The Hampstead Storm
14 August 1975

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In Memoriam

Philip Eden

14 July 1951 – 3 January 2018

UCL Hazard Centre

- Multi-disciplinary- principally interested in geophysical hazards
- Volcanoes, earthquakes, landslides, tsunami
- MSc (geophysical hazards), Natural Hazards for Insurers certificate
- Expertise in flooding, severe convective storms, cyclones
- Strong links to insurance and re-insurance industries
- Industry spin-offs in meteorological hazards-
- *Tropical Storm Risk* (Hurricanes)
- *Eurotempest* (Extratropical cyclones)

Outline of talk

- What happened on 14 August 1975
- Brief review of the scientific literature on the storm
- Nature of the ‘Hampstead Storm’ and *quasi-stationary* convective storms
- Similar events in the UK- localised flooding due to thunderstorms
- Some successes and failures in UK convective storm forecasting since 1975

A hot summer's day...

"*For weeks, you may recall, there has been no rain... walking on the heath early that morning, the hard pan of clay...felt warm to the touch. The sultry breezes raised swirling dust devils that scuttled about like crabs.... [after 5 or 6 hours] the rain and the hail stones barrelled down... At times there seemed to be no rods of rain as you normally see them. It fell in misty sheets with a noise like boiling fat...*"

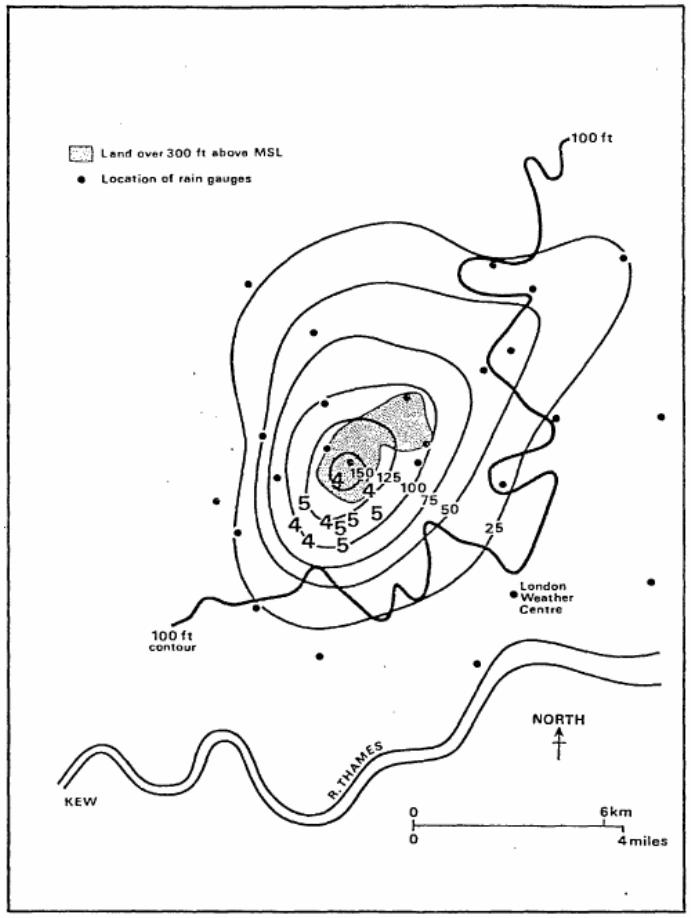
John Hillaby, New Scientist, September 1975

Aftermath...

Figure 1: Key Newspaper Images of the 14th August 1975 storm and headlines.

- 1 fatality (in flooded basement)
- 2 injured (struck by lightning sheltering beneath tree)
- At least 250 made homeless
- Sewer system overwhelmed
- Very rapid onset of severest flooding- 5 mins
- Disruption to infrastructure- 4 mainline stations flooded
- £1 million + loss (2017: £7-8m)

How much rain fell?



- 170.8 mm (6.72 in) at Hampstead
- 200 mm+ estimated due to violence of fall and gauge blocked by hail (observer Tyssen-Gee, HSS and RMS)
- Time 1620-1855 GMT
- Parliament Hill gauge 100 mm
- Max rain rate 125 mm/hr
- Hail to 20-30 mm south of epicentre

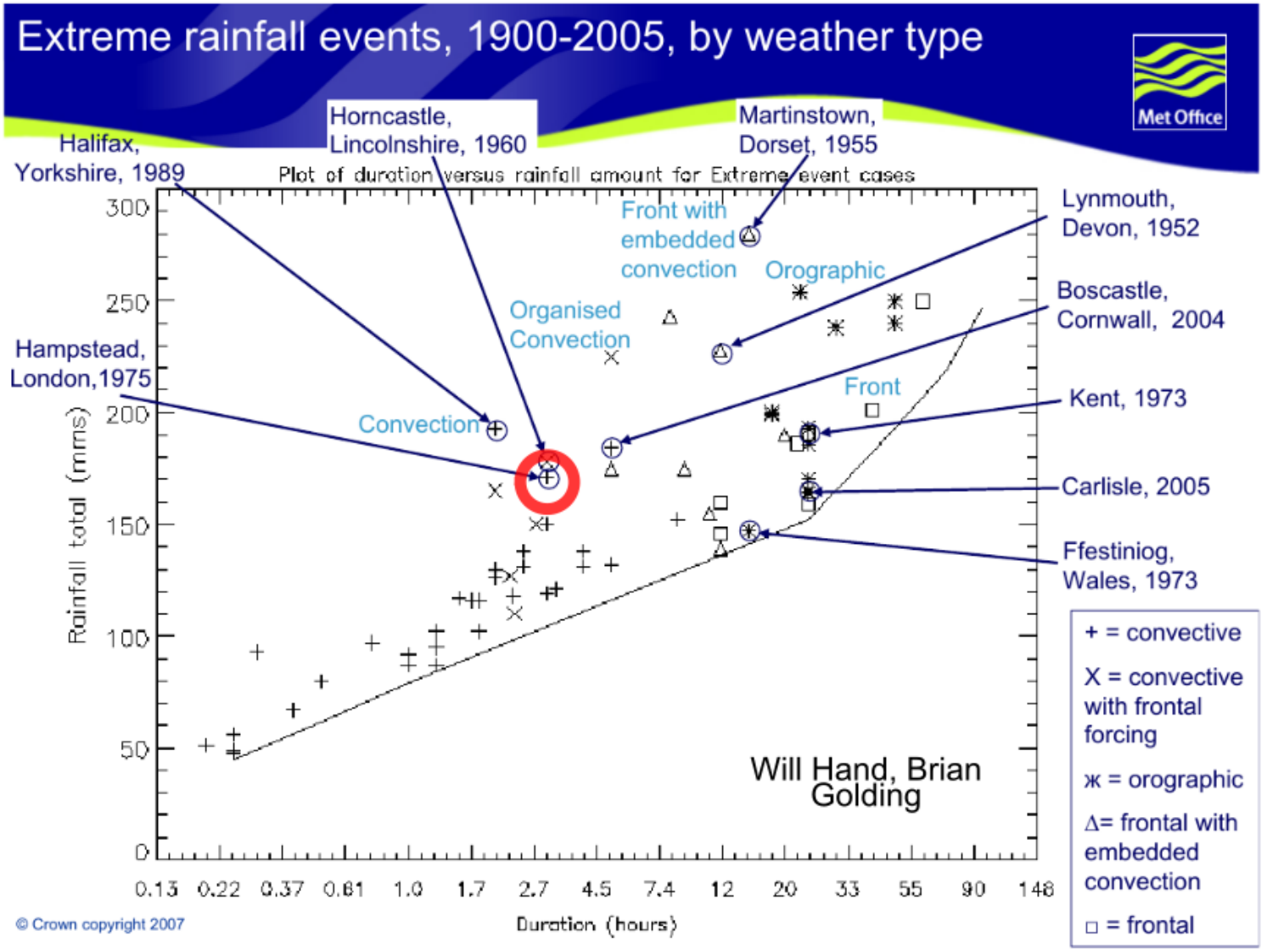
How unusual was the Hampstead storm?

