Modeling the Impact of Global Warming on the Phenology of the Olive Tree in the Mediterranean region

Aicha MOUMNI[1,*], Iman ABOUSEIR[1], Abderrahman LAHROUNI[1]

[1] Physics Department, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakesh, Morocco

* Ach.moumni@gmail.com

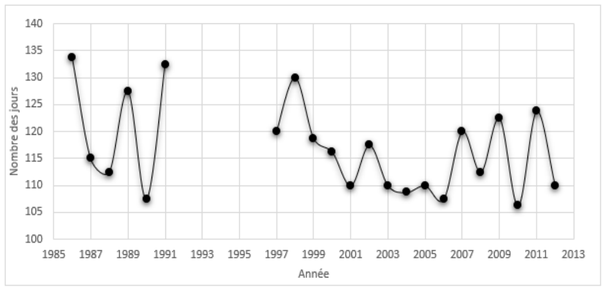
Abstract

Observational evidences from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. These increases of temperature have influenced the phenology of plants. Since olive tree is a characterizing tree of Mediterranean area, the study of its phenology will demonstrate the impact of global warming in this area. For this aim, we modeled the flowering of olive tree in Tassaout region to predict the date of this phase of development, using PMP software. We tested three phenological models to choose the most robust model. The results of this modeling are used to run simulations with future temperatures according to three climate scenarios (SRES): B1 the optimistic scenario, A1B a moderate scenario and A1F1 the pessimistic scenario. For the three scenarios, we found that there is an advancement of the flowering date, but this advancement differs depending on the scenario's severity. So, we concluded that the early flowering of the olive tree can be an indicator of global warming in the Mediterranean area.

Materials and Methods

Dataset (inputs) for PMP

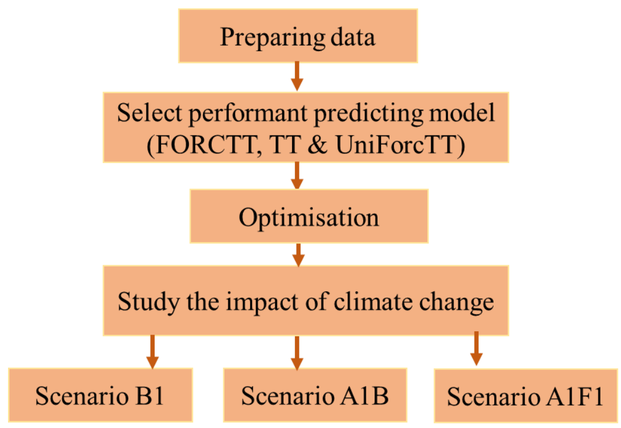
Climatic and phenological Data are collected for the flowering phase of olive tree from field observations between the years 1986 - 1991 and 1997-2012. The studied trees are mature trees, they are not influenced by artificial products to interrupt the dormancy period.



Used Phenological models

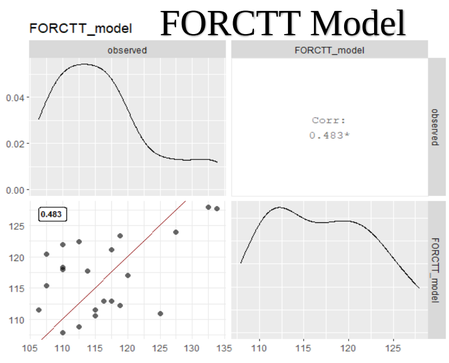
Model	Form	Expression	Parameter
ForcTT Model	Linear	$S_f = \sum_{t_0}^{y} R_f(x_t) = F^*$ $R_f(x_t) = \begin{cases} 0 & x_t < T_b \\ x_t - T_b x_t \geq & T_b \end{cases}$ Où t_0= 1 Janvier	T_b , F^*
Model TT	Linear	$S_f = \sum_{t_0}^{y} R_f(x_t) = F^*$ $R_f(x_t) = GDD = \begin{cases} 0 & x_t < T_b \\ x_t - T_b x_t \geq & T_b \end{cases}$	T_b , F^*,t_0
Model UniForc	Sigmoidal	$S_f = \sum_{t_0}^{y} R_f(x_t) = F^*$ $R_f(x_t) = \frac{1}{1 + e^{w(x_t + c)}} (w \text{ et } c) < 0$	F^*,w, c

