Let’s talk about Europe…

… And obviously about frosts

Are false springs increasing??

Decreasing??

Is absolutely nothing changing with them?

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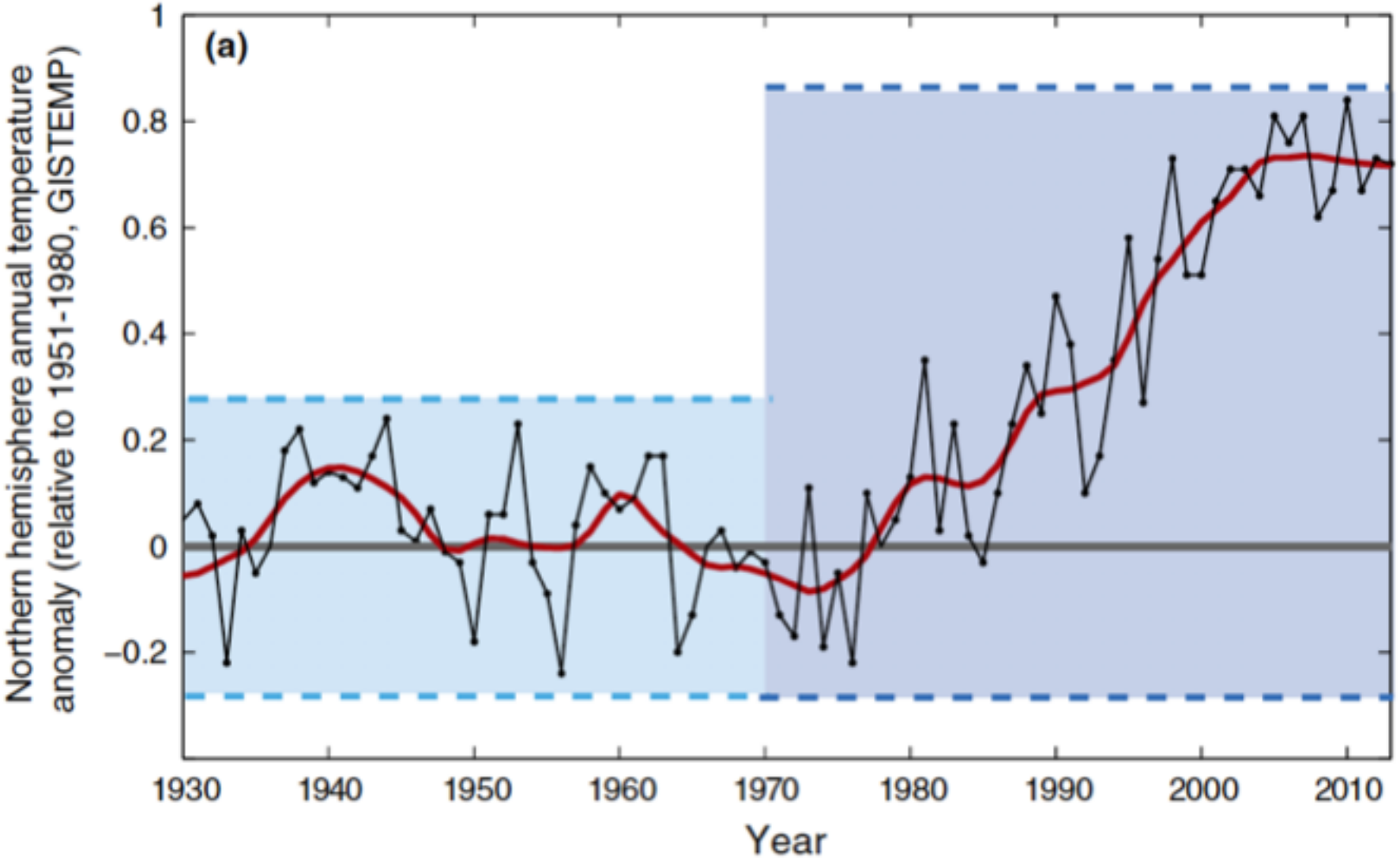
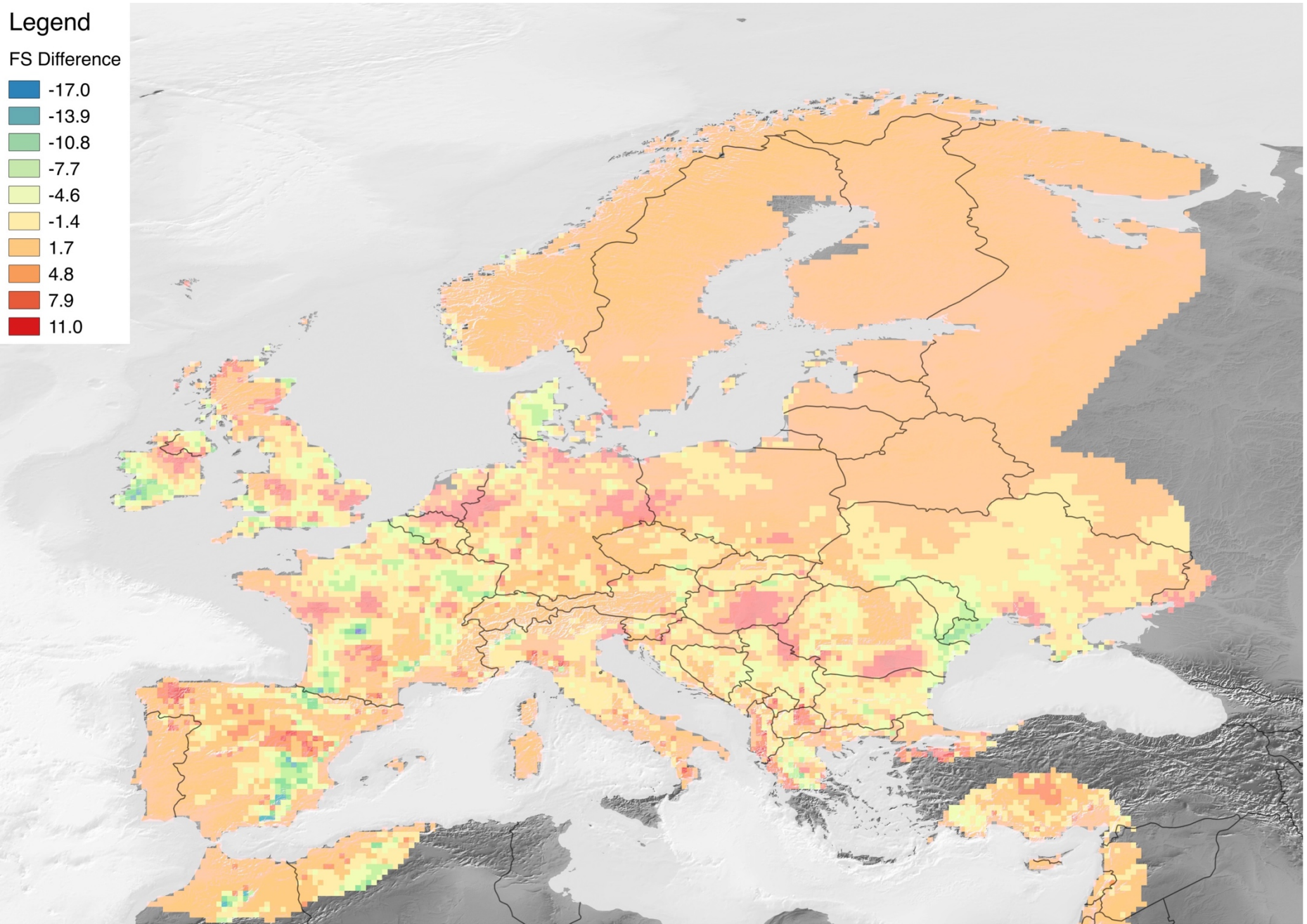

