GEOS-5 Nature Run Helps Understanding DSCOVR Sampling

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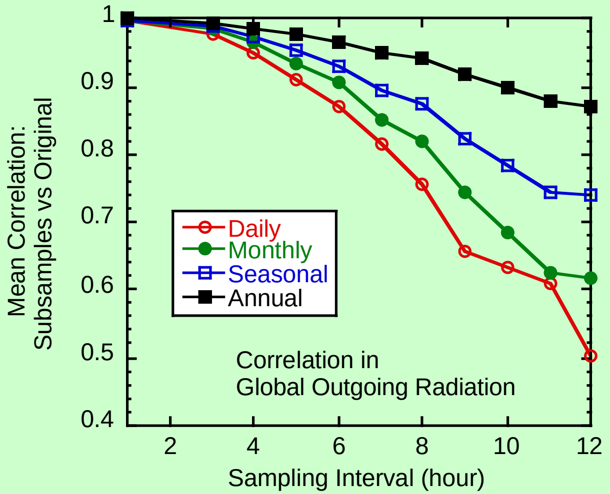

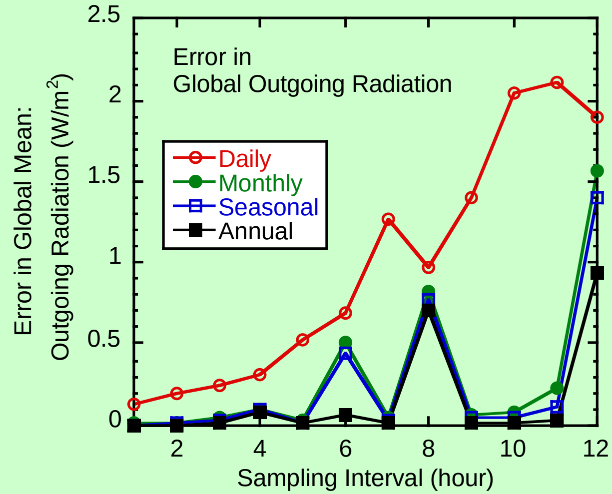

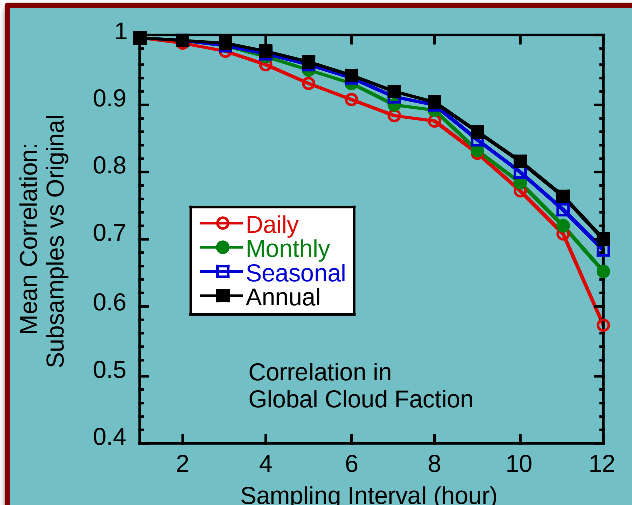

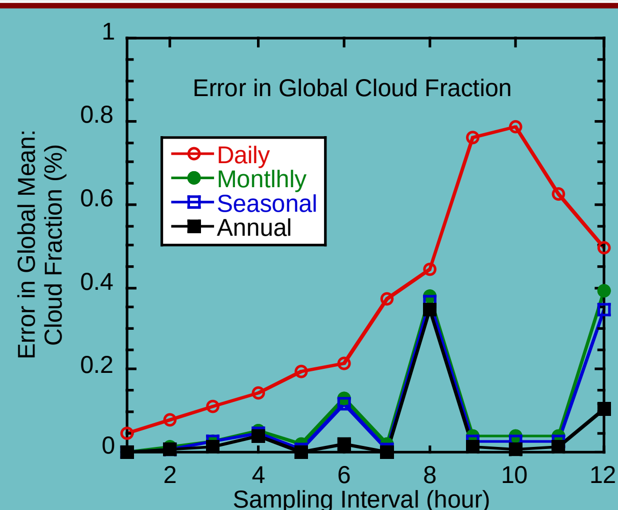

The Deep Space Climate Observatory (DSCOVR), as all satellites, samples Earth at a finite temporal resolution. The limitations of infrequent DSCOVR sampling on global radiation and cloud cover are simulated using high spatial resolution output from NASA's GEOS-5 model. We find that the less frequent the sampling, the worse the error. On the other hand, more frequent sampling is not as beneficial as expected for errors in the global monthly, seasonal and annual means because of the Earth's 24-hour rotation cycle.

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References:
Holdaway, D. and Y. Yang, 2016: Study of the Effect of Temporal Sampling Frequency on DSCOVR Observations Using the GEOS-5 Nature Run Results (Part I): Earth's Radiation Budget. *Remote Sensing,* 8(2), 98, doi:10.3390/rs8020098.

Holdaway, D. and Y. Yang, 2016: Study of the Effect of Temporal Sampling Frequency on DSCOVR Observations Using the GEOS-5 Nature Run Results (Part II): Cloud Coverage. *Remote Sensing,* 8(5), 431, doi:10.3390/rs8050431.

Data Sources: NASA Goddard Earth Observing System Model, Version 5 (GEOS-5) Nature Run Data, available from Goddard Global Modeling and Assimilation Office (http://gmao.gsfc.nasa.gov/global_mesoscale/7km-G5NR/).

Technical Description of Figures:
The figures show simulations of DSCOVR-like observations with GEOS-5 Nature Run at both original temporal resolution (30 min) and subsampled coarser temporal resolution in order to study the ensuing effects.
Upper Left Panel: Mean of the correlation coefficients between the original and subsampled global total outgoing radiation time series as a function of temporal sampling frequency. The different curves represent different time scales. For example, the "Monthly" curve is generated by calculating the correlation coefficients between the subsamples and the original time series for each month and then averaging over the entire Nature Run time period (2 years).
