Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

HZG Report 2019-2 | ISSN 2191-7833

O. Kerimoglu

Parameterization of turbidity in the German Bight

HELMHOLTZ-ZENTRUM GEESTHACHT

HZG Report 2019-2

O. Kerimoglu

Parameterization of turbidity in the German Bight

HELMHOLTZ-ZENTRUM GEESTHACHT

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung GmbH | Geesthacht | 2019

Die HZG Reporte werden kostenlos abgegeben.
HZG Reports are available free of charge.

Anforderungen/Requests:

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung GmbH
Bibliothek/Library
Max-Planck-Straße 1
21502 Geesthacht
Germany
Tel.: +49 4152 87-1690
Fax.: +49 4152 87-1717
E-Mail: bibliothek@hzg.de

Druck: HZG-Hausdruckerei

ISSN 2191-7833

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung GmbH
Max-Planck-Straße 1
21502 Geesthacht

www.hzg.de

HZG Report 2019-2

Parameterization of turbidity in the German Bight

Onur Kerimoglu

9 pages with 6 images

Abstract:

An adequate representation of turbidity is important for being able to realistically simulate primary production in aquatic systems. Here, based on the Scanfish measurements, we develop analytical formulations for the description of cross-shore gradients and seasonal variability in the SPM caused turbidity in the German Bight, and test the effect of these on an ecosystem model, using 1-D and 3-D setups.

Zusammenfassung:

Parametrisierung der Trübung in der Deutschen Bucht

Eine angemessene Darstellung der Trübung ist wichtig, um die Primärproduktion in aquatischen Systemen realistisch simulieren zu können. Basierend auf Scanfish-Daten entwickeln wir analytische Formulierungen zur Beschreibung von seewärts gerichteten Gefällen und der jahreszeitlichen Variabilität der partikuläre Schwebstoffe entstandenen Trübung in der Deutschen Bucht und testen deren Auswirkung auf ein Ökosystemmodell mit 1-D und 3 -D setups.

Dieser Bericht wurde 2014 verfasst. / This report was written in 2014.

Parameterization of turbidity in the German Bight

Onur Kerimoglu

December 18, 2014

1 Motivation

For being able to model the planktonic interactions in the coastal systems, it is necessary to represent the light climate adequately, as light availability is often the limiting factor for primary production. Light availability, in turn, is often determined by the SPM concentrations. Therefore it is desirable to have a coupled, fully mechanistic plankton-SPM model. However, modeling SPM is difficult because of poorly understood processes such as aggregation, resuspension, etc.

Here, as a practical and computationally cheap solution, the SPM-caused 'background attenuation coefficient' is described as simple analytical functions of depth and time (day of year) and these formulations are tested im 1-D and 3-D model setups using MAECS.

2 Description of parameterizations

2.1 functions

k_w=C
Implying that background turbidity (k_w) is constant, set to be $k_w = 0.4$ (see Fig. 2 for an explanation).

k_w=f(z)
actually in form: $k_w = k_{w,max} * f(z)$
where,

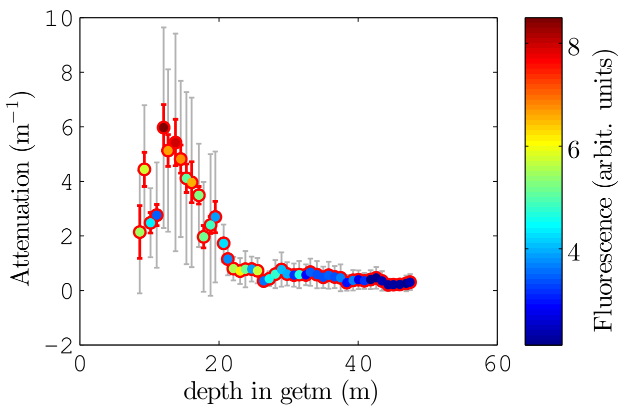
$$f(z) = f_{min} + (1 - f_{min}) * (1 - 1/(1 + e^{d1-d2*Z})) \tag{1}$$

k_w=f(z,t)
In addition to Eq.1, change in $k_{w,max}$ over t (day of year) is taken into consideration:
$k_w = k_{w,max} * f(t) * f(z)$

$$f(t) = F * (B + A * sin(2t\pi/365 + 2L\pi/365)) \tag{2}$$

2.2 fitting to data

Below, it should be kept in mind that the attenuation coefficients include self-shading by phytoplankton.



