



# Ideological underpinnings of climate change beliefs: A 13-year longitudinal study

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## ARTICLE INFO

### Keywords:

Ideology  
RWA  
SDO  
Climate beliefs  
Dual process model  
RI-CLPM

## ABSTRACT

Research demonstrates that conservative political beliefs and ideologies underpin lower environmental concern, as well as climate scepticism and inaction. Our preregistered study extends this literature by examining the dynamic interplay between socio-ideological attitudes and climate change beliefs using longitudinal data spanning 13 years (2009–2022;  $N = 72,910$ ). Specifically, we investigated potential gender differences in the temporal sequencing of Right-Wing Authoritarianism (RWA), Social Dominance Orientation (SDO), and the beliefs that climate change is real and caused by humans. Between-person results from a multi-group random intercepts crosslagged panel model reveal that individuals relatively high on both RWA and SDO across assessments reported lower levels of climate beliefs. Most importantly, within-person increases in SDO predicted subsequent within-person decreases in climate beliefs for both men and women, while RWA only decreased climate beliefs for men. Moreover, SDO had a stronger influence than RWA on climate beliefs over time but a reciprocal association also emerged whereby within-person increases in climate beliefs preceded decreases in SDO for both men and women. Thus, support for hierarchical social structures fosters climate inaction, providing an important extension to the dual process model of ideology and prejudice.

## 1. Introduction

A growing literature has documented the factors that facilitate or hinder proneness to address the climate crisis. Research mapping the factors that motivate climate-related beliefs and actions has examined the role of socio-demographic variables including gender, age and political orientation, as well as psychological variables such as values, personality traits, and ideology (for reviews, see Gifford & Nilsson, 2014; Hornsey et al., 2016; Milfont, 2021a, 2021b; Steg, 2023). Although all these variables contribute to our overall understanding of climate (in)action, strong cross-cultural evidence indicates that motivational drives to protect existing social systems aligned with conservative politics and ideology underlie lower environmental concern, as well as climate scepticism and inaction (e.g., Clayton, 2024; Feygina et al., 2009; Hornsey et al., 2016; Jylhä et al., 2016; McCright & Dunlap, 2011; Milfont et al., 2021; Steg, 2023). To illustrate, Cruz (2017) observed moderate meta-analytical correlations between lower environmental concern and both conservative political ideology ( $k = 75$ ;  $N = 90,741$ ) and conservative political affiliation ( $k = 63$ ;  $N = 58,621$ ) across samples from diverse countries. Similarly, Hornsey, Harris and

Fielding's (2018) 25-country study found that political conservatism had a stronger connection with climate scepticism compared to other ideological factors.

Existing scholarship confirms the importance of ideology for understanding climate (in)action. In particular, the dual-process model of ideology and prejudice (Duckitt, 2001) posits that Right-Wing Authoritarianism (RWA) and Social Dominance Orientation (SDO) are two fundamental motivational orientations that influence people's intergroup attitudes. As discussed in more detail below, research has expanded this model to explain how these motivational orientations affect people's attitudes towards the natural environment and non-human animals (e.g., Dhont et al., 2016; Judge & Wilson, 2018; Milfont & Duckitt, 2010). In brief, individuals who hold comparatively higher levels of RWA and SDO tend to be more sceptical of anthropogenic climate change, as well as to uphold greater speciesist attitudes towards non-human animals and overall anti-environmentalism, than their counterparts who hold lower levels of these socio-ideological variables. In the present study, we expand existing research with pre-registered analyses of longitudinal data—namely, 14 annual waves spanning 13 years and including 72,910 participants who completed at

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least 1 assessment—to examine the associations both RWA and SDO have with central beliefs about climate change (namely, that climate change “is real” and “caused by humans”). By examining the temporal ordering of socio-ideological attitudes and climate change beliefs, we test whether RWA and SDO precede climate beliefs, whether climate beliefs precede RWA and SDO, or whether they reciprocally influence each other over time. We begin with a brief overview of the dual-process model.

## 2. Dual process model (DPM) of ideology and prejudice, and the importance of the socio-ideological attitudes indexed by RWA and SDO

Duckitt's (2001) dual process model (DPM) of ideology and prejudice integrates two key findings from prejudice research: (1) different societies target distinct social groups with prejudice, and (2) individuals within societies vary in their prejudiced tendencies (Duckitt & Sibley, 2017). In other words, groups in a particular society do not experience prejudicial attitudes equally, as some social groups encounter more prejudice than others, and prejudicial attitudes directed to such target groups are not uniform across individuals in that society. For example, individuals from the northeast region of Brazil comprise a distinct social group unique to that society and are targeted with prejudicial attitudes from Brazilians from other regions, but prejudiced tendencies towards northerners vary across individuals (e.g., Batista et al., 2014; Cantal et al., 2015). By integrating these intergroup and individual factors, the DPM details how social situations, personality, and worldviews shape motivationally based prejudices, which then influence whether individuals tend to be generally prejudiced or tolerant.

Notably, the DPM suggests that prejudice-related outcomes are mainly influenced by two broad socio-ideological attitudes: RWA and SDO. RWA indexes the covariation between authoritarian submission, authoritarian aggression, and conventionalism. As such, those high (as opposed to low) on RWA are more prone to endorse submission to established authorities, obedience and support for coercive social control (i.e., social-cultural conservatism; Altemeyer, 1996, 1998). SDO indexes the preference for hierarchy and inequality among groups such that those high on SDO are more prone than those low on SDO to endorse hierarchical group relations and inequality among social groups (i.e., anti-egalitarianism or economic conservatism; Pratto et al., 1994; Sidanius & Pratto, 1999). According to the DPM, the socio-ideological attitudes indexed by RWA and SDO originate from distinct socialization practices, personality traits, social/group contexts, and worldviews. RWA emerges from a punitive upbringing, a social/group context of danger or threat, personality traits of social conformity and a perception of the world as a dangerous place, while SDO emerges from an unaffectionate upbringing, a social/group context of resource scarcity and inequality, tough-minded traits and a perception of the world as competitive.

As outlined in Fig. 1, the factors identified by the DPM make either RWA or SDO chronically salient for individuals, resulting in different motivations for prejudice. Perceived social threat explains why RWA influences outgroup prejudice, while competitiveness over relative group superiority or power explains why SDO influences outgroup prejudice. Since distinct underlying motives explain outgroup prejudice, the DPM also posits that RWA and SDO will predict prejudice towards different social groups (Duckitt, 2006). Whereas RWA predicts prejudice towards dangerous groups perceived as threatening (e.g., “drug dealers”, “violent criminals”), SDO predicts prejudice towards subordinated groups that challenge status or dominance (e.g., “housewives”, “mentally handicapped people”). And both RWA and SDO predict prejudice towards dissident groups who are both threatening and subordinated such as “protestors” and “feminists” (see Asbrock et al., 2010; Cantal et al., 2015; Duckitt, 2006; Duckitt & Sibley, 2007).

