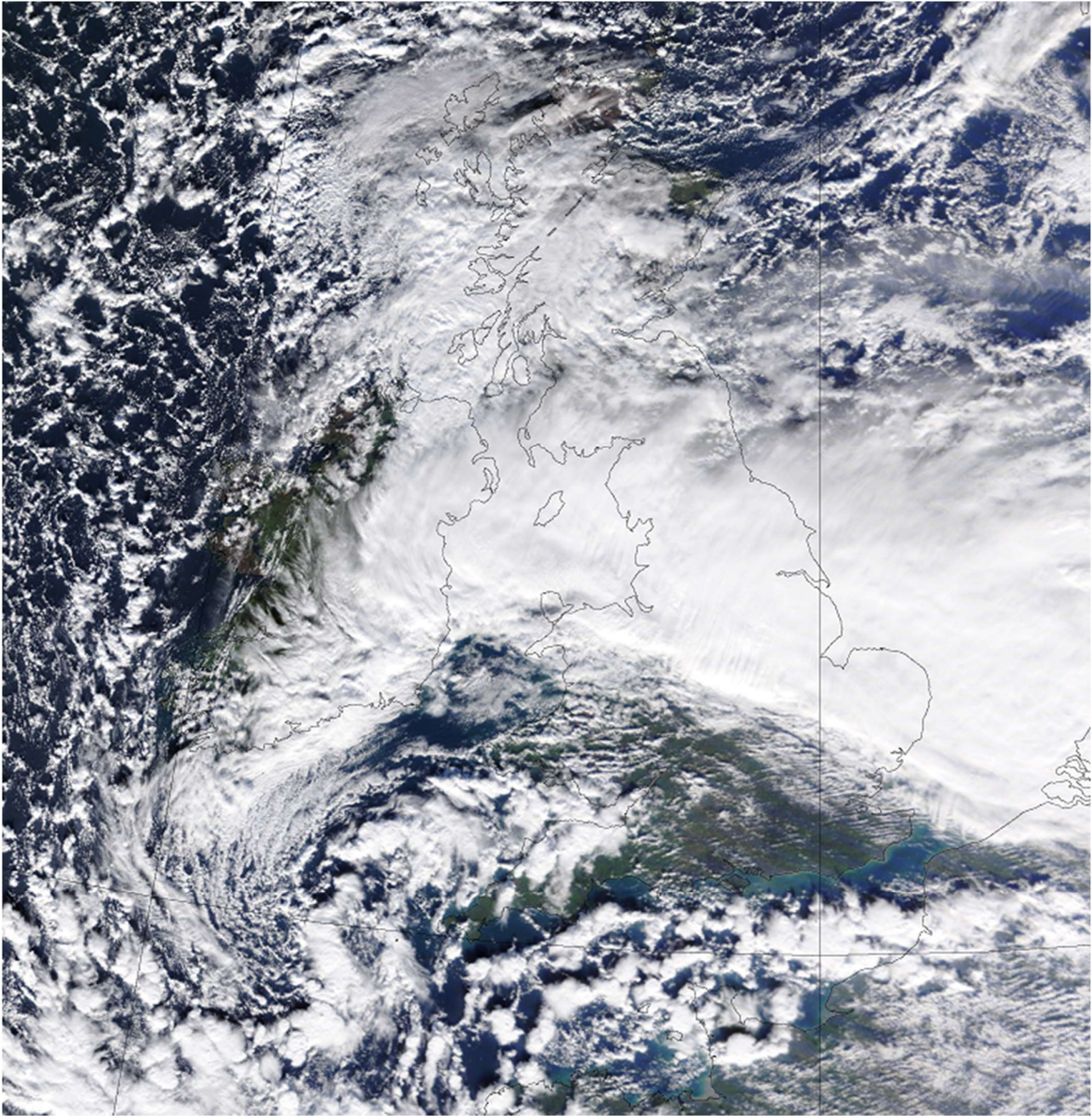


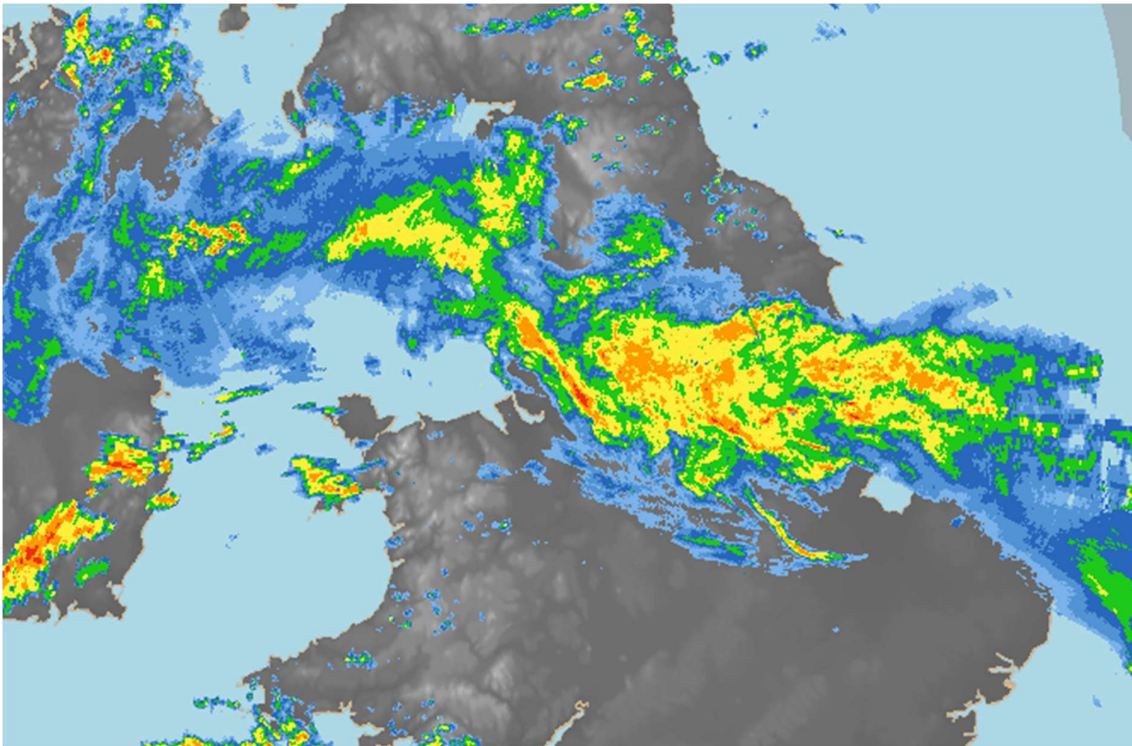


The satellite image on 7 November 2019 shows the occluded front responsible for the persistent heavy rain in an easterly flow across northern England. The low's centre is located near the Isles of Scilly. Image copyright Met Office / NASA/ NOAA.

