Climate Change
Urgent problem requiring immediate investment in solutions

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University of California at San Diego

Climate change can reach crisis levels in few decades, affecting rich and poor ; young and old.

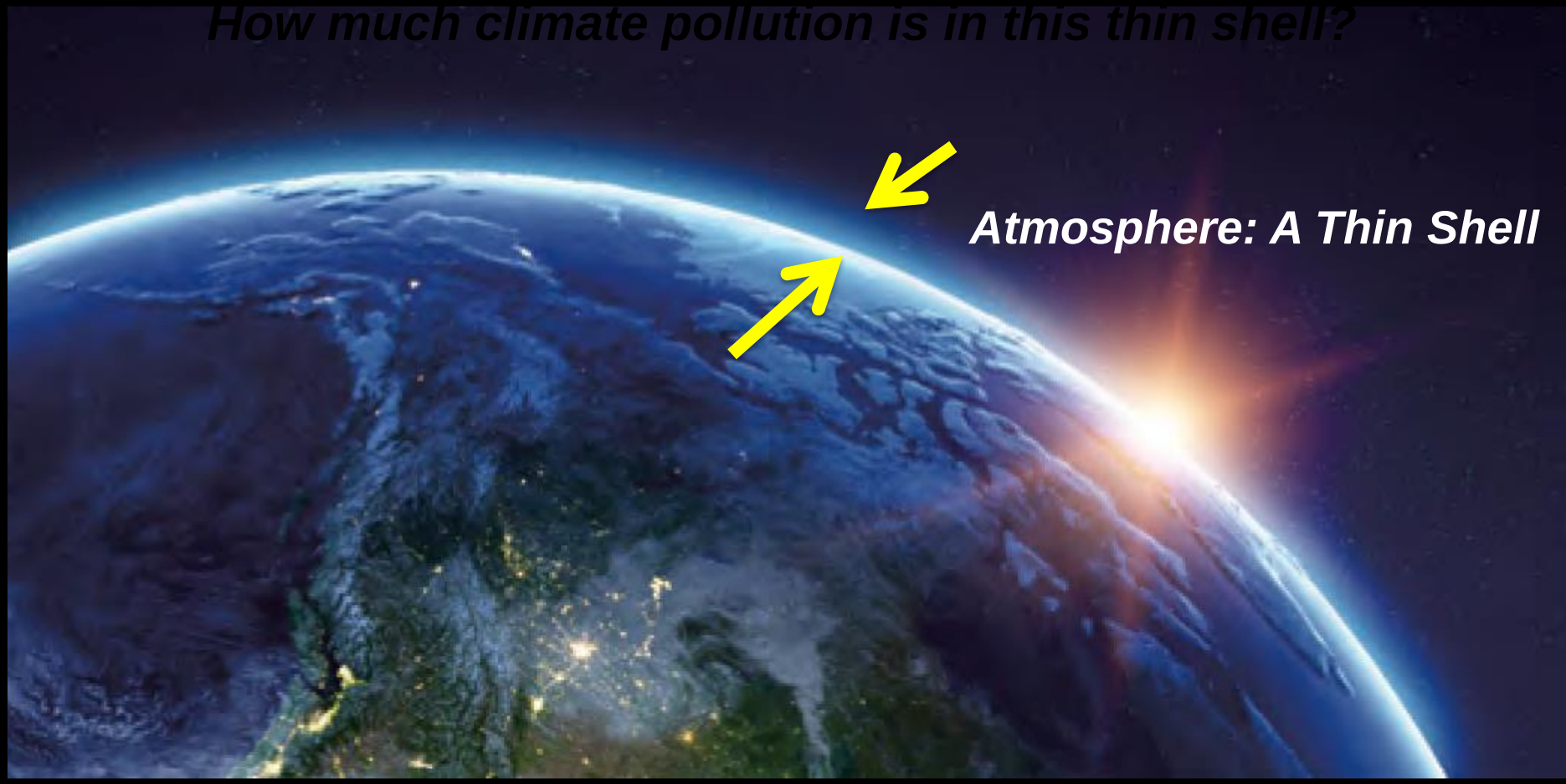
- *Plenty of scalable solutions are available*
- *We have a decade to implement these solutions*
- *Enormous investments are needed to accelerate the implementation*

Climate Change Science is Data Driven

NASA's Earth Radiation Budget Experiment
Ramanathan, Barkstorm and Harrison, 1989

UCSD_Scripps UAV System
Ramanathan et al, Nature, 2007

Carbon Dioxide Blanketing the Earth



Added 2,000,000,000,000 tons of CO_2 Since 1750

Made a prediction 37 Yrs ago to test the theory

15 AUGUST 1980

SCIENCE

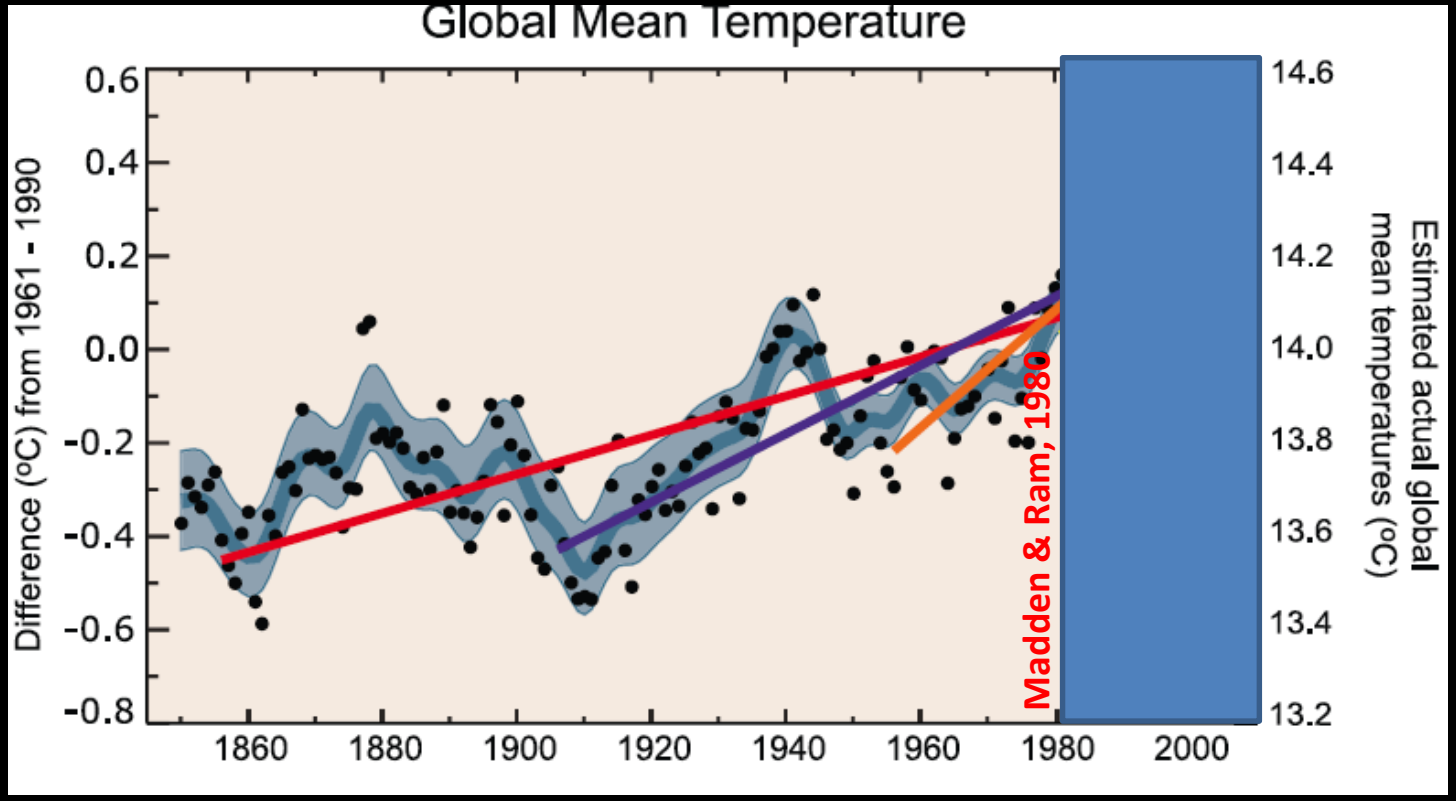
Detecting Climate Change due to Increasing Carbon Dioxide

