Glacier and Permafrost Hazards in Mountains (GAPHAZ)

A Scientific Standing Group of the International Association of Cryospheric Sciences (IACS) and the International Permafrost Association (IPA)

28 September 2016

Twin glacier collapse in Tibet puzzles scientists and triggers rapid international collaboration

On 17 July 2016 a glacier collapse of roughly 60-70 million cubic metres in volume caused a huge ice avalanche in western Tibet, west of the Aru Co lake, Rutog county, Ngari prefecture, killing 9 herders and hundreds of animals. Until then, there was only one site known globally where events with similar characteristics happened – Kolka/Karmadon in the Russian Caucasus. The last Kolka/Karmadon event on 20 September 2002 led to a rock/ice avalanche of 120 million cubic metres in volume, killing more than 100 people.

An international group of scientists affiliated to the scientific commission GAPHAZ (*Glacier and Permafrost in Mountains)* was puzzled about the occurrence of the similarly looking event in Tibet. Strikingly unusual characteristics were this avalanche's immense size and its distant travel on a very low slope. The group investigated the glacier development before the 17 July 2016 glacier collapse in Tibet and the characteristics of the resulting avalanche, based on a large number of visual and radar satellite images and on computer models. The analyses showed that the 17 July glacier collapse was preceded by precursory movements and crevassing since at least 2013. Such slow glacier destabilisations – called glacier surges – are common in some parts of the world, for instance in the Karakoram or in Alaska, but also in Tibet. They can lead to an increase of the glacier flow velocities by a factor of 10 or more, and to a rapid advance of the glacier tongue, but no cases have been known so far where they caused big ice avalanches. Computer simulations of the 17 July avalanche suggest that the extreme length of its runout appears to be caused by water lubrication and that considerable amounts of water must have been stored in the glacier at initiation of the collapse.

During their retrospective investigations based on satellite data, scientists found strongly enhanced crevassing on the glacier that collapsed on 17 July for spring/summer 2016. During this work the scientists discovered also that the neighbour glacier, just south of the one that collapsed in July, showed similar signs of destabilisation. Local Chinese authorities made similar observations from the ground and using unmanned aerial vehicles.

Comparing data from the satellite "Sentinel 2" of 19 September 2016 (available on 21 September) with earlier data from a range of satellites, the scientists then discovered strong crevasses on the southern glacier, which alerted them about the possibility of an upcoming second glacier collapse and avalanche. Avalanche computer models were quickly run to estimate the potential area that could be affected by a similar event if it were to occur. In an ad-hoc coordinated way, facilitated through GAPHAZ, the information was used to alert Chinese colleagues, who then informed the local government. By the time these warnings reached the authorities in charge, though, the southern glacier seems already to have collapsed on 21 September 2016 and produced a second huge avalanche of similar size and appearance as the 17 July avalanche. In this case, fortunately, nobody was killed or hurt by the avalanche.

The scientists involved are starting now careful investigations about causes and triggers of the twin glacier collapses and the characteristics of the resulting avalanches. A particular focus is on why two

nearby glaciers failed at similar times in similar ways, a fact that points to overarching processes behind the twin events, such as meteorological conditions, longer term climate change, or basic geological or topographic factors.

The 17 July and 21 September 2016 glacier collapses are first of all tragedies for the local people. Scientifically they are striking for the coincidence of two nearby glaciers collapsing within a short time, but demonstrate also the progress in early warning capabilities. The fact that remote observations based on a large number of very different satellite data could be carried out with a delay of only few hours or a day between data acquisition from space and analyses on the ground, involving scientists and satellite teams from several nations, in fact is substantial progress for early warning capabilities related to natural hazards in remote regions.

