



CTH/CDO Products and the Remote Oceanic Meteorological Information Operational (ROMIO) Demonstration

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National Center for Atmospheric Research

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NCAR | RESEARCH APPLICATIONS
LABORATORY



Outline

CTH and CDO Products used in ROMIO

ROMIO Demonstration

Product Details & Examples

Summary



Convective Hazard Products: CTH and CDO



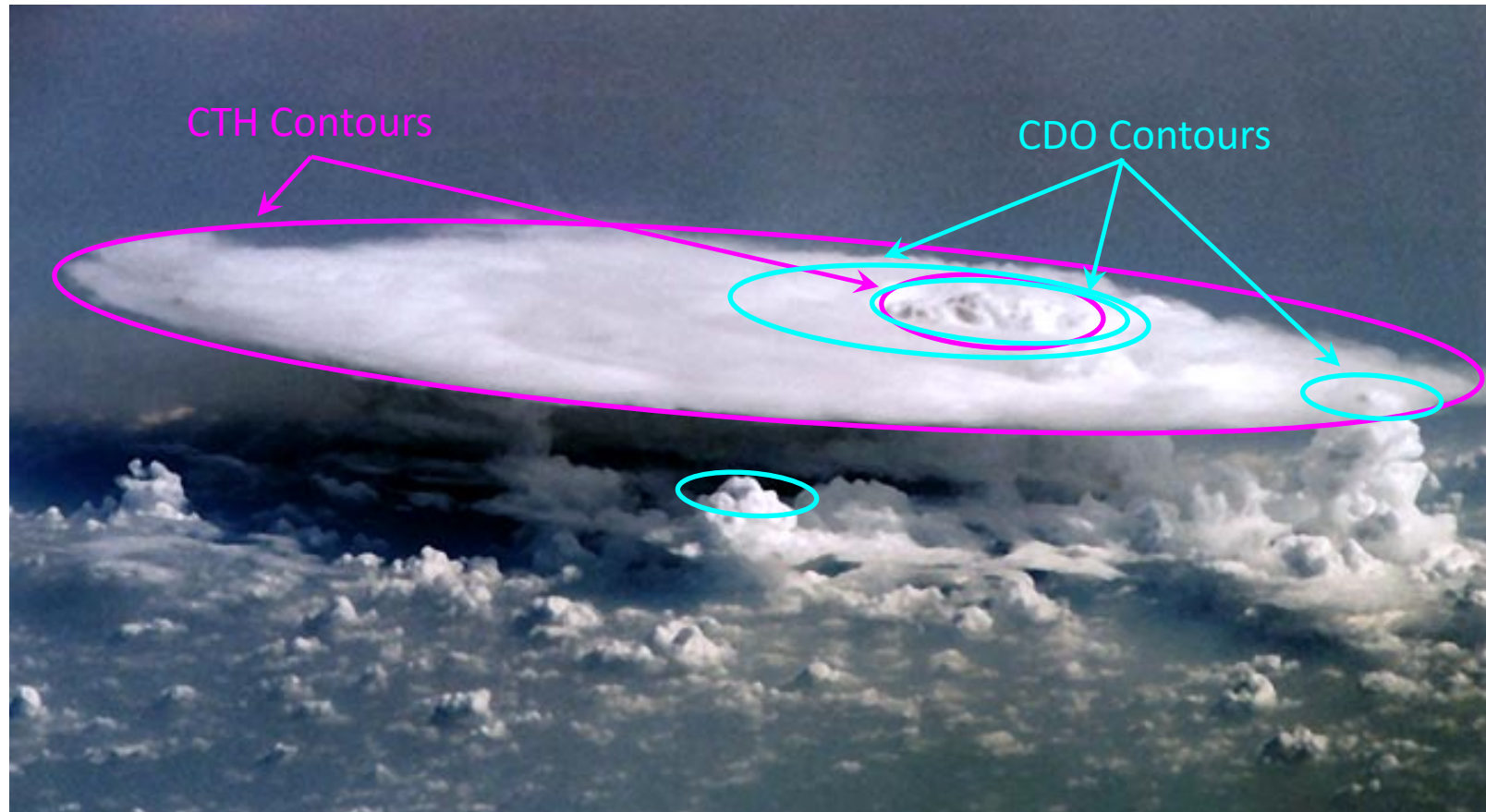
CTH = Cloud Top Heights

- Above 15kft
- For optically thick clouds
- Derived from Satellite and Model
- Updates every 10 minutes

CDO = Convection Diagnosis Oceanic

- Detection of convective hazards, giving additional information to the CTH.
- Hazard indicator (0 to 6).
- Derived from Lightning, Model, and Satellite
- Values ≥ 2 indicate a convective hazard is likely
- Values ≥ 3 indicate lightning and/or an overshooting top is present.
- Updates every 5 minutes

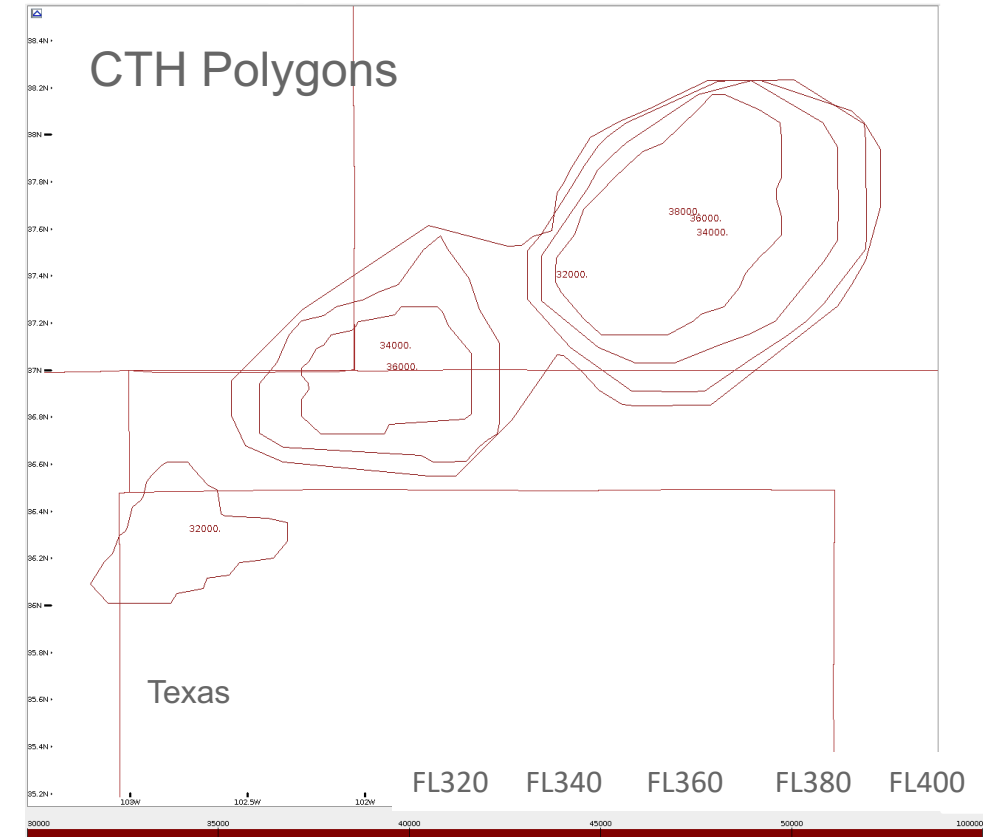
Two Convective Products: CDO and CTH



- Two products better characterize convective storm
- CTH gives full extent of cloud cover and height
- CDO shows location of updraft/lightning hazards

