IS-ENES3 Workshop:
Climate indices - Eastern European perspective
17 May 2021

Climate indices: latest developments and application examples

Lars Bärring
Rossby Centre
Swedish Meteorological and Hydrological Institute (SMHI)
Sweden

The IS-ENES3 project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824084

Overview of talk

1. Introduction – overview
2. Different types of indices
3. Challenges and pitfalls
4. Tools and data sources
5. Three examples
6. Take home messages

Climate indices

Climate indices = simple diagnostic quantities used to describe climate [impact] “oriented towards users’ needs"

Alternative terms:

- indices of climate extremes
- derived statistics
- climate indicators
- climate impact indicators
- tailored climate parameters

irrespective of term they typically target either some extreme condition or/and impact

Different “levels / tiers”:

Tier 1: based only on geophysical data
==>> informs about climate drivers

Tier 2: geophysical data + data on impacts
==>> informs about climate impacts

Tier 3: geophys. + impacts data + monetary valuation
==>> informs about economical ramifications

Climate indices: examples (1)

“Classical” climate indices

ETCCDI Expert Team on Climate Change Detection and Indices
27 core indices (since early 1990s, now discontinued)

ET-SCI Expert Team on Sector-specific Indices) indices focussing on impacts
core indices + **drought and heat** characteristics: duration, intensity

ECA&D European Climate Assessment & Dataset (KNMI)
core indices + impacts (agriculture, tourism and more), mainly observations

Copernicus Range of indices (indicators) related to different sectors (water, agriculture, health…)
Many from ECA&D + derived from [global] models

INDECIS EU-project collecting and publishing 136 different indices,
mainly gridded observations

Climate indices: examples (2)

