An Evaluation of the Relationship Between Cloud to Ground Lightning Events and Precipitation Over Southern Arizona and Northern Sonora

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Presentation Outline

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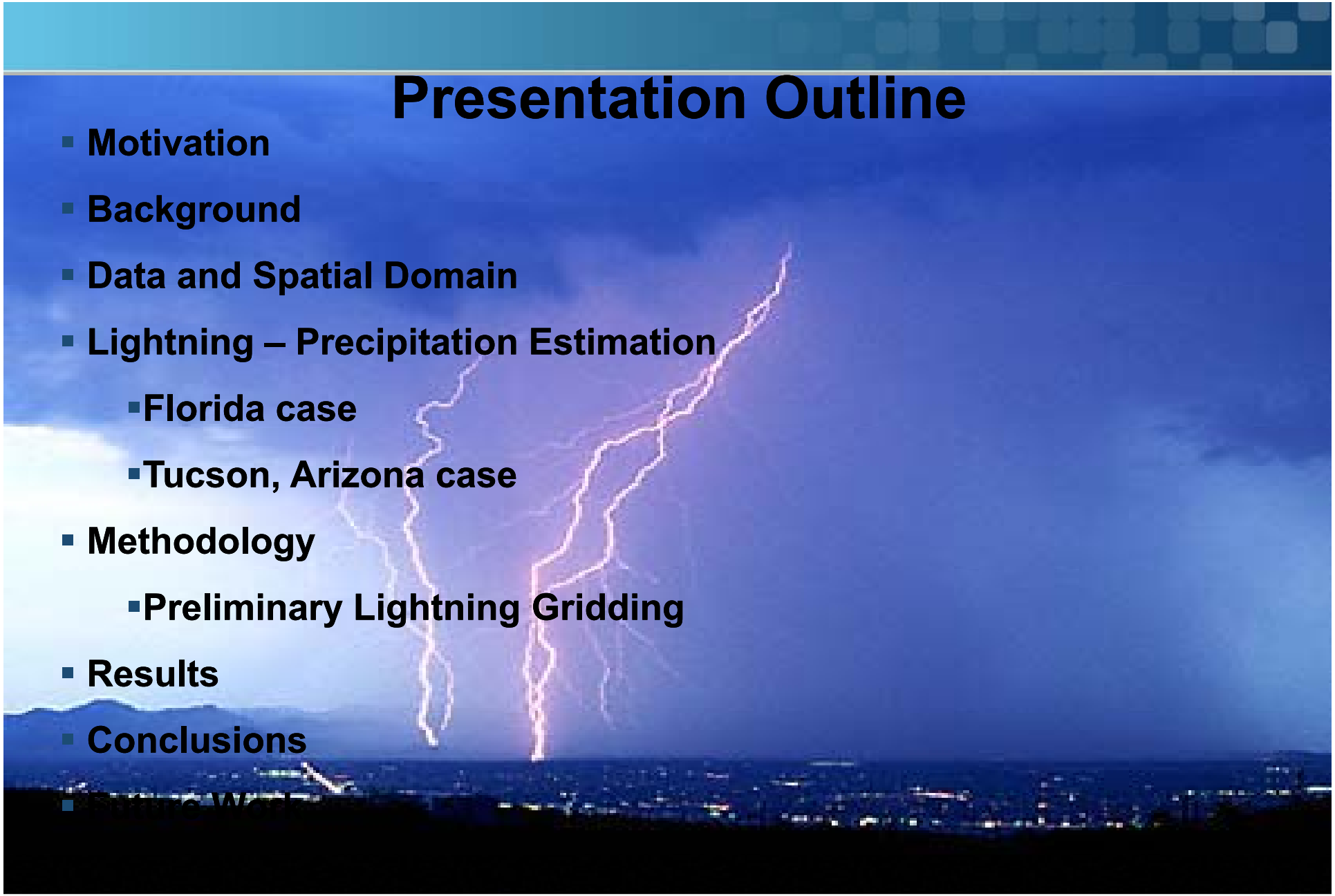

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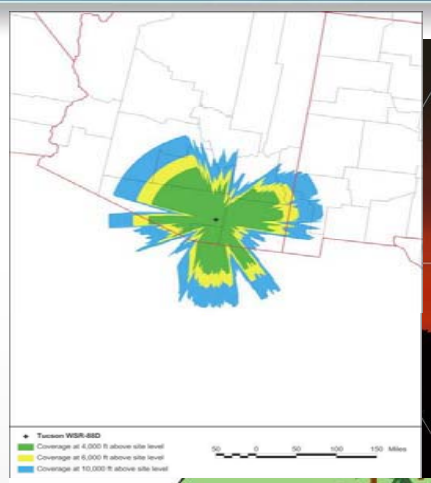
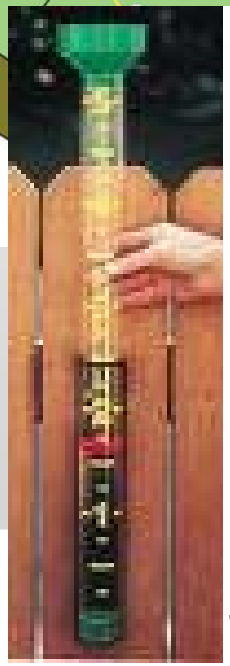
Motivation

- Need for accurate Quantitative Precipitation Estimation (QPE).
- Radar and Rain Gauges have some form of QPE
  - Gauges: Most accurate technique but point measurement.
  - Radar: Good spatial and temporal coverage but an indirect measurement, problems in complex terrain.
- New QPE techniques are being developed using satellite and lightning data, or composites of a combination of methods.



