



# Investigating Lightning Cessation at KSC

Holly A. Melvin  
Henry E. Fuelberg

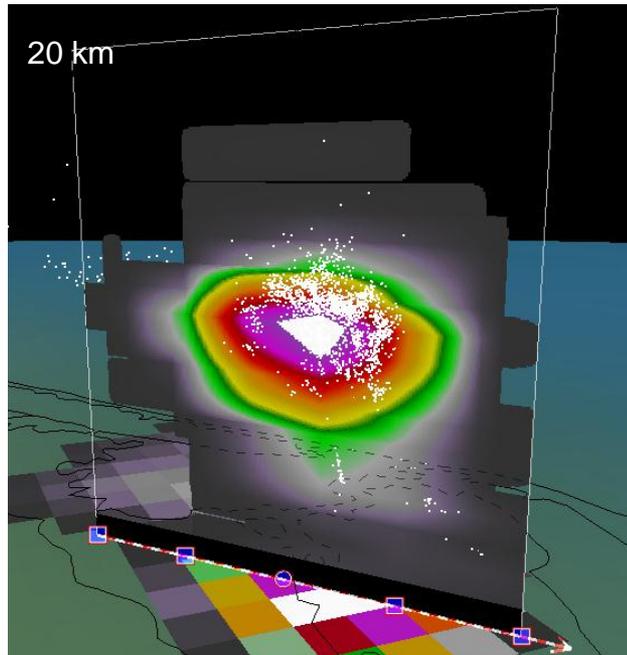
Florida State University

GOES-R GLM Workshop  
September 2009

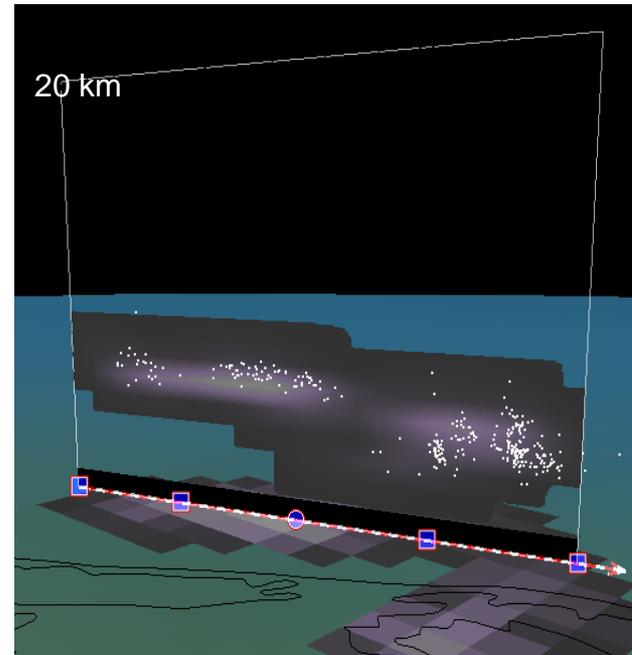


# Purpose

- Better understand electrical activity at the end of a storm
- Gain insight into forecasting the last flash of a storm



Vertical cross-section of 1-min LDAR total lightning source density at 2246 UTC 9 Aug 2005, during the peak rate of core lightning



Vertical cross-section of 1-min LDAR total lightning source density at 2326 UTC 9 Aug 2005, the last IC lightning flash of the storm



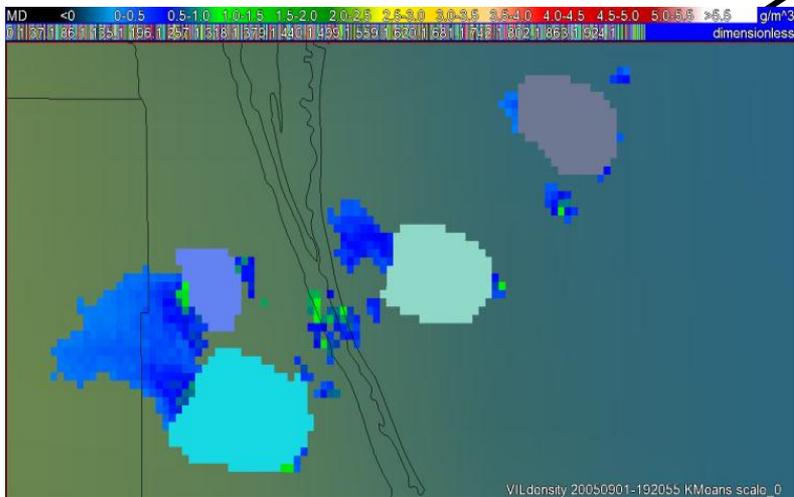
# Methodology

- Consolidate LDAR sources into flashes using a modified version of NASA's flash creation algorithm (Nelson, 2002)
- Match CGLSS/NLDN flashes to LDAR flashes using McNamara's algorithm (2002)
- Separate matched flashes into IC sources, CG sources, IC initiation sources, CG initiation sources, and CG strike location data for further analysis
- Use WDSS-II software (Lakshmanan et al., 2006) to identify and track storms and their associated lightning and radar characteristics



# Storm Cell Tracking

- Using the WDSS-II K-Means clustering algorithm:
  - Identify storms based on VIL density
  - Set clustering thresholds low enough to track storms through lightning cessation
  - Clustering small, isolated, weakening cells presents a major challenge!



