The Convective Storm Initiation Project (CSIP) and the Planned UK Participation in COPS – Convection and Transport in Complex Terrain (CATICT)

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NCAS and University of Leeds

Major Goal of CSIP: Improve Forecasts of Storms

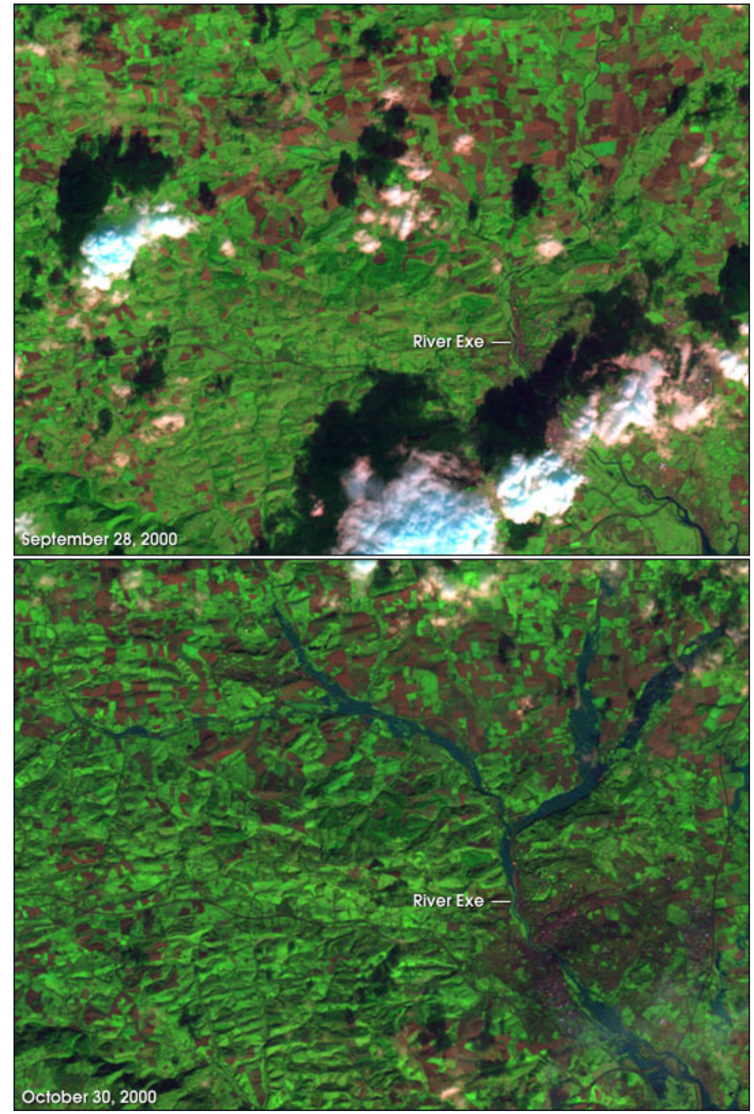
Images from *www.bbc.co.uk*

Specific Aim of CSIP

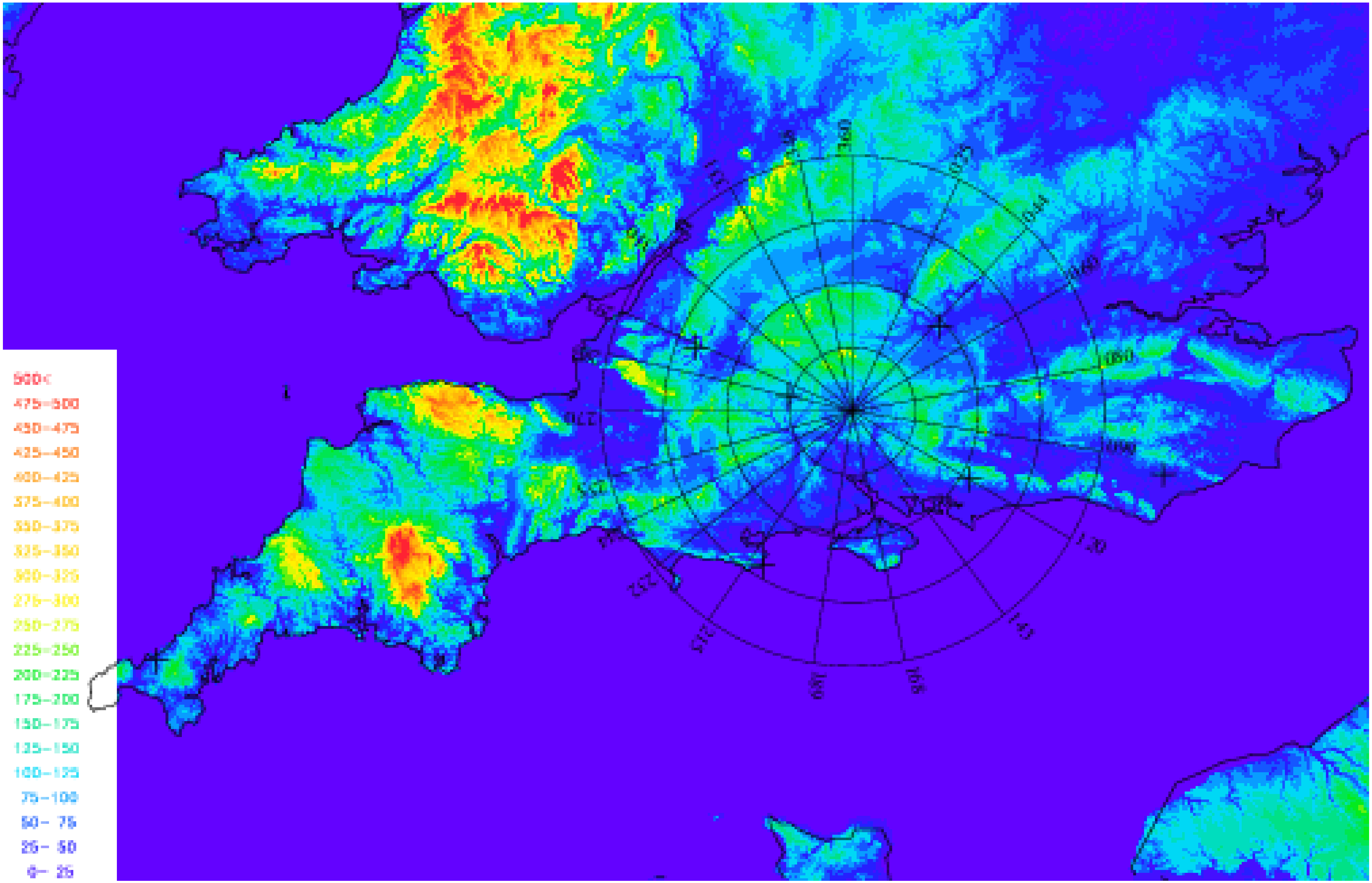
Determine why convective storms form where and when they do.

