PROPAGATION AND LIFETIME CHARACTERISTICS OF THUNDERSTORM ANVIL CLOUDS OVER FLORIDA

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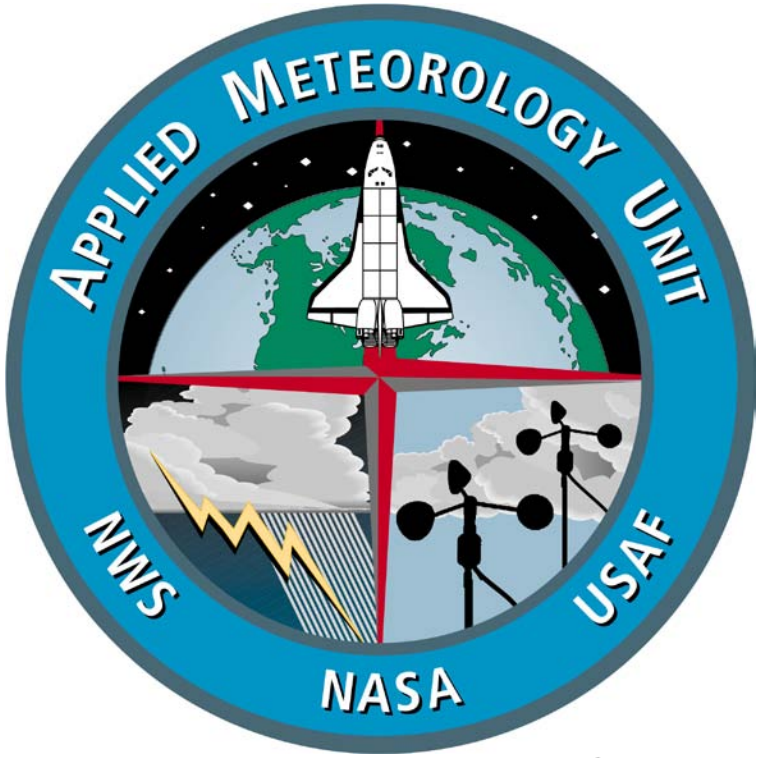

