Geophysical Research Abstracts
Vol. 19, EGU2017-5508, 2017
EGU General Assembly 2017

Uncertainty in Land Cover observations and its impact on near surface climate

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Land Cover (LC) and its bio-geo-physical feedbacks are important for the understanding of climate and its vulnerability to changes on the surface of the Earth. Recently ESA has published a new LC map derived by combining remotely sensed surface reflectance and ground-truth observations. For each grid-box at 300m resolution, an estimate of confidence is provided. This LC data set can be used in climate modelling to derive land surface boundary parameters for the respective Land Surface Model (LSM). However, the ESA LC classes are not directly suitable for LSMs, therefore they need to be converted into the model specific surface presentations. Due to different design and processes implemented in various climate models they might differ in the treatment of artificial, water bodies, ice, bare or vegetated surfaces. Nevertheless, usually vegetation distribution in models is presented by means of plant functional types (PFT), which is a classification system used to simplify vegetation representation and group different vegetation types according to their biophysical characteristics. The method of LC conversion into PFT is also called "cross-walking" (CW) procedure. The CW procedure is another source of uncertainty, since it depends on model design and processes implemented and resolved by LSMs. These two sources of uncertainty, (i) due to surface reflectance conversion into LC classes, (ii) due to CW procedure, have been studied by Hartley et al (2016) to investigate their impact on LSM state variables (albedo, evapotranspiration (ET) and primary productivity) by using three standalone LSMs. The present study is a follow up to that work and aims at quantifying the impact of these two uncertainties on climate simulations performed with the Max Planck Institute for Meteorology Earth System Model (MPI-ESM) using prescribed sea surface temperature and sea ice. The main focus is on the terrestrial water cycle, but the impacts on surface albedo, wind patterns, 2m temperatures, as well as plant productivity are also examined.

The analysis of vegetation covered area indicates that the range of uncertainty might be about the same order of magnitude as the estimated historical anthropogenic LC change. For example, the area covered with managed grasses (crops and pasture in MPI-ESM PFT classification) varies from 17 to 26 million km^2, and area covered with trees ranges from 15 million km^2 up to 51 million km^2. These uncertainties in vegetation distribution lead to noticeable variations in atmospheric temperature, humidity, cloud cover, circulation, and precipitation as well as local, regional and global climate forcing. For example, the amount of terrestrial ET ranges from 73 to 77 $\times$ 10^3 $km^3 yr^{-1}$in MPI-ESM simulations and this range has about the same order of magnitude as the current estimate of the reduction of annual ET due to recent anthropogenic LC change. This and more impacts of LC uncertainty on the near surface climate will be presented and discussed in the context of LC change.

Hartley, A.J., MacBean, N., Georgievski, G., Bontemps, S.: Uncertainty in plant functional type distributions and its impact on land surface models (in review with Remote Sensing of Environment Special Issue)