Upper Right Panel: The error in the global mean total outgoing radiation derived from the subsampled time series as a function of temporal sampling frequency.
Lower Left Panel: Same as the upper left panel, but for global mean cloud fraction.
Lower Right Panel: Same as the upper right panel, but for the global mean cloud fraction.

Scientific significance, societal relevance, and relationships to future missions:
Orbiting around the Earth's L1 Lagrange point, the DSCOVR satellite always stays near the Sun-Earth line. At this location, which lies around 1.5 million km away from the Earth, DSCOVR can view the entire daytime hemisphere continuously. Observations from the two Earth-observing instruments onboard, the National Institute of Standards and Technology Advanced Radiometer (NISTAR) and the Earth Polychromatic Imaging Camera (EPIC), are being used to derive information about the Earth's radiation budget, cloud, aerosol, ozone, and vegetation. DSCOVR, like any other satellite, can only provide observations with a finite temporal resolution. As a result, the information derived from these observations does not represent the true system. We investigate how subsampling affects the mean and how close the sampled time series is to the truth using GEOS-5 Nature Run data. Our analysis shows that the errors in the global monthly, seasonal and annual means, be it radiation budget or cloud coverage, are not a monotonic function of sampling frequency. Error peaks appear at four, six, eight and twelve hour sampling rate because of the 24 hour cycle associated with the Earth's rotation. DSCOVR should therefore avoid sampling at these time intervals. Analysis of correlations between subsamples and the original time series show that while obtaining a mean close to the truth is possible even at large sampling intervals, in general the subsampled time series moves farther away from the truth, the coarser the temporal resolution. Even though this study is about the DSCOVR mission, the results are helpful in understanding the uncertainties in products from other satellites (past, current or future) as well. As shown by DSCOVR, satellites located at the L1 point has the unique advantage in observing the climate system. In the future, should a DSCOVR follow up be planned, this study could provide general guidance in the sampling strategy.