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Inclusion of mountain-wave-induced cooling in a chemistry–climate model and its impact on PSCs and ozone

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An important source of polar stratospheric clouds (PSCs) is from the temperature fluctuations induced by mountain waves. However, this formation mechanism is usually missing in chemistry–climate models because these temperature fluctuations are neither resolved nor parameterised. Here, we investigate the representation of stratospheric mountain-wave-induced temperature fluctuations by the UK Met Office Unified Model (UM) at climate scale and mesoscale against Atmospheric Infrared Sounder satellite observations for three case studies over the Antarctic Peninsula, Antarctica. At a high horizontal resolution (4 km) the regional mesoscale configuration of the UM correctly simulates the magnitude, timing, and location of the measured temperature fluctuations. By comparison, at a low horizontal resolution (around 200 km) the global climate configuration fails to resolve such disturbances. However, it is demonstrated that the temperature fluctuations computed by a mountain wave parameterisation scheme inserted into the climate configuration (which computes the temperature fluctuations due to unresolved mountain waves) are in relatively good agreement with the mesoscale configuration responses for two of the three case studies.

The parameterisation is subsequently used to include the simulation of mountain-wave-induced PSCs in the global chemistry–climate configuration of the UM. An initial sensitivity study demonstrated that regional PSCs increased by up to 50% during July over the Antarctic Peninsula following the inclusion of the local mountain-wave-induced cooling phase. Finally, preliminary results are presented showing the impact of the parameterisation scheme on PSCs and ozone for both the Antarctic and Arctic.