Potential Use of Meteorological Data from the MM5 Prognostic Model in AERMOD

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Why this is important?

- Meteorological data are key inputs to air quality models
- Currently, NWS data are used:
  - Observation sites may not be representative (10-100s km away)
  - Upper air data are sparsely located, especially in mountainous areas
- NWS data have to be QA'd & archived by NCDC prior to use for modeling – there is a time lag
- Significant gaps in NWS data for calms & variable winds; frequency of gaps has increased with ASOS & METAR
- On-site data collection is expensive and time-consuming
- Multi-scale/Multi-pollutant approach requires consistent inputs
- These problems can be alleviated by using outputs from prognostic meteorological models, which provide estimates of the boundary layer variables required by AERMOD

Advantages of using MM5 data

- Prognostic meteorological models have a long history of use in regional air quality models (CMAQ)
- Accuracy has improved: can simulate conditions at time scales of hours & spatial scales <10 km
- Increasingly being used by NOAA in routine forecast modes; run and archived daily – can use most recent meteorological conditions in air quality simulations
- As EPA moves to a “one-atmosphere” modeling approach involving national to local scale air quality assessments, consistency of meteorological data input becomes an issue

Challenges

- Prognostic models are resource intensive when resolution is <10 km (however, this is primarily a computer resource problem that can be solved in principle)

- Can these models serve as an adequate substitute for NWS observations or onsite measurements?

- How can the efficacy of this approach be evaluated or demonstrated?

What we are doing

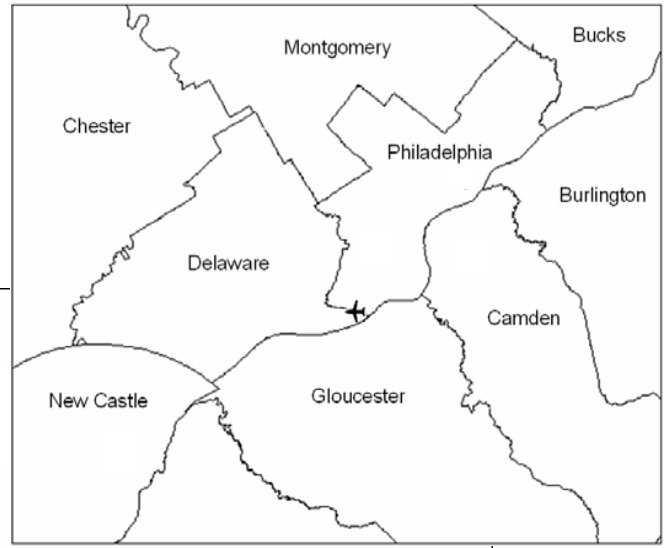
- Demonstrate how the MM5 mesoscale model results might be used in typical urban areas.

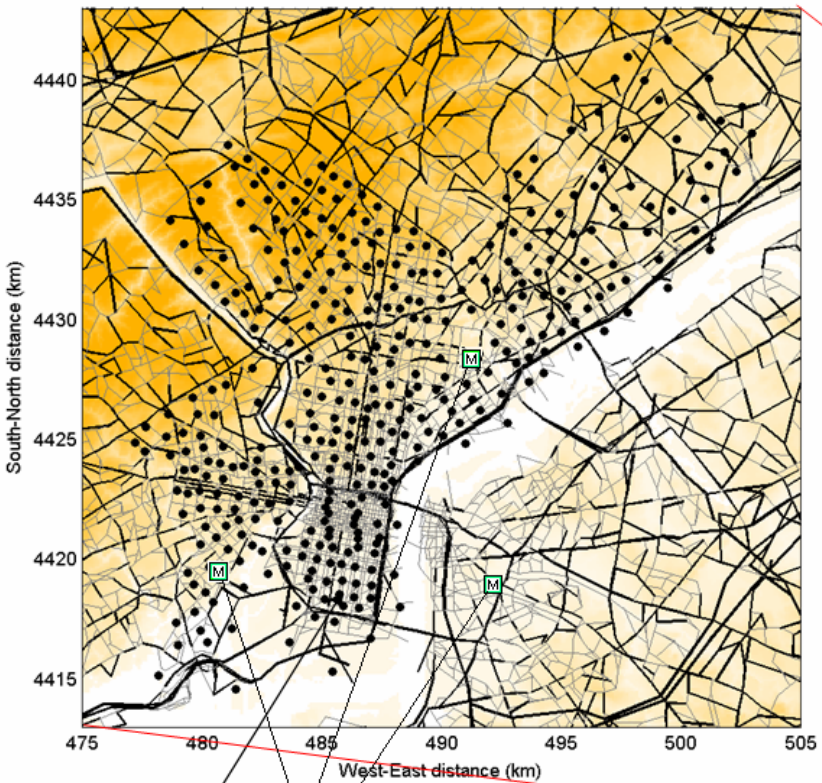
  Working on a paper for publication in the J. of A&WMA

