Emergent properties of a complex ecosystem model in a global general circulation model: Sensitivity to grazing parameterizations

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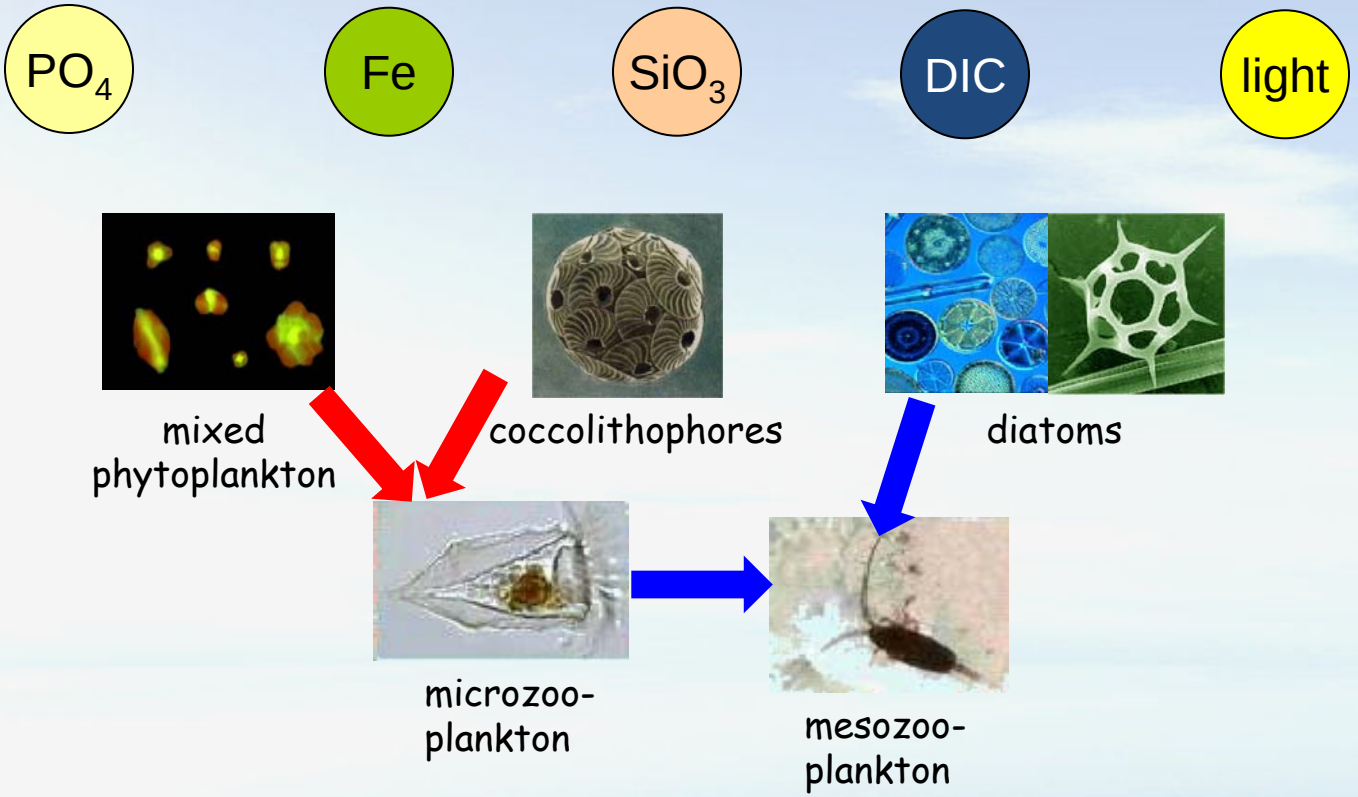
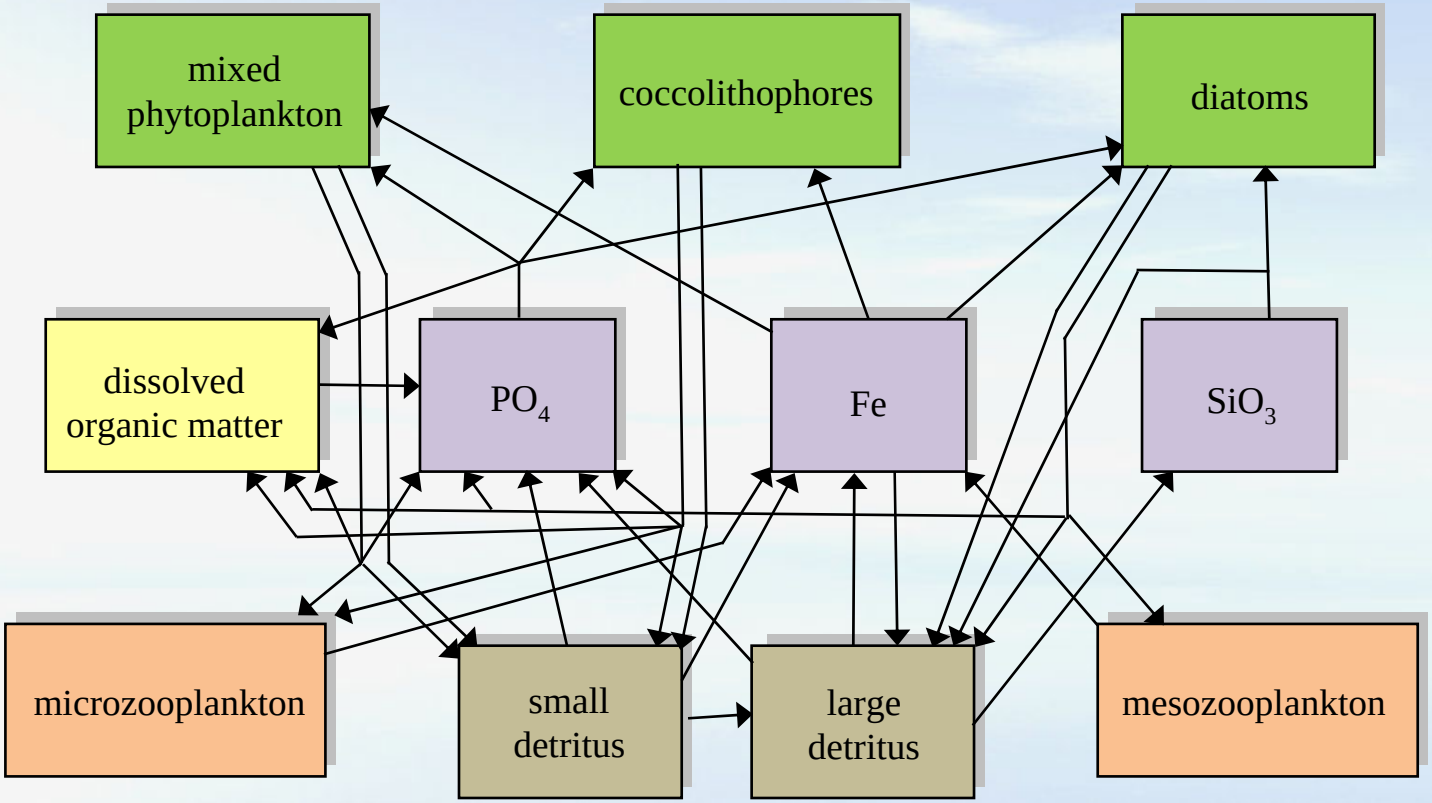
UNIVERSITY OF SOUTHAMPTON AND NATURAL ENVIRONMENT RESEARCH COUNCIL