(a) (provided by J. Maerz) Here, parameters of Eq.1 were visually fit as $k_{w,max} = 5$, $f_{min} = 0.01$, $d1 = 10$, $d2 = 0.5$

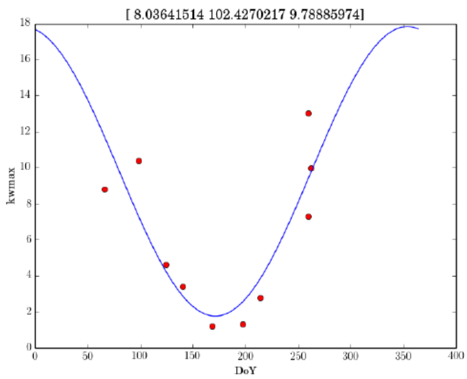


Figure 6: Parameter values: A, L, and B in this order.

(b) (provided by J. Maerz). Here, parameters of Eq.2 were statistically fit as: : $A = 8.036, L = 102.42, B = 9.78$. F was then set to 0.05, such that the resulting function ranges between 0-1

Figure 1: Fitting the parameters from the Scanfish data.

2.3 resulting background-attenuation landscapes

are shown in Fig.2.

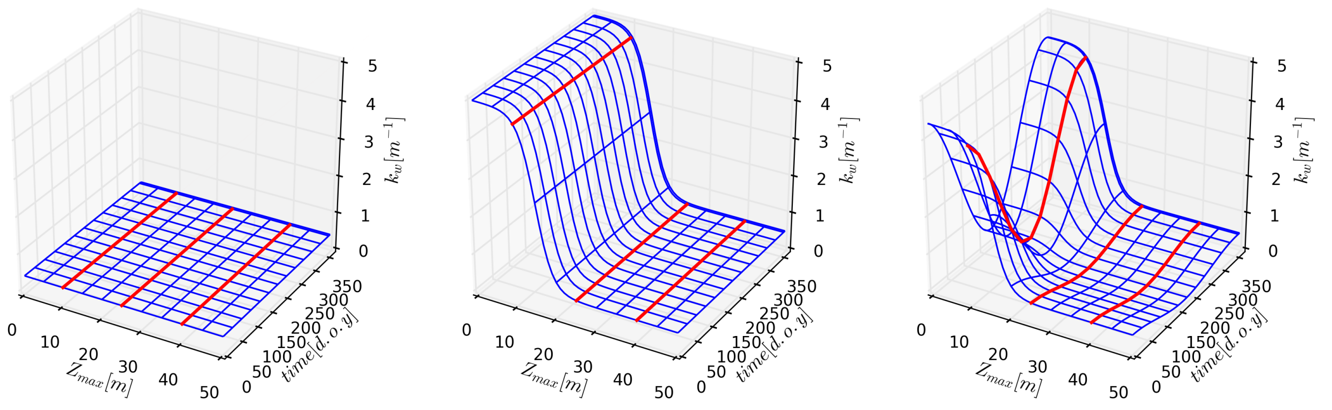


Figure 2: functions of k_w for $k_{w,max} = 5.0$. As f(z=25 (=Helgoland))≈0.4, and as 25m might not be a bad 'average' depth in the German Bight, c was set $c = 0.4$ Red lines mark the position of 1-D setups in Figs.3 and 4: Coastal(10m), Helgoland(25m) and off-shore(40m)

3 Implementation in MAECS 1-D

Background-attenuation parameterizations described above were first tested in MAECS 1-D, in 4 different setups: coast x2(@z=10m), Helgoland (@z=25m) and off-shore (@z=40m) (Fig.3).

