An intensive two-week study of an urban CO_2 dome in Phoenix, Arizona, USA

Craig D.Idso et al.

Reporter : Yang Dong

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◆Outline

- 1.Background
- 2.Objective
- 3.Experiment
- 4.Results & Discussion
- 5.Conclusion
- 6. Extended research

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◆1.Background

- **Urban CO_2 Dome**

Concentrations diminished from the city center towards the outlying rural areas. *(Idso et al. 1998)*

- **Why to choose Phoenix**

The CO_2 dome over Phoenix were considerably larger than the few enhancements measured over other cities *(Clarke and Faoro, 1966; Berry and Colls,1990a, b; Reid and Steyn, 1997)*

Sources of urban CO_2 Dome (of Phoenix)

Vehicles (79.9%), soil respiration (15.8%), power plants (2.2%), human respiration (1.6%), landfills (0.5%), airplanes (less than 0.1%) *Koerner and Klopatek (2002)*

Consequence of urban CO_2 Dome

Do they significantly impact local temperatures and/or vegetative productivity?

Impact local temperatures?

The high urban near-surface air temperatures are not the result of a local CO_2 enhanced greenhouse effect. *Balling et al. (2002)*

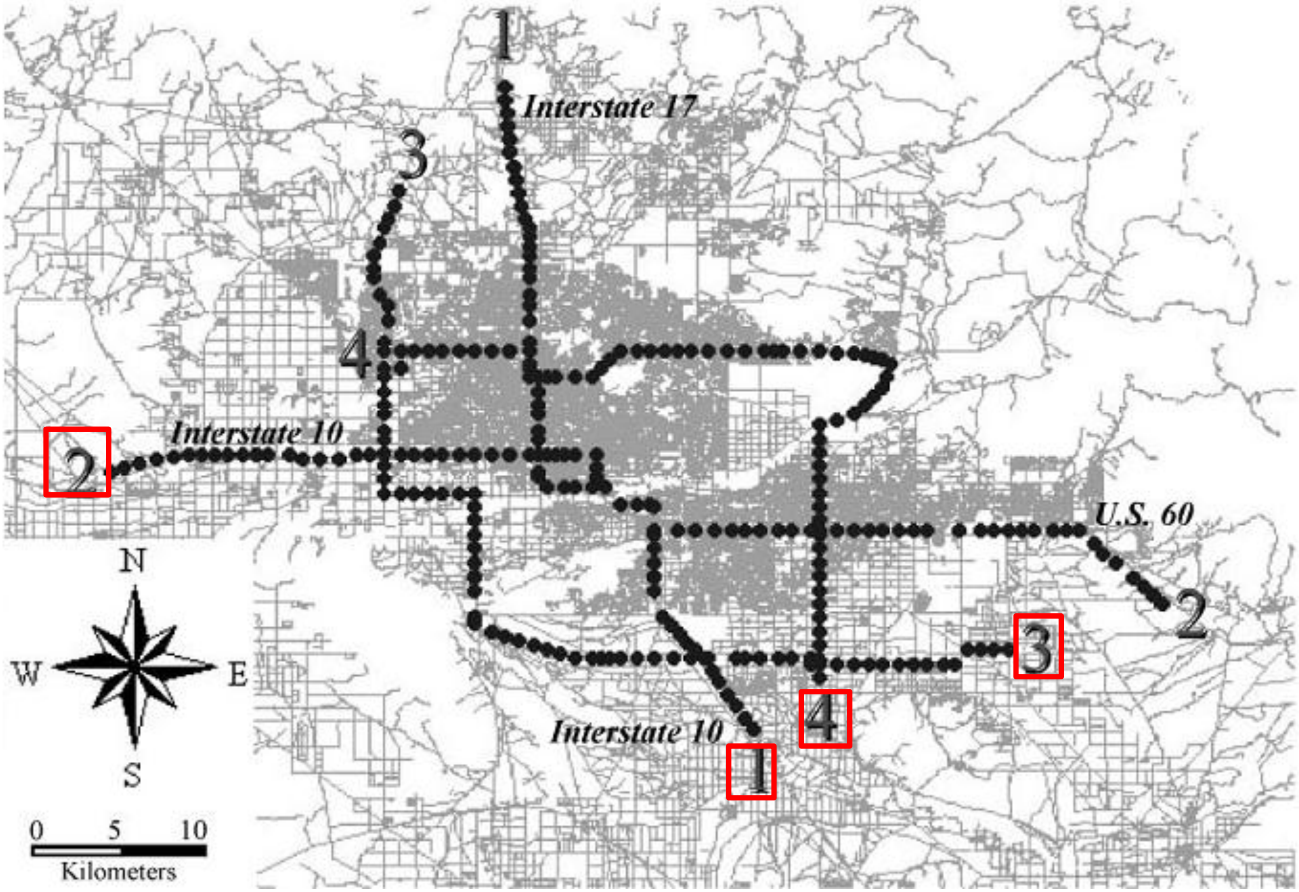
Impact vegetative productivity?

