



National Transportation Safety Board

**Office of Aviation Safety
Washington, D.C. 20594-2000
April 19, 2017**

**ATTACHMENT 5 to the METEOROLOGY GROUP FACTUAL REPORT
DCA16LA214**

United Airlines recurrent training, Spring 2016, convectively-induced turbulence.

*Submitted by: Mike Richards
NTSB, AS-30*

Convectively Induced Turbulence (CIT)

2016 Spring
Recurrent

April 2016



A STAR ALLIANCE MEMBER 

UNITED 

Convectively Induced Turbulence

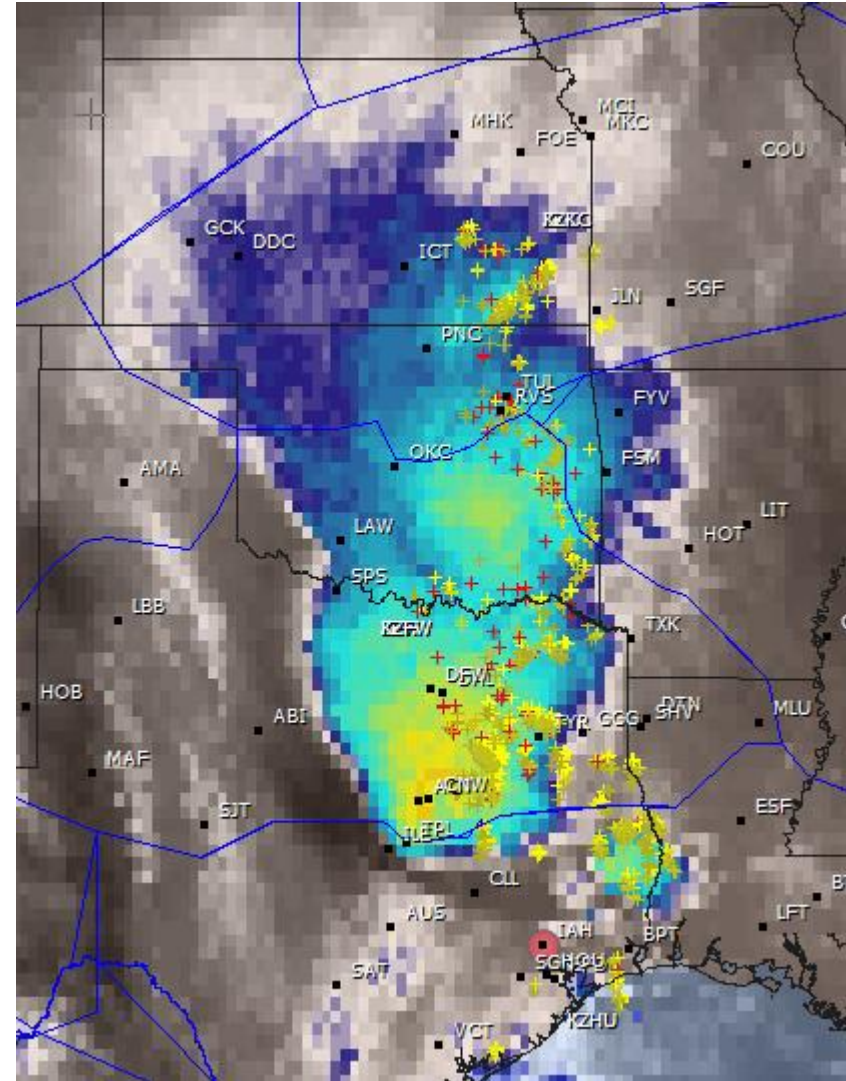
Introduction

Thunderstorms are one type of weather phenomena that can cause multiple issues for a dispatcher in the process of **planning** and **flight following**.

The FAA publication, **Thunderstorm Avoidance Tips** puts it succinctly: “To rely solely on Air Traffic Control (ATC) as a source for weather avoidance is not entirely prudent.

This lesson will discuss the:

- Convective Process
- Turbulence associated with thunderstorms
- Planning Considerations
- Flight Following Considerations
- Investigations



Convective Process

Convective Processes

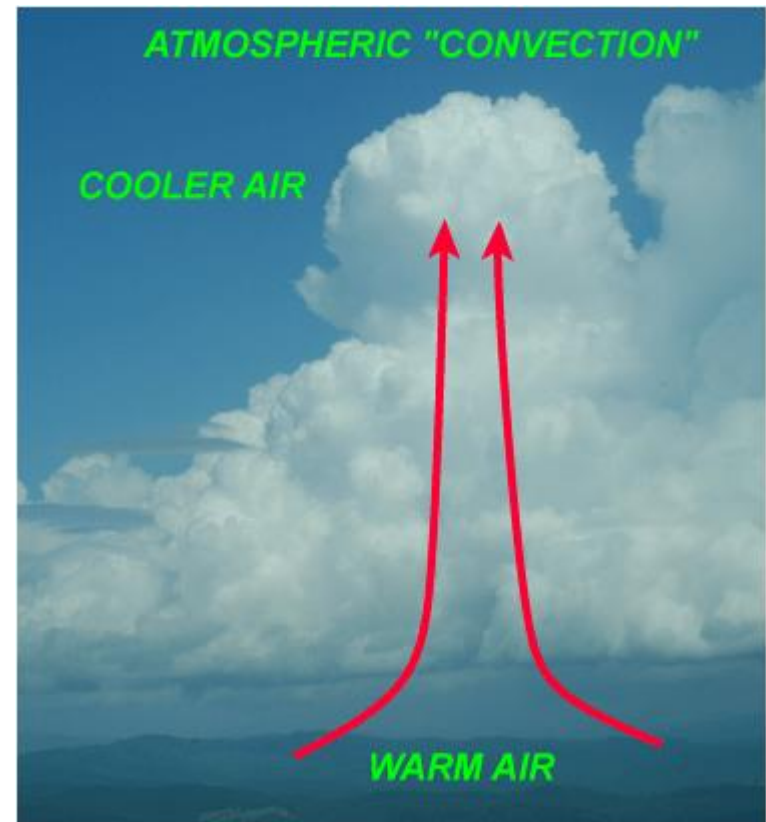
Basic Components

Thunderstorms are formed by a process called convection.

- Convection = Transport of heat energy

Three things are needed, in combination, for convection to be a significant hazard to flight safety:

1. Moisture
2. Lift
3. Instability



Convective Processes

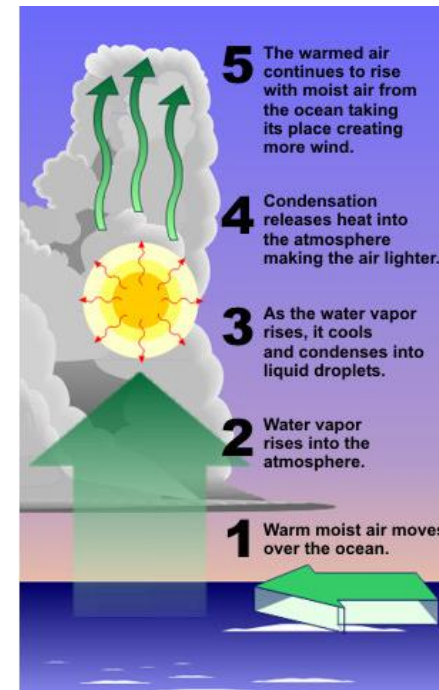
Moisture

For clouds to form the environment must contain:

- Water Vapor
- Condensation Nuclei
- Cooling process

How clouds form:

1. Warm air rises and begins to expand
2. The atmosphere becomes saturated and the water vapor condenses
3. Condensation attaches to condensation nuclei to form tiny droplets.



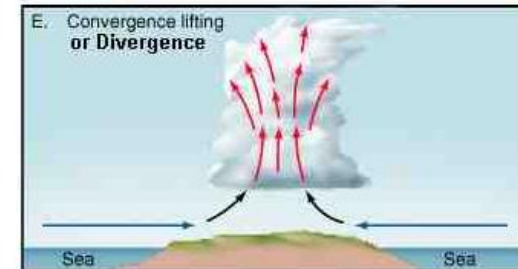
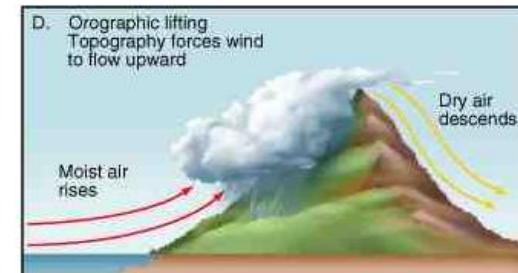
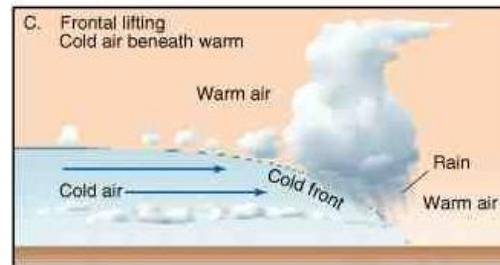
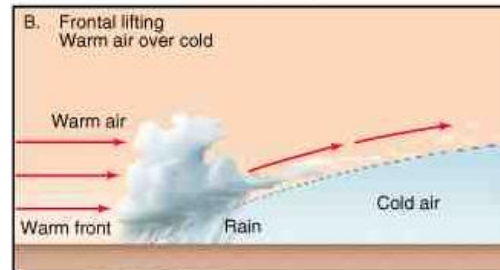
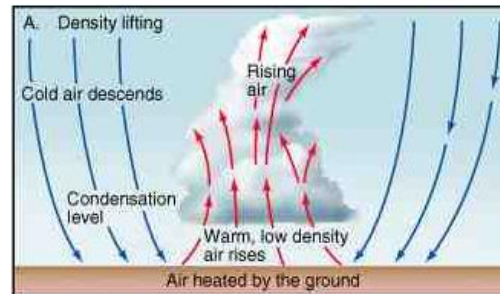
Convective Processes

Lift

Convective processes require a form of lift to maintain the cooling process

Lift in the atmosphere can be accomplished in the following manners:

1. Unequal heating across surfaces
2. Frontal systems
3. Orographic methods
4. Convergence processes
5. Atmospheric turbulence



Convective Processes

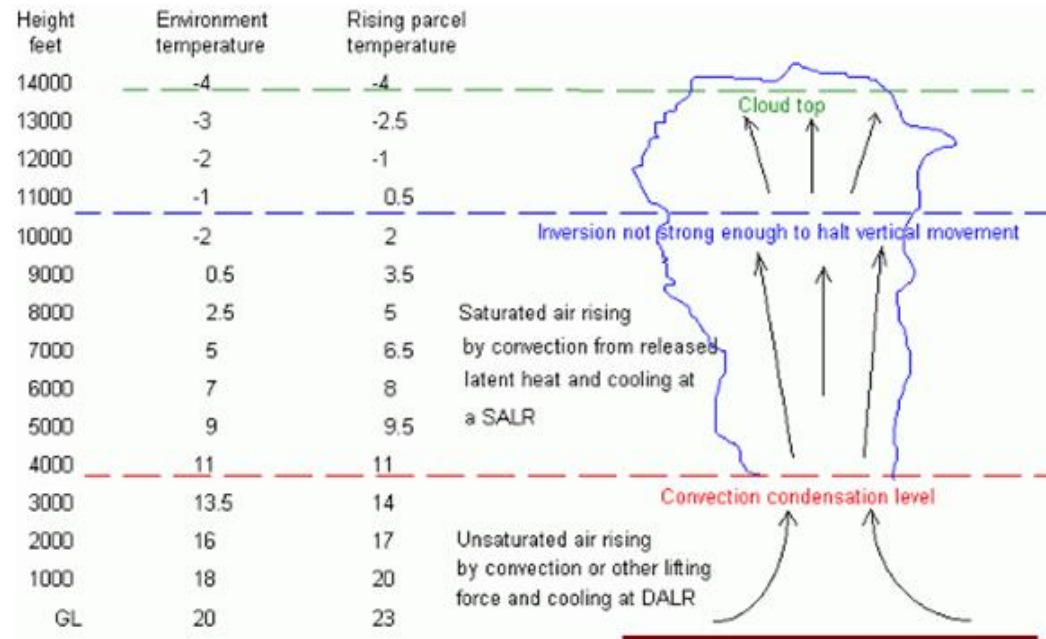
Instability

Adiabatic process – temperature change caused by expansion and contraction of air parcel w/o exchange of heat with surrounding air

Atmospheric instability is measured by the lapse rate of the environment

Different kinds of instability can be measured:

- Environmental (~ 2 C/1000 ft)
- Dry air parcel (3 C/1000 ft)
- Saturated parcel (<3 C/1000 ft)



Convective Processes

Thunderstorm Lifecycle

All thunderstorms require the main ingredients previously discussed for formation.

