Supplemental Material for "The Longwave Cloud-radiative Feedback in Tropical Waves Derived by Different Precipitation Datasets" by Hsiao and Maloney

The supplemental material includes supplemental text (Text S1) describing the method for estimating statistical confidence intervals for the greenhouse enhancement factor, and supplemental figures (Figures S1-S3) demonstrating sensitivity tests using different outgoing longwave radiation (OLR) products.

Text S1

To obtain the 95% confidence interval (CI) of the greenhouse enhancement factor (GEF), we calculate the expected value of the GEF by linear regression of OLR onto precipitation (P). Then, the statistical significance interval based on a Student-t test can be written as:

$$GEF \pm t(0.025, n-2) \cdot s_{GEF}$$

where s_{GEF} is the estimated standard error of GEF, and the term t denotes the value where the cumulative probability density is at 0.025 in a Student-t distribution with n - 2 degrees of freedom. Here, n can be estimated as the number of individual samples, which will be discussed later. s_{GEF} can be obtained as:

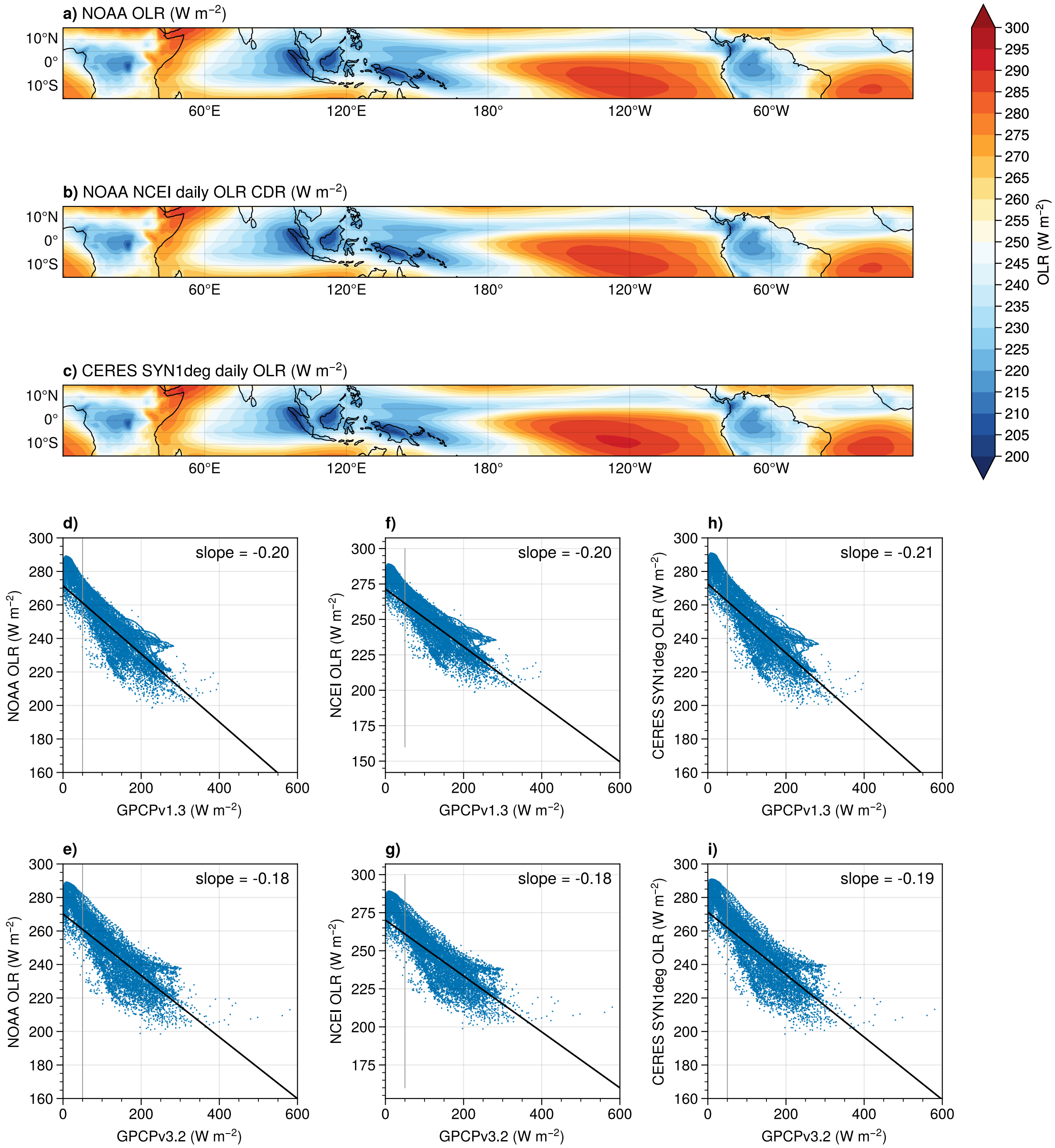
$$s_{GEF} = \sqrt{\frac{\sum_i \left[\left(P_i - \widehat{P_i}\right)^2\right]}{\sum_i[(OLR_i - \overline{OLR})^2]} \cdot \frac{1}{n-2}}$$

