

The Diurnal Cycle in MONC

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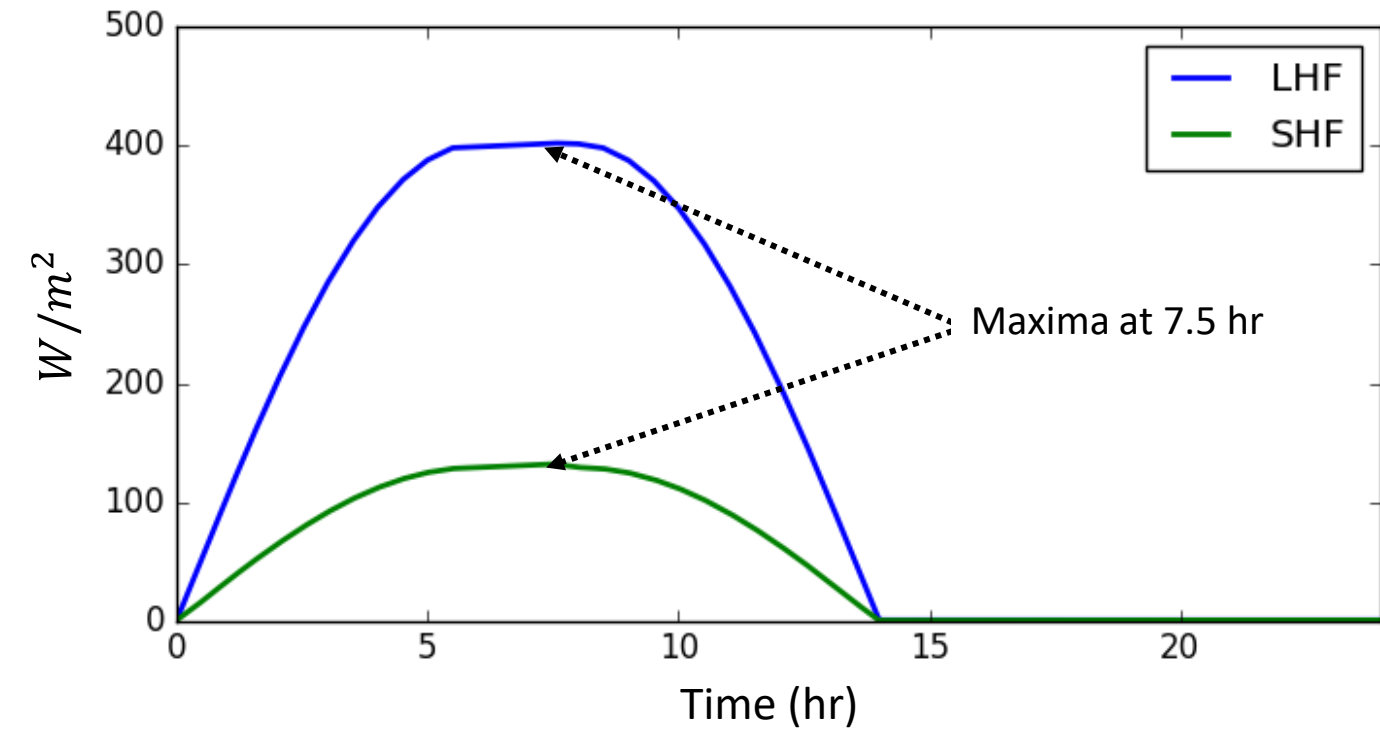
Bob Plant

Steve Woolnough

Diurnal Cycle in MONC – progress

- Prototype run: 50x50 km with 200 m horizontal resolution
 - 120 vertical levels with a 20km top
 - Damping above 16km
 - Prescribed surface forcing
 - Prescribed large scale forcing and radiation
 - Relaxation to initial u and v profiles
 - Casim microphysics
 - 'Conventional' subgrid model constants
- 5 days run (with standard and conditional diagnostic output) takes approximately 26 hours to run on ARCHER using 8 nodes

Prescribed SHF and LHF

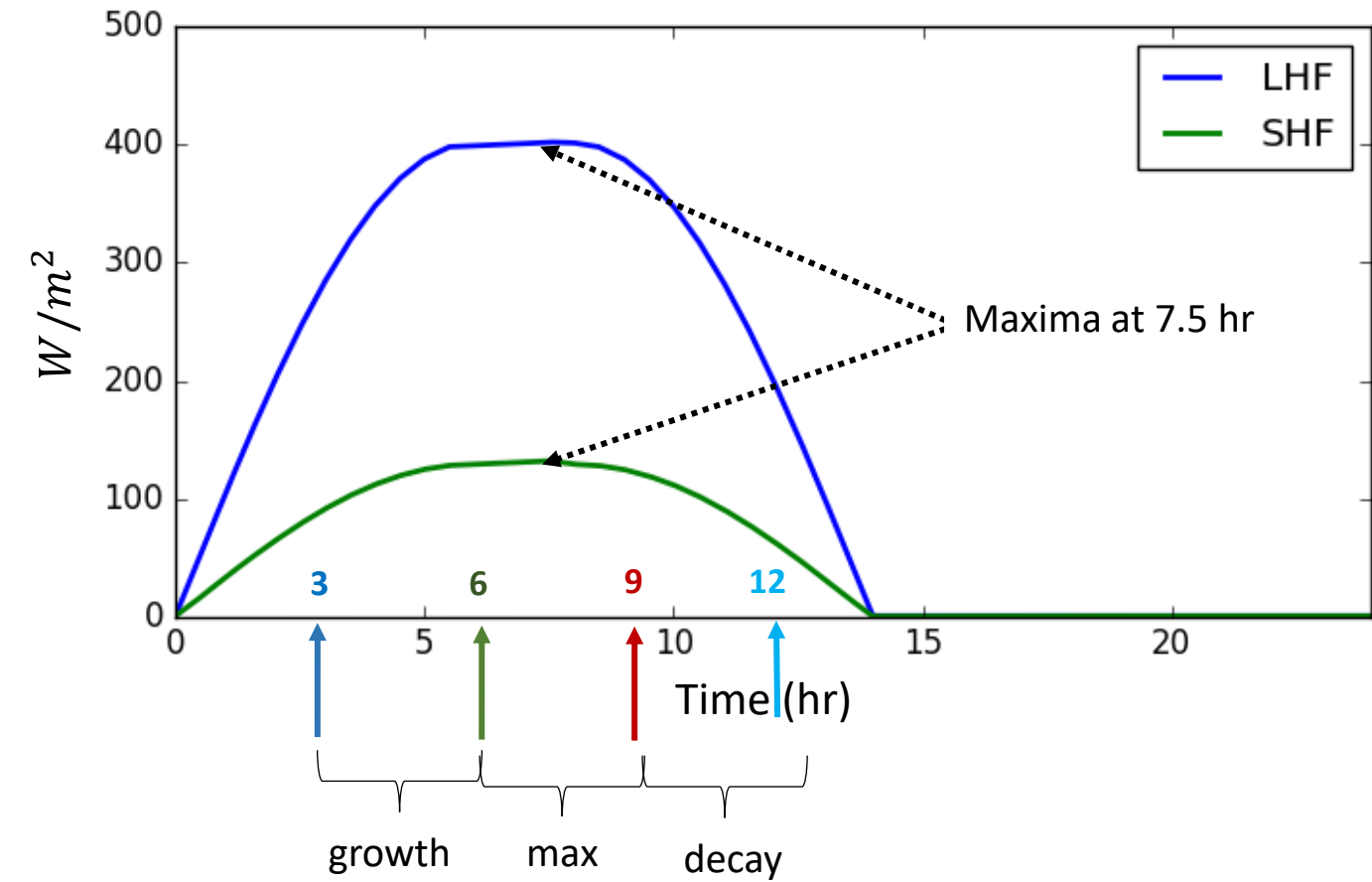


Strong diurnal cycle:
Max SHF = $132 w/m^2$
Max LHF = $402 w/m^2$
Bowen ratio = $\frac{SHF}{LHF} \sim 0.3$

