Climate Hazards
Log of meetings & decisions

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Contents

1 Meeting notes

1.1 20 avril, with Isabelle & Iñaki

See green and gray notebook.

1.2 18-19 avril, discussions with Iñaki

See also `ChatsInaki.txt`. But here are the main notes copied over:

- References on damage due to high heat:
  - Thierry Simonneau worked on 2019 heat wave and why it destroyed so many vineyards in Montpellier (LaCave) – he sent the presentation and thought they had a presentation about sentinel tool (more on anthocyanin)

  - Otherwise work may be in gray literature; he thinks in fruit trees (e.g., cherries get double fruits)
  - Wheat they think 25 C affects yield – is that damage? If yes, they this in their models.
  - Apples with burned skin etc (also damage) and depends on canopy.
  - Also check Zaka thesis and look up Gaetan (umlaut on e) Louarn (Zaka PhD advisor) ... look up P3F system they have and SICLEX
- Incl. air temperature of 30-35 C means leaf surface temperature approaches protein denaturation limits; he does not know (ask Isabelle again)

1.3 14 avril, with Isabelle & Victor: PET

PET ... we do not have RH from ERA5LAND so we cannot use Ben's easy equation (see below). Instead we could use the complicated Penman Monteith which is the Standard FAO method; ET_o in Chapter 2. See also `docs/2023Apr_ETVictor.pdf`. And he shared his code.

T_{dew} is e_a
e_a is basically *vabar*
e_s is basically *vas* (and you can compute with T_{min} and T_{max} ...

1.4 14 avril, with Isabelle

This meeting covered:

- References on risk (damage) versus longer growing season
- What output from PHENOFIT to look at (long discussion)
- Visiting in June: Avoid 26-28 (away) June and 13, 15 (she is busy)

References on risk (damage) versus longer growing season

Yann has some work (I think she meant frost damage); perhaps do a lit review for Chinese species. I asked about *high temperatures* and she is not aware of any, but said there is some literature on floral necrosis (during spring) in crop literature probably. Also, there was heat damage at Peuchabon (field station) due to high temperature and some work on cuticles from this – some by Nicolas Martin (who is now at INRAe Avignon, forest group) but she does not think that it is published.

Air temperature of 30-35 C means leaf surface temperature approaches protein denaturation limits. See paper by Yann Vitasse on this, also ag literature

Which output from PHENOFIT?

A little more complicated than I thought!

1. LeafIndex – impacted only by frost (and contributes to maturation index). We think it should be only impacted by frost. This is continually updated inside the model so Isabelle is checking when the version that is written out is taken.
2. FruitIndex – impacted only by frost (lost due to frost on flowers or perhaps small fruit present early enough to get frosted)
3. MaturationIndex – this one is more of a pain than I realized!
    (a) It depends on: Length of the growing season (including drought during it I think) and LeafIndex
    (b) So if we want to look at impacts of GSL we'd need to look at MaturationIndex x GSL and see how strong the relationship is (could also look MaturationIndex x LeafIndex) ...

So we need to extract:

1. LeafIndex
2. FruitIndex
3. MaturationIndex
4. Fitness – which is the product of survival*FruitIndex*MaturationIndex (in our case, survival should generally always be 1 since this is only below 1 due to lethal cold temperatures and we're not in that range and drought)
5. LeafSenescence and LeafUnfolding dates – this will give GSL, which matters to MaturationIndex for QUEROB and FAGSYL (but likely not PINSYSL) ... could check
6. Could also check (not critical) that LeafUnfolding date is good metric – it should be HIGHLY correlated with FloweringDate and FruitInitDate.

Pinus spp mature fruit over two years; in PHENOFIT the maturation takes place in one year so flowering date and season length should matter less to MaturationIndex (may want to double check model). Thus we **predict** that warming does not impact MaturationIndex for PINSYL as much as for other two species, but all will be impacted by increased variability due to frost loss (though now that I transcribe these notes, I think the least impact should be on species that leaf out the latest, which I suspect is also PINSYL).

I asked about partitioning PHENOFIT fitness due to each part and Isabelle said they did something a little like this in Morin et al. 2006 'Process-based modeling of species' distributions: What limits temperate tree species' range boundaries'

A few more notes maybe in green and gray notebook, but I think I got most stuff here.

1.5 7 avril, with Isabelle

This meeting covered:

- WHC (water holding capacity)
- Coding simulations in PHENOFIT
- Problems with fitness values

WHC. Try 50 and 100%. See 'Lien entre dommages dus a la crise et reserve utile en eau des sols.doc' on Lizzie's computer for some background that helped Isabelle select these.

Coding simulations in PHENOFIT. Use different longitudes as way to code different simulations. (Latitude is used in the model for photoperiod, but longitude is just used as location marker so should be fine.) Isabelle also thought same lat/lon with different data in different rows would work, but using longitude seems easier.

Problems with fitness values. I ran PHENOFIT on the historical data using my gradient of sites from Italy, through Germany and onward to Sweden, but I got pretty low fitness values for FAGSYL and QUEROB. Isabelle said this happens. They usually convert to 0/1 so you don't notice this. She also said they have seen that the fitness is higher closer to where the data used to parameterize the model comes from (see `Phenofit4_Anne_Duputie.pdf` on Lizzie's computer).

