Using Satellite and Climate Model to Study Urban Heat Island and Aerosol Effects

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Urban Related Publications

Jin, M., J. M. Shepherd, M. D. King, 2005: Urban aerosols and their interaction with clouds and rainfall: A case study for New York and Houston. *J. Geophysical Research*, 110, D10S20, doi:10.1029/2004JD005081.

Jin, M, R. E. Dickinson, and D-L. Zhang, 2005: The footprint of urban areas on global climate as characterized by MODIS. *Journal of Climate, vol. 18, No. 10, pages 1551-1565*

Jin, M. and J. M. Shepherd, 2005: On including urban landscape in land surface model – How can satellite data help? *Bull. AMS, vol 86, No. 5, 681-689.*

Jin, M. and S. Liang 2006: *Improving Land Surface Emissivity Parameter of Land Surafce Modele in GCM* **J. of Climate. 19, 2867-2881**

Jin, M., J. M. Shepherd, C. Peters-Lidard, 2007: *Development of a parameterization for simulating the urban temperature hazard using satellite observations in climate model.* **Natural Hazards, DOI 10.1007/s11069-007-9117-2**

Jin, M. and J. M. Shepherd, 2008: *Aerosol Relationships to Warm Season Clouds and Rainfall at Monthly Scales Over East China: Urban-land vs. Ocean* **J. Geophys. Res., 113, D24S90, doi:10.1029/2008JD010276.**

Some Background

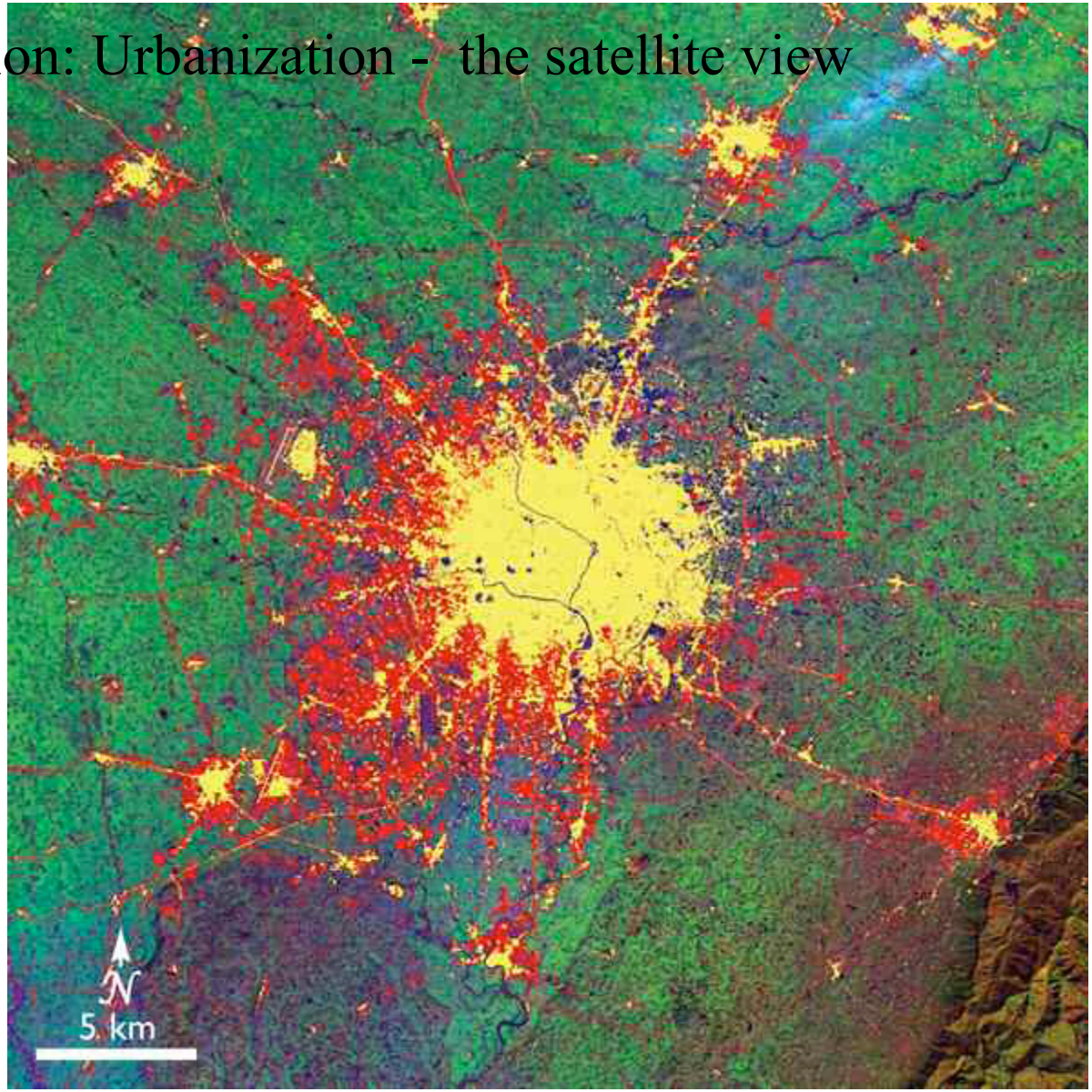
Education:
Ph.D. in Atmospheric Science, The University of Arizona
Research Scientist in University of Maryland /NASA Goddard Space Flight Center

Research Goal – Urbanization and Climate Changege:
Urbanization is an extreme case for Land Use and Land Cover Change.
We use NASA EOS and NCAR Climate Model to examine the urbanization effects, in particular,

urban pollution

urban heat island effect (UHI)

An application: Urbanization - the satellite view

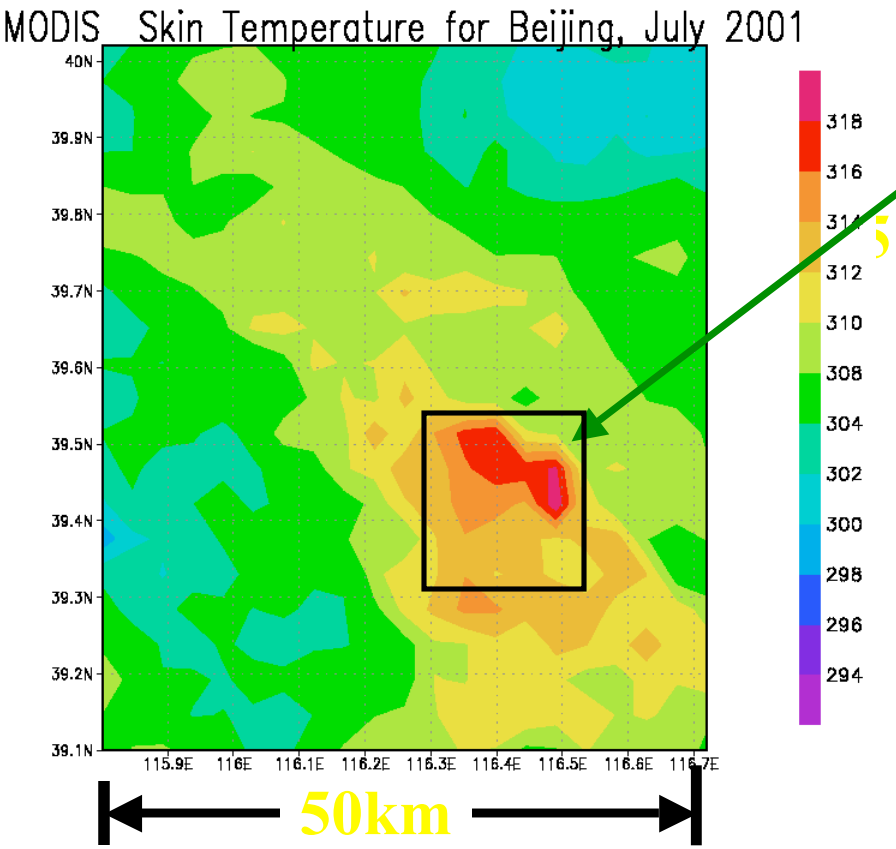


MODIS image for Chen Du, China –satellite provides high resolution information on land cover, temperature, albedo, vegetation, aerosol, etc

