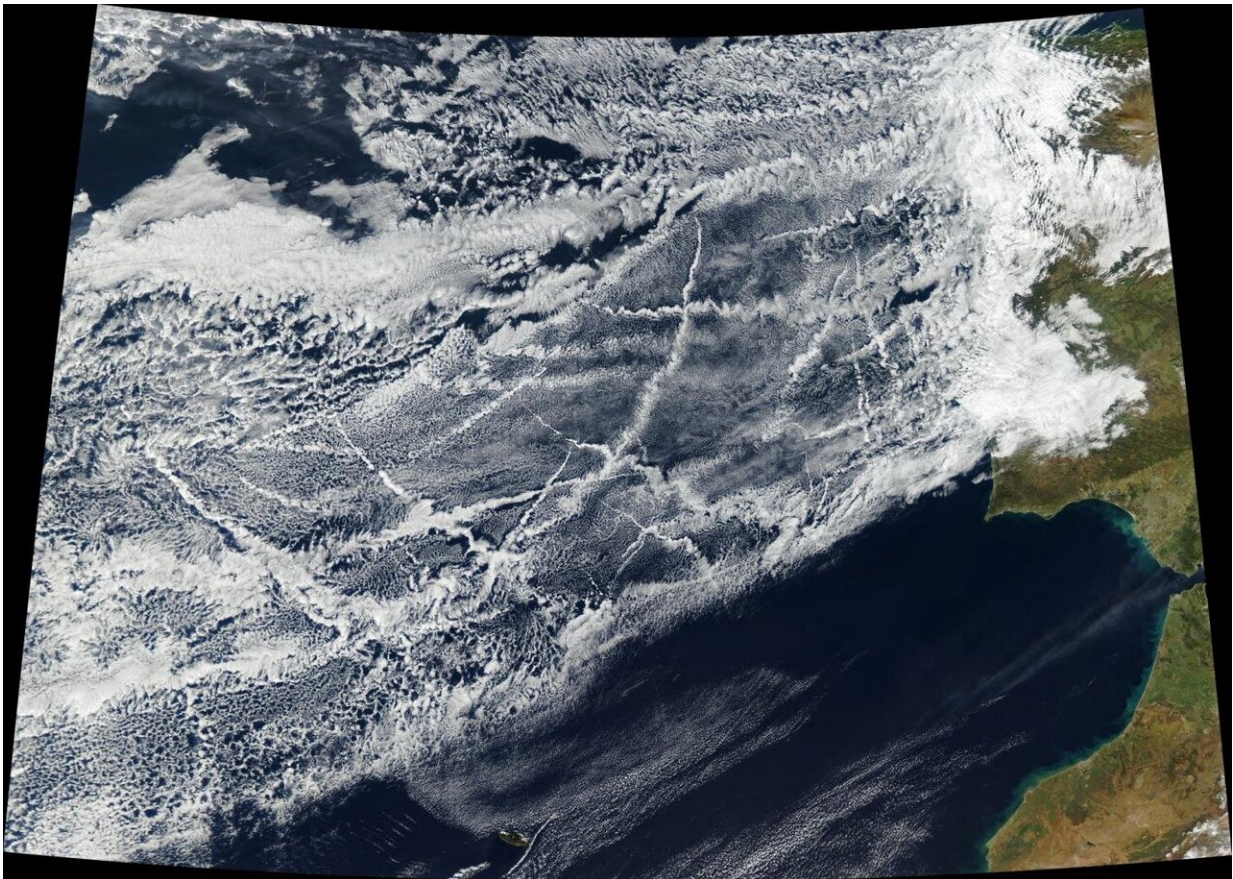


Ships' emissions create measurable regional change in clouds

March 24 2020, by Hannah Hickey



This satellite image was taken January 16, 2018, off the coast of Europe. Pollution from ships creates lines of clouds that can stretch hundreds of miles. The narrower ends of the clouds are youngest, while the broader, wavier ends are older. Credit: NASA Earth Observatory

A container ship leaves a trail of white clouds in its wake that can linger in the air for hours. This puffy line is not just exhaust from the engine, but a change in the clouds that's caused by small airborne particles of pollution.

New research led by the University of Washington is the first to measure this phenomenon's effect over years and at a regional scale. Satellite data over a [shipping lane](#) in the south Atlantic show that the ships modify clouds to block an additional 2 Watts of solar energy, on average, from reaching each square meter of ocean surface near the shipping lane.

The result implies that globally, cloud changes caused by particles from all forms of industrial pollution block 1 Watt of solar energy per square meter of Earth's surface, masking almost a third of the present-day warming from greenhouse gases. The open-access study was published March 24 in *AGU Advances*, a journal of the American Geophysical Union.

