FORECASTING THE PROPAGATION OF THUNDERSTORM ANVIL CLOUDS OVER FLORIDA USING NCEP MODEL DATA

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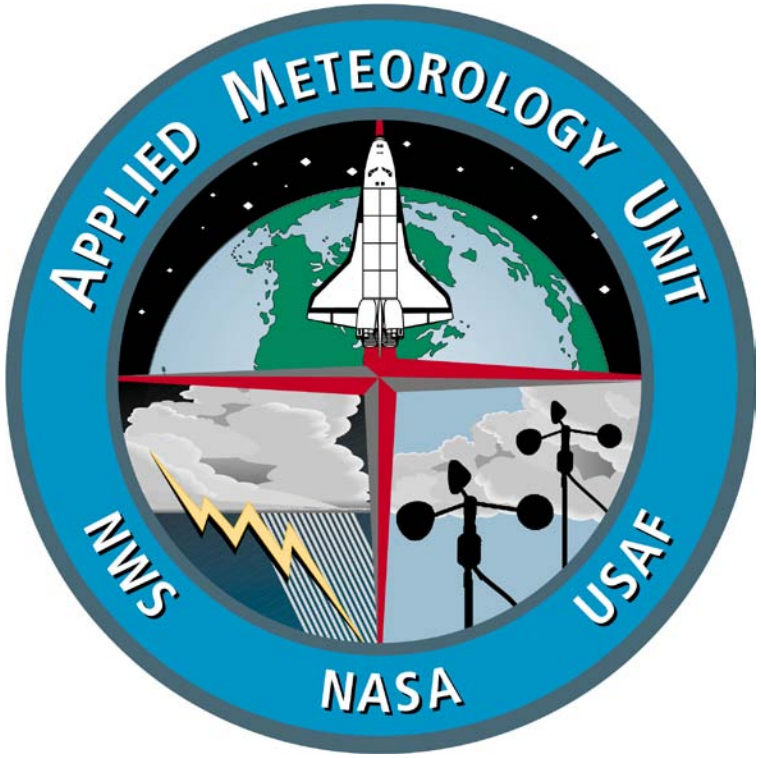
NWA Annual Meeting
22 October 2003
Jacksonville, Florida

