Inferring the Chlorophyll-A vertical distribution in the ocean from satellite data by using Hidden Markov Models and Self Organizing Maps.

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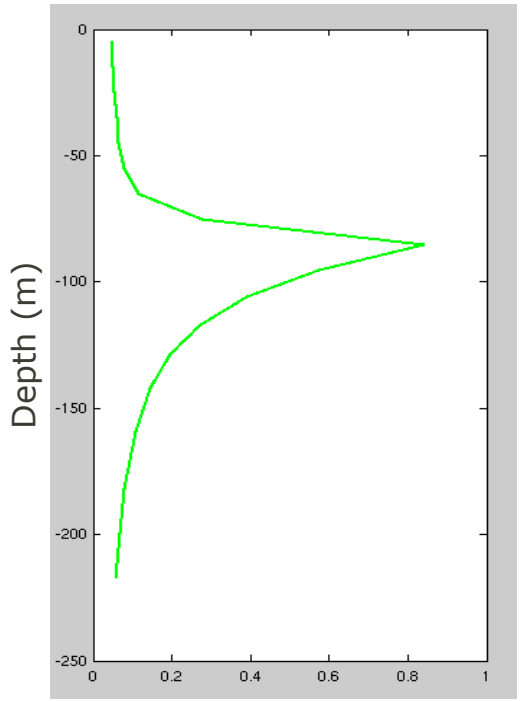
- Introduction
- Methods
  1. Hidden Markov Models
  2. Self Organising Maps
- Data sets
- Application/Results
- Conclusion

Introduction

- The sea-surface concentration of Chlorophyll-A determinable from satellite images.
- Links between sea-surface data, and the vertical distribution of Chlorophyll-A



Is it therefore possible to determine the vertical distribution of Chlorophyll-A from sea-surface data?

Introduction

- Phytoplankton development depends on:
  - Quantity of Nutrients
  - Quantity of availiable radiation
  - Water Temperature
  - Predators and biology
- These are linked to:
  - Sea Surface Temperature
  - Sea Surface Chlorophyll-A distribution
  - Sea Surface Elevation
  - Wind Speed
  - Shortwave Radiation

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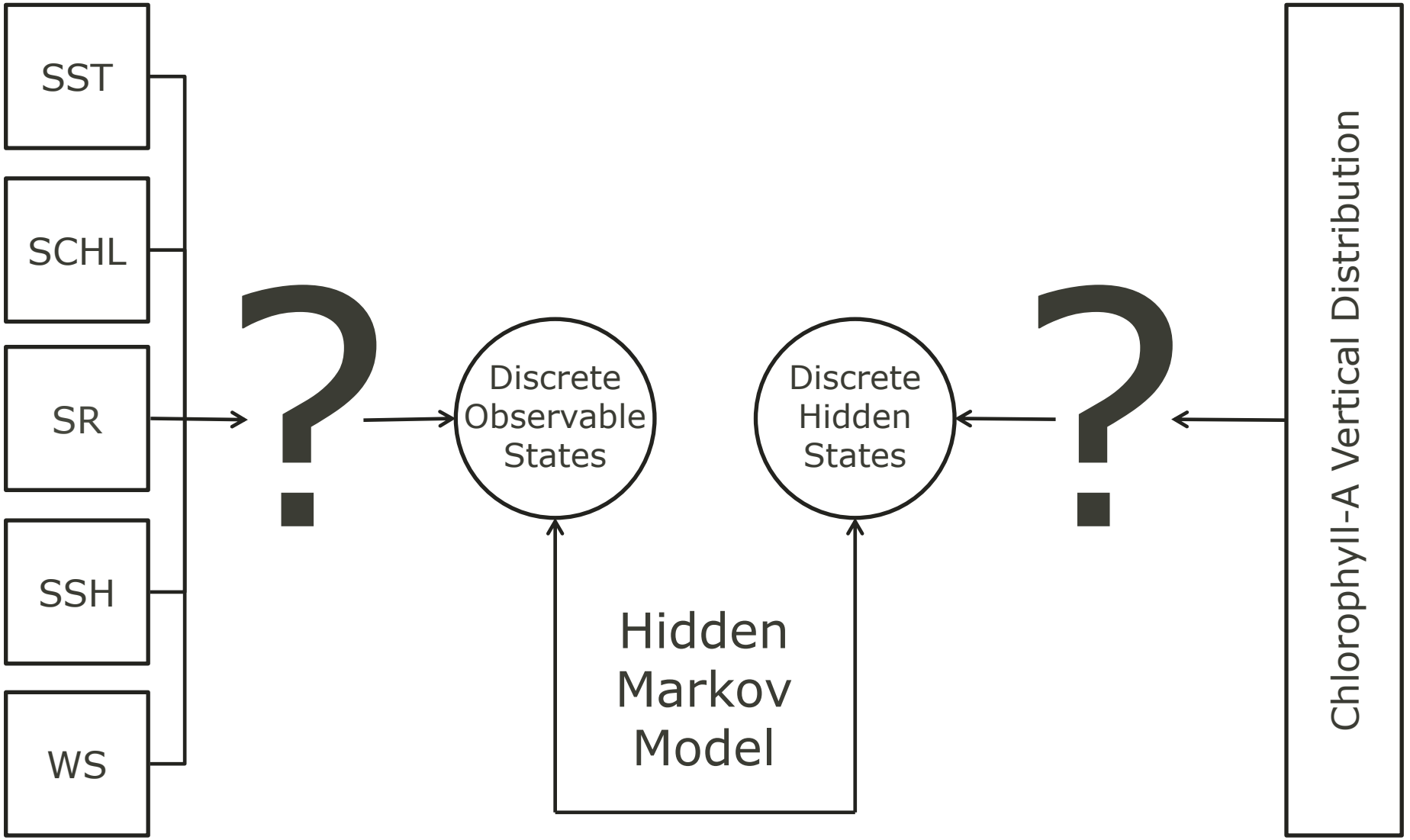
Hidden Markov Models