The major difficulty in forecasting location and timing of convection is caused by uncertaintity in intitiation.

- Before CSIP: models have difficulty with initiation
- After CSIP: models did surprisingly well, but shortcomings in precise location and timings



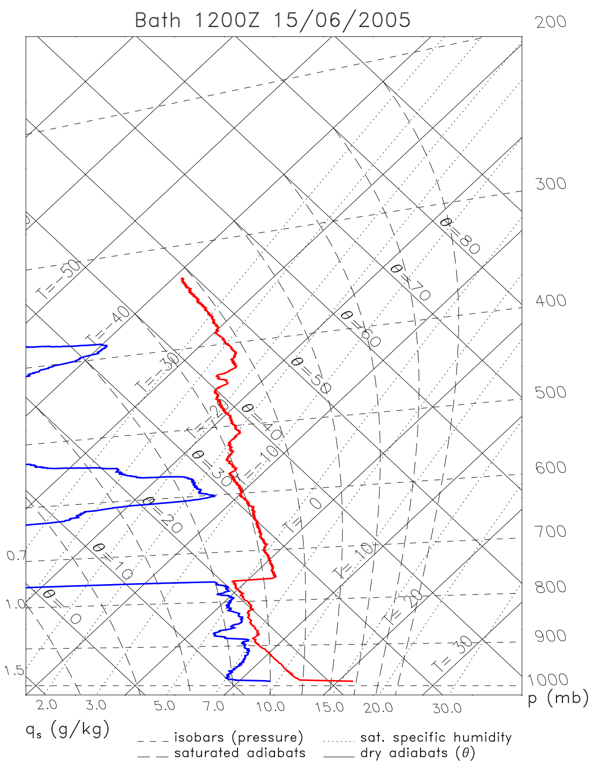
Map of CSIP Area

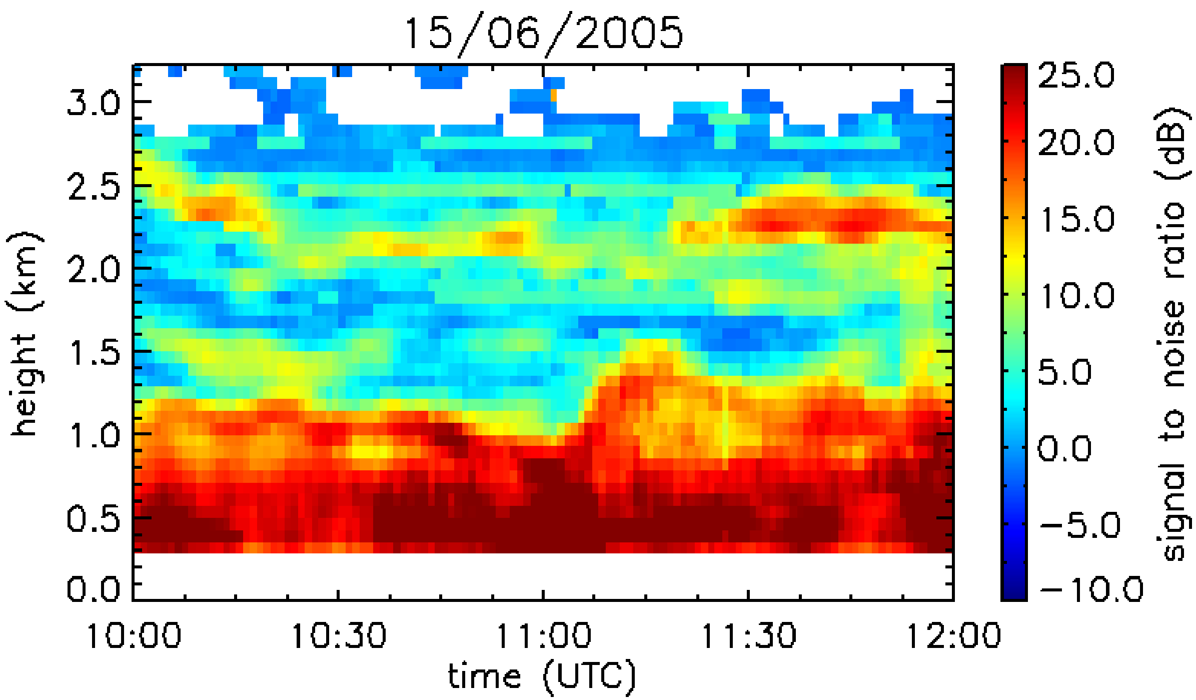


Operational Highlights

- International project. More than 60 people from 11 Groups: BADC, Bath, Chilbolton Observatory, GFZ Potsdam, IMK Karlsruhe, Leeds, Manchester, Met Offi ce, NCAR, Reading, Salford
- 18 IOPs in 2005 (6 α; 7 β; 5 γ); 4 IOPs in 2004: Most objectives met
- Met Offi ce mesoscale model did "surprisingly" well
- Approx 400 UFAM, 160 IMK Graw, 33 mobile Met Offi ce and 191 additional network Met Offi ce sondes