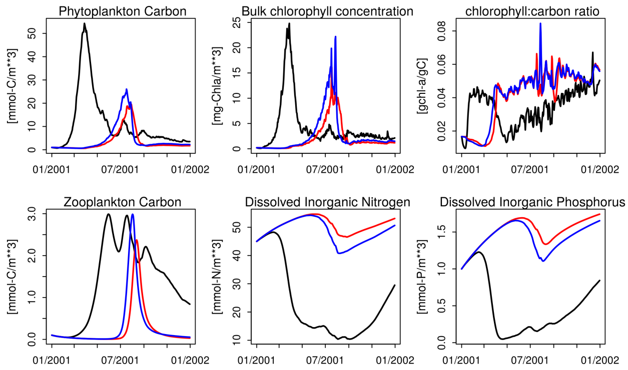
Observations: $k_w = f(z)$ produced quite different results than $k_w = c$ and in the expected directions (i.e, delaying the bloom at the coast and advancing at the off-shore. But $k_w = f(z,t)$ did not produce too significant results than $k_w = f(z,t)$. This is presumably because, during the time $f(t)$ becomes effective, phytoplankton is more limited by the nutrients than light.

Problem: With $k_{w,max} = 5.0$ nutrients don't get depleted at the coast, especially @Z=10m. Possibilities:

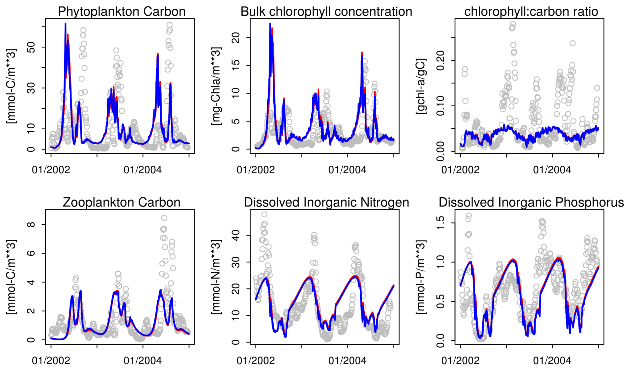
Maybe there is no problem:
: Actually Z=10m is probably the worst average light environment according to the f(z) where k_w approaches $k_{w,max}$ and it's also deep. Indeed,nutrients are depleted more at the even shallower setup @ Z=5m, so maybe this is not too realistic (not shown). Therefore a 3-D simulation is required to see the net effect across the full topography (section 4).

The BGC odel needs to be improved:
: we might be still ignorant about the capability of phytoplankton to adapt to such a turbid environment, which reflects to our formulations/parameterizations (in progress: the parameter issue extends back to the 0-D work). Omission of other components like the benthic algae or misrepresentation of processes such as a stronger denitrification rate (in progress) or forcing factors such as river loadings (in progress) are among the issues to consider.

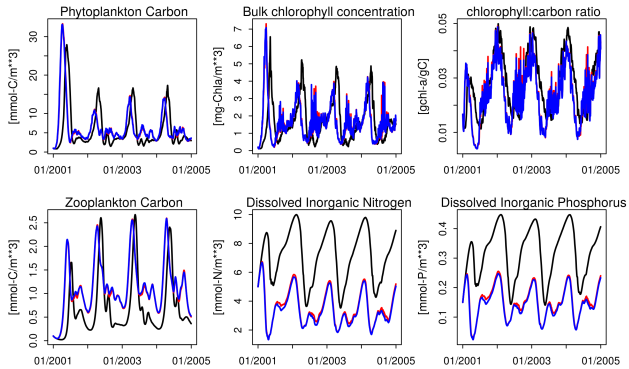
light limitation is simply overestimated by this parameterization:
: setting $k_{w,max} = 1.0$ was observed to result in more realistic representation of nutrient consumption in 1-D simulations (Fig.4), therefore the 3-D simulation is run with $k_{w,max} = 1.0$.