Methodology

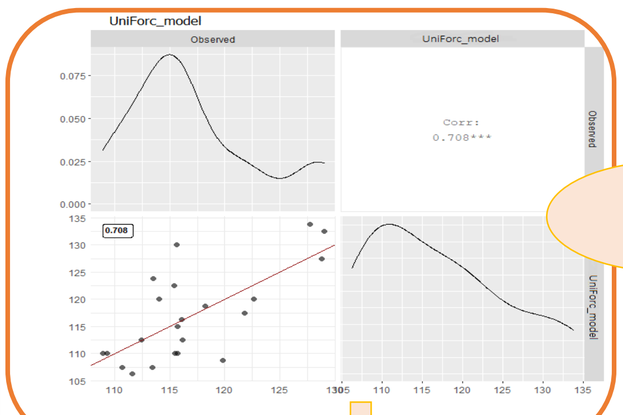


Results and discussions

FORCTT Model

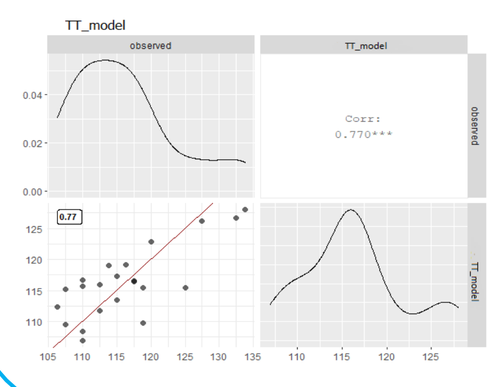


UniForc Model

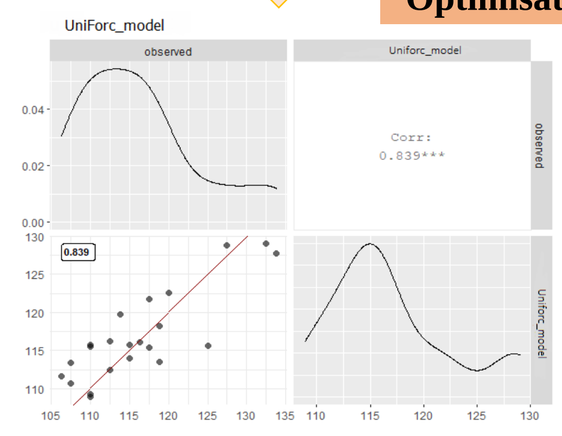


Best Model

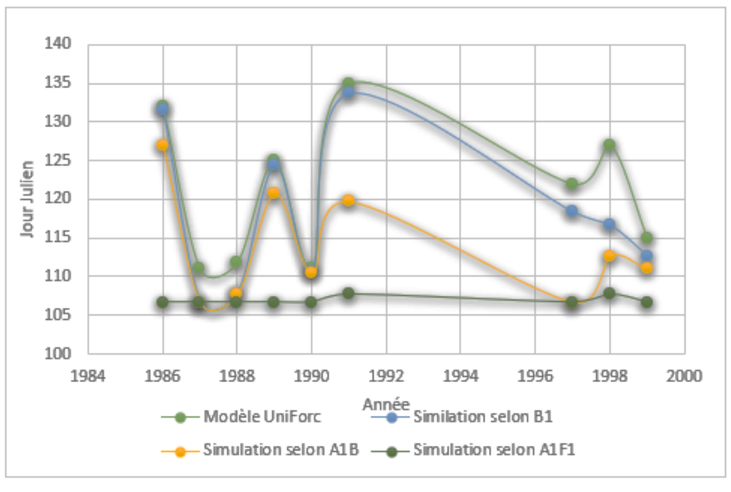
TT Model



Optimisation



The overall pattern of variation in flowering dates under the three scenarios shows that there is a relationship between temperature increase and earlier flowering date. Most dates follow the expected logic, which means that the higher the rate of temperature increase, the earlier the flowering date. For the three scenarios, there is an advance in flowering date that varies between 0.3 and 27.3 days. The averages of these advancements have values of: 3, 7.5 and 14.17 days respectively for the B1, A1B and A1F1 scenarios. Thus we can conclude that the earliness of the flowering date of the olive tree is an indicator of the impact of global warming in the Mediterranean region.



Conclusion

The simulations of the flowering dates according to the different SRES scenarios have shown that the increase in temperature leads to the advancement of the flowering date, this advancement varies between 0.3 and 27.3 days. The higher the temperature increase, the earlier the flowering date. Thus, we conclude from these studies that the date of flowering of the olive tree can be an indicator of global warming in the Mediterranean area

References

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