A Discrete Vector Calculus in Tensor Grids

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Abstract

The key to the success of mimetic discretization methods is that they discretize some underlying description of continuum mechanics, e.g. in the vector calculus or in the differential forms language. For a discretization to be fully mimetic, it must have exact discrete analogs of the important results or theorems from the continuum theory.

In this paper, we will enumerate exactly which results from vector calculus we need to mimic. We will then produce a discrete vector calculus on uniform tensor product grids in three dimensions that is fully mimetic. The results are useful in extending the mimetic approach to more general structured and unstructured grids in three dimensions.