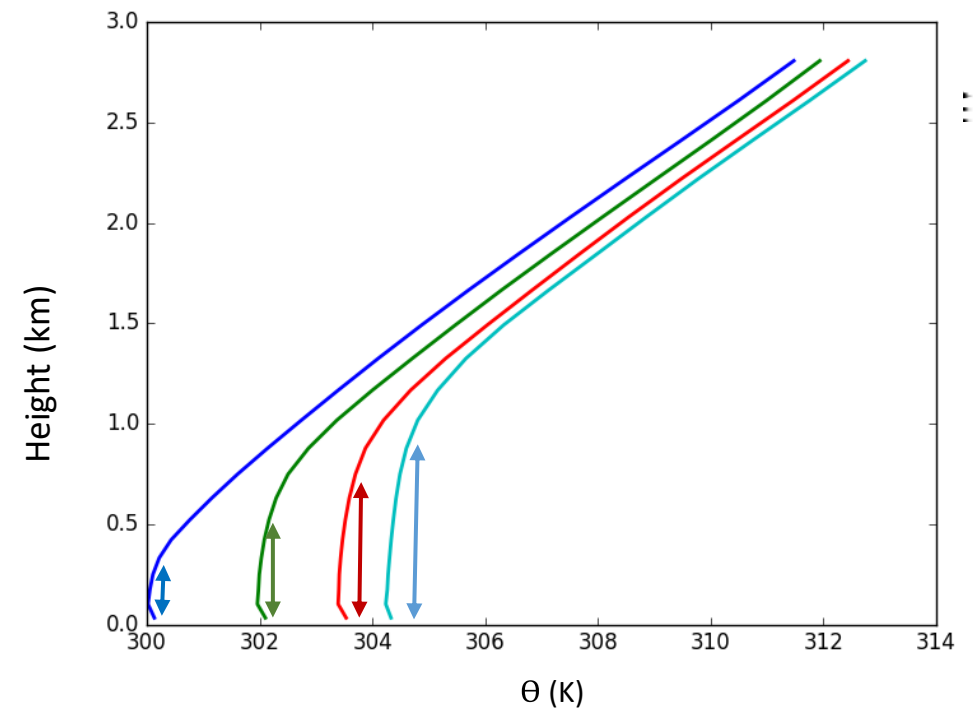
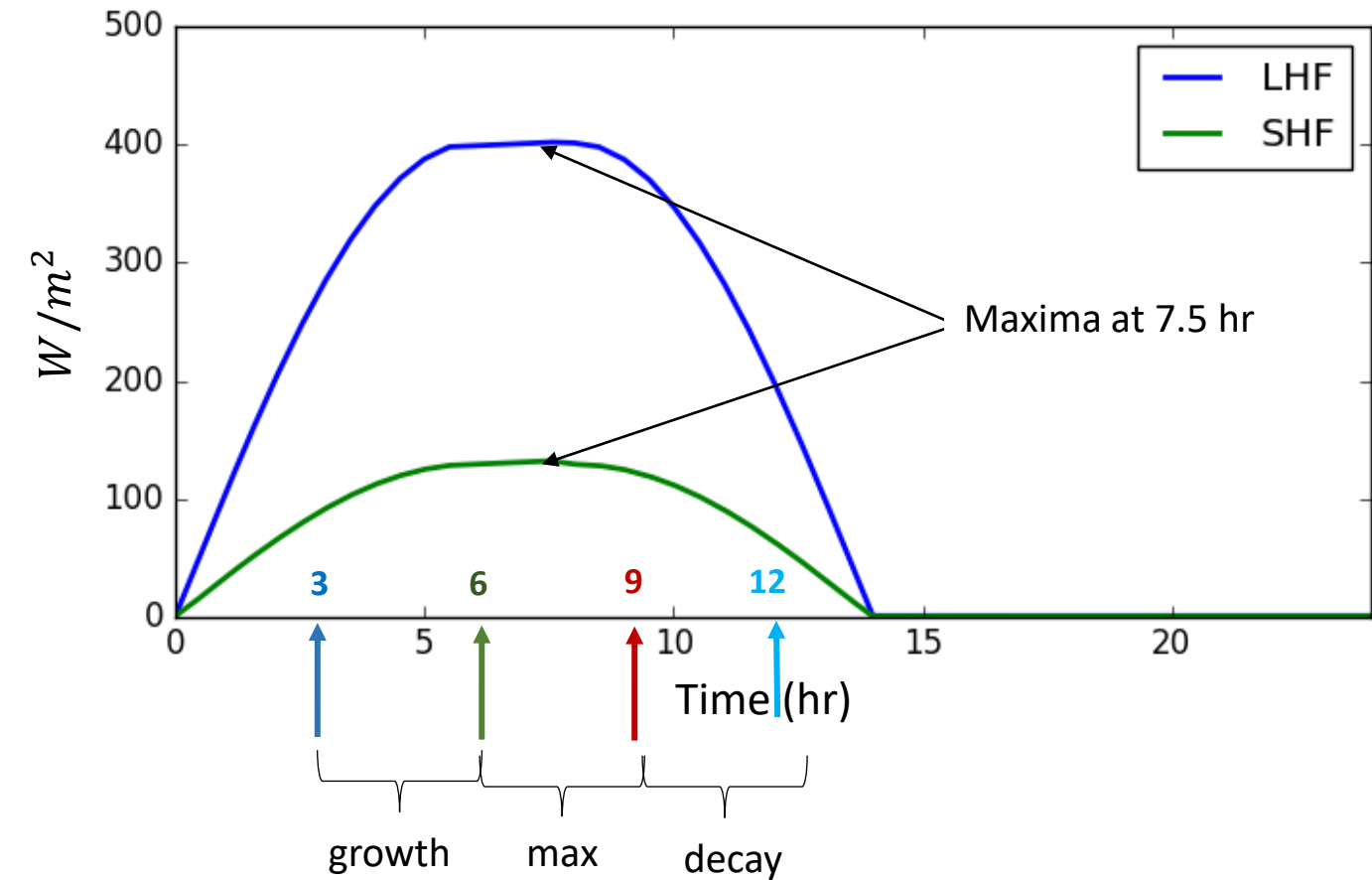
compared to

BOMEX
SHF = $9 w/m^2$
LHF = $150 w/m^2$
Bowen ratio = $\frac{SHF}{LHF} \sim 0.06$

