Aircraft Icing

Items in This Discussion

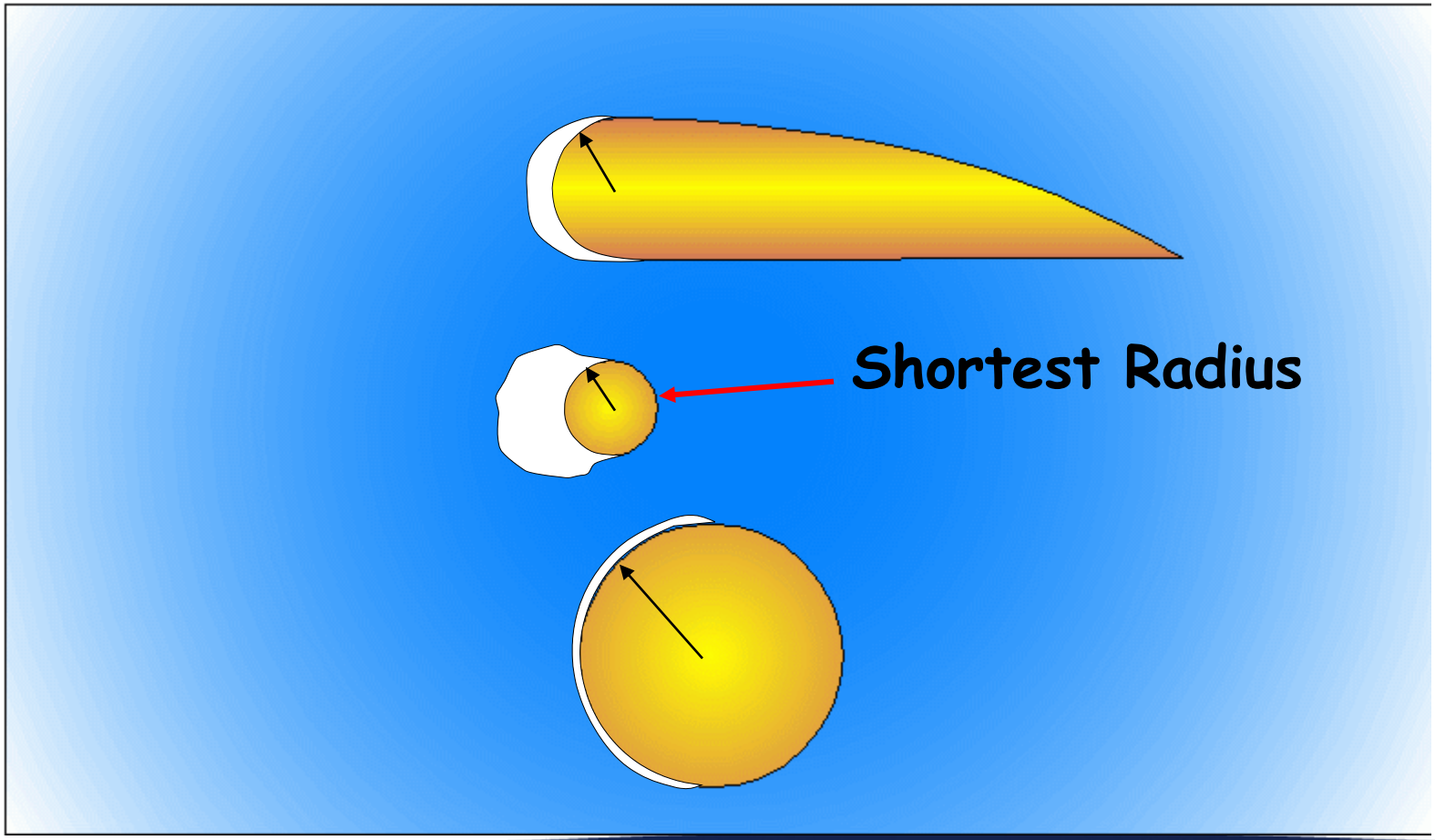
- Affects of icing
- Causes
- Ice formation
- Types of icing
- Icing and cloud types
- Freezing precipitation
- Sources of Information