All thunderstorms progress through a life cycle which can be divided into three main categories:

- Developing
- Mature
- Dissipating



Convective Processes

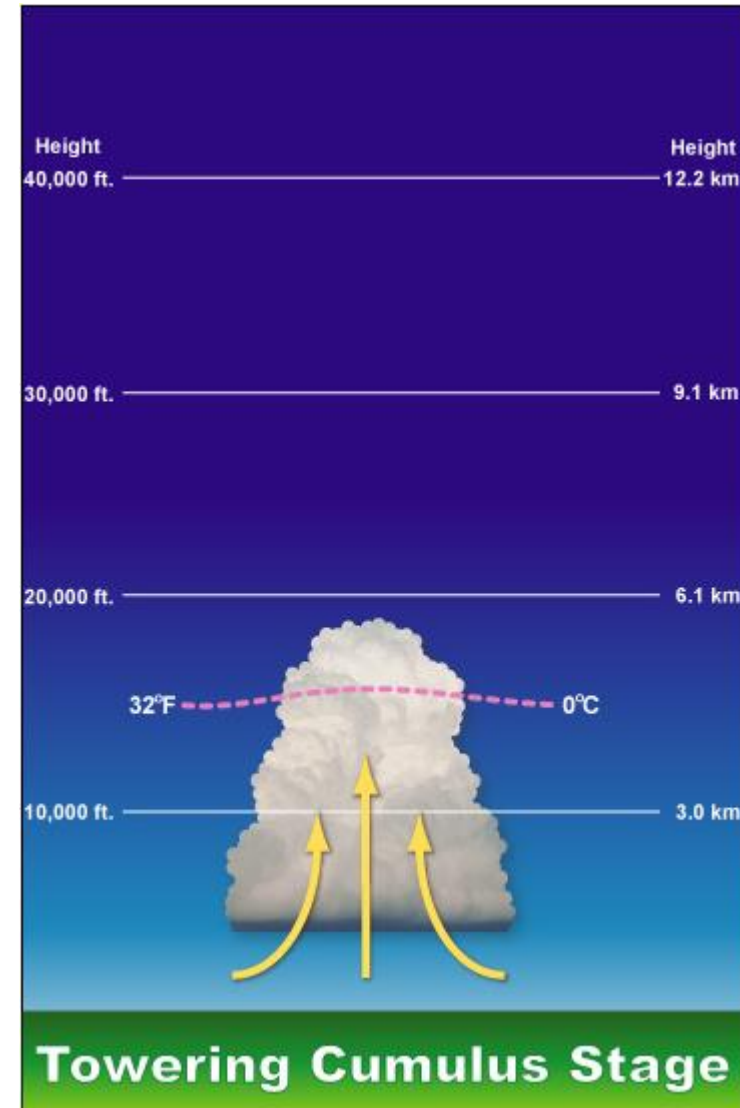
Developing Stage

Process begins with warm plume of moist, rising air which begins condensing into a cumulus cloud

Condensational heating releases heat into the cloud and causes the air to remain warmer than the surrounding environment.

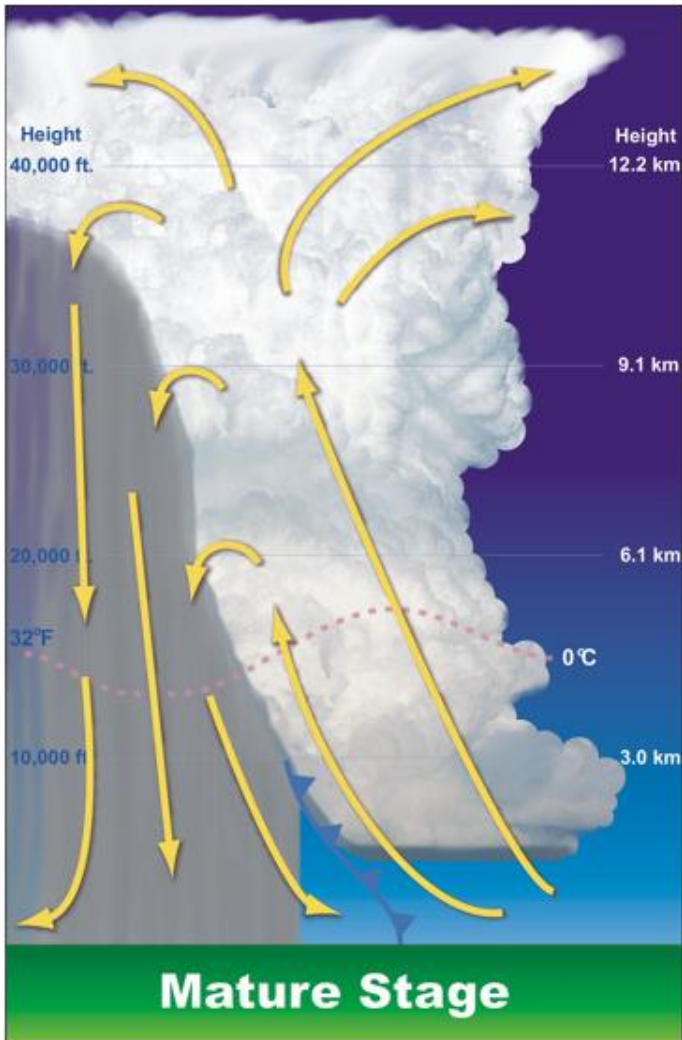
Clouds begin to show considerable vertical development and water droplets are carried above the freezing level.

Note: Characterized by only updrafts in the cloud.



Convective Processes

Mature Stage



The top of the cloud approaches the tropopause and can form an anvil top.

Characterized by both updrafts and downdrafts within the clouds.

Dry air is brought into the cloud during this stage leading to the evaporation of falling particles.

Evaporative cooling leads to negative buoyancy creating stronger downdrafts.

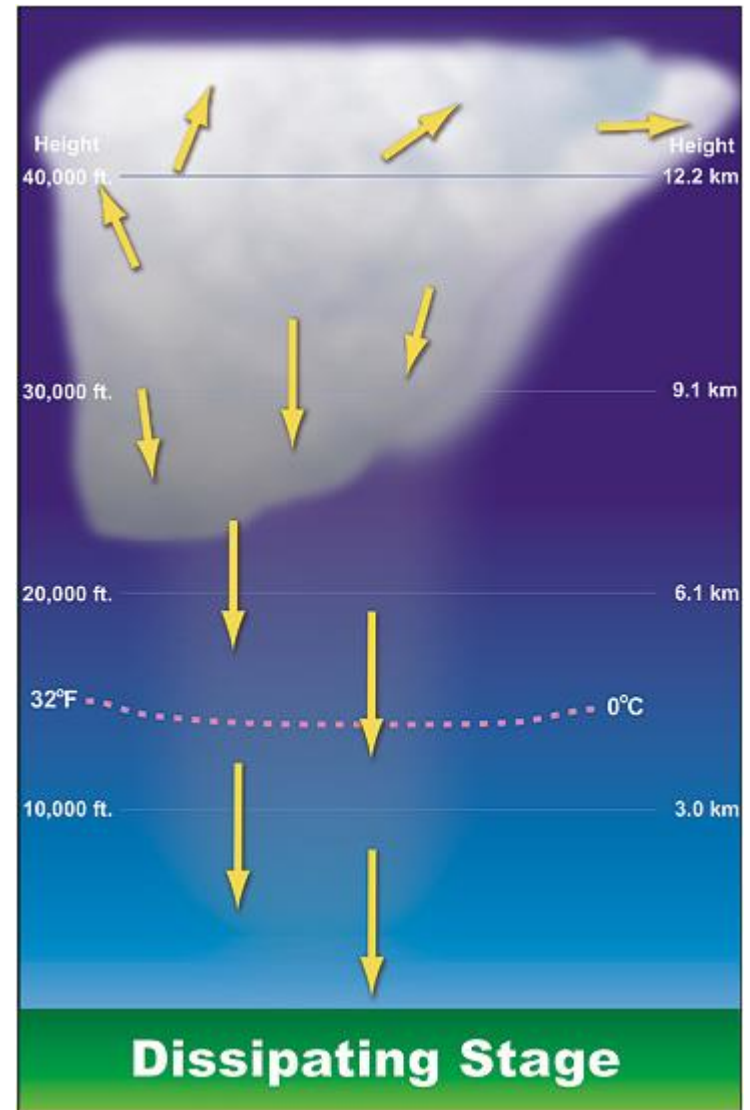
Convective Processes

Dissipating Stage

Characterized by downdrafts taking over the entire cloud which cuts off the supply of warm rising air

Precipitation decrease and the cloud evaporates

Downdrafts often lead to the development of more storms in multicellular structures

