VALIDATION OF THE GAUSSIAN PUFF MODEL PX USING NEAR-FIELD KRYPTON-85 MEASUREMENTS AROUND THE AREVA NC LA HAGUE REPROCESSING PLANT

COMPARISON OF DISPERSION SCHEMES

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IRSN's Gaussian puff model PX is compared against ^{85}Kr measurements around La Hague reprocessing plant. Two case studies are shown:

1. **Continuous measurements of ^{85}Kr in the courtyard of IRSN's laboratory of Cherbourg (LRC), 18 kilometers from the source** (Connan et al. (2013)),
2. **Near-field (1-5 km) measurements in stable situations** (Connan et al. (2014)).

FIELD EXPERIMENTS

The releases of ^{85}Kr occur at the site of AREVA NC La Hague, from the 100-m high stack of the production unit. The plant is located in a coastal area, near cliffs. It contains two production units with high stacks and many buildings (Figure 1).

Figure 1. Aerial view of the AREVA NC La Hague reprocessing plant (left), geographical situation of the plant and IRSN's laboratory (LRC) (right).

The meteorological observations were obtained from 30-meters wind measurements (sonic anemometer) located on AREVA NC site, near the release point. The meteorological measurement frequency is 1 minute. 10-minutes wind averages and standard deviations are computed. Stability parameters such as Monin-Obukhov length or Pasquill stability class were then calculated. SODAR measurements at 100-meter height were also used for comparison.

- The activity concentration in the air sample may be determined by β counting in a Berthold-LB123 gas proportional counter (Connan et al. (2013)). Detection limit is about 500 Bq.m^3 (Fig. 2, top).
- For integrated measurement, air samples are collected in tedlar bag (20-L) and measured by γ spectrometry. The detection limit depends on the counting time duration (Fig. 2, bottom).

Figure 2. Beta counting proportional counter (Berthold-LB123) (top), air sampler VEGA (bottom) for ^{85}Kr air activity concentration measurements.

CONTINUOUS MEASUREMENTS AT LRC

Continuous measurements of ^{85}Kr are made in LRC's courtyard, 18 km from the plant. Six one-month periods between 2012 and 2014 were studied, during which the wind direction allowed several peaks of short duration to be detected (Figure 3). The simulations were carried out with pX, using several meteorological data, and three Gaussian standard deviations: Pasquill (1978), Doury (1976) and formulas based on similarity theory (Hanna et al. (1982), Irwin (1979)).

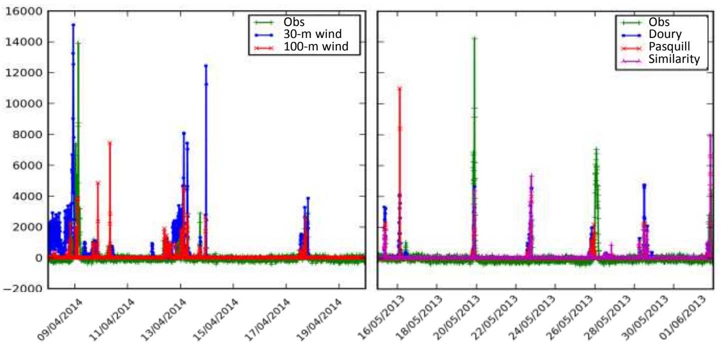

Figure 3. Air activity (Bq/m3) of ^{85}Kr measured at LRC site, for April, 2014 (left) and May, 2013 (right). Observations are in green. On the left, Pasquill results are compared using two different wind data: 30-m anemometer observations (blue) and 100-m SODAR data (red). On the right, 3 Gaussian standard deviations are shown (Doury, Pasquill and Similarity) with 6-m wind data.

