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Interactive comment on "Analysis of the decrease in the tropical mean outgoing shortwave radiation at the top of atmosphere for the period 1984–2000" *by* A. Fotiadi et al.

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I. General Comments

Indeed, cloud amount, Ac (as taken by ISCCP-D2) is a major determinant of OSR in the model used, but it is not the only one since the model takes also into account the effects of other physical parameters, such as cloud optical depth, precipitable water etc. In this sense, it is true that the correlation results shown in the original paper are some measure of the model's OSR sensitivity to cloud amount and to other parameters. Thus, to check the reliability and usefulness of the correlation results between OSR and cloud amount, we have performed a similar correlation between ERBE-S4

OSR flux and ISCCP-D2 cloud amount anomalies, as suggested by the referee. This was done for only the period 1985-1889, based on the availability of ES-4 data, at the pixel level (i.e. for 2.5degx2.5deg latitude-longitude regions). The scatterplot, consisting in 207360 box matched data pairs, gave a correlation coefficient equal to 0.69, which is comparable to the coefficient of 0.785 between 17-year (1984-2000) model OSR flux and ASCCP-D2 cloud amount anomalies (given in the original paper). Furthermore, to make more realistic the comparison between the two correlations, we have repeated the correlation between model OSR flux and ISCCP-D2 Ac anomalies, but for the corresponding period 1985-1989. The resulting correlation coefficient was equal to 0.76, which is closer (compared with 0.785) to the value of 0.69 between ES-4 and ISCCP Ac anomalies. In addition, we computed the correlation between 5-year (1985-1989) model OSR and ERBE-S4 flux anomalies, resulting in a very good correlation coefficient, equal to 0.86. These values support the representativeness of the results presented in this study. In this matter, we have added a Figure (Fig. 4b), which in combination with the previous Fig. 4 (now Fig. 4a), further supports the conclusions taken from this study. We have also added a Figure (Fig. 1c), which displays the differences between our model results and the ERBE-S4 OSR values (Figs. 1a and 1b), as suggested by the referee. In addition, the quality of Figures 3, 5, and 6 has been improved.

II. Specific Comments

1. The version of ERBE S-10N non-scanner data (edition 2) used in this study has been specified in the Abstract (page 456, line 22). Also, the corrected tropical mean OSR trend of 2.1 Wm-2, based on ERBE S-10N non scanner data including corrections, was reported in section 4 (page 464, line 27).

2. In the Abstract, it is has been noted (page 464, line 19) that the increase in solar planetary heating is accompanied by an increased planetary cooling, due to increased outgoing longwave radiation, resulting thus in unchanged net radiation budget.

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3. The acronyms ERBS WFOV, ERBE/ERBS, ScaRab and CERES were defined (page 457, lines 20-21).

4. Page 5 (i.e. 459), lines 2-4. The sentence starting with "For example, ..." was re-written clarifying that "cloud type" refers to low-, mid- or high-level clouds.

5. In this study, we extend the study by Hatzianastassiou et al. (2004a), by focusing on tropical and subtropical regions (30degS-30degN), whereas Hatzianastassiou et al. (2004a) dealt with distributions of OSR, but on the global scale. In addition, in this study we analyse and examine trends in tropical OSR in more detail by using both model computations and satellite observations, and we attempt to identify and quantify the physical sources of OSR trends. These were explicitly stated in the Introduction (page 459, line 8) as indicated by the referee.

6. Yes, "pixel" meant 2.5degx2.5deg latitude-longitude region. In any case, the relevant part has been removed from the text (section 2), according to the suggestion by referee #1.

7. The relevant part of the text (page 460, lines 12 through the end of page) has been removed, according to referee #1, in order to avoid repetition of the work by Hatzianastassiou et al. (2004a). Nevertheless, the uncertainties in ISCCP variables are given by Rossow and Schiffer (1999). As far as it concerns the ISCCP-D2 cloud amount, the uncertainties are $< 5\%$, except in the summertime polar regions (where the bias may be up to 10%). Note that the trends found in our study, especially those for low-level clouds (9.9%+/-0.8%), significantly exceed the uncertainties in ISCCP-D2 cloud amount.

