Annual Report 2019

cmcc
Centro Euro-Mediterraneo sui Cambiamenti Climatici

CMCC Annual Report 2019

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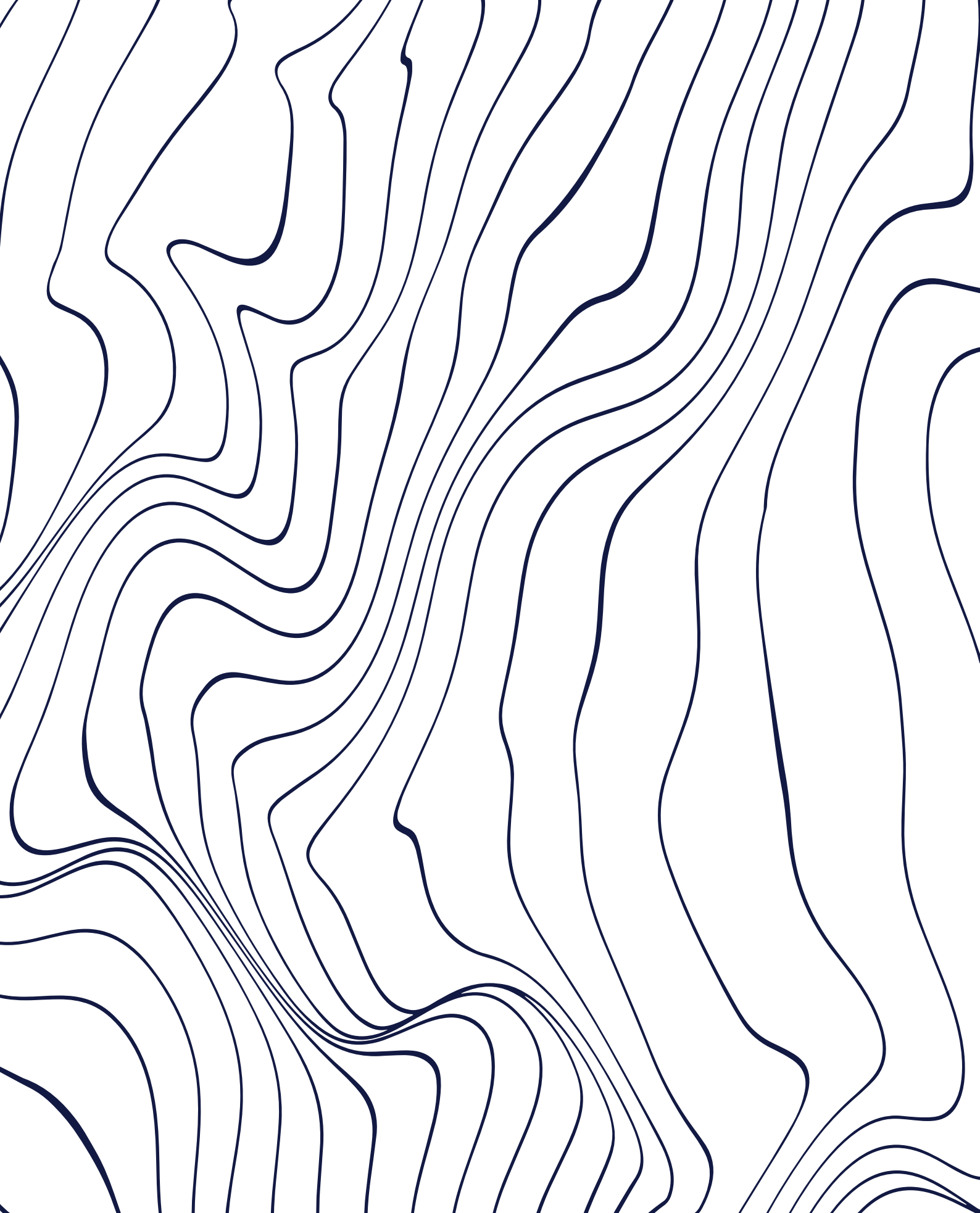
Contents



Message from the President

In 2019 the international community experienced a growing interest in climate change issues, highlighting the demand for scientific knowledge, reliable data and information to find solutions that can benefit decision-making, business, the society as a whole.

These challenges are at the core of the CMCC Foundation's mission, whose research is aimed at identifying today how the processes and the trends that are crucial in shaping the coming decades will interact with the society of the future.

2019 was a very intense year for the CMCC community, a year in which we consolidated some initiatives that represent the pillars on which CMCC wants to strengthen its role as a research actor in the field of the interactions between science and society. We adopted the new strategic plan that outlines the vision that drives CMCC, the strategic imperatives defining the issues and needs of policymakers, business leaders, and every citizen for the future. We started the process of moving the new headquarters in Lecce. CMCC will be able to host its scientific and management structures in a single building, offering a new platform to advance the dialogue with society and the surrounding community, and to provide a space for intense study, competitive research and technological innovation. The new building will also house the Supercomputing Center (SCC), the IT infrastructure which was expanded in 2019 with the installation of Zeus, the new supercomputer. SCC is a state-of-the-art technological facility and contributes to making CMCC a leading player in the international research community.

This annual report highlights a selection of the activities that in 2019 saw CMCC engaged in a wide range of topics. Research projects, scientific publications, reports, collaborations with relevant stakeholders, leading institutions, prominent decision-makers, are some of the activities, at global, national, and local scale, that testify CMCC's commitment to providing reliable and timely answers to future challenges.

Dr. Antonio Navarra
President

Highlights of 2019

9

Research divisions

125

Projects

175

People

163

Refereed papers

144

Events

A snapshot of the year seen through the CMCC's multidisciplinary activities


Future
Earth

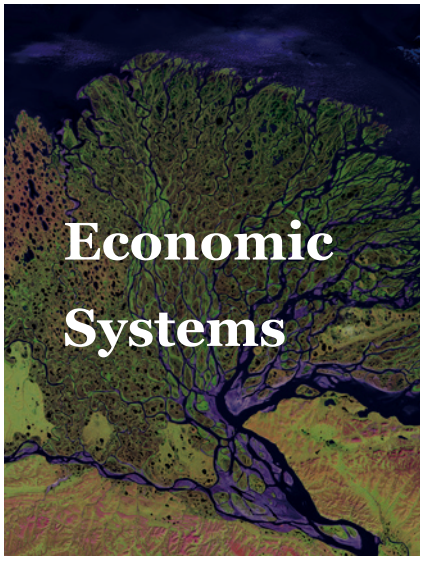

Ocean


Land


Cities &
Coasts


Water &
Food


Energy &
Innovation


Economic
Systems


Climate
Policy


Super-
computing

Future Earth

Advanced analysis of physical processes and their interactions with society, policy, and economics. The CMCC's predictive numerical models, scenarios, and comparisons between observations and simulations are the basis of our quantitative and qualitative studies, and provides science-based information on what the Planet will be like in the coming decades.

Seasonal Prediction System

Enhanced forecasts for society and the economy

Clime

Climate data and solutions

Health and Climate

Getting ready for the transition

CMIP6

Modelling the future climate

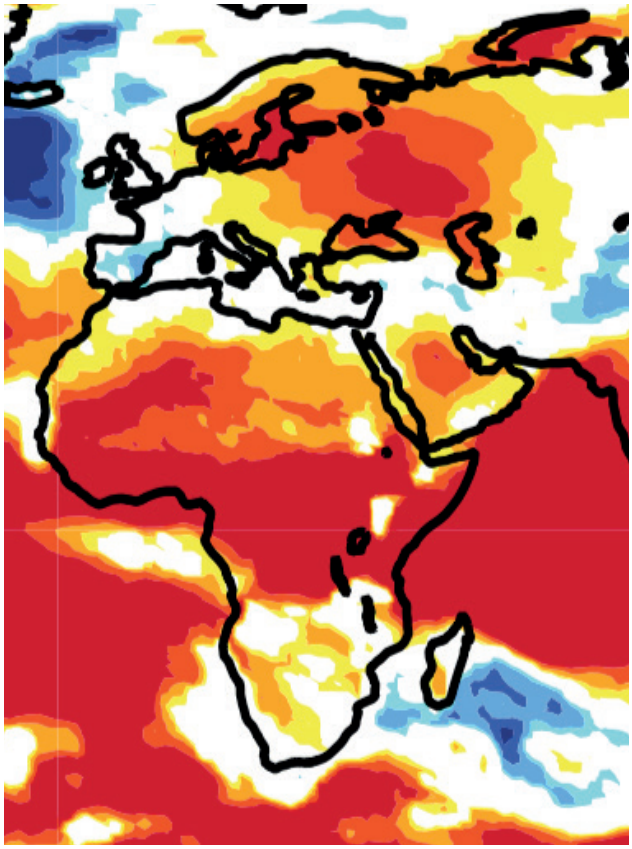
PhD and Education

Future Earth, Climate Change and Societal Challenges

The choices we make today are crucial to shaping the world of tomorrow. To properly understand the climate's role in this process, it is necessary to have an ever clearer idea of what the societies and economies of the future will be like. In 2019, CMCC's Earth System Model activities focused on using innovation and advanced research to build increasingly detailed predictive scenarios, with improved definition, in order to provide reliable and timely data with which to inform policy and strategy implementation in a variety of sectors.

Among these initiatives, the CMCC contributes to the **Copernicus Climate Change Service (C3S) multi-system forecasts.** The new European system provides operational seasonal forecasts that can be used to improve managing systems and processes in all fields in which meteo-climate variables are critical, including a wide range of socio-economic sectors such as agriculture, energy demand and supply, water management, tourism, and many others.

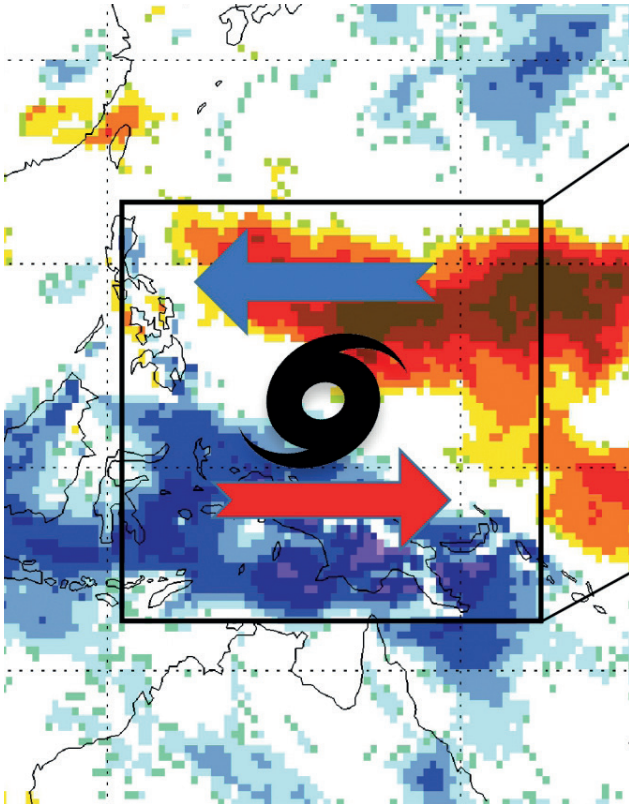
In 2019 CMCC released **Clime**, the user-friendly interactive web platform that allows users to evaluate multiple features of simulated and observed data over different geographical domains. Clime is used to support adaptation strategies, build the climatic profile of cities and regions,



realize climate scenarios for public administrations and businesses, and other diverse applications in several sectors.

