



A constraint for ice cloud feedback over the tropical Pacific in future climate change

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Tropical ice clouds and their changes in future climate remain challenging issues for global climate modeling and projections. These issues are addressed by examining the interannual variability of ice water path (IWP), an important property of ice cloud, with respect to large-scale vertical velocity in observations, reanalysis and climate model simulations, and by relating the unforced variability to the human-influenced climate change. Here we show that a statistically significant linear relation between interannual anomalies of IWP and 500hPa vertical velocity (ω_{500}) can be identified from all data sets and, moreover, such relationship in each model is closely correlated with its simulated IWP change with respect to ω_{500} change for the future climate. This indicates a robust constraint for the future tropical ice cloud change. Such constraint and observed IWP- ω_{500} relation projects a 12.8%-16.4% increase of IWP for every -0.01Pa/s change of ω_{500} , equivalent to $\sim 2.96\%$ - 3.80% decrease of IWP for circulation change associated with every 1K global surface warming. Such IWP change corresponds to $\sim -0.05 \pm 0.007 \text{ Wm}^{-2}$ ($\sim 0.32 \pm 0.03 \text{ Wm}^{-2}$) change of cloud radiative effect at the top of atmosphere (surface) over the tropical Pacific per 1K global warming, implying a decrease of net cloud absorption which needs to be considered for relevant studies such as the changes of hydrological cycle and atmospheric stability.