Roland A. Madden and V. Ramanathan

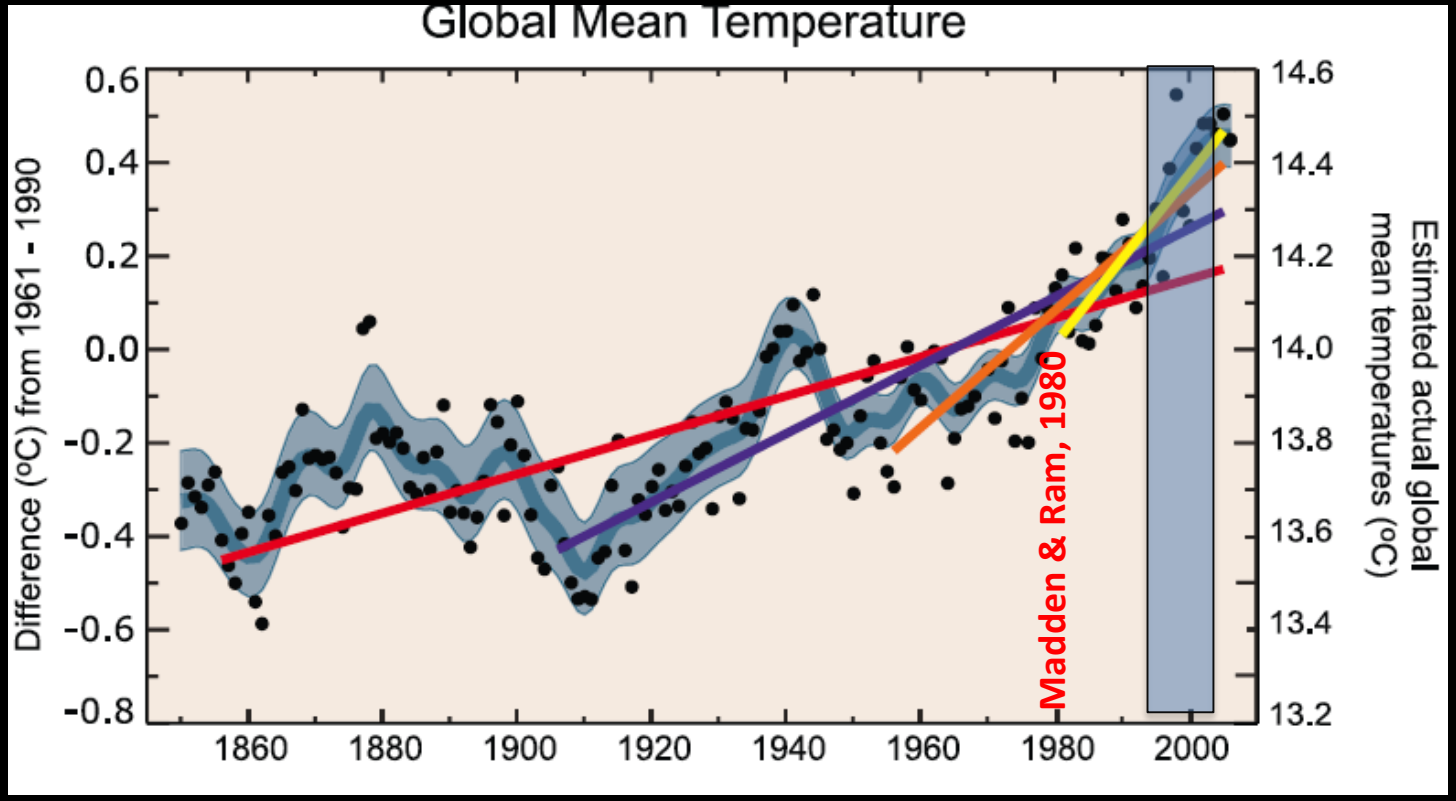
Prediction

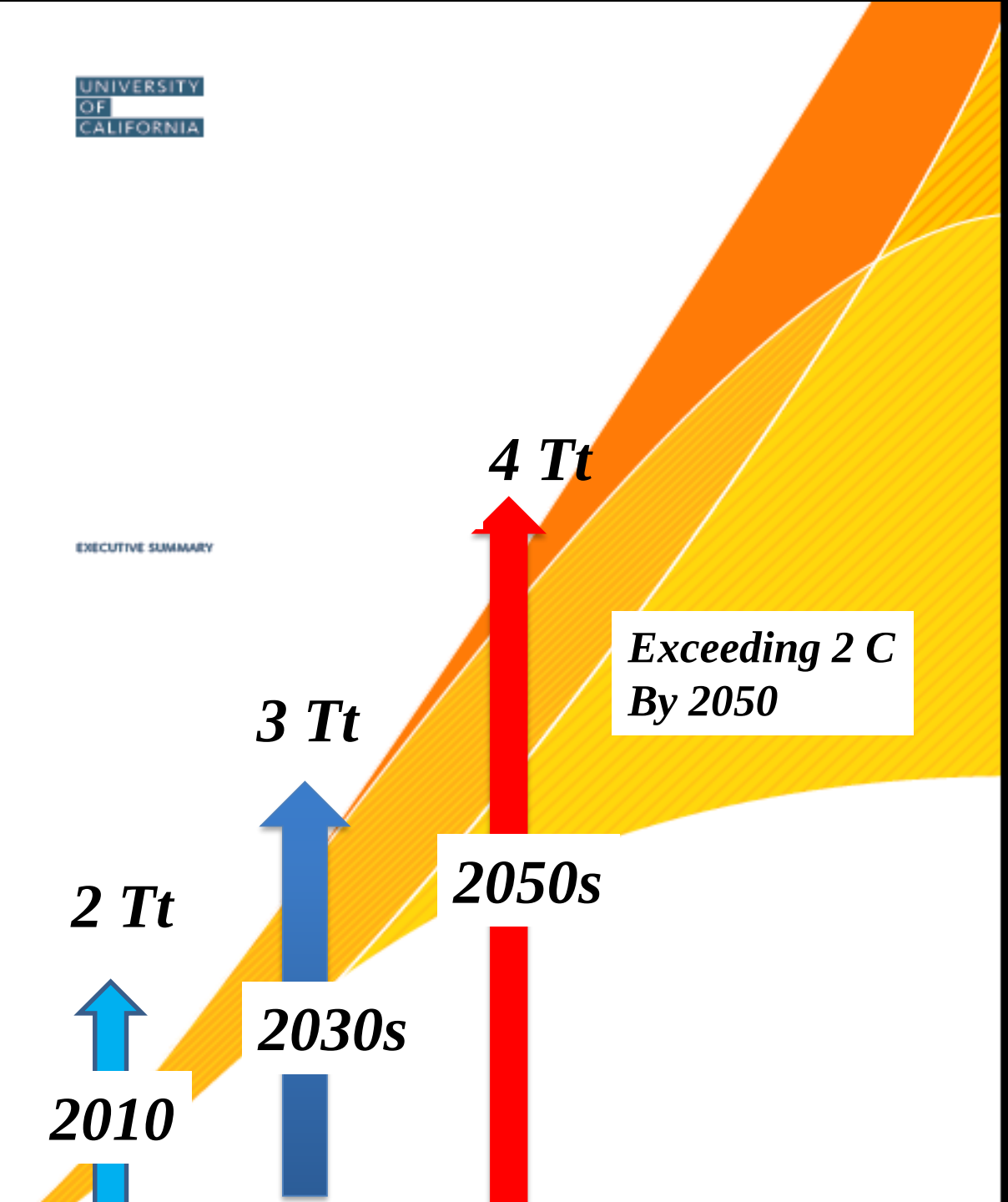
Warming Due To CO_2 Should Be Detectable By Year 2000

"Unequivocal" Warming of the Planet: IPCC, 2001 & 2007



"Unequivocal" Warming of the Planet: IPCC, 2001 & 2007





Consider CO_2

Each trillion tons contribute about 1.3^0F (0.7^0C) warming

Next 30 Years: My Prediction

15 years: Exceed threshold for dangerous climate change

