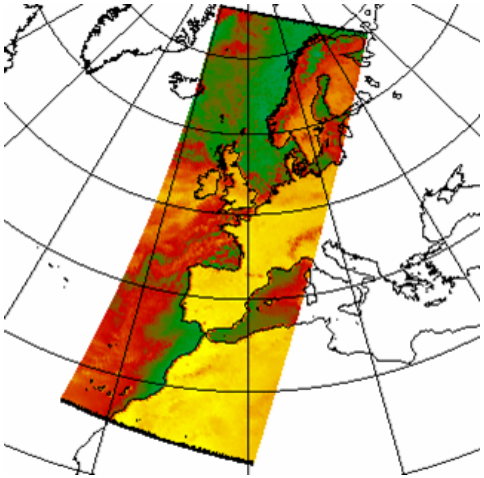
Improved use of AMSU-B data in UK Met Office regional models



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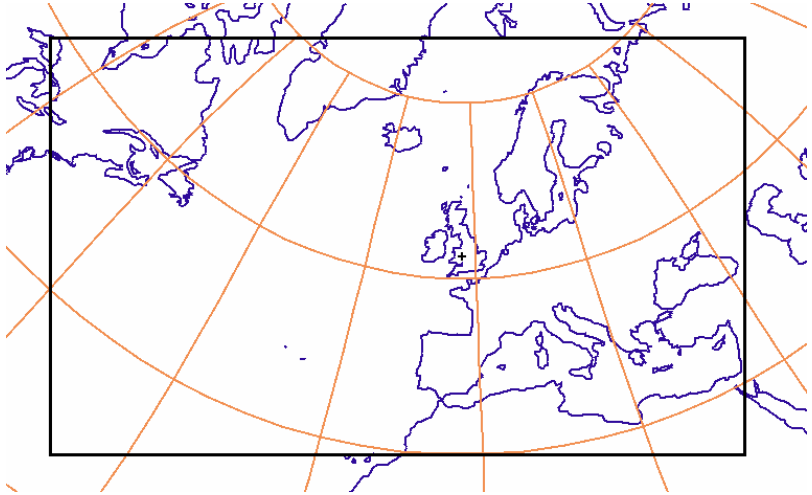
Satellite Applications
UK Met Office, Exeter

Talk Outline

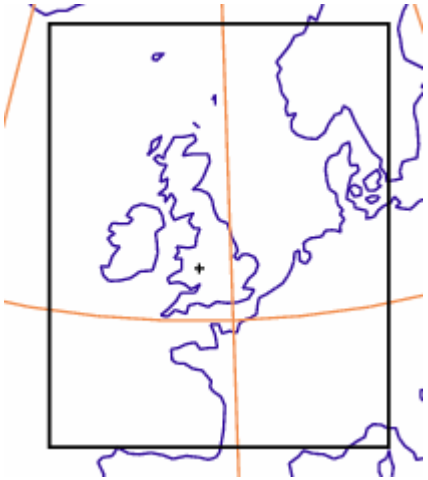
- **Review Limited Area models in Use at the Met Office**
  - Model Domains
  - Current ATOVS usage
- **Advantages of using AMSU-B at full resolution**
- **AMSU-B Quality Control and Channel Selection**
  - Compare with existing scheme
  - Use of Retrieved Liquid Water Path
- **3D-Var Comparisons**
  - Compare the change in resolution
  - Investigate the impact of switching on the 89 and 150 GHz channels
  - How do the increments compare with RadioSondes?
- **Comments on Testing Forecast Impacts and Conclusions**

Limited Area Models at the Met Office

North Atlantic model (NAE)



