



Supplement of

Quantifying the emission changes and associated air quality impacts during the COVID-19 pandemic on the North China Plain: a response modeling study

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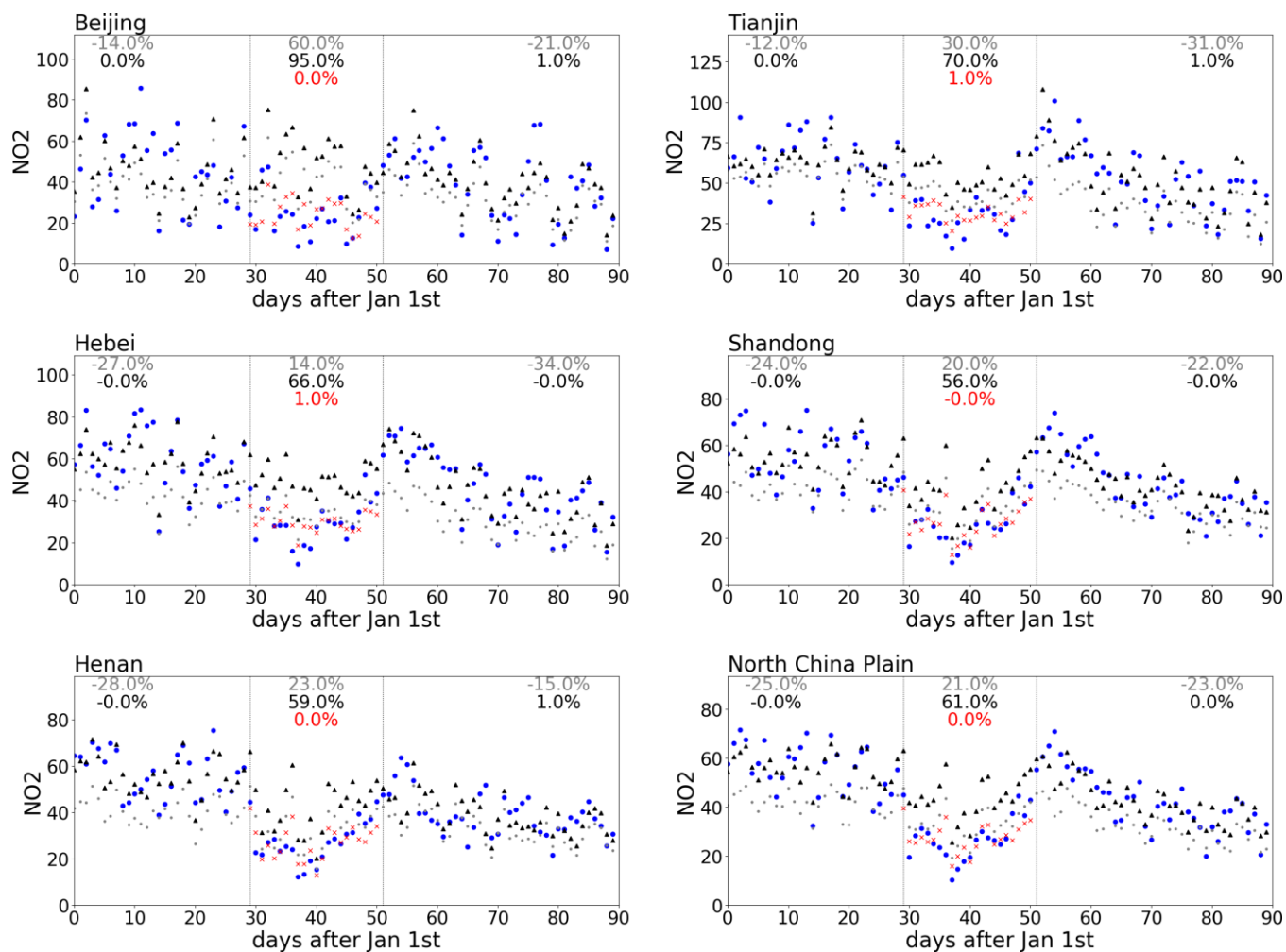


Figure S1 Comparison of the simulated average concentrations of NO₂ in NCP (the percentage numbers indicate the normalized mean biases in hypothesis and actual simulations respectively for Period 2. Blue dots: observations; Black dots: simulations using adjusted emission with no consideration of shutdown influences; Red dots: simulations using adjusted emission with consideration of shutdown influences; Grey dots: original simulation without assimilation; unit: $\mu\text{g m}^{-3}$)

