

# THE ATMOSPHERIC OBSERVATION IN TENERIFE ISLAND DURING THE LAST FOUR CENTURIES AND THE MOUNTAIN OBSERVATORY IN IZAÑA. A SHORT HISTORY OF THE OBSERVATORIO DE IZAÑA, TENERIFE.

Fernando de Ory & Manuel Palomares (I.N.M. – Spain).  
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CANARY ISLANDS

## SUMMARY

The creation of a meteorological observatory in the mountains of Tenerife island was the result of scientific interest, in which historical and political events also played a role. The exceptionality and suitability of the physical and geographic conditions in Tenerife for the study and research of the atmosphere have been known and emphasized since the mid-17th Century. Since then, every area of meteorological importance, from the regime of general circulation of the atmosphere to atmospheric chemistry was the object of observation and studies by scientists visiting the island. The Observatory at Izaña was founded at the beginning of the 20th Century thanks to the triumph of European meteorological science over a diplomatic and political conflict between the Spanish and German governments. Today, after four centuries of scientific interest in Tenerife, the most symbolic characteristic of the Observatory is the universality of its objectives and research projects.

## THE GEOGRAPHIC ENVIRONMENT

Tenerife is an island of volcanic origin, which can be traced to times towards the end of the Tertiary period. Emerging some seven million years ago, it is the largest of the seven islands of the Canary Archipelago. Located between 28° and 29° N and 16° and 17° W, a little north of the Tropic of Cancer, it sits right in the middle of the other Canary Islands. Tenerife is just over 300 km away from the African continent and about 1200 km from the Iberian Peninsula. With a surface of 2034 km<sup>2</sup> and a distinct triangular shape, it is a mountainous island. The gigantic massif of Teide sits above the circular formation of Las Cañadas. Teide, at 3718 m, is the highest peak in all of Spain and the third highest volcano on Earth.

Trade-wind inversion was well-known in the Canary Islands in ancient times. In 1592 the Italian engineer Torriani spoke of the dry warm air at the higher levels of the island of Tenerife.

The earliest antecedent of scientific works on Teide's Peak that we know of dates back to the 17th century. In 1645 The Royal Society of London, requested permission for two fellows of the Society to visit Tenerife to measure the "weight of the air" at the summit of the Peak. It was just a few years before that Torricelli had taken the first measurements with the barometer.

In June 1799 Alexander Von Humboldt climbed the Peak taking measurements of the air temperature and pressure, as well as collecting geological, flora and vegetation data. He fixed the altitude of the sea cloud at over 1170 m, and explained the essential causes.

Charles Darwin arrived at Tenerife with the "Beagle" expedition on 6th January, 1832, although he was unable to disembark due to rumours of a cholera epidemic on his ship. In his book Darwin mentioned the diameter of dust particles and the importance of the Saharan wind in this phenomenon.

The first book specializing in the climate of the Canary Islands dates from 1823 and was written by the German geologist Leopold Von Buch.

In 1850 the astronomer Charles Piazzi Smith spent three months in a place called Altavista, near Teide's Peak, carrying out astronomical observations. He also provided important data concerning Teide's wind and climate.

A series of ozone measurements was taken between November, 1862 and February, 1863 due to an outbreak of yellow fever in the island's capital.

The change in the usual NE wind on the coast of the island to an almost permanent SW wind observed in the high mountains attracted the attention of scientists from early times and was probably well known to Edmund Halley, when he published his "First Wind Charts" in the "Transactions Philosophiques". George Hadley made reference to Tenerife when he offered an explanation for the Equatorial circulation. When William Ferrel published, in 1856, his mathematical model of the circulation of the atmosphere (revised in 1860 and again in 1889), he made explicit mention of the winds observed in Tenerife.

Carl Frisch, vice-director of the Central Institute for Meteorology and Geodynamics (ZAMG) in Vienna, spent a long period in Tenerife during 1864 observing and studying the trade and counter-trade wind regimes. Julius Haan, director of ZAMG, published studies based on observations of cloud and winds in Tenerife during 1884.

In 1888 Abercromby published a report in the Review of the Royal Meteorological Society on "The electrical and meteorological observation on Tenerife's Peak".

Based on the study "On the ultraviolet boundary of solar spectrum in accordance with the clichés obtained by Dr. Simony on Tenerife's Peak", A. Cornu published, in 1890, a report in the French review "Comptes Rendus".

In 1900 K. Angstrom published, in Upsala, the results of his works carried out in Tenerife on "The intensity of solar radiation at several altitudes".

The great drive and excellent results of the aerological investigations until just before the First World War justified the interest shown by the Germans in setting up a permanent Observatory on the peak of Teide. In the year 1920, plans were made in Spain to link up the city of Seville with Buenos Aires using hot air balloons. To do so, the technical collaboration of the Zeppelin company was sought, as this was the only operator in the world with experience in carrying out such ambitious aeronautical projects. The project required the setting up of a landing field in the Canaries for emergencies or as a half-way landing point, with hydrogen and fuel deposits, and another similar emergency landing field in Cordoba, Argentina. The place chosen was Las Cañadas del Teide, with its perfect high plain as a natural aerodrome.

