



## Regional climate modelling and observations for regional reanalyses

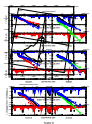
Richard Jones

### Current status of Hadley Centre regional climate models



#### Using improved atmospheric component of HadCM3

- Model at 25km horizontal resolution, 19 levels (50m to 0.5hPa)
- Using ERA40 as boundary conditions
- Incorporating anthropogenic forcings including local sulphur cycle
- Driving catchment-based and grid-based river models
- Driving 2-D storm surge and 3-D shelf seas models



# Example of flow from RCM rainfall



Flow rate

Time (years)

Catchment and RCM  
25km grid

Annual peak flows

Red:  
observed  
rain  
Blue: RCM  
rain:  
Black:  
observed  
flow

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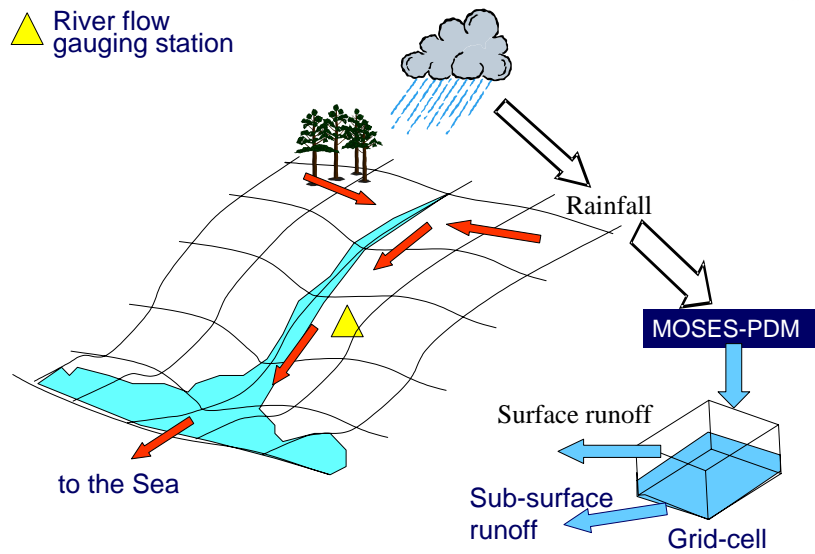
Return periods

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# A runoff-routing model



▲ River flow gauging station



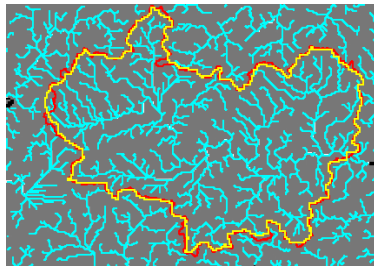
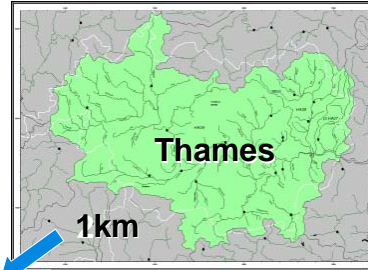
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## Accurate representation of the Thames catchment



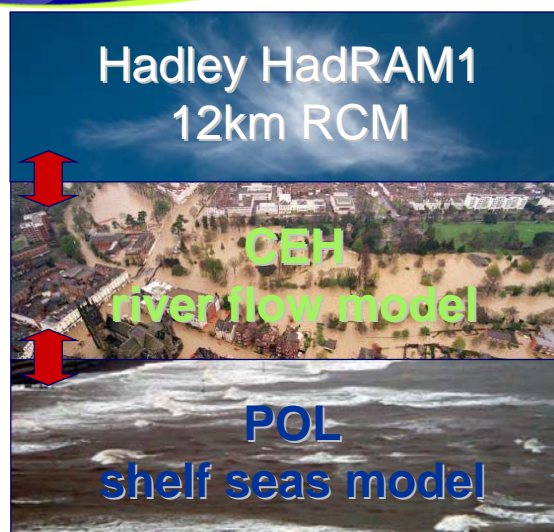
- Current modelling of UK river network at 1km
- Large catchment boundaries well represented



