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, O_3, NO_2 and SO_2 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

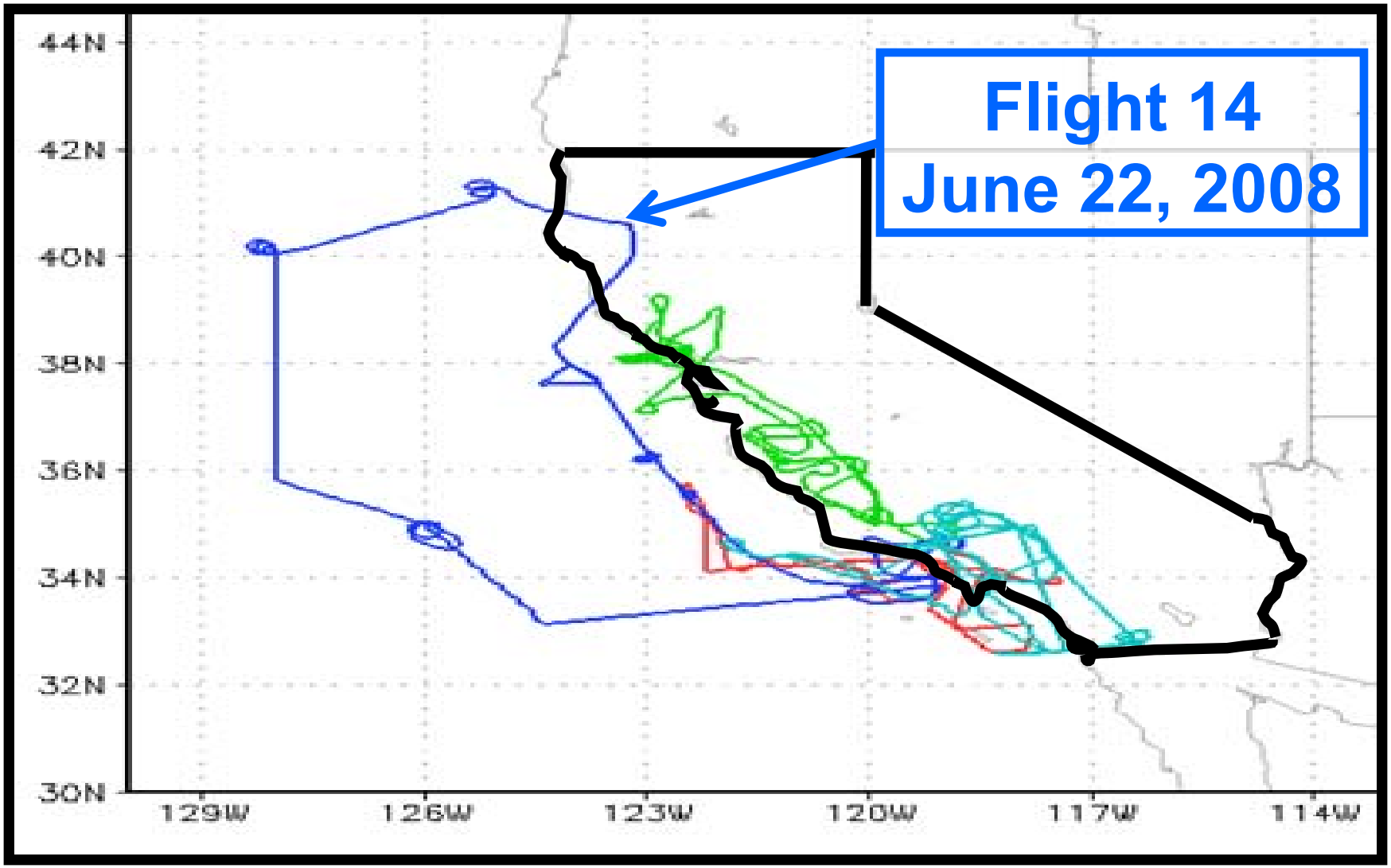
- Domain California
- Grid Size 12km* 12km
- Grid cells 100*100
- PBL Physics YSU Scheme
- Surface Physics Unified Noah land-surface model
- Chemical mechanism – RADM2 and MADE/SORGAM aerosols
- Emission – NEI 2005
- Boundary conditions RAQMS

