

Beyond the Antarctic Coast: Brazil and the Antarctic ice shelf



Figure 2 - The Cryosphere INCT team that crossed over more than 1,400 km from the ice sheet of West Antarctica using modified Hylux Toyota vehicles (three-axis) when they passed through automated module Cryosphere 1. The team took his journey north to the future site of the Cryosphere 2 module (to be set up at approximately 80° S, 94° W in the summer of 2015-2016, green dot in Figure 1).

The largest seasonal phenomenon of our planet occurs in Antarctica, the variation of the frozen sea area, which oscillates every year from 1.8 to 20 million square kilometers, controls the entire climate system in the Southern Hemisphere, particularly the South Atlantic. This ice sheet, which covers 99.7% of the Antarctic continent with its 13.7 million square kilometers of area, has a volume of 25 million cubic km and is very close to Brazil. That's right, it would cover the whole country with a homogeneous layer of ice nearly 3 km thick!

This huge volume, if fully melted, would lead to a rise of 57 meters in the sea level. Thus, any changes to that mass of ice, even if quite small, will have important implications for our coastal regions. In addition, this mantle is the main vortex of energy on the planet and therefore one of the primary drivers of the climate system. But there are other findings that emphasize the role of ice in the environmental system:

1 - Most of the oceans' bottom water is formed under the Antarctic ice shelves (floating parts of the mantle) or under the belt of the sea ice surrounding the continent, and therefore plays an essential role in the oceanic cell of Meridional Overturning;

2 - Variations in coverage of the Antarctic ice (glacial and marine), for example, affect the dynamics of polar air masses, controlling the origin and intensity of cold fronts that there are formed and reach the Brazilian territory; and 3 - Over the past two decades, drastic changes were detected in

the ice: - Ice Platforms disintegrated (over 25,000 square kilometers was lost) and many glaciers have accelerated their flow towards the sea. Recent investigations show that the Antarctic ice melt is already contributing to a rise in average sea level, but still only slightly (about 0.4 mm per year).

Antarctica's interior is the cleanest and unaltered environment on earth and, therefore, an ideal place to monitor the chemical composition of the atmosphere and to detect signs of global pollution. Not only in the present but in the past as well:

- The Antarctic ice sheet is formed by the accumulation of snow crystals over hundreds of thousands of years, and it maintains the atmospheric characteristics at the time of precipitation. An interesting fact is that when scientists withdraw cylinders full of

ice (ice samples in scientific jargon) from the deepest layers of ice, they also analyze the composition of the gas bubbles trapped there. This technique has generated one of the most important contributions of Antarctic science: The determination of the concentration of greenhouse gases in the period prior to the direct measurements in the atmosphere (records date back to 1958 only). The results clearly show an increase of 40% in the concentration of CO₂ (carbon dioxide) and 150% for CH₄ (methane) from the start of the "Industrial Revolution".

Despite all these findings and the proximity of Brazil (incredible as it seems, Brazil is the seventh country closest to 90% of global ice volume), little was known about the influence of Antarctica in the Brazilian environmental system before the creation



Figure 3 - In addition to research in the Antarctic ice sheet (ie, within the continent), the INCT Cryosphere teams search the Southern Ocean, the frozen ground and the Antarctic atmosphere. In the photo, the INCT oceanographic team, supported by helicopter of the Brazilian Navy, places sensors for monitoring icebergs.

of the Brazilian Antarctic Program - PROANTAR in 1982 (in fact, the country did not have a specialist in Glaciology, the science of snow and ice in all its forms).

Since 1992, with the creation of the first national group dedicated to glaciological science at the Federal University of Rio Grande do Sul (UFRGS), a program was initiated to investigate the masses of Antarctic ice, their variability, the evolution of their atmospheric chemistry in the historical past and especially the influence on the variability of South America's atmospheric conditions. This action culminated in 2008 with the creation of the National Institute of Science and Technology of the Cryosphere, which has since then united 8 associated laboratories dedicated to the study of the variability of different components of the mass of planetary ice, including studies of Antarctic sea ice (which seasonal effect is the greatest natural phenomenon on Earth. The Antarctic sea ice covers 1.9 million square kilometers on average in March, and jumps to almost 20 million square kilometers in September of each year), glaciers and the Antarctic ice sheet, Andean glaciers, permafrost (permanently frozen ground) and their responses to climate change. The program includes the installation of a national laboratory for analysis and interpretation of ice survey and the National Center for monitoring the cryosphere, mainly to assess the impact of the melting of part of the cryosphere to the average sea level.

