A methodology to characterize the sources of uncertainties in a atmospheric transport modelling

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Introduction : Some references in atmospheric sciences

Roache, Annu. Rev. Fluid. Mech., 1997

Hanna et al., Atm. Env., 1998

Dabberdt and Miller, Atm. Env., 2000

Irwin et al., Air&Waste Manag. Assoc., 2001

Colville et al., Env. Sci. And Policy, 2002

Stein and Wyngaard, J. Applied Meteor., 2002

Levy et al., Atm. Env., 2002

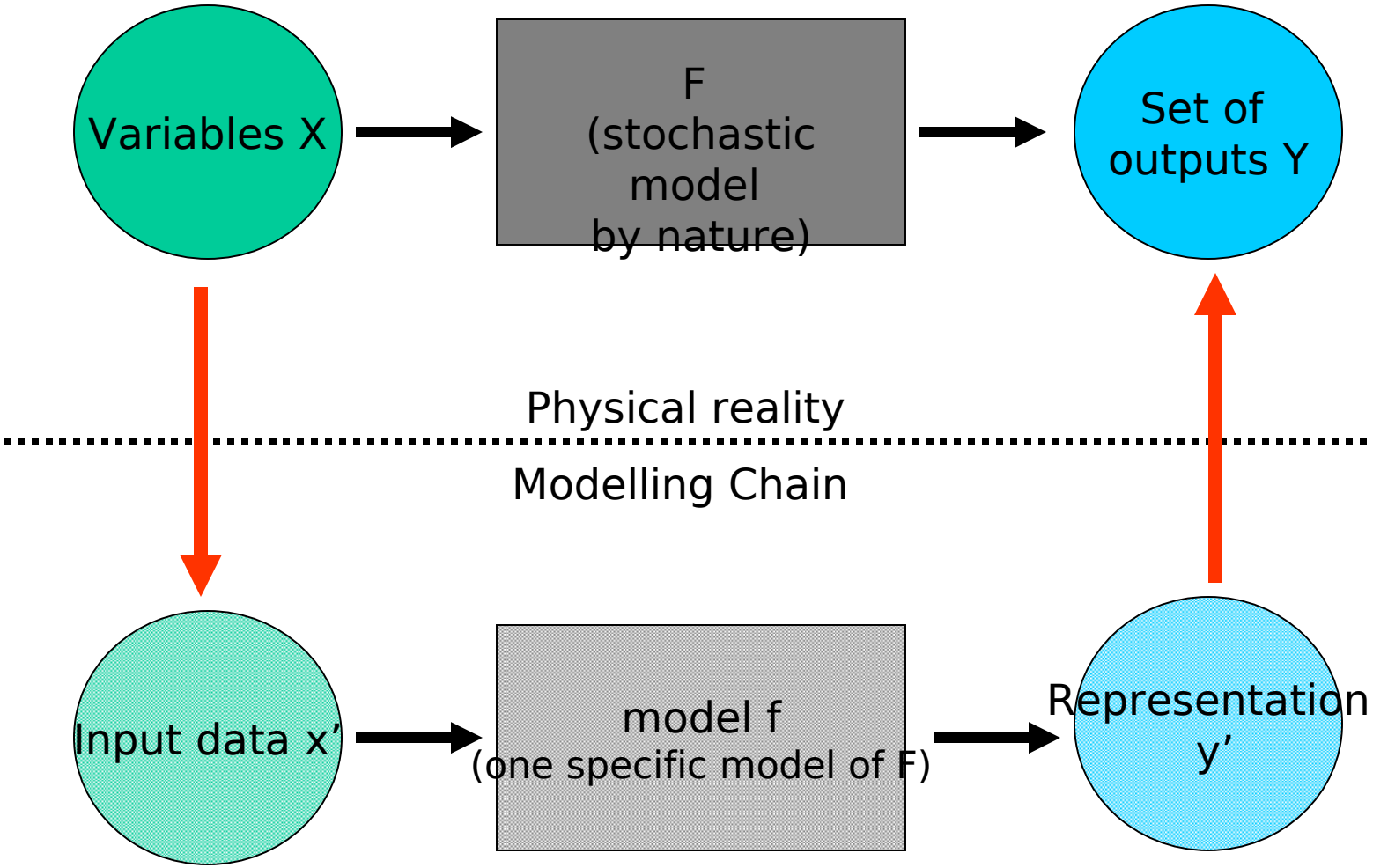
Perkins et al., ECL/LMFA report, 2002

Mallet and Sportisse, J. Geophys. Res., 2006

Godoy et al., Latin Amer. Applied Res., 2006

Brocheton et al., CEA/DASE/SRCE report, 2008

Introduction : Concept of uncertainty, variability and error



Introduction : Concept of uncertainty, variability and error

Example : realization of a survey to determine the mean age of population of a country

- Variability = the age of each probed person is a variable (or stochastic) parameter since it corresponds to a single value in the interval 0-120 years, and since the age of each individual is independent of the age of the other probed people. Increasing the number of probed people will not reduce the range of the possible values for the age of an individual.

- Uncertainty = the average age of the country corresponds to an uncertain parameter since the range of the possible values of this average age will be reduced if the number of probed people increases.

- Error = the method of survey to determine the average age of the population can induce a systematic error if, for example, the survey is made only with adult people.

Introduction : Definition of uncertainties

For uncertainties,

- the natural uncertainty associated to the stochastic nature of turbulence. One can also speak about “variability” or “external uncertainty”.

