SAHFOS
Sir Alister Hardy Foundation
for Ocean Science

CEES
Centre for Ecological and
Evolutionary Synthesis

The use of GAM in plankton modelling

[Generalized Additive Models]

Marcos Llope

Hiroshima
2007

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Temporal

Bay of Biscay

Spatio-Temp.

North Sea

approach

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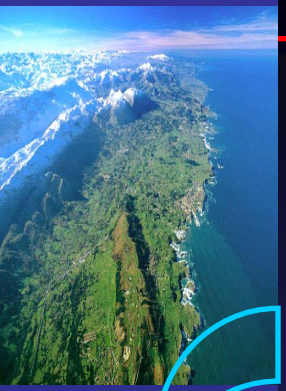


Smooth functions

$$Y_i = b + \sum_j (a_j X_{ji}) + \varepsilon_i$$ Linear Models

$$Y_i = b + \sum_j (g_j X_{ji}) + \varepsilon_i$$ GAMs

Additive

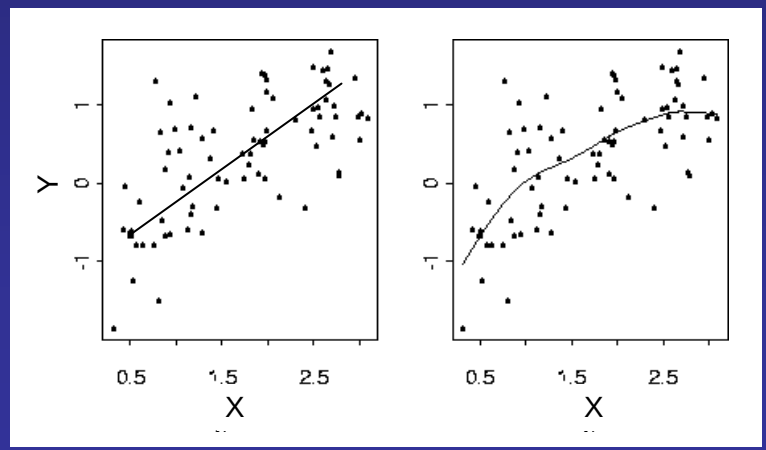
Non parametric

GAMs

a_j Regression coefficients [slopes]

g_j Smooth functions [*spline*]

linear function *spline*



MODEL SELECTION

GAMs

1 Backwards Model Selection

$$Y_i = b + g_1(X_{1i}) + g_2(X_{2i}) + g_3(X_{3i}) + \ldots + \varepsilon_i$$

dropping one term at a time, starting by the least significant.

2 Minimizing the **GCV** (general cross validation) ~ **AIC**

trade off between fit and complexity.

INFERENCE

- ✓ Which variables enter the final model
- ✓ What the functional relation looks like

GAMs

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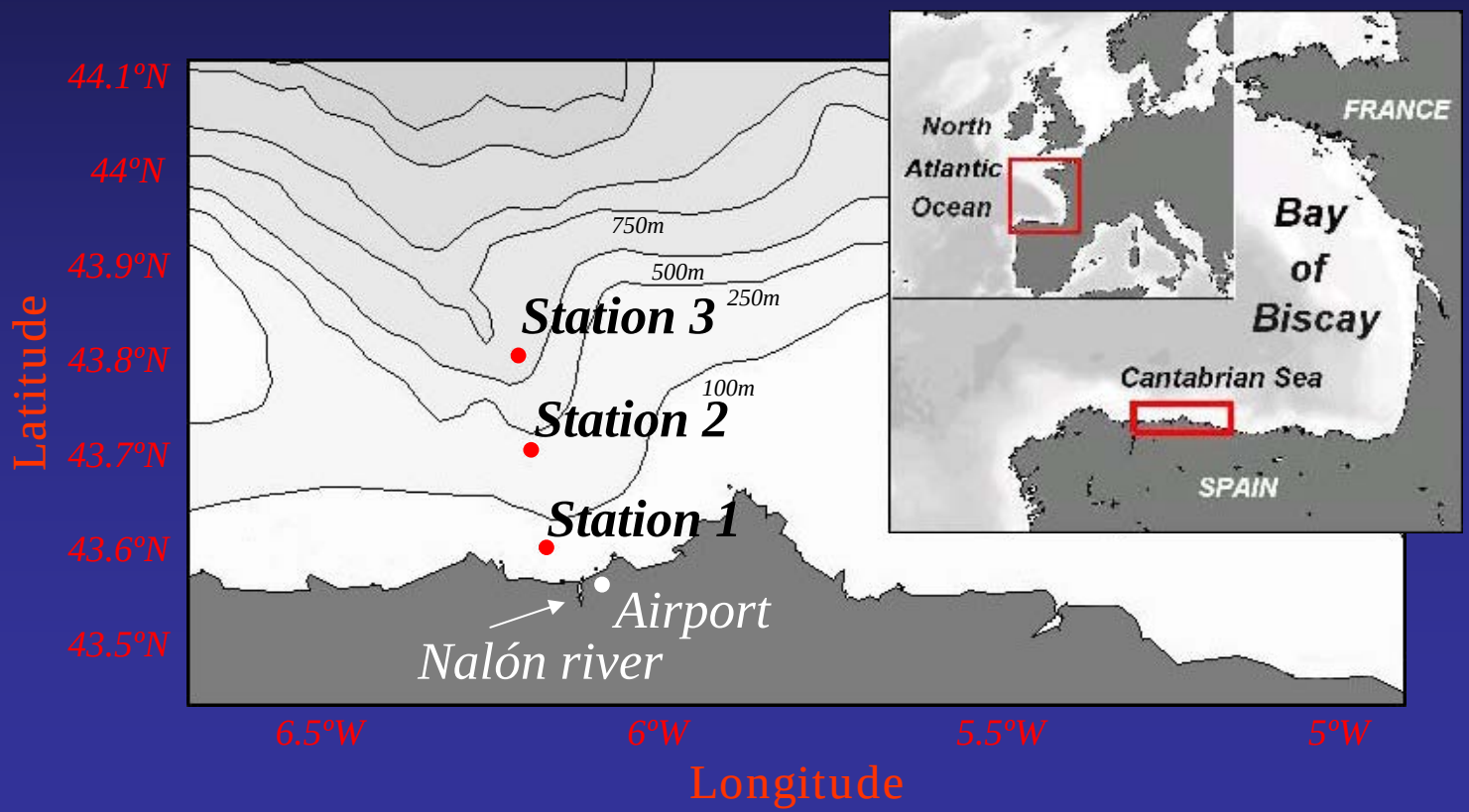
Universidad de Oviedo

