Original Prompt:

You are a climate change research specialist and are helping me find thematic trends in climate change publications.

Thematic elements in climate change research refer to recurring topics, narratives, and conceptual themes that emerge across multiple studies. These themes help categorize research and provide insight into broader trends.

Some key thematic elements in climate change research include:

1. Mitigation Strategies – Renewable energy, carbon capture, emission reduction policies.
2. Adaptation & Resilience – Climate-smart agriculture, infrastructure planning, ecosystem restoration.
3. Climate Justice & Equity – Disparities in climate impact, indigenous knowledge, global policy fairness.
4. Scientific Modeling & Predictions – Climate simulations, AI in climate forecasting, uncertainty quantification.
5. Economic & Policy Implications – Carbon pricing, international agreements (Paris Agreement, UNFCCC policies).
6. Public Perception & Communication – Misinformation, behavioral changes, media influence.
7. Climate Impact on Ecosystems – Biodiversity loss, ocean acidification, deforestation effects.
8. Human Health & Climate Change – Disease spread, heatwaves, food security.

Based on the title, abstract and list of keywords of the article, classify the article into one of the above defined themes.
If there any no trends identified from the context of the abstract, or if its too vague,
then you can suggest 'No Theme'.

Use the contextual understanding of the abstract to make your decision about which theme the article will fall under. Make sure that you pay more attention to the overall context of the abstract, and not just individual keywords. Focus on understanding the core message, especially regarding the

theme's relevance to the paper's primary focus (impacts, strategies, resilience).

For example,
1) Title: Climate change impacts on bumblebees converge across continents

Abstract: For many species, geographical ranges are expanding toward the poles in response to climate change, while remaining stable along
range edges nearest the equator. Using long-term observations across Europe and North America over 110 years, we tested for
climate change-related range shifts in bumblebee species across the full extents of their latitudinal and thermal limits and
movements along elevation gradients. We found cross-continentally consistent trends in failures to track warming through time
at species' northern range limits, range losses from southern range limits, and shifts to higher elevations among southern species.
These effects are independent of changing land uses or pesticide applications and underscore the need to test for climate impacts
at both leading and trailing latitudinal and thermal limits for species.
Keywords: ['ecology']

Output =>
Classification: Climate Impact on Ecosystems
Reasoning: The title has climate change impacts on bumblebess which is an indicator of the article's classification. Further, the abstract
helps with the contextual understanding that the research indeed talks about the impact of climate change on bumblebee species.
Therefore the article is classified as Climate Impact on Ecosystems.

2) Title: Solar geoengineering could redistribute malaria risk in developing countries

Abstract: Solar geoengineering is often framed as a stopgap measure to decrease the magnitude, impacts, and injustice of climate change.

However, the benefits or costs of geoengineering for human health are largely unknown. We project how geoengineering could impact malaria risk by comparing current transmission suitability and populations-at-risk under moderate and high greenhouse gas emissions scenarios (Representative Concentration Pathways 4.5 and 8.5) with and without geoengineering. We show that if geoengineering deployment cools the tropics, it could help protect high elevation populations in eastern Africa from malaria encroachment, but could increase transmission in lowland sub-Saharan Africa and southern Asia. Compared to extreme warming, we find that by 2070, geoengineering would nullify a projected reduction of nearly one billion people at risk of malaria. Our results indicate that geoengineering strategies designed to offset warming are not guaranteed to unilaterally improve health outcomes, and could produce regional trade-offs among Global South countries that are often excluded from geoengineering conversations.
Keywords: ['Environmental health', 'Malaria', 'Projection and prediction', 'Science', 'Humanities and Social Sciences', 'multidisciplinary']

Output =>
Classification: ['Human Health & Climate Change', 'Climate Impact on Ecosystems']
Reasoning: The article talks about how geoengineering impacts malaria risk in different geographical regions. There are lots of mentions about human health (one billion people at risk fo malaria) and the keywords contains Environmental Health, Humanities and Malaria, which is a human health condition. It further is classified as Climate Impact on ecosystems because the article talks about "injustic of climate change".

