

Development Sprawl Impacts on the Terrestrial Carbon Dynamics of the United States

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Objectives

To analyze the impacts of development on the terrestrial carbon dynamics of the 48 states.

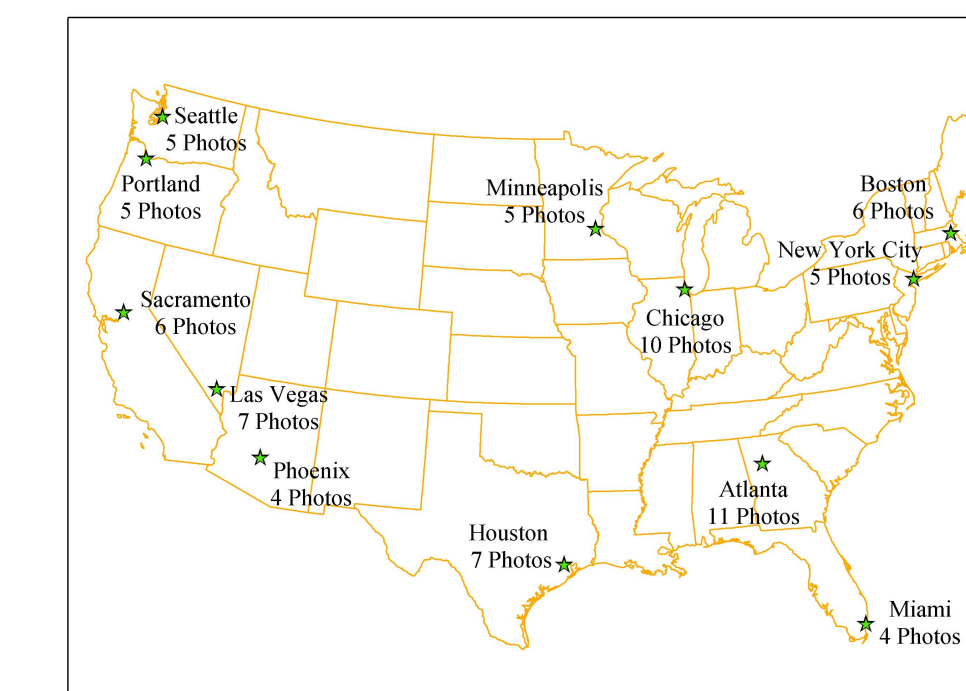
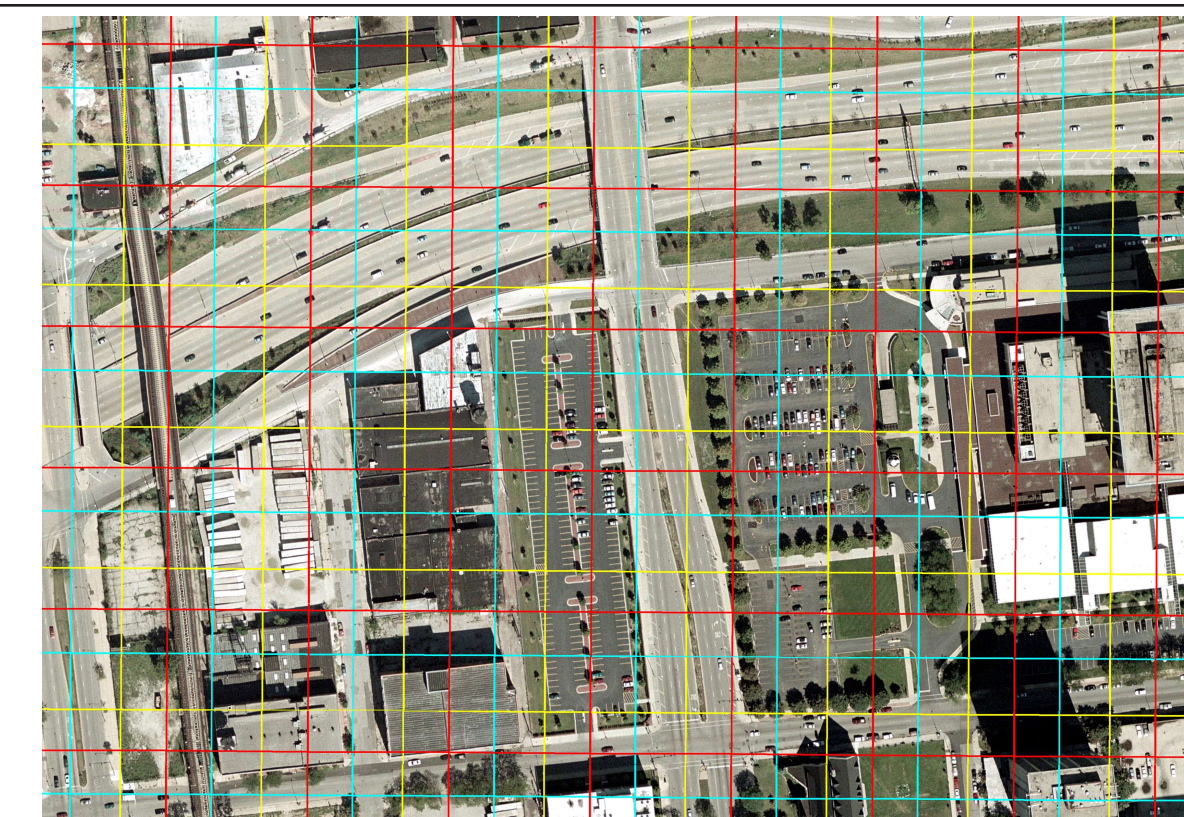
The impact will be analyzed by comparing ecosystem model runs made using land cover data with and without the current level of development. Surfaces covered by constructed materials (roads, buildings, etc.) are withdrawn from photosynthesis and respiration. This loss is counterbalanced to some extent by managed vegetation (lawns, trees, etc.), which may be irrigated and fertilized. Unlike other types of disturbances, development typically does not have a recovery phase. Other disturbances such as deforestation have a demonstrable effect on terrestrial carbon dynamics. We will evaluate the impact development has on terrestrial carbon dynamics, and how this effect varies spatially. This information should be useful for improving our understanding, modeling and prediction of the global carbon cycle and the build up of carbon dioxide in the atmosphere.

