Author's response to Referee #1 comment hessd-10-C3145-2013 on "An original interpretation of the surface temperature-albedo space to estimate crop evapotranspiration (SEB-1S)" hessd-10-6277-2013

Please find below my responses (in italics) to the Reviewer's comments.

Referee #1

This paper exploits the land surface temperature and albedo space for ET retrieval purposes. An interesting paper covering a highly important topic, generally well written and structured with nice figures.

The title however is too general, since it suggests that the author performs some theoretical interpretation of current used LST-Albedo space approaches. This is only partly the case. The current title is not taking into account the limitations of the region of choice and the applies methods/data sets. Hence I would greatly suggest/insist to adapt the title so to better cover the content of the manuscript. Perhaps this one: "An improved use of the surface temperature – albedo space to estimate crop evapotranspiration over an irrigated agricultural area in north-western Mexico". Considering everything, the author only uses a short time period of 5 months with only 7 cloudfree ASTER images, the author implements the method for specific soil characteristics of irrigated agricultural land, etc Hence, again, very specific circumstances/conditions.

Author's response:
I agree with the Reviewer that the proposed modeling approach was validated over a particular region, and its applicability to other areas with different conditions needs to be tested. I also acknowledge that the title could be more specific. However, the suggested title "An improved use of the surface temperature – albedo space to estimate crop evapotranspiration over an irrigated agricultural area in north-western Mexico" does not take into account the coherence that is built between the proposed physical interpretation of the LST-albedo space and the classical physical interpretation of the LST–fvg space. This coherence has several positive implications for the determination of temperature endmembers, and the robustness of a hybrid contextual approach (SEB-1S) based on both LST-albedo and LST-fvg spaces. The objective of this paper is not to improve the use of the T-albedo space over a specific region. As mentioned in the abstract, introduction and conclusion, the objective is to provide an original interpretation of the wet edge of the LST-albedo space consistent with the classical wet edge of the LST-fvg space, and to validate this approach over the Yaqui area. Changing the wet edge significantly changes the physical interpretation of the LST-albedo space, and therefore represents a deeper change than simply improving the use of the LST-albedo space over a specific region.

To address this comment, the following title is proposed: "An original interpretation of the wet edge of the surface temperature – albedo space to estimate crop evapotranspiration (SEB-1S), and its validation over an irrigated area in north-western Mexico".

I wonder what could be the effect of using very detailed albedo/F data retrieved from Formosa in combination with the rougher ATSER thermal data? How will this effect the used approach (LST –Albedo space). Please comment.

Author's response:
Combining 90 m resolution ASTER thermal data with 8 m resolution Formosat-2 reflectances directly (i.e. without aggregating Formosat-2 data at the ASTER thermal resolution as it is done in the paper) would have the effect to increase the variability of albedo and fvg. In this case, the interpretation of both LST-albedo and LST-fvg spaces would be more difficult due to the unresolved variability of LST at the spatial resolution of albedo and fvg. To estimate ET at improved resolution, an alternative and potentially more robust solution would be to disaggregate the LST at the spatial resolution of available shortwave reflectance data (e.g. Merlin et al., 2010) before running SEB-1S. Nevertheless, the robustness at fine resolution of such a coupled LST-downscaling/ET-modeling scheme would need to be tested.

I missed a clear reasoning why one can defend to chose O as reference points (Fig 2b) for the estimation of EF (perhaps I missed something?).

Author's response:
As in S-SEBI (see Fig. 2a), SEB-1S (see Fig. 2b) computes EF=IJ/IK with J being observed and I and K placed on the dry and wet edge, respectively. However, since the wet edge in SEB-1S is not the same as in S-SEBI, I and K are placed differently. For SEB-1S, the point O is used to locate I and K based on the new interpretation of the wet edge. The rationale for choosing O as reference point is purely geometrical: it ensures that I and K always belong to [AD] and [BC], respectively. Mathematically speaking, O is the homothetic center of the transformation of J in I and of the transformation of J in K.

To clarify this point, the following sentences will be inserted in the manuscript: "Note that point O in Fig. 2b is defined as the homothetic center of [AD] and [BC] so that for any point J in the polygon ABCD, I belongs to [AD] and K belongs [BC]."

For better interpretation the observed changes over time of the LST-albedo space, I strongly recommend that the author adds another figure with a time series of NDVI, albedo, F, LST for each station and thus for different crops. This might help the reader to interpret the change over time of the LST-albedo plots, especially on the senescence of crops.

