



Changes in climate and species suitability – How to interpret impacts and uncertainties?

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MOTIVE Final Meeting – Open Session, Freiburg, 10th April 2013





Climate Change

- Climate is expected to change quite considerably over the current century
- Here, we present the climate data we have used for the MOTIVE project.



How would a climate-smart forester interpret scenarios and uncertainties?

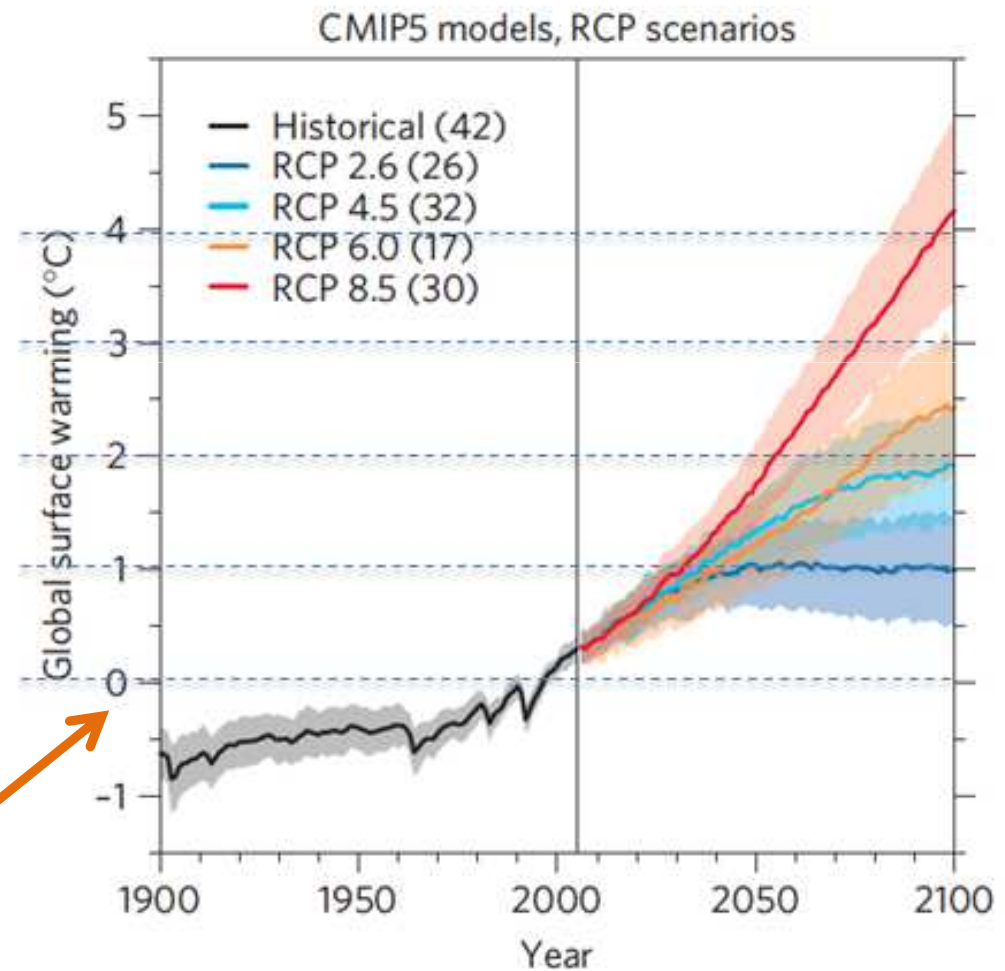
- The models used in MOTIVE originate from the EU project ENSEMBLES, which has generated comparably high resolution climate output for Europe for a range RCM models.



Our future climate is uncertain

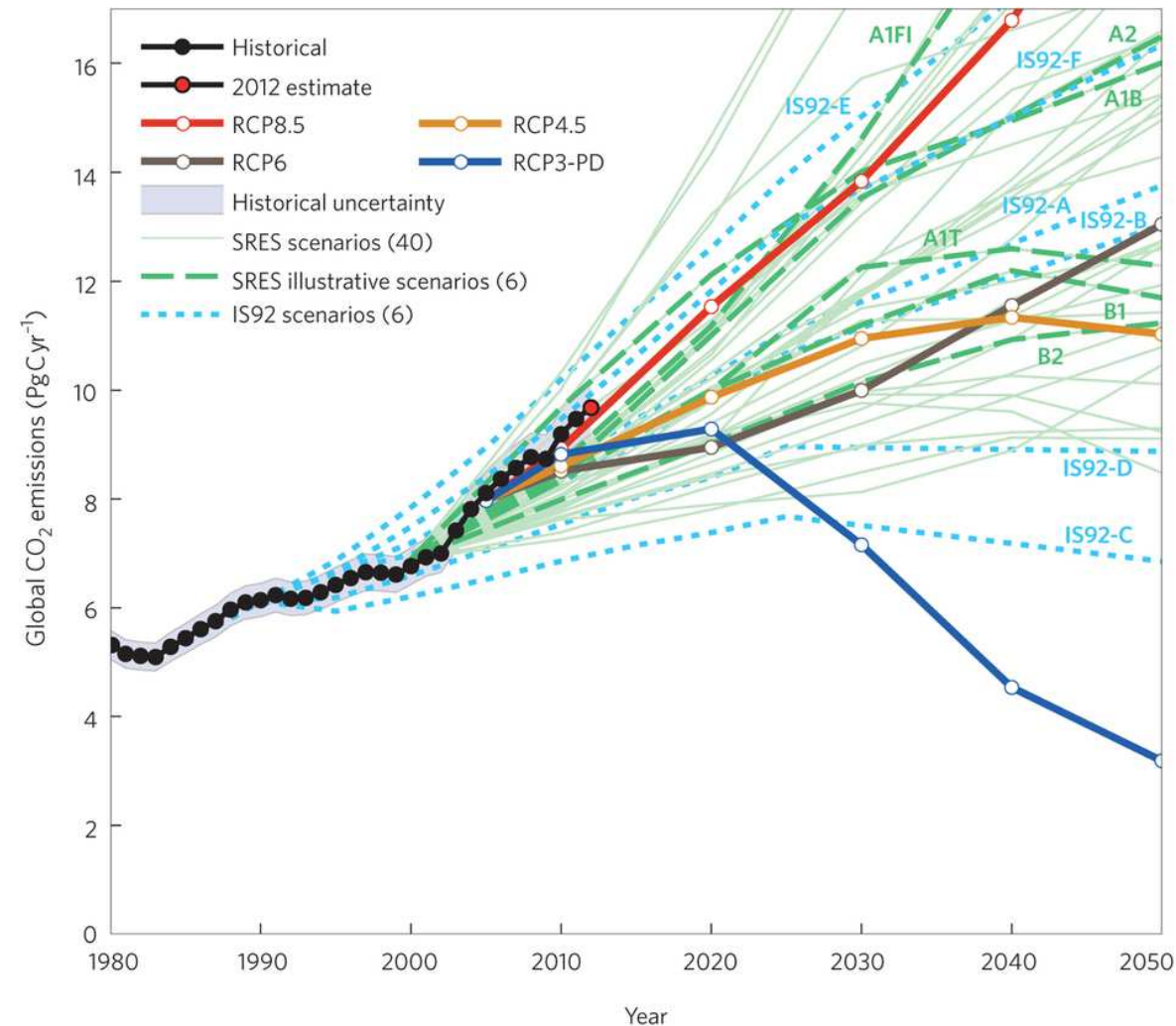
The Fifth IPCC report is going to introduce new RCP scenarios for Representative Concentration Pathways

Scenario data relative to the observed 1986 – 2005 climate





The emissions of 1980 – 2011 are in line with the high end of scenario emission trajectories

