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Halogens enhance haze pollution in China

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Severe and persistent haze events in northern China, characterized by high loading of fine aerosol especially of secondary origin, negatively impact human health and the welfare of ecosystems. However, current knowledge cannot fully explain the formation of this haze pollution. Despite field observations of elevated levels of reactive halogen species (e.g., BrCl, ClNO₂, Cl₂, HBr) at several sites in China, the influence of halogens (particularly bromine) on haze pollution is largely unknown. Here, for the first time, we compile an emission inventory of anthropogenic bromine and quantify the collective impact of halogens on haze pollution in northern China. We utilize a regional model (WRF-Chem), revised to incorporate updated halogen chemistry and anthropogenic chlorine and bromine emissions and validated by measurements of atmospheric pollutants and halogens, to show that halogens enhance the loading of fine aerosol in northern China (on average by 21%) and especially its secondary components (~130% for secondary organic aerosol and ~20% for sulfate, nitrate, and ammonium aerosols). Such a significant increase is attributed to the enhancement of atmospheric oxidants (OH, HO₂, O₃, NO₃, Cl, and Br) by halogen chemistry, with a significant contribution from previously unconsidered bromine. These results show that higher recognition of the impact of anthropogenic halogens shall be given in haze pollution research and air quality regulation.