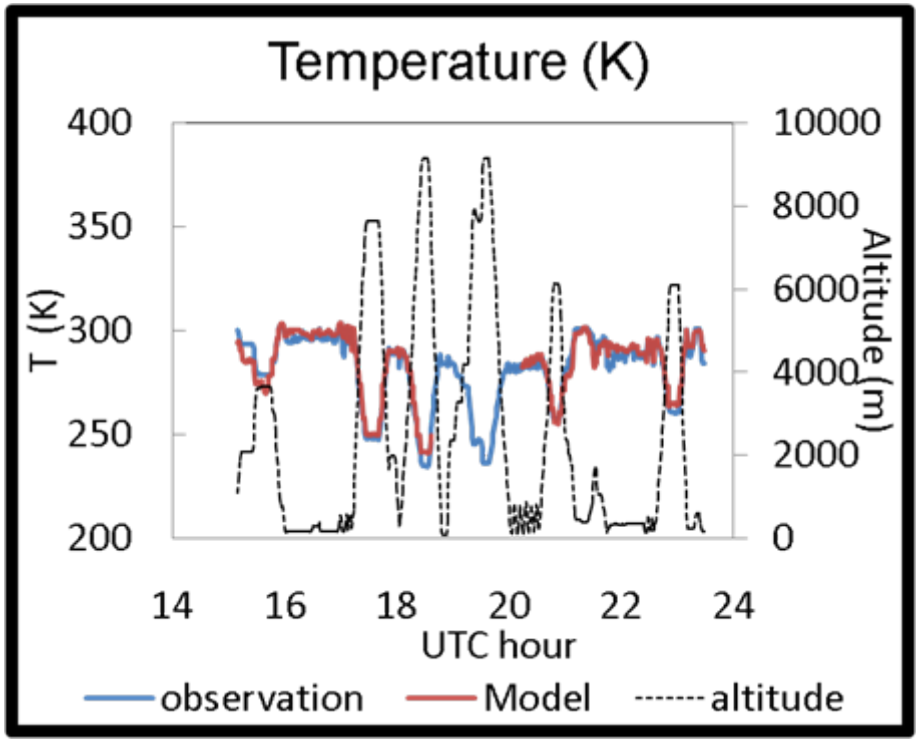
RESULTS

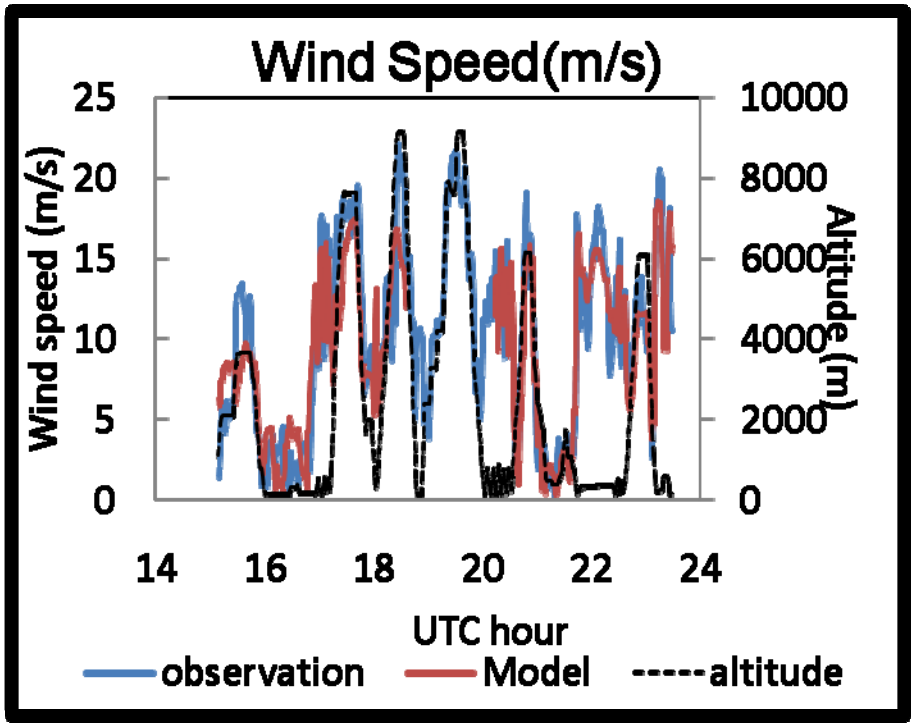
- Area : California
- Comparison of model output with ARCTAS -CA
- Day choose 06/22/2008
- Time 18:00 UTC, 10:00 A.M PST