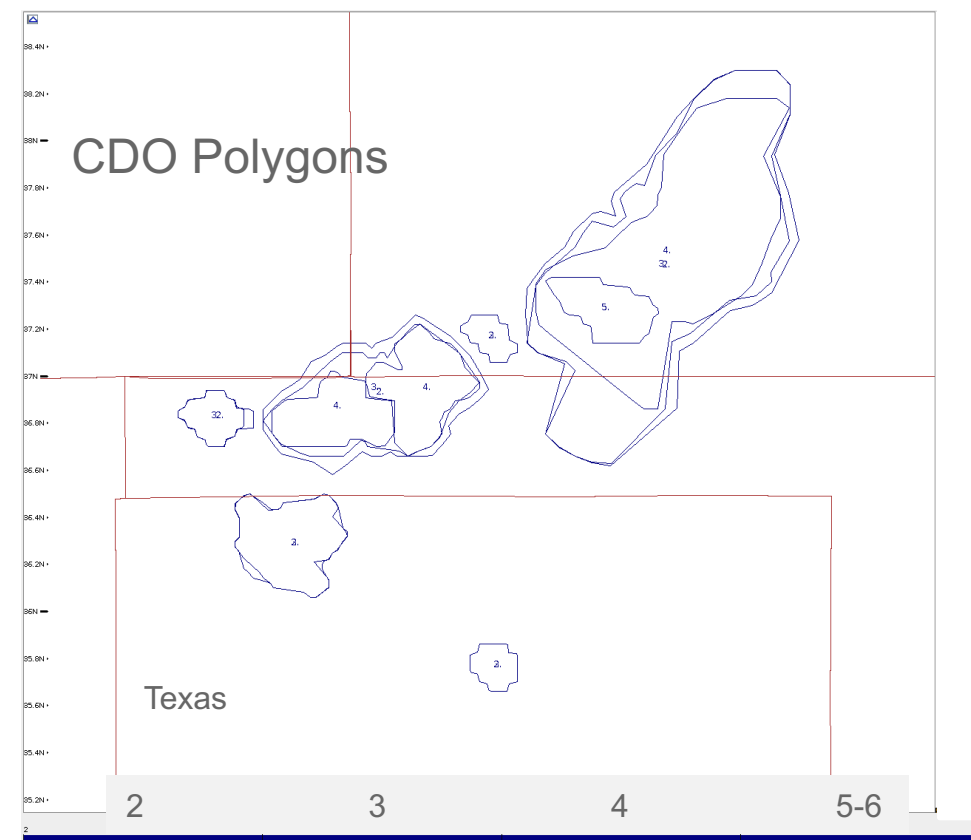
Cloud Top Height (CTH)

- CTH estimates the heights of cloud tops using longwave infrared brightness temperature (~11 micron) and Global Forecast System (GFS) model
 - Opaque clouds
 - Contours: FL320, FL340, FL360, FL380, FL400
- Gridded CTH converted to polygons at specified levels before uplink
 - Provides a “representation” of the cloud top shape, not exact contours
 - Conserves bandwidth
 - Minimum area is a threshold



Convection Diagnosis Oceanic (CDO)

- Defines updraft regions hazardous to aircraft with highest values aligned with convective cells
- CDO inputs:
 - Cloud Top Height
 - Global Convective Diagnosis (WV-IR)
 - GOES-R Overshooting Tops Algorithm
 - GOES Geostationary Lightning Mapper (GLM)
 - EarthNetworks global lightning and NLDN lightning
 - Contours: 2, 3, 4, 5
- Gridded CDO converted to polygons at specified levels before uplink
 - Provides a “representation” of the hazard area, not exact contours
 - Minimum area is a threshold
 - Conserves bandwidth



Remote Oceanic Meteorological Information Operational (ROMIO) Demonstration

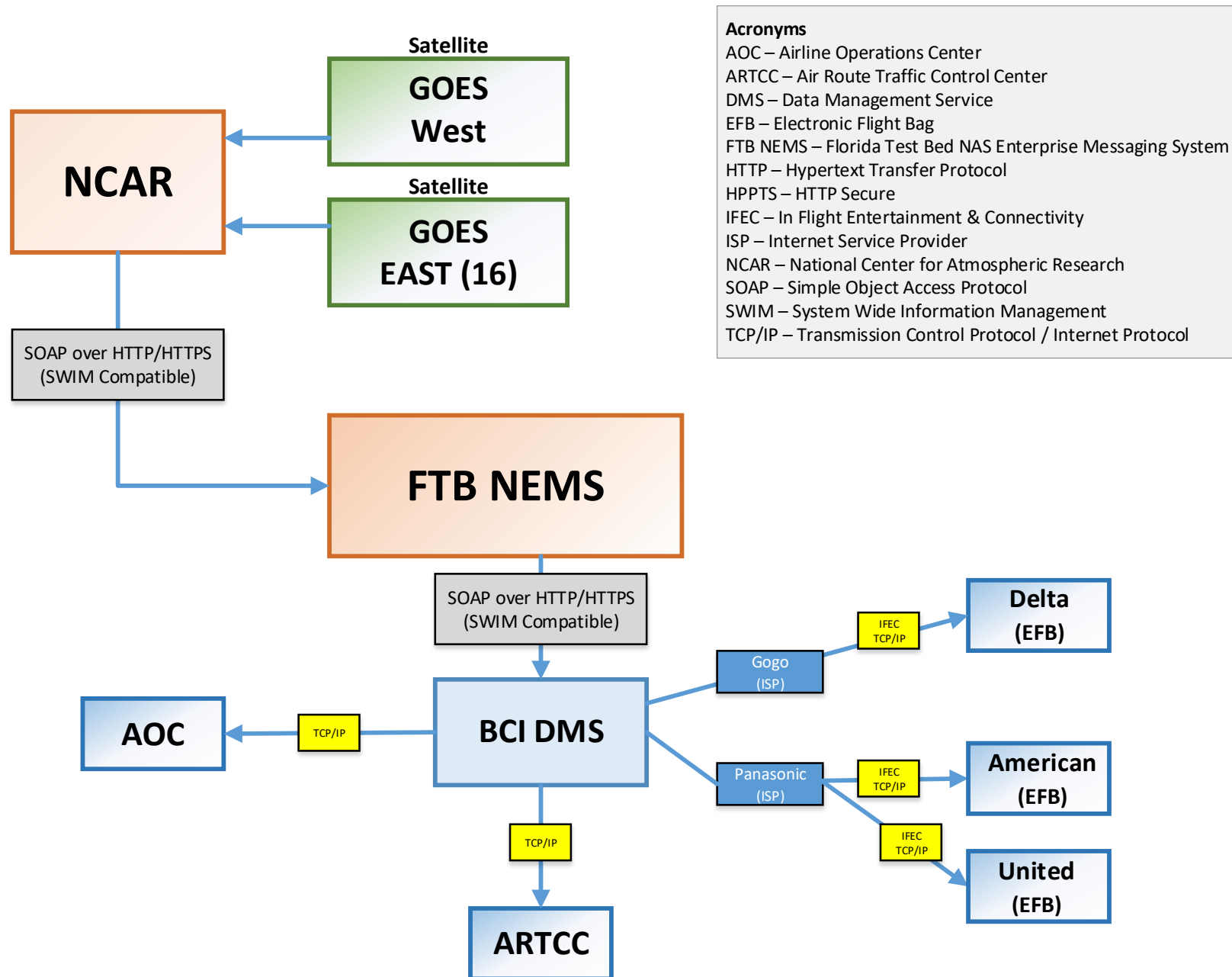
- **Operational demonstration** to evaluate the *feasibility* to uplink convective weather information to aircraft operating over the ocean and remote regions
 - No ground-based radar products available
 - Uses satellite, lightning and model
 - Himawari-8, GOES East/West coverage
 - Schedule: July 2018 – December 2019
 - NCAR Data Production (GOES-W/E only) slated to run through June 30, 2022
- **Explore strategies** for using updated Cloud Top Height (CTH) and Convection Diagnosis Oceanic (CDO) weather products on the flight deck, by Oceanic Control Centers (OCC), by Airline Operations Centers (AOC)
 - Supplemental use only
- **Understand the benefits** associated with providing updated graphical information to the flight deck, ATC, and AOCs
 - Feedback from pilots, dispatchers, controllers being collected/analyzed

