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Interactive comment on "Earth's surface mass transport derived from GRACE, evaluated by GPS, ICESat, hydrological modeling and altimetry satellite orbits" *by* Christian Gruber et al.

Anonymous Referee #1

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Review on the manuscript "Earth's surface mass transport derived from GRACE, evaluated by GPS, ICESat, hydrological modeling and altimetry satellite orbits" (by Christian Gruber, Sergei Rudenko, Andreas Groh, Dimitrios Ampatzidis, Elisa Fagiolini) submitted to the journal "Earth Surface Dynamics"

The paper represents a possible approach of the combination of different observations for determination of the "surface mass transport". In my opinion the work is interesting in itself, but requires a revision in several place before the publication. Major remarks are reported in the following.

1. The paper basically refers to numerical results, which are quite valuable for such

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Discussion paper

regions as Greenland and Antarctic areas. Despite numerous illustrations, it is written rather in a compact way but may not be understood by the reader. For that reason this paper may be considered as a good paper, if authors will introduce a special section with the theory of determination of mass transport including all adopted assumptions (Probably authors supposed that surface masses are concentrated in a thin layer at the surface of the spherical Earth). If so, the following basic reference is missing:

Wahr, J., M. Molenaar, and F. Bryan (1998), Time variability of the Earth's gravity field: Hydrological and oceanic effects and their possible detection using GRACE, J. Geophys. Res., 103, 30,205– 30,229.

2. According to the title of manuscript, the authors should note that the determination of the mass redistribution at the Earth's surface from the given external potential is traditionally treated as special boundary case of improperly posed inverse problem of the gravitational potential. From this viewpoint accuracy estimates of the mass redistribution at the Earth's surface (Greenland, Antarctic) given in this work need to be explained in details. The authors can find the rigorous accuracy estimation for the case of such properly posed inverse problem in the following paper:

Marchenko A. N. (2009) On the Global Density Distribution Based on the Earth's Mechanical Parameters and Piecewise Reference Model. In: "Mission and Passion: Science" A volume dedicated to Milan Burša on the occasion of his 80th birthday , (Ed. P.Holota), Czech National Committee of Geodesy and Geophysics, Prague, 2009, pp. 169-179.

3. The reviewer has a certain doubts concerning the next remark (lines 12-14) of the authors: "In addition, non-conventional methods based on radial basis functions (RBF) and mascons will give the ability to compute models in regional and global representation as well". Such sentence could lead to a violation of understanding of the so-called RBF or radial multipole potentials (as harmonic functions) introduced by Maxwell (1881) and Lunar mascons (as singular objects) approximated by the potential of point

masses, disks, etc. On the other hand this sentence has direct relation rather to the modeling of the external potential then to the Earth's surface mass transport. Because of the Lauricella's theorem the direct modeling of second one is impossible without special study: any density distribution can be represented as simple sum of harmonic density and density of zero potential. See the basic reference:

Moritz, H. (1990) The Figure of the Earth. Theoretical Geodesy and Earth's Interior, Wichmann, Karlsruhe, 1990.

with the application of the Lauricella's theorem to the Earth's density

Marchenko A.N., Abrikosov O.V. A note on the standard parameterization of the Earth's dynamical figure and Darwin's density distribution. Bollettino di Geodesia et Scienze Affini, Anno LIX, (4), pp. 335-348

Summarizing, the reviewer recommends the publication of this manuscript in the Earth Surface Dynamics after improvements, including the Summary, according to given before suggestions.

Anonymous reviewer 26.01.2018

Please also note the supplement to this comment:
https://www.earth-surf-dynam-discuss.net/esurf-2017-70/esurf-2017-70-RC1-supplement.pdf

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