

Sustainability and Climate change

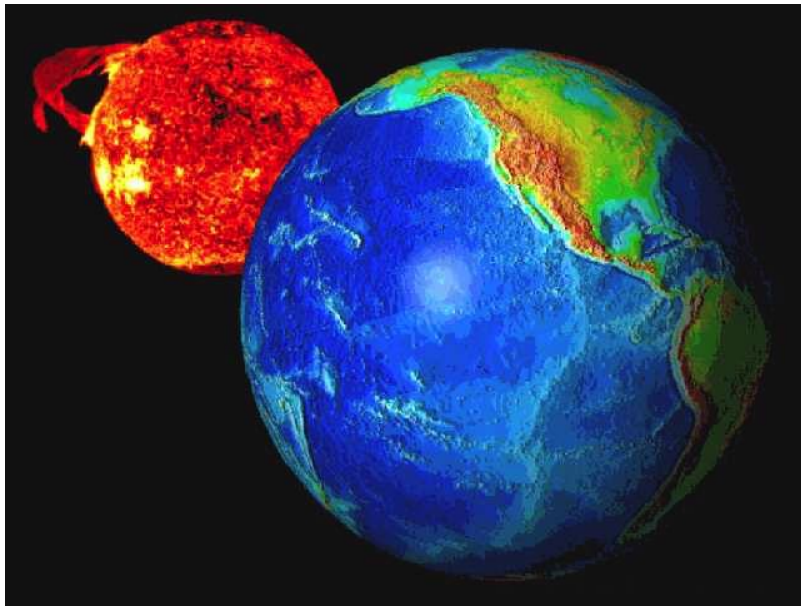
What everyone should know

Jim White,
University of Colorado
INSTAAR



Simple physics

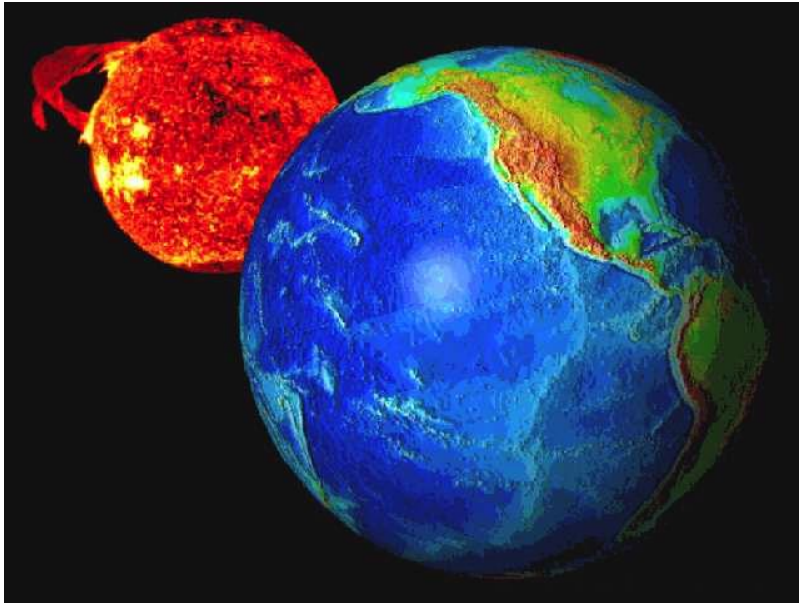
Climate change is real, and actually, really simple



Simple physics: Global climate depends on three factors

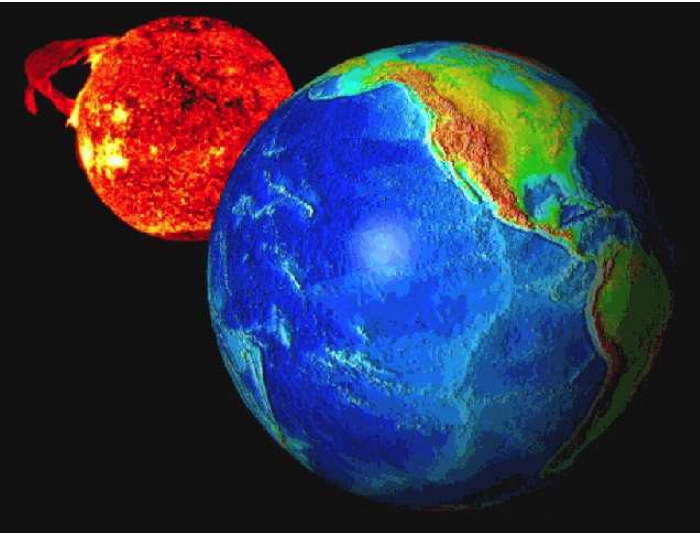
- How much energy we get from the sun
- How much of that energy is reflected back to space (aerosols, ice, etc.)
- Amount of greenhouse gases

Greenhouse gases are a natural and important part of the Earth's climate system



- Earth's temperature without greenhouse gases = -18°C
- Too cold for advanced life?
- Earth's temperature with greenhouse gases = $+15^{\circ}\text{C}$
- ...Cozy...
- Greenhouse gases raise the temperature of the Earth by about 33°C (about 60°F)... *and make the planet habitable*

OK,
then...



If we add lots of
greenhouse gases to
the atmosphere, the
Earth will warm.

