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Rainfall as a trigger for stratification and winter phytoplankton growth in temperate shelf seas

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We present new data from ocean gliders to investigate physical controls on stratification and phytoplankton dynamics, collected in the Celtic Sea between November 2014 and August 2015 as part of the UK Shelf Sea Biogeochemistry programme. This presentation focuses on the winter period (Jan-March) when the diurnal heating cycle results in regular but weak near surface stratification followed by night-time convection. Despite low light conditions, this daily cycle often promotes a daytime increase in observed chlorophyll fluorescence, indicative of phytoplankton growth. This daily cycle is occasionally interrupted when buoyancy inputs are sufficient to outcompete night-time convection and result in short-term periods of sustained winter stratification, typically lasting 2-3 days.

Sustained stratification often coincides with periods of heavy rainfall, suggesting freshwater input from precipitation may play a role on these events by producing a subtle yet significant freshening of the surface layer of the order of 0.005 PSU. Comparing rainfall estimates with observed salinity changes confirms rainfall to often be the initiator of these winter stratification periods. As winter winds subside and solar heating increases towards spring, the water column becomes more susceptible to periods of halo-stratification, such that heavy rainfall during the winter-spring transition is likely to promote sustained stratification. The timing and extent of a heavy rainfall event in March 2015 does suggest it may be the critical trigger for shelf-wide stratification that eventually instigates the spring bloom.

We propose that the timing of these downpours relative to the daily heating cycle can be a triggering mechanism for both short term and seasonal stratification in shelf seas, and so play a critical role in winter and early spring phytoplankton growth and the shelf sea carbon cycle. We further test the importance of this process using historical data, and results from the NEMO-AMM7 model to test how rainfall events have affected previous winter and spring conditions.