## 3. RWA, SDO and environmentalism

Beyond their importance for understanding and predicting generalized prejudice and differential outgroup prejudice, RWA and SDO also explain a vast array of social phenomena including conspiracy belief (Kerr & Wilson, 2021) and vaccine hesitancy (Bilewicz & Soral, 2022; for reviews, see Duckitt, 2022; Osborne et al., 2023). A growing literature has also documented the importance of both RWA and SDO for environmentalism. To illustrate, Schultz and Stone (1994) reported strong negative correlations between RWA and environmental concern, while Pratto et al. (1994) reported strong negative correlations between SDO and pro-environmental policies. In one of the first simultaneous examinations of the associations between RWA, SDO, and environmentalism, Wang (1999) reported that RWA and SDO correlated negatively, whereas a liberal political orientation correlated positively, with pro-environmental attitudes. These correlations were, however, stronger and statistically significant only for female participants.<sup>1</sup>

Role-playing team simulations reported by Altemeyer (2003) further indicate that the future of the world, including climate negotiations, would be worse if put in the hands of high-RWA and high-SDO (or “Double Highs”) leaders. Similarly, Son Hing et al. (2007) showed that Double Highs tend to prioritize profit over environmental and humanitarian concerns. Finally, in their meta-analysis of 53 independent samples, Stanley and Wilson (2019, Study 1) observed that RWA ( $r = -.26$ , 95%CI  $[-.30, -.22]$ ,  $p < .001$ ) and SDO ( $r = -.29$ , 95%CI  $[-.32, -.27]$ ,  $p < .001$ ) had statistically comparable negative cross-sectional associations with environmentalism.

The available findings thus provide strong evidence that both RWA and SDO correlate negatively with environmentalism. The literature also indicates that the associations RWA and SDO have with environmentalism occur independently from each other, supporting Duckitt's (2001) thesis that these socio-ideological attitudes reflect complementary processes. At the same time, some evidence suggests that SDO is more detrimental than RWA to the preservation of the natural environment and to animal welfare. For example, Milfont and colleagues (2013) noted that, “as individuals scoring high in SDO tend to favor dominance and hierarchical relations—which can be extended into dominance over nature, as we postulate, and which is not a defining characteristic of RWA—we would presume that SDO accounts for a significant amount of additional variance in environmentalism over and above RWA” (p. 1128; see also Uenal et al., 2021). Consistent with this reasoning, their results revealed that the associations RWA had with pro-environmental attitudes (Study 3) and climate change beliefs (Study 4) were attenuated when including SDO in a regression model, while SDO made a significant improvement to prediction when added to RWA. Likewise, Häkkinen and Akrami (2014) found that SDO was a stronger correlate of climate change denial than RWA, and Dhont and colleagues (2016) found that only SDO significantly predicted speciesist attitudes towards animals (i.e., supporting the intentional use of non-human animals for human benefit). Following these and other findings, Stanley and Wilson (2019, Study 2) reasoned that environmentalism would have a stronger association with SDO (controlling for RWA) than with RWA (controlling for SDO). Meta-analytical findings across 16 independent samples ( $N = 23,856$ ) contradicted their prediction, as RWA and SDO had statistically comparable associations with environmentalism. Together, these cross-sectional findings indicate that both socio-ideological attitudes have detrimental (and perhaps comparable) effects on environmental protection. We aim to advance this

<sup>1</sup> Besides the lack of statistically significant correlations between RWA, SDO and pro-environmental attitudes among men, no gender differences were observed for RWA in this study. These surprising findings could be due to unexpected characteristics of the sample, which comprised a relatively small number of undergraduates with an uneven gender distribution (97 women, 60 men).

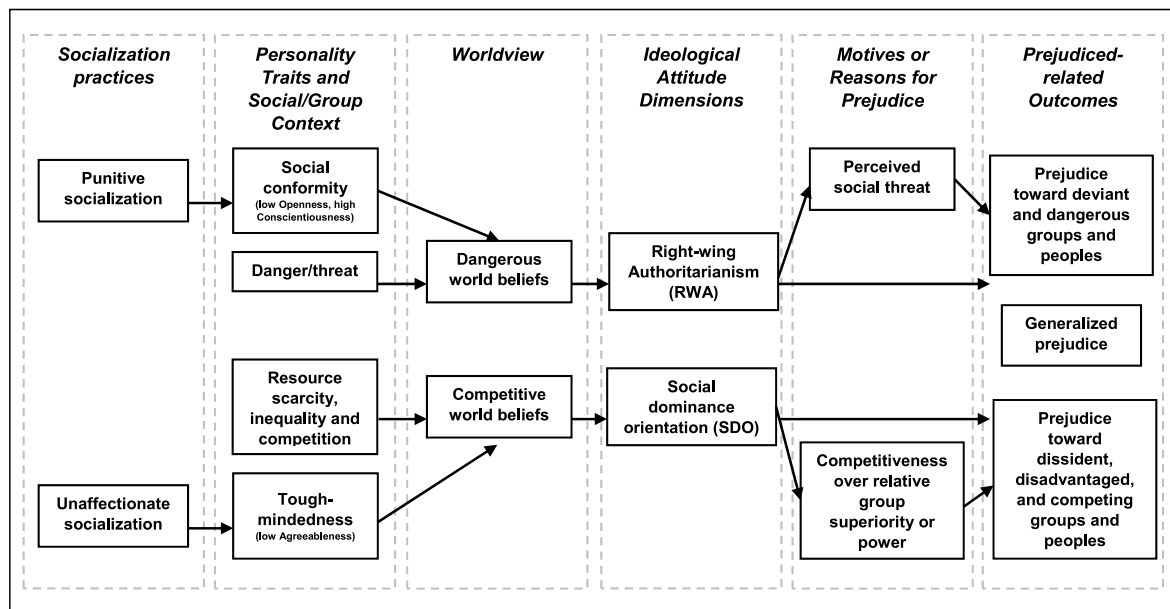


Fig. 1. A dual process motivational model detailing the impact of socialization practices, personality traits and context, and social worldview beliefs on the two ideological attitude dimensions and corresponding motives/reasons for prejudice and prejudice-related outcomes (adapted from Duckitt & Sibley, 2016).

understanding by examining these effects longitudinally, providing insights into the relative predictive power of RWA and SDO over time.

#### 4. The present study

Although a growing literature demonstrates that RWA and SDO correlate negatively with environmentalism, most past research has examined the associations of RWA and SDO in isolation and often with cross-sectional data. To our knowledge, only two previous studies considered both RWA and SDO in the same analysis investigating whether they temporally precede climate denial and environmental attitudes (Stanley et al., 2017, 2019).

