Anonymous Referee #2

The paper gives a good overview of current and future conditions of water availability, climate, population, and water needs for agriculture in the Mediterranean region. It reports on comprehensive simulations to study the interactions among climate change, irrigation improvements, and irrigation water requirements in the Mediterranean region.
The paper is generally well-organized and uses logical methodologies. It provides reasonable conclusions while acknowledging the strengths and weaknesses of the analysis.

Thanks a lot for the effort in reviewing this study. We will address all your comments point by point below.

The following comments and suggestions are given to improve the clarity and quality of the paper. The comments/suggestions refer to specific page (P) and line (L) numbers in the submitted manuscript.

Scientific questions/issues:

P8466, L13: References are given for more details of crop parameterization. However, this paper should briefly describe or mention the general approach of how LPJmL simulates plant responses to changing CO2 concentrations. This information is important because this paper gives results of simulations of yield responses to several CO2 scenarios. Does the model mechanistically simulate stomatal control of CO2 assimilation and effects of CO2 concentration on photosynthesis? How does the model handle differences between C3 and C4 species (e.g., What parameters are used to differentiate their responses to CO2?)?

Thanks for this important point, we will add more details on this in the revision.

P8467, L19: 90% of field capacity as a trigger for irrigation is relatively high. Is this equivalent to just 10% management allowable depletion (MAD)? Most crops can tolerate 30% to 60% MAD, without experiencing water stress. The 90% of field capacity would probably require very frequent irrigations. Please give the rationale for using a relatively high value for triggering irrigations.

This parameter is not differentiated for different plants/crops at the moment. This is one of the reasons for choosing a high threshold to be sure that the most sensible plants do not suffer stress under irrigation conditions. Interestingly, this does not avoid water stress completely, plants still suffer stress, even with fully saturated soil, when atmospheric demand is very high. This makes sense, because plants do not absorb as much water as they would need. Anyway, it is a good idea to include more information on this parameter choice, and also including one additional run with a lower threshold testing the effects on yields. This will be included in the revision of the paper.

P8467, L23: It is not clear how atmospheric demand (D) or potential evapotranspiration is estimated. Is an energy balance approach used, or a combination method (e.g., Penman-Monteith equation)? Also, is rainfall considered in the calculation of D? Conceptually, the NIR should account for any effective rainfall that satisfies part or all of the atmospheric demand.

The approach is based on the Priestley-Taylor equation and accounts for the contribution of rainfall in satisfying water requirements. More details will be included in the revision to allow the reader to have an overview of the approach.

P8468, L4: Please give the data source for WHC values.

WHC is linked to soil texture in LPJmL, more information on this will be included in the revision.

P8468, L1: The assumption of maximum transpirational rate if the soil is saturated seems to be flawed. Saturation indicates water-logged conditions that would be detrimental to most crops that need aerated roots. Should this be "field capacity" instead?

Absolutely right, it is field capacity, and will be rephrased in the revision.

P8470, L10-11: The sentence is fragmented and unclear. Please rephrase.
Will be rephrased.

P8502, Figure 5: In the figure title, please indicate what sub-figures a, b, and c are showing.
Good point, it will be added.

Technical corrections:
P8464, L27: Change "revised literature" to "reviewed literature".
P8464, L29: Spell out "FACE" (Free Air CO2 Enrichment), for readers who are unfamiliar with this acronym.
P8466, L17: Change "consist in climate" to "consist of climate".
P8466, L21: Spell out "CRU" to clarify the meaning of this acronym.
P8467, L8: Change "same than the" to "same as the".
P8467, L15: Change "trajectories for every of these" to "trajectories for all of these".
P8473, L16: Change "when regarding to" to "when considering".
P8473, L17: Change "oppose to" to "opposed to".
P8473, L22: Change "influence" to "influenced".
P8474, L27: Change "CGM" to "GCMs".
P8475, L17: Change "overcompensate" to "exceed".
P8476, L18: Change "20180s" to "2080s".
P8477, L7: Change "aggregated after" to "aggregated for".
P8478, L6: Delete "coincides".
P8480, L10: Change "overcompensate" to "offset".
P8481, L12: Change "6" to "Six".
P8481, L17: Change "strongest" to "strongly".
P8482, L16: Change "Despites" to "Despite".
P8482, L17: Check the year (2014) for the Elliot et al. reference. Should it be 2013?
P8483, L18: Change "counterpart" to "counteract".
P8484, L20: Delete "of" before 20C.
P8486,L18: Define or spell out "COP".

P8487, L28: Change “an” to “a”.
P8488, L1: Change “phosphor” to “phosphorus”.
P8488, L5: Change “have” to “has”.
P8488, L23: Change “values” to “value”. Change “crop choices rather on water productivity” to “crop choices on water productivity rather”.
P8489, L24: Change “being” to “making”.
P8490, L7:Change “this” to “these”.