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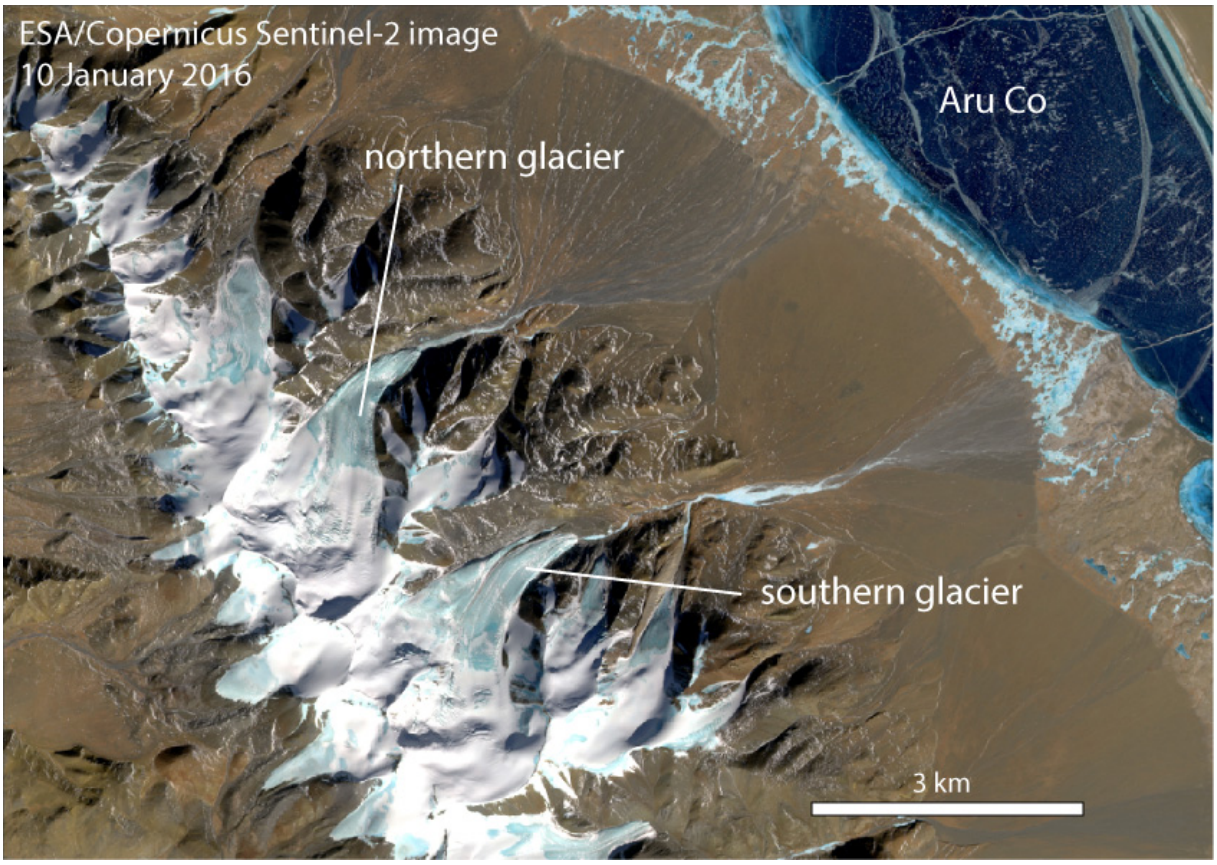
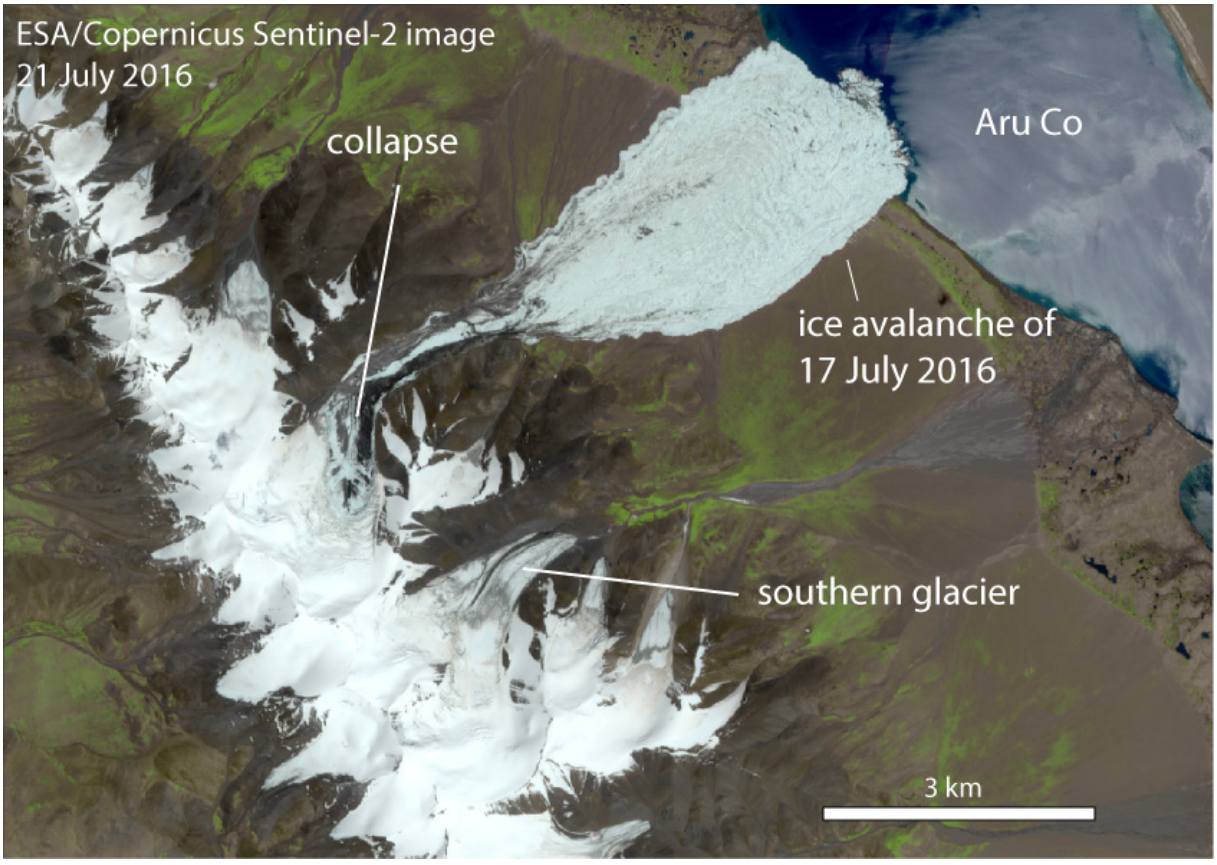