VIL Density and associated storm clusters on 1 Sep 2005

WDSS-II Derived Lightning Parameters	WDSS-II Derived Radar parameters
1-min VILMA of IC LDAR initiation points	Max reflectivity at 0°C/-10°C/-20°C
1-min VILMA of CG LDAR initiation points	Avg reflectivity at 0°C/-10°C/-20°C
1-min VILMA of all CG LDAR sources	Layer Avg reflectivity between 0°C and -20°C
1-min VILMA of all IC LDAR sources	Vertically Integrated Liquid (VIL)
1-min Multiplicity/Peak current for +, -, and all CG strikes	Height of the 30 dBZ above -10°C
1-min Density for +, -, and all CG strikes	Height of the 50 dBZ above -10°C
1-min Height of the Max LMA of IC and/or CG initiation points	Precipitation rates and 5-min, 10-min, and 15-min accumulations

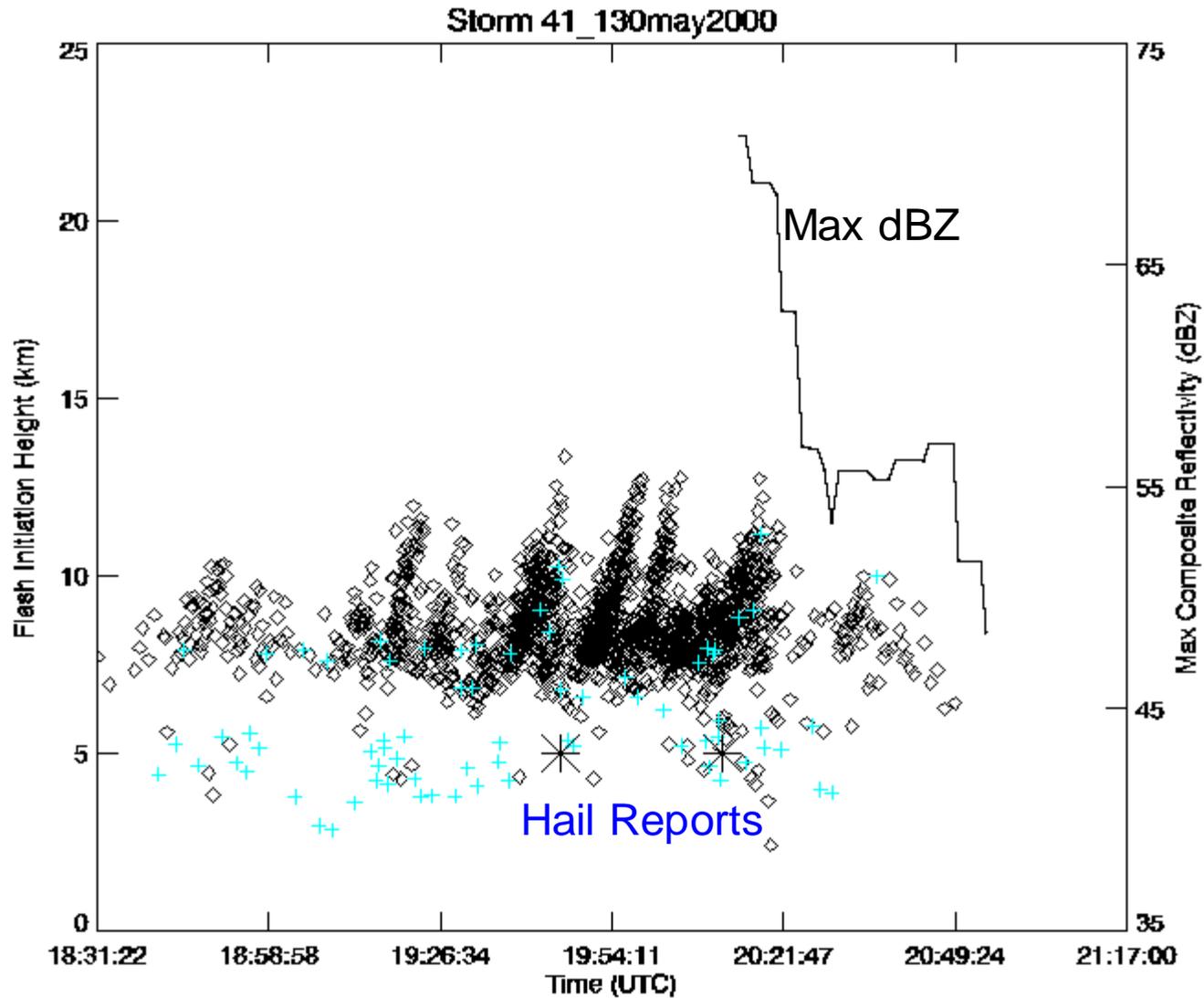


# Different Styles of Cessation

Analyzed 106 storms



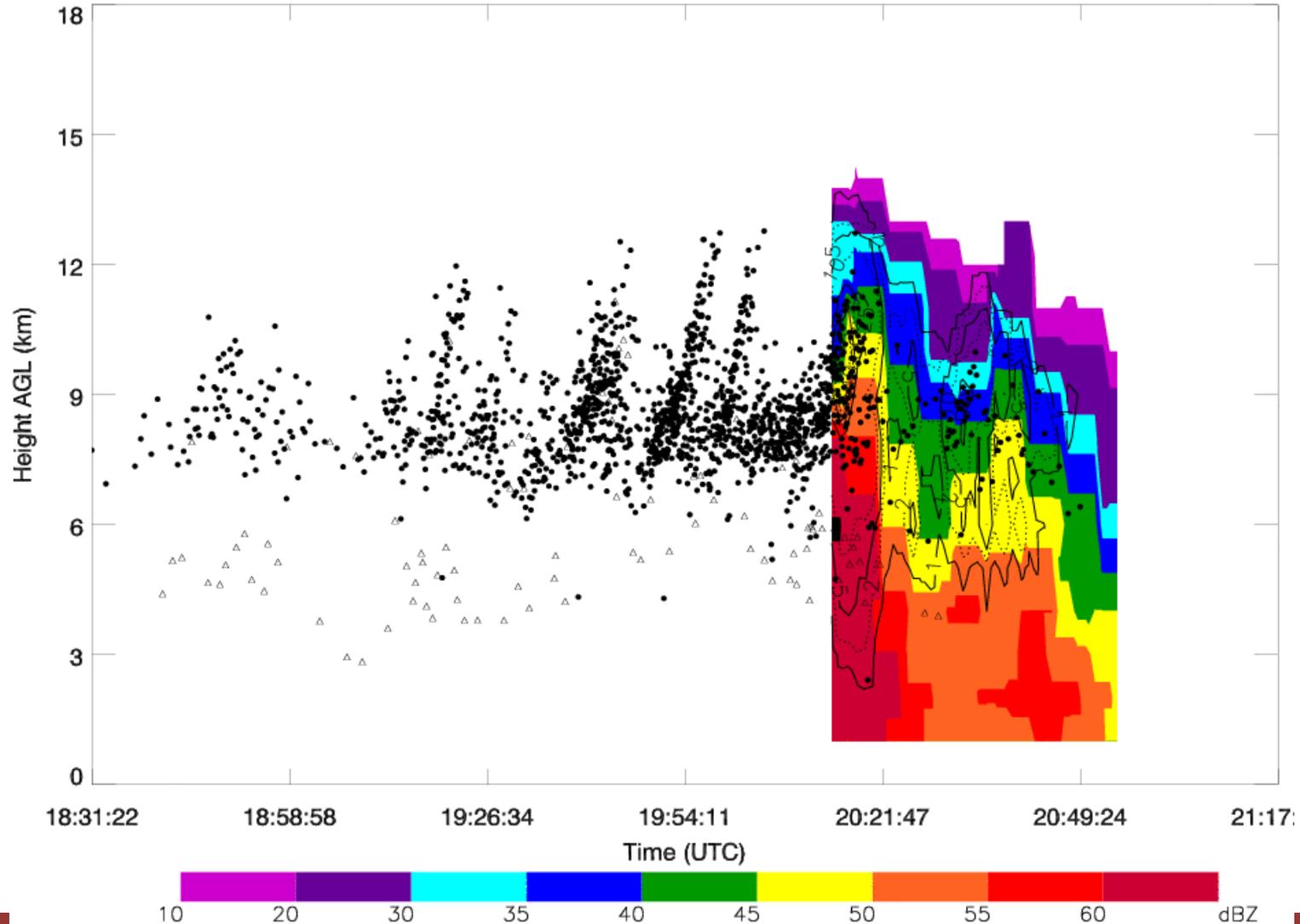
# Abrupt Cessation





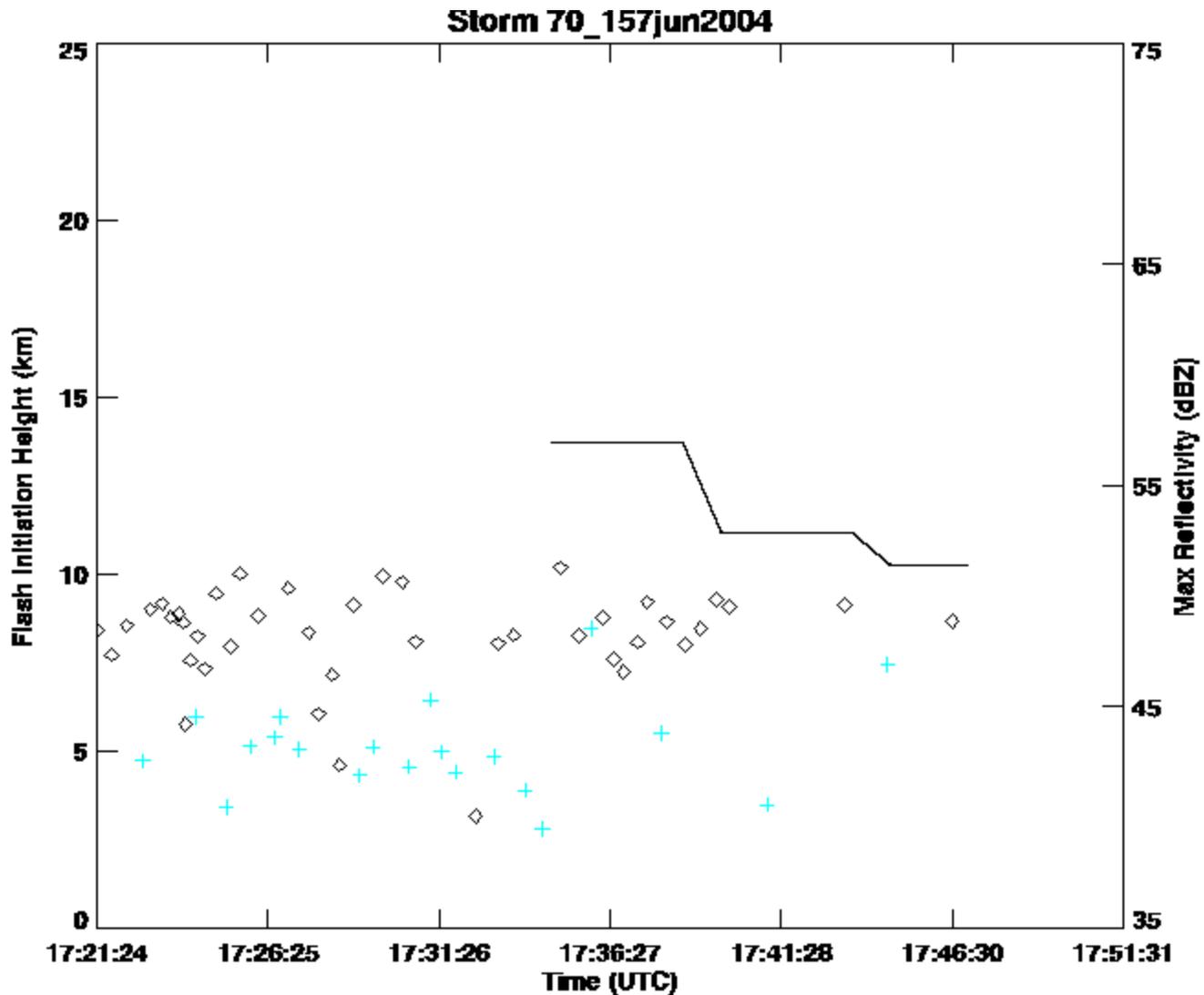
# Time Series of Reflectivity and Source Density