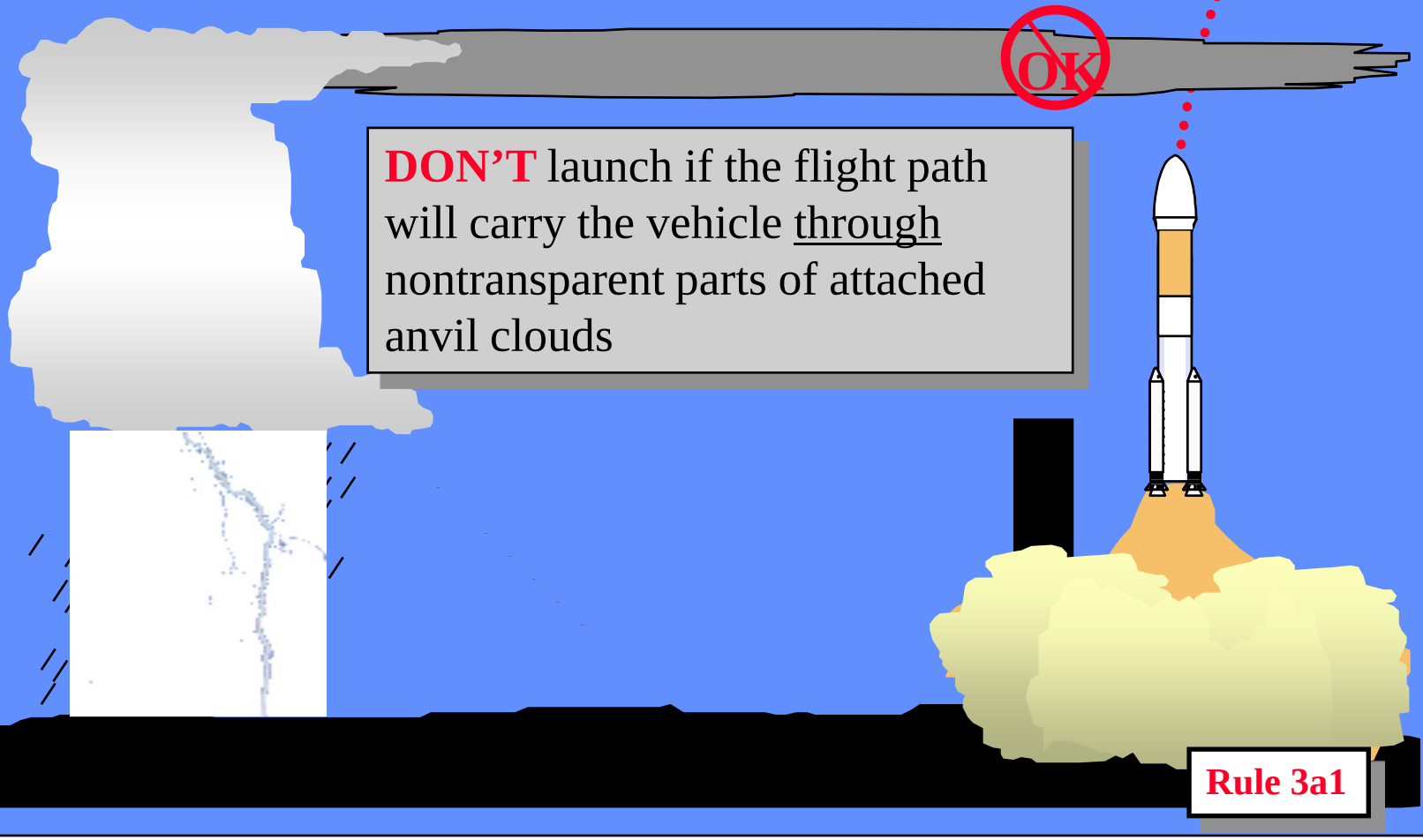


OUTLINE

- **Motivation**
  - Natural & Triggered Lightning:
    - Threat to Space Launch & Landing
- **Empirical Study**
  - Florida Anvil Clouds
    - Lifetime & Propagation Characteristics
- **Nowcast Tool**
  - Used During Countdown
    - Wind Speed/Direction (300 to 150 mb)
- **Forecast Tool**
  - 24 to 48 Hour Scrub Forecast
    - Eta-Model Forecast Winds

Anvil Cloud Rule

Attached Anvil



DON'T launch if the flight path will carry the vehicle through nontransparent parts of attached anvil clouds

