Project Details

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Project Title:
Impact of the 11 year solar cycle on the gravity wave driven circulation

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Summary:
Understanding the coupling of solar-variability to climate is a challenge that must be met to gauge the response of the climate to both natural and anthropogenic forcing. It is a complex problem and we do not yet understand several of the critical physical and chemical pathways within the atmosphere through which this coupling may be channeled. These pathways can involve interactions across multiple altitude regions of the atmosphere. Circulation driven by gravity waves plays an important role in coupling the middle atmosphere to the upper atmosphere and is likely sensitive to solar-cycle variations, thus playing an important role in solar-climate coupling. Here we detail a three-year modeling study to investigate the effect of the solar-cycle on gravity waves and the mesospheric circulation using the Whole Atmosphere Community Climate Model (WACCM). We have assembled a team with the experience in modeling gravity waves, atmospheric circulation and extensive experience of using WACCM. Preliminary model results offer encouragement that significant progress in our understanding of this can be made using a comprehensive atmospheric model and WACCM is a prime candidate. This model includes all of the components essential to study these effects meaningfully because it simulates the impact of the solar-cycle on both stratospheric O3 and planetary wave propagation, and also simulates gravity wave effects throughout the mesosphere. We will identify which regions respond most strongly to the solar input, how these impacts vary with altitude and period of the waves and how these effects vary with season. We will identify the relationship between changes in gravity wave activity and planetary wave activity at lower altitudes. This study will lay a crucial framework for further investigations by identifying which observational parameters associated with gravity wave activity offer the most robust constraints on the simulation of solar-cycle effects on gravity wave activity. This work is essential for understanding both how the whole wave-driven residual circulation in the middle atmosphere responds to the solar cycle and how this may influence other processes such as the transport of NOx to lower altitudes.

Publication References:

Summary: no summary

Reference: Liu, Guiping; England, Scott L.; Immel, Thomas J.; Frey, Harald U.; Mannucci, Anthony J.; Mitchell, Nicholas J.; (2015), A comprehensive survey of atmospheric quasi 3 day planetary-scale waves and their impacts on the day-to-day variations of the equatorial ionosphere, Journal of Geophysical Research: Space Physics, Volume 120, Issue 4, pp. 2979-2992, doi: 10.1002/2014JA020805

Summary: no summary

Reference: Cullens, Chihoko Y.; England, Scott L.; Garcia, Rolando R.; (2016), The 11 year solar cycle signature on wave-driven dynamics in WACCM, Journal of Geophysical Research: Space Physics, Volume 121, Issue 4, pp. 3484-3496, doi: 10.1002/2016JA022455