#### Reviewer #1: https://doi.org/10.5194/gmd-2021-427-RC1

We want to thank the reviewer for carefully reading our manuscript and for thoroughly checking references, equations, and numbering. Especially given the length of this mansucript. It seems we had an error in the numbering of equations, figures, and tables. We carefully went through the whole manuscript again and to our best knowledge have identified and corrected all typos and mistakes therein. In the following we describe in detail how we addressed the remarks:

### **General comment:**

The manuscript presents detailed description of formulation, development and evaluation of a new biogeochemical marine Hg cycling model MERCY v2.0 as a part of a multi-media modelling system. Developments of multi-media capabilities of Hg dispersion modelling is highly topical. The problem of Hg pollution on a global scale is well recognized and currently assessed under the effectiveness evaluation efforts of the Minamata Convention. Despite other pollutants Hg requires model evaluation in various environmental compartments. However, available developments of Hg modelling in the marine environment are still insufficient. The presented a model of Hg cycling in seawater including transport transformation and bioaccumulation processed. The model is applied as a part of a modelling complex in combination with atmospheric and oceanic transport models, and a seawater biogeochemical model to simulate Hg levels and dynamics in the North and Baltic seas. The results are thoroughly evaluated against observations to reveal the model uncertainties and propose ways for further improvement. For this purpose, a system of detailed statistical analysis is developed and applied based on methods used in atmospheric transport modelling. This statistical evaluation system could be useful for application by other marine chemistry modelers.

The subject of the manuscript is relevant to the scope of the journal and the work makes up a new and original contribution to the modelling science. The scientific approaches applied are adequate and explicitly stated. Description of the modelling methods is sufficiently complete and precise to allow reproduction. The manuscript will be suitable for publication after addressing comments mentioned below.

## Specific comments:

Generally, the manuscript contains a large number of typos and misprints and requires careful editing.

#### A: We checked the whole manuscript and corrected all errors to our best knowledge.

Page 3, lines 84: "While there is a large number of emissions ..."

Probably, there should be mentioned a large number of emission inventories.

#### A: Corrected

Page 7, lines 182: "... change in concentration of Hg state variables over time  $\delta C/\delta t$  is estimated by the prognostic equation..."

 $\delta C/\delta t$  is unnecessary here. The partial derivative describes the change rate. The change itself requires integration of the equation over time.

## A: Thanks for pointing out this inaccuracy. We now make clear that we talk about the rate of change so that the equation is correct.

Page 9, lines 220-227: "… *Bioconcentration* … *remineralization rate (see Eq. 9 in Section 2.3.1)*. …" Notations of variables and parameters used in this paragraph differ from those in Eq. 5. It complicates understanding.

**A:** We now use the same variable  $k_{rem}$  in both equations for the remineralization rate.

Page 10, Figure 1: The oxidation pathway via formation of the intermediate oxidation product (Hg\*) is not included to the model (page 13, line 280) but shown in the model scheme.

## A: We corrected the figure.

Page 12, Table 3: Reactions R5, R13, R18 and R20 are not shown in the model scheme (Fig. 1).

# A: We corrected this in figure 1. Please note that the R20 is extending left from Hg<sup>0</sup> out of the figure. We clarified this in the caption.



Figure 1: Corrected MERCY v2.0 Hg chemsitry scheme.

Page 13, line 282: "... oxidation (R5) ...". Should be R4.

## A: Corrected

Page 13, line 283: "... *oxidation (R6) rates* ...". Should be R5.

## A: Corrected

Page 13, line 287: "... of MeHg+ (R19), which ...". Should be R20.

## A: Corrected

Page 15, lines 339-341: Species HgOHCl(aq), Hg2+-POC(s) and MeHg+-POC(s). are absent in Table 2. MeHg+-POC(s) is also absent in Fig. 1.

A: We corrected both Figure 1 and Table 2. We found additional mistakes in Table 2 that were corrected as the species Hg and MMHg bound inside detritus is no longer part of the Hg scheme due to its negligible impact. But the species have still been mentioned in the table from an earlier version of the manuscript.

Nr.	Species	Description	State	Compartments
1-2	Hg <sup>0</sup> <sub>(g)</sub>	gaseous elemental mercury	gaseous	atmosphere, water
3	$Hg^{2+}_{(g)}$	gaseous oxidized mercury	gaseous	atmosphere
4	Hg <sub>(s)</sub>	mercury bound to particulate matter	solid	atmosphere
5-6	Hg-POC <sub>(s)</sub>	mercury bound to particulate matter	solid	water, sediment
7-13	$Hg^{2+}(s)$	dissolved oxidized mercury accumulated inside biota	solid	biota* (see Section 2.3.4)
14-17	$Hg^{2+}(s)$	dissolved oxidized mercury attached onto biota	solid	biota* (see Section 2.3.4)
18	Hg(OH) <sub>2(aq)</sub>	mercury hydroxide	dissolved	water
19	HgOHCl	Mercury hydroxy chloride	dissolved	water
20	Hg(Cl) <sub>2(aq)</sub>	mercury chloride	dissolved	water
21	Hg-DOM <sub>(aq)</sub>	mercury bound to dissolved organic matter	dissolved	water
22	HgS <sub>(s)</sub>	cinnabar	solid	water
23	HgS-DOM	cinnabar bound to dissolved organic matter	dissolved	water
24	MMHg <sup>+</sup> -POC <sub>(s)</sub>	methyl mercury bound to particulate organic matter	solid	water
25-31	MMHg <sup>+</sup> <sub>(aq)</sub>	dissolved methyl mercury accumulated inside biota	solid	biota* (see Section 2.3.4)
32-35	MMHg <sup>+</sup> <sub>(aq)</sub>	dissolved methyl mercury attached onto biota	solid	biota* (see Section 2.3.4)
36	MMHgOH <sub>(aq)</sub>	methyl mercury hydroxide	dissolved	water
37	MMHgCl <sub>(aq)</sub>	methyl mercury chloride	dissolved	water
38	MMHg-DOM <sub>(aq)</sub>	methyl mercury bound to dissolved organic matter	dissolved	water
39-40	DMHg <sub>(g)</sub>	dimethyl mercury	gaseous	atmosphere, water

Table 2: Corrected MERCY v2.0 Hg species list.

Page 15, line 282: "… (*Eqs. 10-13*). …". Should be (Eqs. 10-12).

### A: Corrected

Page 15, line 355 and hereafter: Units of non-dimensional parameters can be given as [1] or [n/d]. A: We replaced all [] by [1].

Page 16, line 369: "... (*Table 2*) ...". Should be (Table 1).

### A: Corrected

Page 42, line 953: "... *Figure 14* ...". Should be Figure 15.

#### A: Corrected

Figures 7, 9 and 17: The circles showing measured data in the figures are very small and not readable.

A: It seems that our high resolution png files have been compressed in the production pdf file and some captions and ledgends are not readable anymore. We now changed these to using a larger font size and increased the circles representing observation. However, if the circles become too large individual obervations become superimposed and the information is partially lost. We think that we found a reasonable compromise here. Moreover, we want to stress that due to the high resolution readers are able to zoom in on the figures to see more details.

Figure 13: The upper and lower panels are not signed in the caption. The legend is not readable.

#### A: Corrected

Figures 14, 15, 16, 19: The legends are not readable.

#### A: Corrected

Figure 18: The panels are not signed in the caption.

#### A: Corrected