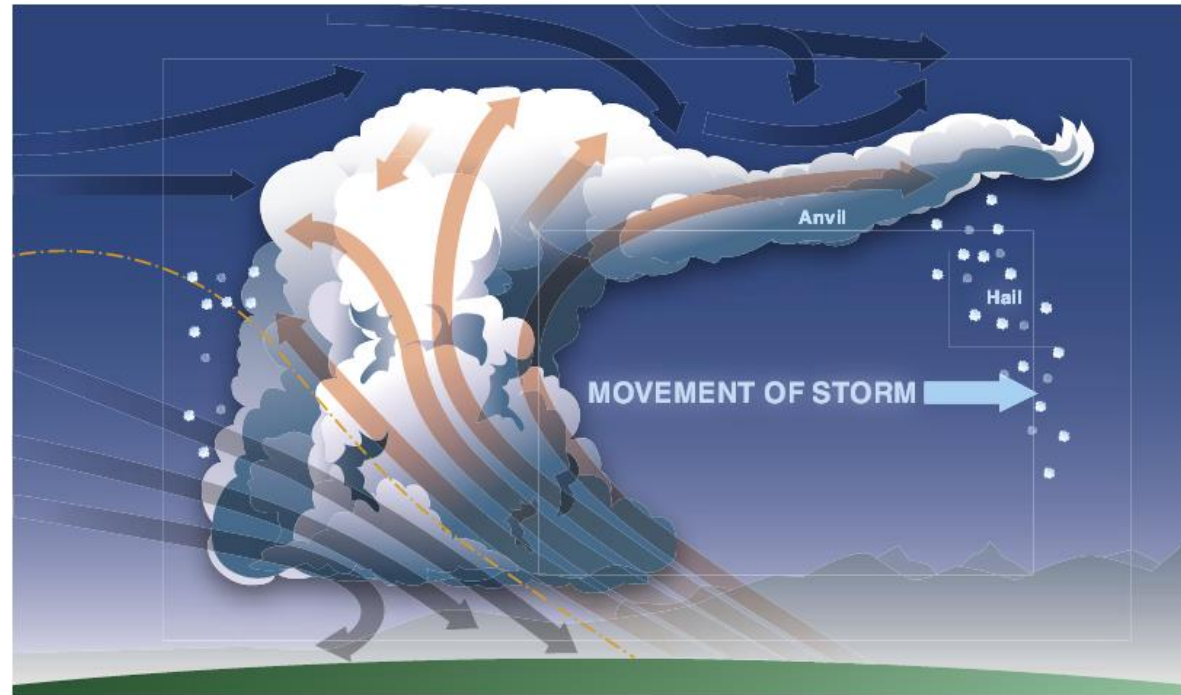


Convective Processes

Thunderstorm Hazards

Thunderstorms contain many hazards to aviation such as the following:

- Surface windshear
 - Microbursts
 - Lightning
 - Hail
 - Significant Icing
 - Tornadoes
 - Turbulence
-
- Pinpointing the timing and location of events is difficult given the short life cycle and motion of thunderstorms



Convectively Inducted Turbulence

Convectively Induced Turbulence

What is it?

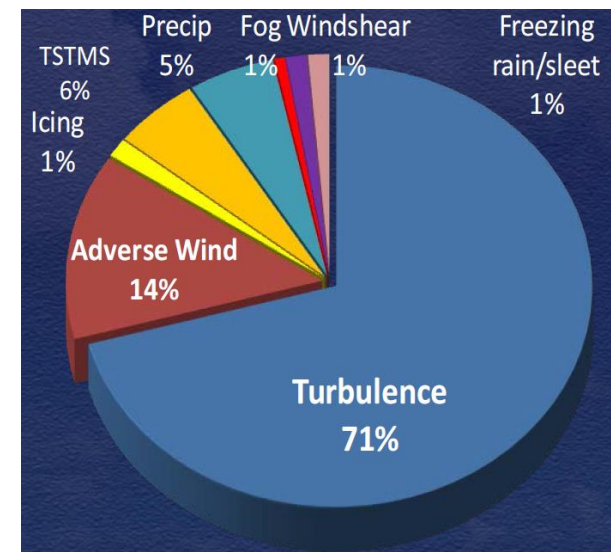
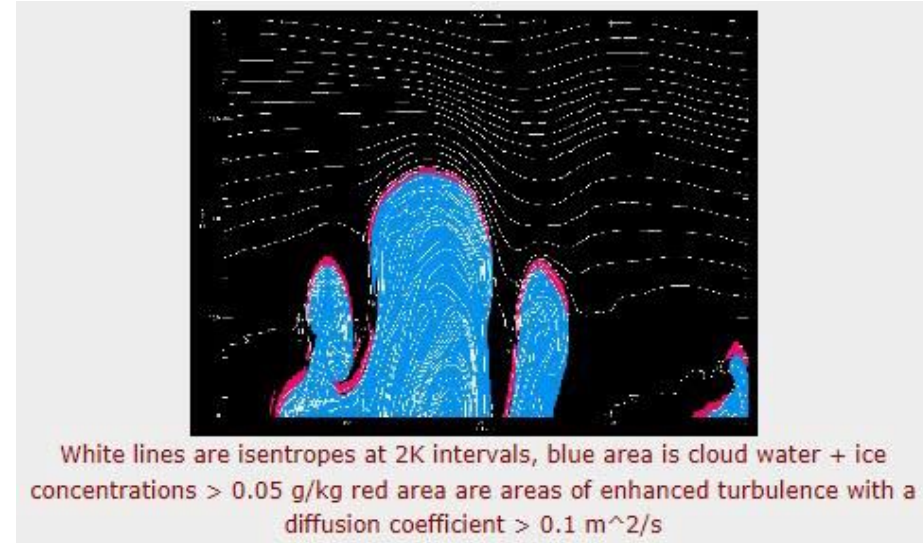
Turbulence occurs when due to:

- A disturbance interrupts the normal atmospheric flow generating wind shear and
- Atmospheric waves steepen and break similar to waves on a large body of water.

Breaking waves result in turbulence across multiple scales of atmospheric motion. There are two forms of wave generation:

- Clear Air Turbulence (CAT)
- Convectively Induced Turbulence (CIT)

Convectively Induced Turbulence is the form of turbulence found in or near thunderstorm activity.



Convectively Induced Turbulence

The vast majority of Part 121 turbulence events are associated with Convectively Induced Turbulence (CIT)

Convectively Induced Turbulence

- Due to being well removed from radar reflectivity
- Occurs often in cloud free environments
- Due to being a more isolated, short-lived mesoscale phenomena
- Difficult to forecast as no computer models or forecast products can predict location and timing

Still occasionally reported as CAT encounters

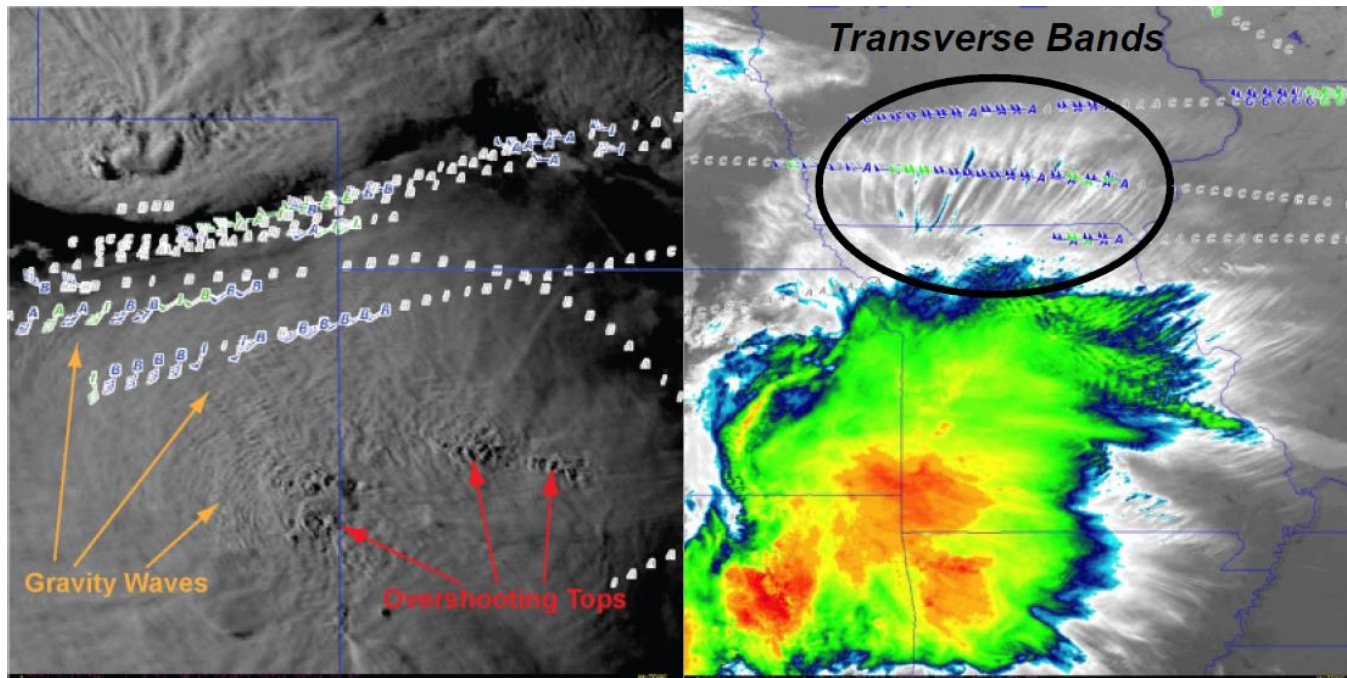
Convectively Induced Turbulence

Common characteristics

DOM 7.30.4

Dispatchers are expected to be aware of and monitor the following indicators of CIT using the latest satellite imagery:

- Rapid vertical development of convective cells
- Rapid anvil expansion
- Transverse banding or striations in cirrus anvil outflow on northern periphery of an MCS
- Overshooting tops and enhanced-V (“warm-wake”) signatures
- Convective gravity waves



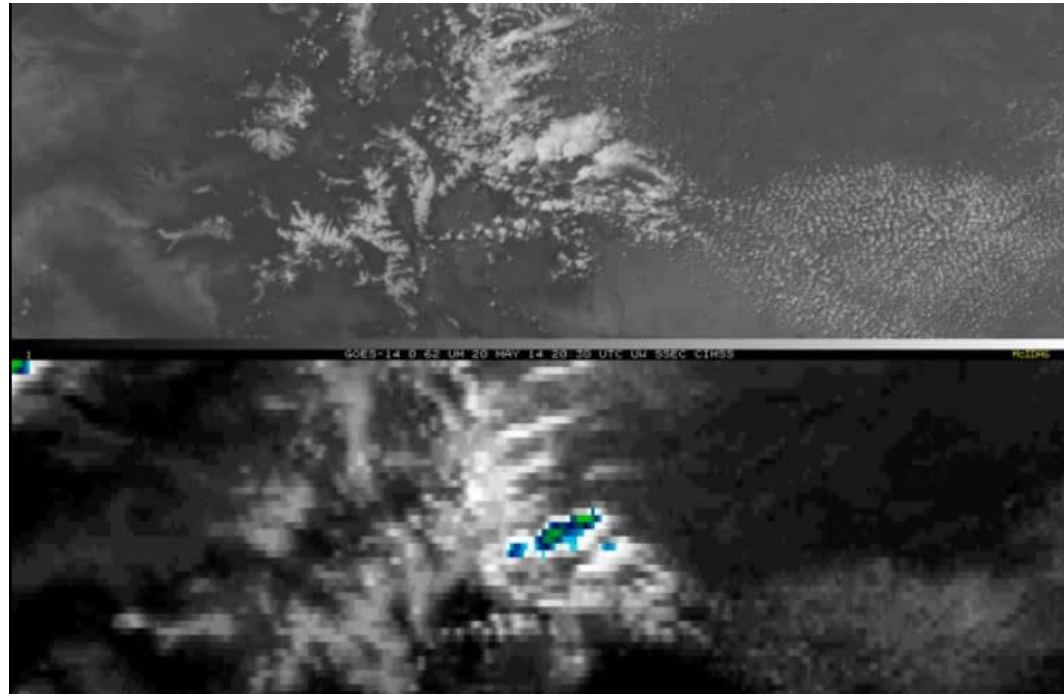
Convectively Induced Turbulence

How to identify using satellite

Identification and monitoring of potential turbulence signature is best accomplished via satellite.