- the uncertainty of formulation of the model such as simplifications in the mathematical description of the physical and chemical processes, parameterisations, numerical methods, discretization in time and in space, … One can also speak about “internal uncertainty” or “model uncertainty”.

- uncertainty of the input data such as meteorological data, emission data.

- uncertainty in the validation of the models related to the stochastic nature of the observations, i.e. the representativeness of the result y' compared to the physical reality. One can indeed compare y' only with a measurement of Y which is in general a sample or averaged value of the true value of Y.

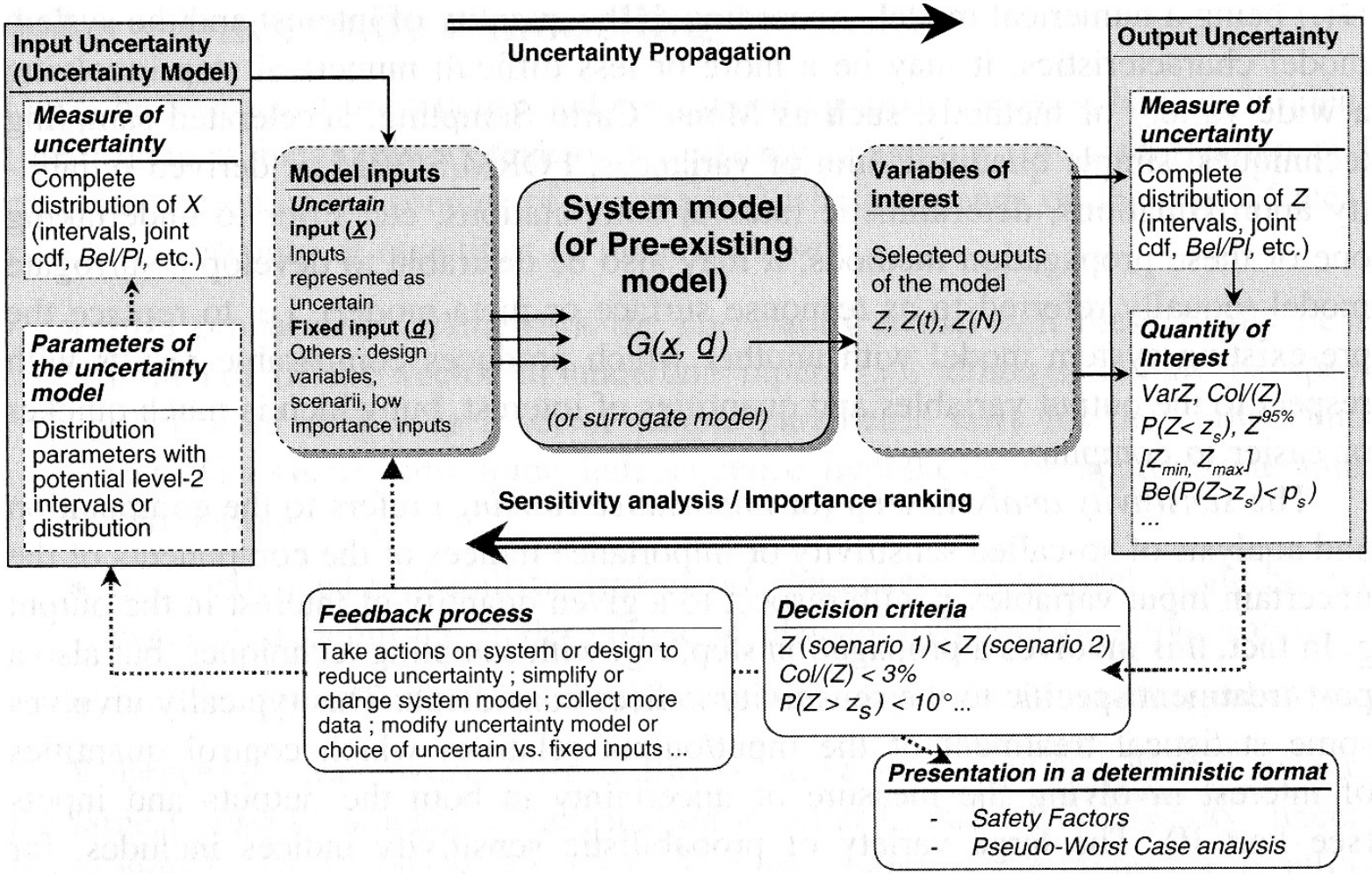
Introduction : Definition of uncertainties

But uncertainties can be introduced by the user during modelling :

