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Understanding the local and global impacts of aerosol

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This study applies a package of diagnostic techniques to understand the local and global responses to a change in model aerosol climatology. The forecast model in question is that of the European Centre for Medium-range Weather Forecasts (ECMWF). The largest difference between old and new climatologies is over the Sahara where, in particular, soil-dust aerosol is reduced. Conventional diagnostics show that the change lead to improvements in local medium-range forecast skill and reductions in seasonal-mean errors throughout the globe. To understand the local physics response to the direct effects of the aerosol change, short-range tendencies in weather forecasts are diagnosed. These tendencies are decomposed into the contributions from each physical process within the model. The resulting 'initial tendency' budget reveals how the local atmosphere responds to the aerosol change. The net tendencies also provide strong evidence to confirm that the new aerosol climatology is superior. Seasonal integrations demonstrate that the tropic-wide response can be understood in terms of equatorial waves and their enhancement by diabatic processes. The so-called 'Rossby-wave source' is used to understand how the tropical anomalies subsequently impact on the global circulation. The mean response in the extratropics is found to be a stationary wave field. Precipitation anomalies that are co-located with extratropical divergent vorticity sources suggest the possibility for diabatic modification of the tropically-forced Rossby-wave response.