

Application of empirical orthogonal functions approach to the analysis of QBO evolution peculiarities

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Outline

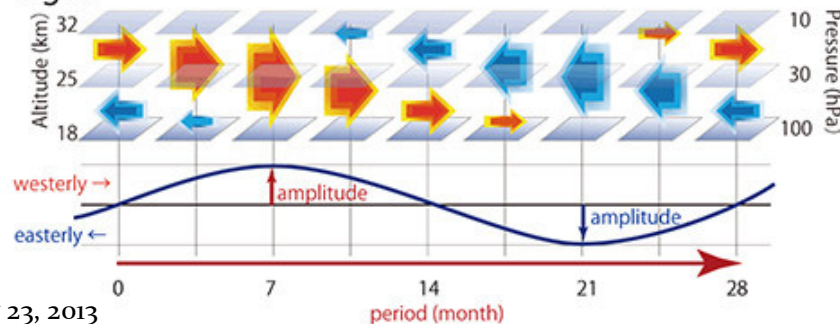
- The QBO is well known to influence the atmospheric circulation at altitudes and latitudes outside the tropical stratosphere.
- It still remains unclear which vertical levels of the QBO exert the strongest influence on the winter polar vortex, and how QBO-vortex coupling interacts with the effects of other sources of atmospheric interannual variability.
- We studied the process of vertical evolution of the QBO phases, tried to estimate the contribution of each possible level for the westerly/easterly QBO phase determination. Obtained new more accurate phases for studying QBO influence on processes in the atmosphere.
- **Data** for the study - Japanese **JRA-55** reanalysis data, **1958-2014**. The method of investigation is the method of Empirical Orthogonal Functions.

What is Quasi-Biennial Oscillation (QBO)?

Fig2a

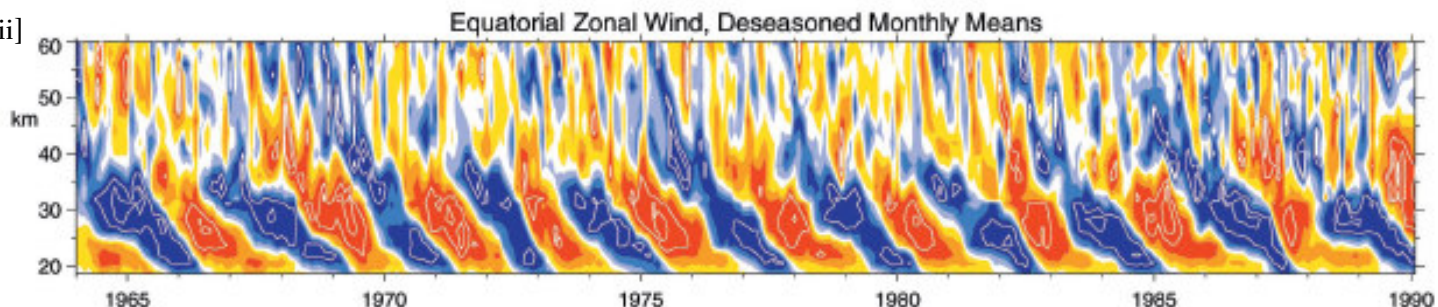


Fig2b



- Region: 15 S-15N; 70-3 hPa
- Westerly/Easterly phase of equatorial zonal wind;
- Mean period of phase oscillations is 28 to 29 months;
- Average speed of vertical phase propagation is 1 km / month;
- Downward motion of the easterlies is usually more irregular than that of the westerlies.
- The amplitude of the easterly phase is about twice as strong as that of the westerly phase.

[May 23, 2013
JAMSTEC
University of Hawaii]



