Global Diurnal Variation of TRMM/LIS Lightning Flash Radiances

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paper in print (BAMS)

The “new” diurnal curves

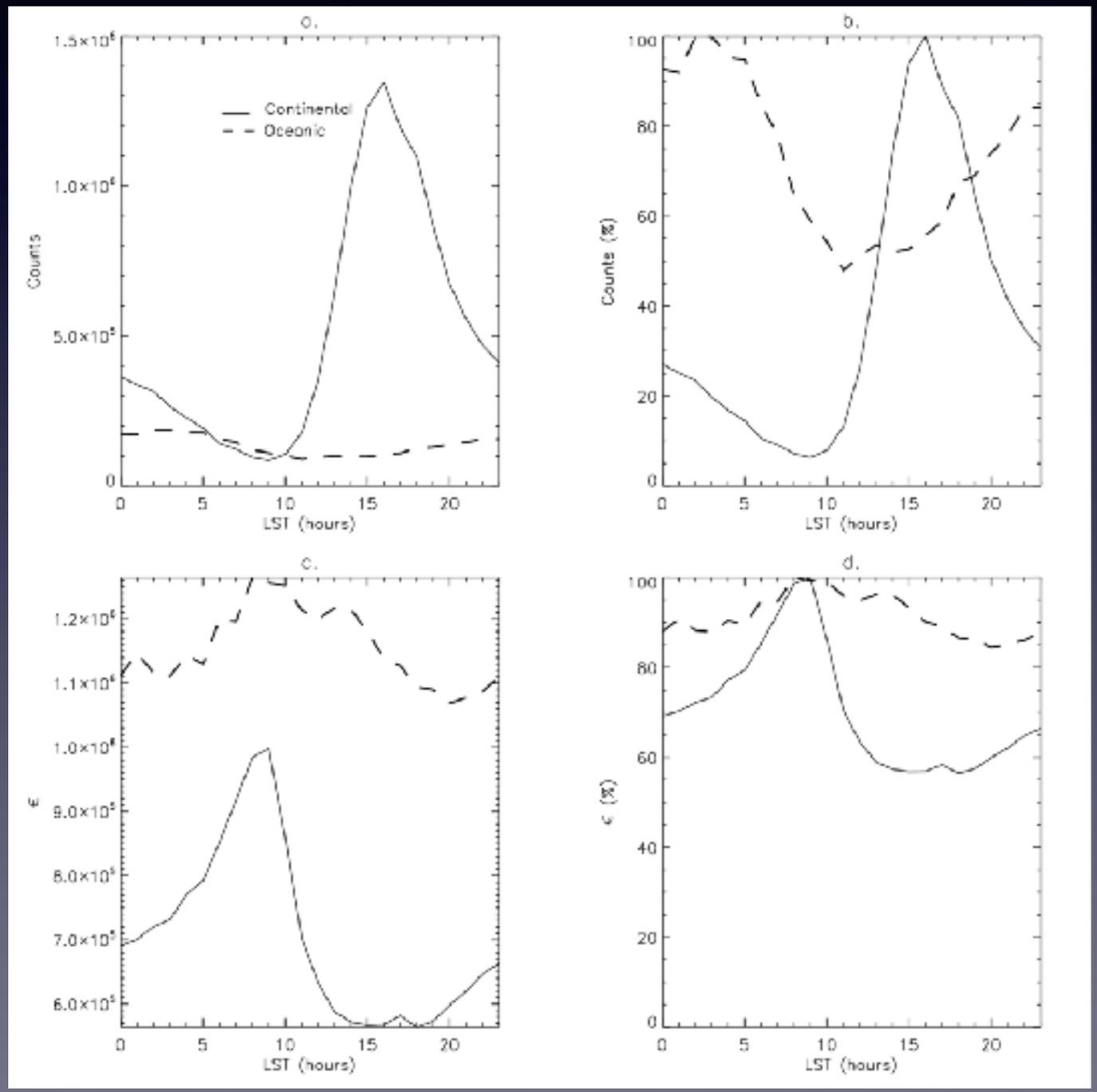
- Since the early ~1900’s no new lightning-related diurnal variation has been documented other than the Carnegie curve (see Blakeslee et al., 2014)