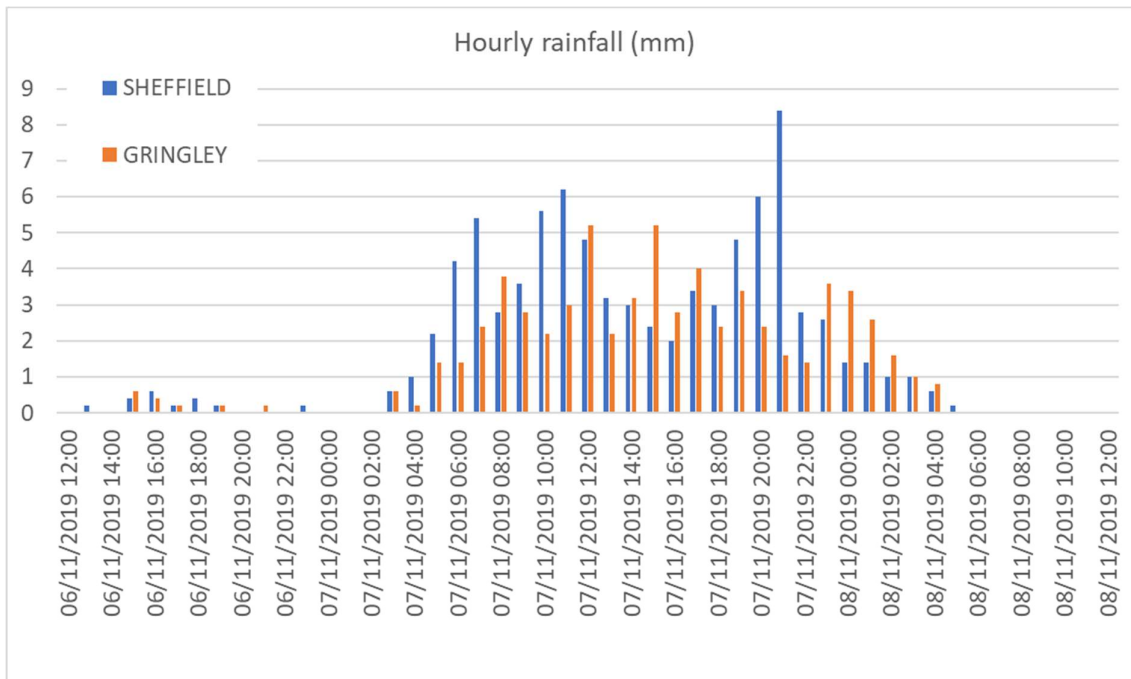




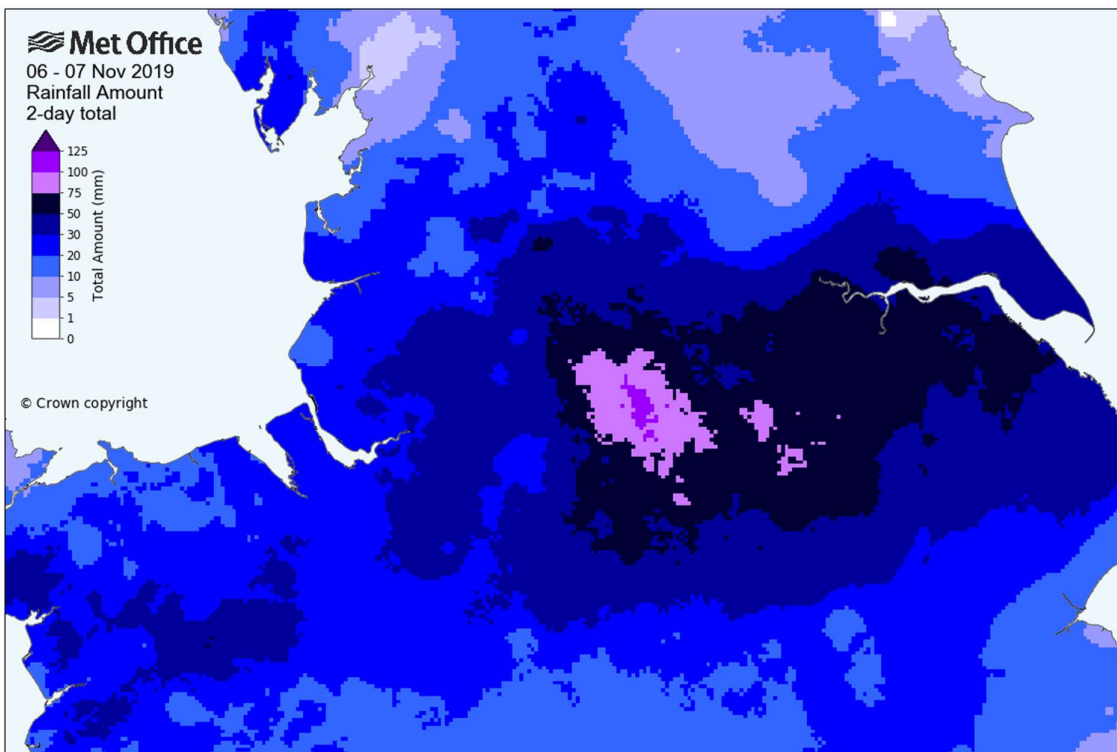
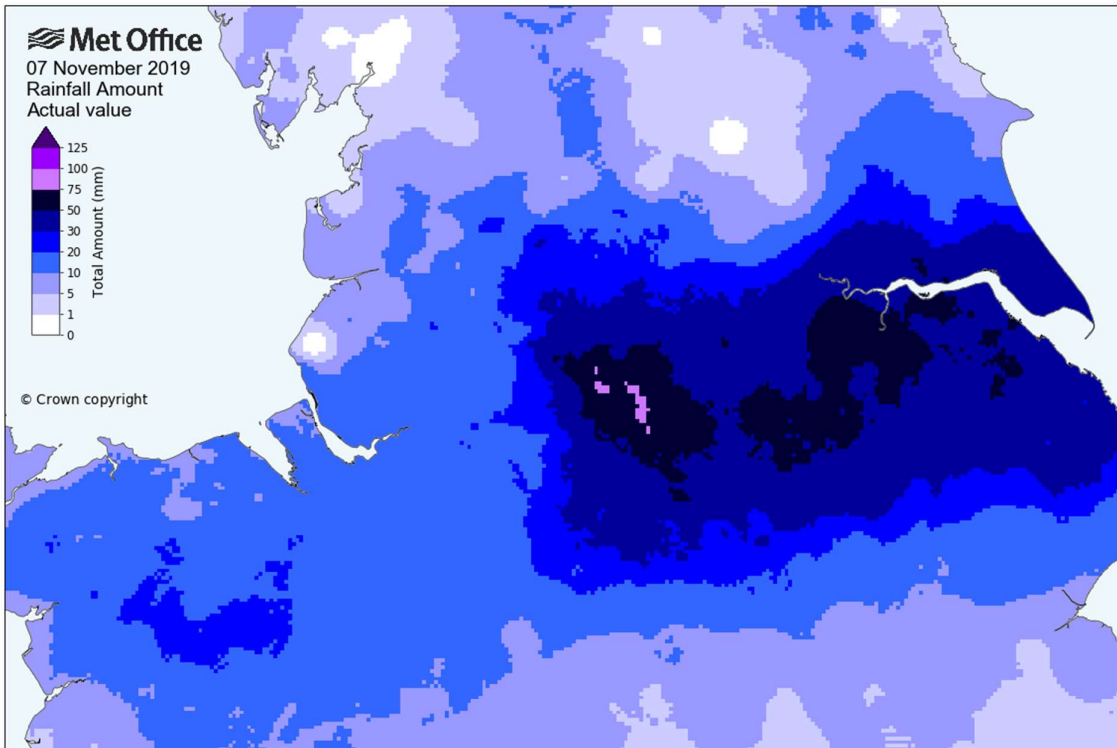
The rain-radar image at 1200 UTC 7 November 2019 shows the persistent heavy rainfall across Lincolnshire and South Yorkshire. The front remained largely stationary from around 0300 UTC 7th to 0300 UTC 8th November in this location.



The chart below shows hourly rainfall at two locations, Sheffield and Gringley-on-the-Hill (located 40km to the east in Nottinghamshire). 82.2mm / 63.2mm fell over a 24-hour period 0300 UTC 7th to 0300 UTC 8th November 2019, this being 104% / 122% of the November 1981-2010 long-term average rainfall at these two respective locations - ie a whole month's rain falling in 24-hours.

