EDITORIAL

Climate change and glacier retreat

Warming of the Earth climate system is unequivocal, since the 1950s, many of the observed changes are unprecedented in recent decades, even millennia. The atmosphere and ocean have warmed, snow and ice volumes have decreased and sea level has risen.

Between 1992 and 2011, the ice sheets of Greenland and Antarctica have been losing mass, and it is likely that the loss has precipitated much faster between 2002 and 2011. The glaciers pass through a global thaw over a hundred years ago and an unprecedented speed. Michael Zemp, leader of Service World Glacier Monitoring (WGMS), argues that today the observed glaciers lose between half a meter and one meter of ice thickness each year, this represents two or three times more than the average of the last century (1). The snowpack in spring in the northern hemisphere continues to shrink. There is a high level of confidence that the permafrost temperatures have increased in most regions since the early 1980s in response to increased surface temperature and the alteration of the snowpack.

In the Arctic, it´s very probable that the annual average surface of sea ice has decreased during the period 1979-2012 in a range of 3,5 % to 4,1 % per decade. The extent of sea ice in the area has declined in each season and in each successive decade since 1979 and it´s in summer when it has registered the highest rate of decline in the average ten-year extension. In Antarctica, it is very likely that the average annual sea ice extent has increased in a range of between 1,2 % and 1,8 % per decade between 1979 and 2012; however, there is a high level of confidence that there are marked regional differences in this continent, with increased expansion in some regions and a decrease in others. During the period 1901-2010, the global average sea level rose 0,19 m (from 0,17 to 0,21 m). Since the mid-nineteenth century, the rate of sea level rise has been higher than the average of the previous two millennia (2).

The retreat of the glacier mass in the Chinese mountains, for example, they´re identified as highly vulnerable to climate change, especially in western China. During the period 1961-2007, approximately 92 % of glaciated areas had a slight vulnerability; today 41,2 % of such areas are strong and stronger levels of vulnerability. In general, the vulnerability of glaciers shows a decreasing trend between 2030 and 2050, but the glaciers in Altai, Tianshan, Kunlun, the central and western areas of Qilian Mountain, central and eastern parts of the Himalayas and Southeast Tibet, they remain classified in the strong and stronger levels of vulnerability.

Precipitation and temperature can affect the process of accumulation. The increased precipitation observed during wet seasons would lead to an increase in solid precipitation at the accumulation area and therefore a more positive annual balance masses in case of precipitation is falling as snow (4); for example, it´s found that in interannual timescales, the rainfall variability seems to be the main driver of fluctuations of glacier mass in the White Mountain range. On the other hand, increased air temperatures during precipitation events also leads to an increase of the snow line. However, the increase in air temperature in the last thirty years is particularly dominant in the season from June to November, relatively dry, where rainfall is rather low.

Rainfall in the White Mountain range have increased significantly between 1980 and 2012, leading to a more positive mass balance if the precipitation falls as snow condition which shows that glaciers have continued backing since the eighties.

The decrease in the glacier surface is particularly high for low-altitude glaciers and isolated glaciers as Yanamarey and Pastoruri. There are researches that report about different retirement scenarios for small glaciers with maximum elevations below 5 400 m above sea level and large glaciers with maximum elevation above such altitude.

Changes in temperature and precipitation from the eighties probably do not fully explain the sharp retreat of glaciers over the past 30 years. Therefore, it´s possible that the recent retreat of glaciers can still occur in response to the sharp rise in temperature of more than 0,3 °C per decade before 1980, especially in the 1970s.

Overall, low ice thickness glaciers in the equilibrium line and large annual ablation in the glacier tongue have faster response to climatic disturbances those large glaciers. There measurements and estimates of ice thickness and annual ablation rates for some glaciers in the White Mountain range (for example Artesonraju) and allow to estimate a response time of about ten to forty years. Therefore, the sharp retreat of glaciers observed during the past three decades may include a signal of increased temperature before the 1980s, depending on the glacier. The rise, moderate during the last thirty years temperature may have induced additional forcing. However, the interpretation of the responses of glaciers climate forcing is a challenge, as some climatic fluctuations occur on time scales shorter than the reaction times time and, consequently, the observed response of a glacier may be a reaction a large number of overlapping causes (5).

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