



# Exploring Remote Sensing Products Online with Giovanni for Studying Urbanization

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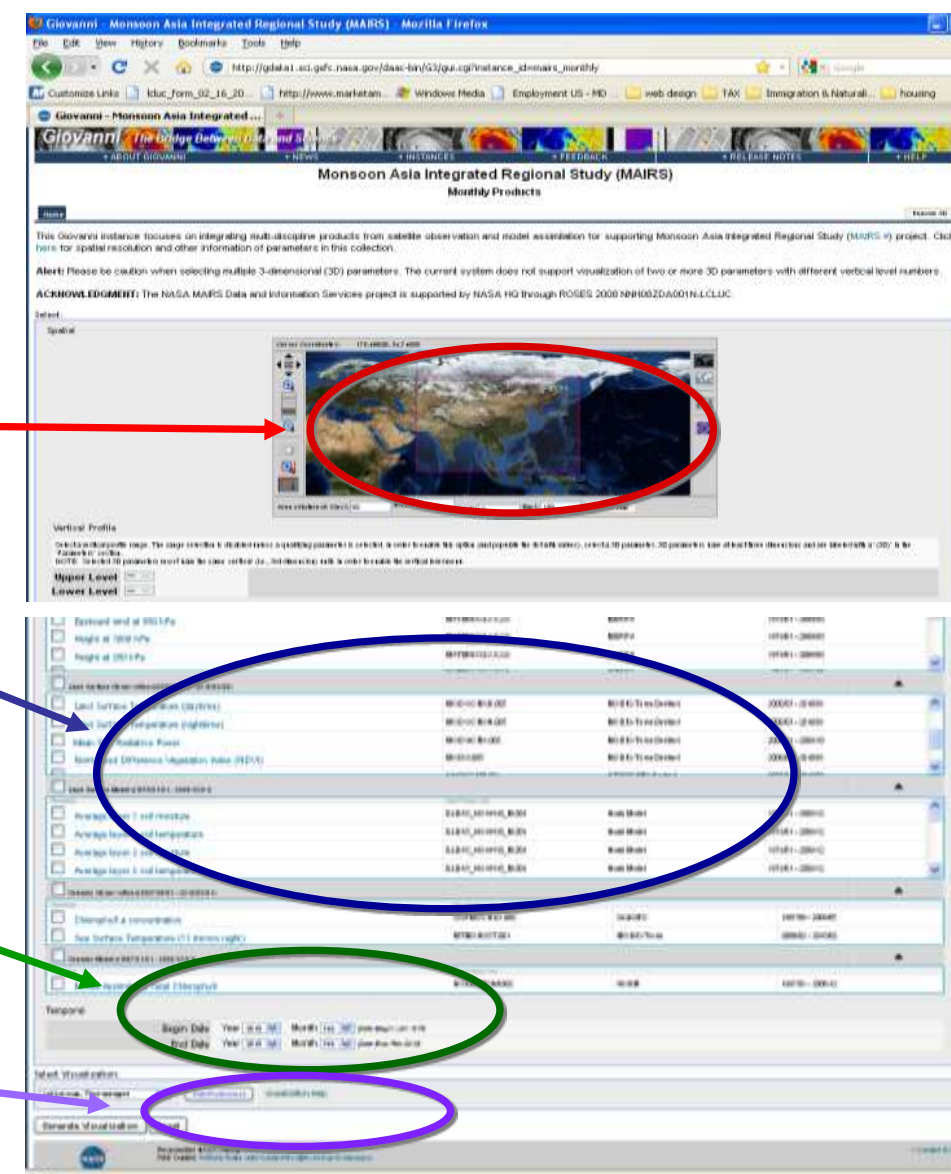
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<http://disc.gsfc.nasa.gov/mairs>

## Abstract

Recently, a Large amount of MODIS land products at multi-spatial resolutions have been integrated into the online system, Giovanni, to support studies on land cover and land use changes focused on Northern Eurasia and Monsoon Asia regions. Giovanni (Goddard Interactive Online Visualization AND Analysis Infrastructure) is a Web-based application developed by the NASA Goddard Earth Sciences Data and Information Services Center (GES-DISC) providing a simple and intuitive way to visualize, analyze, and access Earth science remotely-sensed and modeled data. The customized Giovanni Web portals (Giovanni-NEESPI and Giovanni-MAIRS) are created to integrate land, atmospheric, cryospheric, and social products, that enable researchers to do quick exploration and basic analyses of land surface changes and their relationships to climate at global and regional scales. This presentation documents MODIS land surface products in Giovanni system. As examples, images and statistical analysis results on land surface and local climate changes associated with urbanization over Yangtze River Delta region, China, using data in Giovanni are shown. More information is available at the GES DISC MAIRS data support project portal: <http://disc.sci.gsfc.nasa.gov/mairs>.

