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Estimating area of vector polygons on spherical and ellipsoidal earth models with application in estimating regional carbon flows

Estimating area of polygons on the Earth's surface is required in many fields in earth science, especially for the problems requiring as precise area of regions as possible. In the field of carbon modelling, one application of estimating polygons' area is to estimate carbon flows in regions. The result of regional carbon flows estimation is influenced by the region area estimation. However, in current scientific work about regional carbon estimation, the method to estimate region area is not clear and how many uncertainties introduced by area estimation to the final result is not investigated.

This thesis aims to develop a methodology to estimate area of a polygon on the Earth's surface, which is applied to estimate carbon flows in regions, and to test the uncertainties propagated to the final result by the area estimated by the methodology developed. For method development, three methodologies to estimate area were proposed and tested. Tests show that cylindrical area-preserving projection method is a suitable method to estimate area of a polygon on the Earth's surface for the application of regional carbon flow estimation because it trades off the quality of estimates and computational demands. To assess the uncertainties, a case study was performed to estimate carbon flow in Sweden using the cylindrical equal-area projection method to estimate area of polygon. A regional carbon flow is computed by the product of area of the region and carbon flux in that region. Three atmospheric inversion systems: CTE, CAMS and Jena CarboScope were chosen to provide carbon flux data. The test illustrates the most uncertainties come from the flux data modeled by different inversions. Compared to the uncertainties from flux data, the uncertainties (less than 1%) in polygon area estimation by the projection method is too small to worry about.

Keywords: area of a polygon, atmospheric inversions, map projection, regional carbon flows

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