Hidden Markov Models are stochastic models that infer the *most likely* sequence of *discrete unobservable states*, given a concurrent sequence of observations correlated to these unobservable states through a training-determined set of probabilities.

Hidden Markov Models



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Self Organising Maps

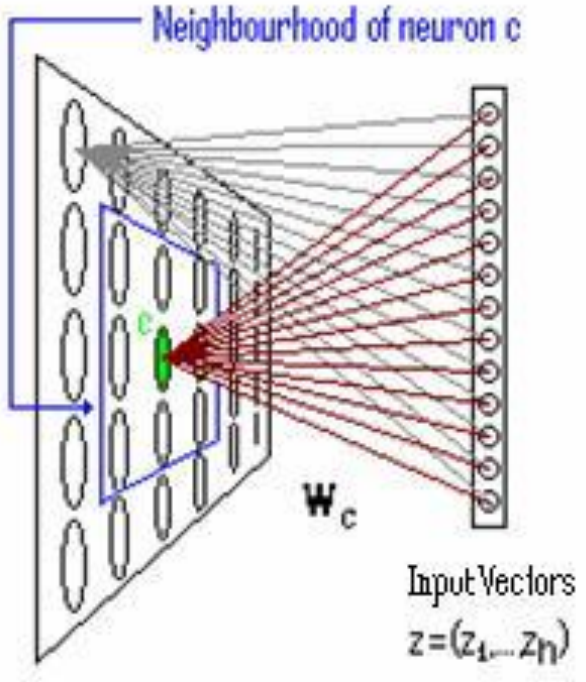
Statistical Neuronal Approach

Input:

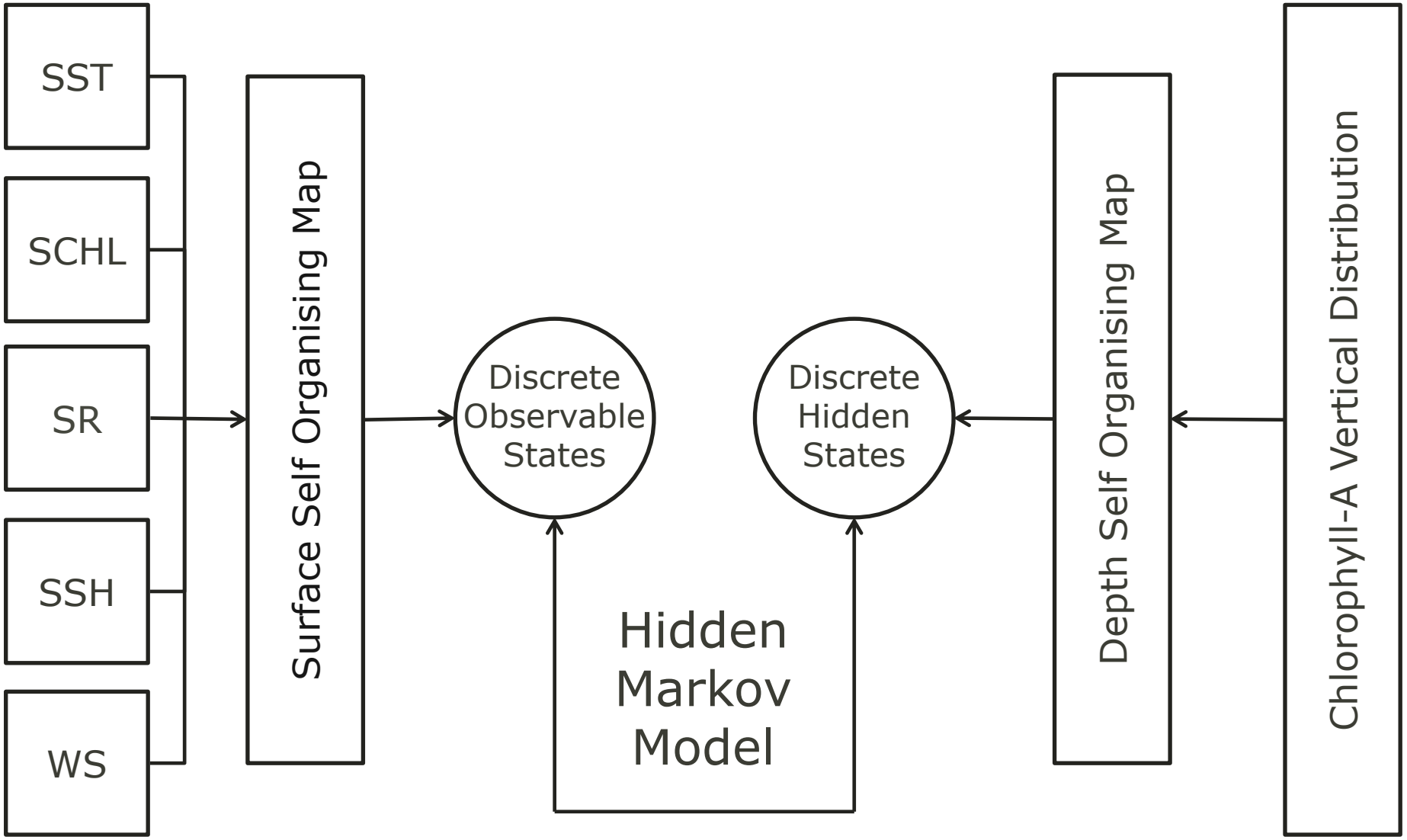
Multidimensional Data

Output:

A clusterization of the data through projection on a topologically organised 2D map, in a way that respects the underlying variability of the higher dimension.



Combination



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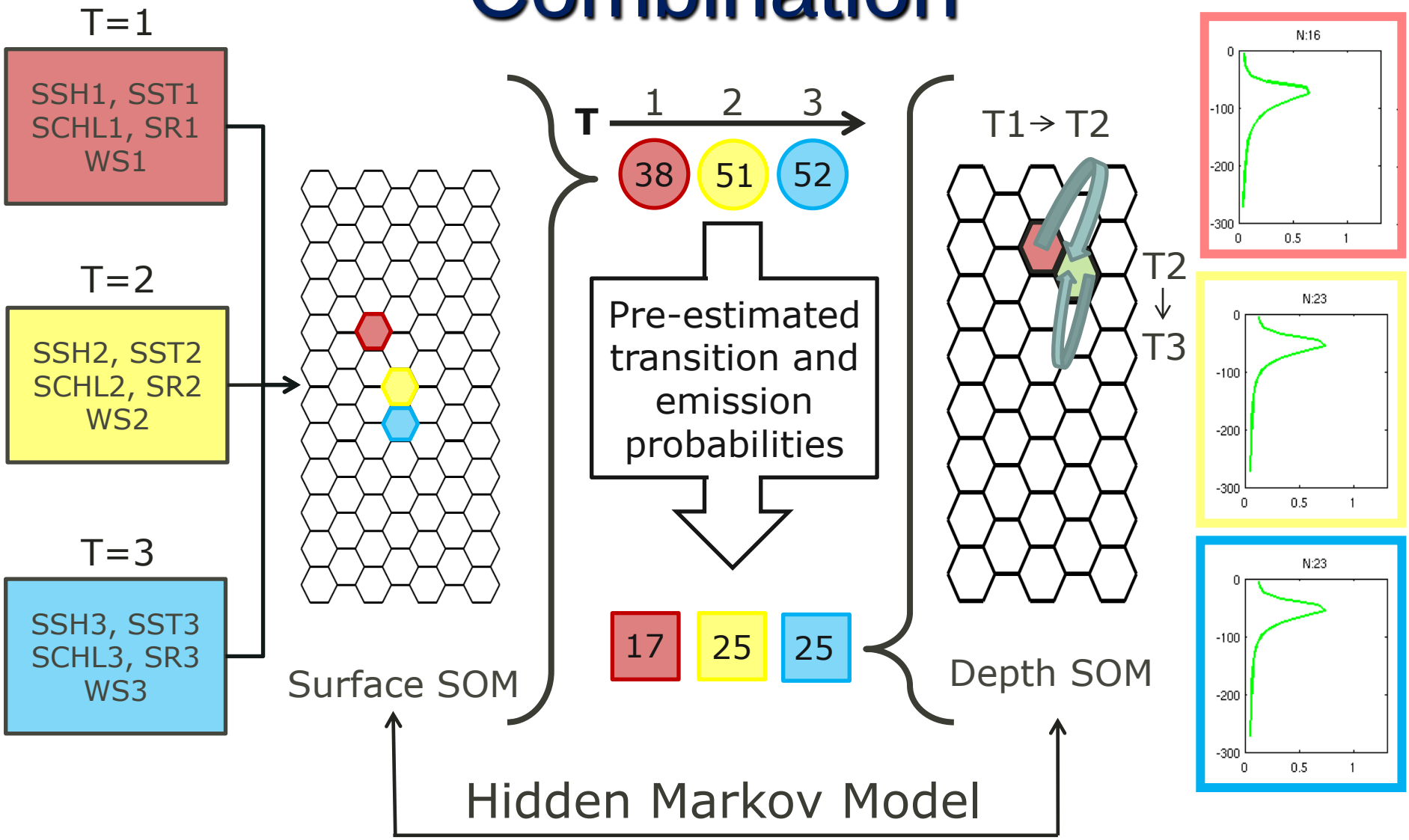

