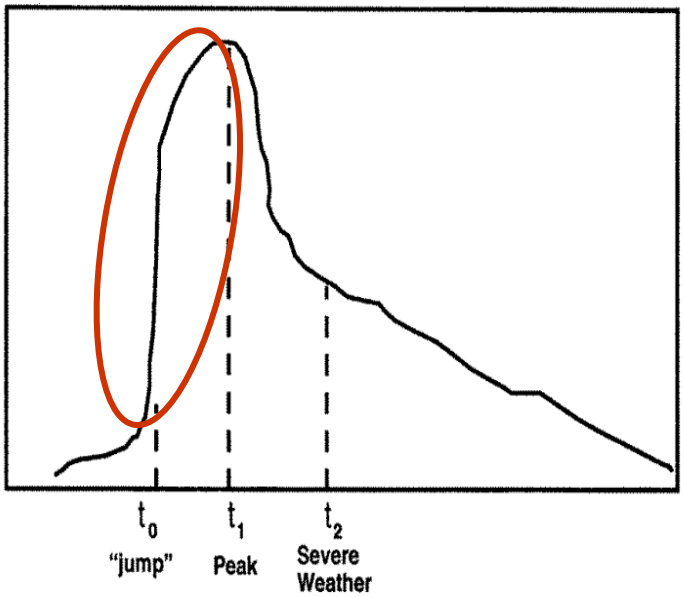
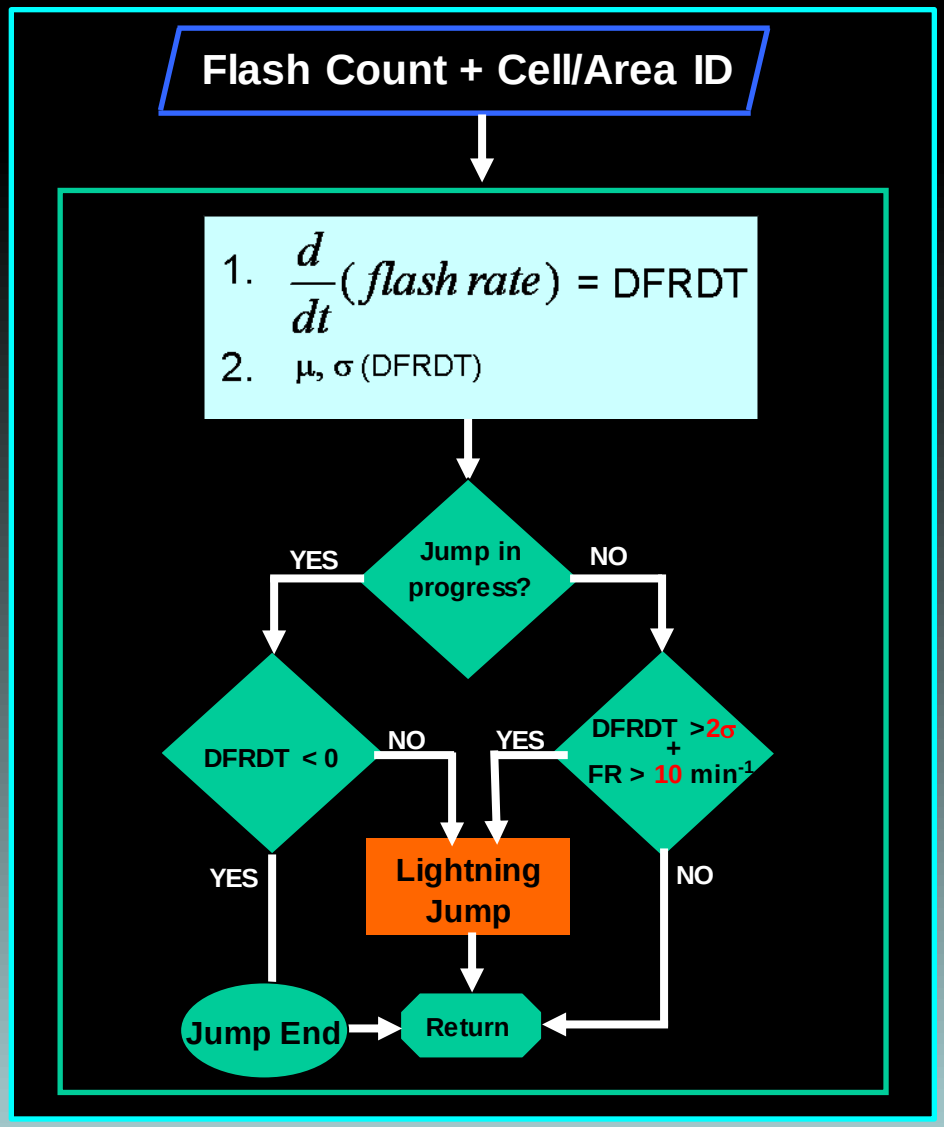
Lightning Jump Algorithm Update



W. Petersen, C. Schultz, L. Carey, E. Hill

Algorithm Configuration



2-Sigma Algorithm

Calculate the average flash rate over two minute intervals.