Remote Oceanic Meteorological Information Operational (ROMIO) Demonstration

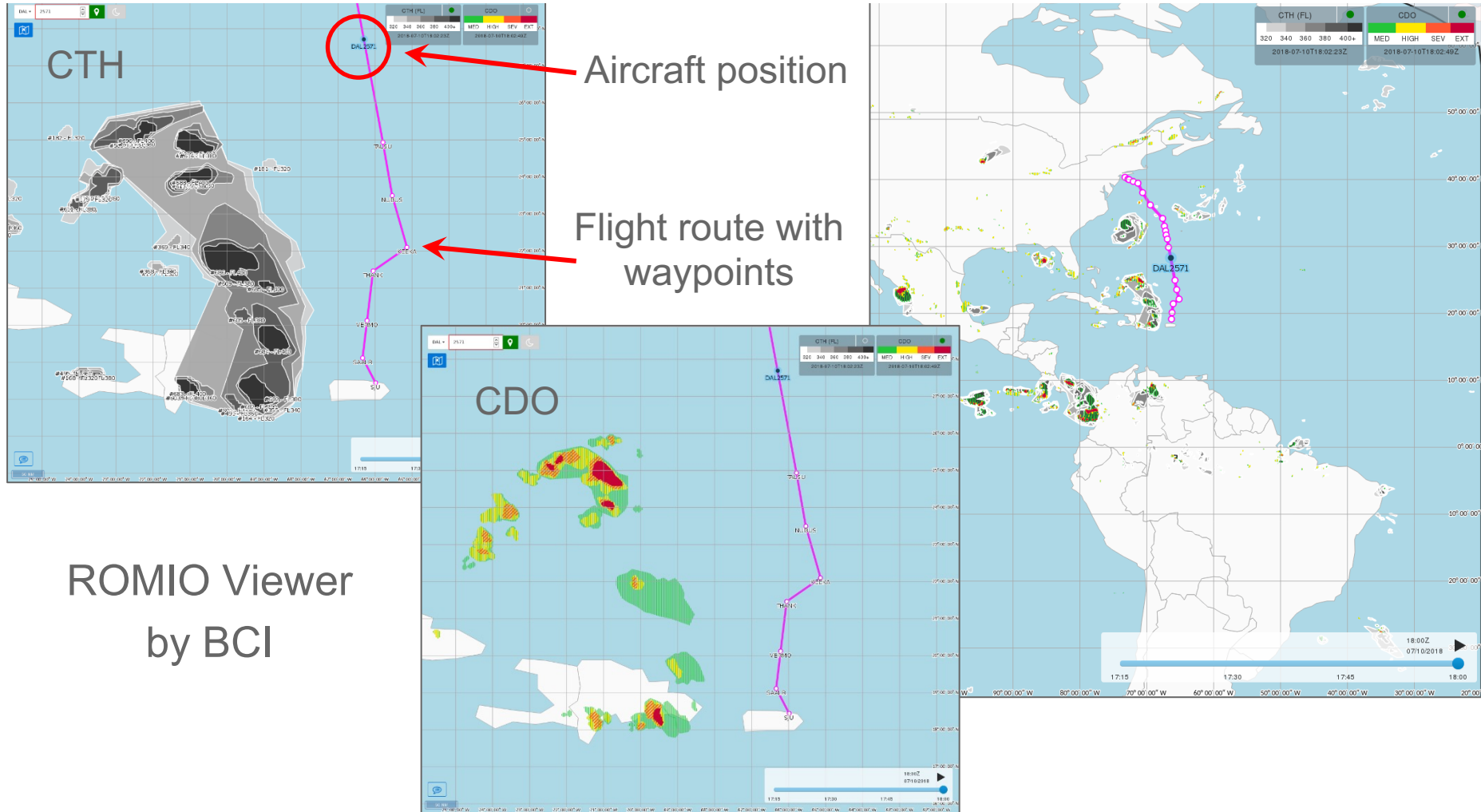
Participants:

- Sponsor: Weather Technology in the Cockpit (WTIC) Program
- NCAR: Principal Investigator and Overall Project Support
- Basic Commerce and Industries (BCI): Software Applications and Communications Support
- Embry-Riddle Aeronautical University: NextGen Testbed
- Airlines: Delta Air Lines, American Airlines, and United Airlines with Panasonic and Gogo as datalink to aircraft providers
- Benefit Analysis: Virginia Tech
- Collaborators: FAA Oceanic ARTCC, FAA Flight Standards AFS-430, and FAA Center Weather Service Units, NATCA

