IMBIE 3

– SW User Manual –

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Distribution List

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1 Introduction

1.1 Scope

The scope of this document is to describe in detail the procedures to install and execute the IMBIE processor v03.00.

1.2 Applicable Documents

AD. 1 “Proposal for the ESA-NASA Ice sheet Mass Balance Inter-comparison Exercise (IMBIE) Phase III”.

2 System requirements

2.1 Hardware requirements

The IMBIE processor is compatible with any computer with a 32- or 64-bit processor of 2.4Ghz clock speed or higher. It requires at least 2GB of RAM.

2.2 Software requirements

The IMBIE processor requires Python 3.5 (or more recent) to be installed, and is compatible with all modern operating systems.

A number of modules not included in the Python standard library are also required. The modules required are:

- `numpy` (http://www.numpy.org/)
- `scipy` (http://www.scipy.org/)
- `matplotlib` (https://matplotlib.org/)
- `PrettyTable` (https://github.com/vishvananda/prettytable/)
- `pandas`
- `seaborn`

Further instructions on how to install these modules are provided in Section 3.1.2

3 Software Installation

3.1 Installing prerequisites

3.1.1 Installing Python

The IMBIE processor requires Python 3.5 (or more recent) to be installed. This is pre-installed on most recent linux distributions, or is available via the distribution's package manager. For Windows, installers are available from (https://www.python.org/downloads/).

Depending on the configuration of the system, this may require administrator privilages.

3.1.2 Installing modules

As listed in Section 2.2, the IMBIE processor requires a number of non-standard modules to be installed. These can be downloaded and installed using *pip*, the Python package manager, with the following command:

```
pip install numpy scipy matplotlib prettytable seaborn pandas
```

Depending on the configuration of the system, this may require administrator privilages.

3.2 Installing the processor

The IMBIE processor will be delivered in a compressed-zip folder, with the following naming convention:

`imbie_<version_number>.zip`

Where <version_number> is in the form 'XX.YY', being 'XX' the major version number and 'YY' the minor version number.

To install the IMBIE processor, extract the compressed package and execute the `setup.py` script in the root directory of the extracted folder, with the argument '`install`':

```
python3 setup.py install
```

This will install the processor to the system's python installation directory, allowing it to be executed from any directory via the command '`imbie`'.

4 Application Execution

4.1 Executing the processor

Once the IMBIE processor has been installed as per the instructions in Section 3, it can be invoked using the command '`imbie`'. This will execute the processor in the current directory.

The general interface to the processor is in the form:

```
imbie [configuration file]
```

The argument provided should be the path to a valid IMBIE configuration file. The format of this file should follow the description in Section 4.2.

If the execution is successful, the output files will be found in the output directory that has been indicated in the configuration file.

Two additional processing utilities are also installed by the setup.py installation script. These are the dM-only processor, and the data pre-processor, which can be invoked by the commands imbie-processdm and imbie-preproc respectively. Each of these commands require an IMBIE configuration file as their only argument.

The dM-only processor will perform the IMBIE processing chain on change-of-mass files which have been created by the pre-processing tool.

4.2 Configuration options

The IMBIE processor has a number of configuration options, which are specified using a configuration file. This file should be a plain-text document. The configuration parameters, their purpose, and their valid values are described below.

All values should be written as Python variables of the appropriate type – for example, text strings should be contained by quote-marks, and numbers should be written without them. Each parameter should be written in its own line of the file, and the name of the parameter should be the first entry in the line, written without quote-marks.

Empty lines are ignored, and the parameters may be specified in any order. Some parameters are optional, which means that it is not compulsory to provide an entry for them in the configuration. In the case that an optional parameter is not provided, the default value/behaviour is described here.

The list of options are:

- `input_path` – The directory to search for input data. Absolute or relative paths can be used. The processor will search all subdirectories of the input path for '`.answers.json`' files which contain details of data submissions. The processor will then read any CSV-format data files specified in the relevant fields of the JSON document

- `output_path` – The directory in which to save plots and tables. Absolute or relative paths can be used.

- `export_data` – Optional field. A Boolean value (`True` or `False`). If True, the processor will export the computed data as CSV files. By default, the value is considered to be `False`.

- `plot_format` – Optional field. Specifies the format in which to save plots – should be one of "`png`", "`jpg`", "`svg`", or "`pdf`". If this parameter is omitted, the plots will not be saved and will instead be rendered in a window.

- `start_date` – Optional field. Specifies the date (in decimal years) from which to begin the analysis. All time-series starting before the specified date will be cropped to begin at this date (or omitted, if ending before the date provided).

- `stop_date` – Optional field. Specifies the date (in decimal years) at which to end the analysis. All time-series ending after the specified date will be cropped to end at this date (or omitted, if starting before the date provided).

- `align_date` – Optional field. Specifies the date (in decimal years) at which to align the integrated time-series. If this parameter is absent, then the time-series are instead offset such that their start-points are aligned with the average time-series.

- `combine_method` – Optional field. Specifies the method used to combine multiple time-series. This must be one of:

    - "`eqg`" – Equally-weighted groups: Each expirment group has an equal contribution to the overall average. By default, this method is used.

    - "`eqs`" – Equally-weighted series: Each individual contribution has an equal contribution to the overall average

    - "`inv`" – Inverse error-weighted: Each individual contribution is weighted according to the inverse of its error margin.

    - "`imbie1`" – A special method designed to replicate the behaviour of the processor used in the IMBIE 2012 analysis: averages are calculated with the same method used when averaging time series in the IMBIE 2012 analysis. Groups are equally weighted, and error margins are RMS over square root of the number of elements.

- `group_avg_error_method` – Optional field. Specifies the method that should be used to compute the error margin when multiple dM/dt time-series from the same experiment group are averaged together to produce a single estimate for the group. If omitted, the default behaviour depends on the method selected in `combine_method`. The value must be one of:

    - "`sum`" – The sum of the errors.

    - "`rms`" – Root Mean Squared.

    - "`rss`" – Root Sum Squared.

    - "`avg`" – The mean.

  - "imbie1" – method used by the IMBIE 2012 analysis: errors are calculated with the same method used when averaging time series in the IMBIE 2012 analysis, they are RMS over square root of the number of elements.

- sheet_avg_error_method – Optional field. Specifies the method that should be used to compute the error margin when multiple dM/dt time-series from different experiment groups are averaged together to produce a single estimate for an ice sheet. If omitted, the default behaviour depends on the method selected in combine_method. The value must be one of:
  - "sum" – The sum of the errors.
  - "rms" – Root Mean Squared.
  - "rss" – Root Sum Squared.
  - "avg" – The mean.
  - "imbie1" – method used by the IMBIE 2012 analysis: errors are calculated with the same method used when averaging time series in the IMBIE 2012 analysis, they are RMS over square root of the number of elements.
- sum_errors_method – Optional field. Specifies the method that should be used to compute the error margin when multiple time-series are summed together. This must be one of:
  - "sum" – The sum of the errors. By default, this method is used.
  - "rms" – Root Mean Squared.
  - "rss" – Root Sum Squared.
  - "avg" – The mean.
  - "imbie1" – method used by the IMBIE 2012 analysis: errors are calculated with the same method used when averaging time series in the IMBIE 2012 analysis, they are RMS over square root of the number of elements.
- average_nsigma – Optional field. Specifies the maximum margin when computing the average of multiple time-series. Values beyond this multiple of the standard deviation from the mean are considered to be outliers, and omitted from the average. By default, there is no maximum margin and all values will contribute to the average.
- users_skip – Optional field. A list of contributions (specified by the contributer's username) to exclude from the analysis. Multiple usernames can be specified, separated by whitespace.
- users_mark – Optional field. A list of contributions (specified by the contributer's surname) to mark in dM/dt and dM time-series plots. Multiple usernames can be specified, separated by whitespace. This parameter can be used to indicate the identity of outlying contributions.
- plot_smooth_window – Optional field. Specifies the time-window (in decimal years) which should be used when applying a moving average to dM/dt time-series plots. By default, no moving average is applied.

- plot_smooth_iters – Optional field. Specfies the number of iteration of smoothing to apply to plotted series. Default is 1 if omitted.

- `bar_plot_min_time` – Optional field. Specifies the minimum date from which the mean and standard deviation dM/dt are calculated for the error-bar plot. By default, there is no minimum date.

- `bar_plot_max_time` – Optional field. Specifies the maximum date from which the mean and standard deviation dM/dt are calculated for the error-bar plot. By default, there is no maximum date.

- `include_la` – Optional field. A Boolean value (`True` or `False`). If `True`, an additional "LA" (Laser Altimetry) expirement group will be considered by the processor. If the parameter is omitted, the value is considered to be `False`.

- `methods_skip` – Optional field. A list of experiment groups to exclude from the analysis. Multiple groups can be specified, separated by whitespace. Valid values are:

    - "`RA`": The Altimetry group

    - "`GMB`": The Gravimetry group

    - "`IOM`": The Mass-Budget group

- `use_dm` – Optional field. Enables reading dM contributions in order to convert these to dM/dt data. `False` by default if omitted.

- `dmdt_window` – Optional field. Sets the length (in decimal years) of the curve-fitting window used for dM-to-dM/dt conversion. If the parameter is omitted, the value is considered be 1 year.

- `dmdt_method` – Optional field. Specifies the method to be used for the curve-fitting in the dM-to-dM/dt conversion. Valid settings are:

    - "`ordinary_least_squares`" – basic fitting (default if parameter is omitted)

    - "`weighted_least_squares`" – inverse-error weighted least squares fitting

- `truncate_dmdt` – Optional field. Sets whether or not dM/dt series produced by the dM-to-dM/dt conversion process should be cropped to the length within which a complete window can be constructed from the input dM data. `True` by default if omitted.

- `truncate_avg` – Optional field. Toggles whether group average series should be truncated to the length of contributions when truncate_dmdt is applied. `False` by default.

- `apply_dmdt_smoothing` – Optional field. Specifies if the dM/dt contributions should be smoothed after reading. The window used for this smoothing is the same as the value of `dmdt_window`

- `reduce_window` – sets the width (in decimal years) of the window over which to apply a moving average on the contributions, reducing the number of data points in each series. If omitted, the averaging is not applied.

- `data_smoothing_window` – Optional field. Specifies the width (in decimal years) of windowed smoothing to apply to internal data. If omitted, no smoothing is applied.
- `data_smoothing_iters` – Optional field. Specfies the number of iteration of smoothing to apply to internal data series. Default is 1 if omitted.
- `export_smoothing_window` – Optional field. Specifies the width (in decimal years) of windowed smoothing to apply to exported data. If omitted, no smoothing is applied.
- `export_smoothing_iters` – Optional field. Specfies the number of iteration of smoothing to apply to exported data series. Default is 1 if omitted.
- `imbie1_compare` – Optional field. Toggles whether to provide a plotted comparison with IMBIE-1 data. True by default.
- `output_timestep` – Optional field. Sets the interval between data points in output files (in decimal years). If no value is provided, the data will not be adjusted.
- `output_offset` – Optional field. Sets the faction of the year at which the first data point in the output files should be provided. All subsequent points will be spaced according the value of output_timestep. If omitted, no adjustment is performed.
- `smb_data` – Specifies the path of Surface Mass Balance CSV data to use for calculating ice sheet dynamics for Greenland
- `data_min_time` – Optional field. In conjunction with data_max_time, sets a time window to be applied to the input data when read.
- `data_max_time` – Optional field. See `data_min_time`
- `dmdt_tapering` – Optional field. Boolean value, when True, applies window tapering method to dm-to-dmdt conversion. Default False.
- `dmdt_monthly` – Optional field. Forces monthly interpolation of data points when performing dm-to-dmdt conversion when set to True. Default False.

ANNEX A: ERROR CODES

When the IMBIE Processor encounters an error, details of the problem will be printed to the terminal window. Additionally, the processor will return a numeric error code. The definitions of these codes are provided here:

Value	Name	Details
1	logging	Cannot open logging file
2	input_path	Input directory does not exist
3	no_data	No data found in input directory
4	config_missing	Config file does not exist
5	config_invalid	Error reading config file
6	output_path	Cannot write to output path

ANNEX B: EXAMPLE CONFIGURATION

Below is an example copy of a configuration file that can be used by the IMBIE processor.

```
input_path "~/imbie/submissions-data/imbie_v2.02_data_20171011_GM"
output_path "output/20200227/"
plot_format "eps"

export_data True

use_dm True
dmdt_window 3
dmdt_method "weighted_least_squares"
truncate_dmdt True
truncate_avg False
apply_dmdt_smoothing False

reduce_window 1

users_skip "mtalpe" "xpwujpl" "roelof" "IMBIE1" "jmouginot" "rignot2"
"ahlstrom"
combine_method "inv"
group_avg_error_method "rms"
sheet_avg_error_method "max"
sum_errors_method "rss"
table_format "html"
bar_plot_min_time 2005
bar_plot_max_time 2015
plot_smooth_window 1.083333
plot_smooth_iters 2

imbie1_compare False
```

ANNEX C: EXAMPLE OUTPUT TRACES

This annex contains the CLI output traces produced by running the processor with the configuration provided in Annex B.

```
IMBIE processor v02.1
reading configuration... done.
reading input data from /home/mark/imbie/submissions-
data/imbie_v2.02_data_20171011_GM... n_gourmelen Noel mass: False rate:
True
Noel Gourmelen
gbabonis Greg mass: False rate: True
Greg Babonis
tsutterley Tyler mass: False rate: True
Tyler Sutterley
brian.gunter@aerospa Brian mass: False rate: True
Brian Gunter
malmcmillan Malcolm mass: False rate: True
Malcolm McMillan
lschroeder Ludwig mass: False rate: True
Ludwig Schröder
denis.felikson Nadège mass: False rate: True
Nadège Pie
vhelm Veit mass: False rate: True
Veit Helm
bcsatho Bea mass: False rate: True
Bea Csatho
bensmith Ben mass: True rate: True
Ben Smith
jayzwally_A Jay mass: False rate: True
Jay Zwally
slss Louise mass: False rate: True
Louise Sandberg Sorensen
kkjeldsen Shfaqat Abbas mass: False rate: True
Shfaqat Abbas Khan
alex.s.gardner Alex/Johan mass: True rate: True
Alex/Johan Gardner/Nilsson
a.shepherd@leeds.ac. Andy mass: False rate: True
Andy Shepherd
jayzwally_B Jay mass: False rate: True
Jay Zwally_B
blazquez Alejandro mass: True rate: True
Alejandro Blazquez
eschrama Ernst mass: True rate: True
Ernst Schrama
ahorvath Alexander mass: True rate: True
Alexander Horvath
save Himanshu mass: True rate: True
Himanshu Save
xpwujpl Xiaoping mass: True rate: True
kiweon Ki-Weon mass: True rate: True
Ki-Weon Seo
sluthcke Scott mass: True rate: True
```

```
Scott Luthcke
mtalpe Matthieu mass: True rate: True
agroh Andreas mass: True rate: True
Andreas Groh
charig Christopher mass: True rate: True
Christopher Harig
bertw_GRACE Bert mass: True rate: True
Bert Wouters
BDVGI Bramha Dutt mass: True rate: True
Bramha Dutt Vishwakarma
bonin Jennifer mass: True rate: True
Jennifer Bonin
dnwiese David mass: True rate: True
David Wiese
velicogna Isabella mass: True rate: True
Isabella Velicogna
roelof Roelof mass: True rate: True
philip.moore@ncl.ac. Philip mass: True rate: True
Philip Moore
rforsberg Rene mass: True rate: True
Rene Forsberg
IMBIE1 Eric  mass: False rate: True
rignot2 Eric  mass: False rate: True
mouginot2 J mass: False rate: True
J Mouginot
colgan William mass: False rate: True
William Colgan
andersen Signe mass: False rate: True
Signe Andersen
thomas.nagler@enveo. Thomas mass: False rate: True
Thomas Nagler
rignot Eric  mass: False rate: True
Eric  Rignot
jmouginot Jeremie mass: False rate: True
ahlstrom Andreas mass: False rate: True
done.
129 contributions read
WARNING: directory "output/20200227/" is not empty, contents will be
deleted. Proceed? (Y/n): RA IceSheet.apis
mean temporal resolution IceSheet.apis/RA: 2.980342474999998
RA IceSheet.eais
mean temporal resolution IceSheet.eais/RA: 0.4932196517241374
RA IceSheet.wais
mean temporal resolution IceSheet.wais/RA: 0.4983752578397207
RA IceSheet.gris
mean temporal resolution IceSheet.gris/RA: 3.141847096774185
GMB IceSheet.apis
mean temporal resolution IceSheet.apis/GMB: 0.08194186640000008
GMB IceSheet.eais
mean temporal resolution IceSheet.eais/GMB: 0.08194186640000008
GMB IceSheet.wais
mean temporal resolution IceSheet.wais/GMB: 0.08194186640000008
GMB IceSheet.gris
mean temporal resolution IceSheet.gris/GMB: 0.08193357552417636
IOM IceSheet.apis
mean temporal resolution IceSheet.apis/IOM: 0.08284023668639054
```

```
IOM IceSheet.eais
mean temporal resolution IceSheet.eais/IOM: 0.08284023668639054
IOM IceSheet.wais
mean temporal resolution IceSheet.wais/IOM: 0.08284023668639054
IOM IceSheet.gris
mean temporal resolution IceSheet.gris/IOM: 0.6375
Greenland RA users min. temporal resolution: 1.0
Greenland RA users max. temporal resolution: 6.0499999999999545
writing per-user data... dm/dt only: 16
   dm only: 1
      both: 15
1-len dmdt: 17
done.
min. dM/dt IceSheet.apis/RA: -29.021548500000005 (Gt/yr), @
2010.9166666666667
max. dM/dt IceSheet.apis/RA: 7.845 (Gt/yr), @ 2003.0
standard deviation in min-max period: 12.246508278344997
min. dM/dt of all groups IceSheet.apis in period 2003-2011 -
127.22500000000001 (Gt/yr), @ 2006.9999999999964
max. dM/dt of all groups IceSheet.apis in period 2003-2011
5.242436190476279 (Gt/yr), @ 2004.9999999999982
LA-only min. dM/dt IceSheet.apis/RA: -29.021548500000005 (Gt/yr), @
2010.9166666666667
LA-only max. dM/dt IceSheet.apis/RA: 4.45 (Gt/yr), @ 2003.0
computing RA average for apis... 303 303 303 ErrorMethod.rms
done.
min. dM/dt IceSheet.eais/RA: -107.115 (Gt/yr), @ 2010.9166666666667
max. dM/dt IceSheet.eais/RA: 136.1 (Gt/yr), @ 2003.0
standard deviation in min-max period: 41.04065364988466
min. dM/dt of all groups IceSheet.eais in period 2003-2011 -
209.20000000000002 (Gt/yr), @ 2006.9999999999964
max. dM/dt of all groups IceSheet.eais in period 2003-2011
190.67173334249424 (Gt/yr), @ 2008.9999999999945
LA-only min. dM/dt IceSheet.eais/RA: -24.290000000000003 (Gt/yr), @
2010.9166666666667
LA-only max. dM/dt IceSheet.eais/RA: 66.3746065 (Gt/yr), @ 2003.0
computing RA average for eais... 303 303 303 ErrorMethod.rms
done.
min. dM/dt IceSheet.wais/RA: -137.885 (Gt/yr), @ 2010.9166666666667
max. dM/dt IceSheet.wais/RA: -12.282734547522965 (Gt/yr), @ 2003.0
standard deviation in min-max period: 27.101420355612692
min. dM/dt of all groups IceSheet.wais in period 2003-2011 -
257.1298752617513 (Gt/yr), @ 2009.9999999999936
max. dM/dt of all groups IceSheet.wais in period 2003-2011 -
4.999613397683464 (Gt/yr), @ 2004.9999999999982
LA-only min. dM/dt IceSheet.wais/RA: -121.53000000000002 (Gt/yr), @
2010.9166666666667
LA-only max. dM/dt IceSheet.wais/RA: -34.585 (Gt/yr), @ 2003.0
computing RA average for wais... 303 303 303 ErrorMethod.rms
done.
min. dM/dt IceSheet.gris/RA: -425.1231035337134 (Gt/yr), @
2009.9999999999939
max. dM/dt IceSheet.gris/RA: -11.695476943840044 (Gt/yr), @ 2003.25
standard deviation in min-max period: 47.646698186095975
min. dM/dt of all groups IceSheet.gris in period 2003-2010 -
406.27525657630076 (Gt/yr), @ 2009.9999999999936
```

```
max. dM/dt of all groups IceSheet.gris in period 2003-2010 -
82.07500000000164 (Gt/yr), @ 2006.9999999999964
LA-only min. dM/dt IceSheet.gris/RA: -302.95500000000004 (Gt/yr), @
2003.6666666666667
LA-only max. dM/dt IceSheet.gris/RA: -127.645 (Gt/yr), @
2003.6666666666667
computing RA average for gris... 181 181 181 ErrorMethod.rms
done.
computing RA average for eais... done.
computing RA average for apis... done.
computing RA average for wais... done.
computing RA average for ais... done.
computing RA average for gris... done.
computing RA average for all... done.
min. dM/dt IceSheet.apis/GMB: -81.14939752617848 (Gt/yr), @
2006.9999999999964
max. dM/dt IceSheet.apis/GMB: 5.242436190476279 (Gt/yr), @
2004.9999999999982
standard deviation in min-max period: 12.825932901401949
min. dM/dt of all groups IceSheet.apis in period 2004-2007 -
127.22500000000001 (Gt/yr), @ 2004.0
max. dM/dt of all groups IceSheet.apis in period 2004-2007 4.45 (Gt/yr), @
2004.0
computing GMB average for apis... 168 168 168 ErrorMethod.rms
done.
min. dM/dt IceSheet.eais/GMB: -114.8643016345339 (Gt/yr), @
2013.99999999999
max. dM/dt IceSheet.eais/GMB: 190.67173334249424 (Gt/yr), @
2008.9999999999945
standard deviation in min-max period: 50.56746777281799
min. dM/dt of all groups IceSheet.eais in period 2008-2014 -
156.11666666666667 (Gt/yr), @ 2010.9166666666667
max. dM/dt of all groups IceSheet.eais in period 2008-2014 136.1 (Gt/yr),
@ 2008.0
computing GMB average for eais... 168 168 168 ErrorMethod.rms
done.
min. dM/dt IceSheet.wais/GMB: -257.1298752617513 (Gt/yr), @
2009.9999999999936
max. dM/dt IceSheet.wais/GMB: -4.999613397683464 (Gt/yr), @
2004.9999999999982
standard deviation in min-max period: 61.210209554424274
min. dM/dt of all groups IceSheet.wais in period 2004-2010 -
235.45833333333334 (Gt/yr), @ 2004.0
max. dM/dt of all groups IceSheet.wais in period 2004-2010 -21.45 (Gt/yr),
@ 2004.0
computing GMB average for wais... 168 168 168 ErrorMethod.rms
done.
min. dM/dt IceSheet.gris/GMB: -444.97044355210596 (Gt/yr), @
2010.9999999999927
max. dM/dt IceSheet.gris/GMB: -103.59655854061596 (Gt/yr), @
2013.99999999999
standard deviation in min-max period: 81.25148905360362
min. dM/dt of all groups IceSheet.gris in period 2010-2014 -
425.1231035337134 (Gt/yr), @ 2010.0
max. dM/dt of all groups IceSheet.gris in period 2010-2014 -
84.5919663848283 (Gt/yr), @ 2010.0
```

```
computing GMB average for gris... 168 168 168 ErrorMethod.rms
done.
computing GMB average for eais... done.
computing GMB average for apis... done.
computing GMB average for wais... done.
computing GMB average for ais... done.
computing GMB average for gris... done.
computing GMB average for all... done.
min. dM/dt IceSheet.apis/IOM: -127.22500000000001 (Gt/yr), @
2006.9999999999955
max. dM/dt IceSheet.apis/IOM: -28.274999999999995 (Gt/yr), @
2009.9999999999927
standard deviation in min-max period: 37.47253994593909
min. dM/dt of all groups IceSheet.apis in period 2006-2010 -
59.94786134831626 (Gt/yr), @ 2006.0
max. dM/dt of all groups IceSheet.apis in period 2006-2010 4.45 (Gt/yr), @
2006.0
computing IOM average for apis... done.
min. dM/dt IceSheet.eais/IOM: -209.20000000000002 (Gt/yr), @
2006.9999999999955
max. dM/dt IceSheet.eais/IOM: 127.86666666666666 (Gt/yr), @
2008.9999999999936
standard deviation in min-max period: 75.51979797201574
min. dM/dt of all groups IceSheet.eais in period 2006-2009 -
69.70067442319916 (Gt/yr), @ 2006.0
max. dM/dt of all groups IceSheet.eais in period 2006-2009
190.67173334249424 (Gt/yr), @ 2006.0
computing IOM average for eais... done.
min. dM/dt IceSheet.wais/IOM: -258.9916666666667 (Gt/yr), @
2012.99999999999
max. dM/dt IceSheet.wais/IOM: -21.45 (Gt/yr), @ 2004.9999999999973
standard deviation in min-max period: 67.19364192607256
min. dM/dt of all groups IceSheet.wais in period 2004-2013 -
257.1298752617513 (Gt/yr), @ 2010.9166666666667
max. dM/dt of all groups IceSheet.wais in period 2004-2013 -
4.999613397683464 (Gt/yr), @ 2004.0
computing IOM average for wais... done.
min. dM/dt IceSheet.gris/IOM: -417.1 (Gt/yr), @ 2009.995
max. dM/dt IceSheet.gris/IOM: 147.1 (Gt/yr), @ 2007.995
standard deviation in min-max period: 38.304778175789004
min. dM/dt of all groups IceSheet.gris in period 2007-2010 -
406.27525657630076 (Gt/yr), @ 2009.9999999999939
max. dM/dt of all groups IceSheet.gris in period 2007-2010 -127.645
(Gt/yr), @ 2007.0
computing IOM average for gris... 325 325 325 ErrorMethod.rms
done.
computing IOM average for eais... done.
computing IOM average for apis... done.
computing IOM average for wais... done.
computing IOM average for ais... done.
computing IOM average for gris... done.
computing IOM average for all... done.
computing inter-group average for apis... 303 303 303
ErrorMethod.max_error
done.
```

```
computing inter-group average for eais... 303 303 303
ErrorMethod.max_error
done.
computing inter-group average for wais... 303 303 303
ErrorMethod.max_error
done.
computing inter-group average for gris... 325 325 325
ErrorMethod.max_error
done.
computing inter-group average for eais... done.
computing inter-group average for apis... done.
computing inter-group average for wais... done.
computing inter-group average for ais... done.
computing inter-group average for gris... done.
computing inter-group average for all... done.
RA <imbie2.model.series.rate_series.WorkingMassRateDataSeries object at
0x7f73ea5c6828>
GMB <imbie2.model.series.rate_series.WorkingMassRateDataSeries object at
0x7f73ea5c6c18>
IOM <imbie2.model.series.rate_series.WorkingMassRateDataSeries object at
0x7f73ea5c6cc0>
group discharge: 3 3
         1992-1997   1997-2002   2002-2007   2007-2012   2012-2017   2005-
2015     1992-2011   1992-2018
Total    -26.1±27.7  -44.0±35.5  -174.4±30.1 -274.9±28.0 -244.0±28.3 -
254.6±20.0     -118.6±15.6 -150.1±13.2
SMB      25.6±35.2   -14.7±36.0  -78.0±36.1  -193.2±37.0 -138.8±38.3 -
162.4±26.1     -56.9±18.4  -75.5±16.2
Dynam    -51.7±44.8  -29.3±50.5  -96.4±47.0  -81.6±46.4  -105.2±47.6 -
92.2±32.9      -61.6±24.1  -74.5±20.9
RA
      contributions         max        mean         min      stdev
year
1992              0         NaN         NaN         NaN        NaN
1993              0         NaN         NaN         NaN        NaN
1994              0         NaN         NaN         NaN        NaN
1995              0         NaN         NaN         NaN        NaN
1996              0         NaN         NaN         NaN        NaN
1997              0         NaN         NaN         NaN        NaN
1998              0         NaN         NaN         NaN        NaN
1999              0         NaN         NaN         NaN        NaN
2000              0         NaN         NaN         NaN        NaN
2001              0         NaN         NaN         NaN        NaN
2002              0         NaN         NaN         NaN        NaN
2003              6 -127.645000 -195.921780 -248.227862  45.168773
2004              6 -127.645000 -196.841010 -248.227862  45.323818
2005              6 -127.645000 -203.582975 -248.227862  45.919221
2006              6 -127.645000 -211.658650 -248.227862  39.590500
2007              6 -127.645000 -215.873771 -257.950000  43.374648
2008              6 -127.645000 -216.302903 -263.472321  44.411567
2009              6 -127.645000 -222.377456 -299.919643  52.248968
2010              2 -302.955000 -311.377500 -319.800000   8.422500
2011              6 -261.000000 -306.663384 -360.539739  29.939363
2012              6 -261.000000 -314.036687 -376.475798  35.598547
2013              5  -93.358757 -241.821789 -302.955000  76.221027
2014              4 -150.064385 -240.714893 -292.920500  54.046747
```

2015	2	-179.961393	-220.480696	-261.000000	40.519304
2016	1	-183.014467	-183.014467	-183.014467	0.000000
2017	1	-11.695477	-11.695477	-11.695477	0.000000
2018	0	NaN	NaN	NaN	NaN

GMB

year	contributions	max	mean	min	stdev
1992	0	NaN	NaN	NaN	NaN
1993	0	NaN	NaN	NaN	NaN
1994	0	NaN	NaN	NaN	NaN
1995	0	NaN	NaN	NaN	NaN
1996	0	NaN	NaN	NaN	NaN
1997	0	NaN	NaN	NaN	NaN
1998	0	NaN	NaN	NaN	NaN
1999	0	NaN	NaN	NaN	NaN
2000	0	NaN	NaN	NaN	NaN
2001	0	NaN	NaN	NaN	NaN
2002	1	-103.596559	-103.596559	-103.596559	0.000000
2003	14	-113.150981	-195.591198	-261.016088	43.025562
2004	14	-143.412901	-194.958455	-249.935524	34.006094
2005	14	-152.786547	-191.947769	-233.941022	25.151303
2006	14	-180.241742	-215.802052	-240.444704	20.608799
2007	14	-185.642885	-225.803519	-259.957576	23.511295
2008	14	-172.016233	-225.192996	-272.477633	29.955991
2009	14	-203.902699	-262.027219	-333.487277	33.789339
2010	14	-266.185552	-340.442001	-407.849373	39.500825
2011	14	-283.729104	-373.016625	-433.700431	43.769050
2012	14	-245.126262	-307.781227	-357.234155	36.170653
2013	14	-154.699468	-193.793504	-230.735734	23.309230
2014	14	-117.771669	-153.041641	-206.884166	25.754963
2015	14	-117.771669	-152.422846	-206.884166	25.337016
2016	1	-165.654984	-165.654984	-165.654984	0.000000
2017	0	NaN	NaN	NaN	NaN
2018	0	NaN	NaN	NaN	NaN

