Mass Source Variations Datasets

We use estimates of the contributions of mass changes of the Antarctic and Greenland ice sheets (AIS and GIS, respectively), glaciers (GLA), and land water storage (LWS). We define LWS anomalies as water mass changes outside glacierized areas: the sum of water stored in rivers, lakes, wetlands, artificial reservoirs, snow pack, canopy and soil (groundwater). For each of the barystatic contributions we use four different estimates.

One of the main sources of observations of Earth's mass changes is the satellite mission Gravity Recovery and Climate Experiment (GRACE) and its follow-on mission (GRACE-FO). We use GRACE mass concentrations (mascons) over land as estimates of changes in AIS, GIS, glaciers and LWS. To avoid methodological biases, we use mascon solutions from two different processing centers:

- RL06 from Center for Spatial Resarch (CSR) (Save et al 2016; 2020),
- RL06 v02 from Jet Propulsion Laboratory (JPL) (Watkins et al, 2015; Wiese et al, 2019

To isolate the individual contributions of AIS, GIS, LWS and GLA in the GRACE mascons, we use an ocean-land-cryosphere mask, which delineates the drainage basins of the ice sheets, the glaciers.

Apart from GRACE data, we use seven other datasets in our analysis, from which five are independent of GRACE and two are partly based on GRACE.
For LWS, we use data from two global hydrological models:

- PCR-GLOBWB (GWB) (Sutanudjaja et al., 2018)
- WaterGAP (WGP) (Caceres et al., 2020).

WGP also incorporates a time series of glacier mass variations from the global glacier model of Marzeion et al. (2012). We use our ocean-land-cryosphere mask to separate the LWS and GLA estimated from WGP.
For GLA, in addition to the WGP model simulations, we also use observational estimates from Zemp et al. (2019), which are based on an extrapolation of glaciological and geodetic observations.
For the GIS and AIS, we use observation- and model-based data from Mouginot et al. (2019) and Rignot et al. (2019), respectively. We refer to these as UCI datasets, since they were both developed at the University of California at Irvine (UCI).
We also use AIS and GIS estimates from the ice sheet mass balance inter-comparison exercise (IMBIE, Shepherd et al.,2018;2020), which combines ice sheet mass balance estimates developed from three different techniques (satellite altimetry, satellite gravimetry and the input-output method).

Contr	Dataset	Temporal range	Source	Dependence on GRACE	Acronym
All	CSR mascon RL06	2003-2020	observations	GRACE	CSR
	JPL mascon RL06	2003-2020	observations	GRACE	JPL
AIS	IMBIE 2018	1993-2017	ensemble datasets	Hybrid	IMB
	Rignot 2019	1979-2017	observations + model	Independent	UCI
GIS	IMBIE 2020	1993-2017	ensemble datasets	Hybrid	IMB
	Mouginot 2019	1972-2018	observations + model	Independent	UCI

Glaciers	Zemp 2019	1962-2016	observations + model	Independent	ZMP
	WaterGAP	1958-2016	glaciers model	Independent	WGP
LWS	WaterGAP	1958-2016	hydrological model	Independent	WGP
	PCR-GLOBWB	1948-2016	hydrological model	Independent	GWB

References

AIS

R19: Rignot et al., 2019. Four decades of Antarctic Ice Sheet mass balance from 1979–201. *Proceedings of the National Academy of Sciences*, 116 (4) 1095-1103; https://doi.org/10.1073/pnas.1812883116

IMB: The IMBIE team, 2018. Mass balance of the Antarctic Ice Sheet from 1992 to 2017. *Nature* 558, 219–222. https://doi.org/10.1038/s41586-018-0179-y

GIS

IMB: The IMBIE Team, 2020. Mass balance of the Greenland Ice Sheet from 1992 to 2018. *Nature* 579, 233–239. https://doi.org/10.1038/s41586-019-1855-2

M19: Mouginot et al., 2019. Forty-six years of Greenland Ice Sheet mass balance from 1972 to 2018. *Proceedings of the National Academy of Sciences* 116 (19) 9239-9244; https://doi.org/10.1073/pnas.1904242116

TWS

WGP: Cáceres et al., 2020. Assessing global water mass transfers from continents to oceans over the period 1948–2016. *Hydrol. Earth Syst. Sci.*, 24, 4831–4851, https://doi.org/10.5194/hess-24-4831-2020

GWB: Sutanudjaja et al., 2018. PCR-GLOBWB 2: a 5 arcmin global hydrological and water resources model. *Geosci. Model Dev.*, 11, 2429–2453, https://doi.org/10.5194/gmd-11-2429-2018

Glaciers:

ZMP: Zemp et al., 2019. Global glacier mass changes and their contributions to sea-level rise from 1961 to 2016. *Nature* 568, 382–386. https://doi-org.tudelft.idm.oclc.org/10.1038/s41586-019-1071-0

WGP: Marzeion et al., 2012. Past and future sea-level change from the surface mass balance of glaciers, The Cryosphere, 6, 1295–1322, https://doi.org/10.5194/tc-6-1295-2012 *(Already incorporated in WaterGAP by Cáceres et al)*

GRACE

CSR: Save, 2020. CSR GRACE and GRACE-FO RL06 Mascon Solutions v02, doi: 10.15781/cgq9-nh24

JPL: Wiese et al., 2019. JPL GRACE Mascon Ocean, Ice, and Hydrology Equivalent Water Height RL06 CRI Filtered Version 02. Ver. 02. https://doi.org/10.5067/TEMSC-3JC62