

White Roofs to Cool your Building, your City and (this is new!) Cool the World

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California Energy Commission.

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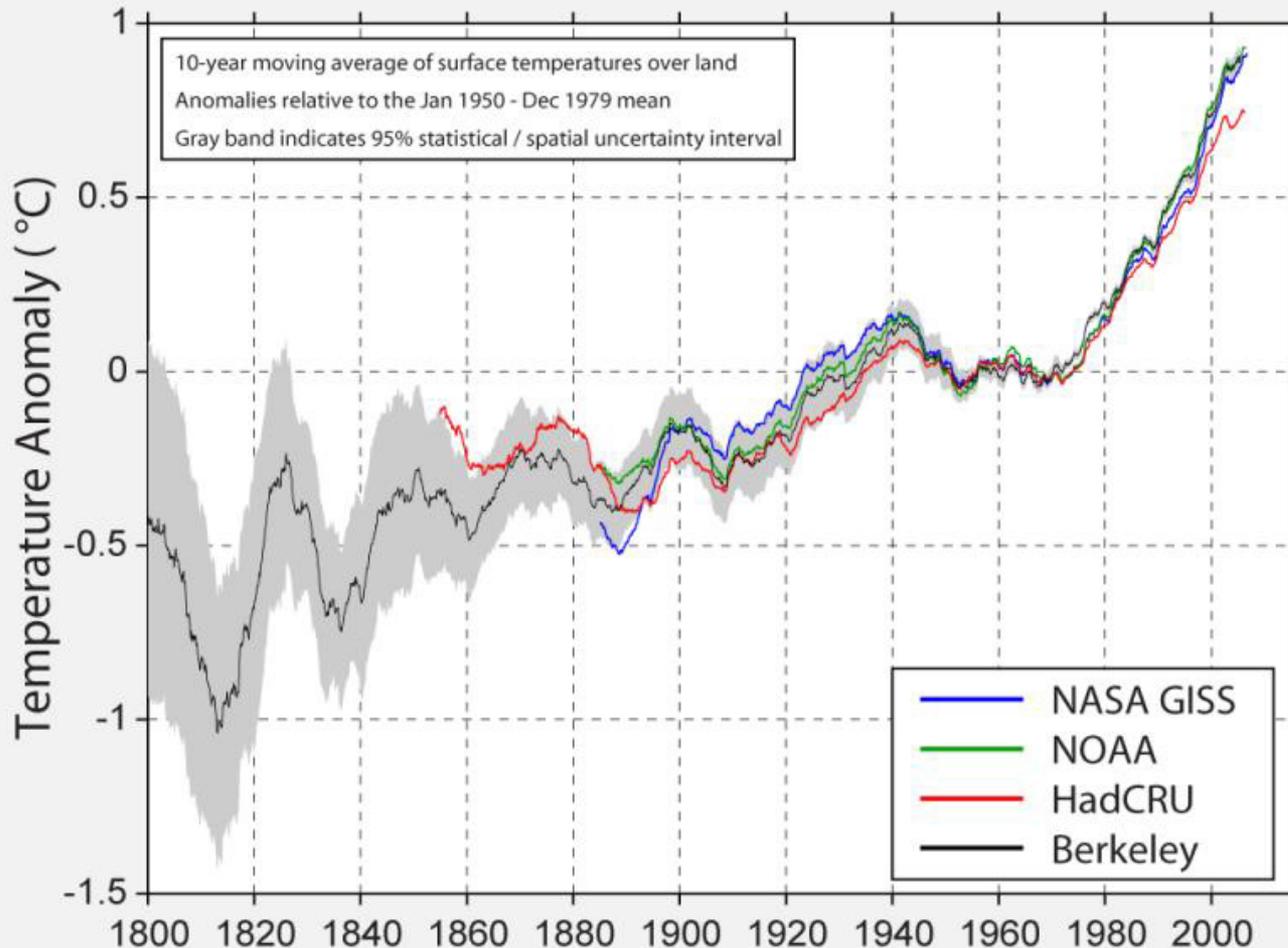
510 495-2227

Presented by Kurt Shickman, Executive Director, Global Cool
Cities Alliance

Presentation available at www.ArtRosenfeld.org

Berkeley Earth Surface Temperature Project

Decadal Land-Surface Average Temperature



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Robert Rohde
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Donald Groom
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Jonathan Wurtele

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Elizabeth Muller

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Novim, U. Calif. Berkeley,
Lawrence Berkeley Lab,
Georgia Tech, Oregon
State