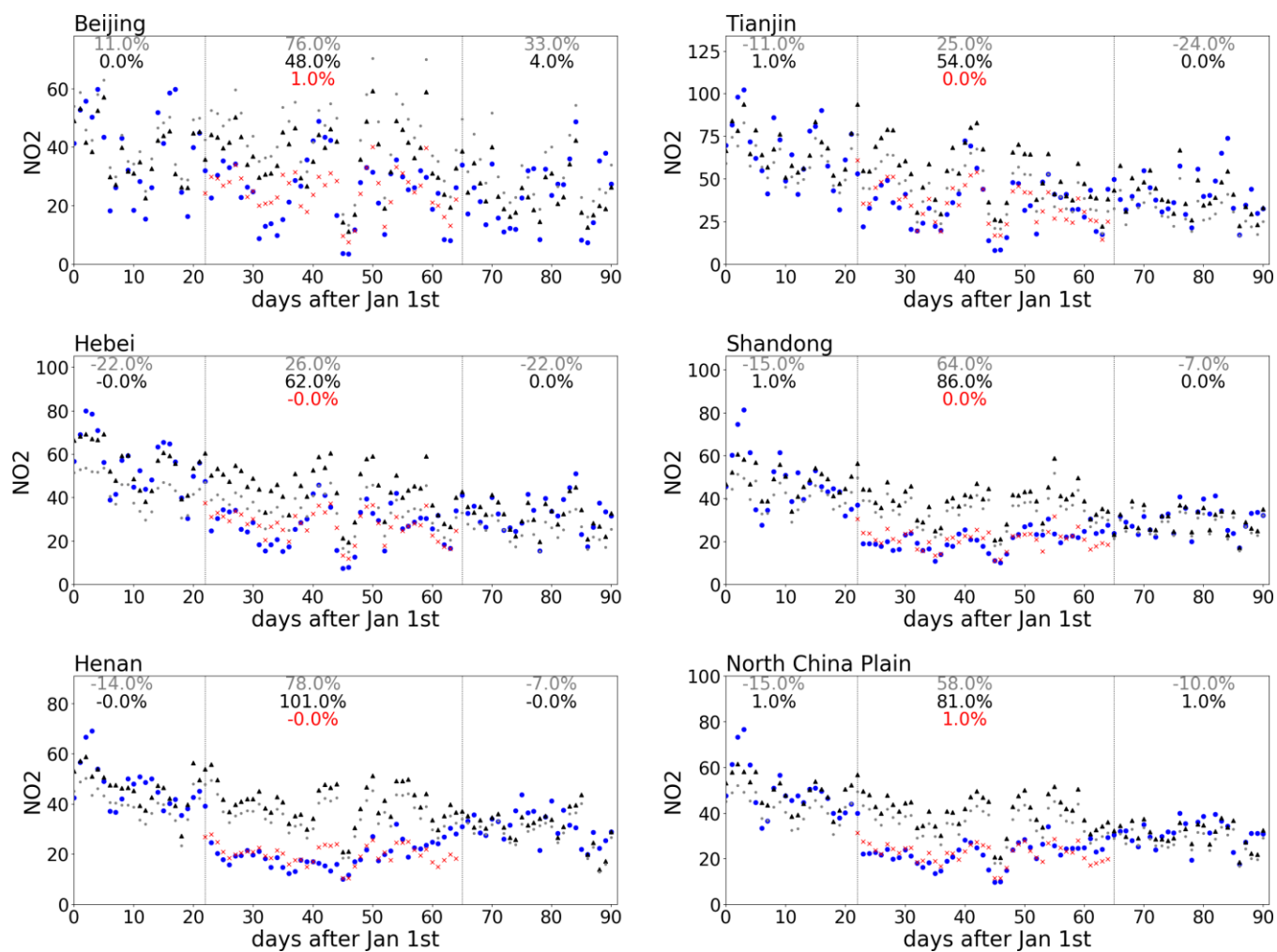


Figure S2 Same as Figure S1 but in 2020

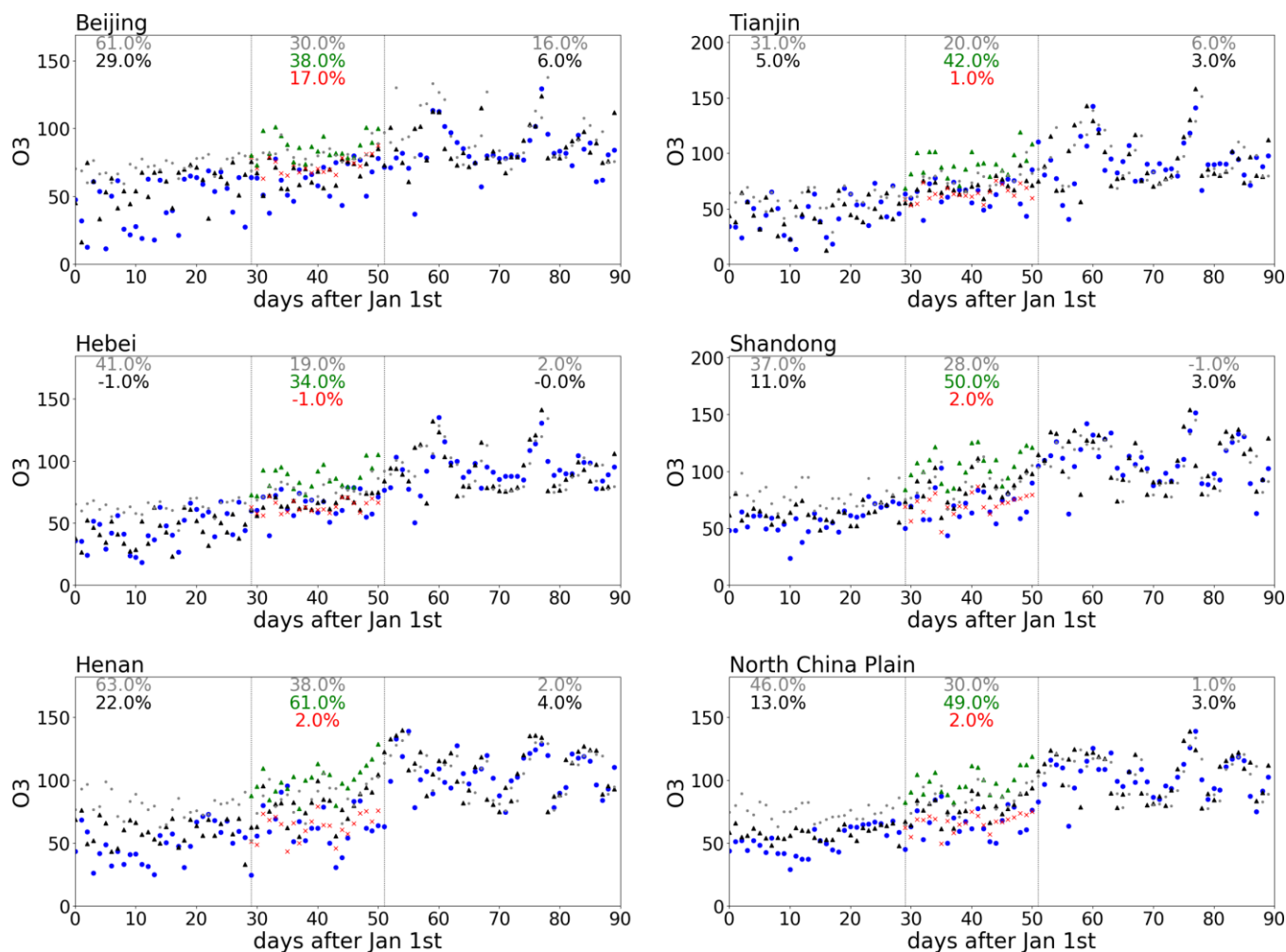
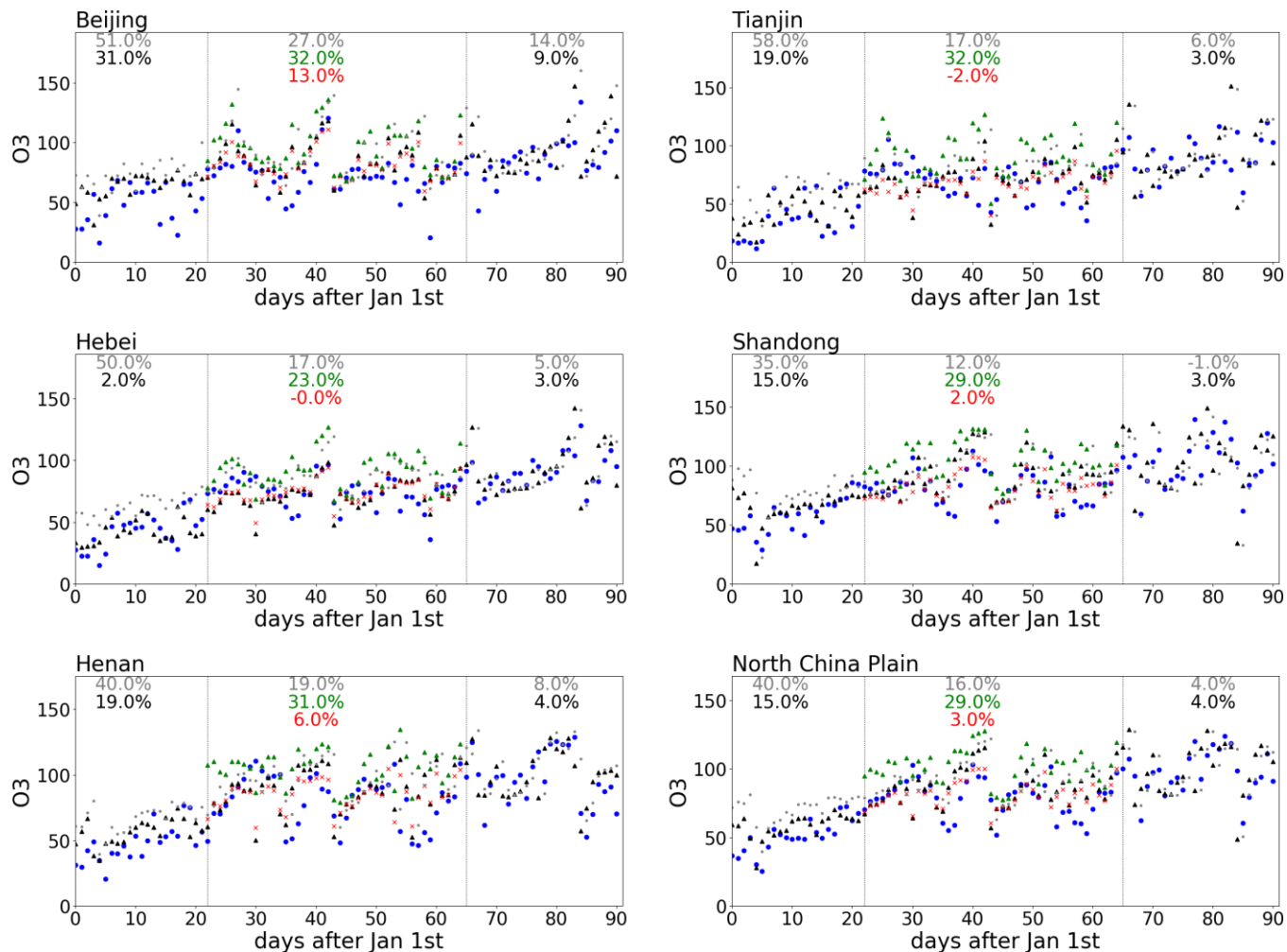