If the flash rate (FR) exceeds 10 min^{-1} then:

- Calculate d(FR)/dT = (DFRDT) every 2-minutes
- Calculate mean (μ) and standard deviation (σ) of the DFRDT over the past 10 minutes.
- Assess jump status: jump = DFRDT-increase beyond threshold of 2σ

Jumps that occur within 6 minutes of each other are counted as 1 jump

End jump when DFRDT value < 0.

Schultz, Petersen and Carey, 2009, JAMC
Gatlin and Goodman, 2009, Wea. Fcst.

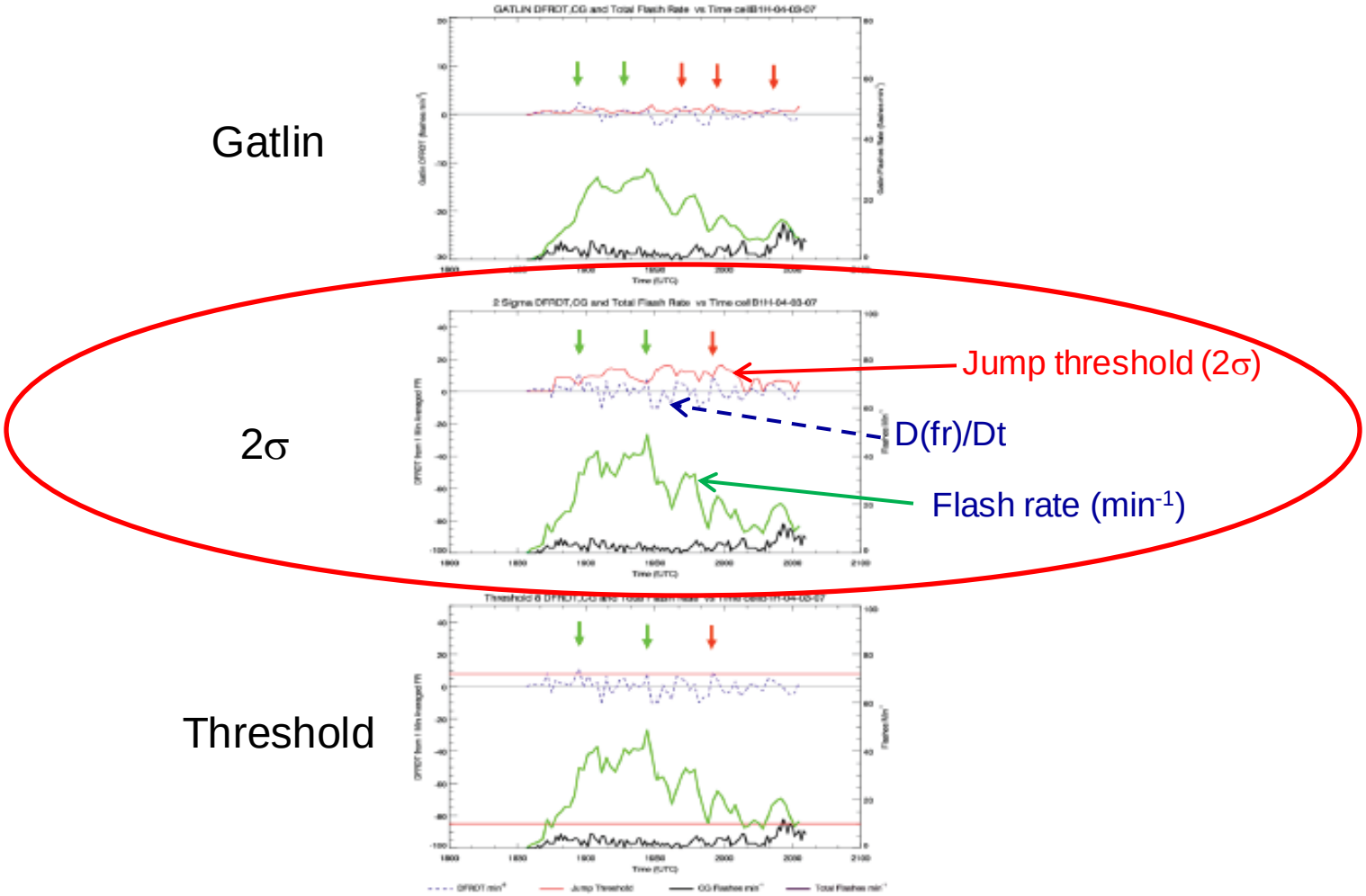


FIG. 1. An example of each type of algorithm is demonstrated for a severe thunderstorm that occurred on April 3, 2007. The three algorithms represented here are the Gatlin (top), 2σ (middle) and Threshold 8 (bottom). In each algorithm the blue dash represents DFRDT, the red line is the jump threshold, the green line is the averaged total flash rate for each algorithm, and the black line is the number of cloud-to-ground flashes. Green arrows represent lightning jumps associated with severe weather, while red arrows represent false alarms. The Gatlin algorithm uses an averaged weighted mean flash rate (see Equations 1 and 2). The 2σ algorithm and Threshold 8 algorithm only use a 1 minute average flash rate (Equation 1).

