Geophysical Research Abstracts
Vol. 20, EGU2018-7808, 2018
EGU General Assembly 2018

Annual and semiannual cycles of near-surface temperature and baroclinic activity in mid-latitudes

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Near-surface air temperature and baroclinicity seasonal cycles from ERA-Interim Reanalysis and a subset of climate model simulations from CMIP3 and CMIP5 projects are here analyzed and compared. The annual and semiannual harmonics of hemispherically averaged fields are investigated using univariate and bivariate spectral analysis. The aim is to assess the agreement between ERA-Interim and coupled models in the reproduction of near-surface temperature and baroclinicity annual and semiannual cycles and their coherency and relative phase. Concerning univariate analysis, a statistically significant power spectrum peak is found at the annual frequency in both hemispheres zonally averaged fields. The semiannual peak is weaker and is only significant in the SH, whereas it has a more regional character in the NH, being mainly observed in the Northern Pacific region. Constraining the bivariate analysis to the SH and the mentioned region of the NH, models and ERA-Interim agree on the coherency between the two signals at the annual and semiannual frequency, as well as on the phase of the annual frequency. We find that at this frequency temperatures lag baroclinicity by about one month. On the contrary, some discrepancies between ERA-Interim and models, as well as among different models, are found for what concerns the semiannual frequency phase. The CMIP5 release provides a significant improvement with respect to CMIP3, but the large model spread still prevents from having a robust reproduction of the mean seasonal cycle semiannual harmonics in both hemispheres midlatitudes.