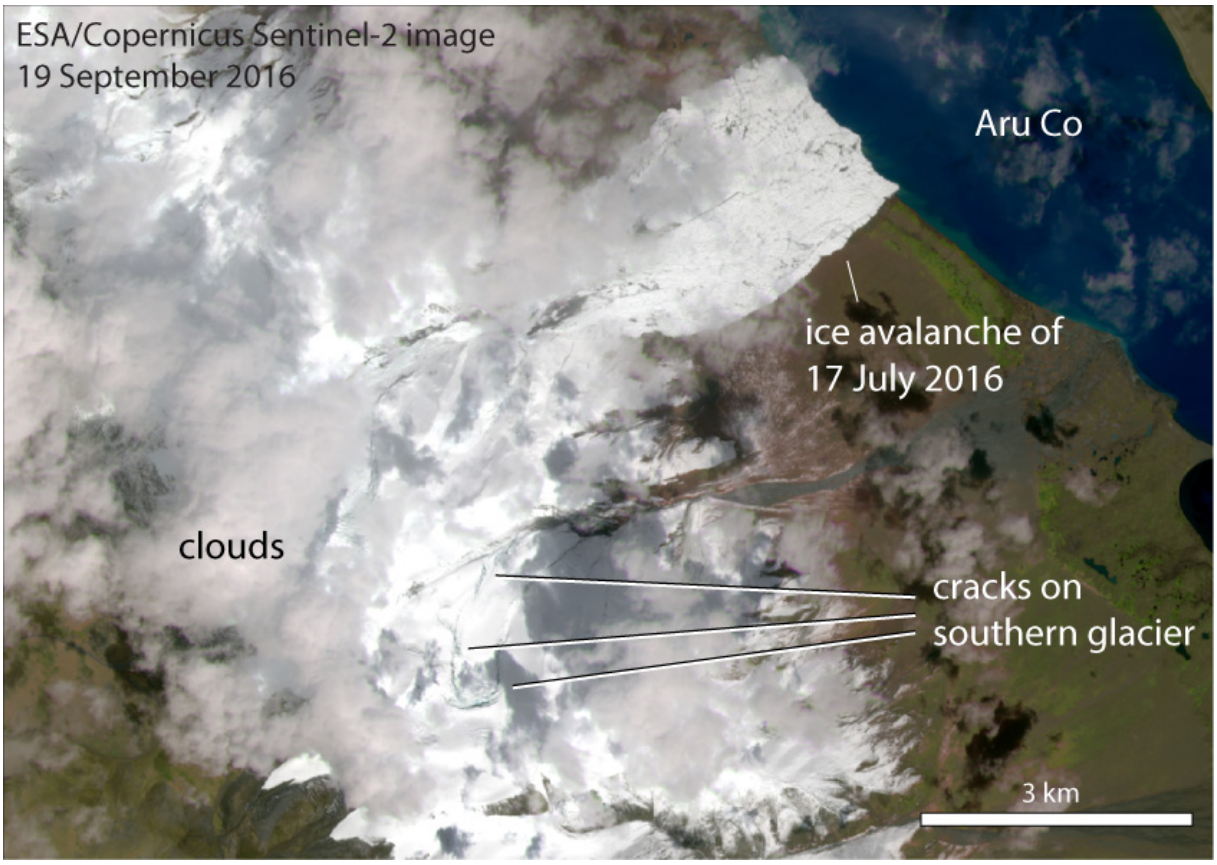