where subscript *i* denotes sample counts, $\widehat{P_i}$ denotes the predicted value of P by OLR based on the linear fit, OLR is the mean of OLR, and n denotes the number of individual samples.

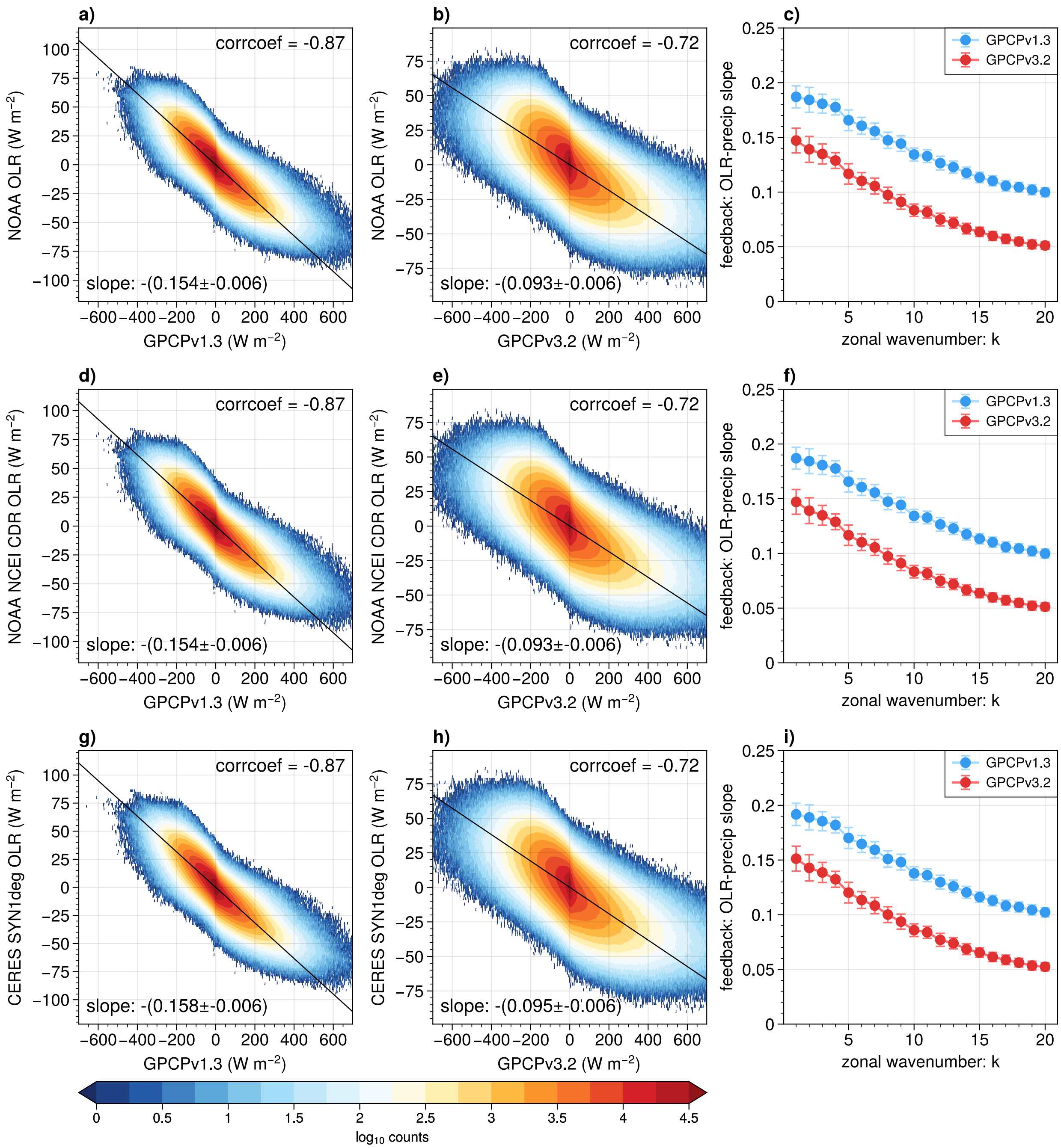
In this study, we estimate the n using OLR products, which have fewer degrees of freedom than precipitation products, to generate stricter (larger) significance intervals. The spatial degree of freedoms are estimated following the "moment-matching" method in Bretherton et al. (1999), which provides a more conservative degree of freedom than other methods utilizing empirical orthogonal functions. The temporal degree of freedoms are estimated by dividing the total length of the timeseries by the decorrelation time scale of the given OLR data. In particular, the decorrelation time scale is estimated with the following procedure considering that the correlation coefficients (*r*) exhibit wave-like behavior along the lead-lag time axis using temporally filtered data. First, the first peaks where the correlation coefficient (*r*) is smaller than e^{-1} on both leading or lagging sides are located, say, which have $r(t_{-1})$ on the lag side and $r(t_1)$ on the lead side. The width where *r* first touches zero is defined as the decorrelation time scale, which is estimated by linearly extrapolating the decay of *r* at t_{-1} and t_1 away from t = 0. The decorrelation time scale (t_d) is calculated with the following equation using only data over 1 September 2000 to 31 August 2003 for computational considerations:

$$t_d = \frac{t_{-1}}{1 - r(t_{-1})} + \frac{t_1}{1 - r(t_1)}$$

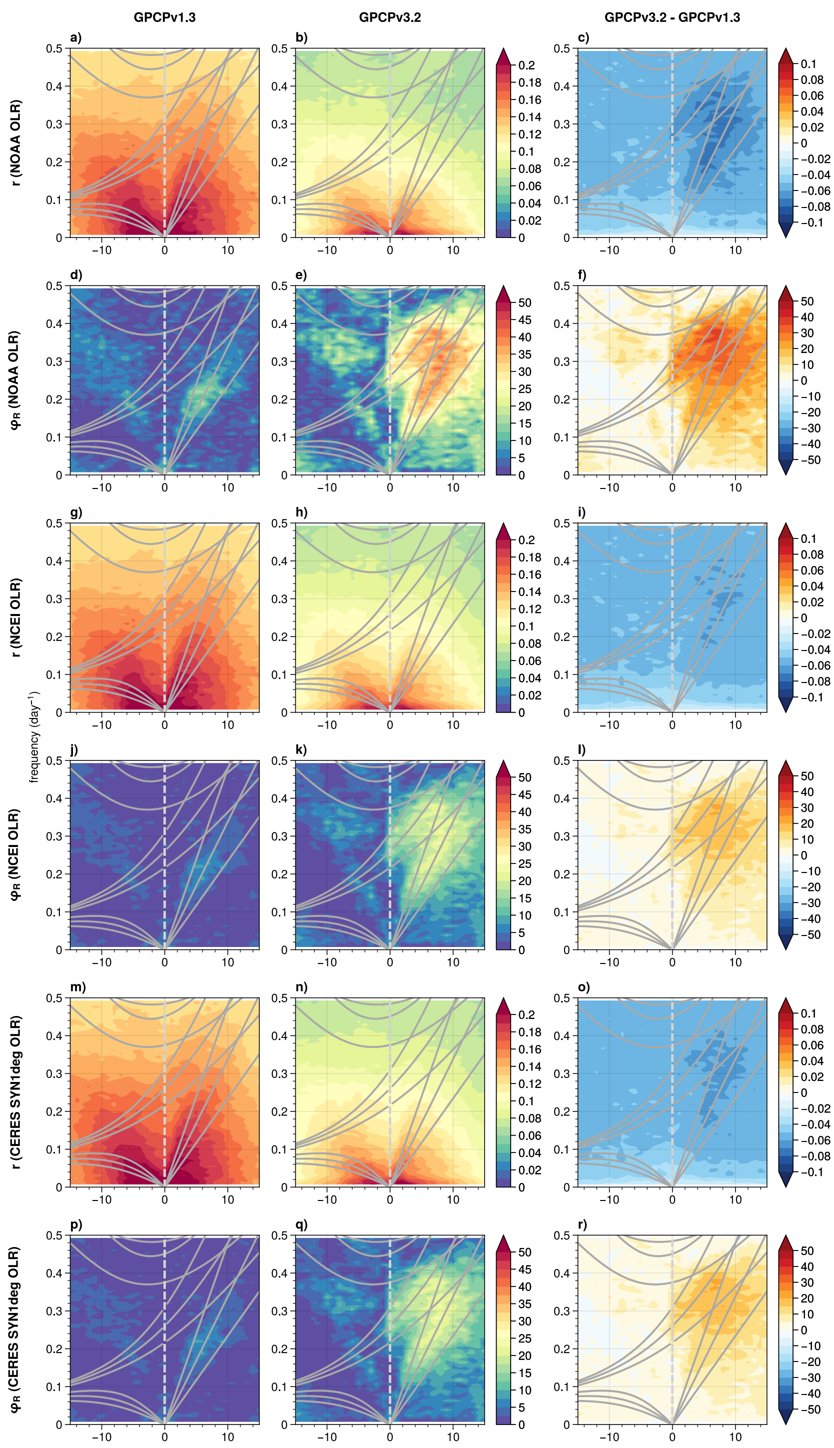
Finally, multiplying the spatial degree of freedom by the temporal degree of freedom yields n. Inserting the value of n into the previous equations yields the significance interval of GEF.



[Figure S1. As in Figures 2d, showing the annual-mean climatological OLR from (a) NOAA OLR, (b) NOAA NCEI CDR daily OLR, and (c) CERES daily OLR. Also as in Figure 2e-f, showing the relationship between two versions of GPCP annual-mean climatological precipitation and OLR from (d-e) NOAA OLR, (f-g) NOAA NCEI CDR daily OLR, and (h-i) CERES daily OLR.]



[Figure S2. As in Figure 3, showing the histograms of 20-100 day filtered OLR and precipitation over the Indo-Pacific warm pool (60°E-180°, 15°S-15°N) using the OLR product of (a-c) NOAA OLR, (d-f) NOAA NCEI CDR daily OLR, and (g-i) CERES OLR.]



[Figure S3. (a-f) as in Figures 4d-i, while (g-l) uses NOAA NCEI CDR daily OLR, and (m-r) uses CERES SYN1deg OLR.]