IOM

year	contributions	max	mean	min	stdev
1992	1	58.573333	58.573333	58.573333	0.000000
1993	1	-75.685714	-75.685714	-75.685714	0.000000
1994	1	-89.614286	-89.614286	-89.614286	0.000000
1995	2	-65.482500	-93.591250	-121.700000	28.108750
1996	2	127.000000	99.568333	72.136667	27.431667
1997	2	57.285000	16.099643	-25.085714	41.185357
1998	2	-53.301667	-120.507976	-187.714286	67.206310
1999	2	-5.940000	-19.377143	-32.814286	13.437143
2000	2	-23.050000	-36.725000	-50.400000	13.675000
2001	2	-14.050000	-43.546429	-73.042857	29.496429
2002	2	-53.170000	-120.156429	-187.142857	66.986429
2003	2	-92.070000	-150.427857	-208.785714	58.357857
2004	2	-115.066667	-163.911905	-212.757143	48.845238
2005	2	-132.936667	-171.618333	-210.300000	38.681667
2006	2	-236.613333	-253.728095	-270.842857	17.114762
2007	3	-261.009500	-284.265865	-298.516667	16.583567
2008	3	-232.263333	-246.069778	-263.546000	13.032057
2009	3	-240.963333	-269.329040	-300.314286	24.300622
2010	2	-337.106667	-368.089048	-399.071429	30.982381

```
2011              2 -342.726667 -371.341905 -399.957143  28.615238
2012              2 -378.657143 -380.300238 -381.943333   1.643095
2013              2 -161.028571 -205.868036 -250.707500  44.839464
2014              1 -242.514286 -242.514286 -242.514286   0.000000
2015              1 -269.785714 -269.785714 -269.785714   0.000000
2016              1 -292.457143 -292.457143 -292.457143   0.000000
2017              1 -159.914286 -159.914286 -159.914286   0.000000
2018              1 -143.800000 -143.800000 -143.800000   0.000000
ALL
      contributions         max        mean         min      stdev
year
1992              1   58.573333   58.573333   58.573333   0.000000
1993              1  -75.685714  -75.685714  -75.685714   0.000000
1994              1  -89.614286  -89.614286  -89.614286   0.000000
1995              2  -65.482500  -93.591250 -121.700000  28.108750
1996              2  127.000000   99.568333   72.136667  27.431667
1997              2   57.285000   16.099643  -25.085714  41.185357
1998              2  -53.301667 -120.507976 -187.714286  67.206310
1999              2   -5.940000  -19.377143  -32.814286  13.437143
2000              2  -23.050000  -36.725000  -50.400000  13.675000
2001              2  -14.050000  -43.546429  -73.042857  29.496429
2002              3  -53.170000 -114.636472 -187.142857  55.248477
2003             22  -92.070000 -191.575599 -261.016088  47.046753
2004             22 -115.066667 -192.649465 -249.935524  39.953813
2005             22 -127.645000 -193.272876 -248.227862  34.443917
2006             22 -127.645000 -218.119856 -270.842857  29.231039
2007             23 -127.645000 -230.838673 -298.516667  36.184408
2008             23 -127.645000 -225.596900 -272.477633  34.061873
2009             23 -127.645000 -252.636214 -333.487277  42.579613
2010             18 -266.185552 -340.284506 -407.849373  38.818572
2011             22 -261.000000 -354.768039 -433.700431  49.050974
2012             22 -245.126262 -316.079899 -381.943333  39.979011
2013             21  -93.358757 -206.378766 -302.955000  48.390705
2014             19 -117.771669 -176.208254 -292.920500  51.054801
2015             17 -117.771669 -167.333350 -269.785714  43.065901
2016              3 -165.654984 -213.708865 -292.457143  56.132619
2017              2  -11.695477  -85.804881 -159.914286  74.109404
2018              1 -143.800000 -143.800000 -143.800000   0.000000
greenland xgroup common: 2003.0 2016.5
greenland xgroup stdev range: 52.166054733285286 72.95512443392295
Greenland/RA common period: None - None
Greenland/RA stdev in x-group common: 64.76564125369147
Greenland/RA common range: -310.243005190822 -11.695476943840044
Greenland/RA common stdev: 72.46378055520245
LA common period: 2003.6666666666667 2009.8333333333335
LA common range: -248.227862 -127.645
Greenland/GMB common period: 2003.0 - 2015.1666666666667
Greenland/GMB stdev in x-group common: 75.2267072837361
Greenland/GMB common range: -380.5666722074082 -150.49210582665214
Greenland/GMB common stdev: 67.67966749022693
groups 2003.00-2015.17 range: -414.87637362637366 -127.39763001974983
xgroup 2003.00-2015.17 range: -346.2735795024747 -153.3446278842826
Greenland/IOM common period: 2007.995 - 2009.995
Greenland/IOM stdev in x-group common: 82.0530557777232
Greenland/IOM common range: -302.9498715317282 -246.14034004617912
Greenland/IOM common stdev: 12.106010437953017
```

```
groups 2007.99-2009.99 range: -329.09510945653824 -210.72051151708357
xgroup 2007.99-2009.99 range: -272.06225185773883 -223.94892509061233
51 51 51 ErrorMethod.rss
writing table: output/20200227/mean_errors.html
writing table: output/20200227/zwally_basins.html
writing table: output/20200227/rignot_basins.html
eais 1992.2-2017.4 (25.2)
apis 1992.2-2017.4 (25.2)
wais 1992.2-2017.4 (25.2)
ais 1992.2-2017.4 (25.2)
gris 1992.0-2019.0 (27.0)
all 1992.2-2017.4 (25.2)
writing table: output/20200227/region_window_averages.html
writing table: output/20200227/region_window_averages_ais.html
writing table: output/20200227/region_group_window_averages.html
writing table: output/20200227/region_group_window_averages_ais.html
51 51 51 ErrorMethod.rss
writing table: output/20200227/time_coverage_RA.html
writing table: output/20200227/time_coverage_GMB.html
writing table: output/20200227/time_coverage_IOM.html
saving plot: output/20200227/discharge_scatter_plot.eps
saving plot: output/20200227/discharge_plot.eps
saving plot: output/20200227/imbie_smb_dynamics.eps
saving plot: output/20200227/ais_four_panel_plot.eps
saving plot: output/20200227/stacked_coverage.eps
saving plot: output/20200227/stacked_coverage_ais_only.eps
saving plot: output/20200227/stacked_coverage_gris_only.eps
saving plot: output/20200227/windows_comparison.eps
saving plot: output/20200227/windows_comparison_apis.eps
saving plot: output/20200227/windows_comparison_eais.eps
saving plot: output/20200227/windows_comparison_wais.eps
saving plot: output/20200227/windows_comparison_gris.eps
apis
year dmdt dmdt_sig1
1992.50,-7.44,8.05
1993.50,-7.44,8.05
1994.50,-7.44,8.05
1995.50,-4.21,7.91
1996.50,-0.33,7.74
1997.50,2.90,7.62
1998.50,2.90,7.62
1999.50,2.90,7.62
2000.50,2.90,7.62
2001.50,2.90,7.62
2002.50,-11.98,36.04
2003.50,-22.87,26.90
2004.50,-18.26,23.46
2005.50,-17.97,22.85
2006.50,-20.38,23.43
2007.50,-45.67,50.40
2008.50,-25.67,23.09
2009.50,-30.75,40.11
2010.50,-12.47,23.30
2011.50,-21.59,38.02
2012.50,-24.59,40.48
2013.50,-22.79,38.14
```

```
2014.50,-17.63,32.28
2015.50,-16.79,28.07
2016.50,-12.53,15.69
wais
year dmdt dmdt_sig1
1992.50,-31.11,26.41
1993.50,-31.11,26.41
1994.50,-32.38,26.41
1995.50,-31.81,26.19
1996.50,-32.49,25.95
1997.50,-32.65,25.77
1998.50,-32.73,25.77
1999.50,-34.52,25.77
2000.50,-33.87,25.77
2001.50,-33.75,25.77
2002.50,-54.93,38.47
2003.50,-64.03,38.07
2004.50,-73.08,37.53
2005.50,-53.72,38.73
2006.50,-74.23,37.31
2007.50,-90.31,36.59
2008.50,-104.19,36.48
2009.50,-138.81,70.72
2010.50,-174.17,57.17
2011.50,-156.77,38.05
2012.50,-148.01,38.97
2013.50,-174.94,55.86
2014.50,-152.57,41.39
2015.50,-158.27,42.08
2016.50,-133.62,50.78
eais
year dmdt dmdt_sig1
1992.50,-35.67,42.60
1993.50,-35.67,42.60
1994.50,-32.96,42.60
1995.50,-14.01,42.36
1996.50,10.46,42.08
1997.50,32.44,41.89
1998.50,33.34,41.89
1999.50,34.57,41.89
2000.50,34.84,41.89
2001.50,35.42,41.89
2002.50,19.61,49.62
2003.50,-0.65,59.73
2004.50,15.03,59.39
2005.50,9.09,57.82
2006.50,-4.37,64.02
2007.50,-43.86,106.48
2008.50,-6.66,88.60
2009.50,69.53,57.69
2010.50,-6.19,74.23
2011.50,21.00,66.55
2012.50,-7.68,80.72
2013.50,-19.38,59.32
2014.50,-71.90,59.91
2015.50,-50.40,60.72
```

```
2016.50,-20.54,71.23
saving plot: output/20200227/annual_dmdt_bars_apis_wais_eais.eps
apis
year dmdt dmdt_sig1
1992.50,-7.44,8.05
1993.50,-7.44,8.05
1994.50,-7.44,8.05
1995.50,-4.21,7.91
1996.50,-0.33,7.74
1997.50,2.90,7.62
1998.50,2.90,7.62
1999.50,2.90,7.62
2000.50,2.90,7.62
2001.50,2.90,7.62
2002.50,-11.98,36.04
2003.50,-22.87,26.90
2004.50,-18.26,23.46
2005.50,-17.97,22.85
2006.50,-20.38,23.43
2007.50,-45.67,50.40
2008.50,-25.67,23.09
2009.50,-30.75,40.11
2010.50,-12.47,23.30
2011.50,-21.59,38.02
2012.50,-24.59,40.48
2013.50,-22.79,38.14
2014.50,-17.63,32.28
2015.50,-16.79,28.07
2016.50,-12.53,15.69
wais
year dmdt dmdt_sig1
1992.50,-31.11,26.41
1993.50,-31.11,26.41
1994.50,-32.38,26.41
1995.50,-31.81,26.19
1996.50,-32.49,25.95
1997.50,-32.65,25.77
1998.50,-32.73,25.77
1999.50,-34.52,25.77
2000.50,-33.87,25.77
2001.50,-33.75,25.77
2002.50,-54.93,38.47
2003.50,-64.03,38.07
2004.50,-73.08,37.53
2005.50,-53.72,38.73
2006.50,-74.23,37.31
2007.50,-90.31,36.59
2008.50,-104.19,36.48
2009.50,-138.81,70.72
2010.50,-174.17,57.17
2011.50,-156.77,38.05
2012.50,-148.01,38.97
2013.50,-174.94,55.86
2014.50,-152.57,41.39
2015.50,-158.27,42.08
2016.50,-133.62,50.78
```

```
eais
year dmdt dmdt_sig1
1992.50,-35.67,42.60
1993.50,-35.67,42.60
1994.50,-32.96,42.60
1995.50,-14.01,42.36
1996.50,10.46,42.08
1997.50,32.44,41.89
1998.50,33.34,41.89
1999.50,34.57,41.89
2000.50,34.84,41.89
2001.50,35.42,41.89
2002.50,19.61,49.62
2003.50,-0.65,59.73
2004.50,15.03,59.39
2005.50,9.09,57.82
2006.50,-4.37,64.02
2007.50,-43.86,106.48
2008.50,-6.66,88.60
2009.50,69.53,57.69
2010.50,-6.19,74.23
2011.50,21.00,66.55
2012.50,-7.68,80.72
2013.50,-19.38,59.32
2014.50,-71.90,59.91
2015.50,-50.40,60.72
2016.50,-20.54,71.23
saving plot: output/20200227/annual_dmdt_bars_fixed_y_apis_wais_eais.eps
<imbie2.model.series.mass_series.MassChangeDataSeries object at
0x7f73e9e52320>
<imbie2.model.collections.mass_collection.MassChangeCollection object at
0x7f73ea26ad68>
gris
year dmdt dmdt_sig1
1992.50,79.20,56.40
1993.50,-75.50,56.50
1994.50,-76.80,56.50
1995.50,-163.34,58.11
1996.50,105.76,76.57
1997.50,33.77,77.21
1998.50,-148.59,79.96
1999.50,-28.12,79.39
2000.50,-34.10,77.89
2001.50,-43.09,78.73
2002.50,-119.42,74.87
2003.50,-165.04,62.94
2004.50,-184.82,65.98
2005.50,-184.50,64.63
2006.50,-218.12,64.29
2007.50,-238.57,63.85
2008.50,-225.98,60.64
2009.50,-242.24,59.56
2010.50,-323.01,59.97
2011.50,-344.68,65.76
2012.50,-333.29,69.94
2013.50,-219.87,66.06
```

```
2014.50,-216.00,54.25
2015.50,-203.57,58.21
2016.50,-247.20,63.77
2017.50,-84.58,75.50
2018.50,-138.10,57.57
saving plot: output/20200227/annual_dmdt_bars_gris.eps
saving plot: output/20200227/sheets_time_bars_gris_mass_gris.eps
saving plot: output/20200227/coverage_combined.eps
saving plot: output/20200227/sheets_error_bars.eps
saving plot: output/20200227/sheets_error_bars_labeled.eps
saving plot: output/20200227/sheets_error_bars_ais.eps
saving plot: output/20200227/sheets_error_bars_ais_labeled.eps
saving plot: output/20200227/sheets_error_bars_gris.eps
saving plot: output/20200227/sheets_error_bars_gris_labeled.eps
303 303 303 ErrorMethod.imbie1
168 168 168 ErrorMethod.imbie1
303 303 303 ErrorMethod.imbie1
168 168 168 ErrorMethod.imbie1
303 303 303 ErrorMethod.imbie1
168 168 168 ErrorMethod.imbie1
181 181 181 ErrorMethod.imbie1
168 168 168 ErrorMethod.imbie1
325 325 325 ErrorMethod.imbie1
saving plot: output/20200227/named_dmdt_all_gris.eps
saving plot: output/20200227/named_dmdt_all_share_x_gris.eps
saving plot: output/20200227/named_dmdt_all_gris_RA.eps
saving plot: output/20200227/named_dmdt_all_gris_GMB.eps
saving plot: output/20200227/named_dmdt_all_gris_IOM.eps
saving plot: output/20200227/named_dmdt_all_gris_col.eps
saving plot: output/20200227/group_rate_boxesapis_eais_gris_wais_RA.eps
saving plot: output/20200227/group_rate_boxesapis_eais_gris_wais_GMB.eps
saving plot: output/20200227/group_rate_boxesapis_eais_gris_wais_IOM.eps
saving plot: output/20200227/groups_rate_intercomparison_eais.eps
saving plot: output/20200227/groups_mass_intercomparison_eais.eps
saving plot: output/20200227/groups_rate_intercomparison_apis.eps
saving plot: output/20200227/groups_mass_intercomparison_apis.eps
saving plot: output/20200227/groups_rate_intercomparison_wais.eps
saving plot: output/20200227/groups_mass_intercomparison_wais.eps
saving plot: output/20200227/groups_rate_intercomparison_ais.eps
saving plot: output/20200227/groups_mass_intercomparison_ais.eps
saving plot: output/20200227/groups_rate_intercomparison_gris.eps
saving plot: output/20200227/groups_mass_intercomparison_gris.eps
saving plot: output/20200227/groups_rate_intercomparison_all.eps
saving plot: output/20200227/groups_mass_intercomparison_all.eps
exporting data: output/20200227/eais.csv... done.
exporting data: output/20200227/eais_dm.csv... done.
exporting data: output/20200227/apis.csv... done.
exporting data: output/20200227/apis_dm.csv... done.
exporting data: output/20200227/wais.csv... done.
exporting data: output/20200227/wais_dm.csv... done.
exporting data: output/20200227/ais.csv... done.
exporting data: output/20200227/ais_dm.csv... done.
exporting data: output/20200227/gris.csv... done.
exporting data: output/20200227/gris_dm.csv... done.
exporting data: output/20200227/all.csv... done.
exporting data: output/20200227/all_dm.csv... done.
```

```
2005-2010: 23/27, RA: -223.16, 20.60, GMB: -239.57, 21.83, IOM: -268.00,
32.26, AVG: -239.45, 25.44
2005-2011: 27/27, RA: -234.01, 18.74, GMB: -258.57, 20.48, IOM: -283.72,
30.33, AVG: -253.95, 23.74
2005-2012: 27/27, RA: -242.05, 17.64, GMB: -265.20, 19.41, IOM: -296.40,
28.93, AVG: -262.66, 22.55
2005-2013: 27/27, RA: -243.73, 16.35, GMB: -257.41, 18.50, IOM: -283.15,
27.46, AVG: -257.78, 21.32
2005-2014: 27/27, RA: -244.20, 15.37, GMB: -246.96, 17.65, IOM: -279.01,
25.37, AVG: -253.80, 19.93
2005-2015: 27/27, RA: -239.24, 14.95, GMB: -238.42, 16.98, IOM: -277.91,
23.64, AVG: -249.35, 18.89
epochs: 120 members: 10
(120,)
epochs: 120 members: 14
(120,)
epochs: 120 members: 3
(120,)
epochs: 120 members: 27
(120,)
```

ANNEX D: EXAMPLE OUTPUT PLOTS

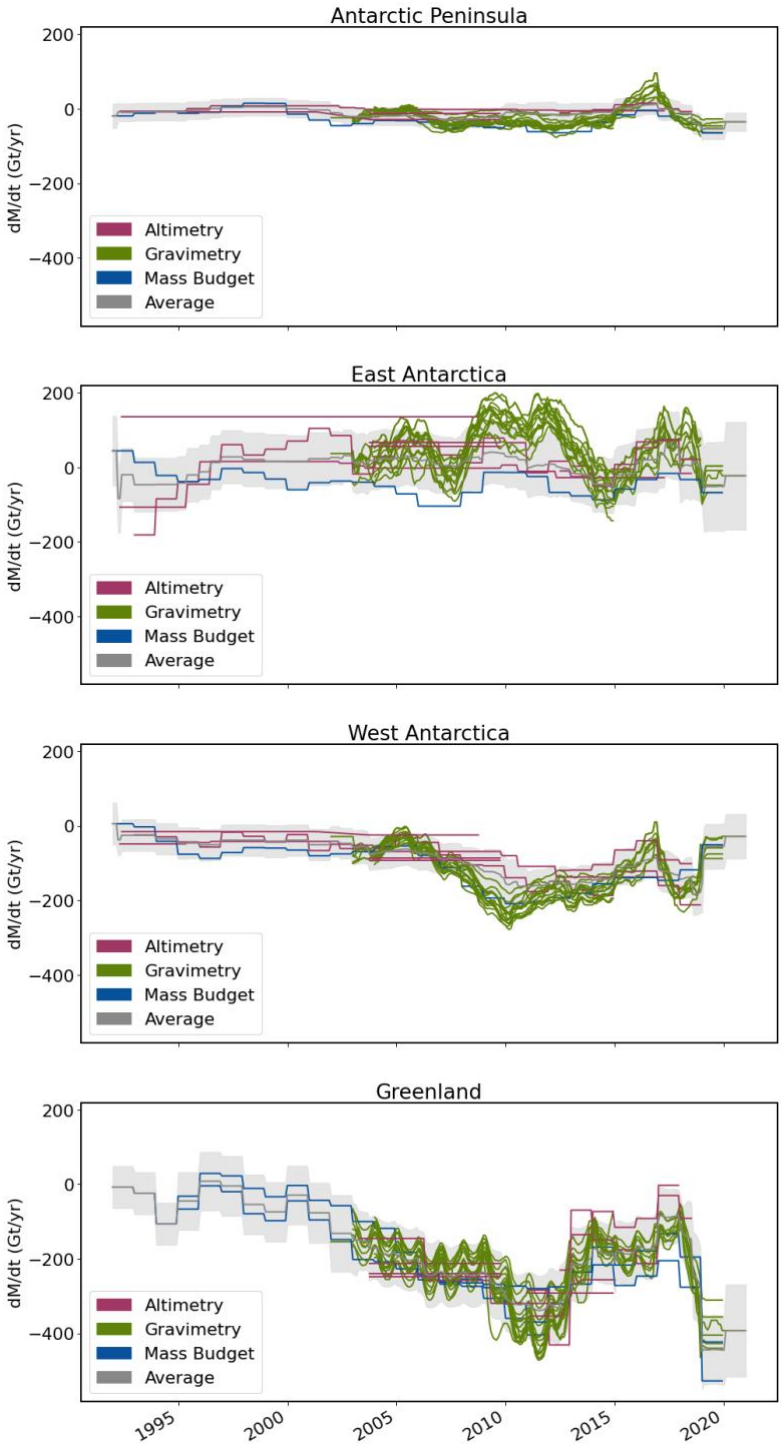

Figure 1 dM/dt per contribution with cross-group average – APIS, EAIS, WAIS, GrIS

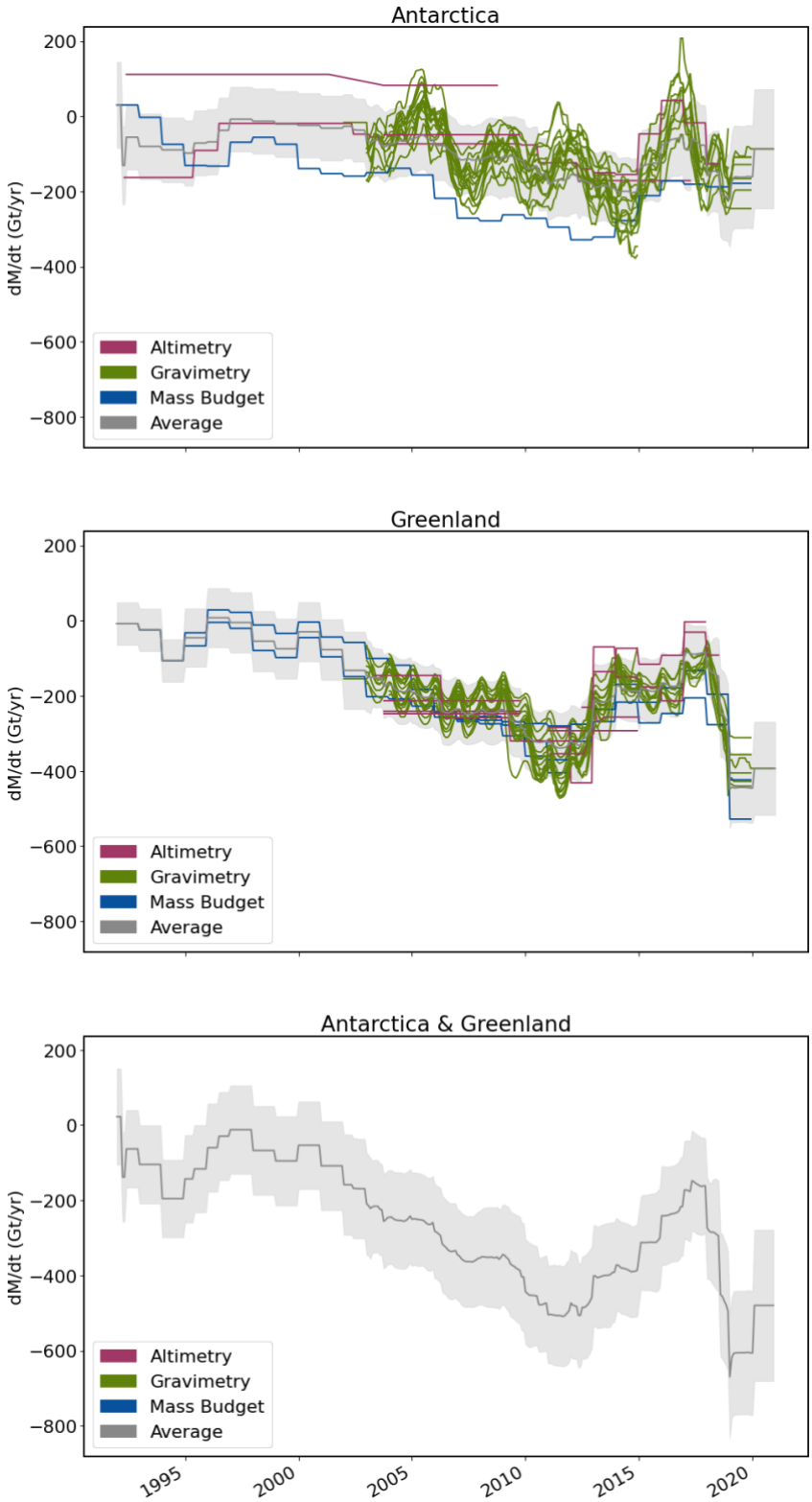

Figure 2 dM/dt per contribution with cross-group average – AIS, GrIS, Total

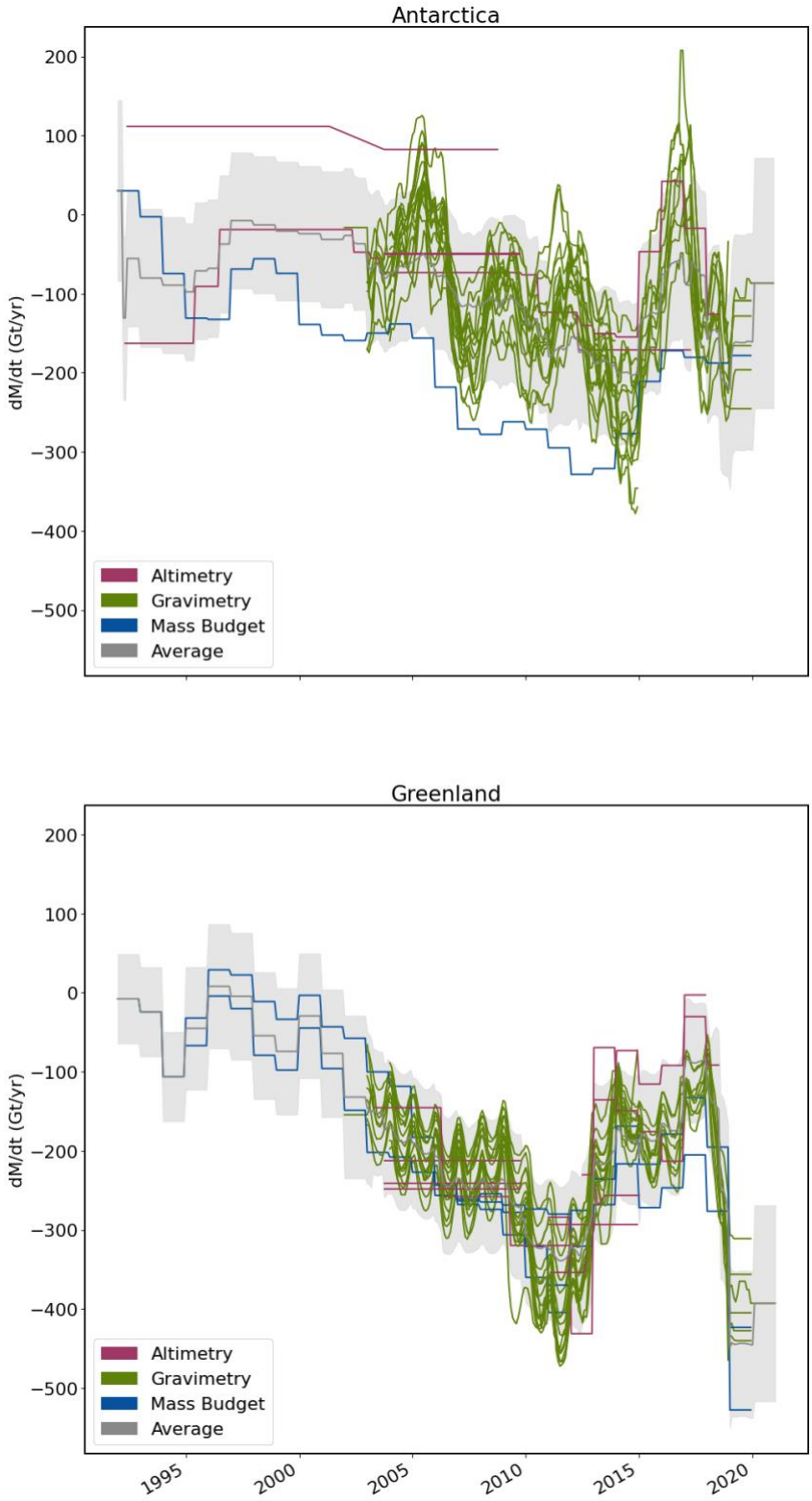

Figure 3 dM/dt per contribution with cross-group average – AIS, GrIS

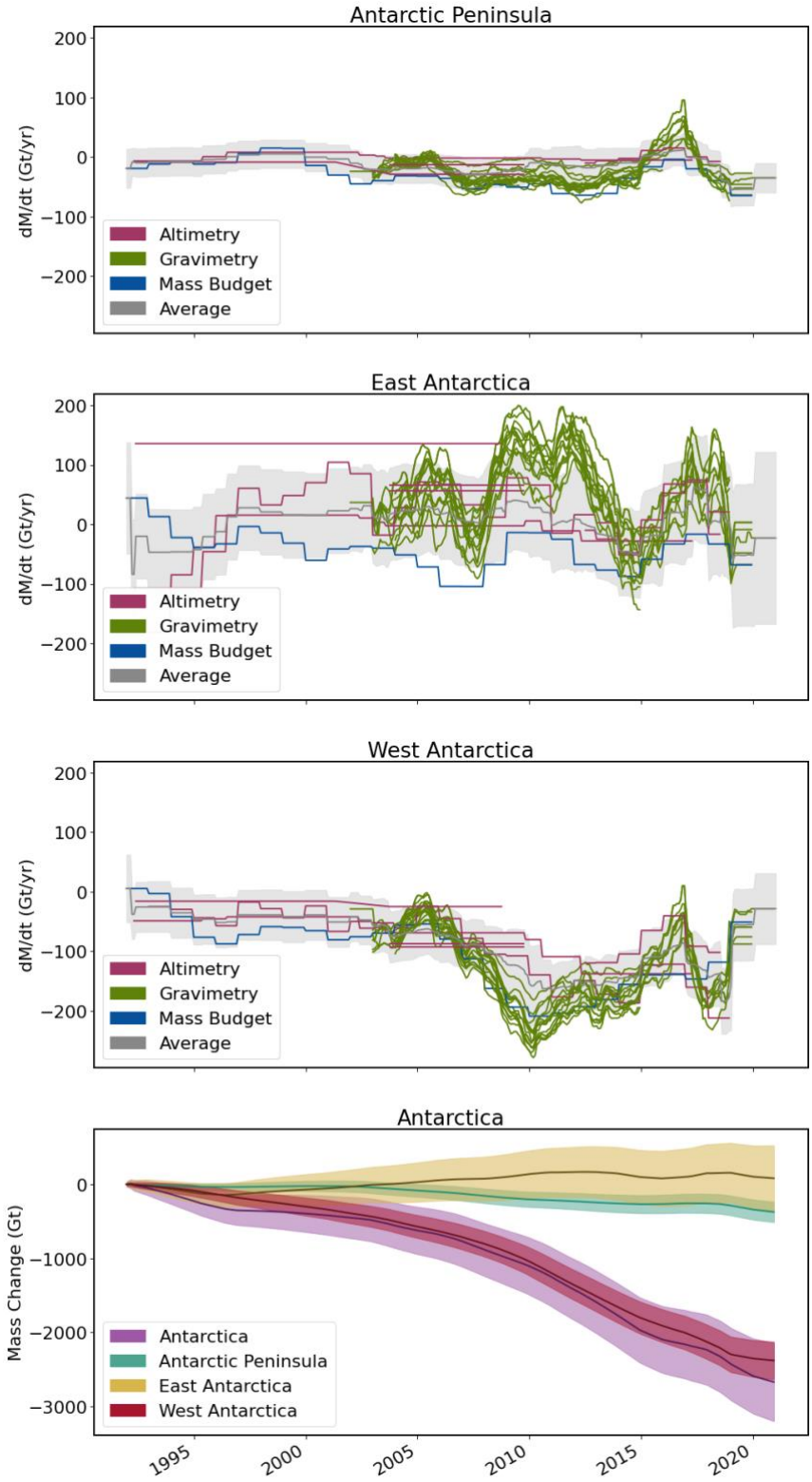

Figure 4 Antarctica: dM/dt per contribution with cross-group average and dM(t) plot