Lids were important



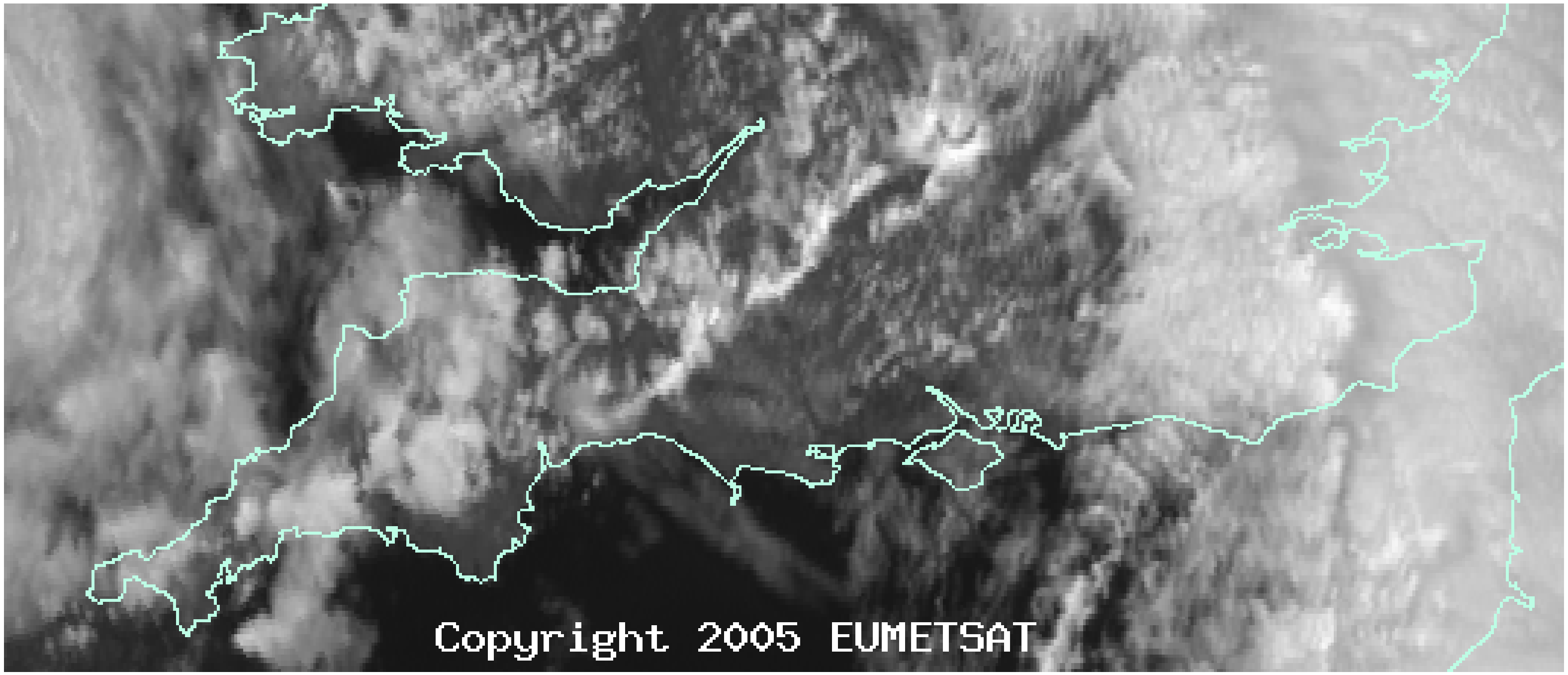


Emily Norton

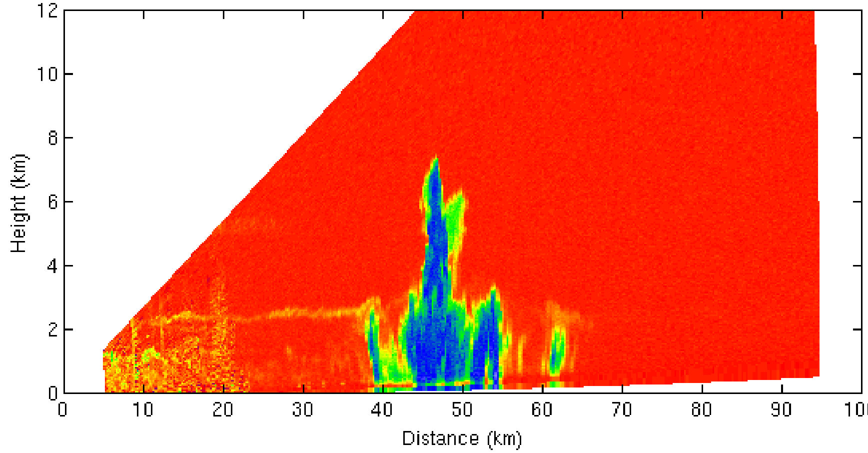
Mechanisms for overcoming lids

- Convergence lines and areas formed by hills and coastlines
- Upper-level forcing
- Frontal upglide
- Longitudinal cloud streets (in strong winds)
- Action of individual thermals and cumulus clouds
- Density currents, gravity waves
- Diurnal heating modulated by shadowing from high cloud

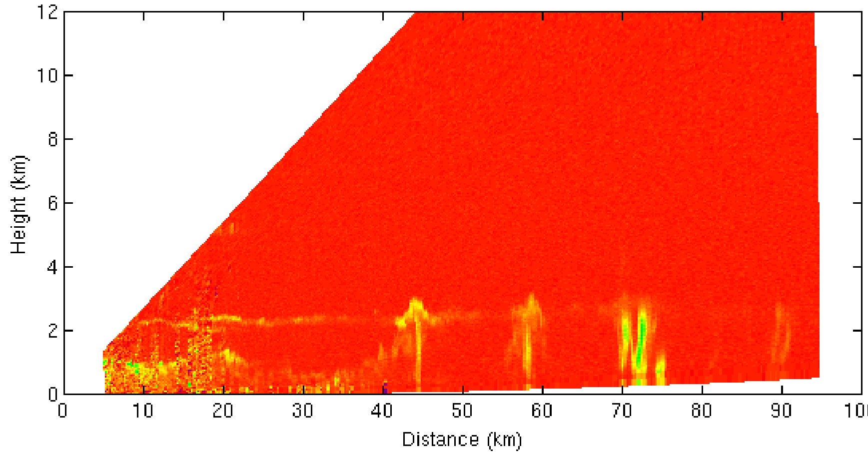
Convergence Line combined with Upper-level Trough