(a)
Northern hemisphere annual temperature anomaly (relative to 1951-1980, GISTEMP)
1
0.8
0.6
0.4
0.2
0
−0.2
1930
1940
1950
1960
1970
1980
1990
2000
2010
Year

Difference in number of spring freezes after temperature trends increased in the 1980s



Blue/Green: More after the 80s

Red: less after the 80s

Depends on location of study apparently…

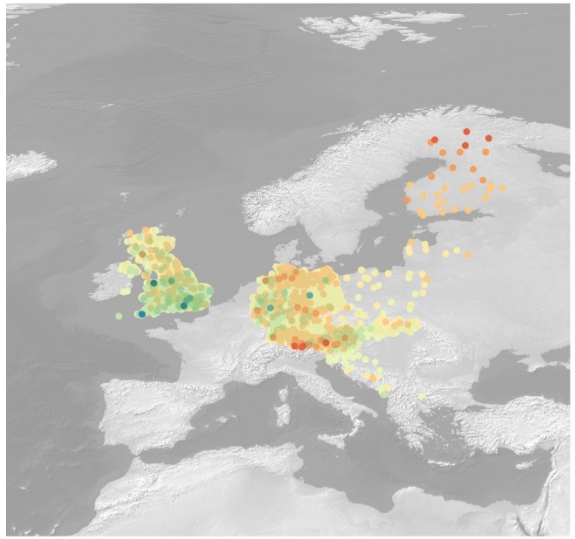
What are scientists looking at?

- **Mean Spring Temperature**
- **Elevation gradients**
- **Latitudinal gradients**

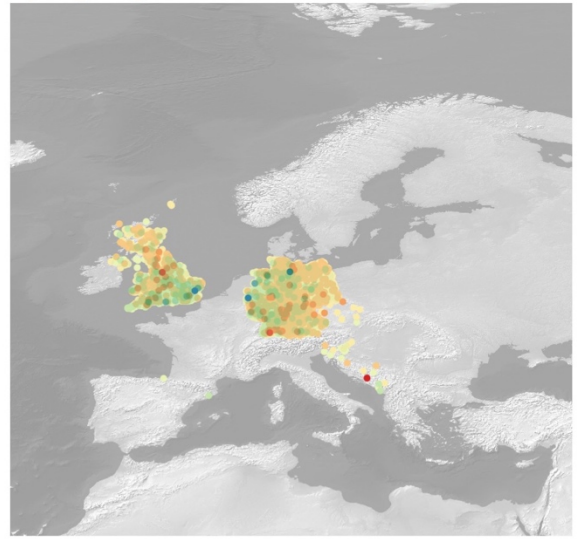
So then what are we missing???

- Distance from the coast!!
- North Atlantic Oscillation Index
- EVERYTHING COMBINED!

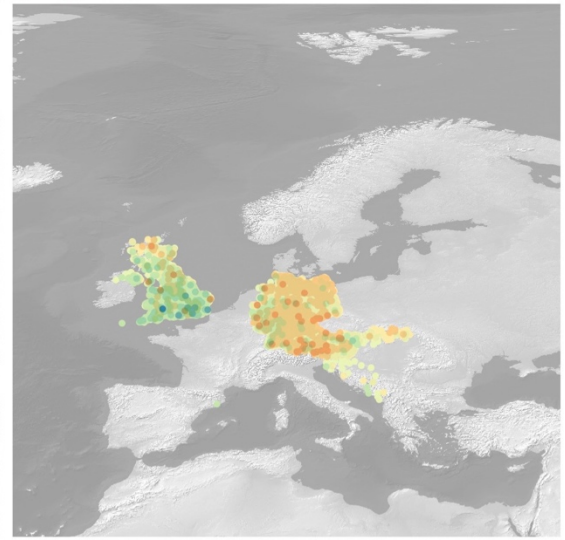
A. Betula pendula
(Avg Day of Budburst = 98.76)



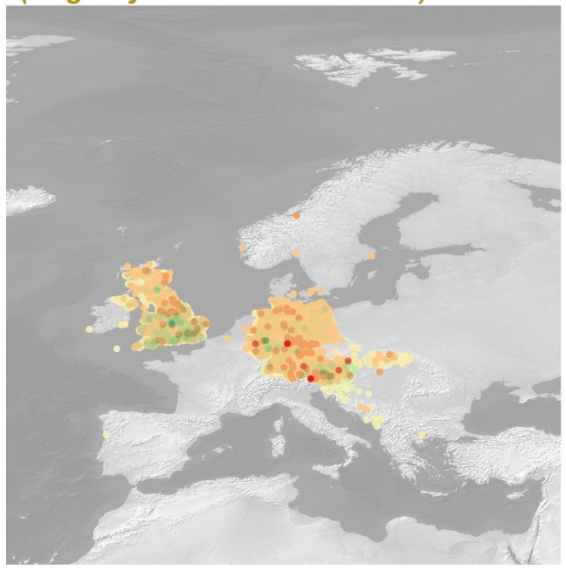
B. Alnus glutinosa
(Avg Day of Budburst = 98.91)