Enhances the robustness of urban vegetation: growth rates, efficiencies of water use, plant health *(Allen, 1990;Pallas, 1965; Kimball and Idso, 1983).*

◆ 2.Objective

To conduct an intensive investigation of Phoenix 's urban CO_2 dome to more rigorously determine its strength and stability.

◆3.Experiment



Transects nos. 1 and 2 pass through the central portion;
Transects nos. 3 and 4 weave in and out of the city.

Fig. 1. Street density map of the Phoenix metropolitan area showing the locations of the four transect routes and the points where the CO_2 concentration data were obtained. Solid gray denotes regions where street density is high. Travel across the routes was from southeast to northwest.

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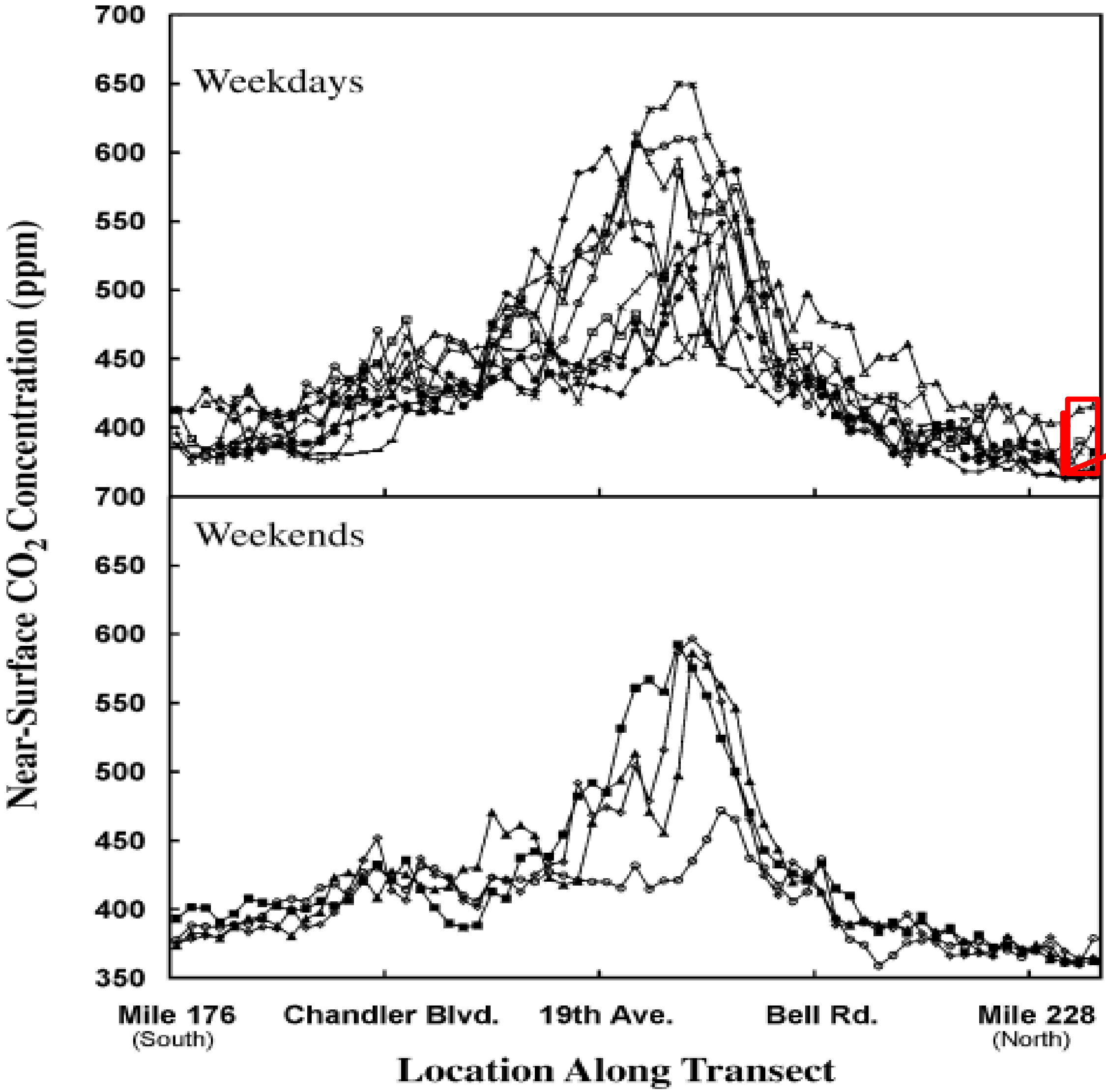
Each of the four transects was simultaneously traversed by four separate automobile crews, starting at 0500 and 1400 LST.

