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Defant, Albert Joseph Maria (*b.* Trient, Austria (now Trento, Italy), 12 July 1884; *d.* Innsbruck, Austria, 24 December 1974), *meteorology, oceanography*.

Defant played a key role in changing oceanography from a descriptive to a physics-based science and in bringing atmospheric and oceanic research closer together. His work covered a wide range, from raindrop sizes and precipitation to radiation, to the turbulent structure and the large-scale circulation of the atmosphere, and further on to water-level changes in lakes and in the ocean, to processes in sea straits, to internal waves, and to the large-scale circulation of water masses in the ocean. Understanding the causes and finding adequate mathematical descriptions motivated his work. He was also a most talented teacher and science organizer.

The Meteorologist. Defant was born on 12 July 1884 in Trient, which belonged to the Austrian Empire at that time (since 1919 Trento in Italy). The name Defant is of Ladin origin, from the Romance language which is spoken in certain regions of Trient and South Tyrol. His parents were Josef and Maria Defant. His father was a teacher who later became an inspector overseeing the schools in North and South Tyrol. Albert Defant went to school in Trient and Innsbruck, Austria, and began studying mathematics, physics, and geophysics at the University of Innsbruck in 1902. Wilhelm Trabert was the professor who had the strongest influence in guiding his interests. Defant proved to be thorough and patient in processing and analyzing field data, but also acquired an excellent knowledge of the mathematical treatment of data and physical processes. He received his Doctor of Philosophy with distinction in 1906, with a thesis on the spectral properties of raindrop sizes, and added a schoolteacher's degree in mathematics and physics in 1907.

He then moved to Vienna to work at the Austrian Central Institution for Meteorology and Geodynamics, first as assistant, then from 1909 as head of the weather department and from 1911 to 1918 as Adjunkt (senior researcher). He found a stimulating environment because this was the time when Austrian meteorology was at its height, with many excellent atmospheric scientists working in Vienna. In 1909 he obtained his *Habilitation* (the permission to teach at Vienna University). During the early years in Vienna atmospheric physics was in the center of his interests, with an emphasis on processes in the region such as mountain wind systems including foehn, wave phenomena, thunderstorms, radiation properties in the mountain range, and snow density in the Alps. About twenty publications in professional journals resulted from this research. His work also made him a member of the weather prediction community, and he tackled the practical aspects of weather prediction successfully as is documented by his first book on weather and weather prediction in 1918 (second edition 1926).

During the later years in Vienna his interests shifted gradually to two other themes: changes in the general atmospheric circulation and related physical processes, and water-level changes in lakes and enclosed or semi-enclosed seas. The second topic was at the beginning of his admirable work in oceanography which dominated his research during the later part of his life. During this early phase he developed a new method which permitted him to determine the detailed structure of resonant oscillations (seiches) in lakes, investigated causes of water-level changes, and particularly studied tidal effects in the Adriatic and the Mediterranean Sea, the North Sea, the Red Sea, and the Persian Gulf.

The time in Vienna also brought changes to his private life. In 1909 he married Maria (called Mimi) Krepper. They had three children, Edgar (b. 1910), Erika (b. 1912), and Friedrich (b. 1914).

In 1919 Defant accepted the chair for cosmic physics (emphasizing meteorology and geophysics) at the University of Innsbruck. In the following years the most important themes of his atmospheric research emerged: the structure of high-reaching cyclones and anticyclones, free and forced waves in the atmosphere, and in particular the meridional heat transport, which balances the heat gain at low latitudes and the heat loss at high latitudes. With the sensible meridional heat flux being much too small to achieve this meridional transport, he showed quantitatively that large organized turbulent structures can achieve the transfer of heat to high latitudes. These findings (Defant, 1921) prepared the ground for studies on climate change of later generations of atmospheric scientists.

He published an important book on statics and dynamics of the atmosphere in 1928. But even during this most productive phase in atmospheric research, he continued carrying out oceanic tide studies, and his reputation in that field resulted in an invitation to join two cruises of the German surveying ship *Panther* in 1925 and 1926 in the North Sea. The acquaintance with the practical work at sea gained during these cruises was to constitute an important basis for his future work.

