The annual announcement of the department of geology and geography, under the faculty of arts and sciences of Harvard College, shows that the assistant professor of climatology is Prof. R. DeC. Ward and the assistant in meteorology is Frederick M. Wilder. According to the classification adopted at Harvard, meteorology and climatology belong to the general subject of geography and the courses of instruction offered in these lines are as follows:

Meteorology (elementary course).—Lectures, written exercises, observations, and laboratory work. Half course (second half year). Monday, Wednesday, and Friday at 11; a laboratory conference of one hour on Tuesday, between 9 and 1, and additional laboratory hours during the week. Assistant Professor Ward assisted by Mr. Wilder. (IV.)

Meteorology (second course).—Lectures, written exercises, and observations. Half course (first half year). Monday, Wednesday, and Friday at 11, and additional laboratory hours. Assistant Professor Ward.

General climatology.—Lectures, library work, and a thesis. Half course (first half year). Monday, Wednesday, and Friday at 2:30. Assistant Professor Ward.

Climatology of the United States.—Lectures, library work, and reports. Half course (second half year). Monday, Wednesday, and Friday at 2:30. Assistant Professor Ward. (VII.)

Of the four courses above mentioned, the first two are intended, primarily, for under graduates; the two latter are intended for the higher classes and possibly for post graduate students having satisfactory preparation. These courses are usually taken in connection with courses in geology, medicine, engineering, and geography. They should also be taken by those who pursue courses in pedagogy with a view to becoming practical teachers of physical geography in high schools and normal schools.

A similar course is carried on at Johns-Hopkins University by Dr. O. L. Fassig, without interfering with his duties as a section director in the Weather Bureau. His courses of lectures next year for students and school teachers, respectively, will be somewhat more extensive than those delivered during the past year. These latter numbered in all seventeen; a complete synopsis of each was circulated at the time of delivery, and the collected synopses form an excellent suggestive basis for a treatise on meteorology or for the preparation of other courses of lectures. These lectures form a part of the system of instruction in advanced physical geography, and are organized under the department of geology.

THE INTERNATIONAL METEOROLOGICAL CONGRESS, PARIS, SEPTEMBER 10-16, 1900.

Through the kindness of Professor Angot, Secretary of the International Meteorological Congress, held in connection with Exposition of 1900 in Paris, the Editor has lately received an early copy of the forthcoming proceedings of the congress. Among the many items mentioned therein, perhaps the following will be interesting to American readers.

In his opening address President Mascart, after alluding to the fundamental source of all meteorology, namely, the action of the solar radiation on the land and water of the globe, says:

> If this view is correct, we see how important must be the study of the upper regions of the atmosphere, of its temperatures and its winds, and of the distribution and transformation of the clouds. * * * We are on the way to realize the complete scientific conquest of the atmosphere. We shall perhaps soon see aerial stations furnishing daily reports adapted to improve the present imperfect service of weather predictions.

With regard to the moon, he says:

> Denials and one-sided statements are not scientific. Every sincere research merits discussion, and the question of the moon is not yet exhausted.

With regard to terrestrial magnetism, he says:

> Here we perceive the periodicity of sun spots, and the perturbations are often accompanied by polar auroras, which express, under another form, the disturbances of the upper regions. These (electric) currents circulate for the most part within the crust of the earth, but the diurnal variations would seem equally to show that a current exists in the atmosphere; possibly also there may be an exchange between the ground and the air.

The second session opened with the reading of the first memoir by Hepites of Bucharest on the Rainfall of Roumania.

Dr. Assmann, as Chief of the Aeronautic Division of the Meteorological Service in Berlin, presented the first copy of the great work on scientific balloon voyages executed by the German Aeronautic Society in Berlin, and edited by Assmann and Berson. He said:

> These volumes show, without any doubt, that in the contest between the observations by Glaisher and modern thermodynamic theories, it is the theory that has achieved the victory. * * * *

