Derivation of AMVs from single-level retrieved MTG-IRS moisture fields

Laura Stewart, John Eyre

11th International Winds Workshop 20th February 2012

Outline

- Motivation and methodology
- Single-level MTG-IRS humidity retrievals
- Feature tracking algorithm and comparison metrics
- Feature tracking using:
  - Model fields
  - Retrieval fields
  - Smoothed retrieval fields

Feature tracking on model levels

Motivation

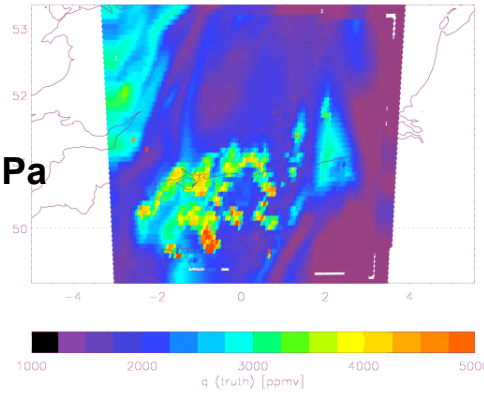
- MTG-IRS data will provide accurate and high-resolution humidity retrievals: ~1km vertical, 4km horizontal, and 30 minute temporal
- Feature tracking at model levels avoids explicit height assignment
- Removes explicit error contribution

Methodology

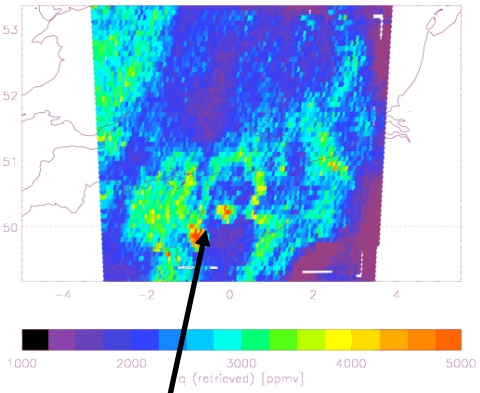
- Use Met Office UKV 1.5km model to generate simulated spectra
- Use NWPSAF 1DVar retrieval to generate single-level humidity fields
- Use feature tracking code to generate AMVs for comparison with true model winds