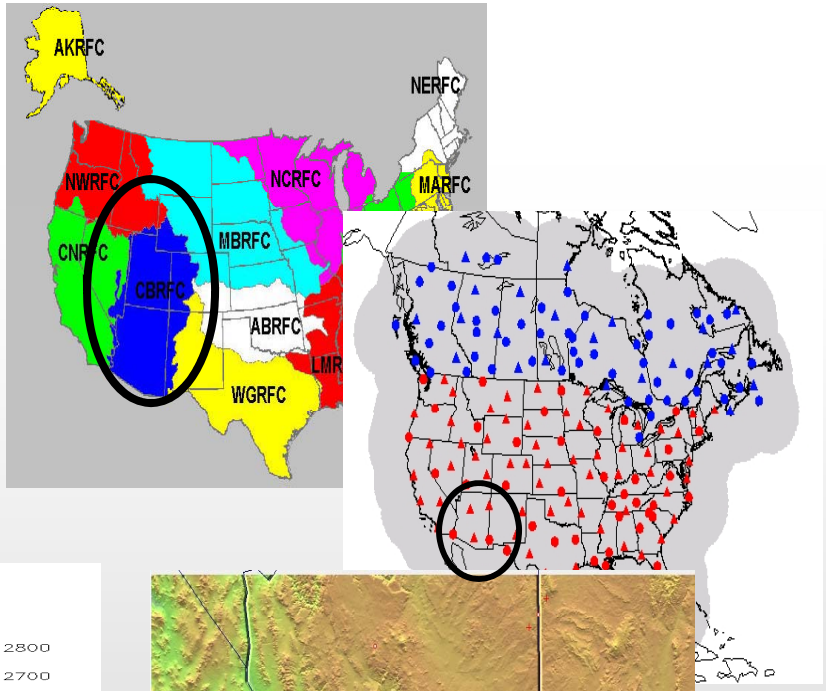


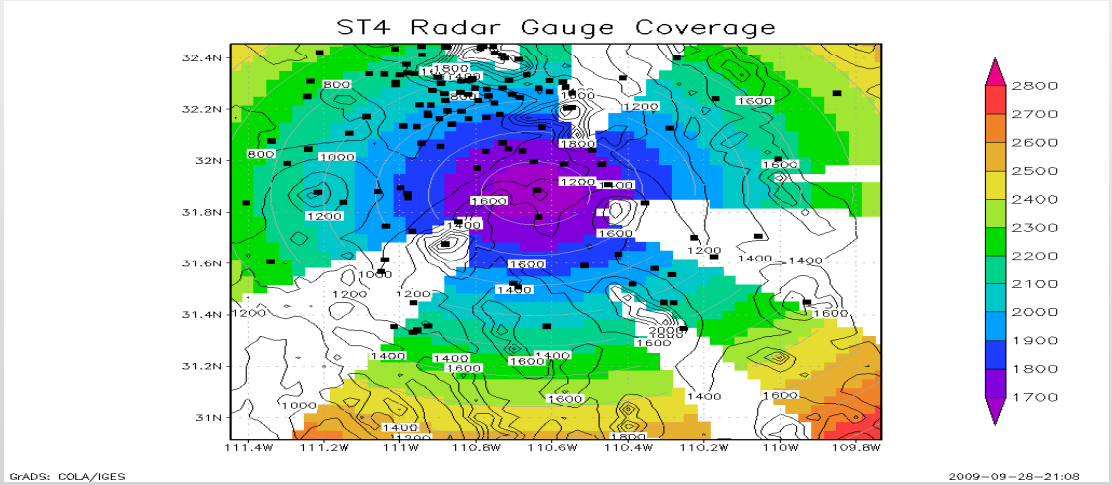
Background

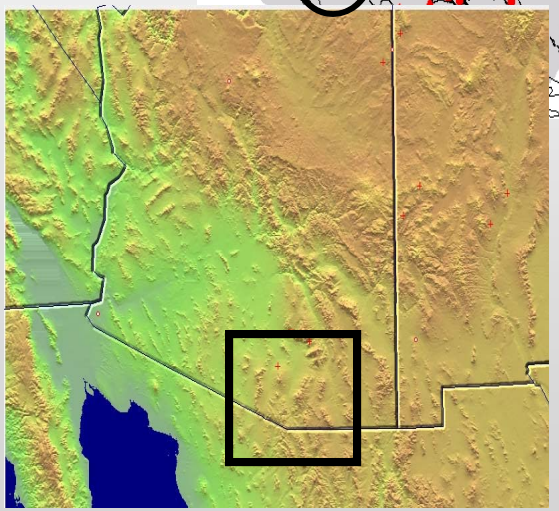
- A number of authors have shown a strong correlation between lightning and convective rainfall.
- Rain gauge and radar-derived precipitation are used for correlation with occurrences of cloud to ground (cg) lightning flashes.
- Once this linear relationship is determined, the lightning flash rate is used to estimate precipitation.
- Current studies show that the precipitation rate per flash varies depending on geographic region and convective environment.

Data and Spatial Domain

- NCEP Stage IV Precipitation Data, August 2005
- NLDN Lightning Data
- Spatial Domain Southern Arizona:
- Lat -111.445 -109.731
- Lon 30.9141 32.4566







Lightning- Precipitation Estimation

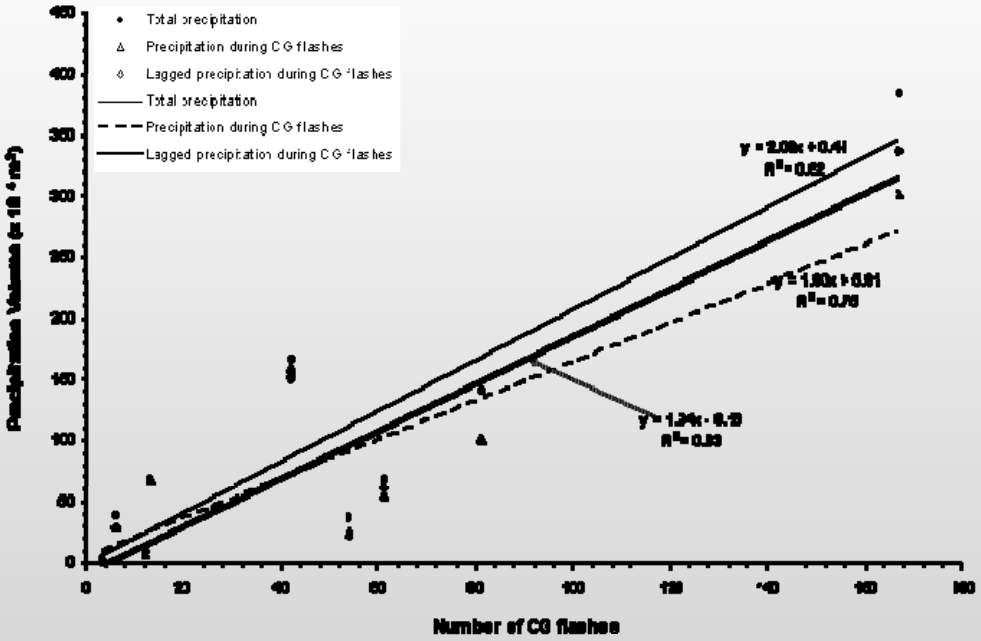
The estimation is made through a simple mathematical inversion between lightning counts and the observed precipitation

Individual storm precipitation volume vs. the total number of CG flashes in 9 Florida thunderstorms

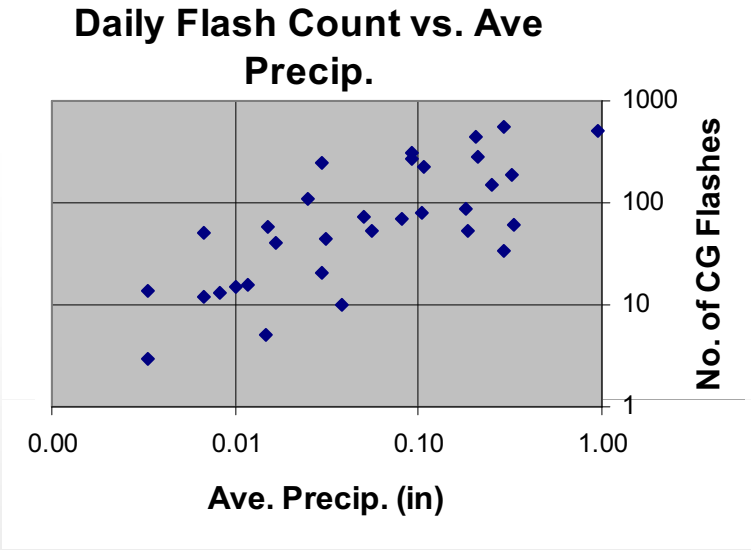
(using 3 methods)

