



# WRF-CMAQ modeling of LISTOS

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## Project objectives

- **Regional Applied Research Effort**

- Collaboration between EPA Office of Research and Development and EPA Region I
- Title: Exploring the cause of persistent high ozone in Connecticut
- Project Goals
  - The primary goal of the project is to better understand why, even though air pollution emissions have decreased substantially in Connecticut and upwind areas, the state has not seen a similar reduction in ozone concentrations as has been experienced by other areas in Northeast.
  - Another goal is to evaluate and demonstrate the capability of state-of-the-art air quality modeling systems to accurately represent how air pollution impacts the LIS and Connecticut coastal region.
  - A third goal is to further develop the modeling system to provide more accurate high-resolution simulations of air quality in complex coastal regions such as the NYC/LIS/CT area



## Science Questions

- Meteorology questions
  - What flow regimes are conducive to high Ozone on CT coast?
  - Role of sea breeze in day and land breeze at night?
  - PBL evolution over land and water?
  - Low level jets?
  - How well does the hi-res WRF model represent these features?
  - **Can we improve model performance with modifications to physics or data assimilation?**
- Chemistry Questions
  - What is the vertical structure of chemical species (O<sub>3</sub>, NO<sub>y</sub>, PM<sub>2.5</sub>) distributions over LI, LIS, CT coast
  - Can emissions be constrained by comparison to measured ambient ratios of VOCs, NO<sub>x</sub>, CO
  - What are the relative contributions of different source sectors (cars & trucks, ships, industrial boilers, stationary diesel engines, consumer products, power plants, and vegetation) to O<sub>3</sub> formation.
  - **Can we refine emissions to improve results.**

