Leveraging the HPC-infrastructure to predict the airco-effect of European forests

Stef Haesen – 13/06/2024

stef.haesen@kuleuven.be

sGlobe lab
FROM INSIGHTS TO SOLUTIONS

DIVISION OF
FOREST, NATURE & LANDSCAPE

Postdoc @ sGLOBE Lab

- ✓ prof. dr. ir. Koenraad Van Meerbeek
- ✓ ERC project FutureNature
- ✓ Gain insights into biodiversity-related questions
  - ✓ remote sensing: drones & satellites
  - ✓ collection of field data
  - ✓ wide range of modelling techniques
  - → HPC widely-used within sGLOBE

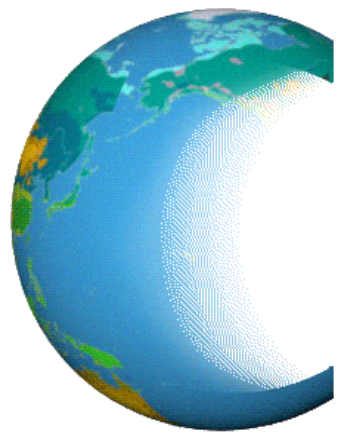
Background

- ✓ BSc & MSc in Bioscience Engineering
- ✓ PhD in Bioscience Engineering
- ✓ No prior knowledge on coding or high-performance computing…