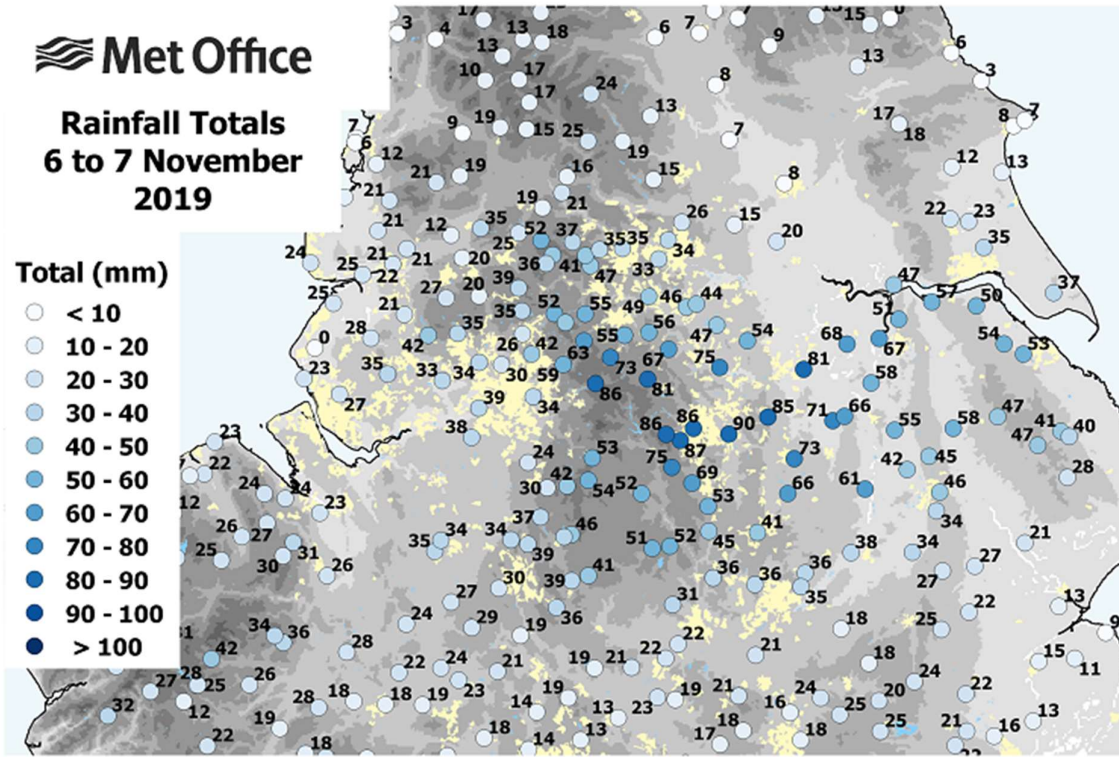


The maps below show rainfall accumulations for the rain-day 7th November 2019 – 0900 UTC 7th to 0900 UTC 8th (a) and two rain-days 6th to 7th November 2019 – 0900 UTC 6th to 0900 UTC 8th (b). The total rainfall for this event exceeded 50mm in a wide swathe from the Humber estuary to the eastern Peak District, with the highest totals in the Sheffield area of 75 to 100mm.

