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Entropy-based method for optimal temporal and spatial resolution of gravity field variations

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Calculation and analysis of variations within the gravity field of the Earth often has to deal with high computational cost and complexity. Choosing a smaller domain can greatly decrease complexity, due to the fact that sample size and computational cost are directly related. Looking for a new subset, we have to select the one that results in minimum loss of information and minimum of redundant information (interpolated data) or of data that increase complexity and not information content. An optimal resolution has to be the closest to the intrinsic resolution of physical phenomena and the new data set has to maintain the statistical properties of the original one.

For this purpose, we developed a feasible tool based on maximum entropy to define optimal temporal and spatial resolution in the specific case of 2 years data set of daily gravity field variations.
First we had to check the maximum frequency content (Nyquist Sampling Theorem). Next we identified regions with similar variability. The more heterogeneous (higher variability) a sample, the larger the sample size required to obtain a given level of precision.
Then, we performed entropy analysis for every region, starting from the highest available resolution and decreasing it progressively. We chose among the possible subsets the one with the highest entropy (Principle of Maximum Entropy). Entropy is a natural measure of complexity and information and since many physical systems tend to move towards maximal entropy configurations over time, maximizing entropy minimizes the amount of prior information and of information loss. In addition, we minimized the cross-entropy between the original data set and the new sub set minimizing the divergence of the two sets (Kullback's Principle of Minimum Discrimination Information).