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Data Sets

- Climatological Outputs of the Biogeochemical Model Nemo – Pisces

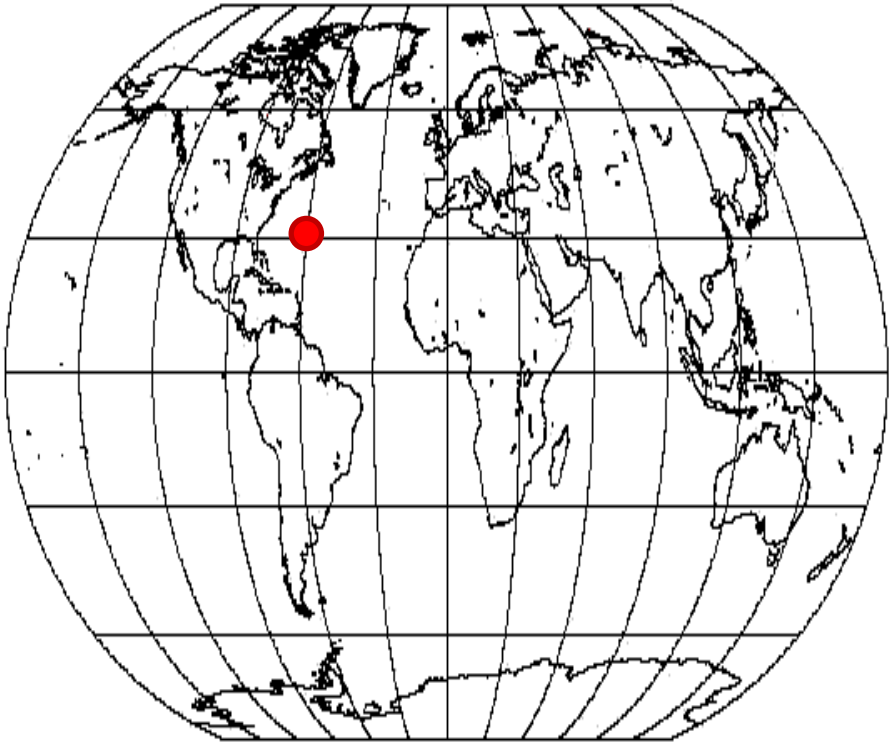
1. Vertical Profiles of Chlorophyll-A distribution
2. Vertical Profiles of Temperature
3. Sea Surface Elevation

- Model Forcing data sets:

1. Shortwave Radiation
2. Wind Intensity

- 1992-2008 period, 5-day means time steps

Data Sets



Study Zone:
BATS (32° N - 64° W)

- 1241 time steps.
- SOM training included vertical distributions of the neighbouring zones of BATS. Total of 13651 vectors.
- Satellite Set:

SST, CHL-A
MODIS 2002-2008

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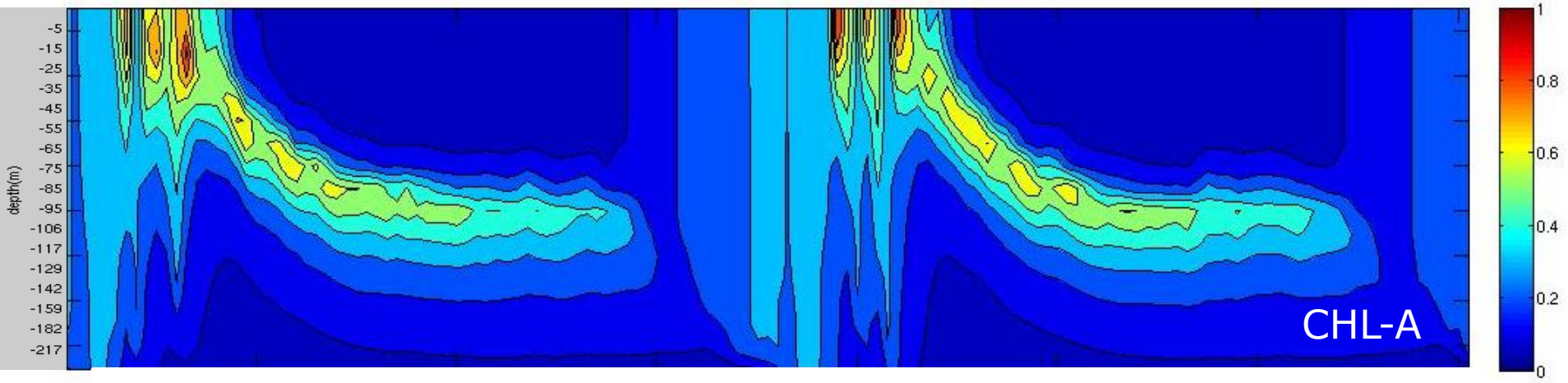
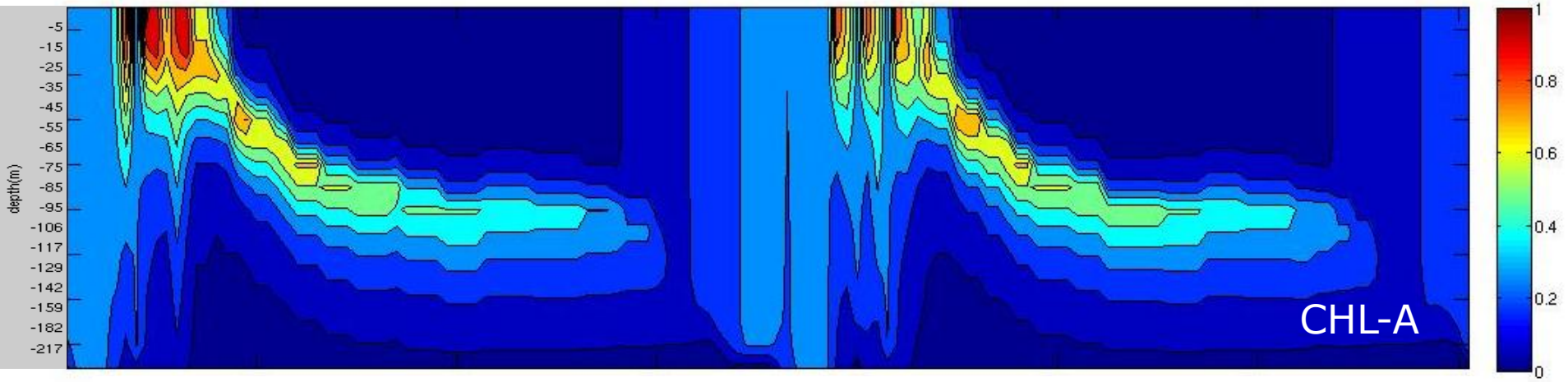
Application/Results

Model outputs at BATS (2002-2003, 5 day steps)



