

## Observations & high resolution modeling of decoupled surface flows during IOP 9c of the COPS field experiment

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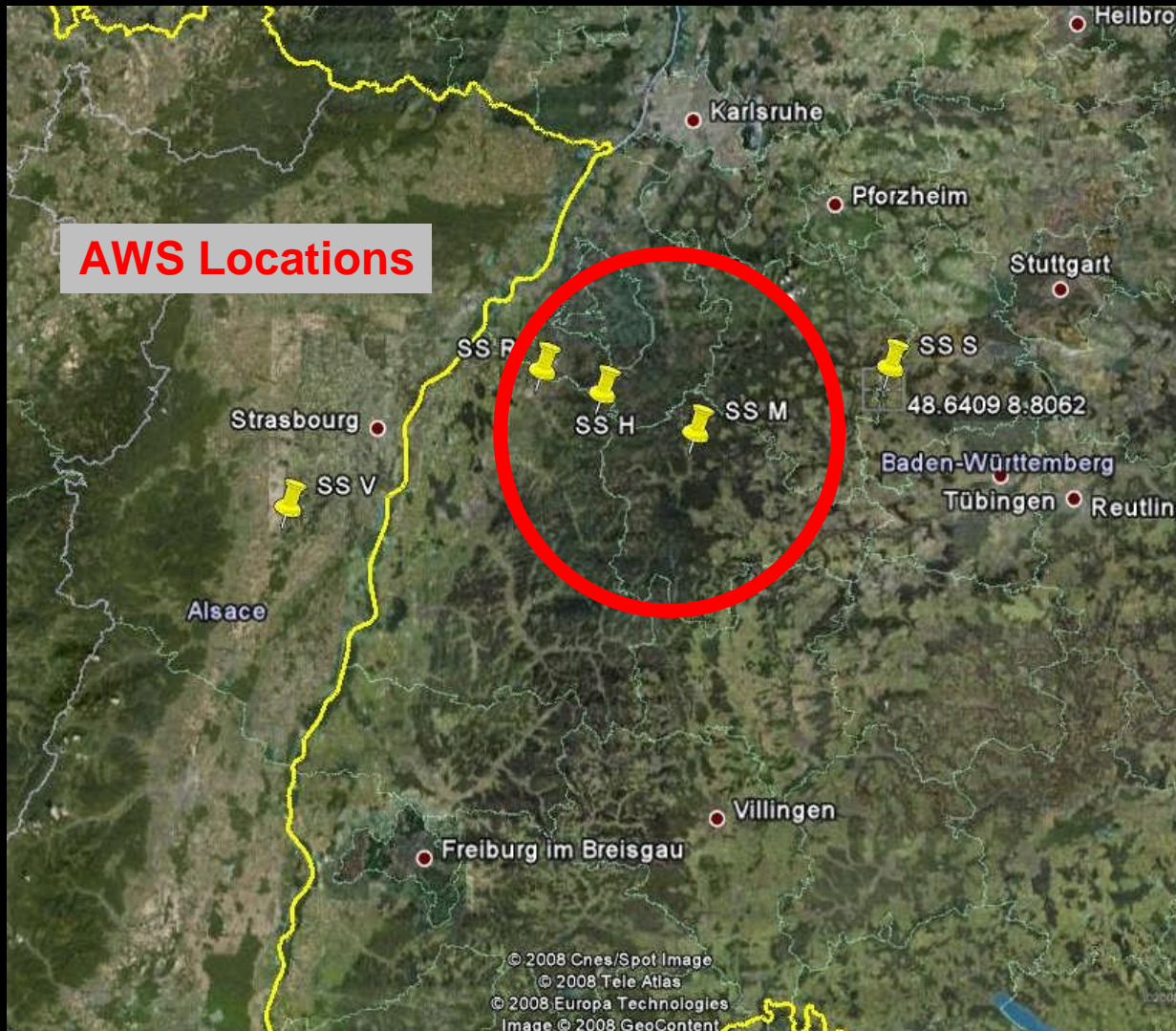




## Talk Overview

- UK deployment of AWS network in COPS
- Overview of IOP 9c Observations
- WRF simulations of IOP 9c
- Conclusions?!

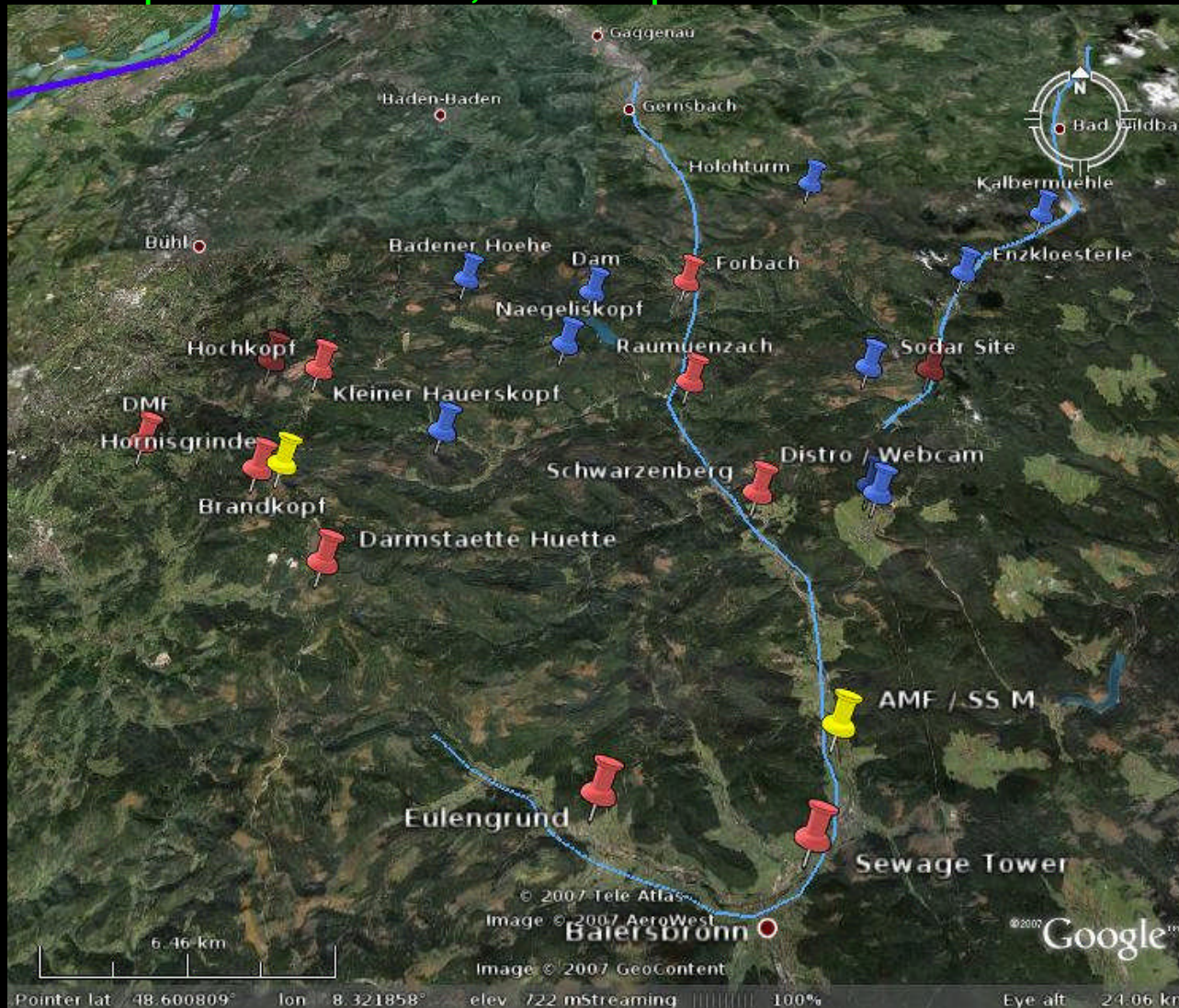
## General Location



- Network of 23 AWS's in Northern COPS region ( $\frac{1}{2}$  Leeds,  $\frac{1}{2}$  Innsbruck)
- Support COPS SS's & other remote instruments
- Location categories relating to orography
  - Western slope
  - Mountain tops / convection hotspot
  - Inflow valleys



Red pins = Leeds, Blue pins = Innsbruck



- Network of 23 AWS's in Northern COPS region (½ Leeds, ½ Innsbruck)
- Support COPS SS's & other remote instruments
- Location categories relating to orography
  - Western slope
  - Mountain tops / convection hotspot
  - Inflow valleys



## Leeds Stations

- Pressure, Temp (~ 0.5m & 2m), Humidity, 2-D Winds (3m)
- Data logged at 4Hz
- Precipitation gauges at 6 sites



## Innsbruck Stations

- Pressure, Air Temp (~2m), Ground Temp (5cm & 30cm), Humidity (~2m), Precipitation, 2-D Winds (3m), Net long & short waveradiation (~2m)
- Data logged as 60 second averages



## Overview of some observations from IOP 9c, 20<sup>th</sup> July 2008

Passage of a Large Mesoscale Convective System (MCS) with convection embedded within its frontal zone & at convergence zones, over the COPS region

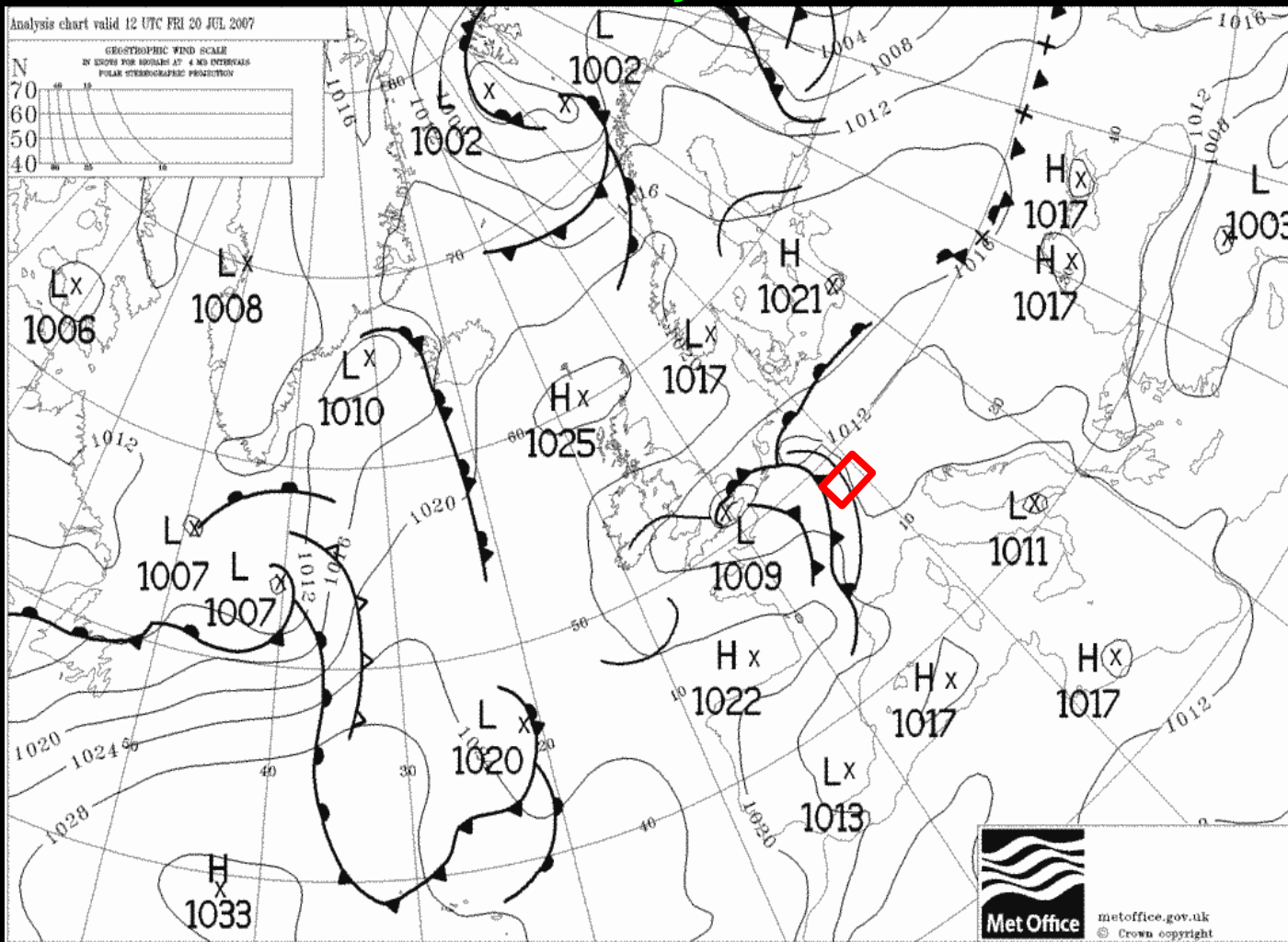
“Excellent case for studying the performance of mesoscale models” Wulfmeyer – SD Summary, 20th July 2007

- .Gust Front associated with MCS frontal zone
- .Promoted squall line of convective activity



