

Interactive comment on “Chlorine activation on stratospheric aerosols: uncertainties in parameterizations and surface area” by T. Wegner et al.

Anonymous Referee #1

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The manuscript by Wegner et al. examines the efficiency of chlorine activation in the Arctic winter stratosphere on (binary) stratospheric aerosol by using in situ aircraft observations as well as vortex mean conditions derived from MLS satellite observations. Their findings provide further observational support for the idea that most of the initial chlorine activation in the Arctic is taking place on cold binary aerosol and polar stratospheric clouds (PSCs) play only a relatively minor role for the initial activation (along the lines of the recent paper by Drdla and Müller). The manuscript provides important observations to improve our understanding of Arctic chlorine activation and I suggest publication in ACP after consideration of a few, mostly minor, comments.

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Specific comments

While overall I find the results very compelling, I wondered how sensitive the results for the Geophysica flight on 7 March 2005 are on possible temperature biases along the calculated trajectories. If I understand this correctly, only a mean bias, based on comparison with temperature measurements, was subtracted. If the bias is temperature dependent, how would that influence the results? For the flight on 7 March 2005 there is excellent agreement between measured and modeled ClOx before 0845 and after 0930, but between 0845 and 0930 modeled additional chlorine activation (difference between modeled ClOx and initialization) is underestimated by almost a factor of 2. How sensitive is this to the assumed temperature bias? And how large is the uncertainty for the inferred initial ClOx, given that this is calculated as the difference between inferred Cly from CH₄ and satellite observations of HCl and ClONO₂? Providing a more quantitative estimate for the uncertainties here would strengthen the conclusions of the manuscript.

To me the sub-title "uncertainties in parameterizations and surface area" does not correctly represent the main findings of this study as there is little new material that tells us about uncertainties in parameterizations.

Why are the parameterizations by Hanson and Ravishankara and by Abbatt and Molina (p.20567) considered as an upper and lower limit, respectively? Simply because they represent the range of available parameterizations, or are there any deeper reasons to assume they constitute limits?

Minor comments and technical corrections

p.20564, l.18: This sentence sounds a bit as if "deliberate enhancement of stratospheric aerosol" is imminent.

p.20566, l.9: Please explain briefly how the almost complete reduction in ozone leads to a Cl increase. (Through the ozone-dependent partitioning between Cl and ClO.)

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p.20566, l.16: don't link deactivation of Cl into HCl and almost complete ozone destruction by "and" in a single sentences, as this implies the wrong causality.

p.20566, l.22: suggestion: "which describes" -> "describing"

p.20567, l.10: better discuss the dependence on H₂SO₄ and temperature separately (not linked in a single sentence by "and").

p.20567, l.14-18: better move these lines somewhere into the next paragraph.

p.20568, l.12: say explicitly which ClO_x compounds are measured (ClO and Cl₂O₂).

p.20568, l.12: "...and back-trajectories indicate that chlorine was activated...": there is some circular reasoning here. Either say "...temperatures along back-trajectories indicate that chlorine activation was unlikely before..." or remove this sentence here.

p.20569, l.4: symbols theta and phi not needed

p.20569, l.22: why are the findings of Brakebusch with WACCM relevant here? Is the 1.5K temperature bias more than just a pure coincidence?

p.20569: how is the temperature bias as a function of potential temperature calculated (Fig.2)? Is ERA-Interim mapped to the Geophysica altitude using potential temperature, or using only pressure? Calculated temperature bias depends on this detail.

p.20570, l.3: "greatest" -> "largest"

p.20573, l.7: how different are these cross sections with those from the latest JPL recommendations?

p.20574, l.16: "In 2004, ..." -> "... steep decline...at the end of December 2004 and at the end of December 2009".

p.20577, l.22: "could demonstrate" -> "demonstrate"

p.20577, l.23: "last seven": please specify explicitly

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Captions to Figs. 2-4: Please include date of flight.

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