35 years: 50% chance for 2C (3.6F) warming

5% Chance for Catastrophic Changes

(In addition to floods, intense storms, wide spread droughts)

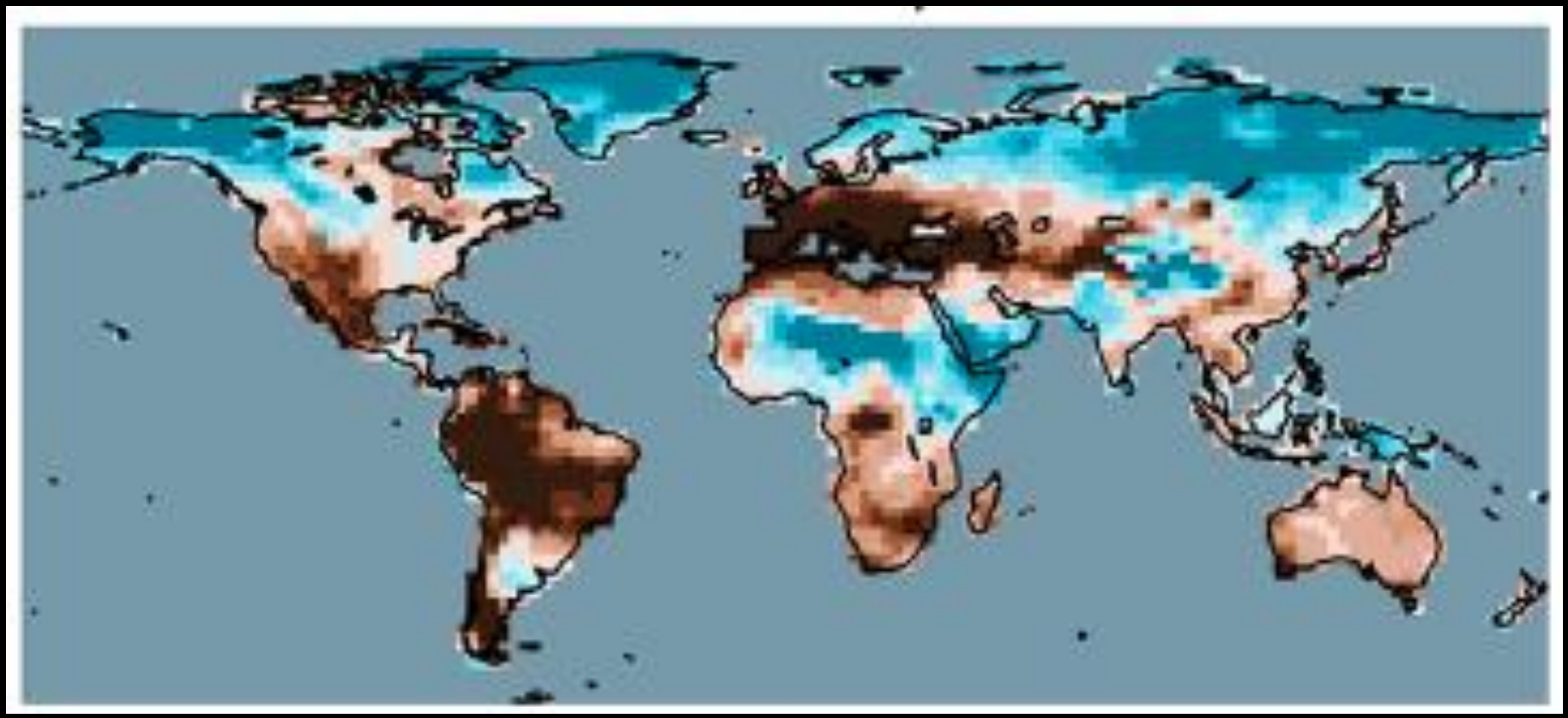
- 3.5 Billion Exposed to Deadly Heat
- 2.4 billion Exposed to Dengue, Chikungunya & 20 Viruses
- Severe wide spread droughts
- Setting the stage for sea level rise > 7 feet (2 meters)
- Velocity of Changes will be too fast
- Multiple Tipping Points for Natural Systems

How do you relate to a 5% probable event?

