Anticipating climate change in Europe using GRNET High Performance Computer ARIS infrastructure

Climate change

In the last decades, the world phenomenon of climate change has put the planet in jeopardy. Global warming, namely the increase of temperature worldwide and the emerging of local extreme weather phenomena , such as prolonged droughts or more frequent floods from heavy rainfall, have had a serious impact on the well - being of the population as well as on the economy.

The Mediterranean region has been classified as a "hot-spot" of climate change[1], namely an area where the effects of climate change are expected to be particularly intense. Agro-food, Biodiversity, Energy, Tourism and Health are sectors that depend closely on the average and extreme climatic values of an area and are expected to be affected over the next decades due to the expected changes in climate, as foreseen by the Intergovernmental Panel on climate change reports[2]. The timely and valid assessment of the magnitude of climate change at a regional level is essential for putting in place a policy to both avoid and address its adverse effects.

The need for computing resources for ClimateStudy

The international scientific community plays a key role in the effort to tackle the impact of climate change. Using numerical models that simulate the processes of the climate system, it is possible to make likely projections of the future climate, in the next century or even more so. To study climate, researchers have been developing since the 1960s climate models which have been gradually evolving to include more and more complex natural processes of the climatic system. Climate models are nowadays much more complex and accurate, but at the same time they are much more demanding in terms of computing and storage resources.

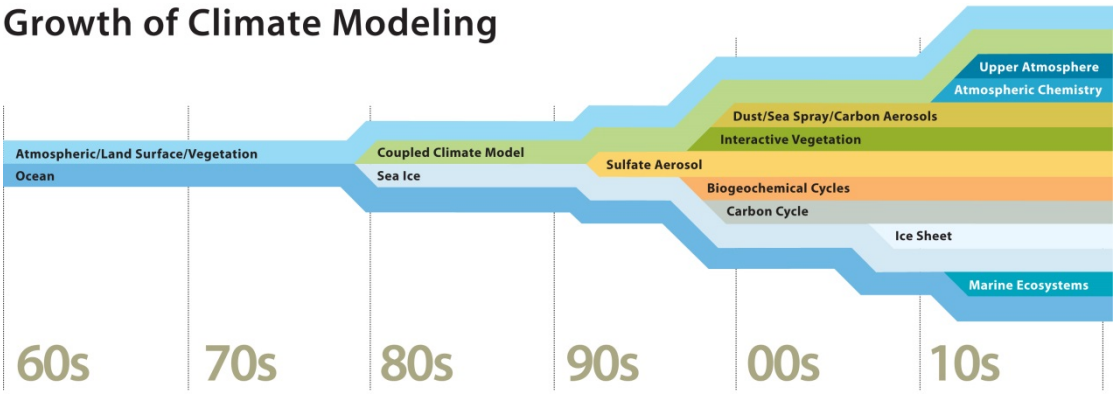

Figure 1: Evolution of numerical models used for studying climate and climate change

Researchers use climate models to implement climate projections with the highest possible spatial resolution. Thanks to the rapid evolution of computing technologies, simulating the climate of an area can be done in much higher spatial resolution than in the past (e.g.≤12 Km at continental level for a regional climatic model, ≤150 Km in a world-wide model). Until recently, climate projections were carried out in small compute clusters that offered limited processing capacity, whereas limited storage space is an additional factor that makes timely integration of climate simulations even harder.

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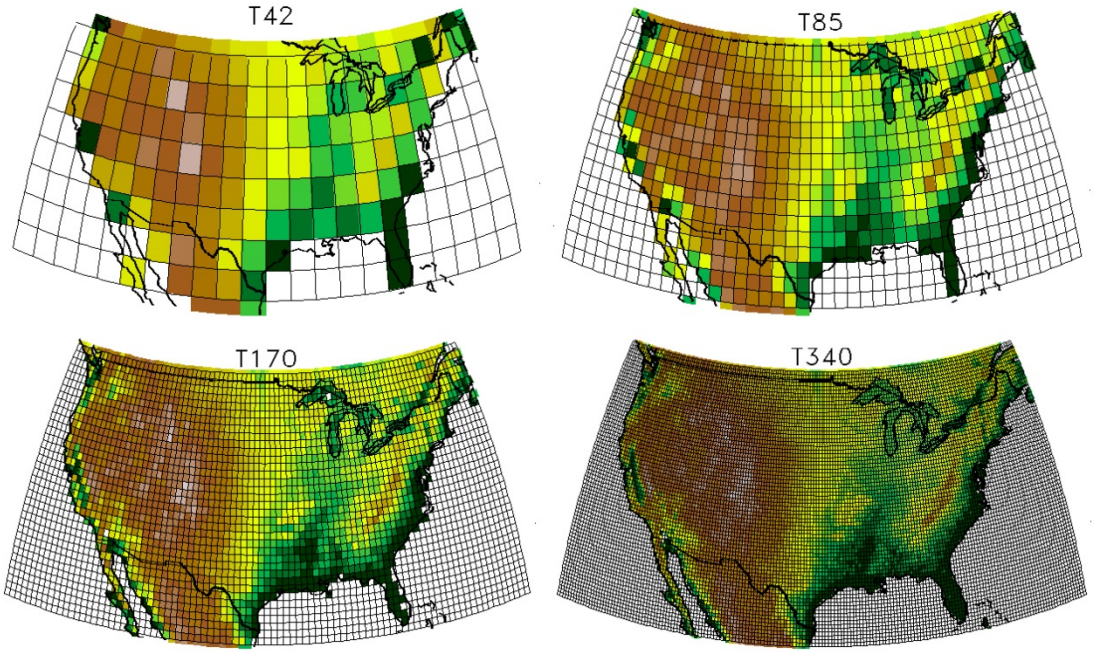