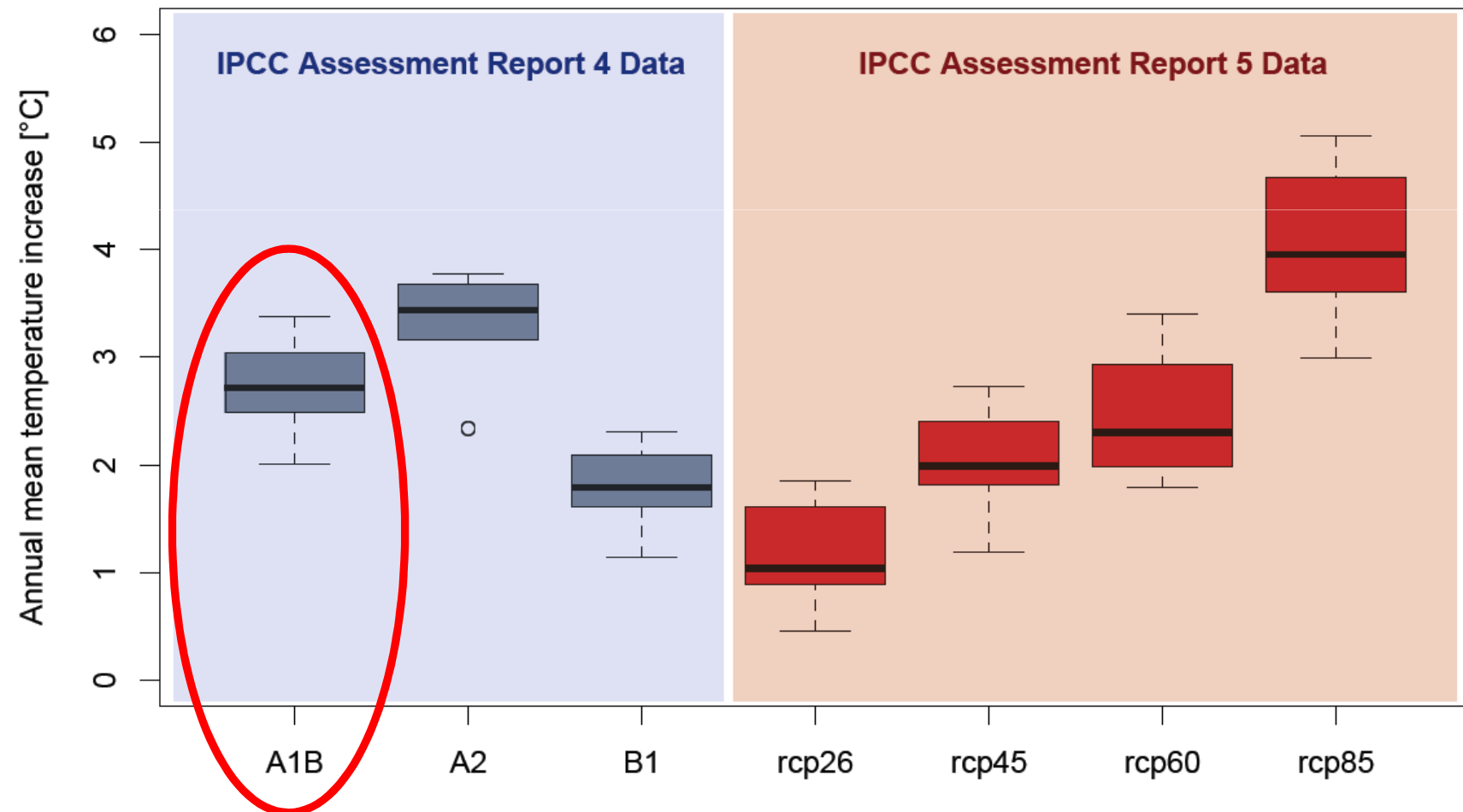


Peters et al. 2013. *Nature Climate Change*



The A1B scenario used in MOTIVE was quite modest compared to the high end of IPCC AR5 scenarios

IPCC AR4/5 data comparison, Anomaly 2071-2100 to 1980-1999





The climate-smart forester says:



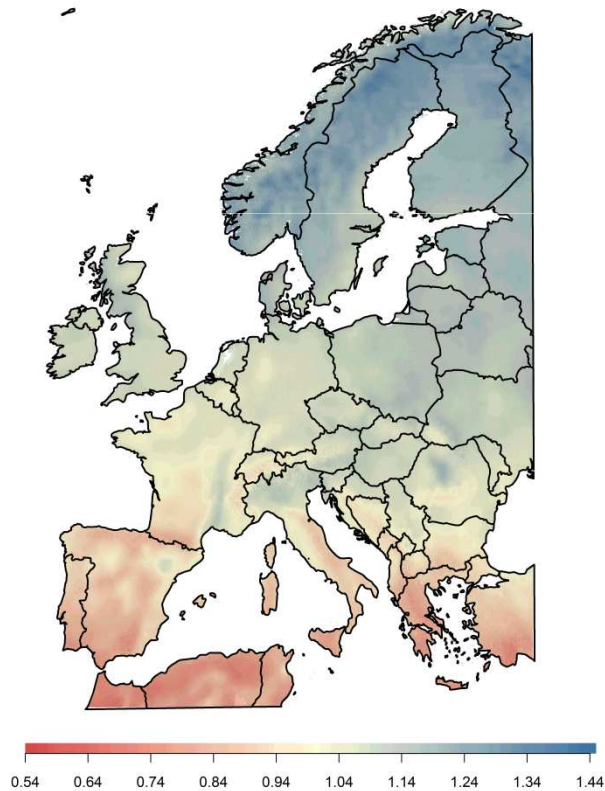
Don't look at MOTIVE scenarios as the most likely future – they are plausible, but our climate may get much warmer...