- Bilham scale- “Very Rare”, Collier *et al* - “extreme event”
- 170 mm highest ever recorded short duration rainfall figure in London
- Only exceeded in records by 193mm in two hours at Walshaw Dean Reservoir, West Yorkshire, on 19 May 1989 (?)
- 1 in 20,000 chance in particular year within 1km (Keers & Wescott, *Weather*, 1976)
- 1 in 25 year event for Greater London area (K&W)
- Highly localised (~100 km^2)

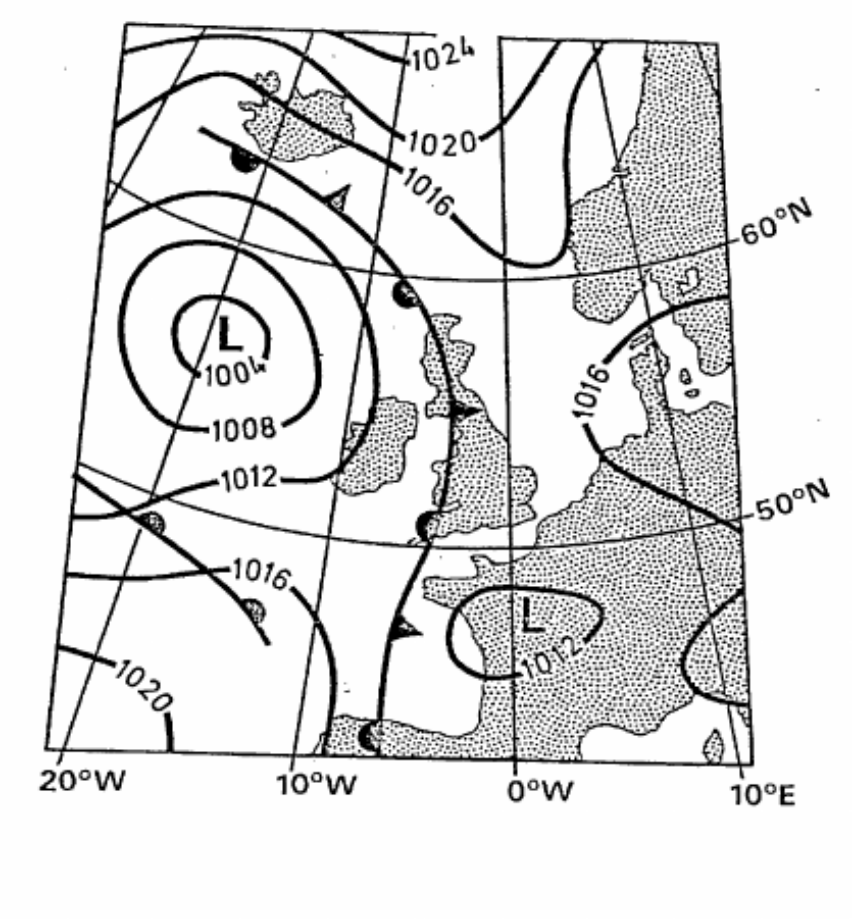
Other examples of high convective rainfall from north London area:

- 23 June 1878- 83.1 mm at Camden Square in 1 1/2hr
- 14 June 1914- 76 mm+ Richmond to Staines
- 6 May 1915- 76mm+ highly localised in City and Kings Cross
- 16 June 1917- 101 mm (4in) + Kensington
- 9-10 July 1923 - 65.3 mm at Hampstead
- 6 August 1952- 120 mm Boreham Wood, Herts, Middlesex
- 7 June 1963- 94 mm Mill Hill, north London
- 8 May 1988- 88.5 mm at Uxbridge, 57 mm at Hampstead
- 7 August 2002- 60 mm in ~1 hr, flooding in Camden

In the context of UK flooding events...

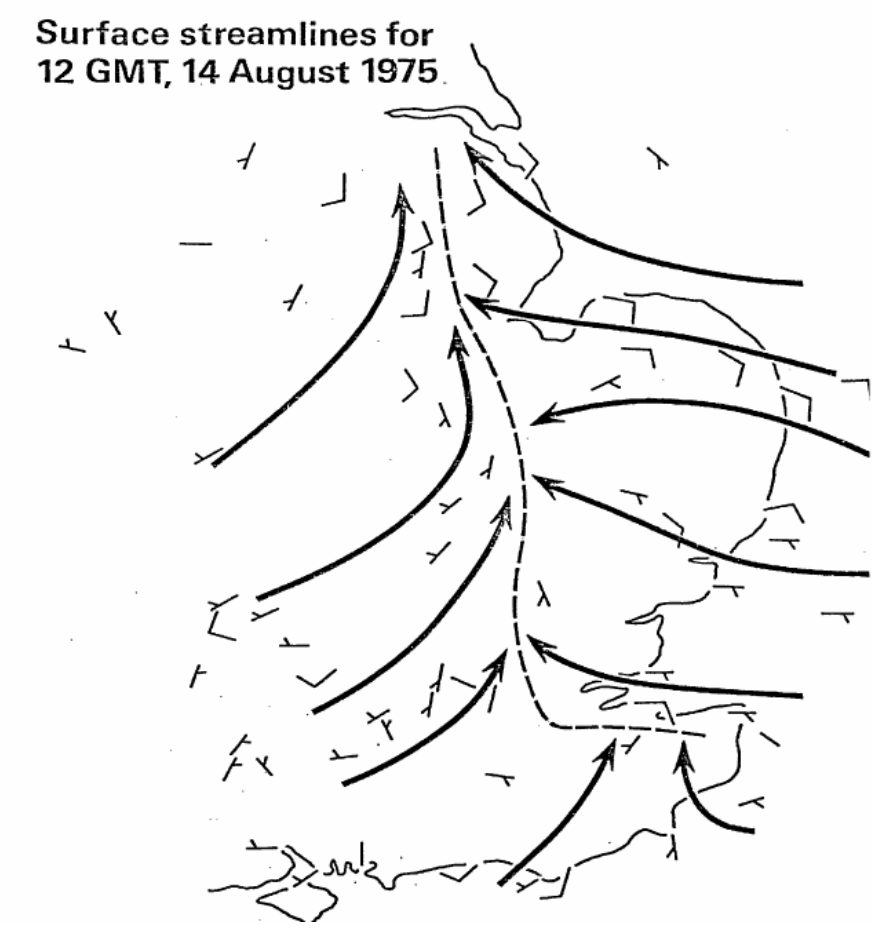


Synoptic situation 14 August 1975



- Slow moving low pressure and frontal system west of UK
- Low pressure over France
- Warm and moist air advected in from continent (WBPT > 20C)
- Drier, cooler air to west- increasing cloud cover
- Not unusual for UK summer

Mesoscale situation 12 UTC



- Temperatures in east to 29-30C
- ‘Heat Low’ forming inland
- Confluence of air masses over east and south-east
- Sea breeze-like flow into London
- Scattered thunderstorms north of London
- Hampstead storm grows from single cumulus cloud into a ‘Cumulo-nimbus’ with at least 3 cells

Visual appearance? No satellite or radar imagery, but...