TIME SERIES

Monthly sampling
11 years (1993-2003)
Cross-shelf gradient



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TIME SERIES

Monthly sampling
11 years (1993-2003)
Cross-shelf gradient

Logistic model

Trophic Levels

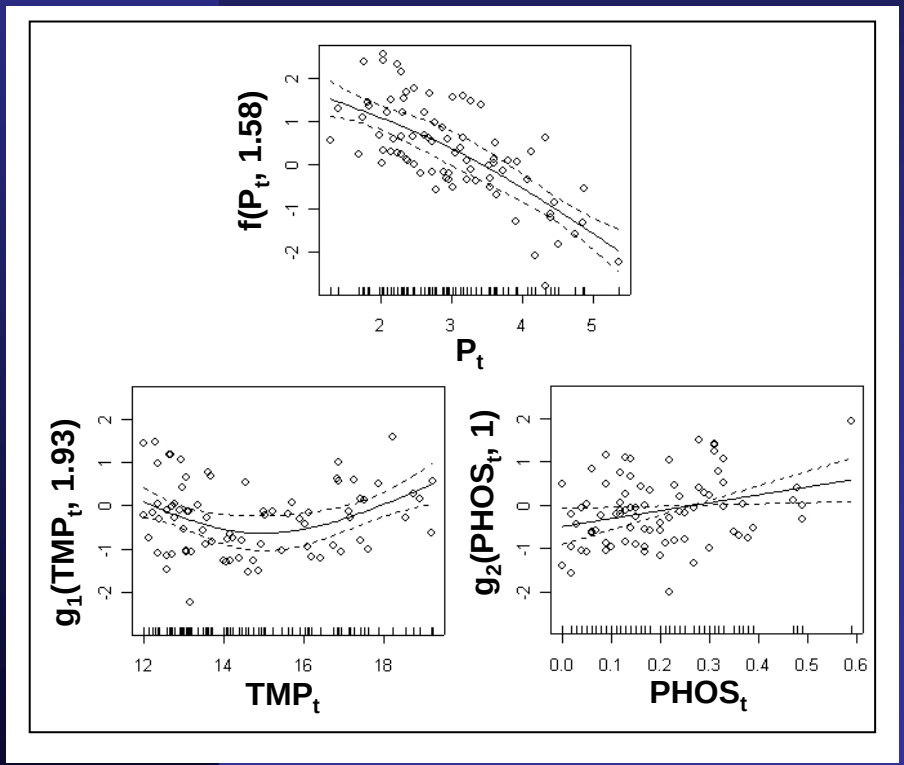
- Phytoplankton
  - Chlorophyll *a*
- Mesozooplankton
  - Zooplankton dry-weight

