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Analysis of Wind and Temperature Spectra over Grassland and Scrubland using a new Scaling Scheme for the Unstable Surface Layer

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We report four sets of velocity and temperature spectra for unstable conditions, measured simultaneously over scrubland and adjacent grassland. The data were collected with sonic anemometers up- and downwind of a paddock-scrub (smooth-to-rough) boundary. A sea breeze from the coast 7 km away provided steady wind direction.

We analyse these spectra using a new similarity model. In this model, instability affects turbulence in the surface friction layer (the "inner layer") through the convection in the boundary layer overhead (the "outer layer"), and not through the local action of buoyancy, as in the widely-used Monin-Obukhov model. The outer-layer convection creates a variable shear stress at the ground and so extra energy in the turbulence of the surface friction layer.

We discuss methods for obtaining the scaling parameters of the new model - the depth of the CBL, the outer-layer dissipation rate and the variable component of the surface shear stress - using field data obtained from small towers. We then use these parameters to scale the spectra from our experiment. We find that separate scaling of the outer- and inner-layer components of the spectra provides a consistent interpretation of the spectra observed over the two surfaces. We show how this finding helps to resolve some long-standing difficulties with the scaling of wind and temperature spectra in the surface layer.