Targeted / complex / advanced climate indices

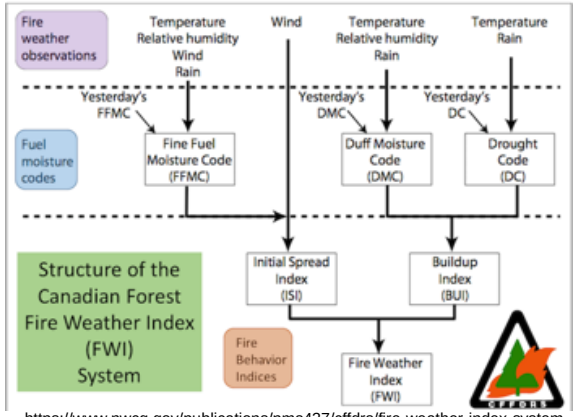
FWI [Canadian] Fire Weather Index

UTCI Universal Thermal Climate Index

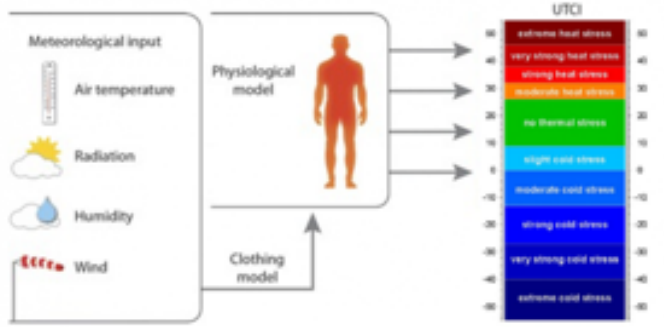
Crop yield --- > crop modelling

PSDI Palmer Drought Severity Index