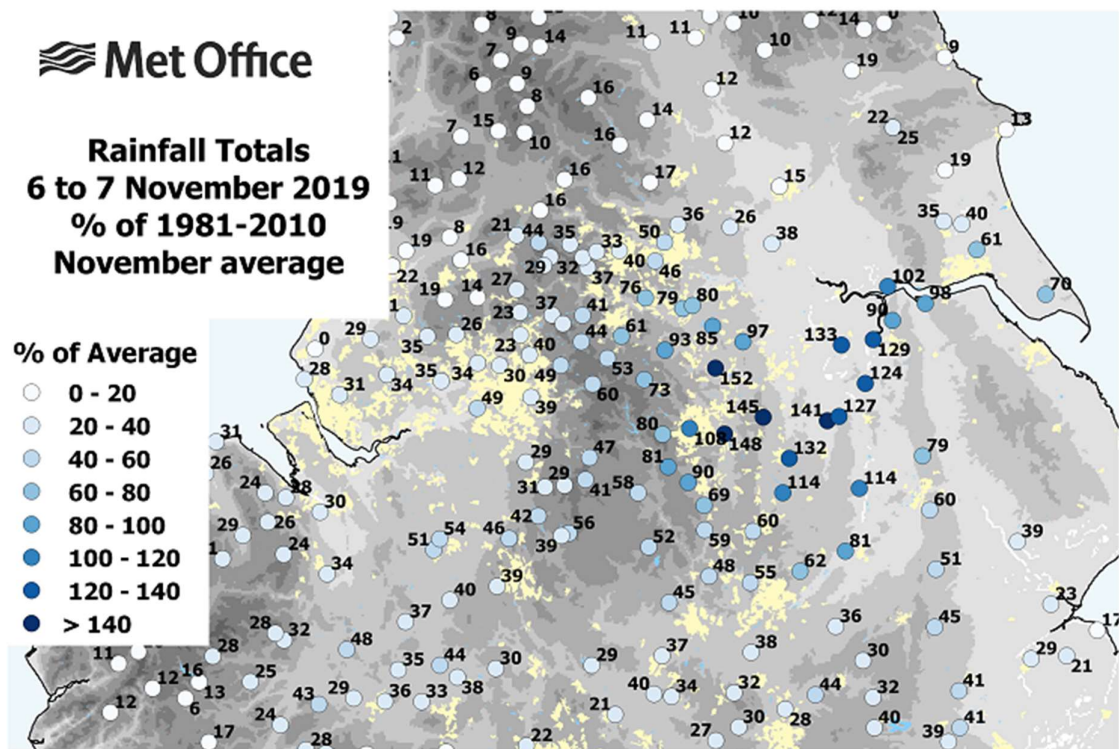




The maps below shows rainfall accumulations at individual stations for the two rain-days 6 to 7 November 2019 – 0900 UTC 6th to 0900 UTC 8th (a) and as a percentage of the 1981-2010 November long-term average rainfall (b). Rainfall totals were around the full-month average in the Sheffield area, and to the east and north-east of Sheffield (climatologically a slightly drier area) typically 120 to 150% of the November long-term average.

