Constraining uncertainty of multi decadal climate projections

Rendicontazione

Informazioni relative al progetto

CONSTRAIN

ID dell'accordo di sovvenzione: 820829

Sito web del progetto

DOI
10.3030/820829

Progetto chiuso

Data della firma CE
3 Maggio 2019

Data di avvio
1 Luglio 2019

Data di completamento
31 Dicembre 2023

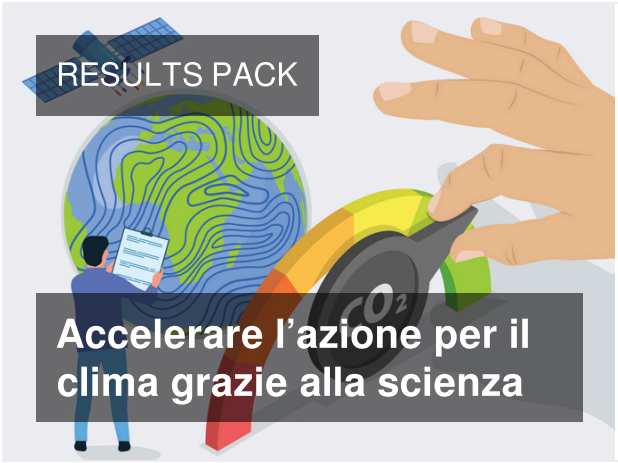
Finanziato da
SOCIETAL CHALLENGES - Climate action, Environment, Resource Efficiency and Raw Materials

Costo totale
€ 7 999 803,75

Contributo UE
€ 7 999 803,75

Coordinato da
UNIVERSITY OF LEEDS
United Kingdom

Questo progetto è apparso in...



26 Marzo 2025

Periodic Reporting for period 3 - CONSTRAIN (Constraining uncertainty of multi decadal climate projections)

Periodo di rendicontazione: 2022-04-01 al 2023-12-31

Sintesi del contesto e degli obiettivi generali del progetto

Predicting how the climate will change over the next 20-50 years, as well as defining emissions pathways to keep the world on track, requires a better understanding of how several human and natural factors will affect the climate in coming decades. These include how atmospheric aerosols affect the Earth’s radiation budget, and the roles of clouds and oceans in driving climate change.

CONSTRAIN uses climate science and its translation into policy to address these questions through pursuing objectives focused on related knowledge gaps. By gaining a better understanding of how natural and human factors affect multi-decadal climate projections at both global and regional levels, CONSTRAIN is helping scientists to improve climate projections in a way that benefits the EU’s climate adaptation and mitigation strategies as well as broader policy.

Combining novel analyses from the sixth Climate Model Intercomparison Project (CMIP6) with high-resolution simulations and new observations to address the first 3 knowledge gaps on radiative forcing, cloud feedbacks and the relationship between ocean variability and atmospheric change. A 4th gap on the effective translation of new physical science understanding into an improved evidence base for policy decisions is addressed through developing climate model emulators that integrate and operationalise learning from across the consortium, providing new capability to assess impacts of climate change under a broad range of emission scenarios.

Focus is on the expected spatially resolved decadal changes until mid-century providing robust evidence on climate sensitivity, and regional temperature, precipitation and circulation changes, taking full advantage of climate model integrations from CMIP6 and leveraging existing H2020 and ERC projects.

Contributes to securing EU science as a world-leader in understanding climate sensitivity and climate variability, delivering significantly improved capability to make climate projections for the next 20-50 years, and providing current scientific evidence for international climate policy.

Delivered a timely characterisation of physical science uncertainty and how it affects projections and committed levels of warming to the 2021 IPCC AR6.

Constraining surface temperature projections for the 2023 UNFCCC Global Stocktake which will be taken forward into reporting period three.

Lavoro eseguito dall'inizio del progetto fino alla fine del periodo coperto dalla relazione e principali risultati finora ottenuti

3 Zero In Reports, The remaining carbon budget and decadal warming rates, New generation of climate models, COVID-19 and the Paris Agreement , Near term warming and our chances of staying within 1.5°C
CONSTRAIN Knowledge Gains: Summary and Implication Report (KGSIR) 1 - Improved characterization and understanding of the ERF concept
KGSIR 2 - State-of-the-art understanding of rapid adjustments
KGSIR 3 - Climate sensitivity and feedbacks in CMIP models
KGSIR 4 - Outlining the CONSTRAIN journal publications used by IPCC AR6 and the overall contribution to IPCC AR6 in the form of 64 published and 4 accepted journal publications
CONSTRAIN website live and active
Open-source Silicone tool developed allowing modellers to include emissions of a broad range of species, rather than just CO2 and CH4, in Integrated Assessment Models (IAMs)

Progressi oltre lo stato dell'arte e potenziale impatto previsto (incluso l'impatto socioeconomico e le implicazioni sociali più ampie del progetto fino ad ora)

Novel findings on sea surface temperature projections (SST) and time-varying feedbacks are being translated into openly accessible climate emulators that will allow the latest climate science to inform policy-relevant information. A particularly unexplored field where research is improving understanding.

