Department of Meteorology

University of Reading

# Investigating the strong surface winds in storm Eunice, Feb '22

a.k.a. Zeynep (Germany) and Nora (Denmark)

Weather RMetS

Original Article | Open Access

Strong surface winds in Storm *Eunice*. Part 1: storm overview and indications of sting jet activity from observations and model data

Ambrogio Volonté, Suzanne L. Gray, Peter A. Clark, Oscar Martínez-Alvarado, Duncan Ackerley

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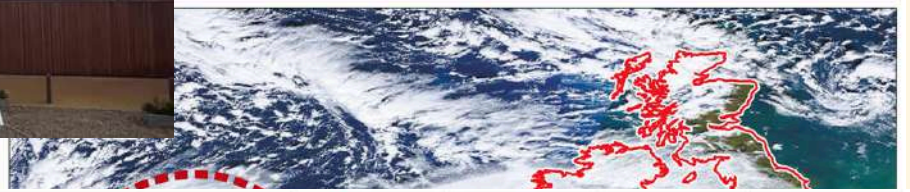


FRIDAY
18 FEBRUARY 2022
Number 3,559

HEALTH

*Women get HIV. So why don't more take PrEP?*

P36

# sting jet storm

» Work from home and avoid travel if possible, people urged, as Storm Eunice hits B
» 'Once in a decade' weather event has same harmful 'sting jet' winds as 1987 Great S
» Threat to life and damage to homes expected, with havoc for road, rail and air tra
» People posing for selfies are ordered to stay away from seafronts, flood defences activated for rivers and coastline, and Army is placed on standby for emergency re
» Red alert weather warning is the highest level, leading to school and bridge closu


WORLD
***The Taliban has locked up my friend***
*John Simpson*

P29

POLITICS
***Post Office scandal shows we need leaders who understand tech***
*Stephen Bush*

P21

SOCIETY
***Have we reached peak culture wars?***
*Ayesha Hazarika*

FORGET WORDLE. HAVE YOU TRIED WORLDLE? P17 | GB MEDAL DROUGHT ENDS! GUARANTEED SILVER OR G
HEALTH – WALK FOR 15 MINUTES TO BOOST YOUR MEMORY IN MIDDLE AGE P11 | WHAT ENERGY DRINKS DO TO TEENAG

**Red warning**
**Wind**

10:00 Today — UTC — 15:00 Today

Storm Eunice causing significant disruption and dangerous conditions due to extremely strong winds on Friday

## What to expect

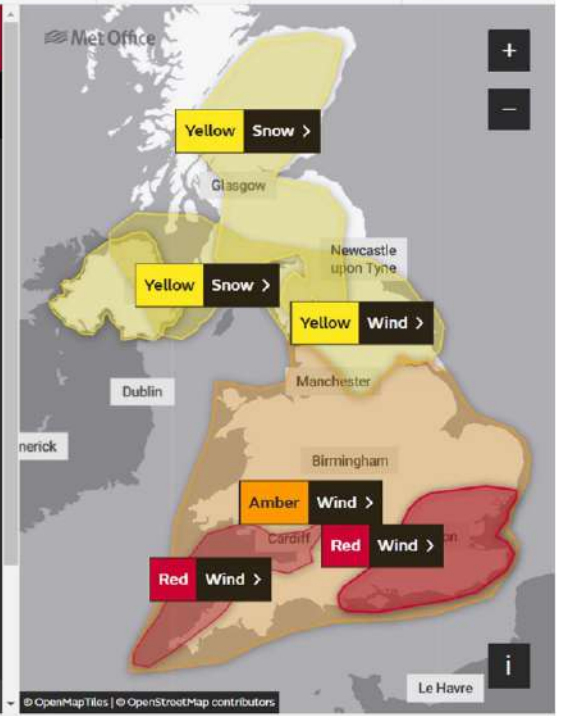
- Flying debris resulting in danger to life
- Damage to buildings and homes, with roofs blown off and power lines brought down
- Roads, bridges and railway lines closed, with delays and cancellations to bus, train, ferry services and flights
- Power cuts affecting other services, such as mobile phone coverage
- Large waves and beach material being thrown onto coastal roads, sea fronts and homes

## What should I do?

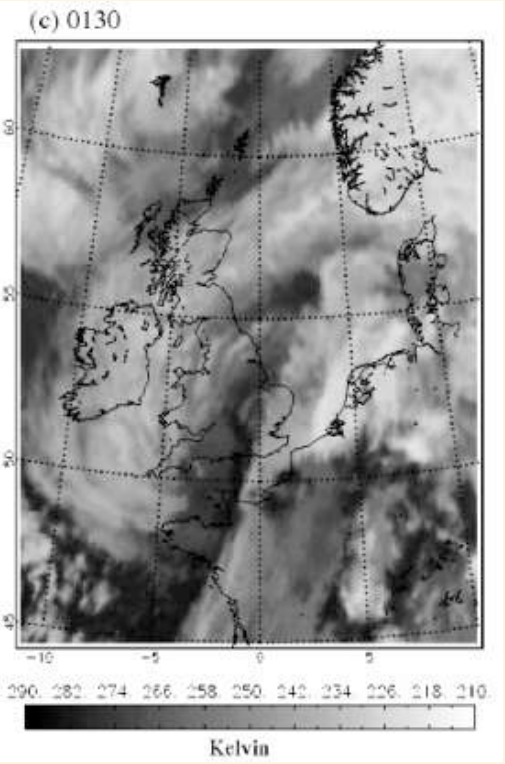
Travelling in storms, rain and strong wind >

Stay safe in a storm >

Further details >



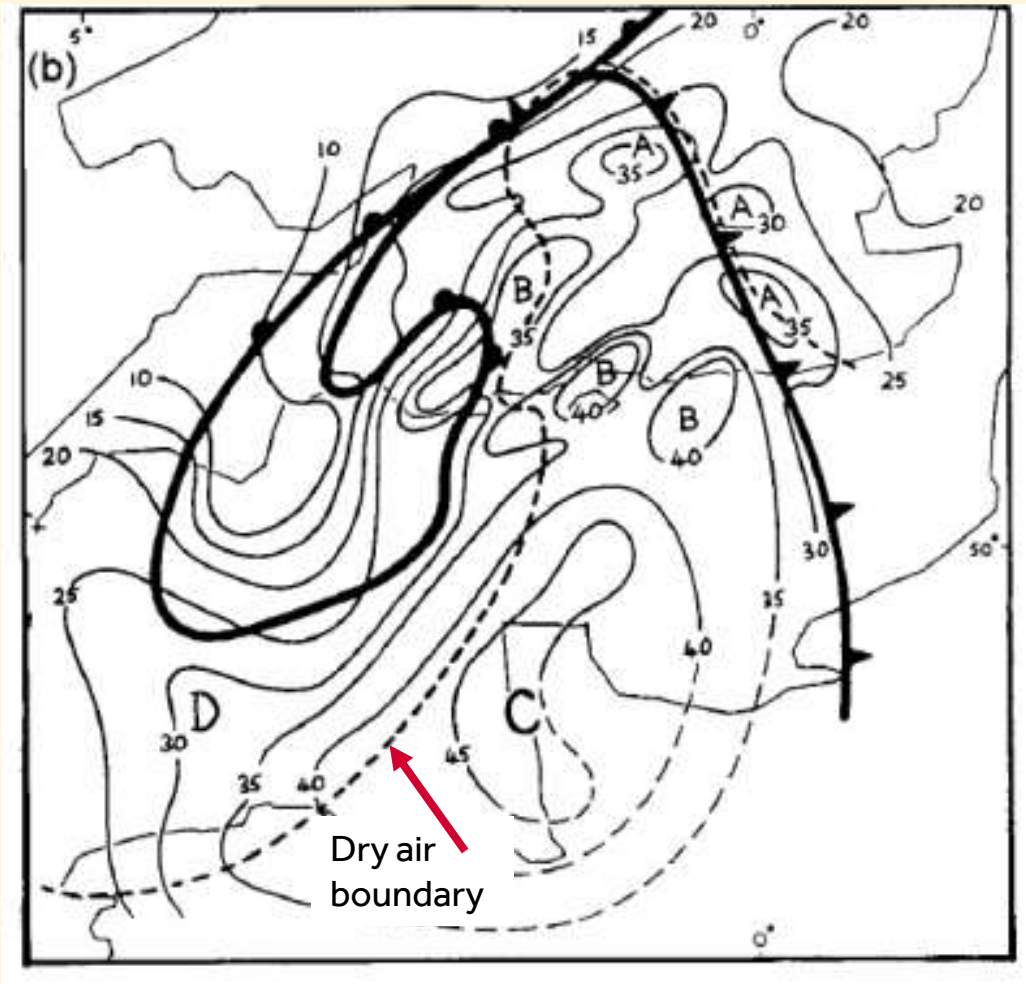
# Causes of damaging cyclone winds




UK 1987 Great October storm

- A: cumulonimbus clouds just ahead of the cold front
- B: Shallow non-precipitating cloud in the dry slot
- C: Sting jet
- D: Cold conveyor belt