Thank you very much for these corrections, we will consider them all in the revision.

Anonymous Referee #1

*General comments
This paper projects water demands of Mediterranean irrigation under different scenarios of climate change, irrigation improvement, carbon fertilization, demographic change and water scarcity. The novel points of this paper are found in the trial to i) include agricultural trees widely grown in the Mediterranean region in the modelling, ii) address irrigation efficiency, iii) address carbon fertilization effect and iv) compare different scenarios to come up with simple suggestions for better adaptation.

Thanks a lot for the review effort. We will address all your comments point by point.

Description and accuracy of the modeling is minimally presented in this paper. Readers are advised to refer to the author’s previous work (Fader et al., 2015) for these two points.

In the revision we plan to include shortly more details on the modelling, especially on the way the model deals with CO2 fertilization, the approaches for calculating supply, demand and potential evapotranspiration, since these are important points for the interpretation of results.

Overall presentation is well structured and clear. Relation between precipitation and different degrees of warming in the climate change scenario needs to be described.

That is a very good idea and will be included in the revision. Thanks for that.

The analysis on water scarcity seems relatively weak, since future water availability is not considered.

Yes, we do not use projections or scenarios of water availability. Alternatively, we preferred to compare future irrigation requirements with current water availabilities. We would argue that this as an advantage of the study, especially because a recent model intercomparison study (Elliot et al., 2013) found out that there is a lack of consistency concerning the degree of change in water availability coming from hydrological and eco-hydrological models, being this uncertainty higher than the uncertainty arriving from different GCM models (Elliot et al., 2013). Additionally, another study found out that population change explains the larger part of the overall

change in water scarcity (Schewe et al., 2013). Moreover, there are additional points, – especially the ones mentioned in detail in table S1 of the supplementary information of our study– that let us think that using future projections of water availability might be a tricky issue leading to potentially high bias, for example:
1) Groundwater use is widespread in many regions of the Mediterranean and water availability projections and scenarios normally do not include the variability or availability of groundwater aquifers,
2) There is strong uncertainty about the future development of water infrastructure (dams, channels, interbasin connections, etc) that might substantially change water availabilities,
3) Land use change, also outside the Mediterranean regions, might strongly affect water availability, for example, expansion of irrigated agriculture in Ethiopia would change the Nile discharge. However, future land use change is very uncertain and land use models differ not only on the extent but also on the patterns of changes, making the simulation of the impacts on water availability very difficult and uncertain.
4) Future water demand for other sectors, especially industry, is largely unknown.

For these reasons we tend to think that the present assessment is actually more robust the way it is now than taking one water availability scenario from any sort of model that necessarily would encompass too many uncertainties and limitations.

However, advantages and disadvantages need to be clearly stated and this is why we mentioned these factors, among others, in the table S1, the discussion and in section 3.5. (Page 8482, L5-24 and Page 8489 L11-29), trying to offer the reader, on the one hand, an overview of influencing factors, and on the other hand, transparency on the pros and cons of our approach.

*Specific comments
p.8474, section 3.2: No information is provided on the amount of precipitation in the climate change scenario. It is important to show to what extent increased evaporative demand and decrease in precipitation (green water) contribute to increase in the NIR under climate change.

Thanks for this important point. It will be added in the revision of the paper.

*Technical corrections
p. 8465, l. 11: what » which
p. 8474, l. 11: collect » collected

Will be corrected in the revision, thanks for that.

References:
Elliott J., Deryng, D., Müller, C., Frieler, K., Konzmann, M., Gerten, D., Glotter, M., Flörke, M., Wada, Y., Best, N., Eisner, S., Fekete, B. M., Folberth, C., Foster, I., Gosling, S. N., Haddeland, I., Khabarov, N., Ludwig, F., Masaki, Y., Olin, S., Rosenzweig, C., Ruane, A. C., Satoh, Y., Schmid, E., Stacke, T., Tang, Q., and Wisser, D.: Constraints and potentials of future irrigation water

availability on agricultural production under climate change, PNAS 2014 111 (9) 3239-3244. doi: 10.1073/pnas.1222474110, 2013.

Schewe, J., Heinke, J., Gerten, D., Haddeland, I., Arnell, N. W., Clark, D. B., Dankers, R., Eisner, S., Fekete, B. M., Colón-González, F. J., Gosling, S. N., Kim, H., Liu, X., Masaki, Y., Portmann, F. T., Satoh, Y., Stacke, T., Tang, Q., Wada, Y., Wisser, D., Albrecht, T., Frieler, K., Piontek, F., Warszawski, L., and Kabat, P.: Multimodel assessment of water scarcity under climate change PNAS 2014 111 (9) 3245-3250; published ahead of print December 16, 2013, doi:10.1073/pnas.1222460110, 2013.