We are sending our children and grand children on that plane!!

5% Probability: Drought Index for 2080-2099:

NOAA-Princeton Univ Model Study [From Cook et al, 2014):

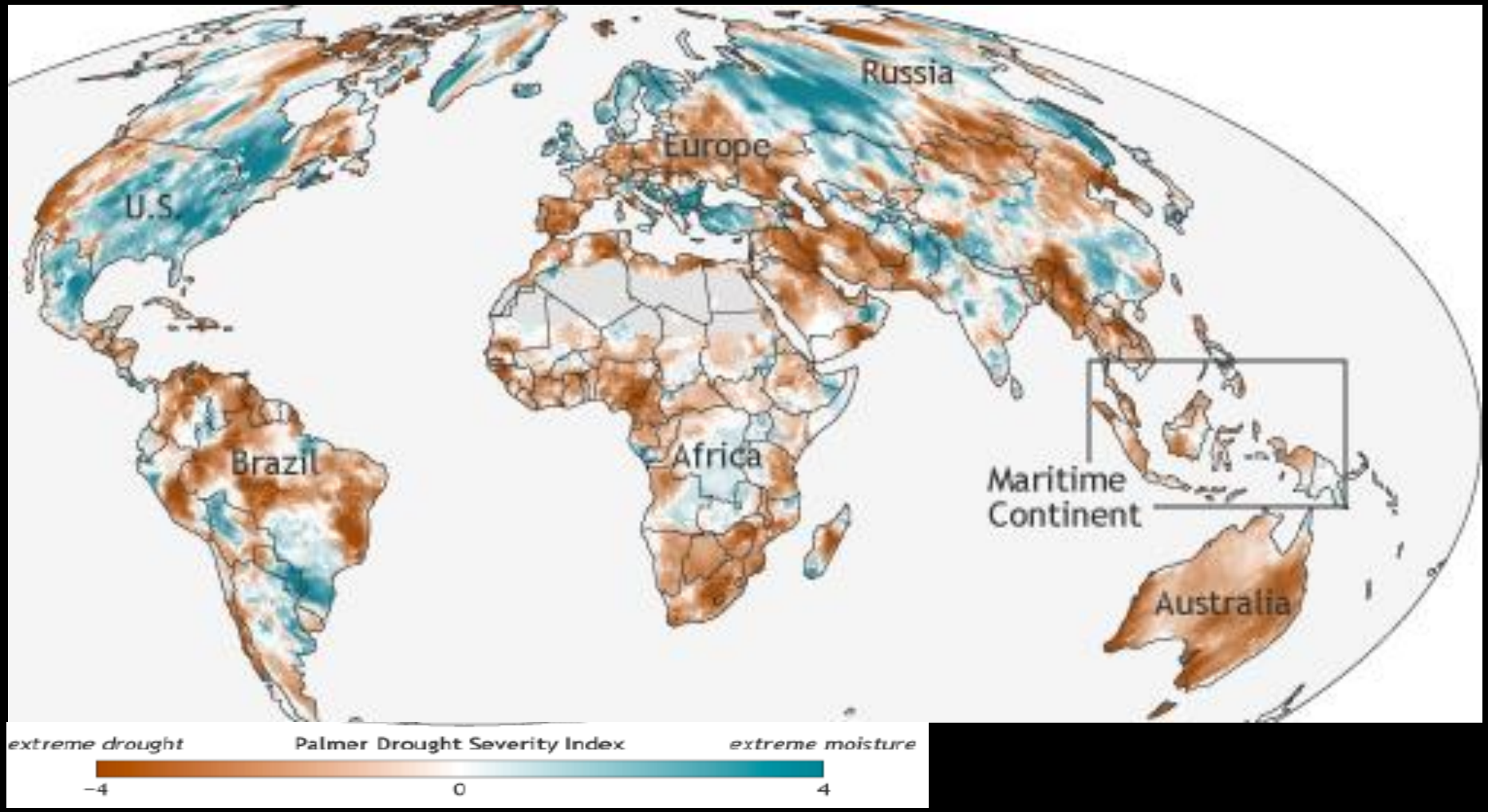


Extreme Severe Moderate Mild

−6 −5 −4 −3 −2 −1 0 1 2 3 4 5 6

Drought in 2015 ***14% land area in severe to extreme drought; highest since record began in 1950.***

climate.gov/print/816791



nature climate change

PERSPECTIVE

PUBLISHED ONLINE: 26 OCTOBER 2012 | DOI: 10.1038/NCLIMATE1562

Clara Deser[1]*, Reto Knutti[2], Susan Solomon[3] and Adam S. Phillips[1]

The Goldilock's Zone: Shrinking

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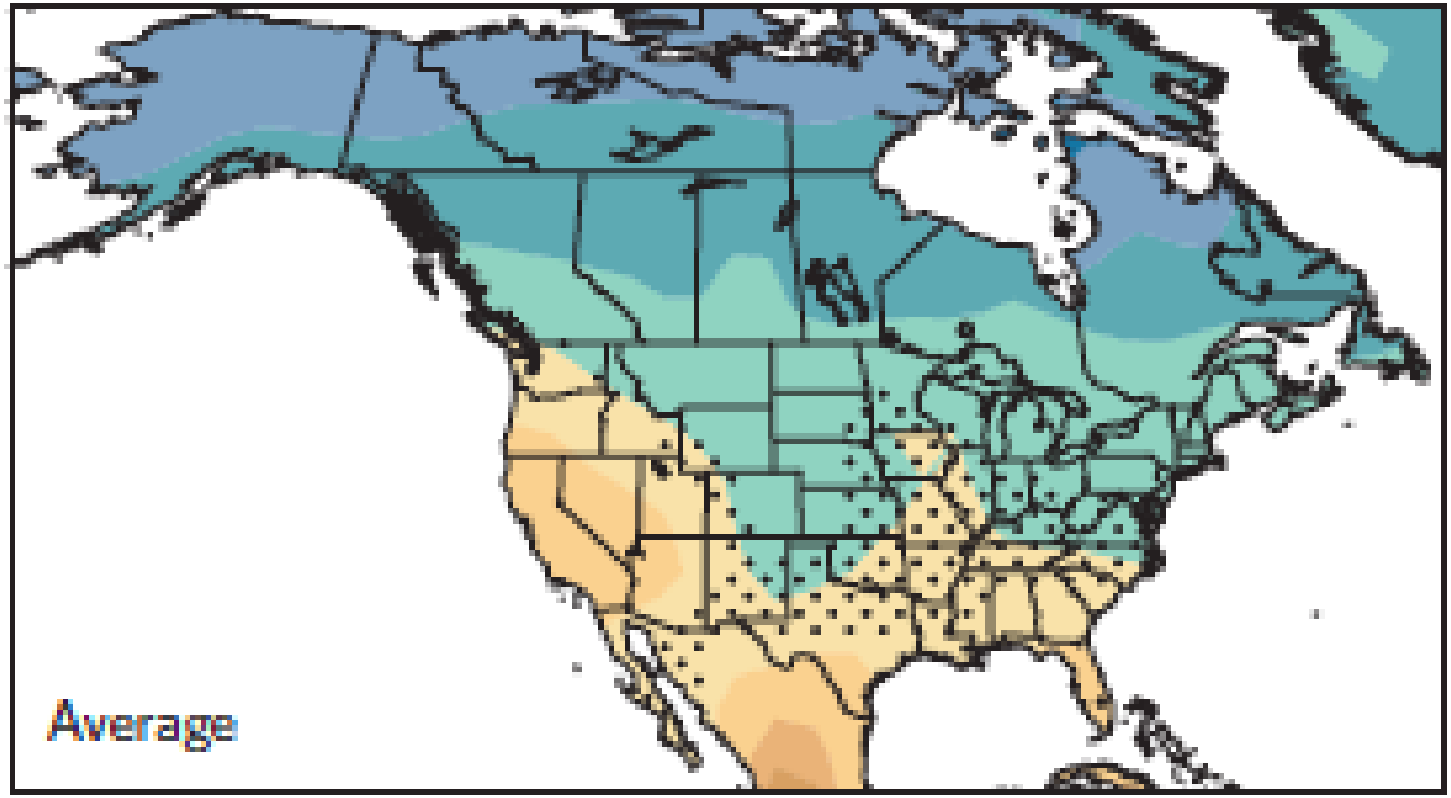


