Young People's Burden: Averting Climate Disaster

Sophie Kivlehan & James Hansen

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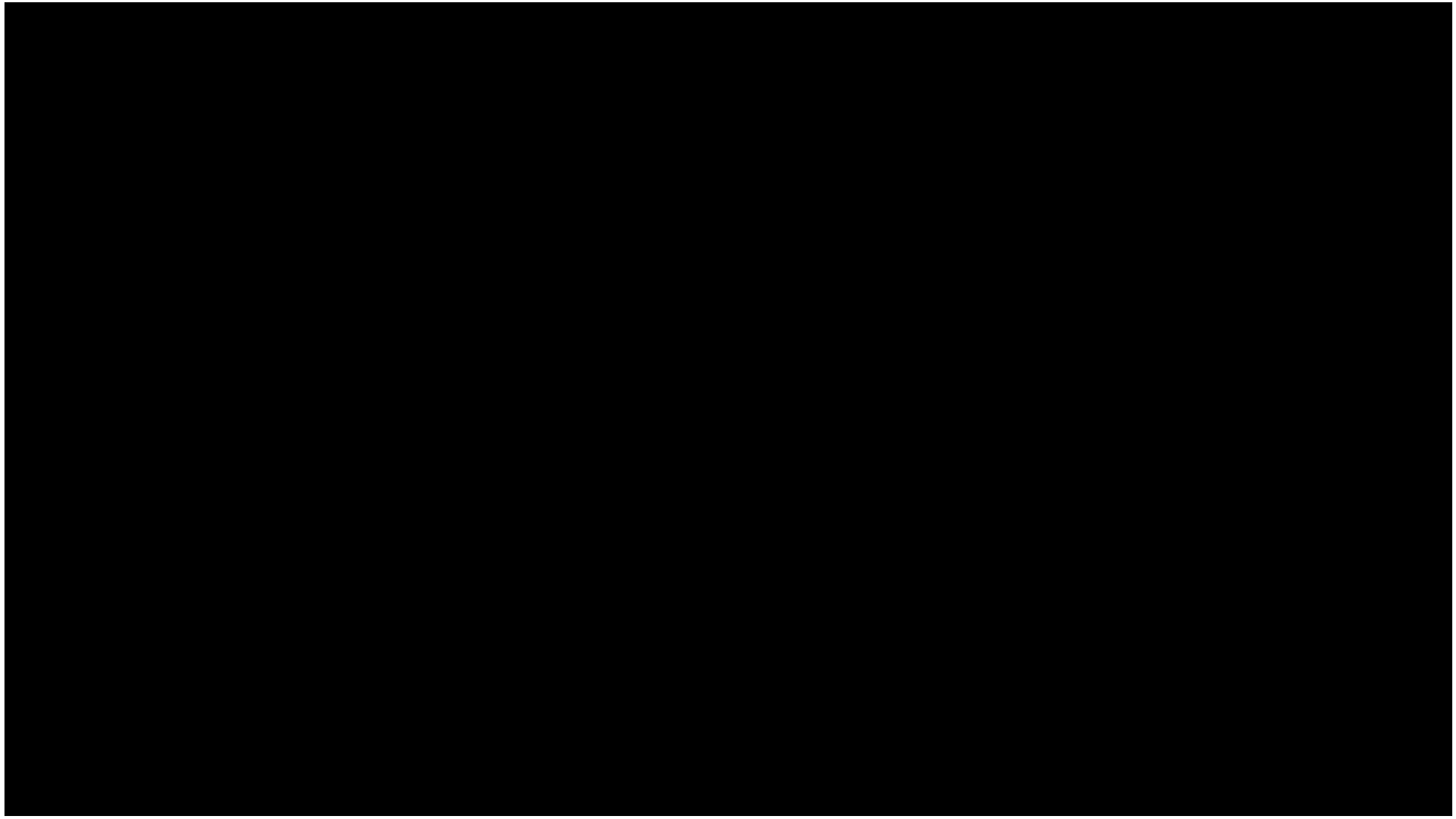
Bonn, Germany



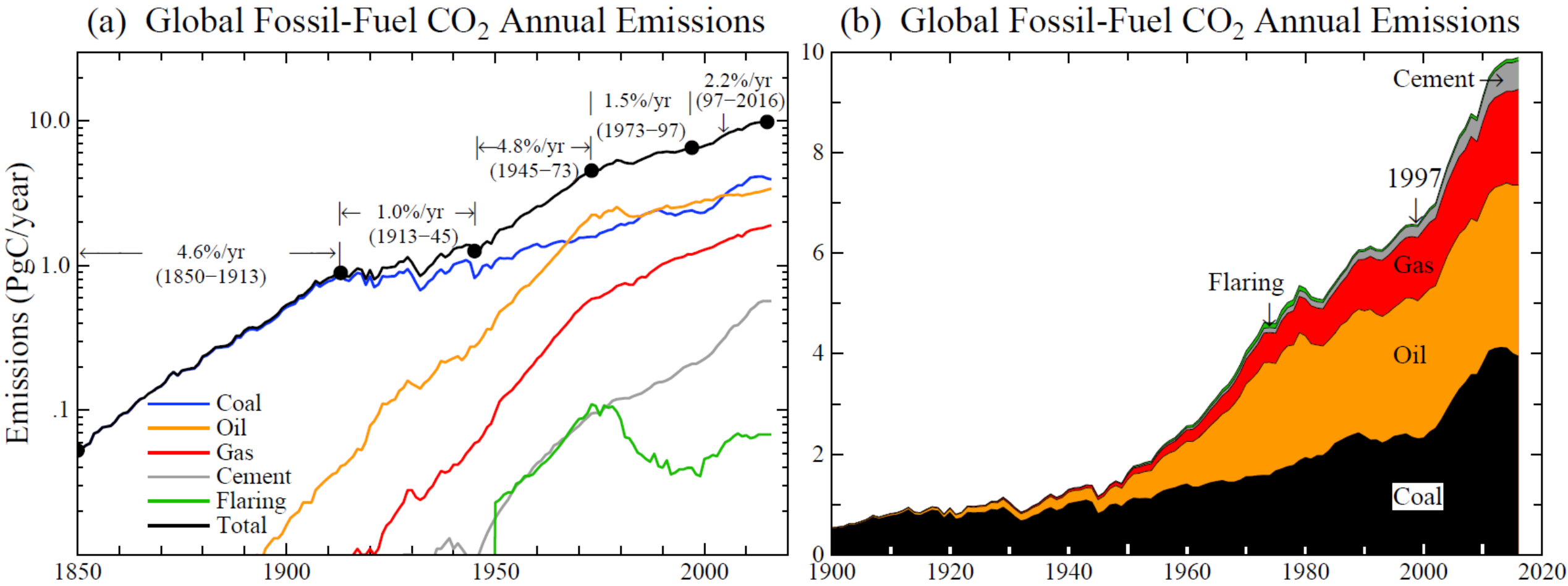


Fig. A1. CO_2 emissions from fossil fuel use and cement manufacture, based on data of Boden et al (2017) through 2014, with results extended using BP(2017) energy consumption data. (a) is log scale and (b) is linear.

