



Understanding weather and the weather forecast

Week 22

Hail and Tornadoes

Terry Hart



AskBOM: What is a thunderstorm?

A YouTube video thumbnail for 'AskBOM: What is a thunderstorm?'. The thumbnail features a man in a plaid shirt smiling. The text on the thumbnail includes the BOM logo, the title 'AskBOM: What is a thunderstorm?', the hashtag '#AskBOM', a play button icon, and the question 'What is a thunderstorm?'. At the bottom, it says 'Watch on YouTube'. There is also a 'Share' icon in the top right corner of the video frame.

AskBOM: What is a thunderstorm?

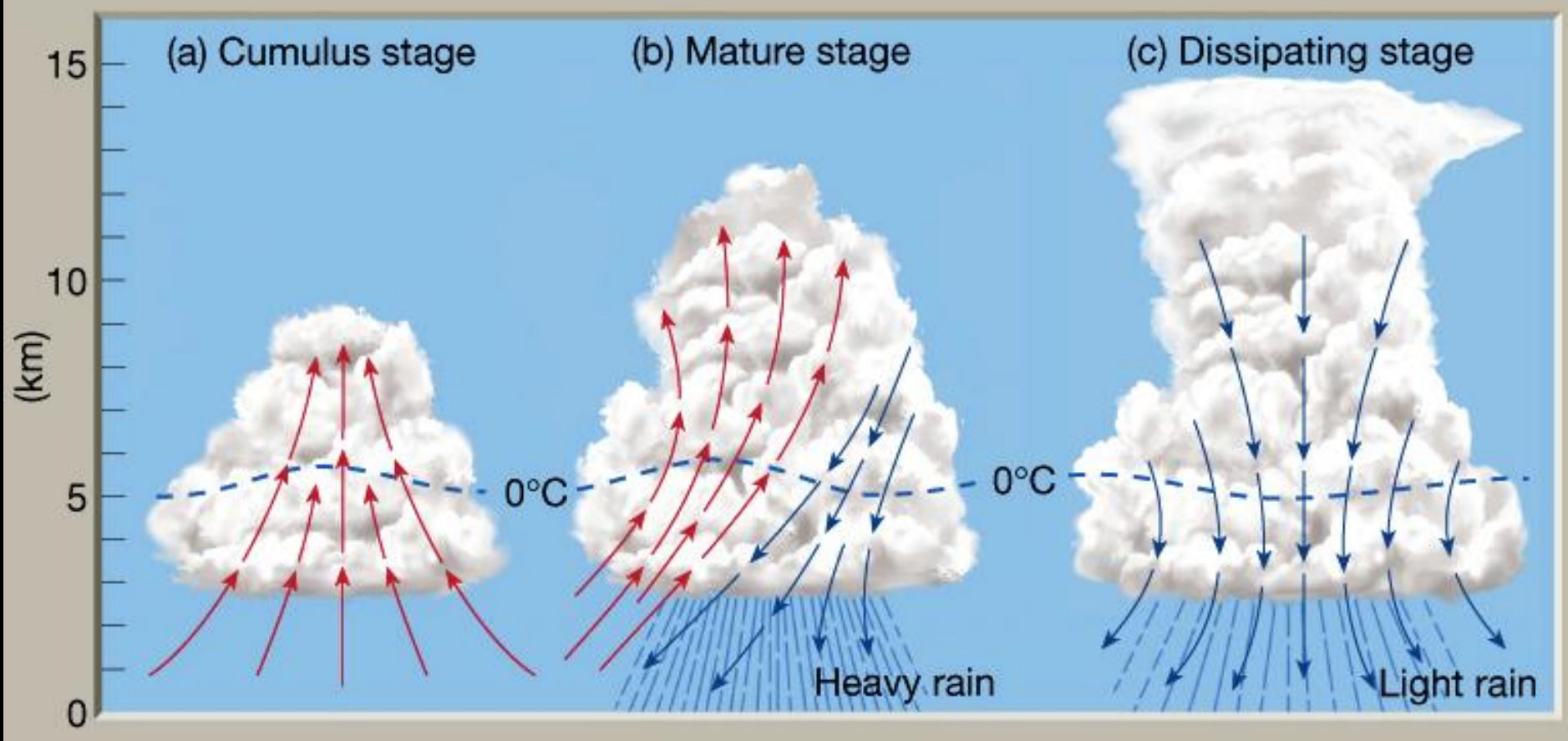
#AskBOM

What is a thunderstorm?