- Our study (*BAMS*, in print) demonstrates a **new diurnal pattern that is globally evident based on** TRMM/LIS data now show a

The “new” diurnal curves

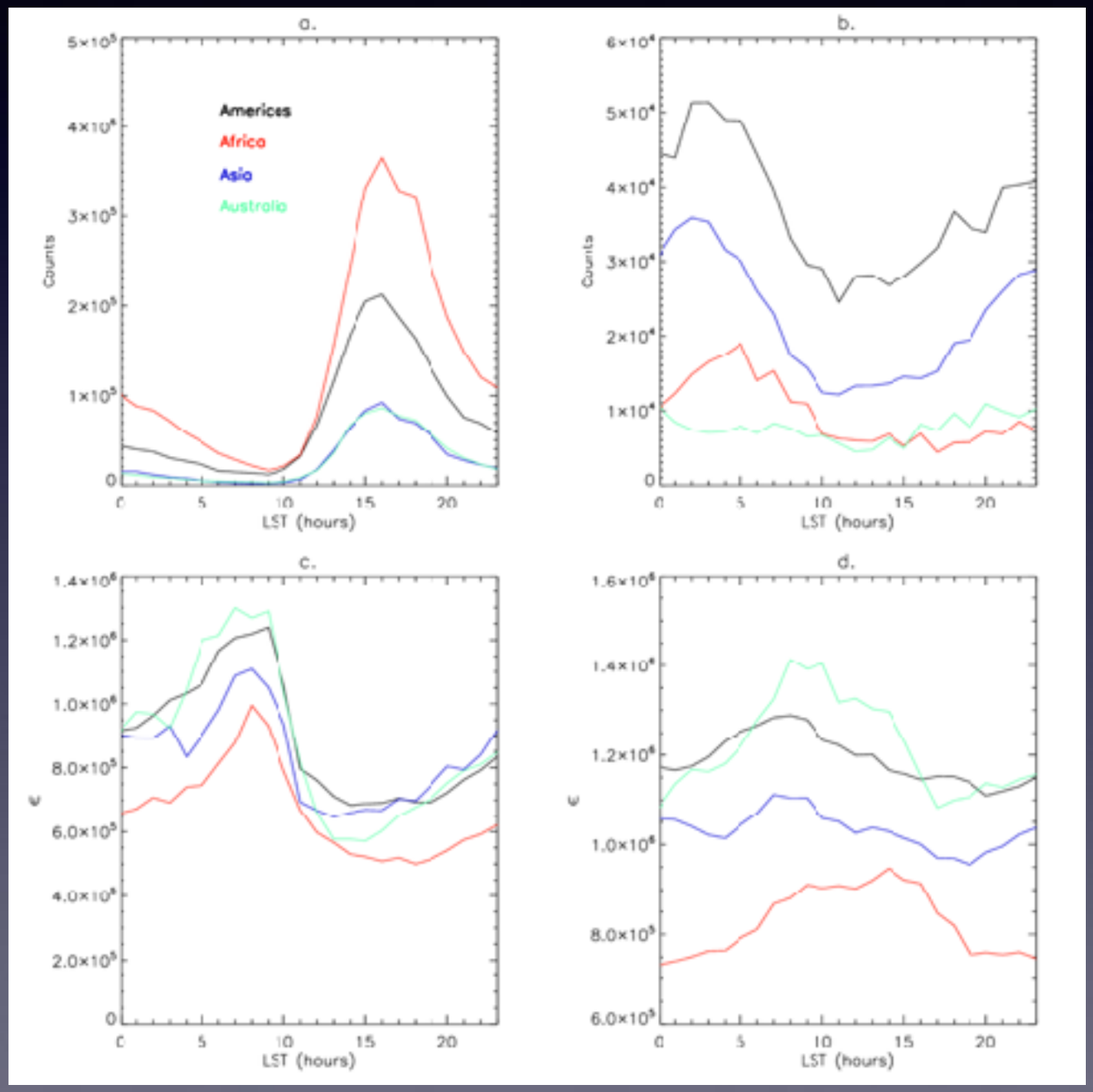
- **Flash radiances** indicate a consistent diurnal (**local solar time**) quasi-sinusoidal behavior between 38S-38N (i.e. TRMM/ LIS FOV)

