Comment 2: Modelling and forecast of global climate (sea-level [SL] and ocean-heat-content [OHC]) based on mutimillennia lagged and recurrent solar influences.

In order to continue complementing the *ESD-2021-84* paper in discussion, the present comment 2 is associated with two of the main global climate variables, sea-level [SL] and ocean-heat-content [OHC, estimated with the ocean mean temparature (MOT)].

These two global climate variables are explained and forecasted taking into account the mutimillennia lagged and recurrent solar influences. As the five variables firstly analyzed in the *ESD-2021-84* paper, these two oceanic variables, are also explained with the slow oceanic transports mentioned in discussion, however these two variables require both longer accumulated distances and their associated "travel times", considering the surface and subsurface flows of the well known OCB.

Then these two mentioned global climate variables will be analyzed. Firstly, sea level records have been reconstructed using several techniques. One important technique considered the Red Sea as a reservoir that "register" SL variations for the Holocene (Sidall et al., 2003; S03). Another, independent reconstruction of SL for the last two and a half millennia is considered (Kopp, et al., 2016; K16)

The model employed to express the SL variability is the model 1, shown in the main document of this work (ESD-2021-84). Using this model, SL is expressed as a lagged linear transformation and trend adjusted of solar activity, the lag applied is 5.7 Kyr. This is shown in Figure 2.1. Although there are periods, for instance 8.6-6.6 Kyr BP, with significant differences, the rest of the Holocene SL is explained well with the adjusted model. This model also provided information to forecast SL for the next two millennia with oscillating but increasing trend.

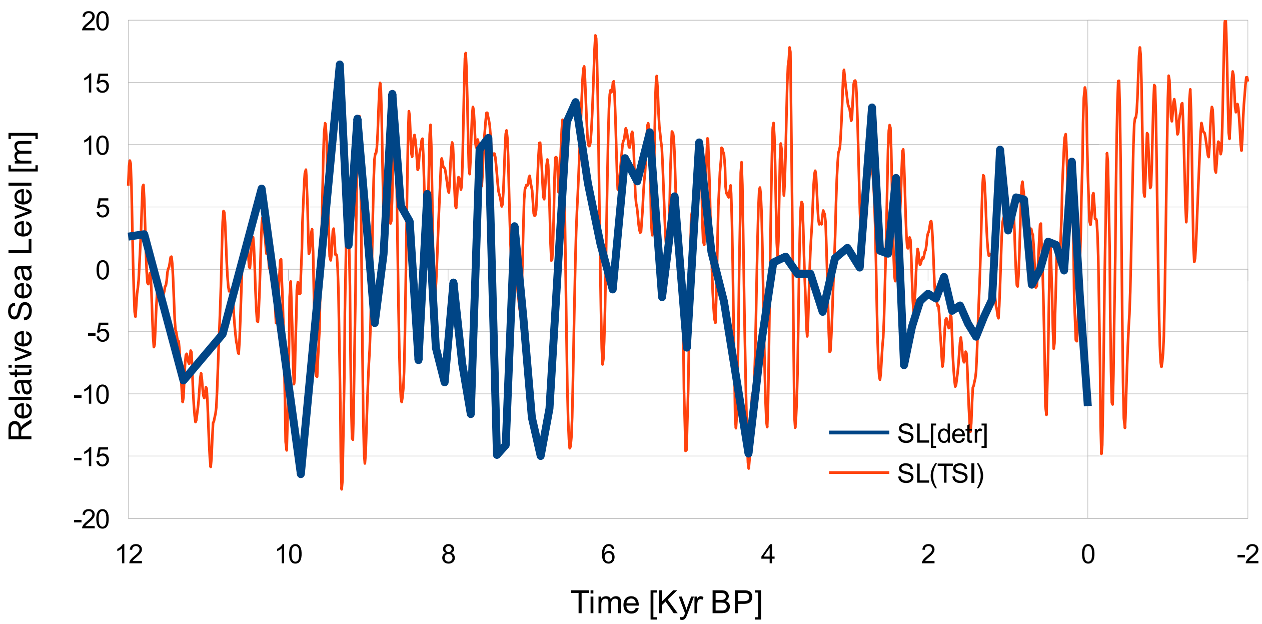


Figure 2.1 Modelling and forecast of SL record over the last 12 and future 2 Kyr, respectively. The SL record (S93) is modelled based on the TSI record (SS16).