- Strong influence of the wind direction (Fig. 3 left): a few degrees shift in wind direction induce a missing peak or false alarms
- Representativeness of wind observations is questionable (complex orography)
- Standard deviations mostly influence the peak intensities (Fig. 3 right)

STATISTICAL INDICATORS FOR PEAK DETECTION

We decided to use indicators based on peak detection: a peak is detected each time a value (observed or simulated) is above a given threshold. If both observations and simulations detect a peak at the same time, it is a *hit*. If the peak is observed, but not simulated, it is a *miss*, and the reverse is a *false alarm*. Then, three indicators can be based on the number of *hit*, *miss* and *fa*:

- The probability of detection: **POD = hit / (hit + miss)**
- The false alarm rate: **FAR = fa / (fa + hit)**
- The measure of effectiveness: **MOE = hit / (hit + 1.5*miss + 0.5*fa)**

Configuration (1-h average, threshold 200 Bq/m^3)		Probability of detection (POD)	False alarm rate (FAR)	Measure of effectiveness (MOE)
30-m anemometer	Pasquill	0.83	0.30	0.66
	Doury	0.80	0.34	0.61
	Similarity	0.78	0.36	0.59
100-m SODAR	Pasquill	0.72	0.37	0.53
	Doury	0.69	0.41	0.50
	Similarity	0.72	0.40	0.52

Table 1:: Statistical indicators (POD, FAR and MOE) computed over the six case studies at LRC for several configurations: 3 Gaussian standard deviations (Pasquill, Doury, Similarity) and two meteorological data (AREVA anemometer and wind at 100-m from SODAR profile).

- Around 70 to 80% of observed peaks are detected, but 30% to 40% of simulated peaks are false alarm
- Wind measurements at 6-m are always better for peak detection than 100-m
- Pasquill gives the best results (peak detection not very sensitive to std deviations)

NEAR-FIELD MEASUREMENTS IN STABLE CASES

Twenty-two measurement campaigns were conducted in stable situations, during nighttime, between 2010 and 2013 (Connan et al. (2014)). Sensors were positioned downwind from the source, at distances varying from 1 to 5 kilometers. Results were integrated over 30 minutes. Here, simulations were made with the pX model, using on-site 30-m wind values, with three Gaussian standard deviations (Doury, Pasquill and similarity) and three release heights: 100 meters (stack height), 50 meters and ground release, in order to take into account building downwash due to the high number of buildings close to the source (Figure 1, left).

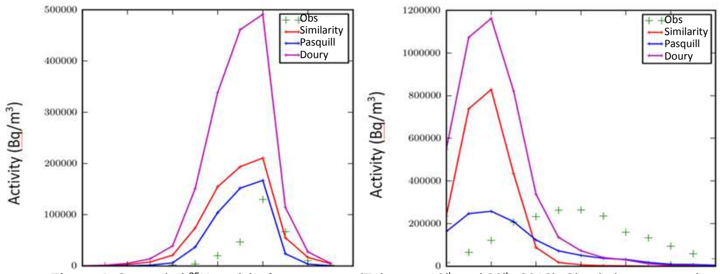

Figure 4. Crosswind ^{85}Kr activity for two cases (February, 19th and 20th, 2013). Simulations are made with a ground release, and 3 Gaussian standard deviations are shown (Doury, Pasquill and Similarity).

- If stack height (100 m) is used, no simulated ground value at these distances.
- Results are best with Pasquill parameterization and similarity theory
- In some cases, discrepancy between observed wind and effective plume direction

CONCLUSIONS AND PERSPECTIVES

- IRSN's Gaussian puff model pX was validated against measurements of ^{85}Kr for 3 Gaussian parameterizations: Pasquill, Doury and similarity theory.
- The continuous measurements at LRC, 18 km from the source, highlighted the importance of meteorological representativeness in a complex orography.
- The near-field measurements in stable cases showed the importance of building downwash: the effective source height was 50-m or ground level for some cases.
- In the future, 3-D meteorological data at fine resolution will be used, and compared to observations.

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We would like to thank the Environment Laboratory at the AREVA NC La Hague plant for their contribution to the experimental campaigns and for making the meteorological and emission parameters data available.