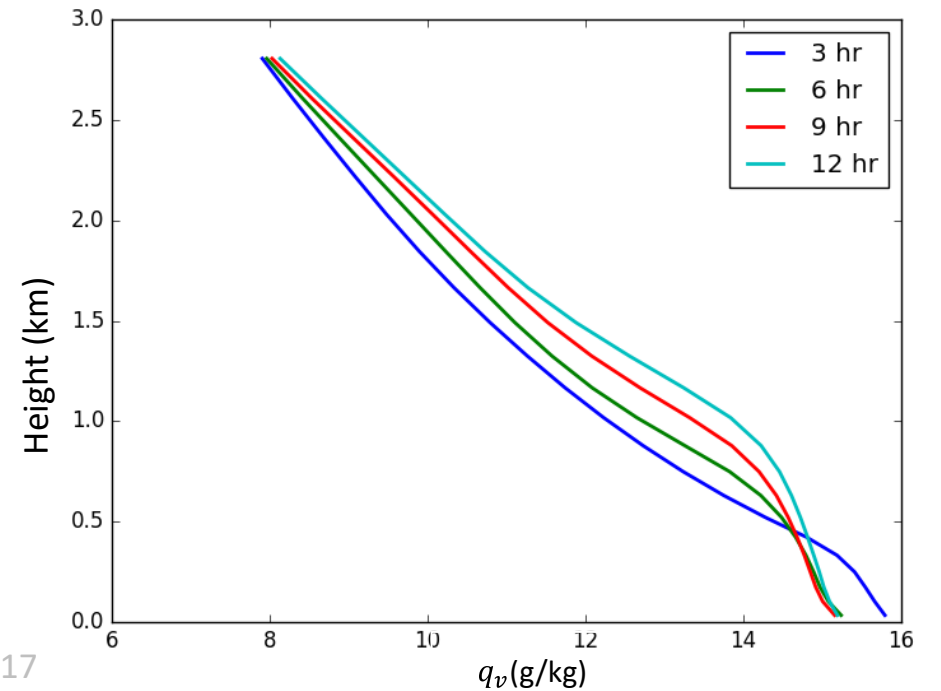
Prescribed SHF and LHF



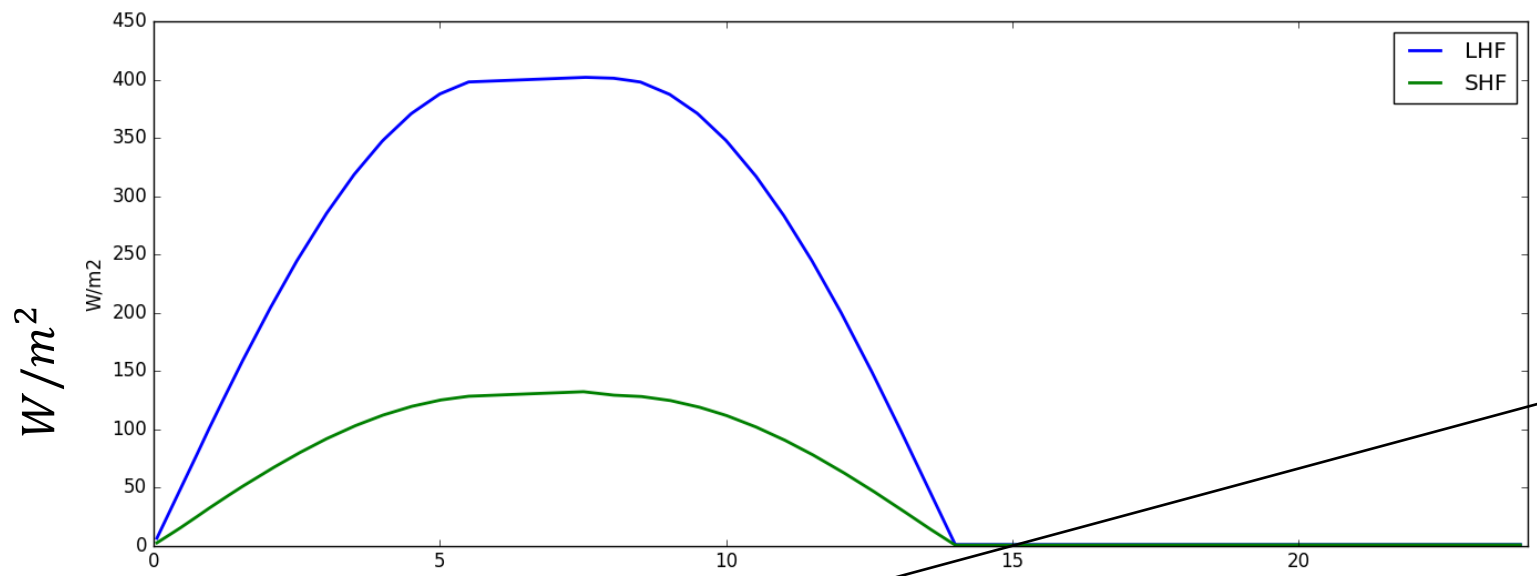
Prescribed SHF and LHF



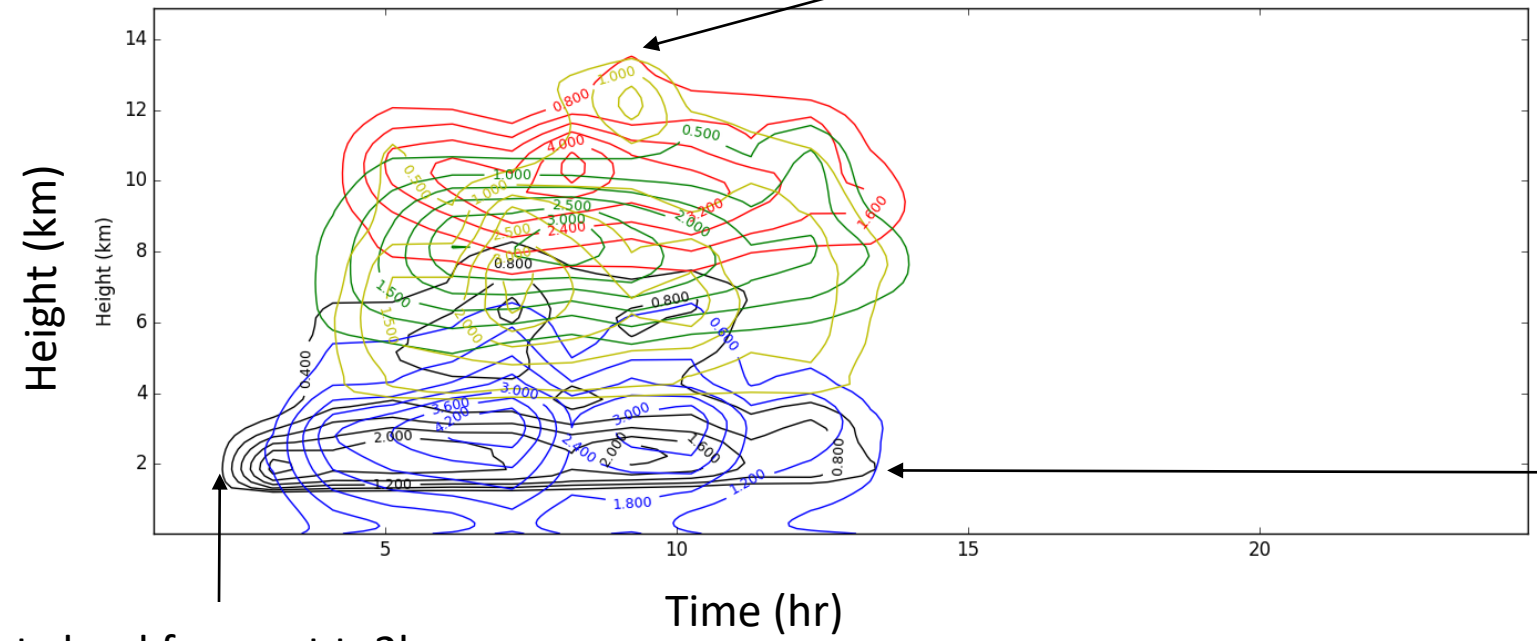
Evolution of the BL



Evolution of condensate



Max cloud top at t=9hr; 1.5 hr after LHF&SHF have reached their maxima

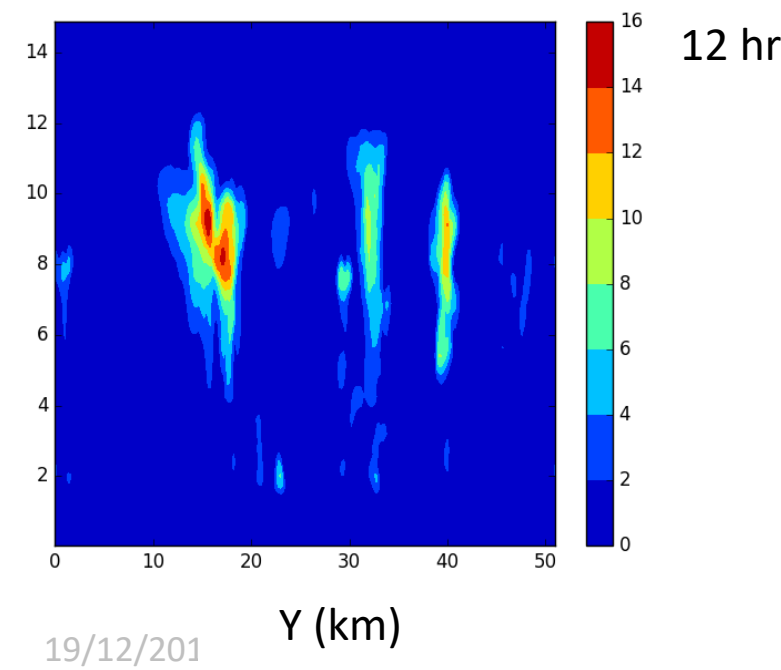
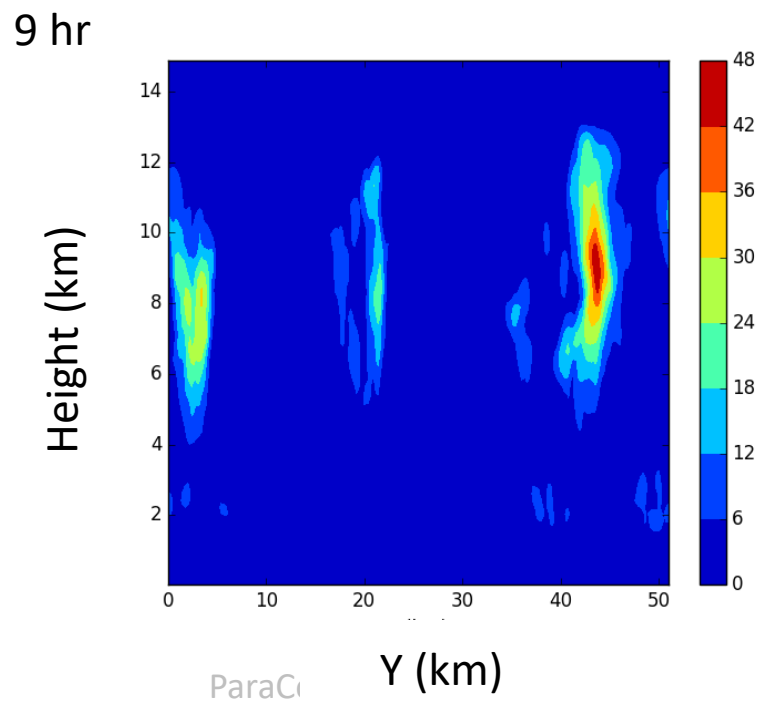
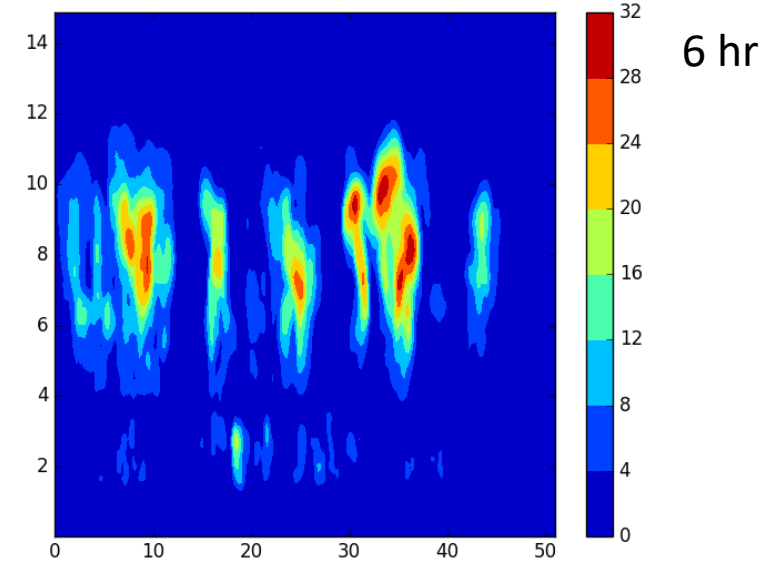
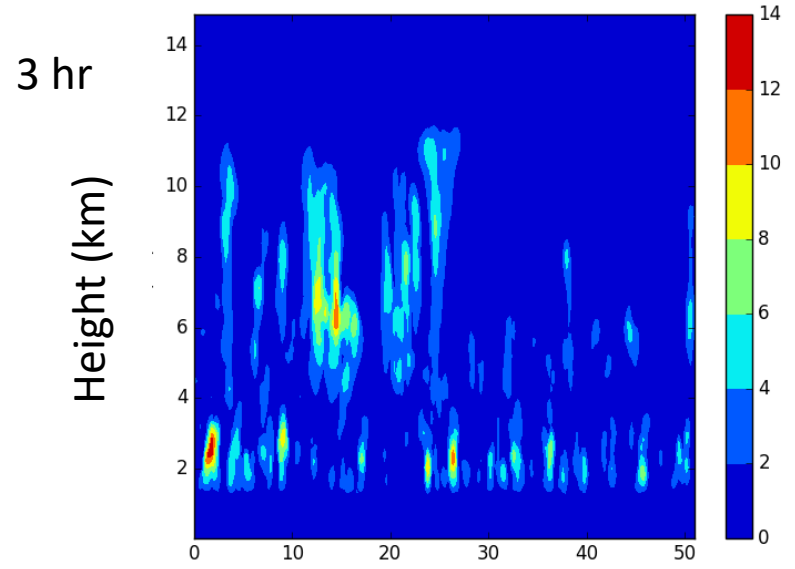