QBO phases

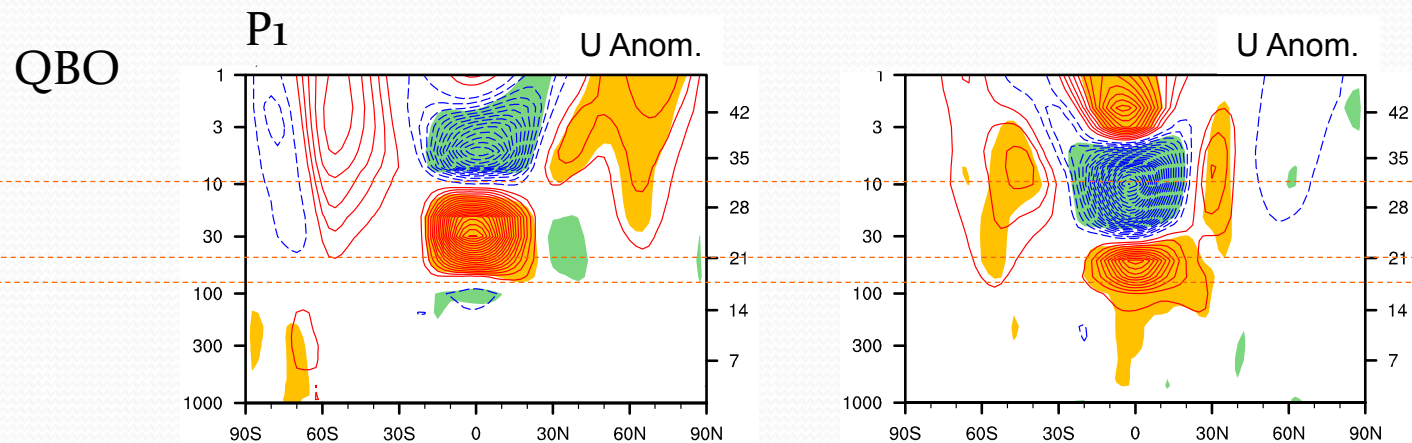
Westerly phase

- The SSW frequency is higher
- Weaker Atlantic jet stream
- Cold winters in Northern Europe

Easterly phase

The SSW frequency is lower
Strong Atlantic jet stream
Mild, wet stormy winters in northern Europe

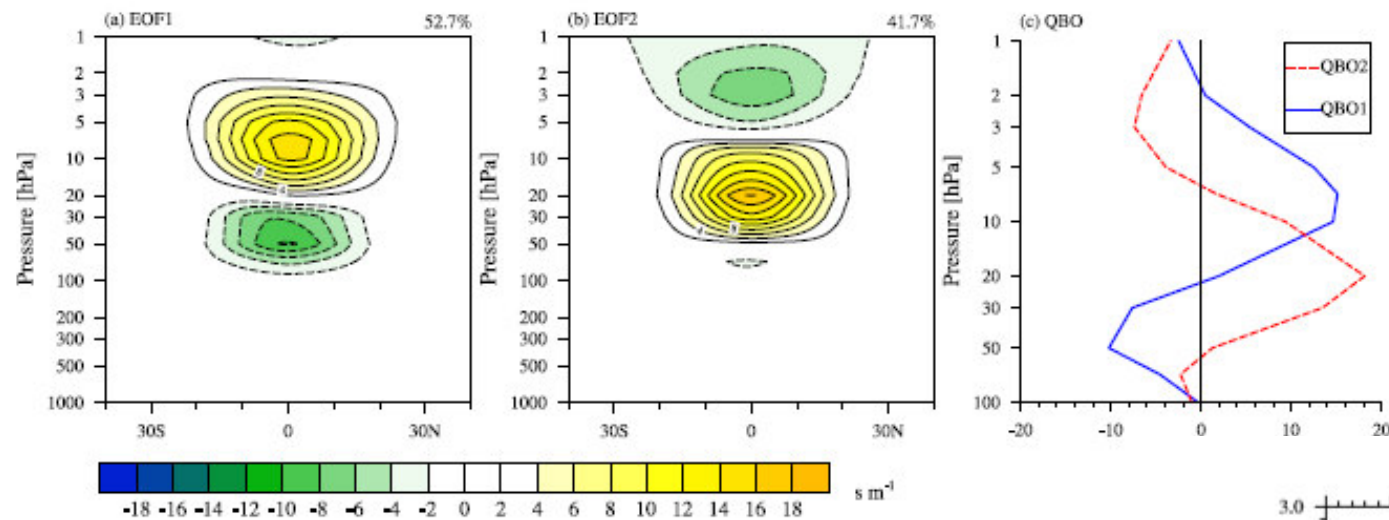
Level to determine QBO phase



If the QBO is defined basing on the zonal-mean zonal wind at the altitude of lower stratosphere (for example, 50 hPa), the above two figures are all westerly QBO. However, they belongs to different phase of the QBO's evolution process.

