On moving mesh methods for the numerical solution of advection dominated problems

Weiming Cao
wcao@math.utsa.edu
Div. of Math and Stats, Univ. of Texas at San Antonio, San Antonio, TX 78249, US

For many engineering problems, the solution exhibits extreme behaviour in small regions of the solution domains which change in time – e.g., as is the case for shock waves, flame fronts, or pollutant transport in strong advection flows. Numerical solution of these problems typically requires use of adaptive meshes. Moving mesh methods, which relocate the grid points by tracking the extreme solution behaviour in time, have been shown to be very promising due to their simplicity and effectiveness. In this talk, we present an analysis for moving mesh methods based on the so-called equidistribution principle (EP). We examine the numerical advection and diffusion caused by mesh movement for one and two dimensional model problems. The analysis reveals that the moving mesh points in the extreme regions basically follow the advection, and the effective advection speed is thus reduced by a constant β depending on the magnitude of the monitor function. Also, it shows that the mesh movement causes an anisotropic distribution of the numerical diffusion, which is small in directions of large solution variation and large otherwise. Numerical results for various one and two dimensional problems are presented to illustrate the above analysis.