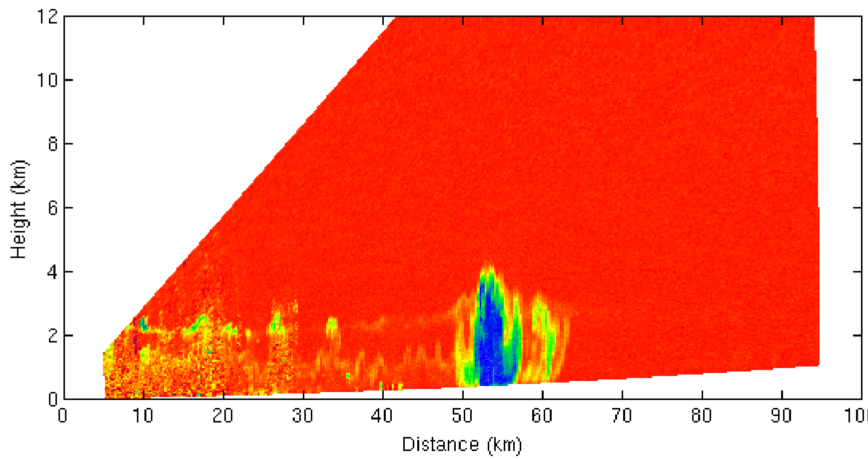
15 June 2005



1115 UTC; 331deg

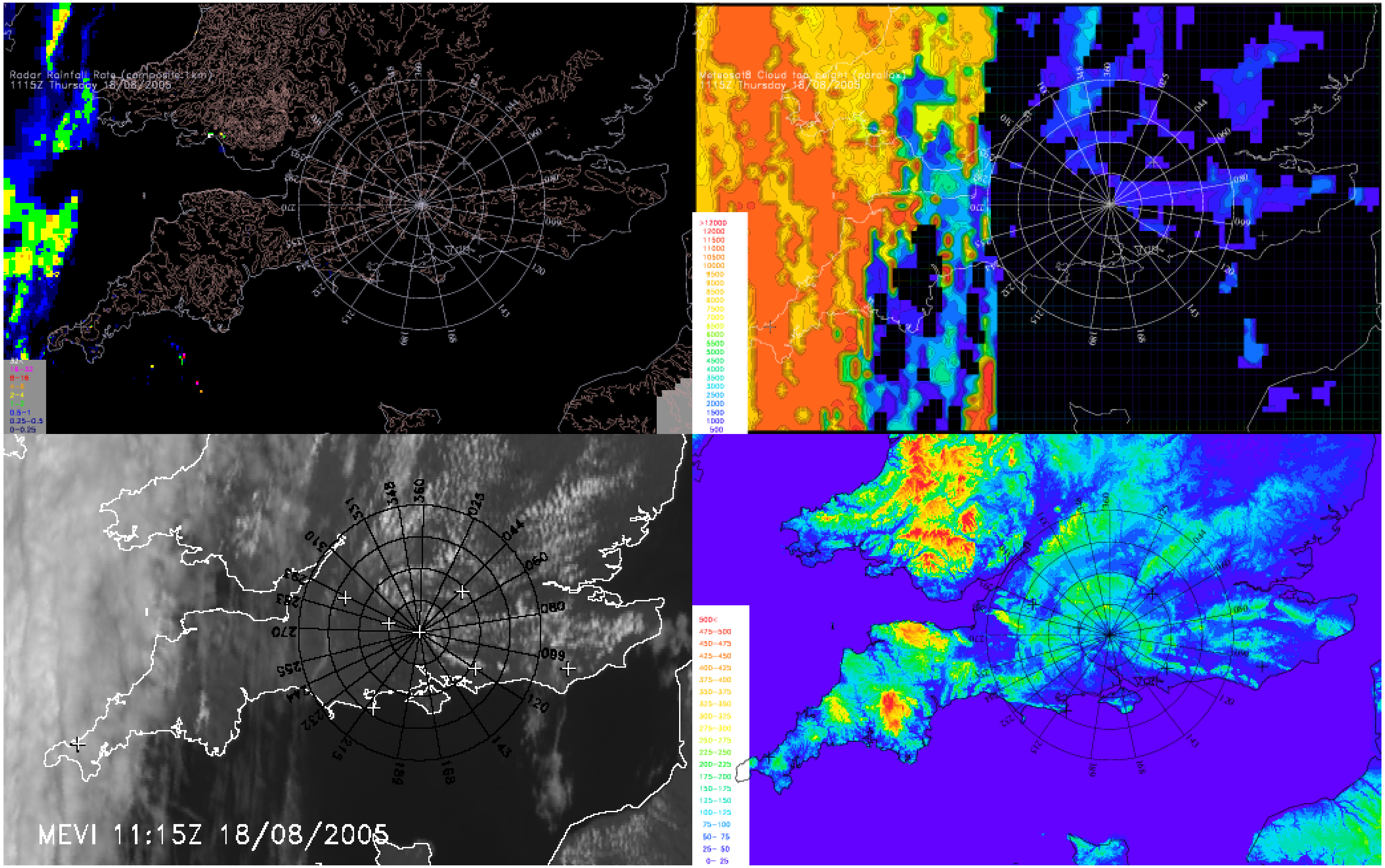


