Dispersion Modeling of Air Pollutants in the Atmosphere: a review

- Pollutants can be released either by approximated point sources or area sources
- Transport and transformation of air pollutants in the atmosphere is mainly governed by advection (wind field). Other processes such as turbulence, chemical reactions and radioactive dacay can play an important role.
- lifetime of Zinc is not know, however it is suspected to be days or weeks.
- The model that we are using is the atmospheric transport equation.
- Near-surface atmospheric turbulence is caused by mechanical and thermal effects. Friction forces in a viscuous flow generate mechanical turbulence, which is driven by wind shear. Therefore **Three dimensional wind data** is necessary to estimate the intensity of mechanical turbulence. However near-surface wind shear can be estimated using the surface roghness (z_0). This parameter represents the strength of the friction between the surface and the atmosphere.
- Turbulent mixing in the atmosphere is driven by wind shear and bouyancy. The approached used to calculate the turbulence parameters is to define categories with respect to variables such as:
  - radiation paramters

- wind speed
- surface roughness
- cloud cover

Here is where the Pasquill stability clases come into play.

- **Monin-Obukhov theory**: The M-O length is a reference scale for boundary layer turbulence, so any height z can be given instead as $\frac{z}{L}$. Monin-Obukhov theory is one of the most reaiable basis for all fields of atmospheric modelling

- There are three ways to model dispersion

  - **Gaussian Dispersion Models**: See derivation in John's paper

    * Advantages: Are applied when robust model setup and fast response time are key factors.
    * Disadvantages: Provide poor result with low wind speeds where the three dimensional diffusion is significant.

  - **Lagrangian models**: Uses the trajectory of each particle and uses ODEs to model

    * Advantages: Computational cost is indept. of the output grid. they are incredibly efficient for short-range dynamics.
    * Disadvantages: For long-range simulations the computational cost increase significantly.

  - **Eulerian models**: The idea is to solve the atmospheric equation in a fixed reference frame

* Advantages: Multipurpose
* Disadvantages: Its computational cost

Source Estimation Methods for Atmospheric Dispersion

- There are two methods for source estimation. Forward and backward modeling. For forward modeling we have topics such as Bayesian updating. Backward modeling uses only one run backward.
- Given the meteorology and concentrations observed at several detectors, these methods characterize the source type and estimate the source strength and location.

Uncertainty analysis in Atmospheric Dispersion Modeling

- Take into account that in general, observations and model predictions are uncertain.
- Once the input parameters to be studied are identified, uncertainty analysis is a two-step sequential procedure. The first step involves assigning a pdf, The second step involves propagating the joind pdf through the model
- In the lack of a body of theoretical knowledge it is expected that the judgement of experts differs considerably to one another. The knowledge of an expert is called **Substantive expertise**