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## Development system using Met Office operational models



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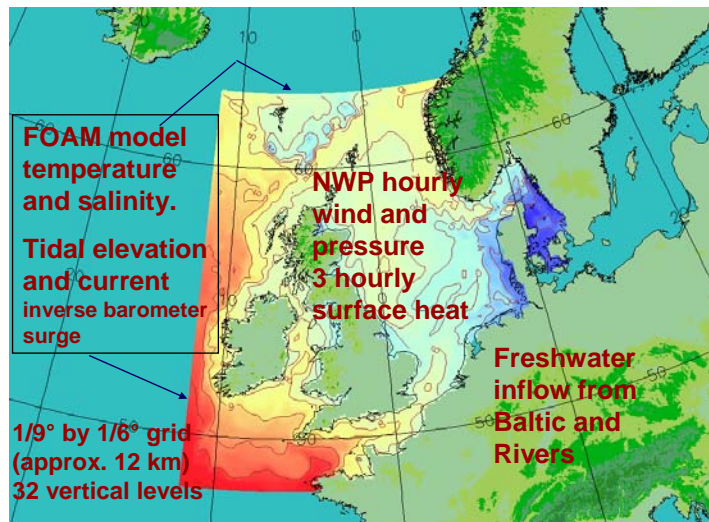
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## Shelf Seas model: POLCOMS

Developed by POL, applied by the Met Office



Tides  
Storm surges  
Seasonal stratification  
Tidal mixing fronts  
River inflows  
Algal blooms  
Sediment  
Shelf slope current  
Norwegian coastal current



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## Application of coupled regional climate model to EURRA



Provide initial high resolution regional reanalysis

- Skilful high resolution information added
- Minimal infrastructure required for initial results
- Does not use available observations ...
- ... but lack of spin-up may improve results
- Provides assessment of quality of model climatology

Use other system components to provide additional validation

- River-flow as integrator of precipitation and soil moisture processes
- Sea-surface/storm surge heights as integrators of surface pressure and winds

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## Hadley Centre SST datasets



- Available now
  - HadISST1 dataset
  - Monthly gridded SST and sea-ice at  $1^{\circ} \times 1^{\circ}$  resolution (1870-present)
  - Used in ERA-40
- Planned for 2007
  - HadISST2 - gridded SST and sea-ice on a user-selectable resolution – incorporating additional in-situ observations and satellite data (1850-present).
  - OSTIA (part of GHRSSST-PP Reanalysis) – 5km daily resolution SST dataset based on satellite/in situ data 1984-present.

## Hadley Centre observations datasets



- Available in 2006
  - HadCRUT3: monthly average temperatures gridded at a variable spatial resolution (1850-present)
  - HadGHCND: Daily maximum and minimum temperatures on a  $2.5^{\circ}$  latitude by  $3.75^{\circ}$  longitude grid (1946-2000).
  - EMSLP: Daily sea-level pressure on a  $5^{\circ} \times 5^{\circ}$  grid (1850-2002).
  - HadAT: Gridded free atmosphere temperatures from radiosondes  $5^{\circ}$  latitude by  $10^{\circ}$  longitude at 9 pressure levels.
  - HadEX: land-based climate extremes dataset - 27 indices of temperature and precipitation on a  $2.5^{\circ} \times 3.75^{\circ}$  grid from 1951 to 2003

## Availability of Hadley Centre data



- Most datasets can be downloaded from [www.hadobs.org](http://www.hadobs.org)
- EMSLP will be available from the EMULATE website at UEA:  
[www.cru.uea.ac.uk/cru/projects/emulate](http://www.cru.uea.ac.uk/cru/projects/emulate)
- Satellite SST data is available from the GHRSSST-PP web-site:  
[www.ghrsst-pp.org](http://www.ghrsst-pp.org)

## Hadley Centre capabilities relevant to EURRA



### Observational data as input

SSTs/sea-ice (at high resolution depending on timescale)