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OUTLINE

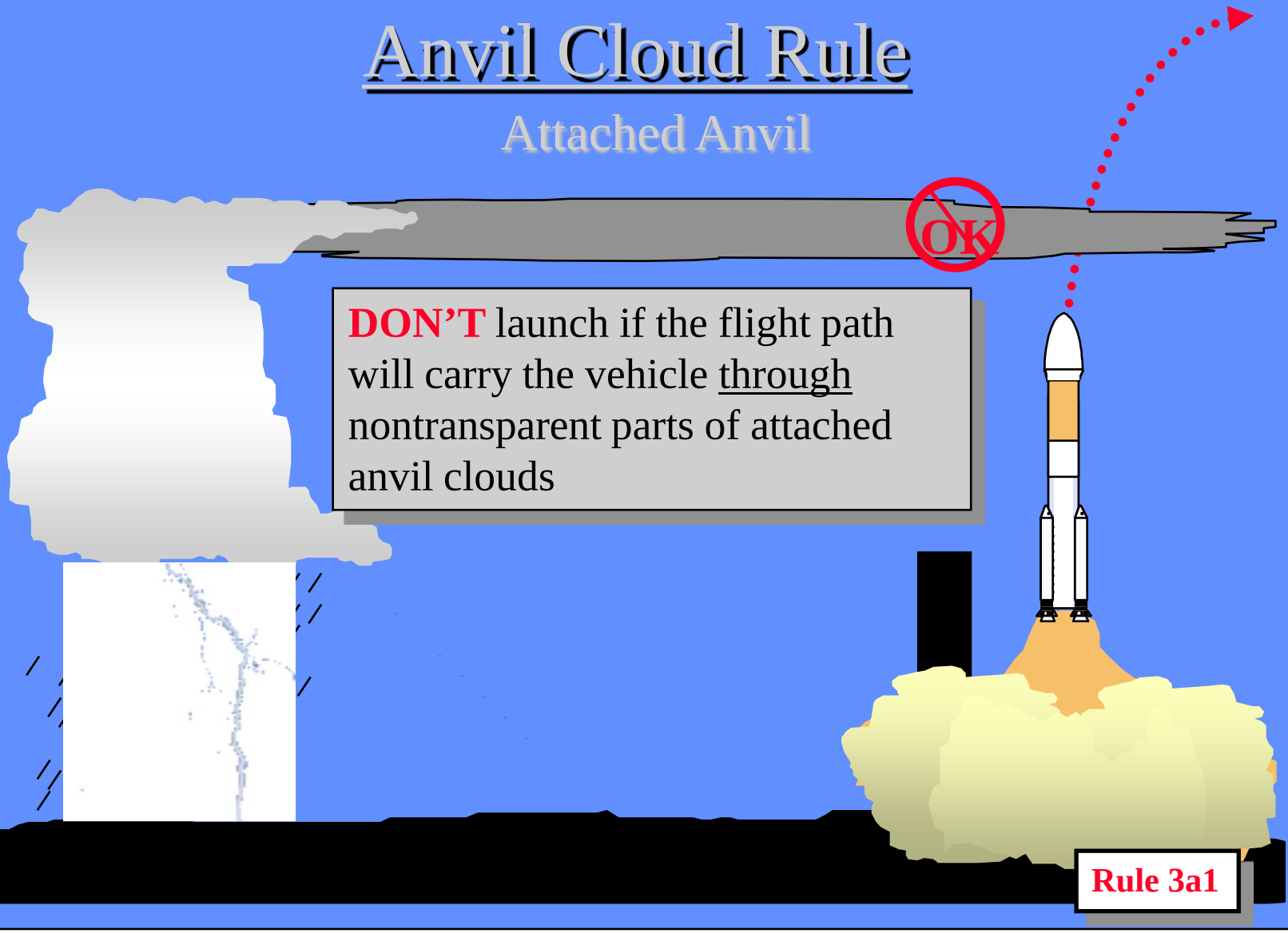
- **Motivation**
  - Natural and Triggered Lightning:
    - Threat to Space Launch and Landing Operations
- **Data Analysis**
  - GOES-8 Visible Imagery:
    - 50 Anvil Days in 2001
  - Wind Speed/Dir. 300 to 150 mb
- **Results**
  - Effective Lifetimes & Propagation
  - An Operational Tool for Anvil Nowcasting

NATURAL AND TRIGGERED LIGHTNING ARE HAZARDS TO SPACE-LAUNCH/LANDING VEHICLES

Lightning Launch Commit Criteria were developed after the loss of Atlas/Centaur-67

Anvil Cloud Rule

Attached Anvil



Aug. 9, 2001 SCRUB Aug. 10, 2001 LAUNCH

STS-105 Post-Mission Summary
Spaceflight Meteorology Group
Johnson Space Center (JSC/SMG)

"... Although no rain was reported at KSC, thunderstorms were close enough to the Return-To-Launch-Site (RTLS) emergency landing approaches to halt the launch countdown. In addition, the anvil cloud from the thunderstorms had moved overhead of both the SLF and the launch pad violating both the Flight Rules for emergency landings and the Launch Commit Criteria."

ANVIL NOWCASTING CHALLENGE

- 45 WS and SMG identify anvil forecasting as their most challenging task when predicting triggered lightning threats

OBJECTIVES

- Determine lifetime and propagation characteristics of thunderstorm anvil clouds over Florida

- Develop an operational, graphical tool to assist forecasters in assessing the potential for lightning threats from thunderstorm anvil clouds

