How will ecosystems respond to changes in the global climate?

Ocean Productivity

*Meehl et al., 2007; sos.noaa.gov*
‘The Problem of Scale’

Ecosystems are the sum of individuals organisms and their interactions

Surface DMS (June)

Lana et al. 2011

http://www.fmap.ca/ramweb/media/phytoplankton_decline/images/
‘The Problem of Scale’

Computational constraints on large scale simulations

Conventional Modeling Approach:

- Small number of ‘functional groups’
- Model an average individual in an average environment
Spatial and Temporal Heterogeneity in Resource Availability

Johnson et al., 2010

Levy et al. 2012
Spatially Heterogeneous Dynamic Plankton Model (SHiP)

SHiP (0D box) model

- Heterogeneity in local environment matters!
- Episodic nutrient delivery
  - Spatial and temporal
  - Fractional area ‘disturbed’
  - Track time since last disturbance

Levine *in prep*
Spatially Heterogeneous Dynamic Plankton Model (SHiP)

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Levine *in prep*
Spatially Heterogeneous Dynamic Plankton Model (SHiP)

SHiP (0D box) model

Based on Moore et al. 2002 and Doney et al. 2009
Spatially Heterogeneous Dynamic Plankton Model

Levine *in prep*
Spatially Heterogeneous Dynamic Plankton Model

Levine in prep

- Nitrate concentration
- Export Carbon
- Disturbance time period

Parameters:
- NO$_3$
- Phyto$_{large}$
- Phyto$_{small}$
- Export
- Zoo
Spatially Heterogeneous Dynamic Plankton Model

Figure 2: Impact of disturbance rate (i.e. probability of submesoscale frontal formation) on community composition. Three scenarios are shown, homogeneous gridcell with mean nutrient delivery (black), homogeneous with episodic nutrient delivery (blue), and SHiP model (red).