Icing Factors

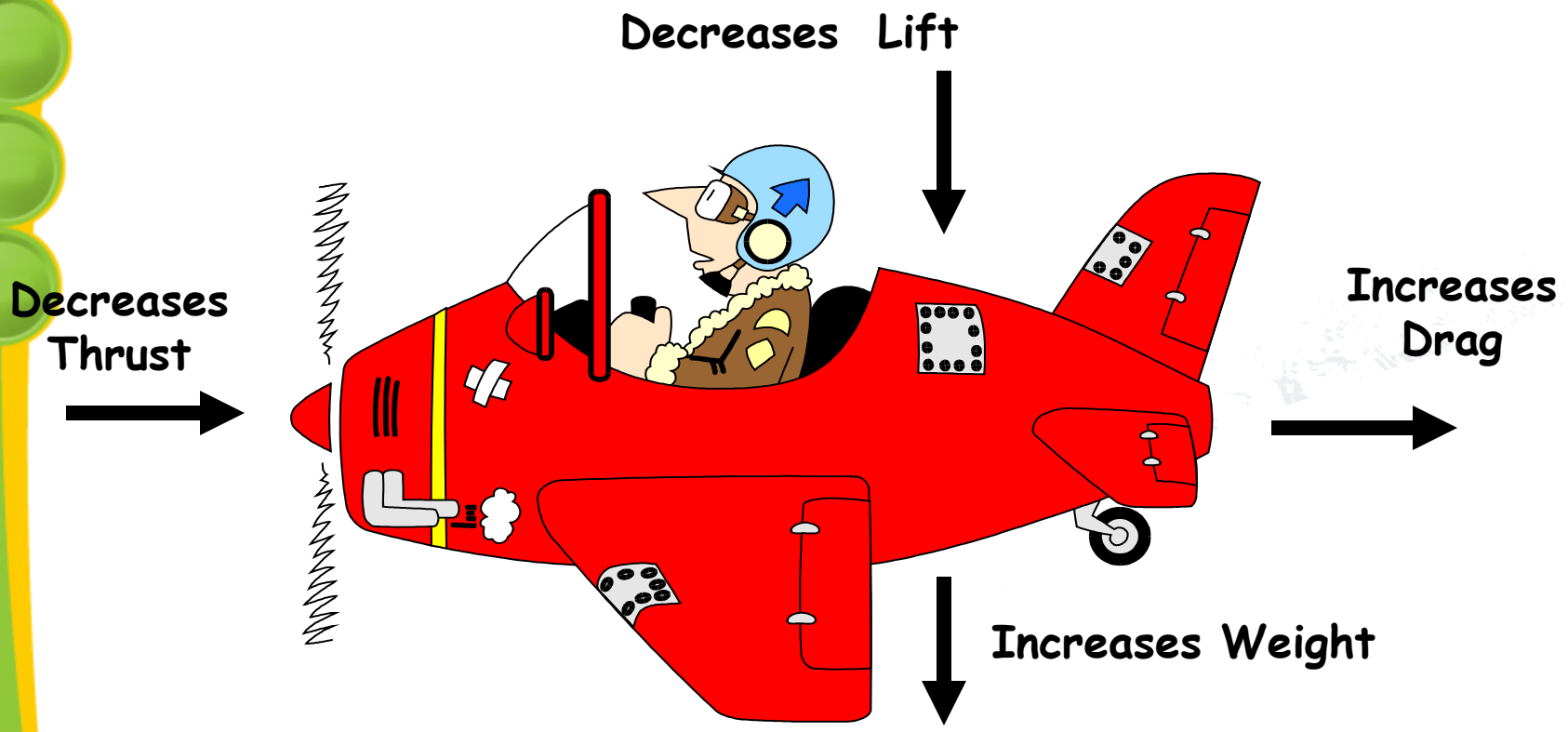
- Liquid water content (LWC)
- Temperature
- Droplet size
- Cloud type
- Airfoil geometry
- Airspeed
- Duration of exposure

