Distinct patterns of cloud changes associated with decadal variability and their contribution to observed cloud cover trends

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With the goal of understanding the relative roles of anthropogenic and natural factors in driving observed cloud trends, this study investigates cloud changes associated with decadal variability including the Pacific Decadal Oscillation (PDO) and the Atlantic Multi-decadal Oscillation (AMO). In the pre-industrial simulations of CMIP5 global climate models (GCMs), the spatial patterns and the vertical structures of the PDO-related cloud cover changes in the Pacific are consistent among models. Meanwhile, the models show consistent AMO impacts on high cloud cover in the tropical Atlantic, subtropical eastern Pacific, and equatorial central Pacific, and on low cloud cover in the North Atlantic and subtropical Northeast Pacific. The cloud cover changes associated with the PDO and the AMO can be understood via the relationships between large-scale meteorological parameters and clouds on interannual timescales. When compared to the satellite records during the period of 1983 to 2009, the patterns of total and low cloud cover trends associated with decadal variability are significantly correlated with patterns of cloud cover trends in ISCCP observations. On the other hand, the pattern of the estimated greenhouse gas (GHG) forced trends of total cloud cover differs from that related to decadal variability, and may explain the positive trends in the subtropical Southeast Pacific, negative trends in the mid-latitudes, and positive trends poleward of 50oN/S. In most models, the magnitudes of the estimated decadal variability contribution to the observed cloud cover trends are larger than those contributed by GHG, suggesting the observed cloud cover trends are more closely related to decadal variability than to GHG-induced warming.

Key words: PDO; AMO; Satellite; Cloud cover trend