Analysis of Mesoscale Model Data for Wind Integration

Marc Schwartz, Dennis Elliott, Debra Lew, Dave Corbus, George Scott, Steve Haymes, Yih Huei Wan
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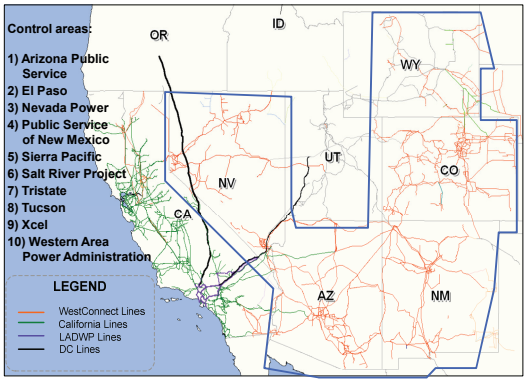
Western Wind and Solar Integration Study (WWSIS)



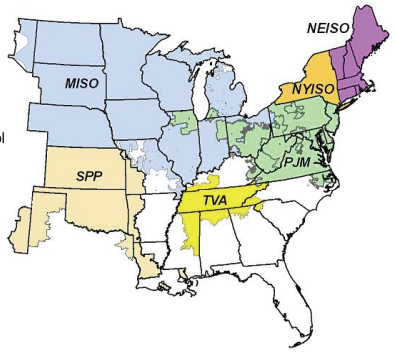
Why Numerical Mesoscale Modeling for Wind Integration Studies?

1. Supports examination of implications of national 20% wind vision
2. Provides input to integration and transmission studies for operational impact of large penetrations of wind on the grid
3. Generates consistent wind speed and power plant output time series data sets
   - Time series capture geographic diversity issues for:
     - Resource planning
     - System operations
     - Transmission expansion analyses

Eastern Wind Integration and Transmission Study (EWITS)

Study area includes:

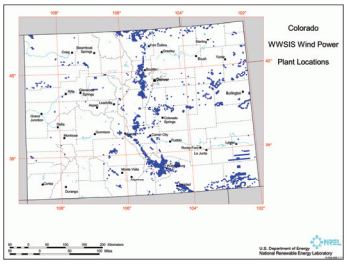
- PJM
- Midwest ISO
- Mid-Continent Area Power Pool
- Southwest Power Pool
- TVA
- New York ISO
- Other interested parties



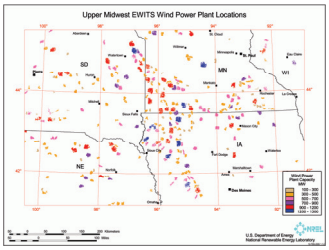
Mesoscale Model Data Sets Evaluated at NREL

	EWITS Eastern Wind Integration and Transmission Study	WWSIS Western Wind and Solar Integration Study
Produced by:	AWS Truewind	3TIER
Horizontal resolution	2km	1 arc-minute (~1.5km)
Temporal resolution	10 minutes	
Period	2004-2006	
Wind speed output	5 heights	
Wind plant output	80m, 100m	100m
Wind plant representation	Amalgamated grid cells used for onshore wind plants, and individual grid cells used for offshore wind plants	Individual grid points represent a wind plant
	1326 onshore wind plants of various sizes (100 MW to 1500 MW); 4948 offshore grid points of 20 MW each	32043 individual grid points of 30 MW each

Wind plant locations and size



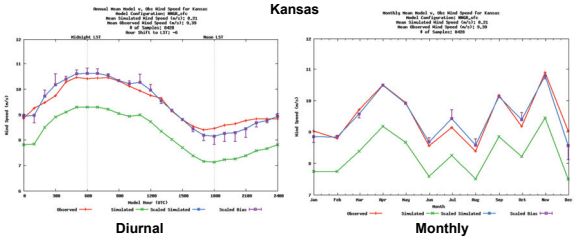
- Each point that represents a wind plant location corresponds to an area of 1 arc-minute or approximately 1.5 km by 1.5 km
- The installed capacity for each point is 30 megawatts



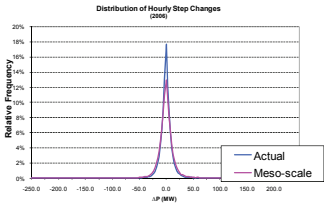
- Each wind power plant location is a grouping of 2 km by 2 km grid points
- The installed capacity for each grid point contained within a wind plant is 20 megawatts

Validation

Model and Observed Wind Speeds at One EWITS Validation Tower



Comparison of Observed and Modeled (WWSIS) Changes in Power from Texas Wind Plants



Validation Conclusions

- EWITS and WWSIS data sets developed using different numerical computer models
  - EWITS used MASS model, part of AWS Truewind's MesoMap@ system
  - WWSIS used WRF model as employed by 3TIER
- Both models were optimized using comparisons between raw model data and measurement from tall towers
- Greatest uncertainty in model data occurs:
  - In complex terrain (e.g. downslope acceleration)
  - Where wind flows are thermally driven (e.g. land-sea breeze)
  - Where there are strong flows near the top of the boundary layer (e.g. low-level jets)

Design of EWITS and WWSIS Mesoscale Data Sets

- Data sets designed to:
  - Provide a robust and consistent data set for modeling studies of integrating significant amounts of wind in balancing areas
    - Used for "what if we had wind turbines here" type of modeling studies
  - Cover the same time period as load data in the studies
  - Recreate historical climate and weather data to enable historic modeling of winds
    - Analyzed in conjunction with load, hydro and other climate/weather related data

Design of Mesoscale Data Sets

- Data sets **are not** designed to:
  - Predict distribution, location, and size of future wind plants across the U.S.
  - Predict the long-term power production from a particular wind plant
  - Predict future wind generation levels from a state or region
  - Replace updated state wind resource maps
  - Be the only basis for investment in wind development

Future Work for Mesoscale Data Sets

- Tall tower measurement campaign to increase understanding of boundary layer and validate mesoscale model data
- Validation of mesoscale wind speed time series
  - Diurnal
  - Seasonal
- Comparison of overlap areas of EWITS and WWSIS data
- Standardization of data set characteristics
  - Wind plant shapes
    - Series of individual grid points versus amalgamated grid cells
  - Horizontal resolution of grid cells and wind plant installed capacity
  - Protocol for converting wind speeds to wind plant production
    - Calculation of losses
    - Appropriate IEC turbine class based on wind speed

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