Ice Formation

- Ice forms first on the shortest radius of curvature



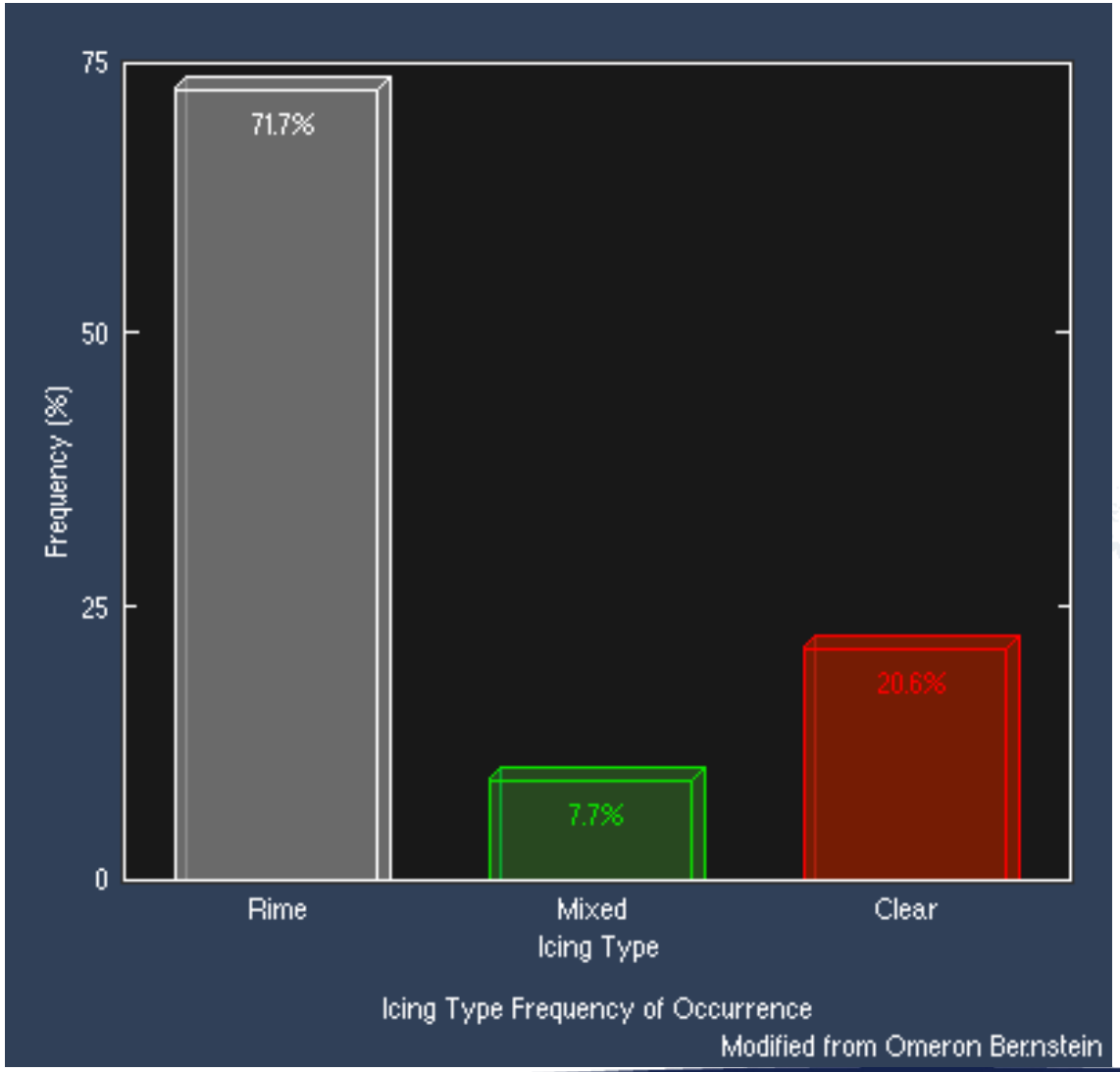
Cumulative Affects of Icing



Types of Icing

- Clear
- Mixed
- Induction (Carburetor)
- Rime

Occurrence of Icing



The Cause of Icing

- *NOT* caused by *ICE* in clouds.
- Is caused by "*Super-cooled*" *liquid* water droplets
  - Strike the leading edge of an airfoil
  - Freeze on impact

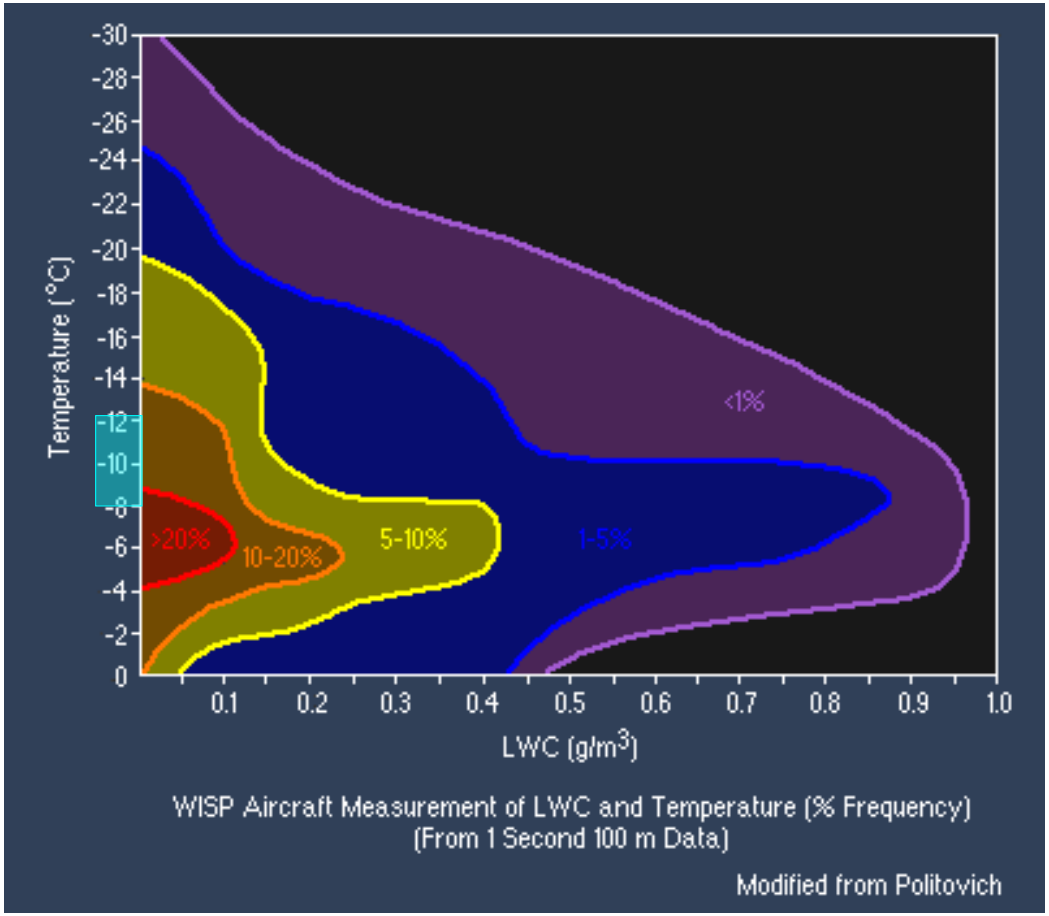
“Super-Cooled Water” Formation

- Begin with water in liquid form (>32 F)
- Water is cooled rapidly, usually by “lifting”
- Super cooled water drops may also form via
  - condensation
  - lack of activated ice nuclei
- There does NOT have to be a warm layer for super cooled water to form.
- Climb to warm layer may not be possible