## Giovanni System

<http://disc.gsfc.nasa.gov/giovanni>



- Spatial Area
- Parameters
- Time Range
- Visualization Functions

## Characteristics:

- Customizable portals
- No need to install software; No need to download and process data
- Provide visualization and basic statistical analysis functions
- Able to download images and data in different formats

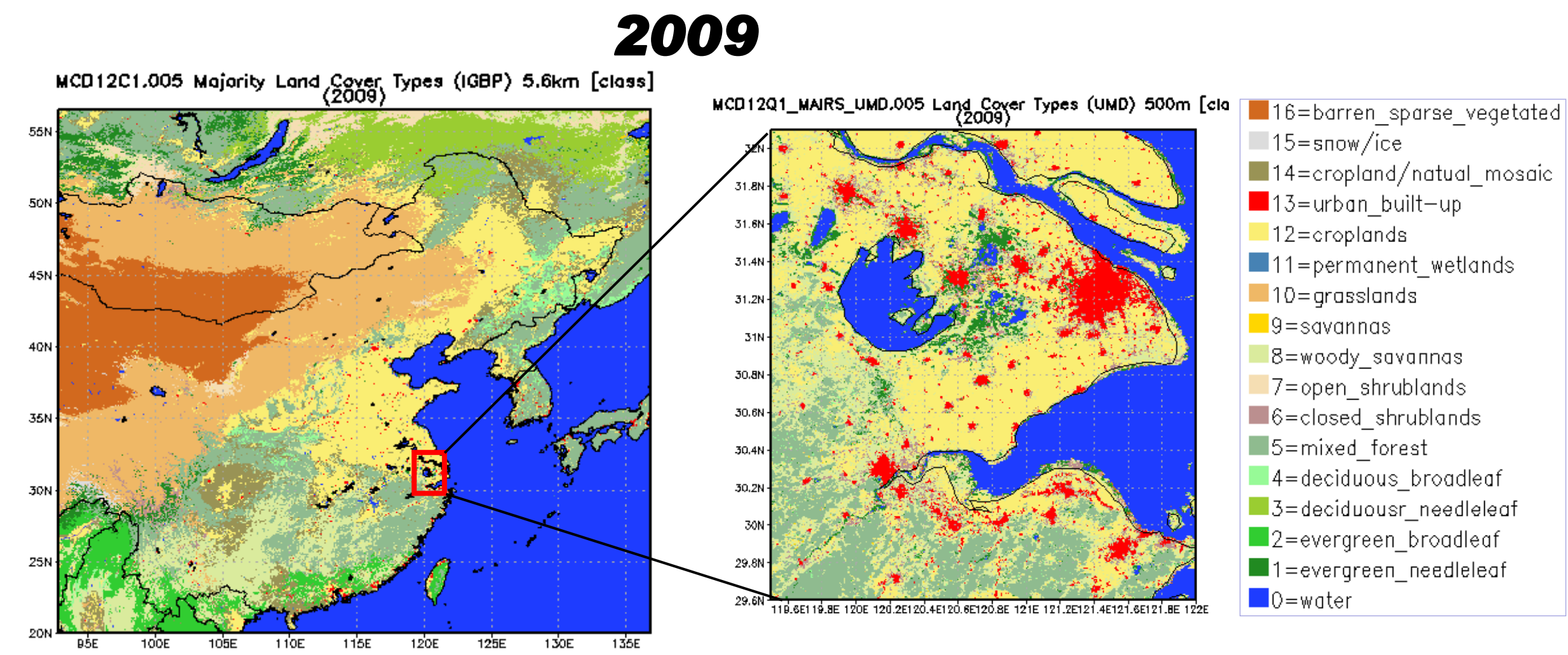
## Land and Social Products in Giovanni MAIRS

<http://disc.sci.gsfc.nasa.gov/mairs/visualization>

Parameter Name	Product Name	Available Since	Time Interval	Spatial Resolution
Vegetation Indices	MODV1.005 MYDV1.005 MOD13A3_MAIRS.005 MYD13A3_MAIRS.005	2000.03	Monthly 16 days	1.0° 1 km, 5.6km
Land Surface Temperature	MOD11CM1.005 MYD11CM1.005 MOD11A2_MAIRS.005 MYD11A2_MAIRS.005	2001.03	Monthly 8-Day	1.0° 1 km 5.6km
Thermal anomalies/Fire	MOD14CM1.005 MYD14CM1.005 MOD14A2_MAIRS.005 MYD14A2_MAIRS.005	2000.03	Monthly 8-Day	1.0° 1 km
Land Cover Types	MCD12C1.005 MCD12Q1_MAIRS.005	2001	Yearly	5.6 km 500m
Land Cover Dynamics	MCD12Q2_MAIRS.005	2001	Yearly	500m
Soil Moisture	AMSRE_AVRMO.005	2002.10-	Monthly	1.0°
Snow/Ice	NESDIS/IMS	2000.01-	Monthly	1.0°
Total Evapotranspiration, Snow Water Equivalent	GLDAS	1979.01	Monthly	1.0°
Surface Runoff, Soil Moisture	GLDAS	1979.01	Monthly	1.0°
Nighttime Lights	DMSP-OLS v4	1992-2010	Yearly	1km 5.6km

