"CROSSING THE ATLANTIC FEASIBLE" SAYS PROF. ROTCH OF HARVARD

He Has Charted the Air Lanes Above the Ocean and Future Balloon Voyagers Will Have Their Wind Currents Marked Out for Them.

A CHART of the ocean of the air, a practical working guide to wind currents, by which the aeronaut or aviator may "lay his course" almost as confidently as does a ship's navigator, has been nearly completed by Prof. A. Lawrence Rotch of Harvard.

In view of Walter Wellman's recent attempt to cross the Atlantic in the dirigible America, it is noteworthy that Mr. Wellman wrote to Prof. Rotch for his opinion, and was told by the Harvard meteorologist that the steady west winds blowing at about twenty miles an hour could not be found lower than 3,000 meters, or very nearly at an altitude of two miles. Mr. Wellman's airship could not attain such a height, so the aeronaut was obliged to take his chances with what Prof. Rotch describes as "the variable surface winds."

Nevertheless, Prof. Rotch has already charted courses for flights from this country to Europe and back again, courses which can be depended upon to carry even a spherical balloon without motive power from one continent to another. He has also laid out the air lanes across this country from coast to coast, with the eddies and "air falls" to be expected at certain altitudes in the vicinity of mountain ranges, although he is not prepared as yet to give an outline of these latter routes.

In fact, Prof. Rotch does not care to have his charts accepted as authoritative, and defers rather to the definitive charts that he expects will be issued by the International Commission for Scientific Aeronautics, which receives wind observations taken on certain days each month, at twenty-five places on land and sea in different parts of the world.

That the wind chart with clearly marked air lanes is the next step toward successful long-distance flights, however, Prof. Rotch does not doubt for a moment, and his long-continued work toward this end was begun before there were any heavier-than-air machines or any dirigibles that were more than clumsy experiments.

As he expresses his recollection of those days, back in the early nineties, his wind observations "possessed chiefly a prospective value." This with a smile, as if he still recalls the jokes that were then made not only at the expense of men who were trying to fly but also of those who took these attempts seriously.

A tall, spare man, with a well-tanned face and keen gray eyes half sheathed by the drooping lids that somehow seem to be the distinctive mark of the aviator, Prof. Rotch might well be taken at first glance as one of the brothers of the air. But here the resemblance ends, for he has viewed the navigation problem of aeronautics strictly from the disinterested standpoint of science. He is a meteorologist first, and whatever he has done in studying the winds, he will tell the insistent inquirer, is a subdivision of his main profession.

A year after his graduation from the Massachusetts Institute of Technology with the class of 1884 he founded the Blue Hill Meteorological Observatory on the summit of Great Blue Hill, the highest point in Boston's Metropolitan Park Reservation, and since then he has made this probably the most famous private establishment of its kind in the country, if not in the world. It is his personal enterprise, and he received the Prussian Orders of the Crown and the Red Eagle in recognition of his studies of the atmosphere before he was invited to take the Chair of Meteorology at Harvard, four years ago.

He was seated in his observatory study overlooking the Neponset Valley and the Blue Hills when the question as to his air chart was broached. His reply was characteristic, for it came as a question.

"Why shouldn't the aeronaut be provided with as much help as we can give him, as much as the navigator of aquatic vehicles?"

He paused next to disclaim any great discoveries to be embodied in his air chart by saying that one of his assistants has been working out certain averages of velocity and direction. Then he turned to the big question of such a chart by saying:

"It is evident that the currents in the various levels of the atmosphere are of vastly more importance to the aeronaut than are the ocean currents or surface winds to the sailor, since the winds above the earth's surface blow much faster than the surface winds, and aerial machines are considerably more bulky than aquatic vehicles of the same carrying capacity.

"Moreover, a balloon or flying machine, wholly immersed in one medium, cannot tack, as a ship floating in the water can advance partly into the wind. Consequently a balloon without motive power can only drift with the current, and a dirigible balloon or flying machine must possess a proper speed superior to that of the current in which it floats in order to make headway against it. Hence the necessity in the case of the balloon without power, and the advisability of the airship or heavier-than-air machine to seek a favorable current in the aerial ocean.

"Since the favorable current may lie at a considerable height, the balloon is best able to rise into it. As yet the airship or dirigible is limited to heights of about a mile. It was for this reason that Mr. Wellman could not go up into the steady west winds between two and three miles up, and this same difficulty seems to be unavoidable as yet in dirigibles that might be said to have limited lifting power.

"Probably no aircraft will be able to stem the tremendous velocities of the higher currents, although the diminished density of the air reduces its pressure. Thus an increase of velocity from 9 meters per second to 54 meters per second means an increase of pressure per square meter from 5 kilograms to 210 kilograms, but the actual pressure of this wind would be only 78 kilograms at a height of 8,000 meters, or five miles. The supporting power of the air is reduced in the same ratio, and since the resistance to propulsion against the average wind at any height increases faster than the density diminishes, it follows that, unless a favorable current can be found, navigation at low levels is preferable.

"The surface winds are more gusty and erratic in their courses because of the obstacles that break the wind currents, obstacles such as mountains, hills, or tall buildings. At night, when there are no ascending currents or changes of temperature, a suitable level for aerial navigation in Summer is at the height of 1,000 meters, or about five-eighths of a mile, for this is a region of little wind and of relative warmth and dryness. In the daytime it is necessary to ascend above the cumulus clouds which mark the limit of the varying surface winds.

