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Presentation of the book:

“The Frontier of Climate Science: Solar Variability, Natural Cycles and Model Uncertainty”

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Abstract

This article summarizes my public presentation of the book *The Frontier of Climate Science: Solar Variability, Natural Cycles and Model Uncertainty*. The book reviews the main current open issues in climate science: the questionable near-total attribution of post-1850 warming to anthropogenic causes alone, the use of unrealistic emission scenarios (SSPs), the wide uncertainty range in equilibrium climate sensitivity, the gap between satellite and surface temperature records, the failure of models to reproduce past warm periods (the Holocene Thermal Maximum, the Roman Warm Period, the Medieval Warm Period), and the potentially underestimated role of solar variability mediated by cosmic rays and cloud cover. Building on these observations, empirical modelling is proposed based on astronomically-derived cycles - linked to the gravitational interactions among the Sun, the Moon, and the major planets - and that reproduces the observed global temperature record with greater fidelity. This yields a substantially lower estimate of climate sensitivity to a doubling of CO₂ (1-1.5 °C) than that used in CMIP models, with important implications for climate policy: moderate warming over the course of the 21st century would be manageable primarily through adaptation strategies, rather than through costly net-zero emission-reduction policies.

Keywords: Natural climate variability; climate sensitivity; astronomical cycles; solar forcing; cosmic rays; urban heat island; SSP scenarios; Paris Agreement; climate adaptation.

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1. Introduction

Public debate on climate change tends to treat the human contribution to global warming as a settled fact, while pushing discussion of the natural component of climate variability to the margins. However, the current state of climate science is much more complex and challenging.

At the 17th EIKE International Conference, I presented the scientific arguments developed in my recent book *The Frontier of Climate Science: Solar Variability, Natural Cycles and Model Uncertainty* (Scafetta, 2026), which draws on a review of roughly 650 peer-reviewed papers and includes forewords by M. Santosh, A. Prestininzi, and J. Curry. The book has also been endorsed by the International Association for Gondwana Research and by the CERI Research Centre at Sapienza University of Rome. Translations of the book in Italian, German, French and Spanish are also available.

The central thesis is that the global climate models used by the IPCC (2021) systematically underestimate natural variability - of oceanic, solar, and astronomical origin - and that this gap leads

to an overestimation of the climate risk expected for the 21st century, with significant consequences for public policy.

2. The Limits of IPCC Attribution

In its Sixth Assessment Report (2021), the IPCC attributes essentially 100 % of the warming observed between 1850 -1900 and the present to anthropogenic forcings alone, chiefly rising CO₂, leaving an almost negligible role for solar, volcanic, and internal variability. This conclusion rests on a comparison between simulations run with natural forcing only - which yield an essentially flat temperature trend - and simulations that also include the anthropogenic component, the only ones able to reproduce the observed warming.

The critical issue, from the standpoint of scientific method, is that the "nature-only" scenario cannot be empirically validated: there is no parallel Earth free of human emissions against which the prediction could be checked. It is therefore a non-falsifiable counterfactual, and the near-total attribution of warming to human activity remains, in this sense, a model output rather than an experimentally established fact.

3. Emission Scenarios and the Paris Target

Alarm over future climate risk rests largely on the Shared Socioeconomic Pathway (SSP) scenarios, including SSP1 (compatible with net zero), SSP2, SSP3, and SSP5. Most of the more alarming projections in circulation are based on SSP5, now widely regarded as implausible, alongside SSP3. The most realistic scenario, consistent with the emission trajectories countries are actually following, is instead SSP2, which - according to the empirical climate change estimates presented in the book - would also keep warming at or below the 2 °C threshold set by the Paris Agreement (2016) without requiring *Net-Zero* to be reached. This point carries political weight: net-zero policies, pursued chiefly in Europe (which account for a minority share of global emissions at around 6-7 %), would have a negligible climate impact at the planetary scale, while imposing very high economic costs.

4. Climate Sensitivity and Model Uncertainty

The principal source of uncertainty in climate models remains equilibrium climate sensitivity (ECS) - the warming expected from a doubling of atmospheric CO₂. Estimates available since 1979 have not narrowed over time - if anything, the range has widened in the most recent assessments - and across the current CMIP models it spans from 1.8 to 5.6 °C, a wide spread that largely reflects uncertainty in how clouds are represented, which are likely the true "*regulator*" of the climate system.

Comparison between models and observations suggests that only low-sensitivity models are consistent with the data, while medium- and high-sensitivity models tend to overstate warming (models "*running too hot*"). If satellite records - which show less warming than surface records - are taken as reliable, the conclusion follows that practically all of the global climate models (GCMs) currently in use systematically overestimate future warming.

