High achiever

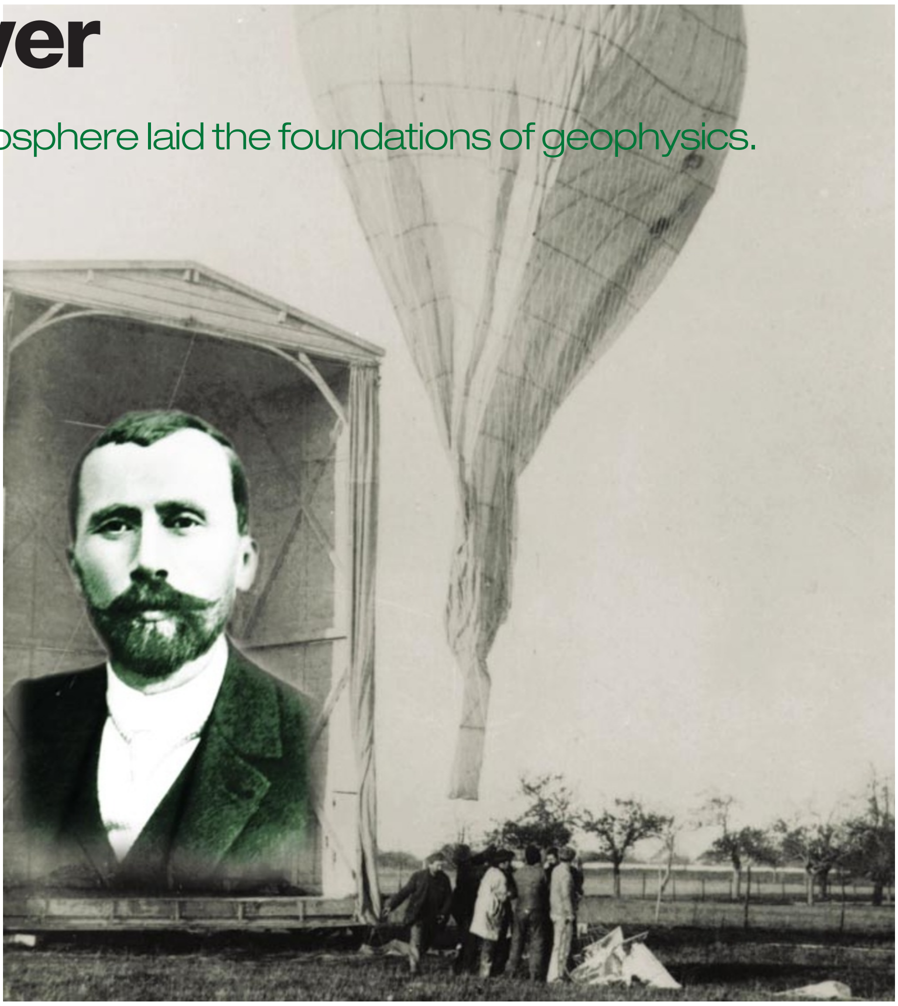
The discovery of the stratosphere laid the foundations of geophysics.

Mott T. Greene

Between 1900 and 1905 the theories of quantum mechanics, special relativity and radioactive transmutation were born, and the atomic theory of matter was confirmed. These events so dominate historical accounts of the period that other breakthroughs languish in obscurity, among them the discovery of the stratosphere in 1902 by the independent French scientist Léon Teisserenc de Bort (1855–1913) — one of the most overlooked events in the history of science.

Teisserenc de Bort, working at his private estate at Trappes, near Paris, was a pioneering investigator of what were then the upper reaches of the atmosphere, up to altitudes of 14 km. He used balloons of his own design, delicate things made of kerosened paper and filled with hydrogen, trailing packets of recording instruments — also of his own design — which parachuted back to Earth.

In 1899 he began a new series of experiments. He had caught the public eye that year when one of his large meteorological kites had broken away, trailing 7 km of wire, and had cut the telegraph link between Paris and Rennes on the day the whole world awaited the verdict in the Dreyfus case. He therefore abandoned kites for a while, and returned to his upper-air work with balloons.



Teisserenc de Bort (inset) was puzzled by what his balloons told him about the upper atmosphere.

The temperature recordings from these new balloon flights were odd. Temperatures decreased with altitude by about 6 °C per kilometre, as theory predicted, but at 11 km or so the temperature record stabilized, usually somewhere between −52 and −54° C, and remained constant for several kilometres. At first, it looked like instrument error — perhaps solar heating of the instrument housing, re-radiated to the thermometer. Teisserenc de Bort wrapped his instrument housings in cork, but saw the same result. He moved the thermometer (a curved strip of two dissimilar metals, expanding and contracting at different rates) outside the housing. Still, the temperatures remained constant, and occasionally even rose. He began to fly the balloons at night to eliminate solar radiation. No change. He decided there might be a seasonal effect and tried flights throughout the year. The signature persisted.

He worked for two full years on the problem, and in 1902, having accumulated 236 ascents to buttress his argument, asserted the existence of an 'isothermal zone' of varying thickness, where the rate at which temperature decreased with altitude diminished to zero, usually at an altitude of 11 km, after which the temperature was constant for several kilometres. The layer was higher over the high-pressure centres known as anticyclones, and lower over low-pressure cyclones. In consequence, he suggested, the problem of the general circulation of the atmosphere would have to be reconsidered, as such an isothermal layer meant that the atmosphere as a whole was not in convective equilibrium, but only that part bounded above by this isothermal zone.

In Germany, Richard Assmann, a much better funded, supported and equipped government meteorologist, read of the work and realized (but too late!) that he had seen the same phenomenon, but had put it down to instrument error. He reviewed the records of his own balloon flights and found that the temperature typically increased for a while above 11 km: Teisserenc de Bort's isothermal zone was really a permanent temperature 'inversion zone'. In the end, neither name stuck, although Teisserenc de Bort came up with names that did stick: the troposphere — 'sphere of change' — and above it the 'stratosphere', a sphere of constant laminar wind-flow around the planet.

Ripples from the discovery spread far beyond meteorology. Between 1902 and 1904 the Swedish oceanographer Vagn Ekman looked for, and found, similar layering of the ocean. In 1909, Andrija Mohorovičić, a Croatian meteorologist, used seismology to establish the existence of a similar discontinuity in the solid Earth now called the 'Moho' or Mohorovičić discontinuity.

The discovery that the Earth–ocean–atmosphere system is composed of concentric shells of different density, from the core of the Earth to the top of the atmosphere, is the founding insight of modern geophysics. This discovery also profoundly influenced the thinking of a young meteorologist named Alfred Wegener, leading him in 1912 to propose the theory of continental drift, with the continents representing the remains of a formerly continuous Earth shell above the ocean floors. Just as air masses and ocean water masses moved under the influence of the Earth's rotation, sliding along surfaces of discontinuity, so, he reasoned, did the continents on a longer timescale — making Teisserenc de Bort not only the discoverer of the stratosphere but an honorary grandfather of continental drift. ■

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