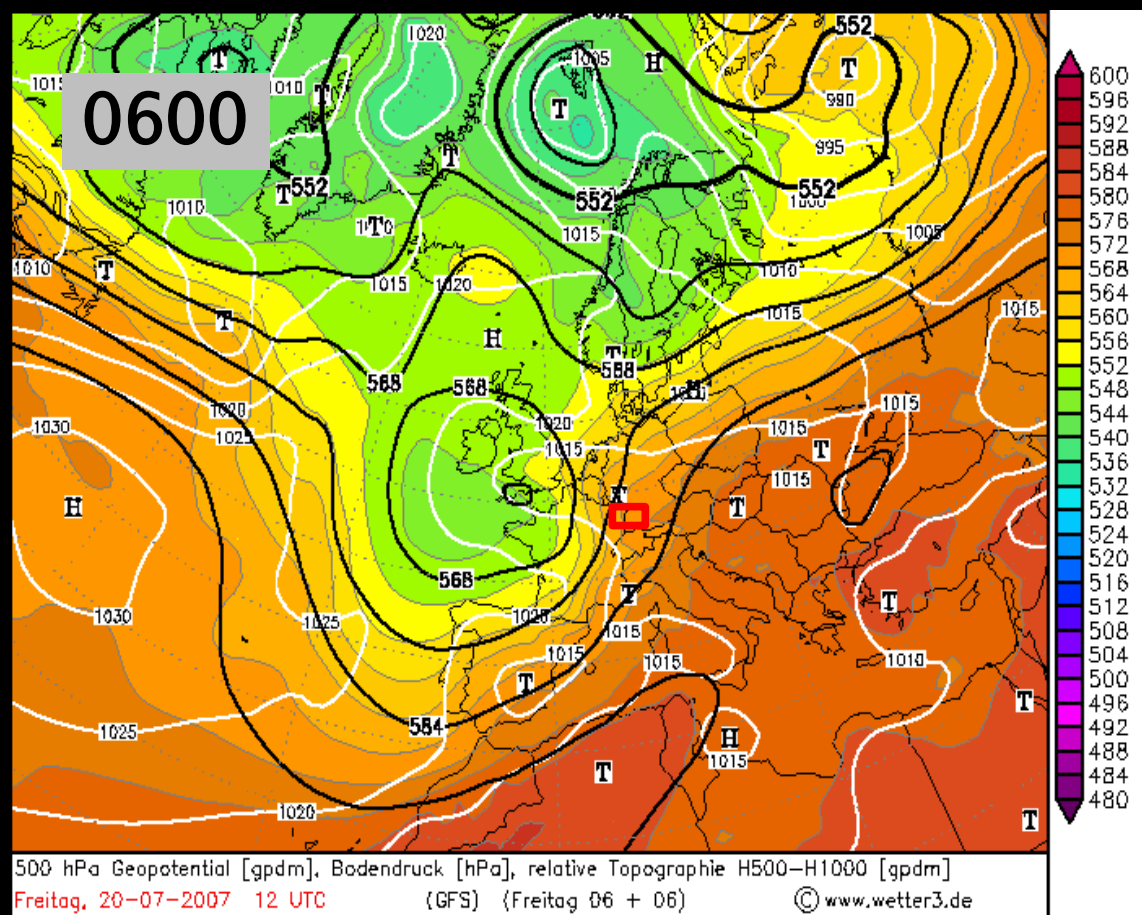
# IOP 9c – 20<sup>th</sup> July 2007

- Prototypic case of convection generated within tropospheric trough with associated frontal zone – Passage of a Mesoscale Convective System (MCS) ↑



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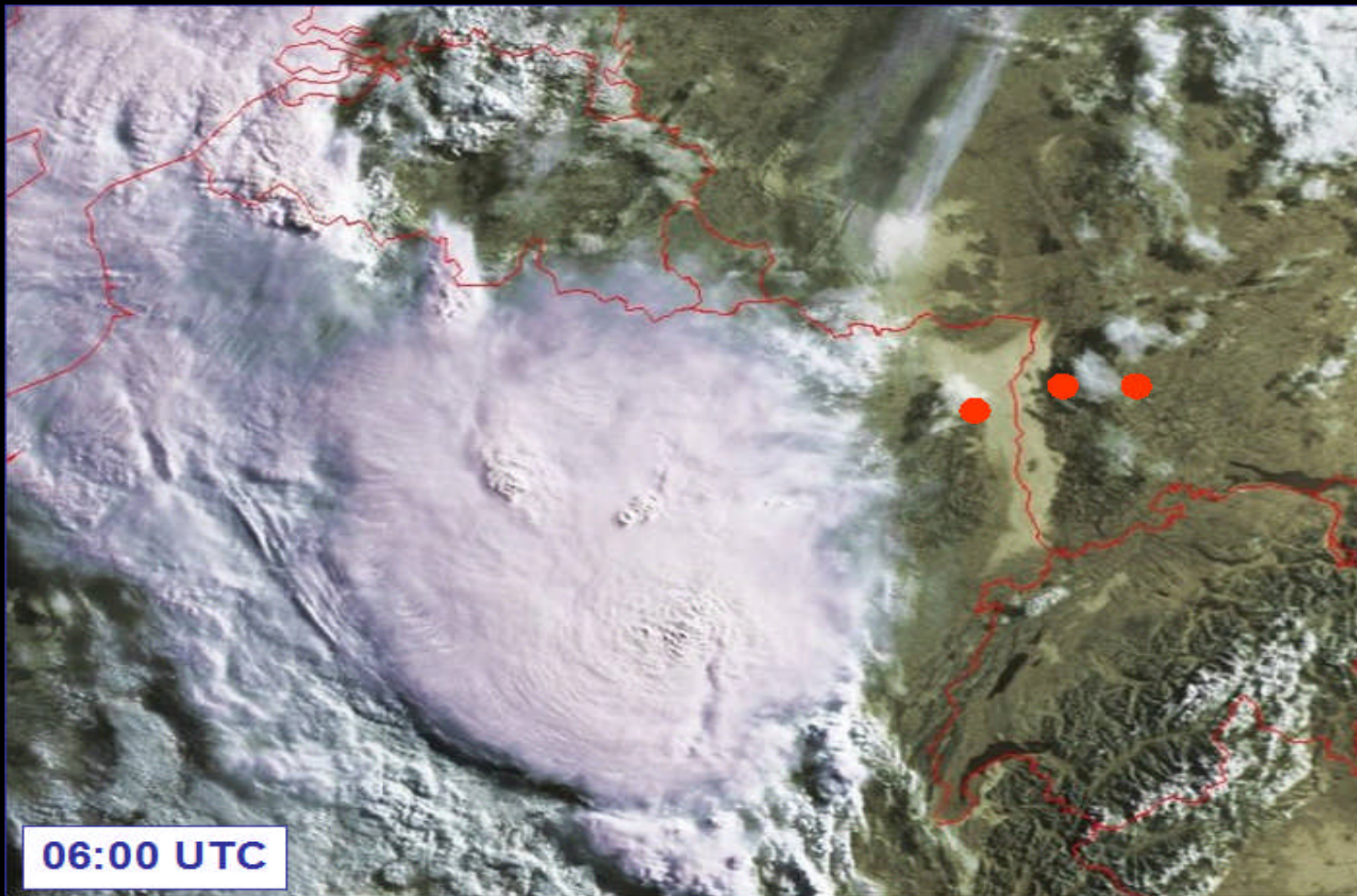


500hPa geopotential height & SLP



## IOP 9c - 20<sup>th</sup> July 2007

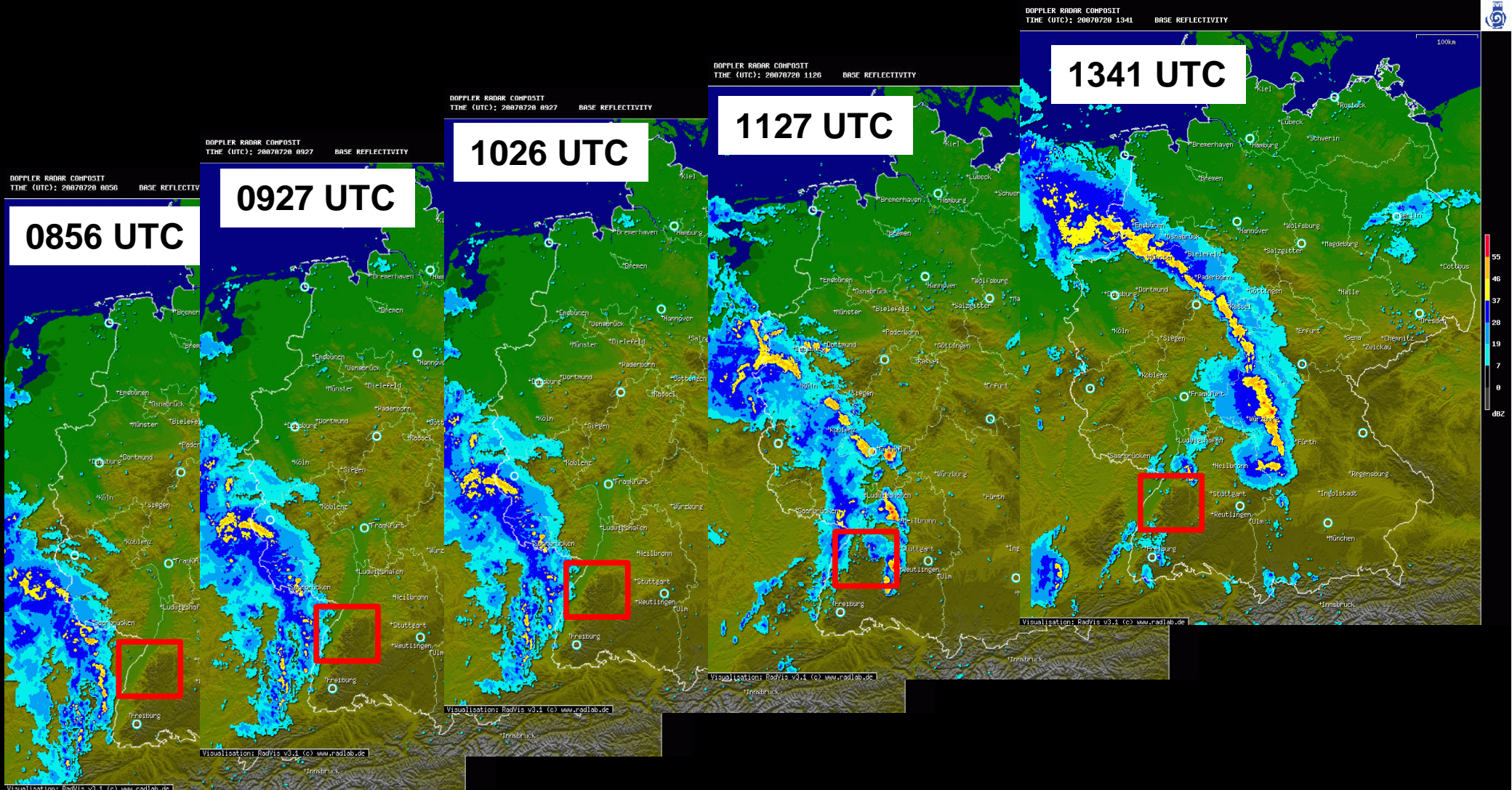
- Prototypic case of convection generated within tropospheric trough with associated frontal zone - Passage of a Mesoscale Convective System (MCS) ↓



NOAA 18 image  
from 0600



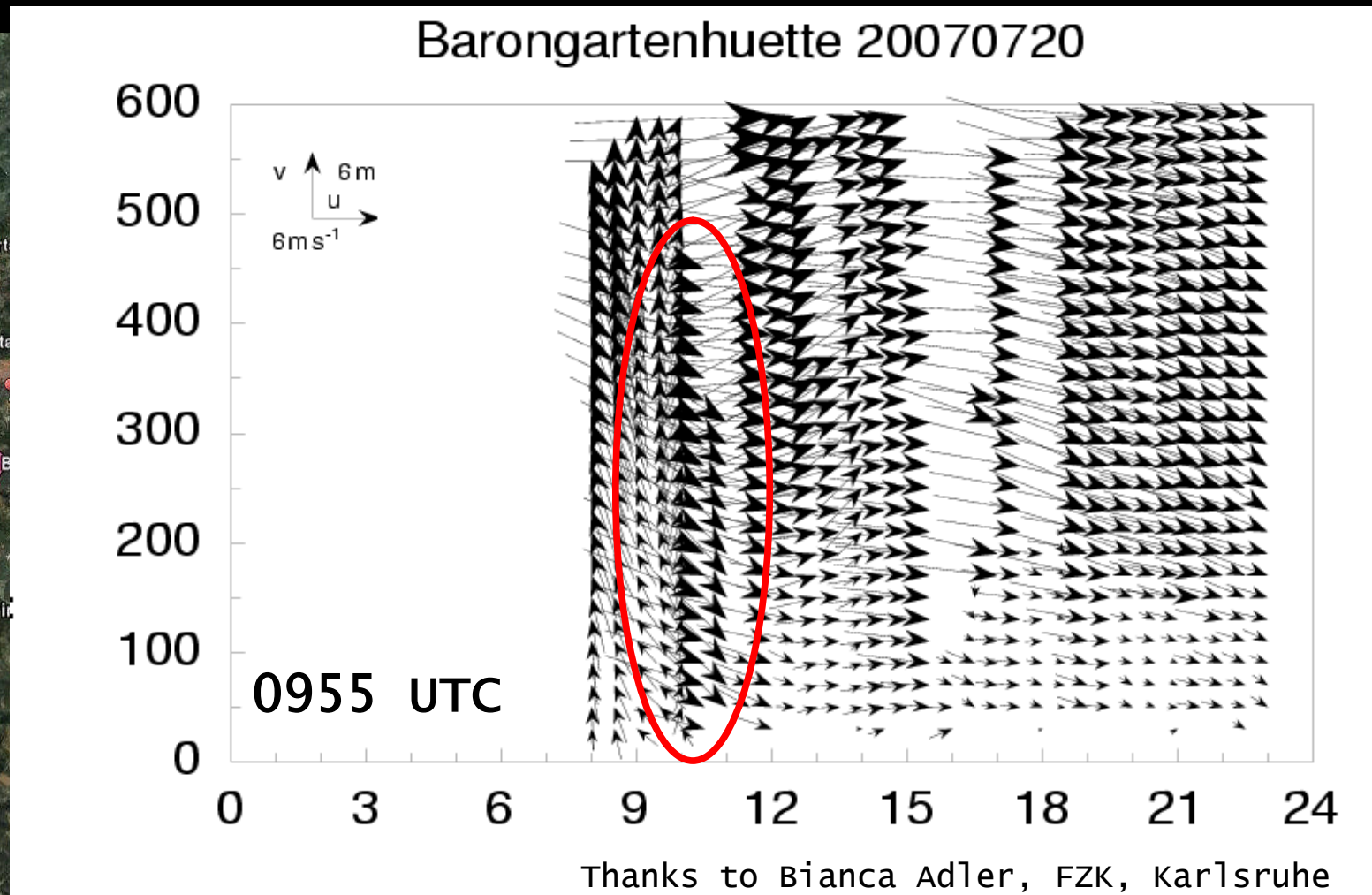
# IOP 9c - 20<sup>th</sup> July 2007 DWD Radar Images





