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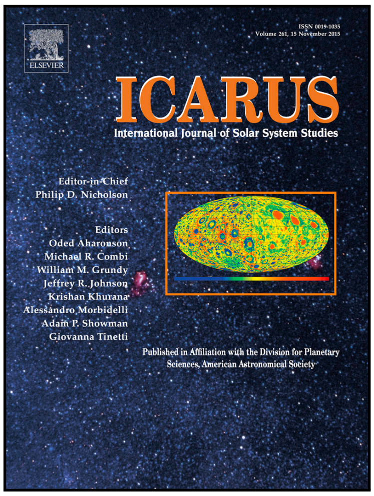

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Multifractal topography of several planetary bodies in the Solar System

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Abstract

Topography is the expression of both internal and external processes of a planetary body. Thus hypsometry (the study of topography) is a way to decipher the dynamics of a planet. For that purpose, the statistics of height and slopes may be described by different tools, at local and global scale. We propose here to use the *multifractal* approach to describe fields of topography. This theory encompasses height and slopes and other statistical moments of the field, taking into account the scale invariance. Contrary to the widely used *fractal* formalism, *multifractal* is able to describe the intermittency of the topography field. As we commonly observe a juxtaposition of rough and smooth at a given scale, the *multifractal* framework seems to be appropriate for hypsometric studies. Here we analyze the data at global scale of the Earth, Mars, Mercury and the Moon and find that the statistics are in good agreement with the *multifractal* theory for scale larger than ~ 10 km. Surprisingly, the analysis shows that all bodies have the same *fractal* behavior for scale smaller than ~ 10 km. We hypothesize that dynamic topography of the mantle may be the explanation at large scale, whereas the smaller scale behavior may be related to elastic thickness.

1. Introduction

Scaling of coastlines was empirically studied by *Richardson* (1961), and *Mandelbrot* (1967) interpreted his results in terms of fractals. Fractals are geometric sets of points that have a scale symmetry. Geophysical examples of scaling include turbulent phenomena including clouds, the wind, the ocean, river flows, as well as various solid earth fields including rock faults and topography. Most systems of geophysical interest are mathematical fields, not geometric sets. When scaling, they will generally be multifractals. A general way to quantify this is to determine the