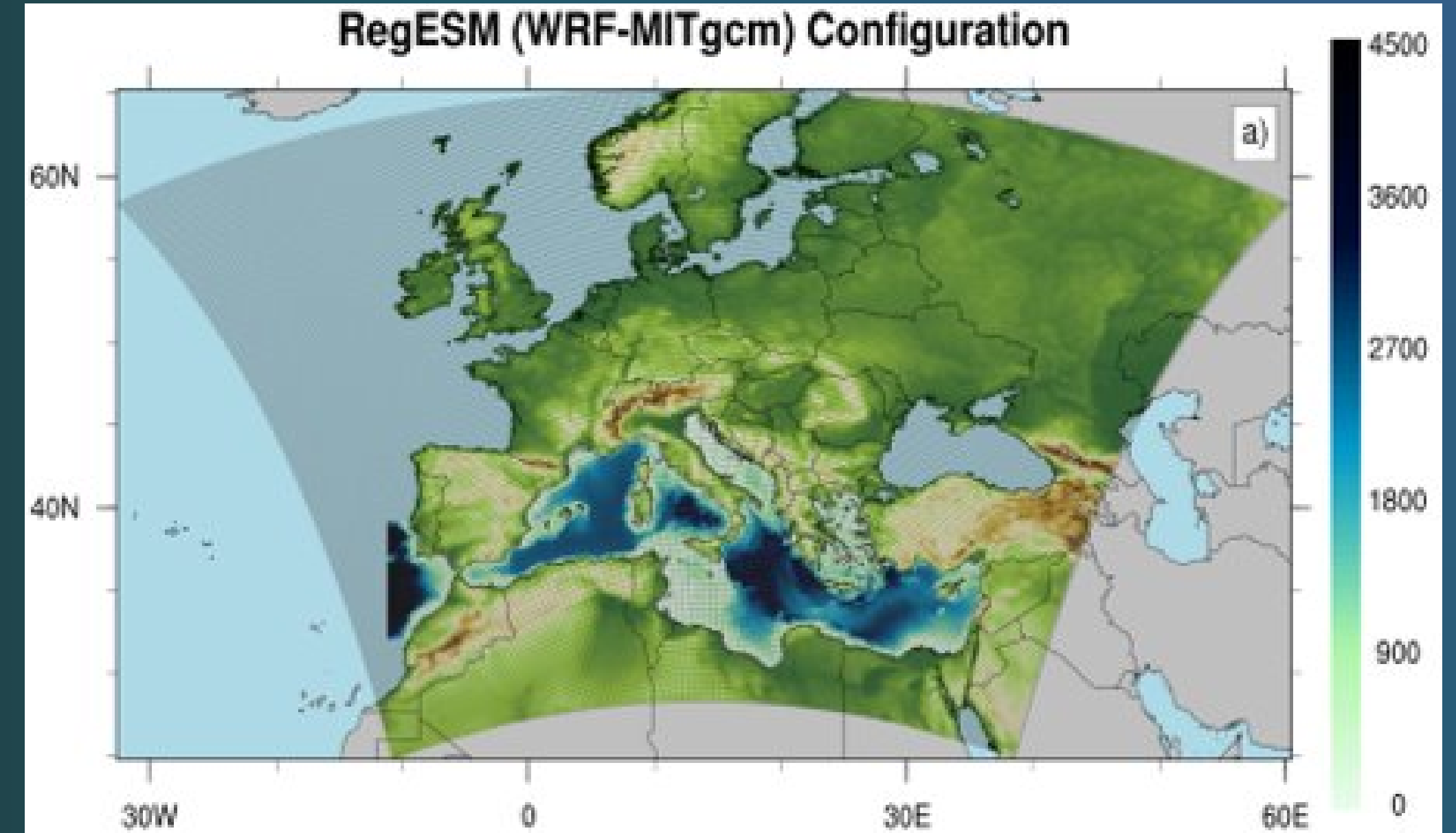


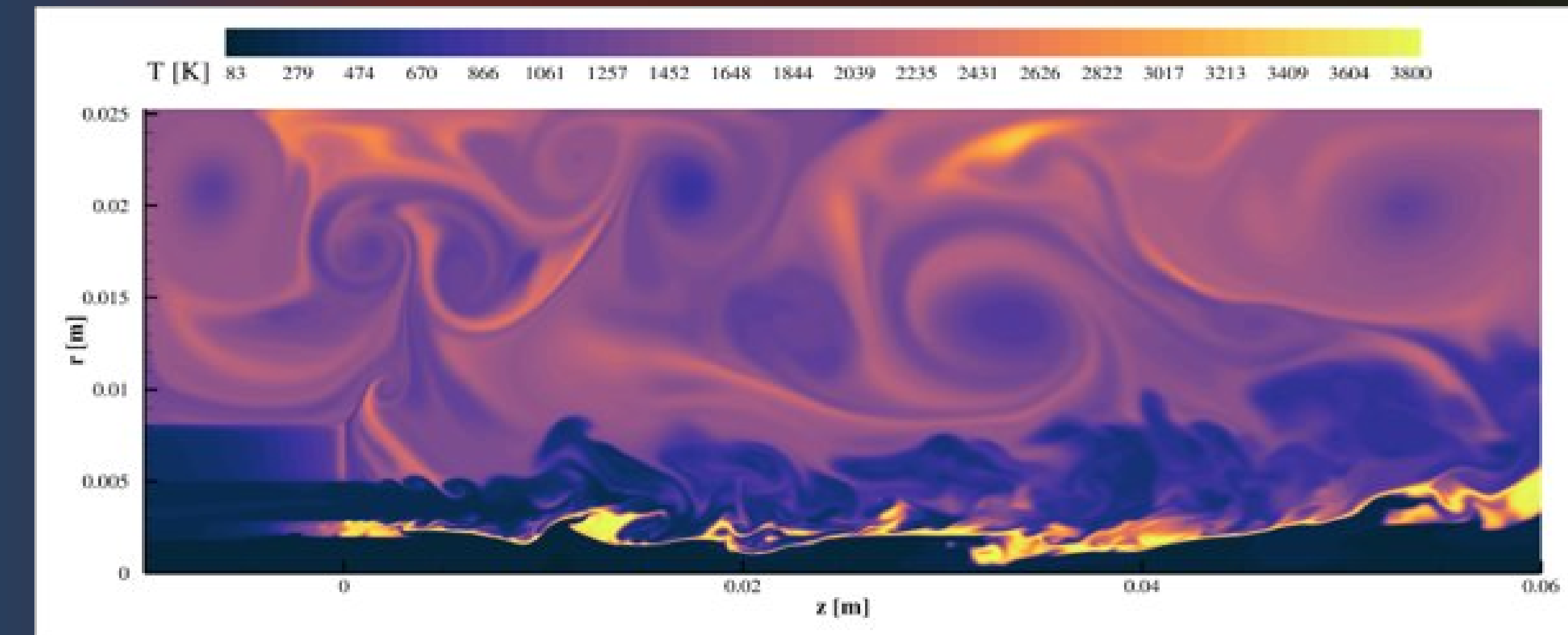
Global Climate Change: ENEA-REG Regional Earth System Model

The Mediterranean basin is a complex region, characterized by the presence of a pronounced topography and a complex land-sea distribution, including a considerable number of islands and straits. These features generate strong local atmosphere–sea interactions leading to the formation of intense local winds, like Mistral, Etesian and Bora which, in turn, dramatically affect the Mediterranean ocean circulation. Given the relatively fine spatial scales at which these processes take place, the Mediterranean basin provides a good opportunity to study regional climate, with a special focus on the air-sea coupling. For these reasons, ENEA developed regional coupled model (the ENEA-REG regional earth system model), which is being used to study both the present and future Mediterranean climate system.



Corse resolution domain of the ENEA-REG system. Green shading represents the topography of the atmospheric model. Solid gray lines indicate the computational grid.

