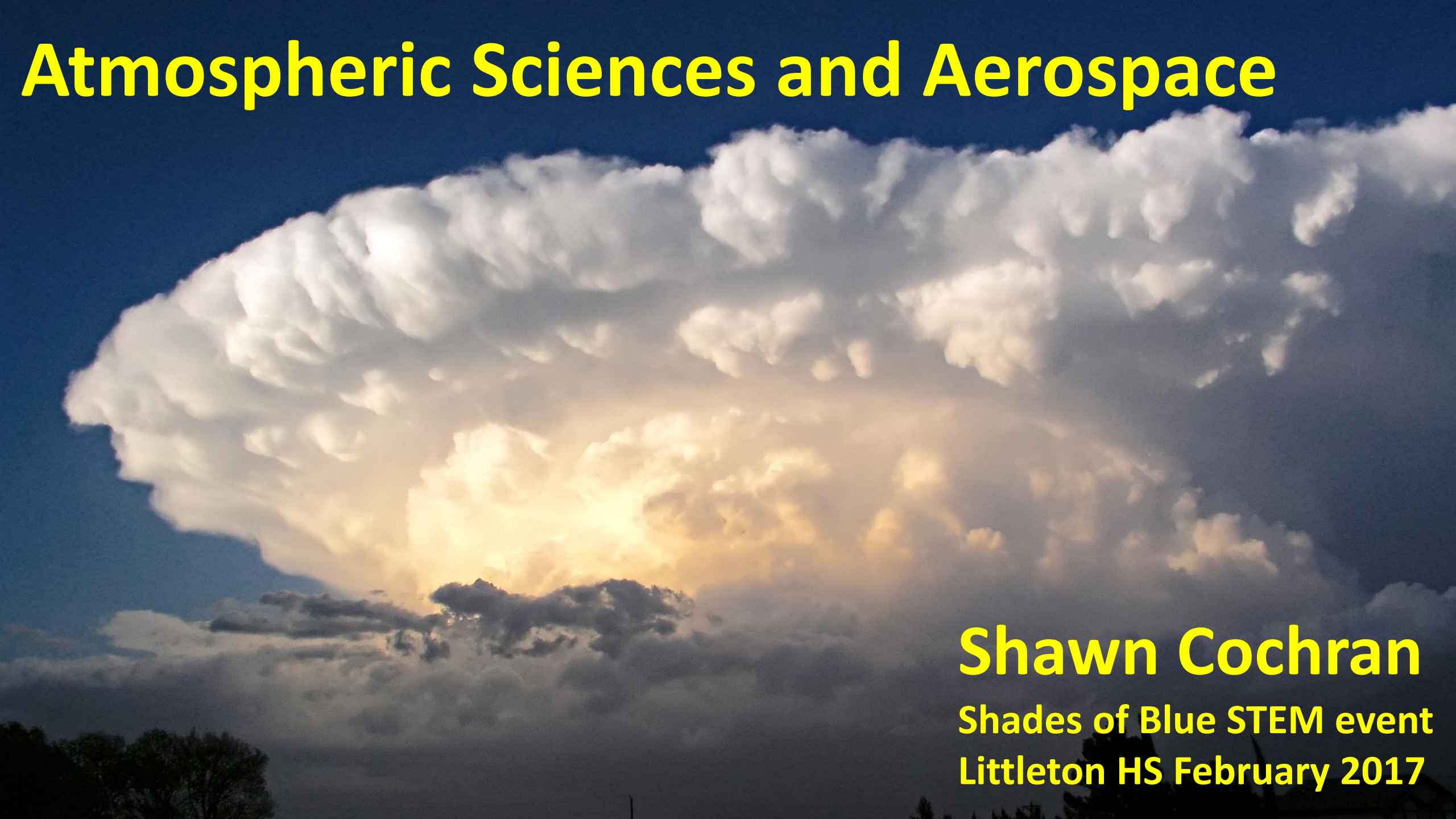
Atmospheric Sciences and Aerospace



Shawn Cochran

Shades of Blue STEM event

Littleton HS February 2017




- Systems Engineer for 23 years specializing in Command and Control systems and Satellite Meteorology.
- Currently serves as the head of Mission Data Services for JPSS.
- Mission Data Services contributes to the design, development, deployment and operations of the next-generation meteorological satellite constellation: the Joint Polar Satellite System.
- JPSS also includes the Common Ground System (CGS) supporting multiple missions and agencies. This includes the DoD Defense Meteorological Satellite Program (DMSP), Japan's JAXA GCOM-W1, European Meteorological Satellite Program's METOP-A/B, the USN WindSat, Coriolis and NSF satellites.
- JPSS is being jointly developed by NOAA and NASA.
- Active pilot. Cessna 310 (N310RL) and Cessna 177 (N370S) owner.



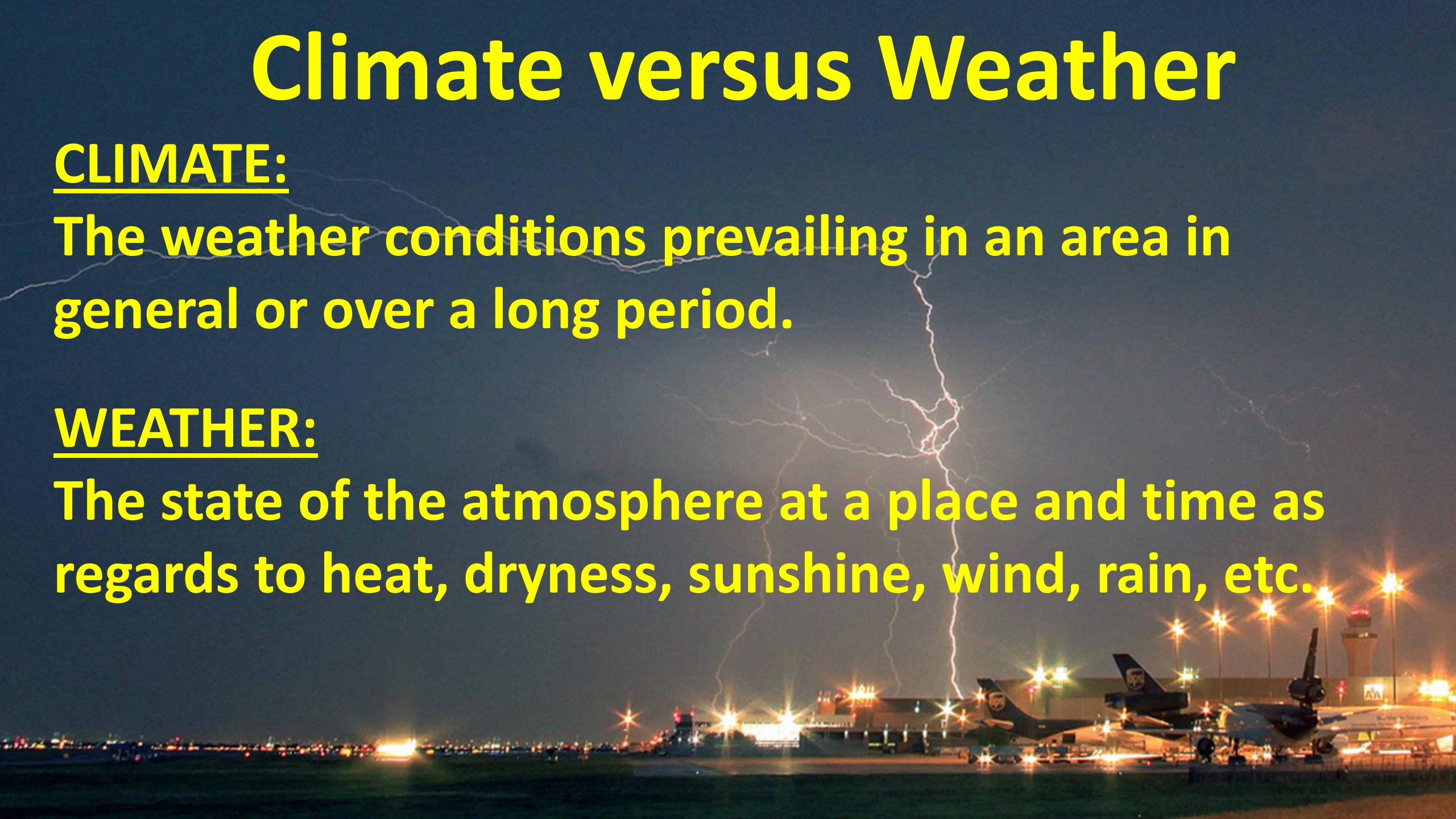

Climate versus Weather

CLIMATE:

The weather conditions prevailing in an area in general or over a long period.

WEATHER:

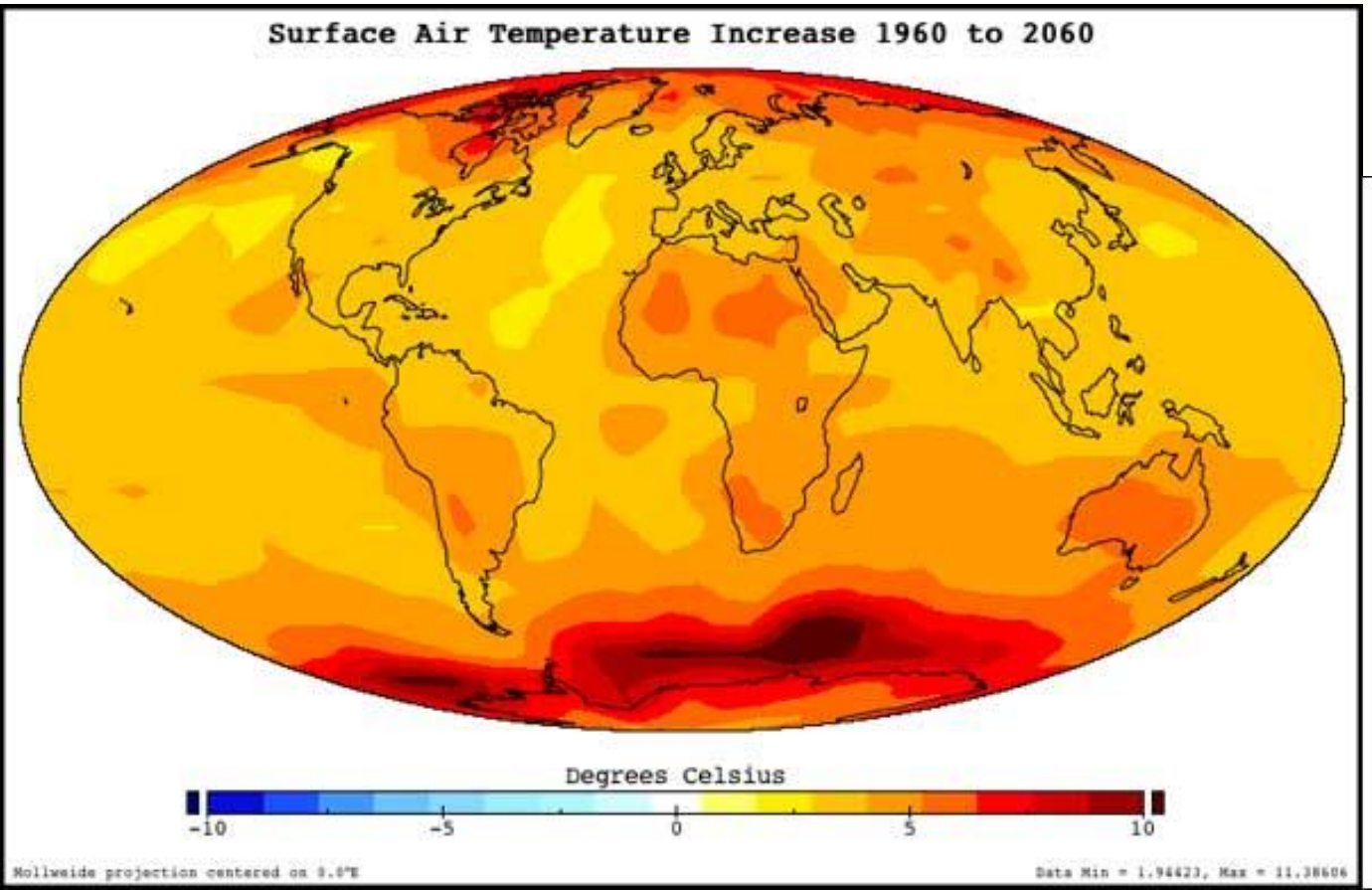
The state of the atmosphere at a place and time as regards to heat, dryness, sunshine, wind, rain, etc.

