The consequences of nuclear war: current evidence

Tilman Ruff AO

International Campaign to Abolish Nuclear Weapons (Nobel Peace Prize 2017)
International Physicians for the Prevention of Nuclear War
(Nobel Peace Prize 1985)
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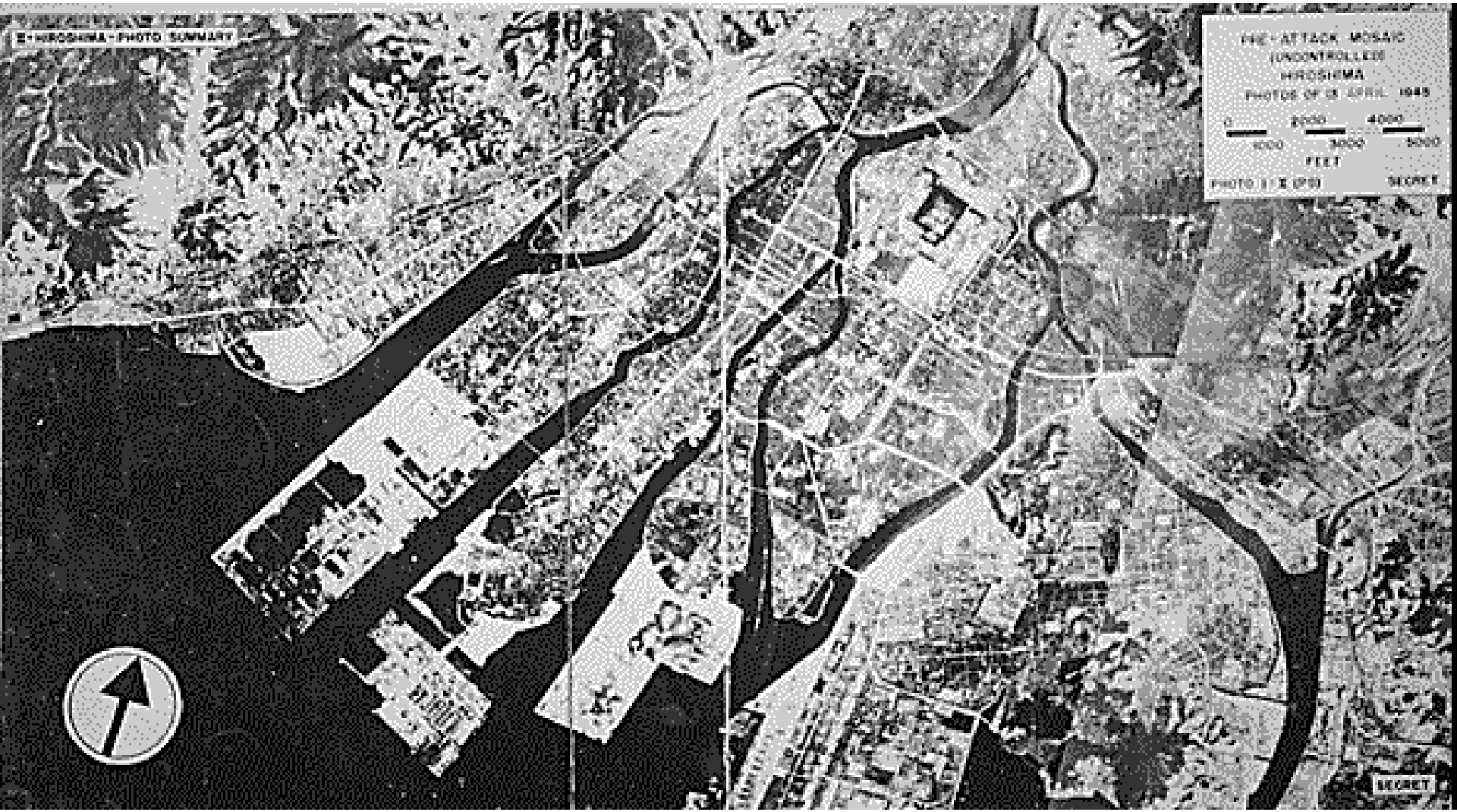
UNE Sydney 14 Feb 2020

Thanks: Alan Robock, Mike Mills, Ira Helfand

Nuclear numbers 2020

- Explosives in all wars >10 Mt
- Largest nuclear test explosion 50 Mt 30 Oct 1961
- Peak nuclear arsenal 1986: 70,300 weapons
- Current arsenal July 2019 (fas.org):
  - 13,890 weapons, 91% Russian and US
  - 3750 deployed
  - 1800 Fr, Ru, UK, US warheads on high alert
  - Average size: 200 kt
- Largest deployed warhead - on Chinese DF-5A land-based missiles, 13,000 km+ range, up to 5 Mt


E-HIROSHIMA-PHOTO SUMMARY
PRE-ATTACK MOSAIC
(UNCONTROLLED)
HIROSHIMA
PHOTOS OF 13 APRIL 1945
0
2000
4000
1000
3000
5000
FEET
PHOTO II/E (PS)
SECRET
SECRET

Hiroshima

6 August 1945

A 15 kT bomb killed 140,000 people

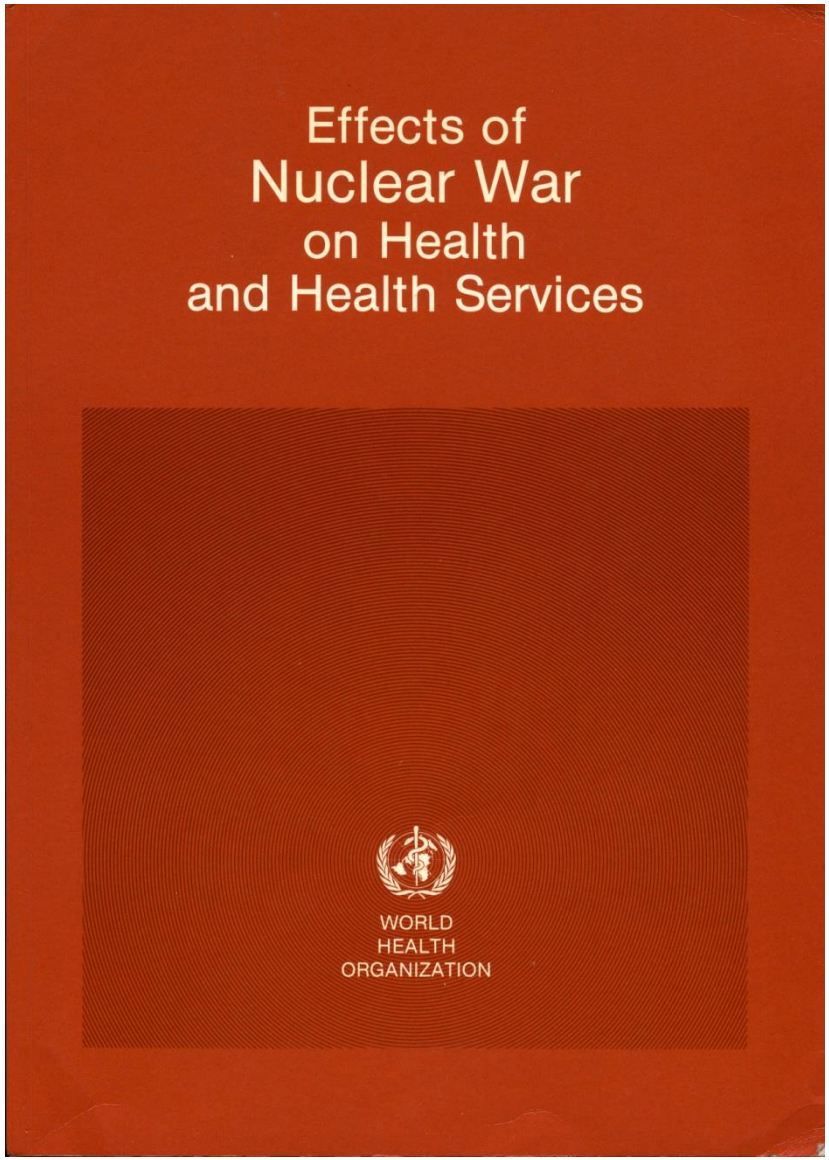
Note: 15 kT = 0.015 MT = 1/1,000,000 of the 1985 world arsenal

