

The Weather and Climate

Emergent Laws and Multifractal Cascades

Shaun Lovejoy

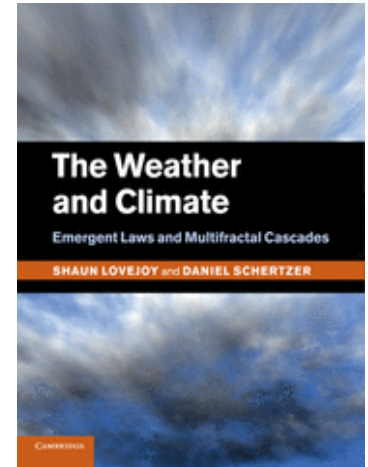
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Advances in nonlinear dynamics, especially modern multifractal cascade models, allow us to investigate the weather and climate at unprecedented levels of accuracy. Using new stochastic modelling and data analysis techniques, this book provides an overview of the nonclassical, multifractal statistics. By generalizing the classical turbulence laws, emergent higher-level laws of atmospheric dynamics are obtained and are empirically validated over time-scales of seconds to decades and length-scales of millimetres to the size of the planet. In generalizing the notion of scale, atmospheric complexity is reduced to a manageable scale-invariant hierarchy of processes, thus providing a new perspective for modelling and understanding the atmosphere. This synthesis of state-of-the-art data and nonlinear dynamics is systematically compared with other analyses and global circulation model outputs. This is an important resource for atmospheric science researchers new to multifractal theory and is also valuable for graduate students in atmospheric dynamics and physics, meteorology, oceanography and climatology.

Preface; Acknowledgements; Acronyms and abbreviations; 1. Introduction; 2. Classical turbulence, modern evidence; 3. Scale by scale simplicity: an introduction to multiplicative cascades; 4. Empirical analysis of cascades in the horizontal; 5. Cascades, dimensions and codimensions; 6. Vertical stratification and anisotropic scaling; 7. Generalized scale invariance and cloud morphology; 8. Space-time cascades and the emergent laws of the weather; 9. Causal space-time cascades: the emergent laws of waves, predictability and forecasting; 10. The emergent laws of macroweather and the transition to the climate; 11. The climate; References; Index.



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