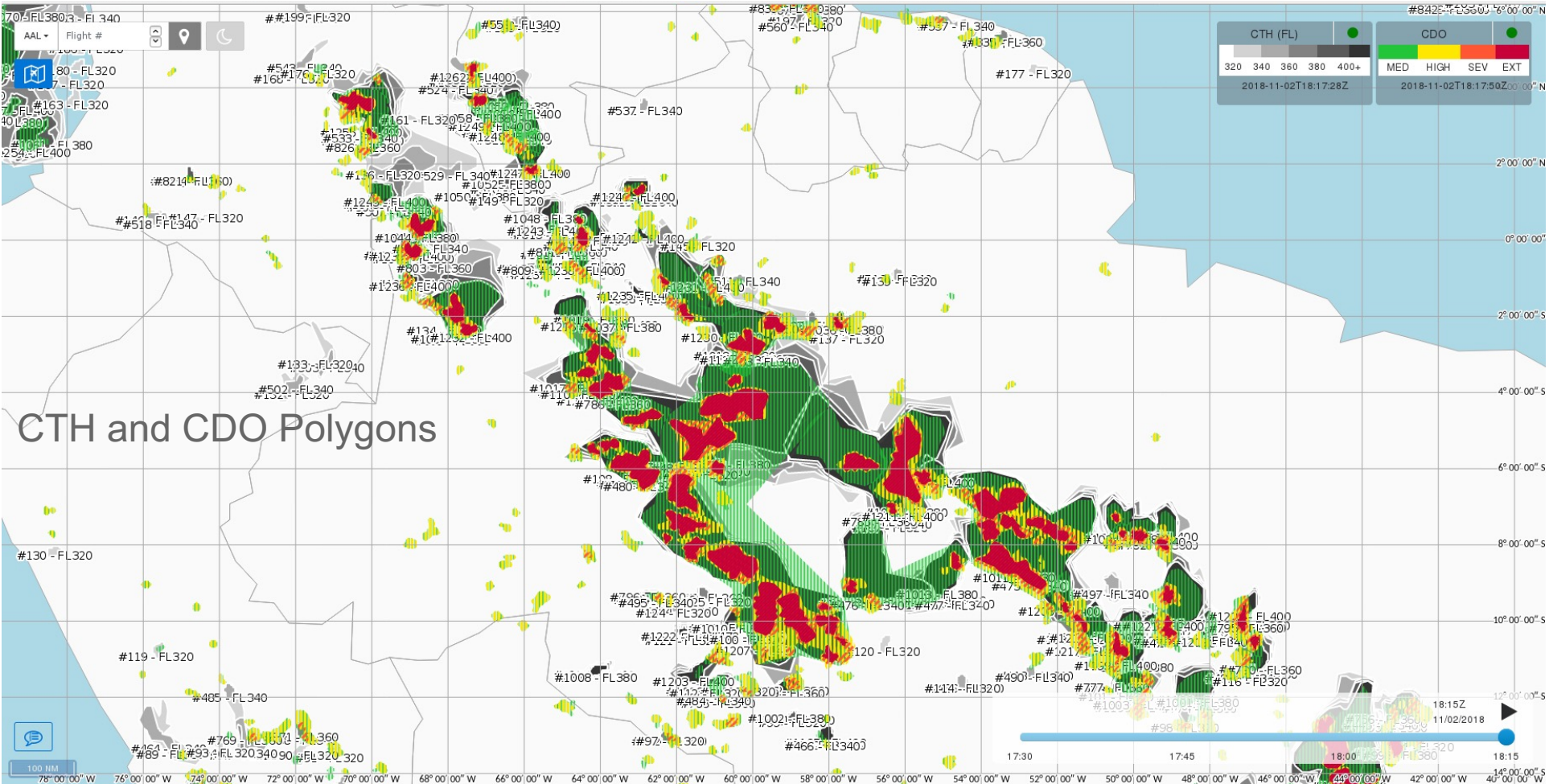
ROMIO Architecture



ROMIO Example Flight from JFK to San Juan, Puerto Rico



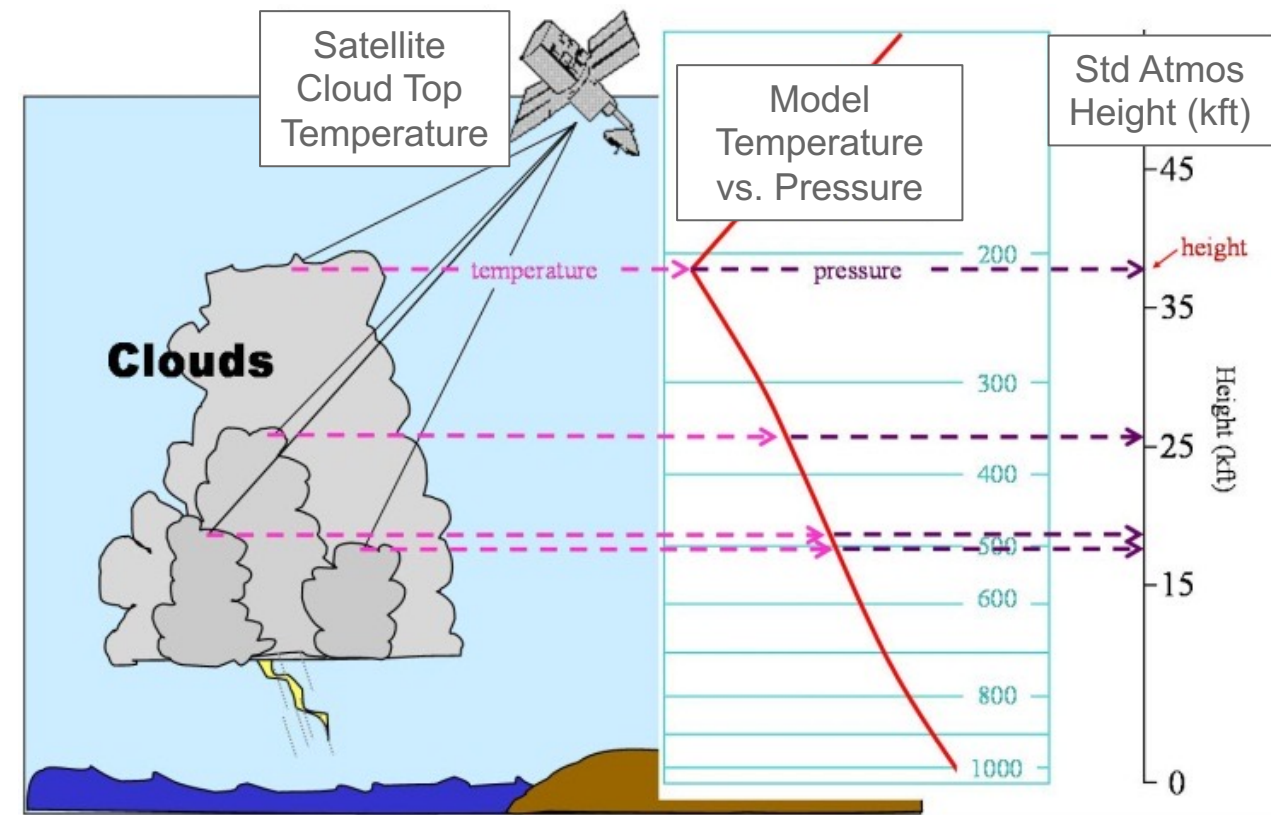
ROMIO Viewer with CDO/CTH Products



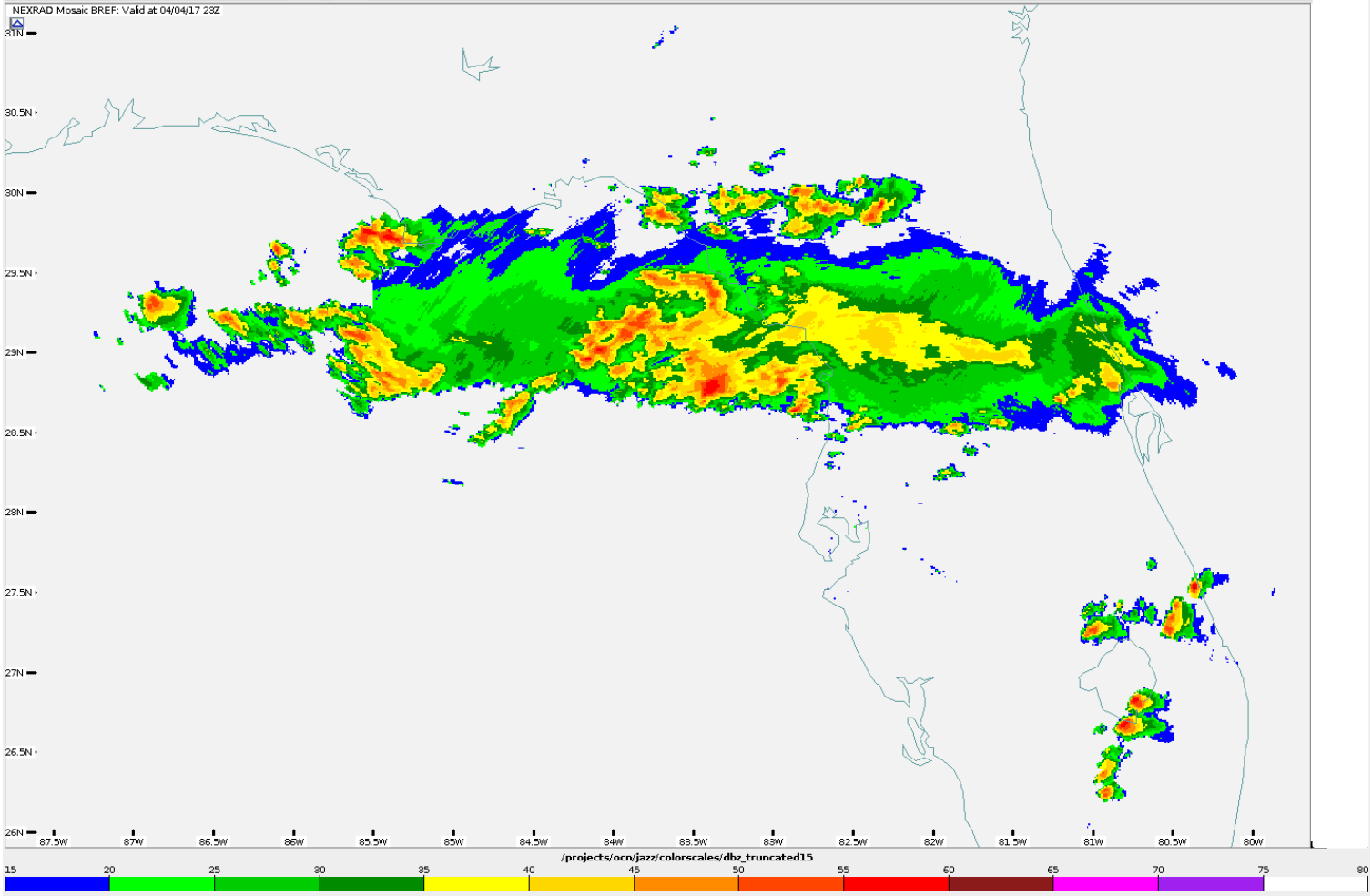
- Each airline had its own version of the viewer for pilots and AOC
- “Public” version for Oceanic Centers, ROMIO participants

