BALTSEM-C – recent development of the BALTSEM model

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State variables

State variables included in the original BALTSEM version

Notation	Meaning	Unit
Pelagic		
S	salinity	-
T	temperature	°C
O_2	dissolved oxygen	g O_2 m^{-3}
N_N	ammonium	mg N m^{-3}
N_O	nitrate + nitrite	mg N m^{-3}
N_P	phosphate	mg P m^{-3}
N_S	silicate	mg Si m^{-3}
D_N	nitrogen detritus	mg N m^{-3}
D_P	phosphorus detritus	mg P m^{-3}
D_S	biogenic silica	mg Si m^{-3}
A_1	cyanobacteria	mg N m^{-3}
A_2	diatoms	mg N m^{-3}
A_3	“other autotrophs”	mg N m^{-3}
Z_H	heterotroph community	mg N m^{-3}
Benthic		
B_N	benthic nitrogen	mg N m^{-2}
B_P	benthic phosphorus	mg P m^{-2}
B_S	benthic silica	mg Si m^{-2}

Additional state variables included in the expanded model version

Notation	Meaning	Unit
Pelagic		
DIC	dissolved inorganic carbon	µmol kg^{-1}
Alk	total alkalinity	µmol kg^{-1}
H_2S_T	total hydrogen sulphide (HS^- + H_2S)	µmol kg^{-1}
DON_L	dissolved organic nitrogen, labile	mg N m^{-3}
DON_R	dissolved organic nitrogen, refractory	mg N m^{-3}
DOP_L	dissolved organic phosphorus, labile	mg P m^{-3}
DOP_R	dissolved organic phosphorus, refractory	mg P m^{-3}
$DOCL_T$	allochthonous dissolved organic carbon, labile	mg C m^{-3}
$DOCR_T$	allochthonous dissolved organic carbon, refractory	mg C m^{-3}
$DOCL_M$	autochthonous dissolved organic carbon, labile	mg C m^{-3}
$DOCR_M$	autochthonous dissolved organic carbon, refractory	mg C m^{-3}
$DETC_T$	allochthonous carbon detritus	mg C m^{-3}
$DETC_M$	autochthonous carbon detritus	mg C m^{-3}
Benthic		
$BENC_T$	benthic carbon, allochthonous	mg C m^{-2}
$BENC_M$	benthic carbon, autochthonous	mg C m^{-2}

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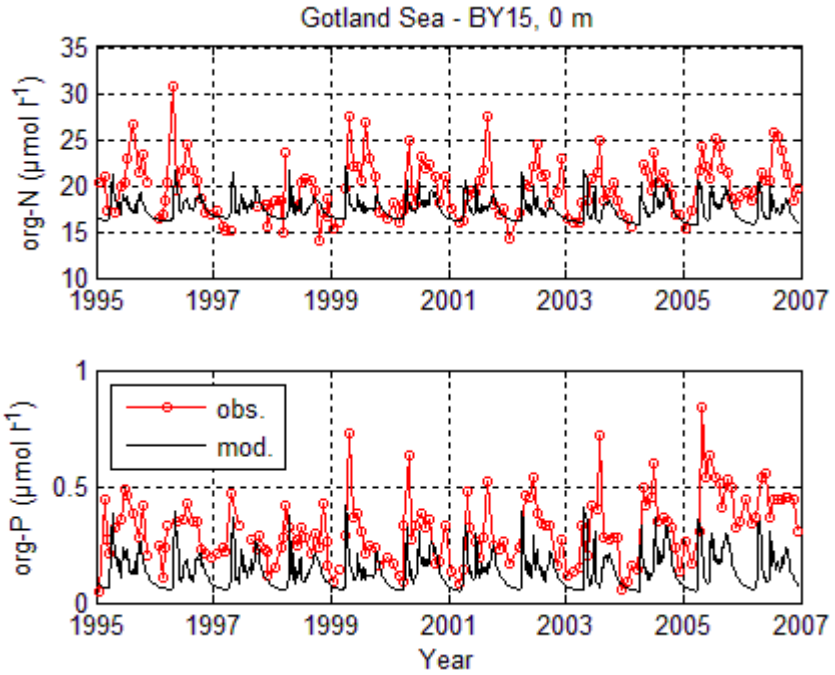
River loads

Riverine organic N
- 20% PON
- 56% DON_R (refractory)
- 24% DON_L (bio-available)

Riverine organic P
- 67% POP
- 0% DOP_R (5%)
- 33% DOP_L (28%)



Stepanauskas, R., Jørgensen, N.O.G., Eigaard, O.R., Zvikas, A., Tranvik, L.J., Leonardson, L., 2002. Summer inputs of riverine nutrients to the Baltic Sea: bioavailability and eutrophication relevance. Ecological monographs 72, 579–597.