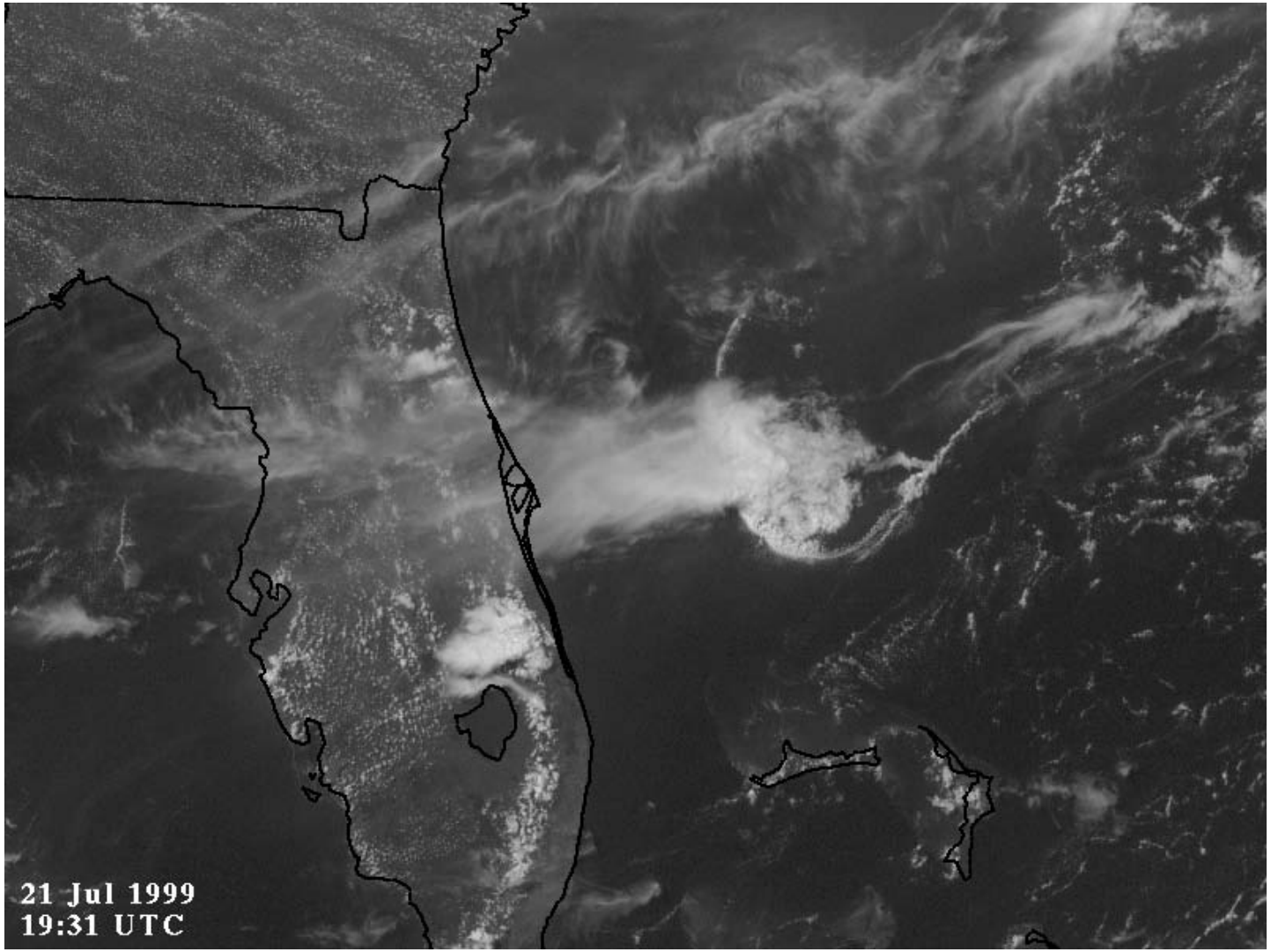
DATA

- **15 Minute GOES-8 Imagery**
  - **Primarily VIS channel 1 (0.55 – 0.75 μm)**
- **Cloud-to-Ground Lightning Surveillance System (CGLSS)**
- **Upper Tropospheric Winds**
  - **300 to 150 mb wind speed and direction**
  - **Nearest radiosonde (space/time)**

