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Atmospheric Waves as a high Reynold's number, scaling phenomena

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Turbulence and waves are two important atmospheric phenomena. While there is no doubt that the atmosphere is so nonlinear as to be turbulent over huge ranges of scales, paradoxically, the treatment of waves is typically low Reynolds' number (Re), quasi linear (or at most weakly nonlinear), focusing on the analytic derivation of dispersion relations.

In this contribution, we pose the problem in terms of space-time localization versus delocalization of structures with the help of space-time propagators obeying the same space-time scaling symmetries as the turbulence. We show that the scaling implies the existence of high Re propagators corresponding to fractional rather than integer order wave equations. We then test the theory by analyzing infrared radiances measured over the south-west Pacific by geostationary satellite MTSAT at 30 km, 1 hr resolution. Building on the approach of Wheeler and Kiladis, we show that after removing a theoretical turbulent (and scaling) background from the measured spectrum, the residuals describe the observed wave-like effects with dispersion relations close to the standard gravity wave dispersion relations but with wave propagators of fractional order Hw $\approx$ 0.15. Waves are thus an emergent, high Re phenomenon.