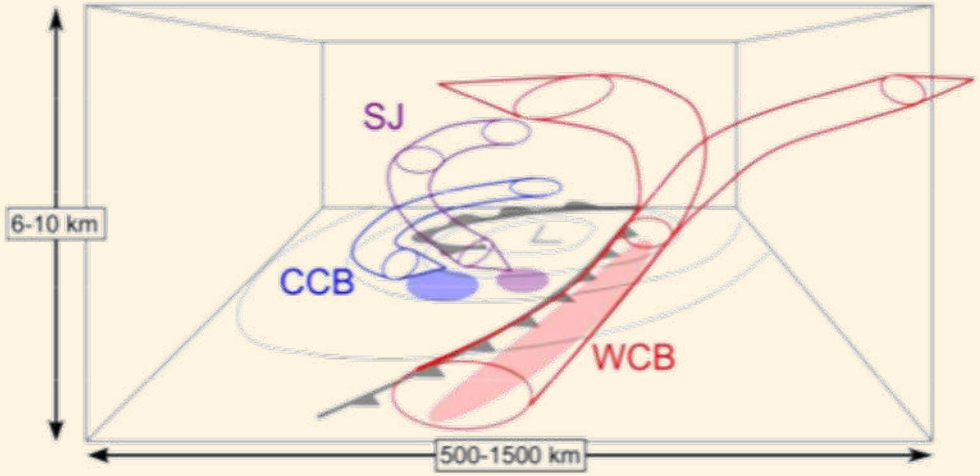
Mesoanalysis of peak surface wind gusts (m/s)




Browning (2004) QJRMS

# Causes of damaging cyclone winds

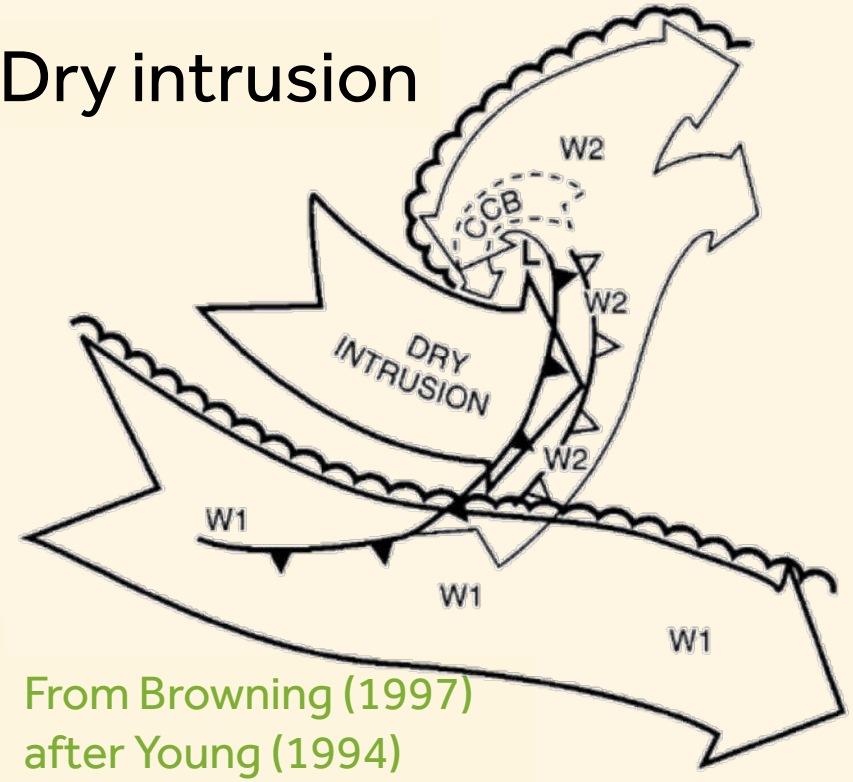
## Sting jet




Transient (few hours), mesoscale (~50km spread) jets of air descending from the tip of the hooked cloud head in the frontal fracture regions of some extratropical storms (see definition in Clark and Gray, 2018).

Cloud head banding suggests mesoscale instabilities such as conditional symmetric instability (CSI) are being released. Studies have provided evidence also of CI, SI and II presence

## Dry intrusion




From Browning (1997) after Young (1994)

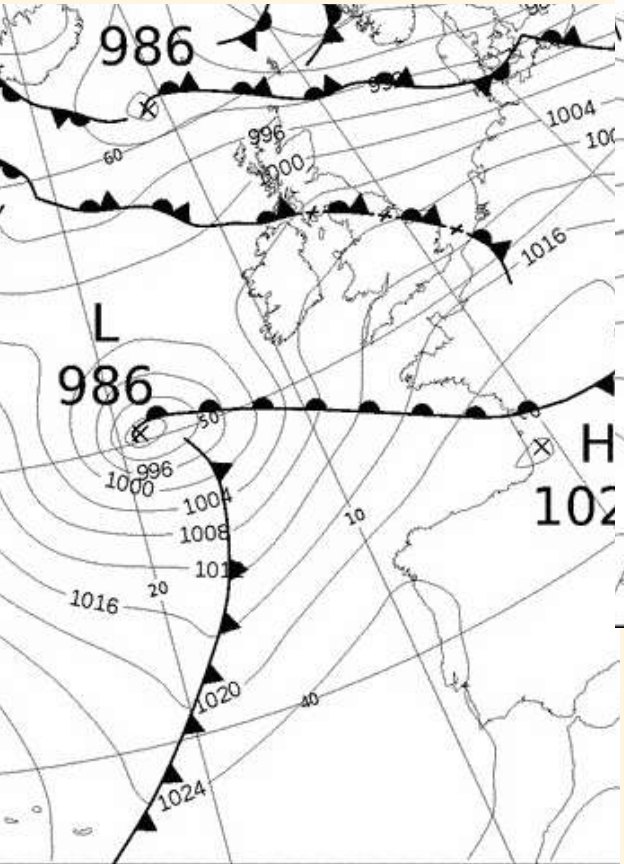
"Significant destabilization of the lower levels occurs beneath DIs, accompanied by increased 10-m wind gusts, intense surface heat and moisture fluxes, and elevated PBL heights"

Raveh-Rubin (2017)

