

# Estimation of natural ventilation parameters by a Bayesian approach

## Background

- ❑ Natural ventilation is an effective method to reduce energy consumption of the air conditioning and improve the thermal comfort of residents.
- ❑ Evaluation of the ventilation performance of a building using the tracer gas experiment always accompanies a large uncertainty.

## Work accomplished

- ❑ We propose a stochastic estimation method of natural ventilation parameters (natural ventilation rate and effective room volume) based on Bayesian statistics.
- ❑ In the proposed method, not only estimates of individual parameters but also information on uncertainty of the estimated values and correlation between parameters can be provided in the form of a probability density function.

- Parameters to be estimated (natural ventilation rate, effective room volume):  $\mathbf{p} = (Q, V_{eff})$

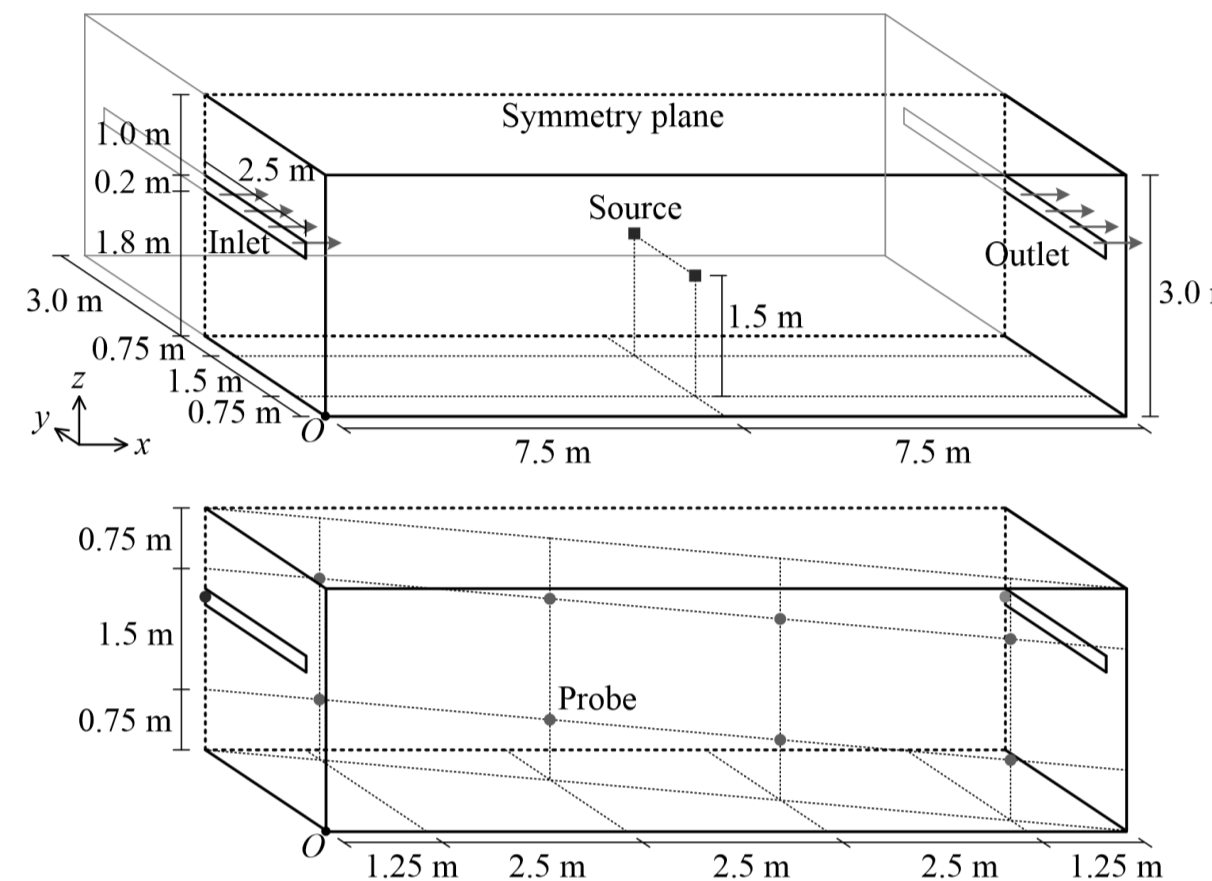
- Predictive model of indoor mean concentration of tracer gas:

$$V_{eff} \frac{dC_r}{dt} = QC_{in} - QC_{out} + f$$

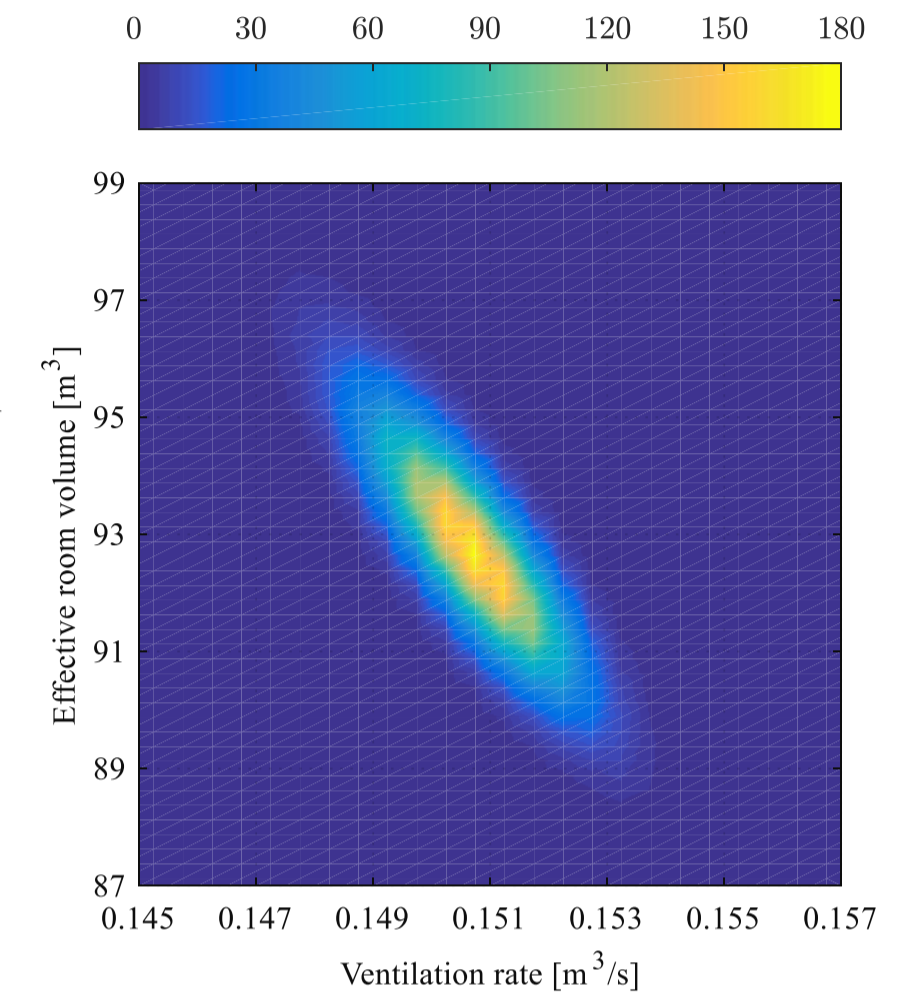
- Bayes' Theorem and posterior distribution:

$$P(\mathbf{p}, r_\sigma | C_m) = \frac{P(C_m | \mathbf{p}, r_\sigma) P(\mathbf{p}, r_\sigma)}{P(C_m)} \propto \frac{1}{r_\sigma^N} \exp \left[ -\frac{1}{2} \sum_{n=1}^N \frac{(C_m^n - C_p^n(\mathbf{p}))^2}{(r_\sigma C_m^n)^2} \right]$$

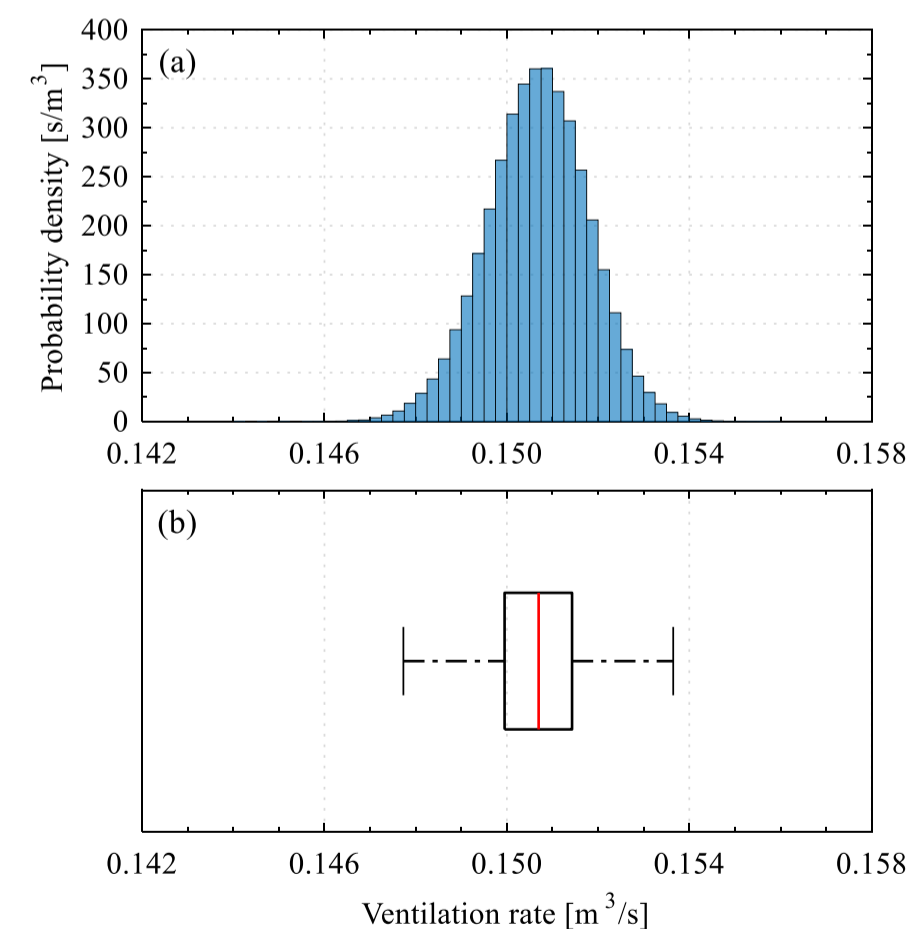
$Q$ : natural ventilation rate,  $V_{eff}$ : effective room volume,  $C_r$ : indoor mean concentration,  $C_{in}$ : inlet conc.,  $C_{out}$ : outlet conc.,  $f$ : tracer release rate,  $C_m$ : observed conc.,  $C_p$ : predicted conc.,  $r_\sigma$ : ratio of concentration deviation between the prediction and observation



Room model and locations of tracer release and measurement



Joint probability density function between estimated parameters



Stochastic estimation of natural ventilation rate and effective room volume