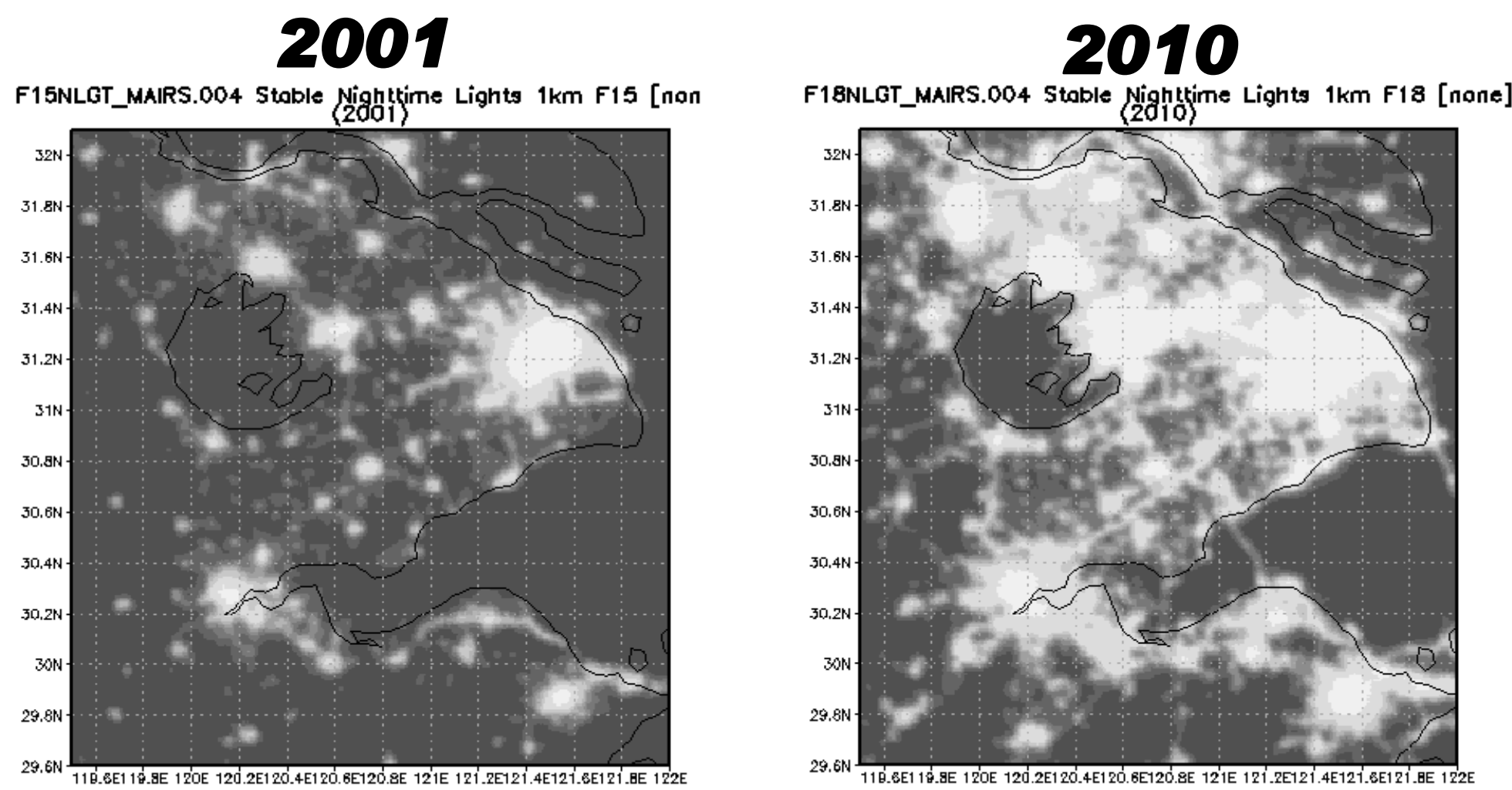
Note: Spatial coverage of data is global for 1x1 degree and 5.6km, and over MAIRS region for 1km

