

Modeling Temporal and Spatial Characteristics of Nitrogen dry Deposition in the Phoenix Metropolitan Area

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Introduction

- Air quality models** offer the opportunity of simulating dry deposition fluxes in urban areas with a relatively high spatial resolution, but usually only over a few day period. Dry deposition fluxes can also be calculated by means of **diagnostic models** which use measured pollutant concentrations and meteorological data at a reference height in the atmosphere as input data. Data are often available on a continuous basis over extended time periods and from sites within urban core areas. However, the low density of monitoring stations makes it difficult to assess the degree of spatial variation in dry deposition.
- A **diagnostic model** was developed in order to determine nitrogen dry deposition fluxes in the Phoenix metropolitan area. The model includes equations describing the surface energy balance and the ability of the surface to take up matter.
- A **Models-3/CMAQ** simulation combined with meteorological modeling for 22-23 July, 1996 was used to predict spatial patterns of NO_x-derived and nitric acid dry deposition in the study area.

Materials and Methods

- Diagnostic model description:** The vertical dry deposition flux was modeled by means of the deposition velocity and the measured pollutant local mean concentrations at a reference height in the atmosphere. The surface resistance was calculated according to Walmsley and Wesely (1995). The temperature response function of canopy stomatal resistance was replaced with the response function suggested by Jarvis (1976) allowing for the parameterization of the temperature response for trees and shrubs in semiarid regions (Larcher 1994). The aerodynamic resistance was calculated according to Hanna & Chang (1992) where the sensible heat flux is a function of a moisture availability factor which depends on the land cover fraction of irrigated vegetation (Oke 2001, personal communication). Input data for the model were measured atmospheric state variables and pollutant concentrations as well as surface characteristics - albedo, emissivity, roughness length. The simulated deposition fluxes were assumed to be representative for an area of about 2 km x 2 km around the air quality monitoring stations.
- Models-3/CMAQ simulation:** US EPA's photochemical model, Models-3/CMAQ was employed to simulate spatial variation of NO_x and HNO₃ deposition fluxes. The computational domain spanned 120 km in east-west direction and 80 km in south-north direction. The spatially and temporally allocated emission data were provided by the Arizona Department of Environmental Quality. Meteorological data were simulated by means of the atmospheric model MM5 (Penn State/NCAR) using nested simulations of four domains. The output of the MM5 innermost domain (2 km x 2 km) was used for the Models-3/CMAQ computations starting at 04:00 July 22 1996 and ending at 00:00 LST July 24 1996. USGS land use data with 30 second resolution were used in both, the MM5 and Models-3/CMAQ simulations (cp. Poster B22B-0756 Hope *et al.*).

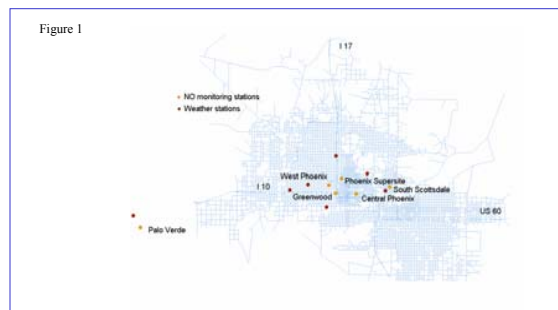


Figure 1

Table 1:

Annual deposition	NO	NO ₂	NO _x [kg ha ⁻¹ year ⁻¹]
Phoenix Greenwood	0.1	6.0	17.9
Central Phoenix	0.05	5.2	11.7
West Phoenix	0.06	4.3	10.6
Phoenix Super Site	0.05	4.6	11.0
South Scottsdale	0.03	3.7	7.4
Palo Verde	0.001	0.3	0.4



West Phoenix Air Monitoring Site

- Monitored data:** Hourly data on ambient concentrations of NO, NO₂ and NO_x were obtained from 6 air quality monitoring stations operated by the Arizona Department of Environmental Quality and Maricopa County Air Quality Division (Figure 1). Five sites were located within the urban core area and one site in the surrounding desert. Hourly air temperature, dew point temperature, relative humidity, solar radiation and wind speed at 10 m) were obtained from the NWS and PRISMS stations.

Figure 3: Simulated annual NO₂ dry deposition flux F_{NO2}

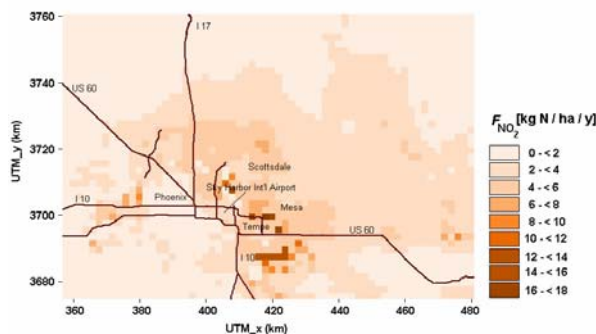
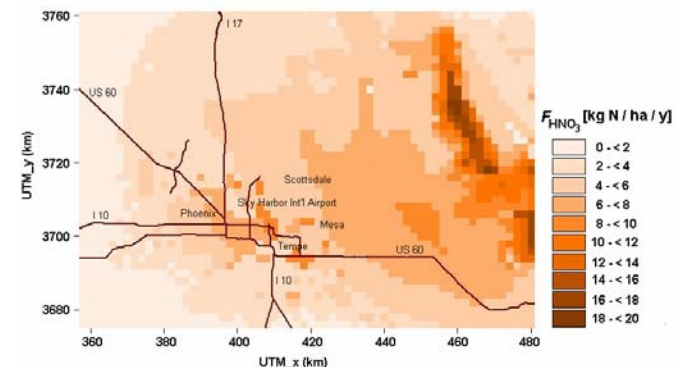


Figure 4: Simulated annual HNO₃ dry deposition flux F_{HNO3}



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Central Phoenix Monitoring Site

