

Global Weather Notification

A real-time, ground-based, weather notification system for pilots

This research is in response to requirements and funding by the Federal Aviation Administration (FAA). The views expressed are those of the authors and do not necessarily represent the official policy or position of the FAA.

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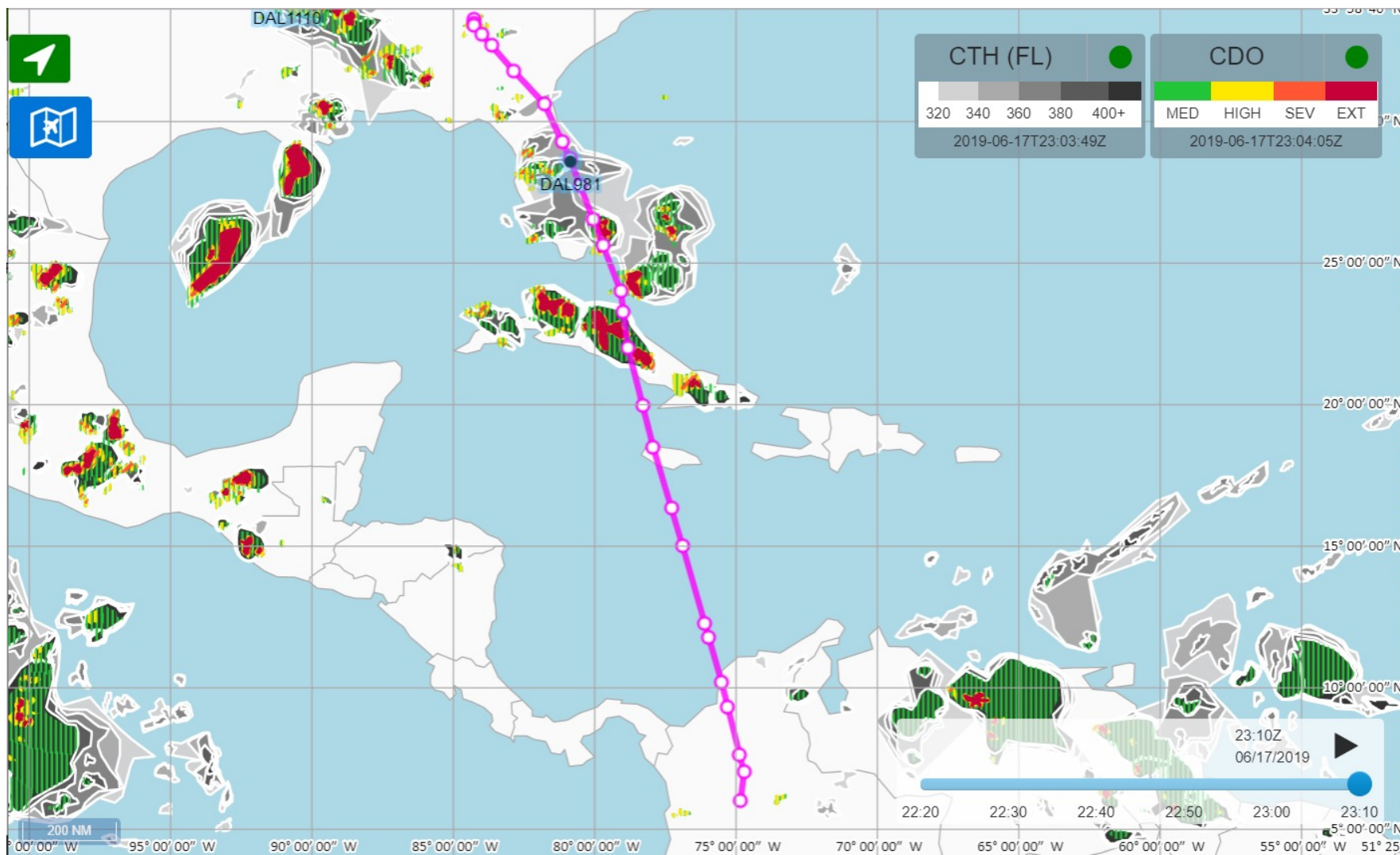
NCAR – WTIC - Aviation Industry Technology Meeting