Watch on YouTube

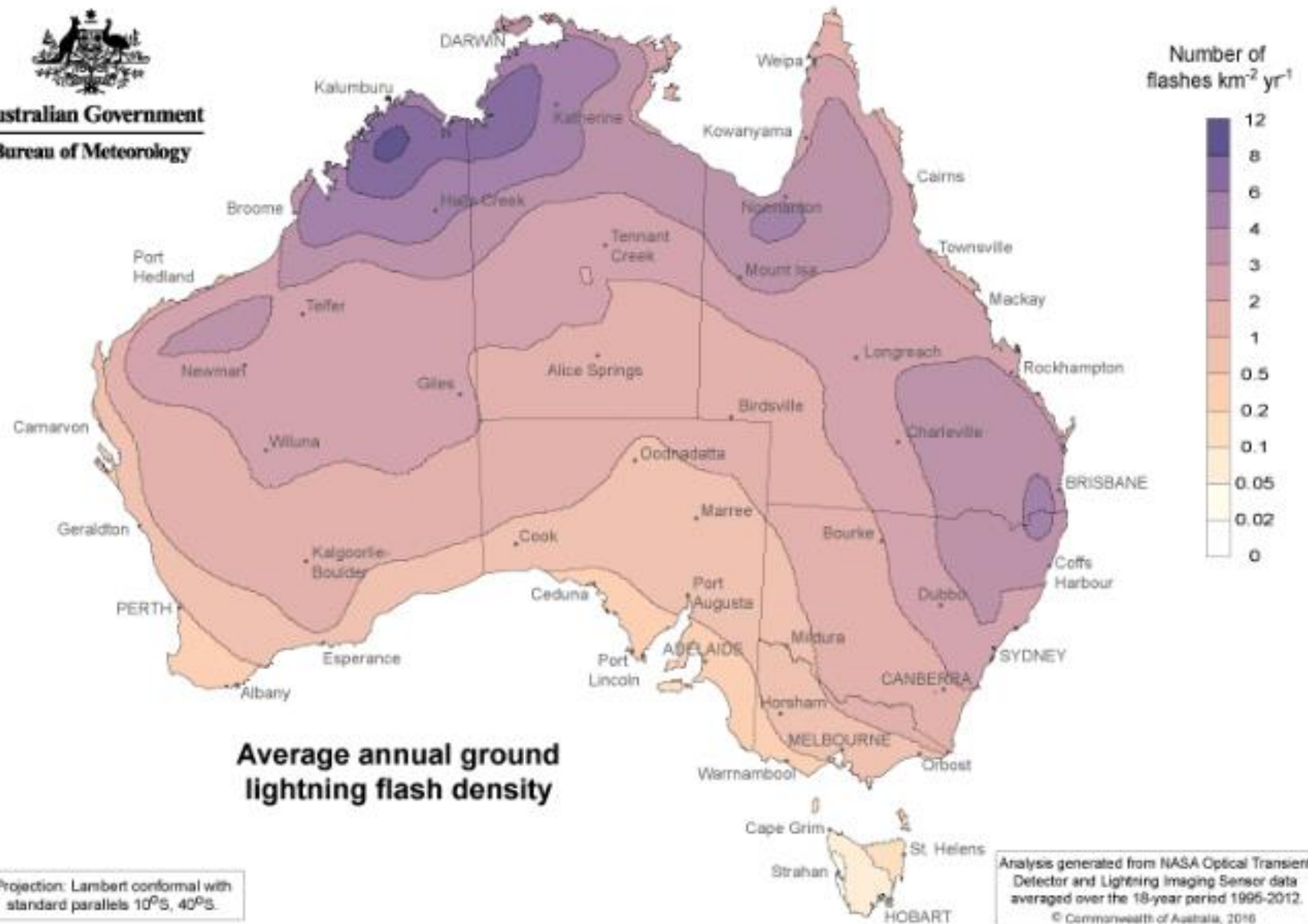
<https://youtu.be/HI5YH4bB-Vg>

Stages in development of a cumulonimbus

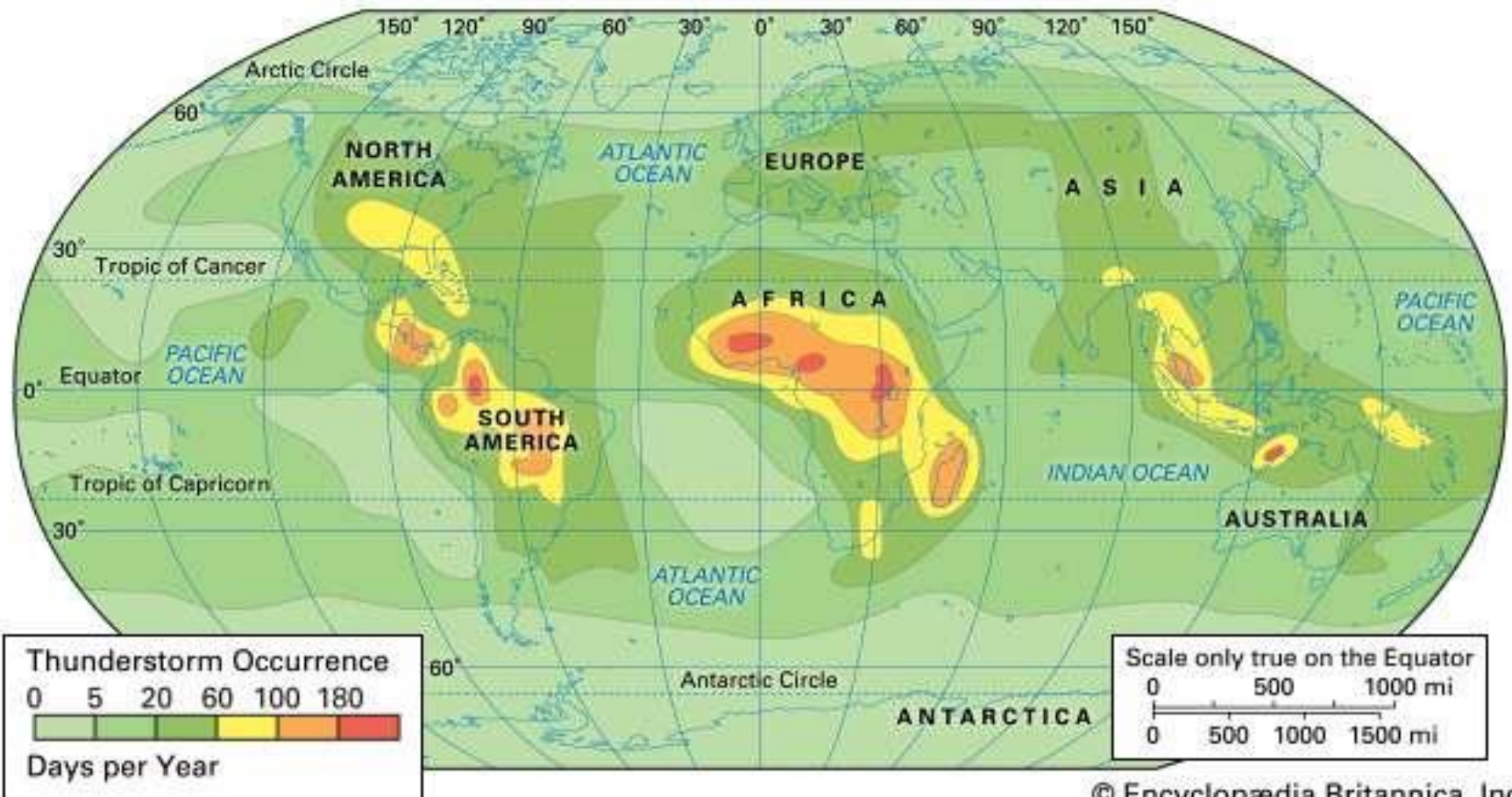




Australian Government
Bureau of Meteorology



WORLD PATTERNS OF THUNDERSTORM FREQUENCY



© Encyclopædia Britannica, Inc.

Severe thunderstorms

While we experience many types of thunderstorms in Australia, some more intense thunderstorms are referred to as severe thunderstorms. Severe thunderstorms can produce damaging wind gusts, large hail, tornadoes and heavy rain which may cause flash flooding and these phenomena can all cause significant damage.



How is a severe thunderstorm defined?

Thunderstorms which produce any of the following are classified as severe in Australia:

- large hail (2 cm in diameter or greater)
- damaging wind gusts (90 km/h or greater)
- tornadoes
- heavy rainfall conducive to flash flooding

Most thunderstorms do not reach the level of intensity needed to produce these dangerous phenomena. The Bureau of Meteorology only issues



<http://www.bom.gov.au/weather-services/severe-weather-knowledge-centre/severethunder.shtml>



A chunk of hail measuring almost 55 millimetres fell at Merlwood, west of Gympie. (Facebook: Sarah Vanderkolk)

