OVERVIEW OF GIFFORD'S 1959 PAPER THAT FIRST JUSTIFIES INVERSE MODELLING

Steven Hanna

Hanna Consultants, Kennebunkport, ME, USA

HARMO 20, Tartu, Estonia 14-18 June 2021

Gifford two page 1959 paper in JAPCA:
Computation of Pollution from Several Sources

Showed the equivalence of forwards and backwards (inverse) plume modeling, which is now a fundamental principle of source term estimation methods based on observations of concentrations and winds and stability

In his 1959 paper, Gifford pointed out that, when run in forwards or backwards mode, the solution describes a probability distribution in space. In forwards mode, the probability distribution describes the distribution of pollutant concentrations, and, in backwards mode, it describes the distribution of probabilities that the source is at a certain location.

In the next slide, Gifford's Figure 1 illustrates this concept.

Gifford 1959 Figure 1. Top is forward modeling of plumes from sources A, B, and C, with emphasis on concentration contours at point P. Bottom is backward modeling from point P

Fig. 1
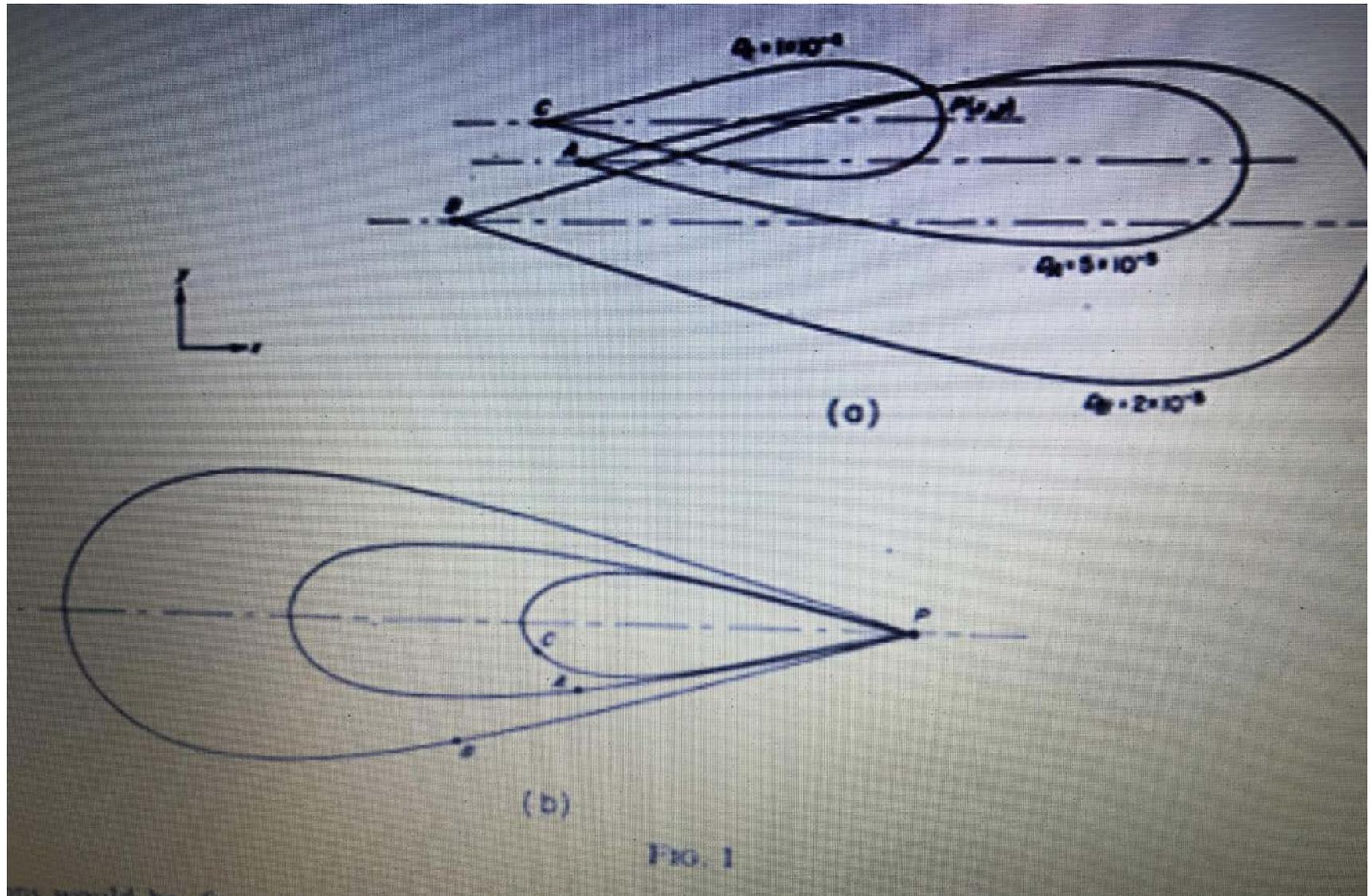
EPA OTM 33A source term estimation method, using local concentration and wind observations by a van around an industrial plant. The dispersion model used is a Gaussian plume model.
