Climate Activism in a Scientific Guise:

Air Pollution as a Case Study

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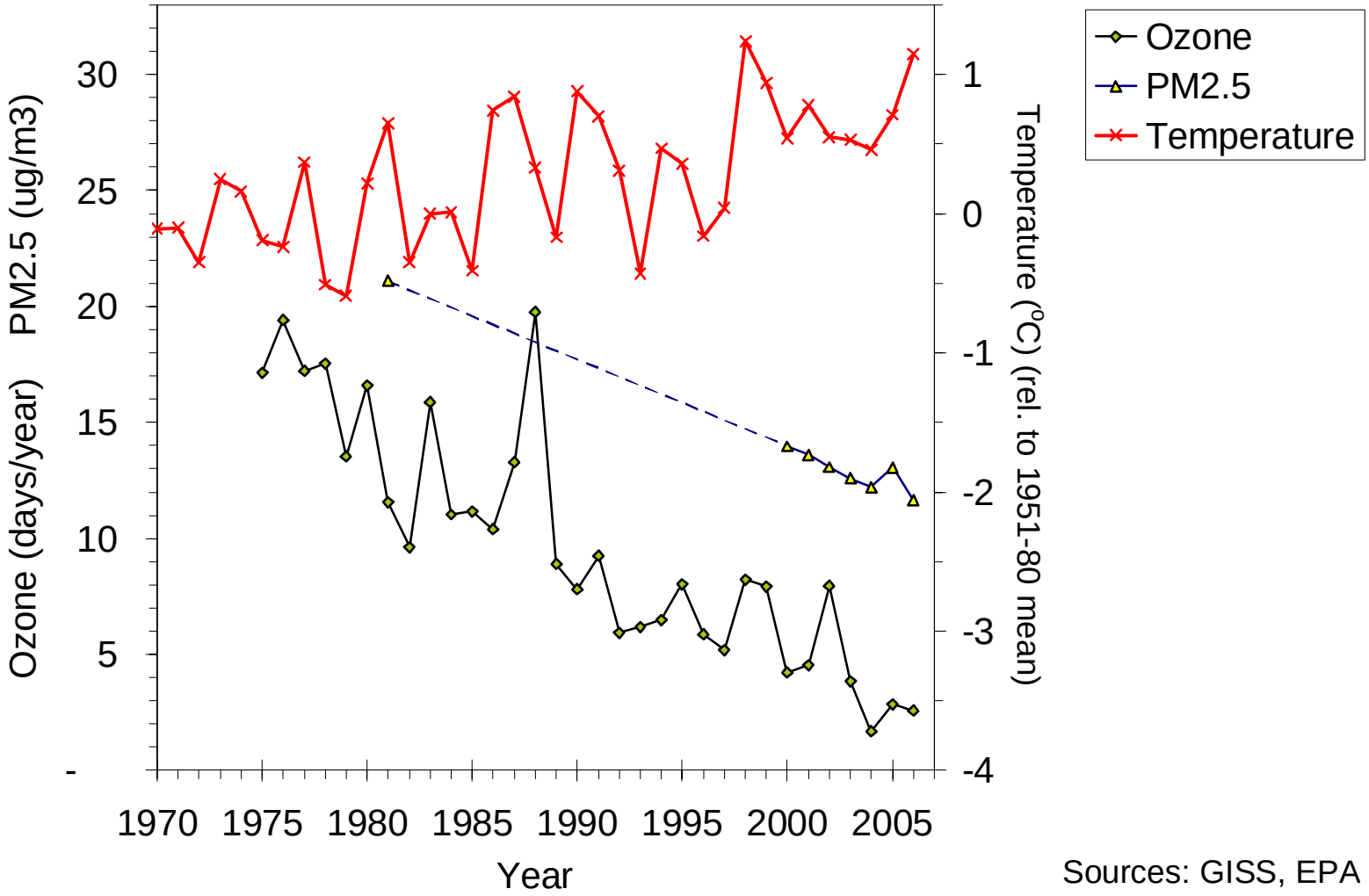
Rising Temperatures…Declining Air Pollution