UK Mesoscale Model

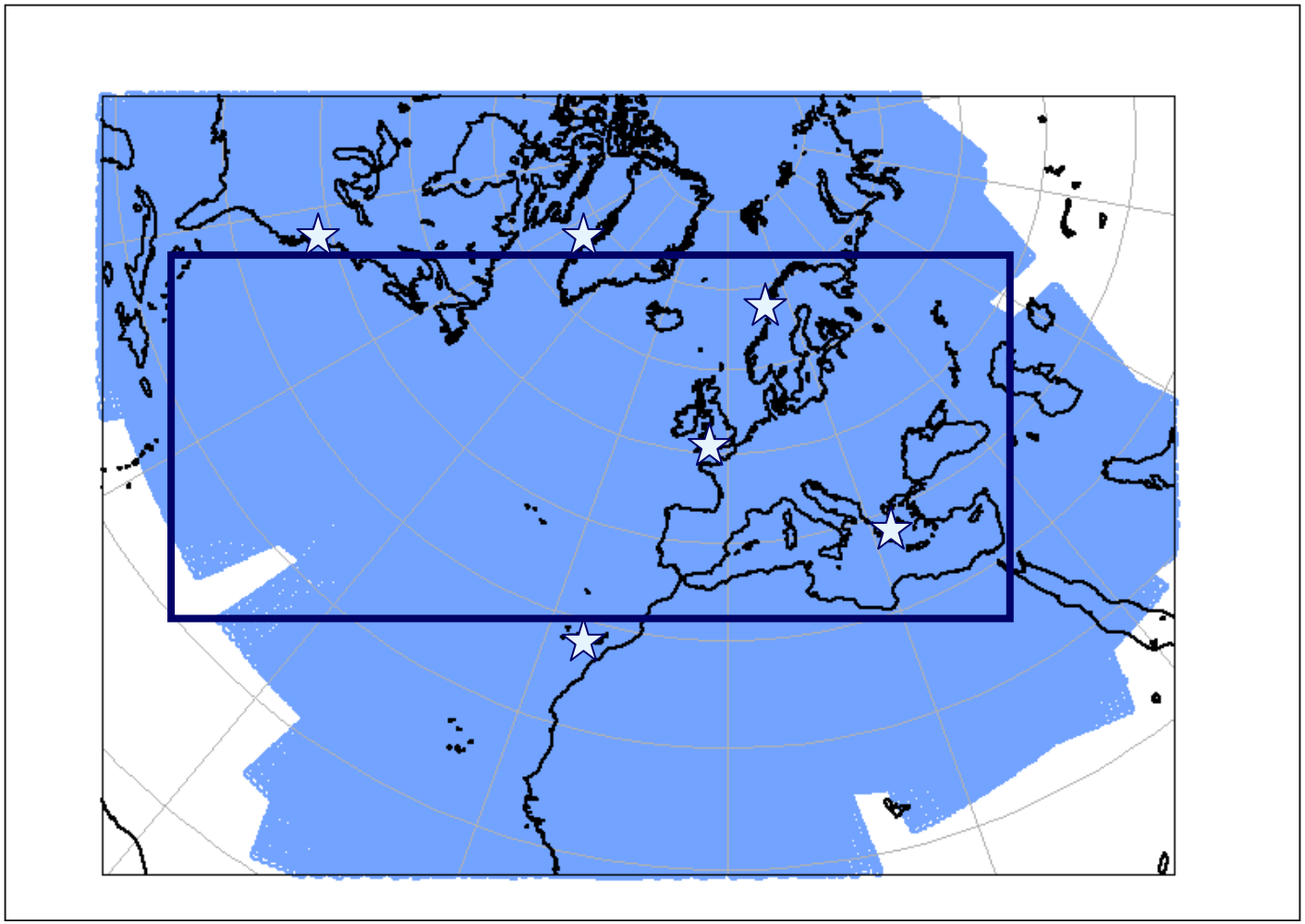


- Both models at 12 km Resolution
- Boundary Conditions supplied from global
- Forecasts out to 48 hours
- UK Mes to be superceded by 4km model with smaller domain
- 4D-Var to be introduced in Early 2006

Current ATOVS usage in Met Office LAMS

- Radiance assimilation in 3D-Var (based on global)
- AMSU-A & B at 40 km Resolution (NOAA15 & NOAA16)
- Humidity information 183 GHz channels
- Bias Correction determined from global model statistics
- Model cutoff for main runs 2hr10
  - ➢ Data is received from the EARS network and local ground station at Met Office HQ
  - ➢ Avoids data coverage gaps due to delayed orbits

Local and EARS coverage



Use of AMSU-B at full resolution

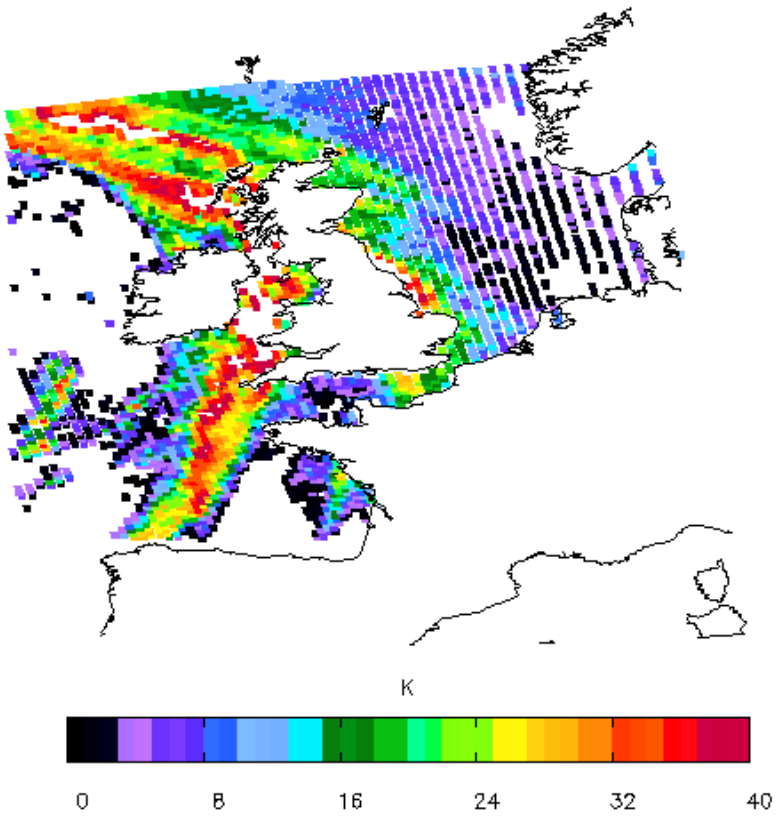
- **Satellite Data is closer to model resolution of 12km**
  - Representation error reduced
  - Correlated errors in the observations may become more important
- **Use 150 GHz and 89 GHz channels**
  - Operationally humidity increments above 700 hPa
- **Quality control and channel selection determined without information from other ATOVS instruments**
  - Currently ATOVS package treated as a 40 channel instrument
  - Robustness against AMSU-A failure
  - E.g NOAA-17

Quality Control and Channel Selection

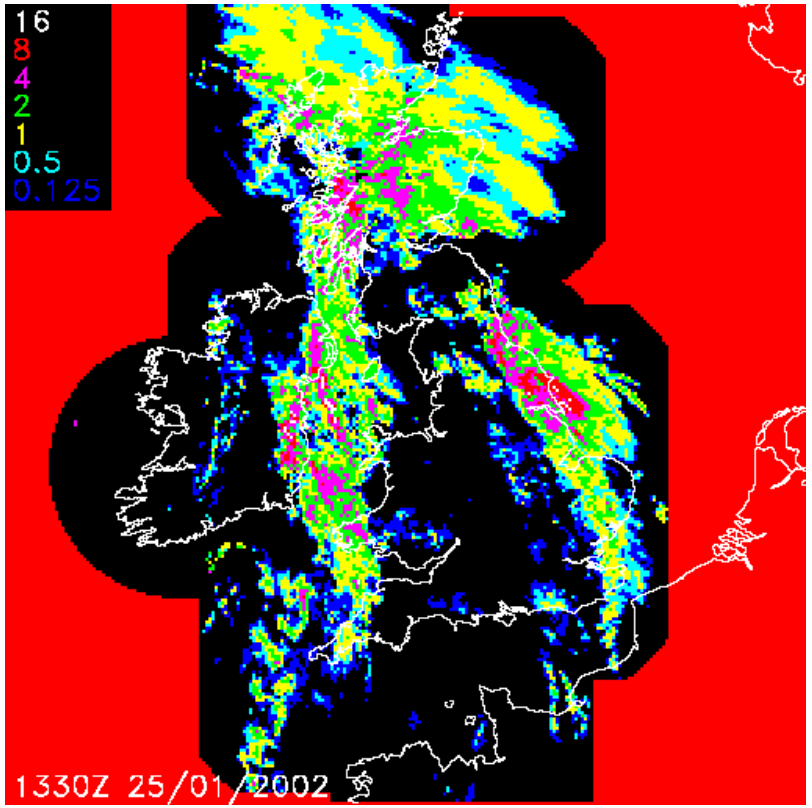
Test	Reason	Instruments	
		AMSU-A + AMSU-B	AMSU-B Only
24/89 GHz scattering	Rain	♦	
89/150 GHz scattering	Rain	♦	♦
183 GHz cost test	Detect Cirrus	♦	♦
AMSU-A Cost test	Areas of high lwp	♦	