~ $2x10^4$ m^3/flash

(*Gungle and Krider, 2006).*

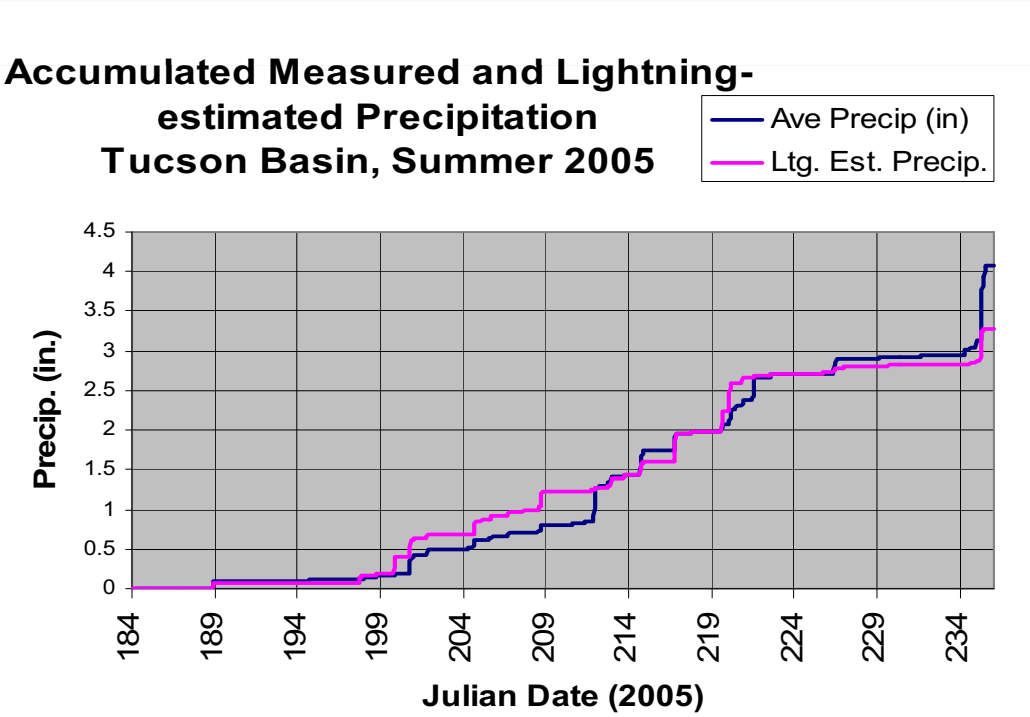


Lightning - Rainfall Correlation in the Tucson Basin



Daily rainfall estimate obtained by averaging measurements from 24 Pima County gauges contained in the Tucson Basin analysis domain

Temporal relationship: Lightning-based rainfall estimate is the number of CG flashes multiplied by 3.5×10^4 m^3/Flash, assumed uniform over the whole analysis domain



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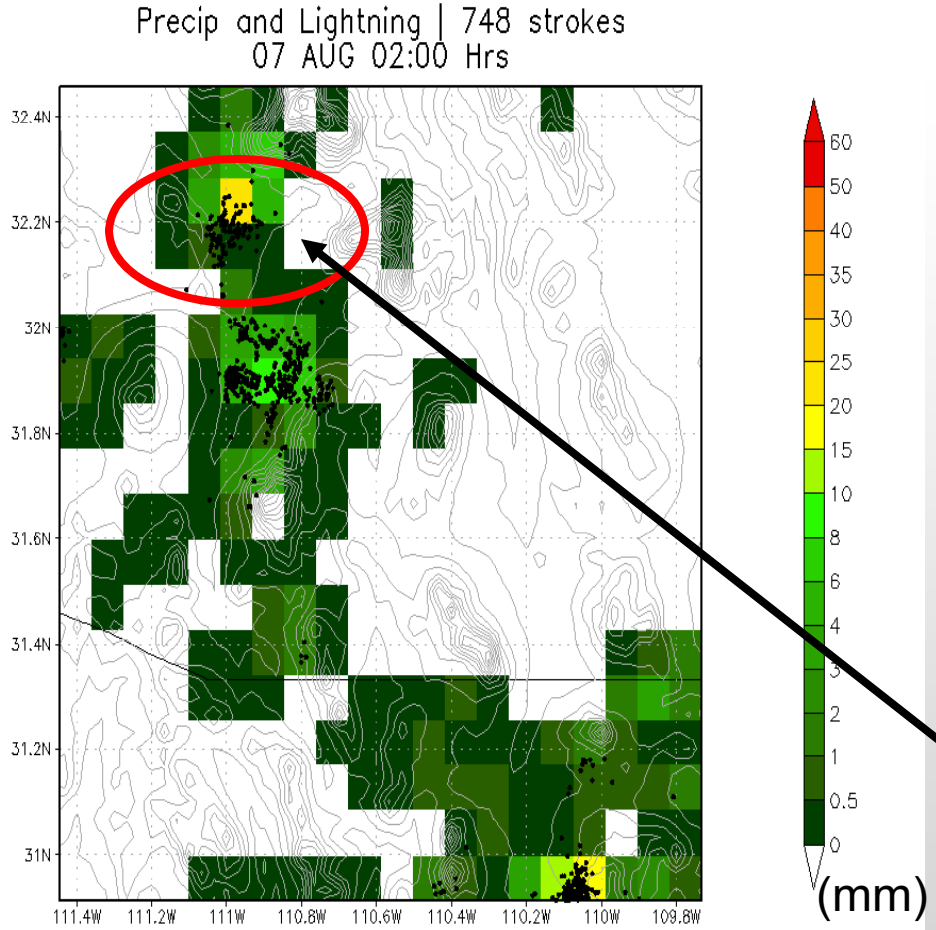
Methodology



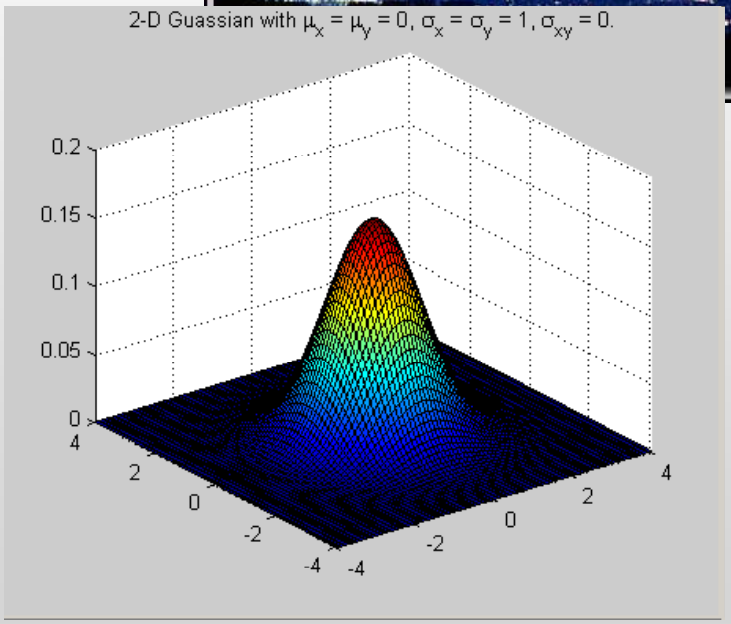
- In ST4 precipitation data we count and grid the lightning strikes indicated by black dots per time period.