The Oceanographer. In 1926 he finally moved into oceanography when he accepted the chair of oceanography at the University of Berlin in Germany and became the director of the Institute and Museum for Marine Research (Institut und Museum für Meereskunde), then the center of ocean science in Germany. He was the successor of Alfred Merz, the promoter and organizer of the famous South Atlantic Expedition (1925–1927) on the Research Vessel *Meteor*. Unfortunately, Alfred Merz had died during the expedition in Buenos Aires, Argentina, in 1925. When accepting the position in Berlin, Defant had agreed to guide the analysis of the data from the expedition and to take care of the Scientific Results series. He joined the last three legs of the cruise to gain firsthand experience with the data gathering. During that cruise he also became familiar with the joint activities of a multidisciplinary community onboard, consisting of physical oceanographers, chemists, biologists, and geologists.

His work in Berlin was concentrating on the physics of the ocean and in particular on the *Meteor* Scientific Results series, both as a data evaluator and author and as an editor. His ability to analyze observational data with a broad knowledge in physics and mathematics led to an improved understanding in many branches of oceanography. The first large-scale systematic survey in the Atlantic during the *Meteor* expedition (1925–1927) had provided a data set with unprecedented quality and spatial coverage. Defant, together with his colleague Georg Wüst, set a standard of excellence in the presentation of oceanographic data. It was not by chance that Defant concentrated on the upper ocean with the interface to the atmosphere where he could bring in his combined know-how in atmospheric and oceanic processes. His analysis of the water masses and the flow field in the Atlantic formed the basis of knowledge about the upper-ocean circulation. It is now known to be an important component of the global overturning circulation of water masses which form and sink in the northern Atlantic, are transported at great depths to all oceans and after modification become part of an upper-ocean flow to the North Atlantic. These global transports have a major impact on climate change. In particular, he was the first one to use the density field for determining the geostrophic flow in the North Atlantic Ocean down to 2000 meters, including evidence of the extent and structure of the return flow east of the Gulf Stream.

The *Meteor* data set and the results obtained by Defant and Wüst from these data were considered of such fundamental nature that the National Science Foundation in Washington, DC, arranged for the translation of three volumes of the *Meteor* results series by William J. Emery. They were published in 1979, 1981, and 1985. Defant also used data from *Meteor*

anchor stations to identify vertical displacements of equal-density surfaces and showed that they were mainly caused by internal tidal waves and by inertial waves. Furthermore, Defant contributed to the understanding of the role of water masses of Arctic and Antarctic origin and particularly helped to realize the significance of the southward deep water overflow across the Greenland-Scotland Ridge, which is now considered a most essential component of the global overturning circulation. His work on tides continued during that time, and he also became an expert in the understanding of the flow in ocean straits. He wrote two important books on dynamical oceanography in 1928 and on the physics of the ocean in 1931.

He also had a major impact on ocean and atmosphere science by being the leader in building up oceanography in Germany in the early part of the twentieth century, furthering links with the meteorological community and connecting researchers in Germany with the atmospheric and oceanic research communities in other countries. He was an impressive personality. His guidance as a director is related to have been cordial, but at the same time pushing successfully for the best scientific quality possible.

World War II changed working conditions and cut his close connections in particular to his Scandinavian colleagues, but he continued his work in Berlin until 1943 when the institute was first hit by bombing. He managed to save the major part of the institute's oceanographic library by transferring it to the small town of Wunsiedel in the center of Germany. He did some teaching in Vienna and then stayed in Wunsiedel, continuing the work on a fundamental book on physical oceanography on which he had started in 1935, based on his teaching at the University of Berlin. At the end of the war the institute in Berlin was completely destroyed, terminating ocean research in that city. The library in Wunsiedel later became the basis of oceanographic libraries at the marine science institute in Kiel, Germany, and at the German Hydrographic Office in Hamburg.

