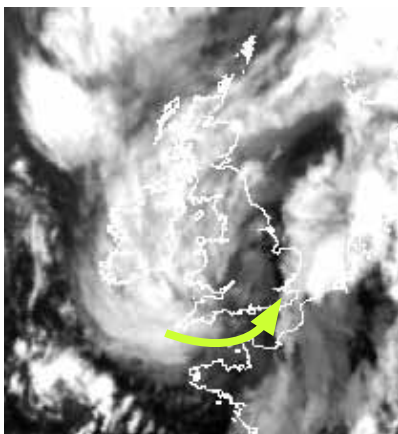


The Sting Jet

Forecasting the damaging winds in European Cyclones

The 'Great Storm' of 1987

The famous 'Great Storm' cut a swathe of damage across South-east England in the early hours of the 16th October 1987. It was a good example of a storm with a 'Sting Jet'.



The satellite image above shows the pattern of the cloud just before the strongest winds hit the south coast of Kent and Sussex near the 'tail' of the hook-shaped cloud wrapping round the cyclone.

The green arrow shows the approximate path of the Sting Jet.

What is the Sting Jet?

Low pressure areas:

- Have well understood causes.
- Sometimes produce very strong winds
- Are generally well represented by our weather forecast models.

Experience has shown that:

- The most damaging winds occur in a very small region, perhaps only 50 km across.
- This is close to the 'tail' of the 'head' of cloud that wraps around the low pressure centre.
- Hence the 'sting in the tail' of the cyclone.

We now know that:

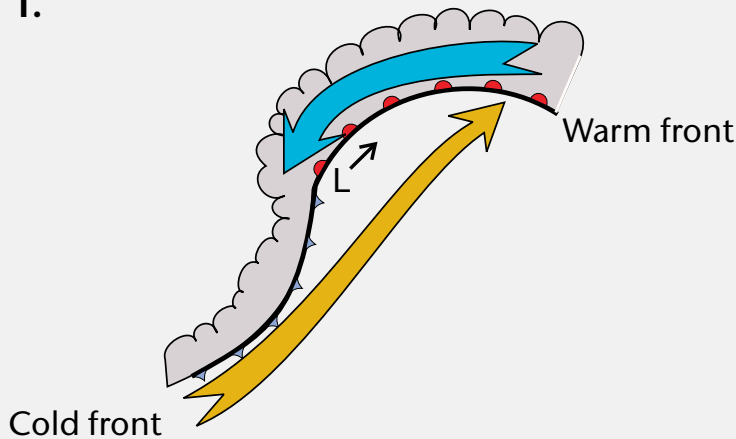
- The 'sting in the tail' is produced by a distinct jet of air- the 'Sting Jet'.
- It starts out 3 or 4 kilometres above the ground and descends over 3 or 4 hours.
- Snow and rain falling into it evaporate and cool it as it descends, helping to accelerate it to high speeds.
- It can accelerate to more than 100 mph

The Sting Jet:

What we see at the ground

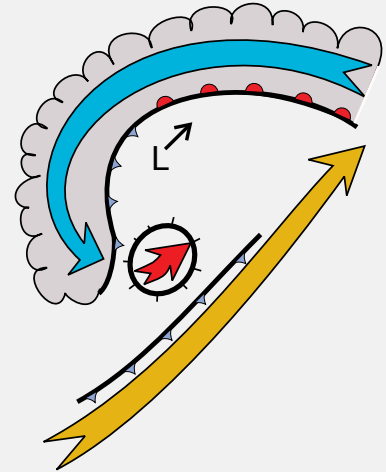
There are four stages in the life of a damaging mid-latitude cyclone:

1.