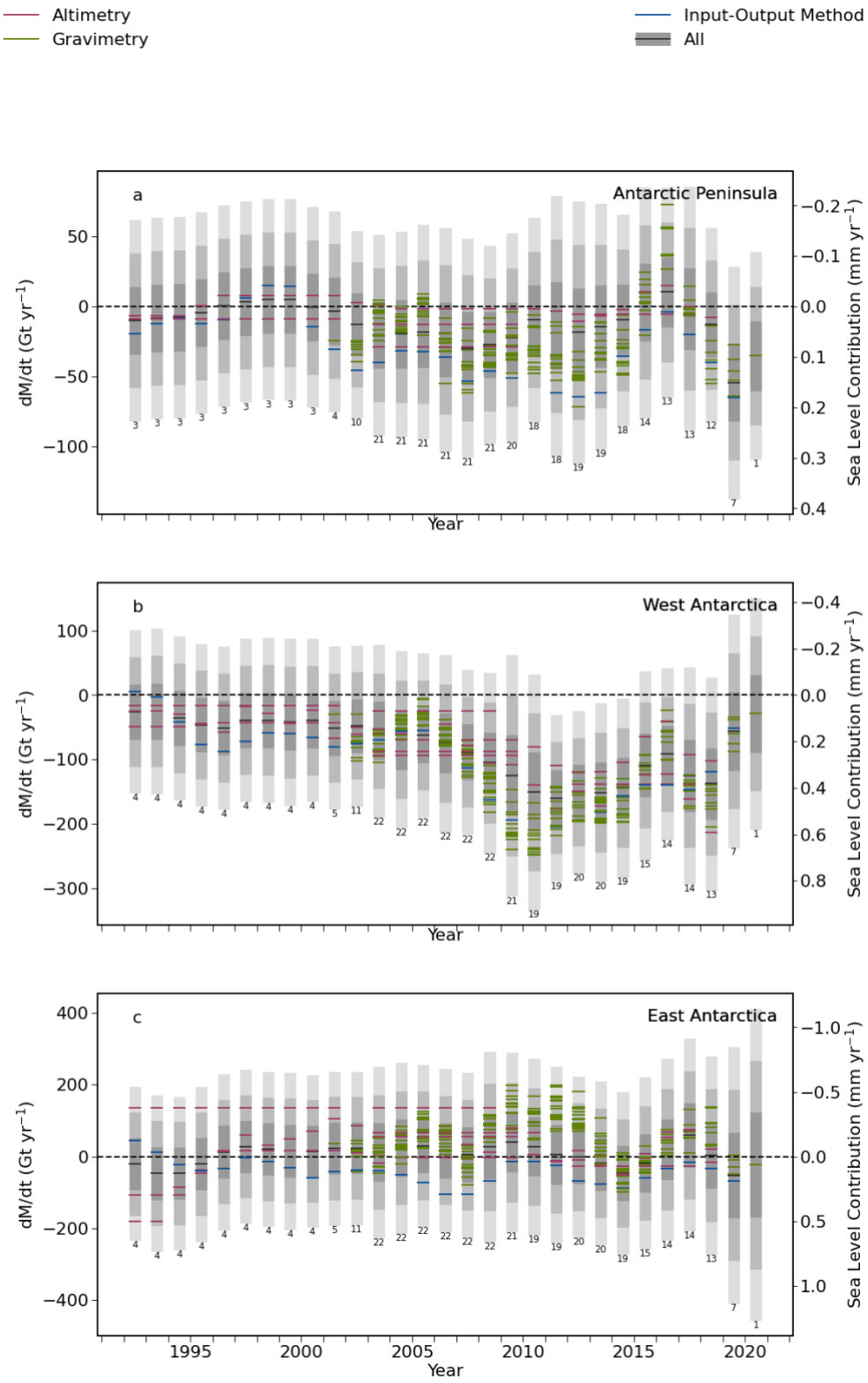

Figure 5 per-annum bar plot of individual contributions and distribtution – APIS, WAIS, EAIS

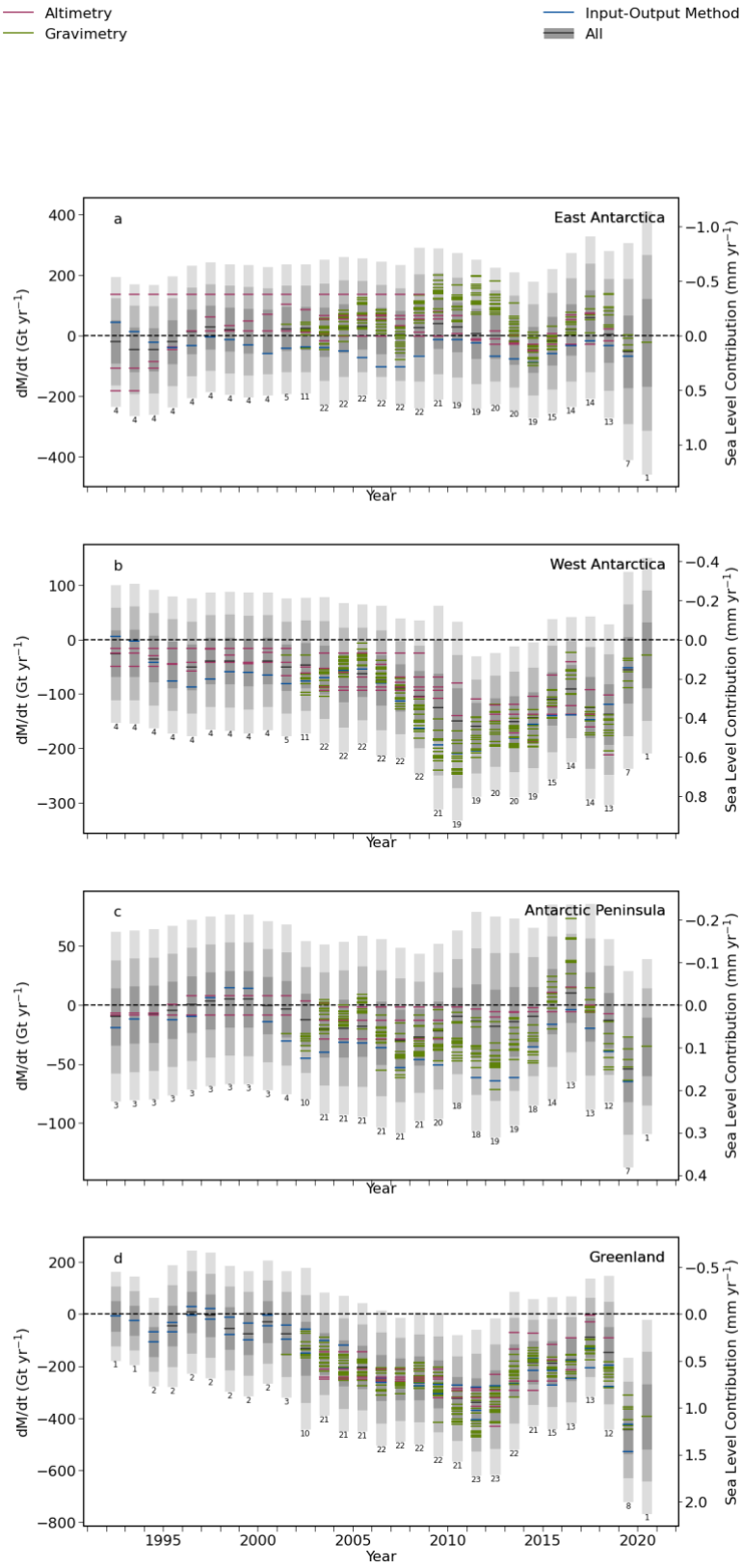

Figure 6 per-annum bar plot of individual contributions and distribtution – APIS, WAIS, EAIS, GrIS

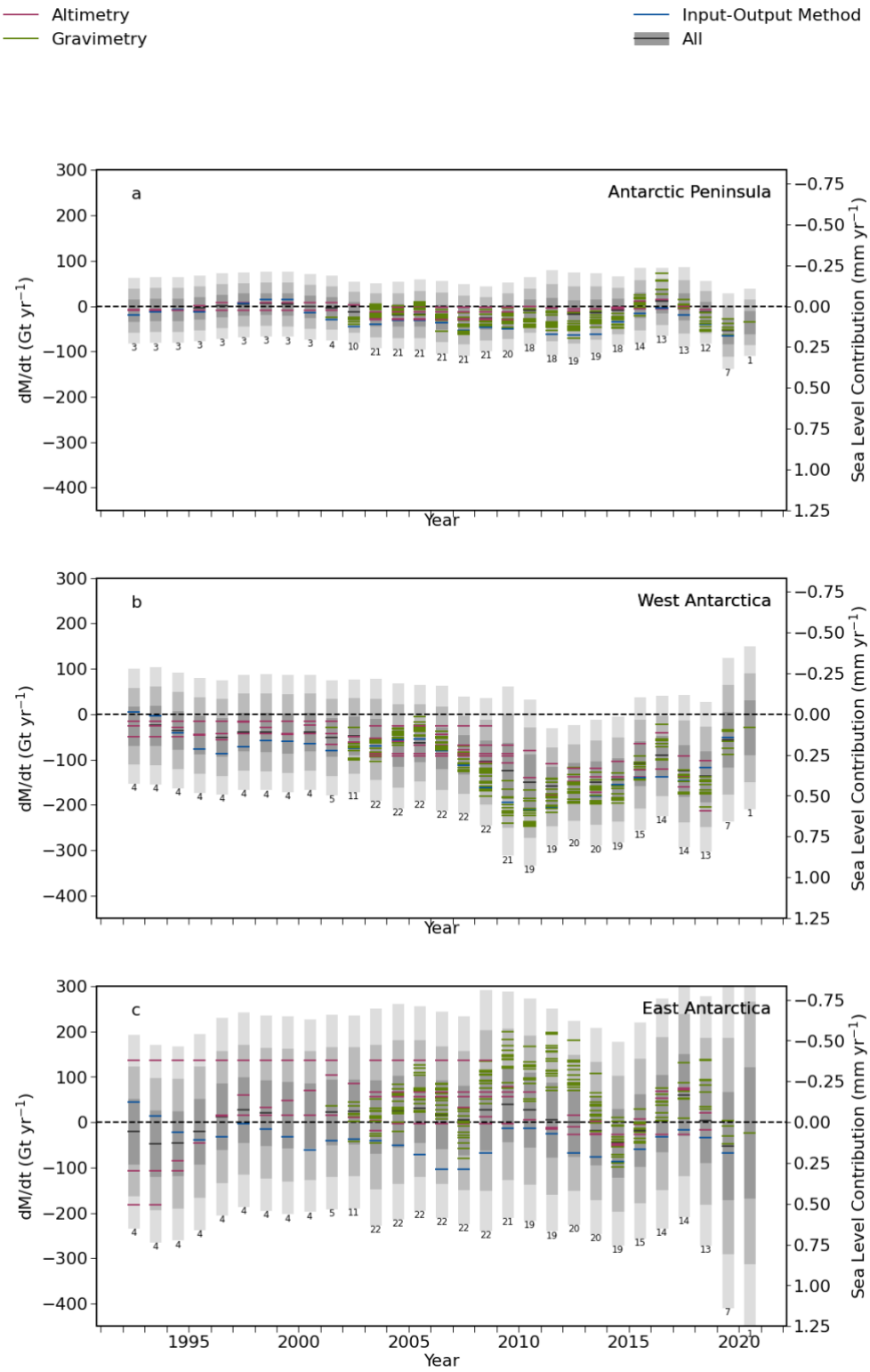

Figure 7 per-annum bar plot of individual contributions and distribtution – APIS, WAIS, EAIS – locked y-axis range

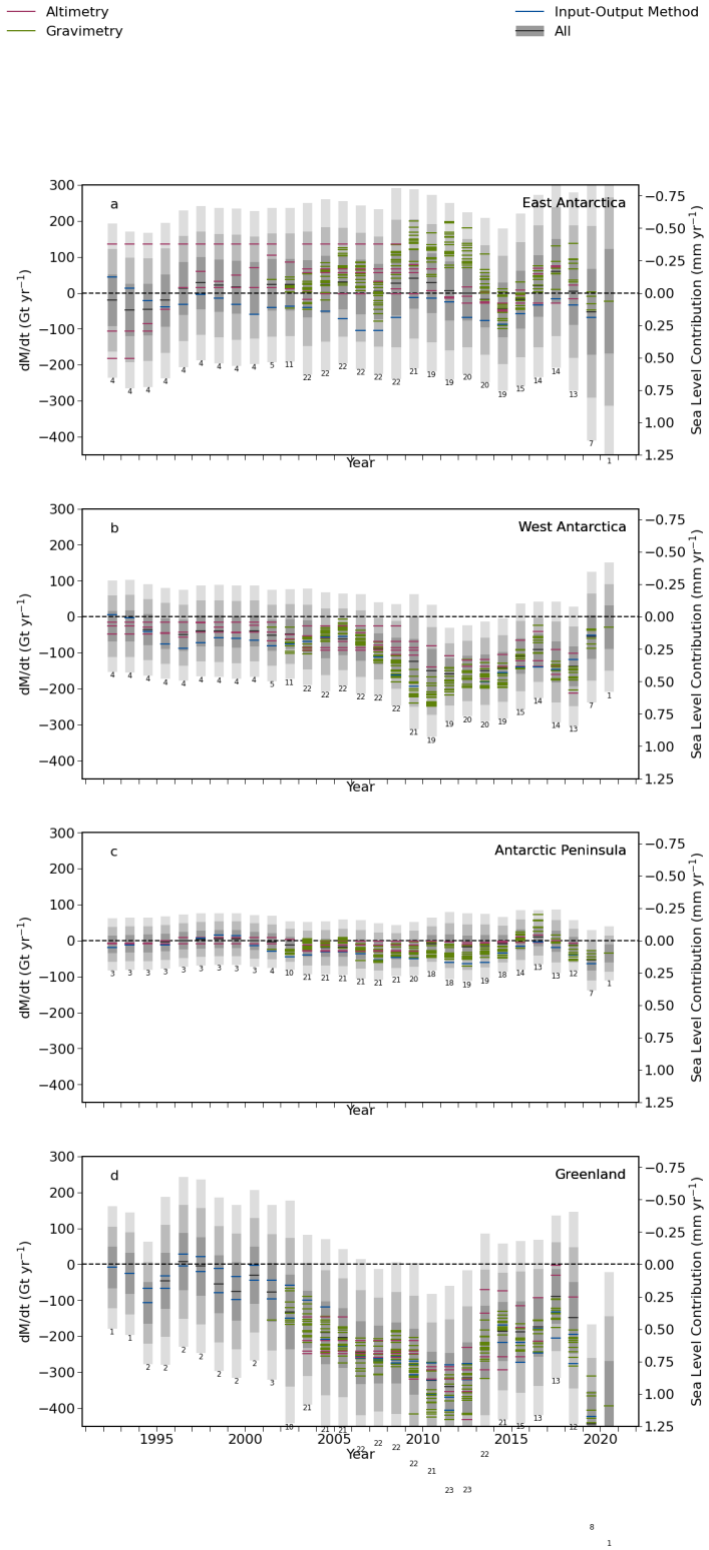

Figure 8 per-annum bar plot of individual contributions and distribtution – APIS, WAIS, EAIS, GrIS – locked y-axis range