- Continents exhibit a ~40% and oceans a ~15% diurnal variation



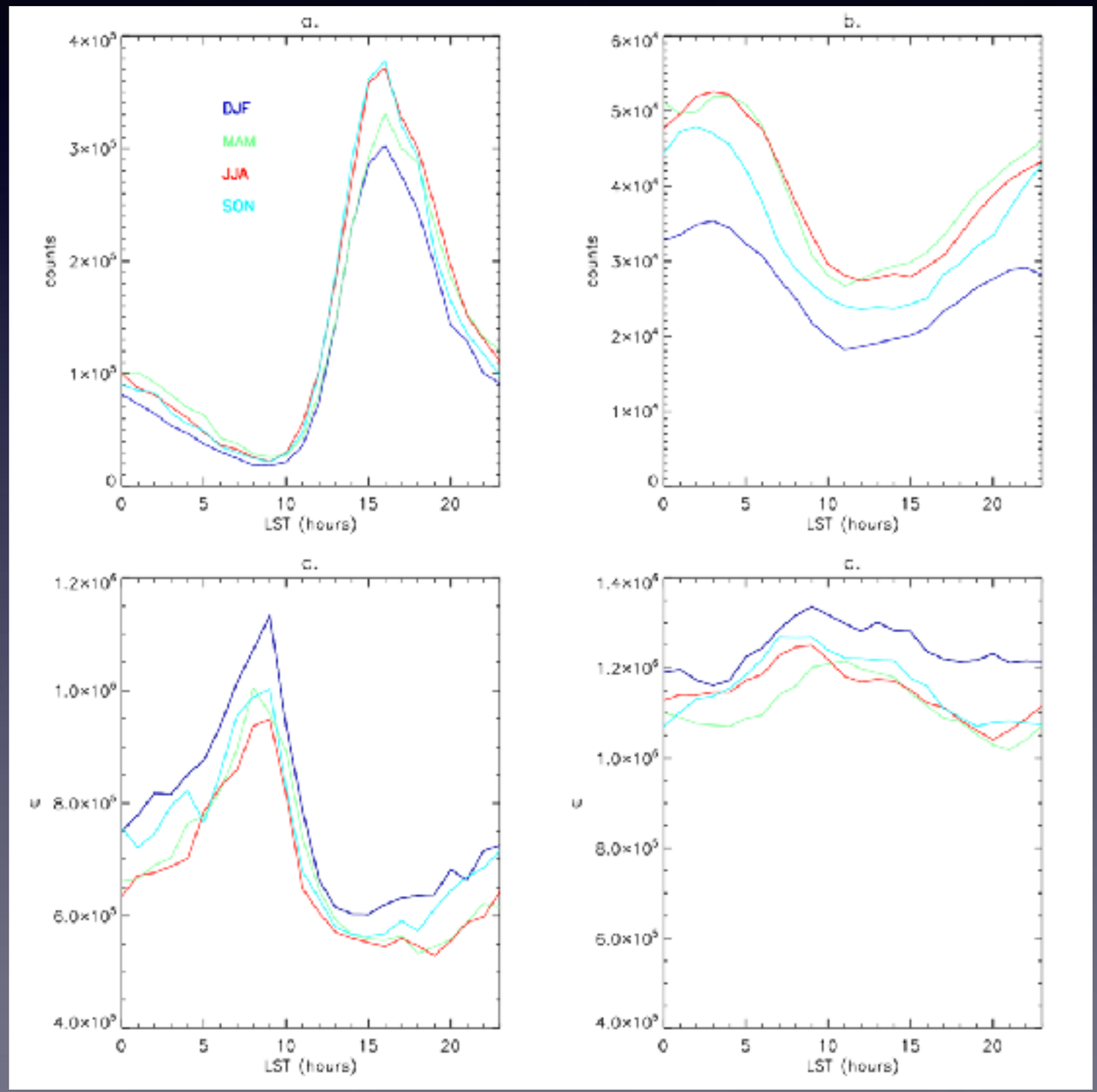
A robust diurnal pattern

- The same diurnal pattern