Stanley and colleagues (2017, Study 3) used data from New Zealand undergraduates ( $N = 674$ ) to examine residualised 5-month associations between RWA, SDO, environmental attitudes (measured with the well-known New Environmental Paradigm scale) and a 2-item measure of anthropogenic climate change denial (“Climate change is an entirely natural phenomenon – human action does not contribute importantly to it” and “Any changes in global climate simply reflects naturally occurring variation”). Cross-lagged structural equation modelling revealed surprising results. Despite expecting ideology to precede environmental-related outcomes, the reverse temporal ordering emerged: higher levels of anthropogenic climate denial led to increases in SDO five months later. Moreover, when considering the expected longitudinal impact of ideology, RWA significantly predicted anthropogenic climate denial but not environmental attitudes, and SDO did not impact these environmental outcomes over time. The authors also tested potential gender differences and reported similar results for men and women. Accordingly, the authors concluded that RWA may be a more consequential ideological variable than SDO. That said, SDO correlates more strongly with environmentalism in the general population compared to student samples (Stanley & Wilson, 2019). As such, the unexpected null longitudinal effect of SDO on environmental-related outcomes reported by Stanley et al. (2017, Study 3) could be due to the use of a student sample.

In a subsequent study using national data from the New Zealand Attitudes and Values Study (NZAVS), Stanley and colleagues (2019) examined residualised 5-year associations between RWA, SDO and a 2-item environmental attitudes measure assessing willingness to make sacrifices for the environment (“Are you willing to change your daily

routine in order to protect the environment?” and “Are you willing to make sacrifices to your standard of living (e.g., accept higher prices, drive less, conserve energy) in order to protect the environment?”). Results from their cross-lagged structural equation model also showed surprising bidirectional longitudinal associations: higher levels of RWA and SDO predicted lower levels of environmental attitudes five years later, and higher levels of pro-environmental attitudes predicted lower levels of RWA and SDO five years later. Although SDO had a statistically stronger longitudinal effect than RWA on environmental attitudes, the longitudinal effect of environmental attitudes on SDO was statistically stronger than the reverse effect of SDO on environmental attitudes. No gender comparisons were reported. Accordingly, cross-sectional findings testing their relative predictive power indicate that RWA and SDO may have comparable associations with environmentalism (for meta-analytical findings, see Stanley & Wilson, 2019, Study 2), but Stanley et al.’s (2019) longitudinal findings indicate that SDO may be a stronger predictor than RWA of environmental-related variables.

Importantly, although theoretical reasoning suggests that both RWA and SDO should temporally precede environmental-related outcomes, Stanley and colleagues (2017, 2019) reveal a more complex relationship. We provide clarity to the extant debate by reporting a pre-registered study (<https://osf.io/8e6gk/>) examining the longitudinal associations between RWA, SDO and core climate change beliefs across 14 annual waves of panel data from a large, nationwide random sample of adults living in New Zealand.

Drawing from theoretical models and empirical findings indicating that RWA and SDO temporally precede both prejudice and political attitudes (Duckitt, 2001; Osborne et al., 2020; Satherley et al., 2021), RWA and SDO should forecast decreases in climate change beliefs over time. At the same time, past longitudinal studies indicate that the temporal precedence might work differently or even in the reverse direction for RWA and SDO (Stanley et al., 2017, 2019). Accordingly, an alternative prediction is that RWA, SDO and climate change beliefs will have bidirectional associations with each other. Extant theorizing and empirical findings do, however, suggest that the cross-lagged effects of RWA and SDO on climate change beliefs will be stronger than the corresponding cross-lagged effects of climate change beliefs on RWA and SDO.

In addition to investigating the temporal ordering of RWA, SDO and climate change beliefs, we examine potential asymmetries in these

associations across men and women given that the associations RWA and SDO have with climate beliefs may be gendered. For example, men generally show higher levels of SDO than women, even when considering cultural or social influences. Indeed, the “invariance hypothesis” from Social Dominance Theory articulates this observed gender difference in SDO (Sidanius et al., 1995). In contrast, women generally show higher levels of RWA than men (Brandt & Henry, 2012; Zubielevitch et al., 2023, Footnote 7). Women also generally show higher levels of environmental concern and climate change beliefs than men (Jylhä et al., 2016; McCright & Dunlap, 2011; Zelezny et al., 2000). Research linking the “invariance hypothesis” to the environmental domain indicates that SDO helps explain the gender difference in environmentalism: Men tend to show less concern than women about environmental issues due to their higher levels of SDO (e.g., Graça et al., 2018; Milfont & Sibley, 2016; see also Feygina et al., 2009, Study 1). Given that men tend to express higher levels of SDO and lower levels of climate change beliefs (e.g., Milfont et al., 2003; Sidanius & Pratto, 1999), the associations between SDO and climate change beliefs should be stronger for men compared to women.<sup>2</sup> Before moving to the next section, we would like to acknowledge that gender exists on a wide spectrum. Unfortunately, the longitudinal dataset considered here has too few non-binary participants to explore this issue appropriately (see Fraser et al., 2020). As such, we focus on men and women in the present study.

To investigate our research questions, we employed a multi-group random intercepts cross-lagged panel model (RI-CLPM) with gender as the grouping variable. Whereas traditional CLPMs confound within-person change with between-person change (Berry & Willoughby, 2017), an RI-CLPM properly partitions the variances between these distinct processes and allows inferences about changes *within* individuals (see Hamaker et al., 2015). Accordingly, we used this analytic approach following the standards established in prior work using the same longitudinal dataset (Osborne et al., 2020; Satherley et al., 2021).

Because there was no reason to expect that the strength of associations would vary systematically across waves, we estimated our multi-group RI-CLPM as a more parsimonious stationary process. To illustrate, the autoregressive effect of RWA at Time 1 on RWA at Time 2 was constrained to be equal to the subsequent autoregressive effect of RWA at Time 2 on RWA at Time 3, and so on. For model simplicity and to avoid potential multi-collinearity issues, we used the mean score of the climate belief items instead of considering the two items separately. Combining the items is justified due to the large correlation between these beliefs ( $r = .54$ ; Sibley & Kurz, 2013). Thus, people who believe that climate change is real also tend to believe that it is caused by humans. Support for our pre-registered hypothesis will be obtained if the cross-lagged effects of RWA and SDO on climate change beliefs are stronger than the corresponding cross-lagged effects of climate change beliefs on RWA and SDO.

To investigate our pre-registered hypothesis that the cross-lagged effects of SDO on climate change beliefs are stronger for men than for women, we estimated a stationary multi-group RI-CLPM using gender as a grouping variable. Specifically, we estimated a baseline stationary multi-group RI-CLPM where the paths were free to vary across men and women. We then constrained the focal paths to equality and performed a chi-square difference test. Support for our hypothesis will be obtained if the equality constraints across gender significantly impair model fit.

<sup>2</sup> This sentence in our pre-registration erroneously included RWA and had a typo (i.e., “will be stronger for women compared to men”), which were fixed here. The rationale leading up to the prediction, however, is consistent across our pre-registration and current study.

