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Atmospheric iron dissolution during a one-year time-series in the Mediterranean Sea

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Studying the fate of atmospheric iron in seawater is crucial to estimate its contribution to iron stock and biogeochemical cycle in the ocean. The parameters that control atmospheric iron dissolution are subject to strong debates. So far, different studies have demonstrated that the dissolution of atmospheric iron depends on physical and chemical properties of atmospheric particles, which are linked to their sources and transport. During a one-year time-series in the Western Mediterranean Sea, the dissolution of Saharan dust in surface seawater was measured monthly. These experiments showed that atmospheric iron dissolution in seawater depends on the biogeochemical conditions of the ocean surface impacted by atmospheric deposition. We show that the percentage of atmospheric iron that dissolves in seawater is linearly dependant on the concentration of iron binding ligands (measured by voltammetry). However, considering the whole pool of dissolved organic matter (assessed by Dissolved Organic Carbon measurements) resulted in an equivalent relationship. A high resolution kinetic study that lasted five days showed that dissolution is characterised by two processes. A fast dissolution process (scale of a few minutes to few hours) was followed by a significantly slower dissolution process. During the "slow" process, atmospheric iron dissolution rates were found to be linearly dependent on iron binding ligands and dissolved organic carbon concentrations ($r^2 > 0.65$, $p < 0.01$, n=9). The dissolution kinetic can be modelled by a first order process relative to iron binding sites. The first step towards a parameterisation of atmospheric iron dissolution taking into account the role of dissolved organic matter is proposed. This work illustrates the importance of considering seawater characteristics, in addition to atmospheric particles characteristics, to estimate the fate of atmospheric iron in seawater.