Vertical Profile for Storm 41 on 9 May 2000





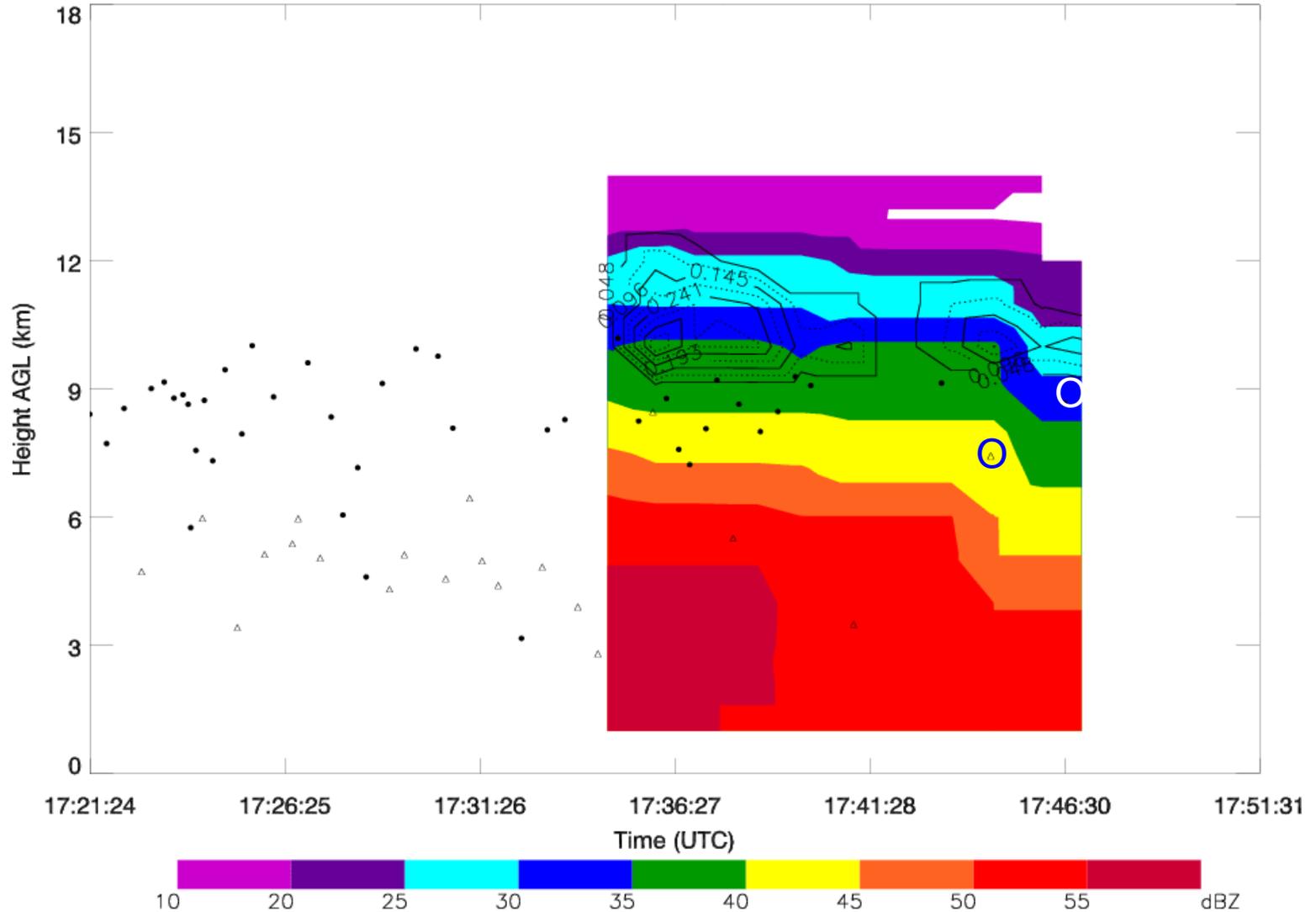
# Gradual Cessation





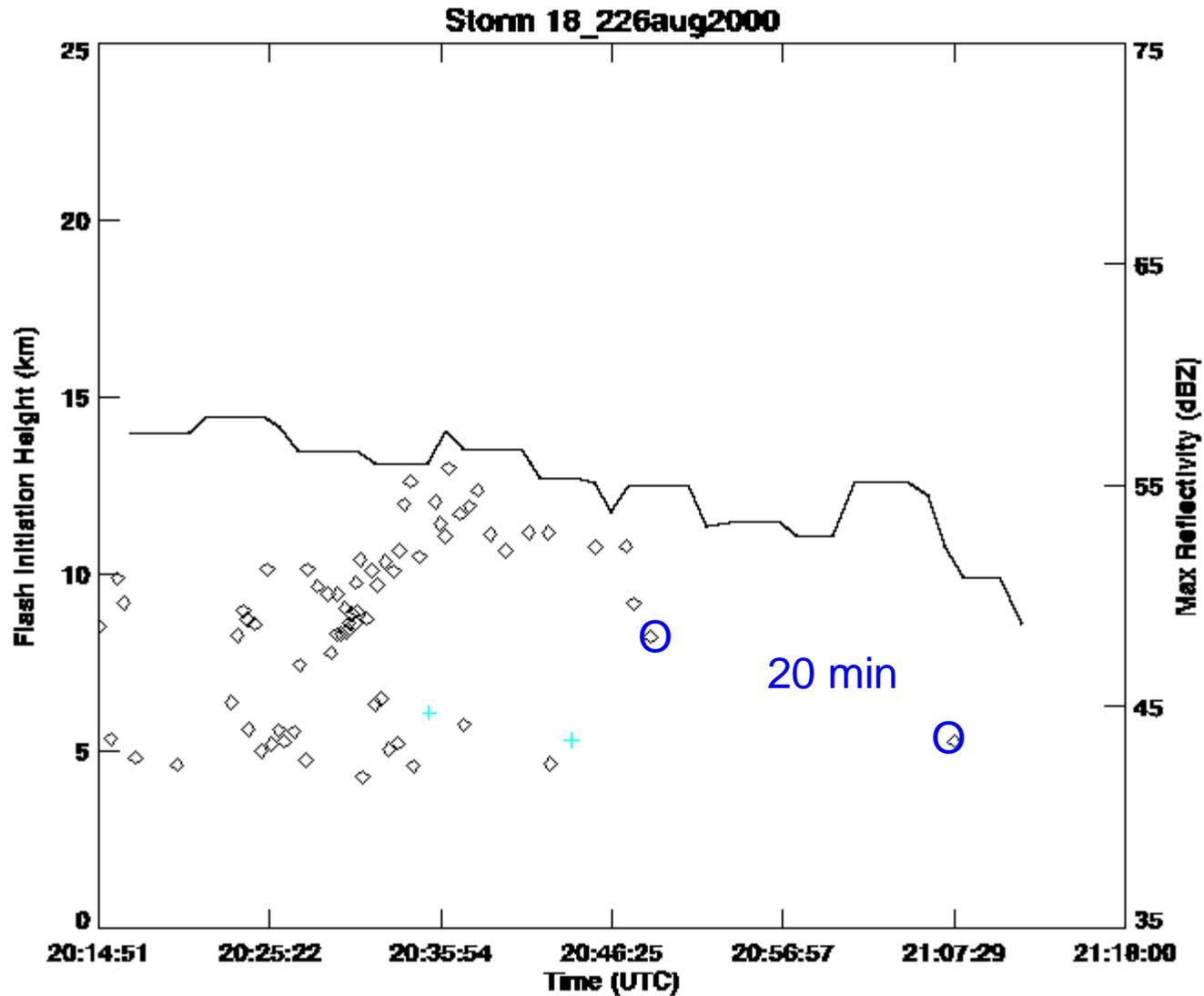
# Time Series of Reflectivity and Source Density