May 24th, 2022

NCAR | RESEARCH APPLICATIONS
LABORATORY

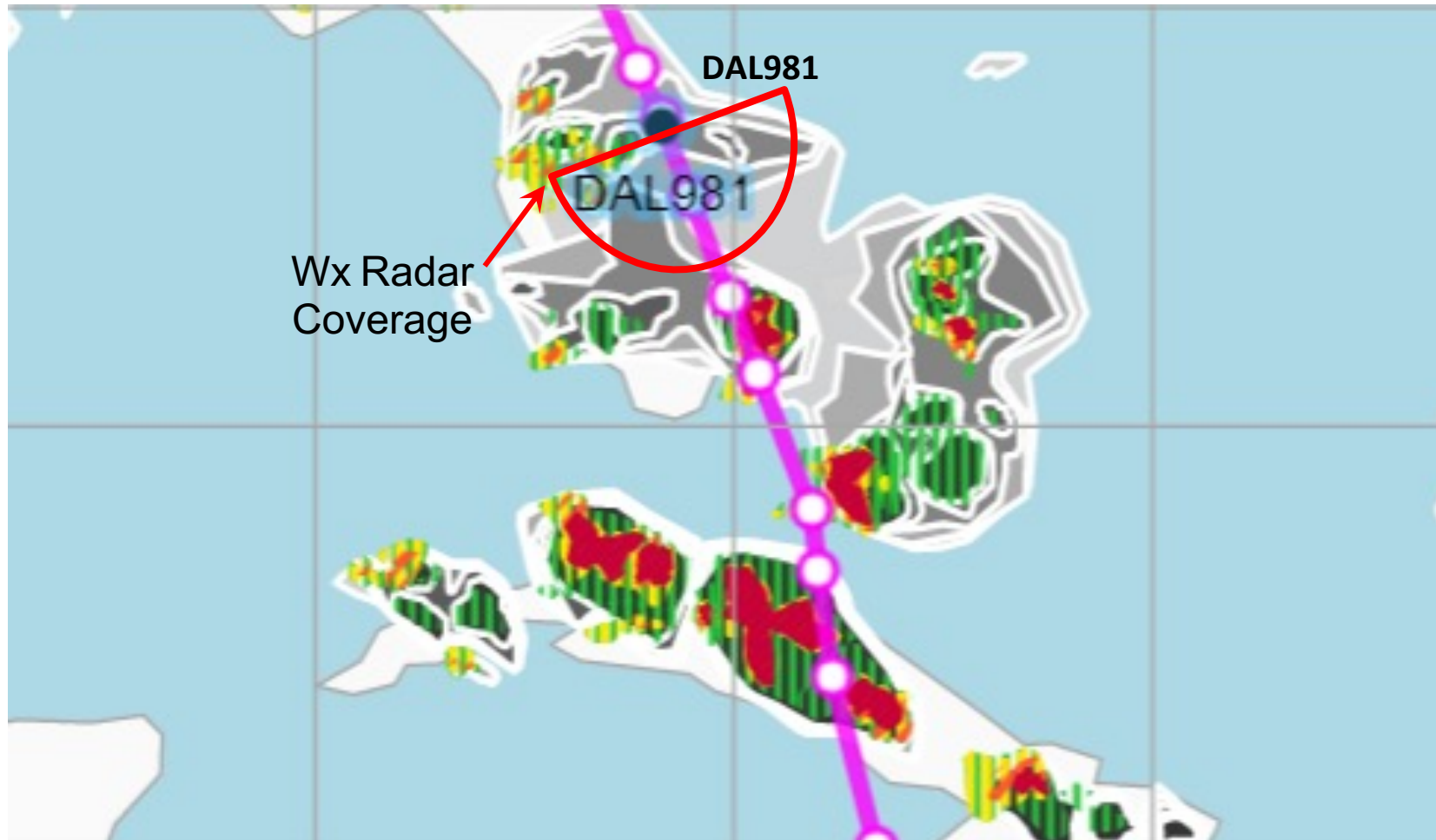


ROMIO Demonstration Display



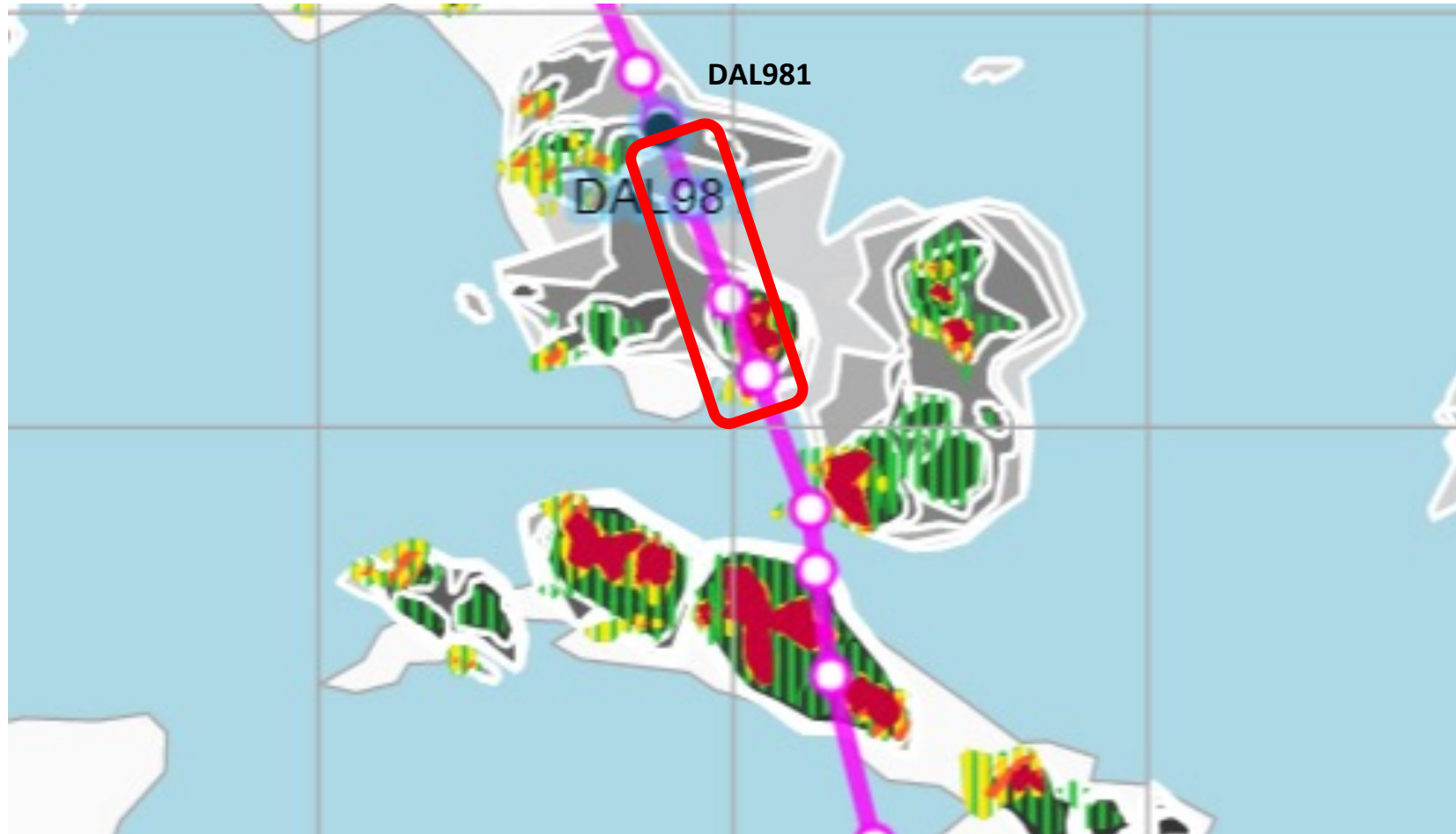
Background image shows ROMIO pilot iPad demonstration display of Cloud Top Height (CTH), in grey scale, and Convective Diagnosis Oceanic (CDO), in color.