- But for small grids, Is this the best idea?

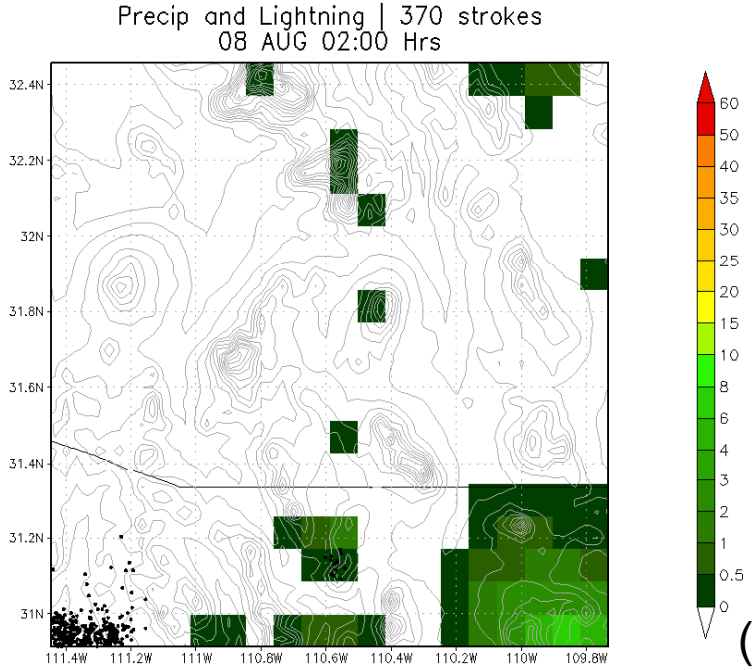
Note that the maximum precipitation and the maximum strikes are not coolocated

Preliminary Lightning Gridding

- Instead of CG lightning counts we use a gaussian distribution that represents the probability that the source of precipitation is located at the same horizontal position as the striking point.
- The counts matrix is convolved in integrated accumulated gaussian probabilities



Can this approach enhance Stage IV radar and gauge derived precipitation?



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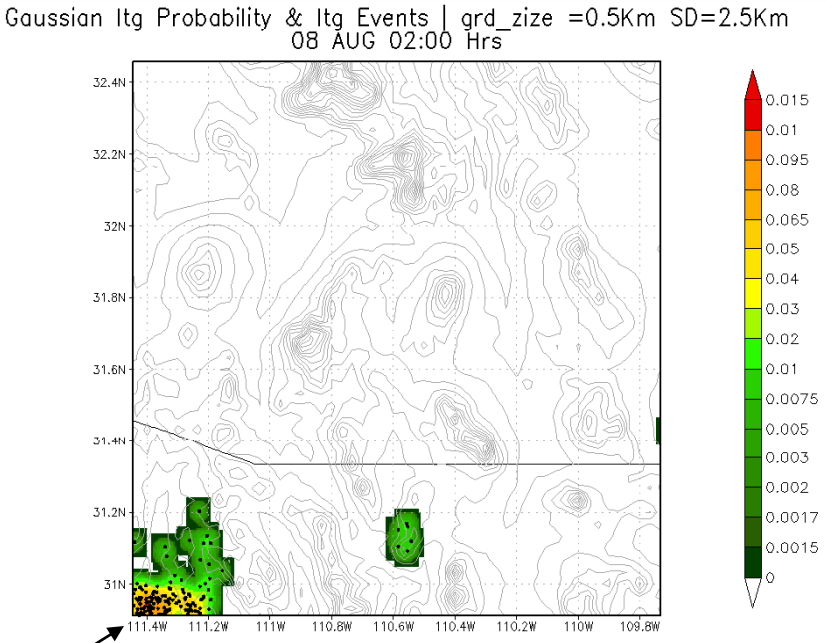
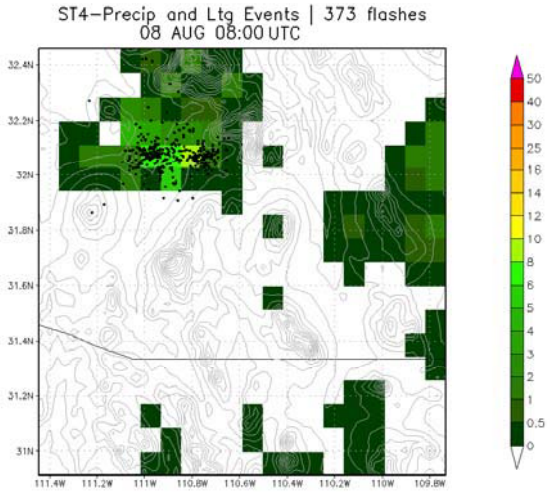
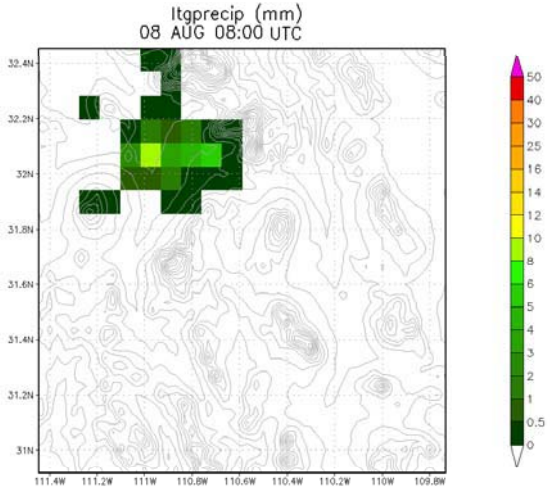


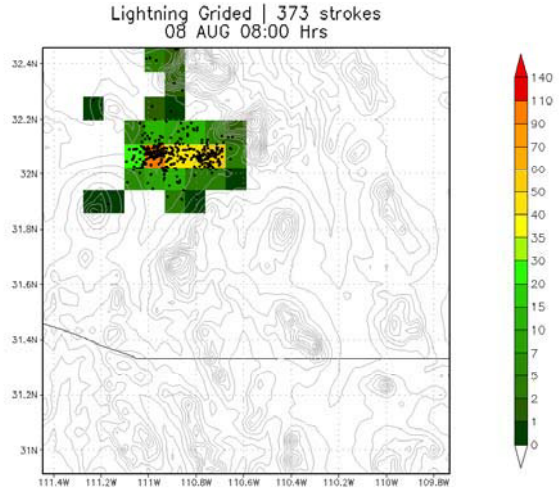
A better approach to the discrete nature of ltg information