From “simple empirical approaches towards parametrised process-based models



https://www.nwcg.gov/publications/pms437/cffdrs/fire-weather-index-system



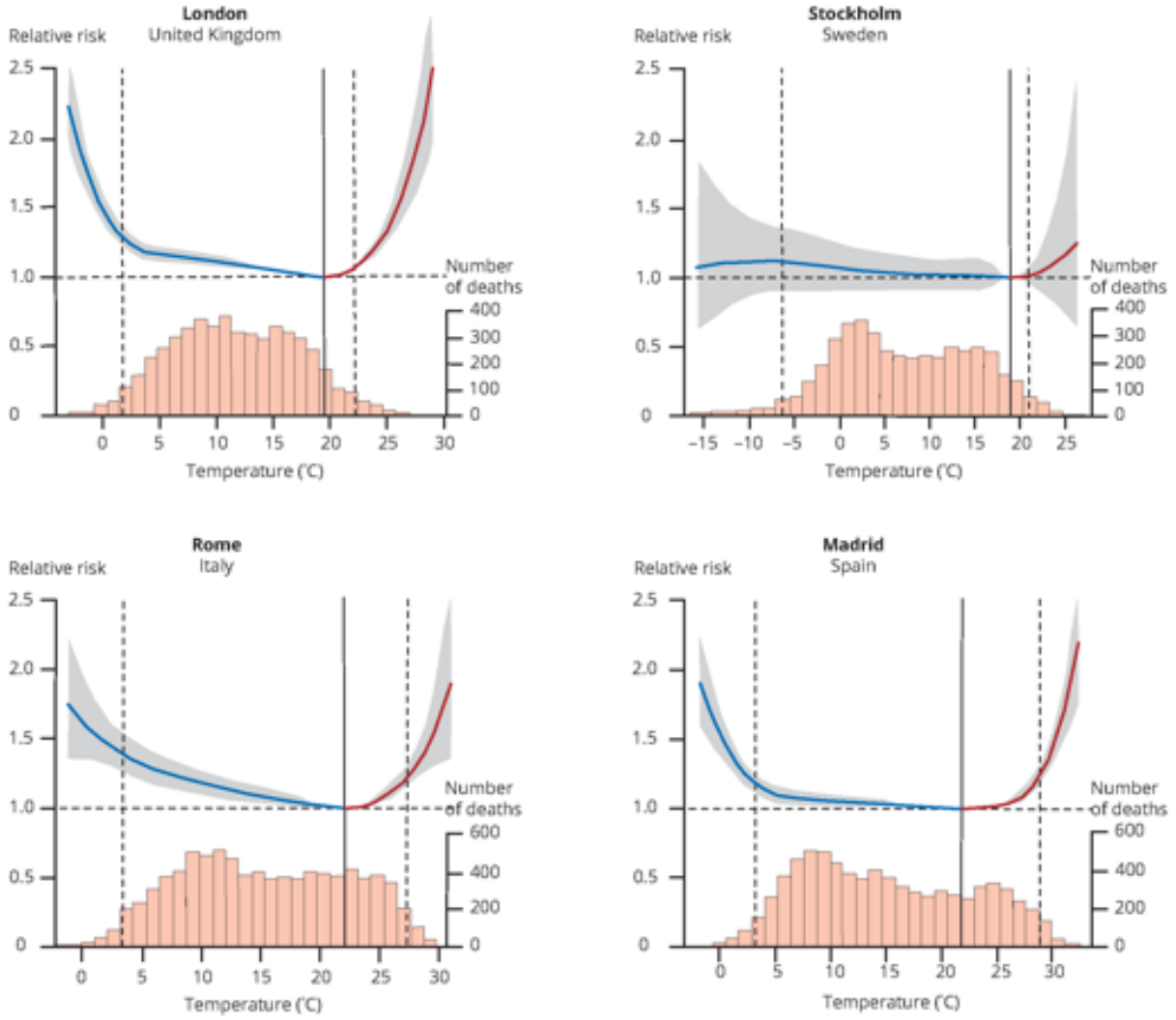
http://aqua.upc.es/anywhere-catalogue-v2/?product=universal-thermal-climate-index-utci-uor

Climate impact indices (Tier 2)