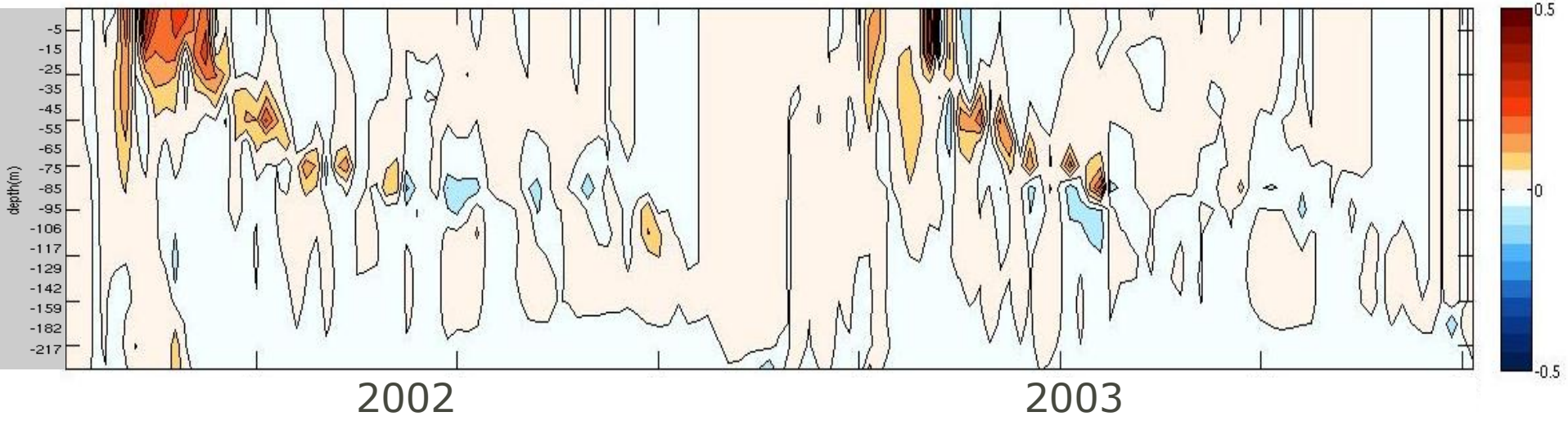
2002 2003

Reconstruction based on the Model's sea surface data

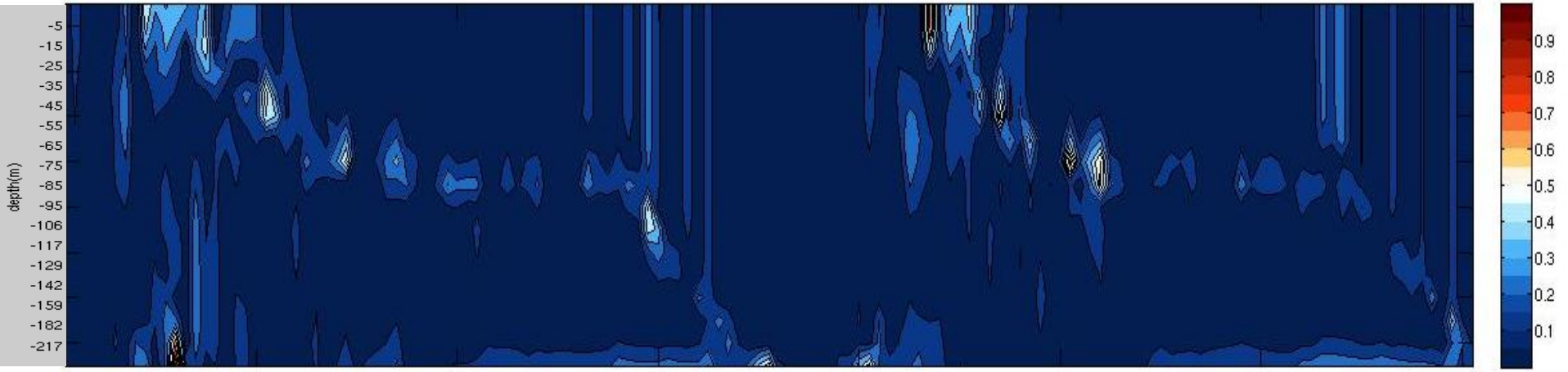


Application/Results

Model minus Reconstruction at BATS (2002-2003, 5 day steps)

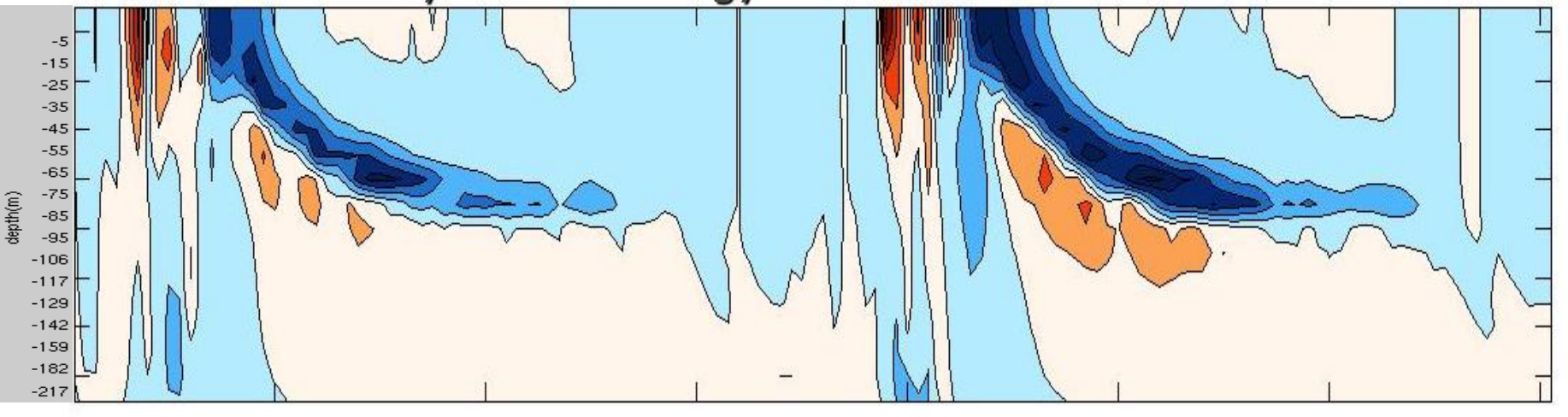


Absolute relative error.