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River loads

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Average riverine DOC loads and concentrations (1996-2000). Collected and compiled as a part of the Baltic-C program (BALTEX Phase II (BONUS+)).

Sub-basin	DOC_T river load (Gmol y^{-1})	Riverine DOC_T (µmol $^{-1}$)
KT	20	610
DS	8.1	950
BP	89	840
BS	51	510
BB	74	640
GR	42	1400
GF	52	500
Total	340	670

External sources

- River loads ≈ 340 Gmol y^{-1}
- Atmospheric deposition* ≈ 1 g C m^{-2} y^{-1} = 34 Gmol y^{-1}
- Gross deep water DOC_T input to the Northern Kattegat basin ≈ 90 Gmol y^{-1}

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* Anttila, P., Paatero, P., Tapper, U., Järvinen, O., 1995. Source identification of bulk wet deposition in Finland by positive matrix factorization. Atmospheric Environment 29, 1705–1718.

Measured/simulated DOC concentrations

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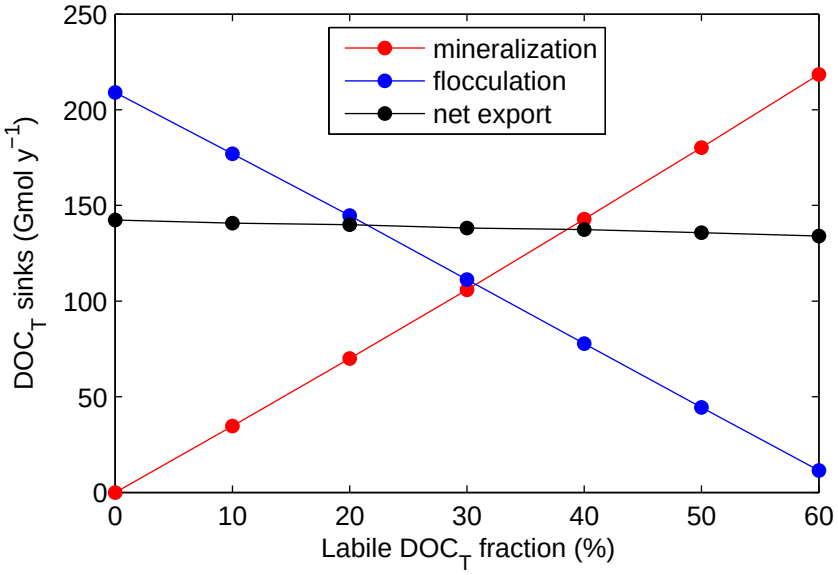
Observed and modelled average DOC_M and DOC_T surface concentrations (µmol l^{-1})

	GS	BS	BB
DOC_T			
Observed	173[2)]-202[1)]	193[2)]-237[1)]	209[2)]-291[1)]
Modelled	201	205-211	242-275
DOC_M			
Observed	100[1)]-126[2)]	79[1)]-123[2)]	43[1)]-99[2)]
Modelled			



1. Alling et al. (2008) – winter values
2. Deutsch et al. (2012) – summer values

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Alling, V., Humborg, C., Mörth, C.M., Rahm, L., Pollehne, F., 2008. Tracing terrestrial organic matter by $d^{34}S$ and $d^{13}C$ signatures in a subarctic estuary. Limnology and Oceanography 53, 2594–2602.

