Radar Observations of Storms that Produce Sprites or Lightning with Large Charge Moment Changes

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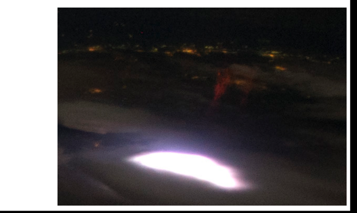
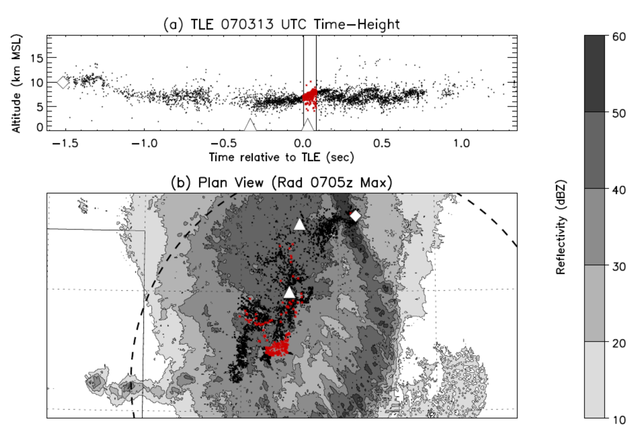
Poster #172



1. Introduction

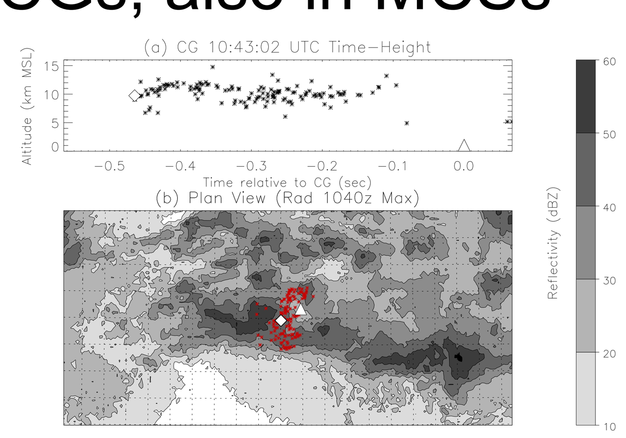
What we think we know:

- Charge moment change (CMC) in cloud-to-ground lightning (CGs): CMC = Q x Z (charge times height)
- The bigger the CMC, the more likely a sprite (> 100-300 C km ideal)
- Positive sprites: +CGs tapping broad stratiform charge layers in mesoscale convective systems (MCSs)



Sprite-parent +CG on 19 August 2009 (triangle). Black Dots – VHF sources from OKLMA (Red during sprite). Diamond – Initiation.

- Negative sprites: powerful convective -CGs, also in MCSs



Large-CMC -CG (973 C km) on 26 March 2011 (triangle). Black/Red Dots – VHF sources from NALMA. Diamond – Initiation.

What we'd like to learn about:

- Microphysics and kinematics of storms that produce sprites or large CMCs
- Unusual cases: sub-MCS storms, sprite-parent +CGs in convection

2. Data

- CSU-CHILL Polarimetric Doppler Radar
- CSU-Pawnee Doppler Radar
- NOAA NMQ Radar Mosaics
- Colorado/Oklahoma LMAs
- Duke CMC Network (CMCN)
- Vaisala NLDN

