LIFE
Climate Change Mitigation

Preliminary results for Action C2: Projections of future climatic conditions for tree crop categories in S. Europe

March 2017

LIFE CLIMATREE (LIFE14 CCM/GR/ 000635)

A novel approach for accounting and monitoring carbon sequestration of tree crops and their potential as carbon sink areas

The **LIFE CLIMATREE** project "A novel approach for accounting and monitoring carbon sequestration of tree crops and their potential as carbon sink areas" (LIFE14 CCM/GR/000635) is co-funded by the EU Environmental Funding Programme **LIFE Climate Change Mitigation**.

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Participating Beneficiaries:

University Research Institute urban environment human resources, Panteion University, Athens

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The current report presents preliminary results for Action C2: Projections of future climatic conditions for tree crop categories in S. Europe, of the LIFE CLIMATREE project. The deadline of this Action is December 2017.

1. Introduction

The aim of this Action is to determine future climatic conditions related to tree crop cultivations in S. Europe. The Action is divided in two parts. In part one the climatic changes over S. Europe are estimated using data from a Global Climate Model (GCM). Since the outputs from the GCM are relatively coarse (i.e, $2° \times 2.5°$ latitude by longitude) in part two, meteorological fields in a finer grid size (i.e, 9km x 9km) over the area of interest are obtained using dynamical regional downscaling. The results of this Action will be used from Action C3 (Interface development of a software application for accounting tree-crop carbon sequestration) as well as from Action D3 (Assessment of the guide impact of the proposed methodology in supporting ecosystem functions restoration.

2. Material and Method

For this action two workstations specifically designed for the purposes of the project (i.e., climate and meteorological simulations) have been set up explicitly for the simulations of the project. The benchmark test performed at the beginning of the project showed that the same line of motherboards and CPU processors where necessary in order to increase the performance capabilities of the workstations and address accuracy issues. To benefit from the existing infrastructure of our lab a CPU processor and two motherboards were purchased. Moreover, given the strong dependence of the software on the installed memory, extra memory was purchased. The upgrade of the workstations to meet the needs of the project has been initially foreseen in the proposal (i.e., computer parts, back up disk drives, memories, etc). Evaluation of the workstation's performance using a benchmark suite of simulations to demonstrate the correctness of computer simulations was performed.

The Weather Research and Forecasting (WRF) mesoscale meteorological model is used to downscale the NASA Goddard Institute for Space Studies (GISS) ModelE Global Climate Model (GCM) simulations in order to determine the change in the climatic parameters of interest. The NASA GISS ModelE GCM was initially evaluated for the correct installation using a benchmark suite provided by NASA and comparing the outputs of the code for all simulations carried out with existing plots of the selected simulations. WRF mesoscale meteorological model is used to dynamical downscale NASA GISS GCM output in S. Europe in a multi-nesting domain (Figure 1). The latest version of WRF mesoscale meteorological model has been set up and tested using the "WRF Testing Framework" utility.

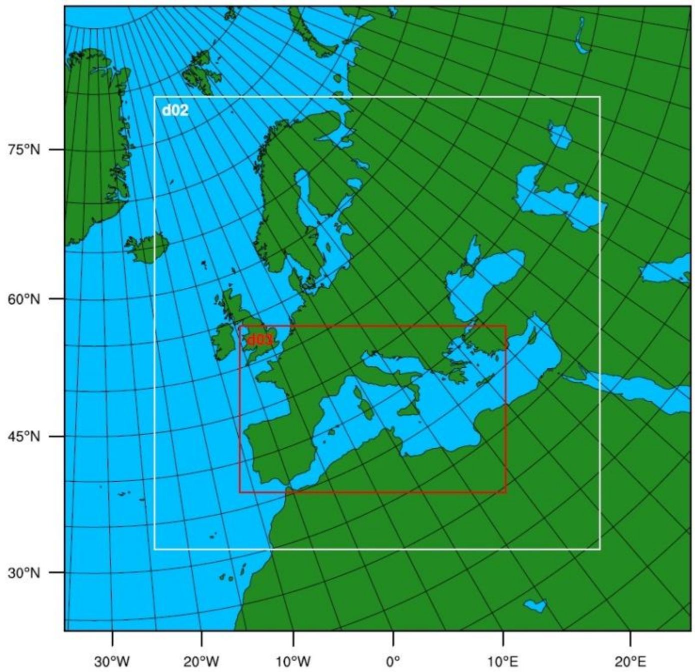

Figure 1: Modeling domains used in WRF simulations with three – nested grid domains from 81Km to 9 Km.

