# THE BOLZANO TRACER EXPERIMENT (BTEX): AN EXPERIMENT ON TRACER GAS DISPERSION FROM AN INCINERATOR STACK AND ON ITS REAL-TIME MODELLING

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## 1. MOTIVATION

- Air quality modeling in complex terrain is challenging due to difficulties in capturing atmospheric and dispersion processes [8].
- In July 2013, a new waste incinerator became operative 2 km Southwest of the city center of Bolzano (Italy) [1].
- The Bolzano Tracer EXperiment (BTEX) was carried out to produce a reliable dataset of ground concentrations to work on a modeling chain suitable for applications over complex terrain.

## 2. AIMS

- To present the BTEX field campaign, the meteorological conditions and the methodologies applied for the tracer releases and the concentration sampling.
- To show the real-time modelling chain used to guide the sampling procedures, reproducing the dispersion pattern of the tracer gas from the incinerator.

## 3. STUDY AREA AND METEOROLOGICAL INSTRUMENTATION

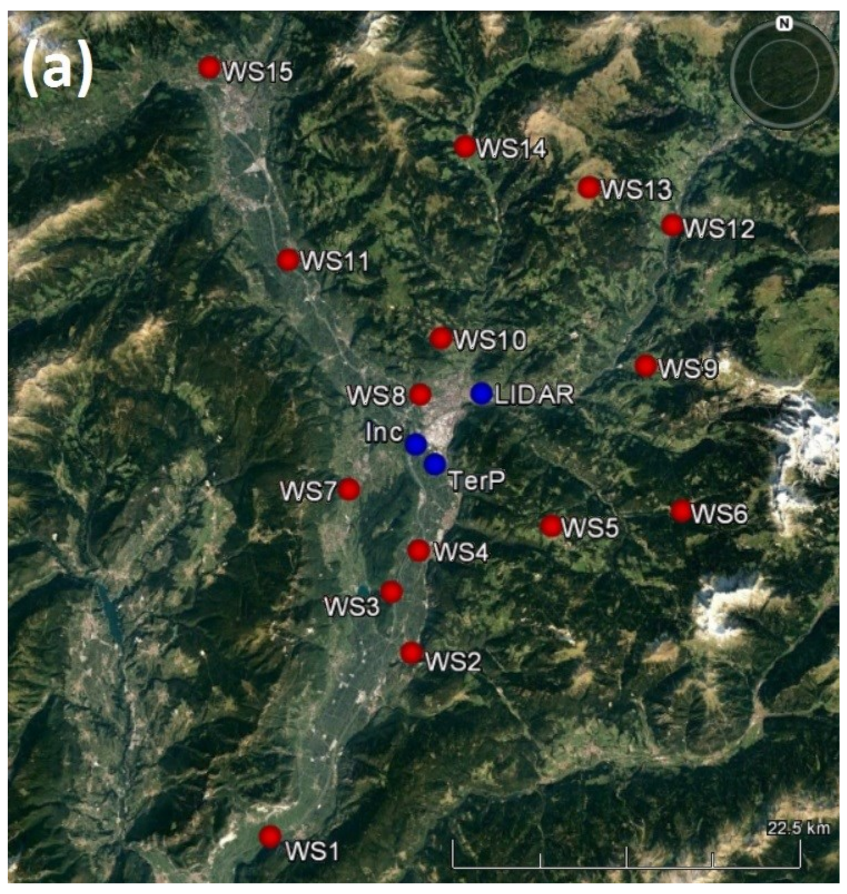


Figure 1: Bolzano basin with its tributary valleys, the incinerator plant position (Inc) and the locations of the available weather stations: the thermal profiler, TerP, the standard weather stations, WS#, and the LIDAR instrumentation.

- Study area:
  1. Bolzano lies at 262 m a.s.l. on the floor of a wide basin at the junction of the Isarco Valley (East) and of the Sarentino Valley (North) with the Adige Valley (South and Northwest) (Fig. 1), in the North Eastern Italian Alps.
- Meteorological dataset from:
  1. **standard weather stations** (both on the valley floor and along the sidewalls): hourly observations of temperature, wind speed and direction, relative humidity and atmospheric pressure;
  2. **thermal profiler** (TerP): temperature observations at 50-m intervals, up to 1000 m a.g.l., measured in the centre of the Adige Valley;
  3. **SODAR instrumentation** (Inc): observations of wind speed and direction at 10-m intervals, up to 340 m a.g.l., measured at the incinerator plant;
  4. **LIDAR instrumentation** (LIDAR): observations of wind speed and direction at 10-m intervals, up to 1100 m a.g.l., at exit of the Isarco Valley, where a strong nocturnal valley jet is recorded in wintertime.