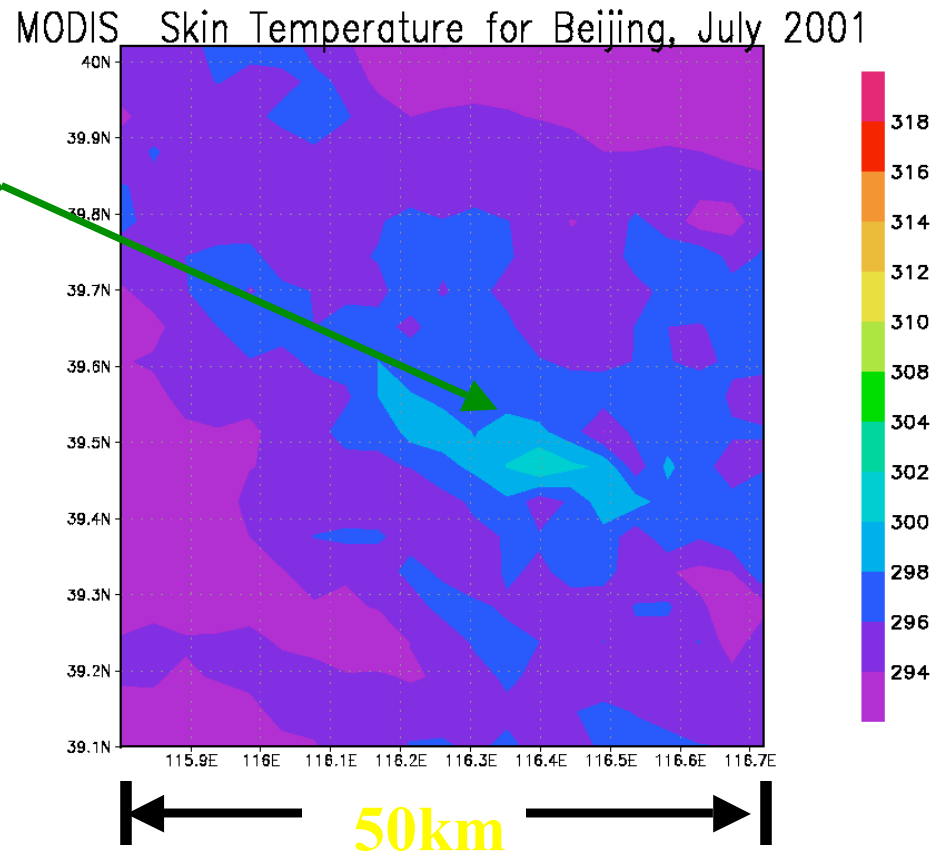
MODIS

Urban heat island effect

Daytime

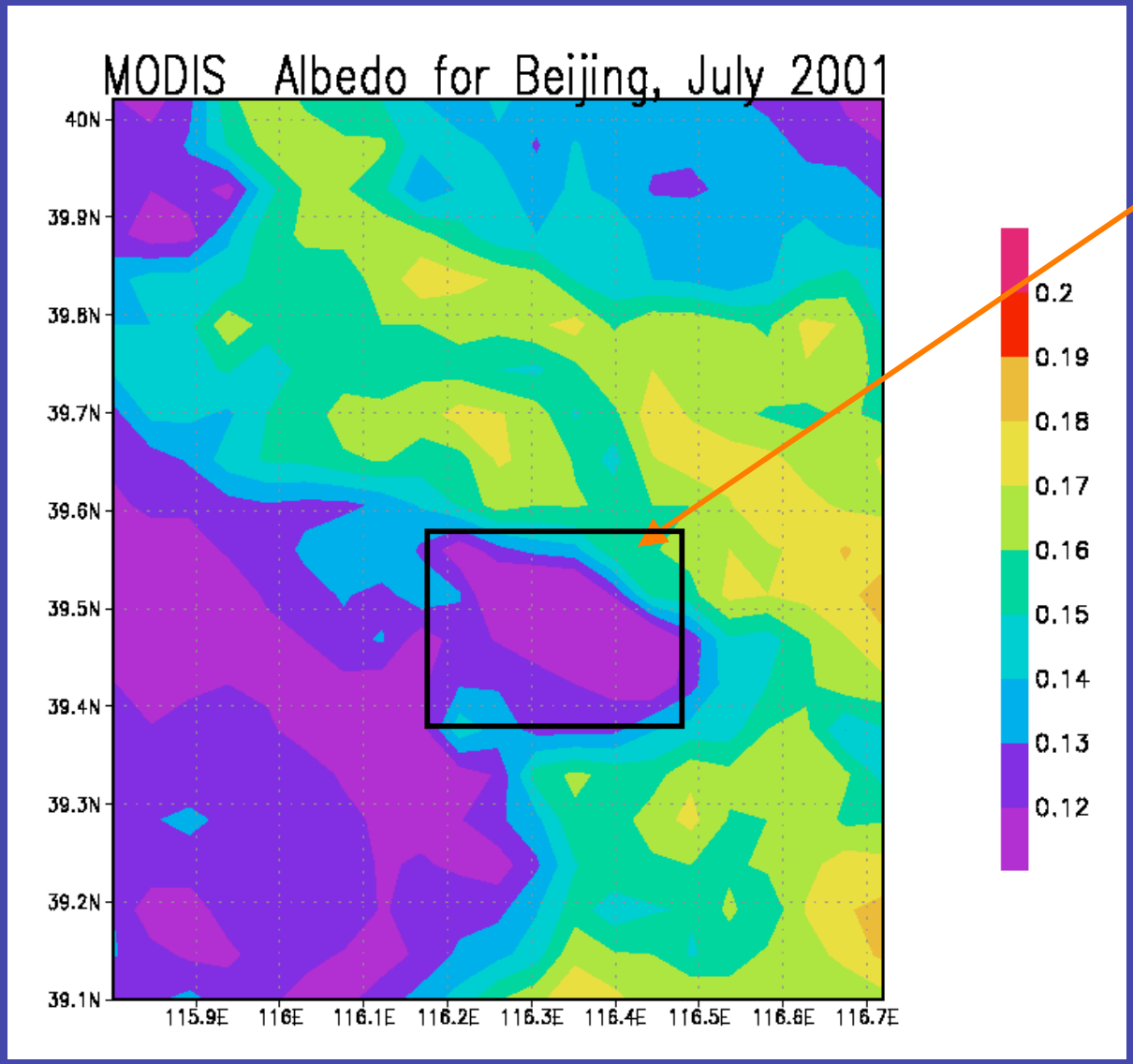


Nighttime



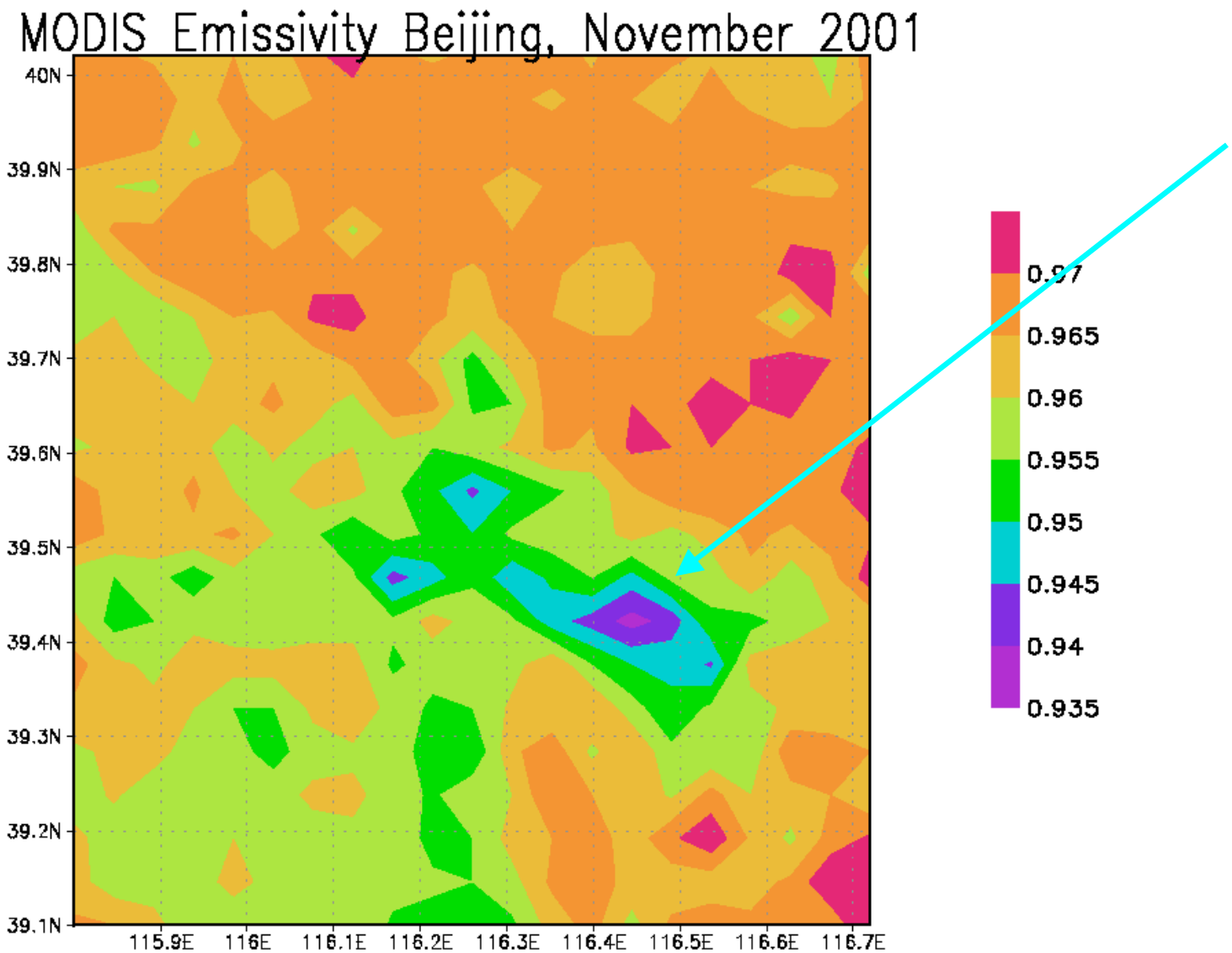
(Jin, Dickinson et al. 2005, J. of Climate)