Source: Update of Fig. A1 of Hansen et al., Young people's burden: requirement of negative CO_2 emissions, *Earth System Dynamics*, **8**, 1-40, 2017.

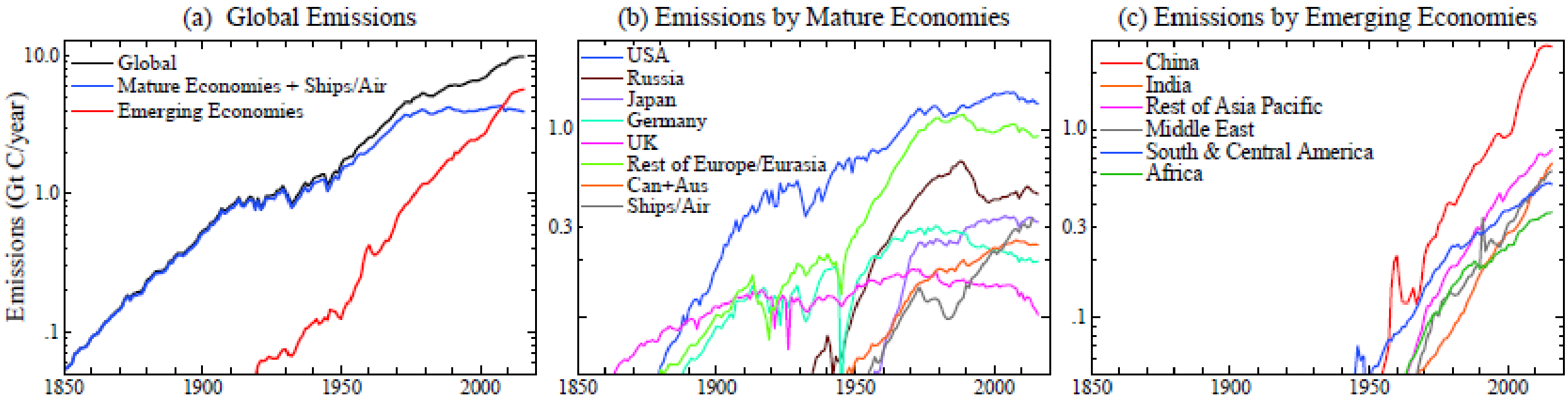


Fig. 1. Fossil fuel (and cement manufacture) CO_2 emissions based on Boden et al (2017) with BP data used to infer 2015-2016 estimates. Europe/Eurasia is Turkey plus Boden et al. categories Western Europe and Centrally Planned Europe. Asia Pacific is sum of Centrally Planned Asia, Far East and Oceania. Russia is 0.6 of USSR in 1850-1991. Ships/air is sum of bunker fuels.

Source: Update of Fig. 1 of Hansen et al., Young people's burden: requirement of negative CO_2 emissions, *Earth System Dynamics*, **8**, 1-40, 2017.