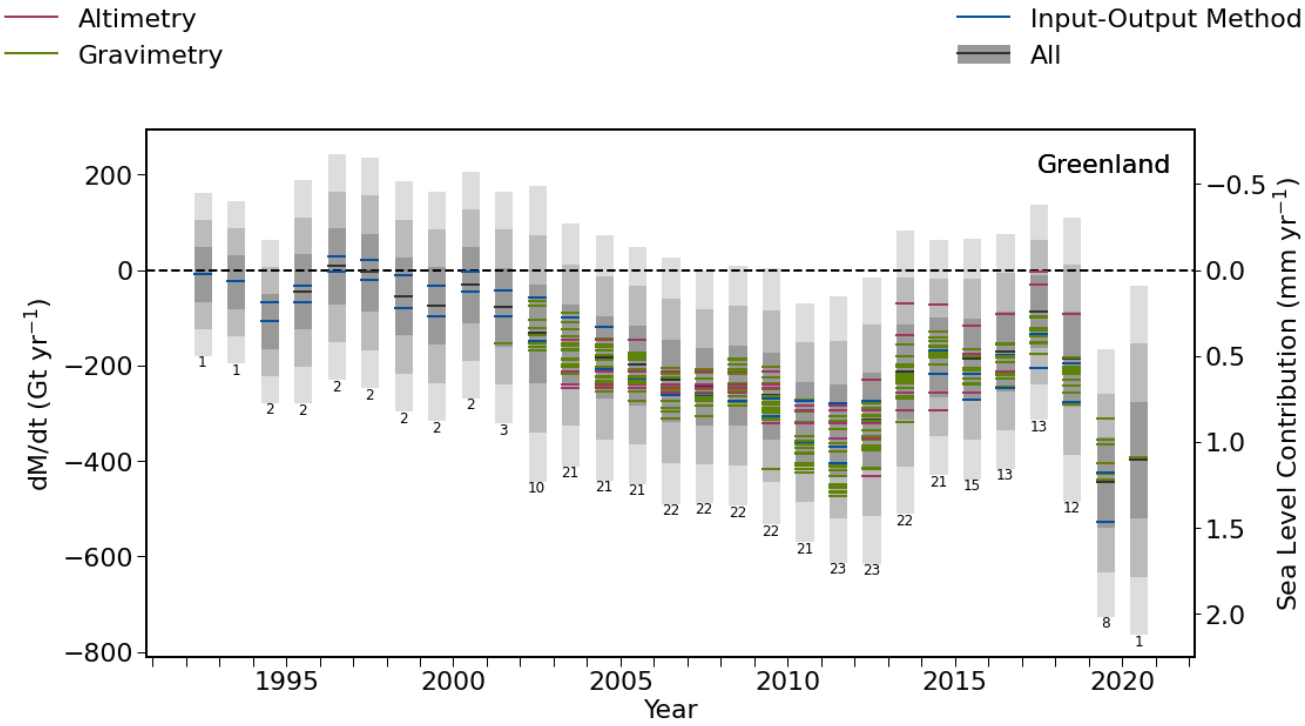

Figure 9 per-annum bar plot of individual contributions and distribtution – GrIS

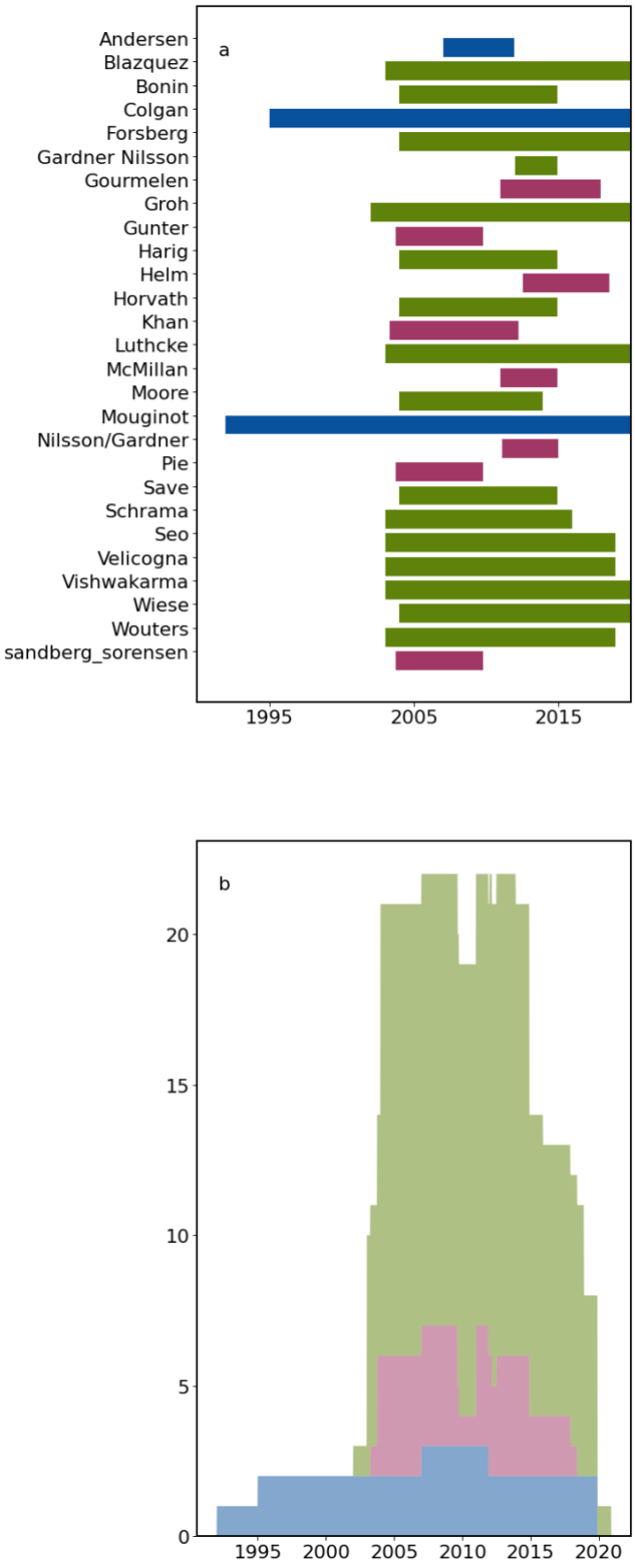

Figure 10 temporal coverage of contributions with histogram

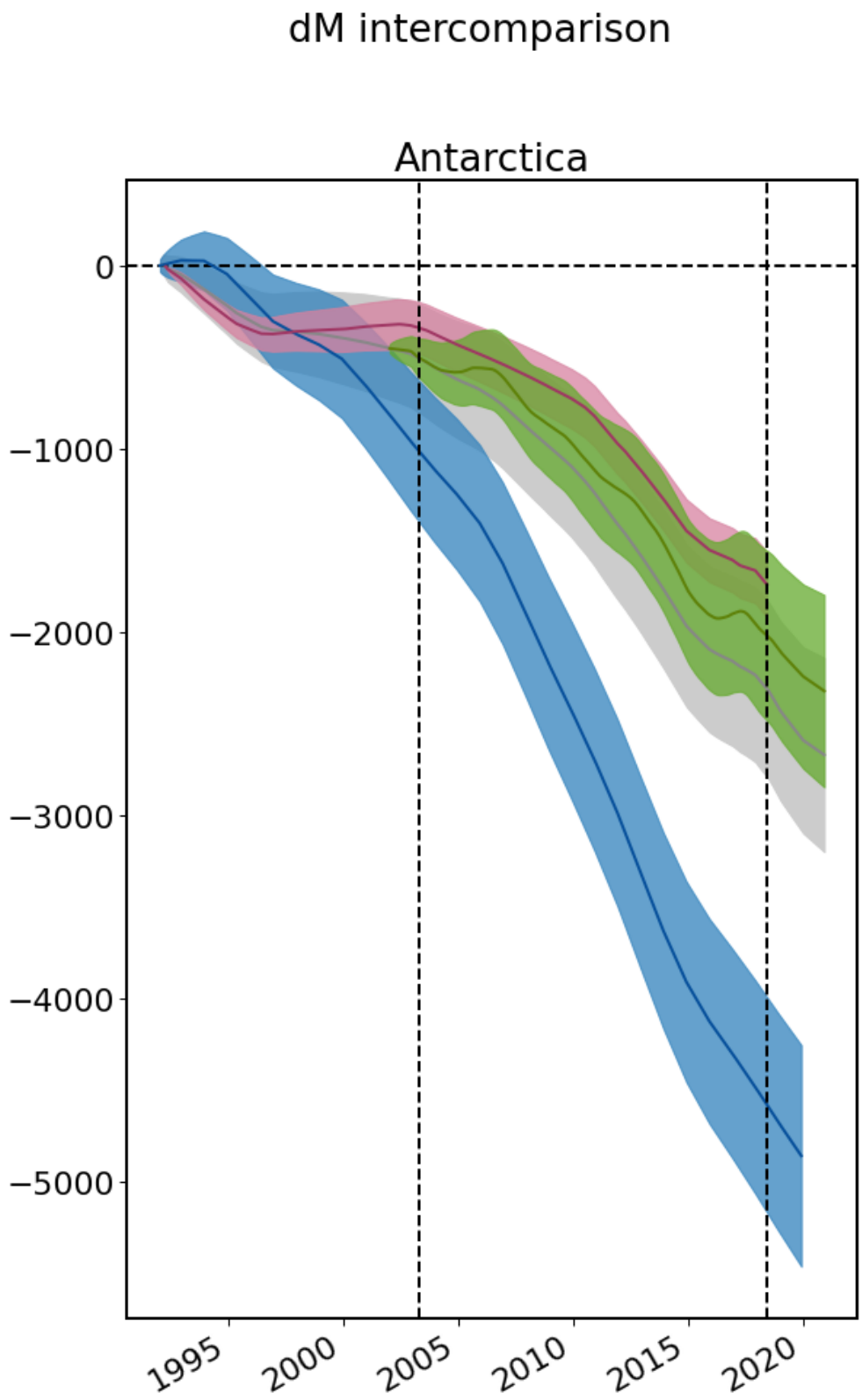

Figure 11 dM(t) and error margin per-group: AIS

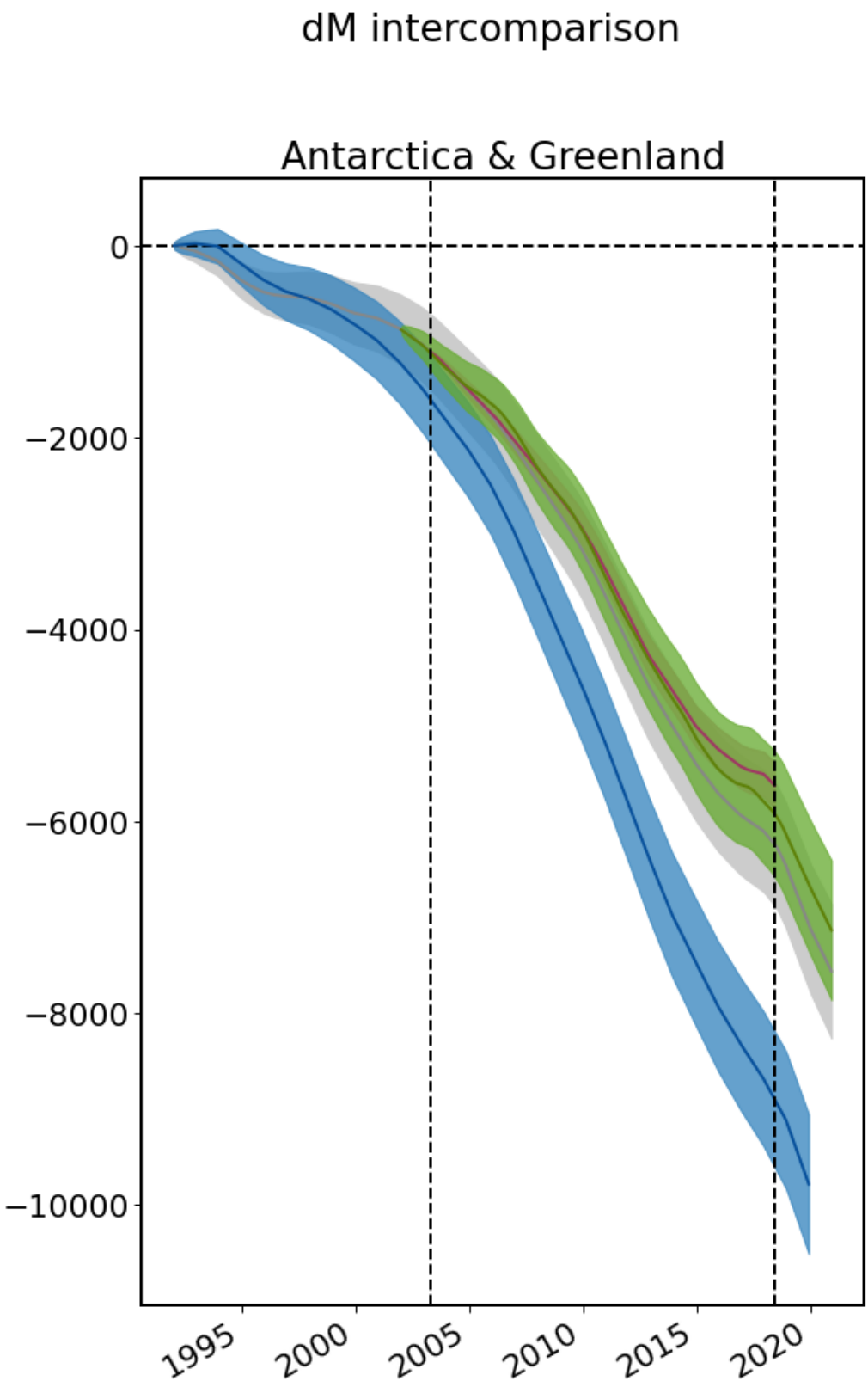

Figure 12 dM(t) and error margin per-group: Total

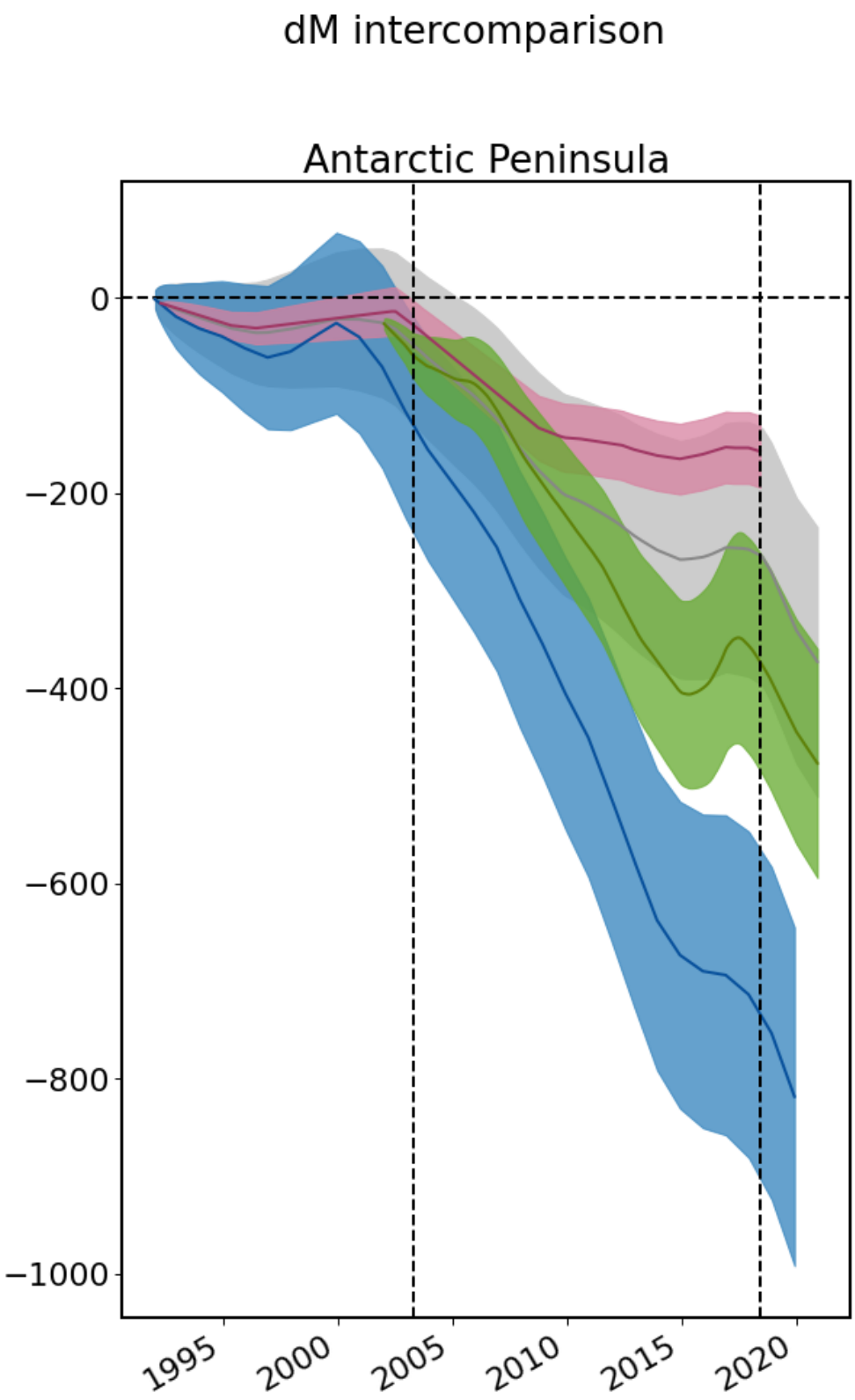

Figure 13 dM(t) and error margin per-group: APIS

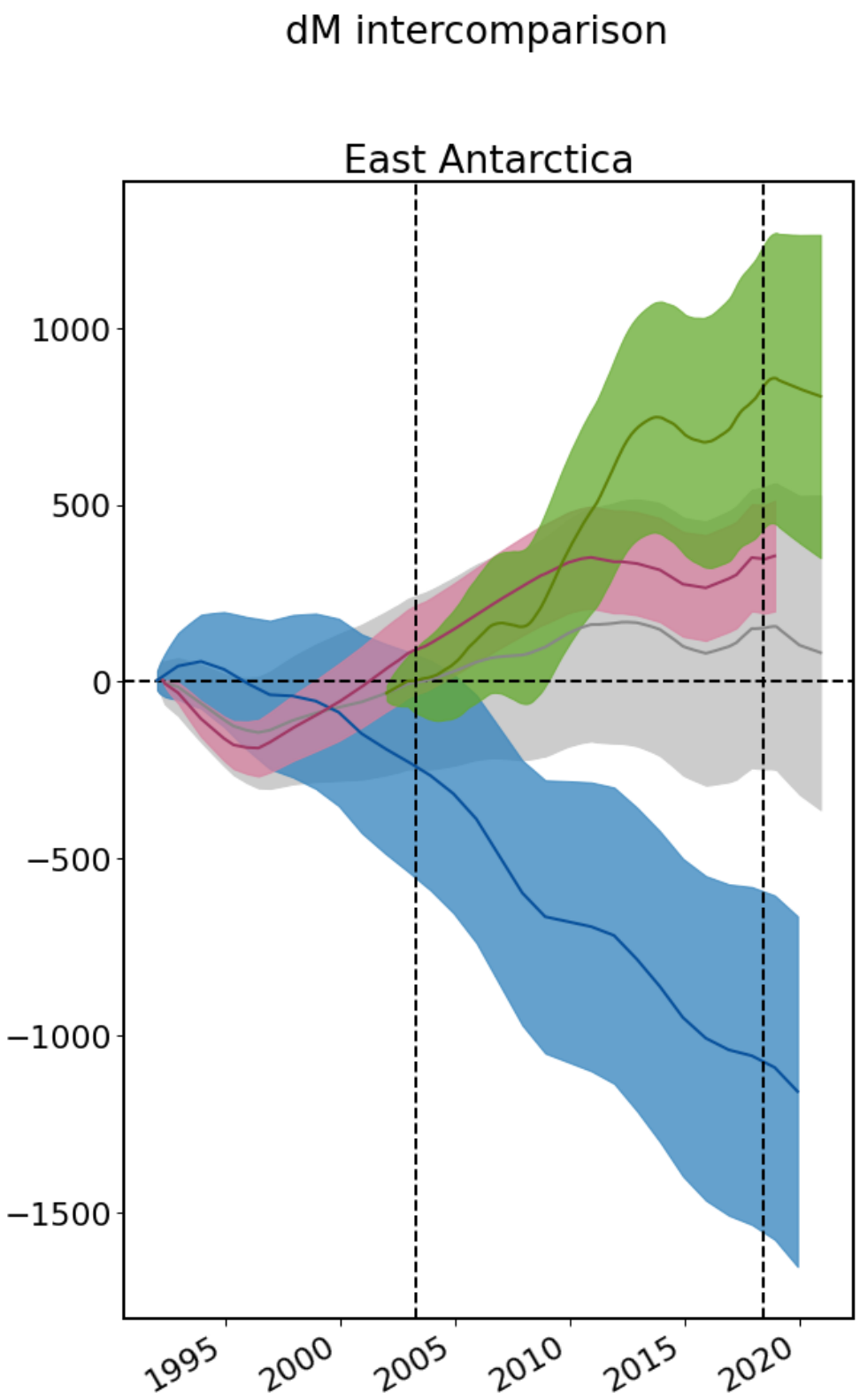

Figure 14 dM(t) and error margin per-group: EAIS

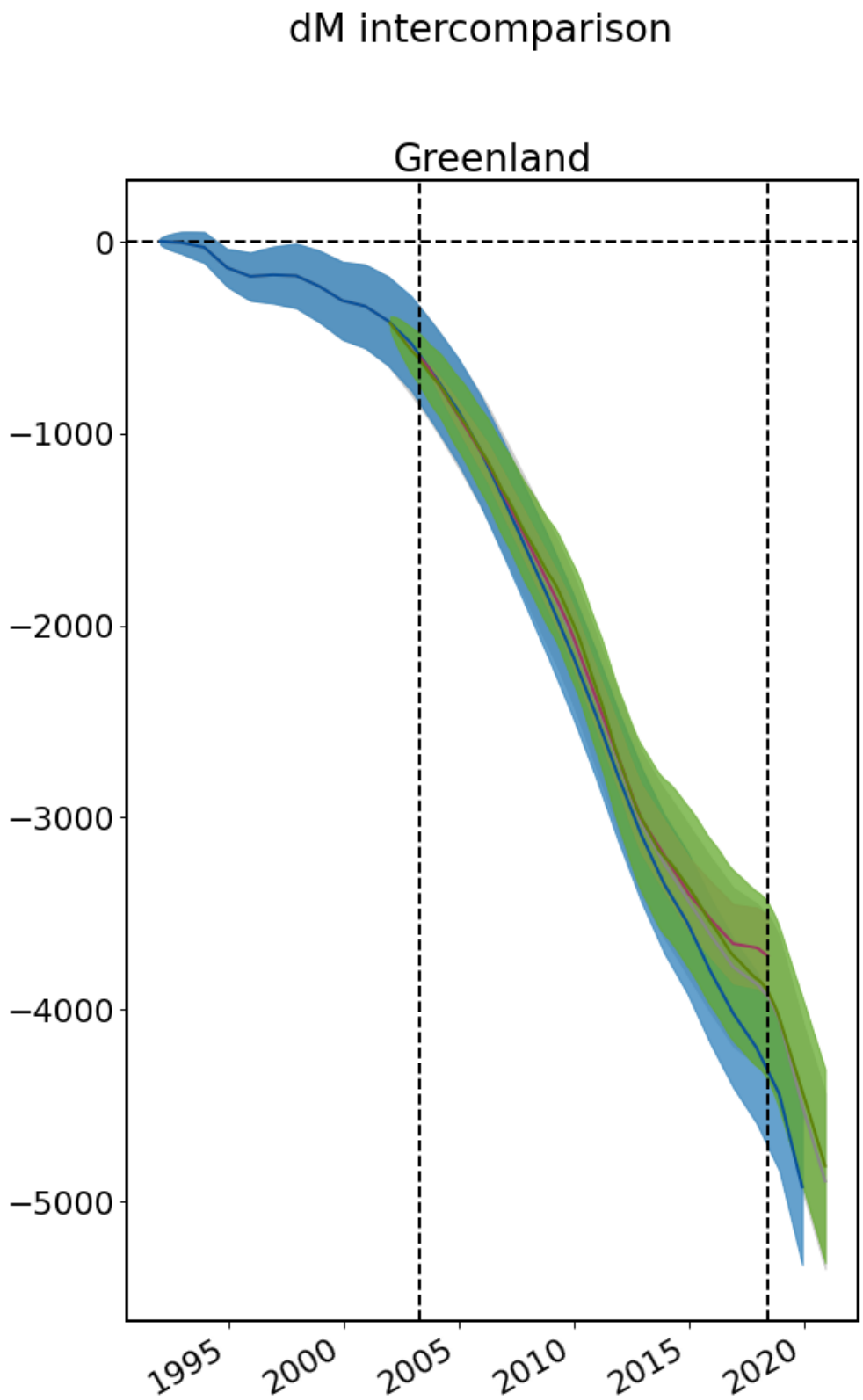

Figure 15 dM(t) and error margin per-group: GrIS

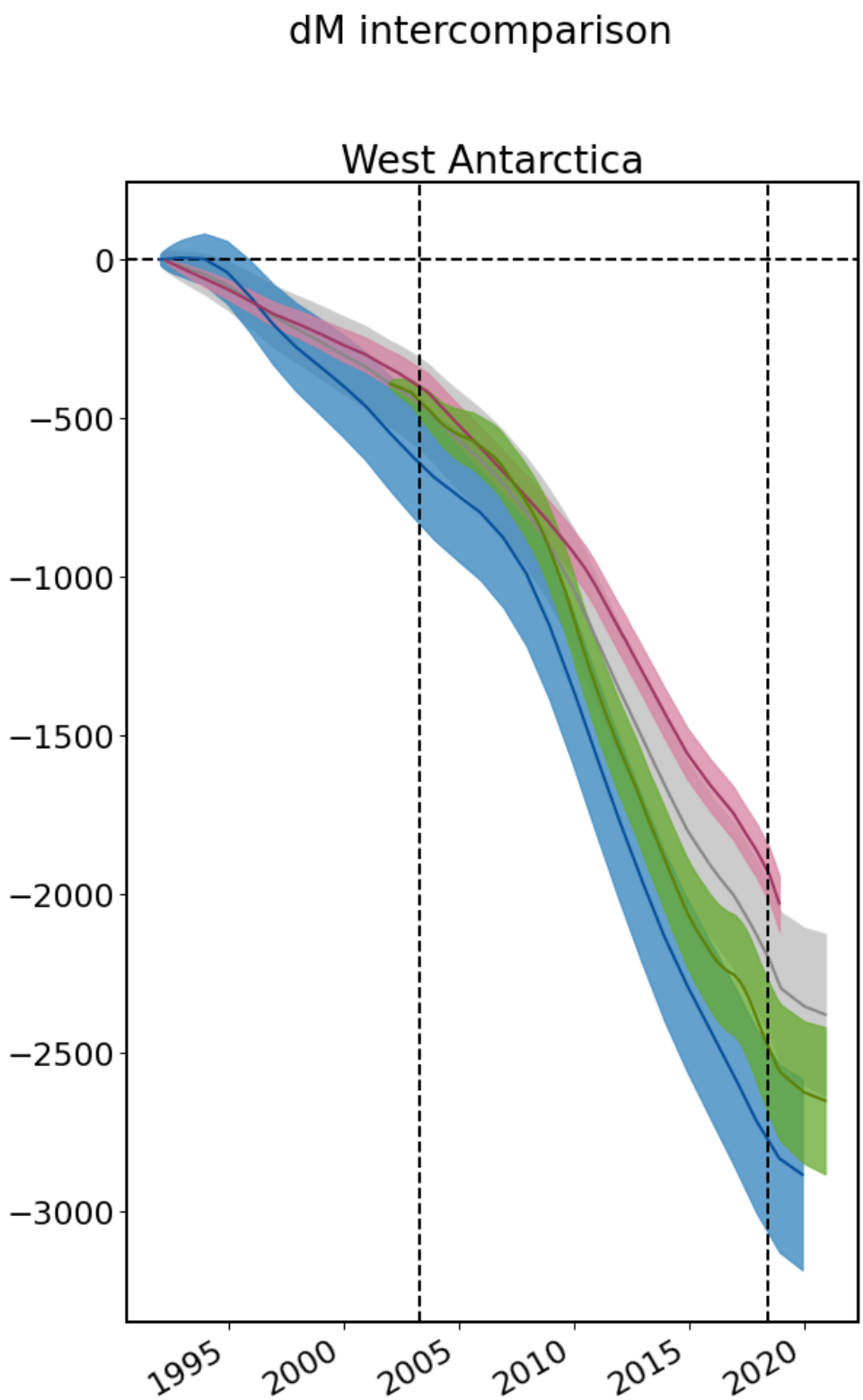

Figure 16 dM(t) and error margin per-group: WAIS

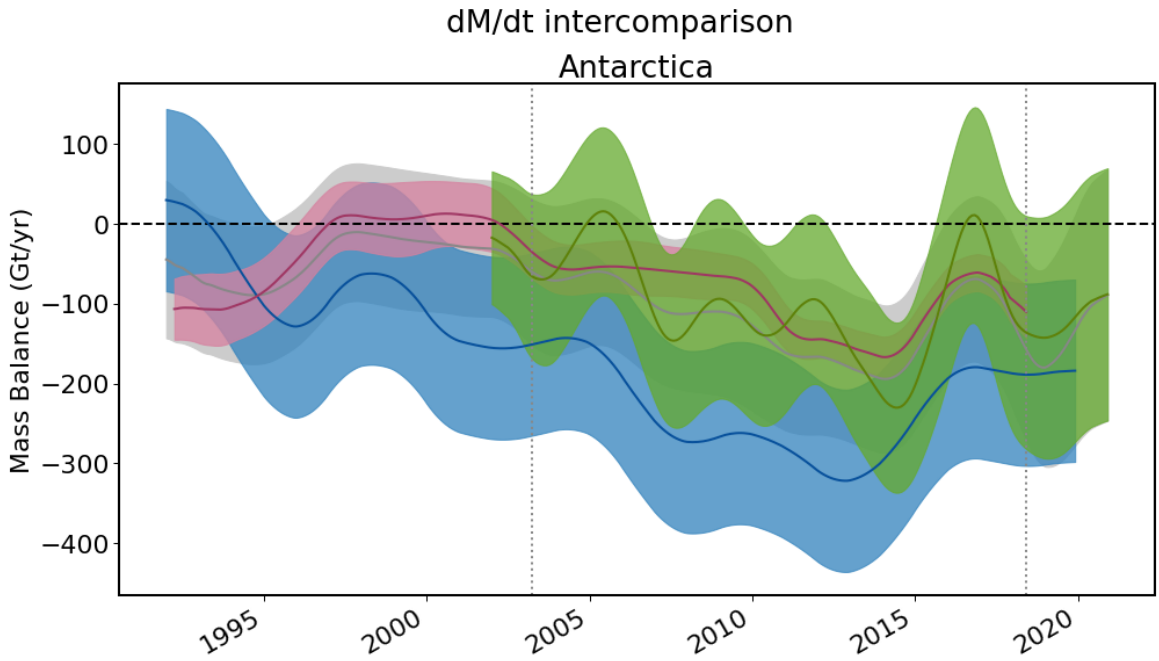

Figure 17 dM/dt and error margin per-group: AIS

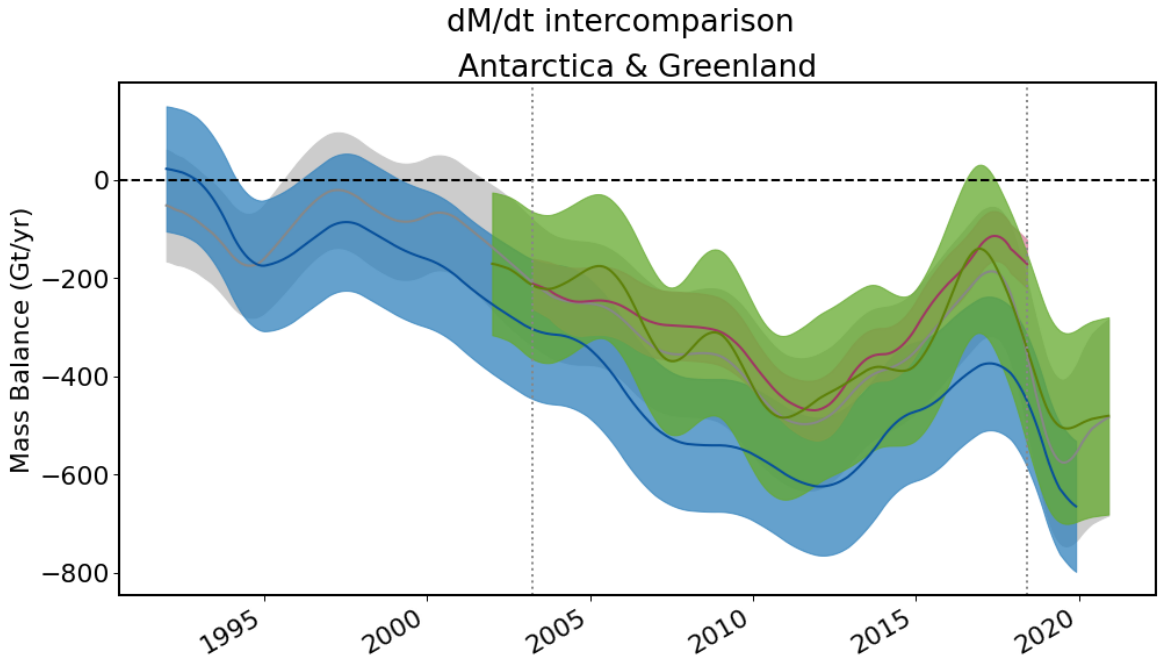

Figure 18 dM/dt and error margin per-group: Total

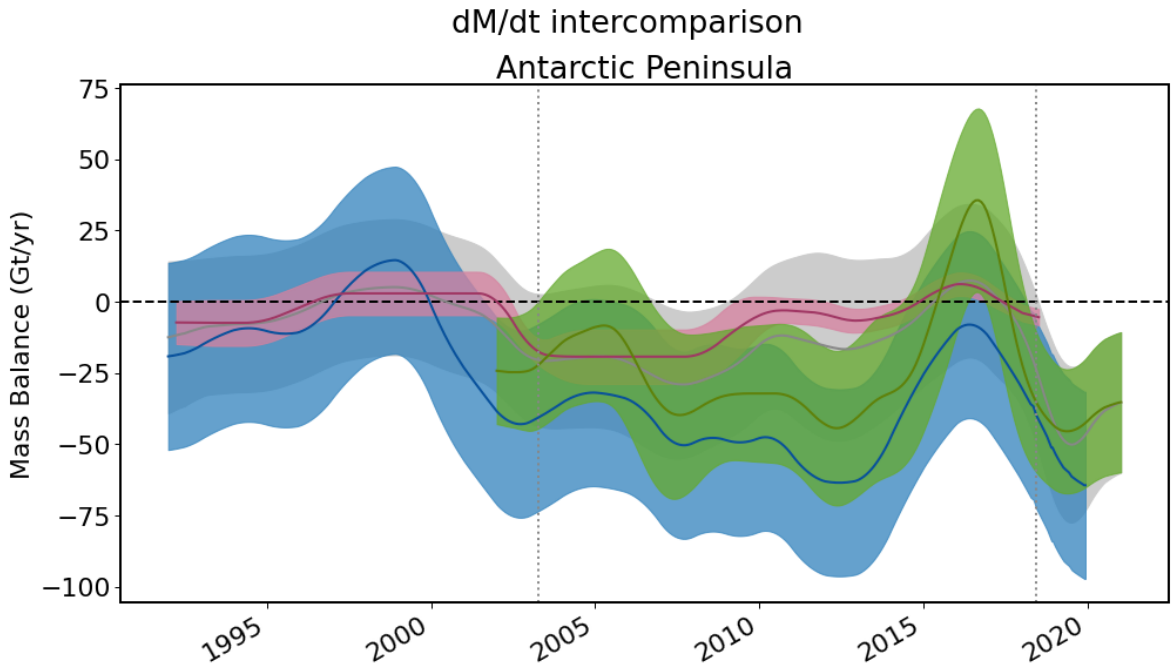

Figure 19 dM/dt and error margin per-group: APIS

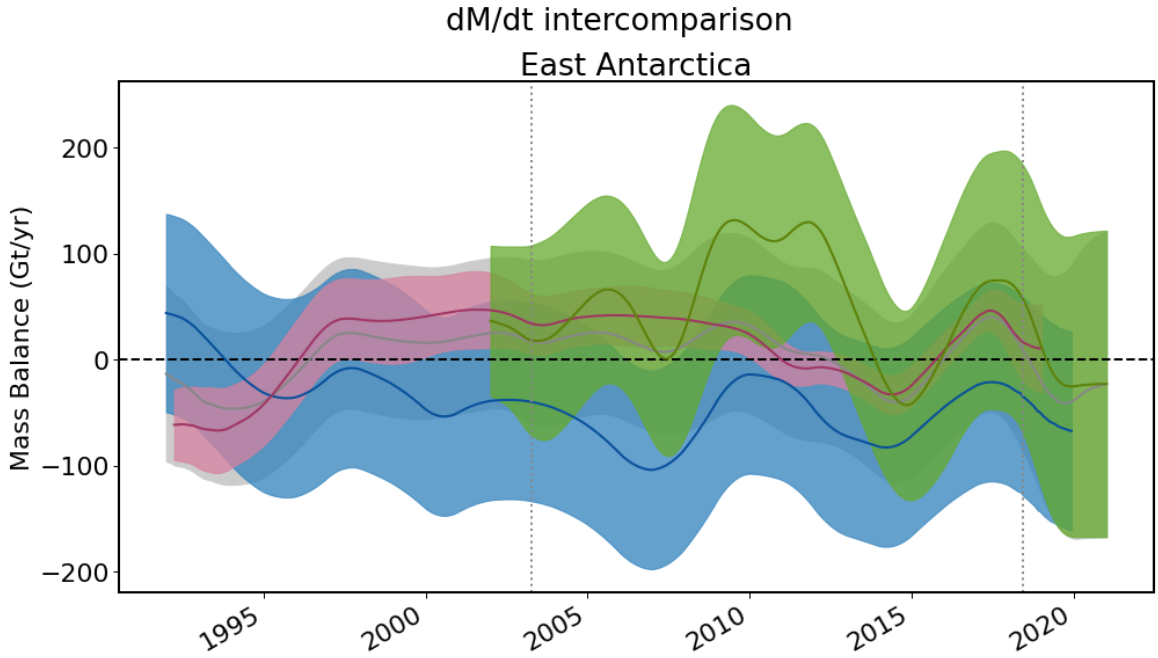

Figure 20 dM/dt and error margin per-group: EAIS

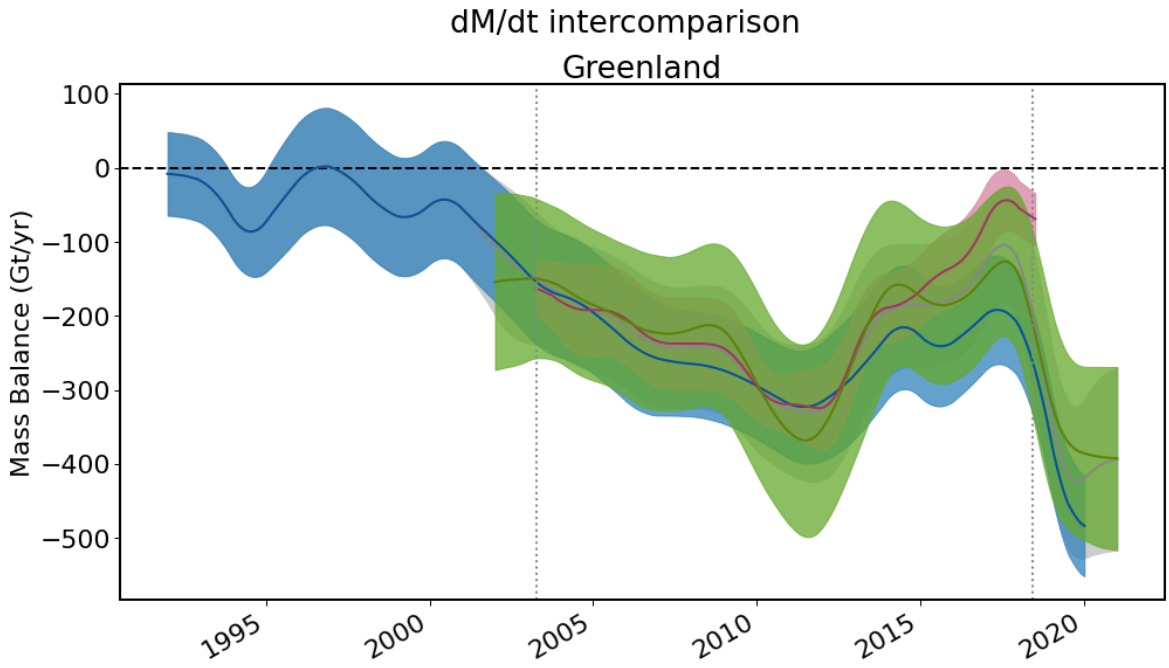

Figure 21 dM/dt and error margin per-group: GrIS