Approach

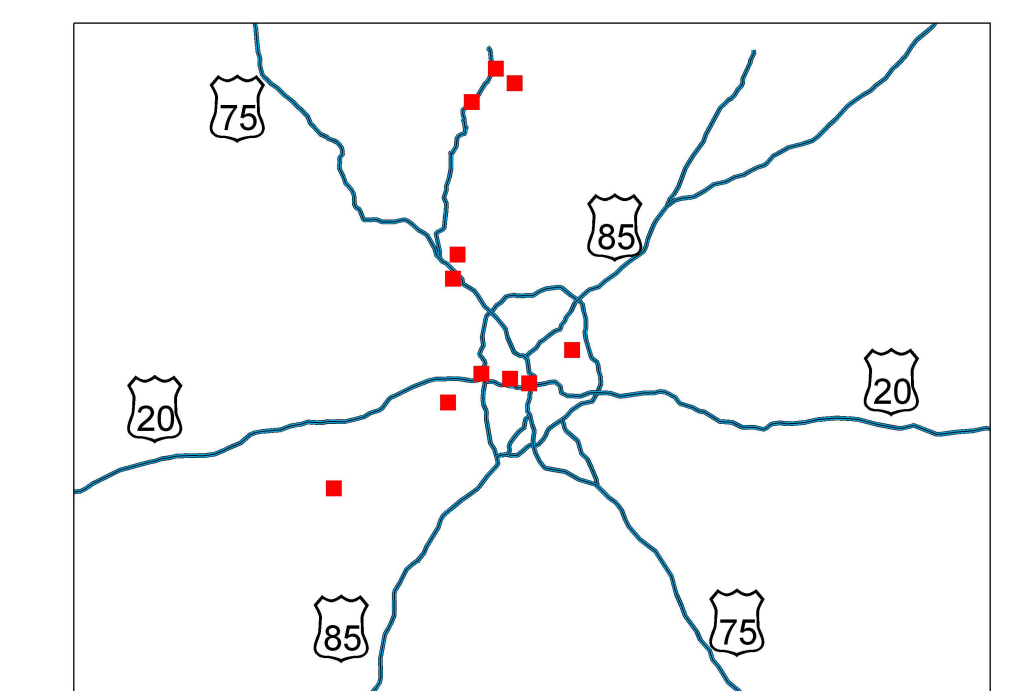
We have assembled a series of one km land cover grids of the USA relevant to development impacts on the terrestrial carbon cycle. The national 1 km Albers Equal Area grids include:

- 1) regrided 30 meter land cover from Landsat TM (MRLC),
- 2) radiance calibrated nighttime lights from the DMSP-OLS,
- 3) road density derived from the U.S. Census Bureau TIGER data

For calibration, percent cover of impervious surface was measured using gridded point counts made on 12 inch resolution color aerial photography tiles, matching the location of 1 km grid cells along transects across 12 urban centers in the USA. Linear regression was applied to define an empirical relationship for estimating the percent cover of impervious surface based on the brightness of lights and road density.



Transect Cities



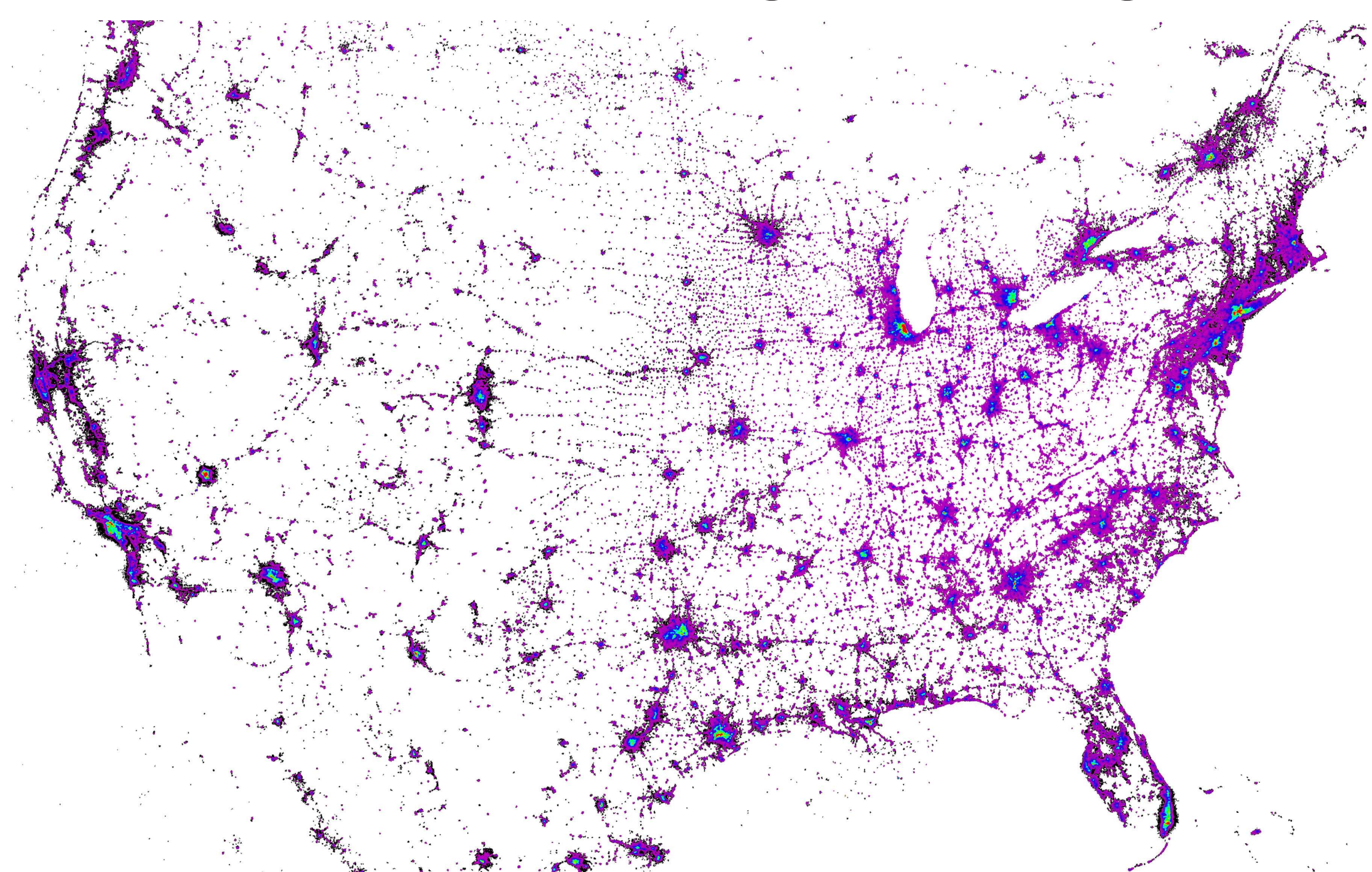
Location of Air Photo Tiles for Atlanta

$$\% \text{ Impervious} = 0.0259 + 0.2209(\text{radiance}) + 0.002299(\text{road density})$$

