EARTH SYSTEM INTERACTIONS CAUSING THE NORTHERN HEMISPHERE GLACIATION (2.75 MA)

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RESUMO: Photosynthetic plants and bacteria in the ocean use the energy of sunlight to fix carbon dioxide (CO_2) into organic material. This process is vital to almost all life on Earth because its carbon products and oxygen serve as energy nutrients and source of maintenance for many forms of life, including the photosynthetic organisms themselves. Because of this, they are called primary producers. In marine waters, the vast amount of energy derived from primary production comes from photosynthetic microbes, collectively termed phytoplankton. Their productivity is the rate at which they produce energy, usually determined in the oceans as the amount of pigments present. The availability of nutrients in certain ocean regions, and therefore, productivity, is controlled in great scale by the ocean circulation and wind patterns, which govern, for instance, the upwelling and downwelling. The wind patterns also transport atmospheric dust loads from Fe-rich terrestrial sources to ocean waters, controlling phytoplankton production in nutrient-rich areas of open sea. Evidence suggests that even though phytoplankton populations are healthy in nutrient-rich regions that lack Fe, the increase in Fe promotes a population bloom, an increase of chlorophyll levels and a depletion of nutrient stocks. Thus Fe availability largely controls phytoplankton productivity. Importantly, an increase in phytoplankton productivity may cause a drawdown of atmospheric CO_2 and ultimately cause global cooling. Therefore, the interactions among different components of the Earth System directly influence global climate changes. This study investigates some of these interactive processes in the Earth System during the Plio-Pleistocene (5.3 – 1.8 Ma), a period that experienced global cooling and the onset of Ice-sheets in the Northern Hemisphere. The pattern of ocean current circulation and productivity in the Northern Pacific Ocean is thought to have greatly influenced the onset of the Northern Hemisphere Glaciation (peak at 2.75 Ma). However, several proposals have been made to explain how ocean circulation patterns and productivity changed to affect climate. We evaluate and compare these proposals to show whether global cooling could have been initiated by isolated events, as proposed, or by a combination of factors. Amongst the main proposals are: 1) the development of a permanent halocline in the Northern Pacific Ocean; 2) the formation of the Isthmus of Panama and its effect in the ocean thermohaline circulation; 3) A gradual global cooling occurring in many steps; 4) iron fertilization of the Northern Pacific Ocean by Fe-rich wind-delivered dust originated from isolated basins in the uprising Tibetan Plateau. Our data evaluation suggest that a combination of such factors, which all led to a decrease in atmospheric CO_2, may better explain the causes for the onset of the Northern Hemisphere Glaciation and global cooling during the Plio-Pleistocene. To understand how Earth systems interacted in the past to produce a major climatic change is crucial to assess the future of the Earth given the current antropogenic climate change.

PALAVRAS-CHAVE: NORTHERN HEMISPHERE GLACIATION, CLIMATE CHANGE. EARTH SYSTEM