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Atmospheric dispersion modeling with AERMOD for comparative impact assessment of different pollutant emission sources in an Alpine context

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MOTIVATION

- Air quality assessment over complex terrain is a delicate issue, especially when many pollutant sources act simultaneously.
- In complex terrain, air quality modeling is a crucial tool to evaluate the spatial distribution of the overall pollutant concentration.
- No standard approach exists in literature concerning the calculation of idling vehicle emissions.

AIMS

- To assess the impact on air quality from the main pollutant sources in the area surrounding the town of Vipiteno, in the Italian Alps.
- To propose a standard approach for the evaluation of different emission sources, in particular for the idling vehicle emissions.
- To analyze the contribution of each pollution source, highlighting their relevance on the local air quality status.

STUDY AREA

- The study area is located in the North Eastern Italian Alps and is centered over the town of Vipiteno in a basin at 950 m above mean sea level.
- Vipiteno lies in the Isarco Valley, which runs from north to south, at its connection with the Ridanna Valley from the West and the Vizze Valley from the East.

AERMOD SIMULATION SETUP

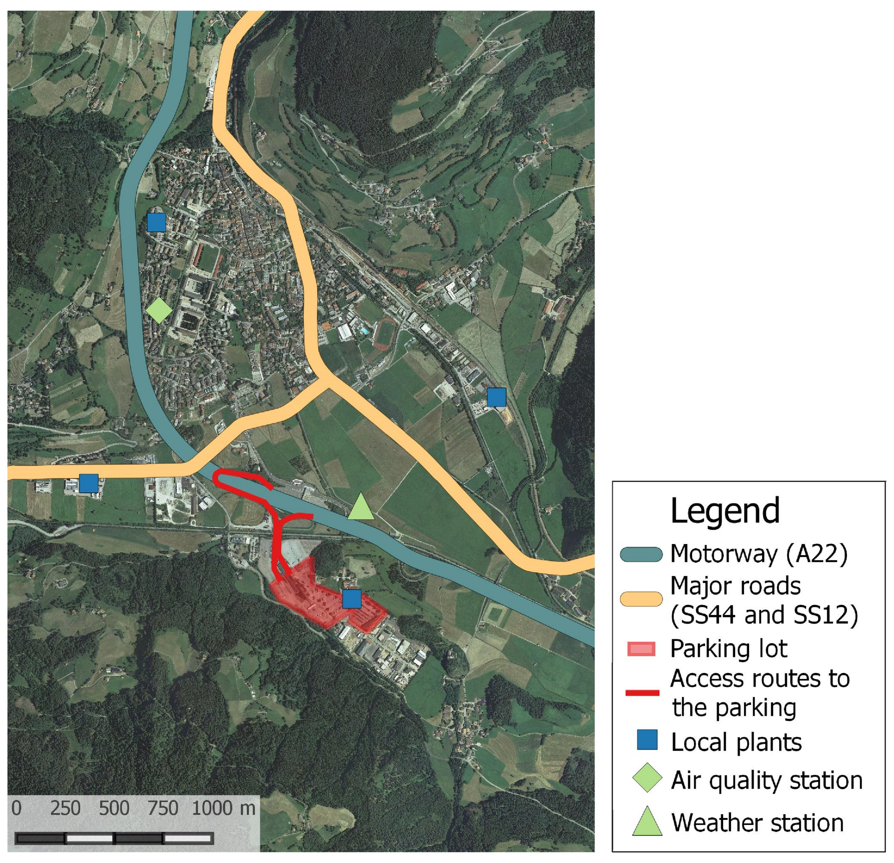

Figure 1: Study area with the main pollution sources and the weather and air quality stations.

- AERMOD model [1] is used to evaluate the impact on air quality of different emission sources in terms of **NO_2** [2] and **PM10**.
- AERMOD was run on a domain of 15 km² with a 25-m horizontally spaced grid.
- The simulation covers the whole 2012 year.
- Static data: 25-m DTM and 30-m land use map .
- Meteorological data:
  1. **ground level data**: hourly measured (Fig. 1) averages of global solar radiation, pressure, temperature, wind speed and direction and relative humidity;
  2. **2-level pseudo-vertical soundings**: ground measured data from two elevated weather stations (1960 m and 3400 m ASL) were used to reconstruct the temperature and wind speed and direction vertical profiles.

MAIN POLLUTANT SOURCES

- The main sources in the Vipiteno area, shown in Figure 1, are:
  1. linear sources: the **main road network** (A22 , SS12 and SS44)
  2. diffuse sources: domestic, manufacturing **local settlements** and secondary traffic;
  3. point sources: three major **local plants**;
  4. a big **parking lot** modeled as the composition of: a point source, a diffuse source and two linear sources
- Table 1 summarizes the methods [3, 4] followed to model each single source and the temporal modulations introduced.