The first volume contains the general history of the scientific balloon, and the subsequent development of modern scientific balloons. The instruments and methods of observation, calculation, and deduction have been discussed and, finally, all the original data are given as resulting from seventy-five scientific ascensions by Berson. The second volume contains the description and results of special ascensions during the years 1888–1899 undertaken by different officials, each of whom describes and discusses his own work. The volume closes with the results of self-registers, both in captive balloons and sounding balloons. The third volume contains discussions of the general results with regard to temperature, moisture, clouds, the wind, solar radiation, and atmospheric electricity, concluding with an important theoretical chapter by Professor von Bezold. The editors expressly protest against any intention of considering this work as a complete discussion of the material thus far collected. On the contrary they hope that much and better scientific results will follow. The three volumes, in large quarto, make a very imposing appearance, and constitute a worthy dress for this important contribution to our knowledge. The most impressive event of the meeting immediately followed Dr. Assmann's remarks, in that President Mascart addressed a telegraphic dispatch to the aged meteorologist and aeronaut, Mr. James Glaisher, the nestor of meteorologists, expressing the congratulations of the congress that he had lived to see the great progress accomplished by means of balloons.

The second memoir was then read by Dr. Börnstein on the Variation of the barometer during the siderial lunar month. This memoir is published in full at the end of the proceedings, and maintains that the hourly records at numerous stations during the past twenty years, show a simple oscillation during the siderial month whose maximum and minimum pressures occur some days before the southern and the northern lunistice. The total range of this oscillation is from two to four millimeters. It agrees, therefore, in general, with the results deduced by A. Poincaré, from the study of the daily weather maps of the Northern Hemisphere that were published for many years by the Chief Signal Officer of the Army.

M. Lemoine presented a paper on the Prediction of river floods in France, which is also printed among the memoirs.

Much interest was shown in a communication by Sprung, director of the meteorological observatory at Potsdam, describing an automatic apparatus for the photogrammetric measurement of the height and motion of the clouds. The two parts of the apparatus are established at Potsdam, about 1,500 meters apart, and Dr. Sprung exhibited a large number of photographs obtained with this apparatus, some of which show very clearly the importance of his researches on

the dynamics of the atmosphere. His memoir is the fourth of this collection.

The remarks of M. Durand-Gréville on the Mammato-cumulus, are printed in the proceedings, and have in fact, also been printed elsewhere. But his article on some barometric changes that accompany a thunderstorm is published as the fifth of the memoirs.

As some confusion seems to prevail relative to the nomenclature of mammato formations, the Editor hopes to have an early opportunity to speak on this subject.

M. Crova announced that the brother of M. E. Roche has undertaken to publish a collection of the memoirs of the latter, reprinted from various sources, and an early copy of this volume was presented to the congress by M. A. Roche.

The meteorological service organized in Spain and the Balearic Isles was described by M. Gorria y Royan whose paper is published as the sixth memoir.

M. Edelstam, Civil Engineer of Upsala, on behalf of Prof. Knut Angström, read a short but important paper by the latter on Actinometric observations at various altitudes, and on the electric compensation pyrheliometer. This paper presented the results of observations made with Angström's new instrument at Teneriffe during the summers of 1895–6. The errors of measurement probably do not exceed 1 per cent; the accuracy of determination of the solar constant is, however, limited by our uncertainty as to the laws governing the absorption of heat by the atmosphere; owing to this it is not yet possible to state with confidence, whether there will be any material alteration of the value hitherto adopted.

The seventh memoir is that by Ernst, of Zurich, on the graphical methods of presenting the weather.

Hilderbrandsson, of Upsala, gave a summary of his official report on the results of international measurements of the heights and movements of clouds. Among these results, he mentions the following: (1) The altitudes of clouds, especially the upper clouds, diminish from the equator toward the pole, as do also the ranges between the maximum and minimum altitudes. (2) The altitudes in general increase with the temperature of the air at the surface of the ground. There are, however, many exceptions to this rule. (3) The altitudes generally increase with the pressure of the air up to a pressure of 760–770 millimeters, but only to again decrease when the pressure becomes greater. (4) There is no clear relation between the height of the clouds and the direction of the barometric gradient. (5) The velocity of the wind at all cloud altitudes is greater in winter than in summer. (6) This velocity increases as the north latitude diminishes, at least down to the latitude of Washington. On the other hand, at Manila the velocity is very small—much smaller even than at Bossekop, near the North Cape. This probably results from the fact that the Philippines are situated at the boundary between the east winds of the tropical zone and the west winds of the temperate zone. (7) The mean direction of the upper winds is nearly always from east to west within the Tropics and from west to east in the temperate zones. (8) In the temperate zones the west wind has generally a component toward the equator in the winter time and a component toward the pole in the summer time; for example, in Europe the wind is between wnw. and nw. in the winter time and between wsw. and sw. in the summer time.

