Particle Dispersion Modeling: A Tool to Identify Pollution Sources

Sandy Ubl
Pirmin Kaufmann

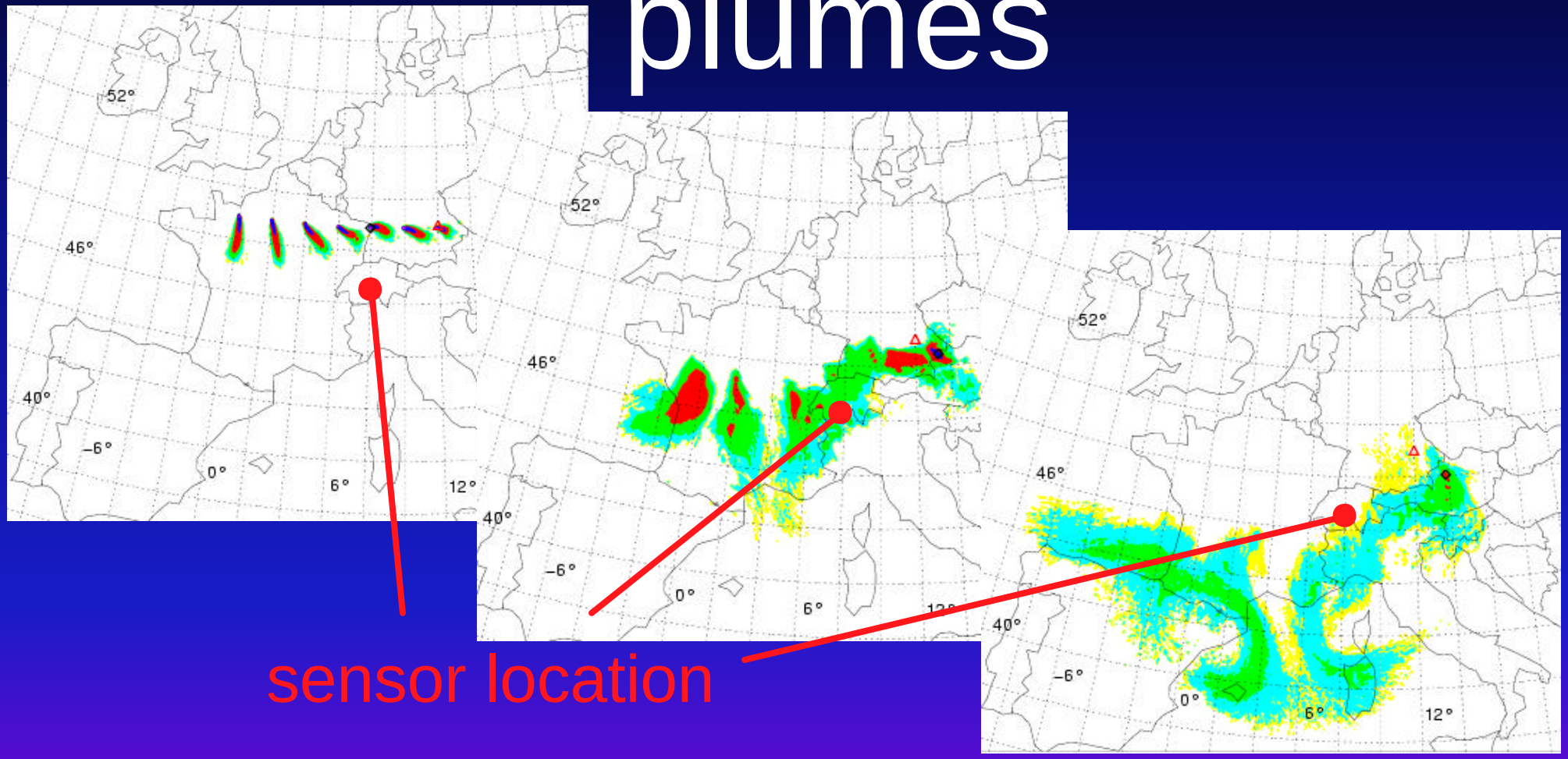
Goal

The goal is to localize pollution sources and to quantify the emissions by combining measurements with numerical modeling.

The focus is on long living substances which are banned in the Kyoto and Montreal protocol.

These substances are green house gases or ozone depleting gases. They occur in air conditioning, cars, windows.