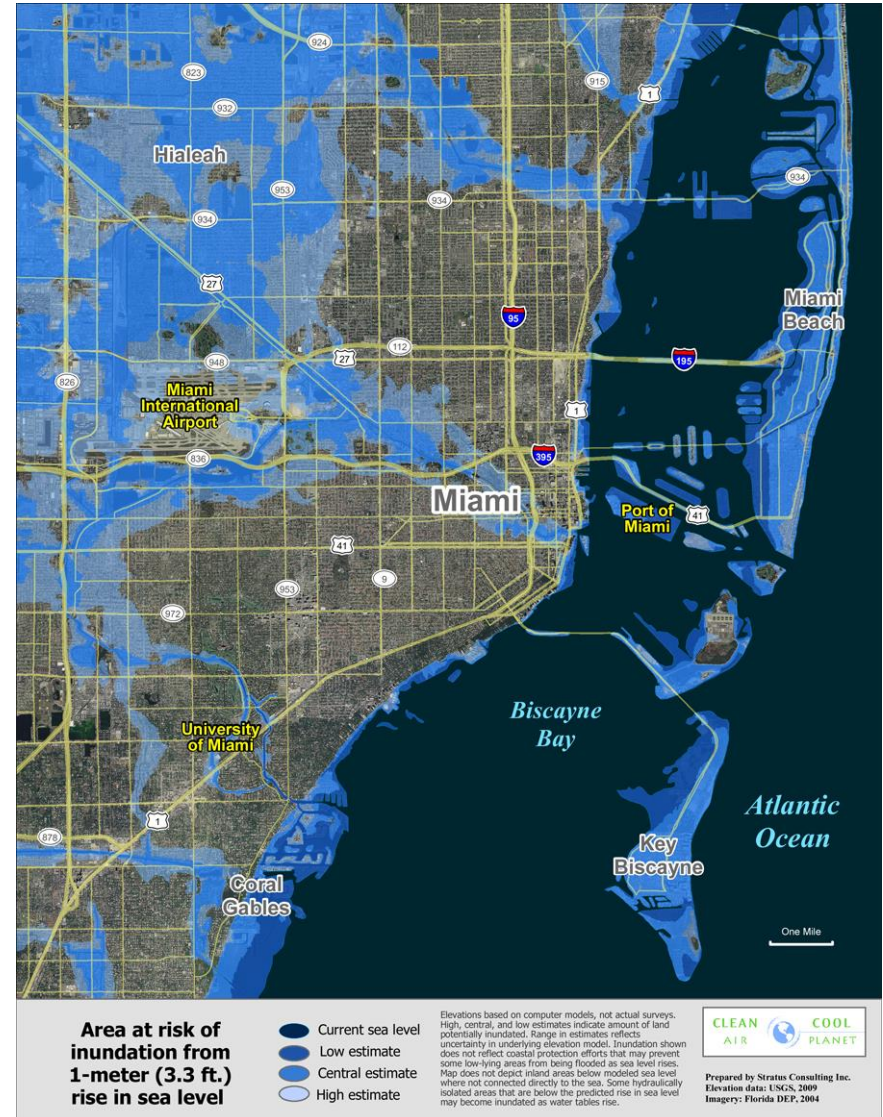
*To expect otherwise
denies simple
physics... and the
next time you feel the
urge to deny simple
physics, try denying
gravity...*

Simple physics and sea level

- When our planet warms, sea level rises. When it cools sea level drops.
- Thermal expansion of water
- Land ice melts
- **Sea level and temperature** is one of the most robust relationships in past climates

Hard and real impacts

Sea level is rising: 1 meter by the end of this century is current estimate...
and it won't stop there...



Think about it...
*Miami has no future
much beyond this
century... and
Miami is not alone.*



