Flemish Fruits Fear Frost

(MODELLING CLIMATE CHANGE INDUCED PHENOLOGICAL TRENDS AND FROST RISKS IN BELGIAN FRUIT ORCHARDS)

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KU LEUVEN

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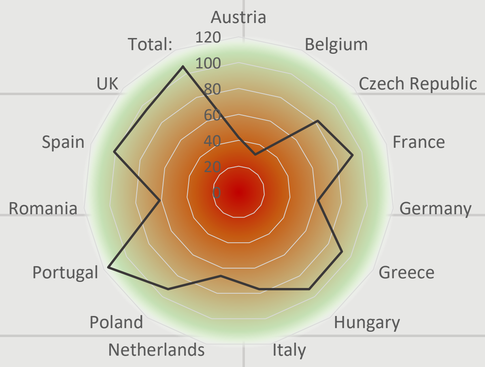
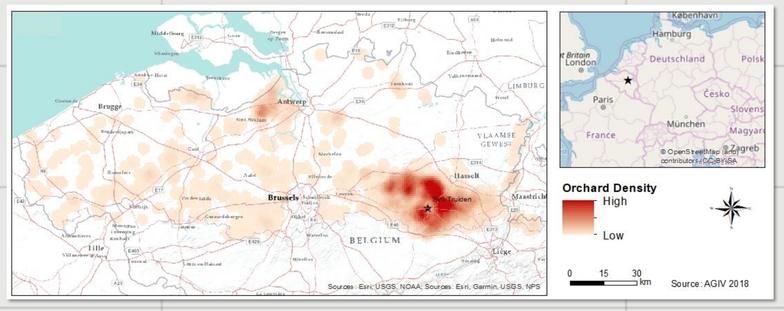
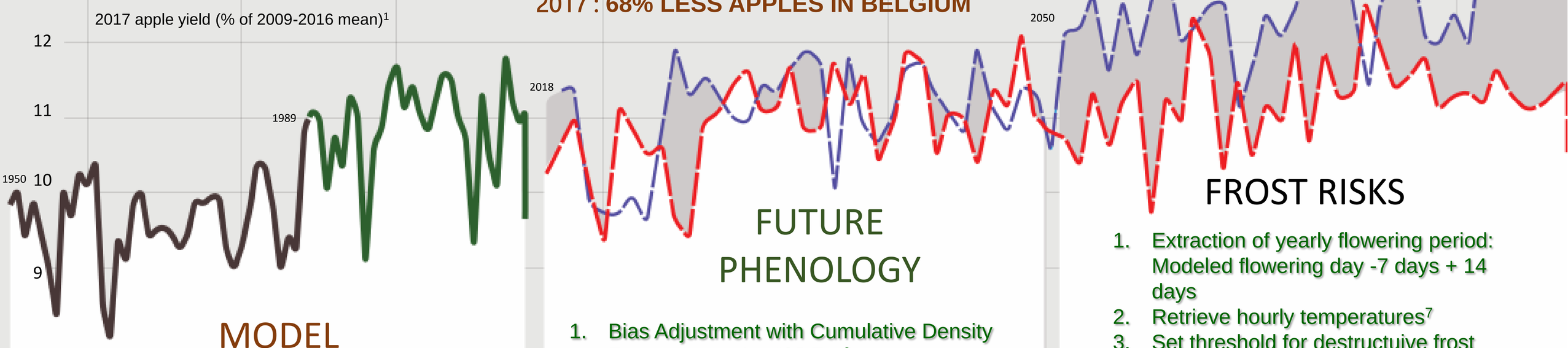


2017 apple yield (% of 2009-2016 mean)[1]

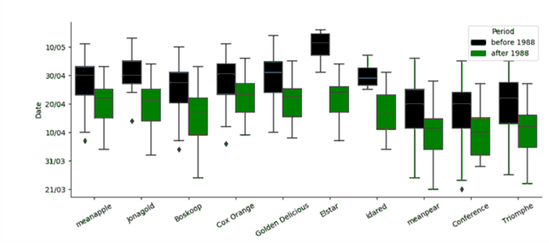


“ 2017 : 68% LESS APPLES IN BELGIUM

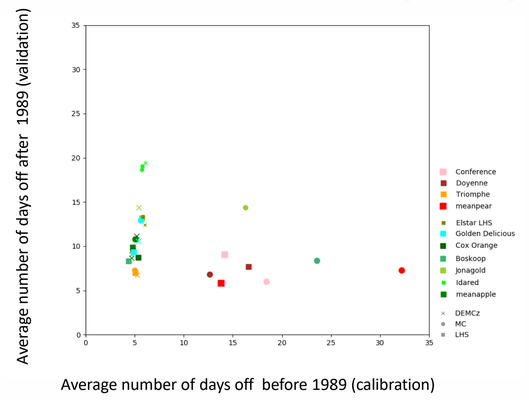


MODEL PARAMETRISATION[2]

