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SYMBOLS AND ACRONYMS

ATBD	Algorithm Theoretical Basis Document
CCI	Climate Change Initiative
CCI-Biomass	Climate Change Initiative – Biomass
CMUG	Climate Modelling User Group
ESA	European Space Agency
GEDI	Global Ecosystem Dynamics Investigation

1. Introduction

1.1. Purpose and scope

This document sets out the considerations behind the products to be produced in the CCI-Biomass project, provides a summary of what those products will be, and relates them to the needs of the users.

1.2. Applicable documents

Table 1. Applicable documents

ID	TITLE	ISSUE	DATE
URD	User Requirements Document	V.1	23/11/18

2. Review of current knowledge

The First CCI+ Biomass User Meeting in Paris 25-26 September 2018 provided an overview of biomass requirements from a range of communities; including climate and carbon modellers; organizations concerned with environmental policy and results-based financing of land management for climate; country-scale needs for forest carbon measurements, and the role of biomass information in REDD+; and climate mitigation. The findings from this Workshop are summarised in the User Requirement Document (Deliverable 1.1). Note that this Workshop was, by definition, attended by individuals and groups already interested in biomass measurements and the possibilities of recovering biomass information from space, and did encompass individuals and groups involved with climate models (or even carbon models). However, information on requirements was also obtained from the Climate Modellers User Group (CMUG) meeting in Exeter 29-31 October 2018. At the CMUG meeting, around 20 % of the modelling groups had an immediate interest in biomass. This reflects the fact that until fairly recently climate models with a fully coupled land carbon cycle focused on carbon fluxes, not stocks, since these are what determine the land-atmosphere transfers that contribute to atmospheric CO_2. Because of this focus, the use of biomass (and stocks in general) as a constraint on model calculations (including model state, model predictions, and key model parameters) has been neglected except by a few groups (most of whom were at the Paris meeting). This neglect contributes in part to the very wide spread of predictions from carbon models about the carbon balance of the land surface over the 21st century. In this respect, the modelling groups involved in CCI+ Biomass are leading the field as regards the use of biomass information as a modelling constraint.

3. Necessary biomass data properties

At the First User Workshop, the starting point for discussing AGB requirements was the following:

a. Wall-to-wall coverage of the entire globe for all major woody biomes is needed at 500 m to 1 km spatial resolution.
b. The current 25 m spatial resolution GlobBiomass biomass product is available for the nominal year 2010.
c. As described in the proposal, the CCI+ Biomass project aims to produce global AGB maps for the mid-2000s (coinciding with the GlobBiomass product year of 2010) and nominally for 2017/18 and 2018/19, together with inter-period AGB change maps.

The requirements for biomass data and its properties essentially came from two directions, the climate and carbon cycle modelling community and the REDD+ community, many of whose requirements overlap but with some significant differences, as described below.

Both communities require full transparency and repeatability in the data products. Hence it is essential that all data products contributing to the biomass product and the estimates of its accuracy are fully reported. This requires fully documented, transparent and standardized mapping methods, robust and standardized validation schemes with well-founded validation protocols, the provision of relevant metadata, and, as far as possible, free and open access to all contributing data, as well as the CCI+ Biomass products themselves. A good template for this is the combined Algorithm Technical Basis Document (ATBD) and Design Justification File of the GlobBiomass global product, which gives an exhaustive description of the different data types and how they were used, together with arguments explaining why they were selected and their role in producing the final product. Since the current approach to the CCI+ Biomass product delivery is essentially the same as in GlobBiomass, the most effective approach to producing the CCI+ documentation is to provide an update of this document. However, major additions to the ATBD are likely once data from the Global Ecosystem Dynamics Investigation (GEDI) lidar come onstream and their contribution to the CCI+ product is clarified.

4. Climate and carbon models

There were no significant differences between the needs for climate and for carbon cycle models, and the main product properties required for their needs are as follows.

The foremost requirement is that the biomass product should be unbiased whatever the value of biomass (note that in the GlobBiomass project, almost all the regional estimators underestimated higher values of biomass and overestimated low values of biomass).

The basic spatial scale of many of the climate and carbon cycle models providing regional to global calculations is that of the climate grid-cell, typically 0.5˚ – 1˚ for century-scale runs (around 55 – 220 km in latitude, while in longitude these values need to be scaled by cos λ, where λ is latitude), though higher model resolution (1-10 km) can be used for annual to decadal runs. However, many models allow sub-grid variations so that a grid-cell can contain non-localised populations with different properties (e.g. a

grid-cell may contain fractional cover by different Plant Functional Types or forest classes with different ages and biomass). Such models are therefore able to exploit biomass information at scales much smaller than the grid-cell. Though most modelers considered biomass measurements at 1 km spatial resolution as sufficient, some suggested that 100 m would be preferable in order to obtain better quantification of forest management and disturbance. This latter implies that the associated biomass change products need to be accurate enough to be useful, which further implies that the precision of the biomass products needs to be sufficiently high. At present we have no clear idea of what this means in quantitative terms.

Temporal sampling of one year is adequate, under the expectation that this will provide information on changes relating to disturbance. However, as noted above, the ability to make useful measurements of biomass changes is dependent on the precision of the biomass measurements, which is likely to depend on the spatial scale of measurement.

As for all climate variables, the longer the time series the better. Although the modellers would like biomass data starting from 2000, this is not feasible from space measurements given the limitations of the available data. In practice, the effective start date for such data is 2004/5 for boreal data based on hyper-spectral Envisat C-band radar data (Santoro et al., 2010) and around the same date for methods based on the Icesat GLAS lidar instrument, which operated from 2003 to February 2010 (Baccini et al, 2012; Saatchi et al., 2011).