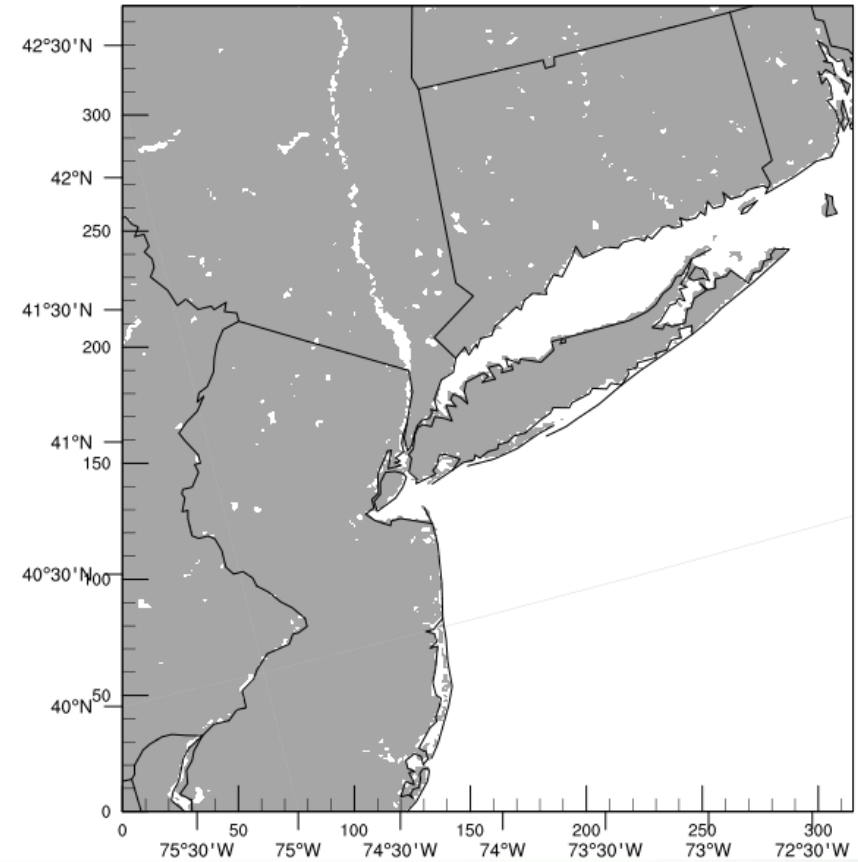
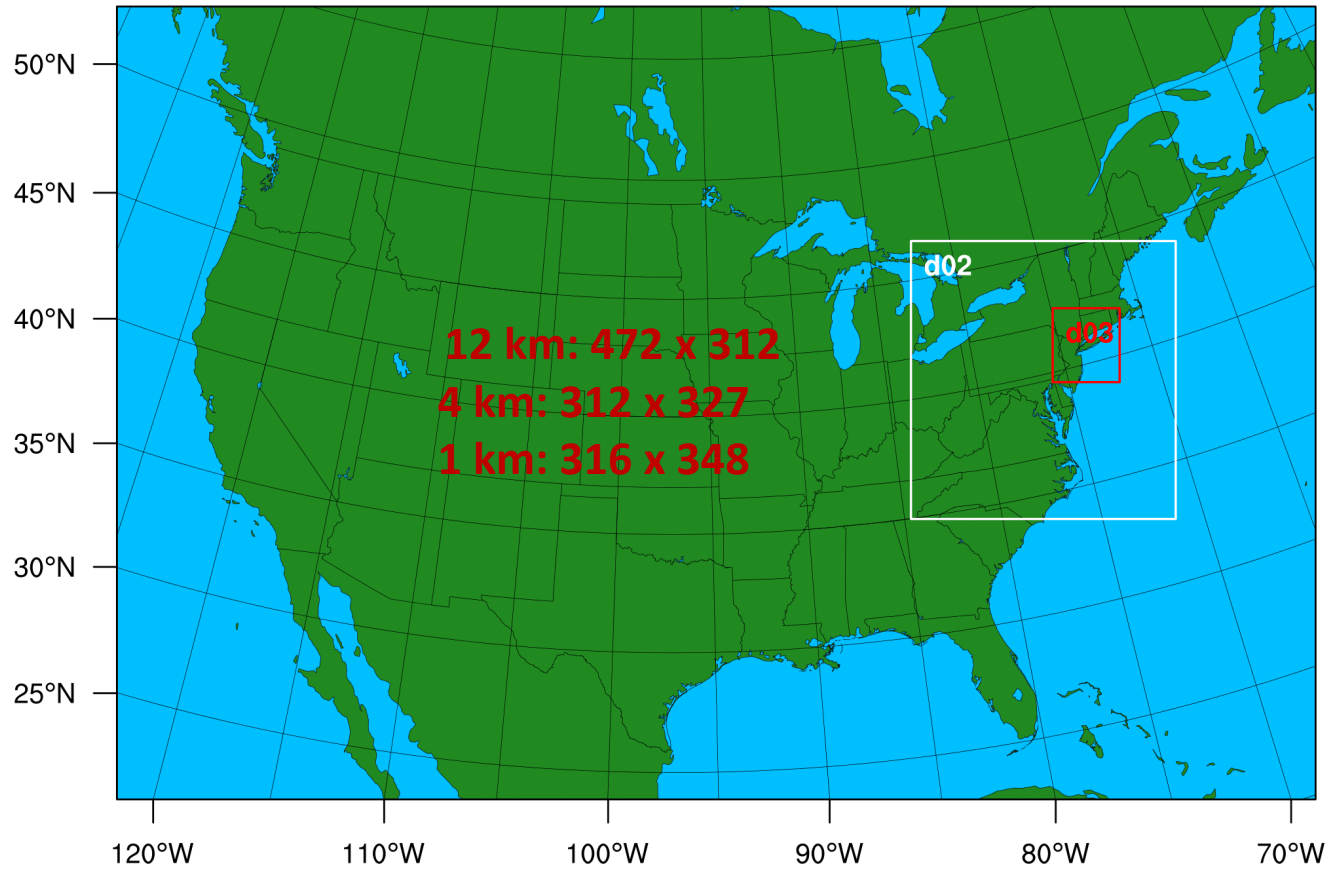


