



CGILS: Met Office LES results

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Met Office LEM/CRM set-up - as requested, I hope!

- Only show 3D LEM but also run 2D for “quick” tests of set-up
- Resolutions 100²m x 40m, 50²m x 25m, 25²m x 5m (s6,11,12)
- Otherwise set-up as for GCSS-RICO
 - Includes 2-moment bulk rain microphysics, cloud droplet sedimentation
- Using the RRTM radiation code provided and revised surface exchange set-up (specified c_H , same at all 3 points except with mixed layer ICs, see later)
- These are long simulations for me (see later)!
 - s6 and s11 took ~40 days to run 10 days
 - s12 took ~40 days to run ~2.5 days



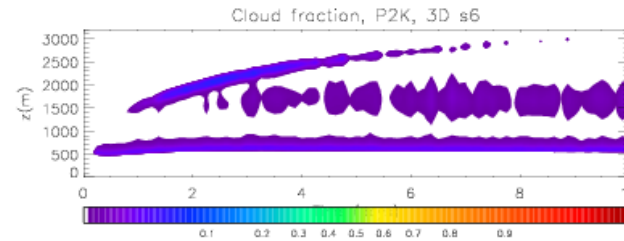
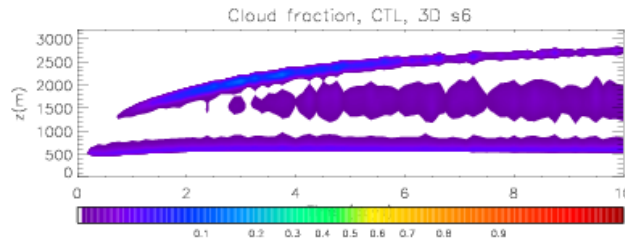
Standard results

Time-height plot of cloud fraction

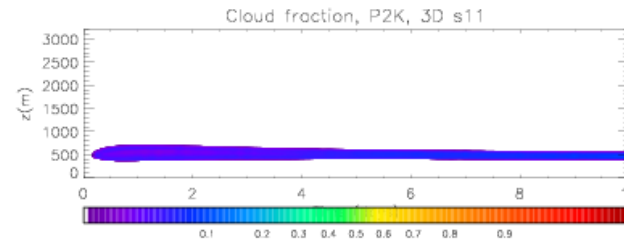
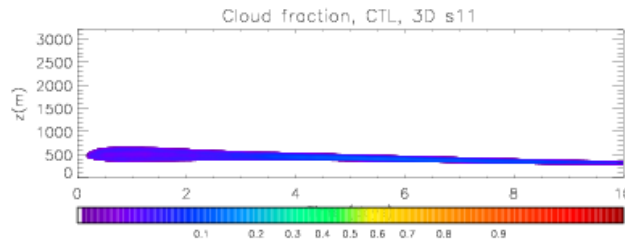
Control

+2K

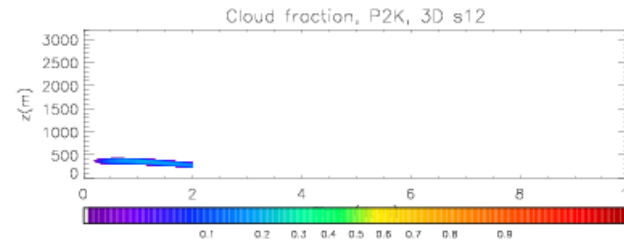
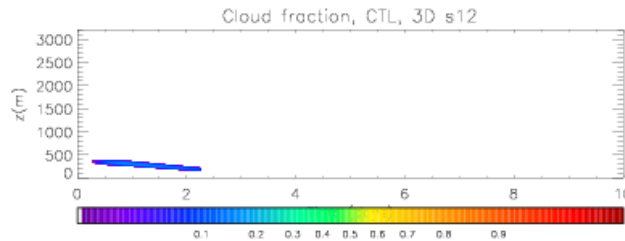
s6