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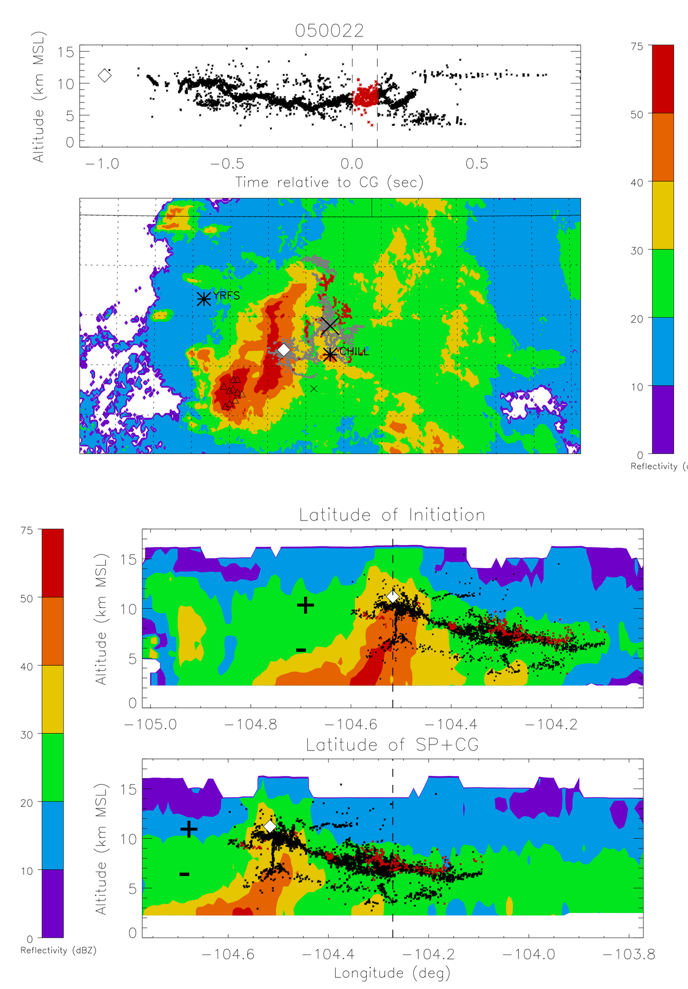
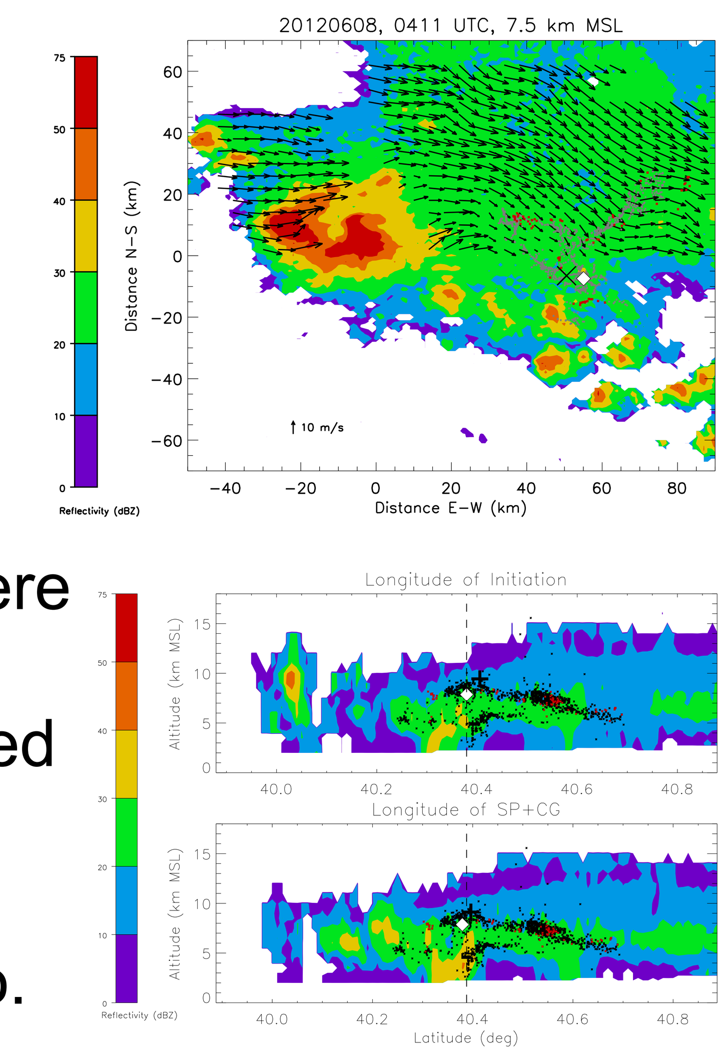
3. Sprite-Parent +CGs in Smaller Storms