Hildebrandsson exhibited and explained the resultantometer, an instrument invented by Sandström in order to mechanically determine the amount and direction of the resultant of many observations of the wind. Angot stated that an analogous instrument, constructed many years ago by Besson, is described in the Annuaire of the Meteorological Society of France.

The director of the Meteorological Service of Japan, M. Nakamura, presented a memoir on the diurnal variation of the temperature at Tokio, which is printed as the eighth memoir. He also exhibited and explained the soroban, a sort of abacus, or calculating machine, used in the extreme East from the most ancient times, and which, by the simplicity of its construction and use, is superior to all the calculating machines employed in Europe. The soroban is composed of a series of vertical parallel rods, on each of which are strung six balls; each rod is intersected by a horizontal bar; one of the balls is on the upper side of this bar, the other five on the lower side. The upper ball represents five units of the order corresponding to one of the lower balls. By sliding either the upper ball or one or several of the lower balls along the horizontal bar, one can represent any figure whatever, and consequently any number by combining the balls of the different rods. This instrument can be used simply and rapidly for addition, subtraction, multiplication, division, and even the extraction of square root.

Dr. Steiner, of the Hungarian Meteorological Institute, expressed the interest that would be found in an annual publication constituting a repertorium of all meteorological publications, and desired that the congress should pass a vote to the international committee to consider this question. M. Rücker remarked that this subject had already been fully provided for in the publication undertaken by the Royal Society of London of a general bibliography of all the sciences.

Father Algué, of Manila, presented the ninth memoir, on the Relation between the microseismic movements of the soil and cyclonic storms.

Dr. Sprung, of Potsdam, in the tenth memoir, compared the duration of rainfall as measured by self-registers with that obtained by estimation, according to Koeppen's method, and finds that the latter gives results two or three times larger than the former, and is to be recommended.

The eleventh memoir was also by Dr. Sprung, on a Telemeter for measuring the heights of clouds. This is the new stereo-telemeter constructed by Zeiss at Jena some five years since, and is the only one that can be used upon objects when they are in motion. It is described in the eleventh memoir of the appendix.

M. Balif, delegate from the Government of Bosnia-Herzegovina, read a report on the Meteorological organization in that country and the results of rainfall observations.

Captain Chaves explained the condition of the meteorological service of the Azores.

M. Nakamura presented a number of his memoirs on the organization of the meteorological service of Japan.

Professor Piltschikoff, of Odessa, presented photographs and a memoir on lightning, also a paper on the polarization of sky light, which are published as memoirs twelve and thirteen.

At the fourth session memoir by M. Chaumeil, on an Improvement in the rain gage was read by M. Angot.

The fourteenth memoir was that by Marchand, Director of the Observatory on the Pic du Midi, and was entitled On the relations between the solar phenomena and those of terrestrial physics.

Van Bebber, of the Deutsche Seewarte, presented a copy of the Decade Bulletin of that institution.

The fifteenth memoir was that of M. Garrigou-Lagrange on the General movements of the atmosphere in relation to the positions of the sun and moon.

Dr. Onimus spoke of the desirability of replacing the expression "tension" of aqueous vapor by some other word such as that of "pressure." He also presented an apparatus for measuring the intensity of light.

The sixteenth memoir was that by Paulsen, of Copenhagen, on the Spectrum of the aurora.

M. Rouna, in the name of M. DeKonkoly described the new meteorological and magnetical observatory established at O' Gyalla, and M. A. L. Rotch spoke of the principal results at Blue Hill.

In the seventeenth memoir M. Leon Teisserenc de Bort gave a summary of the systematic atmospheric soundings that have been taken at his observatory for dynamic meteorology at Trappes, near Paris, since April, 1898. Two hundred and fifty balloon ascensions have been made, and the height of 10,000 meters, or more has been attained 104 times. Nearly all these balloons were of varnished paper, and the capacity varied between 50 and 88 cubic meters. Notwithstanding their small size they attained altitudes of 14,000 meters or more, about twelve times.