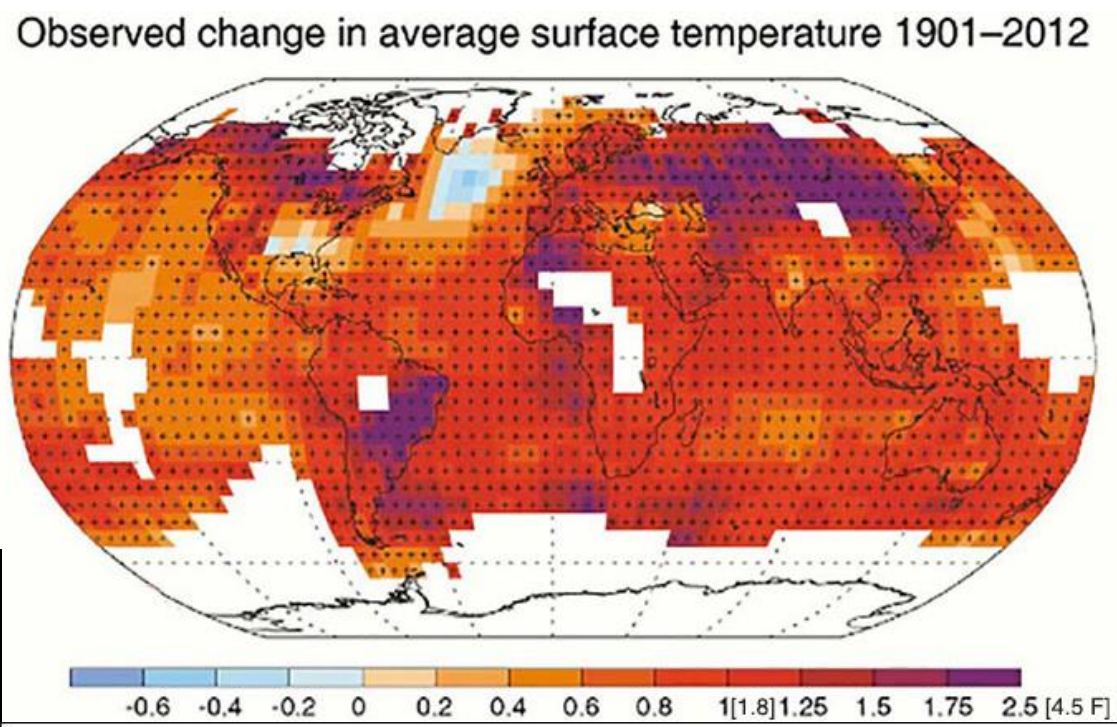


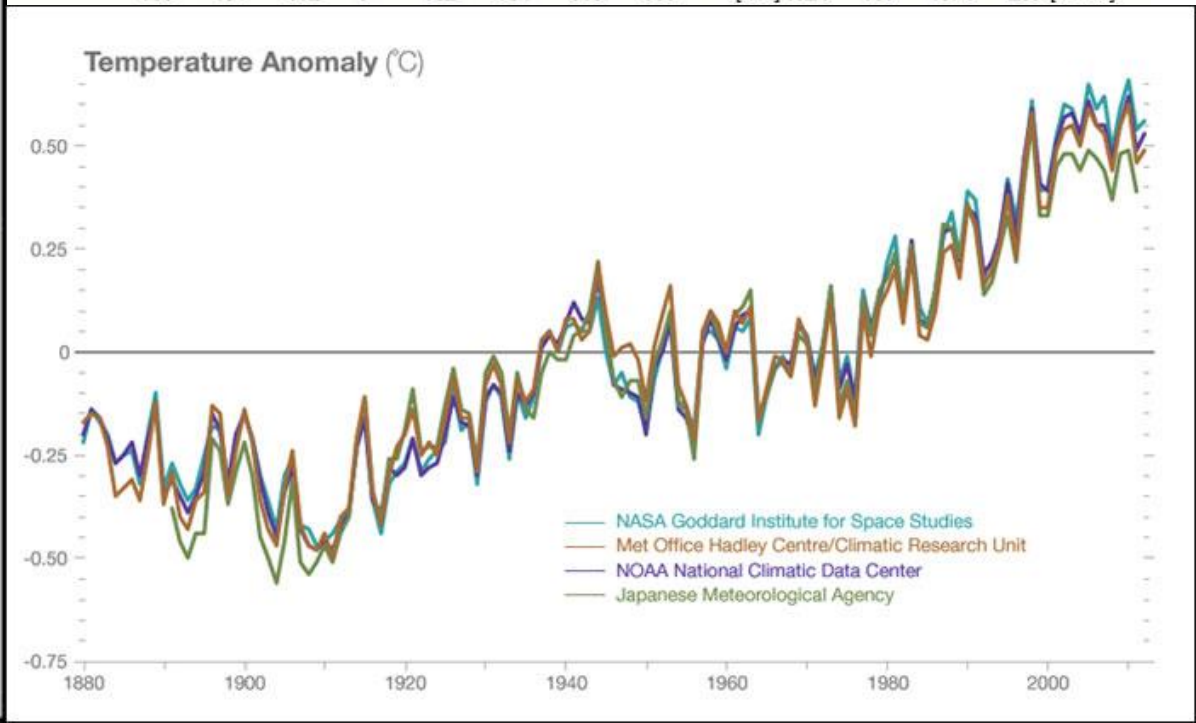
Changes in climate:

Warming of the planet

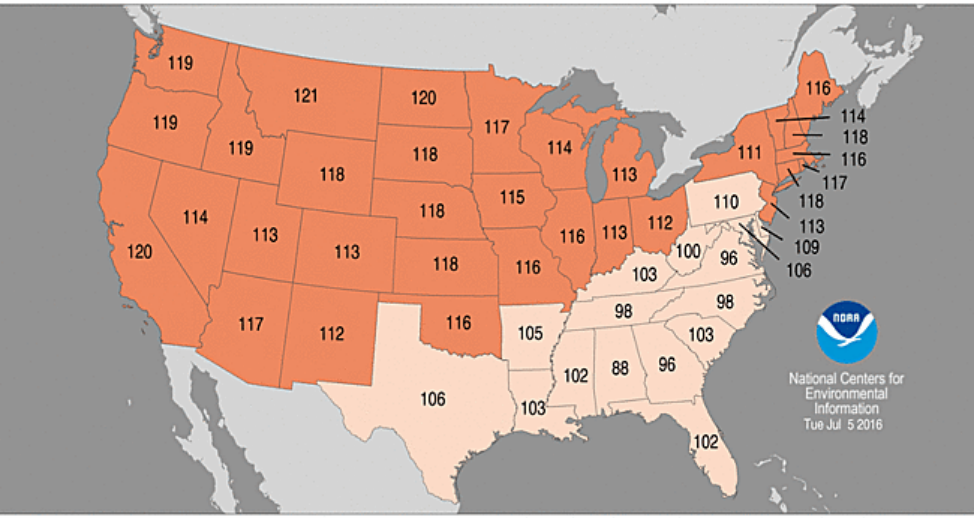
- Movement of the jet stream north
- Increased turbulence due to changes in wind shear; increased severity
- Stronger, more intense storms
- Changes in Convective Available Potential Energy (CAPE)
- Increases in sea surface temperature (the ocean is a giant heat sink)





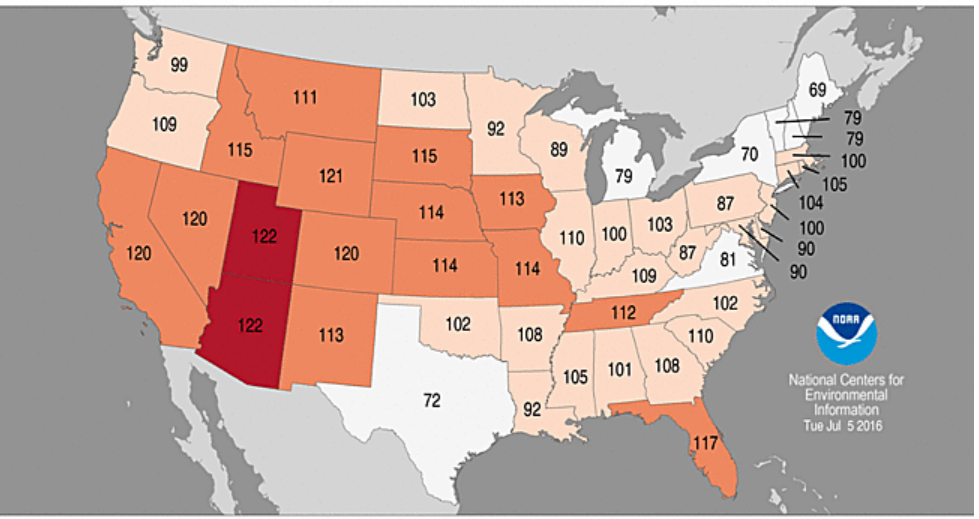


Statewide Average Temperature Ranks
January–June 2016
Period: 1895–2016



Record Coldest (1) | Much Below Average | Below Average | Near Average | Above Average | Much Above Average | Record Warmest (122)

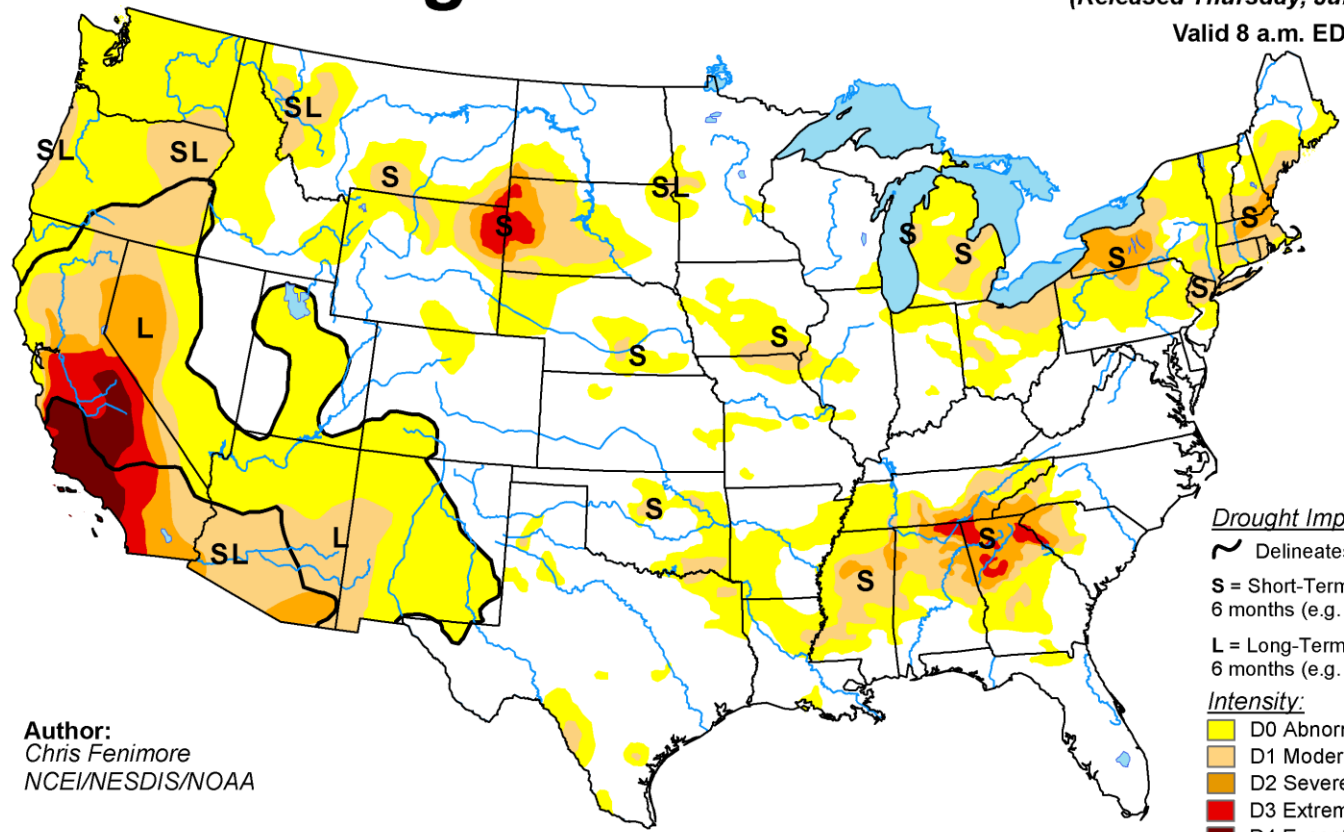
Statewide Average Temperature Ranks
June 2016
Period: 1895–2016



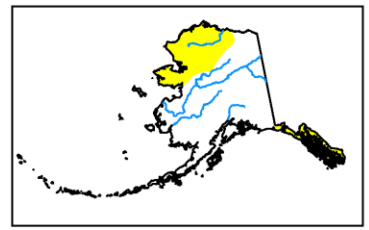
Record Coldest (1) | Much Below Average | Below Average | Near Average | Above Average | Much Above Average | Record Warmest (122)

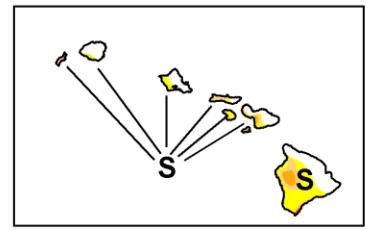
U.S. Drought Monitor

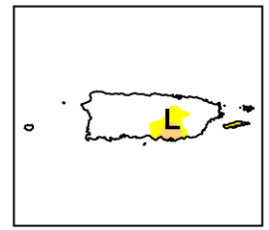
July 19, 2016
(Released Thursday, Jul. 21, 2016)
Valid 8 a.m. EDT



