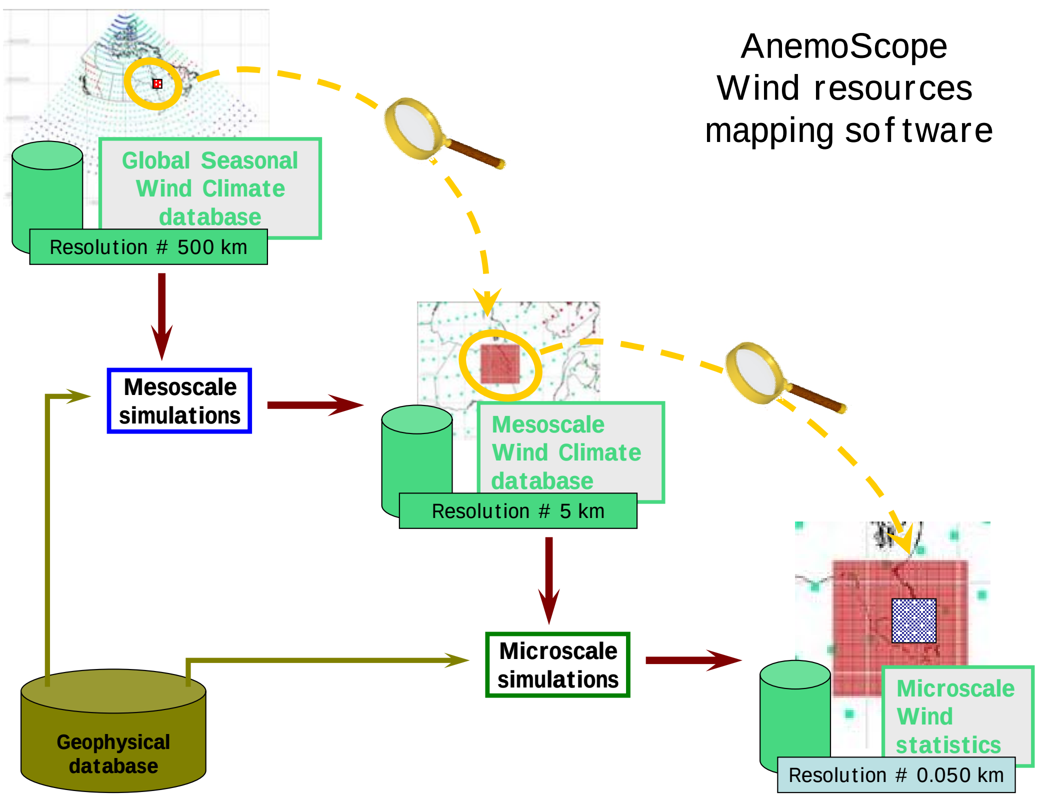
Method Overview

The basic simulation process used by AnemoScope to build detailed wind maps on a local (microscale) area is represented in the figure below. It is based on the statistical-dynamical downscaling method (Frey-Buness et al., 1995) and involves the following steps:

- **Wind climate classification** to produce a wind climate database,
- **Mesoscale simulations** for a representative range of wind climate states and statistical post-processing to produce **mesoscale wind statistics**,
- **Microscale modeling** to refine the mesoscale results and produce microscale wind statistics.

Both the mesoscale and the microscale modeling require **geophysical data** to define the terrain conditions.

Assuming that a climate database is available, AnemoScope integrates the last two steps in a sequential simulation process.