Published Statistics

Schultz, Petersen, Carey, JAMC, (2009)

85 thunderstorms

69 non-severe

38 severe:

22 – supercells

2 – low topped supercells

1 – LEWP

2 – tropical

2 – MCS

1 – MCV

8 – multicellular

Two Sigma

	POD	FAR	CSI	HSS
Within 100 km				
Severe only	87%	23%	69%	0.82
Severe and Non-severe	87%	33%	61%	0.76
Within 150 km				
Severe only	87%	26%	67%	0.80
Severe and Non-Severe	87%	33%	61%	0.75

Three Sigma

	POD	FAR	CSI	HSS
Within 100 km				
Severe only	50%	20%	44%	0.61
Severe and Non-severe	50%	32%	41%	0.58
Within 150 km				
Severe only	56%	21%	49%	0.65
Severe and Non-Severe	56%	29%	45%	0.62

Threshold 10 (5)

	POD	FAR	CSI	HSS
Within 100 km				
Severe only	73%	32%	54%	0.70
Severe and Non-severe	73%	36%	52%	0.68
Within 150 km				
Severe only	72%	37%	51%	0.67
Severe and Non-Severe	72%	40%	49%	0.66

Gatlin (2006)

	POD	FAR	CSI	HSS
Within 100 km				
Severe only	97%	45%	54%	0.70
Severe and Non-Severe	97%	66%	34%	0.52
Within 150 km				
Severe only	97%	49%	50%	0.67
Severe and Non-Severe	97%	64%	35%	0.52

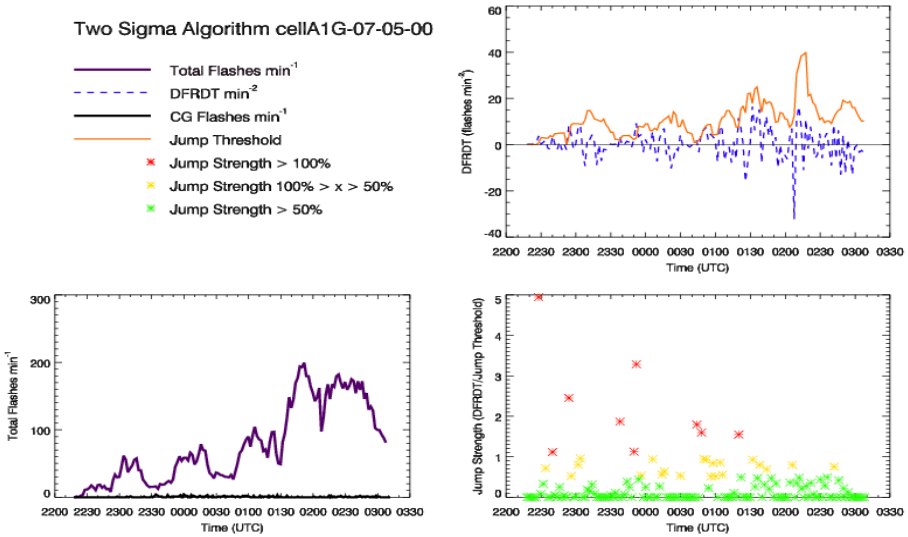
Threshold 8 (4)