CMIP6 is the latest of the **Coupled Model Intercomparison Projects**, which aim to improve our understanding of the climate and provide estimates of future climate change.

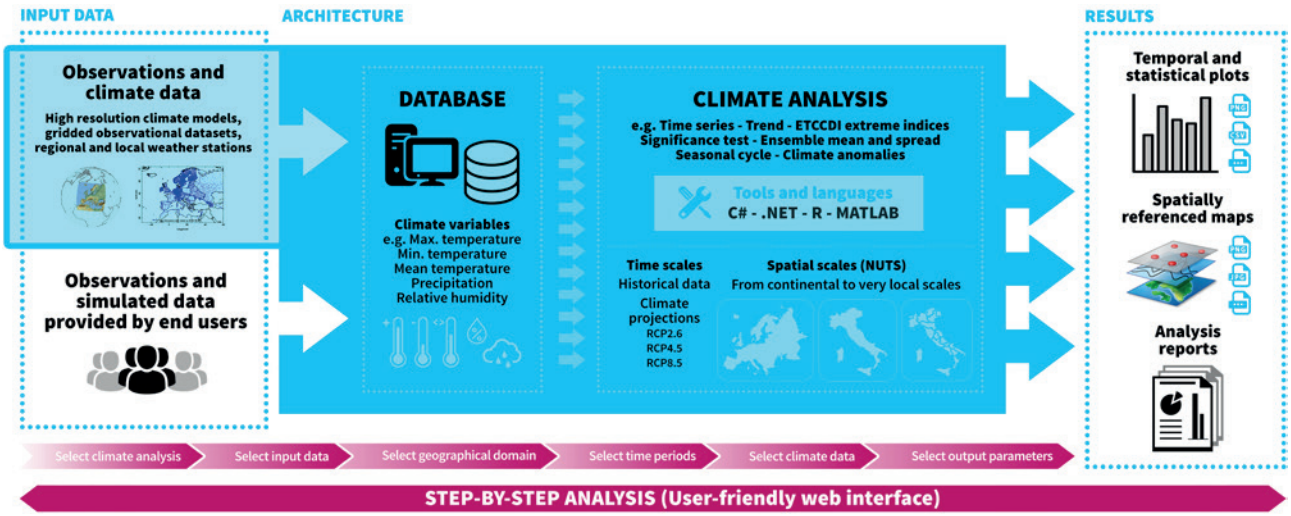
The CMCC is participating in CMIP6 with different versions of the newly developed model CMCC-CM2.



The Lancet Countdown Report 2019: Tracking Progress on Health and Climate Change presentation, organized by the CMCC in collaboration with Ca' Foscari University in Venice, focused on the future of health and the impacts of climate change. The event brought together experts to discuss the latest data, challenges, risks and opportunities, on both a global scale and with a particular focus on Italy.

Future Earth, Climate Change and Societal Challenges is a PhD program inaugurated in 2019 and created by the CMCC in collaboration with the University of Bologna and a variety of other partners. CMCC organizes Graduate Programs in collaboration with partner Universities through their Ph.D. programs. The full list is available at **https://www.cmcc.it/education-programs**

Health, industry, agriculture, energy, natural resources: our climate models and predictions inform policy and strategies on the future planet.



Ocean

The CMCC provides data, analysis, products, and tools that are available for international services and end-users at the forefront of ocean forecasts for global, regional and coastal areas. From interactive maps to participation in global policy initiatives, in 2019 CMCC research interacted with the marine environment and the socio-economic world at sea.

Ocean Forecasting System

Global, regional, and coastal

IPCC Report

Ocean and Cryosphere in a Changing Climate

Desarc - Maresanus

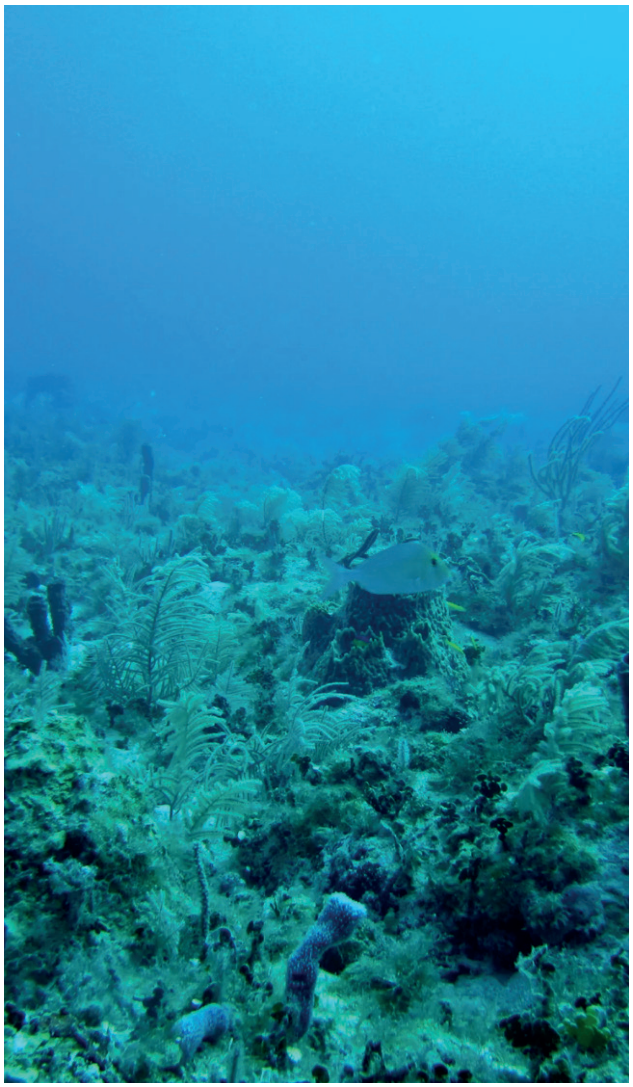
Ocean and CO_2 removal

Immerse

Ocean Modelling for the Copernicus Programme

Marine Litter

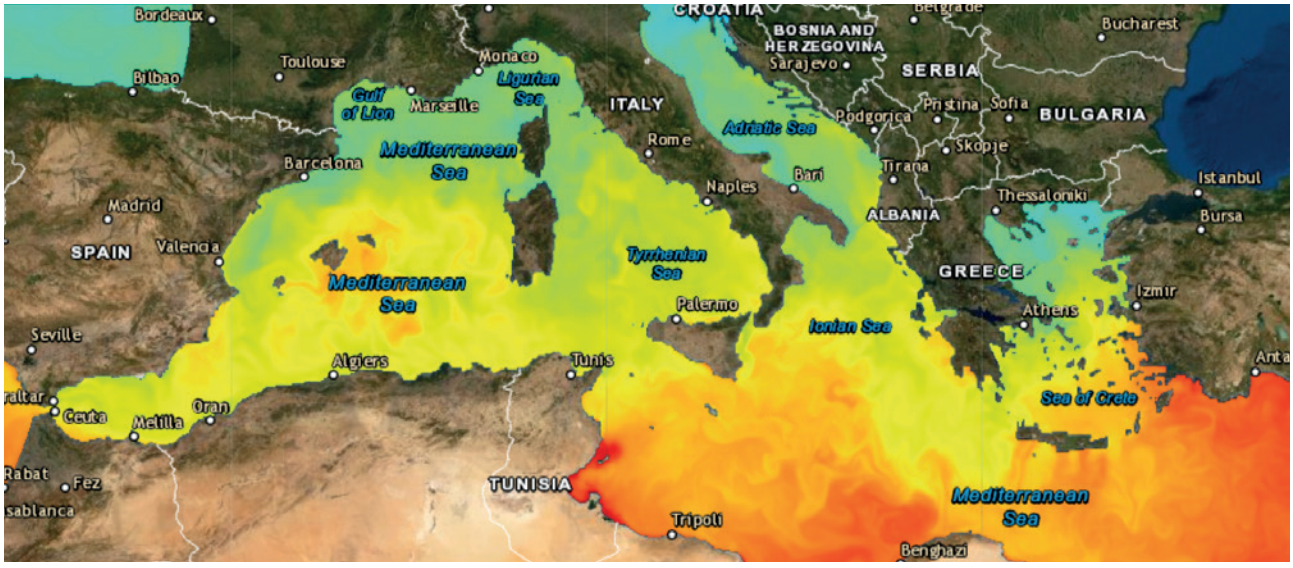
Science and Ocean Literacy



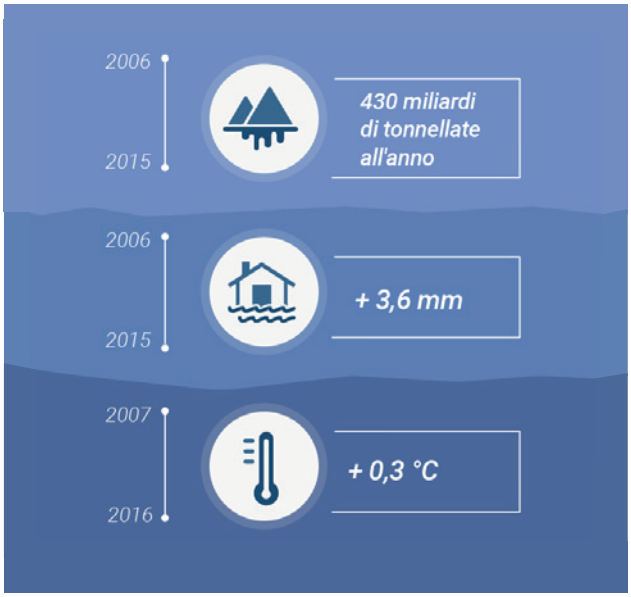
The study of the Ocean in its many aspects - including physics, biogeochemistry, and marine/coastal ecosystems - plays an essential role in supporting socio-economic activities, conservation of the environment, as well as risk management and reduction. The CMCC has enhanced its capacity to develop information produced by scientific research capable of using advanced technologies to provide forecasts.

