PARAMETER ESTIMATION IN ECOSYSTEM MODELLING

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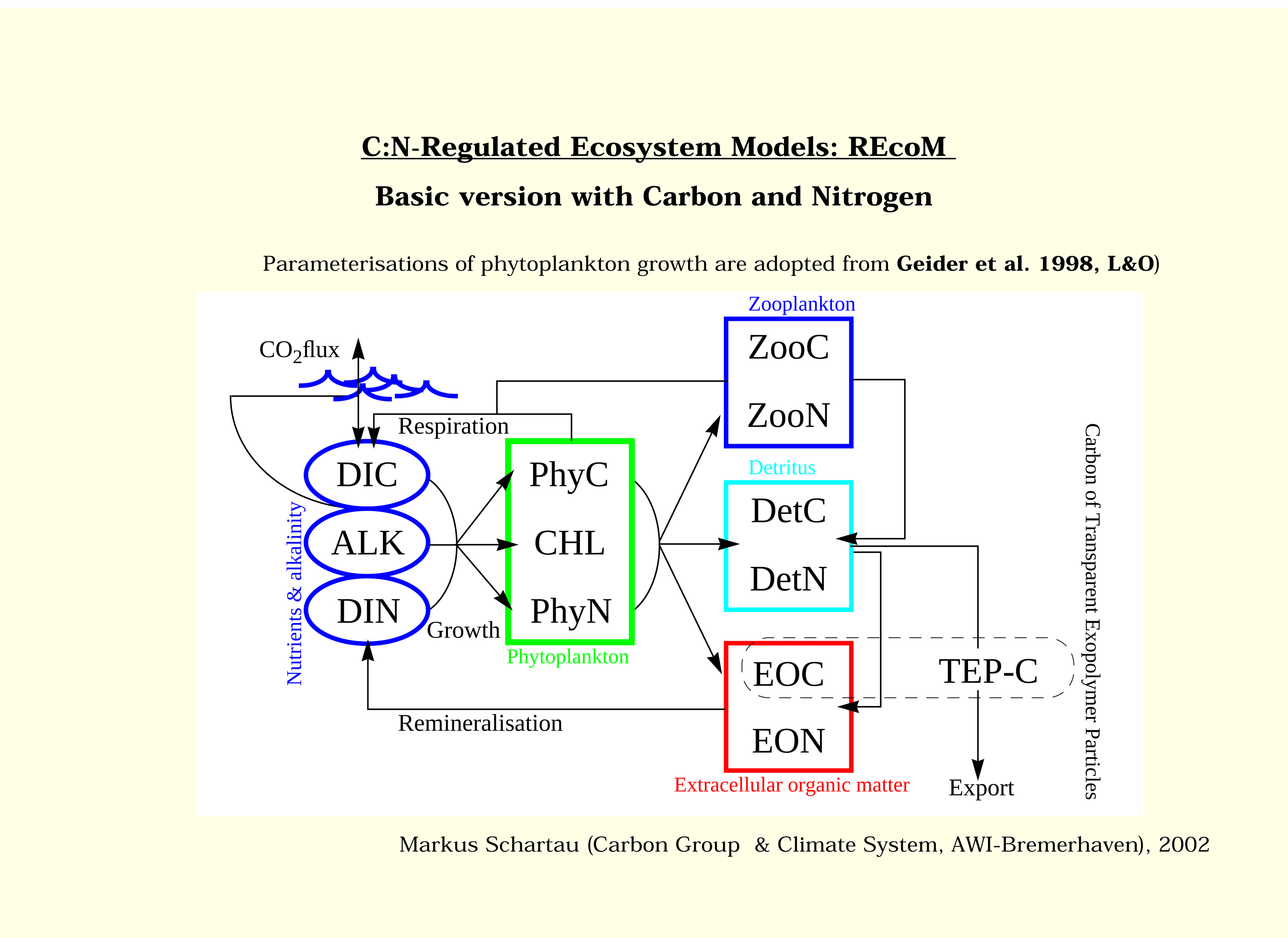
Abstract

C:N Regulated Ecosystem Model (REcoM), developed within the TOPAZ project and describing the carbon and nitrogen fluxes between components of the ocean ecosystem, is validated for two different locations in the North Atlantic . The subject of the study is to investigate whether the model is applicable for the MERSEA operational use on a basin scale. Time series data are used for the validation and tuning the biogeochemical model. Sequential Important Resampling filter (SIRF), an ensemble based data assimilation technique, is implemented to optimize poorly-known model parameters.