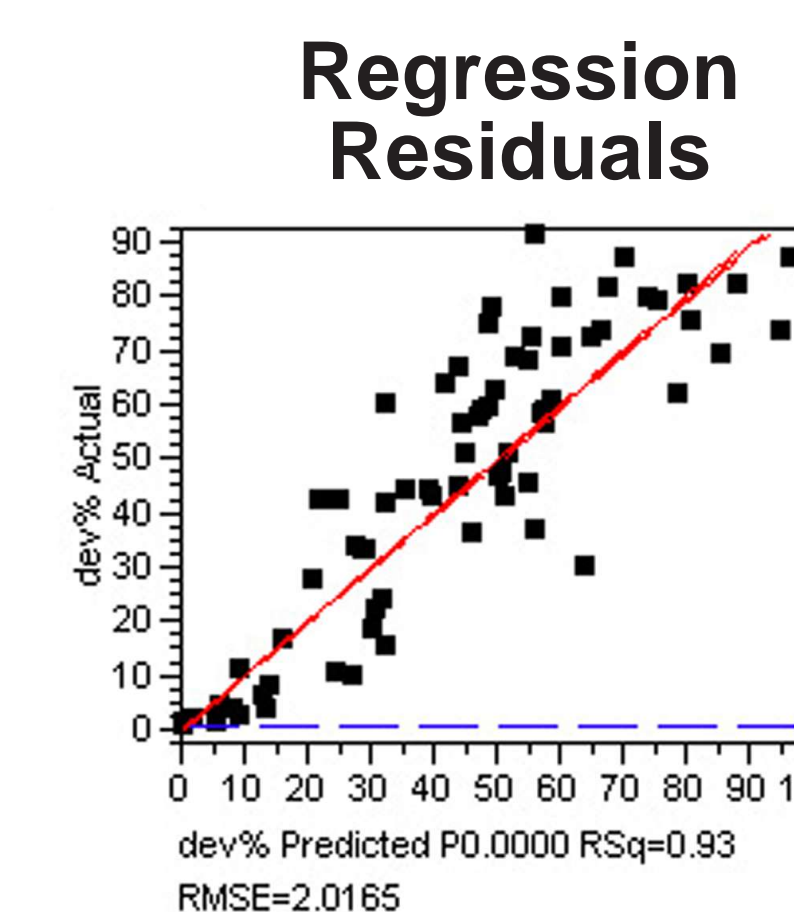