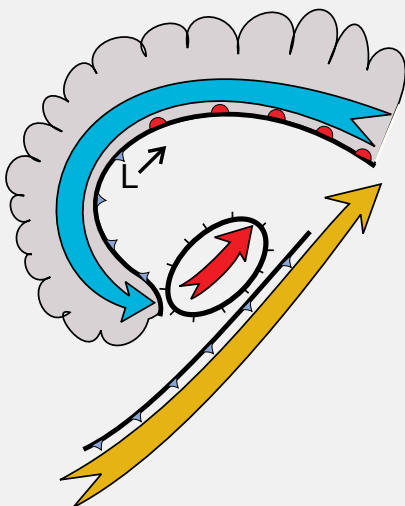
As the pressure starts to drop, two narrow jets of air form near the surface, one cold (blue) the other warm (orange). The low pressure centre (L) is usually moving with the warm jet, so the warm jet produces stronger winds.

2.



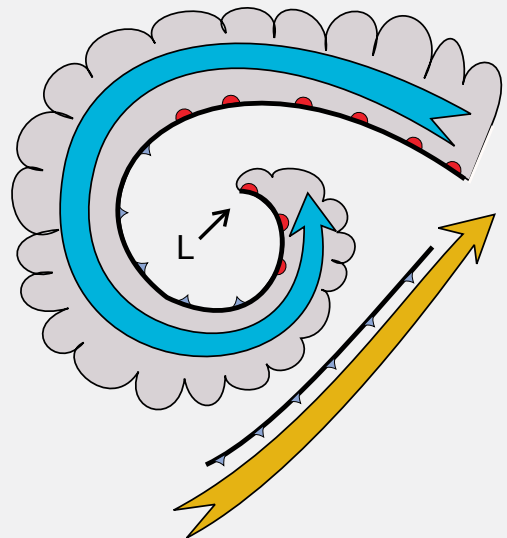
The weather front 'fractures', shortly afterwards the Sting Jet reaches the ground near the break (red). The most damaging winds occur here.

3.



The Sting Jet region enlarges over a few hours.

4.

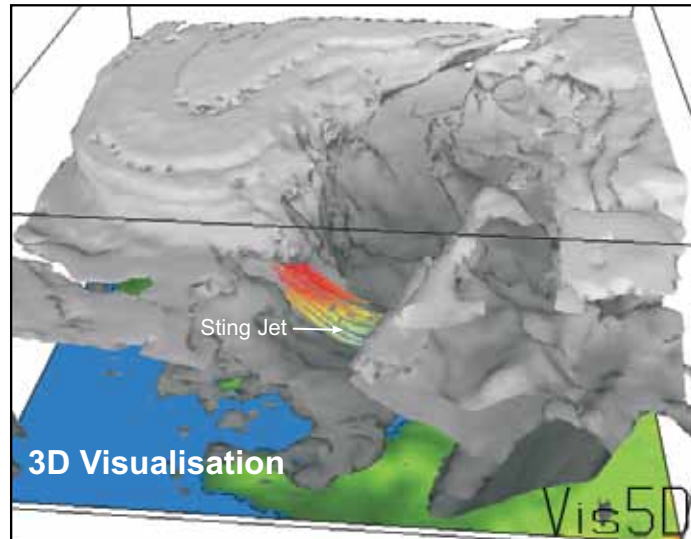


The cold jet eventually wraps round the low centre and catches up with the Sting Jet. Strong winds may still occur, but the most damaging are over.

