2019-2020 South Pacific Blob and Antarctica warming in February 2020

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Hot blobs beneath the sea surface formed by the release of geothermal heat through submarine volcanic eruptions and/or sub-aerially erupted hot volcanic materials including lava flows into the sea are an underestimated natural cause of ocean heat waves [1]. Recent examples include the 2013-2016 North Pacific Blob [2,3] and the 2018-2019 Southwest Indian Ocean Blob [4]. The present study on the development of a blob in the South Pacific Ocean referred to as the 2019-2020 South Pacific Blob [5] has provided evidence to account for the observed recent warming in Antarctica including a new hottest temperature record on February 6, 2020 [6] and heat wave conditions dramatically changing Antarctica in just 9 days [7].

At least three volcanic eruptions (Figure 1) have been identified to contribute geothermal heat during August to December 2019 (spring and early summer in the southern hemisphere) to create the South Pacific Blob with an ocean surface temperature maximum attained on December 30, 2019 (Figure 2). Out of these, two were initially submarine volcanoes located in the territorial waters of Tonga and one was an island volcano with a crater just above sea level off the North Island coast in New Zealand waters.

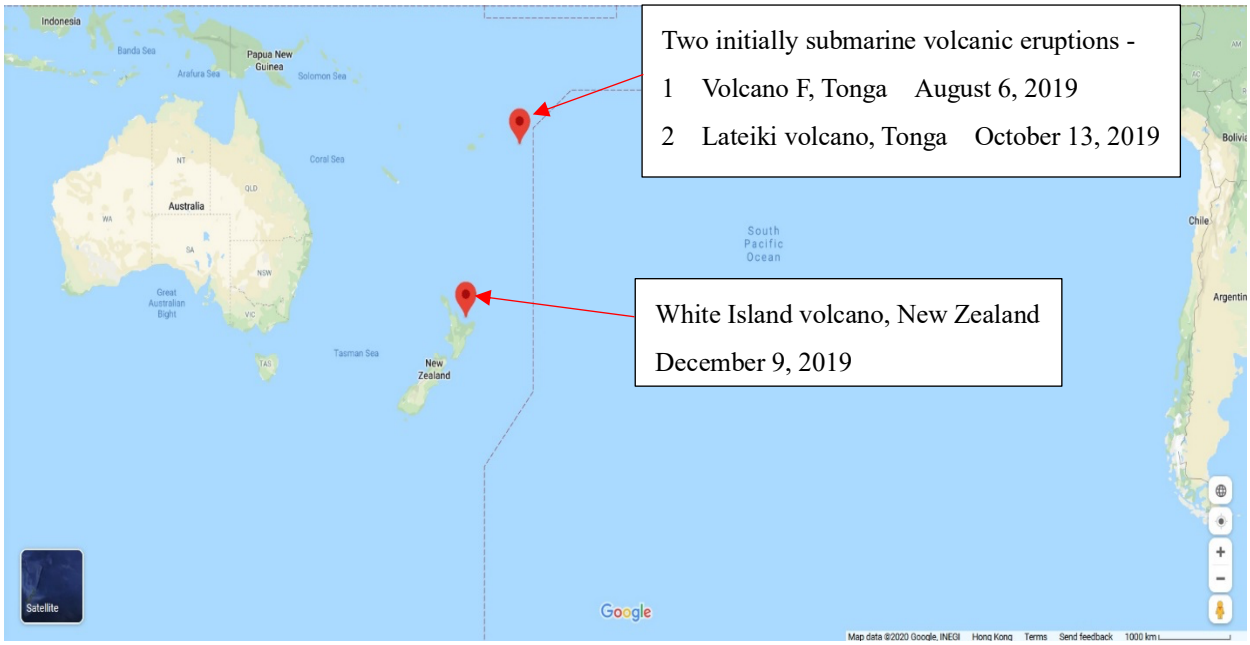

Figure 1 Volcanoes contributing geothermal heat to the 2019-2020 South Pacific Blob.

In August 6-8, 2019 submarine volcano F in the Tofua Arc, Tonga located about 40 kilometers south of Fonualie Island had a major eruption [8]. The detection of this large explosive eruption was assisted by a pumice raft greater than 136.7 km^2 in area on the ocean surface captured by imagery from ESA's Sentinel-2 satellite. In October 13-22, 2019 another submarine volcano erupted destroying Lateiki Island in the Tongan

archipelago followed by the birth of a new island 100 m wide and 400 m long in October 30, 2019 which subsequently disappeared beneath the waves in mid-January 2020 [9]. Meanwhile in December 9, 2019 the White Island volcano in the Bay of Plenty erupted with a 3.7 km ash plume and hot materials was discharged into the ocean through the eruption cloud.