PLANKTOM5.0



Le Quéré et al. (2005): Global Change Biol. 11, 2016-2040.


mixed phytoplankton
coccolithophores
diatoms
dissolved organic matter
PO_4
Fe
SiO_3
microzooplankton
small detritus
large detritus
mesozooplankton

Two experiments

- Comparison of performance in two GCMs: OCCAM and OPA

- Comparison of different zooplankton functional response parameterisations (in OCCAM)

Two experiments

- Comparison of performance in two GCMs: OCCAM and OPA

- Comparison of different zooplankton functional response parameterisations (in OCCAM)

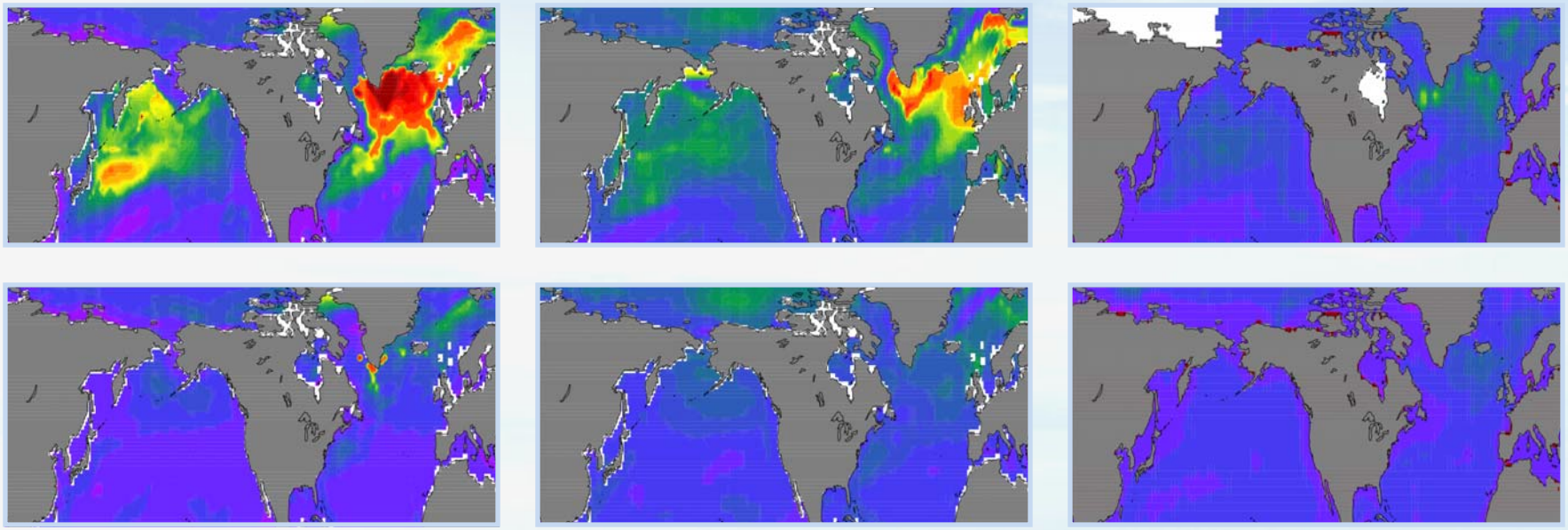
Mixed layer depth

March-May

OCCAM

OPA

climatology



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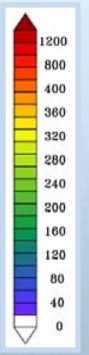


m

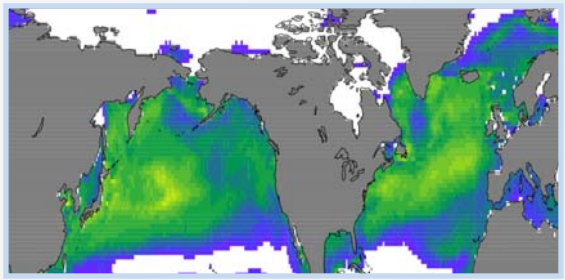
total chlorophyll

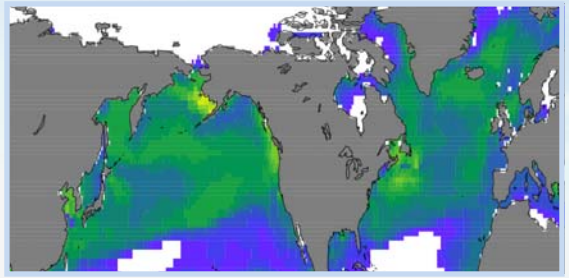
March-
May

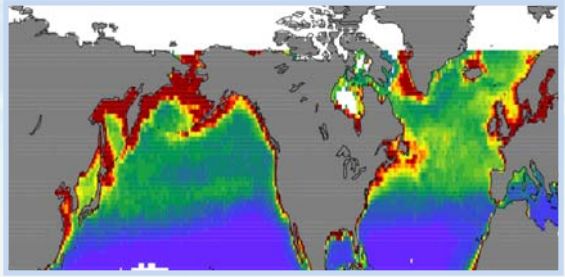
OCCAM

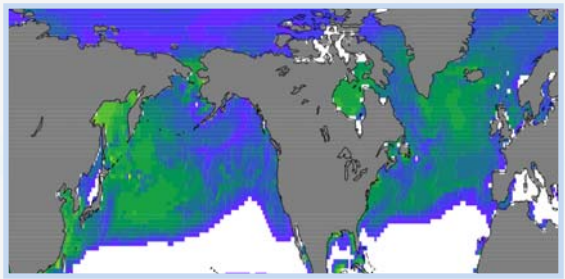
OPA

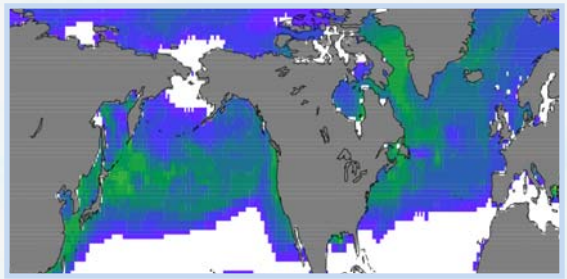
SeaWiFS

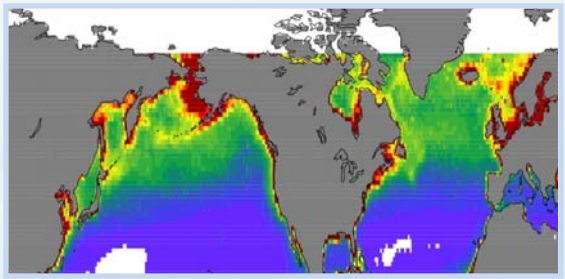












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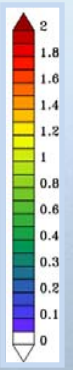


