Air Quality in California: Comparison of WRF-CHEM Predictions with Observations from NASA ARCTAS Field Experiment

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Overview

• Objective

• ARCTAS Details

• Model Settings

• Results and Discussion

• Conclusion
Objective

- Corroborate field campaign data from the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites in California (ARCTAS-CA) that took place during summer 2008.

- Estimation of CO, O₃, NO₂ and SO₂ at California using WRF-Chem.
ARCTAS Description

• ARCTAS-CA Arctic Research of the Composition of the Troposphere from Aircraft and Satellites in California.

• The ARCTAS-CA campaign (June 15-30, 2008), in collaboration with NASA/CARB, aimed at understanding the roles of local summer forest fires, pollution from ships, and contribution from long-distance pollutant sources (such as Asia) on the air quality of California.

• NASA DC-8 flight 14, which circled from Palmdale to San Francisco Bay and back to Palmdale, was selected for this study as it was one of the most representative flights of the campaign in satisfying the ARCTAS-CA objectives.
Model Settings

- Domain California
- Grid Size 12km * 12km
- Grid cells 100 * 100
- PBL Physics YSU Scheme
- Surface Physics Unified Noah land-surface model
- Chemical mechanism – RADM2 and MADE/SORGAM aerosols
- Emission – NEI 2005
- Boundary conditions RAQMS
RESULTS

• Area: California

• Comparison of model output with ARCTAS -CA

• Day choose 06/22/2008

• Time 18:00 UTC, 10:00 A.M PST
Modeled Surface Pollutant Concentrations over California, June 22, 2008 at 10:00 A.M PST
Comparison of modeled and observed pollutant concentrations from NASA ARCTAS DC-8 flight

Carbon Monoxide

Ozone

Courtesy: Glenn S Diskin, NASA LaRC

Courtesy: Andrew Weinheimer, NCAR
Nitrogen Dioxide

- Observation (NCAR)
- Observation (UCB)
- Model
- Altitude

UTC hour: 14 to 24
Units: ppb, Altitude (meter)

Sulfur Dioxide

- Observation
- Model
- Altitude

UTC hour: 14 to 24
Units: (gde), Altitude (meter)

Courtesy: Andrew Weinheimer, NCAR

Courtesy: Paul Wennberg, California Institute of Technology
### Statistical analysis for model results along flight path

<table>
<thead>
<tr>
<th></th>
<th>Temp</th>
<th>RH</th>
<th>Wind Speed</th>
<th>CO</th>
<th>O₃</th>
<th>NO₂</th>
<th>SO₂</th>
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<tbody>
<tr>
<td>R</td>
<td>0.97</td>
<td>0.32</td>
<td>0.88</td>
<td>0.25</td>
<td>0.63</td>
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</table>

### Statistical analysis for model results for altitude<1000 m

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<th>Temp</th>
<th>RH</th>
<th>Wind speed</th>
<th>CO</th>
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</thead>
<tbody>
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<tr>
<td>RMSE</td>
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<td>23.97</td>
<td>2.59</td>
<td>104.56</td>
<td>24.59</td>
<td>4.82</td>
<td>0.79</td>
</tr>
</tbody>
</table>
Vertical Profiles of Modeled Pollutant Concentrations over California, June 22, 2008

CO

Ozone

NO₂

SO₂
Conclusion

- WRF-Chem generally captured the spatial and temporal variability of concentrations of observed primary and secondary gas-phase pollutants during the ARCTAS-CA mission, as shown for DC-8 research flight 14 on June 22, 2008.
- The model over-predicts in urban areas and under predicts in rural areas for selected species.
- Flight observations identify the importance of wildfire emissions on northern California air quality.
Future Work

• Study aerosol direct and indirect impacts on climate and feedbacks on regional air quality.
• Study the impact of wildfire emissions on modeled gas-phase and aerosol transport during ARCTAS.
Acknowledgement

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- Glenn S Diskin, NASA for CO measurements.
- Paul Wennberg, California Institute of Technology, CA for SO$_2$ measurements.
- Andrew Weinheimer, NCAR for NO$_2$, O$_3$ measurements.
- We thank ARCTAS Science Team for providing the data.
- CGRER
- The University of Iowa
Thank You