appears over all convective "*chimneys*"…



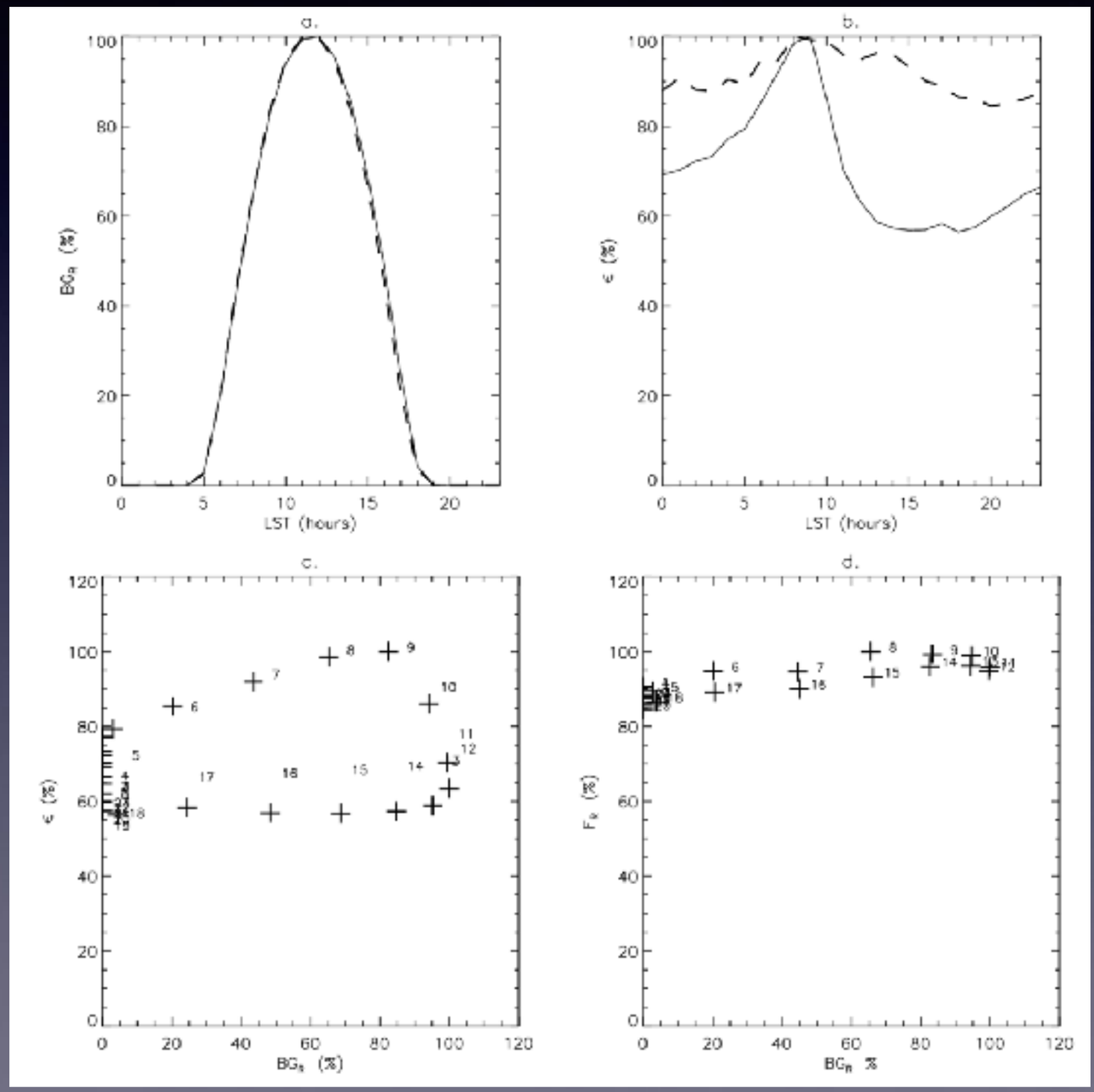
A robust diurnal pattern

- or seasons…



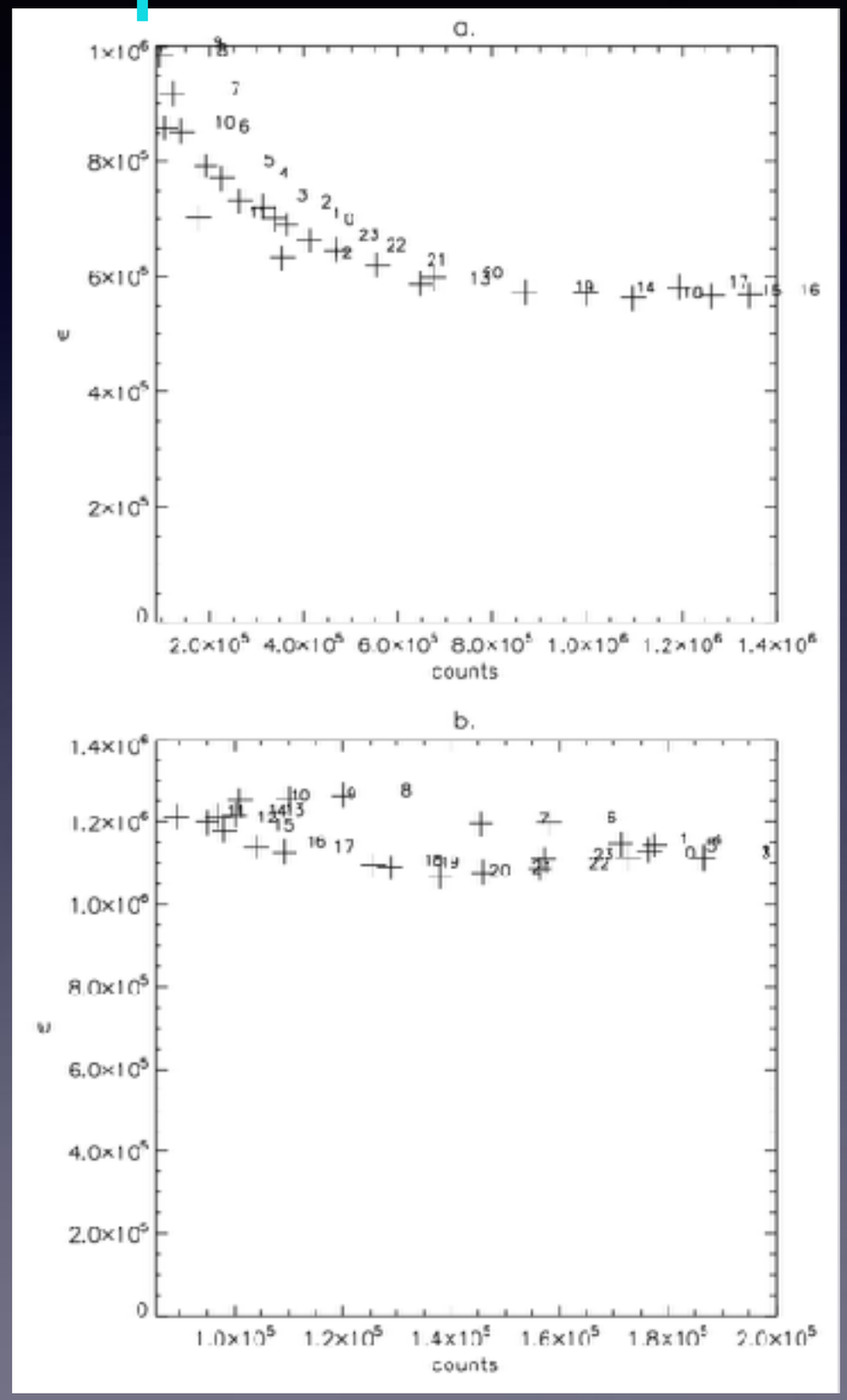
No artifact

- This behavior is NOT a product of LIS detection efficiency e.g. LIS selectively detecting brighter flashes depending on the local solar time