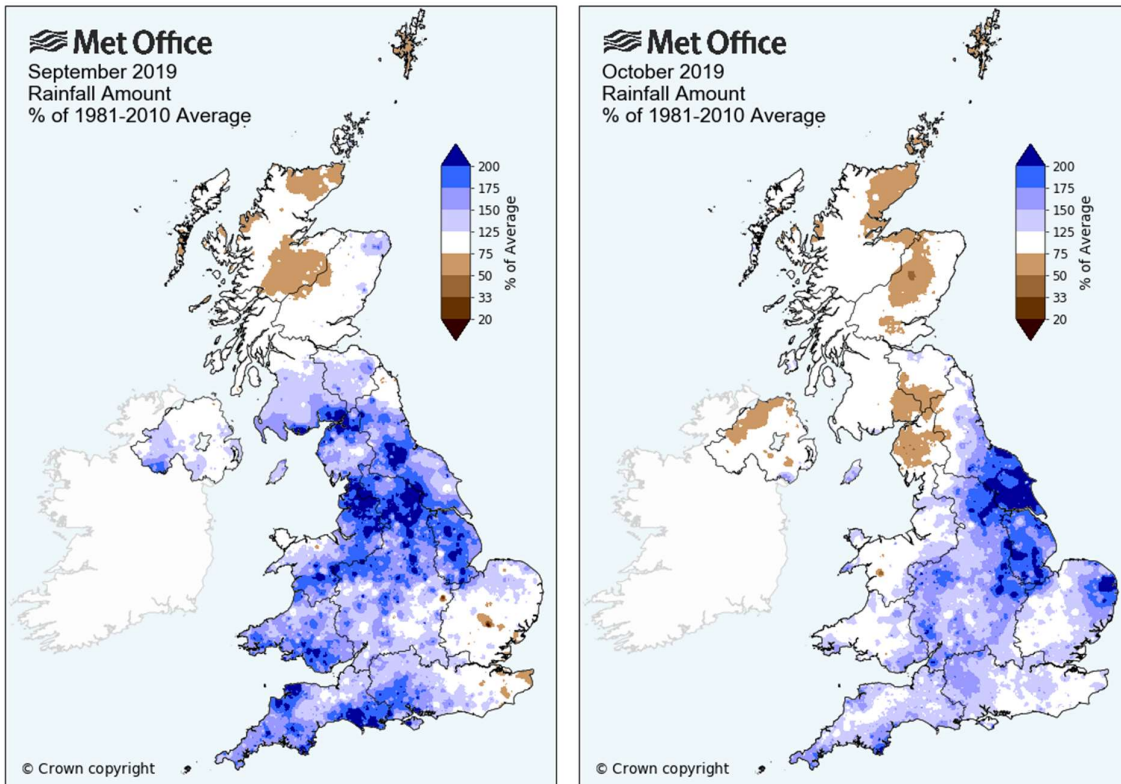


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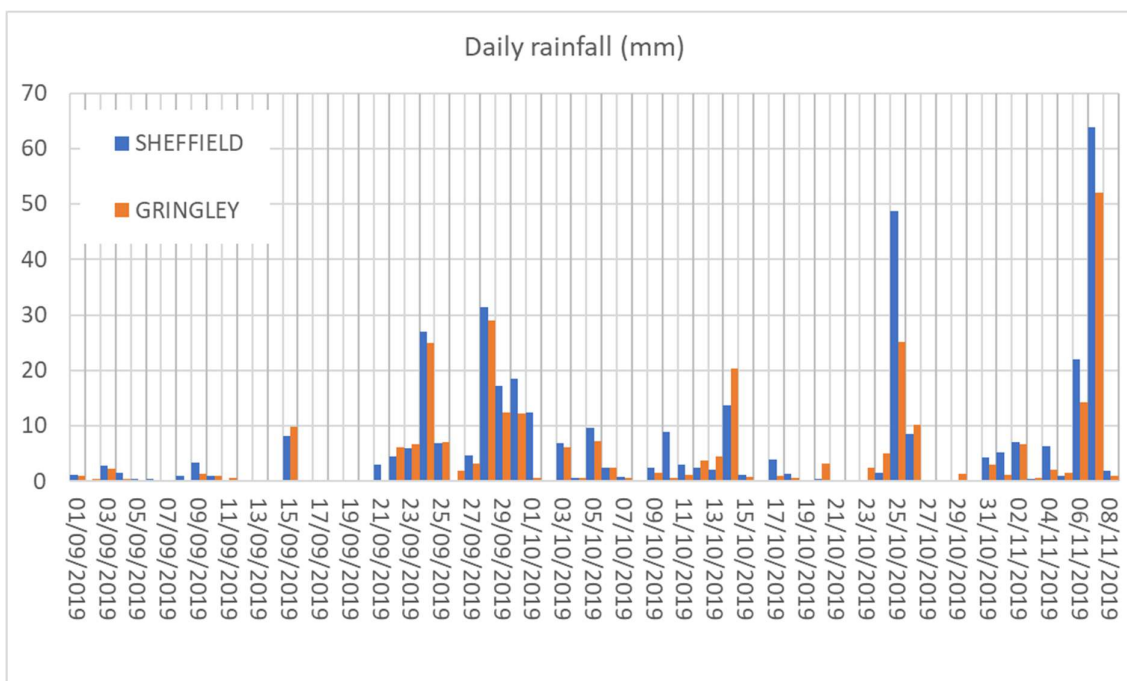


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A key reason for the severity of the flooding was the saturated nature of the river catchments prior to this event. The maps below show rainfall totals as a percentage of the monthly average across the UK for September and October 2019 – the areas affected by flooding having already received well above average rainfall for both these months.