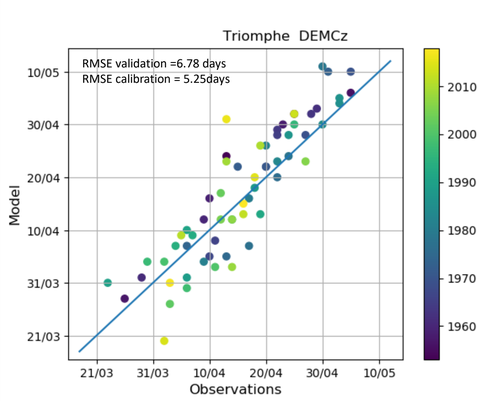
1. Split dataset[3] in 1989[4] for calibration and validation of the sequential model

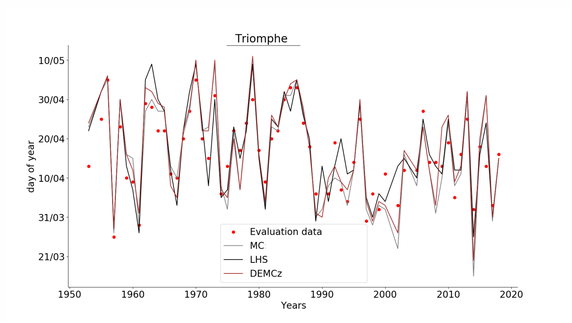


2. Optimisation approaches using SPOTPY [5]
(Monte Carlo (MC), Latin Hyper Cube Sampler (LHS)
Differential Evolution Markov Chain (DE-MCZ)



“ Model accuracy depends on cultivar and optimisation algorithm



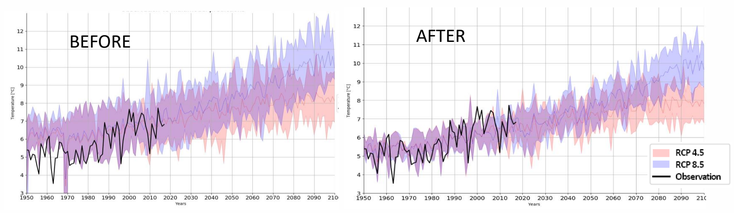


“ Ex. Triomphe : model performs equally well under a warmer regime

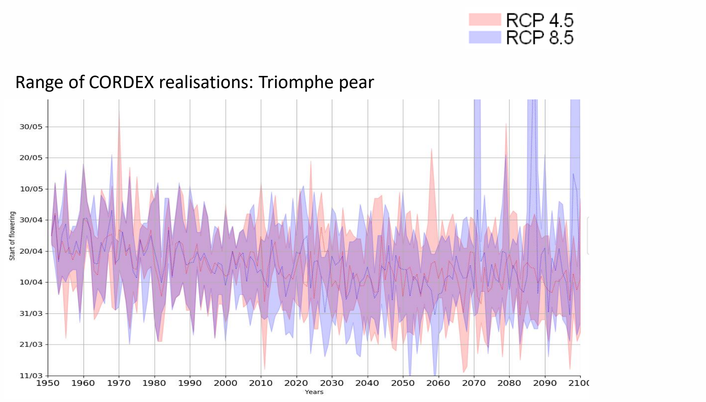
“ Suitability for Climate change modeling not excluded

FUTURE PHENOLOGY

1. Bias Adjustment with Cumulative Density Function transfer (CDFt) [6]



2. Estimate the start of flowering for different CORDEX time series using the best fit sequential model



“ Persisting trend of earlier bloom

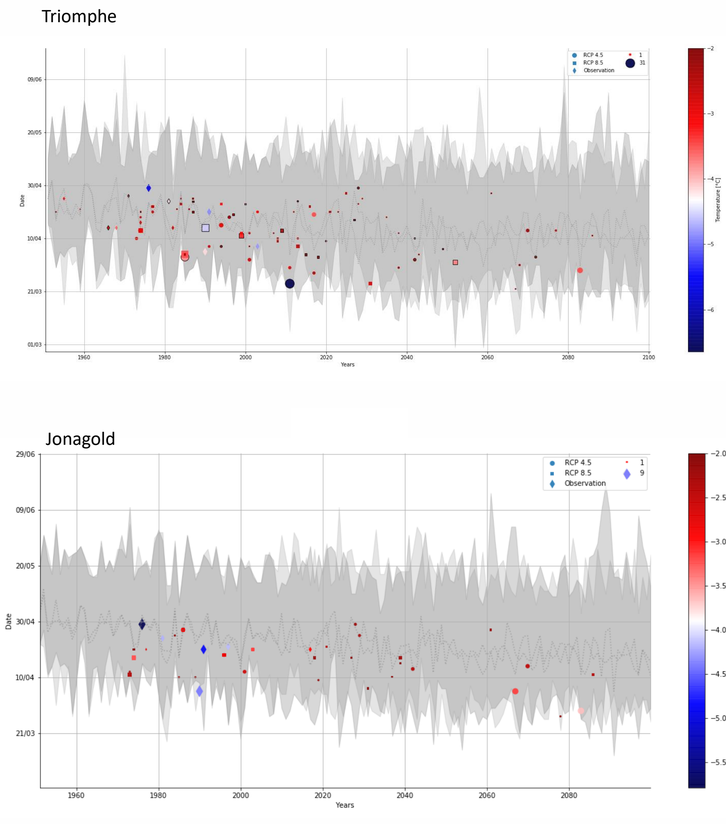
“ More frequent unfulfilled chilling requirements occuring under