Animating infrared satellite imagery on Flight Explorer or use of alternative satellite websites to near time will best identify the classic signatures.

Developing convective system can be inferred by monitoring cloud top temperatures using infrared imagery.



Convectively Induced Turbulence

Rapid Vertical Expansion

Convective updrafts in the developing stage can be hidden hazards to aircraft

Initial convective storm growth signals in satellite imagery can precede significant radar echoes by more than 1 hour.

Thunderstorms can develop at rates exceeding 6000 feet per minute.

The critical concept: Radar doesn't detect turbulence, it displays the precipitation that sometimes (but not always) coincides with areas of strong turbulence.



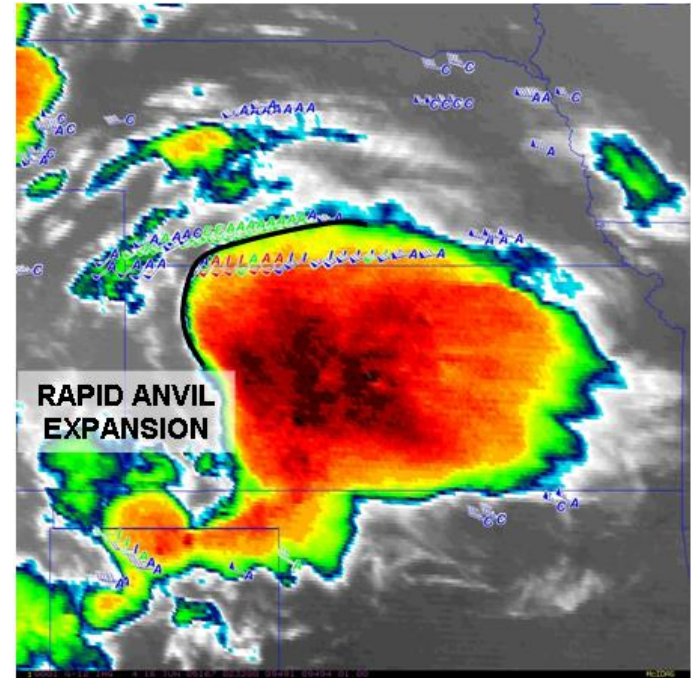
Convectively Induced Turbulence

Rapid Anvil Expansion

Anvil clouds form when rising air in the thunderstorm bumps up against the bottom of the stratosphere.

Warmer air due to the inversion in the stratosphere prevents the warm air from rising further so begins to spread laterally.

Convectively induced turbulence may be encountered 20 or more miles from the anvil cloud edge.



Convectively Induced Turbulence

Transverse Banding

Transverse bands:

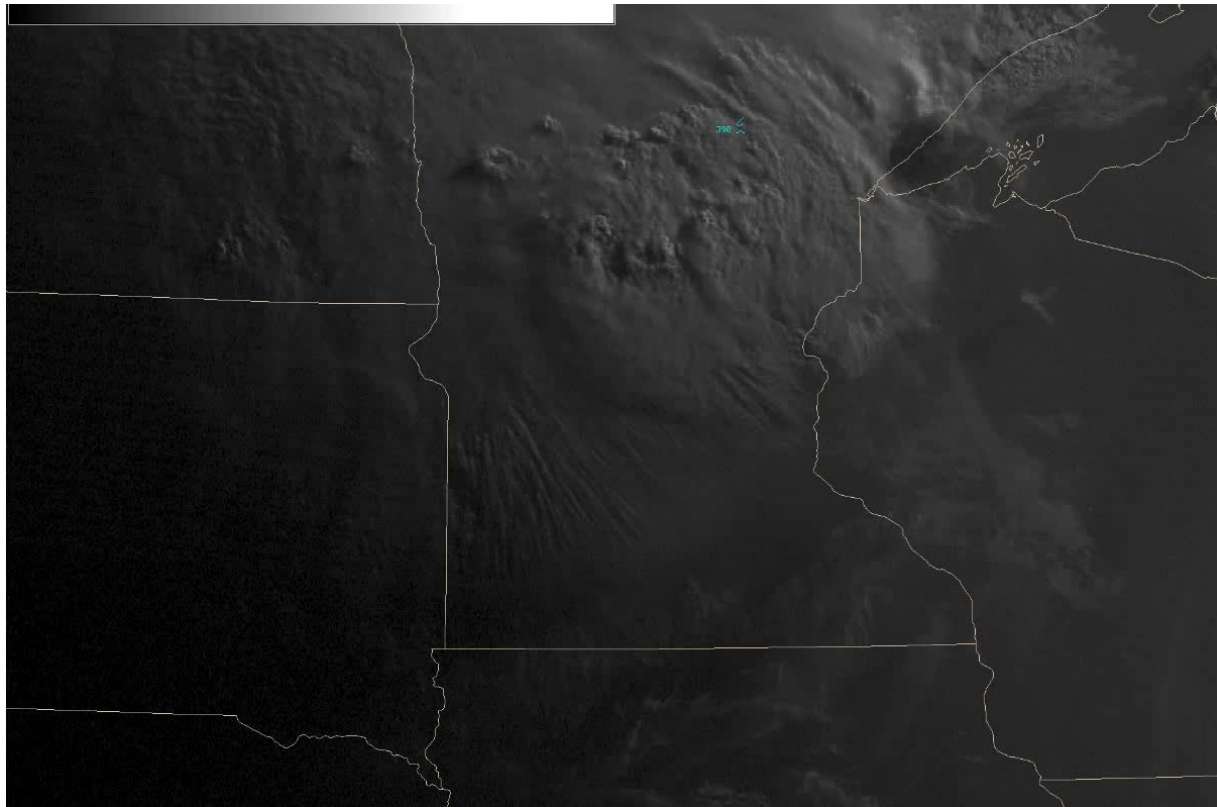
Lines of clouds that form across a jet stream, perpendicular to (transverse or across) the jet flow.

Can be displayed in satellite imagery on:

- Infrared (best seen)
- Water Vapor
- Visible

Commonly observed in the outflow area of thunderstorms along the edge of an anvil

- Predominately on the northern side of the convective system.



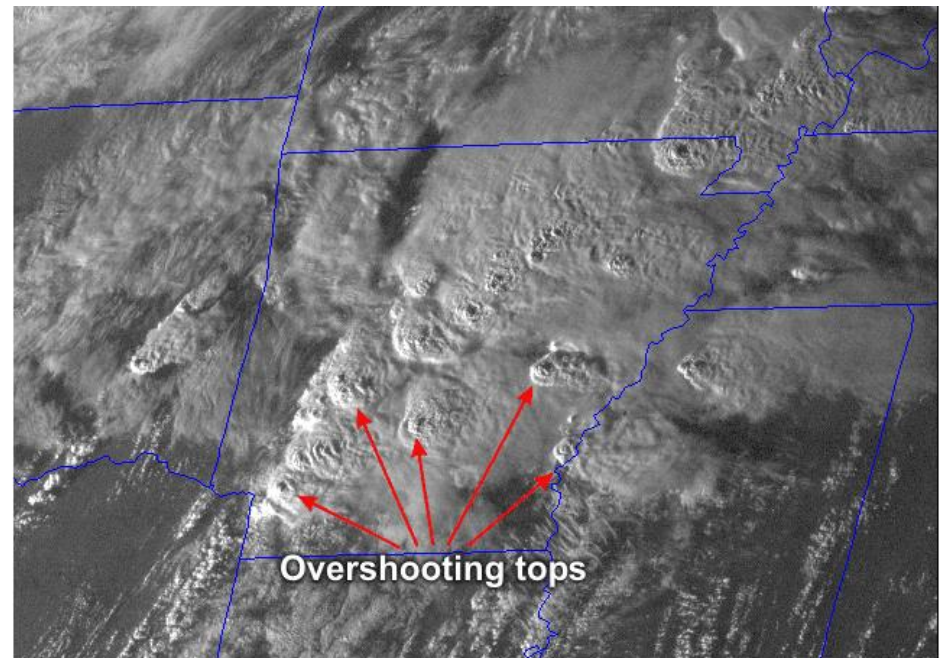
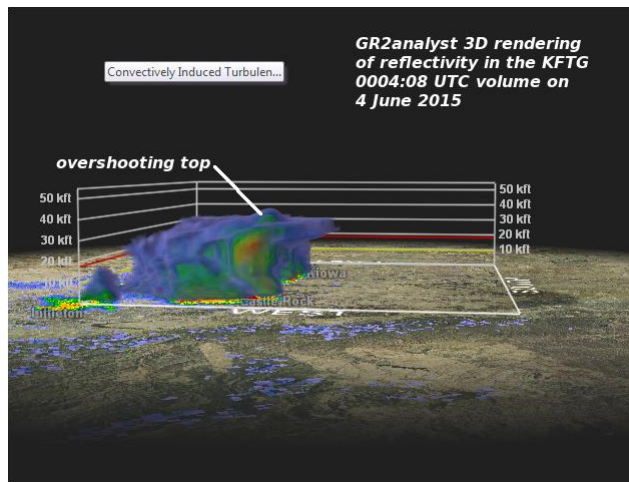
Convectively Induced Turbulence

Overshooting Tops

Overshooting tops are rapidly rising parcels of air that can push through the equilibrium level of the troposphere.

A storm powerful enough to produce an overshooting top will have the following:

- Heavy rain
- Strong winds churning inside them
- Large Hail
- Lightning



Convectively Induced Turbulence

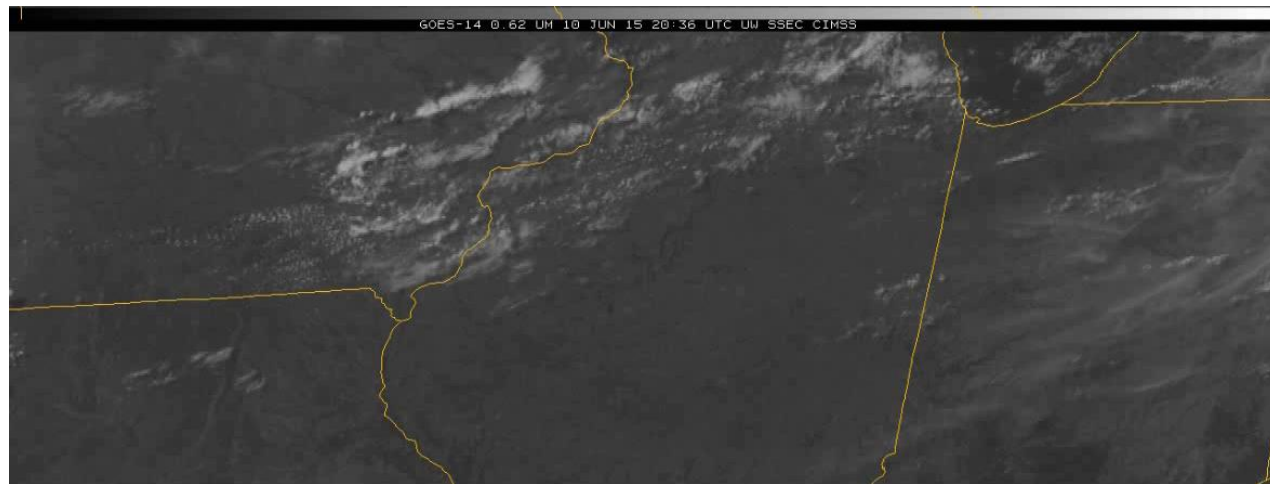
Gravity waves

Convective systems move vast amounts of air vertically disturbing the stability of all surrounding air.