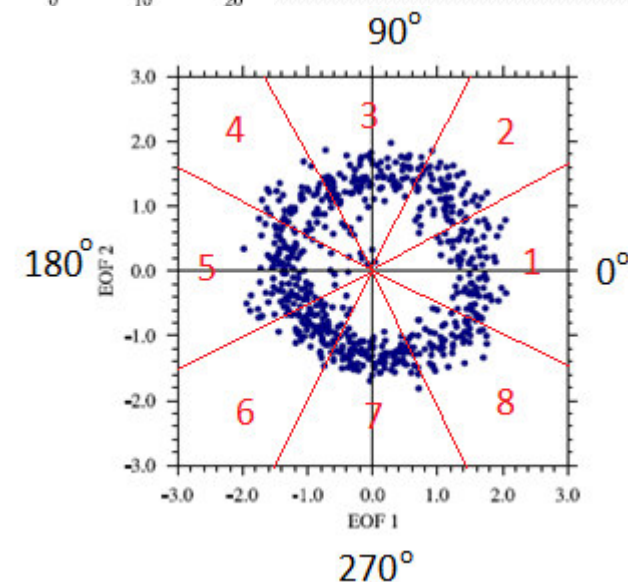
Objective: to group QBO not only as a westerly / easterly phase, but as a vertically propagating westerly / easterly QBO phase.

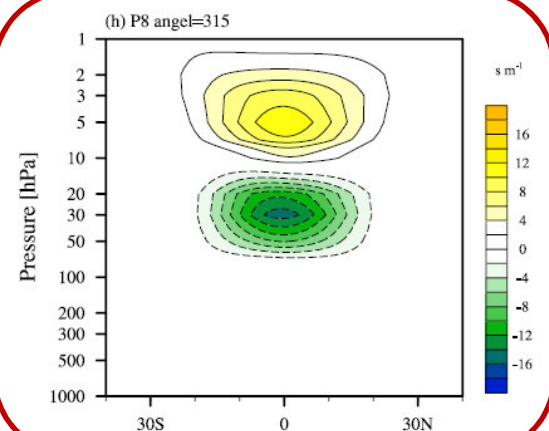
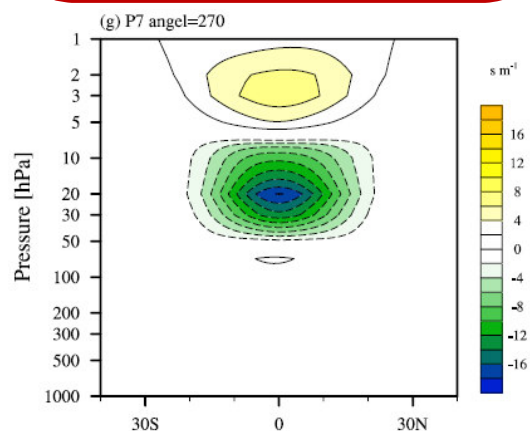
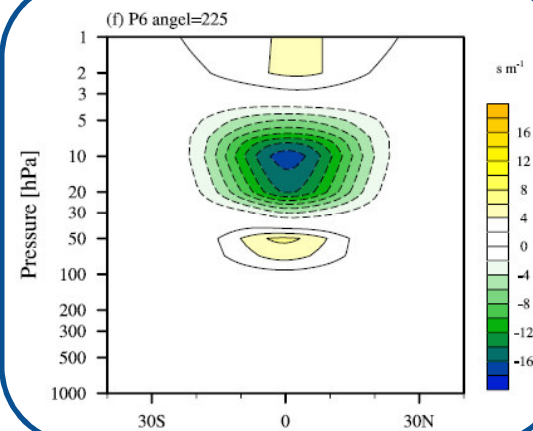
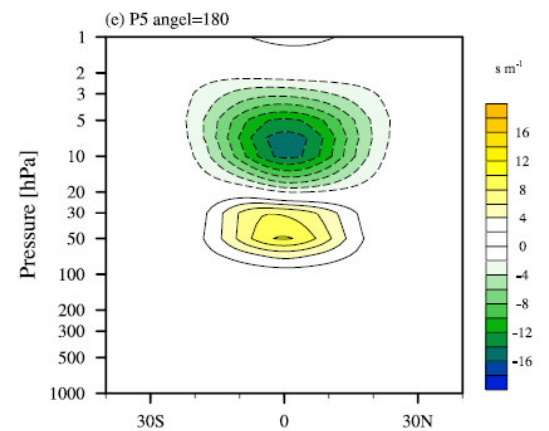
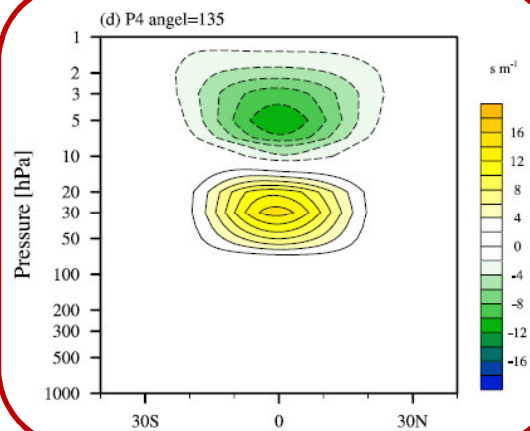
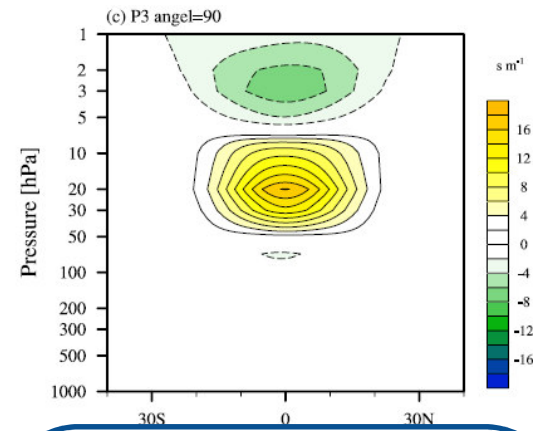
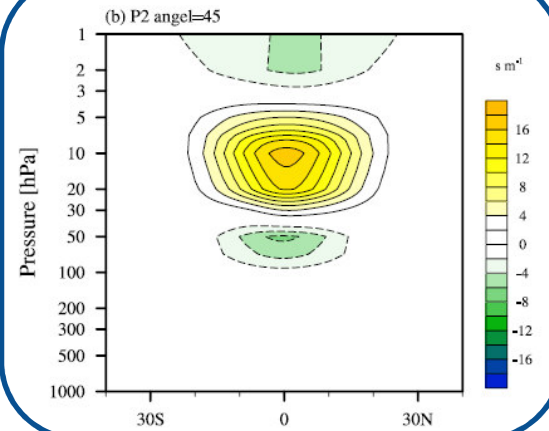
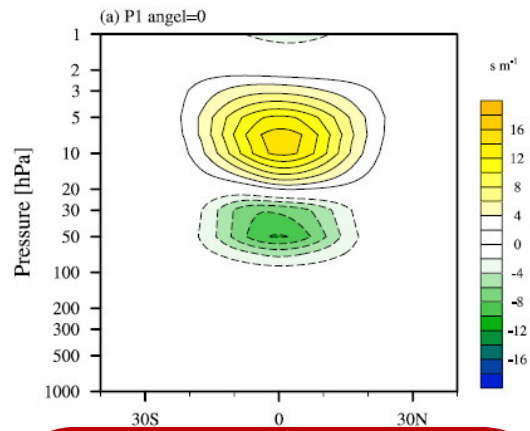
EOF1 and EOF2 of QBO