Temperature / mortality

Combination of temperature data information on mortality and age structure

Can be used to tailor local heat /cold wave indices to regional/local climate and socio-economic conditions



https://www.eea.europa.eu/data-and-maps/indicators/heat-and-health-2/assessment

Challenges and pitfalls

These arise from diversity of available options and lack of common terminology and standards	
Multitude of alternative indices	Think first – what do you want to explore and illustrate?
Inconsistent definitions and software implementations	Ongoing work in IS-ENES3: https://github.com/clix-meta/clix-meta
No standard data format and conventions	
Not always clear what is what	
Are the data sources compatible? – observations, models, indices	Spatial and temporal representativity of the data ? Are the data sources compatible – how to make them ?
Many indices are sensitive to model biases – esp. indices based on thresholds and/or extremes	Bias-adjustment – how to? which method? ….

Climate indices: where to find?

Europe (Observations)

- www.ecad.eu/download/millennium/millennium.php (**ECA&D** - station data)
- surfobs.climate.copernicus.eu/dataaccess/access_eobs.php (**E-OBS** - gridded data)
- www.indecis.eu/data.php (**Indecis**: sector-oriented indices (Agriculture and Food Security, Disaster Risk Reduction, Energy, Health, Water and Tourism), both data and visuals)

Global (Observations)

- www.climdex.org/ (**Climdex** (HadEX2/3, GHCNDEX))

Teleconnection

- climexp.knmi.nl/selectdailyindex.cgi?id=someone@somewhere (**Climate explorer**)

Projections (model)

- climate4impact.eu/impactportal/general/index.jsp (IS-ENES **Climate4Impact**)

Climate indices: how to calculate?

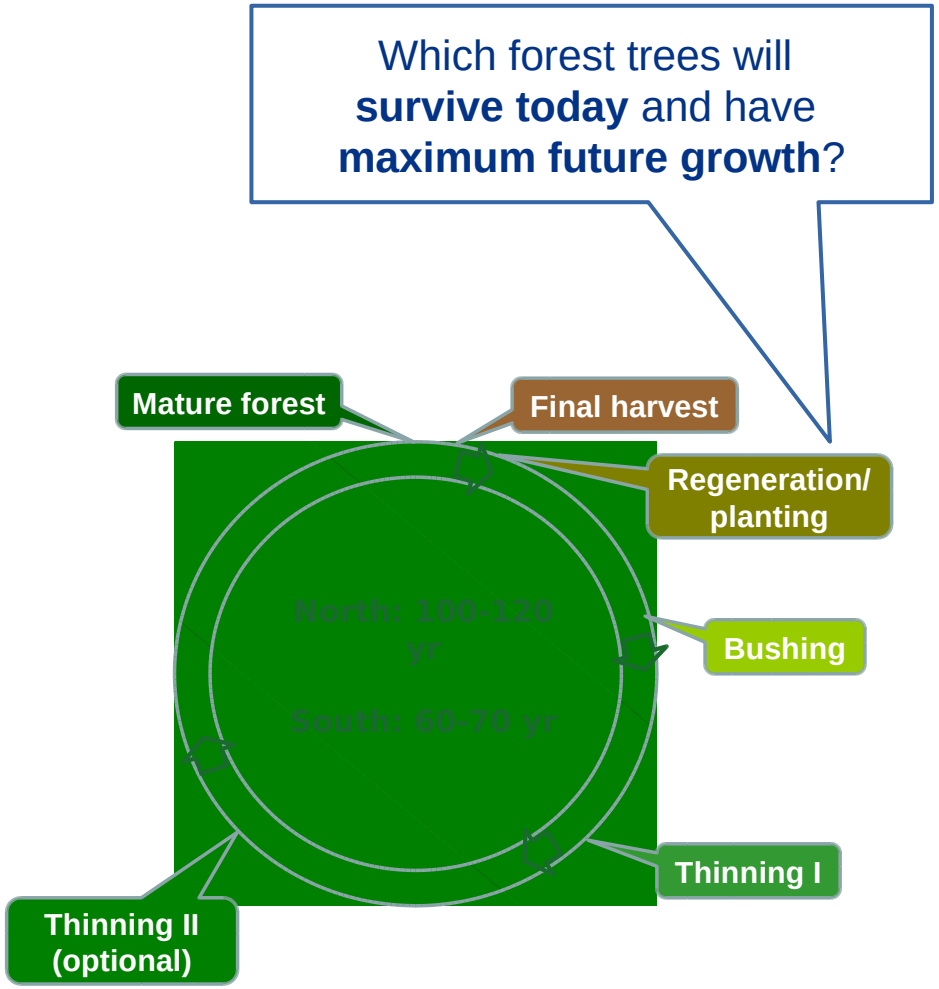
Available software (both online and offline):