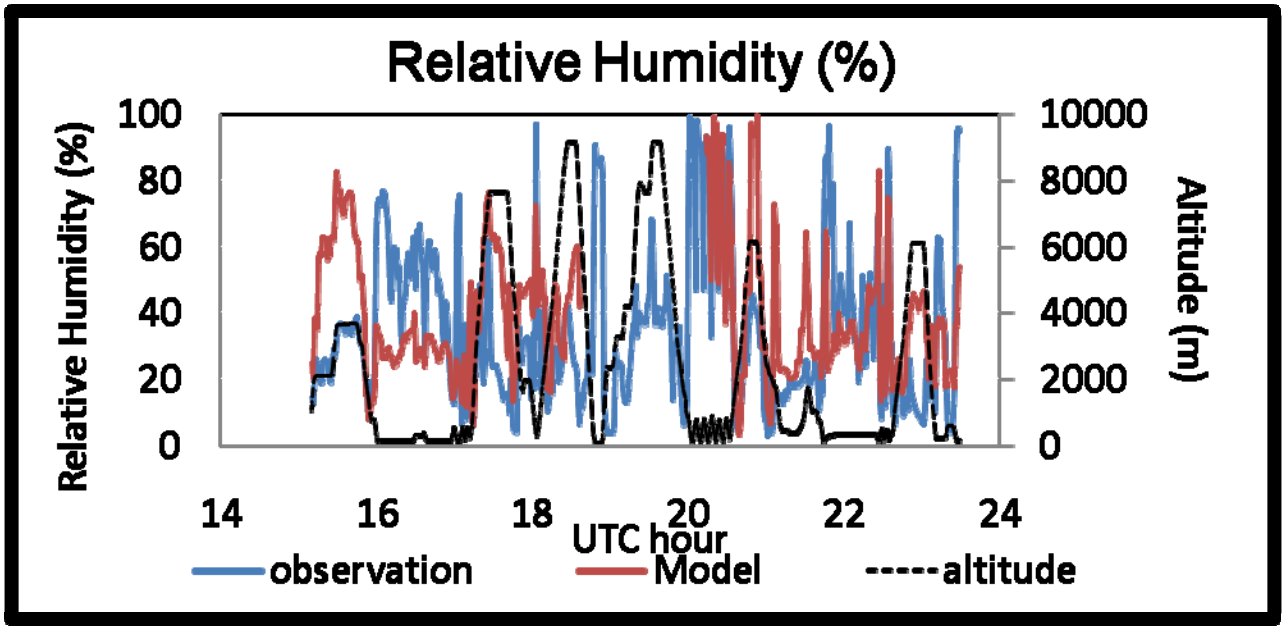
Flight Track

Path : Palmdale - San Francisco Bay - Palmdale

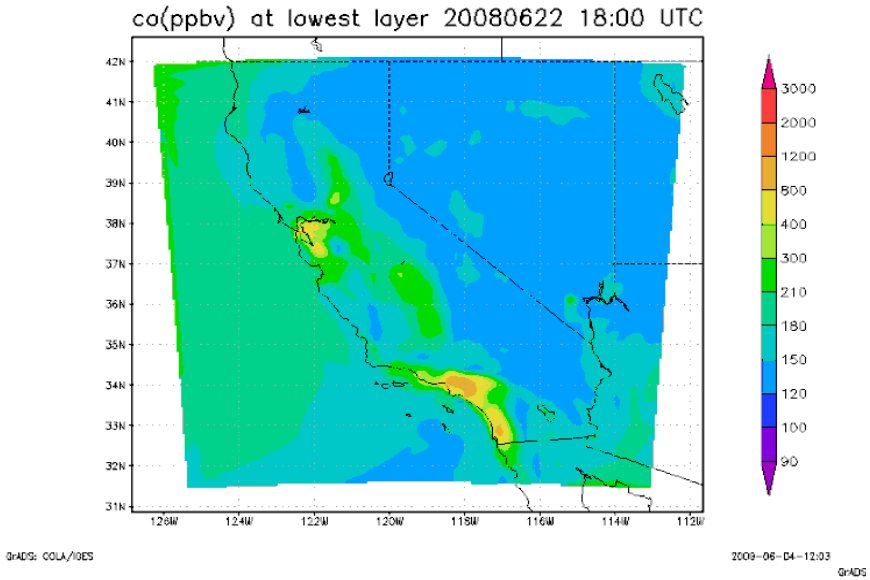


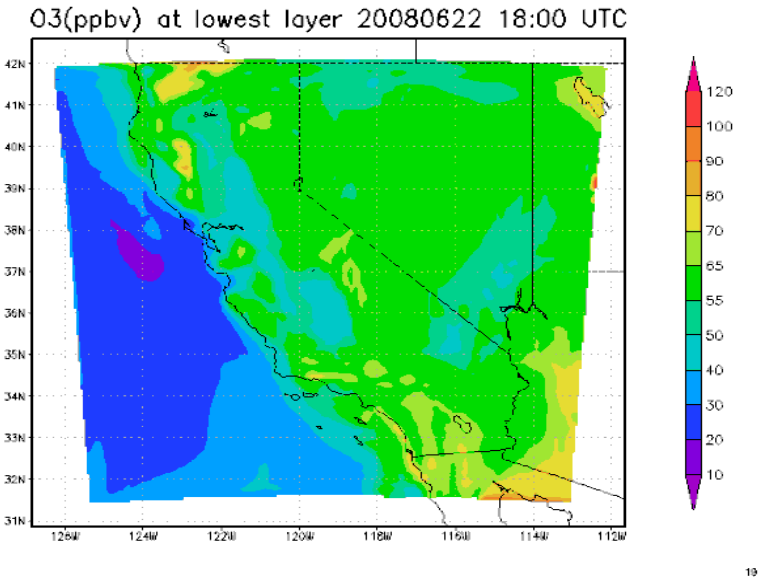

Temperature (K)
400
350
300
250
200
T (K)
10000
8000
6000
4000
2000
0
Altitude (m)
14
16
18
20
22
24
UTC hour
observation
Model
altitude