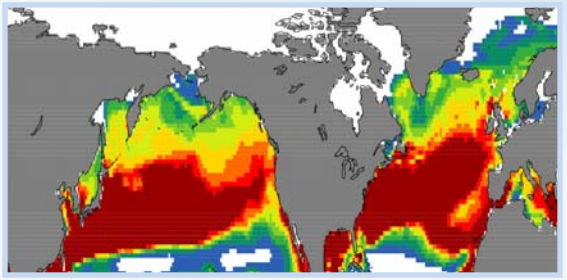
mg m^{-3}

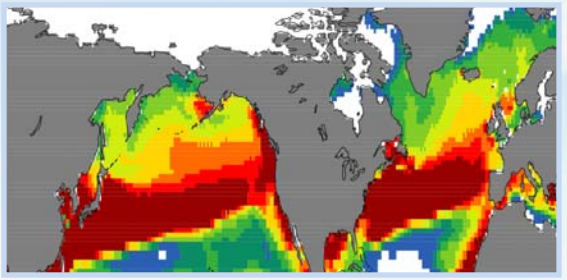
Primary production

OCCAM

OPA

March-May





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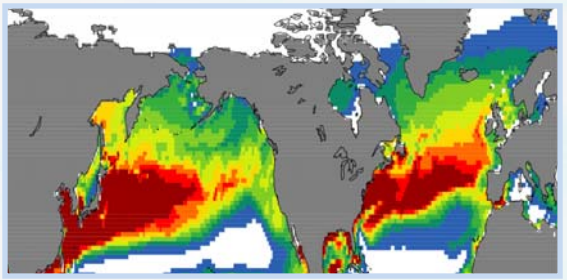
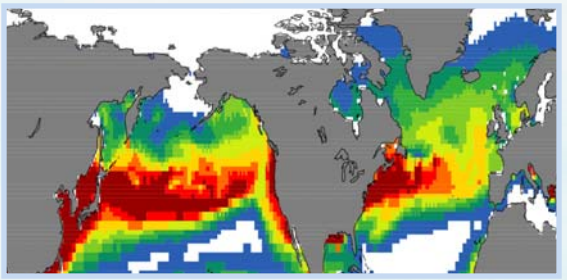
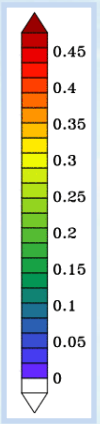






g C m^{-2} d^{-1}

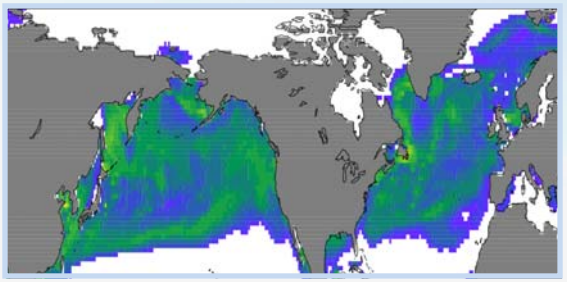
Mixed phytoplankton

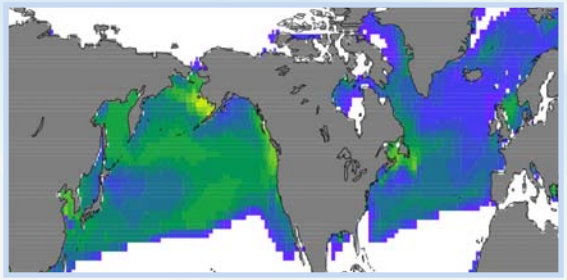
OCCAM

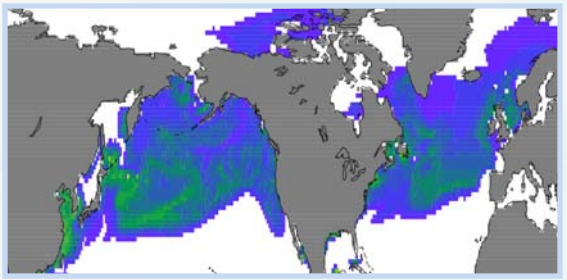
OPA

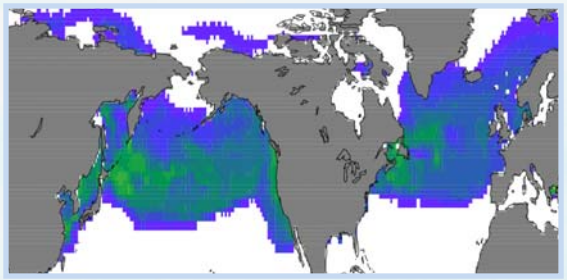
March-May

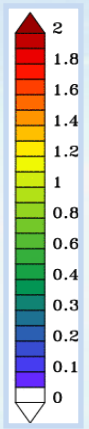
Sept.-Nov.











