Climate Hazards: Outline

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1 Outline

1. Introduction ...
2. Fundamental trade-off in life history of growing season length (mean) versus risk (variability often?)
   (a) Frost risk
   (b) Is there historical literature on heat damage as limiting seasons?

   (a) Introduction stuff here...
3. How much are means versus variability shifting?
4. Info from the literature
   (a) Basics from IPCC?
   (b) Refs from Ben?
   (c) Extremes versus variability
5. Case study in Europe
   (a) Variability across space (sites)
   (b) Shifts since 1950 by month
   (c) Change over time versus sites: Variability across space decreasing?
   (d) Projections
6. PHENOFIT case study
   (a) Do means versus variability shifts alone lead to increases or decreases in fitness? Or is is messier?
   (b) Additive effects...
7. From models to forecasting
   (a) Need more fitness data
   (b) Need more data on events and their impacts (crops?)

2 Manuscript text

Title: Seasonal pressure points of climate change

Abstract

Climate change is reshaping growing seasons globally with major impacts on natural and agricultural ecosystems. Yet we are uncertain exactly how, where, and when impacts will be most pronounced. Working with collaborators from France, we propose to identify the pressure points of climate change—seasonal periods when shifts in climate interact with development to lower growth, reproduction or survival. Using an integrated model of the full annual cycle of plant growth, reproduction and survival (PHENOFIT), we will compare the impacts of future warming versus shifts in frost events on the fitness of three tree species (*Fagus sylvatica, Pinus sylvestris, Quercus robur*). This framework will help identify the challenges and opportunities in adapting to climate change across European forests.