- IS-ENES **Climate4Impact** climate4impact.eu/impactportal/general/index.jsp
- **CDO** (Climate Data Operators) code.mpimet.mpg.de/projects/cdo/embedded/cdo_eca.pdf
- R-Packages
  - **ClimPact**: climpact-sci.org/
  - **ClimInd**: cran.r-project.org/web/packages/ClimInd/index.html
- Python
  - **icclim** – **I**ndex **C**alculation **CLIM**ate: icclim.readthedocs.io/en/latest/ ← *Next talk by Christian Pagé*
  - **Drought indices**: pypi.org/project/climate-indices/
- Additional info provided by **Indecis** project: www.indecis.eu/software.php

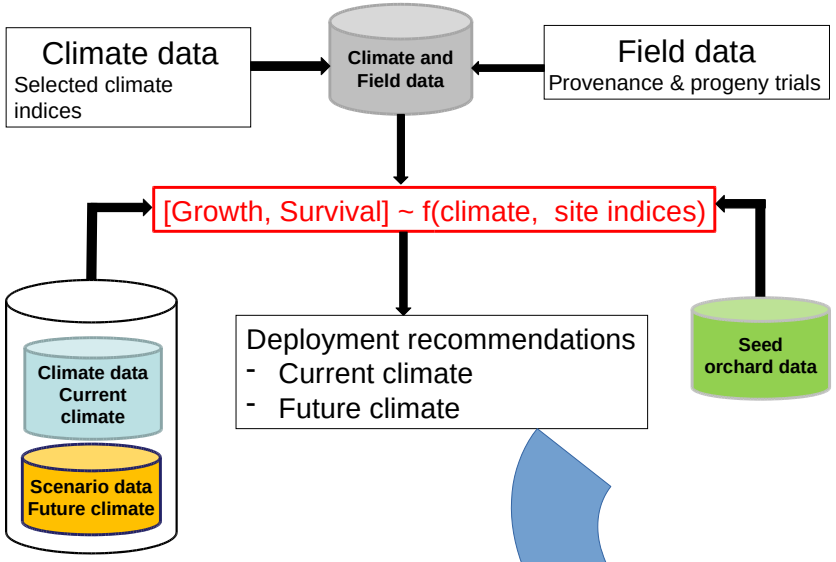
Example 1: Climate indices in operational decision support for Nordic forestry

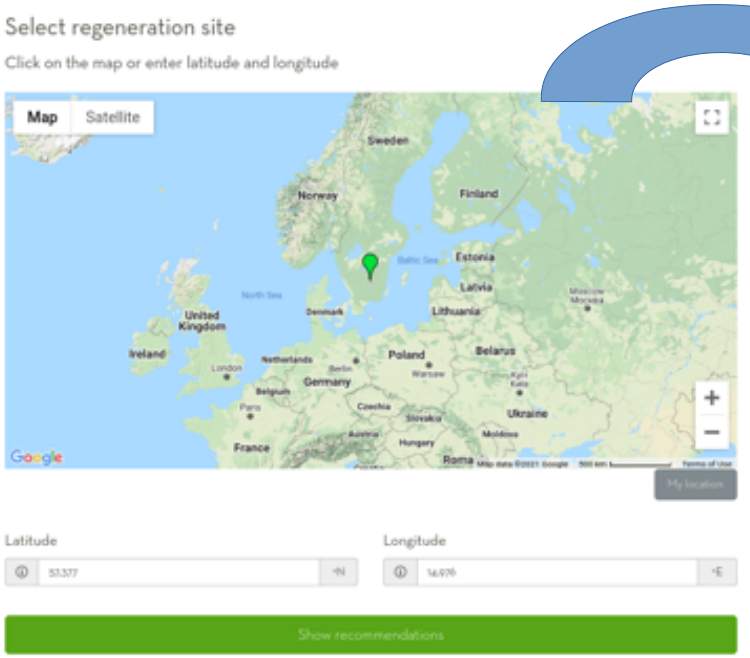
Simple climate indices, some tailored:

- Mean temperature: annual, seasonal
- Average annual temperature span – “continentality”
- Day-of-year for beginning / end of vegetation period
- Length of vegetation period
- Temperature sum during vegetation period
- Precipitation sum: annual, seasonal, April–September
- Longest dry spell (< 1 mm/day) during the year
- Longest dry spell (< 2 mm/day): April–July, August–October

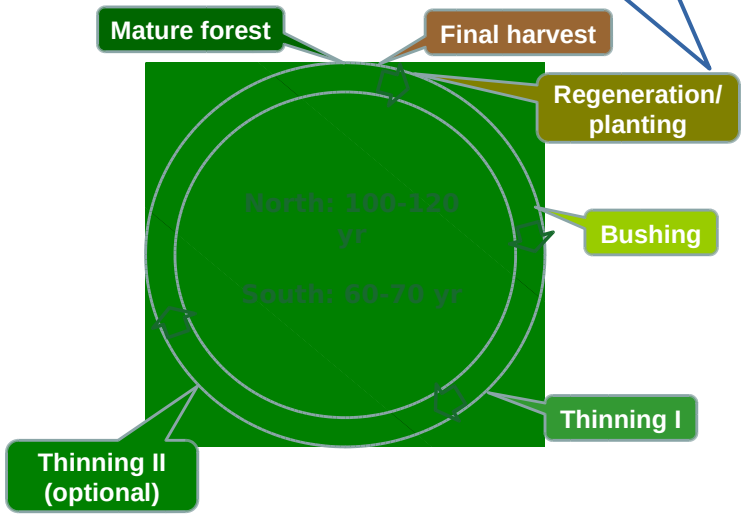


Example 1: Climate indices in operational decision support for Nordic forestry





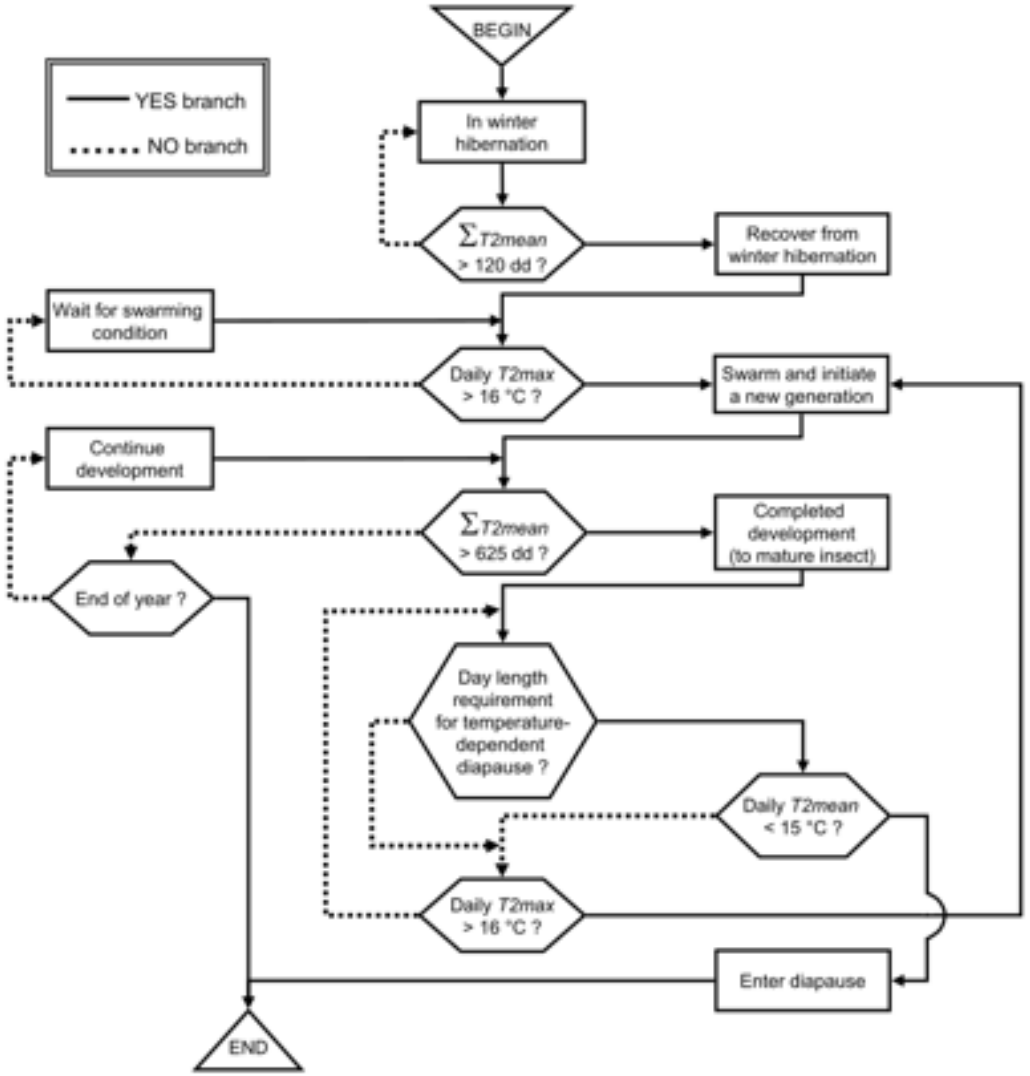
Which forest trees will **survive today** and have **maximum future growth**?



Example 2: Insect phenology ‘model’