Since 2019, the new CMCC website provides access to **ocean forecasting systems** at different geographical scales, including global, regional, and coastal. The **Global Ocean Forecasting System** makes analysis and short-term forecasts for the Global Ocean available daily. The CMCC **Mediterranean Forecasting System (MFS)** is a numerical ocean prediction system that produces, analyses and then re-analyses short-term forecasts for the entire Mediterranean Sea and its areas adjacent to the Atlantic Ocean. It is part of the **Copernicus Marine Service (CMEMS) MFS** and is available 24 hours a day, 365 days a year.

Ocean Models for the next generation of CMEMS are the focus of the **IMMERSE** project, which



was launched in January 2019. The project aims to ensure continued access to world-class marine modelling tools for CMEMS' next-generation systems whilst leveraging advances in space and information technologies, and therefore allowing it to address the ever-increasing and evolving demands for marine monitoring and prediction in the 2020s and beyond.

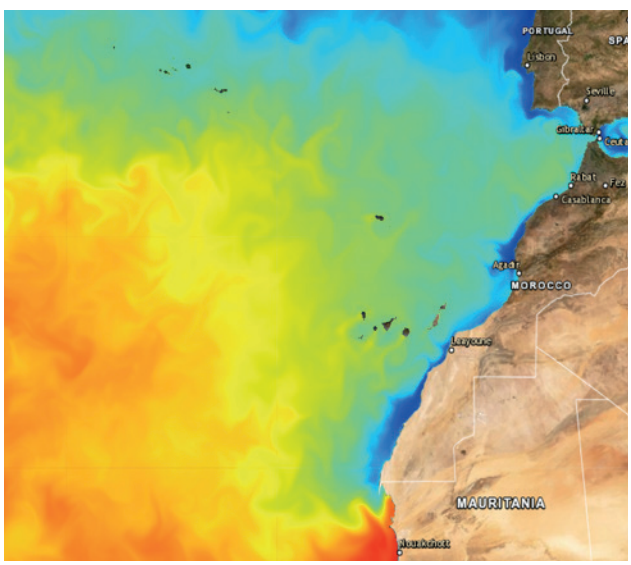


Marine Litter is considered one of the greatest threats to the Ocean. A CMCC team of scientists contributed to an assessment of marine litter pollution in the framework of the AMAre project. The CMCC's research results were published in the Marine Pollution Bulletin.

Global Ocean, Mediterranean and Black Sea, South Adriatic and North Ionian forecasts available 24 hours a day, 365 days a year.

The role of Ocean biogeochemistry in **negative emission technologies** is the topic of **DESARC-MARESANUS**, a project that started in 2019 involving the Politecnico di Milano and the CMCC Foundation with the support of Amundi and the collaboration of CO2APPS. CMCC researchers explore the contribution of alkalization processes in the decrease of ocean acidification in the Mediterranean Sea, whilst at the same time increasing CO2 removal from the atmosphere and evaluating different strategies.

On 25 September 2019, the IPCC released **the Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC)** based on an assessment of available scientific, technical and socio-economic literature relevant to the ocean and cryosphere in a changing climate. CMCC scientist, Momme Butenschön, participated in the report as a contributing author, and a series of initiatives including infographics, press releases, news, and social media activities were used to disseminate the key outcomes of the SROCC to the Italian public.



Land

Information technologies and climate-smart applications for sustainable forest management, cutting-edge models for ecosystem services, land-use analysis, and predictions in support of local/regional planning and global policies: the CMCC's research, provides state-of-the-art tools and methodologies to contribute to the SDGs with options for mitigation and adaptation.

Internet of Things

In the forest
of the talking trees

Adaptation

The future of the Alps

Forests

Solutions and perspectives to
fight climate change

Ecosystems

Impacts, risks and strategies

IPCC Report

Climate Change and Land

Land is a crucial part of the planet's future: it is under increasing pressure from climate change and human activities, involves many sectors that are responsible for a substantial part of GHG emissions, and even hosts many of the potential solutions to these problems.
The CMCC develops international research and collaborations that focus on ecosystem services, forests, land use and management, and the implementation of adaptation and mitigation options.

The latest-generation of Internet of Things technologies are used to transmit data to a cloud-based platform: the **Tree talker** is a sensor that is applied to selected trees and provides information and data related to various eco-physiological/ biological parameters. As of 2019, tree talkers are being used in several research projects, such as the study of *Xylella fastidiosa* and olive trees in the Apulia Region.

One of the most important events of 2019 was the publication of **IPCC Special Report on Climate Change and Land.** The CMCC was part of this international collaboration and provided complete coverage and dissemination of the

Report with a press release, press conference, webinar with experts, and an infographic.

Forests, climate sciences, and the research developed at CMCC were at the core of events and webinars involving international speakers and partner institutions. On the **International Day of Forests** (21 March 2019), the CMCC and the European Forest Institute met online to take stock of existing know-how, research activities, and policies implementing sustainable forest

Where technology meets ecosystems: nature-based solutions, forests, and land-use. Building the future with sustainable development and innovation.

management for climate change mitigation and adaptation. Created under the framework of the Sustainable Development Festival, the webinar **"Exploiting forest biodiversity to increase CO2 sequestration"** focused on ecosystem functions, including primary productivity, and a presentation of TreeDivNet, the largest network of biodiversity experiments in the world.

A team of CMCC scientists analyzed the likely impacts of climate change on forest ecosystems in the Russian Federation, which are expected to face high risks under future environmental dynamics. Published in March 2019 in the Journal Frontiers in Ecology and Evolution, the study **Climate Change and Geographic Ranges: The Implications for Russian Forests** provides useful information for an understanding of the potential adaptation of forests, guiding management strategies, as well as preserving ecosystem services.

The **integration of climate change in local and regional planning for a resilient land and urban management** was the focus of a study created under the European Interreg ALCOTRA-ARTACLIM project framework. The research activity provides an innovative methodology to assess vulnerability to climate change, and introduce adaptation measures and actions in planning processes.

Cities & Coasts

Increasingly precise, detailed, and reliable information on the climate in areas where socio-economic activities are being developed. CMCC's computing capabilities and advanced climate modelling are the starting points for the production of useful data and services with which to identify solutions and strategies that tackle climate change.

Floodmage

Climate modelling
of flood risk

Climate Scenarios

Planning the cities
of the future

Sea Level Rise

Mediterranean coasts and
prevention of natural disasters

BlueHealth

Water-based environments,
health, and wellbeing

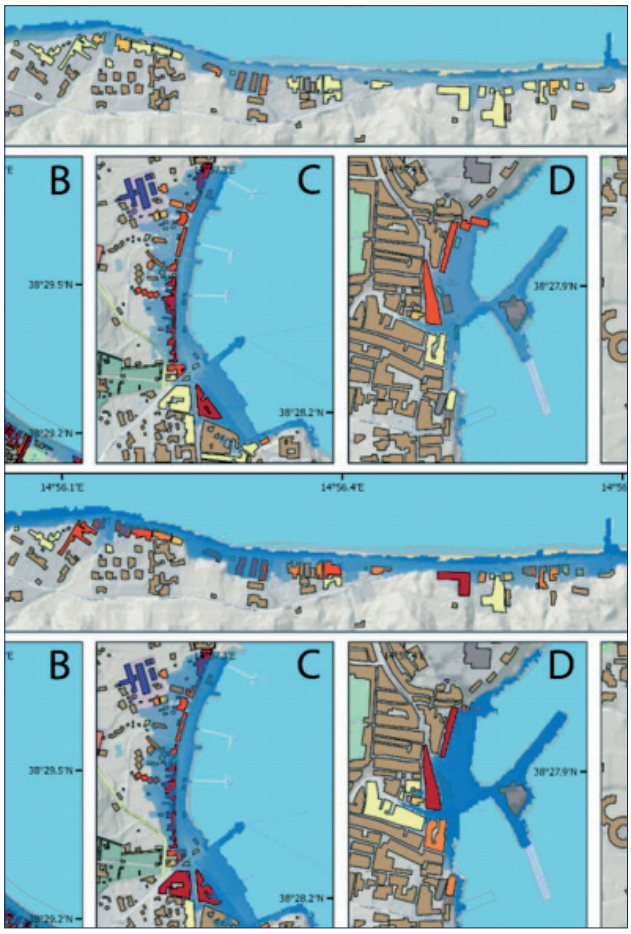
Energy

Urbanization and the rush to air conditioning

Cities and coasts are where most socio-economic activities take place. They are also where important factors contributing to climate change develop and where their impacts have direct and immediate effects on people's lives. CMCC research has developed models with a capacity to produce detailed data that is useful for risk assessment of extreme events, adaptation strategies, and policy planning for the sustainable development of coastal areas and smart cities of the future.

While growing urbanization increases pressure on land, climate variability is expected to affect both the frequency and magnitude of extreme meteorological events that trigger floods. **FloodMage** is a climate service tailored to the needs of decision-makers to help them manage the risks triggered by flood events of different kinds (pluvial, fluvial, and coastal). FloodMage is developed by a team of CMCC scientists under the Horizon 2020 project **CLARA – Climate forecast enabled knowledge services.**

Among its multidisciplinary activities, the CMCC provides climate scenarios for the future of cities, assessments of the impacts of climate change on urban settlements, and support for suitable adaptation measures. In this field, for example, the CMCC has contributed to the **Report to the French Prime Minister and the French Parliament "Des Solutions Fondées sur la Nature pours'adapter au changement climatique"**, published in December 2019 by the Observatoire National sur les effets du réchauffement climatique (ONERC).