Urbanization changes surface albedo (**MODIS**)

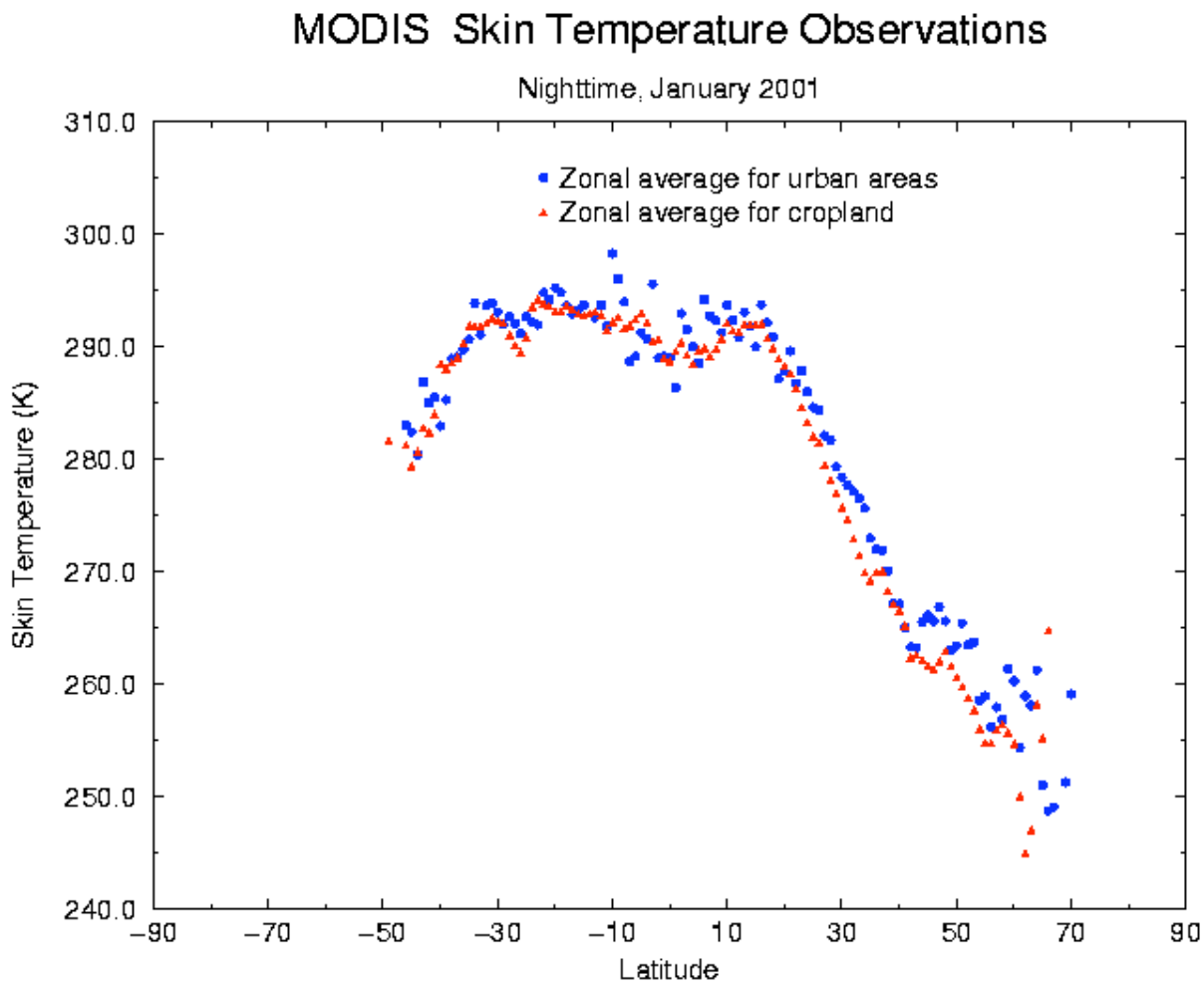


(Jin, Dickinson, and Zhang 2005, J. of Climate)

Urbanization changes surface emissivity (MODIS)



