

# Two decades of spaceborne measurements of Greenland ice sheet changes

## The ESA Greenland CCI project

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### Background

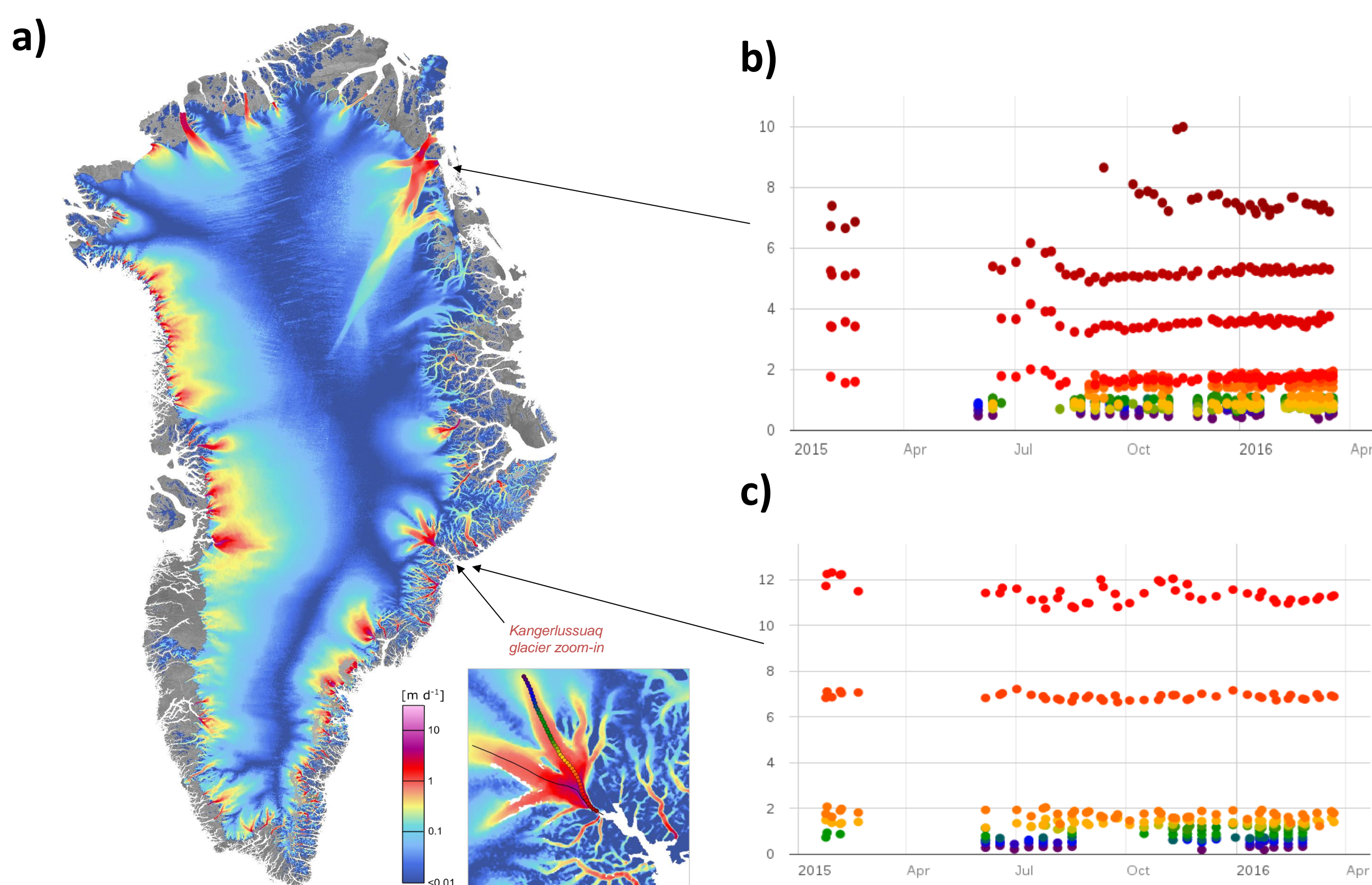
The ESA “Greenland\_ice\_sheet\_cci” project is currently making past and present space measurements of Greenland ice sheet changes available for scientists, stakeholder and the general public. Data are part of a large set of ECV’s made available by the ESA Climate Initiative, as a contribution to GCOS (the Global Climate Observing System). Data are available via the website <http://www.esa-icesheets-greenland-cci.org/> or at <http://products.esa-icesheets-cci.org/>

