Author's response to Referee #2 comment hessd-10-C3196-2013 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.

C. Jimenez (Referee #2)

The paper presents a new interpretation of the surface temperature-albedo space to estimate crop evapotranspiration (ET). I am not a specialist in this high-resolution (space) but low-sampling (time) methods to derive evapotranspiration, but the methodology seems well sounding and should be praised for attempting to estimate ET solely based on satellite-based observations. The evaluation with eddy covariance measurements is comprehensive, but limited to a very specific agricultural site (e.g. irrigated), so confirming the potential of this methodology would require further evaluation in different agricultural sites.

Author's response:
It is true that SEB-1S was tested under the specific conditions of the Yaqui area. To address this comment, the title will be made more specific: "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". Moreover, the following sentence will be inserted in the revised conclusion: "Although SEB-1S was successfully evaluated over the Yaqui area, confirming the potential of this methodology would require further evaluation in different agricultural sites. Several field experiments are already planned in Chile, France, Morocco and Spain to collect eddy covariance measurements under a range of pedo-hydro-climatic conditions.".

In general the paper is well written, their contents are well presented, figures and table are clear, and the subject is of interest for HESSD readers. A few more specific comments are given below.

Specific comments
P6280-L18. It will help defining EF and EE. EE does not seem to be so well known.

Author's response:
Agreed. The sentence "ET is estimated as either remotely sensed EF (evaporative fraction) times the available energy (Jiang and Islam, 1999) or remotely sensed EE (evaporative efficiency) times potential ET (Moran et al., 1994)" will be replaced in the revised manuscript by "ET is estimated either from the remotely sensed evaporative fraction (EF) defined as the ratio of ET to the available energy (Jiang and Islam, 1999) or from the remotely sensed evaporative efficiency (EE) defined as the ratio of ET to potential ET (Moran et al., 1994)".

P6282-L16. Out of curiosity, wondering about the "1S" in "SEB-1S" comes from.

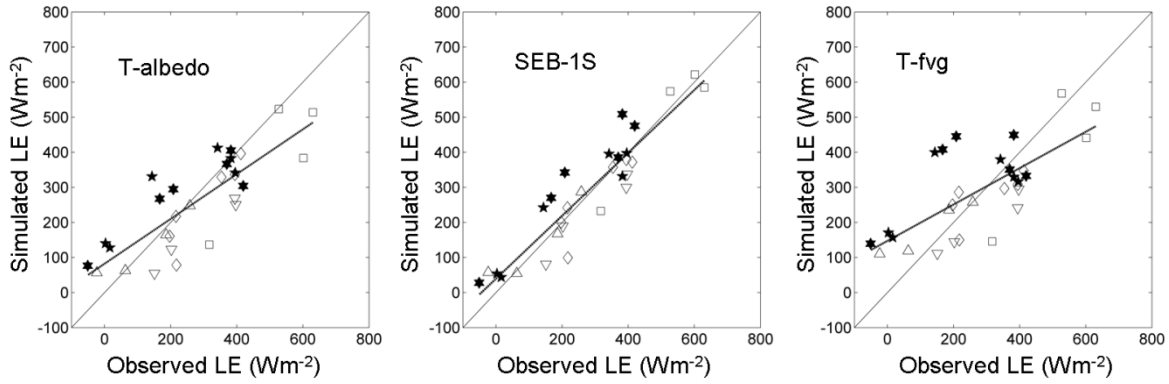
Author's response:

1S corresponds to a mono-source (surface) representation, as opposed to two-source representations including soil and vegetation components for instance. This point will be clarified in the revised manuscript.

P6282-L28. Given that all the "machinery" seems to be in place and that SEB-1S is a T-albedo method made consistent with the T-fvc space , wondering if also reporting ET estimates from the T-fvc method and how they compare with the eddy covariance fluxes (instead of just comparing SEB-1S and T-albedo) would have been of interest.

Author's response:

For your information in this response letter, below is presented a comparison between modeled and observed ET for the T-albedo (left), SEB-1S (middle) and T-fvg (right) method. Since SEB-1S is mainly based on the T-albedo space, a focus is made in the paper on the comparison between SEB-1S and the classical interpretation of the T-albedo space. Further studies will compare SEB-1S with other existing ET models. Note that a comparison between S-SEBI and WDI over the same site was presented in Chirouze et al. 2013.



P6283-L10. Only 7 ASTER images were collected because those were the only cloudfree ones, or because there were considered sufficient for the study?

Author's response:

Cloud cover is not a strong constraint over the Yaqui area: 26 cloud-free Formosat-2 images were obtained from 27 December 2007 to 13 May 2008. The main constraint when using ASTER data is that ASTER is an on-demand instrument. The Data Acquisition Request (DAR) for the Yaqui experiment provided the 7 ASTER scenes used in this study.

Further information can be found on the NASA ASTER website:

- http://asterweb.jpl.nasa.gov/gettingdata/ "ASTER is an on-demand instrument. This means that data will only be acquired over a location if a request has been submitted to observe that area. If the desired ASTER observations have not yet been acquired or even requested, a requestor can become an authorized ASTER User, and can then submit a data acquisition request (DAR) via the DAR Tool."

- http://asterweb.jpl.nasa.gov/authorization.asp "For a variety of reasons, even if a proposal is accepted and you enter a data acquisition request, there is no guarantee that ASTER can acquire the requested data: ASTER observing resources are limited and different requests for new data will often compete for use of the instrument at the same time; Even if ASTER

observes the right area at the right time of the year, the resulting data may not meet your requirements (e.g. the site might have been covered by clouds).”

Why a much larger number of Formosat-2 images are collected?