MODIS Observed **Global** urban heat island effect

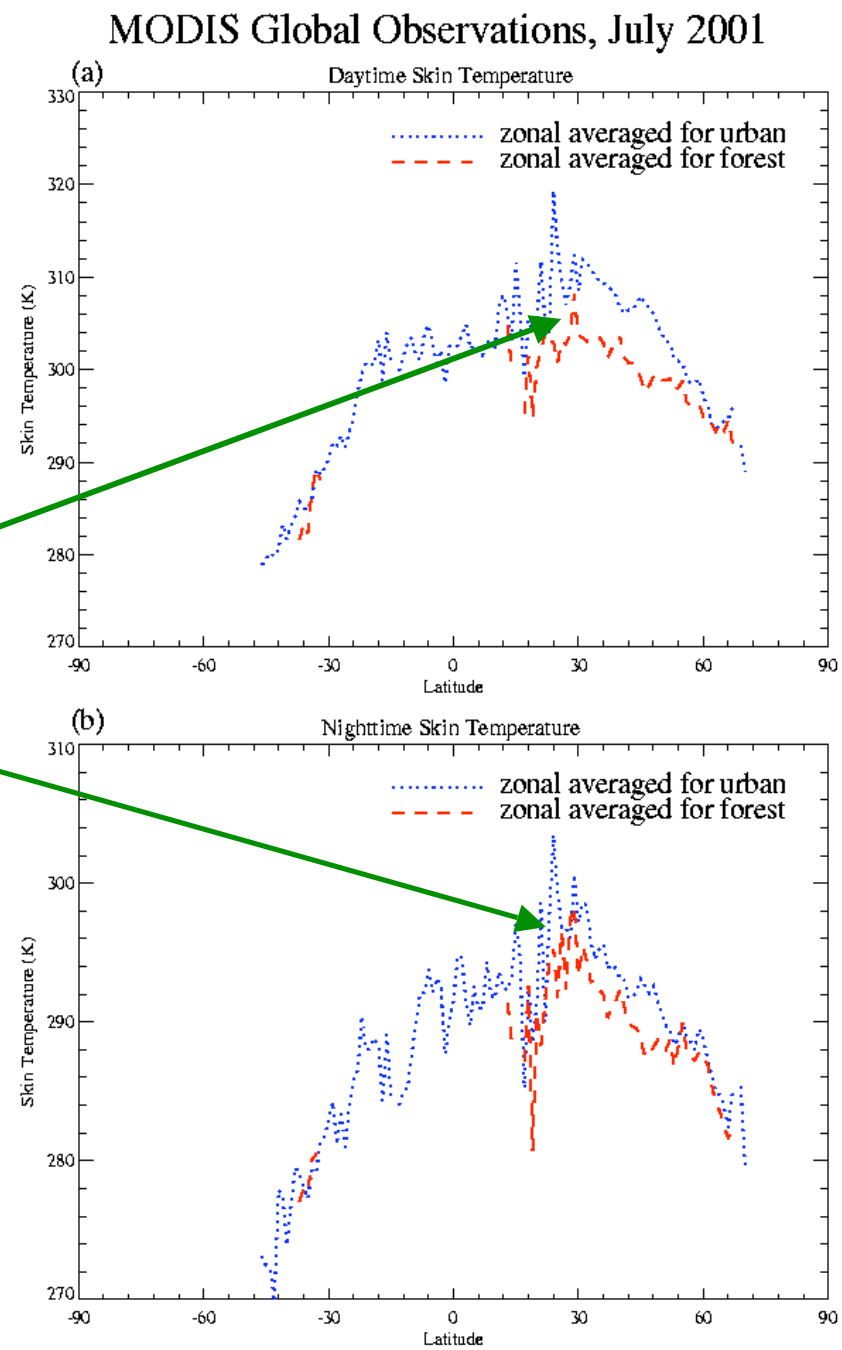


(Jin, Dickinson, et al. 2005)

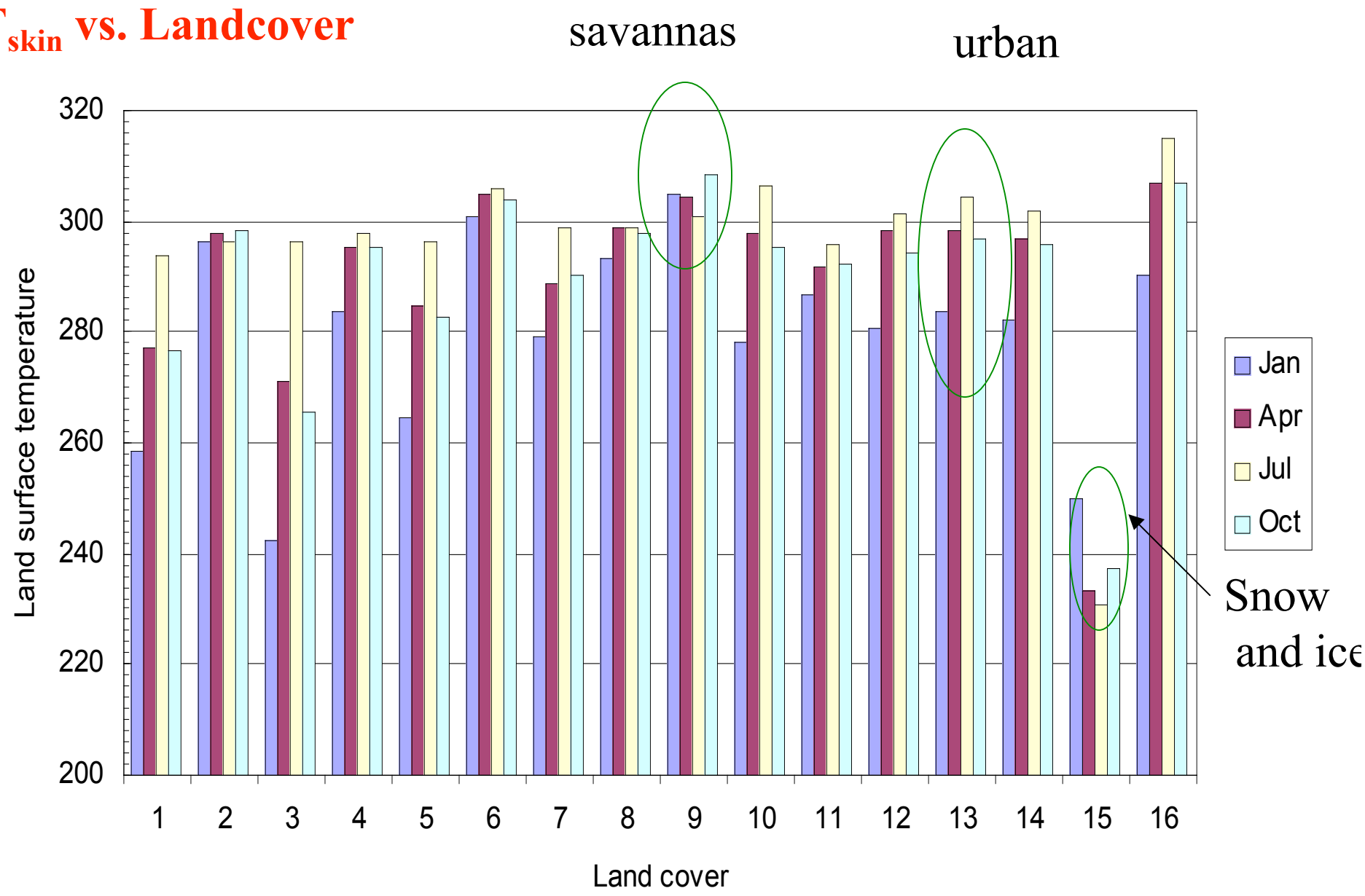
Comparison of skin temperature for urban and nearby forests