Outside air (2 m above the ground) was drawn into CO_2 measurement system , and the concentrations were measured by Model LI-800 Gas Hound infrared gas analyzers .

◆4.Result & Discussion



To display the nature of the Spatial and temporal variability

Mean weekend value measured at the northernmost point was 369ppm

Fig. 2. CO_2 concentration values at each of the measurement locations of the ten weekday and four weekend pre-dawn data acquisition runs of Transect 1. The named locations along the abscissa divide the route into four equal-length segments.

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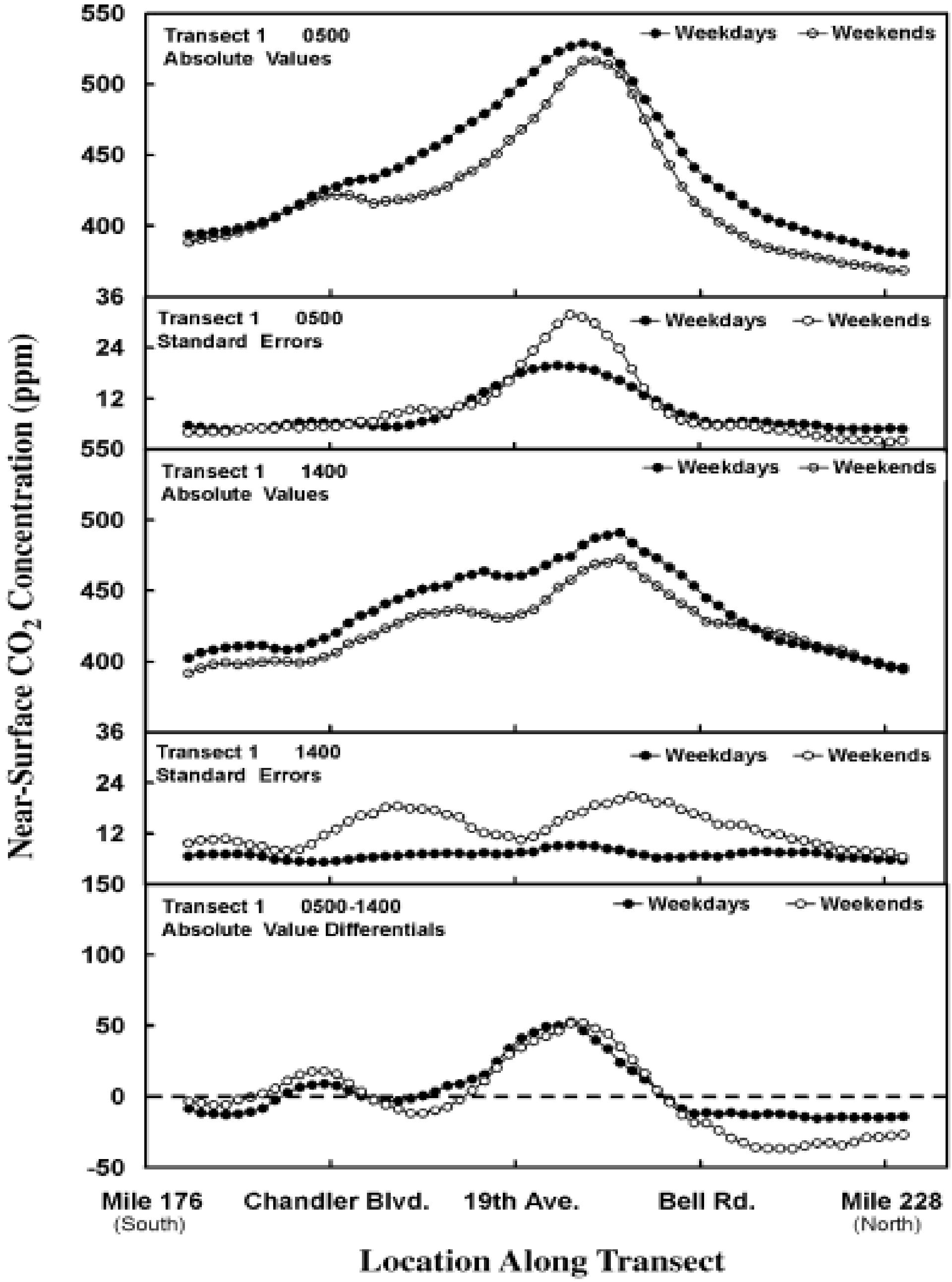
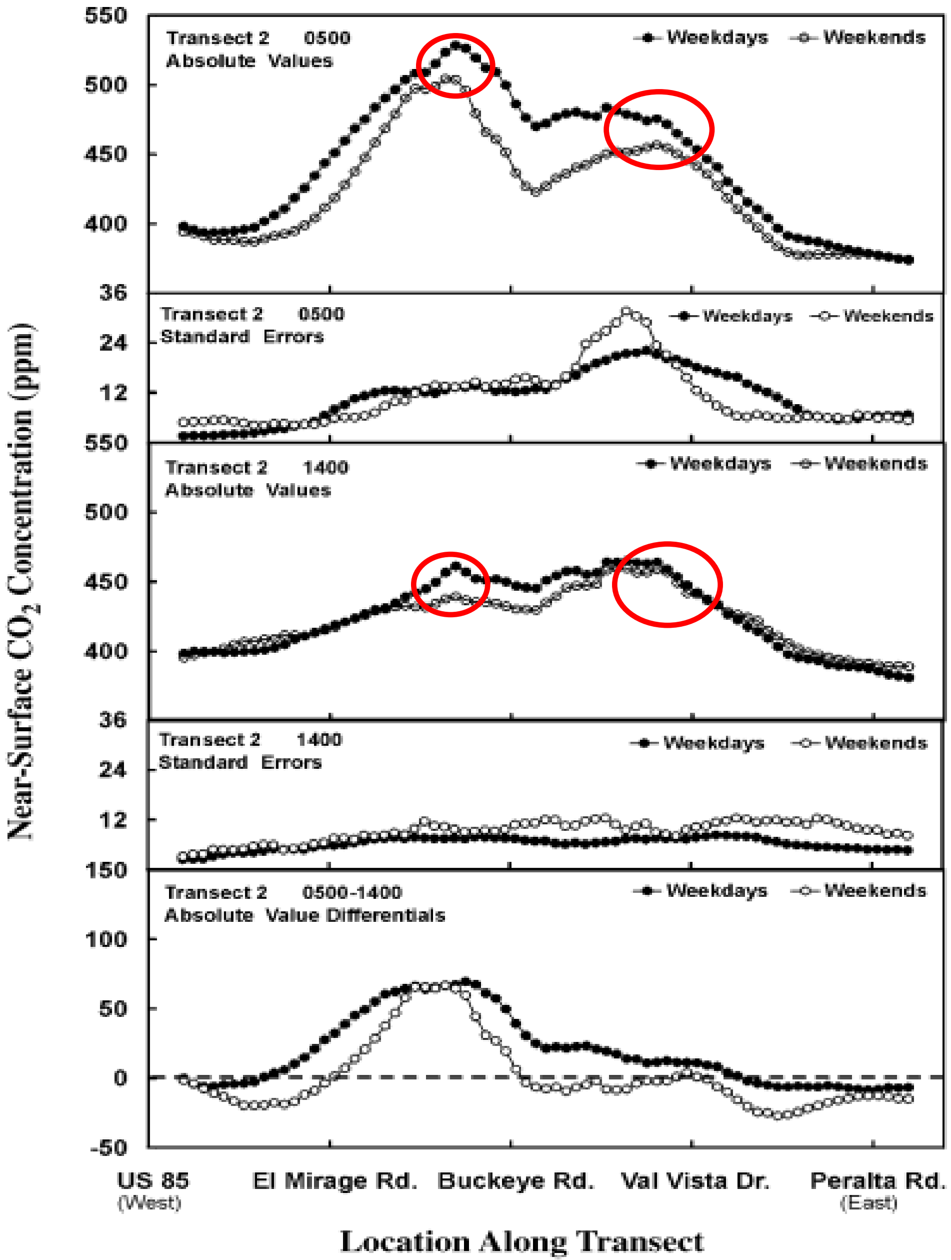