CFD Combustion: Large Eddy Simulation of Transcritical H₂ / O₂ Non-Premixed Flame

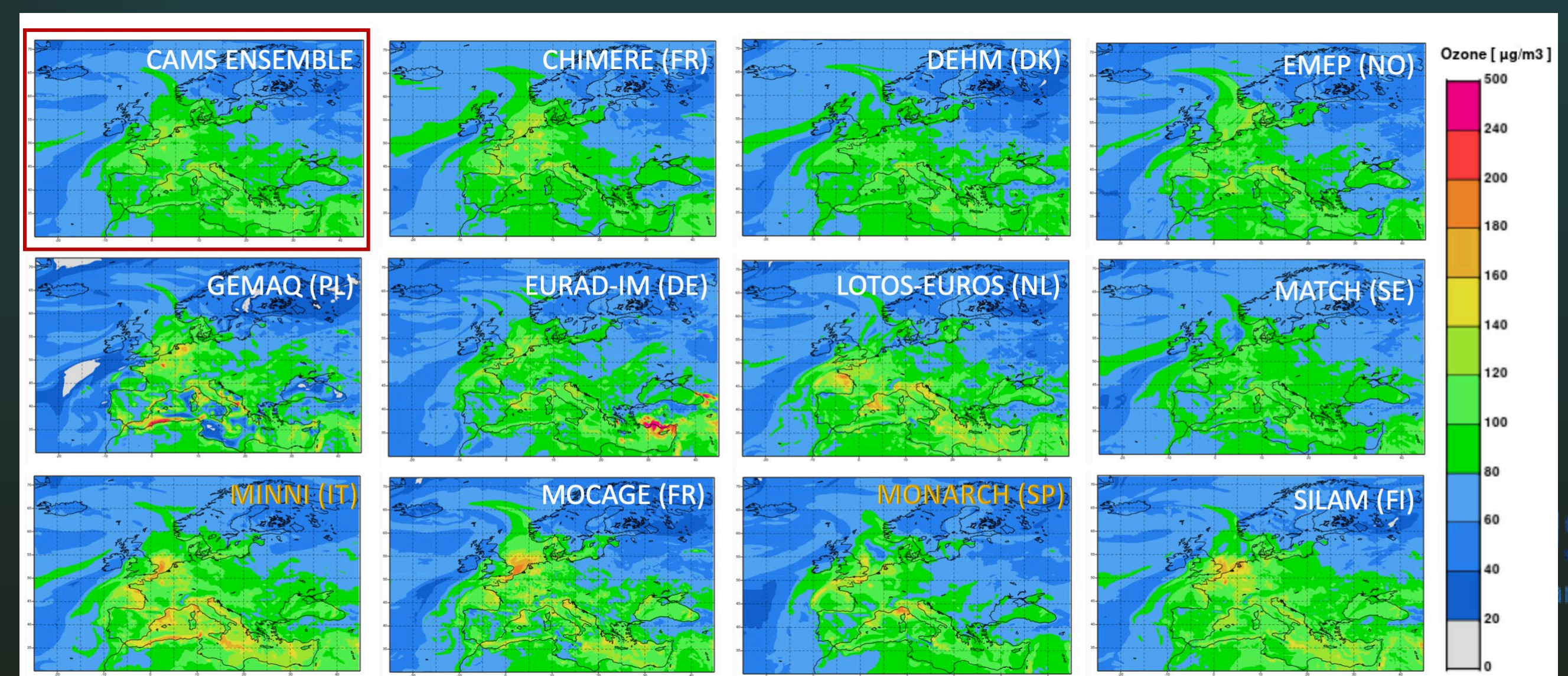


Aerospace applications, such as the study of liquid oxygen rocket engines and cooling systems, call for numerical research on real gas flows. Experimental work at high-pressure conditions typical of these systems may be prohibitive. For this reason, most of research and design in transcritical/supercritical combustion is based on numerical simulations. ENEA developed an in-house parallel code, named HeaRT, to solve the compressible Navier-Stokes equations for a reacting real gas flow in the Large Eddy Simulation framework. We currently run this code on our HPC facility CRESCO6.

The above figure shows an instantaneous temperature snapshot. It can be noted the presence of very thin flames along the liquid O₂ interface, an H₂-jet vortex shedding, inner and outer shear-layers and smaller eddies at the inner shear-layer.