NASA GISS GCM model simulations cover the period from 1880 to 2060, as mentioned in the proposal. Future climate for the period 2031–2060 are assessed for two Representative Concentration Pathways (RCPs) (i.e., RCP8.5 and RCP4.5) and the related changes from the base period (i.e., 1981-2010) is quantified. These outputs will formulate a database containing the climatic parameters relevant to trees cultivations. In order to obtain climatic information in a very fine scale (i.e., 9km x 9km) the dynamical downscaling procedure is used for five current (i.e., 2008 – 2012) and five future (i.e., 2048-2052) years in order to estimate the spatial changes in crucial parameters related to trees cultivations (i. e., temperature, precipitation). These outputs will suggest a database containing monthly average changes in the meteorological parameters affecting the tree cultivations in S. Europe between current (i.e., 2008 – 2012) and future years (i.e., 2048-2052).

3. Preliminary Results

3.1. NASA GISS GCM ModelE simulation

Preliminary results from the GCM simulations under the RCP8.5 for surface air temperature and precipitation changes are presented in Figures 2 and 3, respectively. Results are presented for the annual average changes between current (1981-2010) and future (2031–2060) periods. Ground temperature is estimated to increase by 1.3 ^{o}C ranging from -0.5 ^{o}C up to 6.5 ^{o}C, locally. An increase between 1.0 and 2.0 is estimated for the largest part of Europe. However, a higher increase is simulated over Scandinavia and the Iberian peninsula and a lower one over Great Britain.

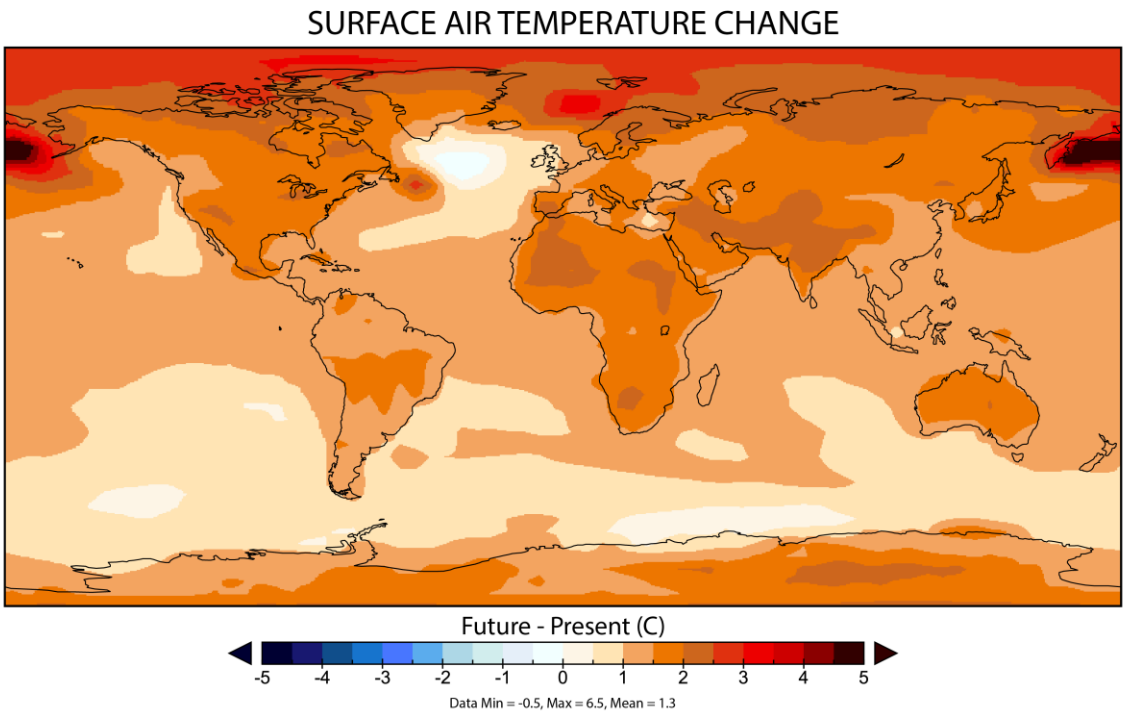

Figure 2: Temperature change between future and present years

Precipitation change is location dependent showing a mixed trend. The average change is simulated to be 0.1 mm/day suggesting an almost stable precipitation rate on average over globe. However, precipitation is very location dependent presenting regions with increasing or decreasing trends in the precipitation rates ranging from -0.5 mm/day to 2.2 mm/day. In general, a reduction up to 0.2 mm/day is simulated over west and south Europe while an increase up to 0.2 mm/day is simulated over East Europe and Great

Britain. However, a higher reduction (i.e., up to 0.4 mm/day) is simulated over the Iberian peninsula and a higher increase up to 0.4 mm/day over Scandinavian peninsula, locally.