MTG-IRS humidity retrievals

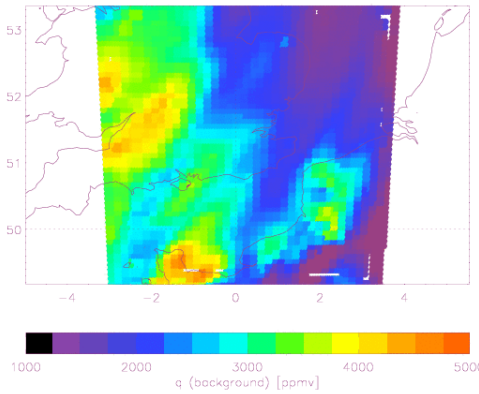
656hPa



Model

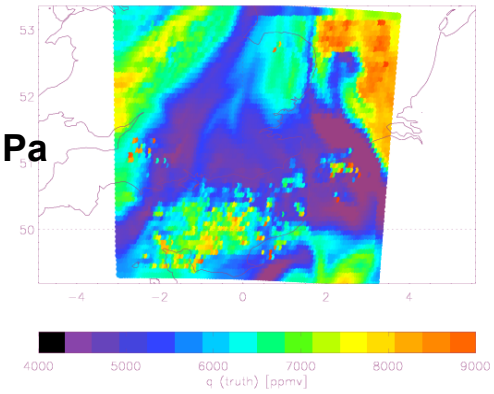


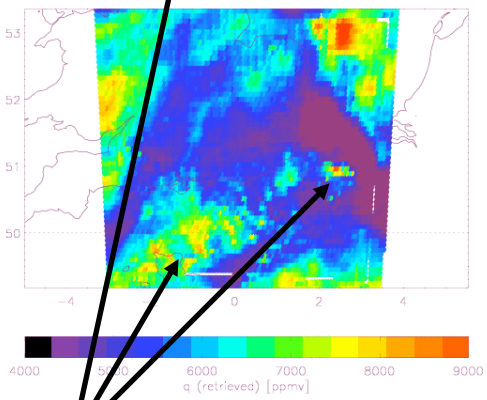
Retrieval

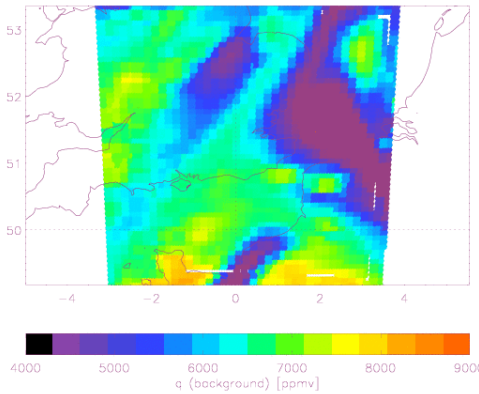


Background

795hPa



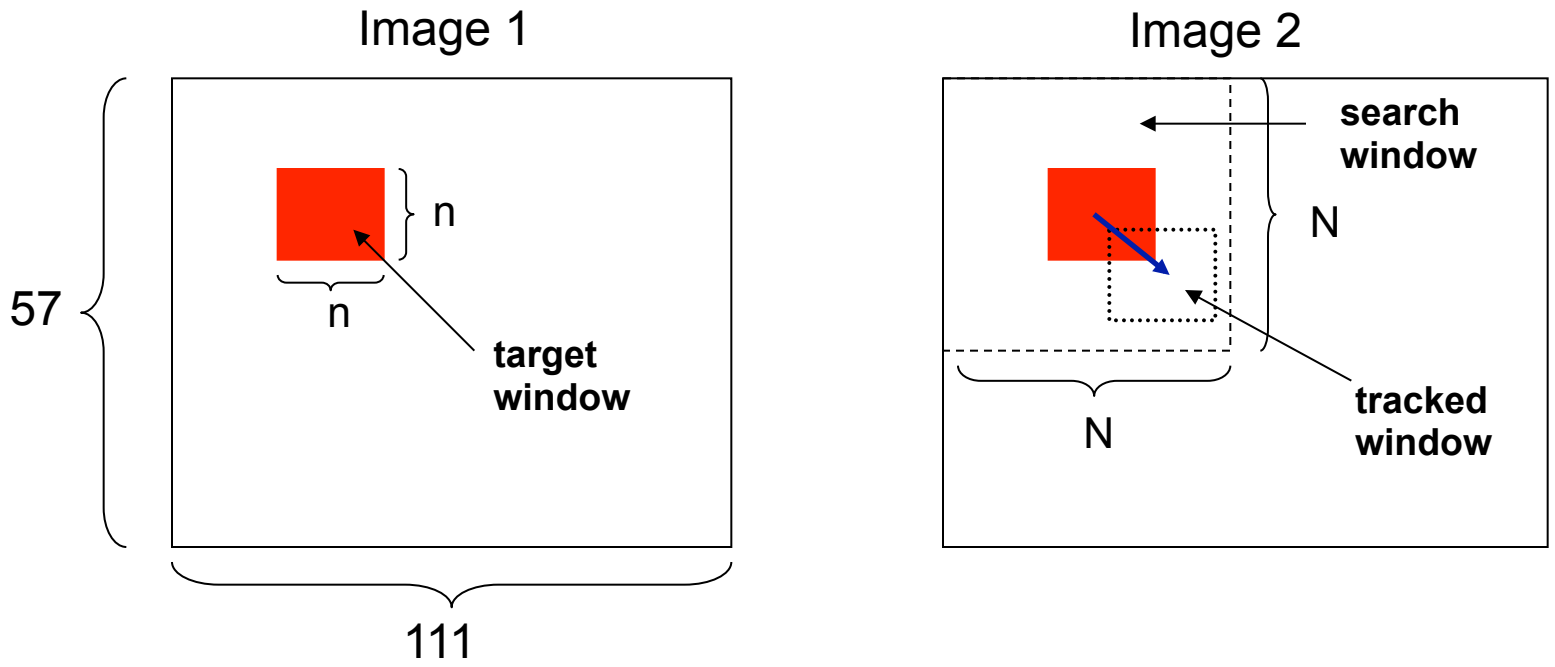




Retrieval of fine scale structure using obs at MTG-IRS resolution

Feature tracking algorithm

- Modified CPTEC tracking software
- Time interval between images = 30 minutes
- Target window size = 6x6, 8x8, 10x10, 12x12
- Euclidean distance technique used for target matching
- Correlation and contrast check, plus AQC scheme



Comparison metrics

- Simulation study allows for direct comparison with UKV model winds

$$MSB = \frac{1}{N}\left(\sqrt{u_T{}^2 + v_T{}^2} - \sqrt{u_D{}^2 + v_D{}^2} \right) \equiv \frac{1}{N}\left(V_T - V_D\right)$$

$$MMVD = \frac{1}{N}\sqrt{V_T{}^2 + V_D{}^2 - 2V_T V_D \cos\left|\theta_T - \theta_D\right|}$$