CTH Details

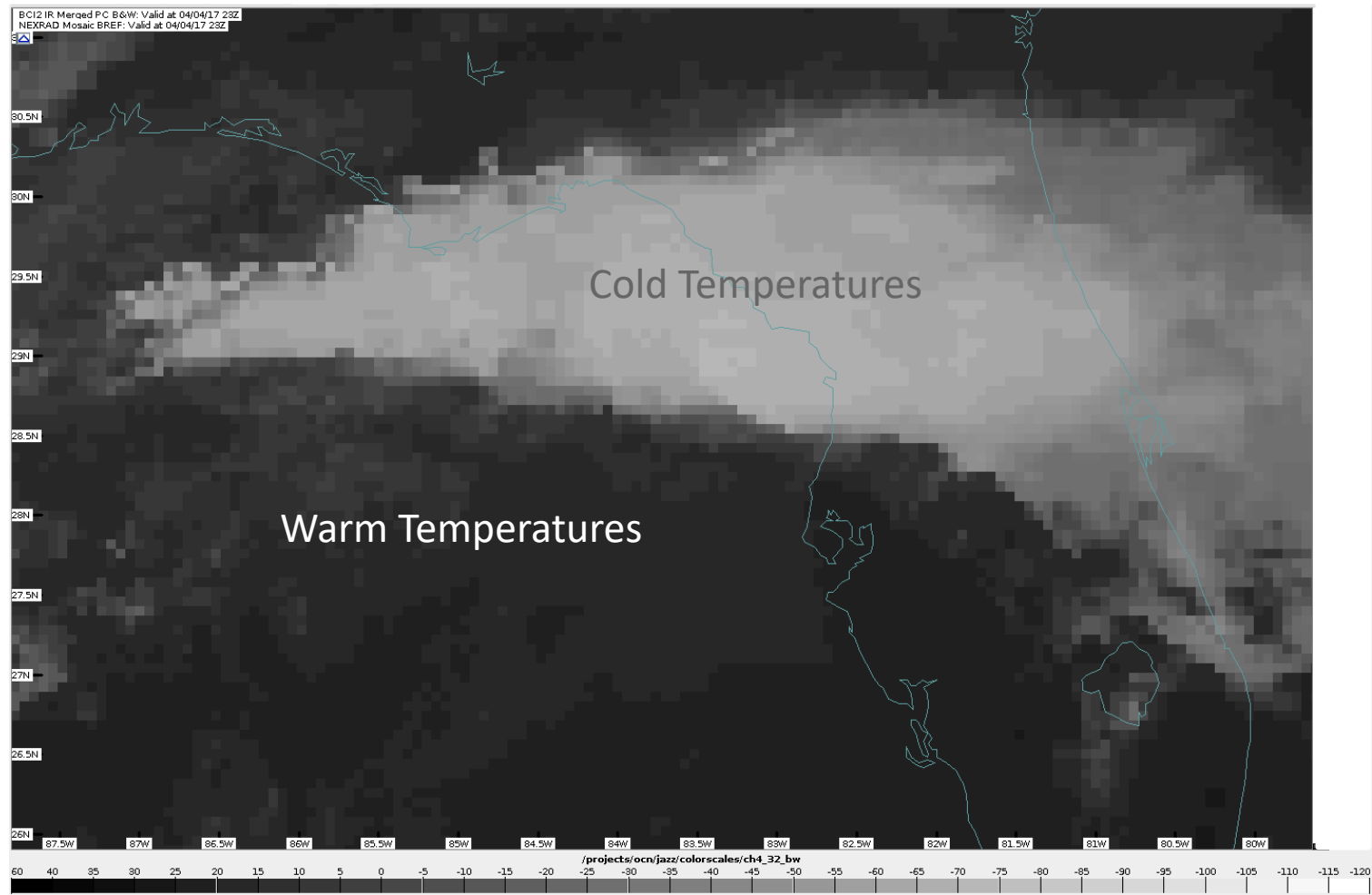
- Cloud Top Height (CTH) is computed by:
 - Converting the satellite 11.2 micron infrared (IR) brightness temperature to pressure by comparison to the WRF model sounding.
 - Converts the pressure to a flight level through the standard atmosphere equation (Miller 2005).
- Defines storm anvil contours
 - May not show individual convective cells



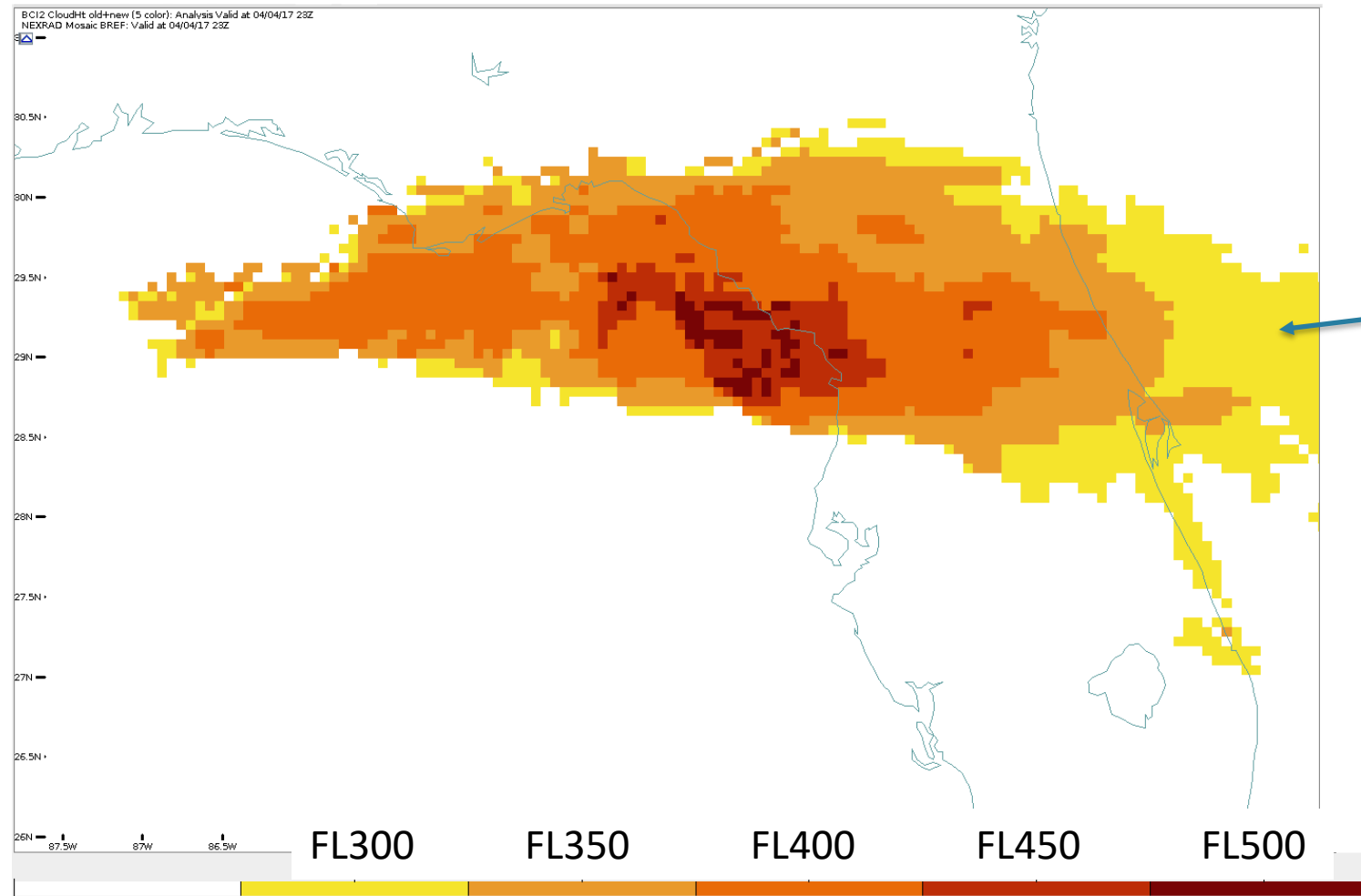
Reflectivity



Infrared Brightness Temperature



Cloud Top Height (CTH) Product



FL300 – FL350

CTH Contours for ROMIO are FL320, FL340, FL360, FL380, FL400

CDO Details

- Convection Diagnosis Oceanic is computed using a combination of inputs:

- 1) Global Convective Diagnosis (GCD) is computed by differencing the brightness temperatures from the longwave IR and water vapor channels (Mosher, 2002).

- Indicates the location of mature updrafts when the difference is near zero.
- Optically thick clouds will exhibit similar LIR and WV radiances (assuming water vapor above the cloud is negligible).

- 2) CTH (as described earlier)

- 3) Overshooting Tops Algorithm

- Computed following Bedka et al. (2010) and shows the locations of overshooting tops