## 4. THE EXPERIMENT

- 14th February 2017.
- 2 releases of tracer gas from the stack were performed (Tab. 1).

| Release | Hour [LST] | Duration [h] | Temperature [°C] | Exit Velocity [m s$^{-1}$] |
|---|---|---|---|---|
| 1$^{st}$ | 7:00 | 1 | 140 | 7.9 |
| 2$^{nd}$ | 12:45 | 1.5 | 140 | 7.8 |

Table 1: Summary of the main characteristics of the two tracer gas releases performed during BTEX

- The tracer gas used is 99% pure sulfur hexafluoride (SF6).
- The tracer was inserted at the basis of the stack, before the ventilation system, obtaining a constant, uniform emission.
- Continuous and real-time measurements taken right before the exit of the smoke from the stack, with two mass spectrometers.
- A real-time modeling chain (WRF[6]-CALPUFF[2,3]and WRF-SPRAYWEB[4,5]) run to give a prediction of the impact scenarios.
- 14 sampling teams were distributed in the area on the basis of the population distribution (a fixed grid of 7 teams) and the output impact scenarios (a moving grid of 7 teams).

## 5. THE METEOROLOGICAL CONDITIONS

- The 1st tracer release took place in the early morning, with a weakly stable atmosphere and weak north-westerly winds at the incinerator plant.
- The 2nd release took place in the early afternoon, in weakly convective conditions with weak southerly winds.
- During both releases, the sky was clear and no strong synoptic forcing occurred.

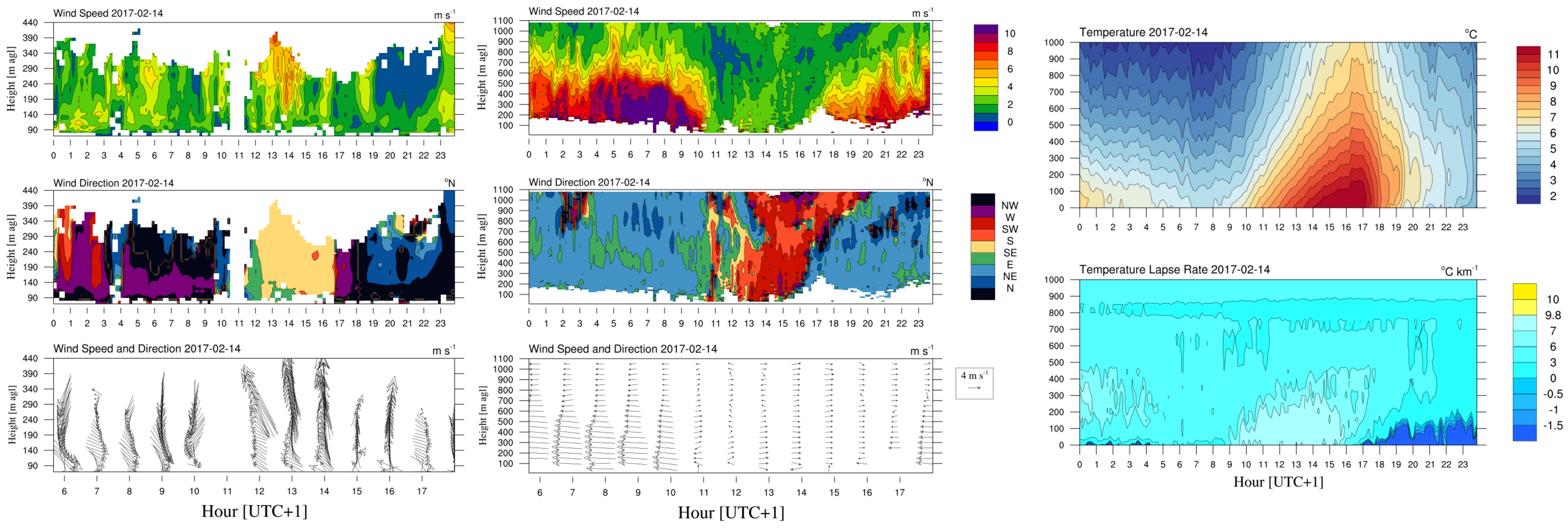


Figure 2: Left: SODAR wind speed (top) and direction (center) observations. Center: LIDAR wind speed (top) and direction (center) observations. Right: Thermal profiler observations of air temperature (top) and temperature gradient (bottom).