[Wallace et.al., 1993]

Data: JRA55 (1958-2015),
monthly mean zonal wind
anomalies.
Region: 15S-15N, 70hPa-3hPa

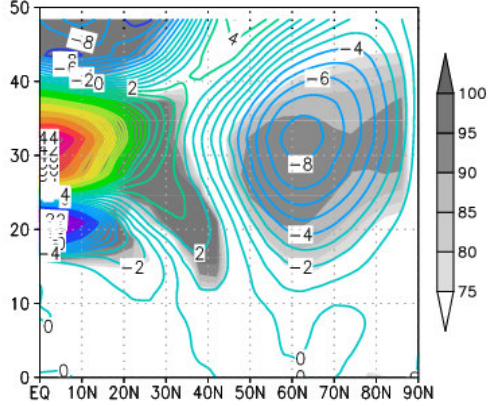




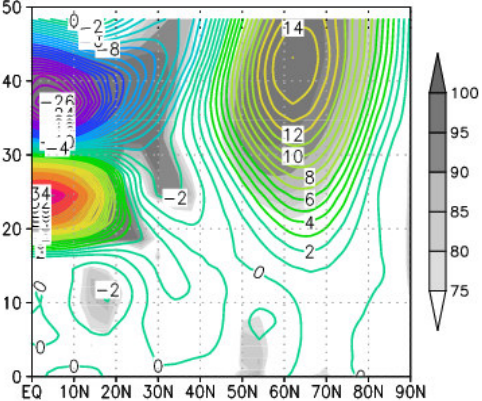
8 QBO phases
 Data: JRA55 (1958-2015),
 monthly mean zonal wind
 anomalies.
 Region: 15S-15N, 70hPa-3hPa

QBO influence on extra-tropical stratosphere. Results for winter months DJF.

