Variability of phytoplankton production rates in the Atlantic Ocean as observed using the fast repetition rate fluorometer
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This thesis examines some aspects of *in situ* phytoplankton physiology and subsequent production rates within the Atlantic Ocean, as observed using a novel instrument, the Fast Repetition Rate Fluorometer (FRRF). The underlying theory and use of this instrument is described in detail. High resolution FRRF data collection was performed during three oceanographic cruises: RV *Pelagia*, March 1998, RRV *James Clark Ross*, May-June 1998 and RRV *Challenger*, August 1999. These data observe characteristics of phytoplankton physiology and, therefore, production, over daily (diel), small (turbulent) and broad (seasonal) scales. The sampling sites for all cruises were chosen within a variety of hydrographic regimes to further assess the light-nutrient dependencies of this variability.

Phytoplankton physiology is described by the functional absorption cross section (σ_{PSII}) and the quantum yield of photochemistry (F_v/F_m) which relate to the rate at which photosystem II (PSII) saturates with light and the proportion of functional PSII reaction centres, respectively. Changes in both σ_{PSII} and F_v/F_m were most evident at the diel scale. σ_{PSII} correlates with corresponding changes in PSII pigments indicating non-photochemical quenching of excess solar energy as part of a diel rhythm in cellular constituents. A novel calculation for the number of *in situ* PSII reaction centres (n_{PSII}), based on FRRF measurements, is described and tested and shows similar diel variability. Smaller-scale variations in σ_{PSII} were also observed continually throughout the diel period apparently as an attempt to balance the distribution of energy between PSII and PSI and, therefore, maintain high rates of photosynthesis. Such smaller-scale processes were most obvious in low nutrient (oligotrophic) waters where hydrographic variability and consequently new nutrient input, remains relatively low. FRRF estimates of production were most related to nutrient conditions in these oligotrophic waters. Conversely, production correlated with light in waters where nutrients were in abundance. FRRF production estimates compared well with corresponding *in situ* gross O_2 measurements but were typically a factor of 3-4 higher than ^{14}C production estimates. This difference can be accounted as the stochiometry between O_2 evolution and carbon uptake for photosynthesis but may also represent the limitations associated with the calculation of production from one or both techniques. These limitations are discussed as a premise for further work.