LONDON 2015
IOHA
10th IOHA International Scientific Conference

www.expostats.ca

A new Bayesian toolkit for the estimation of occupational exposure levels compared to exposure limits

Jérôme Lavoué, Lawrence Joseph, François Lemay

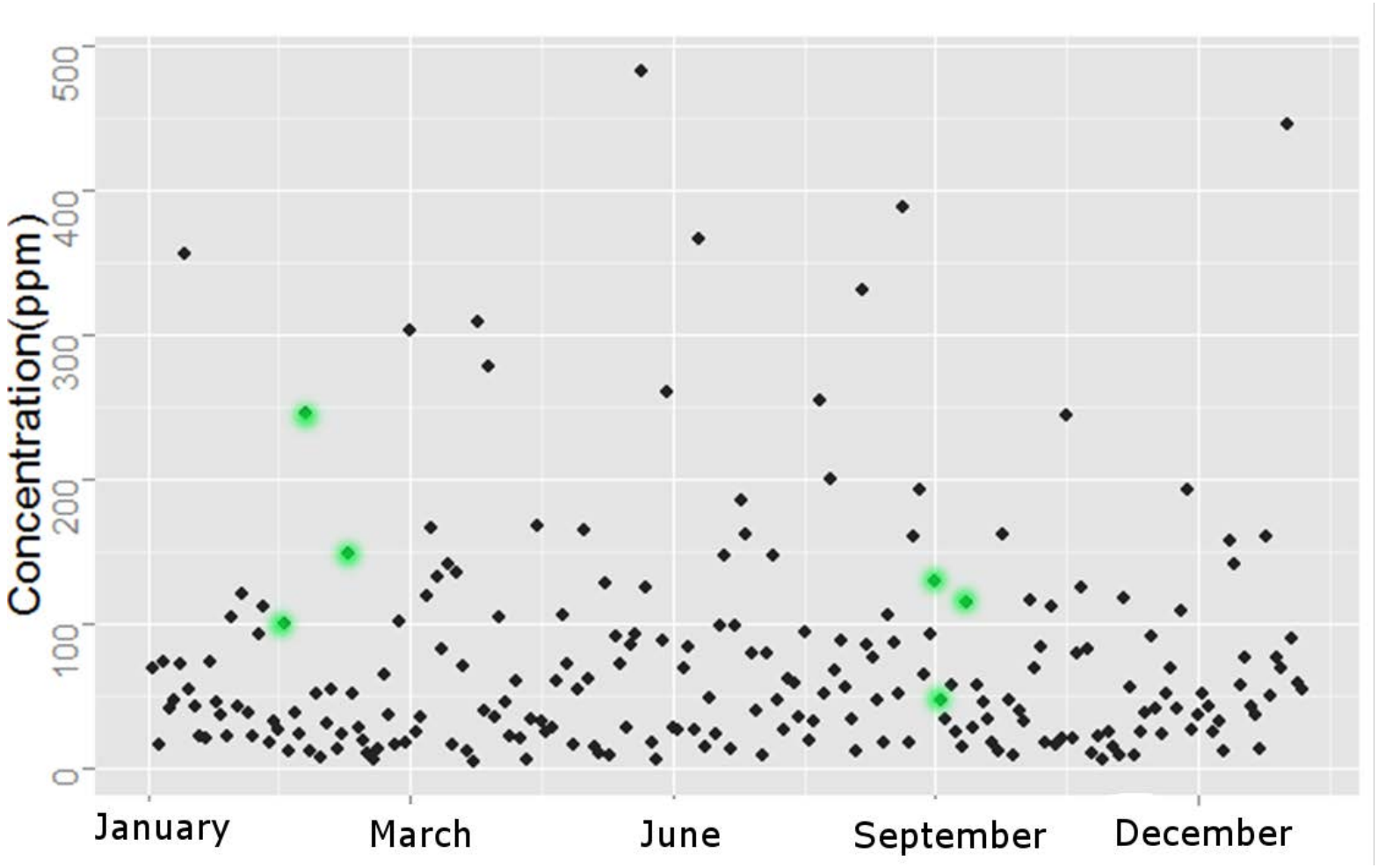