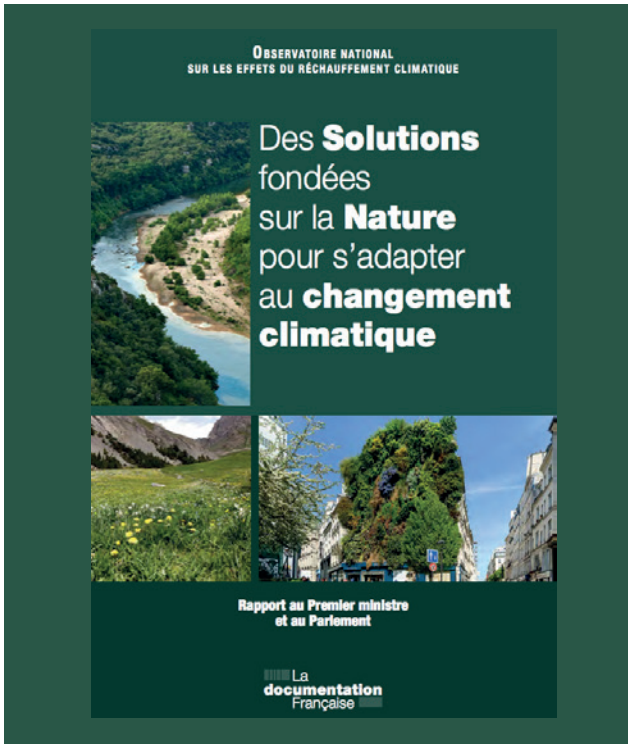


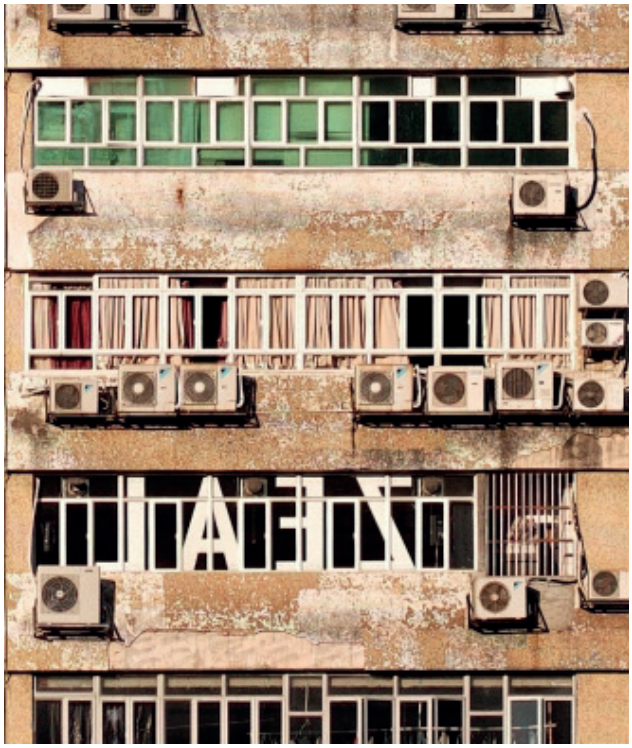
The SAVEMEDCOASTS2 project responds to the needs of people and assets in the prevention of natural disasters in **Mediterranean coastal areas that are experiencing sea-level rise and climate change.** The project aims to integrate climate change scenarios into disaster risk assessment and disaster risk management to increase the availability and use of scientific knowledge on disasters by developing a multi-hazard approach for risk assessment, and macro-regional risk assessment integrating climate change scenarios.

Urban areas, inland waterways, and coastal margins are the focus of **BlueHealth**, a collaboration among scientists, local communities, the private sector, and policymakers that seeks to understand how these environments affect health and diseases. The project brings together a multi-disciplinary team of experts from a variety of European Union countries, and across the environment, health, and climate sectors.

As urbanization continues, climate change will require an increasing amount of households to rely on air conditioners to adapt to rising temperatures, thus generating even more GHG emissions. A study led by the CMCC and published in Environmental Science and Policy analyses, **for the first time, the dynamics which bring households to adopt air conditioning and thermal insulation** in 8 different countries, of which 5 in Europe, from 1990 to 2040.

Natural hazards, sea-level rise, coastal environments, health, smart cities: the CMCC contributes to the sustainable development of cities and coasts.





Water & Food

The water we drink, the food we eat, and the food production system are all elements that interact with socio-economic factors at the global and local level, involving complex processes such as migration, conflicts, GHG emissions, and agribusiness. The CMCC provides insight into these challenges with top-level international activities and tools.

Decision Support Tool

Drinking water resources in Europe

Agriculture

Managing irrigation options

Food & Migration

The geopolitical nexus

SDGs

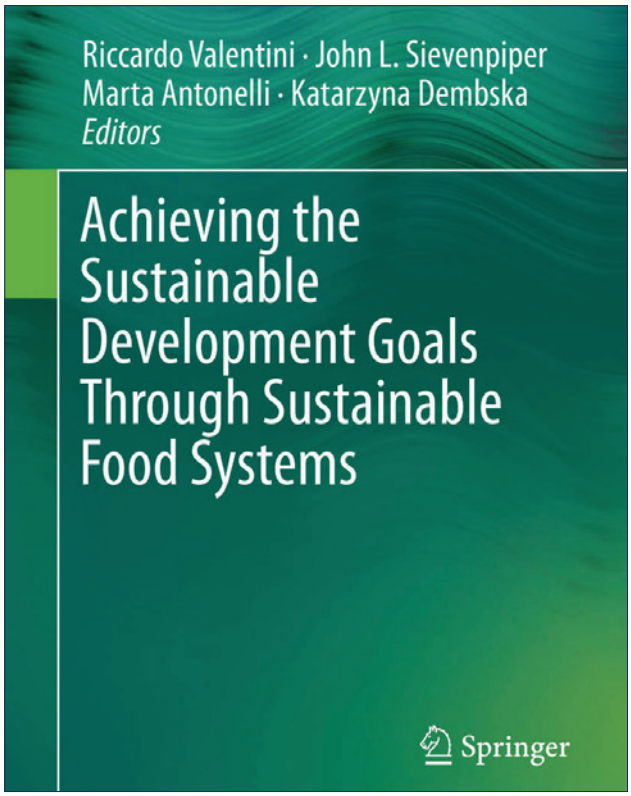
A sustainable food chain

Hazelnuts

The economic value of subseasonal forecasts

Water management, food production, and security are among the major challenges that come with climate change. For example, the food production chain is responsible for a large part of GHG emissions, and the availability and distribution of water and food resources is closely interrelated and can exacerbate conflicts and impact migration. The CMCC develops research and tools that can support choices and strategies for a sustainable management of water and food.

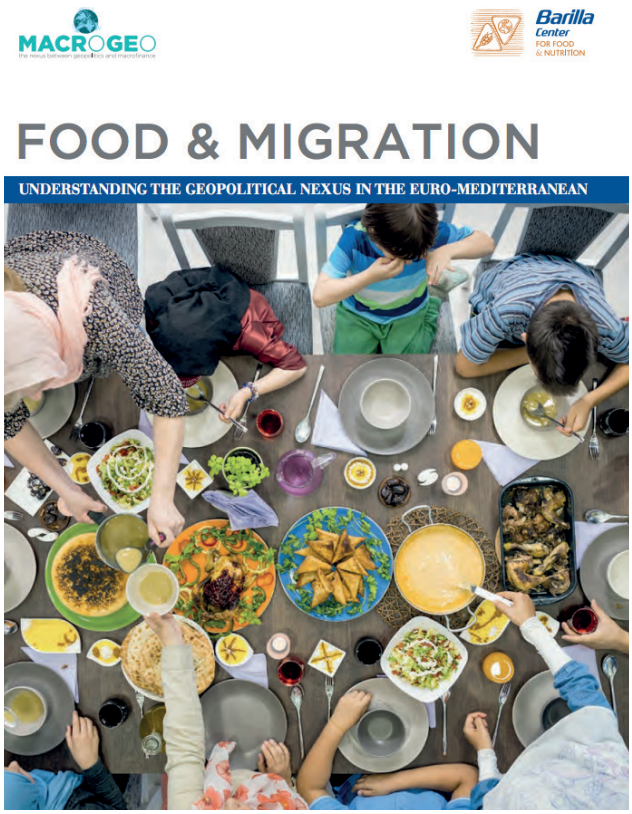
Among the tools, **Goware is the Decision Support Tool** that implements **innovative practices in drinking water** protection and the mitigation of flood and drought risks. It comes with a catalogue of best management practices to help handle water issues in different land use contexts.



Climate change projections indicate that precipitation levels are likely to decrease in regions where agriculture needs irrigation, which will further exacerbate existing problems of limited water resources. Innovative analysis and tools aimed at delivering forecast estimates for evapotranspiration were addressed within the project CITRUS in the public debate **Forecast evapotranspiration: fundamental information for agricultural irrigation management** with international speakers from the CMCC and the University of California-Davis, USA.

The CMCC collaborated with the Barilla Center for Food and Nutrition and MacroGeo to develop a geopolitical analysis of flows and trends in the current and future interlinkages between food and migration, with a focus on Mediterranean countries. The report **Food & Migration Understanding the Geopolitical Nexus** in

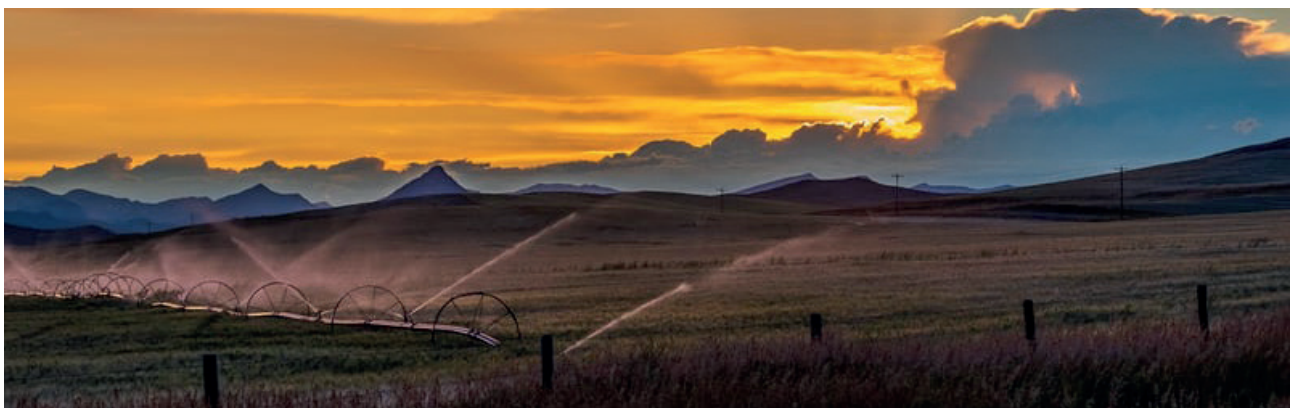
the Euro-Mediterranean is a research tool that combines geopolitical analysis (resources, flows, migratory routes) with an analysis of food and nutrition through a series of essays. The report was discussed in a dedicated event in Milan in February 2019.



Achieving the Sustainable Development Goals Through Sustainable Food Systems offers a systemic analysis of sustainability in the food system, taking the Sustainable Development Goals of the 2030 Agenda of the United Nations as its framework. The book, realized in collaboration with the CMCC, focuses on how sustainability can be achieved along the entire food chain and in different contexts.

Unexpected spring frosts can lead to significant losses in agribusiness. In turn, using sub-seasonal forecasts can bring added economic value of up to 60% to those involved in hazelnut farming. **CMCC research on the topic**, that focuses **on case studies**, was published in the journal Weather and Forecasting, and addresses how anticipating extreme events with the potential for compromise production can have a beneficial effect on a global scale.

Reliable forecasting systems applied to water and food can be essential to understanding the future of society and economies on a global and local scale.



Energy & Innovation

It's not only about decarbonization. It's about reducing CO_2 emissions whilst ensuring positive effects on the economy, people's well-being, and policies. From technology to models and scenarios, the CMCC develops advanced research that takes all options for building a sustainable future into consideration.

