Anthropogenic aerosol impacts on deep convective clouds and precipitation over Houston

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Objective

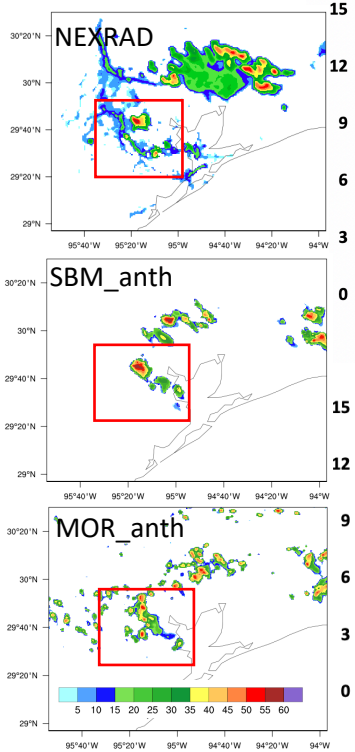
1) Understand how anthropogenic aerosol effect is influenced by cloud microphysics parameterizations.
2) Investigate how anthropogenic aerosol effect works together with the urban land effect in modifying convective storm and precipitation over Houston.

Approach

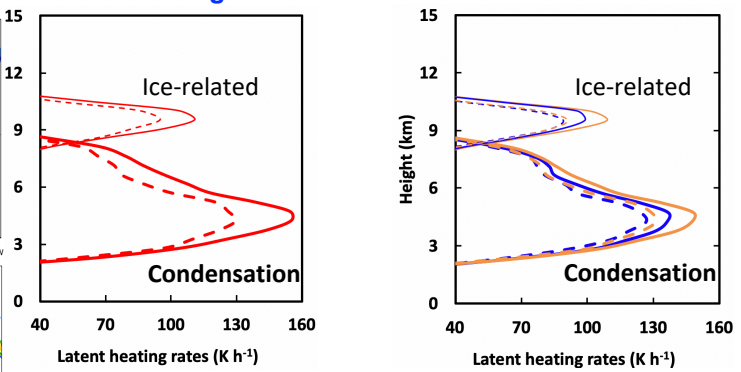
- Case: 19 June 2013 Houston thunderstorm using WRF-Chem-SBM at 0.5 km horizontal grid spacing.
- Carried out sensitivity tests by using Morrison and Spectral-bin schemes for Objective 1.
- Carried out sensitivity tests for Objective 2 by (a) turning off anthropogenic aerosols, (b) replacing urban land with the surrounding cropland, and (c) with both changes.

Results

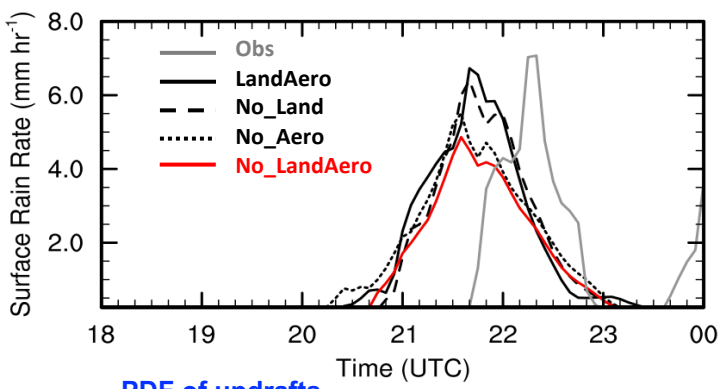
Composite Reflectivity



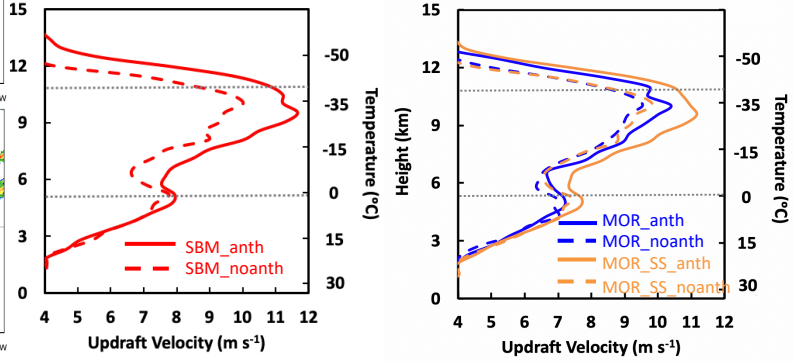
Latent heating



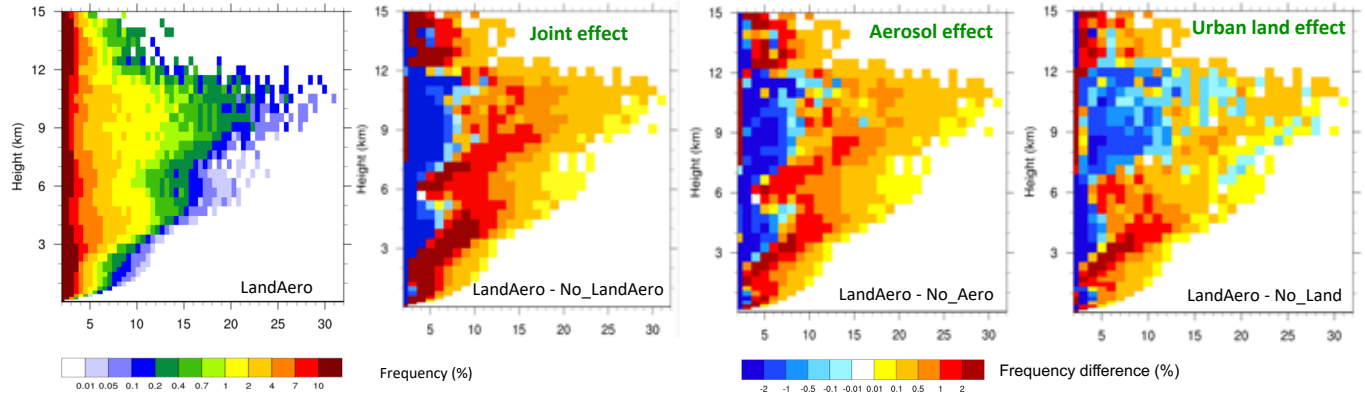
Surface rain rate



Convective intensity (mean of top 25th percentiles)



PDF of updrafts



Key points

- With the SBM scheme, the simulated storm agrees with observations much better and a significant invigoration effect on convective intensity and precipitation by anthropogenic aerosols is shown.
- Whereas the anthropogenic aerosol effect is not significant with Morrison mainly because of the saturation adjustment approach.
- The anthropogenic aerosol effect plays a key role in working with urban land effect to drastically enhance storm intensity and precipitation.

Zhang, Y., Fan, J., Li, Z., and Rosenfeld, D.: Impacts of Cloud Microphysics Parameterizations on Simulated Aerosol–Cloud-Interactions for Deep Convective Clouds over Houston, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-372, in revision, 2020.

Fan, J., Zhang, Y., Li, Z., Hu, J., and Rosenfeld, D.: Urbanization-induced land and aerosol impacts on sea breeze circulation and convective precipitation, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-411, Accepted, 2020.