Université de Montréal

McGill UNIVERSITY

IOHA London 2015, 25-30 April 2015
Hilton London Metropole

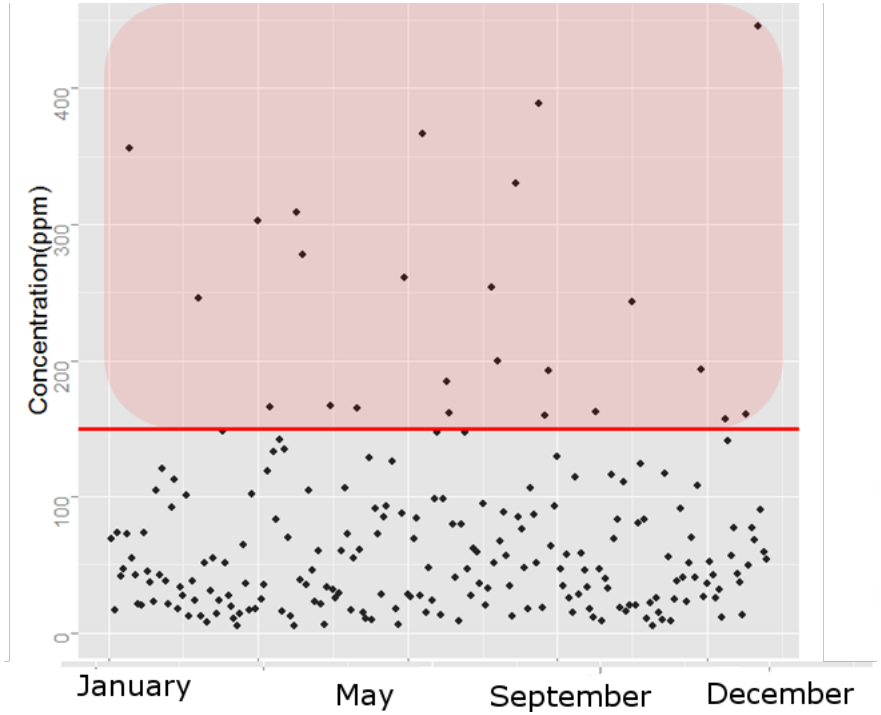
The origin of the problem

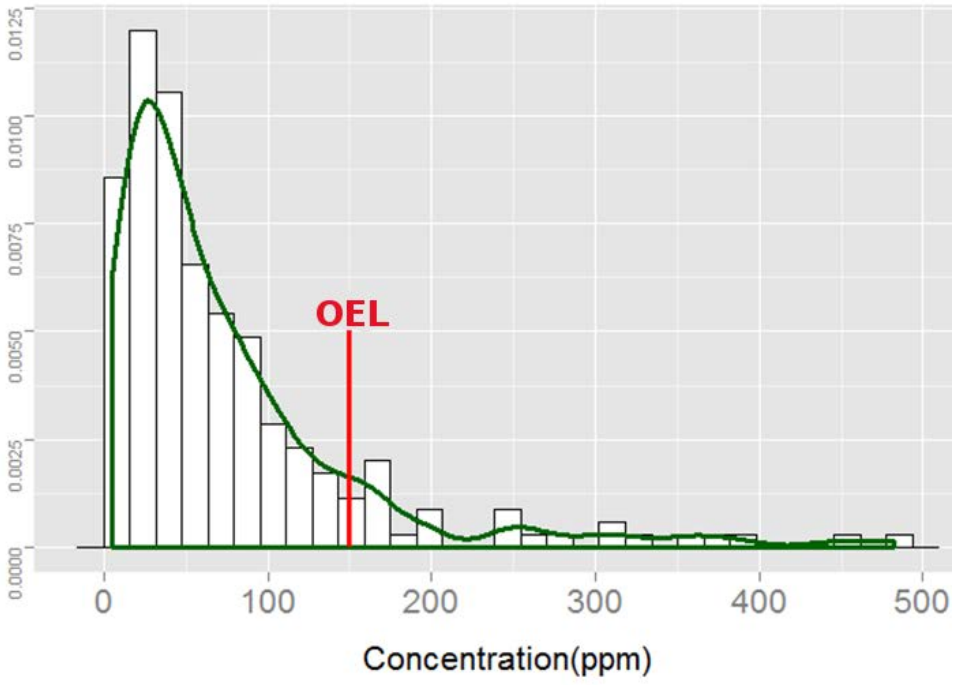
Exposure varies across time and space, and is usually measured very seldom