The Pontifical Academy of Sciences

HEALTH OF PEOPLE, HEALTH OF PLANET AND OUR RESPONSIBILITY CLIMATE CHANGE, AIR POLLUTION AND HEALTH

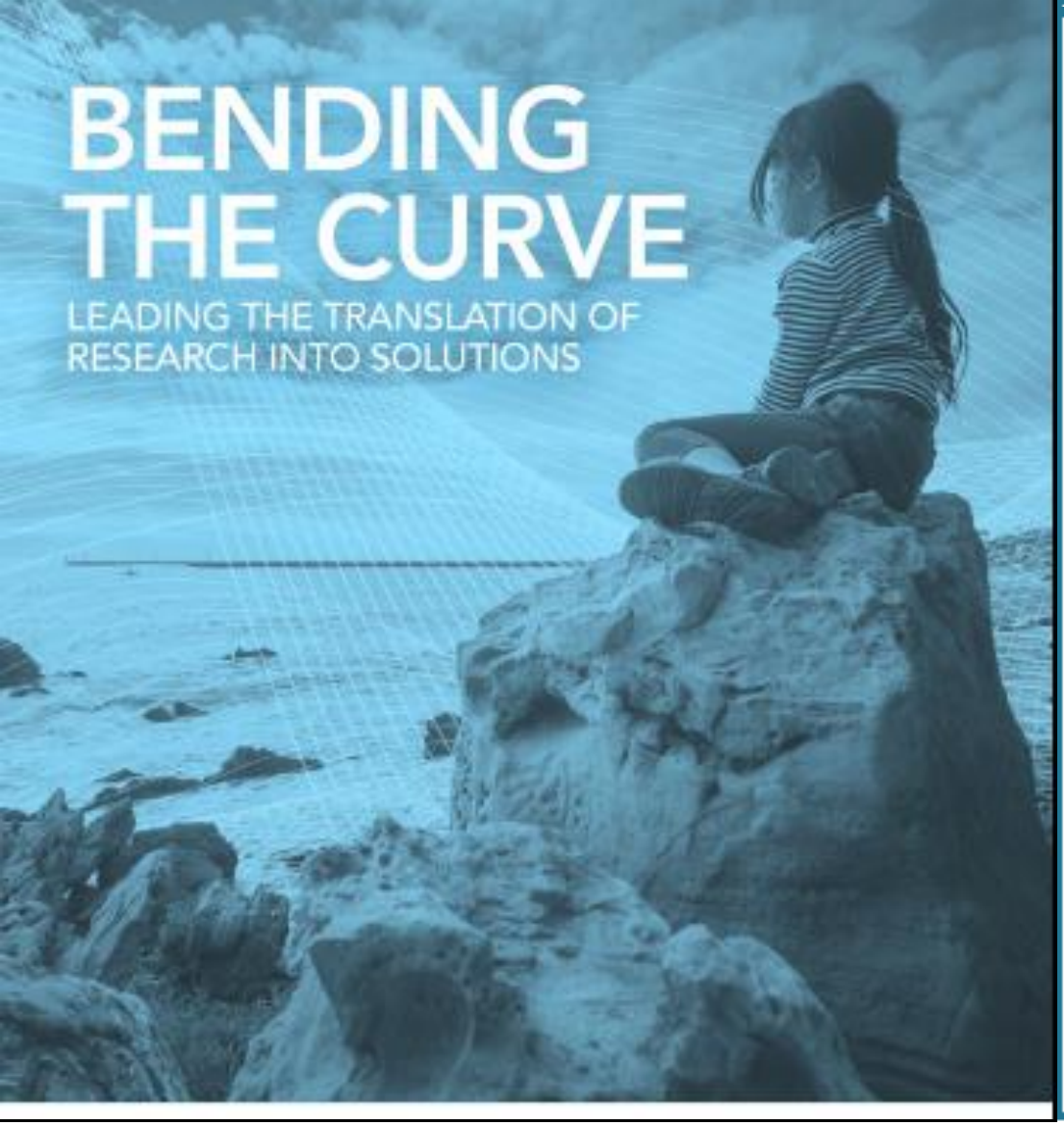
Casina Pio IV • 2-4 November 2017

Fate has put a spirit in his behest
Drives him madly on without a pause
Whose percipitate & rash behest
O'erleaps the joys of Earth & Natural Laws

From: Goethe: Faust

Adapted From: McMichael, 2017

IT'S NOT TOO LATE!