Onboard Radar look-ahead horizon 20min (~160nm)



Background image shows ROMIO pilot iPad demonstration display of Cloud Top Height (CTH), in grey scale, and Convective Diagnosis Oceanic (CDO), in color.

Projection window 32min (~240nm) and 60nm wide



Notification
Message:

17 Jun 2019 23:02Z DAL981 FL328 heading 159, Moderate
Convection ahead at 27.33 -80.82, Cloud Top Height at FL358.

The Global Weather Notification System

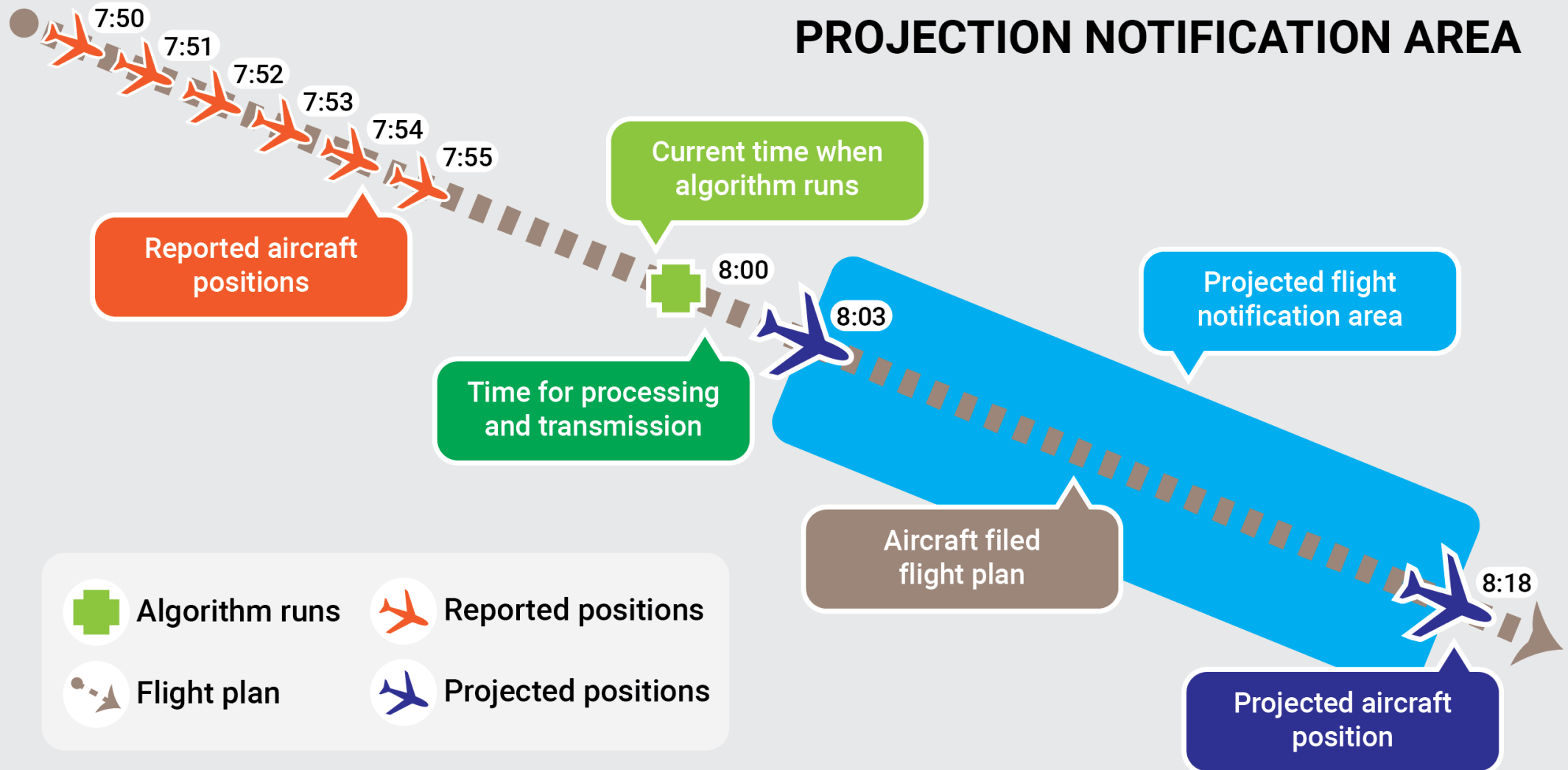
- The system attempts to anticipate whether aircraft will soon encounter or be in close proximity to predicted or observed adverse weather conditions.
- Projects each aircraft's position forward in time (based on the aircraft's flight plan, current speed and heading) and calculates a qualitative categorical severity (examples: 'light', 'moderate', 'severe'), based on a given weather grid and parameterized thresholds, along the aircraft's path.

