The Cryosphere
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Discussions

Interactive comment on "Using MODIS land surface temperatures and the Crocus snow model to understand the warm bias of ERA-Interim reanalyses at the surface in Antarctica" *by* H. Fréville et al.

H. Fréville et al.

helene.freville@meteo.fr

Received and published: 24 April 2014

The response to Reviewer 2 and our proposed revisions are expressed below each of the the raised points.

However I did find some of the Discussion section confusing. I would like to see a clear distinction in that section, between the different models and the impacts of using the LSTs in them. The last sentence of the Discussion section really was enlightening, and a good summation of the importance of the work. Perhaps this point should appear in

the Abstract as well.

Answer : The feeling of confusion in the Discussion section probably stems from 2 missing elements: the absence of subsections and missing reminders of the main differences between models. To make Discussion section more easily readable we propose to divide it into the following sub-sections: a) Confirmation of the widespread ERA-i Ts warm bias with local in-situ observations; b) Impact of the ERA-i Ts warm bias on ERA-i T2m over the Antarctic Plateau (including a new Figure in response to Reviewer 1); c) Causes of the ERA-interim warm bias.

Each of these subsections will remind the main features of the models and data used in the subsection (see also later the response to your comment on p.67, line 17) In the Abstract, we propose to change the last sentence (p56, line 24) into : ".....Numerical experiments with Crocus show that a small change in the parameterization of the effects of stability on the surface exchange coefficients can significantly impact the snow surface temperature. The warm bias appears to be likely due to an overestimation of the surface exchange coefficients under very stable conditions."

It seems that the authors sometimes refer to the MODIS-derived surface temperature as Ts and at other times they refer to LST. Please be consistent in the terminology throughout the paper.

Answer : We refer to MODIS LST when speaking of MODIS Land Surface Temperature products before any treatment has been made and we refer to MODIS Ts after MODIS LST products have been interpolated on the stereoplar grid. To be more clear we will replace P 59, line 5 with : "For the comparison with reanalysis and model outputs, the 1 km resolution MODIS LST product was projected onto a 25 km grid in stereographic polar projection. Once the interpolation on the stereopolar grid and the time binning are made, MODIS LST product is referred as MODIS Ts." In the revised version of the paper, MODIS LST will be referred to MODIS LST product.

Abstract : Please spell out all acronyms including MODIS, BSRN, ERA and Had-

CRUT4. AQUA should be Aqua throughout the paper; it is not an acronym and should be lower case. TERRA should be Terra throughout the paper; it is not an acronym and should be lower case.

Answer : The following changes will be done: P56, line 1 : 'Moderate-Resolution Imaging spectroradiometer (MODIS) land surface temperatures in Antarctica...". P56, line 10 : "...7 stations from the Baseline Surface Radiation Network (BSRN) and Automatic Weather Stations (AWS)." P56, line 14: "Here, we evaluate the performance of surface temperature in the European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis known as ERA-Interim reanalysis." P56, line 15 : "This confirms a recent study which showed that the largest discrepancies in 2m air temperature between ERA-Interim and the global temperature dataset HadCRUT4 compiled by the Met Office Hadley Center and the University of East Anglia's Climatic Research Unit occur in Antarctica.

Introduction : p.57, line 1 – replace word decline with "melt" on this page and throughout the paper, ice sheet should not be hyphenated.

Answer : OK

p.57, line 24 – should read . . .remotely- sensed.

Answer : OK

p.58, line 2 - should read . . .space-borne.

Answer : OK

p.58, line 5 – it is unclear to me how you could run the model at hourly time steps since the MODIS data are not hourly; was this accomplished by interpolating the LST values?

Answer : MODIS Ts were only used for comparisons with in-situ Ts observations and Ts simulations from different models. Crocus was run at an hourly time step from 3-

hours ERA-Interim data which were linearly interpolated at an hourly time step. In situ observations and model simulations were available at full hours, which made it necessary to associate instantaneous MODIS Ts observations with full hours. Therefore MODIS data were time shifted in our data set to the closest full hour time-step, as explained p59 line 7 and p64, line 2. It leads to errors in the actual time less than half an hour. We estimate that this simple treatment is better than a time interpolation because most of the time intervals between 2 instantaneous observations at the same point are generally larger than 1 hour. All biases scores presented in the paper were established on series where Modis Ts were available altogether with the other data sources, making the scores very little sensible to missing data.

p.58, line 19 – replace the words at most with the words "at least".

Answer : OK

p.59, line 3 - . . .to retrieve Ts for each MODIS. . ."

Answer : OK

p.62, line 13 – has SURFEX been spelled out?

Answer : P62, line 13 : "Within the modeling platform SURFEX (EXTernalized land and ocean SURFace platform) (Masson et al., 2013), ..."

p.65, lines 13 – has IFS been spelled out?

Answer : Yes, p61, line 20

p.65 – I found the first paragraph of the Discussion section to be somewhat confusing.

Answer : Please refer to our response to the first comment. Additionnally, we will replace the first paragraph p65, line 19 with : "Genthon et al. (2010) has already noted a significant warm bias in the temperature forecasted by IFS (IFS is the meteorological model used in the ERA-Interim analysis) in summer at all levels of the instrumented Dome C tower (sensors are located from 4.3 m to 45 m above the surface). This warm

bias was attributed to the combination of an underestimated albedo – a previous albedo evaluation from Dome C BSRN data provides an average value around 0.83 – and an attenuation of the nocturnal radiative cooling. In this study a comparison with MODIS Ts shows that the warm bias in ERA-Interim Ts affects most of the plateau (and even most of Antarctica) and all seasons, including the long polar night, which means that it cannot be due to an underestimation of the albedo alone."

p.67, line 17 – I think that the sentence beginning on this line should be re- written for clarity

Answer : We will replace it with : "Most meteorological models parameterize the effects of stability in the calculation of the surface exchange coefficients which are used to derive the turbulent fluxes between the surface and the lowest atmospheric level. For the combined reasons described below, we think that the detected warm bias of ERA-i Ts stems from this parameterization in IFS :"

p.67, line 24 – has HTESSEL been spelled out?

Answer : Yes, p62 line 9

p.71, line 4 – has ABL been spelled out?

Answer : Yes p57, line 16

p.70 – 71 – paragraph starting on line 24 (p.70) – the readability of this paragraph could be improved; perhaps the authors should consider breaking it into two separate paragraphs, with the second paragraph starting on p.71, line15 at the word "According. . ."

Answer : OK

In the Reference list, I am confused about the numbers at the very end of each reference; please explain or delete them.

Answer : In each reference, the first number correspond to the volume number, the

second numbers to the page range and the last number to the year of the publication of the paper. This numbers are required by the editor.

Fig. 2 caption – change the word overpassing to "overpasses"

Answer : OK

Interactive comment on The Cryosphere Discuss., 8, 55, 2014.