Observations.

Kessinger, C., et al., 2017a: The global weather hazards project.
