

SUN'S ROLE IN CLIMATE CHANGE

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Broadly, the Earth's climate is driven by the Sun's output, the Earth's reflectance and the Earth's thermal emission. Of these three fundamental climate variables, the Earth's reflectance is the least well-studied. In fact, variations in reflectance are being implicitly ignored when solar cycle variables are treated as proxies for the net sunlight reaching Earth.

Variations in the solar irradiance have been precisely measured for more than a quarter century combining observations from various satellites, and it appears that the Sun's irradiance has climatologically insignificant variations over the solar cycle. So, why are there terrestrial signatures of the solar cycle in climate records? If the variations of irradiance over the most recent solar cycles were typical, then changes in the net sunlight reaching Earth is a logical source of the terrestrial signatures of solar variability. Here, the relevant component of the net sunlight is the much less well-studied global reflectance of the Earth. Small variations in the Sun's output could be amplified in the much less well-studied terrestrial albedo. This possibility motivates a much more careful study of the Earth's reflectance.

The Moon provides a unique perch from which to measure both the Earth's reflectance in both high and low resolution, as well as the entire spectrum of solar output from hard x-rays to the infrared and from the various components of the solar wind. Ideally, to determine the Earth's reflectance, it would be necessary to observe reflected radiances from the Earth, from all points on the Earth and at all angles. An Earth-facing part of the edge of the Moon would provide an ideal platform from which to measure the Earth's reflectance.

Measuring the Earth as a star would be a first step. The instrument for measuring the

unresolved earthshine could be a carefully calibrated diode with a very low telemetry rate just yielding intensity as a function of time. This instrument needn't weigh more than 1-2 kg and would require no intervention.

To resolve the earthshine, which would be essential for direct input to climate modeling, the diode would be replaced by a CCD covering from the extreme blue to the mid-infrared. Even a small format camera, like 128x128, would provide spatial resolution of 100 miles, which would be useful as essentially direct input to climate models. The aperture of a telescope feeding the CCD needn't be more than one inch to over-resolve the 100 mile square patches of Earth. The telemetry would be low, but would depend on the camera format and the time resolution required.

The unresolved, Earth as a star observations, are so simple with robust hardware that it would be straightforward to do set them up robotically. The resolved earthshine would benefit from being setup and run briefly by an astronaut. Nonetheless, the second phase observations could be robotically set in motion.