Poster 335

The Remote Oceanic Meteorology Information Operational (ROMIO) Demonstration

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Introduction

The Federal Aviation Administration (FAA) Weather Technology in the Cockpit (WTIC) program is sponsoring an operational demonstration to evaluate the feasibility to uplink convective storm products to commercial aircraft flying routes over remote, oceanic regions for display on an electronic flight bag (EFB). The effort is called the Remote Oceanic Meteorology Information Operational (ROMIO) demonstration and is a collaborative effort between the FAA, the weather research community, the airlines and ground-to-air communications providers. The ROMIO will develop and demonstrate operational strategies for the use of rapidly updated Cloud Top Height (CTH) and Convective Diagnosis Oceanic (CDO) products on the flight deck, in the Oceanic Air Route Traffic Control Centers (ARTCC) and as part of Airline Operations Center (AOC) flight dispatch operations. Participating airlines include Delta Air Lines, United Airlines and American Airlines. The domain for storm product creation is contained by the scanning area of the Geostationary Operational Environmental Satellite (GOES) East and West satellites. Routes to be flown are outside the continental United States (CONUS) and South America, Caribbean, Australia, and South Africa, among others. A select number of online pilots will participate in the demonstration. The ROMIO demonstration will begin early in 2018 and be conducted for nine months. During the demonstration, feedback from pilots, AOC dispatchers and Oceanic ARTCC Air Traffic Controllers will be solicited to ascertain the benefits associated with providing realtime, rapidly updated graphical information on convective structure to them.

Purpose and Goals of the WTIC ROMIO Demonstration

The operational demonstration will "exercise" the Aeronautical Information (AI) / Meteorological (MET) Data Link System infrastructure (DO-340, Concept of Use for Aeronautical Information Services and MET Data Link Services). Its purpose is to data link information to the flight deck and ingest that information using near-operational formats, links, and flight deck information transfer. The ability to display the same or similar graphical weather information on the cockpit EFB as well as in ATC / AOC will be "exercised" to evaluate costs and benefits to the ATC / AOC functions.

The overall goal of this RE&D project is to conduct a flight demonstration that will identify and validate the minimum MET information services required for safe and efficient flight in oceanic and remote airspace. In addition, identify MET information gaps that are not fully resolved by providing CTH / CDO information in the cockpit.

Objectives of the WTIC ROMIO Demonstration

1. Identify those decisions pilots make in the current environment without updates, and elicit pilot decisions that can be facilitated with more-frequent weather updates while enroute. This and findings described below will be solicited from aircrews either by direct observation or post-flight, on-line questionnaire.
    - Does updated weather information affect timing of altitude and/or route deviation requests from the aircrew?
    - Does the updated information enhance operational safety? That is, does the availability of additional weather information that augments the airborne radar decrease the flight's potential for a hazardous weather encounter?
    - Do timely weather updates result in reduced flight time, workload, and/or fuel burn?
    - Do the passive uplink of CTH / CDO updates affect volume of pilot communications with dispatch and air traffic control?
    - Does frequently updated information induce timelier cabin management strategies by the flight crew (cabin and cockpit)?
2. Obtain initial AOC and/or Flight Dispatch Subject Matter Experts' feedback on convective weather information needs and display concepts. Specifically:
    - Does the increased potential for information transfer offered by a graphic display in the AOC provide additional efficiency and safety benefit?
    - To optimize benefits, how frequent are CTH / CDO updates needed for the AOC display? On the EFB? and are other weather information uplinks needed?
3. Obtain initial flight crew feedback on convective weather information needs and display concepts. Specifically:
    - Does the increased potential for information transfer offered by a EFB display provide an additional efficiency and safety benefit?
    - To optimize benefits, how frequent would the flight crew like to obtain updates on CTH / CDO? How frequent is too frequent? How frequent is not enough?
4. Identify situations where collaborative decisions between air traffic controllers, dispatch, and aircrews using common, updated weather information can benefit flight operations. What are the benefits? At what costs (e.g., satellite communications)?

Roles of Participating Organizations

The **National Center for Atmospheric Research** (NCAR) Aviation Application Program (AAP) is responsible for the creation of weather products for the demonstration. NCAR will distribute the data in XML format utilizing technology being implemented by the FAA's NextGen Common Support Services – Weather (CSS-Wx) Program.

AAtS (Aircraft Access to SWIM [System Wide Information Management]) is part of the FAA NEXTGEN system architecture that provides access onboard aircraft to FAA data using SWIM's Service Oriented Architecture interface. The **Embry-Riddle Aeronautical University** (ERAU) NextGen Testbed is used to demonstrate AATS capabilities.

Basic Commerce and Industries, Inc. (BCI) will receive the NCAR data via the NextGen Testbed and perform processing primarily to minimize bandwidth requirements during transfer. BCI will utilize web services technologies to transfer data to participating broadband providers (Gogo and Panasonic).