89/150 GHz Scattering Bennartz Test

Scattering Index



Radar



Determining Liquid Water Path (I)

- **Currently 1D-Var pre-processor does not include cloud effects**
  - q can rise to saturation and then held
- **Can we use the 1D-Var to estimate the liquid water path in the field of view?**
  - qtotal scheme developed by Godelieve Deblonde & Steve English for NWP SAF
  - control variable is qtotal = q + ql + qi (cloud forms above RH 95%)
  - with Jacobian $$\frac{dB}{dq_t} = \frac{dB}{dq}\frac{dq}{dq_t} + \frac{dB}{dq_l}\frac{dq_l}{dq_t} + \frac{dB}{dq_i}\frac{dq_i}{dq_t}$$
  - Use parabolic functions to avoid sharp changes in the gradients
  - Ice
    - Simple temperature regression to partition excess qt into ql and qi
    - No radiative effect

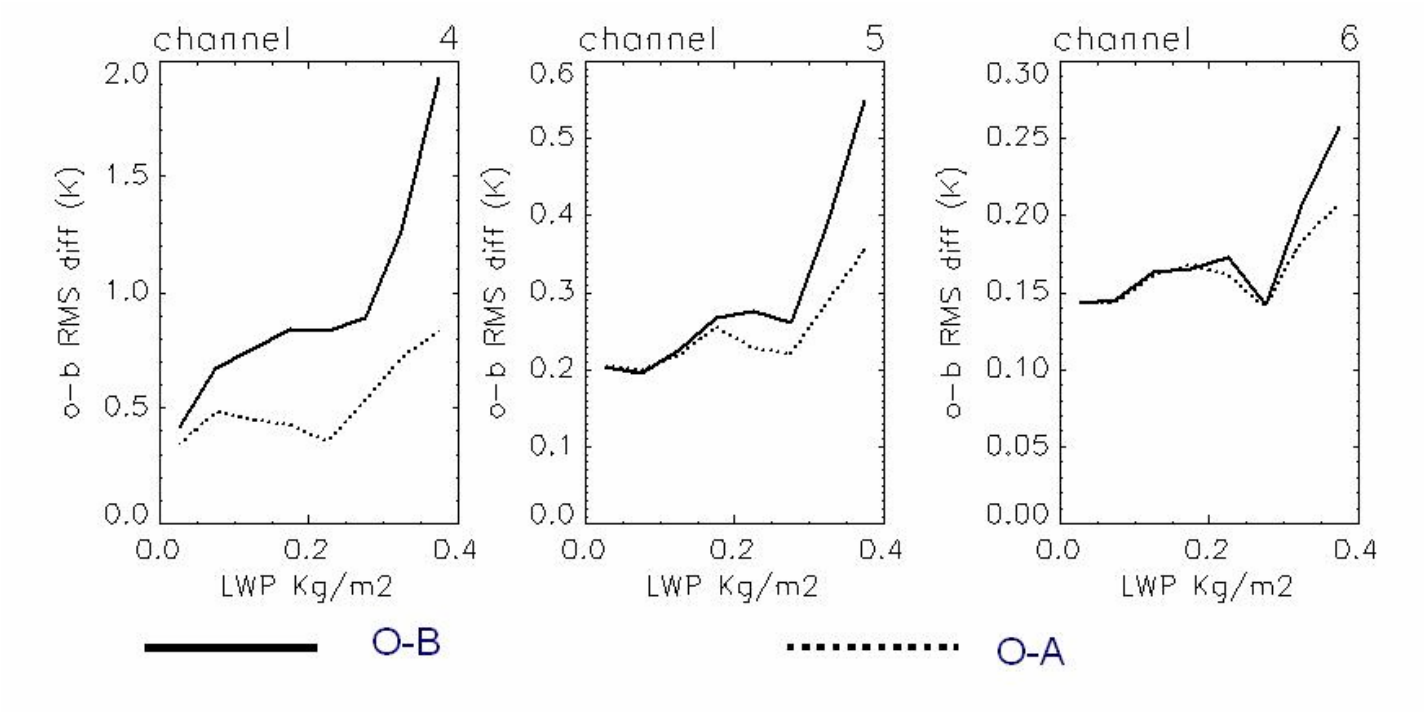
Determining Liquid Water Path (II)

- **Using the retrieved LWP to make channel usage decisions**
  - For the 89/150 GHz channels the level of the cloud does not play a large effect on the radiative impact
  - Not case for the 183 GHz channels

- **Radiative impact of cloud liquid water from an ensemble of LAM model backgrounds**
  - Determine LWP thresholds for each channel
  - Thresholds rising from channel 1 to 5