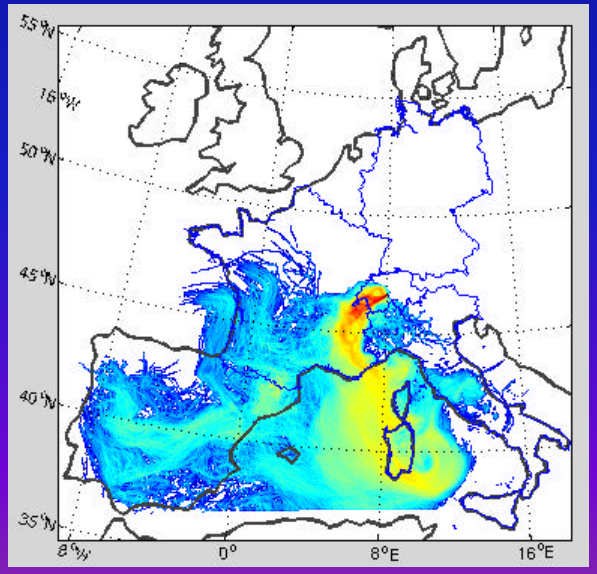
Example of pollution plumes



The pollutants emitted by each source have different probabilities to reach the sensor

Our problem: Unknown locations of pollution sources

In a first step potential source regions are determined (air from this region has nonzero probability to reach the sensor)



How to get the required information

potential source regions (probabilities) result from a backward LPDM.

concentration data result from station measurement.

to connect the data an optimization approach (simulated annealing) is used.

Lagrangian Particle Dispersion Model

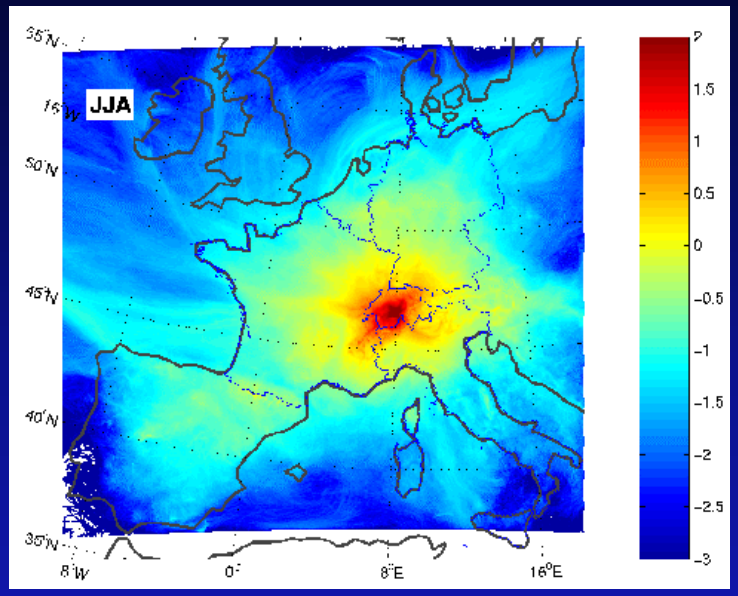
A large number of particles are released to simulate the transport and dispersion of air pollutants in the atmosphere.
Meteorological fields (wind, temperature) of aLMo analyses are used as input fields.
The grid spacing of 7 km x 7 km is much too coarse to represent turbulent eddies. Therefore turbulent diffusion has to be parameterized.

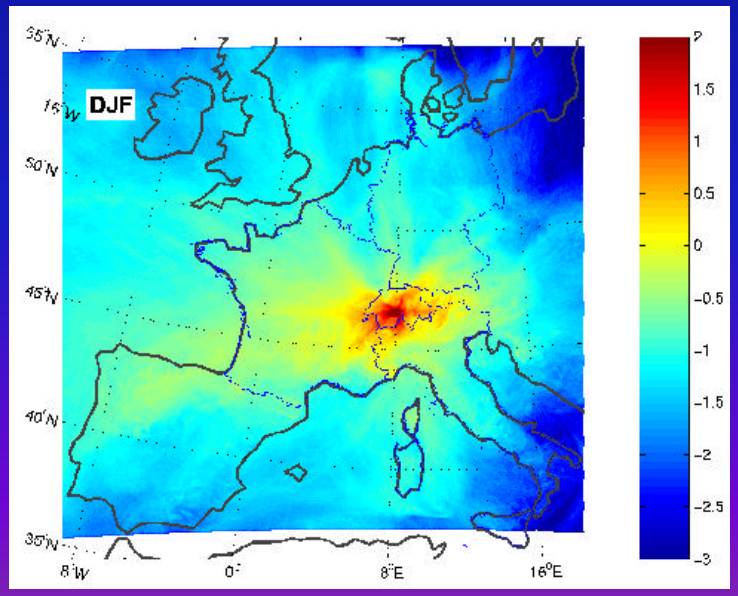
Steering Parameters

emission duration – 24 hours
simulated time span – 72 hours
starting height – 80 m above ground
model time step – horizontal 300 s, vertical 5 s
wind field time resolution – 3 hours
number of particles – 100 000