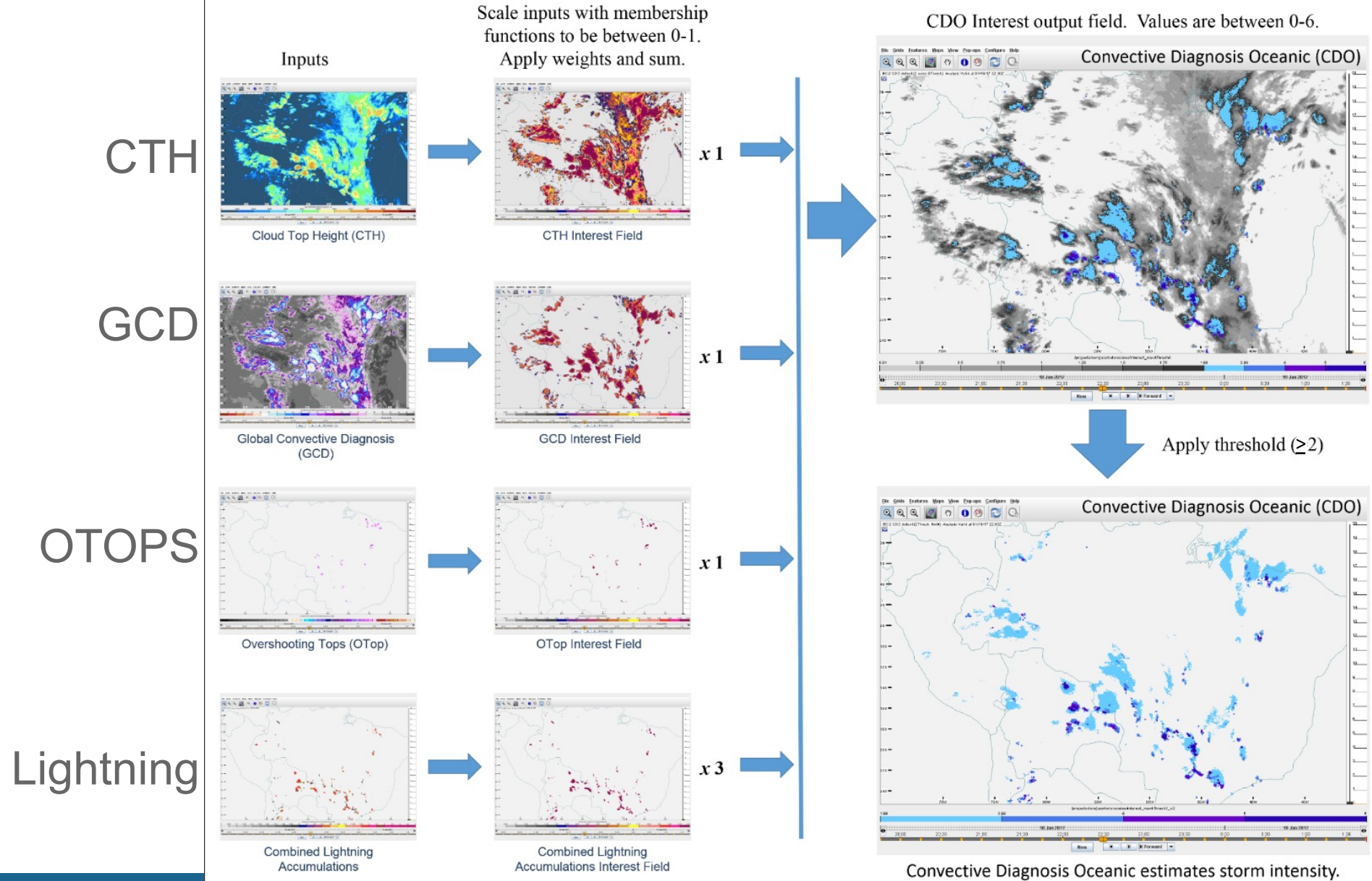
- 4) Lightning accumulation at 10, 30 and 60 minutes.

- Weighted more heavily, equivalent importance to satellite contributions.
- Lightning is critical to determining exact location of hazard.

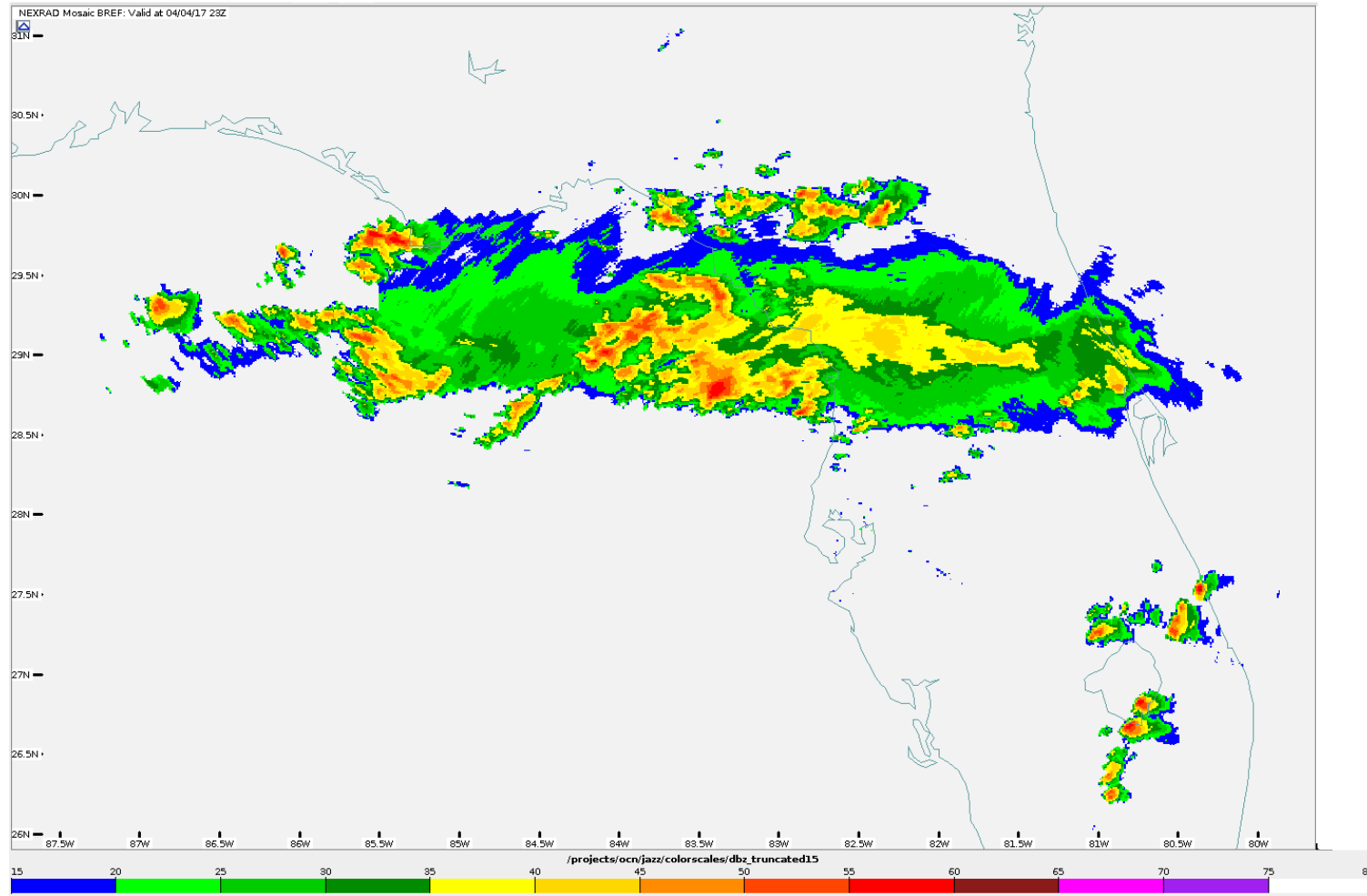
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Defines updraft regions that are most hazardous to aircraft. Highest CDO values are aligned with convective cells