8. The model assumes a plane-parallel atmosphere. The computation of OSR as function of cloud amount is given in detail in the work by Hatzianastassiou et al. (2004a) (Eqs. 13 and 15), and actually considers a type of linear function of cloud amount. We note that the relevant part (page 460, lines 21-) has been removed from the text.

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9. The relevant part of the text (page 460, lines 26-28) has been removed. However, in response to the referee's comment, a note was made on page 461, line 6, that low-, mid-, and high-level clouds are classified according to the ISCCP scheme. The cloud phase functions in the model are consistent with those used in the ISCCP retrieval algorithm.

10. The corrections indicated by the referee were not applied since the relevant part of the text (page 461, lines 20-29, and page 462, lines 1-9) was removed.

11. We have replaced the word "pixel" with "2.5degx2.5deg latitude-longitude region" when referring to ERBE 2.5ž resolution data, as indicated by the referee.

12. According to the referee's suggestion, we have added a deference plot in Fig. 1 (i.e. Fig. 1c), which shows the difference in OSR at TOA between model computations and ERBE-S4 scanner data (i.e. Fig. 1a - Fig. 1b).

13. As suggested by the referee, we have broken section 4 into two subsections. The first one, named "Tropical interannual OSR flux anomalies: Model versus ERBE S-10N", starts on page 463, while the second one, named "Correlation analysis of OSR flux and ISCCP cloud anomalies", starts on page 465.

14. Page 463, line colors have been specified according to the improved Fig. 3.

15. In page 463, line 12, it has been specified how the anomalies shown in Fig. 3 have been determined (actually, they are deseasonalised anomalies). Also, the quality of Fig. 3 has been improved, and we hope that the line of cloud amount anomaly is easier to see now.

16. Indeed, cloud amount (Ac) is a major determinant of OSR flux in our model, though it is not the only one; for example cloud optical depth or asymmetry parameter are also important. In this sense, one can really state that the correlation between model OSR flux and ISCCP-D2 Ac anomalies can be considered as a model sensitivity. To check the representativeness of the correlation results, we have performed another

correlation between the 5-year (1985-1989) ERBE-S4 OSR flux and ISCCP-D2 Ac anomalies, as suggested by the referee. The computed correlation coefficient is equal to 0.685, i.e. it is close to the coefficient of 0.785 between 17-year model OSR flux and ISCCP-D2 Ac anomalies. This finding supports the conclusion drawn from the results of this latter correlation (Fig. 4 in the original version). In particular, getting the two correlations absolutely comparable, i.e. repeating the latter correlation on the basis of 5-year period 1985-1989, the correlation coefficients are equal to 0.685 and 0.76, i.e. they are very close. As regard to this, we have inserted a new figure (Fig. 4b), referring to the correlation between ERBE-S4 OSR flux and ISCCP-D2 Ac anomalies for 1985-1989, accompanying the figure of the original correlation (model OSR flux and ISCCP-D2 Ac anomalies for 1985-2000), which was renamed to Fig. 4a in the revised manuscript. Also, a relevant note was made in the text, in page 466, line 2.

17. "OSR flux anomaly" was replaced by "model-based OSR flux anomaly" in page 466, line 14, as suggested by the referee. This was also done in each occurrence throughout the text.

18. Redundancy has been removed in page 467 (lines 4-20).

19. Hatzianastassiou et al. (2004a, Table 4) have shown, based on a sensitivity study, that OSR is more sensitive to changes in cloud amount (as taken from ISCCP-D2) of low-level clouds, than changes in amounts of mid- and high-level clouds. This can be attributed to the optically thicker low-level than higher clouds, especially over southern subtropical oceans. This was mentioned in page 468, line 24.

20. The statistical significance of the long-term trends was examined by applying the Mann-Kendall test to the anomaly time-series.

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