Biogeosciences Discuss., 6, C983–C990, 2009
www.biogeosciences-discuss.net/6/C983/2009/

Biogeosciences Discussions

Interactive comment on "Modelling LAI at a regional scale with ISBA-A-gs: comparison with satellite-derived LAI over southwestern France" *by* A. Brut et al.

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Received and published: 1 July 2009

Response to Reviewer 3: The authors thank the anonymous referee #3 for his/her review of the manuscript and for the fruitful comments. For an easier comprehension, general comments of the referee are also reported (3.XX).

3.01 [The simulated LAI of a "pure" vegetation type is compared to satellite data products which show "mixed" vegetation, even when the 70% threshold criterion is applied. There are two ways to improve the comparison: 1) to compare simulations where the model simulates the aggregation of the different patches in the vegetation tile, in order to better agree with the different vegetation types seen by the satellite. As this is probably the way how ISBA-A-gs runs within SURFEX for the Météo-France simulation, I wonder why this is not shown here. [. . .] I would greatly appreciate to see the Figure 4 redone with ISBA-A-gs simulating mixed patches]

Response 3.01

The ISBA-A-gs results presented in Fig. 4 correspond to mixed patches. Indeed, ISBA-A-gs simulates the aggregation of the different patches in the vegetation tile. The simulated LAI shown in this study is always the average LAI of different vegetation types weighted by the fraction of area they cover.

3.02 [2) to use satellite time series at a higher spatial resolution (not for the entire domain, but to look at specific areas with a strong dominance of the vegetation type of interest). Corrected daily NOAA/AVHRR 1 km reflectance data can be obtained for Europe, e.g. from the Meteorological Institute of the Free University in Berlin. There is no LAI is provided, but it could probably be calculated in some way]

Response 3.02

Deriving LAI products from remotely sensed reflectances is still challenging. The difference, shown in this study, between the MODIS and CYCLOPES LAI products, demonstrates that the retrieval process may be affected by significant uncertainties. We agree that higher resolution LAI products would increase the chance of observing “pure” pixels (i.e. with a single type of vegetation). However, it would be a work in itself, that would go beyond the scope of this study.

3.03 [When it comes to the comparison of the leaf onset, the information on how this is derived from the satellite data is missing. The combined use of other phenological data would have made the comparison more solid]

Response 3.03

The date of leaf onset is defined as the date when the vegetation reaches intermediate values of LAI. The difference between this intermediate value and the minimum LAI value corresponds to 40% of the amplitude of the seasonal cycle (White et al. 1997, Gibelin et al. 2006). The amplitude of the seasonal cycle is defined as the difference between the maximum and minimum LAI observed over an annual cycle. This method is robust and well adapted for the comparison of different time series (e.g. the remote sensing products and the model have different sampling times). In this study, this method was applied to both model simulations and satellite LAI observations.

White, M.A., Thornton, P.E., and Running, S.W.: A continental phenology model for monitoring vegetation responses to interannual climatic variability, Global Biogeochem. Cycles, 11, 217– 234, 1997.

The available phenological information is summarised below (see also the response to Reviewer 2). LAI observations were performed at the grassland site of Laqueuille in 2002. They are shown in Figure 7 of Vuichard et al. (2007). The low-fertilized and extensively grazed grassland of Laqueuille grew rapidly in June and reached a maximum LAI of about 2.5 m2m-2 at the beginning of July. A few field observations of LAI were performed in 2005, close to Toulouse, over crops and forests (Dolman et al., 2006, Jarosz et al., 2009). In the case of a wheat crop (Lamasquère), maximum LAI was attained at the end of May and the senescence occurred in June. A barley field (Montbartier) presented maximum LAI values at the beginning of May and the senescence occurred in May. A rapeseed field (Auradé) presented maximum LAI values at the end of April and the senescence occurred in June. The maximum LAI of irrigated maize fields (Saint-Sardos) was attained in July and remained stable till the senescence, which occurred in October. In the case of a sessile oak forest (the Agre forest), leaf emergence was observed in March, and maximum LAI was attained in May (at the beginning of May or later, depending where LAI was measured). Over the Les Landes forest (coniferous trees) site of Le Bray, the maximum LAI of the understory and of the trees were observed at the end of June, and at the end of July, respectively. The total LAI of the forest (trees and understory) reached a maximum value of 3.9 m2m-2 at the beginning of July. Calvet et al. (2008) showed that simulations of ISBA-A-gs performed for C3 and C4 crops in the region of Toulouse are consistent with the observations over wheat and maize fields, respectively. However, ISBA-A-gs has difficulties in representing earlier leaf onsets (e.g. those observed for barley and rapeseed).