1119 UTC; 293deg



1200 UTC; 310deg

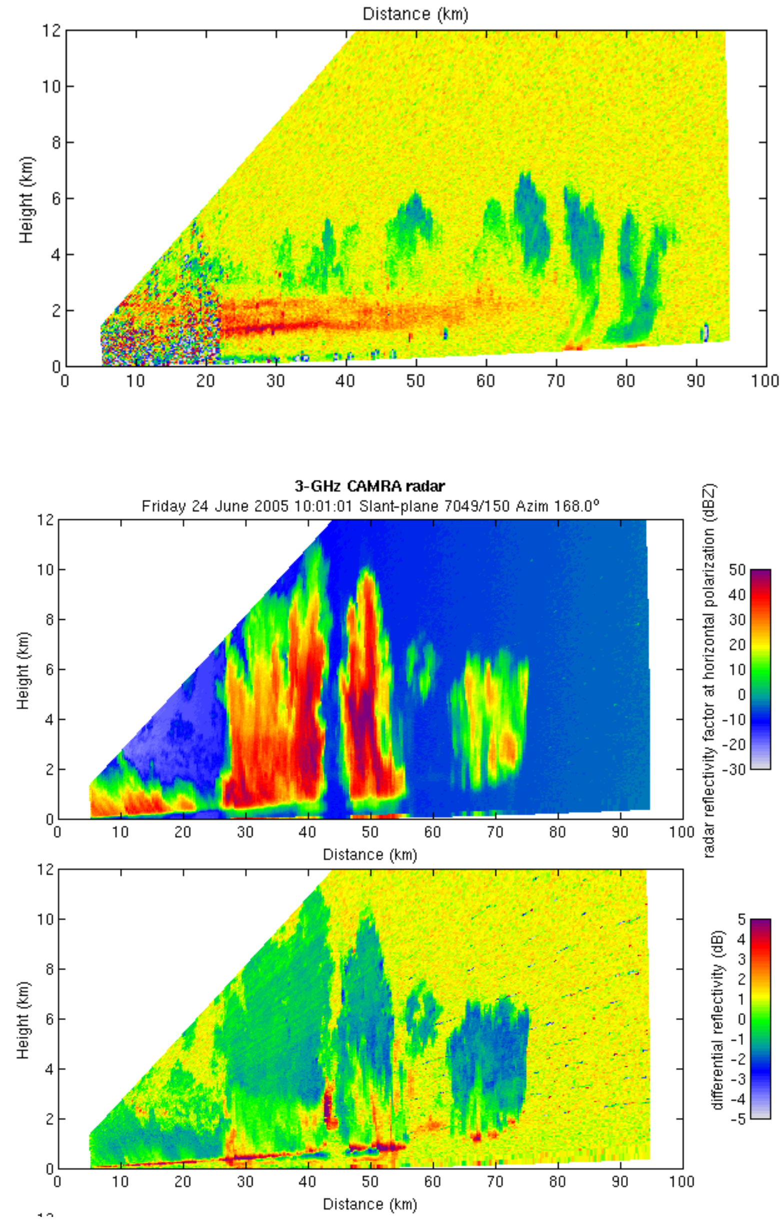
Areas of Convergence over Orography: 18 August ’05