Author:
Chris Fenimore
NCEI/NESDIS/NOAA







Drought Impact Types:
Delineates dominant impacts

S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)

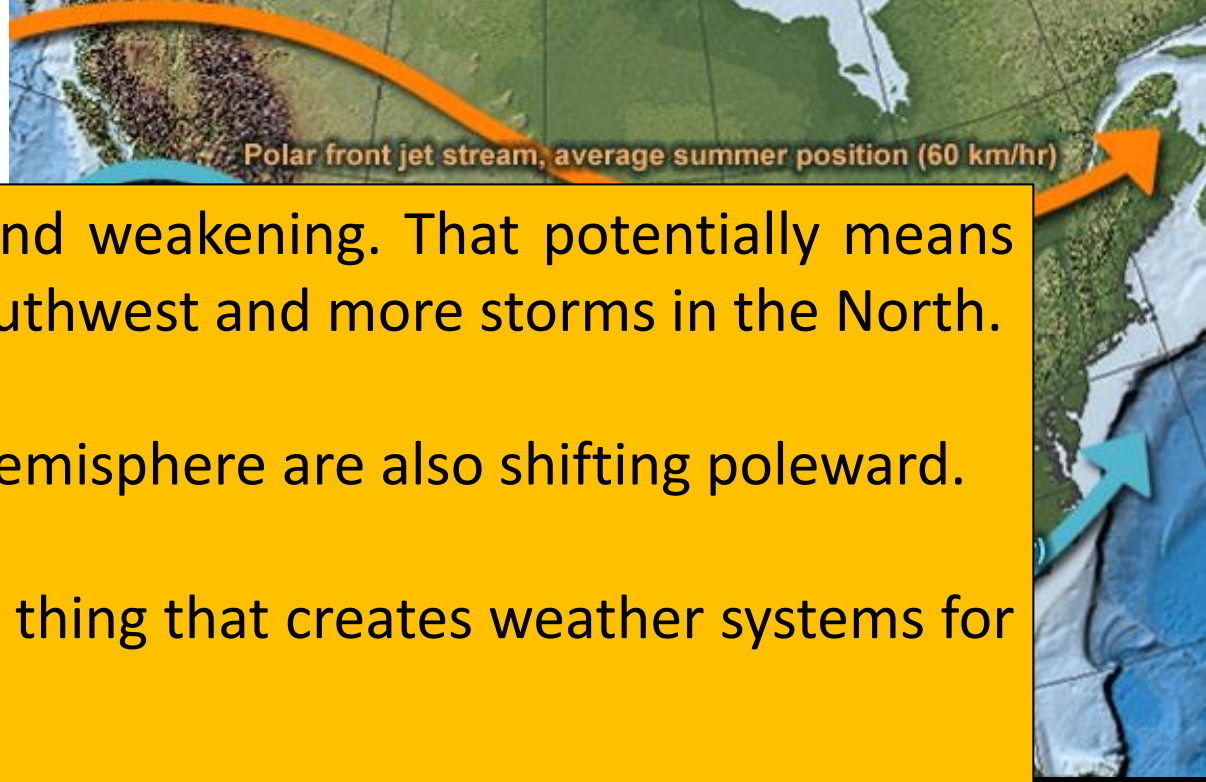
L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

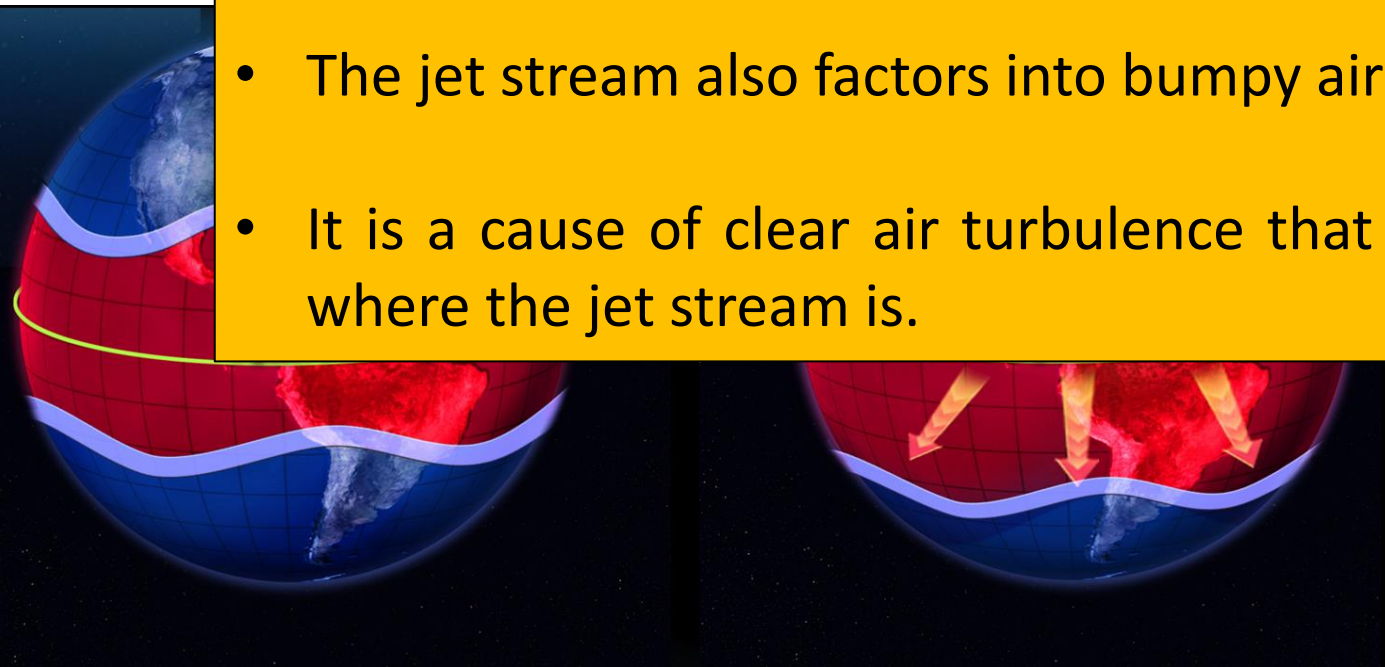
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

USDA | National Drought Mitigation Center | NOAA

http://droughtmonitor.unl.edu/



- The jet stream is creeping northward and weakening. That potentially means less rain in the already dry South and Southwest and more storms in the North.
- Two other jet streams in the Southern Hemisphere are also shifting poleward.
- The northern jet stream is the dominant thing that creates weather systems for the United States.
- The jet stream also factors into bumpy air travel.
- It is a cause of clear air turbulence that airline pilots try to avoid by tracking where the jet stream is.



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‘Terrifying’ fl
turbulence

NEWS WO

By Andy Jechow
Published: July 13, 20

NEWS
JUN 6 2016, 7:47

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17 injured as flight from Frankfurt to Shanghai encounters severe turbulence

By Yang Jian | June 20, 2016, Monday | ONLINE EDITION

Seventeen passengers were injured yesterday on an Air China flight from Frankfurt to Shanghai due to a strong turbulence in the air.

A foreign couple in their 70s were also among the injured passengers.

The aircraft with Flight CA936 suddenly encountered the severe turbulence and fluctuated strongly in the air and several passengers had not yet have their seat belt fasten when it took place, the nation's

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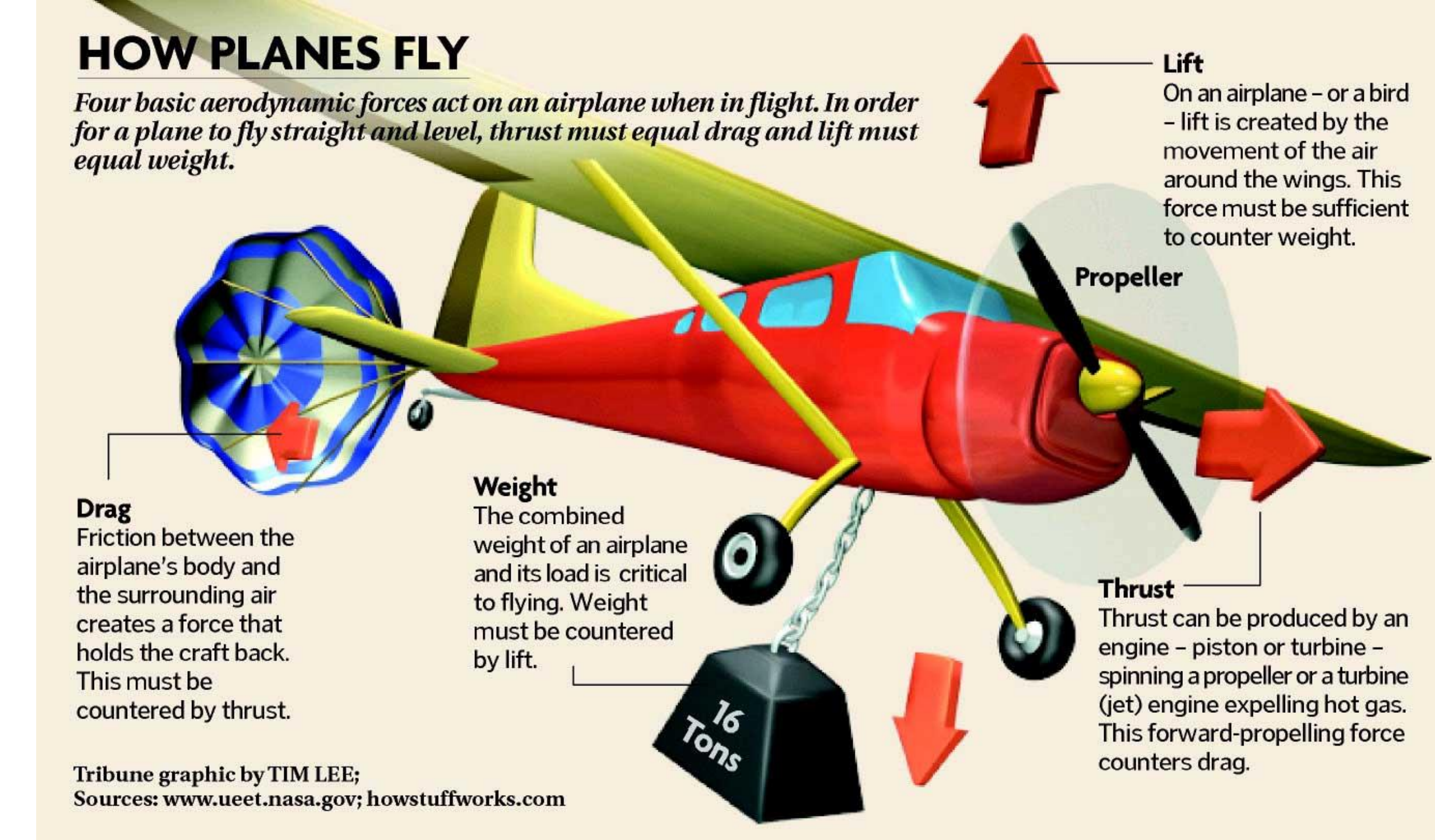
HOW PLANES FLY

Four basic aerodynamic forces act on an airplane when in flight. In order for a plane to fly straight and level, thrust must equal drag and lift must equal weight.



Lift
On an airplane – or a bird – lift is created by the movement of the air around the wings. This force must be sufficient to counter weight.

