



Fine-Scale Application of the Coupled WRF-CMAQ System to the 2011 DISCOVER-AQ Campaign



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Motivation

Many AQ problems have primary or near-source components

- primary particulate emissions are major contributors to PM_{2.5}
- representation of near source gradients
- exposure risk depends on proximity to sources

Complex terrain, coastlines and cities require high-resolution modeling to:

- represent local wind fields, PBL structure, etc.
- represent urban effects

Point and line source emission distributions are sub-grid at any scale

- artificial dilution of primary pollutants due to instantaneous mixing of emissions into large grid-volumes
- subsequent impacts on near-source chemistry and predictions of secondary pollutants

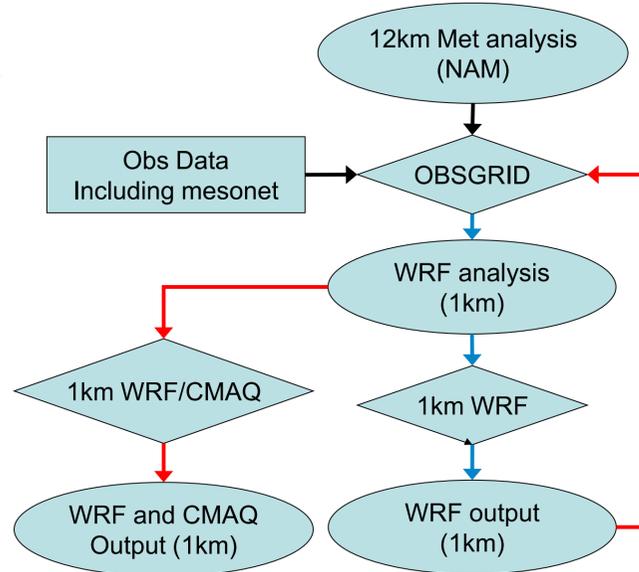
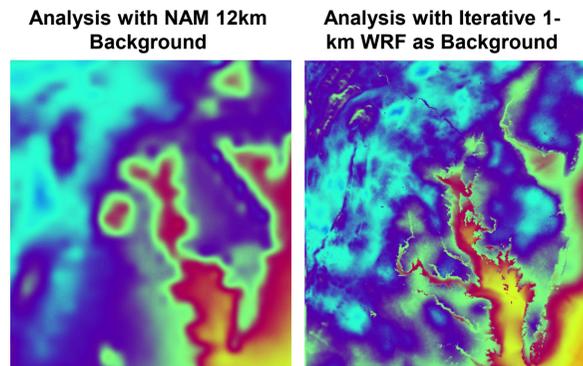
High Resolution Data Assimilation

Basic problem: data too sparse, especially upper air

Surface observations are more dense, including mesonets in some areas, but atmospheric nudging in PBL is not desirable

Solution: Assimilate surface and other observation data (precipitation, satellite) into land surface parameters (e.g. soil moisture, soil temperature)

- HRLDAS (Noah LSM)
- Indirect soil nudging (PX LSM)



The PX LSM uses T-2m and RH-2m analyses for indirect soil moisture and deep soil temperature nudging. Initial WRF output is recycled back to OBSGRID as new background (Mesonet adds high density obs data)

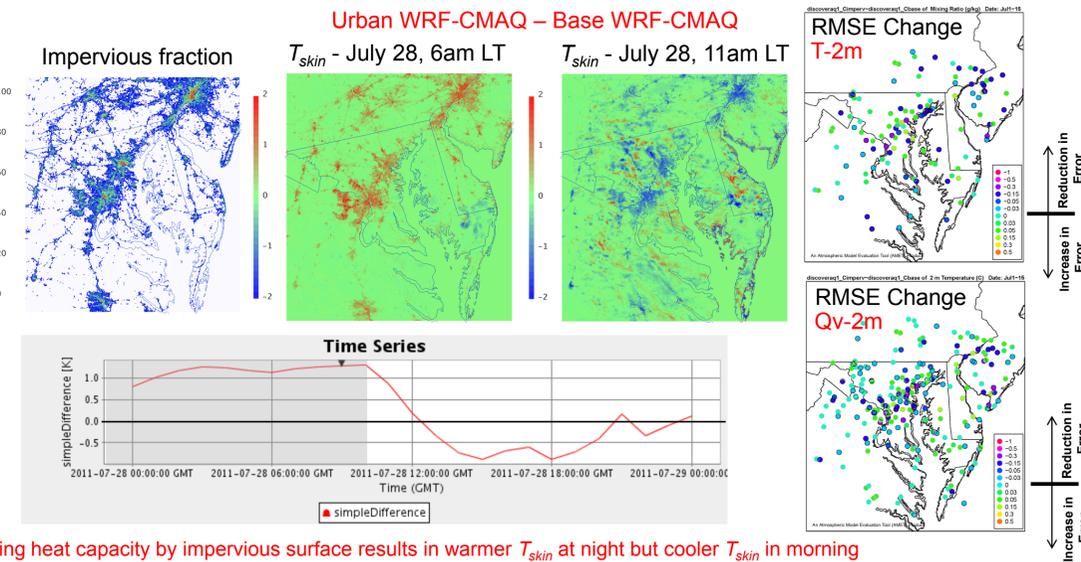
Simple Bulk Urban Approach for Pleim-Xiu LSM

