Atelier
« Modélisation, gestion et atténuation des risques en sciences de la santé »
11 au 13 décembre 2017

Workshop
"Risk Modeling, Management and Mitigation in Health Sciences"
December 11-13, 2017

Global estimation of air quality and the burden of disease associated with ambient air pollution

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Air pollution is a major risk factor for global health, with both ambient and household air pollution contributing substantial components of the overall global disease burden. One of the key drivers of adverse health effects is fine particulate matter ambient pollution (PM2.5) to which an estimated 3 million deaths can be attributed annually. The primary source of information for estimating exposures has been measurements from ground monitoring networks but, although coverage is increasing, there remain regions in which monitoring is limited. Ground monitoring data therefore needs to be supplemented with information from other sources, such as satellite retrievals of aerosol optical depth and chemical transport models. A hierarchical modelling approach for integrating data from multiple sources is proposed allowing spatially-varying relationships between ground measurements and other factors that estimate air quality. Set within a Bayesian framework, the resulting Data Integration Model for Air Quality (DIMAQ) is used to estimate exposures, together with associated measures of uncertainty, on a high-resolution grid covering the entire world. Bayesian analysis on this scale can be computationally challenging and here approximate Bayesian inference is performed using Integrated Nested Laplace Approximations. Based on summaries of the posterior distributions for each grid cell, it is estimated that 92% of the world's population reside in areas exceeding the World Health Organization's Air Quality Guidelines. Estimated exposures from the model, produced on a high-resolution grid (10km x 10km) covering the entire globe, are combined with risk estimates to produce a global assessment of exposures to PM2.5 and to estimate the associated burden of disease attributable to air pollution.

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