Vertical Profile for Storm 70 on 5 June 2004



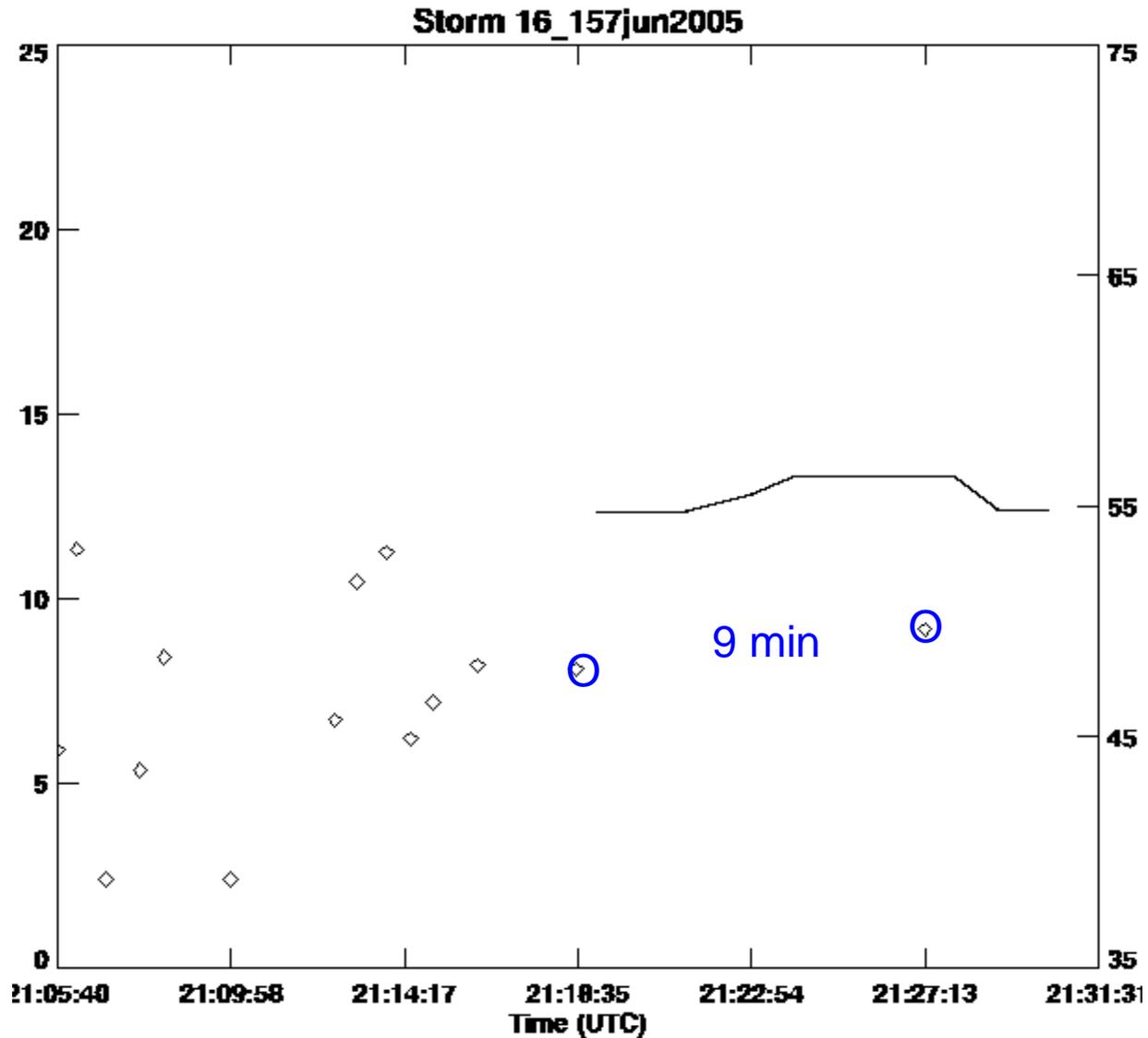


# Outlier





# Another Outlier

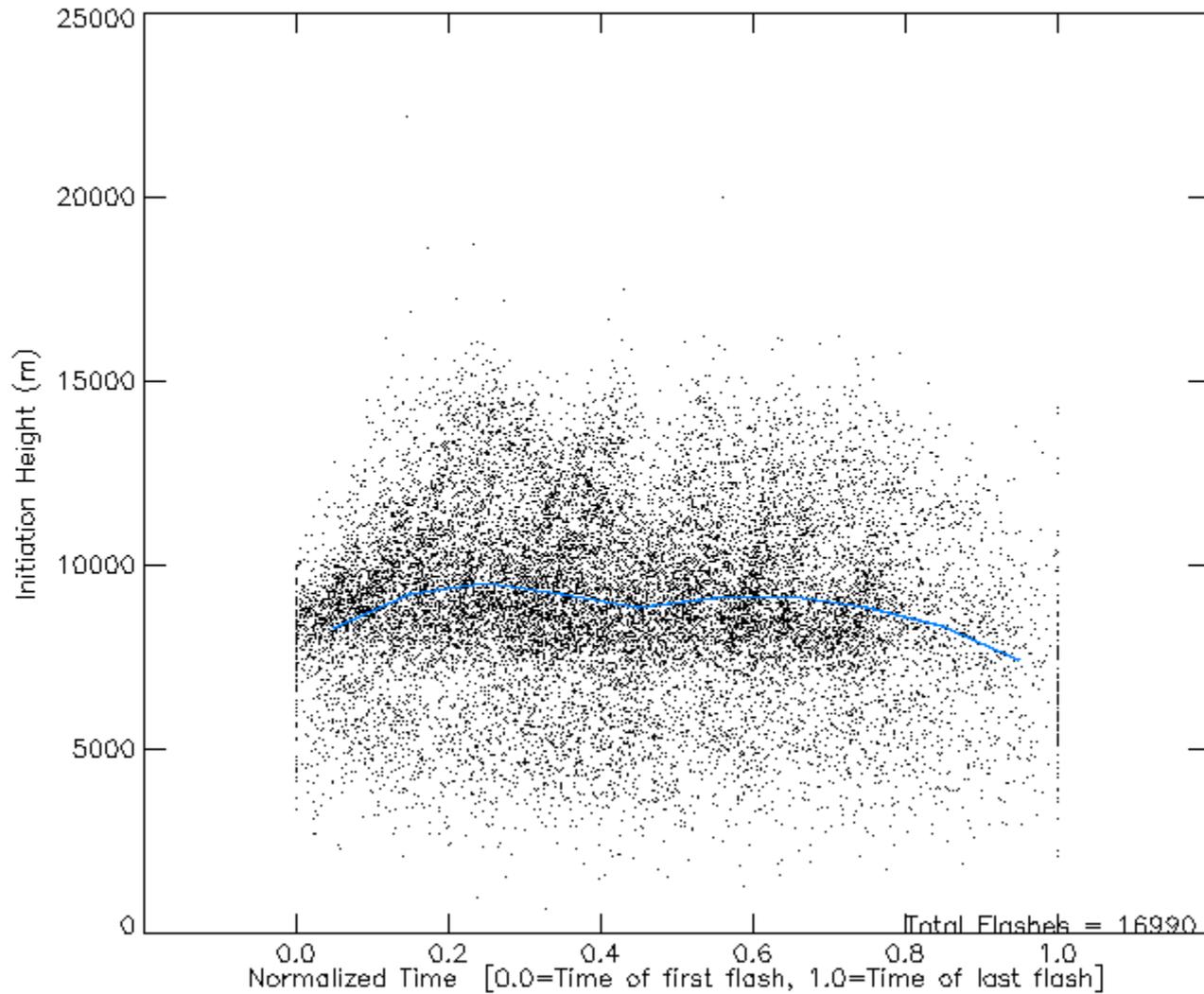




# Trying to Put it all Together