where u_T, v_T, V_T, θ_T relate to the true winds

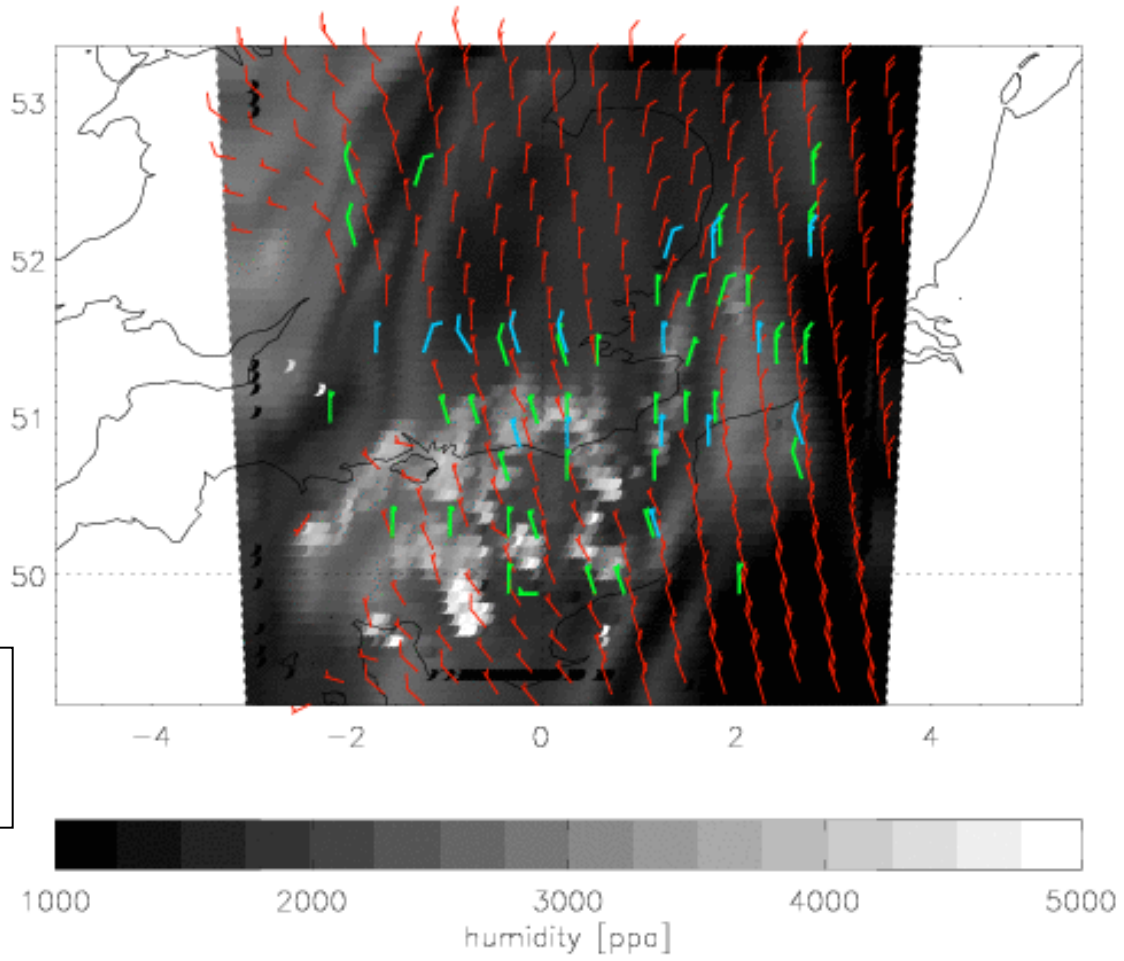
u_D, v_D, V_D, θ_D relate to the derived winds

