nature climate change

SUPPLEMENTARY INFORMATION

DOI: 10.1038/NCLIMATE3325

In the format provided by the authors and unedited.

The increasing rate of global mean sea-level rise during 1993–2014

Xianyao Chen[1]*, Xuebin Zhang[2]*, John A. Church[3], Christopher S. Watson[4], Matt A. King[4], Didier Monselesan[2], Benoit Legresy[2] and Christopher Harig[5]

[1]Physical Oceanography Laboratory/CIMST, Ocean University of China and Qingdao National Laboratory of Marine Science and Technology, Qingdao 266100, China. [2]CSIRO Oceans and Atmosphere, Hobart, Tasmania 7000, Australia. [3]Climate Change Research Centre, University of New South Wales, Sydney, New South Wales 2052, Australia. [4]Discipline of Geography and Spatial Sciences, School of Land and Food, University of Tasmania, Hobart, Tasmania 7001, Australia. [5]Department of Geosciences, University of Arizona, Tucson, Arizona 85721, USA.
*e-mail: chenxy@ouc.edu.cn; xuebin.zhang@csiro.au

Table S1. Global monthly steric sea level datasets

	Dataset	Time range	Maximal Depth
Optimal Interpolation	EN4[1]	1993-2014*	5350 m
	IK9[2]	1993-2012*	1500 m
Model-based Reanalysis	C-GLORS[3]	1993-2013*	5728 m
	ECCOv4[4]	1993-2011*	5906 m
	K7[5]	1993-2011*	5525 m
	ORAS4[6]	1993-2014*	5350 m
	SODA[7]	1993-2010*	5375 m
ARGO-based	CSIRO	2005-present	2000 m
	IPRC	2005-present	2000 m
	SCRIPPS[8]	2005-present	2000 m

* The dataset starts earlier than 1993. Here we only use data starting from 1993.

DOI: 10.1038/NCLIMATE3325

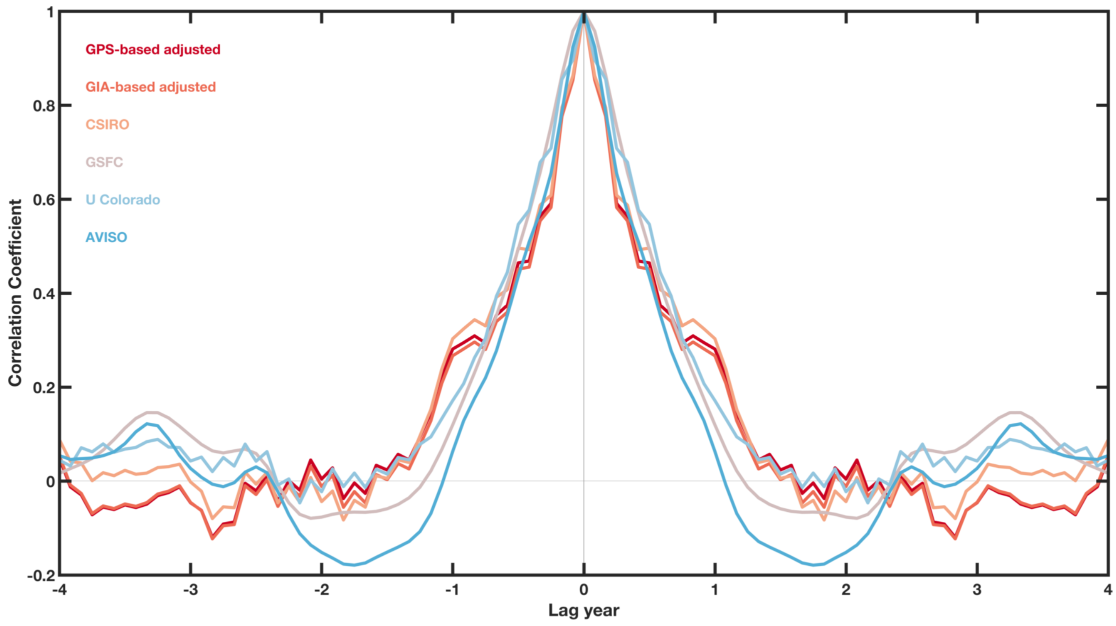

Figure S1 | Auto-correlation of the GMSL records shown in Figure 1.