Upon reaching the tropopause, the rising air can no longer climb so then starts moving laterally away from the updraft.

These waves of air break when they interact with:

- Tropopause
- Other waves
- Jetstream
- Obstructions

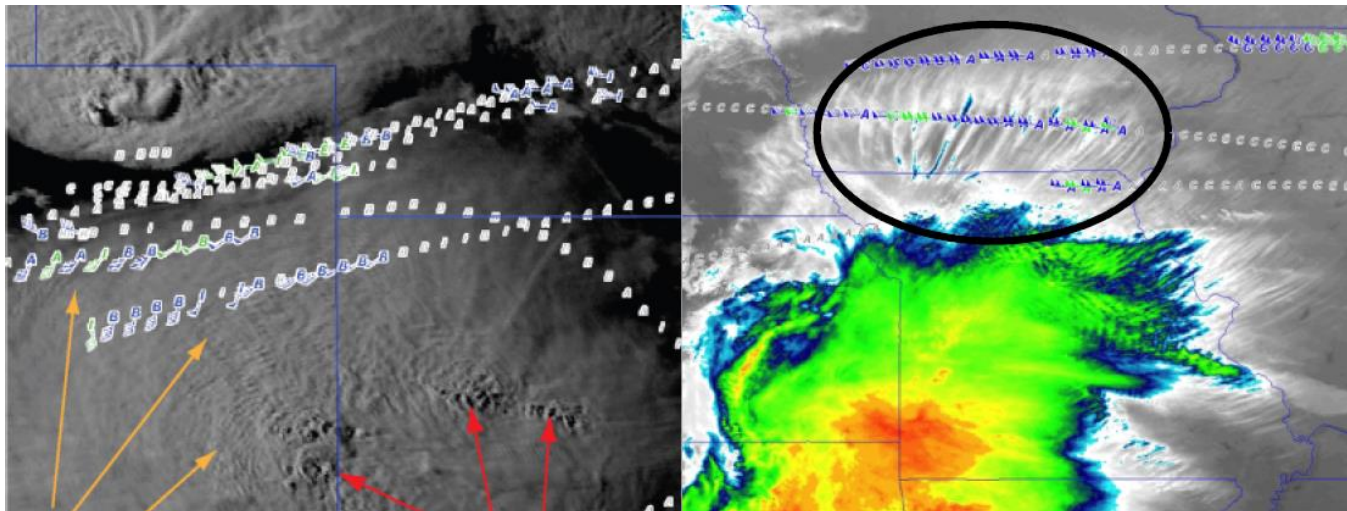


Convectively Induced Turbulence

Satellite Signatures

Dispatchers are expected to be aware of and monitor the following indicators of CIT using the latest satellite imagery:

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- Rapid anvil expansion
- Transverse banding or striations in cirrus anvil outflow on northern periphery of an MCS
- Overshooting tops and enhanced-V (“warm-wake”) signatures
- Convective gravity waves



Planning Considerations

Planning Considerations

Planning Considerations

- Convectively-Induced Turbulence (CIT) threat assessment

- 1. *Is there a threat of organized convective activity along my route?***
- 2. *Will my flight intersect an MCS cloud shield?***
- 3. *What other turbulence indicators are present in satellite imagery that point to a higher threat of CIT?***

This risk assessment should be done during the planning phase and periodically while in the flight monitoring phase.



Planning Considerations

Planning Considerations

Dispatchers shall use the processes described below to address turbulence hazards:

- Review upper-air depictions, enroute hazard forecasts (e.g. WSI SIGMETs and FPGs), PIREPS, and other relevant information to ascertain areas of potential turbulence when planning flights.
- Continuously monitor conditions along the routes of flights enroute for indications of turbulence. This includes but is not limited to:
 - Evaluating satellite imagery for indicators of possible turbulence such as sharply-curved jet stream axes, sharply-defined darkening bands on water vapor imagery loops, and transverse banding.
 - Soliciting and processing PIREPs from company flights and monitoring reports from other carriers.
 - Continuously monitoring and advising the Pilot of newly issued turbulence advisories and forecasts.

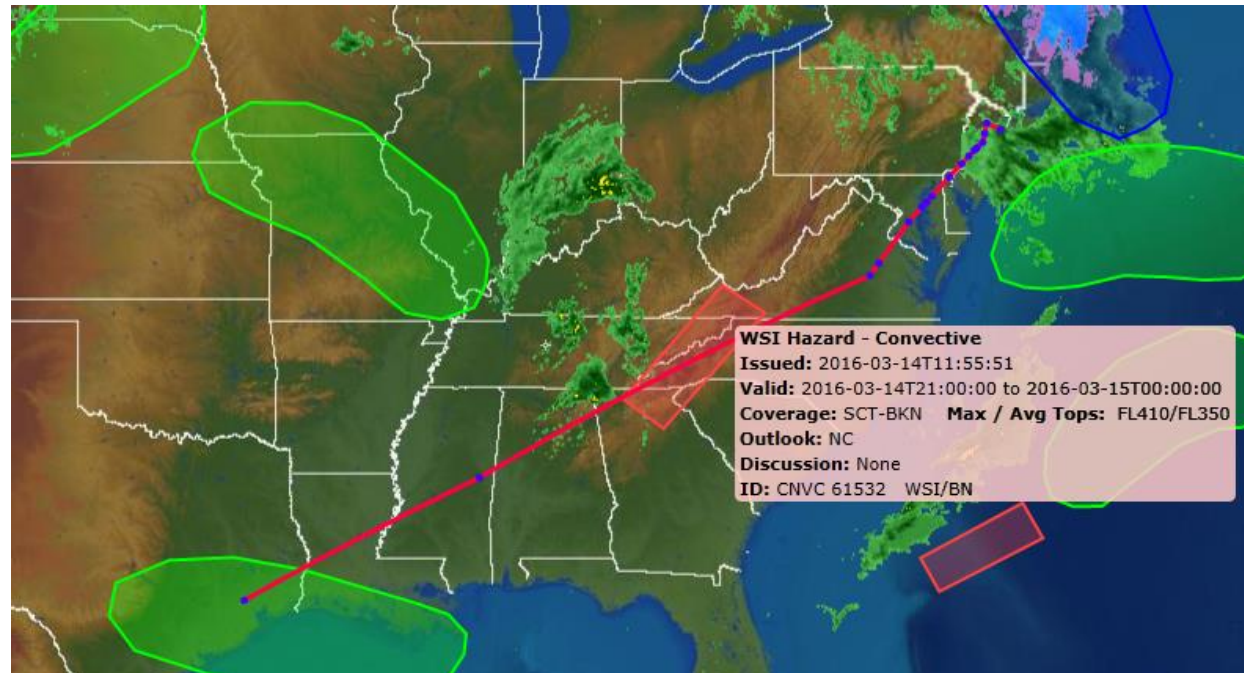
Planning Considerations

WSI FPG/SIGMETs

Primary weather product in making all weather-related flight decisions

Flight Plan Guidance (FPG) forecast areas will be produced in 3 hour time steps out to 12 hours.

WSI SIGMETs are real time advisories when the enroute hazard exceeds specific thresholds for intensity and/or aerial coverage



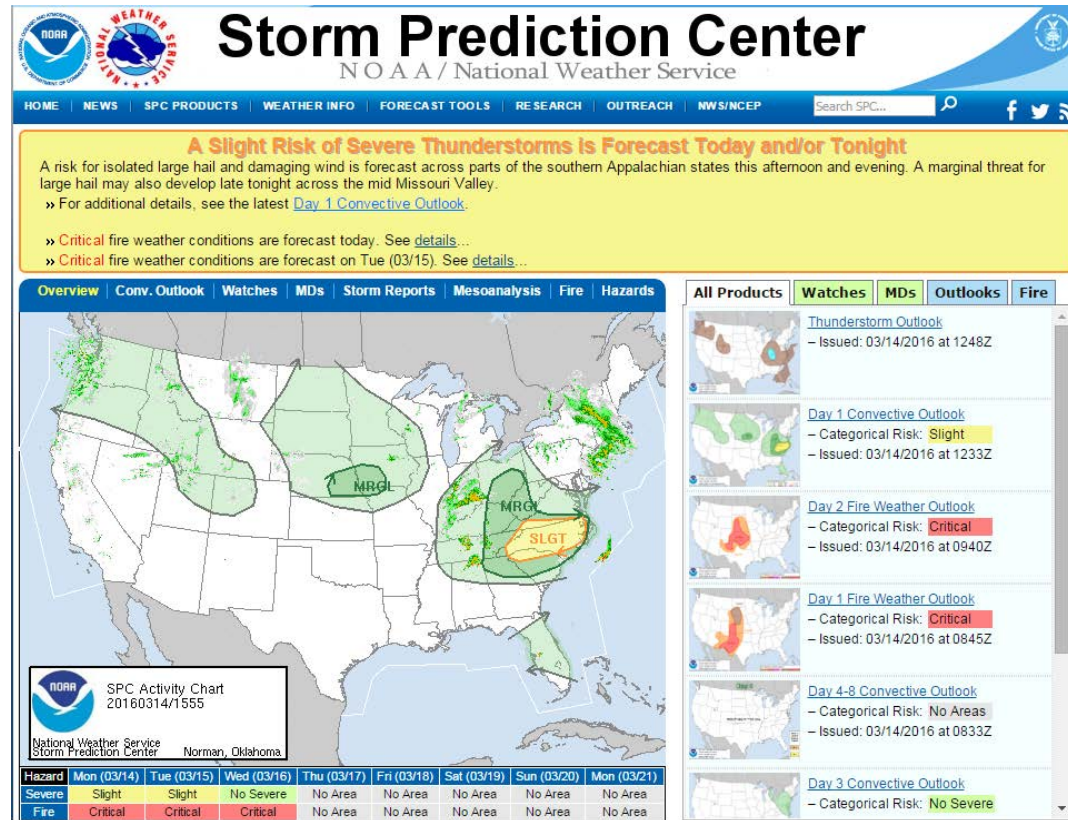
Planning Considerations

Storm Prediction Center

Storm Prediction Center
(<http://www.spc.noaa.gov/>) provides the following resources for identifying most likely locations for convective activity

- Day 1 Convective Outlook
- Thunderstorm Outlook
- Current Weather Watches
- Current Mesoscale Discussions

A detailed explanation will be provided with each product that explains what processes and confidence the forecaster notices