### Ice Sheets CCI – is\_cci

The ECV data produced for the Greenland ice sheet include detailed grids of elevation changes and ice flow velocities, as well as line data of grounding lines and calving front locations for major outlet glaciers. The “ice\_sheets\_cci” goal is to generate a consistent, validated, long-term and timely set of ECV’s, a.o. to improve the impact of satellite data on climate research and coupled ice sheet/climate models. Special focus is on use of data from ESA missions such as ERS, Envisat and the new Sentinel missions, but in the 2<sup>nd</sup> phase of the project, just initiated, mass balance data from the GRACE mission will also be included. Basic data are given on given on 5 x 5 km grids for elevation changes, 500 x 500 m from SAR velocity products,

### Ice Velocities - IV

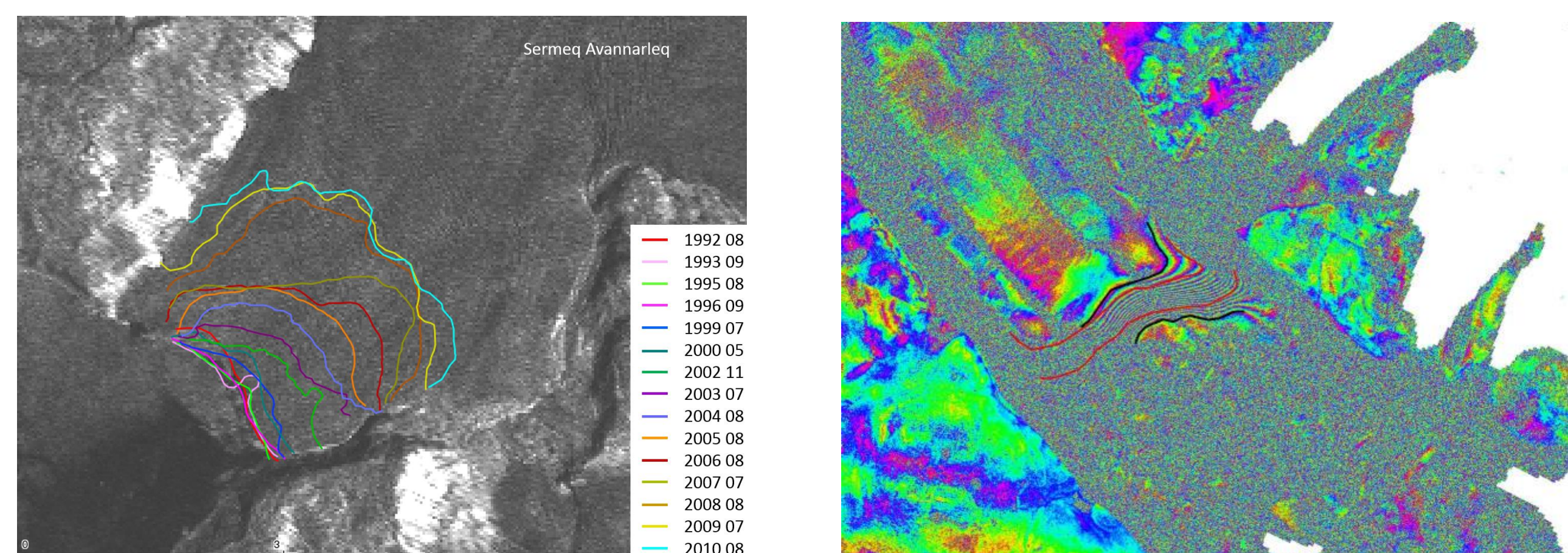
Ice Velocity data being produced by Sentinel-1, RadarSat, ALOS/Palsar, and to a smaller degree by ERS/ENVISAT, by CCI partners ENVEO, DTU and GEUS. Time series of velocities on major ice streams are available as well, with optical velocity tracking is currently being implemented.



