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Interactive comment on “A process-based model to estimate gas exchange and monoterpene emission rates in the mediterranean maquis – comparisons between modelled and measured fluxes at different scales” by M. Vitale et al.

M. Vitale et al.

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Paper: A process-based model to estimate gas Exchange and monoterpene emission rates in the Mediterranean maquis 8211; comparisons between modelled and measured fluxes at different scales8221; by M. Vitale et al.

Answers to Referees8217; Comments

Referee 2

Generalities

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Referee 2. 8220; And that there is no evaluation about leaf area development or even absolute size! In Vitale et al. 2003 LAI is 8230;..but I don't know if this is really a comparable site.8221;

References cited in Vitale et al., 2003 did not refer to Mediterranean maquis but to the Mediterranean evergreen holm oak forest (Vitale et al., 2003; Gratani et al., 1997), whereas Cutini 2002 refers to two intensive forest monitoring plots placed in Sardinia and Tuscany of the same species. As a consequence, these sites are not comparable to Castelporziano maquis. Moreover, during the same experimental campaign presented in our paper, Fares et al. have measured several structural parameters, including LAI (Table 1, Fares et al. currently under BG Discussion).

Referee 2. 8220; Grote 2007 assumes from indirect literature indication that it is in spring after bud-break and has also shown that the assumptions about LAI and foliage development matter for emission estimate. I have also serious doubts that an LAI simulation approach that assumes leaf growth proportional to assimilation of the previous day without consideration of inherent phenology or drought stress impact can be suitable for representing Mediterranean vegetation dynamics. Overall, it remains to be demonstrated if the model assumptions are a) realistic and b) suitable to improve the simulations compared with simpler assumptions (e.g. LAI is constant).8221;

Specific Leaf Area values to be included in the MOCA model have been indirectly calculated from Fares et al. (Table Leaf phenology). SLA has been considered constant because MOCA considers only current year leaves ($SLA = 1/(leaf\ biomass)$) and inserted in MOCA algorithms. Furthermore, in the paragraph addressing specific limitations of the model added to the discussion, it has been highlighted that 8220; A better calibration of SLA in MOCA (i.e. SLA equation expressed as time-based function) will allow to calculate accurately the variables mentioned above (D parameter).8221; Furthermore, for the comparison of measured vs. modelled values, it must also be considered that the experimental campaign limited to 40 days between May and June when SLA and leaf phenology can be considered reasonably constant. Drought stress

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was absent in the dune-system of Castelporziano during the measurement campaign (May-June) that was characterised by some rainfall events (Fig. 4B in Fares et al.) and relatively constant values of soil water content as reported in Mereu et al. (Fig. 1b; paper actually under BG Discussion).

Referee 2. 8220;Secondly, although the simulation assumes that LAI dynamics are important to consider, vertical LAI distribution has been neglected. The authors have spent some effort into discussion the importance of stratified modelling in the literature and ended up that this should not be applied here because 8217;the morpho-structural properties of the vegetation are well characterized8217; (which I would like to see) and 8217;a multi-layer approach is extremely difficult to apply8217; (which should not be the case if condition one is true).8221;

Morpho-structural properties are well known for the Mediterranean plant species growing in the Castelporziano estate. These knowledge, however, are not sufficient to recreate neither a 3D structure nor a multilayer approach for the low Mediterranean maquis due to the non homogeneous coverage of the patchy vegetation and the species mixing of the area, where single species overlaps each to other. Under these conditions the determination of vertical LAI distribution is very difficult and not practical for modelling purpose. In this situation, the big-leaf approach that assumes a homogeneous canopy having LAI as thickness can be considered as a good compromise for the representation of the canopy, while a 3D or multiple layer approach could introduce a larger error than big leaf approach.

Referee 2. 8220;Numerous papers use canopy stratifications to estimate layer-specific micrometeorological conditions from that emission is calculated (some are also mentioned in the introduction). It is also known that Holm oaks concentrate their foliage very much on the top of the canopy (e.g .Sala et al. 1994) and that lower and upper leaves show different emission potentials (e.g. Staudt et al. 2003). Both facts imply that stratification is indeed necessary - except if the LAI at this site is exceptionally small (e.g. <1-2), which is not indicated.8221;

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Holm oaks concentrate their foliage on the top when individuals are growing in a dense forest which has a well defined structure. In the Sala et al. (1994) and Sala Tenhunen (1996) papers, the Holm oak canopy was divided in 10-12 layers of equal LAI, a procedure that is not adaptable to the studied low Mediterranean maquis due to the above mentioned features. In this respect, authors deem useful, from a practical point of view, the big leaf assumptions. As a consequence, estimation of BVOC emission has been calculated by using the Guenther8217;s algorithm at average light and temperature of the big leaf (e.g. light is reduced by the Lambert-Beer law which is a function of LAI(t)). Finally, average LAI values measured in the experimental site was 2.3 (Fares et al., table 1), that is close to the values pointed out by referee 2 (LAI < 1-2) to avoid a stratification approach.