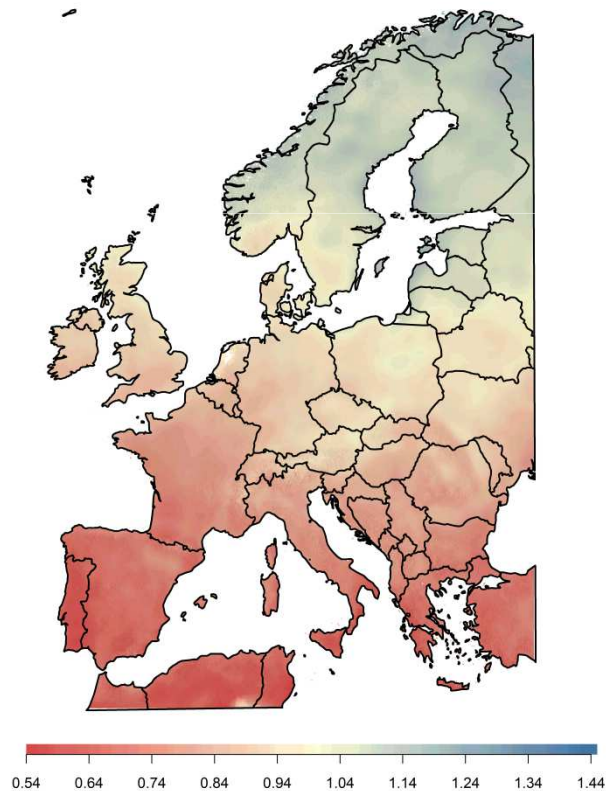
Trends and Uncertainty in Precipitation

Mean and St.dev among 6 RCM's used in MOTIVE for A1B

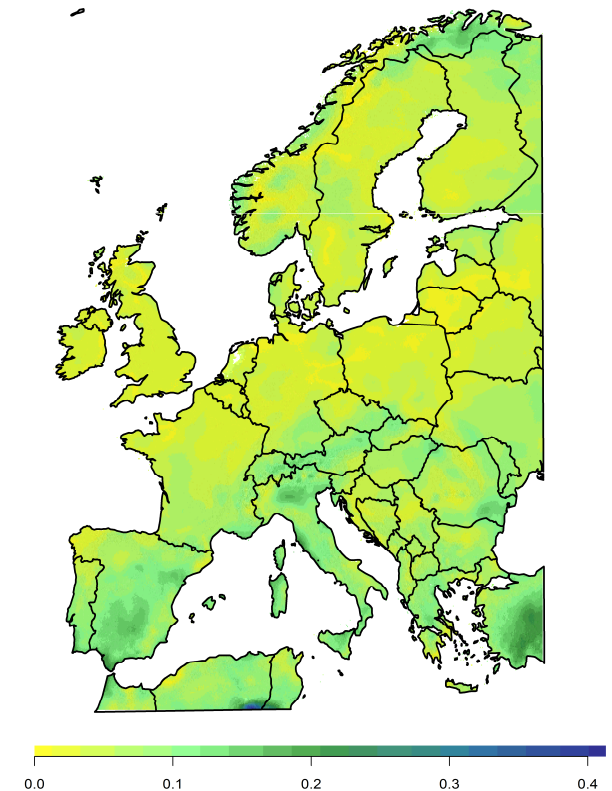
Winter 2051-2080 P-anomaly



Summer 2051-2080 P-anomaly



Uncertainty in summer P-anomaly

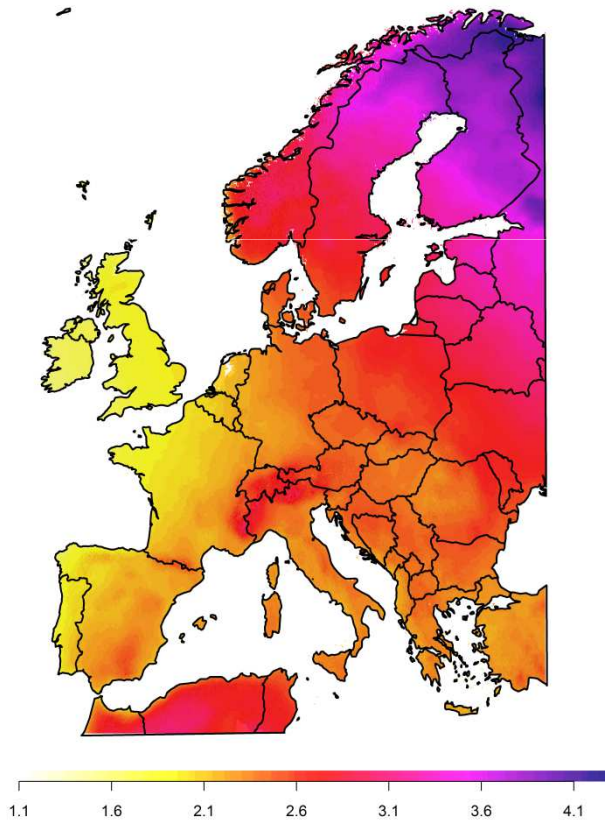




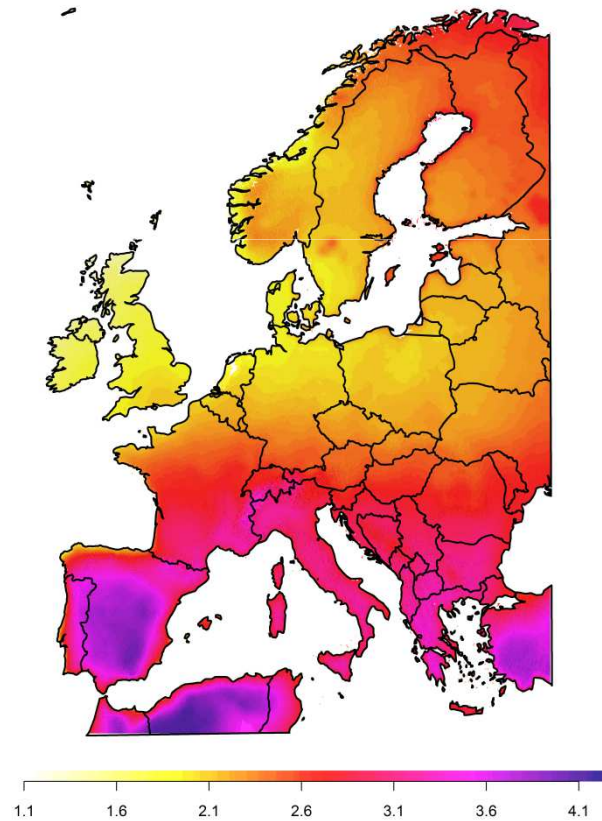
Trends and Uncertainty in Temperatures

Mean and St.dev among 6 RCM's used in MOTIVE for A1B

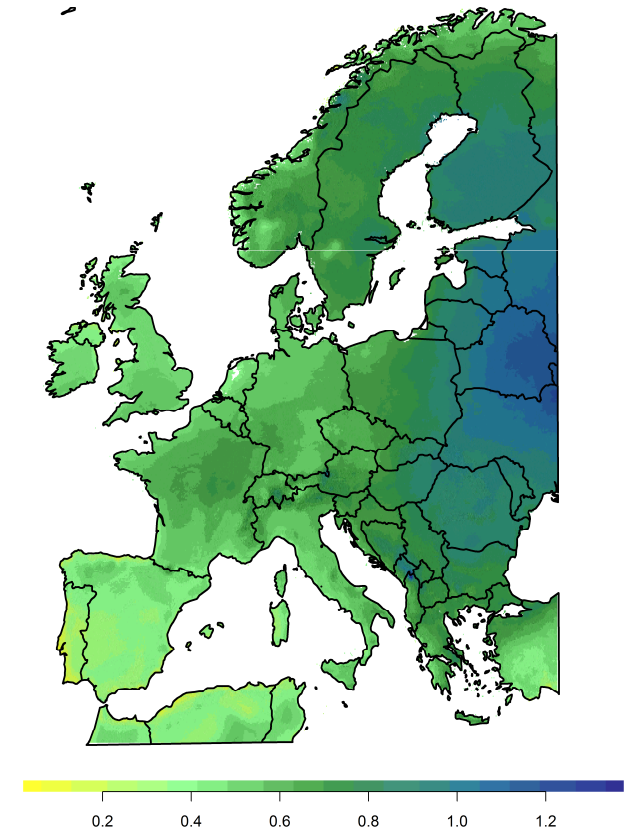
Winter 2051-2080 T-anomaly



Summer 2051-2080 T-anomaly



Uncertainty in summer T-anomaly





The climate-smart forester says:



- Climate change differs between regions in Europe
- Seasonal differences are important (winter / summer)



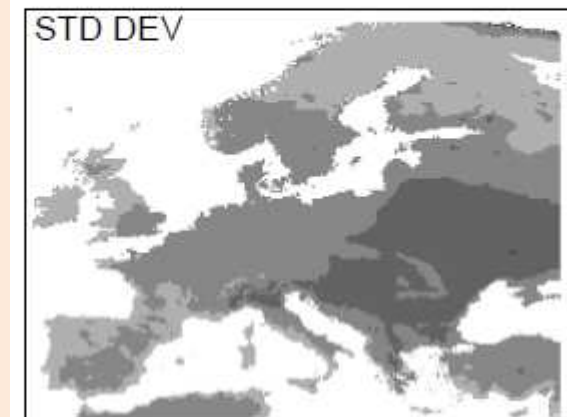
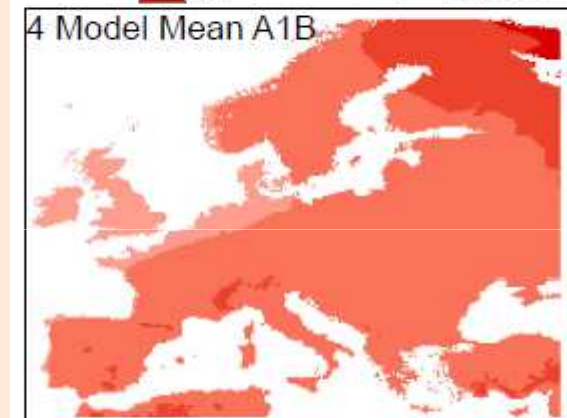
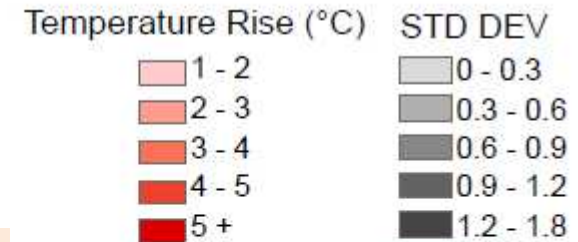
Importance of analysing multiple scenarios

**Absolute Change in Mean Annual Temperature
in Degrees Celsius (av2070-99 - av1961-90)**

Climate scenarios
of different
climate models
(same emission
scenario)
vary a lot!

Ensemble
mean
scenario trend

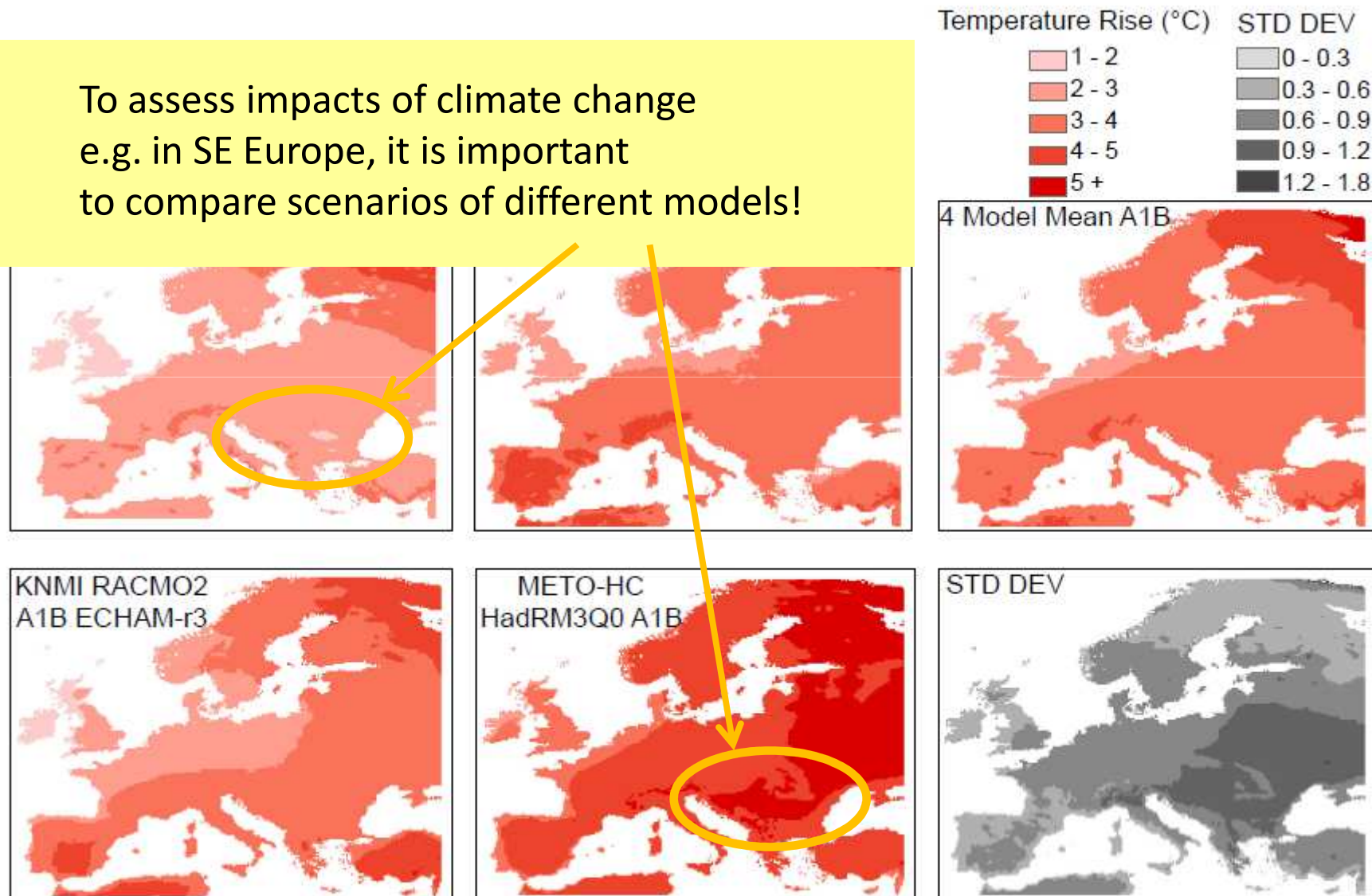
Ensemble
uncertainty





Importance of analysing multiple scenarios

To assess impacts of climate change
e.g. in SE Europe, it is important
to compare scenarios of different models!





