Writing Assignment

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Krumhardt et al., 2019 paper

Abstract

- Introduction
  - CO2 acidifies the ocean
  - Acidification is harmful to calcifying phytoplankton (coccolithophores)
  - Coccolithophores are abundant and the loss of these organisms could have large ecological biogeochemical impacts
- Methods
  - They isolate the impact that co2 has on coccolithophores using functional types in the Earth System Model
- Results/Discussion
  - Increasing CO2 causes reduction in calcification in general
  - There are some areas that show an increase in calcification because the carbon limitation has been lifted in those areas
  - Global calcification is up by 6% per year compared to pre-industrial levels
  - If CO2 increases to 900µatm global calcification will decrease by 11% compared to pre-industrial levels
- Conclusion
  - Much of the ocean show reduced calcification when compared to growth resulting in changes to CO2 cycling between the air and water
  - Coccolithophores become more abundant but with less calcification up to a tipping point that occurs at about 600µatm

Introduction

- Subject: Coccolithophores are the most abundant calcifying phytoplankton in the ocean
  - Coccolithophores are everywhere from the tropics to the subtropics
  - They impact the global carbon cycle through photosynthesis
  - They can be very abundant and contribute up to 90% of the carbonate in the sediments
  - In areas with high concentrations changes in photosynthesis and calcification could have a larger effect on C cycling
    - Bridge: Changes in coccolithophore photosynthesis and calcification from ocean acidification (OA) would not only impact regional plankton ecology but could also influence how carbon moves from the atmosphere into the surface ocean, and finally to the deep sea.
- Subject: Coccolithophores have been the focus of numerous laboratory studies due to their potential susceptibility to OA, but these have yielded contradictory results
  - Many studies have been done looking into the impact of ocean acidification on coccolithophores with mixed results
  - Further work has shown that culturing conditions can explain the discrepancies
  - Coccolithophores tend to calcify less relative to photosynthesis at higher CO2

    - Photosynthesis can be CO2 limited so increased co2 can have contrasting effects
        - Bridge: These contrasting effects complicate future projections of marine calcification by coccolithophores.
- Subject: On a global scale, predicting the effects of increasing anthropogenic CO2 on coccolithophores is important for estimating changes in total global upper ocean calcification and to assess the potential for these changes in calcification to affect other critical carbon cycle processes
    - A tool to model this is Earth System Model with specific parameters coccolithophores
    - None of the existing models take phytoplankton functional type into consideration
        - Bridge: In this study, we describe a novel explicit coccolithophore parameterization in a state-of-the-art Earth System Model, the Community Earth System Model (CESM) version 2.0.
- Subject: A number of studies have modeled pelagic calcifiers, such as coccolithophores, on global and regional scales.
    - Studies have aimed to quantify sensitivity to changes in calcification
    - Decreased calcification because of ocean acidification results in increased co2 uptake in the ocean
    - They test the impact that the changes in calcification have on C cycling by building on other studies and adding parameters that include unique growth rates and calcification and how those rates are impacted by temperature and acidification
    - Asses this on a global and regional scale
- Subject: Here we perform sensitivity studies with our novel model configuration to explore how coccolithophore growth and calcification may change under increasing atmospheric CO2
    - Isolate effects of CO2 by holding other variables constant
    - Increased CO2 leads to increased growth but decreased calcification
    - There was a net increase in production at 400µatm, net zero increase at 600 µatm, and a net decrease at 900 µatm

<u>Final Project Proposal – bullet points done on unrevised abstract and introduction</u>

Abstract

- Introduction
    - Over 95% of the Tamaulipan thorn forest has been lost
    - Restoration is made harder by invasive grasses
    - Allelopathy could help combat invasive species
- Methods
    - Field observations and laboratory tests were performed to identify allelopathic plants
    - Leaf material was used to make extracts
    - Some species slowed growth and germination
    - Proper statistical tests need to be identified to determine significance

