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Air-sea exchange of volatile organic compounds - Experimental results from a wind wave canal facility

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Air – sea gas exchange is of critical importance to the chemistry and physics of the lower atmosphere; as a consequence there is a great need for understanding the mechanisms controlling the gas transfer between ocean and atmosphere. This study focuses on measuring the exchange transfer velocities for a number of key volatile organic compounds (VOCs), as a function of wind speed (e.g. DMS, acetone, benzene, isoprene). To access the gas exchange mechanisms we simulated the ocean - atmosphere interactions in the "Aeolotron" wind wave canal facility in Heidelberg. A range of low and high solubility VOCs were introduced to the 10 m diameter ring-form chamber containing circa 21500 m^3 water and the wind speed varied by the use of ceiling mounted turbines. Low solubility species such as DMS were introduced into the liquid phase and more soluble species such as acetone into the gas phase. The tracer concentrations during the exchange were measured in both the air and the water phase simultaneously using two individual Proton Transfer Reaction Mass Spectrometer (PTR-MS) systems. A third PTR system equipped with a Time of Flight (TOF) Mass Spectrometer has been used to support identification in the gas phase measurements. The water based PTR-MS system used a membrane (within an artificial lung) to establish an equilibrium between the water concentration and the gas stream to be measured. As expected, gas phase tracer concentrations in the "Aeolotron" reached equilibrium more rapidly with higher windspeeds. The calculated transfer velocities will be used to compare with current estimates where available, and the effect of new or altered transfer coefficients will be assessed with state-of-the-art global models. Furthermore, by integrating the PTR-MS measurements with results from other instruments (e.g. wave surface topography, FTIR-Spectroscopy) we aim to elucidate the fundamental physical mechanisms of air sea transfer. These results will lead to a better understanding of the individual VOC global budgets and thereby improve predictions of future atmospheric composition and responses to climate change.