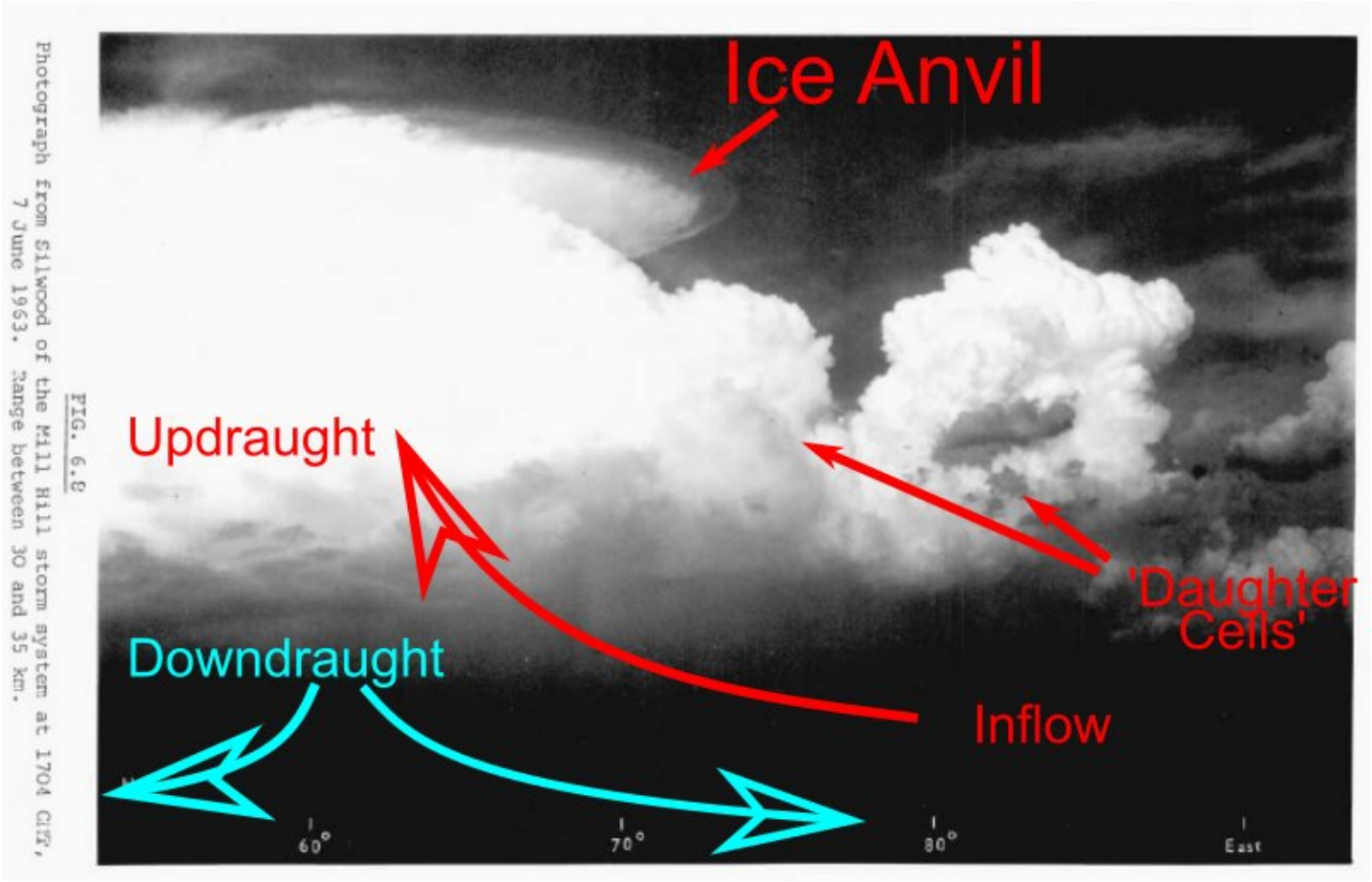


Photo: Mill Hill storm 1963 (Grove, thesis, 1977)

Modelling studies at Imperial College

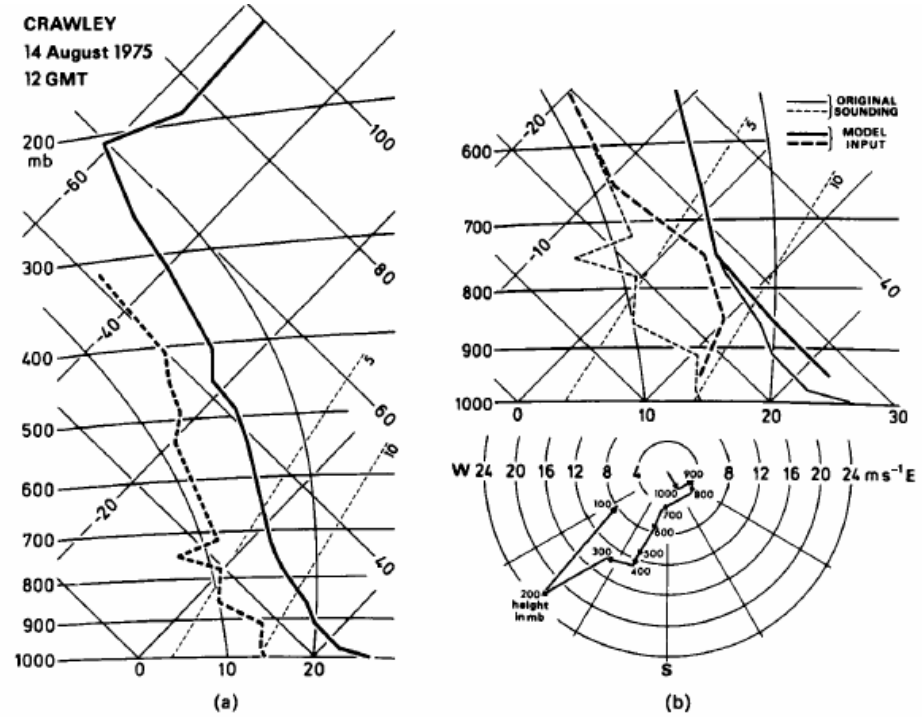
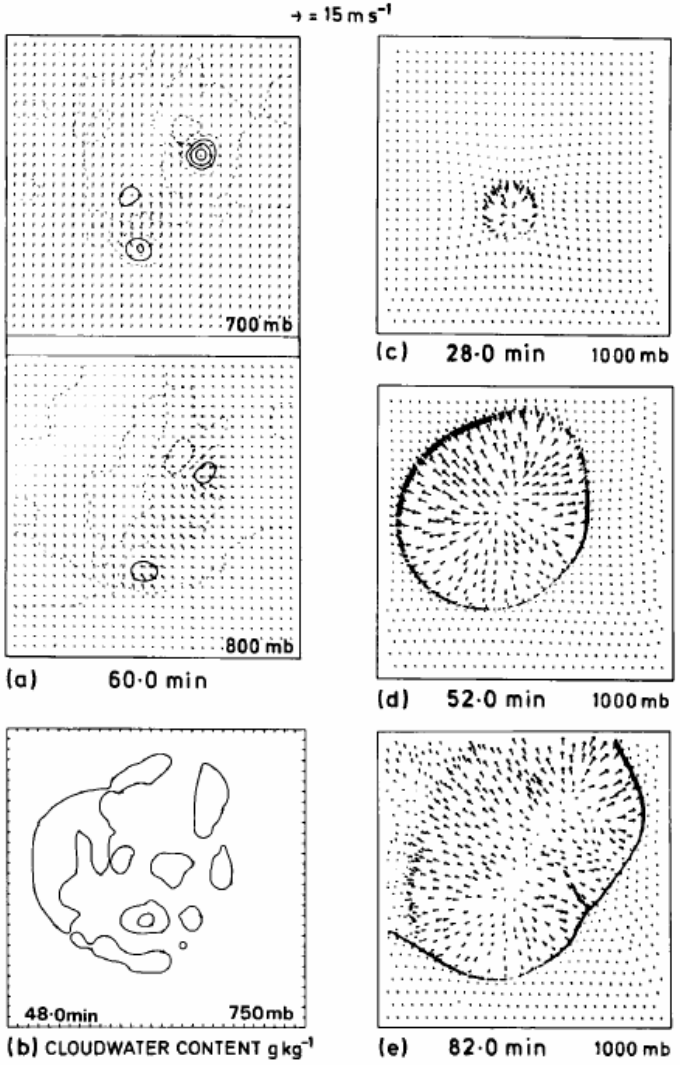


