The Cryosphere Discussions

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Comment on tc-2022-11

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Referee comment on "Megadunes in Antarctica: migration and characterization from remote and in situ observations" by Giacomo Traversa et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2022-11-RC1, 2022

Review of Traversa et al. Megadunes in Antarctica: migration and evolution…

The paper presents a detailed study of the characteristics of two megadune field areas in East Antarctica with a goal of generating well-defined spectral, thermal, and slope correlations, potentially useful for long-term mapping, and characterizing upwind migration and net migration (accretion plus ice flow) of the dunes. This upwind migration had been inferred from radar profile layering, but had not been shown in detail.

Much as I like this paper, and learned from it, it is not ready for publication. In general, the description of the work is too wordy, to diffuse, and it seems to track the path of the investigation, rather than present the results as they were perceived at the end of the study. The paper could be much shorter, and could move some of the detailed comparisions (e.g. between Landsat and Sentinel2 results, other nuances in the SPWD and GPS work) to supplemental information.

I would suggest that the authors lay out a somewhat more direct goal of the research in the abstract and move the statements about confirming past work, setting up the study, to the Introduction. Along the lines of : 'We investigate two EAIS megadune fields with significant past in-situ measurement data, using in addition current imaging sensors (Landsat 8 and Sentinel2), elevation models (REMA), and accumulation models (RACMO) to explore spectral, thermal, and windward slope relationships with a view towards generating a mapping algorithm for time-series investigation. We also use detailed elevation and ice flow data to determine the net migration and the sedimentological migration of the windward face of megadunes. Our study finds strong correlations between …NIR, ..thermal and …slope… but with seasonal variations… and a range of accretionary migration rates that imply all or most of the regional accumulation (as determined by RACMO and other models) is gathered in the accretionary faces.' Results indicate. Xxx corelations, and yyy migration rates…. Our study sets a course for more regional evaluations of…..'

I would suggest combining some of the graphics, since there were few material differences between EAIIST and It-ITASE study sites, and not a lot of justification for showing both the absolute and the normalized plots.

Also, show the correlation scatter plots for the parameters that correlate highly,, with the correlation line adn statistics.

There also seems to be a lot of zig-zagging in the text between Methods, Results, and Discussion. Try to iron these out, saying things once and saying the most definite things that you wish to share in each section.

Detailed comments follow – written as I read the draft.

L16 – change to: …taking advantage of the most recent….

L19 suggest present tense: analyse, not analysed.

L42 – change to: ….that can be observed from satellites…

Figure 1 – suggested caption text: Satellite image map of the Antarctic continent (Jezek, 1999) with elevation contour lines at 1000m a.s.l. intervals. Megadune regions are shown as cross-hatched blue areas (Fahnestock et al., 2000), with net surface mass balance in color for areas with SMB < 50 kg m^{-2} yr^{-1}, based on RACMO (van Wessem et al., 2014). The main study areas, shown as dark boxes in panel a, are the EAIIST region (panel b) and It-ITASE sites, both represented by Landsat 8 images (give path, row, and dates of Landsat acquisitions). (no need to mention the projection)

L63 – change to ….provide a detailed survey of Antarctica's megadunes using remote sensing….

L65 – suggested notation, ….two Landsat 8 scenes, P069 R119 (EAIIST site) and P081 R114 (It-ITASE site), in order…. I suggest not giving a lat-long point here, the scenes cover a large area. Perhaps you could show the corner positions of the scenes in Figure 1, outside the images at their corners.

L67 – in what band will you provide brightness temperature – thermal? passive microwave? (thermal, ok).

L90-91 – This sentence is a bit odd – the katabatic wind direction is known from models and wind observations; this wind direction is fundamental to megadune orientation, not the reverse. I think this sentence could be removed or converted to a different sentence about the katabatic winds and megadunes.

L91-92-93; the SPWD slopes of the leeward and windward sides of megadunes are of opposite sign -- please note that.

L126 – no need to capitalize 'metadata'.

L165 – these sentences, beginning with 'The transect plots…' are hard to understand, I suggest rewording them and referring to Figure 2 and perhaps other figures.

Figure 2 caption – add 'lines' : …of transects (yellow lines) on the …. No need for the lat-long positions, the images cover extensive areas. …green rectangle (b) is the area shown in Figure 3a…. NOTE: if you did not reproject the L8 images, they are in polar stereographic projection, not UTM – that is how they are distributed (all images south of 60°S latitude are in polar stereographic).

L179 'firstly' is not wrong, but old-fashioned – suggest change to 'first'

L180-185 FYI, the USGS is now providing 'analysis ready data' which in fact includes TOA reflectance. I am not certain that this extends globally yet, but a request to USGS to specially process a handful of images would be worth trying. This can be outside this paper, **but** if the 'analysis ready data' is available, it should compared with your work.

L198-204 This could be a significant issue: the Landsat 8 thermal channels 10 and 11 had some problems, and in fact it was recommended that channel 11 not be used for analysis. Depending upon when you retrieved L8 data, it may or may not have had a corrected channel 10 value, corrected for stray light impacts and pushbroom detector noise.