The climate-smart forester says:

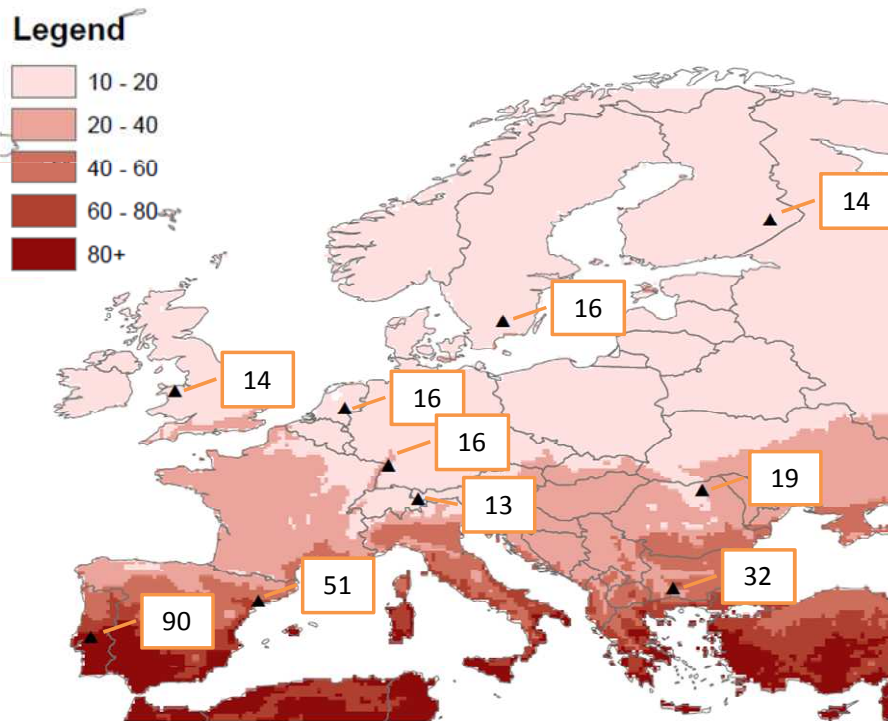


- Ensemble climate means **do not** represent the most likely scenario at regional level
- All regional model projections could become true...

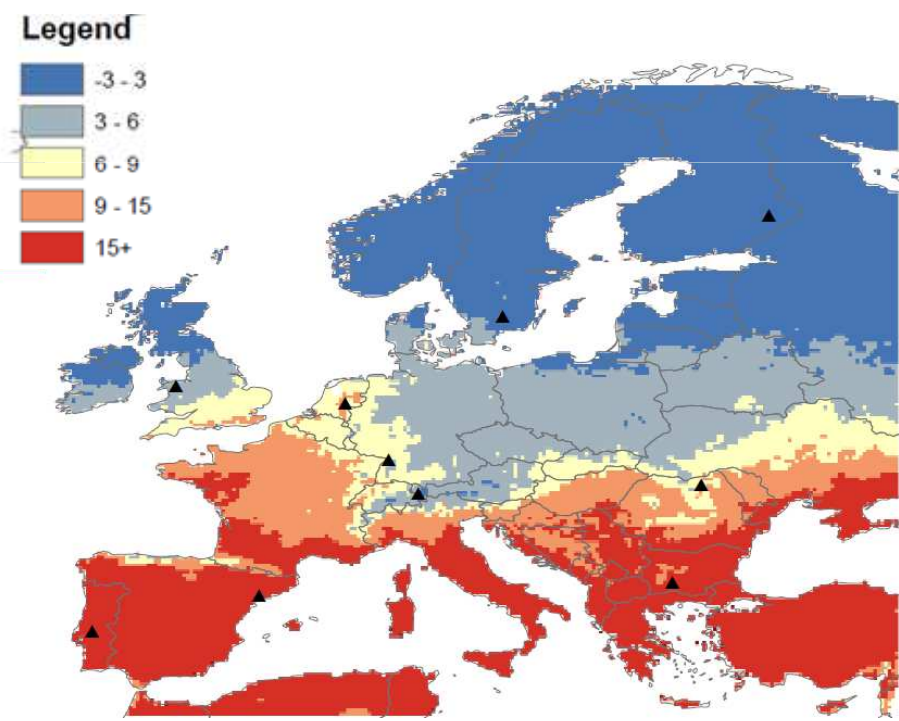


Change in Annual Maximum Number of Continuous Dry Days

Annual Maximum Number of Continuous Dry Days (Mean 1961-1990)



Change (2070-2099 vs. 1961-1990)





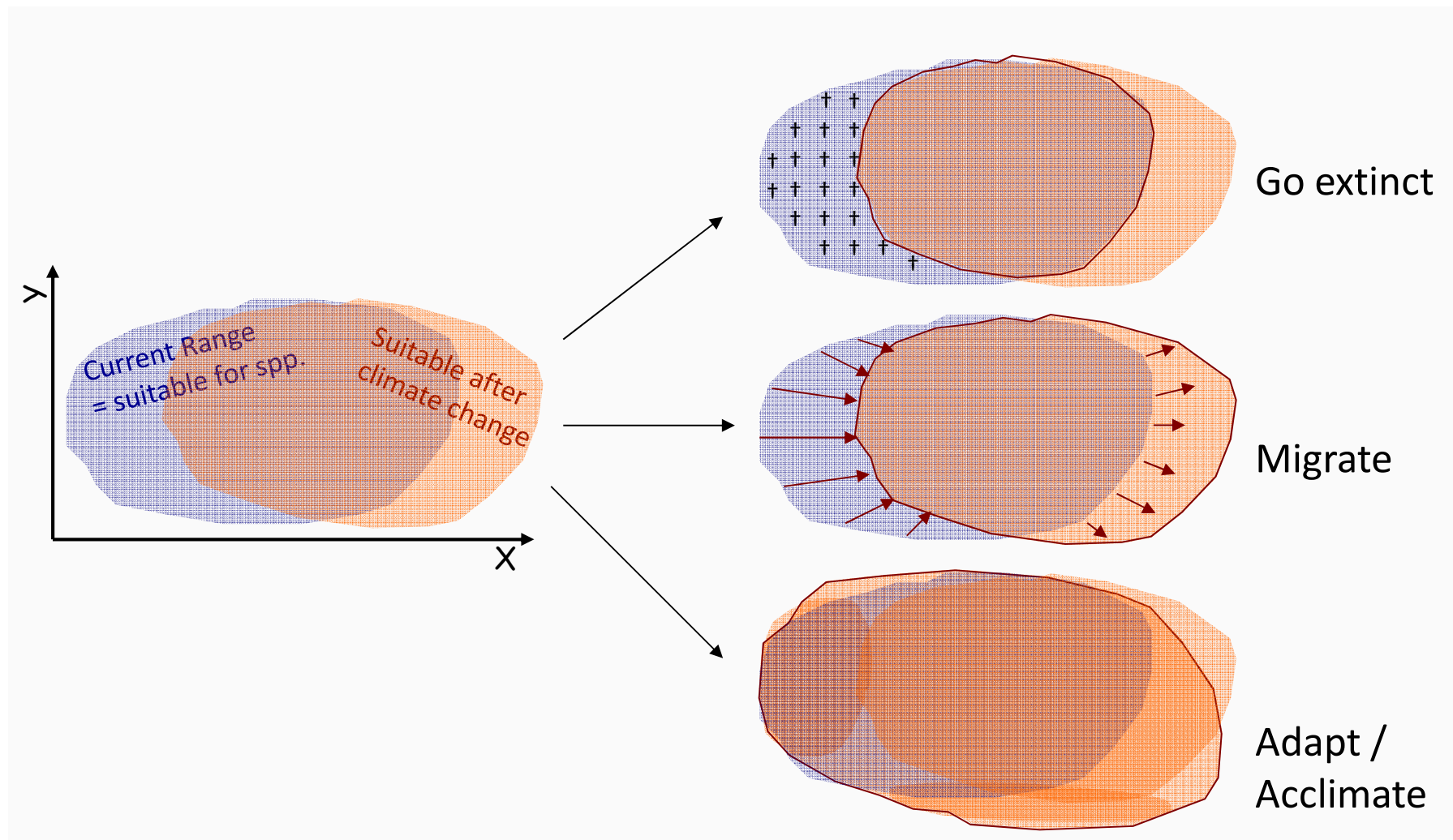
The climate-smart forester says:



- Annual/seasonal changes in T and P do not show the full impacts
- Forests respond more to extreme events (e.g. long dry spells)



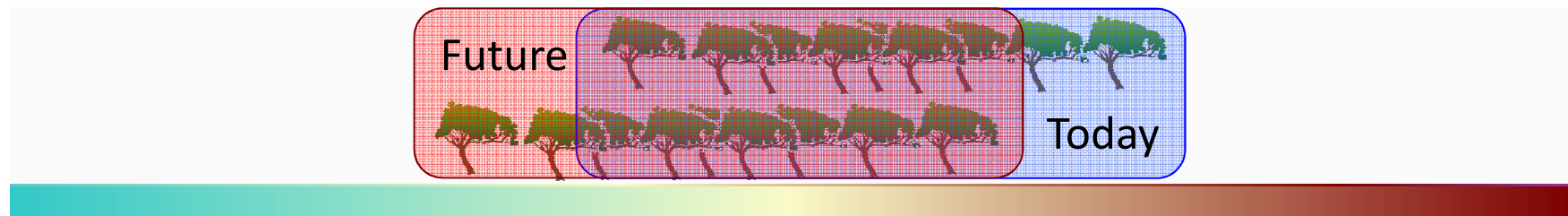
Climate & Tree Ranges





Climate & Tree Ranges

Principle of modelling climate envelopes (spatial distribution models of plant/animal species).