pre-dawn near-surface:
Weekday/weekend=29.0%/22.9% =1.266

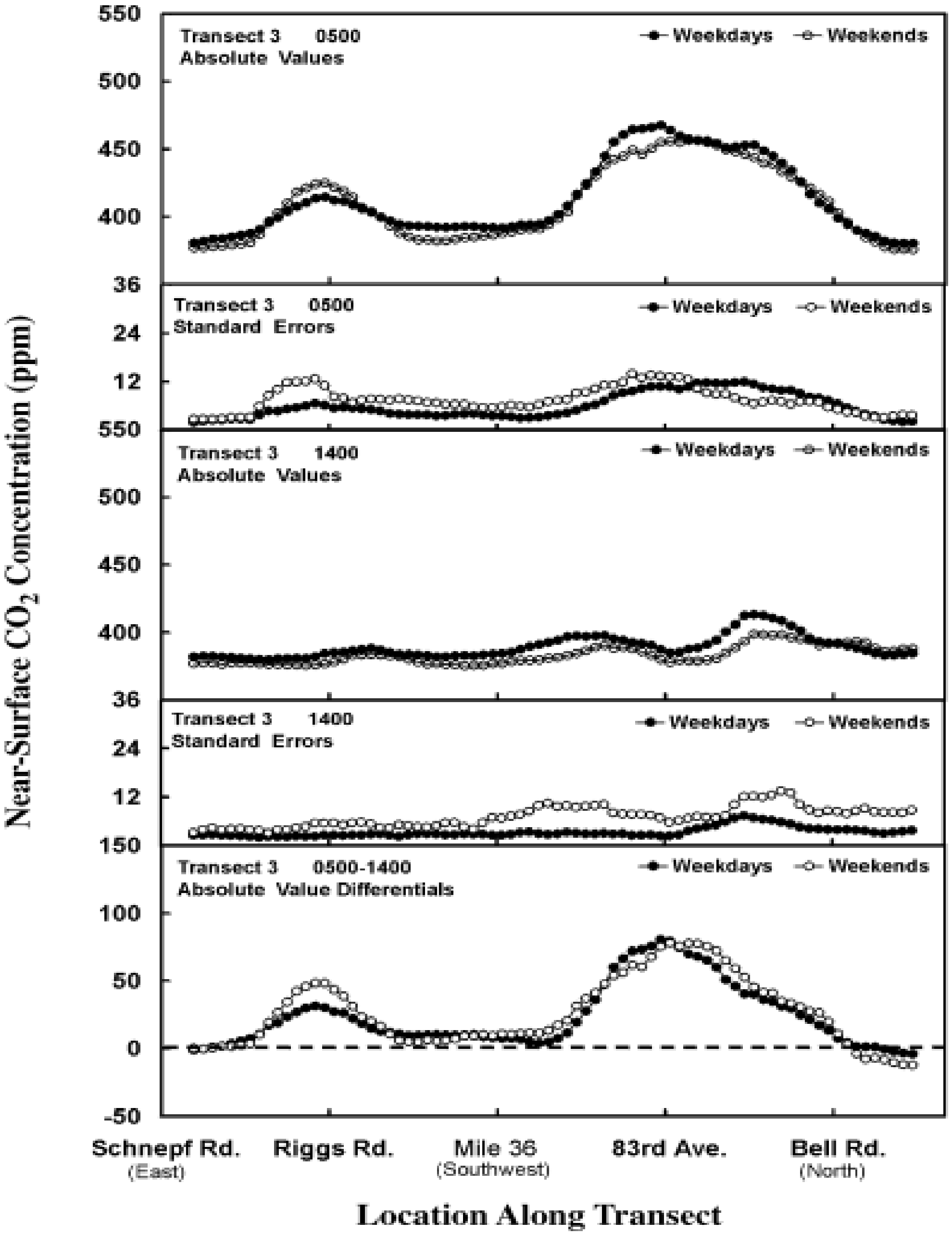
Fig. 3. Seven-term running-average means and standard errors of the means for the pre-dawn and mid-afternoon data acquisition runs of Transect 1. The named locations along the abscissa divide the route into four equal-length segments.