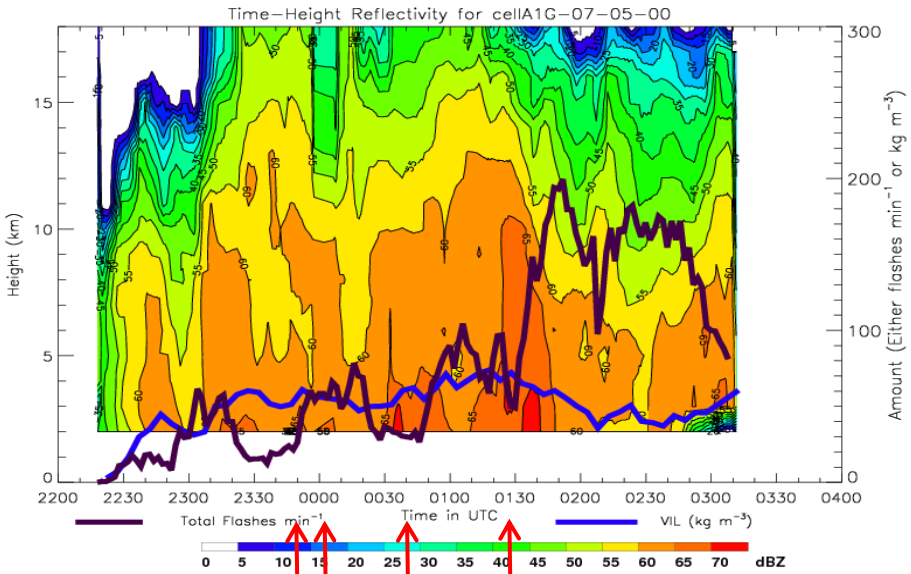
	POD	FAR	CSI	HSS
Within 100 km				
Severe only	82%	37%	55%	0.71
Severe and Non-severe	82%	41%	52%	0.69
Within 150 km				
Severe only	83%	42%	52%	0.68
Severe and Non-Severe	83%	42%	50%	0.67

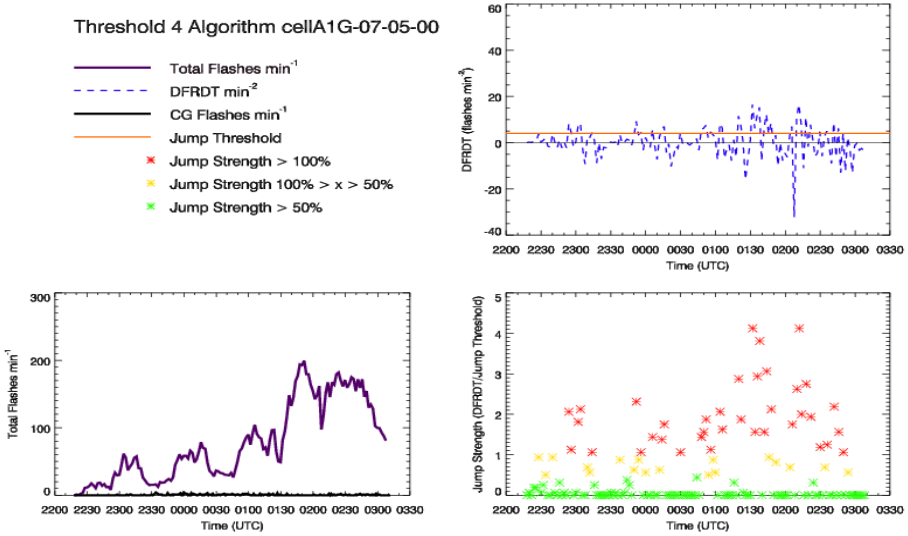
Latest Focus

- STEPS Cases
  - 11 thunderstorms
    - 3 Severe
    - 8 non-severe
- Washington D.C. LMA cases
  - 38 thunderstorms
- Jump “strength” index = (DFRDT/Threshold)