**Figure 1:** a) Sentinel-1 composite ice surface velocity map  $V_h$  for the Greenland ice sheet; b) S-1 ice velocities along Zachariae Isstrøm from 12-day repeat S-1 data; c) S-1 ice velocities along Kangerlussuaq glacier (m/day)

### Grounding Line Locations and Calving Front Locations (GLL and CFL)

Calving Front Locations are currently computed from 29 Outlet glaciers from radar imagery, and Grounding Line Locations from 5 North Greenland floating front glaciers.



**Figure 2:** a) Calving Front Locations example; b) Grounding Line Locations from Sentinel-1, Petermann Glacier

### Data availability

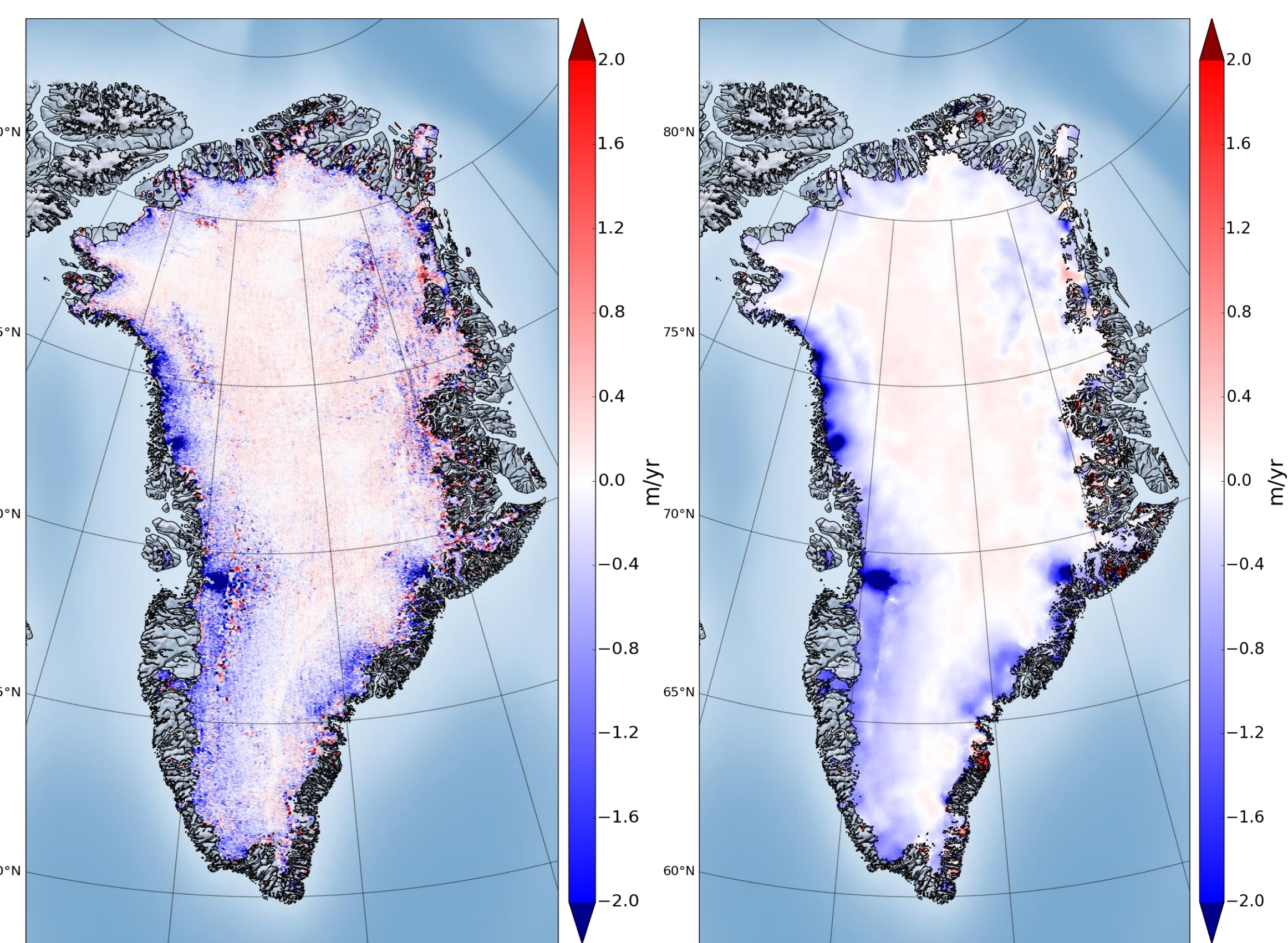
Data are made available to user groups, comprising ice sheet, climate & ocean and surface mass balance modellers, as well as remote sensing scientists, organisations and authorities via the website <http://www.esa-icesheets-greenland-cci.org/>. In Phase II of the Ice Sheets CCI, new data sources have been/will be incorporated, such as Cryosat-2 and AltiKa radar altimetry data for SEC, Sentinel-1 SAR data for IV, and Greenland Mass Balance (GMB) from GRACE, in cooperation with TU Dresden (M. Howarth)

