Hydrol. Earth Syst. Sci. Discuss., 7, C1977–C1982, 2010
www.hydrol-earth-syst-sci-discuss.net/7/C1977/2010/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Combined use of FORMOSAT-2 images with a crop model for biomass and water monitoring of permanent grassland in Mediterranean region" *by* D. Courault et al.

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Received and published: 25 August 2010

Thank you for your useful comments on our manuscript. We have corrected the text in accordance with all your remarks, and have added some phrases for clarification at each point requested by you. Please, find below the specific responses.

>*P3655 line 13, 'Farmers use pumping to irrigate' Is this regulated by the ASA or do*

farmers sometimes pump the water without any notification? This is a bit confusing now, please change.

I added sentences to explain better this paragraph. This pumping is not regulated by the ASA. All grasslands were irrigated by flooding from a dense channel network. Some farmers (<9% on the whole region) have set up pumps to bring more water on some fields when the irrigation round is too long to provide enough water for some fields either too far from channel or very large and more sensitive to the drought in summer. This water quantity is difficult to estimate, but represent a low part of irrigation compared to those provided from channels (1 or 2 events by pumping through the year).

> *Page 3656 Line 10 please change Anenometer in Anemometer and please indicate what kind of method you used to estimate the sensible heat flux*

I corrected Anemometer and added more information on the computation of the sensible heat flux (H). H is estimated from the eddy covariance method, based on the measurements of the vertical windspeed and the instrument and air temperature difference.

> *Equation 2 Did you consider to use the enhanced vegetation index (EVI)? Because the satellite does have a blue waveband and the EVI is considered to be more responsive to canopy structural variations, including LAI and the NDVI more to chlorophyll.*

I didn't use the enhanced vegetation index (EVI) for the following reasons: Several studies have compared NDVI and EVI (Huete et al., 2002) and have shown the higher sensitivity of NDVI to atmospheric corrections compared to EVI. In our study, the atmospheric corrections were performed by O. Hagolle at Toulouse CNES (Hagolle et al., 2008), and have used accurate measurements from a photometer located in the center of the study area. So we can consider that NDVI values were quite correct at the different dates analyzed. Moreover, the correlations obtained between NDVI and LAI measurements for the different crops were quite good (Bsaibes et al., 2009). So we decided to keep this index, very easy to obtain. Besides, EVI is an optimized index

designed to enhance also vegetation signal, but computed from reflectances measured in blue, red and near-infrared spectral range and requiring coefficients linked to the soil line and the sensor. A data set for these coefficients were defined for MODIS data and led to propose EVI as a standard product in the MODIS catalog widely used for various studies (Huete et al., 2006). The determination of these coefficients for other sensors such as FORMOSAT2 remains to be done. Moreover, it should be noted that the use of the blue band is always problematic because of its signal to noise ratio quite poor. (This is mainly due to the nature of the reflected energy in this part of the spectrum over land, which is extremely low (Huete et al., 2002). A new index EVI2 without blue band has been recently developed by (Jiang et al., 2008). It would be interesting to test it in future studies and compared the results with NDVI. I added some references in the text about this point.

.Brisson, N., Mary, B., Ripoche, D., Jeuffroy, M. H., Ruget, F., Nicoullaud, B., Gate, P., Devienne-Barret, F., Antonioletti, R., Durr, C., Richard, G., Beaudoin, N., Recous, S., Tayot, X., Plenet, D., Cellier, P., Machet, J. M., Meynard, J. M., and Delecolle, R.: STICS: a generic model for the simulation of crops and their water and nitrogen balances. I. Theory and parameterization applied to wheat and corn, Agronomie, 18, 311-346, 1998.

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Hagolle, O., Dedieu, G., Mougenot, B., Debaecker, V., Duchemin, B., and Meygret, A.: Correction of aerosol effects on multi-temporal images acquired with constant viewing angles: Application to Formosat-2 images, Remote Sensing of Environment, 112, 1689-1701, 10.1016/j.rse.2007.08.016, 2008.