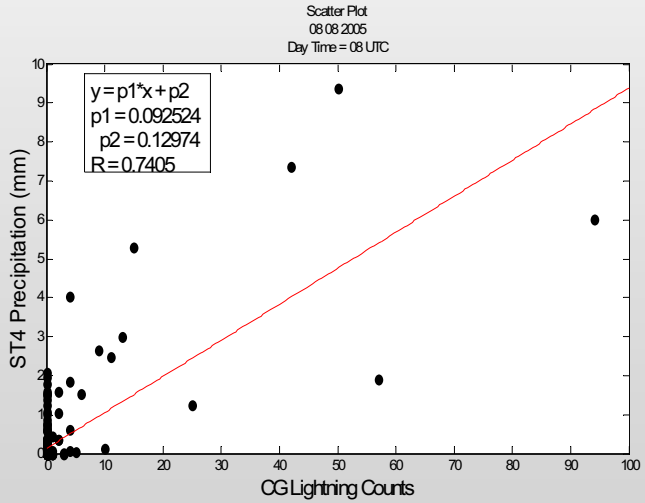
Comparison Between Lightning Counts and Gaussian precipitation relationship





August 8
8:00 hrs





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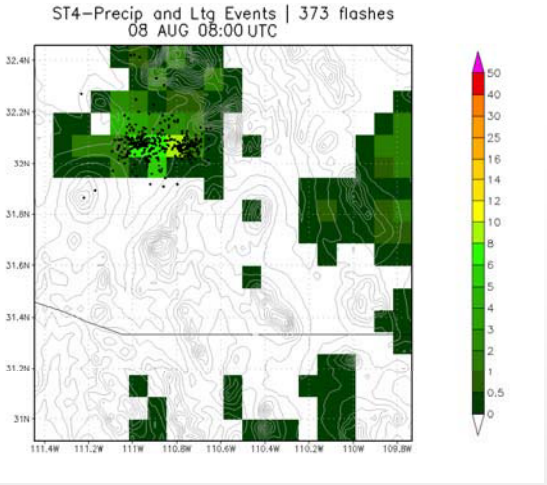
Gaussian – Precipitation Correlation



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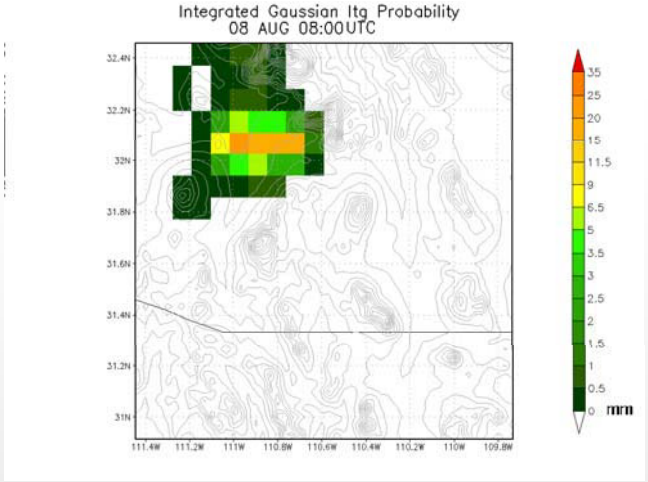