## 5. Method

### 5.1. Sampling procedure

Data for the current study come from Times 1–14 of the NZAVS—a nation-wide longitudinal study that began in 2009. Sampling for the NZAVS occurred on nine occasions. In 2009 (Time 1), a random sample of adults from the electoral roll<sup>3</sup> were invited to participate anonymously in a projected 20-year panel study, yielding 6518 participants (16.6% response rate). By 2011, 3914 participants remained in the study (retaining 60% from Time 1). To address sample attrition, a non-random booster sample was recruited from a nation-wide newspaper’s website yielding 2970 new participants and increasing the sample size at Time 3 to 6884 participants.

To further increase the size and diversity of the sample, the NZAVS team conducted seven additional booster samples by randomly sampling (without replacement) the electoral roll, oversampling hard-to-reach populations. The first booster sampling occasion was in 2012 (Time 4) and recruited 5108 new participants into the study (9.98% response rate). The second occurred in 2013 (Time 5) and recruited 7581 new participants (10.6% response rate), and the third occurred in 2016 (Time 8) and recruited 7669 new participants into the study (9.5% response rate). By 2017 (Time 9), 17,072 participants remained in the study (retaining 77.8% from Time 8). The fourth booster sample occurred in 2018 (Time 10) and recruited 29,293 new participants into the study (9.2% response rate), increasing the sample size to 47,951 participants (retaining 82.3% from Time 9 and 45.5% from Time 1). Two more booster samples occurred in 2019 (Time 11) and 2021 (Time 13), respectively recruiting 6106 and 1301 new participants via paid promotions. The seventh booster sample occurred in 2022 (Time 14) and focused exclusively on 18–23-year-olds, resulting in an additional 2041 participants (5.83% response rate). In total, 72,910 participants completed at least 1 of the 14 waves of the NZAVS reported here. The NZAVS is reviewed every three years by the University of Auckland Human Participants Ethics Committee. The most recent ethics approval was on May 26, 2021 until May 26, 2024 and was renewed on May 02, 2023 until May 26, 2027 (Reference Number: UAHPEC22576).

### 5.2. Participants

Of the 72,910 participants who responded to at least 1 of the 14 annual waves of the NZAVS analyzed here, 72,348 ( $M_{\text{age at Time 1}} = 39.90$ ,  $SD = 15.16$ ; 62.8% women) provided partial or complete responses to our focal variables. Most participants (i.e., 54.7%) did, however, complete three or more waves of assessment ( $M = 4.32$ ,  $SD = 3.08$ ). In terms of ethnicity, participants identified as New Zealand European ( $n = 55,809$ , 78.5% of the sample), Māori ( $n = 9370$ ; 13.2% of the sample), Pasifika ( $n = 2015$ ; 2.8% of the sample) and Asian ( $n = 3911$ ; 5.5% of the sample).

### 5.3. Measures

The NZAVS is an omnibus survey that examines a range of individual-difference measures, socio-political attitudes, and health-related variables. As such, we used short-form measures of RWA, SDO, and climate change beliefs to mitigate participants’ fatigue. The Open Science Framework (OSF) contains a complete list of items assessed at each wave of the NZAVS (<https://osf.io/75snb/>). All items included in the current study were rated on a 1 (strongly disagree) to 7 (strongly

<sup>3</sup> Registration on the New Zealand electoral roll is compulsory for eligible voters under the Electoral Act 1993, with rare case-by-case exceptions. Those who are 18 or older, are citizens or permanent residents, and have lived in the country continuously for at least 12 months at any time in their lives are eligible to enrol and vote.

agree) scale. Table 1 displays the means, standard deviations, and reliabilities of our focal variables at each assessment wave.

**Right-wing authoritarianism** was assessed with these three pro-trait and three con-trait items from Altemeyer's (1996) 30-item RWA scale: (a) "It is always better to trust the judgment of the proper authorities in government and religion than to listen to the noisy rabble-rousers in our society who are trying to create doubt in people's minds", (b) "It would be best for everyone if the proper authorities censored magazines so that people could not get their hands on trashy and disgusting material", (c) "Our country will be destroyed some day if we do not smash the perversions eating away at our moral fibre and traditional beliefs", (d) "People should pay less attention to The Bible and other old traditional forms of religious guidance, and instead develop their own personal standards of what is moral and immoral" (reverse-scored), (e) "Atheists and others who have rebelled against established religions are no doubt every bit as good and virtuous as those who attend church regularly" (reverse-scored), and (f) "Some of the best people in our country are those who are challenging our government, criticizing religion, and ignoring the "normal way" things are supposed to be done" <sup>4</sup> (reverse-scored; Women's  $\omega$ s = .59-.73; Men's  $\omega$ s = .66-.77).

Researchers often use shortened versions of established measures to address time and resource constraints and to reduce cognitive load of survey respondents. This approach has been employed by the NZAVS researchers, for example, by using only six items instead of the original 30-item RWA scale. Although widely employed in large scale survey studies, the use of shortened measures has limitations and might compromise the reliability and validity of the measures (e.g., Krueger et al., 2013). In response to these critiques, Sibley et al. (in press) conducted a large-scale study to examine how the short-form scales used in the NZAVS compared to their full-scale counterparts. Their results confirmed that the six-item RWA scale used in the NZAVS has adequate reliability for research purposes ( $\omega = .68$ , 99% CI [.65, .70]), but that the full 30-item RWA scale is more reliable ( $\omega = .92$ , 99% CI [.92, .93]).

**Social dominance orientation** was assessed with these three pro-trait and three con-trait items from Sidanius and Pratto's (1999) 16-item SDO<sub>6</sub> scale: (a) "It is OK if some groups have more of a chance in life than others", (b) "Inferior groups should stay in their place", (c) "To get ahead in life, it is sometimes okay to step on other groups", (d) "We should have increased social equality" (reverse-scored), (e) "It would be good if groups could be equal" (reverse-scored), and (f) "We should do what we can to equalise conditions for different groups" (reverse-scored; Women's  $\omega$ s = .67-.79; Men's  $\omega$ s = .67-.79). Results reported by Sibley et al. (in press) confirmed the high reliability of this six-item SDO scale ( $\omega = .76$ , 99% CI [.75, .78]), but that the full 16-item SDO scale is more reliable ( $\omega = .88$ , 99% CI [.87, .89]).

**Climate change beliefs** were assessed with these two items used in past studies on New Zealanders' climate change beliefs (e.g., see Milfont, Zubielevitch, Milojevic, & Sibley, 2021; Sibley & Kurz, 2013): (a) "Climate change is real" and (b) "Climate change is caused by humans" (Women's  $\alpha$ s = .69-.82; Men's  $\alpha$ s = .71-.83).

5.4. Data analysis

Data were analyzed using Mplus v8.10 (Muthén & Muthén, 1998-2017) following our pre-registered analysis plan. Missing data were addressed by using Full Information Maximum Likelihood (FIML) estimates. FIML provides a more efficient approach towards missing data than listwise or casewise deletion, as it utilises all available responses from participants (Enders & Bandalos, 2001). Moreover, FIML does not require data to be missing completely at random (Enders, 2001), and produces unbiased parameter estimates without inflating Type I error rates (Enders & Bandalos, 2001).

Table 1  
Means, standard deviations, reliability estimates, and sample sizes of our focal variables at each annual assessment split by gender.

