Reviewer (Comments):

Review of "Structural changes in the shallow and transition branch of the Brewer-Dobson circulation induced by El Niño" by Mohamadou Diallo et al.

Recommendation: Publication after minor revision

The paper is very well organised and written. The topics discussed in this paper are in general of high relevance and some very interesting results are presented. The conclusions are deduced from comprehensive simulations with a state-of-the-art Lagrangian transport model for the stratosphere (CLaMS) driven by ERA-I and JRA55 in combination with MLS ozone observations and a multi regression model analysis in very well traceable way.

The author pointed out that the key aspect of this study is, that the diagnosed structural changes induced by El Niño (discussed in section 4) are important as they alter key radiative species like ozone in the lower stratosphere (LS) by at least 15% (discussed in section 3) and El Niño-like conditions might be increasing in future.
My main objection is connected with this key aspect which is closely linked to section 3 "El Niño-impact on ozone" and its relation to section 4 "Structural changes in the lower stratospheric BDC". Or more precisely: Has the changes in ozone observed by the MLS satellite really the same morphology than the modelled ozone by CLaMS (driven only by ERA-I) and could these changes be really explained by the changes in transport and dynamical diagnostics derived with the multi regression model from CLaMS simulations driven by both reanalyses? Please, see my general comments.

The paper should be submitted after addressing at least the general comments below.

General comments:

The paper pursues two objectives: a) Diagnosing structural changes in the BDC by El Niño using CLaMS simulations driven by two reanalysis datasets, ERA-Interim (ERA-I) and JRA55 respectively, and b) understanding El Niño-induced anomalies in the ozone distribution in the lower stratosphere (LS) as observed by MLS satellite and modelled with CLaMS.
In section 3 or part b), only ERA-I is used for the comparison with ozone MLS observations. This should definitely be done also with JRA55, otherwise it is not possible to interpret the differences between both reanalyses and the relation between El Niño-induced anomalies in transport and dynamical characteristics in terms of observed ozone anomalies in the LS, the climate relevant key aspect (see above).

The part a) is excellently covered in section 4 using CLaMS simulations driven by both reanalyses in combination with a multi regression model decomposing the different parameters for analysing the ENSO-impact on AoA, w^*, RCTT, Ψ, age spectrum, air mass fraction, temperature (T), zonal mean wind (U), Eliassen-Palm (EP) flux and its divergence.
Both reanalysis datasets show similar morphologies for the different parameters, but also some differences (see specific comments). The El Niño-impact on the parameters listed above elucidate the direct dynamical response (Fig. 8) and the changes in residual (Fig. 4b and 5) and tracer (incl. mixing) transport (Fig. 4a/c, 6 and 7) characteristics in the stratosphere. The overall picture evolving from the analysis of CLaMS simulations driven by ERA-I and JRA55 reanalyses for El Niño events is an increased tropical upwelling, a strengthening and upward

shifting of the subtropical jets. The consequence of this is a strengthening of the shallow branch and a weakening of the transition branch of the BDC during El Niño condition (or episodes). However, the overall picture from section 4 differs in some points from the results in section 3 comparing ozone changes induced by El Niño. The two main differences are:

1.) The magnitude of the ozone changes (anomalies)
2.) The structure of the ozone changes in the SH extratropical LS

To 1.) The author is arguing that the magnitude of the anomalies is biased by the missing tropospheric ozone chemistry and the lower boundary conditions for ozone (set to zero).

To 2.) The author does not discuss in the paper the missing (mainly) positive ozone anomalies in SH extratropics (see Fig. 2 and 3) and the much smoother gradients between tropics and subtropics in the MLS observations. The MLS ozone anomalies are showing a hemispheric asymmetry in the extratropics which is not reflected in ERA-I driven simulations – neither in ozone nor in the transport or dynamical diagnostics in section 4. The positive ozone anomalies in SH extratropics between 350 K and 450 K in CLaMS ERA-I simulation are in line with the anomalies derived in section 4, most obvious in RCTT, and AoA.

What should be at least discussed are other explanations for the differences between observed and modelled distribution of El Niño-induced ozone anomalies. This could be for example:

a) The MLS observations itself, e.g. biases or additional smoothing by resolution and sampling. This issue could be addressed by sampling the model in the way as the satellite is probing the atmosphere.

b) The BDC is not correctly represented in CLaMS driven by ERA-I reanalyses. Hypothesis: The tropical upwelling in and into the LS is too strong or the relation of tropical upwelling and quasi-horizontal (or isentropic) mixing between tropics and extratropics is too weak, especially in SH between 380 and 450K during El Niño. The latter hypothesis would (partially) explain both, the too strong gradients and the too large magnitude of the anomalies.

My last point is that it would be easier for the reader to define the shallow and transition branch in terms of potential temperature (the natural coordinate of CLaMS) in the beginning of this paper and to relate this to the Lin and Fu (2013) paper.

Specific comments:

Section 2.1: Please mention the horizontal and vertical resolution of the CLaMS simulations (in the region of interest).

Section 3: The analysis of ozone anomalies related to El Niño derived from CLaMS simulations driven by JRA55 should be added here (see general comments).

P.5, L.13: Releasing the pulses only between 15S and 15N might be biasing the age spectrum results on 350K level in the LMS. It is likely that a significant amount of air originated from outside the tropics (15S-15N) crossing the subtropical jets from the troposphere into the LMS (especially during summer to autumn in the NH), so they are therefore not part of this age spectrum.

P.6, L.25-27: Here, you speculate about the factor of 2 difference between MLS observed and CLaMS ERA-I simulated ozone anomalies. Please see my general comment above. This is important to understand what is driving ozone changes in the LS in order to improve future climate predictions.

P.7, L.12: Description of Fig. 2. Here should be at least mentioned that there are no significant El Niño-induced ozone anomalies in the SH extratropical (30S-60S) MLS observations – in contrast to the CLaMS simulations and to the NH extratropics.

P.7, L30-31: "*In the extratropical UTLS (30◦–70◦), CLaMS model and MLS observations show a related positive O3 anomaly due to enhanced downwelling*."
In the LS, MLS observations show only positive ozone anomalies in the NH extratropics (see Fig.3). This is not true for SH extratropics (see general comments). It is true that CLaMS simulations with ERA-I show enhanced downwelling in SH explaining the ozone simulations, but not the observations in the SH.

P.7, L. 35: Could you please explain, why ozone anomalies above 500K are affected by upper boundary conditions and why they are not affected below.

P.8, L13: Again, only missing tropospheric chemistry and lower boundary conditions are to my opinion not sufficient to explain MLS vs. CLaMS-ERA-I differences in Fig. 2 and Fig 3 (see general comments). Or their impact on the ozone anomalies should be quantified somehow.

P.8, L23-25: "*The picture of negative AoA anomalies in the tropical lower stratosphere and positive AoA anomalies in the mid and high latitudes (30◦–60◦ N and S) agrees well with O3 anomalies from CLaMS simulations and MLS observations (Fig. 3).*"
Yes, the picture of AoA and ozone anomalies simulated with CLaMS-ERA-I is consistent, but the picture is not consistent for MLS observations of ozone anomalies in SH extratropical (30-60S) LS.

P.9, L.16-17: "*…, while the shallow branch is strengthening in both reanalyses.*"
Assuming 420 to 550K as the shallow branch, it seems that RCTT and AoA (residual and tracer transport) from JRA55 is not really indicative for a strengthening of the shallow branch. This statement depends strongly on the definition of both branches in potential temperature coordinates (see also general comments).

Figure 6: Please use the same range for the left y-axis for both tropical (and for both midlatitude) plots.