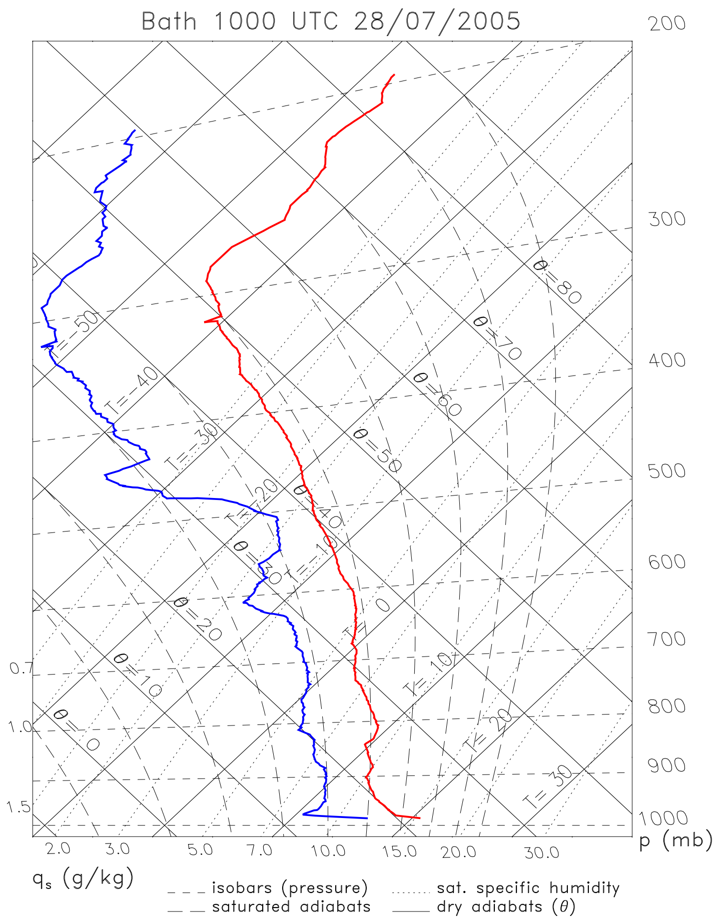
Frontal Upglide: 24 June 2005 – Severe thunderstorms

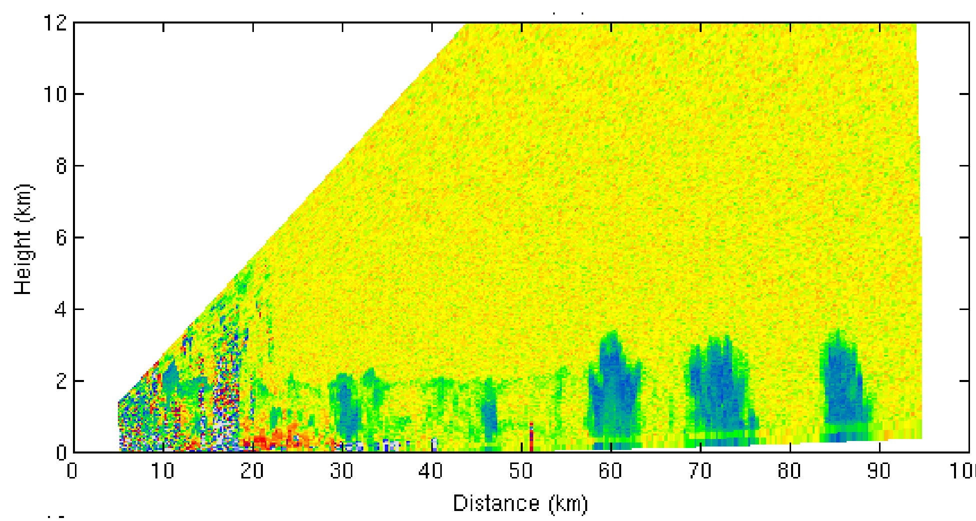
- Tornado near Coventry; music festival flooded;

- High θ_w air over cold air; storms developed from 800 mb level
- Lightning; supercooled raindrops