- Liquid water mass *100000
- Ice mass *100000
- Rain mass *100000
- Snow mass *100000
- Graupel mass *100000

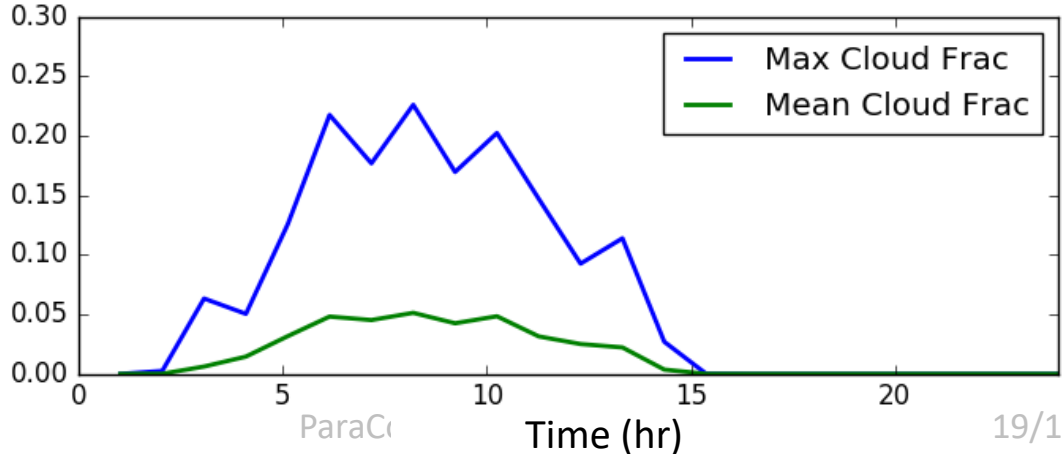
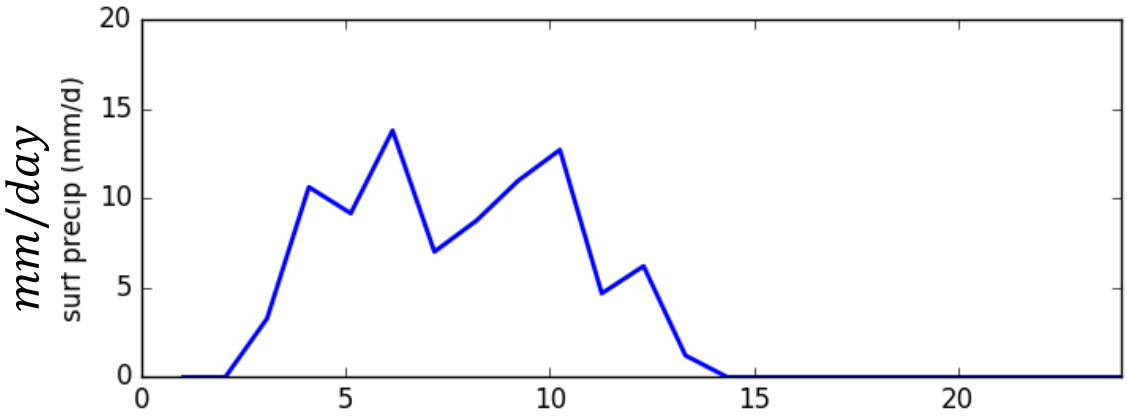
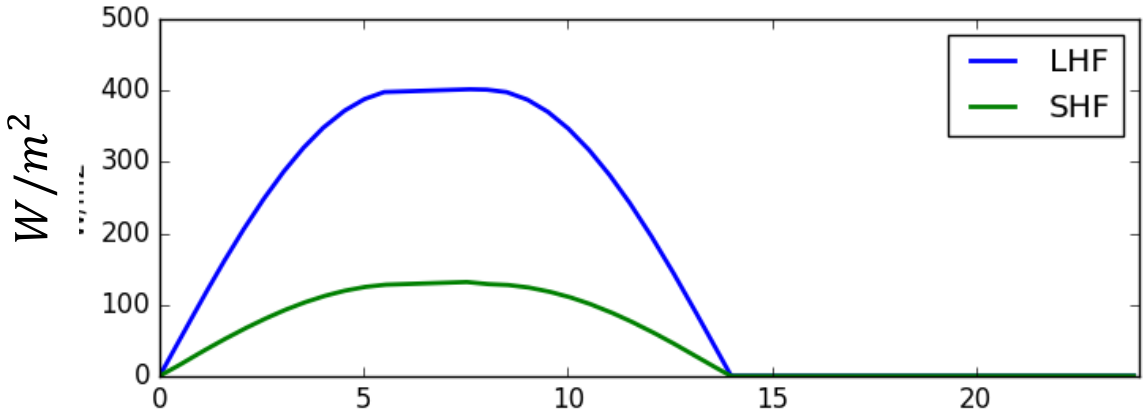
Cloud base: almost constant with time

First cloud forms at t=2hr

Snapshots at t=3, 6, 9, and 12 hrs (liquid water, ice, snow and graupel)