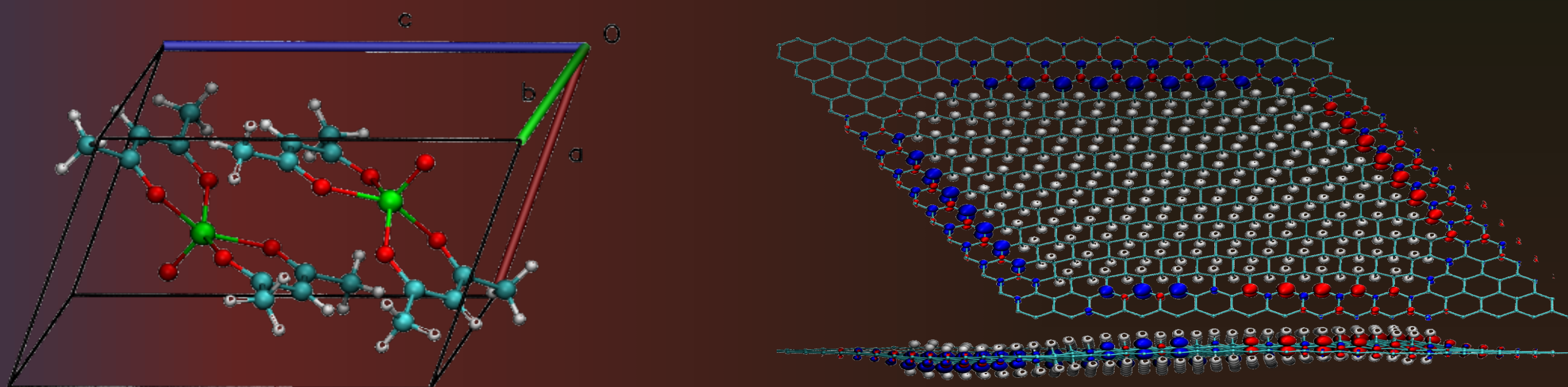
Environment: The CAMS European air quality ensemble

Starting 15 June 2022 the Copernicus Atmosphere Monitoring Service's (CAMS) European air quality forecasts added MINNI, a state-of-the-art model developed by ENEA, in the ensemble of the individual models it uses for air quality forecasts. ENEA's participation in the CAMS Regional Air Quality Production started officially in 2018, with a 3-year "benchmark" period, for setting-up and operating the forecast system in parallel with the operational real-time service.



CAMS surface Ozone forecast for Friday 17 June 2020 16UTC

Materials Science: Magnetic Systems for Quantum Technologies: Structural and Magnetic Properties from the Crystal Phase to the Adsorption on Surface



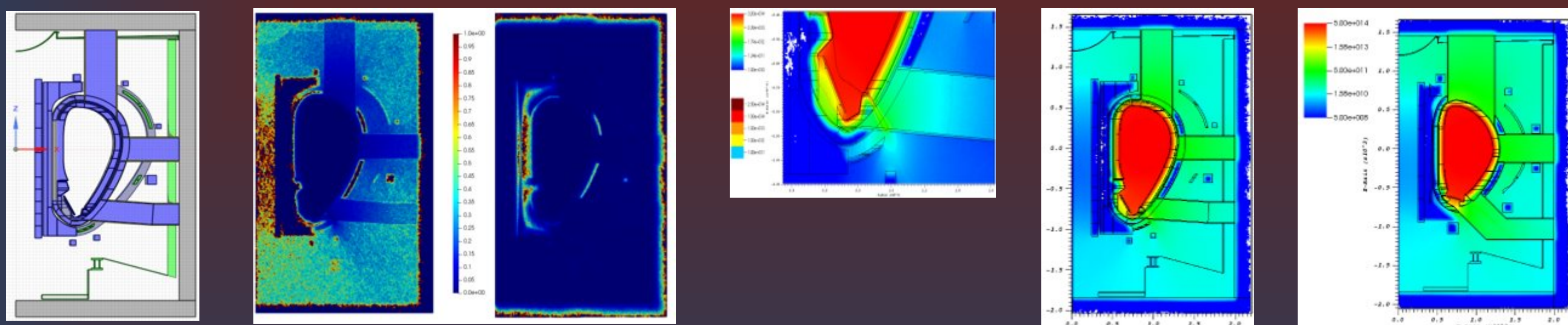
On the left, a primitive cell of [VO(acac)₂] belonging to the triclinic P-1 space group. Colour code: Vanadium = green; Oxygen = red; Carbon = cyan; Hydrogen = white. On the right, a perspective view of a graphene island showing magnetic moments on its interface with surrounding graphene structure. Below, a side view of the graphene island, the ripples formed by hydrogenation are clearly noticeable and can further perturb the band structure. Red and blue correspond to spin densities (up and down, respectively).