Figure S3 Comparison of the simulated average concentrations of O_3 in NCP (the percentage numbers indicate the normalized mean biases in hypothesis and actual simulations respectively for Period 2. Blue dots: observations; Black dots: simulations using adjusted emission with no consideration of shutdown influences; Red dots: simulations using adjusted emission with consideration of shutdown influences; Green dots: simulations using adjusted emission with consideration of shut-down influences but without VOC; Grey dots: original simulation without assimilation; unit: $\mu g m^{-3}$)

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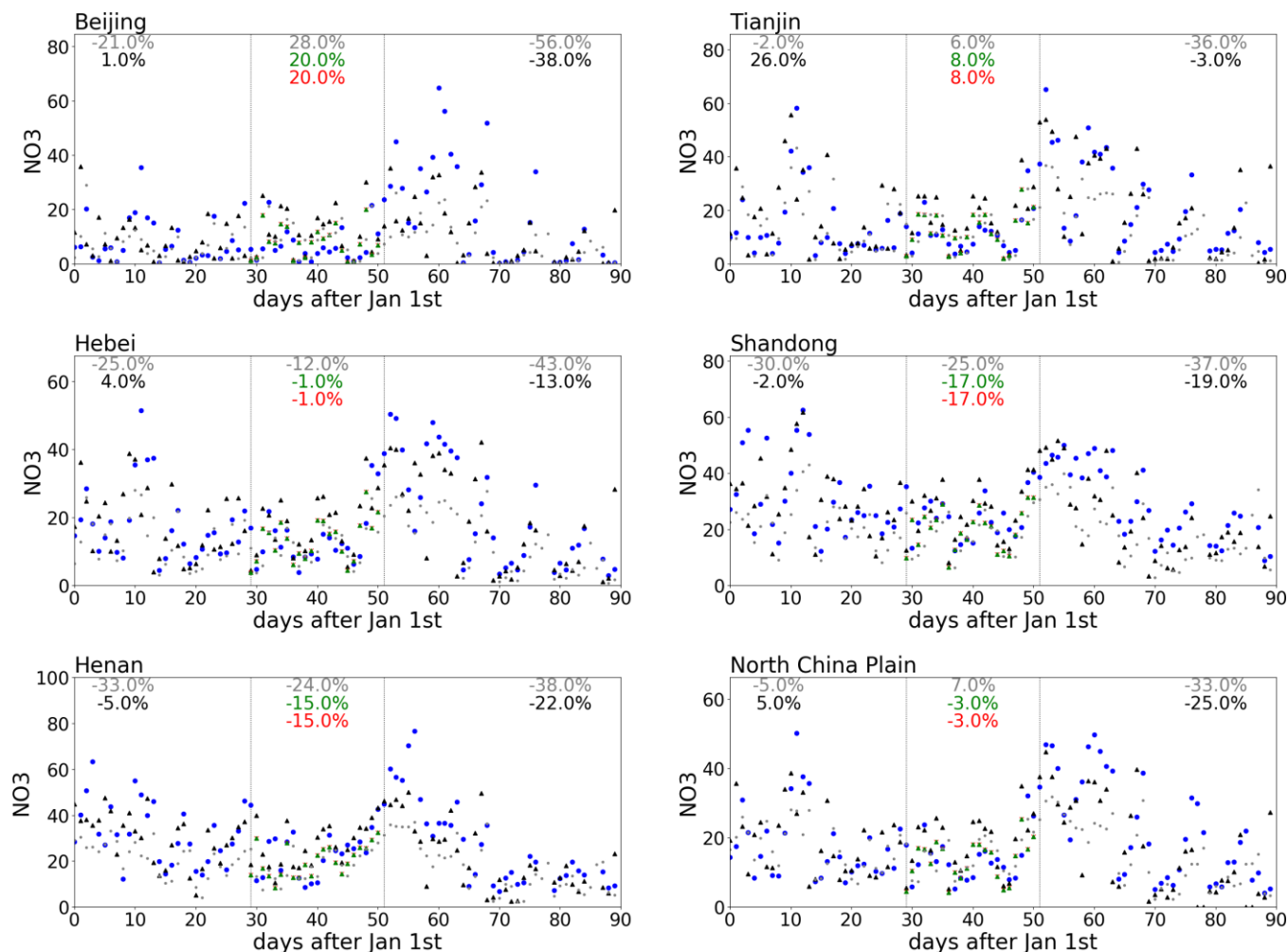