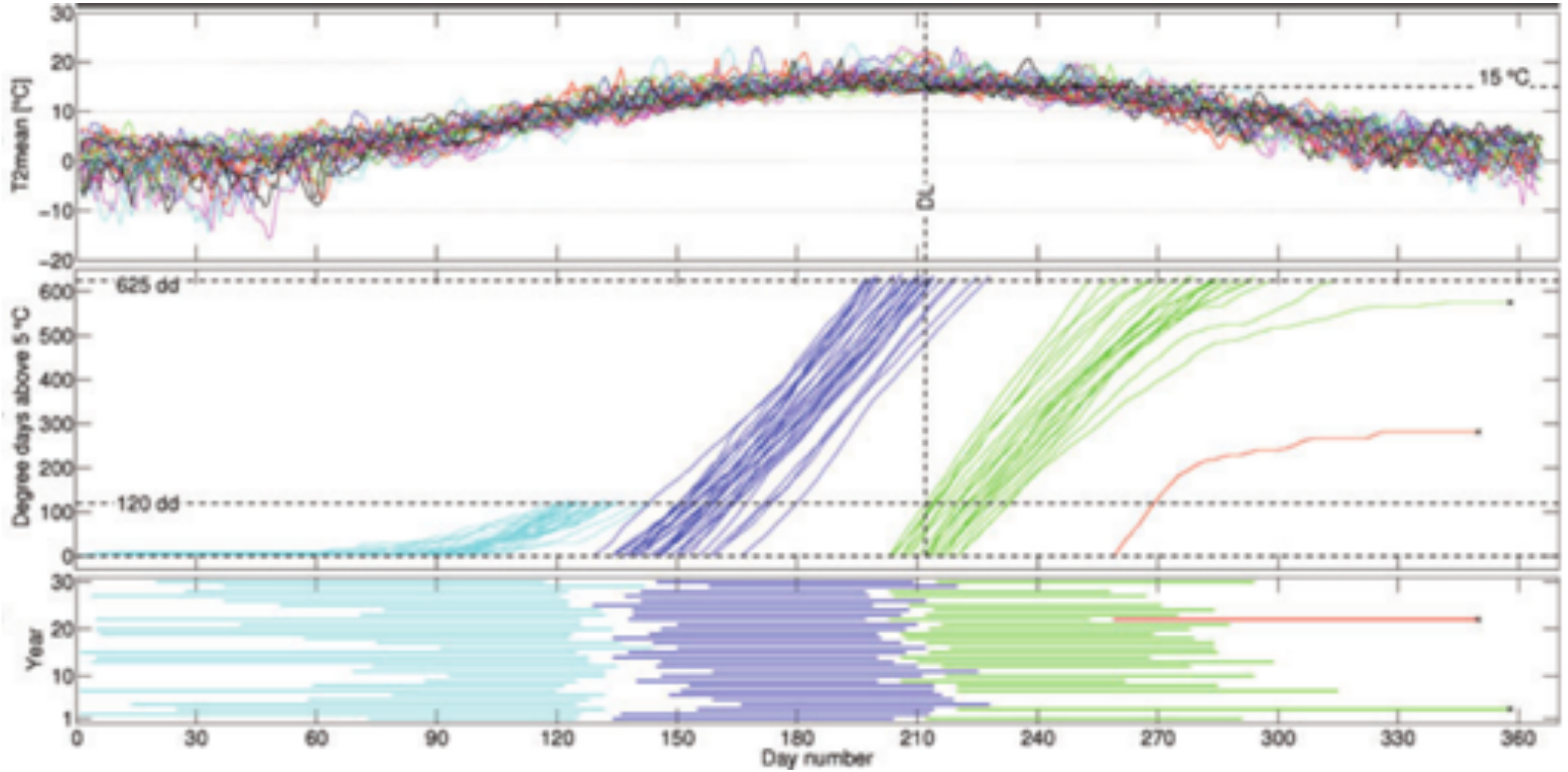
Sequence of simple tailored climate indices:

1. Day number when Tmean ≥ 120 degree-days (>5°C)
2. Day number when Tmax > 16 °C
3. Day number when Tmean ≥ 625 degree-days (>5°C)
4. IF end-of-year THEN step 8
5. IF day > *DL* and Tmean <15 °C THEN step 8
6. ELSE IF Tmax > 16 °C THEN step 3
7. ELSE step 5
8. Hibernate and start over next year



is-enes
INFRASTRUCTURE FOR THE EUROPEAN NETWORK FOR EARTH SYSTEM MODELLING

Example 2: Insect phenology 'model'



Example 3: “Zero-crossing days”

Annual (seasonal) number of days when **Tmin < 0 °C < Tmax**


Image by Markus Sch. from Pixabay

Applications

Winter road maintenance:	preventive actions against slippery roads
Geology / geotechnical:	freeze-thaw cycles, slope stability
Road construction:	formation of potholes
Reindeer hearding:	ice-crust on snow prevents foraging
Winter tourism:	avalanches: wet / icy layers in snow-pack


Image by Jacob Ode from Pixabay


Image by Наталья Коллегова from Pixaby

Image by Rex Landingham from Pixabay

Conclusion – take home message

- Climate indices, climate indicators … many alternative names
- There are many well established indices – can they serve your needs ?
- Simple pre-calculated indices as starting point for further exploration
- Tailored indices that successively focus on the question at hand –
  tool for collaborative work with stakeholders
- There are many “advanced” multivariate indices
  more akin to specialised process parametrisations
- When using indices from different sources
  – make sure they are compatible (the devil is in the details)
- Is bias-adjustment necessary ?