### References

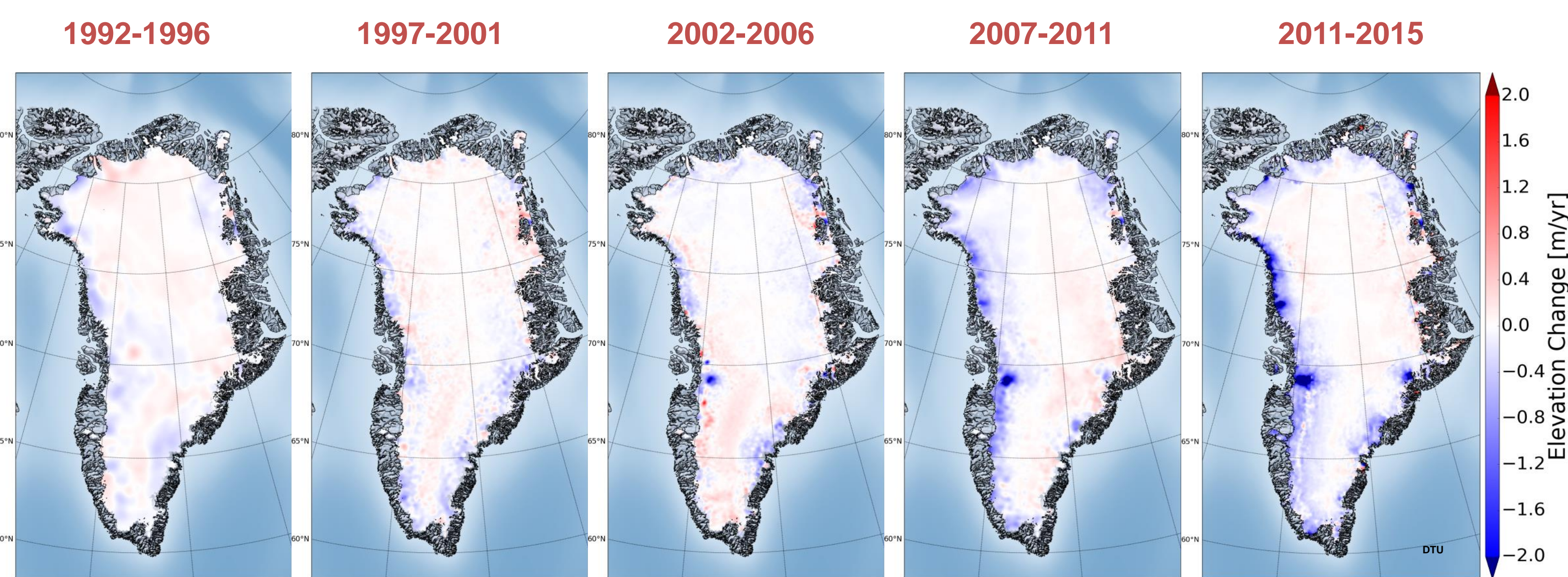
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### Surface Elevation Changes - SEC

A new SEC product is produced from CryoSat-2. It has a much higher spatial resolution than ERS and ENVISAT, so more details for individual glacier systems are seen in the data.