Liquid Water Content (LWC)

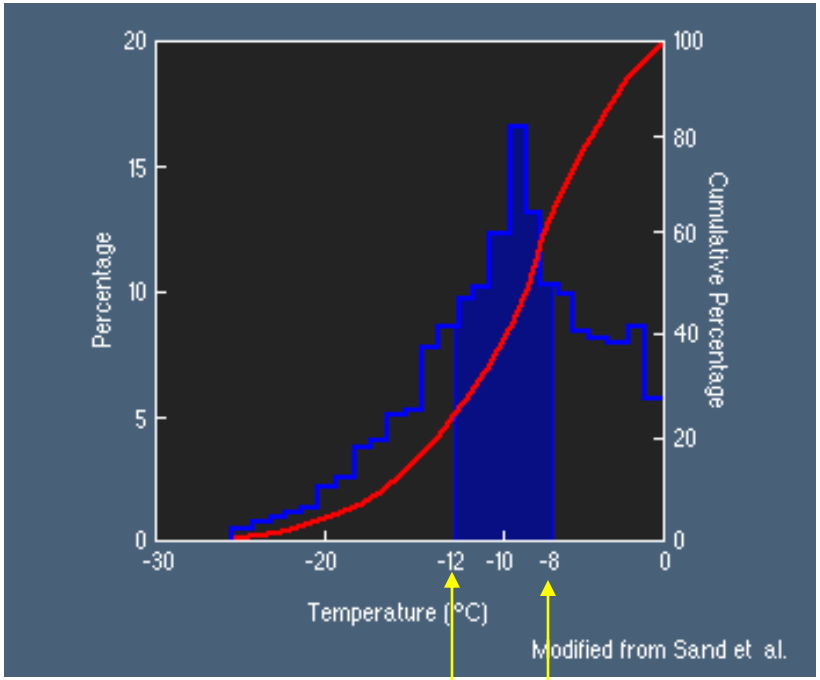
Useful only in Stratiform Clouds

- Amount of available water
- Varies from cloud to cloud
- Varies within same cloud



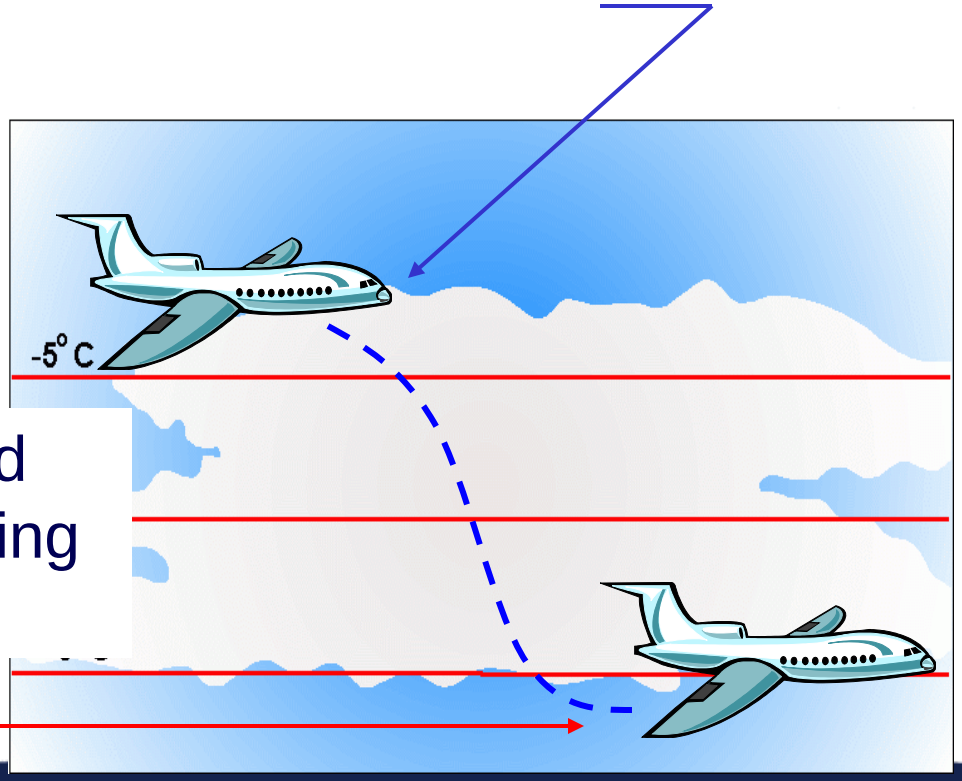
Temperature

- Most icing tends to occur at temperatures between 0° and -20°C
  - More than 50% of those occur between -8 and -12° C



