**Comment: This paper has gone through several rounds of reviews and I think that it is appropriate that no further substantial revision is demanded before it appears in ACP. I strongly recommend the following minor changes in order to make the content of the paper as clear as possible to the reader. Please provide a revised version of the paper in which these changes or something equivalent have been made and I will then be pleased to accept the paper for publication.**

**Reply:** We are glad that on the large and whole the manuscript is now acceptable. In particular we appreciate the wording suggestions that make the revision much easier for us. The wording suggestions maintain the spirit of the original manuscript and none of them distorts the message of the paper.

**Action:** In almost all cases we have included the suggestions. For details, see below.

**Comment: l4-8: You should be explicit about what information you are presenting in the paper – to make sure that a reader does not look at your figures and imagine that they are showing something that they are not. Please modify to 'The method used for this purpose was the direct inversion of the two-dimensional continuity equation for the trace gas concentrations. This inversion predicts an 'effective velocity" that gives the best fit for the evolution of the concentrations on the assumption that Fickian diffusion can be neglected and it is this 'effective velocity' field that is used to characterise the mean meridional circulation. Multiannual monthly mean effective velocity fields are presented along with their variabilities. According to this measure the stratospheric circulation is ...'. [Note that the above is exploiting the term 'effective velocity' which I think is useful and which you have already chosen to introduce in the main body of the text.]**

**Reply:** On the large and whole, we agree, however, with some minor modifications: (1) We use not only the continuity equation of mixing ratios, but also that of air density. We now mention this in the abstract. (2) We use multiple trace gases. Thus, we have replaced 'trace gase concentration' by 'concentrations of trace gases'. (3) We assume that the contribution of Fickian diffusion is somehow aliased into the effective velocities. In order to avoid that the reader misunderstands that the effective velocities are free of any diffusion effects, we restrict the qualification to the EXPLICIT TREATMENT of Fickian diffusion. (4) With all this the new sentence is much longer. Thus we split it.

**Action:** The related part of the abstract now reads: "direct inversion of the two-dimensional continuity equation for the concentrations of trace gases and air density. This inversion predicts an 'effective velocity' that gives the best fit for the evolution of the concentrations on the assumption that an explicit

treatment of Fickian diffusion can be neglected. These 'effective velocity' fields are used to characterise the mean meridional circulation. Multiannual monthly mean effective velocity fields are presented along with their variabilities. According to this measure the stratospheric circulation ..."

**Comment: l55: 'Our results contain considerably more information ... ( ... spent in the stratosphere).' – this doesn't make any sense at this point because you have said nothing at all about what 'your results' are. I recommend moving to the end of the following paragraph.**

**Reply:** Fully agreed.

**Action:** Moved as suggested.

**Comment: l96: 'and (optionally) mixing coefficients' – it is vital that the reader understands that mixing coefficients are NOT being determined by the method that you actually use – please remove 'and (optionally) mixing coefficients' – if you wish you could follow with a parenthetical separate sentence – '(In principle it is possible also to determine mixing coefficients from this inversion, but that is not done in the calculations used for this paper.)'.**

**Reply:** Fully agreed

**Action:** Changed as suggested.

**Comment: [The following comments are less important – it is up to you whether you take account of them or not.] l9: 'The deep branch ... are not separate but intertwined phenomena' – personally I think that it would be better to keep on emphasising that this an similar conclusions are 'according to the effective velocity characterisation of the circulation' – further work is needed to establish which (if either) of the traditional 'TEM advection + eddy mixing' description or your 'effective velocity' characterisation is the most physically meaningful.**

**Reply:** Fully agreed.

**Action:** Inserted "According to the effective velocity characterisation of the circulation..."

**Comment: l55 (again) 'contains considerably more information .. and they provide a better time-resolved understanding ... than the age-of-air method' – that is still open to argument – if one wants a simple measure of the effect of the circulation over several years then the age-of-air measure may be more useful than information on the month-to-month time variation of the circulation.**

**Reply:** We did not say that our results contain 'considerably more information than the age of air method. We said 'considerably more information than the trace gas fields and their variation with time', and a 'better time-resolved understanding of the circulation than the age-of-air method. We realize that our wording is easily misunderstood, thus we have slightly changed it.

**Action:** These lines now read:"Our results contain considerably more specific information on the circulation than the trace gas fields and their variation with time alone. They also provide an understanding of the circulation better resolved in space and time than the age-of-air method (which integrates over the time an air parcel spent in the stratosphere)."

**Comment: A final question that occurs to me is how well the effective velocity would function in a forward model where trace gases were assumed to be transported by advection by the effective velocity with minimal added diffusion. Do you have any information on that?**

**Reply:** We agree that this is an interesting question. We have this issue on our agenda but all related results available so far are based on an old ANCISTRUS version where the sinks were not yet included; thus we do not want to overinterprete these results.

**Action:** None for this manuscript.