Correction to "Tracing the upper ocean's missing heat"

C. A. Katsman[1] and G. J. van Oldenborgh[1]

1. Introduction

Colleagues brought to our attention an error in one computation in "Tracing the upper oceans missing heat" [*Katsman and van Oldenborgh*, 2011]. In the paper, we present modeled distributions of 8-yr trends in upper ocean heat content (UOHC) for the periods with central years ranging from 1969–1999 (Fig. 2a) and for the period 1990–2020 (Fig. 2b). In these figures, 11% and 3% of the distribution consists of zero or negative trend value, respectively.

In converting this percentage of running 8-yr periods with no increase in UOHC into the probability that one or more of these events would occur, we inadvertently used a

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C. A. Katsman, KNMI, Global Climate Division, 3730 AE De Bilt, Netherlands (caroline.katsman@knmi.nl)

G. J. van Oldenborgh, KNMI, Global Climate Division, 3730 AE De Bilt, Netherlands

[1]KNMI, Global Climate Division, De Bilt,

Netherlands

formula that assumed the 8-yr trends were independent. This is obviously not the case, as the periods are overlapping.

2. Corrected results

We have recomputed the probability in two ways. The first was simply counting the number of ensemble members that show a negative trend in these years. The second method consists of estimating the decorrelation time T_d by the lag at which the auto-correlation of the time series of 8-yr trends is $1/e$ and defining the number of degrees of freedom $D = N/T_d$, with $N = 31$ years is the length of the considered time period. The probability P of an 8-yr period without an increase in UOHC is then calcaluated from $P = 1 - (1 - p)^D$ with p the probability of a negative trend value derived from the distributions displayed in Figure 2 of the paper.

For the 8-yr trends, the decorrelation time T_d is about 3 years, so that $D \approx 10$. For the historical period 1969-1999 both methods give a 65% chance of one or more 8-yr periods with a negative trend, rather than the 97% chance mentioned in the caption of Figure 2. For the 1990–2020 period the estimates are 25–30% rather then the reported 57% (Section 3, caption of Fig. 2).

Section 4 of the Supporting Material contains a similar computational error with regard to the distribution of 9-yr periods. For this case, we calculated that $T_d \approx 3.5$ years, so $D \approx 9$ degrees of freedom. The distribution of 9-yr trends has 2.1% negative trends in UOHC for 1990–2020, and 0.4% for 2000–2030. The corrected calculation yields a 5–15% probability of at least one period with a 9-yr negative trend occurring in 1990–2020 and 0–5% in 2000-2030, rather than the reported 48% and 11%.

3. Conclusion

Despite the computational error, the statement that "the analysis reveals that an 8-yr period without upper ocean warming is not exceptional" [abstract of *Katsman and van Oldenborgh*, 2011] remains valid.

The computational error has no impact at all on the analysis in the remainder of the paper, from which we concluded that such a period without upper ocean warming is explained by increased radiation to space, largely as a result of El Niño variability on decadal timescales, and by increased ocean warming at larger depths, partly due to a decrease in the strength of the Atlantic meridional overturning circulation.

References

Katsman, C. A., and G. J. van Oldenborgh (2011), Tracing the upper ocean's 'missing heat', *Geophys. Res. Letters*, *38*, L14,610, doi:10.1029/2011GL048417.