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Physical Controls of the Earth's Climate and Climate change

GRAEME STEPHENS, JPL, California Institute of Technology

The Earth's climate system and changes to it are determined by the physical processes that govern the flows of energy to and from the atmosphere and Earth's surface. Although the energy exchanges at the top of the atmosphere are well determined from available satellite measurements, the global character of the energy flows *within* the climate system, and to and from the Earth's surface in particular, are not directly measured and thus are much more uncertain. The surface energy balance is particularly important since geographical variations of its distribution drives ocean circulations, dictates the amount of water evaporated from the Earth's surface, fuels the planetary hydrological cycle and ultimately controls how this hydrological cycle responds to forced climate change. This talk reviews our state of understanding of the physical processes that determine the energy balance, couple to the Earth's water cycle and are responsible for the most important climate feedbacks that dictate the pace of climate change. Challenges in understanding the mechanisms responsible for feedbacks associated with clouds and precipitation, water vapor, snow cover and carbon will be highlighted. The further complexity and uncertainty that aerosols add to the cloud and precipitation feedbacks will also be reviewed. The effects of uncertainties in our understanding of the physical climate system, and feedbacks within it, will be reviewed in the context of climate change projections.