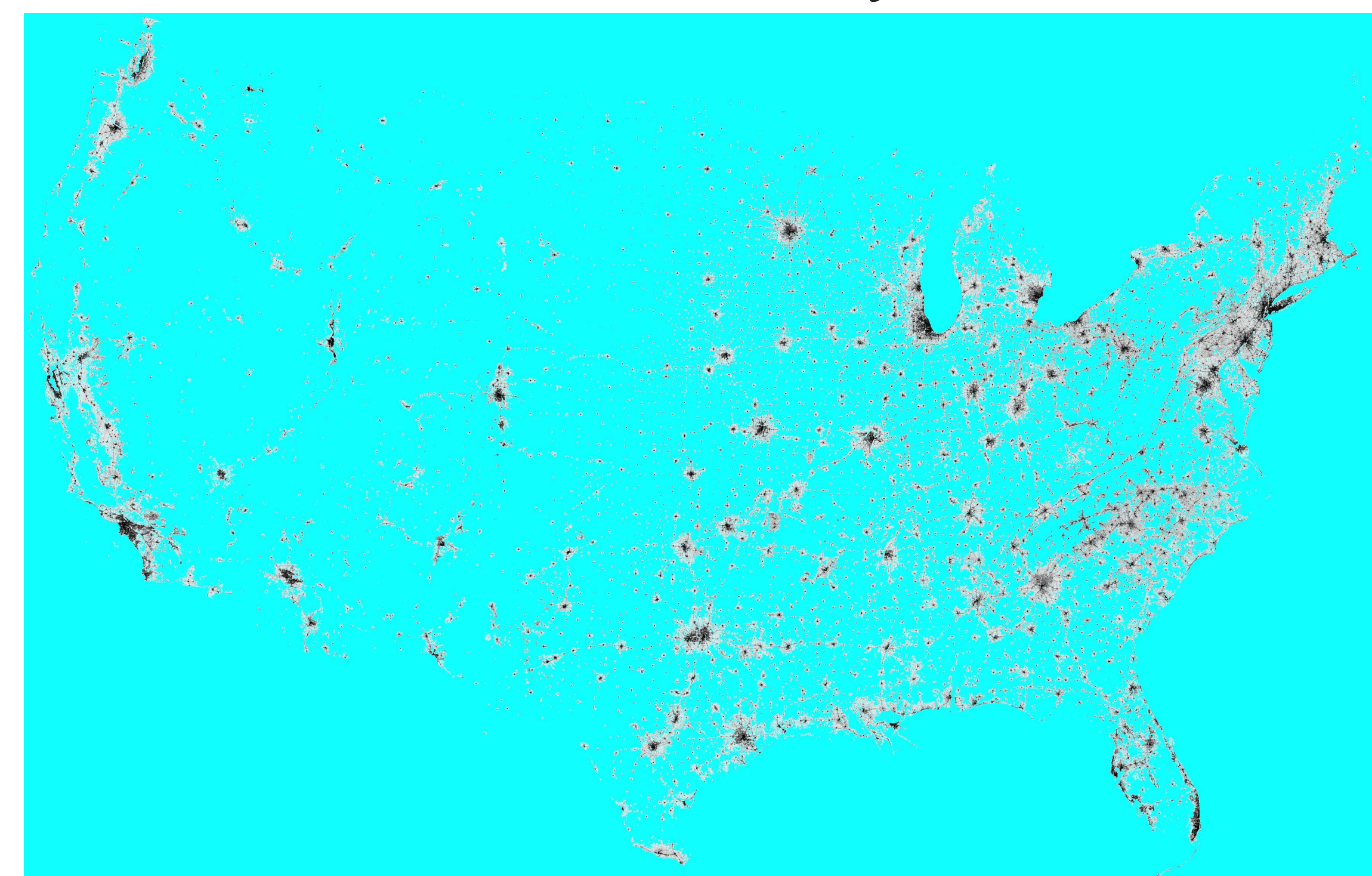
$$R^2 = 0.93$$