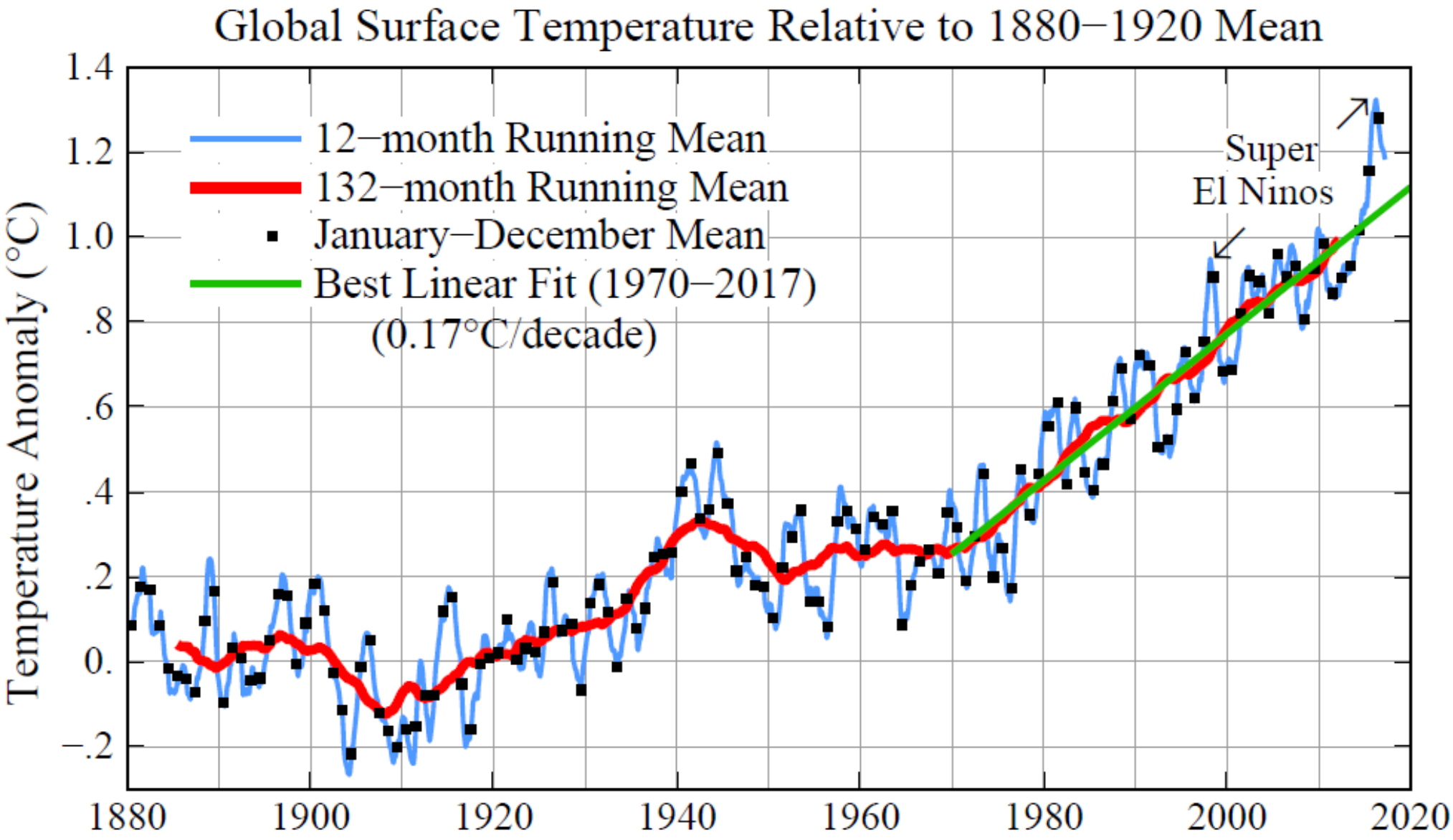


Fig. 2. Global surface temperature relative to 1880-1920 based on GISTEMP analysis. Black squares are calendar year means. Data extend through September 2017.

Source: Update of Fig. 2 of Hansen et al., Young people's burden: requirement of negative CO_2 emissions, *Earth System Dynamics*, **8**, 1-40, 2017.

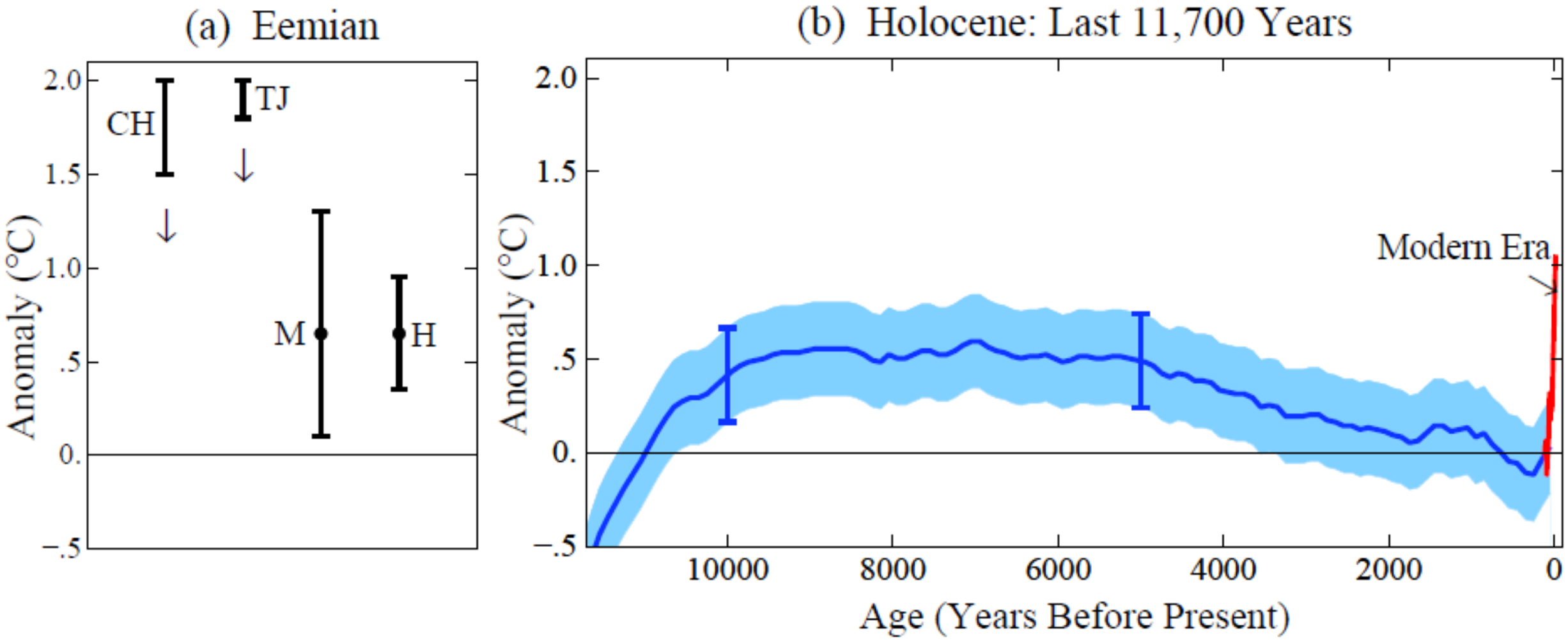


Fig. 3. Estimated average global temperature for the last interglacial (Eemian) period (McKay et al 2011; Clark and Huybers 2009; Turney and Jones 2010), the Holocene (Marcott et al 2013), and 11-year mean of modern data (Fig. 2). Vertical downward arrows indicate likely overestimates.

Source: Hansen et al., Young people's burden: requirement of negative CO_2 emissions, *Earth System Dynamics*, **8**, 1-40, 2017.