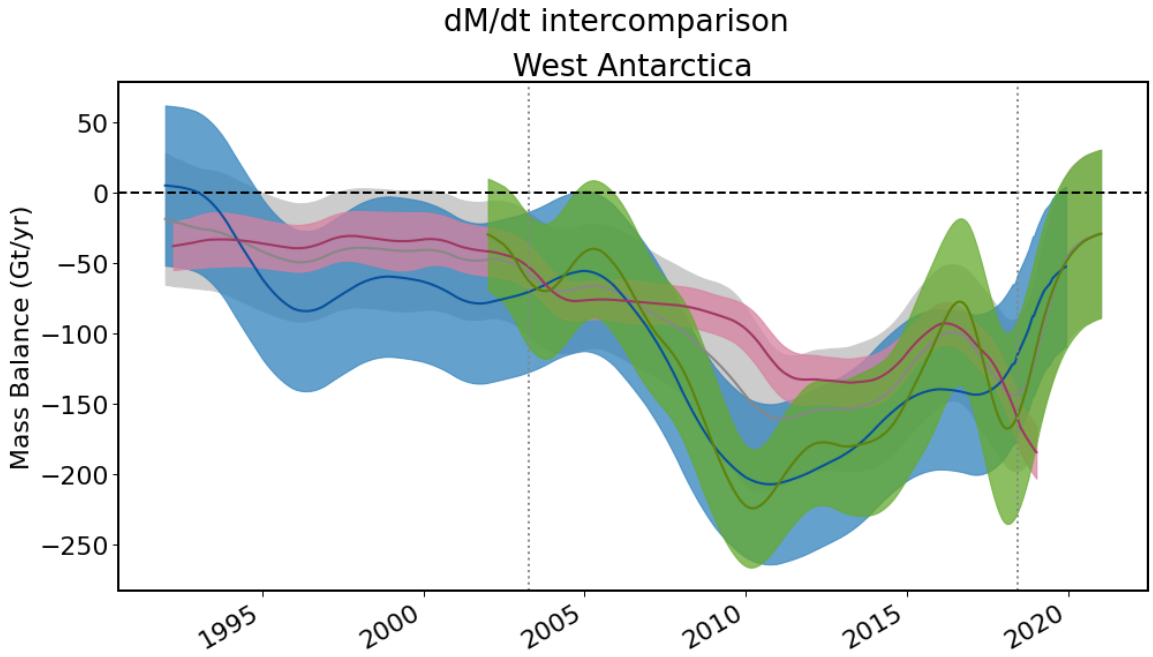

Figure 22 dM/dt and error margin per-group: WAIS

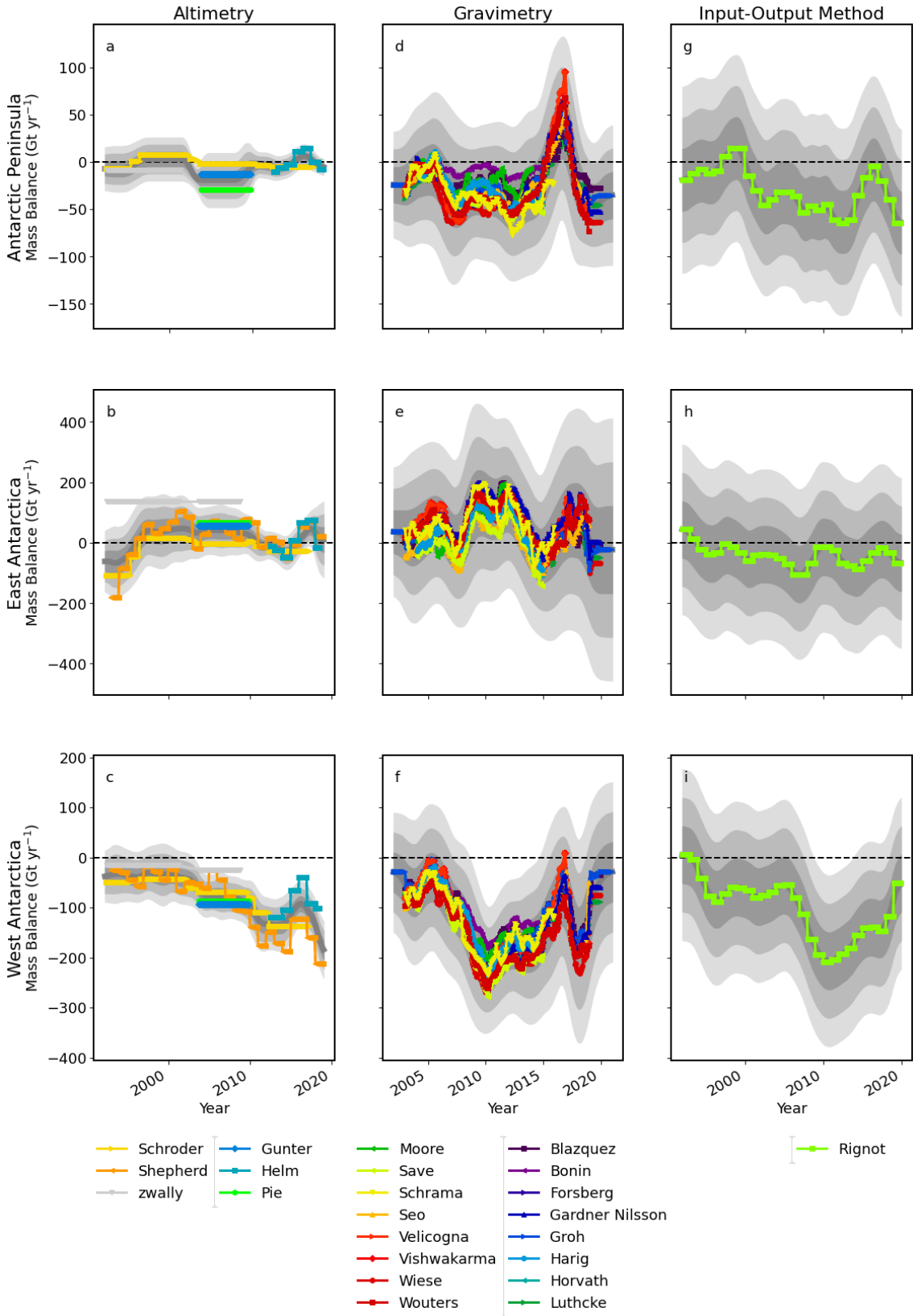

Figure 23 Individual contributions and group averages by ice sheet: Antarctica

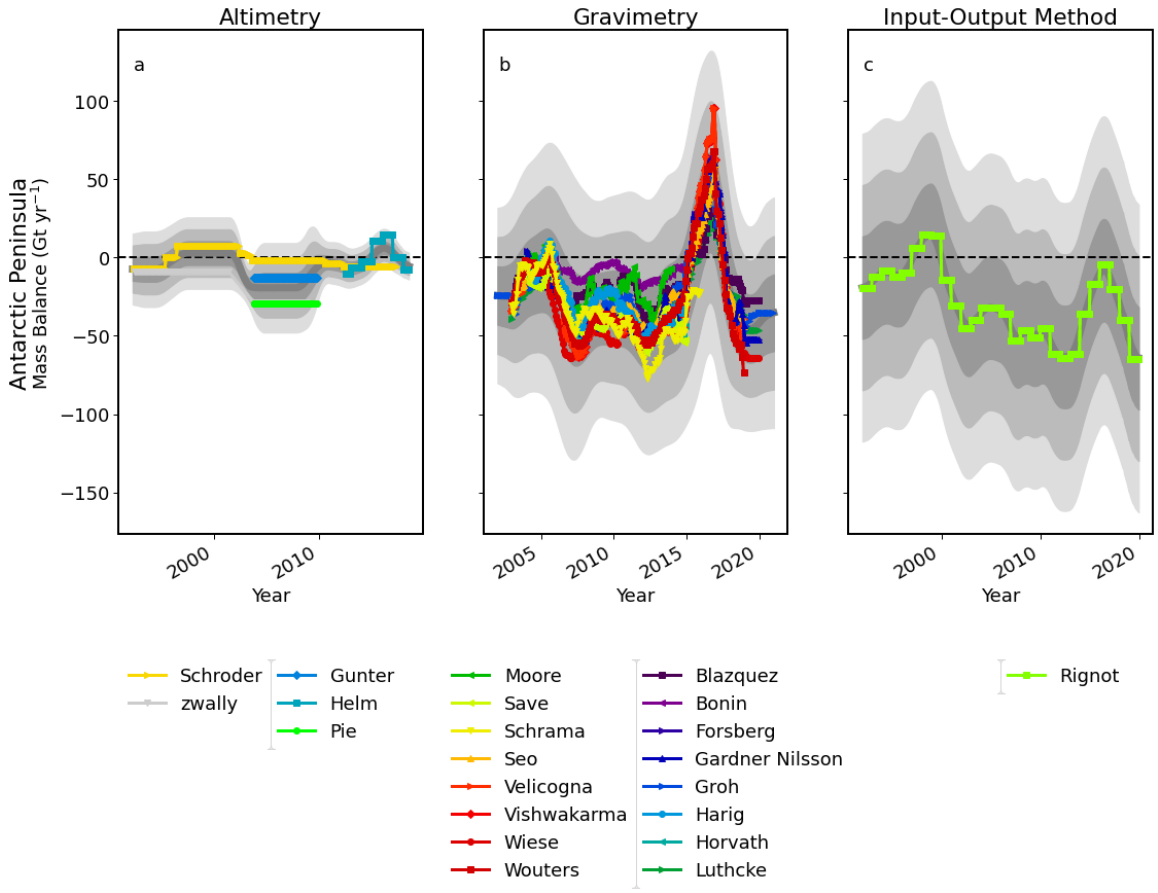

Figure 24 Individual contributions and group averages by ice sheet: Antarctica Peninsula

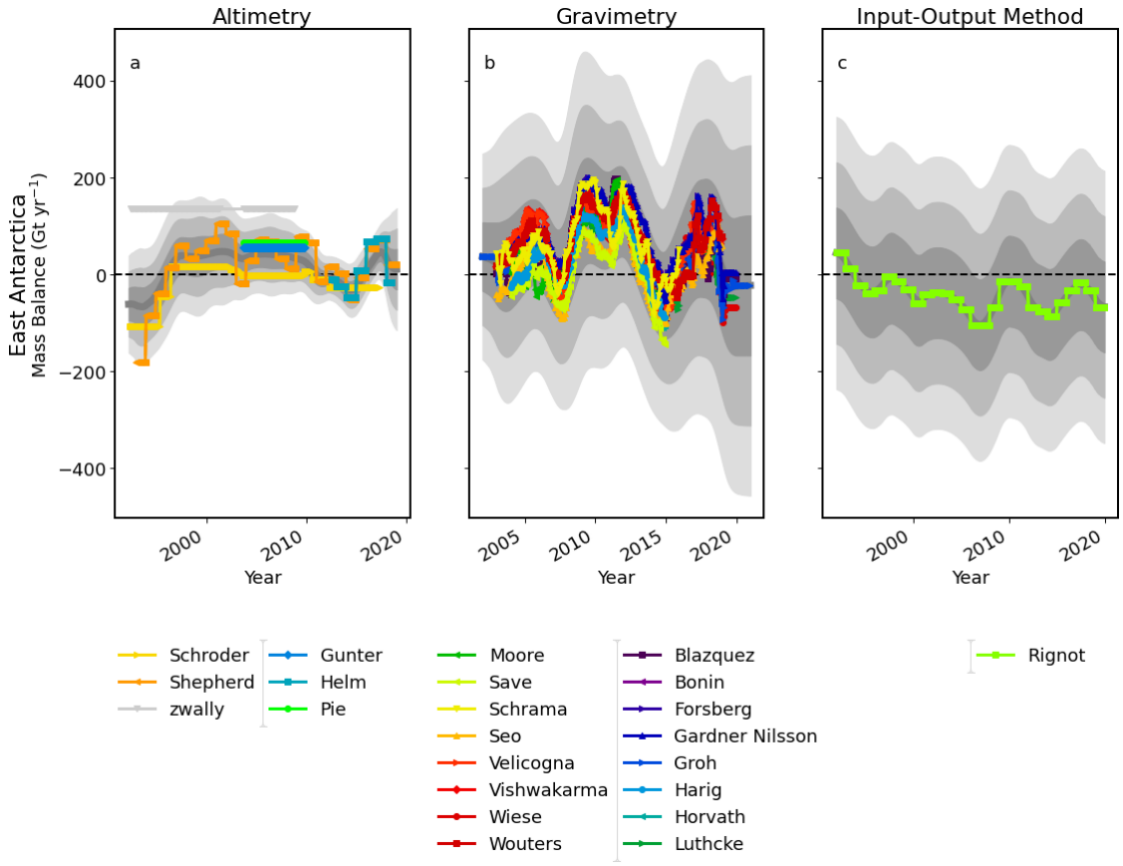

Figure 25 Individual contributions and group averages by ice sheet: East Antarctica

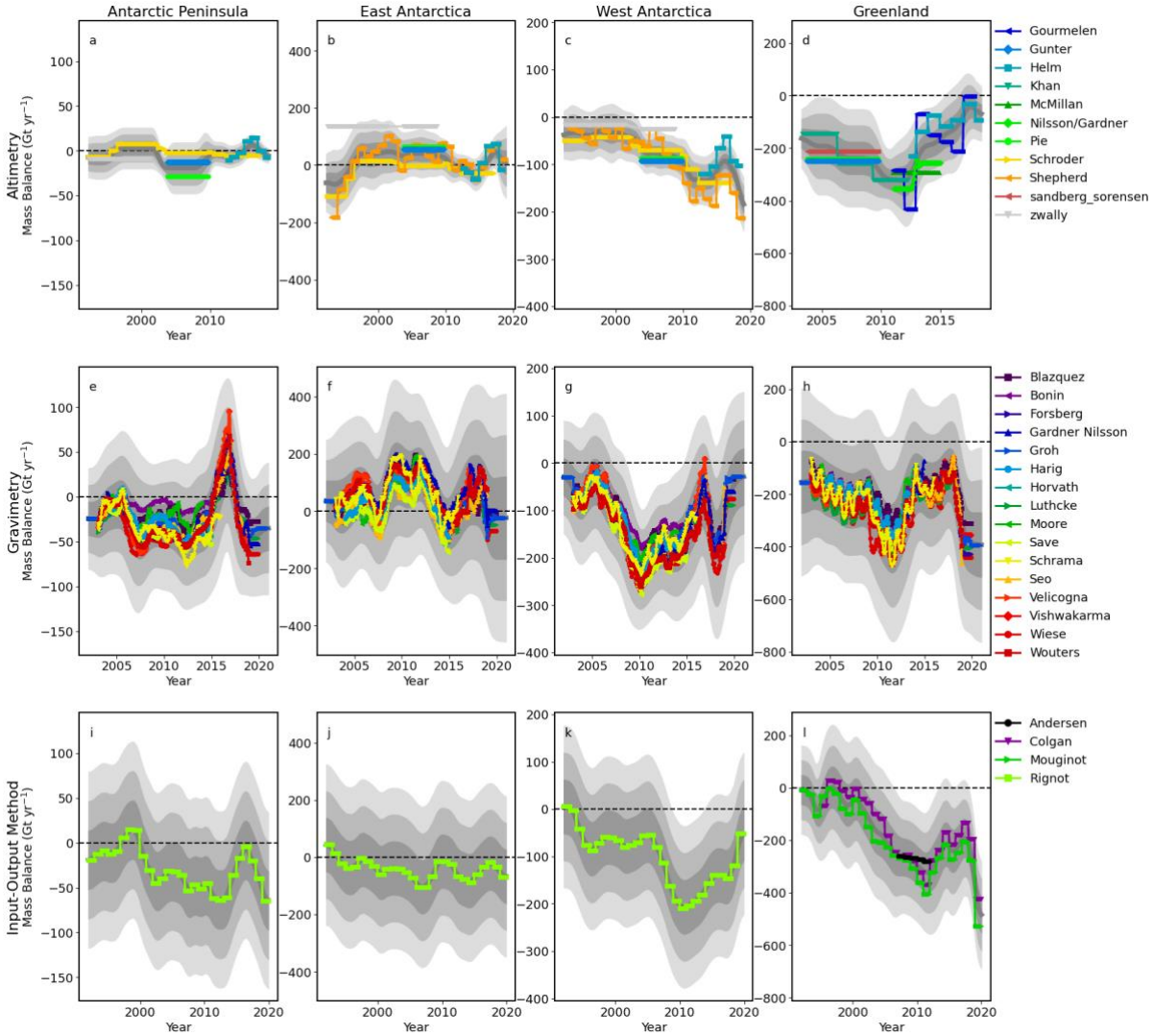

Figure 26 Individual contributions and group averages by ice sheet: Antarctica and Greenland

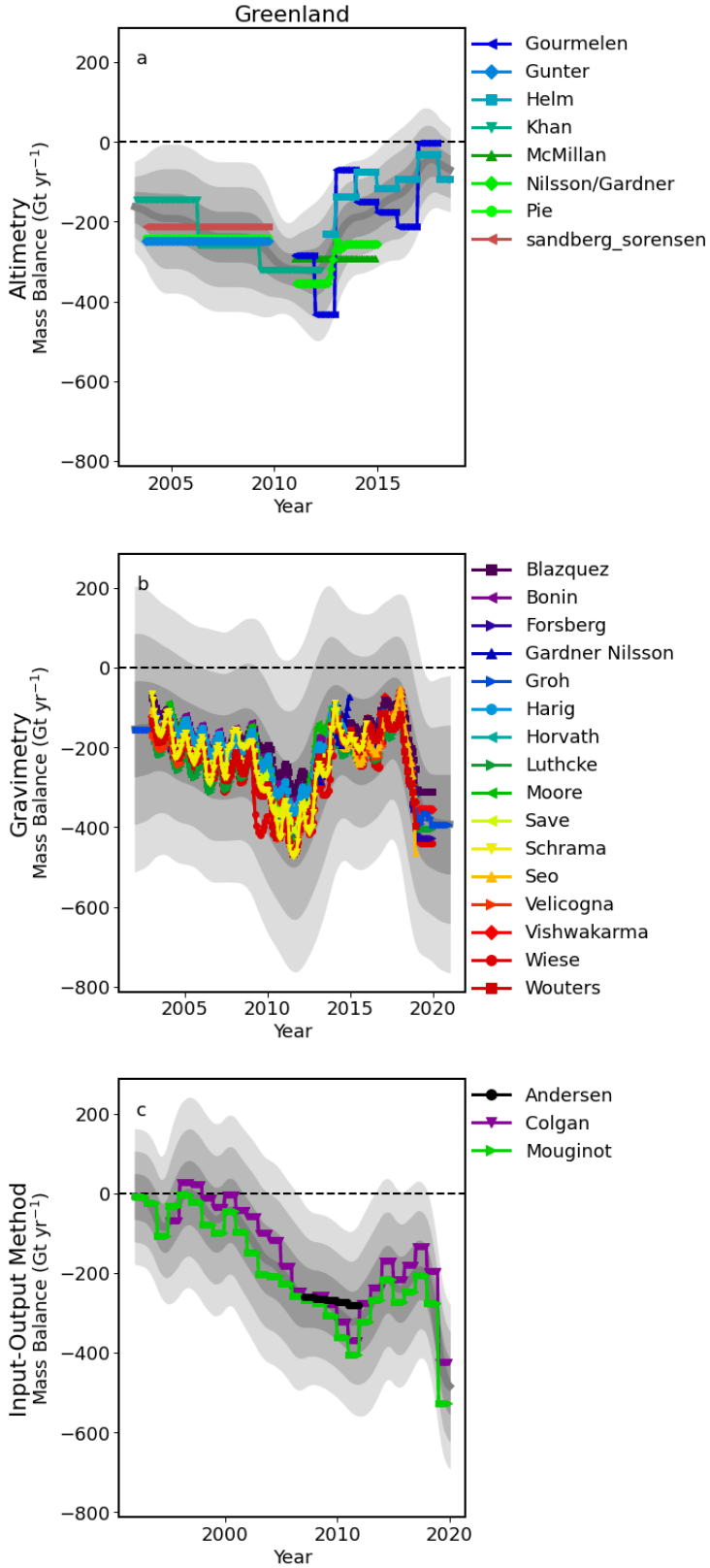

Figure 27 Individual contributions and group averages by ice sheet: Greenland

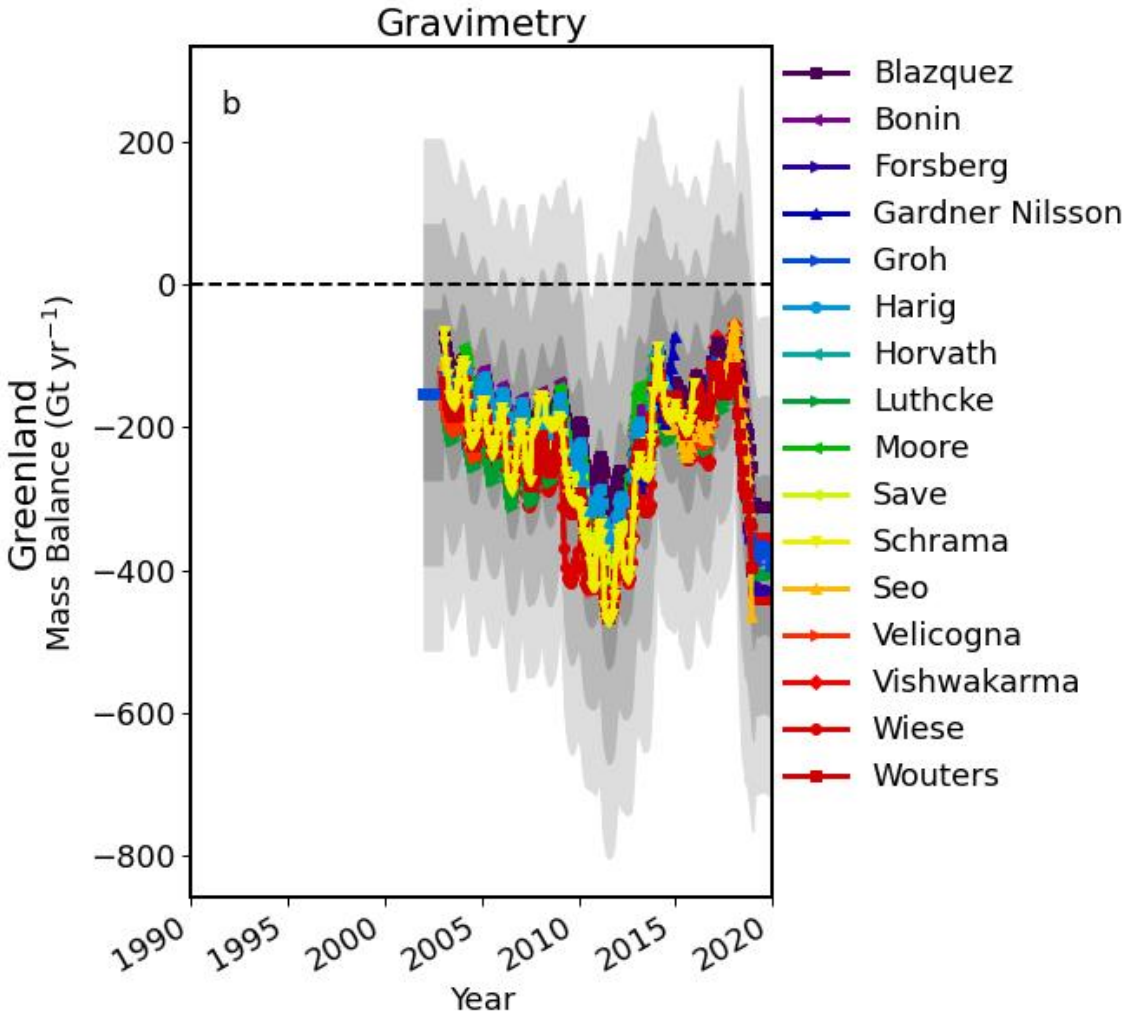

Figure 28 Individual contributions and group average: Gravimetry GrIS

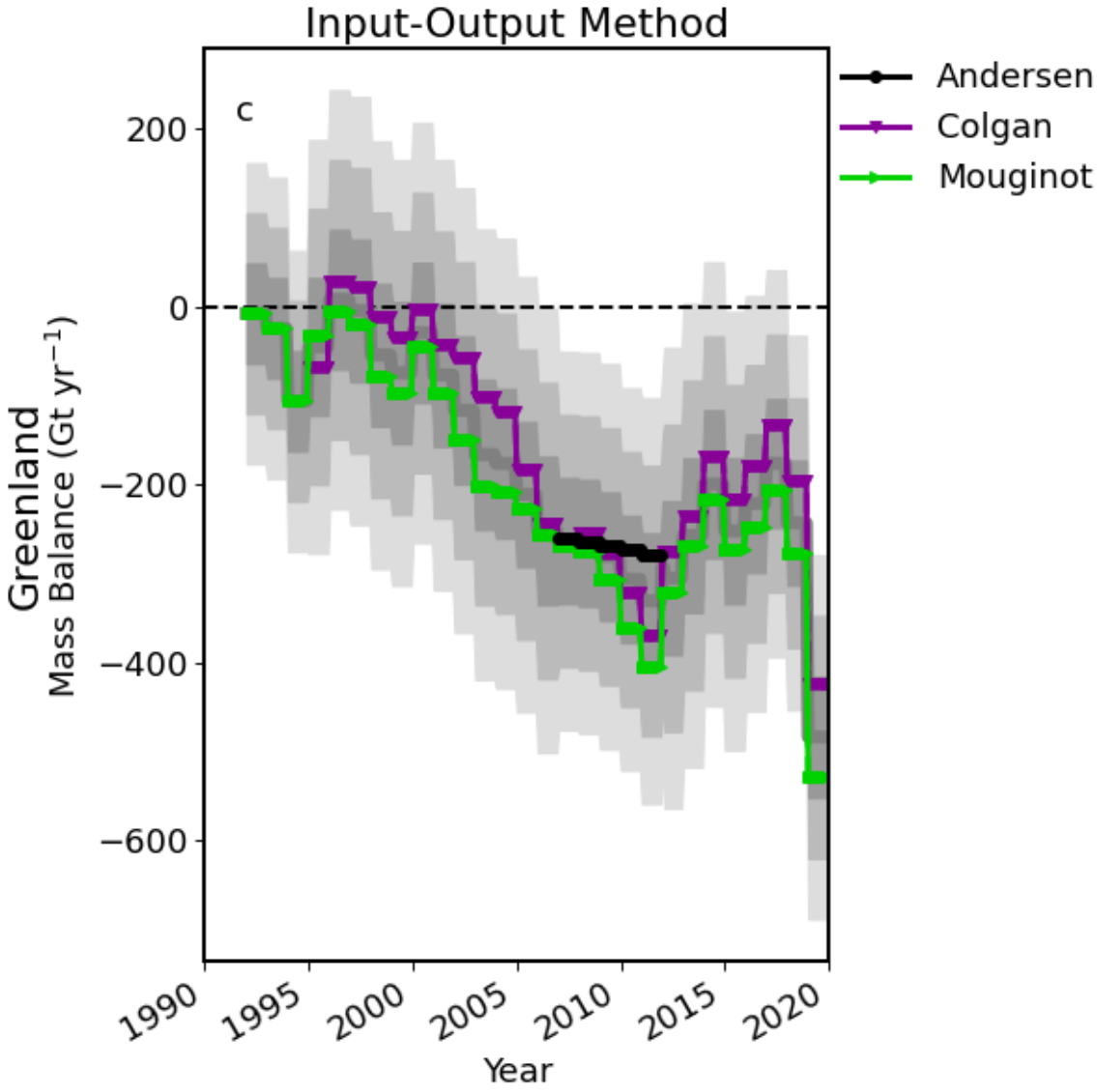

Figure 29 Individual contributions and group average: Input-Output Method GrIS

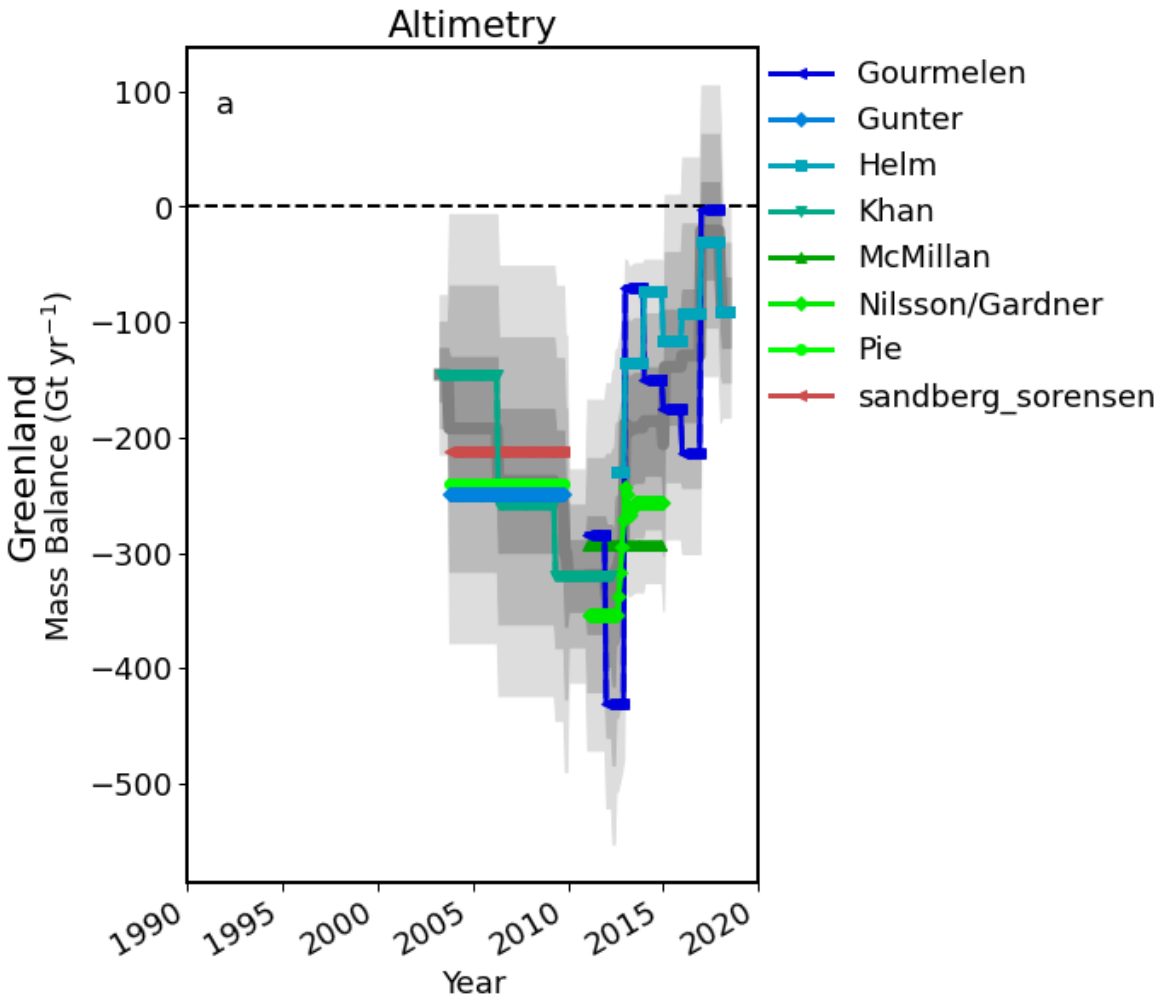

Figure 30 Individual contributions and group average: Altimetry GrIS

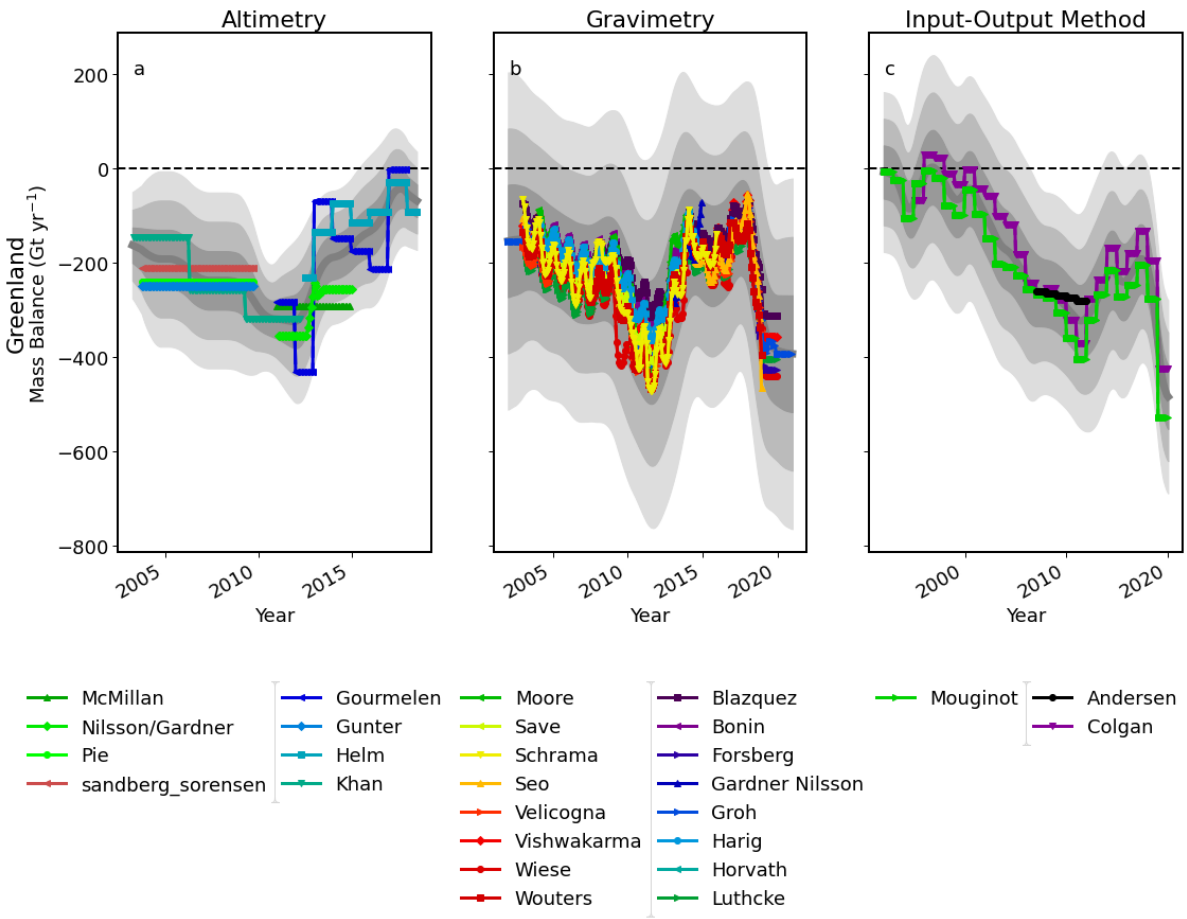

Figure 31 Individual contributions and group averages by ice sheet: Greenland – horizontal orientation