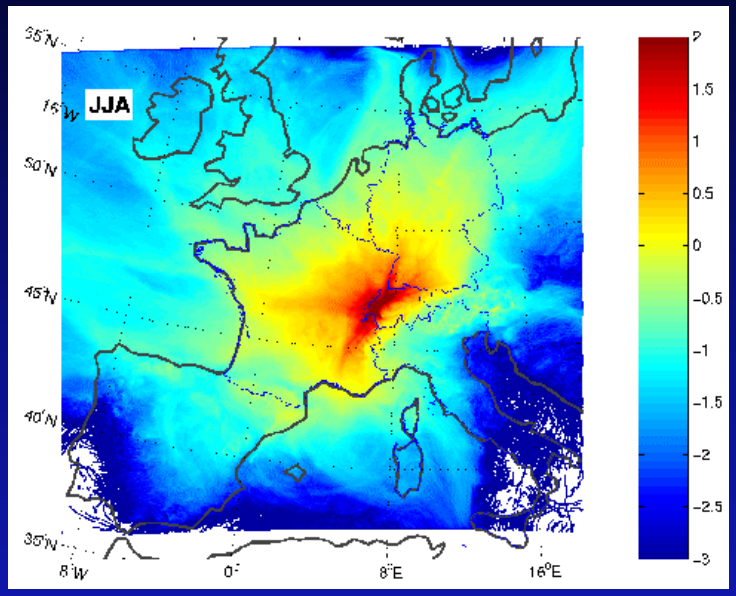
Seasonal Variations in Potential Source Regions