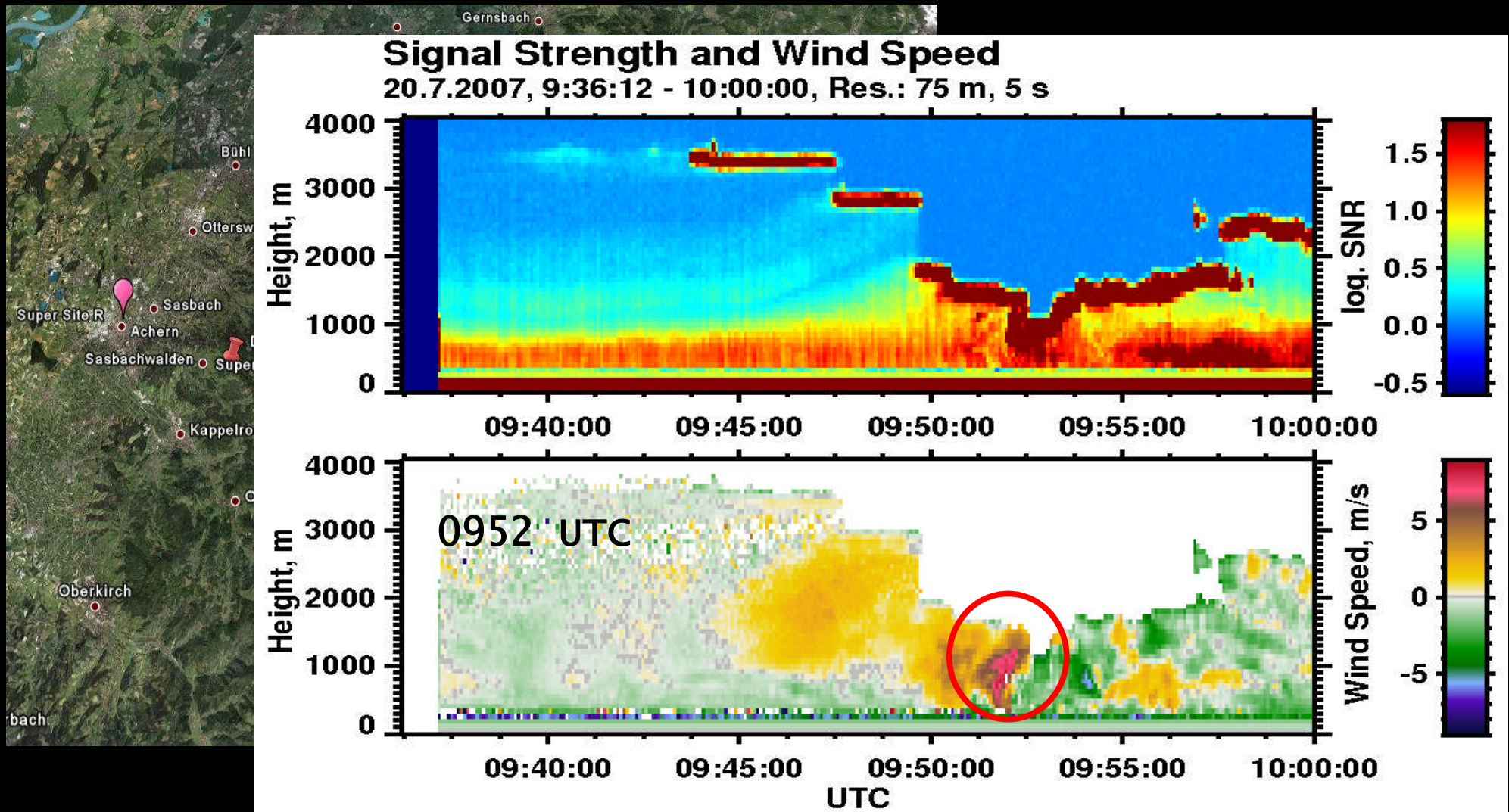
# Observations of IOP 9c by COPS instruments

Gust front seen by Mountain top sodar located between Murg & Enz valley



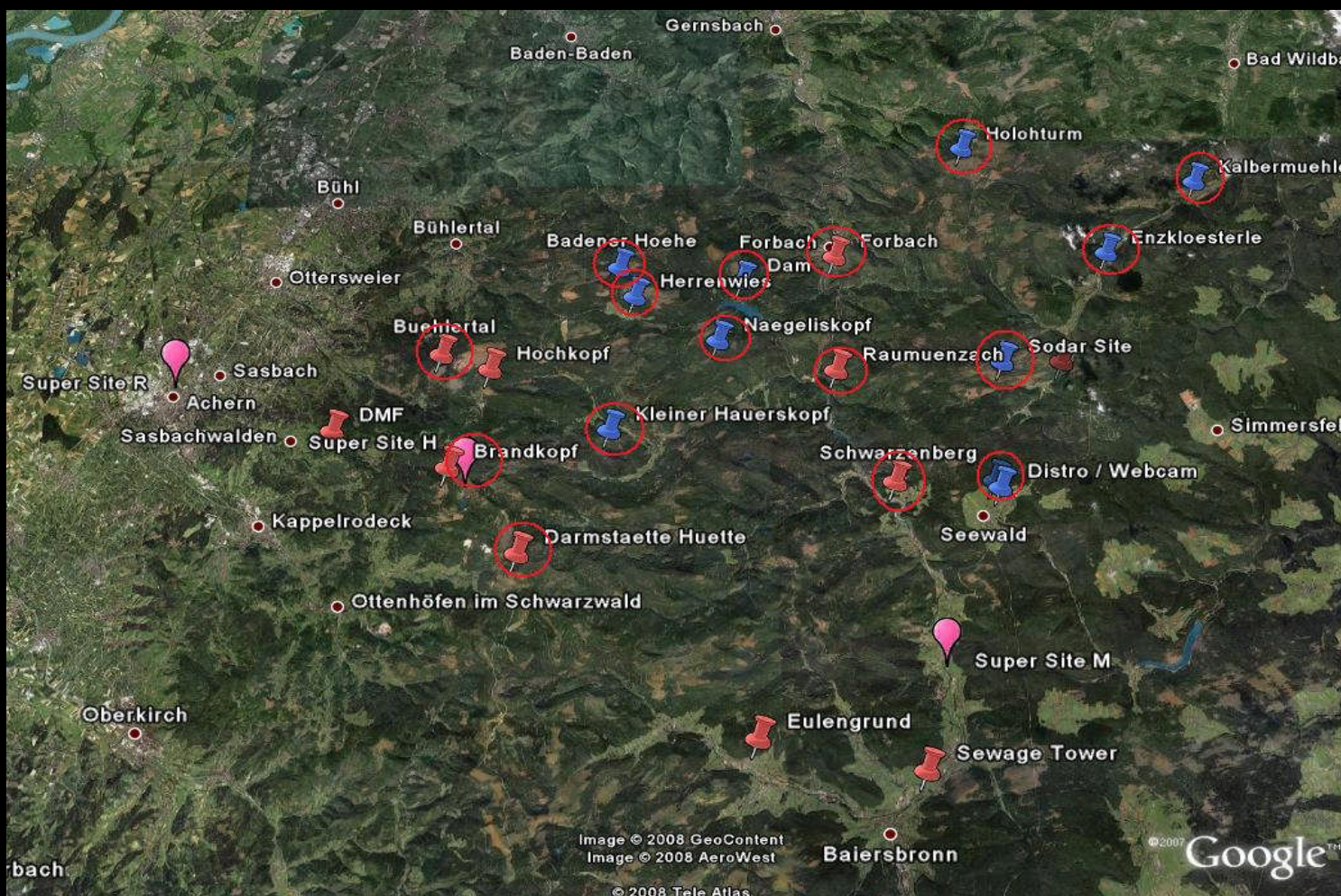
# Observations of IOP 9c by COPS instruments