Global Analysis

Future energy demand

Efficient Buildings

The challenge
of local energy governance

Mitigation

Removing CO_2
from the atmosphere

Adaptation

Climate change and the
European energy system

ERC

Disruptive digitalization for decarbonization

Decarbonization is the imperative emerging from climate science and is central to many energy policies and practices. The analysis of pathways to a zero-carbon society is one of the CMCC's most advanced activities and involves complex inquiry into the most innovative technologies, future scenarios of energy production and demand, and taking into account industrial processes and people's welfare.

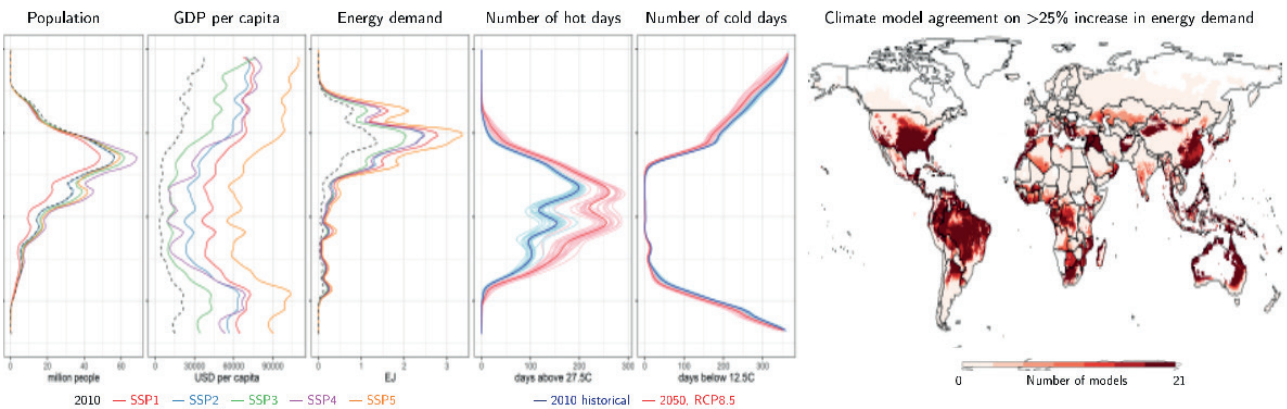
The future demand for energy and the need to cool both public and private spaces is the focus of a global analysis that integrates: temperature projections from 21 climate models, population forecasts, and economic projections for five socioeconomic scenarios. **The study, Amplification of future energy demand growth due to climate change**, published in Nature Communications, includes research that is at the core of ENERGYA, the project funded by the European Research Council (ERC). The authors apply a statistical model to calculate changes in demand for three fuels and four economic sectors to determine how energy demand would shift relative to today's climate under modest and high-warming scenarios around 2050.

An international team of researchers shows the potential of **Direct Air Carbon Capture and Storage (DACCS), a new technology for removing CO2 directly from the atmosphere**, in limiting global temperature rise and lowering the costs of achieving the Paris objectives. The study is published in Nature Communications and gives a detailed description of the critical issues related to energy consumption, costs, and the materials necessary for an extensive roll-out of these technologies in global mitigation strategies.

European Research Council

Established by the European Commission

CMCC and RFF-CMCC European Institute on Economics and the Environment scientist, Elena Verdolini, has been awarded the prestigious ERC Grant for the project **2D4D - Disruptive Digitalization for Decarbonization.** Two key societal challenges, three key disruptive digital technologies, and a focus on the interplay between digitalization and decarbonization: the project

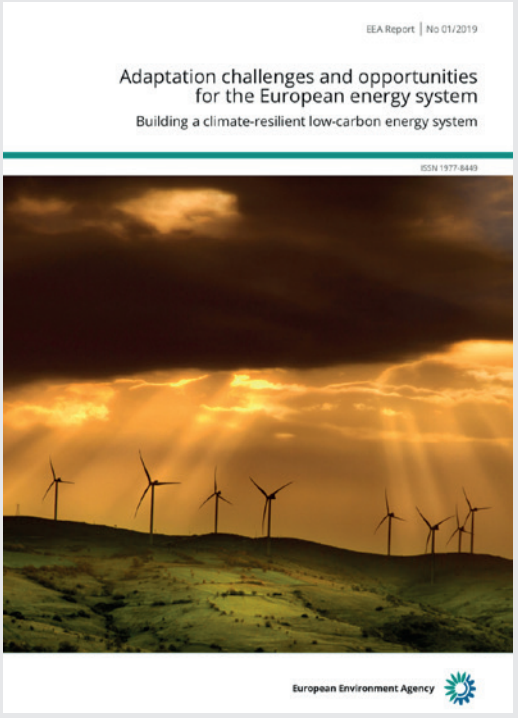


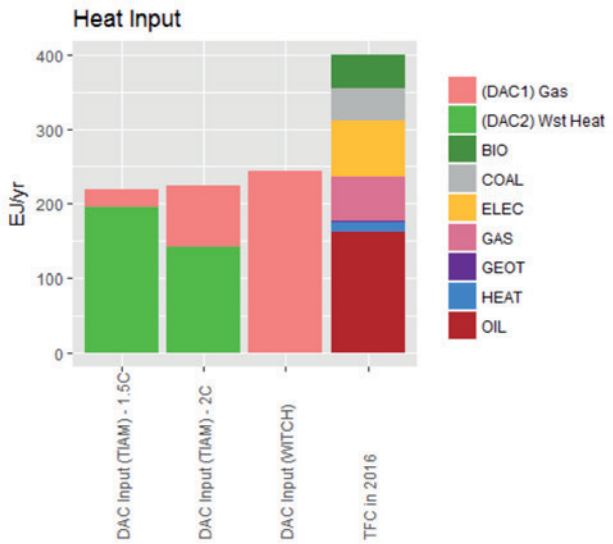
Using science, technology, and innovation to understand the energy needs of the future is among the CMCC's core activities. Zero CO_2 is the key.

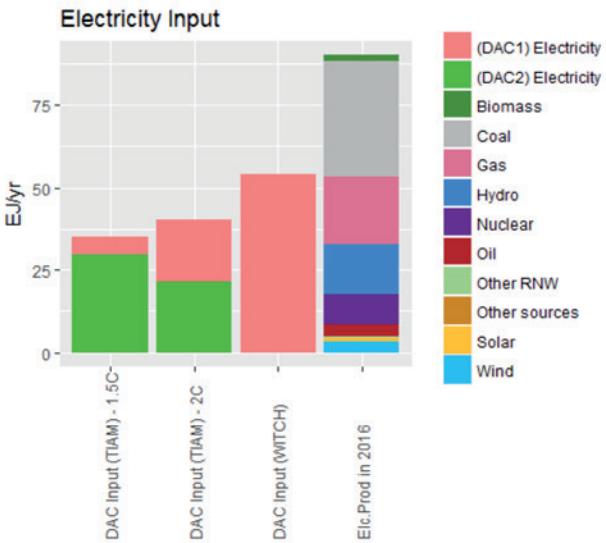
analyses energy demand, mitigation potential, and impacts on the labour market, including competitiveness, distribution of wealth and access to services.

All aspects of Europe's energy system, from the availability of energy sources to energy consumption, are potentially vulnerable to climate change and extreme weather events. CMCC scientists contributed to the European report **Adaptation challenges and opportunities for the European energy system.**

The final event of the Efficient Buildings Community, **supported by the MEDNICE partnership**, took place in Brussels in October 2019. A unique chance for public administrators to learn from peers so that they can better design, implement, and finance efficiency measures in public buildings and neighbourhoods around the Mediterranean.







Economic Systems

GHG emission pathways, technological innovation, individual energy consumption patterns, the financial system, income distribution and inequalities are all intertwined with the climate system. From global to local, CMCC research on socio-economic drivers and opportunities for new, sustainable development models.

RFF CMCC European Institute on Economics and the Environment

Research Insights, Policy Solutions

COACCH

Co-designing the assessment of climate change costs

Green Economy

The costs of climate inaction in Italy

Finance

Impact of climate change on banks

Mitigation

Zero CO_2, the handbook

The high level of multidisciplinarity in CMCC research, use of key global integrated assessment models, and international collaborations with distinguished institutes in the study of the economics of climate change led to the realization of a series of initiatives, publications, and events related to the study of socio-economic factors that interact with the climate system and the analysis of the costs of climate change impacts.

Among these initiatives, **RFF-CMCC European Institute on Economics and the Environment** is the multidisciplinary collaboration between the US think tank Resources for the Future (RFF) and CMCC. With over 50 researchers from 13 different countries, the new Institute develops analysis and studies that aim to ensure sustainable development, limit climate change and its impacts, and understand the social dimension of environmental economics. It was inaugurated on 11 June 2019 at its headquarters in BASE Milano with a public event featuring the Nobel Prize laureate in economics, William Nordhaus, and the participation of representatives from RFF, CMCC, the European Commission, and experts from academic and business circles.

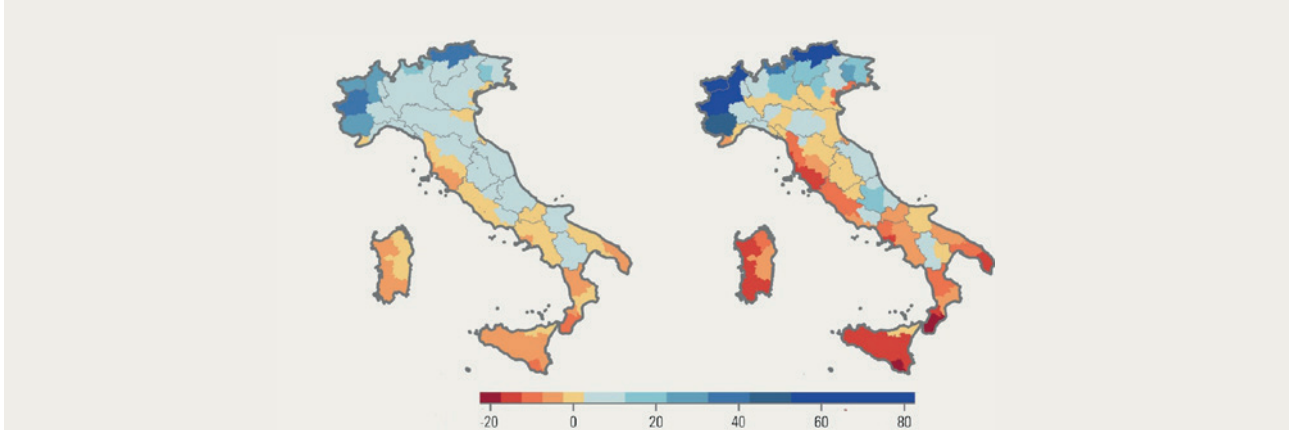
The main aim of **COACCH** is the advancement of knowledge regarding climate change impacts and policy that can be used directly by stakeholder communities. The project develops an integrated and interdisciplinary modelling investigation improving the "downscaled" assessment of risks and costs of climate change and exploiting the deep engagement of stakeholders to co-design its research endeavour. Coordinated by the CMCC, COACCH gathers 14 of the top research institutions in the EU.