The kite ascensions have been very numerous, and rapid progress has been made since we have learned to make up the line in a rational manner, which permits keeping the average inclination of the wire constant whatever may be the length of the line. This system is peculiar to the observatory at Trappes; the highest ascension was 5,150 meters on the 10th of August, 1900. By employing the same system of line, Assmann has attained 4,600 meters, and it is not to be doubted that still greater altitudes can be attained.

Prof. A. J. Woeikoff, of St. Petersburg, spoke of the necessity of studying the upper regions of the air under the Tropics and in the interior of Asia. Others, replying to this, while recognizing its importance, laid stress upon the material difficulties of work experienced in that country.

The eighteenth memoir was by M. Ventosa, on the Determination of the direction of the upper winds by means of the undulations of the images at the edges of the stars. Pernter, of Vienna, announces that a very different view of the subject from that taken by Ventosa is expressed in a forthcoming memoir by Exner.

M. Hervé announced that he has prepared a general bibliography of aeronautics and the dynamics of fluids. This bibliography will be published in Vols. IX–XII of the Revue de l'Aéronautique.

The nineteenth memoir was by M. L. Pallazzo, Director of the Central Meteorological Bureau of Italy, in which he described the organization of the stations established in northern Italy in order to study thunderstorms and check the results obtained by the bombardment of hail clouds.

The twentieth memoir, by M. F. Houdaille, gave a résumé of his mission to upper Italy in 1900 in order to study the organization of the bombardment of hail. M. Rona, Assistant Director of the Meteorological Service of Hungary, gave a résumé of the experiments made in his country to protect the crops from hail by cannonading. He stated that the institute is not yet in a position to give a decided response as to the success of this method, since the problem of the formation of hail is not yet understood, but he could not deny, *a proiri*, that there may be a possibility of success, and he would remit the decision to the experience of many years. The experience of one year will not suffice as a basis for a definitive judgment as to the success of this method. Certainly the people themselves are enthusiastic.

Professor Pernter, of Vienna, remarked that it was necessary to be very conservative with reference to practical results that seemed to have been produced. The experiments made by himself and Trabert showed that in most cases the smoke ring from a cannon did not reach to the height of the clouds.

M. Capus, a delegate from French Indo-China, gave details as to the meteorological work in that country.

The twenty-first memoir was by M. Sprung, who explained his balance barometer of most recent construction. He also remarked that the same method of construction appears in the Marvin barograph and the Marvin self-registering rain gage.

The twenty-second memoir, undoubtedly a very important one, was by Rykatcheff, Director of the Central Physical Observatory at St. Petersburg, and gave the result of a comparison of temperatures and humidities observed under different kinds of shelters parallel with measurements made by means of Assmann's aspiration psychrometer.

M. Kesslitz, chief of the meteorological and magnetic service at Pola, Austria, proposed that the congress recommend that all meteorological services and institutions contribute to the systematic seismological observations and publish them in the daily telegraphic bulletin. This proposition seems to have originated in the Academy of Sciences at St. Petersburg.[1]

Captain Chaves stated that the daily dispatches from the Azores always included earthquake phenomena. The proposition of M. Kesslitz was referred to the international permanent committee.

Father Dechevrens spoke upon the variation of the temperature with altitude within cyclones, as shown by the observations on the tops of mountains. He explained the misapprehensions that seem to exist relative to his announcements of 1886 and 1887, to the effect that from the level of the ocean, and up to an altitude of 1,200 meters, the temperature within a whirlwind, either cyclonic or anticyclonic, varies inversely as the pressure, while in layers above this altitude it varies as the pressure.

Paulsen, Director of the Danish Institute, explained his method of measuring the electric potential of the air as used by him in Iceland in 1899–1900.

The twenty-third memoir was by Teisserenc de Bort, and presented a résumé of the principal results as to the vertical distribution of the temperature deduced from sounding balloons and kites.

M. Hergesell gave some account of the labors of the aeronautic committee, following which the congress resolved that the progress of meteorology demands that international simultaneous balloon ascensions be made periodically at fixed dates, that these ascensions should be supported by kite ascensions and cloud observations; that all institutions for meteorological study, or for military ballooning, should be invited to participate in these ascensions.