s11



s12



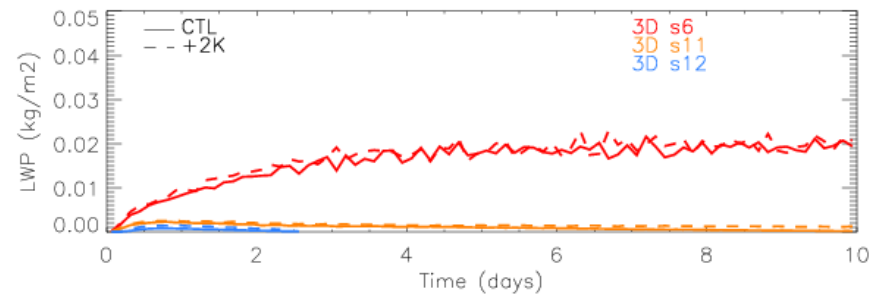
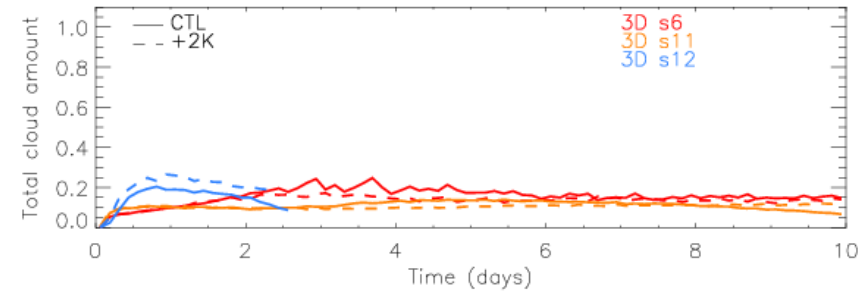
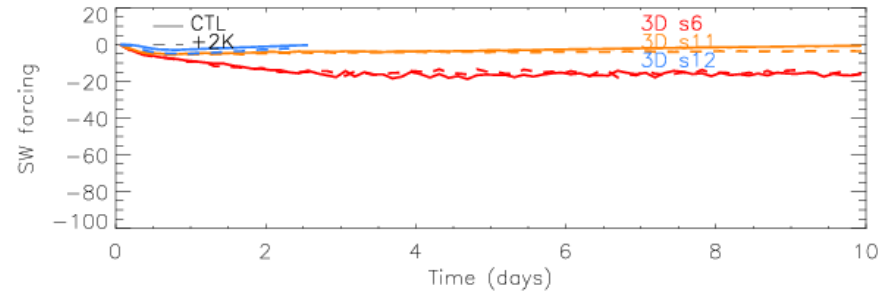
- Very small cloud cover (<20%) at all points
- Slightly higher cloud top in +2K



Standard results

Climate change response

- S6
 - Higher cloud-top
 - Reduced cloud cover
 - Neutral climate response
- S11
 - Small climate response that varies in time
- S12
 - Increased cloud cover
 - Weak negative feedback





Why is the Met Office LES so slow?