Environmental variables

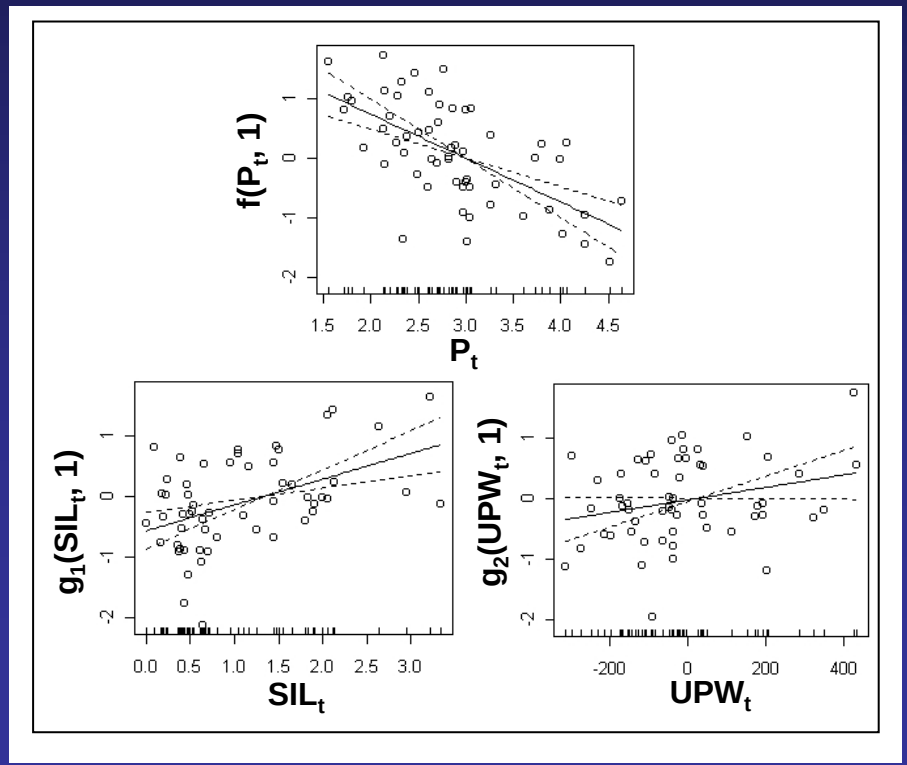
- Temperature
- Photoperiod
- Upwelling index
- Nutrients
  - Nitrate
  - Phosphate
  - Silicate