Huete, A., Didan, K., Miura, T., Rodriguez, E. P., Gao, X., and Ferreira, L. G.: Overview

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Jiang, Z. Y., Huete, A. R., Didan, K., and Miura, T.: Development of a two-band enhanced vegetation index without a blue band, Remote Sensing of Environment, 112, 3833-3845, 10.1016/j.rse.2008.06.006, 2008.

Shuttleworth, W. J., and Wallace, J. S.: Evaporation from Sparse Crops - an Energy Combination Theory, Quarterly Journal of the Royal Meteorological Society, 111, 839-855, 1985.

> *Page 3666 it is not clear what AET product you are showing. Is it the AET based on the crop evaporation equation of the method from Shuttleworth and Wallace. And if you use the crop coefficient approach (probably Priestley and Taylor) how do you deal with the conversion from potential ET to actual ET. This should be addressed in this paper. In addition, I guess the vertical blue lines in figure 7 d are precipitation events and the red dashed lines the cuts?. Please add this information in the figure caption.*

Yes, the AET maps in figure 8 and AET values presented in fig 7d were obtained with the STICS model which uses the Shuttleworth and Wallace method. This method is described in (Brisson et al., 1998;Shuttleworth and Wallace, 1985). I added this information in the figure caption, and also the information on the meaning of the red and blue lines of fig7 which represent respectively cut and irrigation dates.

Brisson, N., Mary, B., Ripoche, D., Jeuffroy, M. H., Ruget, F., Nicoullaud, B., Gate, P., Devienne-Barret, F., Antonioletti, R., Durr, C., Richard, G., Beaudoin, N., Recous, S., Tayot, X., Plenet, D., Cellier, P., Machet, J. M., Meynard, J. M., and Delecolle, R.: STICS: a generic model for the simulation of crops and their water and nitrogen balances. I. Theory and parameterization applied to wheat and corn, Agronomie, 18, 311-346, 1998.

Shuttleworth, W. J., and Wallace, J. S.: Evaporation from Sparse Crops - an Energy

Combination Theory, Quarterly Journal of the Royal Meteorological Society, 111, 839-855, 1985.

>Page 3668 You stated 'It is the traditional method used for century, with a strict water round defined at the district level. If severe droughts increase in the next years, the frequency and duration of irrigations has to be revised. Tools such those proposed here would allow to analyze different scenarios and propose suitable strategies to maintain reasonable production in saving water. That's true but farmers in the Mediterranean regions also flood their land to minimize salinization. Is this also an issue in this region?

In the Crau region, the salinization is not a problem as in the Camargue region located further west in the Rhone delta. Indeed, in this last region, irrigation is necessary to minimize salinization for paddy and wheat fields because the ground table is very superficial and the ground level close to zero with sea entrance in land. In the Crau region, it's different, there is no transfer of salt water from the ground table to the surface. The Crau region was formed by gravels resulting from the erosion of the Alps which were deposited by the Durance River. These gravels dip progressively southwestwards to 50 m below sea-level on the coastline. Two aquifers are identified within the Quaternary deposits in the Rhône delta. The superficial aquifer found in the Holocene deposits is a low permeable, heterogeneous and unconfined aquifer. These superficial groundwater range from freshwater to saline or hypersaline waters (up to 100 mS/cm). The Crau aquifer (second) is constituted by the fluvial Pleistocene gravels. It is a fresh unconfined aquifer greatly exploited for drinking water and industries. This aquifer has a natural discharge which corresponds to a swampy area in the eastern border of the Rhône River, where the formation dips under the confining layer (de Montety et al., 2008). The main problem for the next years, (if irrigation by flooding must be reduced), is the decrease of the groundwater for domestic and industrial uses. Economist and agronomist must discuss together to find sustainable solutions. I add some comments on this point in discussion.

de Montety, V., Radakovitch, O., Vallet-Coulomb, C., Blavoux, B., Hermitte, D., and

Valles, V.: Origin of groundwater salinity and hydrogeochemical processes in a confined coastal aquifer: Case of the Rhone delta (Southern France), Applied Geochemistry, 23, 2337-2349, 10.1016/j.apgeochem.2008.03.011, 2008.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 3649, 2010.