FORAGES MSc Topic: Global tree line dynamics

Introduction

Climate change is expected to raise average global temperatures with at least 2 degrees by 2050. However, this change in mean temperature will not be exactly the same everywhere. In some places actually cooling might occur, while at other places increases by more than two degrees are expected. Also, changes in average temperature do not reflect changes in minimum and maximum temperatures. This is especially true in extreme environments such as near tree lines (Figure 1 & 2). Global warming is expected to cause tree lines to shift to higher altitudes and latitudes. This could have important effects on alpine biodiversity because ecosystems above the tree line are often endemic and diverse. A higher position of tree lines will mean in many cases a smaller extent for areas with alpine vegetation as well as increased fragmentation of these areas.

Detecting changes in tree lines

To analyse the effects of climate on tree lines, data over long time spans are needed. Often this comes from existing field studies that were initially performed for other reasons. Analysing these studies in the light of climate change (so called meta studies) is therefore tricky because they are often based on a sampling design that is not well balanced. There is a high bias towards Europe and North America (Figure 3).

Use of historical satellite imagery

The increased availability of remote sensing imagery at relatively high spatial resolution could offer a solution to this. Sources such as Google Earth (Figure 4 A) provide information on vegetation cover at relatively high spatial resolution but coarse spectral resolution. As the spectral contrast between trees and alpine vegetation in generally high, high spatial resolution is preferred over high spectral resolution. The release of formerly restricted datasets such as from Corona spy satellites (Figure 4 B) by the USA opens up the possibility to analyse tree line positions with remote sensing over relatively long periods (several decades). Given the global coverage of this database (Figure 5), a systematic analyses of treeline positions and their dynamics (advancing or retreating, Figure 6) can be now performed, without a bias in sampling.

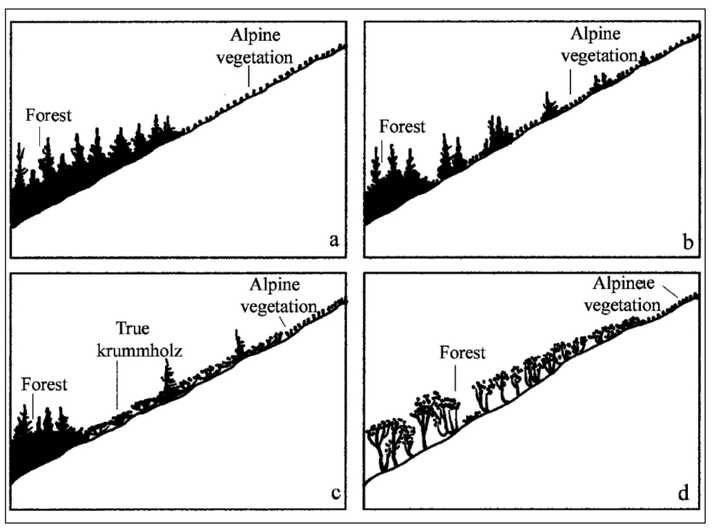

Figure 1:
Different types of tree lines that can be recognized (From Holtmeier, 2009). Tree lines constitute the climatological extreme at which trees still succeed in becoming full grown trees. Tree lines occur along altitudinal gradients that are found in mountainous areas, but also along latitudinal gradients (i.e. from the equator towards the poles).

Fig. 2. Examples of tree lines that are easily recognized in the field. A) Tree line in Bulgaria (Source: T.A. Groen), B) Tree line in Hawaii (Source: http://blog.travelpod.com/travel-photo/ashleys-blog/1/1254192118/above-the-tree-line-on-the-mountain.jpg/tpod.html)