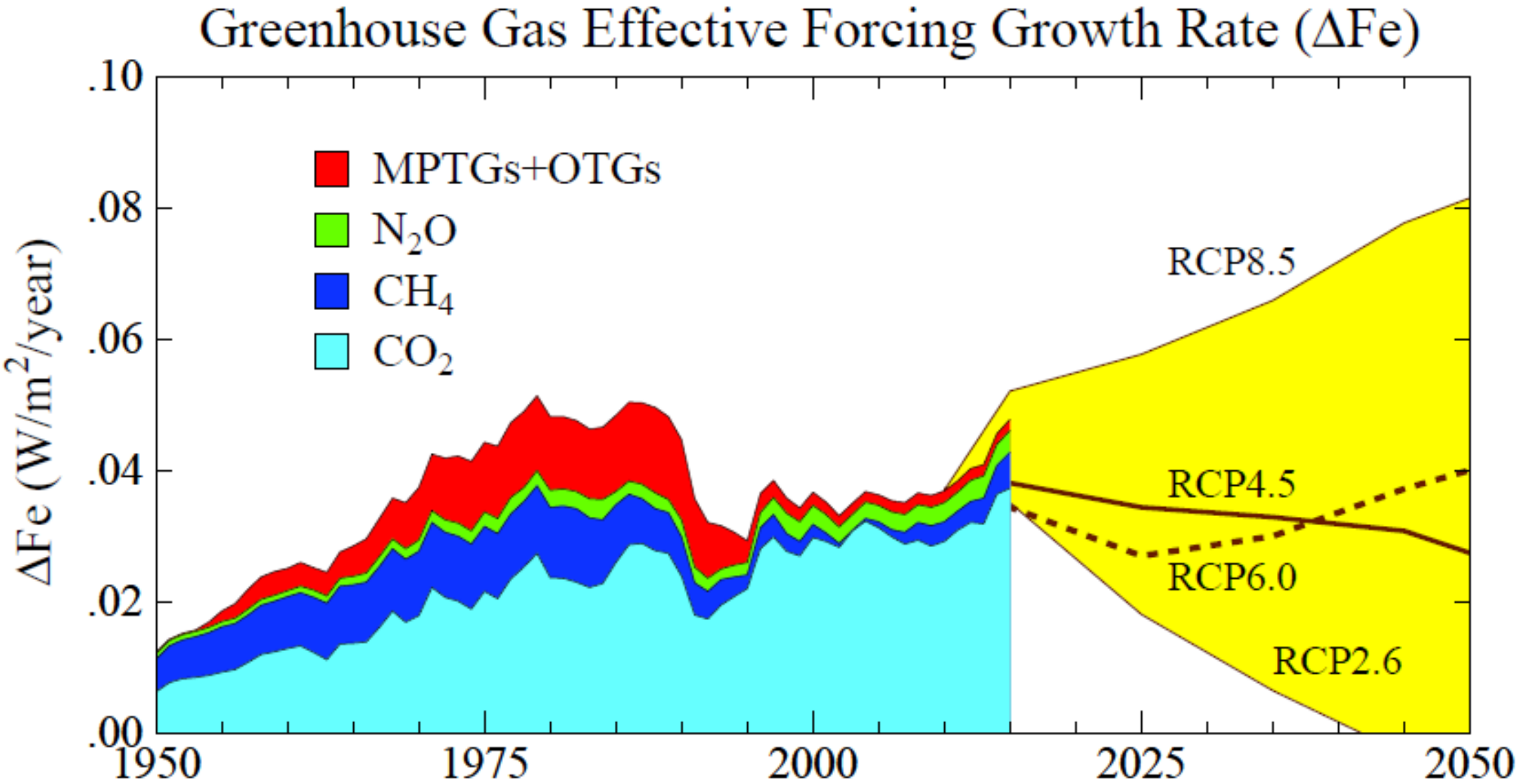
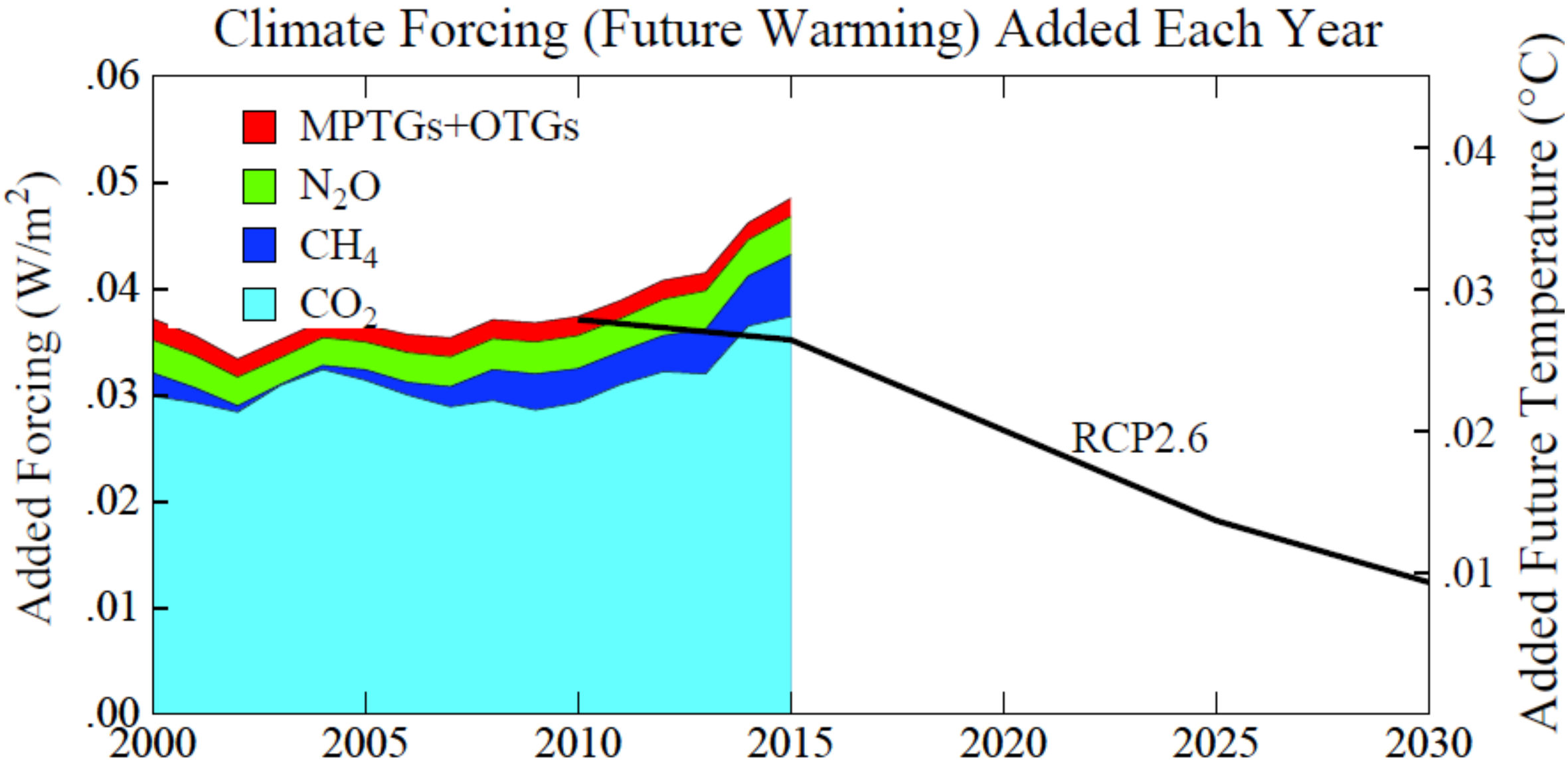
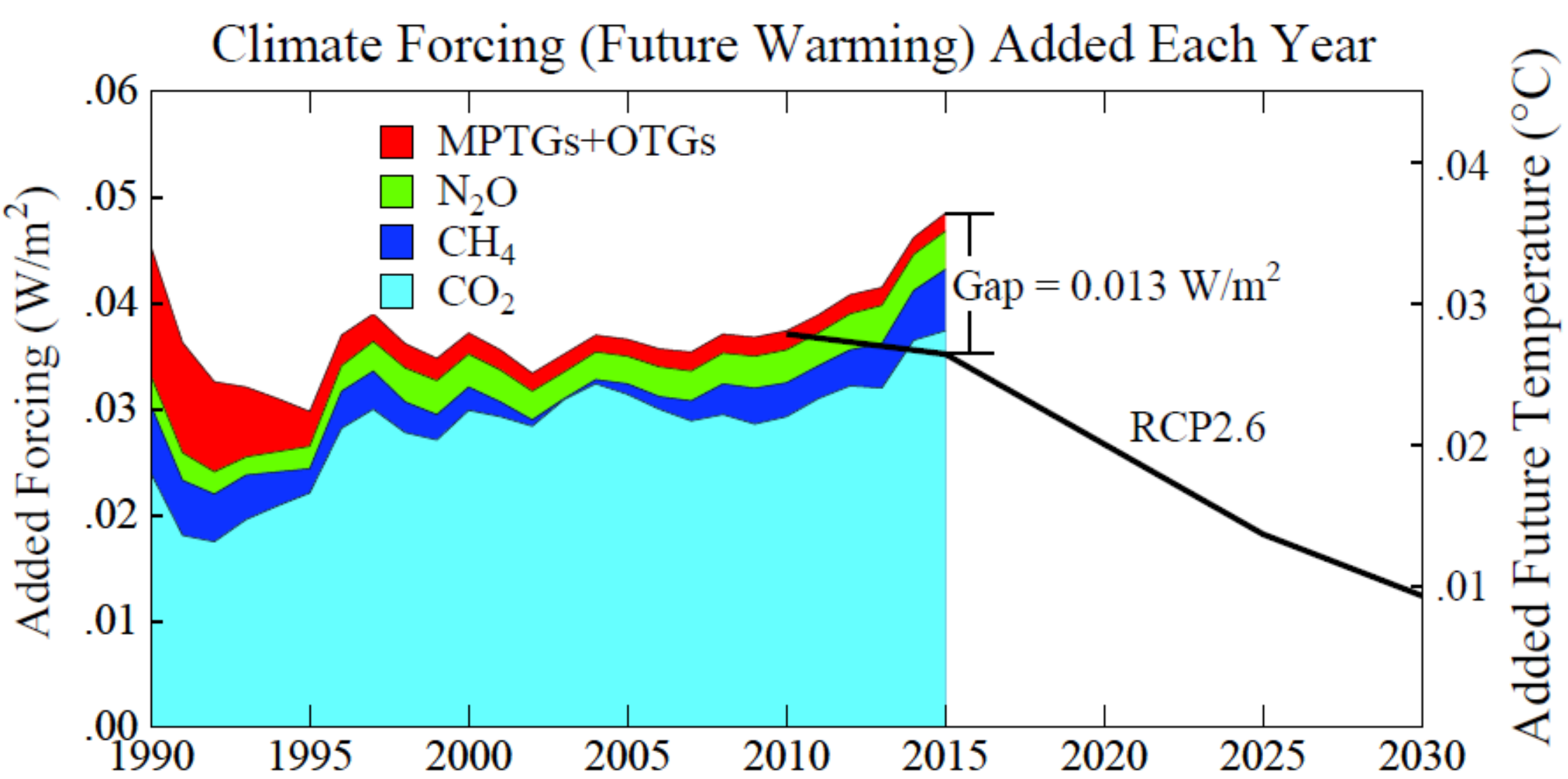