## Satellite Observed Urbanization over Yangtze River Delta Region during Last Decade



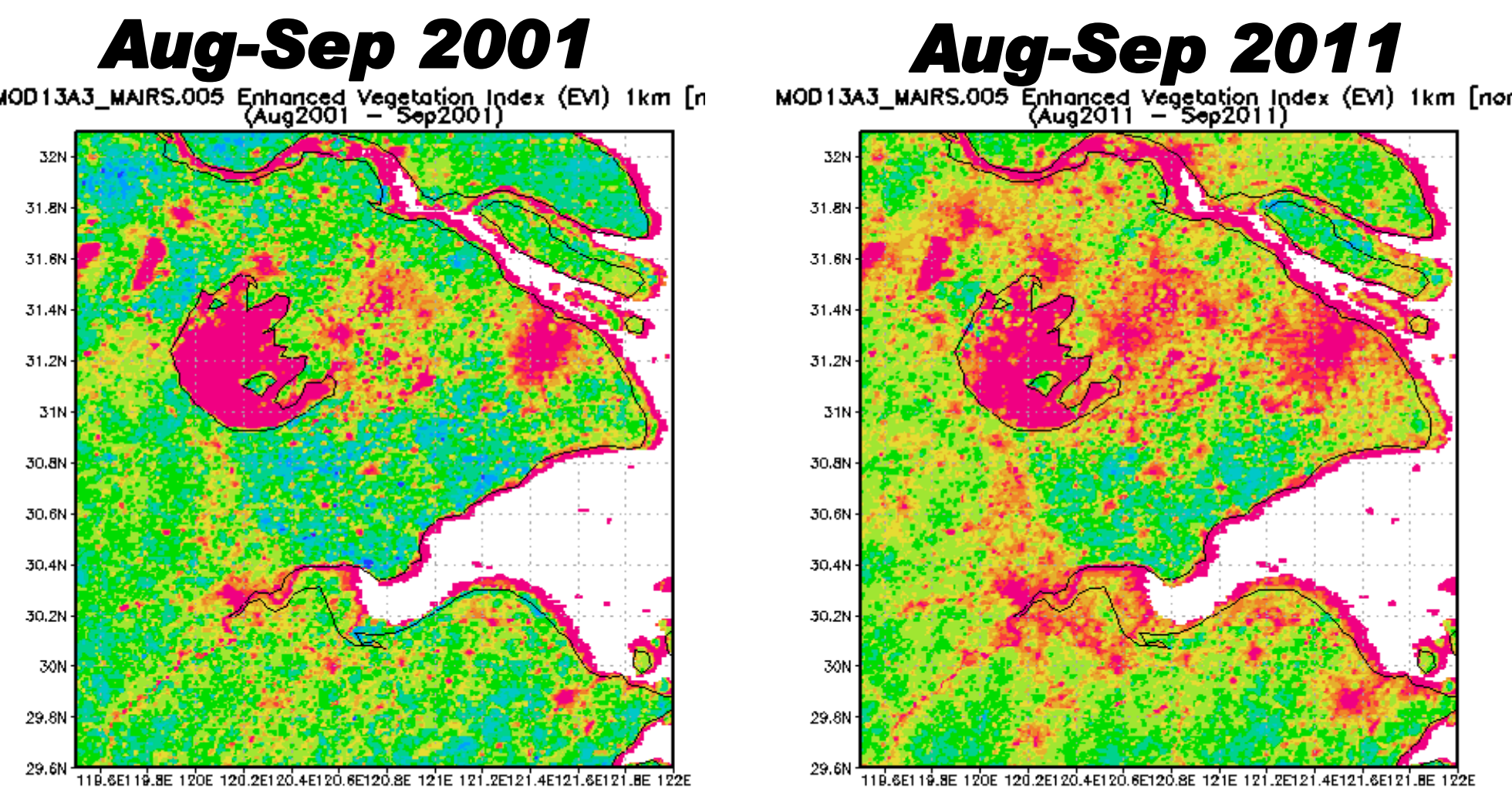
## Land Surface Types

MODIS Terra+Aqua combined yearly Land cover types at 5.6 km (0.05 Deg) resolution over global, and at 0.5km resolution over MAIRS region for several classification methods (IGBP, UMD, LAI, ...) are available in Giovanni.