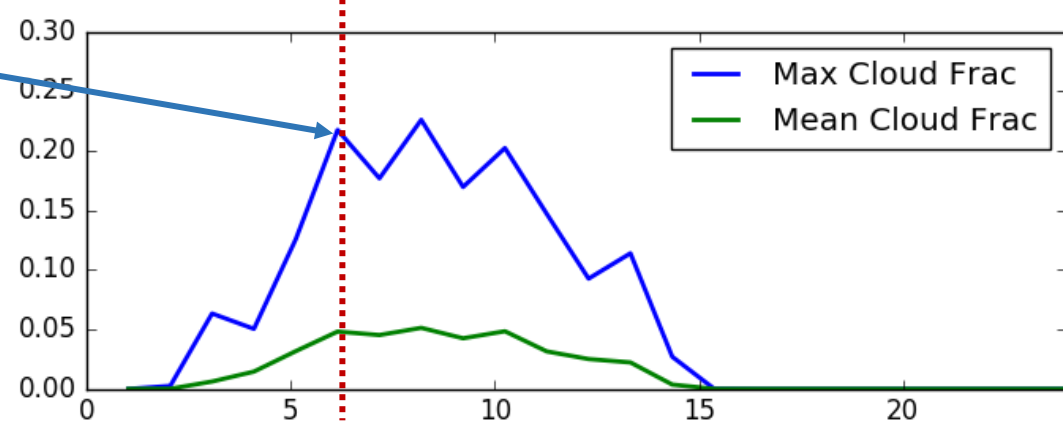
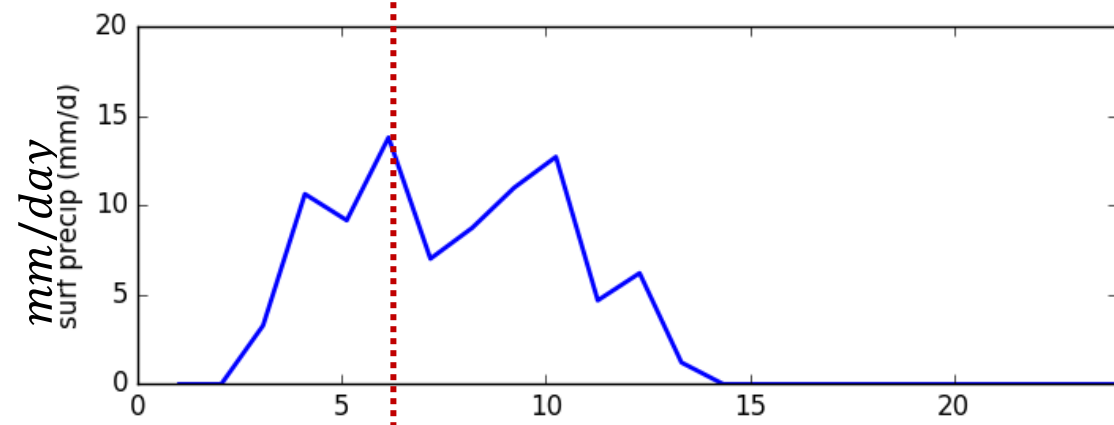
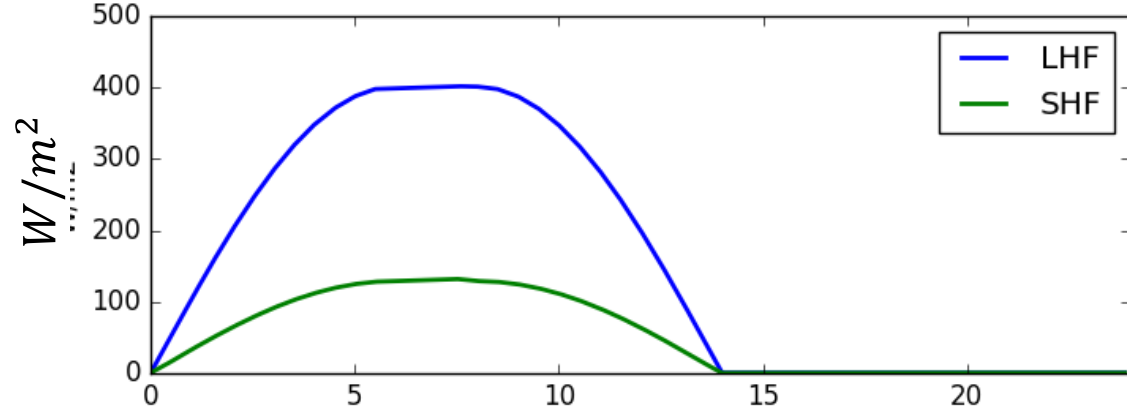


Other time series



mean cloud fraction
(average between 1 and 14 km)

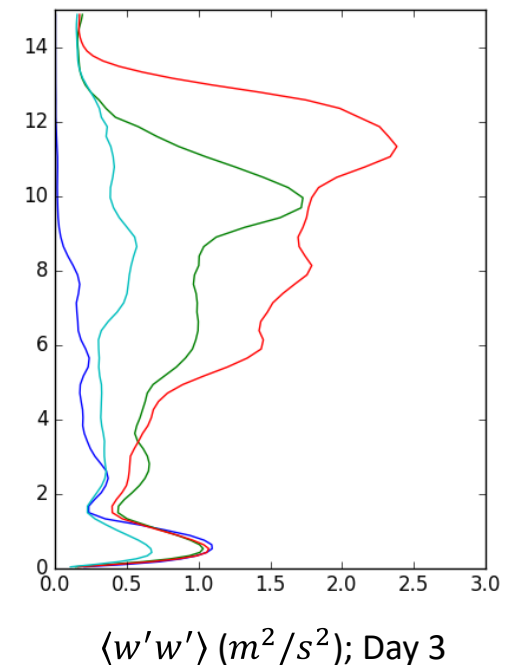
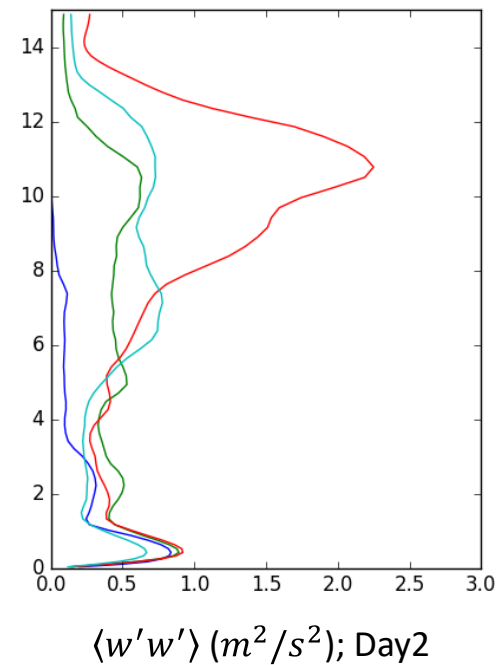
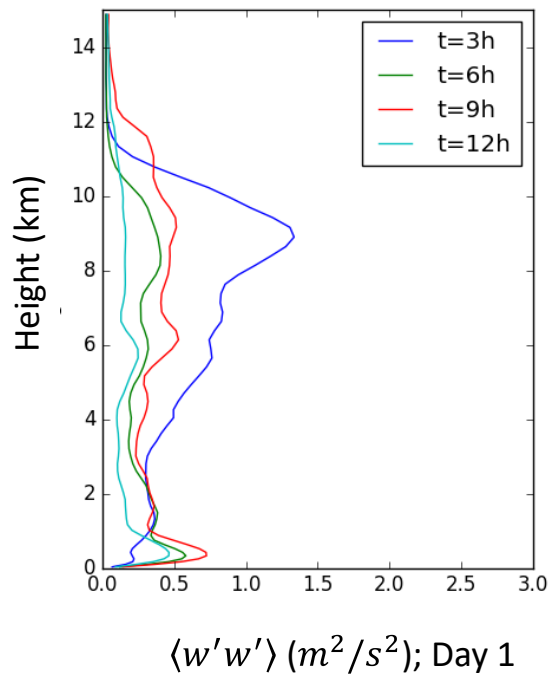
Other time series