	Time 1	Time 2	Time 3	Time 4	Time 5	Time 6	Time 7	Time 8	Time 9	Time 10	Time 11	Time 12	Time 13	Time 14
<b>Women</b>														
RWA (N)	3861	2718	4257	7564	11,433	9987	8716	13,701	10,774	29,938	27,115	24,450	21,605	21,195
M	3.659	3.543	3.296	3.386	3.399	3.275	3.239	3.218	3.131	3.319	3.215	3.311	3.384	3.342
SD	1.174	1.185	1.131	1.145	1.096	1.097	1.126	1.125	1.125	1.121	1.107	1.079	1.026	1.047
$\omega$	.698	.656	.715	.708	.681	.690	.716	.709	.728	.680	.669	.650	.594	.604
SDO (N)	3860	2718	4258	7564	11,433	9988	8714	13,706	10,777	29,943	27,136	24,484	21,747	21,244
M	2.455	2.425	2.291	2.318	2.231	2.230	2.313	2.256	2.212	2.180	2.064	2.038	2.057	2.074
SD	.917	.891	.910	.911	.835	.850	.904	.915	.915	.896	.879	.873	.881	.891
$\omega$	.666	.671	.740	.713	.668	.713	.756	.758	.781	.741	.774	.787	.775	.771
Climate Beliefs (N)	3865	2717	4290	6516	11,025	9652	8478	13,284	10,403	28,454	26,527	23,902	20,977	20,316
M	5.196	5.114	5.195	5.288	5.447	5.569	5.682	5.872	5.930	6.022	5.956	6.024	6.034	5.975
SD	1.431	1.481	1.448	1.421	1.409	1.329	1.322	1.247	1.226	1.249	1.349	1.274	1.286	1.357
$\alpha$	.686	.781	.782	.775	.797	.819	.821	.819	.814	.802	.824	.824	.816	.818
<b>Men</b>														
RWA (N)	2608	1694	2545	4529	6779	5796	5183	8155	6227	17,777	15,216	13,764	12,047	12,106
M	3.573	3.419	3.243	3.296	3.250	3.159	3.152	3.106	3.024	3.237	3.114	3.204	3.247	3.224
SD	1.197	1.234	1.174	1.169	1.167	1.181	1.203	1.200	1.205	1.203	1.188	1.148	1.100	1.123
$\omega$	.702	.688	.743	.714	.717	.743	.758	.756	.776	.733	.726	.707	.662	.670
SDO (N)	2609	1694	2545	4528	6779	5796	5186	8154	6227	17,779	15,225	13,781	12,094	12,122
M	2.821	2.753	2.728	2.679	2.528	2.575	2.689	2.623	2.614	2.592	2.514	2.483	2.494	2.518
SD	1.000	.976	.993	.977	.927	.942	.981	1.007	1.013	1.019	1.019	1.014	1.020	1.040
$\omega$	.674	.698	.735	.704	.670	.711	.741	.754	.778	.746	.777	.786	.777	.783
Climate Beliefs (N)	2619	1695	2563	3909	6580	5588	5016	7932	5988	16,748	14,944	13,508	11,782	11,670
M	4.922	4.793	4.870	4.672	5.148	5.318	5.442	5.643	5.695	5.699	5.619	5.723	5.729	5.611
SD	1.591	1.580	1.574	1.578	1.613	1.511	1.477	1.433	1.433	1.500	1.586	1.501	1.530	1.627
$\alpha$	.706	.721	.739	.754	.786	.806	.802	.806	.806	.806	.806	.806	.820	.832

<sup>4</sup> Due to space constraints, this sixth indicator was not assessed at Time 2.

While larger sample sizes may warrant more conservative  $p$ -values, this approach is inappropriate here due to the limited number of waves in our longitudinal dataset and the nature of RI-CLPMs. Specifically, because RI-CLPMs separate between-person variance from within-person variance, the amount of variance explainable at the within-person level of analysis is often (much) smaller than analyses that do not account for this confounding (see Osborne & Little, 2024). Adopting a more conservative  $p$ -value in this context runs the risk of increasing the Type II error rates. We therefore use a standard  $p$ -value of .05 to determine the strength of evidence against a null hypothesis.

Because we finalized data collection for Time 14 before completing our manuscript, we departed from our pre-registration and included this additional wave of data.<sup>5</sup> We made no other deviations from our pre-registration. Thus, we used a multi-group RI-CLPM to test our hypotheses with gender as a grouping variable.

We first estimated a random intercept for RWA, SDO and climate change beliefs by fixing the factor loadings of each respective mean-scaled score at each assessment to 1. These three random intercepts reflect the mean (or trait-like component) of each construct across all 14 assessments. To recognize that those who are relatively high on SDO and RWA should also be relatively low on climate change beliefs (e.g., see Milfont et al., 2013), we allowed the three random intercepts to correlate. We then estimated within-person deviations from these trait-level means by creating latent variables of each construct at each assessment by fixing to 1 and 0 the factor loading and residual variance, respectively, of each mean-scaled score. Next, we used these newly created latent variables to estimate a stationary cross-lagged panel model. Specifically, the within-person latent variables at Time 14 were regressed onto the within-person latent variables at Time 13, the within-person latent variables at Time 13 were regressed onto the within-person latent variables at Time 12, and so on. Because there was no reason to expect that the size of the autoregressive and cross-lagged effects would differ across assessments, we constrained all congeneric autoregressive and cross-lagged effects to equality (see Osborne & Little, 2024). Finally, we overrode the *Mplus* defaults to estimate these effects in a multi-group framework by constraining the means of the random intercepts and within-person latent variables to 0 for our second group (i.e., men), and by freely estimating the intercepts of the mean-scaled scores at each assessment occasion. Syntax for our models will be available on the project's OSF (<https://osf.io/75snb/>) or can be obtained by contacting the authors.

## 6. Results

Our stationary multi-group RI-CLPM fit these data well,  $\chi^2_{(1608)} = 16459.634, p < .001$ ; CFI = .980; RMSEA = .016 [.016, .016],  $p > .999$ ; SRMR = .054. The top panel of Fig. 2 shows that between-person differences in climate change beliefs amongst women correlated negatively with both RWA ( $b = -.343, 95\% \text{ CI} = [-.354, -.331]; p < .001$ ) and SDO ( $b = -.366, 95\% \text{ CI} = [-.375, -.356]; p < .001$ ), while between-person differences in RWA correlated positively with SDO ( $b = .277, 95\% \text{ CI} = [.269, .286]; p < .001$ ). The lower panel of Fig. 2 shows that these results replicated among men, and that the between-person correlations climate change beliefs had with RWA and SDO looked stronger for men. Thus, we estimated two additional models where we constrained to equality across men and women the correlations between the random intercepts for climate change beliefs and SDO (Model 1) and climate change beliefs and RWA (Model 2). As hypothesized, both constraints reduced model fit relative to our initial model:  $\Delta\chi^2_{(1)} =$

294.255,  $p < .001$  and  $\Delta\chi^2_{(1)} = 56.893, p < .001$ , respectively. Collectively, these results indicate that those who were relatively high on RWA and SDO across all 14 annual assessments also tended to hold relatively low trait-level climate change beliefs, and that these between-person correlations were stronger for men than for women.

