

# INDICATORS DERIVED FROM TRMM/LIS SATELLITE LIGHTNING OBSERVATIONS

## Project Overview:

- ❑ Use lightning observations from the Tropical Rainfall Measuring Mission (TRMM) satellite Lightning Imaging Sensor (LIS) to obtain important lightning-based indicators for the National Climate Assessment (NCA).
- ❑ Extend & integrate earlier 2011 Center Call NCA efforts by the PI (Koshak) that employs national ground-based lightning data to track characteristics of ground flashes & impacts.

## Investigators:

### ❑ *Funded:*

PI: Dr. William Koshak (MSFC)

Co-I: Dr. Brian Vant-Hull (CCNY)

### ❑ *Leveraged:*

Ken Cummins (UA), Dennis Buechler (UAH), Richard Blakeslee (MSFC), Earle Williams (MIT), Harold Peterson (USRA).



# Final Results & Accomplishments

## ☐ Publications:

- Koshak, W. J., K. L. Cummins, D. E. Buechler, B. Vant-Hull, R. J. Blakeslee, E. R. Williams, H. S. Peterson, 2015: Variability of CONUS Lightning in 2003-12 and Associated Impacts, *J. Appl. Meteorol. Climatology*, **54**, No. 1, 15-41.
- Koshak, W. J., B. Vant-Hull, E. W. McCaul, and H. S. Peterson, 2014: Variation of a lightning NO<sub>x</sub> indicator for national climate assessment, XV International Conference on Atmospheric Electricity, Norman, Oklahoma, June 15-20.

## *Additional Leveraged:*

- Koshak, W. J., and R. J. Solakiewicz, 2015: A method for retrieving the ground flash fraction and flash type from satellite lightning mapper observations, *J. Atmos. Oceanic Technol.*, **32**, No. 1, 79-96.
- Koshak, W. J., R. J. Solakiewicz, H. S. Peterson, 2015: A return stroke NO<sub>x</sub> production model, *J. Atmos. Sci.*, XX, No. X, XX-XX.
- Chronis, T., R. Said, K. Cummins, **W. J. Koshak**, E. McCaul, E. Williams, G. Stano, M. Grant, 2015: Climatological diurnal variation of negative CG lightning peak current over the continental United States, submitted to *J. Geophys. Res.*, in press.
- Buechler, D. E., **W. J. Koshak**, H. J. Christian, and S. J. Goodman, 2014: Assessing the performance of the Lightning Imaging Sensor (LIS) using deep convective clouds, *Atmos. Res.*, 135-136, 397-403.
- Beirle, S., **W. J. Koshak**, R. Blakeslee, and T. Wagner, 2014: Global patterns of lightning properties derived by OTD and LIS, *Nat. Hazards Earth Syst. Sci.*, 14, 2715-2726, doi:10.5194/nhess-14-2715-2014.
- Carey, L. D., **W. J. Koshak**, H. S. Peterson, R. Matthee, and A. Lamont Bain, The kinematic and microphysical control of lightning rate, extent and NO<sub>x</sub> production, XV International Conference on Atmospheric Electricity, Norman, Oklahoma, June 15-20, 2014.
- Koshak, W. J., H. S. Peterson, A. P. Biazar, M. Khan, and L. Wang, 2014: The NASA Lightning Nitrogen Oxides Model (LNOM): application to air quality modeling, *Atmos. Res.*, 135-136, 363-369.



# Final Results & Accomplishments (cont.)

## □ Highlights:

- Provided a more comprehensive assessment of the co-evolution of global temperature, lightning, & adverse lightning-caused impacts in the US for the decade 2003-2012 using total of 25 indicators:
  - **CG lightning count dropped by 12.8%**. Small changes in peak current & multiplicity.
  - Dry bulb temp trends up, but wet bulb trends downward (lightning needs heat & moisture!).
  - CG-caused deaths, injuries, wildfires dropped, but crop & property damage increased.
  - +CG fraction (a severe Wx marker) trends upward .
  - **LIS total lightning remarkably constant (increased by only 0.38%)**.
  - Linear model risk assessments (impacts per °C climate warming) given in Koshak et al. (2015).
- We find an 18% change in CG count per 1°C change in average CONUS wet bulb temp. This is close to the recent result of 12% per °C found in Romps et al. (2014).
- **LIS-detected flash optical energies have trended downward over the lifetime of LIS**. This implies LNOx trending downward (assuming LIS instrument stable, & cloud optical thickness not trending upward).
  - **Dec 2014 EPA report shows decline in O<sub>3</sub> due to EPA auto/industry controls ... but decline also from LNOx decline?**
  - Used MSFC Lightning Nitrogen Oxides Model (LNOM) to determine how much LNOx increases EPA CMAQ ozone predictions.
  - Obtained concurrence from Hamilton County Air Pollution Control Bureau(Chattanooga, TN) to apply LNOM as permanent assessment tool for LNOx-caused ozone exceedance monitoring. Extensions of same to Birmingham AL office intended.
- By combining CG lightning data with national radar data, we found that dry lightning indicator (DLI) good at predicting lightning-caused wildfires; performs better than CG or radar data alone.