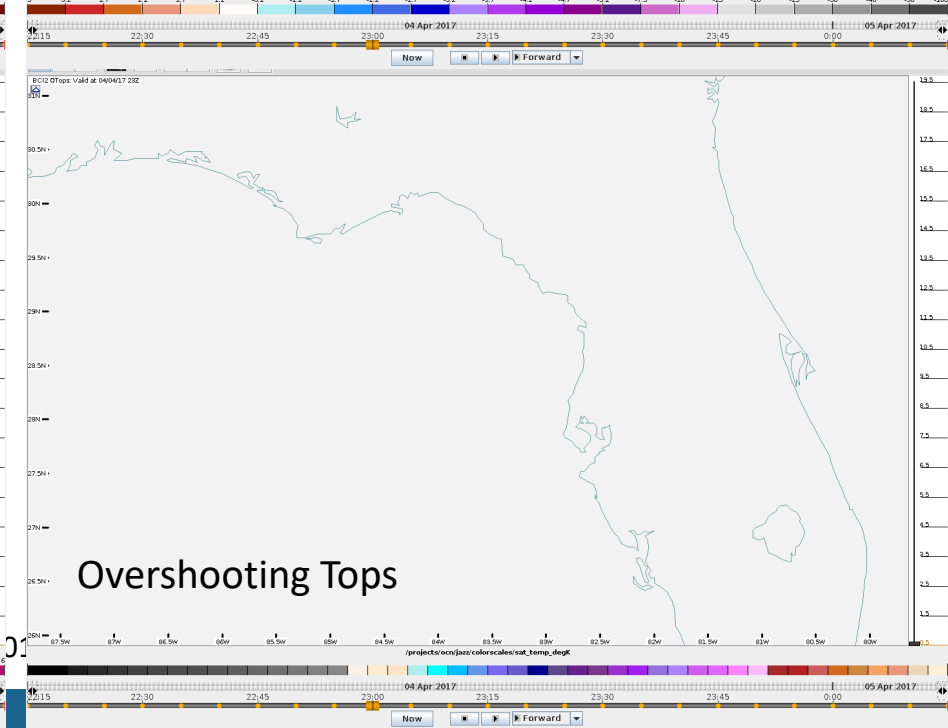
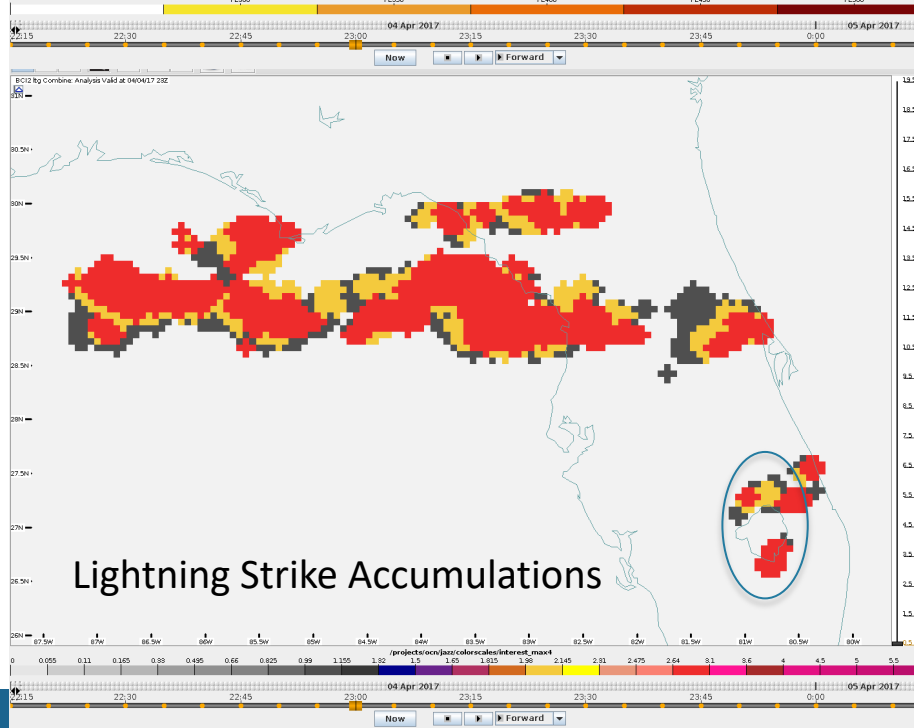
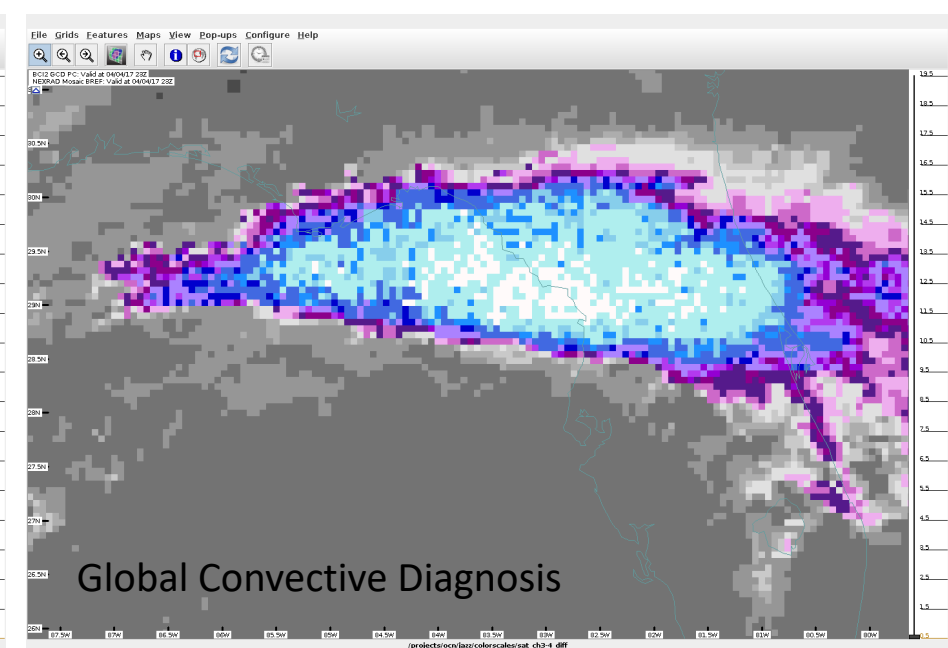
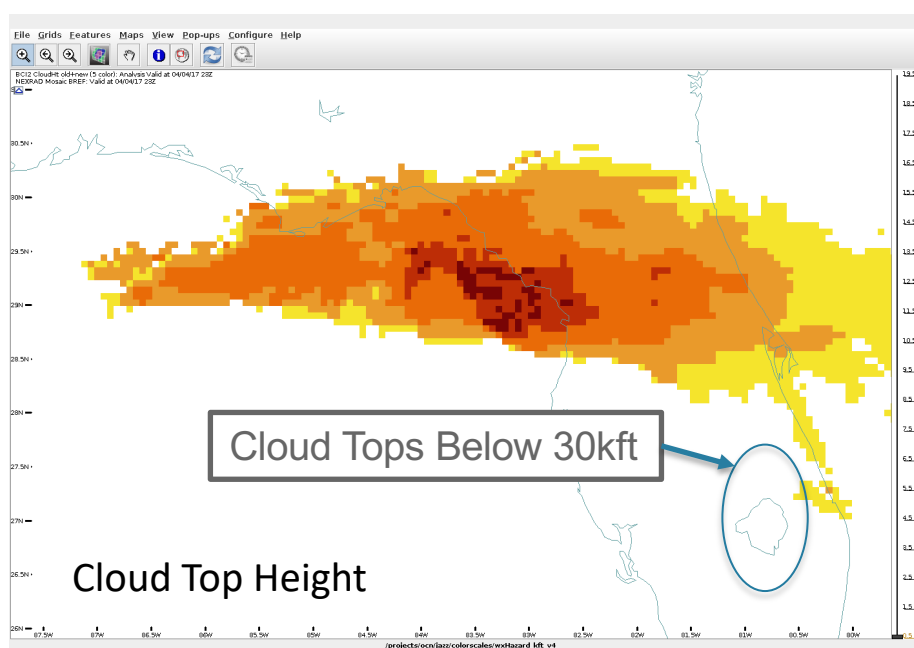
Convection Diagnosis Oceanic (CDO) Fuzzy Logic, Data Fusion Methodology



