Southwest Aviation Weather Safety Workshop

Salt River Project
Phoenix, AZ
April 10-11, 2010

Aviation Hazard Awareness Training

Cloud Recognition Training For Pilots

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Cloud Recognition Training for Pilots

Jody James

Private Pilot
(approx. 200 hours)

WCM - NWS Lubbock

National Weather Service
Lubbock

Outline:

I. Convective Clouds

Thunderstorms
Severe Thunderstorm Signatures
Severe Weather Clues

II. Other Turbulent Clouds

ACCAS Altocumulus Castellanus
Mountain Waves
Kelvin Helmholtz Clouds
Volcanic Eruption
Others

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Convective Clouds

Thunderstorms

- Severe or Extreme Turbulence
- Severe Icing
- Low Level Wind Shear (Mechanical)
- Microbursts (Convective LLWS)
- IFR or LIFR Conditions
- Strong surface winds…30 knots or greater

Thunderstorm Time Lapse

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Towering Cumulus

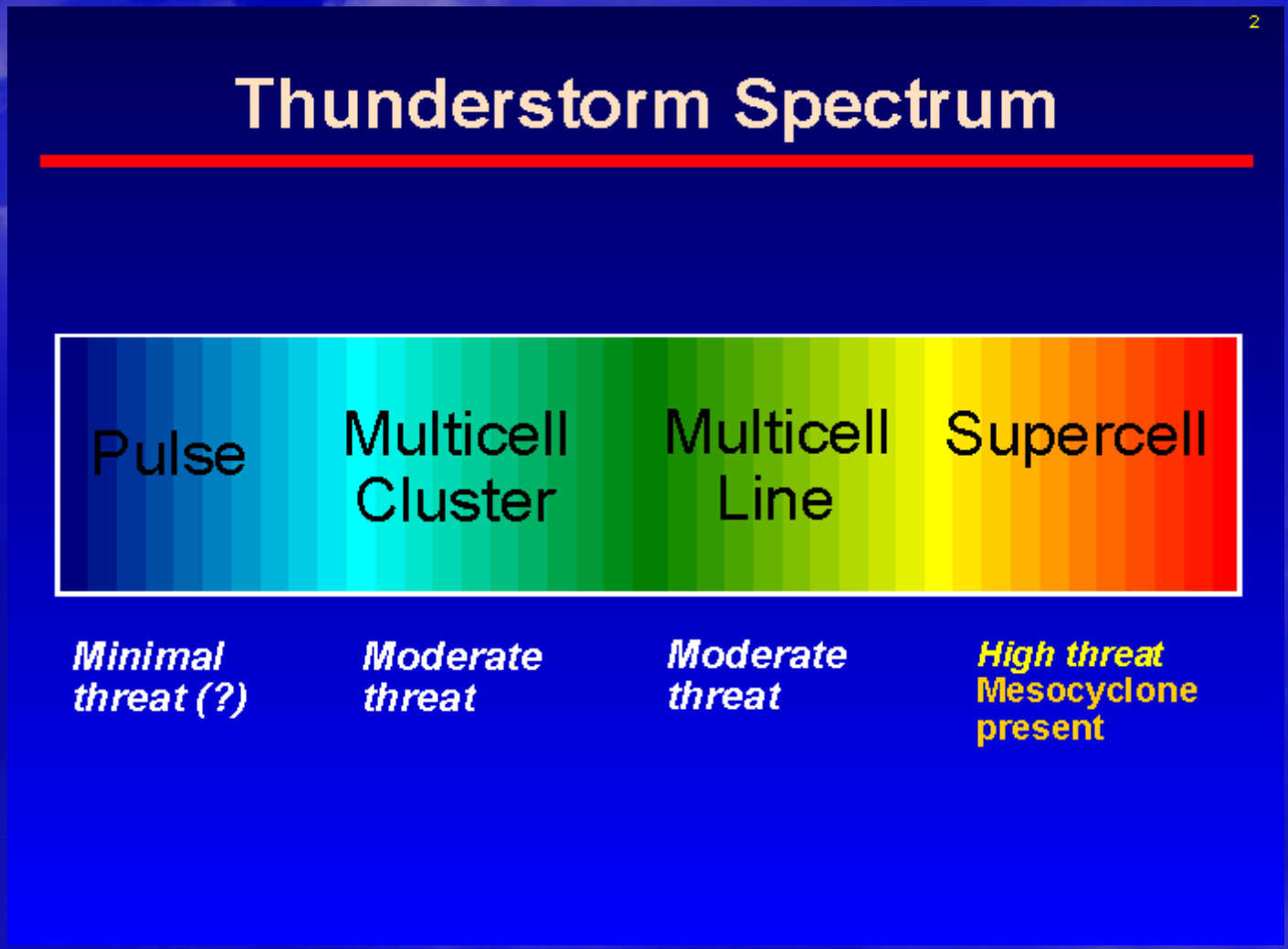
A pilot can expect:

- updrafts to reach 4000 to 5000 feet per minute
- Severe or greater turbulence
- Moderate or greater icing

Height of TCU and texture may help estimate with severity of conditions

Image courtesy UCAR, photo by Carlye Calvin.

All Thunderstorms Are Not Equal!



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Thunderstorms

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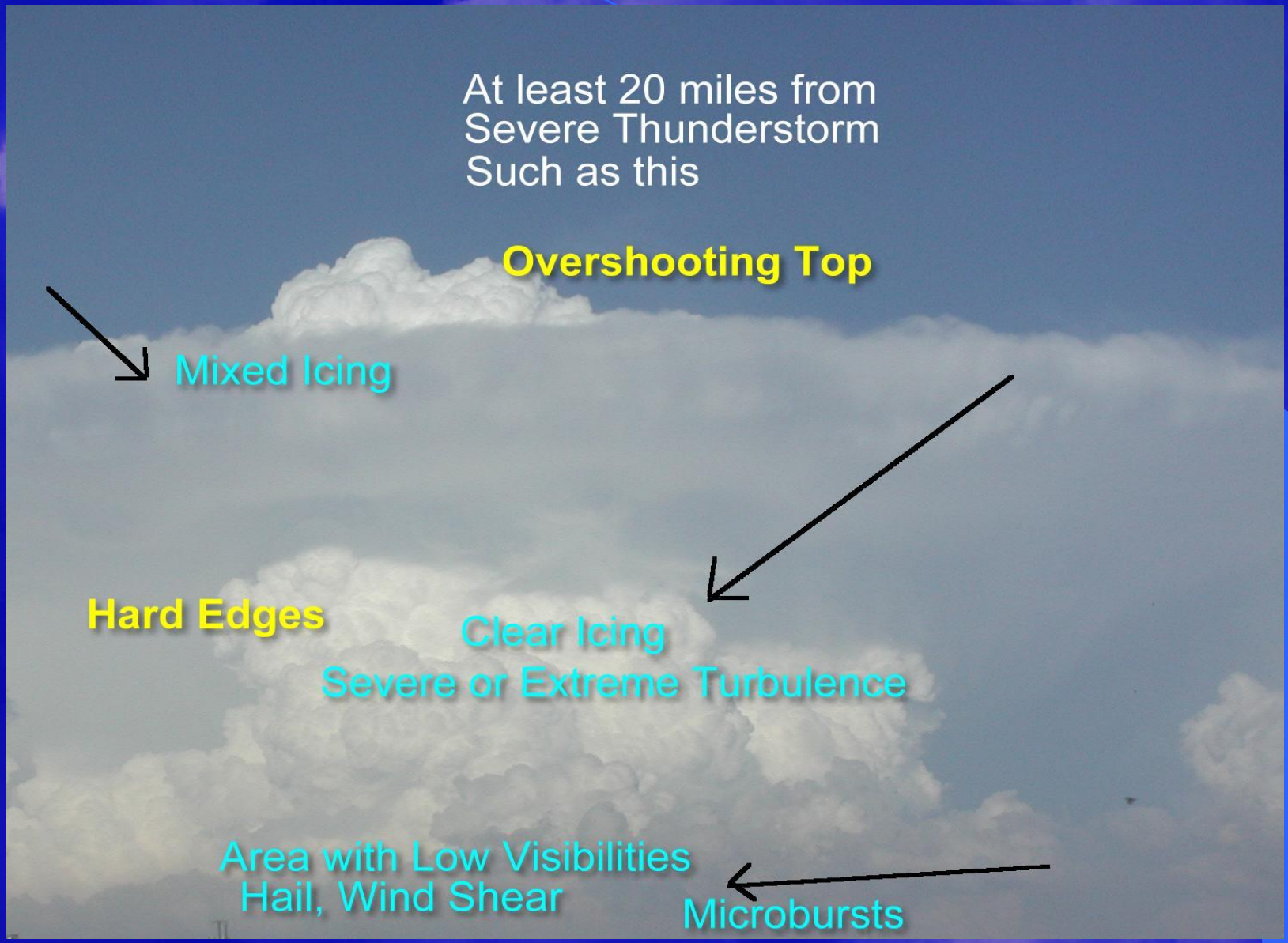
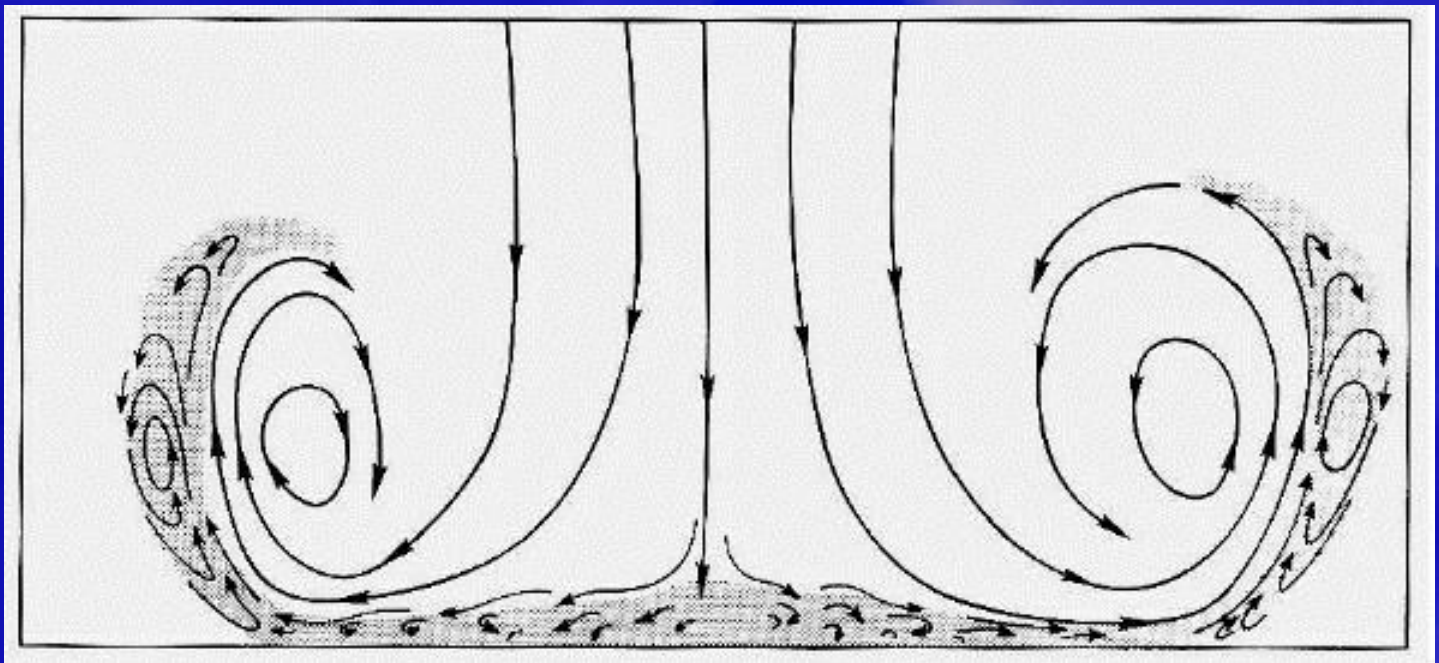
Thunderstorm Avoidance



