The Belgian Pukkelpop case: a challenge for simulating deep convection

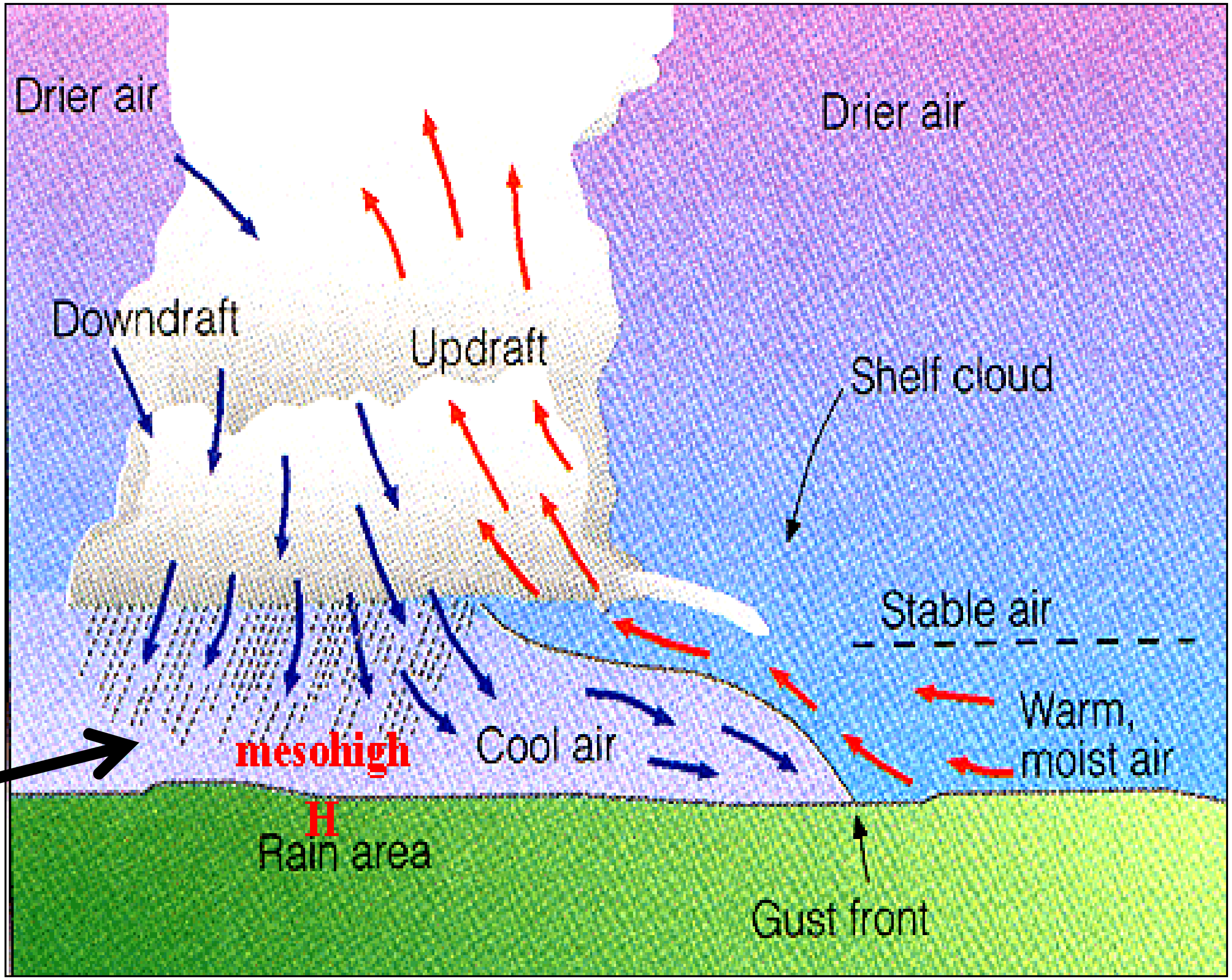
Pieter De Meutter, Luc Gerard, Geert Smet,
Piet Termonia

Overview

- Introduction
- Model setup
- Results
  - Mesoscale: cold pool
  - Microscale: local downdraft speed
- Conclusions

Downburst = very strong downdraft (~ 10 kg/m^2s)

