Channel Sounder Measurement Verification: Random Measurement Error
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Random and systematic measurement errors are prevalent in channel sounder hardware and measurements, and metrologists have provided a litany of reports and technical notes detailing the quantification of the uncertainty associated with these errors [Joint Committee for Guides in Metrology (JCGM), GUM, 2008; Possolo, NIST TN 1900, 2015; A. Koepke, 90th ARFTG 2017]. During the metrology-grade channel sounder verification measurement campaigns, we focused on the random measurement error, which is the "component of measurement error that in replicate measurements varies in an unpredictable manner" [JCGM, VIM, 2012].

The uncertainty due to the random component of channel sounder measurement error is estimated by repeat, roundabout and day-to-day measurements. A repeat is defined as a measurement within a roundabout. A roundabout is a sequence of measurements of a single channel configuration made by all the channel sounders and the reference instrument. We estimated the uncertainty due to random measurement error for three distinct channel sounder hardware architectures.

The measured path gain was modeled using a random-effects model [F. Graybill, Theory and Application of the Linear Model, 1976]. This model quantifies the mean path gain and random error variability due to the different time scales. We will be presenting two random-effect models: Model 1 and Model 2. Under Model 1, we assume that our measurement channels are stable and that all path gain measurements are of the same quantity with some variability due to day, roundabout, and repeats. Model 2 combines the repeat measurements within a roundabout, leaving only variance components attributable to day and roundabout. We checked the assumptions of both models using exploratory data analysis and auto-correlation plots.