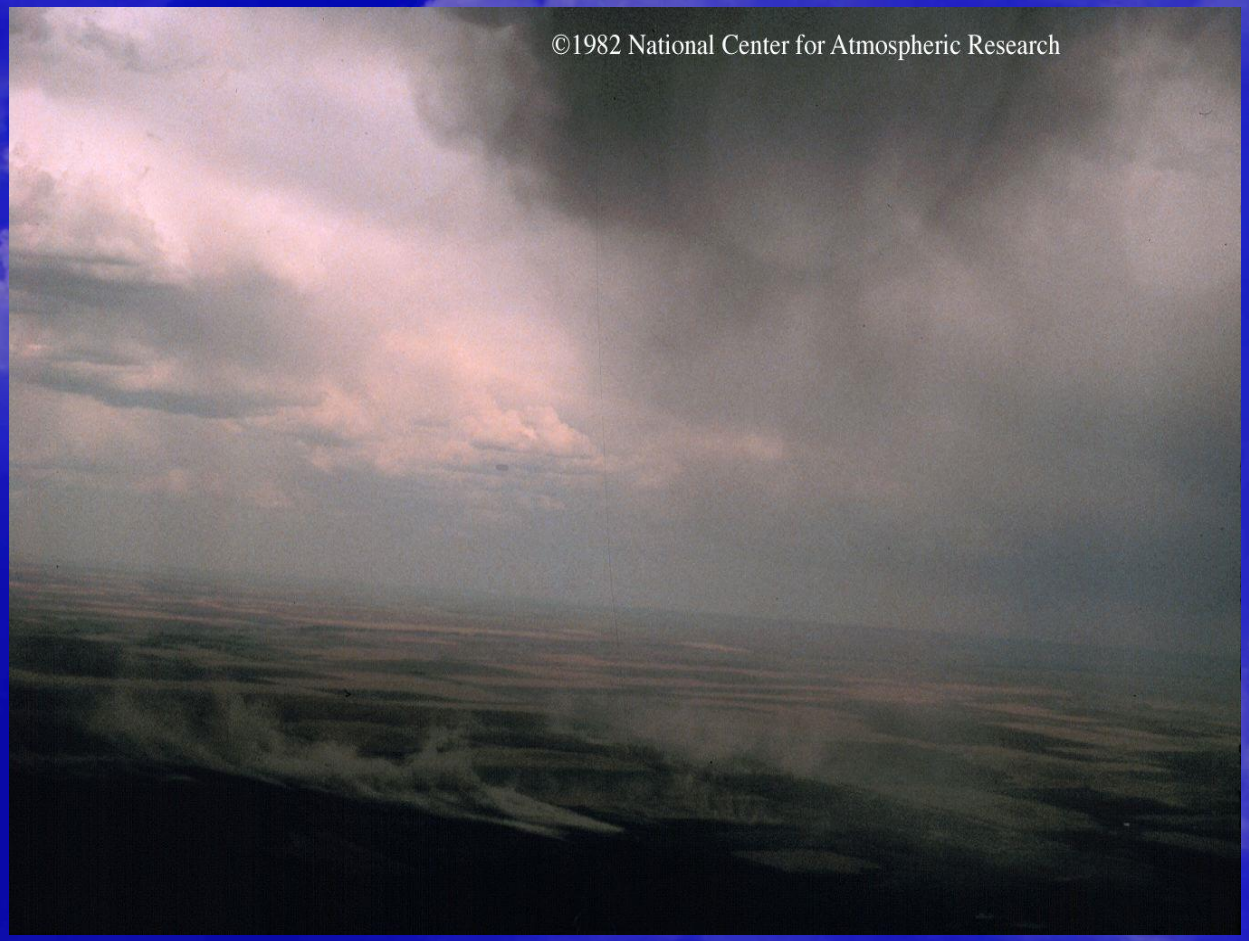
The Downburst

- **Precipitation induced downdraft which can produce winds to 100 knots or greater.**
- **Has caused numerous airline crashes through the years including Delta Flight 191 an L-1011 on August 2, 1985 at DFW Airport.**



Cross section of vortex ring model (Caracena, 1982)

The Downburst



Dry Microburst forming under prominent virga shaft. Note ring of dust beneath rain shaft.

(Photograph by E. Szoke, 14 July 1982,
National Center for Atmospheric Research/National Science Foundation.)

The Downburst – Rain and Dust Foots

Outward deflection of rain or dust along ground.

Photo: © Sam Barricklow

Photo: NWS

Both indicate strong or damaging winds are underway.

