Gradient and other methods

Session 5

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State of the art

- Machine learning to breed next trial solution
- Polynomial Chaos/maximum likelihood
- L1/Entropy norm based minimization (sparse minimization)
- Variational and matrix minimization (non parametric)

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- Met data with errors you can trust.
- More obs (any kinds, better the parameters you are interested in).
- Novel cost function to improve convergence

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Suggest path forward

- Better use of knowledge gained during the estimation procedure (stochastic optimization)
- Representative meteorology ensemble
- Estimation of model error
- Source parameters uncertainty characterization

More observations

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- The problem (rapid response/reconstruction **and observations quality**) defines the method.
- Meteorology cannot be 100% trusted

- 2 approaches:
  - Precalculations
  - Inversion

- Some precalculations can be done to allow computationally expensive solution be used in rapid response (eg: Finland, France agencies)
  - This works if you know a priori where release is likely to come from, eg: power plants, etc.

- Parametric / non parametric methods
  - Parametric better suited to local problems.
  - Non parametric is akin to meteorological data assimilation better suited to synoptic and regional problems.

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- Rain washing can play key role and can hardly be reconstructed even with the best model.
- Forward models are not good enough if we start to look at different scales, and particularly above the boundary layer for long range transport.

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- Group expertise covers gradient and evolutionary algorithm, machine learning.
- Function evaluations
- Number of sources is big issues, because it's an integer.
- Identify source number (L1 norm) first then refine with a gradient descent for the strength.

- Machine learning (trees and rules)
- Each algorithm needs to be courageous at the beginning and chicken at the end
- The cost function needs to be smoothed to reduce iterations.

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Uncertainty

- Uncertainty propagation:
  - Use of ensemble, EnVar
  - Polynomial Chaos