preprints and merged data now online at www.BerkeleyEarth.org

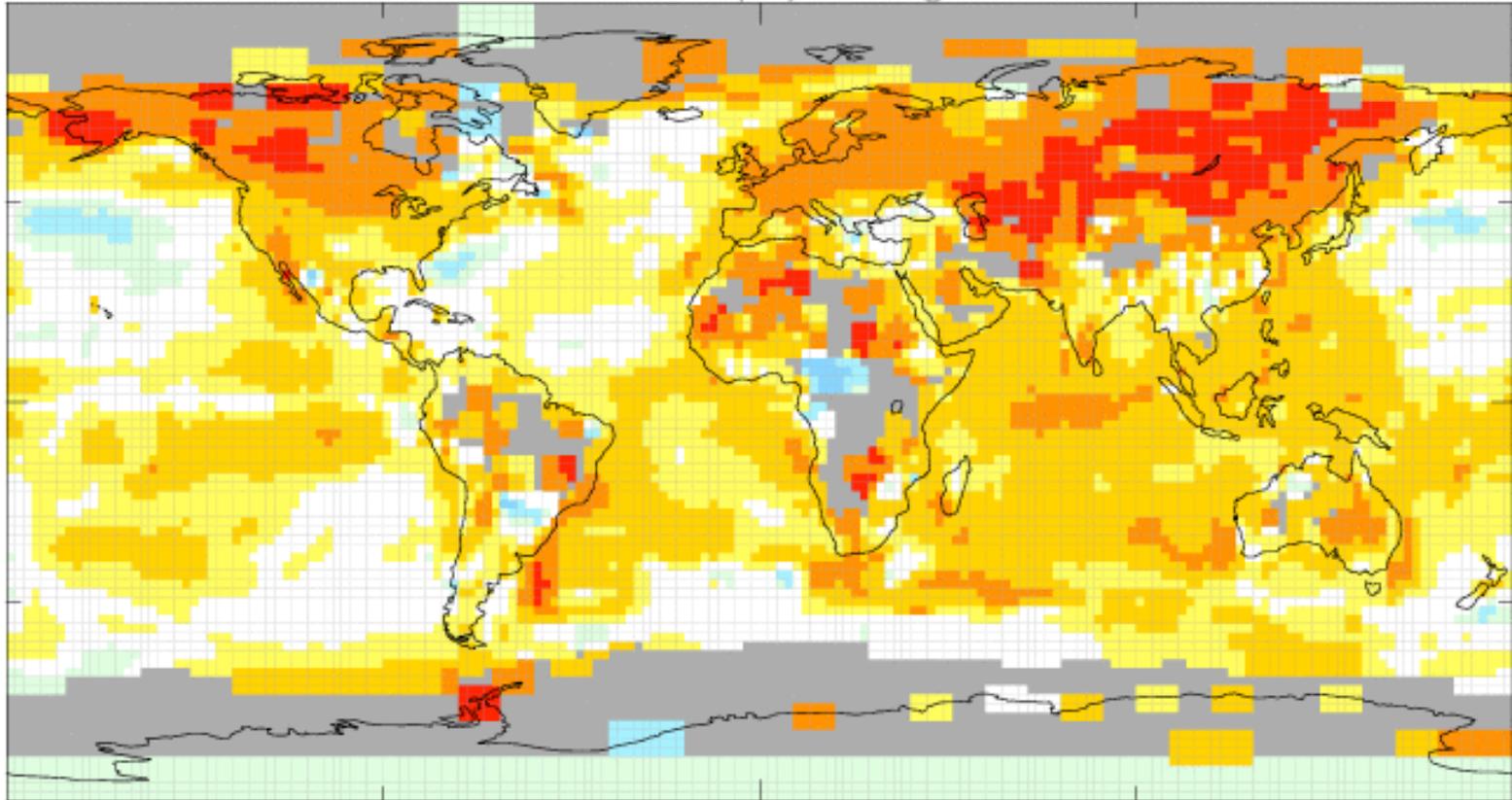


The Planet is Warming

Annual J-D

L-OTI(°C) Change 1950-2008

.56

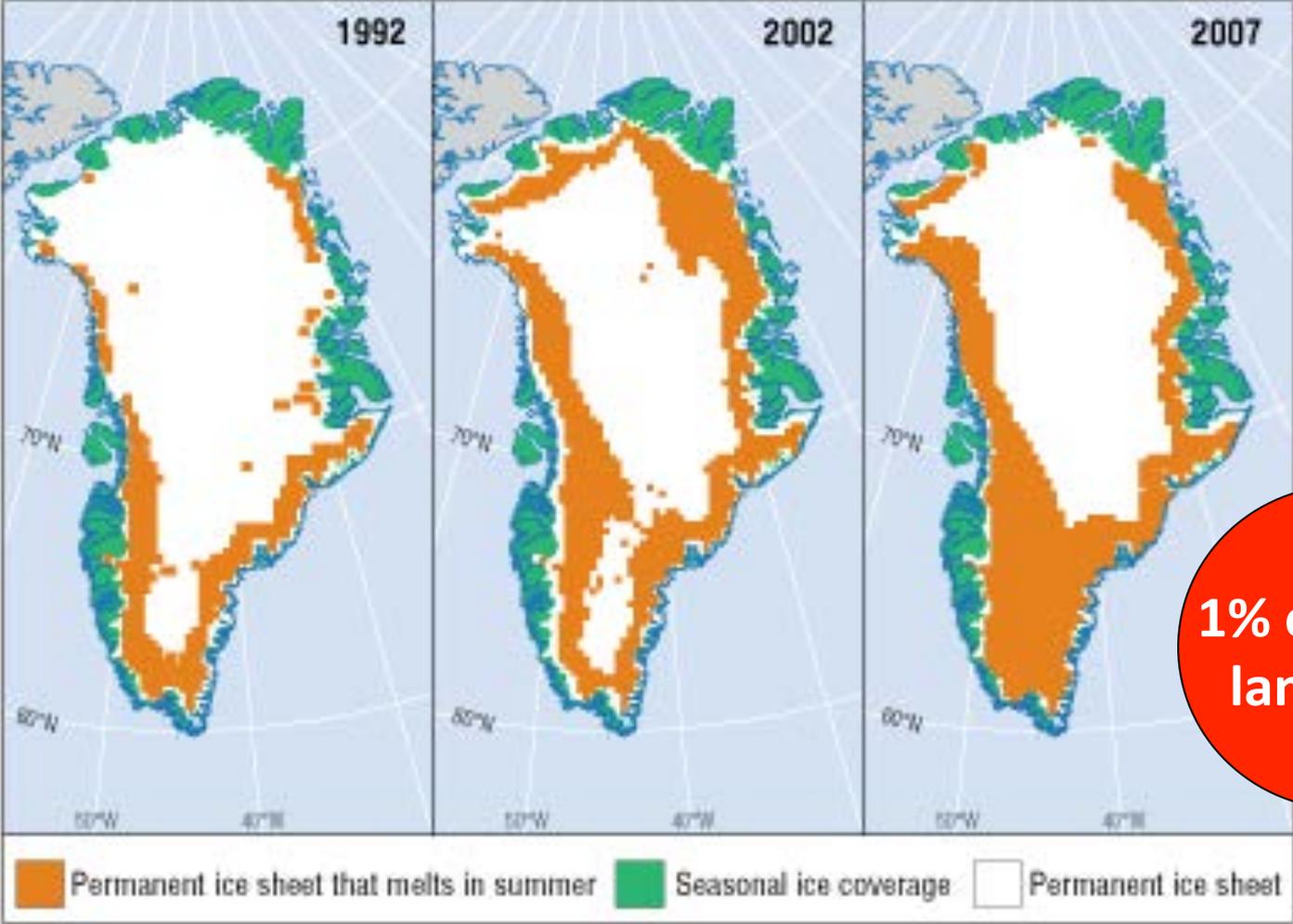


Source: NASA

Greenland is about $\frac{1}{4}$ the size of continental US



Permanent ice sheet has melted substantially



1% of world land area

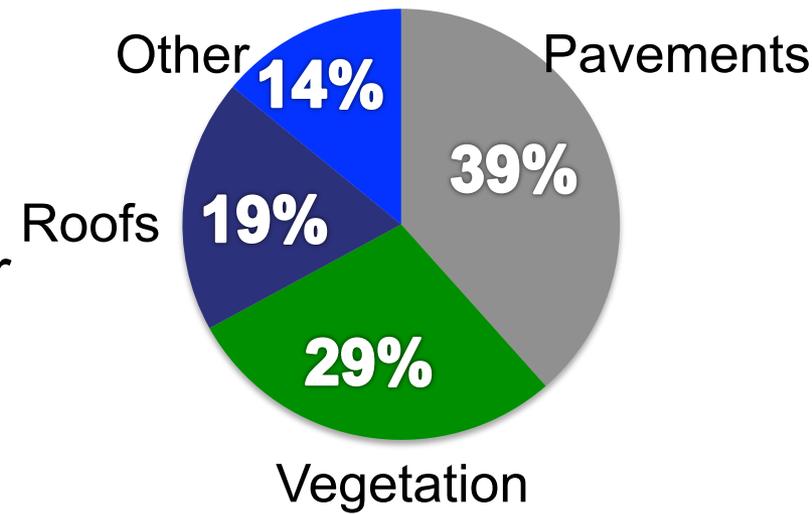
(Comparable to global urban space)

<http://hungerreport.org/2010/report/chapters/four/making-the-connections>

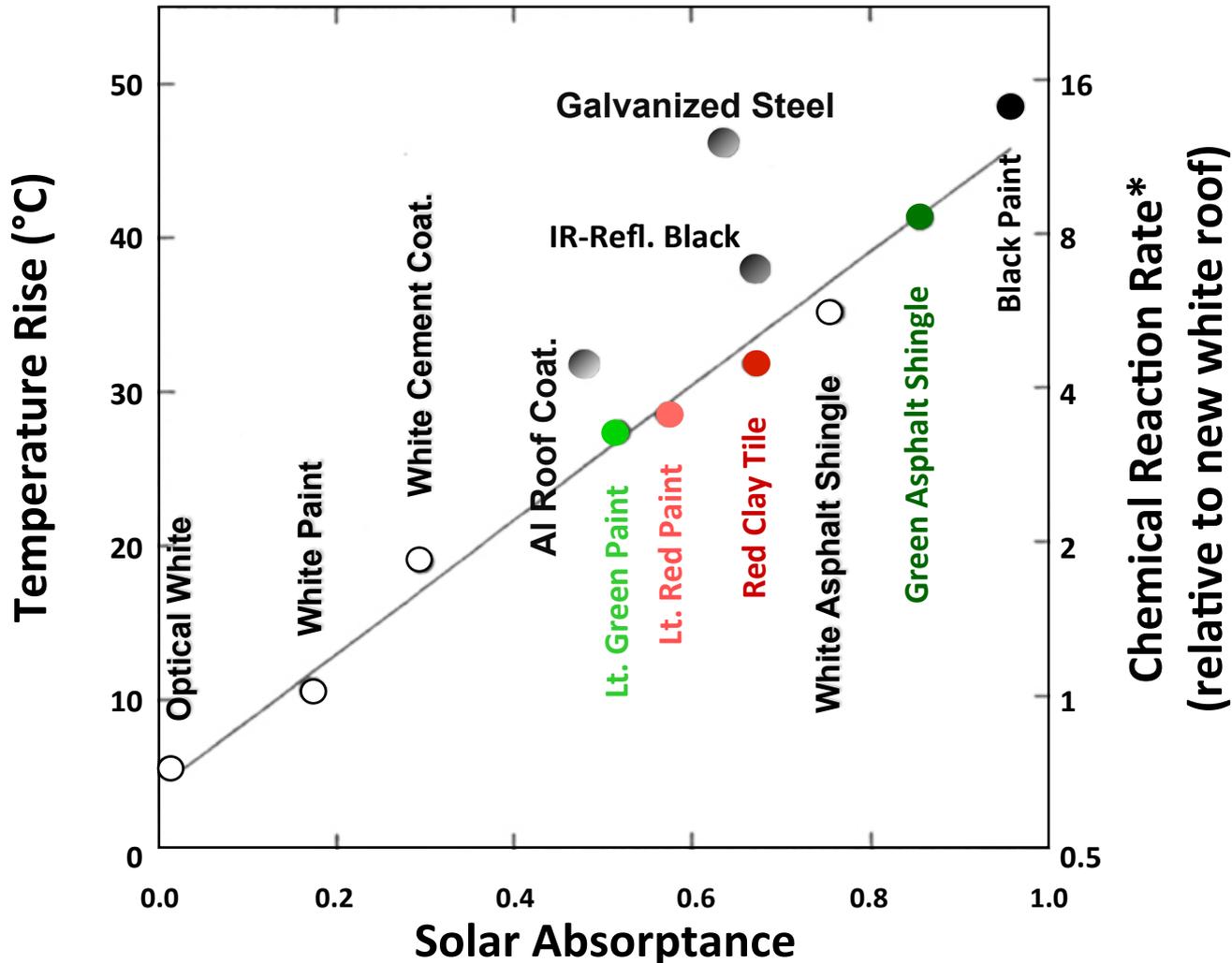
Especially in cities, thanks to the urban heat island effect

- Human activity, combined with dark roofs and pavements, make cities hotter than surrounding rural areas.
- Higher temperatures lead to greater energy use, lower air quality, and a reduced quality of life in urban areas.

