Description: Here, we compare the halo concentration ($z = 0.0 \sim 2.0$) predicted by the Planck18 cosmology with other cosmological models using our universal concentration model and the linear growth factor relation at the halo formation epoch. The comparison is as comprehensive as possible, incorporating all cosmological models considered. The cosmologies used are listed in Table 1, and the comparison results are presented in Fig. 1 and Table 2, where Table 2 provides the relative differences at several specific halo masses.

Results: The main results are summarized as follows:

1. The Planck cosmology predicts higher concentrations than the WMAP cosmologies, except for WMAP1. The order of concentration magnitude is: WMAP3 < WMAP5 < WMAP7 < WMAP9 < Planck18 < WMAP1. Note that we have tested several Planck cosmologies, and they yield essentially consistent concentrations; therefore, only Planck18 is shown here.

2. The results for Planck are consistent with those for MultiDark-Planck, and both predict higher concentrations than Illustris and Bolshoi. The Millennium cosmology predicts the highest concentrations. The predicted concentration depends primarily on the cosmological parameters σ_8 and $\Omega_{\rm m}$ (see Table 1 and Fig. 1). A more detailed description of the effects of different cosmological parameters (σ_8, $\Omega_{\rm m}$, w, $m_{\rm WDM}$, and $n_{\rm s}$) on concentration is provided in our paper.

3. The differences in predicted concentrations among cosmological models decrease as halo mass increases and redshift becomes higher.

Table 1. Pre-set ΛCDM Cosmologies.

ID	H_0	$\Omega_{\rm m}$	$\Omega_{\rm b}$	$n_{\rm s}$	σ_8	Reference
planck18	67.66	0.3111	0.0490	0.9665	0.8102	Planck Collaboration et al. (2020), Table 2
planck15	67.74	0.3089	0.0486	0.9667	0.8159	Planck Collaboration et al. (2016), Table 4
planck13	67.77	0.3071	0.0483	0.9611	0.8288	Planck Collaboration et al. (2014), Table 5
WMAP9	69.32	0.2865	0.0463	0.9608	0.8200	G. Hinshaw et al. (2013), Table 4
WMAP7	70.20	0.2743	0.0458	0.9680	0.8160	E. Komatsu et al. (2011), Table 1
WMAP5	70.50	0.2732	0.0456	0.9600	0.8120	E. Komatsu et al. (2009), Table 1
WMAP3	73.50	0.2342	0.0413	0.9510	0.7420	D. N. Spergel et al. (2007), Table 5
WMAP1	72.00	0.2700	0.0463	0.9900	0.9000	D. N. Spergel et al. (2003), Table 7/4
illustris	70.40	0.2726	0.0456	0.9630	0.8090	M. Vogelsberger et al. (2014)
bolshoi	70.00	0.2700	0.0469	0.9500	0.8200	A. A. Klypin et al. (2011)
multidark-planck	67.80	0.3070	0.0480	0.9600	0.8290	A. Klypin et al. (2016)
millennium	73.00	0.2500	0.0450	1.0000	0.9000	V. Springel et al. (2005)

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Table 2. The $\Delta c/c$ for the Planck18 and other cosmologies at $z = 0.0 \sim 2.0$.