= 3/1,000,000 of the current world arsenal

If one Hiroshima-sized bomb were dropped every *two hours* from the end of World War II to today, it would still not use up the current arsenal

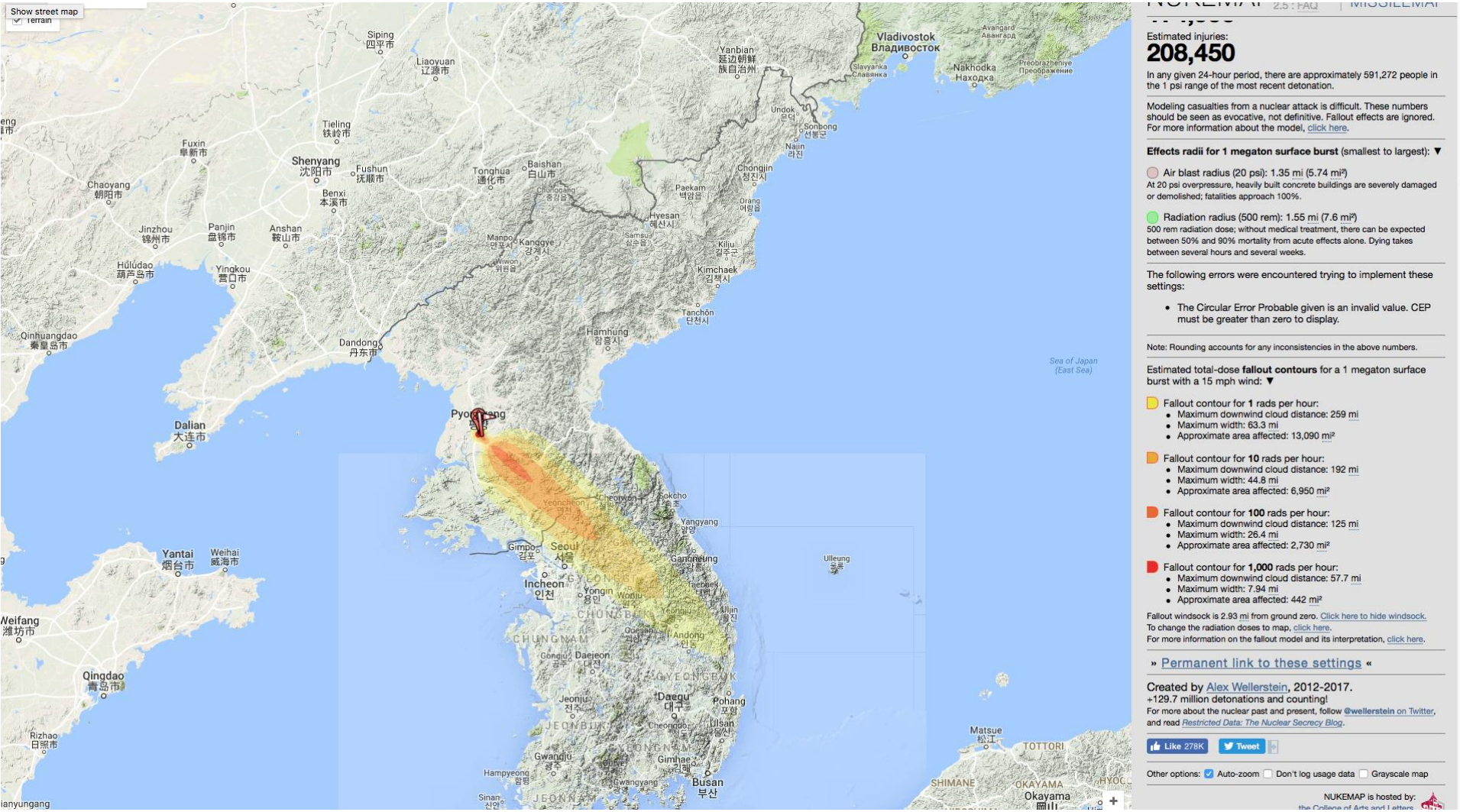
World health Assembly Resolution WHA 36.28 16 May 1983

Effects of nuclear war on health and health services, WHO 1984



- "It is obvious that no health service in any area of the world would be capable of dealing adequately with the hundreds of thousands of people seriously injured by blast, heat or radiation from even a single 1-megaton bomb."
- **"… the only approach to the treatment of the health effects of nuclear explosions is primary prevention of such explosions, that is, the primary prevention of atomic war."**

Radiation dose from 1 Mt ground burst




Nuclear Winter
Cold, dry, dark, and more UV
Crops dying and global famine
© 2009 Scientific American Inc

Nuclear weapon induced fires

"Even the smallest of nuclear weapons, such as the ~15 kt weapon used on Hiroshima, exploding in modern megacities would produce firestorms that would build for hours, consuming buildings, vegetation, roads, fuel depots, and other infrastructure, releasing energy many times that of the weapon's yield."

- Mills MJ, et al. Multidecadal global cooling and unprecedented ozone loss following a regional nuclear conflict. Earth's Future, 2014. doi:10/1002/2013EF000205

Hiroshima: fires released ~1000 times the energy of the explosion

- 15 kt explosion Hiroshima: 13 km^2 burned
- 5 Mt explosion on a city: 1600 km^2 will burn in firestorm; more in a conflagration