Figure 2. (a) Temperature sounding from Crawley for midday, 14 August 1975. (b) Tephigram and hodograph showing the representative temperature and wind data used as input for the numerical simulation.

- Martin Miller- published in QJRMS (1978)
- Relatively simple numerical 3-D cloud model with crude microphysics
- 1km grid 30X30X10 (9000) points
- Initialised with modified profile from Crawley balloon ascent and a ‘warm bubble’

Miller (...and Grove) 1978

FLOW FIELD ON A PRESSURE SURFACE (except (b))



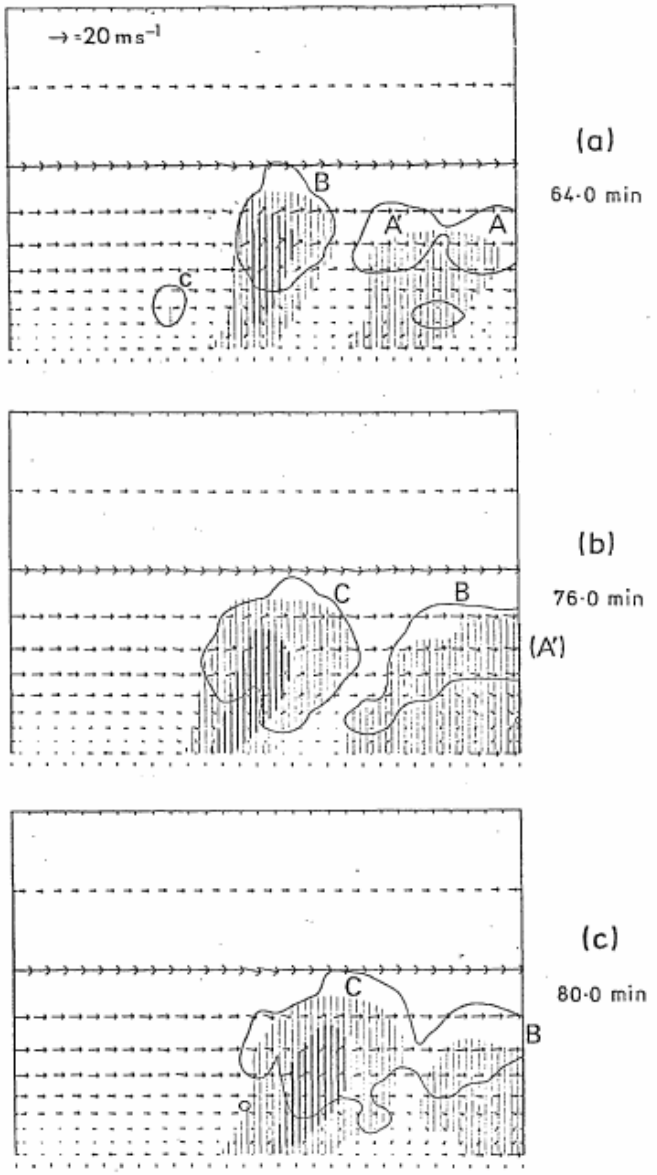


FIG. 5.5
Vertical sections through model, as fig. 5.1.