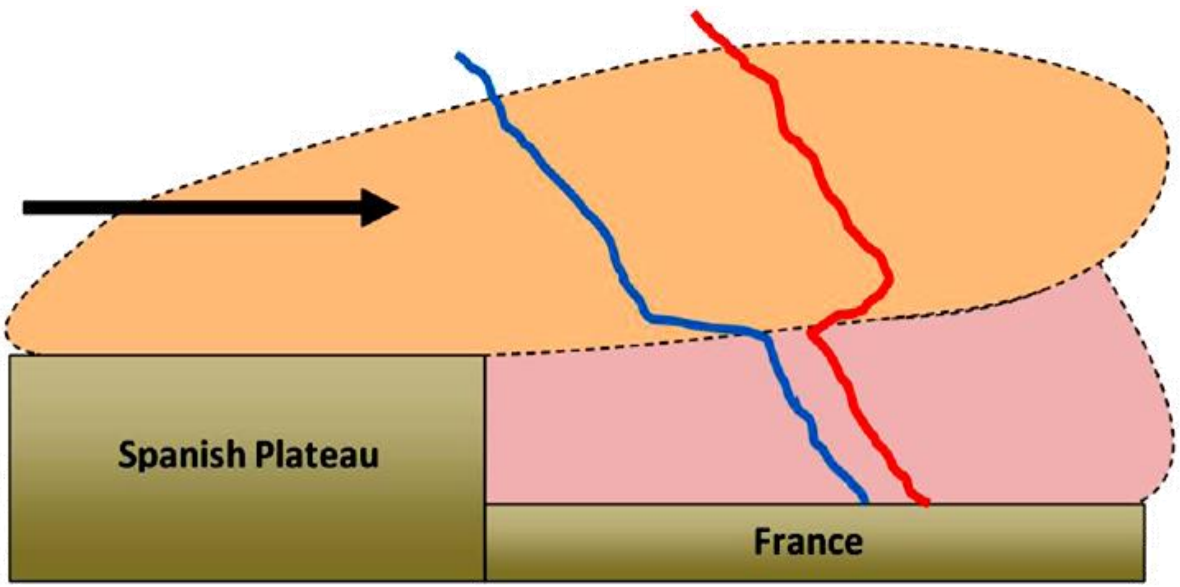
Cold pool

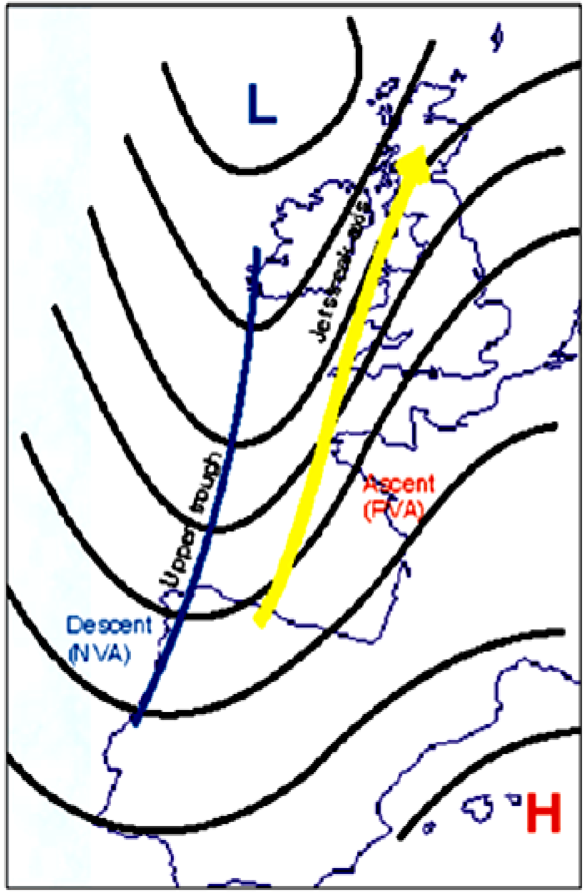


Source: Ahrens 2008

Pukkelpopstorm 18.08.2011

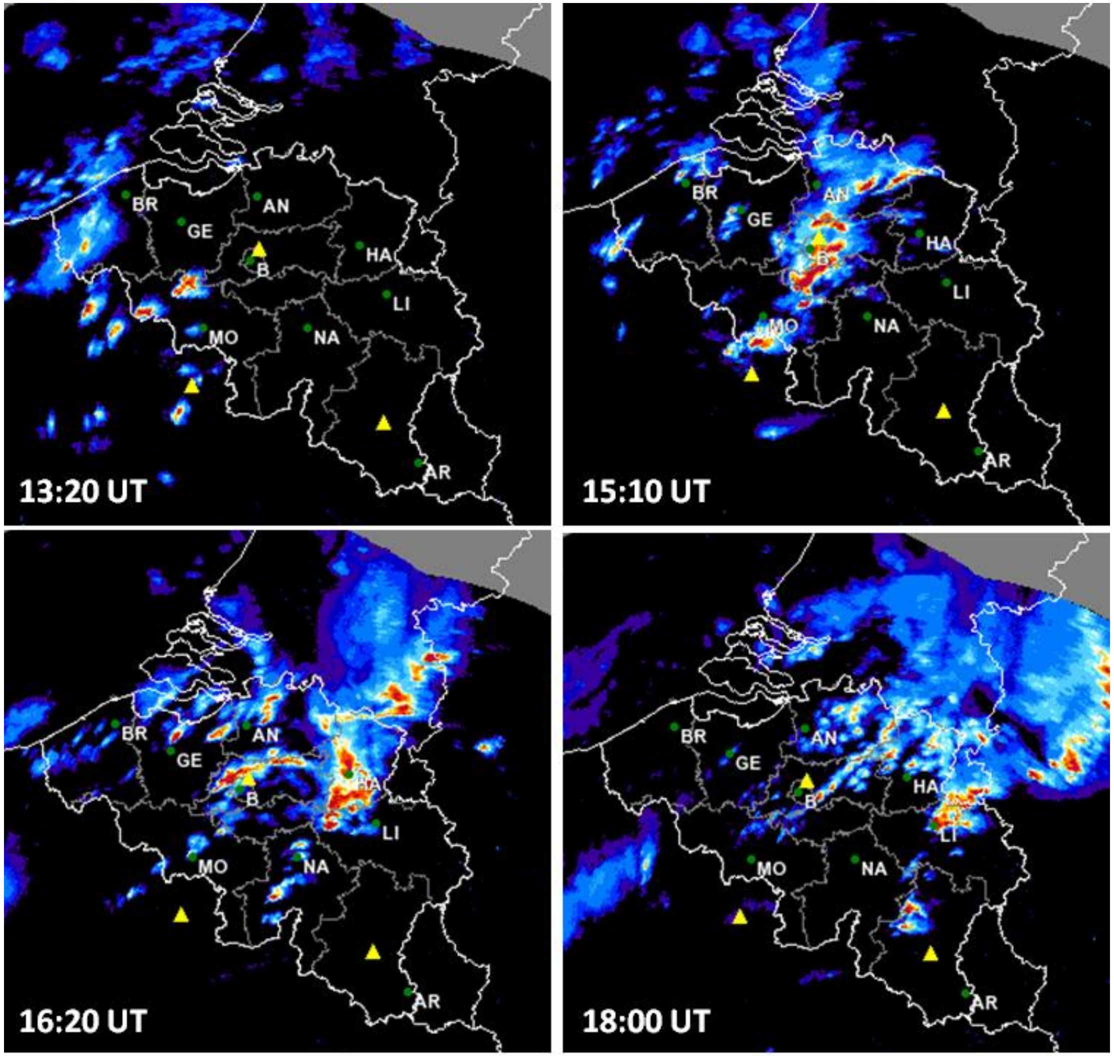
Spanish Plume



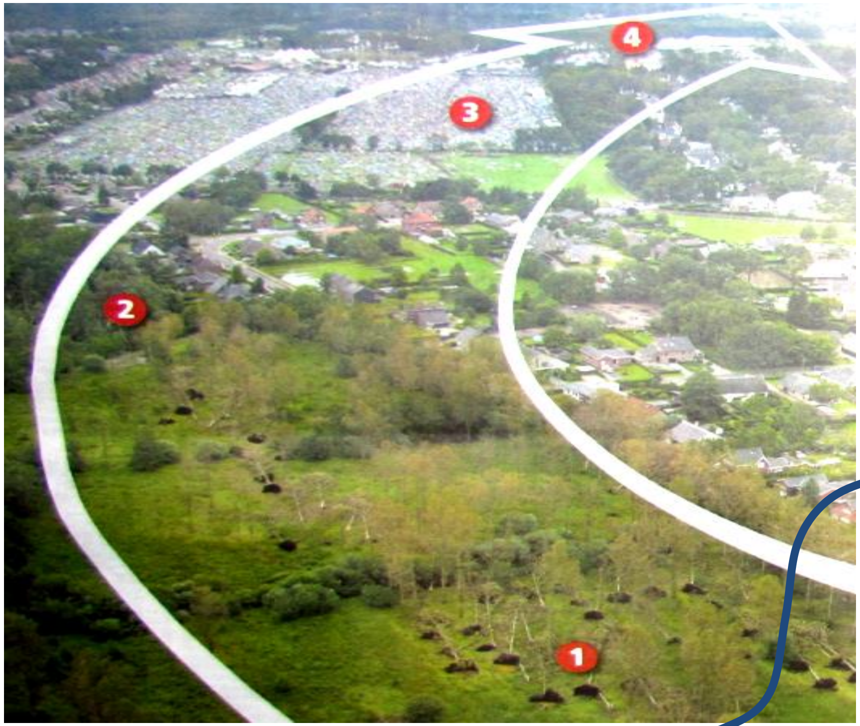


http://www.zamg.ac.at

Pukkelpopstorm 18.08.2011



Scales



Source: “*Het belang van Limburg*”

Downburst ~ 100 m

Operational NWP model

RMI: 4 km grid spacing

- **Predictability of Pukkelpopstorm at 4 km grid spacing?**
- **What is the “truth”?**

Reference run at 1 km

Problems:

Subgrid processes

No observations of e.g. up- and downdraft

Method

- ALARO: deep convective parameterization 3MT
  - 8, **4** and 2 km grid spacings
- Model evaluation
  - Observations
  - 1 km reference run without 3MT
- Focus on downdraft and cold pool

Downdraft parameterization 3MT

$$\left.\frac{\partial \omega_d}{\partial t}\right|_\Phi = -(\omega_d - \overline{\omega})\left(\frac{\partial \omega_d}{\partial \pi} - \frac{\omega_d}{\pi} + \omega_d \frac{\partial \ln T_v}{\partial \pi}\right)$$

