

## CLIMATIC CHANGES.

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**I**S our climate becoming milder, and are our winters less severe? If so, what is the cause? There exists a concensus of opinion among close observers of meteorological conditions that there has been a perceptible change during the last fifty years. We may—they say—be unable to discover any difference from winter to winter, but a comparison of our late winters with the winters of 10, 20, 30, 40 and 50 years ago, appears to justify the belief that a gradual change is occurring in our climate.

There are those who believe that the artificial groves throughout Iowa and adjoining states, have contributed materially to raising the temperature during the winter months. It is no doubt true that the rigor of the winds has been lessened thereby, but as the absolute temperature is unaffected even by blizzards, it appears improbable that the groves have any effect on the climate. There are others who attribute our milder winters to thermal regions in space through which our solar system as a whole is passing. The solar system consisting of the sun, the planets—Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune—their Satellites, the Asteroids between the orbits of Mars and Jupiter, and all meteoric matter and comets that belong to our system, is rushing through space with a velocity of 39,600 miles an hour, and the direction is so near a straight line that it will require many millions of years to complete one revolution. It is therefore not impossible that the regions in space through which we have been passing during the last two, three, four or five decades, has had a higher temperature than that through which we passed before, because we may have approached nearer to some other sun in the sidereal system to which our solar system belongs. The grove theory is unsatisfactory, and the effect of our movement through space is naught else than speculation.

The heat of the surface of the earth and the atmosphere is

derived almost wholly from the sun. If the earth is a molten mass within, the heat from that source, in hot springs, geysers and volcanoes—if any of these have any connection with the central heat, which is improbable—is so small that it need not be considered in a discussion of climatic conditions and causes.

Some substances are transparent to light and heat that are opaque to heat without light. For example, if a pane of glass is held between the face and the sun, the heat passes through the glass and the face is burned. If the same pane is held between the face and an intensely hot cannon ball that is not incandescent, the glass acts as a perfect screen and no heat whatever is felt because the glass is opaque to dark heat.

John Tyndall was the first to call the attention of scientists to the fact that carbonic acid—carbon dioxide  $\text{CO}_2$ —was partially opaque to dark heat, and to suggest its potency in producing a milder climate. The proportion of carbon dioxide now in the atmosphere is only about one-thirtieth per cent, but being opaque to dark heat it absorbs the heat of the earth that otherwise would be radiated into space, and thus acts as a blanket to keep the earth warm. The greater the amount of carbon dioxide in the atmosphere the thicker becomes the blanket, and the more heat it absorbs. The other constituents of the atmosphere—oxygen and nitrogen—are transparent to dark heat, and would therefore permit the radiation of the heat of the earth into space, and the result would be a cold and lifeless planet.

Prior to the Carboniferous era all the carbon dioxide now stored in the coal measures of the earth (which consist of 200,000 square miles in China and Japan; 194,000 in the United States; 35,000 in India; 27,000 in Russia; 9000 in Great Britain; 3600 in Germany; 1800 in France; 1400 in Belgium, Spain and other countries, making a total of 471,800 square miles) was free in the atmosphere, and in consequence thereof there existed a tropical climate extending to the poles, as is indicated by the presence *only* of tropical plants in coal-measures. It is estimated that the amount of carbon dioxide in the atmosphere during that period was from fifty to one hundred thousand times greater than the amount now in the atmosphere, and as a result of the warm moist climate there flourished during that geological era the most luxuriant growth of vegetation the earth has ever known, and the succeeding glacial period was the logical sequence of the withdrawal of the carbon dioxide from the atmosphere.

Prof. Joseph LeConte, in his *Elements of Geology*, says (page

617): "On account of its heat-absorbing properties, the carbon dioxide is vastly the most important element affecting the climate. It now only forms about one thousandth part of the atmosphere. With its thermal potency it will be seen that comparatively slight variation in the amount would produce great climatic effects. Physicists have long recognized this fact. It is believed that doubling the present small amount of carbon dioxide, would produce a mild climate to the poles, and that halving the present amount would bring on another glacial period."

The rapid increase in the consumption of coal, and the inevitable increase in the amount of carbon dioxide thrust into the atmosphere becomes apparent from the following facts: The consumption of coal in the United States in the year 1845, was four and one-half million tons; in the year 1864, twenty-two million tons; in the year 1874, fifty million tons; in the year 1884, one hundred and six million tons; in 1894, one hundred and fifty million tons; in 1899, two hundred and forty-three million tons. In Great Britain in the year 1845, there was consumed thirty-one million tons; in the year 1864, ninety million tons; in the year 1874, one hundred and twenty-five million tons; in 1884, one hundred and sixty million tons; in 1894, one hundred and sixty-four million tons; and in 1899, two hundred and ninety-five million tons. And the rate of increase in other countries—China and Japan, India, Russia, Germany, France, Spain, Belgium and Austria-Hungary—is approximately the same. There is at present a concurrence of opinion among the highest authorities that the world's supply of coal would probably last two or three centuries, but the rapidly increasing rate of consumption is becoming ominous. "The statements of former years that the supply of coal was inexhaustible were not only false and foolish, but pernicious."

The processes of combustion and respiration consume oxygen and liberate carbon dioxide and aqueous vapor. The incalculable combustion of coal and oil is gradually restoring to the atmosphere the hitherto confined carbon dioxide which when free produced a mild climate the world over, and will probably again create the same meteorological conditions of heat and moisture that existed during the Tertiary period—a tropical climate from pole to pole.