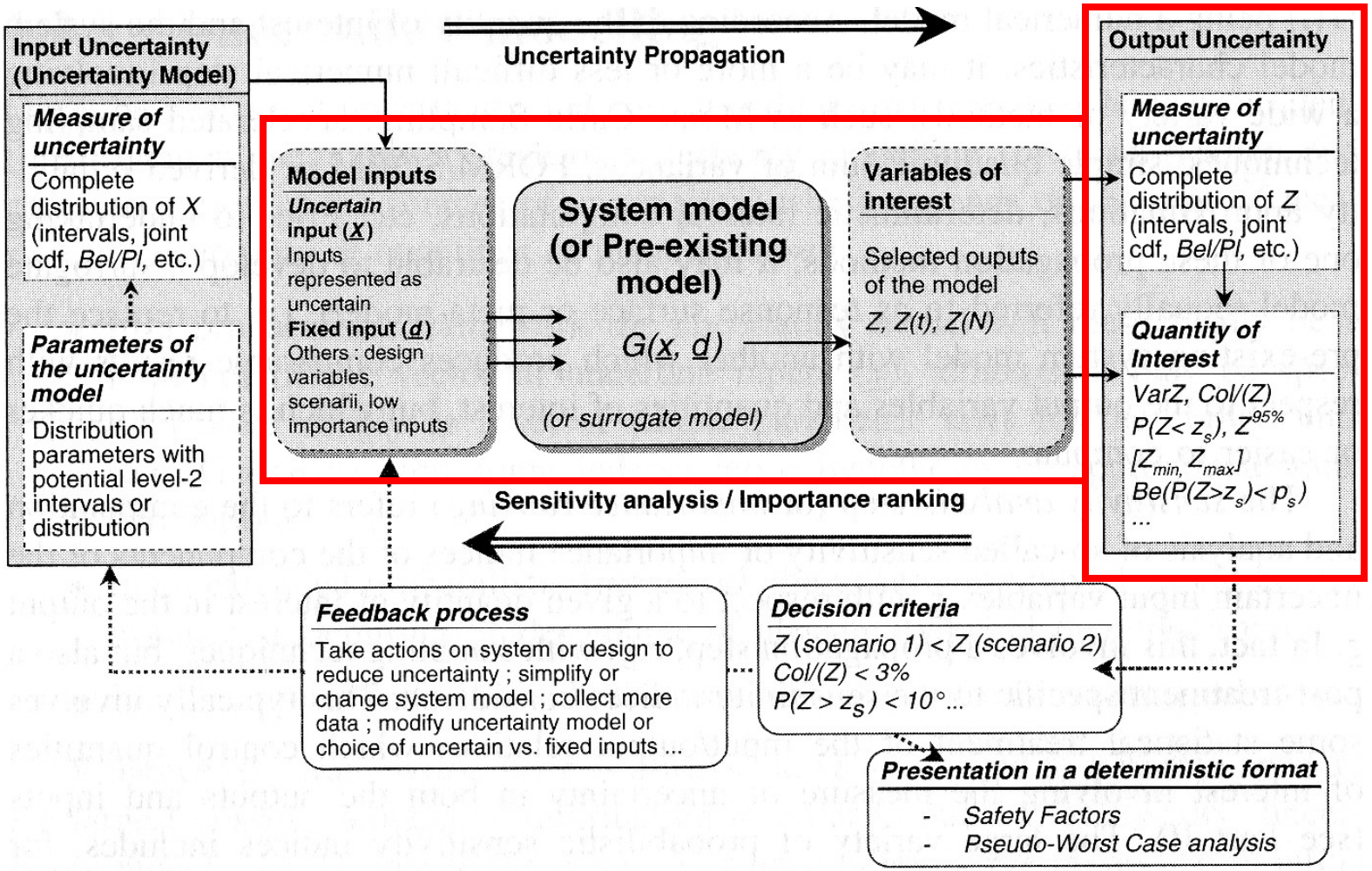
- the error of use related to the ignorance of the modelling tool or to the lack of experience of the user,

- the error of decision related to the choice made by the user to take into account a