Turning to the within-person components of our model, Fig. 2 reveals statistically significant autoregressive effects for RWA, SDO and climate change beliefs for both women (top panel;  $b = .163, 95\% \text{ CI} = [.155, .170]; p < .001$ ;  $b = .168, 95\% \text{ CI} = [.161, .175]; p < .001$ ;  $b = .324, 95\% \text{ CI} = [.316, .332]; p < .001$ , respectively) and men (bottom panel;  $b = .176, 95\% \text{ CI} = [.166, .186]; p < .001$ ;  $b = .192, 95\% \text{ CI} = [.182, .202]; p < .001$ ;  $b = .332, 95\% \text{ CI} = [.321, .342]; p < .001$ , respectively). Whilst autoregressive effects in traditional CLPMs reflect the stability of a construct across assessments, they capture inertia in an RI-CLPM (see Orth et al., 2021; Osborne & Little, 2024). Accordingly, a 1-unit departure in participants' trait-level climate change beliefs at  $T - 1$  carries over as a .324-unit departure for women and a .332-unit departure for men from their trait-level mean at the subsequent assessment.

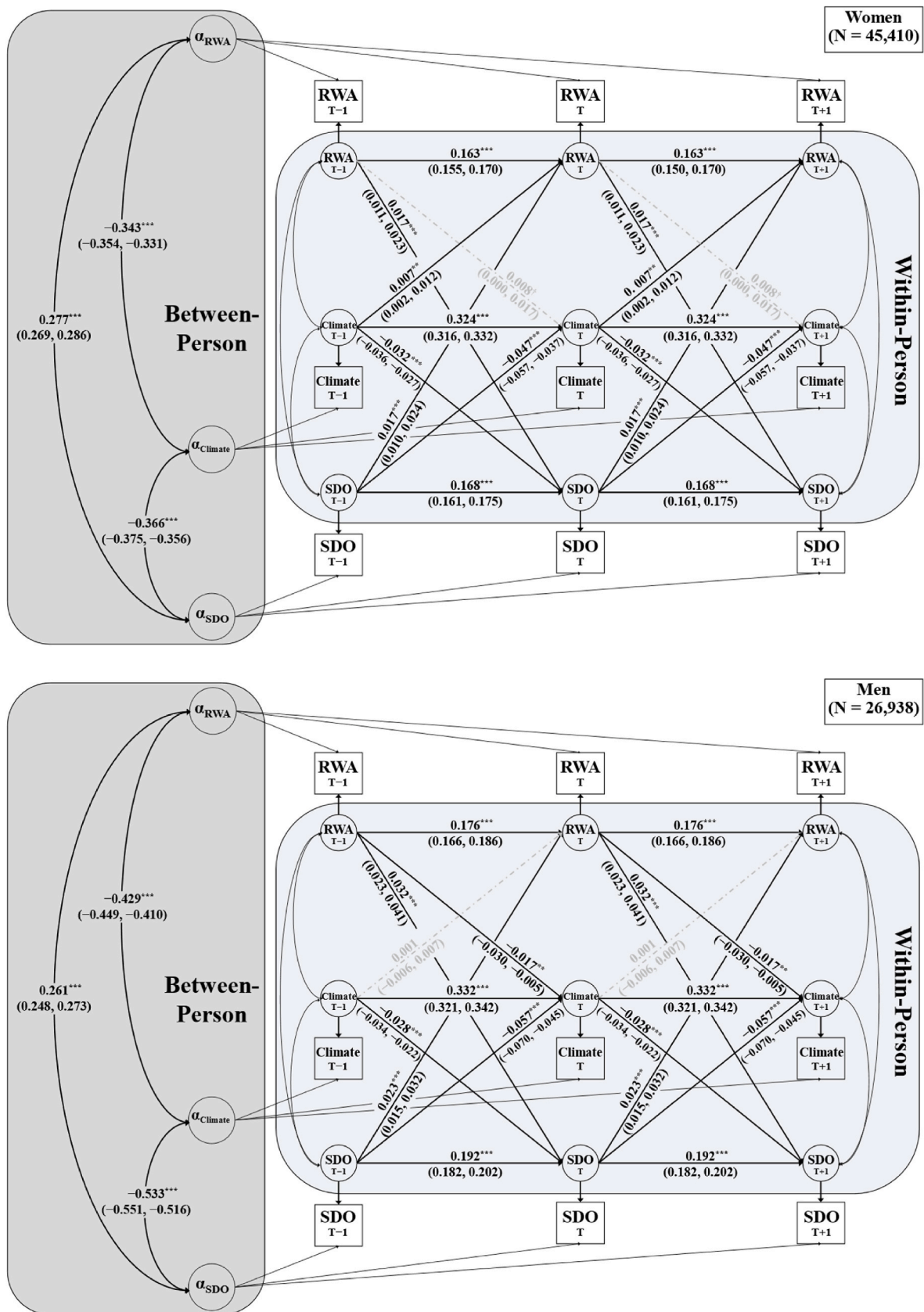
After adjusting for the stable, trait-like differences in RWA, SDO and climate change beliefs, as well as their within-person autoregressive effects, we obtained partial support for our hypotheses for women and full support for our hypotheses for men. For women, within-person changes in SDO had a negative cross-lagged effect on climate change beliefs ( $b = -.047, 95\% \text{ CI} = [-.057, -.037]; p < .001$ ). But contrary to expectations, the correlation between within-person changes in RWA and subsequent within-person changes in climate change beliefs was non-significant (.008,  $95\% \text{ CI} = [.000, .017]; p = .058$ ). Accordingly, constraining the cross-lagged effects that SDO and RWA had on climate change beliefs to equality amongst women led to a significant decline in model fit ( $\Delta\chi^2_{(1)} = 67.491, p < .001$ ). Thus, for women, SDO had a significantly larger cross-lagged effect than the non-significant cross-lagged effect of RWA on climate change beliefs.

For men, both hypotheses were supported: within-person changes in both SDO ( $b = -.057, 95\% \text{ CI} = [-.070, -.045]; p < .001$ ) and RWA ( $b = -.017, 95\% \text{ CI} = [-.030, -.005]; p = .008$ ) preceded negative departures from their trait-level climate change beliefs at the subsequent assessment. Constraining the cross-lagged effects that SDO and RWA had on climate change beliefs to equality among men reduced model fit ( $\Delta\chi^2_{(1)} = 18.367, p < .001$ ). Thus, although both socio-ideological attitudes independently predicted later declines in climate change beliefs for men, SDO had a larger cross-lagged effect than RWA. Further examination of gender asymmetries revealed that the cross-lagged effect of SDO on climate change beliefs was similar in magnitude for men and women ( $\Delta\chi^2_{(1)} = 1.603, p = .205$ ), whereas the cross-lagged effect of RWA on climate change beliefs was stronger for men than for women ( $\Delta\chi^2_{(1)} = 10.645, p = .001$ ).

