ECV T12: Biomass

Assessment of the status of the development of standards for the Terrestrial Essential Climate Variables

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Executive Summary

Introduction

Vegetation biomass is a crucial ecological variable for understanding the evolution and potential future changes of the climate system. Vegetation biomass is a larger global store of carbon than the atmosphere, by far, and changes in the amount of vegetation biomass already affect the global atmosphere by being a net source of carbon, and having the potential either to sequester carbon in the future or to become an even larger source. Therefore, a global assessment of biomass and its dynamics is an essential input to climate change forecasting models and mitigation and adaptation strategies.

Two other emerging issues contribute to the increasing importance of the biomass role as an essential climate variable: i) the growing use of biomass for energy production, so the increasing percentage of global GHGs emitted from biomass consumption, and ii) the increasing concern on the possibility to significantly reduce global GHGs emissions by avoiding biomass losses from deforestation and forest degradation. In this document the focus is mainly related to living terrestrial above ground vegetation biomass, especially woody biomass.

Definitions and units

Biomass is defined as mass per unit area of live or dead plant material, typically reported in mass per unit area, such as g/m^2. The carbon pools of terrestrial ecosystems involving biomass are conceptually divided into above-ground biomass, below-ground biomass, dead mass, and litter. The above ground pool of biomass is often well characterized. The below ground component of biomass is regularly estimated as a function of above ground biomass. The remaining pools are less well characterized and require attention. Biomass can be measured through field sampling, extrapolations from spatial data (such as forest inventories), remotely sensed data, modelling, and combinations of the preceding data sources.

In situ measurements entail harvesting plant species, drying them, and then weighing the biomass. These measurements of forest biomass can be aggregated for a small sample area, or extrapolated to wider levels using allometric equations. While this is the most direct and accurate method for quantifying biomass within a small unit area, it is expensive, time-consuming, damaging to the environment and infeasible at large scale. It is these intensive measures that allow for making extrapolations of biomass from measures made from non-destructive field measures or from forest inventory data.

Remote sensing measures the amount of microwave, optical, or infrared radiation that is reflected or scattered by the imaged area in the direction of the sensor. Generally, biomass is either estimated via a direct relationship between that sensed radiation or spectral response. Remotely sensed data provides a synoptic view of the area of interest (that is, the entire area is characterized in the same way with the same data) that enables the estimation of biomass values over large areas. Different models have been developed to derive biomass estimates over large areas incorporating spatial data (such as elevation and radiation), remotely sensed data, and field samples or forest inventory data.

Available methods, protocols, standards, validation procedures

It is well established that *in situ* measurements are critical to the monitoring of terrestrial carbon stocks, but they impose many limitations, including high costs, inconsistent parameter definitions, inconsistent spatial and temporal scales, and sampling bias in measurements. While satellite approaches to estimating biomass are becoming increasingly reliable, limitations remain related to accuracy and range of predictions. However, satellite technology allows for increasingly frequent measurement of biomass and several satellite methods have demonstrated potential for providing direct and indirect global above-ground biomass information at high resolution (below 1 km). With improved sensor capabilities combined with previous experience and methods, it is expected that satellite and model based estimates of biomass will provide for the large area monitoring of biomass.

Recommendations

The recommendations below to be considered to improve the reliability of biomass estimates and their utility to better monitor and understand climate change:

1. agencies for *in situ* inventories and remote sensing must work together to allow validation and upscaling of the *in situ* measurements based on the remote sensing products
2. the harmonization of the different methodologies for data collection and analysis is required for continuous, standardized and geo-referenced forest biomass inventories and ground measurements
3. the quality and quantity of *in situ* biomass estimates needs to be improved in order to improve the remote sensing validation
4. forest biomass inventories need to be expanded to tropical forests, non-commercial forests, mangroves and woodlands
5. new allometric functions need be developed for better biomass estimations, to convert above-ground biomass to total biomass, and to be extended over larger geographic areas
6. Deriving biomass data directly from remote sensing remains to be a research task (see below). Large area biomass estimations will benefit from improved land cover datasets (see land cover ECV).
7. tree height measurements produced by LiDAR technology can be used to improve the derived biomass estimates, or to supply accurate measures of forest structure (as samples or to map larger areas)
8. Synthetic aperture radar (SAR) and optical data can be used to provide estimates of biomass in a synoptic manner over large areas. Further development and integration of SAR and optical data is to be pursued.
9. Exploring the possibility of defining standard biomass data products from active remote-sensing methodologies, such as SAR or LIDAR is also desirable.