

A Satellite's View of Ship Pollution

For more than a decade, scientists have observed “[ship tracks](#)” in natural-color satellite imagery of the ocean. These bright, linear trails amidst the cloud layers are created by particles and gases from ships. They are a visible manifestation of pollution from ship exhaust, and scientists can now see that ships have a more subtle, almost invisible, signature as well.

Data from the Dutch and Finnish-built [Ozone Monitoring Instrument](#) (OMI) on NASA's [Aura](#) satellite show long tracks of elevated [nitrogen dioxide](#) (NO₂) levels along certain shipping routes. NO₂, is among a group of highly-reactive [oxides of nitrogen](#), known as NO_x, that can lead to the production of fine particles and ozone that damage the human cardiovascular and respiratory systems. Combustion engines, such as those that propel ships and motor vehicles, are a major source of NO₂ pollution.

The map above is based on OMI measurements acquired between 2005 and 2012. The NO₂ signal is most prominent in an Indian Ocean shipping lane between Sri Lanka and Singapore, appearing as a distinct orange line against (lighter) background levels of NO₂. Other shipping lanes that run through the Gulf of Aden, the Red Sea, and the Mediterranean Sea also show elevated NO₂ levels, as do routes from Singapore to points in China. These aren't the only busy shipping lanes in the world, but they are the most apparent because ship traffic is concentrated along narrow, well-established lanes.

The Atlantic and Pacific Oceans also have heavy ship traffic, but OMI doesn't pick up NO₂ pollution tracks because the shipping routes are less consistent. The shapes of landmasses force ships into narrow paths in the Indian Ocean, while ships in the Atlantic and Pacific tend to spread out over a broad areas as they navigate around storms.

In addition, the air over the northeastern Indian Ocean is relatively pristine. Heavy NO₂ pollution (dark red in the map) from cities and off-shore drilling activity along the coasts of China, Europe, and the United States obscures the ship tracks that might otherwise be visible to OMI. In the map, the Arctic is gray because the lack of light during the winter and frequent cloudiness during the summer prevented OMI from collecting usable data in the area.

Urban areas and industrialization aren't the only source of NO₂ in the map. [Agricultural burning](#) in southern Africa and persistent [westerly winds](#) make an elevated band of NO₂ that stretches from southern Africa to Australia. (In central Africa, easterly winds push pollutants from fires toward the Atlantic, keeping NO₂ levels comparatively low over the northern Indian Ocean.) Lightning, which [produces NO_x](#), also contributes to background NO₂ levels.

Just how much shipping contributes to overall NO_x emissions remains an open question for scientists. Research suggests that shipping accounts for 15 to 30 percent of global NO_x emissions; scientists are using satellite observations to [reduce the uncertainty](#) in such estimates.

OMI is not the only satellite instrument observing NO₂ levels in the atmosphere. The [Global Ozone Monitoring Experiment](#) (GOME) instruments on the European Space Agency's [ERS-2](#) and [MetOp-A](#) satellites, as well as the [SCIAMACHY](#) instrument on the [Envisat](#) satellite, have made similar measurements. In 2012, Dutch scientists published [a study](#) combining data from all four instruments to show that the NO₂ signal over major shipping increased steadily between 2003 and 2008, then dropped sharply due to the global recession and reduction in ship traffic.

References

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NASA Earth Observatory image by Jesse Allen, using OMI NO₂ data provided courtesy of Lok Lamsal, [Aura Project Science Office](#). Caption by Adam Voiland, with information from Nickolay Krotkov, Anne Thompson, Geert Vinken, and Folkert Boersma.