BCI will also create a web display application for use by stakeholders categorized as Internet users at the AOCs and OCCs. Weather content of these web displays will match what is being displayed on-board aircraft.

The ROMIO demonstration will utilize existing **Gogo** and **Panasonic** broadband technologies to transfer the BCI formatted weather data to Electronic Flight Bag (EFB) type devices for use by pilots on EFB tablet displays. Pilots may also enter feedback on the ROMIO demonstration using the EFB devices. The feedback data will be sent via the Panasonic and Gogo broadband links back to BCI for collection.

A select group of pilots from **Delta Air Lines, United Airlines** and **American Airlines** will utilize the weather display on the EFB during flight and provide feedback on performance.

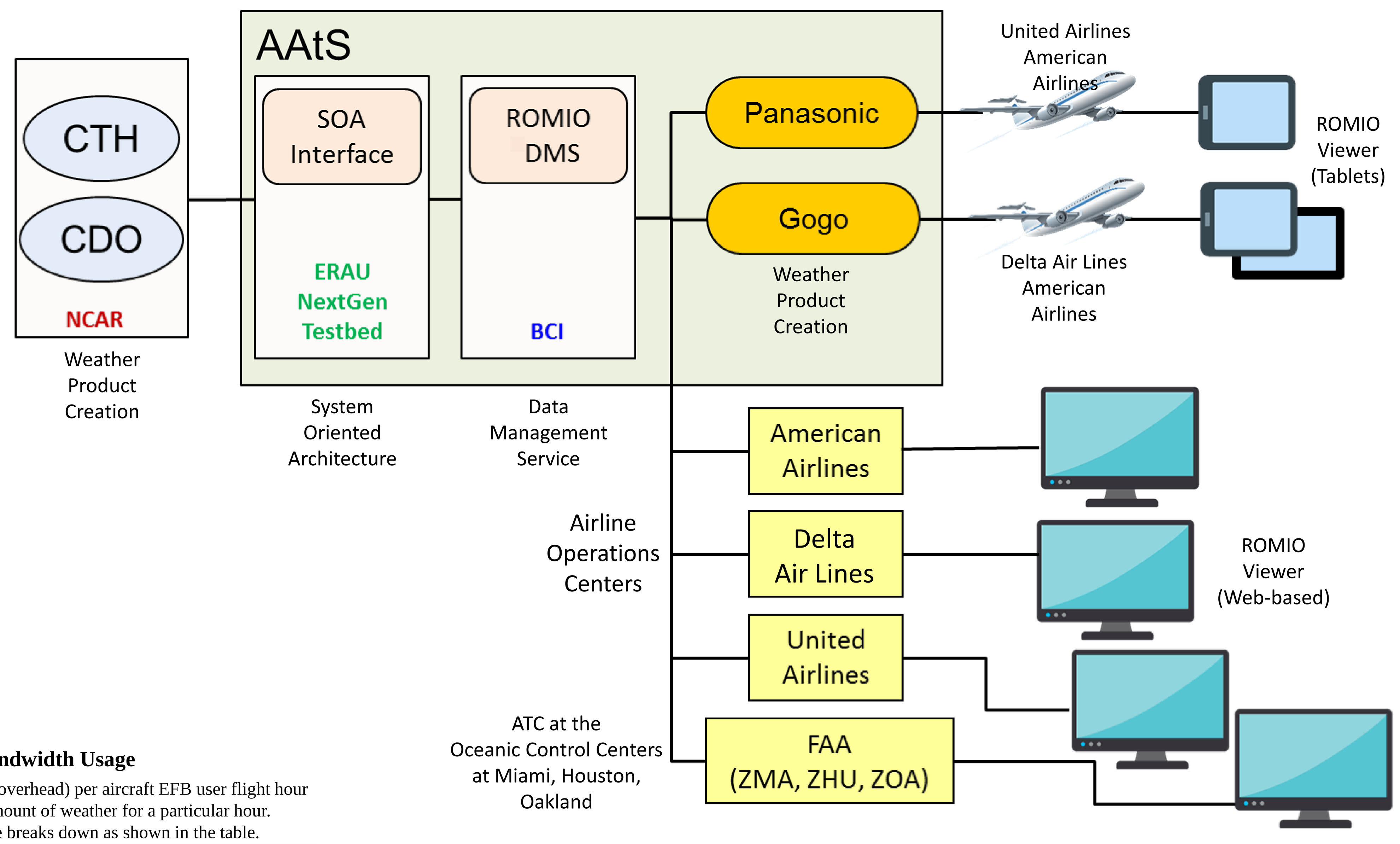
Virginia Polytechnic Institute and State University will develop a model to assess the safety and efficiency impacts and/or benefits associated with the provision of meteorological information to aircraft operating in non-controlled / oceanic airspace.