Composites



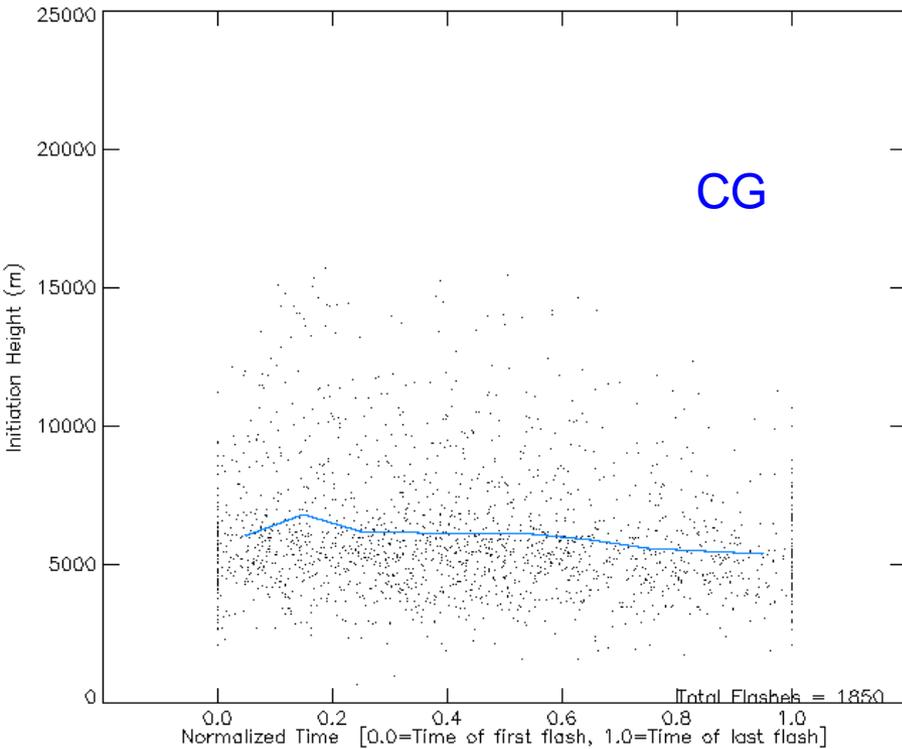
# Initiation Heights in Normalized Time



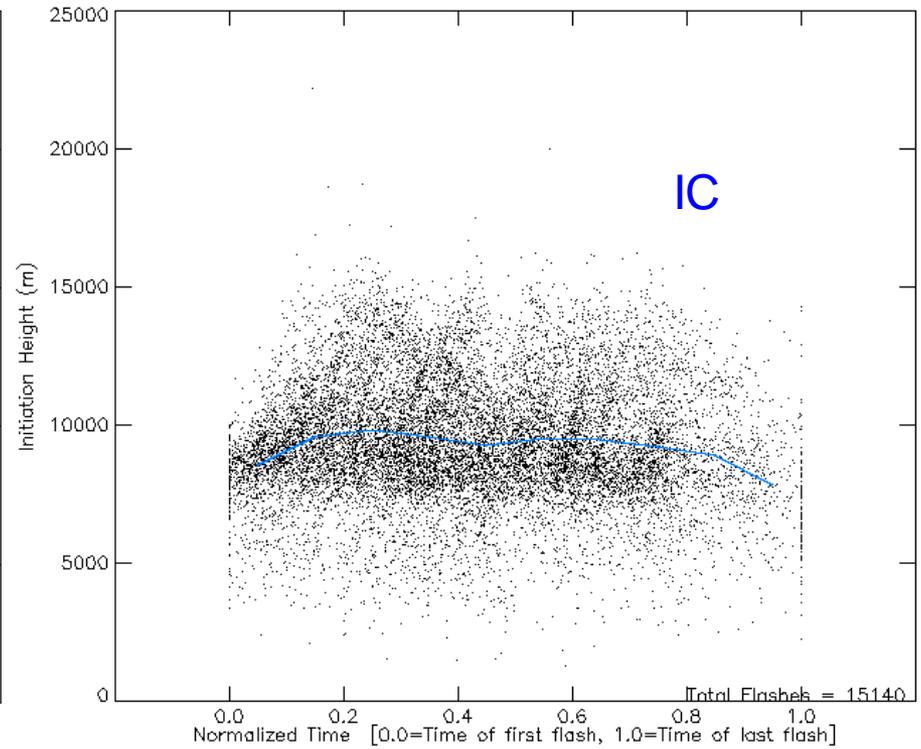


# Initiation Heights CG vs IC Flashes

Time-Normalized Initiation Heights of 116 Storm Cases  
