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European CO budget in relation to synoptic circulation using the GEOS-CHEM model

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CO budget within the European troposphere is studied during 2001, based on the nested-grid application over Europe of GEOS-CHEM global model in relation to the atmospheric circulation. To this aim, a newly developed circulation-pattern classification scheme over the Northern Hemisphere is introduced at sea level pressure (SLP), the middle and the upper troposphere (MT/UT). It is found that regional anthropogenic emissions contribute to surface CO budget up to ∼80%, depending on the season and the atmospheric conditions. In winter, anticyclonic circulation patterns over Europe favour pollutant's accumulation close to sources, while in summer northerly winds transport CO from North Europe southwards. Long range transport (LRT) of anthropogenic pollution from N. America and Asia towards Europe at SLP is favoured by the westerly circulation, contributing up to 18%-20% and 12%-15% each to European CO surface budget in winter and summer, respectively. LRT contribution increases in the free troposphere, with the Asian tracer reaching ∼30% over the Eastern Mediterranean in UT during summer, favoured by the prevailing easterlies, and the N. American tracer contribution being highest during winter in MT at the western parts of the continent (18%). Regional anthropogenic emissions' contribution decreases to 18% (10%) in MT (UT). CO chemical production contribution is enhanced at all levels and seasons, exceeding 50% in UT during summer. Asian and N. American contributions at three station regions in Europe are highest (lowest) in winter and spring (summer and autumn). In winter, LRT is intensive mainly under the prevalence of cyclonic patterns at SLP, while during the rest seasons is enhanced for several cyclonic and anticyclonic types. Asian contribution is higher than the N. American in winter, spring and summer under all CTs. Occasionally, cases that LRT exceeds the European contribution (up to ∼45%) are detected at all station regions mainly in winter and spring.