parameter or process in the modelling methodology (for example, the choice to use a space or temporal averaged data to reduce the computing time).

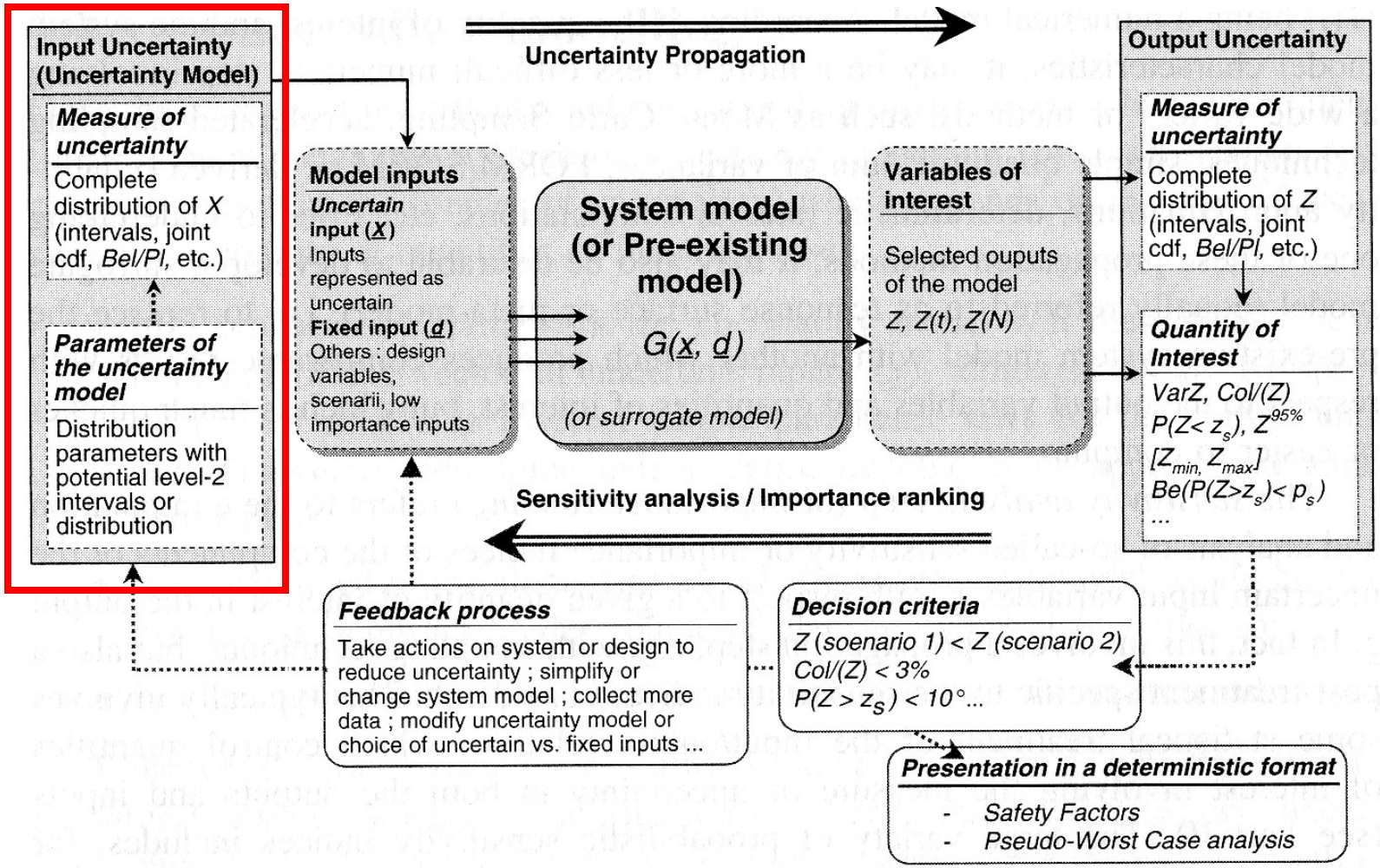
Common framework : de Rocquigny et al. (2008)