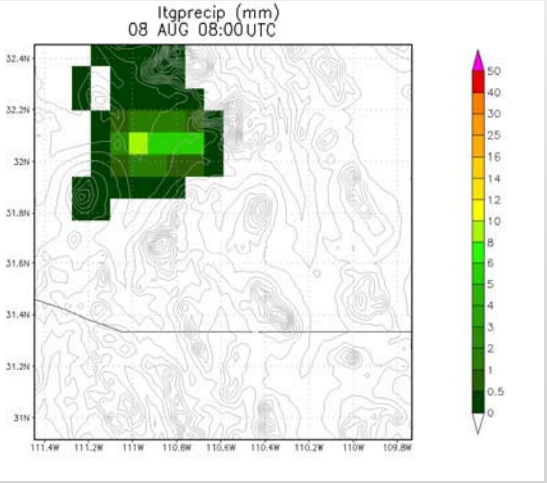

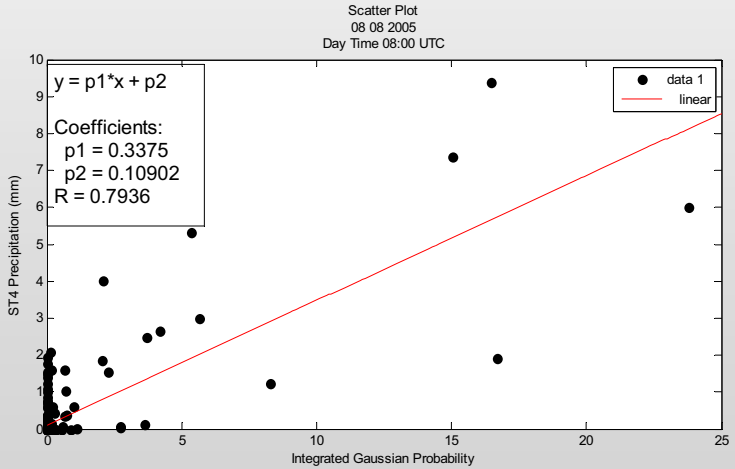

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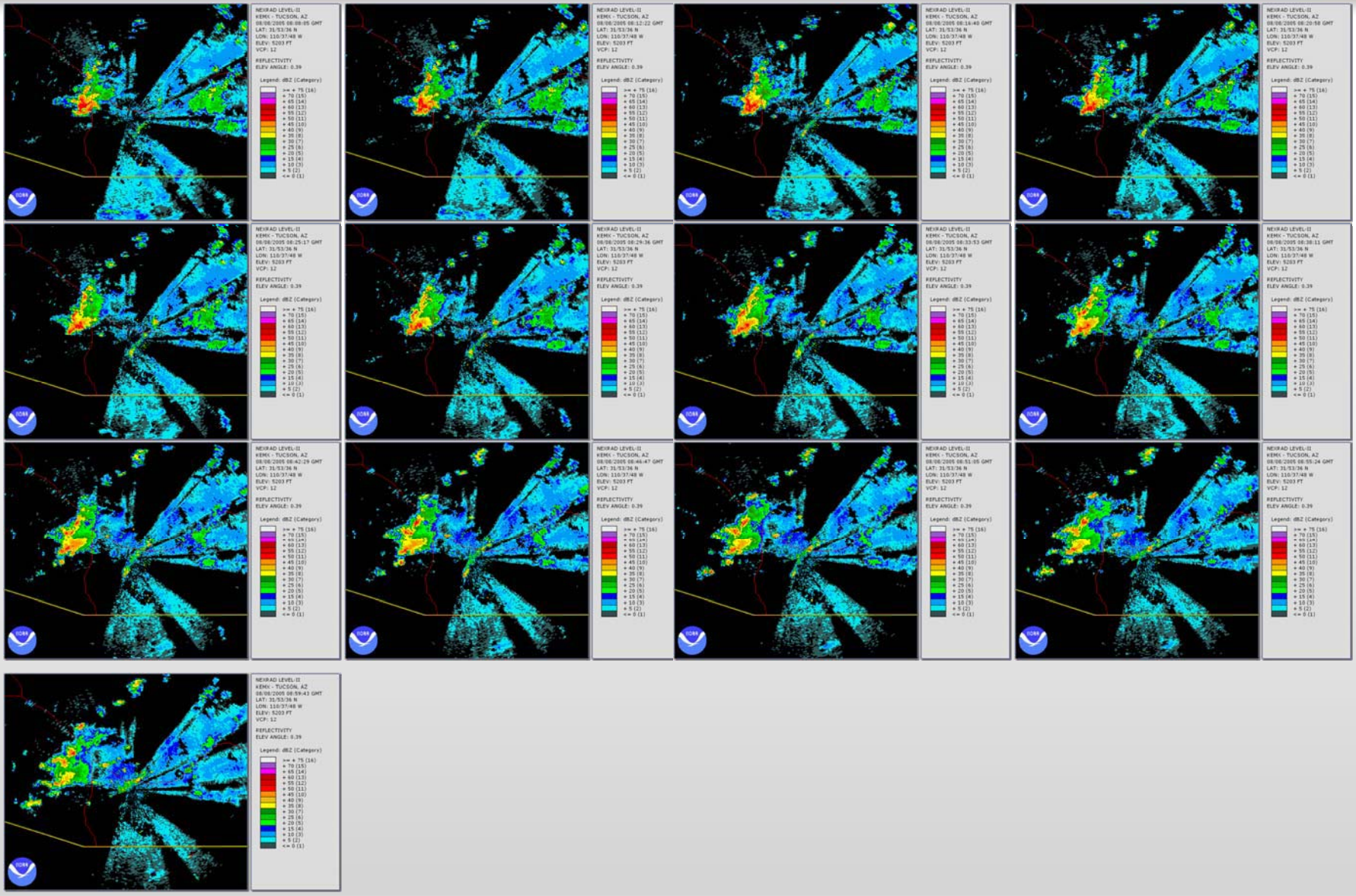

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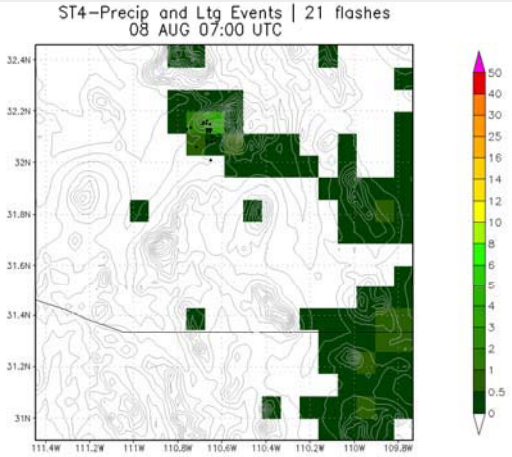

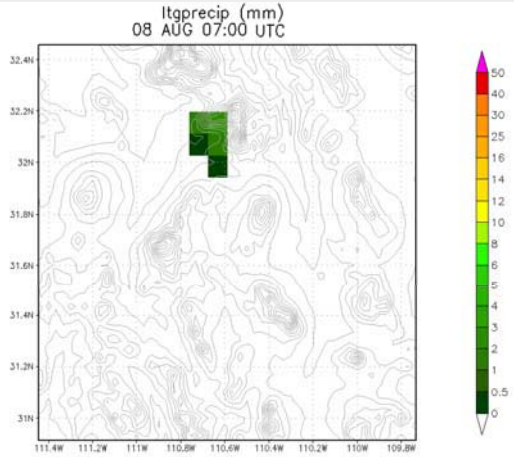

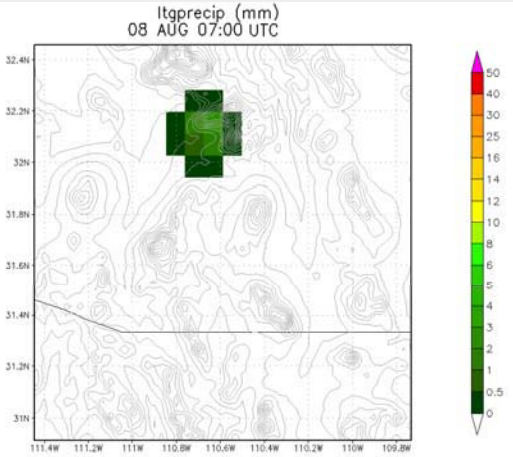

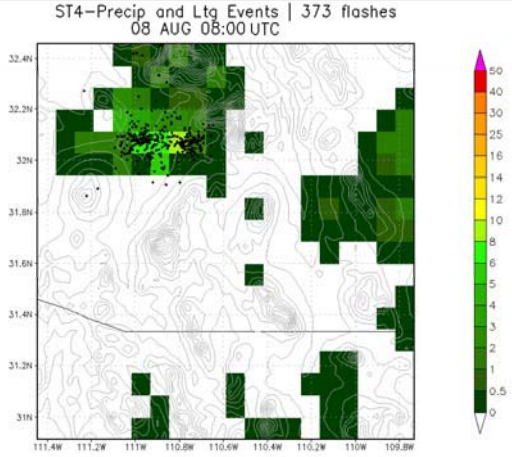

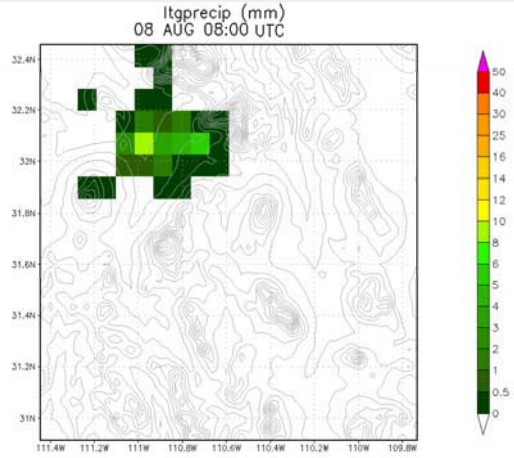

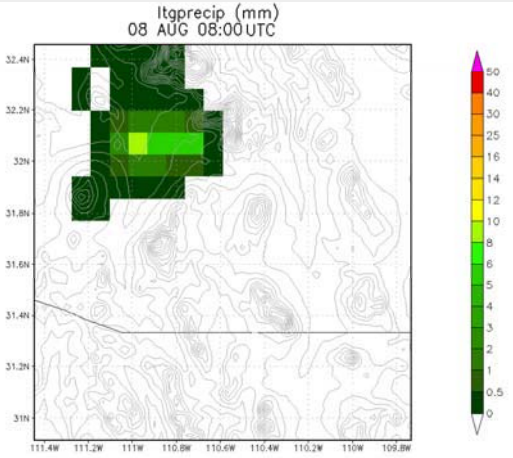

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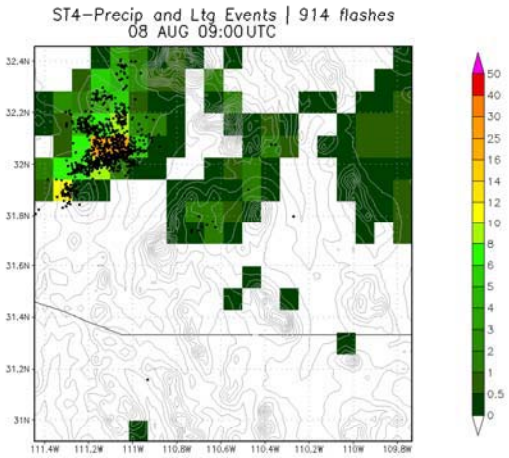