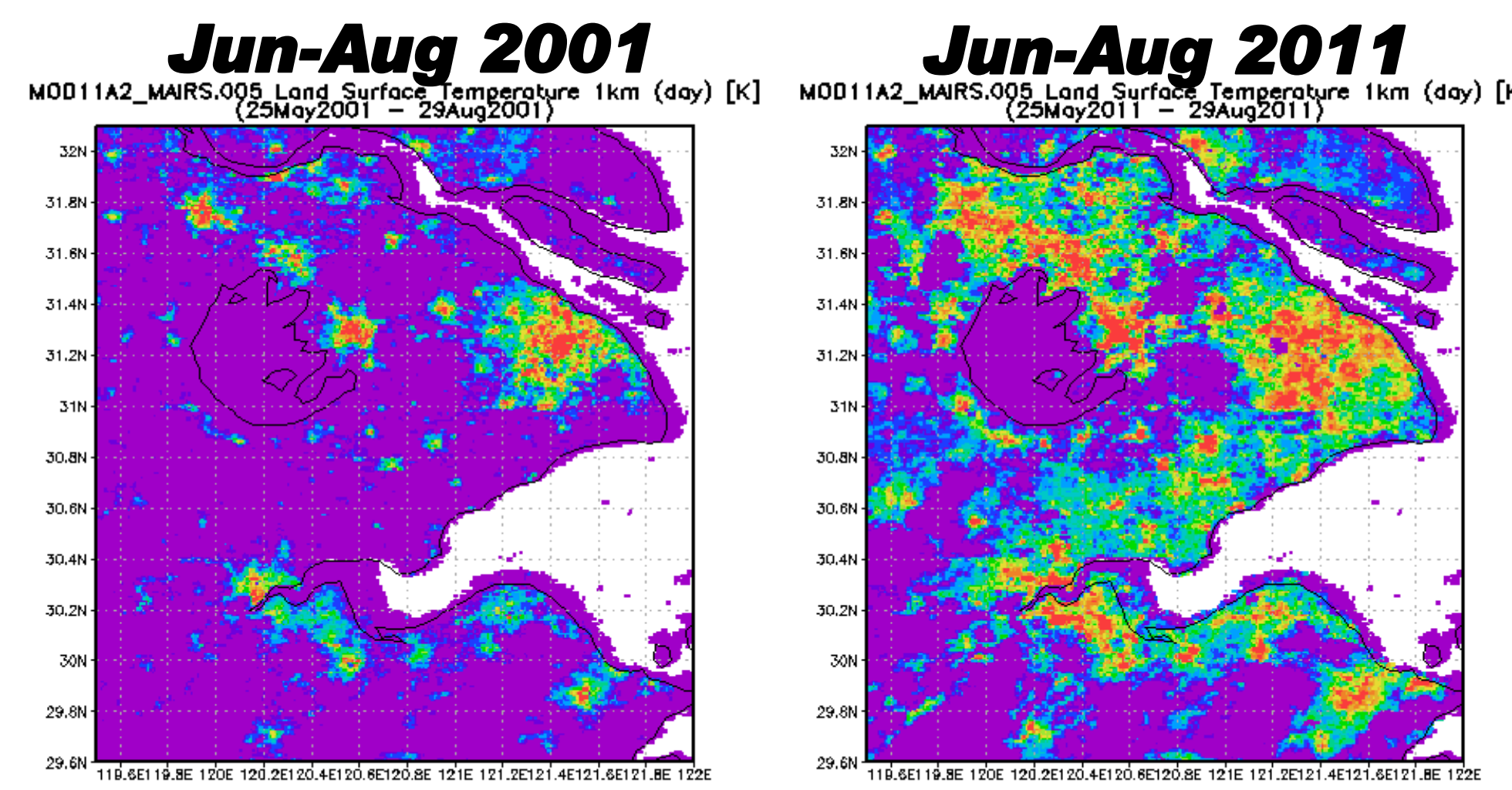
## Nighttime Lights

DMSP-OLS Nighttime Lights data for 1992-2010 from NOAA NGDC have been integrated into Giovanni recently. The 1km resolution data are available for MAIRS region and 5.6km data globally. This product may be used as a proxy of city location and area size. Clearly, the area of high nighttime lights are increased significantly from 2001 to 2010 over Yangtze River Delta region.



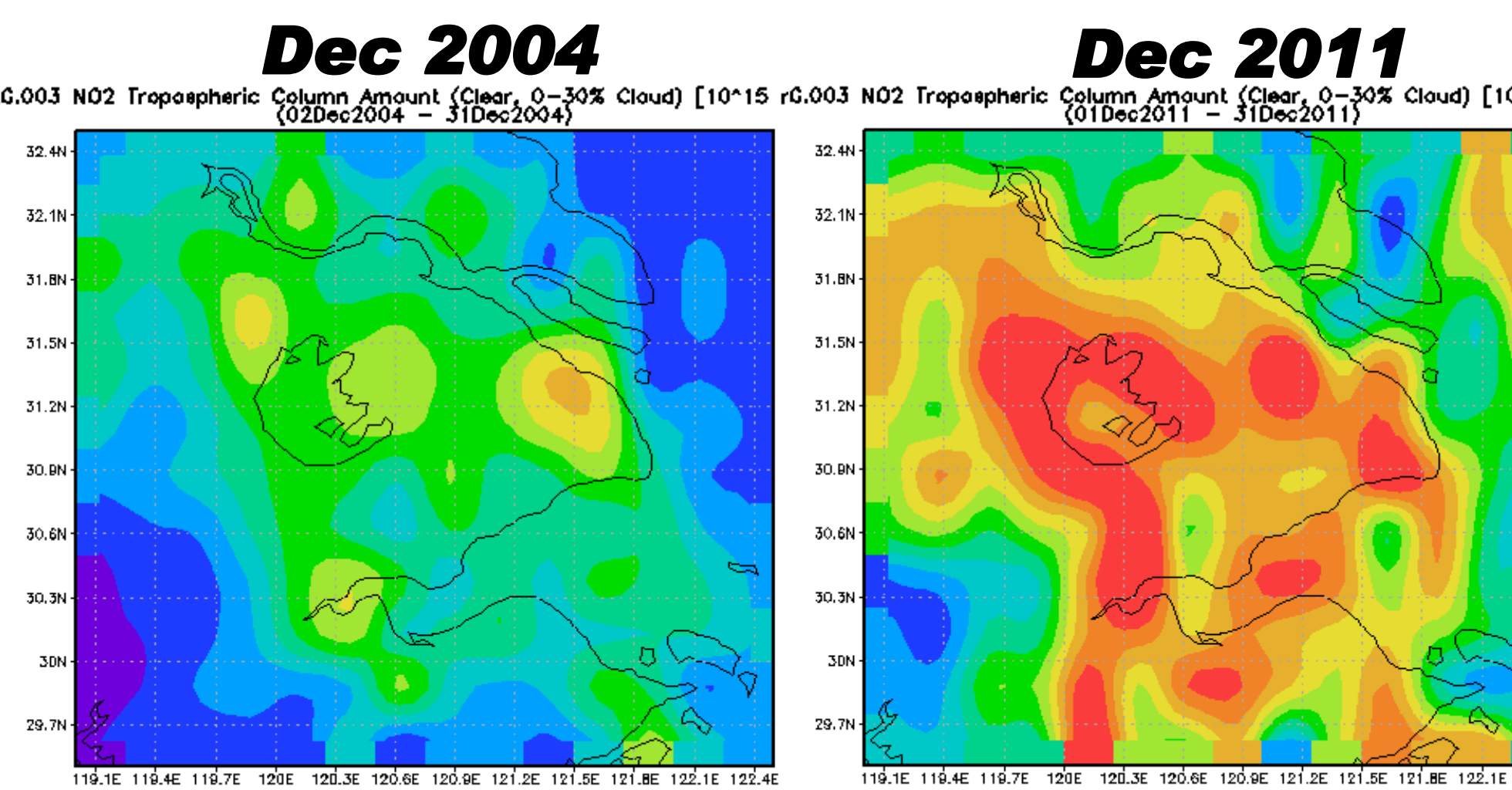
## Enhanced Vegetation Index (EVI)