Propeller

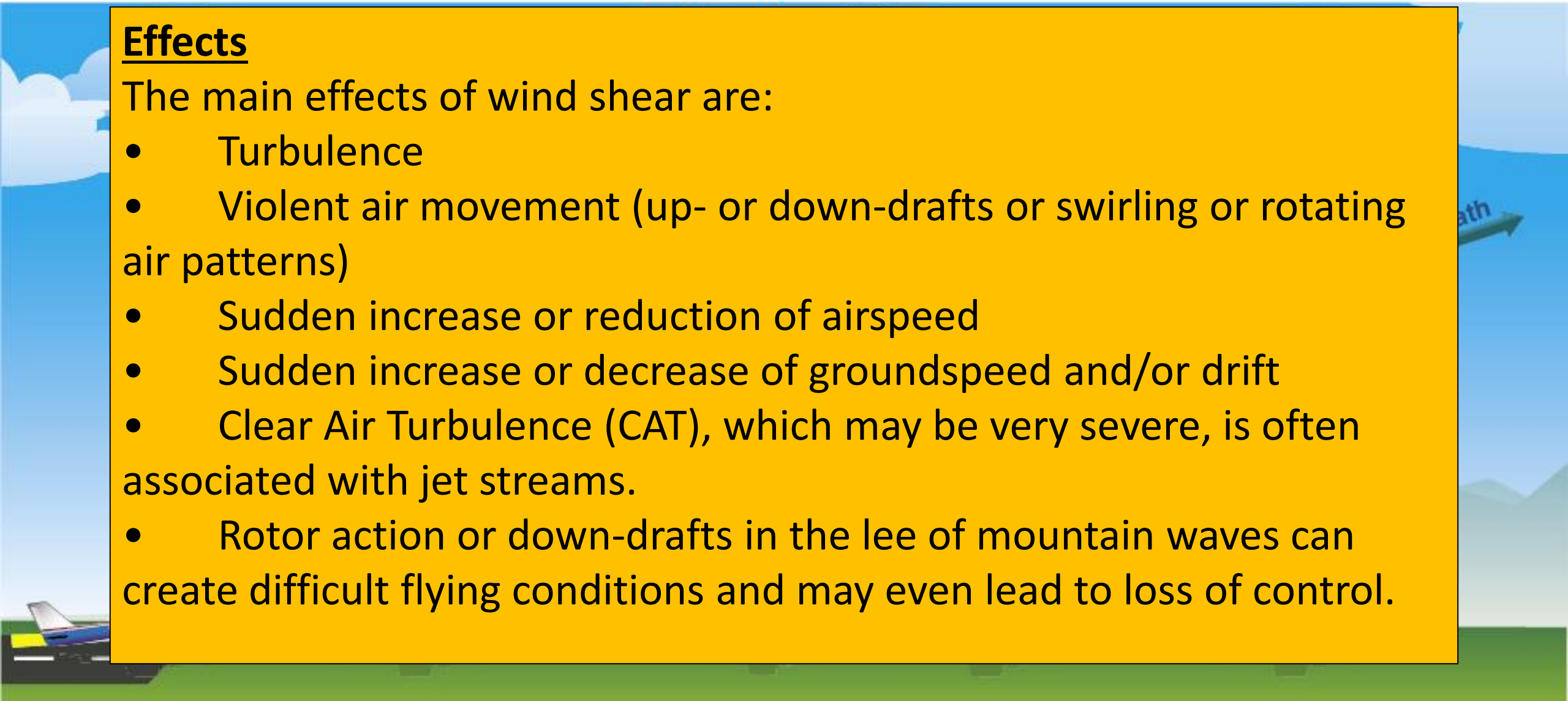
Drag
Friction between the airplane's body and the surrounding air creates a force that holds the craft back. This must be countered by thrust.

Weight
The combined weight of an airplane and its load is critical to flying. Weight must be countered by lift.

Thrust
Thrust can be produced by an engine – piston or turbine – spinning a propeller or a turbine (jet) engine expelling hot gas. This forward-propelling force counters drag.

Tribune graphic by TIM LEE;
Sources: www.ueet.nasa.gov; howstuffworks.com

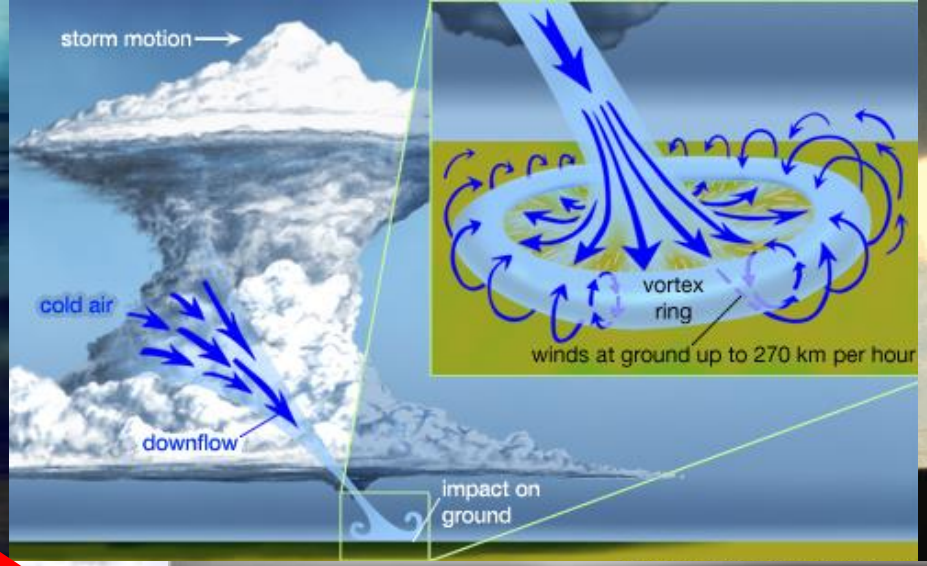
Wind shear: a sudden change of wind velocity and/or direction. Wind shear may be vertical or horizontal, or a mixture of both types. **Vertical wind shear:** change of horizontal wind direction and/or speed with height, as would be determined by means of two or more anemometers mounted at different heights on a single mast. **Horizontal wind shear:** change of horizontal wind direction and/or speed with horizontal distance, as would be determined by two or more anemometers mounted at the same height along a runway.



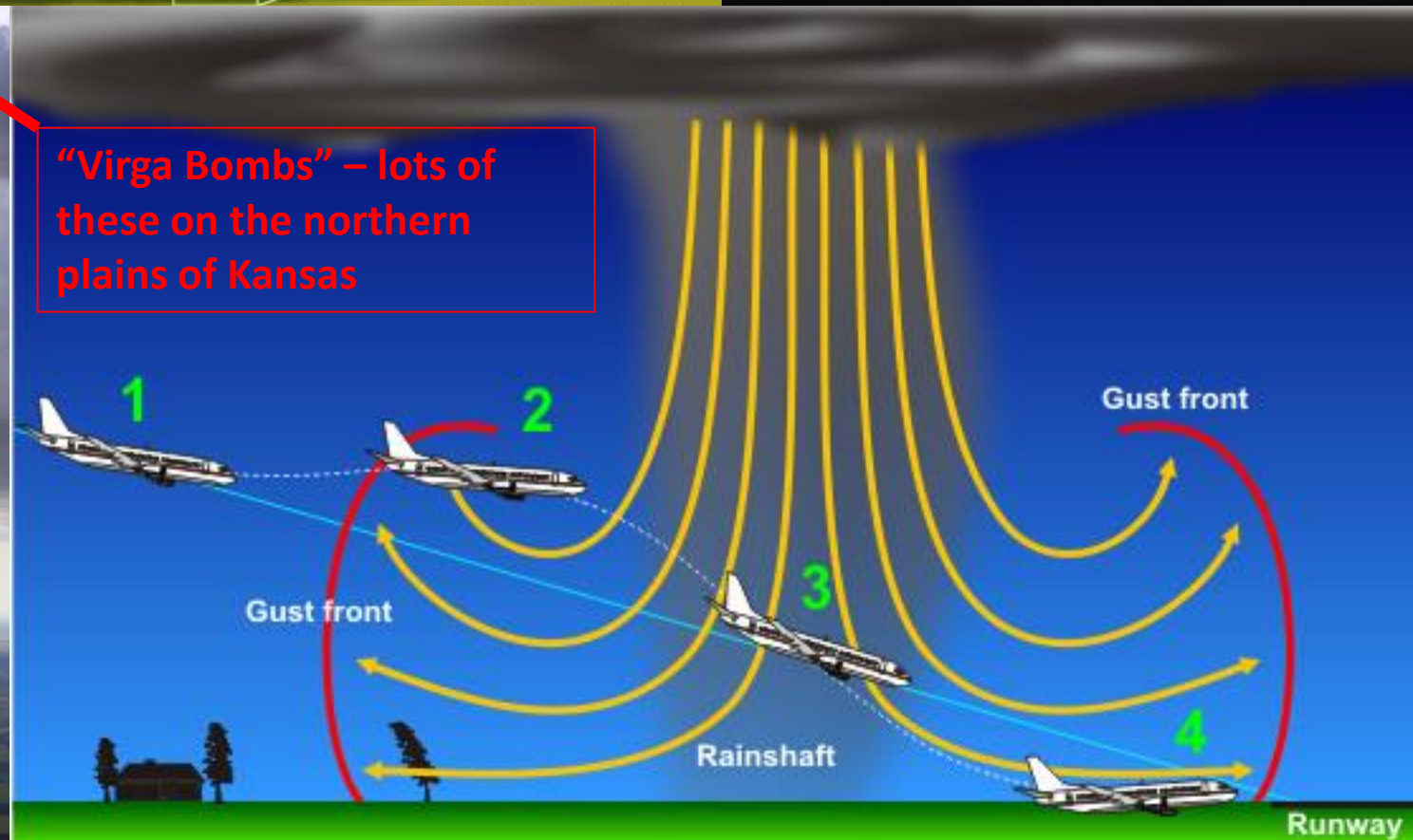
Effects

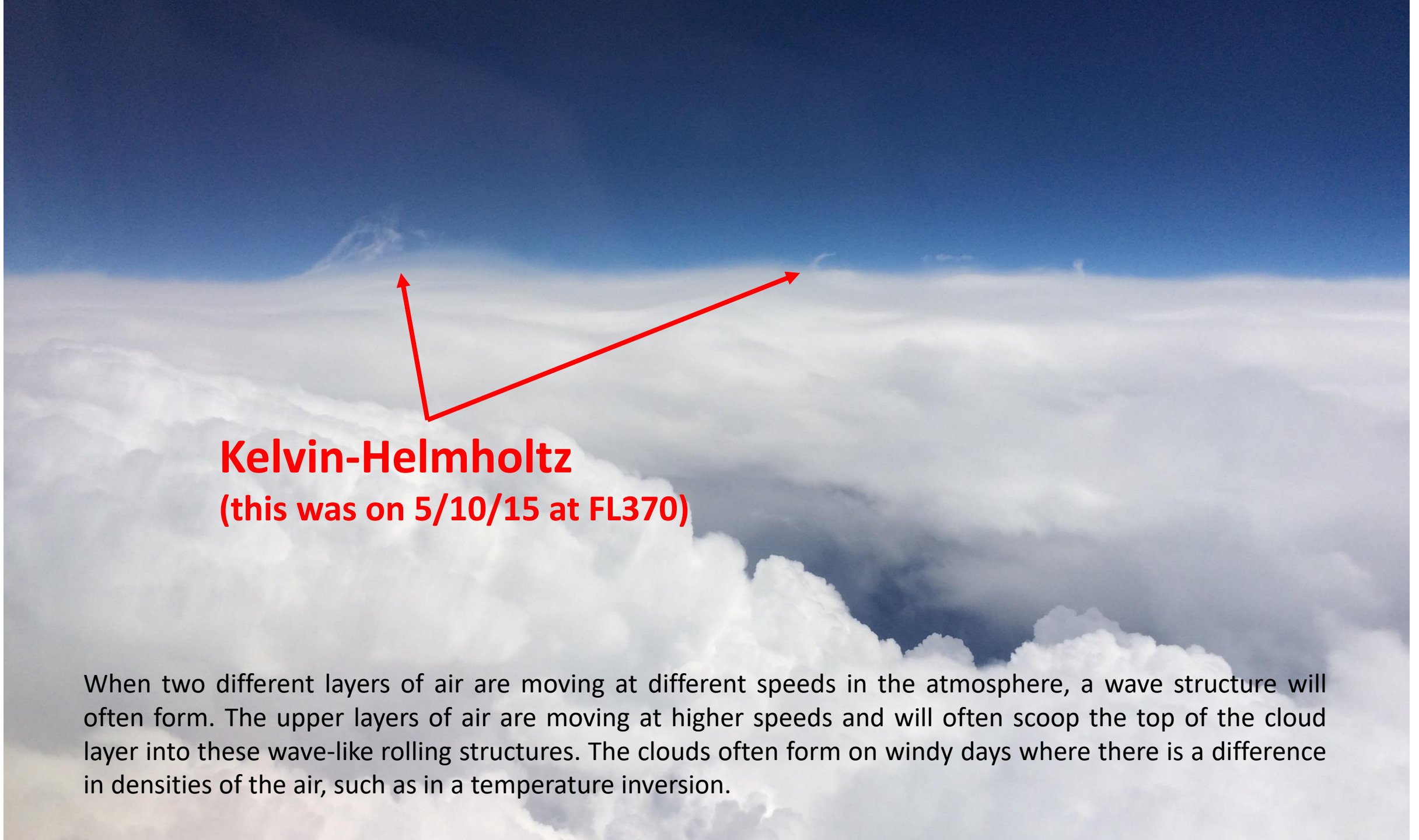
The main effects of wind shear are:

- Turbulence
- Violent air movement (up- or down-drafts or swirling or rotating air patterns)
- Sudden increase or reduction of airspeed
- Sudden increase or decrease of groundspeed and/or drift
- Clear Air Turbulence (CAT), which may be very severe, is often associated with jet streams.
- Rotor action or down-drafts in the lee of mountain waves can create difficult flying conditions and may even lead to loss of control.



