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Predictability of a virtual ecosystem in a drifting mesocosm

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We have previously shown that a Virtual Plankton Ecosystem (VPE) created under the Lagrangian Ensemble metamodel is globally stable when the circulation produces no flux divergence of any variable at any depth. That was proved at a site where the annual surface heat budget was zero.

Here we extend that investigation to show that the virtual ecosystem is still globally stable when it drifts barotropically with the ocean circulation, which gives inter-annual variation in the surface annual heat budget.

We chose a site near Bermuda that is characterised by strong annual surface cooling, strong advection and eddies. Our long-term goal is to simulate the Bermuda Atlantic Time-series Study (BATS.

The immediate aim is to demonstrate that the VPE in a drifting virtual mesocosm is stable; it can be used to predict the BATS data. The scenario has the virtual mesocosm drifting along a closed track that starts near Bermuda and returns to the starting location after two years.

The results of a 24-year integration comprising 12 legs of this circuit confirm that the VPE is stable. After an adjustment from unbalanced initial conditions, the GLI virtual ecosystem exhibits a Geographical Lagrangian Attractor (GLA) that is independent of the initial conditions.

So barotropic advection does not make the GLI virtual ecosystem become chaotic. The variation between legs of the 2-year circuit is small. It is caused by two factors: (1) turbulence in the mixed layer, and (2) small geographical variations in successive locations of the virtual mesocosm every two years.