“Small” regional nuclear war

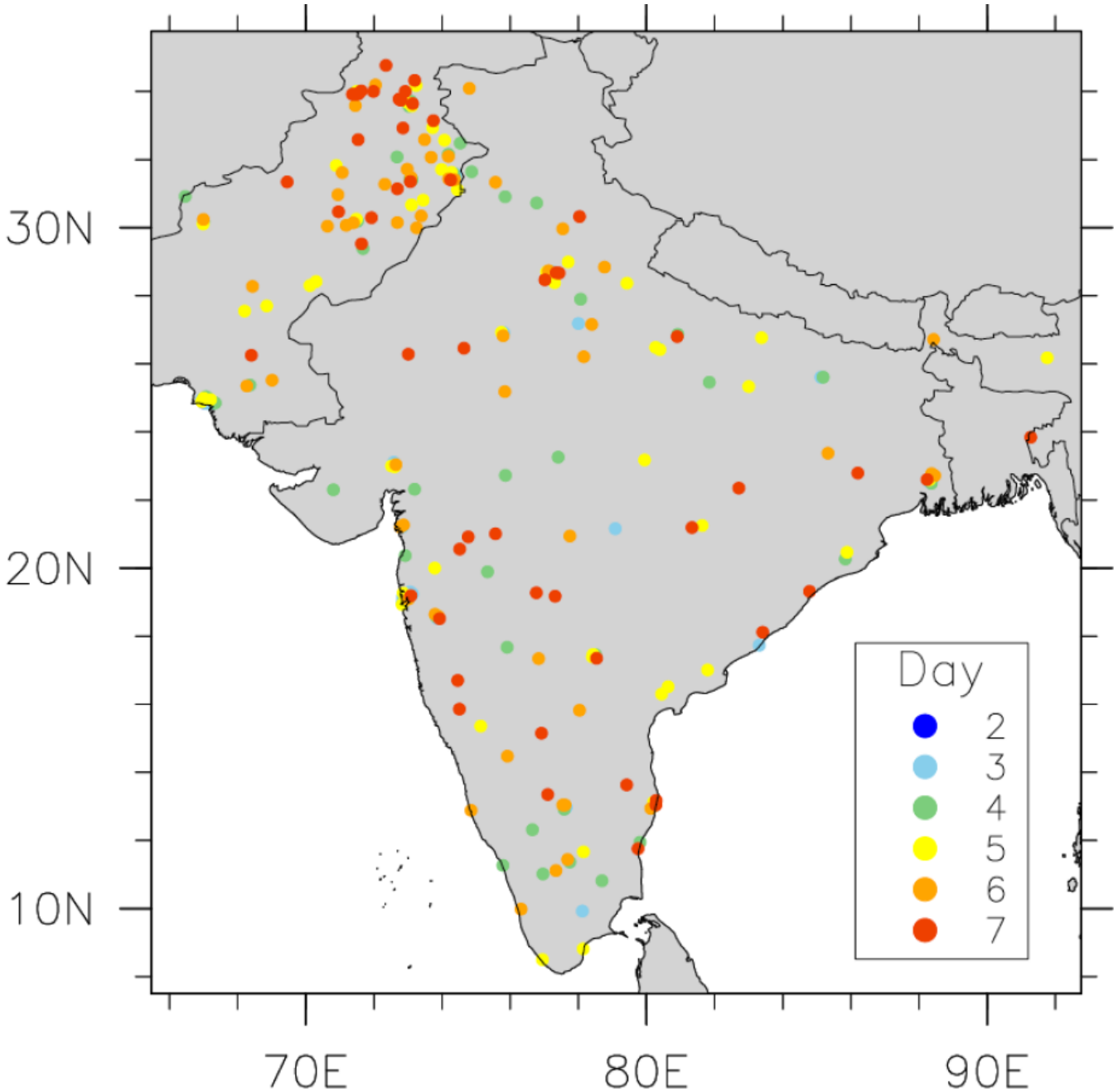
- 250 bombs India – Pakistan
  - 15, 50 or 100 kt
    - Contested Kashmir border with daily shooting, 4 wars since independence, mobilised up to 1 million troops twice more
    - India “Cold Start” invasion plans, Pakistan plans early use of nuclear weapons in a war with India
    - Nuclear weapons use considered in crisis Feb 2019
  - Estimated 16 - 36 million tons of black carbon in smoke

- 52 - 127 million deaths; 83 - 183 million casualties in cities
- Radioactive contamination across South Asia