Leverage very high resolution National Land Cover Database (NLCD) with multi-level urban classifications

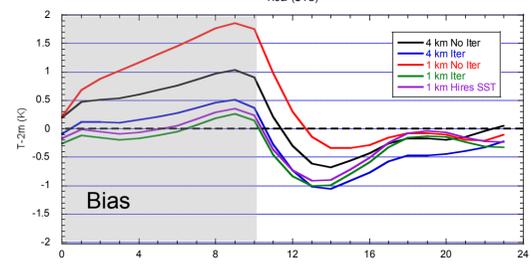
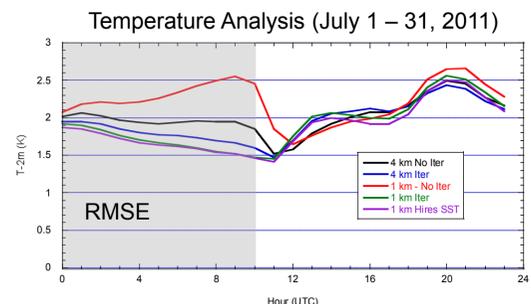
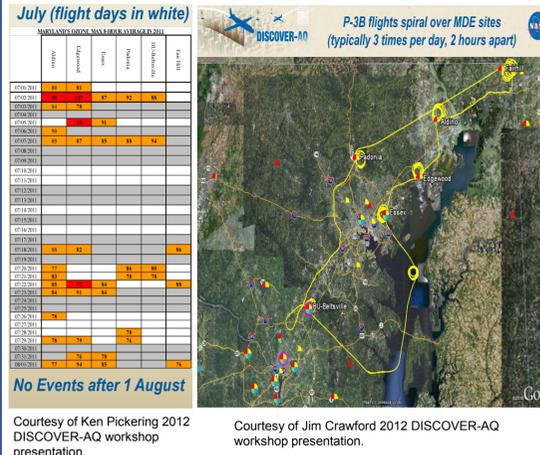
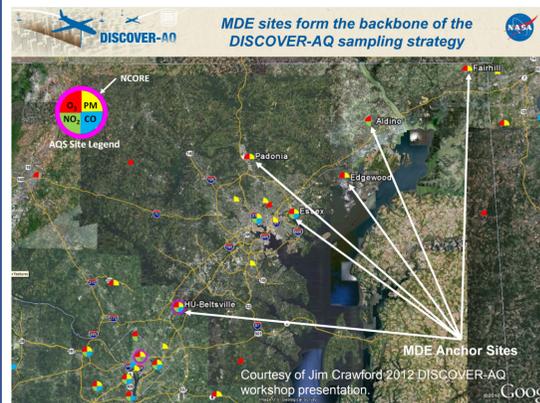
PX LSM considers sub-grid land use fractions • Utilize NLCD-based impervious surface data directly in LSM to scale surface heat capacity

Increase surface roughness for urban land use classes to better represent developed areas

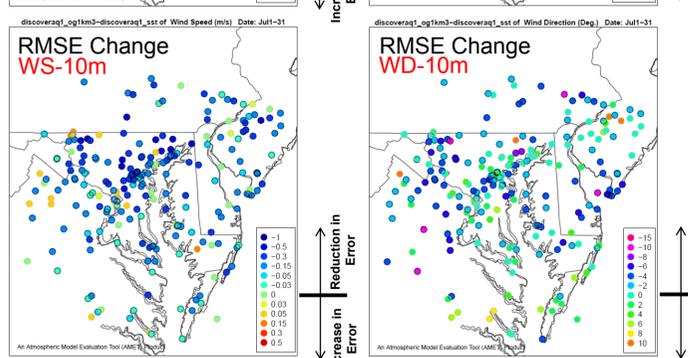
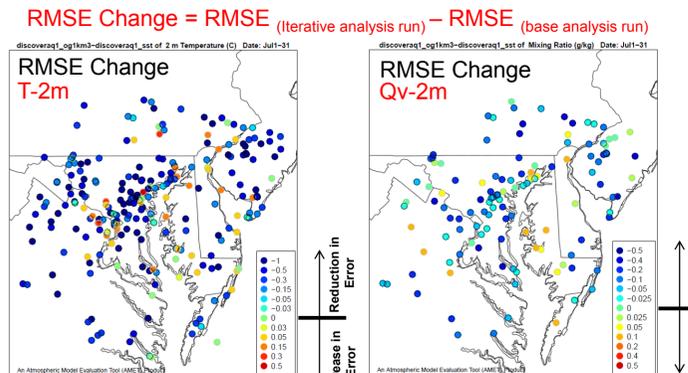
Decrease albedo in urbanized areas to account for sky-view and radiation trapping effects