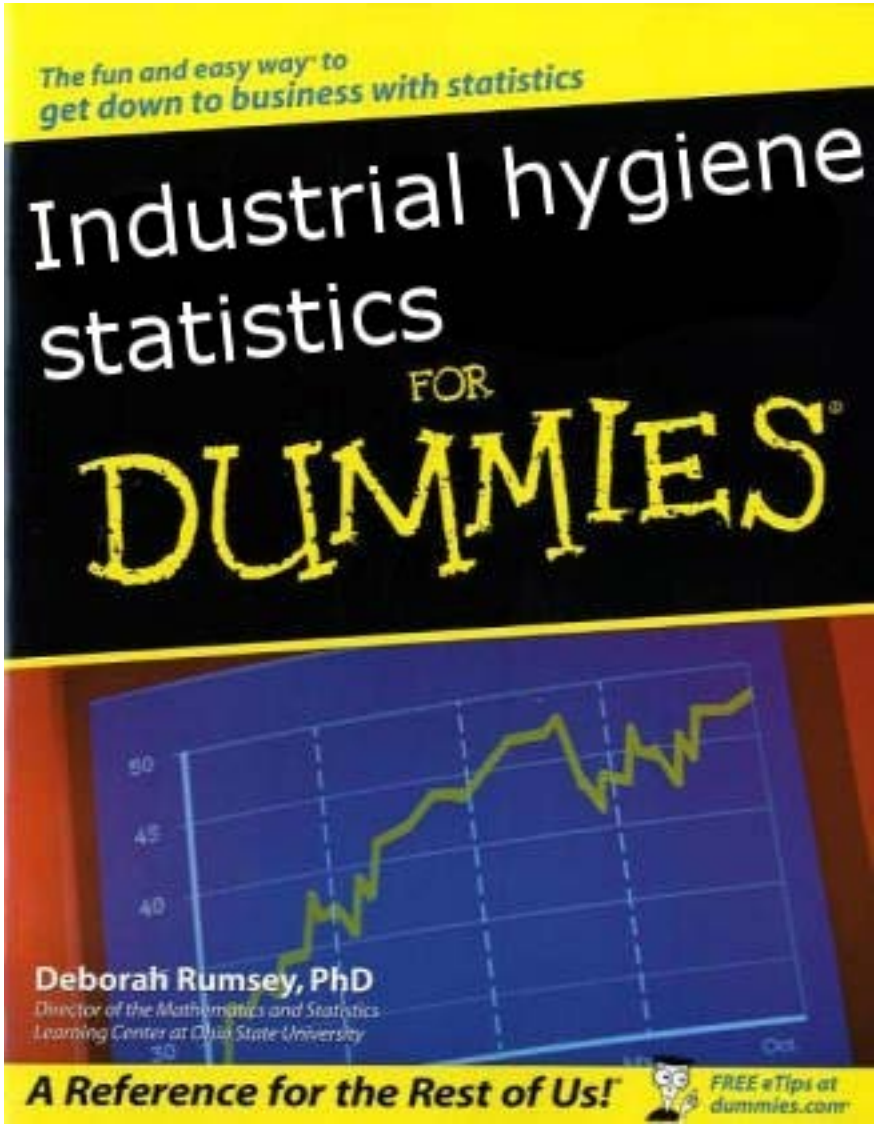
We have a statistical framework

- We assume exposure levels follow a lognormal distribution
- We estimate the proportion of days expected to result in overexposure
- This proportion (exceedance) should not be >5%
- The final decision should take into account statistical uncertainty





We have a statistical framework BUT…..