Urban Fabric above tree canopy



Reflective roofs stay cooler in sunlight
and should age more slowly



White roofs, cool-colored roofs save money and can even avoid the need to air condition

OLD



flat, white



pitched, white

NEW



pitched, cool & colored

1995: Chicago Heat Wave, 739 **reported*** deaths

The highest risk group lived on the top floors of buildings with black roofs

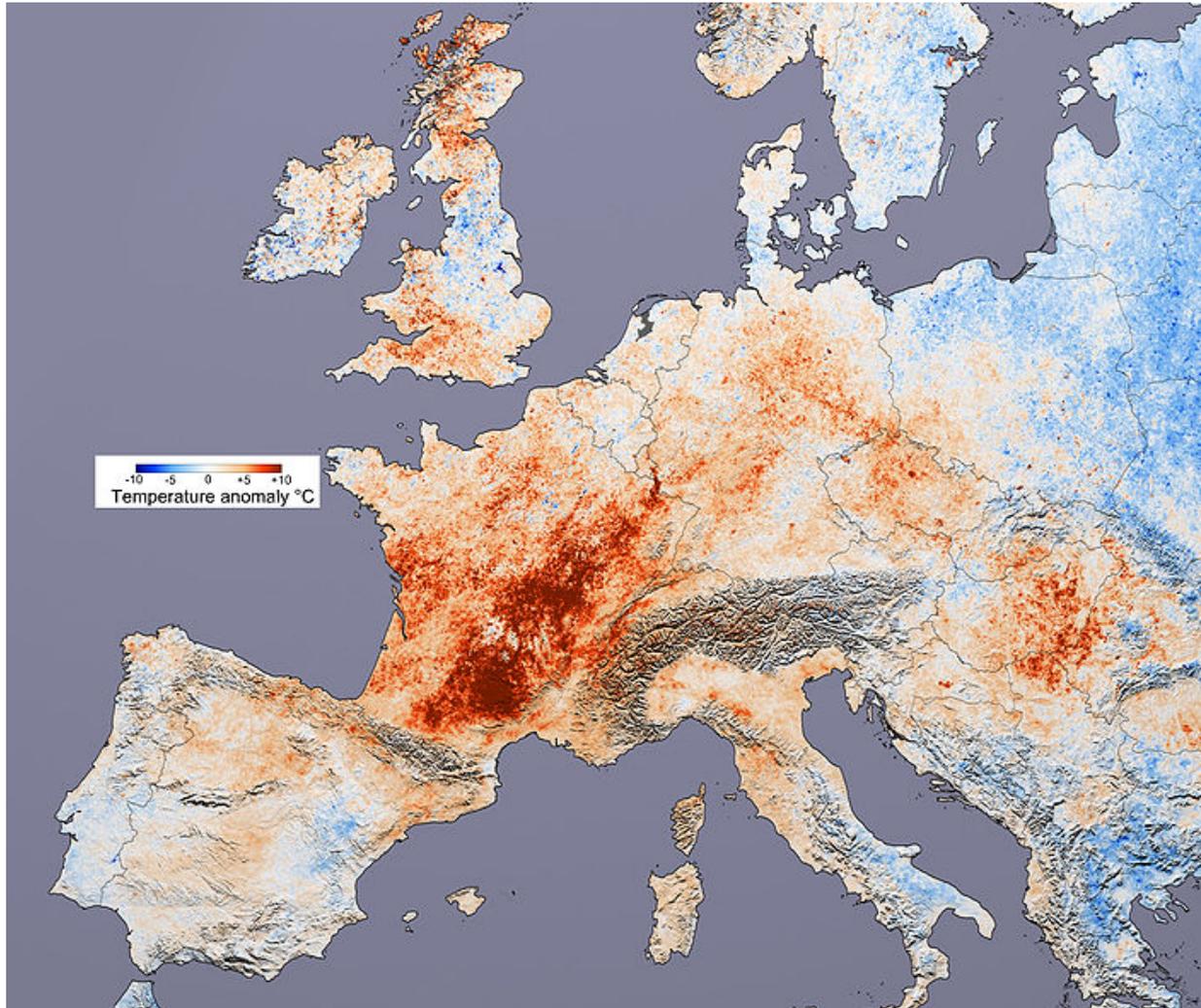


*** More than 250 additional deaths not autopsied**

Aug. 2003: European heat wave

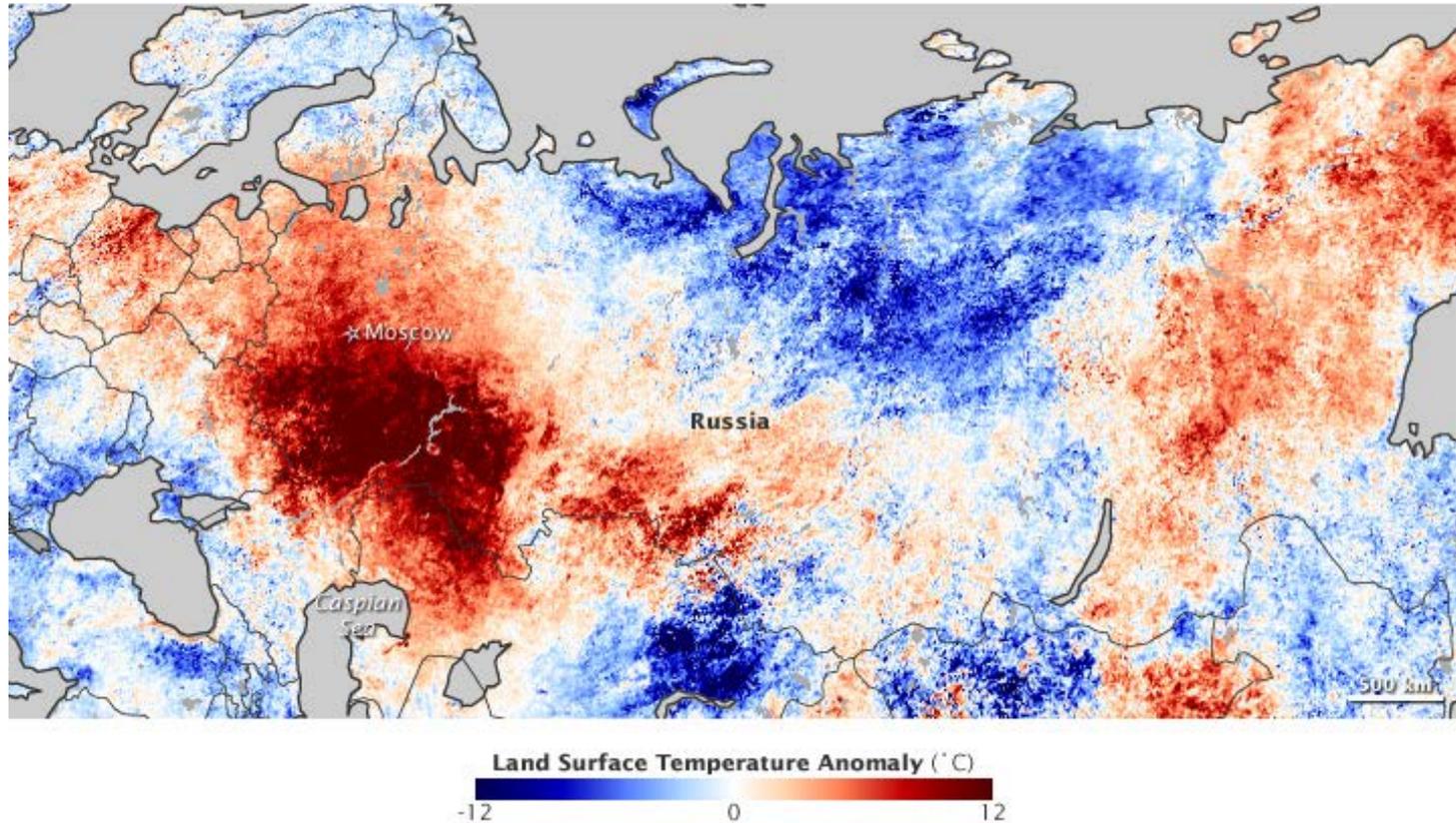
Temperature anomalies reached 10°C

52,000 Europeans died—18,000 Italians (2006 assessment)