DOI: 10.1038/NCLIMATE3325

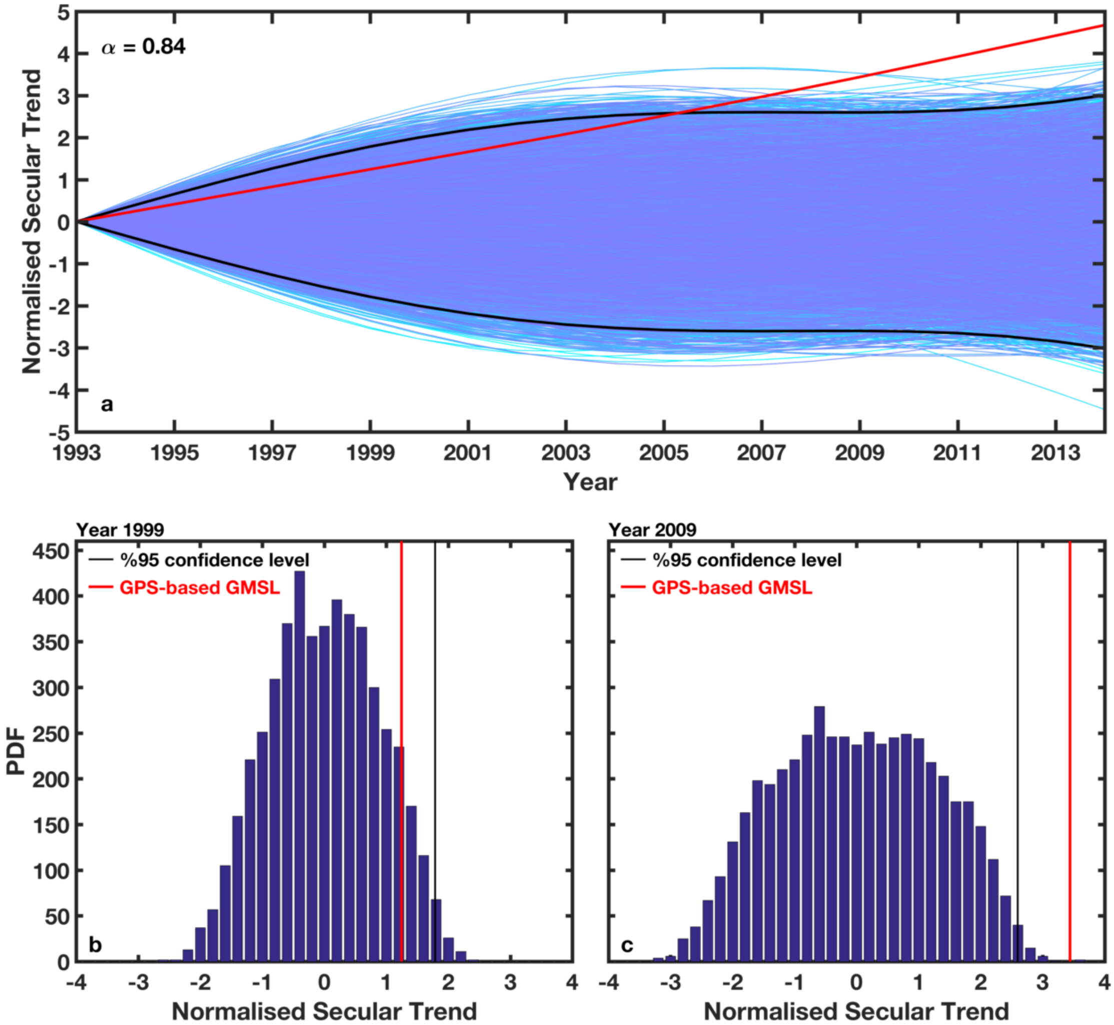

Figure S2 | Statistical significance of GPS-based adjusted GMSL. (a) The intrinsic secular trend of 5000 AR(1) time series with lag-1 auto-correlation coefficient α = 0.84, same as that of GPS-based adjusted GMSL. Two thick black lines are two-standard-deviation spread lines. Red line denotes the normalized intrinsic secular trend of GPS-based adjusted GMSL. (b, c) The empirical probability density function (PDF) of the intrinsic secular trends at the year 1999 and 2005, respectively.