3) Title: Seasonality and reduced nitric oxide titration dominated ozone increase during COVID-19 lockdown in eastern China

Abstract: With improving PM 2.5 air quality, the tropospheric ozone (O_3) has become the top issue of China's air pollution control. Here, we combine comprehensive observational data analysis with models to unveil the contributions of different processes and precursors to the change of O_3 during COVID-19 lockdown in the Yangtze River Delta (YRD), one of the most urbanized megacity regions of eastern China. Despite a 44 to 47% reduction in volatile organic compounds (VOCs) and nitrogen oxides (NO_x) emissions, maximum daily 8-h average (MDA8) ozone concentrations increase from 28 ppbv in pre-lockdown to 43 ppbv in lockdown period. We reproduce this transition with the WRF-Chem model, which shows that ~80% of the increase in MDA8 is due to meteorological factors (seasonal variation and radiation), and ~20% is due to emission reduction. We find that daytime photochemistry does not lead to an increase but rather a decrease of daytime O_3 production during the lockdown. However, the reduced O_3 production is overwhelmed by the weakened nitric oxide (NO) titration resulting in a net increase of O3 concentration. Although the emission reduction increases O_3 concentration, it leads to a decrease in the O_x (O_3 + NO_2) concentration, suggesting reduced atmospheric oxidation capacity on a regional scale. The dominant effect of NO titration demonstrates the importance of prioritizing VOCs reduction, especially from solvent usage and the petrochemical industry with high emission ratios of VOCs/NO_x.

Output =>
Classification: Scientific Modelling & Predictions
Reasoning: Talks heavily about the WRF-CHem model that is used to reproduce observational results in reduced nitric oxide titration dominated ozone increases. The modeling and the results are dominant in the abstract and even though keywords suggest climate change impacts,

the modelling part outweighs the keywords and therefore the article is classified as Scientific Modelling.

4) Title: Limited impact on decadal-scale climate change from increased use of natural gas

Abstract: The most important energy development of the past decade has been the wide deployment of hydraulic fracturing technologies that enable the production of previously uneconomic shale gas resources in North America . If these advanced gas production technologies were to be deployed globally, the energy market could see a large influx of economically competitive unconventional gas resources . The climate implications of such abundant natural gas have been hotly debated. Some researchers have observed that abundant natural gas substituting for coal could reduce carbon dioxide (CO_2) emissions . Others have reported that the non-CO_2 greenhouse gas emissions associated with shale gas production make its lifecycle emissions higher than those of coal . Assessment of the full impact of abundant gas on climate change requires an integrated approach to the global energy-economy-climate systems, but the literature has been limited in either its geographic scope or its coverage of greenhouse gases . Here we show that market-driven increases in global supplies of unconventional natural gas do not discernibly reduce the trajectory of greenhouse gas emissions or climate forcing. Our results, based on simulations from five state-of-the-art integrated assessment models of energy-economy-climate systems independently forced by an abundant gas scenario, project large additional natural gas consumption of up to +170 per cent by 2050. The impact on CO_2 emissions, however, is found to be much smaller (from −2 per cent to +11 per cent), and a majority of the models reported a small increase in climate forcing (from −0.3 per cent to +7 per cent) associated with the increased use of abundant gas. Our results show that although market penetration of globally abundant gas may substantially change the future energy system, it is not necessarily an effective substitute for climate change mitigation policy .

Output =>
Classification: ['Climate Impacts on Ecosystems', 'Scientific Modeling & Predictions']
Reasoning: The article talks about advanced gas production technologies which could have impacts on global climate change.
It also talks about their simulation-base approach shows large additional gas consumptions of upto 170%, and the impact
on Co2 emissions is smaller. In summary, the article actually refutes the idea of abundant gas as a good mitigation policy.
So even though there are words like mitigation in the abstract, and the keywords also has mitigation, you should understand that
mitigation is used in the context of refuting the mitigation strategy being in the works. They have developed an approach that refutes
the strategy and are recalibrating the impacts on climate change, which makes it more relevant as an impacts and modeling article than
a mitigation article.

5) Title: Agricultural risks from changing snowmelt

Abstract: Snowpack stores cold-season precipitation to meet warm-season water demand. Climate change threatens to disturb this balance
by altering the fraction of precipitation falling as snow and the timing of snowmelt, which may have profound effects on food production
in basins where irrigated agriculture relies heavily on snowmelt runoff. Here, we analyse global patterns of snowmelt and agricultural
water uses to identify regions and crops that are most dependent on snowmelt water resources. We find hotspots primarily in high-mountain
sia (the Tibetan Plateau), Central Asia, western Russia, western US and the southern Andes. Using projections of sub-annual runoff under
warming scenarios, we identify the basins most at risk from changing snowmelt patterns, where up to 40% of irrigation demand must be met
by new alternative water supplies under a 4 °C warming scenario. Our results highlight basins and crops where adaptation of water management
and agricultural systems may be especially critical in a changing climate.
Keywords: ['Environmental impact', 'Environmental sciences', 'Water resources', 'Environment', 'general', 'Climate Change',

'Climate Change/Climate Change Impacts', 'Environmental Law/Policy/Ecojustice']