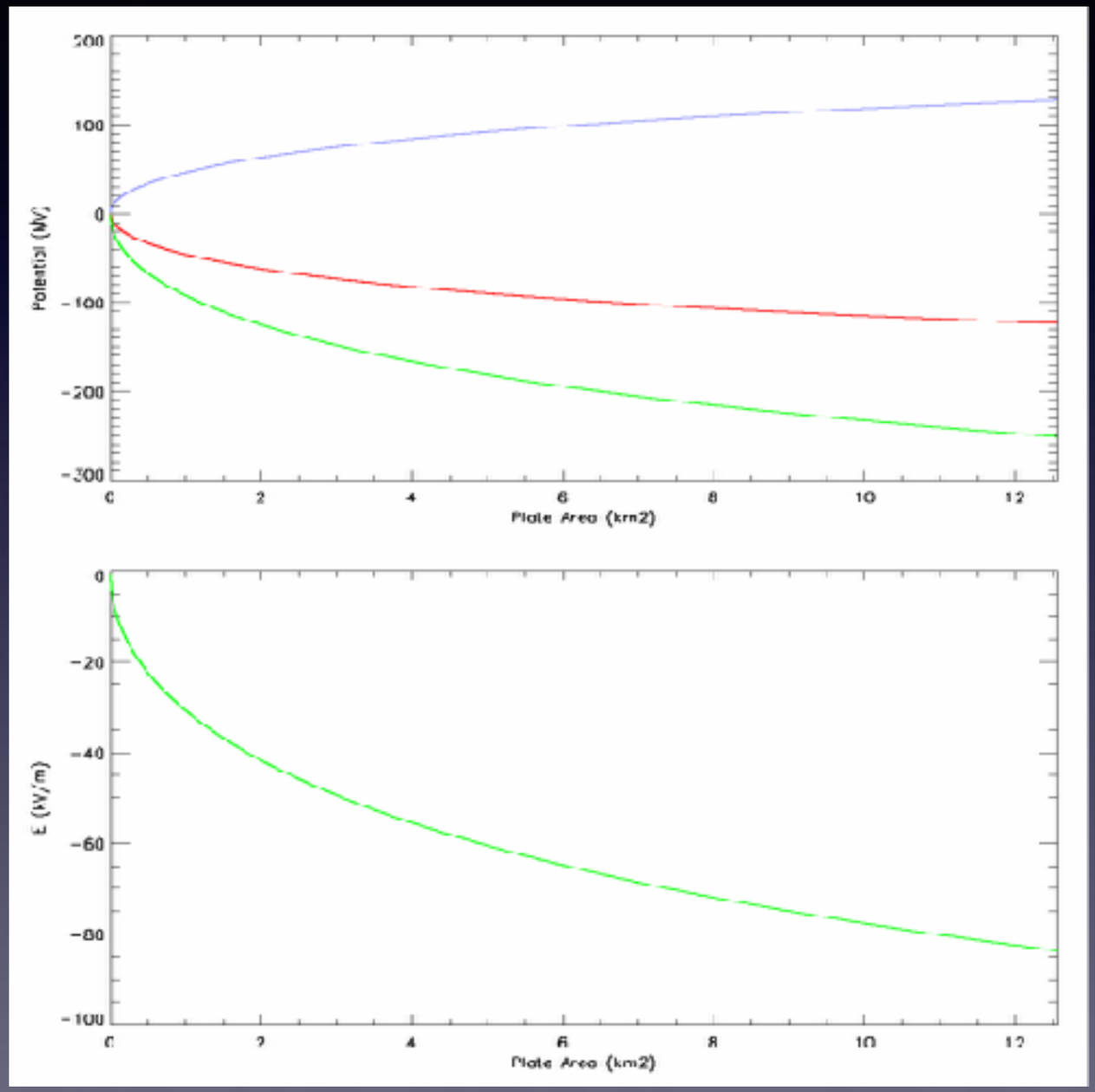
A robust diurnal pattern

- One could make a simplistic argument: "*Flash counts and radiance are inversely related*" hence the diurnal convective activity is the sole contributor to the observed flash radiance pattern. The answer is **more complex than a simple "yes" or "no"**