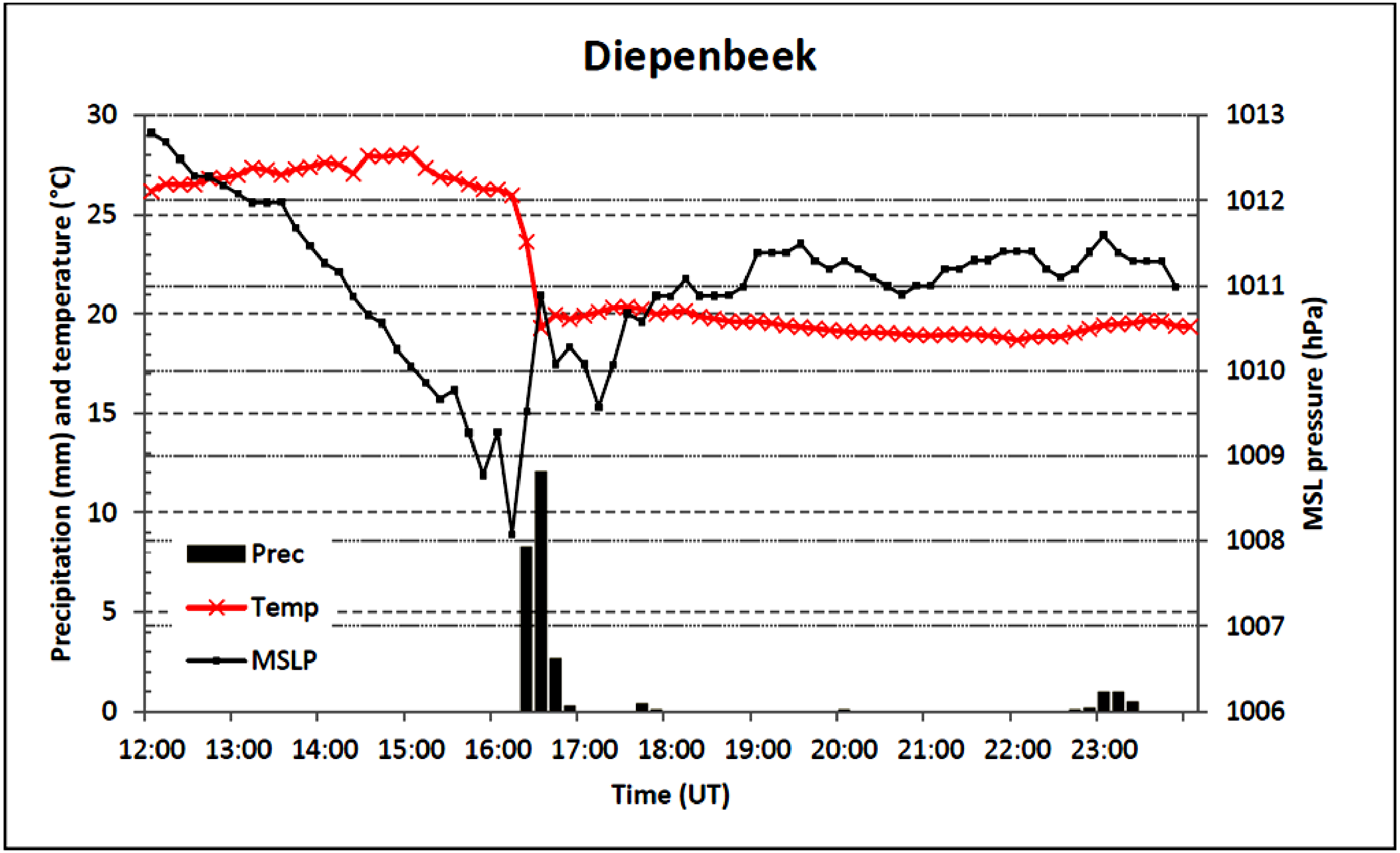
$$- \frac{g^2}{1+\gamma'}\frac{\pi}{R_a}\frac{T_{vd} - T_{ve}}{T_{ve}T_{vd}} \underbrace{- \delta_{d\mathcal{P}}\left\{(\lambda_d + \mathcal{K}_{dd}/g)\frac{R_a T_{vd}}{\pi}\right\}}_{\equiv \chi}(\omega_d - \omega_{\mathcal{P}})^2 - \frac{\text{GDDDP}\delta_d}{(\pi_{\text{surf}} - \pi)^\beta}\,\omega_d^2$$

$$l_d = q_i + q_l$$

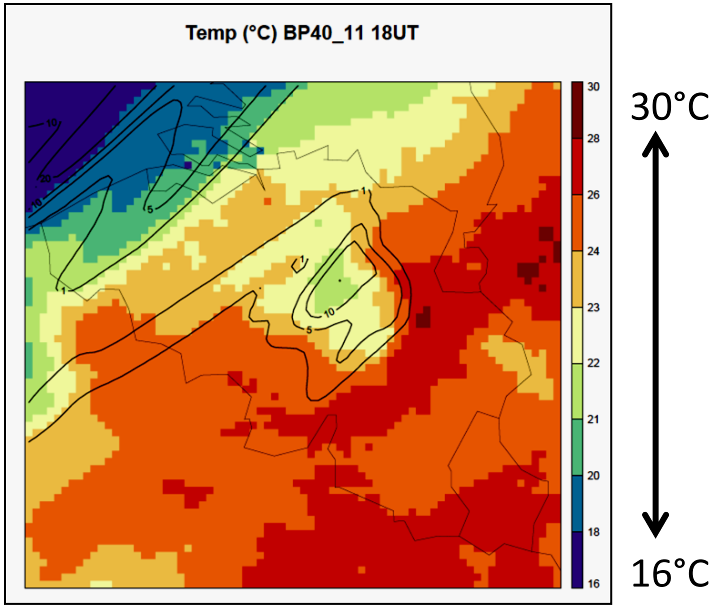
$$T_{vd} = T_d \cdot (1 - l_d + \frac{R_v - R_a}{R_a} q_d)$$

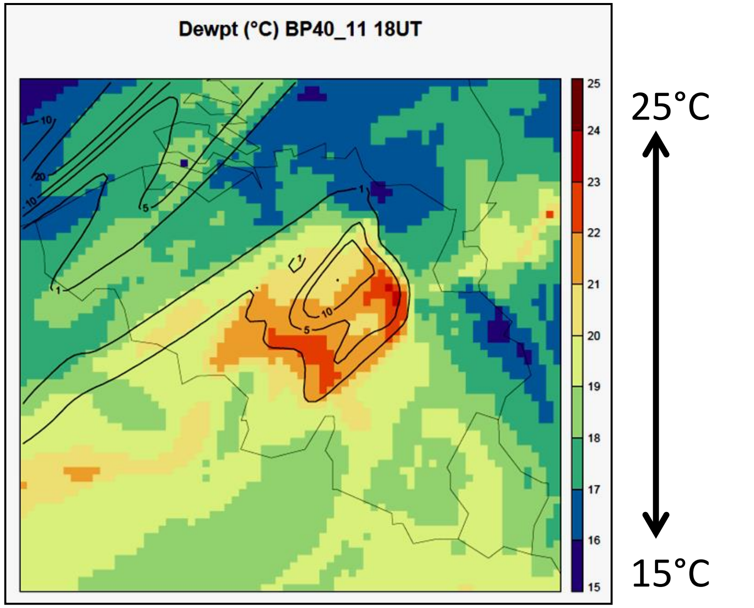
$$T_{ve} = T_w \cdot (1 - l_d + \frac{R_v - R_a}{R_a} q_w)$$