Tracking model fields @ 656hPa

Truth tracked winds d=6

Truth tracked winds d=10

Model wind field



0-2.5m/s	No barb
2.5m/s	Short barb
5m/s	Long barb

Good representation of true wind field

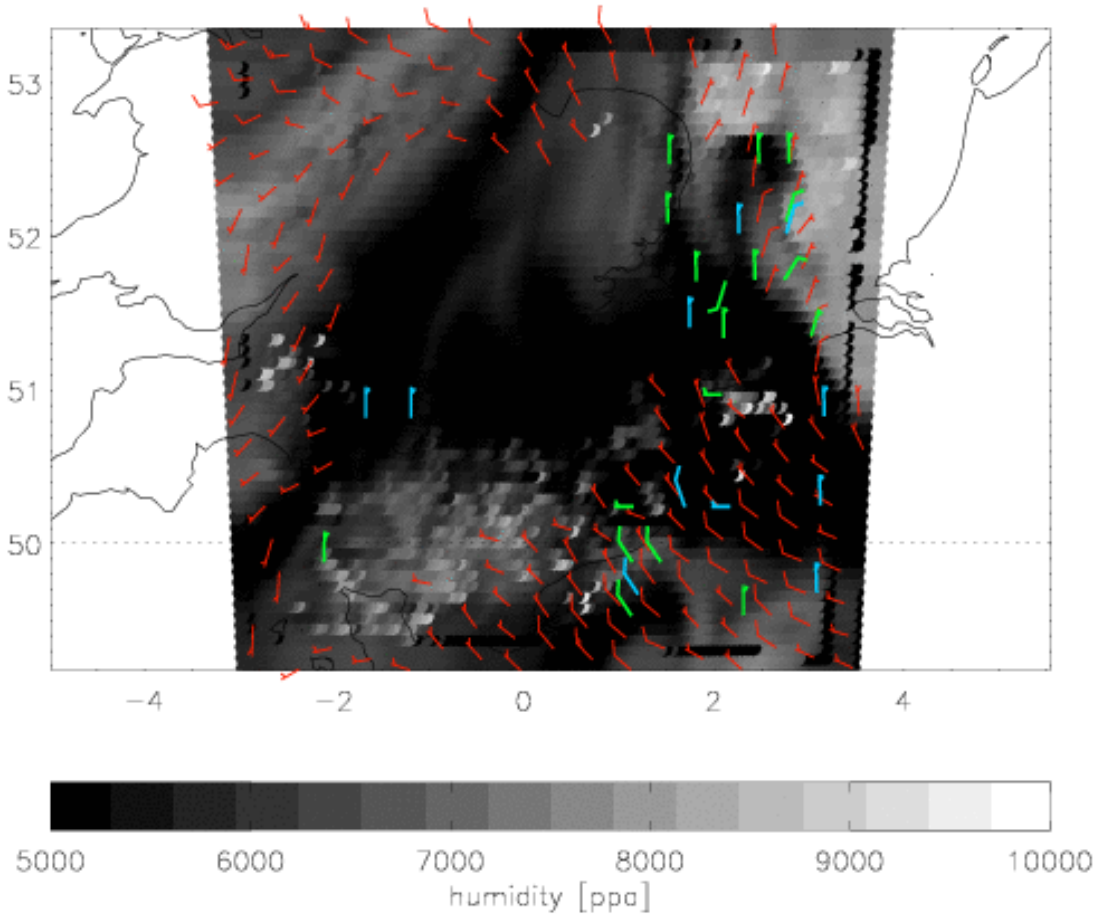
Tracking model fields @ 795hPa

Truth tracked winds d=6

Truth tracked winds d=10

Model wind field

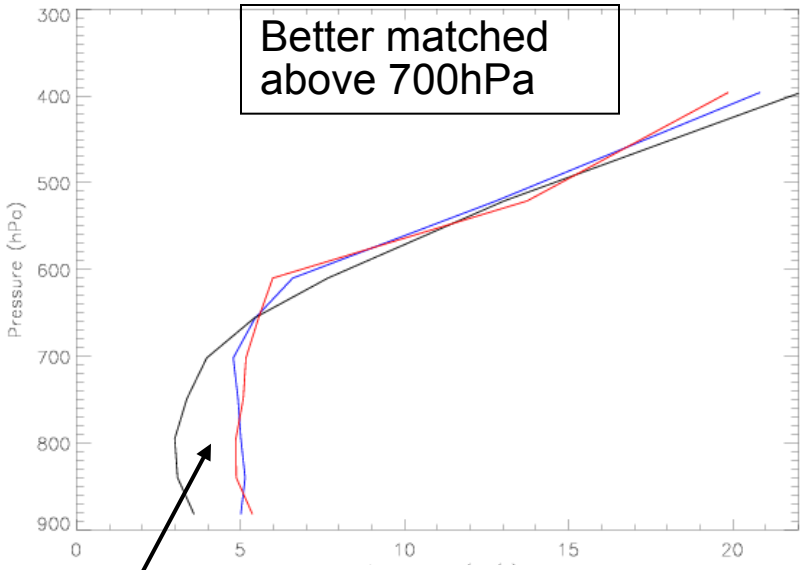
(winds slower than 2.5m/s not seen)