Climate & Tree Ranges

- Too cold today
- No observation of trees under this climate today

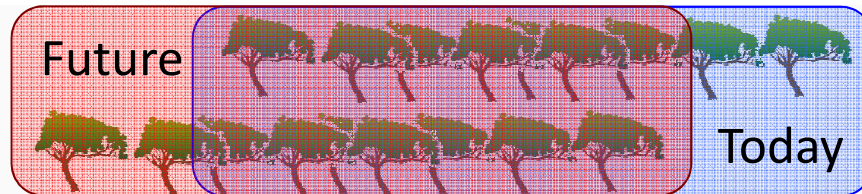
- Will tree migrate to these areas after warming?
- If yes, how fast?
- Shall we assist migration?

Suitable
habitat under
current AND
future climate

- Too dry/warm in future
- No observation of spp. under such future climate

- Will tree locally or generally go extinct?
- If yes, how fast?
- Shall we take measures?

Future



Today

The climate-smart forester says:



Understanding changes in species suitability is crucial to understand threats and opportunities as basis for adaptive forest management



Climate Envelope Shifts

Montane/Subalpine species

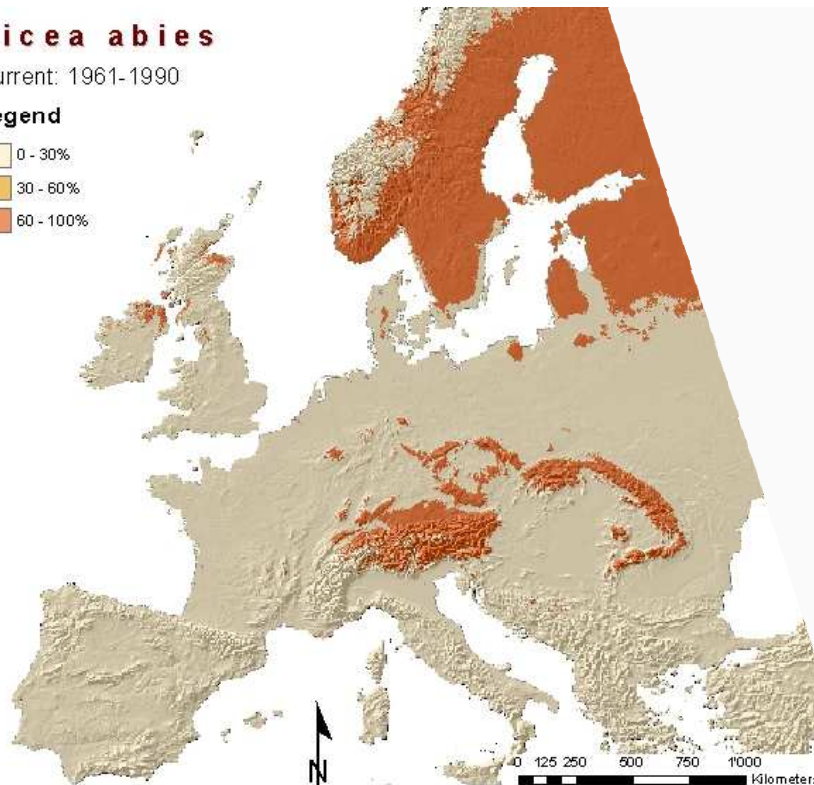
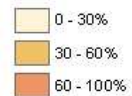
Ensemble predictions from multiple SDMs and RCMs

Suitable habitats in: 0-30% | 30-60% | 60-100% of all model/climate combinations

Picea abies

Current: 1961-1990

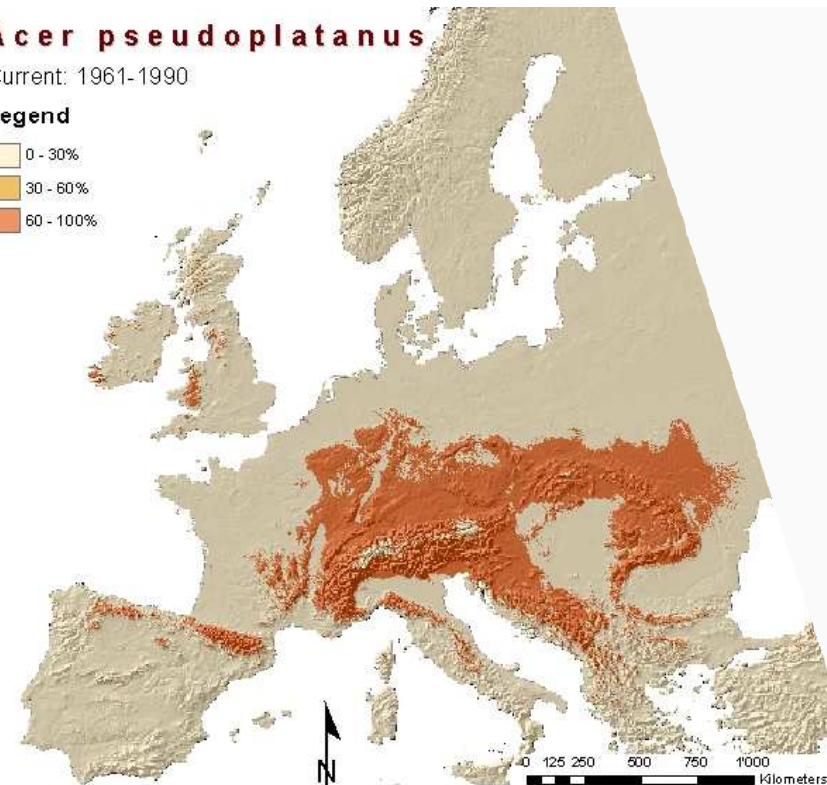
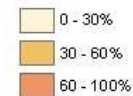
Legend



Acer pseudoplatanus

Current: 1961-1990

Legend





Climate Envelope Shifts

Montane/Subalpine species

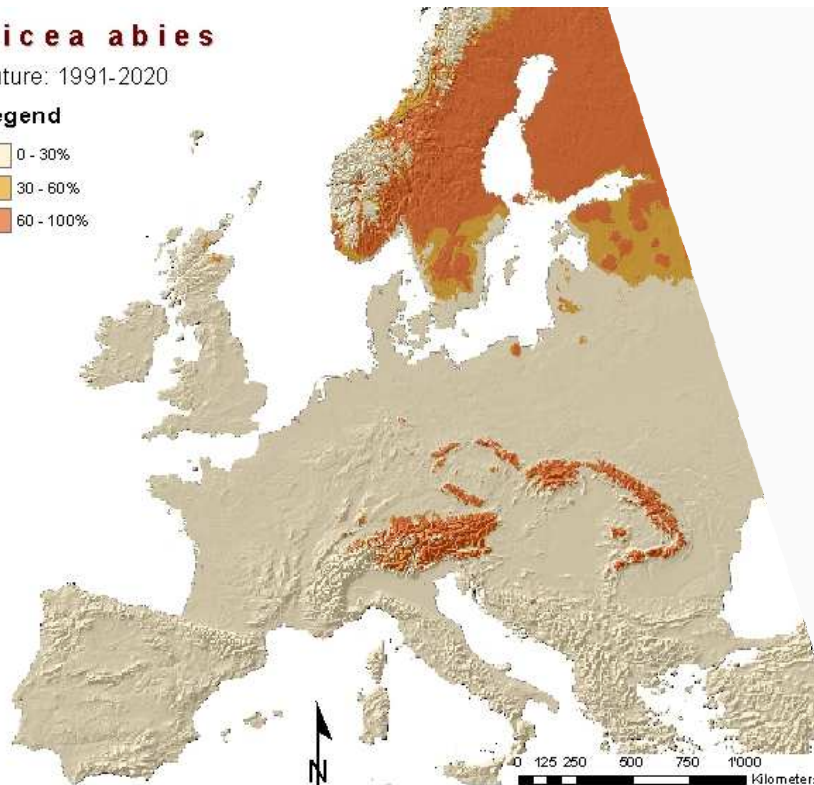
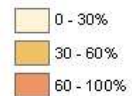
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Picea abies

Future: 1991-2020

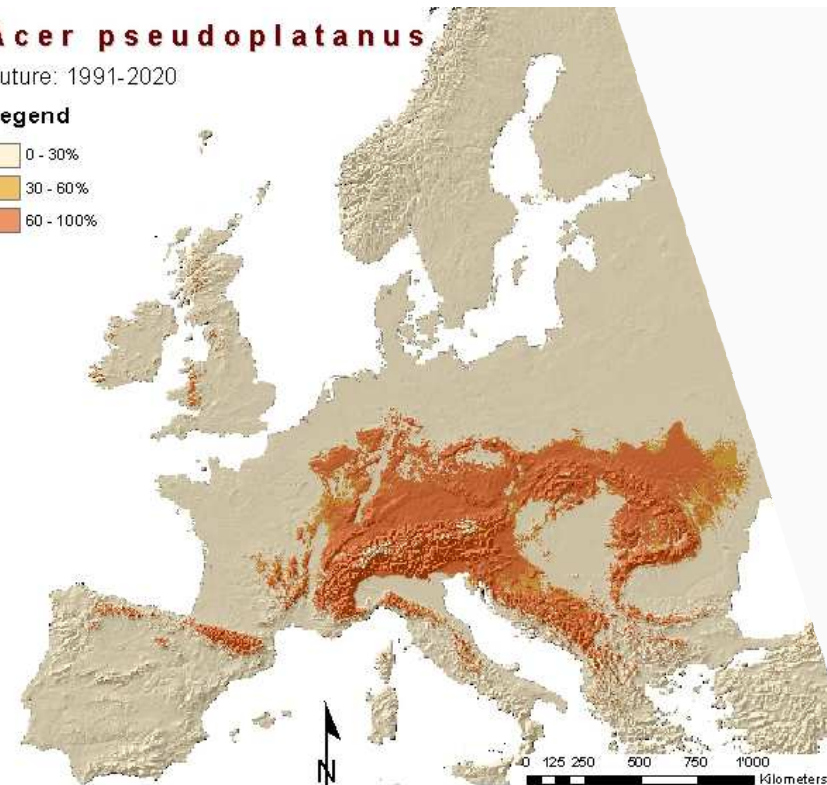
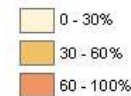
Legend