	Source	ST	Method/Data source	Mod.
Local settlements	Domestic heating and secondary traffic	D	INEMAR 2010	S, w, h
Main road network	A22 Motorway	L	COPET IV	S, w, h
	Two major roads	L	COPET IV	h
Local plants	Hospital	P	INEMAR 2010	-
	District heating	P	INEMAR 2010	m
	Small factory	P	INEMAR 2010	w
Parking lot	Administrative building	P	INEMAR 2010	m
	Access routes	L	COPET IV	S, h
	Parking area	D	As follows	S, h

Table 1: Summary of the analyzed emission sources and the method or data source used for their modeling, where: ST stands for source type: D diffuse, L linear, P point; Mod. stands for temporal modulation: S seasonal, m monthly, w weekly, h hourly.

IDLING VEHICLE EMISSIONS

- The following hypotheses were made:
  1. all the idling vehicles are heavy-duty diesel vehicles (HDDV);
  2. all of them stand with an auxiliary power unit (APU) in use;
  3. each vehicle idles for the whole period of breaking, no matter the season of the year nor the hour of the day.
- The emission rate of the parking lot was determined by multiplying the standard emission factor for this type of engine idling with the APU in use [5, 6] by the mean number of parked trucks.
- Data-based seasonal and hourly modulations were then provided.

VALIDATION OF THE SIMULATION

- Model results (increased with background concentrations from a regional scale model) were compared against observations from an air quality station (Fig. 1).

	Observed [µg m^{-3}]	Simulated [µg m^{-3}]
NO_2	29.6	27.3
PM10	14.2	15.6

Table 2: Observed and simulated annual mean values of NO_2 and PM10 concentrations.

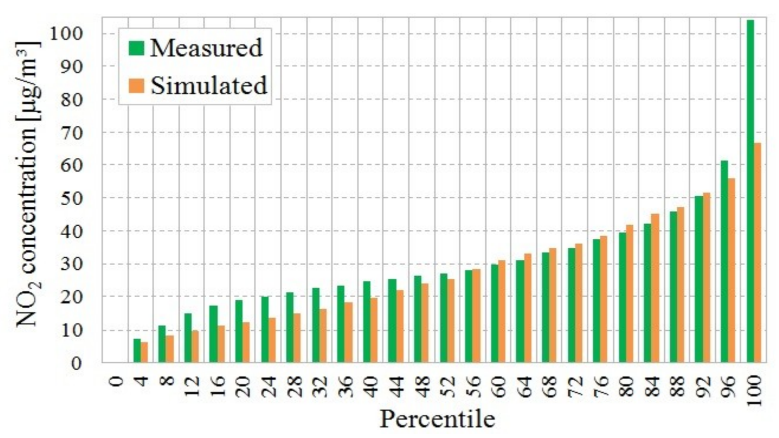

Figure 2: Measured and simulated percentile of NO_2 concentrations.

OVERALL CONCENTRATIONS

- The overall annual mean concentrations of NO_2 and PM10 were compared with the limits set by European legal provisions (40 µg m^{-3}).
- Results are shown in Figure 3:
  1. NO_2 highest concentrations are found along the motorway;
  2. NO_2 values exceed the limit only very close to the motorway;
  3. PM10 maxima are far from the legislative limit;
  4. PM10 highest values are found in the city centre, where most of the population lives.

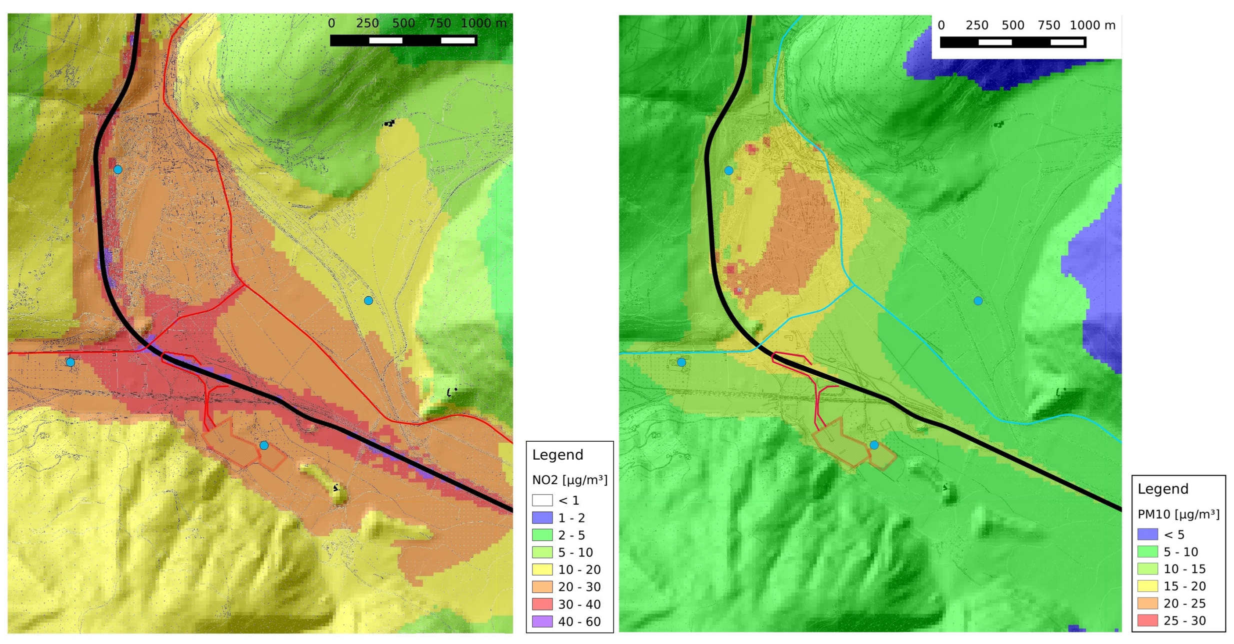

Figure 3: NO_2 (left) and PM10 (right) annual mean global concentrations.

