Geochemical estimates of new production surpass the apparent rate of nutrient supply by vertical mixing by a factor of two or more in subtropical oceans, which constitute some of the largest biomes on earth. Two possible mechanisms to supply the "missing" nutrient locally include nitrogen fixation by cyanobacteria, and intermittent upwelling by mesoscale eddies and submesoscale processes.

Growing evidence suggests that such episodic processes can have a large impact on mean biogeochemical cycles, so they must be included in our conceptual models and resolved in our numerical models. The overall goal of the proposed research is to investigate the role of mesoscale dynamics and upper ocean processes on biogeochemical fluxes in the open ocean. The general approach is to use a three-dimensional coupled physical and biogeochemical model together with in situ observations and a full complement of remotely sensed information (altimetry, ocean color, scatterometry and AVHRR) to study the biological and chemical ramifications of spatially and temporally intermittent physical processes.

Herein we propose a combination of retrospective data analysis and numerical modeling. Our data analysis will focus on illuminating linkages between eddy-driven physical disturbances, changes in phytoplankton species composition, and carbon export from the euphotic zone. In particular, recent observations have shown that, although plankton blooms occur in both cyclones and mode-water eddies, the biological responses differ. Mode-water eddies can generate extraordinary diatom biomass and primary production at depth, relative to the time-series near Bermuda. These blooms are sustained by eddy-wind interactions, which amplify the eddy-induced upwelling. In contrast, eddy-wind interactions dampen eddy-induced upwelling in cyclones. Carbon export inferred from oxygen anomalies in eddy cores is 1-3 times annual new production for the region. In addition, new observations of the colonial diazotroph *Trichodesmium* have revealed distinct mesoscale variability in the distribution of this organism and unexpectedly high abundance at depth, which could have a significant impact on basin-scale nitrogen and carbon budgets. Up to now, basin-scale eddy resolving models have not included the eddy-wind interaction process described above. This effect can be implemented in a straightforward manner by including the surface ocean velocity in the computation of surface wind stress in our existing 0.1 degree resolution nutrient-transport model of the

North Atlantic (based on the Los Alamos POP model). Capturing the detailed biogeochemical responses to cyclones and mode-water eddies will require us to adopt more sophisticated biological models that explicitly represent functional groups of phytoplankton such as picoplankton and diatoms. These simulations will be used to diagnose the effects of mesoscale processes on water column biogeochemistry.

We propose to incorporate the 24-component biogeochemical/ecosystem model of Moore et al. (2004) into our eddy-resolving model of the North Atlantic. We will evaluate the mean state predicted by the model and compare it with both remotely sensed and in situ measurements. Diagnosis of mesoscale physical-biological-biogeochemical coupling will be undertaken, both through phenomenological assessment as well as detailed term-by-term analysis of simulated fluxes. Understanding gleaned from this study will help quantify a major uncertainty in the ocean carbon cycle, and provide the conceptual basis for parameterization of these effects in global climate models.