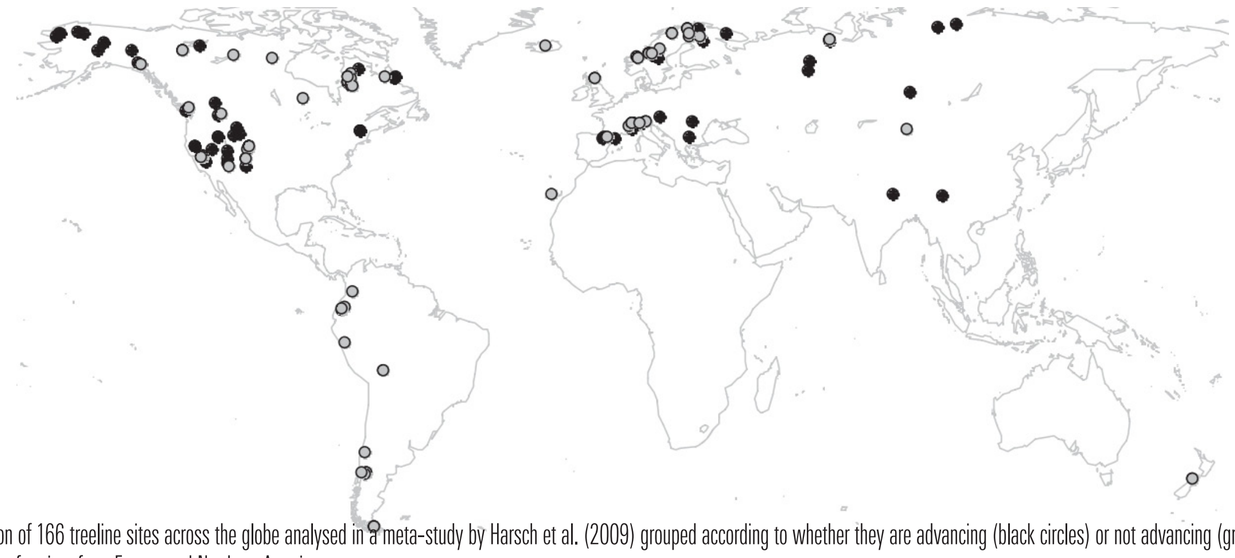

Fig. 3. The location of 166 treeline sites across the globe analysed in a meta-study by Harsch et al. (2009) grouped according to whether they are advancing (black circles) or not advancing (grey circles). You can see a bias for sites from Europe and Northern America.

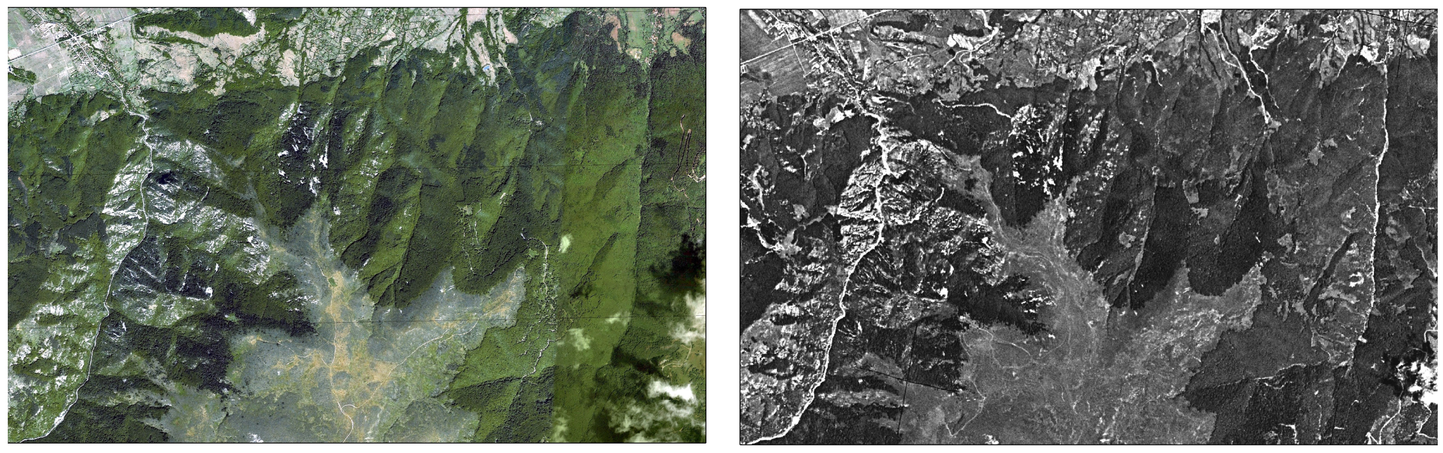

Fig. 4 A). Example of a tree line that is easily recognized on a Google Earth image from 2005. B) Example segment of the same area as the Google Earth image, but then from a Corona Spy-satellite image from 1976.