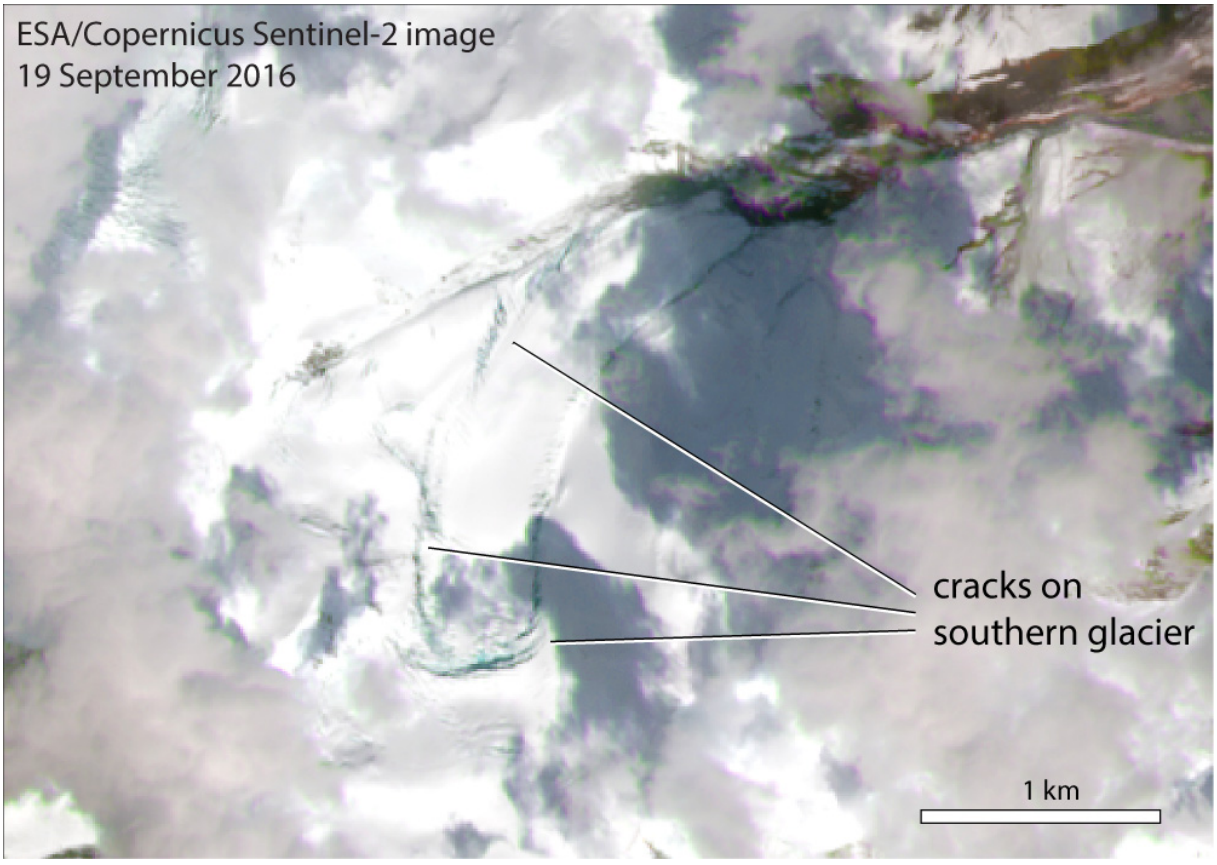
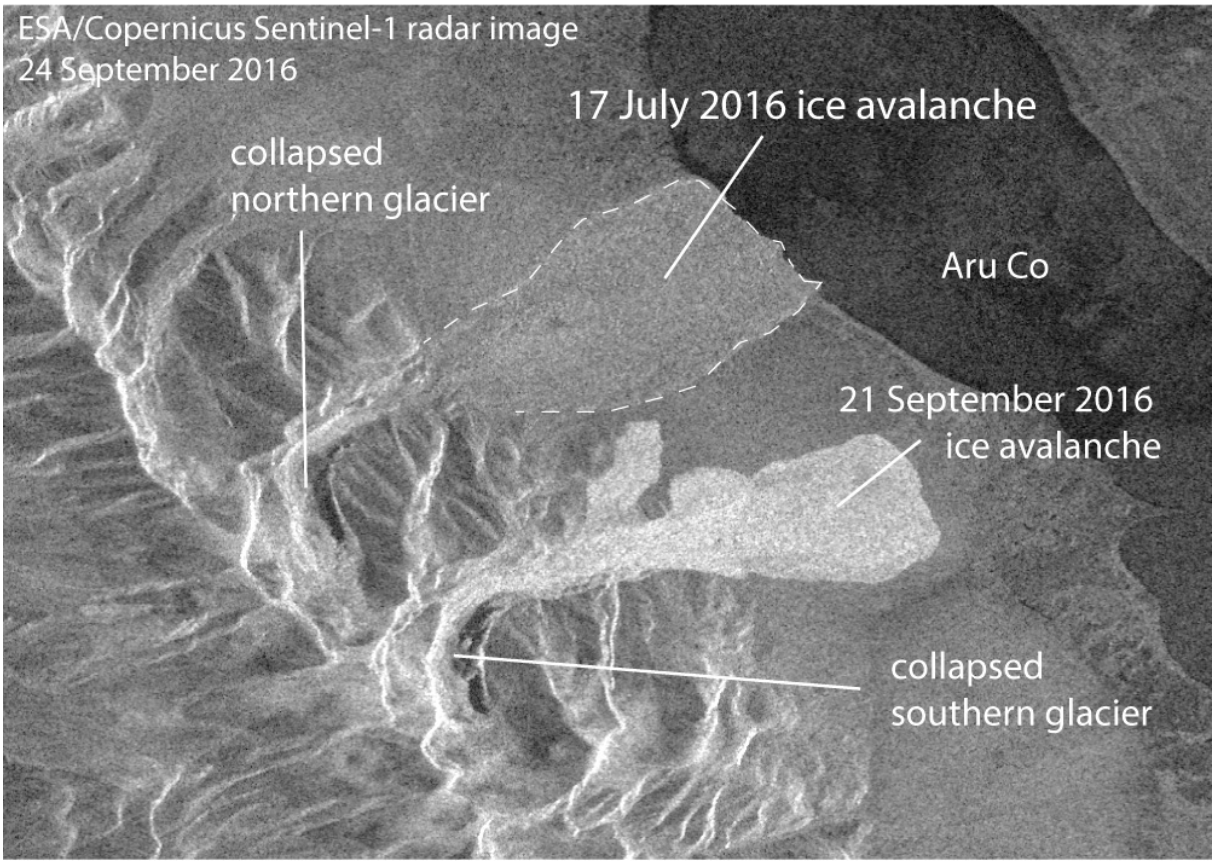