Rule 3a1

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

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

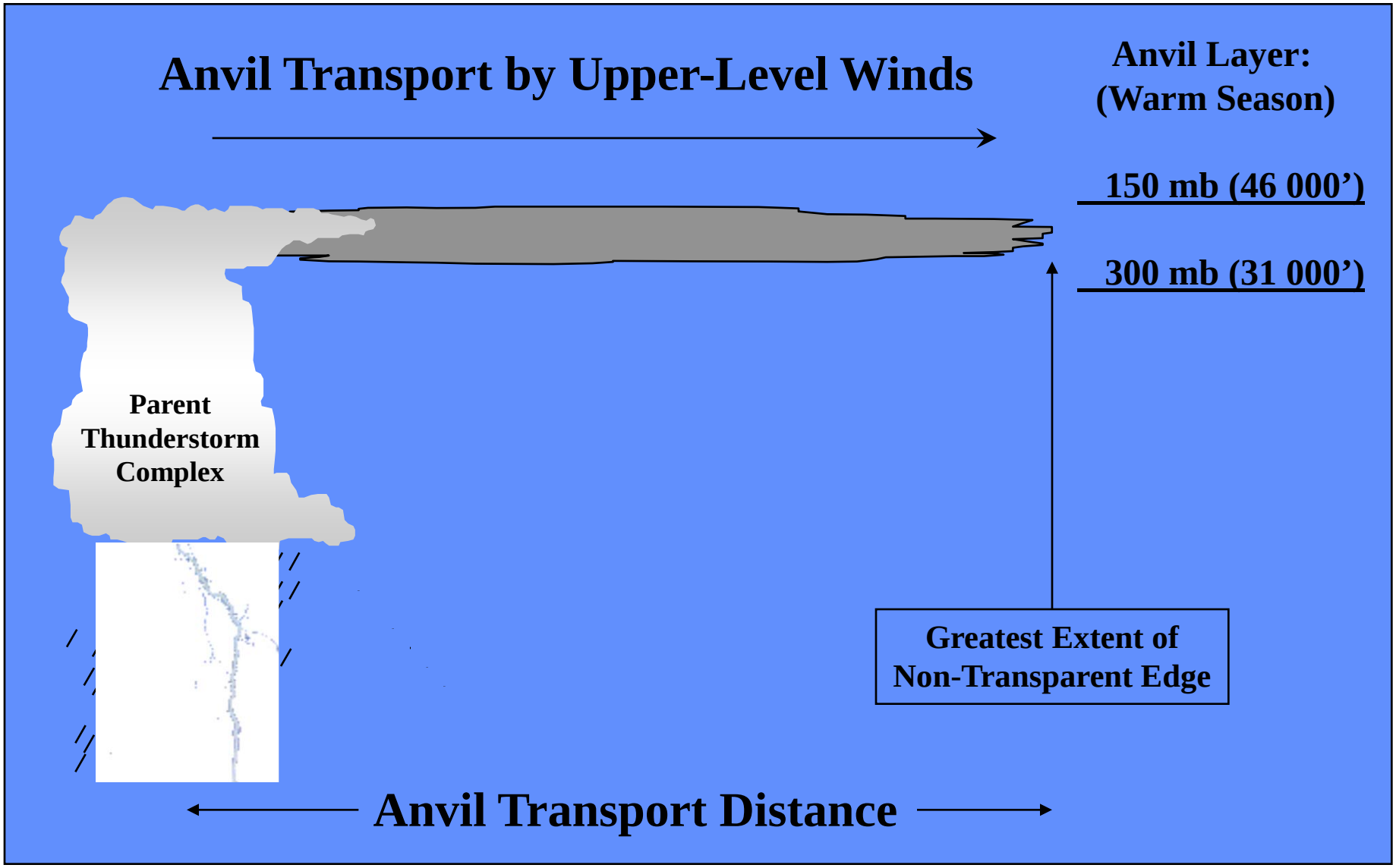
"... Although no rain was reported at KSC, thunderstorms were close enough to the Return-To-Launch-Site (RTLS) emergency landing approaches to halt the launch countdown. In addition, the anvil cloud from the thunderstorms had moved overhead of both the SLF and the launch pad violating both the Flight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