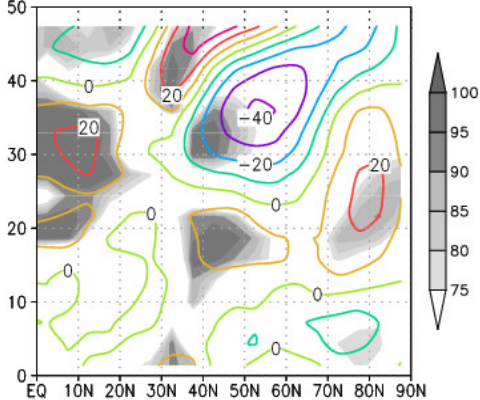
a) Diff. QBO2-QBO6 (Wly-Ely) zonal wind, JRA-55



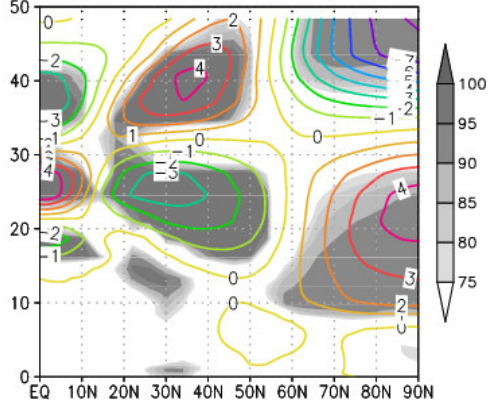
c) Diff. QBO4-QBO8 (EW-WE) zonal wind, JRA-55



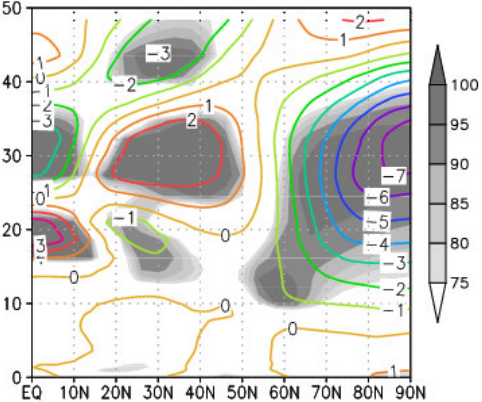
e) Diff. QBO2-QBO6 (Wly-Ely) SPW1, JRA-55



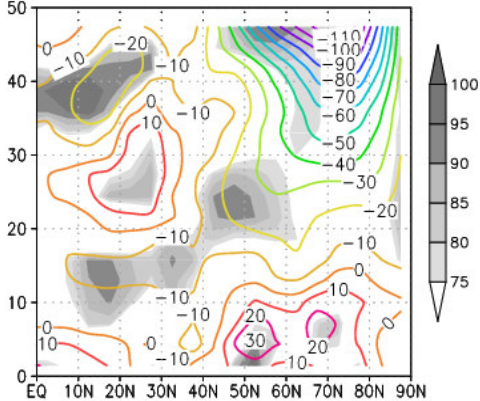
b) Diff. QBO2-QBO6 (Wly-Ely) temperature, JRA-55