Lognormal stuff :

- Not taught in basic sciences
- Not often taught in biostats 101
- Very few user friendly tools

Bayesian statistics for industrial hygiene

Rating Exposure Control Using Bayesian Decision Analysis

Paul Hewett,[1] Perry Logan,[2] John Mulhausen,[2] Gurumurthy Ramachandran,[3] and Sudipto Banerjee[3]

Journal of Occupational and Environmental Hygiene, 3: 568–581
ISSN: 1545-9624 print / 1545-9632 online
Copyright © 2006 JOEH, LLC

An empirical hierarchical Bayesian unification of occupational exposure assessment methods

Pierre-Edouard Sottas, Jérome Lavoué, Raffaella Bruzzi, David Vernez, Nicole Charrière and Pierre-Olivier Droz*, †

STATISTICS IN MEDICINE
Statist. Med. (2008)
Published online in Wiley InterScience
(www.interscience.wiley.com) DOI: 10.1002/sim.3411

Advanced REACH Tool: A Bayesian Model for Occupational Exposure Assessment

Kevin McNally[1]*, Nicholas Warren[1], Wouter Fransman[2], Rinke Klein Entink[2], Jody Schinkel[2], Martie van Tongeren[3], John W. Cherrie[3], Hans Kromhout[4], Thomas Schneider[5] and Erik Tielemans[2]

Ann. Occup. Hyg., 2014, Vol. 58, No. 5, 551–565
doi:10.1093/annhyg/meu017
Advance Access publication 24 March 2014

Bayesian Hierarchical Framework for Occupational Hygiene Decision Making

Ann Occup Hyg (2014) 58 (9): 1079-1093.

Sudipto Banerjee[1], Gurumurthy Ramachandran[2,*], Monika Vadali[2] and Jennifer Sahmel[3]

Bayesian models in www.expostats.ca

Principle

Prior uncertainty distribution about a parameter P
What we know before data

Likelihood function for P
what the data has to say

Posterior uncertainty distribution about P
What we know after data

Prior distributions in expostats

Geometric mean

- Centered on 5% of exceedance given a gsd of 2.3
- Uniform on log(gm)
- 80% of prior in $[10^{-36}\text{-}10^{+34}]$*OEL

Geometric standard deviation

- Based on Kromhout/Rappaport/Symanski (1993)
- Lognormal on log(gsd)
- 80% of prior in [1.5-6.5]