Anoher model is employed to express the SL variability but considering Greenland temperatures (GrT). Using also model 1, SL is expressed as a lagged linear transformation and trend adjusted to GrT reconstructed record (Kobashi, 2018) the lag applied is 1.8 Kyr. This is shown in Figure 2.2 based on a lag for GrT of around 1.8 Kyr. The lag respect the solar activity is evaluated adding 3.85 Kyr that is the estimated lag (See Table1 of the *ESD-2021-84* paper). Then the lag respect TSI is estimated as (3.85+1.8 Kyr) 5.65 Kyr.

This model also provided information to forecast SL for the next two millennia with oscillating and increasing trend only in the first next centuries, and following with a decreasing trend.

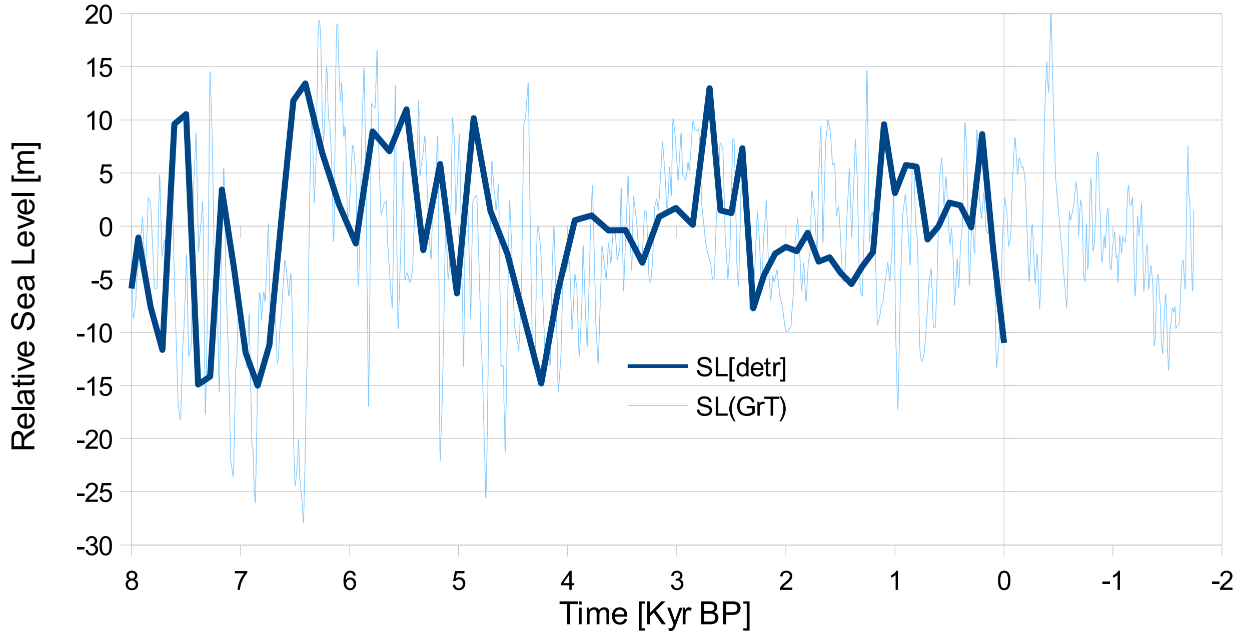


Figure 2.2 Modelling and forecast of SL record over the last 8 and future 2 Kyr. The SL record (S03) is modelled based on the GrT record (K18).

The two SL models employed show two catastrophic scenarios for the SL variability for the next centuries. However in these two graphs, 2.1 and 2.2, the SL record developed by S03 shows a decreasing trend over the Holocene. An important comparison is shown in Figure 2.3 between the SL S03 record and the second model SL(GrT), for the last 2.5 Kyr, with a more recent SL reconstruction provided by K16.

This comparison, of SL records show two important aspects. First, one is a huge decreasing of sea level changes respect those presented some millenia before. For instance, the values estimated with the SL K16 reconstruction, are around 100 times lower than those estimated by the SL S03 [meters to centimeters]. And second, there is a the good modelling performance of the SL(GrT) for the more recent SL reconstruction developed by K16.