predawn near-surface:
Weekday/weekend=31.8%/23.8% =1.336

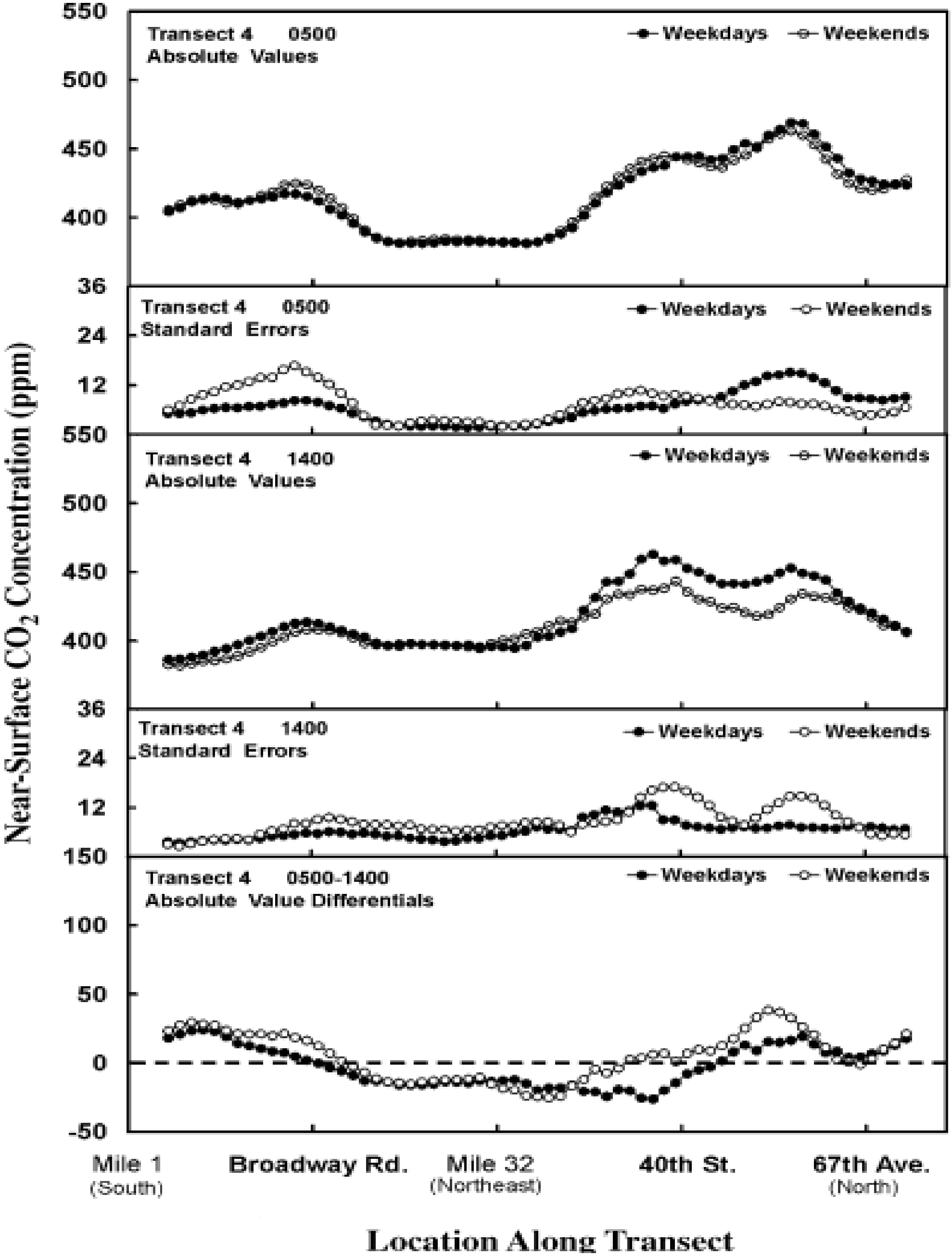
Weekday traffic and commercial activities increased pre-dawn near-surface CO_2 concentrations about 30% more than weekend [(26.6% +33.6%)/2 =30.1%]