How expostats works

Results

Data

LINUX SERVER

Appache Webserver

R Statistical package

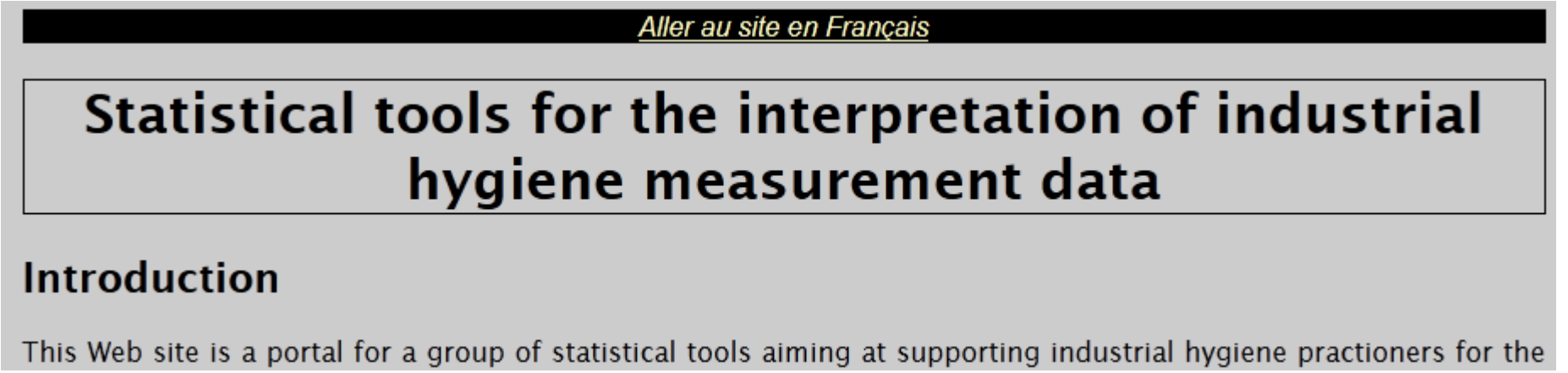
RJAGS Gibbs sampler package

Features

- ~ 30 simultaneous users
- English-French
- Censored data with multiple censoring points
- Tools
  - One lognormal distribution
  - One lognormal distribution (between-within worker variance)
  - 2 lognormal distributions (before/after)
- Statistics : descriptive / Q-Q plot / 95th percentile / Exceedance