In March 1913, the original Observatory in Las Cañadas del Teide was visited by an expedition formed by Professor Lüdeling and Dr. Luyken, of the Königlich Meteorological Institute (Germany), to take measurements of the atmospheric electricity and magnetic declination on Teide. A scientific mission headed by Dr. Dember, professor at Dresden's Physics Institute, spent the months of July and August, 1914 at the provisional Observatory with the purpose of studying the atmospheric extinction of the ultraviolet solar radiation and the skylight polarization (Loschmidt's number determination). Martin Uibe, who came with him, was interested in the distribution of the sky's illumination and in comparing it to existing theories. W. Buchheim (Leonardville University, Kansas, U.S.A.) accompanied them to study the daily curve of ionization from the top levels, while Uibe and Buchheim also took measurements of atmospheric electricity. Additionally, they made three observations concerning optic meteorology.

In accordance with the quality of the results, they emphasized that "Teide's Peak was much more suitable for physics and astrophysics research than the high mountains of Switzerland or Italy", due to low dust and mist content. When they came down from Teide to the Observatory, on 18th September, 1914, they found out about the start of the World War. Buchheim returned to the U.S.A., while the others remained on the island until 1917 continuing their work. After that, foreign scientific research stopped in the Observatory. Only some meteorological and aerological works and solar radiation measurements were carried out. Due to its special situation it was selected as an observation place for geodesic and geophysics works by the National Geographic Institute of Spain.

During the forties the Spanish meteorologist Inocencio Font published many works and articles on Izaña's climatology and meteorology as well as some very interesting studies on winds at high altitudes based on the soundings carried out at Izaña from 1916 to 1935. Other scientists published similar works, notably Von Ficker, Roschkott and Müller. The consequences of the Spanish Civil War and the World War, after 1939, were felt at the Izaña Observatory. The shortage of economic and material resources, as well as of specialized personnel, caused the total absence of studies or special investigations. Only the meteorological observations were maintained and aerological sounding was stopped in 1960, due to the change of location to the main city on the island, Santa Cruz de Tenerife.

Around 1958, foreign scientists once again began to arrive at Izaña, on the occasion of a solar eclipse. Several astronomers and astrophysicists used our Observatory to carry out studies on atmosphere transparency aimed to test the suitability for astronomical observations. From the beginning of 1963, samples were taken with an NaOH dissolution exposed to the air to determine C<sub>14</sub>. These samples were sent to Dr. Neydal at Trondheim University (Norway). In October, 1968, the Meteorological Institute of Mainz University, headed by Dr. Junge, was temporarily at the Observatory to test new instruments to detect and measure atmospheric pollution and which would be used on board the "Meteor", a German oceanographic and meteorological ship, which would make an expedition in 1969.

During the summers of 1973 and 1974, a sounding series was carried out at the Observatory to study microturbulences in the atmosphere in view of the great importance that disturbance has to astrophysical sky observations. These works were conducted by Dr. Barletti of Florence's Astrophysical Observatory. From May, 1975, the Observatory collaborated with Dr. Prospero, of Miami University, on several studies related to the transport of aerosols in the Atlantic Ocean.

From August, 1979 to December, 1979, many observations were carried out for the study of halocarbons (N<sub>2</sub>O, CCl<sub>3</sub>F, CH<sub>2</sub>Cl<sub>2</sub>, and Cl<sub>4</sub>) by Dr. R. A. Rasmussen, from the Oregon Graduate Center for Study and Research. On the results obtained, he wrote a letter to Dr. N. M. Zalote, Head Scientist Izaña Observatory, saying: "the data we are obtaining at Izaña are some of the best in the world."

From 1981, Dr. R. Schmitt and Dr. Balchtrusch, commissioned by Deutscher Wetterdienst of Germany, carried out studies on the suitability of Izaña as a BAPMoN Station, representative of the free troposphere in the southern part of the North Atlantic. They also studied meteorological parameters, turbidity, and solar radiation, CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, typical meteorological situations, etc.

Much of the new interest in Izaña was shown by institutions from Germany. An agreement was signed between the governments of Germany and Spain in 1984, by which the old observatory became a station of the WMO BAPMoN programme (Background Atmospheric Pollution Monitoring Network) under joint co-operation. In 1989 BAPMoN and GO<sub>2</sub>OS (Global Ozone Observing System) merged into the current GAW programme (Global Atmospheric Watch) of which Izaña is one of the principal stations.