(a) Coast, $z_{max} = 10m$

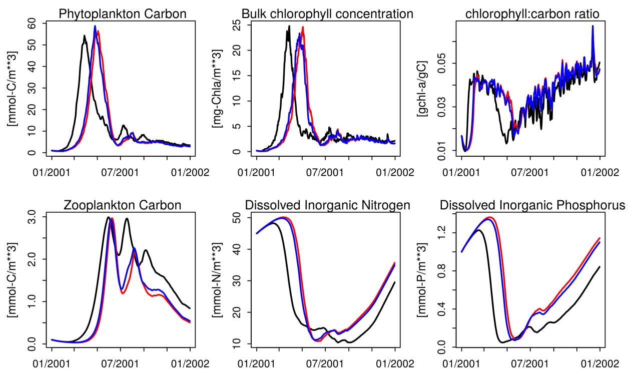


(b) Helgoland

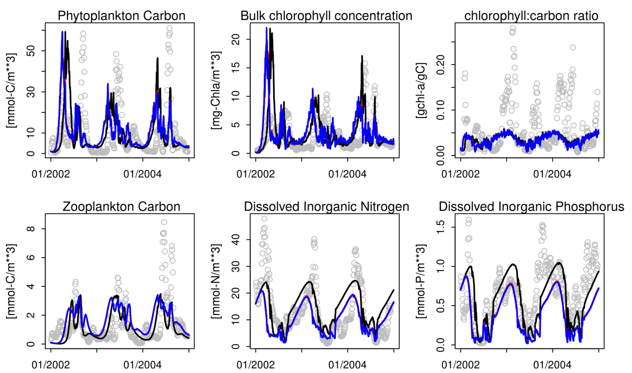


(c) Off-shore

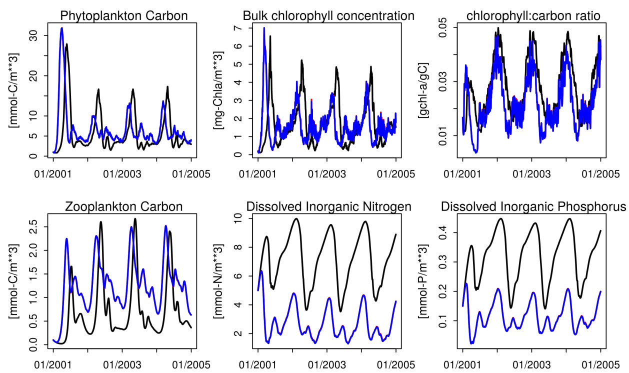
Figure 3: kwmax=5. Black: kw=0.4, Red:kw=f(z), Blue:kw=f(z,t)



(a) Coast, $z_{max} = 10m$



(b) Helgoland



(c) Off-shore

Figure 4: kwmax=1. Black: kw=0.4, Red:kw=f(z), Blue:kw=f(z,t)