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Figure S4 Same as Figure S3 but in 2020

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28 **Figure S5** Comparison of the simulated average concentrations of NO_3^- in NCP (the percentage numbers
 29 indicate the normalized mean biases in hypothesis and actual simulations respectively for Period 2. Blue
 30 dots: observations; Black dots: simulations using adjusted emission with no consideration of shutdown
 31 influences; Red dots: simulations using adjusted emission with consideration of shutdown influences;
 32 Green dots: simulations using adjusted emission with consideration of shut-down influences but
 33 without NH_3 ; Grey dots: original simulation without assimilation; unit: $\mu\text{g m}^{-3}$)

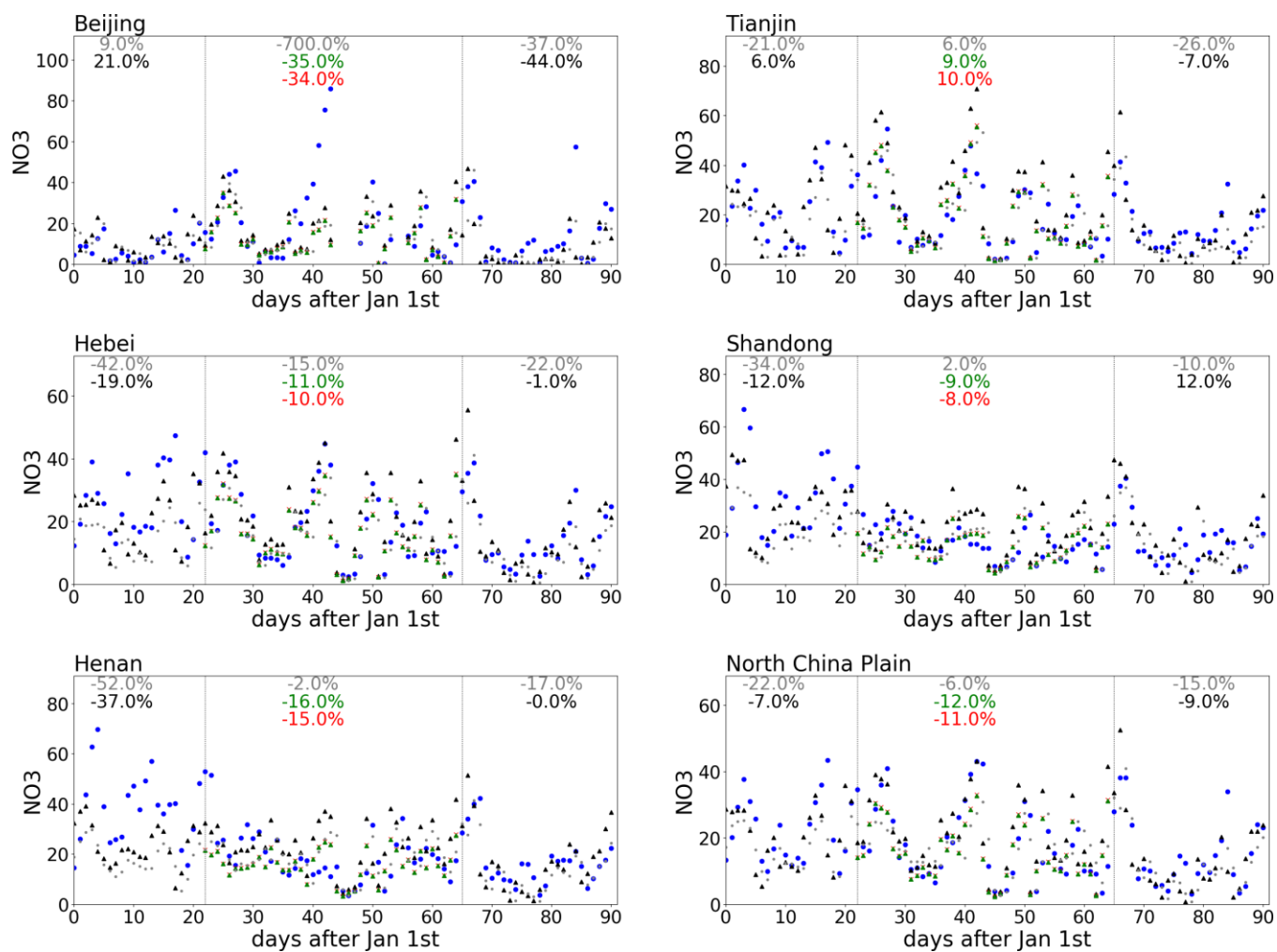
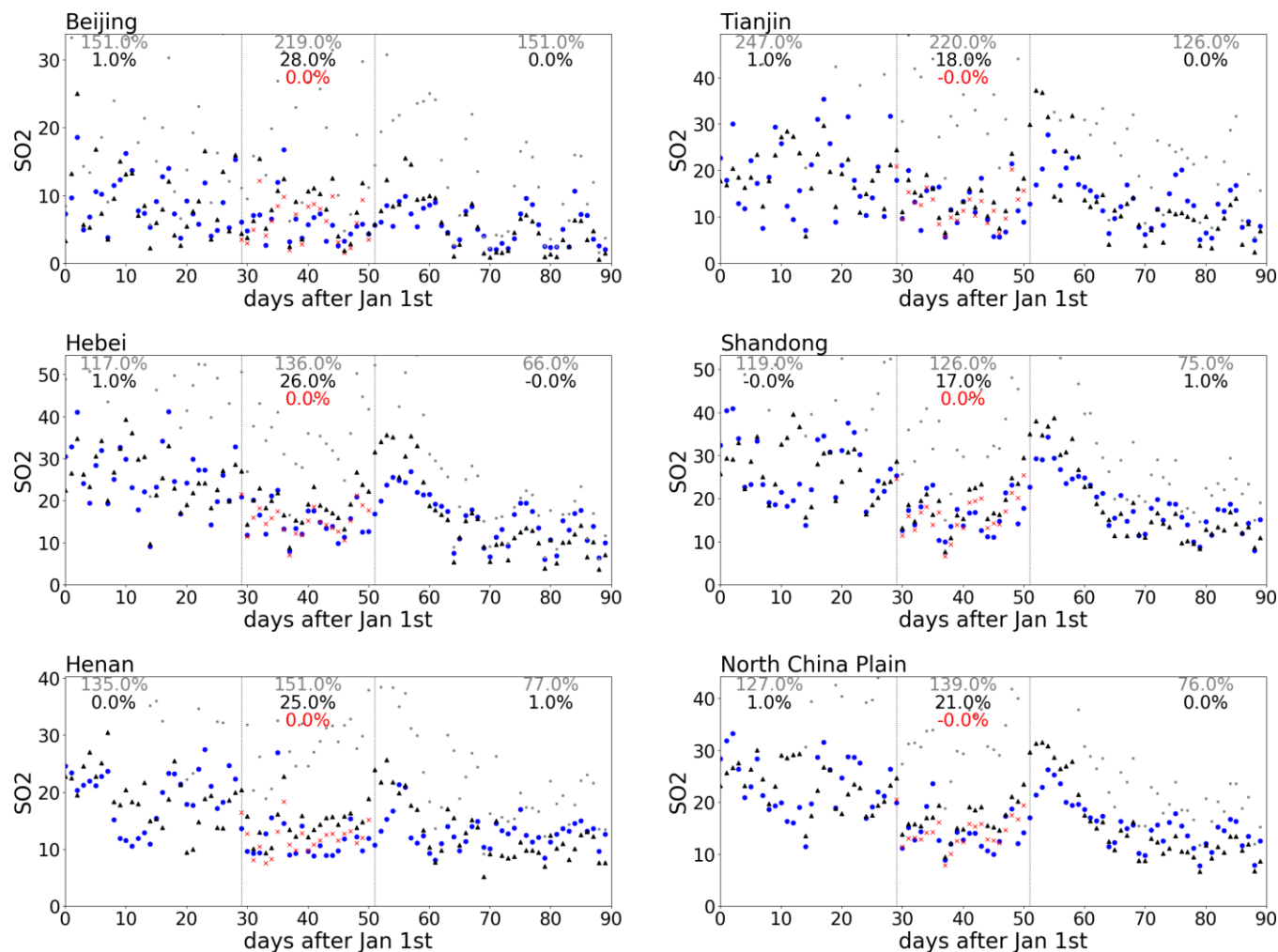