Acer pseudoplatanus

Future: 1991-2020

Legend





Climate Envelope Shifts

Montane/Subalpine species

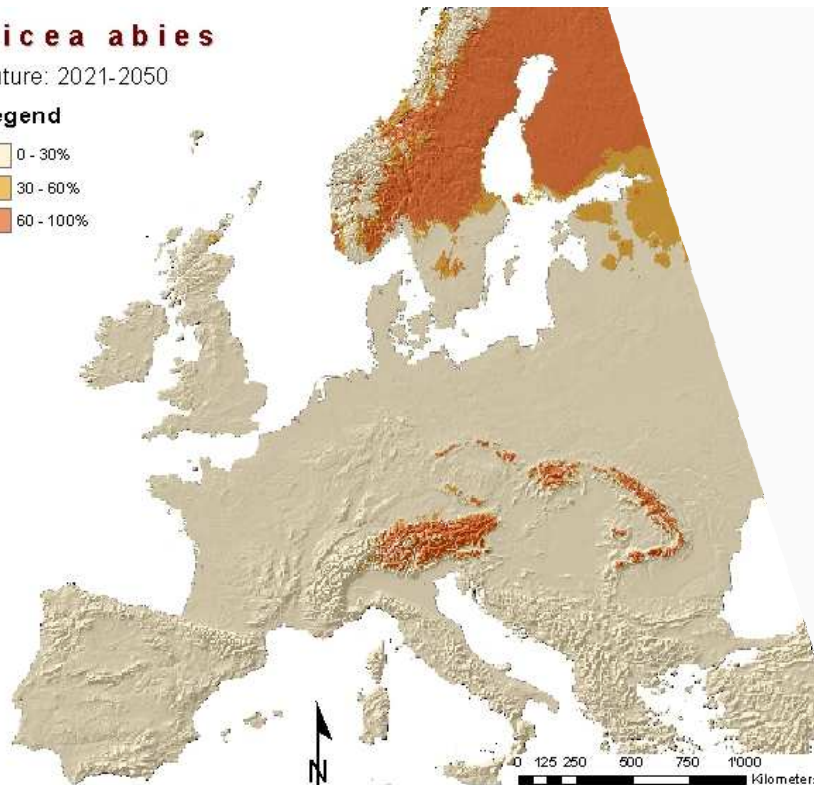
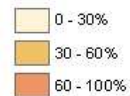
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Picea abies

Future: 2021-2050

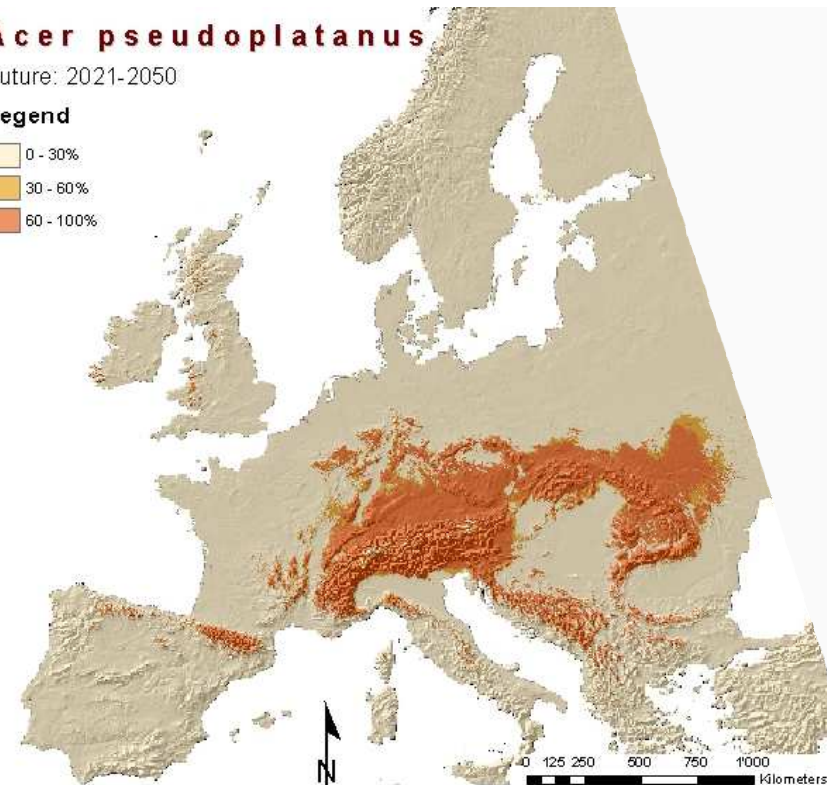
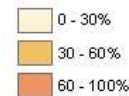
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Future: 2021-2050

Legend





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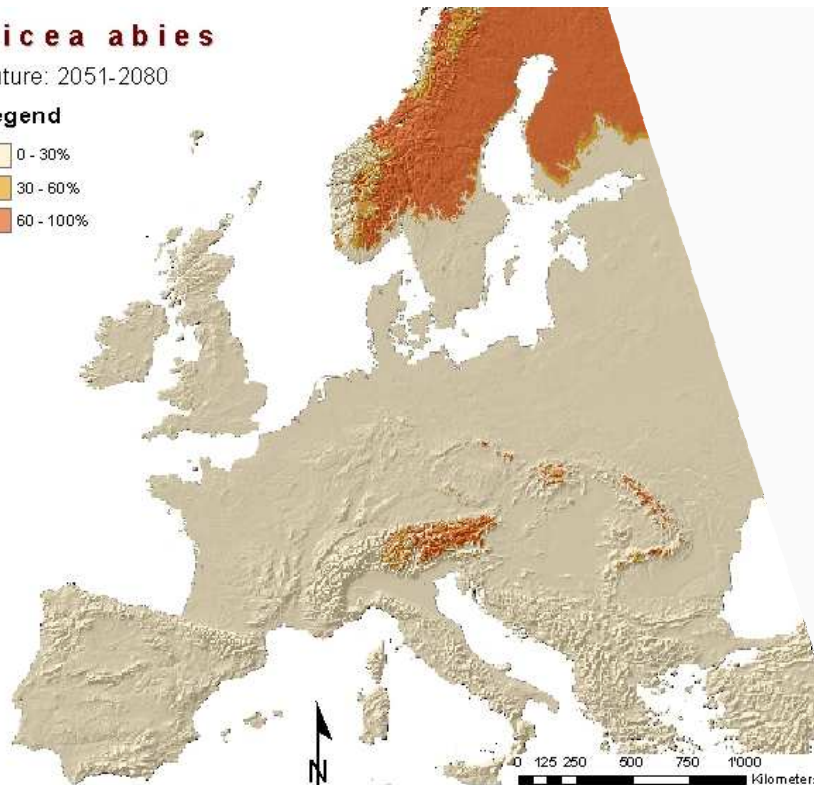
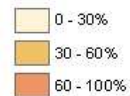
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Future: 2051-2080

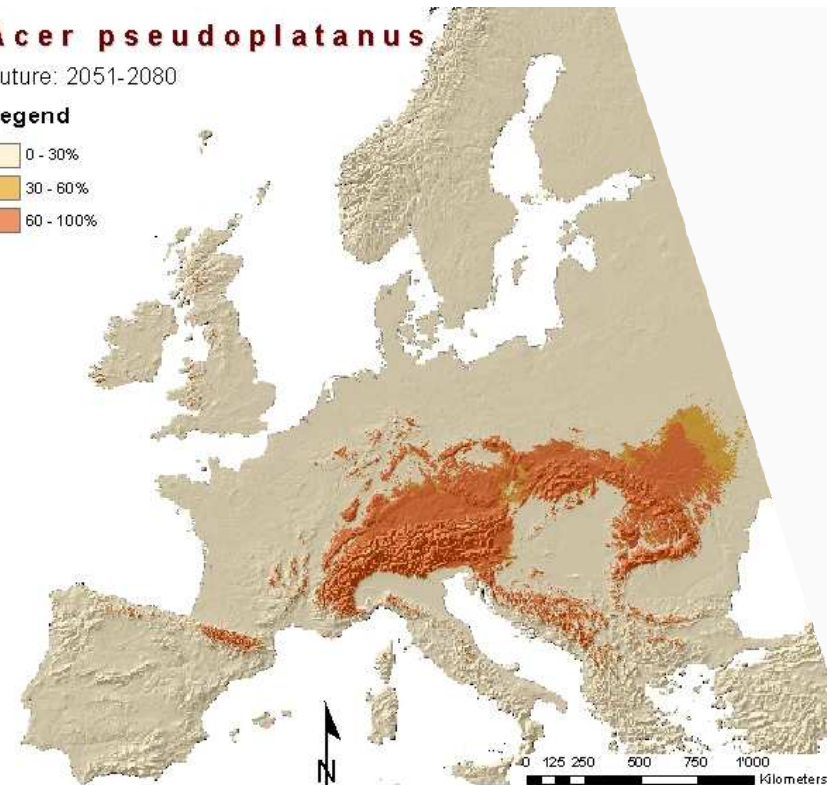
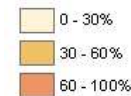
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Future: 2051-2080