MODIS

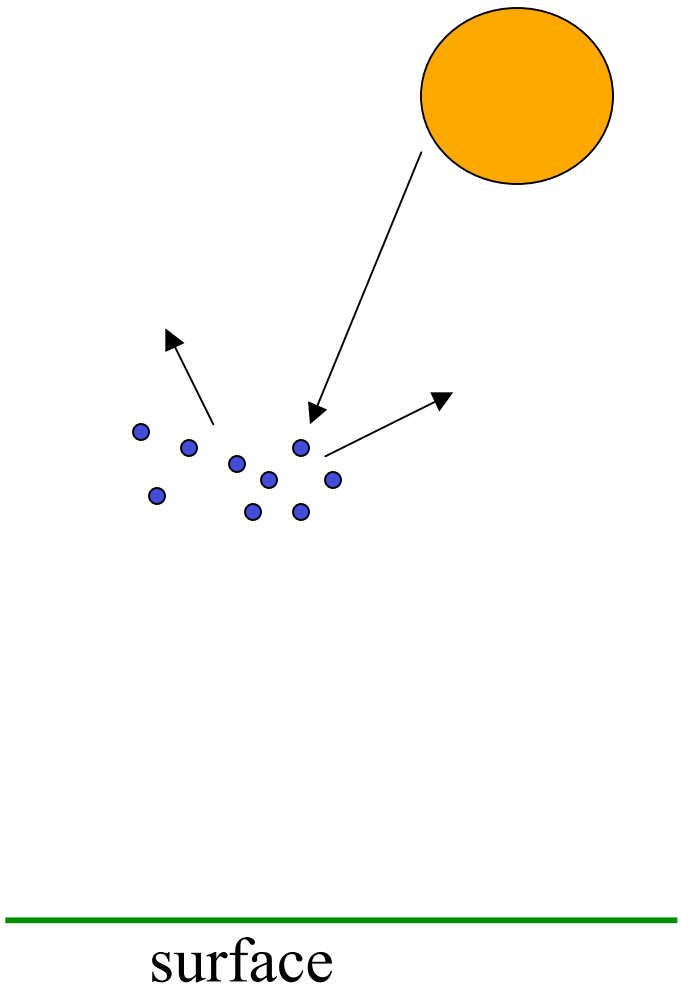
Cities have higher T_{skin} than forests



T_{skin} vs. Landcover

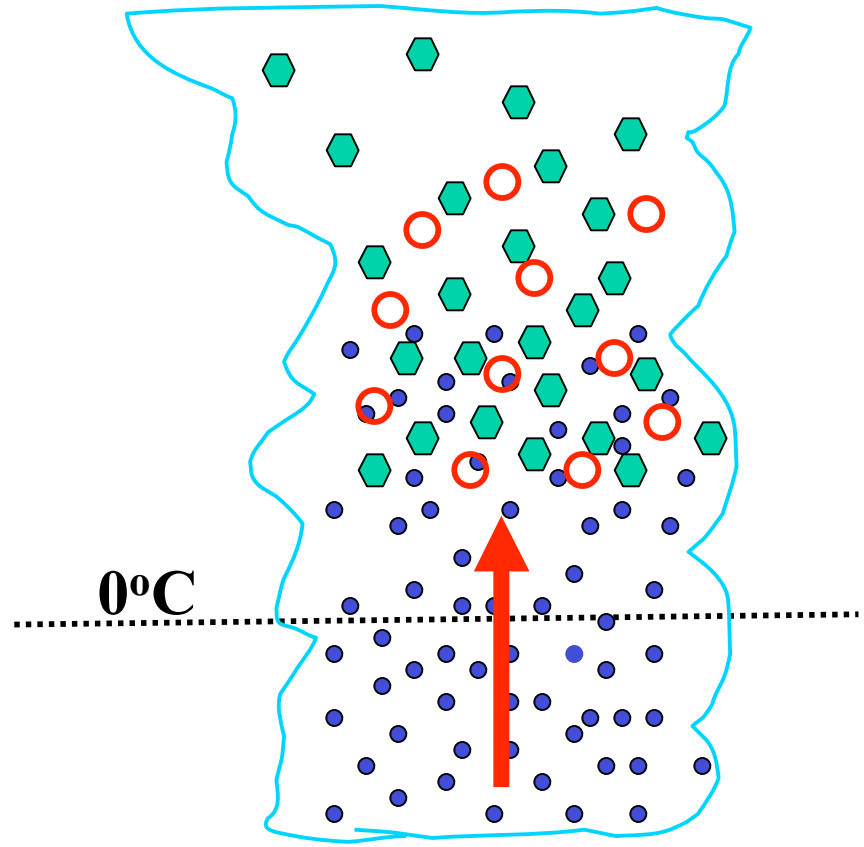


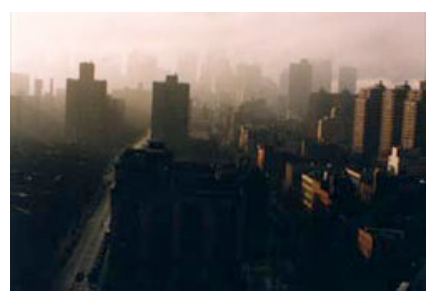
Aerosol <u>Direct Effect</u>: Scattering



Aerosol reduce surface insolation

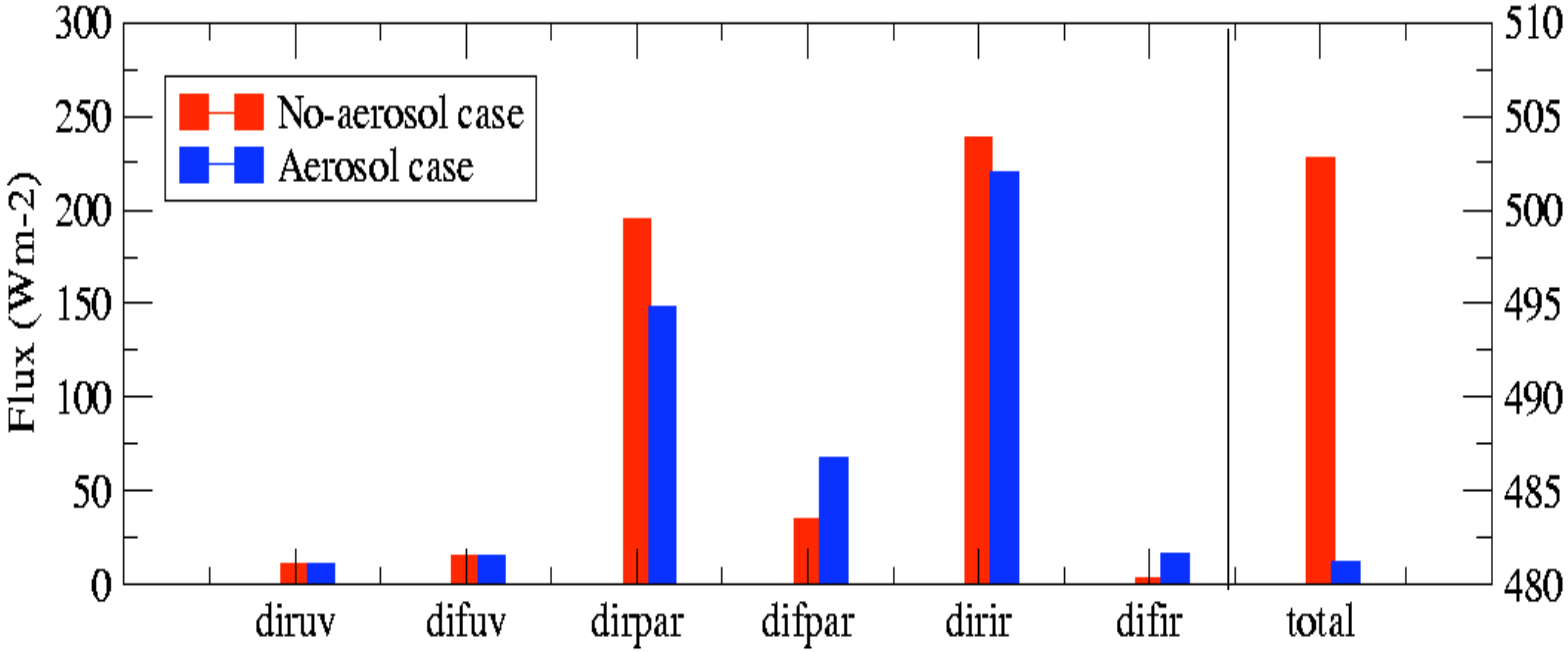
<u>Indirect Effect</u>: serve as CCN





- Cloud drop
- Rain drop
- Ice crystal
- Ice precipitation

Aerosol decreases surface insolation



Total solar radiation decreased by aerosol= 20Wm-2

Based on M-D. Chou's radiative transfer model

(Jin, Shepherd, and King, 2005, JGR)