"From the observations we have taken, it is shown that an aircraft capable of making a speed of 20 miles an hour would be truly dirigible at low levels in the vicinity of Boston for one day in two during the Winter half year, and on five days in six during the Summer season. If the dirigible could develop a speed of thirty miles an hour there would be only about thirty days in Winter when it could not be propelled in any direction.

"Except for the local sea breezes on our coasts in Summer, the surface winds in these latitudes are too variable to be of practical use in aerial navigation. But with aircraft which can ascend into the so-called planetary winds at a height of 3,000 or 4,000 meters and remain in the air for several days certain high-level international routes appear available.

"At this height of between two and three miles a spherical balloon should be able to cross the American continent from west to east and then cross the Atlantic Ocean at a speed of not less than 15 meters per second, or 30 miles an hour, by the drift alone.

"To cross the Atlantic from east to west, the northeast surface trade winds could be used and the start made from the coast of Northern Africa or the adjacent islands. This trade wind surface route would take the balloon to the West Indies at the rate of about 12 metres per second, or 25 miles an hour.

"These rates are for a balloon without motive power, but for a dirigible that time could be very measurably improved. In fact, for a trip across the ocean, an airship such as Mr. Wellman's should make the trip splendidly if started from the African coast for the West Indies. For the trip from the West Indies eastward again, it is necessary, in order to have a favorable and certain current, to ascend into the high altitudes to catch the southwest counter-trade, which probably furnishes an air lane to the eastward between the West Indies and Teneriffe or Madeira.

"The information regarding wind currents has not been furnished by aeronauts, but chiefly by meteorologists operating from the ground and using sounder balloons or kites for their observations. The first experiments with kites carrying anemometers were made at the Blue Hill Observatory in 1895, and the height attained then was only 600 metres, or three times the height of the hill. At that time there were no flying machines, and the dirigible balloon had only been shown to be possible, so that the information we obtained possessed chiefly a prospective value. It was gathered, however, in anticipation of the day when real flights would become a fact.

"The International Meteorological Conference that assembled in Paris in 1896 was impressed by the recent ascensions of sounding balloons to great heights in Europe, when automatic recording instruments had been placed aboard these small aerostats. We had been doing the same sort of work at Blue Hill with sounder balloons and kites.

"The conference appointed the International Commission for Scientific Aeronautics, which has since been collecting data of the free air. There are a number of observatories where wind tests are made every day, and besides these there are on certain specified days in each month observations taken at some twenty-five places on land and sea throughout the world. These observations are sent to the officers of the commission at Strasburg, where they are codified and published. While intended primarily for the elucidation of atmospheric laws much of the data is of value in aerial navigation.

"In the work which we are doing, exploring the air by kites and small balloons while we remain on the solid earth, we have gradually corrected a great many errors. We have found that in order to obtain reliable observations of wind conditions at different heights on different days it is necessary that these observations be made at a fixed station. If observations are taken at the same height above sea level they may show entirely different wind conditions on the same day and at the same time.

"Formerly it was thought that the conditions above a mountain summit were the same as those at an equal height in the free air, but it is now recognized that both temperature and wind are much influenced by the mass of the mountain, for the wind is accelerated just above the obstacles like water passing over a dam.

"Speaking of this property of the wind, we have found at the Blue Hill Observatory, 200 meters high, that the mean velocity for the year is 7.1 meters per second, or 15.8 miles per hour. The increase is fastest just above the hill. At 1,000 meters the velocity is 10.7 meters per second; at 2,500 metres, 12.5 metres per second; at 3,500 meters, 15.5 meters per second, and at 5,400 meters the velocity is 24.9 meters per second. This increase continues until at the height of 9,500 meters, or six miles above sea level, we find the terrific planetary wind of 80.8 miles per hour.

"We have found that the velocity of the upper winds in Winter is nearly twice the rate in Summer, and in exceeds 100 meters per second, or 223 miles an hour. As to the surface winds, they increase nearly twice as fast at night as in the daytime up to about 500 meters or one-third of a mile. Above this height there is a decrease [illegible] velocity, except in Winter. This decrease continues to about 1,000 meters [illegible] and then begins the rapid increase."

Prof. Rotch has made personal observations with sounding balloons not only at different points in this country and in northern Africa, but he was also a member, some five years ago, of an expedition sent by M. Teisserenc de Bort to explore the atmosphere above the tropical Atlantic. Regarding his conclusions from these experiments that will play an important part in the making of the air chart, he said:

"Over the temperate regions of the globe the surface winds are constantly changing their direction as they blow around the passing areas of high and low barometric pressure. Above these shifting winds the wind is generally westerly, as is proved by the drift of the upper clouds. Whatever the direction of the surface wind in our experiments with sounding balloons at St. Louis, it had a tendency to become westerly at a height of a couple of thousand meters. A wind from the southerly quarter generally turned in a right-handed direction, whereas a wind from the north turned to the left hand.

"In the tropics the wind blows steadily from the northeast north of the Equator, and from the southeast south of it, and it has been assumed that above these winds counter-trades blow in the opposite directions in order that the atmospheric circulation may be completed. On the Franco-American expedition of M. de Bort this theory was confirmed. Above the northeast trade we found that the wind gradually turned until it became southwest, and above the southeast trade there was found an overlying northwest wind. Above the Equator the wind was from the east at all heights.

"Of course there are variations that must be considered, especially in the surface winds, with the exception of the trades, possibly, but the fact remains that there are air lanes available for any course if the aeronaut has a craft that can reach the heights at which the more reliable currents are found. The surface winds are naturally unreliable in this latitude, and for a reasonably safe trip from the New England or Middle Atlantic States to Europe the airship must take the upper lanes."

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