AT&D Research Needs and Priorities

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Multiscale Nature

- Every atmospheric dynamical process operating on scales larger than molecular dissipation and smaller than the latitudinal variation of the Coriolis force can play a role in T&D
- Therefore, these space-time flow scales should be represented as accurately as possible when atmospheric transport and dispersion processes are studied

Required Modeling Capabilities

- Pre-Modeling
  - Model execution time is not important
  - But an accurate modeling system is required
- Emergency Response
  - Model execution time is important
  - Accuracy is compromised to some degree
- Post-Modeling
  - Model execution time is not important
  - But an accurate modeling system is required

A Critical Balance

Accuracy

Must Resolve Many Scales

Operational Constrains

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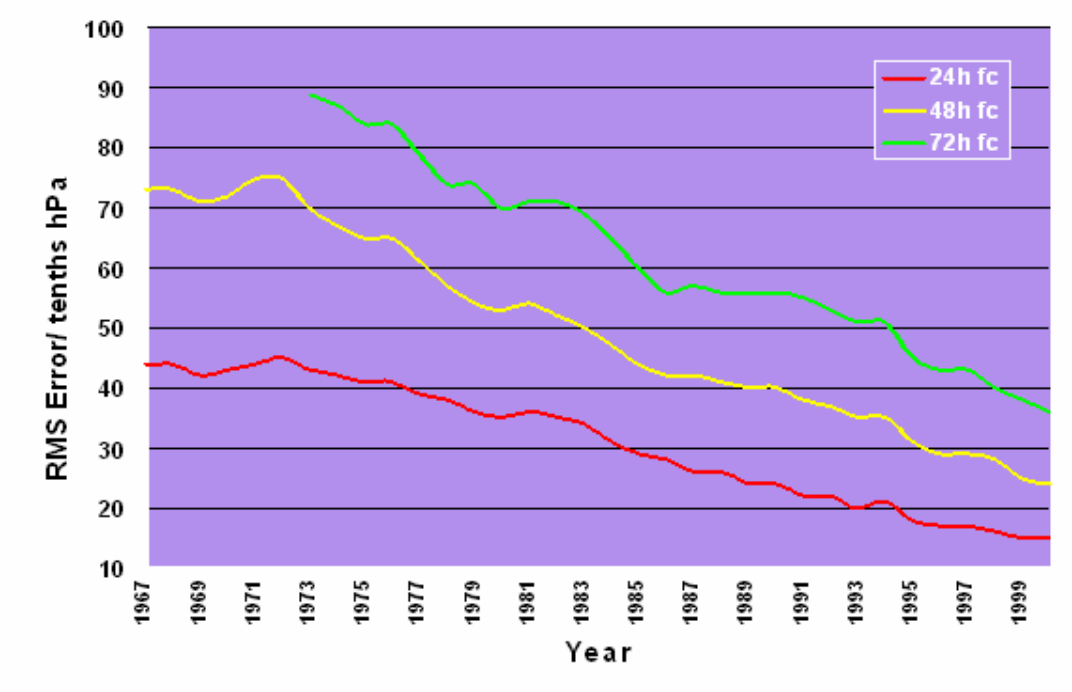
Modeling Systems

- The foundations for such modeling capabilities range from the best available scientific theory to empirical observation
  - Flow models (e.g., Mesoscale Met, CFD, LES, RANS and MC models)
  - T&D models (e.g., Gaussian puff and LPM)
- Frequently, they are also assembled by coupling a number of independent models

Atmospheric Modeling Needs

- Observations are a critical element of atmospheric modeling
- There is a need to improve observational networks
  - Especially around more vulnerable areas
- The current array of remote sense observations needs to be better used in atmospheric modeling
- However, observations alone can not determine the state of atmosphere
- Models are needed to fill the gap

Atmospheric Modeling Needs



- The improvement of the forecasts of mean sea level pressure for the Atlantic and Western Europe region