Author's response:
I thank the Reviewer for this suggestion. An additional figure (Figure 5 in the revised) and the associated discussion below will be inserted in the revised manuscript.
"Figure 5 plots the time series of fvg, albedo and LST for data extracted over each flux station separately. The time series of fvg indicates various crop phenological stages at all ASTER observations dates, meaning that minimum and maximum vegetation covers are generally met within the study domain, consistent with the LST-fvg spaces on all dates (See Figure 4). When looking at the curve for the dominant crop type (wheat), the seasonal cycle - including growing and senescence- is very well marked. The time series of albedo provides information consistent with the LST-albedo spaces plotted in Fig. 4: albedo is close to 0.18 for fvg larger than 0.5, albedo is generally lower than 0.18 for fvg lower than 0.5, and albedo is generally larger than 0.18 during the senescence. For wheat crop, the increase in albedo during the senescence is very significant with values reaching 0.32 on May 13. The time series of LST is more complex to interpret since is it a function of both the surface state and

the atmospheric conditions at ASTER overpass time. However, it is still visible that LST generally decreases with fvg, consistent with the LST-fvg spaces plotted in Fig. 4."

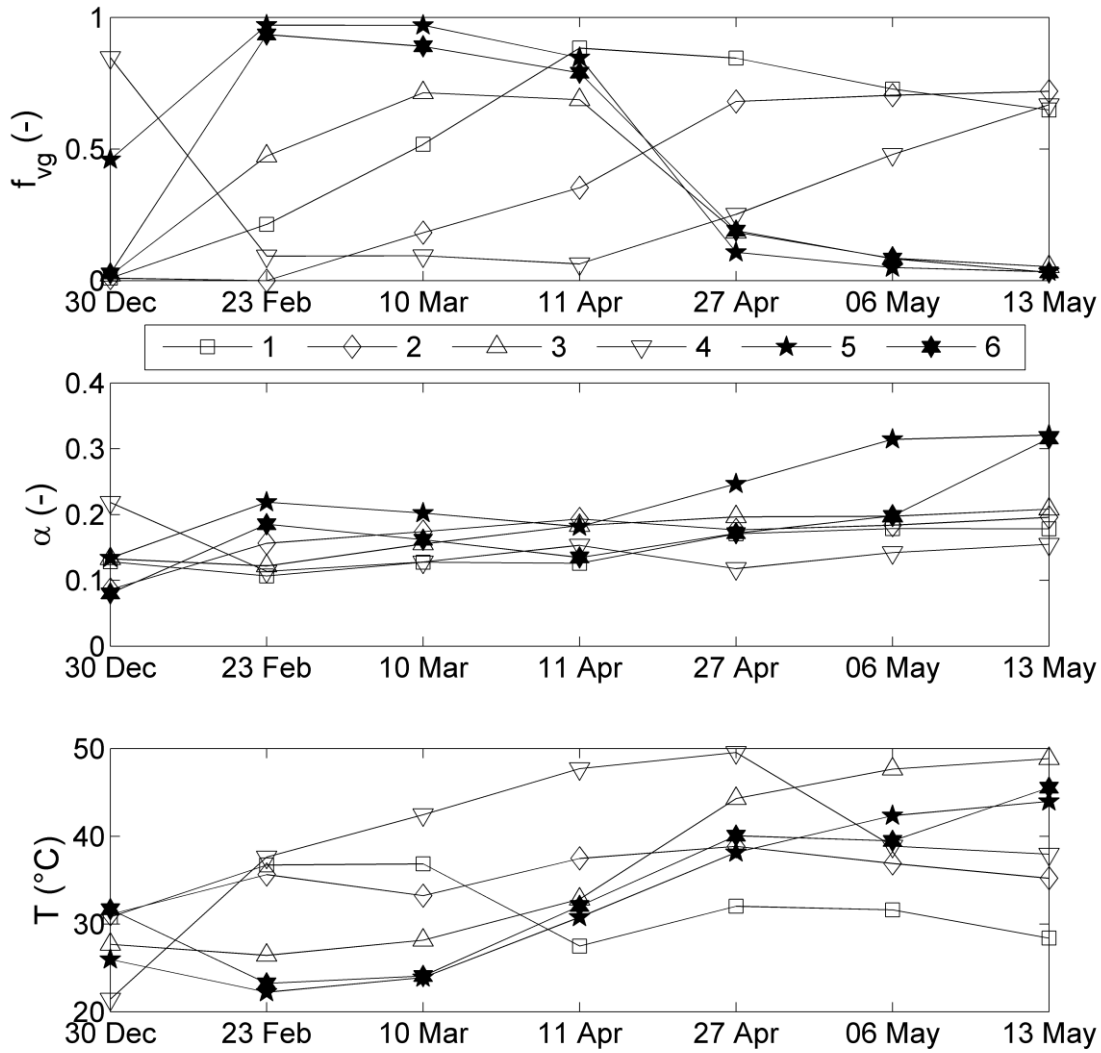

Figure 5. Times series (arbitrary time scale) of fvg, albedo and LST at each flux station separately.