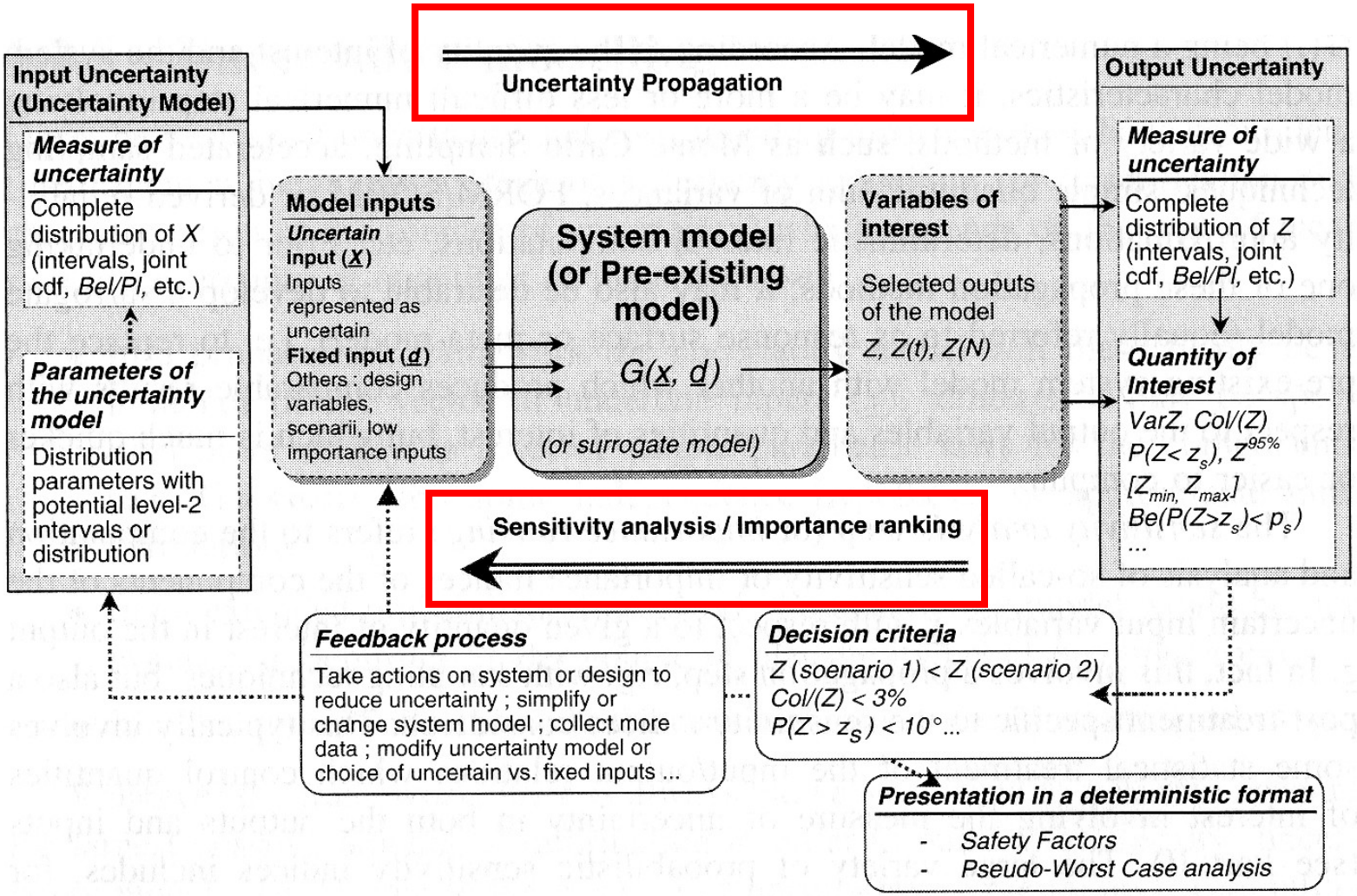
Step A : Definition of the problem



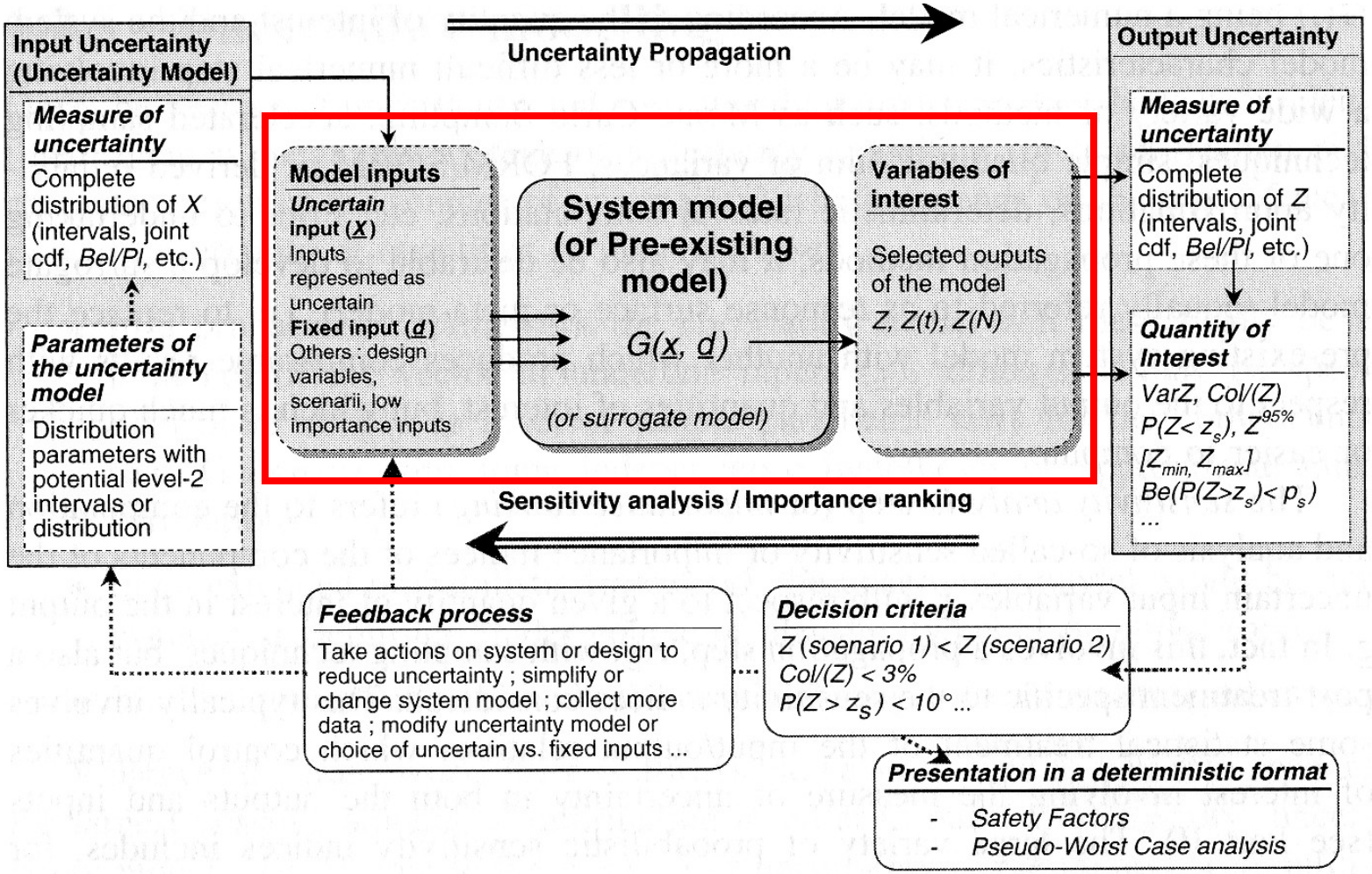
Step B : Quantification of the uncertainty sources