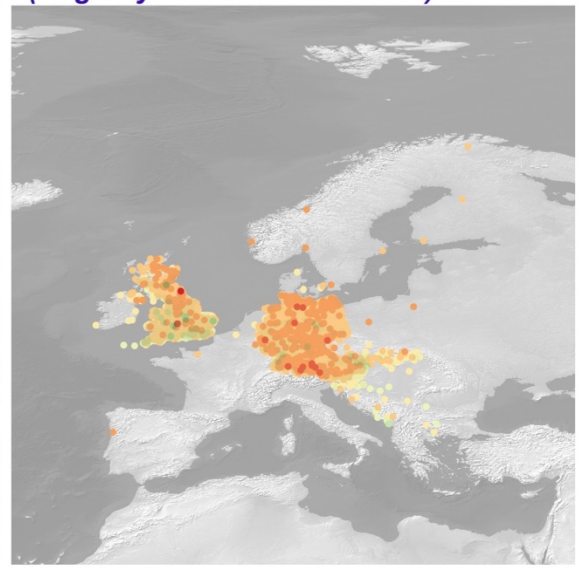
C. Aesculus hippocastanum
(Avg Day of Budburst = 99.24)



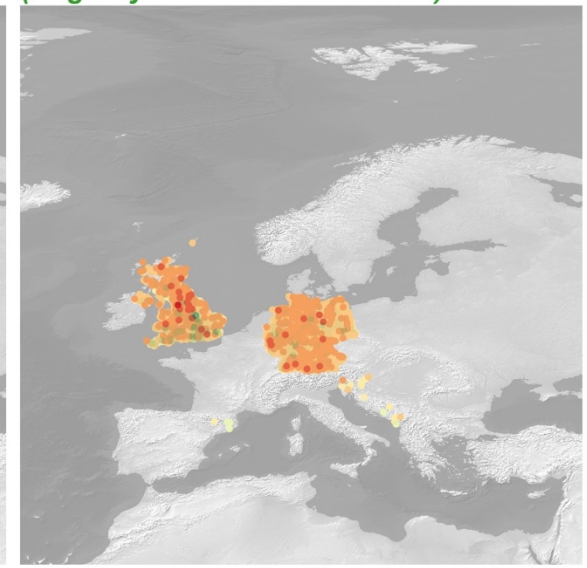
D. Fagus sylvatica
(Avg Day of Budburst = 106.7)



