Supplementary material

Near-surface elevated pollution: what we don't know doesn't hurt? - A numerical study over Mt. Carmel
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S1. Upper-air simulation validation
Since no upper air measurements were available for the region, we used the Israeli Meteorological Service radiosonde from Tel Aviv as a reference. Under synoptically driven easterly flow the presented comparison is feasible. An inland site was chosen for this comparison, upwind of Mt. Carmel (site 9, as in Fig 1). Morning and midday thermal profiles over site 9 were extracted and compared with that day's noon radiosonde profile. The profiles show similar trends and elevations, although surface temperature is slightly higher over site 9 (Fig S1.a, b). The morning profiles in Fig S1(c) indicate that near-surface elevated inversion layer existed along the event, with a very strong gradient along the morning.

Fig S1 Simulated thermal profiles (a, c) over site 9, upwind of Mt. Carmel under the easterly flow; Observed noon profile (b) from radiosonde over the coastal plain south of Haifa. All profiles present near-surface elevated inversion layer(s).
S2. Analysis of near-surface elevated inversion layers

A close look into the inversion layers (Fig 4, 5) suggests they consist of sub-layers with different slopes (subjected to the current resolution of the simulation). Here, we refer to the multi-inversion structure over the domain, where in Sect S2.1 the thermal evolution along the morning is discussed, and in Sect S2.2 thermal profiles over two adjacent mountainous vs. foothills sites are presented. These profiles were chosen to illustrate some significant spatial variability due to the steep topography in the domain.

S2.1 Morning thermal profiles over the bay

Site 1 (Fig 1) is located at the foothills of Mt. Carmel, neighboring large industrial facilities, some of which stacks were used in this study as source terms for the dispersion simulation. In most of the simulated morning thermal profiles over site 1, neutral to superadiabatic ground level lapse rate, while very strong and deep inversions were simulated at adjacent levels just above. The elevation and / or depth of the strong inversions fit with the simulation emissions' height, a result which may support the explanation of the peak concentrations discussed in Sect. 3.3.1. Consecutive simulated morning thermal profiles over site 1 are presented in Fig S2, and a dimension analysis of their inversion sub-layers is detailed in Tab S1, where

\[ \Delta T/\Delta Z \] - Temperature gradient across the inversion layer, K [100 m]^{-1}

\[ H_b \] – The inversion base height [m] agl

\[ \Delta H \] – Thickness of the inversion layer, [m]
**Fig S2** Consecutive morning thermal profiles over site 1 at 6 May 2007, from 0400 UTC to 0900 UTC (sunrise at 0250 UTC). The hourly profiles are composed of surface and near-surface inversions as deep as 200-600 m.

**Table S1** Characteristics of the inversion layers in Fig S3: the sub-layers base height, thickness and slope. The total thickness of the inversion with its sub-layers is presented in the last column.

| Time [UTC] | $H_{1b}$ [m] agl | $\Delta H_1$ [m] | $\Delta T_1/\Delta Z$ K [100 m]$^{-1}$ | $H_{2b}$ [m] agl | $\Delta H_2$ [m] | $\Delta T_2/\Delta Z$ K [100 m]$^{-1}$ | $\Delta H$ Total [m] |
|------------|------------------|----------------|----------------------------------------|------------------|----------------|----------------------------------------|-------------------|
| 0400       | 0                | 170            | 4.1                                    | 170              | 510            | 0.7                                    | 680               |
| 0500       | 50               | 420            | 3.4                                    | 470              | 210            | 1.1                                    | 630               |
| 0600       | 50               | 120            | 3.5                                    | 170              | 220            | 2.0                                    | 340               |
| 0700       | 50               | 120            | 3.0                                    | 170              | 220            | 1.1                                    | 340               |
| 0800       | 170              | 130            | 0.7                                    | 170              | 170            |                                        | 130               |
| 0900       | 0                | 170            | 0.9                                    | 170              |                |                                        | 170               |
S2.2 Midday thermal profiles over two adjacent sites

The two adjacent sites 5 and 7 (Fig 1), are less than 4 km away and at 200 m elevation difference. Midday simulated thermal profiles over this two sites were very similar, eligibly suggesting some terrain-following effect. Pollution simulation at 1100 showed high concentration over site 7, with a 200 μg/m³ at ground level and only background concentrations at the same elevation of the lower inversion sub-layer, while only background concentrations were simulated at these elevations at 1300. At the same time, over site 5 there were negligible to zero concentrations. The simulation suggest that over site 7 the total inversion is thicker and composed of two sub layers (Fig S3). The lower inversion sub-layer over site 7 is similar to the lower inversion sub-layer over site 5 in 1100 profile, while this lower sub layer does not exist in 1300 profile over site 5. In both sites the inversion in 1300 profile is elevated with regard to the inversion in 1100 profile. The thermal profile over the mountainous site 6 (above sites 5 and 7) supports the terrain-following feature over the mountain slope, of the 1300 inversion. At the same time, the profile over site 1 - about 2 km away from the slope - shows a deep inversion (built of sub-layers) with its top at the same level as over site 6 (asl, not shown), with its lower pattern similar to site 7. However, for further understanding of the spatial evolution of the inversion layers as described here, a higher vertical simulation resolution is required, for explicit identification of the layers as described by Haikin et al (2015), there employing high resolution radiosonde observations. Such identification may provide an explanation to the differences between the profiles, and the spatial evolution of the inversion layers.
**Fig S3** A comparison of two thermal profiles over the adjacent sites 5 and 7, at 1100 and 1300 UTC, where site 5 is topographically elevated by about 200 m above site 7. The total inversion over site 7 is composed of two sub layers separated by a different layer. The 1300 inversion layer is elevated with regard to the 1100 level. For illustration, the left panel (site 5) is vertically shifted as the topographic difference 200 m.