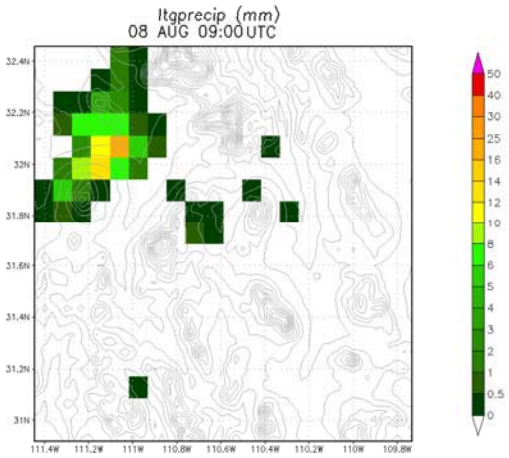

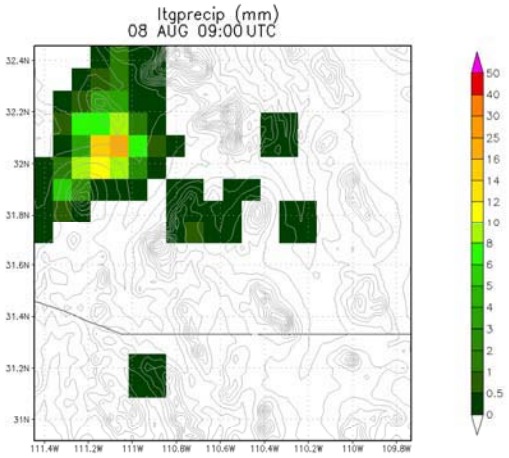

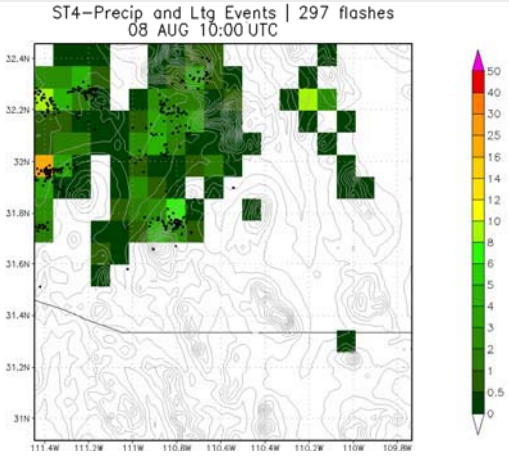

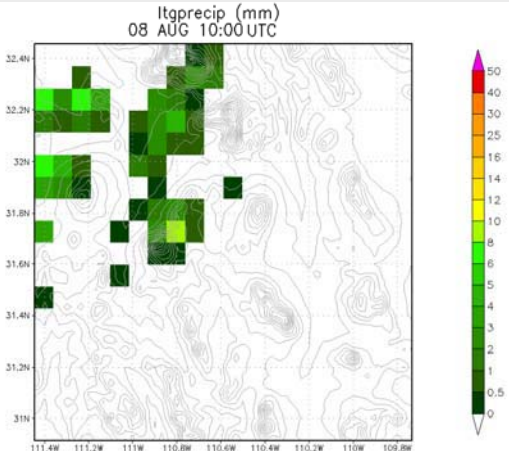

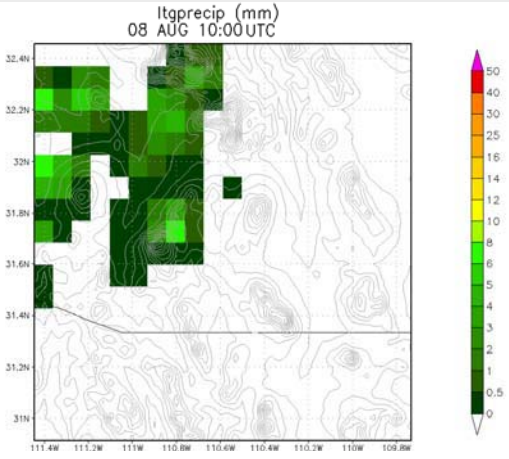

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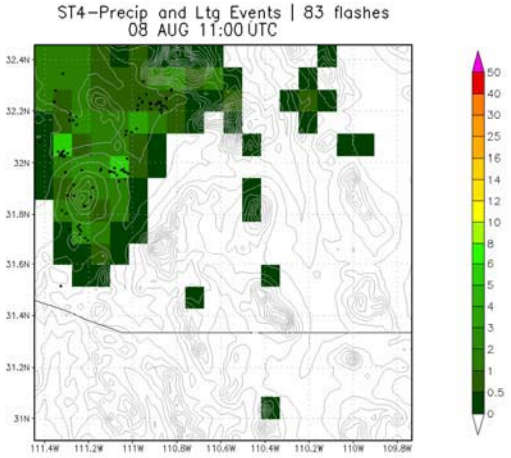

