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Improved estimates of surface energy fluxes derived from CERES [radiation] and the ERA5 energy budget

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We use improved diagnostic methods to infer fields of net surface energy flux from vertically integrated energy budgets derived from full resolution ERA5 analysis data in conjunction with CERES-EBAF 4.0 TOA net radiation . After paying careful attention to mass consistency and to the numerical aspects of calculating the divergence from model level data on the full ERA5 N320 Gaussian grid, the noise level is low even at 1 degree resolution, particularly over the oceans, and thus matches the resolution of the CERES product. Several diagnostics show that the inferred surface energy fluxes are of unprecedented accuracy. Features such as the eastern boundary currents and the ice edge are much more clearly represented. Noise levels are lower than in similar evaluations from ERA-Interim and from the diagnostic budget fields archived in ERA5. Energy budget residuals between our estimates and independent surface energy flux estimates are also smaller than in known studies from the literature. Additionally, the presented surface energy flux fields are globally unbiased by contruction, and thus appear well suited as reference for climate model evaluations. Prospects for reducing residual noise still visible over rough terrain are discussed as well.