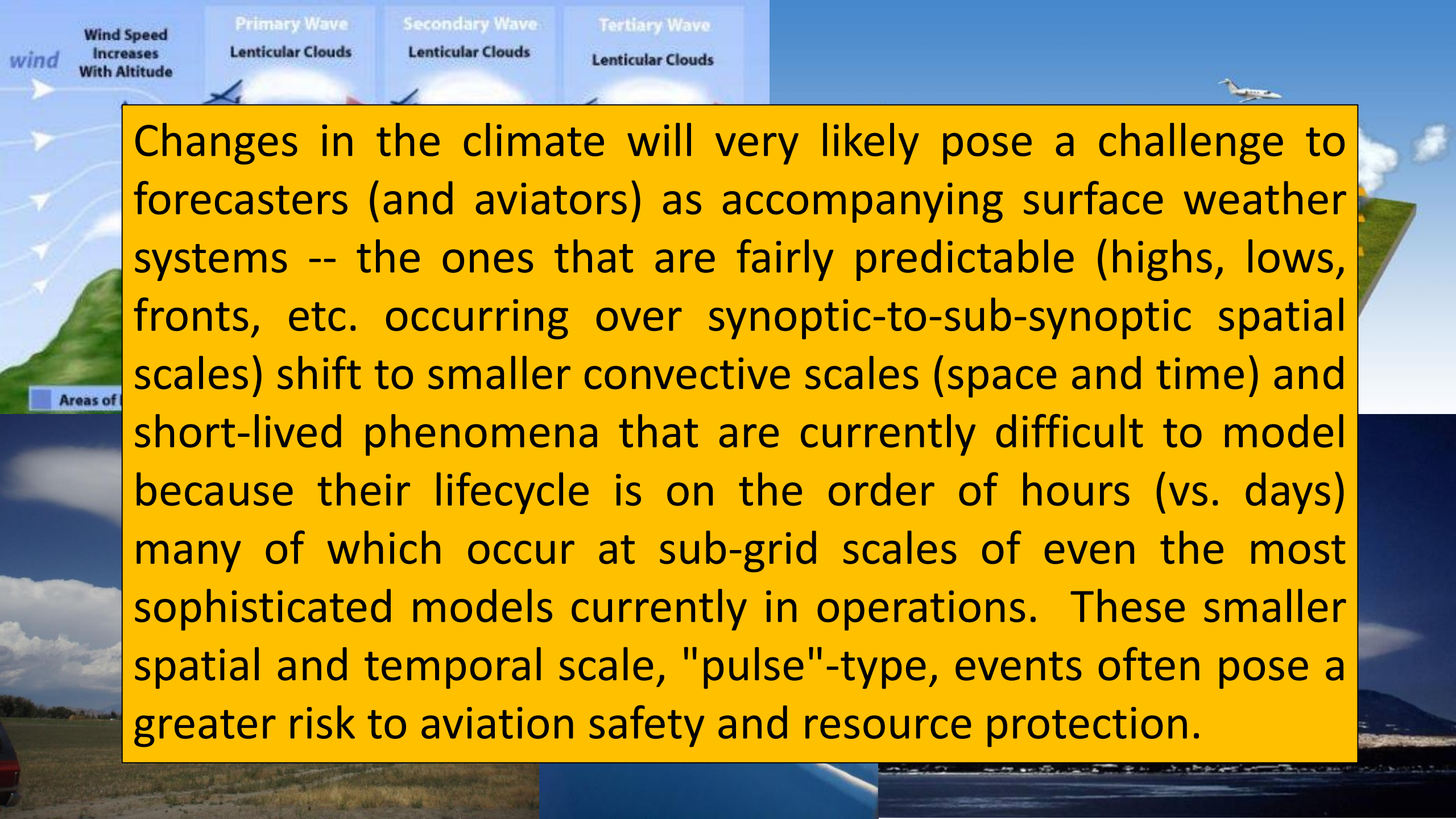
"Virga Bombs" – lots of these on the northern plains of Kansas



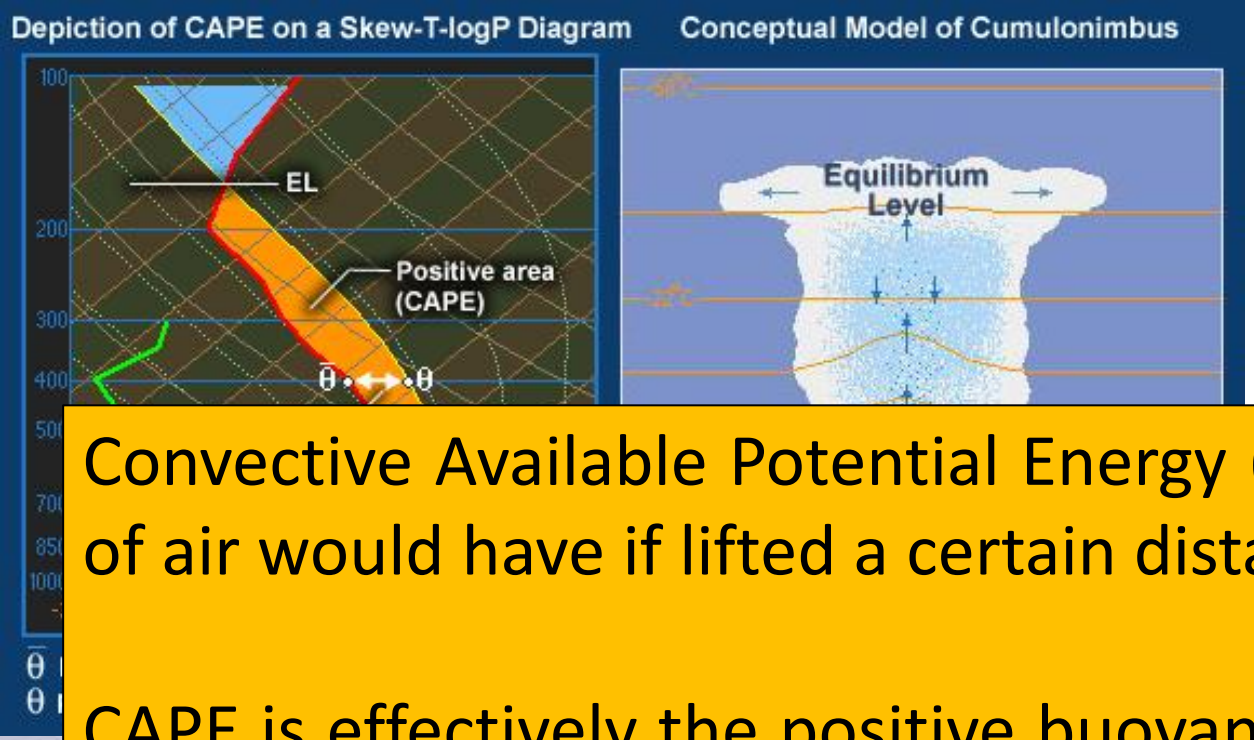


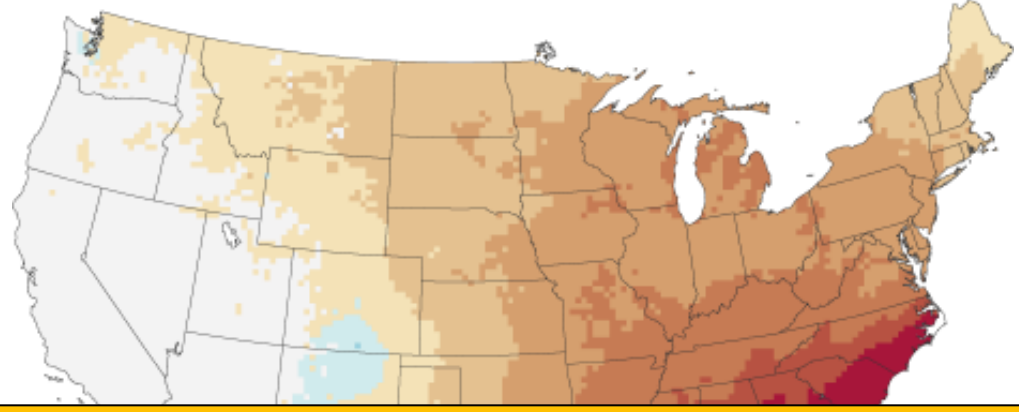
When two different layers of air are moving at different speeds in the atmosphere, a wave structure will often form. The upper layers of air are moving at higher speeds and will often scoop the top of the cloud layer into these wave-like rolling structures. The clouds often form on windy days where there is a difference in densities of the air, such as in a temperature inversion.

These clouds are also known as billow clouds, shear-gravity clouds, KHI clouds, or Kelvin-Helmholtz billows. The rolling eddies seen at the top of the cloud layers are usually evenly spaced and easily identifiable. The clouds are named for Lord Kelvin and Hermann von Helmholtz. These clouds are often good indicators of atmospheric instability and the presence of turbulence for aircraft.



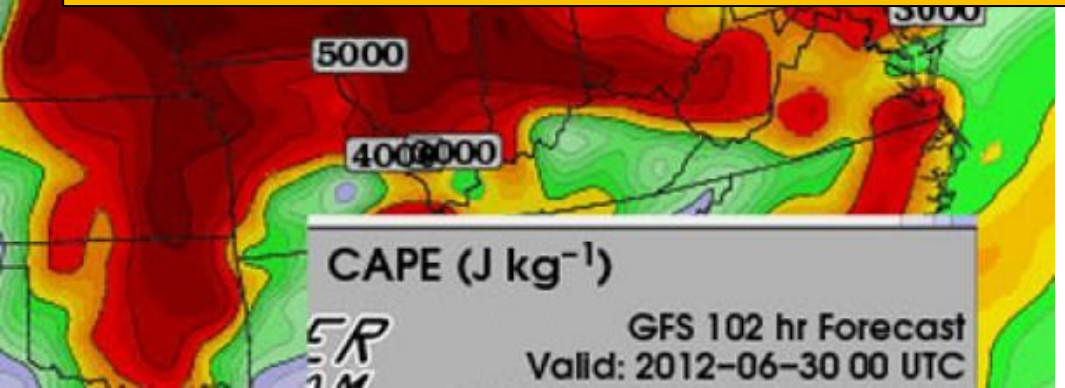
Changes in the climate will very likely pose a challenge to forecasters (and aviators) as accompanying surface weather systems -- the ones that are fairly predictable (highs, lows, fronts, etc. occurring over synoptic-to-sub-synoptic spatial scales) shift to smaller convective scales (space and time) and short-lived phenomena that are currently difficult to model because their lifecycle is on the order of hours (vs. days) many of which occur at sub-grid scales of even the most sophisticated models currently in operations. These smaller spatial and temporal scale, "pulse"-type, events often pose a greater risk to aviation safety and resource protection.

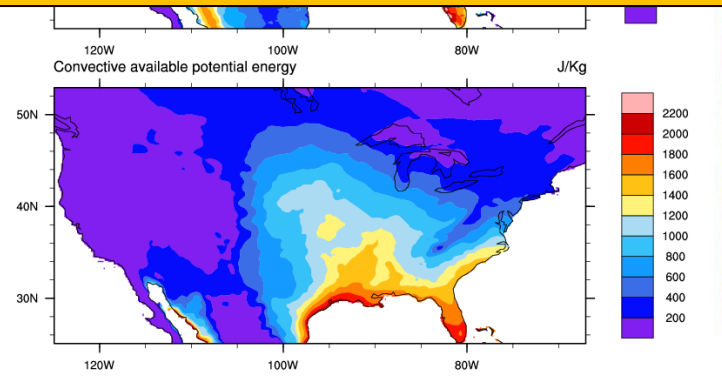


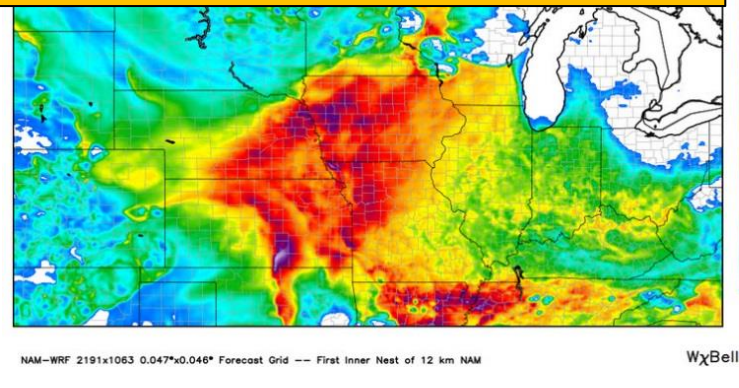


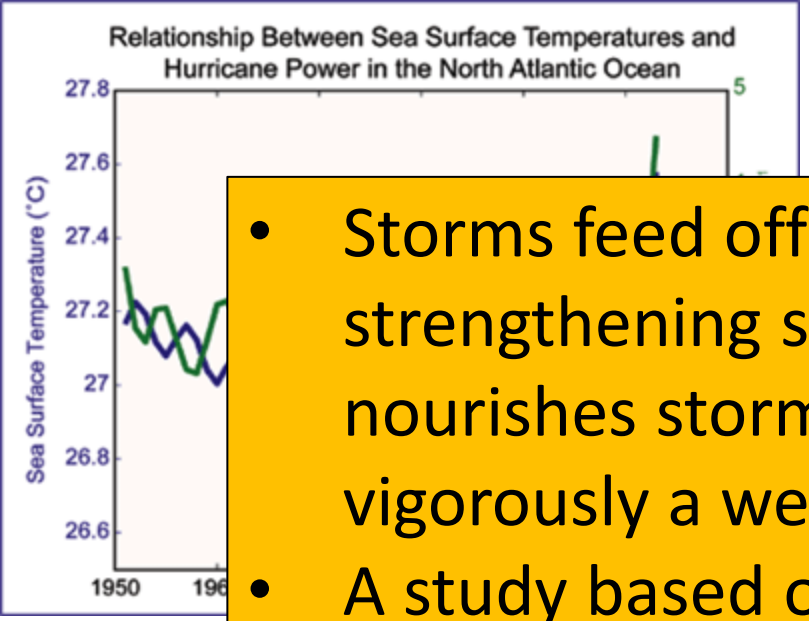
Convective Available Potential Energy (CAPE) is the amount of energy a parcel of air would have if lifted a certain distance vertically through the atmosphere.