Miller (...and Grove) 1978

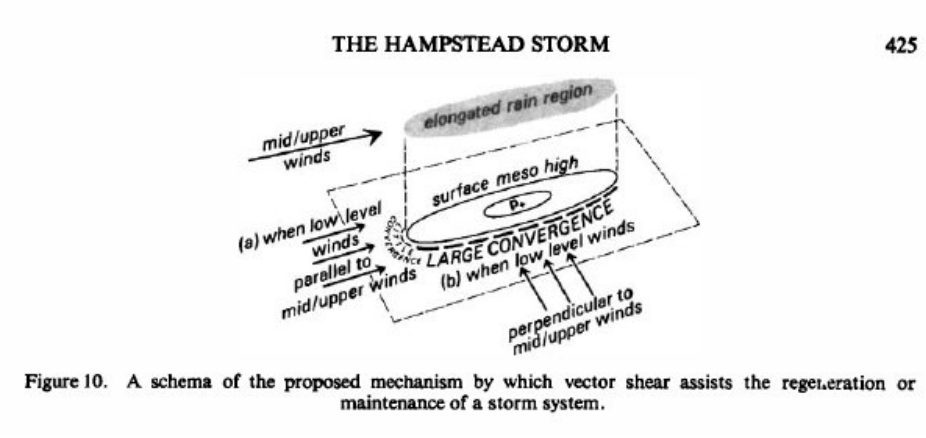
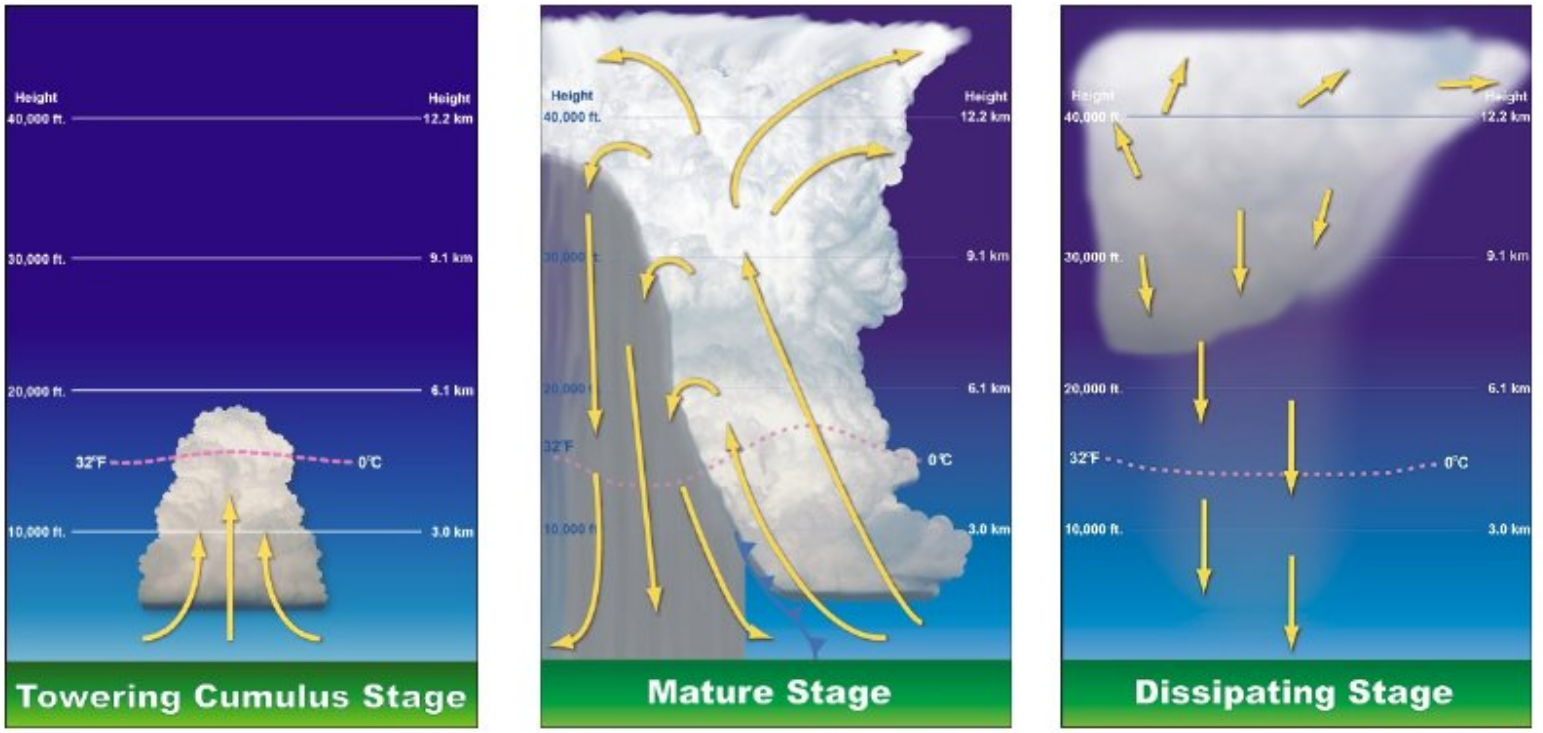


Figure 10. A schema of the proposed mechanism by which vector shear assists the regeneration or maintenance of a storm system.

- Despite simplicity surprisingly successful
- Typical rain rates 25-50 mm/hr
- Grid point rates up to 200 mm/hr (artefact?)
- Inflow from southeast (centre of city)
- Terrain <u>not</u> important in obtaining a severe storm

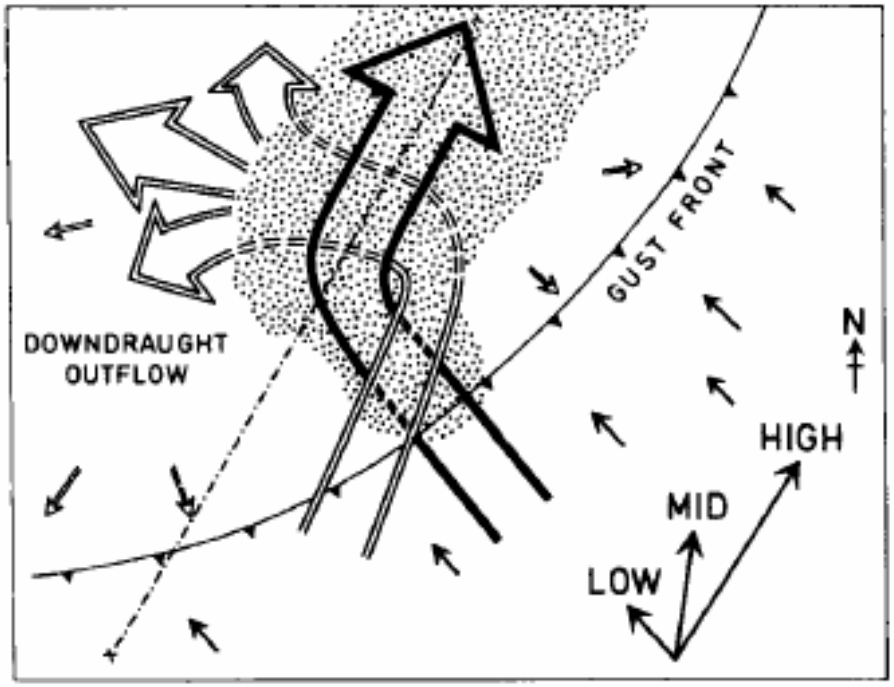
Nature of the Hampstead storm-

Airmass Thunderstorm- low shear



NWS

Nature of the Hampstead storm-



- Increased wind shear displaces downdraught from updraught
- ‘Daughter cells’ form on flank of regenerating storm
- Storm organisation increases longevity and severity
- ‘Cell training’ or ‘back-building’
- Resembles ‘supercell’ conceptual model by Keith Browning early 1960s

Bailey *et al*, Meteorological Magazine (1981)