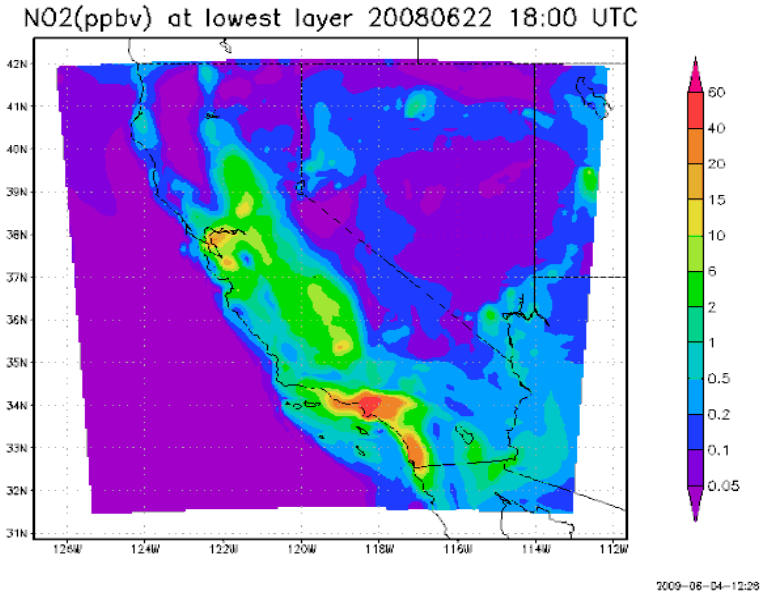

Wind Speed(m/s)
25
20
15
10
5
0
Wind speed (m/s)
10000
8000
6000
4000
2000
0
Altitude (m)
14
16
18
20
22
24
UTC hour
observation
Model
altitude

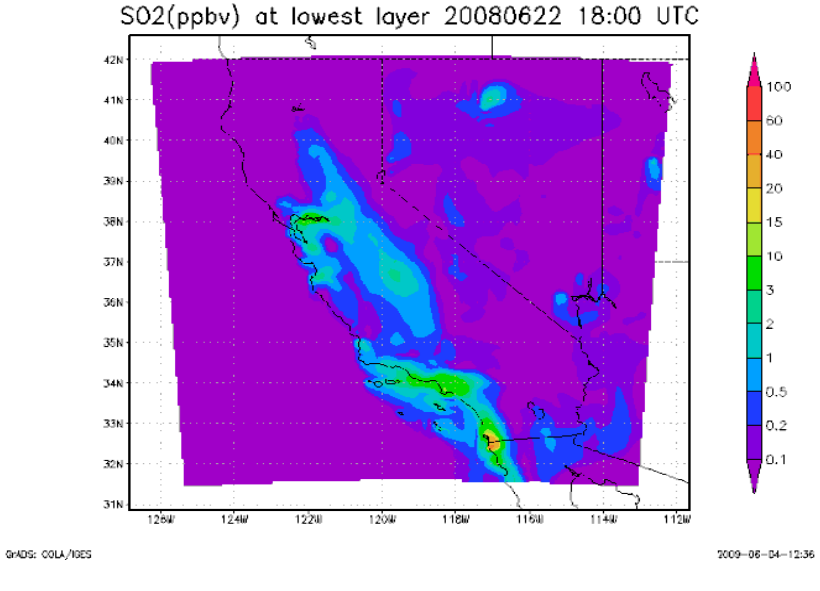

Relative Humidity (%)
100
80
60
40
20
0
Relative Humidity (%)
10000
8000
6000
4000
2000
0
Altitude (m)
14
16
18
20
22
24
UTC hour
observation
Model
altitude

Modeled Surface Pollutant Concentrations over California, June 22,2008 at 10:00 A.M PST