The Global Weather Notification System

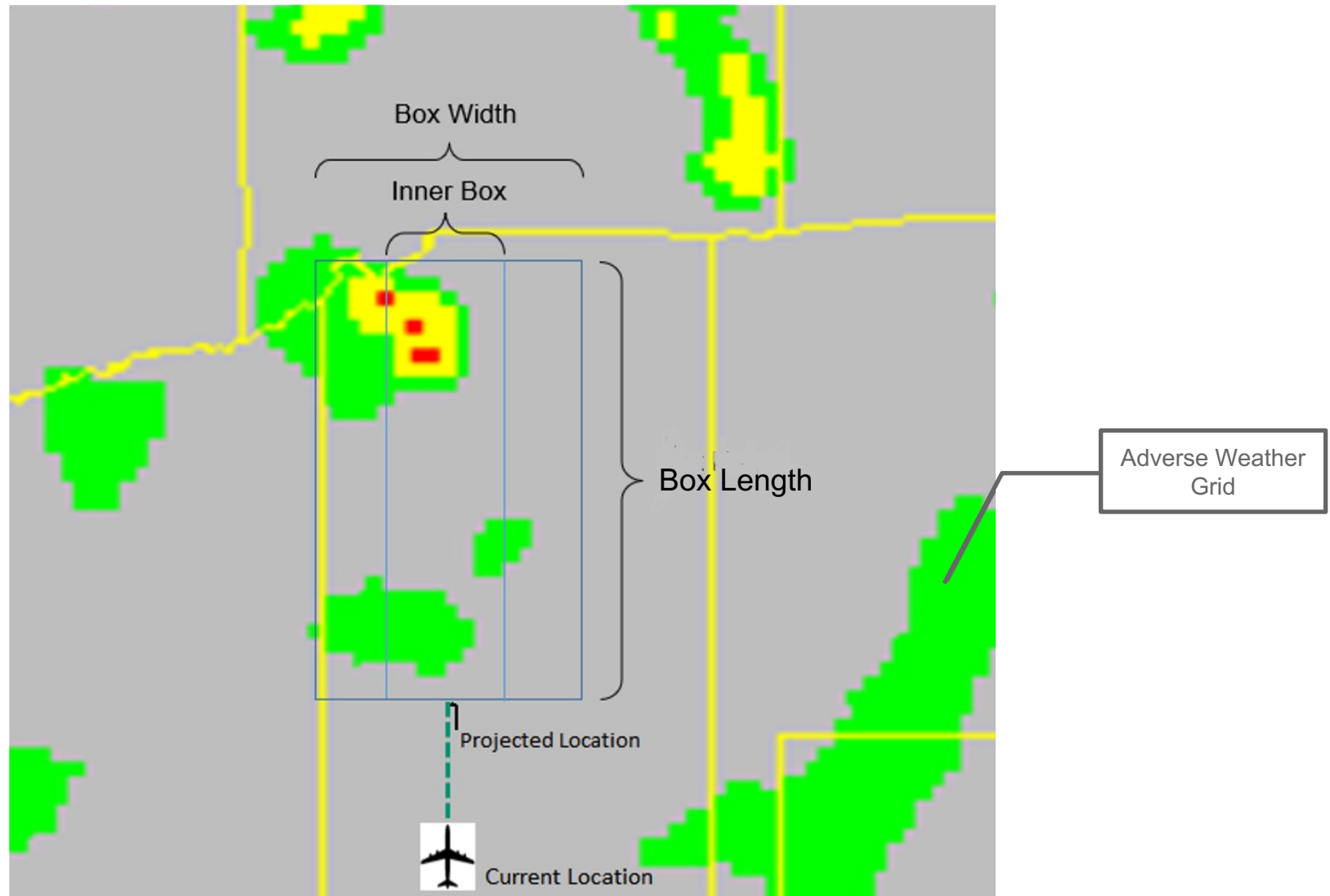
- Runs on the ground ensuring that a large number of aircraft can be processed in a timely manner frequently and large weather grids are not a strain for cockpit bandwidth
- Creates a notification that is designed to give pilots a quick “heads up” message that allows them to seek out additional information, such as an updated weather map or ensuring seat belts are fully fastened for passengers, and is not to replace In-Flight Weather Advisories from official sources.
- This is a novel way to present weather information, by only drawing pilot attention to adverse weather hazards when predicted to be in close proximity in the near future.