Fig. 2 also displays the reciprocal associations climate change beliefs had with both RWA and SDO. For women, within-person increases in climate change beliefs led to within-person increases in RWA ( $b = .007, 95\% \text{ CI} = [.002, .012]; p = .007$ ), but within-person decreases in SDO ( $b = -.032, 95\% \text{ CI} = [-.036, -.027]; p < .001$ ), at the next assessment. Constraining the non-significant cross-lagged effect of RWA on climate beliefs to equality with the cross-lagged effect of climate beliefs on RWA did not, however, significantly reduce model fit ( $\Delta\chi^2_{(1)} = .113, p = .737$ ). Conversely, constraining the cross-lagged effect of SDO on climate beliefs to equality with the cross-lagged effect of climate beliefs on SDO reduced model fit significantly ( $\Delta\chi^2_{(1)} = 10.396, p = .001$ ). Thus, in partial support of our hypotheses, the cross-lagged effect of SDO (but not RWA) on climate change beliefs displayed temporal precedence over the corresponding reciprocal cross-lagged effect among women.

For men, within-person changes in climate beliefs only had a significant negative cross-lagged effect on SDO ( $b = -.028, 95\% \text{ CI} = [-.037, -.022]; p < .001$ ); the cross-lagged effect of within-person changes in climate beliefs on RWA was not significant ( $b = .001, 95\% \text{ CI} = [-.006, .007]; p = .862$ ). Moreover, constraining the cross-lagged effect of climate beliefs on SDO to equality with the cross-lagged effect of

<sup>5</sup> Results were similar when using only 13 annual waves of data, with one exception—RWA had a weak, albeit statistically significant, negative cross-lagged effect on climate change beliefs amongst women in analyses with 13 waves of data. When updating our analyses with the 14th wave of data, this effect became statistically non-significant.



**Fig. 2.** Stationary multi-group random intercept cross-lagged panel model of the associations between right-wing authoritarianism (RWA), social dominance orientation (SDO), and climate change beliefs amongst women (top panel) and men (bottom panel).  
 Note. Our model fit these data well,  $\chi^2_{(1608)} = 16459.634$ ,  $p < .001$ ; CFI = .980; RMSEA = .016 [.016, .016],  $p > .999$ ; SRMR = .054. For clarity, within-person covariances were estimated at each time point, but excluded from the figure. Estimates reflect unstandardised regression coefficients (with 95% confidence intervals in parentheses). Tables S1–S3 present the standardised coefficients.  $^{\dagger}p < .10$ ;  $^*p < .05$ ;  $^{**}p < .01$ ;  $^{***}p < .001$ .

SDO on climate beliefs significantly reduced model fit ( $\Delta\chi^2_{(1)} = 21.416$ ,  $p < .001$ ). Likewise, constraining the cross-lagged effect of climate beliefs on RWA to equality with the cross-lagged effect of RWA on climate beliefs significantly reduced model fit ( $\Delta\chi^2_{(1)} = 7.728$ ,  $p = .005$ ). Thus, as predicted, the cross-lagged effects of both SDO and RWA on climate change beliefs demonstrated temporal precedence over their respective reciprocal associations for men.

## 7. Discussion

We examined the longitudinal relationships between core socio-ideological attitudes and climate change beliefs. Supporting our pre-registered predictions, both RWA and SDO correlated negatively with climate change beliefs at the between-person level. Individuals who consistently scored high on both RWA and SDO throughout the 14 annual assessments also tended to have weaker climate change beliefs. Therefore, when considering stable, trait-like individual differences, higher levels of both RWA and SDO often correspond with lower beliefs in both the reality and human cause of climate change. When considering intra-individual results, SDO had larger cross-lagged effects on climate change beliefs than RWA for both men and women. These results extend previous cross-sectional studies that have also reported negative associations between RWA and/or SDO and environmental-related outcomes (for a meta-analytical review, see Stanley & Wilson, 2019). Also consistent with our pre-registered hypotheses, the between-person correlations SDO had with climate change beliefs were stronger for men than for women; a similar pattern was observed for RWA. Gender asymmetries also emerged for longitudinal associations at the intra-individual level: Both RWA and SDO independently predicted later declines in climate change beliefs for men, while only SDO significantly predicted declines in climate change beliefs for women. Unexpectedly, the size of the SDO effect was comparable across gender.

Our results confirm the importance of these socio-ideological attitudes in the environmental domain. Both Schultz and Stone (1994) and Milfont et al. (2003) noted that the associations RWA and SDO have with environmental-related variables are not easily anticipated by Authoritarian Personality Theory or Social Dominance Theory, respectively. These authors argued that high RWA individuals are strongly attached to, and fully entrenched within, the norms of the prevailing social paradigm, whereas those high on SDO extend their desire to dominate into the natural environment by supporting human dominance over nature (see also Uenal et al., 2021). Both accounts support the view that individuals with comparatively high levels of RWA and SDO are less concerned about environmental problems and endorse weaker beliefs in the reality and human cause of climate change due to motivational drives to protect existing social systems—points that have also been noted by other authors (e.g., Hornsey et al., 2016; Jylhä et al., 2016; McCright & Dunlap, 2011; Milfont et al., 2021).

The fact that climate change beliefs are rooted in socio-ideological attitudes has significant implications for interventions designed to encourage adaptation and mitigation actions. In a recent review of how social psychological research and theory has been applied to environmental problems over the years, Clayton (2024) noted: “Climate change is no longer just a problem to be solved; we will not return to the status quo ante. It is perhaps more significantly an evolving set of conditions within which we will live. Society, and social psychology, need to face the challenge and adapt to the new reality” (p. 1542). Addressing the climate crisis thus requires embracing changes, adopting new public policies and lifestyles, fostering technological innovation, and encouraging widespread behavioural shifts. However, the motivational drives indexed by RWA and SDO—as well as other conservative system-justifying ideologies—counteract these necessary changes by compelling individuals to seek stability and uphold existing conditions. To overcome incompatibilities between protecting existing social systems and tackling the climate crisis, scholars have explored ways to reframe pro-environmental messages to align with conservative

system-justifying ideologies (e.g., Baldwin & Lammers, 2016; Feinberg & Willer, 2013, Study 3; Feygina et al., 2009, Study 3; Wolsko, 2017; Wolsko et al., 2016). Though promising, pre-registered attempts to replicate some of these findings have failed (Kim et al., 2021, 2023; Stanley et al., 2021), indicating the need for further research. Fortunately, cross-cultural evidence reveals that envisioning a future that improves the current conditions can motivate pro-environmental behaviours (Bain et al., 2016). Thus, interventions that promote collective futures may be able to mobilise action across ideological divides (see Billet et al., 2024).