An examination of NOAA satellite sea surface anomalies map archives has revealed that the South Pacific Blob located about 800 kilometres east of New Zealand attained maximum temperature and largest areal extent in December 30, 2019. The sea surface temperature was more than 5 degrees Celsius above normal while the total surface area of the Blob was approximately 1 million square kilometres [10].

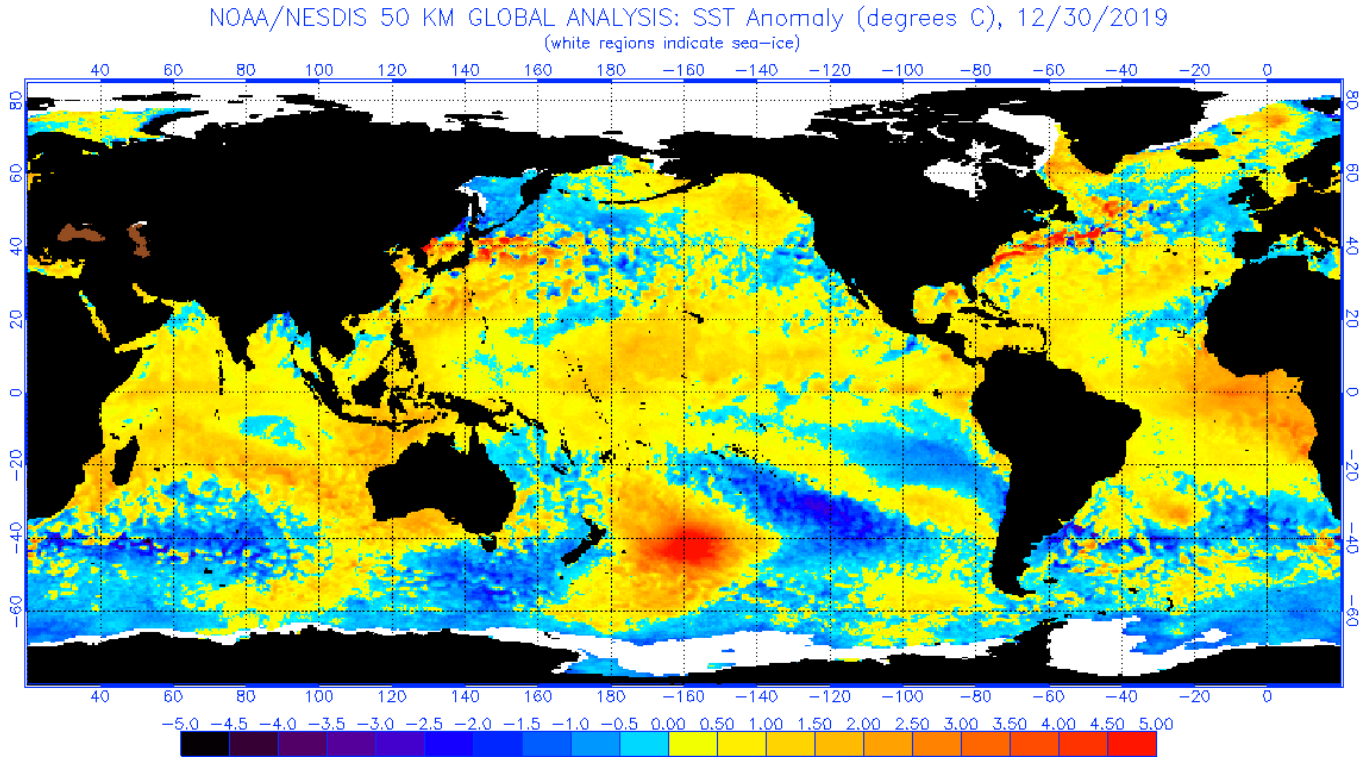

Figure 2 Sea surface temperature anomalies showing the development of the South Pacific Blob east of New Zealand on December 30, 2019. Source: NOAA.

Figure 3 shows a comparison of Argo ocean temperature profiles recorded on data buoys in the vicinity of White Island during the months of December in 2017, 2018, 2019 and the 2005-2016 monthly mean. The anomalous temperature changes with depth observed during December 2019 is best explained by the release of geothermal heat caused by submarine volcanism. A maximum temperature of 20.25 degrees Celsius is observed at the surface and the elevated temperatures down to 50 m confirms the thickness of the warm layer. At greater depths below, elevated temperatures observed between 75 m to 500 m is explained by the release of geothermal heat caused by submarine volcanism on the sea floor.