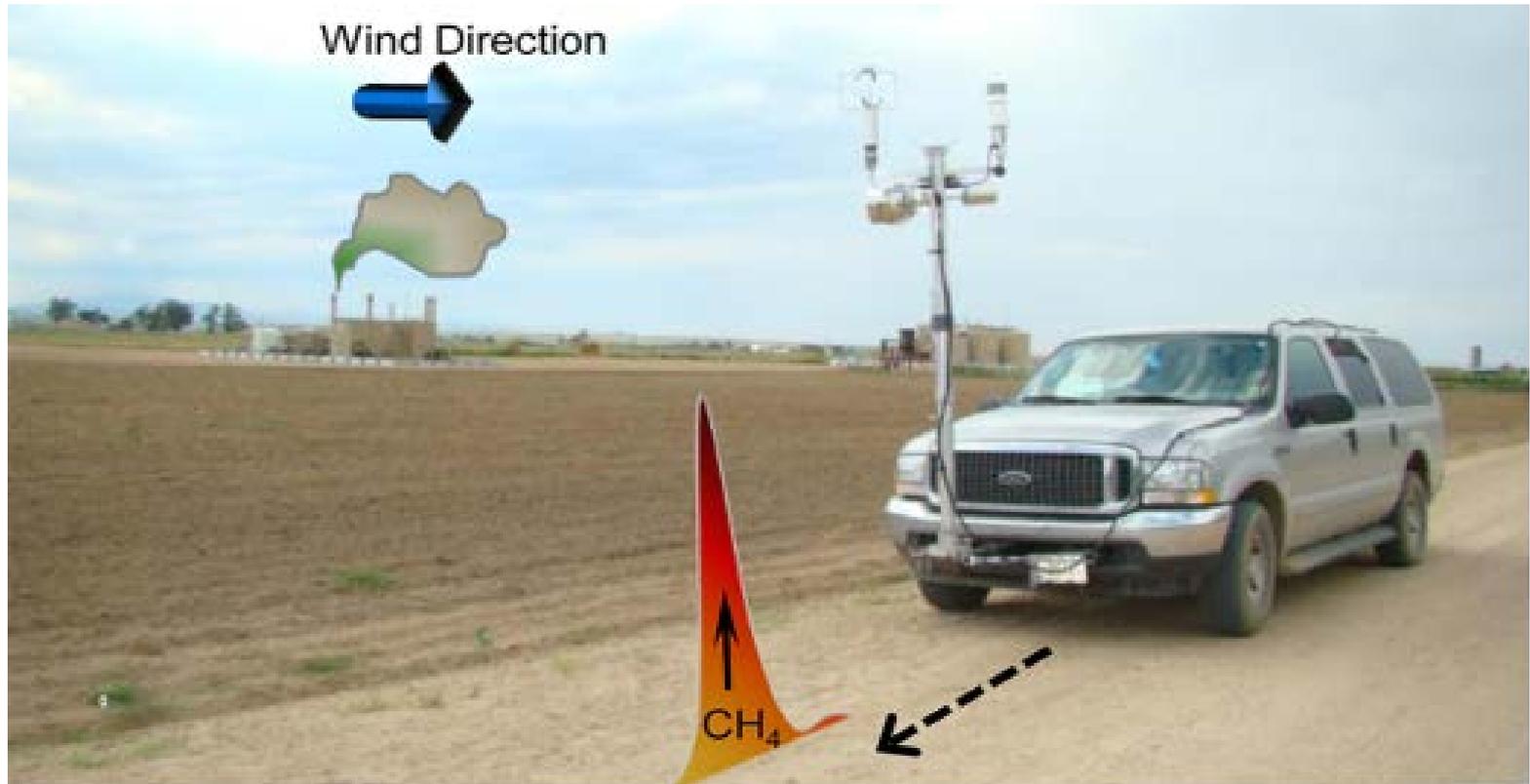
Depiction of a backwards transport and dispersion model STE method (Bieringer et. al. 2015). The dark diamond in part D is the best estimate of the source location.
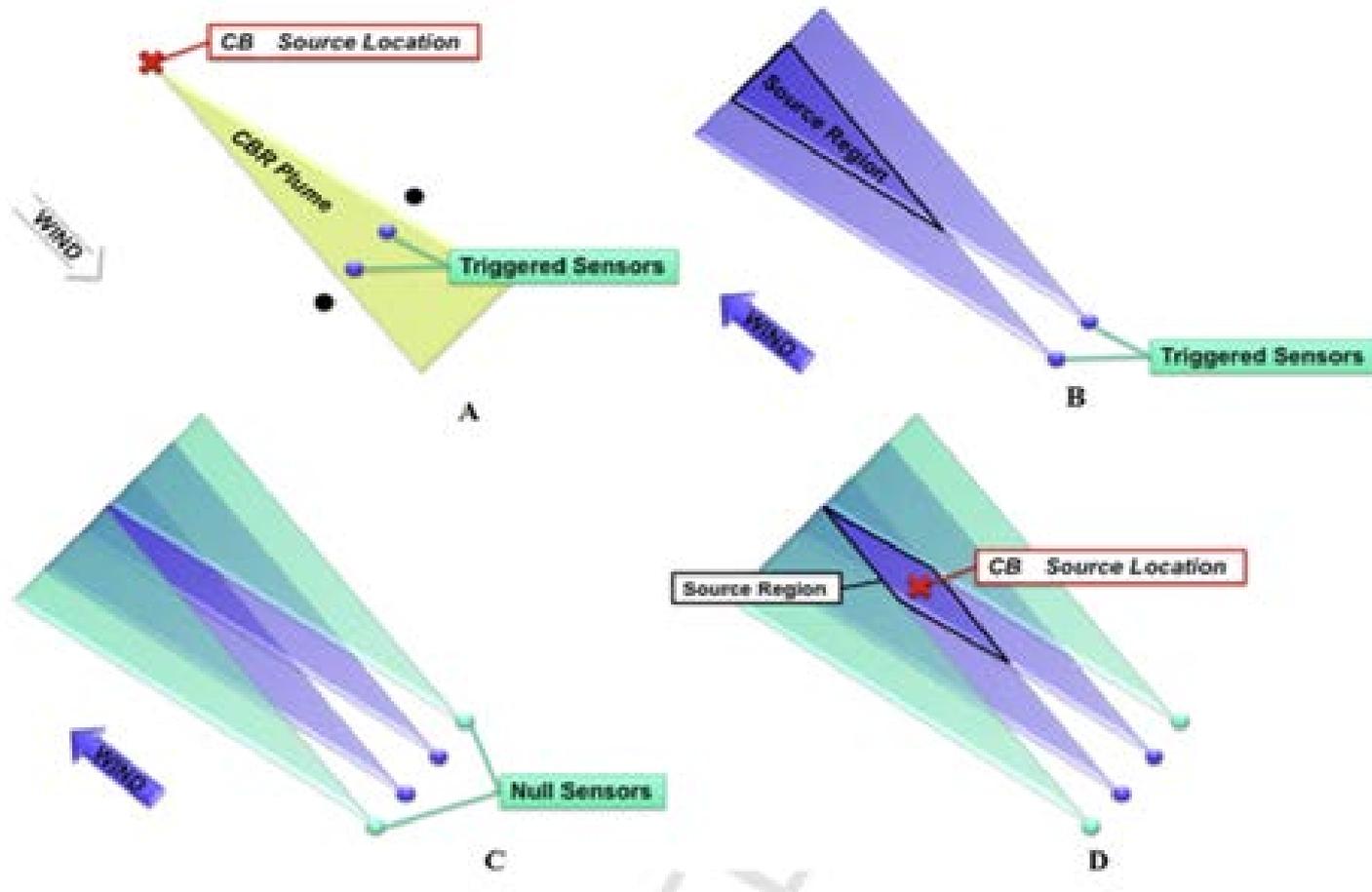
SCIPUFF adjoint model predictions of probabilities (color contours) of source location using observstions from sensors (triangles) during an ETEX field experiment (from Sykes, 2007). Actual source was at black dot near the NW corner of France.
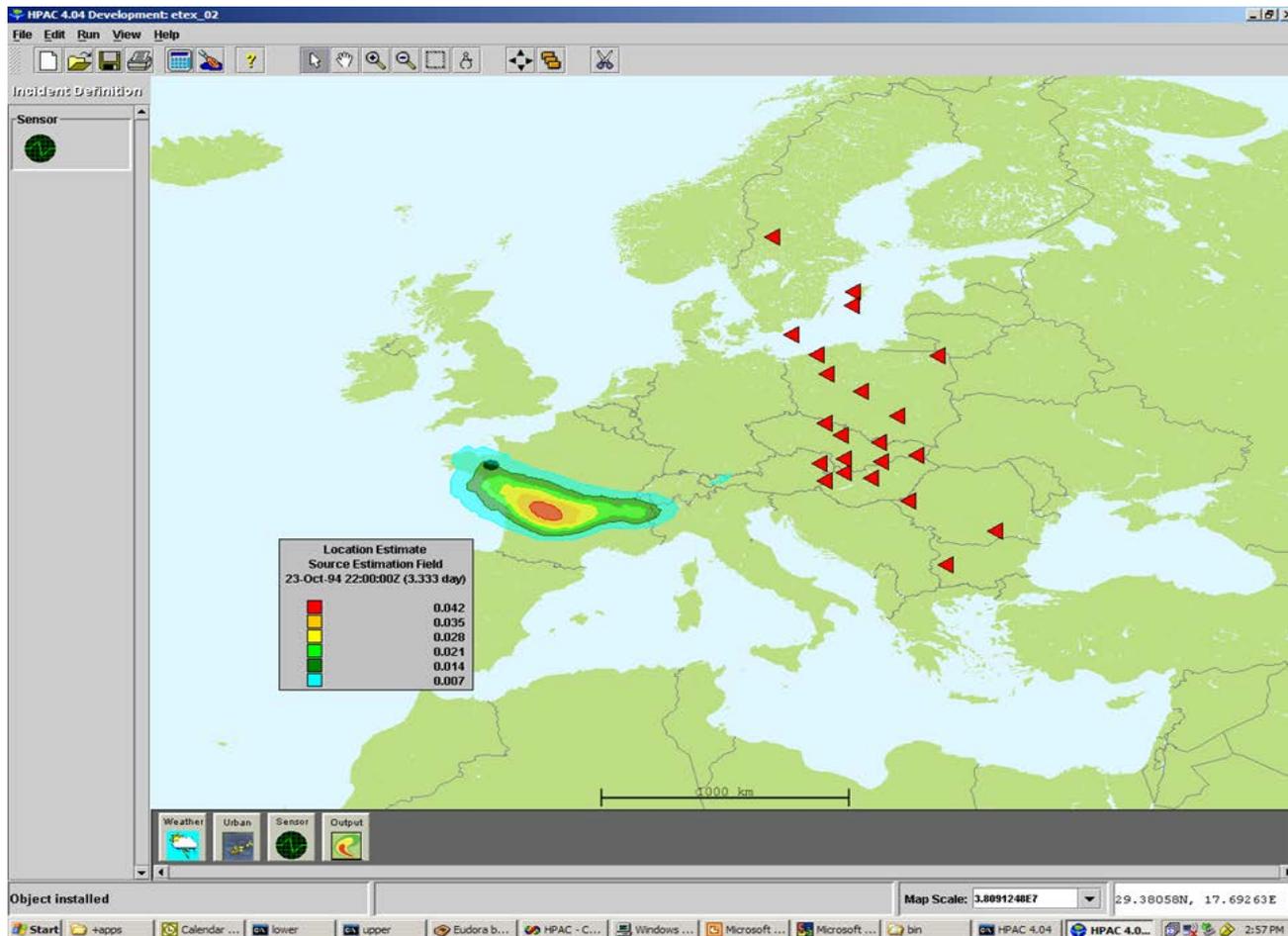
REFERENCES

