769A: A Demonstration to Validate the Minimum Weather Services for Oceanic and Remote Airspace

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Weather Technology in the Cockpit (WTIC) Program

In 2006, the Federal Aviation Administration Aviation Weather Research Program (FAA AWRP), the National Center for Atmospheric Research (NCAR) and United Airlines completed a feasibility study of uplinking a convective weather product (the Cloud Top Height or CTH, product) into selected cockpits using an ASCII display written to the ACARS printer.

In 2012, the FAA Weather Technology in the Cockpit (WTIC) and NCAR completed the Human-Over-The-Loop (HOTL) simulation demonstration at the FAA Next Generation Integration and Evaluation (NIEC) Research Cockpit Simulator (RCS). The HOTL simulations tested the effect that a supplemental graphical (textual and color) display of the CTH product had on pilot decision making and flight procedures in the cockpit of oceanic aircraft

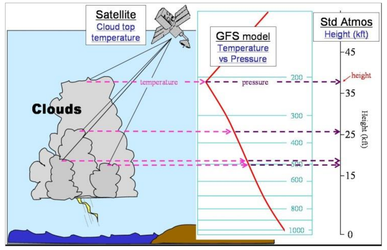
Now, a realtime demonstration is being planned to validate the minimum weather services required for safe and efficient flight in oceanic and remote airspace. This demonstration will be performed with online crews of participating airlines whose aircraft are equipped with portable or installed display capabilities. The feasibility and cost of uplinking convective weather information into the flight deck will be balanced against the operational need for updates. The demonstration is expected to begin in the fall of 2015.

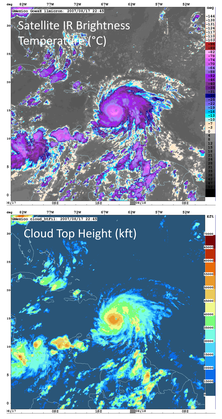
WTIC Plans for the Realtime Demonstration of CTH

- Flights will cross the Inter-Tropical Convergence Zone (ITCZ)
- NCAR roles: Host the oceanic system to generate CTH polygons; Write polygons through Open Geospatial Consortium (OGC) interface using Web Feature Service (WFS) server
- Display vendor role: EFB/PED visualization of CTH polygons; Make display available to airlines
- Participating airlines roles: Provide pilot and dispatch training, with assistance from NCAR; Provide the EFB/PED devices; Provide internet connectivity to the aircraft
- ATC/Dispatch roles: common situational awareness
- FAA roles: Safety Review Board/Flight Standards must approve demonstration; Host a feedback mechanism, expected to be a web page

Creation of Cloud Top Height (CTH) Product

The satellite infrared (11 micron) brightness temperature is converted to a pressure value by comparing it to a nearby sounding from the NOAA Global Forecast System (GFS) numerical model (Donovan et al. 2008). The pressure value is converted to a flight level by comparing to the standard atmosphere sounding.





The CTOP product is designed for opaque clouds and is only valid for clouds above FL150.

2006 CTH Realtime Demonstration with United Airlines in the Pacific

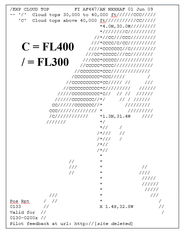
Flights between LAX/SFO and Sydney, Australia

ACARS printer created ASCII display (at right)

Product sent to pilot and dispatcher for *common situational awareness*

Pilot registration and feedback via NCAR web page

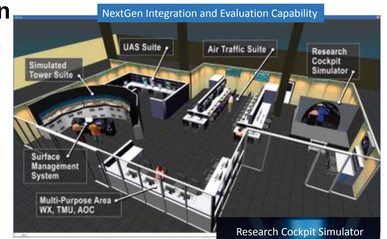
Pilot feedback: Unsolicited weather information raised their attention level

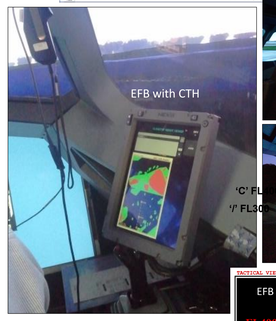


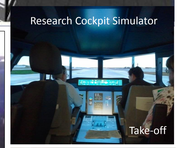
2012 NIEC Research Cockpit Simulator (RCS) Demonstration