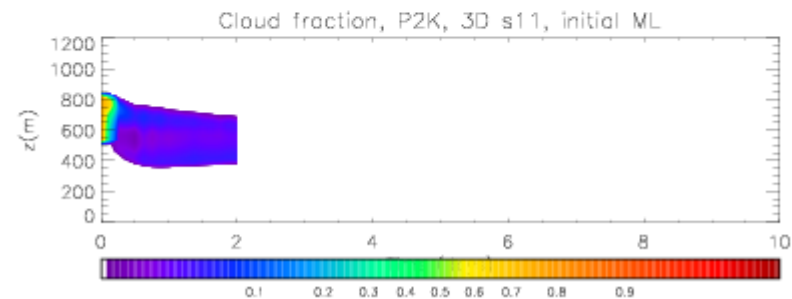
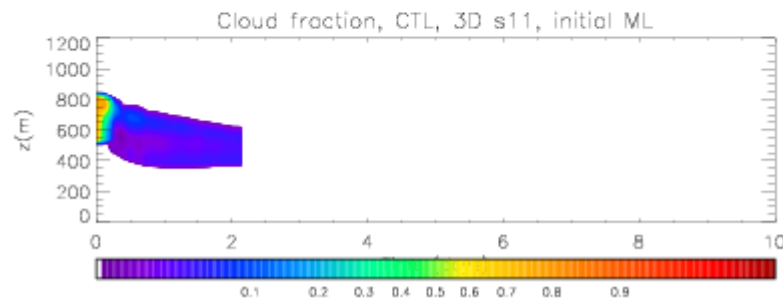
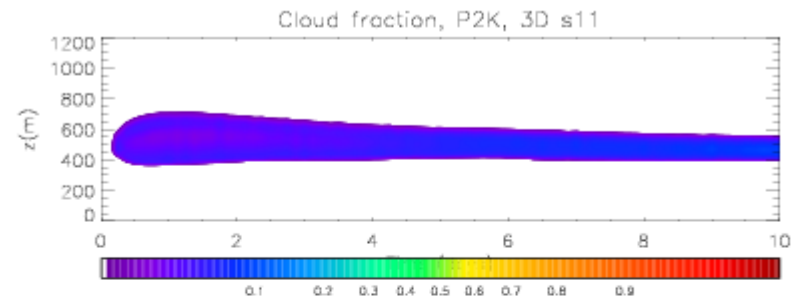
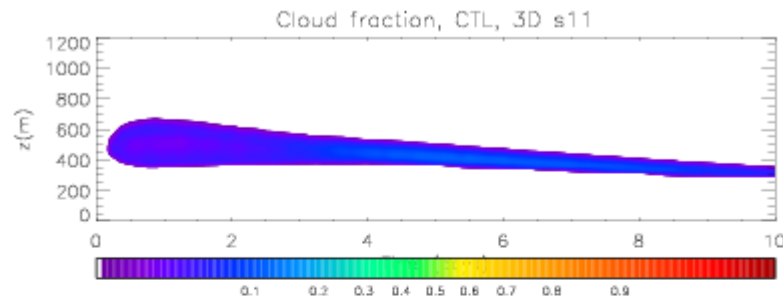
- Simulations are 128x128 points and we can only parallelise in the x-direction → maximum of 64 PEs (cf others use 256?)
- My timestep $\sim 0.3\text{s}$ (cf $>1\text{s}$?) due to maximum CFL limit of 0.4
 - Don't want to increase CFL restriction for numerical accuracy
 - Actually viscous-limited in the cloud layer, rather than advection: $\frac{\nu \Delta t}{\Delta z^2}$
- Met Office LEM uses a Smagorinsky-Lilly type subgrid model with turbulent diffusion coefficients given by $\nu = \lambda^2 Sf(Ri)$
- with neutral asymptotic mixing length $\lambda_0 = c_s \Delta x$ with $c_s = 0.23$
- Simply taking geometric mean, ie: $\lambda_0 = c_s (\Delta x \Delta y \Delta z)^{1/3}$

gives more than double the timestep – is this “standard”?
- In future, for both CGILS and Lagrangians, I'm now using geometric mean as standard and running the old formulation in the background for sensitivity
 - so far none seen