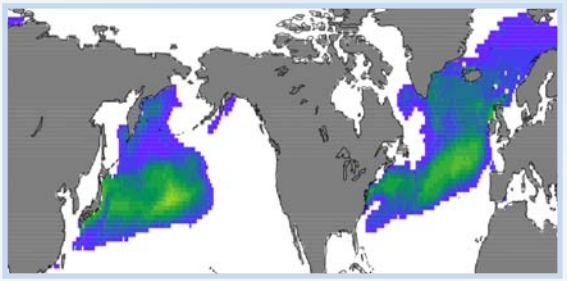
mg m^{-3}

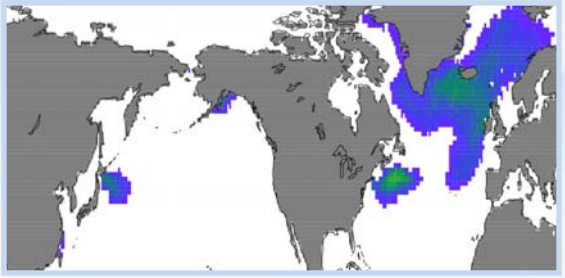
Diatoms

OCCAM

OPA

March-May





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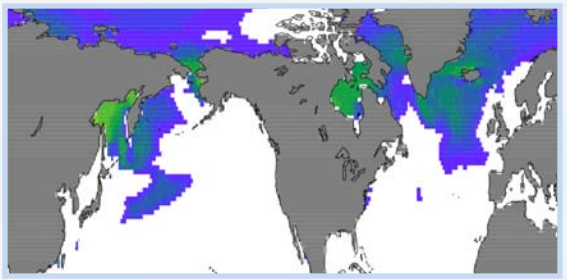
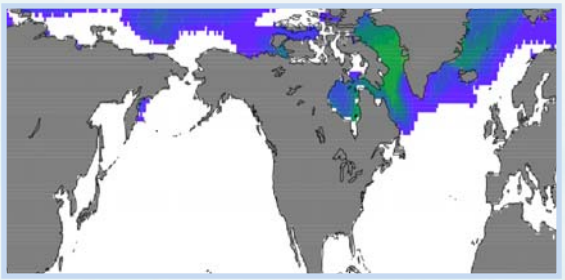
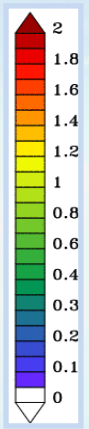






mg m^{-3}

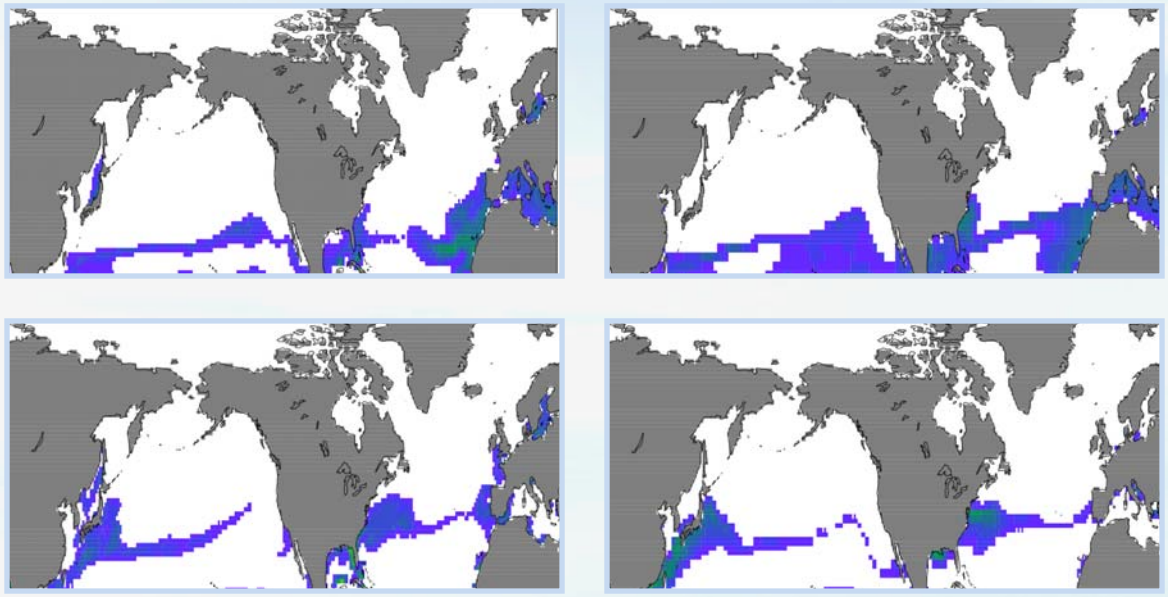
Coccolithophores

OCCAM

OPA

March-May

Sept.-Nov.



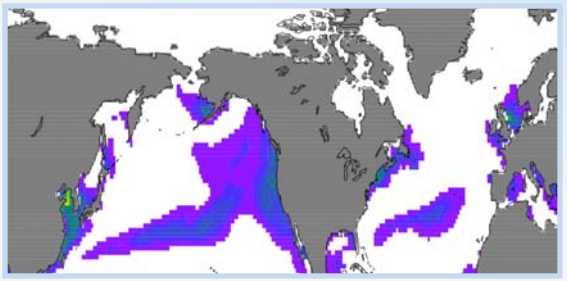
mg m^{-3}

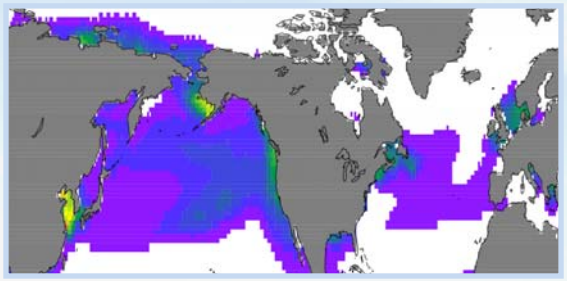
Mesozooplankton

OCCAM

OPA

March-
May





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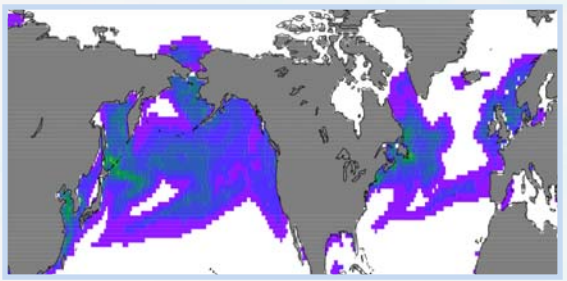
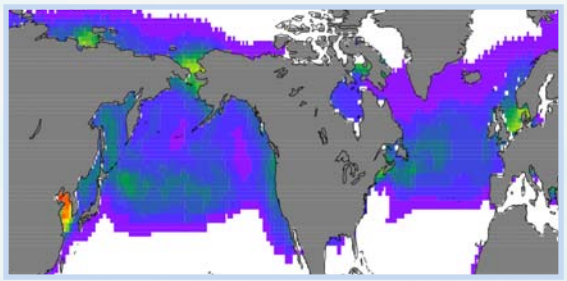
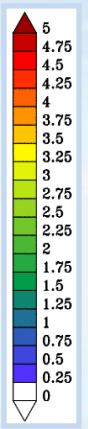