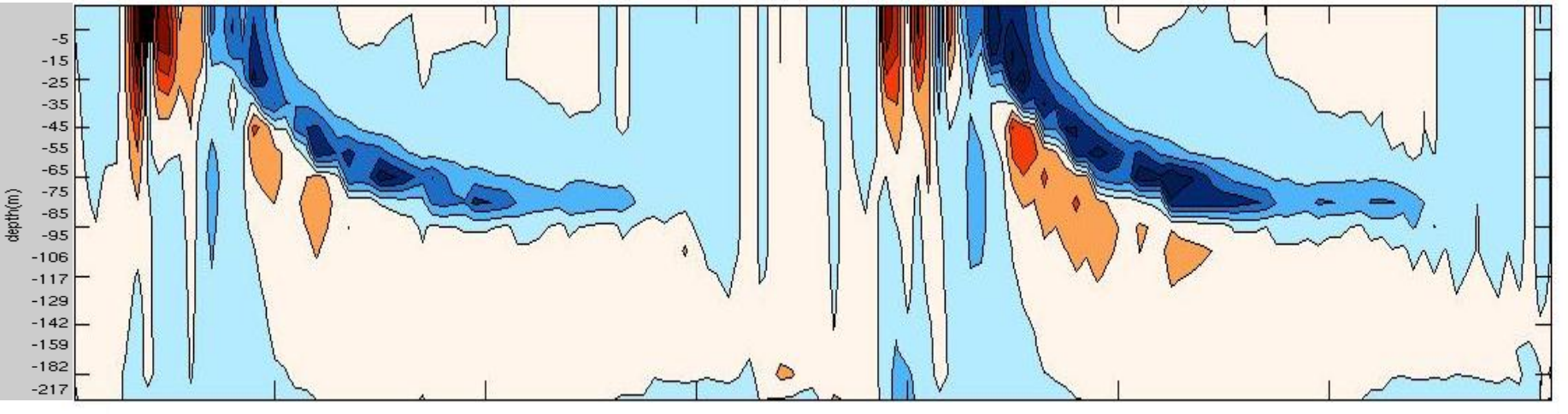
Application/Results

Model minus 20 year climatology



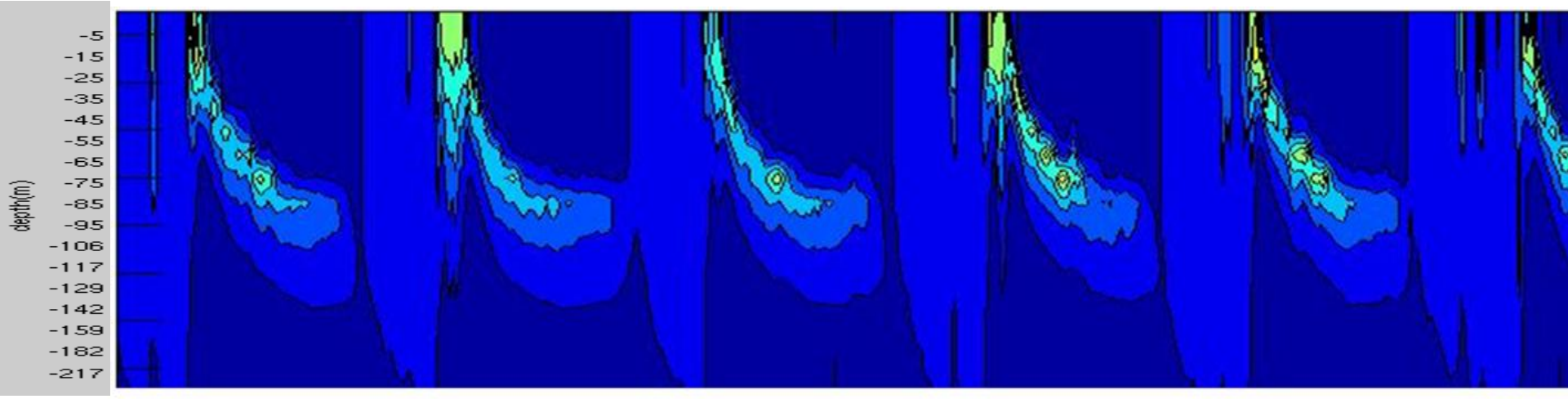
2002 2003

Reconstruction minus 20 year climatology

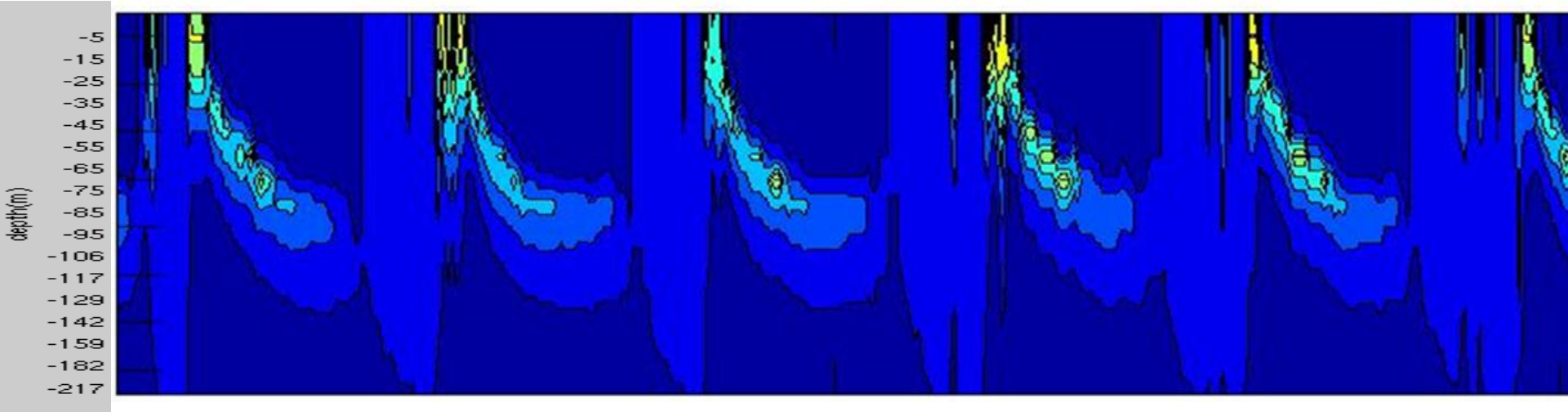


Application/Results

Model 17 years



Reconstruction based on sea surface data: 17 years climatology



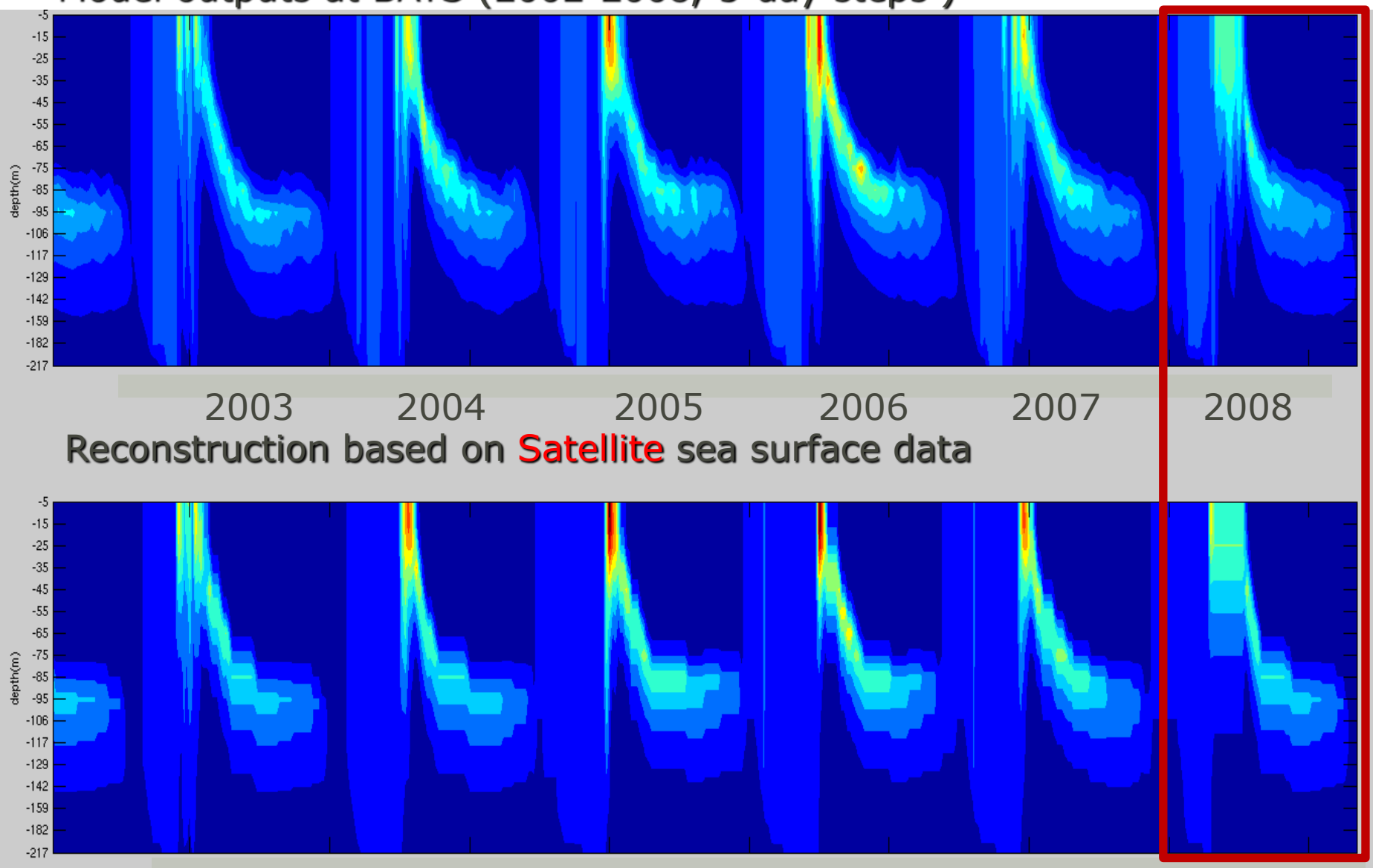
Application/Results

- The previous results used the model's sea-surface data to reconstruct the vertical distribution of Chlorophyll-A, and its probabilities were calculated with 14 years of data.

- The following result is the reconstruction based on satellite sea-surface data, and whose probabilities were calculated with only 5 years of data.

Application/Results

Model outputs at BATS (2002-2008, 5-day steps)



Reconstruction based on Satellite sea surface data

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Conclusion

- The method is able to reconstruct the general form and intensity of Chlorophyll-A.
- It is applicable on other oceanic parameters.
  (Vertical distribution of temperature)
- The method will now be modified in order to perform 3D reconstructions.

Thank you for you attention.

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