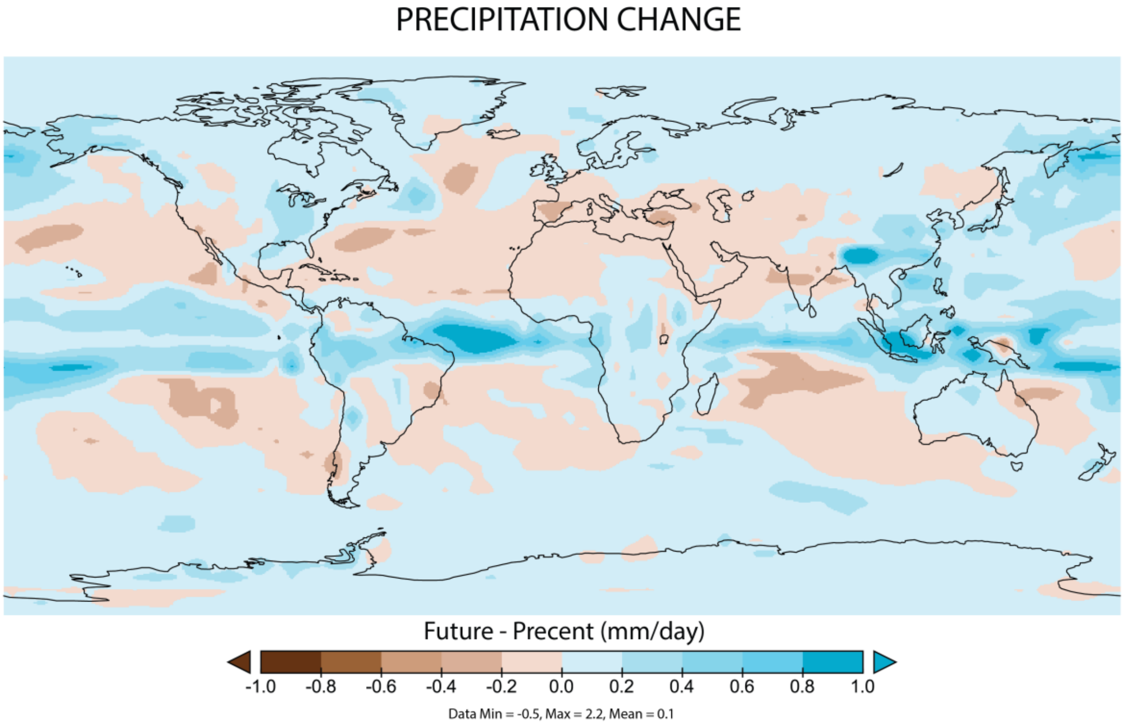

Figure 3: Precipitation change between future and present years

3.2. WRF simulations

The downscaling procedure where WRF simulations were performed using data (i.e., boundary and initial conditions) from the NASA GISS ModelE global model is ongoing. Preliminary results under the RCP8.5 for temperature and precipitation are presented in Figures 4 and 5, respectively.

Results suggest an increase of 1.5 °C for the mean temperature from 2008-2012 to 2048-2052. The most intense temperature increase is expected at the Iberian Peninsula and the North of Italy surpassing 1.5 °C. Winter temperature change is greater in northern Italy and the central Mediterranean. During Spring the greatest change occurs in northern Italy and eastern Portugal with significant increases in the central Mediterranean and across the Iberia, while in the Balkans a decrease is observed. In Summer most intense changes (up to 2.5 °C) are seen in almost all the extent of the Iberia and the greater part of France. In Autumn, the greatest increase shifts spatially to the Central Mediterranean region also affecting the western part of Greece. In the Western Mediterranean a slight decrease is expected. Summer and Winter temperature changes are greater than Spring and Autumn both by measure and spatially.

