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Development of data models and velocity interpolation methods for streamline trajectories on unstructured grids

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This presentation will describe the development of data models and velocity interpolation methods for streamline trajectories on unstructured grids. Flux conservative numerical schemes provide us with the flux across cell faces. However, to obtain the sub-grid spatial resolution provided by streamline techniques it is necessary to develop velocity models that are consistent with the face fluxes. These constructions are well known for Cartesian hexahedral cells, and are reasonably well known for the corner point grids used in petroleum reservoir simulation. However, the extensions to fully unstructured polyhedral cell grids, or to unstructured column layer grids, e.g., 2.5D PEBI grids, are not obvious. We have evaluated several velocity reconstruction approaches on 2.5D unstructured column layer grids, and have found that a grid refinement strategy which reduces the problem locally to that of a corner point grid cell performs the best. This strategy is also consistent with higher order multi-point flux calculations on the unstructured grids. Each cell is characterized by a local three dimensional Cartesian coordinate system, but the indexing of the cells themselves follow the topology of an unstructured column layer grid. A refinement strategy and novel data structure is constructed which allows the streamline tracing to be performed without reference to the global spatial position of the streamline. We also introduce a double boundary layer formulation to ensure flux continuity across faulted portions of the grid, or to manage flux continuity at local grid boundaries (refinement, coarsening, or combinations). The resulting algorithms are as robust and as simple to implement as for an un-faulted Cartesian grid.