Cosmology	Halo Mass ($h^{-1}M_\odot$)																							
	1×10^8			1×10^9			1×10^{10}			1×10^{11}			1×10^{12}			1×10^{13}			1×10^{14}			1×10^{15}		
	$z=0$	$z=1$	$z=2$	$z=0$	$z=1$	$z=2$	$z=0$	$z=1$	$z=2$	$z=0$	$z=1$	$z=2$	$z=0$	$z=1$	$z=2$	$z=0$	$z=1$	$z=2$	$z=0$	$z=1$	$z=2$	$z=0$	$z=1$	$z=2$
WMAP9	−0.03	−0.00	−0.00	−0.03	−0.00	−0.00	−0.03	0.00	0.00	−0.02	0.00	0.00	−0.02	0.00	0.00	−0.01	0.00	0.00	−0.01	0.00	0.00	0.00	0.00	0.00
WMAP7	−0.05	−0.00	−0.00	−0.05	−0.00	−0.00	−0.04	0.00	0.00	−0.04	0.00	0.00	−0.03	0.00	0.00	−0.02	0.00	0.00	−0.02	0.00	0.00	−0.01	0.00	0.00
WMAP5	−0.07	−0.02	−0.02	−0.06	−0.01	−0.01	−0.06	−0.01	−0.01	−0.05	−0.00	−0.00	−0.04	−0.00	−0.00	−0.03	0.00	0.00	−0.02	0.00	0.00	−0.01	0.00	0.00
WMAP3	−0.23	−0.09	−0.09	−0.21	−0.08	−0.08	−0.20	−0.06	−0.06	−0.18	−0.05	−0.05	−0.16	−0.03	−0.03	−0.13	−0.02	−0.02	−0.10	−0.01	−0.01	−0.07	−0.00	−0.00
WMAP1	0.11	0.11	0.11	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.05	0.05	0.07	0.04	0.04	0.06	0.03	0.03	0.04	0.02	0.02
Illustris	−0.07	−0.01	−0.01	−0.06	−0.01	−0.01	−0.06	−0.01	−0.01	−0.05	−0.00	−0.00	−0.04	−0.00	−0.00	−0.03	0.00	0.00	−0.02	0.00	0.00	−0.01	0.00	0.00
Bolshoi	−0.09	−0.03	−0.03	−0.08	−0.02	−0.02	−0.07	−0.01	−0.01	−0.06	−0.01	−0.01	−0.05	−0.00	−0.00	−0.03	0.00	0.00	−0.02	0.01	0.01	0.00	0.01	0.01
MultiDark-Planck	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Millennium	0.08	0.11	0.11	0.07	0.10	0.10	0.06	0.08	0.08	0.06	0.07	0.07	0.05	0.06	0.06	0.05	0.04	0.04	0.04	0.03	0.03	0.04	0.02	0.02
$\sigma_8 = 0.7$	−0.15	−0.09	−0.09	−0.14	−0.08	−0.08	−0.14	−0.07	−0.07	−0.13	−0.06	−0.06	−0.12	−0.05	−0.05	−0.11	−0.04	−0.04	−0.10	−0.03	−0.03	−0.07	−0.02	−0.02
$\sigma_8 = 0.8$	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.00	−0.00	−0.01	−0.00	−0.00	−0.01	−0.00	−0.00	0.00	−0.00	−0.00
$\sigma_8 = 0.9$	0.12	0.08	0.08	0.12	0.07	0.07	0.12	0.06	0.06	0.11	0.05	0.05	0.11	0.04	0.04	0.10	0.03	0.03	0.08	0.02	0.02	0.06	0.01	0.01
$\sigma_8 = 1.0$	0.27	0.17	0.17	0.26	0.15	0.15	0.25	0.13	0.13	0.24	0.12	0.12	0.23	0.09	0.09	0.21	0.07	0.07	0.18	0.05	0.05	0.13	0.03	0.03
$\omega_m = 0.2$	−0.25	−0.07	−0.07	−0.24	−0.06	−0.06	−0.22	−0.04	−0.04	−0.19	−0.03	−0.03	−0.16	−0.01	−0.01	−0.12	0.00	0.00	−0.07	0.01	0.01	−0.02	0.02	0.02
$\omega_m = 0.3$	−0.03	−0.00	−0.00	−0.02	−0.00	−0.00	−0.02	0.00	0.00	−0.02	0.00	0.00	−0.02	0.00	0.00	−0.01	0.00	0.00	−0.01	0.00	0.00	0.00	0.00	0.00
$\omega_m = 0.4$	0.21	−0.00	−0.00	0.19	−0.00	−0.00	0.17	−0.00	−0.00	0.15	−0.00	−0.00	0.12	−0.00	−0.00	0.09	−0.00	−0.00	0.06	−0.00	−0.00	0.02	−0.00	−0.00
$\omega_m = 0.5$	0.44	−0.00	−0.00	0.41	−0.00	−0.00	0.37	−0.00	−0.00	0.32	−0.00	−0.00	0.26	−0.00	−0.00	0.19	−0.00	−0.00	0.11	−0.00	−0.00	0.04	−0.00	−0.00
$w = -0.7$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$w = -0.9$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$w = -1.1$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$w = -1.3$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$m_{\rm WDM} = 0.2$ keV	−0.64	−0.00	−0.00	−0.56	−0.00	−0.00	−0.45	−0.00	−0.00	−0.31	−0.00	−0.00	−0.15	−0.00	−0.00	−0.05	−0.00	−0.00	−0.01	−0.00	−0.00	0.00	−0.00	−0.00
$m_{\rm WDM} = 0.4$ keV	−0.58	−0.00	−0.00	−0.48	−0.00	−0.00	−0.36	−0.00	−0.00	−0.20	−0.00	−0.00	−0.07	−0.00	−0.00	−0.02	−0.00	−0.00	0.00	−0.00	−0.00	0.00	−0.00	−0.00
$m_{\rm WDM} = 0.8$ keV	−0.53	−0.00	−0.00	−0.42	−0.00	−0.00	−0.28	−0.00	−0.00	−0.14	−0.00	−0.00	−0.04	−0.00	−0.00	−0.01	−0.00	−0.00	0.00	−0.00	−0.00	0.00	−0.00	−0.00
$m_{\rm WDM} = 2.0$ keV	−0.48	−0.00	−0.00	−0.37	−0.00	−0.00	−0.23	−0.00	−0.00	−0.09	−0.00	−0.00	−0.03	−0.00	−0.00	−0.01	−0.00	−0.00	0.00	−0.00	−0.00	0.00	−0.00	−0.00
$n_s = 1.0$	39212.65	0.00	0.00	7112.13	0.00	0.00	1303.96	0.00	0.00	246.86	0.00	0.00	48.18	0.00	0.00	9.43	0.00	0.00	1.61	0.00	0.00	0.04	0.00	0.00
$n_s = 0.0$	1466.64	0.00	0.00	425.50	0.00	0.00	126.50	0.00	0.00	38.55	0.00	0.00	11.91	0.00	0.00	3.58	0.00	0.00	0.92	0.00	0.00	0.10	0.00	0.00
$n_s = -1.0$	53.23	0.00	0.00	24.70	0.00	0.00	11.60	0.00	0.00	5.46	0.00	0.00	2.53	0.00	0.00	1.12	0.00	0.00	0.45	0.00	0.00	0.16	0.00	0.00
$n_s = -1.5$	9.51	0.00	0.00	5.40	0.00	0.00	3.05	0.00	0.00	1.70	0.00	0.00	0.92	0.00	0.00	0.49	0.00	0.00	0.27	0.00	0.00	0.20	0.00	0.00
$n_s = -2.0$	1.12	0.00	0.00	0.68	0.00	0.00	0.39	0.00	0.00	0.20	0.00	0.00	0.11	0.00	0.00	0.08	0.00	0.00	0.13	0.00	0.00	0.23	0.00	0.00