Author’s response:
Formosat-2 is the first and only high-resolution satellite able to revisit the same point on the globe every day (and in the same viewing conditions).

Can the nearest Formosat-2 image be far in time from the ASTER image?

Author’s response:
Given the high-temporal resolution of Formosat-2, the largest time difference between Formosat-2 and ASTER overpasses was 3 days (on 07/12/30 and 08/04/11). ASTER and Formosat-2 overpassed the area on the same date on 08/02/23, 08/03/10, 08/04/27, 08/05/06, and 08/05/13.

Out of curiosity, such a number of images (maximum of one each 16 days if we are lucky with the clouds) are considered useful by the agriculture community for a potential practical application of these techniques at these latitudes?

Author’s response:
To address this comment, the following paragraph will be inserted in the revised conclusion:
“A revisit cycle of 16 days for ASTER/Landsat (in cloud free conditions) is long compared to rapid changes in relation with rainfall or irrigation for instance, which makes the practical application of ASTER/Landsat data to ET monitoring relatively indirect. Before the advent of thermal infrared missions with shorter revisit cycles (Lagouarde et al. 2013), several techniques could be used to disaggregate low resolution (e.g. MODIS) temperature data at high-temporal resolution (e.g. Merlin et al., 2010; 2012a) prior to running SEB-1S at high-spatial/-temporal resolution.”

Reference:
J.-P. Lagouarde, M. Bach, J. A. Sobrino, G. Boulet, X. Briottet, S. Cherchali, B. Coudert, I. Dadou, G. Dedieu, P. Gamet, O. Hagolle, F. Jacob, F. Nerry, A. Olioso, C. Ottlé, J.-L. Roujean, and G. Fargant. “The MISTIGRI thermal infrared project: scientific objectives and mission specifications”, 34 (9-10), 3437-3466, Int. J. Remote Sens., 2013.

P6284-L4. If all ASTER images are cloud-free, why not all stations have data for the 7 images? Data gaps in the eddy covariance measurements?

Author’s response:
Details about flux measurements are provided in Chirouze et al. 2013: incoherent data due to instability or malfunction of the instruments were rejected.

Could something be said abut the spatial fetch of the tower flux (wondering about how it compares with the fine ASTER pixel) and the uncertainty of the flux measurements?

Author's response:
Flux towers were installed sufficiently far from parcel boundaries so that the footprint be entirely included in the crop fields. To quantitatively assess the impact of possible changes in size and shape of the measurement footprint, the spatial variability of the ET simulated around the flux towers was estimated as the standard deviation of the ET simulated over the 5 nearest ASTER pixels. The mean spatial variability in simulated ET is estimated as 9 % of the mean simulated ET with a marginal maximum of 35 % on 27 April at site 4. This point will be mentioned in the revised manuscript.

P6285-L10. The fact that not all the observational data comes from ASTER complicates the observational part of the study (e.g. not same collection date, resolution, etc). It may be worth explaining a bit more the reason why only 4 of 7 ASTER shortwave infrared images were usable, even if a reference is given for the reader interested in the details.

Author's response:
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.

P6296-L10. As ET is estimated as EF x Rn-G, and assuming that observed Rn-G is a good approximation of the "true" available energy, given that simulated Rn-G has an RMSD of 40-50 W/m2, can we say that ET uncertainty is at least the EF at each pixel times this 40-50 W/m2? Looking later at Table 3 the RMSD for ET between eddy covariance and simulated ET is clearly larger when using the simulated Rn-G, compared with using the station Rn-G (65-67 versus 74-84), pointing out in that direction (more uncertain Rn-G resulting in more uncertain ET).

Author's response:
It is true that more uncertain Rn-G results in more uncertain ET, and more uncertain EF results in more uncertain ET. An interesting feature is that the impact of modeled EF on ET is found to be stronger than the impact of modeled Rn-G on ET. The correlation coefficient and slope of the linear regression between simulated and observed ET is 0.82-0.84 and 0.64-0.71 respectively for the EF simulated by the T-albedo method, and is 0.90-0.93 and 0.90-0.95 respectively for the EF simulated by SEB-1S, regardless of Rn-G estimates (See Table 3).

P6298-L16. Very interesting to look at such detailed maps of ET. For instance, I noticed that a "blue" patch covering half of a field (3rd-3rd field counting from top-right corner) that remains "blueish" for most of the growing season (no crops planted so we just see limited soil evaporation, I guess) but that start to transpires at the end of the growing season for most of

the other crops (crops planted now, climate conditions, irrigation, and crop type allowing so, I guess).

Author's response:
High-resolution data make it possible to separate crops at different phenological stages. This would have been more difficult using MODIS data for instance.

P6299-L22. Could part of this bias be related to the accuracy of the eddy covariance measurements (e.g., wondering how these specific measurements are closing the energy balance)?

Author's response:
It is true that part of this bias could be related to the accuracy of the eddy covariance measurements. Eddy covariance sites had budget closure issues, with a residual between 24 and 38% of available energy depending on the station (Chirouze et al., 2013). Although a correction was applied to observed fluxes, the non-closure of the energy balance may result in additional uncertainties. This point will be mentioned in the revised manuscript.

P6300-L26. Although I fully understand that the chosen site may be ideal for model development, due to the eddy covariance measurements and local knowledge of the area, it may be worth including in the list of short term actions to apply the method somewhere else to have an evaluation under other conditions (e.g., different soil, crops, climate conditions, no irrigation, and so on).

Author's response:
In the frame of the ANR-funded MIXMOD-E project (P.I. O. Merlin) several specific field experiments are already planned in Chile, France, Morocco and Spain to collect eddy covariance measurements under a range of pedo-hydro-climatic conditions. This point will be mentioned in the revised conclusion.