Overall, the results also supported our pre-registered predictions that the temporal ordering would flow from the socio-ideological attitudes to climate change beliefs. But some statistically significant lagged effects from climate beliefs to SDO also emerged for both men and women, consistent with some previous longitudinal work (Stanley et al., 2017, 2019). The effects were, however, statistically stronger from SDO to climate beliefs. Accordingly, those who experienced temporary increases in their SDO at one year experienced a subsequent decrease in beliefs about the reality and human cause of climate change. Even if statistically weaker, it is worth noting the reverse flow: when individuals had higher levels of climate belief than usual, they experienced a subsequent decline from their trait-level SDO. That SDO and climate change beliefs reciprocally and negatively influence each other over time, and that this reciprocal influence occurs for both men and women, demonstrates the relative importance of SDO in the environmental domain. Indeed, our results confirmed the greater predictive strength of SDO over RWA in forecasting climate change beliefs both between-people and within individuals. The bidirectional nature of SDO–beliefs pathway suggests that attempts to increase awareness of the realities of climate change could have unintended positive consequences for intergroup relations. Specifically, because SDO fosters prejudices towards outgroups (Osborne et al., 2021), declines in SDO precipitated by an increase in climate beliefs should also reduce intergroup hostilities. Future research is needed to examine this potentially important implication of our results.

The comparatively higher importance of SDO in the environmental domain has been observed and discussed in previous research (Dhont et al., 2016; Häkkinen & Akrami, 2014; Milfont et al., 2003; Stanley et al., 2019). By drawing on 14 annual waves of national panel data, our results provide strong evidence that support for hierarchical social structures, where certain groups are perceived as inherently superior to others, is detrimental to our relationship with the natural environment. Although initially developed to account for individual differences in the preference for hierarchical structures in human–human relations (Pratto et al., 1994), SDO is a strong marker of human–nature dynamics perceived through the lens of hierarchical power structures (Milfont et al., 2003; Uenal et al., 2021).

Our results also provide insights into the personality traits underlying these socio-ideological attitudes. According to the DPM (see Fig. 1), RWA reflects personality traits of social conformity (or low Openness to Experience), whereas SDO reflects tough-minded traits (or low Agreeableness). Unsurprisingly, these personality traits are also implicated in pro-environmental attitudes and behaviours, with ample evidence that environmentalism is greater among those with higher levels of Openness to Experience and Agreeableness (Hopwood et al., 2022; Milfont, 2021a, 2021b; Reist et al., 2023; Soutter et al., 2020). Individuals high in Openness exhibit a curiosity for unique ideas and people, appreciate the beauty of art and nature, and are intellectually curious, sensitive, and open to new experiences. Individuals high in Agreeableness exhibit trustworthiness and a readiness to cultivate harmony, as well as the tendency to offer help, forgive, compromise and cooperate with others. Believing in the reality and human cause of climate change is thus linked to being curious about new ideas and sensitivity to beauty, while also being kind, helpful, and willing to cooperate. Notably, both Openness to Experience and Agreeableness predict pro-social behaviour (Kaiser & Byrka, 2011; Thielmann et al., 2020), which is essential for addressing



the climate crisis.

The links with personality traits also help contextualise our results in relation to gender differences and the stronger effects of SDO (vs. RWA) on climate change beliefs. SDO reflects low levels of Agreeableness, and women tend to be higher than men on this trait (Feingold, 1994; Murphy et al., 2021). Moreover, both Agreeableness and SDO help explain gender differences in environmentalism (Milfont & Sibley, 2016). Therefore, Agreeableness seems to be the underlying foundation for the “invariance hypothesis” proposed by Social Dominance Theory to explain gender differences in SDO (Sidanius et al., 1995), as well as the documented gender differences in environmentalism (Zelezny et al., 2000). It is worth noting, however, that the range of responses to RWA and SDO were more restricted for women compared to men (see Table 1). These floor effects for women may have influenced the gender differences reported here. That is, range restrictions in RWA and SDO may have attenuated their correlations with climate change beliefs for women compared to men. With this caveat in mind, the pattern of longitudinal results observed separately for men and women nevertheless adds to the extant literature by showing that conservative socio-ideological attitudes predict subsequent declines in climate change beliefs.

Our results also provide insights into the differential prediction of RWA and SDO articulated by the dual process model. The theoretical focus has been on how these socio-ideological attitudes differentially predict prejudice towards different social groups (Duckitt, 2006; Duckitt & Sibley, 2007), as RWA predicts prejudice towards groups seen as threatening, SDO predicts prejudice towards groups who challenge the status quo, and both RWA and SDO predict prejudice against groups seen as threatening and challenging status. Extending this theoretical argument to consider the “natural environment” and “non-human animals” as outgroup entities, the results from the current study suggest that those high in RWA and SDO perceive these entities and their protection as a threat to the status quo. This interpretation corroborates Cantal and colleagues’ (2015) observation that the social group “environmentalists” clustered mainly under derogated groups (subordinated but not threatening; e.g., “housewives”, “mentally handicapped people”) but with a substantial cross-loading under dissident groups (both threatening and subordinated; e.g., “protestors”, “people who criticize those in authority”). Together with the cross-lagged effects of RWA and SDO on climate change beliefs observed here, these findings indicate that environmentalists, attempts to protect the natural environment, and belief in the reality and human cause of climate change trigger competitive desires to maintain dominance and safeguard existing social systems.

Before concluding, it is worth noting that climate change beliefs are an important factor that motivates people to engage in climate action (Steg, 2023). Indeed, past research has shown that the more individuals believe climate change is real and caused by human activity, the more likely they are to (intend to) engage in mitigation and adaptation behaviours, and support climate policies (e.g., Abrahamse et al., in press; Heath & Gifford, 2006; Van Valkengoed et al., 2021). However, our study focuses only on climate change beliefs and does not provide insights into how they may or may not translate into mitigation/adaptation actions. Future studies could examine the extent to which RWA and/or SDO moderate the link between climate change beliefs and action.

In conclusion, our longitudinal study provides compelling evidence of the enduring impact that socio-ideological attitudes have on climate change beliefs. By elucidating the complementary and differential effects of RWA and SDO on beliefs about the reality and human cause of climate change, we underscore the importance of considering individual differences when shaping responses to environmental challenges. We also extend theoretical understandings of human–human relations described by Duckitt’s (2001) DPM to human–nature relations. Moving forward, addressing the climate crisis requires interdisciplinary efforts to develop system-based strategies to enact meaningful change and

safeguard the health of our planet for generations to come.

### CRedit authorship contribution statement

**Taciano L. Milfont:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Chris G. Sibley:** Writing – review & editing, Resources, Methodology, Investigation, Funding acquisition, Data curation. **Danny Osborne:** Writing – review & editing, Writing – original draft, Resources, Methodology, Formal analysis.

### Author note

The New Zealand Attitudes and Values Study is funded by a grant from the Templeton Religion Trust (TRT-2021-10418). The funders play no role in the study design, data collection and analysis, decision to publish, or preparation of the article.

### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jenvp.2025.102554>.

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