All CG Flashes



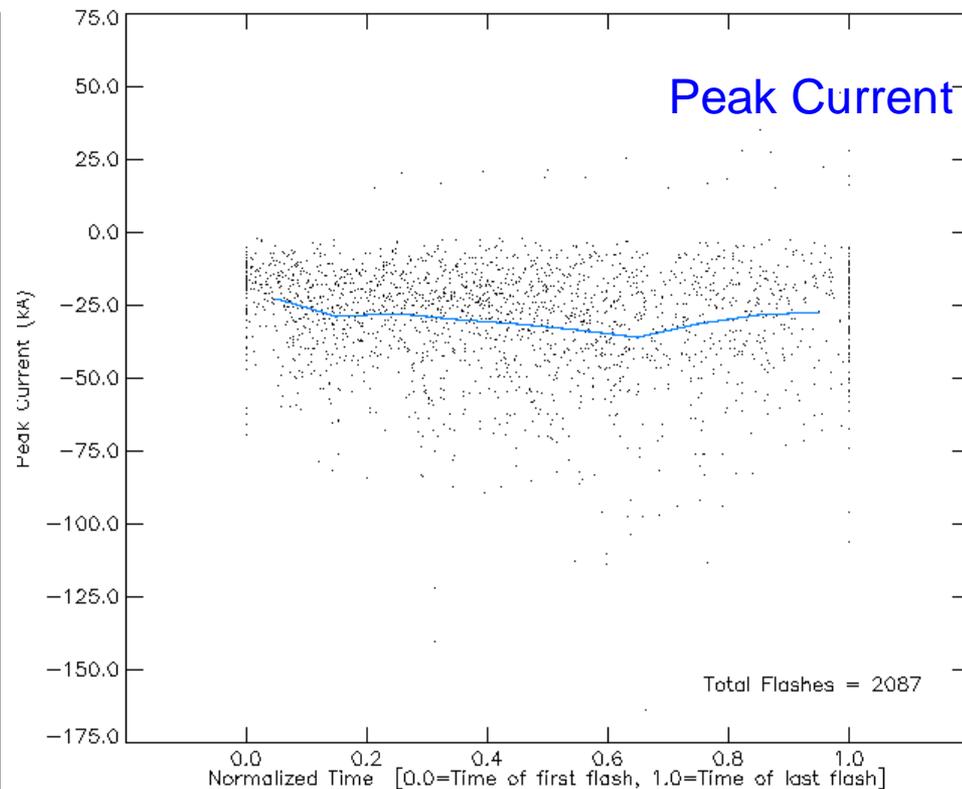
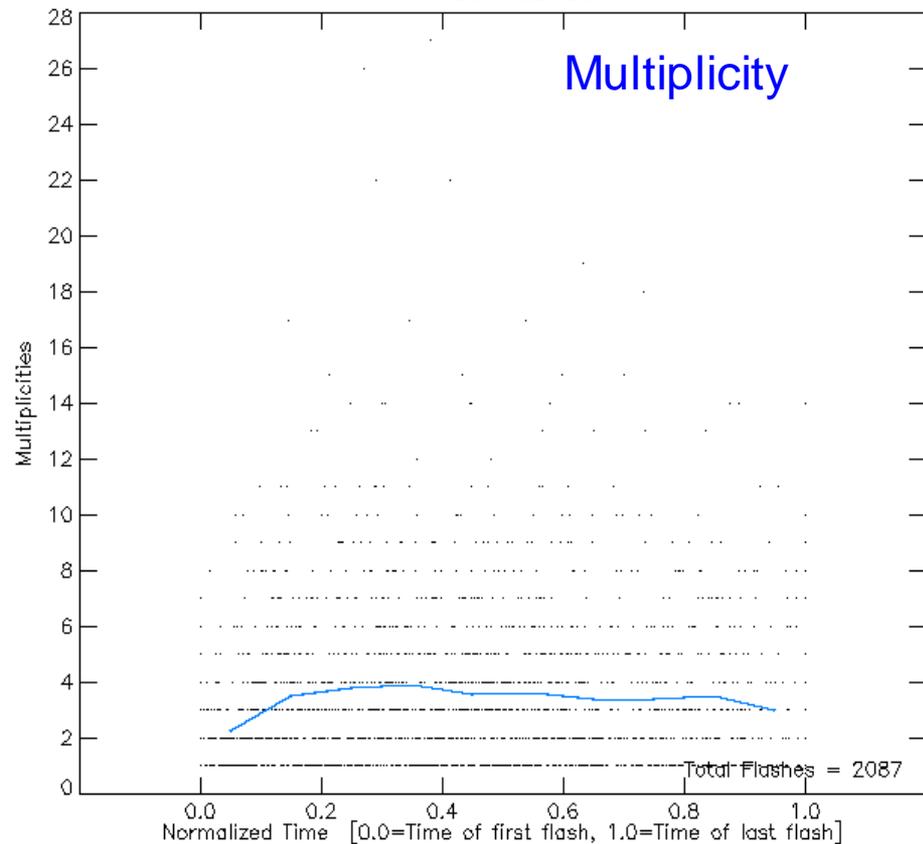
Time-Normalized Initiation Heights of 116 Storm Cases  
All IC Flashes





