Biomass retrieval of boreal forest for the satellite P-band synthetic-aperture radar BIOMASS

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BIOMASS is one of three remaining mission candidates for the 7th Earth Explorer in the European Space Agency's Living Planet Program due for launch in 2018. The mission concept is based on a Polarimetric and Interferometric long wavelength (P-band; 435 MHz centre frequency and 6 MHz bandwidth) synthetic aperture radar (SAR) that will systematically acquire radar data over all major forested areas of the Earth. The primary objective is to produce (biannual) global maps of forest biomass at a spatial resolution of 100 m with an accuracy of 20% (1σ). Secondary mission objectives include mapping of subsurface structures (lithology in arid regions, polar ice and ice-stream flow regimes) as well as permanent and seasonal forest inundation.

Forest biomass is one of the most important parameters in the Earth's carbon cycle and, hence, for projections of future climate change. The principle cause of the present climate change is due to fossil fuel burning and accumulation of CO2 in the atmosphere. However, it is also known that global deforestation contributes as a significant CO2 source. The present estimate is that deforestation is up to 20% of the total anthropogenic CO2. The range of uncertainty is quite large, however, which mainly is due to the lack of accurate observational techniques - a fact that BIOMASS aims to change. Development of robust algorithms for ionospheric corrections and biomass estimation from P-band radar data has been considered to be the most critical task to resolve at present. Focus of the research is to investigate biomass inversion for two main biomes, i.e. tropical broadleaf forests and boreal forests.

The algorithm development activities has been supported by several airborne SAR data collections, i.e. the BioSAR experiments in 2007, 2008 and 2010 over hemiboreal and boreal forests in Sweden and TropiSAR in 2009 for tropical forests in French Guiana. Biomass estimation algorithms has been developed and evaluated by a consortium involving the Swedish Defence Research Agency (FOI) and Chalmers University of Technology in Sweden, the German Aerospace Center (DLR) in Germany and the Centre d'Etudes Spatiales de la BIOsphère (CESBIO) in France. Chalmers and FOI are responsible for developing the algorithms for boreal forests based on the data collected during the BioSAR experiments. Results show the importance of including multiple polarisations and ground slope for topographic corrections based on 50-m grid digital-elevation models. Evaluation of the developed retrieval algorithm gives a root mean square error of 40-59 tons/ha for a biomass range 10-287 tons/ha, i.e. 22-32%. Note that in contrast to all previous studies the data sets for training and evaluation have been strictly separated.