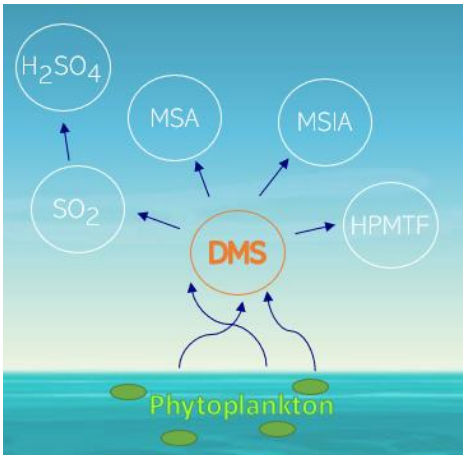
Dana Lüdemann

Small bacteria in the ocean form clouds in the atmosphere

When walking along the seashore, one cannot help but notice a distinct sulfuric smell in the air. This well-known seaside aroma comes from a rather difficultly named, organic compound called dimethyl sulfide (DMS), which is produced by small bacteria in the ocean. Other than giving the ocean its scent, DMS has an impact on the global climate by forming tiny particles in the atmosphere – aerosol particles.

From car exhaust to dust or pollen, aerosol particles can be found everywhere on earth and have a large variety of sources. To distinguish their origins, particles which are directly emitted to the atmosphere are called primary aerosol particles (e.g. windblown dust), while secondary aerosol particles stem from a gas-to-particle conversion such as DMS aerosol particles. Most aerosol particles act like parasols in the sense that they reflect sunlight back into space which has a net cooling effect on Earth's surface (direct effect). However, they also have an indirect effect by serving as sites upon which cloud droplets can form, also known as cloud condensation nuclei (CCN).



Cloud formation gets majorly important over the oceans since marine clouds can reflect sunlight which would otherwise be absorbed by the oceans as heat. More than 70 percent of earth's surface are covered in oceans, but over these remote regions there are only little sources of CCN with DMS being the main source. Therefore, since the particle formation from DMS can alter marine cloud properties it may have a large impact on the global climate. However, to form particles in the atmosphere, DMS first undergoes an oxidation (loss of electrons during a chemical reaction) resulting in several oxidation products such as methanesulfonic acid (MSA), methanesulfinic acid (MSIA), sulfuric acid (H2SO4) (see figure above). All these oxidation products contribute to the particle formation, but we lack detailed knowledge about the chemistry that leads to their formation or their ongoing fate in the atmosphere. DMS can undergo reactions in its gas-phase or dissolved in water (aqueous-phase) leading to multiple reaction pathways which pose a large uncertainty for quantifying the total climate impact of DMS aerosols. The ocean warming and further consequences of climate change increase the need for accurate estimations on the aerosol formation from DMS.

This thesis will investigate the aerosol particle formation and growth from DMS with a closer look on how outer influences such as UV-light intensity, relative humidity and cloud passages affect the DMS oxidation and oxidation products. The aerosol particle formation and growth will be simulated through a numerical model called Aerosol Dynamics, Gas- and Particle-phase Chemistry Kinetic Multi-layer Model (ADCHAM) and further, compared to laboratory smog chamber experiments done at Aarhus university, Denmark. The results of this thesis may help to find a better representation of the DMS oxidation scheme that leads to aerosol formation. Further, it could help quantifying the influence DMS aerosols have on the global climate such that future climate models become more accurate. The more knowledge we gain about DMS will not only deepen our understanding of the atmosphere, but also lets us look up the sky, when we smell the sea.

Supervisor: **Pontus Roldin**
Thesis work for 15 ECTS – Spring 2020
Division of Nuclear Physics, Department of Physics, Lund University