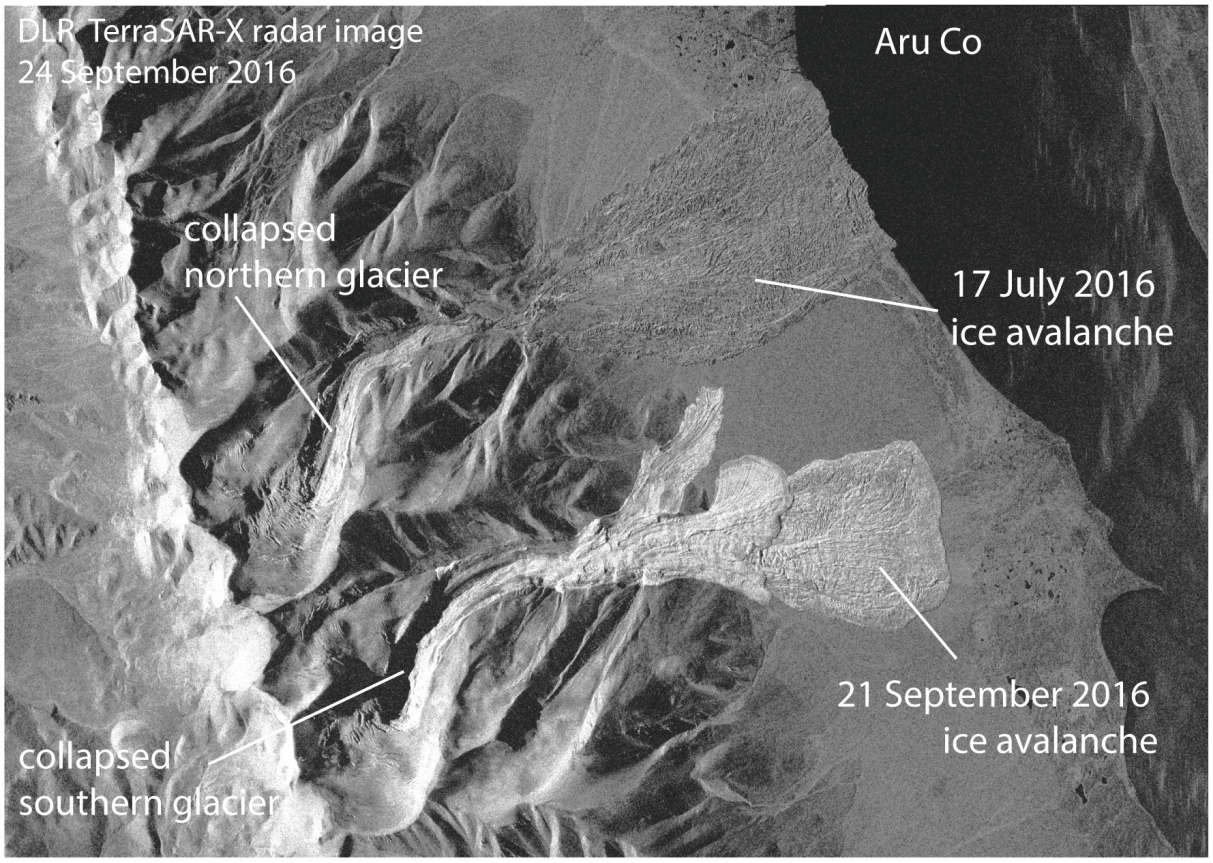