Gust front seen by WiLi Doppler lidar at SS M





# So – what do we see in the surface observations ???

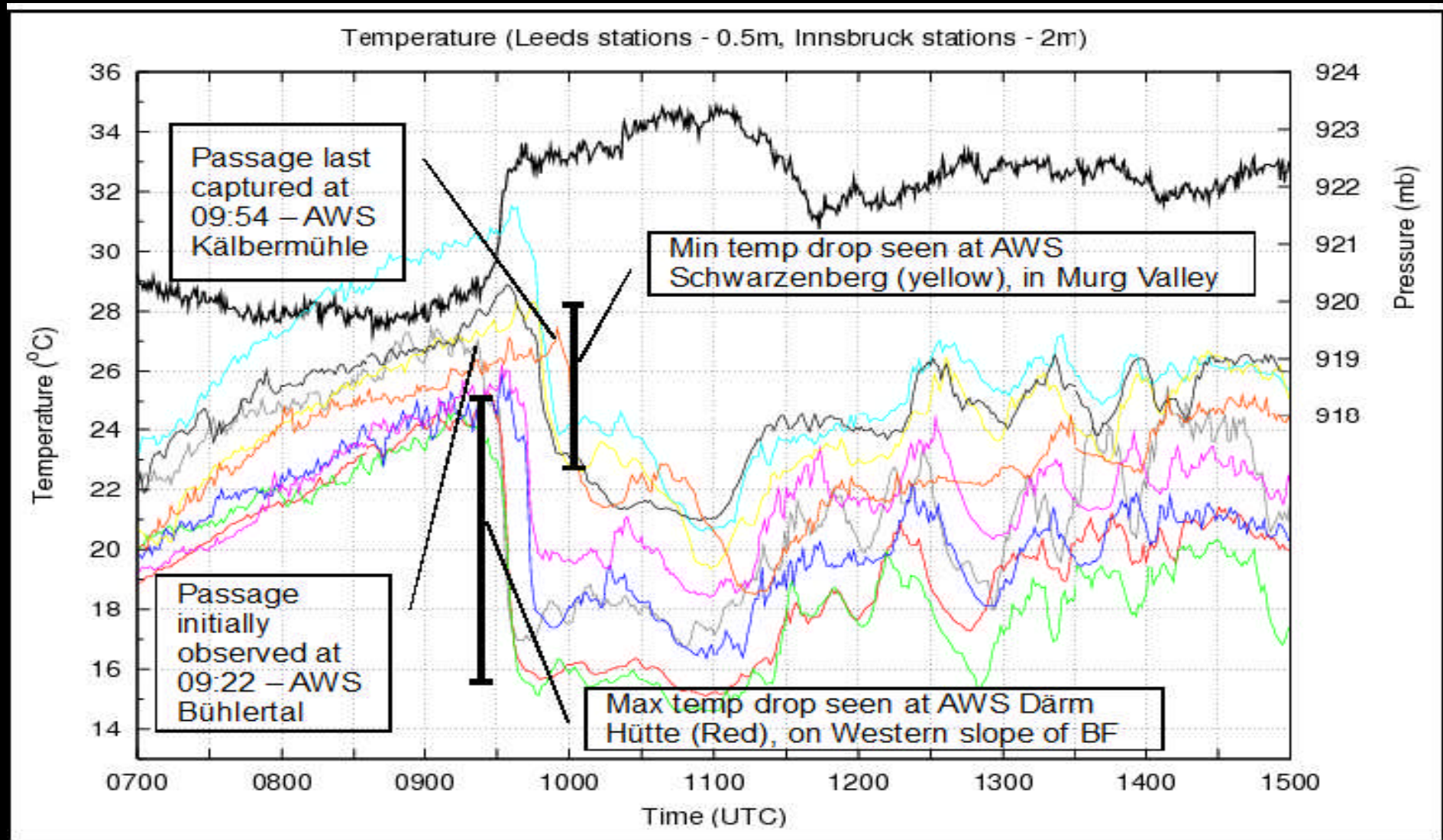


- . All 11 Innsbruck
- . 6 Leeds AWS's

Map to show which AWS's were logging during IOP



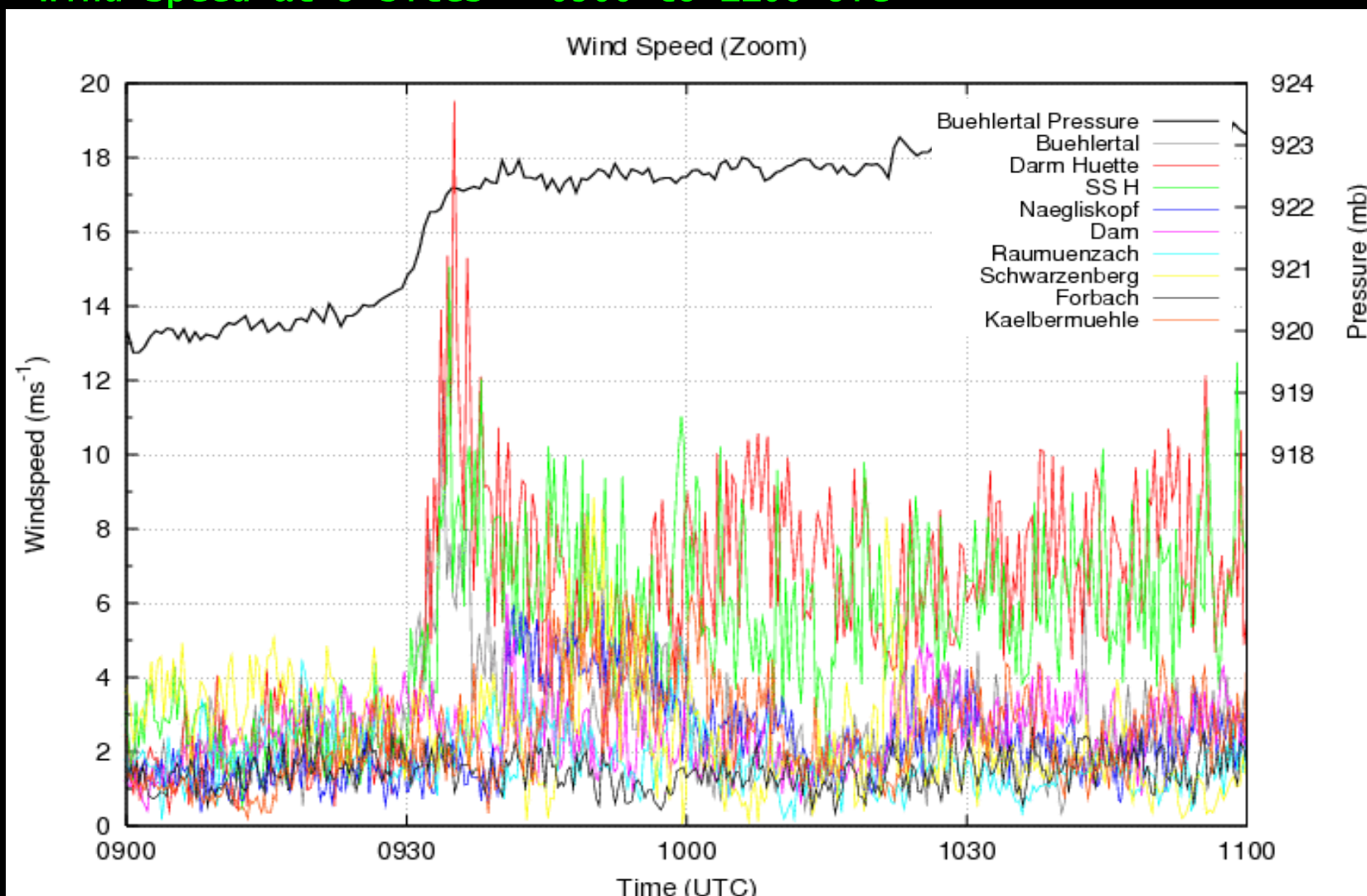
# So – what do we see in the surface obs???



\*\*\* Temperature drop seen at ALL locations as cold front passes \*\*\*

# So – what do we see in the surface obs???

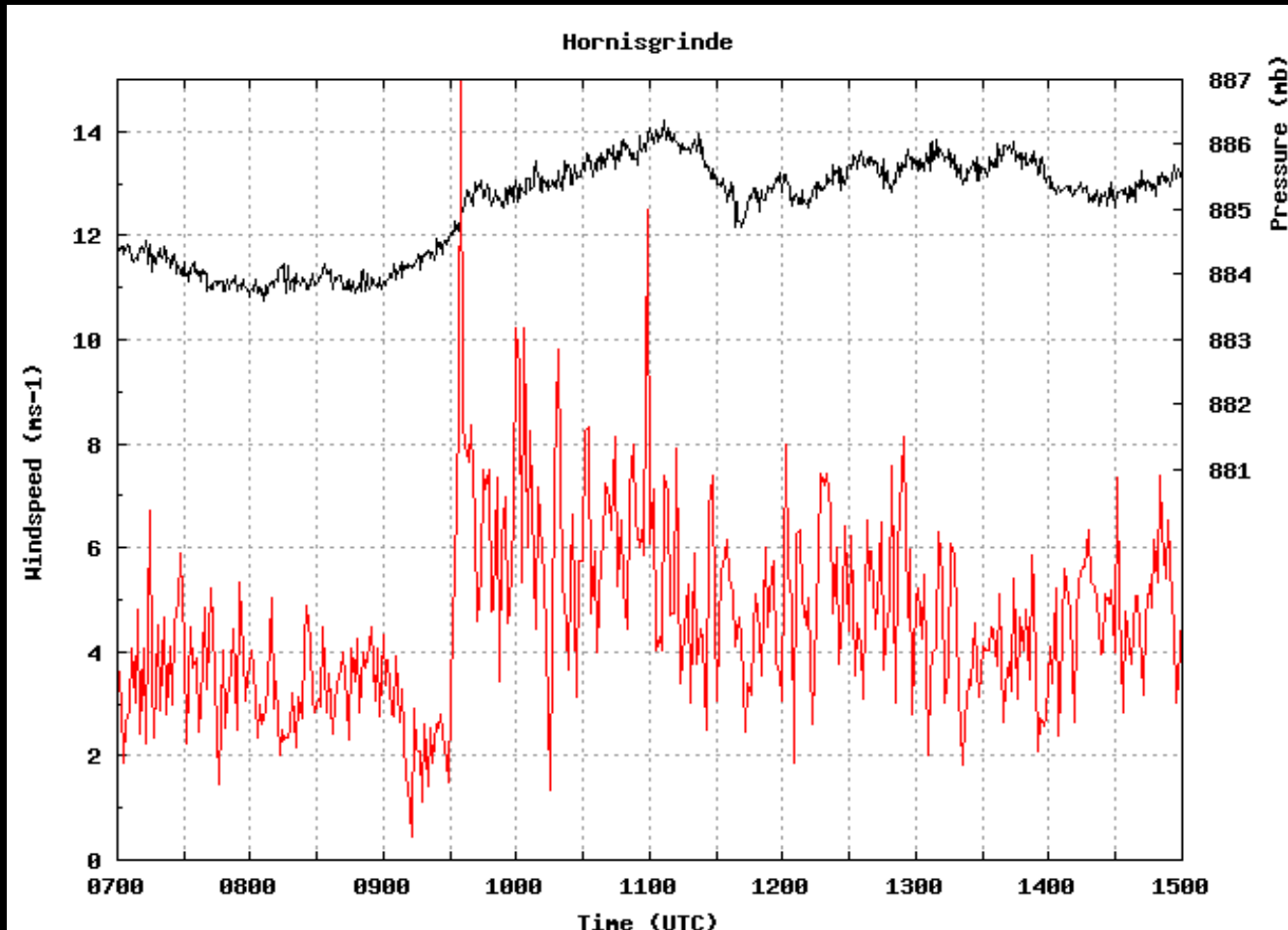
Wind Speed at 9 sites – 0900 to 1100 UTC



\*\*\* sharp increase in w/s NOT seen at ALL locations as cold front passes \*\*\*

# So – what do we see in the surface obs???

closer look at individual sites – Hornisgrinde (SS H)†



Wind speed  
increase from  
 $2\text{ms}^{-1}$  to  $16\text{ms}^{-1}$   
as gust front  
passes

\*\*\* Sharp increase in w/s NOT seen at ALL locations as cold front passes  
\*\*\*





So – what do we see in the surface obs???

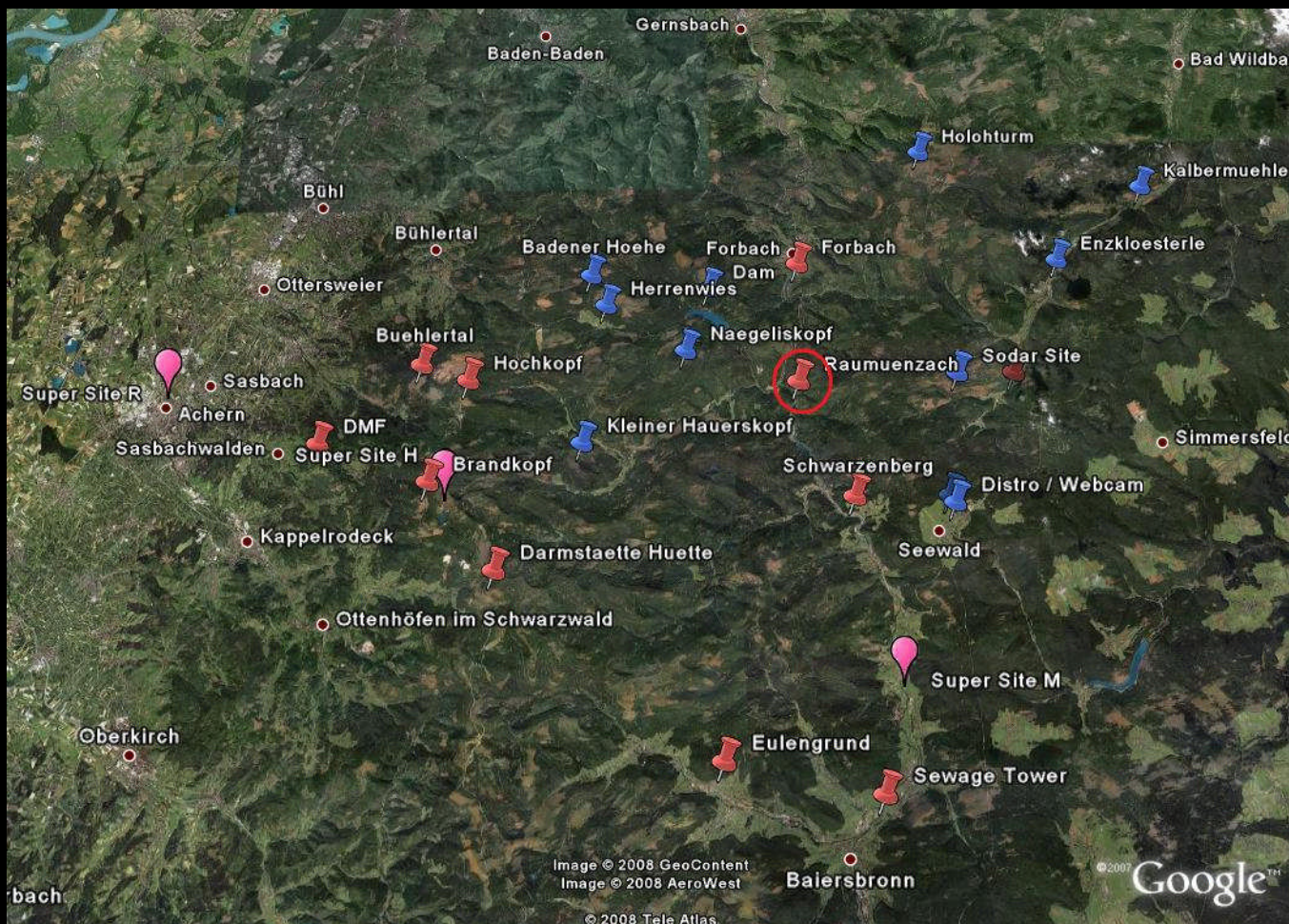
closer look at individual sites

valley sites !!!!!

\*\*\* Sharp increase in w/S NOT seen at ALL locations as cold front passes \*\*\*

# So – what do we see in the surface obs???

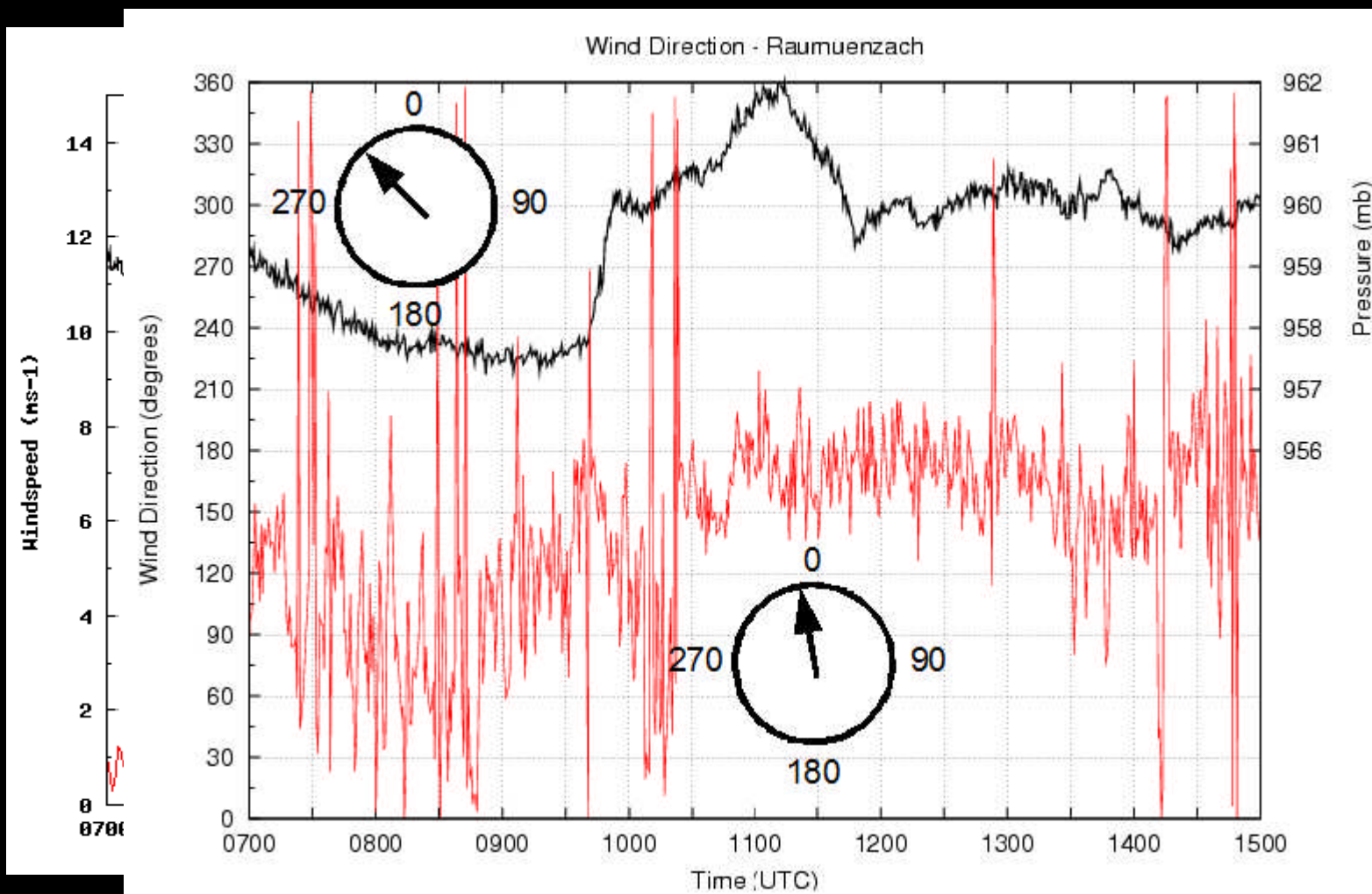
## closer look at individual sites – Raumuenzach