sGlobe lab
FROM INSIGHTS TO SOLUTIONS

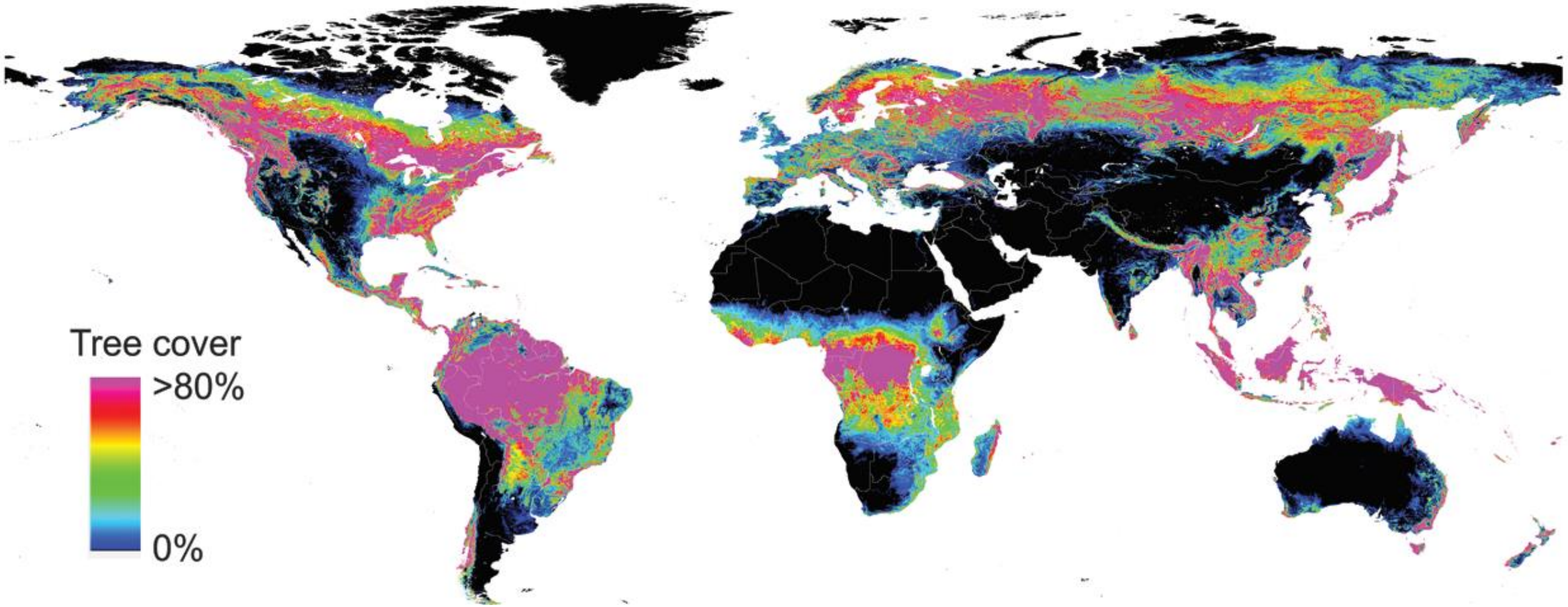
DIVISION OF
FOREST, NATURE & LANDSCAPE

WorldClim

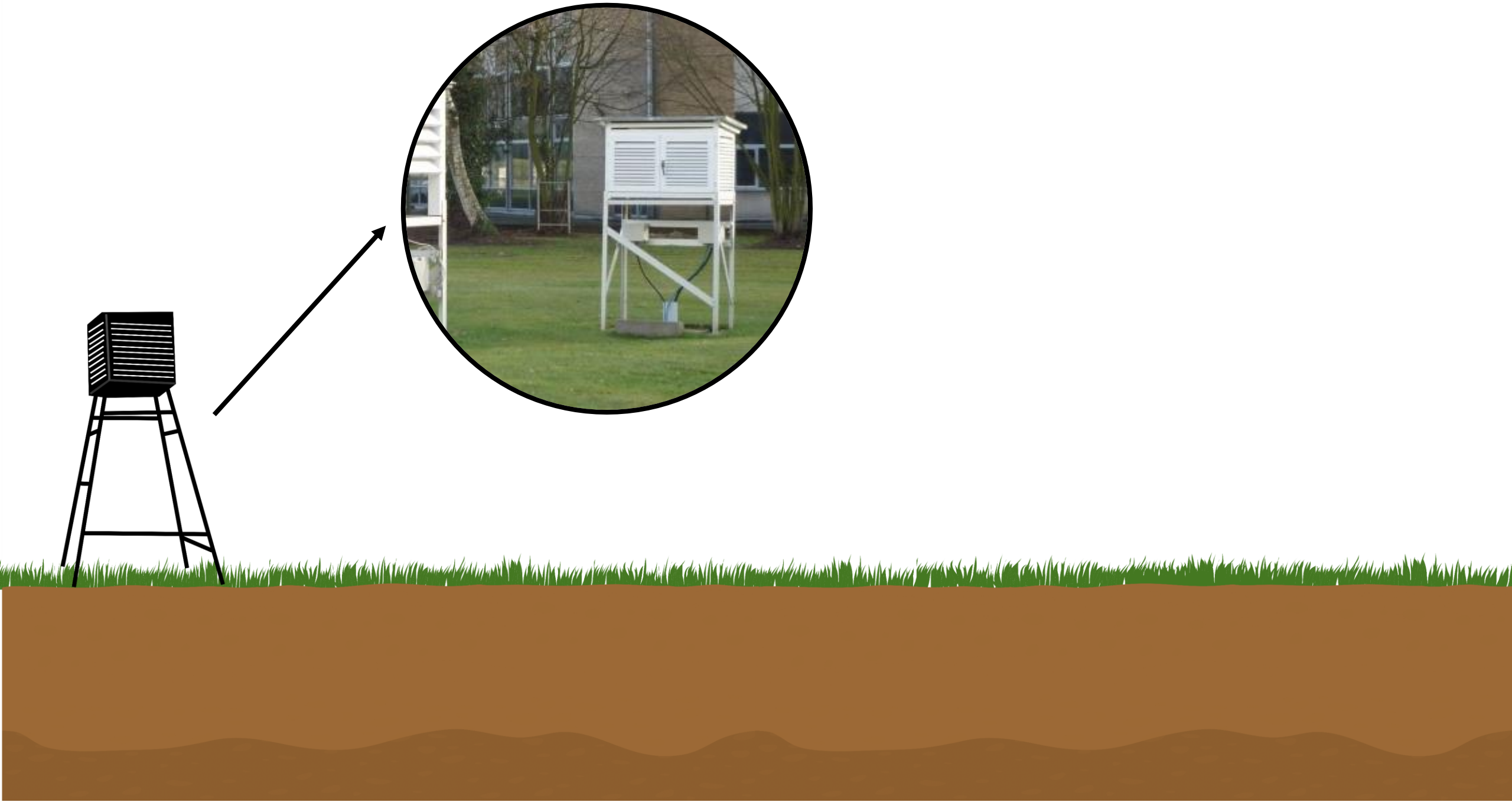


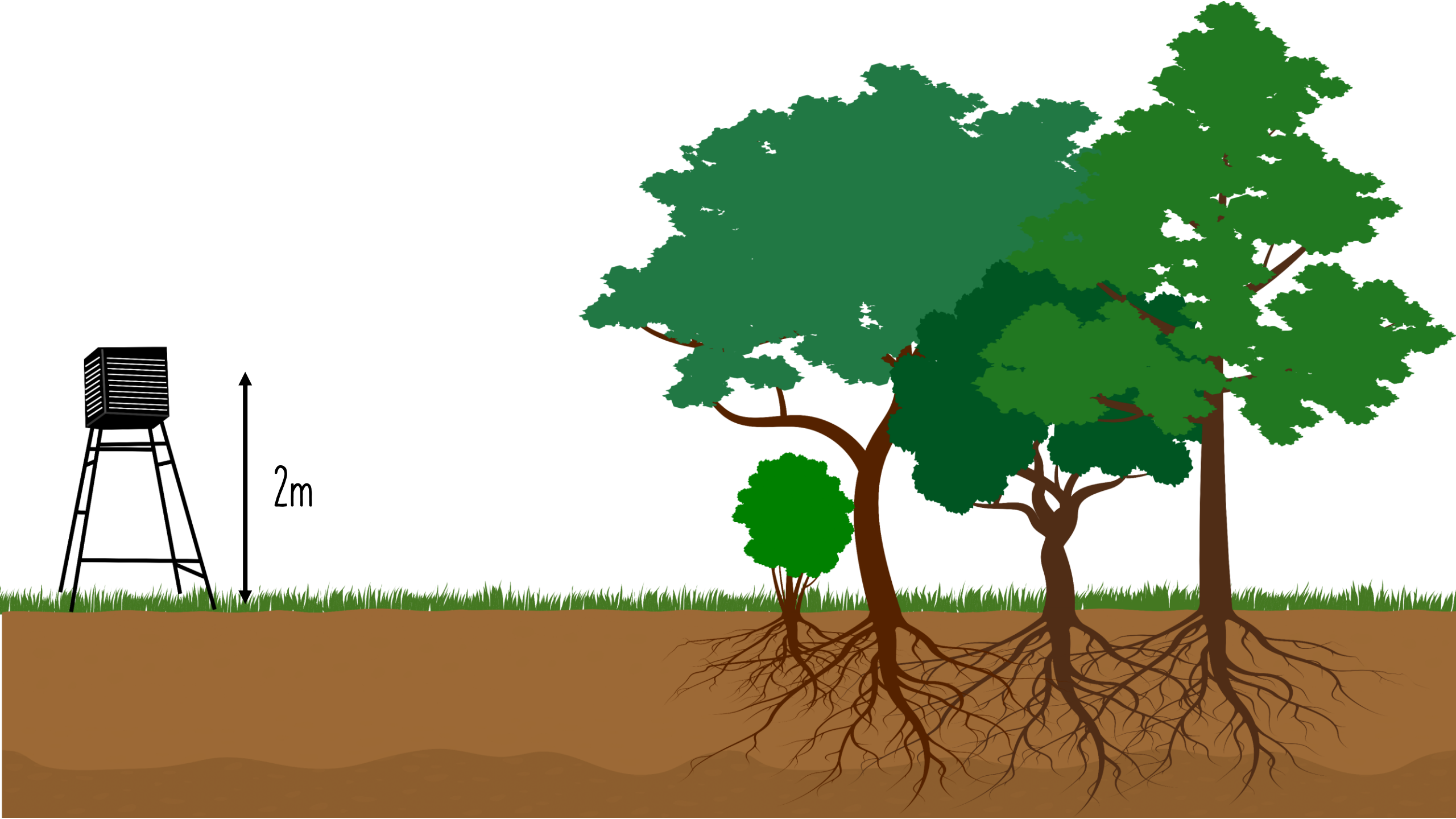
CHELSA

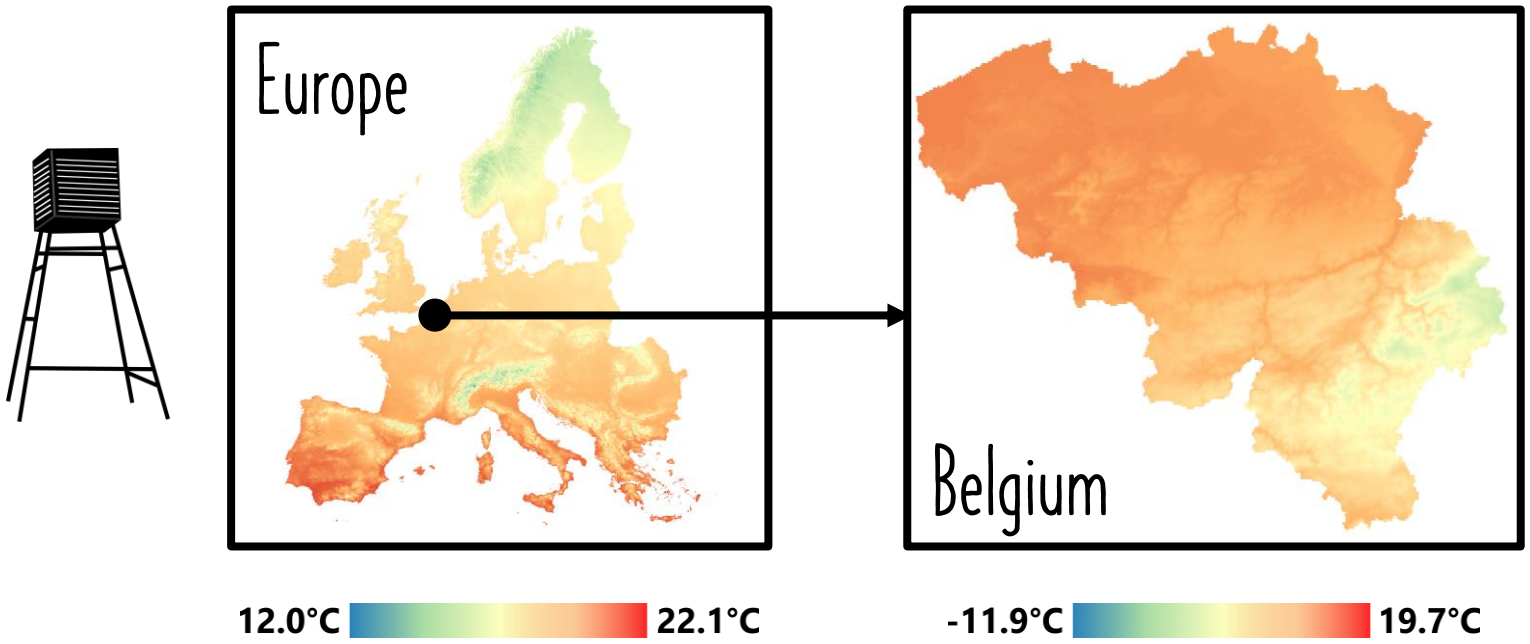
Hansen *et al.* (2013) *Science*

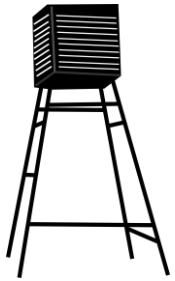


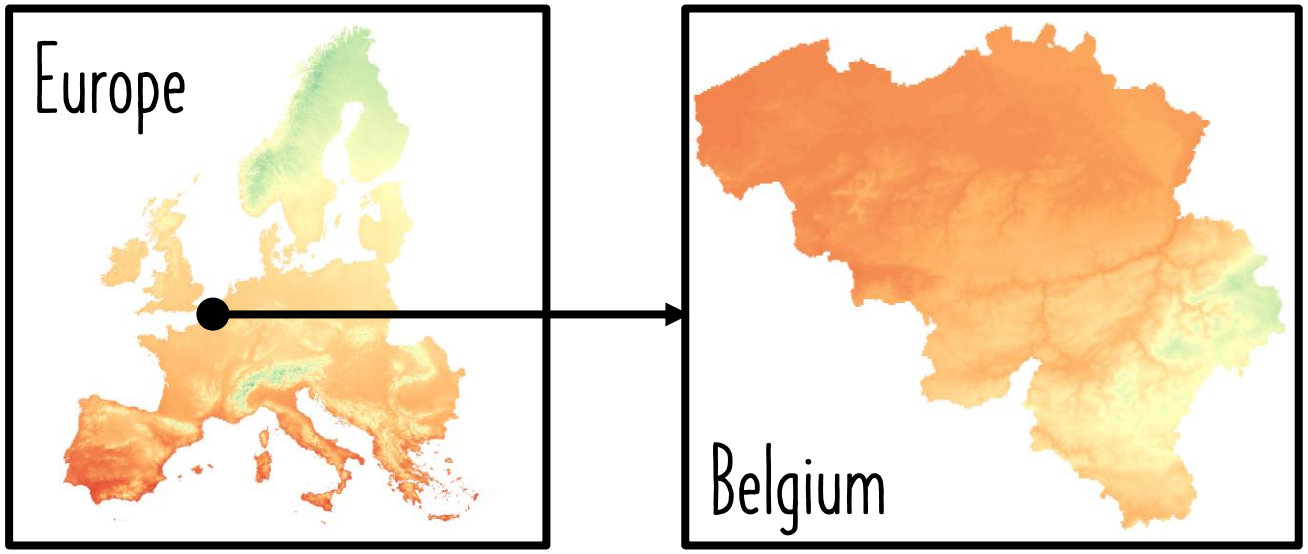
Hansen *et al.* (2013) *Science*