Bandwidth Usage

Usage ~1.3 MB (including overhead) per aircraft EFB user flight hour but is dependent on amount of weather for a particular hour. The bandwidth usage breaks down as shown in the table.

Data Service Transaction	Estimated Size in KB (request + response)	Interval Between Transactions (Minutes)	Data Traffic per Hour
FlightAware Location	0.5	5	6
Route Decode	2		2
CTH Timestamp	1	1	60
CDO Timestamp	1	1	60
Missing Polygon Timestamp	1	1	60
CTH Data	120	15	480
CDO Data	90	15	360
Missing Polygon Data	2	15	8
Total Kilobytes			1036
Total Megabytes Before Overhead (1024 KB)			**1.01**

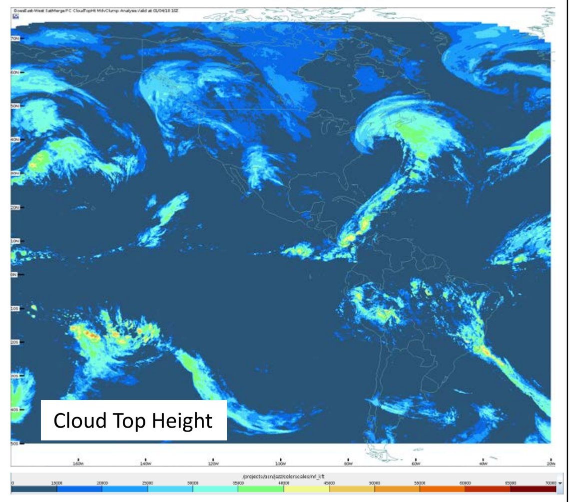
WTIC ROMIO Overall Communications Diagram



Convective Hazard Products

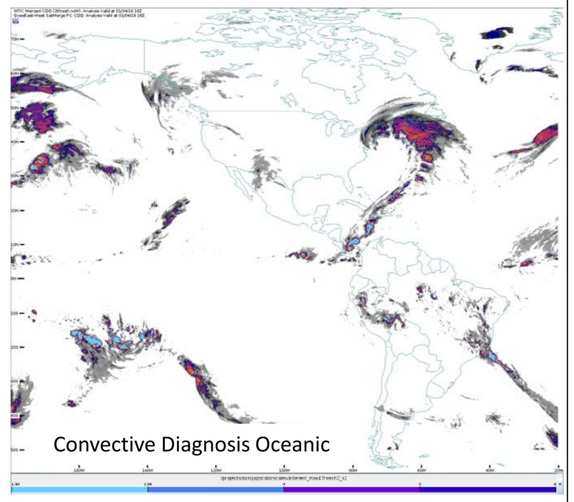
The ROMIO domain includes the GOES-East and GOES-West coverage area. A mosaic is constructed with the two geostationary satellites.

Cloud Top Height (CTH) shows the heights of the cloud tops and is computed by: 1) converting the satellite 11 micron infrared (IR) brightness temperature to pressure by comparison to the NCEP Global Forecast System (GFS) model sounding and then 2) converting the pressure to a flight level through the standard atmosphere equation (Miller et al. 2005). The CTH product is shown at right.



The IR brightness temperature only measures the temperature of the tops of deep convection and cannot resolve internal structures. The anvil clouds can have a much larger area than the convective region.

Convective Diagnosis Oceanic (CDO) indicates the approximate location of the convective updraft and its associated hazards. The CDO is computed through a scaled and weighted combination of four inputs using a fuzzy logic, data fusion methodology. The algorithmic inputs include the CTH product, the Global Convective Diagnosis (GCD; Mosher, 2002) product, the GOES-R Overshooting Tops (OTops; Bedka et al. 2010) product and a lightning accumulation algorithm from the EarthNetworks global lightning network.

