# IMPACTS OF INTEGRATING HIGH-RESOLUTION REMOTE-SENSING SURFACE AND VEGETATION DATA ON THE WEATHER RESEARCH FORECASTING (WRF) MODEL FORECAST

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## 1. **Introduction**

Correctly representing the interactions between the land surface and lower atmosphere is critical for weather models to capture the development of boundary layer structures, clouds, and precipitation (Betts et al., 1997; Beljaars et al., 1996; Chen et al., 1997, Ek et al., 2003). Today's weather models typically incorporate complex land surface models (LSM). For instance, the Noah LSM (Chen et al., 1996; Ek et al., 2003) in the community Weather Research and Forecasting (WRF) mesoscale model includes vegetation, snow, hydrology, and urban processes. Such complex models require an accurate description of land surface and vegetation characteristics, because the specification of LSM parameters (e.g., albedo, roughness length, canopy resistance, etc) heavily relies on these characteristics. Recent progress in remote-sensing community provides an excellent opportunity for weather models to ingest high-resolution (temporal and spatial) satellite data. In this paper, we present some examples to show possible benefits of using high-resolution remote sensing data in fine-scale applications of weather models.

## 2. **Utilizing MODIS land/vegetation products in WRF**

Currently the coupled WRF-Noah model uses a constant leaf area index (LAI) as function of land-cover types (as shown for the USGS AVHRR (Advanced Very High Resolution Radiometer)-based land-cover map, Fig. 1a, and for MODIS-based land-cover map, Fig. 1b). Evidently, the 1-km near-real time data from the Moderate Resolution Imaging Spectroradiometer (MODIS) LAI (Fig. 1c) provide fine-scale details about the vegetation distribution and reflect the reduction of vegetation density in the regions west of 98°W due to the 2002 drought. We conducted a 12-member ensemble using the coupled WRF-Noah for a typical summertime convection episode (28–31 May 2002) over the U.S. Southern Great Plains that occurred during the IHOP_2002 field experiment. This ensemble set of simulations includes a new photosynthesis-based gas-exchange model, and MODIS LAI, green vegetation fraction (GVF), the scaled LAI by GVF (Fig. 1d). Analysis of these 12-member ensemble simulations shows that:

(1) there are significant differences between new MODIS land-cover and old USGS AVHII-based land-cover maps; 2) modeled surface air temperature is much improved by assimilating MODIS land-cover, LAI, and GVF data. There is also improvement in the 5-cm soil moisture and temperature in MODIS data-assimilation experiments; and 3) using the MODIS 1-km real-time LAI and GVF data in the coupled WRF-Noah significant improved surface latent and sensible fluxes, which are lower boundary conditions to drive the development of atmospheric boundary layer in WRF.