2m

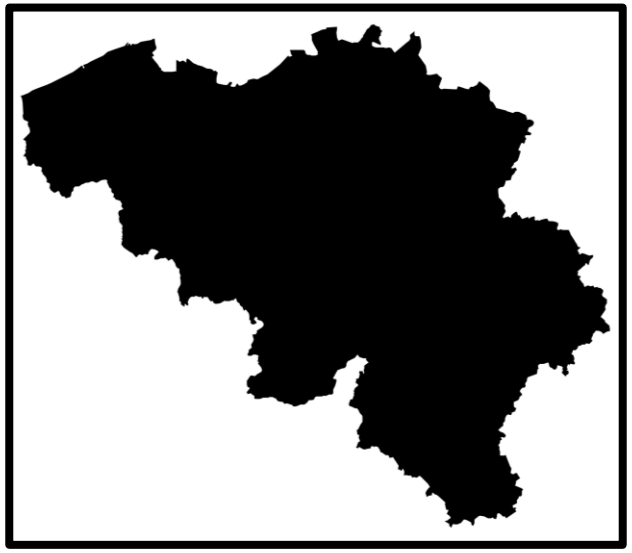

Europe
Belgium
12.0°C
22.1°C
-11.9°C
19.7°C

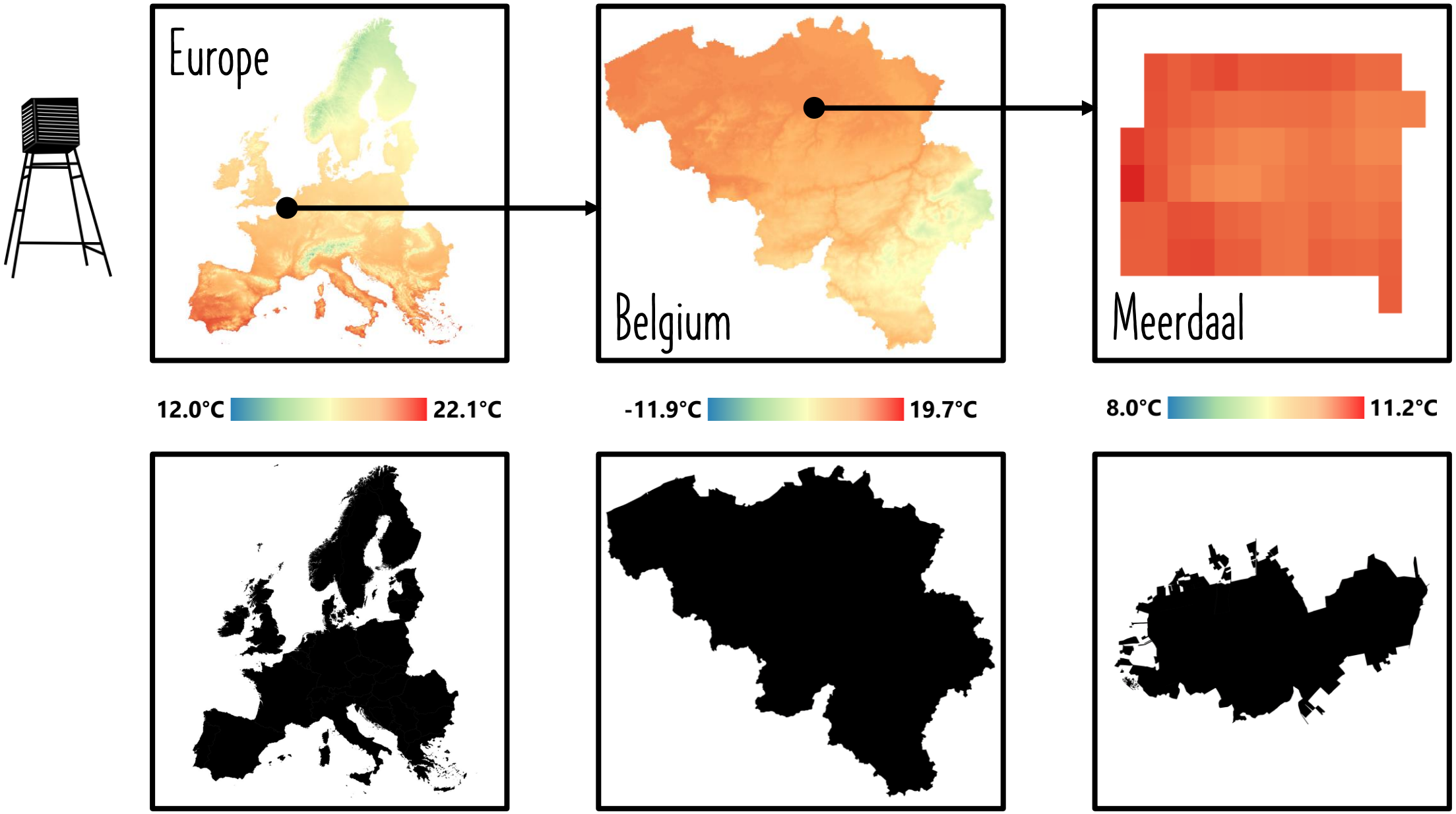


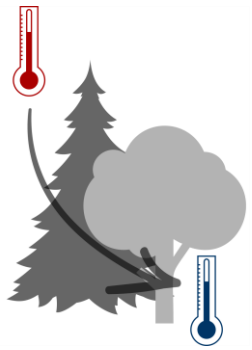


12.0°C 22.1°C

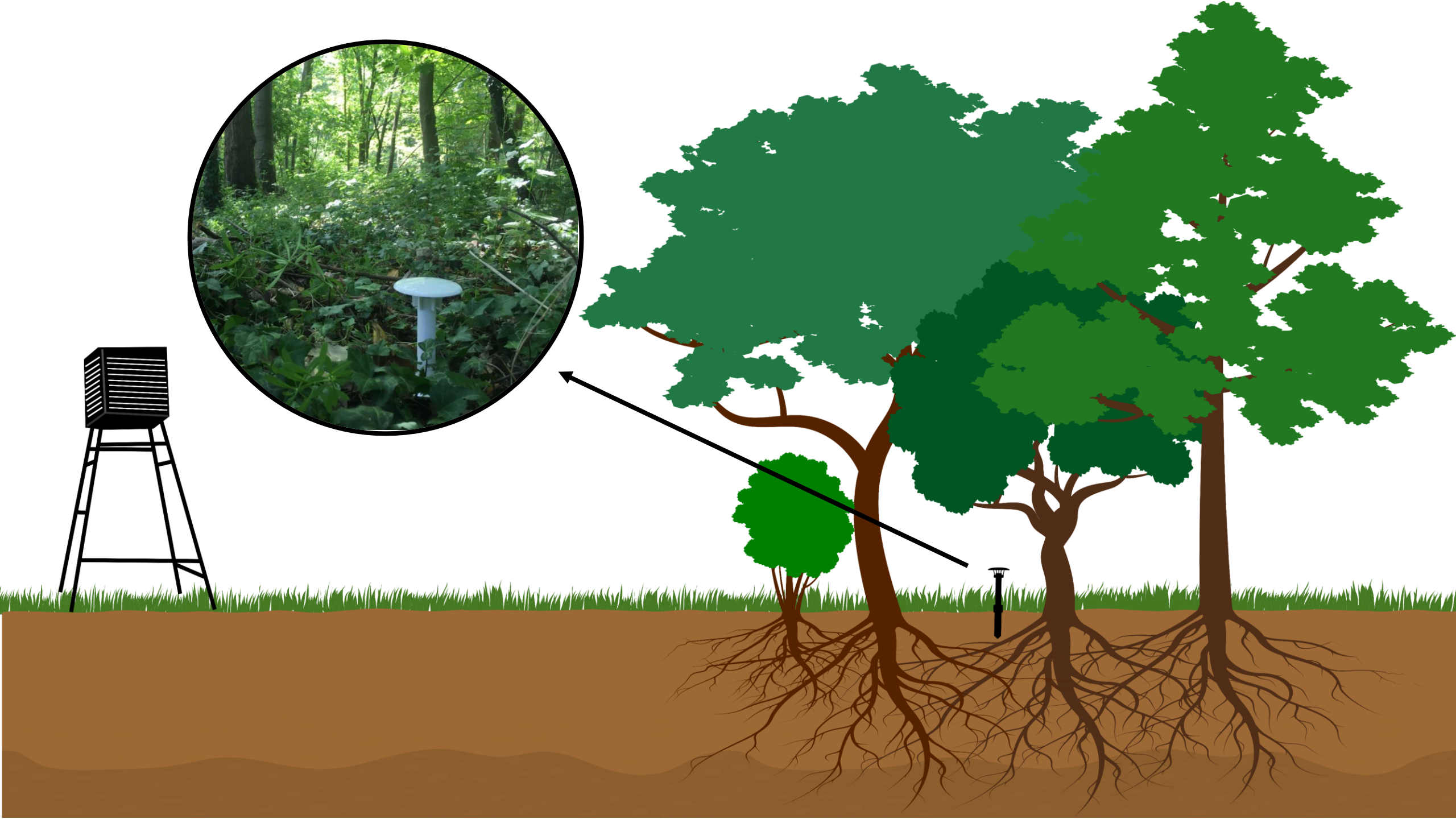
-11.9°C 19.7°C




Europe
Belgium
Meerdaal
12.0°C
22.1°C
-11.9°C
19.7°C
8.0°C
11.2°C



Can we quantify and map the buffering capacity of European forests?



