

Feedback loop in lightning initiation through ice and nitrogen oxides

Harold Peterson¹, Matthew Bailey², John Hallett², Danyal
Petersen³

1- NASA-Marshall Space Flight Center, Huntsville, AL, USA

2- Desert Research Institute, Reno, NV, USA

3- University of Oklahoma School of Meteorology, Norman,
OK, USA

Lightning nitrogen oxide production

- Numerous studies have shown that electrical discharges in the atmosphere produce nitrogen oxides
 - Peterson et al. (2009) via laboratory discharges
 - Ott et al. (2010) using a thunderstorm model
 - Koshak et al. (2010) using a model applying laboratory results to Lightning Mapping Array data

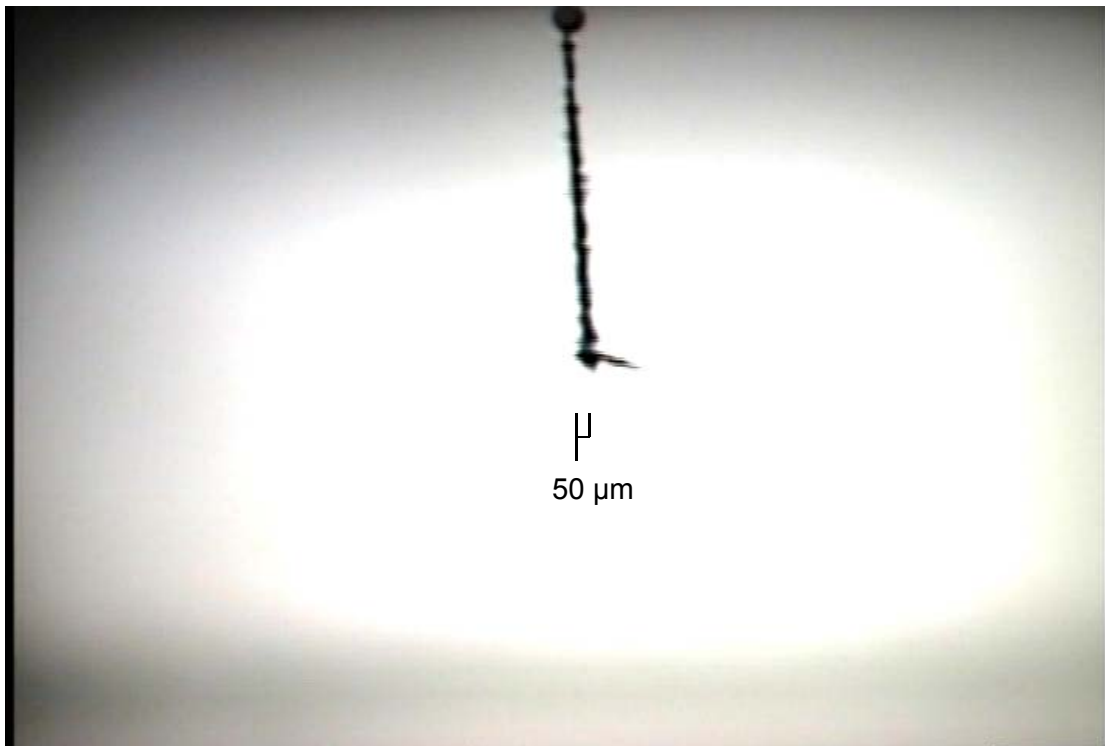
Ice and lightning

- Petersen et al. (2006) suggests that streamer discharges from ice crystals may be a necessary step in the lightning initiation process
 - Showed that streamers may be initiated at temperatures down to -38 C, much colder than previous studies such as Griffiths and Latham (1974)

