Mapping wind resources - state of the art

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Mapping wind resources – state of the art

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Observational wind atlas
**European Wind Atlas**

- 12 countries in Europe
  - EU project 1981-89
- 220 met. stations
  - Wind data for 10 years
  - wind atlas analyses
- 656-page book
  - EU wind potential
  - handbook of siting
  - database of wind
- CD-ROM containing
  - observed wind data
  - modelled wind data
- Applications
  - only overall planning

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**Numerical wind atlas – mesoscale**

- Inputs
  - NCEP/NCAR reanalysis data-set
  - terrain topography – elevation and roughness – satellite and SRTM data
- Outputs
  - generalised regional wind climate for large domains
- Applications
  - planning and project preparation
  - assessment of mesoscale effects at wind farm projects
Numerical Wind Atlas for Egypt

- Numerical wind atlas
  - NCEP/NCAR data
  - mesoscale modelling
  - SRTM30 elevations
  - GLCC land use
- Observational wind atlas
  - 30 met. stations
  - microscale modelling
  - SRTM3 elevations
  - Land use from GE
- Comprehensive outputs
  - Wind Atlas for Egypt
  - OWC/RWC databases
  - > 50,000 *.lib files!
  - Verified and reliable
  - Application ready!

Verification – example

Typical mean absolute error on the wind speed: 5-10 %
### State-of-the-art wind atlas methodology

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#### Met. stations
- **Sino-Danish Wind Energy Development Programme** - Dongbei 2008-2009
- **Strategy**
  - Twinning arrangement – initiate long-term, strategic cooperation between CMA and Risø DTU
  - Development of numerical wind atlas methodologies
  - Development of measurement practices
  - Emphasis on application of results for wind energy planning and project preparation.
  - Emphasis on verification and uncertainties
  - Full-scale testing and verification in Dongbei: Liaoning, Jilin and Heilongjiang

#### Mesoscale and microscale modelling in China

**“Sino-Danish Wind Energy Development Programme” - Dongbei 2008-2009**

- **Pre-processing**
  - Wind speed distributions
  - Wind direction distribution
  - Terrain elevation
  - Terrain roughness
  - Sheltering obstacles

- **Modelling**
  - WAsP
  - MS-Micro
  - CFD-models etc.

- **Post-processing**
  - Regional wind climate
  - Predicted wind climate
  - Predicted wind resource for selected terrain site coordinates

- **Applications**
  - Best practices
  - Courses and training
  - Microscale flow model
  - Wind term wake model

**Observational WA**
- **Mesoscale maps**
- **WAsP®** LUF files
- **Uncertainties**
- **Parameters**
Measurements

- Lattice-type meteorological towers
  - 12 tall masts (70 & 100 m)
  - accurate installation of sensors
  - easy inspection and maintenance

- Sensors
  - high-quality, double instrumented
  - wind speeds at 3 or 4 levels ⇒ vertical wind profile
  - temperature difference sensors ⇒ atmospheric stability

- Data acquisition system
  - Daily GSM transfer to database
  - local backup in logger
  - high data recovery rates

70-m mast installed in Dongbei
70-m mast installed in Dongbei
Modelling

• **Mesoscale modelling**
  - KAMM/WAsP numerical wind atlas
  - covers large areas
  - fast and cost-effective
  - regional wind climate @ grid points
  - provides inputs for microscale
  - comparisons of several models: KAMM, WRF, MMS and MC2

• **Microscale modelling**
  - analysis of 12 met. towers
  - analysis of CMA met. stations
  - WAsP observational wind atlas
  - regional wind climate @ tower
  - parameter studies used for localisation of model setup
  - same model as for applications

By the end of 2009

• **12 measurement stations** in operation
  - nine 70-m + three 100-m masts
  - double instrumentations: Risø and CMA

• **Observational Wind Atlas**
  - measurements and microscale modelling
  - for regions close to the towers and met. stations

• **Numerical Wind Atlas**
  - reanalysis data and mesoscale modelling
  - covering all of Dongbei with a resolution of 5 km

• **Verification** of numerical wind atlas against towers and met. stations

• **Databases, tools and guidelines**
Ideas for the future

So, the mean wind climate is being done now, what’s next...?

Here are some quick ideas:
• Wind conditions and site assessment (IEC 61400-1)
  - extreme winds
  - wind profiles and shear
  - terrain and flow angles
  - free-stream turbulence intensity
  - wind farm wake turbulence
• Extreme Wind Atlas
• More on stability effects
• Long-term wind climatologies at reference stations
• ...

And, not to forget, application of improved methodologies to all of China!