Notification System

PROJECTION NOTIFICATION AREA



Determination of the notification

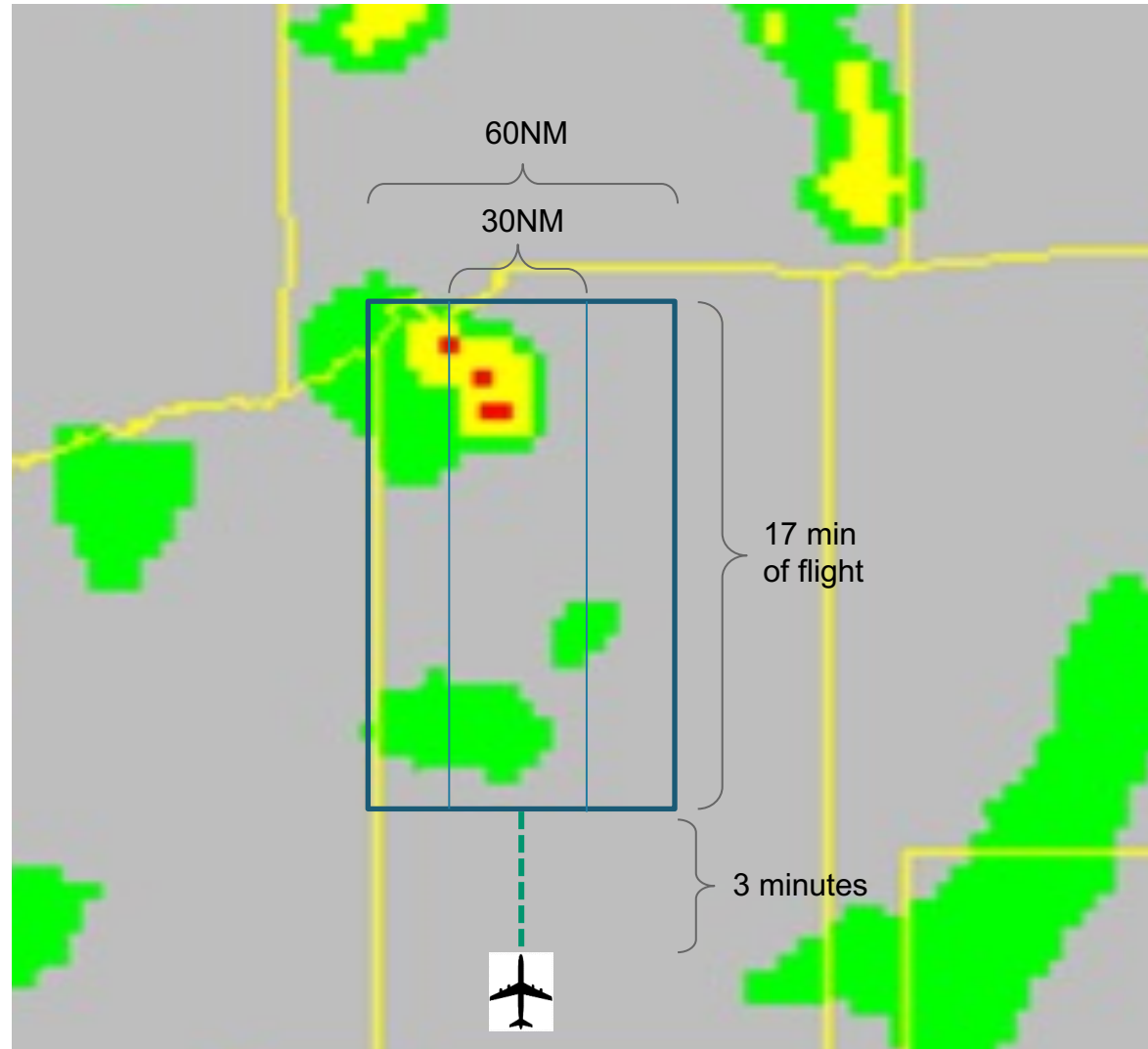


Box Width: Static based on adverse weather type

Box Length: Based on weather type + adjusted with aircraft ground speed

Determination of notification for turbulence

Calculate number of GTGN pixels in box(s) to determine notification type

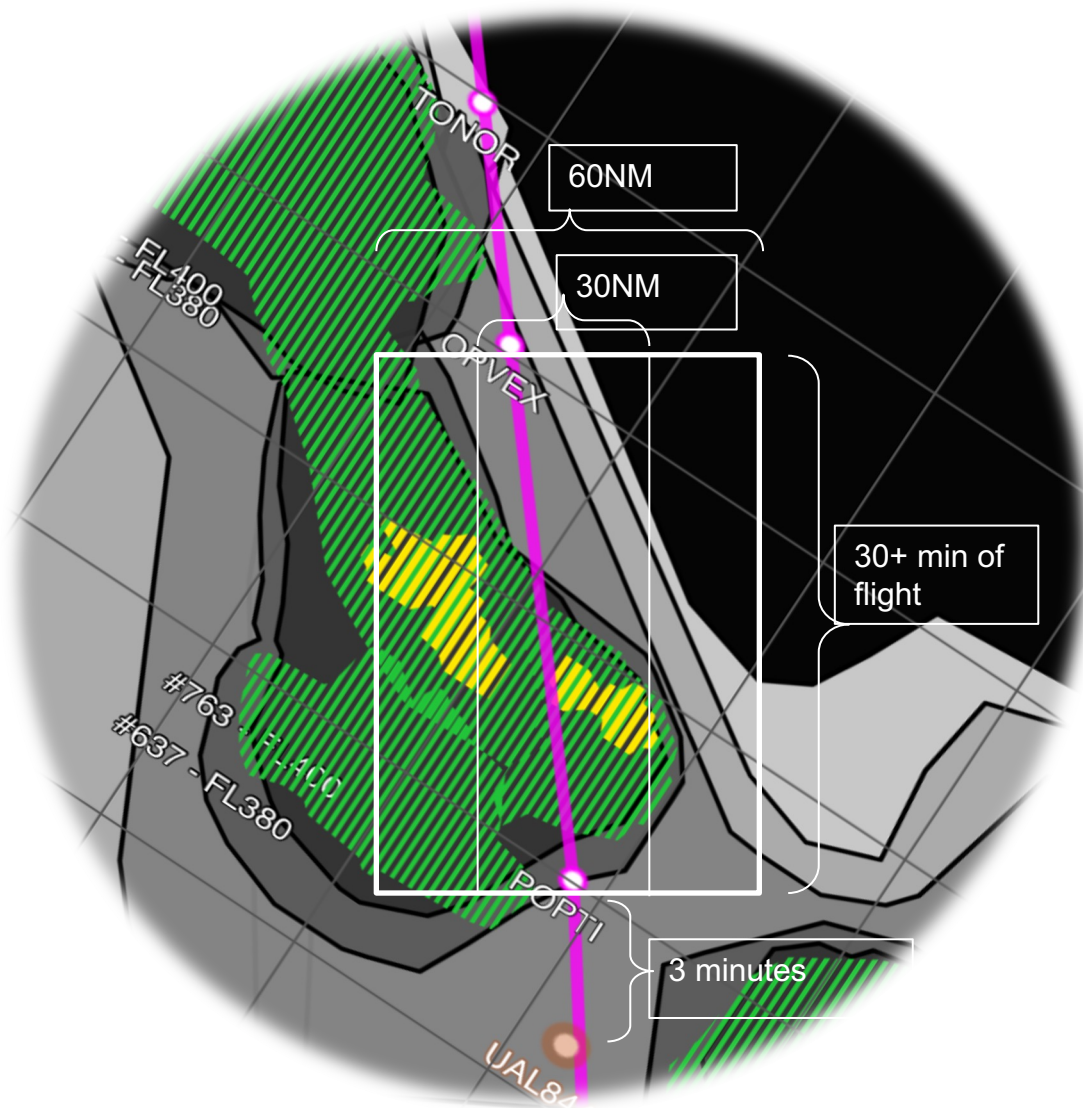


Turbulence Notification Types:

NULL
Light
Moderate
Severe

Determination of notification for Convection

Calculate number of CDO pixels in box(s) to determine notification type



Convection Notification Types:

NULL
Convection
Moderate
Heavy

Development Demonstration

Utilized the FAA's Next Generation Integration and Evaluation (NIEC) cockpit simulator with airline pilots to:

- Identify flight risks (if any) associated with providing frequently updated adverse weather information directly to the pilots.
- Increase our understanding of impacts to pilot, dispatch, and air traffic management (ATM) decision making in a collaborative environment when frequently updated adverse weather information is provided directly to the flight deck.
- Validate an easy to understand notification format for frequently updated adverse weather information to pilots.
- Demonstrate the use of an agnostic data link for onboard information connectivity, such as in-flight entertainment communications system, satellite data links, cellular connectivity or other emerging technologies for aircraft data connectivity.

Development Phase 1

- Developed a method for presenting frequently updated turbulence nowcast information into the cockpit
- Developed the system for frequently updating turbulence information
- Demonstrated the feasibility to implement real-time notifications with the necessary latency to the cockpit
- Evaluated running the system in the CONUS region.

