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EMAC model evaluation in calculated aerosol and aerosol optical properties

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This study evaluates global and regional aerosol optical depth (AOD) trends in view of aerosol (precursor) emission changes between 2000 and 2009. We use AOD products from MODIS, MISR and AERONET, and emission estimates from the EMEP, REAS and IPCC inventories. First we compare trends in global Level 3 AOD products of MODIS, MISR and AERONET (Level 2). We find generally negative trends over Europe and North America, whereas over South and East Asia they are mostly positive. The negative trends over parts of Europe and North-East America appear to be significant. Second, we analyze MODIS Level 2 AODs for three selected regions with good data coverage (Central Mediterranean, North-East America and East Asia) and compare with Level 3 products. This corroborates that the 2000 - 2009 AOD trend over the Central Mediterranean is negative and corresponds well with the MODIS Level 3 analysis. Also for North-East America the trend is generally negative and in agreement with MODIS Level 3 products. For East Asia the trends derived from Level 2 products are mostly positive and correspond with the MODIS Level 3 results. Over Europe, the trends in aerosol single scattering albedo, as derived from MISR data, appear to be positive (declining solar radiation absorption), whereas this is not the case over the USA, though these data are not yet validated. Third we compare trends in AOD with emission changes of SO_2, NO_x, NH_3 and black carbon. We associate the downward trends in AOD over Europe and North America with decreasing emissions of SO_2, NO_x, and other criteria pollutants, and consequently declining aerosol concentrations. Over East Asia the MODIS Level 2 trends are generally positive, consistent with increasing pollutant emissions by fossil energy use and growing industrial and urban activities. It appears that SO_2 emission changes dominate the AOD trends, although especially in Asia NO_x emissions may become increasingly important. Our results suggest that solar brightening due to decreasing SO_2 emissions and resulting downward AOD trends over Europe may have weakened in the 2000s compared to the 1990s.