picture: Josef Bruna

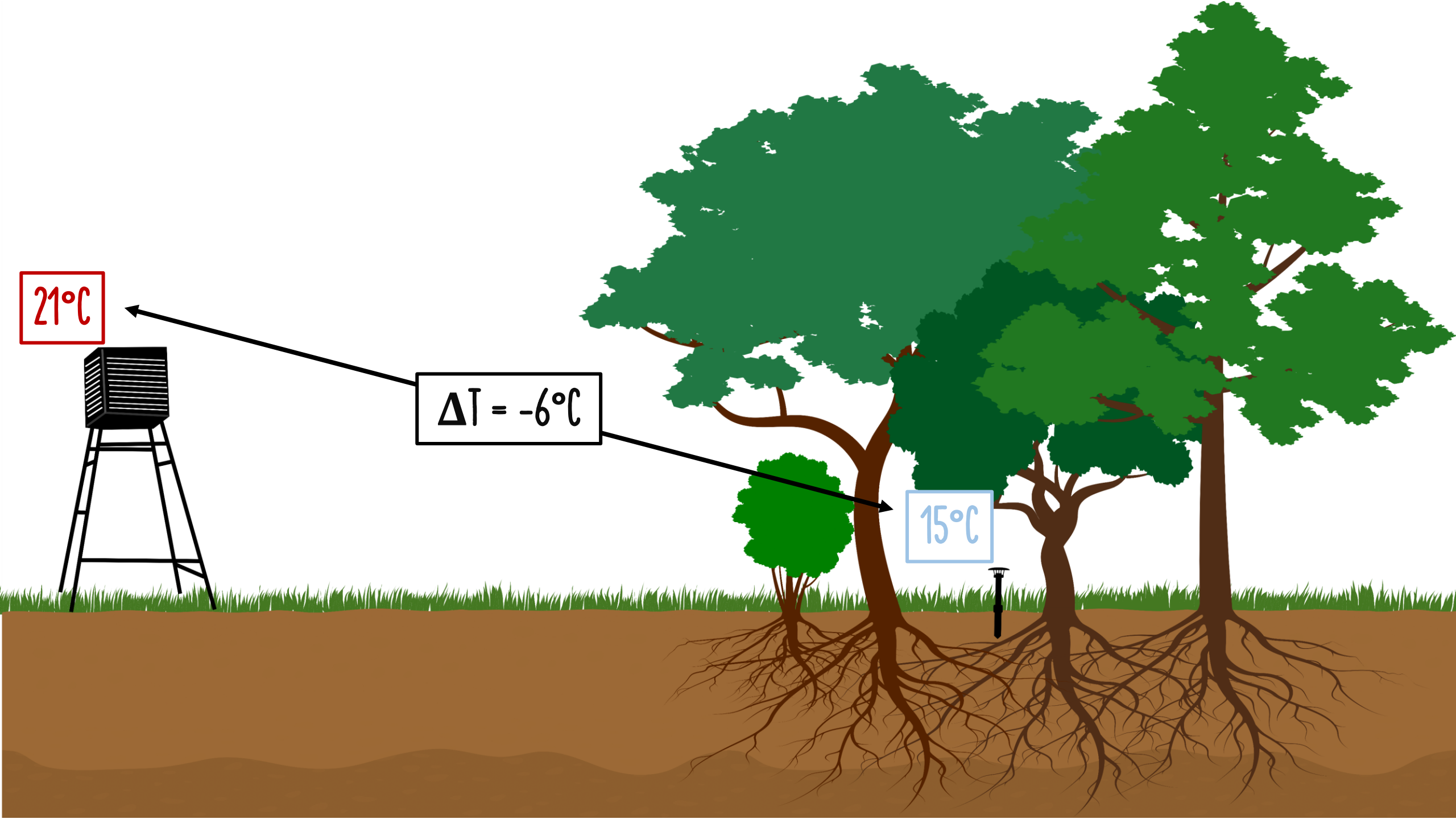
picture: Martin Macek

SoilTemp

picture: Julia Kempinnen

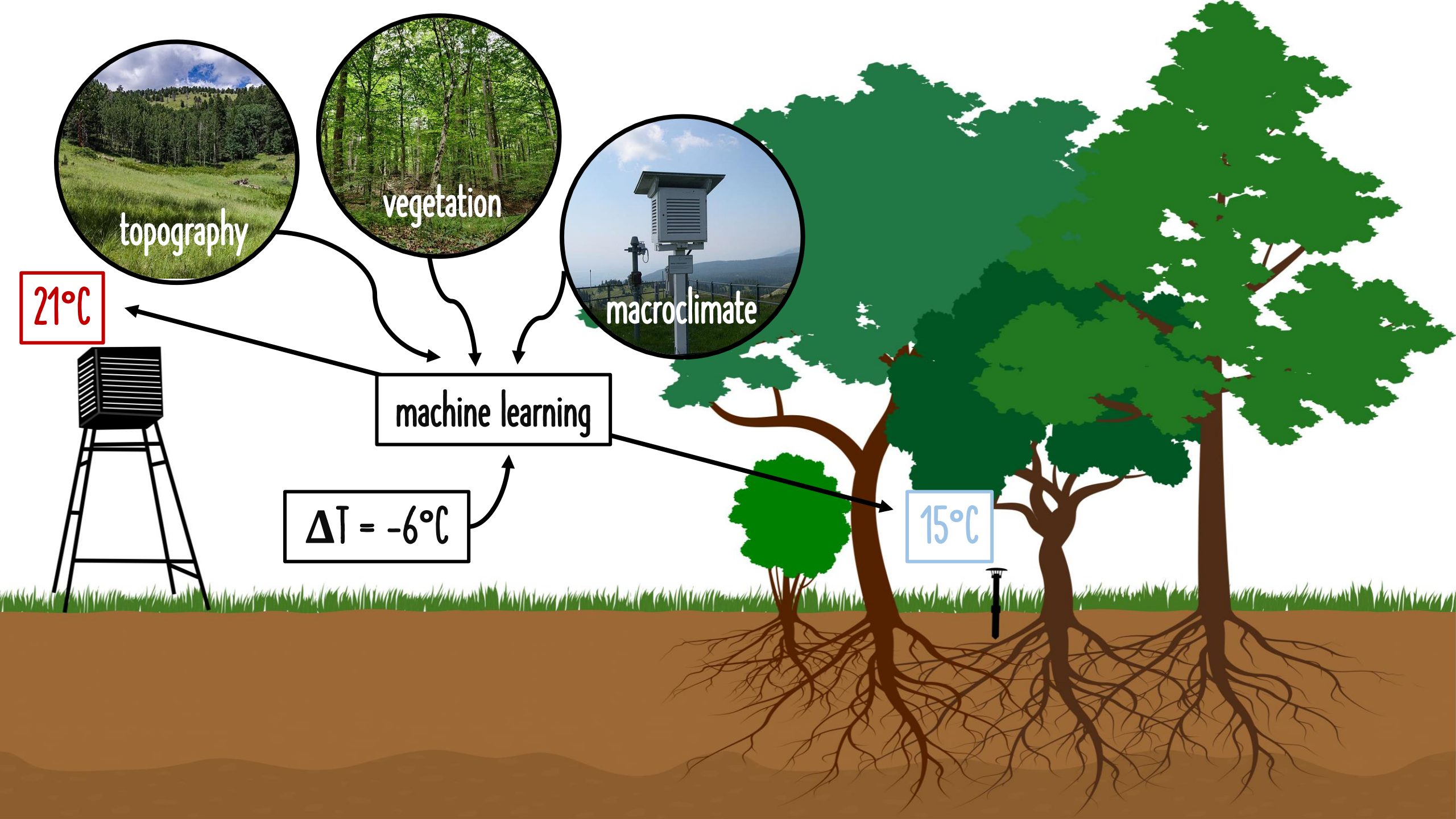
picture: Jonathan von Oppen

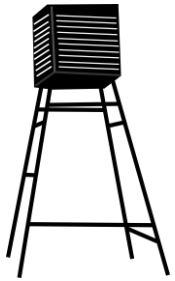
picture: Catherine Hulshof

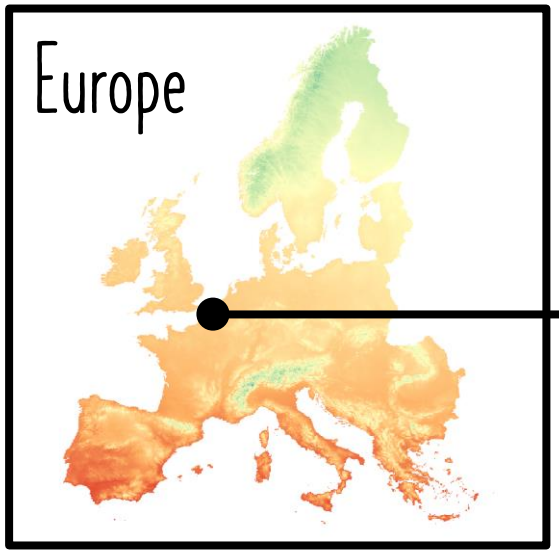

21°C
ΔT = -6°C
15°C

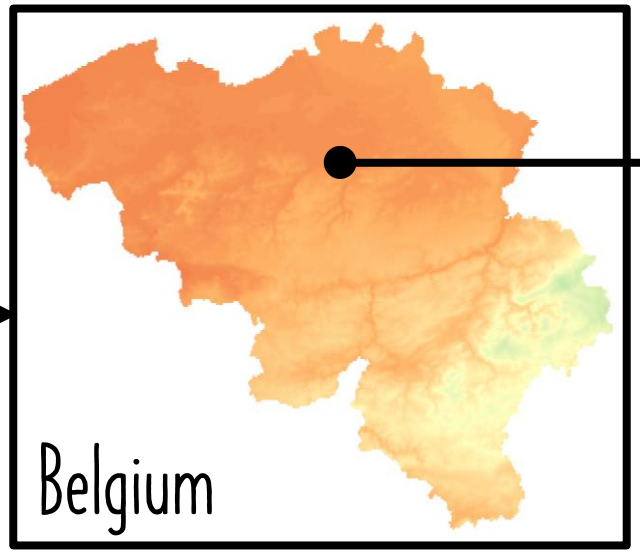

PYTHON
OUTPUT
INPUT
HIDDEN
LEARNING
SIGMOID

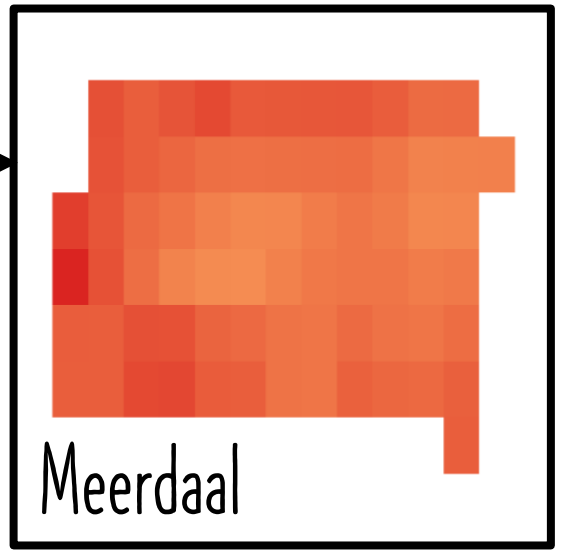

ART OF MODERN ROCK
THE DREAM CATALOG
DON McCULLIN
TONY HANCOCK
Remember When
PEEL
NIGELLA CHRISTMAS
BLACK HOLE