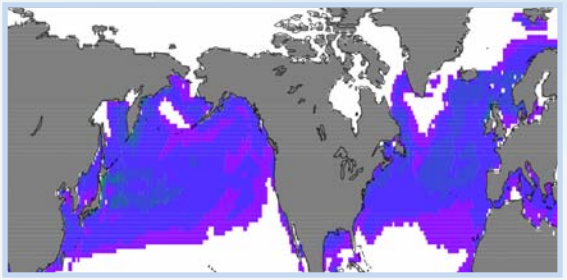
mmol C m^{-3}

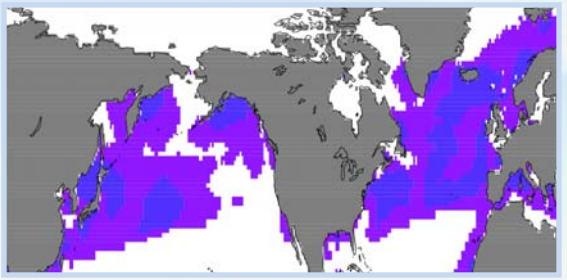
Microzooplankton

OCCAM

OPA

March-
May





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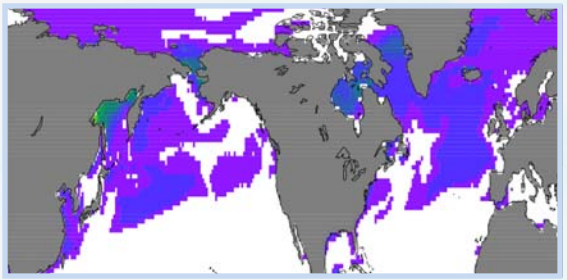
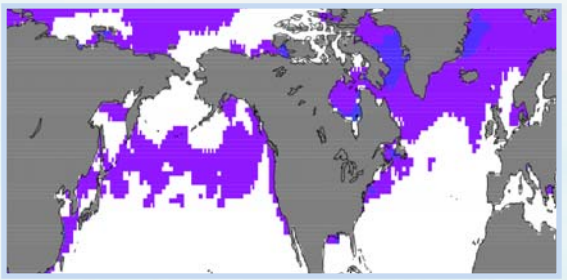
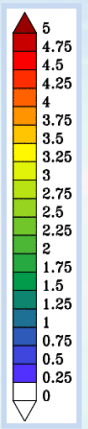






mmol C m^{-3}

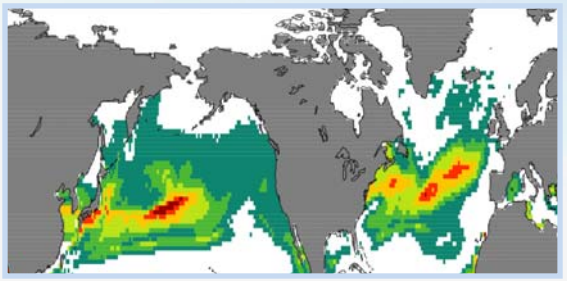
Export

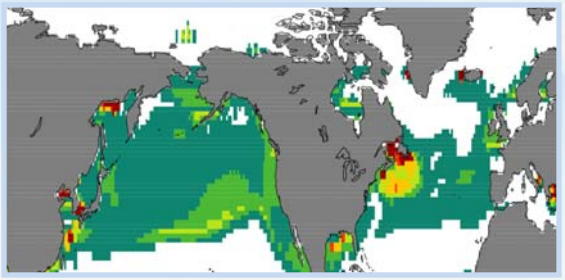
OCCAM

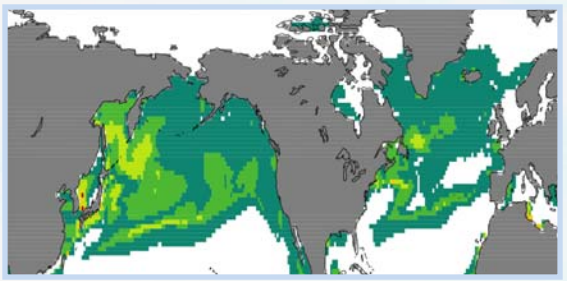
OPA

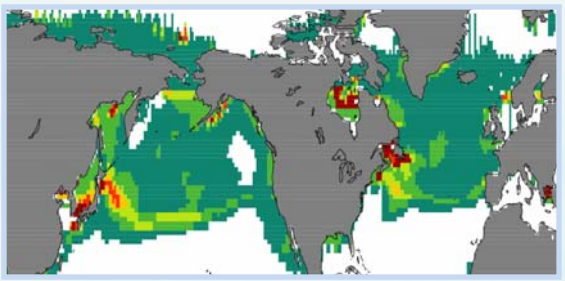
March-May

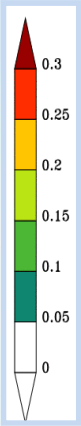
Sept.-Nov.











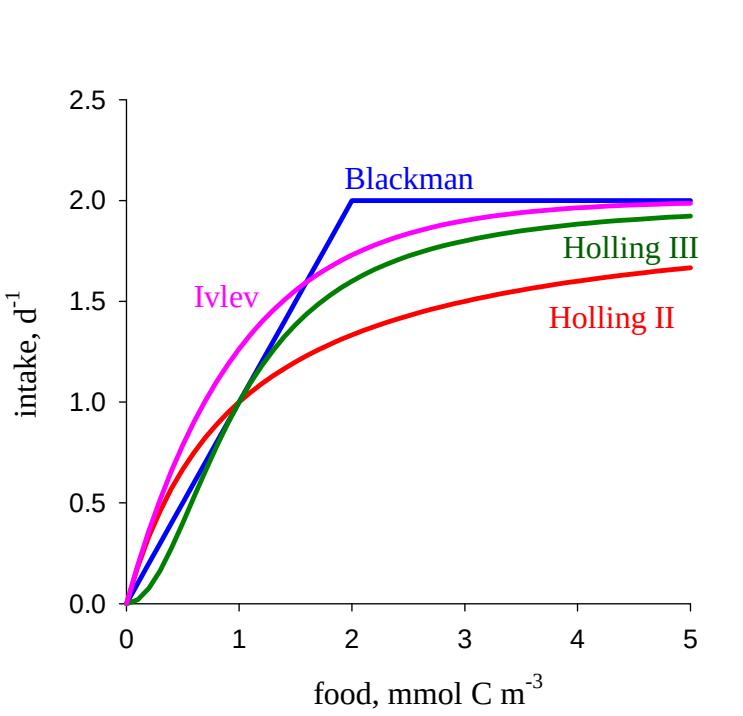
g C m^{-2} d^{-1}

Two experiments

- Comparison of performance in two GCMs: OCCAM and OPA

- Comparison of different zooplankton functional response parameterisations (in OCCAM)

