Surface of the oceans affects climate more than thought

September 30 2015

More isoprene is apparently produced on the border between ocean and atmosphere than previously thought. The gas contributes to the formation of clouds and has therefore influence on the global climate. Credit: Tilo Arnhold/TROPOS

The oceans seem to produce significantly more isoprene, and consequently affect stronger the climate than previously thought. This emerges from a study by the Institute of Catalysis and Environment in

Lyon (IRCELYON, CNRS / University Lyon 1) and the Leibniz Institute for Tropospheric Research (TROPOS), which had studied samples of the surface film in the laboratory. The results underline the global significance of the chemical processes at the border between ocean and atmosphere, write the researchers in the journal *Environmental Science & Technology*.

Isoprene is a gas that is formed by both the vegetation and the oceans. It is very important for the climate because this gas can form particles that can become clouds and then later affect temperature and precipitation. Previously it was assumed that isoprene is primarily caused by biological processes from plankton in the sea water. The atmospheric chemists from France and Germany, however, could now show that isoprene could also be formed without biological sources in surface film of the oceans by sunlight and so explain the large discrepancy between field measurements and models. The new identified photochemical reaction is therefore important to improve the climate models.

The oceans not only take up heat and carbon dioxide from the atmosphere, they are also sources of various gaseous compounds, thereby affecting the global climate. A key role is played by the so-called surface microlayer (SML), especially at low wind speed. In these few micrometers thin layer different organic substances such as dissolved organic matter, fat and amino acids, proteins, lipids are accumulating as well as trace metals, dust and microorganisms.

For the now published study, the research team took samples from the Norther Atlantic Ocean. The surface film was collected in the Raunefjord near Bergen in Norway. For this purpose, a glass plate is immersed in water and then again carefully pulled from the water. The 200 micron thin film sticks to the glass and is then scraped off with a wiper. The sample thus obtained is analyzed in the laboratory later. At the Institute of Catalysis and Environment in Lyon (IRCELYON), which

belongs to the French research organization CNRS and the University of Lyon 1, the team investigated its photochemical properties during which collected samples were irradiated with light and the gases were analyzed: it became clear that isoprene was produced in magtnetudes that were previously attributed solely to plankton. "We were able for the first time trace back the production of this important aerosol precursor to abiotic sources, so far global calculations consider only biological sources," explains Dr. Christian George from IRCELYON.

The surface film was collected from the Leipzig scientist Dr. Manuela van Pinxteren in the Northern Atlantic Ocean with the glass plate technology. Credit: Tilo Arnhold/TROPOS

Thus, it is now possible to estimate more closely the total amounts of isoprene, which are emitted. So far, however, local measurements

indicated levels of about 0.3 megatonnes per year, global simulations of around 1.9 megatons per year. But the team of Lyon and Leipzig estimates that the newly discovered photochemical pathway alone contribute 0.2 to 3.5 megatons per year additionally and could explain the recent disagreements. "The existence of the organic films at the ocean surface due to biological activities therefore influences the exchange processes between air and sea in a unexpected strong way. The photochemical processes at this interface could be a very significant source of isoprene", summarizes Prof. Hartmut Herrmann from TROPOS.

The processes at the boundary between water and air are currently of great interest in science: In August, the team from the CNRS and TROPOS presented evidence in *Scientific Reports*, the open-access journal of Nature, that dissolved organic material in the surface film is strengthening the chemical conversion of saturated fatty acids into unsaturated gas phase products under the influence of sunlight. For the first time it was realized that these products have to be of biological origin not only, but also abiotic processes at the interface between two media have the potential to produce such molecules. In early September another team from Canada, the US, Great Britain and Germany showed in the journal Nature that organic material from the surface film of the oceans can be an important source for the formation of ice in clouds over remote regions of the North Atlantic, North Pacific and Southern Ocean. The recent publication of the teams from CNRS and TROPOS in *Environmental Science & Technology* provides indications how the climate models in the important details of the influence of isoprene could be improved. Because of the great importance this paper will be open access as "Editor's Choice".

More information: Raluca Ciuraru, Ludovic Fine, Manuela van Pinxteren, Barbara D'Anna, Hartmut Herrmann, and Christian George (2015): Unravelling new processes at interfaces: photochemical isoprene

production at the sea surface. *Environmental Science & Technology*. Just Accepted Manuscript. DOI: 10.1021/acs.est.5b02388

Raluca Ciuraru, Ludovic Fine, Manuela van Pinxteren, Barbara D'Anna, Hartmut Herrmann & Christian George (2015): Photosensitized production of functionalized and unsaturated organic compounds at the air-sea interface. *Scientific Reports*, 5:12741, DOI: 10.1038/srep12741