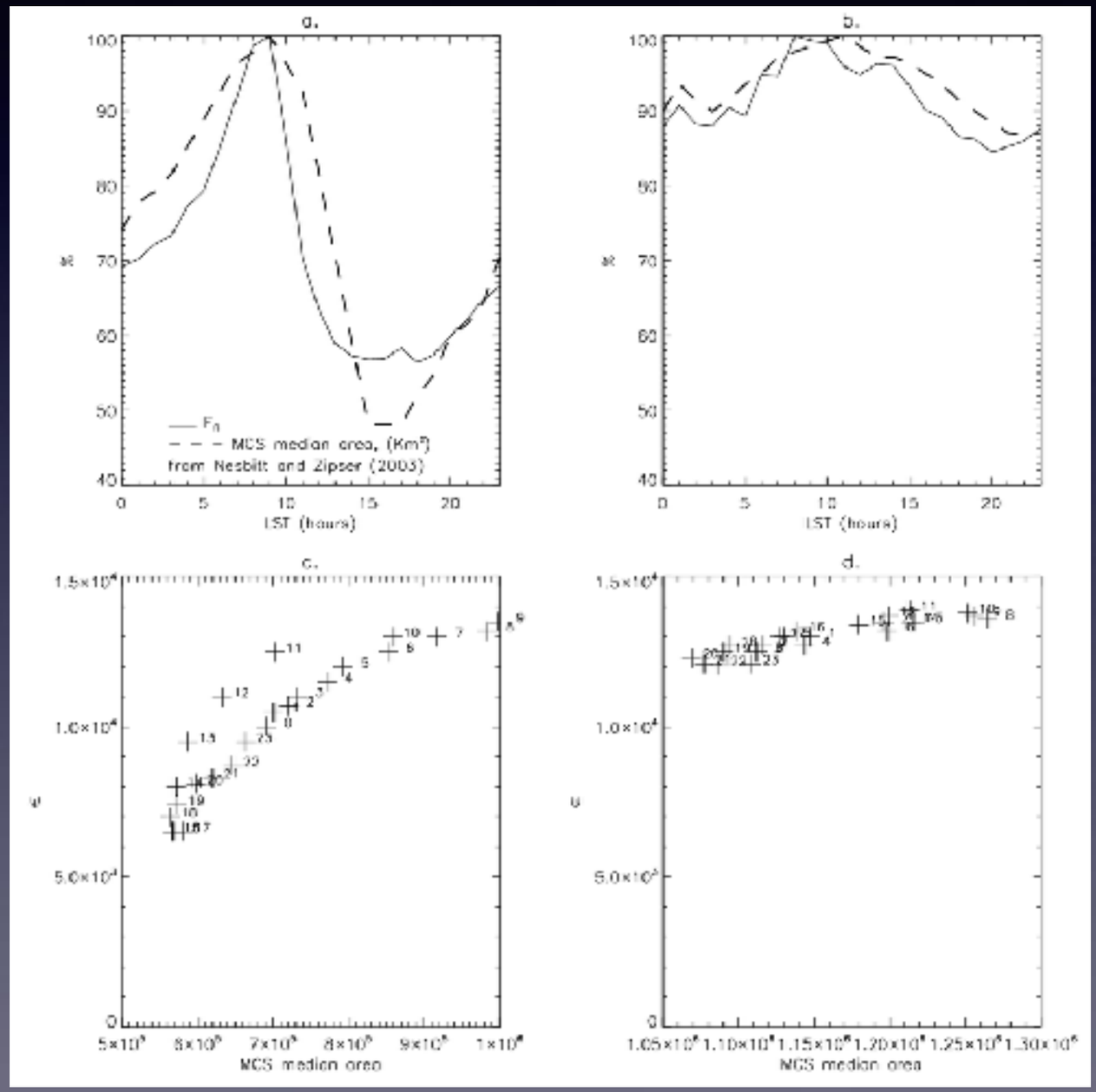
Capacitor hypothesis

- Area of capacitor over a conductive plate (i.e., thundercloud over Earth) is proportional to potential. So we expect larger storms to exhibit larger potential, more energetic discharges (i.e., radiances) but also larger Ip currents… (Stolzenburg and Marshall, 2008)