Figure S6 Same as Figure S5 but in 2020

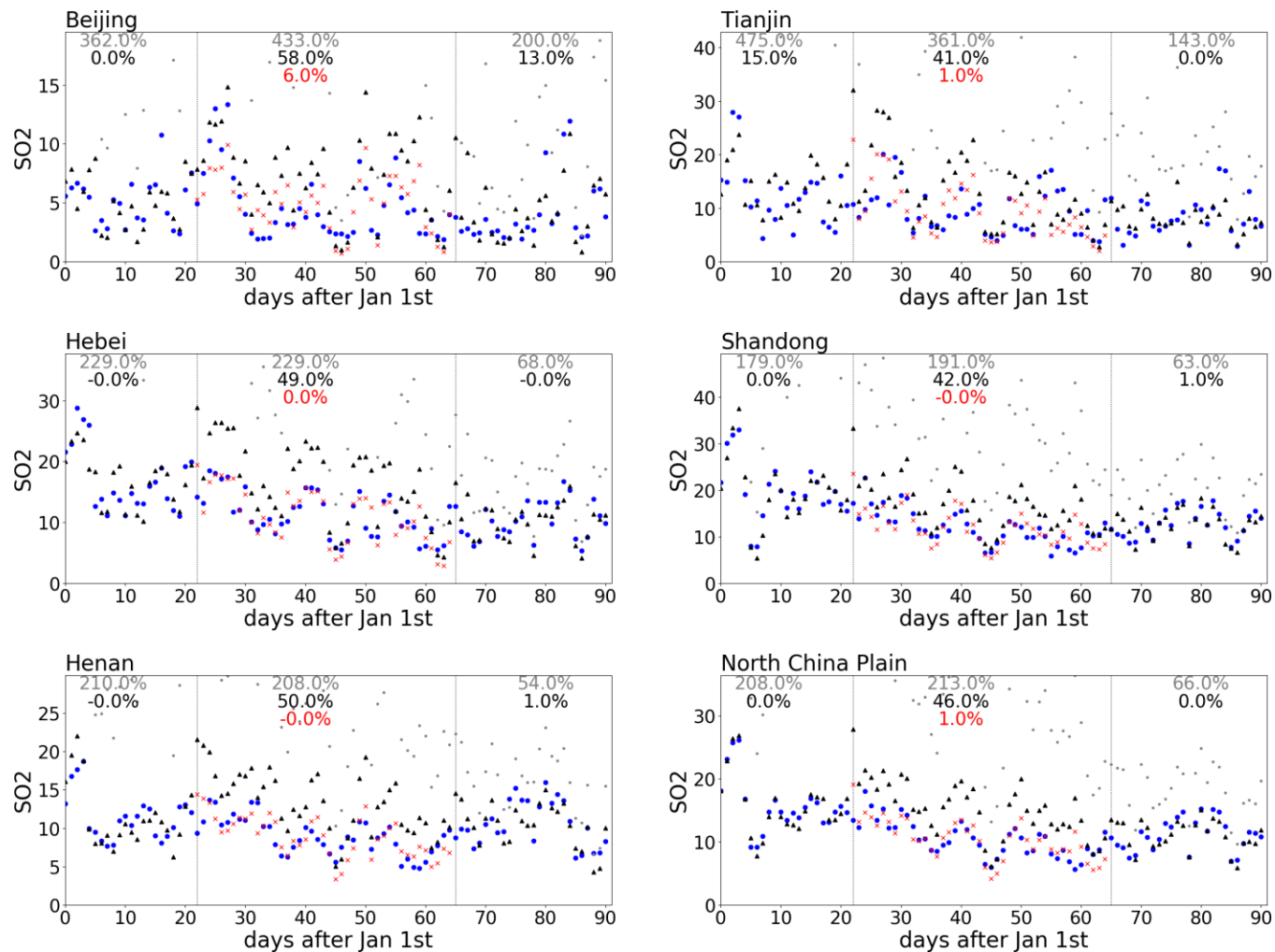


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40 **Figure S7** Comparison of the simulated average concentrations of SO₂ in NCP (the percentage numbers
 41 indicate the normalized mean biases in hypothesis and actual simulations respectively for Period 2. Blue
 42 dots: observations; Black dots: simulations using adjusted emission with no consideration of shutdown
