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How important are air-sea nitrogen exchanges?.

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We have recently reported an assessment of the magnitude and impact of atmospheric nitrogen (excluding N2 gas) deposition on the oceans (Jickells et al. Global Biogeochemical Cycles in press). The nitrogen budgets we present show a substantial component of the gross nitrogen deposition to the oceans being contributed from recycled marine emissions of organic nitrogen and ammonia. This recycling means that the net deposition of nitrogen to the oceans is 25% less than gross deposition, with 40% of gross deposition of ammonia/ammonium and organic nitrogen from recycled marine sources (Kanakidou et al., Global Biogeochemical Cycles, 2012). There is no doubt that these recycling fluxes occur. However, their relative importance, compared to atmospheric inputs from land based emissions, is uncertain. In the case of ammonia, the recycling mechanism is believed to be via direct emissions of ammonia from seawater. Thermodynamic calculations suggest that such ammonia emissions should occur predominantly at low latitudes. In the case of organic nitrogen, the emission mechanism is likely to be via organic nitrogen associated with sea-spray production, because volatile organic nitrogen concentrations in seawater are too low to sustain any significant flux. There is some indirect evidence both in support of, and in contradiction of, these large recycling fluxes for both organic nitrogen and ammonia. This reveals a major uncertainty in our understanding of the marine nitrogen cycle, one of the key biogeochemical cycles regulating the Earth system. In this contribution I will illustrate the scale of this uncertainty in the nitrogen cycle, consider the evidence in support of quantitatively large scale recycling, and consider methods by which these uncertainties can be reduced.