A Climatological Study Of Nighttime Rapidly Developing Low Cloud Ceilings In A Stable Environment

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Outline

- Project objectives
- Data and period of record
- Definitions
- Methodology
- 8 January 2004 Event
- 28 December 2004 Non-Event
- Summary/Results
Project Objectives

• Improve forecast for shuttle de-orbit burn GO/NO GO decision
• Assemble database of nighttime events with rapidly developing ceilings below 8000 ft
• Document the atmospheric regimes favoring the rapid, stable cloud formation
• Identify the onset and dissipation times
Data and Period of Record

- Cape Canaveral (XMR) evening and morning radiosondes
- Hourly surface obs at Kennedy Space Center Shuttle Landing Facility (SLF)
- Infrared satellite imagery
  - Every 15-30 minutes
- Nighttime only
  - 2200 to 1200 UTC
- Florida cool-season months
  - November to March
  - 1994 to 2005 (12 cool seasons)
Definitions

• Rapid development: Ceiling forms in less than 90 minutes
• “Event days”
  – Low ceiling violations at SLF
  – Rapid development confirmed via infrared satellite imagery
• “Non-Event days”
  – Low ceiling violations at SLF
  – Rapid development did NOT occur
  – Low ceilings from other mechanisms
    • Fog
    • Rain
    • Cloud advection
Methodology

• Identified inversions from XMR radiosondes below 8,000 ft
  – Height & strength
  – RH in layer beneath inversion
  – Mean wind & shear to ~ 15,000 ft

• Examined SLF surface obs
  – Identified ceilings below 8000 ft
  – Extracted nighttime hours
  – Eliminated cases with fog burn-off, widespread clouds or precip
  – Kept cases with ceiling development
Methodology

- Combined cases with low ceiling development and low-level inversions
  - Identified 86 possible cases
- Examined infrared satellite imagery for all cases
- Confirmed whether each case was development or advection
  - Very difficult with infrared imagery despite enhancements
- Identified only 6 cases with rapid ceiling formation
8 January 2004 Event
Summary/Results

Nighttime

- Only nighttime events
- 4 km infrared satellite imagery
- 83% of events had winds veering with height
- Mean inversion strength 2.5 °C
- Average onset time 0511 UTC
- 6 out of 86 cases identified as events
  - Meaningful statistics could not be calculated
  - Nighttime rapid low cloud development not a common occurrence

Daytime

- Only daytime events
- 1 km visible satellite imagery
- 85% of events had winds veering with height
- Mean inversion strength 4.0 °C
- Average onset time 1403 UTC
- 20 out of 48 cases identified as events
- Identified atmospheric regimes favoring rapid, stable cloud formation