The financial system, costs of inaction, the zero-emissions society: climate change economics is critical to sustainable development.

An innovative study investigates **the costs of climate inaction in Italy.** More in detail, CMCC researchers address the economic consequences of a changing climate with a focus on the Italian territory, providing updated estimates based on the analysis of thousands of high-resolution observations and a review of the most recent scientific studies. The study is part of the Report on the State of the Green Economy 2019.

In October 2019, Nature Climate Change published a study that highlights **how climate-related damages impact the stability of the global banking system.** By focusing on the consequences of climate change and climate-related extreme events on the financial system, authors show how climate change will increase the frequency of banking crises and that rescuing insolvent banks will cause an additional fiscal burden and increase in public debt relative to GDP.

The CMCC is part of the international research team dedicated to outlining support pathways for the Paris Agreement climate goals, address climate change, and achieve sustainable development. In an article published in March 2019, a team of scientists and members of the Deep Decarbonization Pathways Project (DDPP) demonstrates how to build concrete **strategies towards zero emissions**, that go hand-in-hand with sustainable development, in 16 different national contexts.



Climate Policy

International negotiations, an active role in the IPCC, scientific support for mitigation, adaptation, and risk management policies and strategies in Italy, Europe, and the world at large. In 2019, the CMCC has consolidated its role as a translator of research results into science-based messages that can inform decision-making processes.

Adaptation

The map of resilient Italy

IPCC AR6

Contributing mitigation policies

COP 25

At the UN Climate Conference

Europe

The interface between science and adaptation policy

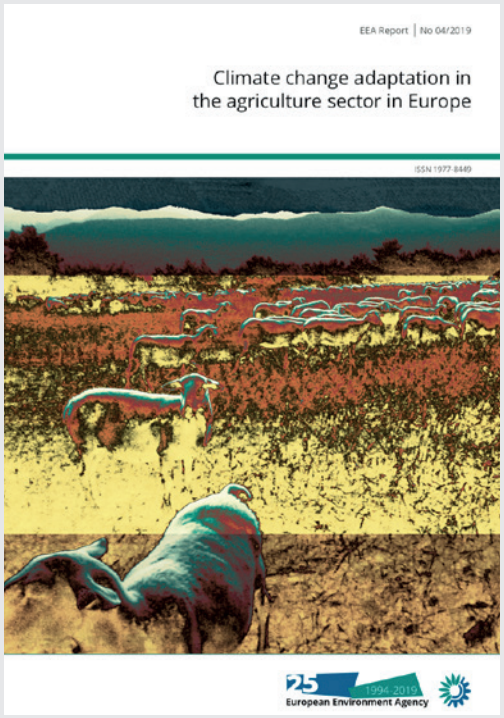
Mediterranean

Climate change and challenges

The CMCC is an active player in providing the results of scientific research to policymakers. The Center's consolidated activity in building scenarios through the most up-to-date technologies and methodologies, as well as experience in integrating climate sciences into socio-economic projections, are the pillars of the CMCC's contribution to the definition of mitigation, adaptation, and risk assessment and management policies in support of decision-makers and other stakeholders at a global, national, and regional level.

A **map of resilient Italy** emerges from the study "Constructing a comprehensive disaster resilience index: The case of Italy" and ranks Italian municipalities according to their resilience capacity. The report is a step forward in creating public understanding of how resilience capacity is spread throughout the country. It provides new, reliable, and essential information for policymakers in the design of disaster risk reduction and climate change adaptation policies.

The IPCC is now in the **Sixth Assessment Report (AR6)** cycle, which involves the most comprehensive and updated assessment on climate sciences. Three CMCC and RFF-CMCC European Institute on Economics and the



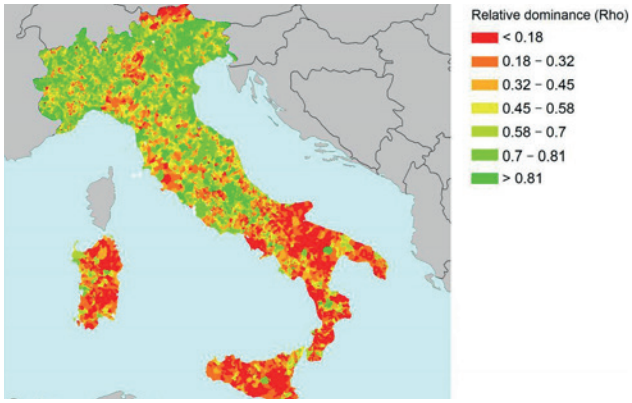
Environment scientists are contributing to the report as lead authors of the WG3 Mitigation on Climate Change. More specifically, Valentina Bosetti is contributing to Chapter 1 "Introduction and Framing", Massimo Tavoni, Chapter 3, "Mitigation pathways compatible with long-term goals", and Elena Verdolini, Chapter 16, "Innovation, technology development, and transfer".

The CMCC intensifies its collaboration with policymaking at the international, national and local level by providing science-based knowledge.

At COP25 in Madrid, Spain, the CMCC contributed to the international debate during the climate negotiation process. Hosted in the Italian Pavillion, the CMCC organized and took part in a series of events addressing multidisciplinary topics, such as energy and decarbonization policies, climate innovation and finance, adaptation strategies, standardized observations, and the insight of climate sciences for the support of transitions to low-carbon and climate-resilient societies.

The CMCC coordinates the **European Topic Centre on Climate Change Impacts, Vulnerability, and Adaptation (ETC/CCA)**, a consortium of 15 European institutions that supply thematic expertise to the European Environment Agency (EEA) working to support policy development and implementation across Europe. ETC/CCA contributes to a range of EEA thematic and assessment reports that are realized with the contribution of CMCC scientists.

The scientific collaboration between Israel and Italy fosters cooperation and future joint research between the two countries. CMCC scientists took part in the workshop Mediterranean climate: changes and challenges. Held in Tel-Aviv, Israel, the workshop focused on the mechanisms of climate variability and observed trends, current and expected extreme events across the **Mediterranean region, the effects of climate change** on the agricultural sector, and economic impacts.



Supercomputing

World-class technological infrastructure for cutting-edge research in the field of climate sciences. High-Performance Computing and Information Technology puts the CMCC at the centre of a globally distributed infrastructure by providing workflows, tools, and knowledge to address research, industry, and societal challenges.

Zeus

The renewed infrastructure

EOSC-Pillar

European Open Science Cloud

IS-ENES3

European e-infrastructure for Earth System Modelling

ESiWACE2

Unprecedented weather and climate predictions

OFIDIA2

Prevent and fight wildfires with IT

SUPERCOMPUTING CENTER

12.528 cores

1.202 TFlops

theoretical peak performance (1TFlop = 1,000 billion operations per second)

over **4 PetaBytes**

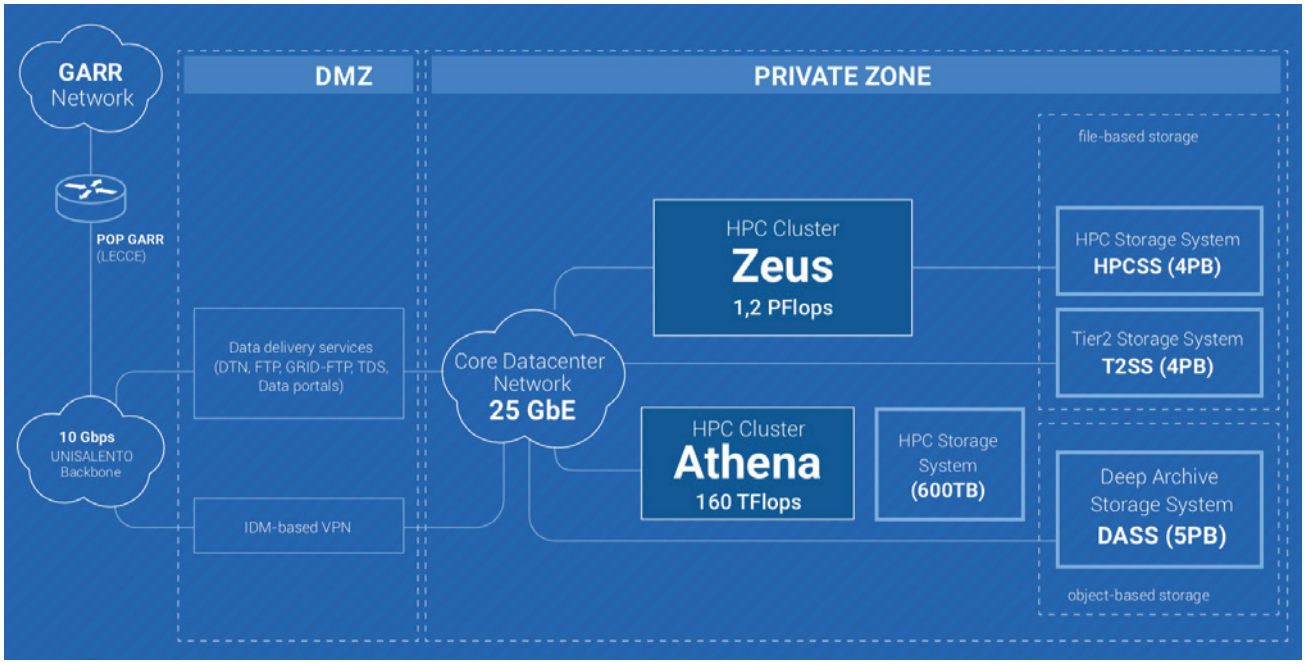
storage system capacity

5 PetaBytes

Tape Library (archiving system)

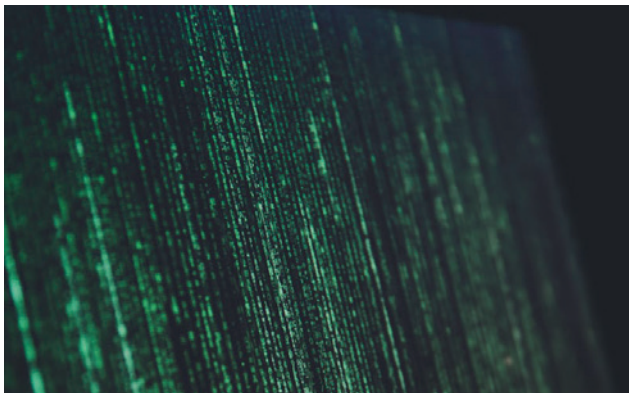
Zeus, the parallel scalar supercomputer installed in 2019, is the latest upgrade to the CMCC Super Computing Center found in Lecce, Italy. It provides an improvement to the CMCC's technological infrastructure, efficiency, productivity, and ability to address increasingly advanced challenges in the cutting-edge and highly interdisciplinary arena of climate science. Investigating the interaction between Artificial Intelligence and scientific research; developing machine learning methods applied to climate simulation and forecasting; applying technological innovation to enhance and improve monitoring, prevention and management of risks arising from natural disasters; as well as participating in international programs for the optimization of systems and environments for the use and storage of data, and for the realization of climate models are all aspects that have marked significant milestones in the CMCC's Supercomputing and IT activities throughout 2019.

