



Supplement of

Future changes in Beijing haze events under different anthropogenic aerosol emission scenarios

Lixia Zhang et al.

Correspondence to: Lixia Zhang (lixiazhang@mail.iap.ac.cn)

The copyright of individual parts of the supplement might differ from the article licence.

Experiment	GHG forcing	AA	Model	neriod	Realiz-
Experiment	Gird Intellig	1 81 8	Widder	periou	ations
Historical experiment (His)	CMIP5 historical		HadGEM3-GC2	1960-2014	4
	forcing prior	CMIP5			
	2005 and	historical		1961-2014	4
	RCP4.5	forcing	GFDL-CM3		
	afterward				
Current legislation emissions (CLE)	CMIP5 RCP4.5	globally as	HadGEM3-GC2	2015-2050	4
		ECLIPSE		2010 2000	•
		high range	GFDL-CM3	2015-2050	3
Maximum	CMIP5 RCP4.5	ølobally as	HadGEM3-GC2	2015-2050 2015-2050	50 4 50 3
technically		ECLIPSE low			
feasible reduction		rango	GFDL-CM3		
(MTFR)		Tange			

Table S1 Brief introduction to the design of the experiments

Table S2 Brief introduction to CESM-LEs experiments¹

Exp.	CUC foreing		nariad	Realiz-
	GIIG forcing	AA	periou	ations
Historical	CMIP5 historical forcing CMIP5 historical			
	prior to 2006 and RCP8.5 forcing prior to 2006		1984-2014	40
	after 2006	and RCP8.5 afterward		
RCP8.5	CMIP5 RCP8.5	CMIP5 RCP8.5	2015-2050	40
XGHG		Same as historical prior	ne as historical prior	
	Fixed at 1920 condition	to 2006, and following	1984-2050	20
		RCP8.5 afterward	RCP8.5 afterward	
XAER	Same as historical prior			
	to 2006, and following	Fixed at 1920 condition	2084-2050	20
	RCP8.5 afterward			

¹ The CESM1 Large Ensemble simulations are available from <u>http://www.cesm.ucar.edu/experiments/</u> cesm1.1/LE/#single-forcing and <u>http://www.cesm.ucar.edu/projects/community-projects/LENS</u>.



Fig.S1 (a) Distribution of the observational stations (dots) in NCDC GSOD. Shading indicates the altitude of the topography (unit: m). (b) Spatial distribution of climate winter mean number of haze days (unit: days) of 1974-2013 by gridding stations on to a $0.5 \times 0.5^{\circ}$ grid. (c) Same as (b), but for VN3day (unit: km). The red dot denotes the location of Beijing.



Fig. S2 Spatial distributions of the winter mean (DJF) sulfur dioxide emissions difference (kg/season) between (a) CLE (2015-2049) and His (1984-2013), (b) MTFR (2015-2049) and His (1984-2013), and (c) MTFR (2016-2050) and CLE (2015-2049). The green dot in each plot indicates the location of Beijing.



Fig. S3 Regions used to calculate the EAWM index.



Fig.S4 DJF mean sea level pressure (shading, hPa), 850hPa winds (vector, m s⁻¹) and 500hPa zonal wind (contour, m s⁻¹) averaged over 1984-2013 in (a) JRA-55, (b)

HadGEM3-GC2, and (c) GFDL-CM3.



Fig.S5 Composite circulation anomalies with monthly HWI \geq 1 during 1984-2013 in HadGEM3-GC2 (left) and GFDL-CM3 (right). (a)-(b) temperature anomalies (K) along 40N, (c)-(d) 500hPa winds anomalies (vector, m s⁻¹) and 500hPa zonal winds anomalies (shading, m s⁻¹), (e)-(f) 850hPa winds anomalies (vector, m s⁻¹) and 850 hPa meridional winds anomalies (shading, m s⁻¹). The green boxes/lines indicate the location of the boxes/lines used in the calculation of HWI.



Fig.S6 Same as Fig.4, but for each component of HWI. (a), (b) ΔT , (c),(d) U500 and (e),(f) V850.



Fig.S7 Difference in DJF 850hPa temperature (left) and DJF 250hPa temperature (right) between (a)-(d) CLE and His, and between (e)-(h) MTFR and CLE for HadGEM3-GC2 and GFDL-CM3.



Fig.S8 Same as Fig.8e, but for the three components of EAWM. SLP₁, SLP₂ and SLP₃ stand for the standardized SLP averaged over Siberia, North Pacific and Maritime continent, respectively.



Fig. S9 Climate mean AOD_ratio in CLE (left) and MTFR (right) projected by (a)-(b) HadGEM3-GC2 and (c)-(d) GFDL-CM3. The dotted area denotes that the difference from baseline is statistically significant at the 10% level by using Student's t-test. Blue and red shadings are lower and higher than present climate mean, respectively.



Fig.S10 Box plots for 5000 bootstrapped samples of changes in (a) winter mean HWI, and (b) frequency of month with HWI≥1 from CESM-LEs. Hist (grey boxes) is estimated from the baseline of ALL forcing experiment for the period 1984-2013. RCP8.5 (red boxes) denotes the difference between RCP8.5 (2015-2049) and Hist. XGHG (XAER) denotes the difference between 2015-2049 and 1984-2013 when GHG (AA) is fixed at 1920, and it is used to estimate the role of AA(GHG) forcing under RCP8.5. Boxes show the interquartile ranges of the 5000 bootstrapped samples, and black lines show the median. End points are the 5th and 95th percentiles. Significant difference is seen when the median from one experiment falls outside the interquartile range of another (Wilcox et al., 2020).