Atmospheric observations at Amsterdam Island in the southern Indian Ocean – restarting the site after a major fire.

Located in the heart of the Southern Indian Ocean, Amsterdam Island is one of the few background atmospheric observatories in the Southern Hemisphere. Its geographical isolation limits the direct influence of continental anthropogenic sources of pollution, making it a key site for the study of climate, atmospheric physical chemistry, and contaminants.

Located 3,400 km from Madagascar and 5,000 km from South Africa, Amsterdam Island (37°50'S, 77°30'E) is one of the most isolated islands in the world (Fig. 1). Together with Saint Paul Island, 85 km away, it forms the Saint Paul and Amsterdam Islands District, one of the five districts of the French Southern and Antarctic Lands (TAAF). Its remoteness from any major human activity makes it an ideal site for studying the composition of the atmosphere far from anthropogenic sources. The establishment of a scientific base dates back to December 1949, when Martin de Viviés set up the first weather station (Fig. 1). Since then, about twenty people have overwintered there each year, and the base is resupplied four times a year by the research vessel *Marion Dufresne II*.

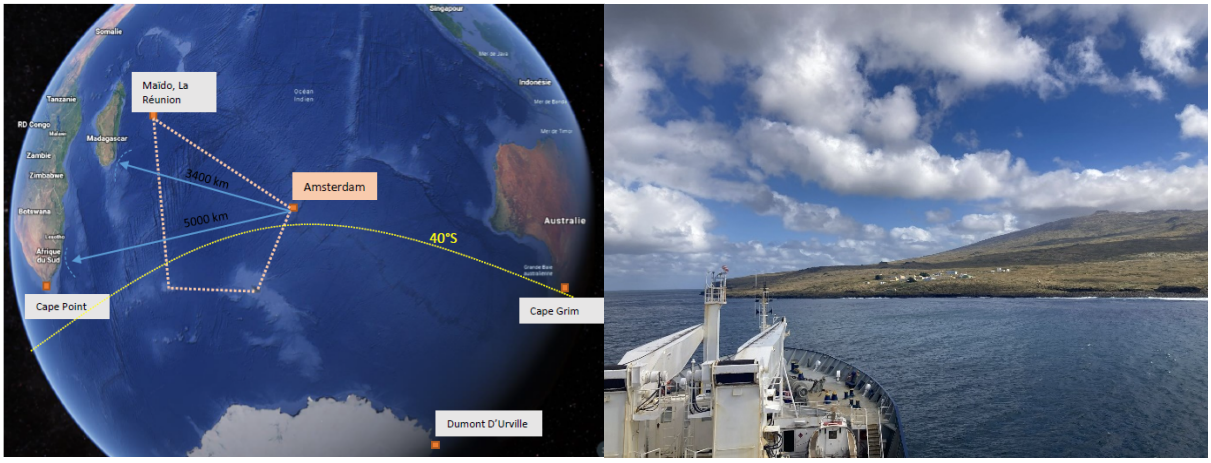

Fig.1: On the Left: location of AMS and its position relative to the GAW stations at Cape Point and Cape Grim, which are located on the same latitudinal band (35-45°S). The Marion Dufresne II makes several round trips each year between Réunion, the Crozet and Kerguelen archipelagos, and Amsterdam Island (shown in dotted lines on the map). The Maïdo Observatory (Reunion Island) is located at an altitude of 2,300 m and a latitude of 21°S. On the right: picture of Martin-de-Viviés base taken from the Marion Dufresne research vessel (Credit: A Dommergue)

Since 1980, Amsterdam Island, specifically the Pointe Bénédicte site, located 1.5 km from the Martin-de-Viviés main station has hosted a suite of measurements recognized by several international networks, including the World Meteorological Organization (WMO). As such, Amsterdam is one of the few GAW Global stations in the Southern Hemisphere within the WMO Global Atmosphere Watch network. At this site, for example, continuous measurements of carbon dioxide (CO_2) are conducted, and these time series are among the longest in the Southern Hemisphere, playing a key role in the long-term monitoring of this greenhouse gas and in the study of Earth's climate.