Lessons from the earth

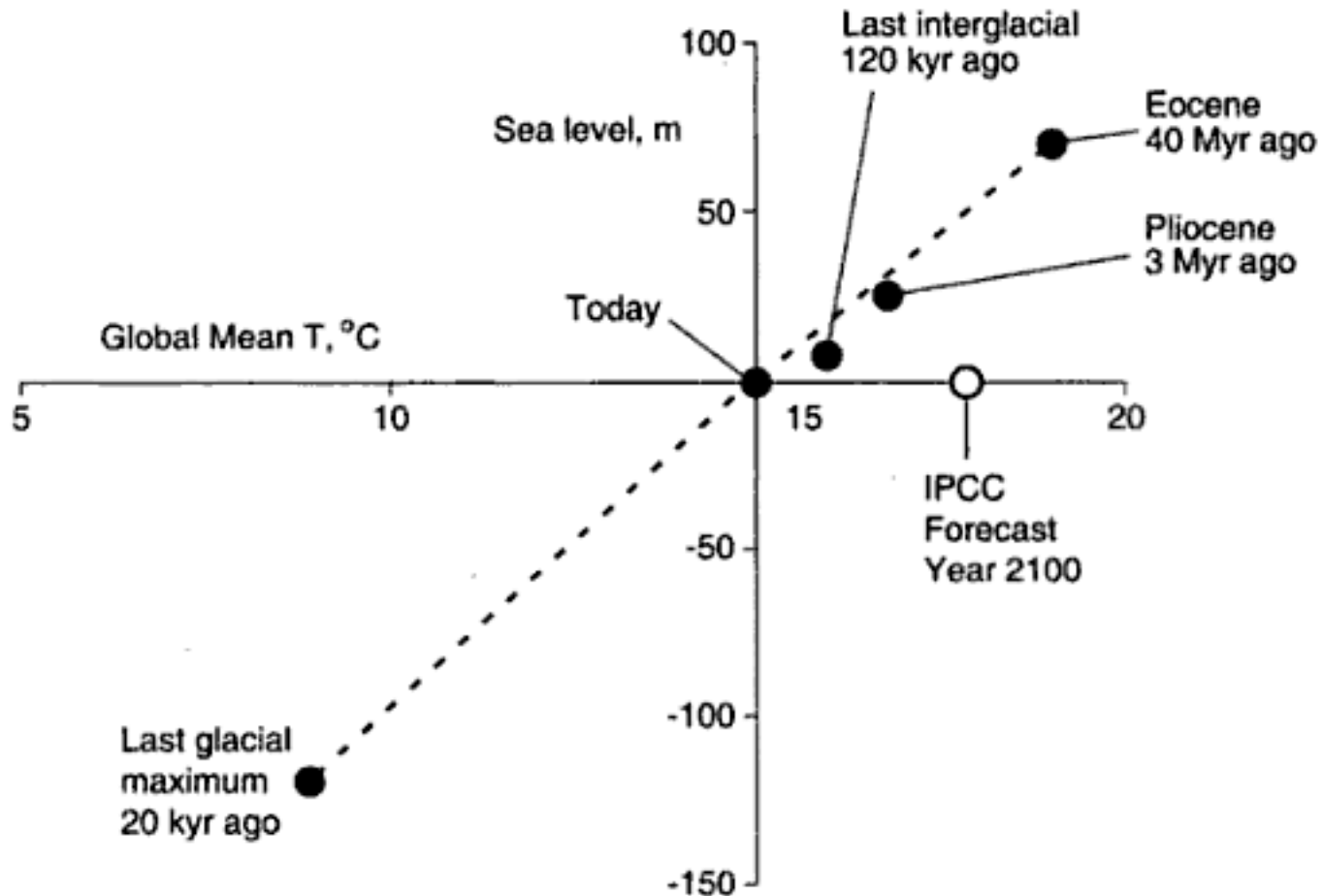
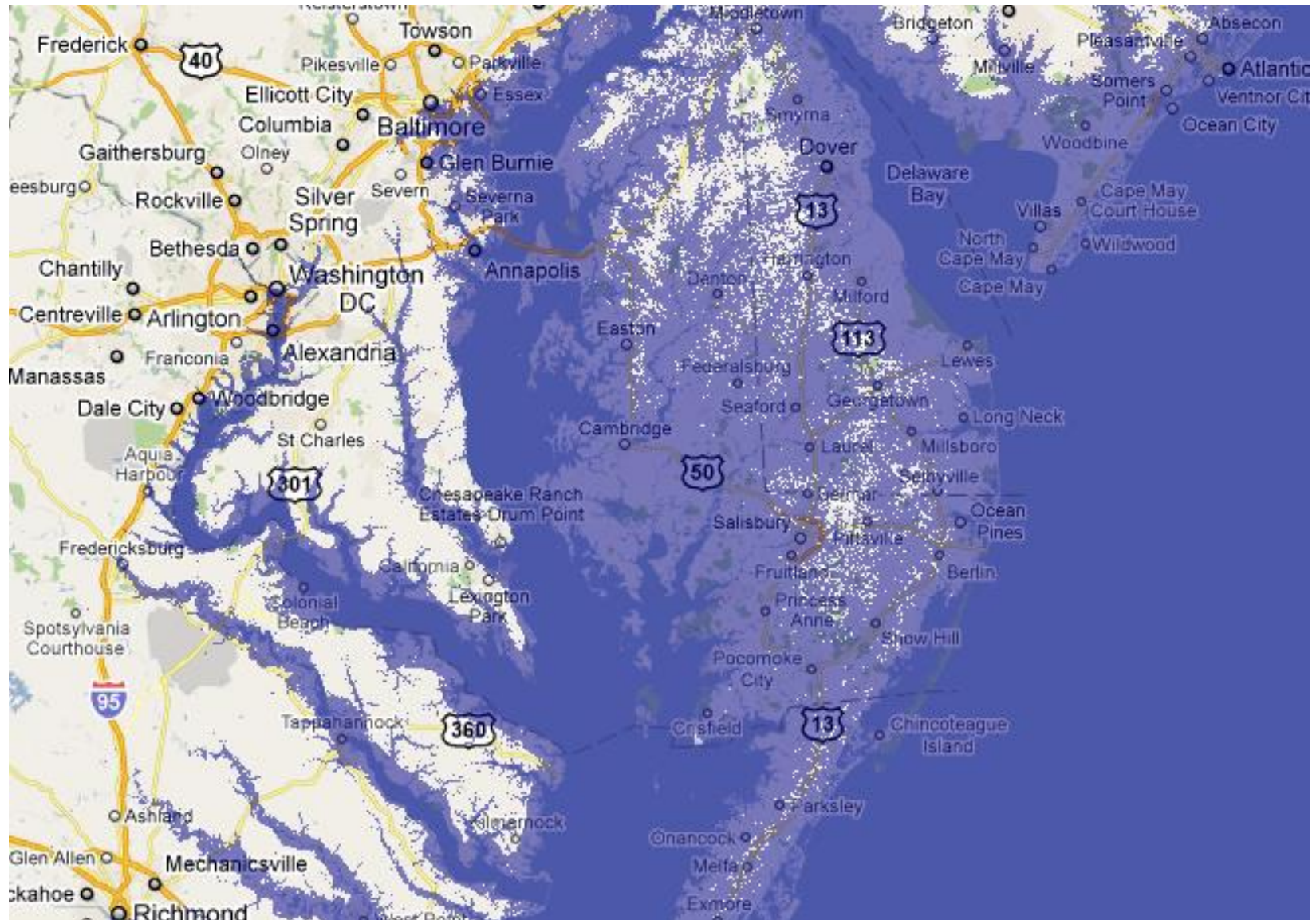
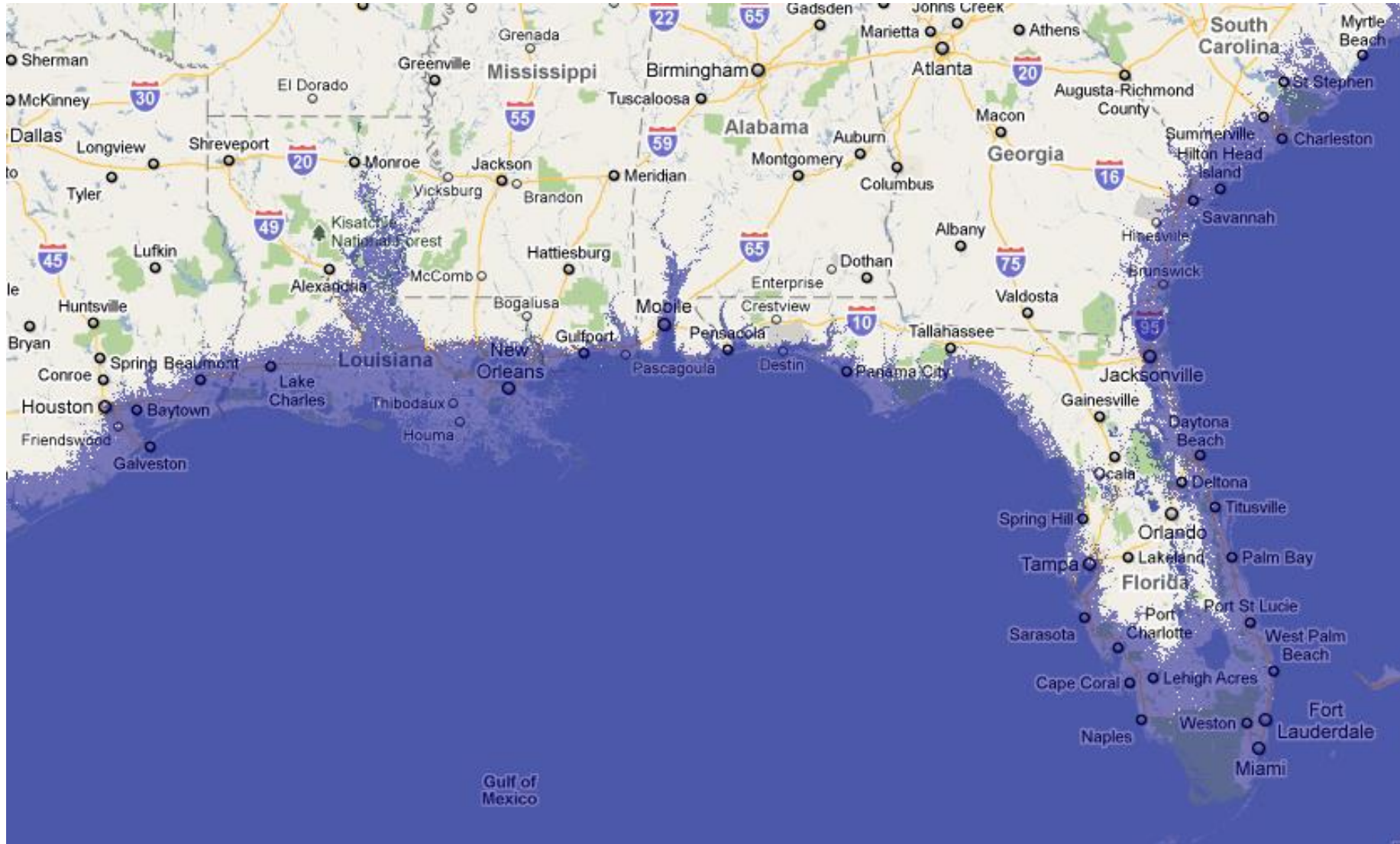


FIGURE 17. Covariation of sea level with global average temperature in the geologic past, compared with the IPCC forecast for sea level rise by the year 2100.

