We appreciate the constructive comments and suggestions from the editor.

Editor:

Dear Authors,

Thanks a lot for revising the manuscript and taking into account the final comments of the referee.

However, I think that your abstract needs some work to really capture the attention of the readers and not loose them in too many numbers. The structure of the abstract is also not very clear. See suggestions below.

Next round, I will just check the abstract.

Best regards,

Etienne Berthier

The abstract is now quite long. If you could streamlined and shortened it, it would have more impact on the reader. I provide some suggestions below but I think it is better to really rewrite it.

Response:

Thanks. The abstract is revised accordingly.

Abstract. *Antarctic ice velocity maps describe the ice flow dynamics of the ice sheet and are one of the primary components used to estimate the Antarctic mass balance and contribution to global sea level changes. In comparison to velocity maps derived from recent satellite images of monthly to weekly time spans, historical maps, from before the 1990s, generally cover longer time spans, e.g., over 10 years, due to the scarce spatial and temporal coverage of earlier satellite image data. We found velocity overestimations (OEs) in such long-span maps that can be mainly attributed to velocity gradients and time span of the images used. In general, they are less significant in slow-flowing grounded regions with low spatial accelerations. Instead, they take effects in places of high ice dynamics, for example, near grounding lines and often in ice shelf fronts. Velocities in these areas are important for estimating ice sheet mass balance and analyzing ice shelf instability. We propose an innovative Lagrangian velocity-based method for OE correction without the use of field observations or additional image data. The method is validated by using a set of "ground truth" velocity maps for the Totten Glacier and Pine Island Glacier which are produced from high-quality Landsat 8 images from 2013 to 2020. Subsequently, the validated method is applied to a historical velocity map of the David Glacier region from images from 1972–1989 acquired during Landsat 1, 4 and 5 satellite missions. It is demonstrated that velocity*

overestimations of up to 39 m a^{-1} for David Glacier and 195 m a^{-1} for Pine Island Glacier can be effectively corrected. Furthermore, temporal acceleration information, e.g., on basal melting and calving activities, is preserved in the corrected velocity maps and can be used for long-term ice flow dynamics analysis. Our experiment results in PIG show that OEs of a 15-year span can reach up to 1,300 m a^{-1} along the grounding line and cause an overestimated GL flux of 11.5 Gt a^{-1} if not corrected. The magnitudes of the OEs contained in both velocity and mass balance estimates are significant. When used alongside recent velocity maps of 1990s – 2010s, they may lead to underestimated long-term changes for assessment and forecast modeling of the global climate change impact on the Antarctic ice sheet. Therefore, the OEs in the long span historical maps must be seriously examined and corrected. We recommend that overestimations of more than the velocity mapping uncertainty (1σ) be corrected. This velocity overestimation correction method can be applied to the production of regional and ice sheet-wide historical velocity maps from long-term satellite images.

L14: here the reader could think of acceleration through time. Maybe "velocity gradients" or "ice flow acceleration (in space)" are better

Response:

We revised it, using "velocity gradients".

L15-16. I am note sure you need to include these examples here because they are other numbers now further down in the abstract to illustrate the magnitude of the OEs.

Response:

The examples with numbers are removed.

L28-31. Could you try to simplify these sentences. "Heavy" writing style.

Response:

They are simplified: "*The magnitudes of the OEs contained in both velocity and mass balance estimates are significant. When used alongside recent velocity maps of 1990s – 2010s, they may lead to underestimated long-term changes for assessment and forecast modeling of the global climate change impact on the Antarctic ice sheet. Therefore, ……*"