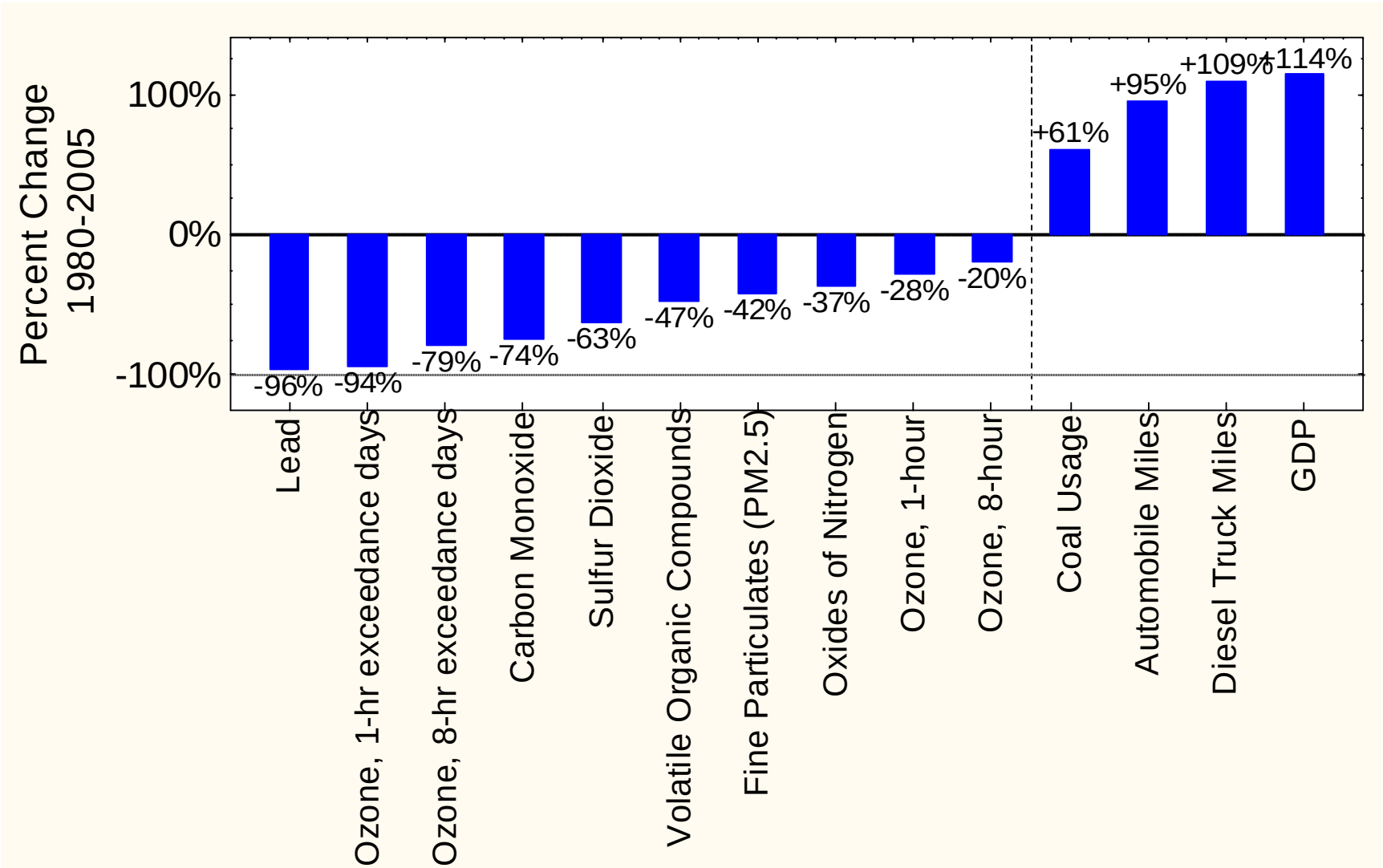


Sources: GISS, EPA

Ozone: 8-hour exceedance days/year; PM2.5: annual average.
Temperature and pollution levels are national averages.

More driving, more energy…less air pollution

Change in ambient pollution levels, 1980-2005



Sources: EPA, DOT, DOE

Existing Requirements Will Eliminate Most Remaining Emissions

- Standards for new cars, trucks, and off-road diesels will eliminate more than 80% of NOx, VOC, and soot, even after accounting for growth in driving
- Clean Air Interstate Rule (CAIR) will eliminate 70% of SO2 and mercury, and more than 50% of NOx during the next 15 years
- CAA “Hazardous Air Pollutant” rules will eliminate most emissions of about 180 different pollutants from a wide range of industrial and commercial sources
- Overall, existing requirements will eliminate at least 70%-80% of remaining pollutant emissions during the next 20 years or so
- Air pollution is a solved problem. Regardless of effect of warming, it will be irrelevant by the time the warming occurs.

doi:10.1038/nature06059

LETTERS

Indirect radiative forcing of climate change through ozone effects on the land-carbon sink