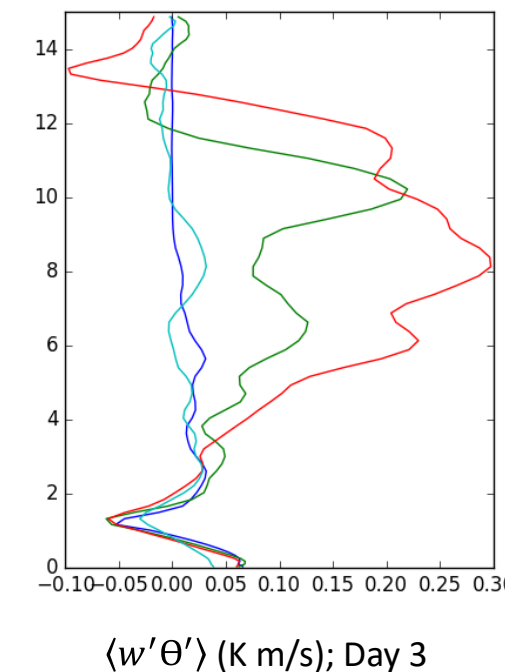
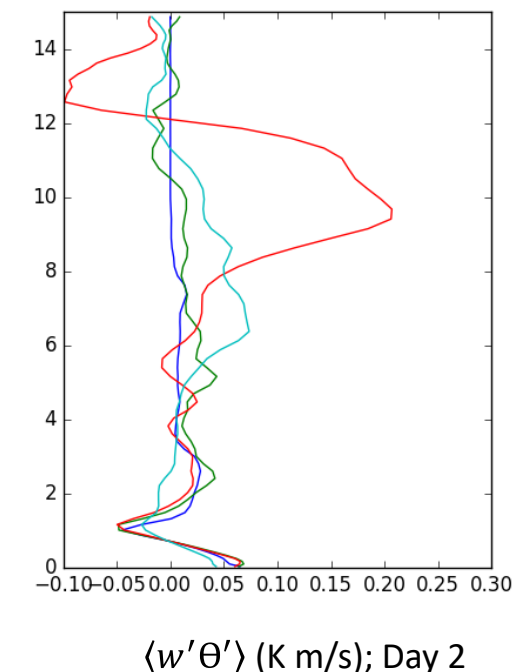
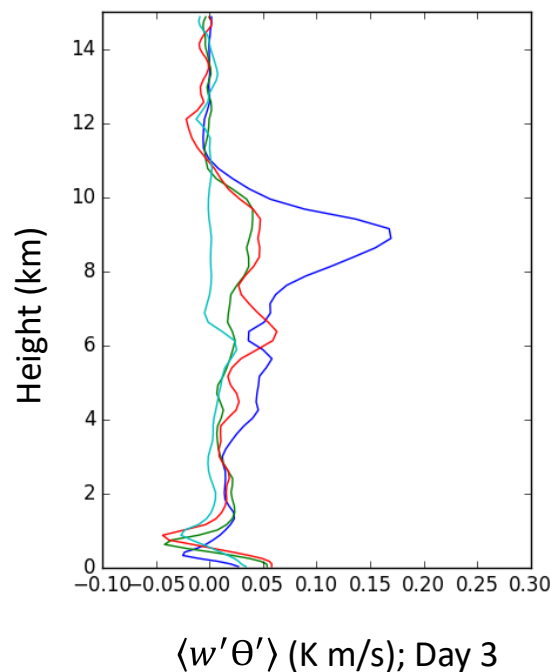
At t=6 hr more than 20% of the domain is covered by clouds

mean cloud fraction (average between 1 and 14 km)

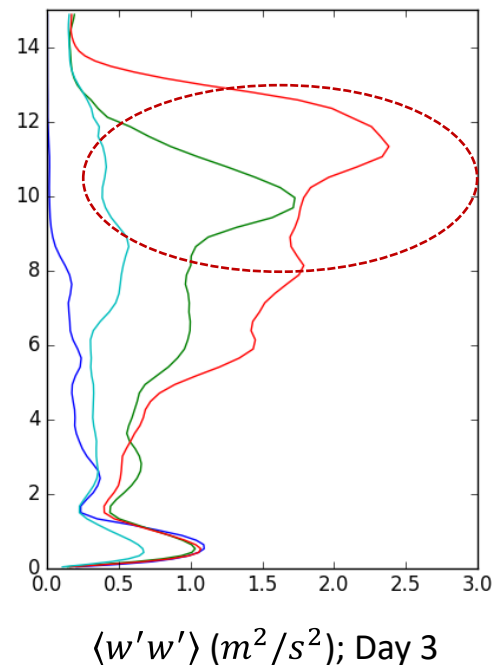
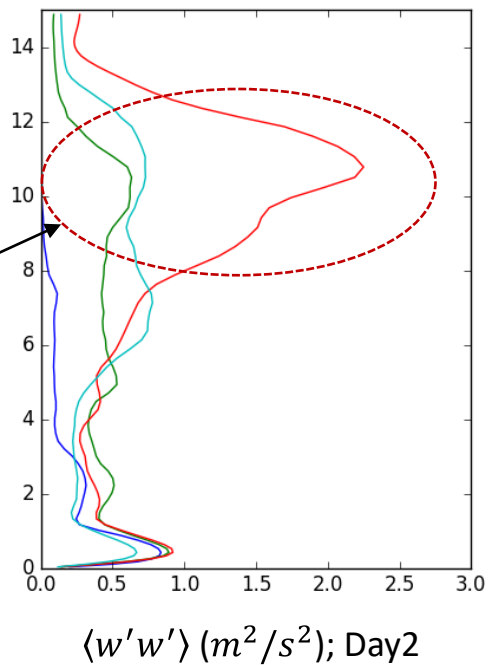
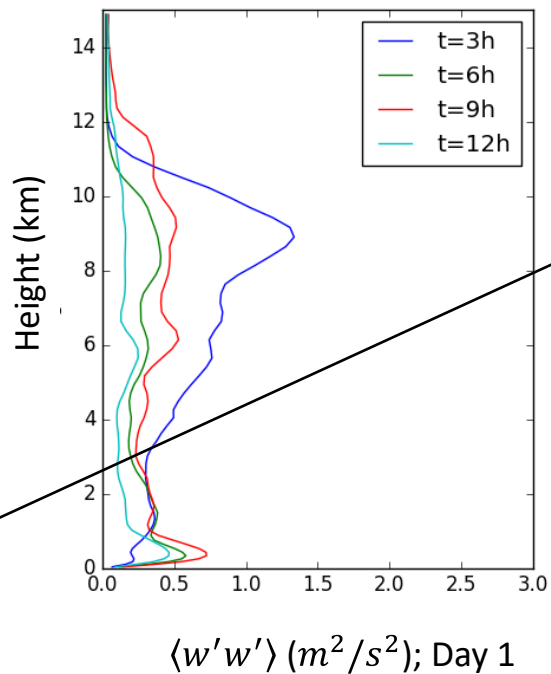
Profiles of $\langle w'w' \rangle$



Profiles of $\langle w'\theta' \rangle$

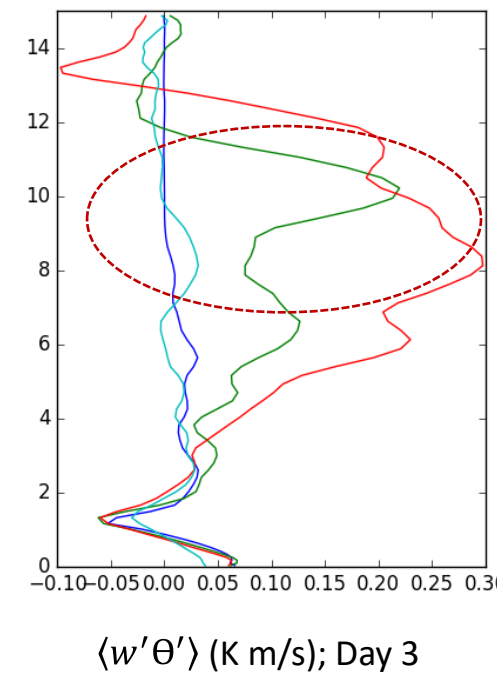
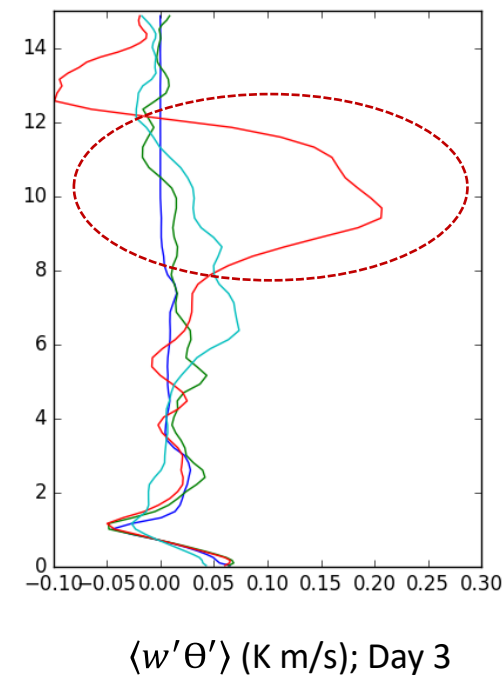
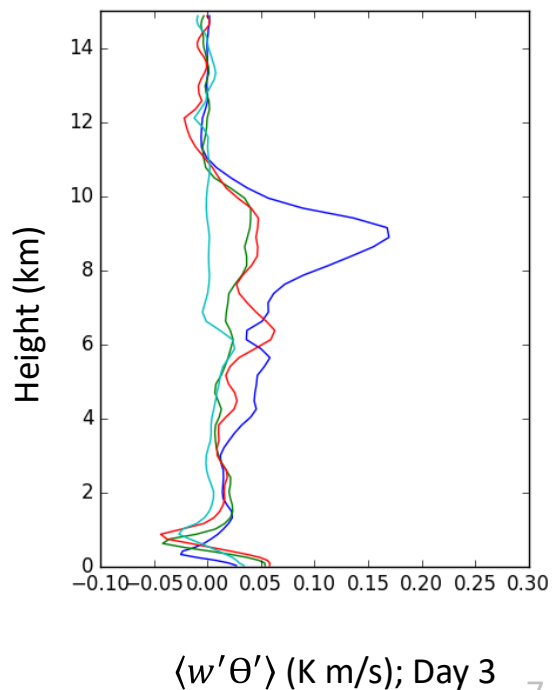


Profiles of $\langle w'w' \rangle$



Are the maxima at upper levels associated with deep convective activities?