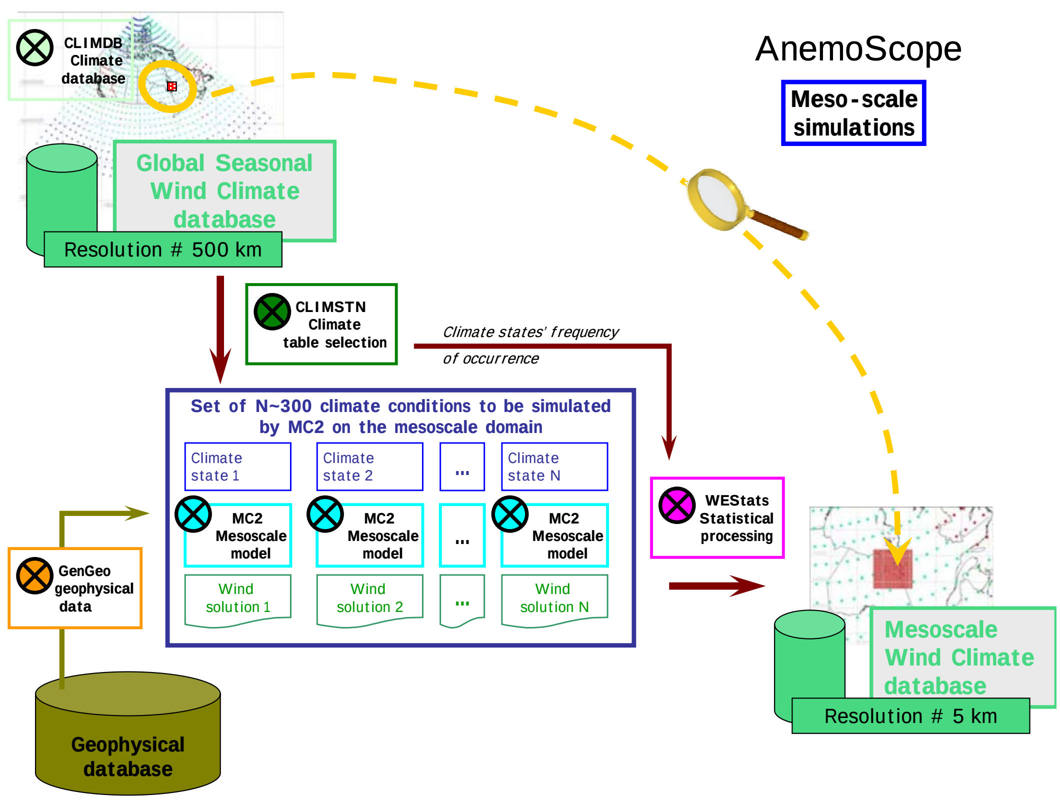
The downscaling simulation process used by AnemoScope

Meteorological centres (such as CMC, NCEP, or ECMWF) collect and analyze, every six hours, the data from surface stations, radiosondes, ships, airplanes, radar installations, and satellites. They provide long-term (several decades) quality-controlled and analyzed 3D weather data covering the world. However, the horizontal resolution of the data is too low (on the order of hundreds of kilometres) to be directly used for wind farm siting. AnemoScope is specifically designed to make the best use of this global climate data for wind energy mapping by adapting the large-scale atmospheric flow to local effects and providing mesoscale maps. The mesoscale maps are in turn used to perform refined microscale studies, which are one of the key elements of wind farm siting.

Wind Climate Classification

AnemoScope users will normally not need to perform the wind climate classification step because a global, seasonal wind climate database is delivered with the software. This database is the product of a wind climate classification at climate stations distributed all over the world with a 2.5 degree resolution (~ 500 km at Canadian latitudes). For each station, about 350 climate states are defined and characterized by their frequency of occurrence. This database is described in more detail in the Reference Guide.

