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Comparative study of five current reanalyses in characterizing total cloud fraction and cloud radiative effects over the Asian monsoon region

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This study evaluates total cloud fraction (TCF) and top-of-the-atmosphere cloud radiative effects (CREs) in five widely used reanalyses (CFSR, ERA-Interim, JRA55, MERRA2 and NCEP1) using satellite-based observations for the period 2001–2014, with the emphasis on the Asian monsoon region (AMR) including East Asia (EA) and South Asia (SA). The results indicate that despite certain biases, most reanalyses (especially CFSR and ERA-Interim) broadly capture global spatial patterns of TCF and CREs, with pattern correlations with the observations being greater than 0.7, and also generally reproduce the pronounced contrast of the winter and summer means over EA and SA. In contrast, biases and differences in TCF and CREs in reanalyses are significantly larger over the AMR, particularly in summer. Over EA, the reanalyses underestimate annual and winter mean TCF, short-wave CRE (SWCRE), and net CRE (NCRE), with negative biases of 0–40%. Over SA, the reanalyses broadly reproduce the observed annual cycles of each CRE component, but most of them have considerable biases in magnitude, with an overestimation of NCRE by up to 90%, and an unrealistic ratio of long-wave (LWCRE) to SWCRE. Such an unrealistic relationship between LWCRE and SWCRE in some reanalyses may produce an unrealistic annual mean state, annual cycle, and inter-annual variation of NCRE over SA. Comparatively, ERA-Interim and JRA55 give better performance in the inter-annual variations of CREs, with a temporal correlation coefficient of about 0.9 with observations over EA. The inter-annual biases of TCF and NCRE in CFSR are substantially larger over SA while its TCF reproducibility over EA is the best of the reanalyses. This study suggests that improving cloud physical properties and developing a consistent description of LWCRE and SWCRE in reanalysis model parameterization are key to obtaining reasonable TCF and CREs over the AMR.
Key words: cloud fraction, cloud radiative effect, reanalyses, Asian monsoon region