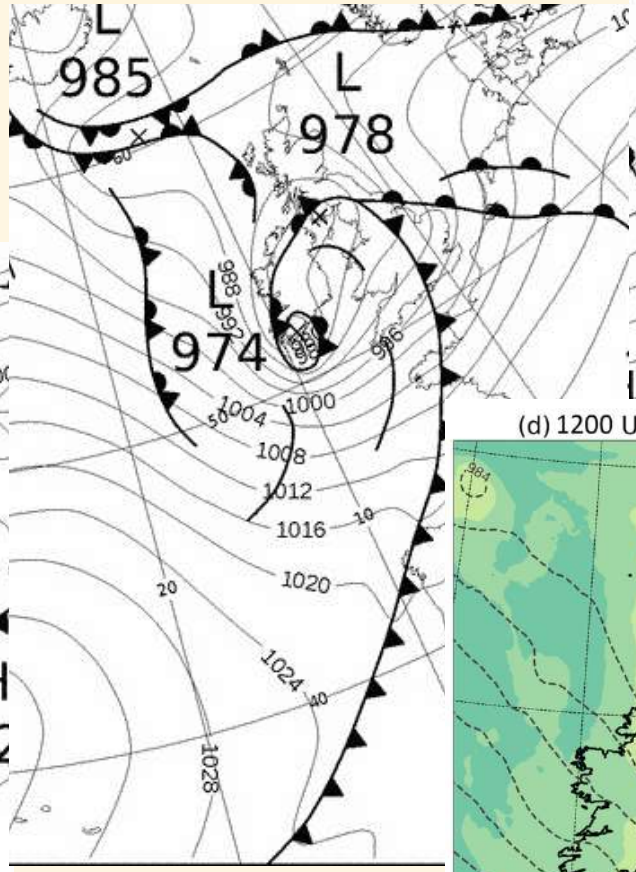
# Eunice synoptic overview:

12 UTC 17th 1002 hPa
00 UTC 18th 975 hPa
27 hPa in 12 hrs.

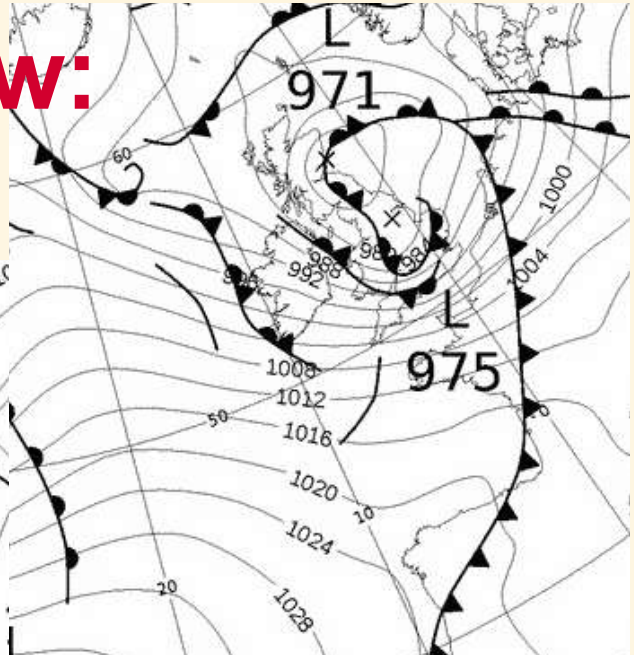
18 UTC 17 Feb. 2022

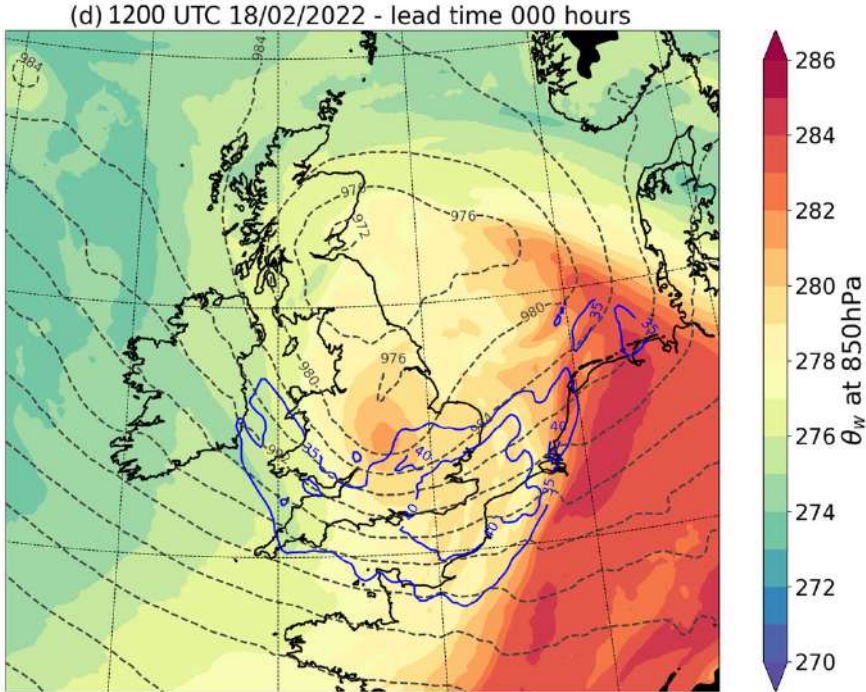



06 UTC




12 UTC

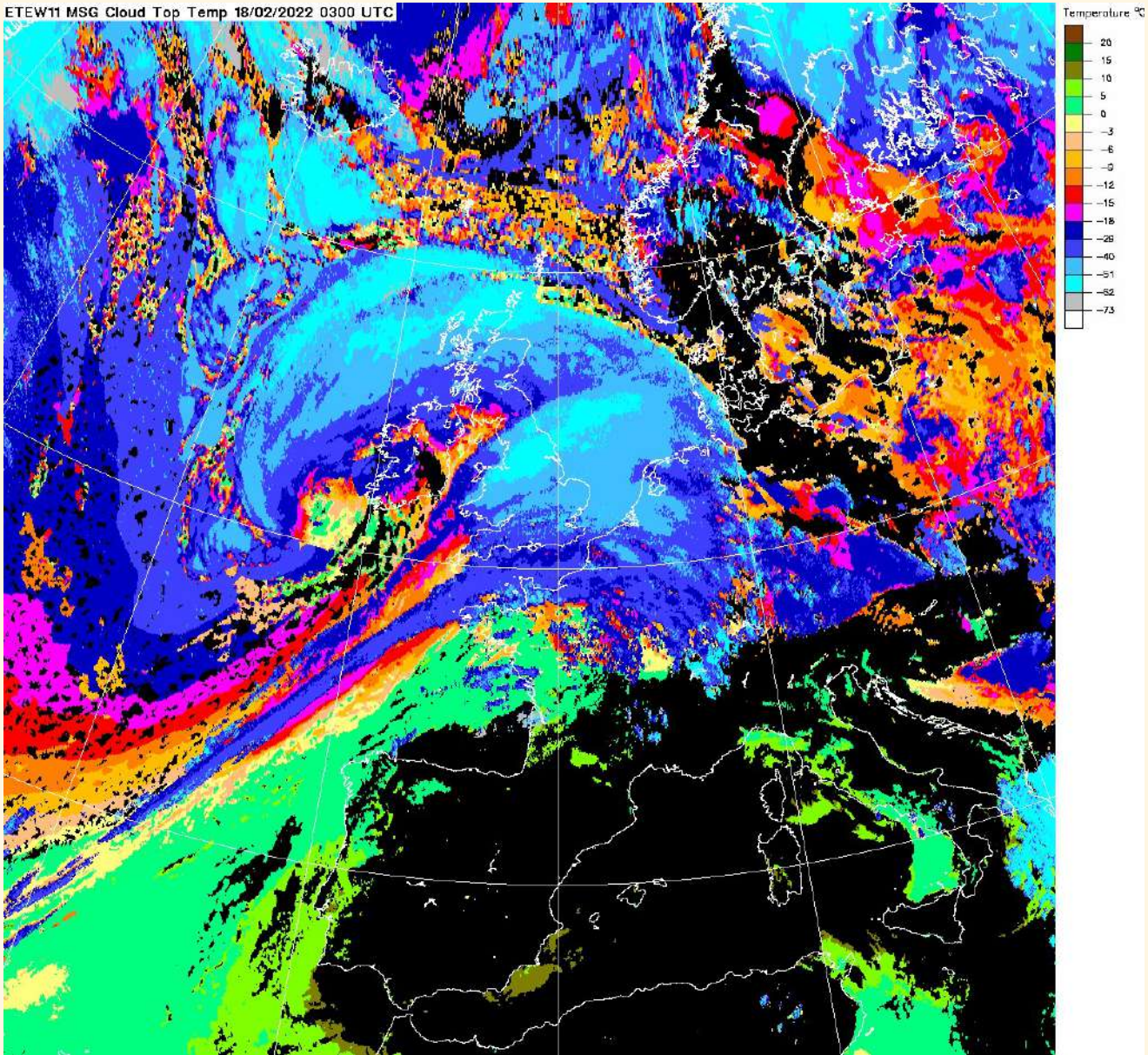


# Mesoscale instability release

MSG cloud top temperature

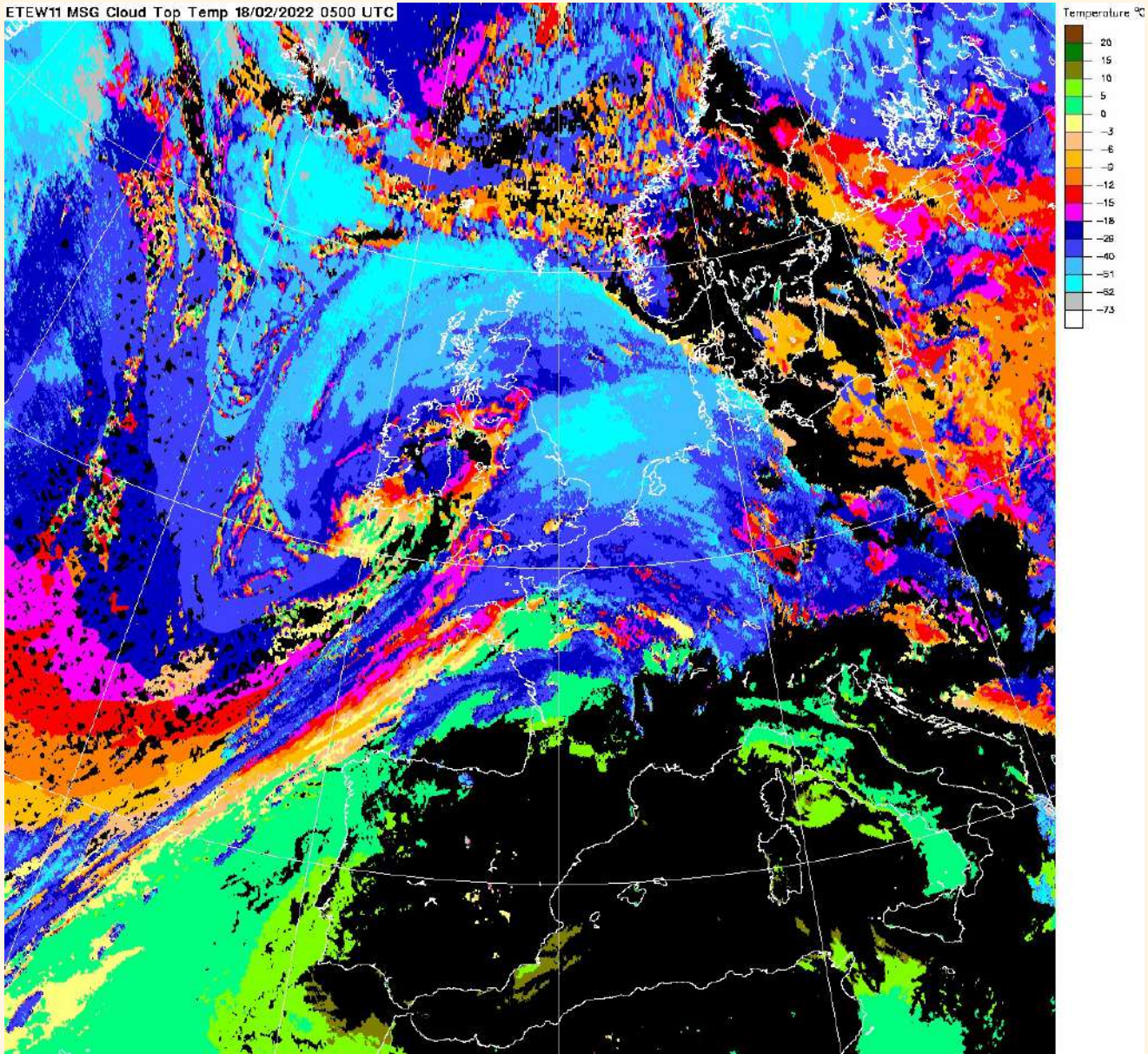
**0300 UTC**



# Mesoscale instability release

MSG cloud top temperature