Vuichard, N., Soussana, J.-F., Ciais, P., Viovy, N., Ammann, C., Calanca, P., Clifton-Brown, J., Fuhrer, J., Jones, M., and Martin, C.: Estimating the greenhouse gas fluxes of European grasslands with a process-based model: 1. Model evaluation from in situ measurements, Global Biogeochem. Cycles, 21, GB1004, doi:10.1029/2005GB002611, 2007.

Jarosz, N., Béziat, P., Bonnefond, J.-M., Brunet, Y., Calvet, J.-C., Ceschia, E., Elbers, J.A., Hutjes, R.W.A., and Traullé, O.: Effect of land use on carbon dioxide, water vapour and energy exchange over terrestrial ecosystems in Southwestern France during the CERES campaign, Biogeosciences Discuss., 6, 2755-2784, 2009

3.04 [The test with the Laqueuille grassland is interesting and much more of such local tests are required to evaluate large-scale models. But the authors should extend the discussion to the need of implementing some parameterizations of management practices within the model]

Response 3.04

Yes, see above. Generally, ISBA-A-gs has difficulties in representing the earliest leaf onsets (e.g. those observed for barley and rapeseed). Working on model parameters could help solve this problem. Then, a specific patch would have to be added in order to represent those early growing crops. Regarding crops sown in May and growing at summertime, a simple representation of seeding and irrigation practices are implemented in ISBA-A-gs for the C4 crops (maize), only, as maize is the main irrigated crop in the studied region. An irrigation amount of 30mm is added to the precipitation forcing each time the simulated extractable soil moisture content (dimensionless) reaches a predefined threshold. This threshold decreases from 0.70 for the first irrigation, to 0.55 for the second, 0.40 for the third, and 0.25 for the following ones. We acknowledge that a specific patch representing C3 summer crops (e.g. sunflower) is missing. However, upgrading the model would require, also, a detailed land use map for crops, covering the studied area. As far as we know, such a detailed land use map does not exist so far. Finally, it is important to note that agricultural practices are not the only source of uncertainty. For example, the plant-extractable water capacity of soils and the plant rooting depth used in the model are quite uncertain parameters. In the functional approach used in ISBA-A-gs, these parameters influence the plant response to drought and the date at which the simulated maximum LAI is reached.

3.05 [p.3: "... at this scale, different types of vegetation can be found in a model grid cell...": it is written as if it was not the case before, although the resolution was coarser (1 degree). What should we understand?]

Response 3.05

It should read: "At this scale, as well as at coarser scales, different types of vegetation (crops, forests, grasslands) can be found in a model grid cell and the sub-grid heterogeneity has to be represented".

3.06 [2.1 The ISBA-A-gs model: the text of the 1st section could be improved]

Response 3.06

Yes. A possible upgraded version: "The ISBA model (Interactions between Soil, Biosphere and Atmosphere) (Noilhan and Planton, 1989; Noilhan and Mahfouf, 1996) is a land surface model designed to calculate the exchanges of water and energy between the land surface and the atmosphere, for use in numerical weather prediction models and climate models. A CO2-responsive version of ISBA, called ISBA-A-gs (Calvet et al., 1998; Calvet and Soussana, 2001; Gibelin et al., 2006), allows accounting for the effect of the atmospheric carbon dioxide concentration and the interactions between all environmental factors on the stomatal aperture. ISBA-A-gs also calculates the two main carbon fluxes between the land surface and the atmosphere (i.e. gross primary production and total ecosystem respiration). Optionally, ISBA-A-gs calculates the green LAI."