\*\*\* Sharp increase in w/S NOT seen at ALL locations as cold front passes  
\*\*\*

# So – what do we see in the surface obs???

## closer look at individual sites – Raumuenzach



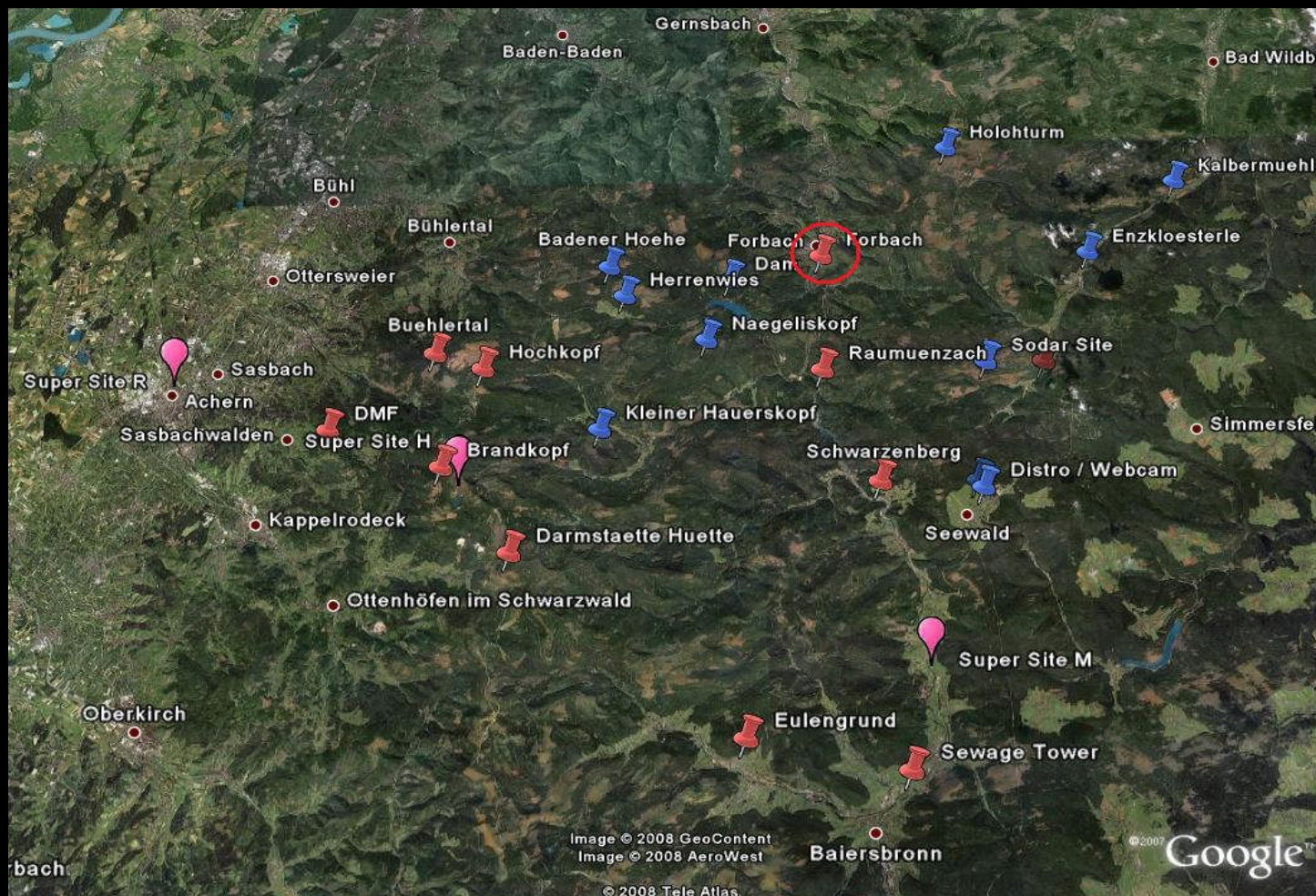
Almost no  
modification to  
the wind  
direction

\*\*\* Sharp increase in w/s NOT seen at ALL locations as cold front passes  
\*\*\*



# So – what do we see in the surface obs???

closer look at individual sites – Forbach

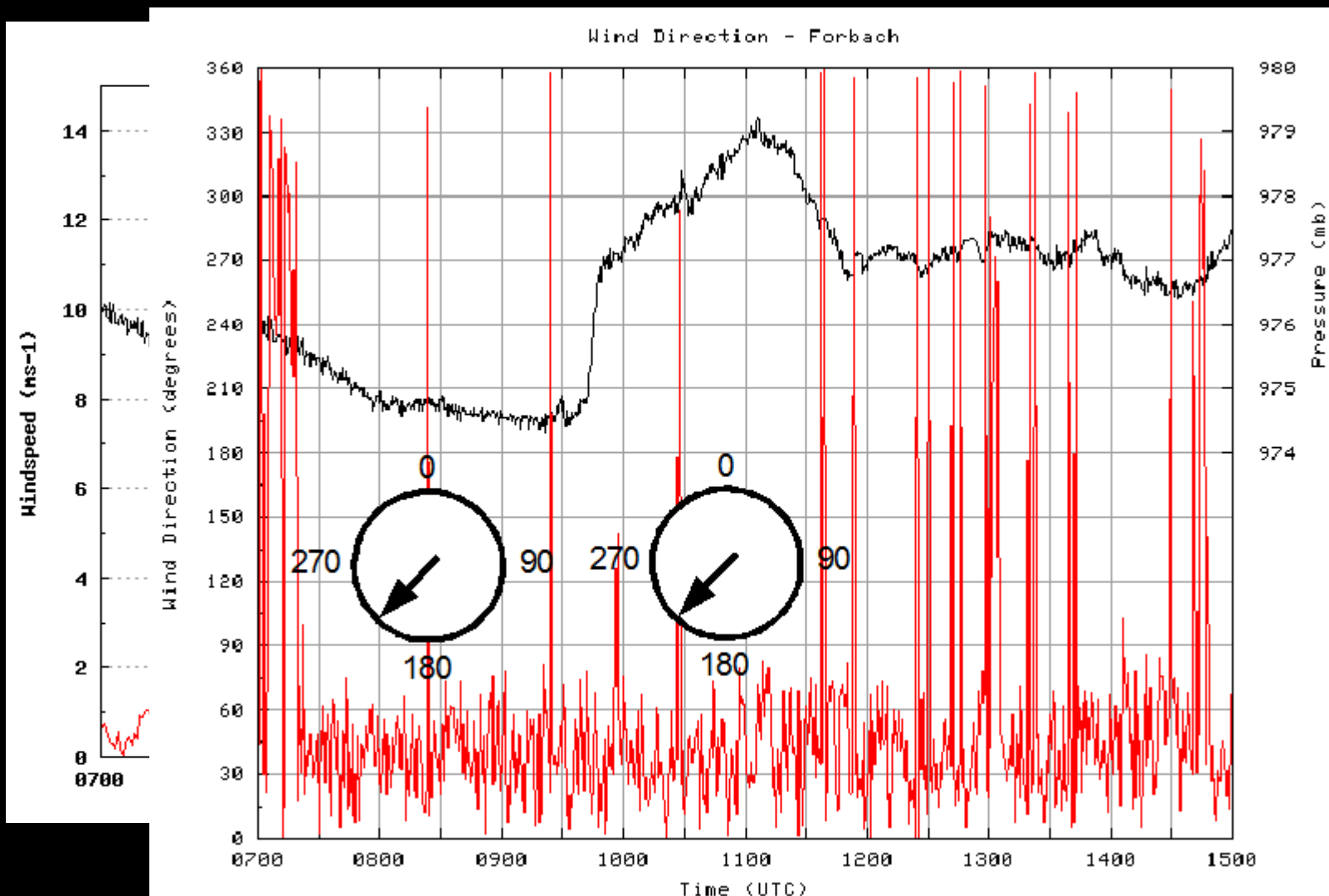


Located deep in  
Murg valley,  
approx 2m above  
height of river

\*\*\* Sharp increase in w/S NOT seen at ALL locations as cold front passes \*\*\*

# So – what do we see in the surface obs???

closer look at individual sites – Forbach



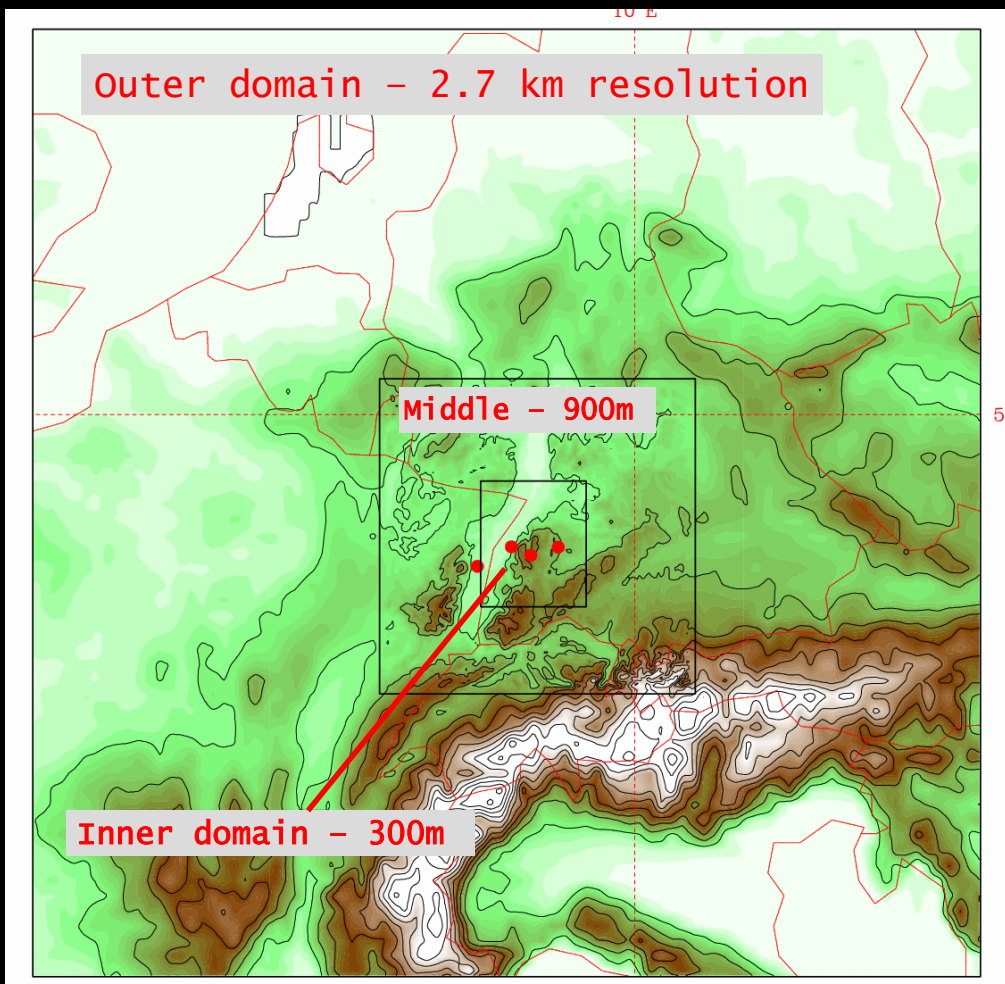
NO EVIDENCE  
IN WIND DATA  
FOR PASSAGE  
OF GUST FRONT  
OVER AWS  
LOCATION – OR  
WIND  
DIRECTION  
DATA

\*\*\* Sharp increase in W/S NOT seen at ALL locations as cold front passes  
\*\*\*



# WRF simulations of IOP 9c

Initial attempt to model this case – preliminary results  
& analysis – comments / suggestions very welcome



