PAMIP Webinar Series

Icy, moist, and seasonal: Polar amplification in a hierarchy of climates

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Abstract

The drivers of polar amplification are investigated by isolating the role of sea-ice processes, moist energy transport, and the seasonal cycle of insolation in two models, an energy balance model and an idealized general circulation model. Relative to a simple ice-albedo feedback, the addition of thermodynamic-ice processes and the seasonal cycle of insolation profoundly affects seasonal polar warming. Climatologically limited-extent ice in the warm season permits only small increases in absorbed solar radiation, producing weak warming, while thick, cold ice in the cold season enables a large radiatively forced response. Despite this enhanced winter warming, the annual-mean polar amplification is modestly reduced by thermodynamic-ice processes. When latent heat transport is disabled, polar amplification is further reduced by a factor of 1.8 across the range of ice representations, suggestive of a nearly additive warming by ice and moist-transport processes. Comparison to more complex models suggests that sea-ice loss leads to winter warming that enhances the positive lapse rate feedback and that the increase in moist energy transport also leads to additional warming via the water vapor feedback.