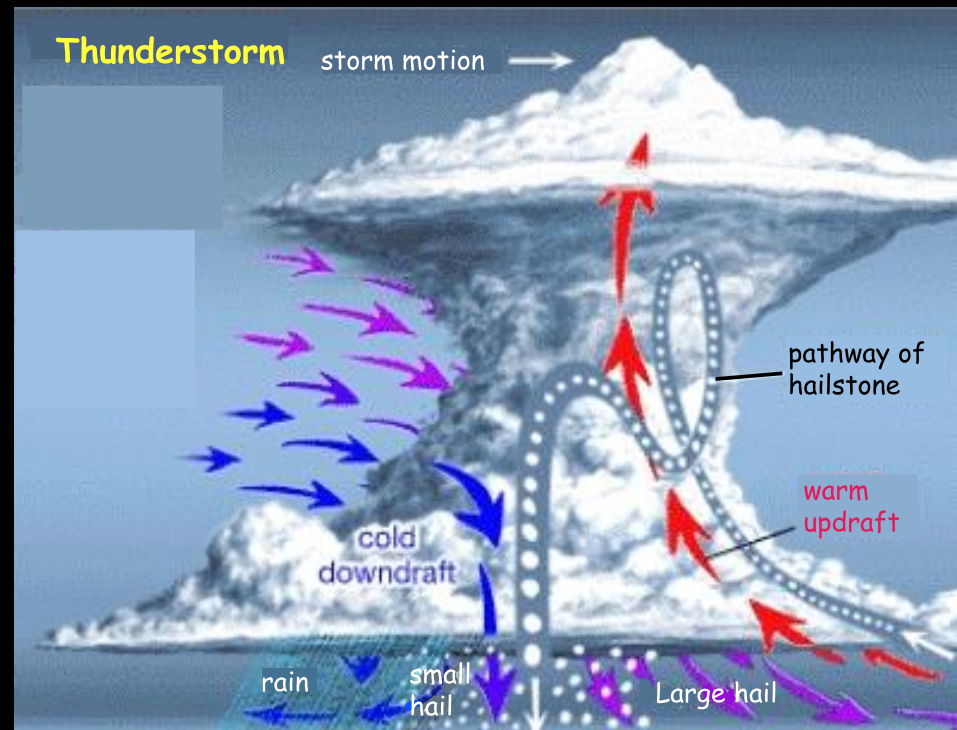


Weather wise videos

Hail <https://www.youtube.com/watch?v=6M-ycZLSF1w>

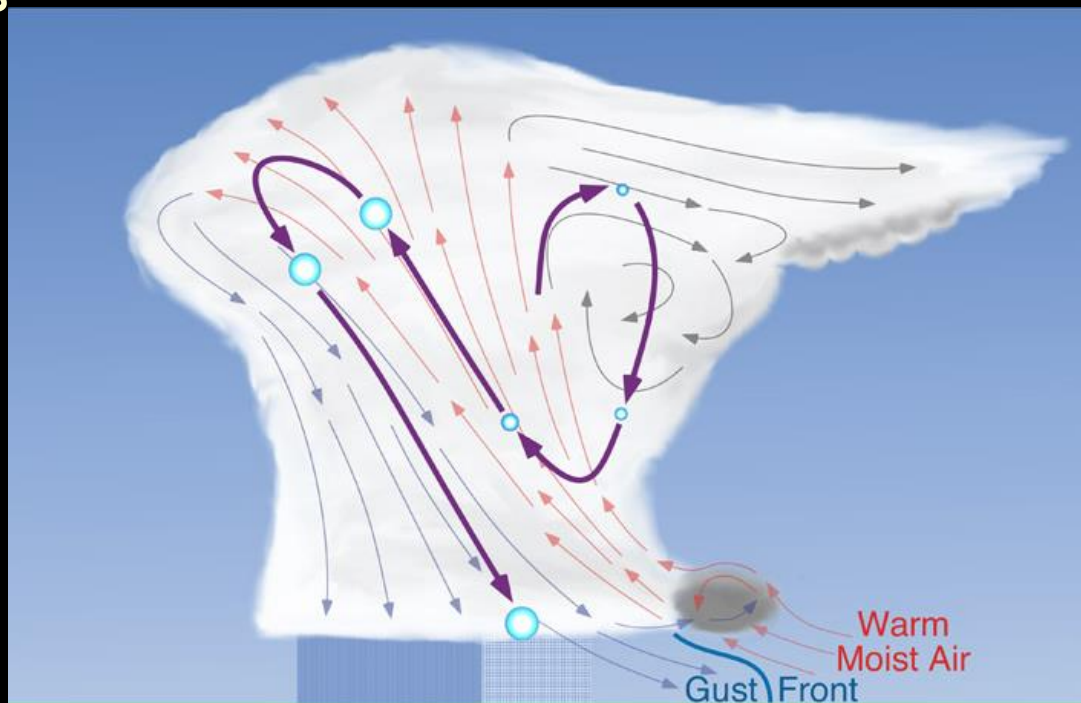
Hail formation

- Hailstone formation requires strong updrafts, cold upper air and condensation nuclei
- strong updrafts in cumulonimbus lift hail to higher levels → updrafts weaken → hail descends → again uplifted → fall from the cloud
- a layer of dry air in mid layers promotes hail development
- hail rare in tropical storms