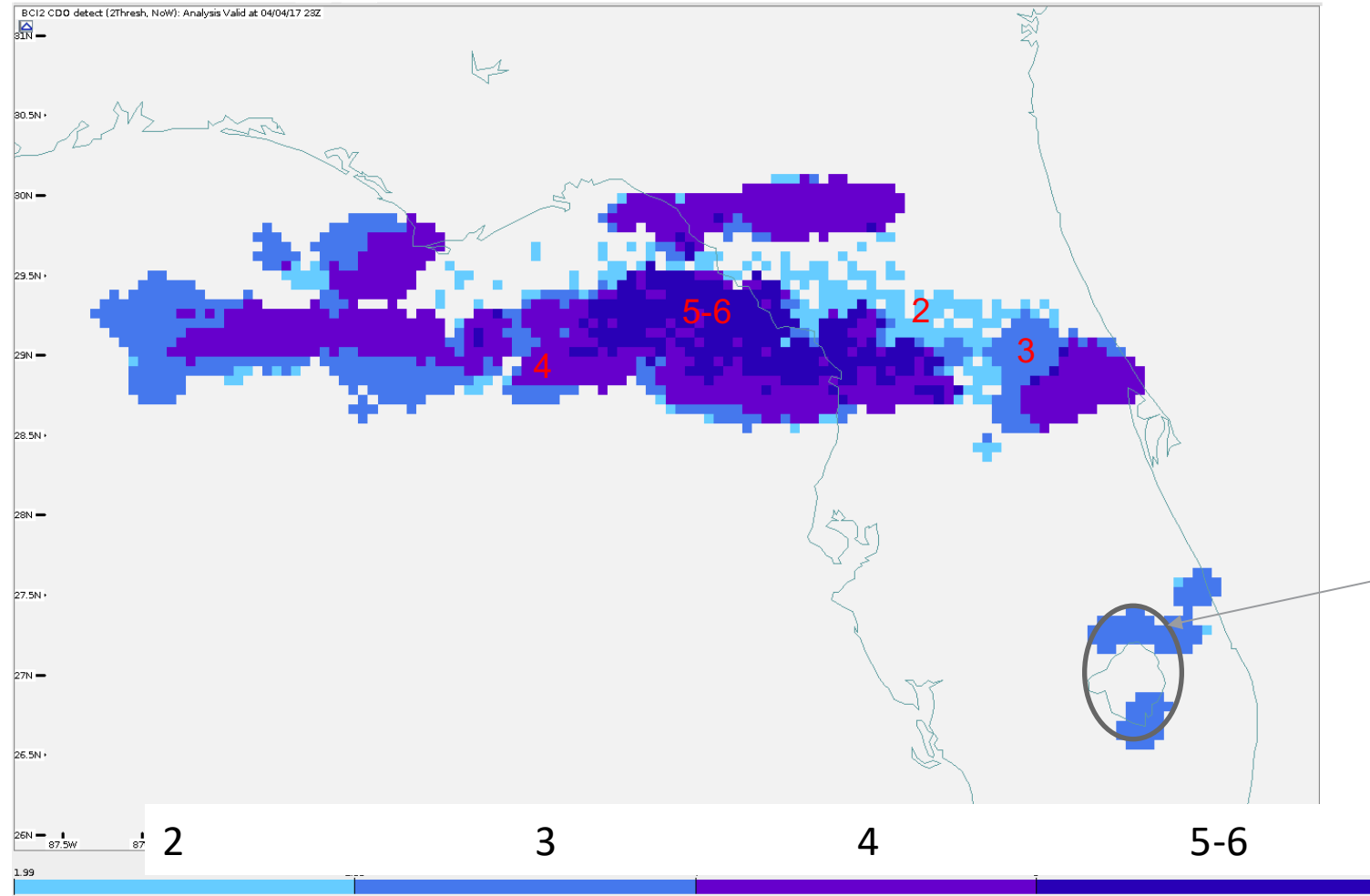
Same case from earlier



CDO Inputs



Convection Diagnosis Oceanic (CDO) Values 0-6



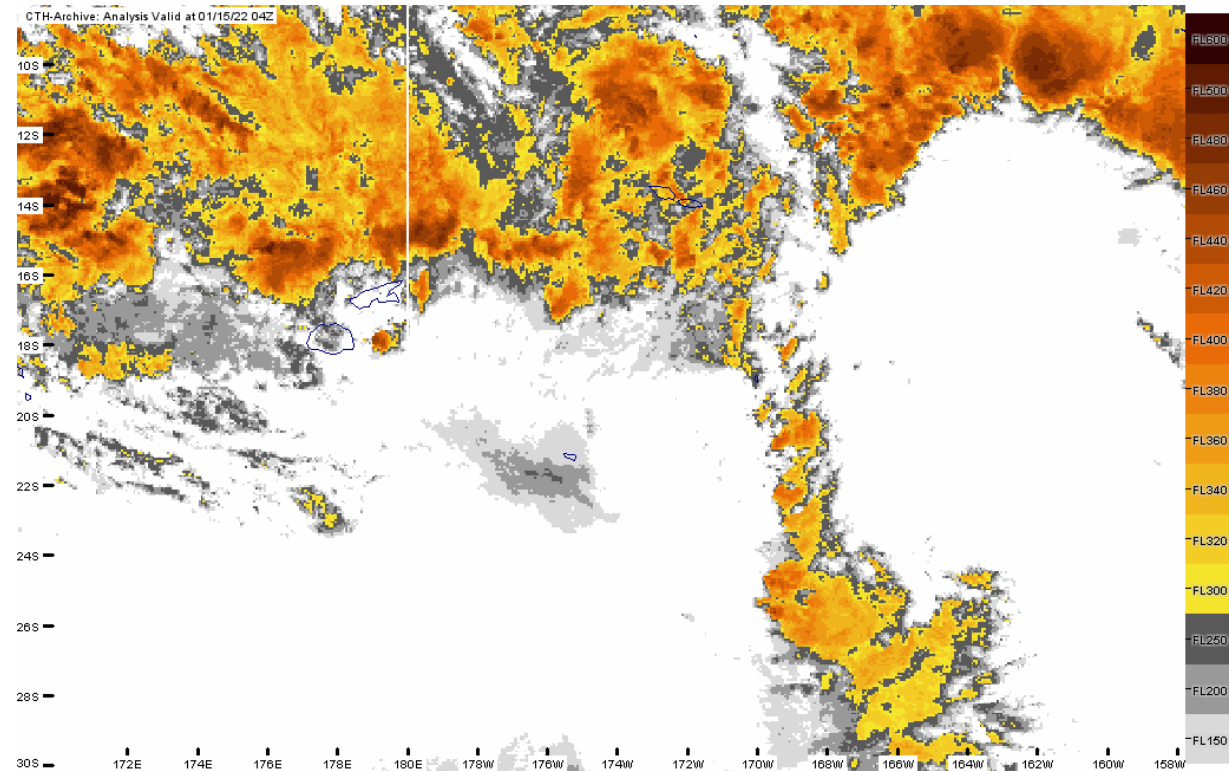
Lightning important
for CDO > 2 in
absence of
overshooting tops.

Summary

WTIC ROMIO Demonstration successfully conducted (more details later this morning)

CTH and CDO products are useful and usable weather hazard guidance products for aviation concerns

Current CTH/CDO prototype processing/distribution from NCAR to end June 30, 2022



CTH product showing Tonga volcano
January 15, 2022
0400 – 0800 UTC

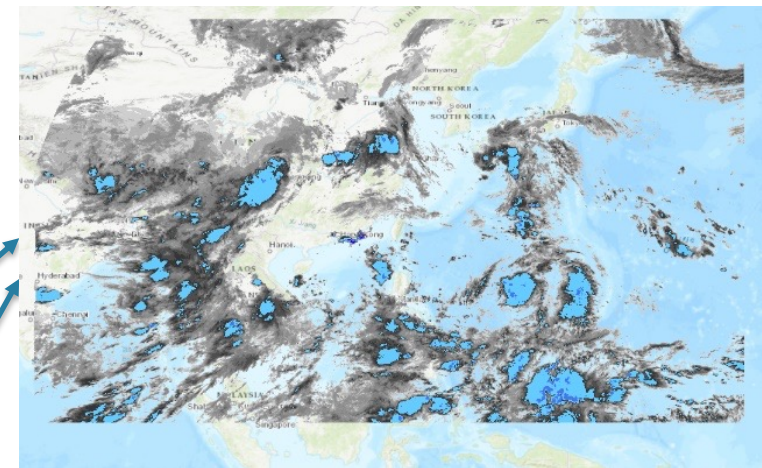
Back-up Slides



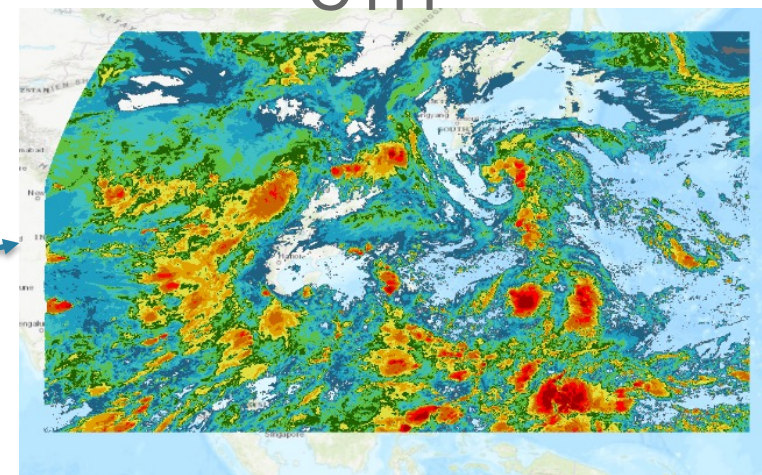
Satellite Channels Used

	avelength (μm)	Band number	Spatial resolution at SSP (km)	Central wavelength (μm)
	0.47	1	1	0.47063
	0.51	2	1	0.51000
	0.64	3	0.5	0.63914
	0.86	4	1	0.85670
	1.6	5	2	1.6101
	2.3	6	2	2.2568
	3.9	7	2	3.8853
Water Vapor	6.2	8	2	6.2429
	6.9	9	2	6.9410
	7.3	10	2	7.3467
	8.6	11	2	8.5926
	9.6	12	2	9.6372
Longwave IR	10.4	13	2	10.4073
	11.2	14	2	11.2395
	12.4	15	2	12.3806
	13.3	16	2	13.2807

CDO



CTH



Water Vapor

Longwave IR

CDO Inputs Scaled (0-1)