5 July 2000 STEPS





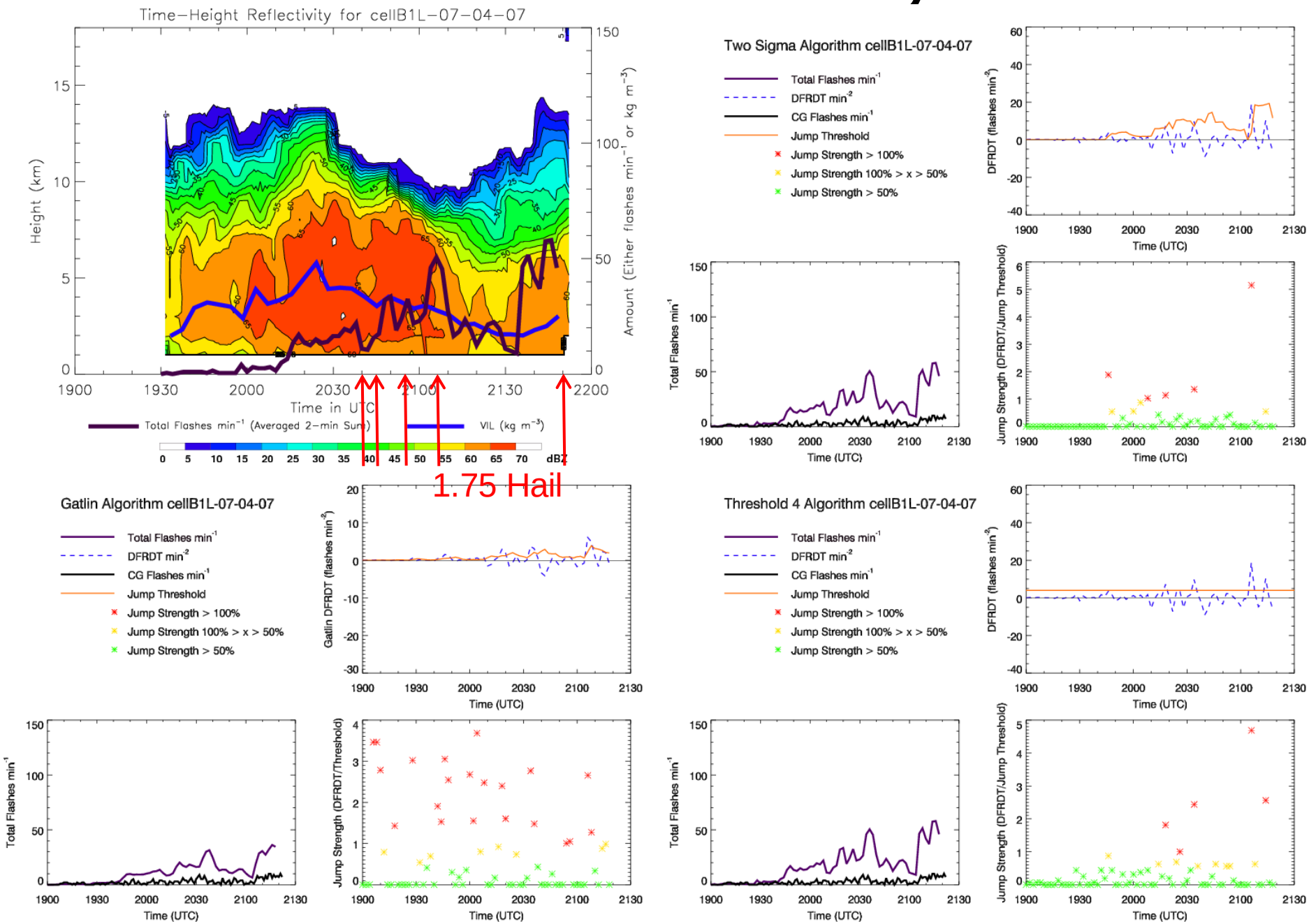


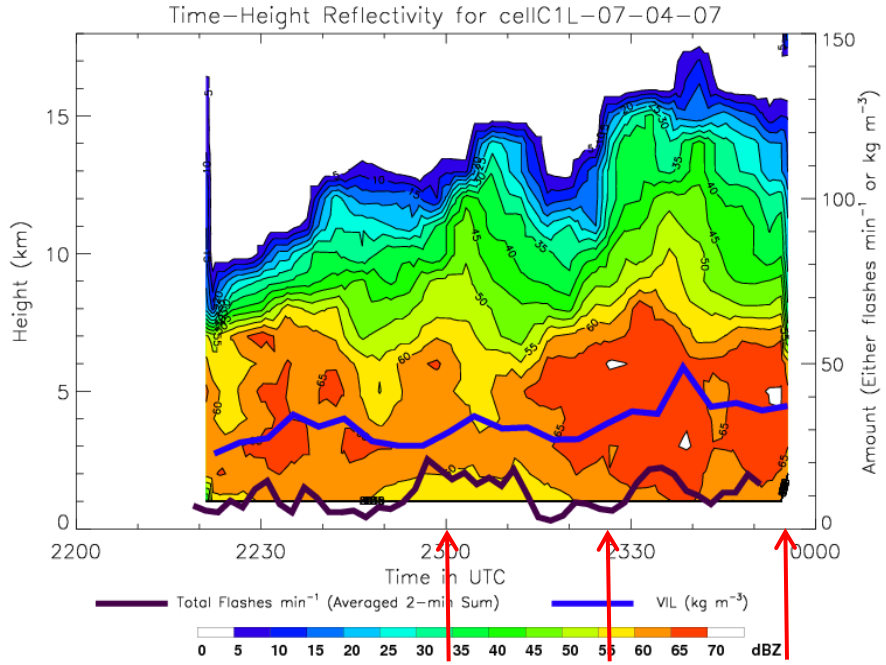
Hail Reports
1.75 inch max

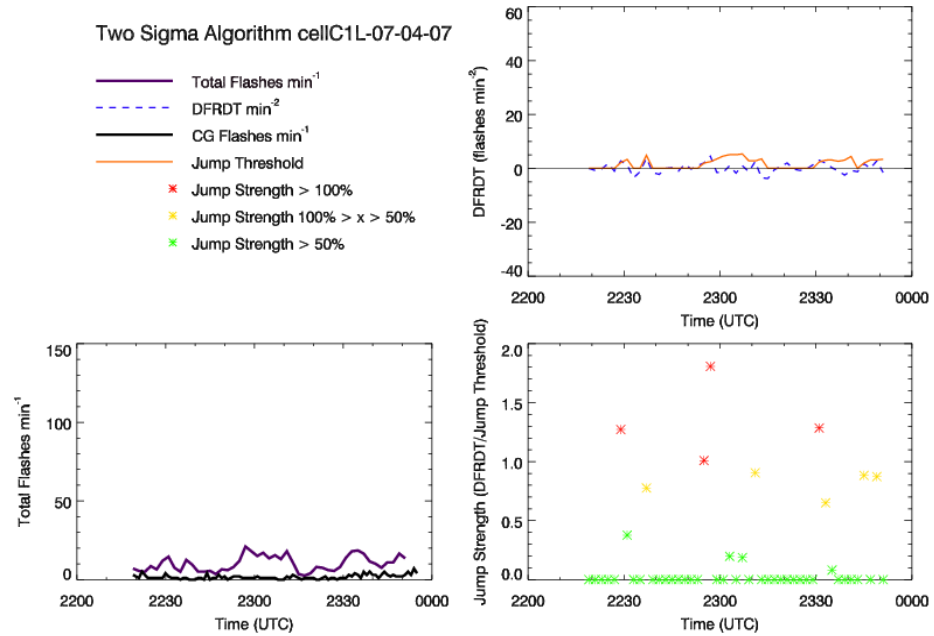
STEPS Notes

- Negative DFRDT's "preventing" 2 and 3 sigma algorithms from detecting missed events (since standard deviation accounts for both positive and negative values)
- Flash rates from STEPS are higher than storms sampled in N. Alabama
- Need more cases from this region
  - Working on more case dates from STEPS field program