## 6. COLLECTED GROUND CONCENTRATION SAMPLES

- Collected samples were analyzed with mass spectroscopy technique with a detection limit of 30 pptv

| Time average | Instrument | # of samples |
|---|---|---|
| 60 min | Vaq. bottles | 34 |
| 20 min | Vaq. bottles | 21 |
| 25 min | Bags | 1 |
| 15 min | Bags | 4 |
| 10 min | Bags | 8 |
| 5 min | Bags | 11 |
| TOT | | 79 |

Table 2: Summary of the characteristics and number of the available BTEX samples.

Figure 3: Vacuum bottles used for the sampling of ambient air during BTEX

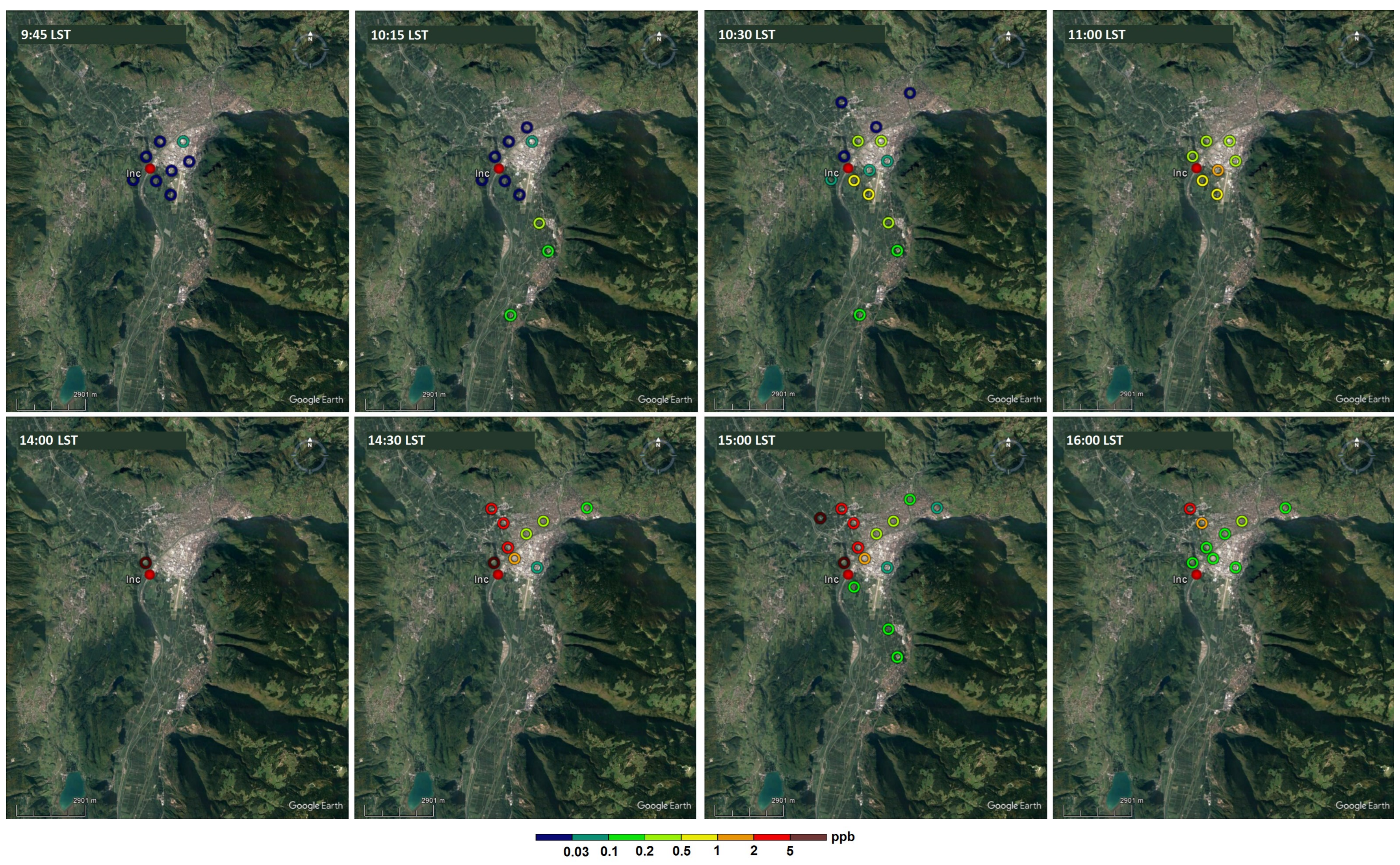


Figure 4: Time evolution of the tracer concentrations measured during the 1st (top) and 2nd (bottom) releases (background maps from Google Earth).