0-2.5m/s	No barb
2.5m/s	Short barb
5m/s	Long barb

Fewer (and slower) winds at lower levels

Tracking model fields: MSB and MMVD



Better matched above 700hPa

Average wind speed

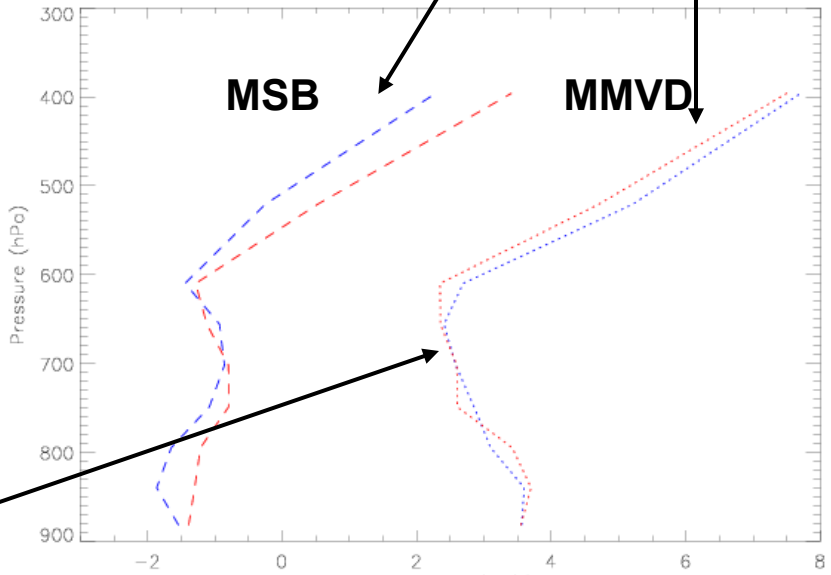
Derived winds are too fast below 700hPa

---- model wind speed

---- wind speed d=6

---- wind speed d=10

Large values due to small domain



Comparable MMVD errors in mid troposhere

Wind speed m/s

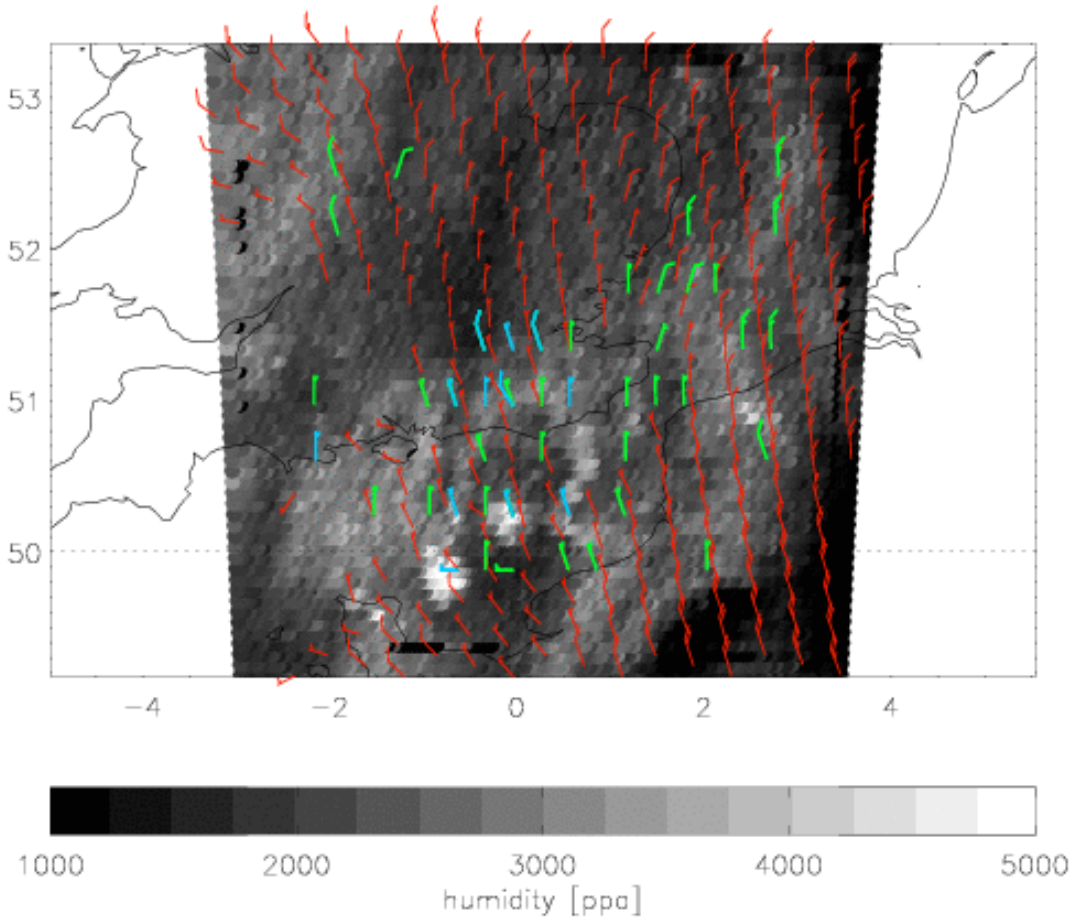
Tracking retrieval fields @ 656hPa

Retrieval tracked winds d=6

Model tracked winds d=6

Model wind field

0-2.5m/s	**No barb**
2.5m/s	**Short barb**
5m/s	**Long barb**



Humidity field at 09:30 [ppa]

Much fewer winds!