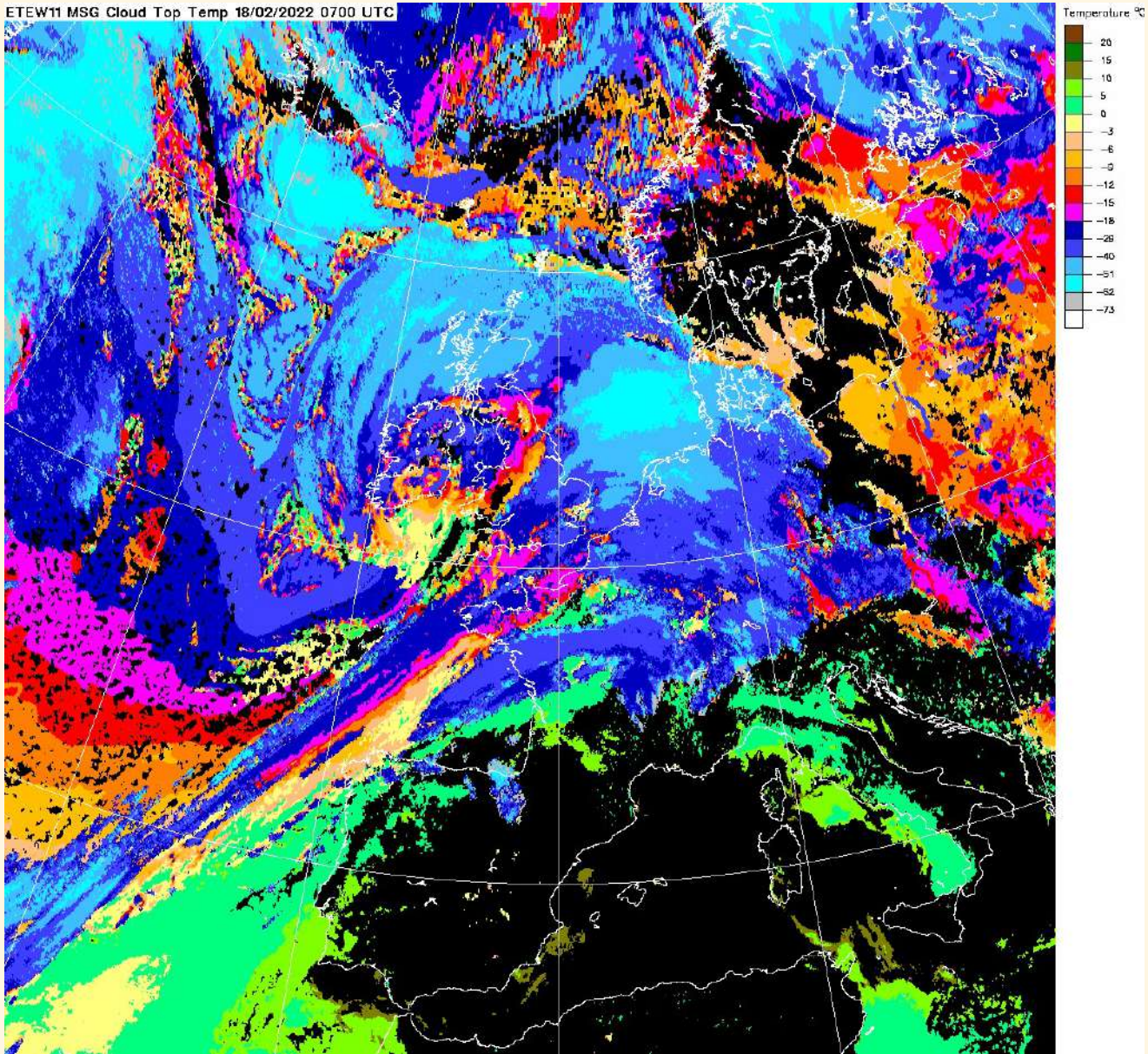
**0500 UTC**



# Mesoscale instability release

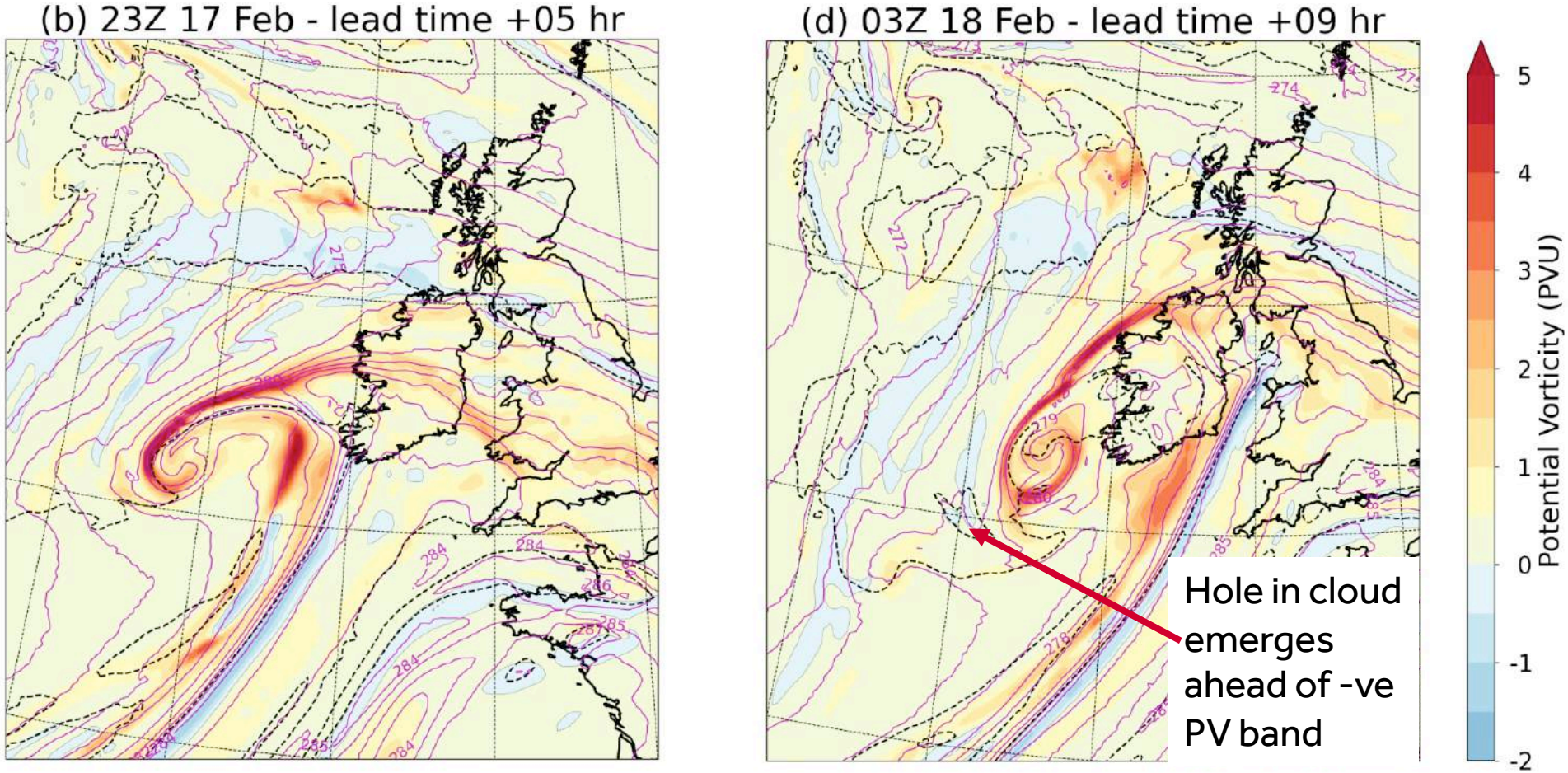
MSG cloud top temperature

**0700 UTC**



# Mesoscale instability release: SI

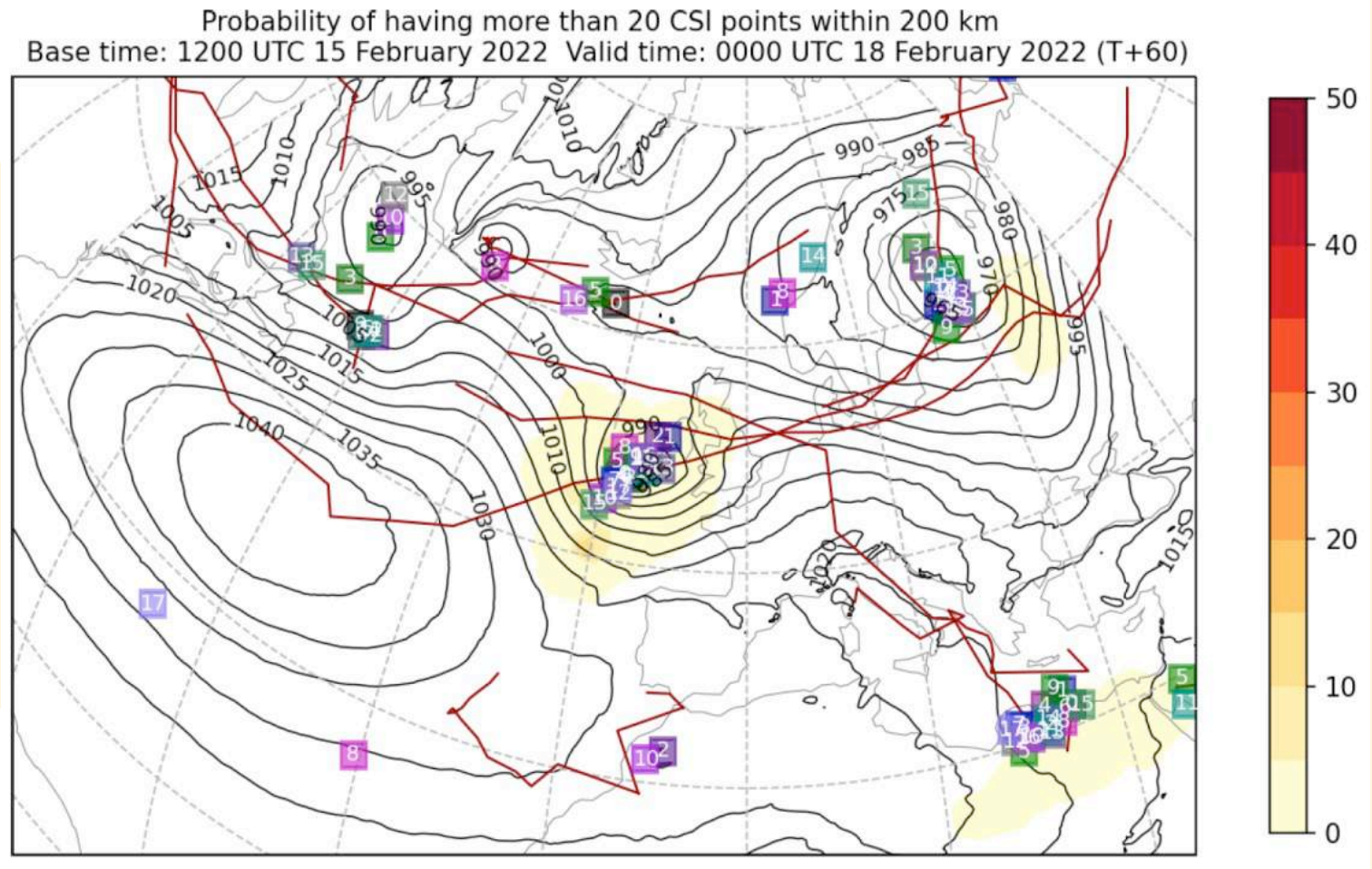
Negative PV bands track along the bent-back front towards the cloud head tip. Implies presence of (dry) symmetric instability