## 7. REAL TIME MODELLING CHAIN

- In order to have approximate impact scenarios during the releases a real-time modelling chain was designed and ran.
- The WRF simulations ran with 4 nested domains up to a 550-m horizontal resolution. Observational nudging was used to assimilate data from all the available meteorological stations.
- WRF was coupled with two different dispersion models: the CALPUFF semi-Lagrangian Gaussian puff model and the SPRAYWEB particle Lagrangian model.
- A WRF-SPRAYWEB Interface (WSI) [7] was developed to process and feed WRF data into SPRAYWEB.

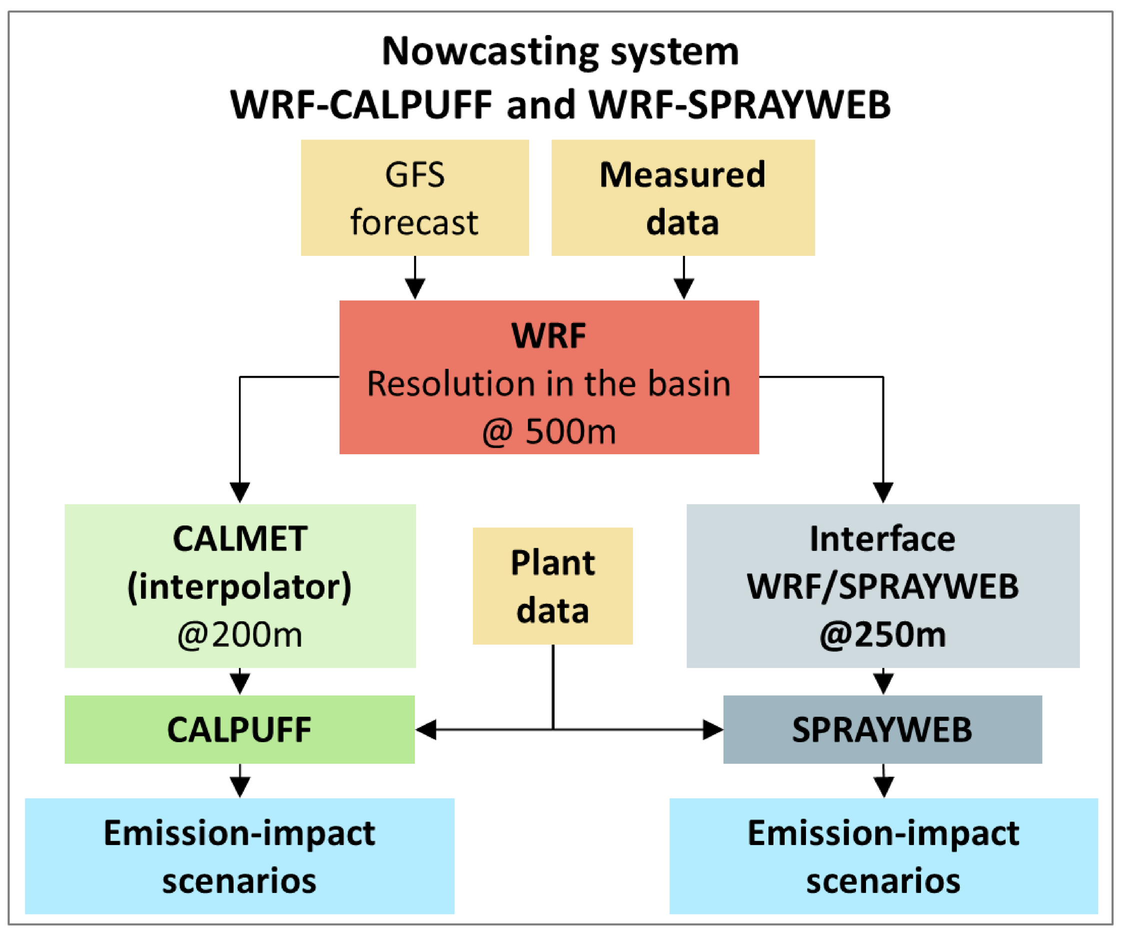


Figure 5: Simulation flow chart with the meteorological modeling chain coupled with two different dispersion modeling approaches.: the CALPUFF Gaussian semi-Lagrangian puff approach and the SPRAYWEB purely La-

## 8. COMMENTS AND CONCLUSIONS

- A unique dataset of tracer ground concentrations was collected and is available for the validation and testing of numerical dispersion models.
- The patterns of dispersion obtained with the nowcasting modeling chain were consistent with the measured ones.

## CONTACTS

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