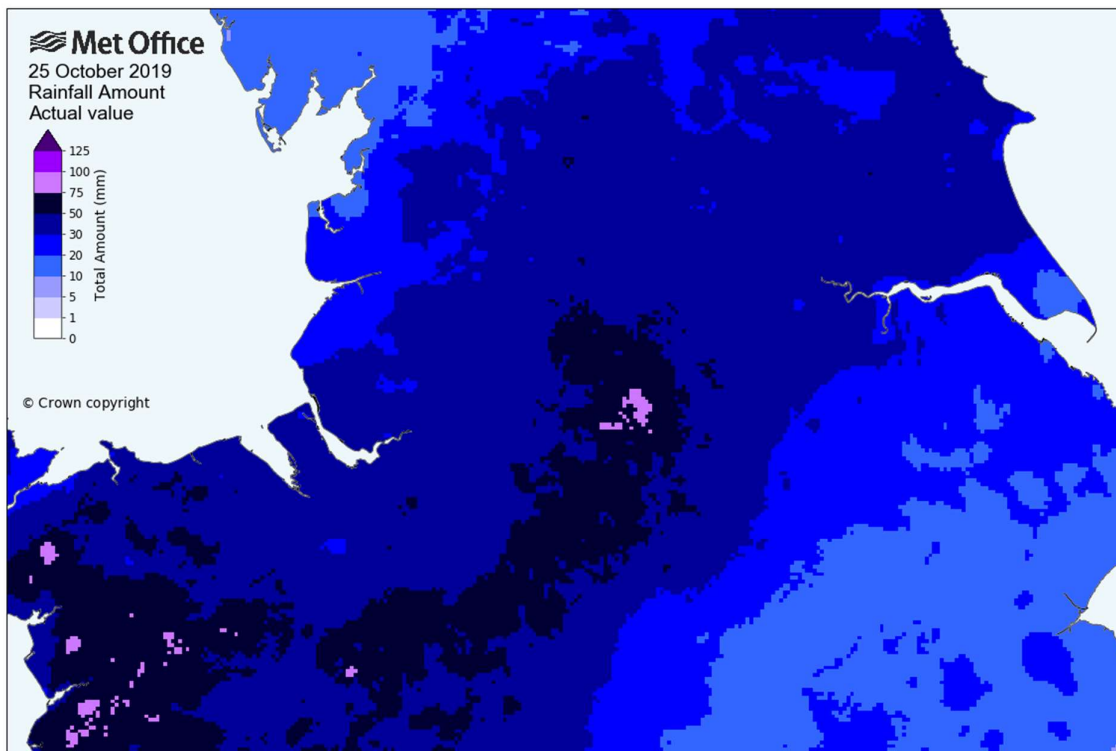


The chart below shows daily rainfall totals for the autumn – from 1 September 2019 to 8 November 2019 at these two locations Sheffield and Gringley-on-the-Hill. The unsettled and generally wet nature of the weather can be seen from 22nd September onward. Two weeks earlier, 25 October was another particularly wet day with almost 50mm falling at Sheffield; a map for this event is shown below with rainfall totals comparable to 7 November 2019.