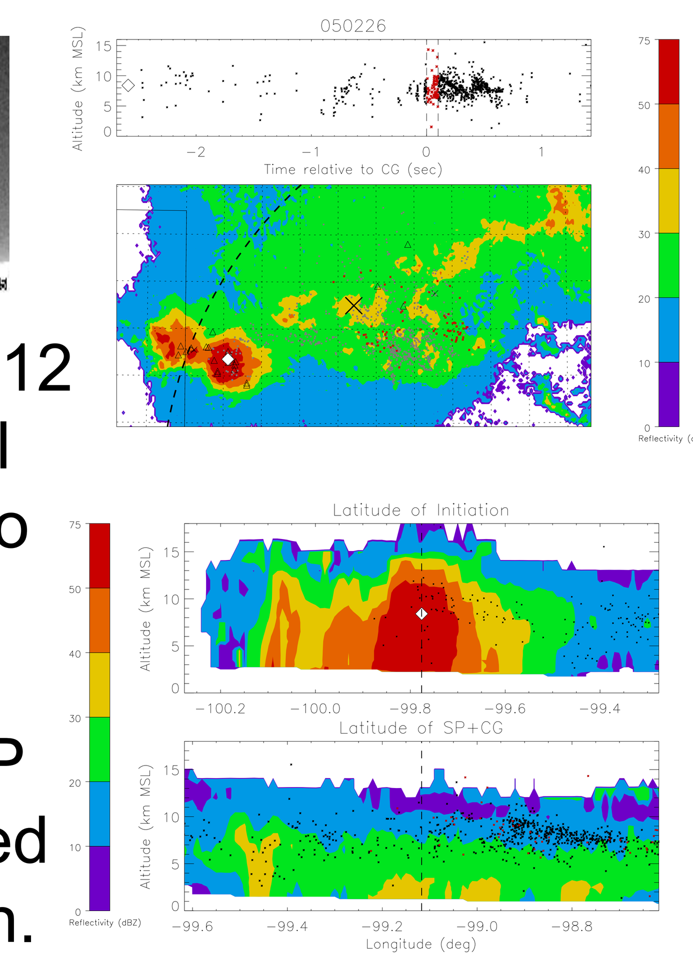


Diamond = Initiation
Big X = Sprite +CG
Dots = LMA Sources
(red = CG to CG+100 ms)
Small Xs = +CGs
Small triangles = -CGs
Gridline spacing = 0.2 deg

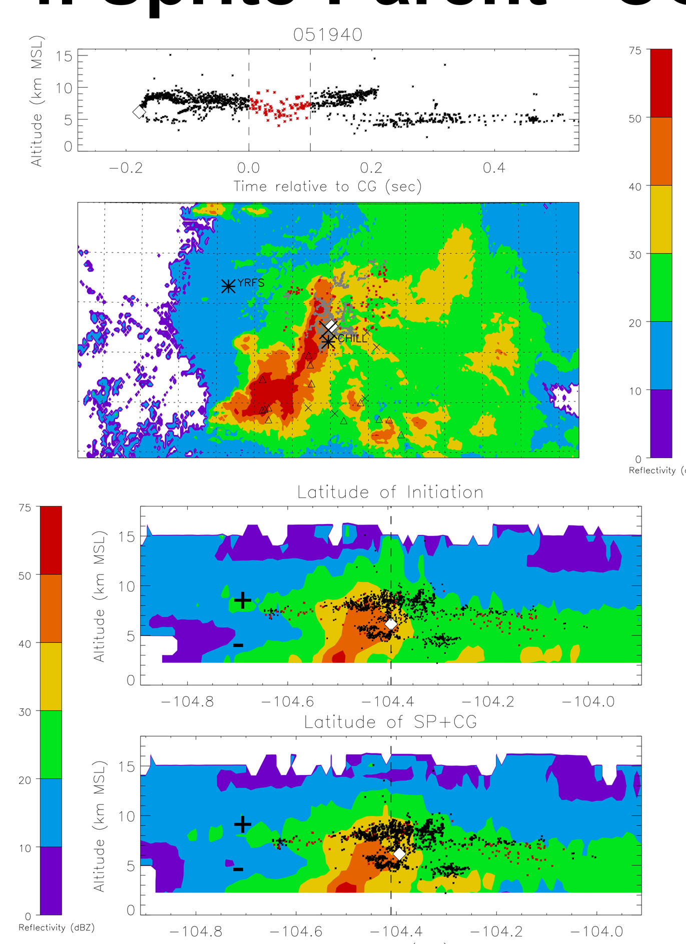
8 June 2012 was a severe hailstorm. SP+CGs in stratiform regions initiated in convection. Charge advection allowed weak convection to initiate too.

