Radiative effect of two contrail cirrus outbreaks over Western Europe estimated using geostationary satellite observations and radiative transfer calculations

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Estimation of the perturbation to the Earth’s energy budget by contrail-cirrus outbreaks is required for estimating the climate impact of aviation and verifying the climate benefits of proposed contrail avoidance strategies such as aircraft rerouting. Here we identified two large-scale and successive contrail-cirrus outbreaks in geostationary and polar-orbiting satellite infrared images of Western Europe lasting from 22 to 23 June 2020. These two outbreaks last 18 and at least 7 hours and have a mean optical depth of 0.3 and 0.6, respectively. Their cloud radiative effect is calculated using geostationary satellite cloud retrievals and radiative transfer calculations, is weak or negative during daytime and positive during nighttime. Surface albedo affects the sign of the cloud radiative effect, which switches from negative over ocean to positive over land in the first outbreak. The cumulative energy forcing of the outbreak is 7 PJ and –8.5 PJ, respectively, with uncertainties from individual cloud retrievals being about 3 PJ. This study suggests that automated quantification of contrail-cirrus radiative forcing for monitoring or avoidance verification should be possible based on geostationary satellite observations.