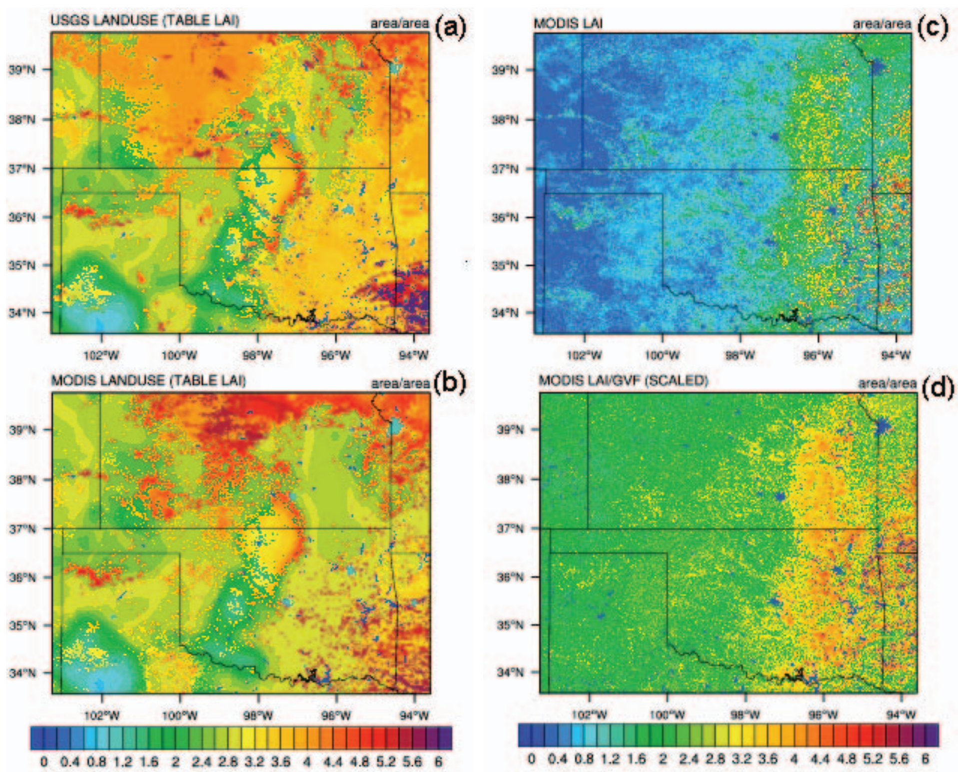


Fig. 1: Spatial distribution of LAI for the Southern Great Plains. (a) look-up-table dependent LAI using USGS land-cover; and (b) using MODIS land-cover; (c) MODIS based LAI for June 2002, and (d) MODIS based LAI divided by GVF.

3. **Utilize remote sensing data for urban modeling**

A recent community effort was devoted to develop an integrated urban modeling system as a community tool to address urban environmental issues (Chen et al., 2009). Using the new addition of urban canopy models in WRF requires users to specify at least 20 urban canopy parameters (UCPs). A National Urban Database and Access Portal Tool (NUDAPT) project (Ching et al., 2009) was developed to provide the requisite gridded sets of UCPs for urbanized

WRF and other advanced urban meteorological, air quality and climate modeling systems. These UCPs account for the aggregated effect of sub-grid building and vegetation morphology on the grid-scale properties of the thermodynamics and flow fields in the layer between the surface and the top of the urban canopy. For instance, in WRF we use the USGS National Land Cover Data (NLCD) classification with three urban land-use categories based on 30-m resolution Landsat data: 1) low-intensity residential with a mixture of constructed materials and vegetation (30-80 % covered with constructed materials), 2) high-intensity residential with highly-developed areas such as apartment complexes and row houses (usually with 80-100 % covered with constructed materials), and 3) commercial/industrial/transportation including infrastructure (e.g. roads, railroads, etc.)

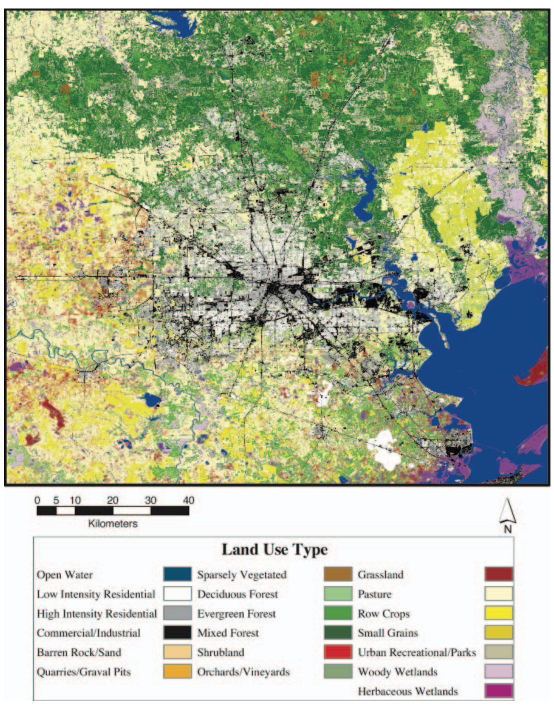


Fig. 2: Land use and land cover in the Greater Houston area, Texas, based on 30-m Landsat from the National Land Cover Database (NLCD) 1992 data.

An example of the spatial distribution of urban land-use for Houston is given in Fig. 2. Once the type of urban land-use is defined for each WRF model grid, the related urban morphological and thermal parameters can be assigned using an urban-parameter table

The coupled WRF/Urban model was applied to major metropolitan regions (e.g., Beijing, Guangzhou/Hong Kong, Houston, New York City, Salt Lake City, Taipei, and Tokyo), and its performance was evaluated against surface observations, atmospheric soundings, wind profiler data, and precipitation data. We will present results that show the improvement in modeled surface temperature, and wind fields by using high-resolution Landsat and MODIS data, due to the fact these data reasonably capture recent urbanization for major Asian cities.

4. **References**

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