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The active liquid Earth – importance of temporal and spatial variability

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The Planet Earth is indeed liquid and active - 71 percent of its surface is water-covered and this water never rests. Thanks to the water cycle, our planet's water supply is constantly moving from one place to another and from one form to another. Only 2.5% of the water is freshwater and it exists in the air as water vapor; it hits the ground as rain and snow; it flows on the surface from higher to lower altitudes in rivers, lakes, and glaciers; and it flows in the ground in soil, aquifers, and in all living organisms until it reaches the sea. On its way over the Earth's crust, some returns quickly to vapor again, while some is trapped and exposed to many "fill and spill" situations for a long journey. The variability in the water balance is crucial for hydrological understanding and modelling. The water cycle may appear simple, but magnitudes and rates in fluxes are very different from one place to another, resulting from variable drivers such as solar energy, precipitation and gravity in co-evolution with geology, soil, vegetation and fauna. The historical evolution, the temporal fluxes and diversity in space continue to fascinate hydrological scientists. Specific physical processes may be well known, but their boundary conditions, interactions and rate often remain unknown at a specific site and are difficult to monitor in nature. This results in mysterious features where trends in drivers do not match runoff, like the Sahelian Paradox or discharge to the Arctic Ocean.
Humans have always interfered with the water cycle and engineering is fundamental for water regulation and re-allocation. Some 80% of the river flow from the northern part of the Earth is affected by fragmentation of the river channels by dams. In water management, there is always a tradeoff between upstream and downstream activities, not only regarding total water quantities but also for temporal patterns and water quality aspects. Sharing a water resource can generate conflicts but geopolitical research also shows that it is often a reason for collaboration, which stabilizes turbulent regions politically. The Planet Earth has now entered the new geological era 'Anthropocene' when humans do not only affect the water as such, but also the key drivers such as climate, vegetation, topography, and soils. The challenge for hydrological scientists today is thus not only to predict present conditions from poorly known boundary conditions, but also the effect of simultaneous changes in these unknown boundary conditions. We face global warming, population growth, rapid urbanization, and demand of higher living standards for the poor. For a sustainable development, we need to progress humans from consumers to care-takers of the Planet. In this, we must secure agricultural and industrial production, water consumption in new and rapidly growing cities, protection from intense precipitation and flooding, and retain good ecological status. Adaptive management, international agreements and local participation will be the means, and the Earth Science community has a great potential to contribute with knowledge and innovations from new open-data sources and observations, advanced IT and interdisciplinary collaboration. Resilience to changes is based on diversity. Let's embrace diversity in science and in temporal and spatial patterns of the Liquid Planet, to enter the Anthropocene in resilience.