d) Diff. QBO4-QBO8 (EW-WE) temperature, JRA-55

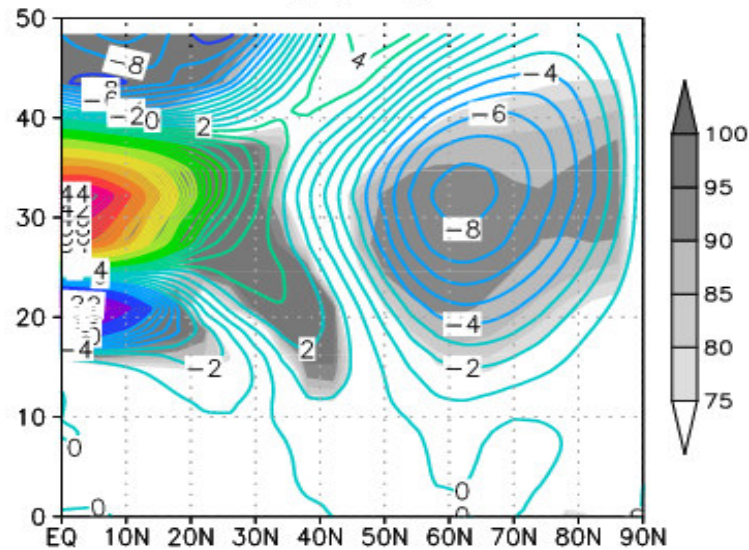


f) Diff. QBO4-QBO8 (EW-WE) SPW1, JRA-55

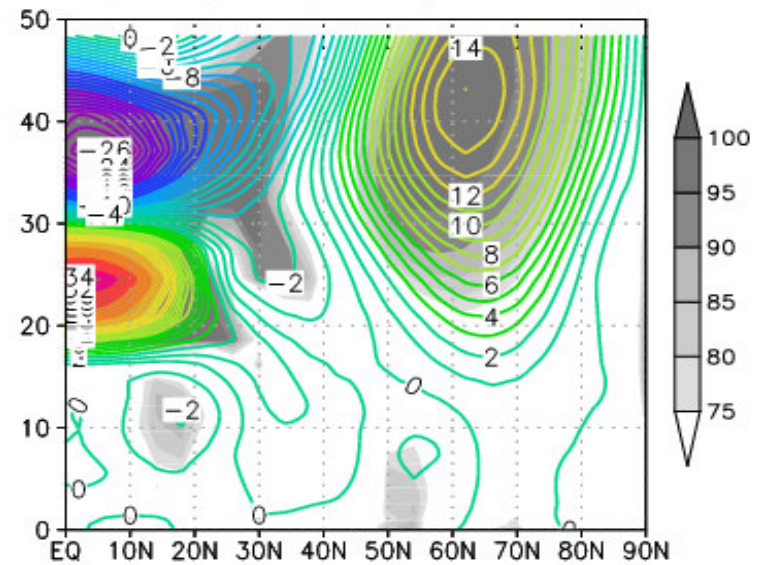


QBO influence on extra-tropical stratosphere. Results for zonal wind, winter months DJF.