GANGS


topography
vegetation
macroclimate
21°C
machine learning
ΔT = -6°C
15°C





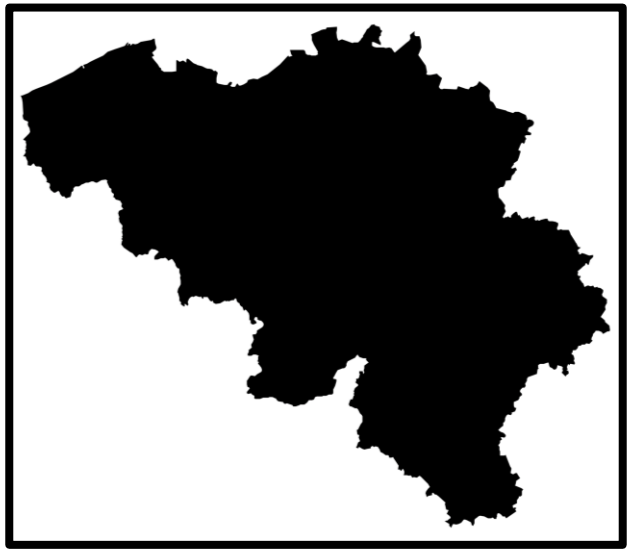


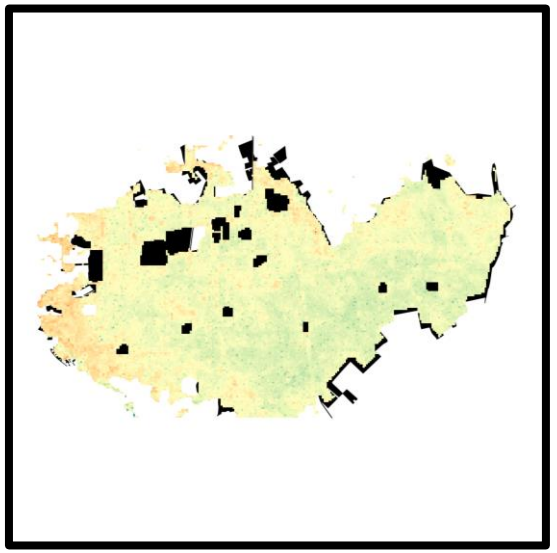


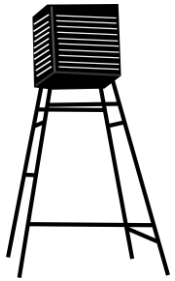
12.0°C 22.1°C

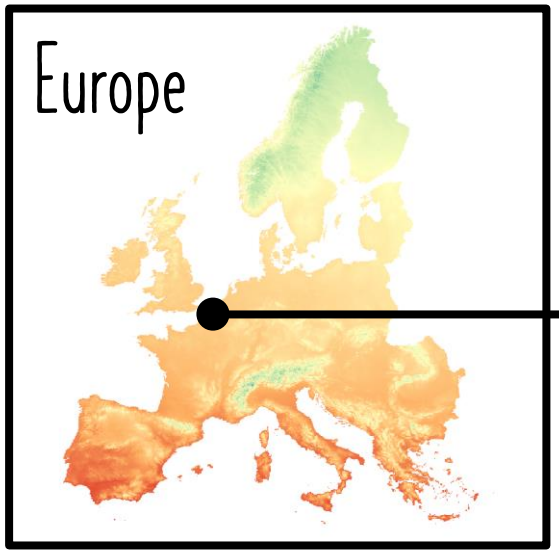
-11.9°C 19.7°C

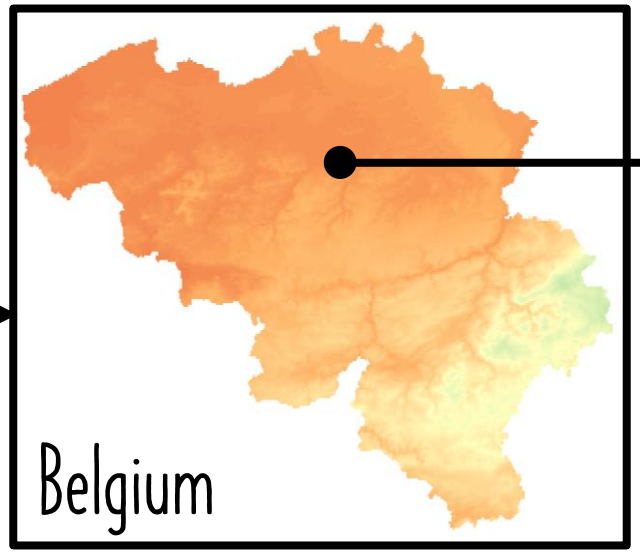
8.0°C 11.2°C

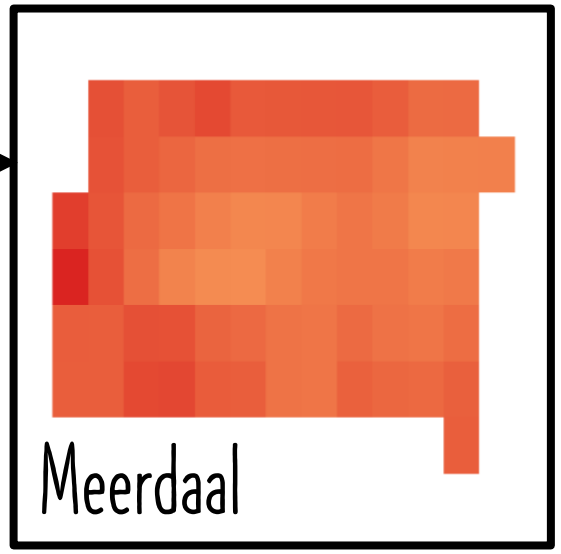








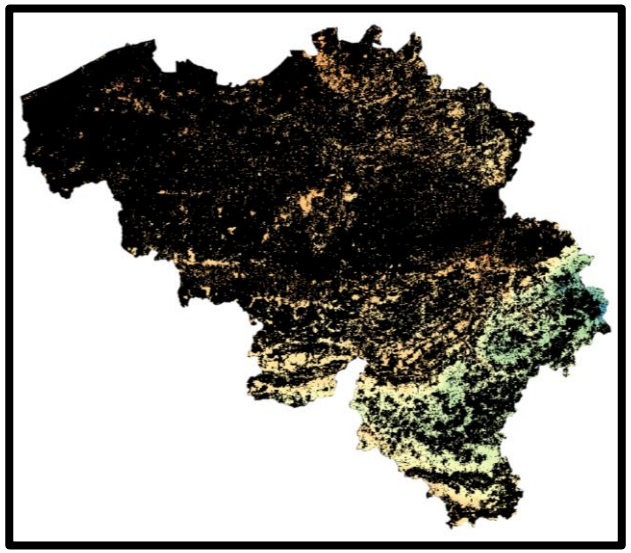


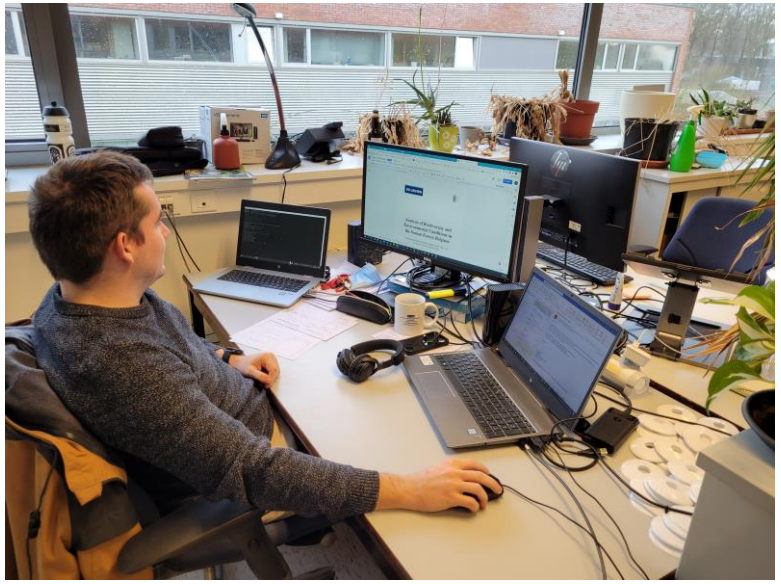


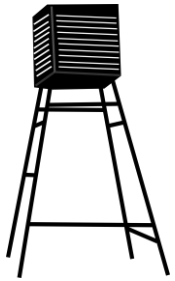
12.0°C 22.1°C

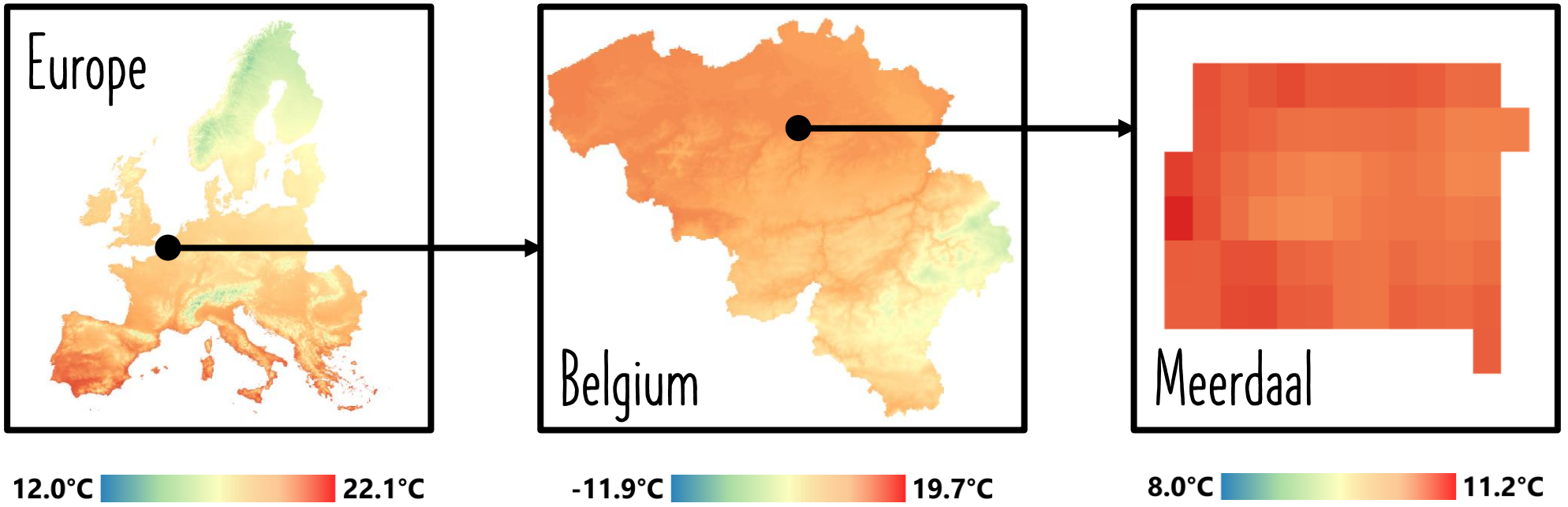