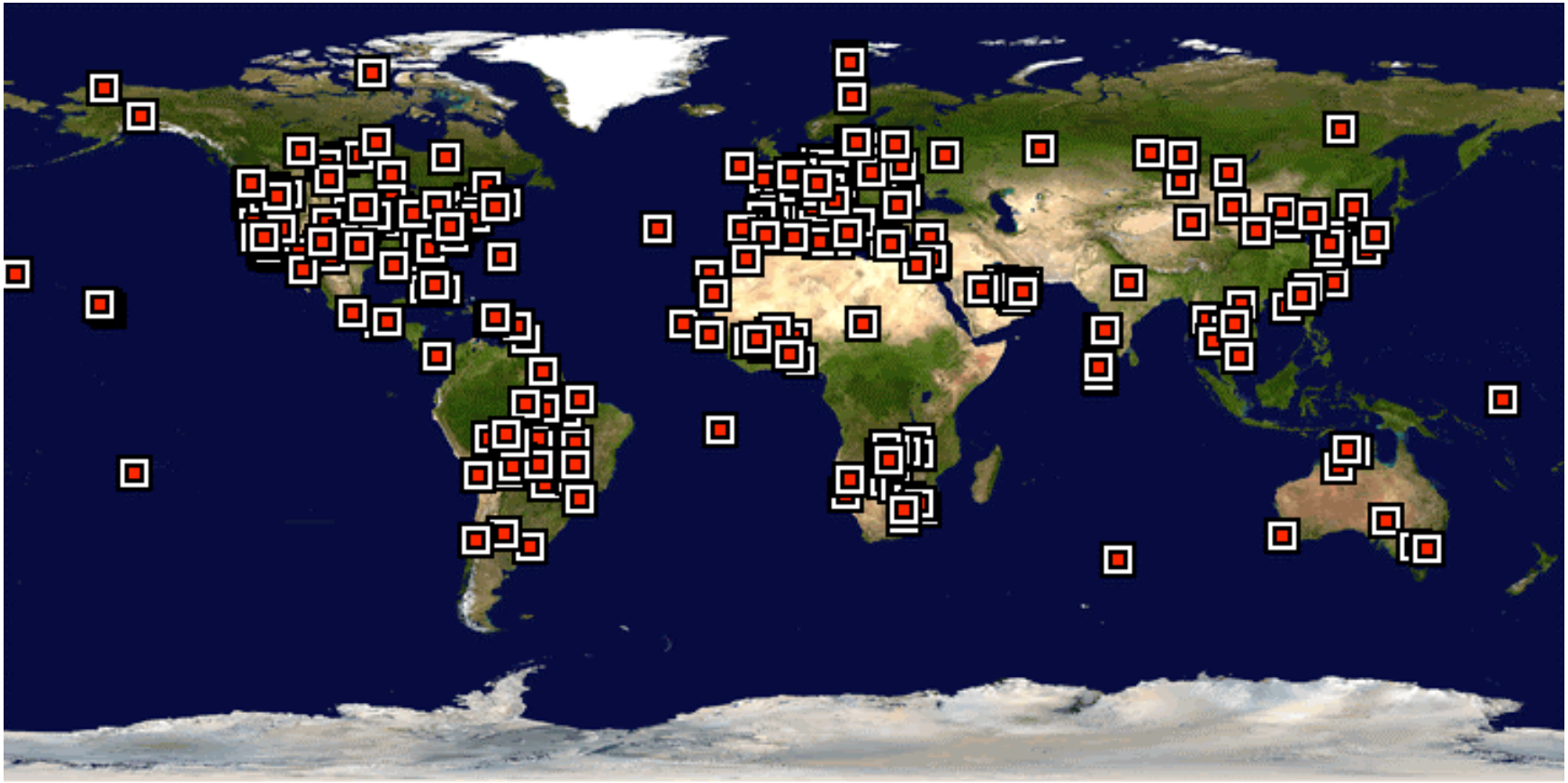
2. Data Sets

1. MODIS Daily and Monthly Aerosol Observations
2. MODIS Daily and Monthly Cloud Observations
3. Hourly Aeronet *in situ* Observations
4. Hourly EPA PM2.5 Measurements