ANVIL FORECASTING CHALLENGE

- The 45th Weather Squadron and the Spaceflight Meteorology Group identify anvil forecasting as one of their most challenging tasks when predicting natural and triggered lightning threats

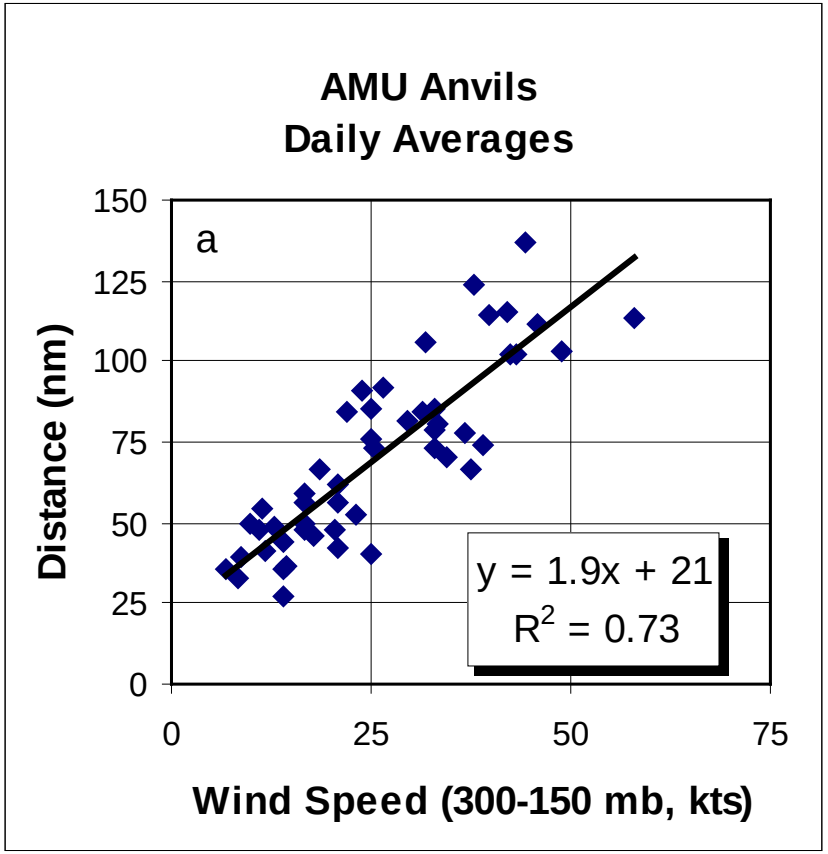
IMPLEMENTATION

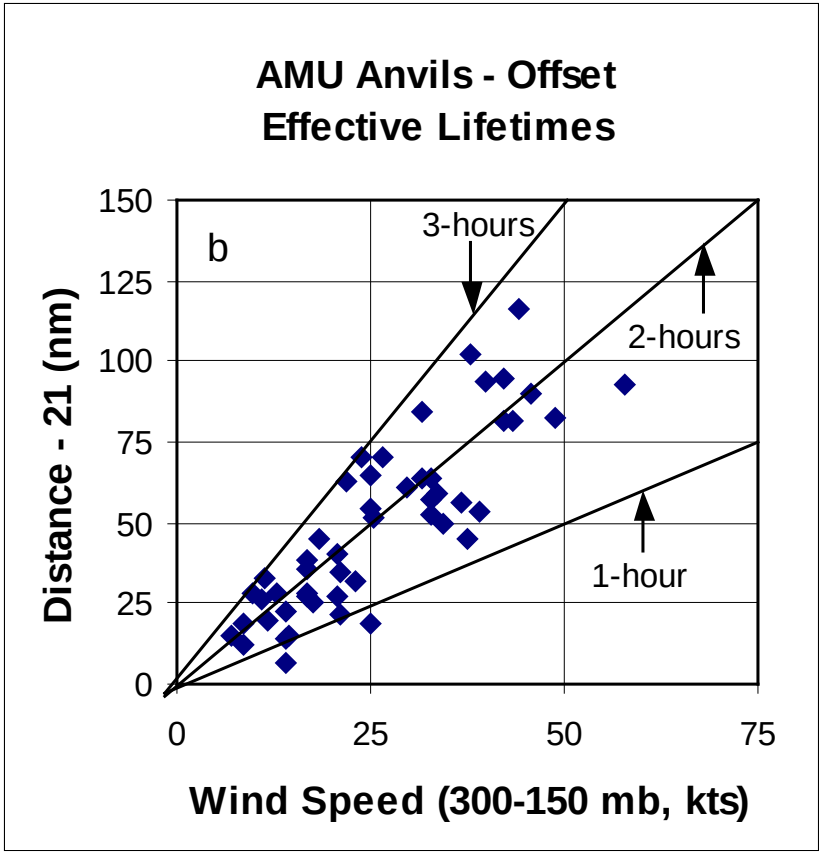
- Combine lifetime and propagation statistics of thunderstorm anvil clouds over Florida with
- an operational, graphical forecast tool to assist forecasters in assessing the potential for lightning threats to space launch and landing operations from thunderstorm anvil clouds


Anvil Transport by Upper-Level Winds
Anvil Layer:
(Warm Season)
150 mb (46 000')
300 mb (31 000')
Parent
Thunderstorm
Complex
Greatest Extent of
Non-Transparent Edge
Anvil Transport Distance

Analysis of 50 case days in May – July 2001

(167 anvils)



