Impact of errors in modeled precipitation on regional smoke transport and lifetime---implications for retrospective studies

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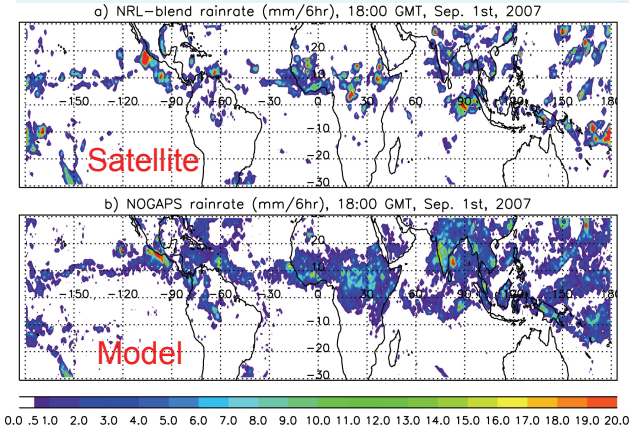
1. Introduction

- Aerosol and climate models are dependent on the parameterizations of the underlying meteorological model. Precipitation schemes in global meteorological models are designed to close the regional water budget, without concern for representative wet removal of atmospheric constituents.
- Investigation of the intensity of daily precipitation simulated by atmosphere-ocean coupled general circulation models shows that most of the models produce light precipitation (<10 mm/day) more often than observed, too few heavy precipitation events and too little precipitation in heavy events (>10 mm/day) [*Dai.*, 2006, *Sun et al.,* 2007].
- Numerical weather prediction (NWP) models, though incorporating updated observational meteorological fields, nevertheless exhibit some of the same characteristics as climate models. The figure below is an example.
- A potential implication is that this excessive light precipitation in models may over-scavenge aerosol particles and prevent simulation of aerosol cloud interaction in large convective events.



2. Data and Methodology

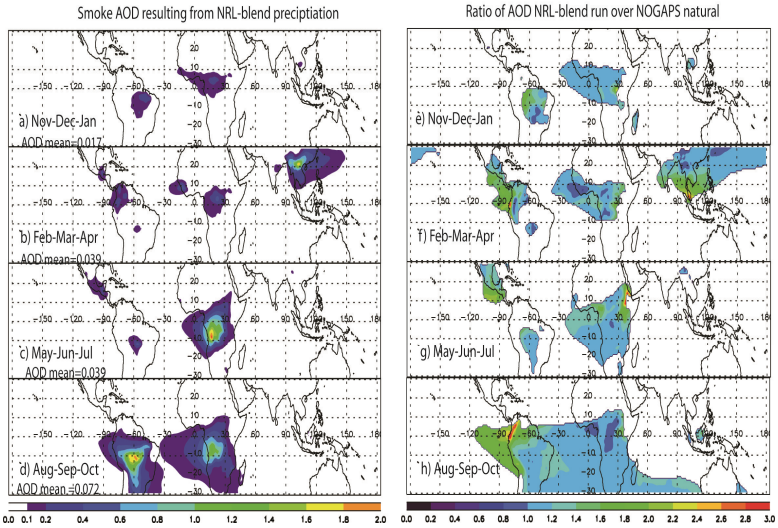
• NAAPS (Navy Aerosol Analysis and Prediction System) is the U.S. Navy's global aerosol, air quality and visibility forecast model.

• NOGAPS is the Navy's global weather forecast model [*Hogan and Rosmond,* 1991].

• NRL-Blend is a multi-satellite high resolution precipitation product [*Turk et. al.,* 2008].

• By substituting NOGAPS precipitation for the NRL-Blend (for 2007), we demonstrate the impact of modeled versus satellite-derived precipitation on aerosol optical depth (AOD) in NAAPS.

4. Comparison of model AOD resulting from different precipitation fields



• Substituting NOGAPS precipitation for the NRL-Blend results in an increase in mid-visible AOD of about 20-200% in parts of Southeast Asia and South America during the burning seasons (or 0.1-0.2 in AOD).

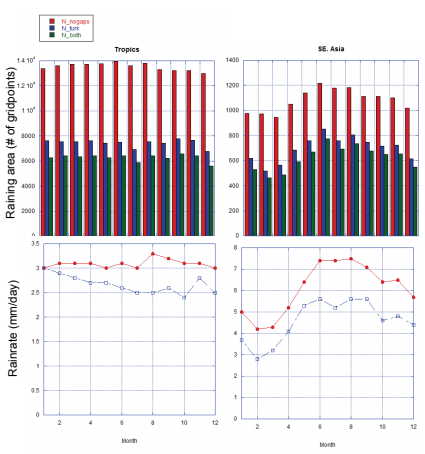
•In South America, outflow to the Pacific Ocean is due to model's overestimate of orographic precipitation in the Andes.

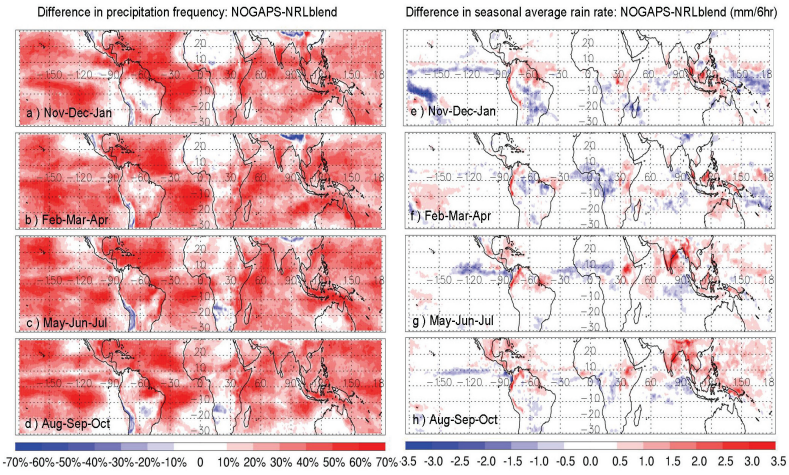
•Smoke lifetime is increased from 6.1 days (with NOGAPS rain) to 6.7days (with NRL-blend rain), or 7.0 days (with CMORPH rain) with satellite precipitation.

5. Implications for AeroCom

- The significant regional increases in AOD with satellite-derived precipitation in NAAPS improves our understanding of smoke long range transport. It helps to close the gap between modeled and observed optical thickness in clear spots within regions with convective activity or in outflow regions that pass through convective regions.
- Current climate models, which have an aerosol component, might underestimate AOD in regions of excessively light rain in the model, thus underestimate aerosol direct and indirect effects on the climate.
- The large changes in modeled AOD demonstrates the magnitude of uncertainty in wet scavenging. Inverse modeling experiments that attempt to use models to estimate source magnitudes by comparison with observations must consider this error.
- In retrospective studies of aerosols, satellite retrieved precipitation rather than modeled precipitation might be considered.

3. Comparison of satellite measured and modeled precipitation fields





• Histogram: NOGAPS precipitation is comparable in amount to NRL-blend, but spreads over a larger area.
• Figures on the right: Precipitation occurs much more frequently in NOGAPS than in the NRL-blend almost over the whole Tropics and for all seasons.
• Both imply lighter rain over larger areas in NOGAPS compared to the NRL-Blend.

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Reference: Xian, P., J. S. Reid, J. F. Turk, E. J. Hyer, and D. L. Westphal (2009), Impact of modeled versus satellite measured tropical precipitation on regional smoke optical thickness in an aerosol transport model, *Geophys. Res. Lett.*, 36, L16805, doi:10.1029/2009GL038823.