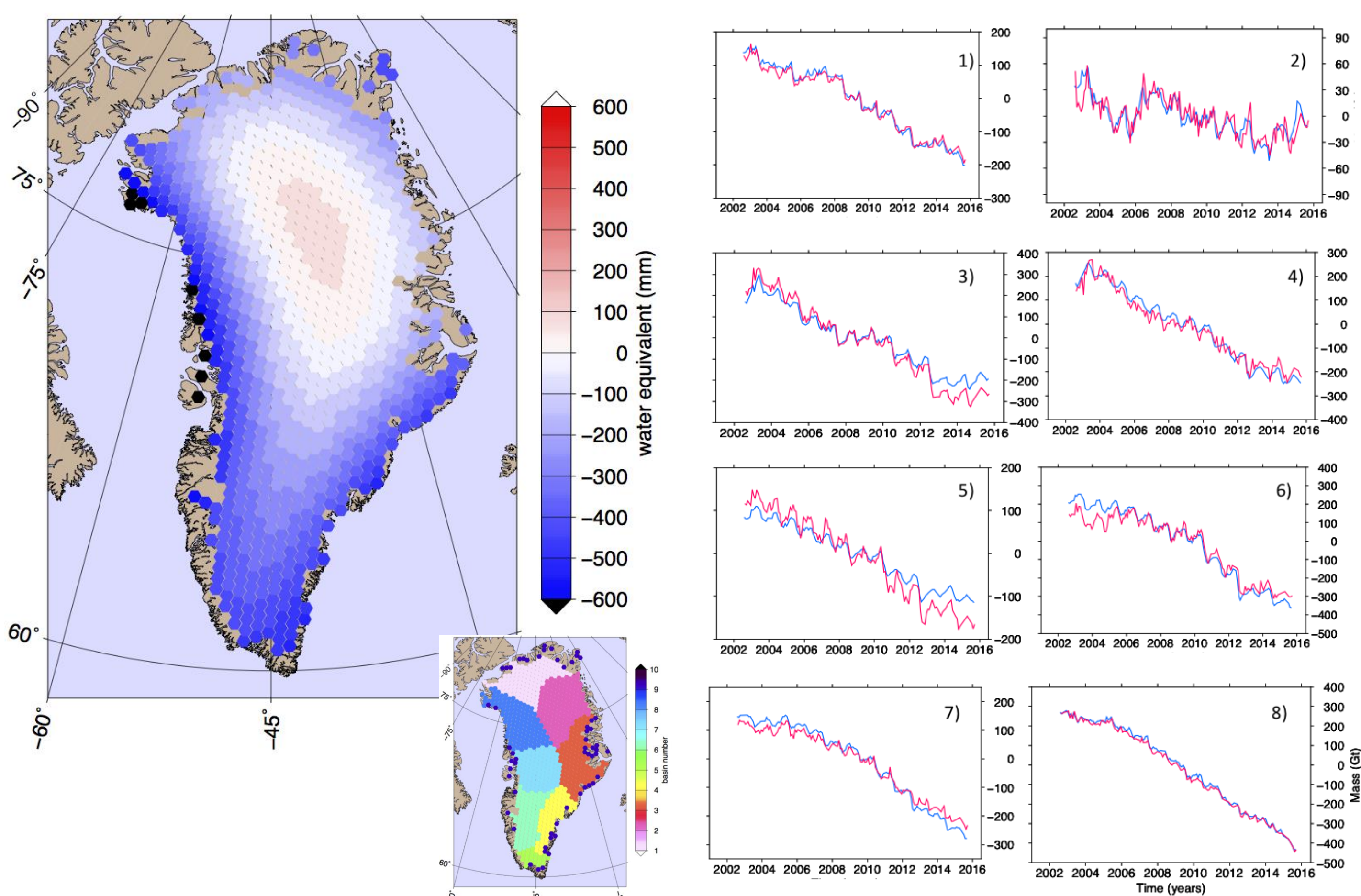
**Figure 3:** CryoSat-2 Elevation Changes 2010-14 in m/yr, unsmoothed (left) and smoothed (right)



**Figure 4:** Example of 5-year running means of ERS/Envisat/CryoSat surface height changes

### Gravimetric Mass Balance - GMB

Following a user consultation, a gravimetric mass balance product was added to the list of ECV’s. This product provides both grids of mass change for the entire Greenland Ice Sheet, as well as time series of Greenland-wide and basin scales mass changes 2002-present.



**Figure 5:** Mass trend grids 2010-14 (left panel) and basin time series (right panel) for Greenland derived from GRACE for the 8 “Zwally” drainage basins. The GRACE solutions are based on point mass inversion methods.