1.8% of global nuclear weapons, 0.14 - 0.9% of total yield

Toon OB, Bardeen CG, Robock A et al. *Sci Adv* 2019;5:eaay5478 2 Oct 2019

Urban targets



Precipitation and temperature

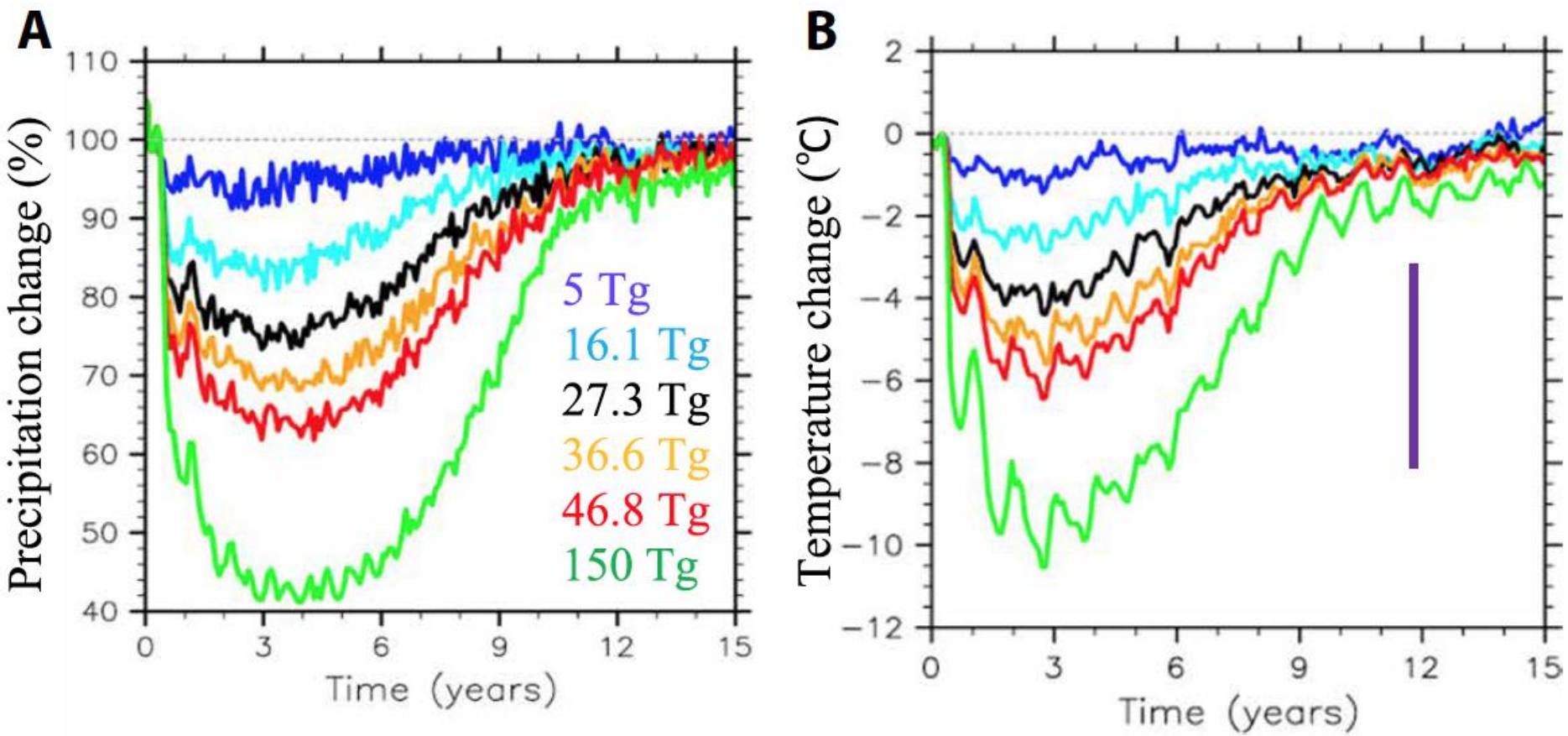
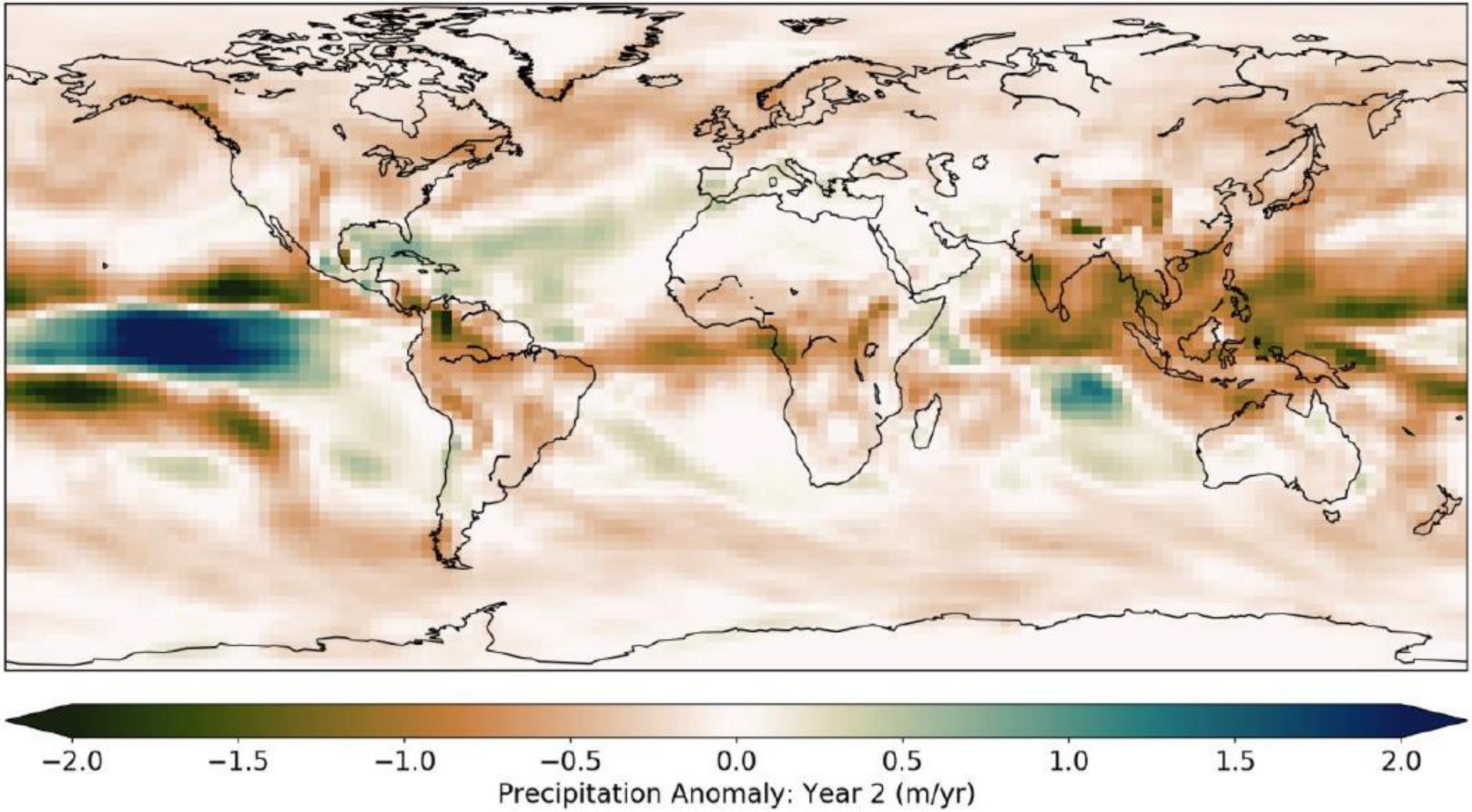


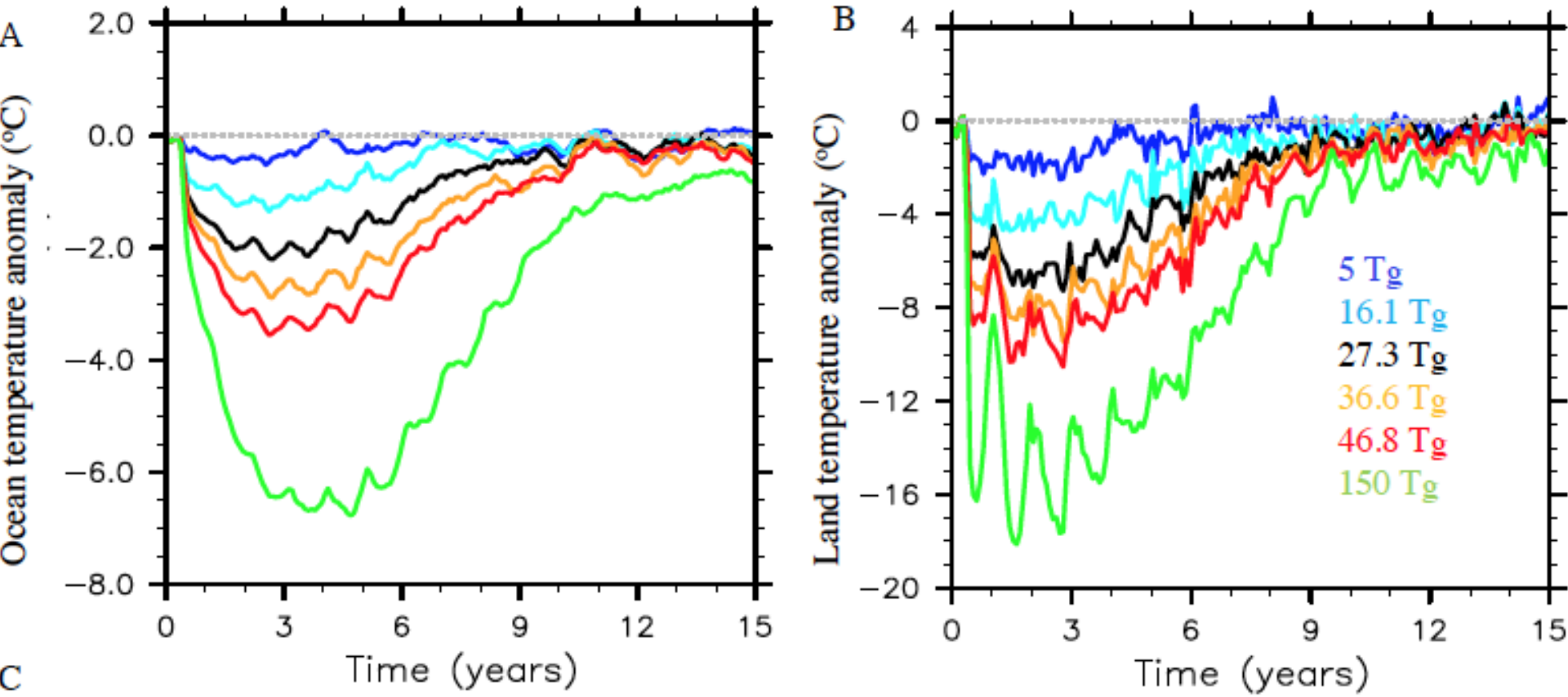
Fig. 5. Temporal variation in global precipitation and temperature following a nuclear conflict. (**A**) Global average precipitation and (**B**) global average temperature,