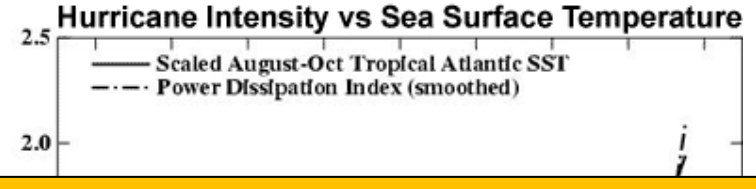
CAPE is effectively the positive buoyancy of an air parcel and is an indicator of atmospheric instability, which makes it very valuable in predicting severe weather. It is a form of fluid instability found in thermally stratified atmospheres in which a colder fluid overlies a warmer one.

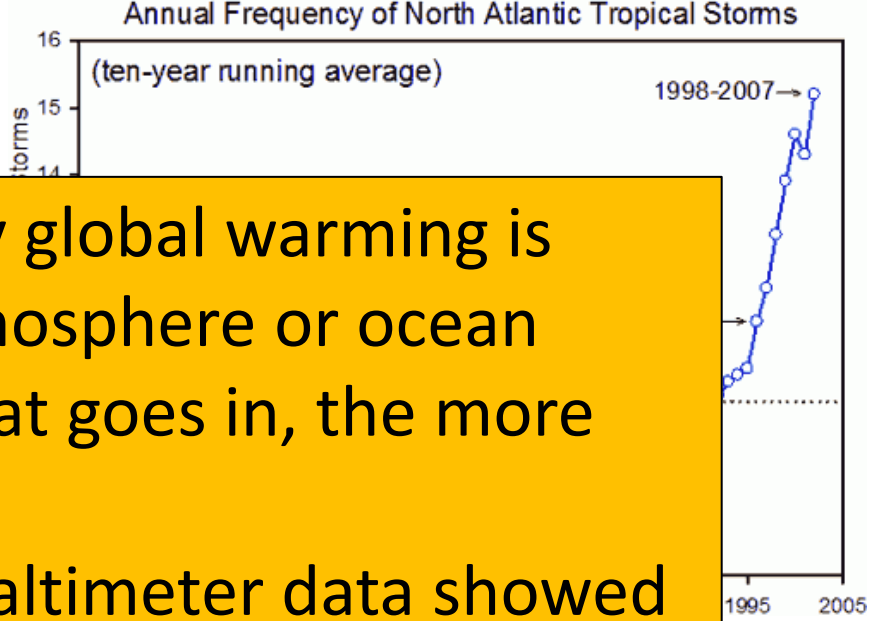




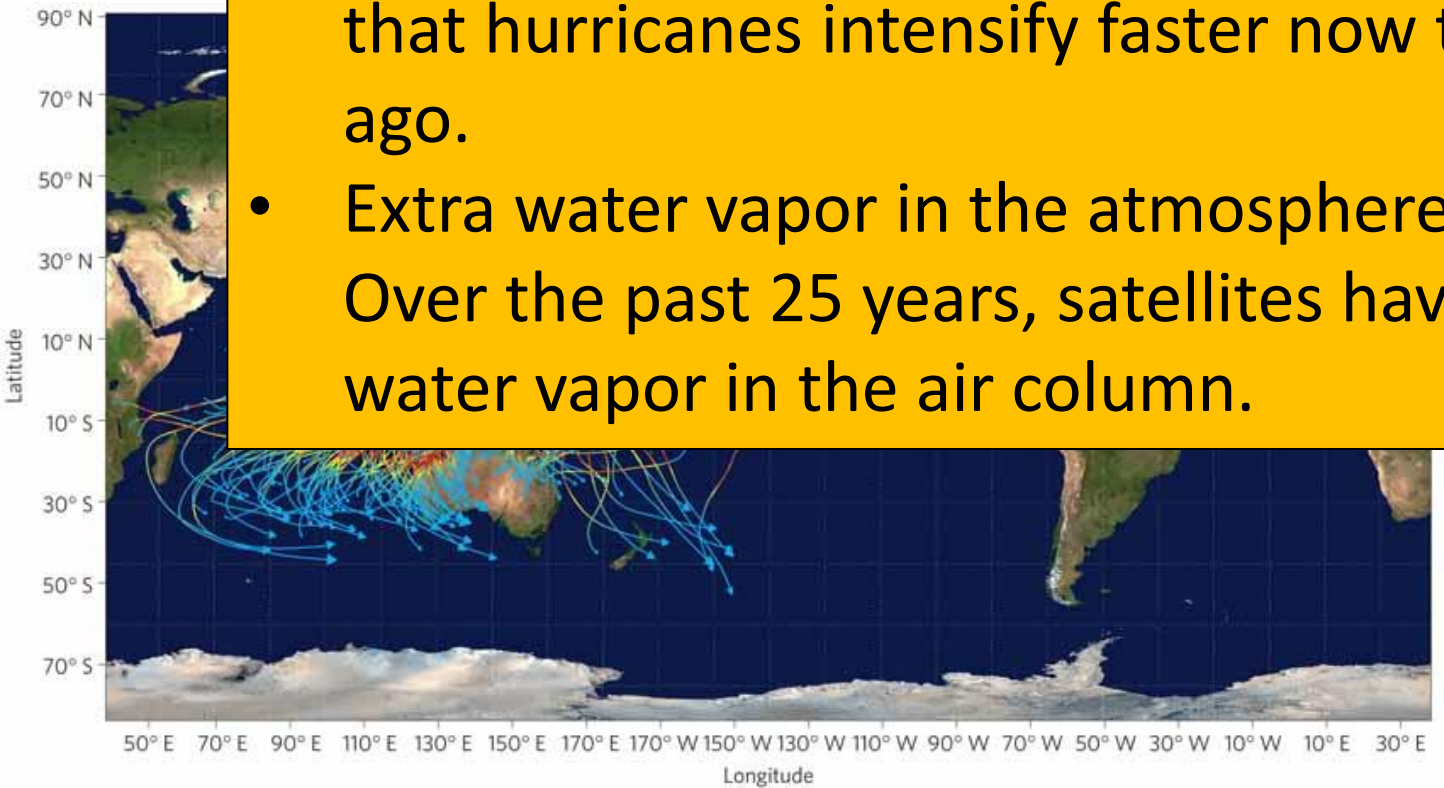


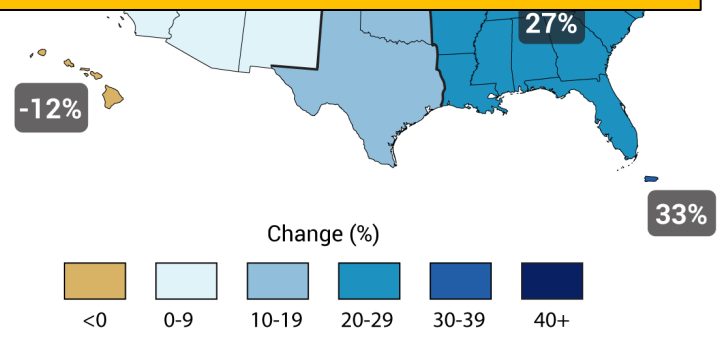


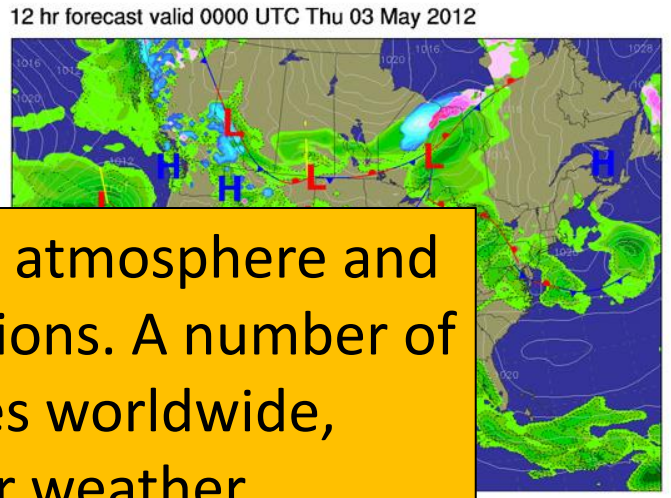




- Storms feed off of latent heat, which is why global warming is strengthening storms. Extra heat in the atmosphere or ocean nourishes storms; the more heat energy that goes in, the more vigorously a weather system can churn.
- A study based on over 20 years of satellite altimeter data showed that hurricanes intensify faster now than what they did 25 years ago.
- Extra water vapor in the atmosphere is also making storms wetter. Over the past 25 years, satellites have detected a 4 percent rise in water vapor in the air column.

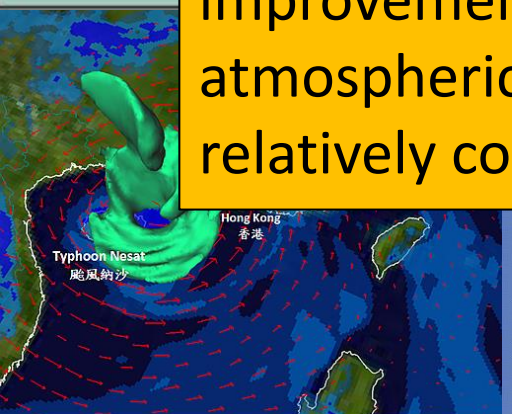


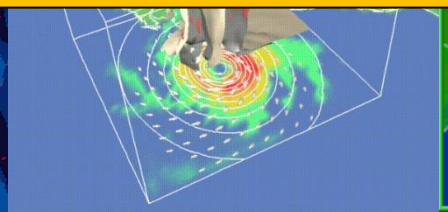


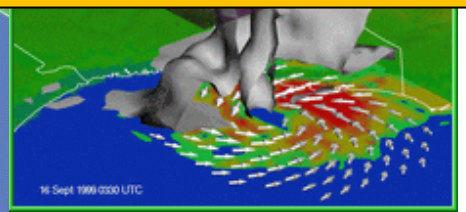


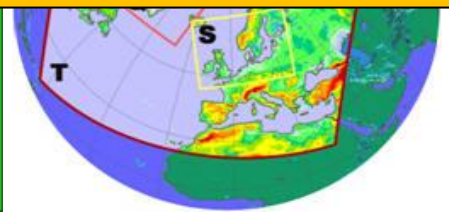
Numerical weather prediction uses mathematical models of the atmosphere and oceans to predict the weather based on current weather conditions. A number of global and regional forecast models are run in different countries worldwide, using current weather observations relayed from radiosondes or weather satellites as inputs to the models.

