Comments to the Author:

I think that the changes you have made in this revision are helpful and I am pleased to accept the paper.

Dear Peter!

We appreciate and would like to thank you very much for your efforts in accepting this paper!

Please find below our response to your two minor comments which we addressed.

Best regards,

Wuke and Katja

Two minor comments that you may wish to address before publication:

(i) Abstract l2 -- 'an unexpected warming' -- why 'unexpected'? You might think it is unexpected but someone else might not. It seems to me that variations in tropical tropopause temperatures over the last 25 years or so have simply shown significant variations on inter annual timescales of from 2-10 years. But this is not a very substantial point!

Thank you for this comment. We have removed the word ‘unexpected’ to avoid any confusion and leave it to the respective reader to judge on the results him- or herself.

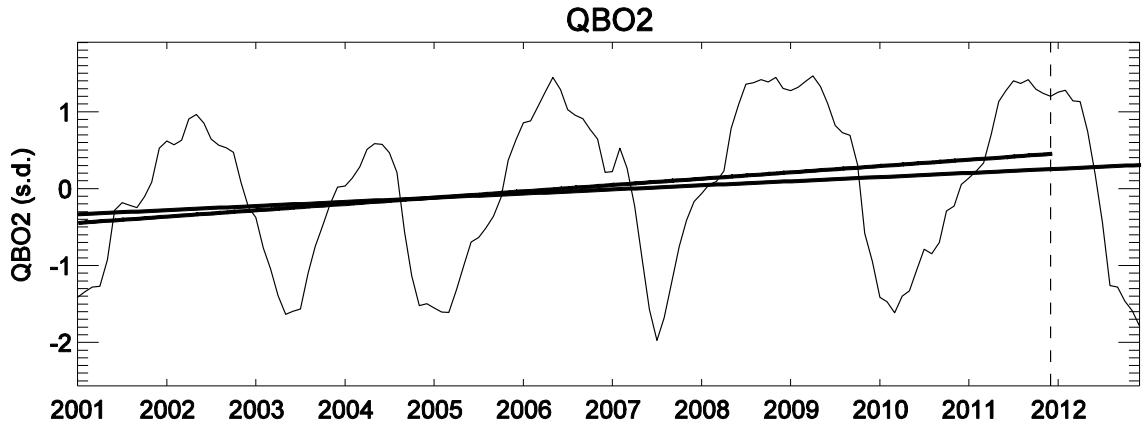
(ii) Perhaps more substantial -- when I first read your paper I was a bit confused about the nature of the QBO-associated variations. I had the impression that these might be associated with some subtle measure of the long-term variation of the QBO. But in fact it is now clearer to me that what you are identifying is the QBO signal in temperatures that has been known for a long time. The fact that the 'state' of the QBO is different at the end of some multi-year period compared to the beginning then implies a corresponding temperature difference. My suggestion is that you check your text to make sure that is as clear as possible.

We are sorry to have not addressed this issue clear enough.

At the beginning, we try our efforts to investigate the impacts of the long-term variation of the QBO, i.e. amplitude, on temperature variations in the TTL. However, after changing our method and further revisions, we found that the QBO amplitude may mainly influence variances of temperature, but might play only a minor role in long-term temperature trends. Therefore, we used the normal QBO time series as indices in estimating the QBO contribution to the TTL temperature variability.

Beyond the well known QBO signal in temperatures (Fig. 5a), we also estimated the relative long-term QBO impacts on the TTL temperatures. We totally agree that, the short-term trend in QBO depends on the QBO phase or ‘state’ of the beginning and ending years. However, as we addressed in the text, even if we chose a date of 2012 ending with a relative minimum of the QBO, we can still find a significant QBO increase, which means stronger westerlies and weaker easterlies in the QBO cycle-to-cycle variability

(see figure below). These cycle-to-cycle stronger westerlies therefore contribute to the recent warming in the TTL during 2001-2011.



We have updated the corresponding text to address this issue clearer.