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Possible Aerosol Effects on Lightning Activity and Structure of Hurricanes

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Abstract

According to observations of hurricanes located relatively close to the land, intense and persistent lightning takes place within a 250–300-km radius ring around the hurricane center, whereas the lightning activity in the eyewall takes place only during comparatively short periods usually attributed to eyewall replacement. The mechanism responsible for the formation of the maximum flash density at the tropical cyclone (TC) periphery is not well understood as yet. In this study it is hypothesized that lightning at the TC periphery arises under the influence of small continental aerosol particles (APs), which affect the microphysics and the dynamics of clouds at the TC periphery. To show that aerosols change the cloud microstructure and the dynamics to foster lightning formation, the authors use a 2D mixed-phase cloud model with spectral microphysics. It is shown that aerosols that penetrate the cloud base of maritime clouds dramatically increase the amount of supercooled water, as well as the ice contents and vertical velocities. As a result, in clouds developing in the air with high AP concentration, ice crystals, graupel, frozen drops and/or hail, and supercooled water can coexist within a single cloud zone, which allows collisions and charge separation. The simulation of possible aerosol effects on the landfalling tropical cyclone has been carried out using a 3-km-resolution Weather Research and Forecast (WRF) mesoscale model. It is shown that aerosols change the cloud microstructure in a way that permits the attribution of the observed lightning structure to the effects of continental aerosols. It is also shown that aerosols, which invigorate clouds at 250–300 km from the TC center, decrease the convection intensity in the TC center, leading to some TC weakening. The results suggest that aerosols change the intensity and the spatial distribution of precipitation in landfalling TCs and can possibly contribute to the weekly cycle of the intensity and precipitation of landfalling TCs. More detailed investigations of the TC–aerosol interaction are required.

Keywords: Tropical cyclones, Lightning, Aerosols, Clouds, Numerical weather prediction/forecasting

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Cited by

Thomas C. Peterson, Thomas R. Karl, James P. Kossin, Kenneth E. Kunkel, Jay H. Lawrimore, James R. McMahon, Russell S. Vose, Xungang Yin. (2013) Changes in Weather and Climate Extremes: State of Knowledge Relevant to Air and Water Quality in the U.S.. *Journal of the Air & Waste Management Association*131011102914005
Online publication date: 11-Oct-2013.
CrossRef

Edward R. Mansell, Conrad L. Ziegler. (2013) Aerosol Effects on Simulated Storm Electrification and Precipitation in a Two-Moment Bulk Microphysics Model. *Journal of the Atmospheric Sciences* **70**:7, 2032-2050
Online publication date: 1-Jul-2013.
Abstract . Full Text . PDF (2600 KB)

Scott A. Braun, Ramesh Kakar, Edward Zipser, Gerald Heymsfield, Cerese Albers, Shannon Brown, Stephen L. Durden,

Stephen Guimond, Jeffery Halverson, Andrew Heymsfield, Syed Ismail, Bjorn Lambrigtsen, Timothy Miller, Simone Tanelli, Janel Thomas, Jon Zawislak. (2013) NASA's Genesis and Rapid Intensification Processes (GRIP) Field Experiment. *Bulletin of the American Meteorological Society* **94**:3, 345-363
Online publication date: 1-Mar-2013.
Abstract . Full Text . PDF (4068 KB)

A.I. Calvo, C. Alves, A. Castro, V. Pont, A.M. Vicente, R. Fraile. (2013) Research on aerosol sources and chemical composition: Past, current and emerging issues. *Atmospheric Research* **120-121**, 1-28
Online publication date: 1-Feb-2013.
CrossRef

Po-Lun Ma, Kai Zhang, Jainn Jong Shi, Toshihisa Matsui, Albert Arking. (2012) Direct Radiative Effect of Mineral Dust on the Development of African Easterly Waves in Late Summer, 2003–07. *Journal of Applied Meteorology and Climatology* **51**:12, 2090-2104
Online publication date: 1-Dec-2012.
Abstract . Full Text . PDF (3380 KB)

Sutapa Chaudhuri, Anirban Middey. (2012) Disparity in the characteristic of thunderstorms and associated lightning activities over dissimilar terrains. *Meteorology and Atmospheric Physics*
Online publication date: 30-Oct-2012.
CrossRef

Kyo-Sun Sunny Lim, Song-You Hong. (2012) Investigation of aerosol indirect effects on simulated flash-flood heavy rainfall over Korea. *Meteorology and Atmospheric Physics*
Online publication date: 17-Oct-2012.
CrossRef