 43 influences; Red dots: simulations using adjusted emission with consideration of shutdown influences;
 44 unit: Grey dots: original simulation without assimilation; μg m⁻³)

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Figure S8 Same as Figure S7 but in 2020

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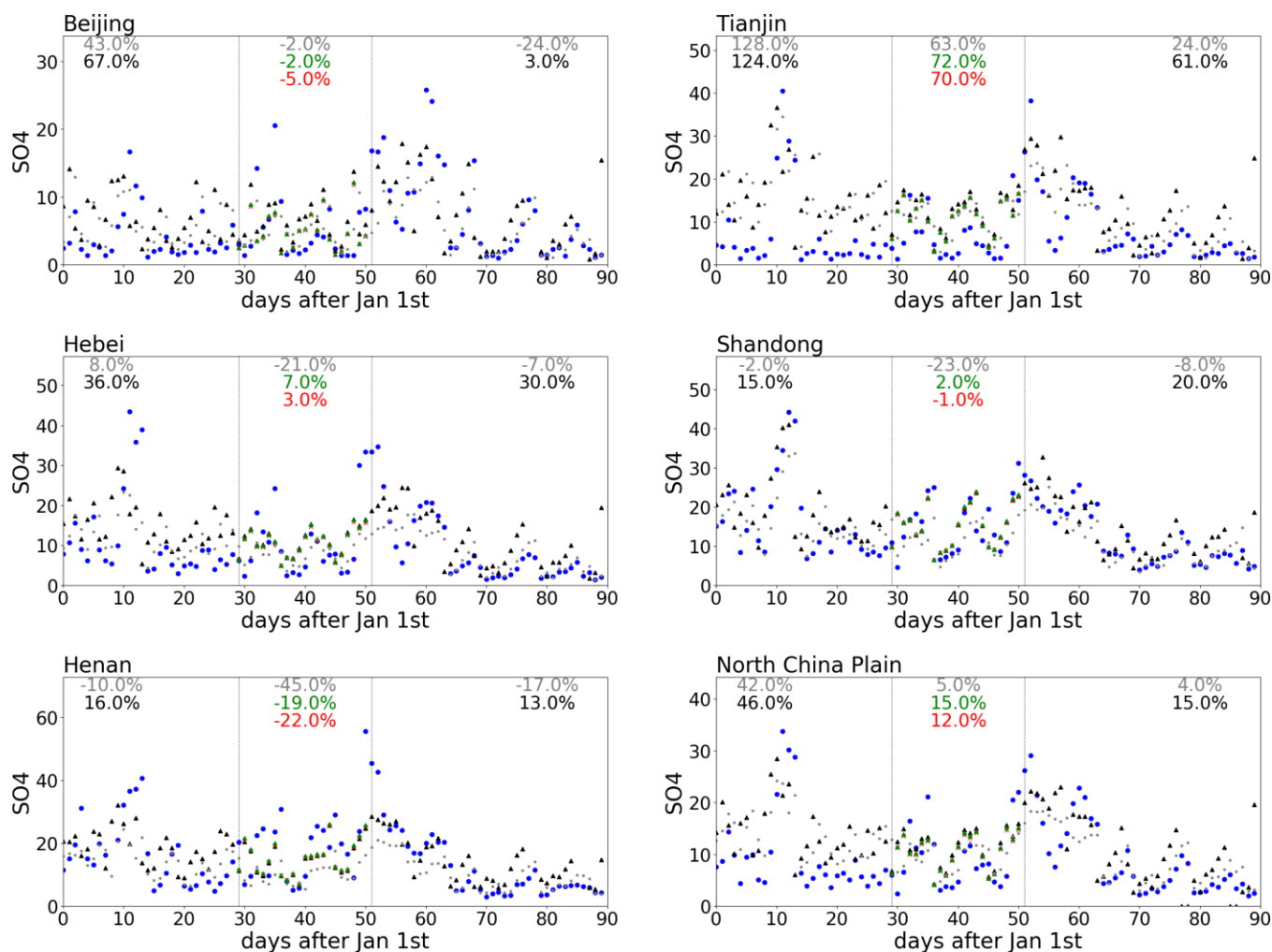
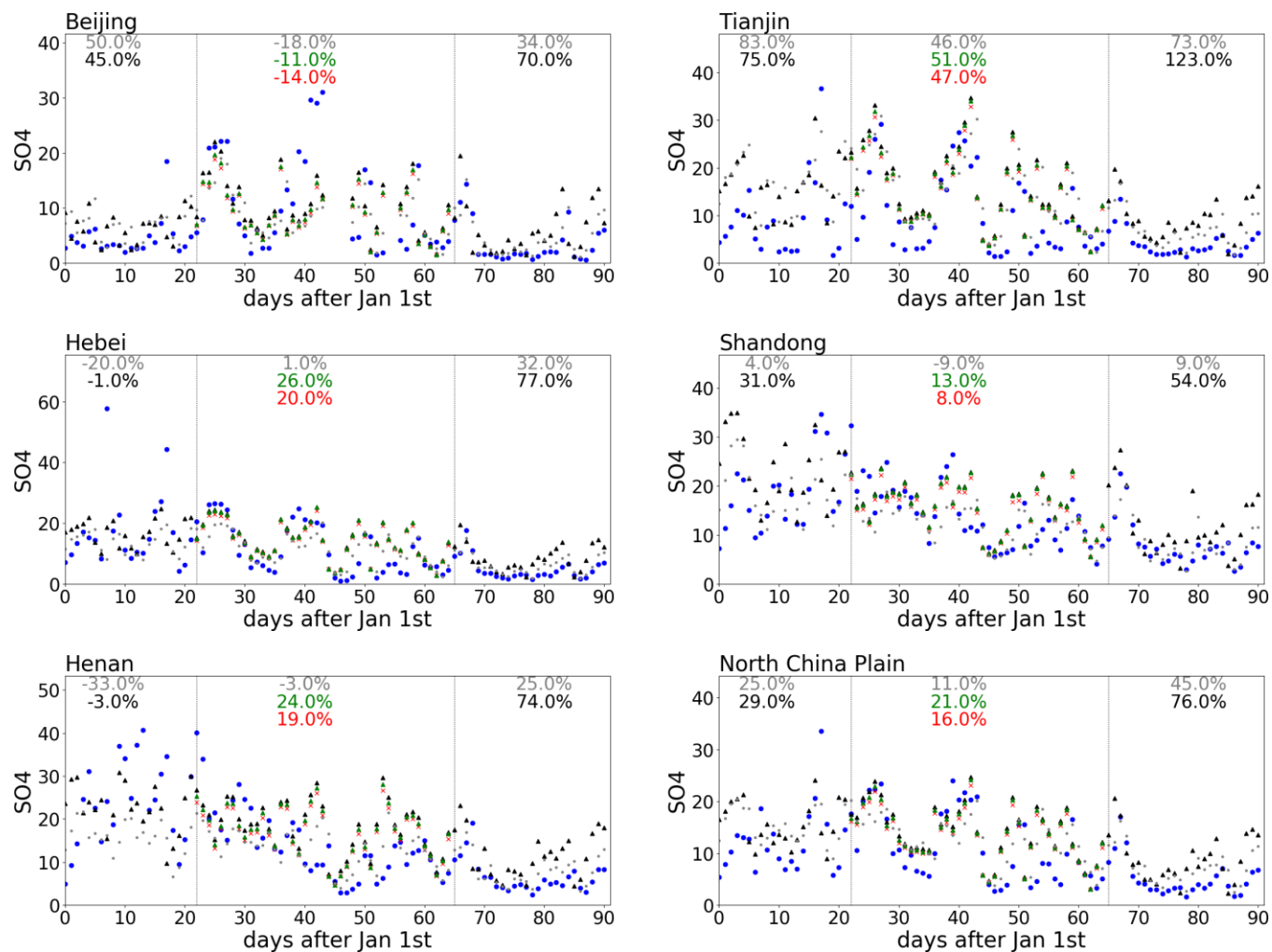