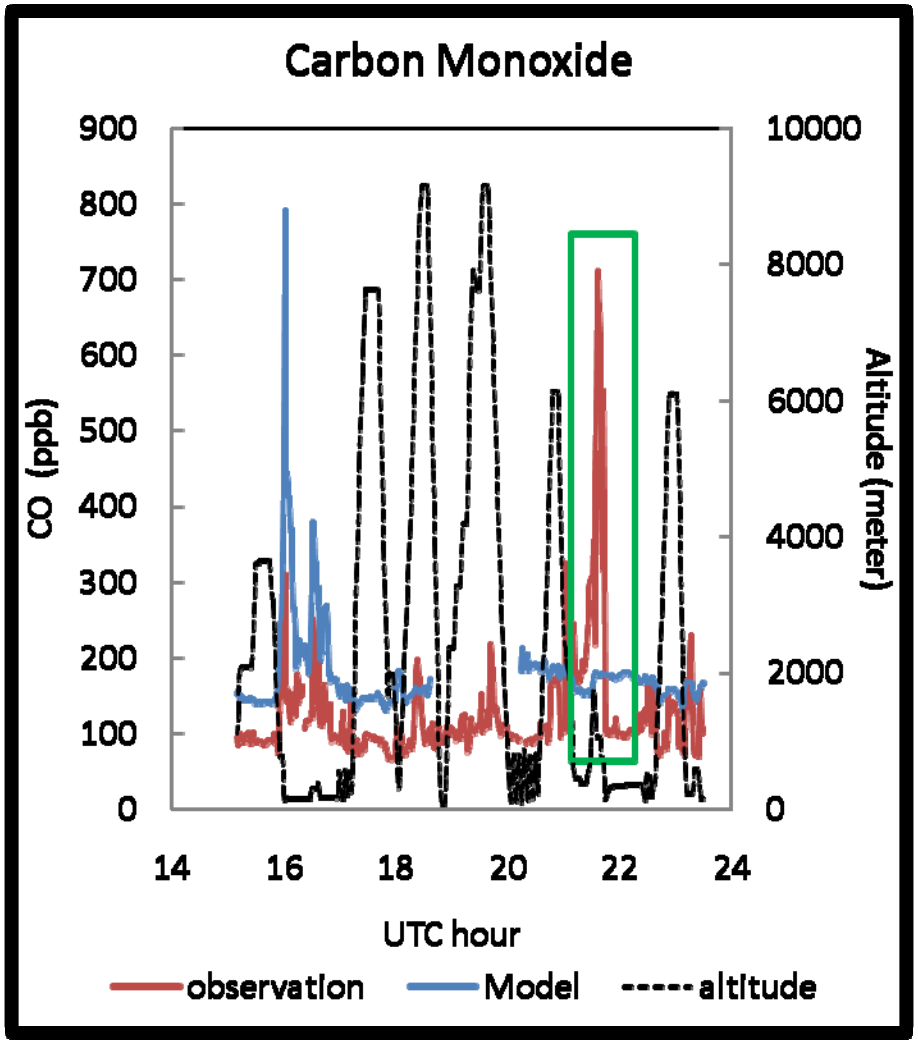




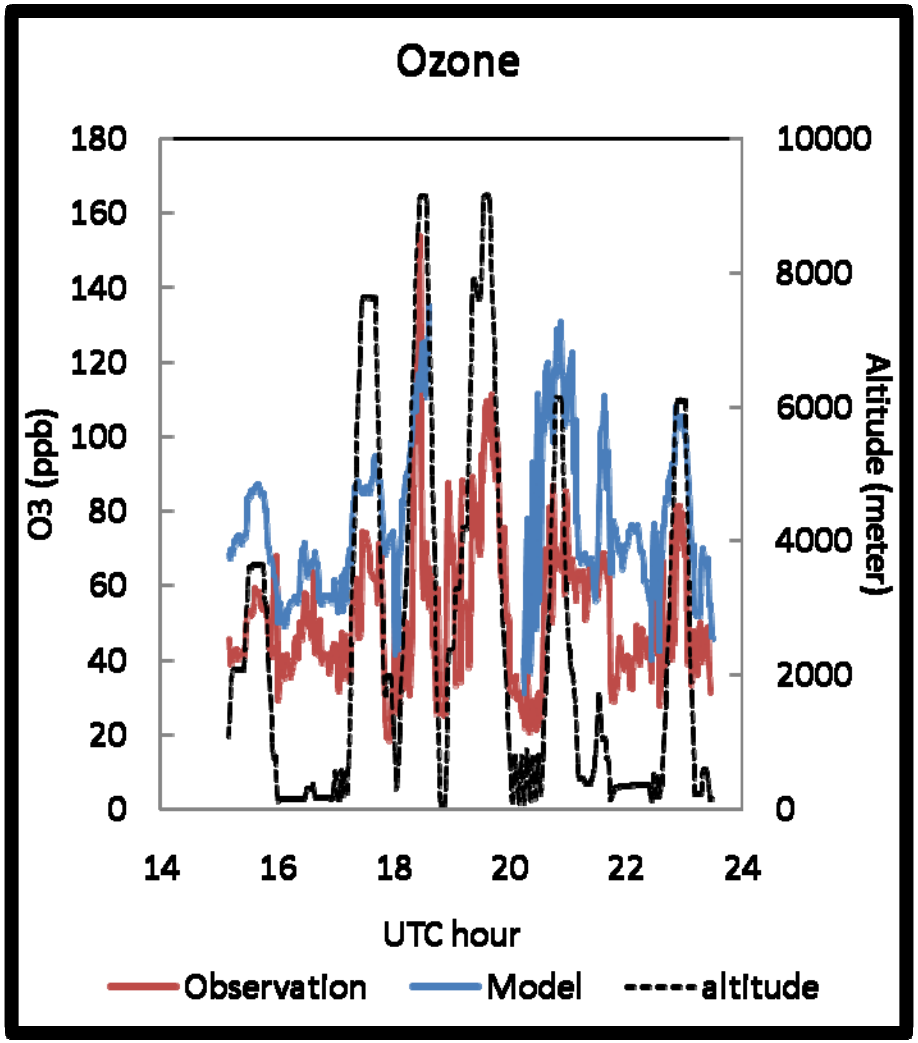




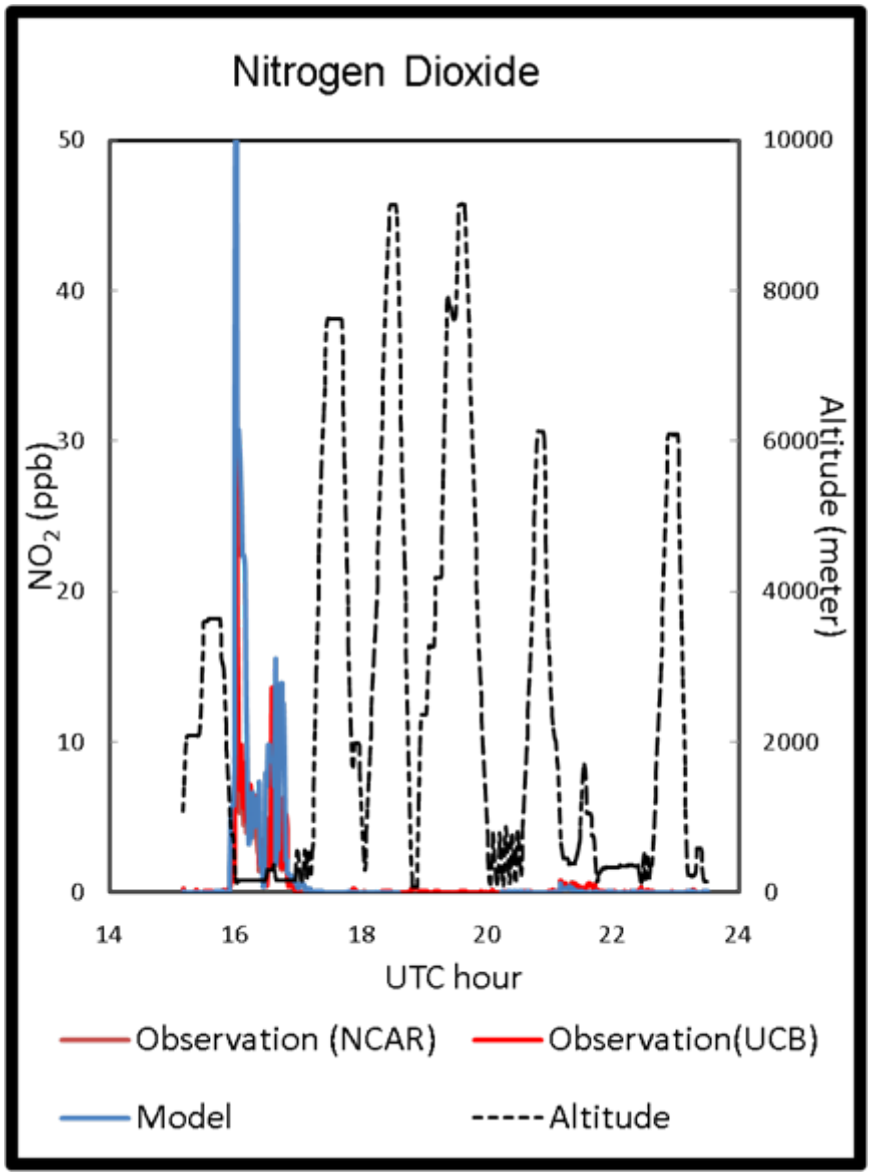
Comparison of modeled and observed pollutant concentrations from NASA ARCTAS DC- 8 flight