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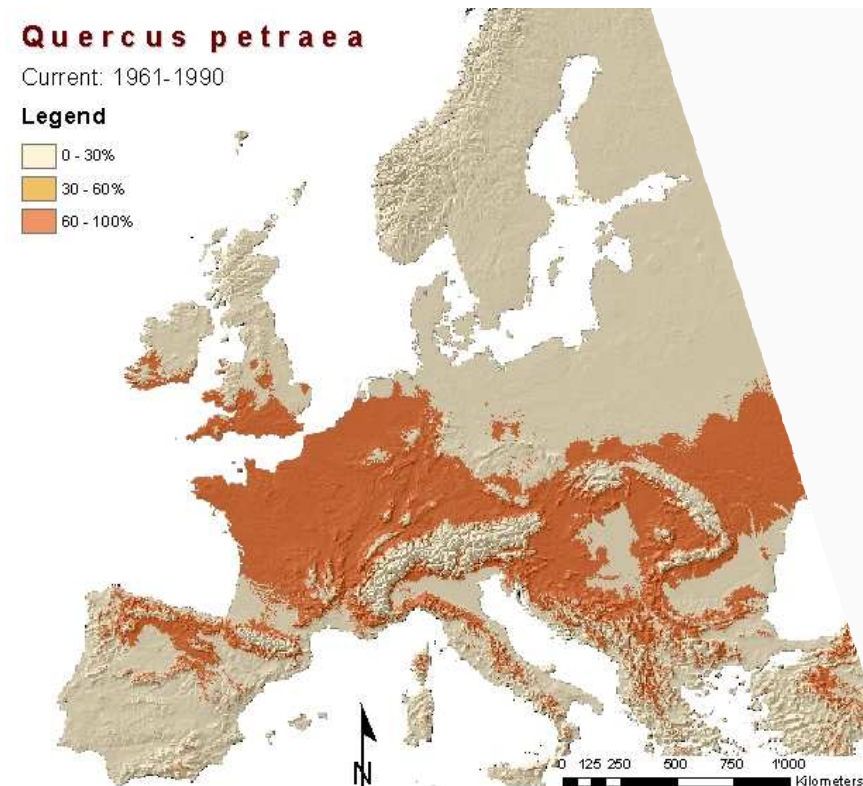
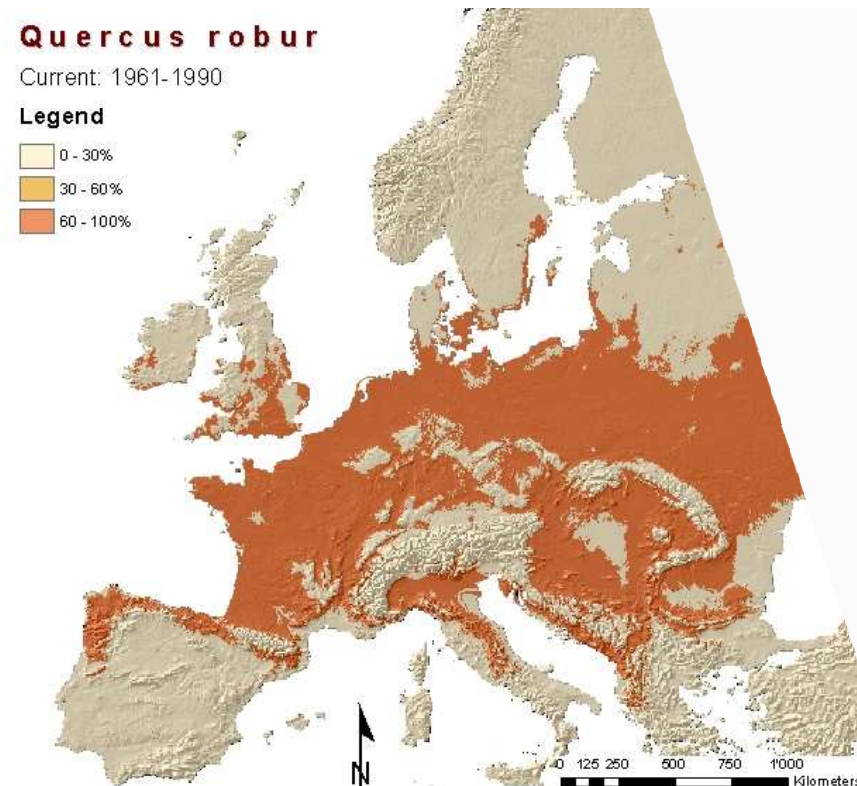


Climate Envelope Shifts

Two Central European Oak Species

Ensemble predictions from multiple SDMs and RCMs

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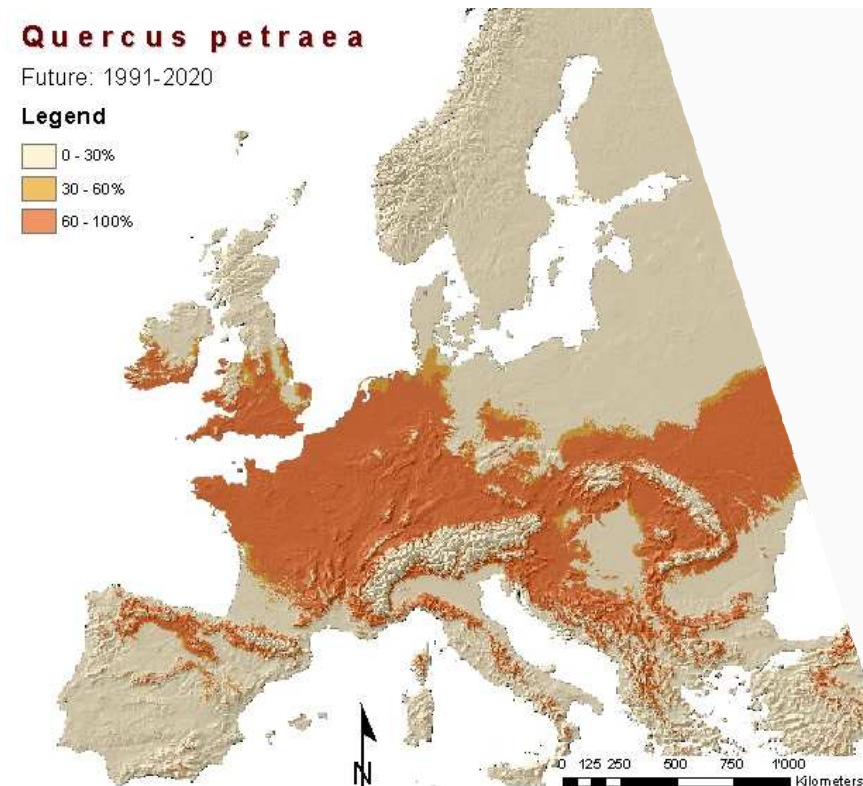
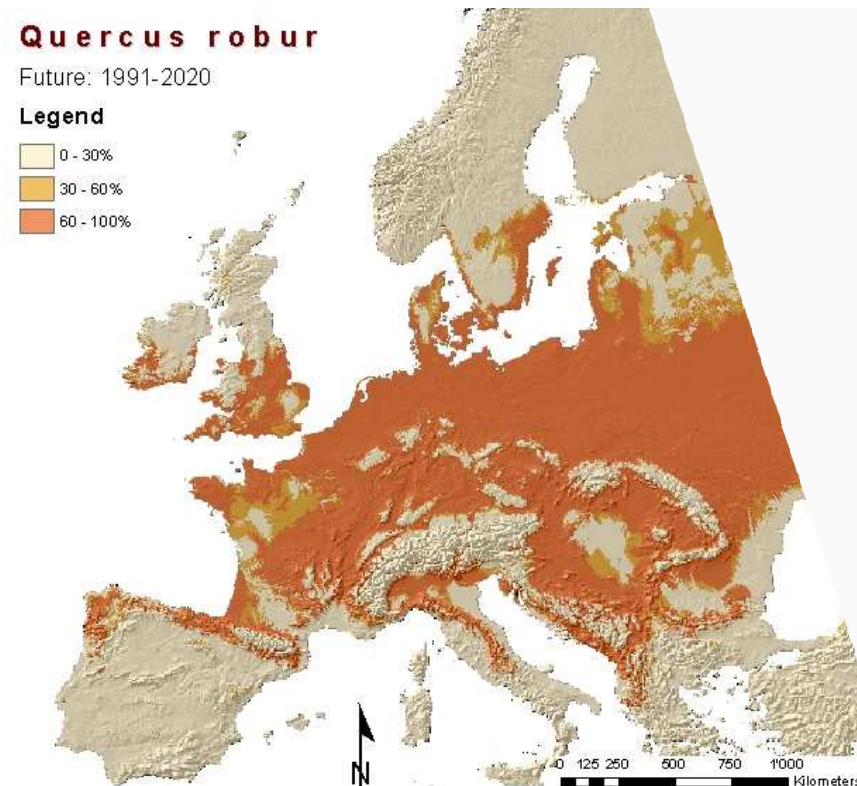