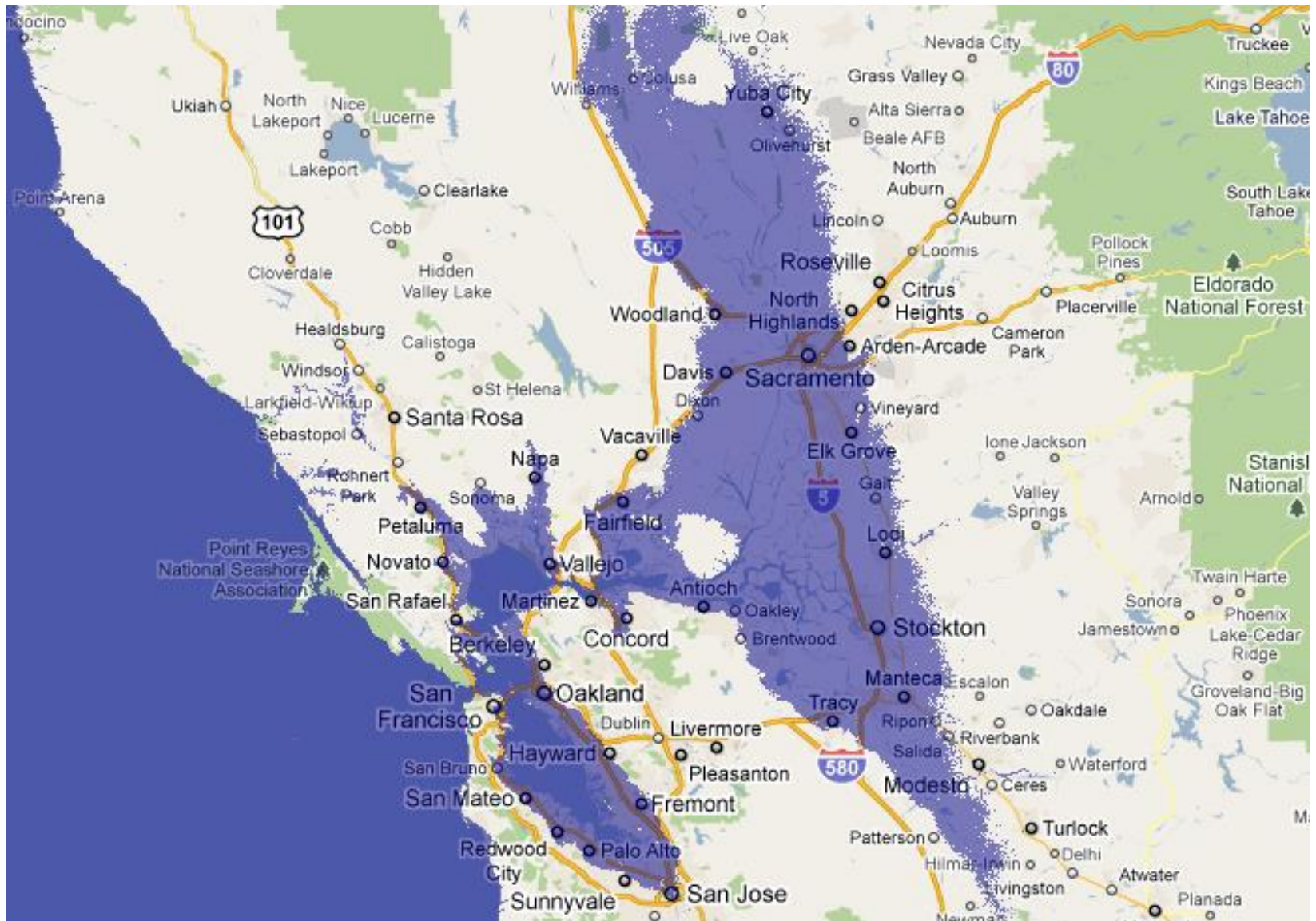
What does 20 meters (65 feet) of sea level rise look like?