MODIS-Terra and MODIS-Aqua EVI and Normalized Difference Vegetation Index (NDVI) at multi-spatial resolution (1 Deg, 5.6 km, and 1km) for monthly and 16-day period are available in Giovanni. The images show area of lower EVI (similar to NDVI, not shown) indicates the urban areas and their expanding from 2001 to 2011.



## Land Surface Temperatures (LST)

The local climate, in term of surface temperature, has changed due to the land use changes associated with urbanization. The urban heat island (UHI) area calculated by LST has increased during the last 10 years. LST from MODIS-Terra and MODIS-Aqua at 1km, 5.6km, and 1 degree are available in Giovanni, that makes easy to explore and analysis of regional or local climate variations.

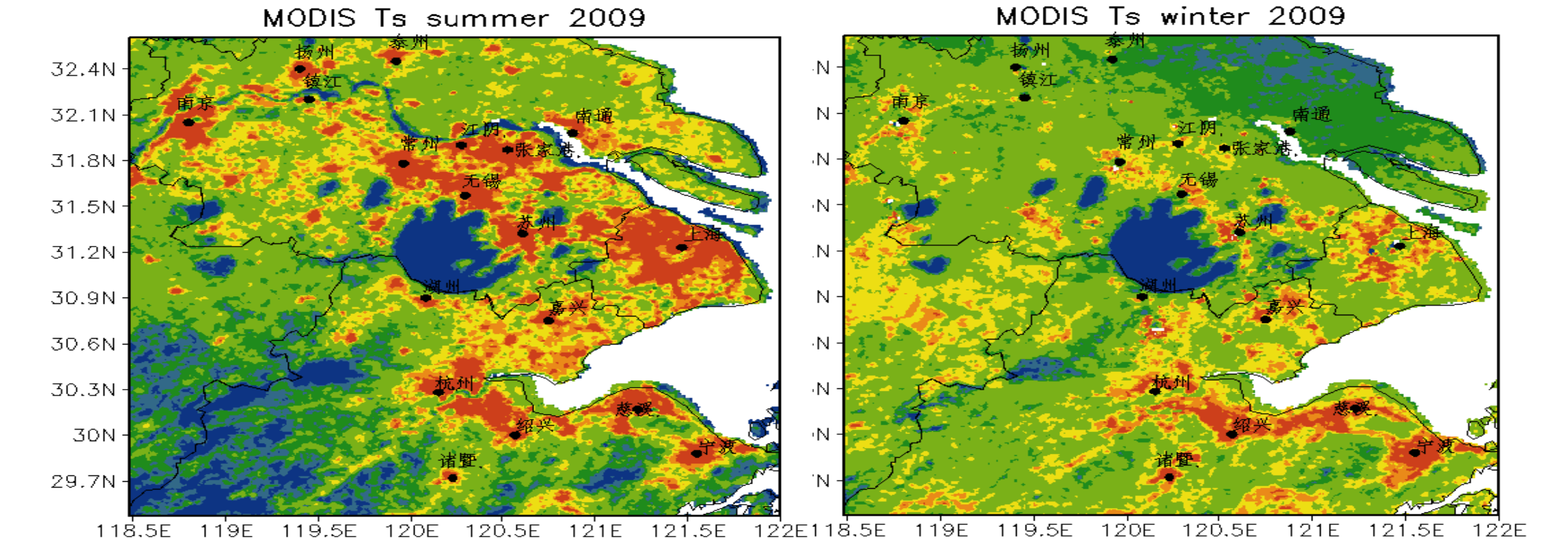


## Nitrogen Dioxide (NO<sub>2</sub>):

NO<sub>2</sub> is toxic by inhalation, which may decrease lung function and increase the risk of respiratory symptoms. The tropospheric (and total) column NO<sub>2</sub> measured from OMI-AURA, at 0.25 resolution from 2004 to present, are available in Giovanni. Images show that NO<sub>2</sub> values in Dec 2011 is elevated significantly compared with 2004. This is likely due to urbanization, such as increased industry, cars, etc. More air quality data, such as SO<sub>2</sub>, CO, O<sub>3</sub> are also available in Giovanni.