L214-216 section between the commas: … , where Band 5 NIR …. Frezzotti et al., 2002b), … Remove from the sentence, perhaps find another place for these words. It is distracting from your edge-detection of sastrugi method for determining wind direction from the imagery.

L218 – what was the variation in degrees between (a) extracted wind directions in a uniform section of the images, and (b) among the wind directions determined in the repeated imagery for the same areas? 'Only small differences'… I'm sure you are right, but a value in degrees would be useful to underscore that.

L222-230 – I suspect this adjacent-pixel method was a bit noisy – and you are saying that determining the SPWD over a 90m cell (3x3 pixels) would significantly reduce the slope? This does not seem right to me. Also – I'm not seeing how Equation 4 does not include either trigonometric functions, or, more than two pixels with some kind of ratio for the elevations of the windward pixels - ?

L233 'modules' is not the right word here – 'modes' might be what you mean, but while it sort of works, the meaning is unclear. Perhaps just end the sentence at 'directions'.

L234 remove 'thus', not needed.

Figure 3. It would be a bit better to flip the x-axis of 3b around, since 3a shows the wind moving from left to right, and the topography goes downhill left to right as well.

L250 This approach may have a problem. In Landsat 8, there is a strong correlation, even spanning years, to the linear sastrugi pattern and 'surface roughness' at the decameter scale; the megadunes themselves are much 'softer' features and are probably not the features that would be tracked by IMCORR (or PyCORR – see GoLIVE data at NSIDC; or ITS_LIVE data at NSIDC as well). You could address this by filtering --- use a high-pass filter of ~150m length scale on the image pairs to isolate the sastrugi pattern and erase the megadunes; and a low-pass filter of the same scale to smooth out the sastrugi and leave the megadune features for IMCORR or PyCORR. You may want to use a large high-pass filter as well for the megadunes (~6km), to supress bedrock-driven features (the 'undulation field') from the megadunes-only image pair. Note you would need to use a large reference area size to track the megadune pattern after filtering (or downsample the images, or both). This should allow a direct comparison of the two motion maps you are after. The high-pass filtered mapping should isolate the true ice sheet flow, directly downhill; and the low-pass filtered map should emphasize the megadune migration, a combination of sedimentological advance and ice flow. I see in L270 you attempted this with edge-detection of glaze-accumulation zones.

L257-259 – please include these attempts in the table.

L290-309 – I think this section could be stated more briefly and simply. Also – did you explore surface grain size or a normalized red-infrared band difference? NDSI?

L295 and Figure A1 – do you have any explanation for the decreased albedo with increased SZA? (sastrugi shadowing…).

L322-328 – again please check – it may be that for this analysis, brightness temperature only, and perhaps with some spatial averaging of values? This application will be ok – but prior to 2020 there were significant issues with Band 11 in Landsat 8 (which were partiall addressed by processing for the entire archive in 2020). It would be better to base your brightness temperature solely on Band10

Figure 5 Please re-plot with the y-axis warmer=up!

L347 change to '….is generally east (….'

L348-349 change to '…The regional topographic slope (10 km scale) is on average 1.5 m km^{-1}….'

Table2 – please put the regions in the upper left of each sub-table, EAIIST (left) and It-ITASE(right).

L355-362 this could be written more concisely.

Section 3.4 – the goal of this section could be presented more concisely with crossplots of the parameters showing the strong correlations.

Overall - -most of this up to this point is nice to see, but not a surprise – NIR albedo lower, temperature higher, SPWD trends, sastrugi versus model wind, all these are tightly correlated and are a function of the published characteristics and formation ideas for megadunes. So, while I understand that it was work to put it all together, and you'd like to show it, it is much more interesting that you combined them to create a classification method for megadunes that you can use to look for seasonal and interannual changes.

Section 3.5 – I think this is the best part of the manuscript – a slghtly quicker pace to get to this part of the paper might be better.

Figure 7 – can you present this as an image with the change (glaze in November not January; and glaze in January not November) shown as colored strips on the black-and-white NIR image?

L405 – Can you assemble Landsat images of the entire dune area for, e.g. 2013 and 2020, and look for regional expansion of glaze areas in January? This would be a very important result.

Section 3.6 – 'Superficial' in English means 'unimportant' or 'trivial'– I think just 'Ice sheet velocity and upwind megadune migration' would make a better heading here.

L422 – do you have a figure of the nine megadunes traversed by GPS? I see Figure 3b, but perhaps a graphic highlighting the GPS plus REMA assessment of migration?

Also – what local accumulation rates are indicated by the frontal accretion? Assuming the glaze areas on the lee side of the dunes have near-zero accumulation, what does this mean for the regional accumulation rate, e.g. from RACMO, compared to what you observe?

L444 – change to 'near-identical' or 'identical within the limits of determination'

L451-467 – could you not evaluate the inter-annual changes using only, e.g. mid-January images?

L484 – 'scalarly summed?' would it not be a vector sum to get the net migration?