The Third Phase. Defant returned to Innsbruck in 1945, where he had been offered the chair for meteorology and geophysics. Nevertheless, ocean-related research continued to dominate his work. In 1949 his wife died. Shortly thereafter, he followed an invitation to the Scripps Institution of Oceanography in La Jolla, California in 1949–1950. He served as *Rektor* (president) of Innsbruck University in 1950–1951. In 1952 he married his second wife Maria Theresia Schletterer. After official retirement in 1955, he continued to be an active researcher and teacher by accepting visiting professorships at the University of Hamburg, Germany, until 1956 and at the Free University of Berlin from 1956 to 1958. He wrote a state-of-the-art chapter on tides for the *Encyclopedia of Physics* in 1957.

The publication of his book on physical oceanography had been impossible during the postwar years. With the help of Carl-Gustaf Rossby in Sweden and support from the Office of Naval Research in the United States, he was able to prepare an English version, partly during a stay at the International Institute of Meteorology in Stockholm, Sweden, in 1957–1958. He also had the help of his son Friedrich Defant, an atmospheric scientist who later headed the meteorology department at the oceanographic institute in Kiel, Germany. The two volumes of *Physical Oceanography* were finally published in 1960 and 1961 and became a standard text in oceanography for a long time. Defant himself considered these volumes his lifework. His scientific activities and publishing continued until the mid-1960s. Albert Defant died on 24 December 1974 in Innsbruck.

International Relations and Honors. Defant's work was strongly influenced by the ocean/atmosphere researchers in Scandinavia, in particular by Vagn Walfrid Ekman, Björn Helland-Hansen, Johan Wilhelm Sandström and Jonas Ekman Fjeldstad. Defant was on the same route which was leading from geographical description to a mathematics-physics approach in ocean research. His excellent scientific and personal relationship with Scandinavian scientists is documented by numerous honors: the Vega Medal of the Royal Swedish Geographic Society, Stockholm (1932); the Galathea Medal of the Royal Danish Geographic Society, Copenhagen (1936); memberships in the Finnish Academy of Sciences,

Helsinki (1942), the Royal Academy of Sciences, Göteborg, Sweden (1939), the Royal Swedish Academy of Sciences, Stockholm (1945), and the Norwegian Academy of Sciences and Letters, Oslo (1964).

Defant was also held in high esteem in many other countries, documented by the Agassiz Medal of the National Academy of Sciences, Washington, DC (1933) and the Golden Honorary Medal of the Oceanography Society of Japan, Tokyo (1975 posthumous), as well as honorary memberships in the Russian Geographic Society, Leningrad (1938), the Royal Netherlands Geographic Society, Amsterdam (1939), and the New York Academy of Sciences (1949).

With his scientific achievements and his leadership in organizing top-class research, the scientific honors in Germany and Austria were manifold: Memberships in the German Academy of Sciences Leopoldina, Halle (1919), the Prussian Academy of Sciences, Berlin (1935), the Göttingen Academy of Sciences (1935), the Austrian Academy of Sciences, Vienna (1939), the Academy of Sciences and Literature in Mainz (1949), and the Bavarian Academy of Sciences, Munich (1951); honorary memberships in the Society for Science and Medicine, Innsbruck (1926), the Pomeranian Geographic Society, Greifswald (1939), and the German Scientific Commission for Marine Research (1956).

He received numerous scientific medals and awards: the Ludwig Haitinger Award of the Royal Academy of Sciences, Vienna (1912), the Ackermann Award of the University of Leipzig (1928), the Arrhenius Award of the University of Leipzig (1943), the Honorary Ring of the Austrian Society of the United Nations League, Vienna (1947), the Golden Wiechert Medal of the German Geophysical Society (1956), the Joachim Jungius Medal of the University of Hamburg (1963), the Golden Anniversary Medal of the University of Innsbruck (1974), and the Austrian Decoration for Science and Art, Vienna (1974). He was granted a honorary doctorate by the Free University of Berlin (1958), and was made *Ritter der Friedensklasse des Ordens „Pour le mérite“* in 1962, a distinguished award dating back to a proposal by Alexander von Humboldt in 1842 which has been given only to a select number of scientists and artists. A Festschrift was dedicated to him on the occasion of his seventieth birthday in the *Archiv für Meteorologie, Geophysik und Bioklimatologie* in 1954.