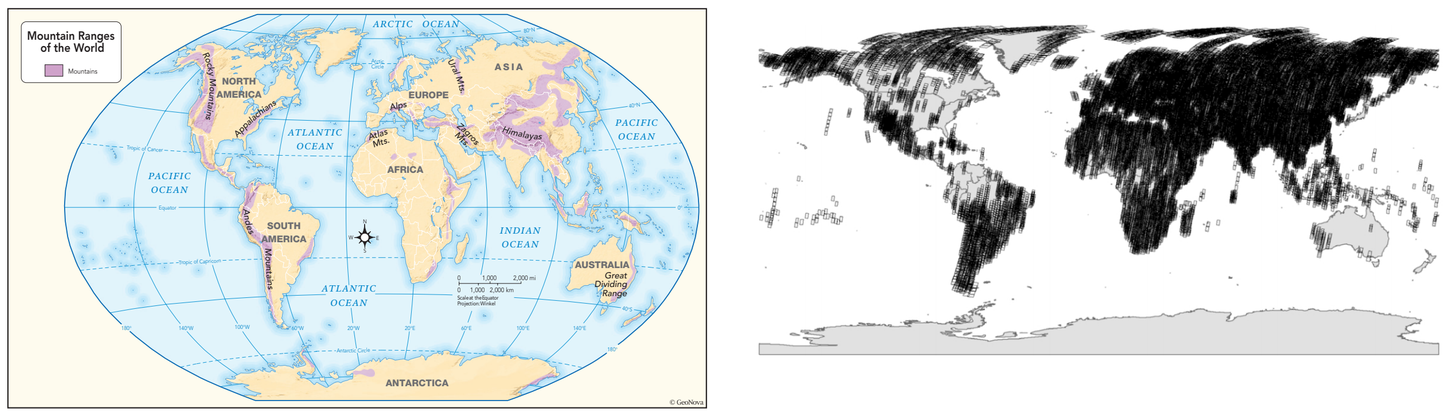

Figure 5: A) Dominant mountain ranges in the world. (source: http://static.howstuffworks.com/gif/maps/pdf/WOR_THEM_Mountains.pdf) (B), global coverage of the declassified Hegaxon imagery (source: Surazakov and Aizen 2010)

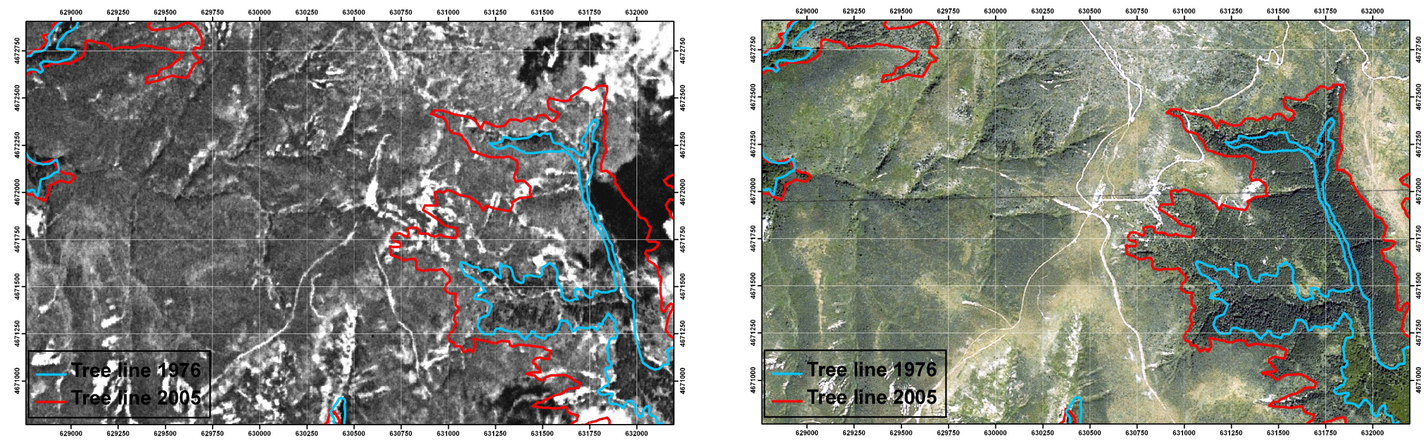

Figure 6: Differences in treeline positions between (A)1976 and (B) 2005 for the Osogovo mountain in Bulgaria.

Further Information

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