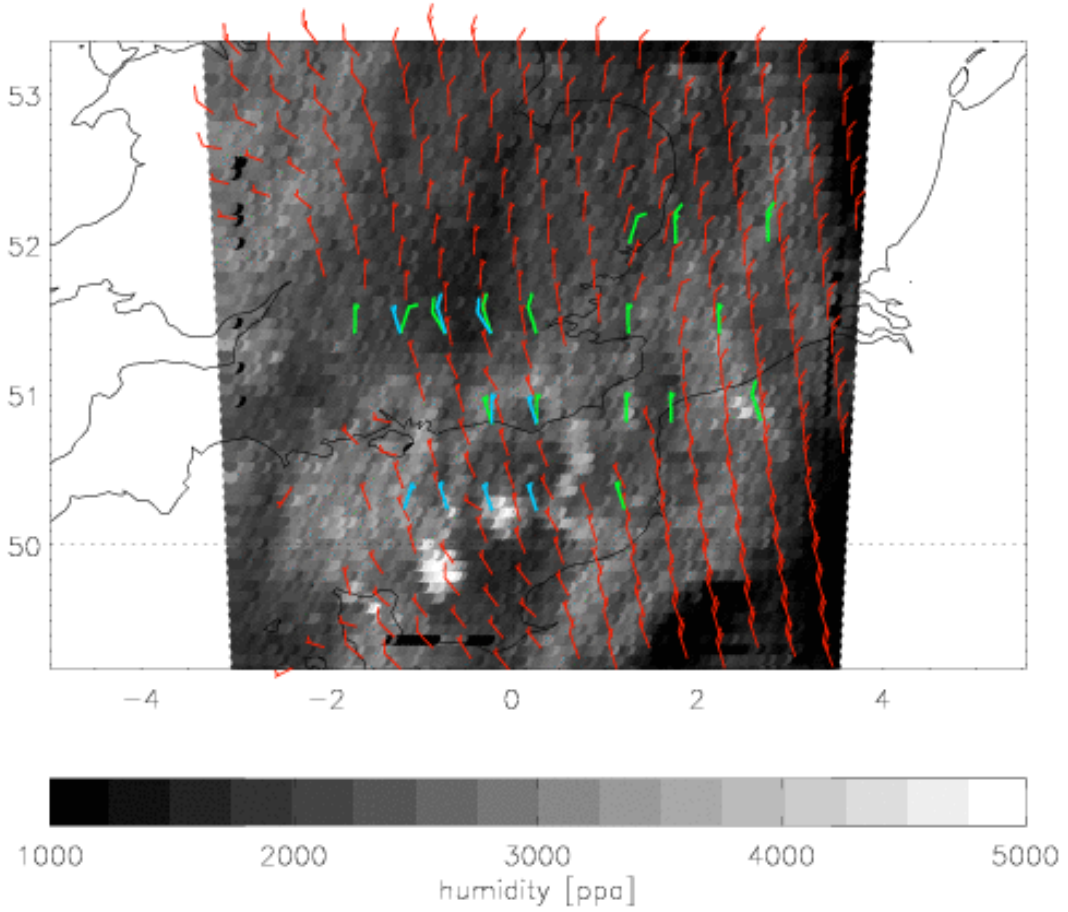
Tracking retrieval fields @ 656hPa

Retrieval tracked winds d=10

Truth tracked winds d=10

Model wind field

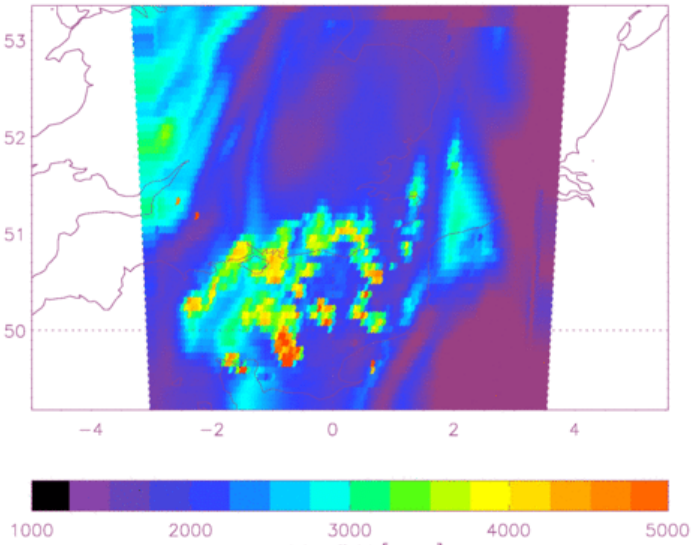
0-2.5m/s	**No barb**
2.5m/s	**Short barb**
5m/s	**Long barb**



Humidity field at 09:30 [ppa]

Much fewer winds!

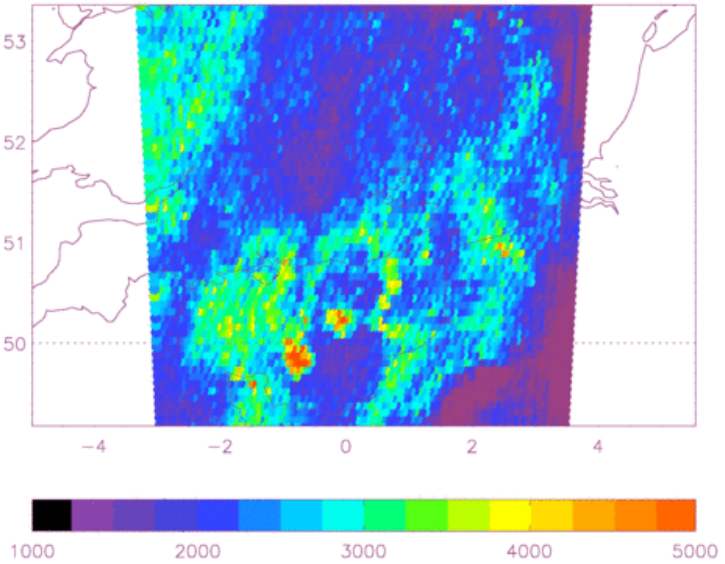
Are the humidity retrievals too noisy?



Model field @ 656hPa

Similar structure to model field but noise makes gradients less well-defined

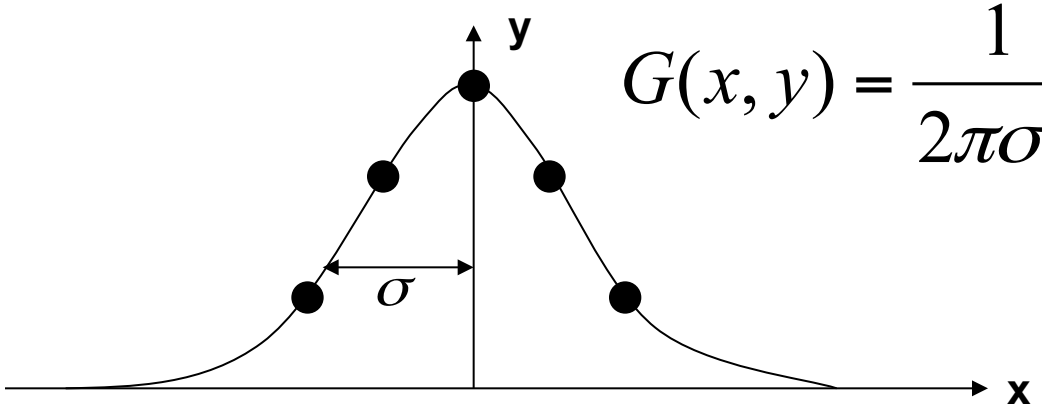
Results in far fewer feature tracked winds generated



Retrieval field @ 656hPa

Gaussian multi-scale representation

- Smoothing technique
- Convolution of the image with a 2D Gaussian kernel G(x,y)
- σ^2 dictates the spread of the Gaussian function and hence the level of smoothing/range of frequencies removed
- Choose σ^2 such that the noise is reduced without smoothing away fine-scale features and strong gradients