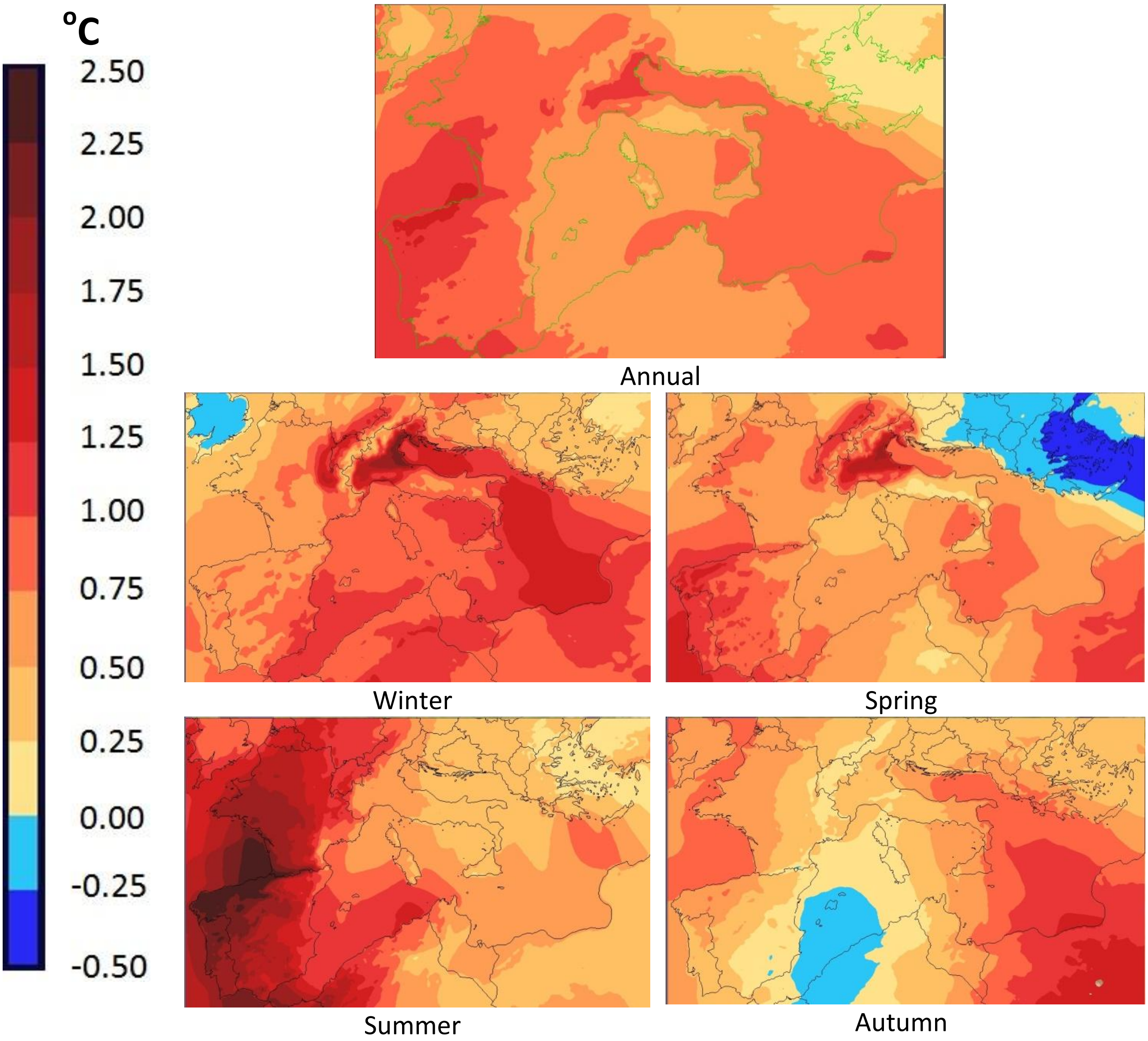

Figure 4: Temperature change between future and present years

Precipitation change between 2008–2012 and 2048-2052 presents a mixed trend with high spatial variability. A significant increase up to 80% is anticipated in the central Mediterranean. Southern Italy and a big part of the Balkans are found to face a 20%-

40% precipitation increase. Winter estimations for the central Mediterranean are in line with the annual change. Throughout most of the continental part of southern Europe a decrease in precipitation is projected. In Spring, an increase in precipitation is estimated almost in the whole of the Mediterranean sea unlike the mainland of Europe. For Summer a spatial distribution that is not consistent with the annual average is seen, exhibiting a very significant increase in Greece surpassing 80%. Similar increases are found sporadically in parts of the Iberian peninsula. In Autumn we observe a significant increase in the Central Mediterranean, Southern Italy and the Northern Iberian region.