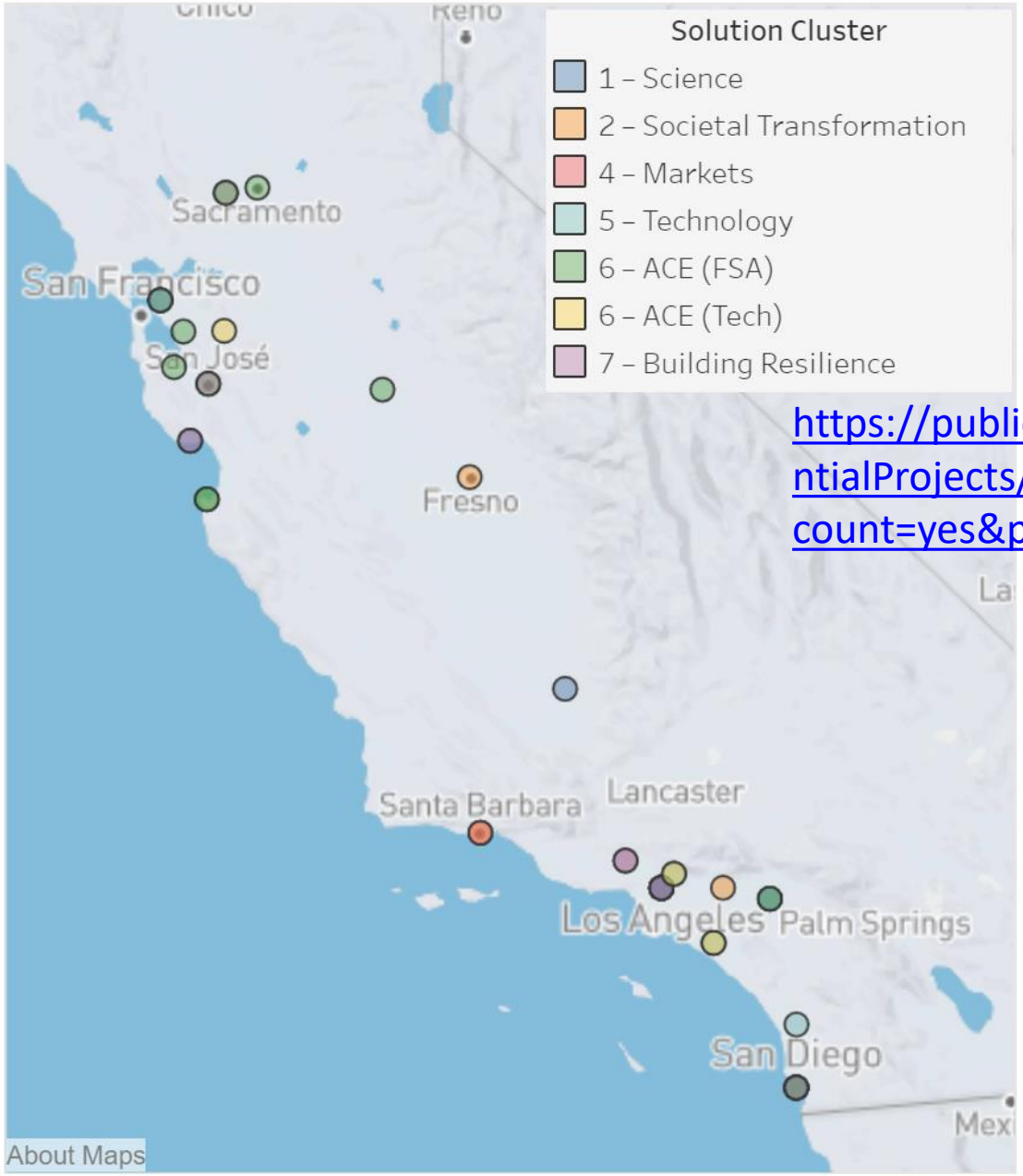


Coming together to solve climate change.

Caltech
CSU Bakersfield
California State University East Bay
Fresno State
Humboldt State University
Cal State LA
California State University Monterey Bay
California State University Northridge
Cal Poly Pomona
Sacramento State
San Diego State University
SJSU San José State University
California State University San Marcos
Columbia University in the City of New York
Sonoma State University
Lawrence Livermore National Laboratory
Berkeley Lab
Stanford University
Berkeley
UC Davis
UC Irvine
UC Merced
Ucla
University of California Office of the President
UC Riverside
UCSB
University of California Santa Cruz
UC San Diego
UC San Diego Extension
USC University of Southern California

California Collaborative for
Climate Change Solutions

Map of Potential Projects



https://public.tableau.com/views/MapsofPotentialProjects/Dashboard1?:embed=y&:display_count=yes&publish=yes

California Collaborative for
Climate Change Solutions

Who We Are

The California Collaborative for Climate Change Solutions (C4S) is a 21st century consortium of researchers and technologists from leading California institutions, including the University of California system, the California National Laboratories, Stanford University, the California Institute of Technology, the California State University System, University of Southern California, as well as government experts, representatives from commercial and non-profit institutions, foundations and donors. Our aim is to work cooperatively to solve climate change for the benefit of people and the planet.

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MISSION STATEMENT

To accelerate the translation of research findings into practical climate solutions, to test innovative technologies through high-impact pilot projects, and to rapidly scale promising solutions to the national and global level.

We are developing a transformational vision and mission, not only for California's role in climate change, but also a vision for the future of the state in a rapidly transforming world.

California Collaborative for
Climate Change Solutions

Characteristics of Solutions

C4S proposes convening experts from the private sector, academia and government to devise a core set of demonstration projects which meet the C4S mission statement and criteria of producing local benefits with global impact. The demonstration projects will include: massive transformation of society through innovative education projects targeting schools, colleges and adult education; testing advanced mini and micro grids of renewable power generation; developing hydrogen generated using solar energy as energy carrier; carbon extraction through soil restoration; innovative agriculture practices to reduce emissions of GHGs such as nitrous oxide and methane; restoration of soils and forests to capture atmospheric carbon; among others. The projects would address the following solutions clusters:

Start by doing what's necessary; then do what's possible; and suddenly you are doing the impossible.

— Francis of Assisi

CLUSTER 1
Science Solutions Cluster
Develop robust monitoring and evaluation of demonstration projects.

CLUSTER 2
Societal Transformation Solutions Cluster
Create a massive increase in public support for climate mitigation.

CLUSTER 3
Governance Solutions Cluster
Ensure local and state efforts are ambitious enough for the challenge.

CLUSTER 4
Market Mechanisms & Instruments Solutions Cluster
Ensure solutions promote a just transition for all Californians as well as a future climate-smart workforce.

CLUSTER 5
Technology Solutions Cluster
Find the innovative technologies that have maximum impact.

CLUSTER 6
Restoration of Agriculture, Forests and Soils
Ensure efforts focus on reducing GHG's from natural and managed lands and extraction of atmospheric carbon.

CLUSTER 7
Mitigating Impacts on Californians
Ensure Californians are given the resources to adapt to the existing impacts of climate change.