$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/2\sigma^2}$$

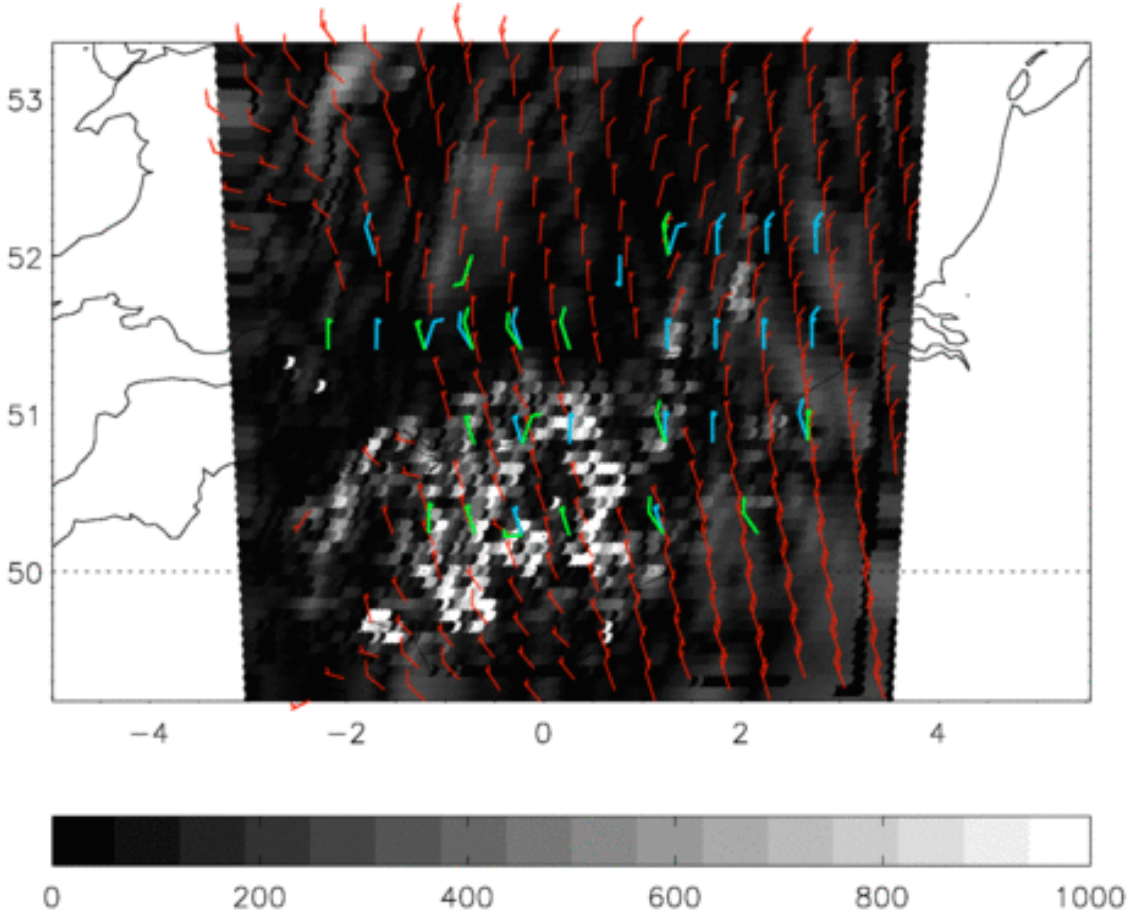
Truth tracked vs smoothed retrieval tracked winds

Truth tracked winds d=10 (#winds = 22)

Smoothed retrieval tracked winds d=10 (#winds = 17)

Model wind field

0-2.5m/s	**No barb**
2.5m/s	**Short barb**
5m/s	**Long barb**



Difference in Q field between 09:00 & 09:30

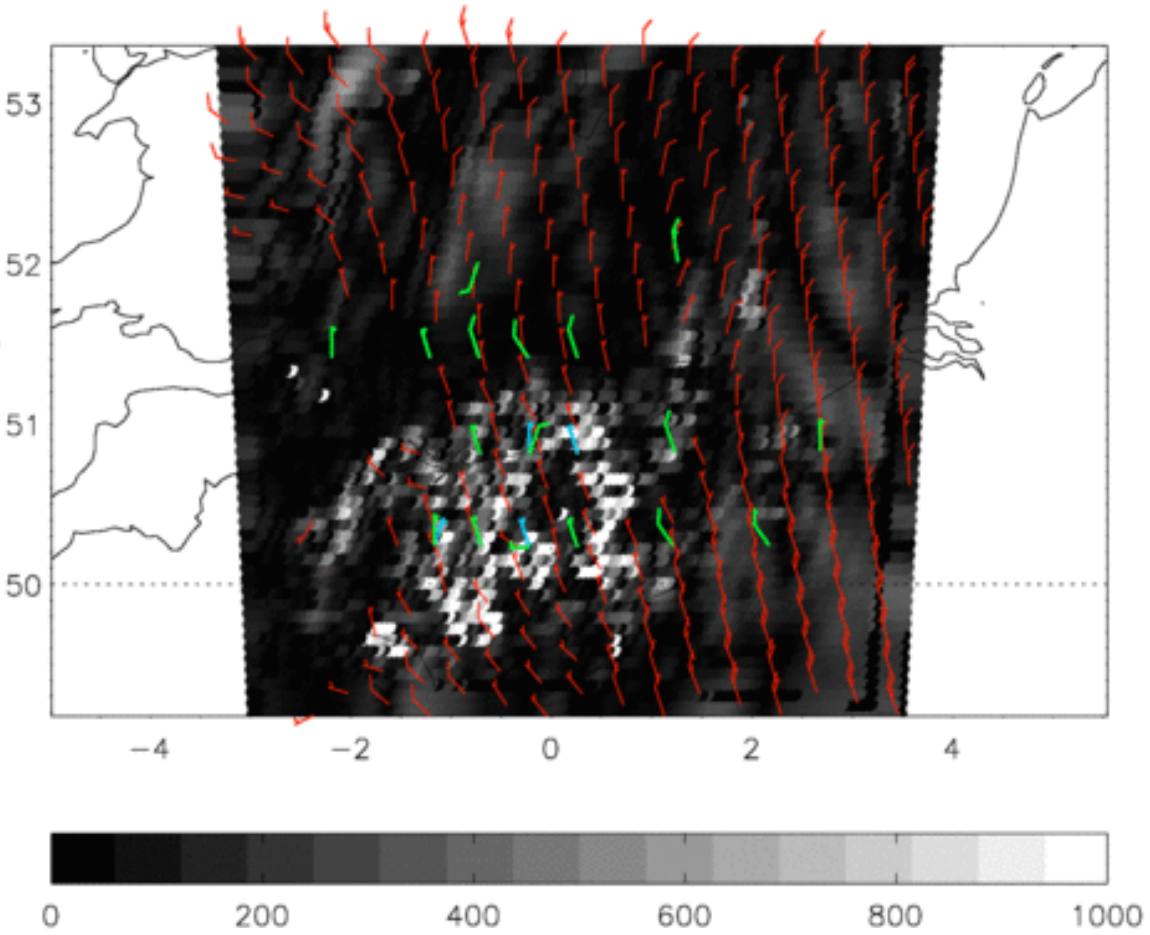
Reduced contrast check

Smoothed vs retrieval tracked winds

Smoothed retrieval tracked winds d=10 (#winds = 17)