Development Phase 2


- Modified the system for effectiveness and accuracy in oceanic regions and tuned it for Cloud Top Height and Convection information based on the Remote Oceanic Meteorology Information Operational (ROMIO) demonstration.
- Evaluated running the system in the oceanic region.
- Finalized documentation and software package

Development Demonstration Display

iPad 8:14 AM 68%

GTG-N Turbulence Notification

2015-01-30 13:14



05 Jan 2015 23:04:14Z AAA1457
FL260 heading 289 Light
Turbulence in area ahead.

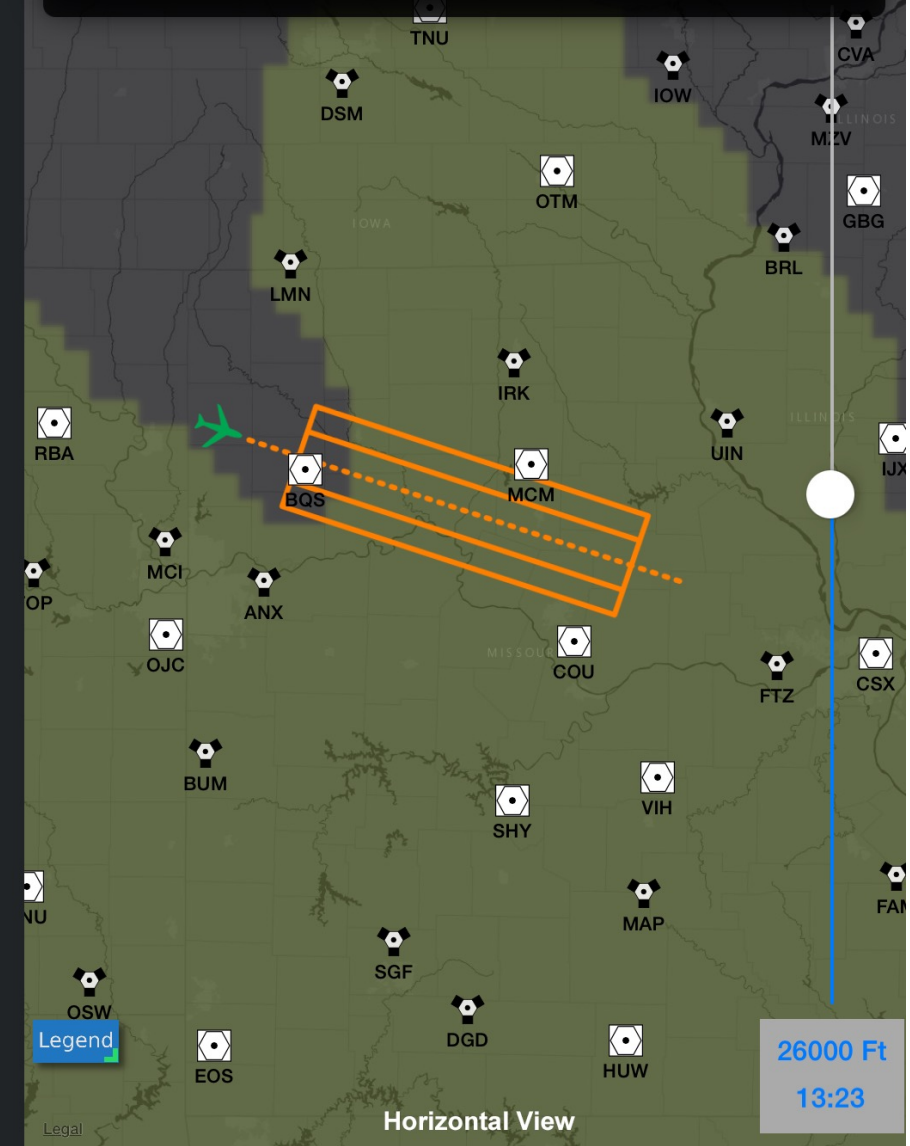
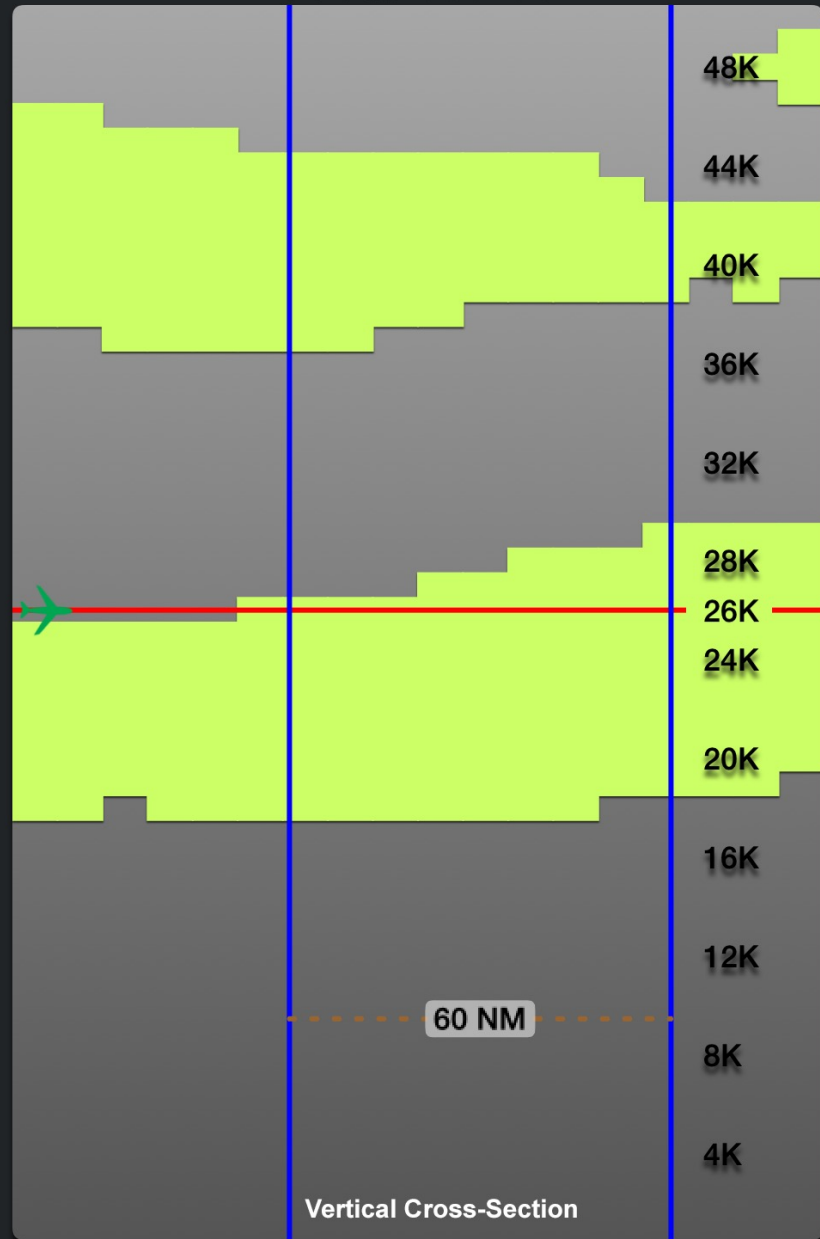
[More Info](#)