5. Satellite Observations and the Urban Heat Island

A further point of discussion concerns the discrepancy between satellite data (e.g., the UAH MSU record) and surface temperature data. Over the ocean the two records are broadly consistent; over land, however, the surface record shows significantly greater warming. One possible explanation is the persistence, in the land surface record, of an incompletely removed urban heat island component linked to the expansion of urbanized areas around weather stations. If correct, this would imply that the warming measured over land is partly overstated relative to the genuine climate signal.

6. Past Warm Periods Missing from the Models

An important test of model credibility is their ability to reproduce past climate variability. The models used by the IPCC reproduce neither the mid-Holocene Thermal Maximum (6,000 - 8,000 years ago), since it finds no counterpart in a corresponding CO₂ maximum (the so-called "temperature-CO₂ conundrum"), nor the Medieval Warm Period, as the IPCC itself explicitly acknowledges for periods prior to 1300. Indirect evidence - from Viking farming settlements in Greenland, to wood remains found beneath alpine glaciers, to the discovery of the Similaun Ice-man in an area then free of ice - indicates that these warm periods were real and, in some regions, of an intensity comparable to or greater than today's.

The reconstruction of the last two thousand years reveals a recurring succession of warm and cold phases - the Roman Warm Period, the Dark Ages Cold Period, the Medieval Warm Period, the Little Ice Age, the Modern Warm Period - consistent with a roughly millennial cycle that repeats over earlier millennia as well, as shown by Alpine records. The fact that current models fail to reproduce this oscillation suggests the absence of a relevant physical mechanism, one plausibly also partly responsible for recent warming.

7. Solar Forcing, Cosmic Rays, and Cloud Cover

The correspondence, sustained over millennia, between proxies for solar activity (such as carbon-14) and climate records appears difficult to reconcile with the standard models' assumption that the Sun has had a negligible effect on climate since 1850. Two questions remain open: the true magnitude of total solar irradiance variations (with the ACRIM and PMOD reconstructions in disagreement), and the existence of a second solar-forcing mechanism, independent of luminosity alone, linked to the modulation of galactic cosmic-ray flux by the solar magnetic field.

The mechanism proposed - traceable to the work of H. Svensmark - holds that strong solar activity strengthens Earth's magnetic shield, reducing cosmic-ray flux, atmospheric ionization, and consequently cloud formation, with a net warming effect. Observations of Forbush events (sharp drops in cosmic-ray flux associated with solar storms) reportedly show a measurable decrease in cloud cover in the following days, offering direct empirical support for this mechanism.

8. A New Paradigm: The Astronomical Theory of Climate Cycles

Just as Milankovitch theory explains the large-scale glacial-interglacial oscillations through orbital variations induced by gravitational interaction among the planets, the sixth part of the book proposes extending the same principle to shorter time scales. The relative configurations of the giant planets (Jupiter, Saturn, Uranus, and Neptune) generate a set of frequencies - so-called orbital invariant inequalities - clustering around periodicities of roughly 45, 60, and 90 years (the Gleissberg cycles), 200 years (the de Vries/Suess cycle), 1,000 years (the Eddy cycle), and 2,318 years (the Bray-Hallstatt cycle). Each of these periodicities finds an independent counterpart in both climate records and solar activity records.

A model built on three principal harmonics — the solar dynamo cycle (about 10.87 years), modulated by the Jupiter orbital cycle and the Jupiter-Saturn tidal cycle (about 9.93 years) — reproduces, through beating, millennial and secular (100 -150 year) cycles plus a roughly 60-year multidecadal cycle consistent with the observed global temperature record, including the 1940s warming that standard models fail to explain.

9. Implications for Climate Policy

If the natural component of the warming observed over the last 175 years were equal to or greater than 50 %, as argued here - with a further roughly 20 % attributable to incompletely filtered urban heat island bias - the anthropogenic contribution would be reduced to about one-third of the total

warming, corresponding to a climate sensitivity of around 1-1.5 °C per CO₂ doubling, considerably lower than the 1.5-6 °C range typical of CMIP models.

In this framework, the warming expected over the course of the 21st century would be moderate and manageable primarily through region-specific adaptation policies, rather than through net-zero mitigation policies, whose economic costs, on this analysis, would be disproportionate to the global climate benefits expected, especially if adopted unilaterally by economies that account for only a minority share of global emissions.

It should also be noted that the millennial and multidecadal cycles described here are currently in an ascending phase, but the 60-year component is expected to enter a negative phase between 2060-2070 and 2100, while the millennial component should begin a slow decline after 2060: this makes plausible a further slowdown, or a new hiatus, in global warming toward the end of the century, before the Milankovitch orbital cycles, operating on scales of thousands of years, drive the climate system back toward a new glacial phase.