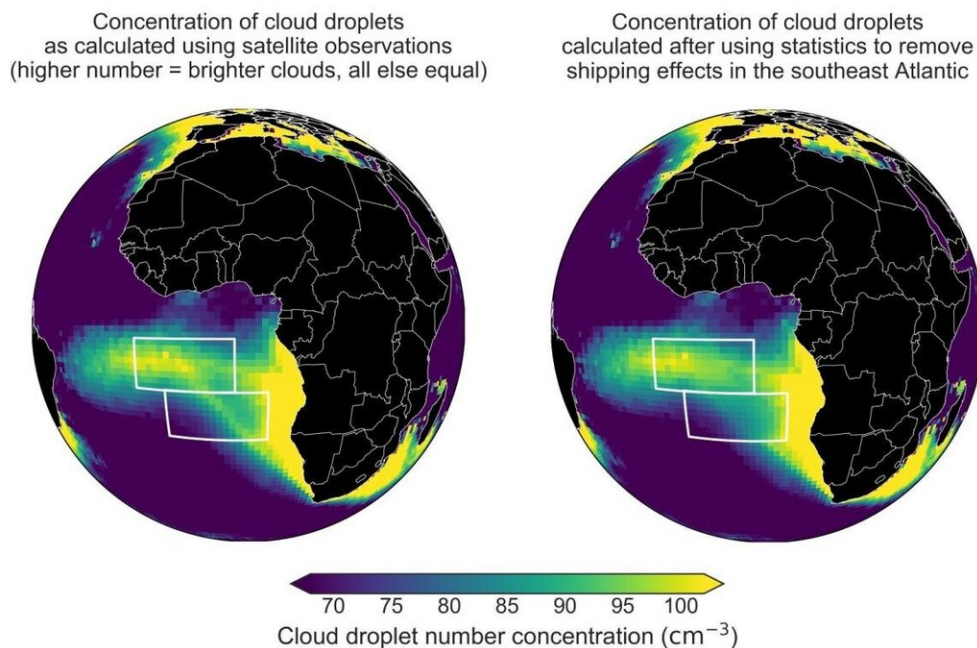
"In [climate models](#), if you simulate the world with [sulfur emissions](#) from shipping, and you simulate the world without these emissions, there is a pretty sizable cooling effect from changes in the model clouds due to shipping," said first author Michael Diamond, a UW doctoral student in atmospheric sciences. "But because there's so much natural variability it's been hard to see this effect in observations of the real world."

The new study uses observations from 2003 to 2015 in spring, the cloudiest season, over the shipping route between Europe and South Africa. This path is also part of a popular open-ocean shipping route between Europe and Asia.

Small particles in exhaust from burning fossil fuels creates "seeds" on which water vapor in the air can condense into cloud droplets. More particles of airborne sulfate or other material leads to clouds with more

small droplets, compared to the same amount of water condensed into fewer, bigger droplets. This makes the clouds brighter, or more reflective.

Past attempts to measure this effect from ships had focused on places where the wind blows across the shipping lane, in order to compare the "clean" area upwind with the "polluted" area downstream. But in this study researchers focused on an area that had previously been excluded: a place where the wind blows along the shipping lane, keeping pollution concentrated in that small area.



The left shows cloud droplet concentrations from 2003 to 2015 averaged over the months of September, October and November, as observed by NASA satellites. The right side shows what the study calculated the concentration of cloud droplets would be without emissions along the shipping route (yellow line). The difference helps explain how much industrial pollution influences clouds. Credit: Michael Diamond/University of Washington

The study analyzed cloud properties detected over 12 years by the MODIS instrument on NASA satellites and the amount of reflected sunlight at the top of the atmosphere from the CERES group of satellite instruments. The authors compared cloud properties inside the shipping route with an estimate of what those cloud properties would have been in the absence of shipping based on statistics from nearby, unpolluted areas.

"The difference inside the shipping lane is small enough that we need about six years of data to confirm that it is real," said co-author Hannah Director, a UW doctoral student in statistics. "However, if this small change occurred worldwide, it would be enough to affect global temperatures."

Once they could measure the ship emissions' effect on solar radiation, the researchers used that number to estimate how much cloud brightening from all industrial pollution has affected the climate overall.

Averaged globally, they found changes in low clouds due to pollution from all sources block 1 Watt per square meter of solar energy—compared to the roughly 3 Watts per square meter trapped today by the greenhouse gases also emitted by industrial activities. In other words, without the cooling effect of pollution-seeded clouds, Earth might have already warmed by 1.5 degrees Celsius (2.7 F), a change that the Intergovernmental Panel on Climate Change projects would have significant societal impacts. (For comparison, today the Earth is estimated to have warmed by approximately 1 C (1.8 F) since the late 1800s.)

"I think the biggest contribution of this study is our ability to generalize, to calculate a global assessment of the overall impact of sulfate pollution

on low clouds," said co-author Rob Wood, a UW professor of atmospheric sciences.

The results also have implications for one possible mechanism of deliberate climate intervention. They suggest that strategies to temporarily slow global warming by spraying salt particles to make low-level marine [clouds](#) more reflective, known as marine cloud brightening, might be effective. But they also imply these changes could take years to be easily observed.

"What this study doesn't tell us at all is: Is marine cloud brightening a good idea? Should we do it? There's a lot more research that needs to go into that, including from the social sciences and humanities," Diamond said. "It does tell us that these effects are possible—and on a more cautionary note, that these effects might be difficult to confidently detect."

More information: Michael S. Diamond et al. Substantial Cloud Brightening From Shipping in Subtropical Low Clouds, *AGU Advances* (2020). [DOI: 10.1029/2019AV000111](https://doi.org/10.1029/2019AV000111)

Provided by University of Washington

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