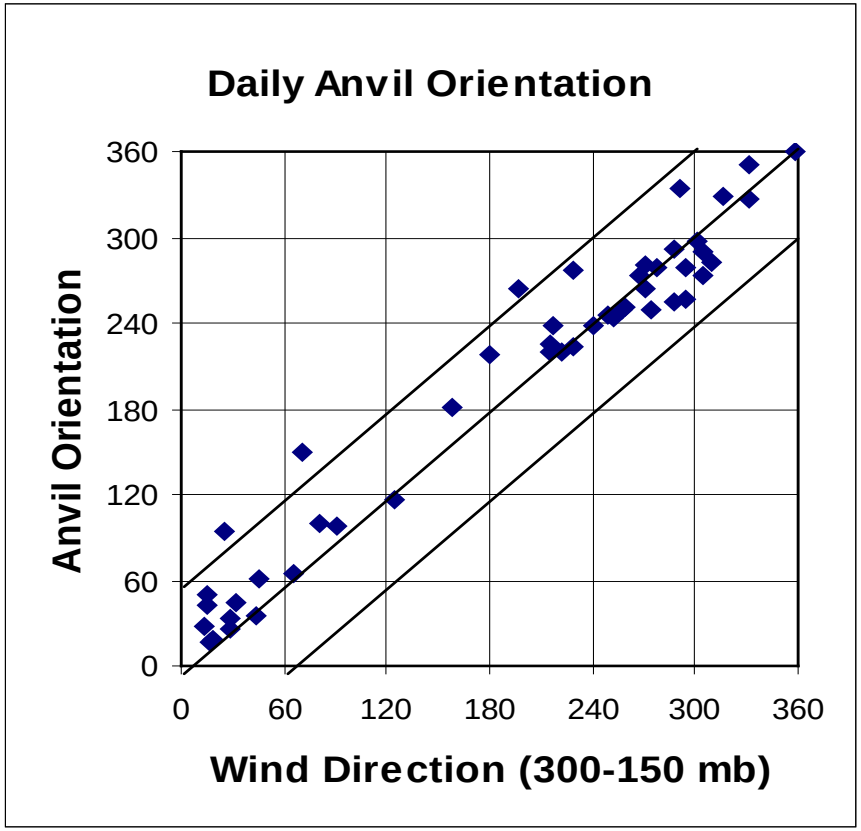


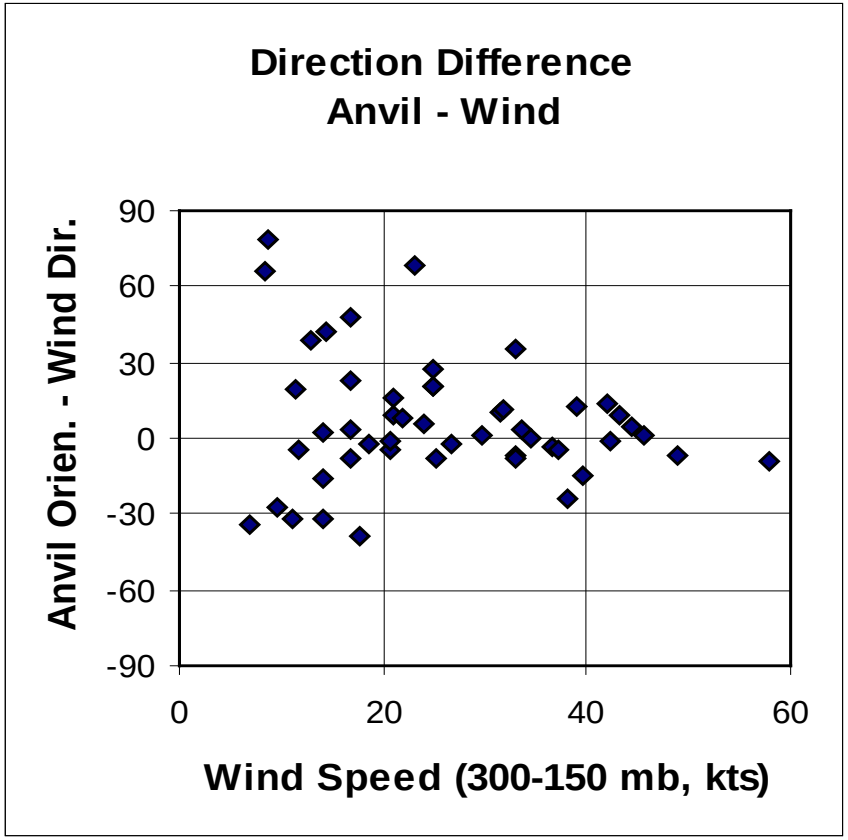
Australian Anvil: Diameter ~ 20 n mi

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

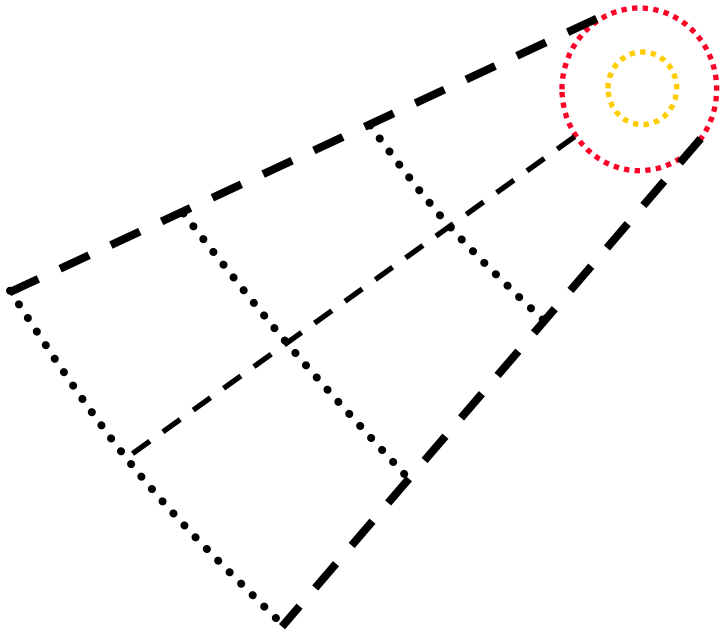
Anvil Orientation and Wind Direction

(300 to 150 mb Layer)