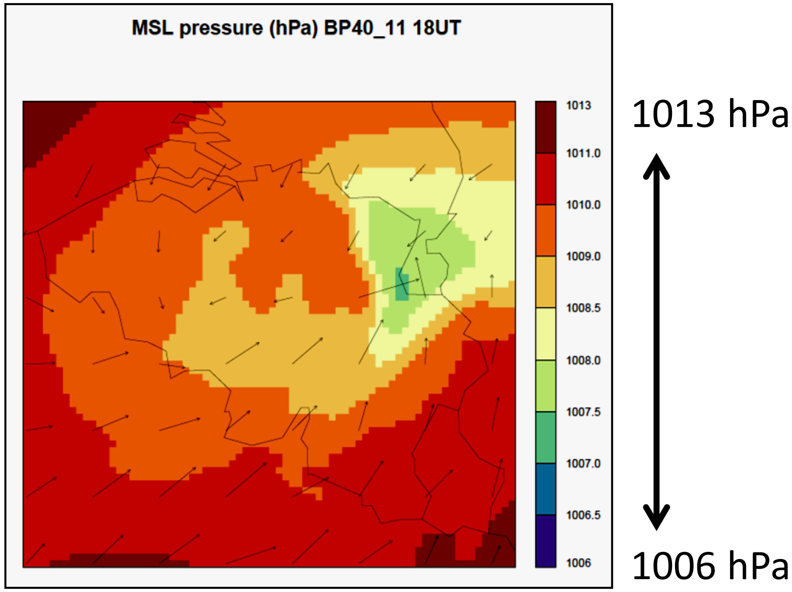
Observations AMS Diepenbeek

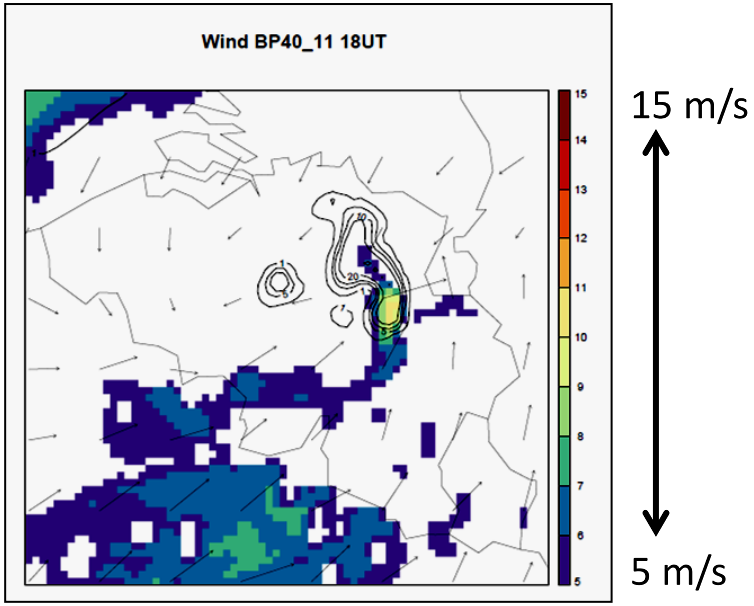


Results: cold pool



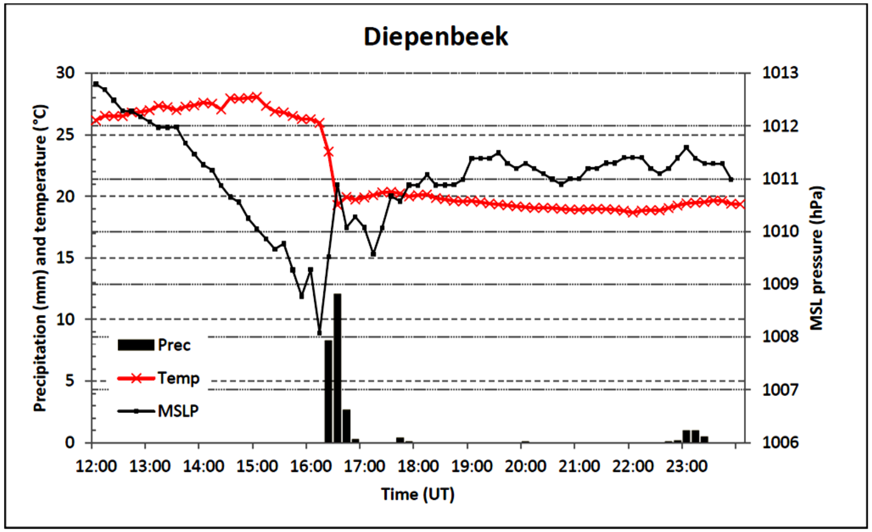




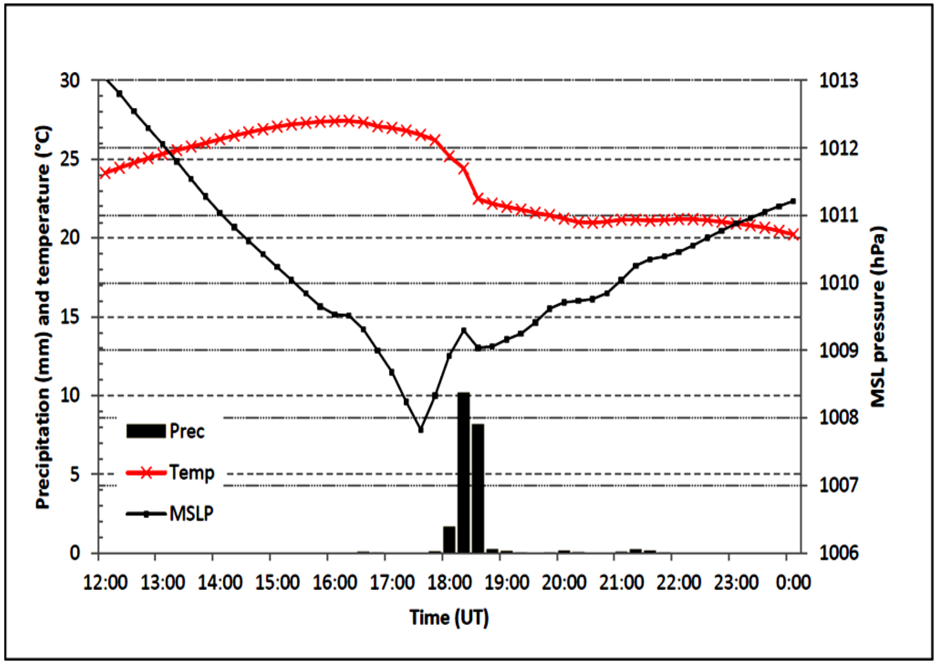


Results: cold pool