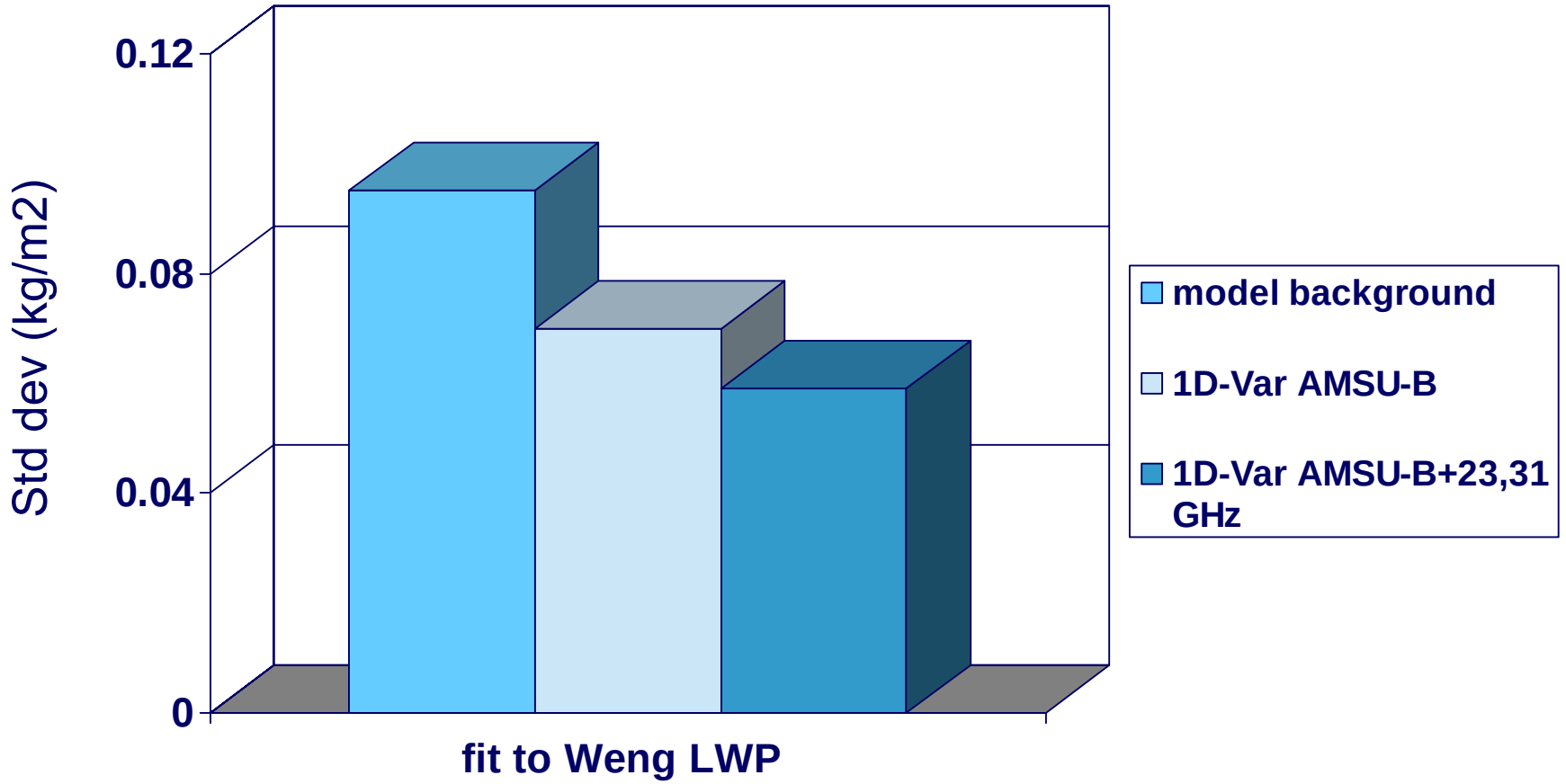
How Good is the Retrieved LWP? (I)

- **Map AMSU-A & B to common grid, retrieve qtotal using AMSU-B channels and look at fit to AMSU-A sounding channels**



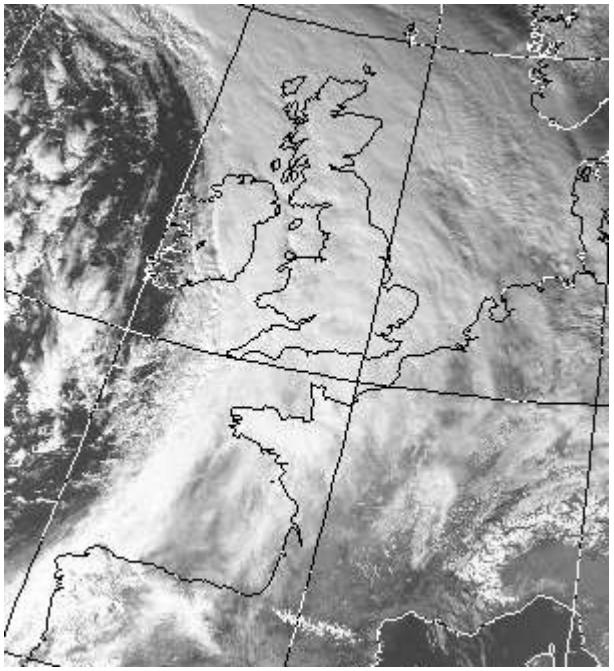
How Good is the Retrieved LWP? (II)

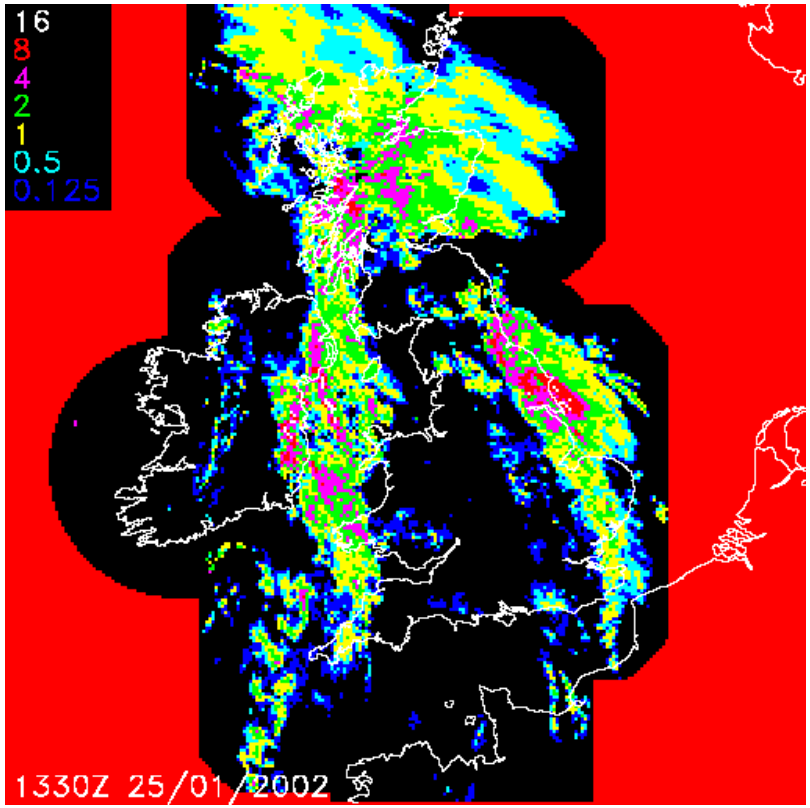
- **Again on common grid compare retrieved LWP with estimates from AMSU-A channels (Weng 23/31 GHz) Algorithm**
- **North Atlantic Region**