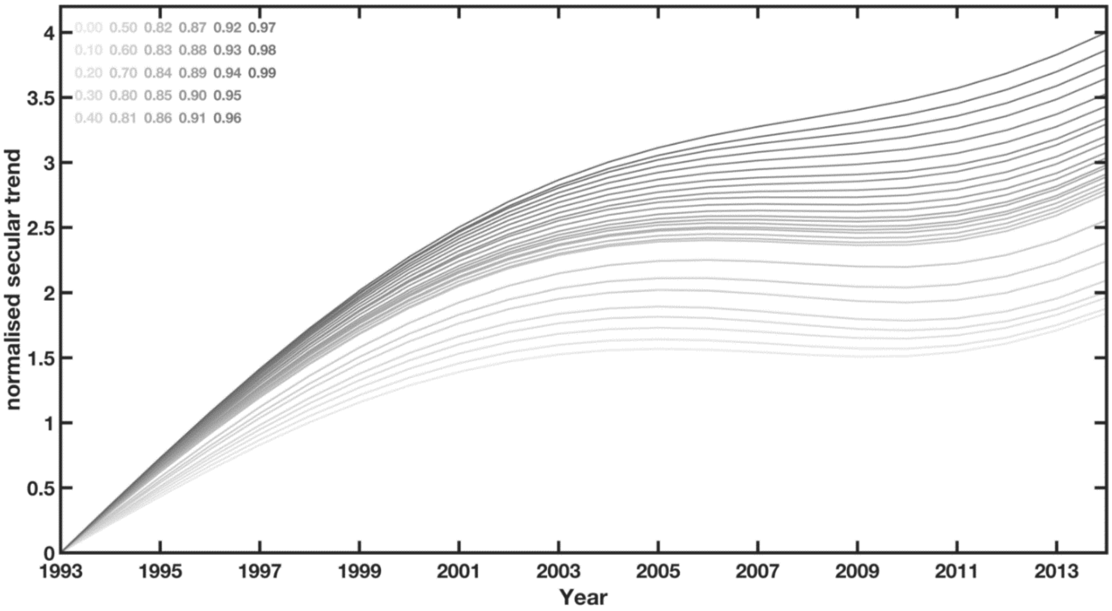

Figure S3 | The two-standard-deviation lines of the intrinsic secular trend of AR(1) processes with the lag-1 auto-correlation ranging from 0 to 0.99.