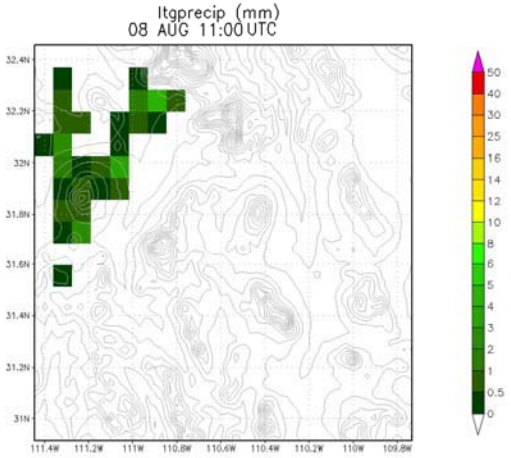

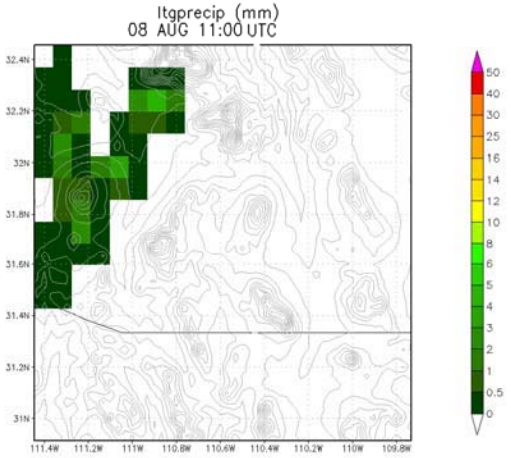

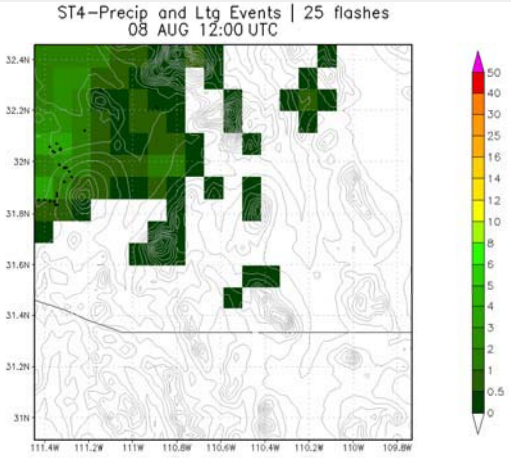

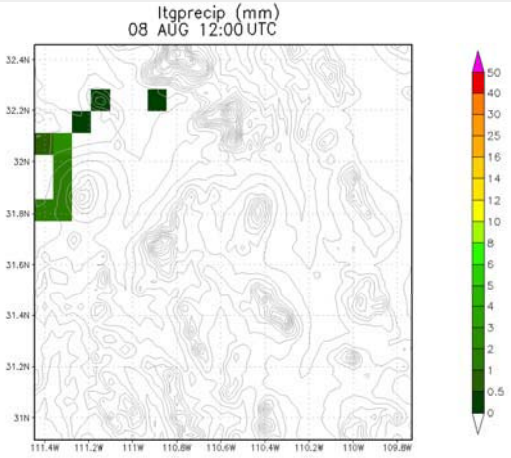

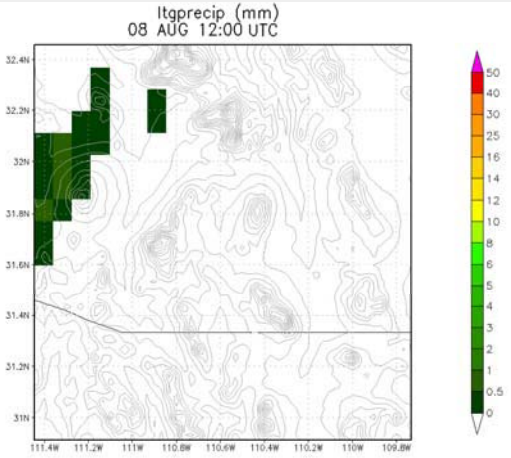

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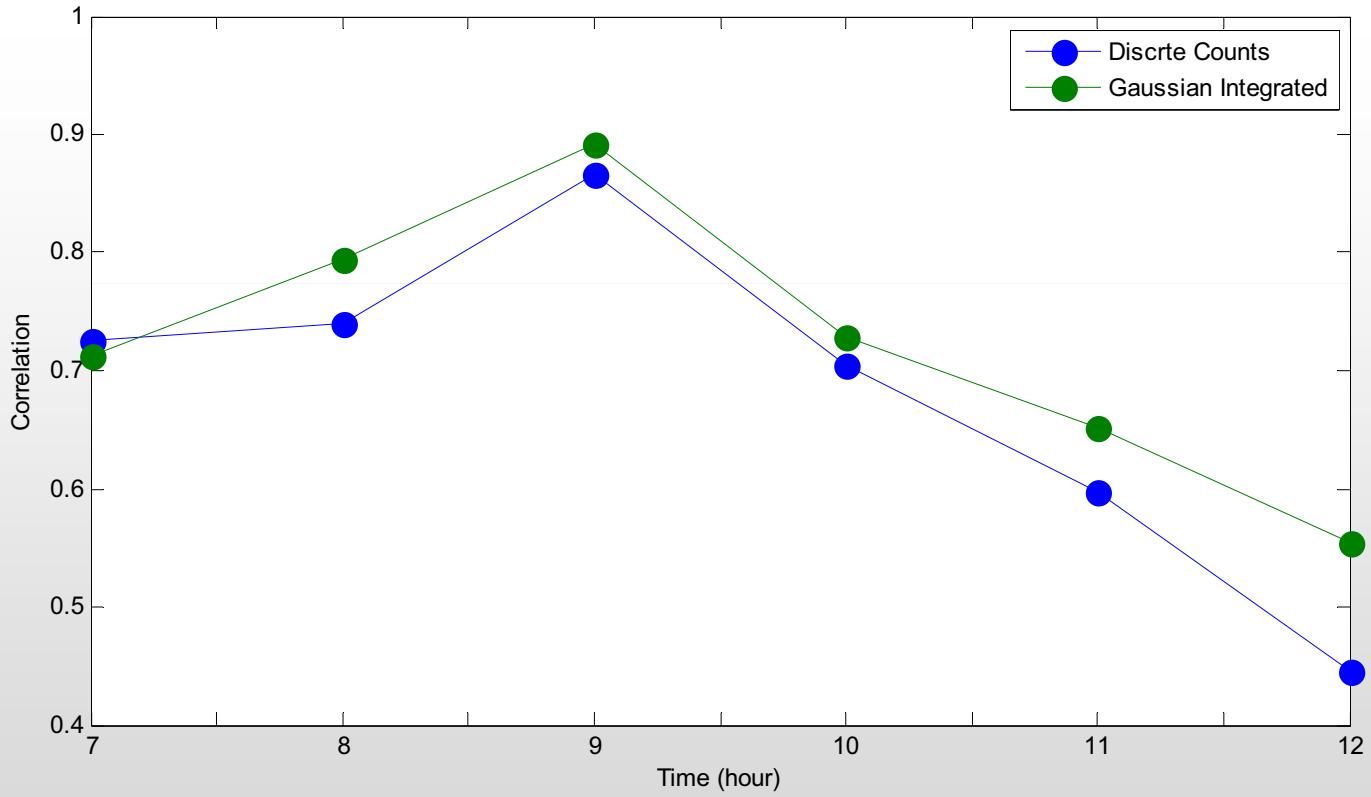
Correlation time Series



Overall the Correlation fall when stratiform rain is mostly present

Conclusions

- The results show for some cases that the correlation improve

- The gaussian convoluted matrix can cover more spatial grids than the discrete mode, this may implies better QPE coverage by lightning – precipitation relationship.

- Therefore lightning precipitation estimation can be used as a complement of the current composite precipitation products.

Future Work

- Look for a higher time resolution data and test correlation for varying time and spatial resolution and find the optimal resolution for QPE.

- Test a new statistical distribution and for some other meteorological cases.