The twenty-fourth memoir was by Mr. Walz, giving a report on the collaboration of the Weather Bureau, with the works of the international committees. Mr. Walz also submitted to the conference copies of Professor Bigelow's report on the international cloud work.

Mr. Wragge, of Queensland, Australia, after giving some details about the organization of his service, submitted the twenty-fifth memoir, A note on the mountain observatories of Kosciusko (2,235 meters altitude) and de Merimbula (near the base of Mount Kosciusko, in New South Wales).

Finally, Dr. Blitz, of London, presented a communication on the Principles of meteorology; but President Mascart explained that an especial point of view elaborated in this paper removed it from the list of questions that could be advantageously discussed in this general assembly.

The sessions of the special committees on international meteorological telegraphy; on solar radiation; on cloud observations; on terrestrial magnetism, and on scientific aeronautics are also reported in full in this volume of proceed-

[1] About 1885, at the instigation of the Editor, an attempt was made to form a joint organization between the different governmental departments in Washington, interested more or less directly in earthquakes. The meetings of the committee promised to result in considerable addition to our knowledge, and to an organized system of observation. New forms of apparatus were devised and constructed, but unfortunately the movement was not kept up. It would not be difficult for the Weather Bureau to collect and publish crude earthquake reports, but it is not likely that such publication would add much to exact science, and it is undoubtedly more proper to wait until such work is recognized as one of the duties of the United States Geological Survey.

ings, and add eleven more memoirs to the above list, making thirty-six in all, so that the whole constitutes one of the most important recent meteorological publications and gives one a clear impression as to the advanced problems that agitate meteorology at the close of the nineteenth century.

The editorial work, by Professor Angot, has been executed most conscientiously and the pages bear no evidences of the many vexatious annoyances and delays to which he was subjected in the course of the work.

KNUT ANGSTROM ON ATMOSPHERIC ABSORPTION.

While the recent Bulletin G by Prof. F. W. Very, on atmospheric radiation was in press, Prof. Knut Angström of Upsala, was preparing a short paper on the part played by aqueous vapor and carbon dioxid gas in the phenomena of absorption in the earth's atmosphere, which was published in the Annalen der Physik immediately afterwards. In this memoir based on unpublished researches of Dr. J. Koch at Upsala, on the absorption of radiation from heat sources at different temperatures by various depths of gas, Professor Angström approximately determines the influence of a layer of carbon dioxid gas 30 centimeters thick and under a pressure of 780 millimeters, absorbing the radiation from a black body at 100° temperature, and finds that it is about 10 per cent and that it does not change more than four-tenths of one per cent of the original radiation when the pressure is decreased to 520 millimeters. He infers, therefore, that a layer so thick as to be equivalent to that contained in the earth's atmosphere will absorb about 16 per cent of the earth's radiation, and that this absorption will vary very little with any changes in the proportion of carbon dioxid gas in the air. This limitation of the absorption to spectral regions between definite wave lengths is also rendered very probable by Paschen's observations in the Annalen der Physik, volume 51, page 33.

The influence of carbon dioxid gas in absorbing the direct radiation from the sun is more difficult to determine; it certainly absorbs all the broad band designated by the letter Y in the solar spectrum, but this does not amount to more than one-fifth per cent of the total solar radiation.

An attempt is made to determine the absorptive effect of aqueous vapor on the total solar radiation. By passing a smooth curve tangent to the maxima of the energy curve of the solar spectrum between 0.3 and 4.0 microns, and assuming, what is no doubt true, that the difference between these curves is principally due to the absorption of aqueous vapor, minimum values of 15 and 27 per cent are obtained for this quantity with solar altitudes 32° and 5° 40′, respectively, the pressure of the vapor of water being 3.3 millimeters and relative humidity 70 per cent at noon. An additive correction of 5 per cent is made to allow for the absorption of solar rays of greater wave length than 4 microns, giving 20 and 32 per cent, respectively, which are considered to be maximum values of the aqueous absorptions under the given conditions. But since the total radiation had diminished from 1.320 to 0.627 small calories, or by more than 50 per cent, between the high-sun and the low-sun measurements, and as a considerable part of this additional loss is undoubtedly to be attributed to the vapor of water, one or the other of the maximum values assigned for the absorption of total solar radiation by aqueous vapor may possibly need to be doubled.