Colours show PV, red contours are $\theta_w$, dashed line indicates cloud (all at 700 hPa)

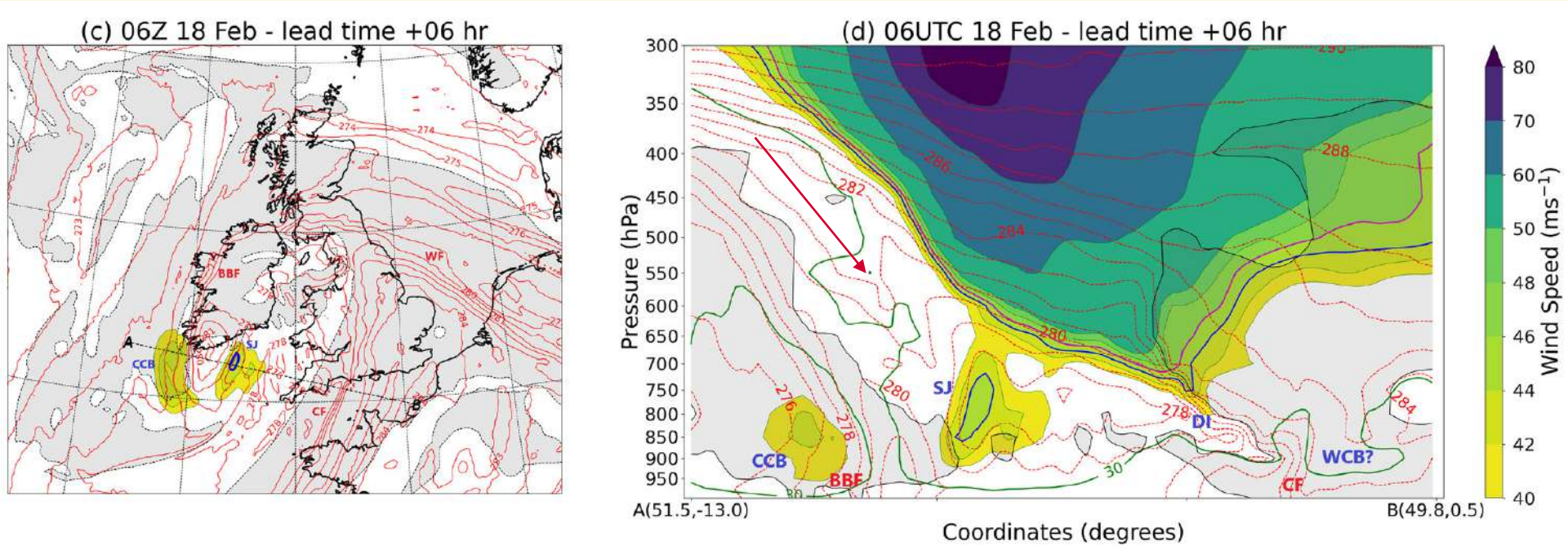
# Mesoscale instability release: CSI

Conditional symmetric instability (CSI) points are defined where DSCAPE exceeds a threshold in moist cloud head



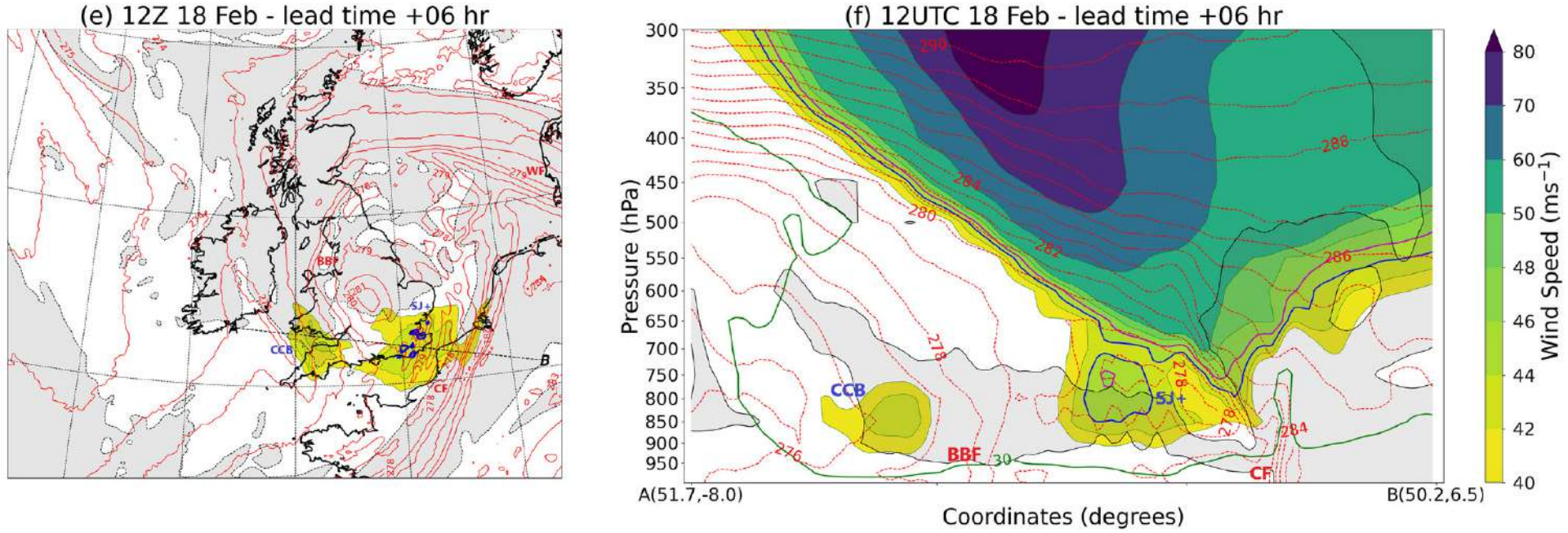

Sting jet precursor diagnostic applied to Met Office global ensemble.
60h forecast. Numbers in squares are ensemble # of cyclone centres; MSLP and tracks are from the control forecast.

# Low-level wind field evolution




Colours show horizontal wind speed (left) at 850 hPa and (right) along A-B vertical section. Red contours are $\theta_w$, gray shading is cloud.

# Low-level wind field evolution




Colours show horizontal wind speed (left) at 850 hPa and (right) along A-B vertical section. Red contours are $\theta_w$, gray shading is cloud.