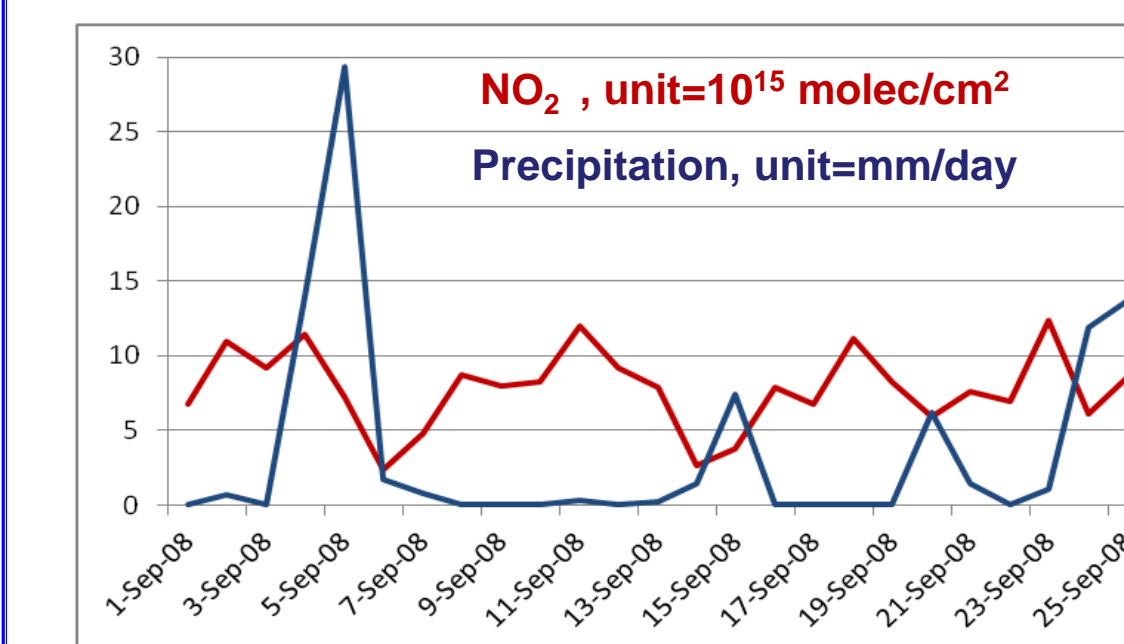
## Analysis Data associated with Urbanization

### Seasonal Variation of UHI from MODIS LST



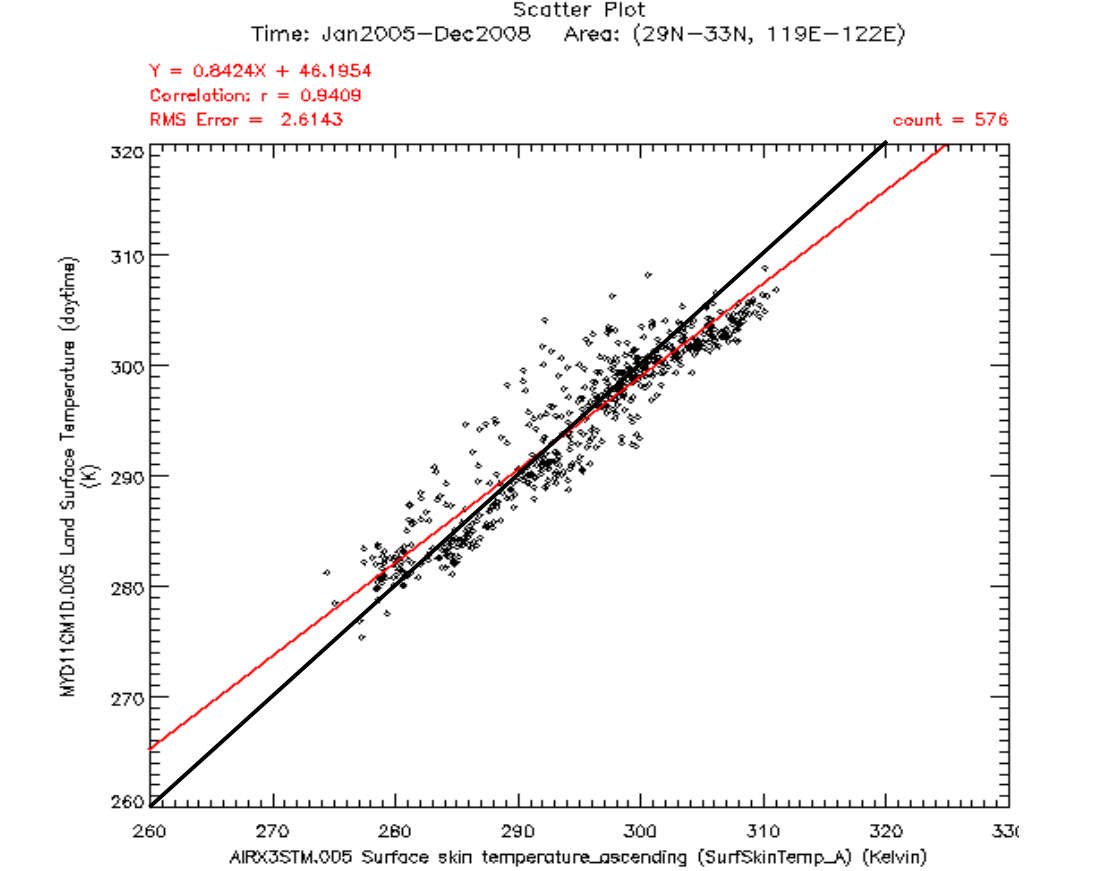
Above: Urban Heat Island (UHI) calculated from 1km daily MODIS-Terra LST for Jun-Aug 2009 (left) and Dec 2009-Jan 2010 (right), indicating that UHI effect observed from LST is more evident in the summer than the winter (Dong, et al, 2012, J. Geographic Sci., submitted).