Figure S9 Comparison of the simulated average concentrations of SO_4^{2-} in NCP (the percentage numbers indicate the normalized mean biases in hypothesis and actual simulations respectively for Period 2. Blue dots: observations; Black dots: simulations using adjusted emission with no consideration of shutdown influences; Red dots: simulations using adjusted emission with consideration of shutdown influences; Green dots: simulations using adjusted emission with consideration of shut-down influences but without SO_2 ; Grey dots: original simulation without assimilation; unit: $\mu\text{g m}^{-3}$)

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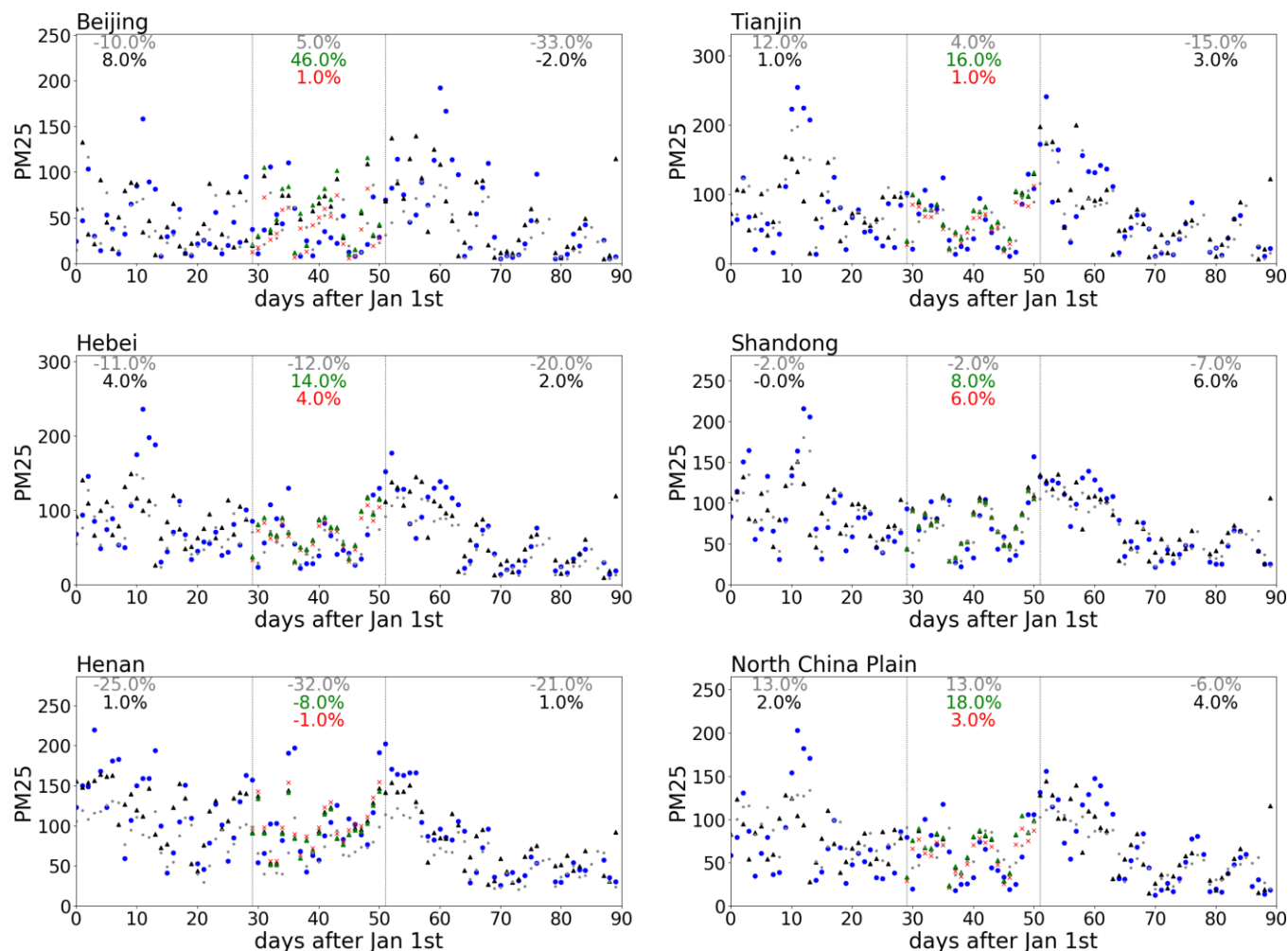
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Figure S10 Same as Figure S9 but in 2020