The remainder of Angström's paper is devoted to a destructive criticism of the theories put forth by the Swedish chemist, S. Arrhenius, in which the total absorption of CO_2 is quite inadmissibly inferred from data which include the combined absorption of CO_2 and the vapor of water. On these incorrect premises Arrhenius has founded an hypothesis as to the cause of the Ice Age, attributing it to variation in the amount of atmospheric CO_2. The geologists who have adopted Arrhenius's views should recall that his hypothesis evidently fails in the light of present knowledge of the absorptive powers of carbon dioxid.

Undoubtedly the aqueous vapor powerfully absorbs the terrestrial radiation, but no quantitative estimates of its effect are made by Professor Angström.

The preceding preliminary statement by Angström is of interest in connection with the very instructive article published by Maurer in the Meteorologische Zeitschrift for May, 1901. A translation of this article will be interesting, not only on account of its high appreciation of Professor Very's work, but because of its instructive presentation of the present state of our knowledge of the obscure but very important details of atmospheric radiation and absorption.

On the basis of Very's quantitative determinations of aqueous absorption in certain special cases, Maurer adopts the value of 75 per cent for the atmospheric absorption of radiation from a terrestrial surface at the freezing point, obtaining thereby the further estimate of 0.052 small calories per minute as the radiation from such a surface toward space. But, as is evident from the variation in the aqueous absorptive power, which Professor Very has demonstrated and which he attributes to the varying complexity of the vaporous molecules, depending upon the prevailing relative humidity, such estimates must be subject to a wide range of uncertainty.

A more exhaustive report on the general subject of atmospheric absorption will be published in a few months in the MONTHLY WEATHER REVIEW.—*F. W. V.; C. A.*

ERRATA.

MONTHLY WEATHER REVIEW for April, 1901, page 176, column 2, interchange lines 24 and 26 from the bottom.

MONTHLY WEATHER REVIEW for May, 1901, page 212. In table of meteorological observations at Honolulu, make max. sea-level pressure for the 12th read, "30.11", instead of "29.11."

MONTHLY WEATHER REVIEW for May, 1901, page 213, column 1, line 4, in the expression "thirty-four of new forms," omit the word "of." Page 211, rainfall table for Hawaii, column 2, heading for "elevation," read "elevation approx." Page 211, table of rainfall data for Hawaii, column 2, for "Kukuinaele," read "Kukuihaele;" for "Kohola," read "Kohala;" for "Hawi Mill," read "Hawi;" for "Kipahullai," read "Kipahulu;" for "Keomoku," read "Keomuku;" Manoa, "Woodlawn D" should read "Woodlawn Dairy;" for "Makiki" (reservoir), read "Makiki," and add approximate elevation "150 feet;" Nuuanu (electric station), elevation, for "450," read "405" feet; for "Waimamalo," read "Waimanalo;" for "Wahiawa, Mount," read "Waiawa, Mountain;" Olowalu, annual normal rainfall, add "8.80" inches; transfer annual normal rainfall "34.80" inches from "Haiku" to "Kula (Erehwon)." Same page, column 1, line 9 from bottom, highest mean temperature at sea level, for "84," read "86."

Page 212, column 1, line 6, extremes of precipitation, for "0.07 at Niulii," read "0.02 at Awini;" same line, for "Wahiawi, Mount Kauai," read "Wahhiawa Mountain on Kauai Island. Same page, column 1, line 4 from bottom, barometer, greatest 24-hour change, for "0.9," read "0.09;" column 2, line 7, Kapiolani Park, for "—," read "no report;" line 29, average temperatures, Oahu, add "mean 75.4°."

Page 219, "Hail Insurance," column 2, line 13, "167,340,000," should read "167,270,400;" line 16, for "1,000,000," read "5,000,000" tons; line 20, for "5,000,000 foot-tons," read "five thousand million;" lines 30 and 31, "by an engine of 1,000,000 horse-power, and therefore represents the work," to be struck out, and line 31, "1,000,000," should read "5,000,000;" line 33, "local winds," should read "forces of evaporation and diffusion."