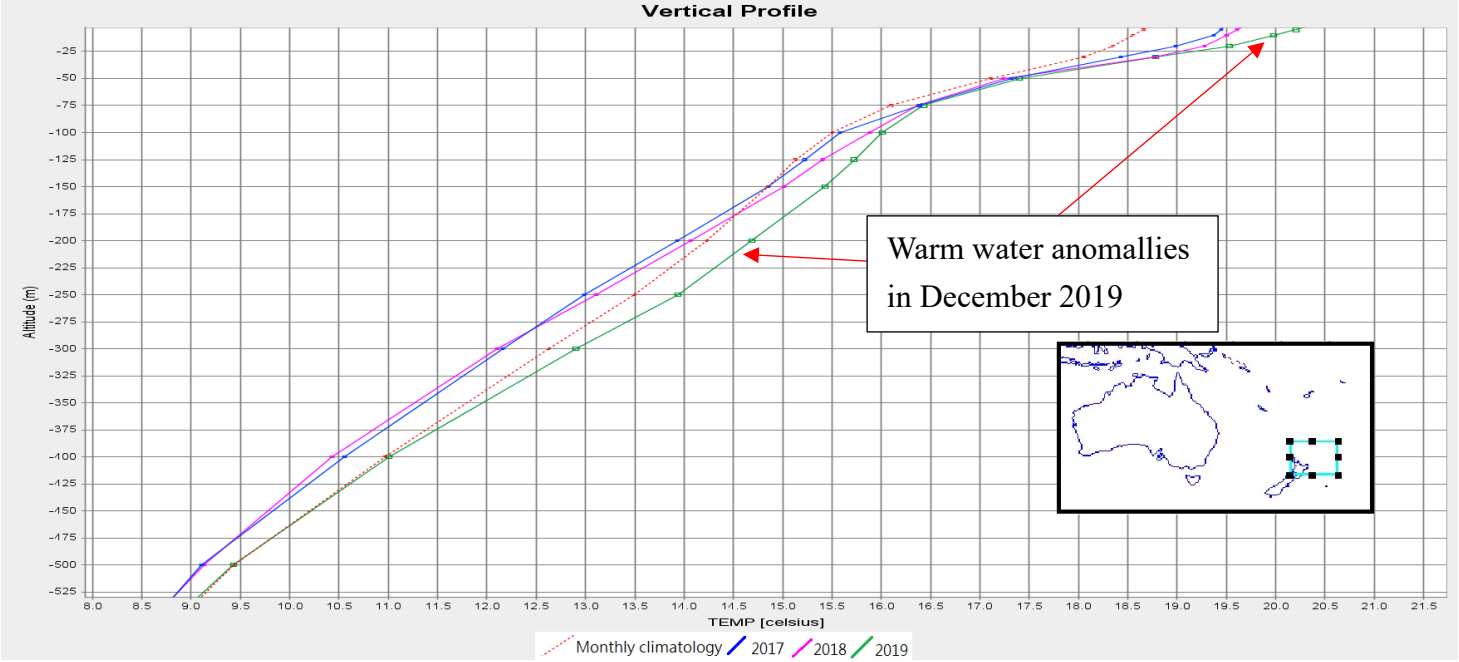

Figure 3 Comparison of Argo ocean temperature profiles in the vicinity of White Island during December in 2017, 2018, 2019 and the 2005-2016 monthly mean. Source: IPRC Argo.

An important climatic impact of the 2019-2020 South Pacific Blob at a latitude of 40-50º South is the weakening of the Roaring Forties changing the 'normal' ocean circulation. Under the sun's influence near the peak of the southern hemisphere summer, stable anticyclonic conditions favorable for heat wave development was generated. A ridge of high pressure centered over Cape Horn appeared at the beginning of February, and this allowed warm temperatures to build [7]. A new record in hottest temperature of 18.3 degrees Celsius was established in February 6, 2020 at the Esperanza Base on the northern tip of the Antarctica Peninsula and a hot spell lasting 9 days was responsible for accelerated melting of glaciers, ice sheets and sea ice.

The heat is apparent on the map shown in Figure 4 which shows temperature across Antarctica on February 9, 2020. The darkest red areas are where temperatures at 2 m above the ground exceeded 10 degrees Celsius.