Vertical bar: Last Glacial Maximum 3-8ºC, 20,000 y ago

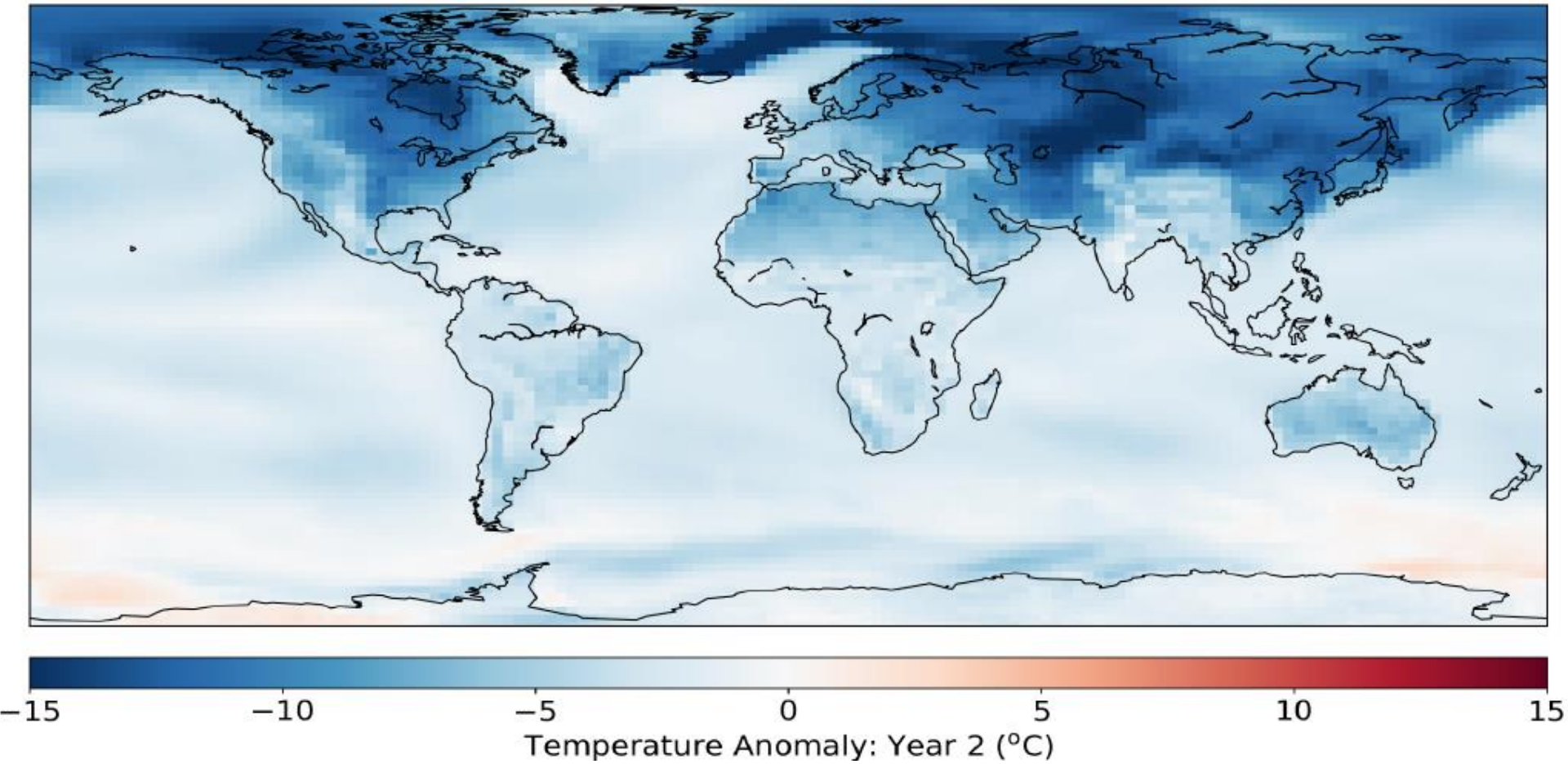
Precipitation year 2 after war with 50 kt weapons