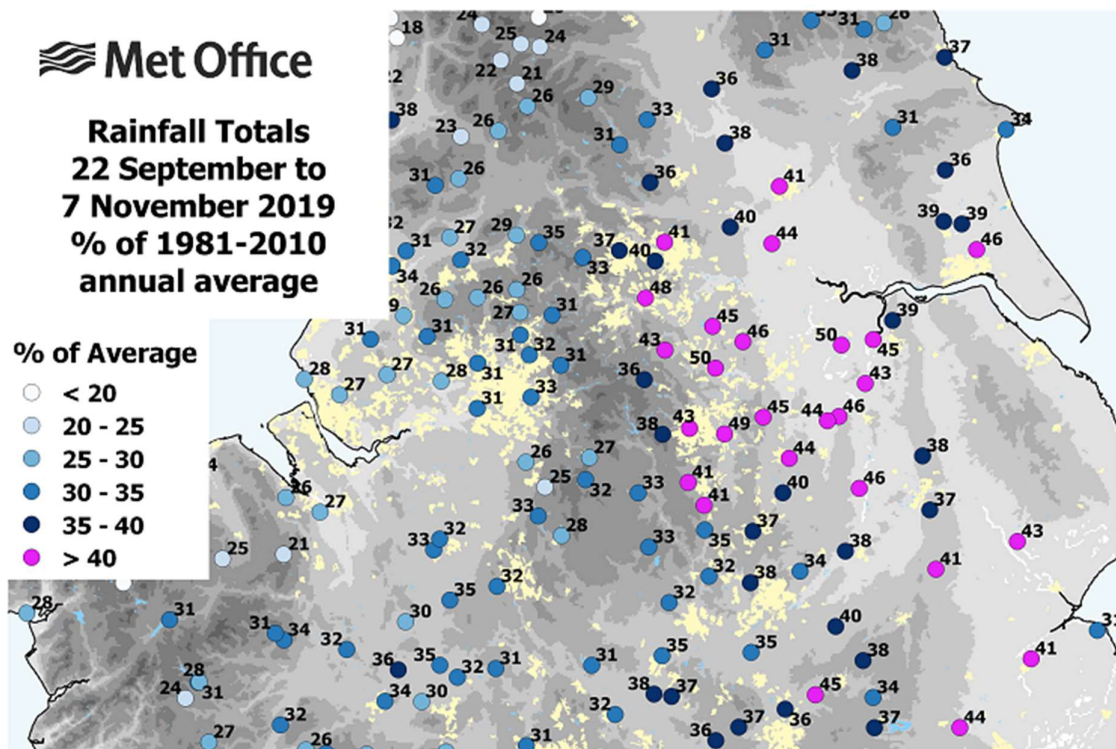




Daily rainfall totals 25 October 2019, two weeks earlier. This event caused flooding further west – across parts of Wales, Shropshire, Staffordshire and Manchester.



The chart below shows station totals for the 47-day period 22 September to 7 November 2019 as a percentage of the annual average rainfall. Over this period 250 to 300mm of rain fell across the area to the east of Sheffield, with 300 to 400mm or more to the west of Sheffield. In these locations this represents typically between a third and a half of the annual average rain falling in a period of just over a month and a half.



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## Historical Context

The weather station at Sheffield provides a useful long-term context for this event, with records back to 1883.

The daily total of 63.8mm at Sheffield on 7 November 2019 was seventh highest daily total in this series, exceeding 61.4mm from Storm Bronagh on 20 September 2019. All historical events which exceeded 7 November 2019 occurred in the summer months (June, July and August), and six of the ten highest daily totals for the month which exceeded 60mm have occurred since 2000. 7 November 2019 was also the wettest November day at this station, exceeding 45.8mm on 5 November 2000.