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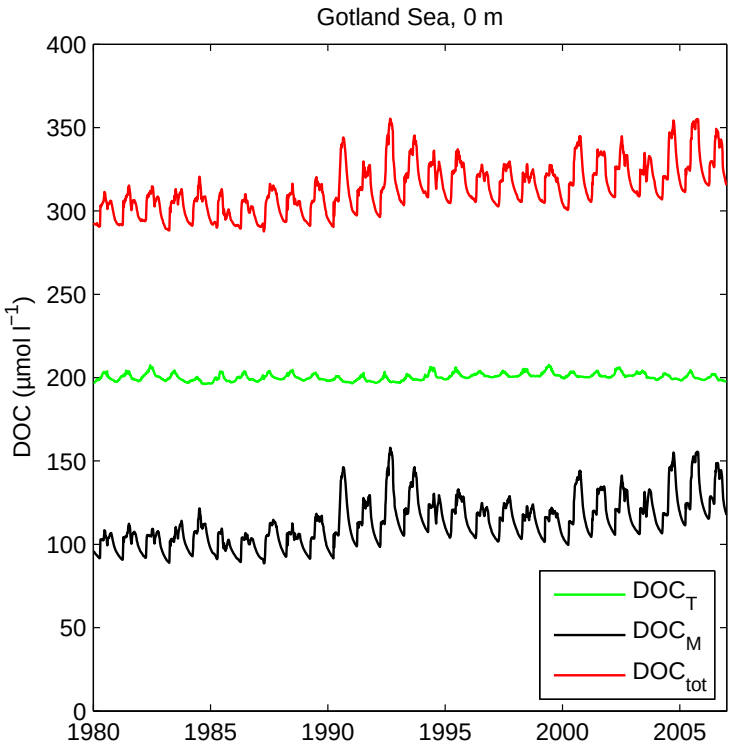
DOC_M			
Observed	100[1)]-126[2)]	79[1)]-123[2)]	43[1)]-99[2)]
Modelled	113	72	39



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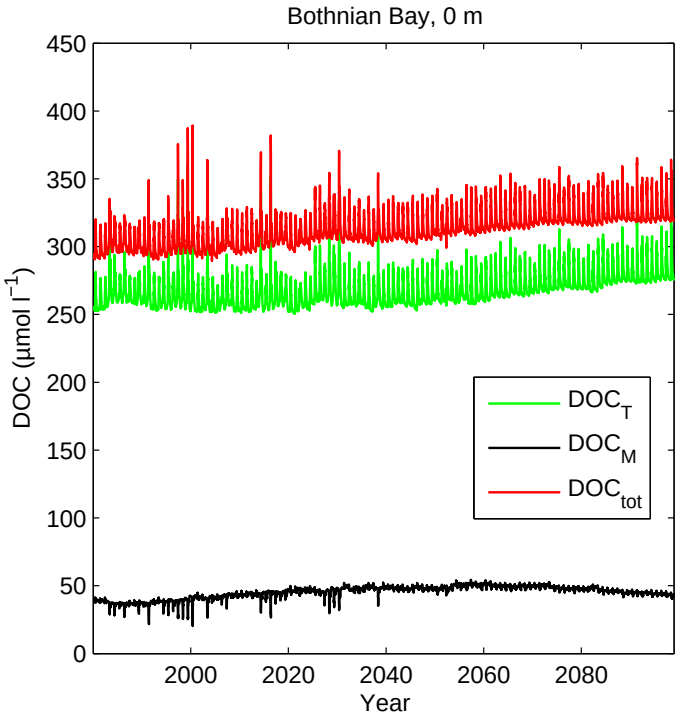
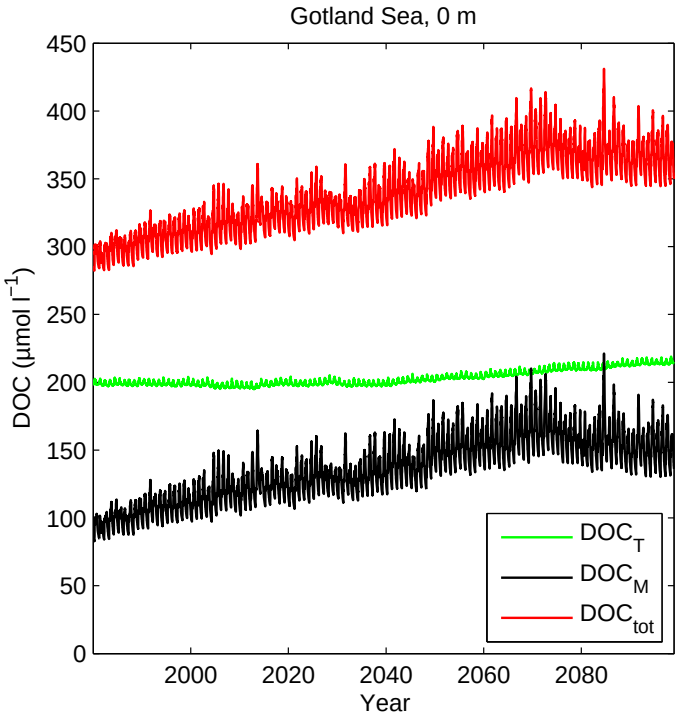
Scenario simulations...

