Introduction
A high-impact weather event associated with severe convection affected Israel and the eastern Mediterranean on 25 October, 2015. Several cities in Egypt and Israel saw streets flooded. In Israel strong winds knocked down trees and power lines, leaving thousands of homes and businesses without electricity. The winds and significant hail caused widespread property damage, including to agricultural infrastructure. The storm even caused one death in a construction site when the wind blew over a wall, and one moderately injured when a tree fell on a bus. Below is an analysis of the antecedent conditions that led to the severe storm’s formation, and the storm’s features.

Synoptic and Mesoscale Analysis
A positively-tilted upper-level trough progressed southeastward from western Europe to the central Mediterranean Sea and north Africa. From 22-24 October, a surface low tracked from southern Italy to the coast of Libya. Meanwhile a trough extended northward from the Red Sea over the Arabian Peninsula, Israel and eastern Egypt. The surface low ultimately moved into the area of the inverted trough, which deepened as the upper-level trough approached (Figure 1).

Also in the days leading up to the event, a tropical plume of moisture was advected in mid-tropospheric southwesterly flow from tropical west Africa to the eastern Mediterranean (Figure 2). These features (the surface “Red Sea Trough” and tropical moisture plume) are typical in the fall in the eastern Mediterranean (Dayan et al. 2001). The sea-surface temperature is still warm from the summer (mid-20s °C), rendering the atmosphere potentially unstable. Normally when an upper-level trough causes an “active Red Sea Trough” in this moist, potentially unstable atmosphere, the result is ordinary thunderstorms in Israel.

On 24 October 18UTC, as the surface low joined the inverted trough, there was forcing for ascent from the upper troposphere: a jet streak embedded within the subtropical jet approached the Nile Delta and eastern Mediterranean (Figure 3a), while a region of positive (cyclonic) vorticity at 300 hPa was moving into the area, leading to cyclonic vorticity advection (Figure 3b). Meanwhile a dry slot aloft was advancing toward the eastern Mediterranean, as seen in the water vapour satellite image (Figure 4). The dry slot indicates a tropopause fold, whereby an upper-tropospheric front leads to the downward advection of dry stratospheric air into the troposphere. This approaching dry slot in an atmosphere of high total column water vapour increased instability. The lift induced by the jet streak and cyclonic vorticity advection then triggered convection. This convection can be seen...
oriented in a NNE-SSW line over the eastern Mediterranean between Egypt and Cyprus in the satellite image. Convection continued to produce multiple cells along this NNE-SSW line over the next few hours.

During this period, a warm, dry airmass pushed in from southeast, which is a desert region (Figure 5). The warm, dry air moved over an area of very high values of wet-bulb potential temperature near the surface (Figure 6). Thus instability grew significantly in the eastern Mediterranean, as demonstrated by the stark increase in CAPE and decrease in CIN over the next few hours (Figure 7). The wind profile at this time shows winds turning clockwise with height (not shown), indicating the warm air advection, and vertical wind shear.

As a result of the wind shear and greatly-increased instability in the convectively active atmosphere, severe convection was triggered around 02UTC on 25 October off the coast of the Nile Delta, forming a supercell. Over the next five hours, the cell
Figure 7: top, a: Convective available potential energy on 24 October 2015 18 UTC (left) and 25 October 2015 00 UTC (right). bottom, b: Convective inhibition on 24 October 2015 18 UTC (left) and 25 October 2015 00 UTC (right).

Figure 8: IR satellite image from 25 October 2015 07:35 UTC. Brightness temperature (contours every 5°C, -50°C and below). Red dots indicate lowest BT from every 5 minutes beginning at 00 UTC. Pink diamonds indicate top of the hour.

Figure 9: Satellite imagery from 25 October 2015 07:30 UTC. Clockwise from top left: IR, day microphysics, high-resolution visible, convective storms.
progressed eastward, to the right of the mid-level (southwesterly) flow, while consistently registering extremely cold cloud top temperatures (-70°C to -74°C) (Figure 8). A right-moving storm with such cold cloud tops are characteristics of a supercell.

Figure 10: Three-dimensional rendering of the storm using Bet Dagan radar data. Pink areas indicate reflectivities above 45 dBZ.

Figure 11: Cross-sectional analysis of the storm using Bet Dagan radar data on 25 October 2015 at 07:25 UTC (top) and 07:50 UTC (bottom).
The Storm’s Landfall and Impact

The storm made landfall in Israel at about 07UTC on 25 October. The storm cell had such violent vertical motions that overshooting tops into the stratosphere are clearly visible by the colouring and texture in the satellite imagery (Figure 9). The brightness temperature was below -70°C, at a height of 17 km. The three-dimensional rendering of the storm shows a significant core of reflectivities exceeding 45 dBZ over Herzliya, indicating the presence of hail (Figure 10). A second, smaller core is located further south, just off the coast. More details of these features can be seen in figure 11.

The gust front from the storm produced winds of 17 m/s, and gusts up to 28 m/s, in the vicinity of where it made landfall (the central coastal plain and Sharon region). The strongest winds were recorded at Hadera Port, with a sustained wind speed of 28.5 m/s and gusts up to 36.8 m/s. The storm also dumped heavy rain during a short period of time over each given location; in Maale Gilboa, the rainfall rate reached 26.8 mm in 10 minutes.

Conclusion

On 25 October 2015, a rare combination of synoptic and mesoscale conditions took hold in the eastern Mediterranean. In a convectively active environment carried over from the previous evening, a warm, dry airmass overrode high values of low-level wet-bulb potential temperatures in an area of vertical wind shear. A supercell storm formed, and a severe thunderstorm made landfall in Israel a few hours later. The storm caused significant hail, winds and short-term precipitation. It caused widespread damage and even one death. This storm was historic in its features and its impact.

References

