

sample report

Report on Weather Conditions Related to Turbulence

(Carrier and dates removed for this sample report)

by

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General

The Flight departed Los Angeles International Airport located 33.94 degrees North latitude, 118.39 degrees West longitude, and arrived at Benito Juarez International Airport, Mexico City, located at 19.43 degrees North latitude, 99.07 degrees West longitude. An apparent incident of turbulence occurred approximately one half hour prior to landing. Available meteorological data were assessed to determine the meteorological cause of this incident.

Data were obtained from the National Climatic Data Center and include meteorological charts, satellite data, surface weather observations from the United States and Mexico and other meteorological bulletins. Radar data from the United States were available, but despite several attempts, Mexican radar data were not.

Although there are many weather reporting stations in Mexico, data were often incomplete with stations sometimes shutting down at night. Other stations report only periodically; only a few report each hour.

Definitions

Clouds

Convective clouds are dense clouds with sharp outlines. They tend to be small in diameter – typically on the order of 5 to 10 milers but can reach to heights in excess of 50,000 feet. These clouds are characterized by rapid vertical air motions. They also distort the wind flow in their vicinity. The following are examples of convective clouds.

- Cumulus humilis – small convective clouds with vertical extent only a few thousand feet.
- Cumulus mediocris – similar to cumulus humilis but of greater vertical extent
- Cumulus congestus – vertical extent may reach 20,000 feet or more. These clouds are frequently accompanied by showers.
- Cumulonimbus – may reach heights of 50,000 feet or more. These are clouds with which thunderstorms are associated.
- Altocumulus – some of these are convective clouds – if they show vertical development.

Turbulence

Aviation turbulence is defined in terms of the response of the aircraft to disorganized and certain organized atmospheric motions (Lester p.1-3). See Appendix 1 for turbulence characteristics. Types of turbulence include:

- High altitude turbulence occurs with rapidly changing wind speed or direction generally at altitudes above 15,000 feet.
- Convective turbulence occurs in and in the vicinity of convective clouds. Rapid changes in vertical wind speeds within the cloud results in this type of turbulence. Additionally, convective clouds distort the wind pattern in their vicinity resulting in turbulence outside of the actual cloud. Turbulence in the vicinity of thunderstorms is often severe.

Summary of meteorological conditions during the flight

Upper level weather charts are produced every 12 hours. These charts reveal an upper level low over northern Baja California and what appears to be the core of the subtropical jet stream extending from the northwest part of the Mexican state of Sonora into southern parts of Arizona and New Mexico. Maximum winds in this core exceeded 70 knots at 300 millibars (30,000 feet). An upper level high is centered over Mexico near 22 degrees North, 101 degrees West latitude.

Weather radar

Radar charts based on United States based weather radar indicate extensive areas of showers and thunderstorms extending in a continuous band from northern Baja California east through the northern part of the state of Sonora and into southern Arizona and New Mexico. Thunderstorm tops over northern Baja California and extreme southern Arizona were reported to be 35,000 and 39,000 feet, respectively. The aircraft would have had to penetrate this area of convective activity. Even avoiding thunderstorms as is the rule, at least moderate turbulence would be expected in the vicinity of the thunderstorms. This would have been early in the flight. Attempts to obtain Mexican weather radar data were fruitless.

Surface weather observations near the route of flight

In surface weather observations, clouds based below 10,000 feet above ground level (AGL) are reported in height above the ground in feet, while clouds based above 10,000 AGL are reported in height above mean sea level (MSL) in feet. Flight levels are reported in height above MSL.

United States

- Phoenix Sky Harbor Airport reported cumulonimbus clouds based at 9,000 feet
- Nogales Arizona reported heavy rain
- Tucson, Arizona reported light rain

Mexico

Toluca 19.283 North, 99.68 West, altitude 8,923 feet (2720 meters)

overcast – no cloud bases or cloud type given

- 2,500 overcast, cumulonimbus, altostratus opacus, lightning visible, no thunder heard
- 0.31 inches of rain reported for the 24 hour period
- inches of rain reported for the 24 hour period

Manzanillo 19.05 North, 104.32 West, altitude 10 feet (3 meters)

- scattered cumulus congestus
- scattered cumulus humilis
- scattered cirrus

Tropical cyclones

Two tropical cyclones affected Mexico in the days prior to the reported incident. After a tropical cyclone has dissipated over land, it frequently continues to enhance convective activity and rainfall for several days.

