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Extension of the prognostic model of sea surface temperature to rain-induced cool and freshwater lenses

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The Zeng and Beljaars (2005) sea surface temperature prognostic scheme, developed to represent diurnal warming, is extended to represent rain-induced freshening and cooling. Effects of rain on salinity and temperature in the molecular skin layer (first few hundred micrometers) and the near-surface turbulent layer (first few meters) are separately parameterized by taking into account rain-induced fluxes of sensible heat and freshwater, surface stress, and mixing induced by droplets penetrating the water surface. Numerical results from this scheme are compared to observational data of near-surface ocean stratifications caused by rain in various situations from the December 2011 R/V Kilo Moana cruise and from the PALAU2013 campaign in the tropical western Pacific, and from JAMSTEC campaigns in the Indian Ocean near the coast of Sumatra Island that were lead in the framework of the Years of the Maritime Continent (YMC, 2015-2019). Theses results are also compared to surface drifter observations and to previous computations with an idealized ocean mixed layer model. The scheme produces temperature variations consistent with in situ observations and model results. It reproduces the dependency of salinity on wind and rainfall rate and the lifetime of fresh lenses. In addition, the scheme reproduces the observed lag between temperature and salinity minimum at low wind speed and is sensitive to the peak rain rate for a given amount of rain. Finally, a first assessment of the impact of these fresh lenses on ocean surface variability is given for the near-equatorial western Pacific. In particular, the variability due to the mean rain-induced cooling is comparable to the variability due to the diurnal warming so that they both impact large-scale horizontal surface temperature gradients. This parameterization can be used in a variety of models to study the impact of rain-induced fresh and cool lenses at different spatial and temporal scales.