Temperature

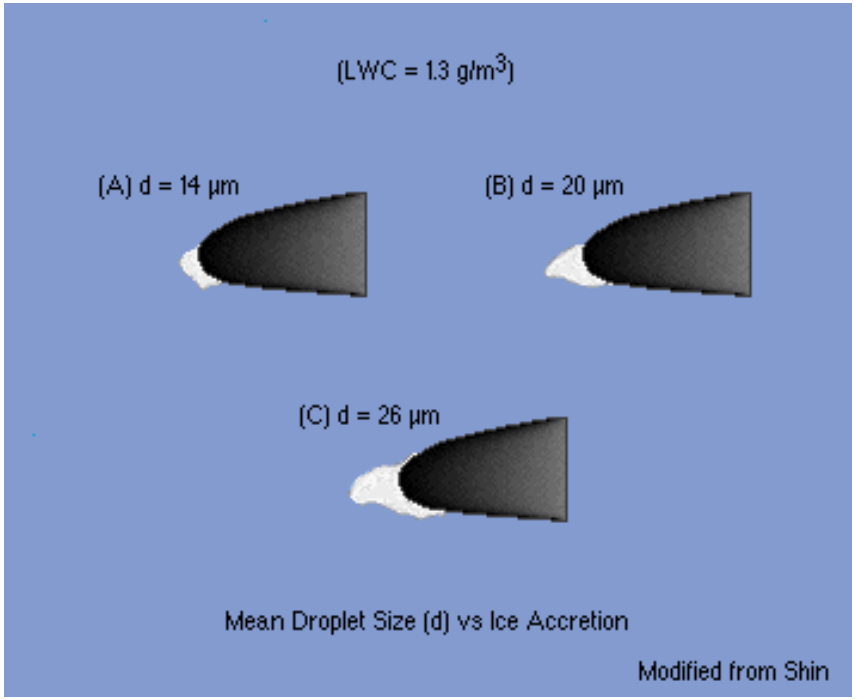
- ‘Cold Soaked’ Aircraft can be a cause
  - Sustained flight in below freezing air
  - Descends to warm air, but…



•The aircraft must be in cloud (visible water droplets) for icing to occur

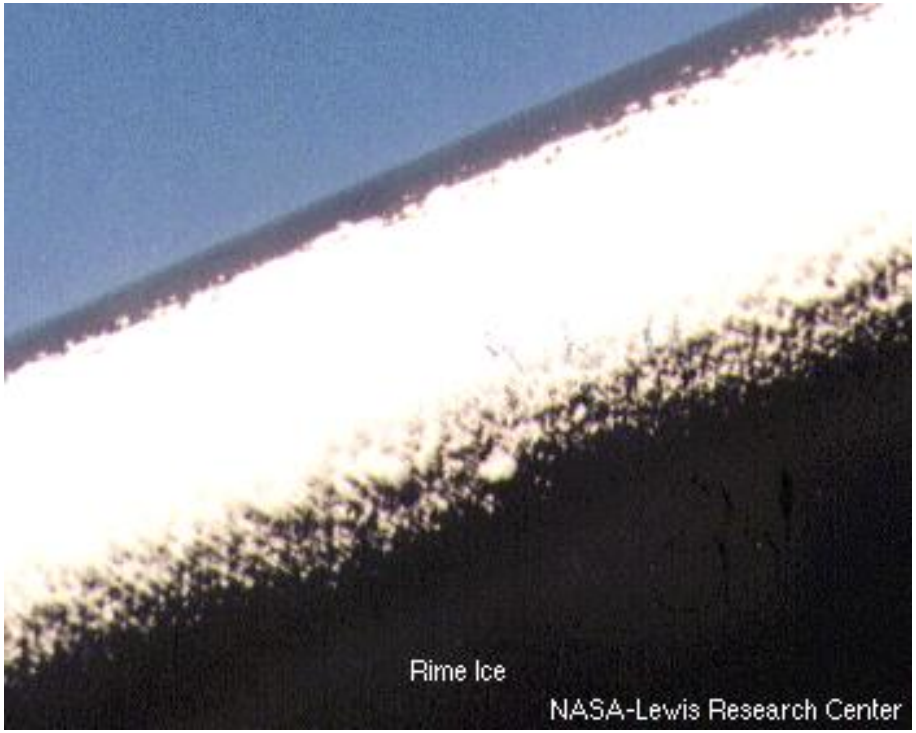
Water Droplet Size

- Icing patterns change with droplet size. But...
- In relation to icing hazards
  - Droplet size not as important as
  - LWC and
  - Temperature