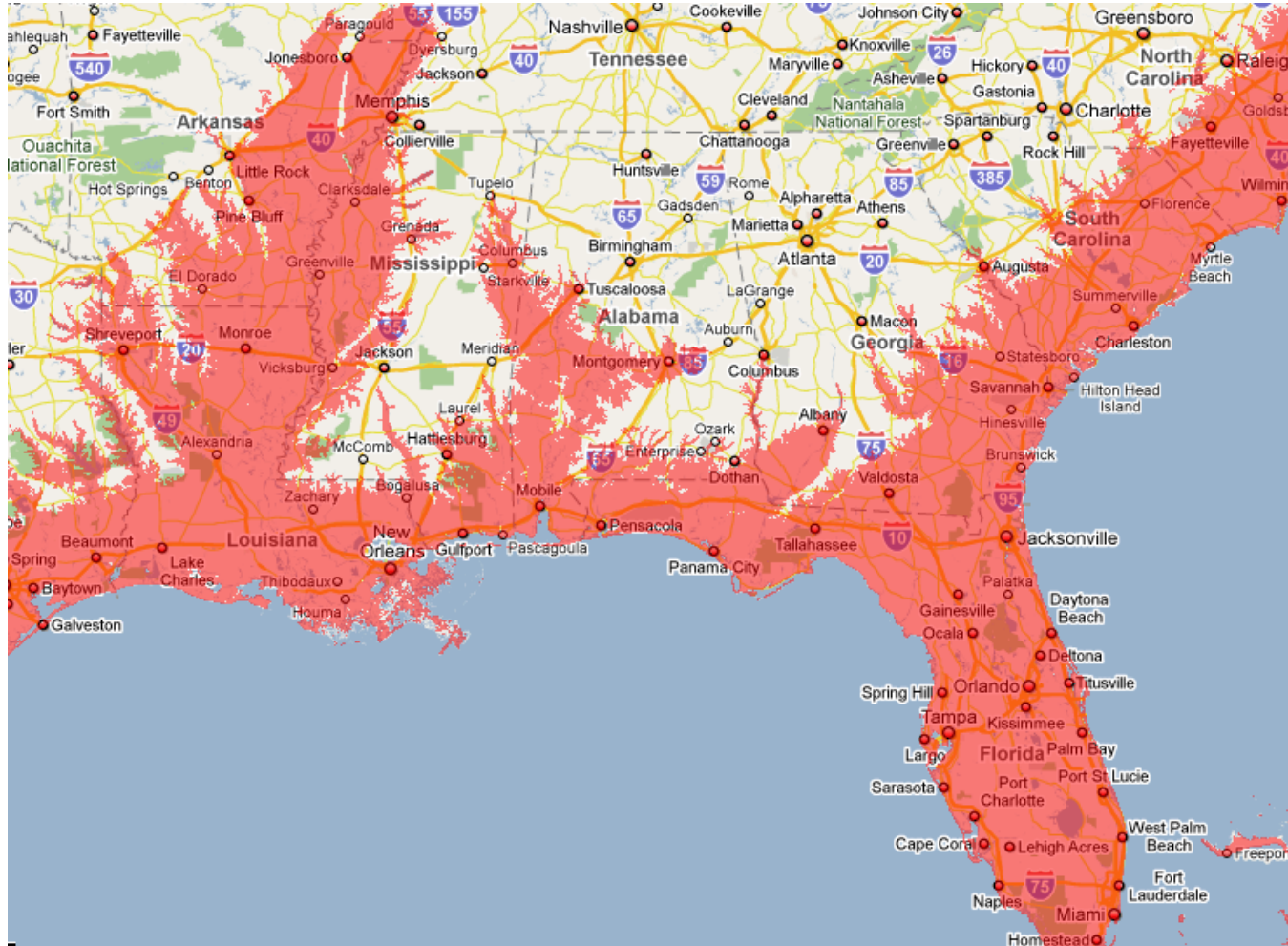
What does 20 meters (65 feet) of sea level rise look like?



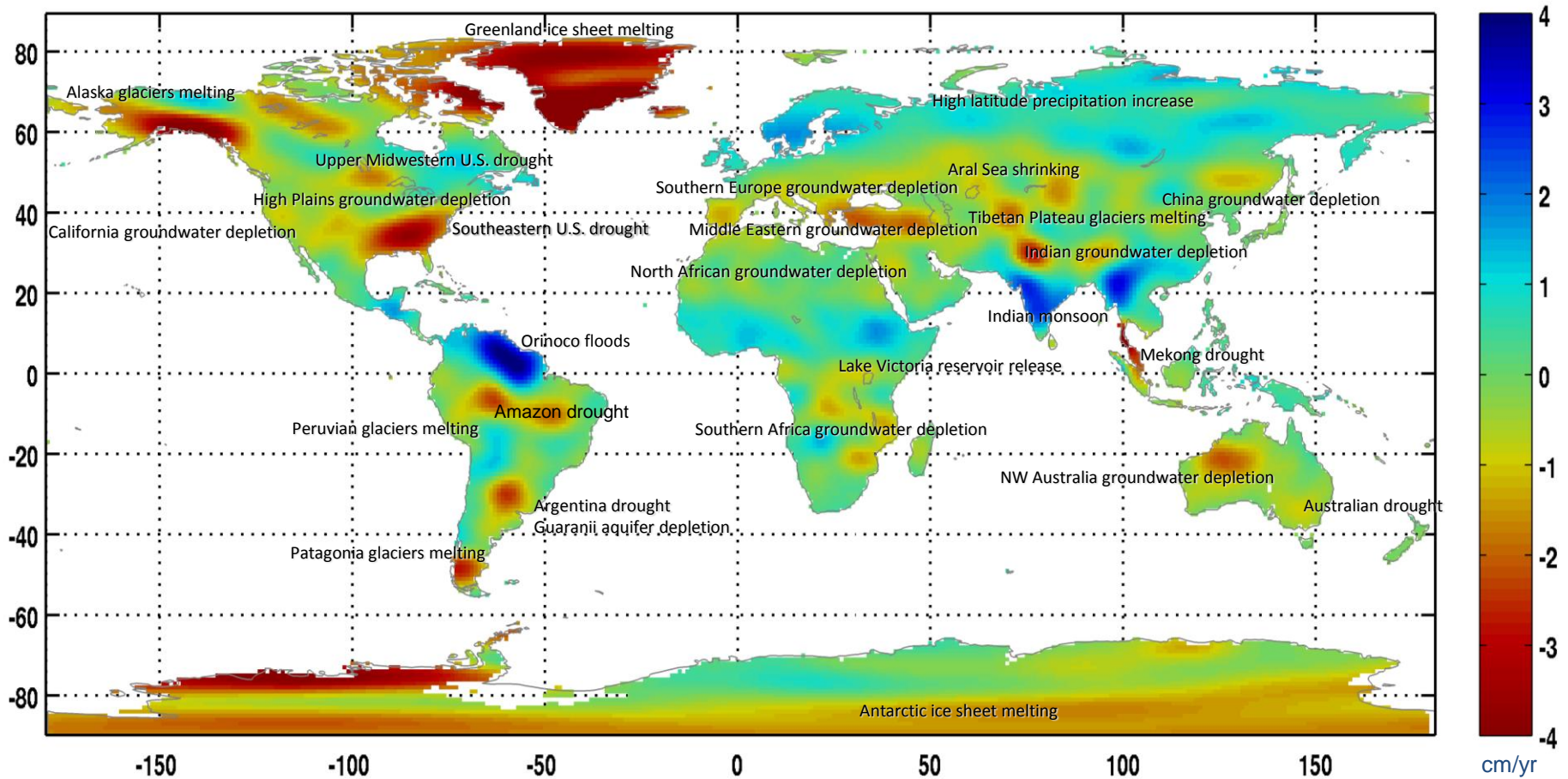
What does 20 meters (65 feet) of sea level rise look like?