S. Sitch[1], P. M. Cox[3], W. J. Collins[4] & C. Huntingford[2]

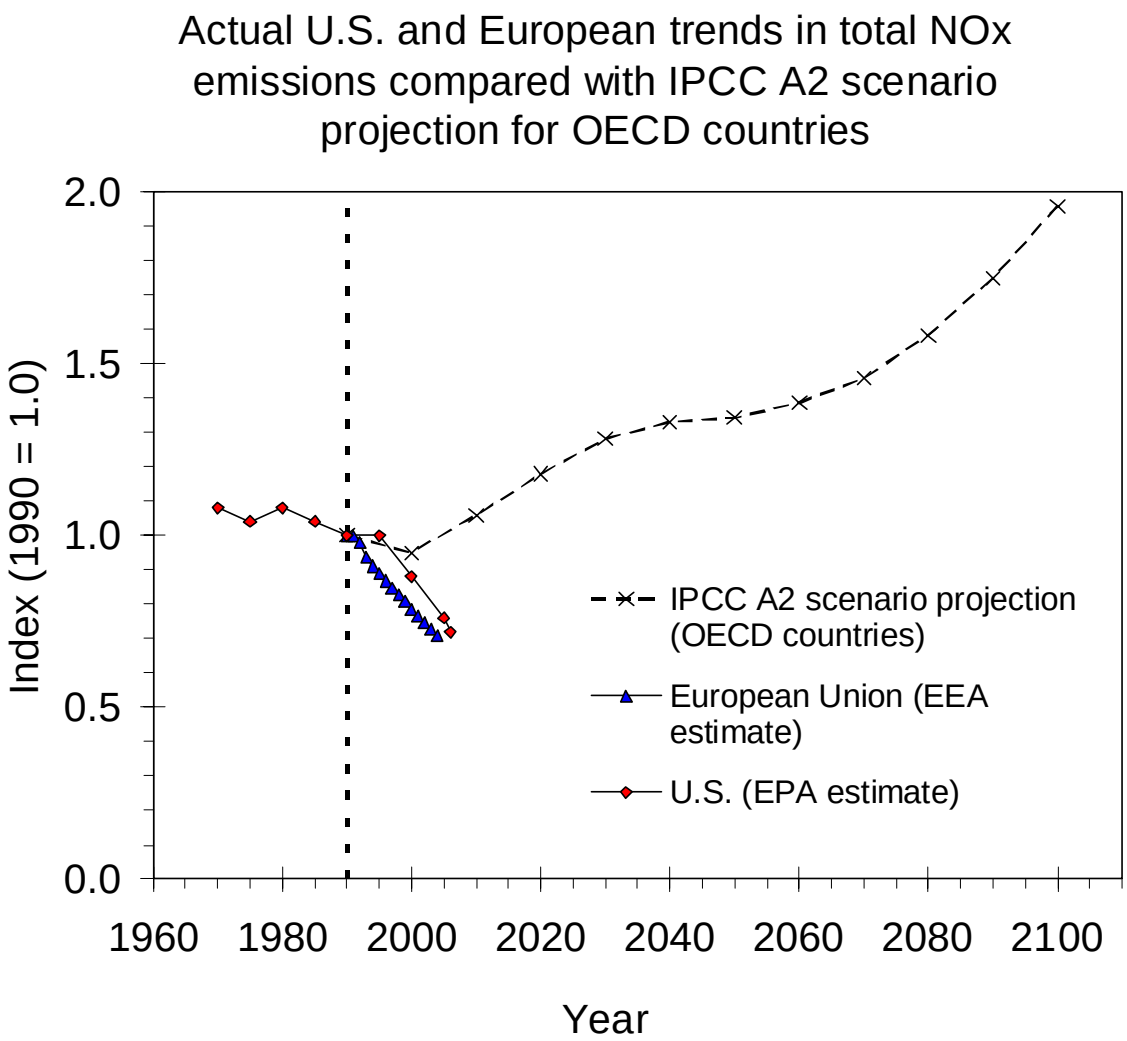
The evolution of the Earth's climate over the twenty-first century depends on the rate at which anthropogenic carbon dioxide emissions are removed from the atmosphere by the ocean and land carbon cycles[1]. Coupled climate–carbon cycle models suggest that global warming will act to limit the land-carbon sink[2], but these first generation models neglected the impacts of changing atmospheric chemistry. Emissions associated with fossil fuel and biomass burning have acted to approximately double the global mean tropospheric ozone concentration[3], and further increases are expected over the twenty-first century[4]. Tropospheric ozone is known to damage plants, reducing plant primary productivity and crop yields[5], yet increasing atmospheric carbon dioxide concentrations are thought to stimulate plant primary productivity[6]. Increased carbon dioxide and ozone levels can both lead to stomatal closure, which reduces the uptake of either gas, and in turn limits the damaging effect of ozone and the carbon dioxide fertilization of photosynthesis[6]. Here we estimate the impact of projected changes in ozone levels on the land-carbon sink, using a global land carbon cycle model modified to include the effect of ozone deposition on photosynthesis and to account for interactions between ozone and carbon dioxide through stomatal closure[7]. For a range of sensitivity parameters based on manipulative field experiments, we find a significant suppression of the global land-carbon sink as increases in ozone concentrations affect plant productivity. In consequence, more carbon dioxide accumulates

above 40 p.p.b. over almost all regions, and to exceed 70 p.p.b. over western and central Eurasia, eastern and western North America, Brazil, central and southwestern Africa, and East Asia, during the Northern Hemisphere summer (Fig. 1).

Ozone causes cellular damage inside leaves that adversely affects plant production, reduces photosynthetic rates and requires increased resource allocation to detoxify and repair leaves[5]. There have been few global modelling studies of the impact of tropospheric ozone on plant production and global land-carbon storage[11], and no study has estimated the indirect radiative forcing of tropospheric ozone through feedbacks on the global carbon cycle. Here, we are concerned with the possible impacts of future tropospheric ozone on global-scale plant primary production, land-carbon storage, and its implications for twenty-first-century climate change.