-11.9°C 19.7°C

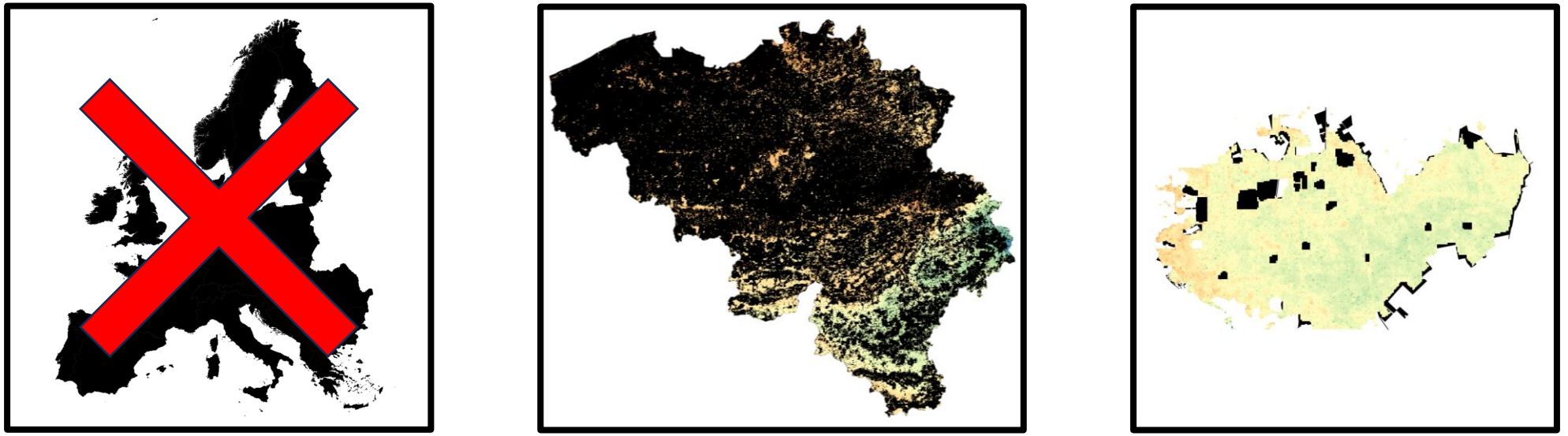
8.0°C 11.2°C



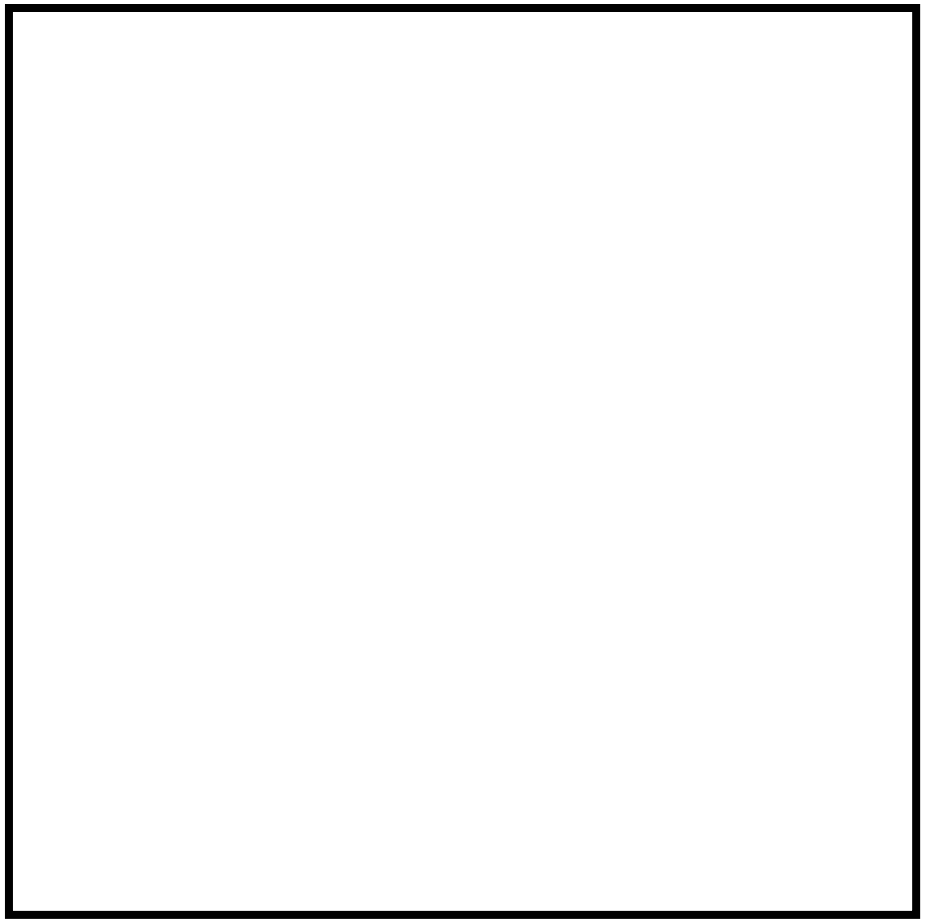




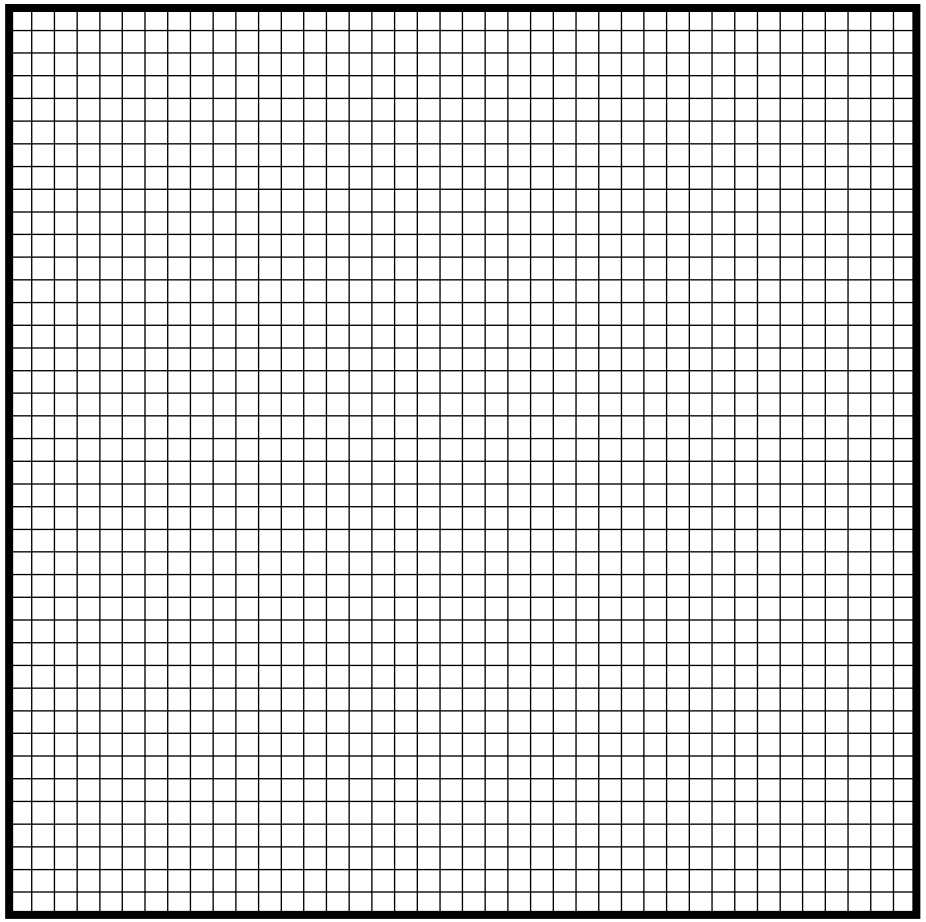

Europe
Belgium
Meerdaal
12.0°C
22.1°C
-11.9°C
19.7°C
8.0°C
11.2°C




VLAAMS
SUPERCOMPUTER
CENTRUM
Vlaanderen
is supercomputing



1 pixel

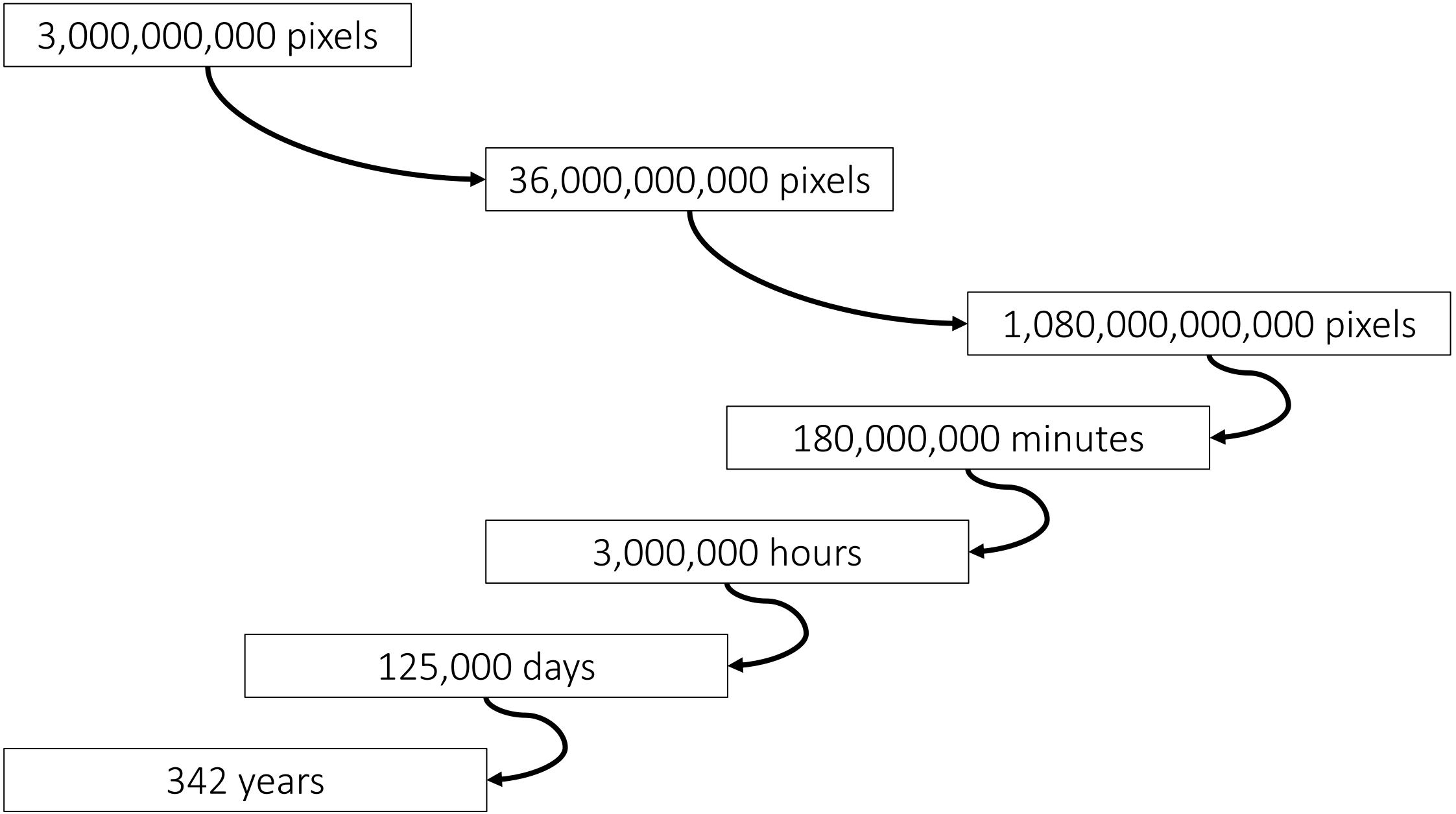


1600 pixels

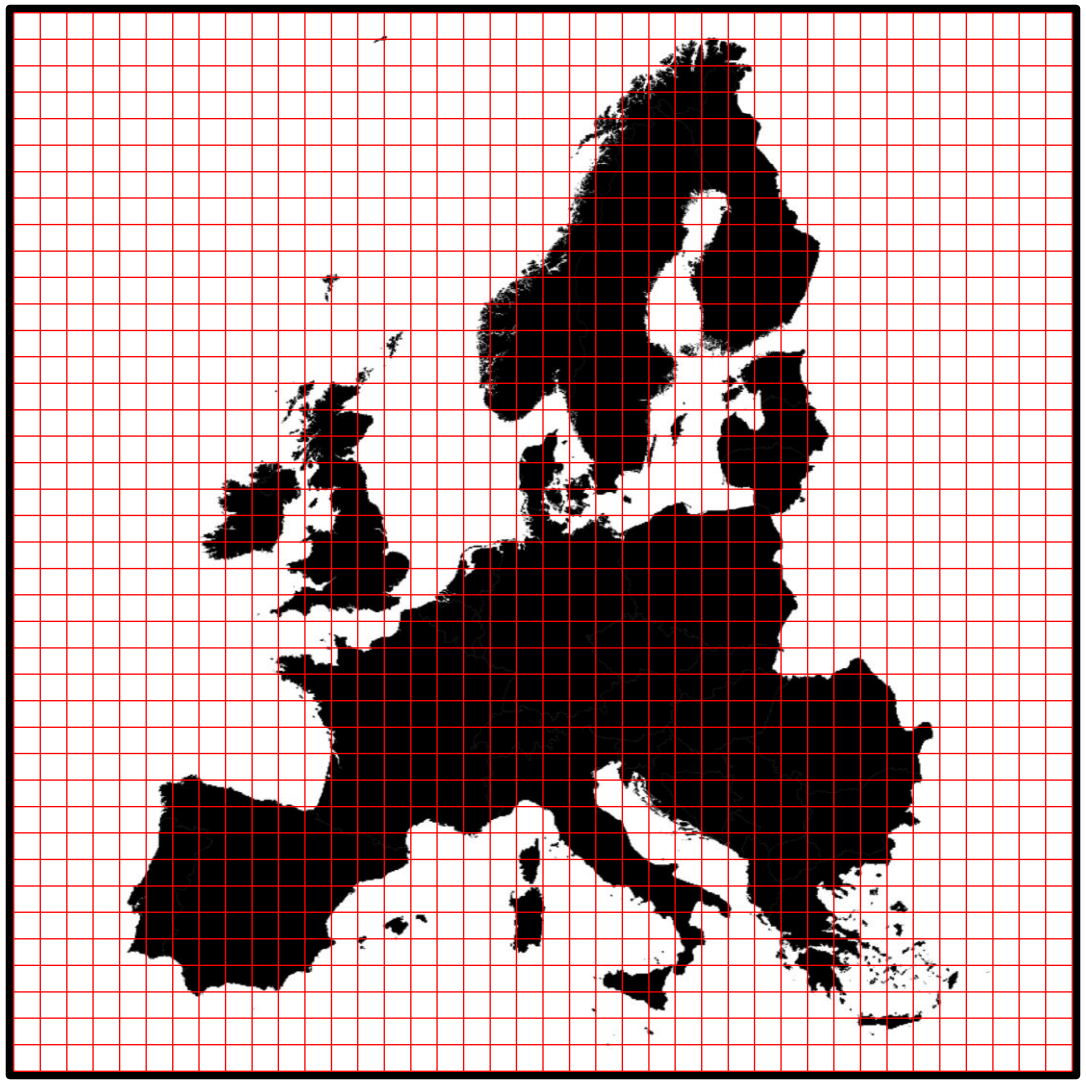
± 1,875,000 pixels → ± 3,000,000,000 pixels

± 1,875,000 pixels → ± 3,000,000,000 pixels

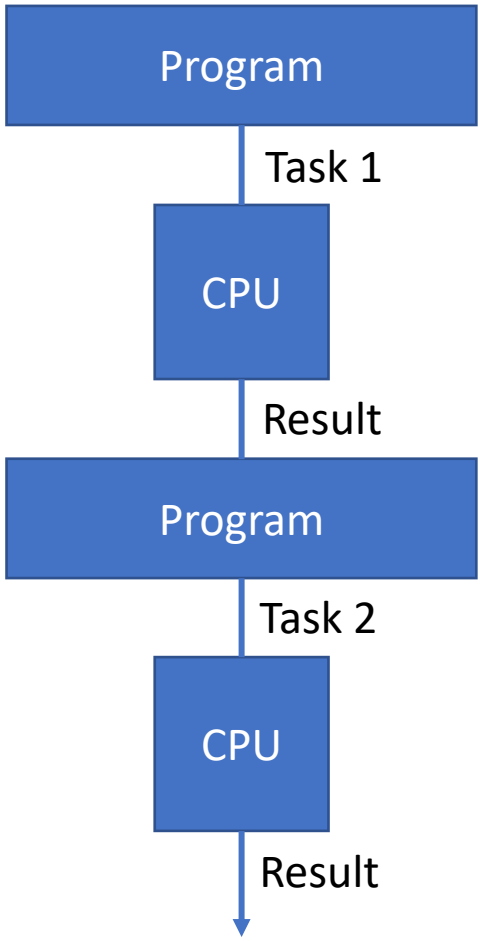
and there is more...