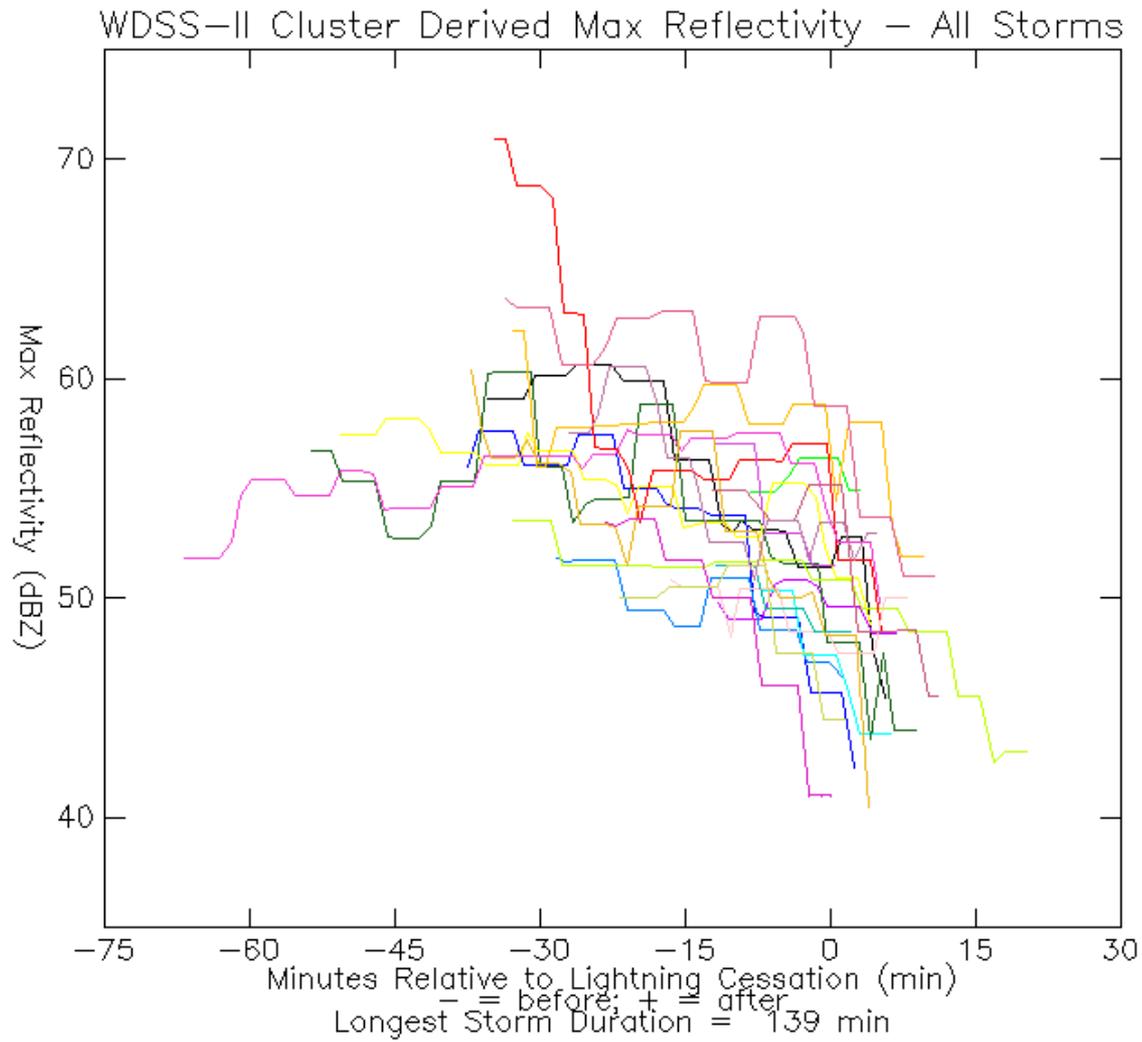
# Multiplicity and Peak Currents

Time-Normalized Multiplicities of 116 Storm Cases  
All CG Flashes





# Max Reflectivity





# Reflectivity Data Being Analyzed

Much More Work Remains  
Detailed Statistical Studies