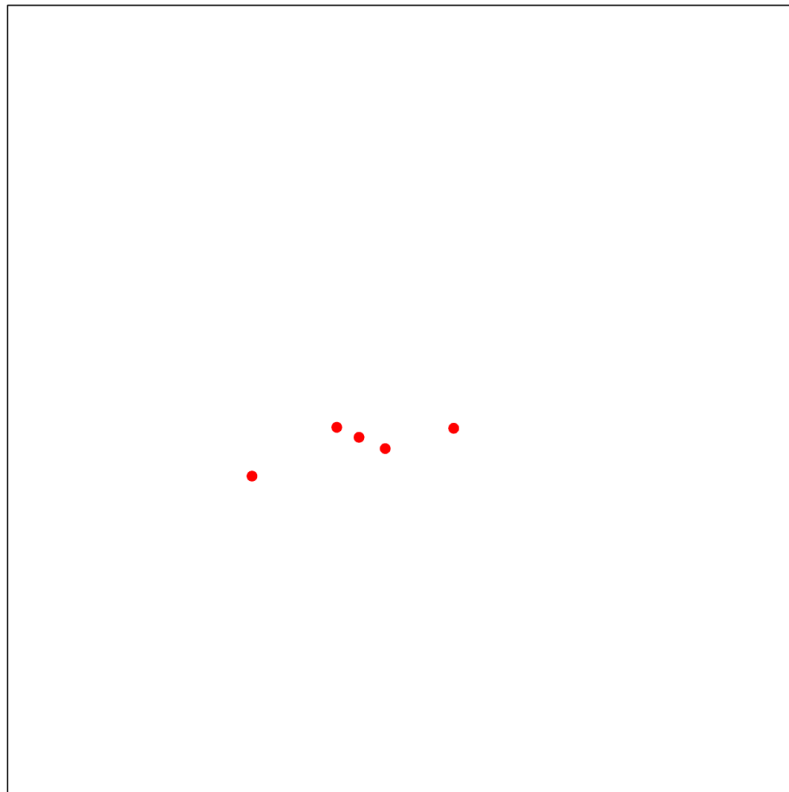
- Convection parameterised in outer domain (Betts-Miller)†
- Ferrier Microphysics Scheme
- Initialised with GFS analysis
- 400 x 400 GP's in each domain
- Initialised with GFS Analyses
- Outputs d01 - every hr
- d02 - 30 mins
- d03 - 5 mins

Intend to repeat with  
ECMWF analyses soon



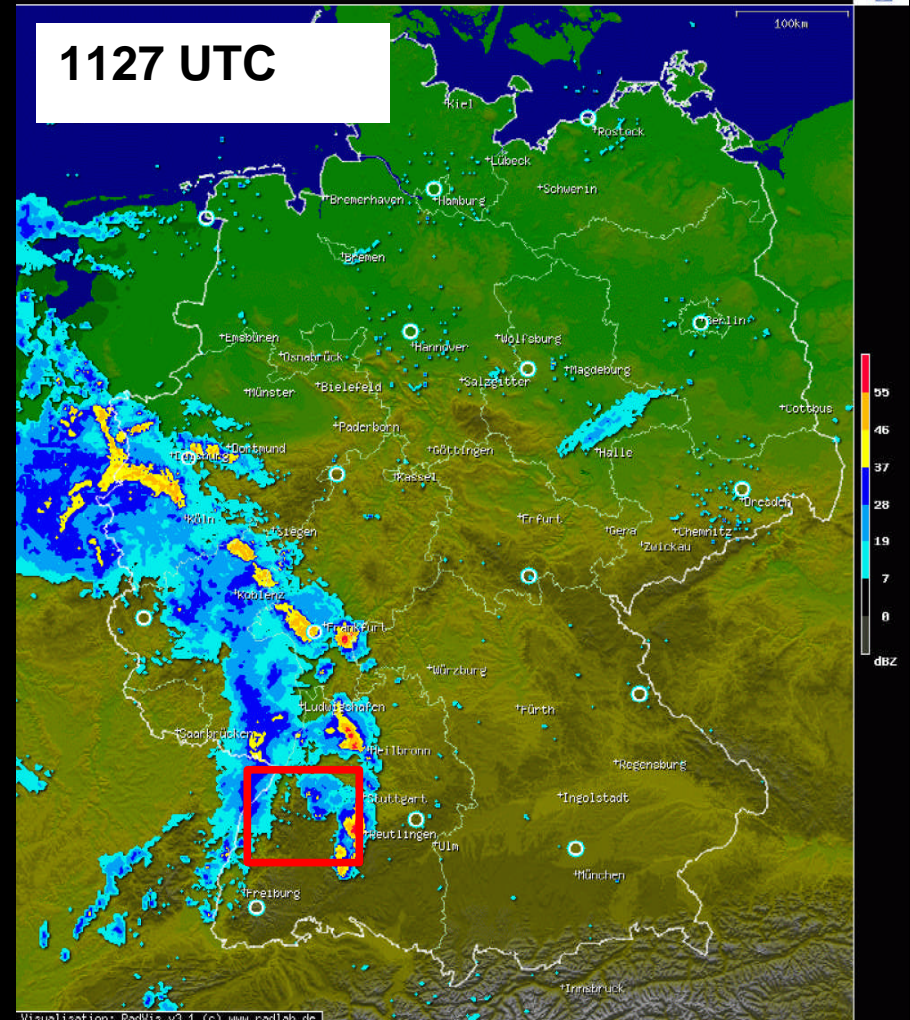
# WRF simulations of IOP 9c

COPS IOP9c 20th Jul (WRF d02, res 900m, GFS) Init: 0600 UTC Fri 20 Jul 07  
Fcast: 0.00 h Valid: 0600 UTC Fri 20 Jul 07 (0600 LST Fri 20 Jul 07)  
Reflectivity at k-index = 120



Model Info: V3.0 M No Cu YSU PBL Ferrier Ther-Diff 900 m, 120 levels, 6 sec  
LW: RRTM SW: Dudhia DIFF: full KM: 2D Smagor

DOPPLER RADAR COMPOSITE  
TIME (UTC): 20070720 1126 BASE REFLECTIVITY

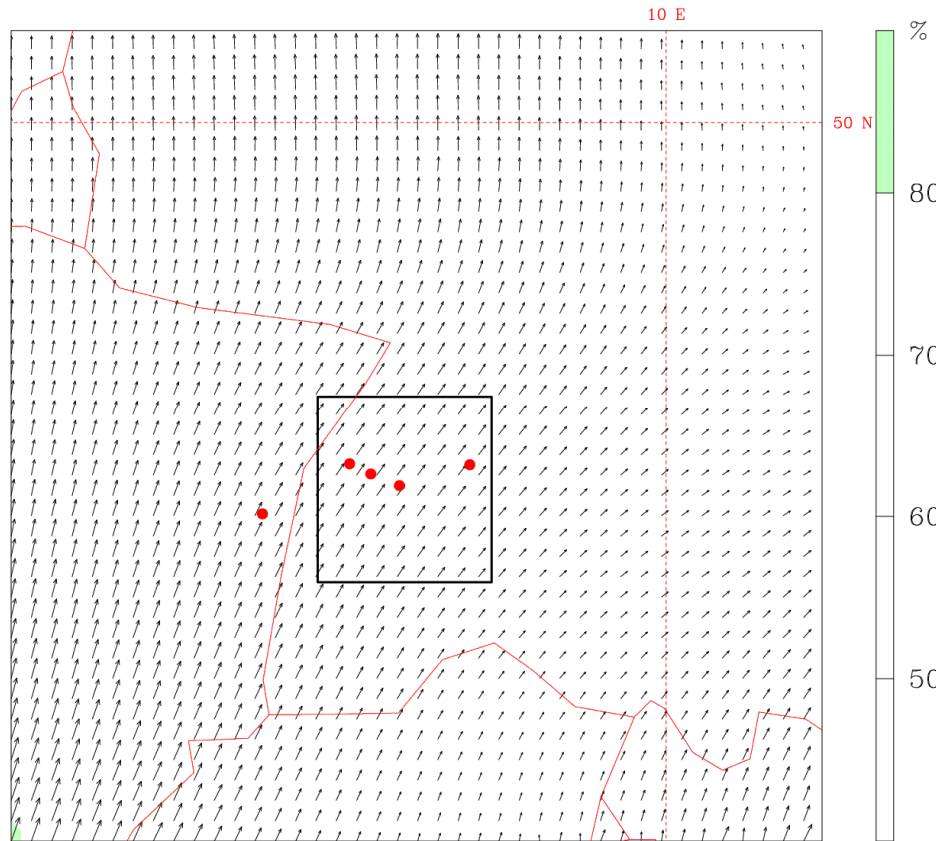


Visualisation: RadVis v3.1 (c) www.radlab.de

Radar reflectivity, WRF on left, DVD analysis on right

# WRF simulations of IOP 9c

COPS IOP9c 20th Jul (WRF d02, Res 900m, GFS) Init: 0600 UTC Fri 20 Jul 07  
 Fcst: 0.00 h Valid: 0600 UTC Fri 20 Jul 07 (0600 LST Fri 20 Jul 07)  
 Relative humidity (w.r.t. water) at pressure = 700 hPa  
 Horizontal wind vectors at pressure = 700 hPa



Model Info: V3.0 M No Cu YSU PBL Ferrier Ther-Diff 900 m, 120 levels, 6 sec  
 LW: RRTM SW: Dudhia DIFF: full KM: 2D Smagor

-----  
 DOPPLER RADAR COMPOSIT  
 TIME (UTC): 20070720 1126 BASE REFLECTIVITY



Visualisation: RadVis v3.1 (c) www.radlab.de

Relative Humidity at 700mb, WRF on left, DVD radar analysis on right



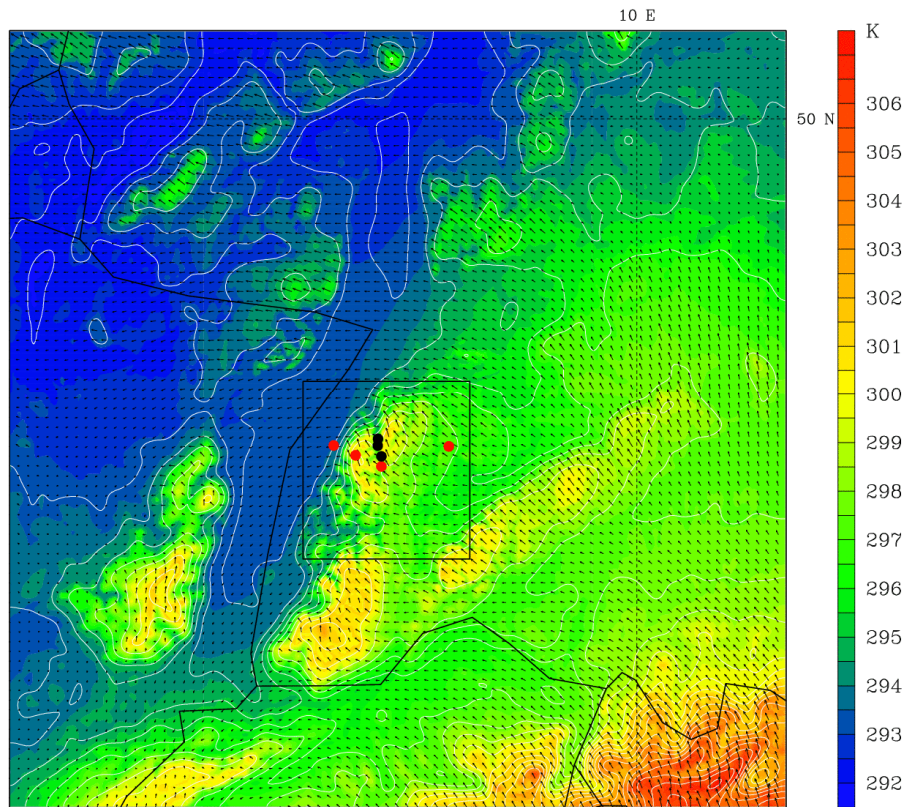


## WRF simulations of IOP 9c

- MCS location & form appears to be well represented & forecasted by WRF
- Timing late, BUT, features more important at this stage
- Subsequent development of convective cells downstream of COPS region well captured by WRF

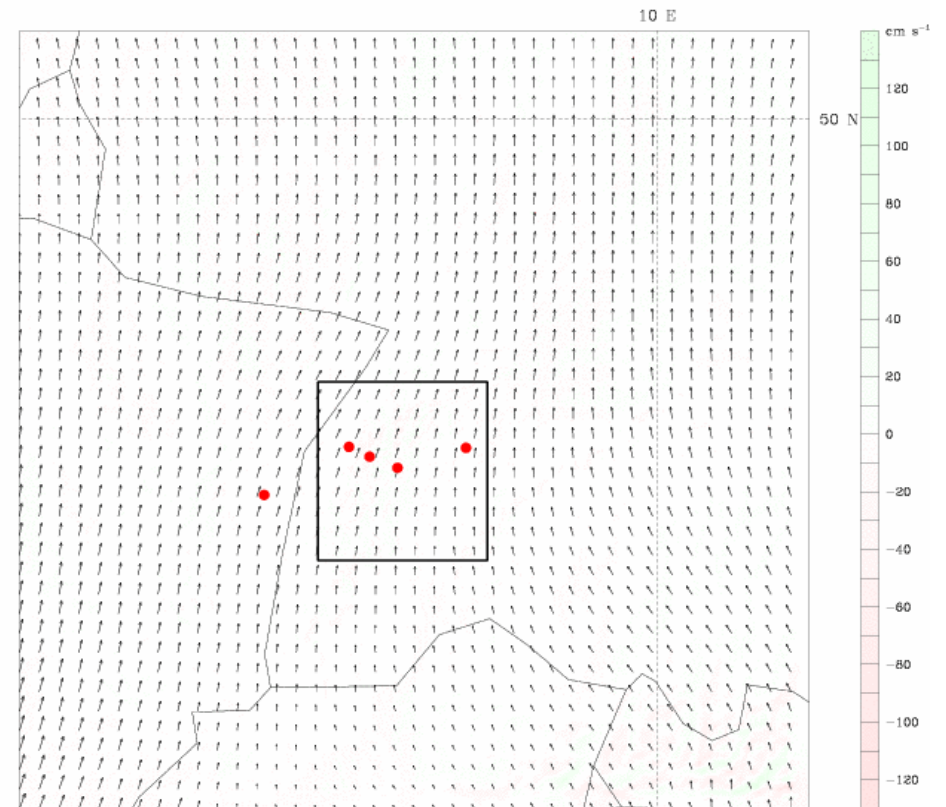
# WRF simulations of IOP 9c

COPS IOP9c 20th Jul (WRF d02, Res 900m, GFS) Init: 0600 UTC Fri 20 Jul 07  
 Fcst: 0.00 h Valid: 0600 UTC Fri 20 Jul 07 (0600 LST Fri 20 Jul 07)  
 Potential temperature at k-index = 120  
 Terrain height AMSL sm=30  
 Horizontal wind vectors at height = 0.00 km