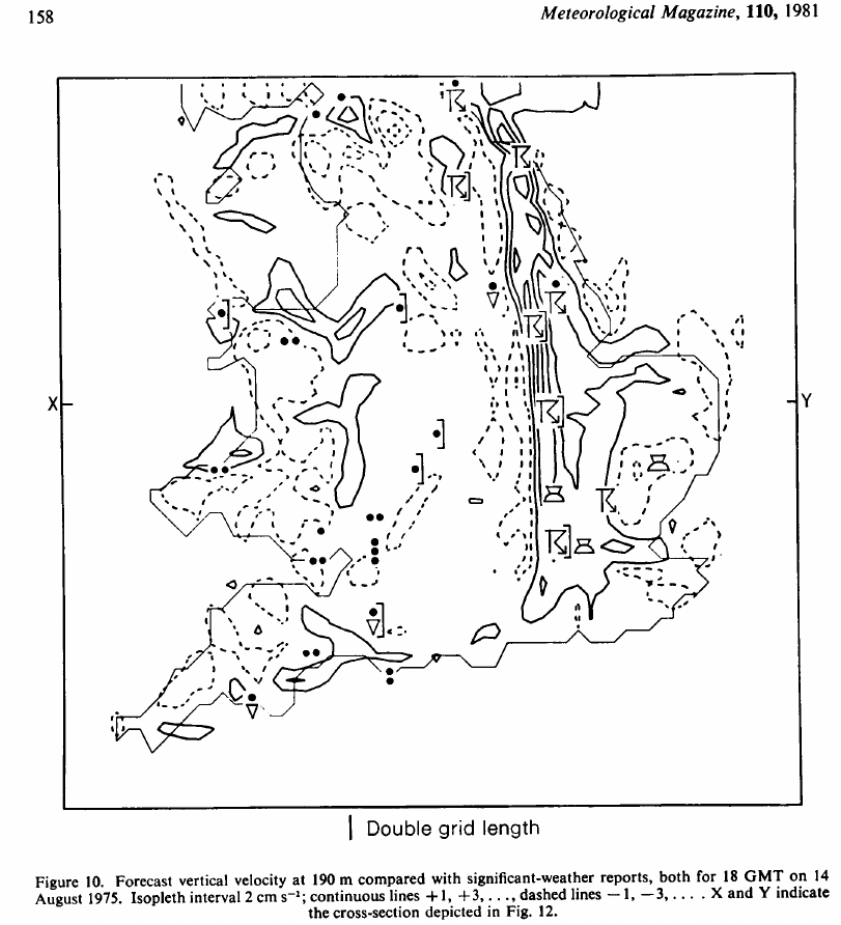


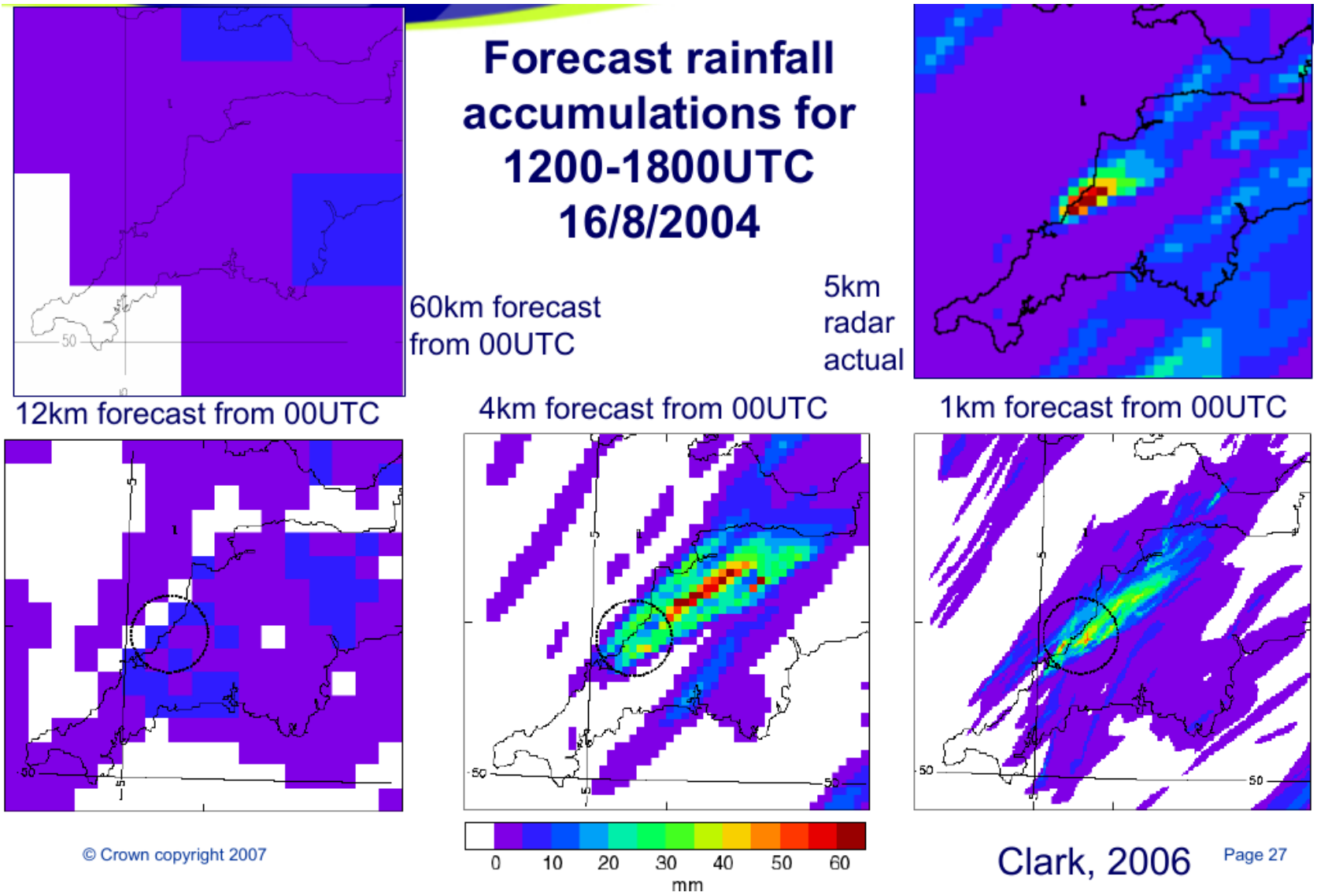
Figure 10. Forecast vertical velocity at 190 m compared with significant-weather reports, both for 18 GMT on 14 August 1975. Isopleth interval 2 cm s^{-2}; continuous lines +1, +3, . . ., dashed lines −1, −3, ... X and Y indicate the cross-section depicted in Fig. 12.

- Early Met Office mesoscale forecast model- 10 km grid 61X62X10- 36,000 points (current UKV ~35 million)
- Predicts thunderstorms but 4 hrs late
- Depiction of cloud cover over England important to forecast
- Rain rates and totals?!
- Hints at things to come...

Advances since 1975- Boscastle Flash Flood, August, 2004

Boscastle- 16 August 2004

Boscastle- reforecasts



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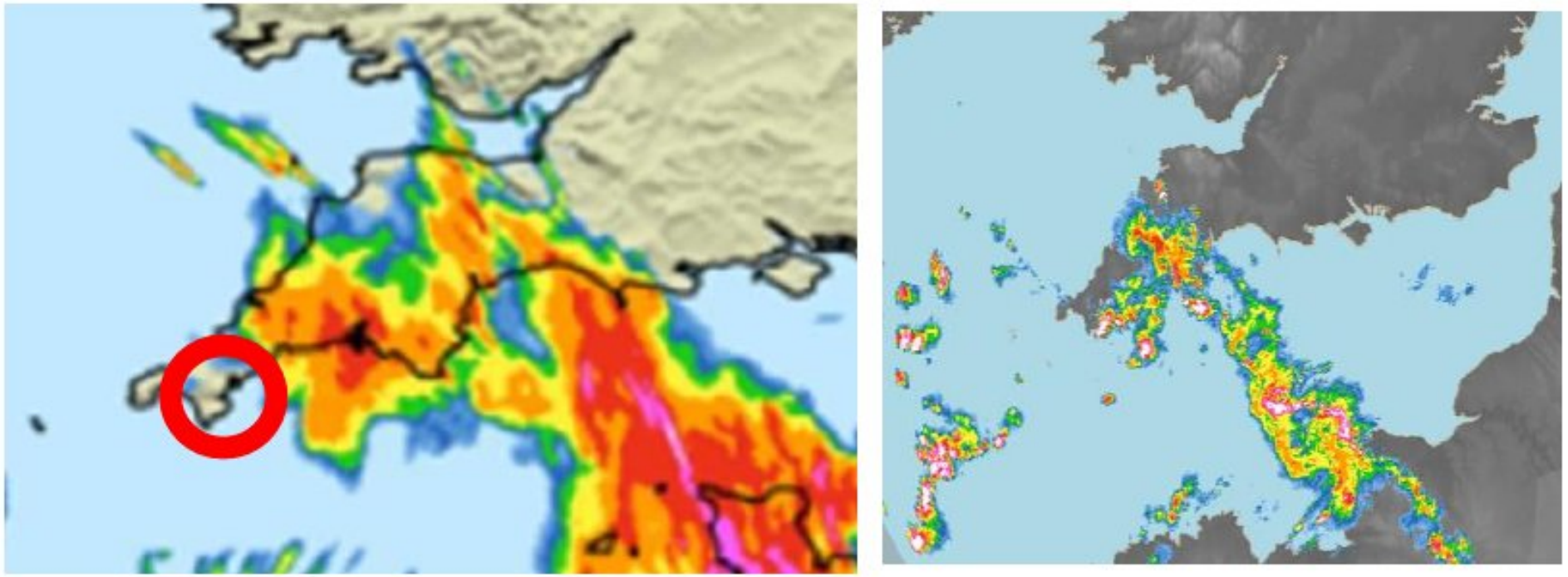
Clark, 2006