### Observational data for validation

HADCRUT3 – and methodology for European observations?  
HADAT – for validation of upper air trends etc

### Regional climate models for initial products

Testing RCMs/LAMs as initial quality check before RA

### Coupled regional climate models for further products and integrating validation



## Atmospheric data assimilation for Europe.

EURRA, ECMWF, November 2005

*Andrew Lorenc*

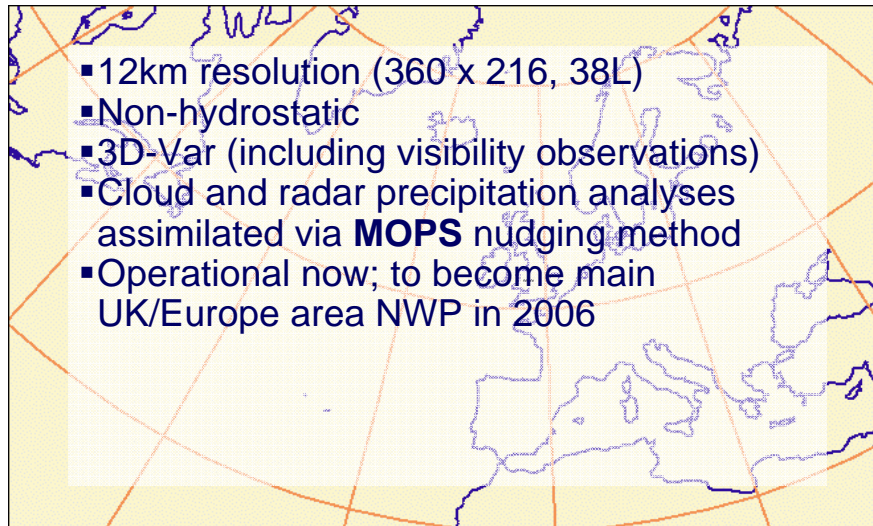
### DA Outline & Summary



- **Operational Regional NWP system**
  - NAE model.
  - 3D-Var (incl. visibility). Cloud and radar nudging.
  - Good forecasts.
- **Development plans**
  - 4D-Var operational, March 2006.
- **Radar data**
  - NIMROD processed data & analysis
  - European Data Hub



## North Atlantic European (NAE) Model



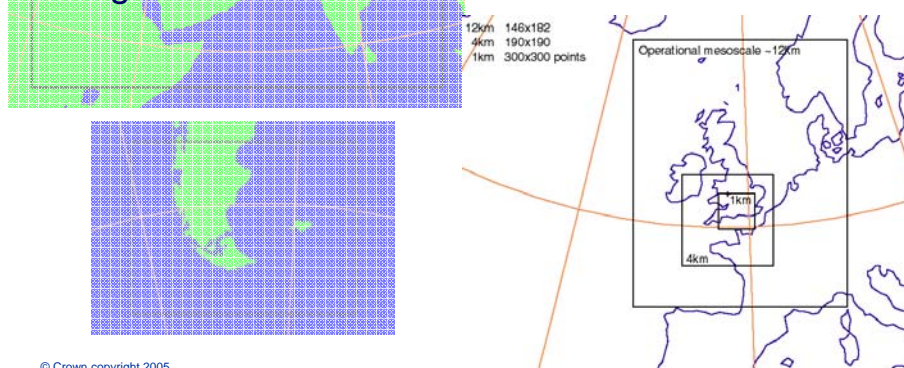
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## Flexible Unified Modelling system