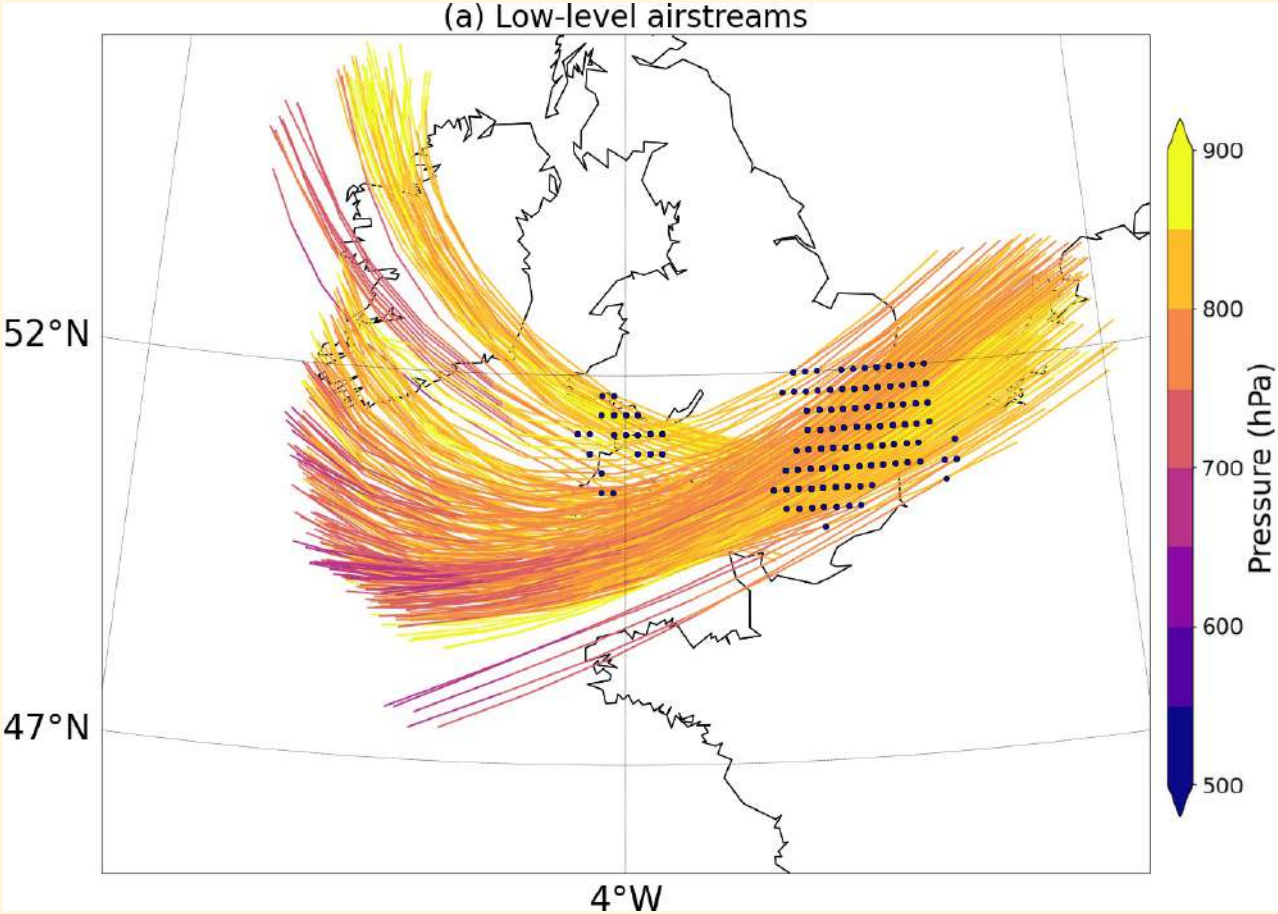
# Origins of low-level wind jets

Lagrangian trajectories calculated with LAGRANTO (Sprenger and Wernli, 2015)

Forecast start time 06 UTC 18th
Trajectories start time 12 UTC 6 hrs backwards and 2 hours forwards

Windspeed > 42 $ms^{-1}$ between 950 and **800 hPa** at start points (black dots)
Colours are pressure along trajectories

**Criteria:** none



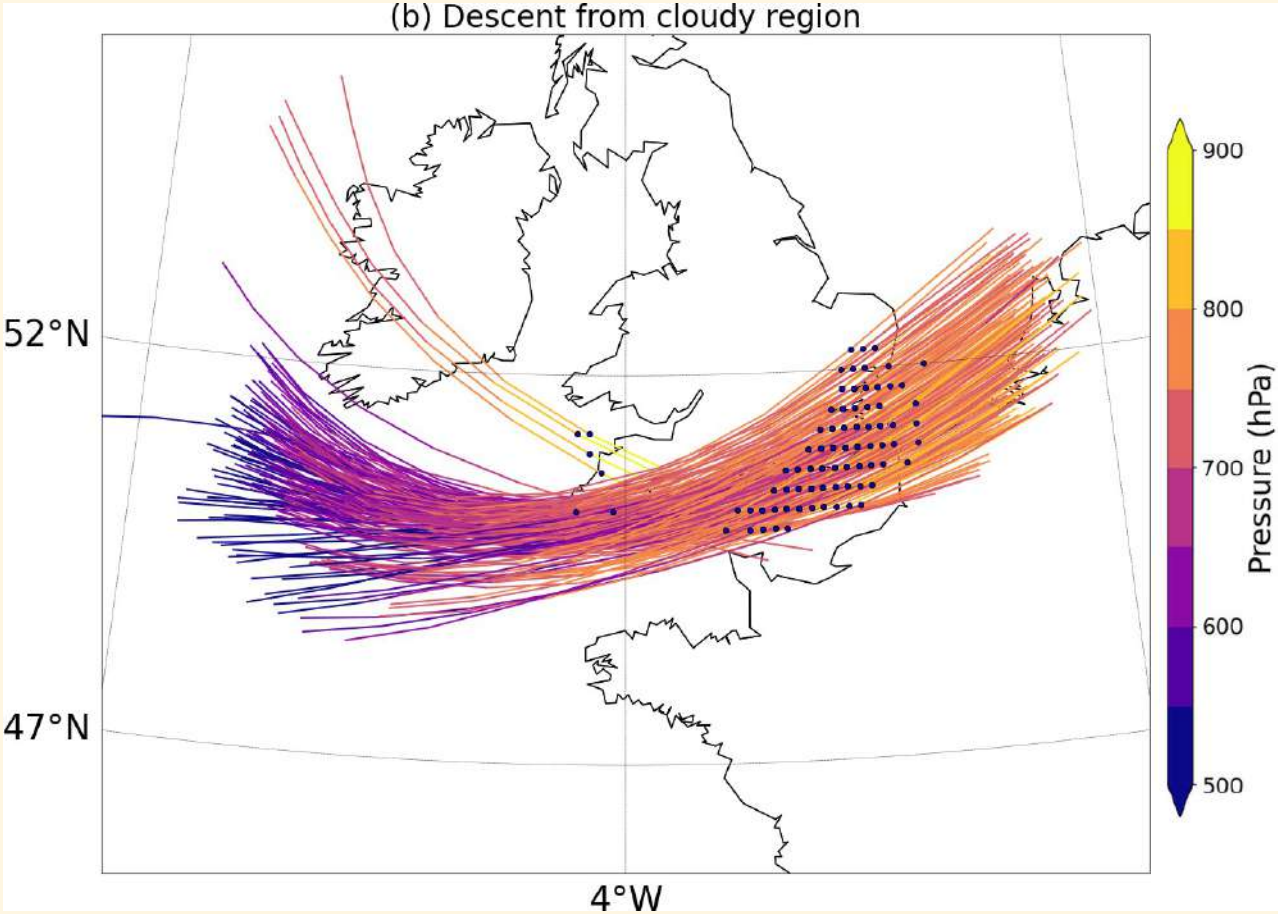
# Origins of low-level wind jets: SJ

Lagrangian trajectories calculated with LAGRANTO (Sprenger and Wernli, 2015)

Forecast start time 06 UTC 18th
Trajectories start time 12 UTC 6 hrs backwards and 2 hours forwards

Windspeed > 42 $ms^{-1}$ between 950 and **700 hPa** at start points (black dots)
Colours are pressure along trajectories