Coverack, Cornwall 18 July 2017

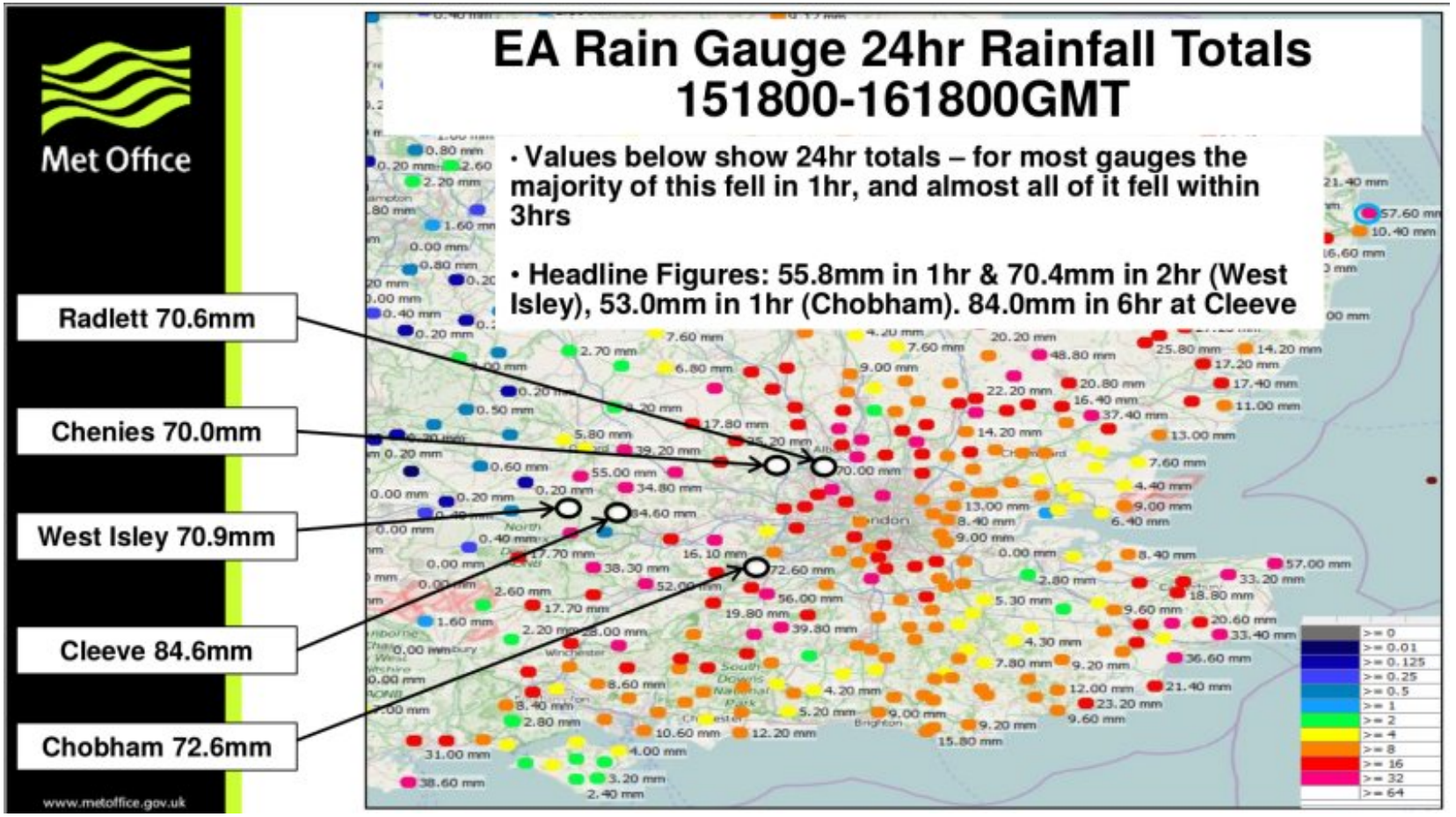
In ~1 hour- 105 mm at gauge 3km away, 200+mm radar estimate (contaminated by hail?), ~170mm from bucket estimate, 30 mm hail.

Coverack- Met Office forecast model



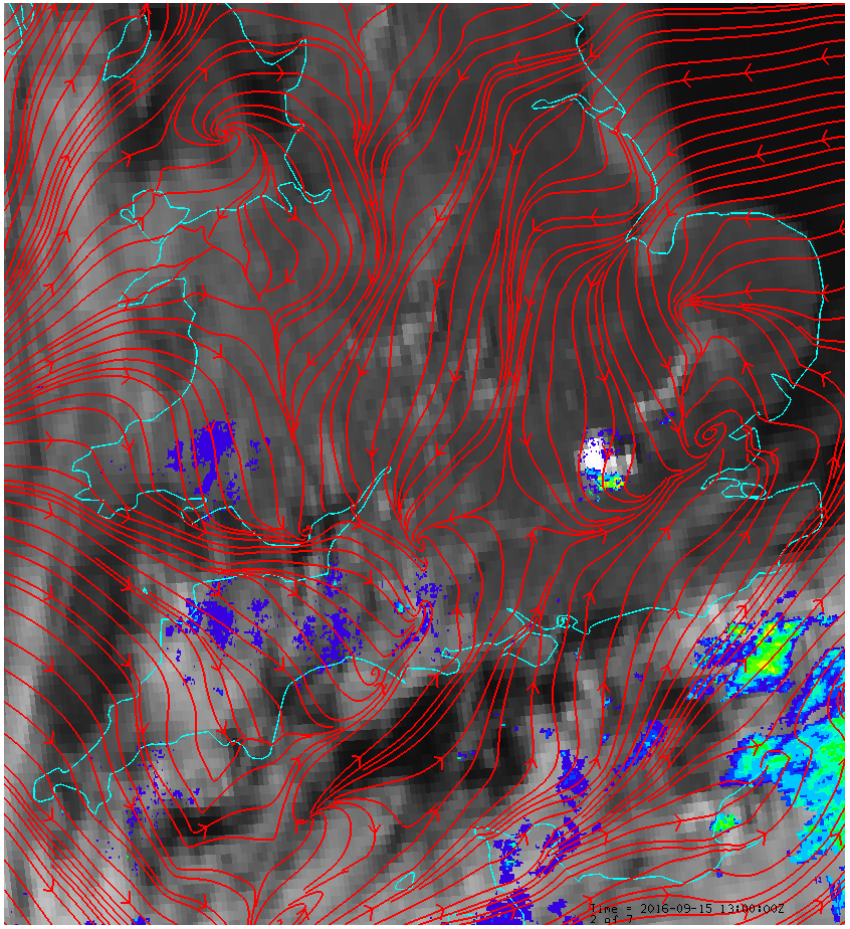
Left: UKV 1.5km model forecast. Right: radar image

