Large Scale Cultural Festivities and Their Impacts on Urban Light Energy Use

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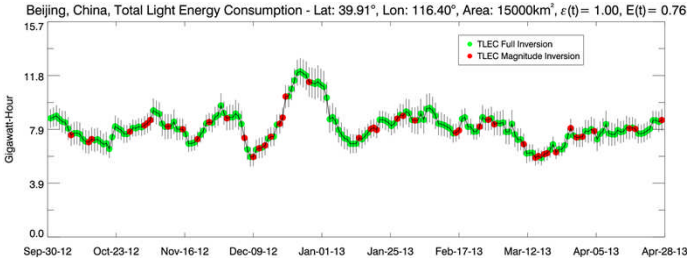
OVERVIEW

The next generation of low-light visible sensors, represented by the VIIRS Day/Night Band (DNB), offers enhanced nighttime observation capabilities over the heritage DMSP/OLS instrument. In land research and applications, the VIIRS-DNB will advance the study of urbanization dynamics at regional and global scales. In particular, the availability of stable, well-calibrated, nighttime radiances is of particular value to improve our understanding of urbanization trajectories through the explicit representation of urban land cover, urban population, and urban economic activities. This project consist of two parts: (1) demonstrating the VIIRS's ability to identify change in nighttime electricity consumption both spatially and temporally; and (2) assessing the ability of the VIIRS to distinguish between different types of energy use (e.g., residential, commercial, industrial, etc.) by exploiting the temporal signature of nighttime observations.

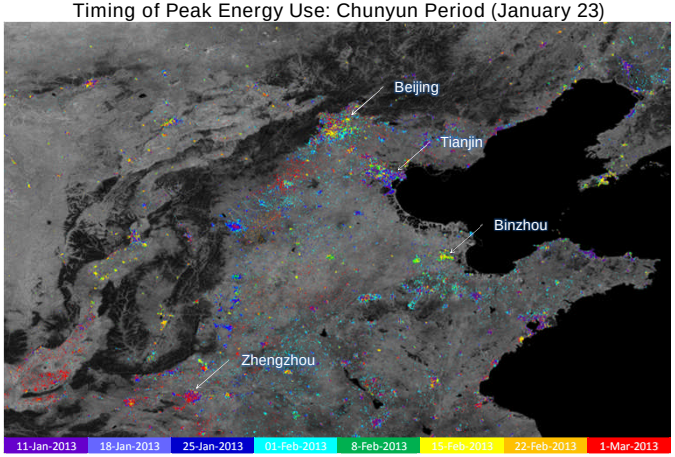
APPROACH

In previous work, nighttime lights have served as a proxy for total electricity use, energy consumption, and green house gas emissions. By measuring the variation in nighttime lights during festivities, we can observe how energy use and green house gas emissions vary seasonally and intraseasonally. As urban areas are responsible for 78-90% of global greenhouse gas emissions, the fundamental goal of this research is to gain a more comprehensive understanding of carbon dynamics within these urban landscapes. This study attempts to see if we can monitor variations in urban light energy consumption over time using the VIIRS Day/Night Band (DNB). Analyzing data before, during, and after festival time periods lets us see the effects of human social activities through the lens of urban light use, introducing the implementation of a new approach to understand the role of urban landscapes in the climate system.

Tracking the Largest Annual Human Migration
2013 Chinese New Year

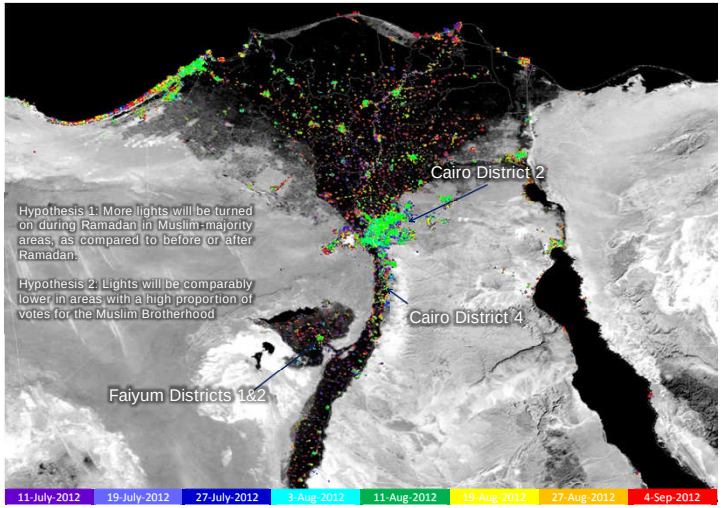


Timing of Peak Energy Use: Chunyun Period (January 23)



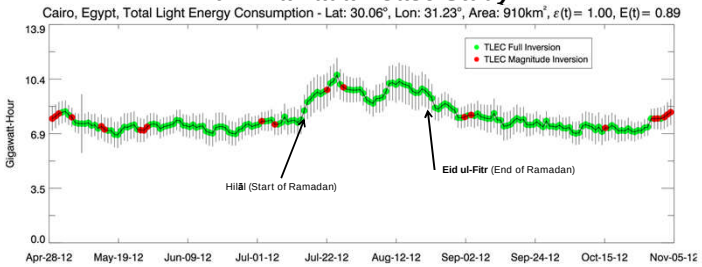
Chinese months are reckoned by the lunar calendar, with each month beginning on the darkest day. New Year festivities traditionally start on the first day of the month and continue until the fifteenth, when the moon is brightest. In China, people may take weeks of holiday from work to prepare for and celebrate the New Year. This image shows the migration of workers from the cities to the more rural villages, predominantly shown in Cyan and Blue.

