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Atmospheric planetary boundary layer feedback in climate system and triggering of climate change at high latitudes

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Recent publications have revealed that modern, state-of-the-art climate-change models (CCMs) are not sensitive enough to reproduce some fine features of the observed changes in the surface air temperature (SAT) especially at high latitudes. We propose that this problem results from inaccurate representation of the very shallow long-lived stable (LS) and conventionally neutral (CN) atmospheric planetary boundary layers (PBLs) typical of high latitudes, especially of Polar regions. LS and CN PBLs, not yet included in the context of climate modelling, are almost an order of magnitude shallower than mid-latitudinal nocturnal stable (NS) and truly neutral (TN) PBLs, which are the only concern of the traditional theory of stable PBLs. In is only natural that factually observed shallow PBLs respond to thermal impacts (e.g. to the changes in the surface heat balance) much stronger than much deeper PBLs reproduced by the current PBL schemes. In this paper we investigate analytically the PBL feedback in climate system for all known kinds of PBL: stable (distinguishing between NS and LS), neutral (distinguishing between TN and CN) and also convective). Besides very high sensitivity of LS PBLs, quite consistent with the observed variability in SAT, our analyses reveal that in some specific conditions global warming could cause "strange cases" of local cooling. We also obtained analytically that the daily minimum temperatures are more sensitive to the global warming than the daily maximum temperatures, which, at least partially, explains such observed phenomena as asymmetry in the diurnal temperature trends and almost global reduction of the diurnal temperature range.