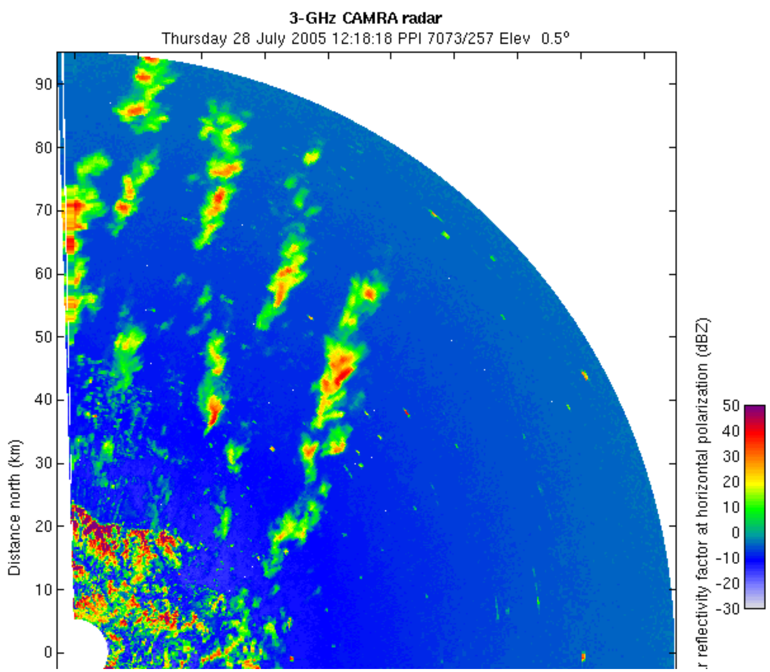


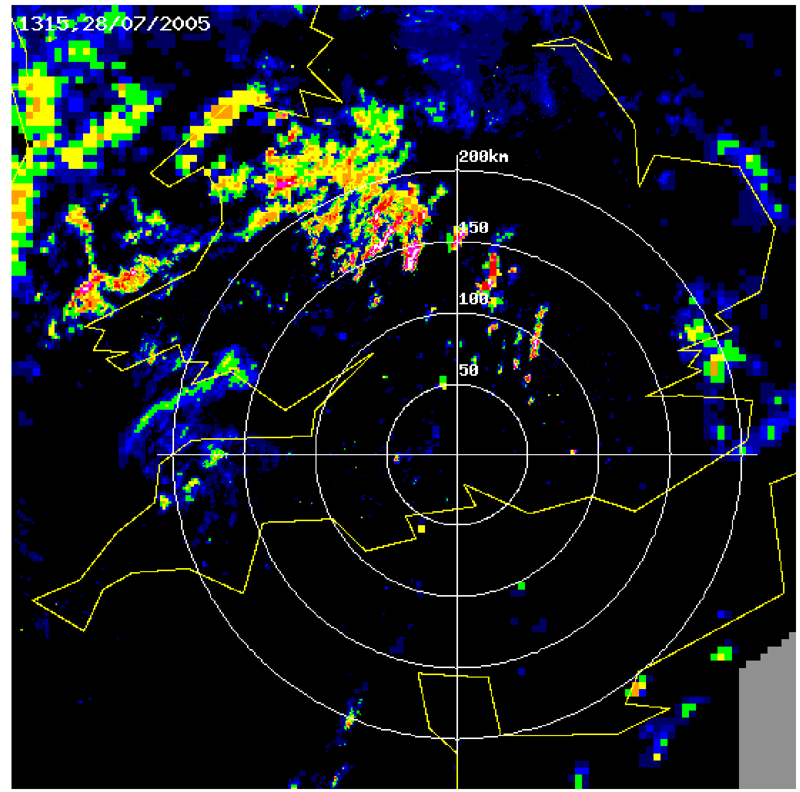
Longitundinal cloud streets: 28 July 2005





Severe storms in N began as cumulus cloud streets






CAR PARK

Summary of CSIP Processes

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Primary Initiation	x				x	x				x	x	x	x	x		x	x	x
Secondary Initiation							x					x	x				x	x
Intense showers	x		x		x	x	x		x			x	x	x			x	x
Upper-level forcing	x				x	x	x		x		x	x		x	x			x
Orography					x	x		x			x	x	x			x		
Coastal effects	x							x			x		x	x				
Convergence lines	x							x	x	x		x	x	x		x		x
Cloud shadowing					x				x							x	x	
Multiple lids	x		x		x			x				x						
Organised showers			x		x		x		x			x	x		x			x

Conclusions

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- Very successful project: minefield of excellent data; real progress can be made
- Lids are important
- No single phenomenon to overcome CIN
- Cloud microphysics more important than previously thought:
  - quantity of precip;
  - evaporation of precip (secondary convection);
  - timing of precip formation