Fig. 8. GHG climate forcing growth rate with historical data being 5-year running means, except 2015 is 3-year mean. N_2O, MPTGs (Montreal Protocol Trace Gases) and OTGs (Other Trace Gases) data are from NOAA/ESRL.

Figure is from Hansen et al., Young people's burden: requirement of negative CO_2 emissions, *Earth System Dynamics*, **8**, 1-40, 2017.


Climate Forcing (Future Warming) Added Each Year
Added Forcing (W/m^2)
Added Future Temperature (°C)
MPTGs+OTGs
N_2O
CH_4
CO_2
RCP2.6
.06
.05
.04
.03
.02
.01
.00
.04
.03
.02
.01
2000
2005
2010
2015
2020
2025
2030



0.013 W/m^2 → 1 ppm CO_2 (Required Atmospheric CO_2 Reduction) → 2 ppm CO_2 = 4 GtC (Required Extraction)

If Extraction Cost = $150-350* per ton → $600 Billion to $1.4 Trillion to Remove the Gap in A SINGLE YEAR.

*Smith, P. et al.: Biophysical and economic limits to negative CO_2 emissions, *Nature. Clim. Change* **6**, 42-50, 2016.

Landmark Decision in Pipeline Case

13 Youth Granted "Intervenor" Status

Public Utilities Commission Hears Case

Enbridge Energy proposes to build a pipeline across Minnesota carrying 760,000 gallons/day of tar sands oil.

Judge Ann O'Reilly accepts argument that the youth will disproportionately feel the burden of climate change.

Akilah Sanders-Reed, 23-year-old founded the group: Youth Climate Intervenors.

Jada Brown, 20: "Being an indigenous woman and Youth Climate Intervenor, it's a responsibility of mine to speak out and fight for climate justice and protect the land and water… especially for those who don't have a voice."

