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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Properties of polar stratospheric clouds obtained by combined ACE-FTS and ACE-Imager extinction measurements" *by* A. Y. Zasetsky et al.

Anonymous Referee #2

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ACE (the Atmospheric Chemistry Experiment) is a Canadian satellite mission that is measuring a large number of atmospheric constituents by absorption spectroscopy, using the sun as a light source. The principle instrument of ACE is an IR Fourier transform spectrometer (FTS). According to Bernath (Anal. Chem. 25, 647, 2006) the FTS operates in the range 750-4400 cm-1. Another instrument that is part of ACE is a filtered “Imager” that measures solar radiation at 1.02 m and 0.525 m. This instrument measures extinction and is used to monitor aerosols and clouds. Note that the wavelengths used in the imager are the same as used in SAGE II and POAM, and should thus allow for some very interesting comparisons of observations of PSCs.

I was definitely looking forward to reading this paper, as the abstract suggests that it will give interesting insights into PSCs, specifically by simultaneously determining the size distribution and the composition of the PSC particles. I must confess to being somewhat disappointed in the sense that the paper has much to offer, but could have offered so much more. Nevertheless, I recommend publication after minor revisions.

To begin with, the analysis boils down to studying six clouds during the time period 24 to 26 January, 2005 at latitudes between 64.9 and 65.5 N. I realize that there are not all that many PSCs in the Northern Hemisphere. The text mentions that during the Jan-Feb time period, 20 PSC-type clouds were observed in latitudes ranging from 60 to 67 N. I don’t know why the authors decided to only look at 6 of them. Furthermore, as I understand it, the ACE measurements range in latitude from nearly 80 S to 80 N. Since PSCs are much more common in the Southern Hemisphere, why were these clouds not analyzed? I think the authors have lost an opportunity to generate a valuable corpus of knowledge on the characteristics of PSCs in the two hemispheres, perhaps contrasting compositions and size distributions in the Arctic and Antarctic.

The compositions for the 6 clouds considered (in Table 1) are described as “NAT”, “STS” and “Ice.” This is fine for NAT and ice, but for STS it would be very helpful to know just what the composition is, that is, what are the weight percentages of the three substances? This would be extremely valuable in checking against model calculations.

The authors state that, “...the physical and chemical conditions of the stratosphere vary considerably from one year to the next, further reducing the number of cases where comparable measurements can be made under similar conditions of temperature and gas phase composition.” I think this is not quite true. The temperature may reach lower values one year or another, but it will definitely go through the same values in reaching the minimum (albeit not on the same day of the year). Also the chemical composition is reasonably constant, at least as far as water, sulfuric acid and nitric acid are concerned. I would suggest that there are many opportunities to

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compare measurements from one year with those from another.

The technique used is explained, but I am still somewhat uncertain how it works. The explanation offered by the authors is, “It uses these reference spectra in a least squares approach that varies the size distribution to minimize the square of the difference between the (weighted) measured spectrum and trial spectra computed for a range of assumed compositions and sizes, as shown in the following expression:” and there follows an equation that I cannot reproduce here.

Is this some sort of standard notation that I have never run into before? Why the superscript “min” and a subscript “P”? I presume the authors are using the double bar to mean matrix. I do not understand, however, why the weighting is applied to both terms in (M-KP). I would think that it should be applied only to M. The quantity P is the “size distribution vector on which the (non negative) least squares minimization is done.” This means that the composition has already been determined? The expression, I would assume, only gives the differences or deviations and then these must be minimized. Is that the meaning of superscript “min”? Anyway, it is clear that I am having a hard time understanding this. Perhaps the authors could clear this up by re-writing the discussion and being a bit more explicit about the meaning of their relations and give a few more mathematical details about the process.

The authors justify their technique by stating that it agrees with a system of ice crystals and water droplets in an ice/water aerosol. That is, of course, good. However, the water system is much simpler than the system to which the method is being applied and I would have been happier to see it applied to, say, ternary system droplets.

When the authors state that the wavenumber range is from 750 to 20,000 cm-1 this means that they are including the two measurements from the imager which (I believe) do not give the same sort of information on gases as the 750 to 4400 cm-1 range of the FTS.

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Do the two instruments look at the same region of space? On page 13277 it is mentioned that the imager measurements are “coaxial” with the FTS observation. I have the impression that the FTS measurements cover a much larger observational region of space. This should be spelled out clearly.

In conclusion, I would say that this paper is a contribution to the literature, but it has a few problems which the authors should address in revision. I think it is particularly incumbent upon them to explain why they only used 6 cases and why they did not consider Southern Hemisphere sightings of PSCs.

A few minor comments are:

Page 13272 lines 17-19: Unclear sentence. It is unclear whether the depletion of O3 is extensive or the presence of PSCs is extensive. Please re-write.

Page 13273 line 7: “The clouds resulting from this process are composed mostly of HNO3. Suggest changing “clouds” to “cloud particles.”

Page 13273 lines 15-16: “All these components can be thought of as members of the STS system.” They are the STS system, not “members” of it.

Page 13273 line 20: I believe that a paper by Tabazadeh also discussed the formation of PSCs and ozone depletion in the expected colder Arctic stratosphere.

Page 13275 line 10: “The retrieval uses a library reference spectra ...” Is the word “a” redundant? Or should it be, “a library of reference spectra...”?

Page 13280 line 13: xHNO3 means (I think) mole fraction of nitric acid. It should be written as O3) or maybe HNO3.

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Page 13281 line 11: “These clouds are found at higher temperatures of 195-198.” Word missing? The sentence does not read well.

Page 13287 Figure 2 caption. There should be a closing parenthesis after 2005.

Page 13288 Figure 3. The caption should explain what all the squares and diamonds are. Do these represent points at which the size distribution was evaluated? What do the error bars mean?

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