The first seven clusters were taken from the University of California's Bending the Curve Report (https://uc-carbonneutralitysummit2015.ucsd.edu/_files/Bending-the-Curve.pdf) and were motivated in part by the California experience in curbing air pollution emissions, as well as the bold steps the State has recently taken to bend the carbon curve. The core objective of C4S is to develop scalable solutions for all six clusters. These solutions represent an integrated approach that includes familiar goals for achieving carbon neutrality through renewable energy, with new goals for reducing short-lived climate pollutants immediately; building on California's success to encourage sub-national governance, regulations, and market-based instruments; and pursuing innovative approaches in education, communication, and incentives to encourage attitudinal and behavioral changes.

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C4S will pull on four levers to drastically reduce climate pollution and bend the warming curve below 1.5°C.

THE CARBON LEVER
We have to pull on this lever to bring down carbon emissions to zero by 2060. This can be achieved by converting ALL end uses to electricity and generating the electricity by solar, wind, geothermal, hydro, and nuclear as fuels, except in the case of aircraft where liquid fuels or hydrogen made of renewables have to be used.

SHORT LIVED CLIMATE POLLUTANTS LEVER
The SLCPs lever is needed to reduce emissions by 50% to 100%. Off the shelf technologies are mostly available for the SLCPs but they have to be improved for scalability.

LONG LIVED CLIMATE POLLUTANTS LEVER
The other major non-CO_2 long-lived climate warming pollutant is nitrous oxide emitted by agriculture. Agriculture also emits methane (an SLCP). New techniques and bottom-up innovations are being developed to reduce N_2O emissions from agriculture, promoting healthy soils without reducing crop yields.

ATMOSPHERIC CARBON EXTRACTION LEVER
The ACE (Atmospheric Carbon Extraction) lever is required to pull and extract the CO_2 that will be emitted beginning 2018 until the time we reach carbon neutrality.

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The C4S Platform

There are currently many efforts to pull on all four levers but they are largely uncoordinated. The fundamental goal of C4S is to drastically reduce the time it takes from knowledge creation to actions in the field and thus accelerate the process of deploying scalable solutions within the state and in turn to rest of the nation. Towards this goal, C4S proposes to build a multi-institutional platform for climate actions and demonstration projects that will leverage existing research activity and expertise to attract additional intellectual and financial capital to address this complex challenge. The platform will consist of a coalition of innovators from academic, governmental, social, commercial and non-profit institutions in California that will test the efficacy of individual climate innovations for scalability, cost effectiveness and user-friendliness. The platform will focus on five major objectives:

Applied Knowledge Creation

Work with the California academic community (public and private) to innovate and develop shovel-ready technology and education solutions and pilot projects.

Fund Generation

Engage state agencies, Under2 MOU jurisdictions, entrepreneurs, federal agencies and foundations to ensure adequate funding for demonstration projects.

BETA Testing

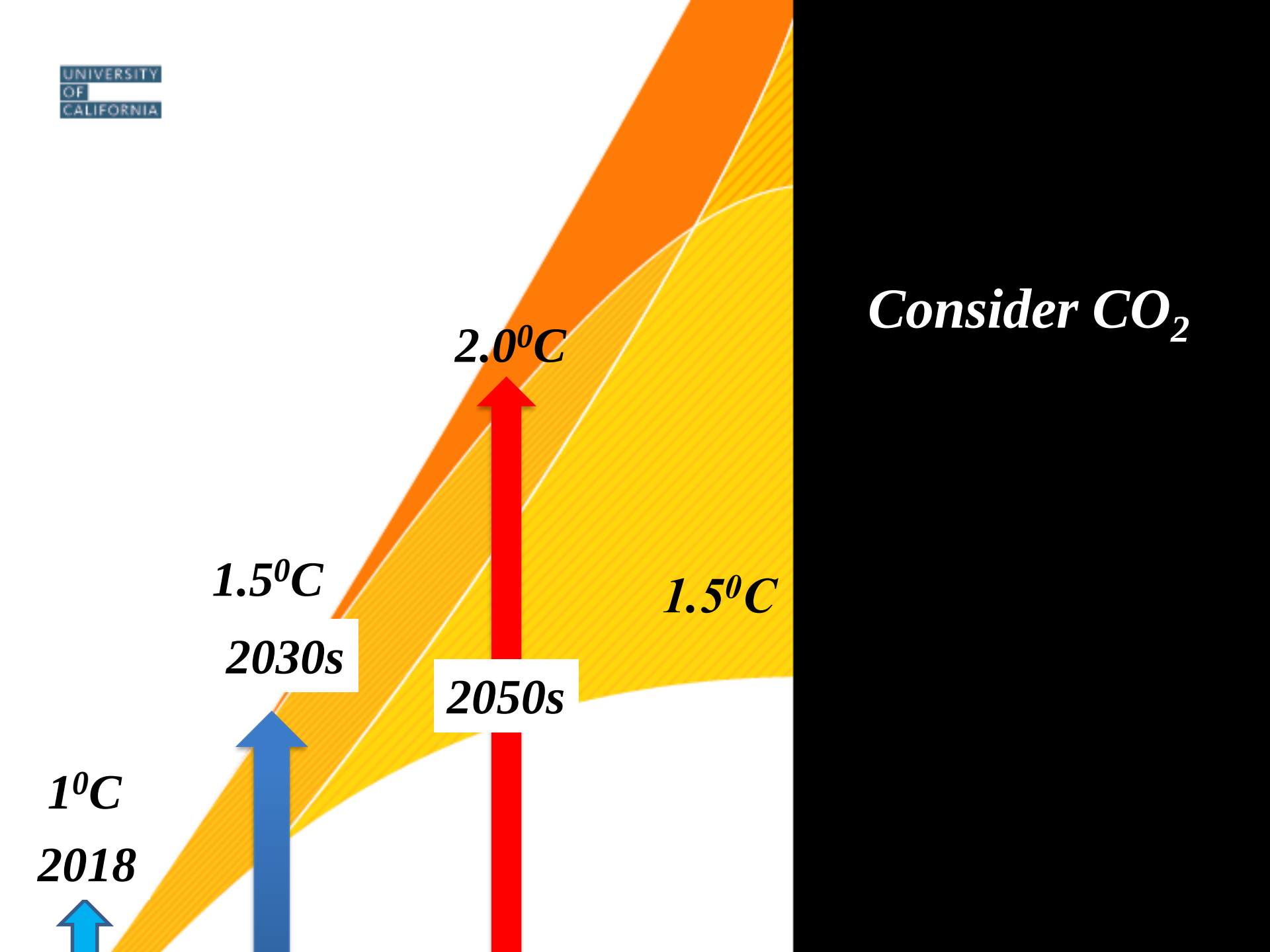
Work directly with industries, California academic institutions, mayors of cities who signed the 100% by 2035 renewables pledge, and other jurisdictions to successfully implement demonstration projects.