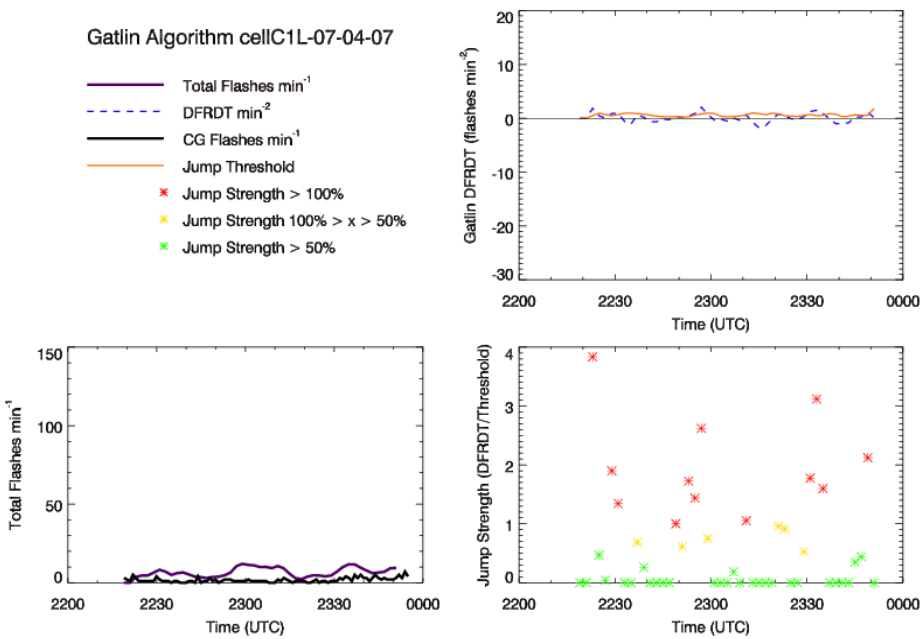
4 July 2007 DC

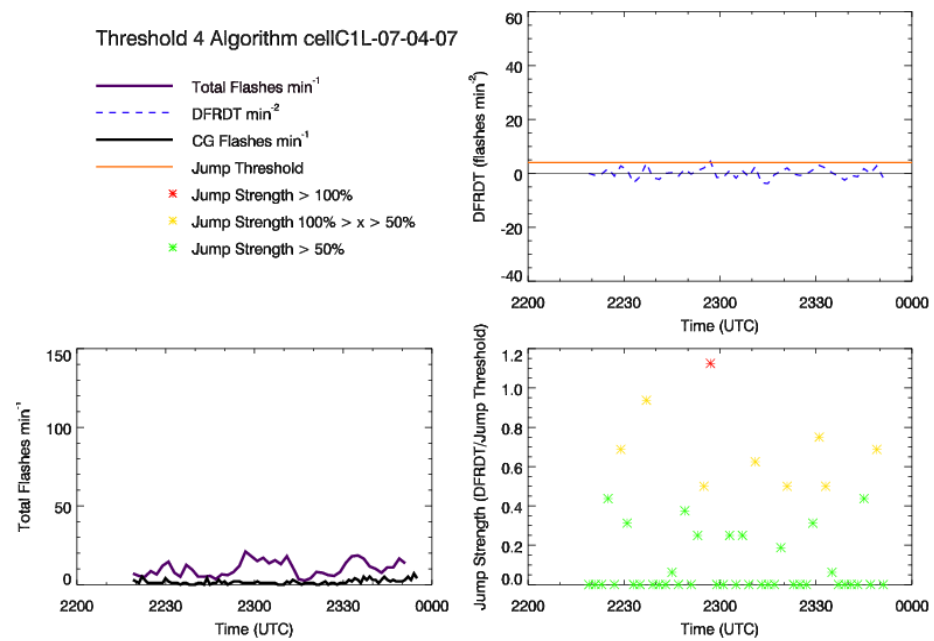






0.75 Hail Reports + wind



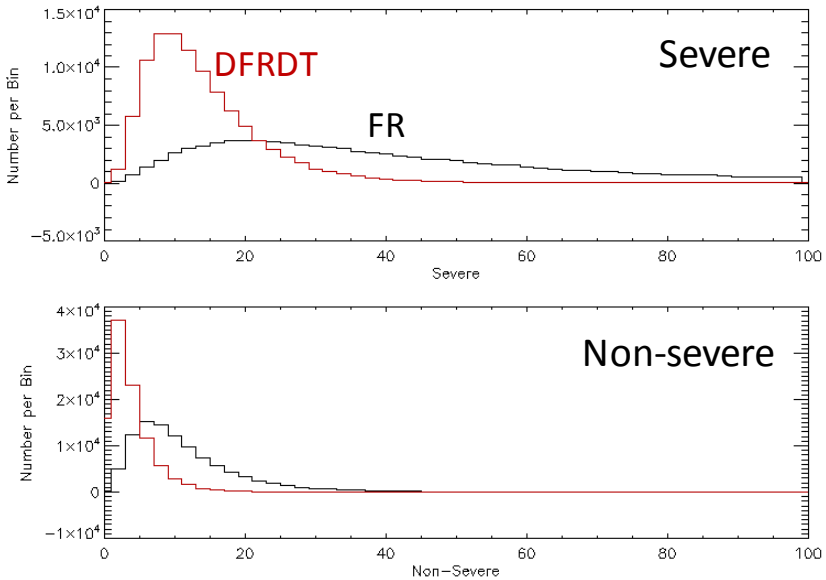


DC LMA Case Summary
38 Cells (36 severe reports)

	Gatlin (2)	2 Sigma	3 Sigma	Thresh4	Thresh5
POD	0.92	0.81	0.61	0.56	0.41
FAR	0.66	0.31	0.15	0.39	0.36
CSI	0.33	0.59	0.55	0.41	0.33
HSS	0.49	0.74	0.71	0.58	0.50