So, Isabelle said it might have to do with where the data that the parameterized with from (France) versus where our points are (more Central Europe). We discussed changing to other parameters for the leaf phenology (from a K. Kramer book), but then Isabelle realized that we don't have similar parameters to use for flowering.

So I changed to sites that track more through France.

1.6 4 April 2023 with Ben

Calculating ET ... and a little more on simulated climate data

Detrending removes trends in central tendency

1. Use detrended data for long-term baseline
   (a) Z-score them
   (b) Then multiple the SD by 1.2 for a 20% increase in variability *normal distribution
   (c) Check your output

ET ... **MAKE sure to use min and max RH correctly**

- if you have relative humidity and temperature, then that's enough
- Use this: `https://en.wikipedia.org/wiki/Clausius%E2%80%93Clapeyron_relation#August%E2%80%93Roche%E2%80%93Magnus_formula`
- This is how Ben typically does it

- Need: max RH and min RH (and temperature)
- Remember: Tmax is associated Tmin RH (and vice versa)
- RH tells you how saturated the air is; use temperature to calculate how much water the air is
  - Step 1: Put in the August Roche Magnus – hypothetical maximum (e_s) using just T – see the link: Basically it's $6.1^{((17.625*T)/(T+234))}$
  - Step 2: Now multiple e_s by RH: $e_S * (RH)$
  - (Make relative RH is measured as a fraction)
  - Now you have the ET!
  - Check with an online calculator! Or check that every degree warmer get about a 7% increase.

1.7 15 mars 2023

See `ChatsBenNotes.txt` for thoughts on how to do the climate.

1.8 17 mars 2023

MW Isabelle:
- Two ideas for climate
- How to adjust for other climate variables
- How to ask for climate data from Victor
- Which months around budburst

1.9 9 mars 2023

1. Sites
   (a) Previously discussed: Southern beech forest as site (Massan and sites in Pyrenees) may not be ideal as lengthening of growing season is not happening in southern range (because drought is shortening the length of the growing season; senescence now in August sometimes). That's the REAL world though, the current PhenoFit shows it lengthening (Isabelle has a postdoc starting in May who may try to work on the drought aspect to fix this)
   (b) Right now the model (Phenofit 4; Delpierre) does not include drought effect on senescence ... just temperature and daylength affect senescence
   (c) But do we need specific sites? Only if we want to compare to what is happening.... But we do need for some climate data.
   (d) But be sure to pick a site that is FLAT (because using climate re-analysis)
2. Adding heat damage: Need good experimental data ... 60C at surface for adult leaves, lower for young leaves (June 2019 saw leaf damage, even on Holm Oak) – so no, don't add.

3. Species
    (a) There are parameterized models for 20 species or so, could use one of these. Or, an artificial species – make up parameters.
    (b) Work with a broadleaf and an evergreen needleleaf.
    (c) Quercus robur and patraea are basically the same species.
    (d) Actually do these three (based on comparisons and having well parameterized models for them) Do querob/quepet (pick one), fagsyl, and pinsyl. Look at the overlay distributions for somewhere flat and not too far south. Look at the new European atlas (European atlas of forest trees) .... `https://forest.jrc.ec.europa.eu/en/european-atlas/` .. see also SI of Duputie...
4. Phenofit5 is still being parameterizing and tested. Used already for beach and Oak.
5. What we'll measure?
    (a) Phenofit 4 has annual fitness: sum(survival + reproductive success) ... reproductive success is based on ripe fruit by end of season before leaf senescence. Survival has a crude carbon metric. – so fitness is constrained by spring frost and length of season.
    (b) Survival is the product of 3 survival parts (temp, drought, carbon: most of survival is drought).
    (c) MaturationIndex is a metric of if the season was long enough .... so this is a way to measure season length
    (d) FruitIndex and LeafIndex only go below 1 due to frost ... so these are ways to measure frost loss.
    (e) LeafDormancyBreakDate relates to leaf-unfolding and to frost risk.
    (f) We can hold phenology constant (at least in PHENOFIT 4)...YES! Can do this – when initializing you can do this, 'activate the date files' – give it specific dates (see methods Duputie et al. 2015 on plasticity GCB). Not sure if it works for Phenofit 5 (see Gauzere Evolution Letters 2020 .... new standing variability in phenology may make this hard).
6. Some notes on climate. ...
    (a) ERA5land model at 10km (includes scenarios and future)
    (b) WHC is hard to calculate – so many want to try across three values (low/medium/high).

1.10 Before 9 mars 2023

Notes from getting going ...

- What site and species do we want to use?
    - Ideally one with an existing model we do not have to spend a long time verifying?
    - Both historical climate and future climate ... so we can compare
    - But also one where some events (frost, heat damage) may have shifted at the same time that growing season length or seasonal warmth has had an impact.

- High temperatures?
- What do we want to measure?
  - Phenological shifts related to end/start of season and particular damage events
  - Tissue or ideally reproduction lost due to each event type
  - Reproduction changes due to longer/warmer season
  - What else?
- What *in silica* experiments do we want to run?
  - Historical climate
  - CMIP future climate scenario (maybe) – characterize future climate: what is mean shift, what is variance shift?
  - Historical climate + 2C?
  - Historical climate with increased variability in spring (and summer?)
  - Historical climate + 2C? with increased variability in spring (and summer?)
  - We want to test how phenological shifts x extremes matter, so I wonder if there is a scenario where we can try to hold phenology more constant and layer on climate variability? Not sure what that will show us ...