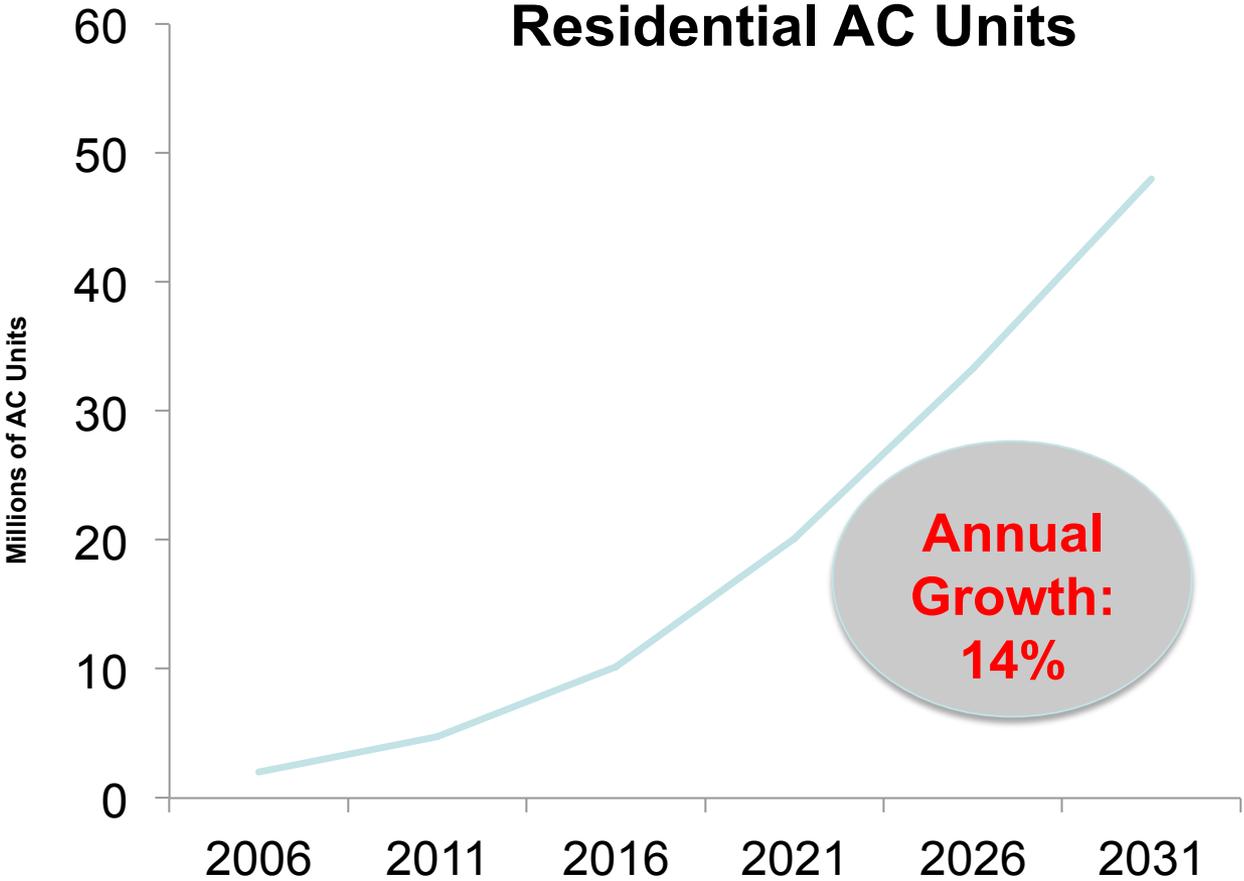
Country	Fatalities
Italy	18,257
France	14,802
Germany	7,000
Spain	4,130
England & Wales	2,139
Portugal	2,099
Smaller countries	4,025
Total of above	52,452

2010: Heat wave centered Southeast of Moscow
Temperature **anomalies** reached 12°C
10,000-15,000 deaths



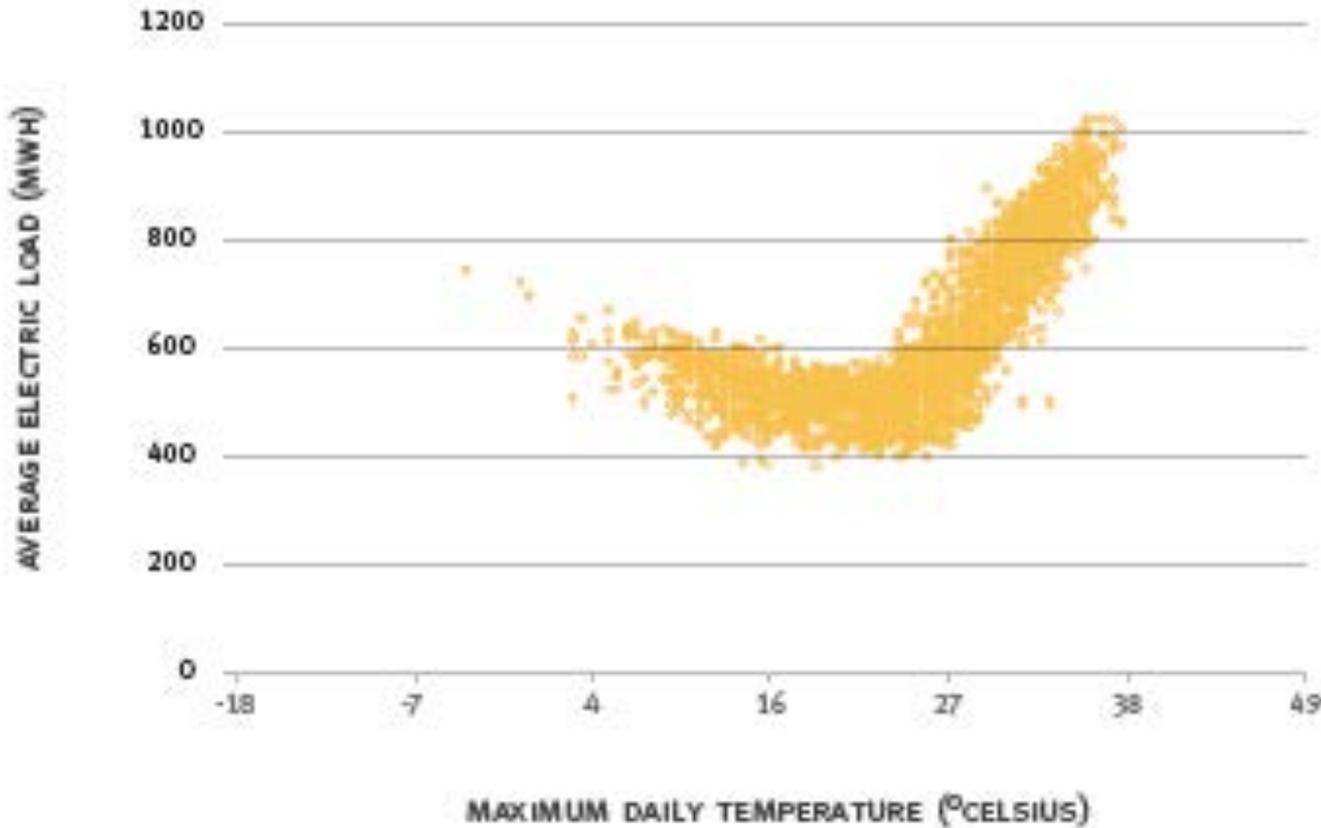
<http://takvera.blogspot.com/2011/10/climate-change-fractional-attribution.html>

New AC Load: India



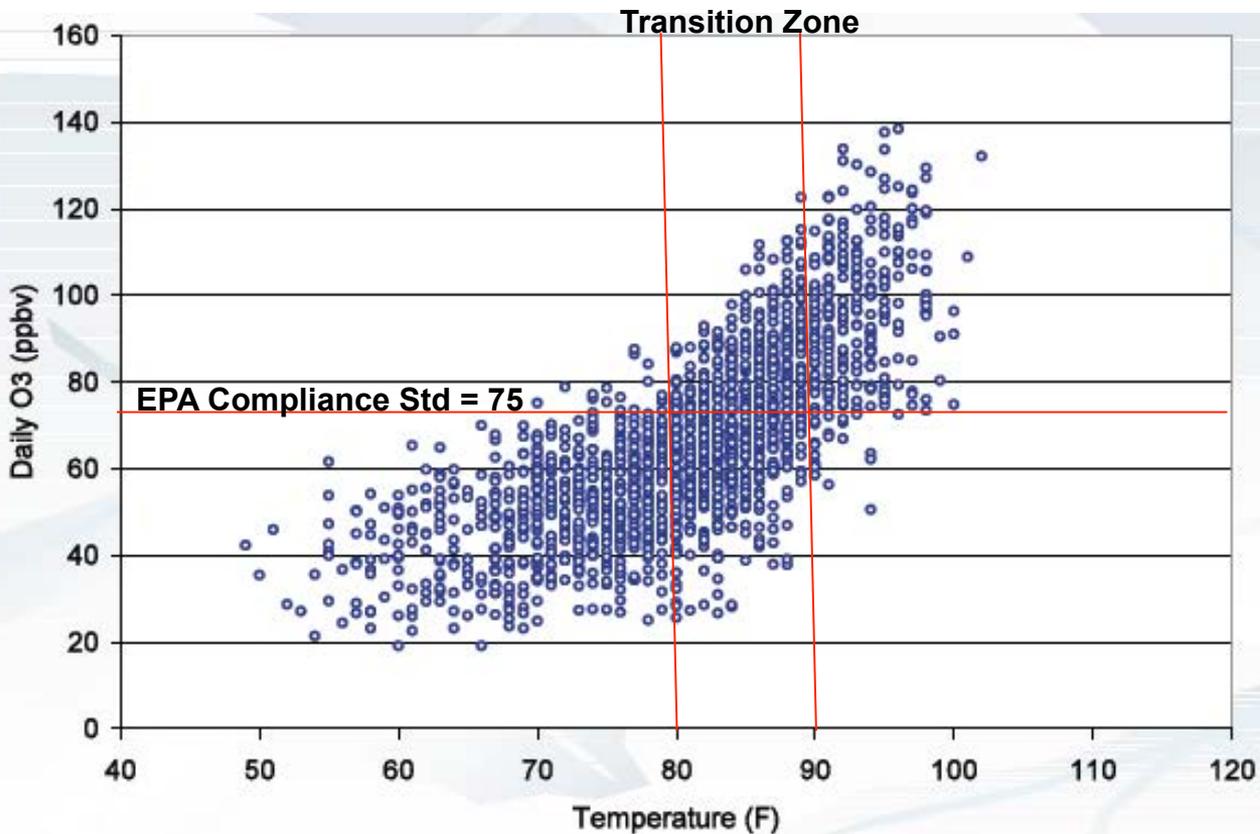
Source: World Bank

Electricity Load and Temperature



Adapted from Sailor, D. J. 2002. Urban Heat Islands, Opportunities and Challenges for Mitigation and Adaptation. Sample Electric Load Data for New Orleans, LA (NOPSI, 1995). North American Urban Heat Island Summit. Toronto, Canada. 1–4 May 2002. Data courtesy Entergy Corporation.