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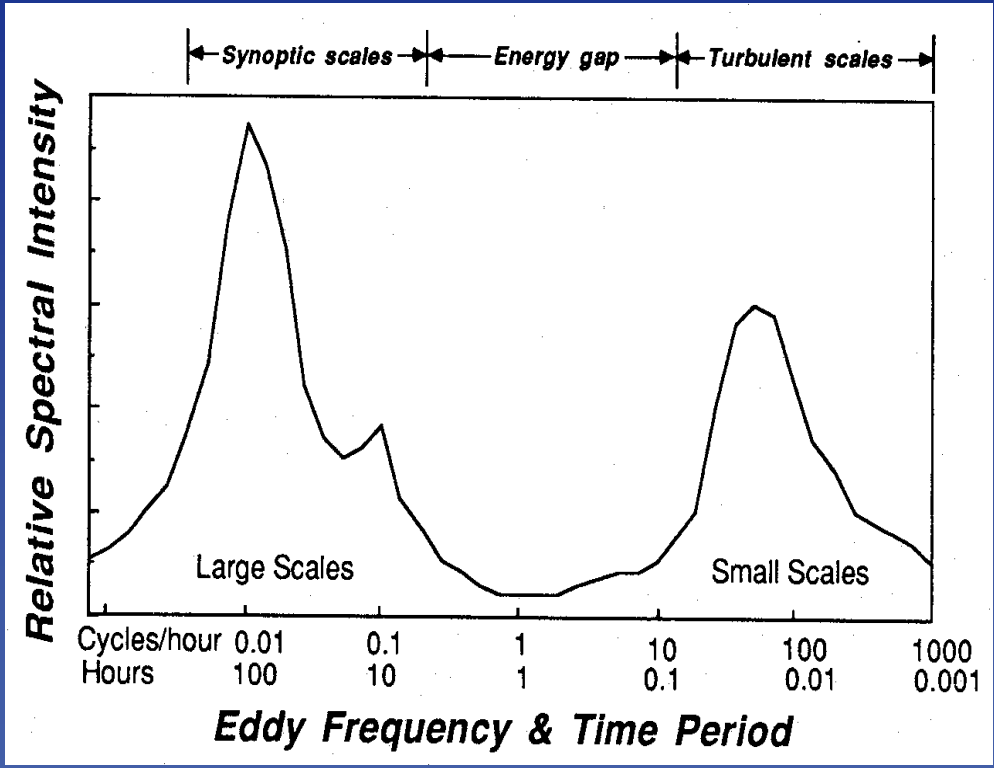
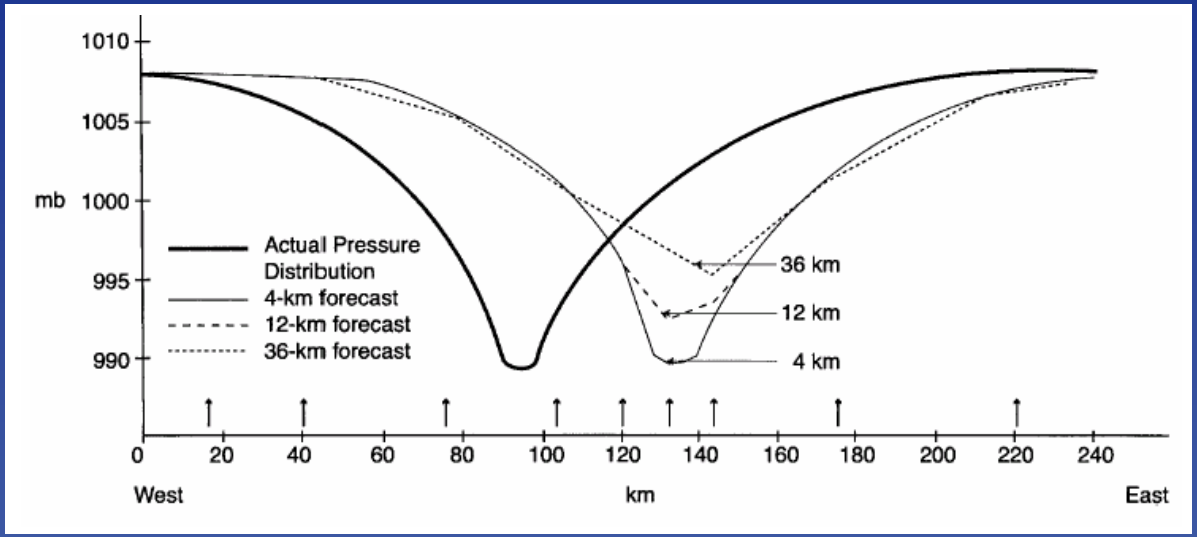
Atmospheric Modeling Needs



- If resolution is increased to a much greater than a few km, are the parameterizations valid?

Atmospheric Modeling Needs



- Sea level pressure variation in the east-west direction of an observed trough (solid line), and MM5 model predicted thoughts from 36, 12, and 4 km horizontal grid resolution runs (adapted from Mass et al., 2002).

Atmospheric Modeling Needs

- Unstable boundary layer has been studied to some extent successfully
- It is, however, questionable whether the properties and behavior of the stable boundary layer (SBL) are well understood
- SBL can be characterized by the inertial oscillation, intermittent turbulence, and gravity waves that they imposes severe restrictions in simulating accurately the structure of SBL
- It is with this in mind that the worst-case (i.e, highest concentrations) dispersion conditions are known to occur when the boundary layer is stable

Atmospheric Modeling Needs

- The poor understanding of SBL structure is due in part to the lack of field experiments
  - 1956 Prairie Grass Experiment
  - New field experiments are needed in the SBL
- On the other hand, a strong ongoing research is also needed for better understanding of the SBL structure

Atmospheric Modeling Needs

- Often, the atmospheric boundary layer is nonhomogeneous and frequently in a state of transition from one land use type to another
- For these reasons, it is important to consider how models obtain their surface characteristic data and how models represent their physical processes

Atmospheric Modeling Needs

- Focused field experiments are also needed especially with measurements in vertical direction (in coastal areas?)
  - to understand the behavior of modeled T&D in different weather regimes
  - to allow for testing, evaluation and development of existing and new modeling systems

Atmospheric Modeling Needs

- As decision and policy makers come to rely increasingly on estimates and simulations produced by these models, the need for ***objective*** and ***non-partisan*** evaluation of the accuracy and utility of such models become more urgent and important
- A key question is, however, ***how good these complex computer models really are for their intended purposes*** and ***what uncertainties involve in their predictions***
- More research needed to determine if it is beneficial to construct ensembles of model solutions on the urban scale so that probalistic rather than deterministic