Figure 2: Improvement in spatial analysis of the climatic information over time from ~ 300Km (T42) to 40 Km (T255). The ability to run climatic simulations in higher resolution was made possible by the use of high performance computing systems.

High Performance Computing ARIS: GRNET technological solution for high-resolution Climate Simulations

Dr. Eleni Katragou and her research team from the Aristotle University of Thessaloniki perform climate simulations of the 21st century European climate in the framework of the international project "Coordinated Regional Downscaling Experiment" ('CORDEX')[3], using high performance computing infrastructures. She contacted GRNET-the Greek Research and Technology Network to request access to use the national high performance computing ARIS infrastructure and services, as the optimal solution for the implementation of the research project.

"The use of GRNET's HPC resources and services has been a key factor for the integration of climatic projections at high spatial scale (<15 km for Europe and <3Km for sub-regions of Europe)" explains Dr. Katragou. "The high spatial analysis in the results of a model is necessary when the impact of climate change on areas such as Health, Agriculture, Biodiversity, Energy, Tourism, etc., is to be assessed. The impact assessment of climate change is very important for maintaining people's quality of life and safety and for preserving the environment, whereas it is often associated with significant economic consequences. The results of the simulations[4] form part of the European program EURO-CORDEX[5], supported by the World Climate Research Program[6]."

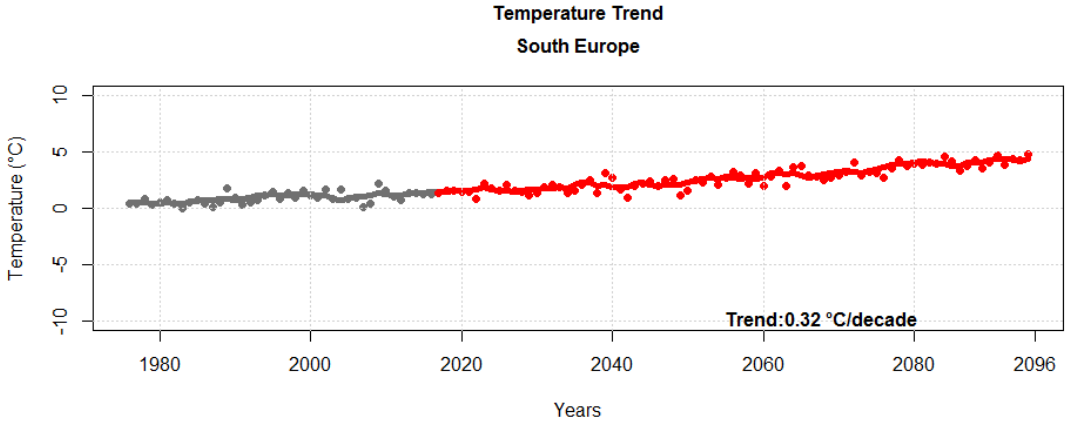

Figure 3: Change of average temperature in relation to the reference period 1976-2005 over Southern Europe on the basis of climate simulations performed on GRNET HPC infrastructure in the framework of Regina Project, 1st production call. Gray color refers to the current climate (until 2017). The dots refer to the average annual temperature values, and the line to the 5-year rotating average[7]

The total number of core hours spent on HPC ARIS system was 1,129,211. The maximum scaling of the research application, namely the maximum number of cores used simultaneously by one process, was 640 cores.

GRNET High Performance Computing infrastructure can support large-scale projects in the field of climate and climate change studies. At the same time it offers academic institutions the opportunity to participate in international actions and contribute to the promotion of relevant research matters by deploying their own resources. In the long run, it contributes to the networking of Greek academic institutions with respective reference centers abroad, thus offering the opportunity for high level academic actions and education to young scientists.

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