SINGLE SOURCE RELATIVE CONTRIBUTION

- The contribution of each single source to the overall pollutant concentrations is analyzed.
- The percentage relative contribution of each source to the total concentrations is presented in Figure 4 (NO_2) and Figure 5 (PM10).

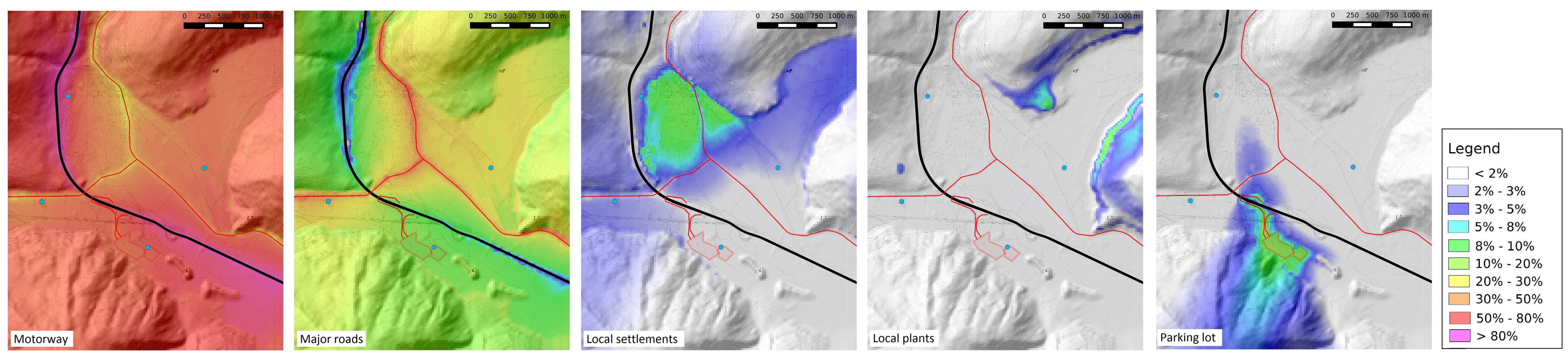

Figure 4: Percentage contribution of each source to the total amount of NO_2 concentrations.

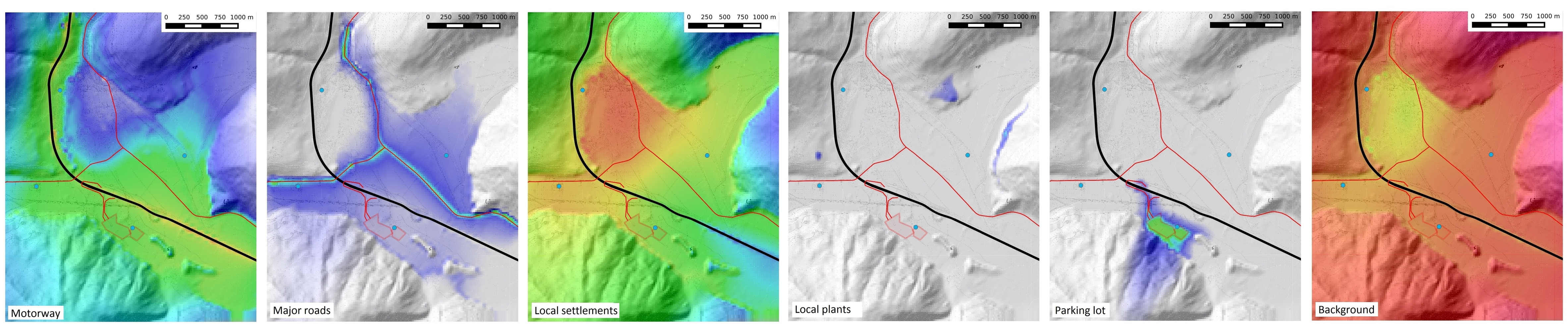

Figure 5: Percentage contribution of each source to the total amount of PM10 concentrations.

CONCLUSIONS

- The validation process assessed the reliability of the performed simulations.
- Results demonstrate that the primary source of NO_2 is the main road network.
- The NO_2 concentration exceeds the legislative limit only next to the motorway.
- Adopting a fine computational grid allows a clear identification of concentration gradients near the emission point, and an exact verification of where limits are exceeded.
- The annual mean PM10 concentration is lower than the prescribed limit.
- The main source of PM10 is the residential area of Vipiteno.
- Local plants and the parking lot have little impact on the local global pollution.

CONTACTS

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