Introduction

- Subject: The Tamaulipan thorn forest encompasses parts of the Gulf coast plain in north-eastern Mexico and southeastern Texas and the study region is in Cameron county, Texas.
    - This biome is diverse with 1850 plant species
    - Some plants are invasive grasses, others belong to the fabaceae family
- Subject: The floodplain along the Rio Grande was once a continuous old growth thorn forest but is now highly fragmented by agriculture and urbanization.
    - Invasive grasses are not common in remaining old growth forest, something is keeping it out
    - “Novel weapons” hypothesis and “homeland security” hypothesis
    - Many plants in the fabaceae family are allelopathic and have been found to suppress invasive grass
- Subject: Further research examining legume and non-legume species concluded that leaf litter of some species can benefit the grass, calling attention to the necessity for screening prior to implementation.
    - Many thorn forest species belong to the fabaceae family
    - Some of these may be what prevents invasion in undisturbed areas
    - Screening for allelopathy begins by performing bioassays on lettuce seedlings using leaf extracts
    - 11 species were tested for their ability to reduce growth and germination of lettuce

<u>Revised Abstract and Introduction</u>

Abstract

The Tamaulipan thorn-forest is one of the most biodiverse regions in North America and has been affected by extensive deforestation for agriculture, grazing, and urban development, resulting in a loss of over 95 percent of the original habitat. Most restoration and reforestation efforts occur in abandoned fields that are frequently invaded by C4 African grasses which hinder restoration efforts. The “novel weapons" hypothesis suggests that some invasive species are very successful due to allelopathic compounds that native species are not adapted to tolerate. It is possible that this effect can be reciprocal, the “homeland security" hypothesis proposes that invasive species may be naïve to, and therefore susceptible to allelochemicals produced by native species.

To identify potentially allelopathic native plants, field surveys for grass exclusion were performed. Aqueous extracts were prepared from dried leaf material of native plants and used to run bioassay experiments on lettuce seeds. Differences between treatments were observed indicating that statistical analysis needs to be performed to determine if there is significant variation between groups.

Due to the non-normality of the data the Kruskal-Wallis test was run followed by post-hoc analysis using the Wilcoxon Rank-Sum test.

Introduction

The Tamaulipan thorn forest encompasses parts of the Gulf coast plain in northeastern Mexico and southeastern Texas and the study region is located in Cameron county, Texas. The thorn forest biome is incredibly diverse due to the location and sub-tropical climate which allow for the survival of both temperate and tropical species. Over 1850 plant species can be found in this region, including many in the fabaceae (legume) family. In addition to the native flora there are many exotic species. Most of these are ornamental and pose no threat of invasion but there are several wide spread invasive species, most notable are the C4 African grasses that were planted as forage beginning in the 1950's (Smith et al., 2009).

The floodplain along the Rio Grande river was once a continuous old growth thorn forest but is now highly fragmented by agriculture and urbanization. Within plots of old growth forest, the presence of invasive grass is very low despite adjacent plots having a high prevalence of invasive grasses. This suggests that there is something about the old growth forests that protects against invasion. The "novel weapons" hypothesis, proposed by Callaway and Ridenour (2004) suggests that some plant species are able to become invasive because they produce biochemicals that are inhibitory to plants and soil biota that did not coevolve with the plant, and that these same biochemicals have little to no inhibitory effect on other species in their native range. Cummings et al. (2012) proposed the "homeland security" hypothesis which suggests that a similar effect to that seen in the novel weapons theory could be at play in intact ecosystems, allowing them to resist invasion because novel species will be intolerant of the allelochemicals produced by the native plants. Cummings et al. (2012) point out that many plants in the Fabaceae family produce allelopathic chemicals and they found that there was a lower presence of an invasive C4 grass under these species. This suggests that allelochemicals from the legumes are suppressing the growth of the grass.

Further research examining legume and non-legume species concluded that leaf litter of some species can benefit the grass, calling attention to the necessity for screening prior to implementation of allelopathic interventions. Because there are many species from the Fabaceae family in the Tamaulipan thorn forest, it is very possible that allelopathy could be what allows undisturbed thorn forest to resist invasion. Studies to determine allelopathic species typically begin by running petri dish bioassays on lettuce seedlings using aqueous leachates of suspected allelopathic species. In this study, 11 species

were tested for their ability to reduce lettuce seedling growth and germination. Statistical analysis will be performed to determine which species and concentrations exhibit allelopathy.