- Evaluating the performance of such applications in urban areas with complex flow conditions with ORD.
- Developing a tool to extract meteorological data from the MM5 meteorological model for use with the AERMOD dispersion model

Philadelphia study

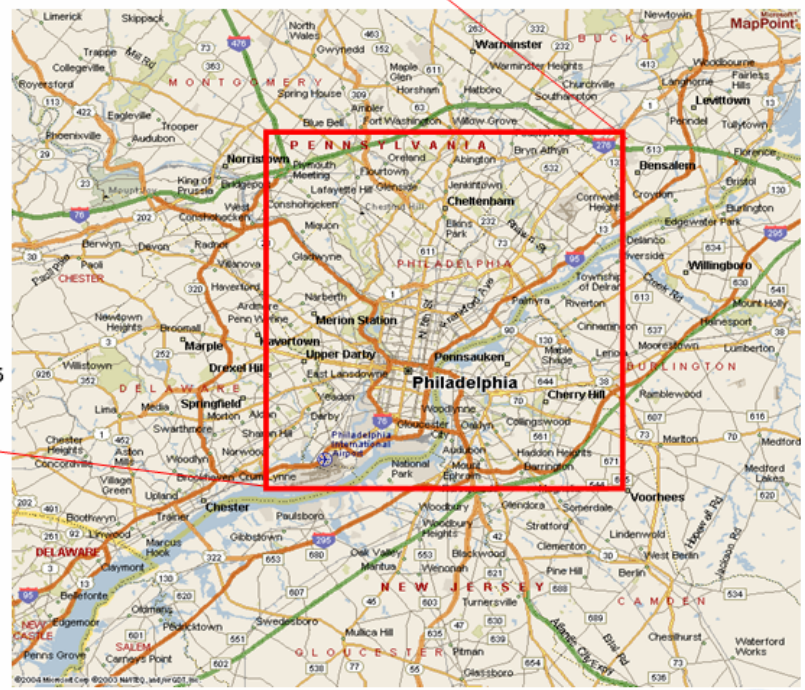
Annual AERMOD simulations using NWS and MM5 meteorology