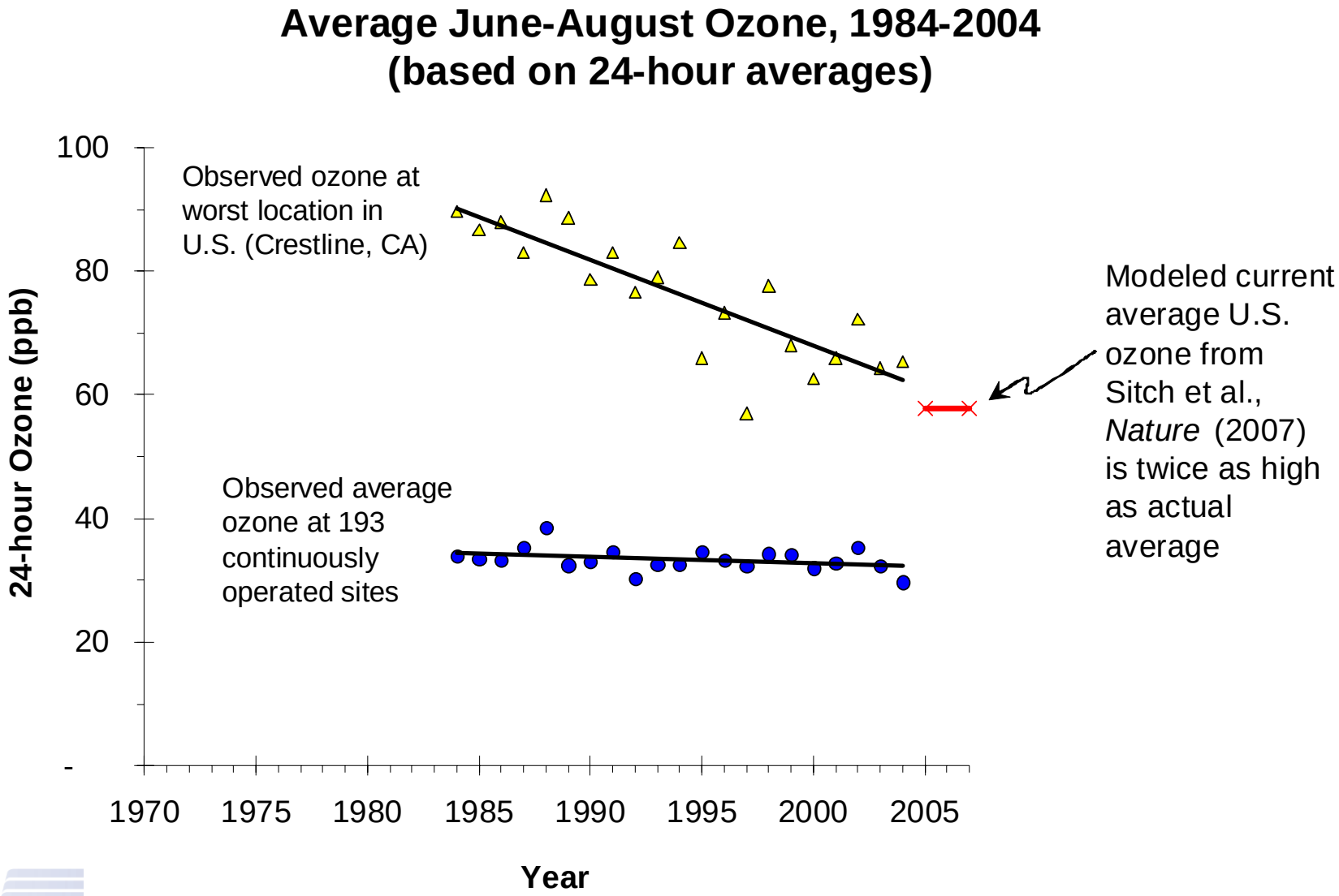
Future elevated [CO_2] may itself lead to reductions in stomatal conductance[12] at levels that act to alleviate future O_3 plant damage. Hence, future O_3 effects on plants are defined by the interplay of ambient [O_3], [CO_2] and climate change on stomatal conductance and plant production, with important ramifications for global land-carbon and hydrological cycles[7,11]. Free air CO_2 enrichment (FACE) experiments and other ambient air experiments indicate a nonlinear interaction between plant responses to CO_2 and O_3 (refs 6, 13–15). To account for these interactions, we use a flux-gradient approach to modelling ozone damage[16], rather than the more usual empirical approach based on the accumulated ozone exposure above

Sitch et al.'s emissions trend is opposite of reality

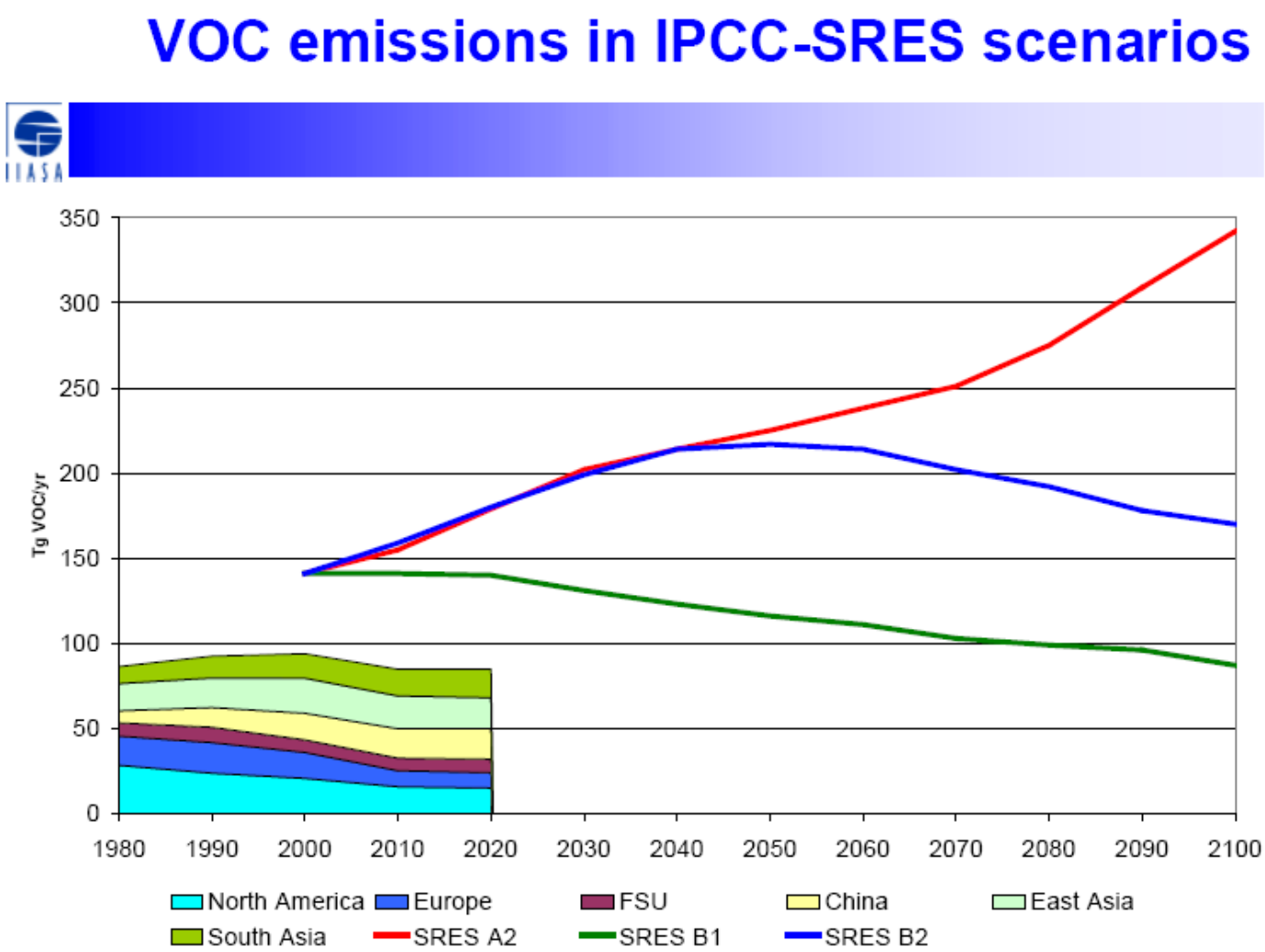


- Study used IPCC A2 scenario for future ozone precursor emissions.
- A2 assumes rising NOx and VOC in developed countries—just the opposite of the actual trend.