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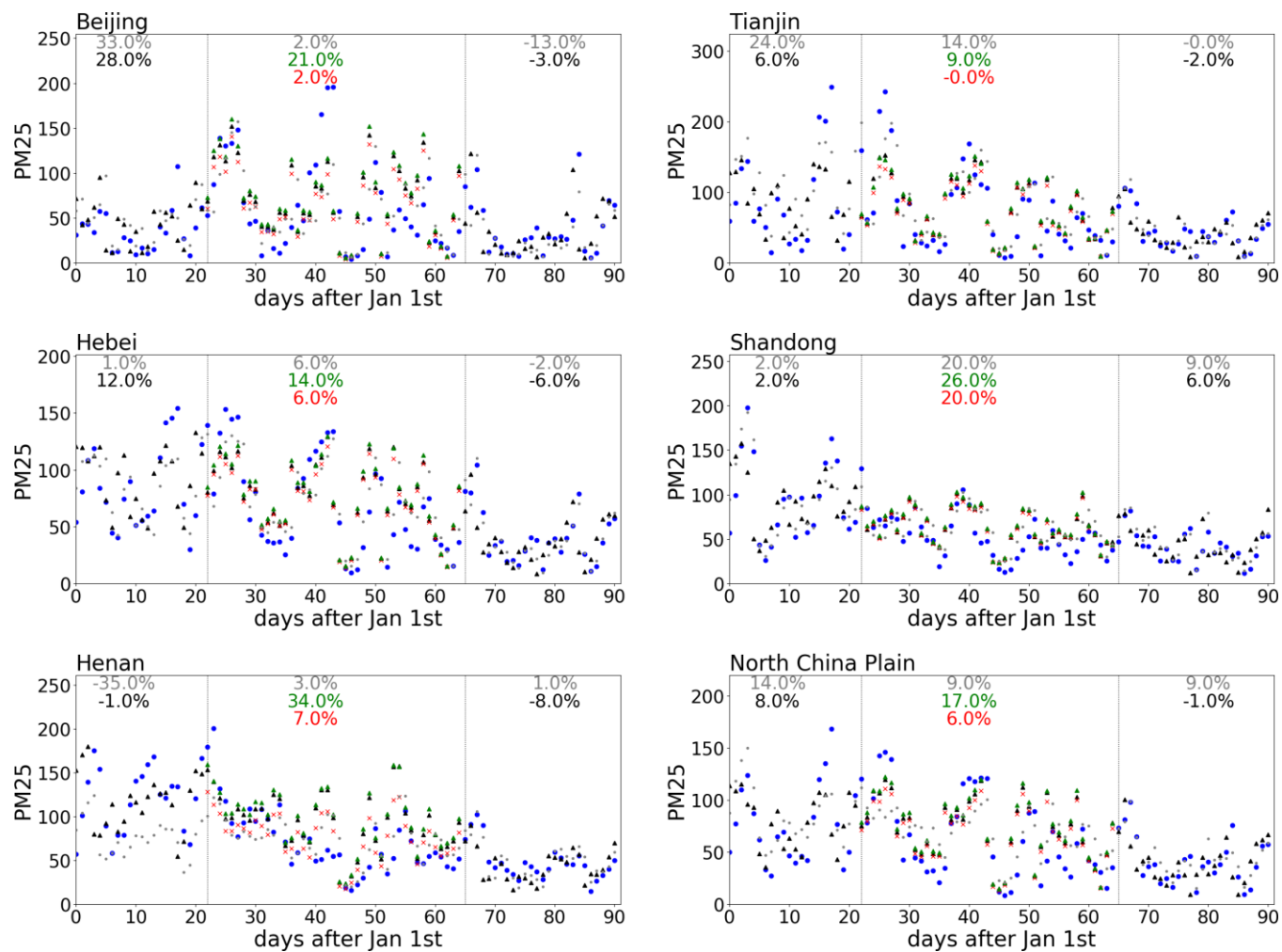
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Figure S11 Comparison of the simulated average concentrations of PM_{2.5} in NCP (the percentage numbers indicate the normalized mean biases in hypothesis and actual simulations respectively for Period 2. Blue dots: observations; Black dots: simulations using adjusted emission with no consideration of shutdown influences; Red dots: simulations using adjusted emission with consideration of shutdown influences; Green dots: simulations using adjusted emission with consideration of shut-down influences but without primary PM_{2.5}; Grey dots: original simulation without assimilation; unit: $\mu\text{g m}^{-3}$)

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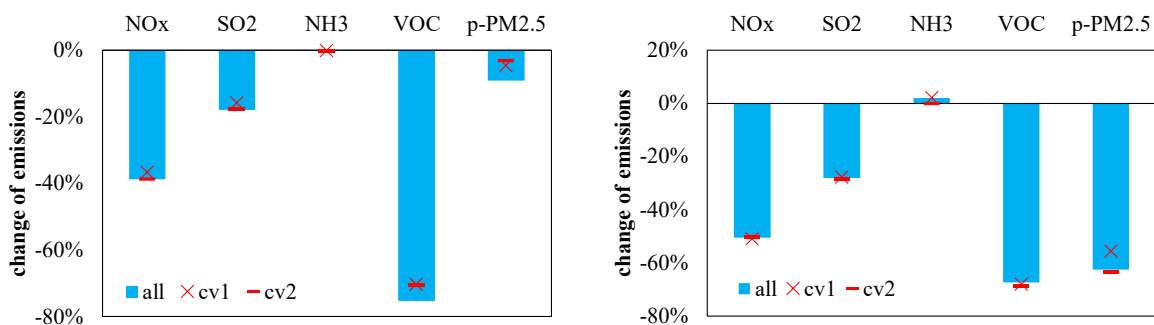


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Figure S12 Same as Figure S11 but in 2020

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76 **Figure S13.** Comparison of estimated percent changes in emissions due to the shutdown in Period 2
 77 from cross-validation (cv1-cross validation #1 by using randomly selected half of the observation sites
 78 in each province for correction; cv2-cross validation #2 by using the rest half of the observation sites in
 79 cv1 for correction; all-used all observation sites)