a) Diff. QBO2-QBO6 (Wly-Ely) zonal wind, JRA-55

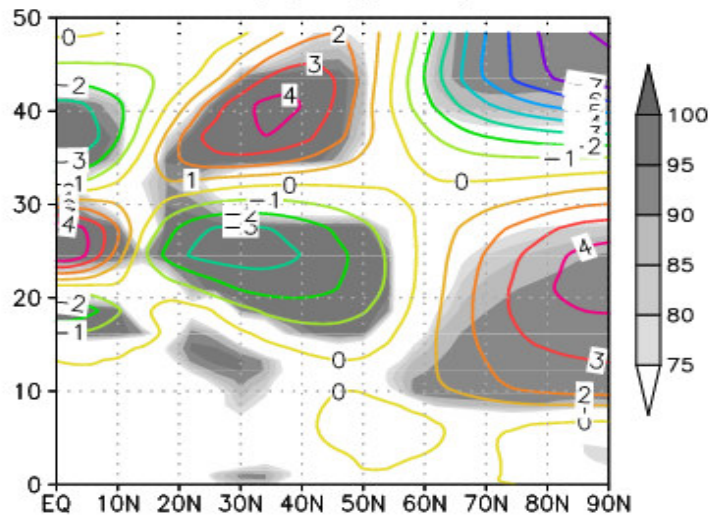


c) Diff. QBO4-QBO8 (EW-WE) zonal wind, JRA-55

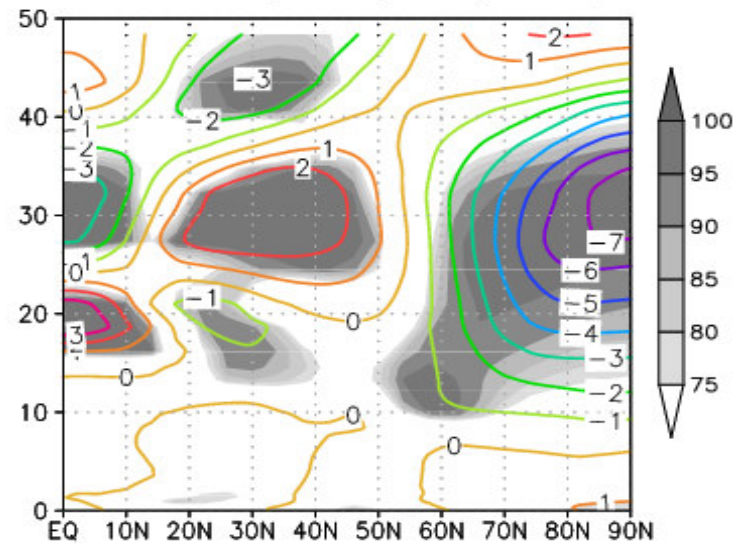


QBO influence on extra-tropical stratosphere. Results for temperature, winter months DJF.

b) Diff. QBO2–QBO6 (Wly–Ely) temperature, JRA–55

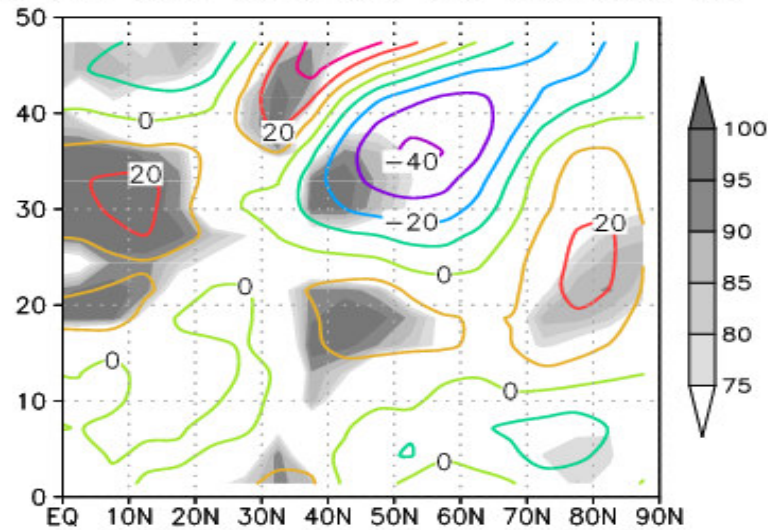


d) Diff. QBO4–QBO8 (EW–WE) temperature, JRA–55

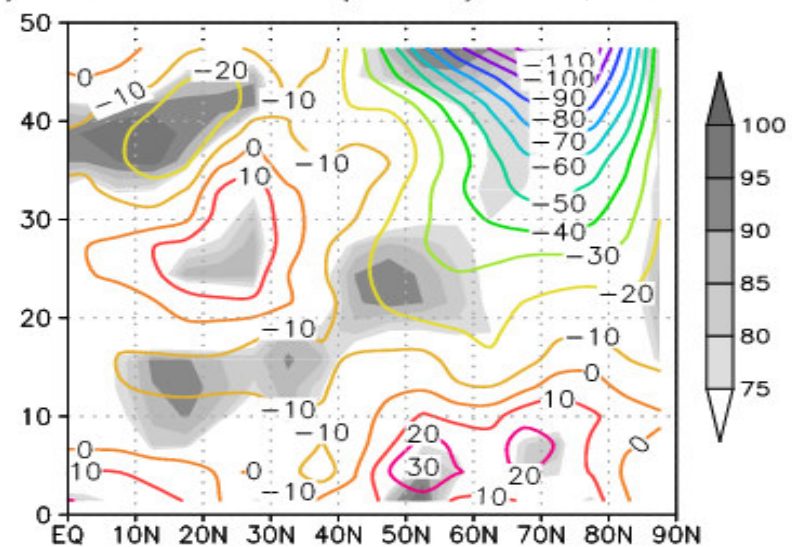


QBO influence on extra-tropical stratosphere. Results for SPW1, winter months DJF.

e) Diff. QBO2-QBO6 (Wly-Ely) SPW1, JRA-55




f) Diff. QBO4-QBO8 (EW-WE) SPW1, JRA-55



Conclusion

- New 8 phases of the QBO vertical evolution were obtained.
- Considering the QBO's evolution process when choosing easterly or westerly particular phase gives an opportunity to study the QBO impact on the atmosphere in more detail.
- Results for atmosphere response at QBO easterly/westerly phases and at QBO transition phases gives us differing results. This should be taken into account.



Thank you!
Questions?