Functional response curves



parameter values

mesozooplankton

I_{max} = 1 d^{-1}, $k_{1/2}$ = 1 mmol C m^{-3}

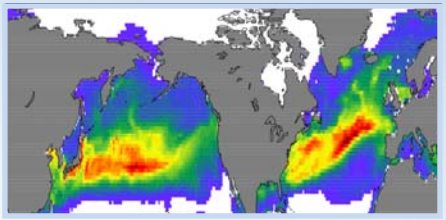
microzooplankton

I_{max} = 2 d^{-1}, $k_{1/2}$ = 1 mmol C m^{-3}

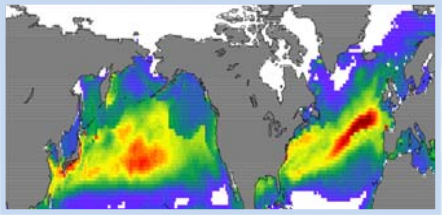
Total chlorophyll

March-May

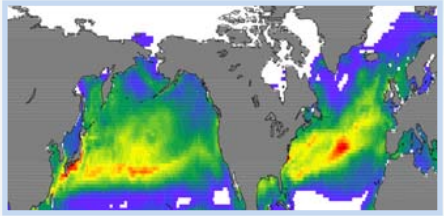
Holling II



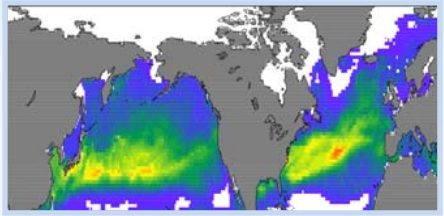
Blackman

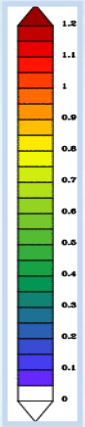


Holling III



Ivlev

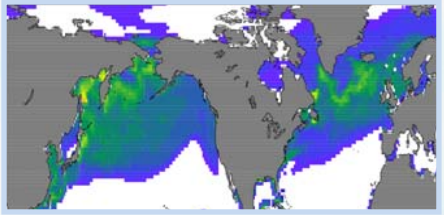




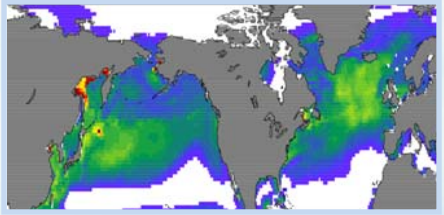
mg m^{-3}

Sept.-Nov.

Holling II



Blackman



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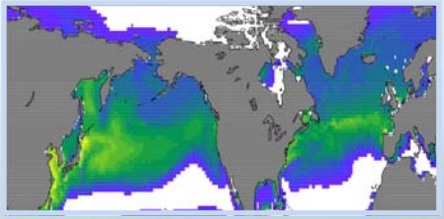

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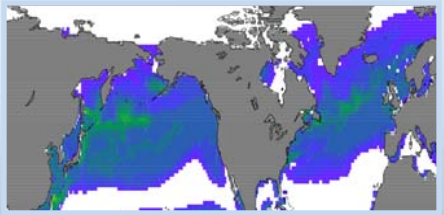
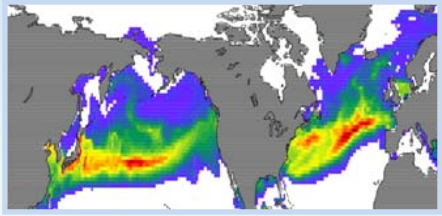
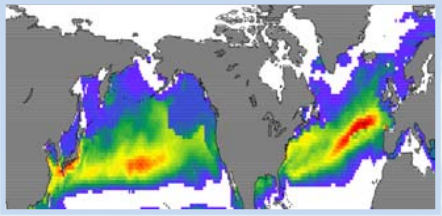


Mixed phytoplankton

March-May

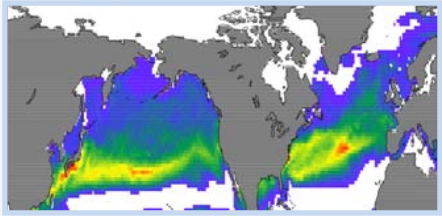
Holling II

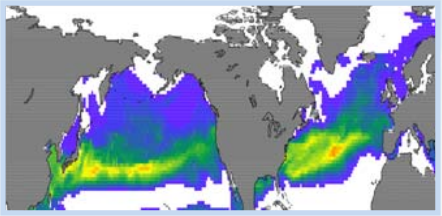




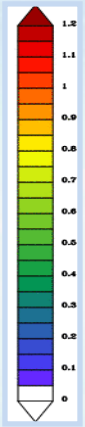
Blackman

Holling III





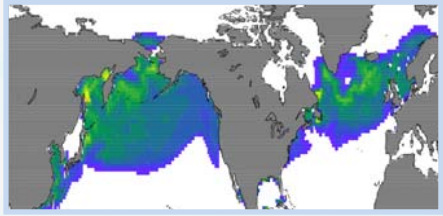
Ivlev

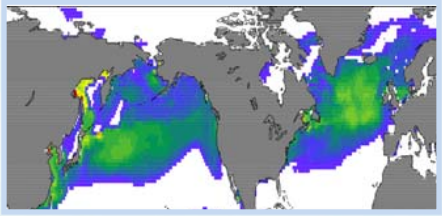


mg m^{-3}

Sept.-Nov.

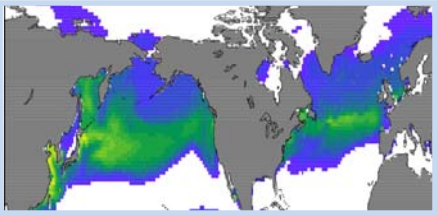
Holling II

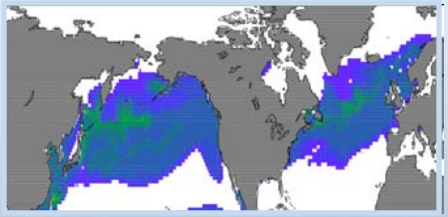




Blackman

Holling III



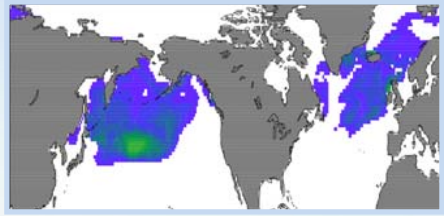


Ivlev

Diatoms

March-May

Holling II



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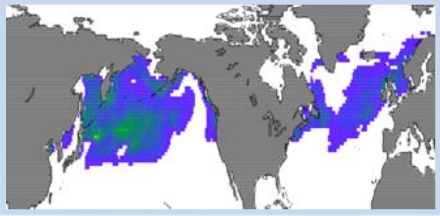

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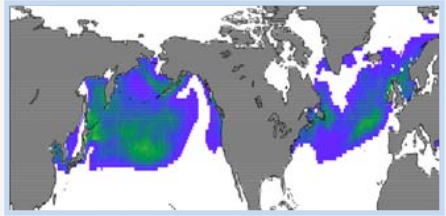

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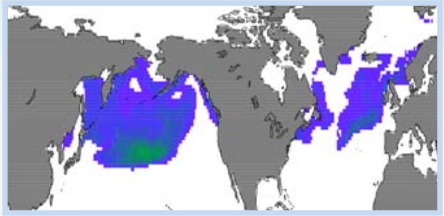
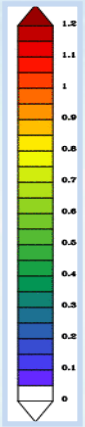
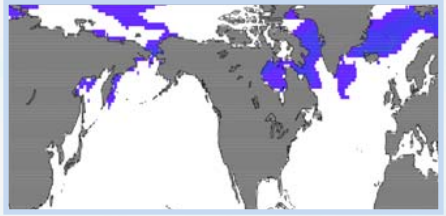




mg m^{-3}

Sept.-Nov.