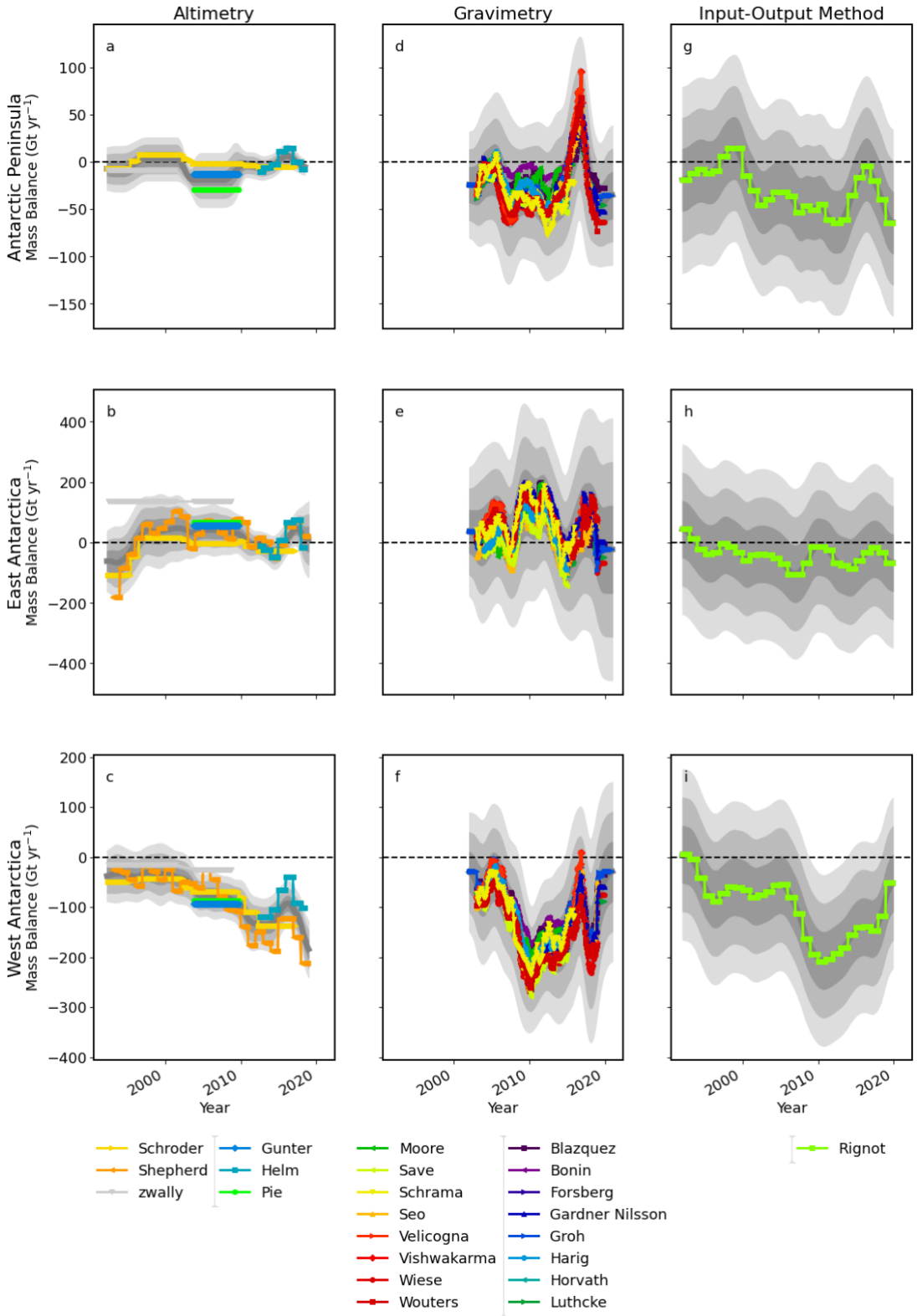

Figure 32 Individual contributions and group averages by ice sheet: Antarctica - locked x-axis range

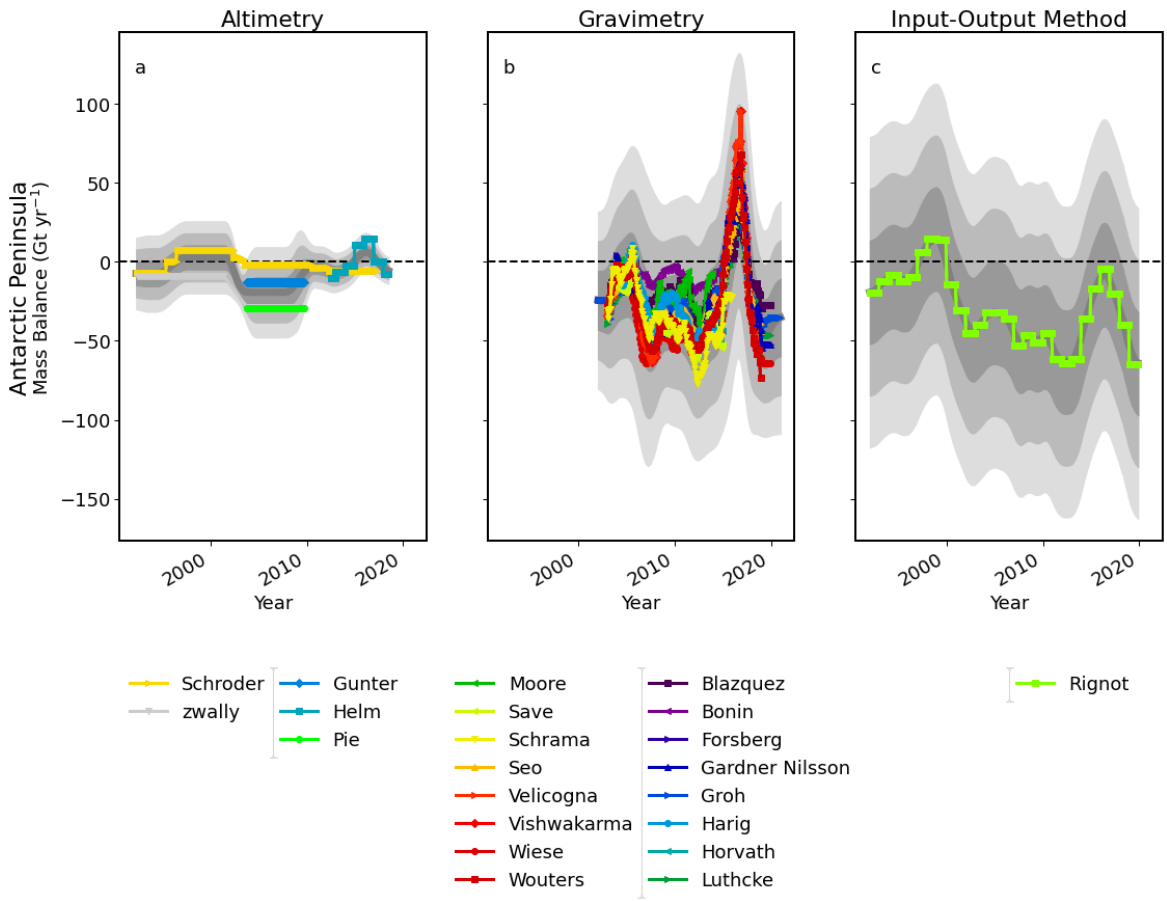

Figure 33 Individual contributions and group averages by ice sheet: Antarctica Peninsula – locked x-axis range

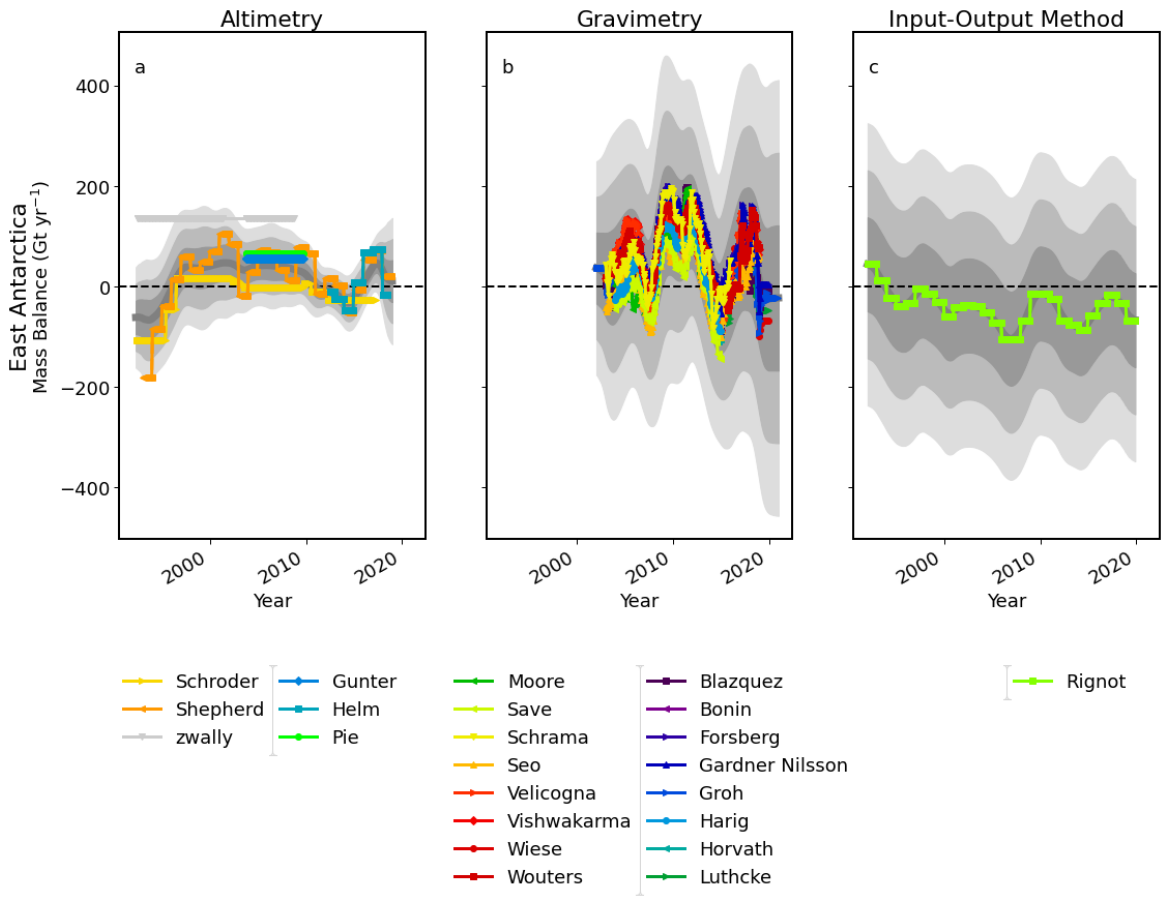

Figure 34 Individual contributions and group averages by ice sheet: East Antarctica – locked x-axis range

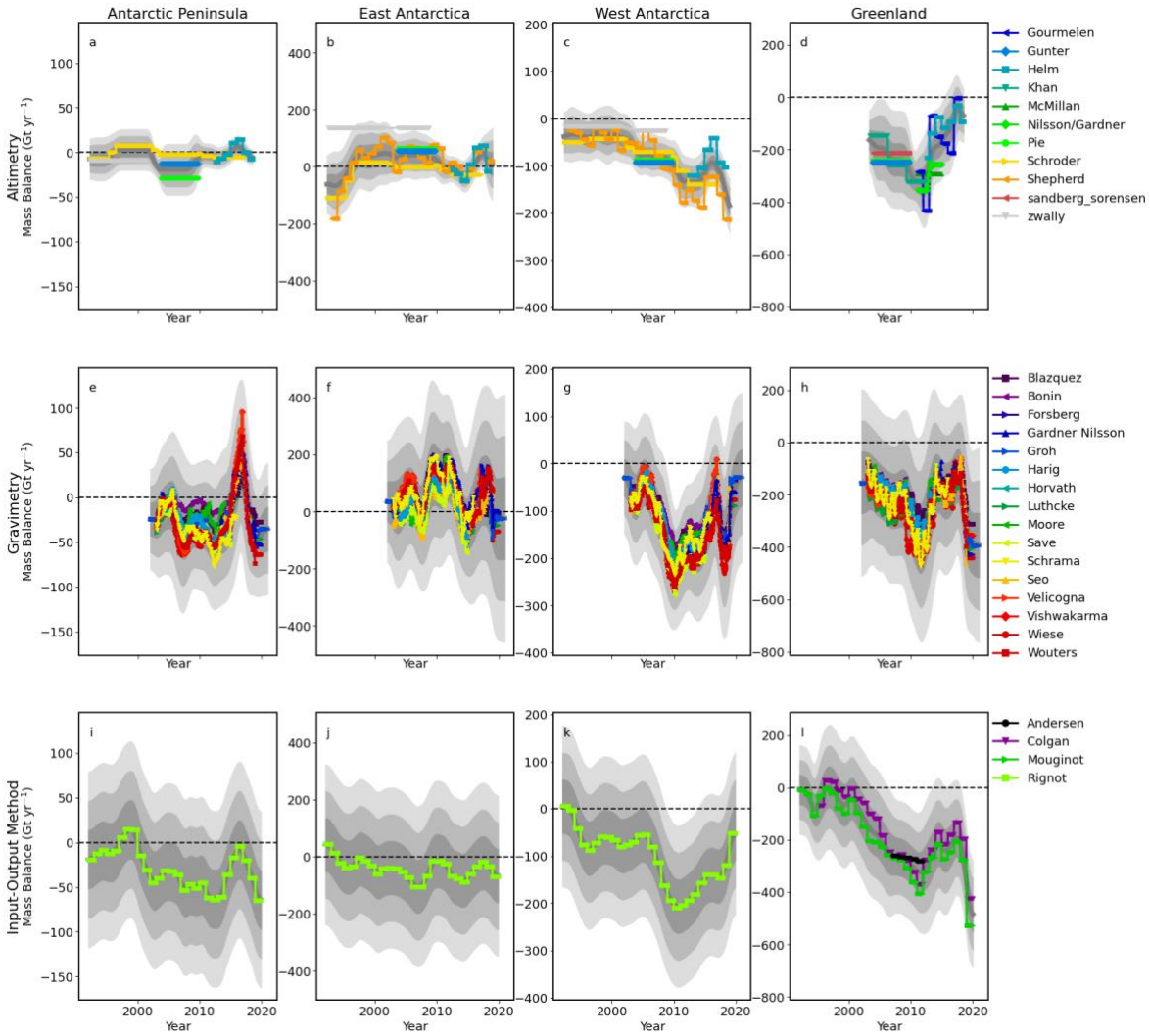

Figure 35 Individual contributions and group averages by ice sheet: Antarctica and Greenland – locked x-axis range

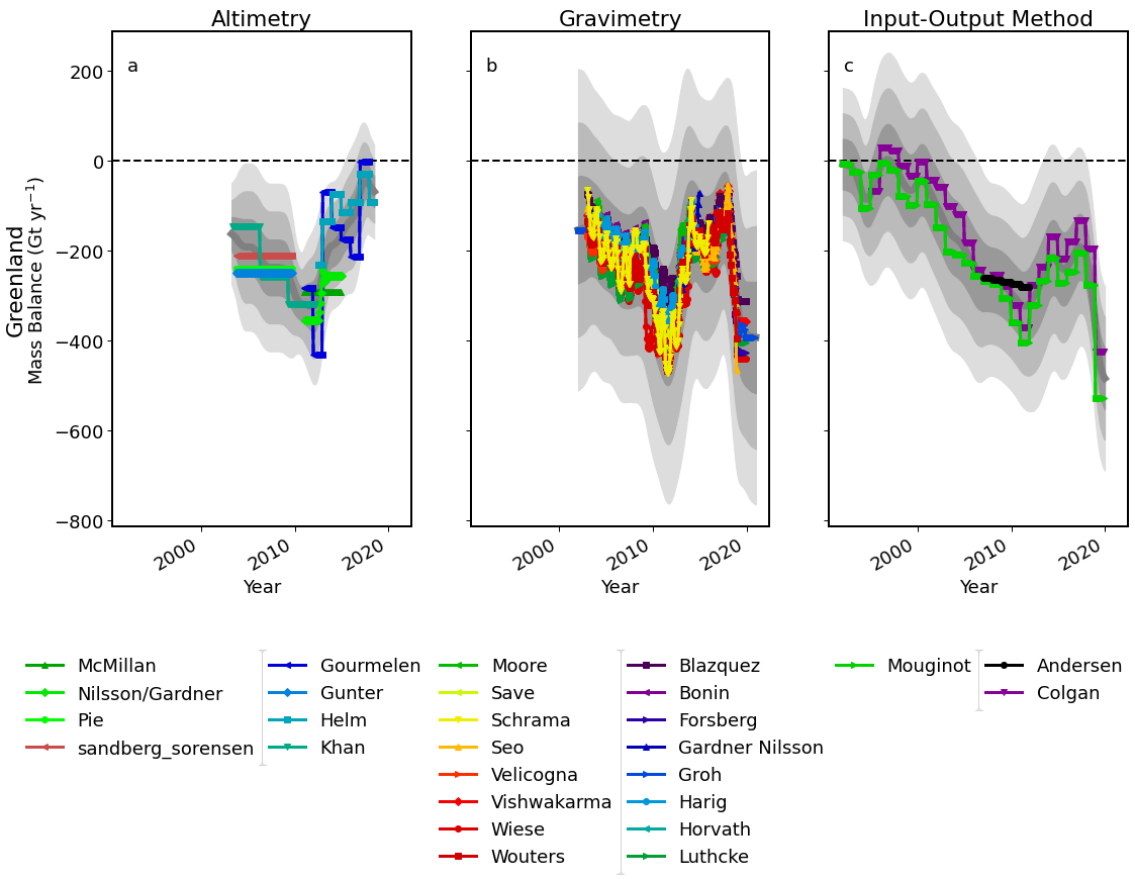

Figure 36 Individual contributions and group averages by ice sheet: Greenland – locked x-axis range

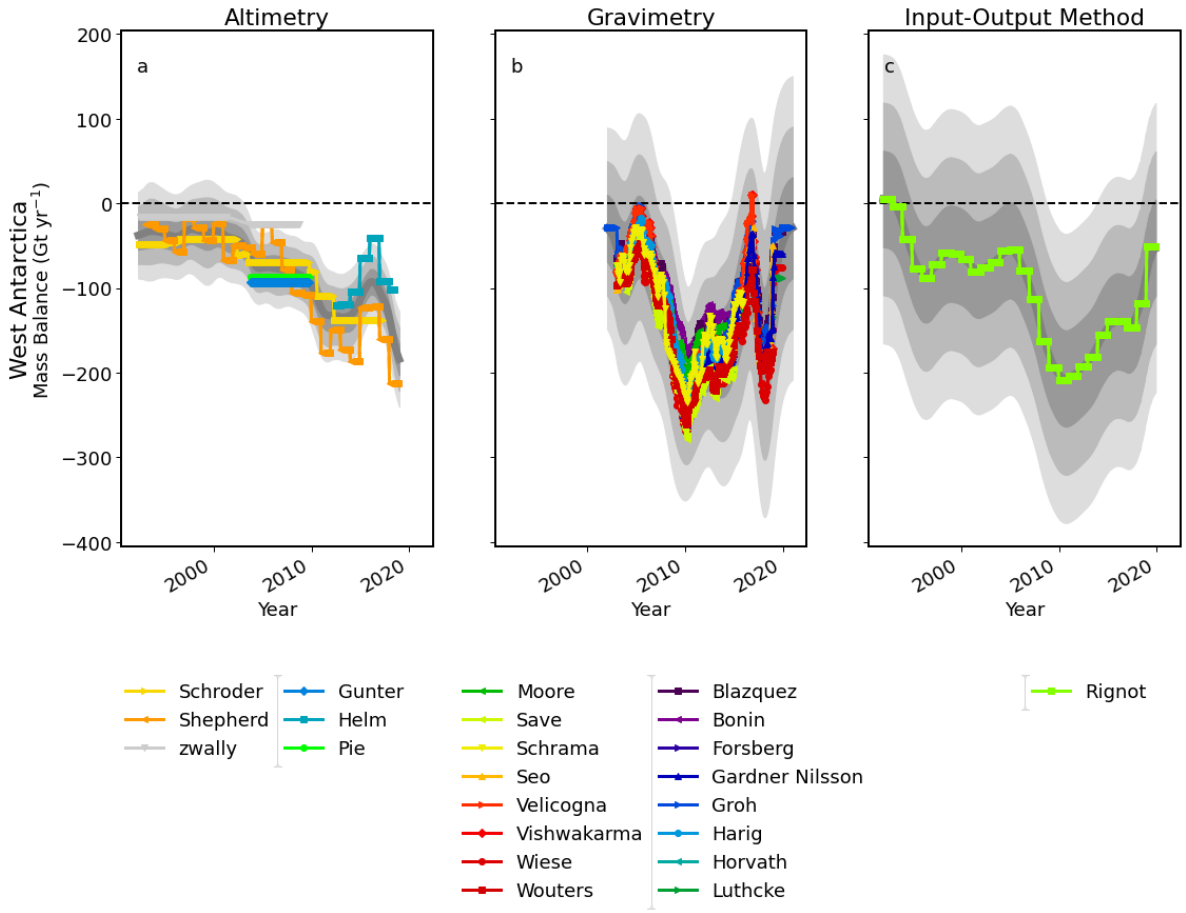

Figure 37 Individual contributions and group averages by ice sheet: West Antarctica – locked x-axis range

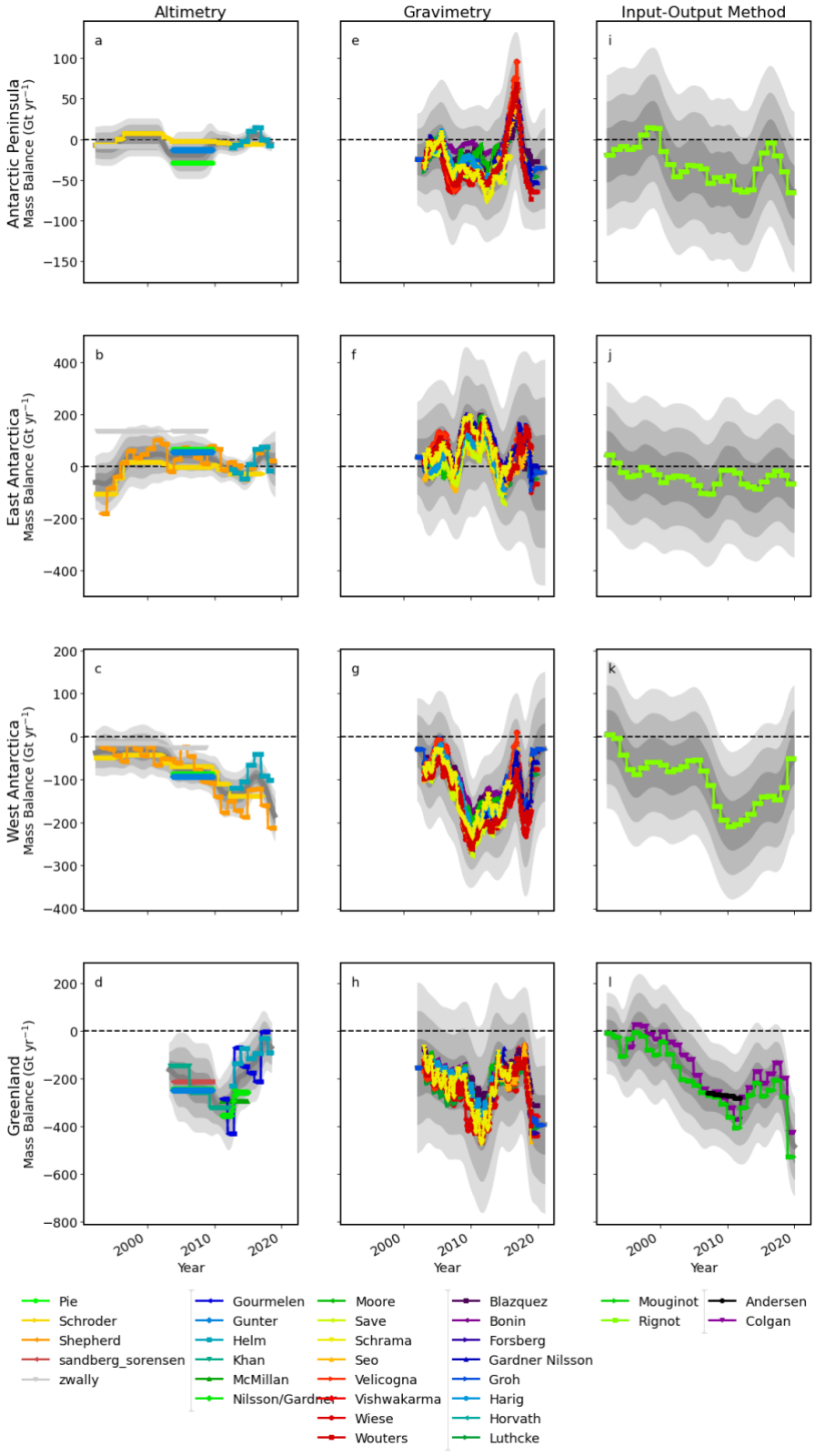

Figure 38 Individual contributions and group averages by ice sheet: Antarctica and Greenland – locked x- and y-axes