Smog Formation and Temperature



Maximum surface temperature at BWI versus peak 8-hr ozone concentrations in the Baltimore non-attainment area for the period May-September, 1994-2004 (Piety, 2007).

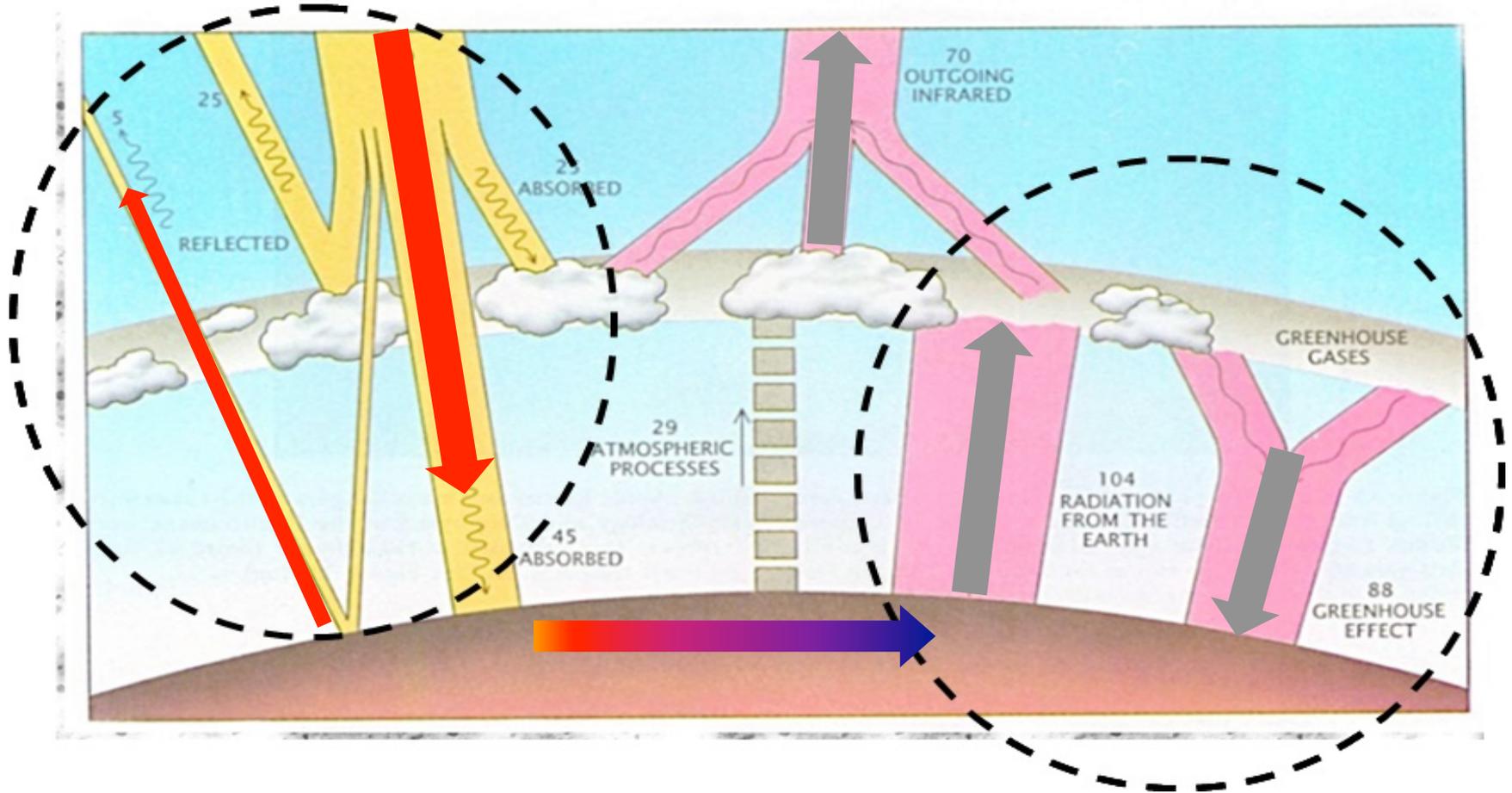
A Real-World Example of Cooling



The whitewashed greenhouses of Almeria, Spain have cooled the region by 0.8 degrees Celsius each decade compared to surrounding regions, according to 20 years of weather station data.

Cooling our planet

Solar-reflective surfaces cool the globe via “negative radiative forcing”



Source: Intergovernmental Panel on Climate Change (IPCC)

GLOBAL COOLING: whitening 100 m² (~1000 ft²) of gray roofing cancels out the **emission** of 10 t of CO₂



How much CO₂ equivalent is offset if we whiten all eligible urban flat roofs world-wide? (i/ii)

- Answer: **24 Gigatonnes (Gt)**
 - 2/3 of a year's worldwide emission
 - Gigatonne = billion metric tons
- If implemented over 20 years (the life of a roof or a program) this is \approx 1.2 Gt/year.

How much CO₂ equivalent is offset if we whiten all eligible urban flat roofs world-wide? (ii/ii)

- Offset is equivalent to **taking half the cars in the world off the road for 20 years.**
 - There are about 600 million passenger cars world wide, and they each emit ≈ 4 t CO₂/year.



In terms of avoided power plants

- Full white roof potential avoids **500** medium-sized coal fired power plants or **1,000** medium-sized gas fired power plants
- For comparison, global power plants emit annually ~15 Gt CO₂, equivalent to the output of **6,000** typical midsized power plants (2/3 coal, 1/3 gas)
- Further comparison – the real avoided emissions from global CFL deployment is equivalent to **400** power plants.

Addressing Urban Heat Islands Help to Achieve Goal of Sustainable and Resilient Urban Areas

Building Scale

- Up to 20% reductions in cooling demand on top floor.
- Improved thermal comfort and productivity in unconditioned buildings (e.g., homes, warehouses etc.).
- Longer lasting roofs.

Urban Scale

- Improved air quality – a \$10 billion energy and health cost reduction opportunity in the U.S. alone per year.
- Reduced peak electricity demand and avoided adoption of air conditioning.
- Greater resiliency to heat events and climate change.

Global Scale

- Offset the warming effect of 24 gigatons of CO₂ – equivalent to taking 500 coal power plants offline for 20 years.
- Every 10 square meters of white roof = 0.5 tons of CO₂ offset per year.