Mesoscale Simulations and Mesoscale Wind Statistics



The mesoscale simulation process used by AnemoScope

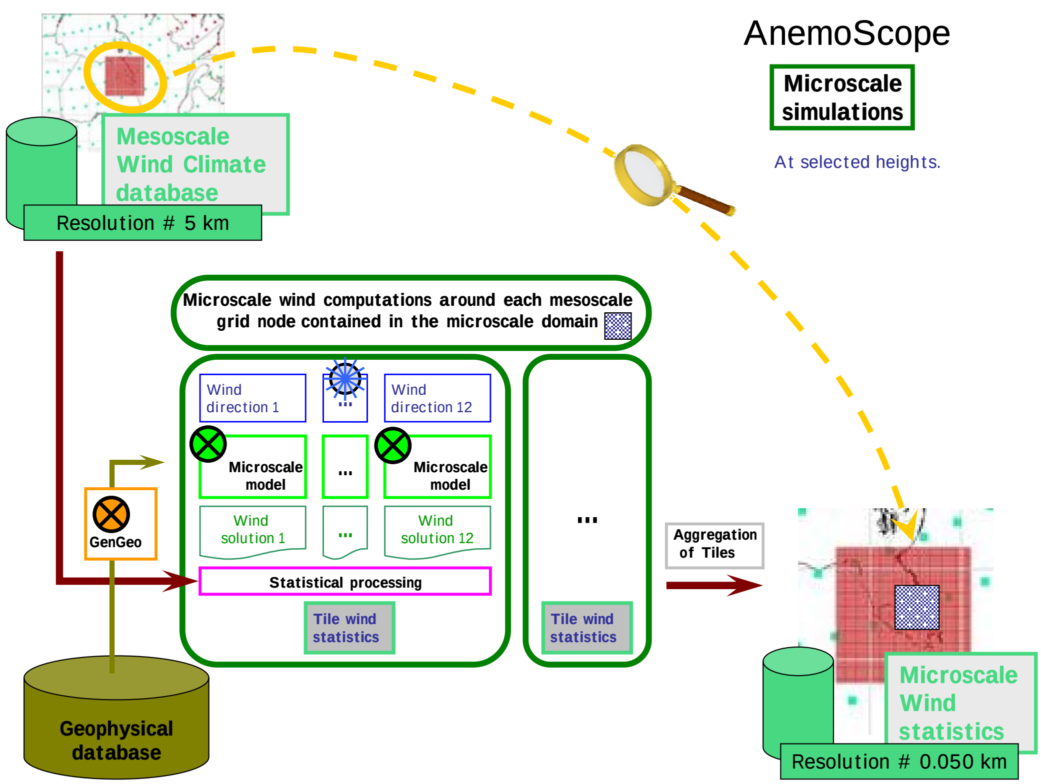
After defining the domain of interest and the corresponding climate station, a series of mesoscale simulations is launched, one for each of the climate states occurring at the selected climate station. A **statistical processing** is then applied to the results of the mesoscale simulations and wind statistics are obtained. The mean wind speed, the mean wind power, frequency distributions of the wind speed, and wind power in speed classes and angular sectors are computed.

This step allows wind information to be produced on a regional scale at a resolution of a few kilometres (1 to 5 km) from wind information at a much larger resolution (about 500 km).

The central tool in this step is **MC2**, the mesoscale atmospheric model integrated into AnemoScope. MC2 is described in greater detail in a specific section of this reference guide.

Microscale Wind Statistics

In this step, the resolution is increased again, to about 50 m, on a subset of the mesoscale domain. The wind statistics are further refined in this microscale domain. The microscale model computes the modification of the mesoscale wind solution due to the effects of local topography and terrain roughness.



The microscale simulation process used by AnemoScope

The microscale model works on small tiles centered at each of the mesoscale nodes. The size of the microscale tiles is on the order of the mesoscale grid cells (a few kilometres) and the microscale grid resolution is as fine as a few tens of meters.

MMC, the Meso/Microscale Coupler, prepares and executes a series of microscale simulations for each of the microscale tiles included in the microscale domain. The program decomposes the mesoscale subdomain into hundreds or thousands of overlapped tiles, depending on the resolution of the microscale modeling. It then prepares and launches the microscale simulations, and finally gathers the results of all the tiles into one single high-resolution wind map of the mesoscale subdomain. Very detailed mean wind speed and mean wind power maps are obtained this way.

The **Meso/Microscale Coupler** and the microscale model **MS-Micro** used by AnemoScope are further described in the AnemoScope reference guide.

Geophysical Data

The wind is influenced by the topography and by the land cover. These geophysical features are required by the mesoscale and microscale models and have to be described for the computational domain.

Topographic and land cover data are available in databases from different sources. AnemoScope includes the **GenGeo** tool, which is specifically designed to extract the relevant information for the domain under consideration from large databases.

A worldwide database (the GENGEO_DB) of geophysical information is also provided. This database is sufficient for mesoscale simulations, but higher resolution data will be required for microscale studies.

The **GenGeo** software and the format and content of the geophysical databases are detailed in the AnemoScope reference guide.