Sitch et al.'s modeled ozone levels are much higher than actual levels



Why is Sitch et al. so far off? IPCC scenarios drastically overstate pollutant emissions



Source:
M. Amman, "Emissions trends of anthropogenic air pollution in the northern hemisphere," IIASA

Nature news article highlighted Sitch et al.

“Carbon sinks threatened by increasing ozone”

“Rising levels of ozone pollution over the coming century will erode the ability of plants to absorb carbon dioxide from the atmosphere, a new climate-modelling study predicts.”

Environmental Health Perspectives • VOLUME 112 | NUMBER 15 | November 2004

Assessing Ozone-Related Health Impacts under a Changing Climate

Kim Knowlton,[1] Joyce E. Rosenthal,[1] Christian Hogrefe,[2] Barry Lynn,[3] Stuart Gaffin,[3] Richard Goldberg,[3] Cynthia Rosenzweig,[4] Kevin Civerolo,[5] Jia-Yeong Ku,[5] and Patrick L. Kinney[1]

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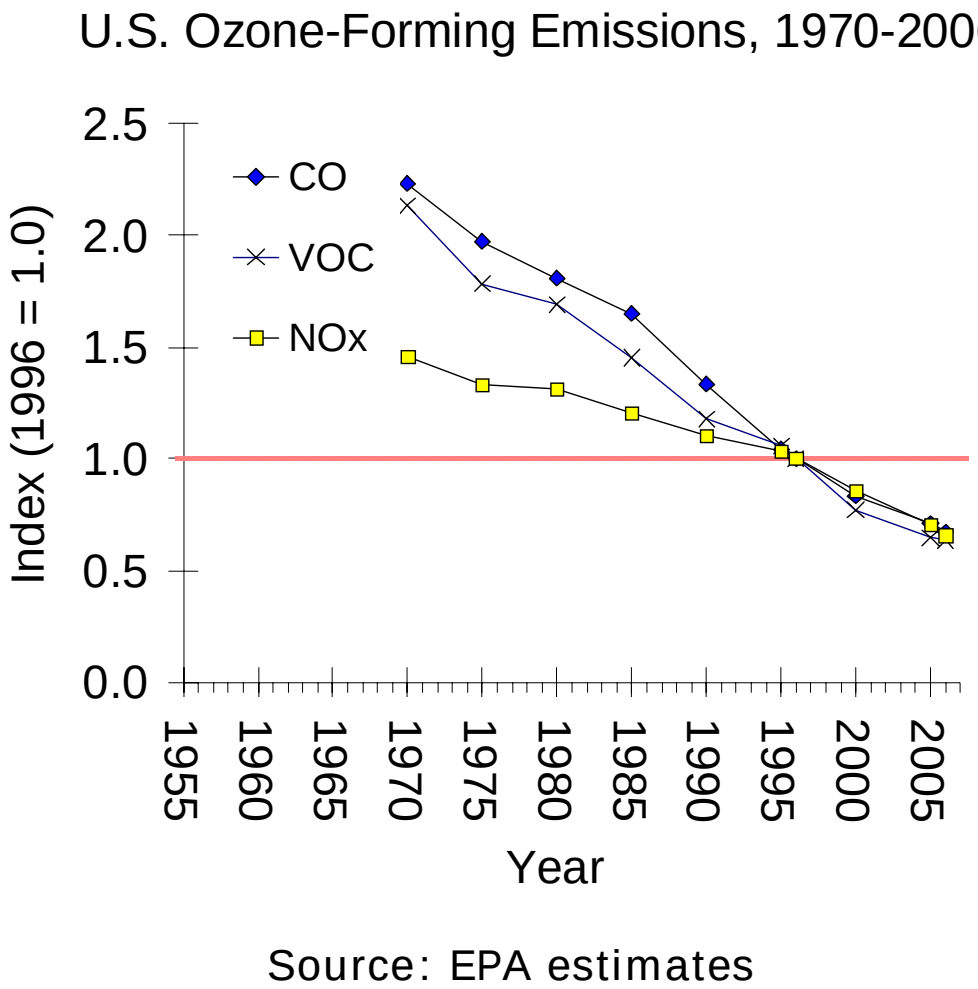
Climatic Change (2007) 82:61–76
DOI 10.1007/s10584-006-9166-7