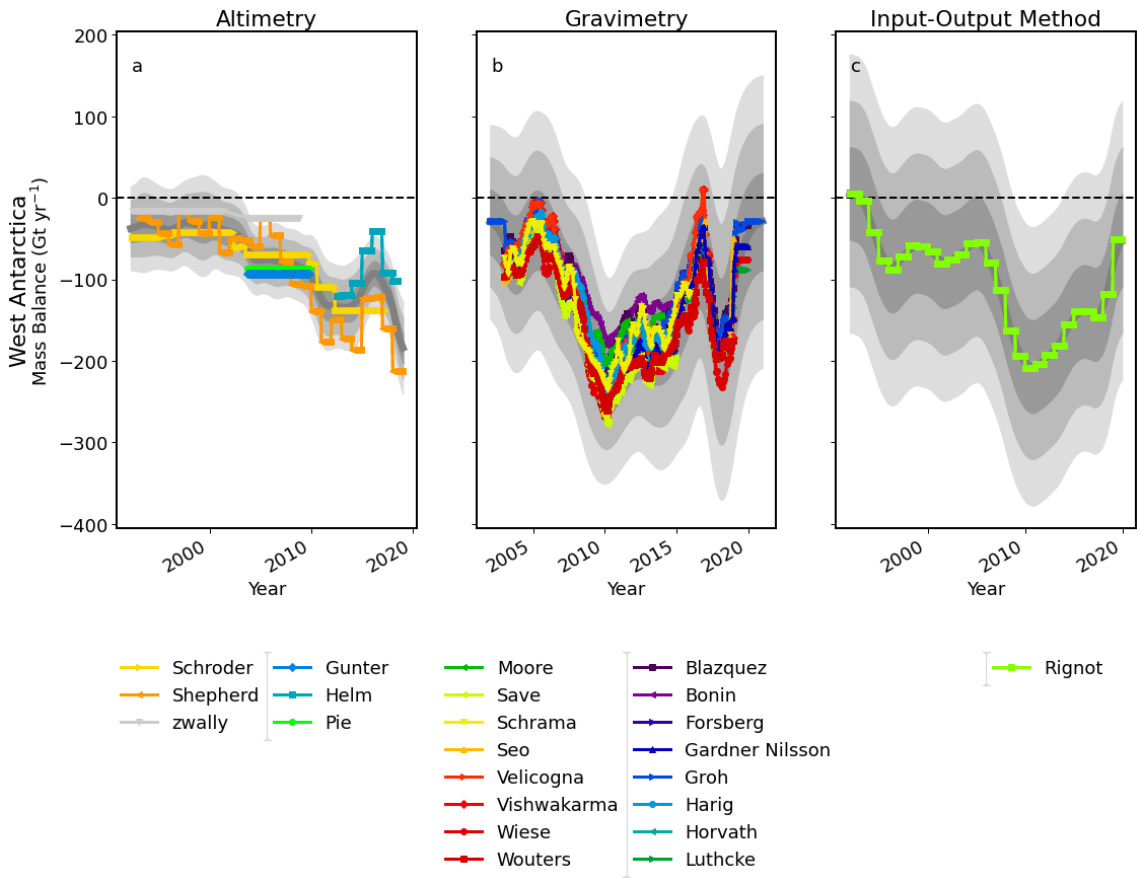

Figure 39 Individual contributions and group averages by ice sheet: West Antarctica – locked y-axis range

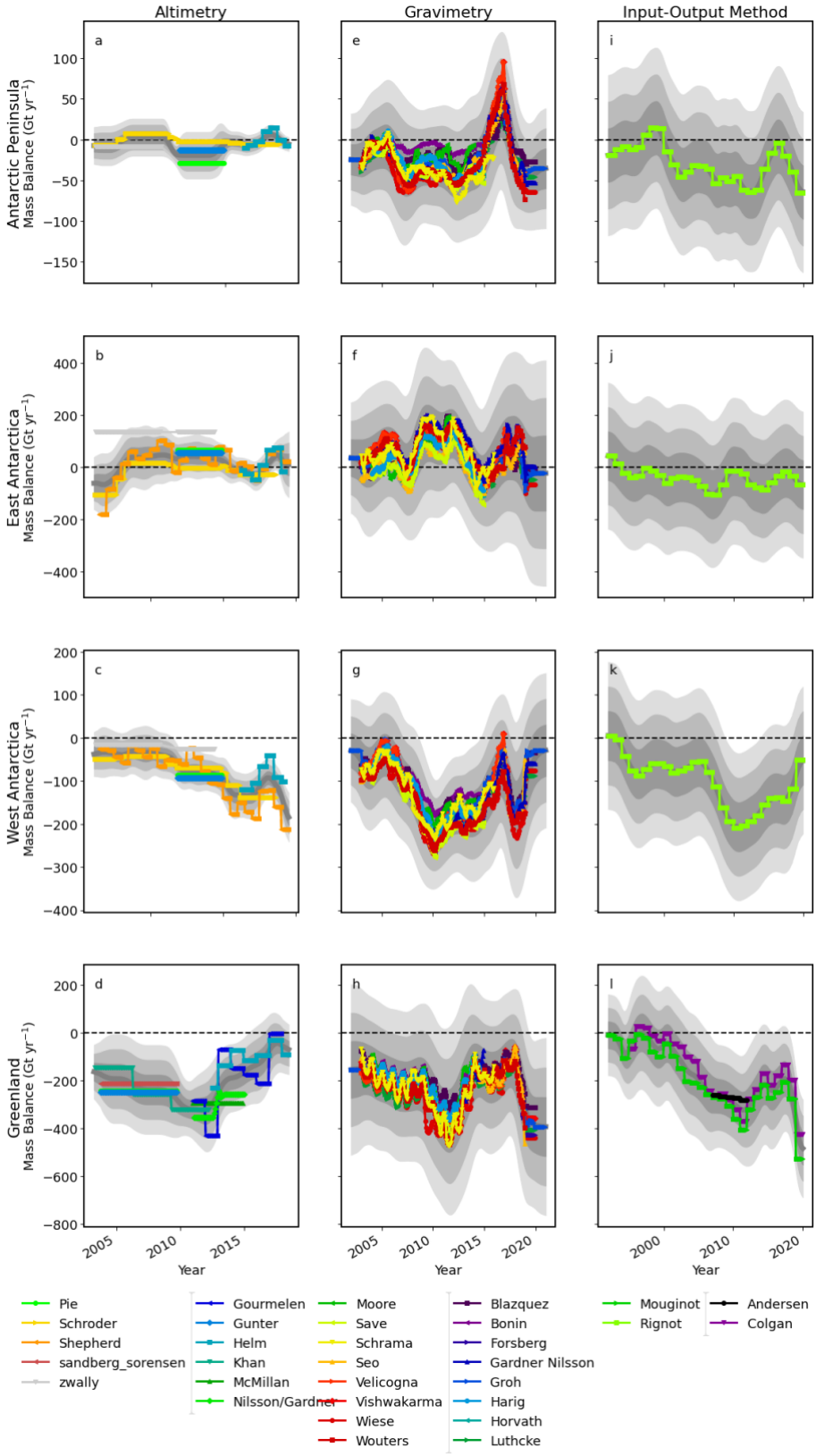

Figure 40 Individual contributions and group averages by ice sheet: Antarctica and Greenland – locked y-axis range

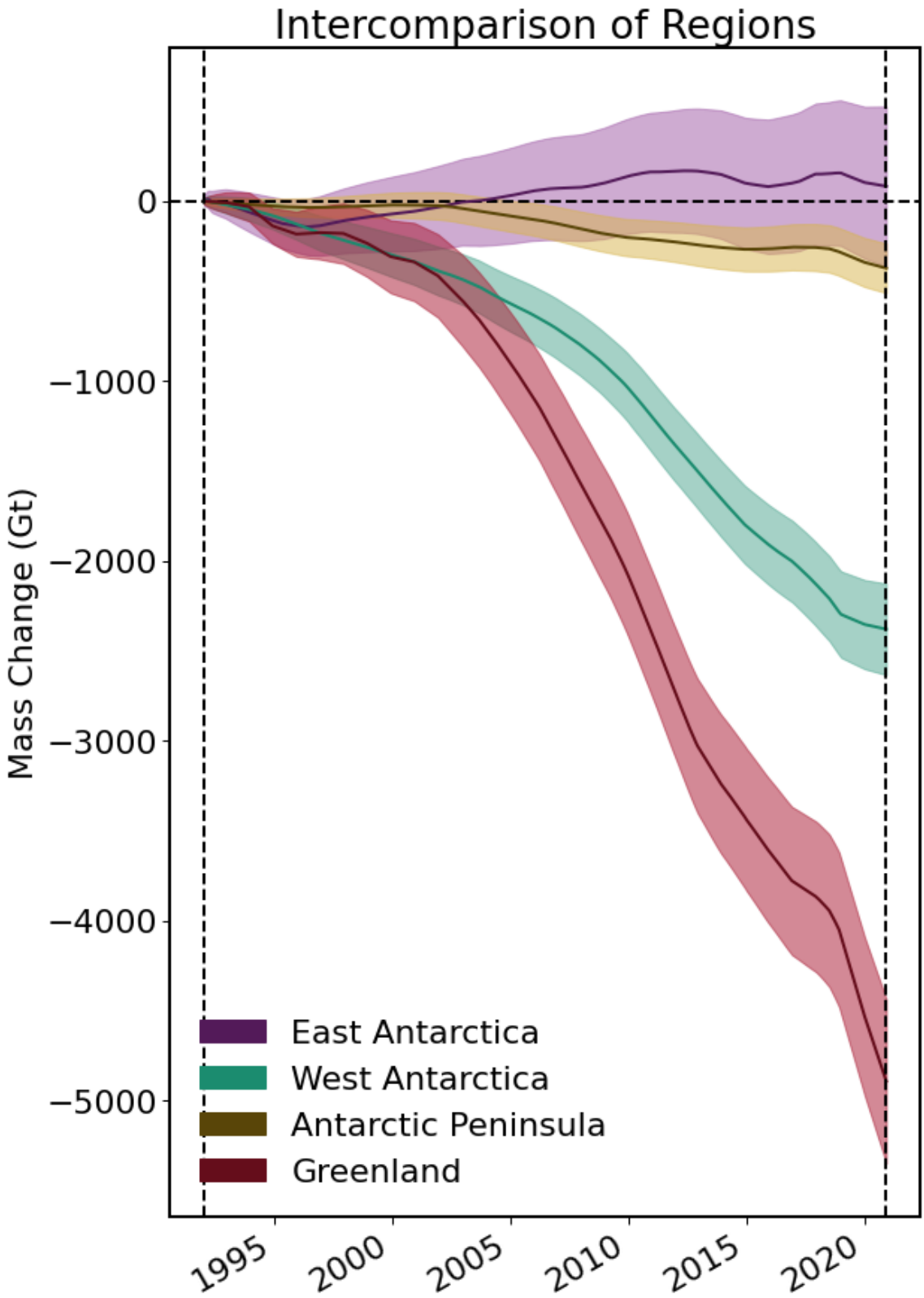

Figure 41 dM(t) and error margin per ice sheet

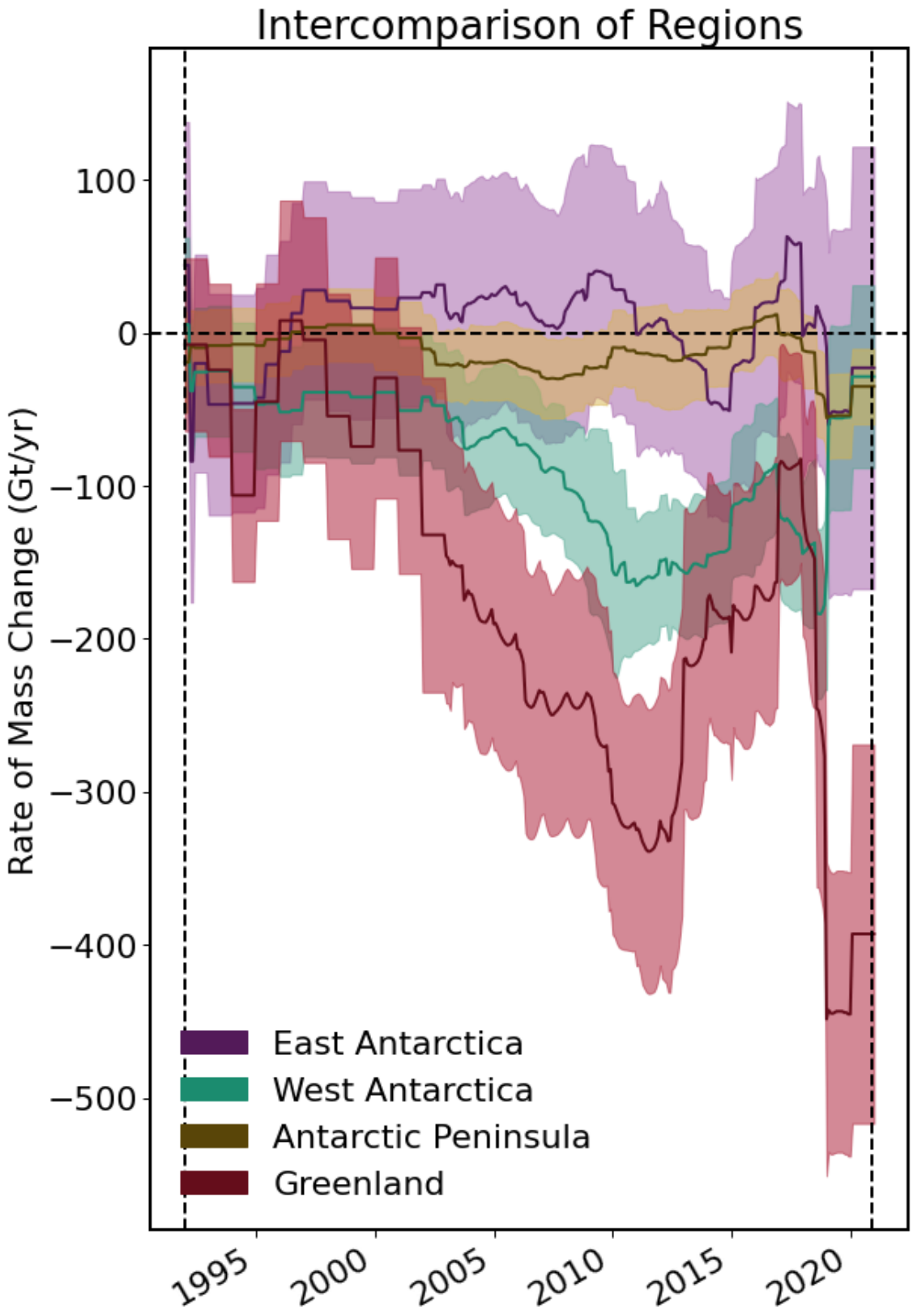

Figure 42 dM/dt and error margin per ice sheet

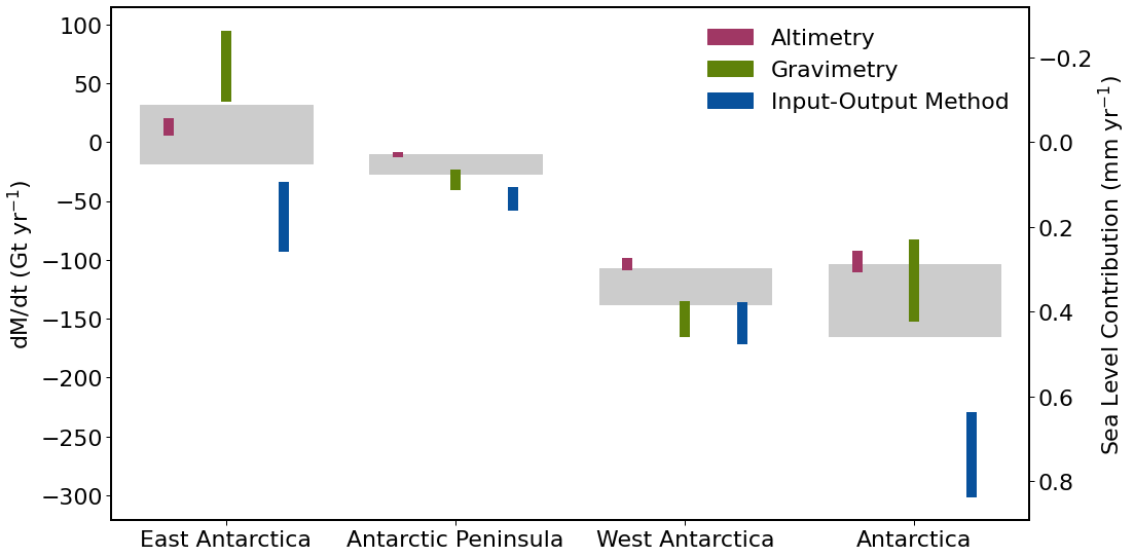

Figure 43 average dM/dt and error by experiment group and ice sheet with equivalent sea level contribution: Antarctica

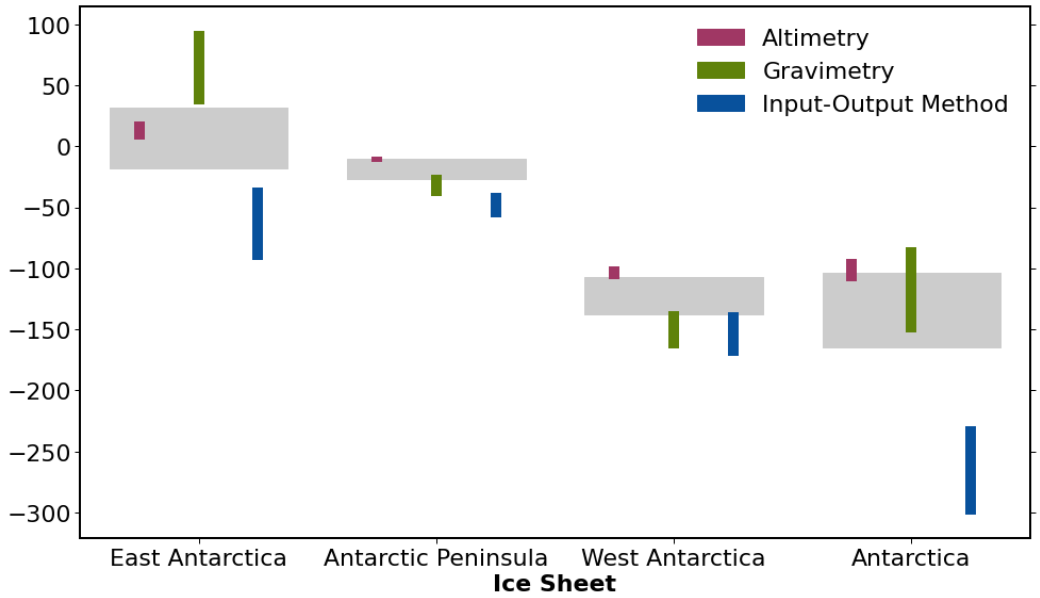

Figure 44 average dM/dt and error by experiment group and ice sheet: Antarctica

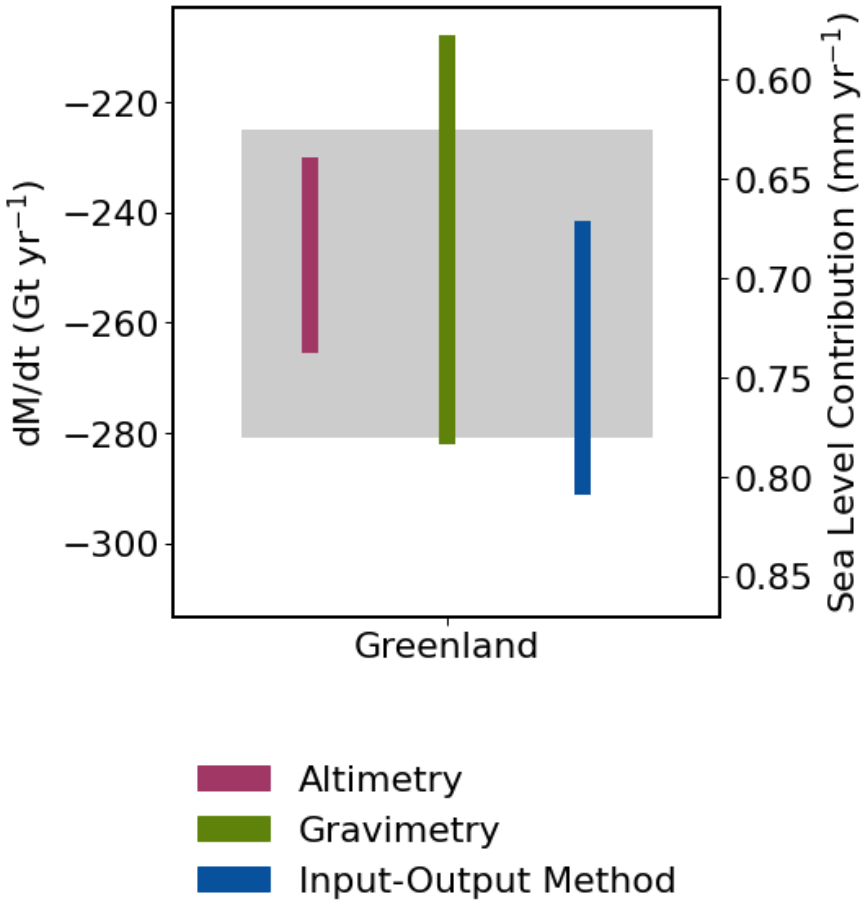

Figure 45 average dM/dt and error by experiment group with equivalent sea level contribution: Greenland

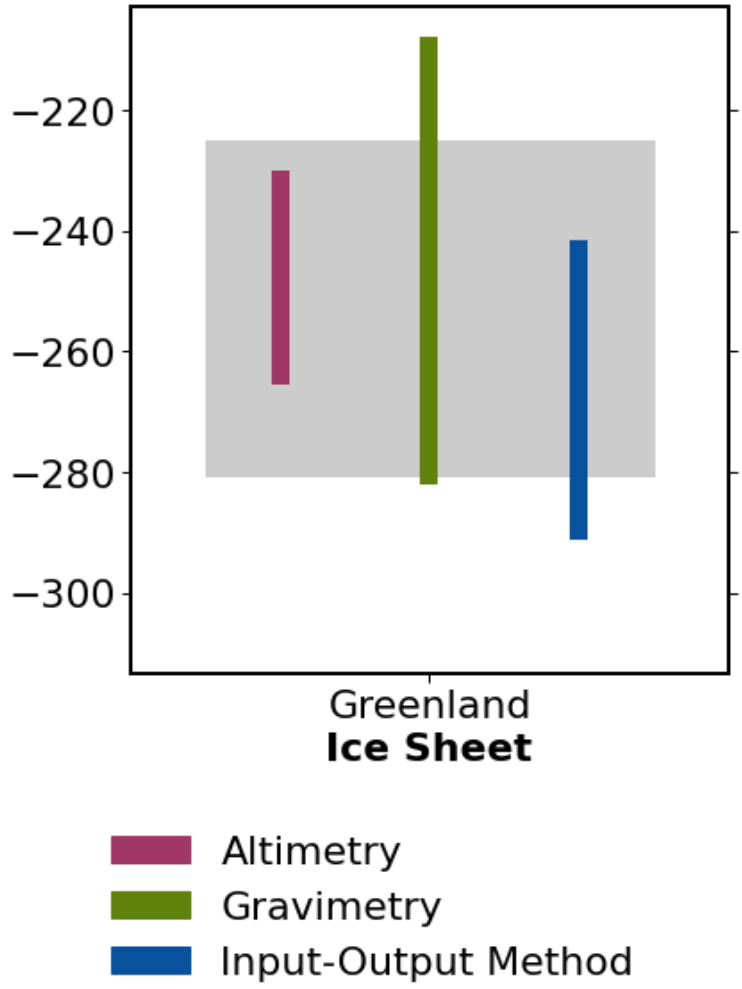

Figure 46 average dM/dt and error by experiment group: Greenland

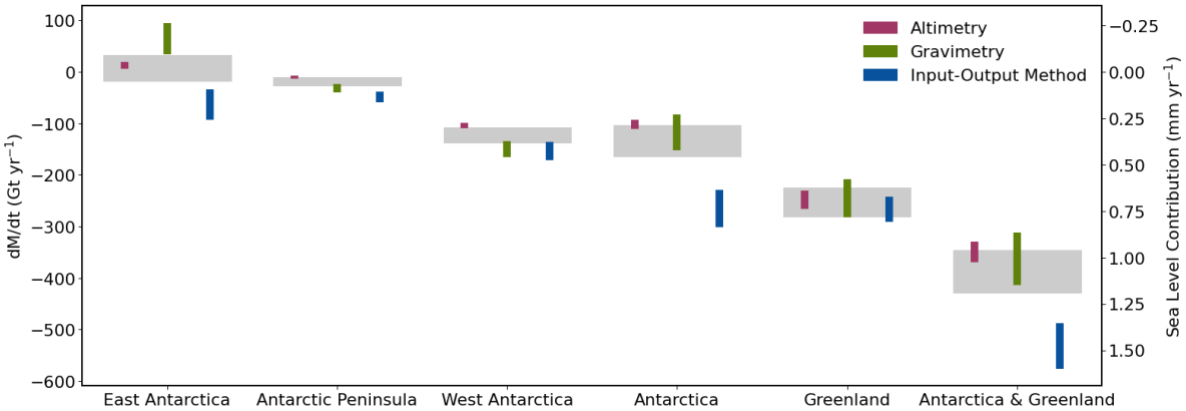

Figure 47 average dM/dt and error by experiment group and ice sheet with equivalent sea level contribution: Antarctica and Greenland

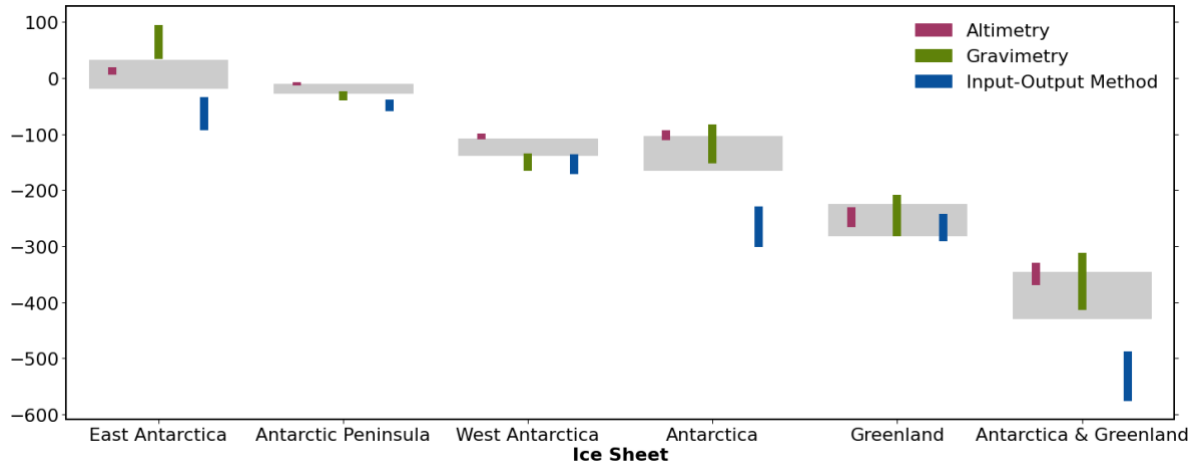

Figure 48 average dM/dt and error by experiment group and ice sheet: Antarctica and Greenland