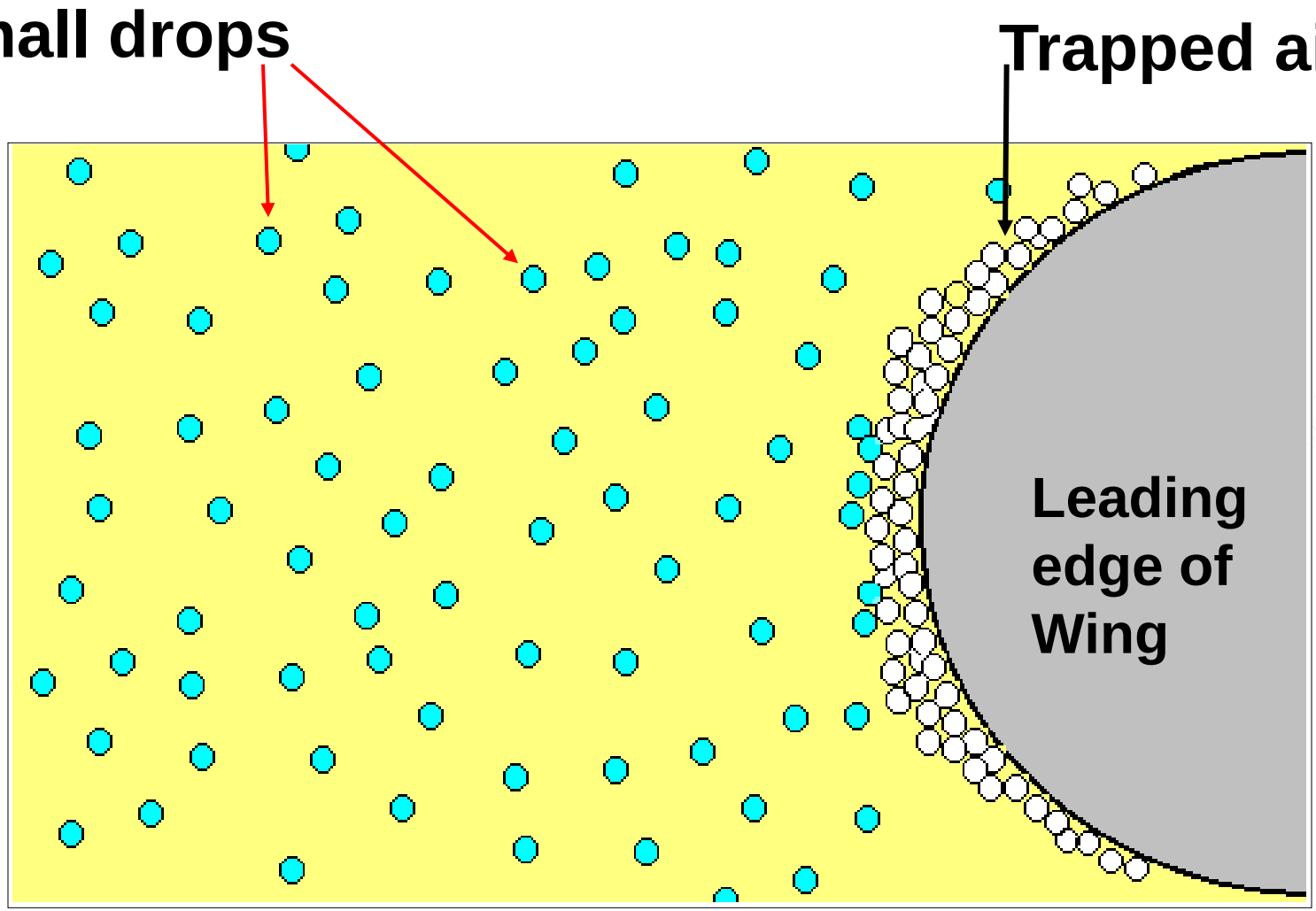


Rime Icing

- Is opaque
- Easily seen



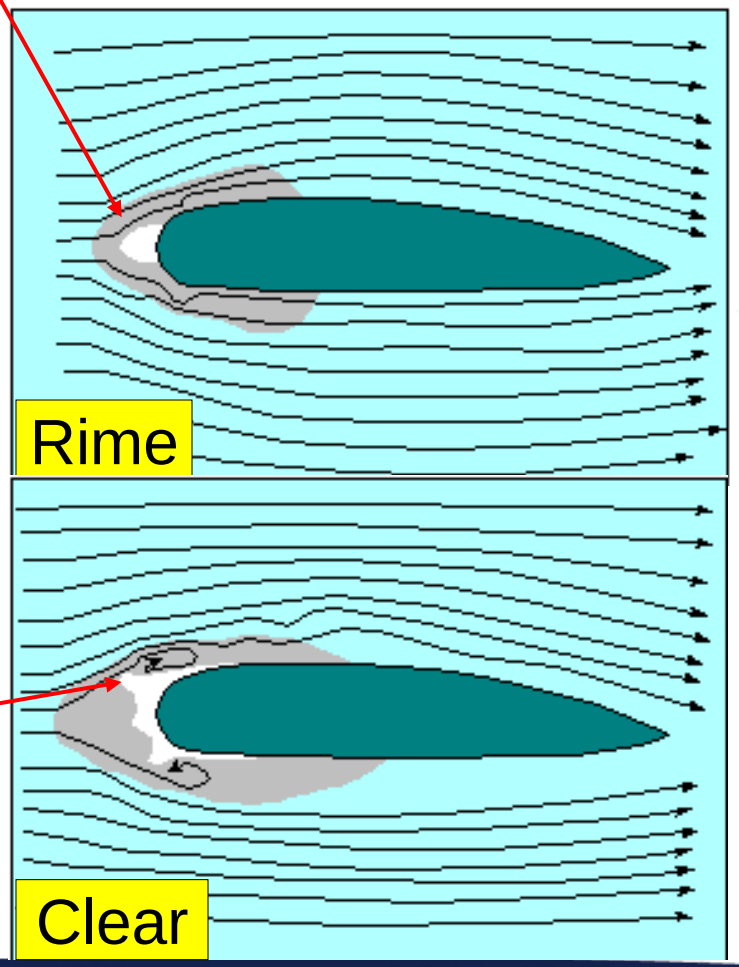
Rime Icing



Rime Icing

Gray is region where air is stagnant

- Tends to form at leading edge of airfoil
- More easily for de-icing equipment to remove