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Convective Clouds
Haboob

Strong Thunderstorm Outflow – indicates very strong winds and low visibilities.
Winds Speeds usually exceed 30 mph, and dust can be raised to 3000 feet.

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Convective Clouds

Mammatus

A pilot can expect:

Severe to extreme turbulence in this highly sheared environment

Can have hail fall beneath these clouds

Indicative of strong storm

Mammatus clouds over San Antonio, Texas, 2009

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Convective Clouds

Wall Clouds/Funnels/Tornadoes

NOAA picture - May 3, 1999, central Oklahoma.

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Convective Clouds

Wall Clouds

Wall Clouds indicate an area of rapid ascent beneath very strong updraft

Strong inflow into these clouds

Many times, this feature will precede tornado development

Photo: Mike Umscheid

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Convective Clouds

Funnel Clouds

Indicates rapid rotation

Connected to cloud base

Violent rotation not in contact with ground

Often times, this feature will precede tornado development

Funnel Cloud, NWS San Antonio, TX; NOAA Central Library

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Convective Clouds

Tornadoes

Violent rotation attached to cloud, in contact with ground

Usually develop in association with “Supercells”

Can develop from towering cumulus clouds

Landspout Tornado

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Convective Clouds

Outflow Clouds – Shelf Cloud

Indicates thunderstorm outflow

Usually slopes away from the rain area

Strong winds, heavy precipitation can occur immediately following passage

Photo – National Weather Service

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Convective Clouds

Outflow Clouds – Roll Cloud

Indicates thunderstorm outflow

Can have horizontal rotation

Strong winds, heavy precipitation can occur immediately following passage

Photo – John Wright

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Convective Clouds

Outflow Clouds – Gustnado

Develops in area of thunderstorm outflow

Circulation is shallow (200-300 ft) , and does not extend to cloud base

Winds speeds can reach 80 mph

Gustnado east of Tulia, TX – July 2009

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Convective Clouds

Dust Devil

Develops due to intense heating at the surface

Circulation can extend several hundred feet

Winds speeds can reach 60 mph

"dust devils are implicated in ~100 light aviation accidents in the last 15 years and thus can be considered a genuine hazard "

– NASA, Applied Information Systems Research

Dust Devil: Glendale Community College, Earth Science Image Archive

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Turbulent Clouds

Mountain Wave Clouds

Form in stable conditions

Can indicate turbulence near this level

Photo of the Moul n'ga Cirque in the Tadrart region, Southeast Algeria, with wave clouds above.

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Turbulent Clouds

Mountain Wave Clouds

Lenticular Cloud is a signpost in the sky that Indicates Mountain Wave Activity

Extreme turbulence can exist

Lenticularis cloud formation over Mt Wash, 2004

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Turbulent Clouds

Mountain Wave Clouds

Lenticular Cloud is a signpost in the sky that Indicates Mountain Wave Activity

Extreme turbulence can exist

Image Courtesy of UCAR

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Turbulent Clouds

Mountain Wave Clouds

Lenticular Cloud is a signpost in the sky that Indicates Mountain Wave Activity

Watch for rotor clouds near the ground

Cross barrier flow and strong winds (<30 knots)