Sensitivity tests

Starting with mixed layer in the initial profile: s11

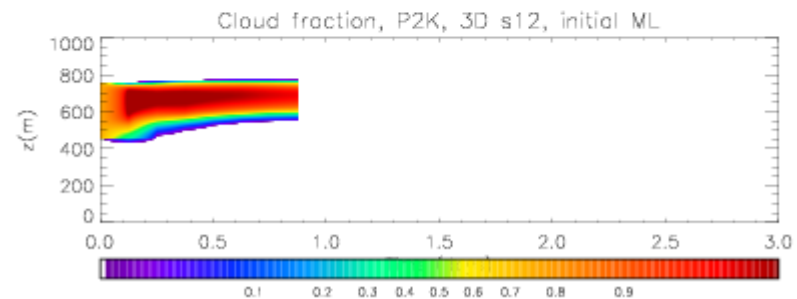
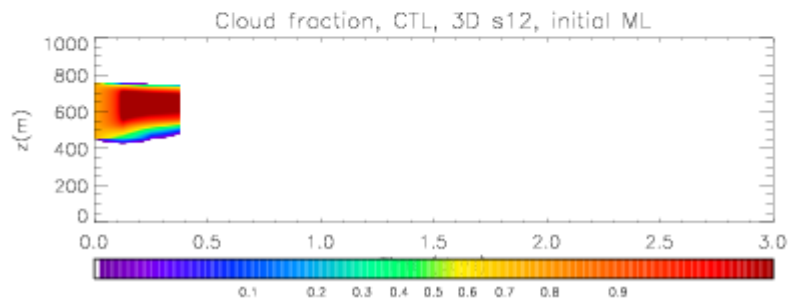
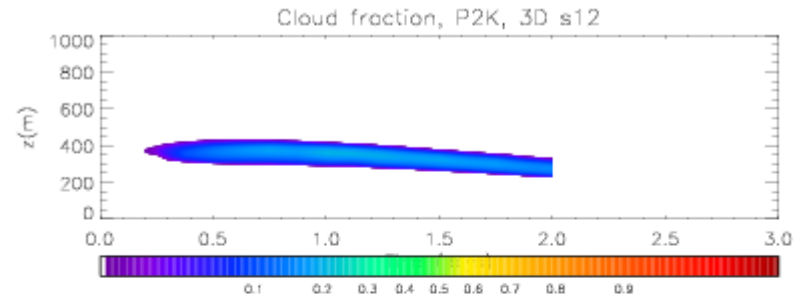
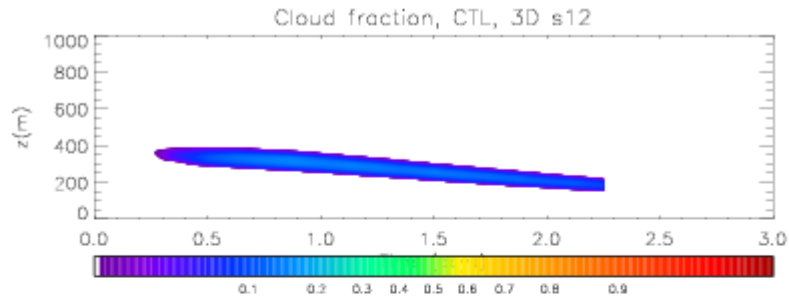


- S11: after 2 days the mixed layer LES are almost identical to the standard set-up (hence stopped)



Sensitivity tests

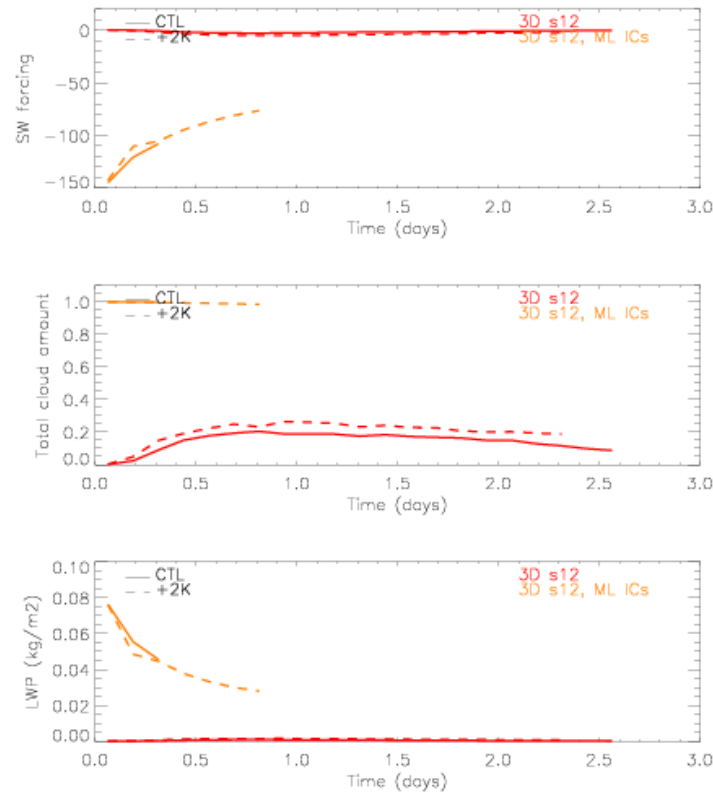
Starting with mixed layer in the initial profile: s12



- S12: after ~1 day (10 days on the computer) the mixed layer LES are looking much better (large cloud fraction, cloud-top up at around 800m)

Sensitivity tests

Starting with mixed layer in the initial profile: s12



- S12 climate change response initially a positive feedback when LES has stratocumulus cloud, via reduced LWP



Met Office



Questions?