3,000,000,000 pixels
36,000,000,000 pixels
1,080,000,000,000 pixels
180,000,000 minutes
3,000,000 hours
125,000 days
342 years

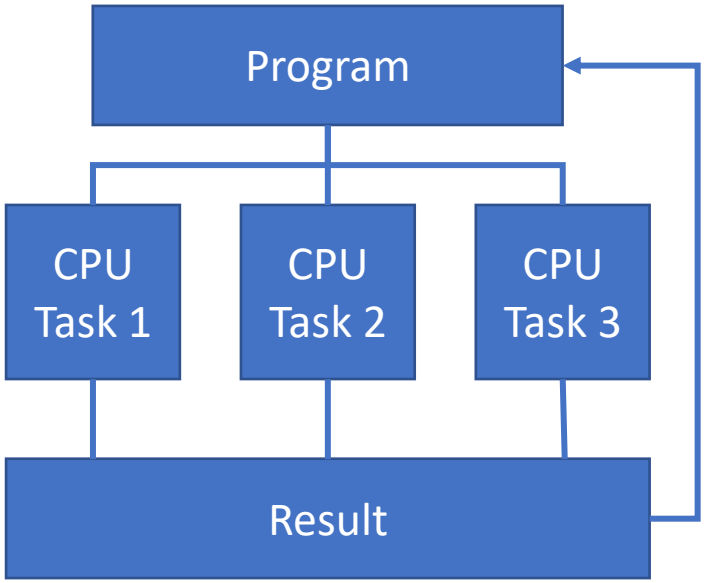
Tiling …

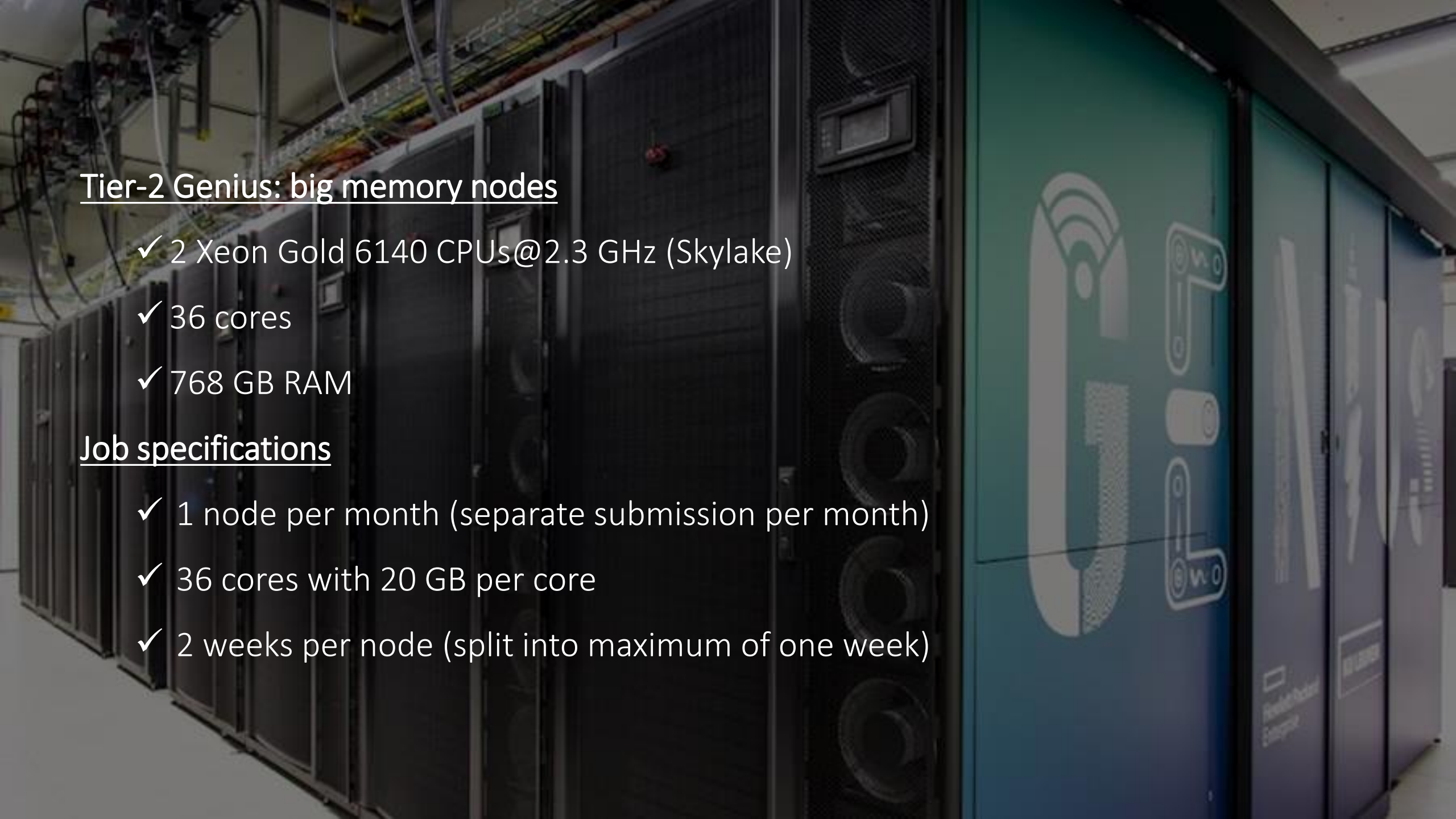


Serial



Parallelization





Tier-2 Genius: big memory nodes

- ✓ 2 Xeon Gold 6140 CPUs@2.3 GHz (Skylake)
- ✓ 36 cores
- ✓ 768 GB RAM

Job specifications

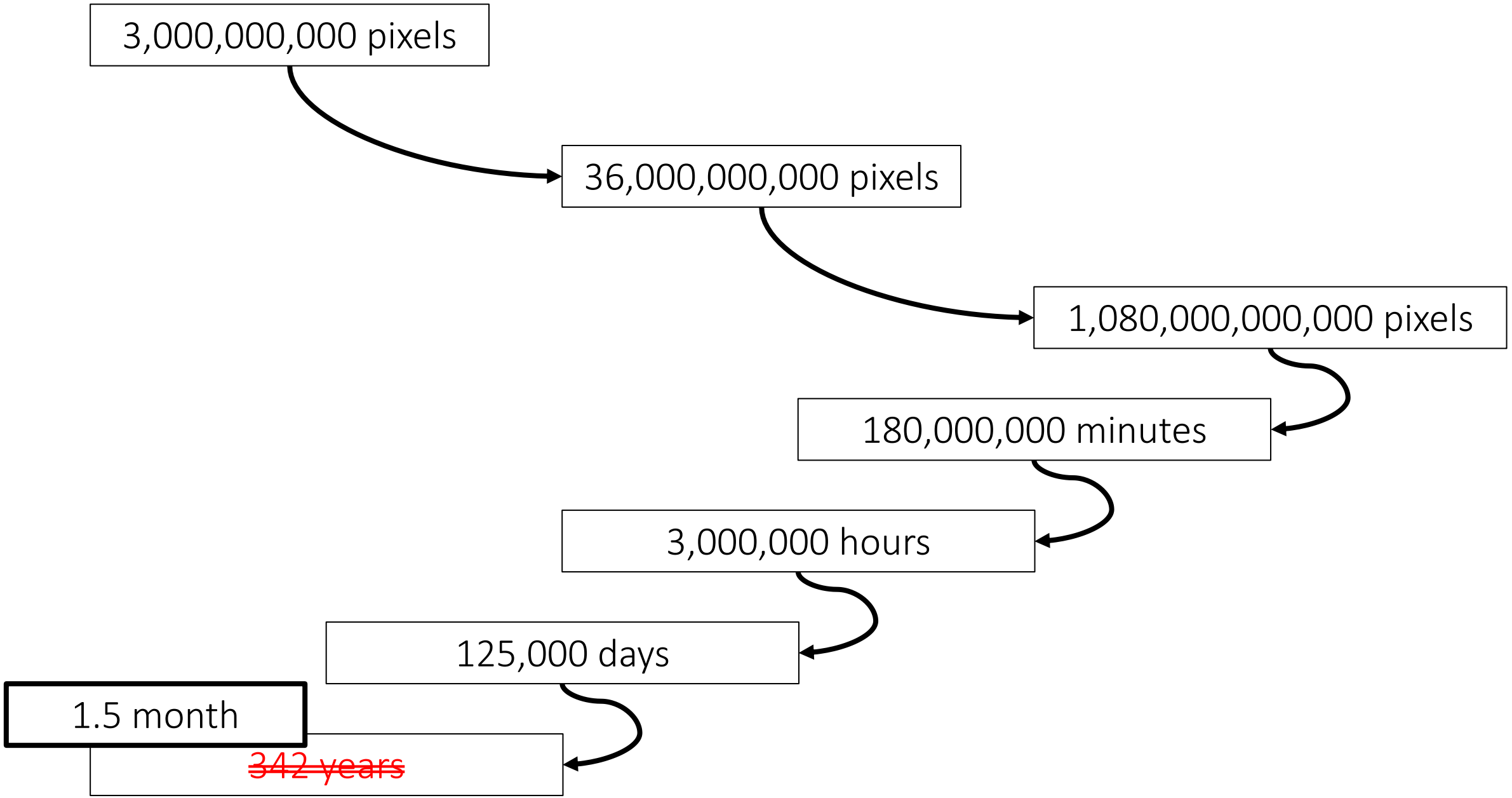
- ✓ 1 node per month (separate submission per month)
- ✓ 36 cores with 20 GB per core
- ✓ 2 weeks per node (split into maximum of one week)