For what its worth... we're likely to hit Eocene levels of CO₂ ... no land ice



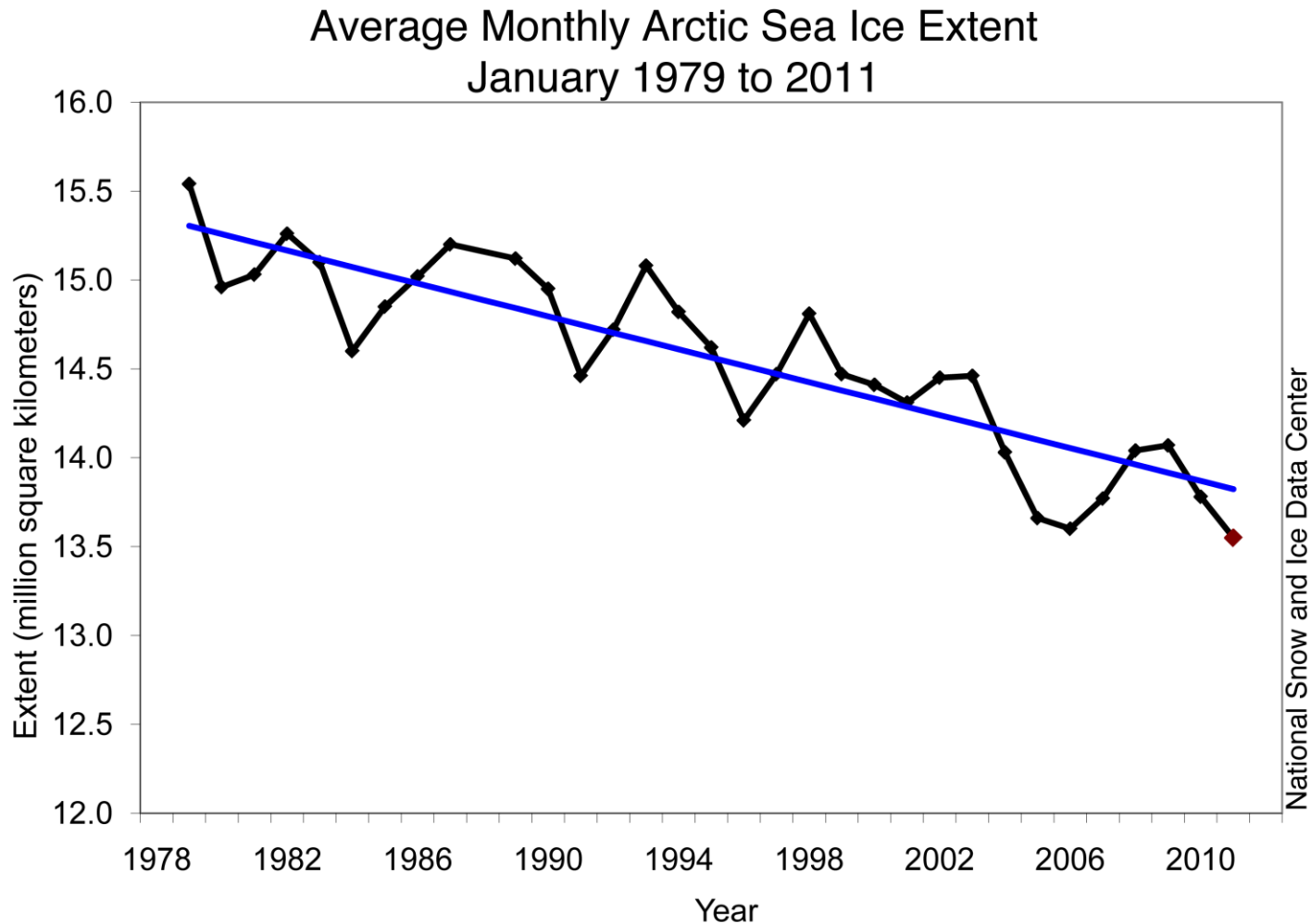
Trends in Freshwater Storage from GRACE, 2002-2010



Famiglietti et al., 2012, in prep

Impacts are
happening
now.

Arctic Sea ice is shrinking



Real impacts

Arctic Sea ice is thinning,
with consequences for us



Yes, It's a hard problem that will take many of us to solve it

Why is it hard?

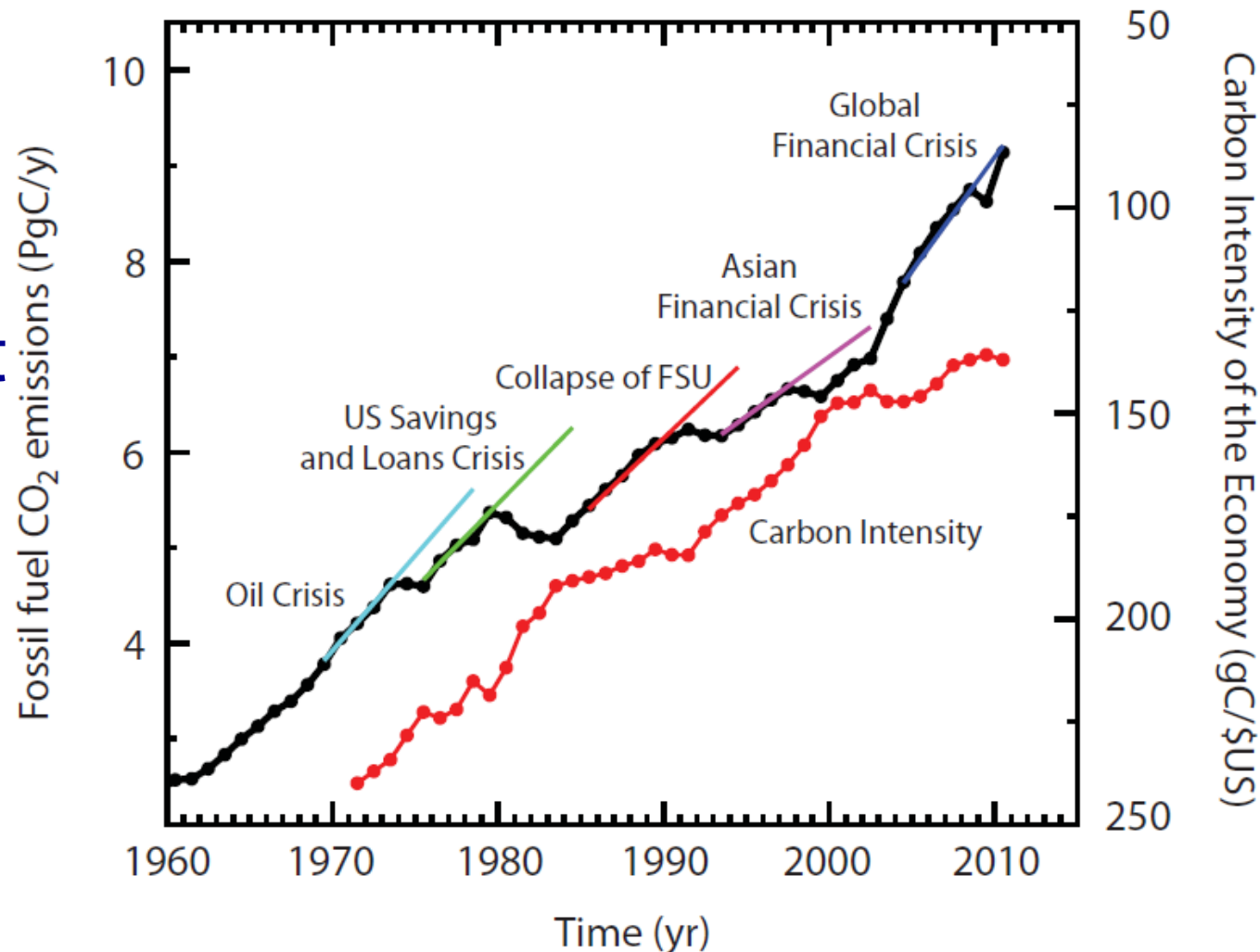
- Its political
- There's a lot of \$ at stake: **the US alone spends about \$1.4 Trillion per year on energy**... but is it all about money?

