



**GLOBAL CLIMATE  
OBSERVING SYSTEM**

GCOS SC-30

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Item 2.3

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## **GCOS STEERING COMMITTEE THIRTIETH SESSION**

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Virtual Session

### **Proposal for the implementation of the Earth Energy Imbalance into the WMO/GCOS Global Climate Indicator framework**

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#### **Rationale**

The Earth Energy Imbalance (EEI) is the most fundamental global climate indicator that the scientific community and the public can use as the measure of how well the world is doing in the task of bringing anthropogenic climate change under control. The EEI is given by the difference between incoming solar radiation and outgoing radiation, which determines the net radiative flux at the top of the atmosphere (Hansen et al., 2011; Hansen et al., 2005). Today, the Earth climate system is out of energy balance, leading to a positive EEI. As a consequence, heat has accumulated continuously over the past decades in the Earth's climate system, warming the ocean, the land, the cryosphere and the atmosphere (von Schuckmann et al., 2016, 2020). According to IPCC AR6, this planetary warming is human-driven and results in unprecedented and committed changes to the Earth climate system, with adverse impacts for ecosystems and human systems (IPCC, 2021, 2022).

The EEI is a global climate indicator integrating fundamental aspects of the Earth system under global warming, and represents a robust measure of the rate of climate change, and related future commitment. The EEI enables an integrated view of the effective radiative climate forcing, Earth's surface temperature response and the climate sensitivity (Forster et al., 2022; Hansen et al., 2011; Hansen et al., 2005; Palmer & McNeall, 2014; Smith et al., 2015). The EEI informs about the status of global warming in the Earth system as it integrates the heat 'in the pipeline' that will ultimately warm the deep ocean and melt ice sheets in the long term (Hansen et al., 2011; Hansen et al., 2005; IPCC, 2021).

With respect to the current capabilities of the Global Climate Observing System (GCOS), assessing the Earth heat inventory (von Schuckmann et al., 2020, 2022) provides today's best estimate of the absolute value of the EEI (Cheng et al., 2017; Cheng et al., 2019; Hakuba et al., 2021; Hansen et al., 2011; Loeb et al., 2012, 2022; Trenberth et al., 2016). This global climate indicator hence also reveals how much and where surplus anthropogenic heat is available for melting the cryosphere and warming the ocean, land and atmosphere. This in turn allows for an evaluation of associated changes in the climate system and is essential to

improve seasonal-to-decadal climate predictions and projections on century timescales to enable improved planning for and adaptation to climate change (Hansen et al., 2011; von Schuckmann et al., 2016, 2020; 2022). Regular international assessment on this global climate indicator enables concerted international and multidisciplinary collaboration and advancements in climate science, including to contribute to the development of recommendations for the status and evolution of the GCOS (GCOS, 2021; von Schuckmann et al., 2020; 2022).

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