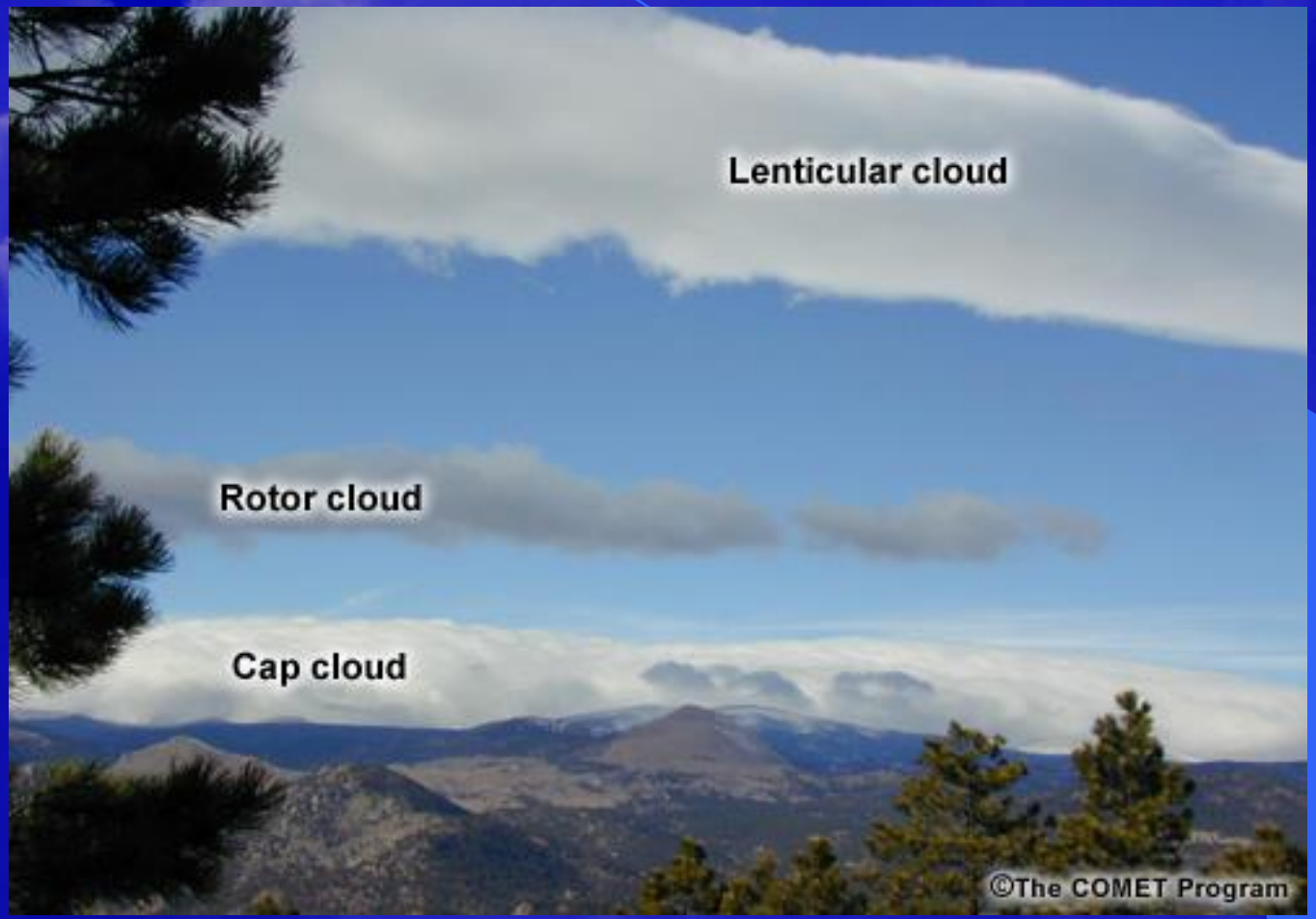

Image Courtesy of UCAR/Comet

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Turbulent Clouds

Kelvin-Helmholtz Wave Clouds

KH clouds also indicate Severe Wind Shear

Usually less than 2 miles

Develop in stable environments with balance of wind shear and stability

Use Caution!

Kelvin-Helmholtz breaking wave cloud over Laramie, Wyoming; Photo by Brooks Martner

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Turbulent Clouds

Alto-cumulus Castellanus (ACCAS)

Indicate Instability

Should Expect light to moderate turbulence

Often a pre-cursor to thunderstorm activity

ACCAS Clouds

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Turbulent Clouds

Cirrus Fall Streaks

Indicate Strong Winds Aloft

May Encounter Turbulence near this altitude

Usually well into the Flight Levels, FL180 and above

Cirrus with evaporating ice crystals; Photo by Ronald L. Holle, Univ. of Illinois Cloud Catalog