1 Ecosystem Model



The ecosystem model describes the cycle of nitrogen and carbon (including the production of extracellular carbon) and possesses an individual equation for phytoplankton chlorophyll dynamics.

The C:N REcoMs chematic diagram shows the compartments and inter-compartmental flows of the upper mixed layer ecosystem.

2 Parameter estimation experiment

The model is constrained by monthly mean data of

- the Bermuda Atlantic Time-series Study (BATS $32^0 N$, $65^0 W$), averaged over the period December 1988 to January 1998,
- the North Atlantic Bloom Experimen (NABE, $47^0 N$, $20^0 W$),

particularly, by measurements of dissolved inorganic nitrogen and chlorophyll concentrations.

A version of the Sequential Importance Resampling filter (Rubin, 1988) is implemented for estimating annual means of poorly-known biological model parametrs.

For both BATS and NABE sites, the 1D model has been integrated for a year with some model noise added to the model equetions. Then monthly means of chlorophyll and dissolved inorganic nitrogen concentrations are calculated. The integration is repeated 200 times with different, slightly perturbated biological parameters. Biological parameters with the best fit of the model chlorophyll and DIN to the data are kept in a resampling step. Small parameter noise is added again and the procedure is repeated until convergence.

Optimized model parameters

Symbol	Parameter	Initial values	Optimal BATS	Optimal NABE	Units
$loss_N$	phytoplankton loss of organic nitrogen	0.05	0.048	0.047	day^{-1}
$loss_C$	phytoplankton loss of organic carbon	0.400	0.268	0.513	day^{-1}
α	initial slope of the P-I curve	0.10	0.120	0.082	m^{2}W^{-1}day^{-1}
V_p^*	phytoplankton maximum growth rate constant	0.70	0.74	0.70	day^{-1}
res_H	respiration by heterotrophs	0.01	0.008	0.009	day^{-1}
$loss_H$	mortality of heterotrophs	0.10	0.079	0.10	day^{-1}
agg_1	stickiness for PCHO-PCHO	0.0075	0.0062	0.0075	
agg_2	stickiness for TEP-PCHO	0.24	0.22	0.24	
$deg_C HL$	chlorophyll degradation rate	0.05	0.04	0.060	day^{-1}
$remin_N$	remineralisation rate of detritus	0.1	0.1	0.01	day^{-1}
$remin_C$	detritus	0.1	0.1	0.01	day^{-1}
ϵ	grazing half saturation constant	20.	20.	11.02	mmol N^2 m^{-6}
w	detrital sinking rate	4.0	4.0	18.	m day^{-1}