E. Quercus robur
(Avg Day of Budburst = 113.0)

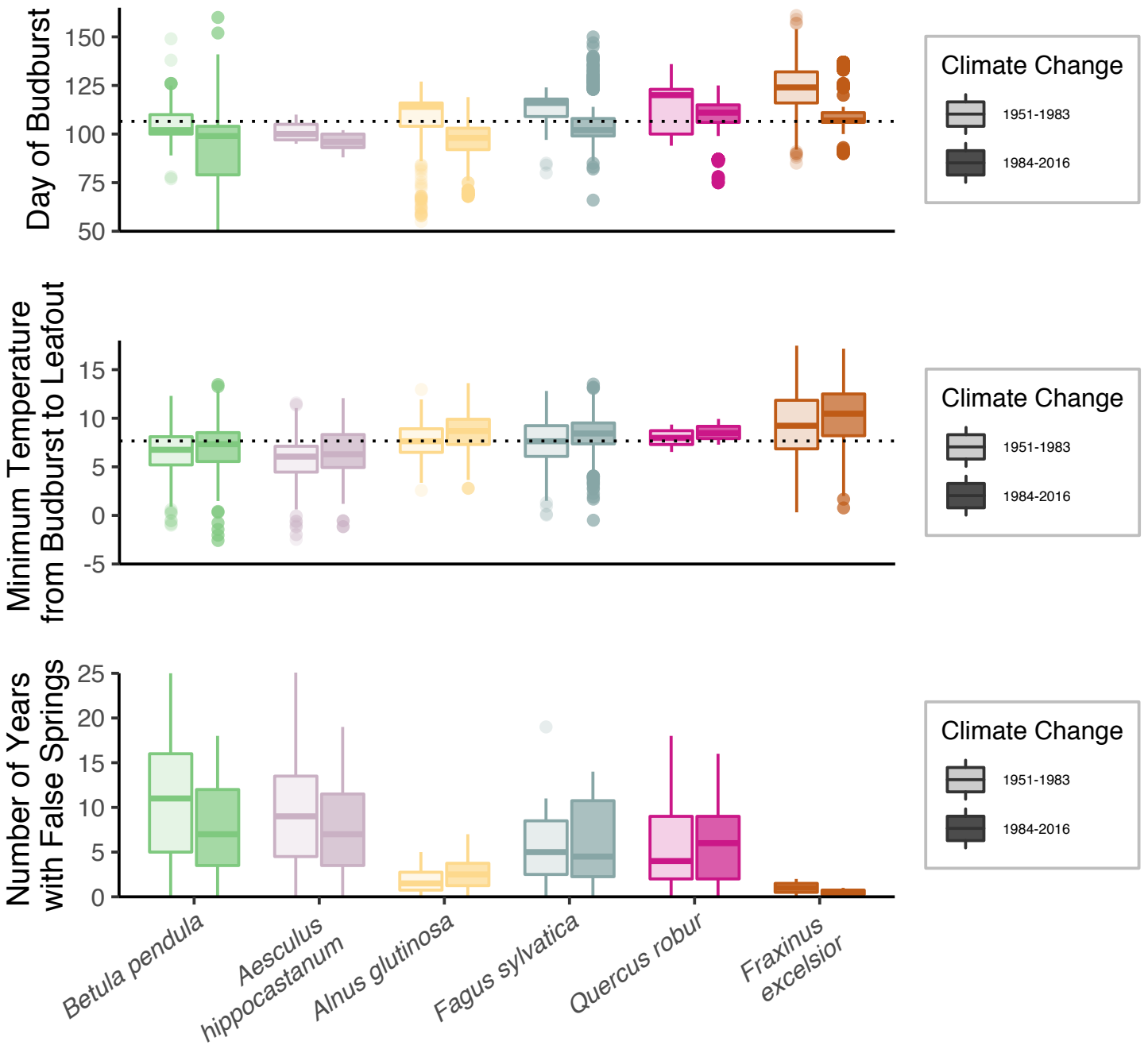