Note: Negative (positive) values indicate that the predicted concentration for a given cosmology is lower (higher) than that of Planck18 by $\Delta c/c$.

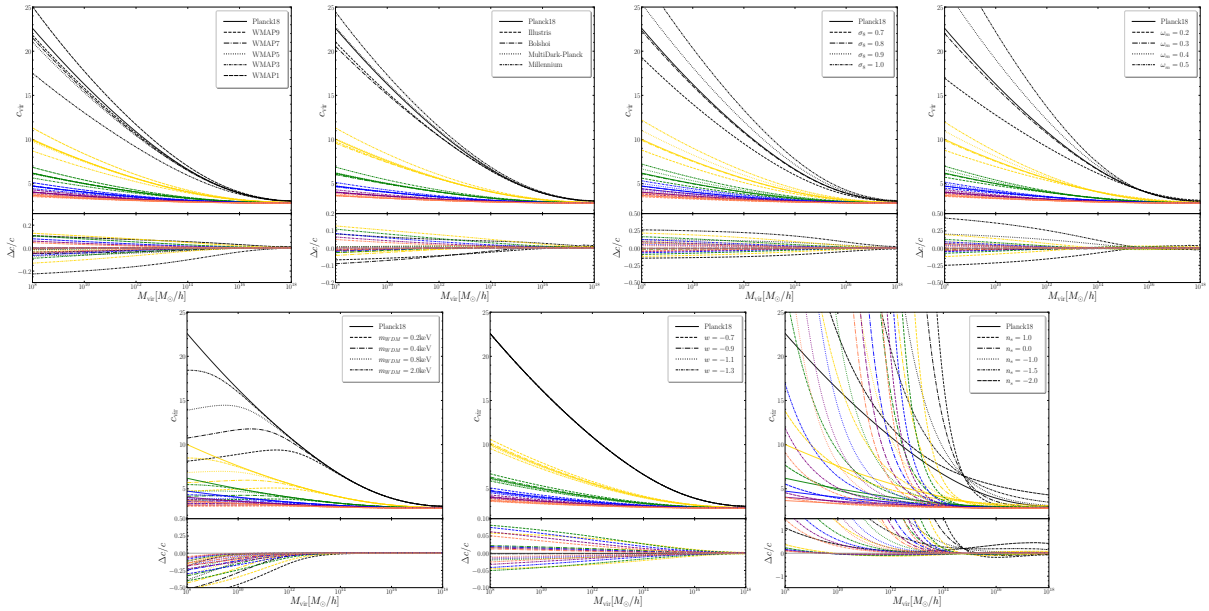

Figure 1. The $c_{\rm vir} - M_{\rm vir}$ relations for different cosmologies are shown.

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