GLOBAL CLIMATE OBSERVING SYSTEM
KEEPING WATCH OVER OUR CLIMATE

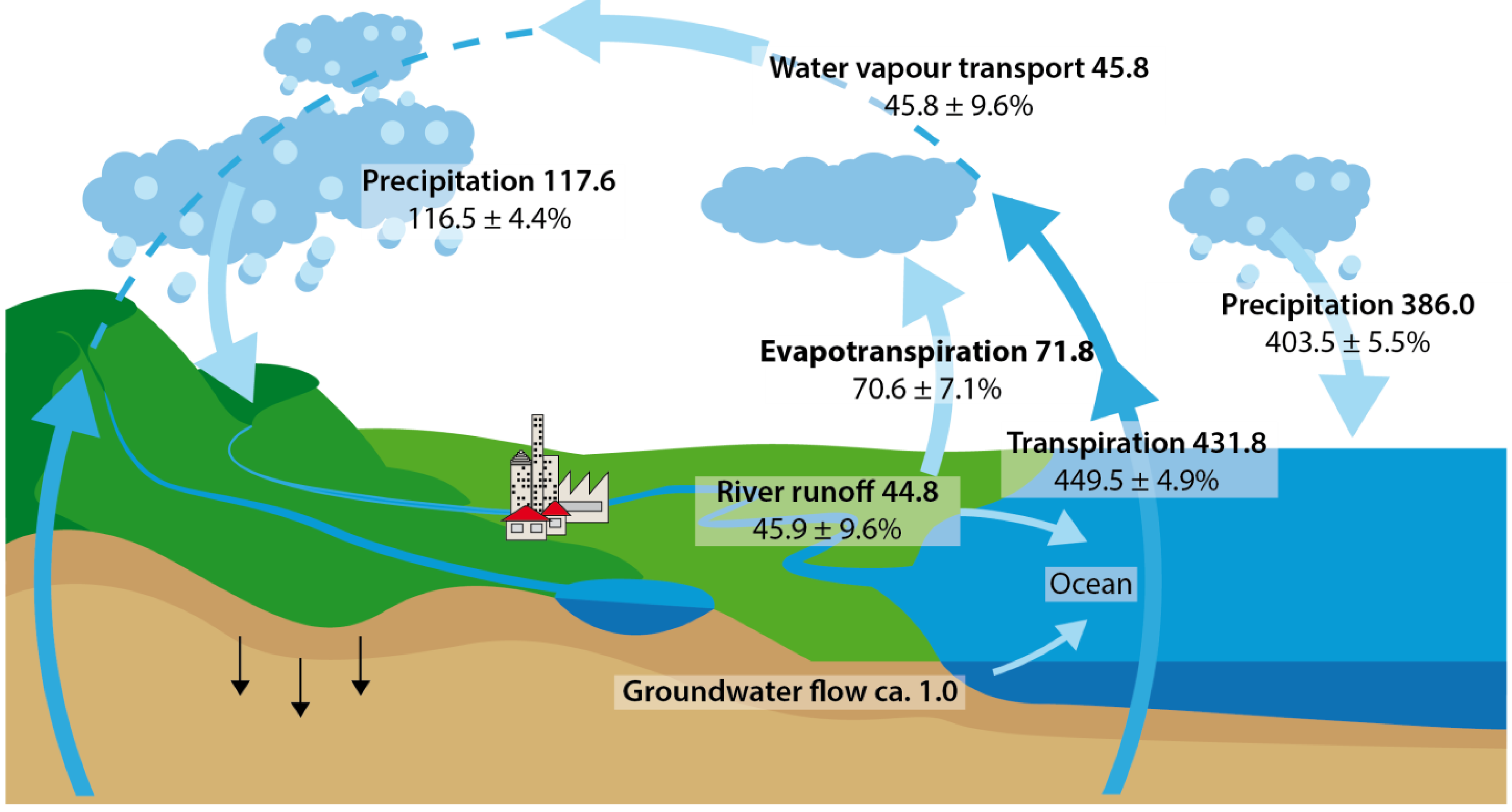
WMO | UNESCO | IOC | International Science Council | UN environment

Consistent monitoring of water cycle variability with Earth observations: What are we missing?

Life on earth is closely linked to the availability of water. With a growing world population and living standards, human pressure on freshwater resources is continuously increasing, and so is the exposure of humans to weather and climate related extremes like droughts, storms, and floods. Climate Change exacerbates our vulnerability to variability and changes in the water cycle, e.g. by causing shifts in precipitation patterns, intensification of extreme events, and glacier melt. The availability of water resources is changing and the risks arising from climate change increasing.

Essential Climate Variables

The Global Climate Observing System (GCOS) defines a suite of Essential Climate Variables (ECVs), many of them related to the water cycle, that are required to systematically observe the Earth's changing climate. However, since they are typically derived from different observation techniques, platforms, instruments, and independent retrieval algorithms, they often lack consistency at multiple spatial and temporal scales. In combination with the small signal-to-noise ratios of the datasets, detecting changes in the hydrological cycle, especially with regard to long-term trends, remains difficult: the uncertainty of the measured trends is greater than recent decadal changes.