“ Uncertainty of climate change realisation is greater than the difference between cultivars

“ Single realisations are not representative for the ensemble

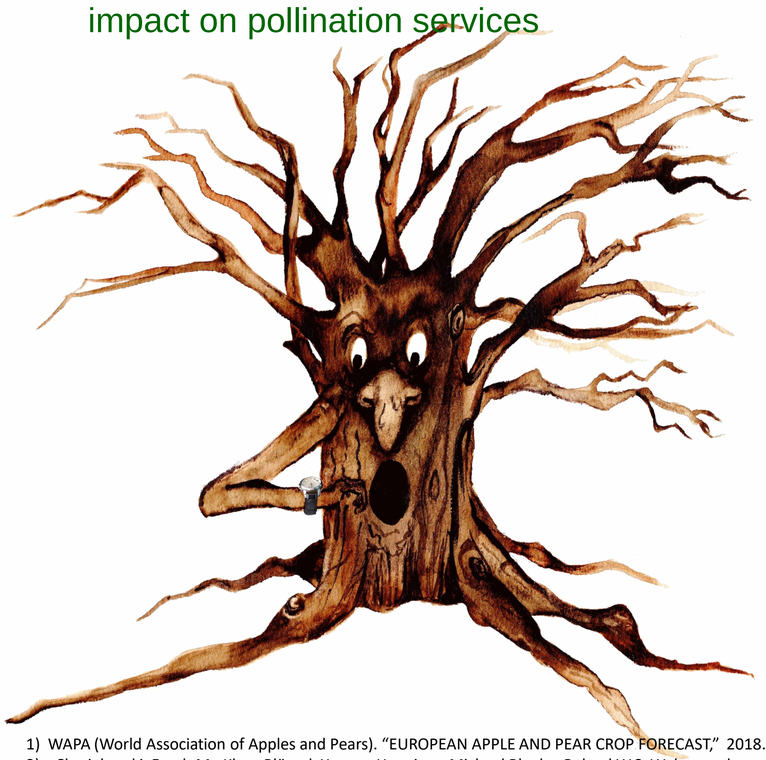
FROST RISKS

1. Extraction of yearly flowering period: Modeled flowering day -7 days + 14 days
2. Retrieve hourly temperatures[7]
3. Set threshold for destructuive frost as -2°C



“ Frost risk is decreasing but only towards the end of the century

“ Further research:
Risk of insufficient chilling;
diversification as risk reduction;
spatial variability
impact on pollination services



1) WAPA (World Association of Apples and Pears). “EUROPEAN APPLE AND PEAR CROP FORECAST,” 2018.
2) Chmielewski, Frank-M., Klaus Blümel, Yvonne Henniges, Michael Blanke, Roland W.S. Weber, and Michael Zoth. “Phenological Models for the Beginning of Apple Blossom in Germany.” *Meteorologische Zeitschrift* 20, no. 5 (October 1, 2011): 487–96.
3) Phenological timeseries provided by pcfruit research centre (https://www.pcfruit.be)
4) Gobin, A. “Weather Related Risks in Belgian Arable Agriculture.” *Agricultural Systems* 159 (January 1, 2018): 225–36.
5) Houska, Tobias, Philipp Kraft, Alejandro Chamorro-Chavez, and Lutz Breuer. “SPOTting Model Parameters Using a Ready-Made Python Package.” Edited by Dafeng Hui. *PLOS ONE* 10, no. 12 (December 17, 2015): e0145180.
6) Michelangeli, P.-A., M. Vrac, and H. Loukos. “Probabilistic Downscaling Approaches: Application to Wind Cumulative Distribution Functions.” *Geophysical Research Letters* 36, no. 11 (June 11, 2009).
7) Luedeling, Eike. “Statistical Methods for Phenology Analysis in Temperate Fruit Trees (Package ChillR),” February 15, 2019.