Fig. 4. Seven-term running-average means and standard errors of the means for the pre-dawn and mid-afternoon data acquisition runs of Transect 2. The named locations along the abscissa divide the route into four equal-length segments.



Little built-up areas to either the south or west, in the afternoon, the mini-CO_2 domes were essentially swept away by the combined action of vertical mixing and the prevailing surface airflow from the southwest.

Fig. 5. Seven-term running-average means and standard errors of the means for the pre-dawn and mid-afternoon data acquisition runs of Transect 3. The named locations along the abscissa divide the route into four equal-length segments.



Mini-CO_2 domes were preserved in the afternoon by the advection of city-produced CO_2 from the south and west.

Fig. 6. Seven-term running-average means and standard errors of the means for the pre-dawn and mid-afternoon data acquisition runs of Transect 4. The named locations along the abscissa divide the route into four equal-length segments.

◆5.Conclusions

- Cities produces a sizeable increase in the CO_2 concentration of the near-surface boundary layer air.

- Over the extended portion of the city, weekday-weekend dichotomy was more pronounced; over the primarily residential areas of the city, no significant differences between weekday and weekend.

- Vertical mixing and airflow will influence near-surface CO_2 concentrations over the city.

What remains to be learned

What happens throughout the rest of the year and over a complete diurnal cycle?

