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A dynamic model reduction algorithm for atmospheric chemistry models

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Understanding the dynamics of the chemical composition of our atmosphere is essential to address a wide range of environmental issues from air quality to climate change. Current models solve a very large and stiff system of nonlinear advection-reaction coupled partial differential equations in order to calculate the time evolution of the concentration of over a hundred chemical species. The numerical solution of this system of equations is difficult and the development of efficient and accurate techniques to achieve this has inspired research for the past four decades. In this work, we propose an adaptive method that dynamically adjusts the chemical mechanism to be solved to the local environment and we show that the use of our approach leads to accurate results and considerable computational savings. Our strategy consists of partitioning the computational domain in active and inactive regions for each chemical species at every time step. In a given grid-box, the concentration of active species is calculated using an accurate numerical scheme, whereas the concentration of inactive species is calculated using a simple and computationally inexpensive formula. We demonstrate the performance of the method by application to the GEOS-Chem global chemical transport model.