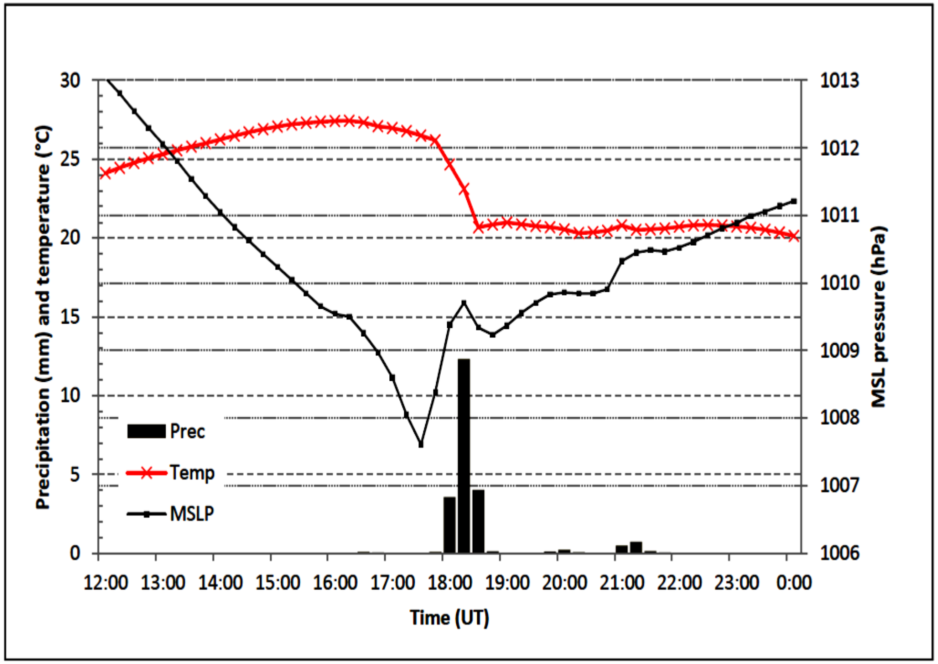
Observations



4 km run

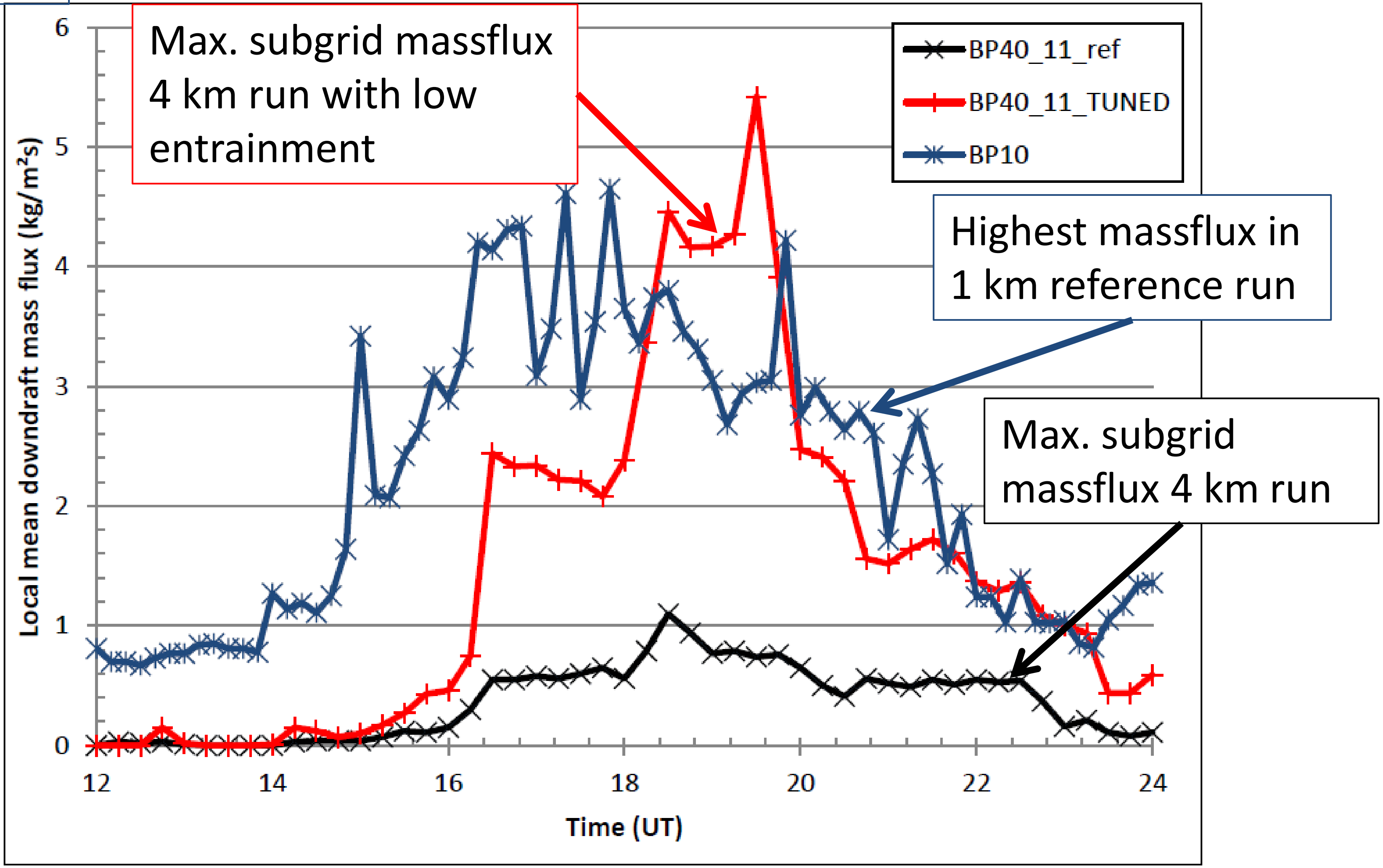


4 km run with stronger downdraft



Downdraft mass flux

Downburst > 10 kg/m²s



Conclusions

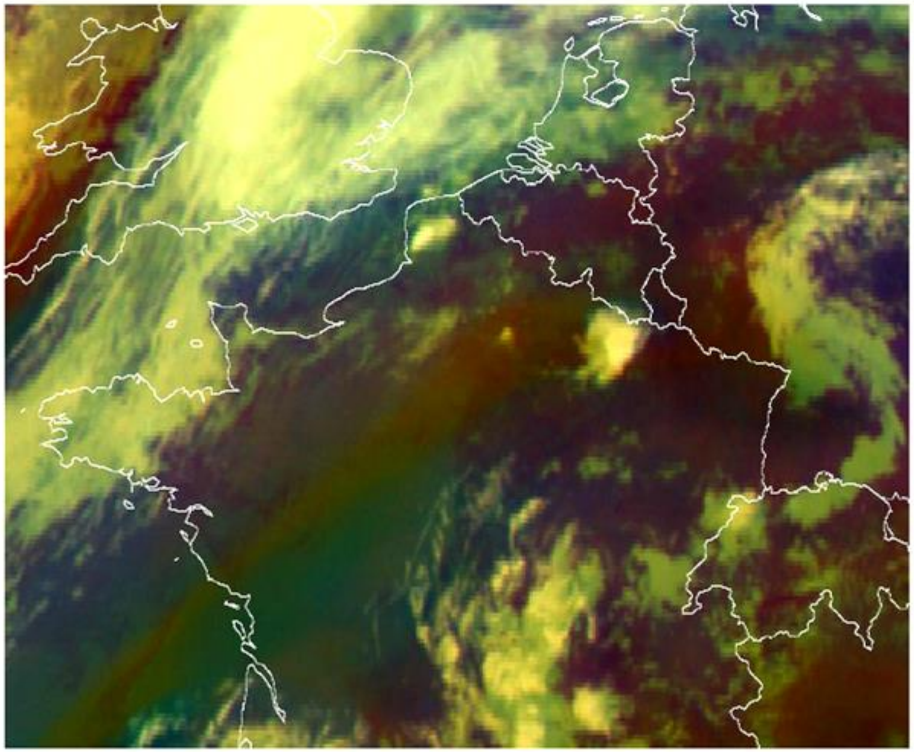
- Retuning of the downdraft based on the cold pool characteristics leads to
  i. a downdraft more in agreement with the reference run
  ii. better storm outflow wind speeds
  iii. a better representation of the dewpoints within the cold pools
  iv. slightly increased storm propagation

QUESTIONS?