METHODOLOGY

- **Analysis of satellite imagery**
  - **McIDAS image analysis/enhancement tools**
  - **Measure distance and direction from origin of anvil to end of mature anvil (non-transparent edge)**
- **Analysis of upper tropospheric winds**
  - **Compute average wind speed and direction in 300 to 150 mb layer from nearest sounding prior to convective initiation**

Ocean Anvil case from 45 WS Pilot Study



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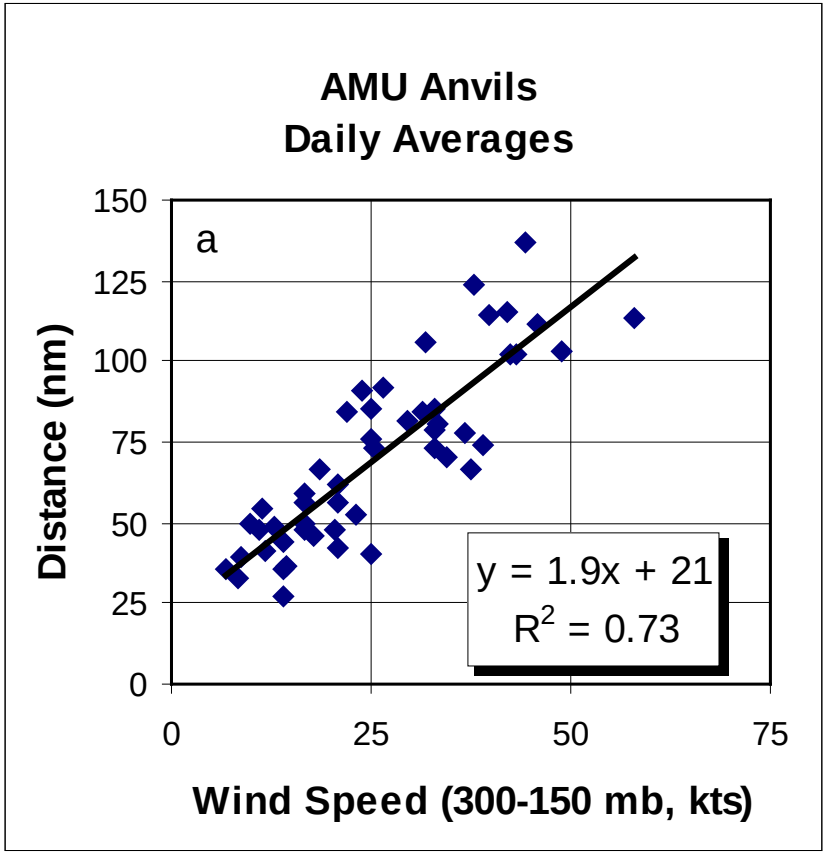
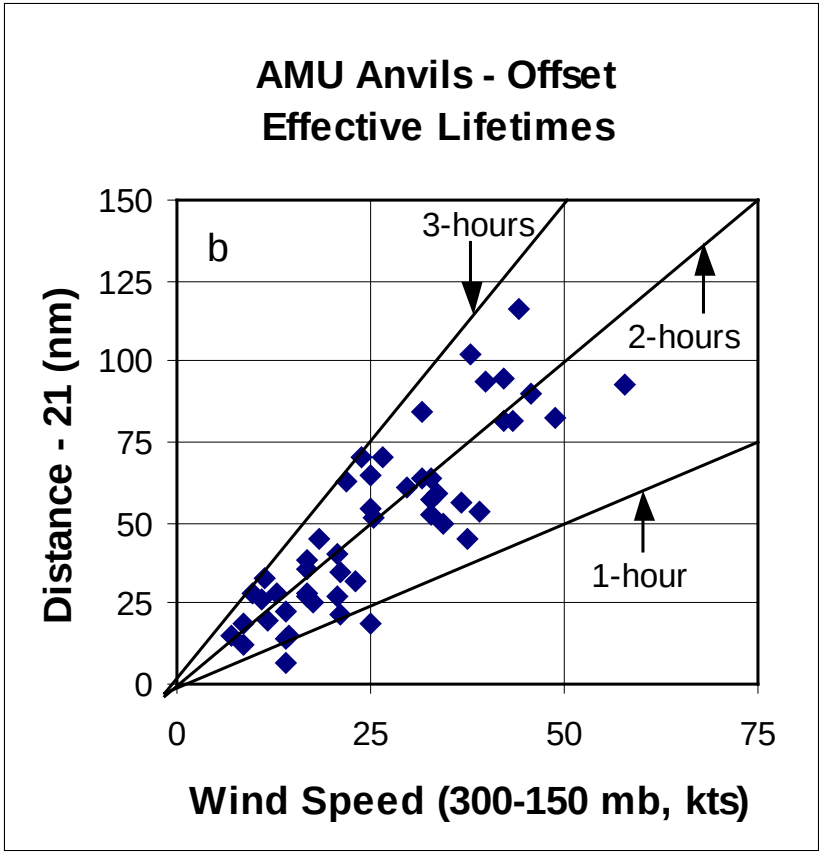
Analysis of 50 case days in May – July 2001