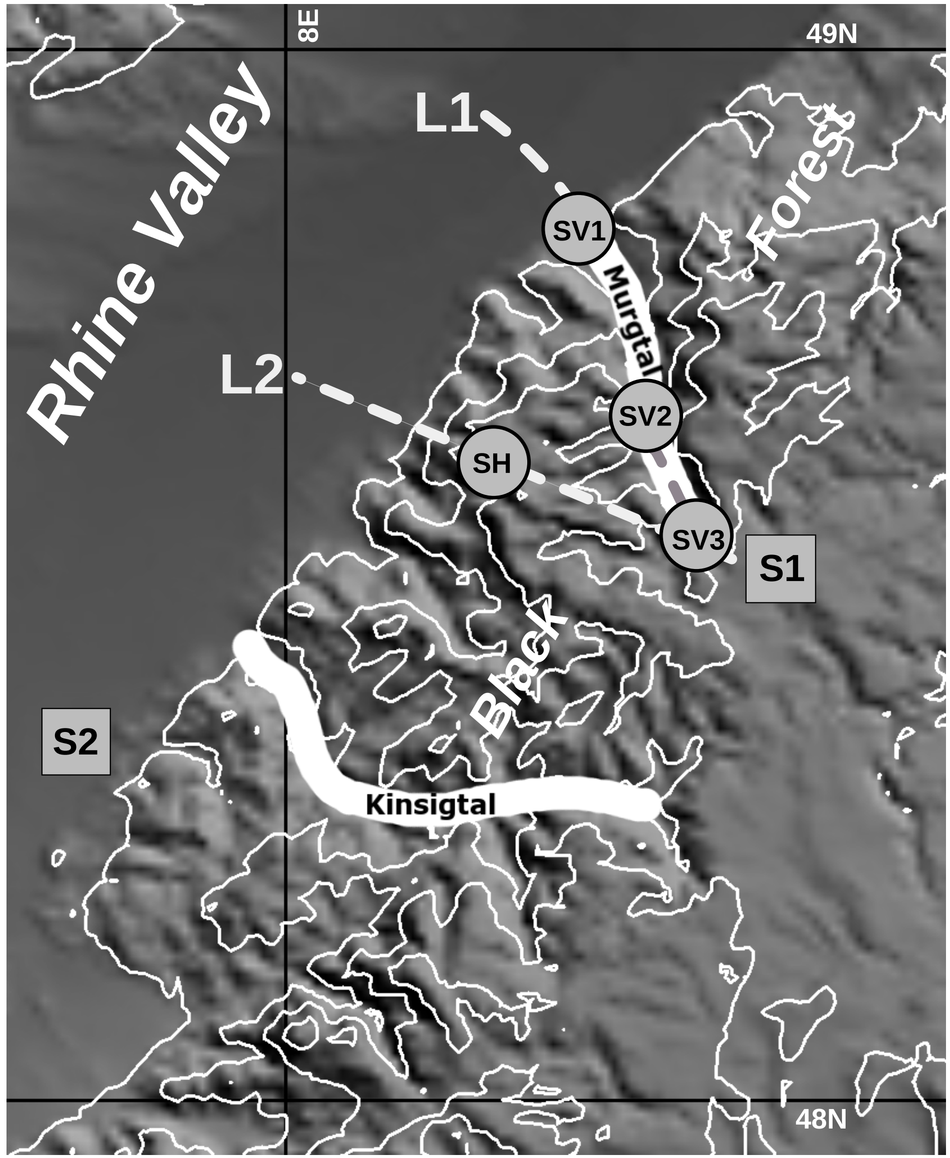
UK Participation in COPS: Convection and Transport in Complex Terrain (CATICT)

- Coordination by UFAM – Universities' Facility for Atmospheric Measurement. Part of NCAS – National Centre for Atmospheric Science
- Contributing universities:
  - Leeds
  - Manchester
  - York
  - Reading
  - Salford

Overarching Scientific Questions

- What are the pathways for heat, mass, water vapour, aerosols and trace constituents to enter terrain-locked convective cells?
- How is the development of deep convection and precipitation over complex terrain influenced by the cloud/aerosol interaction?

CATICT Region



Goals 1: Orographic Flows

How do orographic flows generate the horizontal convergence necessary for development of convective cells?

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- To determine the factors controlling whether anabatic up-valley and up-mountain-range flows are trapped or penetrate the free troposphere
- To determine the critical factors (e.g. surface fluxes, resolution, stability) affecting the ability of the Met Office UM to reproduce the observed inflows to convection

Goals 2: Venting

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- To determine the factors affecting the ability of the Met Office UM to reproduce the observed fluxes of aerosols and chemical species into convection
- To determine the evolution of both short and long-lived chemical species (e.g. isoprene, ozone) in the convective boundary layer and to relate these to air mass history

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- To determine how the orographic cumulus congestus clouds process the aerosols, thereby influencing the aerosols ingested into clouds.

Goals 4: Convective transport

What influence do convective systems have on the regional-scale redistribution of aerosols and chemical species and hence on further development of precipitation and air quality?

- To quantify the concentrations of aerosols and trace chemical species upwind and downwind of orographic convection in the free troposphere

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- To determine the factors affecting the ability of the Met Office UM to reproduce the upwind–downwind changes in aerosol concentration across orographic convection

Instrument	Measurement	Group	Location
Wind Profiler	3D winds; reflectivity	Manchester	SV2
Ozone DIAL	Ozone; aerosol backsct	Manchester	SV2
3 Radiosonde stations	Profiles of met	Lds/Mcr/Rdg	SV1,2,3
3 Doppler Lidars	Aerosol backsct, vel.	Slfrd(2)/Rdg	SV1, SH
Radiometer	Profiles of T, RH	Slfrd	SV1
Cessna	T, RH, wnds, aersls, NO_x, O_3, sfc T	Mcr	SV1-SV3
3 Sodars	Profile of 3D winds	Leeds	SV1,2,3
10 AWSs	Surface Met	Leeds	L1, L2
5 masts	3D winds, turb & rad flxs	Lds, Rdg	SH, SV1, 2, 3, S1
5 energy-blnce stns	Fluxes of heat	Leeds, Rdg	SH, SV1, 2, 3, S1
GB aerosol, chem	Aersls conc, comp	Mcr	SV1
GB aerosol, chem	Volty, $N(d)$, opt thck, O_3	Lds	SH
Tethered balloon	Wds, T, RH, O_3, arsl, VOCs	Lds, York	SV1
3 GB aerosol, chem	Size and conc, opt thick; O_3	Lds	SV1, 2, 3

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