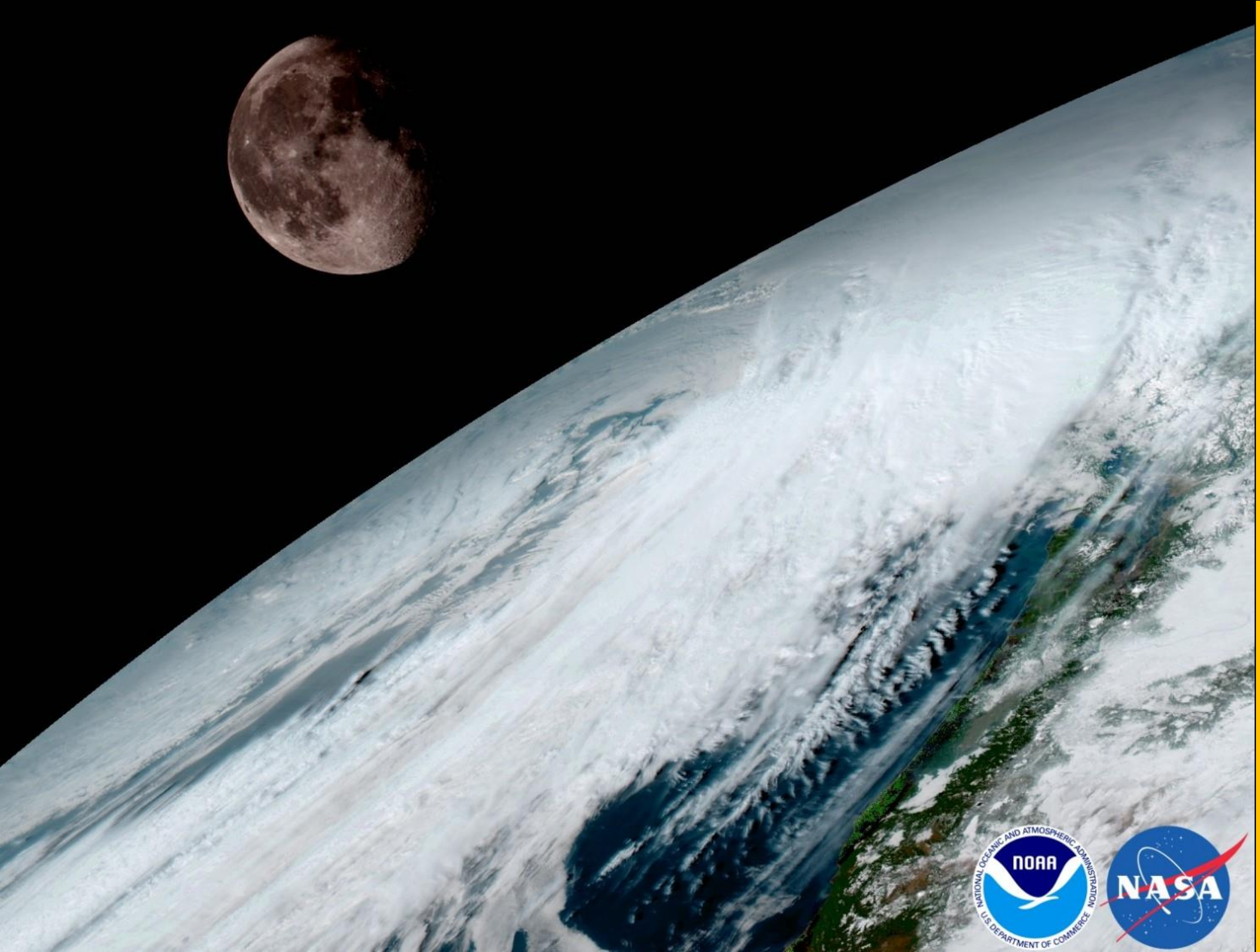
Mathematical models based on the same physical principles can be used to generate either short-term weather forecasts or longer-term climate predictions; the latter are widely applied for understanding and projecting climate change. The improvements made to regional models have allowed for significant improvements in tropical cyclone track and air quality forecasts; however, atmospheric models perform poorly at handling processes that occur in a relatively constricted area, such as wildfires







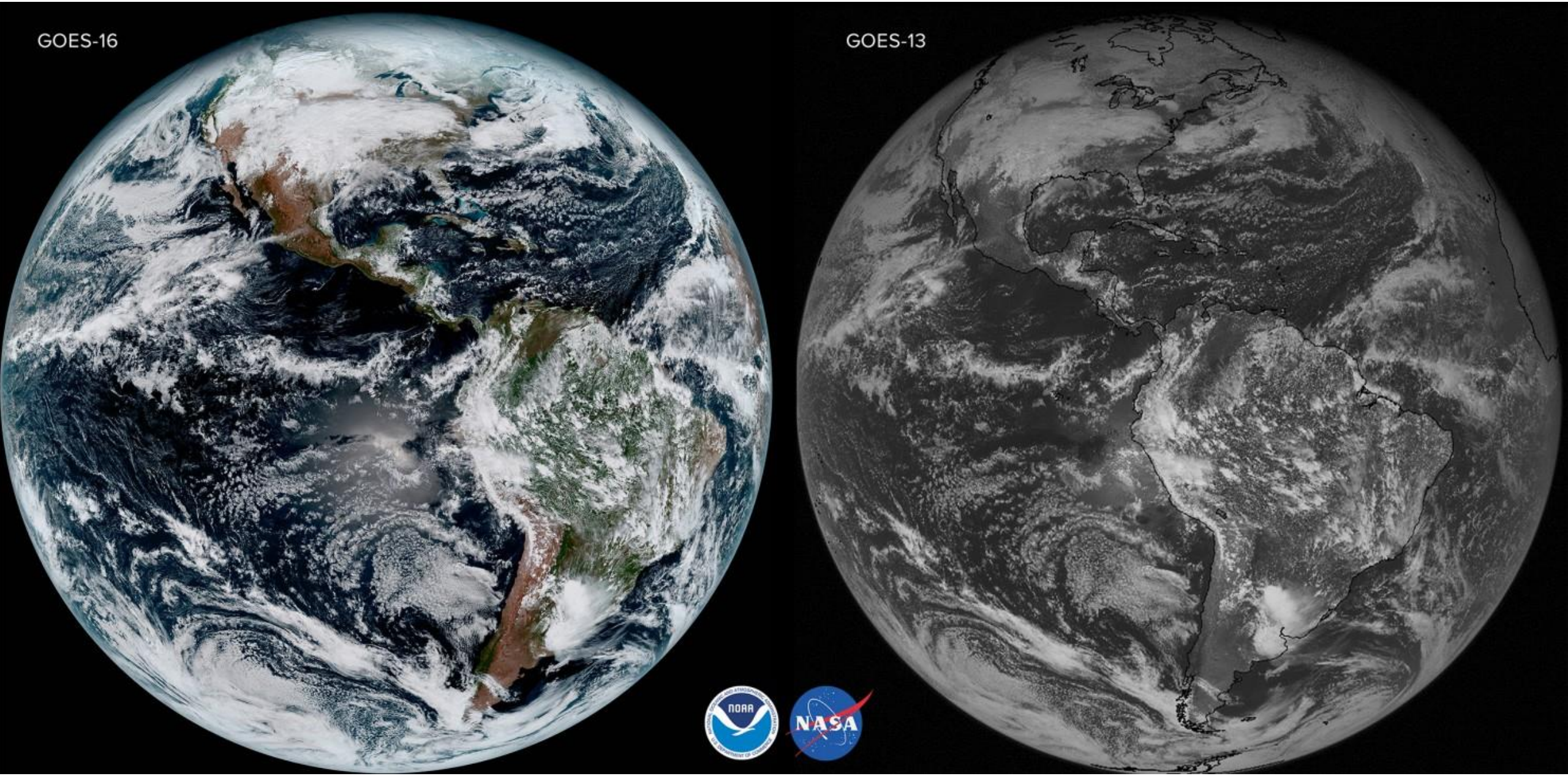


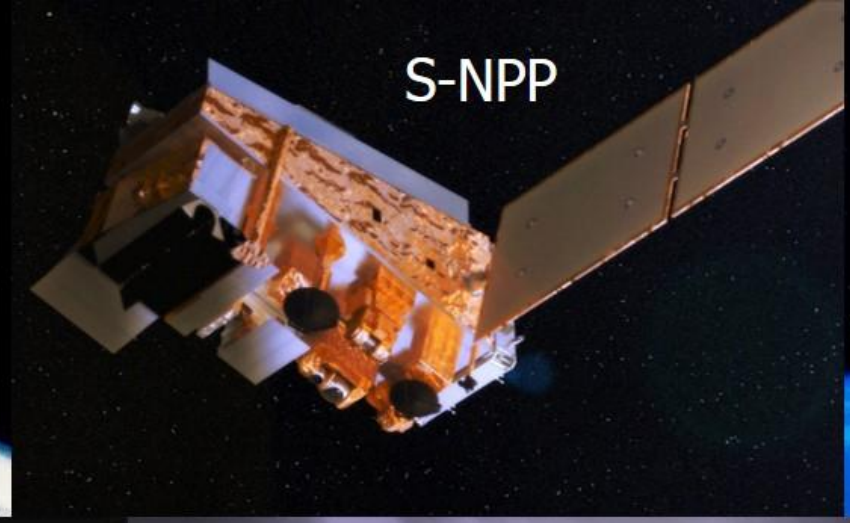


NOAA's newest GEO (geostationary with the earth) weather satellite is the GOES-R – which represents a significant improvement over older GOES satellites.

The GOES-R (now known as GOES-16) was launched on November 19th 2016 and the first images were published in late January of 2017.

See the first image on the left from the new GOES-16 imager.


GOES-16
GOES-13
NOAA
NASA



NASA

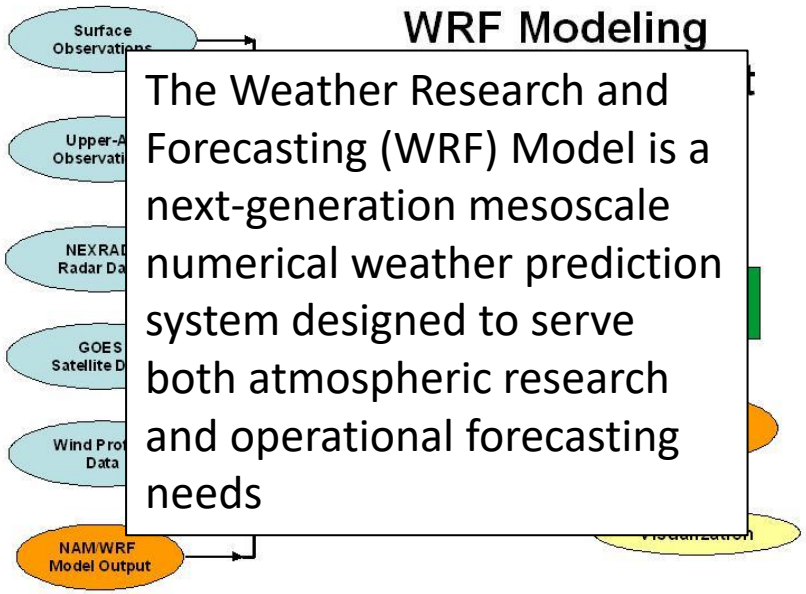
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

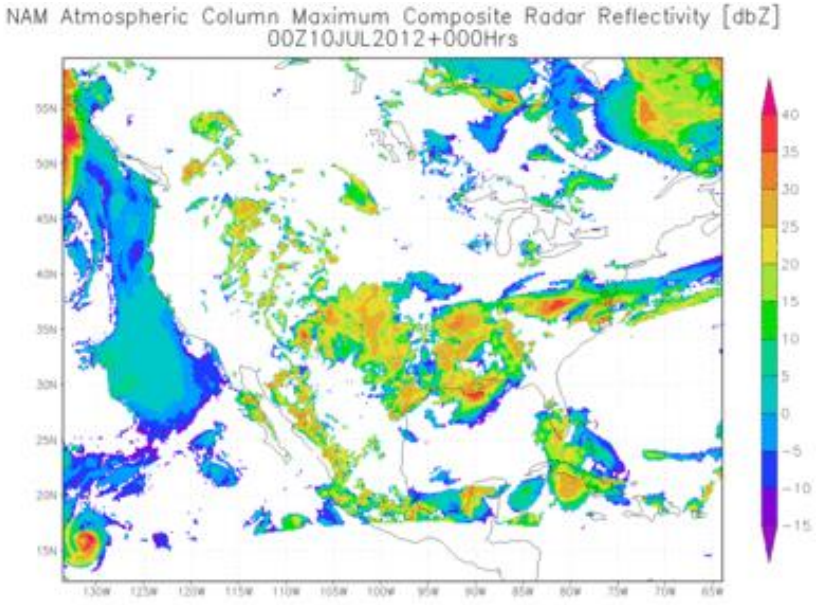
DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

EUMETSAT

空へ挑み、宇宙を拓く
JAXA
宇宙航空研究開発機構


JPSS2
JPSS1





[Global Data Assimilation System (GDAS)]

GDAS is the set of assimilation data, both input and output, in various formats for the Global Forecast System model, which has been archived since 2004.

[Global Ensemble Forecast System (GEFS)]

GEFS is a global-coverage weather forecast model made up of 21 separate forecasts, or ensemble members, used to quantify the amount of uncertainty in a forecast. GEFS is produced four times a day with weather forecasts going out to 16 days.

[Global Forecast System (GFS)]

The GFS model is a coupled weather forecast model, composed of four separate models that work together to provide an accurate picture of weather conditions. The entire globe is covered by the GFS down to a horizontal resolution of 28 km.

[North American Mesoscale (NAM)]

NAM is a regional weather forecast model covering North America down to a horizontal resolution of 12 km. Dozens of weather parameters are available from the NAM grids, from temperature and precipitation to lightning and turbulent kinetic energy.

[Rapid Refresh (RAP)]

RAP is a regional weather forecast model of North America with separate sub-grids (with different horizontal resolutions) within the overall North America domain. RAP forecasts are generated every hour with forecast lengths going out 18 hours.