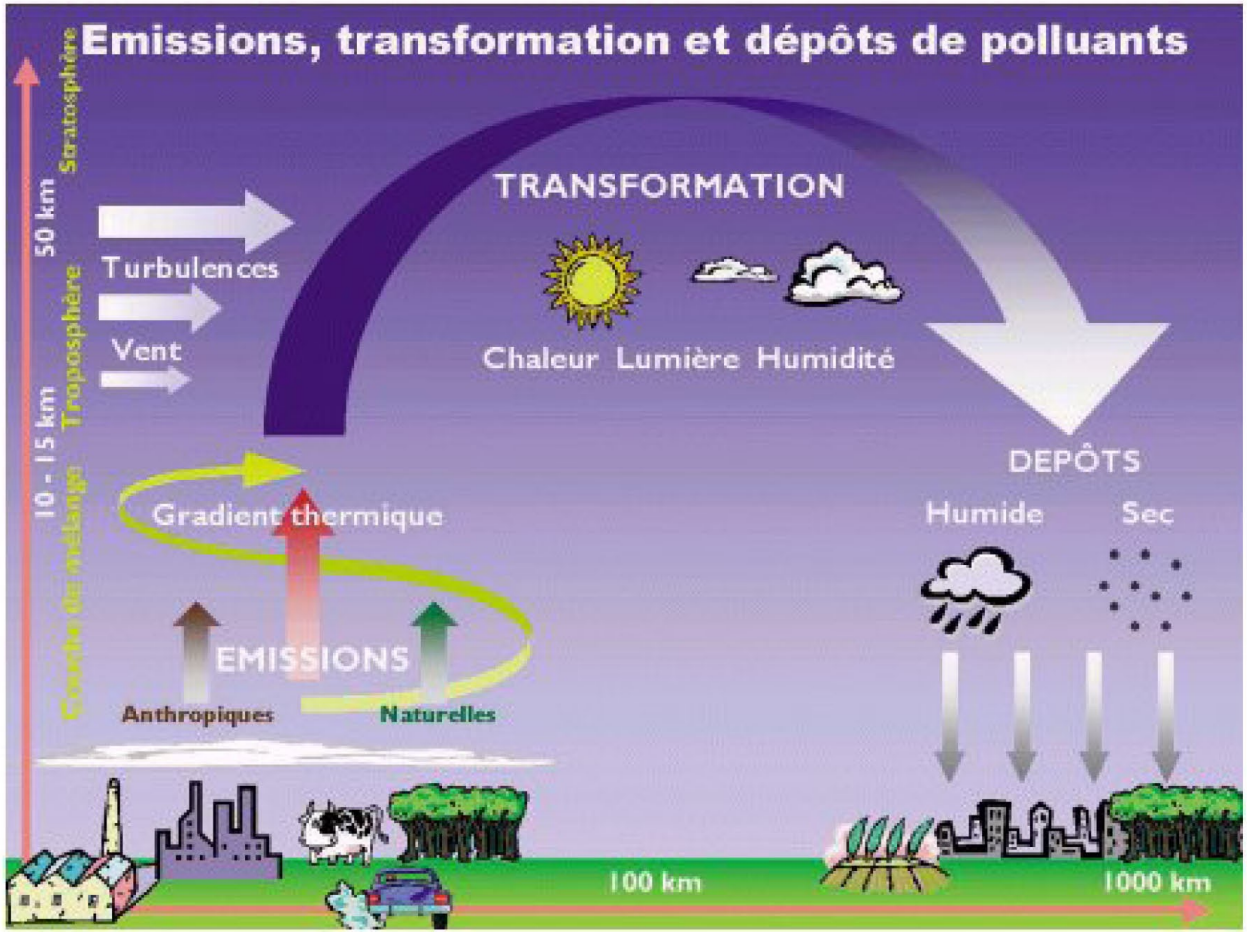
Step C / C' : Propagation and sensivity analysis _



Our approach : application to atmospheric transport _



Atmospheric processes



Step 1: Input data

Characteristics of release:

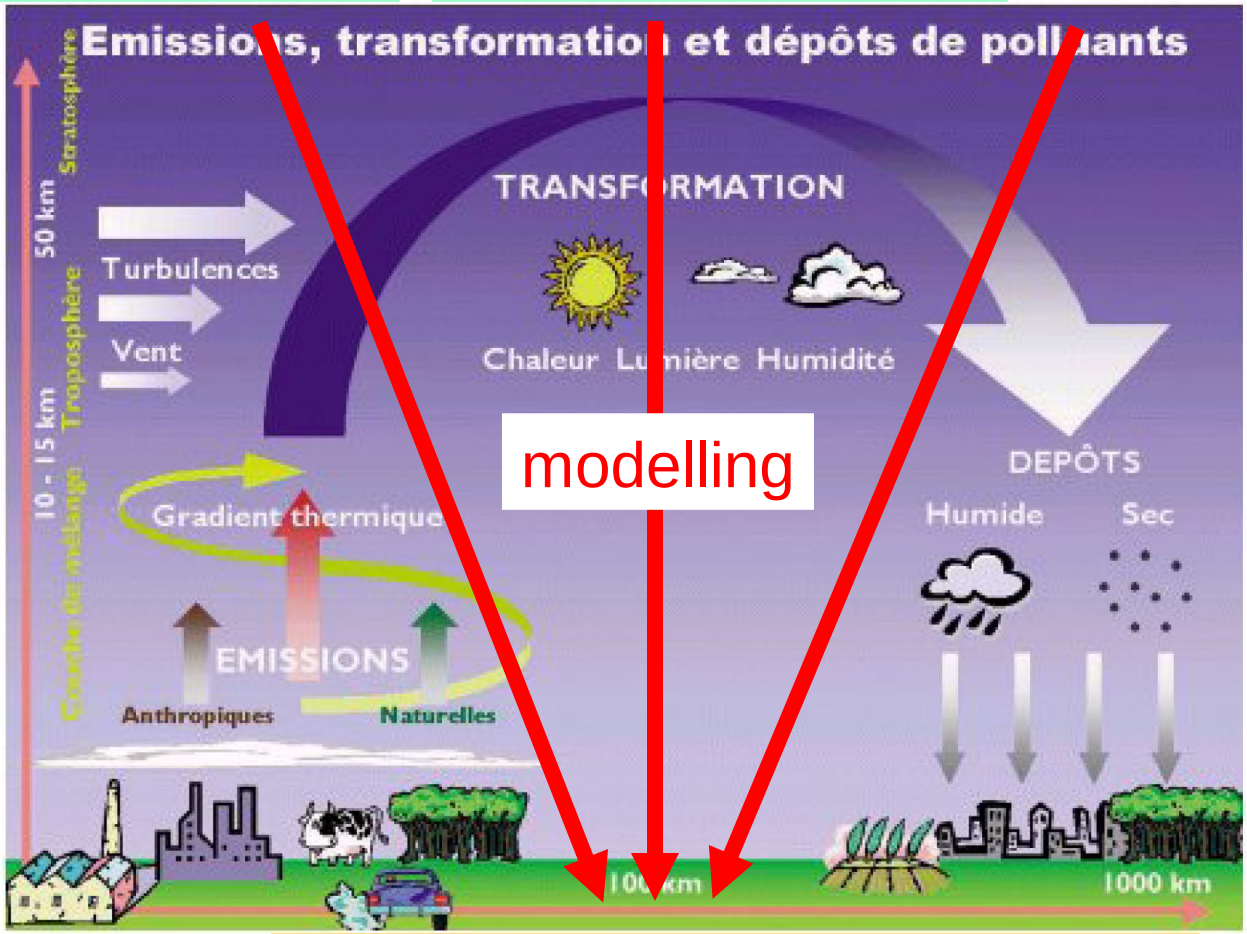
- Location and geometry
- Velocity and temperature of release
- Amount of release
- physicochemical properties of pollutants

