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Seeing Storms Ahead



Oceanic Convective Weather Guidance

Flight crews can anticipate hazardous convection along long-range oceanic routes using frequently updated, satellite-based weather information designed to support strategic decision-making.

Knowing that hazardous convection lies ahead allows flight crews and dispatchers to make earlier routing decisions, improving safety while reducing fuel burn, delays, and operational impacts. NSF NCAR scientists and engineers have developed in-flight products that improve awareness of convective hazards along remote and transoceanic routes.

Oceanic Convective Weather Hazards

Historically, long-duration oceanic flights have had limited access to the detailed weather information available over land, where ground-based radar networks provide frequent observations of convective storms. For transoceanic operations, satellite-based convective hazard information helps fill this observational gap. In-flight displays of these products provide pilots with additional information for strategic route planning during long flights, some lasting up to 19 hours.

Satellite-Based Hazard Detection

Global geostationary satellite observations are the foundation for detecting and characterizing convective hazards over oceanic regions where ground-based radar coverage is limited. Two key

Benefits & Impacts

- Provides clear visual mapping of convective hazards and storm-top heights from FL200 through FL500
- In-flight displays supplement onboard weather information with satellite-based views of convective hazards
- Earlier awareness supports strategic routing decisions that can save time and fuel

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products developed by NSF NCAR are Cloud Top Height (CTH) and Convection Diagnosis–Operational (CDO).

CTH combines satellite-observed cloud-top temperature with atmospheric temperature profiles from numerical weather prediction models to estimate cloud-top altitude. Selected contours from FL300 to FL500 provide particularly relevant information to aircraft crew flying transoceanic routes.

Extending weather awareness beyond radar for safer, more strategic routing.

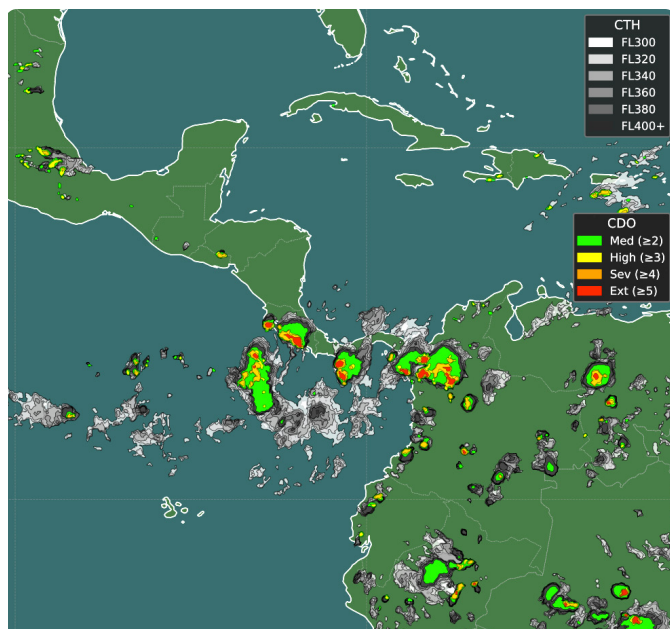
CDO identifies regions of active convection by combining multiple satellite-derived indicators with geostationary and global lightning observations. These inputs are scaled, weighted, and integrated through a data-fusion methodology to estimate the likelihood and location of convective hazards. While CTH depicts the broader storm structure, including the anvil, CDO emphasizes regions associated with active convective updrafts and the hazards they may produce. For aircraft uplink, the gridded products are converted to polygons to reduce communications bandwidth requirements.

Weather in the Cockpit

To evaluate how this information could support pilots in operational settings, the Remote Oceanic Meteorology Information Operational (ROMIO) Demonstration, sponsored by the FAA Weather Technology in the Cockpit program, delivered convective weather products directly to the cockpit. By demonstrating the uplink of oceanic convective hazard products aboard commercial aircraft, ROMIO helped identify information and technology gaps affecting weather-related decision-making in remote airspace.

Operational Benefits

ROMIO demonstrated the value of shared weather situational awareness among pilots, dispatchers, and air traffic personnel. Frequently updated, objective convective hazard information allowed flight crews to identify developing threats earlier and shift from short-range tactical avoidance toward more strategic route planning. Pilots reported improved situational awareness and greater confidence in their ability to anticipate and



Cloud Top Height and the Convection Diagnosis Oceanic Products in a Prototypical Electronic Flight Bag (EFB) display.

avoid hazardous convection, with potential benefits including improved safety, reduced fuel burn, and fewer emissions.

From Research to Operations

Following the ROMIO demonstration, NSF NCAR worked to transition these capabilities from research into operational use across the broader aviation community. The technology has been licensed and implemented by industry partners and supports aviation weather operations internationally, including in Taiwan. Through continued partnerships and technology transfer, these products are extending advanced convective weather information to remote and transoceanic aviation operations.

Advancing Aviation Guidance

NSF NCAR continues to advance weather decision-support capabilities by improving how hazardous weather is observed, translated into operational information, and delivered to aviation users. For remote and transoceanic operations in particular, satellite-based products extend situational awareness beyond the reach of ground-based radar and support safer, more strategic decision-making.

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