10. Conclusions

The argument developed in the book does not deny climate change or the human contribution to it but rescales its expected magnitude in light of a broader natural variability of oceanic, solar, and astronomical origin, not adequately represented in the global climate models currently in use. A fuller understanding of the underlying physical mechanisms - particularly the role of clouds, and the second solar-forcing channel linked to cosmic rays - appears indispensable before numerical models can be fully trusted for climate scenario prediction and related risk assessment. In the meantime, an empirical approach based on observed cycles suggests a more modest level of 21st-century climate risk than currently assumed, and points policy priorities toward adaptation rather than net-zero mitigation.

The positions set out here belong to an ongoing scientific debate and are subject to critical discussion within the climate science community; interested readers are encouraged to consult both the book from which this article is drawn and the literature that critically engages with its conclusions.

Author Biography

Nicola Scafetta is Professor of Atmospheric Physics and Oceanography at the Department of Earth, Environmental and Resource Sciences, University of Naples Federico II. Trained as a physicist, he has conducted research in the United States, focusing in particular on solar variability, astronomical cycles, and their relationship to natural climate variability, as well as on the analysis of uncertainty in global climate models. He is the author of numerous peer-reviewed papers on climate sensitivity and empirical climate modeling and several books.

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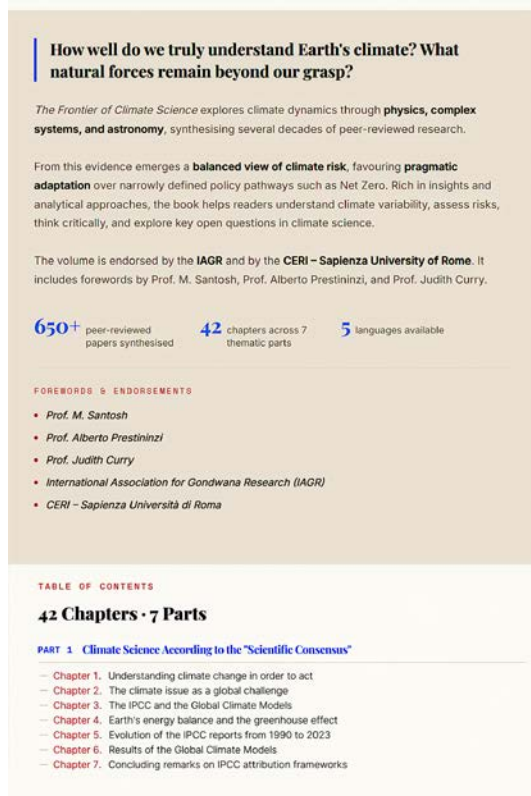
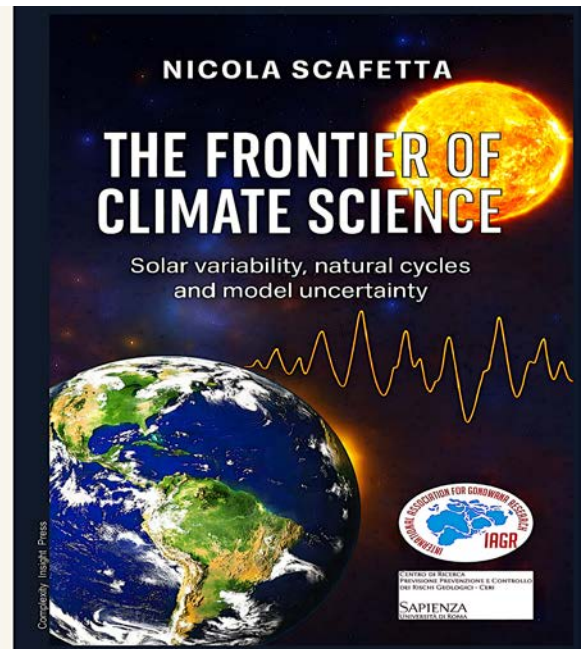
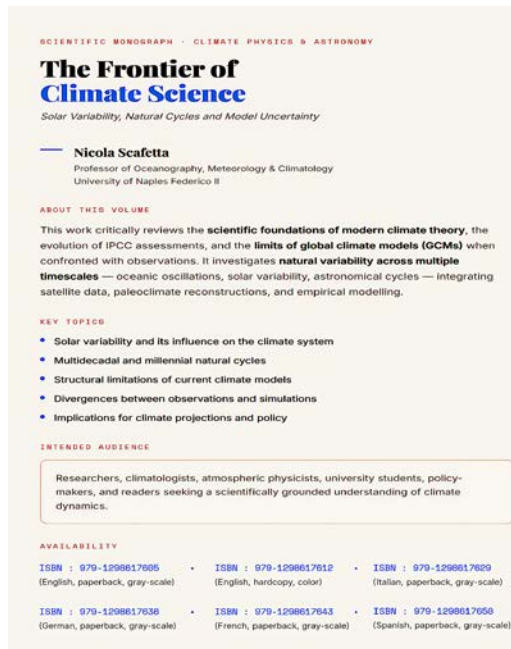
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See book presentation on the following page!



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