Our children

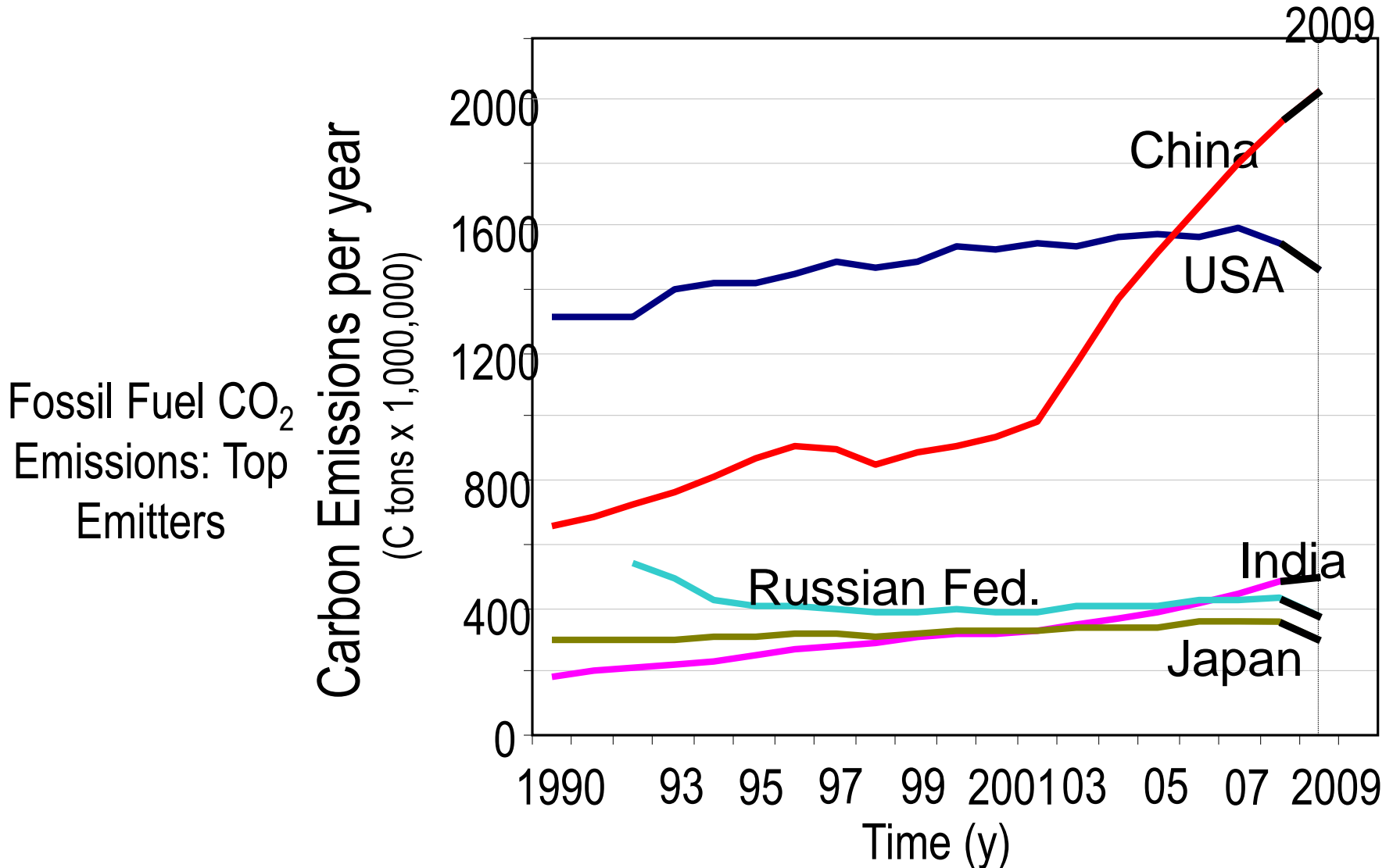
The impacts come after the causes by 50 years or more: ours is a water planet and it takes time to heat up the water...
if cause and effect are not immediate, its hard to provoke action (true for today's temperatures as well...).

Is it economics, or is it ethics, morals and religion?

Economic arguments have won; grow is what we do.



It requires global cooperation: Climate change is training wheels for sustainability



Adapt: Admit the inevitable

Its not just about energy... CH_4 and N_2O are food greenhouse gases... *we still think we can live without a large environmental footprint and that's not true.*

Mitigate: Do not go silently...

Hey! We're smart, resourceful, and fundamentally good. We can do better than an ostrich



Is it surprising that humans are causing climate change?