4 Implementation in MAECS 3-D

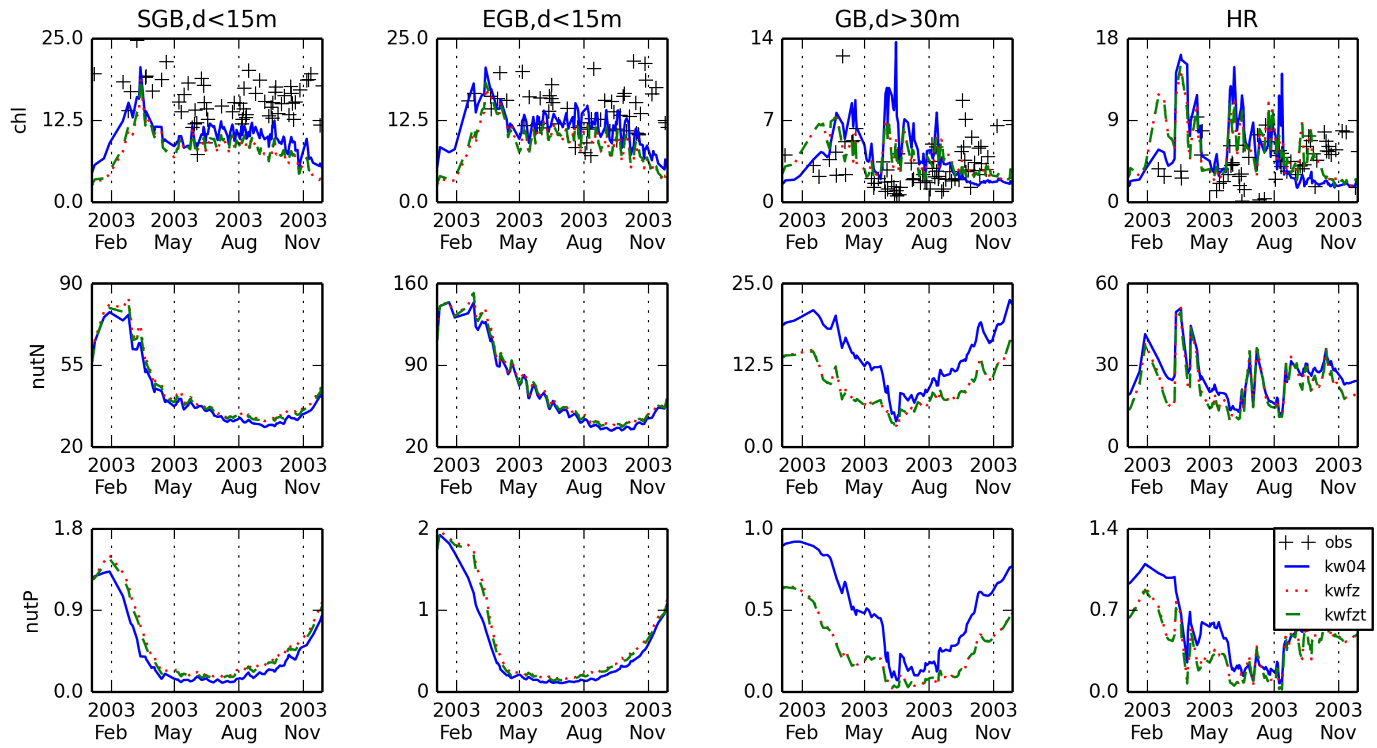


Figure 5: Surface concentrations of chl, DIN and DIP averaged over the Southern German Bight (SGB), Eastern German Bight (EGB), German Bight and Helgoland Roads, as shown in Fig.6. Note that $k_{w,max} = 1.0$

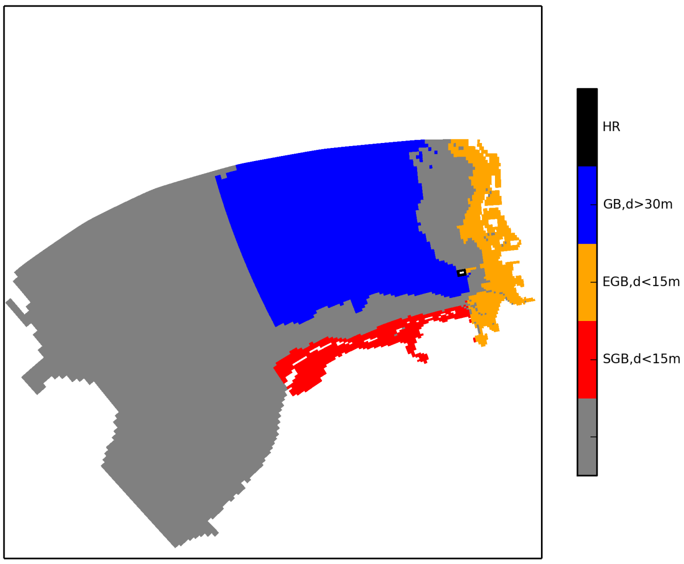


Figure 6: regions shown in Fig.5

FOR PEOPLE AND THEIR
FUTURE ENVIRONMENT

Helmholtz-Zentrum
Geesthacht
Zentrum für Material- und Küstenforschung

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung GmbH
Max-Planck-Straße 1
21502 Geesthacht
www.hzg.de

ISSN 2191-7833

wissen
schafft
nutzen