A 3D-Var Case Study

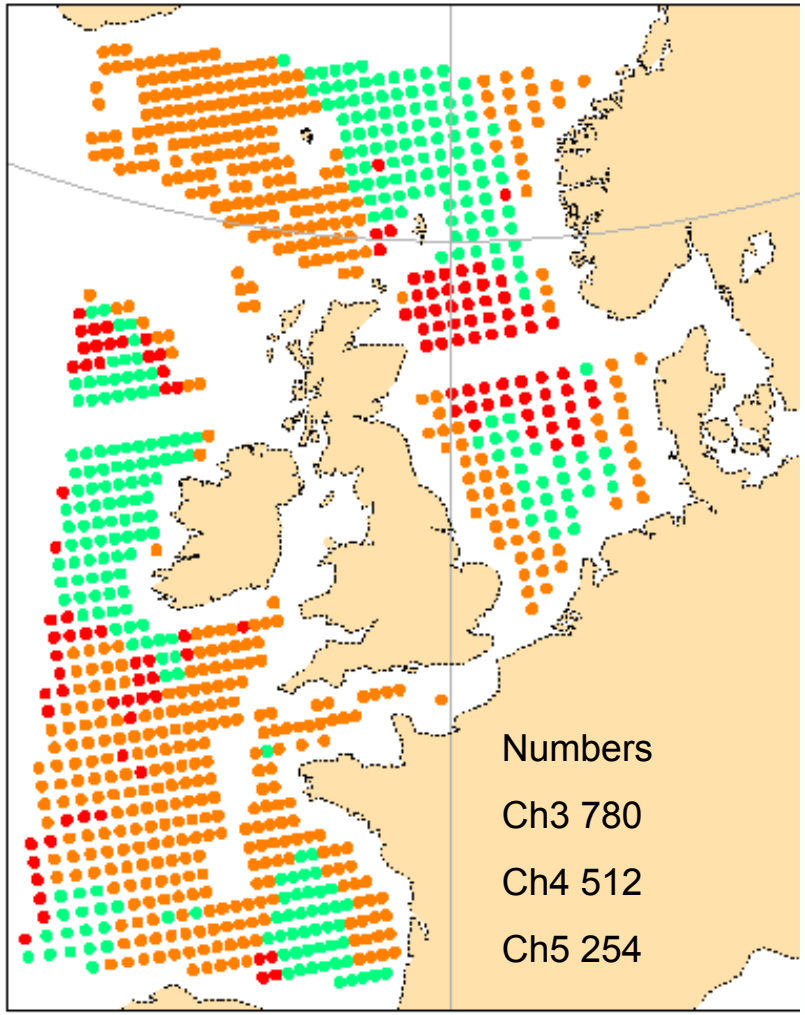
- **Classic Mid-Winter Atlantic Depression**
  - What is the effect of moving to the new AMSU-B scheme with 183GHz channels
  - What is the effect of switching on the lower frequency channels