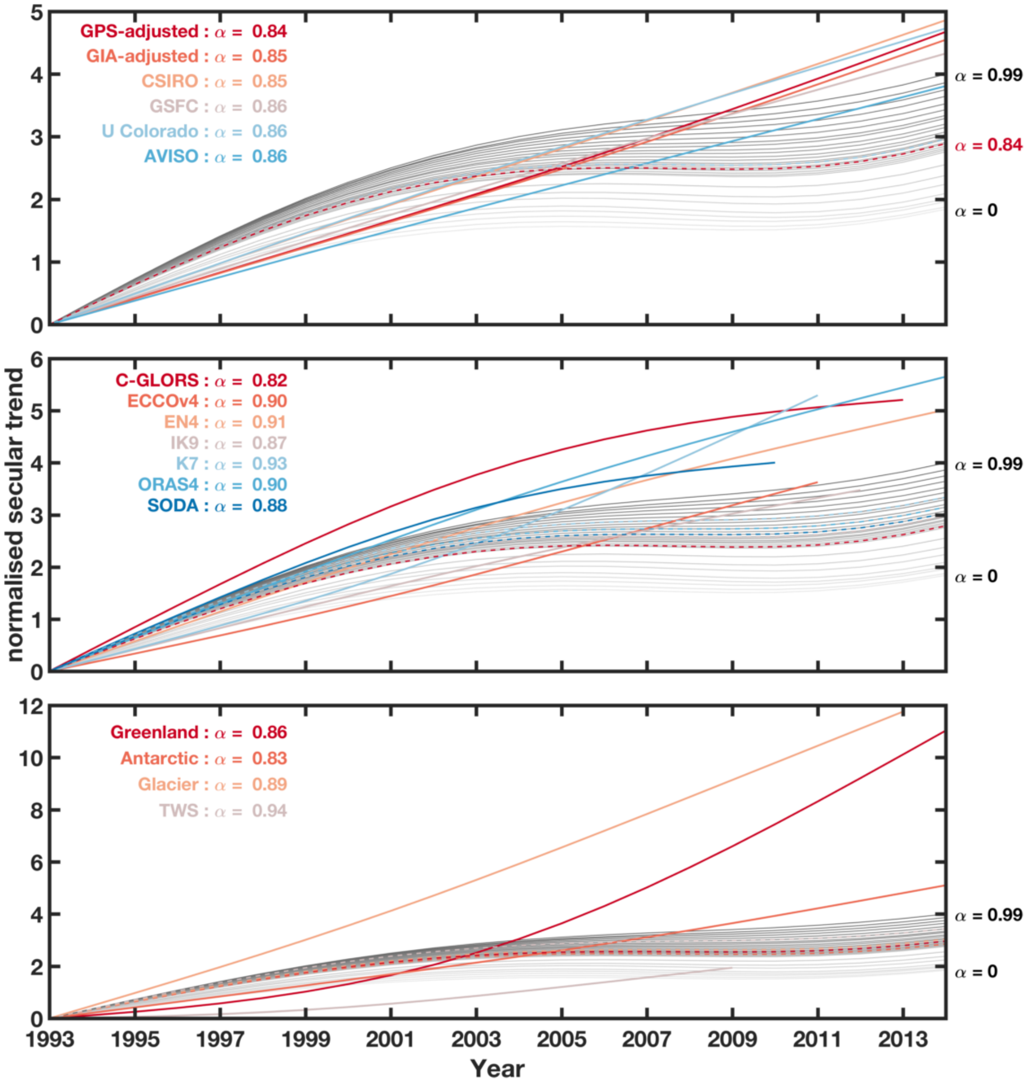

Figure S4 | Statistical significance test of the intrinsic secular trends of (a) the GMSL time series, (b) the GMSSL time series, and (c) the global ocean mass change time series. The gray lines in each panel show the secular trend derived from randomly generated AR(1) red noise with the lag-1 auto-correlation ranging from 0 to 0.99 (in order from light gray to dark gray). The coloured lines show the secular trend of each sea level time series, which is normalized by the standard deviation of the linear detrended time series. The dashed lines show the two-standard-deviation of the secular trend derived from randomly generated AR(1) red noise with the corresponding lag-1 auto-correlation coefficient, as indicated in the legend.

