Abstract for the General Public

Project goal: This study will explore how shallow underwater areas near the edges of continents, called continental shelves, and especially those near the equator, may influence the Earth's climate over long periods, ranging from hundreds to thousands of years. We aim to test a new idea: that when sea levels rise and flood these wide, shallow areas, or when sea levels fall and expose them, it can affect how much carbon dioxide (CO_2) is released into or absorbed from the atmosphere. This matters because CO_2 is a major greenhouse gas that contributes to global warming. The theory suggests that when sea levels rise during warmer periods, flooding these shelves, this added more CO_2 to the atmosphere, making the planet even warmer. On the other hand, when sea levels dropped during colder times, exposing these areas may have helped remove CO_2 from the atmosphere, contributing to cooling. No one has directly measured this process before in these regions. This project will be the first to investigate how these shallow shelves might help slow down or speed up climate change. It will focus on how the breakdown of minerals in sediments and the growth or loss of forests on these shelves may play a role in the release or capture of CO_2.

Description of research: In this research, we will study sand and silt collected from beneath the ocean floor near southern China to learn more about Earth's climate history and how nature may help remove carbon dioxide (CO_2) from the atmosphere. The sand contains tiny crystals of a rare mineral called zircon. These crystals originally form deep underground in magma before being uplifted in modern mountains. The grains are later carried down to the sea by rivers as mountains erode over time. By measuring the age of these zircon grains, we can figure out where the sand originally came from, tracing it back to specific mountain regions. This helps us understand how erosion and rainfall patterns have changed over time, especially as Earth's climate has shifted between warmer and colder periods. For example, heavy rainfall today mainly occurs in eastern parts of the Pearl River basin, but during drier ice age periods, the pattern may have been very different. We also study the chemistry of the sediment to see how much it has changed since it was eroded from the mountains. Some elements dissolve in water and wash away, while others remain. This process, called chemical weathering, can remove CO_2 from the atmosphere. To understand how much CO_2 may have been absorbed, we use images made with sound waves to measure how much sediment is buried under the seafloor. If we know how much sand is there and how much CO_2 each part can absorb through weathering, we can estimate the total amount of CO_2 removed during certain periods in Earth's past. If this area is similar to other parts of Southeast Asia with wide continental shelves, our findings could help estimate how much CO_2 has been naturally taken out of the atmosphere across a much larger region.

Reasons for attempting research topic: As human activities continue to release carbon dioxide (CO_2) into the atmosphere, it's more important than ever to understand how sensitive Earth's climate is to changes in CO_2 levels. Scientists believe that in the past, rising sea levels may have triggered a chain reaction, known as a "positive feedback", that made the Earth even warmer. If this is true, it could be a key factor we need to consider when predicting the effects of future sea level rise and climate change. However, this process hasn't been properly measured yet, and it could have a major impact on long-term climate patterns. There's also growing interest in using natural materials, like certain types of sediment, to remove CO_2 from the atmosphere. This research gives us a chance to see how this natural process works on a large scale, which could help guide future efforts to use similar methods, known as geoengineering, to help slow climate change.

Substantial results expected: The project will train a PhD student to become an expert in environmental geology and geochemistry. The research itself will be published in the scientific literature, as well as made available in a more accessible form via a dedicated website, as well as in short educational videos to be posted on YouTube and/or similar venues. Estimates of the effectiveness of chemical weathering in SE Asia can be used to understand the potential for enhanced weathering as a way of moderating global warming. The work will also help build working relationships between scientists in Poland and colleagues in London (UK) and in Guangzhou (China) and will have a major impact on the development of the University of Szczecin as a marine research center.