Planning Considerations

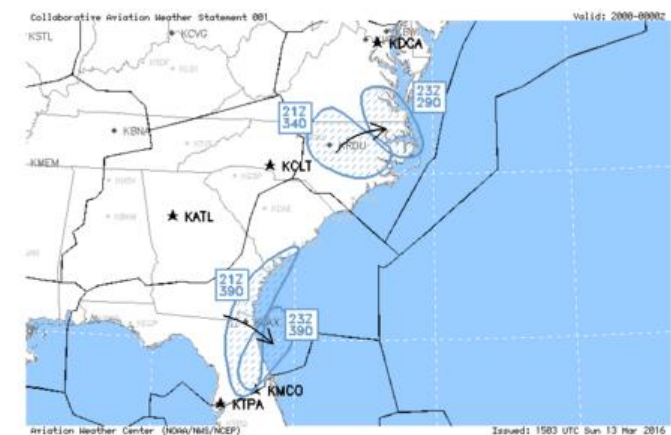
CCFP/CAWS

Collaborative Decision Making Convective Forecast Planning (CCFP) (<https://www.aviationweather.gov/ccfp>) guidance:

- Provides graphical representation of convection meeting specific criteria
- Produced every two hours for 2, 4, 6, and 8 hours after issuance
- Available 24 hours/365 days
- Completely automated with no human feedback

Collaborative Aviation Weather Statement (CAWS) (<https://www.aviationweather.gov/caws>)

- Replaced CCFP as tool used to update ATC decision makers on adverse weather
- Issued only when large traffic demand is impacted
- Human generated, revised, or corrected
- Currently only issued for convection



Weather: Thunderstorms
Valid: 2000-0000Z

ARTCCs affected: ZDC, ZJX
Terminals affected: KMC0

CCFP: 15Z - Coverage/confidence too low

SUMMARY: TS Impacts Expected over Southern VA/Eastern NC and across South Carolina through Northeastern Florida Coastal Plains

DISCUSSION: Adding finer detail to CCFP for TS Impacts from the Southern DELMARVA area through Northeastern FL.

Do not anticipate additional CAWS for this region.

BOUNDING BOX: 39.24,-77.78 35.04,-82.69 29.64,-83.72 27.06,-81.48
29.45,-76.79 37.76,-71.61 39.24,-77.78



Planning Considerations

CoSPA (Consolidated Storm Prediction for Aviation) & CIWS (Corridor Integrated Weather System)

Industry accepted radar display for the
FAA and airlines.

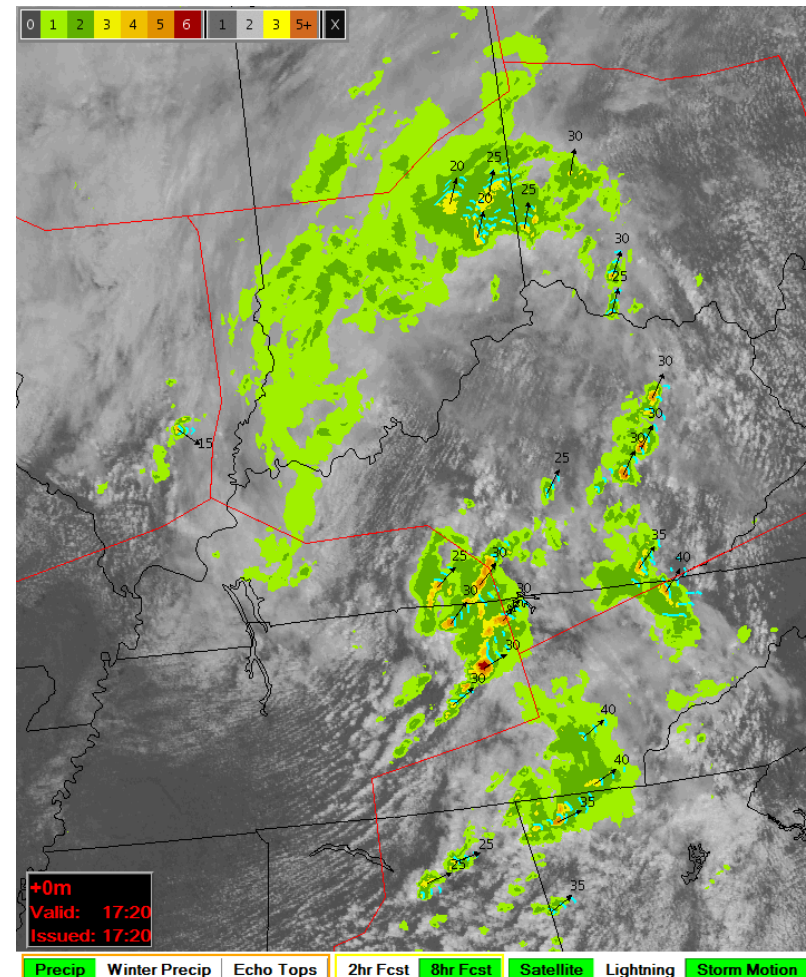
Used by ATC decision makers for
updates on adverse weather

Provide extrapolation forecasts of future
positions for tactical planning:

- CIWS – 2 hours
- CoSPA – 8 hours

Account:	united
Password:	muyRD3j@B

Note: Use Firefox to access CIWS and CoSPA to ensure accurate display of
radar information



Planning Considerations

GFS LAMP Convection Probability

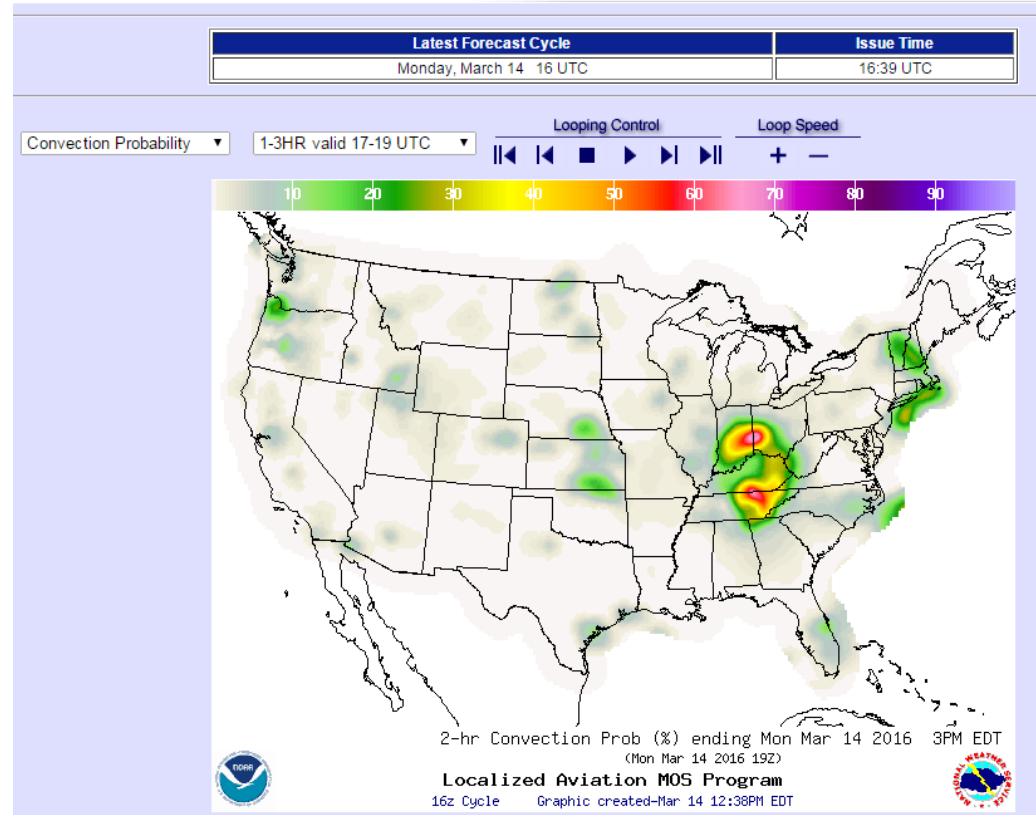
LAMP (Localized Aviation MOS Program)

(http://www.nws.noaa.gov/mdl/gfslamp/cn_vltg.php)

is a statistical system which provides:

- Forecast guidance for convection and lightning
- Provides thunderstorm guidance based on 20 km grids out to 25 hours
- Can be animated for probability over 3 hour blocks
- Updated at the top of every hour

LAMP Convection and Lightning Comparison Images



Flight Following Considerations

Flight Following Considerations

Tactical Situational Awareness

Tactical situational awareness is key

- Strategic planning may indicate potential development which does not develop until after the planning phase of the flight
- Strategic planning tools are not capable of predicting the minute characteristics of CIT
- Communication and flight monitoring are the only consistent ways to mitigate this threat.

Planning Considerations

Flight Following Considerations

- Convectively-Induced Turbulence (CIT) threat assessment

- 1. *Is there a threat of organized convective activity along my route?***
- 2. *Will my flight intersect an MCS cloud shield?***
- 3. *What other turbulence indicators are present in satellite imagery that point to a higher threat of CIT?***

This risk assessment should be done during the planning phase and periodically while in the flight monitoring phase.



Flight Following Considerations

Route deviation

- Dispatchers should be mindful of the following items when evaluating potential route deviations due to convective weather:
 - Flight deviations are typically based on radar reflectivity (i.e. rainfall) gradients and FOM avoidance criteria, and in no way ensure the avoidance of lightning, hail, or turbulence in areas where deviations are occurring.
 - The most effective way to evaluate deviations is to monitor terminal traffic via one of the company approved flight monitoring tools. Soliciting Pilot input via ACARS is also effective.



Flight Following Considerations

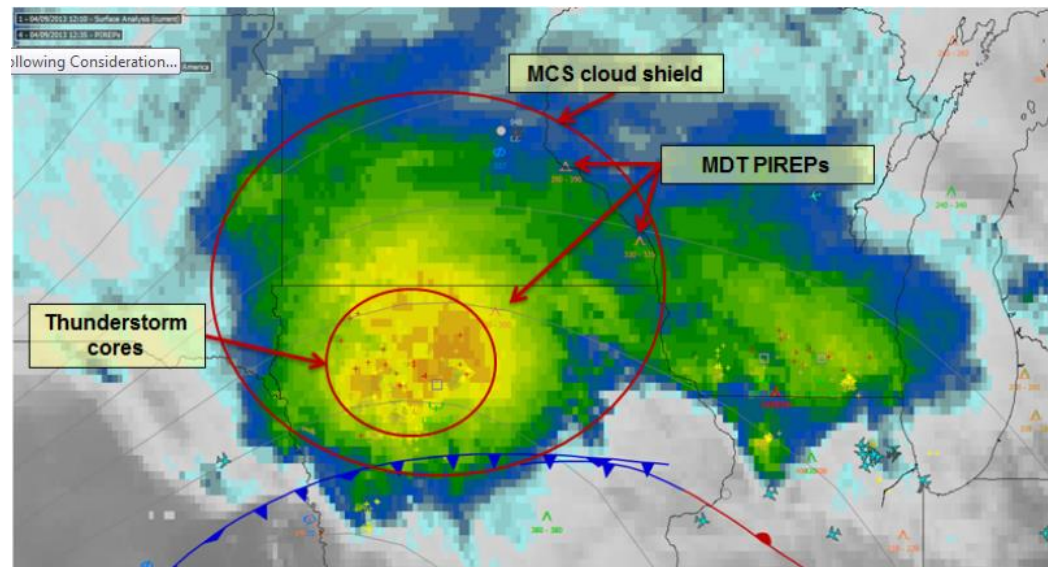
Mesoscale Convective System (MCS)

Closely-packed thunderstorms organized into lines or clusters that persist for several hours or more.