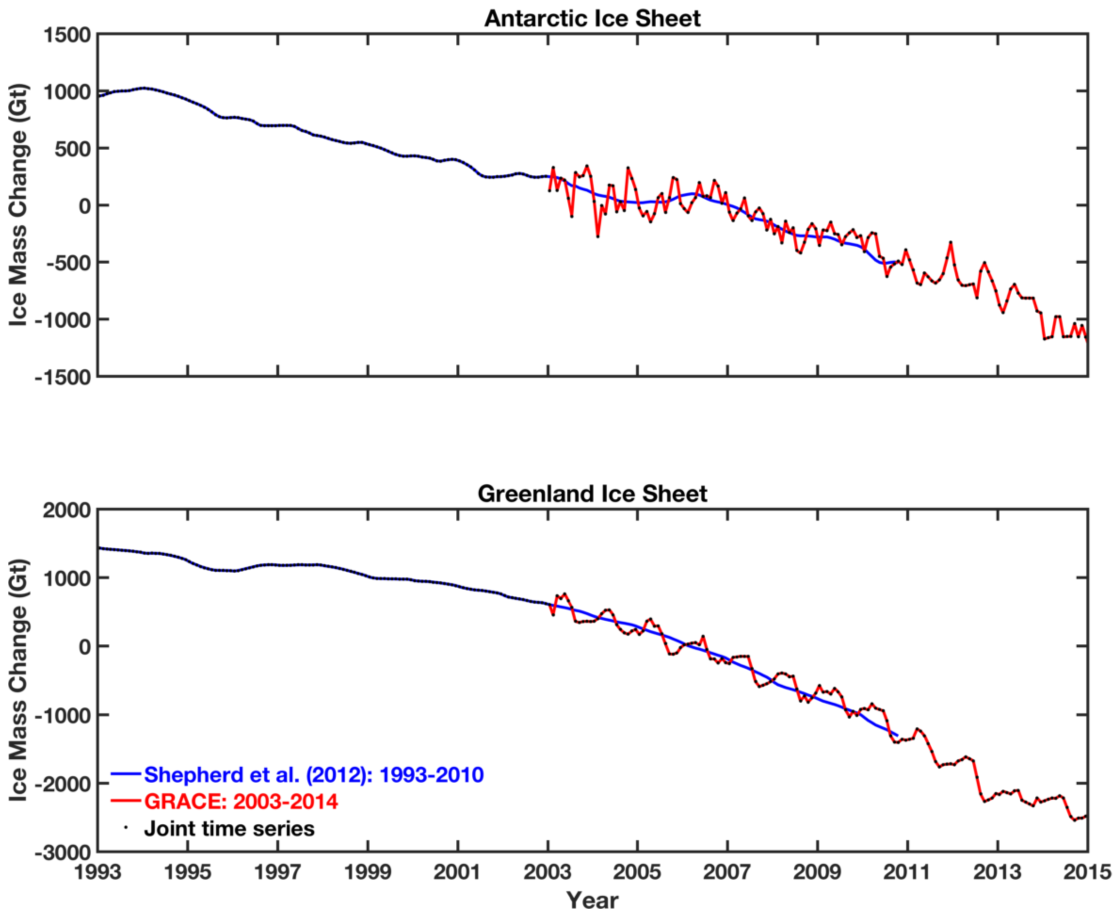

Figure S5 | Monthly mean time series of Greenland and Antarctic ice sheet mass losses. Blue line is the data available at http://imbie.org/data-downloads[9] from the and red line is the data from GRACE record[10]. Black dots denote the joint time series in 2003.

References.

1 Good, S. A., Martin, M. J. & Rayner, N. A. EN4: Quality controlled ocean temperature and salinity profiles and monthly objective analyses with uncertainty estimates. *Journal of Geophysical Research: Oceans* **118**, 6704-6716, doi:10.1002/2013jc009067 (2013).

2 Ishii, M., Kimoto, M., Sakamoto, K. & Iwasaki, S.-I. Steric sea level changes estimated from historical ocean subsurface temperature and salinity analyses. *Journal of Oceanography* **62**, 155-170, doi:10.1007/s10872-006-0041-y (2006).

3 Storto, A., Masina, S. & Dobricic, S. Estimation and Impact of Nonuniform Horizontal Correlation Length Scales for Global Ocean Physical Analyses. *Journal of Atmospheric and Oceanic Technology* **31**, 2330-2349, doi:10.1175/jtech-d-14-00042.1 (2014).

4 Forget, G. *et al.* ECCO version 4: an integrated framework for non-linear inverse modeling and global ocean state estimation. *Geosci. Model Dev.* **8**, 3071-3104, doi:10.5194/gmd-8-3071-2015 (2015).

5 Masuda, S. *et al.* Improved estimates of the dynamical state of the North Pacific Ocean from a 4 dimensional variational data assimilation. *Geophysical Research Letters* **30**, doi:10.1029/2003gl017604 (2003).

6 Balmaseda, M. A., Mogensen, K. & Weaver, A. T. Evaluation of the ECMWF ocean reanalysis system ORAS4. *Quarterly Journal of the Royal Meteorological Society* **139**, 1132-1161, doi:10.1002/qj.2063 (2013).

7 Carton, J. A. & Giese, B. S. A Reanalysis of Ocean Climate Using Simple Ocean

Data Assimilation (SODA). *Monthly Weather Review* **136**, 2999-3017, doi:10.1175/2007mwr1978.1 (2008).

8 Roemmich, D. *et al.* Argo: The Challenge of Continuing 10 Years of Progress. *Oceanography* **22**, 46-55, doi:10.5670/oceanog.2009.65 (2009).

9 Shepherd, A. *et al.* A reconciled estimate of ice-sheet mass balance. *Science* **338**, 1183-1189 (2012).

10 Harig, C. & Simons, F. J. Accelerated West Antarctic ice mass loss continues to outpace East Antarctic gains. *Earth and Planetary Science Letters* **415**, 134-141, doi:10.1016/j.epsl.2015.01.029 (2015).