

## ***Interactive comment on “Cloudiness and snow cover in Alpine areas from MODIS products” by P. Da Ronco and C. De Michele***

### **Anonymous Referee #1**

Received and published: 8 May 2014

General comments: The paper presents an innovative approach for estimating snow cover in cloud obscured pixels of a remote sensing product, the MODIS daily Snow Covered Area. The strategy is based on a stepwise procedure taking advantage of spatial and temporal filtering techniques, already know in the literature. The innovation stems in exploiting the complementarities of different methods, by their combined use. In my opinion, this aspect, together with the reasons for the sequence order, should be emphasised and clarified in the text.

Though the paper is clear enough as a whole, sometimes the style in written English and the improper use of lexicon make it difficult to make out the actual meaning; both aspects must be revised.

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The paper shall be restructured: The state of the art, as well as its discussion, must be reported in only one section (currently it is partly described in the "Introduction" and partly in the "Cloud removal procedure" section). Please state that you are only considering techniques referred to the MODIS sensor, there is a huge literature in remote sensing regarding the cloud obstruction issue. The introduction must state clearly the objectives and contain an outline of the paper contents. The "Case study" section is quite puzzling: it contains the study area description; a brief account on materials; the pre-processing of snow cover products.

Specific comments: Though the overall procedure is scientifically sounding to me, anyway I have some comments and some major concerns.

The descriptions of the steps of the cloud removal procedure are quite cursory and should be detailed, decision rules must be clearly stated at each step. Some more rules/tables describing all possible cases or value combinations, together with a figure depicting the complete workflow may be of help. For instance for step 2 the temporal filtering final decision is not clear for all possible incongruities, and in step 4 rules are not even sketched.

In step 5, since the flag depends on the threshold, a preliminary data analysis is needed to account for the choices at different elevations.

In step 3 you consider 4 different aspect classes during the calculation of the regional snow and land lines. I agree that aspect strongly controls the snowmelt locally, but you claimed the approach to be regional, and you use the whole basin, which is characterized by very different landscapes, in all the other steps. Don't you think that the aspect subdivision turns your approach to a different level of detail as regards meteo and morphologic conditions?

My first major concern regards the stepwise procedure. Given that the initial products (which actually have some inaccuracies) are good, at every step some errors could be introduced, especially if there are very few cloud-free pixels; on these errors the next

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step is applied. Even if the results seem accurate, maybe some sensitivity analyses could help to better understand critical conditions at each step.

My second major concern regards validation strategy: even if the final aim is not to evaluate the MOD101A and MYD101A accuracy, I do not think the use of synthetic images, as the ones described in the paper, could provide an independent observation for accuracy assessment. In fact the likelihood of synthetic images to natural dynamic conditions (several subsequent days of cloud coverage) seems not to be arranged. The time dependency of filtering techniques could take advantage of it, if the artificial imagery is not correctly designed.

Minor scientific and Technical corrections

Please always cite the data sources and characteristics: the DEM (is it aggregated at 500m? its vertical accuracy?), the glacier map (creator, reference scale,...) . As regards glacier the sentences are not clear to me: is the problem solved or is it a pending issue? Are you sure it is relevant for the overall procedure? Maybe it is not an issue: Alpine glaciers are generally very small as compared to the spatial resolution of the MODIS products, is their surface so relevant as compared to classification errors of the satellite products?

MYD and MOD products contain a quality flag for each pixel; there is no needed to make assumptions about their quality. As regards quality, I do not think it consistent to use pixels flagged as "missing data" and "no decision", since they have stated problems of signal or its interpretation.

Please avoid to use the term "cloudiness" in favour of cloud-cover or cloud obstruction. I advise to revise the remote sensing terminology, please refer to the one adopted in the MODIS snow cover product ATBD, also regarding the product legend. (The algorithm is called SNOMAP please fix in the text). Please avoid using the term satellite crossing (which is usually referred to the Equator) in favour of overpass.

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The clouds that can be misclassified as snow are mainly cirrus clouds.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 3967, 2014.

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