Referee 2. 8220;Finally, I am of the opinion that a model that does not consider drought stress or at least inherent seasonal dynamics (other than a 20

In the photosynthesis module, the actual to maximum stomatal conductance ratio has been calculated at aiming to consider the seasonal stomatal closure. Maximum values of stomatal conductance were derived from literature (200 mmol m-2s-1 for Holm oak; 250 mmol m-2s-1 for Phillyrea and 240 mmol m-2s-1 for Arbutus unedo). The ratio has been inserted in the algorithm for calculating daily net photosynthesis (eqn. 2). Although, as reported by referee 2, the seasonal dynamic of BVOC emissions has been demonstrated, this seasonality is often of empirical derivation and depending on light and temperature (Sabillon and Cremades, 2001) and phenology (Staudt et al. 1997, 2000; Ciccioli et al., 2003). The latter is not considered in MOCA model because the big leaf has functional characteristics typically related to current year fully expanded leaves. However, Fares et al. reported similar emission rates coming from young and mature leaves of Holm oak suggesting that the rate of biosynthesis and emission is not under strong developmental control, being fundamentally linked to growth temperature. Thus, it is not surprising that simulated monoterpene emissions were on average similar to measured ones.

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Some specific comments

INTRODUCTION Referee 2. 8220;The introduction only deals with canopy scaling (without conclusive outcome as mentioned above) but fails to give an overview about the importance and state of the art of BVOC (monoterpene) modelling. Shouldn8217;t that be considered when presenting a 8217;new model to estimate monoterpene emission8217;? 8220;

There is not a specific sentence declaring a presentation of 8220;a new model to estimate monoterpene emission8221;.

Referee 2. 8220;What is different to other modelling approaches, particularly those carried out in comparable environments? Why is the MOCA model used as basis?8221;

Figure 1 is sufficiently clear. Monoterpene algorithms are affected either by environmental parameters (light, temperature) or by physiological ones (photosynthesis, and, as a consequence, LAI). MOCA is used to modulate all these dynamics in the monoterpene flux calculation. Furthermore, one of the aim of the paper was to demonstrate the suitability of a model that has a relatively limited set of parameters to simulate canopy fluxes in the presented conditions.

METHODS Referee 2. 8220;However, the authors seem to have missed that that equation 6 is applied to emission from storages only, while the temperature dependence factor CT from equation 7 is for emissions that are produced as a direct response to temperature and light. If the 8217;pool8217; factor is later on set to 0, half of equation 9 and equation 6 gets irrelevant.8221;

Referee 2 is right. However, eqn. 9 was entirely reported for its full presentation. Eqn. 6 is not useful, therefore it will be removed.

Referee 2. 8220;The assumed emission potential of 24.9 is the value derived by Simon et al. 2006 as average from numerous publication that vary from 6-58. From the (falsely indicate) three references only Owen et al. 1997 was included in this list.8221;

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Average values of E_s varying between 6 and 58 were reported in Street et al. (2007). Pio et al. (1993) and Owen et al. (1997) and were both cited in Table 1 of Simon et al. (2006) paper; Kesselmeier and Staudt (1999) was cited as review paper. However, the latter can be deleted because it did not directly related to E_s value.

RESULTS Referee 2. 8220; There might be some terrible misunderstanding but in Figure 5 GPP measured seems to be at app. 5 gC m⁻² d⁻¹ whereas modelled values are around 13. I would have indicated this as app. 200-300

Figure 5 is incorrect. MOCA output was rather constant regarding GPP values whereas GPP measured values showed more articulate pattern. Figure 5 has been corrected. GPP modelled values are, in fact, higher than measured ones of about 8

DISCUSSION Referee 2. 8220; There are really good reasons to discuss the limitations of the MOCA model here. There are some more as mentioned in the general statements. In my opinion these short-comings actually do not justify the application of the model at all. 8221;

In the Discussions we have shown some limitations of the MOCA model when it was applied in the Mediterranean maquis; however, taking into account these limitations they deem that MOCA model represents a good compromise between accuracy and easy-to-use when it was applied in a plant community that, traditionally, is very hard to simulate.

Finally, the corresponding author wants to apologise for some mistakes done in writing incorrect sentences, for which he assumes full responsibility.

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