## Research Plan

- Model LISTOS summer 2018 field study with latest versions of WRF-CMAQ
  - Nested domains – 12 km/4 km/1 km grid resolution
  - Key aspects of meteorology modeling
    - High resolution surface data: GHRSSST (1 km), UnRestricted Mesoscale Analysis (URMA) (2 km)
    - Surface data assimilation of URMA through PX LSM soil moisture and temperature nudging
    - High resolution land use from NLCD including impervious surfaces and tree canopy coverage
  - Key aspects of emissions
    - Onroad mobile sources – Run MOVES with county specific updated VMT, age distribution, temporal profile from 2017 (adjust for day of week for 2018 )
    - Marine – hourly GPS ship data from 2017 (adjust for day of week for 2018)
  - Key aspect of AQ modeling
    - CMAQ version 5.3



# Modeling Domains



1 km grid resolution WRF domain

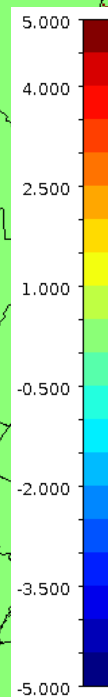
# 1 km Domain SST

Aug 6, 2018

GHRSSST  
21 UTC

NAM SST  
21 UTC

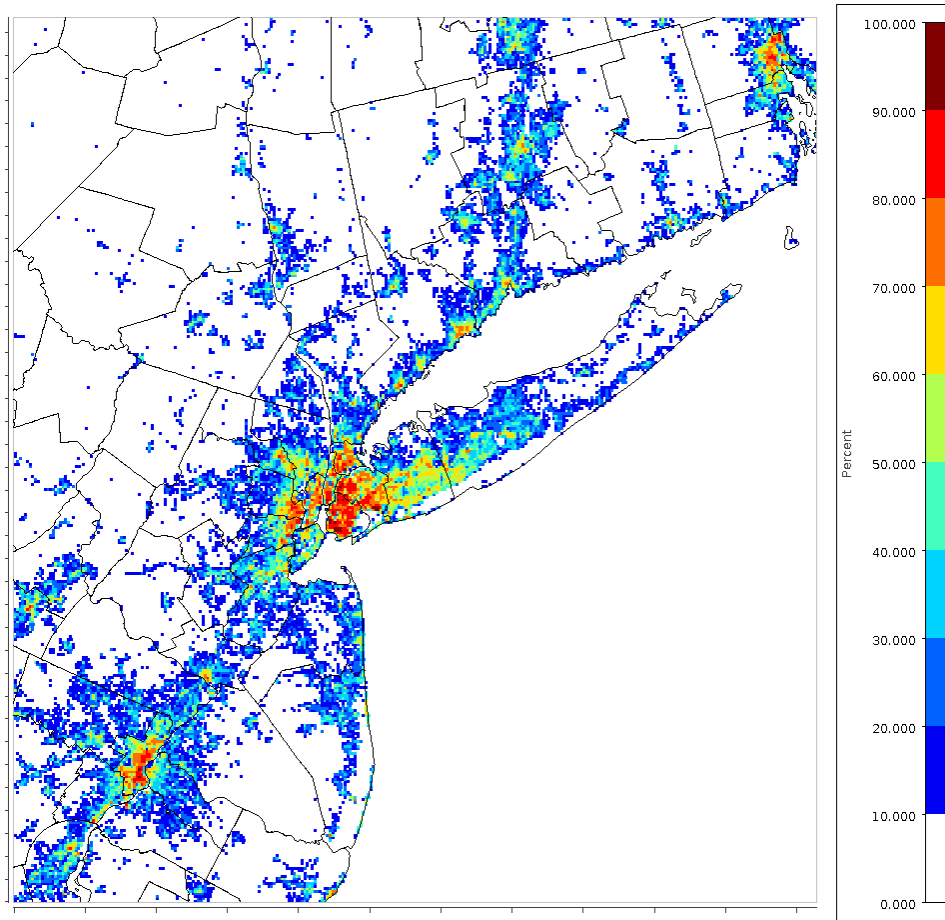
Diff NAM-GHRSSST  
21 UTC



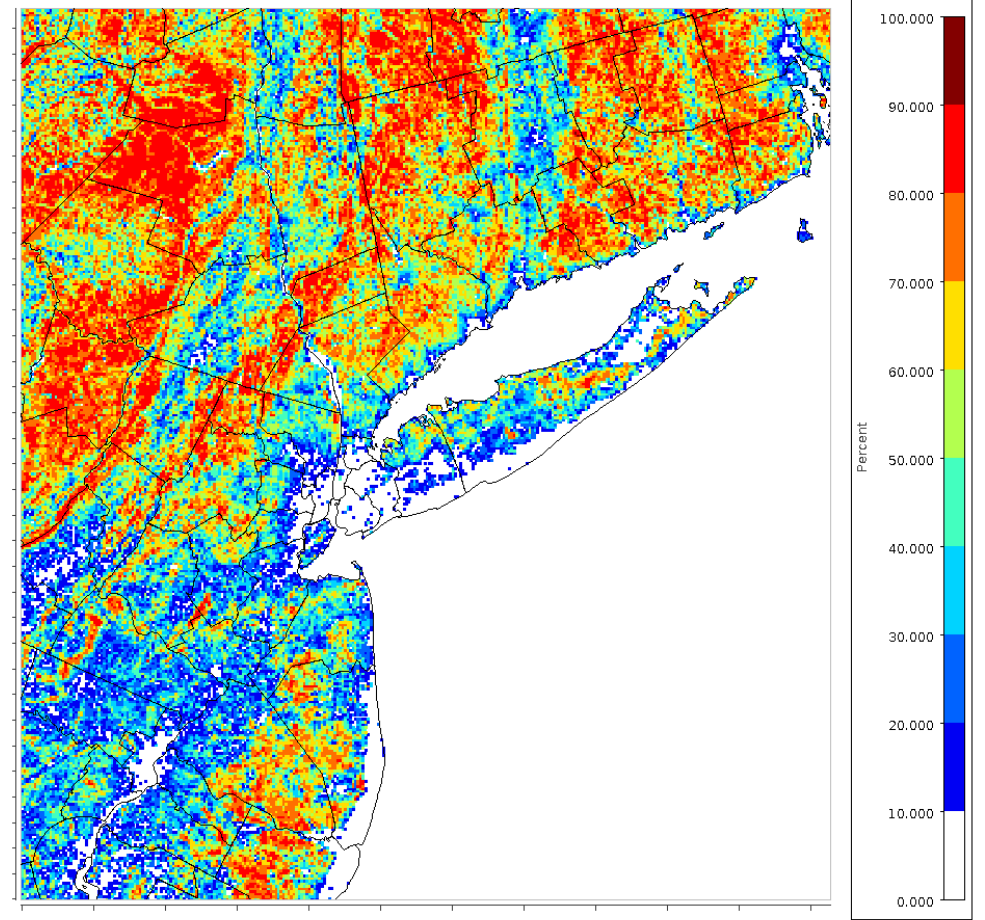




# Impervious surface and canopy fraction from NLCD



Impervious surface fraction

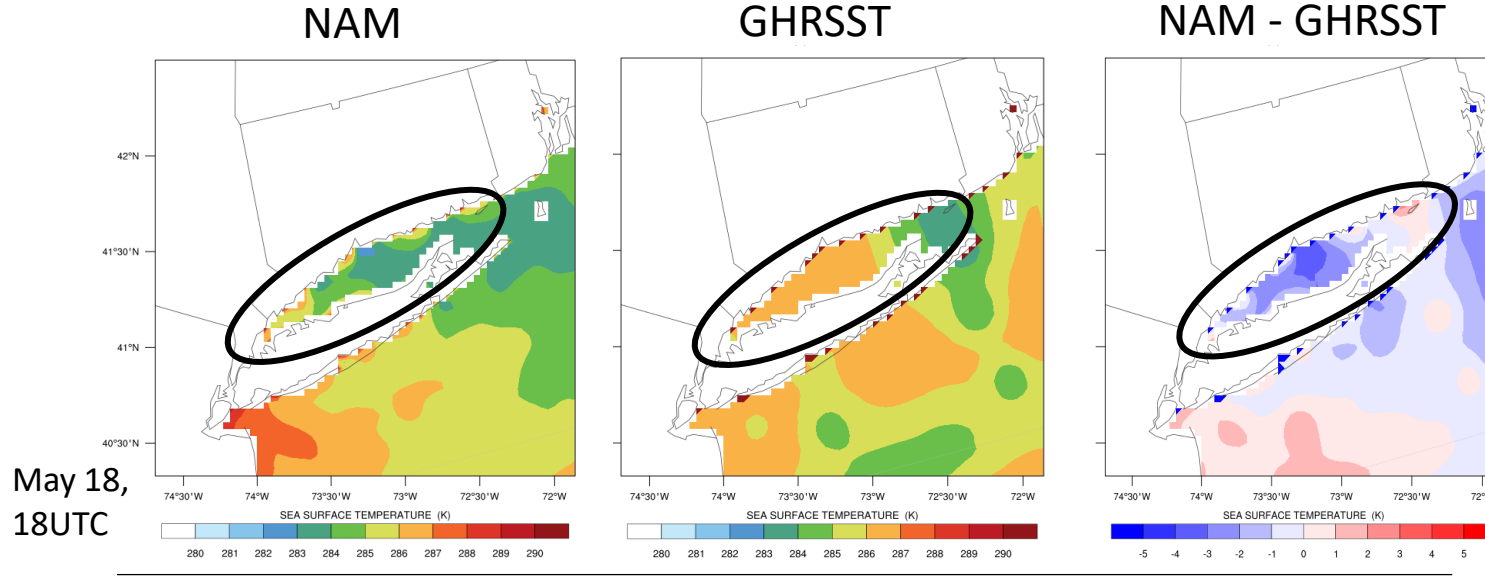


Tree canopy fraction

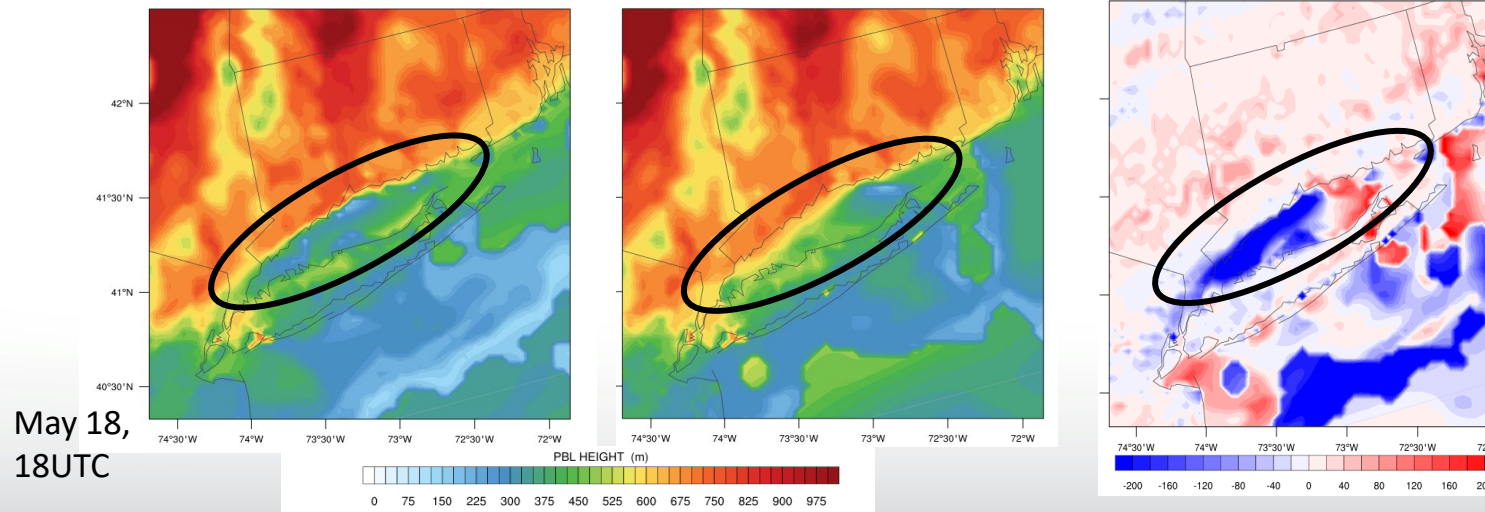


# Sensitivity to SST at 4 km resolution

SST



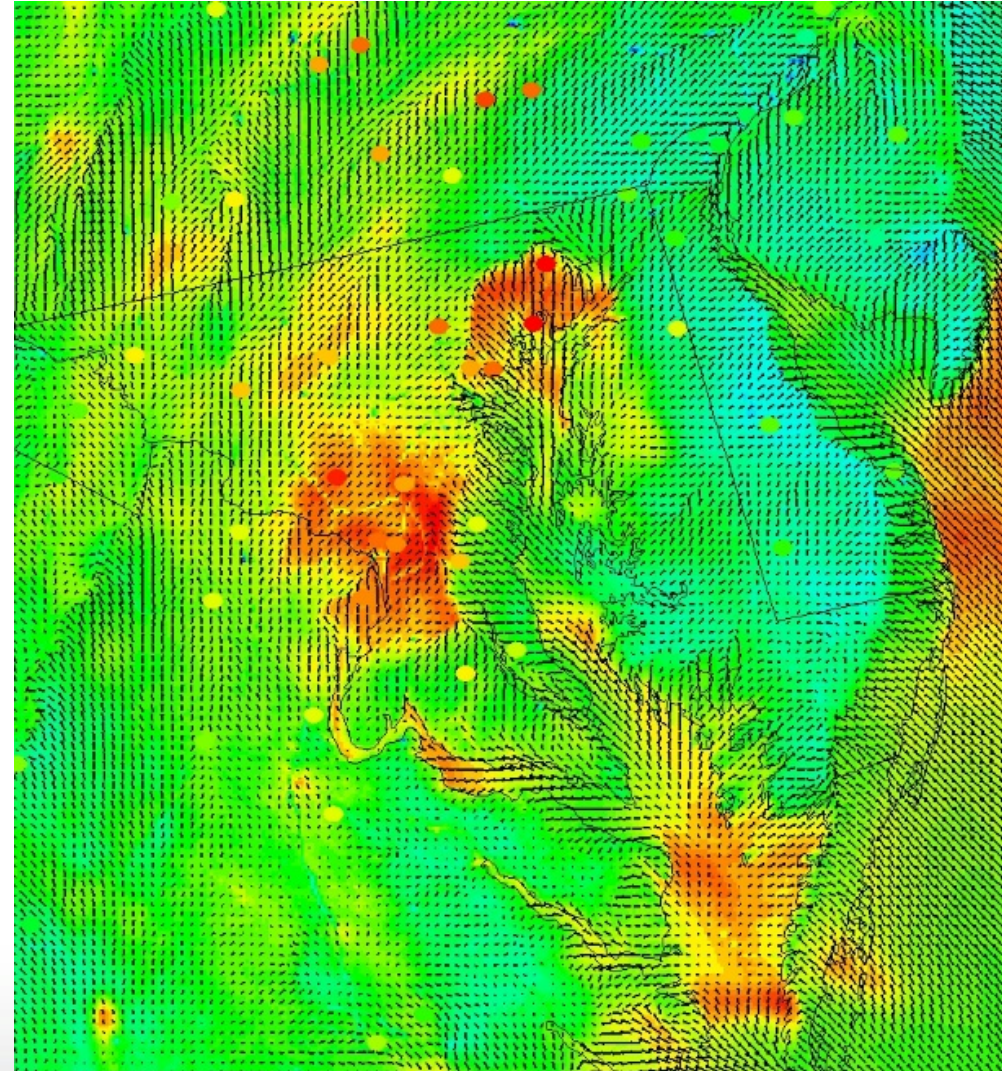
PBL Height





- Coupled WRF-CMAQ with 1 km grid resolution
  - High resolution GHRSSST
  - High resolution NLCD land use w/ impervious surfaces

O<sub>3</sub> concentration and layer 1 wind field  
at 5 pm LT on July 2, 2011





## Evaluation w/ study data

- Evaluate wind fields over LI, LIS, CT
  - Stony Brook Aircraft
- Vertical Profiles of meteorology, chemistry and aerosols
  - Profilers, ozonesondes, aircraft
- Spatial AQ fields
  - GeoTASO/GCAS, aircraft, ferry, vans, pandoras, site data