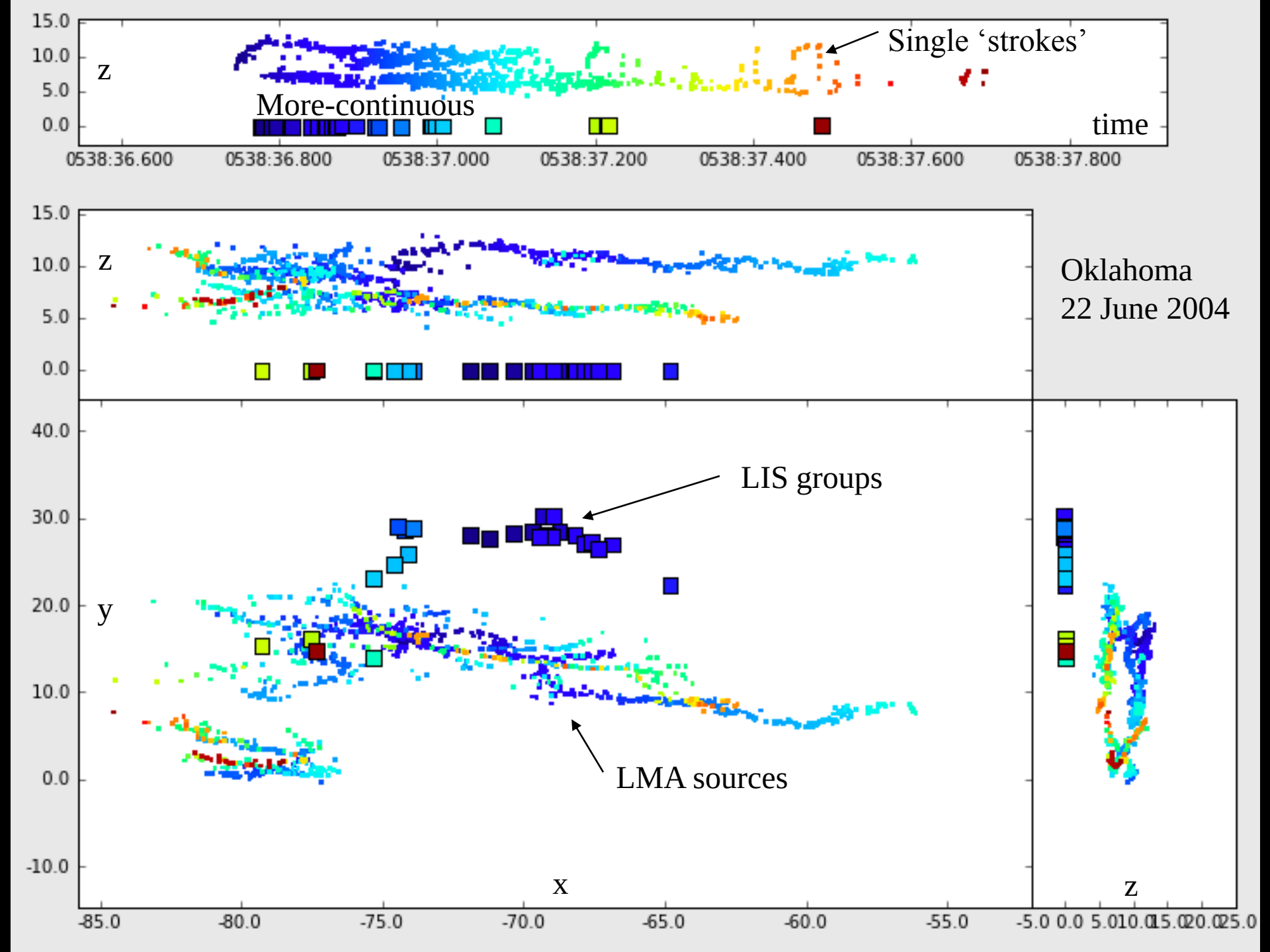
Simulating optical pulses from observed VHF sources

Eric Bruning
University of Maryland / ESSIC / CICS
and NOAA / NESDIS / STAR

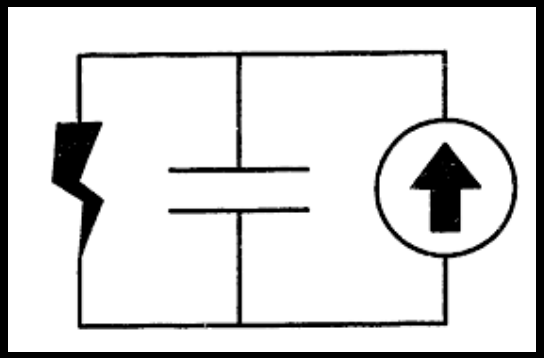
GLM Science Meeting
Huntsville, AL
29 September 2008

- Need: Simulation of flashes, groups, and events for proxy data.
  - Testing LCFA
  - Operational delivery trials (GOES-R Proving Ground)

- Given VHF source data when do optical pulses occur during a flash?


Single ‘strokes’
More-continuous
z
time
0538:36.600
0538:36.800
0538:37.000
0538:37.200
0538:37.400
0538:37.600
0538:37.800
Oklahoma
22 June 2004
LIS groups
LMA sources
y
x
z

Proposed approach



- Heckman's (1992) Ph.D. thesis proposes a model predicting when CGs produce strokes vs. continuing current
- Modeled as a 0-D circuit, with a **resistive** lightning channel in parallel with **capacitance** and **a current source**.
- Unstable (strokes) for $RC > \tau$, stable (continuous) for $RC < \tau$
- Drive a flash with enough current, and its resistance remains low enough for continuous optical emission

The differential equations

- Predict resistance and potential, with varying channel length and current source

$$\frac{\partial V}{\partial t} = \frac{I_0}{C} - \frac{V}{RC}$$

- Current source I_0 is provided by channel extension.
  - LMA sources show channel extension!
  - Parameterize using source power

$$\frac{\partial R}{\partial t} = \frac{R}{\tau} + \left(1 - R\frac{\partial V}{\partial I}\right)\frac{V}{I_0 \tau}$$

- Parameterized differential resistance from King (1961)
- Parameterized τ from Heckman (1992)
- Parameterize L from LMA flash extent

$$C = \frac{2\pi\varepsilon_0 L}{\ln\left(\frac{L}{R}\right)}$$

Status

- Idea is about 1 week old, have skeleton of code
- Need to code King, Heckman parameterizations, then tune L and I_0 parameterization
- Have GUI to easily select any LMA flash and corresponding LIS groups and run algorithm

- Goal is statistically similar proxy data that flashes believably
- Operational run time is a concern
  - Must LMA data be sorted into flashes, or will simply looking at everything within a 10 km pixel work just as well?