Profiles of $\langle w'\theta' \rangle$



Buoyant cloudy updrafts (BCu)

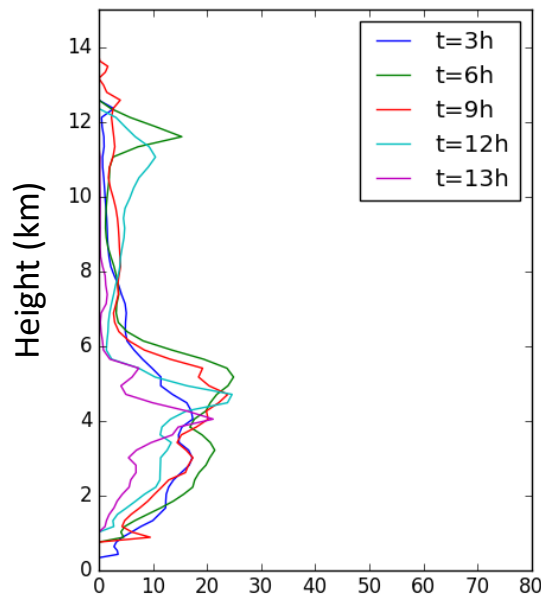
A local point i is considered to be BCu if:

$$\theta_{v_i} - \langle \theta_v \rangle > 0$$

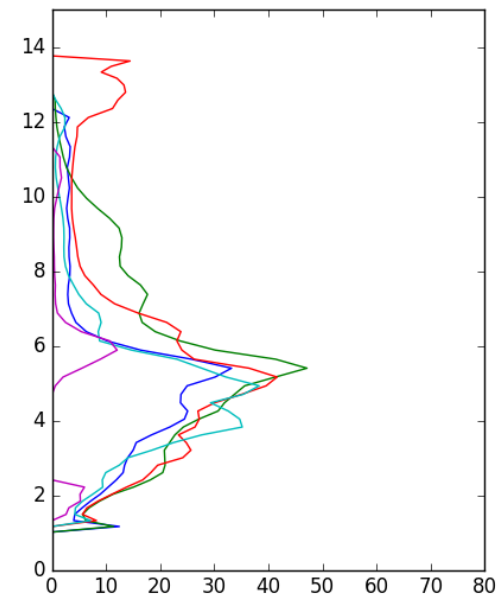
$$w_i > 0 \text{ and}$$

$$q_{liq_i} \text{ or } q_{ice_i} \geq 10^{-5} \text{ kg/kg}$$

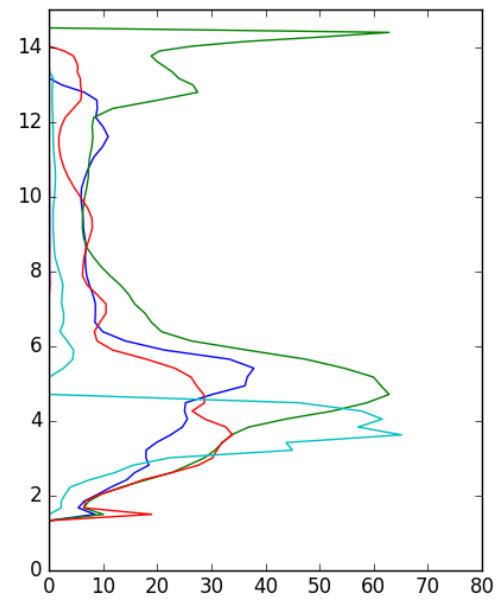
Profiles of $\langle w'w' \rangle_{BCu}$



$\langle w'w' \rangle$ (m^2/s^2); Day 1

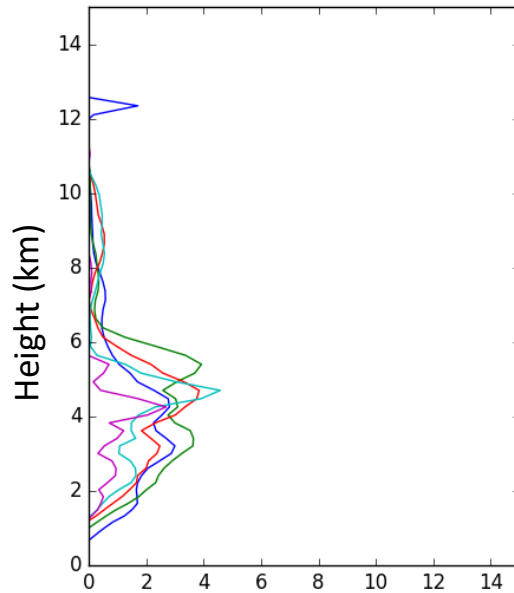


$\langle w'w' \rangle$ (m^2/s^2); Day 2

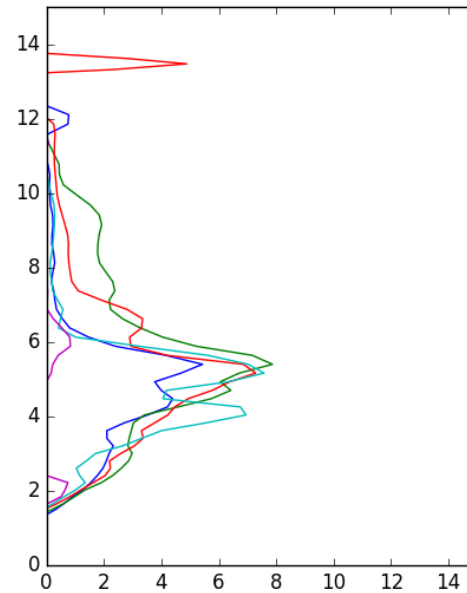


$\langle w'w' \rangle$ (m^2/s^2); Day 3

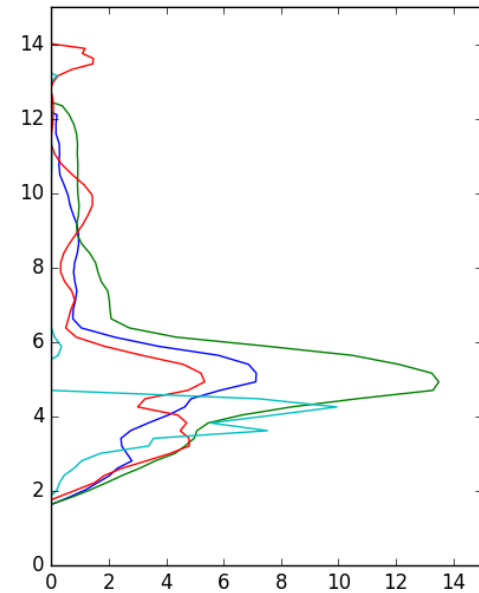
Profiles of $\langle w'\theta' \rangle_{BCu}$



$\langle w'\theta' \rangle$ (K m/s); Day 2



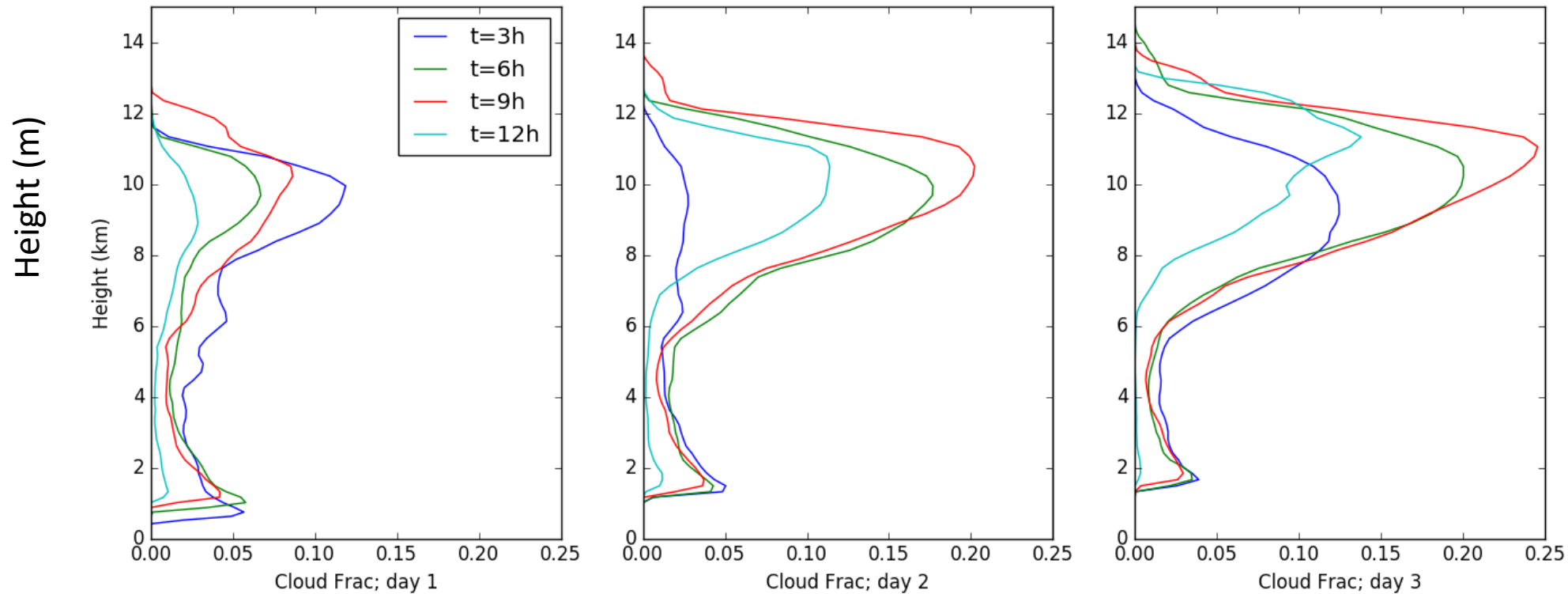
$\langle w'\theta' \rangle$ (K m/s); Day 2



