# The power spectrum of solar convection: Why so low at low k?

Jesse Lord[1], Robert Cameron[2], Mark Rast[1], and Matthias Rempel[3]
[1]Department of Astrophysical and Planetary Sciences, Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309, USA
[2]Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany
[3]High Altitude Observatory, National Center for Atmospheric Research, Boulder, CO 80307, USA

Keywords: solar convection, supergranulation, giant cells
Presenting author email: mark.rast@lasp.colorado.edu

Recent helioseismic observation (Hanasoge et al. 2012) suggest a deficit of low wave number power in solar convective turbulence at scales larger than the solar supergranulation. Moreover, surface observations of giant cell scale convection in the photosphere have been historically unsuccessful, with only very recent evidence for weak flows at these scales (Hathaway et al. 2013). These observations are incompatible with both local area and global simulations of solar convection, and it is likely that both classes of simulations overestimate flow velocities at large scales. We illustrate this conundrum with a model of the solar photospheric horizontal velocity power spectrum at supergranular scales and larger. The model employs a two component approximation to the mass continuity equation, a one dimensional mixing length model of the solar convection zone, and the assumption that large scale motions are driven only in the deepest layers. We show that even in the presence of stratification, low wave number flows, if they exist in the deep solar convection zone at the amplitudes expected from current numerical simulations, should be visible in the photosphere. That they are not seen implies sustained correlations in the turbulence at smaller scales to maintain the heat transport. The origin of those correlations is unknown, but possibly magnetic.

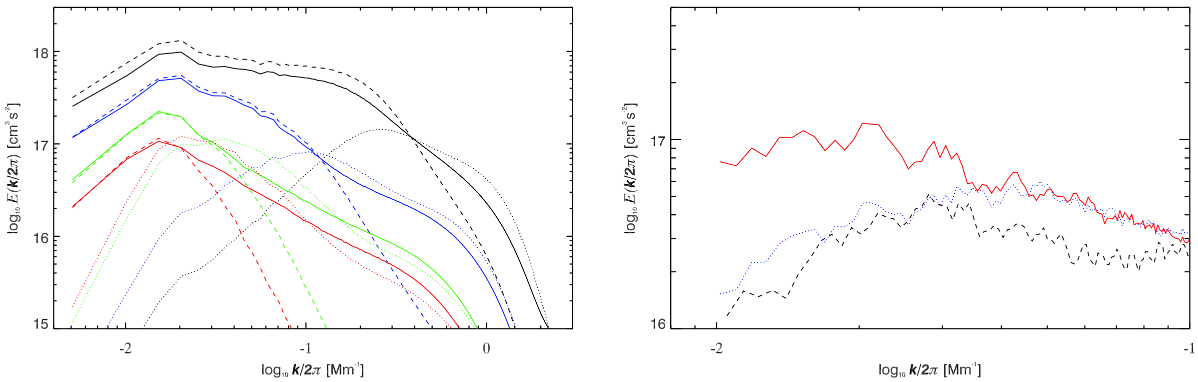


Figure 1: Left: The horizontal velocity power spectra (*solid* curves) from a hydrodynamic simulation of solar convection: black 1.3Mm, blue 5.4Mm, green 15.7Mm, and red 23.9Mm below the photosphere. The *dashed* and *dotted* curves show the horizontal velocity spectra deduced from the vertical velocity based on a two component continuity balance. Right: The photospheric power computed using Coherent Structure Tracking (Roudier et al. 2012). The *dashed* curve computed from HMI observations, the *solid* (red) from intensity maps of the hydrodynamic simulation, and the *dotted* (blue) curve from intensity maps from a simulation within which an artificial flux that carries the solar energy below 8 Mm.

References:

Hanasoge S. M., Duvall, T. L., & Sreenivasan, K. R. 2012, Proc Natl Acad Sci 109, 11928
Hathaway, D. H., Upton, L., Colegrove, O. 2013, Science 342, 1217
Roudier, T., Rieutord, M., Malherbe, J. M., Renon, N., Berger, T., Frank, Z., Prat, V. Gizon, L., & Švanda, M. 2012, A&A 540, 8