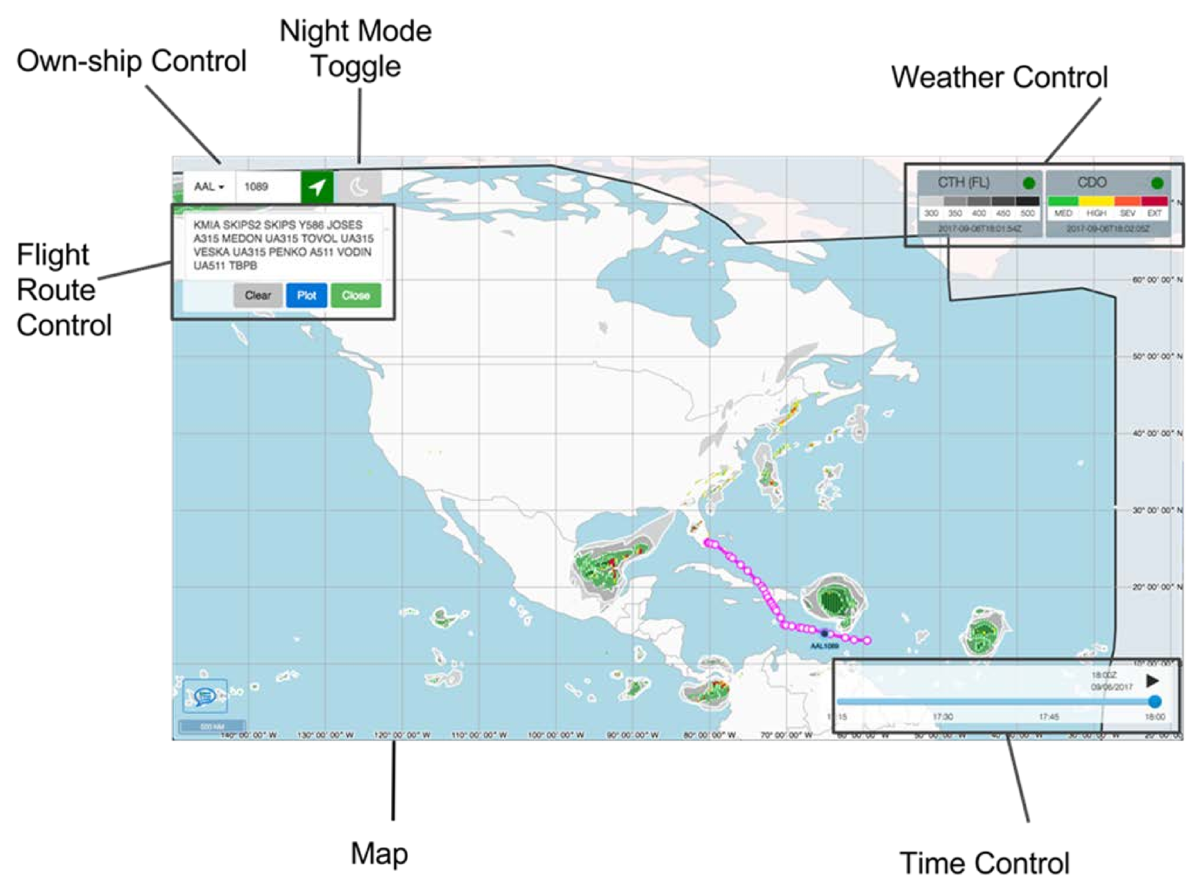


The CTH is described above; the GCD indicates the location of mature updrafts using a channel differencing technique; the OTops finds the location of overshooting tops/updrafts;and the lightning accumulation algorithm uses 15 min, 30 min and 60 min accumulation fields and then combines them within a fuzzy logic framework to produce an interest map that is input into the CDO.

The GOES-16 Advanced Baseline Imager (ABI) imagery products are being used within the ROMIO system. The Geostationary Lightning Mapper (GLM) will be incorporated within the ROMIO system shortly and will be combined with the EarthNetworks ground-based lightning network to ensure coverage over the GOES-East and GOES-West domain.

ROMIO Viewer

The ROMIO Viewer developed by BCI (right) is designed to display Cloud Top Height (CTH) and Convective Diagnosis Oceanic (CDO) weather products to pilots, dispatchers, and FAA controllers. The viewer provides better situational awareness of convective weather over oceanic regions where ground-based weather radar coverage is lacking. This application is available on iOS, Windows 10, and the web. The application will share the same look and feel and user interface on all platforms to ensure similar experiences for all users. The features of the ROMIO Viewer include: Weather Control, Time Control, Own-ship Control, Night Mode, Flight Route Control and Map.



Benefit Analysis

The Virginia Polytechnic Institute and State University will identify and model the benefits associated with providing updated graphical weather information to the flight deck, within the Air Traffic Control (ATC) and as part of the Airline Operation Centers (AOC). User feedback from all stakeholders will be collected during the demonstration and will form the basis of the analysis. The analysis methodology will describe how the safety (i.e., cabin management) and efficiency (i.e., flight routing, airspace management, and cockpit/ATC communications) impacts and/or benefits will be evaluated and will describe all areas where impacts were identified and where benefits can be achieved. The Global Oceanic Model is a fast-time simulation tool to evaluate various aviation operational concepts (i.e., fuel burn, travel time, conflicts and flight deviations) and will be modified for ROMIO purposes. The Global Oceanic Model will be used to assess the safety and efficiency impacts and/or benefits associated with the provision of meteorological information to aircraft operating in non-controlled/oceanic airspace.

ROMIO Demonstration Schedule

The ROMIO demonstration is planned to begin in early 2018 and will be conducted for 9 months.

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