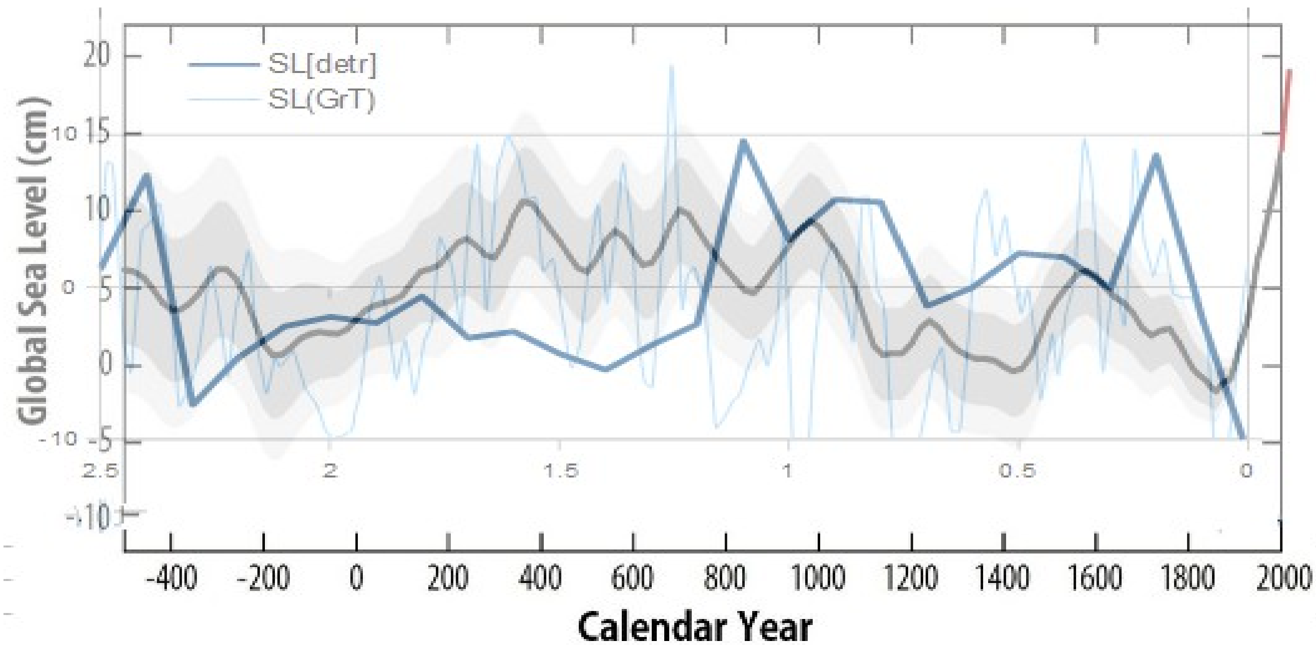
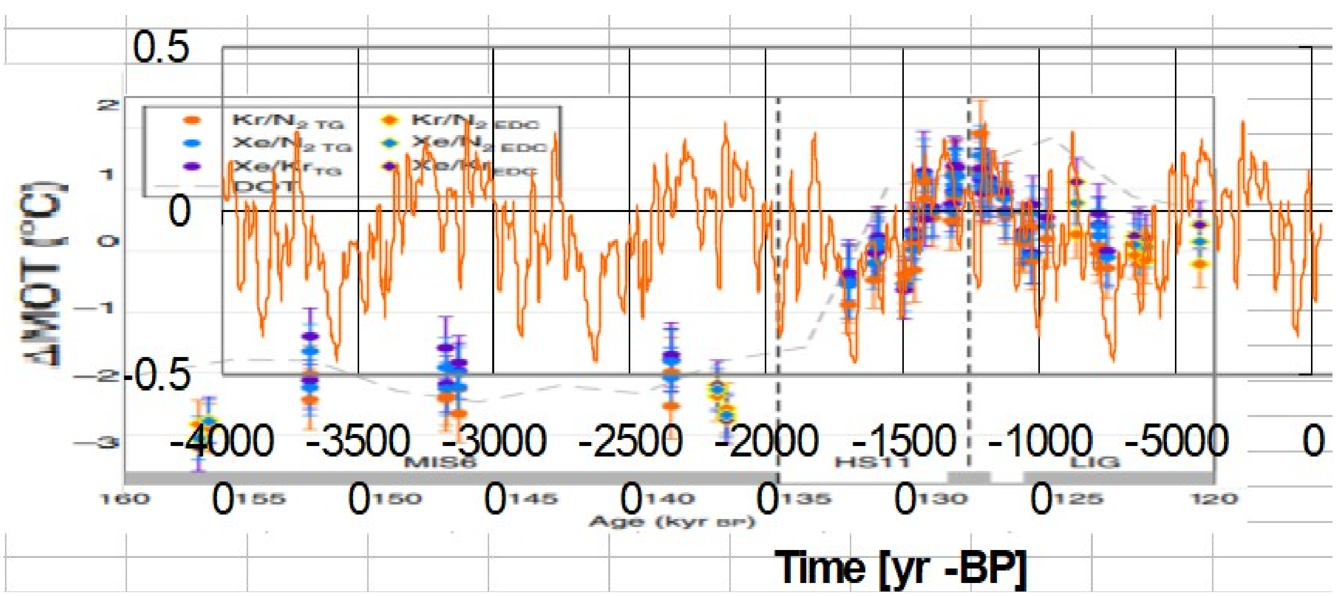