Mean annual fluxes (10^3 km^3 yr^{-1}) of the global water cycle, and associated uncertainties, during the first decade of the millennium including estimates that have been optimized by forcing water and energy budget closure, taking into account uncertainty in the original estimates (Rodell et al., 2015). The uncertainties are here expressed as relative errors for comparison with the GCOS target of closing the water cycle on 5%. Changes in water storage are not shown.

Observations

The current observations allow a comprehensive quantification of the global water cycle (see above). However gaps have been identified in the quantification of anthropogenic water use, areas with poor coverage and in the detection of extreme events. At a regional scale there are gaps in the reporting of in situ observations. Below are examples for rain gauges and river discharge. While more observations are made, they are not exchanged globally so regional assessments are difficult.

Satellite data can fill some of these gaps(see left). Here, the Grace satellites allow measurements of gravity be used to estimate changes in terrestrial water storage.

Assessment

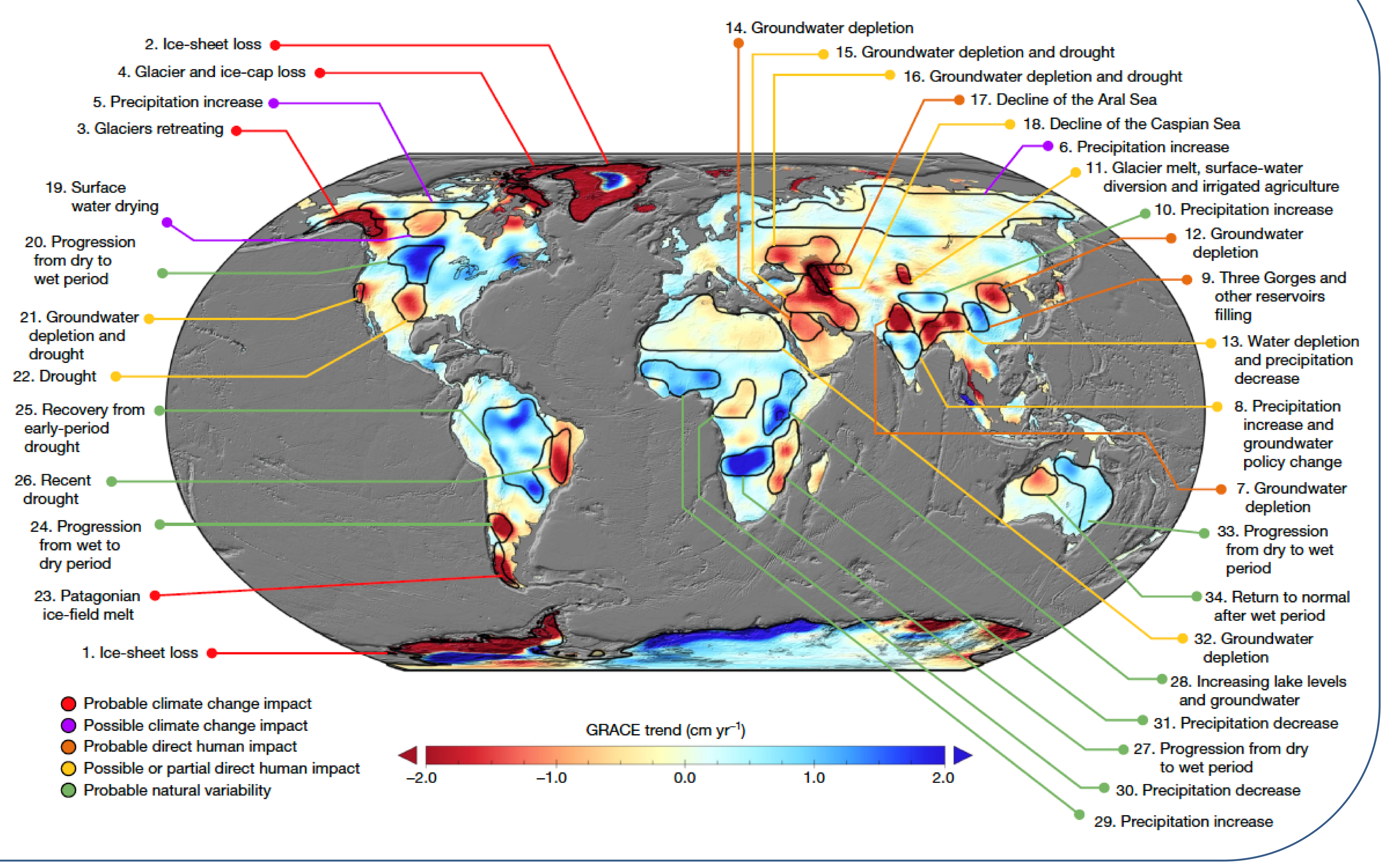
As part of GCOS' assessment of the observations of the key climate cycles, energy and water cycles and the Earth's energy balance, we are currently assessing the status of systematic observations of the of the hydrological cycle, and its variability, at various spatial and temporal scales. We will critically assess the relevant land, atmosphere, and ocean water storages and the fluxes between them, including anthropogenic water use.

