-- Choose -- Computing -- Choose -- ECMWF Newsletter #179 Newsletter Number 179 – Spring 2024 Published in April 2024 Medicane Daniel: an extraordinary cyclone with devastating impacts Tim Hewson Abdelwanees Ashoor (Omar Al-Mukhtar University, Al Bayda, Libya) Souhail Boussetta Kerry Emanuel (Massachusetts Institute of Technology) Kostas Lagouvardos (National Observatory of Athens/Institute for Environmental Research) David Lavers Linus Magnusson Fatima Pillosu Ervin Zsoter In early September 2023, a set of extreme rainstorms led to devastating flooding in parts of Greece, Bulgaria and Turkiye.Likewise, aerosol optical depths from a Copernicus Atmosphere Monitoring Service (CAMS) numerical model run (40 km resolution), used to pinpoint dust and sand, showed no sign of near-centre concentration (compare Figures 2c,d).This is based on UK Met Office surface analyses, augmented, from 12 UTC on 9 September onwards, by reassessment of 15-minute interval satellite imagery sequences (from the EUMETView tool: https://view.eumetsat.int/productviewer) and other observations, alongside ECMWF high-resolution (HRES) analysis fields.The other panels show (b) the cyclone central pressure trace (colour scheme as on panel a), with dates on the x-axis (labels at 00 UTC), (c) topographic height at 1 km resolution (marked sites as on panel a, in white), and (d) the catchment of Wadi Derna (red outline) – source: https://mghydro.com/watersheds.Siwa Oasis winds reached 34 kts at 11 and 12 UTC on 11 September as the low passed by. Meanwhile, visible imagery early on 11 September showed a substantial tower of elevated dust/sand in the cyclone centre (Figure 2c), which would have needed near-centre 10 m wind speed in excess of 20-25 kts to accrue, which even 9 km resolution model solutions did not show.Supplementary forecast and observation charts for this episode can be found in two case links in ECMWF's online severe event catalogue: https://confluence.ecmwf.int/display/FCST/Severe+Event+Catalogue.In subsequent days, Daniel meandered slowly across the Mediterranean before adopting an east-south-eastward trajectory near northern Libya late on 8 September, whereupon it became a medicane.The resulting intense rainfall over the Akhdar (Green) mountains of northern Libya on the night of 10-11 September drained into the small Wadi Derna catchment and went on to cause catastrophic flooding in the city of Derna.This article examines some of the meteorology and hydrology at play, whilst providing insights into predictability aspects, forecast quality and event rarity.Reassessment led to a deeper, repositioned centre over northern Libya on 10 and 11 September, and track extension across Egypt (beyond the Met Office chart domain) on 11 and 12 September.Evidence for the adjustments included hourly METAR observations of mean sea-level pressure and 10 m mean wind, from Siwa Oasis on 11 September and Cairo on 12 September (Figure 1a), that conflicted with model data.These events related to development of a surface cyclone nearby on the night of 4 September, assigned the name 'Daniel' as part of a EUMETNET cyclone naming initiative (Cusack et al, 2017).This was likely the deadliest rainfall-related flooding disaster since ECMWF started producing operational forecasts in the late 1970s and the second most deadly dam-related disaster of all time.FIGURE 1 FIGURE 1 Background to the flooding events, showing (a) the full track of cyclone/medicane Daniel from Met Office surface analysis charts (blue and black at 6 h intervals), with reanalysed positions at 3 h intervals in red.Landfall was near Benghazi around 23 UTC on 9 September.Two dams burst, and there were 5,000-15,000 fatalities as buildings were swept away.In so doing we synthesise many aspects of ongoing work at ECMWF, and

beyond.Numbers denote the date (September 2023) for 00 UTC positions.Remarkably, the medicane deepened further over land.Defining Daniel's full history Figures 1a,b depict the full eight–day lifecycle of Daniel – its track and central pressure.Large dots are for 00 UTC, medium for 06, 12, 18 UTC, small for 03, 09, 15, 21 UTC.Green markers are sites discussed in the text.This all pointed to a deeper low with a tighter core, which had probably existed for some time.