Properties of dispersion site:

- Surface roughness
- Thermal and radiative properties of surface
- Topography
- Obstacles / Buildings

Meteorological data:

- Global or local data
- 0D, 1D, 2D or 3D data
- Data from observation, modelling or mixing of the two



modelling

Outputs and their statistical treatment :

- air concentration fields and deposition fluxes at surface
- temporal mean or instantaneous value
- spatial mean or local value

Step 4: Statistical processing of the results

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Step 1: Input data

Step2: Meteorological field

Step 3: Atmospheric dispersion process

Step 4: Statistical processing of the results

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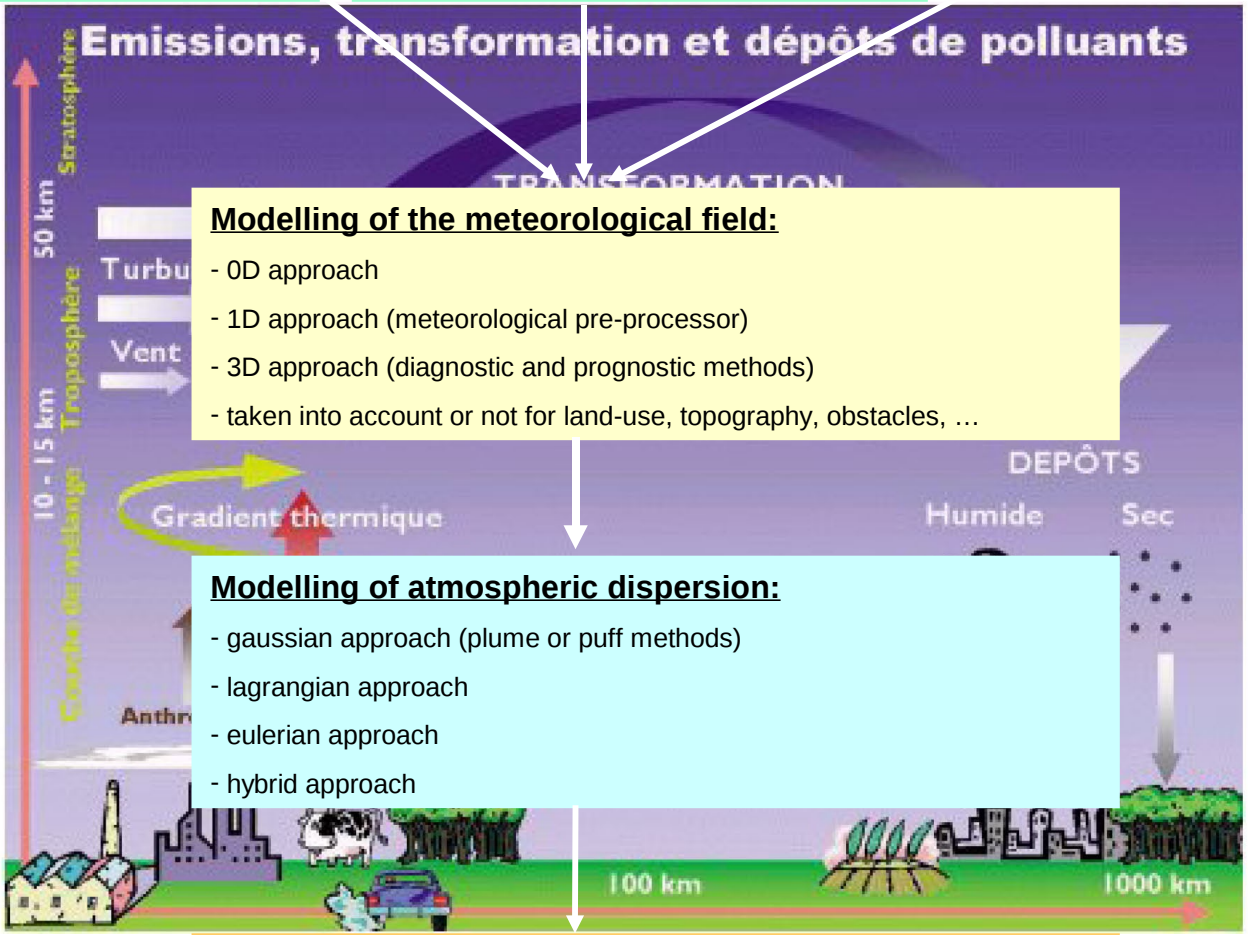