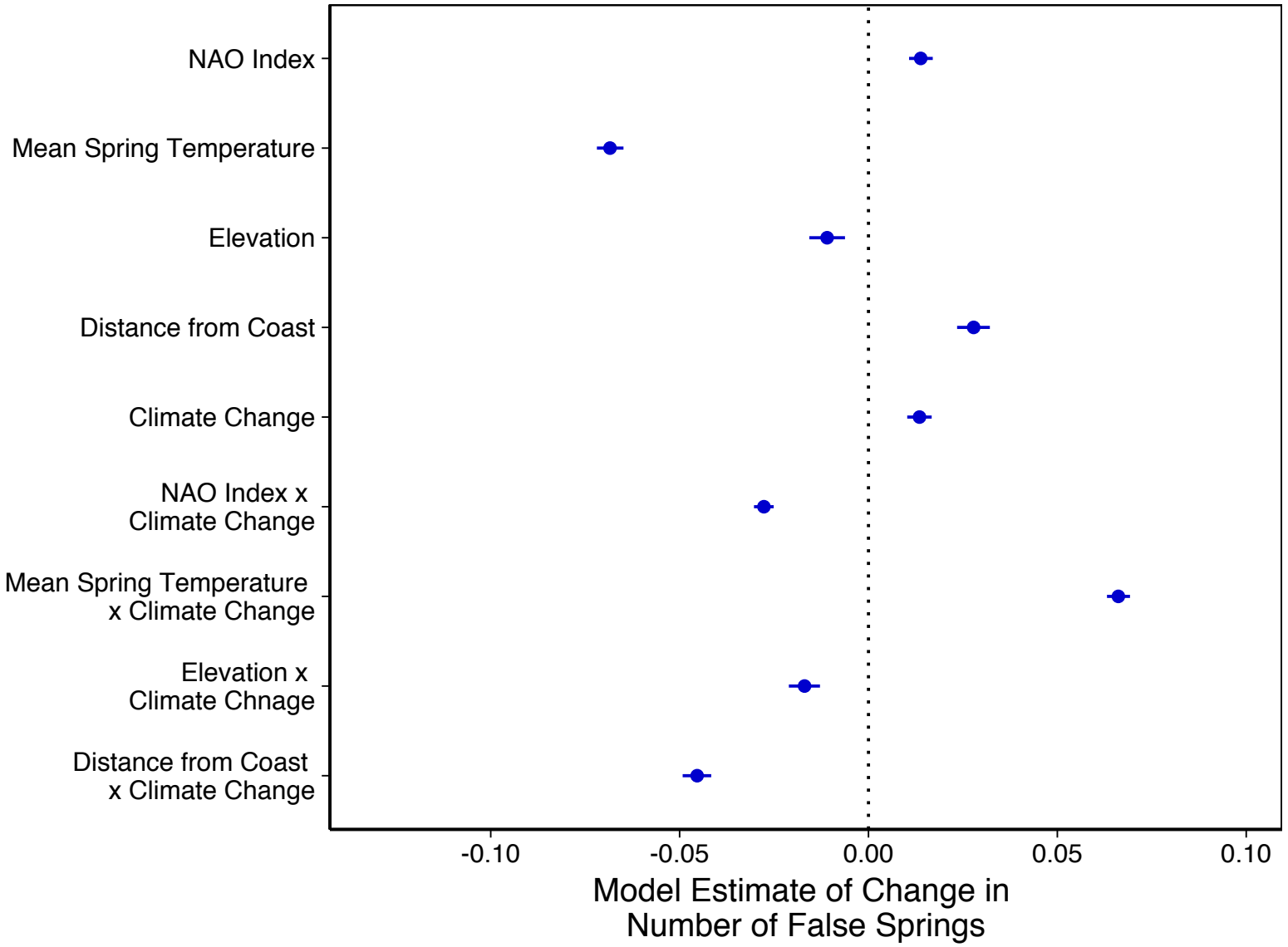
F. Fraxinus excelsior
(Avg Day of Budburst = 116.34)