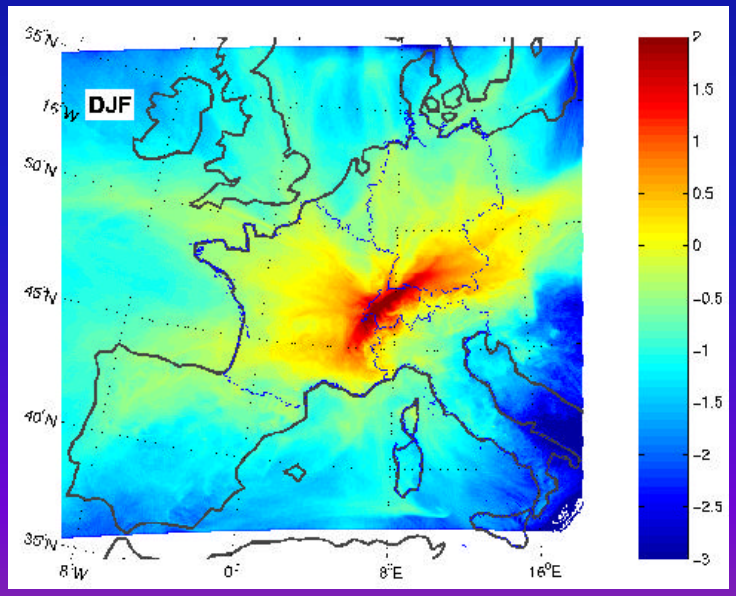
Jungfraujoch, 3600 m MSL



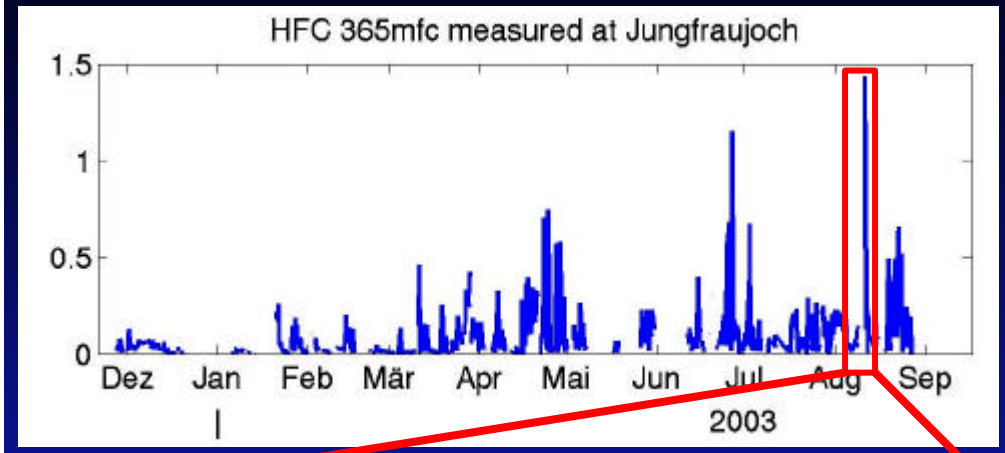


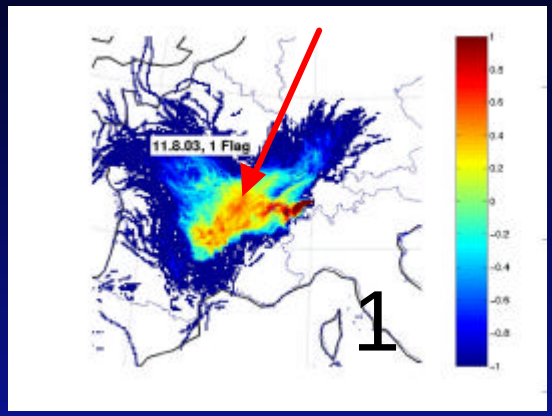
Payerne, 490 m MSL

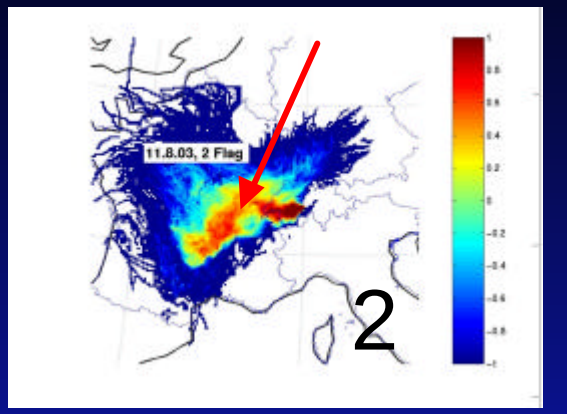


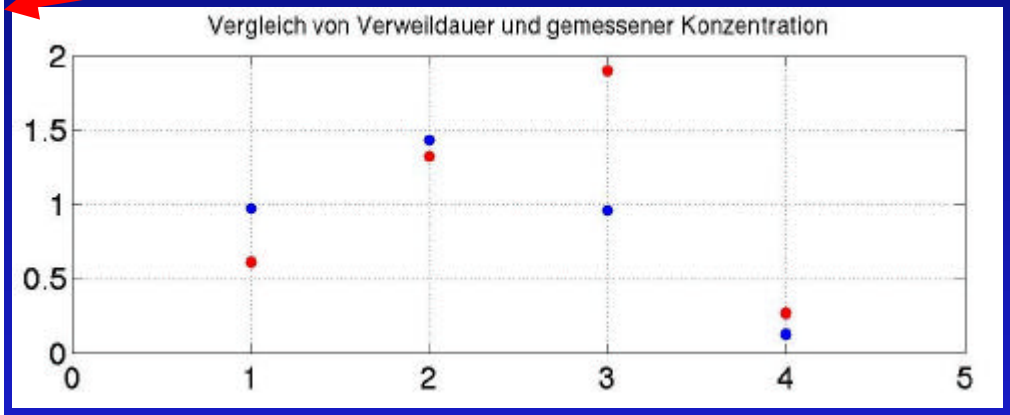


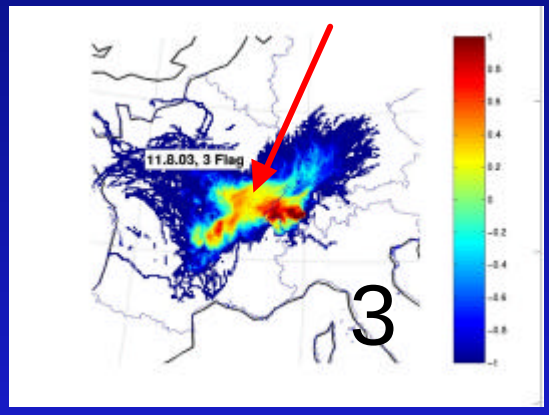
Combining Model Results with Measurements

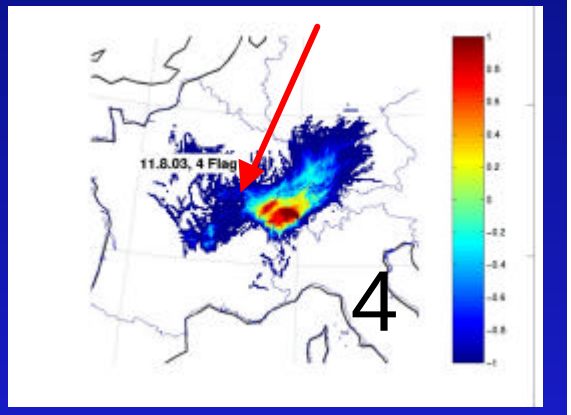












6-h time steps

- probability * emission = concentration

Summary

The potential source regions of Jungfraujoch & Payerne have been determined using a backward LPDM.

The potential source regions show seasonal variations.

Measurement data and potential source regions will be combined (simulated annealing) and emissions will be estimated.