3 Results

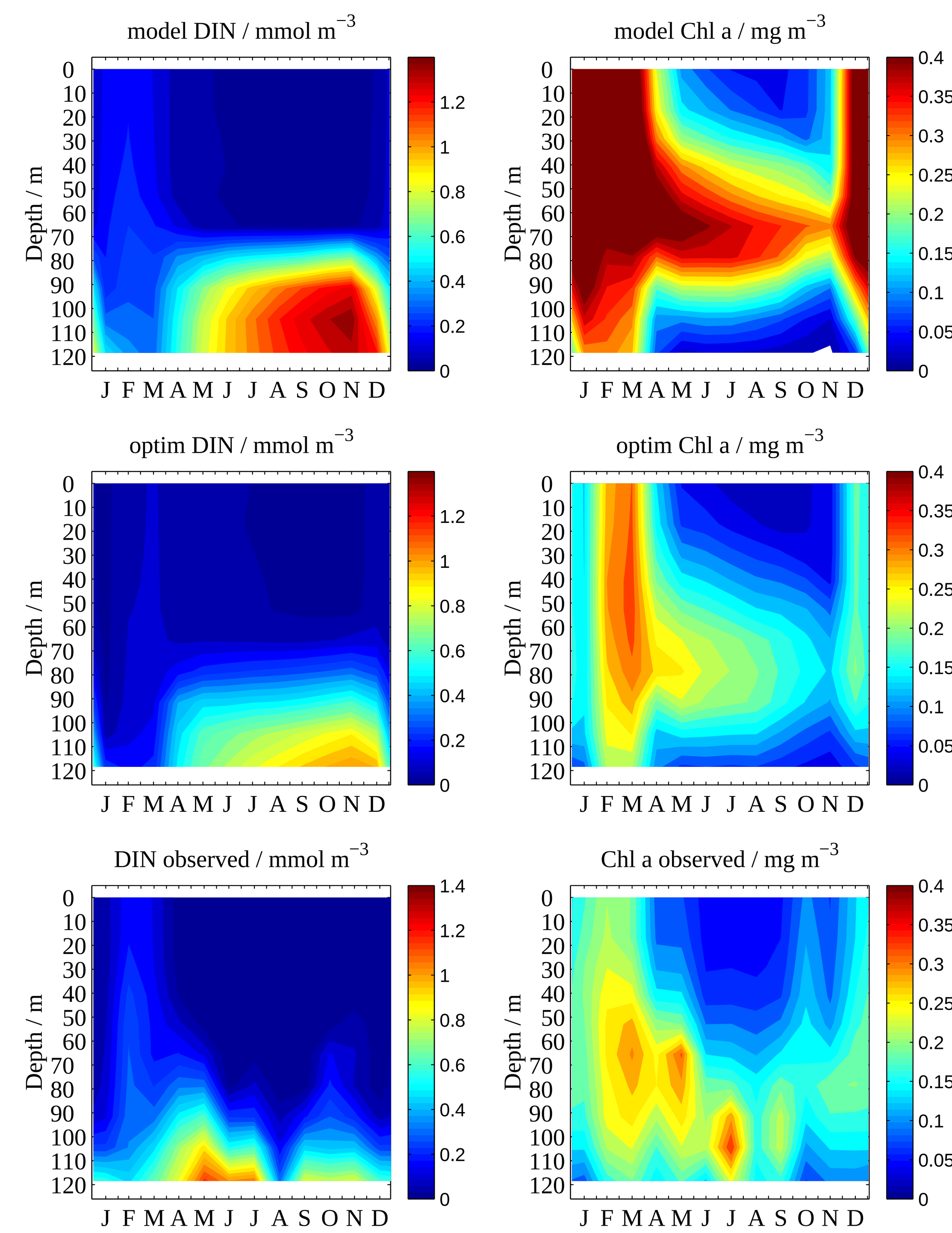


Figure 1: Seasonal means of the chlorophyll "a" (right panels) and dissolved organic nitrogen concentrations (left panels) at the BATS site: model solution with the initial guess of the model parameters (upper panels); model solution obtained with optimal parameter values (middle panels); BATS data (bottom panels).