4 km WRF Simulated Reflectivity Forecasts

Loop Mode:

Animate Frames:

Dwell First:

Dwell Last:

Adjust Speed:

Advance One:

Frame No: 26

Omit Frame:

01 02
03 04
05 06
07 08
09 10
11 12
13 14
15 16
17 18
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27 28
29 30
31 32
33 34
35 36

Questions & Comments to: jack.kain@noaa.gov

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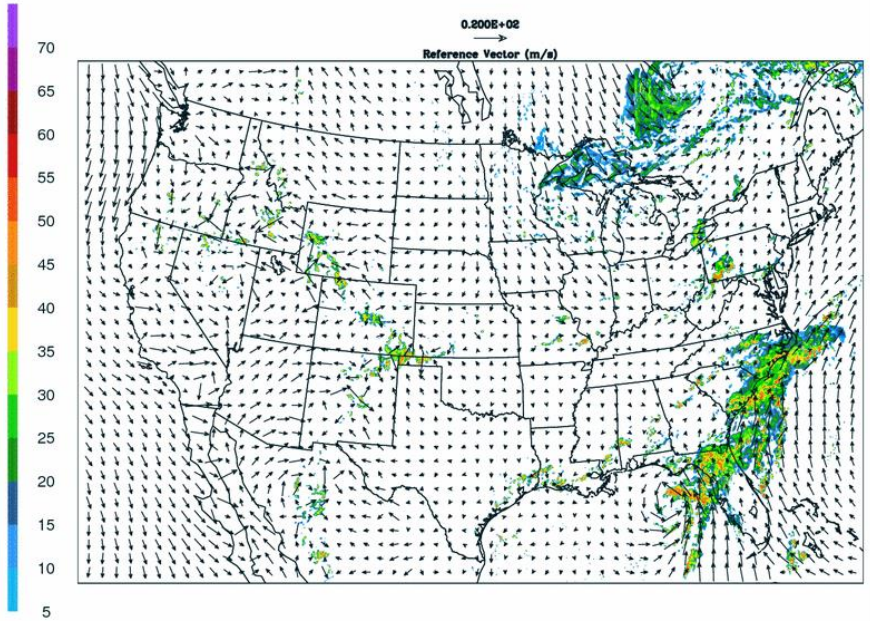
VALID 02Z 07 JUN 16

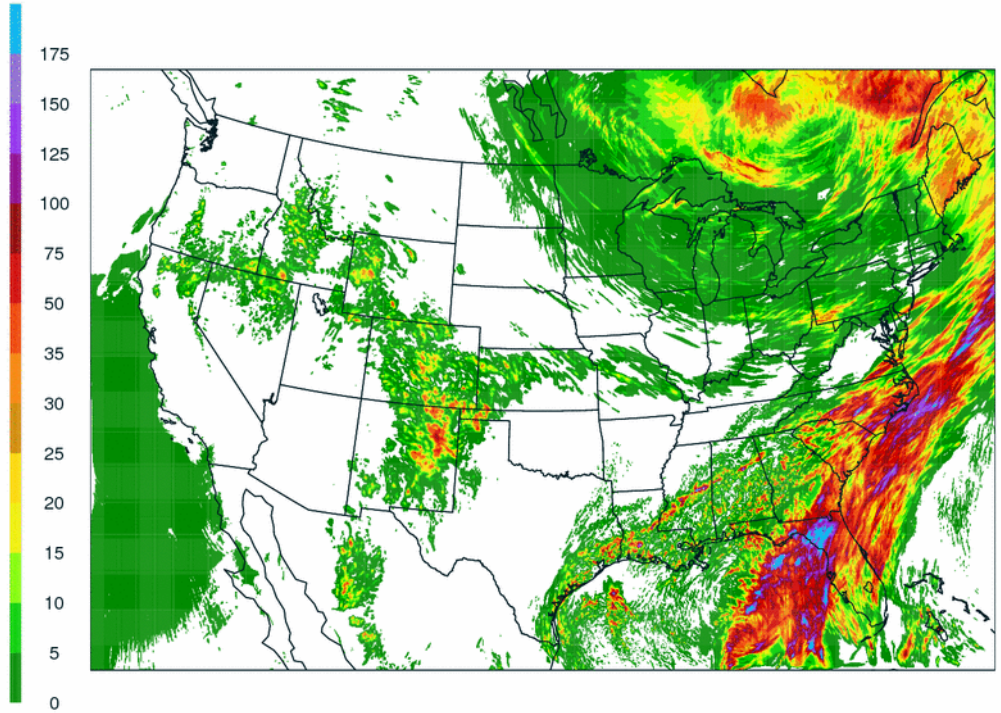
NSSL Realtime WRF
26-H FCST
4.0 KM LMB CON GRD



26 hr fcst

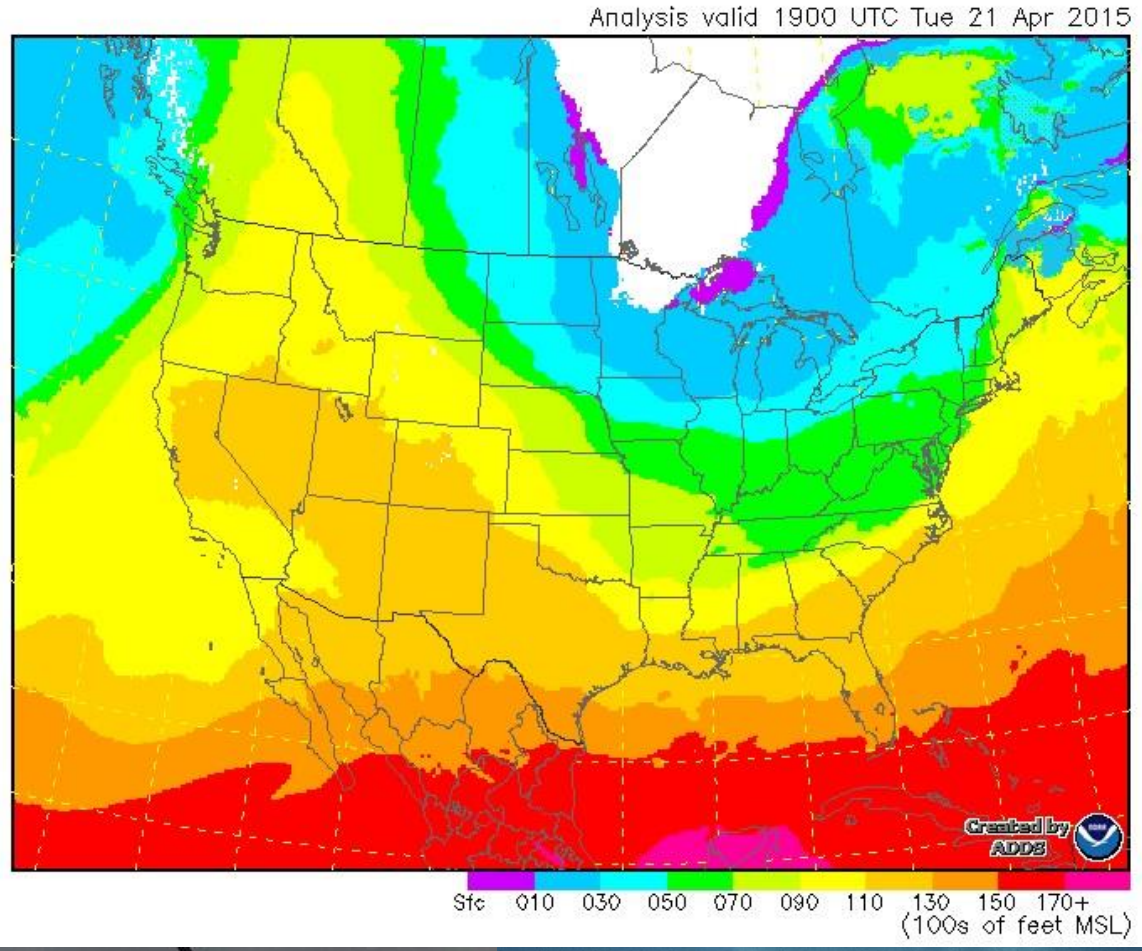
PRECIP(mm)
36h accum
VALID 12Z 07 JUN 16

NSSL Realtime WRF
36-H FCST
4.0 KM LMB CON GRD

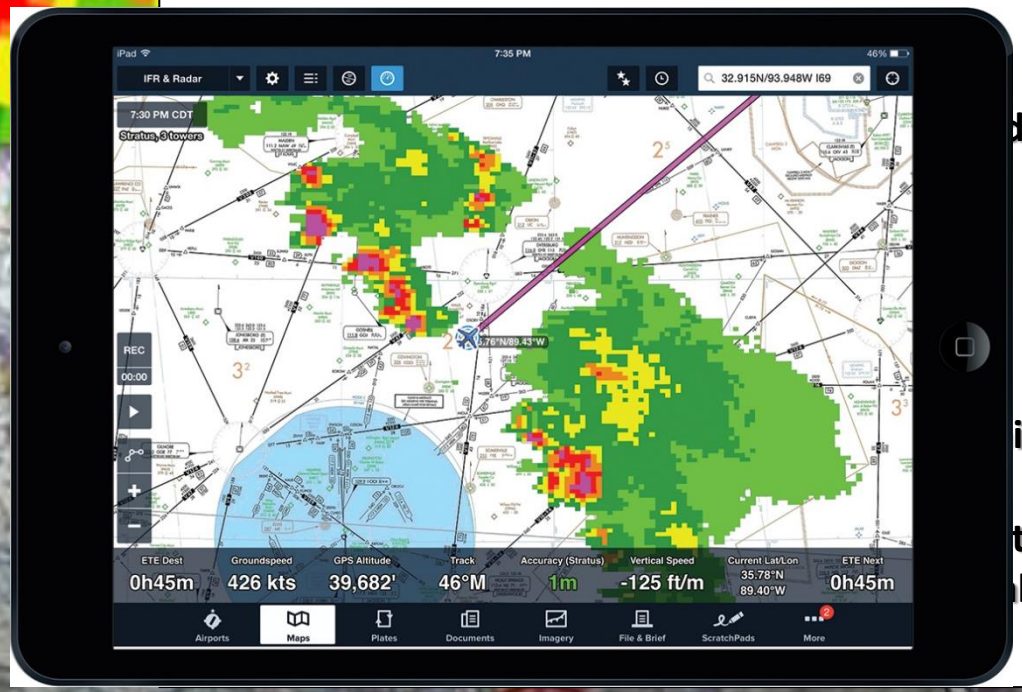


http://wrf.nssl.noaa.gov/refl_loop.html

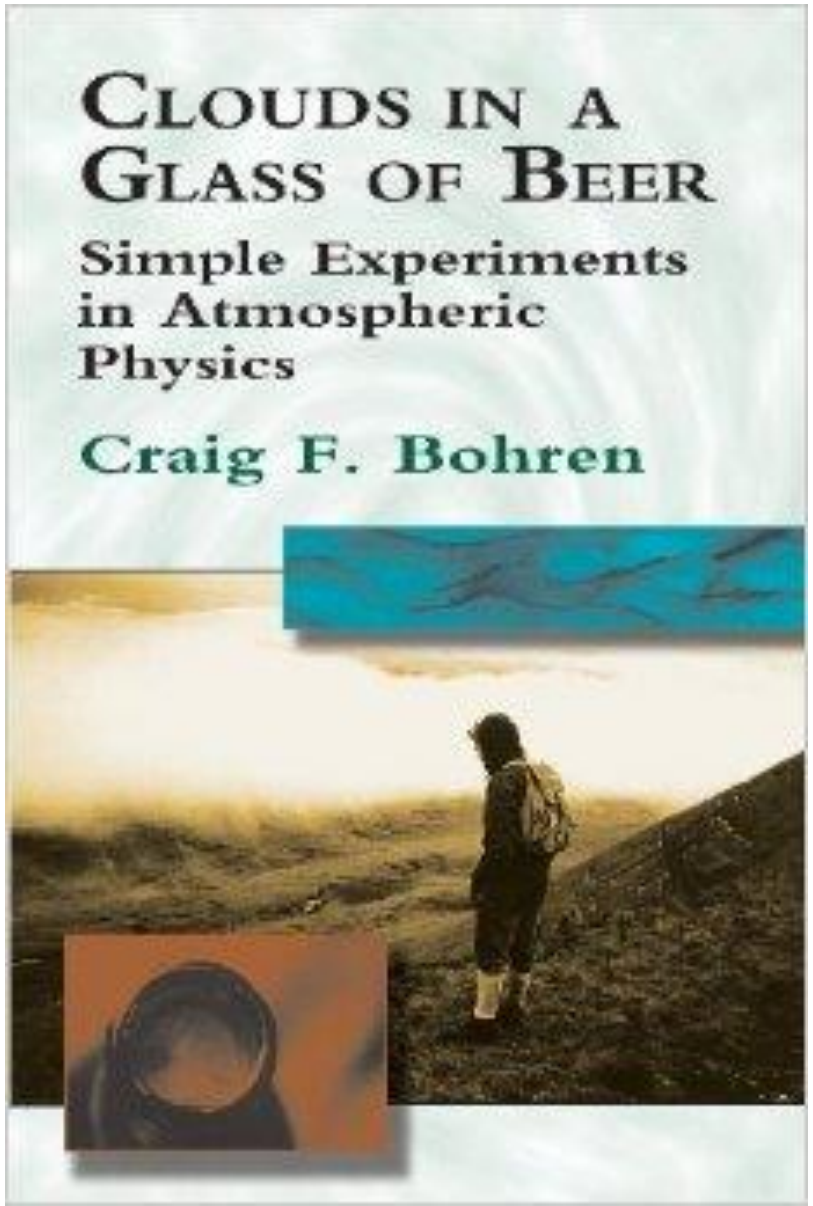
Lowest freezing level (100s of feet MSL)



other flight information to the general aviation
sceiver (UAT) equipment. FIS-B includes the



More on atmospheric science and physics…..



Clouds in a Glass of Beer: Simple Experiments in Atmospheric Physics
Craig F. Bohren

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Questions?