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Combined 11 year solar cycle and QBO effects in transient HAMMONIA simulations

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We use the coupled general circulation and chemistry model HAMMONIA to simulate the stratospheric response to the 11-yr solar cycle (SC) in a set of transient experiments, in which the model is forced with realistic (observed) 11-yr SC variations in solar irradiance, GHGs and observed SSTs.

The impact of the QBO on the SC, and on the combined QBO-SC effects is investigated by introducing an assimilated QBO in two HAMMONIA realizations. Two additional experiments are performed with a self-consistent QBO.

The response in the upper stratosphere is robust and does not depend on the QBO setting. Results in the tropical and extratropical lower stratosphere are highly sensitive to the QBO phase. It is shown that the observed QBO-SC relationship during late-winter in the Northern Hemisphere can only be reproduced by HAMMONIA if the observed winds are assimilated in the tropical stratosphere. We show that the model response to the solar cycle depends on the phase-relationship between QBO winds and the 11-yr solar cycle. This means that the QBO-SC relationship in HAMMONIA is produced by accidental alignment of certain QBO and SC phases in the available observational record. Further implications of this work are discussed.