Typically develop in late afternoon as the result of interactions and mergers of smaller groups of thunderstorms.

Reach their maximum development overnight and weaken toward the early morning hours.

Characteristics of systems that develop convectively induced turbulence.

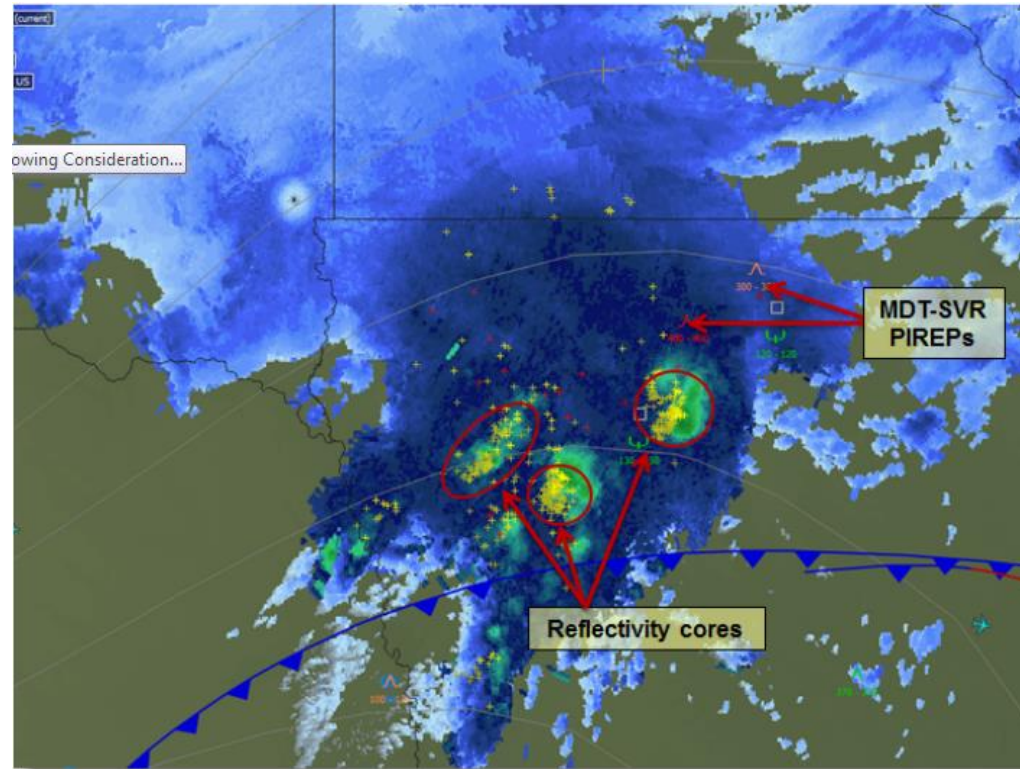


Planning Considerations

Echo Tops

Echo tops are the radar estimated indicated top of an area of precipitation where the value of backscattered reflective energy (dBZ) exceeds a specified threshold..

- Can be used to assess the intensity of a storm.
- Enhances the situational awareness by clearly displaying an anvil cloud shield.
- Rule of thumb is that the higher the echo tops, the stronger the updrafts of that system.



Flight Following Considerations

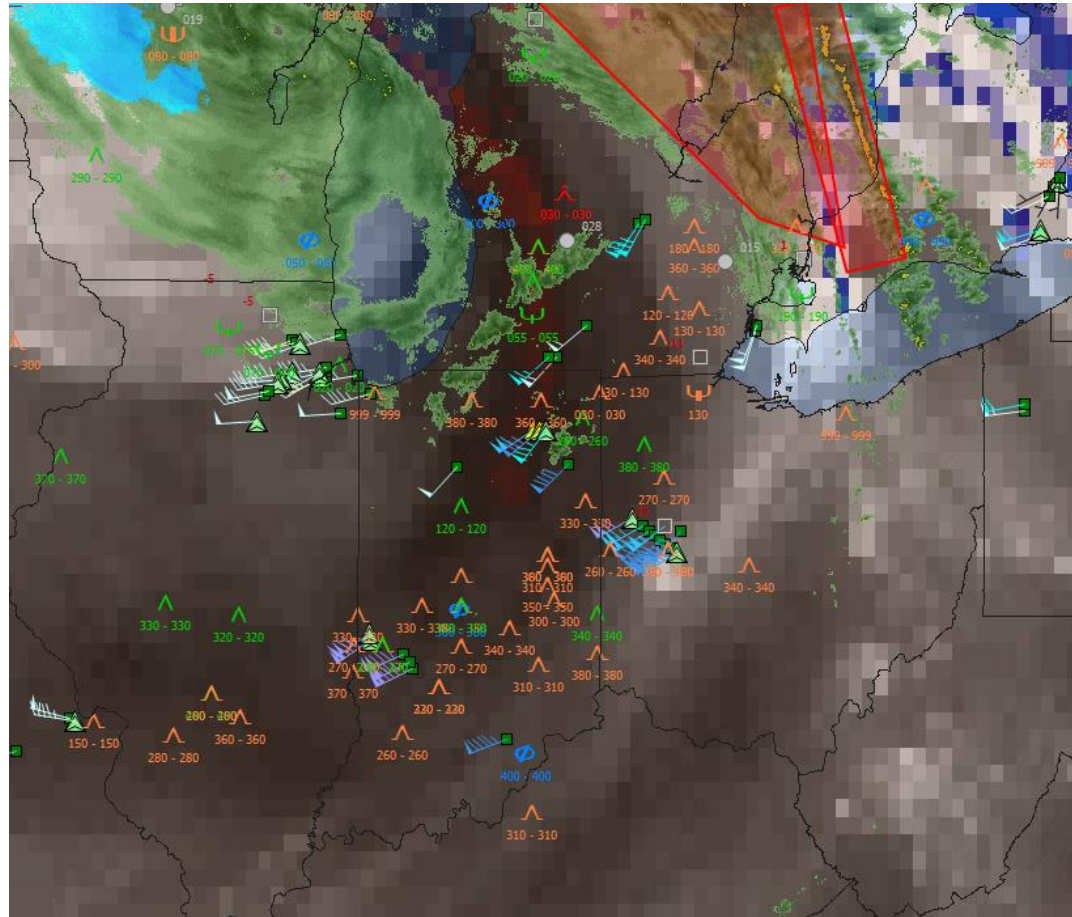
PIREP importance

Monitoring PIREPs is an effective way to confirm the existence of where hazardous weather conditions are occurring.

Used by the National Weather Service and WSI to verify or amend conditions in their forecasting tools

Alerts other users of the national airspace to potential/lack of hazardous conditions

Dispatchers are responsible for actively soliciting PIREPs to validate forecast conditions and promptly advising others through use of the Unimatic PIREP SAMI page.



Flight Following Consideration

How to Read PIREP

PIREPs are classified as UA (upper air) or UUA (urgent upper-air).

- UUA PIREPs may trigger meteorologists at the AWC to convert an existing airmet into a sigmet based on a single pirep.

A standard format is used by the FAA, NWS, and other organizations for entering PIREPs

Items 1 through 6 are required for all PIREPs.

In addition, one of more items from items 7 through 13 must be reported

	Field	Field	Field	Field	Field
①	3 Letter station identifier	XXX	Nearest weather reporting location to the reported phenomenon		
②	Report Type	UA,UUA	n/a	UA UUA	Upper-Air Urgent Upper-Air
③	Location	OV	Nautical miles and degrees magnetic north from a station	/OV DEN 20 N /OV DEN 360020	20 nm north of Denver International Airport (Same)
④	Time	TM	UTC	/TM 1315	1315 UTC
⑤	Altitude/ Flight Level	FL	100s of feet, MSL (This is a "pressure altitude" value based on the ground altimeter setting and the altimeter equation)	/FL070 /FL10-12 /FLUNKN /FLDURC /FLDURD	7,000 ft MSL 10,000 to 12,000 ft MSL Flight level unknown During climb During descent
⑥	Aircraft Type	TP	Coded	/TP BE02 /TP B727	Beechcraft 1900 Boeing 727
⑦	Sky Conditions	SK	Usually, overcast cloud deck altitude	/SK 080 OVC /SK 085 BKN 220	8,000 ft MSL overcast Cloud base 8500 ft broken, tops at 22,000 ft
⑧	Weather	WX	Restrictions to visibility, precipitation	/WX FV02SM ZL-FG SFC-050	Flight visibility 2 miles in freezing drizzle and fog from the surface up to 5,000 ft
⑨	Outside Air Temp.	TA	°C	/TA -20 /TA 01 e 040	-20°C 1°C @ 4,000 ft
⑩	Wind Speed and Direction	WV	Radial direction and knots	/WV 270022eFL050	22 kt from the west at 5,000 ft
⑪	Turbulence Severity	TB	Light, Moderate, Severe, Extreme	/TB LGT /TB MDT /TB SVR /TB EXTRM	Light Moderate Severe Extreme CAT or CHOP should be used when appropriate
⑫	Icing Severity	IC	Trace, Light, Moderate, Severe	/IC TRC /IC LGT /IC MDT /IC SVR	Trace Light Moderate Severe Type of ice should be reported: CLR (clear), RIME (rime), or MXD (mixed)
⑬	Remarks	RM	Free form with abbreviations	/RM DURGC /RM HYR Lyr ABV /RM IMC 030-090 /RM ¼" IN 10 MIN /RM LOST ICE 035	During climb Higher cloud layer above Instrument meteorological conditions (i.e., clouds or precip.) between 3,000 and 6,000 ft Accumulated ¼ inch of ice in 10 minutes Exited icing conditions at 3,500 ft

Flight Following Considerations

Unimatic Pirep entry (DOM Appendix i.7.3-4)

UA Enter the flight number, date, and departure airport (e.g. 122-061 AX)

IC Enter reported icing condition:

Attachmate Accessory Manager - [Unimatic3]

File Edit View Tools Session Options Window Help

```
SIRD/DD041/PIREP
XXXZZ 30DEC08 CHIAT 042465 *00357
>SEND
CHITB
```

```
1 UAL *USE "FLT-DT STA" FOR
2 OVER *THE UAL ENTRY. EXAMPLE:
$ LAX
```

Attachmate Accessory Manager - [Unimatic3]

File Edit View Tools Session Options Window Help

```
SIRD/DD041/PIREP
XXXZZ 30DEC08 CHIAT 042465 *00357
>SEND
CHITB
```

```
1 UAL *USE "FLT-DT STA" FOR
2 OVER *THE UAL ENTRY. EXAMPLE:
3 TIME * 122-06 LAX
4 FL *
5 TEMP *MUST TRANSMIT ON THE LINE
6 WIND *BELOW "ADV"
7 TURB *IF OVER IS FIX,RADIAL,DME
8 ICE *ENTER AS FIX (SPACE) RAD
9 RMK *THEN DME EX: MVA 090140
10 ADV *U FLT # - B 4 BELL
```

Pg=1 Row=14 Col= 6

POLL

```
2 OVER *THE UAL ENTRY. EXAMPLE:
3 TIME * 122-06 LAX
4 FL *
5 TEMP *MUST TRANSMIT ON THE LINE
6 WIND *BELOW "ADV"
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9 RMK *THEN DME EX: MVA 090140
10 ADV *U FLT # - B 4 BELL
```

Pg=1 Row=14 Col= 6

POLL

as perceptible.

cumulation may become a problem if flight is
/ironment.

ccumulation is such that even short encounters

cumulation is such that anti-icing fails to reduce or

escriptive comments (32 characters maximum).

will be retained in the local AIREP data files
y the AIREP SEARCH tool, but will not be retained in
not add the city pair the flight is operating, as this is
ovided in the AIREP Search Tool Database.

e code to advise Pilots of PIREPs via ACARS (57
Use the following address codes for transmitting to

AIREP Code

U flight# flight# flight#

U* flight# flight# flight#

B flight# flight# flight#

B* flight# flight# flight#

P flight# flight# flight#

P* flight# flight# flight#

US flight# flight# flight#

UP flight# flight# flight#

ned for three hours.

data is retained for 4 hours.