A. P. Khain, V. Phillips, N. Benmoshe, A. Pokrovsky. (2012) The Role of Small Soluble Aerosols in the Microphysics of Deep Maritime Clouds. *Journal of the Atmospheric Sciences* **69**:9, 2787-2807
Online publication date: 1-Sep-2012.
Abstract . Full Text . PDF (3637 KB)

Daniel Rosenfeld, William L. Woodley, Alexander Khain, William R. Cotton, Gustavo Carrió, Isaac Ginis, Joseph H. Golden. (2012) Aerosol Effects on Microstructure and Intensity of Tropical Cyclones. *Bulletin of the American Meteorological Society* **93**:7, 987-1001
Online publication date: 1-Jul-2012.
Abstract . Full Text . PDF (1782 KB)

John Xun Yang, Alexis Kai Hon Lau, Jimmy Chi Hung Fung, Wen Zhou, Mark Wenig. (2012) An air pollution episode and its formation mechanism during the tropical cyclone Nuri's landfall in a coastal city of south China. *Atmospheric Environment* **54**, 746-753
Online publication date: 1-Jul-2012.
CrossRef

Mark DeMaria, Robert T. DeMaria, John A. Knaff, Debra Molenar. (2012) Tropical Cyclone Lightning and Rapid Intensity Change. *Monthly Weather Review* **140**:6, 1828-1842
Online publication date: 1-Jun-2012.
Abstract . Full Text . PDF (1642 KB)

Zhan Zhao, Michael S. Pritchard, Lynn M Russell. (2012) Effects on precipitation, clouds, and temperature from long-range transport of idealized aerosol plumes in WRF-Chem simulations. *Journal of Geophysical Research*
Online publication date: 1-Jan-2012.
CrossRef

Fernando Simões, Robert Pfaff, Jean-Jacques Berthelier, Jeffrey Klenzing. (2011) A Review of Low Frequency Electromagnetic Wave Phenomena Related to Tropospheric-Ionospheric Coupling Mechanisms. *Space Science Reviews*
Online publication date: 10-Dec-2011.
CrossRef

Kelsey N. Scheitlin, James B. Elsner, Shawn W. Lewers, Jill C. Malmstadt, Thomas H. Jagger. (2011) Risk assessment of hurricane winds for Eglin air force base in northwestern Florida, USA. *Theoretical and Applied Climatology* **105**:3-4, 287-296
Online publication date: 1-Oct-2011.
CrossRef

Daniel Rosenfeld, Michal Clavner, Ronit Nirel. (2011) Pollution and dust aerosols modulating tropical cyclones intensities. *Atmospheric Research* **102**:1-2, 66-76
Online publication date: 1-Oct-2011.
CrossRef

Peter Yaukey. (2011) Wind Speed Changes of North Atlantic Tropical Cyclones Preceding Landfall. *Journal of Applied Meteorology and Climatology* **50**:9, 1913-1921
Online publication date: 1-Sep-2011.
Abstract . Full Text . PDF (791 KB)

Jason P. Dunion. (2011) Rewriting the Climatology of the Tropical North Atlantic and Caribbean Sea Atmosphere. *Journal of Climate* **24**:3, 893-908
Online publication date: 1-Feb-2011.
Abstract . Full Text . PDF (3682 KB)

Tianle Yuan, Lorraine A. Remer, Kenneth E. Pickering, Hongbin Yu. (2011) Observational evidence of aerosol enhancement of lightning activity and convective invigoration. *Geophysical Research Letters* **38**:4, n/a-n/a
Online publication date: 1-Feb-2011.
CrossRef

Baojun Chen, Yan Yin. (2011) Modeling the impact of aerosols on tropical overshooting thunderstorms and stratospheric water vapor. *Journal of Geophysical Research* **116**:D19,

Online publication date: 1-Jan-2011.
CrossRef

A. Khain, B. Lynn, J. Dudhia. (2010) Aerosol Effects on Intensity of Landfalling Hurricanes as Seen from Simulations with the WRF Model with Spectral Bin Microphysics. *Journal of the Atmospheric Sciences* **67**:2, 365-384
Online publication date: 1-Feb-2010.
Abstract . Full Text . PDF (5845 KB)

Alexander Khain, Barry Lynn. (2009) Simulation of a supercell storm in clean and dirty atmosphere using weather research and forecast model with spectral bin microphysics. *Journal of Geophysical Research* **114**:D19,
Online publication date: 1-Jan-2009.
CrossRef

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