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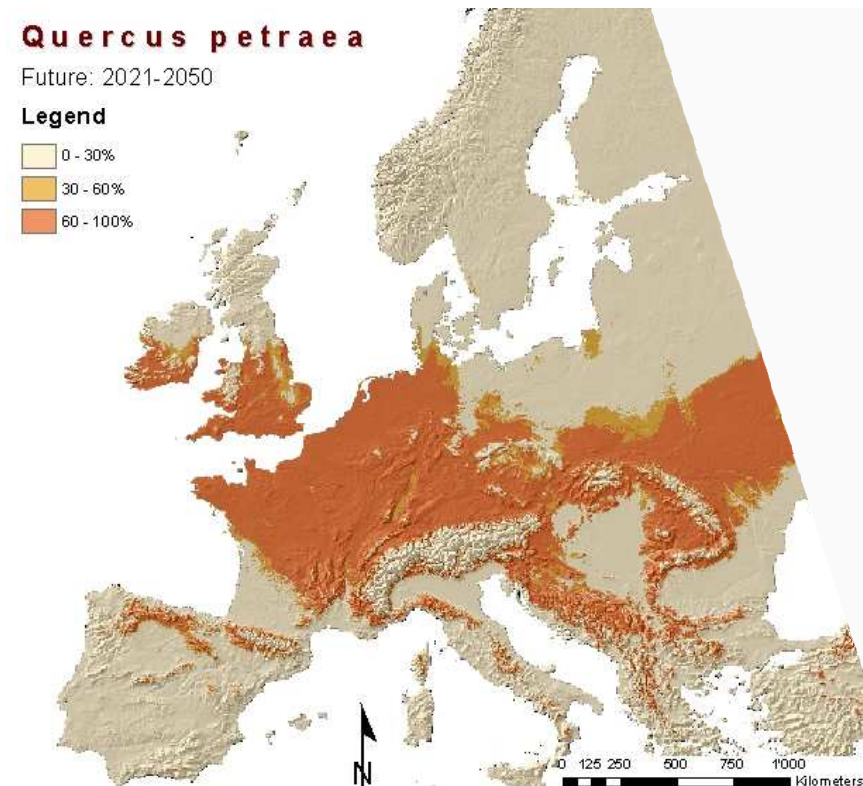
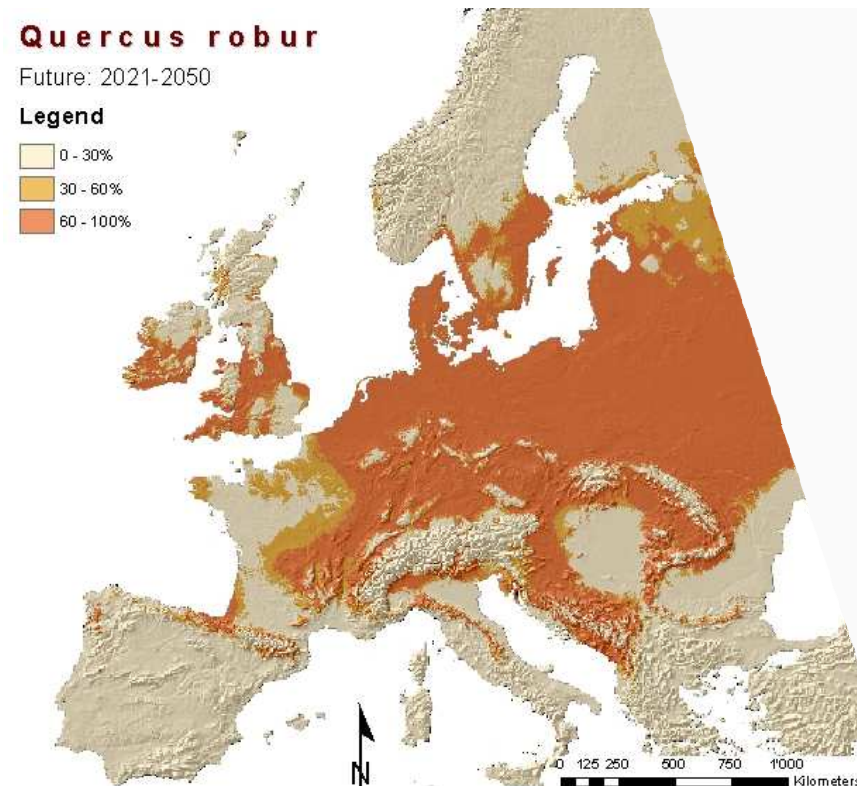


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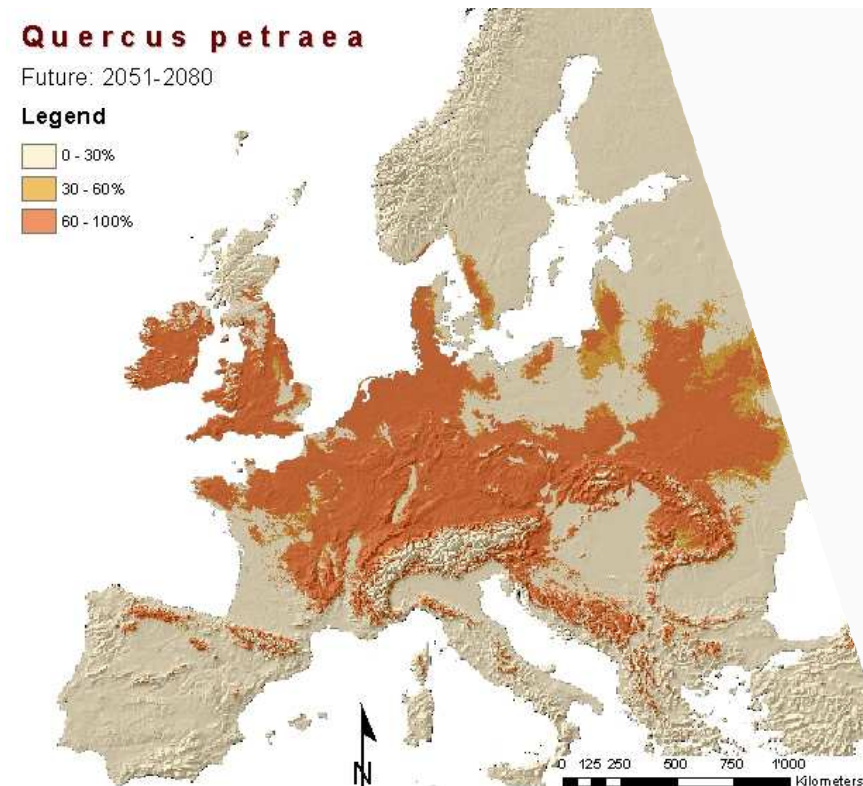
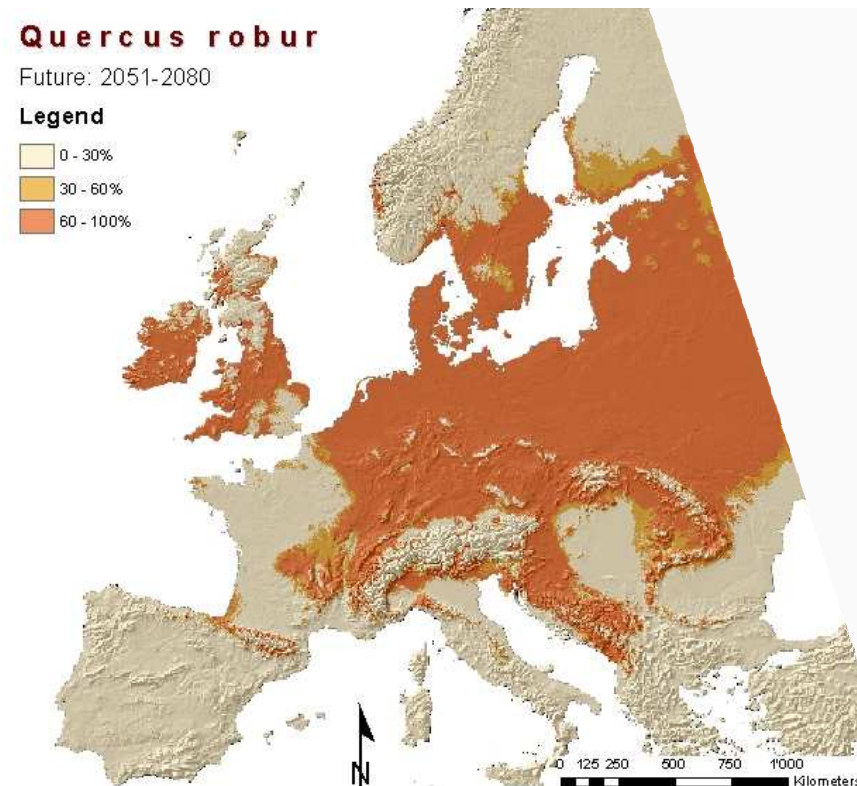


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The climate-smart forester says:



- European forestry has a long tradition of planting unsuitable species...
- Better understanding of physiological limits and genetic adaptation are crucial to interpret envelop model results



Conclusions

- Climate change scenarios are uncertain
- Many different aspects need to be considered in impact assessments (and some of them are not well captured in global climate models)
- It is easy to draw wrong conclusions from climate change scenarios, it is important to compare multiple scenarios and to study changes in critical environmental conditions such as long dry spells
- Species suitability is going to change drastically in the future, important current species are contracting their ranges, many areas that are suitable today will become unsuitable
- Better drought adapted species may expand their ranges considerably
- The changes may take place rapidly or slowly, this much depends on the evolution of climatic extremes. And changes will be fast if extremes become more severe and more frequent fast.



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