We will critically discuss gaps in existing observation systems based on remote sensing, in-situ observations, and reanalyses and conclude with formulating guidelines for future water cycle observation strategies.

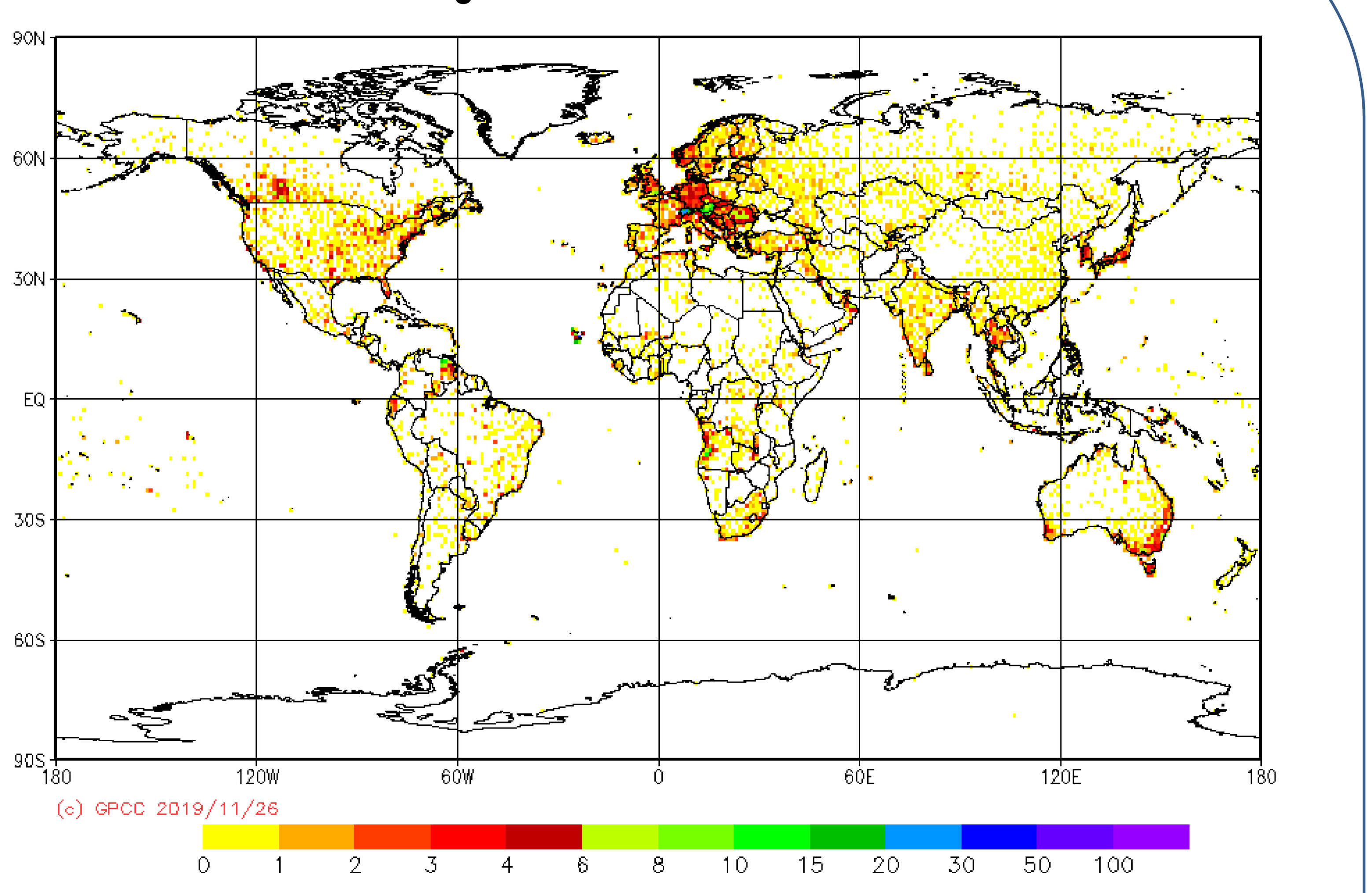
The results of this study will be published shortly and will feed into future GCOS proposals for the requirements for Essential Climate Variables (ECV) and plans for the Global Climate Observing System.

Changes in Terrestrial Water Storage measured by the GRACE satellites (2002-2016),

SOURCE: Emerging Trends in Global Freshwater Availabilit M. Rodell, et.al., Nature. 2018 May; 557(7707): 651–659. doi: 10.1038/s41586-018-0123-1, corrected Nature, 2019 Jan;565(7739):E7. doi: 10.1038/s41586-018-0831-6.



Number of gauge-based stations per 1.0 degree grid cell contributing data to the GPCC in March 2019



Latest date of contribution of river discharge data to the GRDC