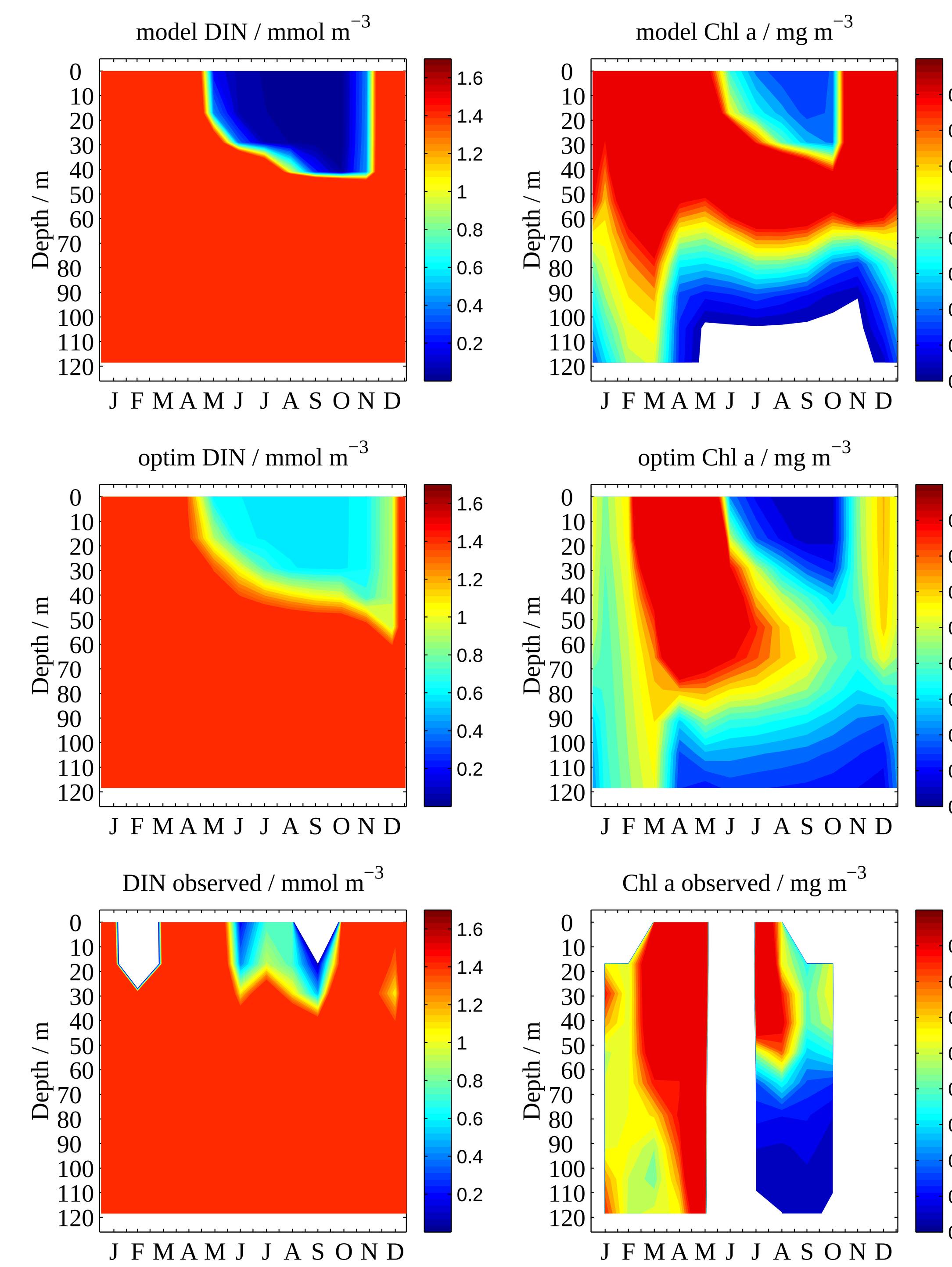


Figure 2: Seasonal means of the chlorophyll "a" (right panels) and dissolved organic nitrogen concentrations (left panels) at the NABE site: model solution with the initial guess of the model parameters (upper panels); model solution obtained with optimal parameter values (middle panels); NABE data (bottom panels).

4 Conclusions

The model has revealed much better skills in reproducing the observed ecosystem dynamics at the BATS site, while, at the NABE station, the model, obviously, suffers from some uncertainties in the forcing and in parameterizations of biological processes.
The parameter estimation procedure is still under our investigation. However, we can hardly expect a unique parameter set, which would suit both the locations, to be found.

References

[1] Rubin D.B., 1988. Using the SIR algorithm to simulate posterior distribution, in Bayesian Statistics 3 (Eds. J.M. Bernardo, M.H. Degroof, D.V. Lindleyand, A.F.M. Smith). *Oxford Univ. Press.*,395-402.

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