Holling II



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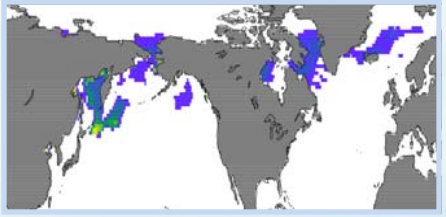

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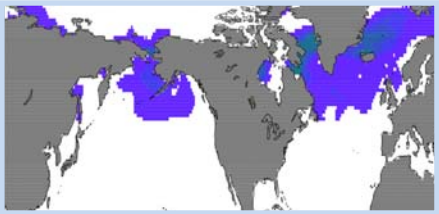

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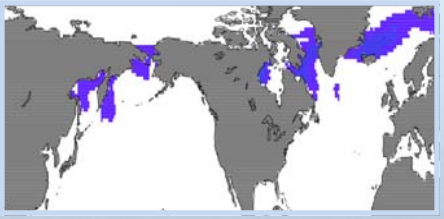
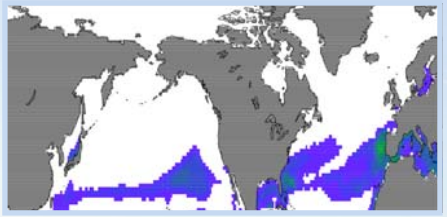


Coccolithophores

March-May

Holling II



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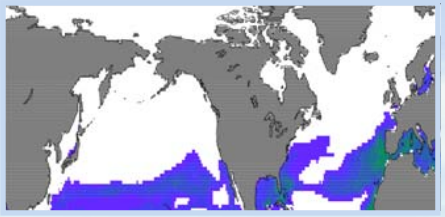

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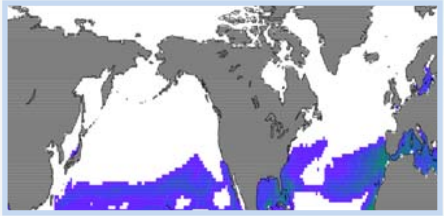

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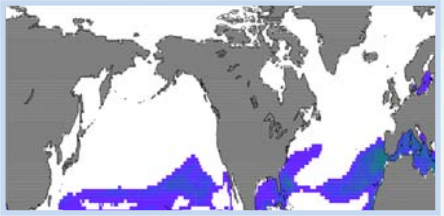
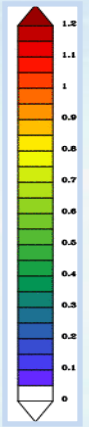
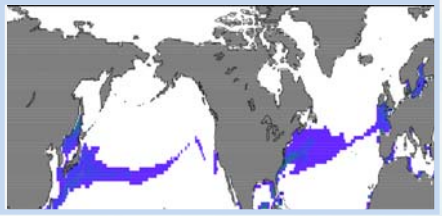




mg m^{-3}

Sept.-Nov.

Holling II



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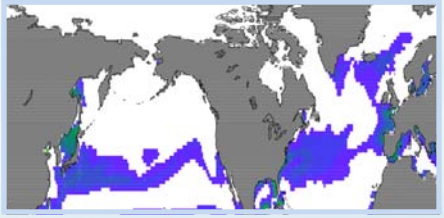

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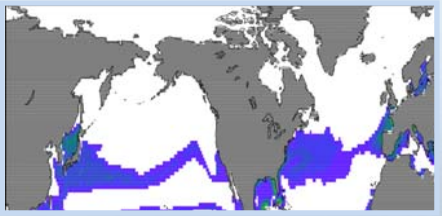

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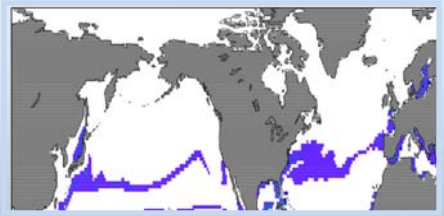


Mesozooplankton

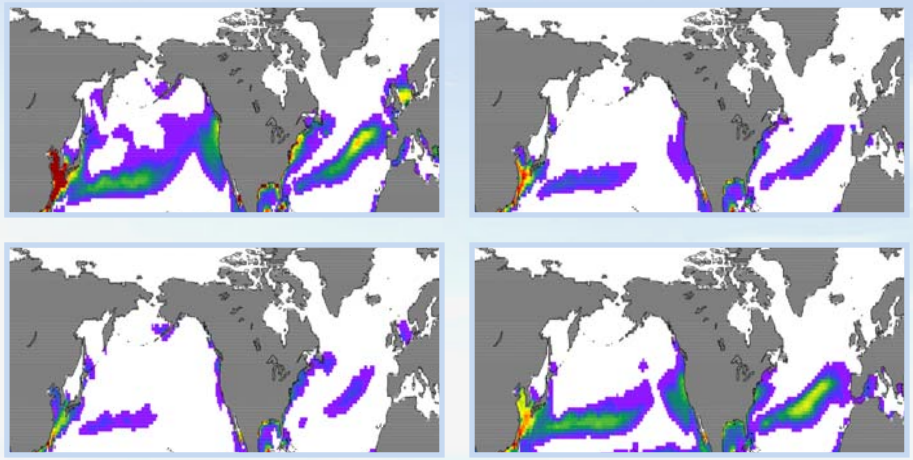
March-May

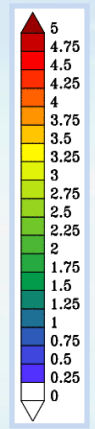
Holling II

Blackman

Holling III

Ivlev





mmol C m^{-3}

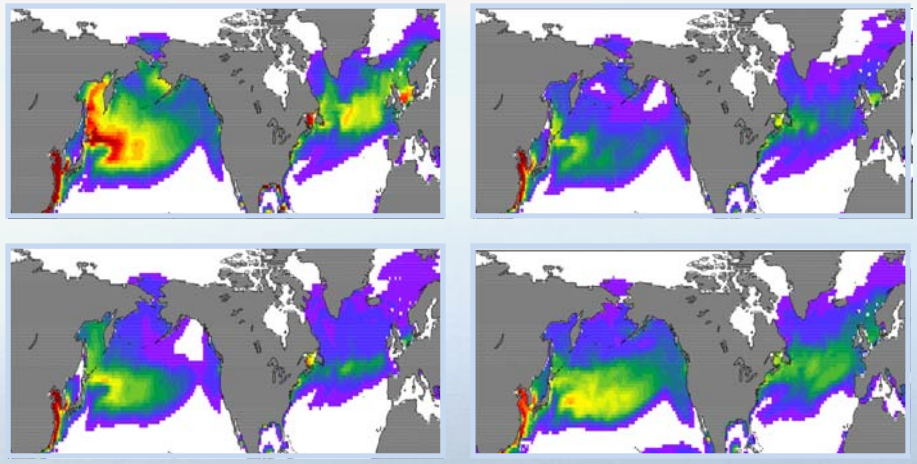
Sept.-Nov.