15 September 2016- back-building thunderstorms in NW London



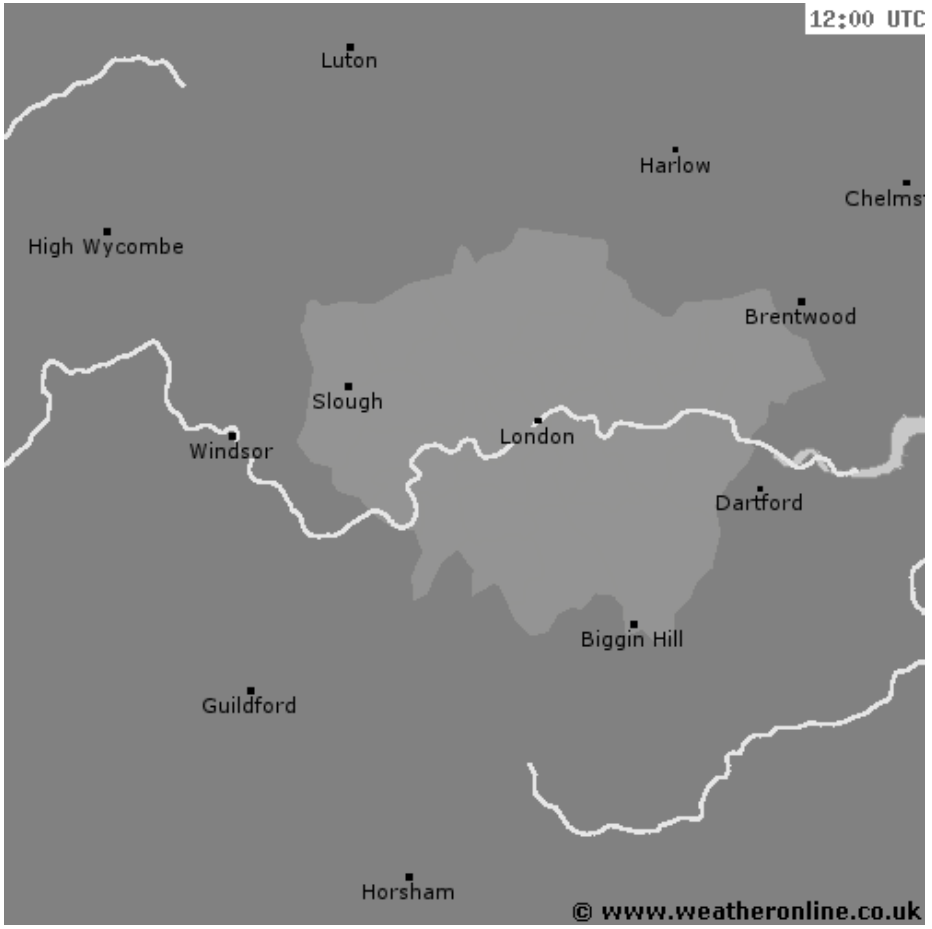
Extensive surface water flooding and transport disruption NW London

15 September 2016

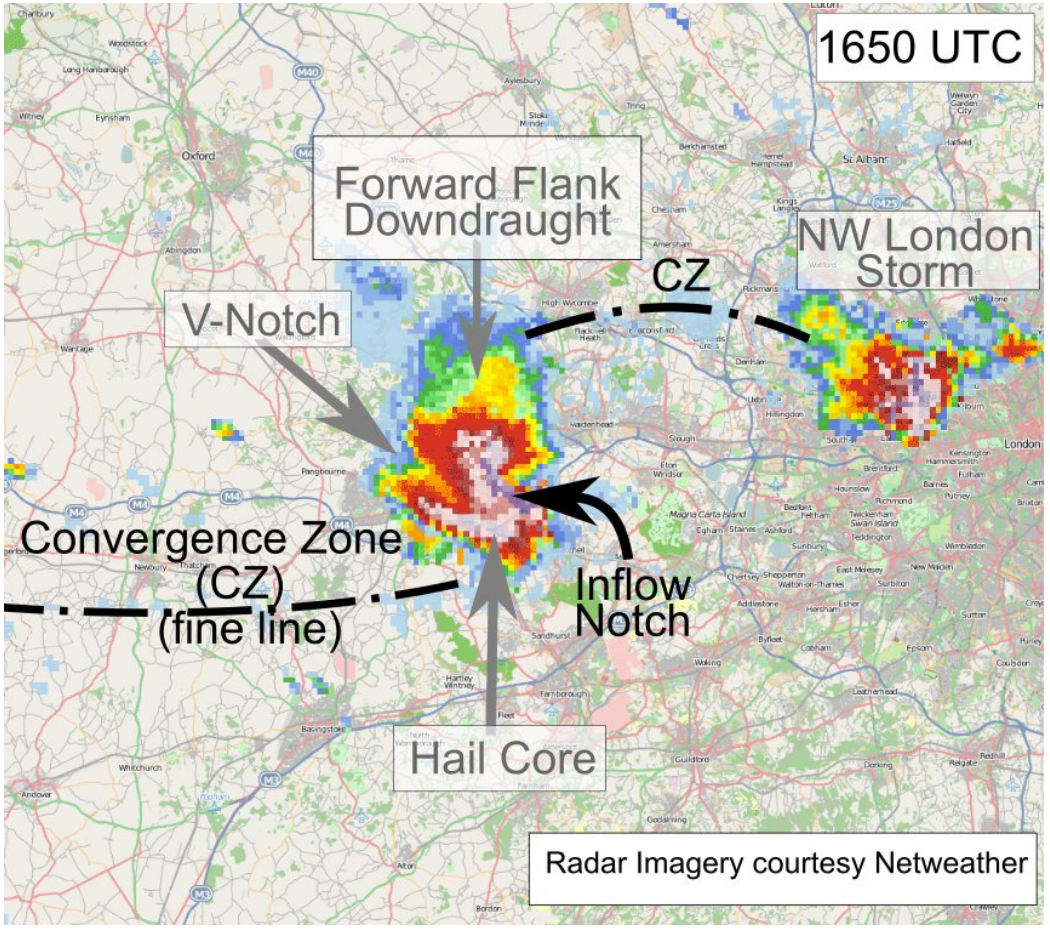


Analysed surface airflow, satellite image, radar 15 UTC

15 September 2016- radar loop



15 September 2016



Organised thunderstorm (‘supercell’) in Reading area produced 2-3 cm hail.

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Summary

- ‘Hampstead Storm’ a paradigm event for quasi-stationary thunderstorm flash flooding in UK
- Questions:
- Predictability?
- Frequency?
- Role of local orography and urban fabric in London conurbation?
- Is current infrastructure up to the job of coping with these sorts of events now and in the future?

John Constable, Hampstead after a Thunder Storm, ~1830.
Yale Center for British Art, Paul Mellon Collection