PHYTOPLANKTON

Coastal Station



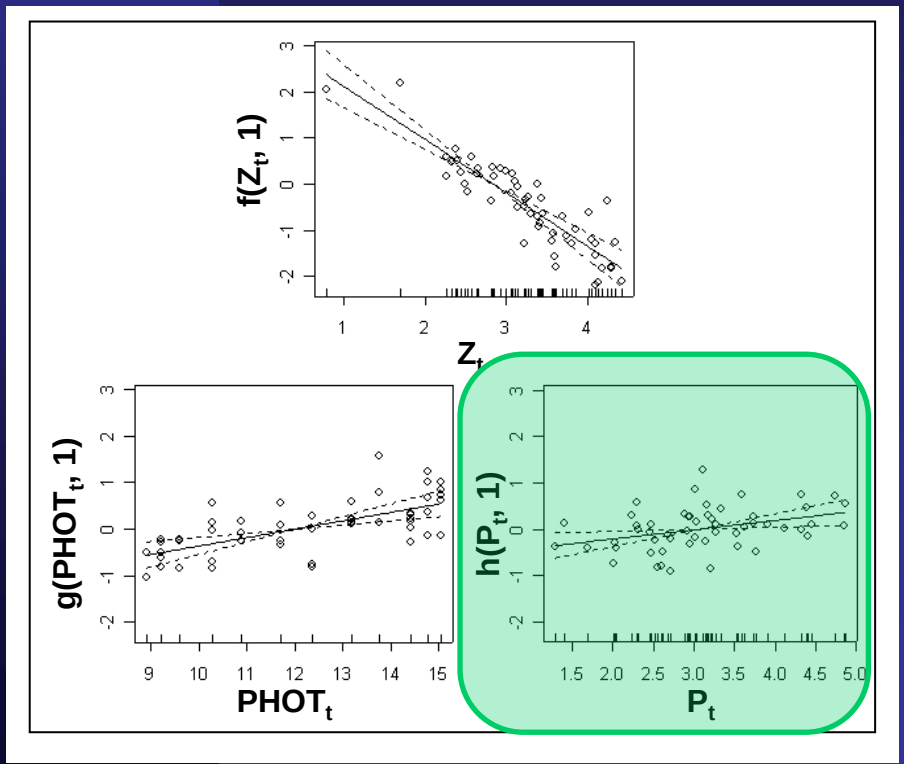
Oceanic Station



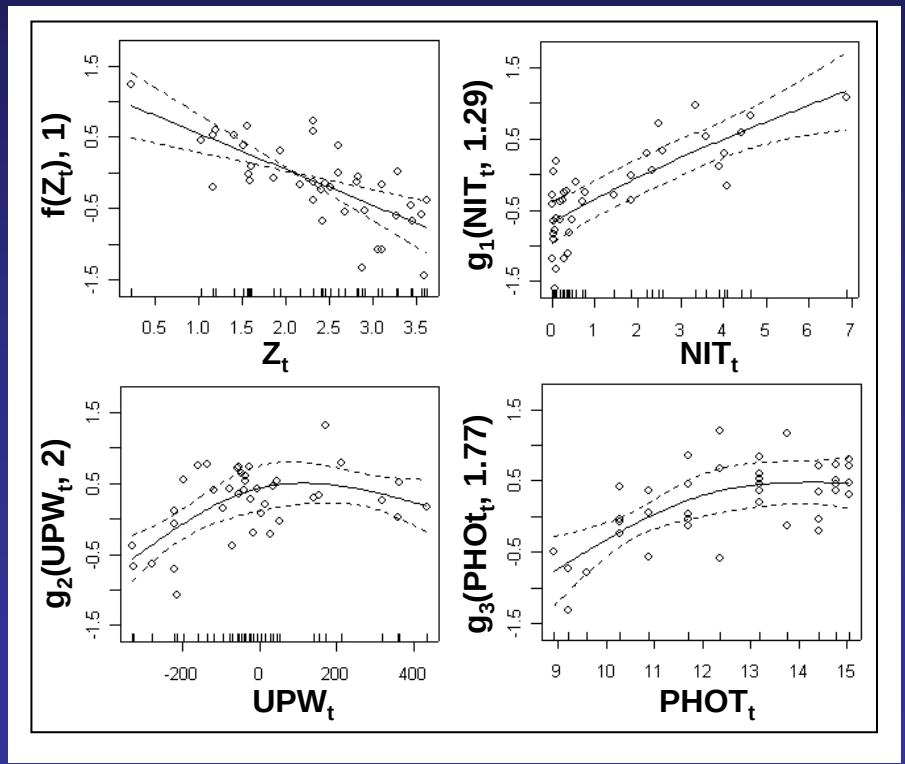
Stenseth, Llope & *al.* (2006) PRSB

ZOOPLANKTON

Coastal Station

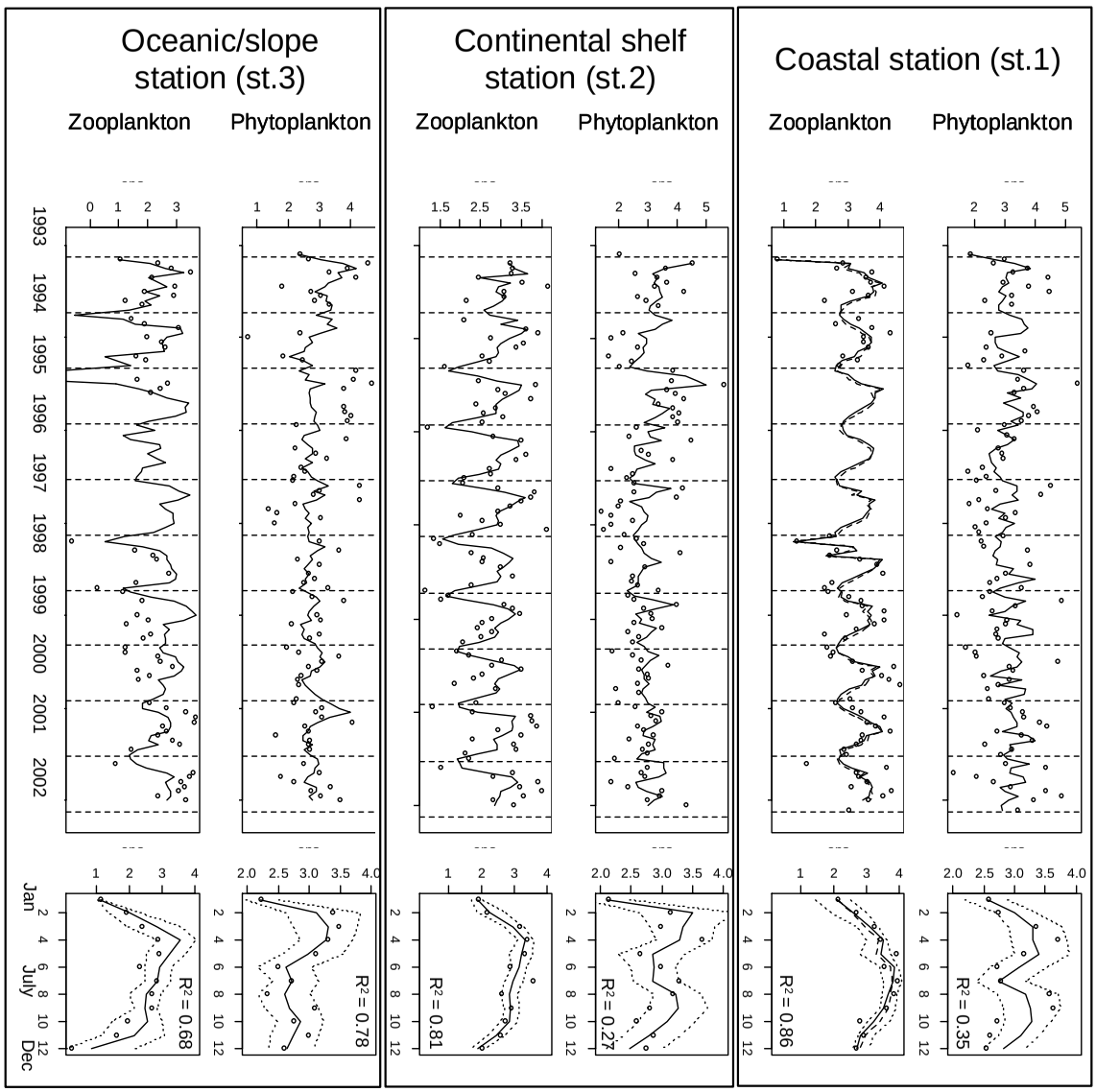


Oceanic Station



Stenseth, Llope & *al.* (2006) PRSB

SIMULATION

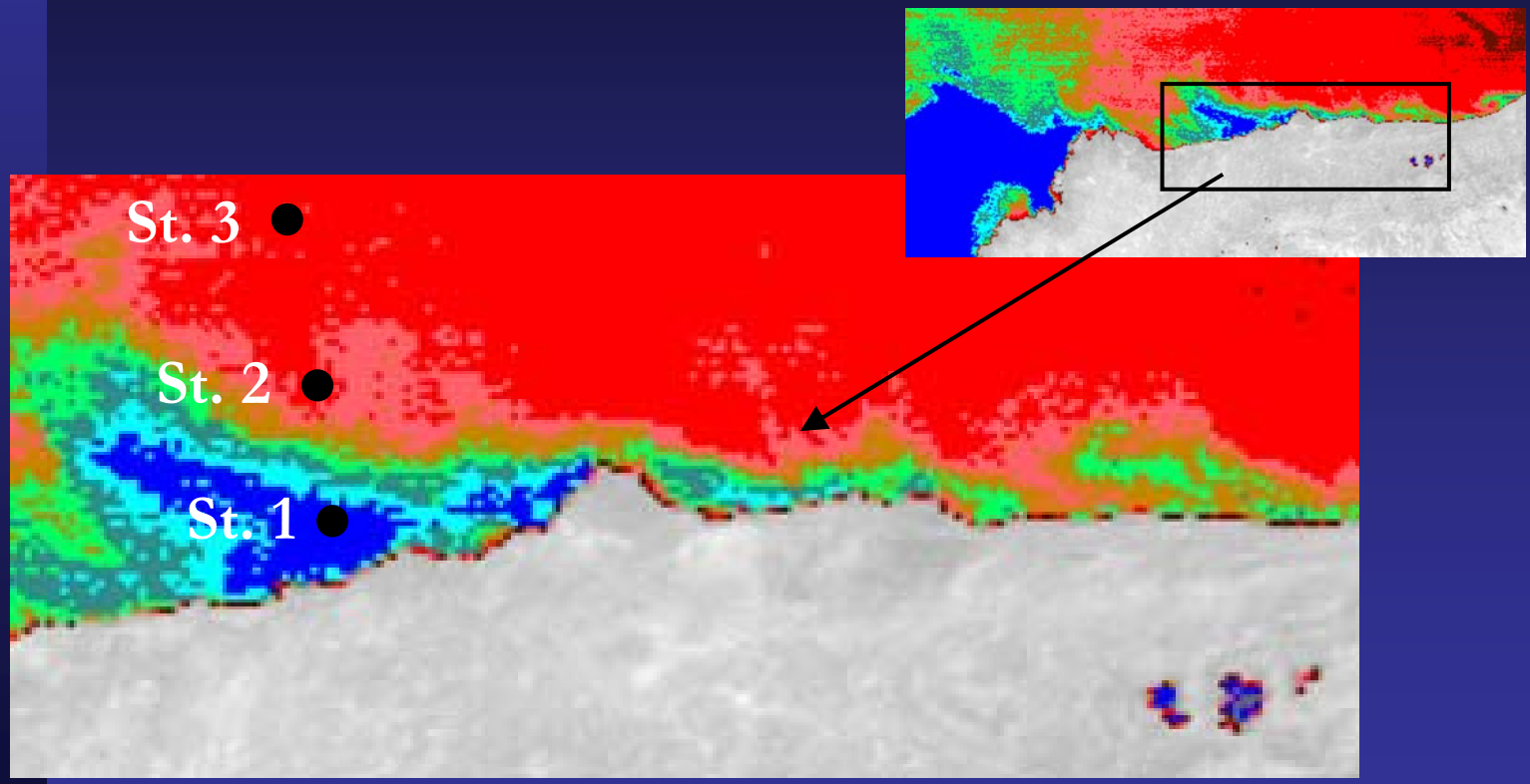

Coastal station (st.1)
Zooplankton
Phytoplankton
R² = 0.86
R² = 0.35
Continental shelf station (st.2)
Zooplankton
Phytoplankton
R² = 0.81
R² = 0.27
Oceanic/slope station (st.3)
Zooplankton
Phytoplankton
R² = 0.68
R² = 0.78
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Jan
July
Dec

INFERENCE

apart from the predicting ability....
....Can we infer any ecological information?