Role of updrafts in hail formation

- For hail to grow → granules need to be suspended in super-cooled water environment for an extended period of time
- strong updrafts are required to overcome gravity
- updrafts commonly have speeds between 35 and 150km/hr
- hail falls from cloud under influence of gravity or is carried down by downdrafts





Large hailstone with concentric rings



Hail records (Wikipedia)

Heaviest: 1.02 kg
Gopalganj District, Bangladesh,
14 April 1986.

Largest diameter officially measured: 7.9 inches (20 cm) diameter, 18.6 inches (47.3 cm) circumference; Vivian, South Dakota, 23 July 2010.

Greatest average hail frequency:

Kericho, Kenya experiences hailstorms, on average, 50 days annually. Kericho is close to the equator and the elevation of 7,200 feet contributes to it being a hot spot for hail. Kericho reached the world record for 132 days of hail in one year.

Tornadoes

Oklahoma, 1999



Nimmitabel (NSW) 2008



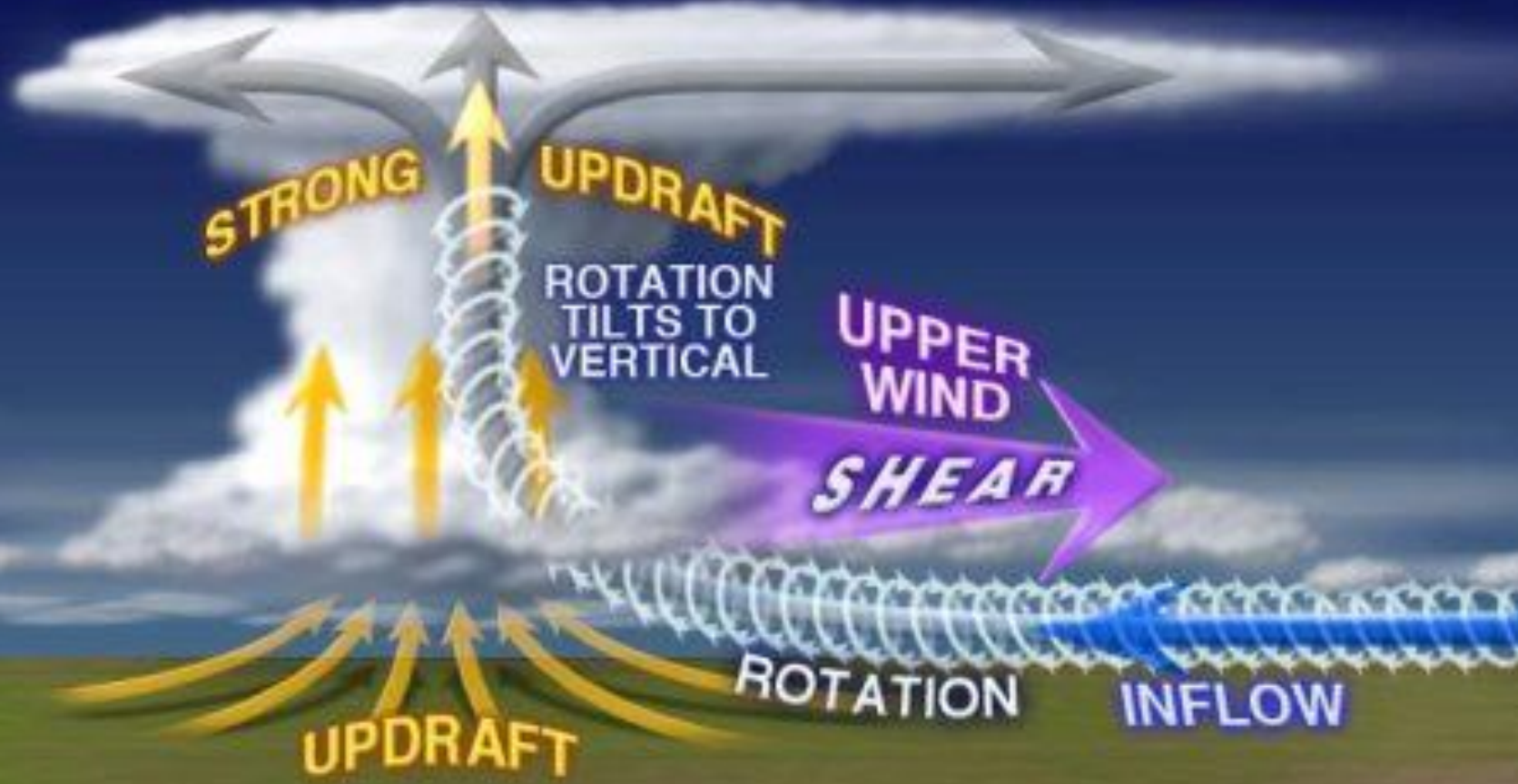
Tornadoes

- A narrow, violently rotating column of air that extends from the base of a **thunderstorm** to the ground. (to be classified as a tornado, it must be in contact with both the ground and the cloud base.)
- Maybe invisible unless it forms a condensation funnel made up of water droplets, dust and debris.
- Most violent of all atmospheric storms.
- Theory of formation still has many unknowns, but ingredients are:
 - Cumulonimbus cloud (severe thunderstorm or tropical cyclone)
 - Strong horizontal winds that change with height above the ground (*wind shear*)

Tornadoes

- As air is drawn in, the vortex narrows and spins faster (conservation of angular momentum), and extends below cloud base
- This spinning vortex may be invisible until it reaches the ground (or water) and picks up dust, debris or water
- As pressure decreases in the vortex, condensation of water vapour may occur and a *funnel cloud* becomes visible and may extend down to reach the ground.
- They generally spin cyclonically (but not necessarily)