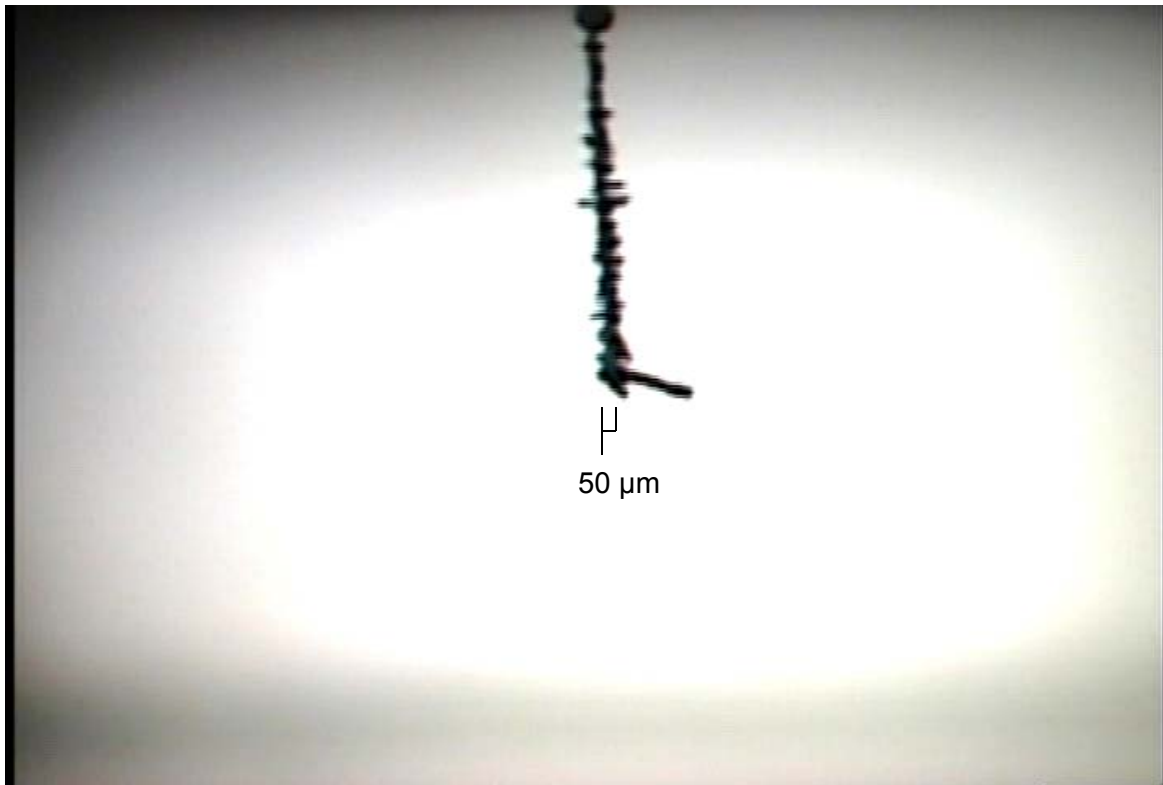
Ice and nitrogen oxides

- Cloud chamber results by Peterson et al. (2010) show that ice growth is enhanced by the presence of nitrogen oxides

- Ice crystal grown for one hour in air with a background nitric oxide concentration (<0.01 ppm)



- The NO concentration in the chamber was raised to 0.37 ppm, and the crystals were allowed to grow for an additional hour



- The addition of dry air to the chamber should have caused the ice crystals to grow more slowly or even shrink
 - Decreased ice supersaturation
 - Decreased vapor diffusivity (higher air pressure)
- Instead, ice crystals grew more quickly with a higher concentration of NO
 - Some crystals thickened more rapidly than they lengthened

Suggested feedback mechanism

- Lightning produces nitrogen oxide
- Lightning + ice leads to catalyzed nitrogen oxide production (Peterson and Beasley 2011)
- Nitrogen oxides enhance ice growth, particularly by thickening some ice crystals
- Thicker ice crystals are more easily able to produce positive streamers, potentially enhancing lightning flash rates
- This is not meant to suggest lightning rates are higher than what they are; rather, this feedback mechanism is part of the explanation for a particular flash rate in a storm

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