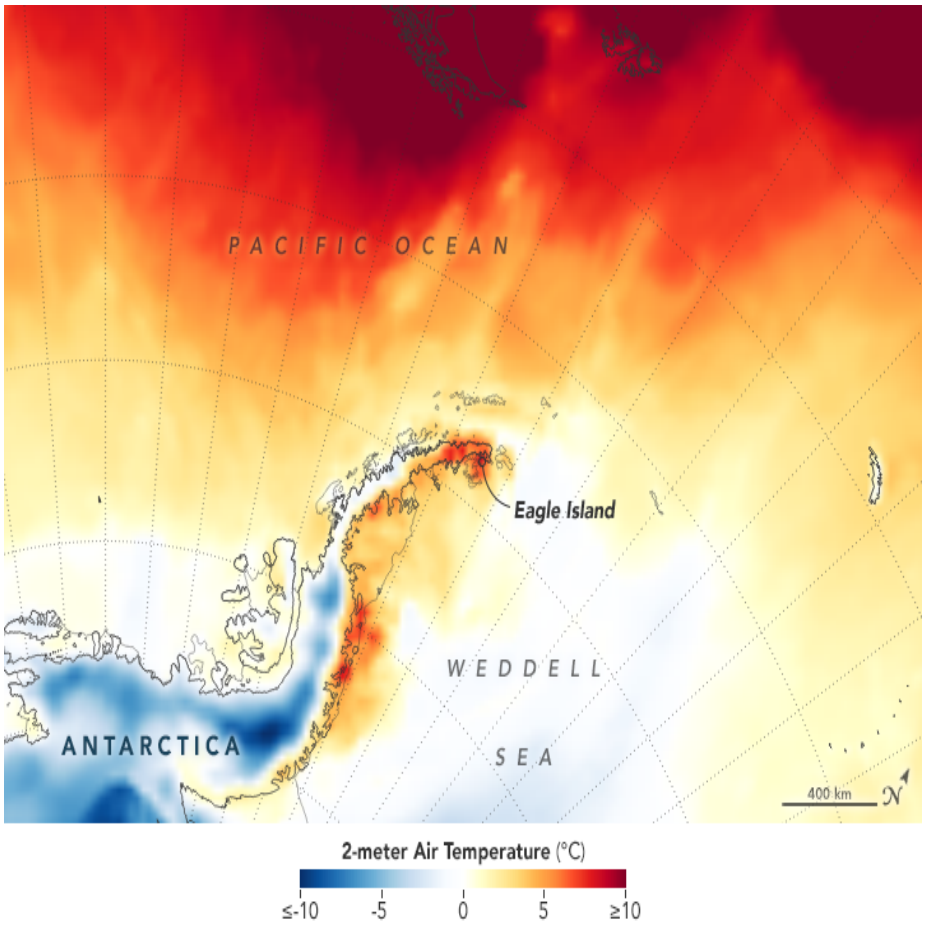

Figure 4 Map derived from the Goddard Earth Observing System model representing air temperatures at 2 m above the ground on February 9, 2020. Source: NASA.

Figure 5 shows a comparison of Argo ocean temperature profiles in the channel between Cape Horn and Eagle Island, Antarctica during January in 2017, 2019, 2020 and the 2005-2016 monthly mean. Because of the easterly drift of the warm seawater from the South Pacific Blob caused by the earth's rotation, the sea surface temperature at Eagle Island was impacted the most. January 2020 sea surface temperature was 4.7 degrees Celsius at the sea surface (about 2.6 degrees Celsius above the 2005-2016 monthly mean) decreasing to 1.8 degrees Celsius at a depth of 100 m (about 3.6 degrees Celsius above the 2005-2016 monthly mean). At a depth below 250 m the seawater temperature difference between January 2020 and other all years are relatively small. This is consistent with heat dispersion from the White Island region where the heat source originated from the sea floor from greater depths through submarine volcanism. The warm seawater being less dense would in time accumulate as a surface layer.