Modelling of the meteorological field:

- 0D approach
- 1D approach (meteorological pre-processor)
- 3D approach (diagnostic and prognostic methods)
- taken into account or not for land-use, topography, obstacles, …

Modelling of atmospheric dispersion:

- gaussian approach (plume or puff methods)
- lagrangian approach
- eulerian approach
- hybrid approach

Outputs and their statistical treatment :

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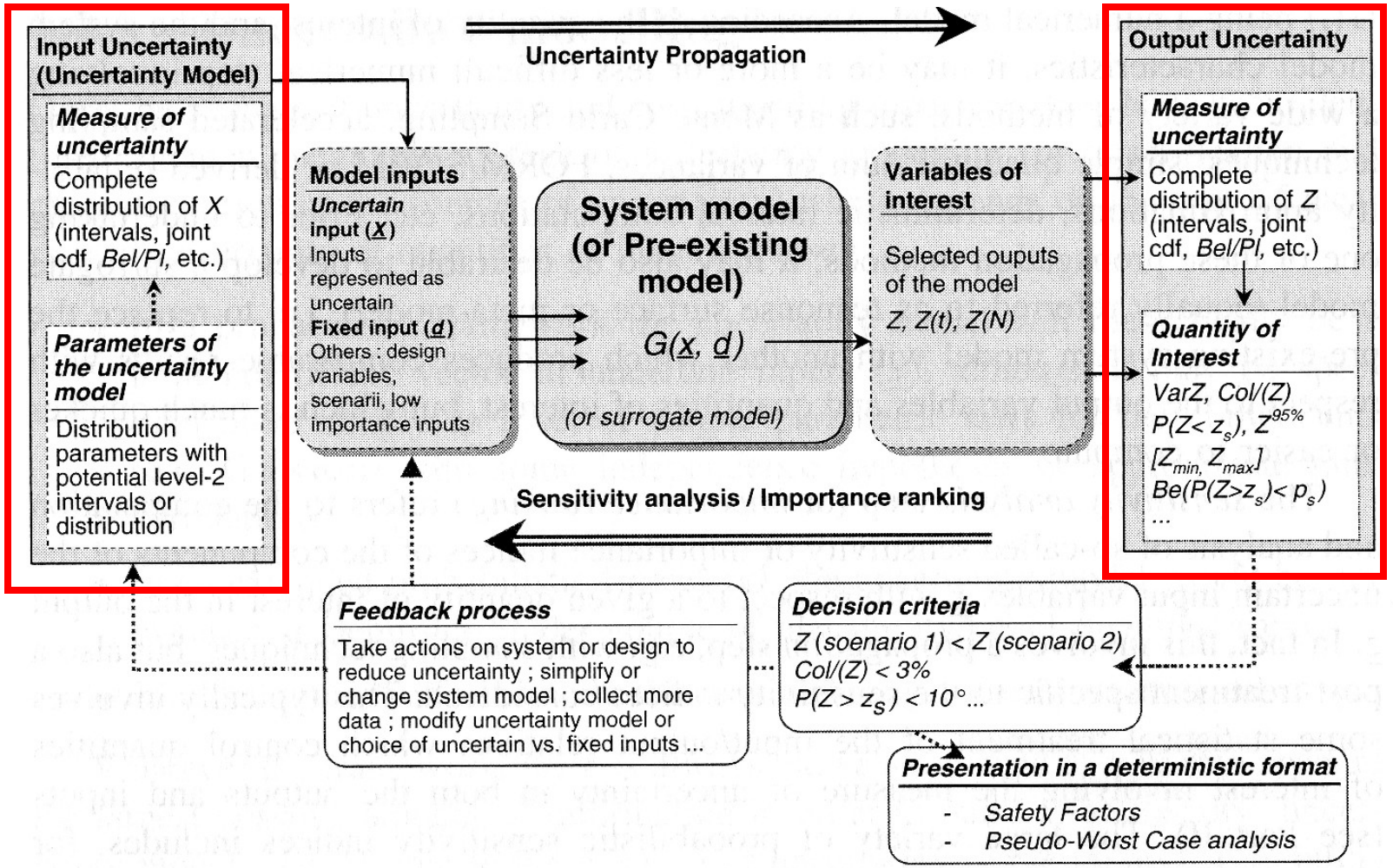
Conclusion and perspectives



Conclusion and perspectives

Workshop for presentation of this work

Workgroup for air dispersion modelling community

Long term objective : provide uncertainty associated to model results in air dispersion regulatory models.

Short term objective : Application to regulatory studies : long term (> 1 year) and local scale (< 10 km)

Model used : gaussian air dispersion model, as ADMS, CERES (CEA)