Response to Scambos' comments

Authors' responses are in BLUE color.

Unfortunately, there are a number of issues with this manuscript, and I think the best solution is to ask the authors to withdraw the paper and resubmit a new work with many changes.

Response: We revised the manuscript according to all reviewers' comments and suggestions. We thought the revised version is much better in both science description and English.

Thank you for taking time to review the manuscript.

MODIS is a tricky tool to use for glacier velocity mapping, because of its coarse resolution. The large pixels (250 m) tend to smooth over many of the features used for image correlation -based feature tracking in finer-resolution sensors like Landsat or ASTER or SPOT. On grounded ice, features associated with the bedrock structure begin to dominate the content of the image chips used. These do not move with ice flow. This is likely why the Peninsula itself is mapped as having generally slow flow of 100 - 150 m year (Figure 6), when in fact several large east-flowing, and smaller west-flowing glaciers have previously been shown to have flow rates of up to a few meters per day. However MODIS has been used successfully to map flow speed on ice shelves. On ice shelves, there are no bedrock-resting features, so all surface features here too, however, caution is needed near the edges of the shelf. Near the edges, stationary features like the grounding line and bedrock outcrops force the correlation to match those nearly motionless parts of the scene. Figure 6 appears to suffer from this.

Response:

Agree. We revised Figure 6. For surface features of larger spatial scale (larger than the image resolution) such as flow speed on ice shelves or large glaciers, MODIS performs well. For features of spatial scale smaller than the spatial resolution, the mapping accuracy may be compromised. We added such discussion in the revised version when we discuss the mapped edges of the shelf.

The method used, image cross-correlation, and the software, COSI-Corr, have a long history, and so the Method section does not need to be so long or detailed.

Response:

Agree. We removed some figures, most of formulae and unnecessary sentences (Figs. 3, 4, and 5, Eq.2, Eq.3, Eq.5, Eq.6, Eq.7and Eq.8). The routine procedure was now briefly introduced, with an emphasis on the specification of the parameter settings.

There are other issues with the understanding of glaciology and English usage.

Response:

We revised the manuscript and paid more attention to the technical description and English usage. We believe the revised version should be much better.

Suggestion: consider only the floating ice areas larger than 10 km by 10 km; mask out the grounded areas. Use more images by going through the MODIS archive more thoroughly and look for clear images of the shelf surface (there are many tens of such images).

Response:

We adopted this suggestion and only considered the floating ice areas larger than 10×10 km （Fig.1）by masking out the grounded areas, e.g. glaciers on Grahm Land where velocity derived from MODIS data may have much larger errors. Eventually, the study site has an area of approximately 46,000 km^2, mainly covering the Larsen C Ice Shelf and its far southerly neighbour ice shelf. Additionally, we used more images with high quality (e.g. little or no clouds) (table1). To be consistent with these changes, we also changed the title to “Spatiotemporal variations in the surface velocities of ice shelves, Northern Antarctic Peninsula”.

The new results show that: (1) The spatial pattern of the velocity field exhibits an increasing trend from grounding line to the maximum at the middle section of ice shelf front on Larsen C with a velocity of approximately 700 m a^{-1}. Ice flows relatively quicker in the outer part than in the inner parts of the ice shelf (Figure 2 as an example). (2) Surface velocity showed a continuous increase from 2000 to 2012. It’s worth noting that, the acceleration rate was relatively higher during 2000-2009 than during 2009-2012. The ice movement on the northeast and southern Larsen C, as well as on Smith Inlet from 2009 to 2012 showed a deceleration. This phenomenon may be related to the reduction of longitudinal stress caused by the rapid thinning of ice shelves.

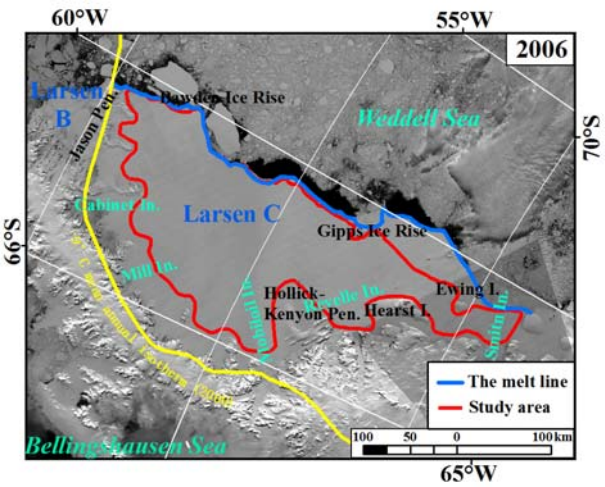

Figure 1. Location of the study area

Table 1. The details of used MODIS images

period1	period2	period3	period4	period5
27-MAR-2000(13:15)	10-FEB-2003(12:45)	5-JAN-2006(14:45)	8-APR-2009(14:15)	19-JAN-2012(13:25)
29-MAR-2000(13:05)	20-MAR-2003(13:45),	7-JAN-2006(14:20)	1-JAN-2009(13:10)	25-JAN-2012(12:50)
24-AUG-2000(14:15)	8-APR-2003(14:15)	10-NOV-2006(12:35)		21-FEB-2012(14:10)
26-AUG-2000(15:40)	18-APR-2003(14:50)			19-AUG-2012(13:50)
24-SEP-2000(11:55)	11-DEC-2003(14:50)			23-AUG-2012(13:25)

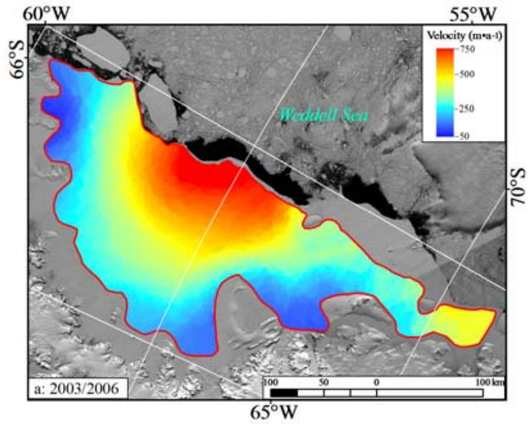

Figure 2. The surface velocity of ice shelves in the northern Antarctic Peninsula (2003-2006).

Compare the results to the several published maps of ice shelf flow speed, e.g. Rignot et al, 2011, Haug et al., 2010 in more detail. There are very large differences here. See a paper by Rott et al., in Geophysical Research Letters, 2014 on ice flow speeds of some glaciers in the northern AP.

Response:

Since we now only focused on the ice shelf, the velocities derived are only about the ice movement on ice shelf. The updated results agreed generally with the flow speed maps of Larsen ice shelf reported by Rignot et al. (2011), Haug et al. (2010), and Khazendar et al. (2011). We did not compare with the results of Rott et al (2014), because now our study area is only ice shelf.