This INCT allowed for an expansion of the studies carried out by the Brazilian Antarctic Program (PROANTAR) into the Antarctic continent, culminating with the installation of the scientific module "Cryosphere 1" ($84^{\circ} 00'S$, $79^{\circ} 30'W$) in the summer of 2011/2012 for climate monitoring and atmospheric chemistry in a joint action of researchers from the State University of Rio de Janeiro (UERJ), UFRGS and the National Institute for Space Research (INPE). Recently, in the austral summer of 2014/2015, the first national crossing of the Antarctic ice sheet was carried out. A small INCT team crossed more than 1,400 km from the Antarctic ice sheet to collect surface samples of snow and taking the route and the location for the second national module installation within the interior of Antarctica, the "Cryosphere 2" in the summer of 2015/2016.

The INCT of the Cryosphere also leads the Brazilian oceanographic research in the Austral Ocean, performing operations on

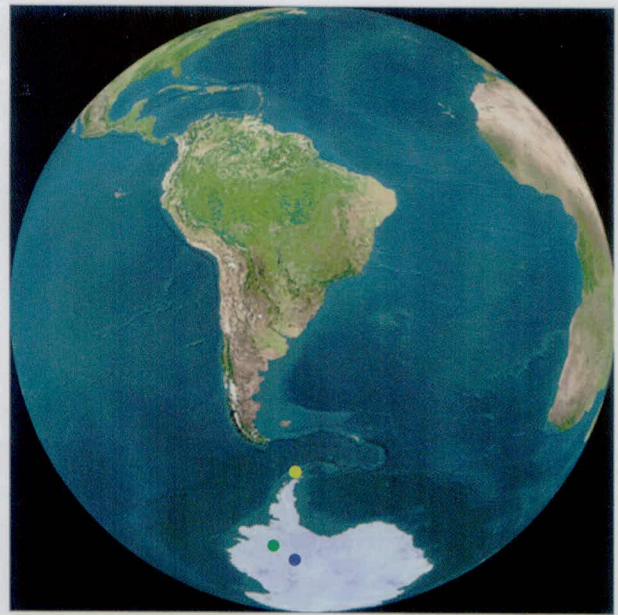


Figure 1 - A better perspective of the Antarctic ice sheet, showing the real proximity to the South American continent. The colored dots identify the geographical location of the Comandante Ferraz Antarctic Station - EACF ($62^{\circ}05'S$, $58^{\circ}24'W$ - yellow), the Cryosphere 1 scientific module ($84^{\circ} 00'S$, $79^{\circ} 30'W$ - blue) and where the Cryosphere 2 module scientific will be installed (green dot) in the summer of 2015-2016. The EACF-Cryosphere 1 distance is about 2500 km.

board the Polar Ship Admiral Maximiano of the Brazilian Navy, collecting oceanographic data on the characteristics of water masses in the Bransfield Strait and northwestern sea of Weddell. In general, the activities carried out within INCT also contribute to the acquisition of oceanographic and glaciological data in areas of the world with few observational data, studying the ocean-atmosphere interaction in the South Atlantic Ocean and the Southern Ocean and the impact on the weather forecast and climate in the south-southeast region of Brazil. Laboratory and field oceanographic research is carried out by researchers at the Federal University of Rio Grande - FURG, INPE and University of São Paulo - USP. The group led by researchers at the Federal University of Viçosa (UFV) is studying the permafrost response to climate variations. The INCT team also investigates organisms that have evolved under the extreme temperature conditions and the humidity of the interior of Antarctica (Federal University of Minas Gerais - UFMG). Finally, since 2012, we have been monitoring the environmental, socioeconomic and geopolitical consequences of the rapid reduction of the area covered by sea ice in the Arctic, including the opening of new maritime routes in the far north.

Source: Prof. Dr. Jefferson Cardia Simões - Glaciologist - General Coordinator of the National Institute of Science and Technology of Cryosphere - INCT Federal University of Rio Grande do Sul - UFRGS.