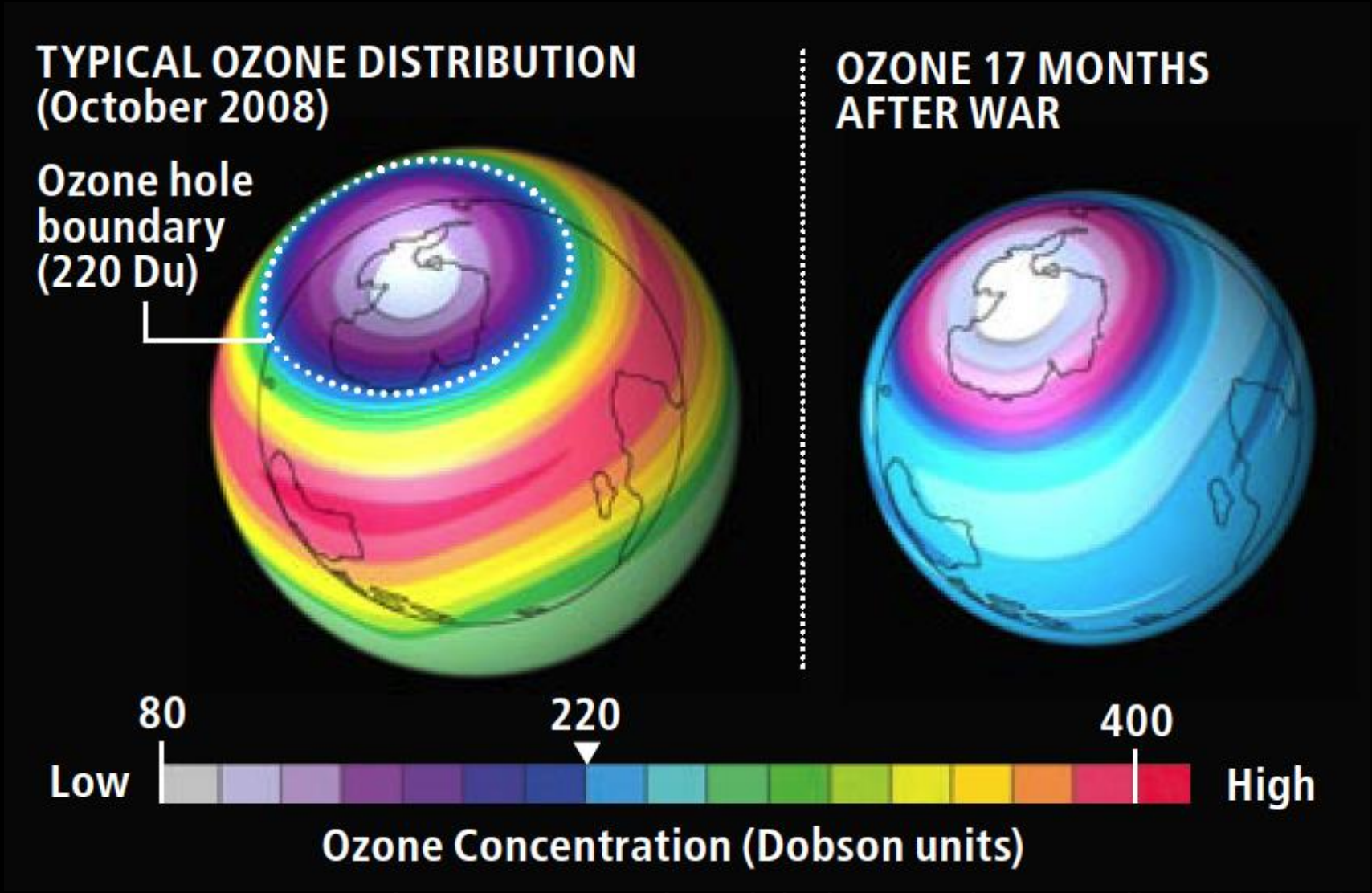
Ocean and land surface temperature



Temperature year 2 after war with 50 kt weapons



Global ozone hole after regional nuclear war



Mills et al., *Massive global ozone loss predicted following regional nuclear conflict*, Proc. Nat. Acad. Sci., 2008

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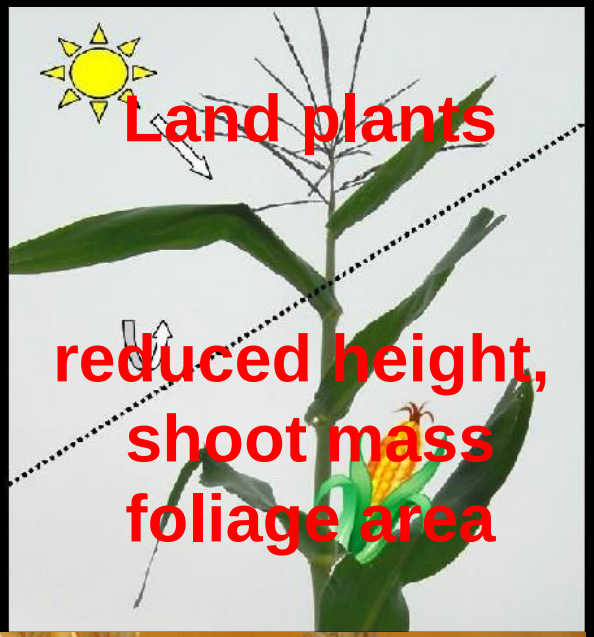
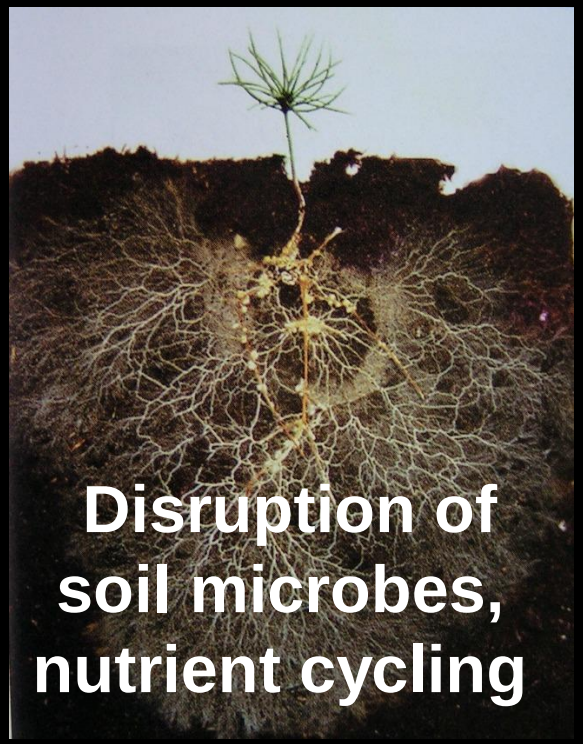
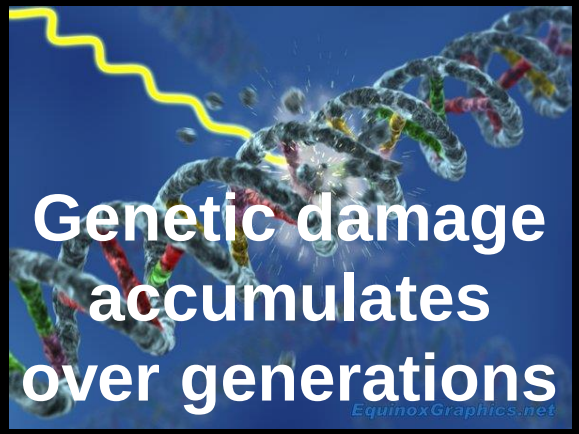
Consequences of severe ozone loss





See discussion and references in Pierazzo,et al., Ozone perturbation from medium-size asteroid impacts in the ocean, *Earth and Planetary Science Letters*, 2010.



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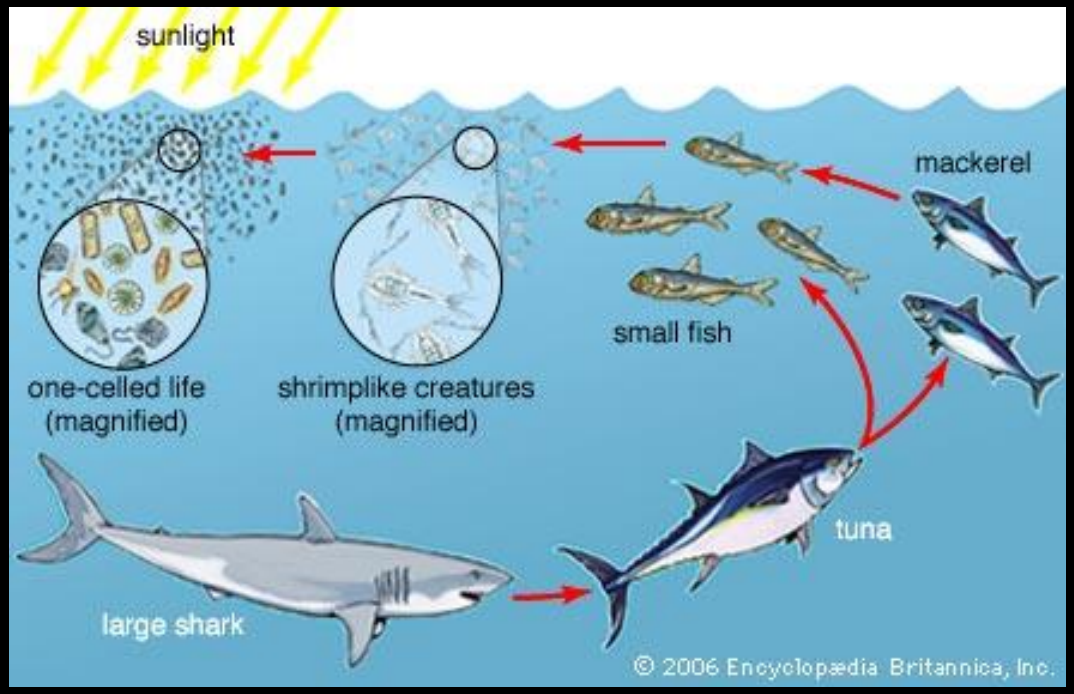

Aquatic ecosystems supply more than 30% of the animal protein consumed by humans

The combined effects of elevated UV levels alone on terrestrial agriculture and marine ecosystems could put significant pressures on global food security

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Hader et al., Effects of increased solar ultraviolet radiation on aquatic ecosystems - Publications of the IAS Fellows, *Ambio*,1995.