Cloud feedbacks remain the most important source of uncertainty in climate sensitivity. Investigated using knowledge gained by the EUREC4A field campaign which was coordinated by Work Package 2 leads. This provided new insights into cloud processes in the Tropics and fed into broader assessments of feedbacks and climate sensitivity, and also how these are represented in CMIP6 models

CONSTRAIN scientists contributed to the landmark Sherwood et al. (2020) assessment of climate sensitivity, narrowing the likely range of Equilibrium Climate Sensitivity (ECS) to 2.3–4.5K. The high

estimates of ECS in CMIP6 models compared to CMIP5 are likely due to changes in mixed phase cloud processes and Antarctic sea ice representation.

Step changes in the quantification of Effective Radiative Forcing (ERF) were set out in the project's first KGSIR, including a method to calculate ERF from climate model simulations keeping SST constant, which can be applied to a large range of climate drivers and is important for understanding climate change. Historical ERF has also been constrained to a range representing an almost 40% reduction compared to that of IPCC AR5, suggesting ERF may be too small in up to one-third of CMIP5 climate models.

Advances made on the understanding of rapid adjustments were set out in a second KGSIR. Including improvements to anthropogenic aerosol representation, forcing and feedbacks in climate models; and a narrowing of the range of aerosol forcing compared to CMIP5.

The new Silicone pathway tool has delivered improved climate projections by allowing Integrated Assessment Models to include emissions of a broad range of species, rather than just CO2 and CH4. Silicone is now being used widely in major climate assessments and to inform policy decisions.

CONSTRAIN's robust estimate of and framework for calculating the remaining global carbon budget is increasing understanding of the concept among stakeholder communities and providing a strong platform for future communications efforts. Updates to the remaining global carbon budget are provided in the annual Zero In reports alongside additional information and context on the concept.

Investigation of the latest (CMIP6) climate models, comparing the model results with temperature observations, have found that most of the models with high ECS values also overestimate recent warming trends,
indicating that their future temperature projections are also too high (Zero In 2).

Near-term warming rates have also been investigated further using climate emulators and more complex climate models, highlighting how strong climate action limit the amount of overall warming and slow down warming rates in coming decades.

The CONSTRAIN and IPCC Emulator workshop in 2021 harnessed expertise from across the scientific community to highlight the use of climate model emulators in AR6

Time-evolving feedbacks have been investigated using a climate emulator. Results show how different strengths of climate feedback form differences in global temperatures of up to 1 °C by 2050. Implications for warming rates, regional temperature change, and rainfall patterns. This work is a first step in providing clarity on how temperatures and rainfall will respond to future emissions.

CONSTRAIN is ambitious about knowledge transfer, and adapted well to pandemic restrictions, reaching new audiences through the 2020 virtual UNFCCC Climate Dialogues, Commission-organised knowledge transfer events and cross-project events in place of the postponed COP26. CONSTRAIN then launched Zero In 3 at COP26 in 2021.

New scientific opportunities arose regarding the climate impact of COVID-19, using novel techniques and tools developed as part of the project, Silicone tool and the use of widely available mobility data. This attracted widespread interest and increased CONSTRAIN's external profile, attracting considerable media attention.

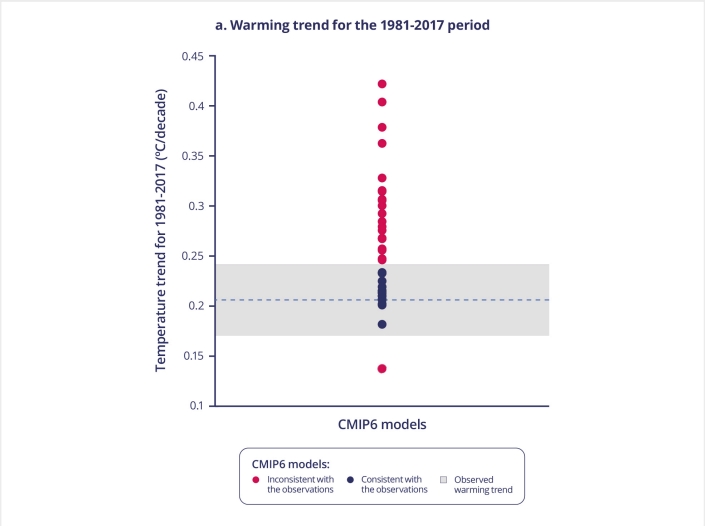


Fig 1a from Zero In 2

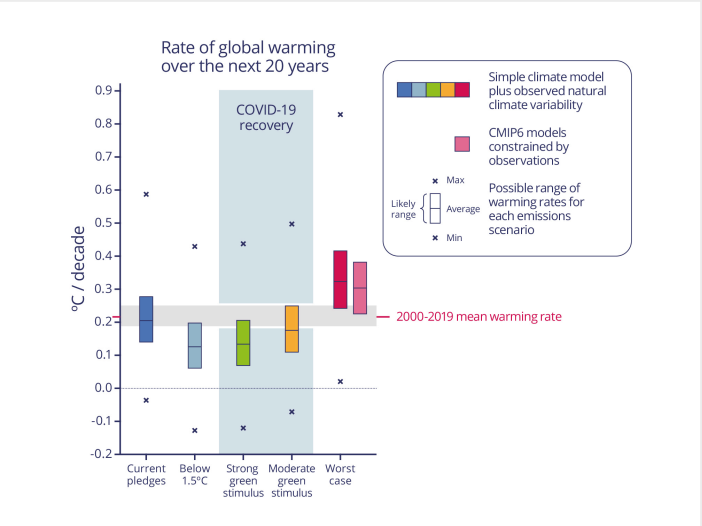


Fig 3 from Zero In 2

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