As part of the programs supported by the French Polar Institute (IPEV), additional research is also being conducted on atmospheric particles and their role in climate, cloud formation, the chemical composition of the atmosphere and its reactivity, and the transport and variability of contaminants such as mercury. The support of the ANR OBS4CLIM (*ANR-21-ESRE-0013,* https://www.obs4clim.fr/) was instrumental in enabling investment in new research equipment.

Today, several research institute in France (LSCE, LOA, LAMP, IGE) run instrumentation dedicated to atmospheric observations including (but not limited to) : CO_2, CH_4, N_2O, and CO, radon measurement, ozone, atmospheric particles (size, composition, and properties) (NAIS, nephelometer, WIBS, ACSM, CPC, SMPS), atmospheric gaseous mercury, mercury in rainwater, and collection of emerging contaminants in air, rain and seawater, atmospheric particulate matter collection on filters, optical and microphysical properties of particles of atmospheric column (LIDAR, photometer).

These measurements not only fuel original research but also, when combined with observations made at other sites around the world by international groups, help us better describe and understand the state of our atmosphere and climate. Furthermore, these observations are invaluable for developing numerical tools that allow us to project future changes.

A major fire in January 2025 causing the stop of atmospheric observations

In January 2025, a major fire broke out and led to the emergency evacuation of the island. The fire, now extinguished, burned more than 50% of the island's surface area and caused extensive damage to the flora and numerous vital infrastructures. In terms of scientific infrastructure, power supplies and data transfer systems were damaged, causing a sudden halt to atmospheric observations.

For such an observatory, a break in data series poses a major scientific challenge, since only continuous series allow us to detect small-scale trends, interannual variations, or identify new atmospheric events.

Fig.2: Picture of fire at Amsterdam Island (Credit: Terres Australes et Antarctique Francaises)

Restarting atmospheric observations

The primary objective of the summer campaign in November and December 2025 was therefore to resume all atmospheric measurements that had been interrupted following the fire. Since the Pointe Bénédicte site still had no power supply - the cable having been severely damaged by the fire - the first step during the field operation was to move most of the instrumentation that had remained on site and bring it back to base. The wooden shelter named CGT and funded as part of the ANR OBS4CLIM project and installed in 2024 was airlifted by helicopter and positioned on the main base located on the heights of the base.

Although the fire did not directly damage the instruments, the long period of downtime and storage in a humid and corrosive environment caused by sea salt led to numerous problems and even the breakage of certain parts. Some instruments could not be restarted and will be repaired in the coming months.

The coming months will be crucial for assessing the quality of the new observations, both because of potential damage to the instruments and due to the influence of the base itself.

Fig. 3: left: location of the new monitoring site (black arrow), right: view from above of the wooden shelter.

Less than a year after the fire, the 2025 mission restored a vital link in the global atmospheric observation network. In a part of the world that remains under-instrumented, Amsterdam Island remains a key reference point for understanding the global climate system, atmospheric phenomena in the Indian Ocean, and global pollution. While observations have resumed at the Martin de Viviés station, they will nevertheless be subject to human influence that will be difficult to overcome, especially since research aims to detect minute signals or analyze trends spanning multiple years or even decades. Indeed, the scientific value of a station like Amsterdam is not measured on the scale of a single campaign, but rather over decades.

Within the framework of the OBS4CLIM project, in coordination with several French institutes and with the support of the French Polar Institute, atmospheric observations will be maintained in the coming years. Although this requires significant human and financial resources, the atmospheric science community that has been active at this site for many years strongly hopes that the Pointe Bénédicte site, which is unique due to its privileged location and minimal human influence, can be restored as quickly as possible in order to continue these unique observations.

In the future, additional new and original atmospheric observations at Amsterdam Island would be highly welcome. These may include, but are not limited to, more detailed studies on halogen chemistry, VOCs, reactive gases, stable isotopes, etc. Such developments would contribute to improving our understanding of atmospheric processes over the southern Indian Ocean, a region that remains sparsely documented despite its key role in air-sea exchanges and large-scale atmospheric circulation. In the context of a changing climate, and given the rapid warming observed in parts of the Indian Ocean, strengthening observational capabilities at this site would provide valuable insights into the evolution of atmospheric composition and coupled ocean-atmosphere processes.

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