Two primary indicators of data quality, i.e. accuracy, are needed:

a. Evidence that the data are unbiased across the whole biomass range and for all forest biomes; this is intimately connected with (in fact, entirely dependent on) having a validation strategy and dataset that allow this assessment to be made. If there is evidence that the estimates may be biased over some part of the biomass range, this needs to be reported with the data products.
b. The precision of the data, described by its standard deviation, is of less concern as long as the data are unbiased, since spatial averaging of unbiased data improves the precision without introducing bias. Precision can often be estimated based on statistical models for the terms contributing to the error, typically by assuming they are Gaussian with a known variance, as was done with the GlobBiomass global product. It is highly desirable that the estimated precision is supplied as a map product at the same spatial scale as the biomass product.

The preferred data format is netcdf.

5. REDD+ requirements

A summary of REDD+ requirements for the specification of the global biomass map products is given in D1.1 but repeated here for convenience:

Table 2. Summary of REDD+ requirements for the specification of the global biomass map

Global biomass mapping product specifications		
	Threshold (minimum) Requirements	Target (desired) Requirements
Product	Map of above-ground biomass with associated uncertainty	• Map of aboveground biomass (incl. belowground) • Map of change in biomass all with uncertainty estimated, definition of biomass might vary for different countries circumstances
Spatial Coverage	Global	Global with targeted/calibrated products for specific countries or other areas of interest
Spatial Resolution	100x100 m / 1 ha resolution or better	0.25-1 ha; resolution might vary depending on forest and ecosystem type, and country needs
Temporal Extent	One time coverage for most recent period	2000 to the present
Temporal Resolution	One time	1 year (annual maps)
Reference System	Lat-Long (WGS-84) and equi-area projections	Provided in country-specific reference grids
Accuracy	Accuracy should be higher than existing maps. Continental-scale uncertainty estimation.	Data should unbiased and with high precision (≥ 90% rel. RMSE) for target estimation regions (i.e. countries)
Delivery Mode	FTP or Web Service	FTP or Web Service and combined with training materials on how to use the data and within country capacity development
Data Format	GeoTIFF	GeoTIFF (or other country-preferred formats)
Other Requirements	• Fully documented, transparent and standardized mapping methods • Robust and standardized global validation scheme with protocol • Metadata available	• Fully documented, transparent and standardized mapping methods • Metadata available • Robust calibration and validation using available national data sources (i.e. NFI

	• Free and open access	data) • Access to underlying data in an accessible processing system to produce their "own" data • Clear and transparent reporting of regional accuracy / uncertainty • Consistent spatial-temporal coverage • Consistency with forest area change data • Free and open access

The points of agreement with modelling needs are:

a. Global coverage
b. Annual products are desirable, but no specification of the properties of biomass change products are given. Since REDD+ requires finer spatial resolution than the models, there are likely to be significant problems in detecting change with usable accuracy, as noted above
c. The data should be unbiased but, if this cannot be guaranteed, indicators are needed of where and for what ranges of biomass bias may be present; this relies heavily on a comprehensive validation strategy
d. Biomass should be reported with an associated uncertainty which is to be understood in the first instance as precision (a confidence interval would be highly desirable but depends on knowing the error distribution)
e. Uncertainty should be reported as a map product at the same scale as the biomass product

Disagreements with the needs of modellers arise because REDD+ is essentially country-based and concerned with national reporting consistent with the IPCC Good Practice Guidebook. This has the following implications:

a. Different countries may use different definitions of biomass, and this may need to be taken into account when interpreting the CCI+ Biomass products
b. Validation of the data products may be carried out for individual countries
c. Spatial resolution of 100x100 m (1 ha) or finer is needed
d. Data may need to be provided in a variety of projections/reference grids, or tools to convert the primary CCI+ Biomass data products to these reference grids may need to be developed.
e. The preferred data format is GeoTIFF

However, since the set-up of the CCI+ Biomass project (and indeed the whole CCI+ programme) emphasises the need for climate models, these extra requirements for REDD+ will not be specifically addressed during the project.

6. Conclusions

The user requirements elucidated during the First CCI+ Biomass User Meeting in Paris from 25-26 September 2018 provided clear guidance to the CCI+ Biomass project from the point of view of the climate and carbon modelling and REDD+ communities represented (but note that use of biomass information has not yet been developed by many of the climate modellers in the CMUG). Although these two communities agree on many of the major desirable properties of the products, there are significant differences because the models are based around the grid-cell structure of climate models whereas REDD+ is country-based. The emphasis in CCI+ Biomass is on serving the needs of modelling, so only some of the country-scale issues can be addressed. In particular, the project will consider the implications of finer spatial resolution for validation, accuracy and biomass change estimation.

7. References

Baccini, A., and Coauthors, 2012: Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps, Nature Clim. Change, 2, 182-185, doi:110.1038/nclimate1354.

Saatchi, S. S., and Coauthors, 2011: Benchmark map of forest carbon stocks in tropical regions across three continents, Proceedings of the National Academy of Sciences, 108 (24), 9899–9904.

Santoro, M., Beer, C., Cartus, O., Schmullius, C., Shvidenko, A., McCallum, I., Wegmüller, U., Wiesmann, A. (2011). Retrieval of growing stock volume in boreal forest using hyper-temporal series of Envisat ASAR ScanSAR backscatter measurements, Remote Sensing of Environment **115,** 490-507.