Lights + Road Density => Percent Cover Impervious Surfaces

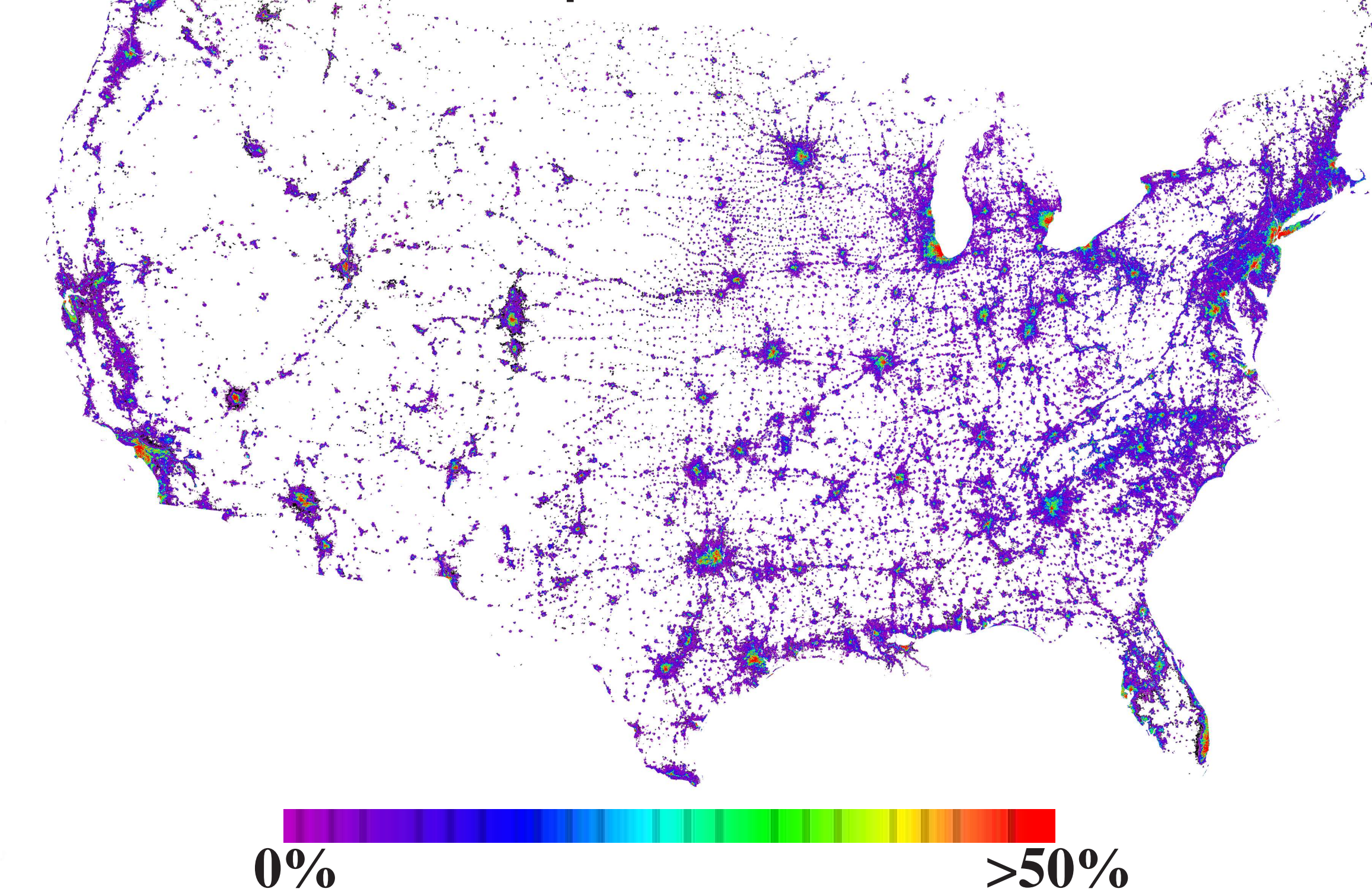
Radiance Calibrated Nighttime Lights 2001



