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Horizontal wave number spectra of atmospheric acoustic fields in range-dependent environments

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The parabolic equation (PE) is a powerful method for computing sound propagation in range-dependent environments. However, the PE gives only the total field, with no information on the horizontal wave number spectrum of the acoustic field. In many situations, e.g., for propagation over irregular terrain, the horizontal wave number spectrum is valuable for analyzing the modal content of the acoustic field. For example, one might want to know the strength of the surface wave component at different ranges. A spectral decomposition method developed by Gilbert and Evans for ocean acoustics is applied here to atmospheric propagation over irregular terrain. This paper shows that for a PE field $p(z)$ at range r, the horizontal wave number spectrum $\phi(\kappa,z)$ can be obtained directly and efficiently by solving a one-dimensional elliptic equation that uses the field $p(z)$ as a source term. The derivation of the spectral decomposition equation is given along with a numerical method for solving it. Examples are presented and discussed for propagation over irregular terrain. [Research supported by the U. S. Army TACOM-ARDEC at Picatinny Arsenal, New Jersey]