**Criteria:**
descent > 100 hPa from 06-12 UTC, $RH_i$>80% at 06 UTC



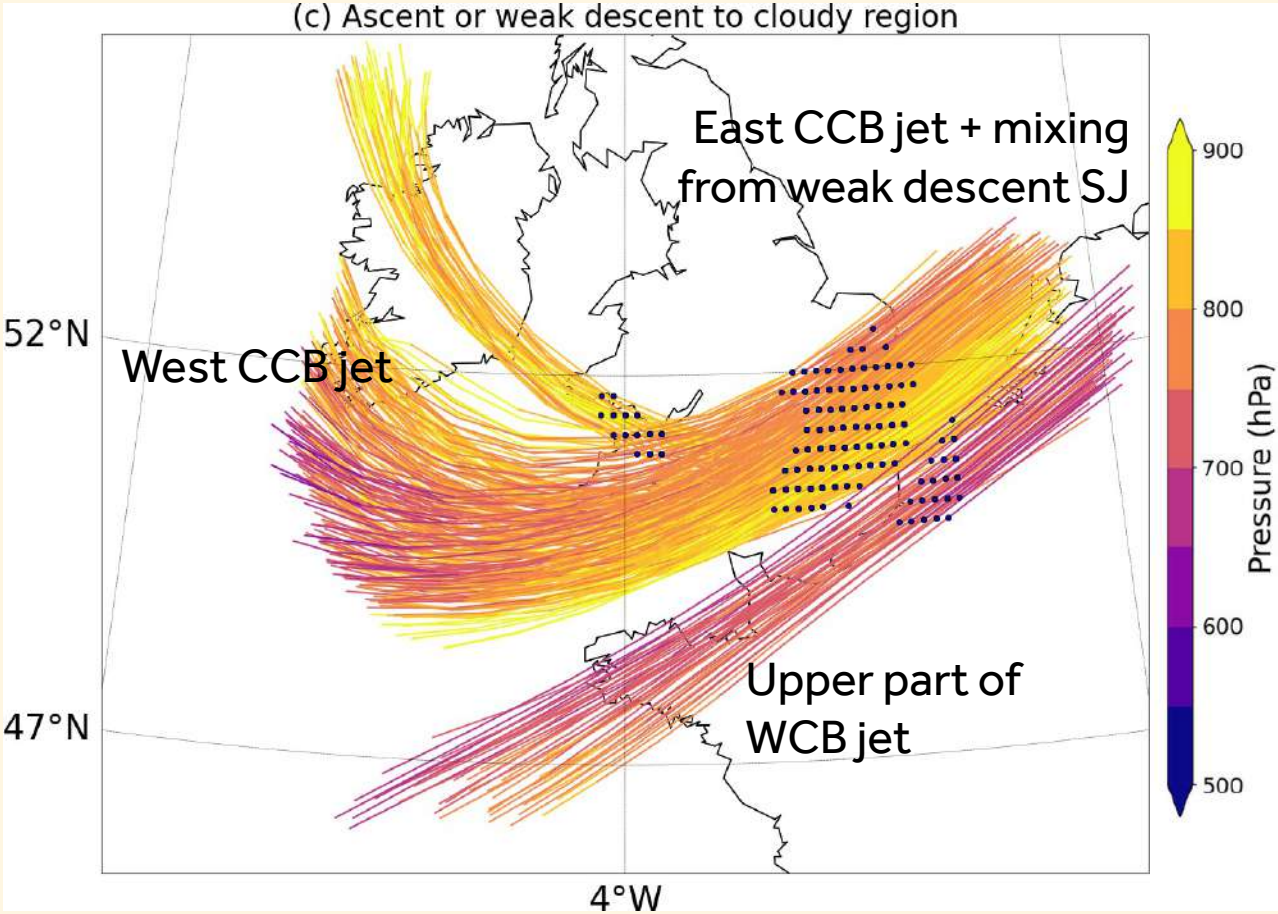
# Origins of low-level wind jets: CCB & WCB jet

Lagrangian trajectories calculated with LAGRANTO (Sprenger and Wernli, 2015)

Forecast start time 06 UTC 18th
Trajectories start time 12 UTC 6 hrs backwards and 2 hours forwards

Windspeed > 42 $ms^{-1}$ between 950 and **700 hPa** at start points (black dots)
Colours are pressure along trajectories

**Criteria:**
descent <100 hPa (which can include ascent of course) from 06-12 UTC, $RH_i$>80% at 12 UTC



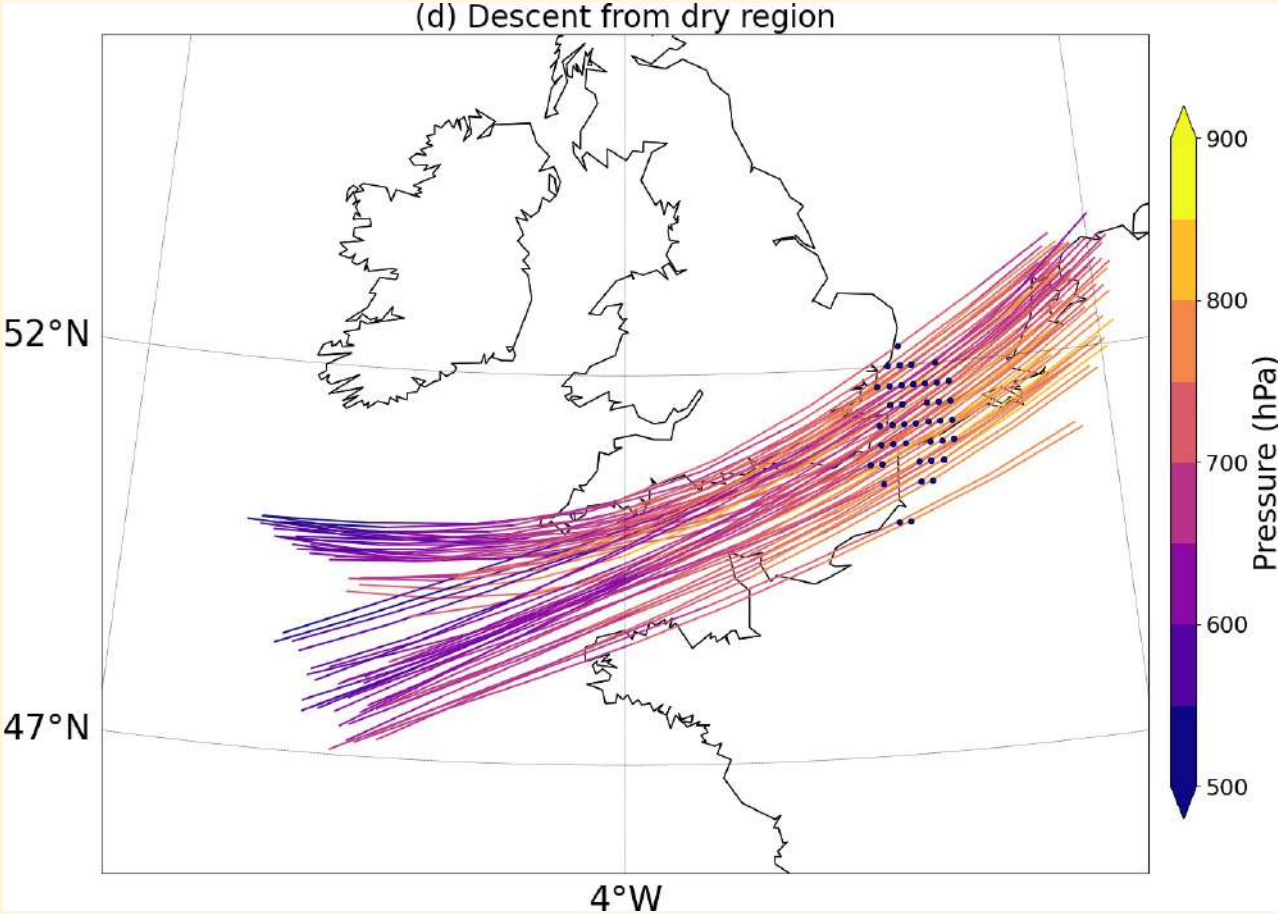
# Origins of low-level wind jets: DI jet

Lagrangian trajectories calculated with LAGRANTO (Sprenger and Wernli, 2015)

Forecast start time 06 UTC 18th
Trajectories start time 12 UTC
6 hrs backwards and 2 hours forwards

Windspeed > 42 $ms^{-1}$ between 950 and **700 hPa** at start points (black dots)
Colours are pressure along trajectories

**Criteria:**
descent > 100 hPa from 06-12 UTC, $RH_i$<60% at 06 UTC



# Summary

- Storm Eunice was a well forecast, intense and damaging windstorm.
- Two main regions of strong low-level winds (>42 $ms^{-1}$).
- The more westwards region was associated with a CCB jet.
- The more eastwards region is due to a mix of different airstreams: a stronger CCB, SJ and DI at 12 UTC.
- There is evidence of mesoscale instability presence/release (CSI/SI) in the cloud head tip: this will have strengthened the SJ.