MAXIMUM VECTOR: 7.4 m s<sup>-1</sup> →  
 CONTOURS: UNITS=m LOW= 100.00 HIGH= 2000.0 INTERVAL= 100.00  
 Model Info: V3.0 M No Cu YSU PBL Ferrier Ther-Diff 900 m, 120 levels, 6 sec  
 LW: RRTM SW: Dudhia DIFF: full KM: 2D Smagor

COPS IOP9c 20th Jul (WRF d02, Res 900m, GFS) Init: 0600 UTC Fri 20 Jul 07  
 Fcst: 0.00 h Valid: 0600 UTC Fri 20 Jul 07 (0600 LST Fri 20 Jul 07)  
 Vertical velocity at pressure = 850 hPa  
 Horizontal wind vectors at pressure = 850 hPa



MAXIMUM VECTOR: 9.8 m s<sup>-1</sup> →  
 Model Info: V3.0 M No Cu YSU PBL Ferrier Ther-Diff 900 m, 120 levels, 6 sec  
 LW: RRTM SW: Dudhia DIFF: full KM: 2D Smagor

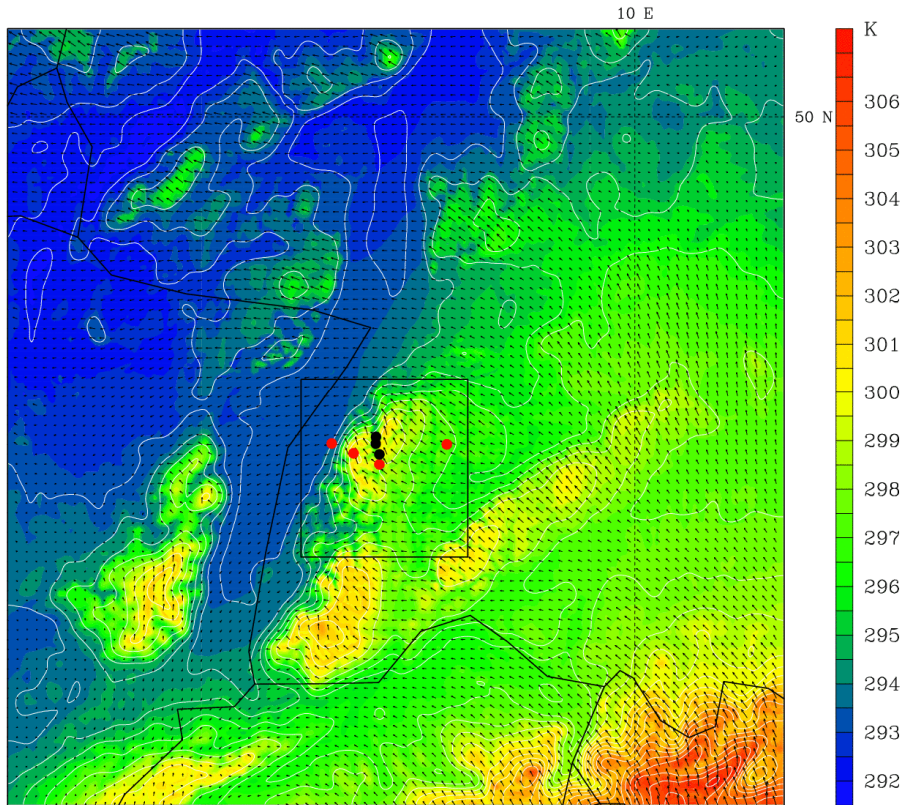
Surface Theta & horizontal winds

Vertical (colour) & horizontal (vectors) winds at 850mb



# WRF simulations of IOP 9c

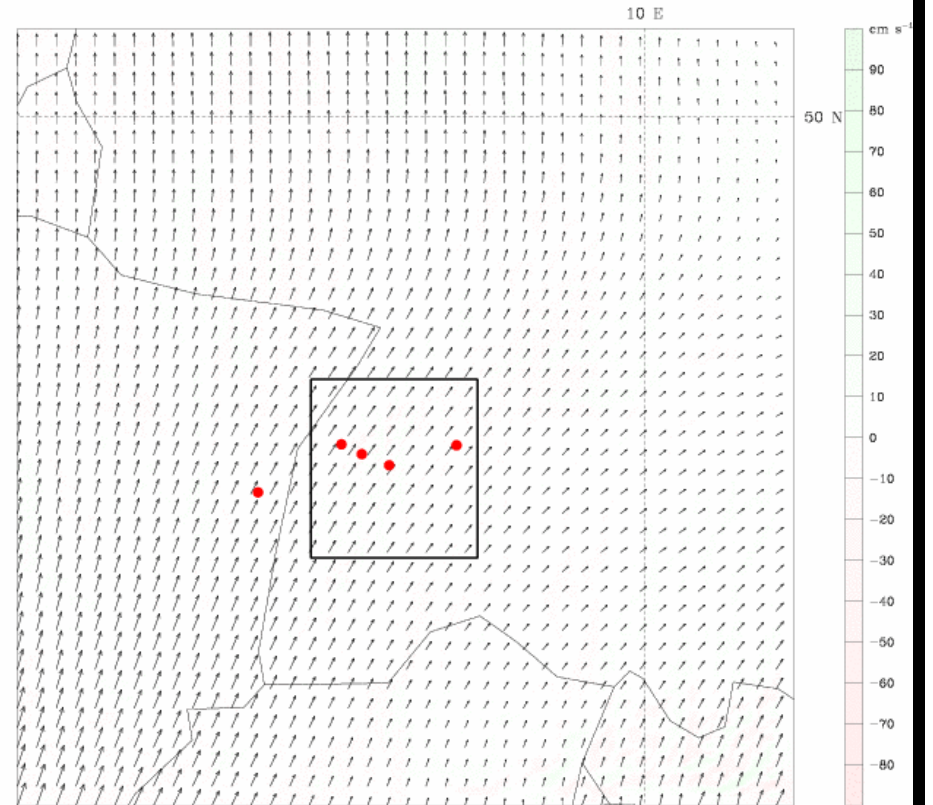
COPS IOP9c 20th Jul (WRF d02, Res 900m, GFS) Init: 0600 UTC Fri 20 Jul 07  
 Fcst: 0.00 h Valid: 0600 UTC Fri 20 Jul 07 (0600 LST Fri 20 Jul 07)  
 Potential temperature at k-index = 120  
 Terrain height AMSL sm=30  
 Horizontal wind vectors at height = 0.00 km



MAXIMUM VECTOR: 7.4 m s<sup>-1</sup> →  
 CONTOURS: UNITS=m LOW= 100.00 HIGH= 2000.0 INTERVAL= 100.00  
 Model Info: V3.0 M No Cu YSU PBL Ferrier Ther-Diff 900 m, 120 levels, 6 sec  
 LW: RRTM SW: Dudhia DIFF: full KM: 2D Smagor

Surface Theta & horizontal winds

COPS IOP9c 20th Jul (WRF d02, Res 900m, GFS) Init: 0600 UTC Fri 20 Jul 07  
 Fcst: 0.00 h Valid: 0600 UTC Fri 20 Jul 07 (0600 LST Fri 20 Jul 07)  
 Vertical velocity at pressure = 700 hPa  
 Horizontal wind vectors at pressure = 700 hPa

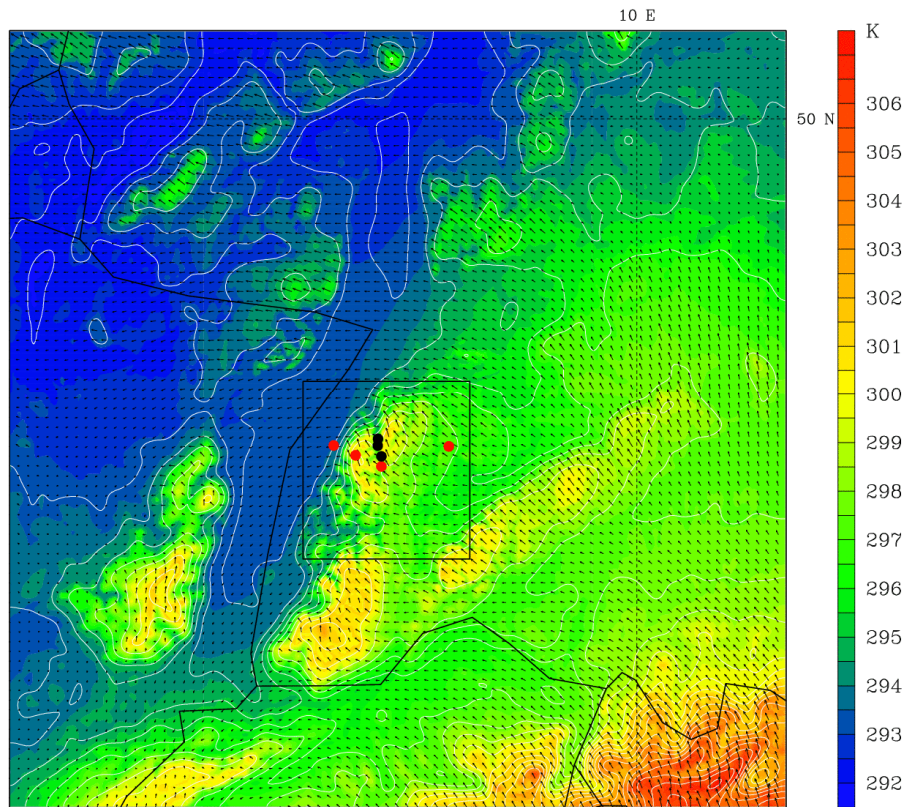


MAXIMUM VECTOR: 14.8 m s<sup>-1</sup> →  
 Model Info: V3.0 M No Cu YSU PBL Ferrier Ther-Diff 900 m, 120 levels, 6 sec  
 LW: RRTM SW: Dudhia DIFF: full KM: 2D Smagor

Vertical (colour) & horizontal (vectors) winds at 700mb

# WRF simulations of IOP 9c

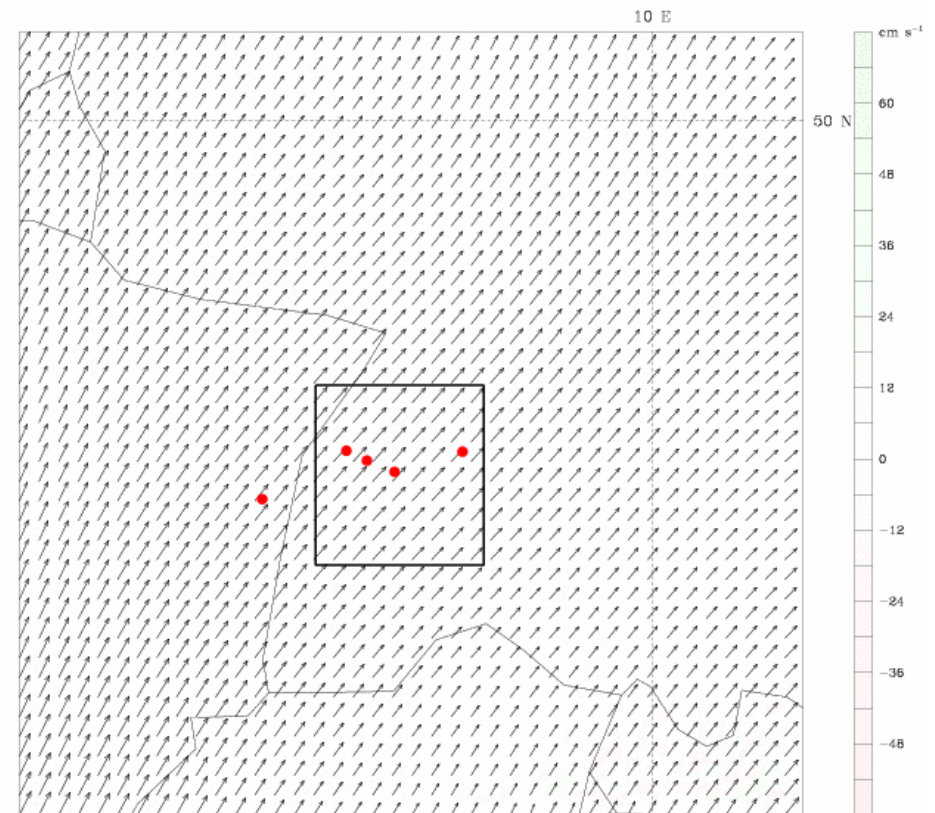
COPS IOP9c 20th Jul (WRF d02, Res 900m, GFS) Init: 0600 UTC Fri 20 Jul 07  
 Fcst: 0.00 h Valid: 0600 UTC Fri 20 Jul 07 (0600 LST Fri 20 Jul 07)  
 Potential temperature at k-index = 120  
 Terrain height AMSL sm=30  
 Horizontal wind vectors at height = 0.00 km



MAXIMUM VECTOR: 7.4 m s<sup>-1</sup> →  
 CONTOURS: UNITS=m LOW= 100.00 HIGH= 2000.0 INTERVAL= 100.00  
 Model Info: V3.0 M No Cu YSU PBL Ferrier Ther-Diff 900 m, 120 levels, 6 sec  
 LW: RRTM SW: Dudhia DIFF: full KM: 2D Smagor