1 Upwelling effect → Role of Advection

UPWELLING



Surface TEMPERATURE

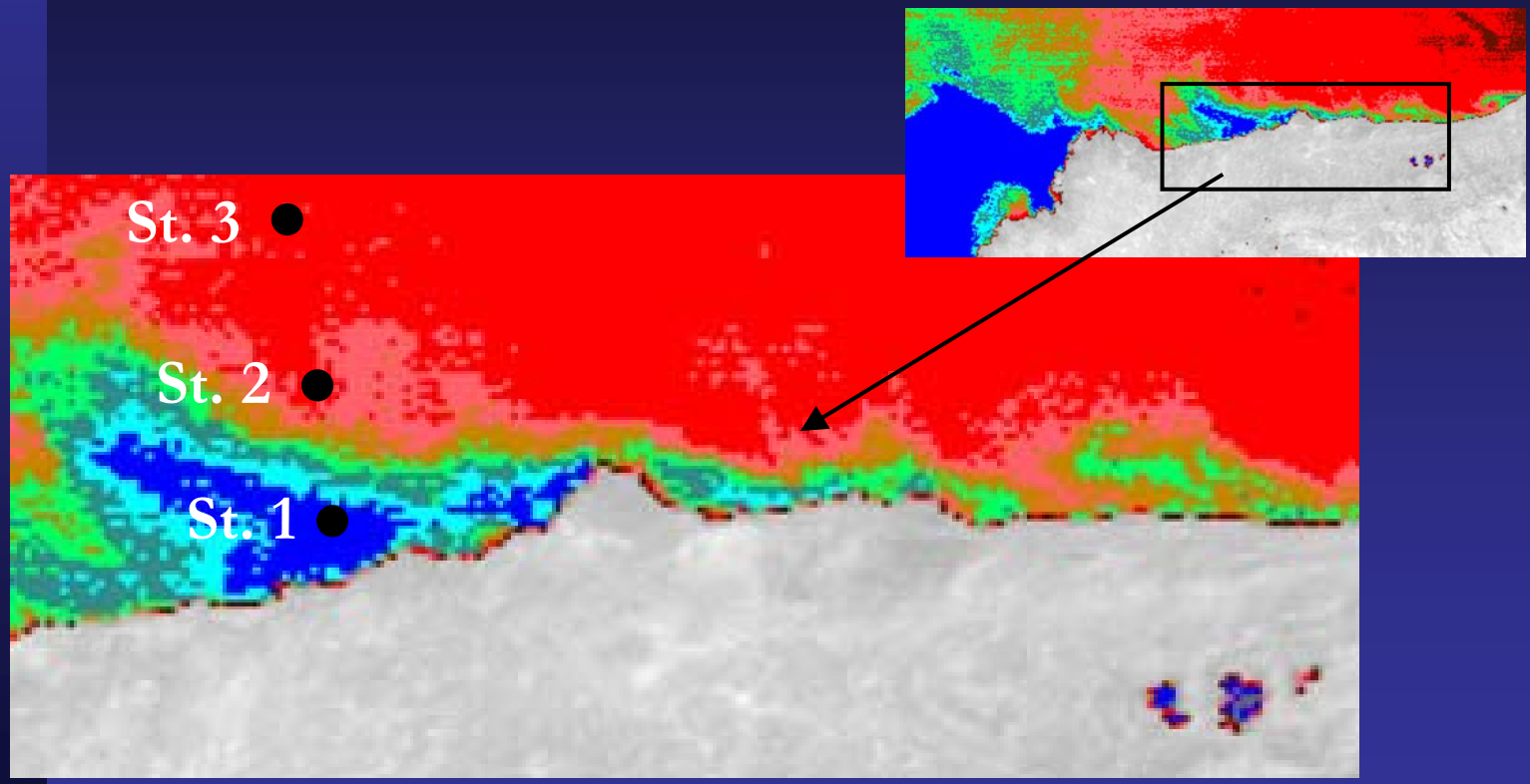
INFERENCE

apart from the predicting ability....
....Can we infer any ecological information?