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Turbulent Clouds

Volcanic Clouds

Indicate Volcanic Eruption

Should Avoid

Low Visibilities, Problematic for jet engines

Eyjafjallajokull glacier in Iceland, Wednesday April 14; Xinhua/Reuters

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Convective Clouds

CAT Clouds

Region with no cumuloform clouds

Most likely in the upper atmosphere near tropopause

Cirrus can indicate potential for CAT

Cloud Recognition Training for Pilots

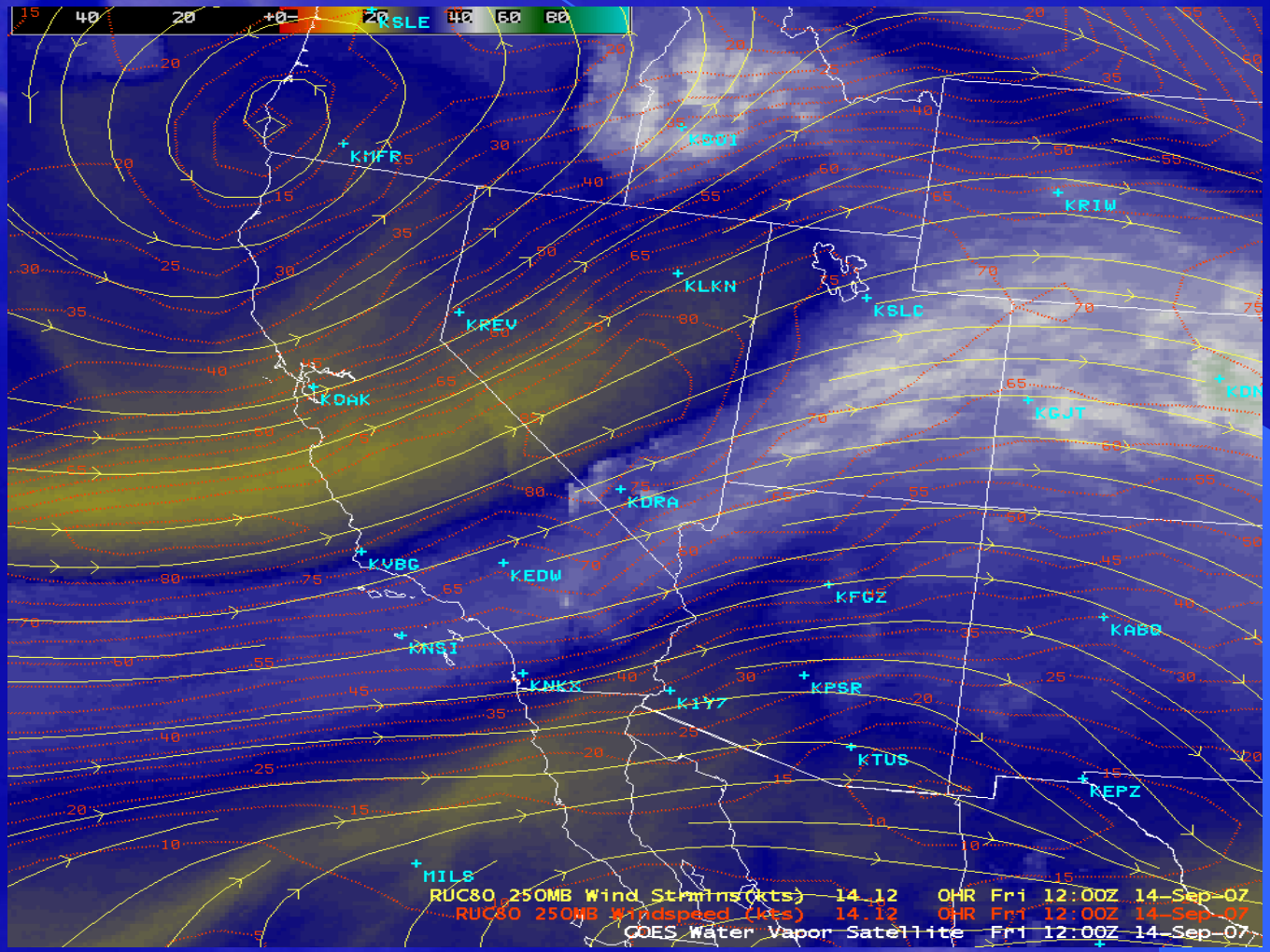
Convective Clouds

CAT Clouds

Region with no cumuloform clouds

Most likely in the upper atmosphere near tropopause

Cirrus can indicate potential



Cirrus will often develops along axis of stronger upper level winds; RUC80 model with streamlines and water vapor satellite imagery

Questions?


Thank You…
Please Fly Safely!