

GPM observations of a tropical-like hailstorm over the Mediterranean Sea

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In the last years tropical-like precipitation systems, i.e. with large horizontal extent, tropical cyclone features (i.e. Medicanes), or characterized by very deep and intense convection, have become more and more frequent also at mid-latitudes.

On September 05, 2015 a violent hailstorm hit the Gulf and the city of Naples in Italy. The storm was caused by a southward plunge of the jet stream that carved into Western Europe, sending an upper disturbance into the Italian peninsula. That instability, associated with high Sea Surface Temperature (SST), and low-level convergence, stirred up an impressive severe thunderstorm with intense lightning activity and strong winds, that started developing around 0600 UTC over the Tyrrhenian Sea off the coast of Naples, and reached maturity by 0637 UTC, hitting the coast around 0900 UTC, moving inland afterwards, until its complete dissipation around 1200 UTC. The storm dropped 5-8 cm diameter hailstones along its path over the sea, and in Pozzuoli, near Naples. Meteosat Second Generation (MSG) SEVIRI VIS/IR images show the extremely rapid development of the thunderstorm, with cloud-top temperatures (at 10.8 μm) dropping from 270 K at 0657 UTC to the extremely low value of 205 K at 0637 UTC (65 K in 40 minutes). The occurrence of a very well defined convective overshooting top is evidenced by the VIS images. Sounding at Pratica di Mare station (180 km NE of Naples) at 0000 UTC shows the tropopause height at about 13.5 km and the typical “loaded gun” features providing a strong capping inversion inhibiting the premature release of the convective instability: moist air in the boundary layer, due to the low-level southerly flow, with warm and dry air aloft. The LINET ground-based lightning detection network registered over 37000 strokes between 0500 and 1200 UTC.

During its mature phase, at 0845 UTC, the hailstorm was captured by one overpass of Global Precipitation Measurement (GPM) satellite launched in February 2014. The GPM Core Observatory (GPM-CO), equipped with the GPM Microwave Imager (GMI), the most advanced multichannel conical-scanning microwave radiometer available, and with the Ka/Ku band Dual-frequency Precipitation Radar (DPR), provides unique measurements of extremely rare, tropical-like features of the storm. Close-in-time observations of the hailstorm are also available from the AMSU/MHS radiometers (MetOp-A overpass at 0834 UTC and MetOp-B overpass at 0929 UTC). DPR shows vertical extension of more than 16 km a.s.l. and with tropical-like reflectivity values (40dBZ top height at 14 km and 20 dBZ top height at 16 km, sign of strong updraft, supporting large ice hydrometeors), confirming the presence of a deep overshooting above the 13.5 km tropopause. GMI observations show strong brightness temperature (TB) depressions, with the 37GHz, 89GHz, and 166GHz as low as 97K, 67K, and 87K, respectively, similar in both V and H channels (sign of round shaped ice hydrometeors). Such low values of TB are extremely unusual at mid latitudes, and can be measured only thanks to the high-resolution capability of GMI. The analysis of the TB differences in the three AMSU/MHS 183 GHz water vapor channels, usually applied to tropical convective clouds, confirms the presence of convective overshooting. Around the time of the GMI (and AMSU/MHS) overpass (between 08:30 and 09:00 UTC), the LINET registered about 5000 lightning strokes (3500 intracloud), another indication of the severity of the storm.

In this study GPM observations will be thoroughly analyzed and discussed, along with the analysis of other spaceborne and ground-based measurements, providing observational evidence of the severity and rarity of this type of storm at mid-latitudes.