New data on the variability of the Earth's reflectance over the last 16 years

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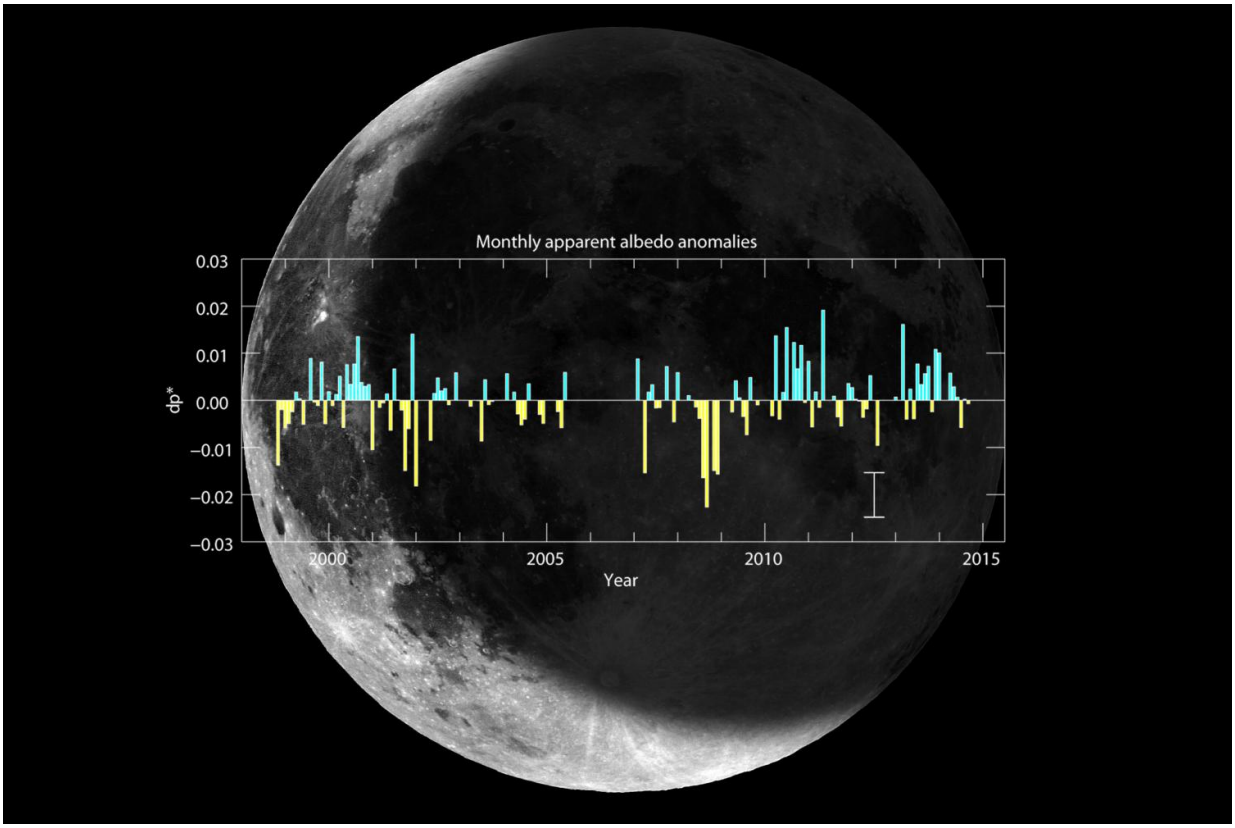

Composition of the earthshine, the light reflected from the Earth to the night-time face of the Moon, and the figure showing the monthly mean apparent albedo anomalies from December 1998 through December 2014. Anomalies were calculated over the mean of the full period, positive anomalies are shown in red and negative in blue. Averaged standard deviation (error) of the monthly data is also indicated in the lower right corner for simplicity. Only months with at least 5 nights of observations are shown. From November 2005 to August 2006 several months of earthshine data are missing due to the replacement of the

dome of the solar telescope, while the new automated telescope under a separate dome was not yet operational. Credit: Daniel López/IAC.

The Earth's albedo, or reflectance, is a fundamental atmospheric parameter having deep implications for temperature and climate change. For that reason, experiments have been performed to monitor it over the past two decades to reveal how it evolves. One of these, in which the Instituto de Astrofísica de Canarias is a participant, has brought up to date the observations made since 2007 and adds to, and gives a new systematic record of the Earth's albedo covering the period between 1998 and 2014 from California. This study, whose first author is IAC researcher Enric Pallé, has been published in *Geophysical Research Letters*, and shows that although the albedo fluctuates both monthly and annually, but there is no trend over those years.

The effect of the albedo is important for life on Earth because it affects the energy budget of the planet: it plays a key role in the process by which the planet achieves an equilibrium between the solar radiation which enters the atmosphere and the radiation emitted as heat into space. The albedo is defined as the fraction of sunlight that the Earth reflects back directly into space, and it varies according to cloud composition, ice, snow, and the nature of the surface onto which the sun's rays fall. The term comes from the Latin "albus" (white), and a rise or fall in the albedo will have consequences for the planet's global warming or cooling.

To check how the albedo has evolved, since the 1990's it has been measured from space with instruments such as ERBE and CERES, whose estimations are made using absolute photometric measurements, which could be affected by any degradation in the instrument while in space.

However, a complementary way to measure the reflectance, which does not suffer the same calibration errors since it is a relative measurement, is from the ground, using telescopes that observe the so-called earthshine (the light reflected from the Earth to the night-time face of the Moon). This method has been used during the period 1998-2014 from the Big Bear Solar Observatory (BBSO) in California, and also, since 2007 from the Earthshine telescope at the Teide Observatory (Tenerife), to measure this climate parameter. These observations were aimed at increasing the temporal coverage of the measurements, and reducing the measurement errors.

The result of this study is that, applying strict quality criteria to the measurements of the earthshine, and after re-calibrating the measurements taken from the CERES instrument in space, the variations found in the value of the albedo not only agree in magnitude but also show identical, small annual variations over the 14 years that the two types of observations overlap. Philip Goode, lead earthshine researcher at BBSO explains that "Although the measurements that we have made of the albedo over the past 16 years show monthly and annual variations, there is virtually no change in the long term. This also coincides with a stabilization in the mean temperature of the planet", he says.

Even so, although a consensus has been reached about the results of the two types of measurements, the origin of the anomalies is not completely clear. "We need to continue the experiments to measure this phenomenon accurately and see where we get to in a few more years. For example, the construction of a global network of robotic telescopes around the world or the launching of a micro-satellite dedicated to the study of earthshine will give us data to improve our knowledge of changes in the albedo, and see how they affect the climate", concludes Pallé.

More information: E. Palle et al, Earth's albedo variations 1998-2014

as measured from ground-based earthshine observations, *Geophysical Research Letters* (2016). DOI: 10.1002/2016GL068025

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