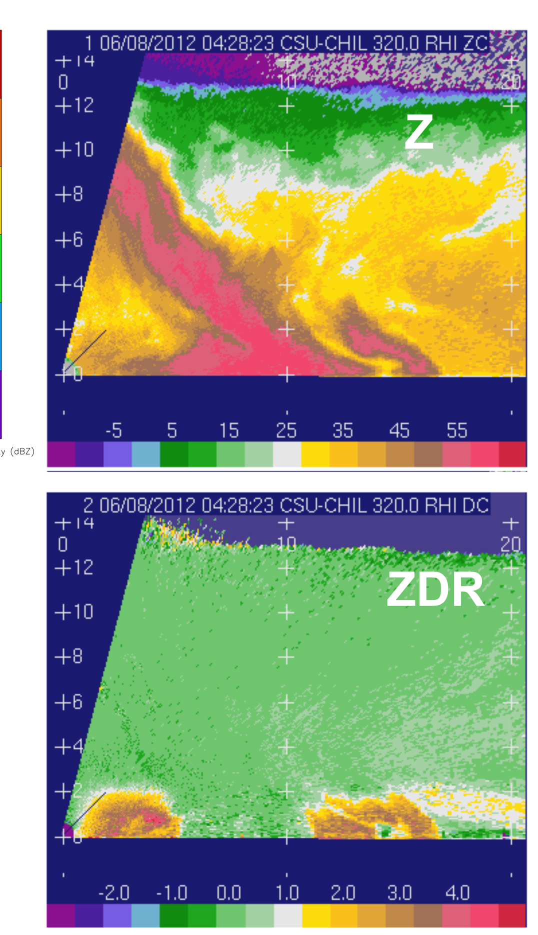


30 March 2012 OK supercell produced two sprites in ~15 min. Stratiform SP +CGs initiated in convection.



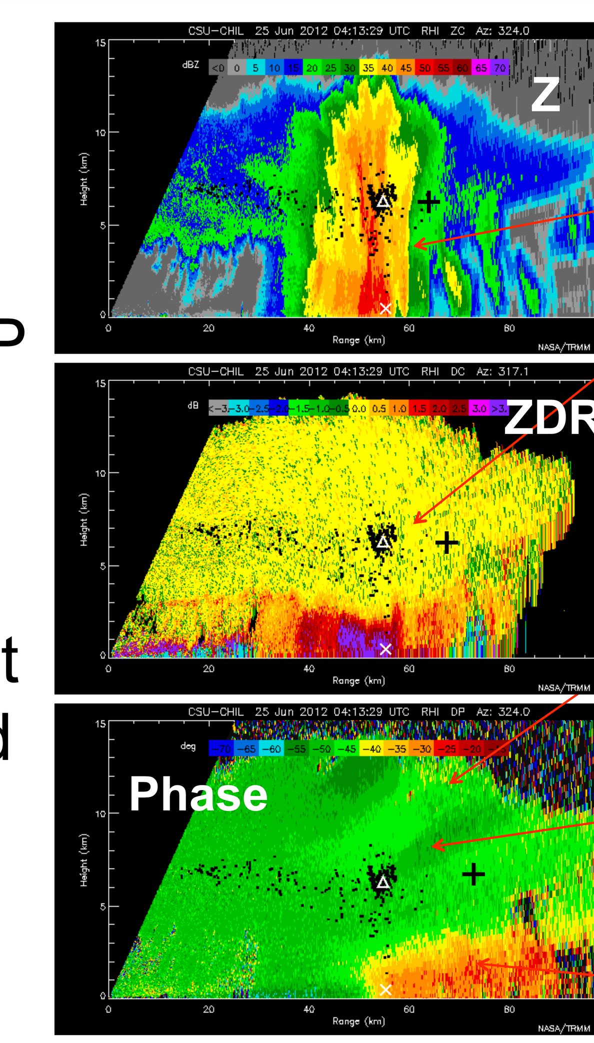
4. Sprite-Parent +CGs in Convection





Some SP+CGs in 8 June 2012 occurred in convection. Evidence of shear causing tilted dipole.

The 25 June 2012 storm produced SP +CGs within convection. It featured inverted charge. The parent flashes discharged mid-level anvil.



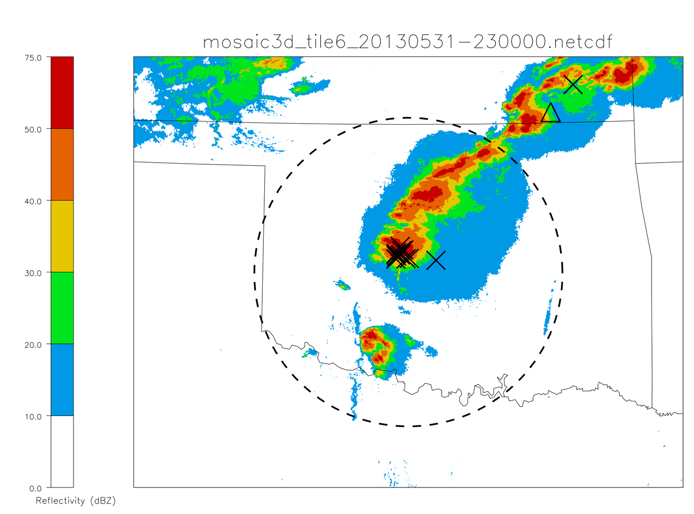
Hail shaft melting to heavy rain

Positive phase shift (horizontal alignment)

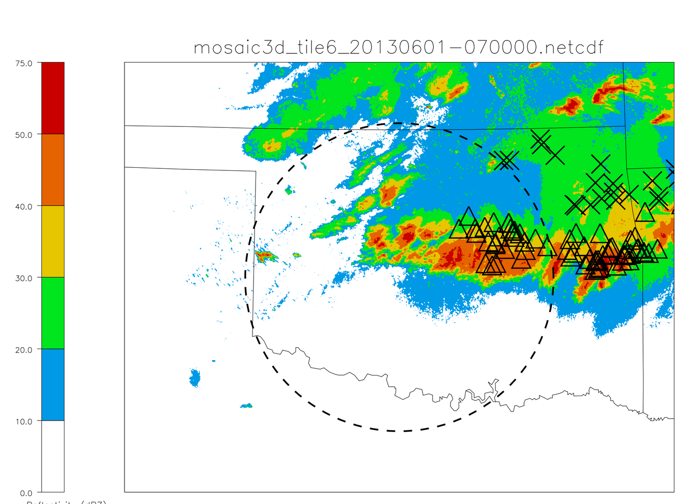
Negative phase shift (vertical alignment)

Rain

5. Future Work – 31 May/1 June 2013 (El Reno)



Early – 2300 hour
Tornadic Supercell
Large +CMCs in convection



Late – 0700 hour
Huge MCS/MCC
Large -CMCs in convection,
+CMCs in stratiform

+CMCs: Xs
-CMCs: Triangles (>100 C km)
Circle: OKLMA 200-km range

6. Conclusions

- Sprite-parent/large-CMC +CGs need adjacent convective & stratiform/anvil regions with charge pathway between them.
- Convective sprite-parent/large-CMC +CGs associated with mid-level positive charge or tilted dipole.
- El Reno case an archetypal example of both conventional and unconventional large-CMC lightning.