Ways agriculture can be affected by a nuclear war

- **Colder temperatures**
  - shortened frost-free growing season
  - cold spells during growing season
  - slower growth → lower yield
- **Darkness**
- **Less rainfall**
- **Enhanced ultraviolet radiation from ozone**
- Radioactivity
- Toxic chemicals in atmosphere, soil, and water
- Lack of water supplies
- Lack of fertilizer
- Lack of fuel for machinery
- Lack of pesticides (but not of pests)
- Lack of seeds (and those that do exist are genetically engineered for the current climate)
- Lack of distribution system

Currently being modeled

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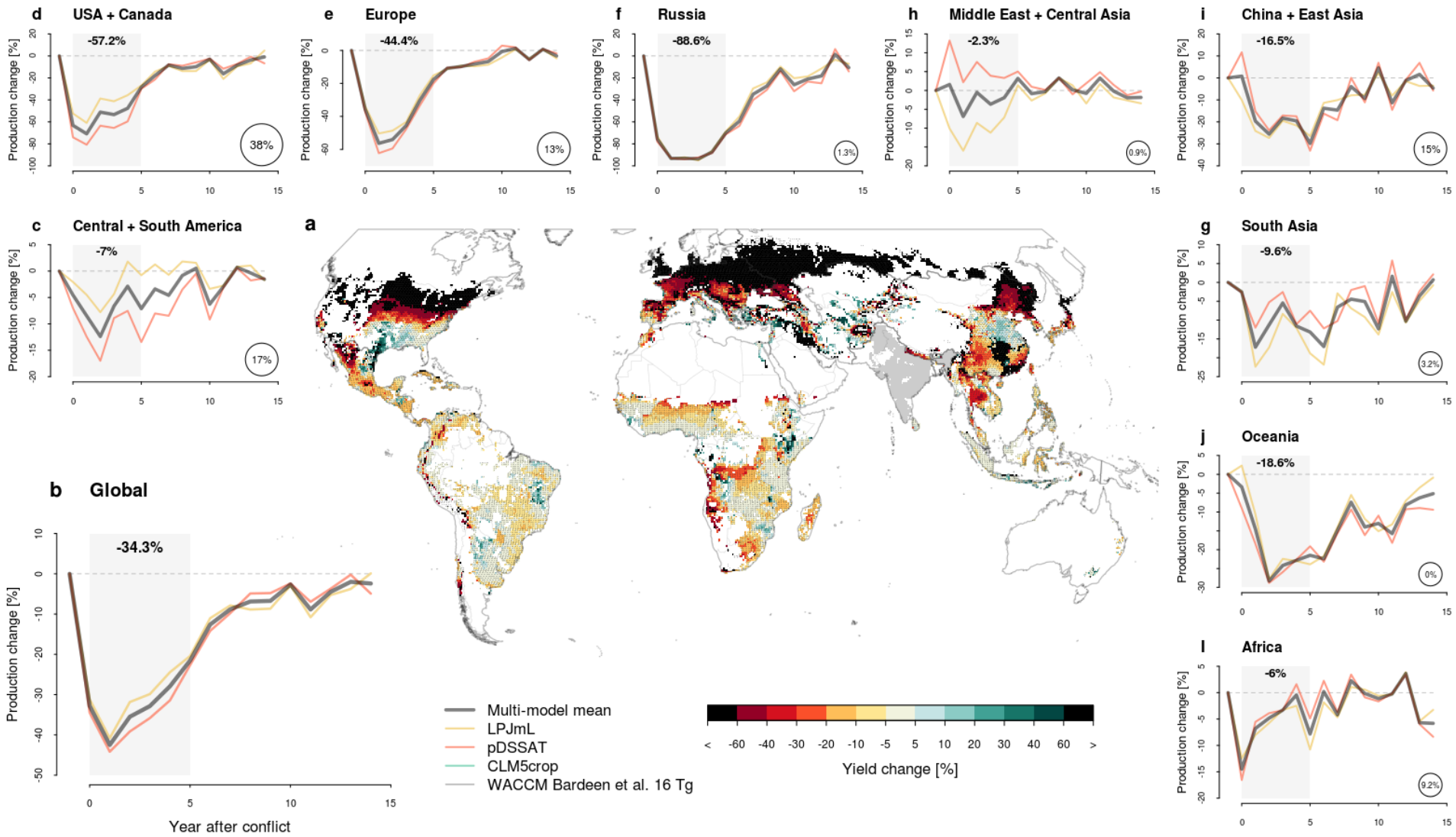
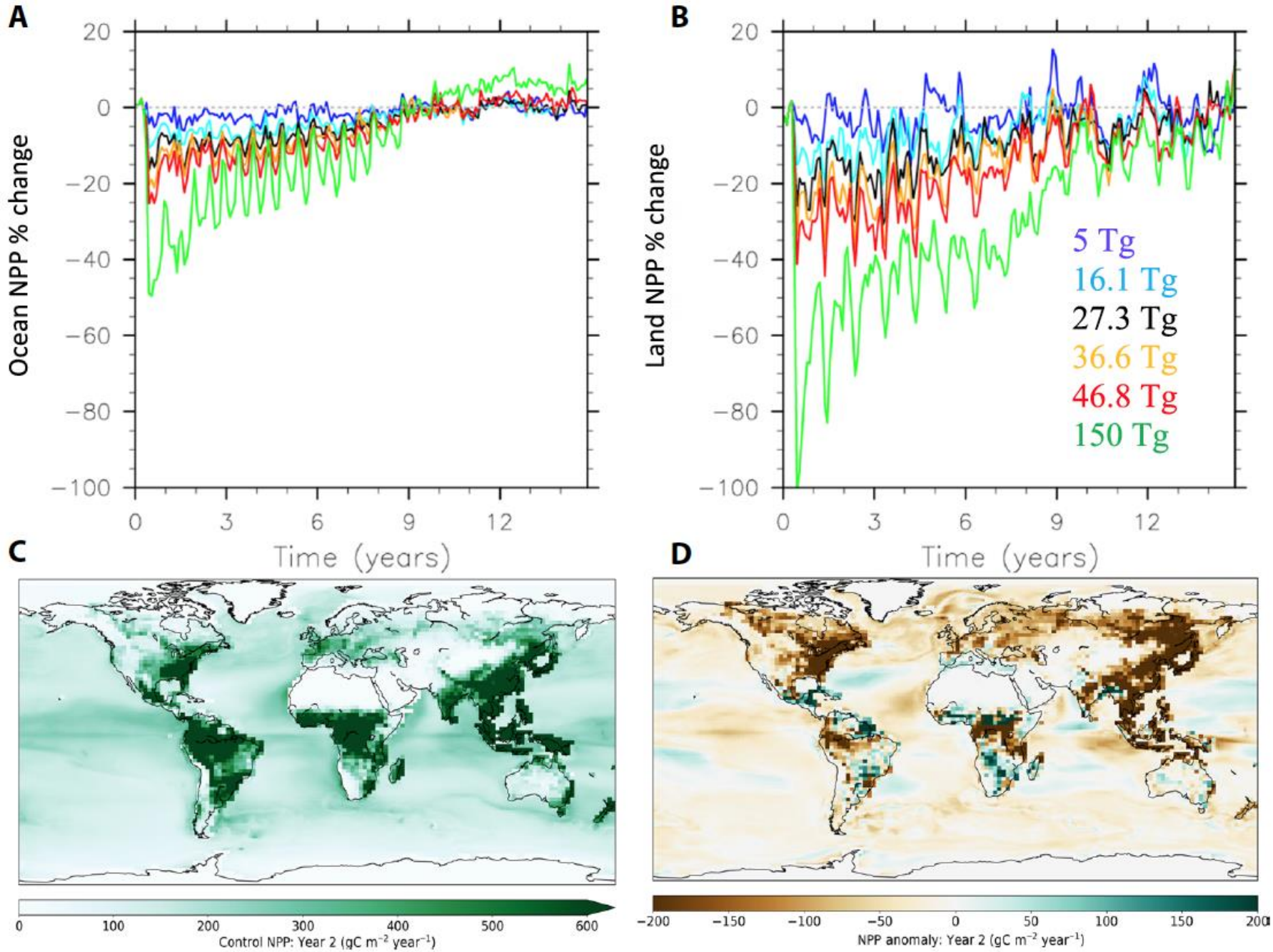
Multi-model maize response 16 Tg