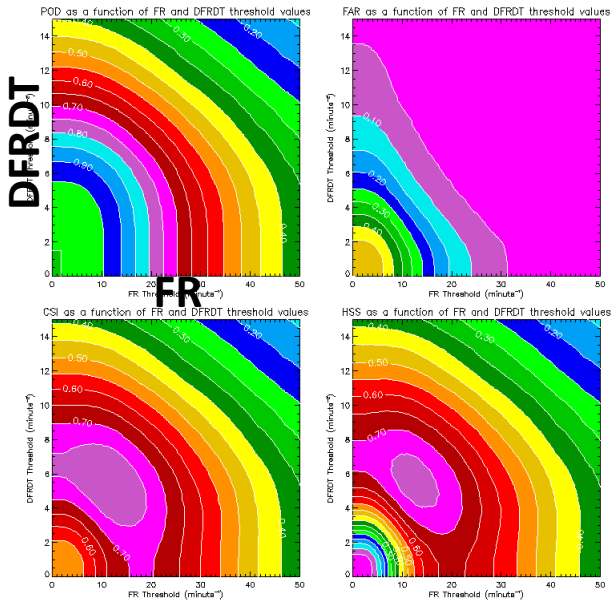
Lowered POD of 2σ associated with missed marginal events (apparently wind)
Hail and tornadic events were well-handled

Lightning Jump Game: "Threshold Approach" Sensitivity to Mean Flash Rate and DFRDT



POD

FAR



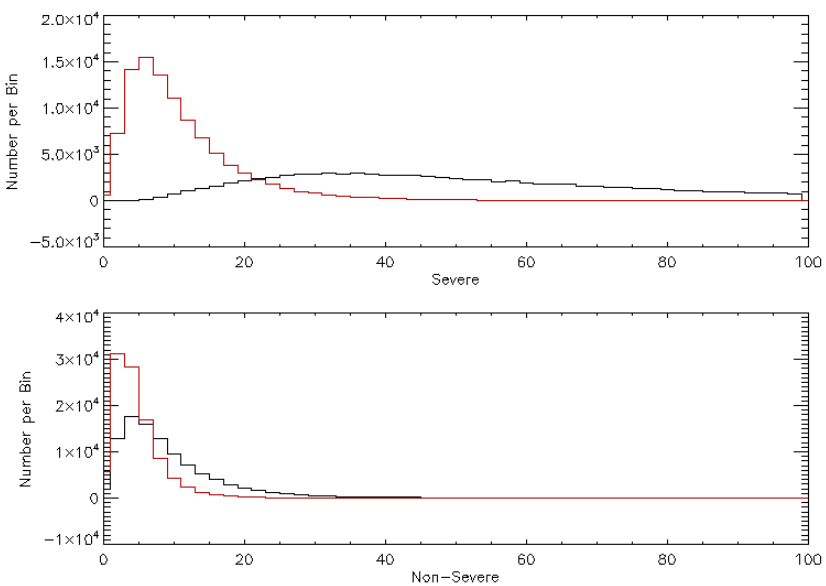
EACH MEAN

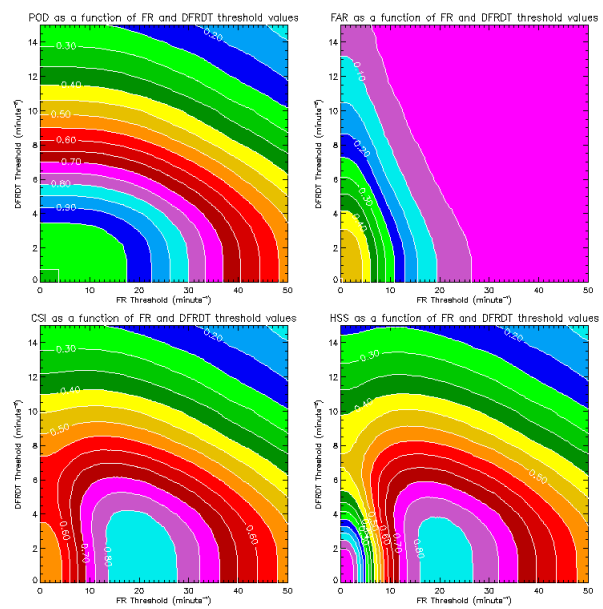
FR

20% CLOSER

CSI

HSS





EACH MEAN

DFRDT

20% CLOSER

Future Work

- Expand study to more regimes
  - Several more STEPS (Plains) cases
  - New Mexico Tech data (SW U.S.)
    - White Sands and Socorro
  - Florida LDAR cases
  - DC Cases (NE U.S.)
- Tailor jump algorithm to overall dataset using information from the "Jump Game"
  - First, expand "Jump Game" to include simulations of 2-σ jump algorithm.
- Spring program