Zeus and the entire CMCC computing infrastructure contribute significantly to the IPCC coordinated



climate scenario experiments. The CMCC has also been the protagonist of a series of initiatives that confirm its leading role in European and global research.

One of which is **EOSC-Pillar**. This project provides a virtual environment with open and seamless services for storage, management, analysis and re-use of research data, across borders and scientific disciplines in Europe.

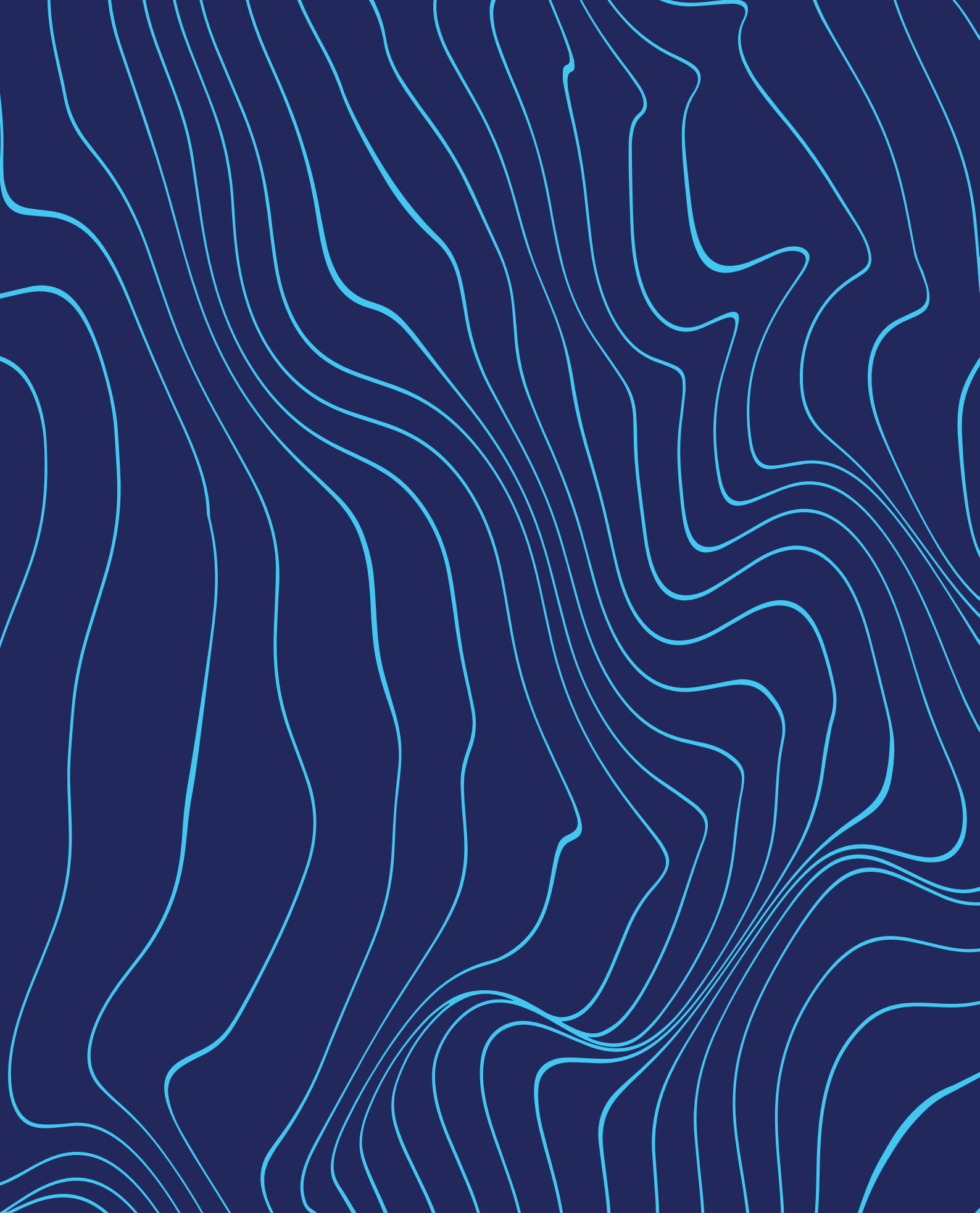


AI, machine learning, IT, climate simulations and predictions: supercomputing is at the core of the CMCC's cutting-edge research.

Data postprocessing, analytics and visualisation at scale in the weather and climate domain is the leading contribution of CMCC to **ESiWACE2**, the project that kicked off in March 2019 and provides leading models that can make efficient use of the largest supercomputers in Europe and run at unprecedented resolution for high-quality weather and climate predictions.

A network of technologies – including HD video cameras, wireless sensor networks and infrastructure – and scientific knowledge are the main features of **OFIDIA2**, the research project that aims to develop environmental protection measures to prevent and fight wildfires in forests and rural areas. Engaging public opinion and young generations is a crucial part of the project. Therefore, schools were involved in a contest that asked students to deal with the design and set-up of a weather station based on the Arduino technology.

IS-ENES, the distributed infrastructure of the European Network for Earth System modelling, and **Earth System Grid Federation** were the protagonists of a high-profile meeting that focused on user requirements, solutions, gaps and challenges concerning the compute and analytics services in the climate change domains.



2019 in Numbers

PEOPLE

FTE (full-time equivalent)

175 People at **CMCC**

86% Research Area

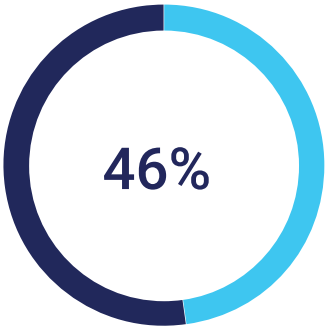
14% Services for Research

50% Under **40**

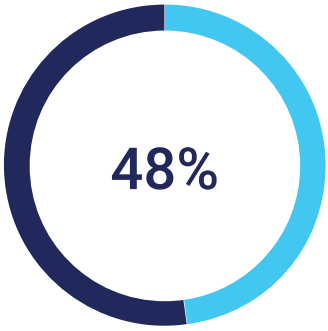
88% Under **50**

46% **Senior** positions

WOMEN AT CMCC



of the people at CMCC



with a senior role

To submit a CV to the CMCC Human Resources Office, join the Job Application Manager:
www.cmcc.it/jam

PUBLICATIONS

View the full list of publications: **www.cmcc.it/publications**

163 *refereed papers published*

EDUCATION AND TRAINING PROGRAMS

View the complete list of Education and Training Programs:
www.cmcc.it/education-programs

6 *PhD Programs in collaboration with partner Universities*

168 *Students*

1 *Master of research*

RESEARCH PROJECTS

125

Running Projects in 2019

365

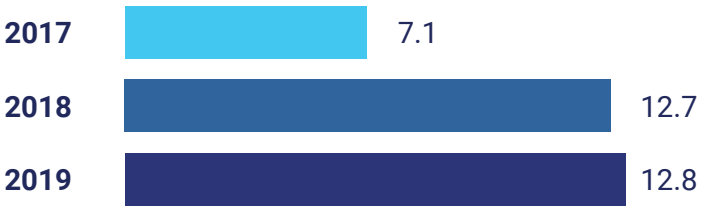
CMCC Projects Portfolio

50%

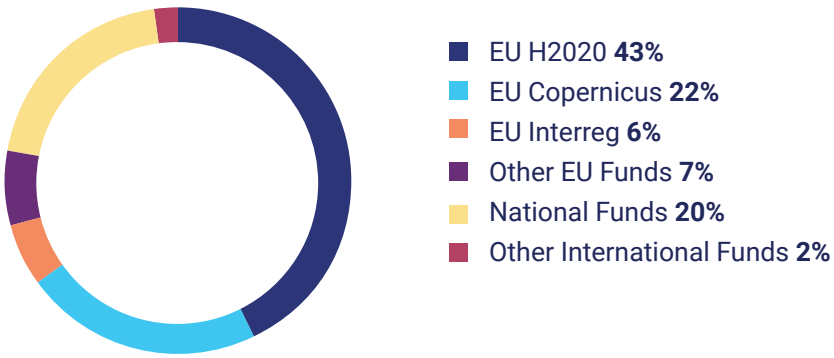
CMCC as Lead Partner and Coordinator

FUND RAISING CAPACITY:

The CMCC's capacity to attract new funds over the last three years. These funds are over and above the annual operating grants (Milion €).



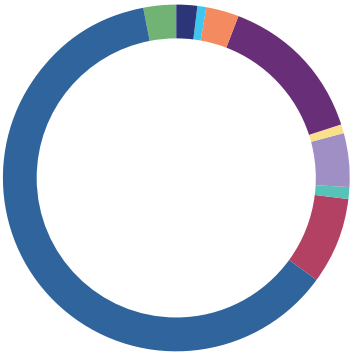
SOURCE OF FUNDING (PER BUDGET) LAST 5 YEARS



CMCC PARTICIPATION IN H2020 WORK PROGRAMS

- Societal Challenges **73%**
- Excellent Science **20%**
- Industrial Leadership **7%**

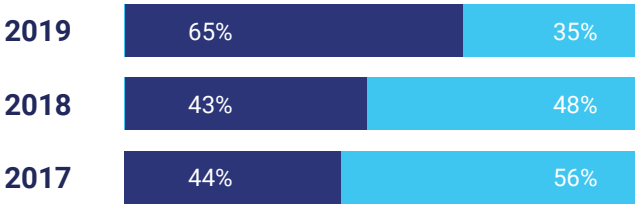
CMCC PARTICIPATION IN H2020 WORK PROGRAMS



- ERC **2%**
- Future and emerging technologies **1%**
- Marie Skłodowska-Curie actions (MSCA) **3%**
- European research Infrastructure **14%**
- ICT **1%**
- Space **5%**
- Health, demographic change and wellbeing **1%**
- Food security **8%**
- Climate action, environment, resource efficiency and raw materials **62%**
- Secure societies **3%**