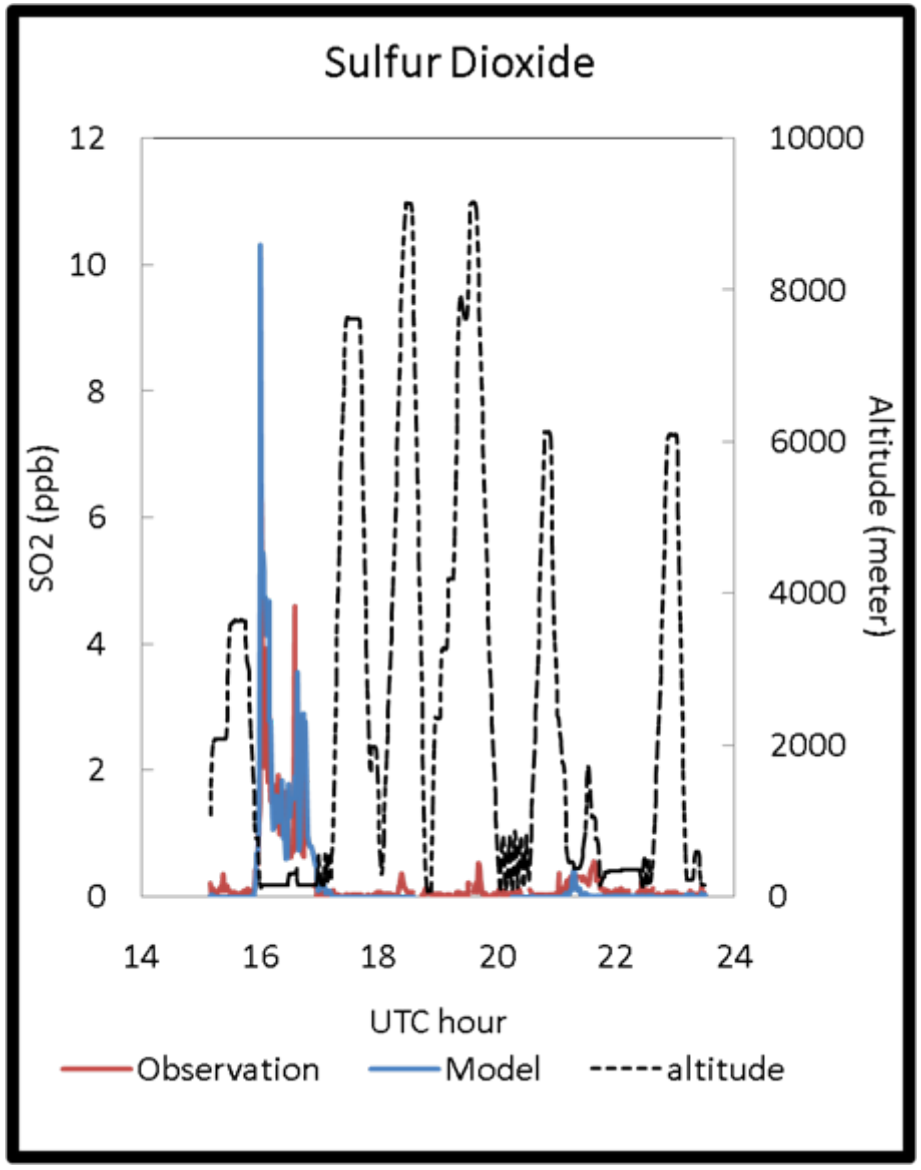
Courtesy : Glenn S Diskin, NASA LaRC



Courtesy :Andrew Weinheimer, NCAR



Courtesy :Andrew Weinheimer, NCAR



Courtesy: Paul Wennberg, California Institute of Technology

Statistical analysis for model results along flight path

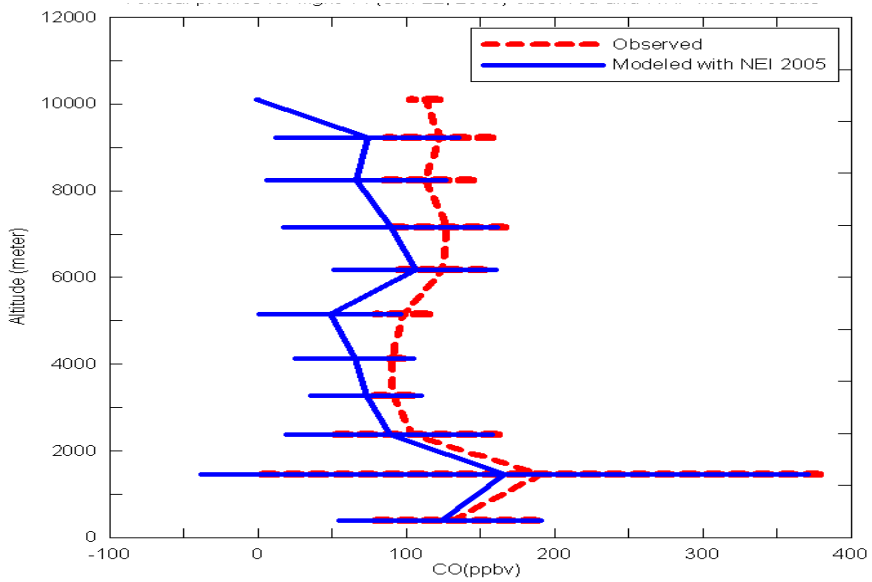
	Temp	RH	Wind Speed	CO	O_3	NO_2	SO_2
R	0.97	0.32	0.88	0.25	0.63	0.87	0.83
Bias	3.10	19.49	2.06	76.06	27.22	1.02	0.23
RMSE	3.98	25.04	2.69	101.05	31.75	3.50	0.58

