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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Investigation of negative cloud radiative forcing over the Indian subcontinent and adjacent oceans during the summer monsoon season" *by* B. V. Thampi and R. Roca

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Main comments

This paper first finds an interesting cloud radiative forcing (CRF) result, namely anomalously strong negative net forcing (cooling) over the Indian subcontinent and adjacent oceans during the summer monsoon period. Then authors try to understand why those areas (especially three bounded regions) show such strong negative values, contrasting to the near equal shortwave (SW) and longwave (LW) CRFs over the tropics which

are generally accepted view to describe the net cloud radiative forcing over the tropics. Authors finally made a conclusion that increased water vapor over those regions is the main contributor to such anomalous net cooling due to clouds over the tropics. This paper is not only important to find anomalous regions which are not subject to the near cancellation but also to understand the negative features in terms of cloud macroscopic/microphysical physics. The paper is well written and easy to follow. Thus I recommend this paper to be published in the ACP after reflecting comments given below.

Water vapor contribution to the negative net effect. Sohn et al. (2006) cited in this paper gives a cautious warning that near cancellation in CRF between SW and LW radiation should not be interpreted only from perspective of cloud properties. It is because of different atmospheric environment (upper tropospheric humidity in there) between clear-sky portion and all sky should be different. In other words, a clear-sky water vapor distribution corresponding to satellite-derived clear-sky radiation filed should be drier than the overcast area since the cloud development induces UT moistening, and clear-sky radiation fluxes are determined using pixels away from clouds. Environmental difference in water vapor between clear sky and cloudy sky is in fact effectively added in the CRF. Author's diagram (left in Fig.) delineates this view very well. Please find Figure 1 as a part of this review.

1. Thus A and B create an environmental difference between clear sky and total sky, giving rise to bigger cloud forcing than one calculated from the same atmospheric environment (in this paper between C and B). From this figure it is clear that author's LW CRF should be smaller than would be expected from the case allowing the environmental difference. Authors are asked to interpret the result reflecting the perspective of different environment and its impact on the CRF determination.

2. Water vapor damping effect. Even if no environment difference is assumed between clear sky and all sky (here between C and B) there seems to be a water vapor damping effect on the CRF as one of authors pointed out (Roca et al. 2004). It is interesting and

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I think important to understand the nature of cloud contribution to the TOA radiation. What could be the physical explanation of the water vapor damping effect on the CRF?

3. Thus, intercomparison result between Indian subcontinent area and western Pacific can be interpreted differently. Over the western Pacific the water vapor over the clear-sky area may be smaller than the cloudy area (larger difference between clear-sky and total-sky environment), resulting in CRF between A and B. On the other hand, if current analysis area may not have such humidity difference between total and clear sky area, then CRF induced by more or less between C and B. If this is the case, NETCRF difference between India and the western Pacific can be in part explained by the environment contrast. This may be more reasonable in thinking that clouds are generally scattered over the western Pacific (giving rise to larger humidity difference between clear area and cloudy area). Please discuss this possibility.

4. Aerosol influences. It is well known the Indian subcontinent area shows very high aerosol optical thickness. It is not difficult to find maps showing large aerosol optical thickness over the Bay of Bengal and oceanic areas off the subcontinent. Thus it is possible to blame the enhanced cloud reflection associated with aerosols (through indirect effect) as a cause of large negative value of NETCRF. It may be in such way that SW cloud forcing can be unusually high because of the cloud-aerosol interactions, which were not counted in the modeling approach in this study. Please look at this possibility.

Minor comments

I find some grammatical errors in particular related to singular/plural forms of verb. I give some I caught. I am sure there should be more. Please read carefully.

Page 28899, line # 20: is –> are Page 28904, line # 10: suggest –> suggests, exist –> exists line # 9: Inter comparison –> Intercomparison Page 28905, line # 29: in to –> into Page 28906: line #1: do not –> does not

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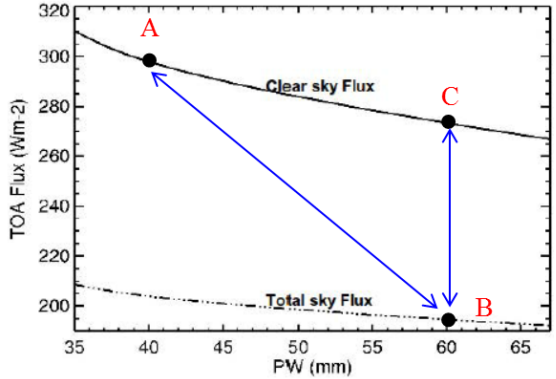

Figure 1 A: water vapor and TOA flux at the clear sky point. The clear-sky area should be drier than the total sky water vapor (B). Of course, clear-sky area is a part of the total sky. Water vapor at point B should be more humid than at clear-sky point A.

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