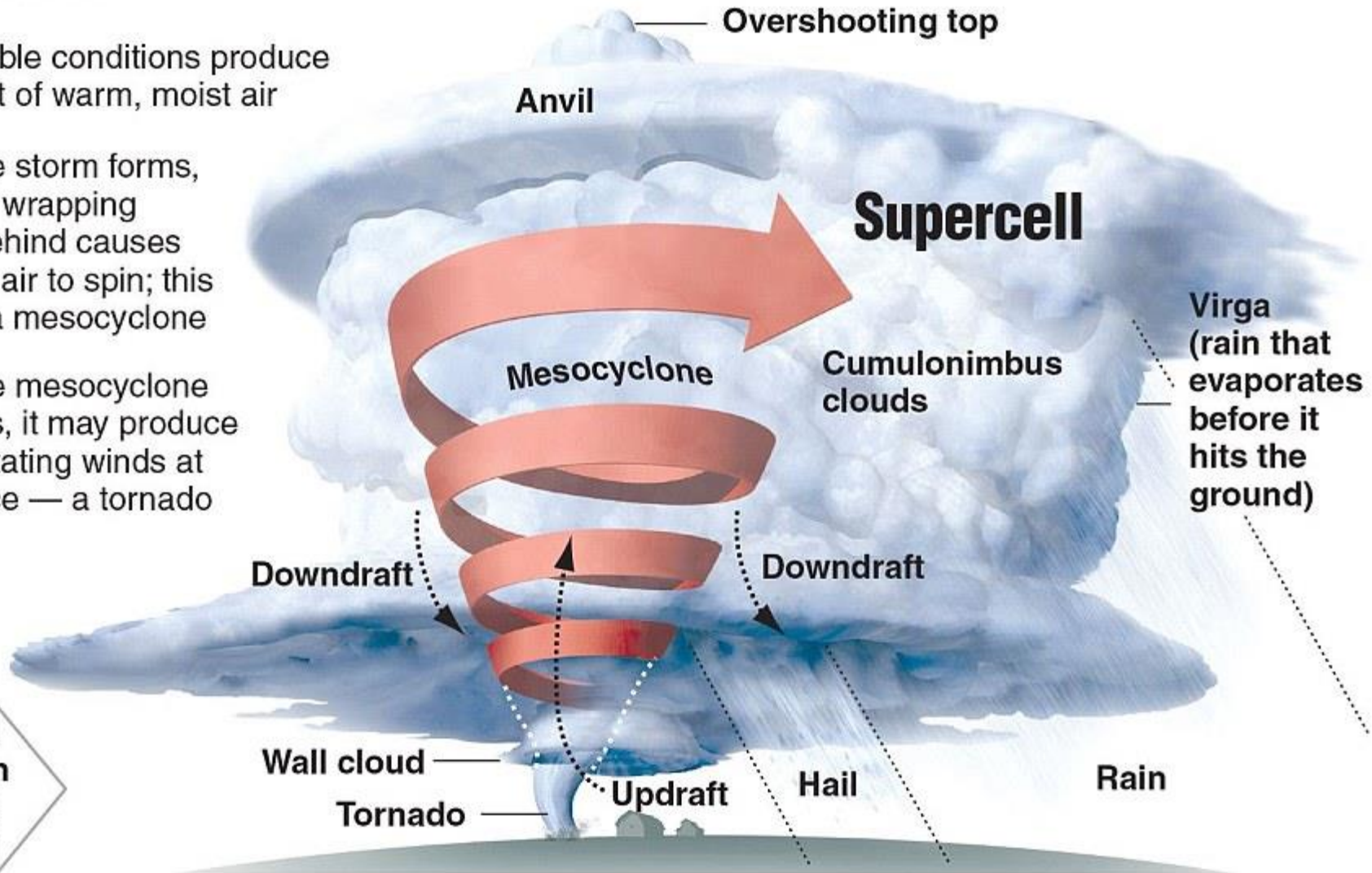
TORNADO FORMATION



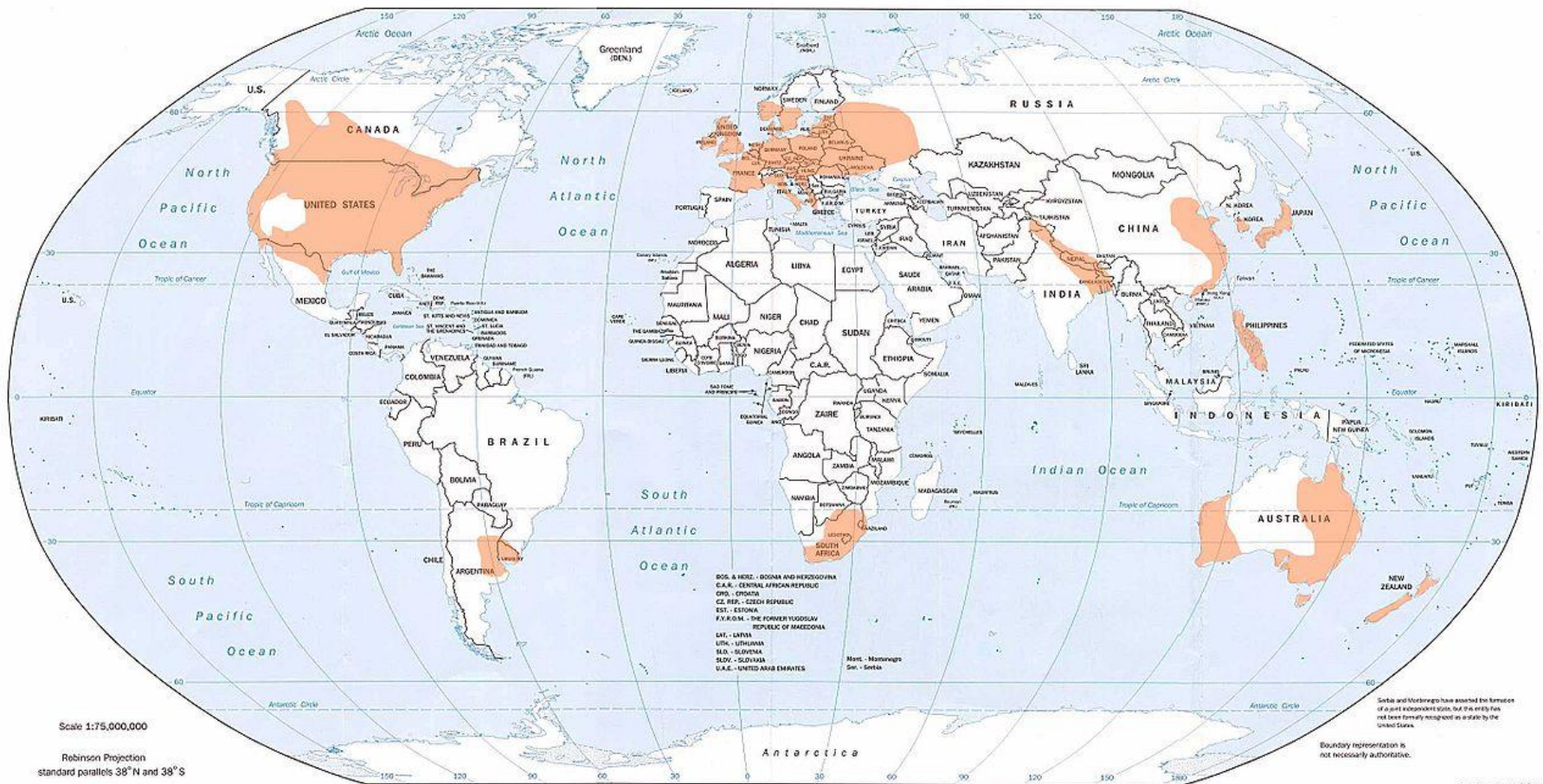
Destructive vortex

Tornadoes develop out of thunderstorms, where there's a steady, upward flow of warm, low-pressure air. Some tornadoes consist of a single vortex, but other times multiple suction vortices revolve around a tornado's center.