Climate change, ambient ozone, and health in 50 US cities

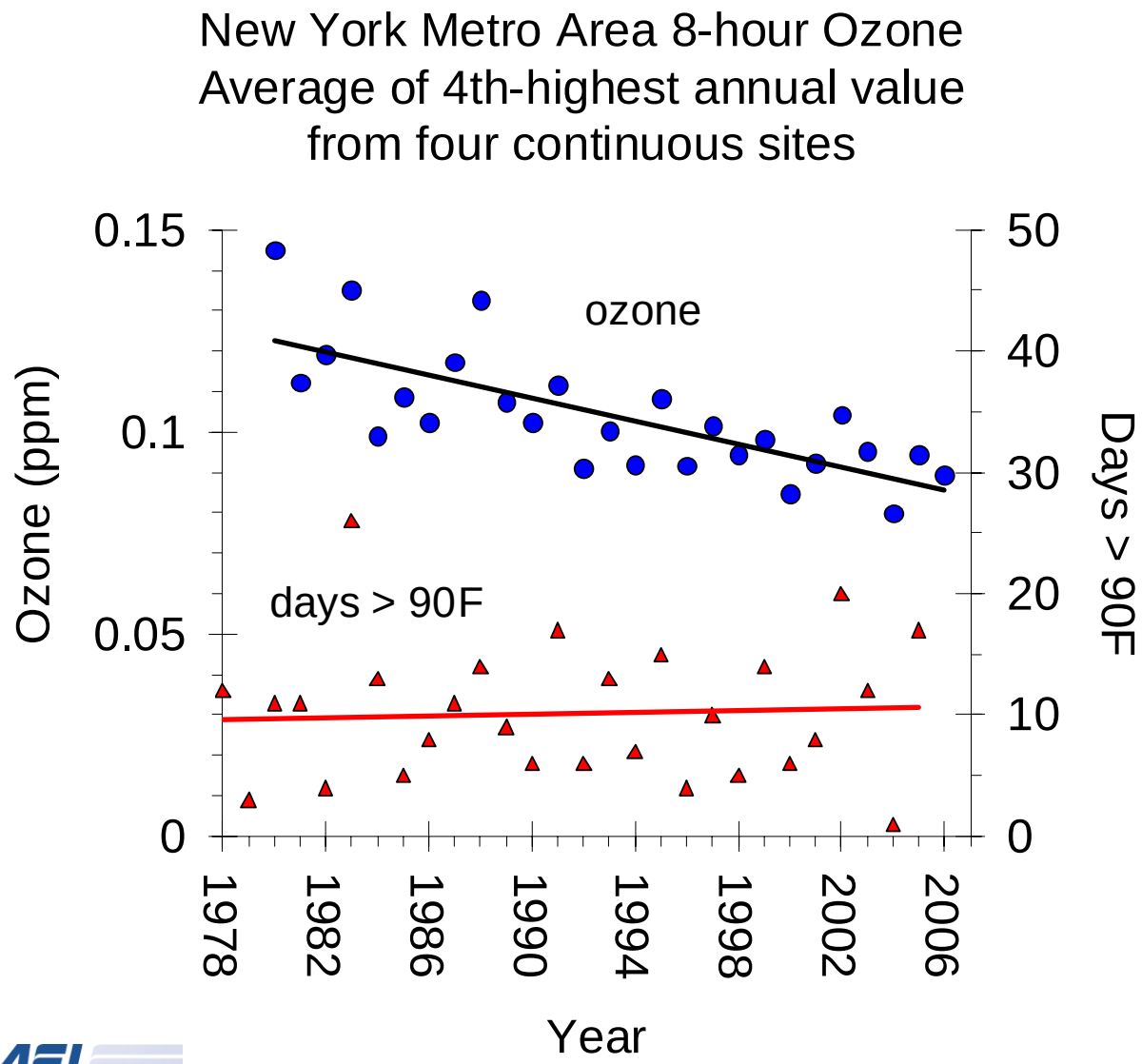
Michelle L. Bell • Richard Goldberg • Christian Hogrefe •
Patrick L. Kinney • Kim Knowlton • Barry Lynn •
Joyce Rosenthal • Cynthia Rosenzweig • Jonathan A. Patz

Knowlton et al. and Bell et al. used emissions from 1996 to "predict" ozone levels in 2050



- "Ozone precursor emissions were held constant at the 1996 county-level U.S. EPA National Emissions Trends inventory; thus, no projected changes in anthropogenic precursor emissions were applied in the [model] projections of 2050s summer [ozone]."
  – Knowlton et. al., *Env Health Persp*, November 2004
- They claim to be holding emissions "constant". But by using 1996 emissions, they in fact assumed that between 2004 and 2050 NOx and CO would increase by 35% and VOC would increase by 50%.

More hot days, but less ozone



- Heat Advisory scientists never compared their models and assumptions against real-world observations.
- Ozone has been dropping as the climate has warmed.

HEAT ADVISORY

How Global Warming Causes More Bad Air Days

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Deceptive and evasive response to criticism

- Knowlton et al. response to Schwartz, Michaels, & Davis critique:
  - “Schwartz et al. suggest incorrectly that our model runs were intended to project what is likely to actually happen with ozone and mortality in the 2050s under a changing climate. Had we wished to do that, we would have needed to include realistic estimates of ozone precursor changes over the period of interest. However, because there are no reliable estimates of precursor emissions extending to the mid 21st century, such an exercise would have been extremely speculative.”
- Now look at Knowlton et al.’s original paper:
  - "When a more fully elaborated picture of the likely regional future was evaluated--that is, including population growth and anthropogenic [ozone] precursor emissions increases--much greater changes in summer mortality are projected ”

NRDC
THE EARTH'S BEST DEFENSE

HEAT ADVISORY

How Global Warming Causes More Bad Air Days

July 2004

EXECUTIVE SUMMARY

As global warming causes hot summer days to get hotter, concentrations of an air pollutant called ozone increase—forming lung-damaging pollution commonly known as smog. This report presents a comprehensive new analysis by medical experts at the Johns Hopkins University's Bloomberg School of Public Health and Columbia University's Mailman School of Public Health in collaboration with University at Albany SUNY, Yale University, and the University of Wisconsin-Madison. The analysis assesses how much smog levels could rise over the eastern United States because of global warming—and what that could mean for public health.