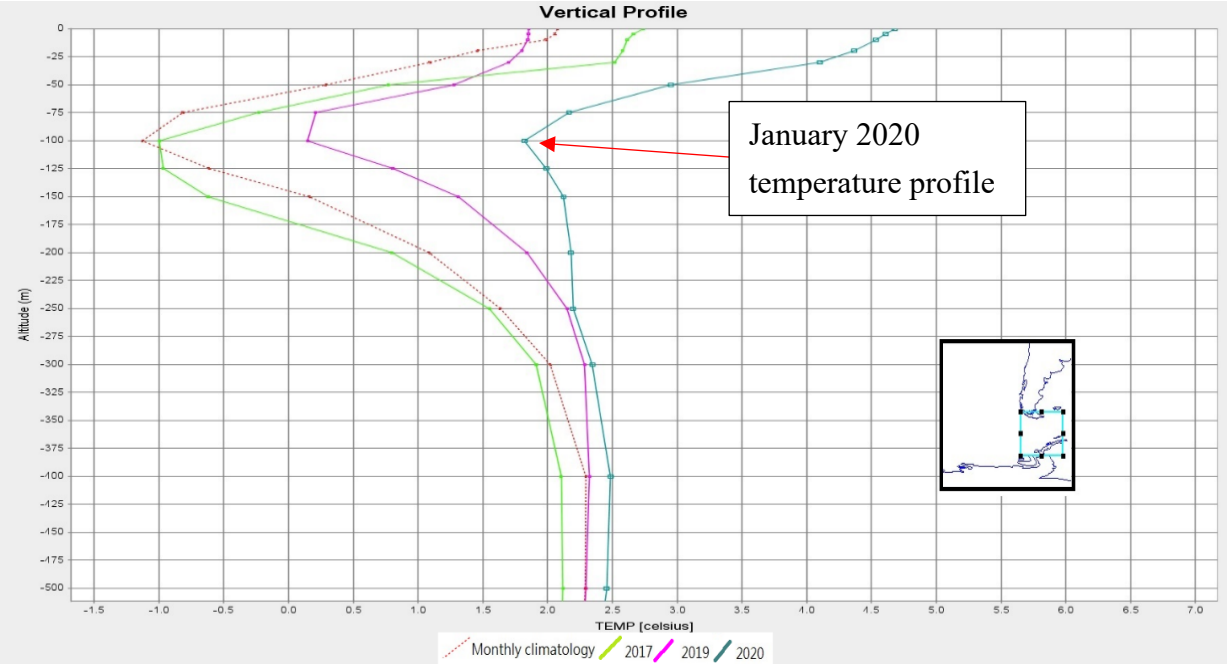

Figure 5 Comparison of Argo ocean temperature profiles in the channel between Cape Horn and Eagle Island, Antarctica during January in 2017, 2019, 2020 and the 2005-2016 monthly mean. Source: IPRC Argo.

Under the influence of warm spell for 9 days from February 4 to 13, 2020, there was widespread accelerated melting of nearby glaciers, ice sheets and sea ice in the Antarctica Peninsula region. Dramatic changes can be observed in Landsat 8 images taken 9 days apart during the period February 4-13, 2020 in the Eagle Island region (Figure 6).

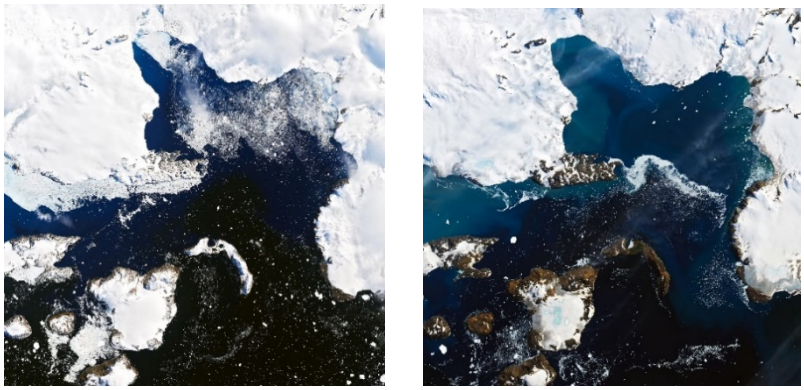

Figure 6 Landsat images showing the conditions in the Eagle Island region of Antarctica on February 4, 2020 (left) in comparison to the Landsat image on February 13, 2020 (right) showing the dramatic melting over the 9-day period. Source: NASA.

In conclusion, ocean heat waves caused by blobs formed by the natural release of geothermal heat through submarine volcanic eruptions acting, in combination with the sun, to warm the surface waters of regional oceans. The 2019-2020 South Pacific Blob not only impacted the proximal seawater in the Pacific Ocean

east of New Zealand but also distally to impact the channel region between Cape Horn and the Antarctica Peninsula. Such warming may account for a significant proportion of missing heat in oceans claimed by proponents of anthropogenic global warming.

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