Lapse-rate feedback assessment from reanalysis data

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Sensitivity of global climate to external forcing depends on climate feedbacks (FB) [1]. One of significant feedbacks is related with the rate of temperature decrease with height in the troposphere (lapse rate - LR). It is a characteristic of atmospheric static stability. Cyclonic (anticyclonic) and convective activity in the atmosphere depend on LR. The contribution of LR variations is important for the Arctic amplification [2]. We use here ERA-Interim reanalysis data [3] for the period 1979-2014 with 0.75^ox0.75^o horizontal resolution for assessment of LR FB characteristics.

We analyze, in particular, the relationship between the tropospheric LR γ and the surface air temperature (SAT) T as it was done in [4,5]. The relationship parameter $d\gamma/dT$ is estimated from the corresponding linear regression of γ on T.

Figure 1 shows the latitude dependence of the annual-mean LR values in the Northern Hemisphere (NH). The LR values for various latitudes were normalized on the LR value for the NH as a whole γ_{NH} = 6.3 K/km.

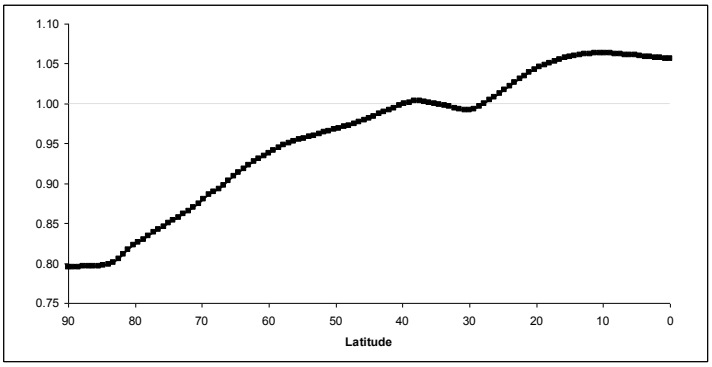

Fig. 1.

Figure 2 shows the latitude dependence of the $d\gamma/dT$ estimates obtained with the use of the annual-mean values in interannual variability. The $d\gamma/dT$ estimates for various latitudes were normalized on the corresponding estimate $(d\gamma/dT)_{NH}$ = 0.045 km^{-1} for the NH as a whole. According to Fig. 2 the $d\gamma/dT$ estimates in the Arctic latitudes can be twice larger than for NH as a whole.

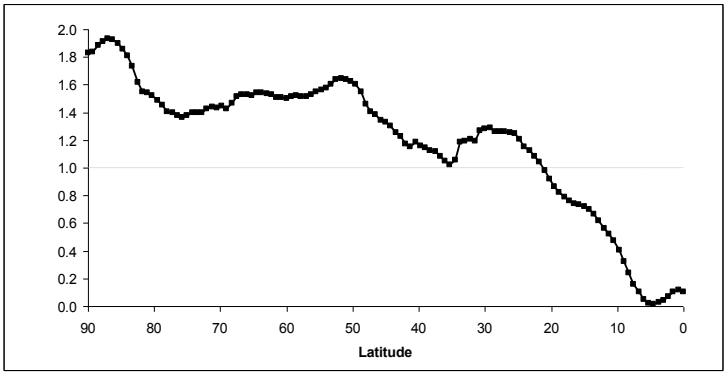

Fig. 2.

Figure 3 presents a parameter $p=P/P_{NH}$ characterizing the relative variations of vertical temperature stratification in the troposphere on different NH latitudes in interannual variability during 1979-2014. Parameters P and P_{NH} are defined as $\gamma^{-1}(d\gamma/dT)\delta T$ and $\gamma_{NH}^{-1}(d\gamma/dT)_{NH}\delta T_{NH}$, correspondingly. Values δT and δT_{NH} characterize standard interannual deviations for SAT at different latitudes and for NH as a whole.

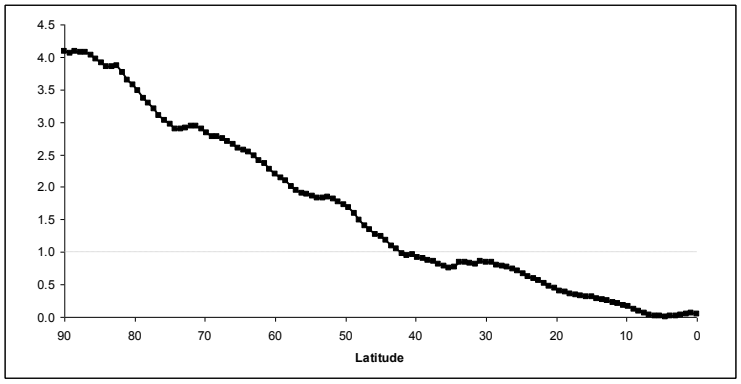

Fig. 3

According to the results obtained from reanalysis data for the period 1979-2014 the relative LR interannual changes in the troposphere of the Arctic latitudes are up to 4 times larger than for the NH as a whole and much larger than for tropical latitudes. The positive correlation of LR and SAT is a characteristic of positive climate FB.

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References

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