One of the main motivations for work in quantum information science is that several computational tasks might be executed exponentially faster on a quantum processor than on a classical processor. Recent advances in material science, specifically in the field of molecular magnetism, will help design quantum computing devices. Synthetic chemistry can play a fundamental role in modulating specific interactions between microscopic constituents as phonons and spins in order to achieve the desired molecular properties. Among the open challenges that ENEA is taking up, both the control of intrinsic properties of magnetic molecular systems and development of synthetic strategies to control the spatial distribution of the molecules at the surface and interphase, are of major importance.

Nuclear Fusion:

Exploring alternative divertor configurations for DEMO

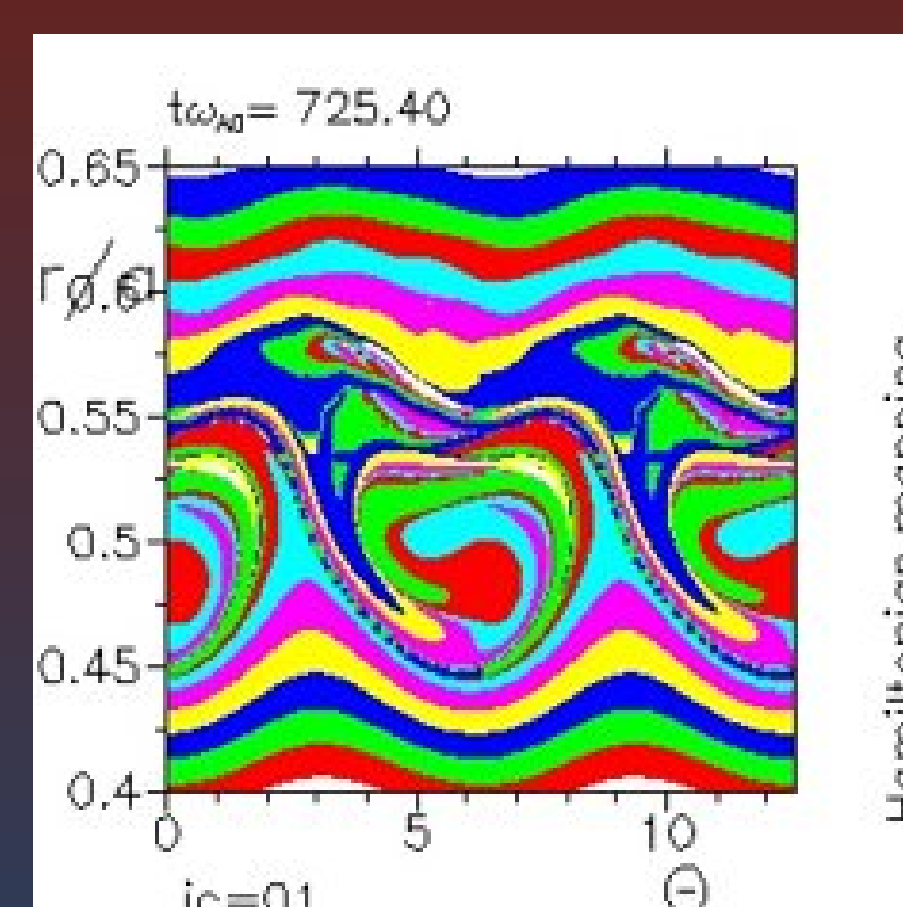
The investigation of alternative divertor configurations for DEMO aims at finding solutions to complex challenges through analyzing the physics and engineering viability of various divertor configurations. Currently, neutronic performances of three configurations are under investigation: the single null (SN), the SuperX (SX) and the X divertor (XD). ENEA has developed the MCNP model of the XD configuration.



Simulation output. From left to right: cross section of the model DEMO XD, statistical errors before and after weight windows computed by CRESCO 6, neutron flux

Non-linear dynamics of chirping Alfvén modes

Alfvén modes can be driven unstable, in Tokamak plasmas, by resonant interaction with alpha particles produced by fusion reactions and/or energetic ions produced by auxiliary heating methods. ENEA researchers have been investigating the nonlinear dynamics of chirping Alfvén modes by numerical particle simulations performed with the XHMGC code.



Test particles are represented by markers in the plane (Θ, r), where Θ is the wave phase seen by the particle, r is its radial coordinate. Due to mode-particle interaction, an island-like structure is formed in such plane, shown in the figure at a certain time.