•Compare with “horns” of Clear icing

Clouds and Droplet Size

- Cumulus - Large drops
- Stratus - Small drops
- High clouds - Ice crystals

Icing Vs. Cloud Type: Stratiform

Small Cloud Droplets

- Rime/Mixed most common
- Usually confined to layer 3,000-4,000’ thick
- Max values occur in upper part of cloud
- Large horizontal extent

Icing Vs. Cloud Type: Cumuliform

Large Cloud Droplets

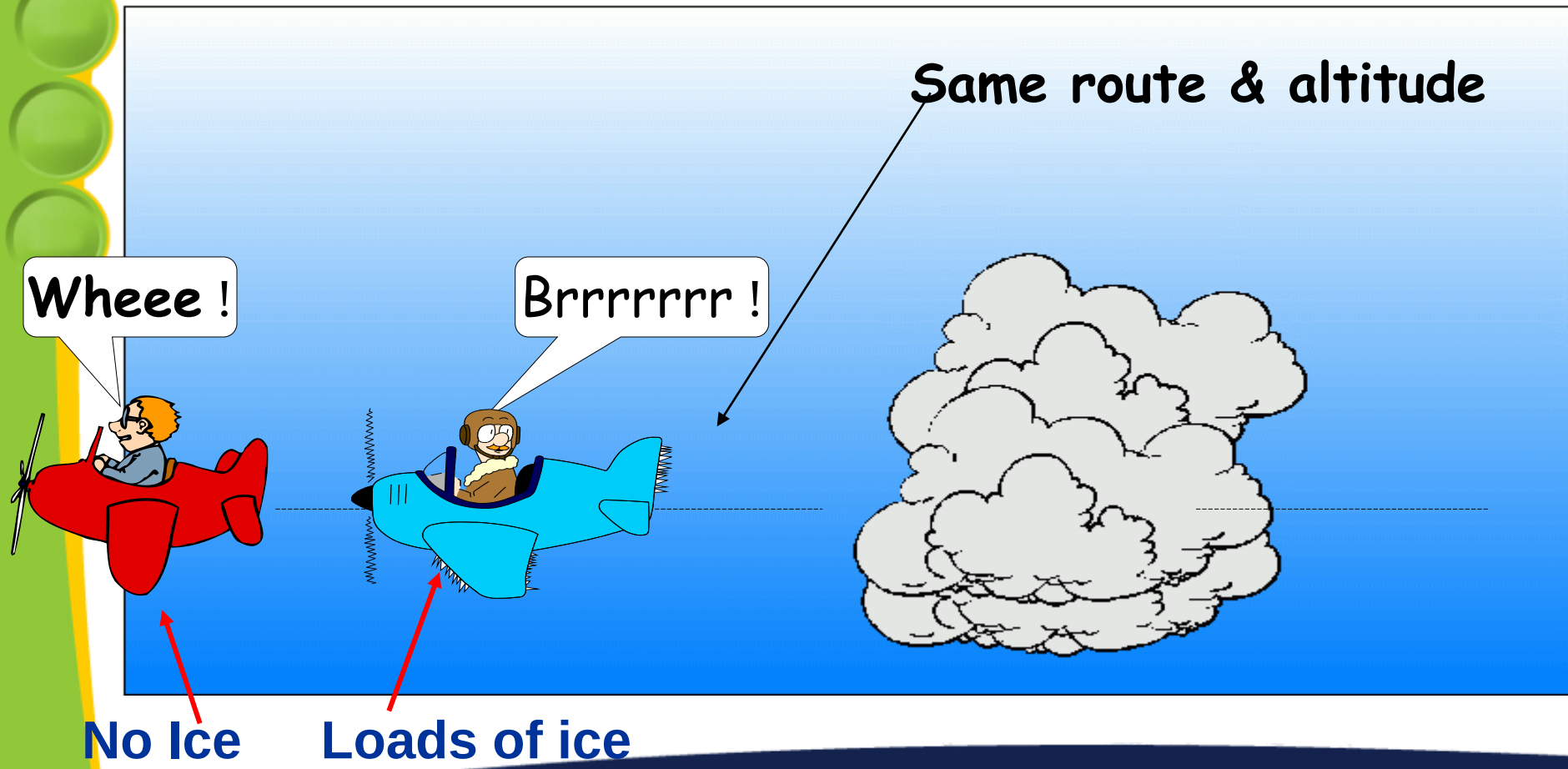
- Icing found in “updraft” portion of cloud
- Heavy rime most frequently in cloud tops
- Clear icing most likely in building Cu
- Rime often found in fully developed TS
- Relatively small horizontal extent

Icing Vs. Cloud Type

- Previous statements ‘generally’ true…
- BUT research has found…
  - Mixed-phase clouds of all types may harbor sufficient amounts of Super- Cooled water.