Smog is formed when pollutants from vehicles, factories, and other sources mix with sunlight and heat, which means that key air quality measures are highly sensitive to temperature. Researchers project under a climate change scenario that by mid-century people living in 15 cities in the eastern United States would see a 60 percent increase—from 12 to almost 20 days per summer—in the average number of days exceeding the health-based 8-hour ozone standard established by the U.S. Environmental Protection Agency (EPA) (see Figure ES-1). The number of unhealthy "red alert" days would double. Correspondingly, these citizens would enjoy, on average, nearly 20 percent fewer healthy air days in future summers because of global warming (see Figure ES-2).

NRDC's response to Schwartz's 2007 critique of *Heat Advisory*: Deception and evasion

- **NRDC:** "The project on which *Heat Advisory* is based kept anthropogenic ozone precursor emission levels constant as a way of evaluating the effect that climate change alone could have on ozone concentrations."
  - Misleading: "Constant" really means "constant at 1996 levels", that is, 35%-50% higher than today, and at least four or five times higher than emissions in coming decades.
- **NRDC:** "While we would expect significant reductions in [ozone-]precursor emissions over the next decade there are no reliable estimates of precursor emissions extending to the mid 21st century."
  - This applies even more so to climate model predictions.
  - How does this justify assuming that emissions will rise, when we know they already fallen and will continue to fall?
  - Imagine NRDC's or Real Climate's reaction if climate skeptics assumed CO2 emissions would stay constant at 1996 levels to predict future climate.

NRDC certainly knows that air pollution will decline; NRDC press releases highlight the new regulations

- **EPA Rule Means Progress Against Diesel Pollution According to Natural Resources Defense Council**, May 10, 2004
  - These standards…will reduce particulate soot and nitrogen oxide emissions [from non-road diesel vehicles] by 90-95 percent in most cases
- **NEW DIESEL FUEL HITTING PUMPS NATIONWIDE ON OCTOBER 15 CUTS POLLUTION, ENABLES NEW LOW-EMISSION ENGINE TECHNOLOGY**, October 10, 2006
  - …when combined with a new generation of engines hitting the road in January, it will enable emission reductions of up to 95 percent, according to the Natural Resources Defense Council
- **EPA touts new, cleaner cars,** January 26, 2004:
  - Mike Leavitt, head of the Environmental Protection Agency, unveiled 17 new cars and trucks designed to meet stricter "Tier 2" emissions standards set in 1999. The vehicles, which burn low-sulfur fuel, are 77 percent to 95 percent cleaner than current models.

- NRDC then claimed *Heat Advisory* wasn't really making predictions of future ozone levels:
  - "The project on which *Heat Advisory* is based kept anthropogenic ozone precursor emission levels constant as a way of evaluating the effect that climate change alone could have on ozone concentrations. Other researchers may choose alternative assumptions about how anthropogenic ozone precursors could change in the future, and will arrive at different projected ozone concentrations. Projections of how global warming would affect ozone levels are not predictions of what will happen."
- **Now look at NRDC's press release:**

"Smog Poses Greater Health Risk Because of Global Warming

More Bad Air Days for Southern, Eastern U.S. Cities

WASHINGTON, DC (September 13, 2007) -- People living in ten mid-sized metropolitan areas are expected to experience significantly more 'red alert' air pollution days in coming years due to increasing lung-damaging smog caused by higher temperatures from global warming.

Researchers project that, unless action is taken to curb global warming, by mid-century people living in a total of 50 cities in the eastern United States would see:

A doubling of the number of unhealthy 'red alert' days

A 68 percent (5.5 day) increase in the average number of days exceeding the current 8-hour ozone standard"

Only one study has tried to use a realistic estimate of future air pollutant emissions

JOURNAL OF GEOPHYSICAL RESEARCH

Impacts of global climate change and emissions on regional ozone and fine particulate matter concentrations over the United States

Efthimios Tagaris,[1] Kasemsan Manomaiphiboon,[1] Kuo-Jen Liao,[1] L. Ruby Leung,[2] Jung-Hun Woo,[3] Shan He,[3] Praveen Amar,[3] and Armistead G. Russell[1]

Received 18 November 2006; revised 9 February 2007; accepted 3 May 2007; published 31 July 2007.

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GA Tech/NESCAUM assumptions & results

- Assumptions
  - Climate warms about 2.5°F by 2050 (IPCC A1B scenario)
  - NOx and SO2 emissions drop 50%; VOC emissions drop more than 40%
- Results
  - “The combined effect of climate change and emission reductions lead to a 20% decrease (regionally varying from 11% to 28%) in the mean summer maximum daily 8-hour ozone levels (M8hO3) over the United States. Mean annual PM2.5 concentrations are estimated to be 23% lower (varies from 9% to 32%).”
  - Modeling suggests warming alone increases ambient pollution in some regions of U.S. and decreases it in others, but climate effects are small compared to direct effect of emission reductions

GA Tech study is actually too pessimistic

- Future air pollution declines will be greater than Georgia Tech/NESCAUM study predicts
  - NOx has already declined more from 2001-2006 than GA Tech study assumed for 2001-2020.
  - VOC has already declined more than half the amount predicted for 2001-2020.
  - In last six years, the U.S. has achieved more than one-fourth the ozone and PM2.5 decline GA Tech predicts for 2001-2050

GEOPHYSICAL RESEARCH LETTERS, VOL. 35, L03809, doi:10.1029/2007GL031101, 2008

Click Here for Full Article

On the causal link between carbon dioxide and air pollution mortality

Mark Z. Jacobson[1]

Received 22 June 2007; revised 14 December 2007; accepted 3 January 2007; published 12 February 2008.