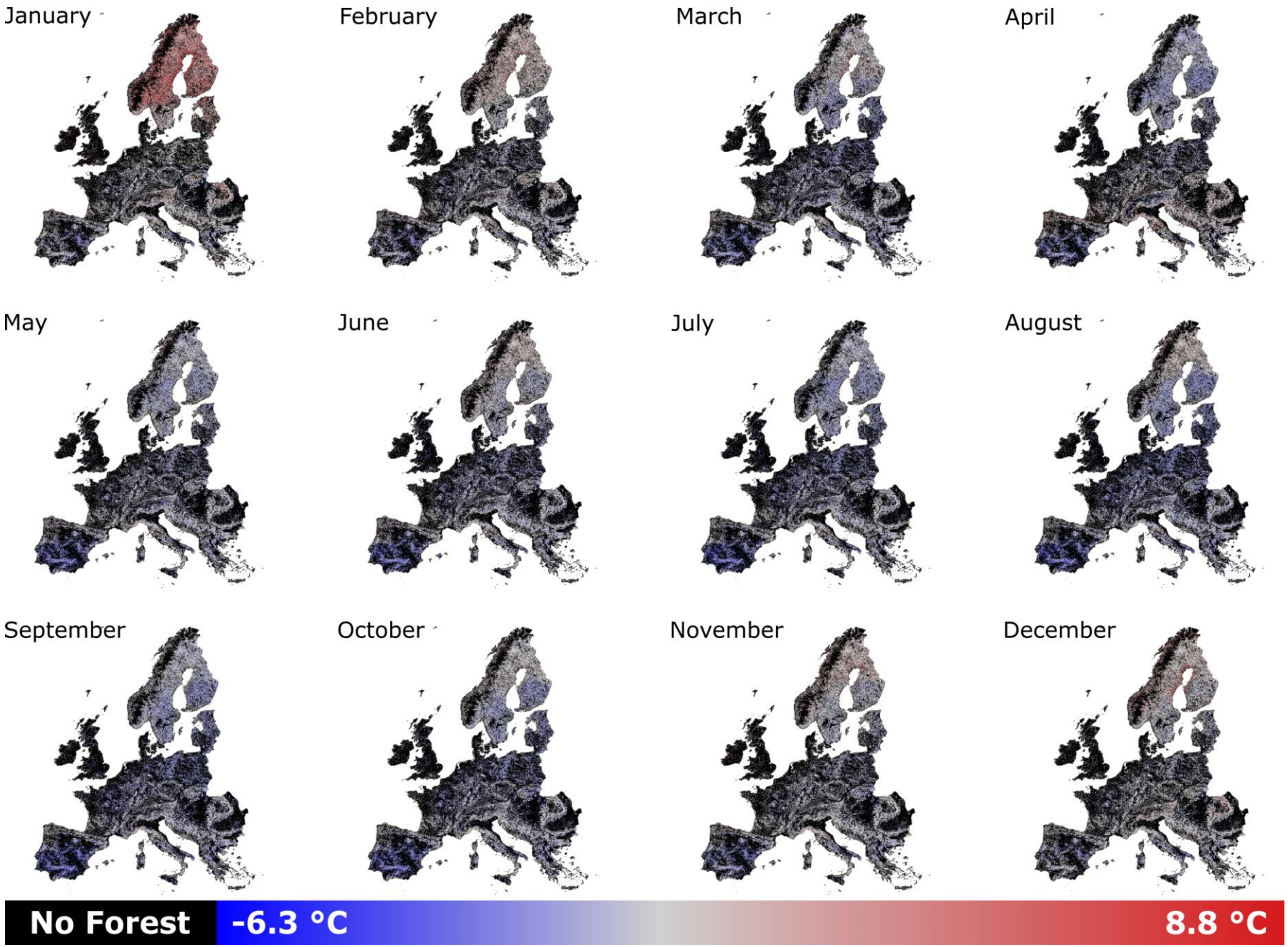
Software

- ✓ Data transfers: FileZilla
- ✓ Analysis: R
- ✓ Package management: Miniconda

Modules

- ✓ GDAL/2.2.3-intel-2018a-Python-3.6.4
- ✓ GEOS/3.6.2-intel-2018a-Python-3.6.4
- ✓ PROJ/5.0.0-intel-2018a


3,000,000,000 pixels
36,000,000,000 pixels
1,080,000,000,000 pixels
180,000,000 minutes
3,000,000 hours
125,000 days
1.5 month
~~342 years~~


January
February
March
April
May
June
July
August
September
October
November
December
No Forest
-6.3 °C
8.8 °C

ForestTemp: sub-canopy microclimate temperatures of European forests

Cite | Download all (215.86 GB) | Share | Embed | + Collect

Version 4 Dataset posted on 2023-03-09, 16:44 authored by Stef Haesen, Jonas Lembrechts, Pieter De Frenne, Jonathan Lenoir, SoilTemp, Koenraad Van Meerbeek

Combining more than 1,200 time series of *in situ* near-surface forest temperatures with topographical, biological and macroclimatic variables in a machine learning model, we predicted the monthly offset for minimum, mean and maximum temperature between sub-canopy temperature at 15 cm above the surface and free-air temperature over the period 2000-2020 at a spatial resolution of 25 x 25 m² across Europe.

When using any of these layers, please cite:

- Haesen et al. (2021). ForestTemp –Sub-canopy microclimate temperatures of European forests. Global Change Biology, *27*(23), 6307–6319. https://doi.org/10.1111/gcb.15892

To mask pixels by the proportion of extrapolation, the file 'extrapolation.tif' can be used. All layers are projected in epsg:3035.

Version history:

- v1: original layers (DO NOT USE)
- v2: corrigendum layers
- v3: added layers for maximum temperature offsets
- v4: added layers for minimum temperature offsets

HISTORY

- **2021-09-09** - First online date
- **2023-03-09** - Posted date

USAGE METRICS

2928	7282	1
views	downloads	citations

18

https://doi.org/10.6084/m9.figshare.14618235

CATEGORIES

- Ecology not elsewhere classified

KEYWORDS

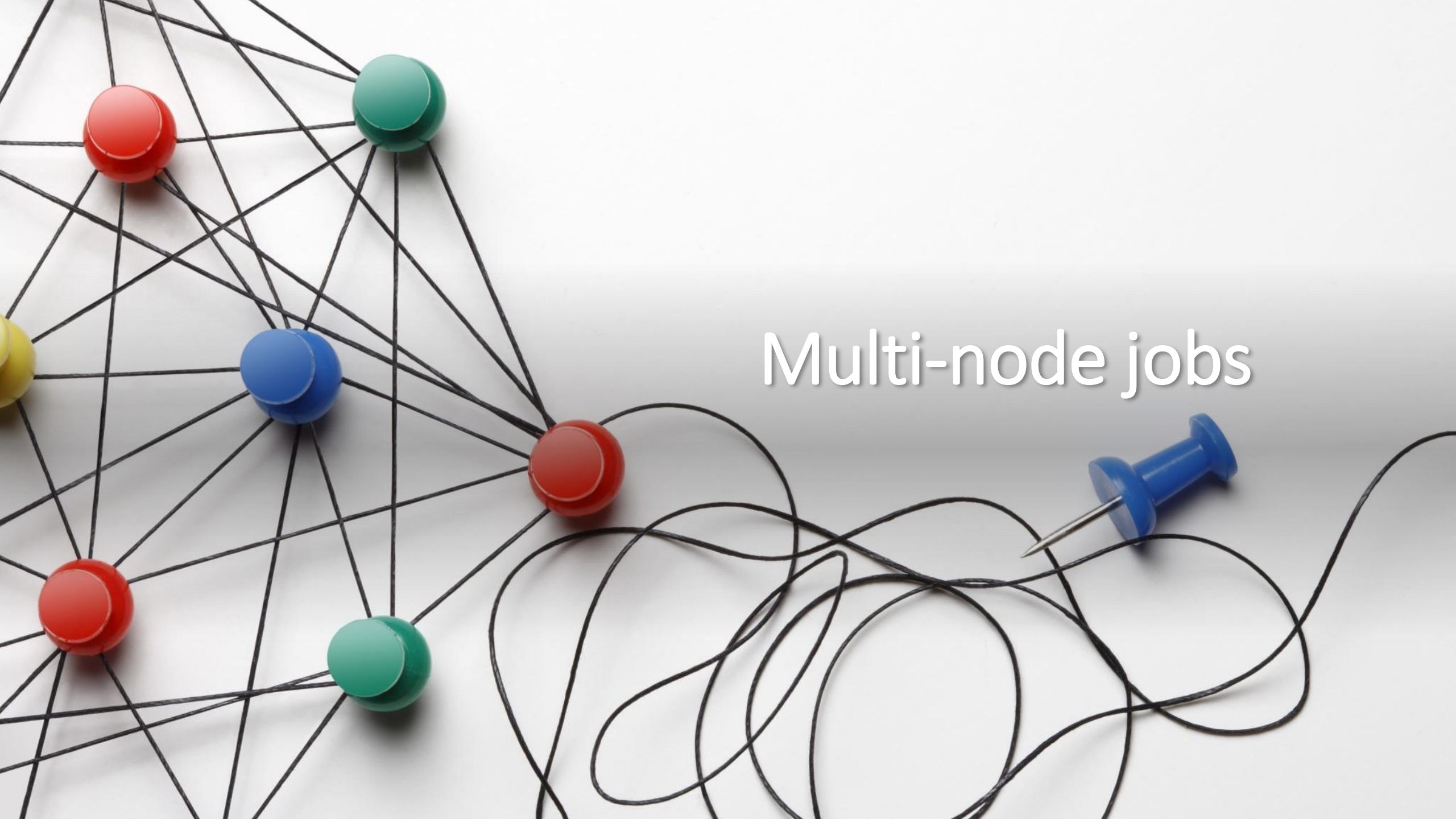
biodiversity | boosted regression trees | climate change | ecosystem processes | forest microclimate | SoilTemp | species distributions | thermal buffering | woodlands | Ecology

LICENCE

EXPORTS

Select an option


BEST
BETTER
GOOD


Multi-node jobs

Graphics processing units (GPUs)

ForestTemp – Sub-canopy microclimate temperatures of...

By: Stef Haesen and Koenraad Van Meerbeek Ecological research continues to rely on coarse-gridded

ForestClim—Bioclimatic variables for microclimate...

By: Stef Haesen and Koenraad Van Meerbeek Bioclimatic variables play a pivotal role in various scientific

Microclimate reveals the true thermal niche of forest plant species

By: Stef Haesen and Koenraad Van Meerbeek Species distribution models have become the go-to tool

ıy S./Wikimedia Commons/CC BY-SA 1.0

IN KAART: Hoe koel zijn de bossen en het groen in jouw buurt? Ontdek het hier

De bossen in Europa zijn in de zomer gemiddeld twee graden koeler dan hun omgeving. Tijdens hittegolven kan dat verschil zelfs oplopen tot 10 graden. Onderzoekers hebben voor het eerst een heel gedetailleerde kaart gemaakt waarop het verkoelend effect van de bossen en het groen in te zien is.

© Getty Images

Redactie Knack
04-10-2021, 08:09 • Bijgewerkt op: 08-10-2021, 08:01 •

Europese bossen zijn tot tien graden koeler in de zomer, en tot 12 graden warmer in de winter. Dat blijkt uit een grootschalige studie van KU Leuven, UAntwerpen en UGent.

Het is de eerste keer dat het isolerend effect van bossen zo gedetailleerd in kaart is gebracht. De studie is gepubliceerd in het wetenschappelijk tijdschrift Global Change Biology.

DAILY SCIENCE

Using supercomputers, scientists bring climate measurements down to eye-level for critters

With data from over 1,000 sensors across Europe—and running as much as half a quadrillion calculations per second—the team has created exquisitely detailed maps pinpointing cool habitat oases in a warming planet

DOI: 10.1111/gcb.15892

TECHNICAL ADVANCE

Global Change Biology WILEY

ForestTemp – Sub-canopy microclimate temperatures of European forests

Stef Haesen, Jonas J. Lembrechts, Pieter De Frenne, Jonathan Lenoir, Juha Aalto, Michael B. Ashcroft, Martin Kopecký, Miska Luoto, Ilya Maclean, Ivan Nijs, Pekka Niittynen, Johan van den Hoogen, Nicola Arriga, Josef Brůna, Nina Buchmann, Marek Čiliak, Alessio Collalti, Emiel De Lombaerde, Patrice Descombes, Mana Gharun, Ignacio Goded, Sanne Govaert, Caroline Greiser, Achim Grelle, Carsten Gruening, Lucia Hederová, Kristoffer Hylander, Jürgen Kreyling, Bart Kruijt, Martin Macek, František Máliš, Matěj Man, Giovanni Manca, Radim Matula, Camille Meeussen, Sonia Merinero, Stefano Minerbi, Leonardo Montagnani, Lena Muffler, Romà Ogaya, Josep Penuelas, Roman Plichta, Miguel Portillo-Estrada, Jonas Schmeddes, Ankit Shekhar, Fabien Spicher, Mariana Ujházyová, Pieter Vangansbeke, Robert Weigel, Jan Wild, Florian Zellweger, Koenraad Van Meerbeek