3.07 [2.2 why are irrigated crops not distinguished in C3/C4 crops?]

Response 3.07

See response 3.04. In the studied region, the impact of this simplification is limited, as the majority of irrigated crops consist of maize fields.

3.08 [p.11. I certainly agree that the the crop mixture is the reason for the difference between the simulated and the observed LAI for C3 crops. More than the presence of other C3 crops (the phenology of barley and rape do not differ so much to that of wheat), it is the presence of other vegetation types (C4 crops, forests, grasslands) which is responsible for the longer cycle seen by the satellite. The satellite pixels are not pure: up to 30% is covered by other vegetation types. Why was it not possible to include these patches as well (with the appropriate weighting factor) in the simulation? The same problem arises for all vegetation types, and is even more acute for coniferous forests. Indeed the Pine coniferous forest Les Landes in not very dense. Some lots are regularly cut, maize fields and grazing areas occur between plots. It is therefore normal that the simulation of the LAI of a pure coniferous forest does not fit with the observations.]

Response 3.08

See response 3.04. P. 4071: The observations we have show that the phenology of barley, rapeseed and wheat may be quite contrasting (see response 3.03). The presence of other vegetation types (C4 crops, forests, grasslands) is accounted for by the patches, through ECOCLIMAP. However, the patch fractions derived from ECOCLIMAP are affected by uncertainties.

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3.09 [For the C3 crops alone, the simulated senescence is too late: these crops are already yellow before July and they are harvested in early summer.]

Response 3.09

In this region, the senescence of C3 crops (e.g. wheat) generally occurs in June (see response 3.04) and these crops are harvested in July. However, both leaf onset and leaf offset may vary from one year to another.

3.10 [p. 12. The second growth in summer for C3 crops is actually rather correct regarding the vegetation impact on the climate. Depending on the farming practices, grass is allowed to grow after the main C3 crop cycle, or some inter-cop is used, e.g. nitrogen-fixing legumes. Cases of patches being kept "bare soil" may exist, but they are probably not dominating. It would be nice if the authors could precise the usual practices in the area.]

Response 3.10

Intermediate crop (like nitrogen fixing legumes) are not commonly used in the area. In most cases the agricultural fields are left unperturbed after the harvest and natural vegetation growth or crop regrowth may occur.

3.11 [Fig.8: there are many methods to calculate the leaf onset from satellite data. How is that done here with the MODIS data?]

Response 3.11

See response 3.03.

3.12 [End of p.13 As already mentioned above, the model simulates a pure field and is therefore able to show a regrowth in 2002. The satellite sees a mixture of different fields: even when C3 crops dominate, other vegetation types are present, and the different C3 crops fields certainly also differ (difference in soil, orientation, variety, management...). The fact that the satellite LAI displays a smoother descent of the LAI

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curve compared to its sharp growth indirectly confirms the presence of some active vegetation in late summer.]

Response 3.12

No, the model simulates mixed patches. See responses 3.04 and 3.08.

3.13 [The second cycle simulated by ISBA-A-gs seems however too long. In many places in Europe, C3 crops are largely winter crops, sown already in autumn. The authors say that the parameters used for C3 crops permit to represent wheat, but which one: winter or summer? In any case, winter crops remain in a vegetative phase during winter, due to several processes (photoperiod and vernalization response) which slow its development. If it is expected that the simulated LAI reproduces reality more closely, ISBA-A-gs would need an appropriate crop phenological model, which responds not only to the climate variability, but also to the management practices.]

Response 3.13

See response 3.04. In the model, crops growing at springtime (i.e. as soon as meteorological conditions become favourable to plant growth) are simulated like natural vegetation. No sowing or emergence date has to be prescribed. As a consequence, no difference is made between winter wheat and spring wheat.

Interactive comment on Biogeosciences Discuss., 6, 4059, 2009.