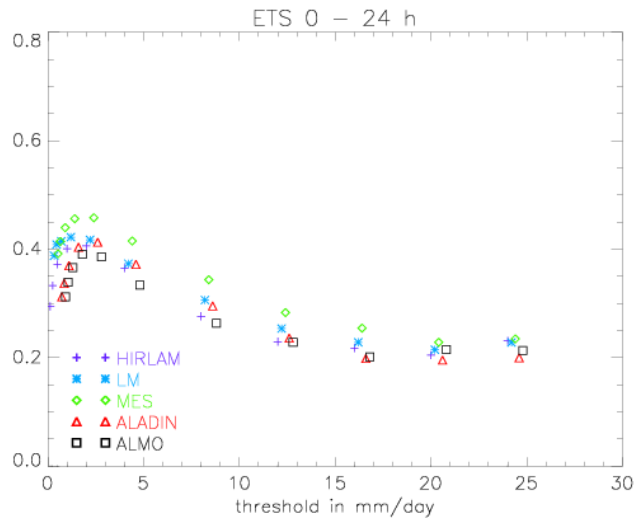
- NWP Model & Regional Climate Model are essentially the same
- NWP is easily configured for other areas, so could re-analyse using exactly same model and grid as RCM.



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## UM LAM forecasts as good as any in Europe



00 UTC run of each model verified since Jan 2004, against UK radar data, averaged to common 22km (HIRLAM) grid.

<http://www.metoffice.gov.uk/research/nwp/numerical/precipitation/emip.html> (password protected)

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## NAE 4D-Var development strategy



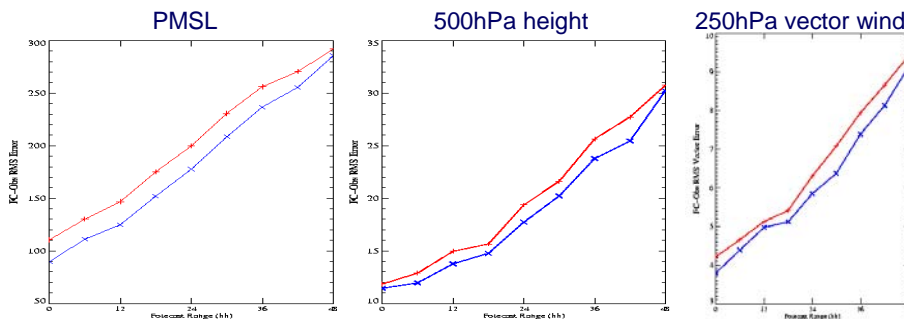
- Operational by March 2006
- Base design on successful Global 4D-Var:
  - 6-hourly cycle
  - Similar science
- Observations specific to regional models assimilated as in current system:
  - Nonlinear visibility observation operator
  - hourly  $T_{2m}$ ,  $RH_{2m}$ ,  $V_{10m}$
  - **MOPS** nudging of cloud and rainfall data.
- Research into 4D-Var assimilation of cloud and radar precipitation underway. Implementation in stages 2006-9.

*Bruce Macpherson*

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## Preliminary Results -2



- 24km UM / 48km PF test suite
  - one week, March '05, 14 forecasts → t+48
  - RMS errors v surface & sonde obs
  - NAE domain

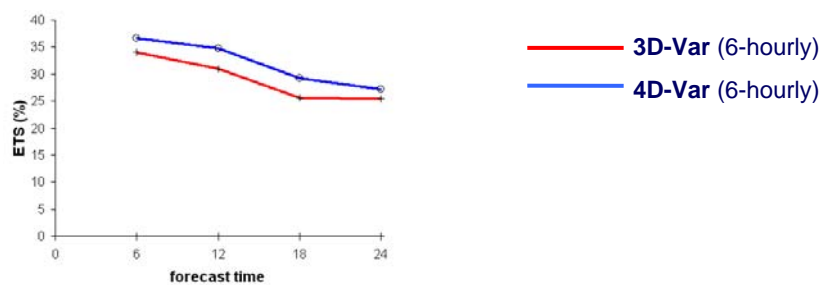
— 3D-Var (6-hourly)  
 — 4D-Var (6-hourly)

*Mark Naylor, Richard Renshaw*

## Preliminary Results – 3



### skill of 6-hourly rainfall accumulations of >4mm



- 24km outer UM / 48km inner PF test suite
  - one week, March '05, 14 forecasts
  - v stations, NAE domain