Statistical analysis for model results for altitude<1000 m

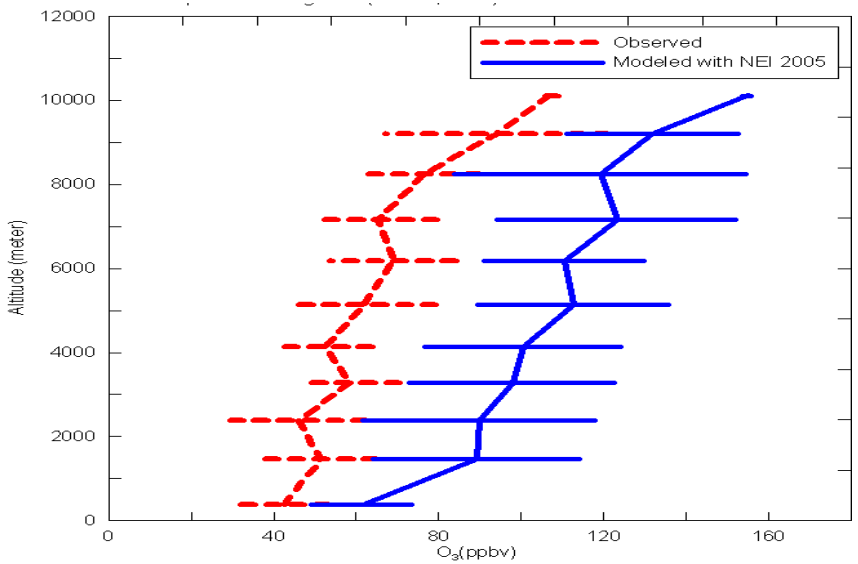
	Temp	RH	Wind speed	CO	O_3	NO_2	SO_2
R	0.86	0.61	0.91	0.28	0.28	0.86	0.82
Bias	2.96	17.73	1.88	83.03	20.43	1.89	0.38
RMSE	3.87	23.97	2.59	104.56	24.59	4.82	0.79

Vertical Profiles of Modeled Pollutant Concentrations over California, June 22,2008

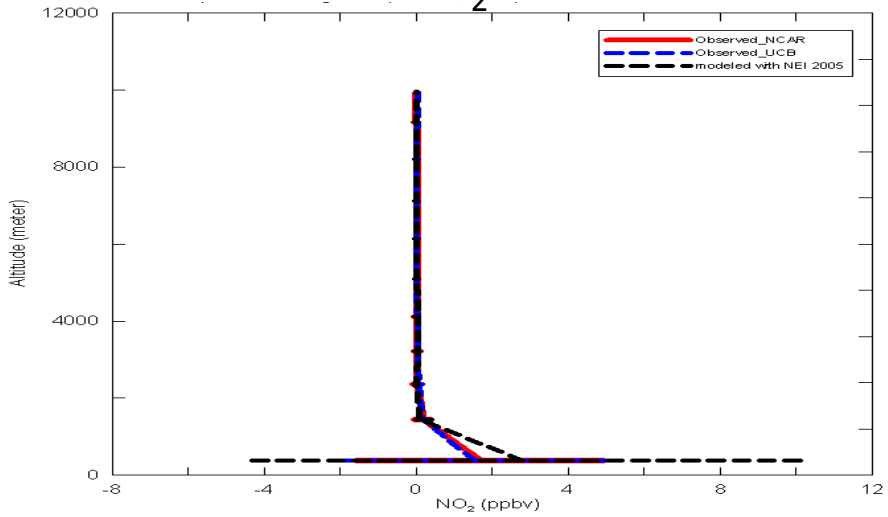
CO



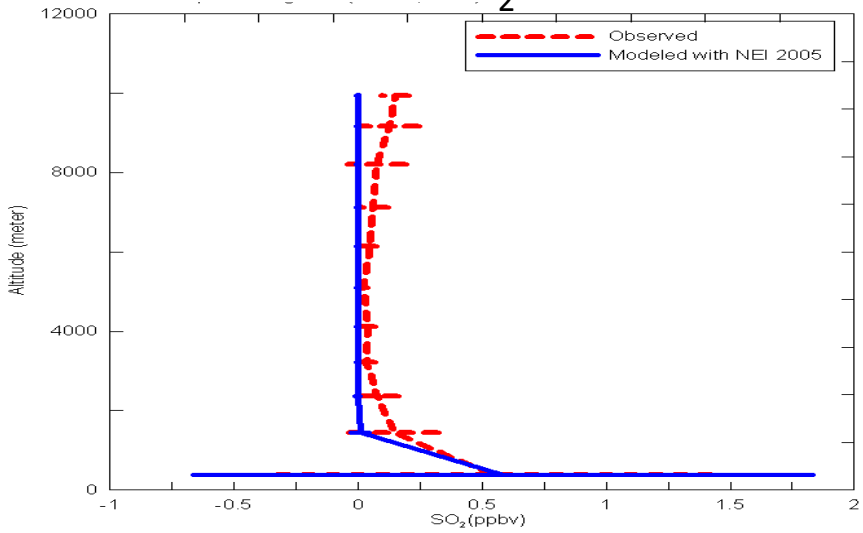
Ozone



NO_2



SO_2



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.

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Thank You