mentary to us as a nation to say that our patriotism, fear of death, or nerves compare unfavourably with similar attributes of the Japanese; and, after all, this is a matter of opinion. The fact to face is the transformation which science has effected in Japan, and the sooner our statesmen are educated to see it, the more promising will be the outlook for the British nation.

SOLAR CHANGES AND WEATHER.

DURING the last few years more than usual attention has been paid to the question of the relationship between sun-spots or prominences and "weather," and to the possibility of being able in the near future to forecast the characters of approaching seasons. Quite recently in this Journal (vol. lxxi. p. 493, March 23) we referred briefly to a pamphlet published by the United States Department of Agriculture, Weather Bureau, summing up the general state of the problem of long-range weather forecasting. In this it was stated that advances in the period and accuracy of weather forecasts depend upon a more exact study and understanding of atmospheric pressure over large areas, and a determination of the influences, probably solar, that are responsible for normal and abnormal distributions of atmospheric pressure over the earth's surface.

In the April number of the *Popular Science Monthly* the question of the relationship between sun-spots and weather is summarised in an article by Prof. Ernest W. Brown, of Haverford College. In this we have an interesting account of the problems waiting solution, and he brings together in a very clear manner a general survey of the relationship, or rather non-relationship, as he concludes to be the case. Thus he says, "it is highly probable that the direct effect of the spotted area is unimportant compared with the effects produced in our atmosphere by other causes." In his final summing up he remarks that his opinion is expressed by Prof. Cleveland Abbe, who stated that:—"The key to the weather problem is not to be found in the sun or indeed in any external influence, but that the solution is to be worked out by the conditions which hold in the atmosphere itself—conditions which can only be discovered by a thorough examination of the internal laws of motion, quite apart from any external forces which may modify the results."

In referring to the difficulties which are met with in examining the meteorological conditions on the earth's surface, Prof. Brown points out that observations made "at one place should be kept separate from those at other places, for it is theoretically possible and even probable that a maximum at one place of observation may occur at the same time as a minimum at another place. For example, the yearly averages might show that a maximum rainfall in one place always occurred with a minimum rainfall in another and *vice versâ*."

In the last quotation Prof. Brown makes a suggestive remark which recent work has shown to be an actual meteorological fact; it has already been completely established for pressure, and must therefore hold good as regards rainfall, since the latter depends on the former.

In the case of these variations of barometric pressure it has been shown, and referred to at some length in this Journal (vol. lxx. p. 177, June, 1904), that there exists a barometric see-saw on a large scale the presence of which has been amply corroborated by Prof. Bigelow, of the United States Weather Bureau. There seems little doubt that it is this pressure change that will eventually prove the "key" to the situation, and its solar origin has already been suggested in the changes in the frequency of prominences, which are, after all, allied to sun-spots.

Up to the present time those who have been attempting to explain variations of weather on the supposition of solar changes have been looking for the effect of solar action as either increasing or decreasing simultaneously the rainfall over the whole earth. The consequence has been that a study of a great number of statistics has shown that in some regions the rainfall varies directly with the number of sun-spots, and that in others the variation is inverse, while, again, in other parts there seems to be no apparent relation at all. In fact, these deductions, though quite correct, have led to the conclusion that the solar connection is of a very questionable character, as it was considered impossible for such opposite results as the first two just named to have their origin in one solar change.

It is the employment of this incorrect working hypothesis that has probably retarded the progress of the study of the connection between solar and meteorological changes.

The now recognised existence of this barometric see-saw shows that the sun's action must have a *double* effect on our atmosphere, and this of an opposite nature. Such a result is quite natural, and it is curious that use has not been made of it before.

When it be considered that the amount of air in our atmosphere is a constant quantity, a greater piling up of it on one side of the earth must necessarily mean a diminution in the antipodal regions. If greater heating power of the sun takes place, then the atmosphere must also be heated to a greater extent, and consequently more intense up-currents of warm air are formed, resulting in more pronounced low-pressure areas. There must, however, be a compensating effect somewhere, and this is found on the opposite side of the earth when the previously heated air arrives, descends, and creates an area of excess pressure.

This backward and forward transference of air becomes, therefore, of great importance in studying the weather changes in any one region, because the rainfall phenomena are so closely related to the pressure changes.

Away from the middle portions of those two large areas which behave in this see-saw manner, the variations of pressure should, and actually do, have a different periodic nature. It is of extreme importance, therefore, when trying to trace the sun's action on our atmosphere, to separate the regions over which the variations may be truly solar from those which exhibit variations modified by the mechanism of the atmosphere itself.

There is therefore no reason why we should take a pessimistic view of the attempts made to solve this fascinating riddle of the relationship between changes of solar activity and the vagaries of the weather. An enormous amount of accumulated material is ready for discussion, and efforts should be made to secure the continuity of these observations and at the same time to coordinate the data along lines most suitable for this particular research.

WILLIAM J. S. LOCKYER.

THE SURVEY OF INDIA.[1]

THE extracts from the narrative reports of the Survey of India for the years 1902–3 are contained in a thin and attenuated volume of some eighty pages, which, as compared with previous reports, represents the effects of Indian financial economy applied to one of its most interesting departments.

[1] "Extracts from the Narrative Reports of the Survey of India for the Season 1902–3." (Calcutta: Government Printing Office, 1905.) Price 2s. 3d.