White roofs around the world

...in Santorini, Greece



...in Hyderabad, India

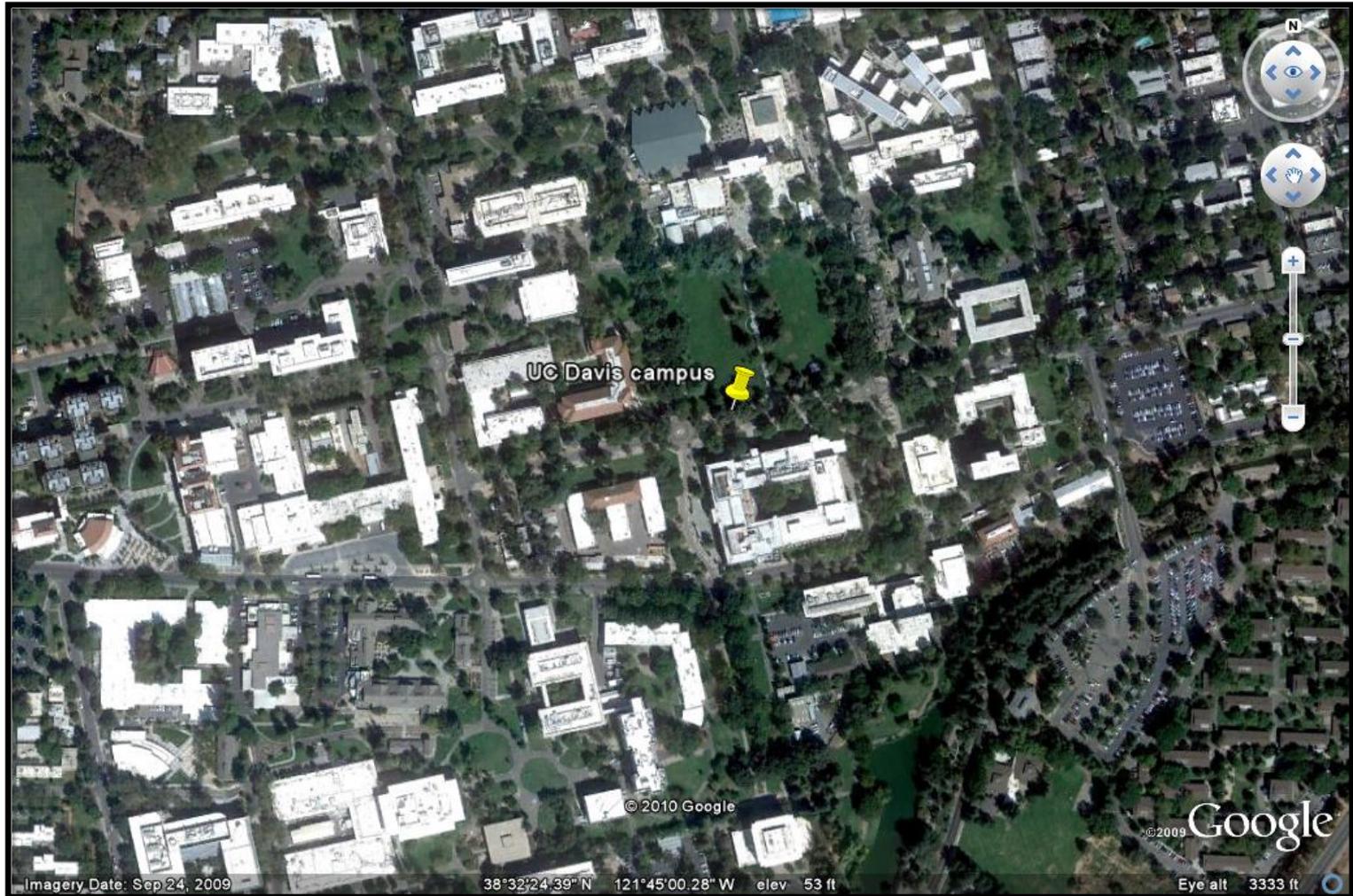


**...and widely
in the state of
Gujarat, India.**

Walmart store in northern California, ~2006



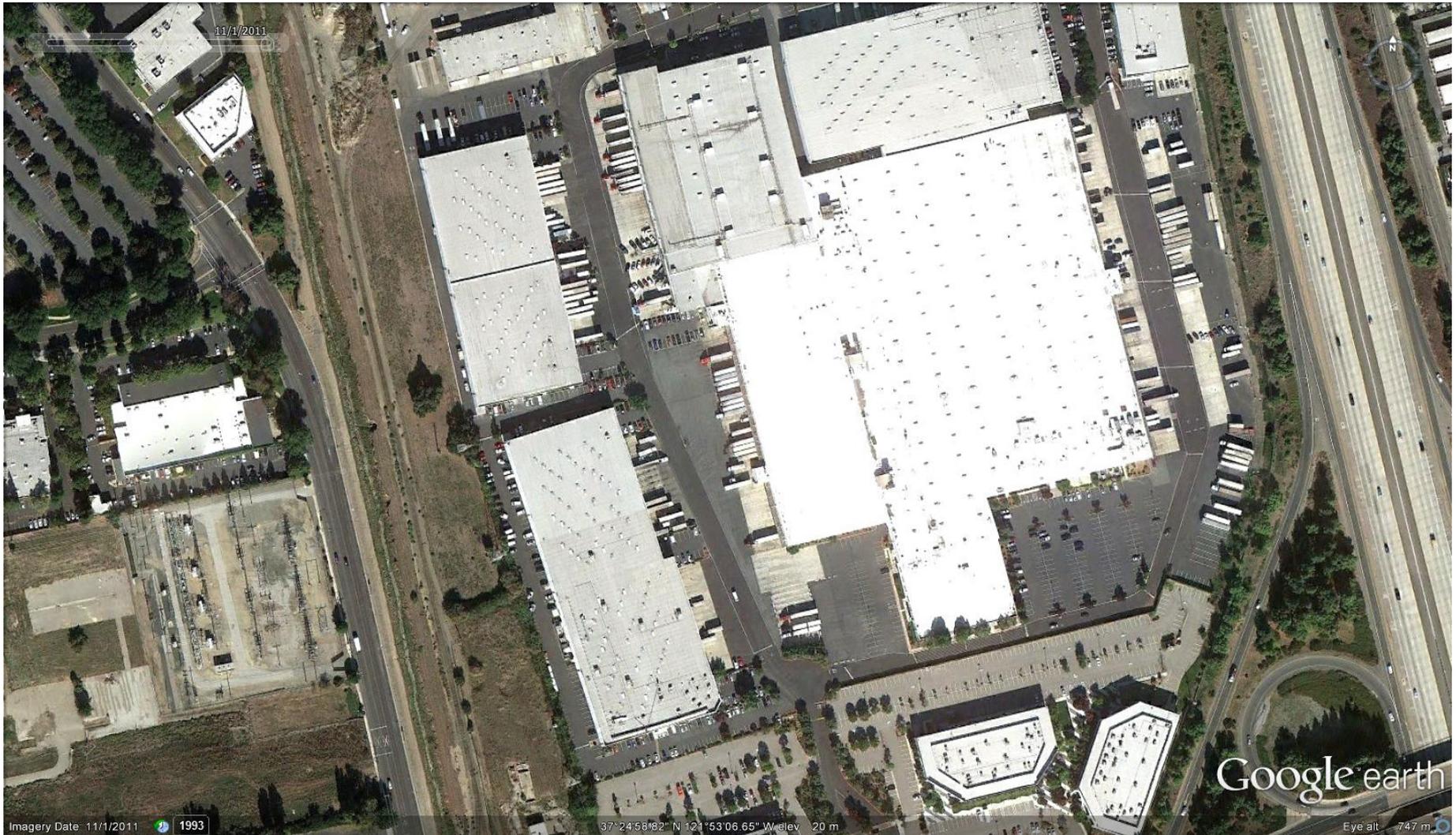
UC Davis switched to white membranes ~1980—
Congrats, and some still in service 30 yrs later



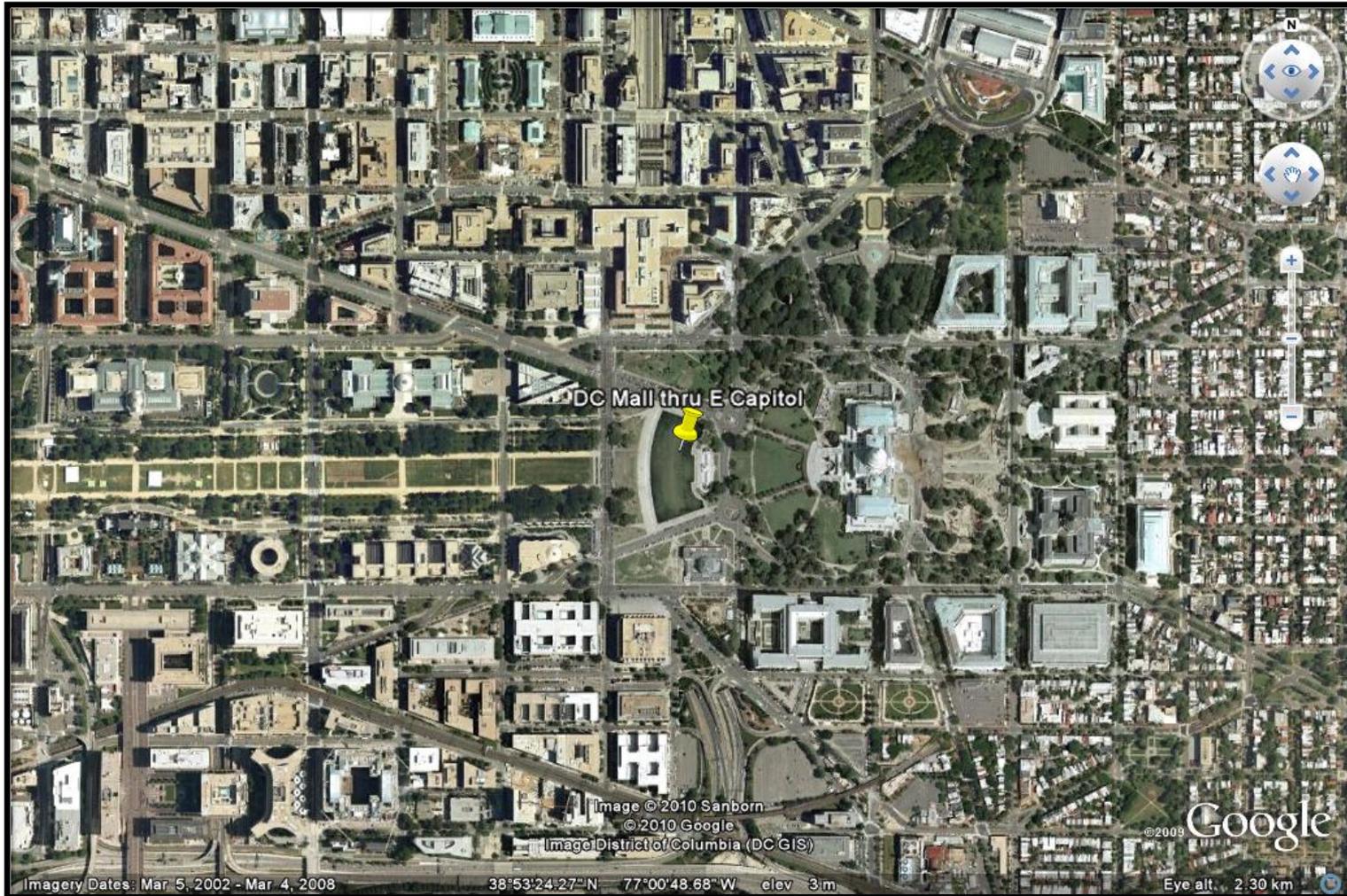
San Jose, CA – 1993



San Jose, CA – 2011



Washington, DC (Federal) has problems with historical buildings



Pentagon





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SCIENCE AT THE THEATER

COOL CITIES, COOL PLANET

What to do now

Progress in energy efficiency standards

- In 2005, California's "Title 24" energy efficiency standards prescribed white surfaces for low-sloped roofs on commercial and large residential buildings (apartments, hotels, etc.). Several hot states are following.
- In 2008, California prescribed "cool colored" surfaces for steep residential roofs in its 5 hottest climate zones, but not yet Los Angeles.
- **Other U.S. states & all countries with hot summers ought to follow.**