    Output =>
    Classification: ['Adaptation & Resilience', 'Climate Impacts on Ecosystems']
    Reasoning: The article talks about the imbalance of cold-season precipitation and warm-season water demand due to climate change.
        The article also uses projections to identify basins most at risk from chaning snowmelt patterns, and highlights crops where adaptation
        of water management and agricultural systems could be extremely useful. Hence, the article showcases ways to adapt and therefore
        the article is classified as Adaptation & Resilience. Further, since its talks about climate change impacts in context, supplemented
        by the fact that there are keywords of climate change impacts, it can be classified into another category 'Climate Impacts on Ecosystems'.
        Note that even though the keywords contain Law, Policy and ecojustice, the article doesn't really talk about these and so the individual
        weightage on keywords should be less, the focus on context of the abstract should be more and therefore the article doesn't have a
        classification for Economic & Policy Implications.

Return the output strictly in this JSON format:
{{
  "classification": "<one of the themes or 'No Theme'>",
  "reasoning": "<brief reasoning including keywords or abstract understanding>"
}}
Do not add any extra text, explanations, or formatting outside this JSON.
Note: If there are multiple themes that fit an article then for classification you can return a list of the themes, but order them based on
which one is more probable for the article (decreasing order of relevance)

Prompt with changed example:

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theme's relevance to the paper's primary focus (impacts, strategies, resilience).

For example,
1) Title: Discrepancies between observations and climate models of large-scale wind-driven Greenland melt influence sea-level rise projections

Abstract: While climate models project that Greenland ice sheet (GrIS) melt will continue to accelerate with climate change, models exhibit
limitations in capturing observed connections between GrIS melt and changes in high-latitude atmospheric circulation.
Here we impose observed Arctic winds in a fully-coupled climate model with fixed anthropogenic forcing to quantify the influence
of the rotational component of large-scale atmospheric circulation variability over the Arctic on the temperature field and the
surface mass/energy balances through adiabatic processes. We show that recent changes involving mid-to-upper-tropospheric anticyclonic
wind anomalies – linked with tropical forcing – explain half of the observed Greenland surface warming and ice loss acceleration since 1990,
suggesting a pathway for large-scale winds to potentially enhance sea-level rise by ~0.2 mm/year per decade. We further reveal fingerprints
of this observed teleconnection in paleo-reanalyses spanning the past 400 years, which heightens concern about model limitations to capture
wind-driven adiabatic processes associated with GrIS melt.
Keywords: ['Atmospheric dynamics', 'Climate and Earth system modelling', 'Cryospheric science', 'Science', 'Humanities and Social Sciences', 'multidisciplinary']

Output =>
Classification: Scientific Modeling & Predictions
Reasoning: The title talks abot climate models which is an indicator of the article's classification. Further, the abstract

helps with the contextual understanding that the research indeed talks about the model and various ways to quantify it. There are

details on the model and lots of metrics as well. Therefore the article is classified as Scientific Modeling & Predictions.

2) Title: Global irrigation contribution to wheat and maize yield

Abstract: Irrigation is the largest sector of human water use and an important option for increasing crop production and reducing drought impacts.

However, the potential for irrigation to contribute to global crop yields remains uncertain.

Here, we quantify this contribution for wheat and maize at global scale by developing a Bayesian framework integrating empirical

estimates and gridded global crop models on new maps of the relative difference between attainable rainfed and irrigated yield (∆ Y).

At global scale, ∆ Y is 34 ± 9% for wheat and 22 ± 13% for maize, with large spatial differences driven more by patterns of precipitation

than that of evaporative demand. Comparing irrigation demands with renewable water supply, we find 30−47% of contemporary rainfed agriculture

of wheat and maize cannot achieve yield gap closure utilizing current river discharge, unless more water diversion projects are set in place,

putting into question the potential of irrigation to mitigate climate change impacts.

Keywords: ['Agroecology', 'Environmental sciences', 'Science', 'Humanities and Social Sciences', 'multidisciplinary']

Output =>

Classification: ['Scientific Modeling & Predictions', 'Climate Impact on Ecosystems']

Reasoning: The article talks about the contribution of global irritation to wheat and maize yield and questions the potential of irrigation to

mitigate climate change impacts. Since the abstract discusses the framework they built and the quantifications and metrics, it is

classified into Scientific Modeling & Predictions predominantly. We also classify it into Climate Impact on Ecosystems because
of the potential impacts that are also likely discussed in the article.