Holling II

Blackman

Holling III

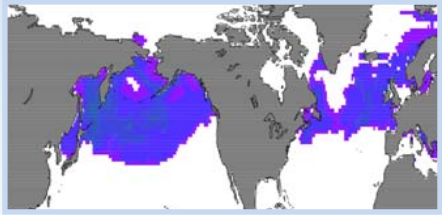
Ivlev



Microzooplankton

March-May

Holling II



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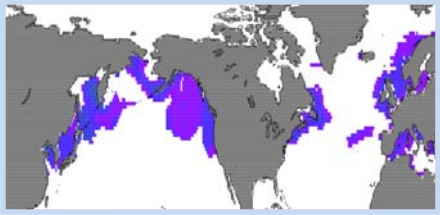

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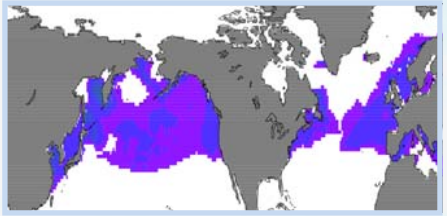

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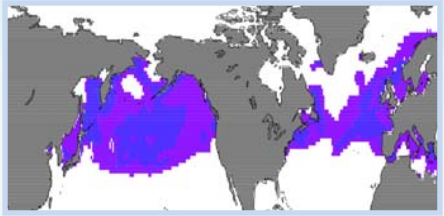
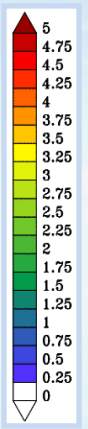
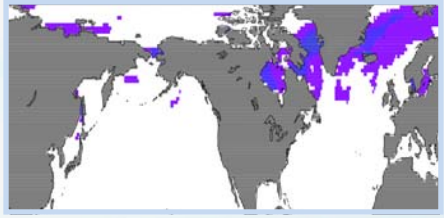




mmol C m^{-3}

Sept.-Nov.

Holling II



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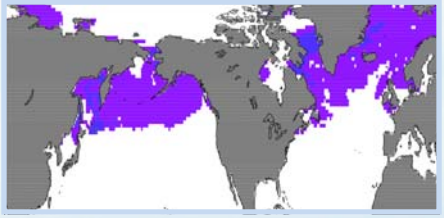
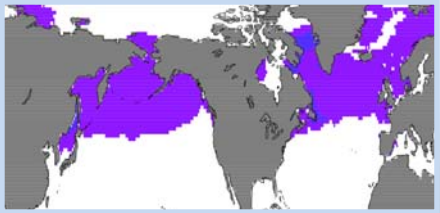


Holling III



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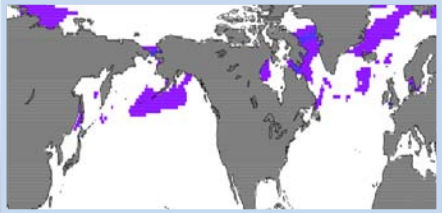
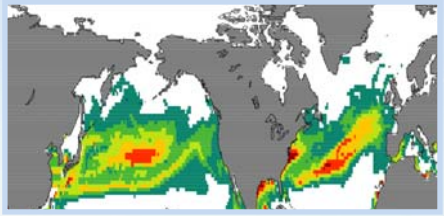


Export

March-May

Holling II



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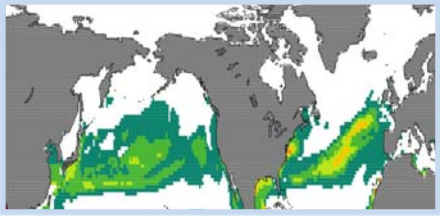

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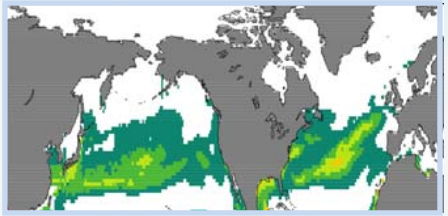

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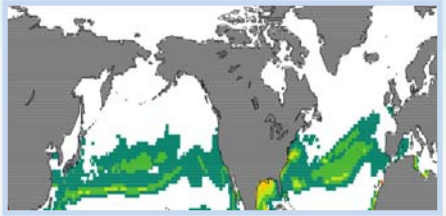

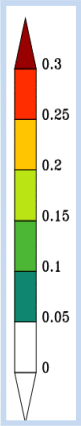

g C m^{-2} d^{-1}

Sept.-Nov.

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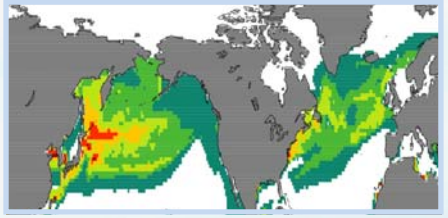

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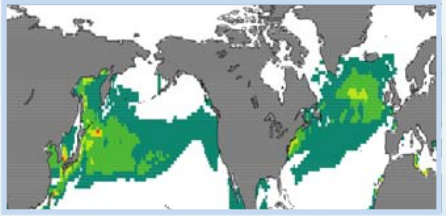

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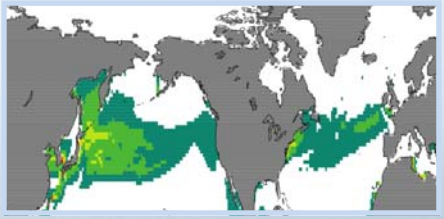

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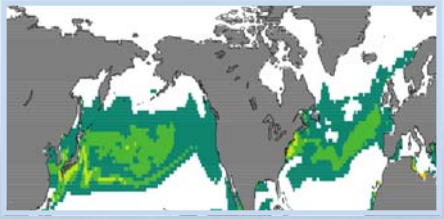

Conclusions

- Bulk properties display similar order of magnitude - controlled by light, upwelling/downwelling and mixed layer depth.

- Simulated distributions of individual plankton functional types display regional differences in the two GCMs, and are sensitive to the biological parameterisation.

- Implication: it is necessary to do a good job with both model physics and biology if we are to realistically and reliably predict PFTs and their possible response to changing climate!