Recent cool roof progress (2005 – 2012)

- 2005
 - California Title 24 – “Flat roofs shall be white” (15 out of 16 climate zones). Walmart adopts white roofs for ALL stores.
 - EPA ENERGY STAR lists Cool Roof Materials
 - 2010
 - June 1st, 2010 – Memo from U.S. Energy Secretary Steven Chu calls for all DOE Buildings to have white roofs, if cost-effective
 - June 16th, 2010 – Marine Corp follows suit, Pentagon GSA following.
 - June 19th, 2010 – *RetroFIT Philly* announces winner of “coolest block” contest to white-coat black roofs of row houses.
 - 2011-12
 - 100 Cool Cities launched – see www.GlobalCoolCities.org
 - 2012--US launched, at G20 Energy Ministers meeting, a voluntary Cool Roofs Working Group, and offers technical assistance to “charter” developing countries: India, Japan, Mexico, & US joined (further discussions with Brazil, China, South Africa).
- 34 – New York City and Chicago adopt “If it’s flat it shall be white or green”

To come in 2013...

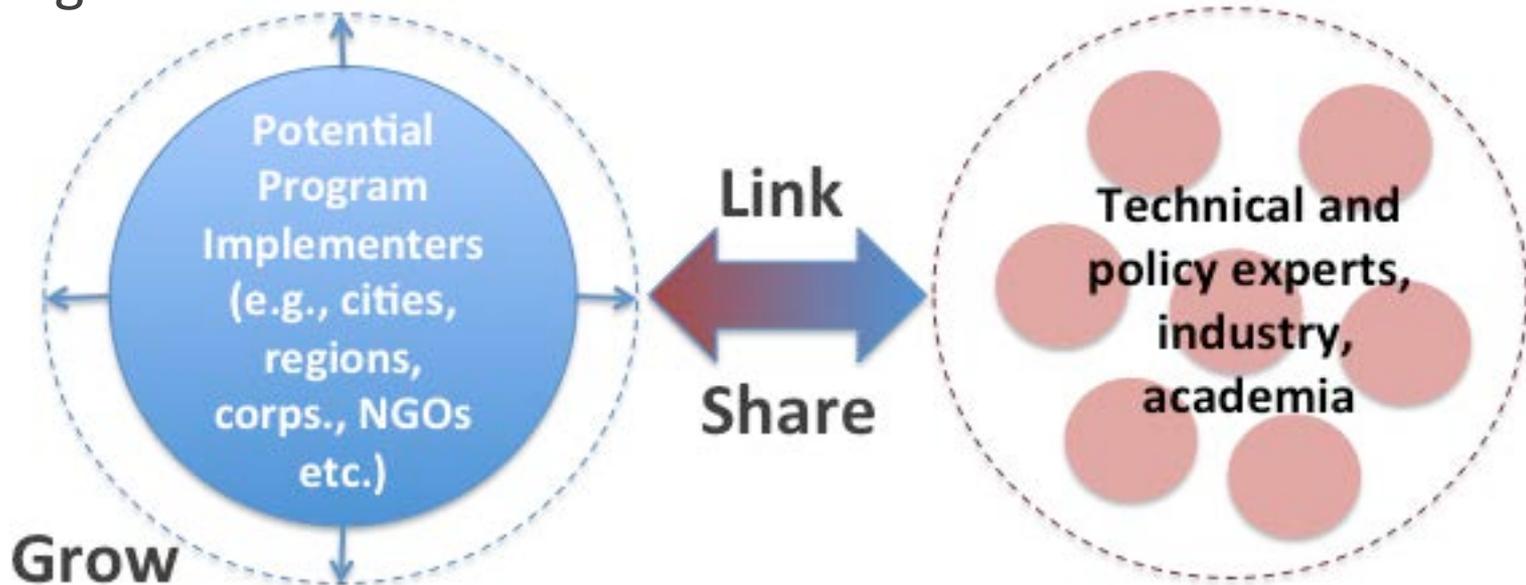
- Model codes will be modified to prescribe “flat roofs shall be white”
 - ASHRAE for commercial buildings
 - IECC for residential buildings
- But states and cities must still ***adopt*** model codes

OPPORTUNITIES

- The dramatic and simple advantages of white roofs are easily understood worldwide – people just “get it”
- Those of cool-colored roofs are harder to describe, but can eventually be significant
 - At least for wealthier nations
- Paved surfaces are a harder sell but a large source of untapped potential – a typical “tragedy of the commons”

Global Cool Cities Alliance (GCCA)

The Global Cool Cities Alliance is dedicated to advancing policies and actions that increase the solar reflectance of our buildings and pavements as a cost-effective way to promote cool buildings, cool cities, and to mitigate the effects of climate change through global cooling.



The Cool Roofs and Pavements Toolkit – www.CoolRoofToolKit.org

- Descriptions of the science, the benefits, and the costs of cool surfaces.
- Simple actions to design programs and policies drawn from global best practices.
- Links to sample materials and relevant organizations.
- Coming soon: a comprehensive “knowledge base” of research, best practices, code/ ordinance language, sample program materials and an expert forum.



The Cool Roofs and Pavements Working Group

- Formed under Clean Energy Ministerial's Global Superior Energy Performance Partnership
- Four official members – India, Japan, Mexico, and the U.S.
 - Participation from Brazil and South Africa
 - Countries include 8 of the 20 largest cities.
- Robust participation from industry, NGOs, and technical experts
- Initiatives: affordable housing, building codes with active projects in India and Mexico
- Next meeting: New Delhi October 3rd – 5th

Working Together

- Participate in the Cool Roofs and Pavements Working Group
- Join GCCA Technical Advisory Council
- Participate in Expert Forum (coming soon)
- Participate in the codes collaborative

Resources on the web

- **LBNL – Heat Island Group**
 - HeatIsland.LBL.gov
- **Art Rosenfeld’s website**
 - www.ArtRosenfeld.org
- **Global Cool Cities Alliance**
 - www.GlobalCoolCities.org
- **Cool Roofs and Cool Pavements Toolkit**
 - www.CoolRoofToolkit.org



Thank You!

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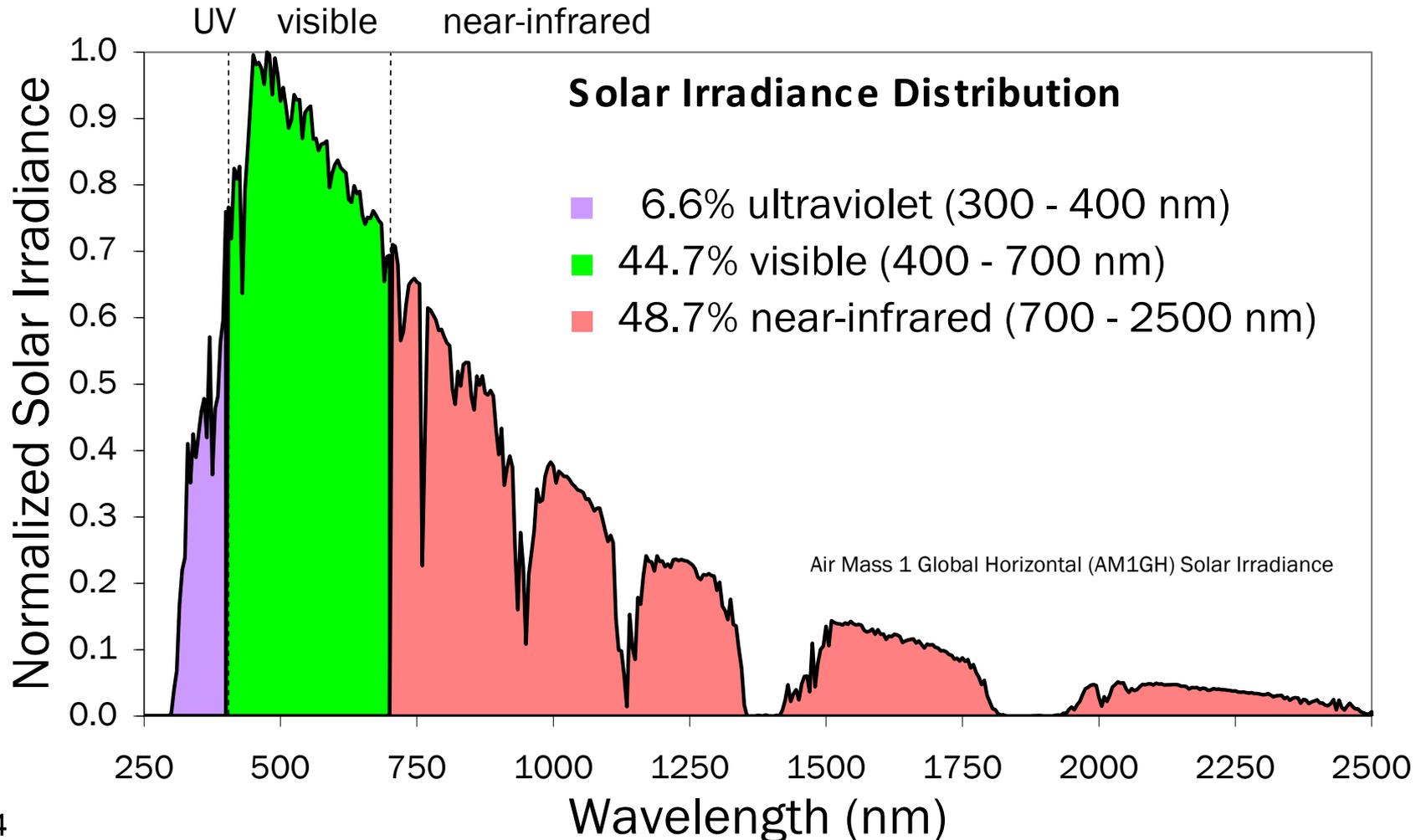