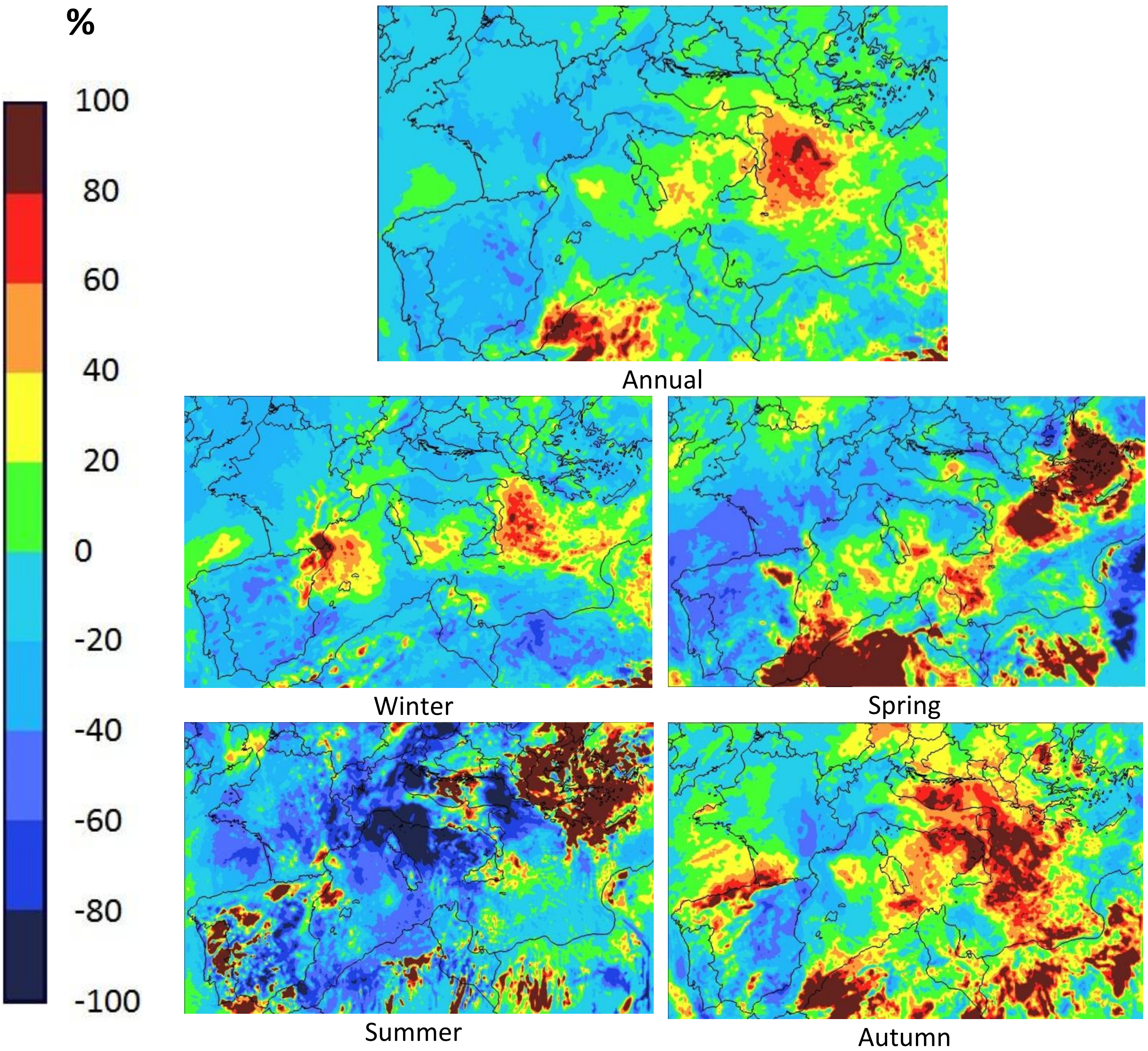

Figure 5: Precipitation change between future and present years