Connected: AAA1457

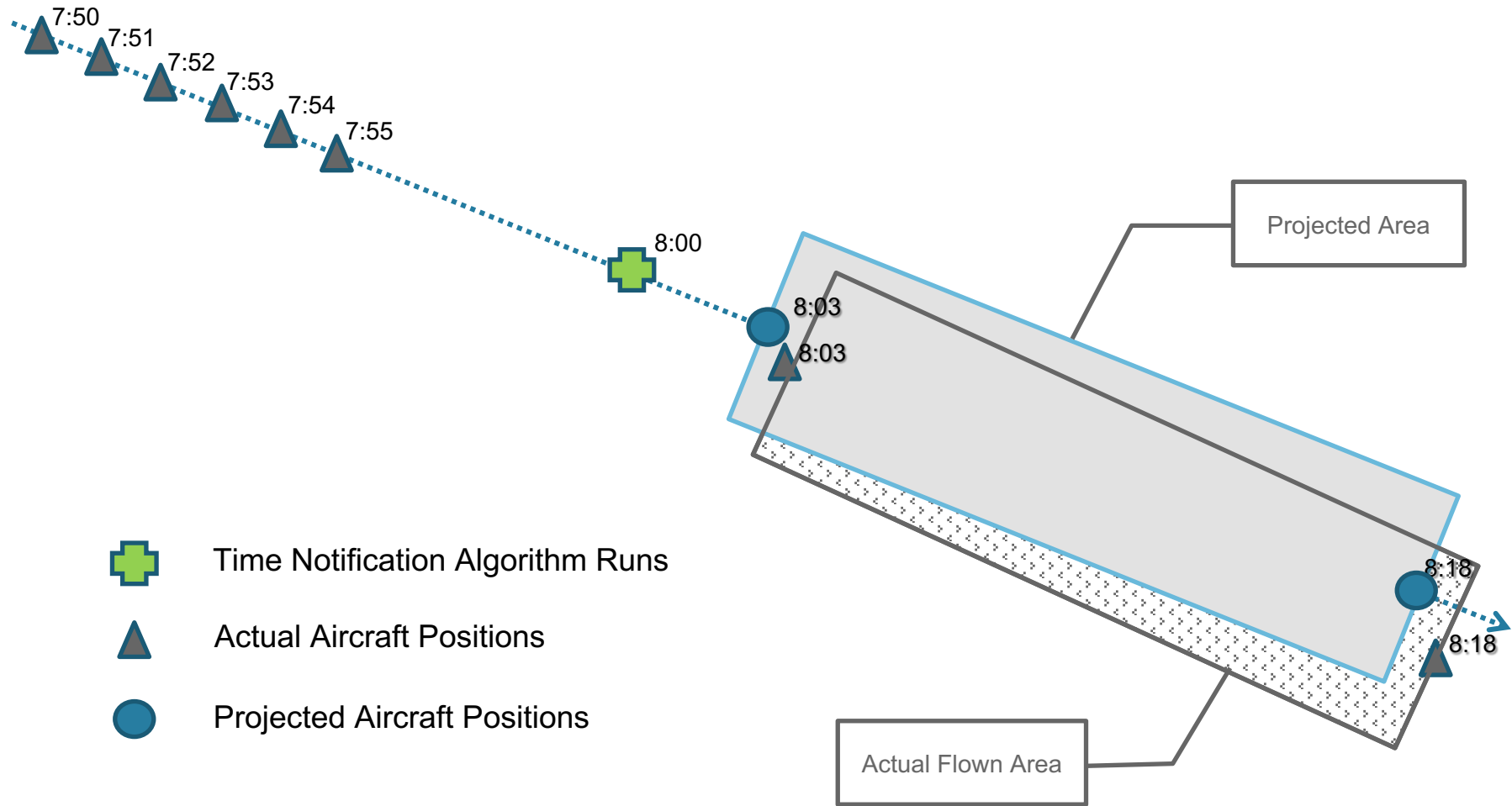





05 Jan 2015 23:04:14Z AAA1457 FL260 heading 289
Light Turbulence in area ahead.

Back



Comparing the Projected vs Flown Areas



-  Time Notification Algorithm Runs
-  Actual Aircraft Positions
-  Projected Aircraft Positions

