

It is a mistake to say that latent heat thus liberated [from the condensed moisture] will warm the air enough to allow the condensed vapor to evaporate again; for the latent heat is completely expended in the work of pushing away the air that surrounds the ascending expanding mass, and therefore cannot be applied to any other task. Espy made this error for a time, but afterwards corrected himself. It is regrettable to see the error now revived by Hazen." As all these computations were based on commonly accepted theories, it is a little difficult to comprehend these expressions. I hope to show that the confusion is where it is least suspected. I am aware that the ordinary theories have such a fascination, there is little hope in bringing the philosophers who accept them to what the facts seem to indicate; but there are an increasingly larger number of persons who have grave doubts as to the sufficiency of present meteorological inferences to account for the facts observed, and it is for these I write, as well as to explain my position.

The fact that there is no exchange of air *en masse* from one level to another has been proved by the strongest arguments, and such as have not been controverted. It is a great pity that this assumption should be boldly made at this day without answering the objections. It seems high time to lay aside "glittering generalities," and carry out our analyses to the actual conditions we observe. To do this it is only necessary to set forth quantitative computations of the effects produced by certain inferences. I am not aware that this has been attempted save once (see *Science*, xiii. p. 369). In that case the assumptions and results were so absurd and so easily controverted, that it is not surprising that no philosopher has taken up that line since.

There are two points to be made plain. First, regarding "work." This is the great shibboleth of theoreticians. If there is a troublesome quantity of heat to get rid of, or the formation of vapor which is the source of energy to account for, "work," and the difficulty disappears. If we place *a* pounds of gunpowder in a cannon, and discharge a ball upward, a certain number (say, *b*) of foot-pounds of work is done, and this can be definitely computed. If a similar amount of gunpowder be strewed over a field, there is, what we may call, the same potential energy present as before; but no one believes that firing the powder will carry a shot, or that a single foot-pound of effective work will be done by it. This would appear one of the most serious defects in modern theories. The philosopher sits down, draws on his thinking-cap, and, seeing rain falling at the rate of two inches per day, in a twinkling finds that 11,796,000 cubic inches of water is condensing over a single acre. Next he finds a million times that in an ordinary storm, and this represents billions on billions of foot-pounds of energy. Is not this the veriest nonsense? What these theoreticians need most of all is to transport their steam-engine, if they can find one, into the cloud region, and then compute the amount of work actually made effective. No one, outside of these philosophers, would boil away tons of water in the open air on the Atlantic coast, and imagine by this means to obtain effective energy enough to transport a great steamer across the ocean in less than six days.

A word regarding the "using-up of the latent heat of condensation by doing work in pushing aside the air which surrounds the ascending expanding mass." Nothing can better illustrate the views just enunciated than this inference. It is universally accepted that air blows toward our storms almost normally to the isobars at the outside, but more and more at an angle as it approaches the centre, till it becomes tangential at ten to two hundred miles from the centre. This whirling column has, it is also inferred, an upward convectional movement at the centre. It is impossible for us to imagine that there is a central core, forming a convectional current, and that on all sides of this there is a vertical cylinder of air pressing in on the core, and which must be pushed aside; for just beyond this core the air is whirling in the same circle, and it is believed by some that the centrifugal effect would even throw this outward. This shows conclusively that there is absolutely no air to push aside, and, even if there were, the work needed to move it in a frictionless medium would be inappreciable. Is not this inference a most weak attempt to bolster up an exceedingly weak theory?

It is probable that the old inference that the sun heats up a limited portion of the earth's surface, and sets up a convectional current

which ultimately results in a violent tornado, will soon disappear. Professor Ferrel, one of the most ardent advocates of this inference, has recently declared, that, in order that this convectional current may not be broken up from the greater speed of the upper portion, it is necessary to suppose that the upper part separates from the lower, advances in front of the storm, and sends its gyrations through a frictionless medium to the earth. Verily, to use a homely but forcible and apt expression, "this is cutting off the tail of this theory close behind its ears."

It is now known that the sun's heat has no direct effect upon air-columns near the earth. We know,

1st, That the earth becomes very hot, but the air is almost a non-conductor of this heat; and this effect extends only a few inches.

2d, That convectional currents occur only between contiguous air strata, and there is no transport of air *en masse* by them.

3d, On some days the air is heated thirty or more degrees above the morning temperature; but this produces no effect on the moisture contents of the air, it does not produce any convectional current, and the heat extends over a circle about a thousand miles in diameter.

4th, As a storm approaches, clouds cover the sky, and the direct effect of the sun's heat is almost entirely removed.

5th, Notwithstanding the removal of the sun's direct influence, the moisture in the air is most remarkably affected. We find enormous additions to this moisture over a region extending for hundreds of square miles in front of the storm. Whence comes this moisture? We have indubitable evidence that heat has nothing to do with it. Its occurrence is entirely independent of the winds. It does not descend from above, for there is ordinarily less moisture there than below, and theory indicates an upward and not downward motion. It seems to me this is one of the most important points to be determined. It would seem that the moisture collects in the upper regions before the storm, for the first indication of the storm is the high cirrus four hundred or five hundred miles in advance. This shows plainly that the origin of the storm is not from convectional currents beginning at the earth's surface. Is there a condition in the atmosphere which is so changed upon the approach of a storm that the air begins to absorb moisture? Is there an influence from the sun that only requires a slight change on the advance of a storm to cause the moisture to mass itself? Is there a condition in front of the storm itself that attracts moisture directly without its transport by air or heat currents? Does the moisture come from the whole region near the storm, and mass itself at it? These are startling hypotheses, but they have much to support them. Our storms come over the arid plains of the West with little moisture in them. Almost suddenly, as they approach the more fertile valleys, there is a marked increase in the moisture. Light rain begins, which becomes heavier the farther east the storm moves. At times the storms move clear across the country without depositing much moisture. Is this because the attractive force has less power, or because it holds the moisture more tenaciously, or because the air is too dry to allow precipitation? We have here what seems a most important field of research, and one that promises much.

H. A. HAZEN.

Washington, Dec. 13.

INDUSTRIAL NOTES.

Calendars.

AT this season, when every one is looking for a convenient calendar for use during the coming year, there should not be overlooked the various very attractive calendars, issued as advertisements, it is true, but in which the advertising feature is not introduced in a way to make the calendar objectionable. Among these we have just seen that issued by the well-known firm of C. I. Hood & Co., of sarsaparilla fame. This calendar can be had for the asking at any druggist's, or is sent postpaid on receipt of 6 cents in stamps at the main office of the firm in Lowell, Mass. The head of a young girl lithographed in fourteen colors appears on the face of the card, and is an admirable example of what can be done in this line of art. It is a very pretty bit of color to brighten up some dark spot.