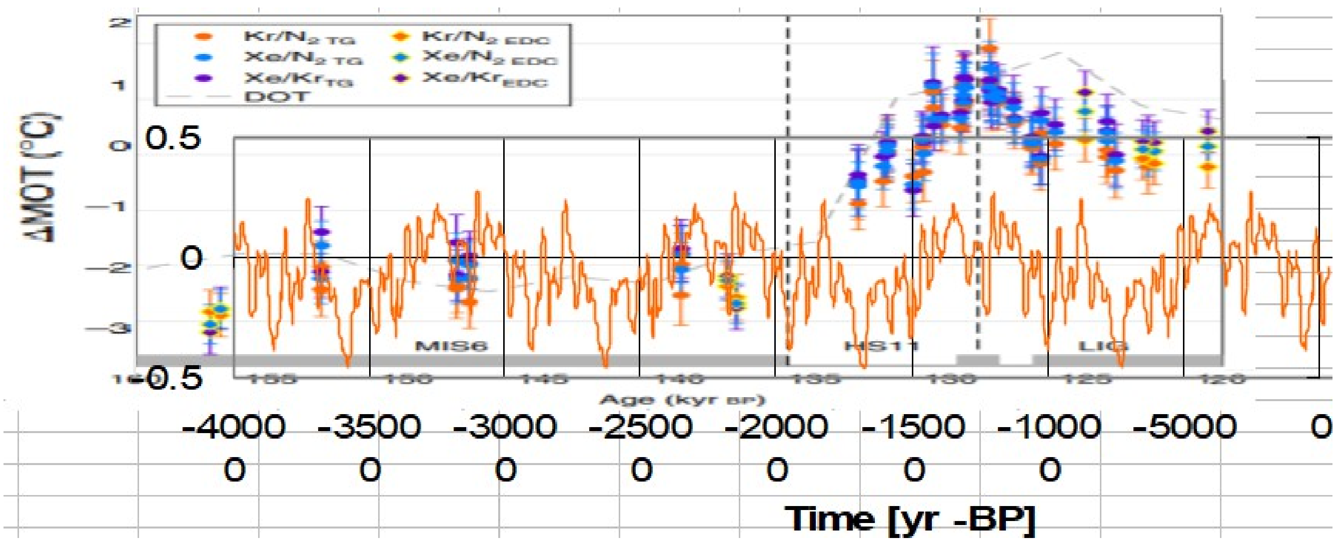
Figure 2.3 Comparison of SL records and model for the last 2.5 Kyr. SL S03 (Dark blue line) reconstruction [with small numbers in Kyr BP and meters] and its model SL(GrT) are compared with SL K16 (Gray line) [with greater numbers in Calendar Year and SL in centimeters]. The SL(GrT) model follow the Kopp values of SL that indicate SL values 100 times lower than those estimated by Sidall.

The second variable to be analyzed is the ocean-heat-content (OHC) or mean ocean temperature (MOT). There are two MOT records that have been reconstructed using a technique based on the rare gases content in ice-cores. These gases "registered" MOT variations both for the Eemian (Shackleton, et al., 2019; S19) and the Holocene (Bereiter et al., 2015; B15) periods.