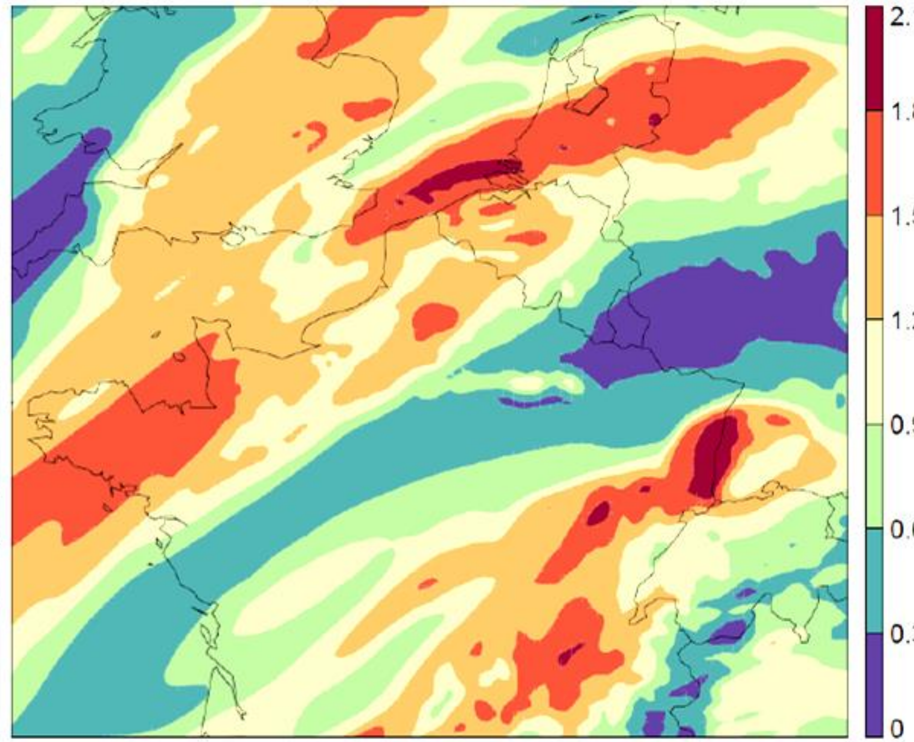
(Hamid, 2011)

Spanish Plume

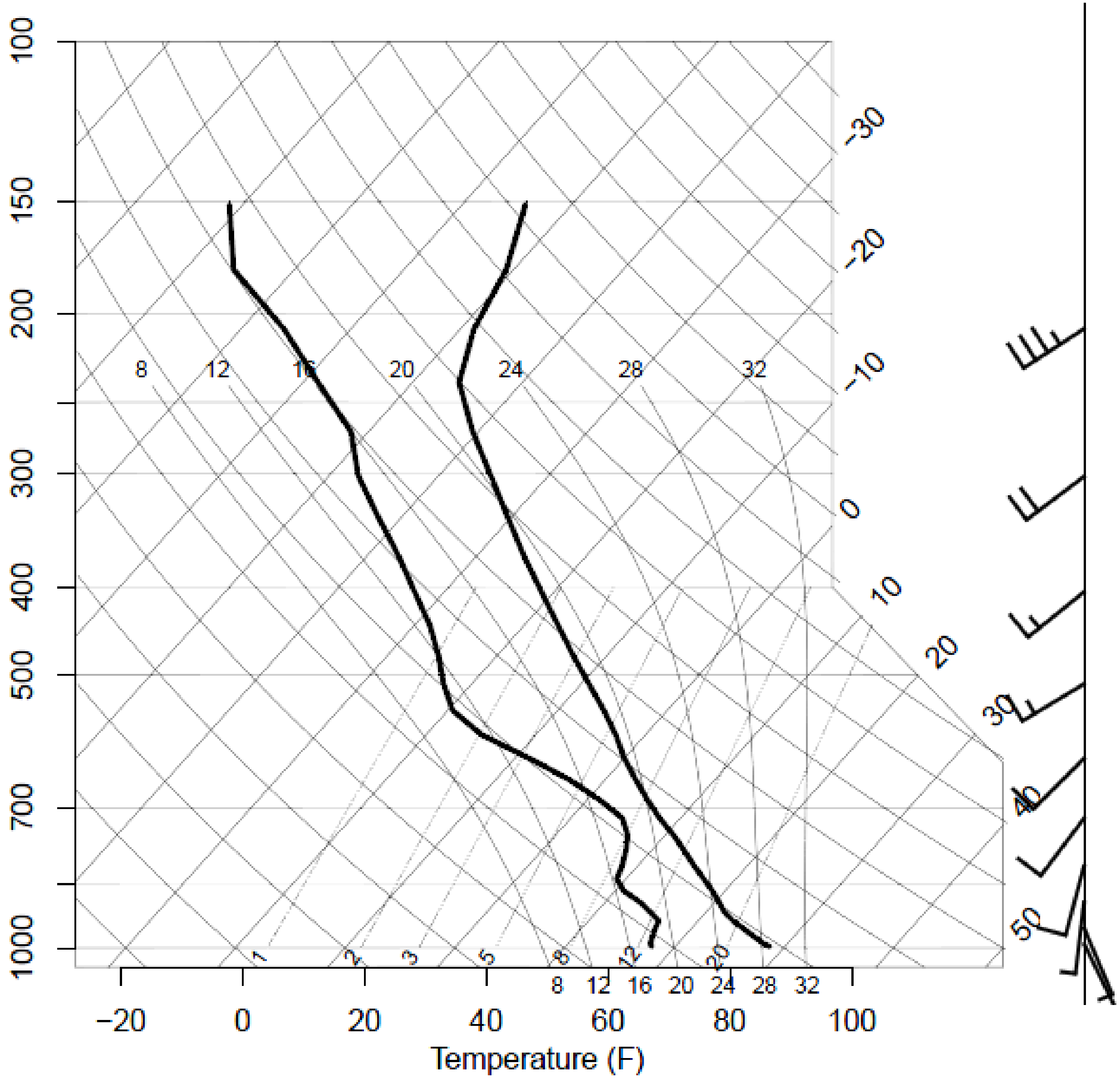
RGB airmass meteosat



600 hPa specific humidity (g/kg)



Pseudo-sounding



BIAS and RMSE Uccle