5. TRMM Monthly Rainfall Observations

6. NCEP Reanalysis

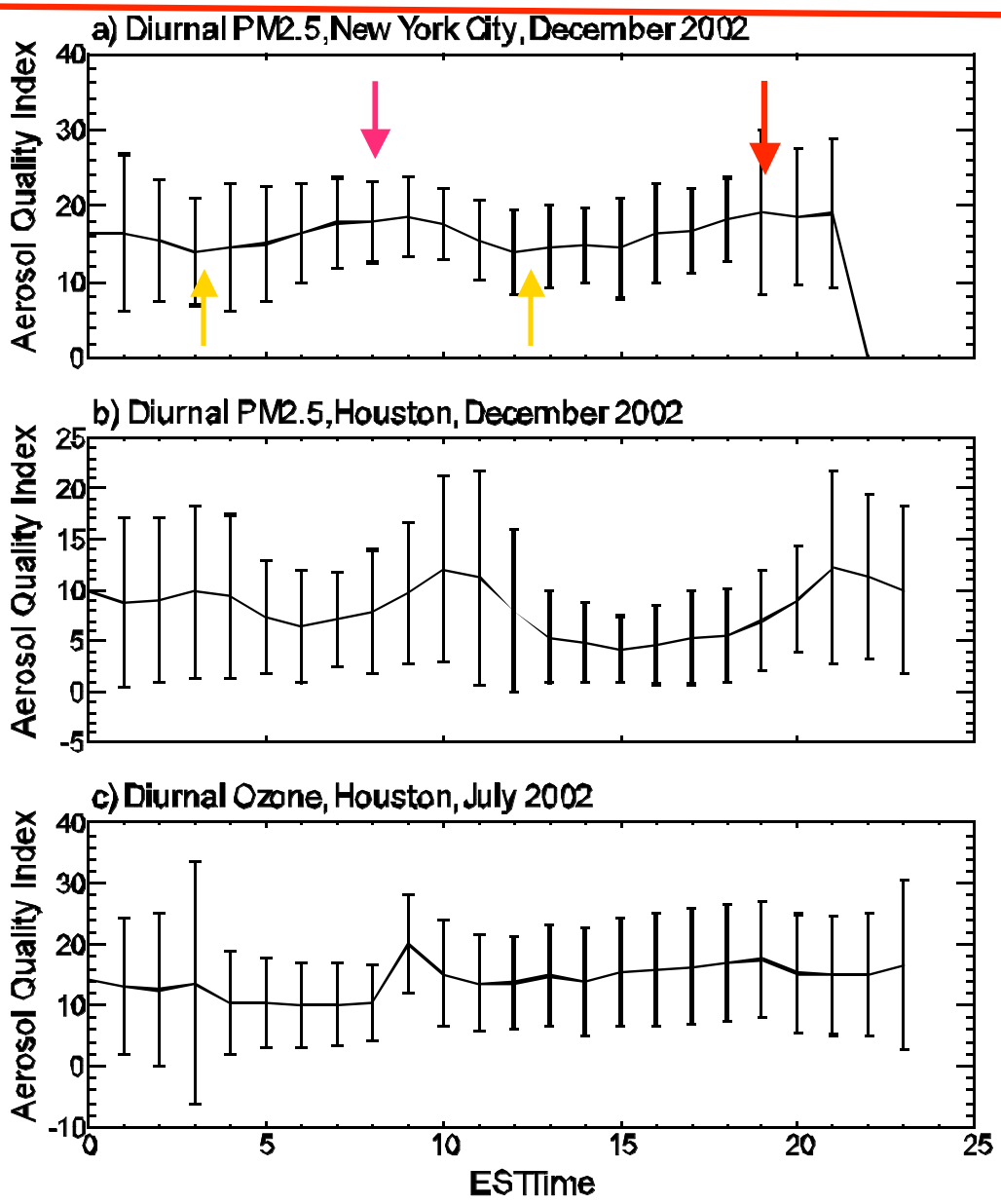
NASA Aeronet Sites



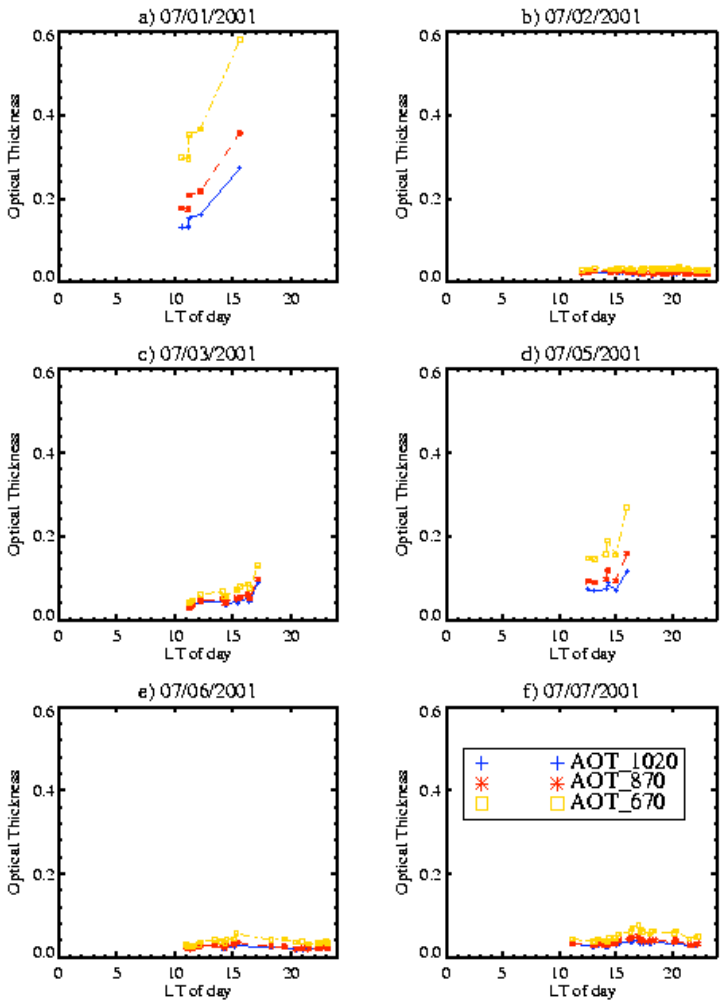
http://aeronet.gsfc.nasa.gov/

Ames has on of this site!

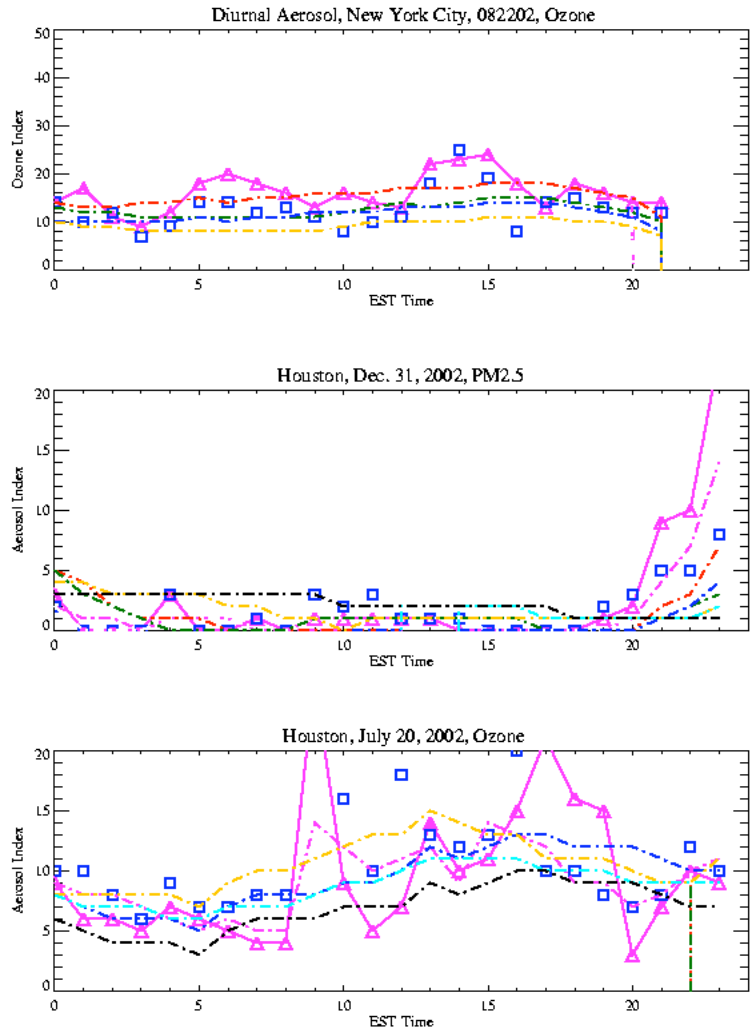
3. Result: Diurnal Cycle of Urban Aerosols