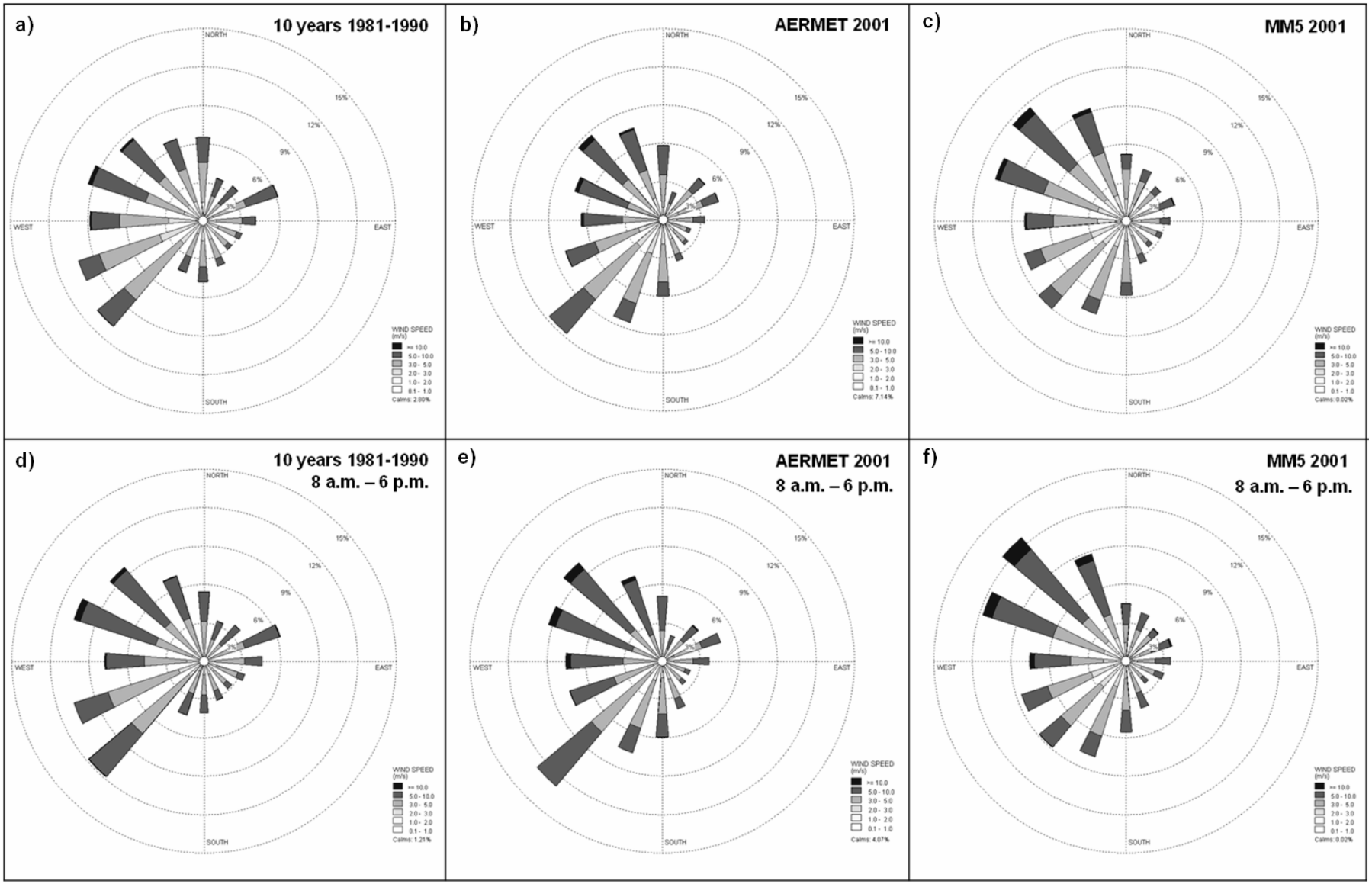




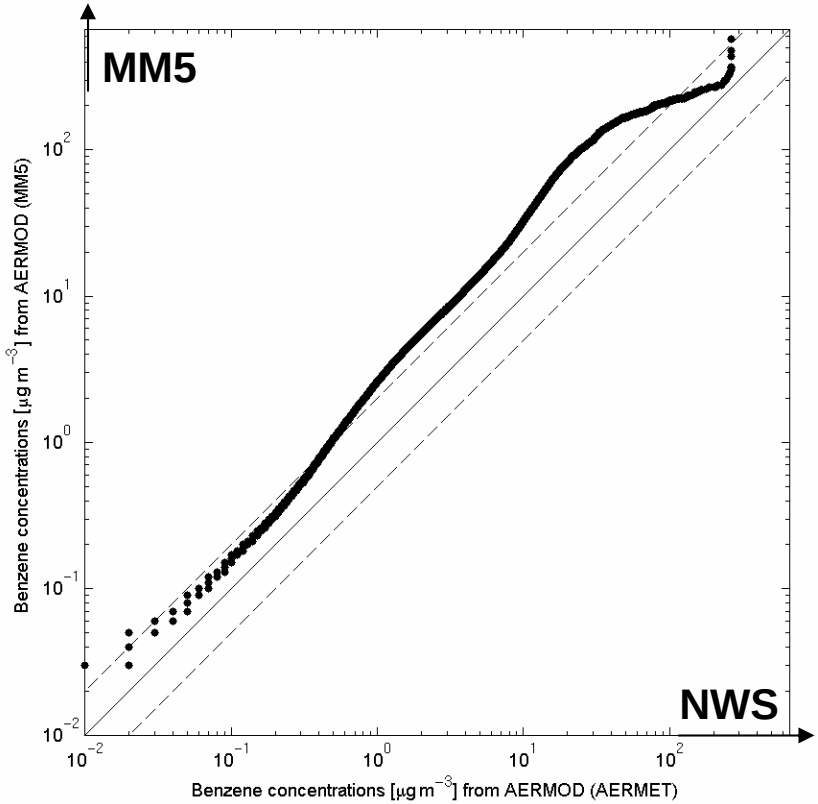
Monitors

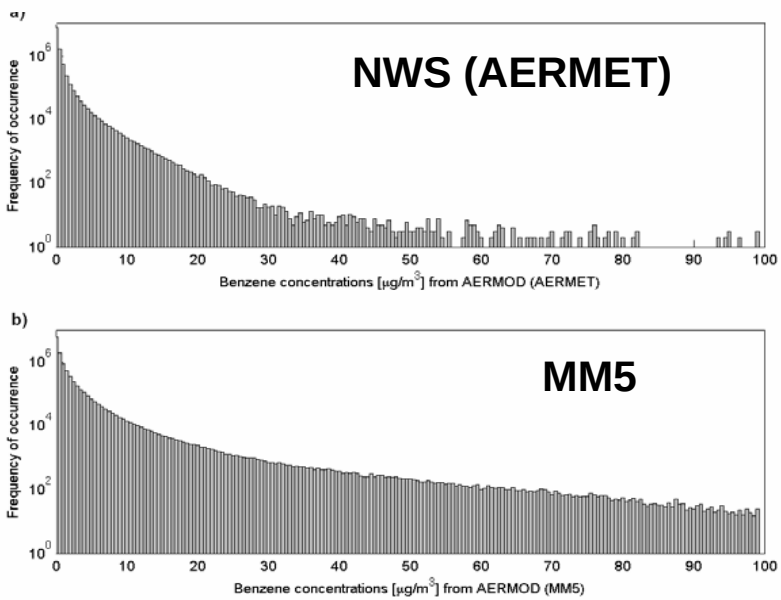
Census Tract Centroids (Philadelphia County)