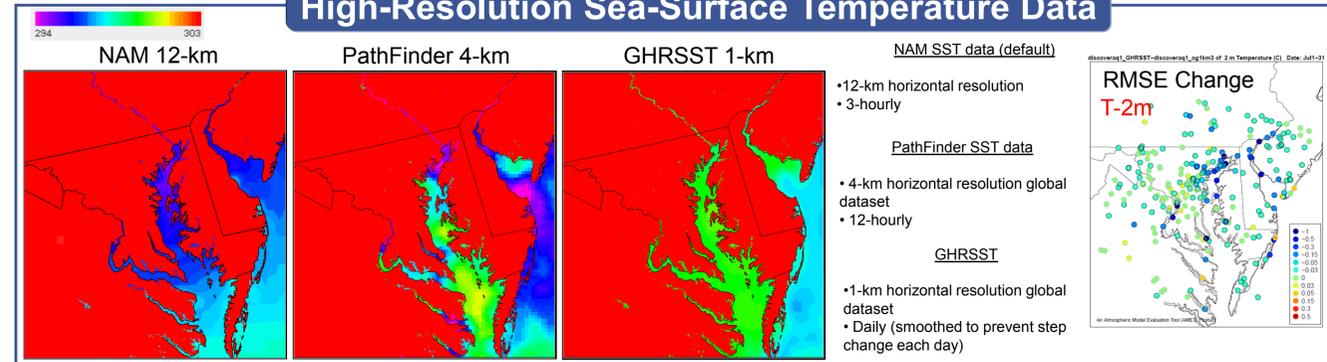
DISCOVER-AQ 2011



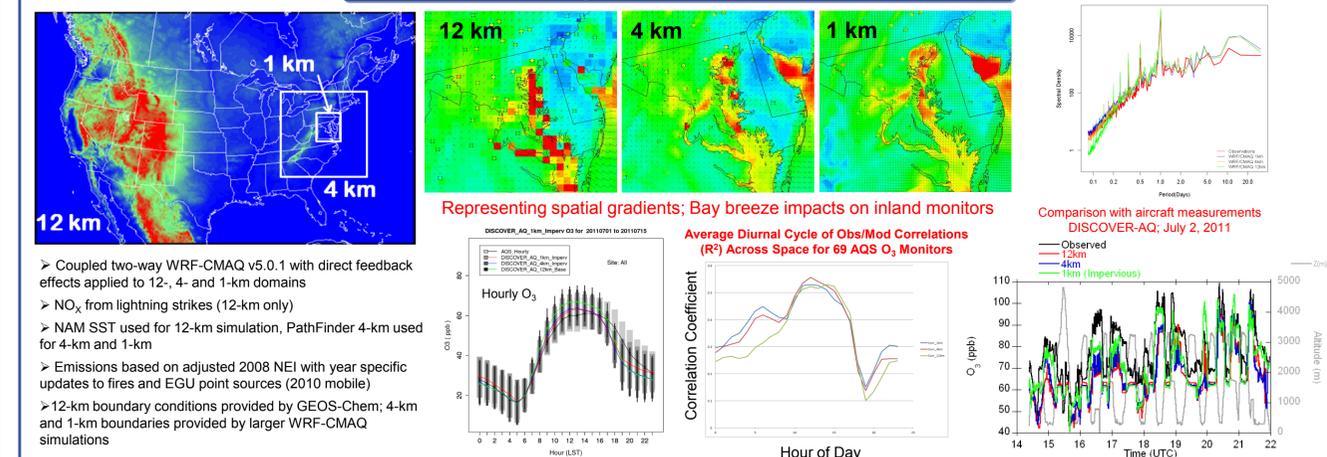
4km base
4-km w/ iterative analysis
1-km base
1-km w/ iterative analysis
1-km w/ hi-res SST (ignore)
Iterative analysis reduces error mostly at night and afternoon with large bias reductions at night



High-Resolution Sea-Surface Temperature Data



Preliminary WRF-CMAQ Results



- Coupled two-way WRF-CMAQ v5.0.1 with direct feedback effects applied to 12-, 4- and 1-km domains
- NO_x from lightning strikes (12-km only)
- NAM SST used for 12-km simulation, Pathfinder 4-km used for 4-km and 1-km
- Emissions based on adjusted 2008 NEI with year specific updates to fires and EGU point sources (2010 mobile)
- 12-km boundary conditions provided by GEOS-Chem; 4-km and 1-km boundaries provided by larger WRF-CMAQ simulations