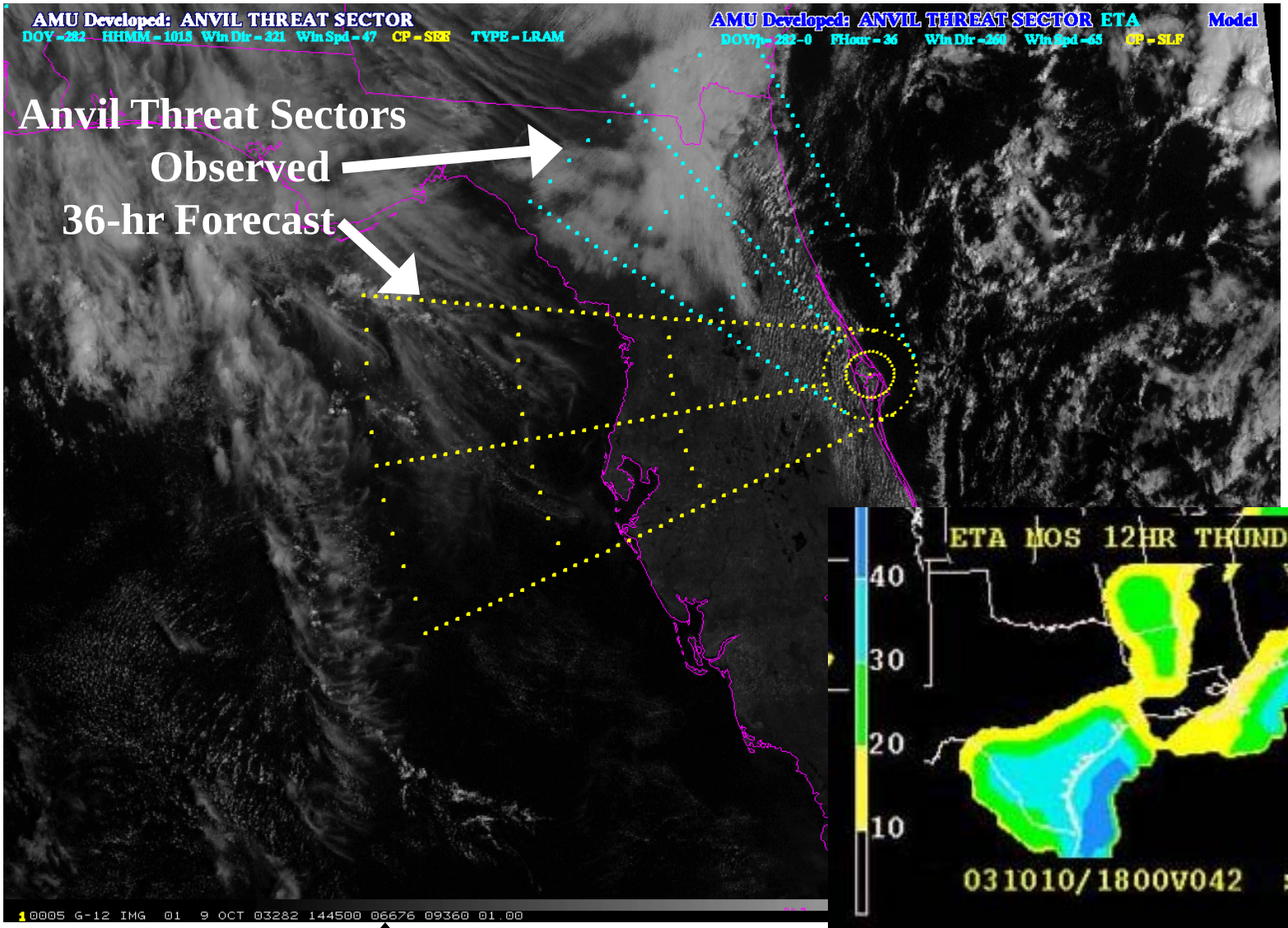




Parameters for an Anvil Threat Sector:



- 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



EXAMPLE TSTM GUIDANCE:

ETA-MOS 12-HR PROBABILITY OF THUNDERSTORMS (LTNG):
The probability that a thunderstorm will occur in a 40 km grid box during the 12 hour period ending at the specified time.
A thunderstorm is defined as 1 or more cloud-to-ground lightning strikes.