- Made landfall near Mazatlan at 23.8 North, 106.7
- Made landfall as a tropical storm at 19.2 North, 104.6 West, 15 miles west of Manzanillo

Convective SIGMETS

CONVECTIVE SIGMETs are issued in the conterminous U.S. for: Severe surface weather including:

- Surface winds greater than or equal to 50 knots
- Hail at the surface greater than or equal to 3/4 inches in diameter
- Tornadoes
- Embedded thunderstorms
- Line of thunderstorms
- Thunderstorms greater than or equal to VIP level 4 affecting 40% or more of an area at least 3000 square miles (Aviation Weather Center)

Any Convective SIGMET implies severe or greater turbulence, severe icing, and low level wind shear. A Convective SIGMET may be issued for any convective situation which the forecaster feels is hazardous to all categories of aircraft. Bulletins are issued hourly at Hour+55. The text of the bulletin consists of either an observation and a forecast or just a forecast. The forecast is valid for up to 2 hours.

Convective SIGMET 1 W was issued at and was valid for a line of thunderstorms 25 miles wide extending from 50 nautical miles west southwest of Tucson to 50 nautical miles south southeast of Tucson with tops to 38,000 feet.

Area Forecast

The Area Forecast consists of a:

- 12 hour forecast plus a 6 hour outlook. All times are Coordinated Universal Time (UTC). All distances except visibility are in nautical miles. Visibility is in statute miles.
- synopsis section which is a brief summary of the location and movement of fronts, pressure system, and circulation patterns for an 18 hour period.
- VFR clouds and weather section which is a 12 hour forecast, in broad terms, of clouds and weather significant to flight operations plus a 6 hour categorical outlook. This section is usually several paragraphs. AIRMET Sierra supplies information regarding Instrument Flight Rule (IFR) conditions. The breakdown may be by states, by well known geographical areas, or in reference to location and movement of a pressure system or front. A categorical outlook, identified by OTLK, is included for each area breakdown. (Aviation Weather Center)

Pilot Reports (PIREPs)

U.S. air carriers are generally the only aircraft to transmit voice Pilot Reports via National Weather Service communication circuits. Therefore, there are rarely PIREPs outside of the continental U.S. and the immediate coastal regions. There are some Canadian and Alaskan PIREPs but almost no Mexican reports. (Aviation Weather Center)

The following PIREPs were made for locations close in time and location.

- Flight from 37.8 North, 108.9 West to 70 nautical miles south of Las Vegas reported continuous light chop at Flight Level 33,000 feet
- Agua Dulce, Big Bear to 20 nautical miles northeast of Blythe, CA at 11, 500 feet, light chop.
- 100 miles east of Phoenix VORTAC, Flight level 29,000 to 26,000 feet, moderate turbulence.
- near Clovis VORTAC (36.9 North, 119.8 West), Flight Level 33,000 feet, moderate chop.
- Over Inyofern, CA (35.7 North, 117.8 West) , Flight Level 7,500 feet, light to moderate chop.
- Over Mojave, CA, Flight Level 10,500 feet, Light, occasionally moderate turbulence.

Satellite imagery

At night only infrared satellite imagery is available. High cloud tops appear white, lower tops varying shades of gray. Thick clouds effectively radiate infrared radiation from their tops, while thinner clouds allow warmer radiation from lower altitude to be sensed. The clouds appearing on the satellite imagery to the north of Mexico City appear to be thick with cold tops. The cold tops coupled with the “lumpiness” of the clouds strongly suggest convective type clouds are present in the cloud area.