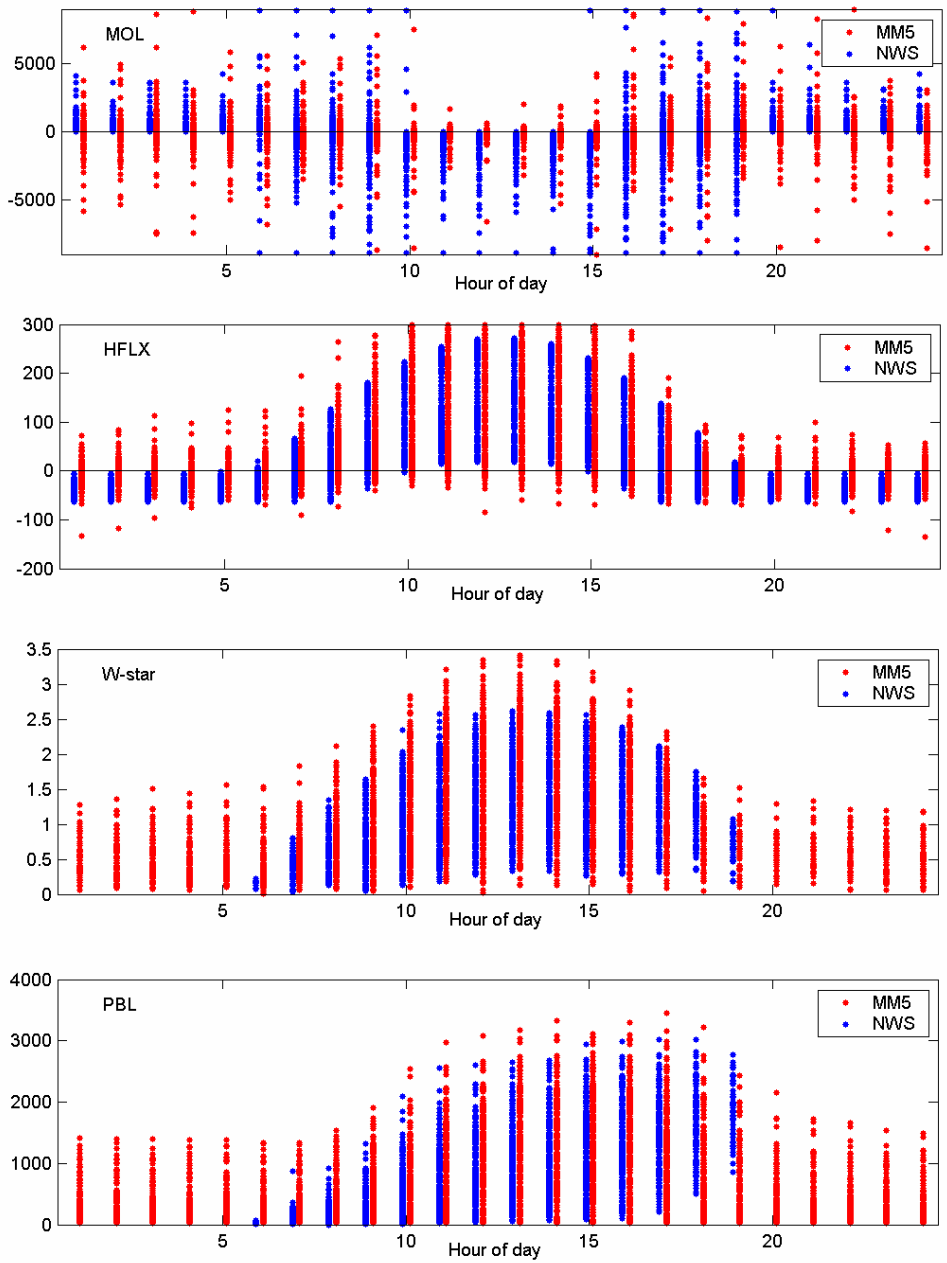




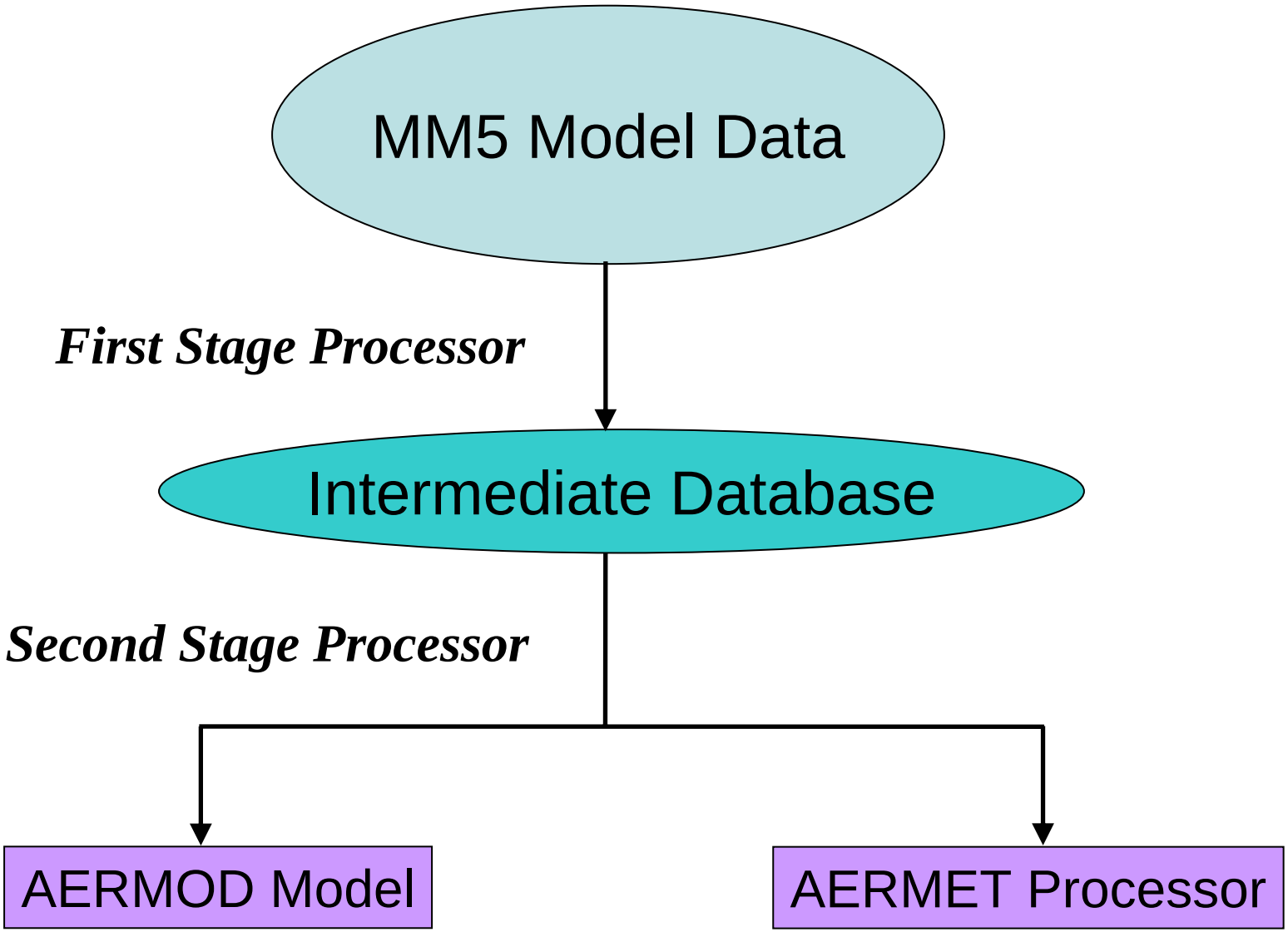
Comparison of wind patterns in Philadelphia from NWS 10-year climatology (a), NWS data processed by AERMET for 2001 (b), and simulated by MM5 for 2001 (c).
Similar comparison is provided for daytime hours between 10-year climatology (d), NWS data processed by AERMET (e), and data from MM5 (f).