(167 anvils)





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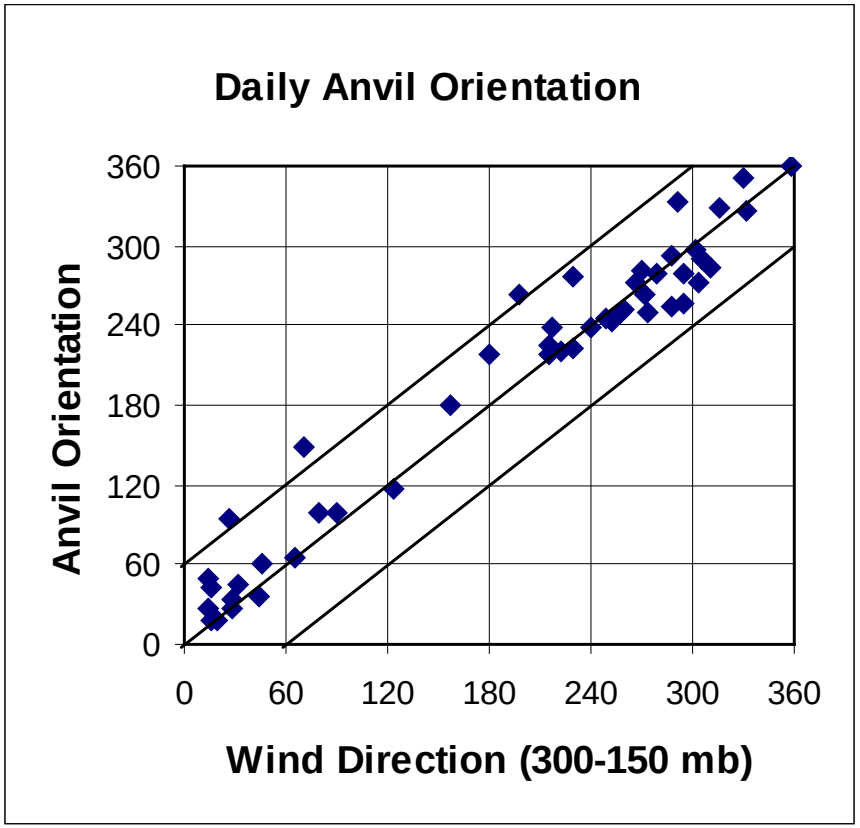
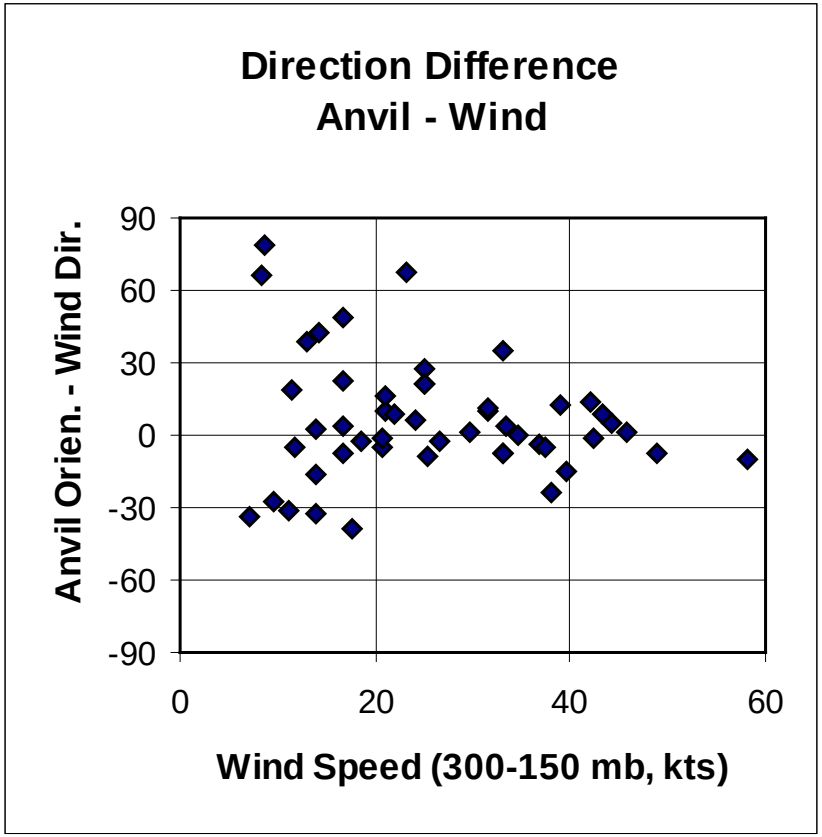
Australian Anvil: Diameter ~ 20 n mi