- DOC simulations?
- Repeat experiments from the Baltic-C program?





RCAO-ECHAM5, A1B1 emission scenario, constant N & P loads

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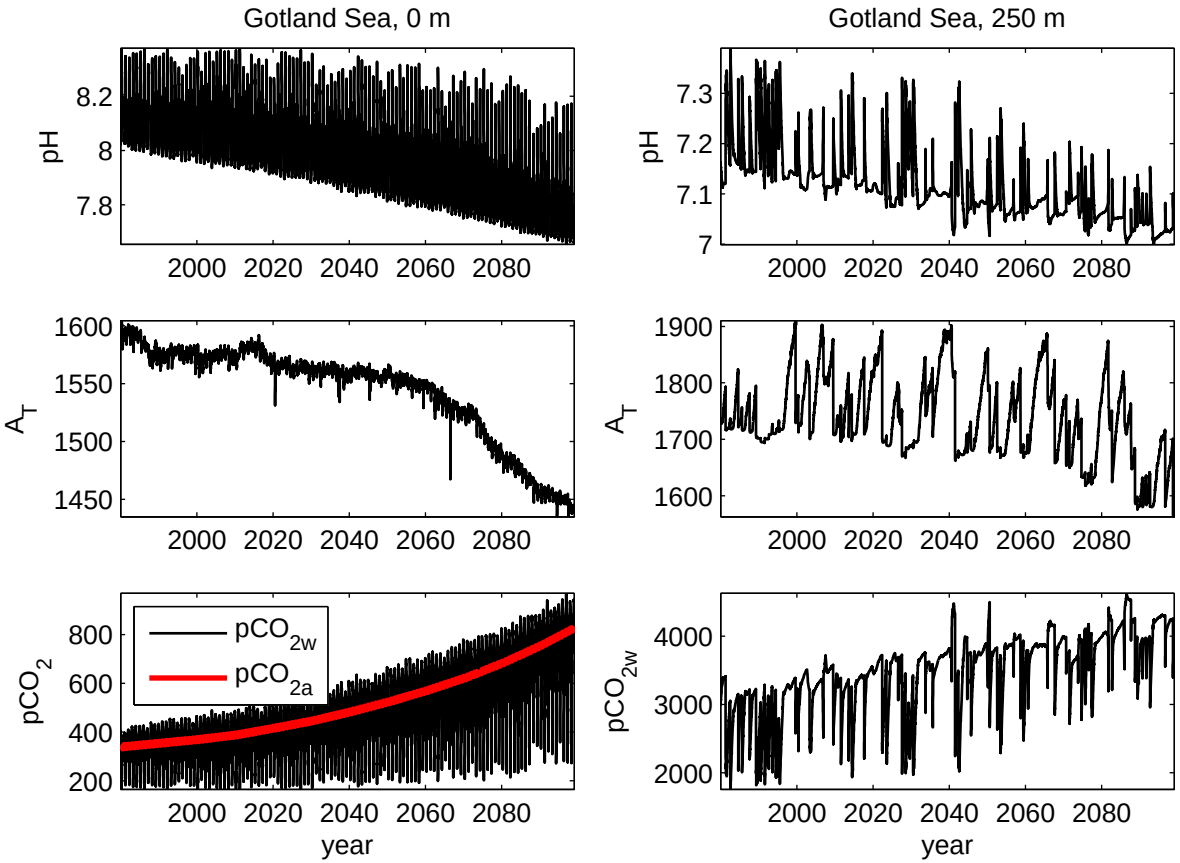

RCAO-ECHAM5, A1B1 emission scenario, constant N & P loads