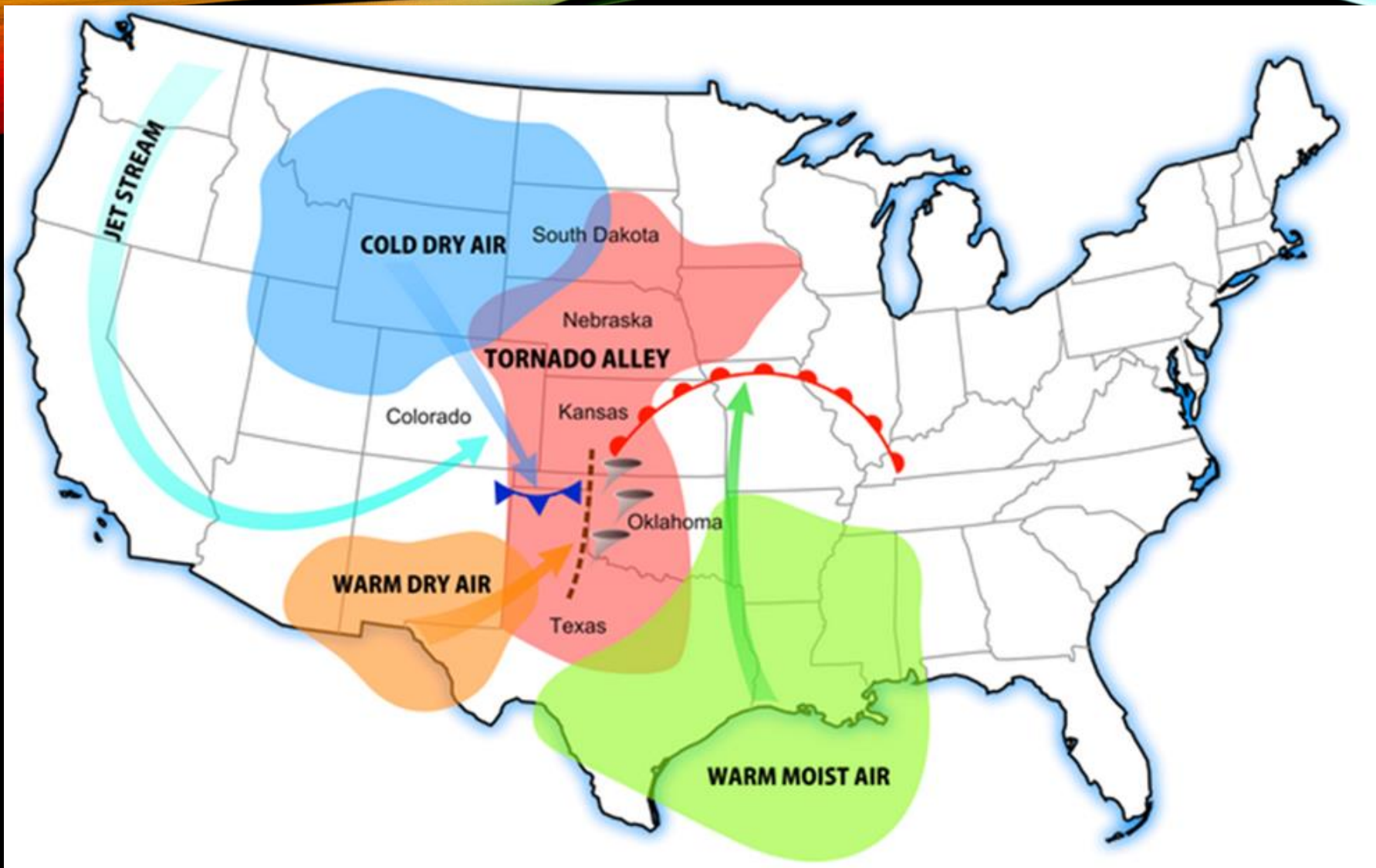
- 1 Unstable conditions produce an updraft of warm, moist air
- 2 As the storm forms, cooler air wrapping in from behind causes the rising air to spin; this is called a mesocyclone
- 3 As the mesocyclone intensifies, it may produce violent rotating winds at the surface — a tornado



Where tornadoes occur



NOAA (USA)



<https://youtu.be/lsEA9tGMFQQ>

Tornado Alley