Comparing the Projected vs Flown Areas

Turbulence in Projected Area

Turbulence
in Flown
Area

(Counts)	NULL	LIGHT	MOD	SEVERE
NULL	17803	317	309	78
LIGHT	176	3538	210	32
MOD	211	132	4424	312
SEVERE	38	15	171	1590

False
Positives
in grey

False Negatives in orange

Comparing the Projected vs Flown Areas

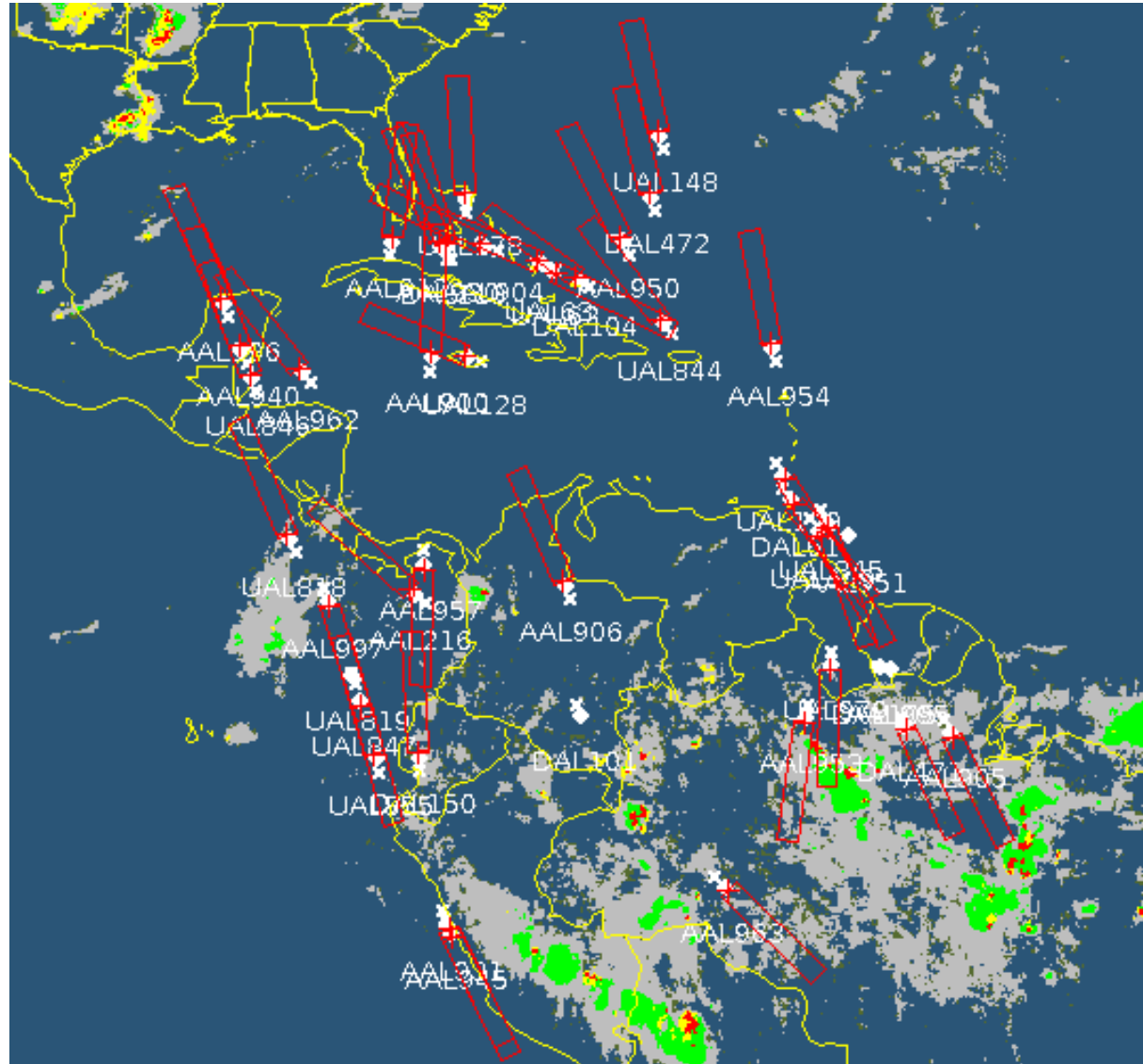
Turbulence in Projected Area

(%)	NULL	LIGHT	MOD	SEVERE
NULL	96.2	1.7	1.7	0.4
LIGHT	4.5	89.4	5.3	0.8
MOD	4.2	2.6	87.1	6.1
SEVERE	2.1	0.8	9.4	87.7

False
Positives
in grey

False Negatives in orange

GlobalWeatherNote running in real-time with CTH/CDO



Global Weather Note Design Features

- Designed for use with high update weather products, such as Nowcasts or Observational weather. (Turbulence Nowcast, Icing Nowcast, Oceanic Convection, Volcanic Ash ...) Not intended for use with long term forecast products.
- Pilots currently viewing these weather products in route can reduce the in cockpit bandwidth by utilizing this system. “Let me know when there is weather up ahead.”
- Some airlines already have similar features built in to their weather app. Benefits of Global Weather Note is it runs on ground based systems. This allows tie in with AOC, requires no bandwidth in the cockpit to run, allows processing very high resolution data, ability to utilize new and emerging weather products and more.
- Pilots with no ability to view weather products in route can get notice of weather in advance, before they see or experience it.
- Often the pilot may already know about the weather in the notification, but the system can always be checking and picking up rapidly developing storms.

Frequently Asked Questions

- What is the message transmission method?
 - Many options for this and this likely will vary by airline and aircraft. Integration into a weather application is preferred, but yes *some* type of connectivity for the message is needed.
- Why not more advanced notice? Tell me 2 hours in advance!
 - In the oceanic space, farther out requires predicting where the weather where will be in an hour or two, 30-45 minutes is a good range for looking at what the weather is now up ahead. Going out farther is possible.
 - In the CONUS space 15-20 minute look ahead gives a good notice of rapidly developing storms, and allowing some time to “prepare” for un-expected turbulence.
- There's a lot of weather today, won't a pilot get bombarded with messages?
 - The system would only notify the first time of each “category” in a give time frame. For example one message about light turbulence, then only another message if the turbulence category was moderate or severe. And a “Silence” button could easily be integrated into a weather application.
- False alarm! The Moderate/Severe Turbulence didn't happen.
 - This will not make the pilot or passengers happy, but what is the best way to resolve?
 - The system is completely separate from any weather product, so the best it can do can vary based on what it is being feed. Pilot feedback about the weather products could be a good thing.

How do we get this to pilots?

- As a research institute NCAR cannot implement the system.
- Many details remain as they are heavily implementation specific.
- Integration could be directly into existing weather applications.
- Integration could also be through a web page interface to register a flight, for pilots without a weather application, and receive notification through the web page or via text message.
- Each target aircraft or airline could have different methods.
- Airlines could integrate the system with their AOC and monitor or approve the messages.
- Target aircraft or airlines could set their own preferred system settings. When notifications should happen and how. Including projection window, the weather products, message customizations and more.
- Who can implement a system like this?