Salty sea spray affects the lifetimes of clouds, researchers find

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All over the planet, every day, oceans send plumes of sea spray into the atmosphere. Beyond the poetry of crashing ocean waves, this salt- and carbon-rich spray has a dramatic effect on the formation and duration of clouds.

Yes, clouds, which cover 60 percent of the Earth's surface at any given time. In a new study in *Proceedings of the National Academy of Sciences*, online Dec. 21, Colorado State University's Paul DeMott, a senior research scientist in the Department of Atmospheric Science, says sea spray is a unique, underappreciated source of what are called ice nucleating particles - microscopic bits that make their way into clouds and initiate the formation of ice, and in turn affect the composition and duration of clouds.

"The presence of these particles is critically important for precipitation and the lifetime of clouds, and consequently, for their radiative properties," said DeMott, who works in the lab of Sonia Kreidenweis, professor of atmospheric science, associate dean for research in the College of Engineering and a University Distinguished Professor.

Clouds' effect on climate

Clouds, with their ability to reflect solar energy and absorb terrestrial radiation, have dramatic effects on climate. Their radiative properties are greatly influenced by the number, size and type of droplets and ice particles inside the cloud. These cloud particles can initiate from any number of sources of aerosols - particles suspended in air - from land and ocean surfaces. From desert dust to burning fossil fuels, aerosols that affect clouds are everywhere.

DeMott's study has confirmed that ice nucleating particles from oceans are distinct, both in their abundance as well as their ice-making properties, from land-sourced particles. Hence, their influence on the liquid/ice phase structure of clouds, and their subsequent radiative impacts, can differ over vast swaths of Earth.

Center for Aerosol Impacts on Climate and the

Environment

The laboratory portion of the study was conducted with other researchers at the National Science Foundation-supported Center for Aerosol Impacts on Climate and the Environment (CAICE), at which DeMott is a senior scientist. Based at University of California-San Diego, CAICE boasts the world's most cutting-edge laboratory wave flumes that simulate closely how ocean waves send sea spray aerosols into the air. In turn, the researchers can study the biological and chemical makeup and transformations of these particles, and using specialized instruments, how they influence cloud formation. DeMott and colleagues compared these data to other measurements made over oceans.

The study offers one hypothetical explanation for why global climate models have consistently underestimated reflected, short-wave solar radiation in regions dominated by oceans, particularly in the southern hemisphere.

"Our paper gives a clearer picture of the behavior of major classes of atmospheric aerosols in cold clouds - factors that need to go into global-scale climate modeling," DeMott said.

Added Nick Anderson, program director in the National Science Foundation's Division of Atmospheric and Geospace Sciences, which funded the research: "The development of clouds and precipitation is a core issue for understanding weather and climate processes. By studying ice nuclei, which can be considered a building block for clouds, these researchers will help piece together the puzzle of how clouds and precipitation form, especially over remote oceanic regions."

More information: Sea spray aerosol as a unique source of ice nucleating particles, *Proceedings of the National Academy of Sciences*, www.pnas.org/cgi/doi/10.1073/pnas.1514034112

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