1 Upwelling effect → Role of Advection

2 Food web structure → Grazing vs. Microbial

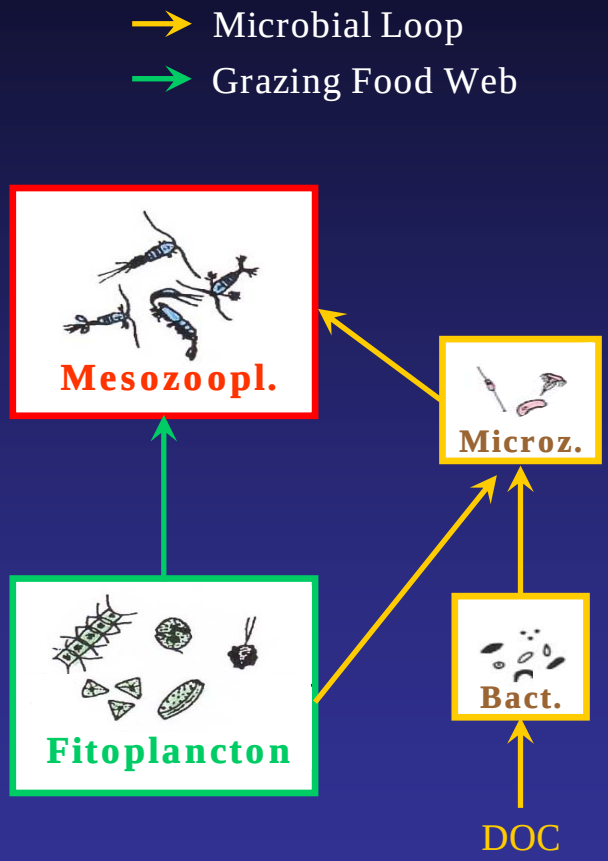
UPWELLING



Surface TEMPERATURE

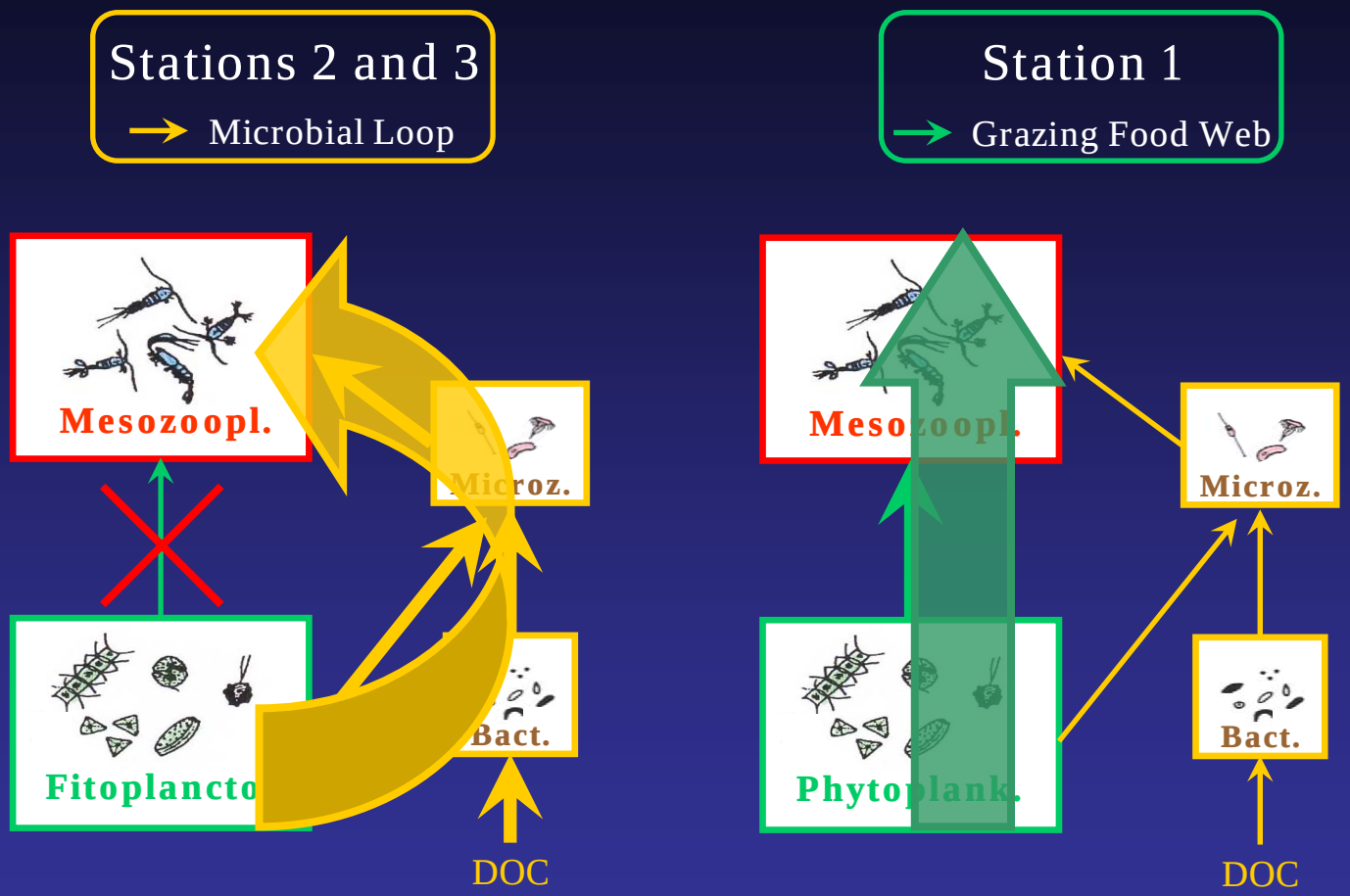
plankton food webs

grazing/classical vs. microbial loop



plankton food webs

grazing/classical vs. microbial loop



INFERENCE

apart from the predicting ability....
....Can we infer any ecological information?

1 Upwelling effect → Role of Advection

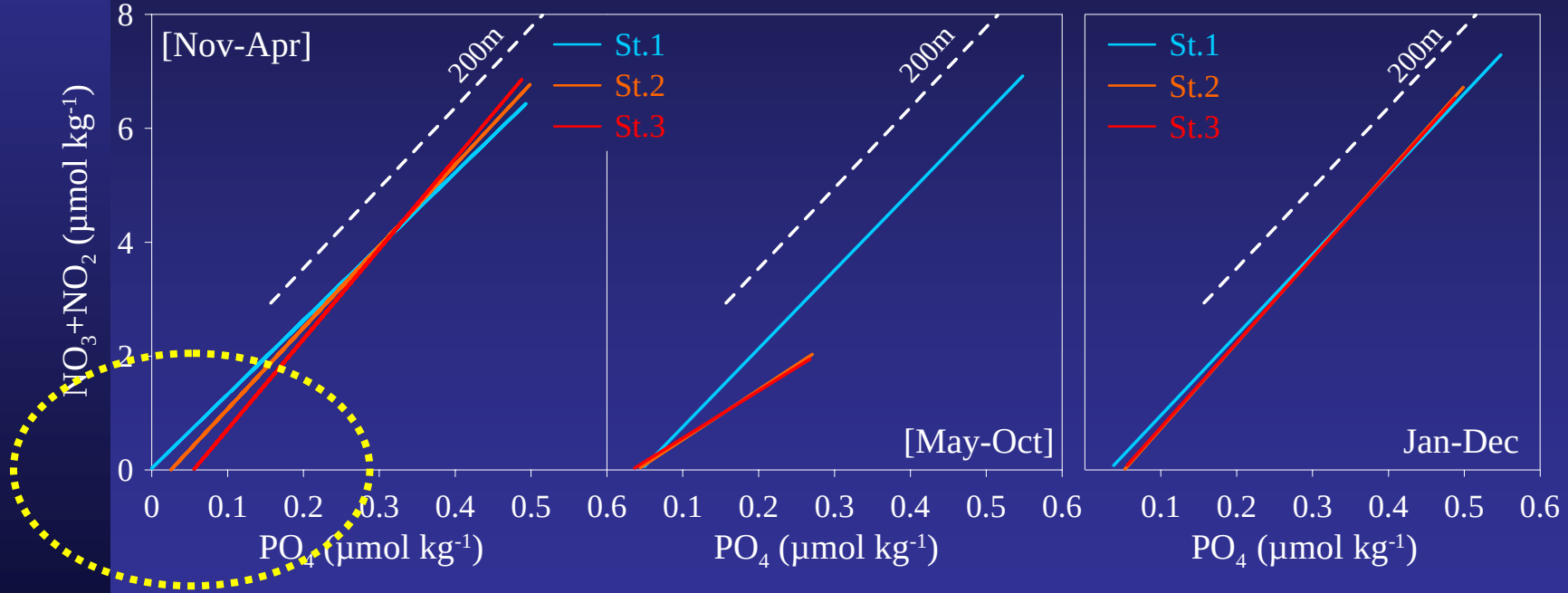
2 Food web structure → Grazing vs. Microbial

3 Nutrient Limitation → Phosphate vs. Nitrate/Silicate

N:P RATIO

Intercepts

St.1 [**0, 0.03**] µmol Kg-1
St.2 [**0.02, 0**] µmol Kg-1
St.3 [**0.06, 0**] µmol Kg-1



Llope & *al.* (2007) JGR

CONCLUSION

- ✓ These models are able to reasonably reproduce the spatio-temporal plankton dynamics.
- ✓ They can gives us some clues about how the environment structures the plankton.
- ✓ The can be used to predict how the system would change if the environment changes.

GAM

THANKS FOR YOUR ATTENTION!

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