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# Liquid detrainment in convection embedded in a cold front

Oscar Martínez-Alvarado Bob Plant

Department of Meteorology University of Reading

#### 2. Spectral decomposition of bulk mass flux parameterisation output



- Spectral decomposition using entrainment  $\epsilon$  as single parameter.
  - 1. Construction of a plume ensemble consistent with the model sounding
  - 2. Solve

$$\min \left| M(z^{\alpha}) - \sum_{i} c_{i} M_{i}(z^{\alpha}) \right|, c_{i} \ge 0$$

- *z<sup>a</sup>* : *a*-th height level
- M: bulk mass flux
- $M_i$ : *i*-th plume mass flux
- *c<sub>i</sub>* : *i*-th coefficient

## Analysis method: Motivation Plant (2010)





Mean West Indies sounding data for "hurricane season" (Jordan 1958)



Vertical profiles of mass flux in ensemble (after Plant 2010)

# Analysis method: Motivation Plant (2010)



The liquid water detrained from each individual plume is given by the bulk value:

$$l_{D_i} = l_i = l_B = \frac{\sum_i M_i l_i}{\sum_i M_i}$$



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Ensemble detrained liquid water Bulk liquid water (after Plant 2010)

#### Preliminary results



- Case at the end of DIAMET first field campaign:
  - 30 September 2011
  - Low-pressure system centred to the south-west of Iceland
  - Long trailing active cold front
- Model:
  - Met Office Unified Model (MetUM) version 7.3
  - North-Atlantic—Europe (NAE) domain
  - Grid spacing 0.11° (~12 km)
  - 38 vertical levels (lid ~40 km)
  - (MetUM Modified) Gregory—Rowntree convection scheme

#### DIAMET field campaign 0600 UTC 30 September 2011



#### Model-derived OLR

30 September 2011 0600 UTC



850-hPa equivalent potential temperature



Rain





### Updraught mass flux



cv, mflux, 30 September 2011 0600 UTC



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#### Updraught mass flux



### T-φ-gram and plume ensemble Reading



### T-φ-gram and plume ensemble Reading





#### On-going work

- Quantification of the effect of discrepancies between spectral and bulk convective scheme formulations on the large-scale circulation
- Use of Lagrangian budget method to determine origin and downstream impact of moisture and energy sources/sinks from convection (and other parameterised processes)



#### References

- Jordan, C. L. 1958 Mean soundings for the West Indies area, J. Meteorol. 15, 91—97.
- Plant, R. S. 2010 A review of the theoretical basis for bulk mass flux convective parameterization, *Atmos. Chem. Phys.* 10, 3529—3544.
- Yanai, M., Esbensen, S. and Chu, J.-H. 1973 Determination of bulk properties of tropical cloud clusters from large-scale heat and moisture budgets, *J. Atmos. Sci.* **30**, 611–627.