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Challenges of the surface energy budget and proposed ways forward

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To understand how the Earth's climate system balances the energy budget, we have to consider processes occurring at three levels: the surface of the Earth, where most solar heating takes place; the Top of the Atmosphere (TOA), where sunlight enters the system; and the atmosphere in between. At each level, the amount of incoming and outgoing energy, or net flux must, on average, be equal on longer time scales in an unchanging climate. Under the influence of external and/or internal climate forcing energy is not balanced anymore, and can hence, lead to a temporal positive or negative Earth's Energy Imbalance, which is currently estimated of the order of 0.5-1 Wm-2 (IPCC, 2013). Although it is known that the majority of this energy is stored in the global ocean (∼93%), an overarching scientific challenge faced by the whole climate science community is related to achieving accuracy in the changes in storage and flows of energy throughout the climate system, hereby raising the question: "How is heat entering the global ocean?" This highlights the vital role of understanding the surface flux budget, though it is currently impossible to detect an imbalance equivalent to 1 Wm-2 via the estimation of the surface energy budget. This presentation is discussing the need of quantifying sea surface heat fluxes to the required level of accuracy needed to support the various climate science applications, which is currently a very challenging task of the surface energy budget community. The current level of uncertainties in global ocean mean and trends of heat and moisture fluxes remain higher than is required by many applications and it is still unclear which of the components of surface net heat flux contributes mostly to our uncertainties and where regionally these contributions are most significant. Using constraints on energy budget considerations, and hence, inter-comparisons to other independent observing systems as well as to re-enforce interdisciplinary collaborations for climate research application will contribute to advances urgently needed for estimates of surface energy fluxes. This proposed way forward is currently tackled under the umbrella of WCRP/CLIVAR/GEWEX and ESA TIE-OHF, which will be introduced here.