### Relationship between Daily NO<sub>2</sub> and Precipitation



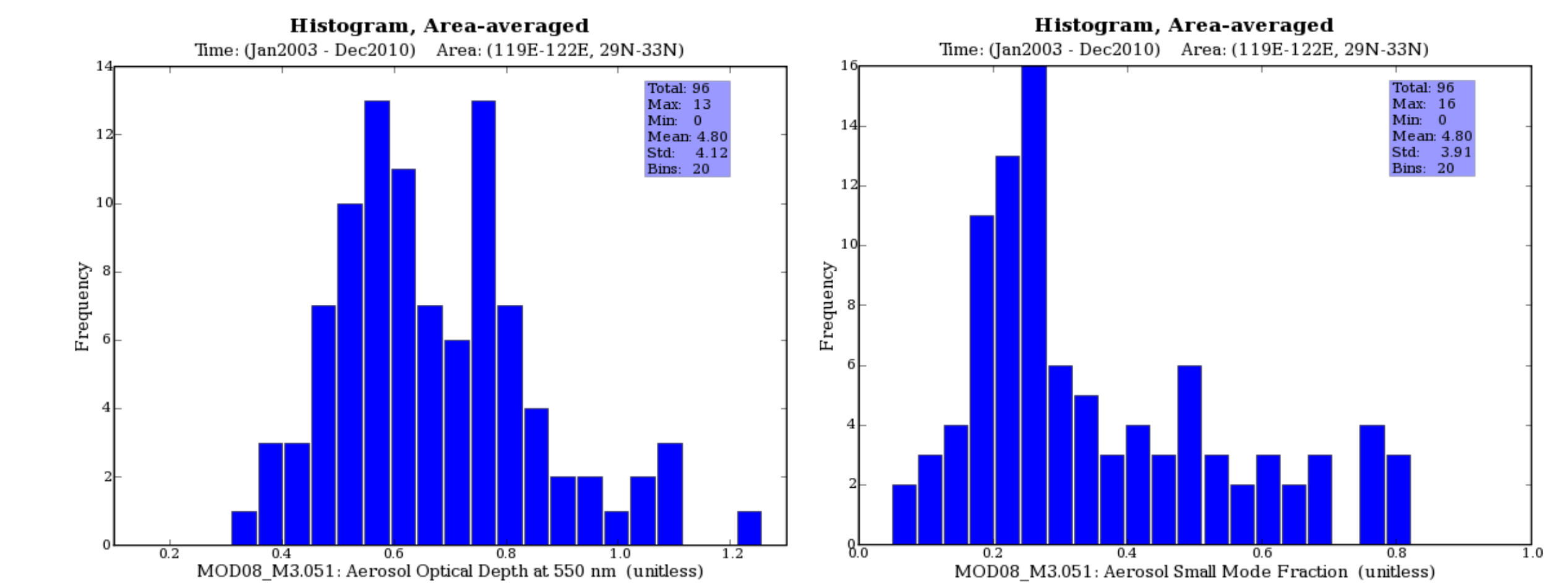
Left: Time-series of area averaged daily tropospheric column NO<sub>2</sub> from AURA/OMI (red line) and precipitation from GPCP (blue line) for Sep 2008. Clearly, the NO<sub>2</sub> values drop significantly on the same or next day of rainfall events.

### Comparisons of Monthly LST MODIS and AIRS



Right: Scatter plot to compare monthly daytime LST from MODIS and AIRS on Aqua over the study area for the period of 2005.01-2008.12. Both data are at 1x1 degree resolution. Interestingly, the daytime LST from MODIS is lower than that from AIRS at higher value; this relationship is reversed at the lower value.

### Aerosol Load Distributions



Above: Frequency distribution of the area-averaged monthly aerosol optical depth (AOD) at 550 nm (left) and the aerosol small-mode (or fine-mode) fraction (right) from MODIS-Terra from 2003.01 to 2010.12. The medium of AOD at 550nm over the study area is 0.6, varying from 0.3 to 1.2, and about 25% is small-mode aerosols.

## Summary:

Through Giovanni at NASA GES DISC, preliminary analyses have been conducted on changes associated with urbanization over Yangtze River Delta region from 2001-2011 using satellite remote sensing data, such as EVI (or NDVI) and LST from MODIS, NO<sub>2</sub> from OMI, and other atmospheric data:

- Urban area expansion is observed clearly by the significant outward increase of lower vegetation index area over the cities;
- The local LST are increased significantly over the areas converted to urban, resulting in increased significantly UHI areas;
- The UHI effect observed from LST is more evident in the summer than the winter;
- Air quality, such as increased NO<sub>2</sub>, is reduced over this area. Rainfall helps to improve air quality by removing NO<sub>2</sub> amount in the air;
- The area-averaged AOD varies from 0.3 to 1.2, and about 25% is small-mode aerosols.

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