Jägermeyr et al. (in prep.)

Ocean and land net primary productivity



Net primary productivity

- Declines 15-30% over land and 10-20% over oceans for several years
- Loss size comparable to total human use/y
- High fractions of land NPP used by humans:
  - W Europe 72%, S Central Asia 80%, E Asia 63%
  - >100%: most of India, E China, parts Middle East, areas of equatorial Africa – no margin for loss
- 50 kt weapons:
  - 100% NPP decline >60º N over first 3y
  - very large decreases in India, China, SE Asia incl Indonesia, tropical S America and Africa

Chronic malnutrition today

821.6 million people in 2018

People experiencing moderate or severe food insecurity (*SDG Indicator 2.1.2*)

2018: 2.014 billion
2014: 1.696 billion

(FAO 2019)

Global food supply

Global cereal ending stocks 2019/20 forecast:

114 days utilisation

Based on FAO Cereal Supply and Demand Brief 7 Nov 2019

People dependent on imported food for >50% energy intake:

>300 million

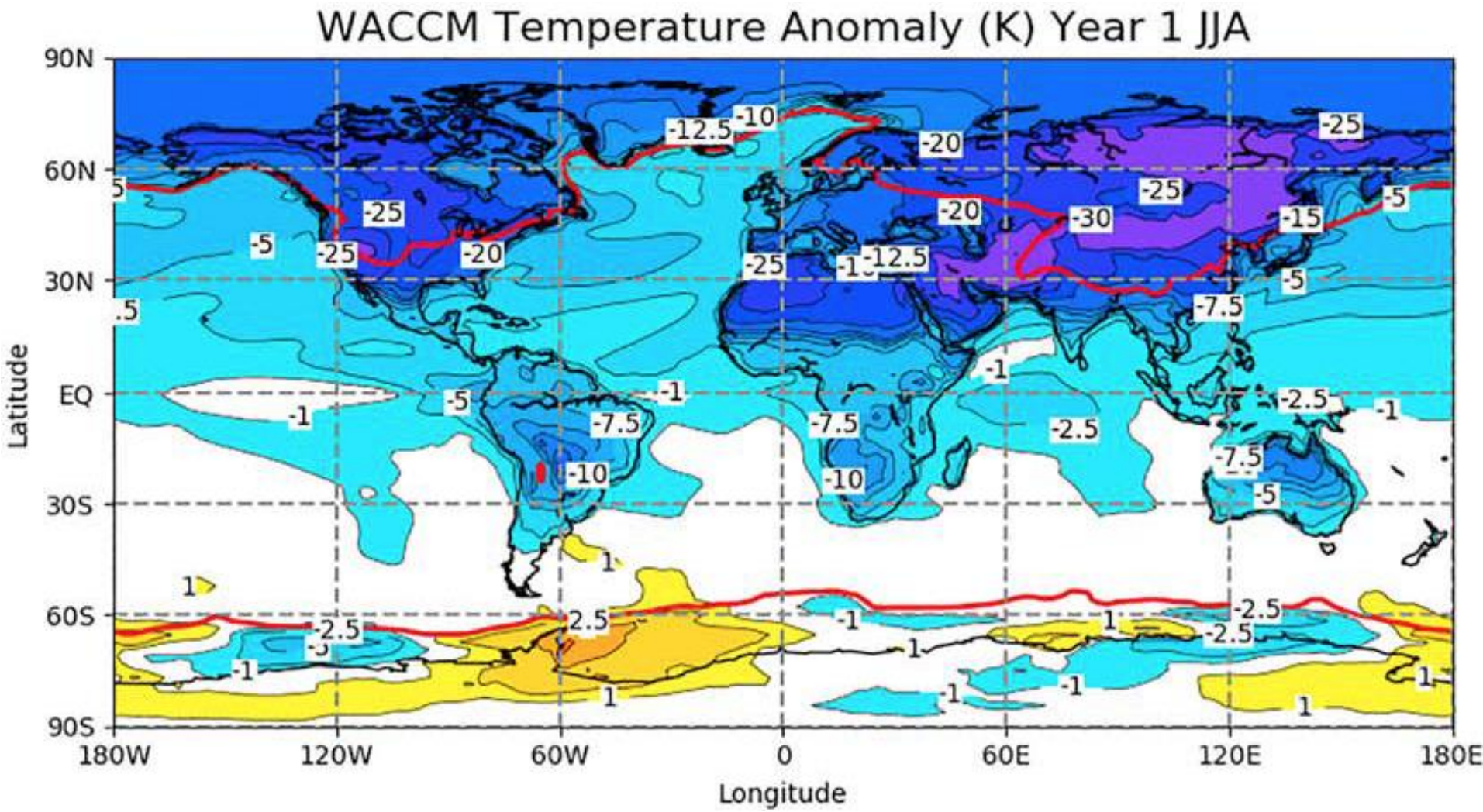
Limited regional nuclear war with low yield weapons:

2 billion victims of starvation from nuclear famine?

+ epidemics, conflict

Helfand I. Nuclear famine: two billion people at risk? 2nd ed. IPPNW 2013

Russia-US nuclear war: 150 million tons of smoke



Actual temp below freezing polewards of red lines

Coupe J, Bardeen C, Robock A, Toon OB.
J Geophysical Res: Atmospheres 2019:124:8522

Bulletin of the Atomic Scientists

IT IS 5 MINUTES TO MIDNIGHT

Feature

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Self-assured destruction: The climate impacts of nuclear war

Alan Robock and Owen Brian Toon

Nuclear weapons are global suicide bombs