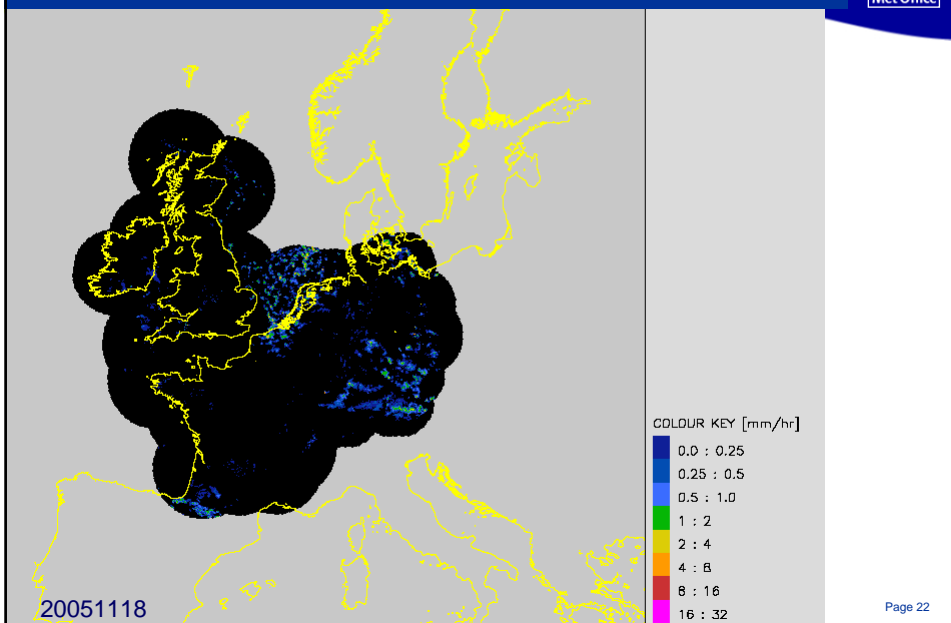
*Mark Naylor, Richard Renshaw*

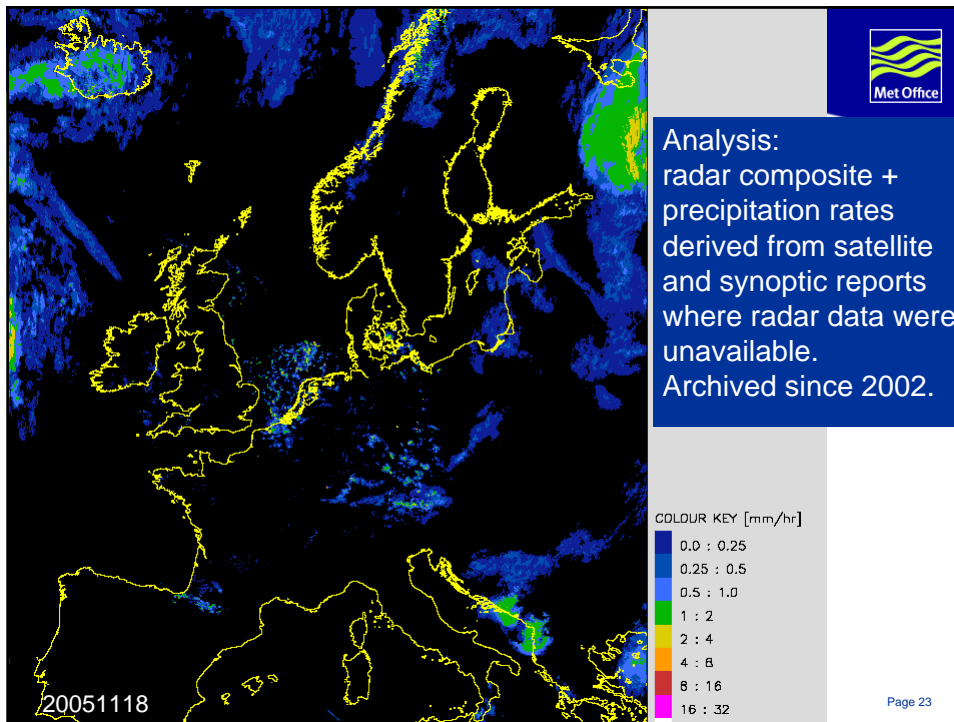
## Likely Computational Cost



- 6-hour 4D-Var window
- 12km outer UM / 36km inner PF
- ~70 iterations (needed for nonlinear visibility)
- ~30min on 4 nodes of SX-8  
(~1/8 of total supercomputers)
- ~ 1/2 area (and cost) would cover European land

