

picture of the weather and water conditions of the Pacific Ocean, all ships and all lighthouses operating in this region should be equipped to take water temperature and atmospheric pressure observations. These observations should be made available within a month of the time they are taken, if possible at some international establishment where they can be used immediately for the construction of maps. At this bureau, there could be a corps constantly engaged in mapping the data, getting averages for 10-day and 30-day maps, and making the computations necessary for the construction of forecast maps.

On the research side a profitable beginning has been made by T. Okada⁸ and others in their investigations of weather correlations in the Pacific region. In closing, I wish to call attention to the desirability of applying to the Pacific certain correlations which have been worked out for the Atlantic Ocean. P. H. Gallé is now making winter temperature forecasts for central and western Europe on the basis of the strength of the trade winds during the preceding May to October.⁹ February to March and March to April temperatures for the same region are indicated fairly well by the pressure gradient between Copenhagen and Stykkisholm during the preceding September to January, inclusive, or by the December water or air temperatures on the middle Norwegian coast.¹⁰ The summer temperatures in all the Baltic region are indicated by the winter temperatures of the water about Iceland; and the general character of the April to September rainfall at Berlin, at least, is indicated by the Thorshavn rainfall of the preceding January to March.¹¹

Expressed in terms of the Pacific region, these correlations would be as follows: The departures of the strength of the trade wind from the normal at Hawaii during the period May to October (perhaps earlier) may indicate a departure of the same sign in British Columbia during the months December to February following. The pressure gradient between Seattle and Dutch Harbor, September to January, inclusive, or the December air or water temperatures on the coast of southern Alaska when compared with the corresponding values of the year before may give a direct indication of the coming February to March and March to April temperatures relative to those of the same periods of the year before, which will probably have a chance of verification greater than 80 per cent in the region west of the continental divide and north of the forty-second parallel. Finally, the winter water temperatures at Dutch Harbor, and the January to March rainfall on the south Alaskan coast may give for the following summer a direct indication of the temperature and rainfall, respectively, for British Columbia and Washington.

These are, necessarily, rather generalized weather indications; and in themselves may not be of much use. They are, however, convenient as starting points for the many years of investigation which lie ahead of us to determine what the meteorological conditions of the North Pacific are, and how they may be used for making seasonal forecasts for the bordering lands, and with the help of Atlantic conditions, perhaps for the whole of North America.

OCEAN TEMPERATURES AND SEASONAL WEATHER IN SOUTHERN CALIFORNIA.

By WM. E. RITTER and GEO. F. McEWEN.

(Extracts from open letter, dated La Jolla, Cal., Nov. 9, 1918.)

So much does the well-being of the people of California and the whole western United States depend on the amount of precipitation and its time of occurrence each season, that even small, if trustworthy, [advance] indications would be valuable.

The researches on the ocean water off the coast of Southern California prosecuted by the Scripps Institution during the last 10 years, coupled with United States Weather Bureau records for the same time, bring to light somewhat suggestive facts.

Stated very briefly, they are these: During July, August, September, and October, 1917, the temperature of the sea at the institution averaged about 5° F. higher than for the same months of the preceding nine years, and the force of the northwest ocean wind for the same time was about 20 to 30 per cent below the average.

These exceptional conditions of water and wind were followed, as is well known, by exceptional weather conditions of the ensuing winter months. There was almost no rain until January, 1918, and the total precipitation was low for all California.

The conditions of sea and wind for summer and fall months of 1918 have repeated in essential features the conditions of those months for 1917.

As to the character of the data, there can be no question so far as concerns the sea temperatures at La Jolla for the period of February, 1916, to the present (November, 1918). Six temperatures a day, distributed evenly through the 24 hours, every day in the year except Sundays, are taken at the outer end of the institution pier; that is, where conditions are almost typically oceanic. In addition to this extensive and systematic series of temperatures many are taken at numerous stations near shore, and offshore to a distance of 75 to 100 miles from Point Conception to far south of the United States-Mexico boundary line. For the time previous to the completion and utilization of the pier, all temperature observations were of the distributed, intermittent kind, though in the aggregate large numbers were made.*

The defectiveness of the data in this case is the small number of years and the narrow area over which the observations extend. To give such data high predictive value, they would have to be extended over many years and over a far larger portion of the ocean.

As to the question of whether there are known cases elsewhere of connection between peculiar weather conditions on land and peculiar conditions of the ocean, it is to be said that while knowledge in this field is exceedingly meager, some of what we do possess indicates strongly the existence of such connections, and that investigations carried on long enough and widely enough will make possible seasonal and long range weather forecasting on the basis of a combination of atmospheric and oceanic observations much as daily forecasts are now made from observations on the atmosphere alone.¹

⁸ Journ. Meteorological Soc. of Japan, December, 1915, May and June, 1917; also, M. W. R., 1916, 44: 17-21, 238-240; 1917, 45: 299-300, 535-538.

⁹ "On the relation between the summer changes of the North Atlantic trade winds and winter temperature in Europe." Proc. Amsterdam Roy. Acad. of Sci., vol. 18, 1916, pp. 1435-1448.

¹⁰ W. Meinardus "Ueber einige meteorologische Beziehungen zwischen dem Nordatlantischen Ozean und Europa im Winterhalbjahr." Met. Zeits. 1898, 2 pl., pp. 85-104.

¹¹ H. H. Hildebrandsson "Quelques recherches sur les centres d'action de l'atmosphère." V. (last). Kungl. Svenska. Vetenskapskad. Handl. Bd. 51, No. 8, 1914, 16 pp., 13 pl.

* Cf. Summary and Interpretation of hydrographic observations made by the Scripps Institution for Biological Research of the Univ. of California, 1908-1915. Univ. of Cal. Pubs. in Zool., Dec. 6, 1916, v. 16: 235-356, pls. 1-38.—Ed.

¹ Those who would like further information relative to oceanic conditions and their relation to the weather will find a popular treatment of these subjects in Bull. No. 7, of the Scripps Institution for Biological Research of the University of California, at La Jolla, Cal., by George F. McEwen, oceanographer, entitled: "Oceanic Circulation and Its Bearing Upon Attempts to Make Seasonal Weather Forecasts: a Sketch of Observational Methods and Explanations." The paper is now in the press and will soon be ready for distribution by the Scripps Institution.