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Global relationship of low cloud amount with inversion strength and its association with sea surface temperature

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Ship-based cloud observations and temperature and sea level pressure data obtained from the ECMWF 40-year reanalysis (ERA-40) are used to investigate the seasonal relationship between the amount of low stratiform clouds (LSCs) and estimated inversion strength (EIS) proposed by R. Wood and C. S. Bretherton over the global ocean. The LSC amounts are positively correlated with EISs over all ocean areas including those in which the LSC amounts are climatologically small. The sea surface temperature (SST) is also examined. The global correlation between EIS and SST is shown to be negative, but two linear relationships with different sensitivities exist. Their boundary lies at an SST of 16–22^{o}C. The amounts of stratocumulus (Sc) and stratus/sky-obscuring fog (St/Fo) increase in the warmer and colder SST domains, respectively, as EIS increases. These differences are more clearly explained by the difference between the surface air temperature (SAT) and SST. In the colder SST domain, EIS increases as SAT-SST differences increase from negative to positive, which corresponds to an increase in the St/Fo amount. In the warmer SST domain, where the Sc amount increases with EIS, the SAT-SST difference is generally negative but has no correlation with EIS. Examination of the expected difference in the vertical levels of the inversion contributing to EIS reveals that the inferred inversion strength between 925 hPa and the surface (850 and 925 hPa) increases in the colder (warmer) SST domain, following the above-mentioned variations in the LSC types. It is found that the boundary of the two domains coincides with that of the large and small SST gradients observed in the global distribution.

Keywords: low stratiform clouds, temperature inversion strength, lower-tropospheric stability, sea surface temperature, air-sea temperature difference