Occurrence of Icing

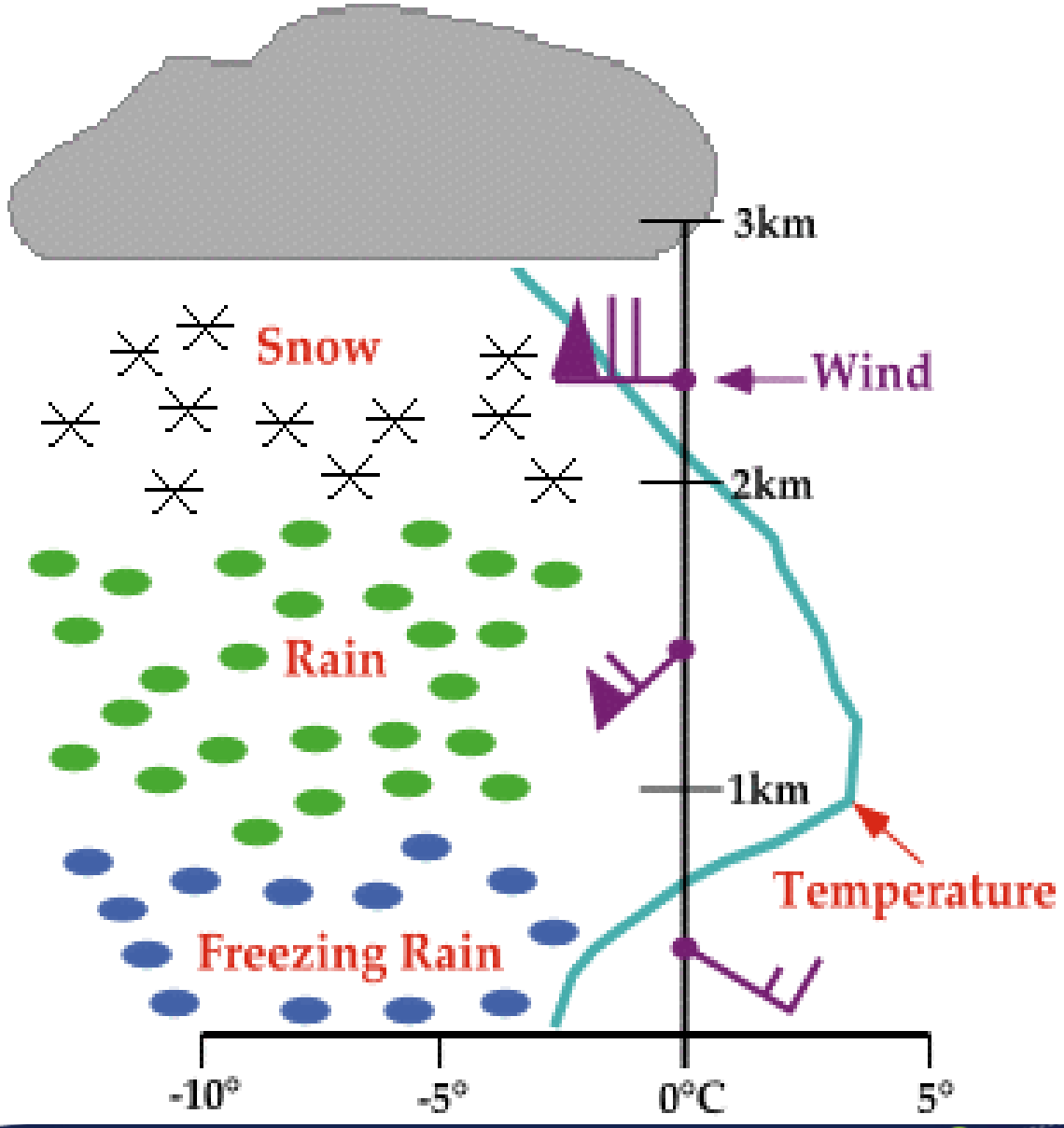
- Aircraft type and speed affect icing occurrence



Freezing Rain

- Heavy icing in short time
- Warm air/moisture over-running Cold air
- Begins as rain,
  - Then falls through Cold air
  - Becomes ‘Super Cooled Water’
  - Freezes on impact
- Best maneuver *may* be to gain altitude
  - Check with a weather briefer first!

g Rain

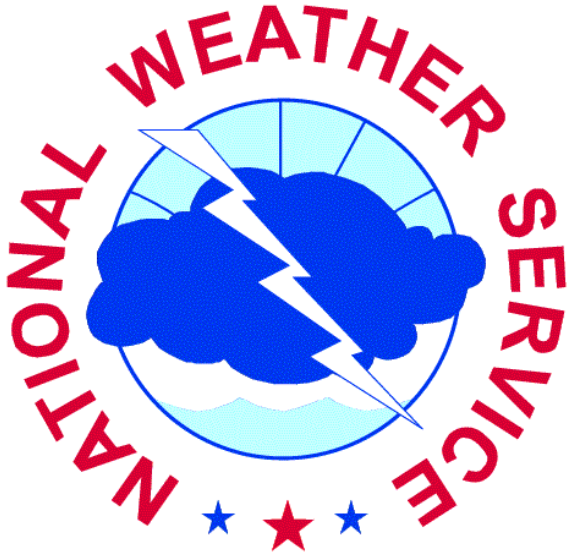

3km
Snow
Wind
5 km
2km
0 km
A
Rain
1km
Temperature
Freezing Rain
-10°
-5°
0°C
5°

Information Sources

- Pilot Weather Briefings
- Internet
  - aviationweather.gov
  - AOPA
  - DUATS

Expanded version of this presentation

- Narrated, web based slide show
- Will be posted on the Indianapolis web site
- Email me to be notified when it’s posted.
- http://weather.gov/ind
- sally.pavlow@noaa.gov



The End

Thank You