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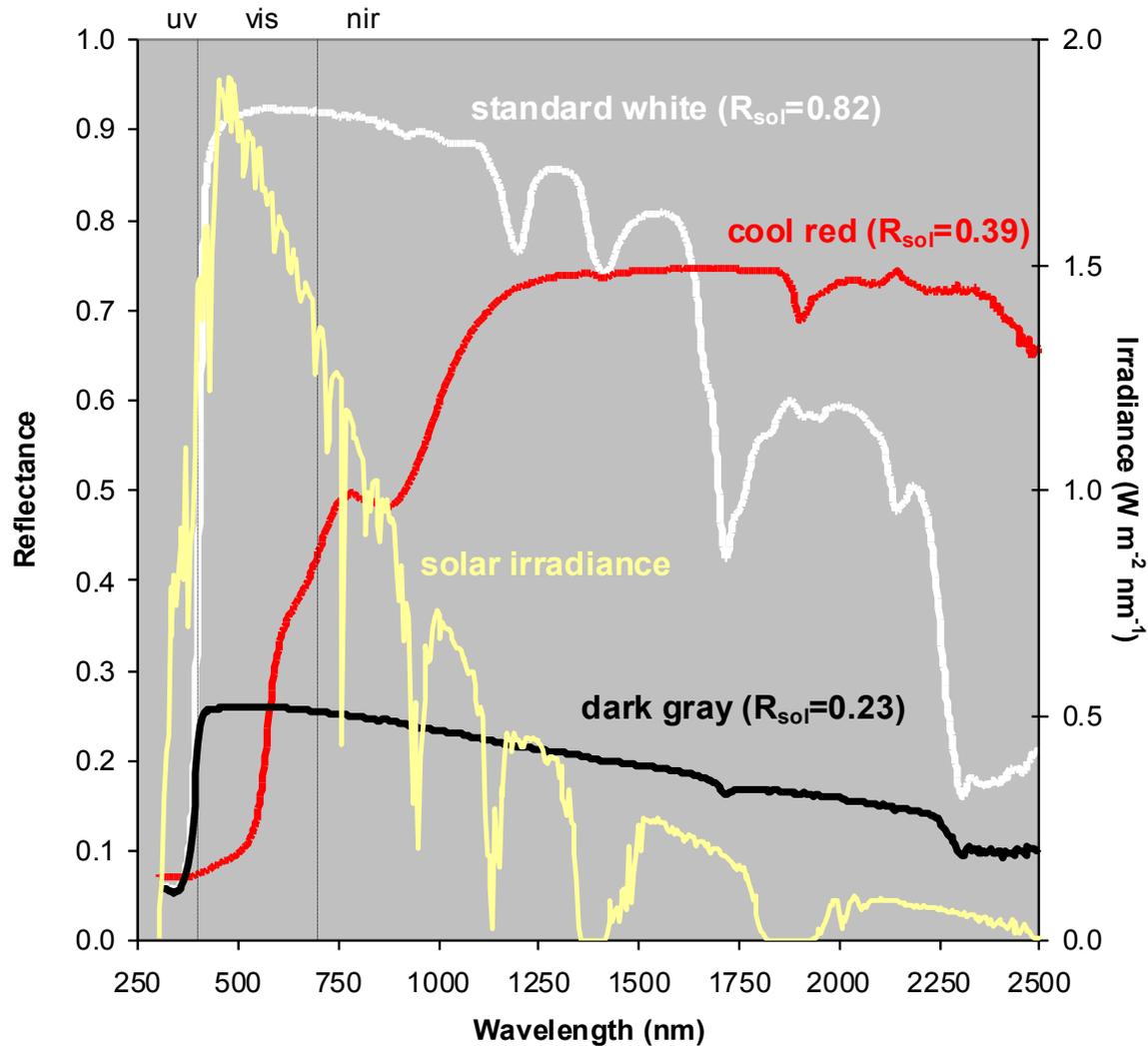
COOL CITIES, COOL PLANET

Cool Colors

Sunlight — more than meets the eye



White, cool color, warm color



white roof

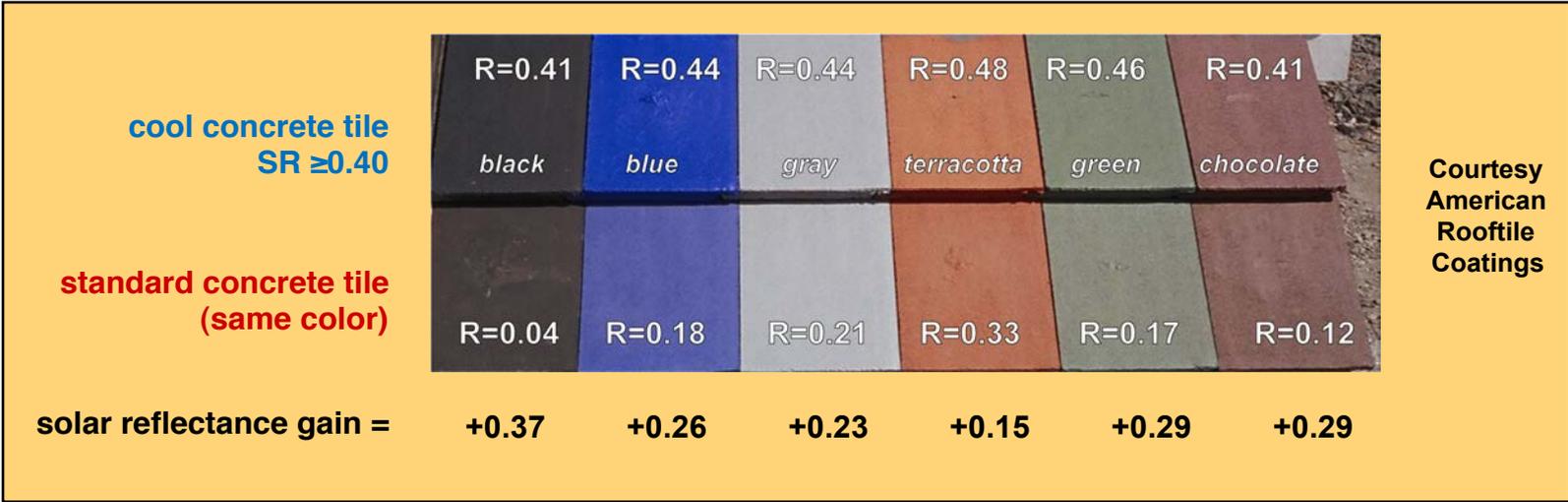


cool red roof



gray roof

Cool colored roofs available today



cool clay tile
SR ≥ 0.40

Courtesy
MCA Clay Tile



Concord Cream 87274 87.3 (95.4)	State Gray 87008 38.1 (9.6)
Riverdale 87278 87 (97)	Bright Red 87296 38.5 (98.5)
Serra Tan 87077 58.8 (97.6)	Brick Red 87296 38.8 (94.7)
Pearl Gray 87204 48.7 (91.6)	Medium Bronze 87211 34.8 (12)
Marine Green 87052 41 (91.8)	State Blue 87295 34.4 (91.3)
Patina Green 87205 41 (99.2)	State Bronze 87075 33.8 (99.6)

cool metal
SR ≥ 0.30

Courtesy
BASF Industrial
Coatings



cool fiberglass asphalt shingle
SR ≥ 0.25

Courtesy
Elk Corporation