Modelling the Sting Jet

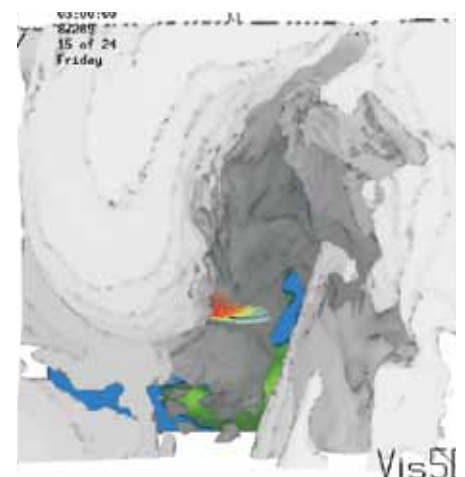
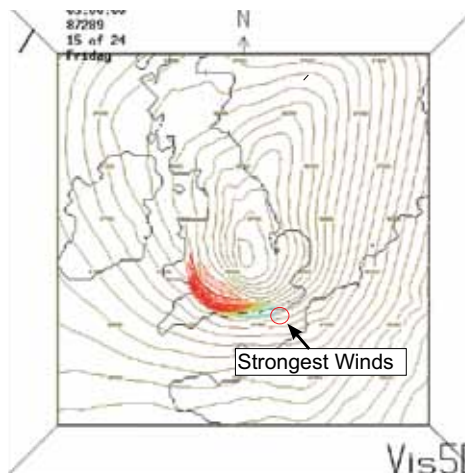
What we see at the ground

These results are from a simulation of the 16 October 1987 'Great Storm' using a version of the Met Office's forecast model (as at Autumn 2002). It was started using a re-analysis of the atmospheric state at 12 UTC 15 October 1987 by the European Centre for Medium Range Weather Forecasting (ECMWF).



The modelled sea level pressure pattern (left) and a 3D representation of the model cloud (right) corresponding. The cloud is shaded according to the height above the surface - lighter gray is higher up.

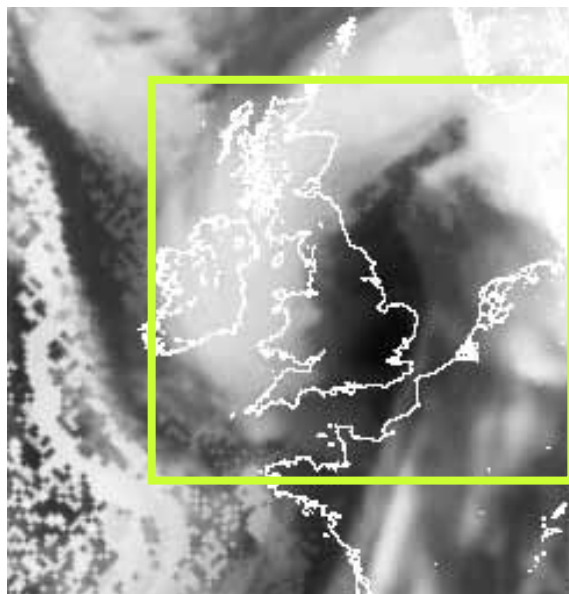
The coloured streaks show the track of air in the Sting Jet leading to the strongest surface winds for 4 hours back from the time shown. The tracks are coloured by altitude - red is about 4 km above the surface, yellow 3 km, green 2 km, blue 1 km. Strong surface winds are shown circled in red (left).



Simulated image from Met Office Unified Model 15 hour forecast from 12UTC 15 October 1987.

If we simulate what a satellite would see of our model results and compare with a satellite image we find a remarkably similar pattern in the cyclone cloud. However, it is not perfect; in particular the model cloud is not so 'hooked', suggesting that the real cyclone may have been more intense.

The green box shows the area on the 3D pictures (above).



Why do we need to understand the Sting Jet?

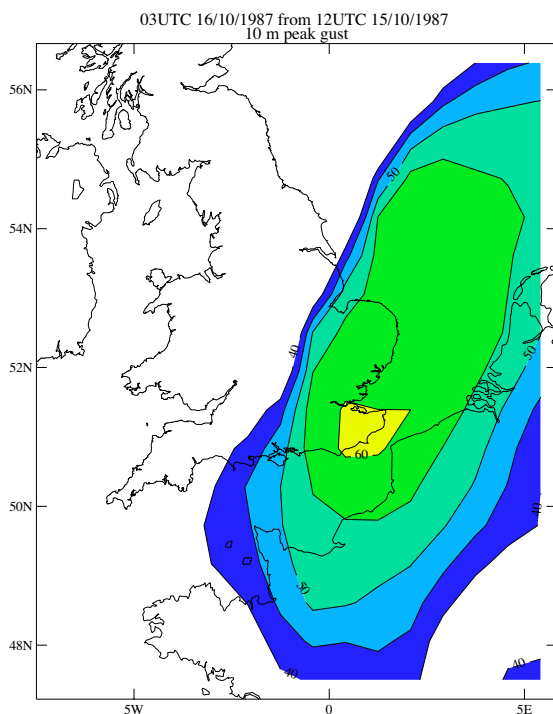
We need to understand why the Sting Jet forms to make sure our model can represent it well.