McIDAS-type Display: Anvil Tool written in McBASI

SUMMARY:

- **Thunderstorm Anvil Threat Sector:**
  Delineates potential area of concern
- **Nowcast Threat Sector:**
  Based on observed 300 to 150 mb winds
- **Forecast Threat Sector:**
  Based on Eta or MRF point data (winds)

[Other guidance needed for thunderstorm probability]

❖ **AMU Quarterly Reports:**

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

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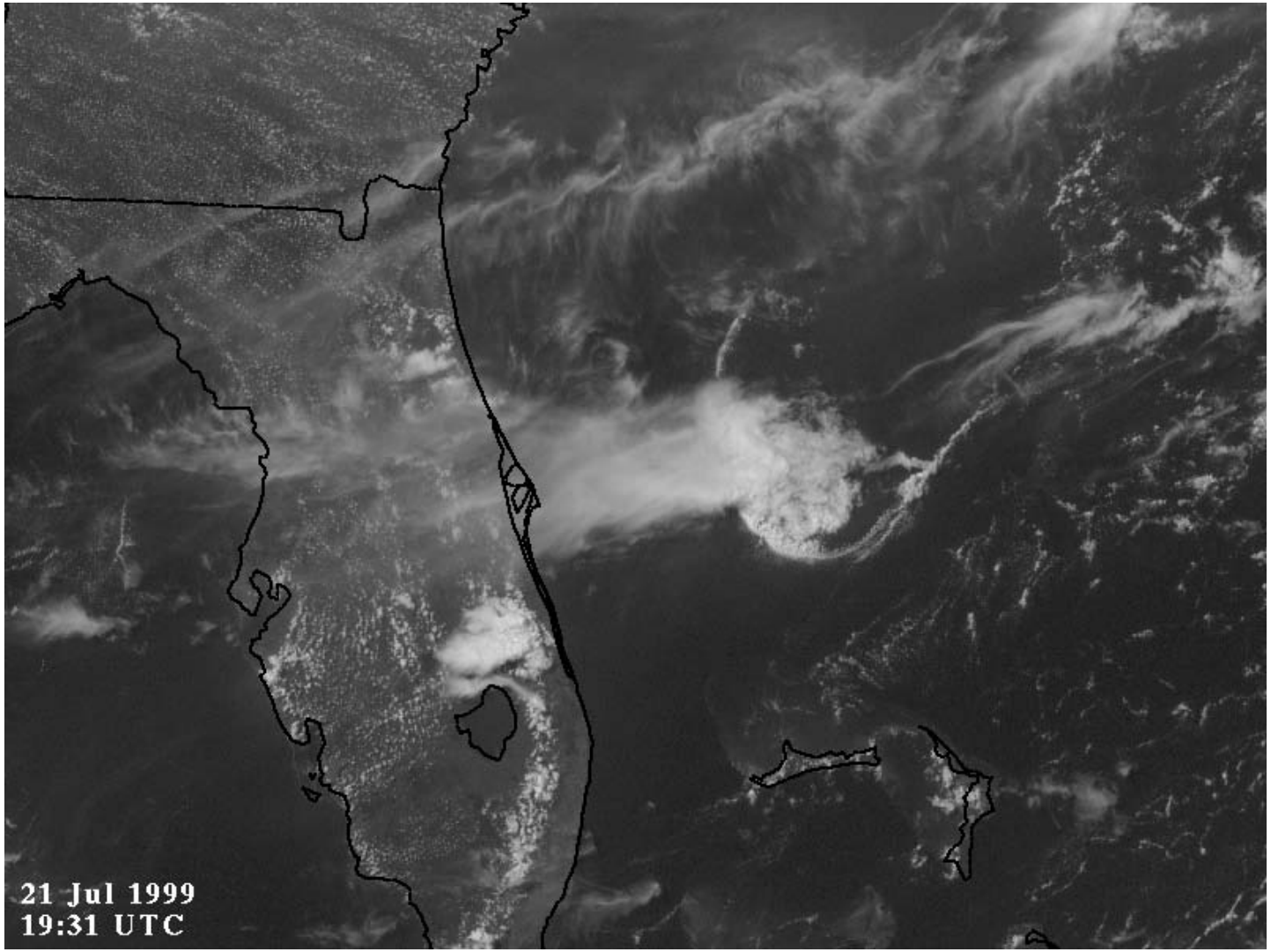
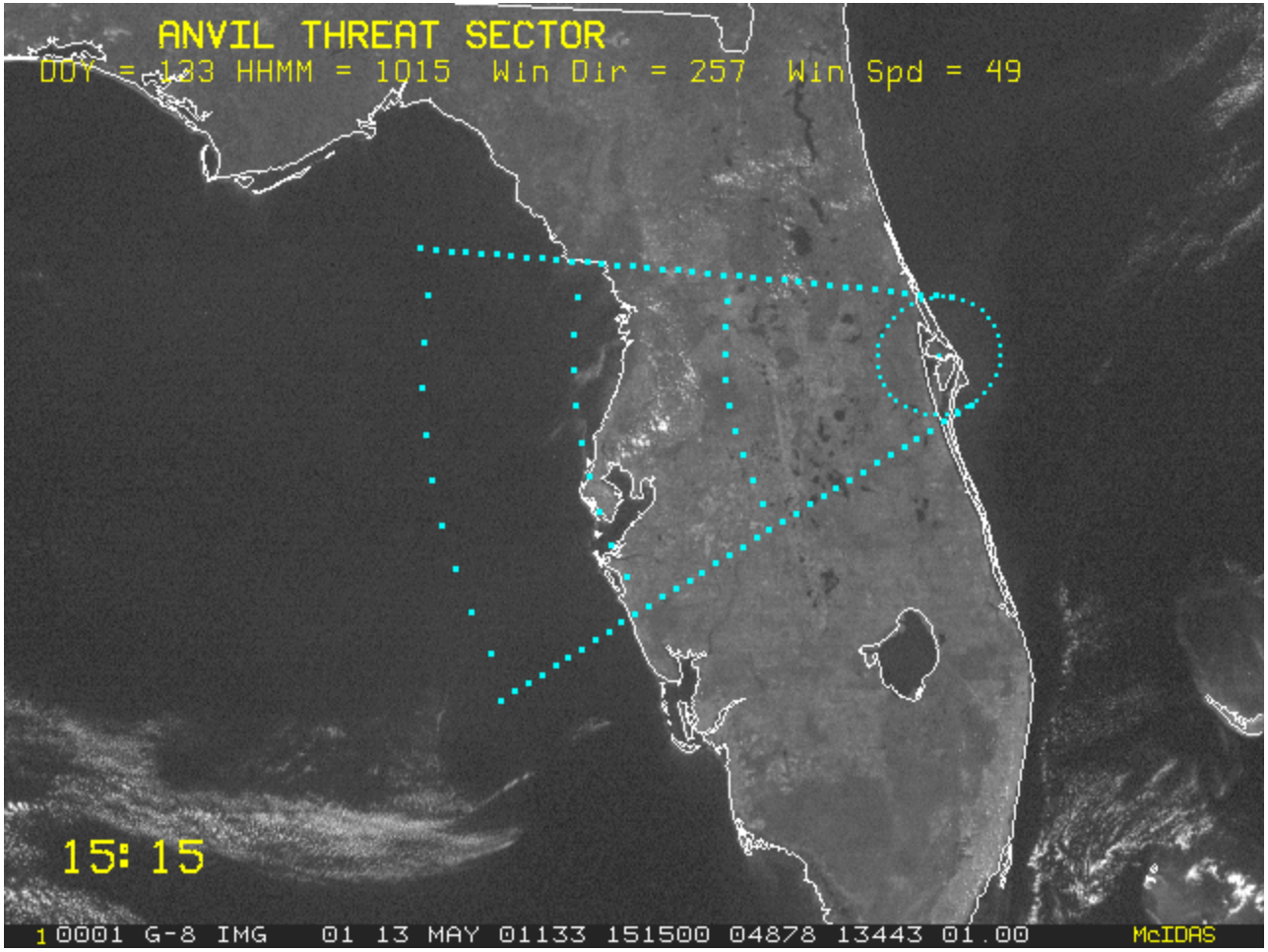
Ocean Anvil case from 45 WS Pilot Study



GOES-8; May 13, 2001



Prototype Threat Sector Tool (McBASI)

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