Global Vegetation and its Response to Climate Change, C02, and Global Warming

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Orion Living Learning Community is focused on building a community that uses science to serve humanity and improve the environment. Students develop professional skills and have access to academic support. The Citizen Science Project, is an introduction to scientific research and data collecting by civilians to help researches. Our team, Torrey Schwab (environmental engineer), Xavier Starks (physicist), and Sefunmi Ashiru (computer engineer), decided to tackle the Scieneering Project. This incorporated collaborating with the Engineering Educational department and a rocket designing team to capture atmospheric data and concluding its environmental effects on the local vegetation in comparison with global trends found our cited research paper.

Background

The research paper we planned to compare our findings to talked about the terrestrial ecosystems and vegetation which had a substantial impact from The climate regime shift during the 1980s. The mechanisms driving vegetation changes, before and after the shift are unknown. In the study, they applied a biophysical dynamic vegetation model to estimate large-scale trends using carbon fixation, vegetation growth, and expansion during the period 1958–2007. They linked these changes to environmental drivers including elevated atmospheric CO2 concentration (hereafter eCO2), global warming, and climate variability (hereafter CV). observation-based data was compared to simulated leaf area index (LAI) and gross primary production (GPP).

SSiB4/TRIFFID (Simplified Simple Biosphere model version 4/Top-down Representation of Interactive Foliage and Flora Including Dynamics) was used to gather the data for this study.

Currently the SSiB4/TRIFFID includes seven PFTs, evergreen broadleaf trees, deciduous broadleaf trees, needleleaf broadleaf trees, grasses, C4 plants, shrubs, and tundra. Tundra, evergreen, and deciduous broadleaf trees were separated from their original categories to more appropriately reflect their respective biomes.

Method

The SSiB4/TRIFFID estimates the net plant photosynthesis assimilation rate, autotrophic respiration, and other surface conditions for TRIFFID. TRIFFID updates the coverage of a PFT (plant functional type) based on the net carbon available to it. The SSiB4/TRIFFID simulated the global distribution of vegetation and the sensitivity of the environment to trends in climate and eCO2(elevated atmospheric CO2). The two simulations conducted included a 100-year quasi-equilibrium simulation with the focus being climatological forcing and a simulation focused on real forcing from 1984 to 2007.

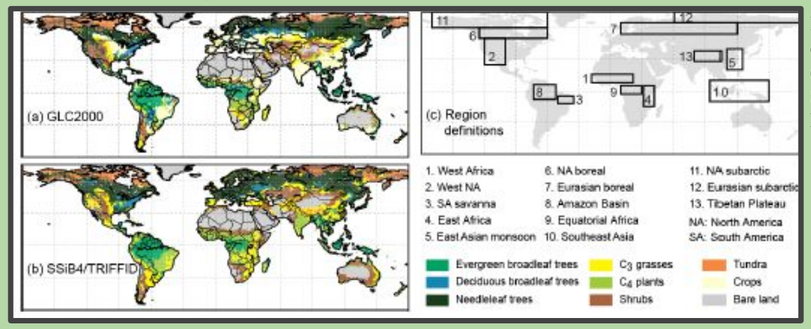

Figure 1. Vegetation comparison between (a) GLC2000 and (b) SSiB4/TRIFFID. (c) Defined regions.

Implications

SSiB4/TRIFFID shows an increase in leaf area index (LAI) and gross primary production (GPP) post-1980s. (FIGURE 8) The increases could be caused by atmospheric carbon dioxide concentrations and the warming surface temperatures in areas with high latitudes. Some areas in low areas did see a decrease in LAI and GPP, most likely as a result of less precipitation and/or higher temperatures. GPP is better at determining changes in atmospheric carbon concentration; however, both LAI and GPP are needed to understand the biochemical processes in vegetation and the effect of climate on ecosystems.

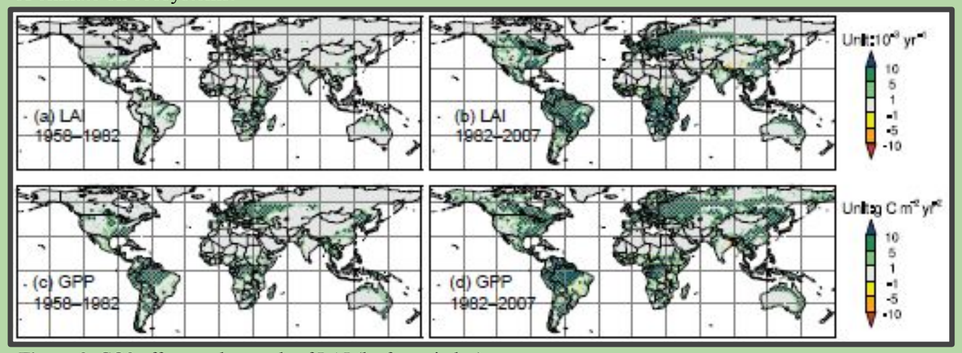

Figure 2. CO2 effect on the trends of LAI (leaf area index)

Conclusion

SSiB4/TRIFFID model can simulate the vegetation and temporal variability by simulating the land surface carbon fixation, plant growth, and competition. In the monson areas of East Asia, west and central Africa, and eastern US, the trend of LAI (14.2%) and GPP(11.4%) went from negative to positive. However, the trend went from positive to negative in western North America, South American savanna, and in east Africa (LAI: 11.7% and GPP: 19.3%).

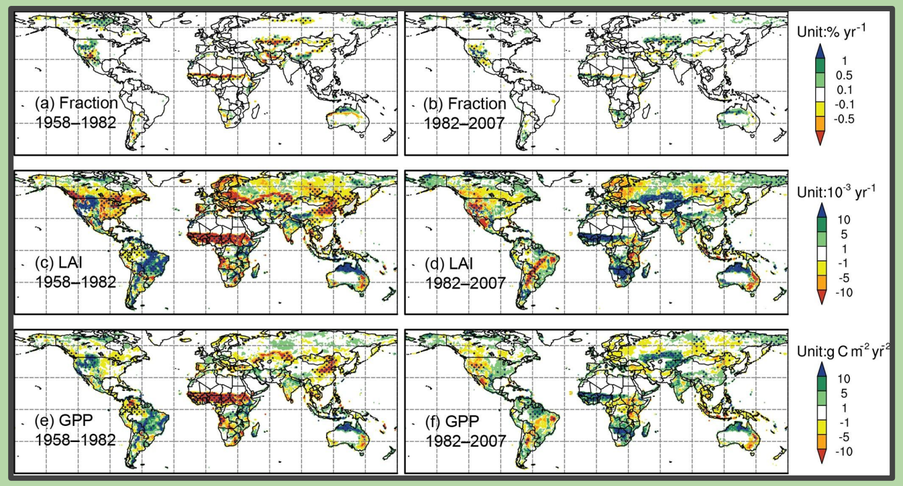

Figure 3. Warming effect on the trends of LAI

Future Work

The research and study was successful. In the future, the experiment should be conducted again to continue to track carbon dioxide in the atmosphere as climate change has become more and more part of our daily lives.

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References

Liu, Y., Xue, Y., MacDonald, G., Cox, P., & Zhang, Z. (2019). Global vegetation variability and its response to elevated CO2, global warming, and climate variability–a study using the offline SSiB4/TRIFFID model and satellite data.