Bieringer, P., L. Rodriguez, F. Vandenberghe, J. Hurst, G. Bieberbach, I. Sykes, J. Hannan, J. Zaroga and R. Fry, 2015: Automated source term and wind parameter estimation for atmospheric transport and dispersion model applications. *Atmos. Environ.,* **122**, 206-219.

Brantley, H., E. Thoma, W. Squier, B. Guven and D. Lyon, 2015: Assessment of methane emissions from oil and gas production pads using mobile measurements. *Environ. Sci. Tech*., **48**, 14508-14515.

Chowdhury, B. and R.I. Sykes, 2008: Progress on SCIPUFF adjoint for source term estimation, TP9 Conf., Montreal, Canada, 28 pp.

Gifford, F.A., 1959: Computation of pollution from several sources. *Int. J. Air Poll*. 2, 109-110.

Hanna, S.R. and G.S. Young, 2017: The need for harmonization of methods for finding locations and magnitudes of air pollution sources using observations of concentrations and wind fields. *Atmos. Environ.,* **148**, 361-363.

Platt, N. and D. Deriggi, 2012: Comparative investigation of source term estimation algorithms using FUSION field trial 2007 (FFT-07) data: linear regression analysis. *Int. J. Environ. and Poll*., **48**, 13-21.

Sykes, R.I., 2007: Source estimation using sensor data and reverse transport. Chem/Bio IS Conf. Austin, TX, 8-12 Jan., 20 pp.