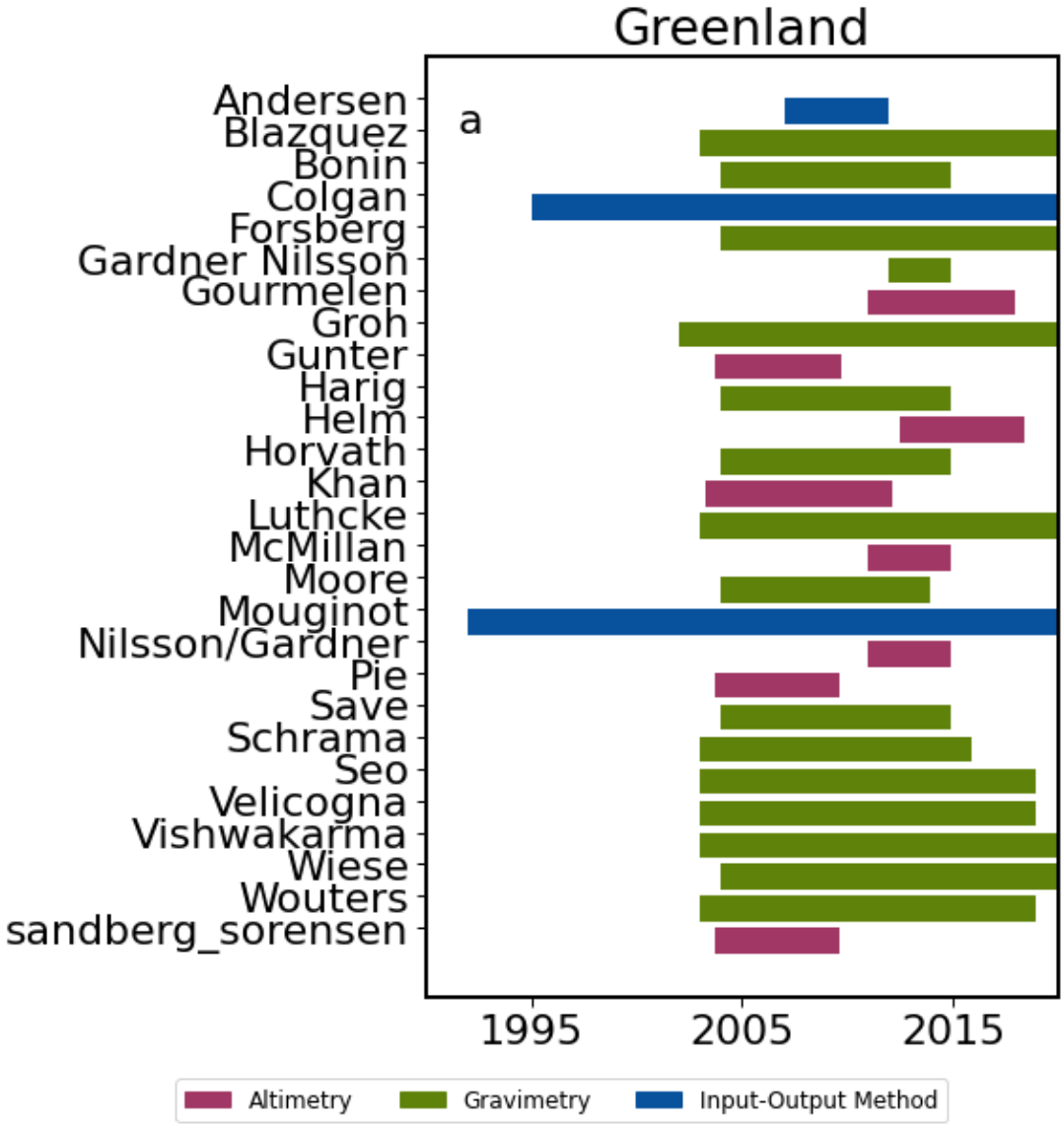

Figure 49 Temporal coverage bar plot - Greenland

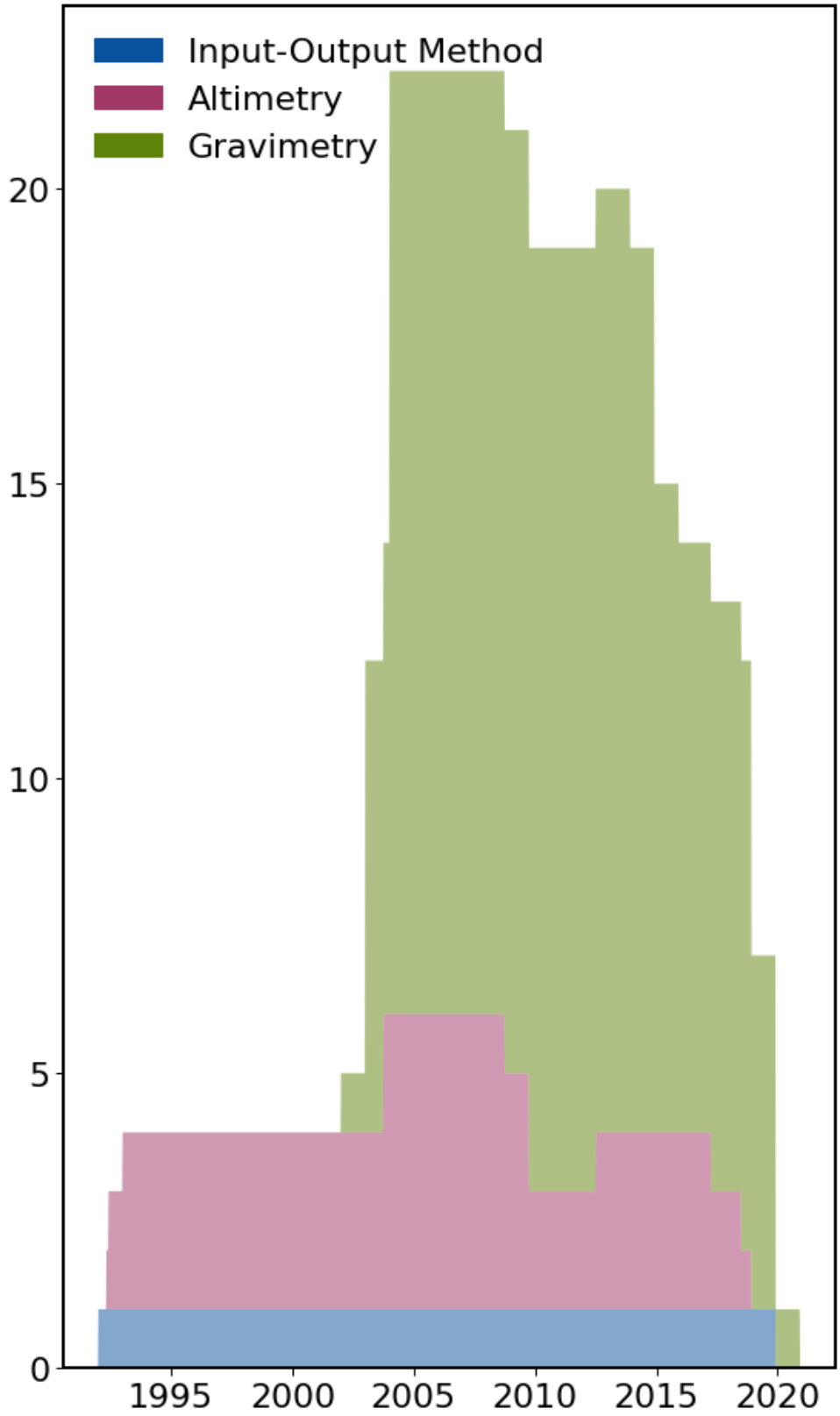

Figure 50 temporal coverage histogram plot - Antarctica

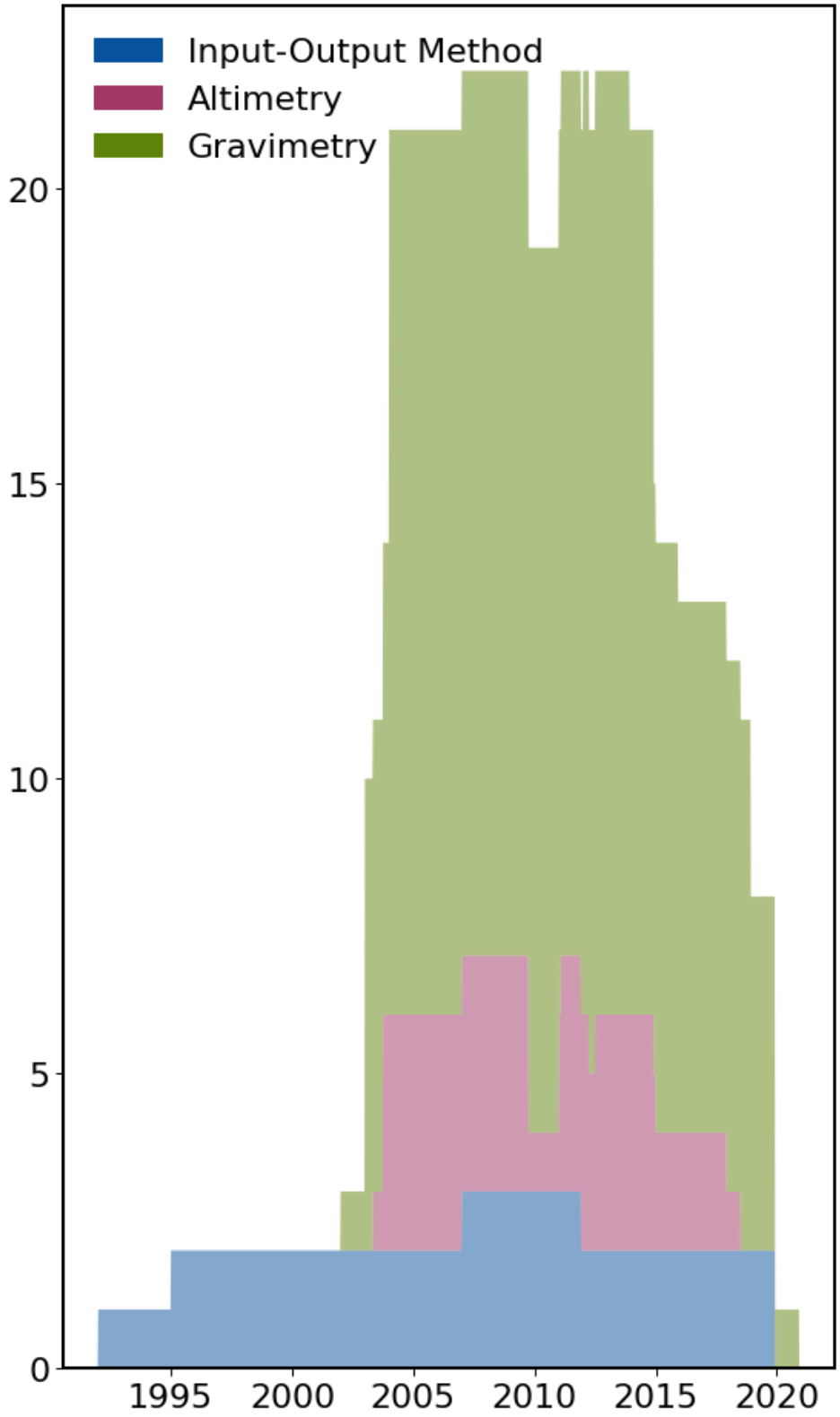

Figure 51 temporal coverage histogram plot - Greenland

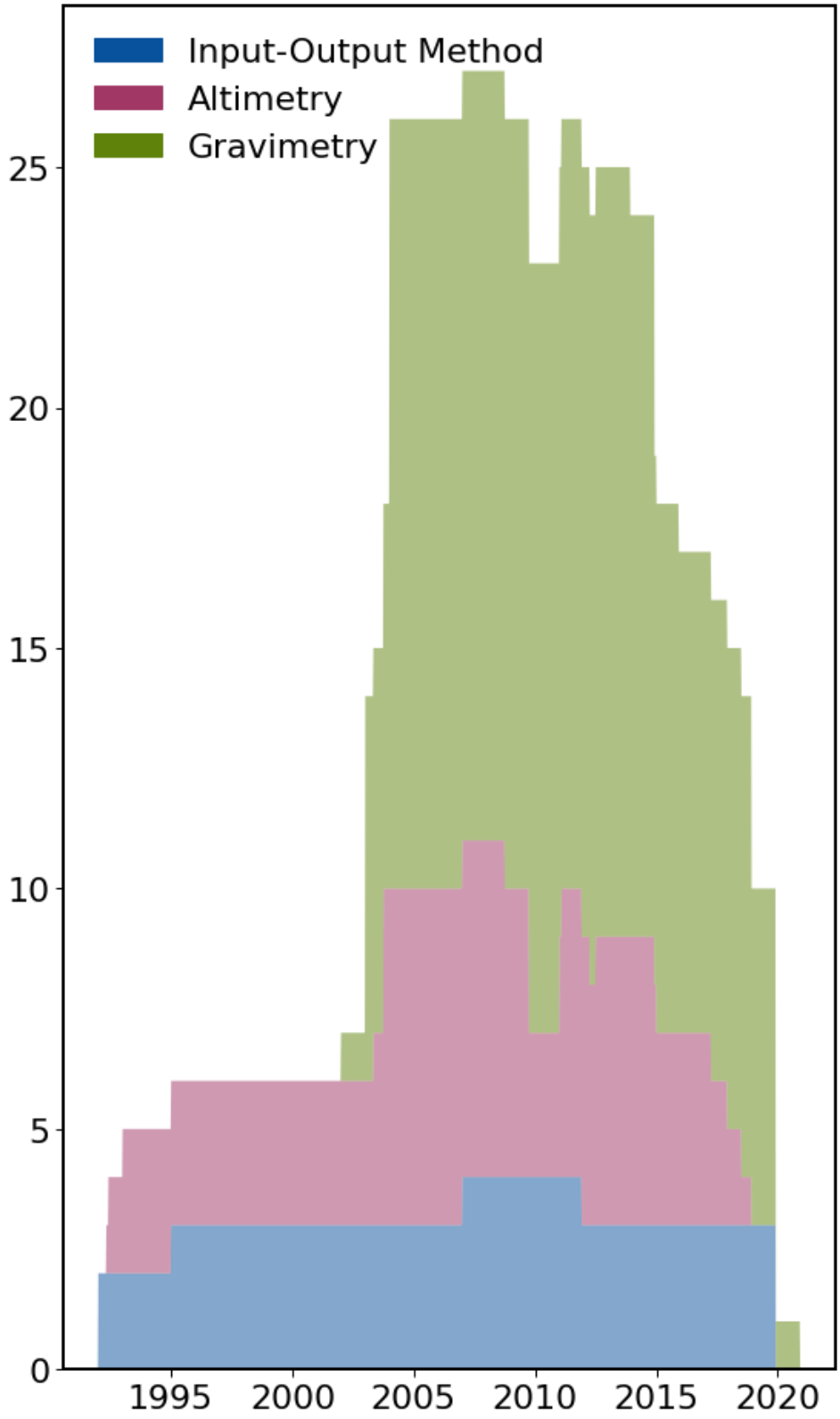

Figure 52 temporal coverage histogram plot – Antarctica and Greenland

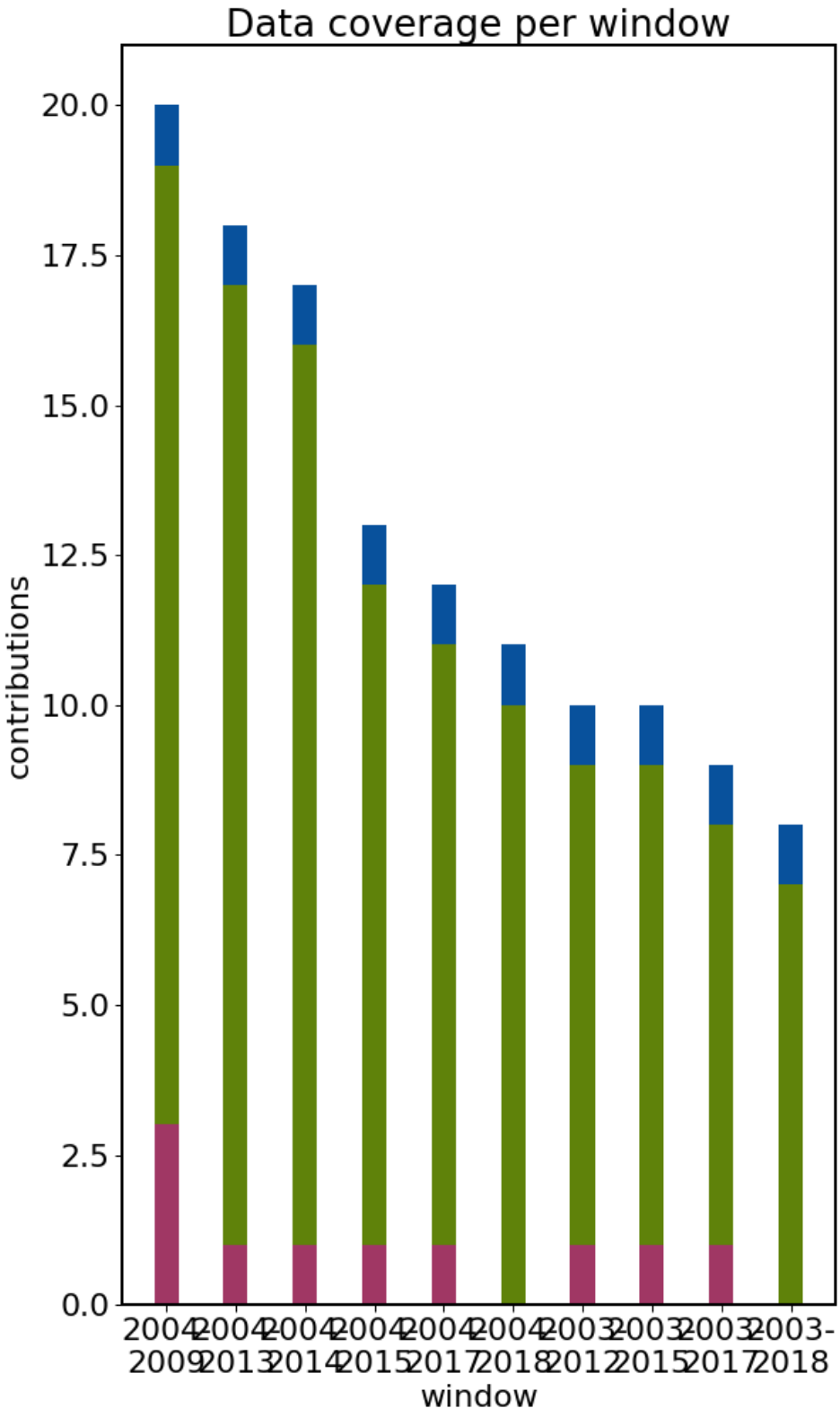

Figure 53 complete contributions per time window

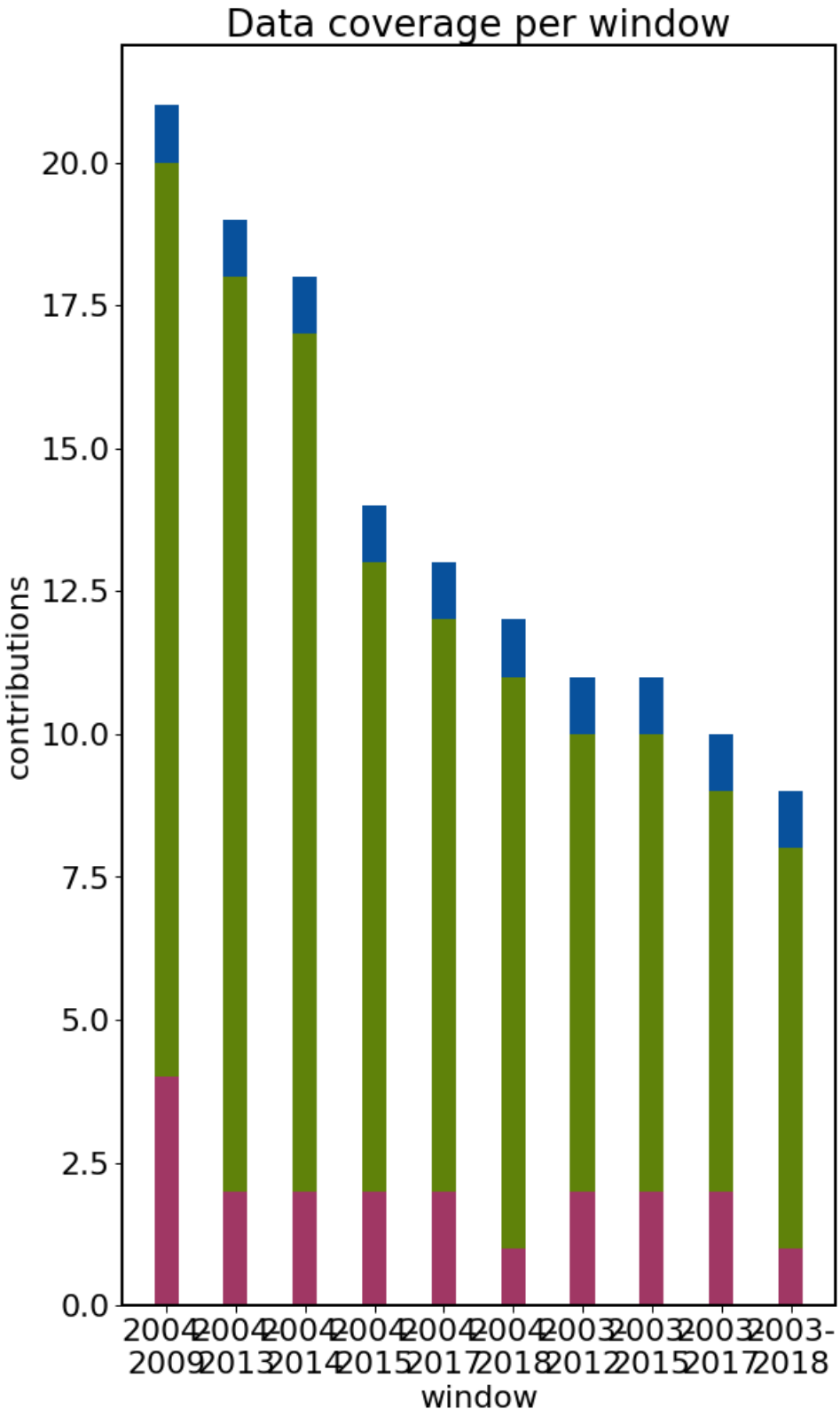

Figure 54 complete contributions per time window - APIS

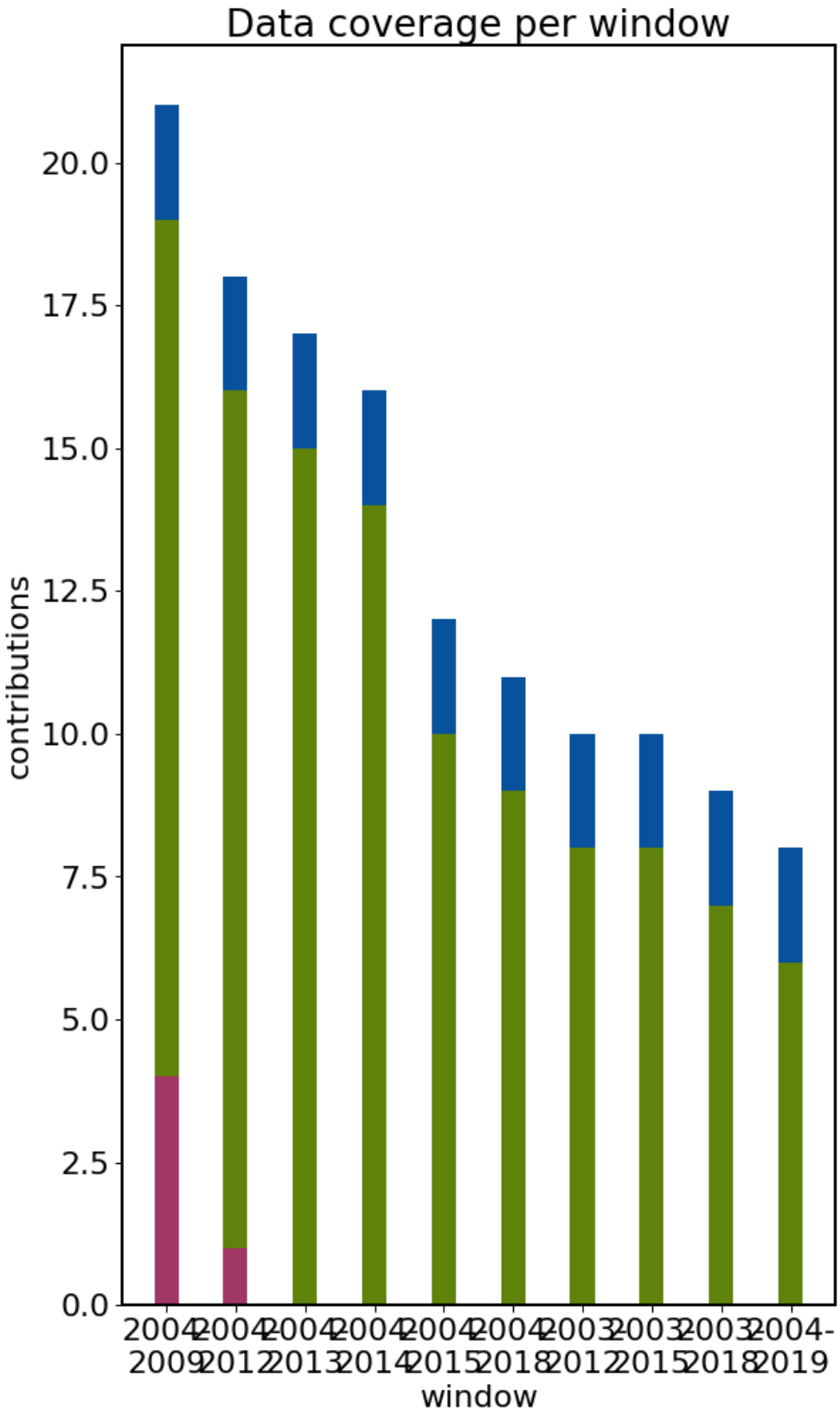

Figure 55 complete contributions per time window - EAIS

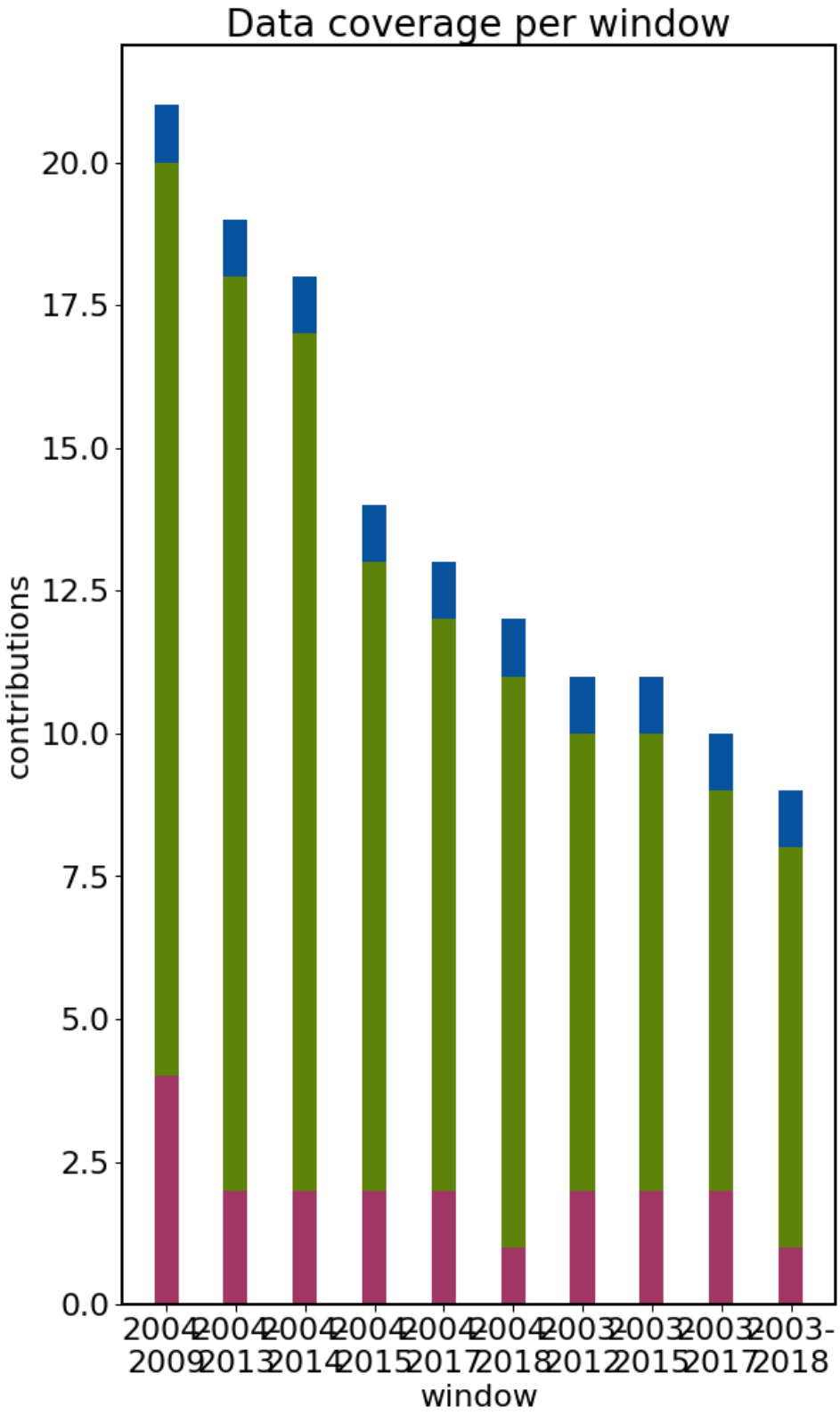

Figure 56 complete contributions per time window - GrIS

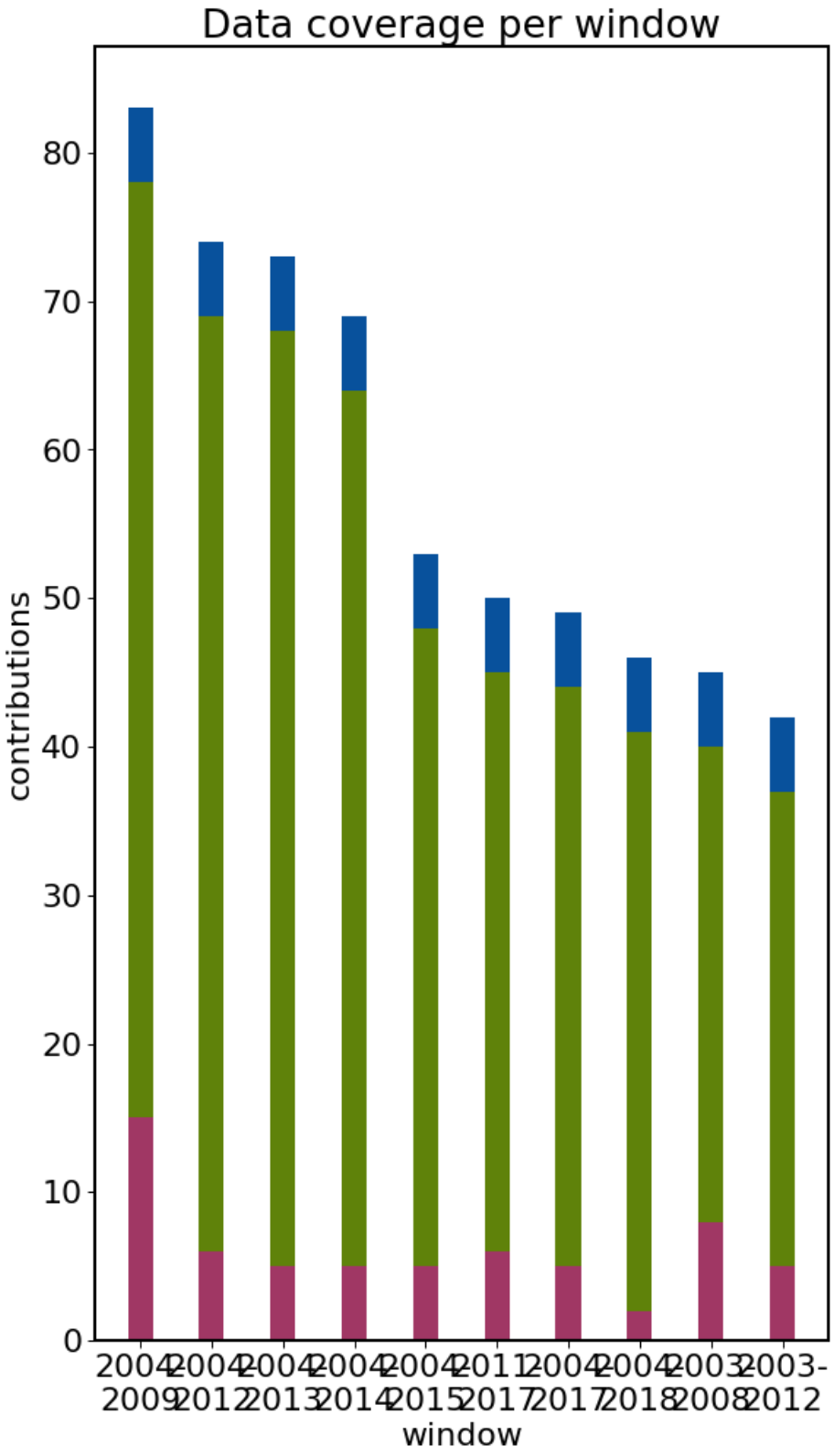

Figure 57 complete contributions per time window - WAIS

End of document