Tar Sands at Night

Photographer: Garth Lenz

Tar Sands development eats into the most carbon rich forest ecosystem on Earth, with vast mines, tailings ponds, and pollution belching refineries.

From: Canada's Tar Sands and the True Cost of Oil. Photography by Garth Lenz.

Remaining Charts Are Backup Only

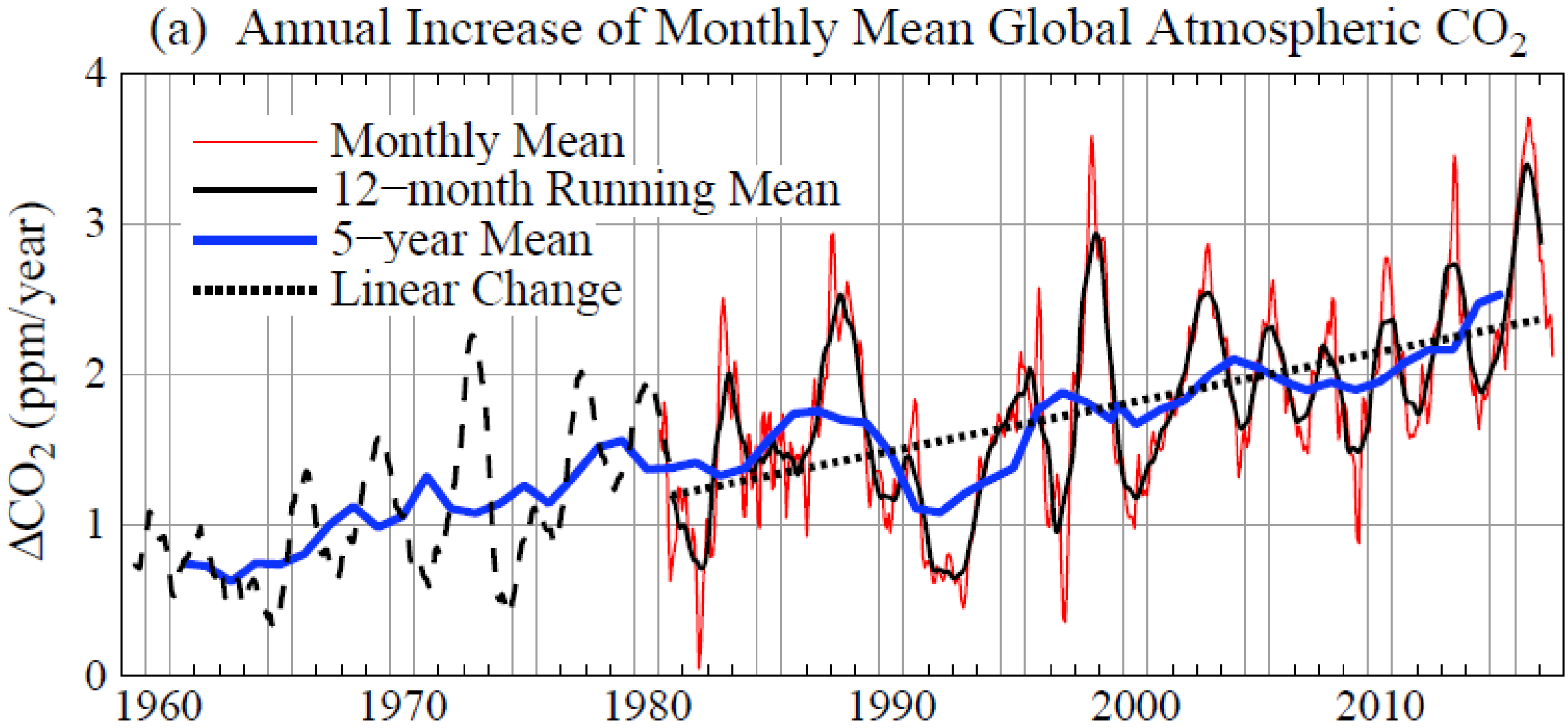
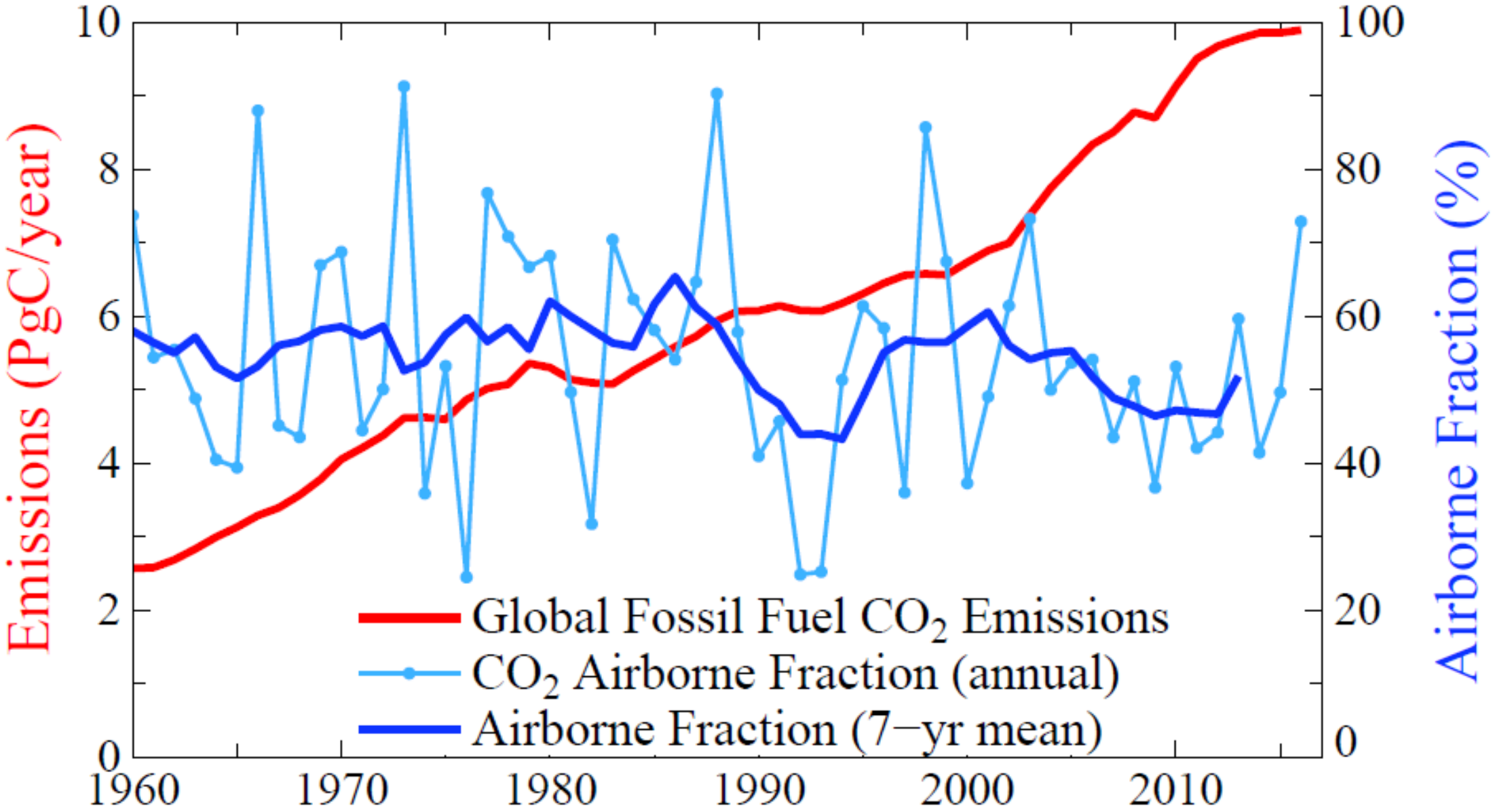