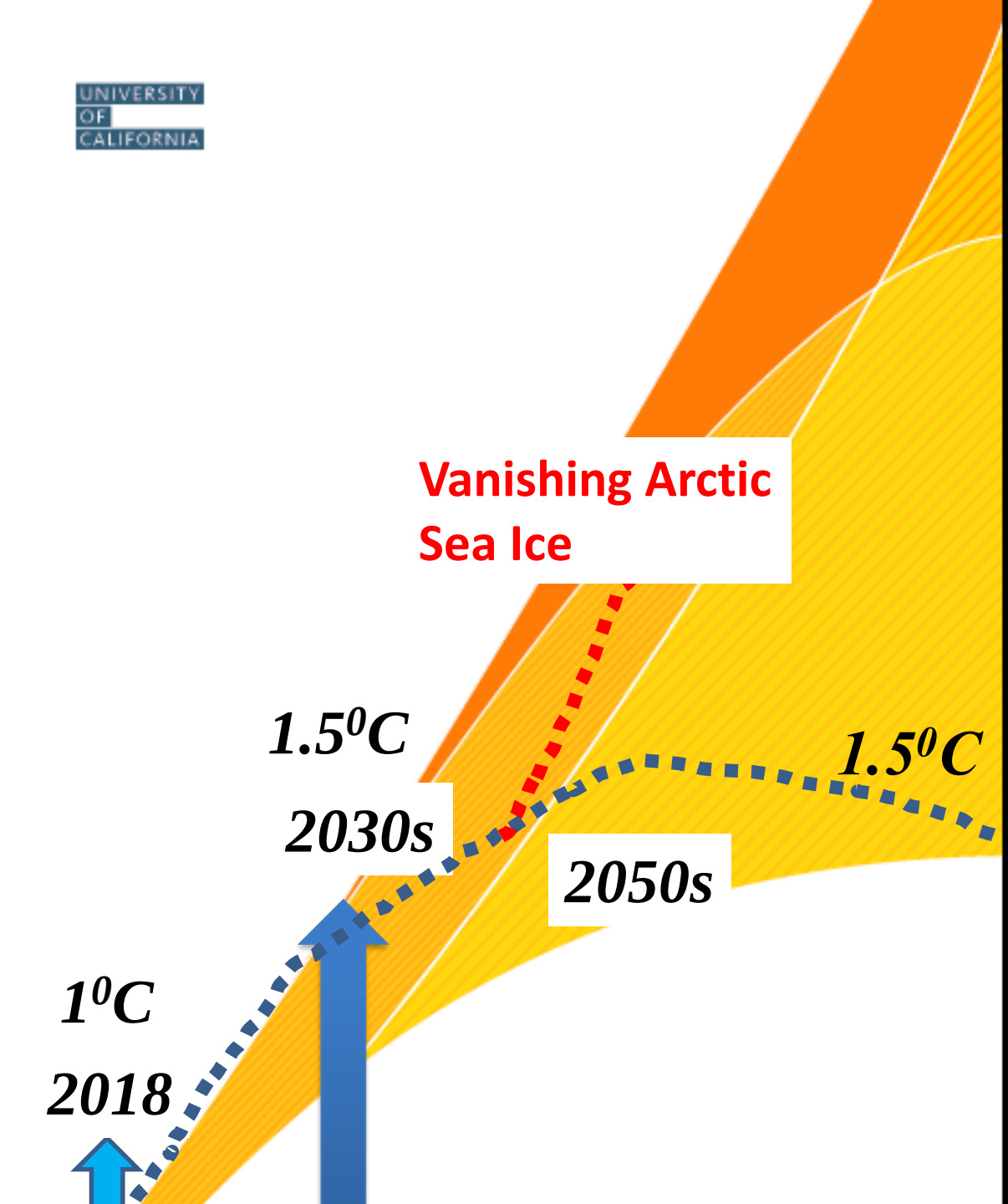
Private-Public Partnership

Work with industries, foundations and state and local governments to accelerate, broaden and deepen commercialization in the early-adopter market.

Open Access

Create an open data portal and transparent selection process with a collaborative governance model, in which criteria will center on creating local benefits for Californians in terms of job creation, resilience, public health with potential global GHG reductions at scale.


UNIVERSITY OF CALIFORNIA
2.0⁰C
1.5⁰C
2030s
1.5⁰C
2050s
1⁰C
2018
Consider CO_2



Consider CO_2

2 Minutes Parking Lot Pitch

May 06, 2014

A New Alliance Between Science, Religion And Policy

April 28th 2015 Summit With The United Nations

Human-induced climate change is a scientific reality, and its decisive mitigation is a moral and religious imperative for humanity;

In this core moral space, the world's religions play a very vital role. These traditions all affirm the inherent dignity of every individual linked to the common good of all humanity. They affirm the

Omaha, Nebraska. *February 21, 2018*

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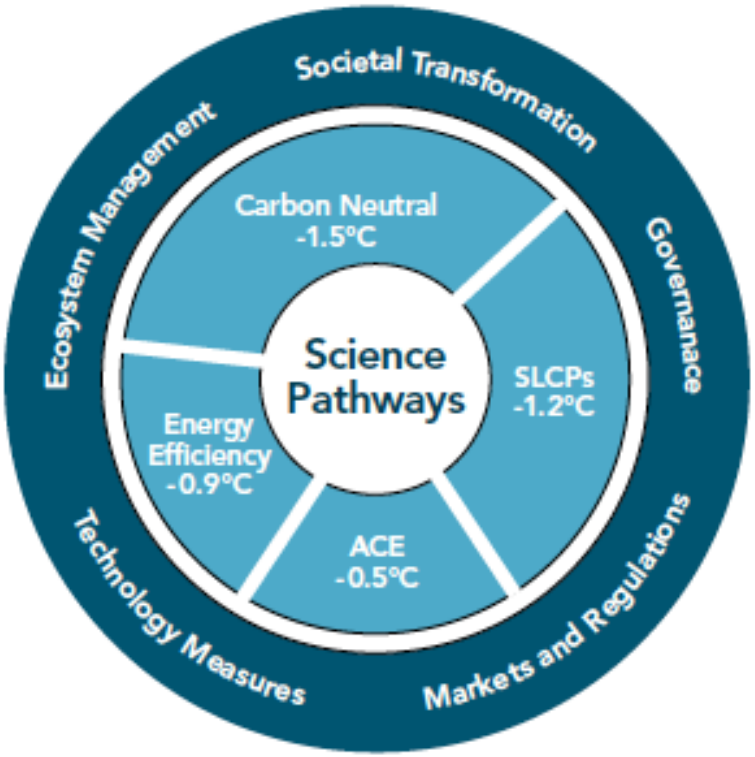
Cooling and Stabilizing Climate

The magnitude of potential cooling by 2100 that can be achieved by the Carbon lever, Short Lived Climate Pollutants lever, and Atmospheric Carbon Extraction lever if implemented well before 2030. Energy efficiency by itself can cool only by 0.9°C.



Projections for 2100