Satellite Sampling of Climate

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Abstract

Satellite observations provide uniform global coverage of the Earth, unrivaled in studies of climate. Their application, however, requires the gridding or mapping of global structure, which can be used in scientific interpretation and validation of climate models. It is limited by the asynoptic nature of satellite data: Different sites are observed at different times. This feature of satellite data fuses variations in space and time, limiting the scales which can be unambiguously determined. Sampling considerations for asynoptic data are reviewed. They are then applied to address two major issues surrounding their application in studies of climate.

Many of the important issues facing the study of climate involve convection and related properties, like cloud, humidity, and diabatic heating. Mapping the global structure of these properties is complicated by small-scale and diurnal variations that comprise the global convective pattern. They leave much of the variance undersampled, which is then misrepresented in asynoptic measurements.

The diurnal cycle of convection introduces a bias into time-mean behavior. This source of systematic error has been evaluated in high-resolution Global Cloud Imagery (GCI), which has been composited from 6 satellite platforms simultaneously observing the global convective pattern. Having synoptic coverage of the Earth (all sites observed at the same time), with space-time resolution of 50 km and 3 hrs, the GCI resolves the dominant scales of organized convection. It has been sampled asynoptically according to orbital and viewing geometries of several satellites. Comparing retrieved structure against that actually present in the GCI establishes the bias due to diurnal aliasing. It is significant for all of the orbital geometries, even for a precessing platform that drifts through local time. This source of systematic error is shown to be alleviated with measurements from multiple platforms, which push back the Nyquist limits of asynoptic sampling.

Random variance that is undersampled can be treated through a cancellation of incoherent error. A procedure has been developed to identify small-scale undersampled variance and reject it. This leaves a more accurate representation of large-scale variance that is adequately sampled. Comparing the space-time behavior retrieved against that actually present in the GCI shows that the error variance is reduced to 10representation of large-scale coherent variations, which can then be mapped synoptically on periods as short as 2 days. By recovering the organization of convective properties, this opens the door to a wide range of scientific studies into climate and its interaction with the global circulation.