3) Title: Atmospheric feedback explains disparate climate response to regional Arctic sea-ice loss
Abstract: Arctic sea-ice loss is a consequence of anthropogenic global warming and can itself be a driver of climate change in the Arctic and at
lower latitudes, with sea-ice minima likely favoring extreme events over Europe and North America. Yet the role that the sea-ice plays
in ongoing climate change remains uncertain, partly due to a limited understanding of whether and how the exact geographical distribution
of sea-ice loss impacts climate. Here we demonstrate that the climate response to sea-ice loss can vary widely depending on the pattern
of sea-ice change, and show that this is due to the presence of an atmospheric feedback mechanism that amplifies the local and remote
signals when broader scale sea-ice loss occurs. Our study thus highlights the need to better constrain the spatial pattern of future
sea-ice when assessing its impacts on the climate in the Arctic and beyond.
Keywords: ['Atmospheric dynamics', 'Climate and Earth system modelling', 'Earth Sciences', 'general', 'Climate Change/Climate Change Impacts',
'Atmospheric Sciences', 'Climatology', 'Atmospheric Protection/Air Quality Control/Air Pollution']
Output =>
Classification: Climate Impact on Ecosystems
Reasoning: The article strongly talks about the disparate climate response to the Artic sea-ice loss which shows the impact of this
climate change event on the ecosystems. Further, the keywords also indicate that the authors would tag this article as a climate impact

research. Hence it is classified into Climate Impact on Ecosystems.

4) Title: Dihydroxyacetone valorization with high atom efficiency via controlling radical oxidation pathways over natural mineral-inspired catalyst

Abstract: Diminishing fossil fuel resources and calls for sustainability are driving the urgent need for efficient valorization of renewable resources with high atom efficiency. Inspired from the natural goethite mineral with Mn paragenesis, we develop cost-effective MnO_2/goethite catalysts for the efficient valorization of dihydroxyacetone, an important biomass-based platform molecule, into value-added glycolic acid and formic acid with 83.2% and 93.4% yields. The DHA substrates first undergo C−C cleavage to selectively form glycolic acid and hydroxymethyl ($\cdot CH_2OH$) radicals, which are further oxidized into formic acid. The kinetic and isotopic labeling experiments reveal that the catalase-like activity of MnO_2 turns the oxidative radicals into oxygen, which then switches towards a hydroxymethyl peroxide (HMOO) pathway for formic acid generation and prevents formic acid over-oxidation. This nature-inspired catalyst design not only significantly improves the carbon efficiency to 86.6%, but also enhances the oxygen atom utilization efficiency from 11.2% to 46.6%, indicating a promising biomass valorization process.

Keywords: ['Bioenergy', 'Catalytic mechanisms', 'Heterogeneous catalysis', 'Science', 'Humanities and Social Sciences', 'multidisciplinary']

Output =>
Classification: Scientific Modeling & Predictions
Reasoning: The article talks about advanced techniqes and highly domain specific terms that are used to quantify the biomass valorization process.

Since the article goes into the details of their modeling process and discsses the metrics, it is classified into Scientific

Modeling & Predictions.

5) Title: Costs and health benefits of the rural energy transition to carbon neutrality in China

Abstract: The rural energy transition is critical in China's efforts to achieve carbon neutrality and improve air quality.
However, the costs and health benefits associated with the transition to carbon neutrality remain unclear. Here we explore the cost-effective transition pathways and air quality-related health impacts using an integrated energy-air quality-health modeling framework.
We find that decarbonizing rural cooking and heating would triple contemporary energy consumption from 2014 to 2060, considerably reducing energy poverty nationwide. By 2060, electric cooking ranges and air-to-air heat pumps should be widely integrated, costing an additional 13 billion USD nationally in transformation costs, with ~40% concentrated in Shandong, Heilongjiang, Shanxi and Hebei provinces. Rural residential decarbonization would remarkably improve air quality in northern China, yielding substantial health co-benefits. Notably, monetized health benefits in most provinces are projected to offset transformation costs, except for certain relatively lower-development southwestern provinces, implying more financial support for rural residents in these areas will be needed.
Keywords: ['Climate-change mitigation', 'Climate-change policy', 'Energy and society', 'Environmental impact', 'Science', 'Humanities and Social Sciences', 'multidisciplinary']

Output =>
Classification: ['Mitigation Strategies', 'Human Health & Climate Change']
Reasoning: The article explores modeling frameworks, but instead of quantifying and detailing metrics, we see themes of how the discussion is

structured around renewable sources and alternatives that can achieve carbon neutrality, and adoption of this would lead to mitigation of climate change on a wider scope. The keywords also suggest mitigation. Hence, its predominantly classified into Mitigation Strategies. Further, the article ties ot to human health benefits in both the title as well as the abstract. Hence, we further classify the article into Human Health & Climate Change as well. Other categories are too generic and we see this article is more relevant for the two themes we classified and so those are the only two we will choos for classification.

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{{
  "classification": "<one of the themes or 'No Theme'>",
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