Fig. 6. Global CO_2 annual growth based on NOAA data (http://www.esrl.noaa.gov/gmd/ccgg/trends/). Dashed curve is for a single station (Mauna Loa). Red curve is monthly global mean relative to the same month of prior year; black curve is 12-month running mean of red curve


Emissions (PgC/year)
Airborne Fraction (%)
10
8
6
4
2
0
100
80
60
40
20
0
1960
1970
1980
1990
2000
2010
Global Fossil Fuel CO_2 Emissions
CO_2 Airborne Fraction (annual)
Airborne Fraction (7−yr mean)

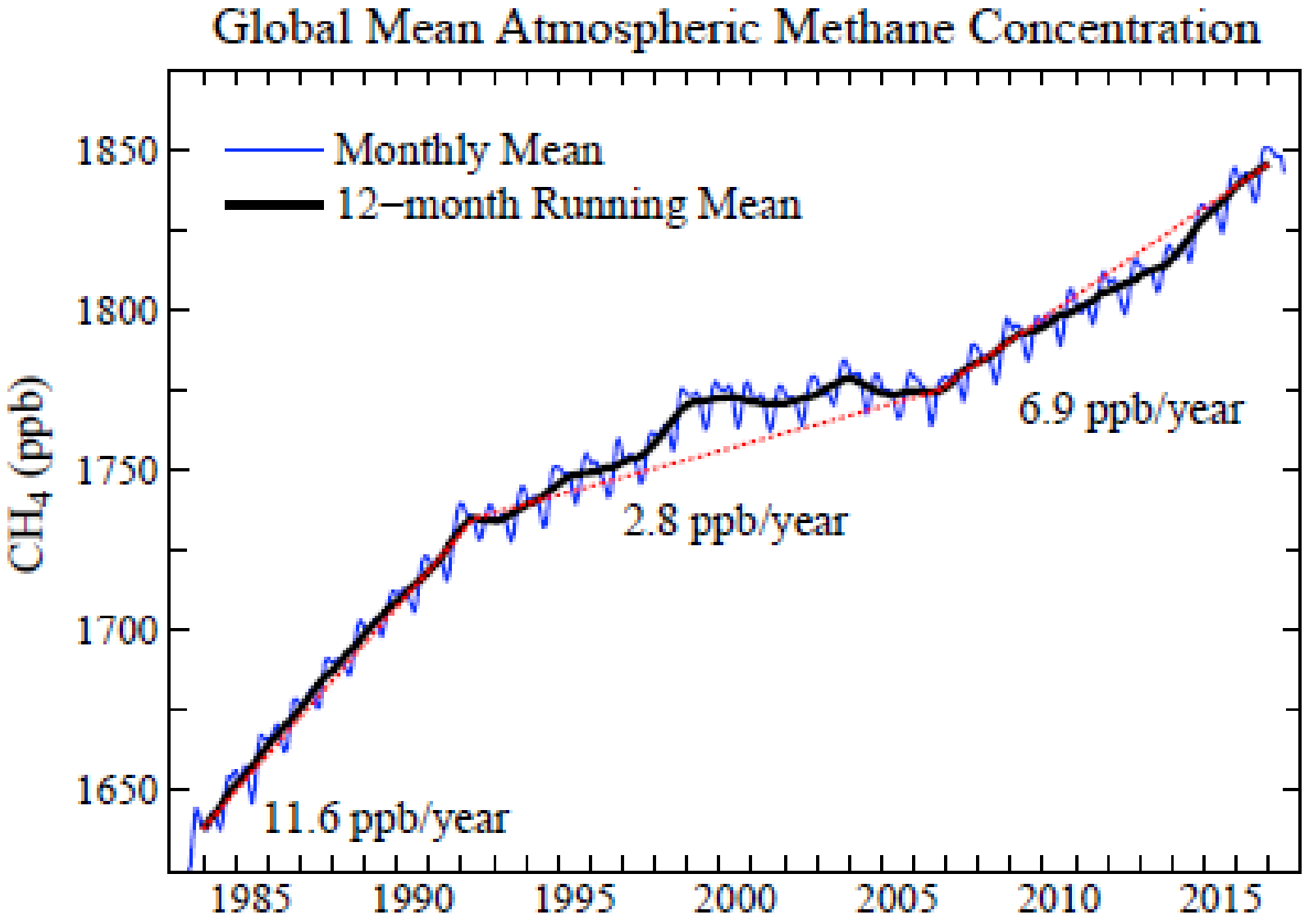


Fig. 7. Global CH_4 from Dlugokencky (2017), NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends_ch4/).