## 21ST CENTURY. THE FUTURE OF THE OBSERVATORY

During the last years Izaña has increased at a spectacular rate the quantity and quality of atmospheric observations. The observatory is now involved in a considerable number of programmes and experiments such as those of NDSC (Network for Detection of Stratospheric Change) and the Global Atmospheric Watch (GAW) with scientific and measurement programs of radiation, ozone, green-house gases and many other trace components. The Observatory hosts the Regional Brewer Calibration Centre for Europe (RBCC-E) from WMO. Izaña has also a bright future in the role of validating and calibrating satellite sensors. Collaboration with the European Space Agency on this subject is currently ongoing.

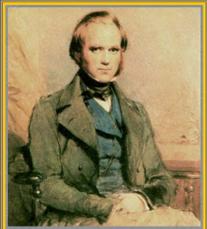
This is the happy end of the very ancient attraction of Tenerife and its mountains for scientists and the result of some historical events during the first years of 20th century closely related to the initial development of modern meteorology.



LEONARDO TORRIANI



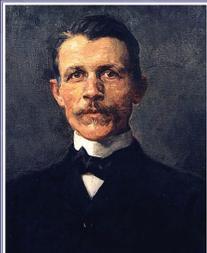
ALEXANDER VON HUMBOLDT



CHARLES DARWIN



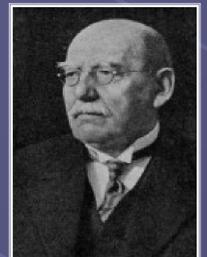
CHARLES PIAZZI SMITH



KNUT ANGSTROM



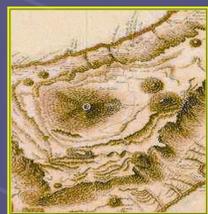
TEISSERENC DE BORT



HUGO HERGESSELL



Fig. 141. — A l'Observatoire des Cañadas. De gauche à droite, debout: Prof. Ory, M. Curriero, M. H. Panowitz, Prof. Gantz, P. Barredo, P. Venzler, Dr. Wenger, Prof. Panowitz; assis: M. Schaper, Dr. H. v. Schützer, M. J. Mauceri, Prof. Durig.



VIEW OF THE TOP OF LAS CAÑADAS DEL TEIDE



OBSERVATORIO DE LAS CAÑADAS DEL TEIDE (1910)

## 20TH CENTURY. THE FOUNDATION OF THE OBSERVATORY

In 1904 Prince Albert of Monaco, in the company of the German Professor Hugo Hergesell, president of the International Commission for Scientific Aerostation, carried out soundings around the island of Tenerife using balloons to study the regimen of counter-trade winds in the upper atmosphere.

In the summer of 1906 Léon Teisserenc de Bort and Lawrence Rotch visited Tenerife on board the ship "Otaría" launching 40 pilot and captive balloons from the peak between 8th-10th August. They also made a number of observations and atmospheric soundings from the surrounding sea.

The first simultaneous soundings in Tenerife were made on 28th July 1908, by Wenger at the Orotava Valley and Hergesell on board the German warship "Victoria Luisa". In the same year Hildebrandt made wind studies right at the peak of Teide.

Since then, international interest in establishing a permanent Observatory at the peak of Teide increased. In 1909, and following a German initiative, concern raised by the Spanish government and diplomatic negotiations, a provisional Observatory was installed in Las Cañadas with the co-operation of Germany and Spain. It comprised two large huts lent by the German Emperor, Wilhelm II. The observations started shortly after that and the first studies were published by Wenger and Hergesell in 1911.

In the autumn of 1913 the Spanish Government began to build the final Izaña Observatory at 2367m above sea level, on top of a mountain plateau on the ridge which crosses the island. Formally inaugurated on the first day of 1916, it is located at 28° 18' N, 16° 29' W at 1000 Km from the nearest place in Europe and 400 Km. from Africa. Its early works were addressed to the study of high atmosphere, as well as conventional meteorological parameters through aerological observations.



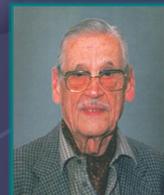
OBSERVATORIO DE IZAÑA (1916)



METEOROLOGICAL SOUNDING (1925)



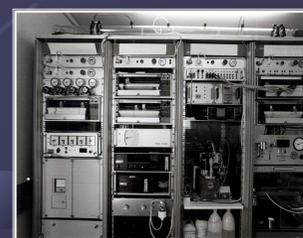
OBSERVATORIO DE IZAÑA (1948)



I. FONT-TULLOT



C. E. JUNGE



BAPMoN STATION (1984)



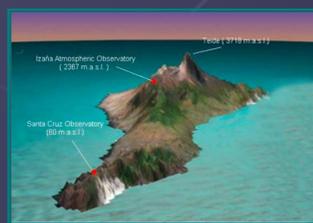
BREWER SPECTRORADIOMETER INTERNATIONAL INTERCOMPARISON



THE FIRST OZONE SOUNDING (1992)



RADIOMETER CALIBRATION



PANORAMIC VIEW OF THE ISLAND



OBSERVATORIO DE IZAÑA (2004)