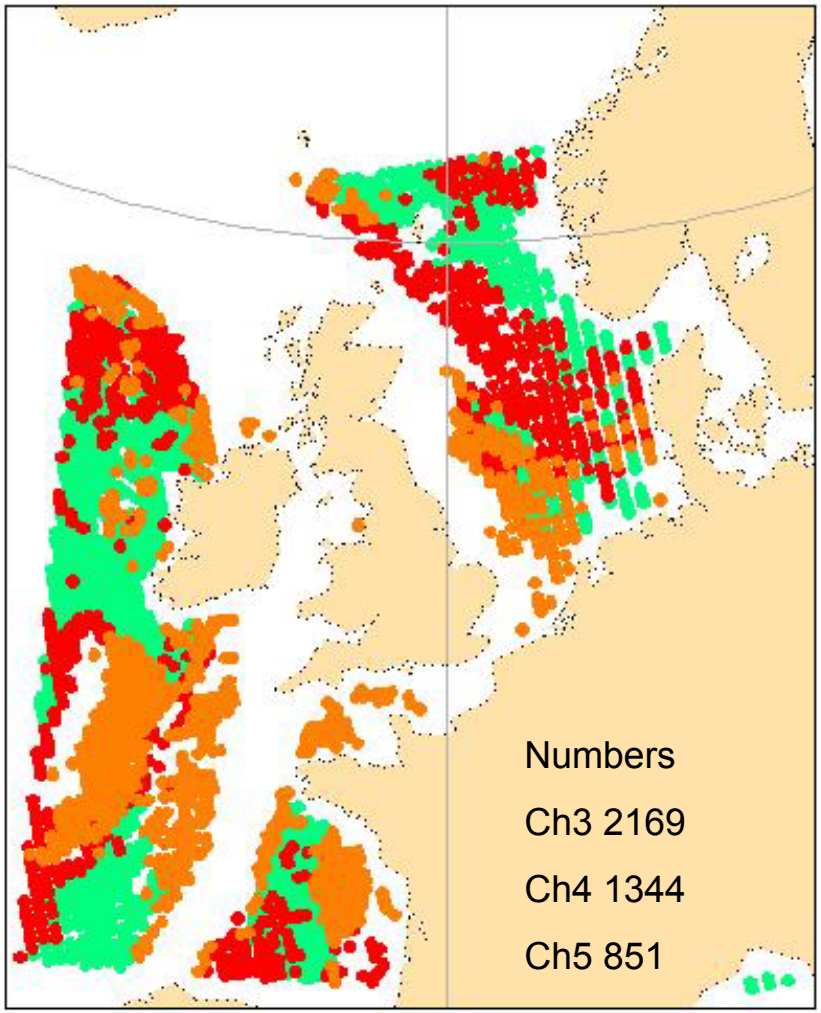


Quality Control Compared: 183 GHz Channels

40km res old qc



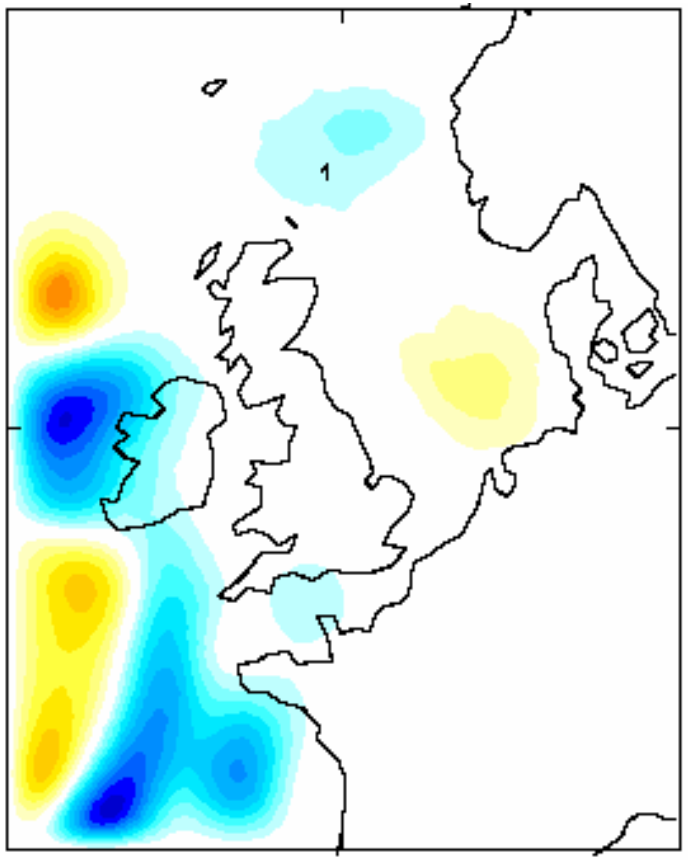
16km res new qc



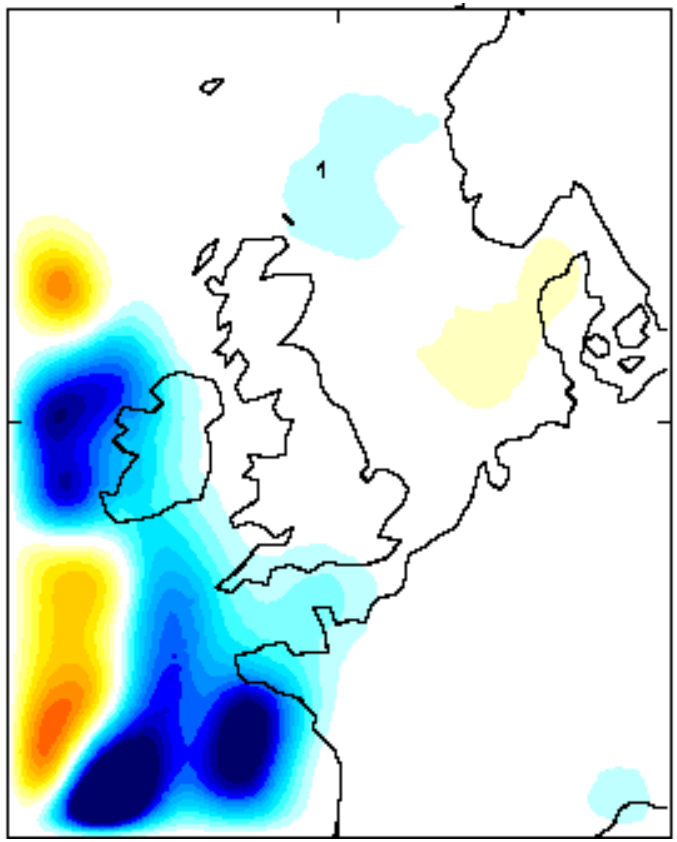
3D-Var Increments Compared

humidity increments at model level 10 ~800 hPa

ATOVS res old qc



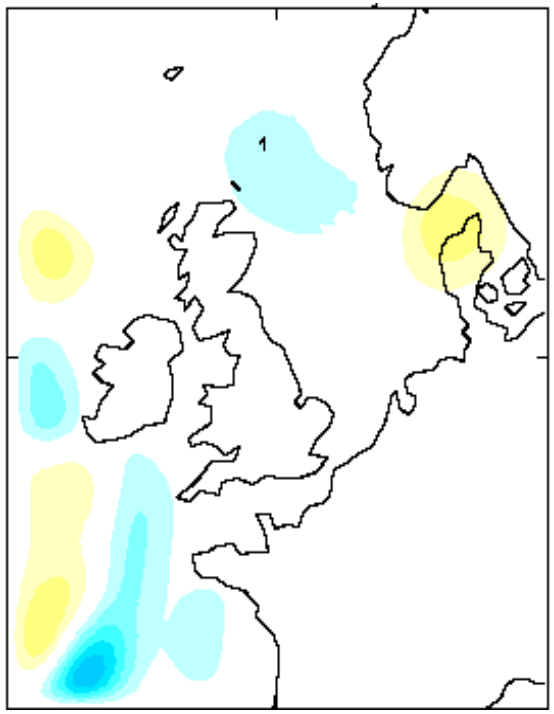
AMSU-B res new qc



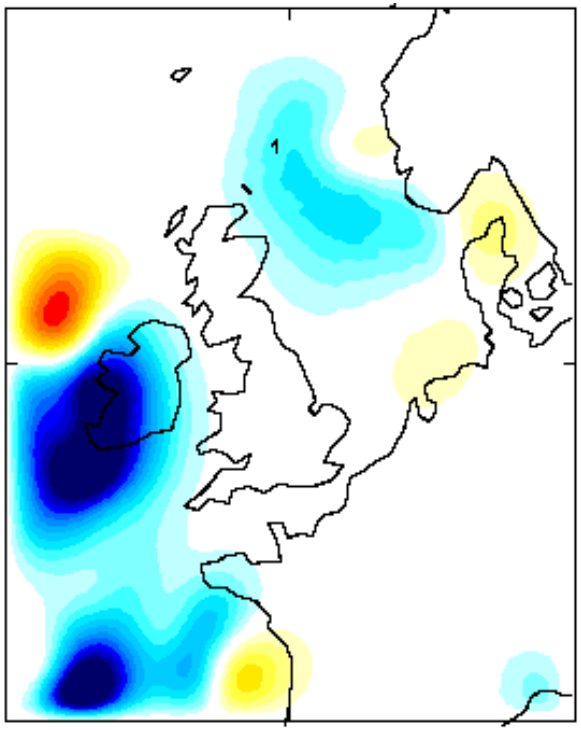
3D-Var Increments Compared

humidity increments at model level 7 ~1km

183 GHz channels



+ 89,150 GHz

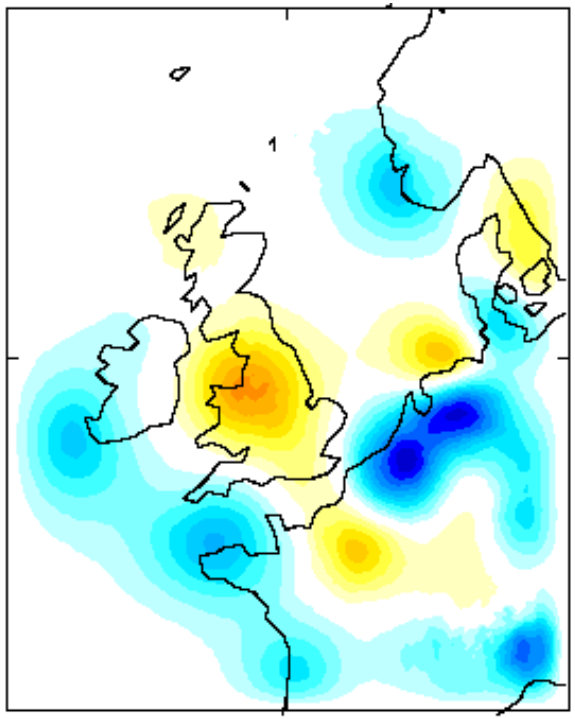


Observing Methods Compared in 3D-Var

humidity increments at model level 7 ~1km

Radio Sonde RH

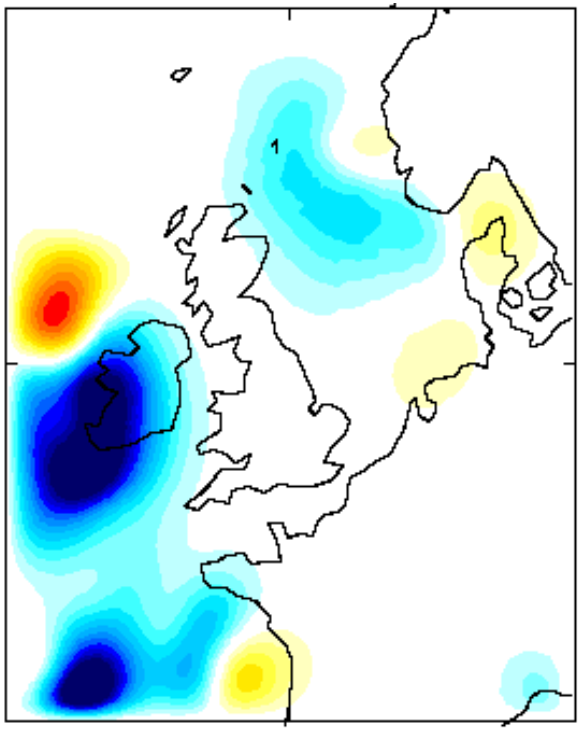
12 iterations to converge



Max: 5.88×10^{-4} Min: -8.30×10^{-4}

AMSU-B

18 iterations to converge



Max: 7.53×10^{-4} Min: -1.35×10^{-3}

Forecast Impact Tests