ESA/Copernicus Sentinel-2 image
10 January 2016
Aru Co
northern glacier
southern glacier
3 km

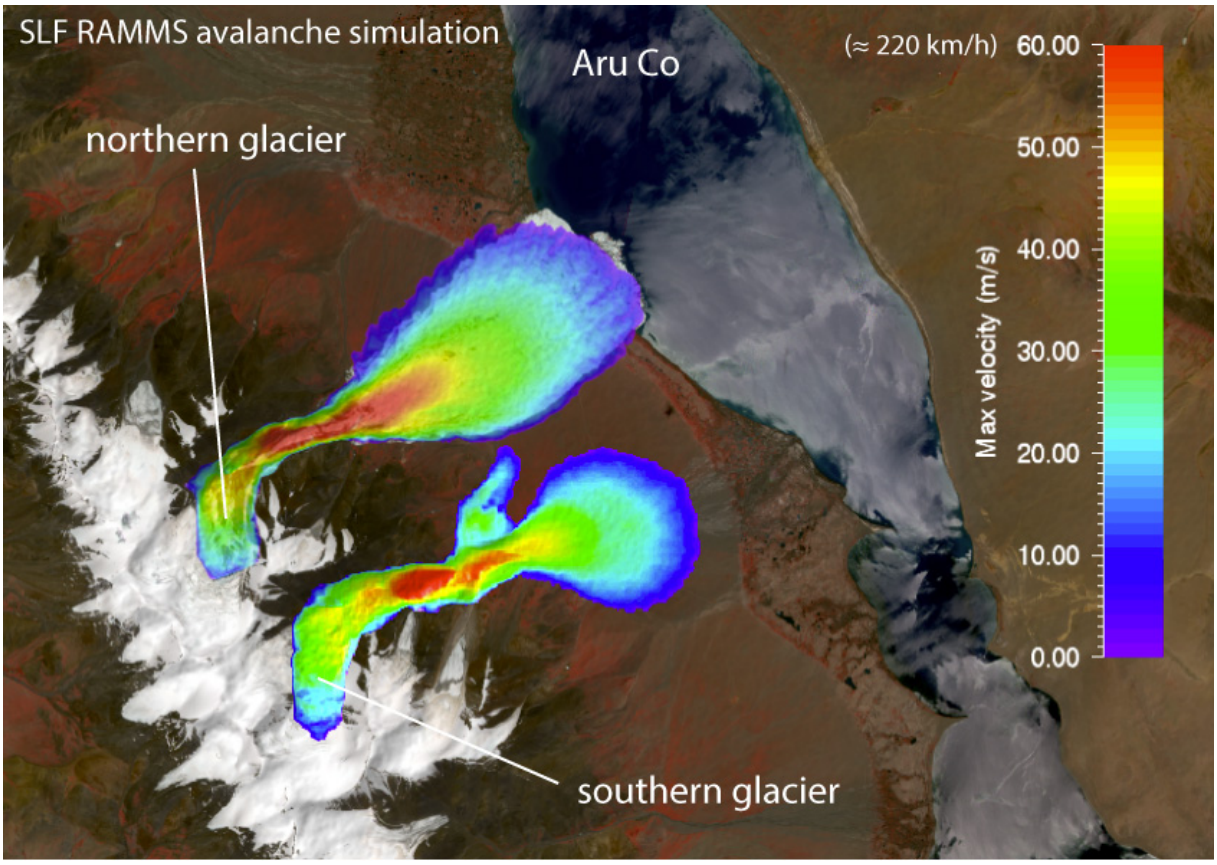

ESA/Copernicus Sentinel-2 image
21 July 2016
Aru Co
collapse
ice avalanche of
17 July 2016
southern glacier
3 km


ESA/Copernicus Sentinel-2 image
19 September 2016
Aru Co
ice avalanche of
17 July 2016
clouds
cracks on
southern glacier
3 km


ESA/Copernicus Sentinel-2 image
19 September 2016
cracks on
southern glacier
1 km


ESA/Copernicus Sentinel-1 radar image
24 September 2016
17 July 2016 ice avalanche
collapsed
northern glacier
Aru Co
21 September 2016
ice avalanche
collapsed
southern glacier


DLR TerraSAR-X radar image
24 September 2016
Aru Co
collapsed
northern glacier
17 July 2016
ice avalanche
21 September 2016
ice avalanche
collapsed
southern glacier


SLF RAMMS avalanche simulation
Aru Co
(≈ 220 km/h)
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Max velocity (m/s)
northern glacier
southern glacier