The author gives a nice overview of papers dealing with the LST-albedo-vegetation space, but I miss some references, for example the overview paper on ET/SMC of Verstraeten et al., 2008 in Sensors and references herein, Li et al, 2009, in Sensors, etc

Author's response:
The reference Verstraeten et al., 2008 will be included in the revised manuscript. The reference Li et al., 2009 was already cited (P6279 L14).

P6284, L13-14 and L 1920: Twice almost the same sentence: "The 90m resolution ASTER channel emissivity retrieved by the "temperature and emis sivity separation" algorithm was

used." Better to merge these two sections (2.2.1 and 2.2.2), since temperature and emissivity are retrieved together with ASTER

Author's response:
Agreed. These two sections will be merged together in the revised manuscript.

P6285, L9-10: Why were the NIR data of ASTER not usable? Please explain.

Author's response:
This comment applies to the shortwave infrared (SWIR) data, not to the near infrared data. On the NASA ASTER website http://asterweb.jpl.nasa.gov/swir-alert.asp one reads:
"ASTER SWIR detectors are no longer functioning due to anomalously high SWIR detector temperatures. ASTER SWIR data acquired since April 2008 are not useable, and show saturation of values and severe striping. All attempts to bring the SWIR bands back to life have failed, and no further action is envisioned. VNIR and TIR data continue to show excellent quality, meeting all mission requirements and specifications."
An explanation will be inserted in the revised manuscript.

Fig. 4: I cannot see the grey overlays. Please change figure (magnify, use red instead of grey?).

Author's response:
For clarity, grey overlays will be replaced by red overlays.

Conclusions: since the authors use thermal data, it cannot be named a optical-based ET model, but it should be optical-thermal based model..

Author's response:
I do not agree with the Reviewer. The optical domain corresponds to the spectral region over which optical geometry remains valid. In that sense, the thermal-infrared region of the electromagnetic spectrum belongs to the optical domain, which should not be confused with the solar (or shortwave) region. To clarify this point, the term "optical-based" will be replaced by "solar/thermal-based" in the revised manuscript.

Considering all the data presented, models used and analysis performed I wonder if the author did this all by himself? Should the contributions by others not being recognized?

Author's response:
I imagined the modeling approach, coded the model in C, pre-processed Formosat/ASTER data, implemented the model over the Yaqui area, extracted remotely sensed ET estimates at the flux stations, analyzed the results and wrote the manuscript. Since the contributions by other researchers to the Yaqui'08 data set were recognized in two recent papers (Merlin et al., 2010; 2013), I believe that signing this study as a single author is fair. I also agree with the Reviewer that proper acknowledgement of data providers should be made. To address this comment, the acknowledgement section was changed into:

"The author is grateful to Gilles Boulet, Ghani Chehbouni, Jonas Chirouze, Benoît Duchemin and Lionel Jarlan for providing the Yaqui data set. Funding from the French space agency (Centre National d'Etudes Spatiales, CNES) for the MiSTIGRI (MicroSatellite for Thermal Infrared Ground surface Imaging) phase A study, as well as the FORMOSAT acquisition, the MISTRALS (Mediterranean Integrated STudies at Regional And Local Scales) SICMed (Continental Surfaces and Interfaces in the Mediterranean area) program, the European FP7 SIRIUS, the PLEIADES (Participatory multi-Level EO-assisted tools for Irrigation water management and Agricultural Decision-Support) program as well as the IRD (Institut de Recherche pour le Développement), the ITSON (Instituto Tecnologico de SONora), the University of Sonora and the Cadi Ayyad University (Morocco) in the setting up of the "Yaqui experiment" are gratefully acknowledged. This study is part of the MIXMOD-E project funded by the French ANR (Agence Nationale de la Recherche)."

References:

Merlin O., J. Chirouze, A. Olioso, L. Jarlan, G. Chehbouni, and G. Boulet: An image-based four-source surface energy balance model to estimate crop evapotranspiration from solar reflectance/thermal emission data (SEB-4S), under review for Agr. For. Meteor., 2013.

Merlin O., B. Duchemin, O. Hagolle, F. Jacob, B. Coudert, G. Chehbouni, G. Dedieu, J. Garatuza, and Y. Kerr: Disaggregation of MODIS surface temperature over an agricultural area using a time series of Formosat-2 images, Remote Sens. Environ., 114, 2500-2512, 2010.