Surface Theta & horizontal winds

COPS IOP9c 20th Jul (WRF d02, Res 900m, GFS) Init: 0600 UTC Fri 20 Jul 07  
 Fcst: 0.00 h Valid: 0600 UTC Fri 20 Jul 07 (0600 LST Fri 20 Jul 07)  
 Vertical velocity at pressure = 600 hPa  
 Horizontal wind vectors at pressure = 600 hPa



MAXIMUM VECTOR: 15.6 m s<sup>-1</sup> →  
 Model Info: V3.0 M No Cu YSU PBL Ferrier Ther-Diff 900 m, 120 levels, 6 sec  
 LW: RRTM SW: Dudhia DIFF: full KM: 2D Smagor

Vertical (colour) & horizontal (vectors) winds at 600mb





# Inner Domain, (300m resolution)

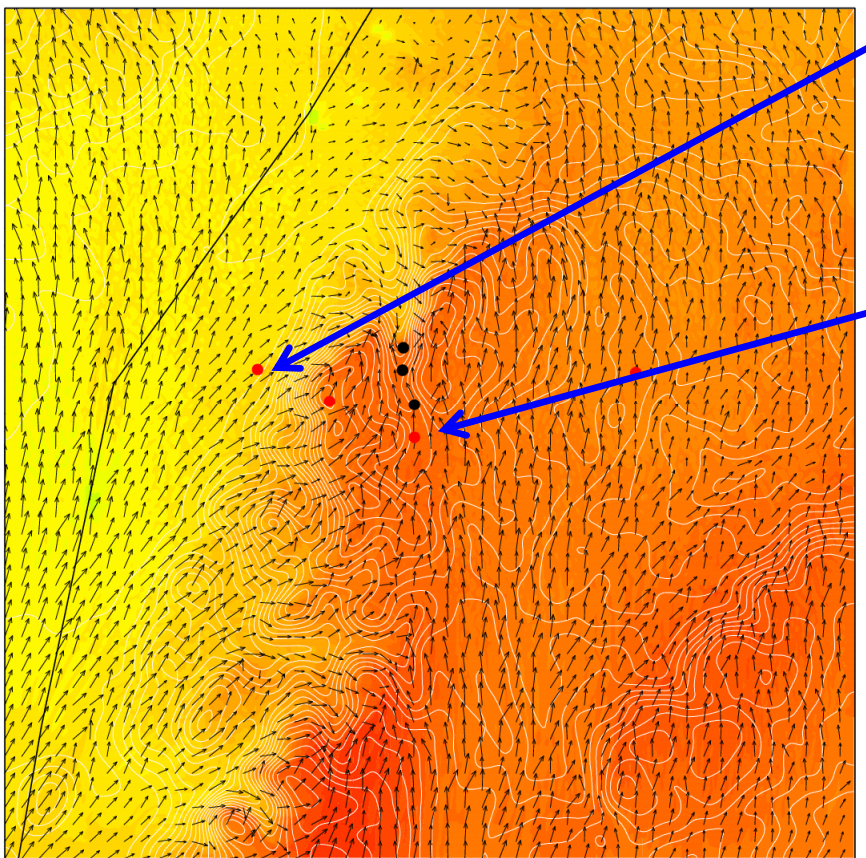
COPS IOP9c 20th Jul (WRF d02,Res 900m,GFS) Init: 0600 UTC Fri 20 Jul 07  
 Fcst: 4.00 h Valid: 1000 UTC Fri 20 Jul 07 (1000 LST Fri 20 Jul 07)  
 Potential temperature at k-index = 120  
 Terrain height AMSL  
 Horizontal wind vectors at height = 0.00 km sm=50



**UNIVERSITY OF LEEDS**

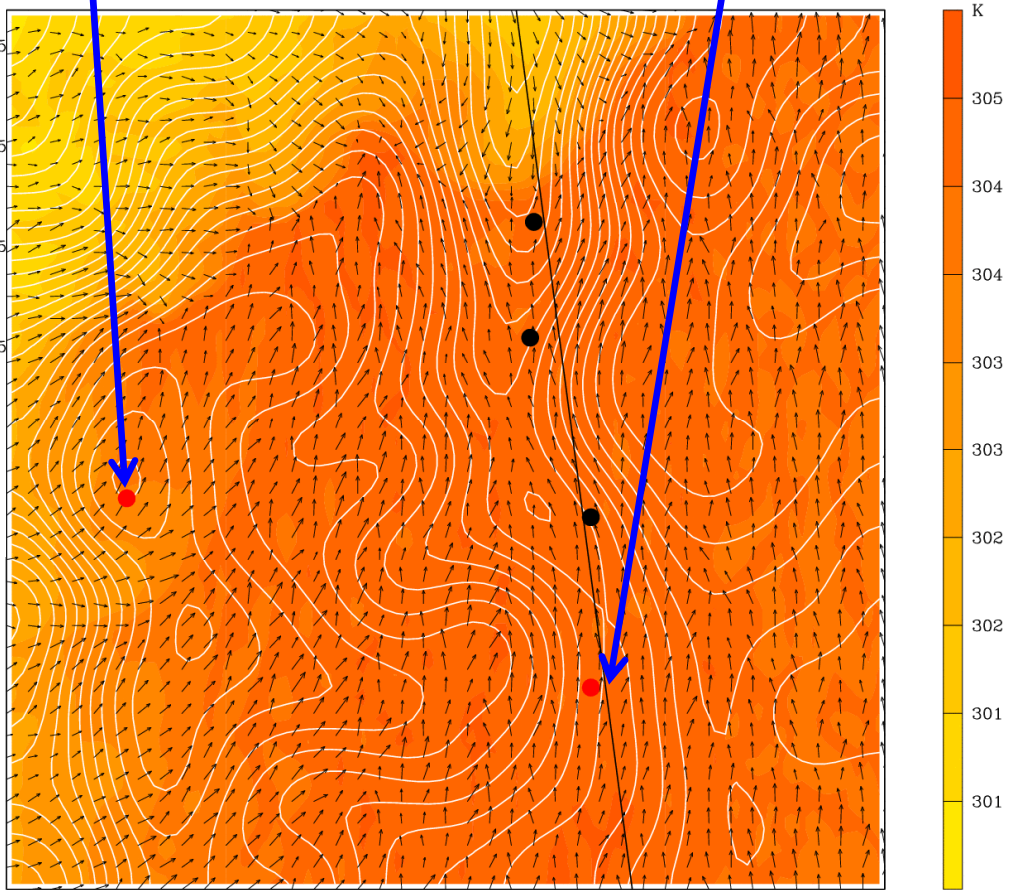
**Hornisgrinde**

**Super Site M**



MAXIMUM VECTOR: 6.1 m s<sup>-1</sup> →  
 CONTOURS: UNITS=m LOW= 120.00 HIGH= 1000.0 INTERVAL= 40.000  
 Model Info: V3.0 M No Cu YSU PBL Ferrier Ther-Diff 300 m, 120 levels, 2 sec  
 LW: RRTM SW: Dudhia DIFF: full KM: 2D Smagor

20th Jul (WRF d02,Res 900m,GFS) Init: 0600 UTC Fri 20 Jul 07  
 Fcst: 4.00 h Valid: 1000 UTC Fri 20 Jul 07 (1000 LST Fri 20 Jul 07)  
 Potential temperature at k-index = 120  
 Terrain height AMSL  
 Horizontal wind vectors at height = 0.00 km sm=30



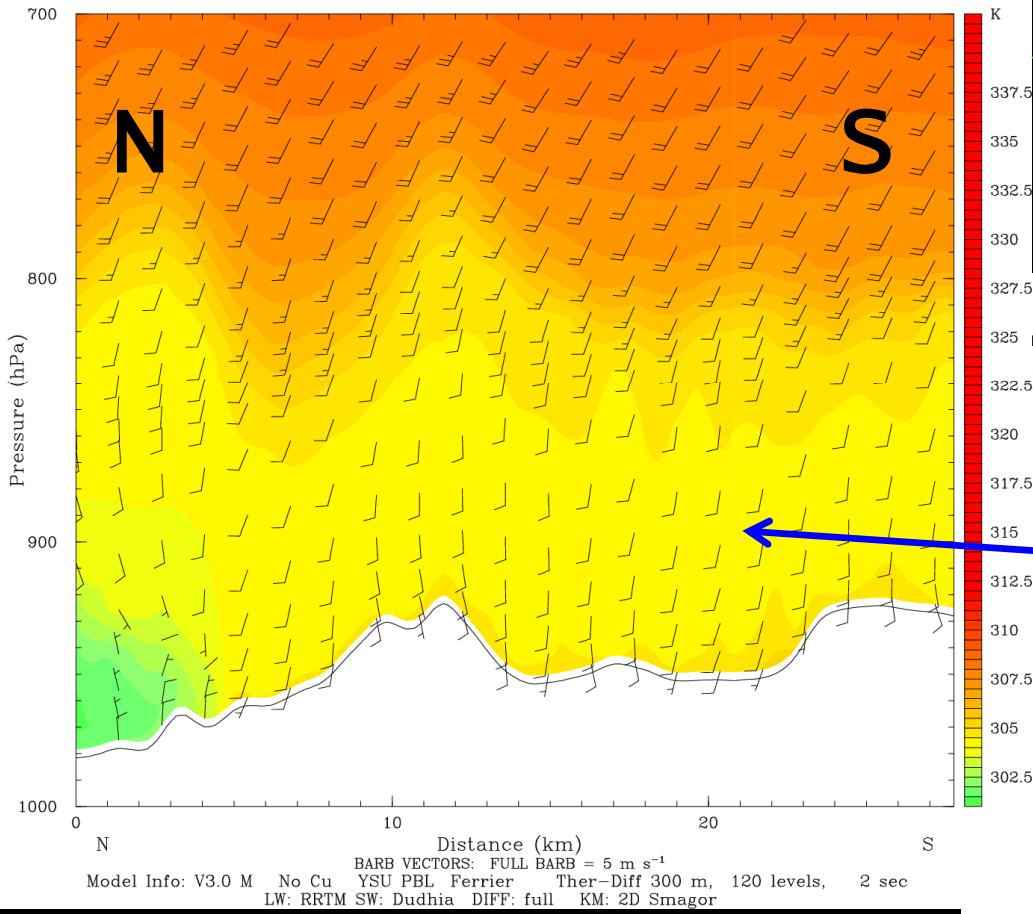
MAXIMUM VECTOR: 6.7 m s<sup>-1</sup> →  
 CONTOURS: UNITS=m LOW= 270.00 HIGH= 930.00 INTERVAL= 30.000  
 Model Info: V3.0 M No Cu YSU PBL Ferrier Ther-Diff 300 m, 120 levels, 2 sec  
 LW: RRTM SW: Dudhia DIFF: full KM: 2D Smagor

Surface Theta & horizontal winds, whole inner domain & zoom in aloft Hornisgrinde & Murg Valley



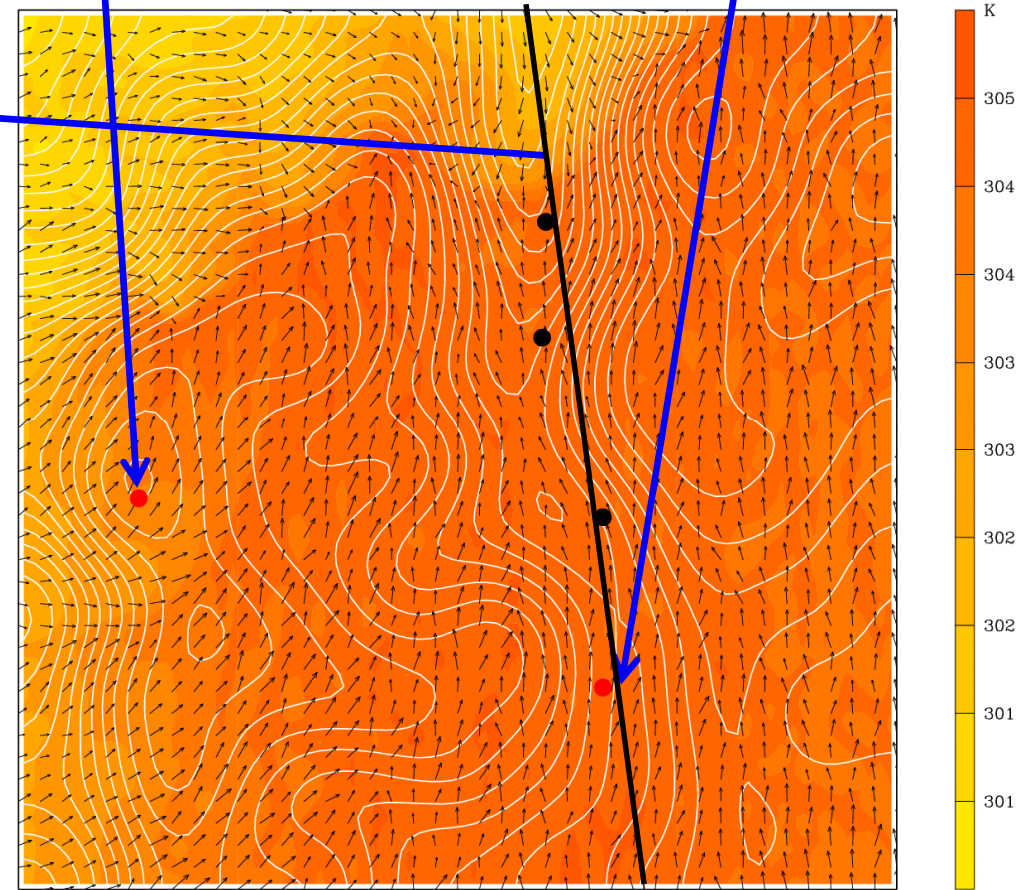


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**Hornisgrinde**

**Super Site M**



Theta & horizontal winds, in cross section from surface to 700mb, along Murg valley

Surface Theta & horizontal winds, whole inner domain & zoom in aloft Hornisgrinde & Murg valley