Conclusions

The meteorological data imply strong evidence of convective cloud activity along the route of flight in two areas.

- The first of these areas would have been early in the flight in the vicinity of a line of showers and thunderstorms that extended from northern Baja California into southern Arizona. Also, shear associated with the subtropical jet stream could be associated with light turbulence.
- A second area of convective cloud activity appears to be to the north of Mexico City GOES infrared satellite imagery. This imagery coupled with weather reports from Licenciado y Gen Ig, 19.38 North, 102.03 West (thunderstorm reported), Toluca, 19.283 North, 99.68 West (cumulonimbus and lightning visible), and Tlaxcala, 19.32 North, 98.25 West (various types of convective clouds reported at 10/0000 UTC) strongly suggest the cloud area in the vicinity of Mexico City to be associated with convective type clouds. Other stations in the vicinity of the incident reported clouds, but cloud type was not reported. These stations included Licenciado Benito Juarez, 19.43 North, 99.07 West altitude and Puebla 19.05 North, 98.17 West. Turbulence is frequent in, and in the vicinity of convective clouds, so turbulence would be expected within the cloud mass that appears near Mexico City.

Reference

Lester, P.F., 1993: *Turbulence a new perspective for pilots*, Englewood, CO: Jeppesen.

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Appendix 1

(Excerpted from the Aeronautical Information Manual, Chapter 7)

Turbulence Reporting Criteria Table

Intensity	Aircraft Reaction	Reaction Inside Aircraft	Reporting Term-Definition
Light	Turbulence that momentarily causes slight, erratic changes in altitude and/or attitude (pitch, roll, yaw). Report as Light Turbulence ; ¹ or Turbulence that causes slight, rapid and somewhat rhythmic bumpiness without appreciable changes in altitude or attitude. Report as Light Chop .	Occupants may feel a slight strain against seat belts or shoulder straps. Unsecured objects may be displaced slightly. Food service may be conducted and little or no difficulty is encountered in walking.	Occasional-Less than $\frac{1}{3}$ of the time. Intermittent- $\frac{1}{3}$ to $\frac{2}{3}$. Continuous-More than $\frac{2}{3}$.
Moderate	Turbulence that is similar to Light Turbulence but of greater intensity. Changes in altitude and/or attitude occur but the aircraft remains in positive control at all times. It usually causes variations in indicated airspeed. Report as Moderate Turbulence ; ¹ or Turbulence that is similar to Light Chop but of greater intensity. It causes rapid bumps or jolts without appreciable changes in aircraft altitude or attitude. Report as Moderate Chop . ¹	Occupants feel definite strains against seat belts or shoulder straps. Unsecured objects are dislodged. Food service and walking are difficult.	NOTE 1. Pilots should report location(s), time (UTC), intensity, whether in or near clouds, altitude, type of aircraft and, when applicable, duration of turbulence. 2. Duration may be based on time between two locations or over a single location. All locations should be readily identifiable.
Severe	Turbulence that causes large, abrupt changes in altitude and/or attitude. It usually causes large variations in indicated airspeed. Aircraft may be momentarily out of control. Report as Severe Turbulence . ¹	Occupants are forced violently against seat belts or shoulder straps. Unsecured objects are tossed about. Food Service and walking are impossible.	EXAMPLES: a. Over Omaha. 1232Z, Moderate Turbulence, in cloud, Flight Level 310, B707.
Extreme	Turbulence in which the aircraft is violently tossed about and is practically impossible to control. It may cause structural damage. Report as Extreme Turbulence . ¹		b. From 50 miles south of Albuquerque to 30 miles north of Phoenix, 1210Z to 1250Z, occasional Moderate Chop, Flight Level 330, DC8.
¹ High level turbulence (normally above 15,000 feet ASL) not associated with cumuliform cloudiness, including thunderstorms, should be reported as CAT (clear air turbulence) preceded by the appropriate intensity, or light or moderate chop.			

This table is available on-line at: <http://www.faa.gov/ATpubs/AIM/Chap7/aim0701.html#7-1-23>