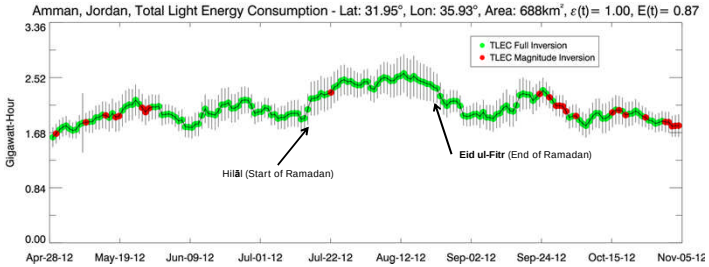
Timing of Peak Energy Use: 2012 Ramadan Period (Jul 19 – Aug 18)



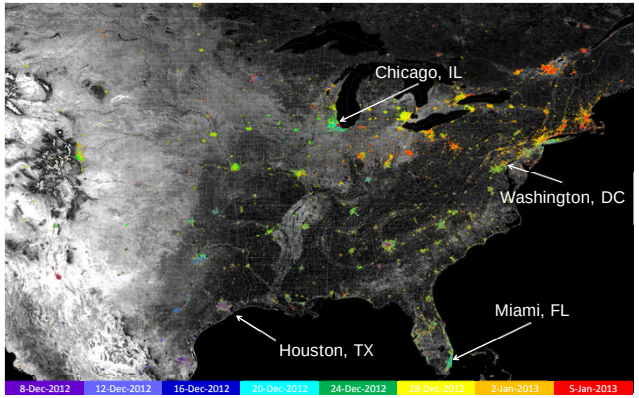
Ramadan is a month of religiously-obligated fasting without food or water from dawn to dusk. Observing Ramadan is considered one of five fundamental obligations for Muslims to perform, barring medical or other exemptions. During the period of the fast, extra prayers are held after sunset in addition to the standard five prayers. The dawn and sunset prayer mark the start and end of the daily fast. The rhythm of the daily prayers influences light usage and is thus should be observable using the VIIRS. Those who rise before dawn to perform the daily prayer and eat breakfast before the fast starts often turn on lights. If light usage is greater amongst those observing the fast and praying, then during Ramadan light usage may be a useful proxy for religious observance.

A Proxy for Religious Observance
2012 Ramadan Case Study



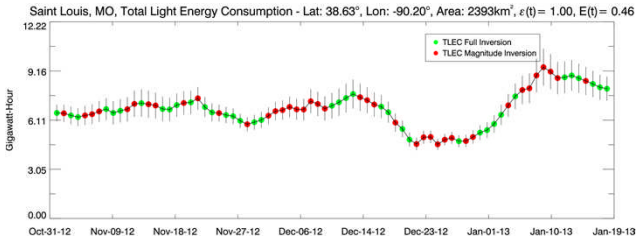


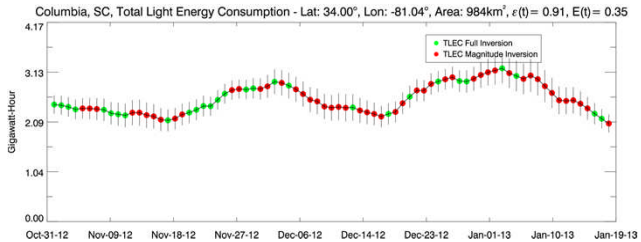
Timing of Peak Energy Use: 2012 Holiday Season



This figure shows urban areas in multiple colors -- designating peak energy use (based on a time series between 8-Dec-2012 and 9-Jan-2012). Areas that peaked during Christmas (25-Dec) are shown in green (e.g., small towns across the plains and the Carolinas). Notice also that the cities in Eastern Texas (Dallas, Houston, Austin, San Antonio) have similar peak-timings (early December during the peak-shopping/pre-holiday season). Atlanta has quite a unique donut-shaped signature (with the metro area peaking later than the suburbs).

Defining Communities and their Social Connections
2012 Holiday Season Case Study





SCIENTIFIC SIGNIFICANCE & RELEVANCE TO NASA:

This study of urban energy sectors using the Suomi-NPP VIIRS Day/Night Band is relevant to NASA's 10-year Strategic Plan, specifically the "Overarching Strategy of Committing to environmental stewardship through Earth observation and Science". This study focuses on Strategic Goal 2.1 to: "Advance Earth System Science to meet the challenges of climate and environmental change". The ability to use the VIIRS to gather data about changes in urban light energy use provides a powerful tool in NASA's ongoing investigation of carbon emission dynamics within urban landscapes.

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