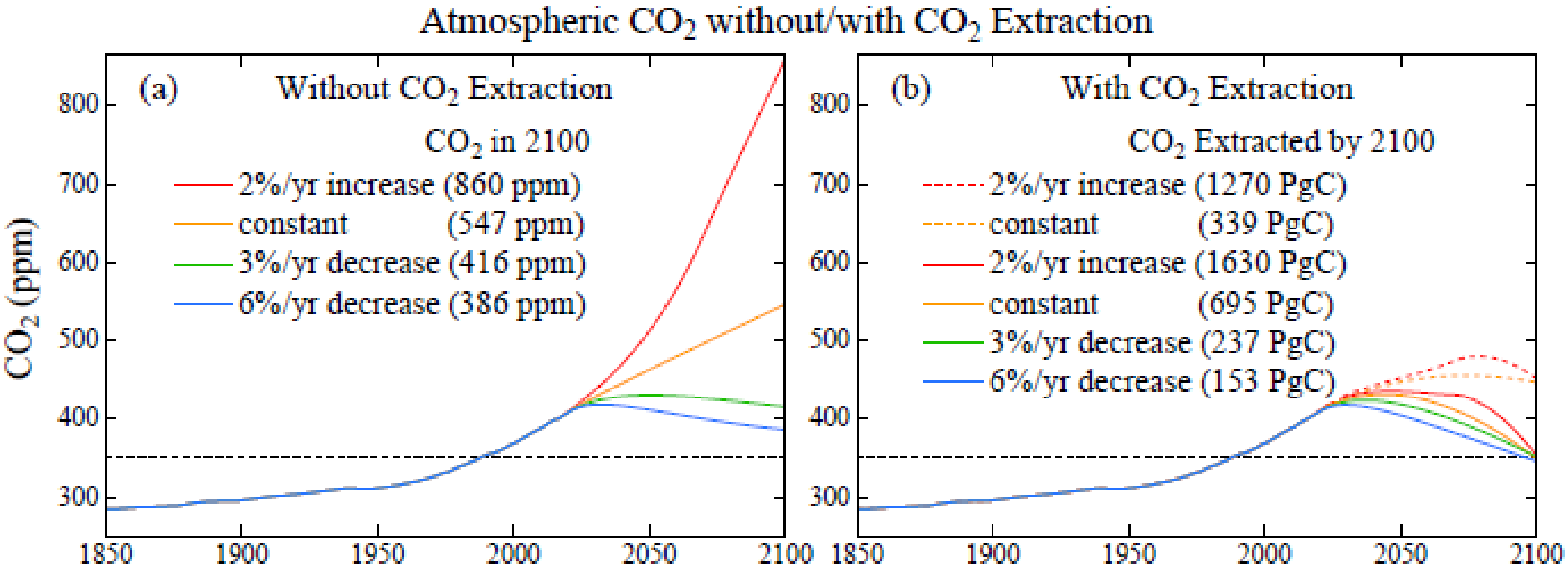


Fig. 10. (a) Atmospheric CO_2 for emission scenarios of Fig. 10a. (b) Atmospheric CO_2 including effect of CO_2 extraction that increases linearly after 2020 (after 2015 in +2%/year case). 1 ppm is ~2.12 GtC.

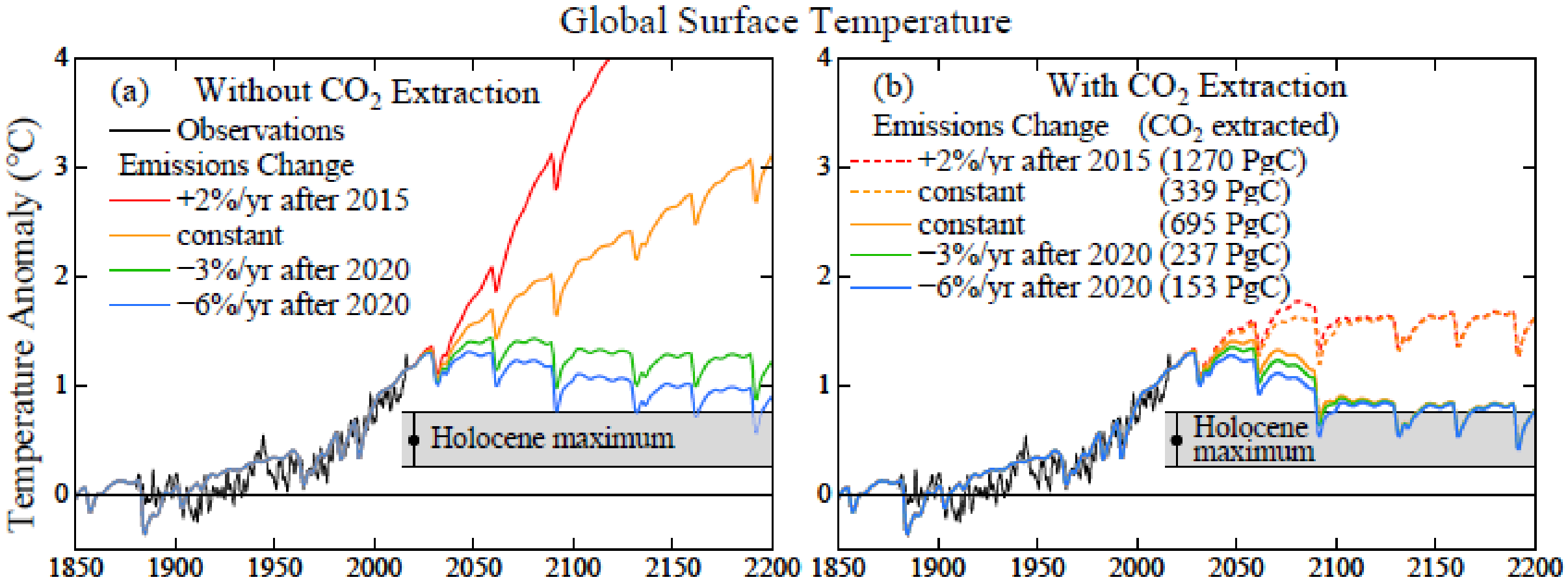


Fig. 12. Simulated global temperature for forcings of Fig. 12. Observations as in Fig. 2. Gray area is 2σ (95% confidence) range for centennially-smoothed Holocene maximum, but there is further uncertainty about the magnitude of the Holocene maximum, as noted in the text and discussed by Liu et al (2014).