Arctic albedo changes are small compared with changes in cloud cover in the tropics

Pistone et al. (1) argue that decreases in planetary albedo as a result of the decrease in sea ice cover over the last 30 y is negatively correlated with surface air temperatures averaged over the Arctic. The authors conclude that this is a significant global climate forcing—about 25% as large as that arising from increases in atmospheric CO_2—that is not offset by feedbacks resulting from cloud–albedo effects.

Calculation of albedo as the ratio of reflected solar radiation to incoming solar radiation can be problematic, particularly in Polar Regions where the ratio arises from small numbers. Total solar energy input is a better metric to evaluate climate forcing because it includes not only changes in albedo but also changes in clouds and atmospheric transmissivity. This result differentiates whether changes in solar radiation reaching the surface are responsible for at least part of the global-scale signal that Pistone et al. (1) attribute to Arctic darkening. In particular, our focus is on their assertion that vanishing sea ice results in a significant decrease in planetary albedo and represents "a substantial climate forcing that is not offset by cloud albedo feedbacks" at the global scale.

Consider the total solar energy input from 2000 to 2012 [obtained from The Clouds and Earth's Radiant Energy System (CERES) data] for the globe using an equal-area projection (Fig. 1). The tropics provide the main driver of the climate because of their size relative to that of the Polar Regions and because of increased energetics (2, 3). Changes in cloudiness in the tropics—driven by a strong trend toward La Niña conditions in the western Pacific over this period—exhibit larger trends, both positive and negative, and over much larger areas than those observed in the Arctic. Trends in decreased cloudiness also extend through the Southern Indian Ocean, the West Australian Current, and over the South Pacific Convergence Zone. Indeed, significant decreases in cloudiness can be observed over the South-Central United States and Argentina, which experienced significant droughts toward the latter portion of this time series. Moreover, the Earthshine project (4) that accounted for both CERES's albedo data and International Satellite Cloud Climatology Project radiation flux data recently concluded that changes in properties of clouds explain their observations of planetary albedo variations from 1984 to 2007, including the rather flat-trend in planetary albedo since about 2001.

Our point is that although Arctic changes may be important, they are small compared with the larger picture of changes in cloud cover in the tropics (Fig. 1). Although the change in total solar energy input is large in the Arctic over the 2000–2012 period, global solar energy input actually decreased by (-0.14 Wm^{-2}), with a majority of the decrease resulting from the Southern Hemisphere (-0.26 Wm^{-2}) rather than the Northern Hemisphere (-0.03 Wm^{-2}). Thus, we argue against Pistone et al.'s (1) conclusion that Arctic darkening "is not offset by cloud albedo feedbacks."

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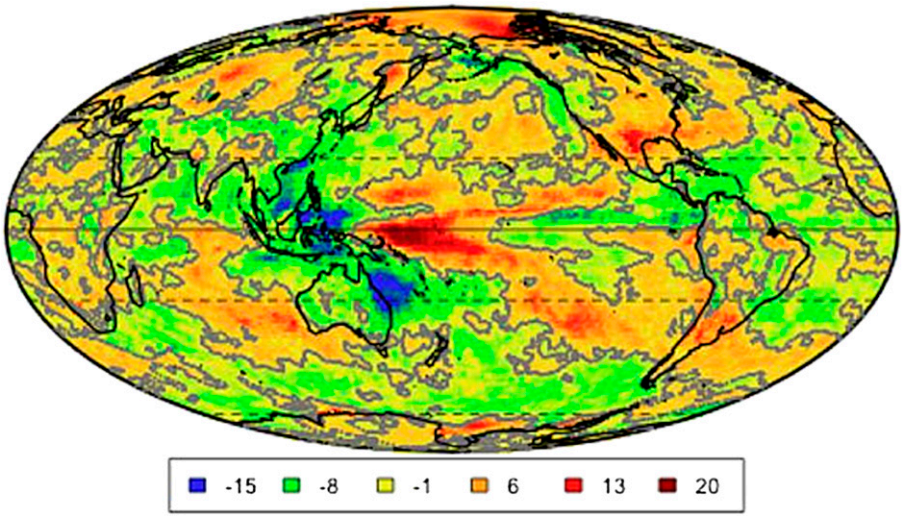

Fig. 1. Change in total solar energy input from 2000 to 2012 as measured by the CERES dataset. Units are in Wm^{-2}·$decade^{-1}$.