Retrieval tracked d=10 winds (#winds = 9)

Model wind field



Difference in Q field between 09:00 & 09:30

0-2.5m/s	No barb
2.5m/s	Short barb
5m/s	Long barb

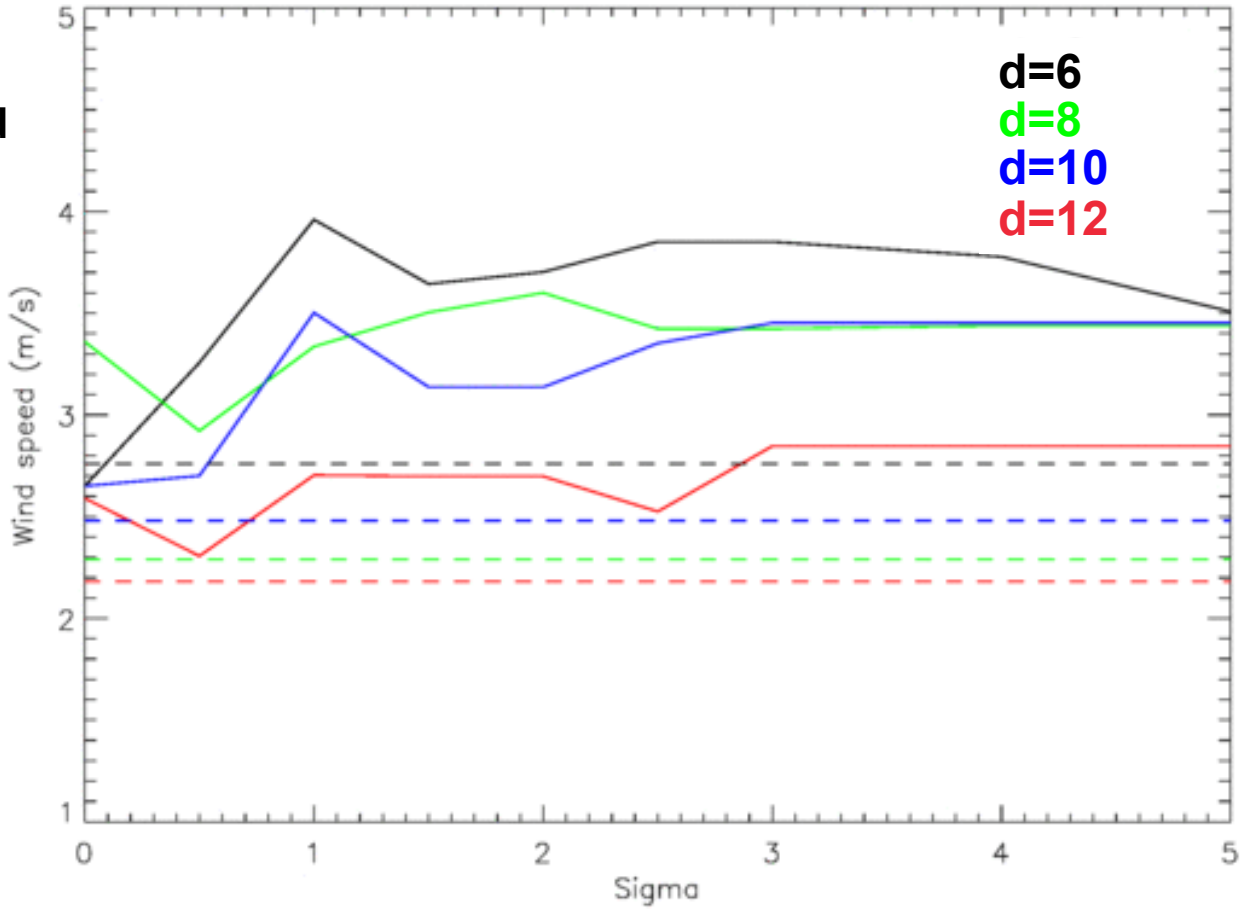
Reduced contrast check

MMVD for smoothed retrievals

---- MMVD for tracked MODEL fields

MMVD for tracked SMOOTHED RETRIEVAL fields

More AMVs but larger MMVD



Summary

- Feature tracking in model humidity fields provides a good representation of the true wind field
  - Best results in mid-troposphere - comparable MMVD and MSB
- Tracking retrieval fields provides useful wind information but the quantity and distribution of the derived winds is significantly reduced relative to tracking model fields
  - Retrieval fields too noisy
  - Good quality but fewer AMVs
- Gaussian smoothing can eliminate the noise from the retrievals but still retain much of the trackable structure
  - Need to reduce the contrast check -> larger MMVD
  - Increased number of AMVs
  - sigma between [1,2] gives the best results

Kia ora!
Questions and answers

Tracking model fields @ 521hPa