MM5
NWS
Benzene concentrations [μg m^{-3}] from AERMOD (MM5)
Benzene concentrations [μg m^{-3}] from AERMOD (AERMET)


a)
NWS (AERMET)
Frequency of occurrence
Benzene concentrations [μg/m^3] from AERMOD (AERMET)
b)
MM5
Frequency of occurrence
Benzene concentrations [μg/m^3] from AERMOD (MM5)


MOL
MM5
NWS
Hour of day
HFLX
W-star
PBL

Design for MM5-AERMOD Tool



Two Main Options for using MM5 Data in AERMOD

A) Create inputs for use directly by AERMOD in the form of surface and profile files; or

B) Create inputs suitable for Stage 3 processing through AERMET in the form of AERMET Merge files.

Both options include several alternatives depending on what specific MM5 data to include in the extraction – scaling parameters, mixing heights, and vertical profiles of wind and temperature.

Option A:

Extract for AERMOD (formatted as .SFC and .PFL files):

1. **Full extract including scaling parameters, mixing heights, and vertical profiles of wind and temperature up to at least 5,000 meters;**

2. **Partial extract including scaling parameters and mixing heights with only partial vertical profiles;**

   a) Vertical wind profiles only
   b) Vertical temperature profiles only
   c) No vertical profiles (single level wind and temperature only)

Advantage: Internal consistency of met data

Option B:

Extract for AERMET (formatted for Stage 3 input):

1. **Prepare data including mixing heights and vertical profiles, formatted as pseudo-NWS surface and onsite profile data;**
2. **Prepare data as pseudo-NWS surface and upper air stations with no onsite profile data.**

Advantages:

- Allows for use of AERMET boundary layer algorithms for consistency with AERMOD formulations
- Allows use of local surface characteristics with AERMET

Disadvantages:

- May introduce inconsistency between MM5 wind and AERMOD-derived turbulence profiles
- Use of local surface characteristics raises same concerns that exist with applying AERMOD using NWS data (measurement vs. application site)

Next Steps

- How to make this technical tool more useful?
- How to evaluate the performance of AERMOD with MM5 data (vs. obs.; vs. NWS data)?
- Long term plans for dissemination of MM5 data and MM5-AERMOD Tool
- We need your feedback

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