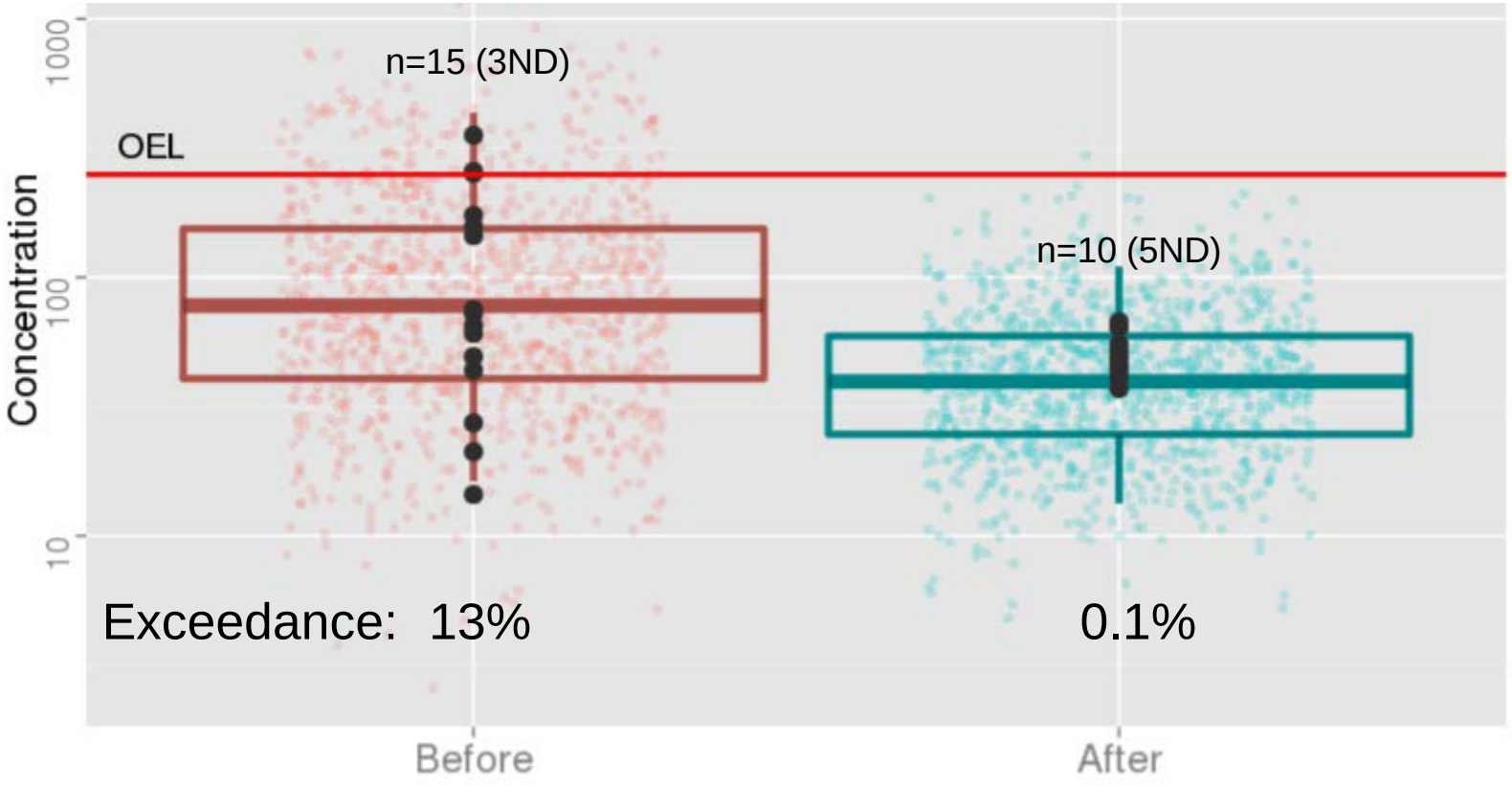
How expostats look

Quite basic at the moment….



But a new version is coming up !

Example : Effect of an intervention



Reduction % in the geometric mean : 52% [8.6 ; 77]

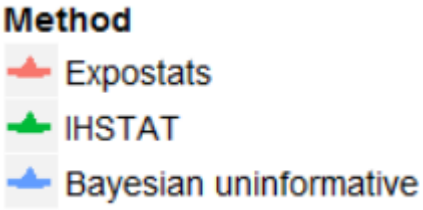
Reduction in the geometric standard deviation (in gsd unit) : 0.94 [-0.68 ; 2.8]

Reduction in the exceedance fraction (in exceedance %) : 12% [3 ; 27]

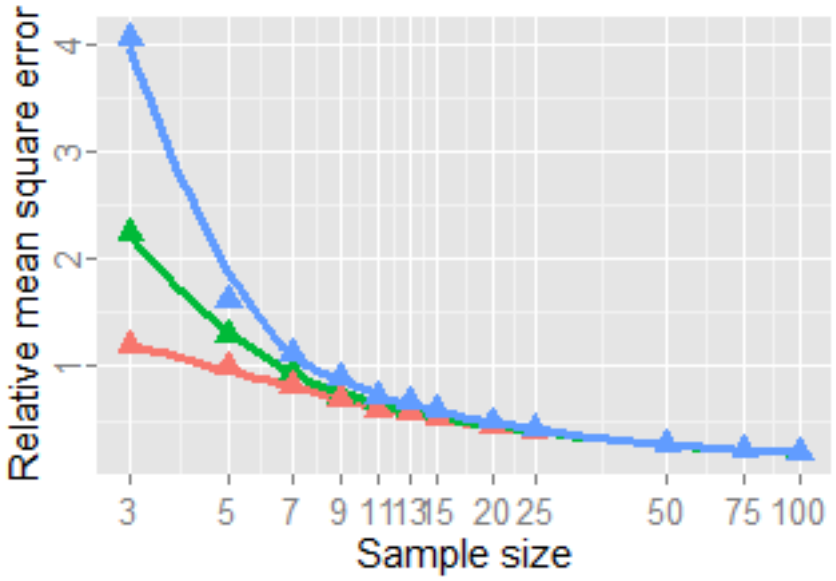
Chance that the expected decrease was achieved (%) : 83%