- **Challenge in limited area models is to run enough representative cases to obtain reliable statistics of forecast impact.**
- **NAE is expensive to run (2xglobal cost) so its important to makemost use of the forecast data for verification**
  - Small scale impacts (precip, surface temperature over land,etc)
  - Large scale impacts (500 hPa ht….)
- **Approach is to commence with the smaller domain model and run a larger set of cases. Then smaller set with NAE**
  - Impact on precip fields using calibrated Radar data as verification source
  - Impact on humidity analyses using IWV estimates from european GPS network
- **How do other NWP centres approach this?**

Conclusions

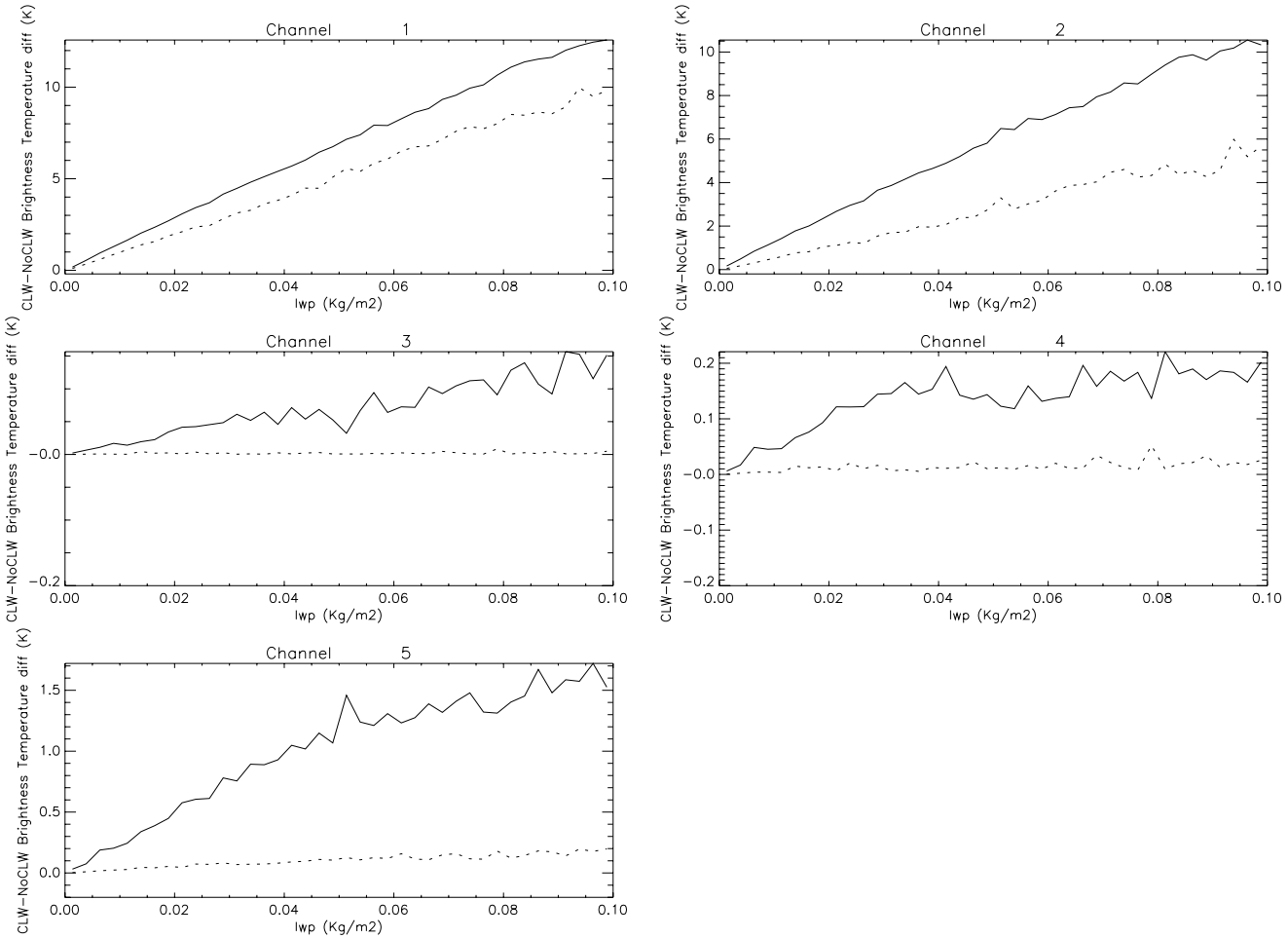
- **A standalone scheme for using AMSU-B at full resolution**
  - Retrievals of cloud liquid water for channel selection
  - Cloud liquid water estimates appear sensible
  - Scheme is flexible and so could be used for other radiance assimilation