The model employed to express the OHC variability is, also the model 1, shown in the main document of this work (ESD-2021-84). Using this model, MOT is expressed as a lagged linear transformation and trend adjusted to solar activity. On one side, Figure 2.4 shows the analysis for the Eemian MOT considering a lag of around 7.5 Kyr.



a)



b)

Figure 2.4 Graphical modelling and forecast of OHC (or MOT) record over the 155 to 120 [Ky BP] based on recurrent and lagged TSI variation (matching TSI time at 0 yr BP with 116Kyr BP [9.5 Kyr*13-7.5 Kyr] of Eemian reconstructed record S19); a) the TSI record matching the Eemian interglacial; b) the TSI record matching the 20 Kyr period prevoius to the Eemian.

On the other side, Figure 2.5 shows the analysis of deglaciation and Holocene MOT record, considering a lag of around 7 Kyr.

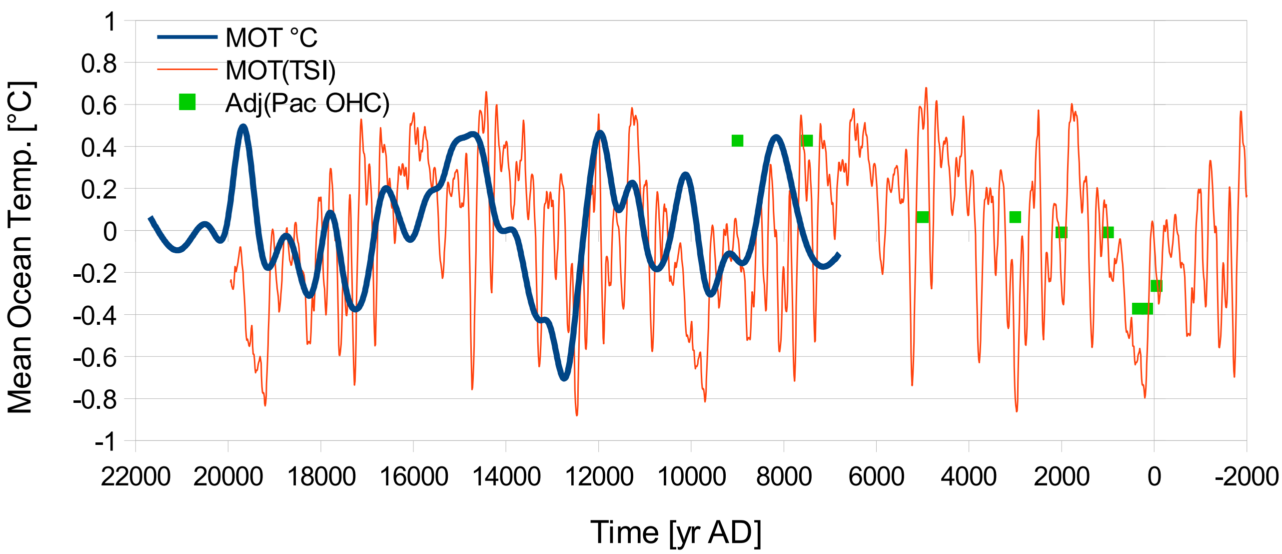


Figure 2.5 Modelling and forecast of MOT from WAIS ice-core (B18) and its modelling based on lagged TSI variation. Green squares indicate Ocean heat content converted to MOT values for the Pacific Ocean (Rosenthal et al., 2013).The TSI lag employed is 7.0 Kyr.

The delayed solar influences on both SL and MOT variations provide additional elements to better model climate variabilities, and more than 2000 years of global marine climate forecast.