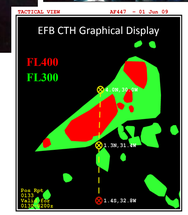
Research Cockpit Simulator utilized Jul-Aug 2012 for testing (Lindholm et al. 2013)

- Tested pilot response with and without CTH display
  - Two flight crews during demonstration (each with pilot, co-pilot)
  - Flight route: Miami, FL to Lima, Peru; through InterTropical Convergence Zone (ITCZ)
  - Archived ITCZ storm cases fed the simulator
- Displayed CTH as an ASCII graphic and as a color graphic (see figure at lower right) on an Electronic Flight Bag (EFB)
- Uplink triggered after position report sent





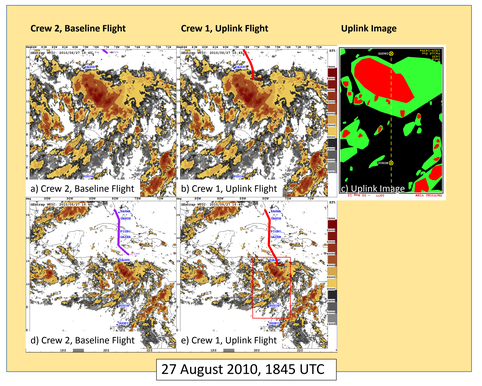


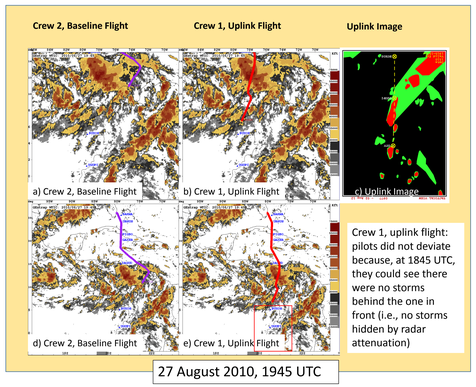


Findings:

- Uplinked CTH product proved to be valuable in all aspects:
  - Crew situational awareness of convective hazards
  - Workload reduction
  - More precise weather hazard avoidance
  - Crew decision making
- EFB character graphic was understandable and desired in place of no weather updates
- EFB color graphic was preferred and very understandable
- No safety issues identified as a result of the uplinked CTH product
- Flight crews need to be briefed on CTH and interpretation of the presentation, including its limitations

Case Study Results from Simulation



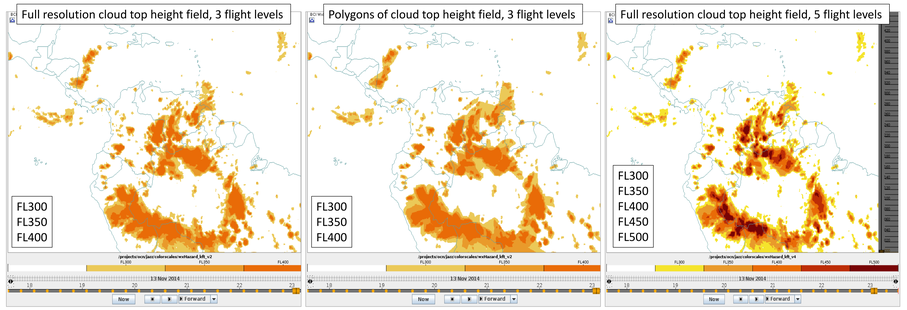


Crew 1, uplink flight: pilots did not deviate because, at 1845 UTC, they could see there were no storms behind the one in front (i.e., no storms hidden by radar attenuation)

Cloud Top Height Polygon Creation

The CTH polygons are created by running an object tracker, called Thunderstorm Initiation, Tracking and Nowcasting (TITAN; Dixon and Wiener, 1993), over the gridded, high resolution CTH field. TITAN is run once for each desired flight level to create the respective polygons.

For the 2012 NIEC RCS demonstration, the flight levels shown to the pilots on the EFB were FL300 and FL400. Pilot feedback suggested that an additional level would be beneficial, and the FL350 polygons were added. Feedback from Lufthansa Airlines pilots (see ARAM paper #13.4) suggested the addition of FL450 and FL500 polygons would be beneficial. Examples of the three versus five flight levels contours are shown. The middle figure shows the three flight level CTH polygons.



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