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Online-coupled meteorology and chemistry models: history, current status, and outlook

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Abstract. The climate-chemistry-aerosol-cloud-radiation feedbacks are important processes occurring in the atmosphere. Accurately simulating those feedbacks requires fully-coupled meteorology, climate, and chemistry models and presents significant challenges in terms of both scientific understanding and computational demand. This paper reviews the history and current status of the development and application of online-coupled meteorology and chemistry models, with a focus on five representative models developed in the US including GATOR-GCMOM, WRF/Chem, CAM3, MIRAGE, and Caltech unified GCM. These models represent the current status and/or the state-of-the-science treatments of online-coupled models worldwide. Their major model features, typical applications, and physical/chemical treatments are compared with a focus on model treatments of aerosol and cloud microphysics and aerosol-cloud interactions. Aerosol feedbacks to planetary boundary layer meteorology and aerosol indirect effects are illustrated with case studies for some of these models. Future research needs for model development, improvement, application, as well as major challenges for online-coupled models are discussed.

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