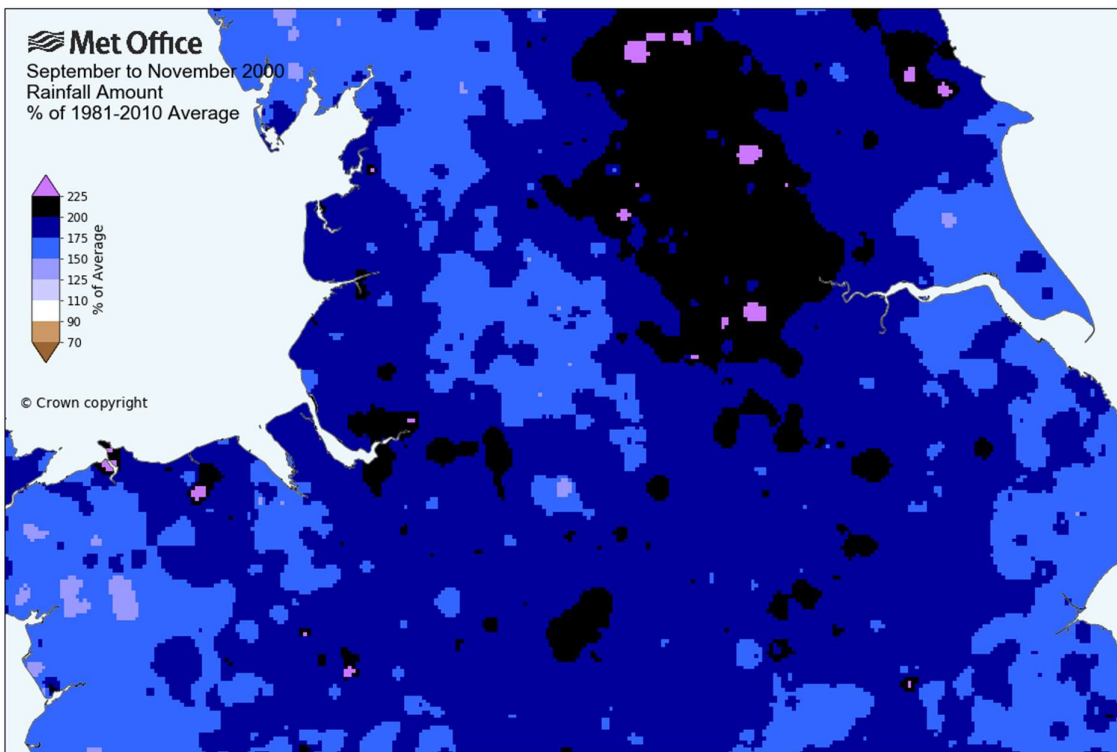
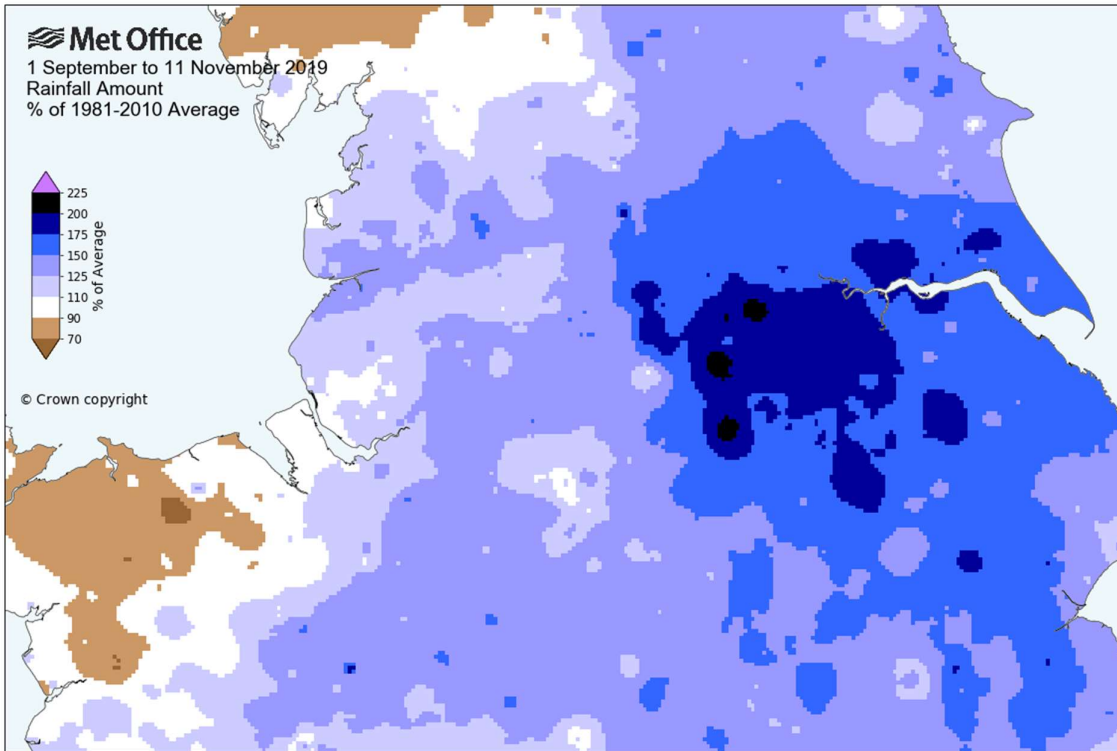
The table below provides a break-down of rainfall totals at Sheffield for the autumn 2019 compared to previous years. September to October 2019 was the third-wettest September to October period at Sheffield in the series from 1883, behind only 1960 and 1903. The 2019 autumn rainfall total from 1 September to 7 November 2019 was equal-third wettest autumn in the series exceeded by only 2000 and 1960 – with three-quarters of November still to go.

Sep to Oct (mm)	% of 1981-2010 Average	Year	Sep to Nov (mm)	% of 1981-2010 Average	Year
287.7	198	1960	425.2	189	2000
283.1	195	1903	403.9	180	1960
274.8	189	2019	380.6*	170	2019
262.6	181	1976	380.4	169	1935

\* total for 1 September to 7 November 2019

The maps below compare rainfall totals for autumn 2019 so far (a) and autumn 2000 (b) as a percentage of the 1981-2010 long term average. Rainfall totals for autumn 2019 from 1 September to 11 November 2019 exceed 175% of the long-term average across much of South Yorkshire – with over 200% in a few locations. For comparison, in autumn 2000, over 200% of average fell widely across the eastern Pennines resulting in severe flooding problems in the north-east, with around 5000 properties flooded in York.





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