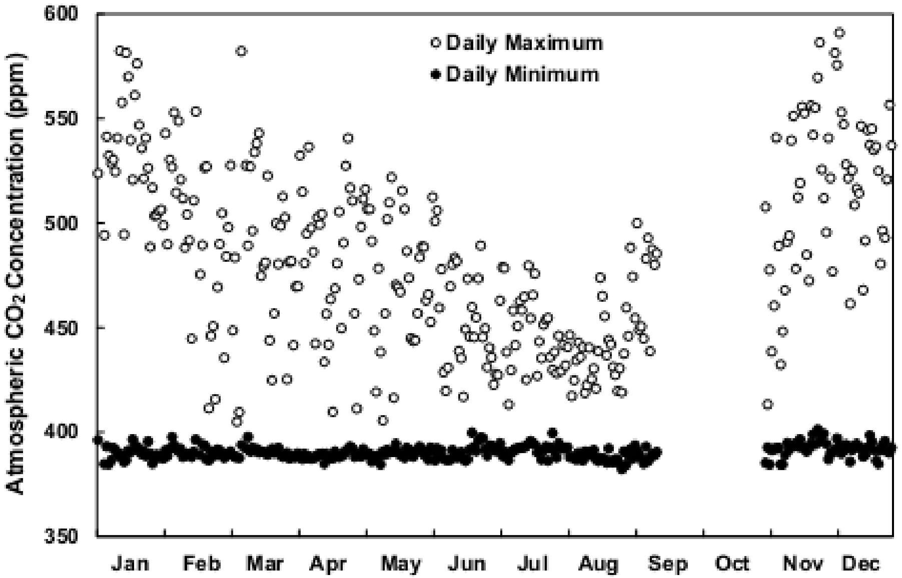
◆ 6 Extended research

Seasonal and diurnal variations of near-surface atmospheric CO_2 concentrations within a residential sector of the urban CO_2 dome of Phoenix, AZ, USA.

--Sherwood B. Idso , Craig D.Idso, Robert C. Balling Jr.

What was done

Measured atmospheric CO_2 concentration, temperature and wind speed two meters above the ground every minute of most of an entire year (315 days of the year 2000) in a residential neighborhood of a suburb of Phoenix.



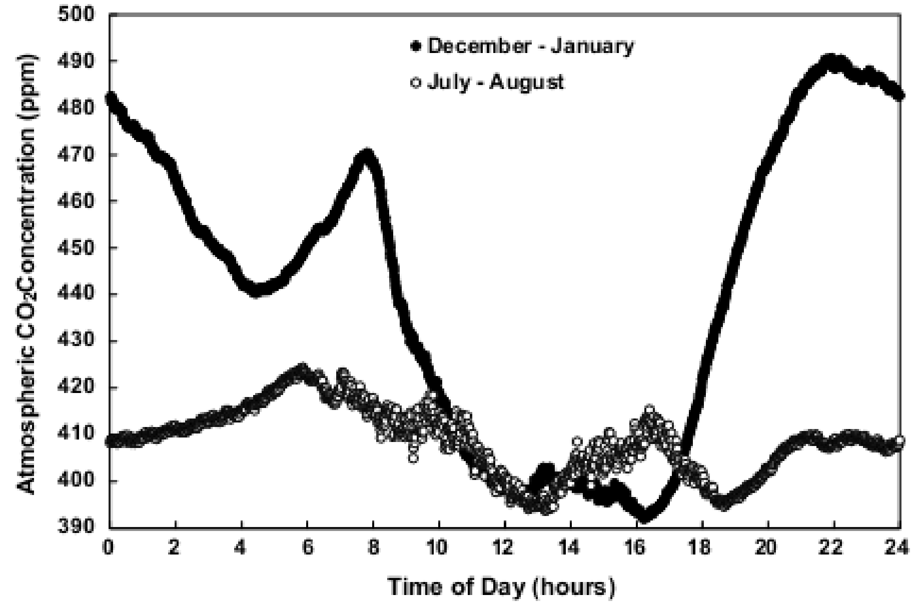


Fig.7. Daily maximum and minimum values of 30-min averages of near-surface atmospheric CO_2 concentration over the course of year 2000.

Fig.8. Mean diurnal courses of near-surface atmospheric CO_2 concentration (2-month averages of 1-min data) for the coldest Two months of the year(December-January)and the warmest 2 months of the year (July–August).

What was learned

A mean cold-season maximum atmospheric CO_2 concentration: at the center of the city , enhancement 67% ;at the residential site, enhancement 33% ;

Averaged over the entire night enhancement :25% in the cold season,11% in the warm season; over the complete daylight period :10% in both seasons;

The maximum weekday-weekend CO_2 differential was 40 ppm in the cold season and 22 ppm in the warm season.

The **primary** controlling factors of the strength of the CO_2 dome :

(1) the presence of air temperature inversions at night and in the early morning ;

(2) solar-induced convective mixing during the midday period.

Secondary controlling factors :

(a) wind speed ; (b) wind direction.

What it means

Near-surface atmospheric CO_2 concentrations in large cities may often be much higher than those of surrounding rural areas. but they tend to drop off rapidly with distance from the city-center and major roadways.

Thank You