TerrA-P

Estimation of GPP and NPP from Sentinel-3 data starting from first principles

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TerrA-P Objectives

As part of ESA's Scientific Exploitation of Operational Missions (SEOM) program, TerrA-P aims to exploit Sentinel 3 data for ecosystem productivity modelling. Within the project, a model to derive information on GPP and NPP will be defined, implemented and validated. The project combines the expertise from three domains.

DEFINITION
The P-model developed by Imperial College London (ICL) will be used as a basis for the Gross Primary Productivity (GPP).

IMPLEMENTATION
VITO remote sensing will implement the model on global MERIS and Sentinel-3 data.

VALIDATION
The models outcome will be validated by the University of Antwerp using FLUXNET GPP and historical in-situ and biomass measurements,

Methods

The P-model is a universal model, unifying the Farquhar and Light Use Efficiency models. It starts from first principles, has a firm basis in theory and provides the optimum combination of parsimony, theoretical foundation, and empirical support (Wang, et al. 2016)

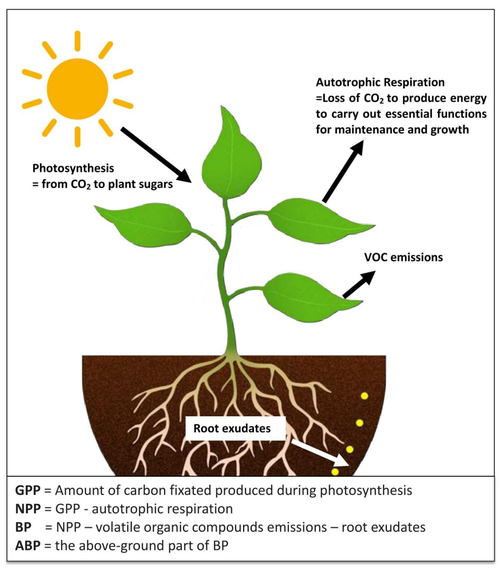
The final product will be based on OLCI GVI (fAPAR) of Sentinel-3A, but MERIS data is also used for development and testing the algorithm with historical in-situ data. The use of other earth observation datasets such as SLSTR based LST will be investigated.

An uncertainty evaluation will combine two independent methods, taking into account the differentiated uncertainty quantities of the algorithm (Type B) and its credibility based on findings of the evaluation study (Type A).

The model will use meteorological data from ECMWF HRES (or probabilistic ENS) model at 0.25 (0.75) degree. Global daily estimates of incoming radiation , temperature and vapour pressure deficit will drive the model.

Do you know the difference?

The different variables to describe ecosystem productivity are often confused. Here we describe four terms,



GPP = Amount of carbon fixated produced during photosynthesis
NPP = GPP - autotrophic respiration
BP = NPP – volatile organic compounds emissions – root exudates
ABP = the above-ground part of BP

GPP Gross primary production – the rate of total carbon fixation (photosynthesis) by the ecosystem. This is the most fundamental measure of primary production, as all ecosystem functions depend on it. Also, thanks to flux measurements, GPP data are available – at time scales from half-hourly up to multi-annual – for some hundreds of locations worldwide (albeit with a bias towards temperate regions) and for crops as well as natural and managed ecosystems.

ABP Above-ground primary production – the rate of production of plant matter, excluding roots. This is a practically important measure, because – for example – this is the production rate of forage for grazing animals; it is closely related to the production rate of timber for harvest; and it can be converted (through data on the harvest index of different crops) to estimates of crop yield. There are data on ABP, occasionally at a monthly time scale but more commonly at the annual time scale, for many ecosystems, especially crops and managed forests but also for natural ecosystems.

BP Biomass production – the rate of production of plant matter, including roots. For most crops the root production is of less interest than the above-ground production. (Even for root crops, there are data on the harvest index, i.e. the ratio of yield to ABP.) There are data on BP but in most cases the root production has not been measured directly, but rather inferred from above-ground measurements using standard conversions, thereby increasing the associated uncertainty.

NPP Net primary production – equal to GPP minus respiration. Formerly, NPP was assumed to equal to BP, and most data that claim to be NPP are in fact BP. But it is now understood that a fraction of NPP – under some circumstances this can be as much as 20% of NPP – is "lost" from the plant in the form of volatile organic compounds (such as isoprene) and/or root exudates. Published data sets of "NPP" are of poor quality.

Help us defining the product

In the first phase of the project (December 2016 – February 2017), we are collecting user requirements to specify the output products. An online survey will collect feedback from potential users of earth observation based ecosystem productivity estimates.
Some example questions are:

What should be the content of the product?
GPP/NPP/BP/ABP

Should the model distinguish between C3/C4 plants?
Yes/No
How?

What additional information is needed?
Uncertainty, quality?

Timeliness?
After 1 year, regularly updated, within 5/3 days after acquisition

Preferred revisit for your application?
Daily, 5/7/10-daily, monthly, annually

Spatial resolution?
300m, 1 km, 0.25° , 0,5

Accuracy?
5%, 10%

Online survey: WEBSITE URL

Wang, H., Prentice, I.C., et al. (2016). A universal model for carbon dioxide uptake by plants. BioRxiv preprint first posted online Feb. 13, 2016; doi: http://dx.doi.org/10.1101/040246.

WEBSITE Online survey: WEBSITE.WWW

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