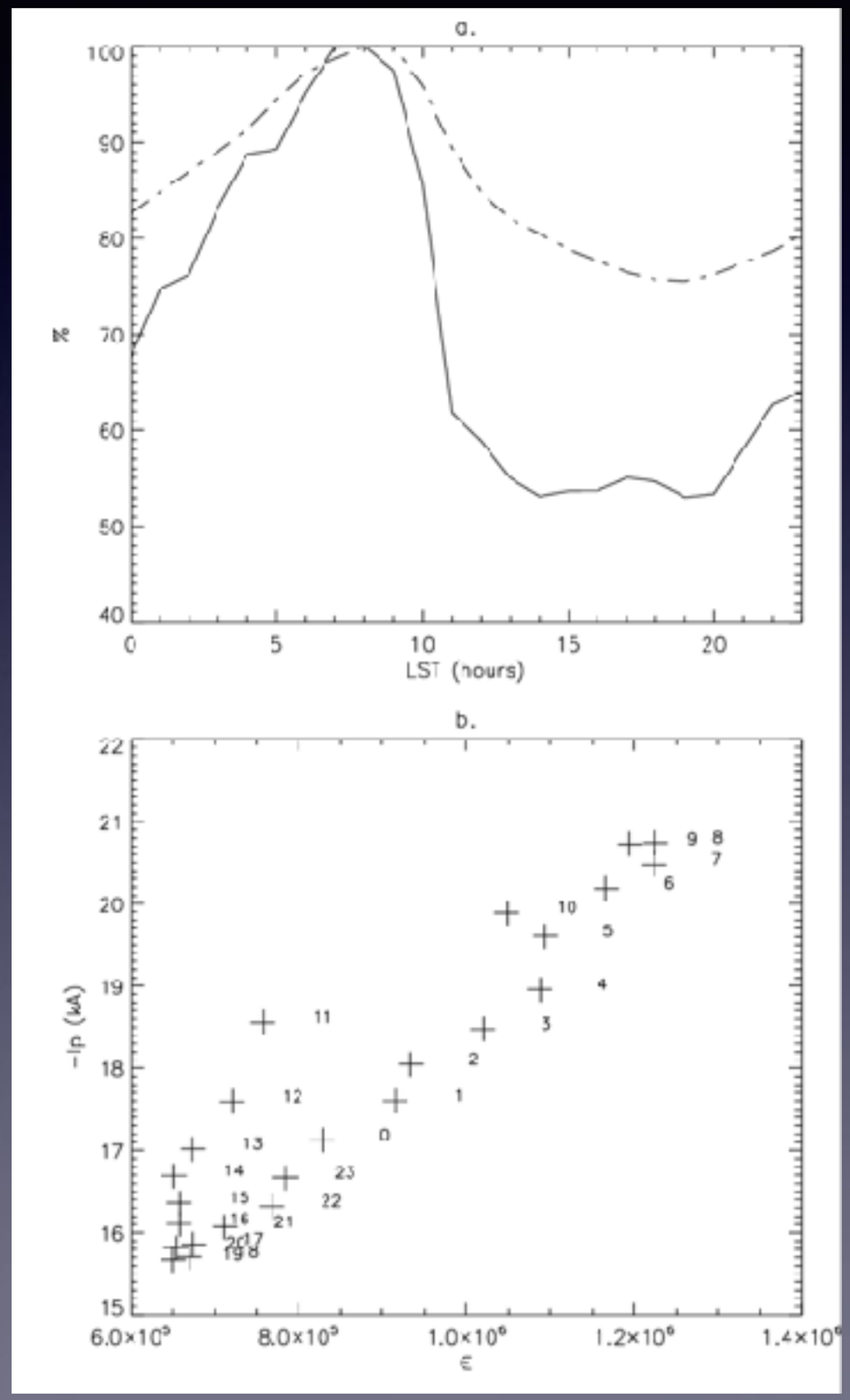
Capacitor Hypothesis

- Even more interesting is the fact that diurnal flash radiance further exhibits a robust covariation with storm horizontal extent (i.e., in agreement with the capacity model). Global (~38S-38N) MCS horizontal extent over continents and oceans from Nesbitt and Zipser (2003)



Further clues

- Flash radiance is known to exhibit a good covariance with Ip (e.g. rocket-triggered lightning Wang et al., 2005)
- On a diurnal scale, evidence over CONUS also supports the latter (Chronis et al., 2015)



The verdict

- This new diurnal flash radiance pattern **is not an artifact and likely related to a real and currently overlooked, physical mechanism**.

- Simple capacitor model (on a conductive Earth) indicates that part of this physical mechanism could be played by **the storm's horizontal extent**.

- Some uncertainties relate to the simplifications made in the capacitor model, storm types (e.g. MCSs)

- This study is just an example that **flash energetics have been utterly overlooked and our current knowledge is not as thorough**

Acknowledgments

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