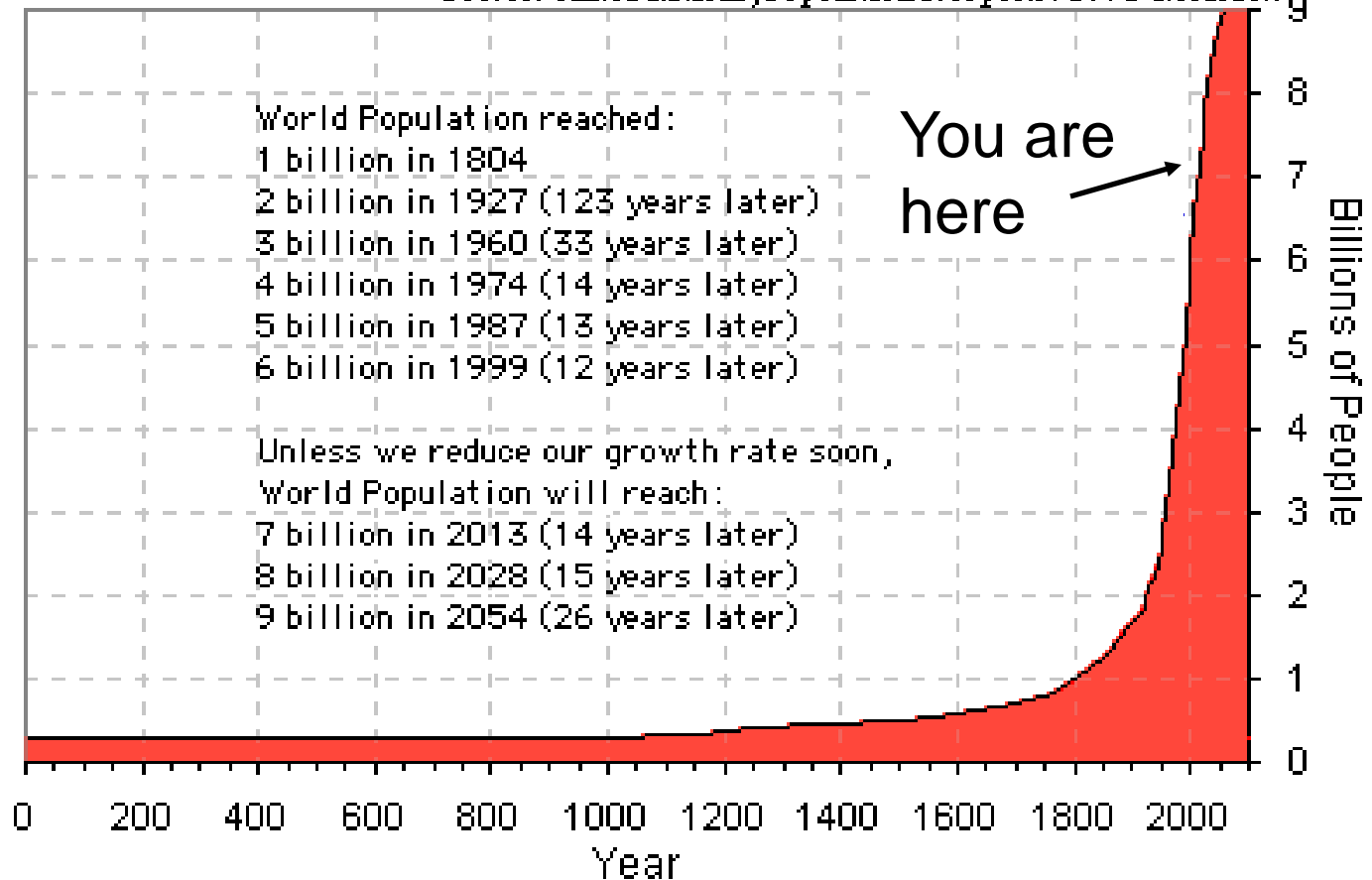
- Simply put...we're impressive, the biggest cause of change on the planet.
- We have altered the Earth's energy balance *and changed climate*
- We cause 10 times more erosion *than all natural processes*
- We make more fertilizer *than all bacteria in the world*
- We make more sulfate *than all ocean phytoplankton*
- Our current energy needs equal *all harvestable wind energy in the atmosphere*

How is this possible?... the power of the exponential!



Population

Source: United Nations, Population Prospects: 2004 Revision

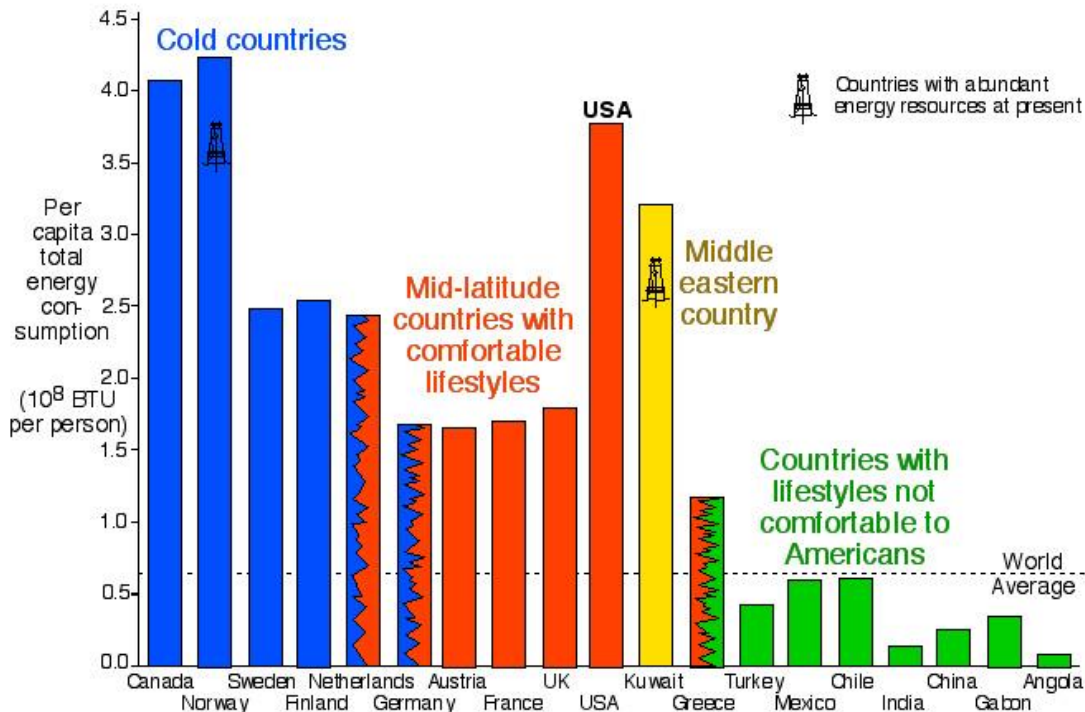


Energy use per capita: the big multiplier

China: 5 times below Europe

India: 8 times below Europe

US: 2 times more than Europe



The Nasty Dilemma:
we want others to live well, but if they do, the energy and resource needs will be staggering

A quick trip to the soapbox

- Politics and science...
- The value of science in our society is being undermined
- The value of education, and an educated electorate is also threatened

It takes all of us

- **It is OUR Responsibility.**
- Climate change is only one piece of the **sustainability** challenge... food, water, minerals, population... **Every problem faced is a step towards sustainability**

Ethics and economics

Final comments: Responsibility

My 3 simple rules of sustainability:

1. Everything must cycle
2. Population must be controlled (equality of the sexes), and vary inversely with resource use per capita
3. Equity must be considered and acted upon