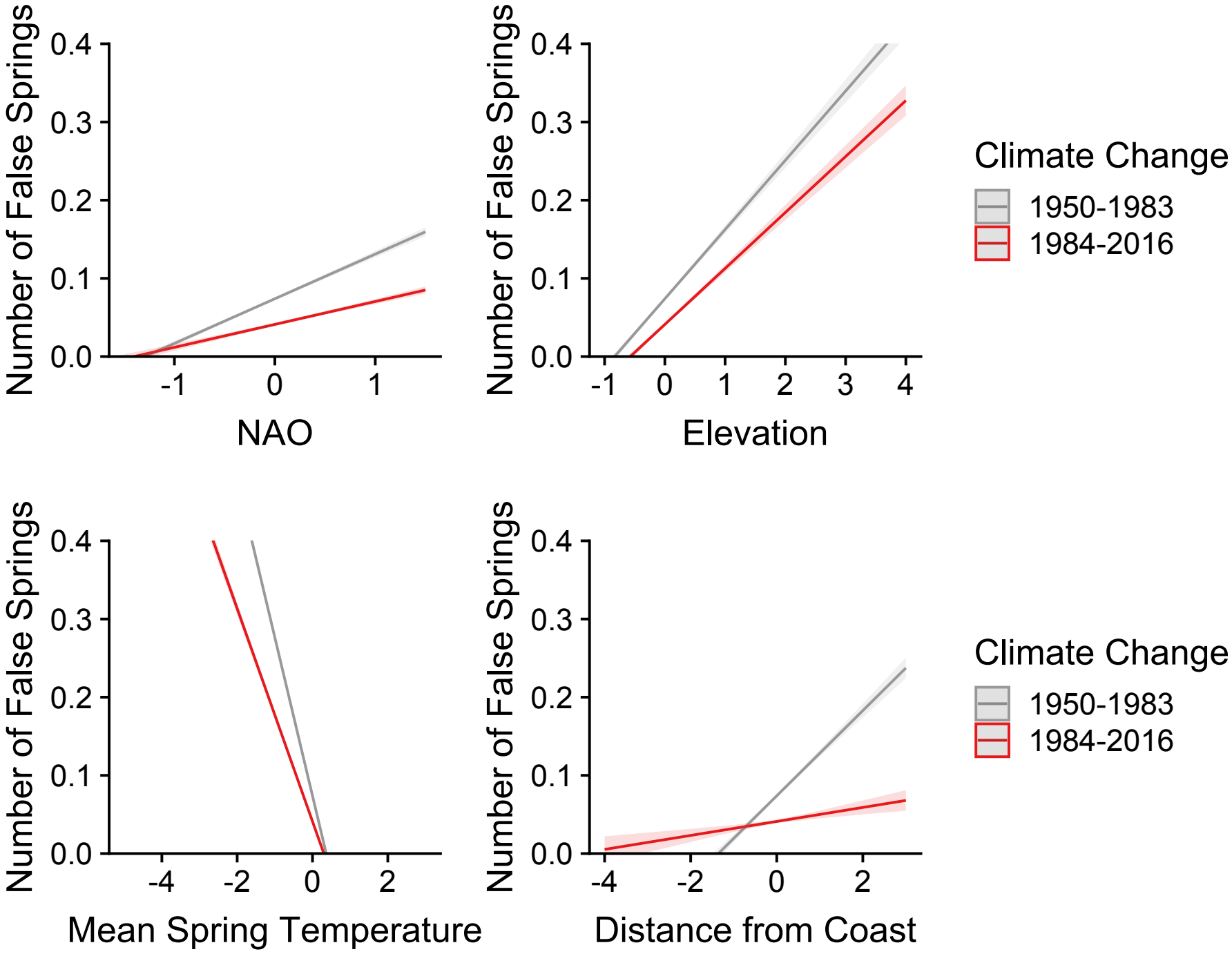


Avg Day of Budburst

- 0 - 36
- 36 - 51
- 51 - 66
- 66 - 81
- 81 - 96
- 96 - 111
- 111 - 126
- 126 - 141
- 141 - 156
- 156 - 170


Day of Budburst
150
125
100
75
50
Climate Change
1951-1983
1984-2016
Minimum Temperature from Budburst to Leafout
15
10
5
0
-5
Climate Change
1951-1983
1984-2016
Number of Years with False Springs
25
20
15
10
5
0
Climate Change
1951-1983
1984-2016
Betula pendula
Aesculus hippocastanum
Alnus glutinosa
Fagus sylvatica
Quercus robur
Fraxinus excelsior


NAO Index
Mean Spring Temperature
Elevation
Distance from Coast
Climate Change
NAO Index x
Climate Change
Mean Spring Temperature
x Climate Change
Elevation x
Climate Chnage
Distance from Coast
x Climate Change
-0.10
-0.05
0.00
0.05
0.10
Model Estimate of Change in
Number of False Springs


Number of False Springs
0.0
0.1
0.2
0.3
0.4
-1
0
1
NAO
Number of False Springs
0.0
0.1
0.2
0.3
0.4
-1
0
1
2
3
4
Elevation
Climate Change
1950-1983
1984-2016
Number of False Springs
0.0
0.1
0.2
0.3
0.4
-4
-2
0
2
Mean Spring Temperature
Number of False Springs
0.0
0.1
0.2
0.3
0.4
-4
-2
0
2
Distance from Coast
Climate Change
1950-1983
1984-2016

Our Paper

- PEP 725 data:
  - 6 species
  - 11648 sites
  - 66 years (1950-2016)
  - Leaf out data
- Climate Data: E-OBS
- Parameters:
  - NAO
  - Mean Spring Temperature
  - Elevation
  - Distance from Coast
  - Climate Change
  - Species
- Model:

Num FS ~ nao.z + mat.z + dist.z + space.z + elev.z + cc.z
+ species + mat.z:species + dist.z:species +
space.z:species + elev.z:species +
cc.z:species + mat.z:cc.z + dist.z:cc.z +
space.z:cc.z + elev.z:cc.z

Ma, *et al*. paper

- PEP 725 data:
  - 27 species
  - 5565 sites
  - 63 years (1950-2013)
  - First observation thru July 15th
- Climate Data: E-OBS
- Parameters
  - Elevation
  - Distance from Coast
  - Species
  - Years
- Models: random slopes for site; random intercept for species

$$y_{ij} = \alpha + \beta x_{ij} + a_j + \varepsilon_{ij}$$

$$logit(p_{ij}) = log\left(\frac{p_{ij}}{1-p_{ij}}\right) = \alpha + \beta x_{ij} + a_j$$

Our Paper

- Earlier BB species were more susceptible to frost risk
- Ditto.
- No major effect from NAO
- Reduced risk of frost in warmer regions
- Reduced risk overall with climate change

Ma, *et al*. paper

- Earlier BB species had increased probability and severity of frost risk
- More coastal regions had increased probability and severity of frost risk over time, whereas high elevations had lower risk
- Advancing spring phenology decreased slightly over time with increasing elevation but LSF advanced significantly – less risk at higher altitudes with climate change
- No change in sensitivity analysis – results were the same