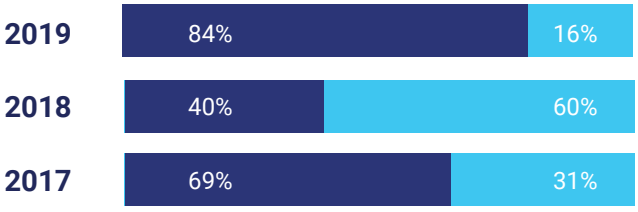
Type of funding % per n. projects

Grant Service



Type of funding % per budget

Grant Service



EVENTS

144 Total events

30 Webinars that involved

85 Speakers and experts

34 International institutions

2,500 Participants

WWW.CMCC.IT

+10% *Page views*

+55% *Facebook Fans*

+44% *LinkedIn followers*

+36% *Twitter followers*

+44% *Mentions in the media*

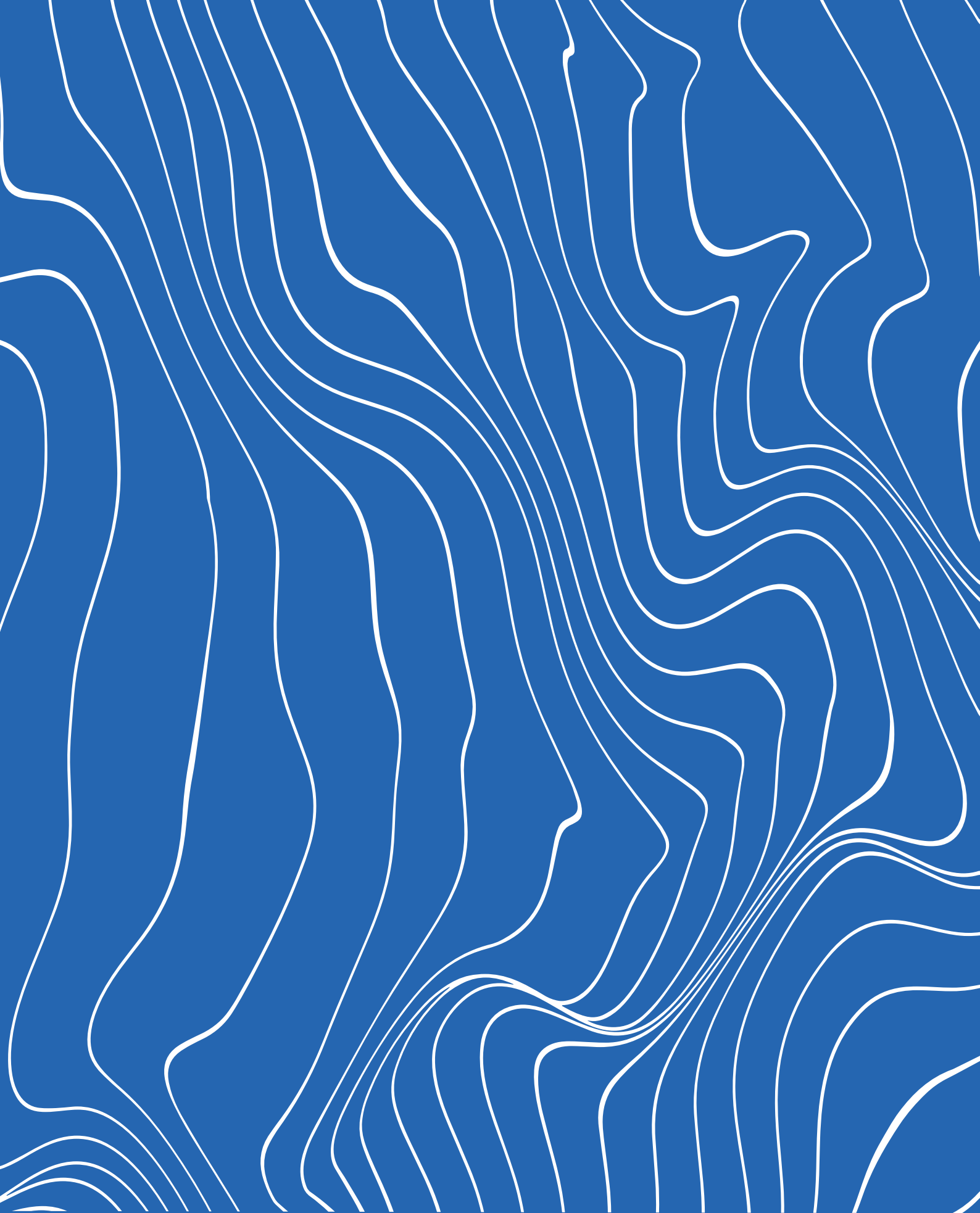
Compared to 2018

FINANCIAL REPORT

BALANCE SHEET: ASSETS	2019	2018
A) Receivables from shareholders for contributions due	**0**	**0**
B) Fixed assets	**9,255,176**	**1,267,348**
I. Intangible fixed assets	284,795	281,428
II. Tangible fixed assets	8,324,441	508,105
III. Financial assets	645,940	477,815
C) Current Assets	**17,836,010**	**16,049,945**
I. Inventories (Work in Progress - WIP)	9,864,096	9,681,350
II. Receivables	777,290	545,708
III. Current financial assets	2,000,000	2,000,000
IV. Cash at hand	5,194,624	3,822,887
D) Prepayments and accrued income	**28,307**	**21,355**
TOTAL ASSETS	**27,119,493**	**17,338,648**

BALANCE SHEET: LIABILITIES	2019	2018
A) Net Liabilities	**5,717,156**	**5,776,928**
Capital	662,000	606,000
Reserve Funds	5,170,929	4,086,798
Profit for the year	-115,773	1,084,130
B) Provisions for risks and charges	**252,946**	**159,414**
C) Employee Severance Indemnities	**953,249**	**731,801**
D) Payments from Clients	**15,931,053**	**10,312,100**
E) Accruals and deferred charges	**4,265,089**	**358,405**
TOTAL LIABILITIES	**27,119,493**	**17,338,648**

PROFIT AND LOSS	2019	2018
A) Revenues	**15,225,762**	**13,393,533**
Revenues from sales and services	3,012,148	2,825,313
Variations in stocks (WIP)	182,746	1,651,173
Other revenues	12,030,868	8,917,047
B) Expenses	**15,142,797**	**12,141,796**
Consumable	93,139	56,136
Services	6,501,520	5,317,498
Leases	327,275	335,558
Personnel	6,465,148	5,601,155
Depreciation	1,467,543	670,477
Other Operating Expenses	288,172	160,972
Difference between revenues and expenses (A-B)	**82,965**	**1,251,737**
C) Financial income and charges	**-22,109**	**30,832**
D) Impairment on financial assets	**0**	**0**
E) Extraordinary income and charges	**-158,241**	**-169,561**
Results before taxes (A-B±C±D±E)	**-97,385**	**1,113,008**
Income tax expenses - current and deferred	**18,388**	**28,878**
a) Current taxes	**18,388**	**28,878**
b) Deferred taxes	**0**	**0**
Profit (loss) for the year	**-115,773**	**1,084,130**

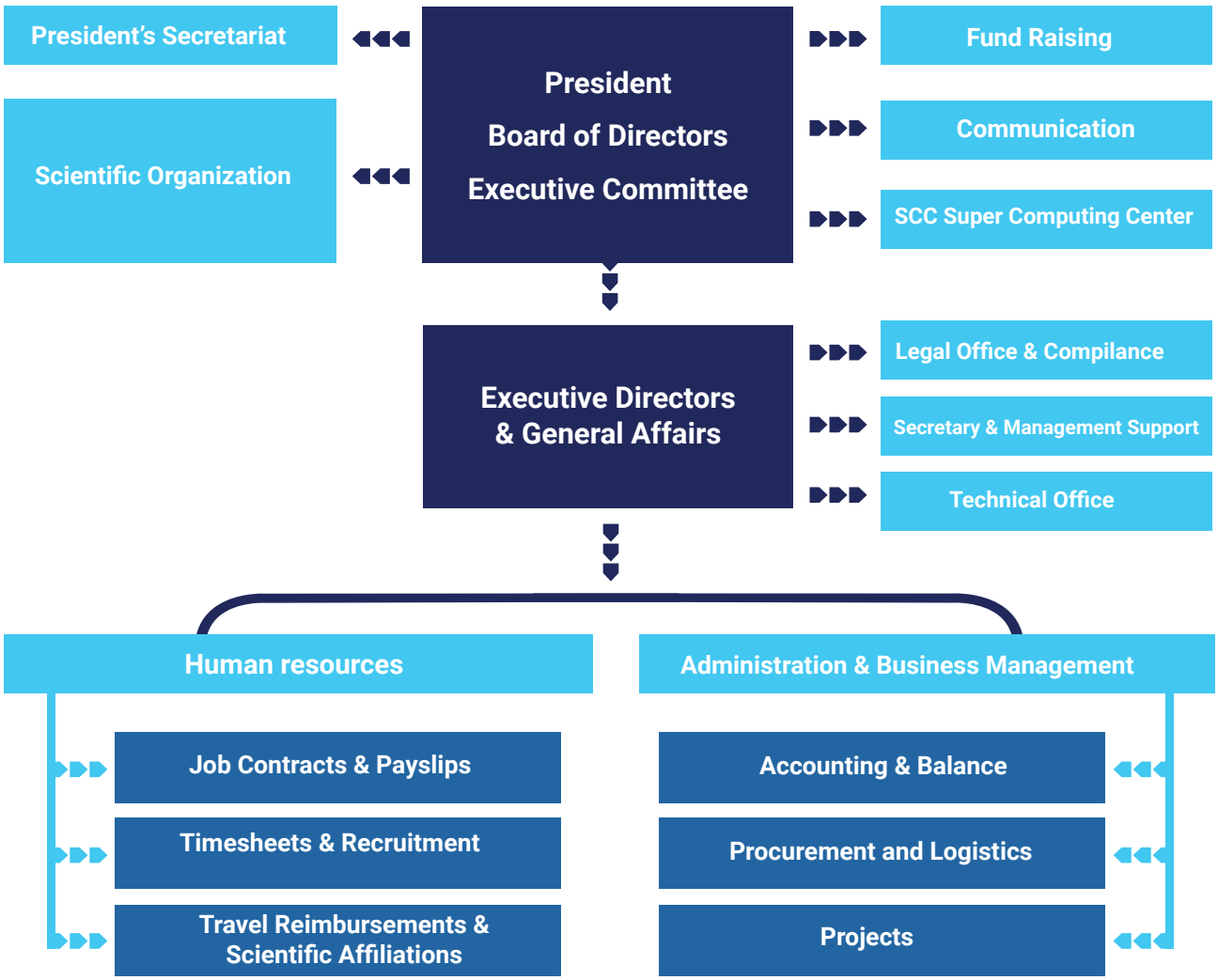


The CMCC Foundation

Mission

To investigate and model our climate system and its interactions with society to provide reliable, rigorous, and timely scientific results to stimulate sustainable growth, protect the environment and develop science driven adaptation and mitigation policies in a changing climate. To develop foresights and quantitative analysis of our future planet and society.

Administration and management



COFOUNDERS

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Centro Italiano di Ricerche Aerospaziali
Università Ca' Foscari Venezia
Università di Sassari
Università della Tuscia
Politecnico di Milano
Resources for the Future
Università di Bologna

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CMCC Foundation

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