- **3D-Var tests show**
  - 183 GHz channels: New quality control scheme gives similar results to old scheme
  - Switching on low frequency channels provides information in the boundary layer
  - Boundary layer increments consistent with those from radiosondes

- **Forecast Impact studies imminent**

- Extra Slides

AMSUB sensitivity to clw

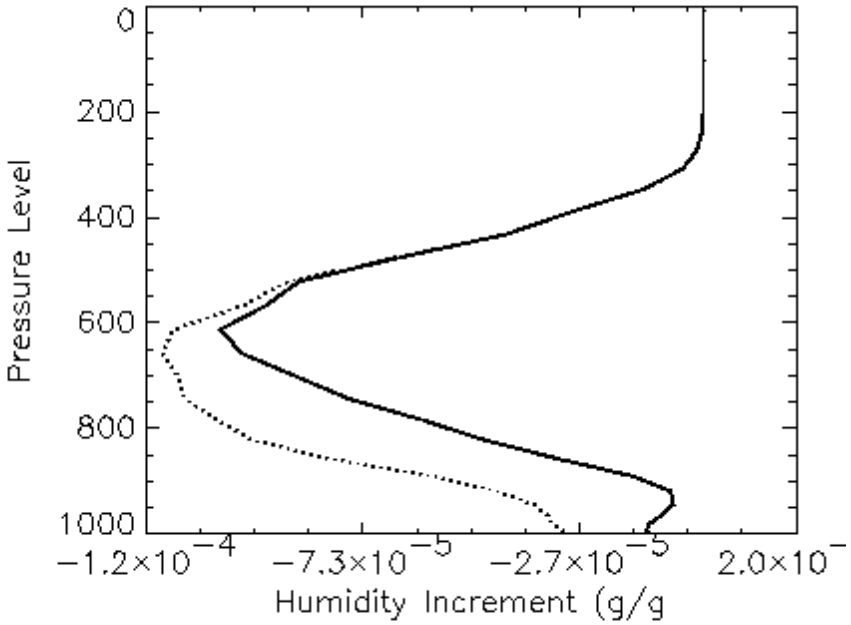


Impact of Fixed CLW in 3DVar

Case clw 100 g/m2

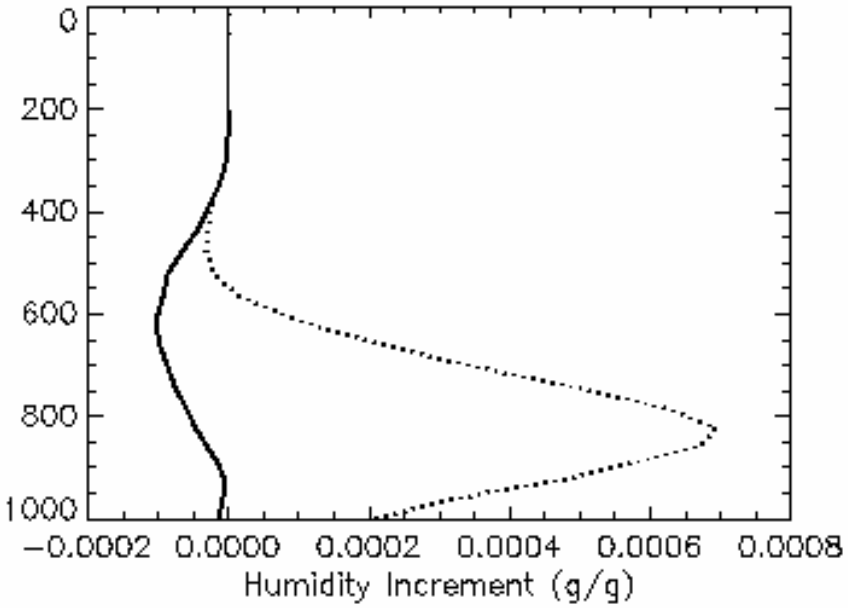
Bold line: AMSU-B3,4,5 **Dashed line:** All AMSU-B channels

Clw



Both runs dry profile

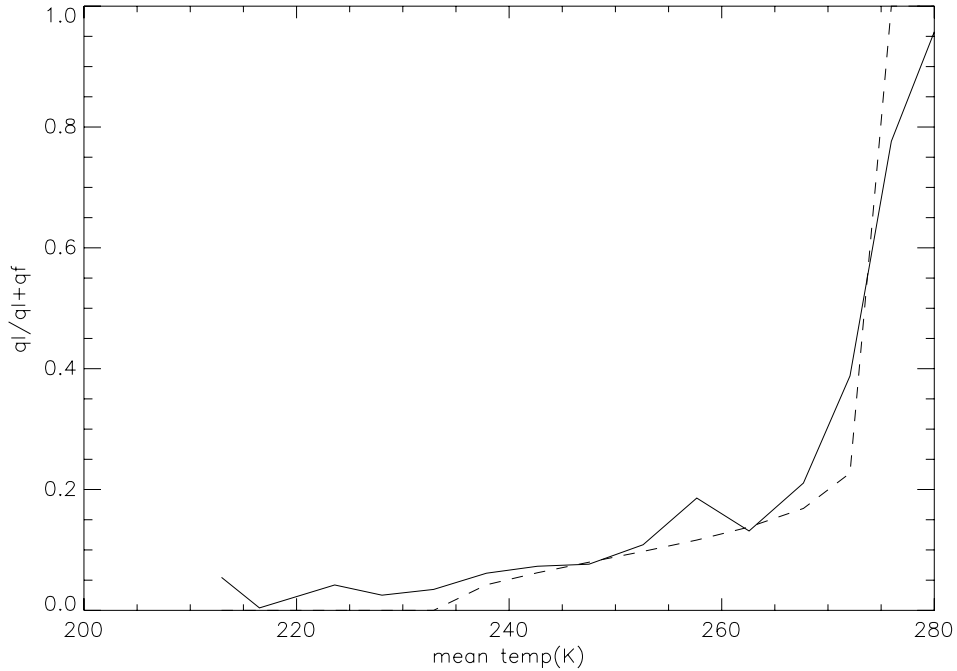
No Clw



Inconsistency: Lower channels try to moisten profile

Ice

- Some of the clw increments above 400hpa looked too large
- T < 260 K most of the cloud will be composed of ice which the scheme ignores
- Solution is to incorporate ice following Dave Jones' parametrisation



Qsplit parametrisation