Flight Following Consideration

PIREP example

As a class exercise, we will enter the following PIREP into Unimatic:

Make sure to have TRAIN*ON in Unimatic!!!!

Scenario:

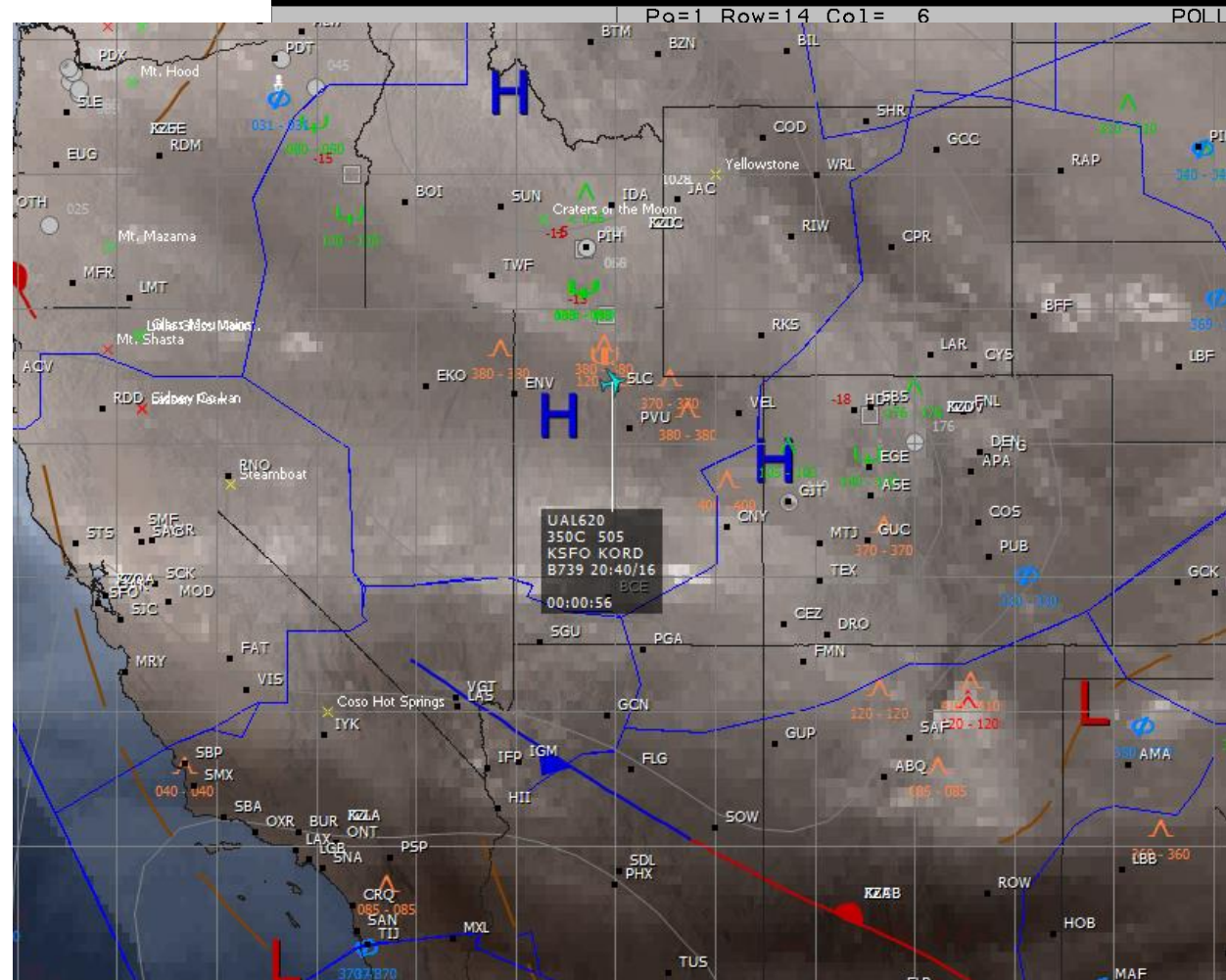
On the day of recurrent the following ACARS message is sent at 2029z

/C4 SFOORD

OCNL MOD CHOP TURB
CURRENTLY. STARTED AT
30NM DUE W OF
SLC+CONTINUES. WINDS
216087. CONTINOUS MDT AT
310.

Attachmate Accessory Manager - [Unimatic3]
File Edit View Tools Session Options Window Help
SIRD/DD041/PIREP
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*USE "FLT-DT STA" FOR
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* 122-06 LAX
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*MUST TRANSMIT ON THE LINE
*BELOW "ADV"
*IF OVER IS FIX,RADIAL,DME
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*THEN DME EX: MVA 090140
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Turbulence Investigation

Turbulence Investigation

Turbulence Investigation

Turbulence incidents/accidents can be serious to the point that an investigation may be requested.

Typically, anytime a flight encounters severe turbulence or any injury occurs due to turbulence a Forensic Turbulence Request will be ordered.

The following information will be analyzed for the report:

- Weather package
- Dispatcher Log
- DSAP information

WSI will analyze all the weather data to determine whether weather/turbulence was a factor.



1. Flight Number-Date	XXXX-05
2. City Pairs	MCO-???
3. Aircraft number and type	A/C 84XX – B747
4. Approximate incident location (latitude/longitude or proximity to a station) and flight level.	34000 FEET – 80 SE MCO
5. Time the event occurred.	2015Z
6. Potential incident cause and turbulence intensity: moderate or severe.	Severe Turbulence
7. Verify if the seat belt signs were on.	Yes, on.
8. Verify if the Flight Attendants were seated.	Yes
9. Dispatcher (First/Last). Sector	– Sector Dispatcher XX
10. Emergency declared?	No.
11. Injuries?	No
12. Medical Assistance Requested?	No
13. Medlink contacted?	No.
14. Additional comments.	No.

Turbulence Investigation

Flight Safety Investigation

Safety concerns involving flight movement issues will be investigated further by opening a Flight Safety Investigation (FSI)

The goal of the investigation is to understand what happened and how to prevent future occurrences.

An investigator will be assigned to the flight who will collect:

- Flight Plan
- Voice Recordings
- ACARS history
- DSAP data



Turbulence Investigation

Flight Safety Investigation Interview

To collect information the FSI investigator will conduct interviews with:

- Flight crew
- WSI meteorologists
- Dispatcher

Interviews will involve the investigator, member of Flight Operations Safety team, Senior Manager – Network Operations, Quality Assurance/Safety/Regulatory & Standards Compliance, PAFCA safety rep (if interviewee requests)

Interview topics will include:

- Personal experiences w/ turbulence
- Workload
- Communication with crew
- Weather concept understanding
- Event weather awareness
- Recommendations



Turbulence Investigation

Safety Summary

Upon conclusion of the fact gathering, the investigator will issue a report that contains:

- Synopsis of the event
- Narratives of the interviews
- Recommendations

United Airlines Flight Safety Investigation Safety Summary - Company Confidential



Safety Summary

Flight Safety Investigation [REDACTED]

Flight Attendants: Injury: Turbulence Related

Aircraft Manufacturer/Model: Boeing 737-724

Departure / Destination: [REDACTED]

Event Date: [REDACTED]



Turbulence Investigation

NTSB Investigation

For an event where there was physical bodily injury, the investigation phase may be turned over to the NTSB.

NTSB investigations will be similar in technique to United Airlines, but may involve more experts on the topic.

NTSB investigations may occur when the company investigators are unable/uncertain as to the cause of an accident.



Turbulence Investigation

NTSB Investigation

NTSB investigations will look at the following concerns:

- Synoptic conditions
- Upper Air Data (soundings, model data)
- Satellite imagery
- Weather Radar – CoSPA/WSR-88D, lightning
- PIREPs
- NWS Forecasts & in-flight weather advisories
 - Turbulence/convective model/guidance products
- Weather briefing data – dispatch, flight updates
- Statements/Witnesses – crew coordination
- Major issues that need to be identified
 - Was the weather conditions properly forecast
 - Role of controller, dispatcher, flight crew in mitigating the event

NTSB Press Release

National Transportation Safety Board Office of Public Affairs



NTSB Investigating Turbulence Event [REDACTED]

7/21/2010

The National Transportation Safety Board is investigating yesterday's turbulence event experienced by United Airlines Flight [REDACTED].

The airplane, a [REDACTED], en route from [REDACTED] to [REDACTED] encountered severe turbulence at approximately 6:14 p.m. (MDT) about 60 miles southeast of Kansas City, Missouri and about 40 miles north of Springfield, Missouri, at approximately 34,000 feet. The aircraft diverted and landed in Denver, Colorado.

The airplane had 255 passengers and 10 crew members onboard. Seventeen passengers and four flight attendants reported minor injuries. Initial reports indicate minor damage to the interior of the cabin.

Information from the flight data recorder was downloaded in Denver and was received at NTSB headquarters today where it will be studied by investigators.

Senior Air Safety Investigator, Bill English, is the Investigator-in-Charge. Mr. English and the NTSB technical experts assisting him will conduct the investigation from the NTSB headquarters in Washington, D.C. and will not travel to the scene.

Crew member, passenger, and weather information will be gathered over the coming days.

###

The National Transportation Safety Board (NTSB) is an independent federal agency charged with determining the probable cause of transportation accidents, promoting transportation safety, and assisting victims of transportation accidents and their families.

Related Press Releases

- [REDACTED]
- [REDACTED]

More NTSB Links

- Investigation Process
- Data & Stats
- Accident Reports
- Most Wanted List

Turbulence Investigation

Conclusion

Dispatchers should now have an understanding of the following items:

- Know the satellite signatures for CIT
 - Rapid vertical development
 - Rapid anvil expansion
 - Transverse banding
 - Overshooting Tops
 - Gravity Waves
- CIT Threat Assessment Questions:
 - Is there a threat of convective activity along my route?
 - Will my route intersect an anvil cloud shield?
 - Are there any satellite signatures typical of CIT displayed?
- Active flight monitoring is of paramount importance to flight safety.