The two presented global forecasts, for SL and MOT, provide further elements to accept the OCB with its surface and intermediate ocean circulations where thermal anomalies are transported, to all the world.The model for lags of solar influences and their accumulated distance,complemented with two red points corresponding to SL and MOT is shown in Figure 2.6. The sea level with a lag of 5.7 Kyr,is associated with an accumulated distance of 16 Earth's Equatorial Circumference (EEC)/4 when the deep flows go around the Antarctic continent. The mean ocean temperature with a lag of 7.2 Kyr, is associated with an accumulated distance of 19 of EEC/4 when the deep flows go around the North Pacific. [Please note that EP is changed by EEC]

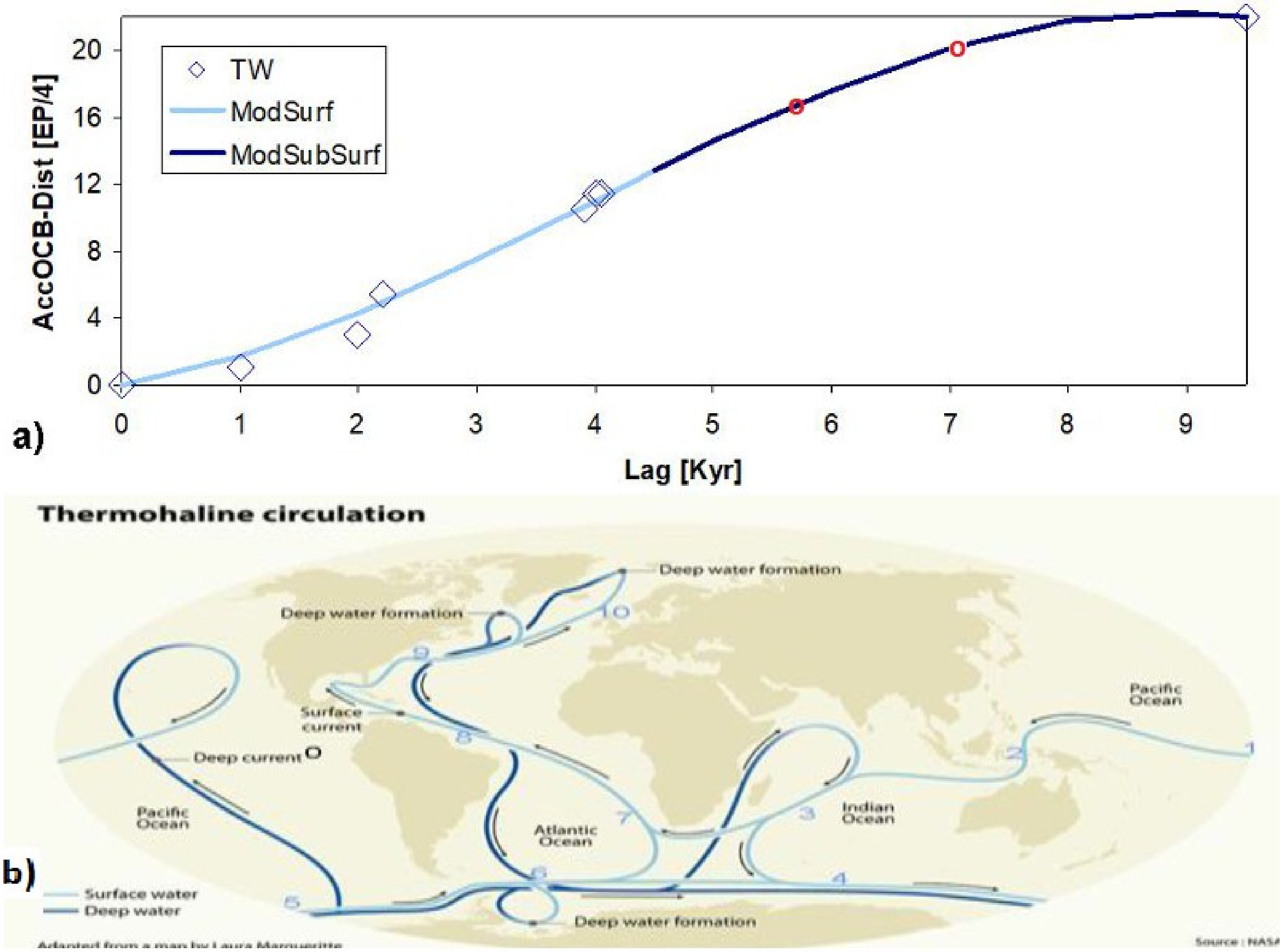


Figure 2.6 Modelling of OCB-lagged climate connections and its graphical surface and deep ocean currents. a) the lags and accumulated distance model for surface and deep flows, including with red circles the SL and MOT lags and their accumlated distances; b) the graphical representation of the OCB with surface (light blue) and deep (dark blue) circulations.

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