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 available 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 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

Chlorophyll-A Vertical Distribution

SST
SCHL
SR
SSH
WS

Discrete Observable States
Discrete Hidden States
Hidden Markov Model
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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

Surface Self Organising Map

Discrete Observable States

Hidden Markov Model

Discrete Hidden States

Depth Self Organising Map

Chlorophyll-A Vertical Distribution

SST

SCHL

SR

SSH

WS
Combination

Taking into account the probabilities of being in a state of the Depth SOM knowing the previous state on the Depth SOM and the state of the Surface SOM.

Pre-estimated transition and emission probabilities

Hidden Markov Model
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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

- 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)

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
Introduction

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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 your attention.

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