## Composite QC'ed & corrected radar ppn. Assimilated. Archived since 2002.





### European Radar Data Hub prototype available early 2006

Met Office

Country	Response received	Data to be supplied	Number of composite products available	Number of single site products available	Number of composite products delivered	Number of single site products delivered
Germany	Y	Y	1	16	1	16
United Kingdom	Y	Y	1	13	1	13
Poland	Y	Y	0	8	0	8
Switzerland	Y	Y	1	3	1	3
Italy	Y	Y	0	5	0	3
Netherlands	Y	Y	1	2	1	2
Czech Republic	Y	Y	1	2	1	2
Belgium	Y	Y	0	2	0	2
Ireland	Y	Y	0	2	0	2
Croatia	Y	Y	0	2	0	2
Channel Islands	Y	Y	0	1	0	1
Slovenia	Y	Y	0	1	0	1
France <sup>1</sup>	Y	Y	1	0	1	0
Hungary	Y	Y	1	0	1	0
Sweden	Y	Y	0	12	0	0
Finland	Y	Y	0	8	0	0
Norway	Y	Y	0	5	0	0
Portugal	Y	Y	1	2	0	0
Greece	Y	F	0	0	0	0

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Dawn Harrison

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RadarnetIV - RADDEV SITE UNDER DEVELOPMENT - DATA ARE NOT LIVE

RADUK RADDEV RADEU

**INCOMING DATA**

- IN DATA
- Thumbnail
- Select from map
- Europe: Link to map
- Latest delivery times
- Raw reflectivity data

**RECEPTION SITES**

- Daily sites
- Monthly sites (all sites)

**PRODUCTS**

- 1000 km h0, composite
- 1 km composite
- Large Area European Composite
- Composite AFC
- Product logs
- Latest key product times
- Key single sites status
- Key composite status

**PRODUCTS STATISTICS**

- Daily: single site
- Daily: composite
- Monthly: single site
- Monthly: composite

**RADARNET IV MONITORING**

- Data monitoring
- Gauge - Radar comparison
- Single site
- Composites
- Process monitoring
- Adjustment factors
- Monthly FODs
- Monthly conditional rainfall rates
- Calibration
- Targets
- Antenna pointing

**RADARNET TRIALS**

- 1 km: single site
- 1 km: single site

**RADARNET SYSTEM**

Map last updated 30/06/05

**Processed images: Select from map**

Click on a marker to show the latest radar image for that station.  
Click on a country in the list to go to radar image thumbnails for that country.

- Austria
- Belgium
- Bulgaria
- Croatia
- Czech
- Denmark
- Denmark
- France
- Germany
- Greece
- Hungary
- Ireland
- Italy
- Netherlands
- Norway
- Poland
- Portugal
- Romania
- Slovakia
- Slovenia
- Spain
- Sweden
- Switzerland
- United Kingdom

- Inputs vary in terms of processing already applied. This presents a challenge to ensure appropriate subsequent processing
- Processing options include:
  - Clutter identification (ground and sea)
  - Anaprop removal
  - Occultation correction
  - VPR correction
  - (Gauge adjustment)

The Met Office wants to help define and develop the EURRA proposal. *In particular it is ...*



*... well placed to contribute to the following work packages, early in the project:*

- Regional climate modelling.
- Regional atmospheric data assimilation.
- Sea-Surface Temperature analysis.
- Climate change and multi-decadal variability.

*... interested in developing capability to contribute to the following workpackages later in the project:*

- Radar data assimilation.
- Coastal Ocean Assimilation.