http://www.auf.asn.au/meteorology/section3.html

Anvil Orientation and Wind Direction

(300 to 150 mb Layer)





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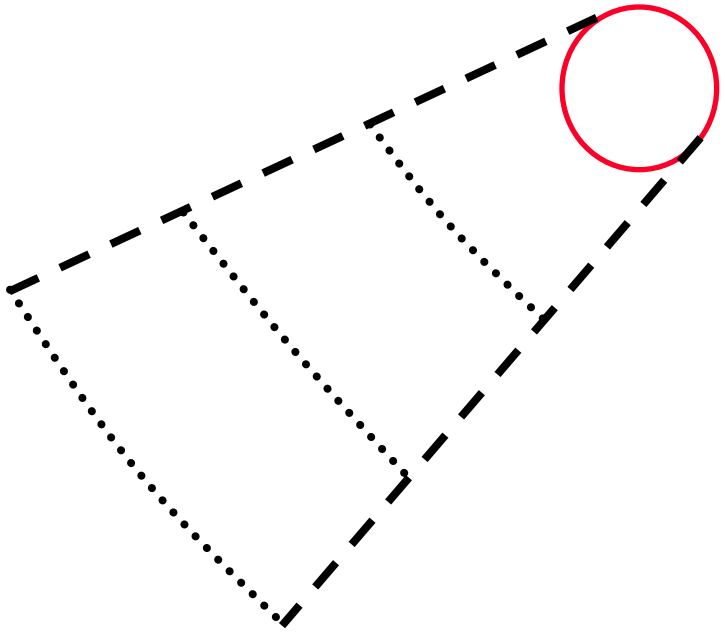
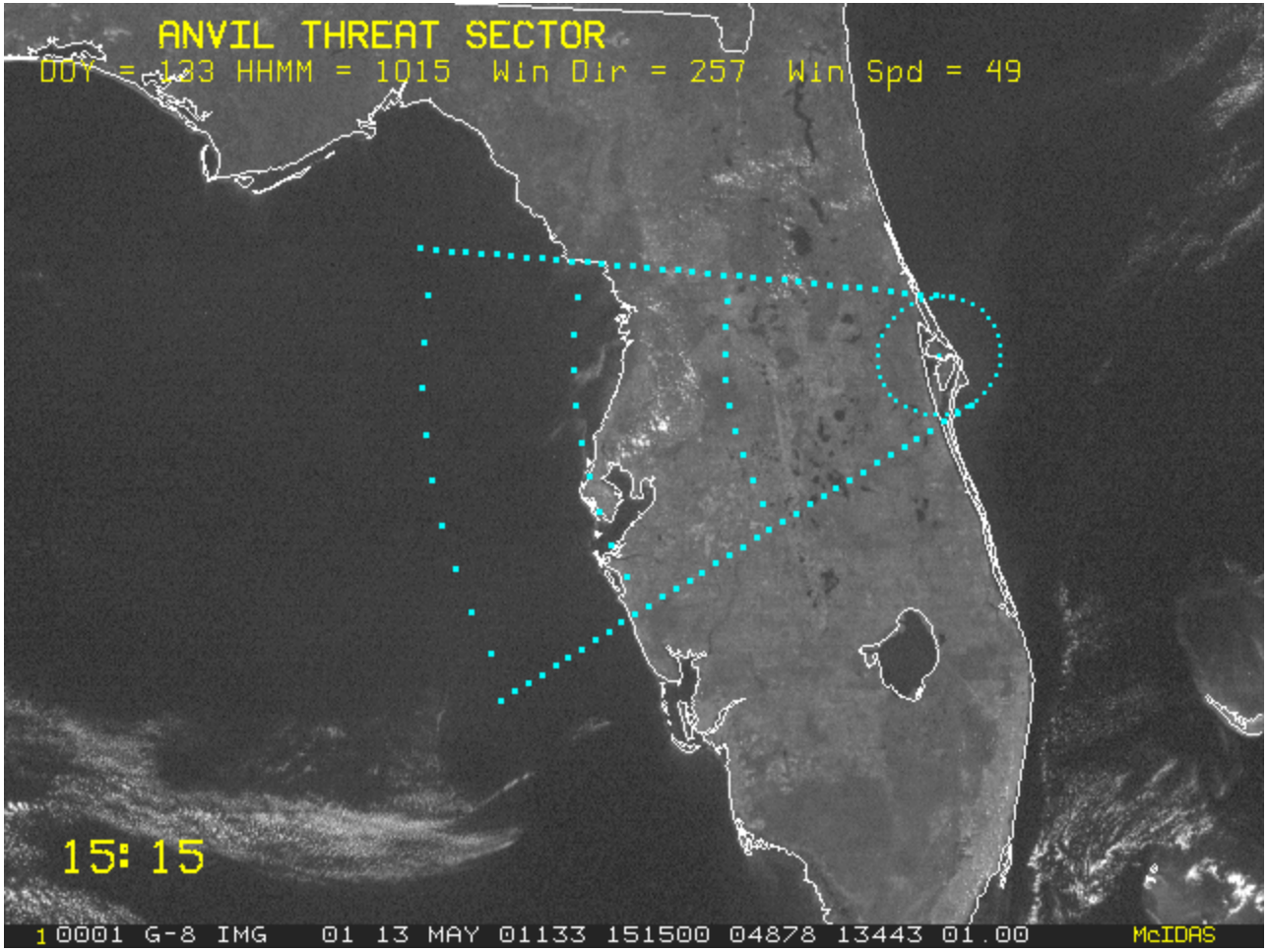
Parameters for an Anvil Threat Corridor:



- 20 n mi Stand-off Circle
- 30° Threat Sector Width
- Orientation given by 300 to 150 mb Wind Direction
- 1-, 2- and 3-hour Arcs in Upwind Direction
- Distances given by 300 to 150 mb Wind Speed

GOES-8; May 13, 2001



Prototype Threat Sector Tool (McBASI)

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SUMMARY:

- **Effective Propagation Lifetime of Anvils**
  - **~ 2 hours +/- 30 minutes**
- **At max. extent of non-transparent edge**
- **Distance and Direction**
  - **Average Wind in 300 to 150 mb layer**

❖ **AMU Quarterly Reports:**

http://science.ksc.nasa.gov/amu/home.html