Simulations – complete samples

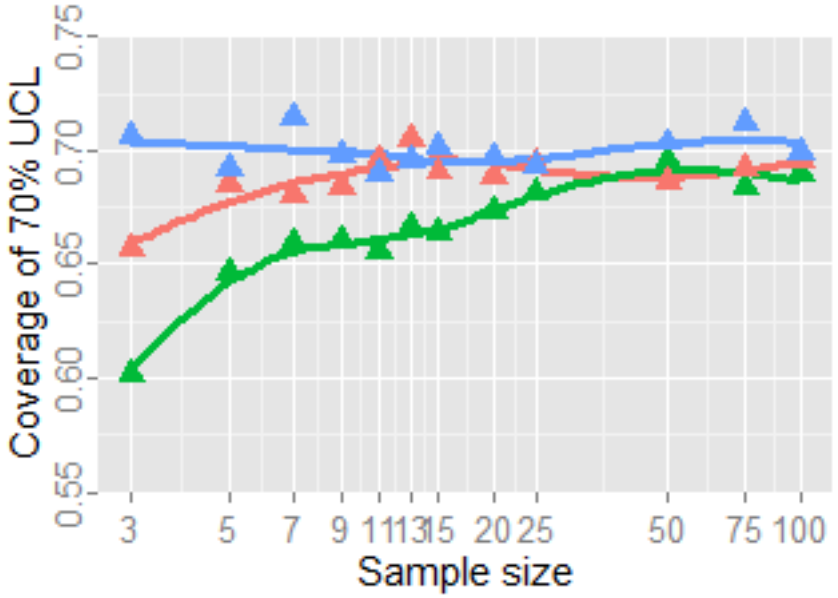
GM=0.3*OEL
GSD=2.5
4 000 iterations



RMSE



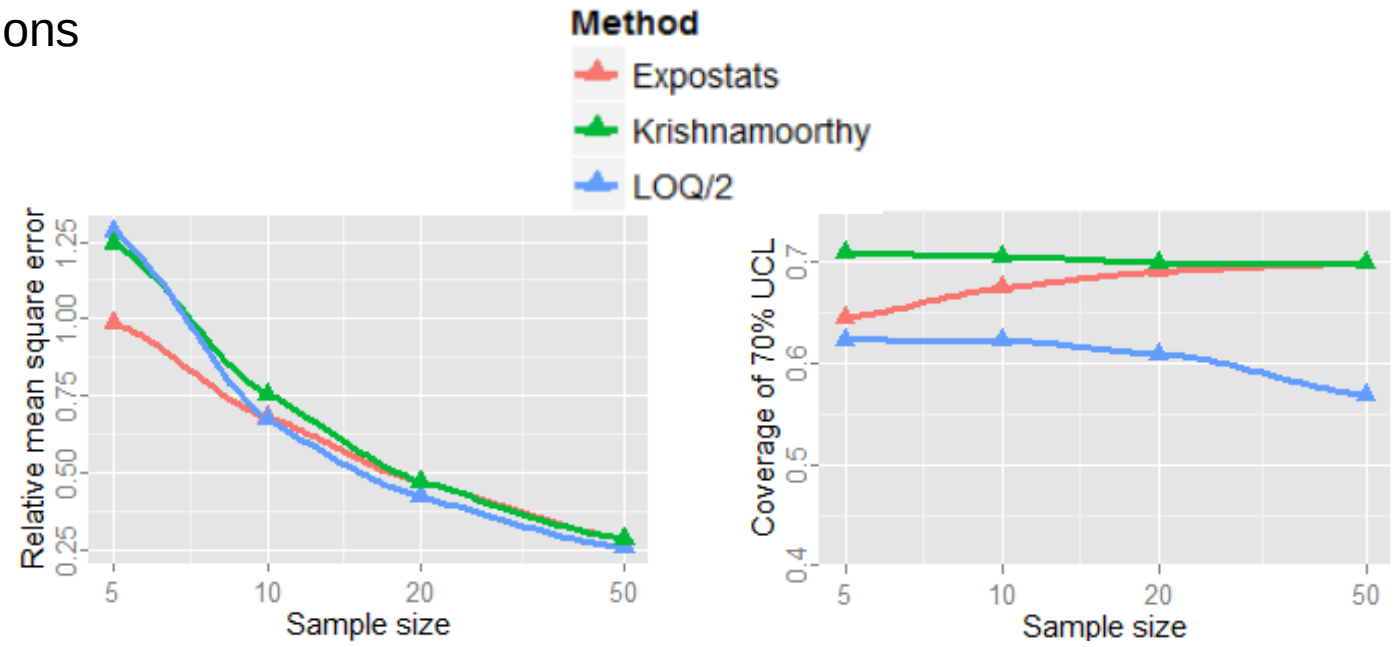
Tolerance limit coverage



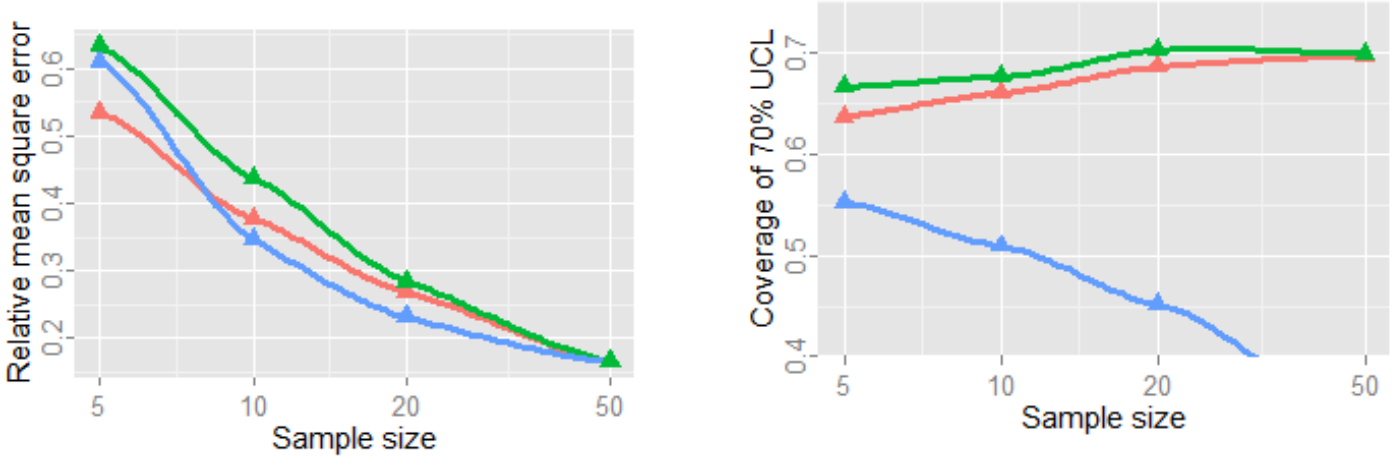
Simulations – censored samples

30 000 iterations
GSD=3

30% censored



50% censored



Future developments: WEBEXPO

Results

Data

LINUX SERVER

Appache Webserver

This part is painful

R Statistical package

RJAGS Gibbs sampler package

Webexpo project (2015-2018)

irsst Institut de recherche Robert-Sauvé en santé et en sécurité du travail

Objective : Create a library of code in Javascript and Csharp/Java that implements IH calculations using Bayesian routines

LONDON 2015
IOHA
10th IOHA International
Scientific Conference
April 25th-30th 2015
London Metropole Hotel
IOHA & BOHS 2015
London: Building on Occupational Hygiene Together
www.iohalondon2015.org
BOHS
The Chartered Society for
Worker Health Protection
IOHA