We now know that we need:

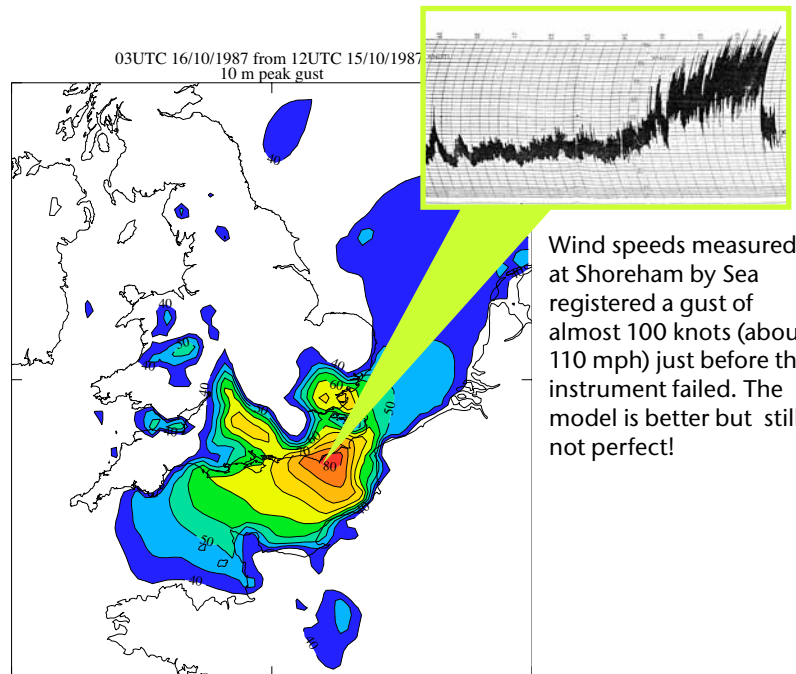
- 1) To capture the width of the Sting Jet (about 50 km)
- 2) To capture the depth of the Sting Jet (about 1 km)
- 3) To capture the evaporation of snow (as it falls about 500 m).
- 4) To capture the interaction of the Sting Jet with the air flowing near the surface.

Our current global forecast model has a horizontal gridlength of about 60 km over the UK and has 38 levels going up to nearly 40 km. It does a good job of warning of strong winds, but predicts peak gusts of only about 60 knots (70 mph) (right). It predicts no Sting Jet.

A version of the model run over a region of about 3000 km x 3000 km and with 90 levels produces a Sting Jet and does a much better job, predicting gusts above 80 knots (95 mph).



Predicted wind gusts at 03 UTC 16th October 1987 during the 'Great Storm' using a model with 60 km resolution, 38 levels. The model predicts a large area of strong winds peaking at more than 60 knots (about 70 mph) in a region just crossing the south coast.



Predicted peak wind gusts at 03 UTC 16th October 1987 during the 'Great Storm' using a model with 12 km resolution and 90 levels. The model predicts more than 80 knots (about 95 mph) in a region just crossing the south coast.

For more information please read our historical fact sheets
www.metoffice.gov.uk/learning/library/publications/historical-facts

Acknowledgement: This work was performed in collaboration with Prof. Keith Browning at the Joint Centre for Mesoscale Meteorology, University of Reading

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