AERONET, New York

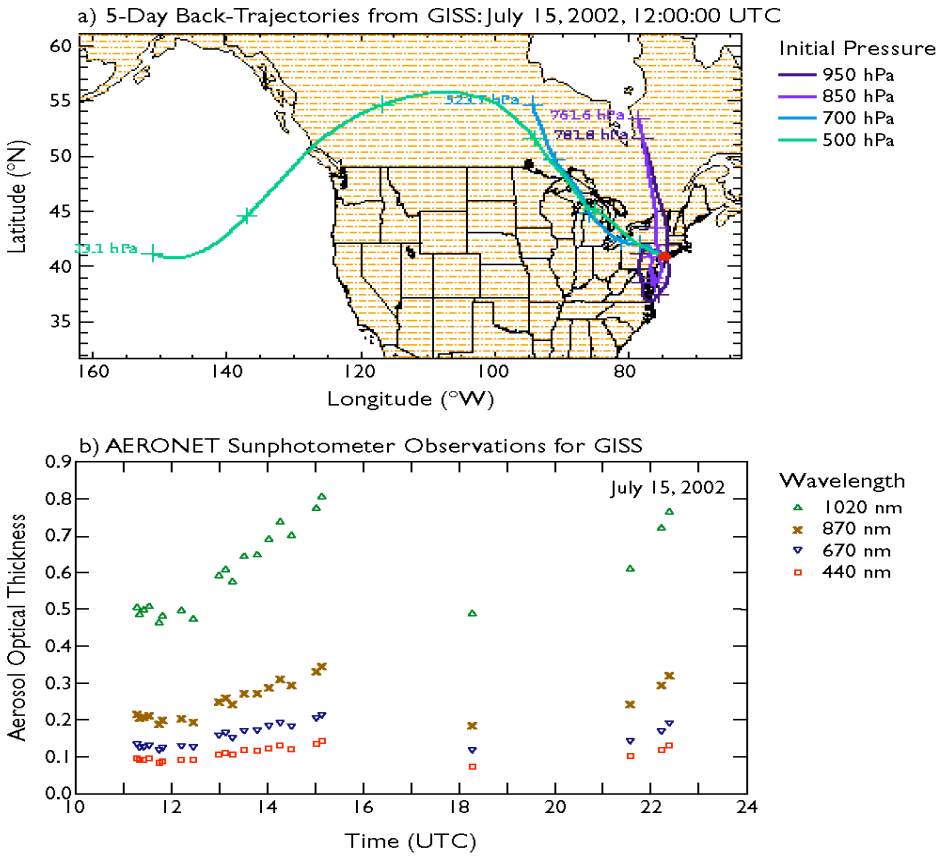


EPA



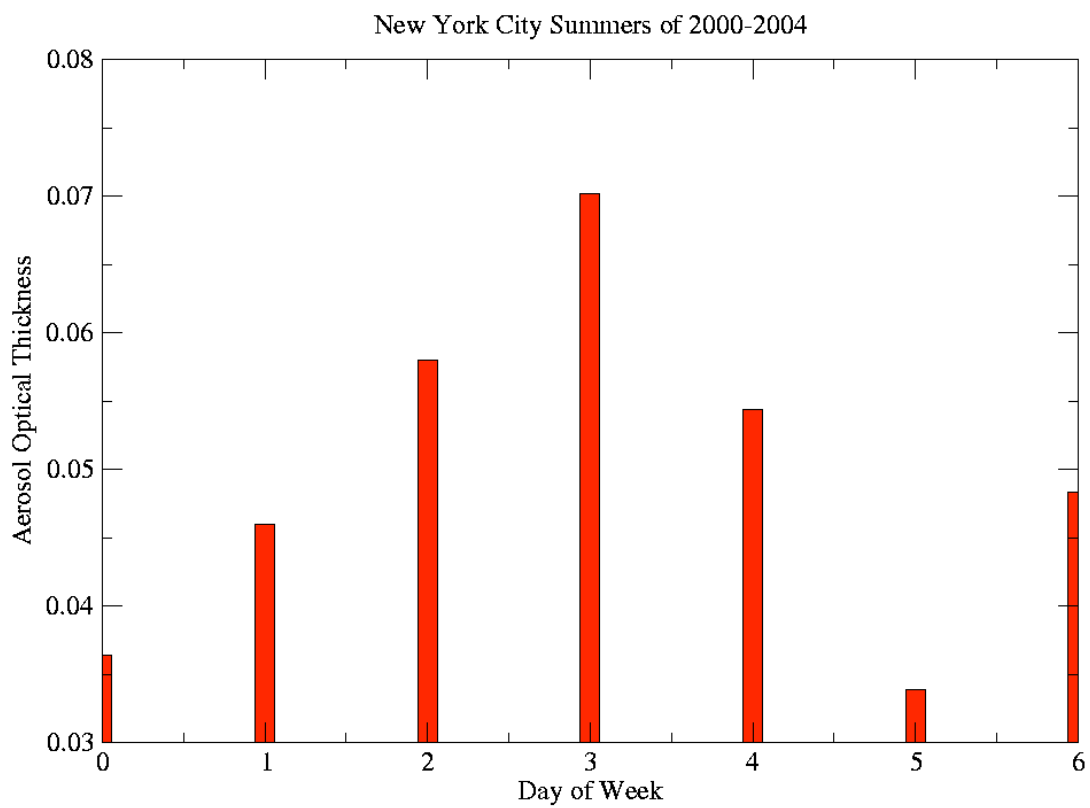
Scale, Scale, Scale!!

Back Trajectory Analysis (Anne Thompson)



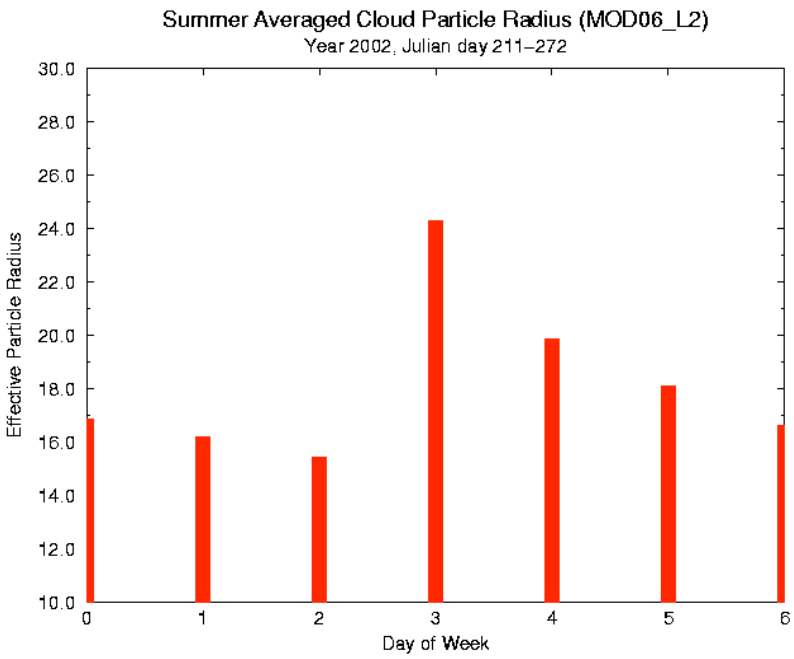
http://www.aeronet.gsfc.gov

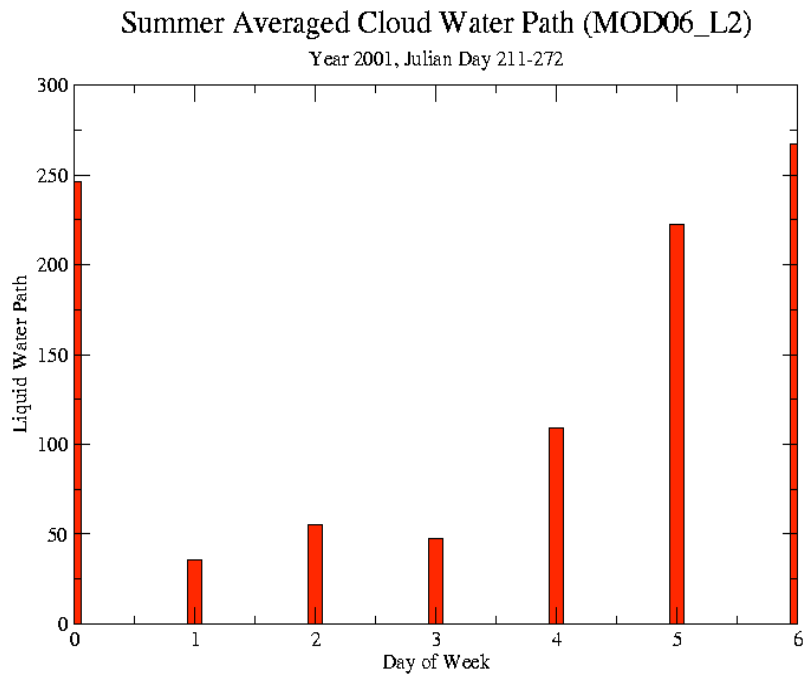
3.3 Results: Weekly Cycle



Averaged weekly distribution of aerosol optical thickness based on AERONET GISS station (41˚N, 74˚W).
Data are from August-September 2000, June-September 2001, and June-September 2002. To minimize the transport effect, for each day, only observations within nighttime hours 17:00pm-22:00pm are used to calculate the daily average. And only daily averages smaller than 0.15 are used to analyze the weekly variation.
X-axis is day of the week, with "0" as Sunday, "1" as Monday, "2" as Tuesday, "3" as Wednesday, "4" as Thursday, "5" as Friday, and "6" as "Saturday".

Weekly Cycle – signature of human activity





Future Interests – Local Component

Urbanization heat island effect and local agricultur
(example: cherry)

Urbanization and traffic and energy use