[1] Greenhouse gases and particle soot have been linked to enhanced sea-level, snowmelt, disease, heat stress, severe weather, and ocean acidification, but the effect of carbon dioxide (CO_2) on air pollution mortality has not been examined or quantified. Here, it is shown that increased water vapor and temperatures from higher CO_2 separately increase ozone more with higher ozone; thus, global warming may exacerbate ozone the most in already-polluted areas. A high-resolution global-regional model then found that CO_2 may increase U.S. annual air pollution deaths by about 1000 (350–1800) and cancers by 20–30 per 1 K rise in CO_2-induced temperature. About 40% of the additional deaths may be due to ozone and the rest, to particles, which increase due to CO_2-enhanced stability, humidity, and biogenic particle mass. An extrapolation by population could render 21,600 (7400–39,000) excess CO_2-caused annual pollution deaths worldwide, more than those from CO_2-enhanced storminess. **Citation:** Jacobson, M. Z. (2008), On the causal link between carbon dioxide and air pollution mortality, *Geophys. Res. Lett.*, *35*, L03809, doi:10.1029/2007GL031101.

pendently increase ozone more with high than low ozone. This analysis helps to explain the causal link between CO_2 and health in areas where most people live, as subsequently found in 3-D global-regional simulations.

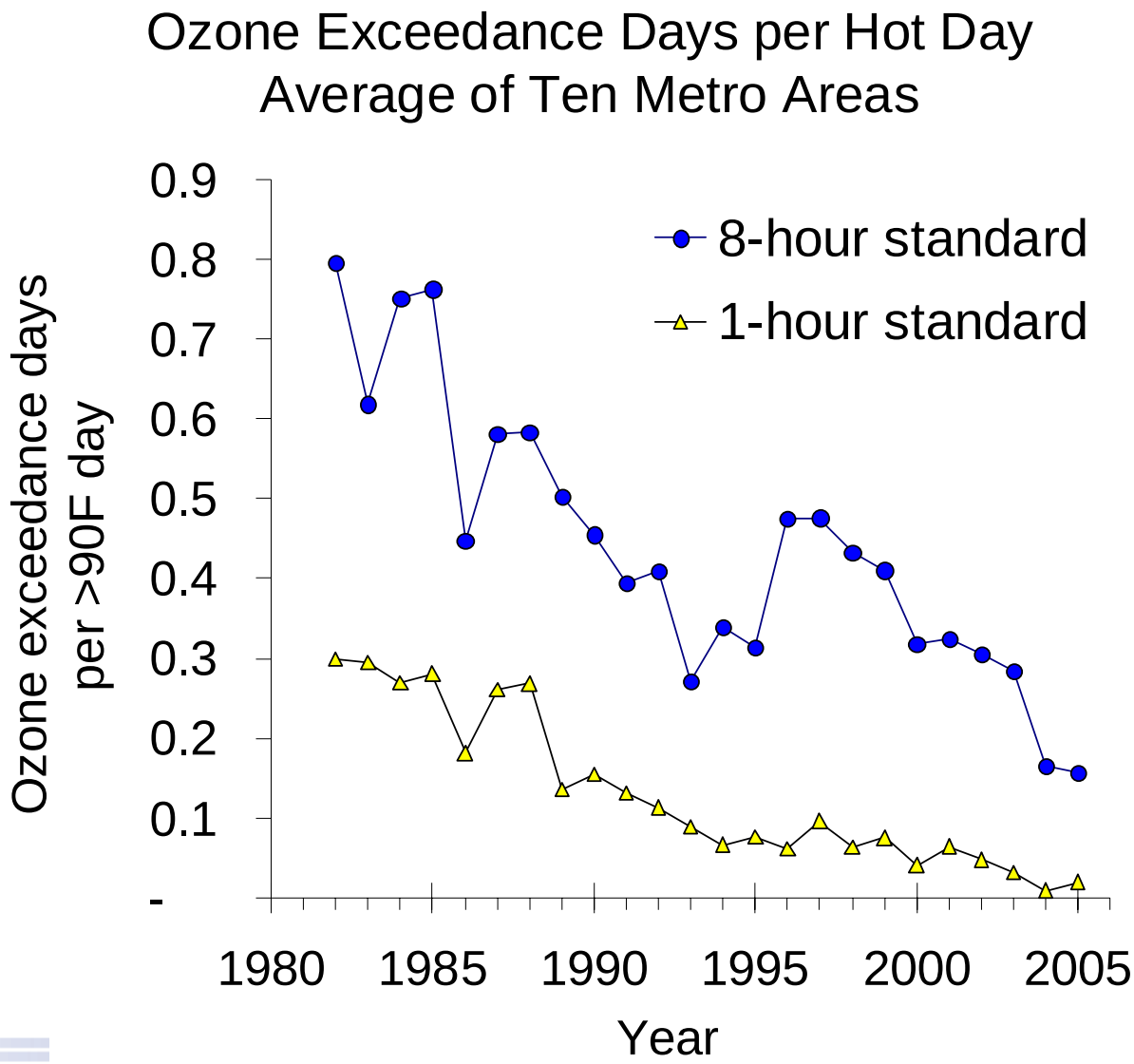
2. Chemical Effects of CO_2 on Ozone

[4] The SMVGEAR II chemical solver was used first in box mode, without dilution or entrainment, to solve chemistry for 12 hours among 128 gases and 395 inorganic, organic, sulfur, chlorine, and bromine reactions (including 57 photoprocesses) (mostly given by *Jacobson et al.* [2007], also see the supplementary material of *Jacobson* [2007]). Cases with different initial NO_x and organic gas were run.

[5] Figure 1 shows the water-vapor (H_2O) and temperature-dependence of ozone under several ozone precursor combinations. For initial $NO_x < 8$ ppbv, ozone decreased with increasing H_2O. For initial $NO_x > 80$ ppbv and moderate initial NO_x with low organics, though, ozone increased with increasing H_2O, by up to 2.8 ppbv-O_3 per 1 ppthv-H_2O. Between these extremes, ozone increased

Used 2002 NOx and VOC emissions to “predict” future ozone levels

Ozone is becoming less and less sensitive to temperature



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