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黒潮暖水域の下層雲への影響：平滑化海面水温を用いた数値実験
Impact of the Kuroshio warm SST on low altitude clouds: Numerical model simulation with smoothed SST

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Along the Kuroshio ocean current, high sea surface temperature (SST) is maintained even in winter and a steep SST gradient is formed across the current. In winter and spring, cold northwesterly air often flows from the Asia continent into the East China Sea. Once this cold air reaches the Kuroshio warm current, a large temperature contrast between sea surface and surface air (SAT) causes the marine boundary layer unstable and affect low altitude cloud formation. The northwesterly wind also transports a large amount of anthropogenic aerosols to East China Sea. These aerosols work as cloud condensation nuclei (CCN) and they affect microphysical properties of clouds. Because the marine boundary layer stability affects aerosol activation to form cloud particles, the large contrast between SST and SAT over the Kuroshio can also affect the aerosol-cloud interaction as proposed by Koike et al. [2012].

In order to assess the impact of Kuroshio warm SST on low clouds, we made WRF model calculations for a period between 21 Mar and 30 Apr 2009. In addition to the control calculation, we made sensitivity calculations, in which artificially smoothed SST was given for a lower boundary condition. In this smoothed SST, the SST gradually decreases toward higher latitudes and the maximum along the Kuroshio current no longer exists.

In the control calculation, the monthly mean cloud fraction (frequency of cloud occurrence in April 2009) was high in the south of Kuroshio and had a steep north-south gradient, corresponding to the SST steep gradient. A monthly mean liquid water pass (LWP) was large along Kuroshio and small in East China Sea, although it enhanced when cyclones passed. As compared with the control calculation, both the cloud fraction and LWP decreased over the Kuroshio in smoothed-SST calculations, and their north-south gradients became gentler.

LWP differences between control and sensitivity calculations varied depending on the wind direction. In northerly wind conditions, the LWP decreased in warmer frank (downwind) of a SST front. Under calm and horizontally homogeneous wind conditions, water vapor transport convergence was relatively small over the Kuroshio and column-integrated water vapor increased mainly by evaporation from the sea surface. In such case, LWP decreased on the Kuroshio in sensitivity calculation. This suggests that warm SST associated with Kuroshio enhances the evaporation and contributes to increase LWP of low clouds.

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