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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. In the field of carbon modelling, one application of estimating polygons' area is to estimate carbon flows for regions. This thesis aims to develop a methodology to estimate area of a polygon on a spherical/ellipsoidal surface applied to the problem to estimate carbon flows in regions.

It is common that field data are stored in grid which covers the Earth's surface in earth science. Region area estimation is inevitable for computation of sum of field data or density of data in regions. Region area can be computed by summing up the whole or partial area of grid cells covered by the region. The Earth is usually modelled as a sphere or an ellipsoid. Area of the overlay polygon on spherical/ellipsoidal surface can be considered as the product of cell area and fraction (partial value) of overlay area in the grid cell. Three methodologies to estimate partial value of overlay area in a grid cell were proposed and tested: 1) using latitude-longitude plane, 2) using cylindrical area-preserving projection and 3) using the area of corresponding of spherical polygons. Cell sizes were estimated by cylindrical equal-area projection method. Tests show that 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.

Estimation of carbon flows in regions is interesting in many research domains. Atmospheric inversion is one technique of carbon flux modelling to provide carbon flux data in grid with various resolutions. Regional carbon flows can be estimated as the sum of fluxes in grid cells overlapped by the polygonal region. In most models, flux is modelled constant everywhere in each grid cell. A case study was performed to estimate carbon flow in Sweden using the methodology developed to estimate area of polygon. The uncertainties in the estimation of carbon flow in Sweden are influenced by the estimation of geographic extent of Sweden and the flux data in grid provided by atmospheric inversions. Four groups of test were done to test the effects of different factors on the flow estimation: partial values, earth model, interpolation and inversion systems. The test result illustrates partial value, earth model and interpolation have less than 1% effect on final result. The region flow is mainly influenced by flux data modeled by different inversions.

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

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Master degree thesis, 30 credits in Physical Geography and Ecosystem Analysis, 2017

Department of Physical Geography and Ecosystem Science, Lund University. Student thesis nr 436