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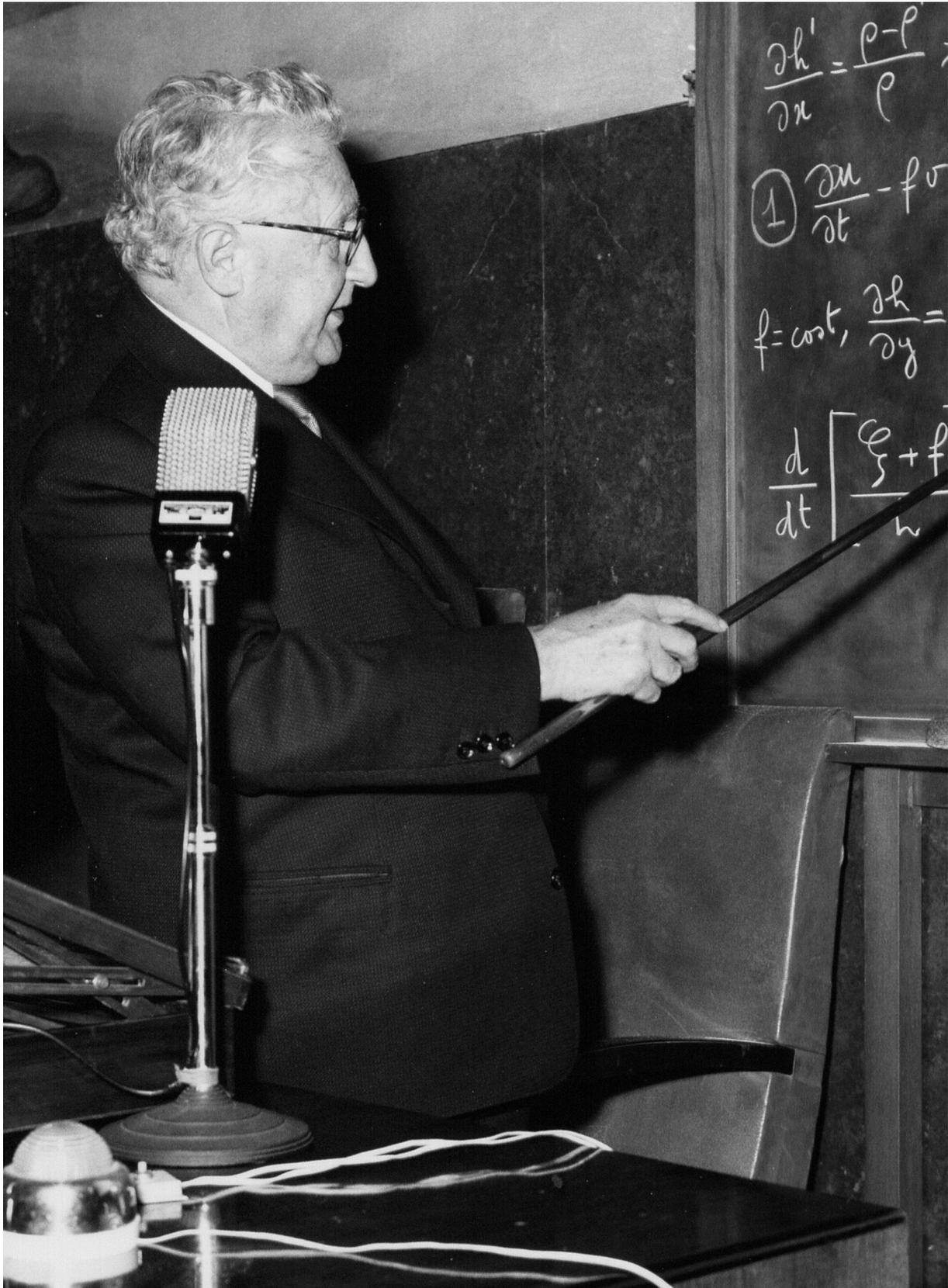
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Gerold Siedler



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