TIGER Road Density 1998



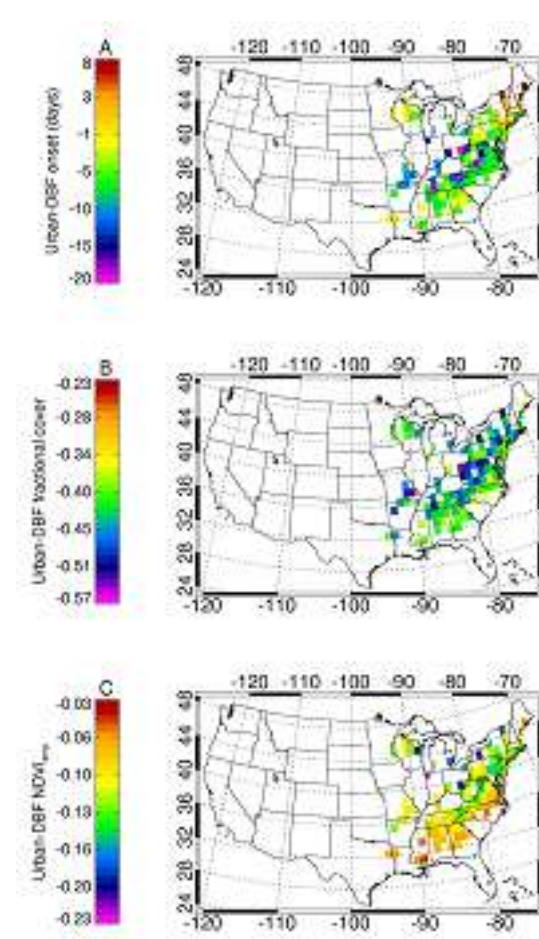
Impervious Surfaces



Results

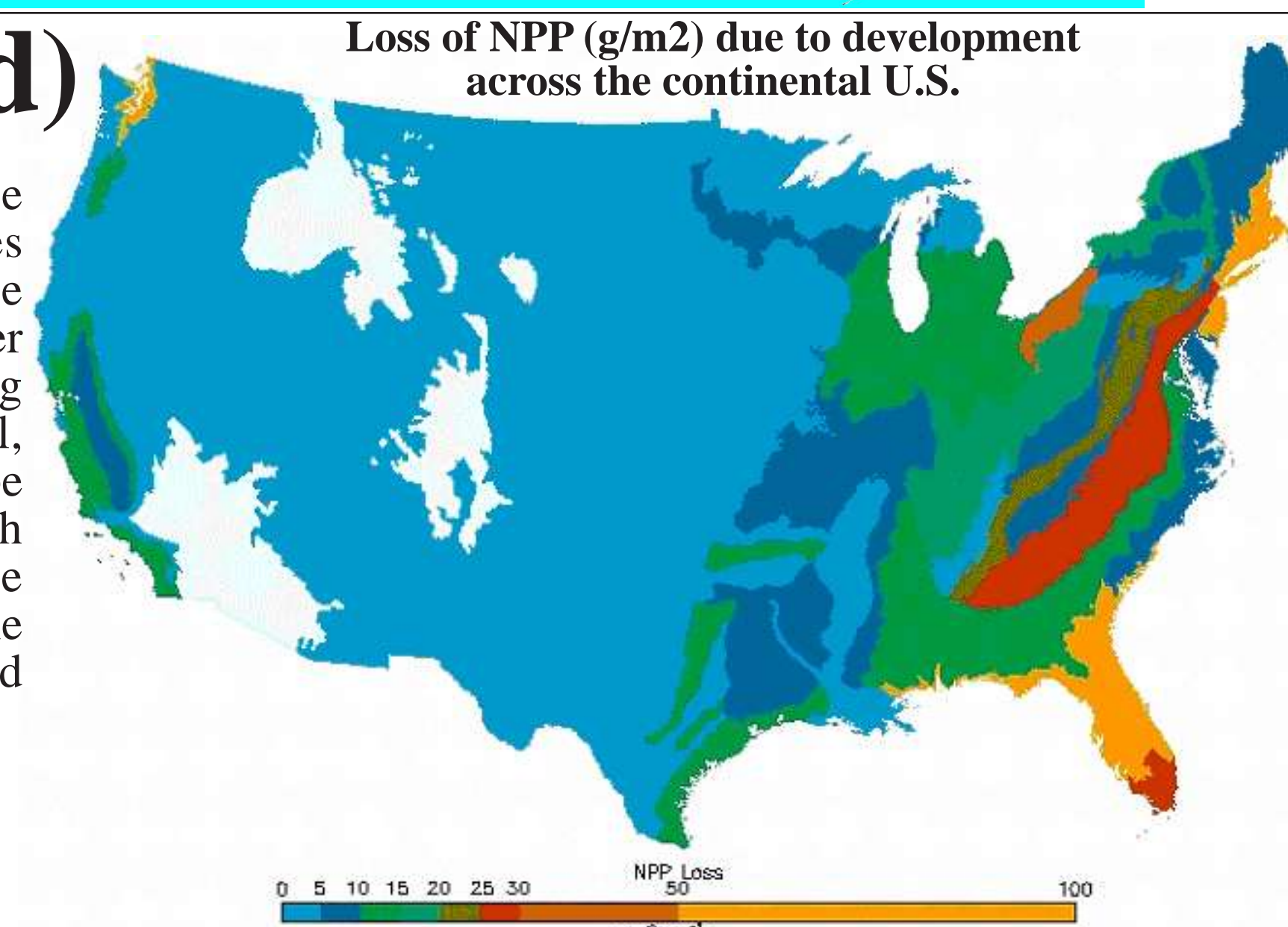
We found the onset of greenness is earlier in urban areas by 2-7 days. The reason for such an advancement is found to be enhanced temperatures as a result of urbanization. The fraction of vegetation cover is a significant factor in controlling the phenological differences. Areas with low fractional cover (high development) showed the earliest onset of greenness in urban areas.

Phenological and vegetation differences between urban and DeciduousBroadleaf Forest (DBF) land covers. Panels show, for all 1° latitude by 1° longitude blocks with statistically different growing season length between urban and DBF regions, the within block difference of: (A) onset of greenness, (B) fractional cover, and (C) normalized difference vegetation index amplitude.



Results (continued)

The total NPP for the U.S. is estimated to be 2.6 Gt/yr which is similar to earlier estimates for the U.S. Then, for each ecoregion, we estimated the fraction of landscape that is under "development". This was done by aggregating land cover classes (from MRLC): residential, commercial and mines etc. This area came to be about 1.75% of the continental U.S. For each eco-region, we adjusted the NPP based on the fraction of area that is under development. The total NPP lost due to development is estimated to be 0.058 Gt/yr or 2.2%.



The data are available for download at:
<http://dmsp.ngdc.noaa.gov/html/download.html>

- One Km Grids:**
- 2001 Lights
 - Road Density
 - % Impervious Cover
 - MRLC Land Cover