$\langle w'\theta' \rangle$ (K m/s); Day 3

Profiles of cloud fraction

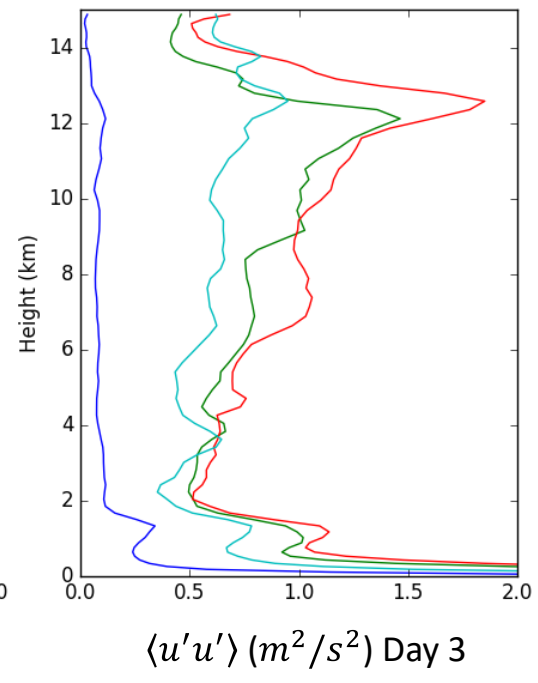
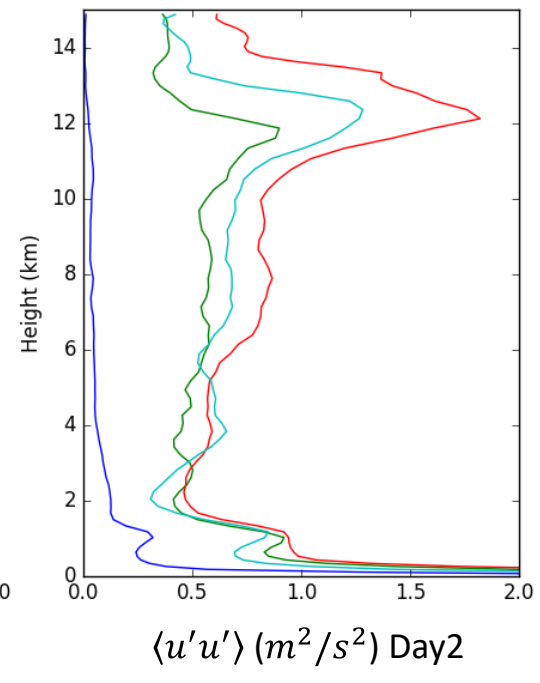
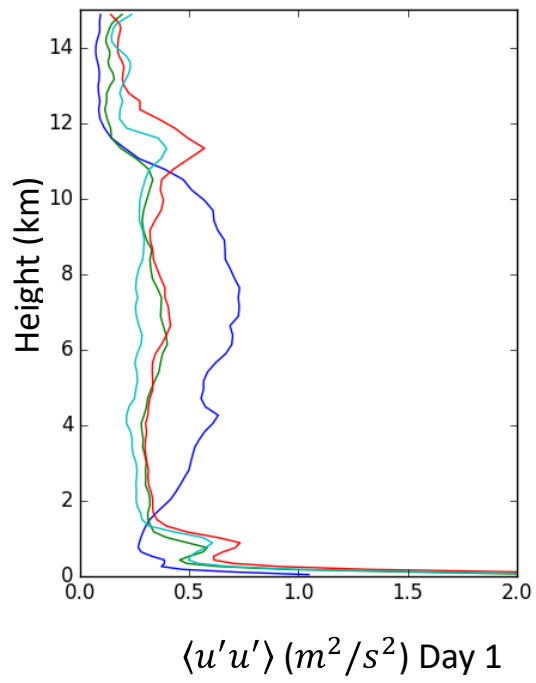
A local point i is considered to be cloudy if: q_{liq_i} or $q_{ice_i} \geq 10^{-5} \text{ kg/kg}$



Diurnal Cycle – Next steps

- The simulation differs from one day to the other?
- Run the simulations until a statistical equilibrium state is achieved
 - Do the daily differences persist throughout the rest of the simulation; even at equilibrium?
- Diurnal cycle: MONC vs LEM?
 - is this MONC configuration fit for use as one of the reference simulations?
- Investigate more conditional diagnostics
- Investigate more diagnostics required for the prototype simulations

Profiles of $\langle u'u' \rangle$



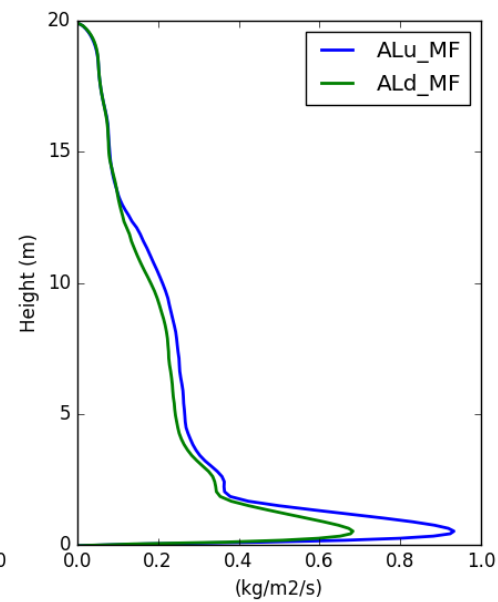
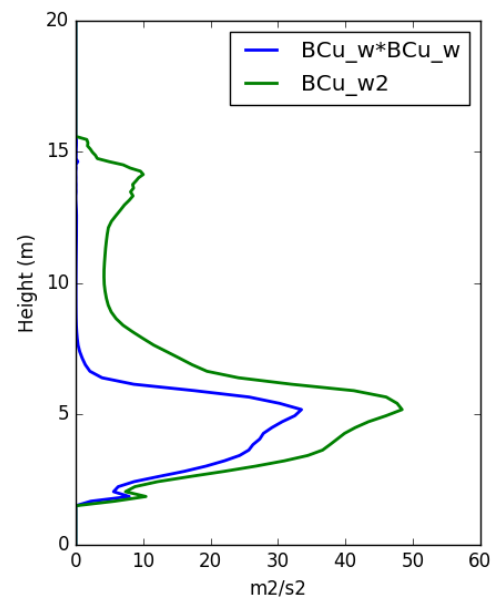
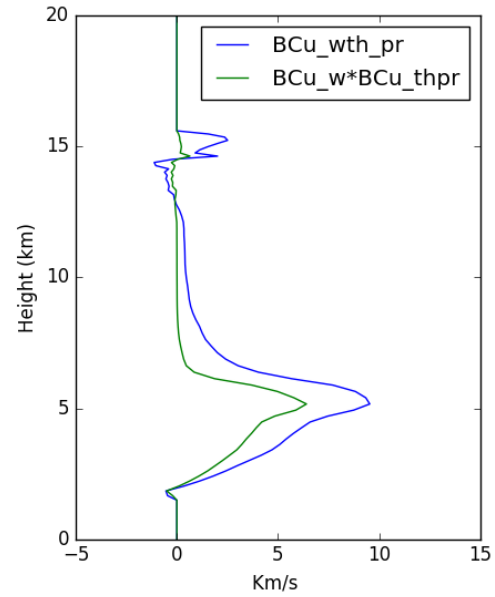
Height (km)

$\langle w'\theta' \rangle$ (K m/s) Day 1

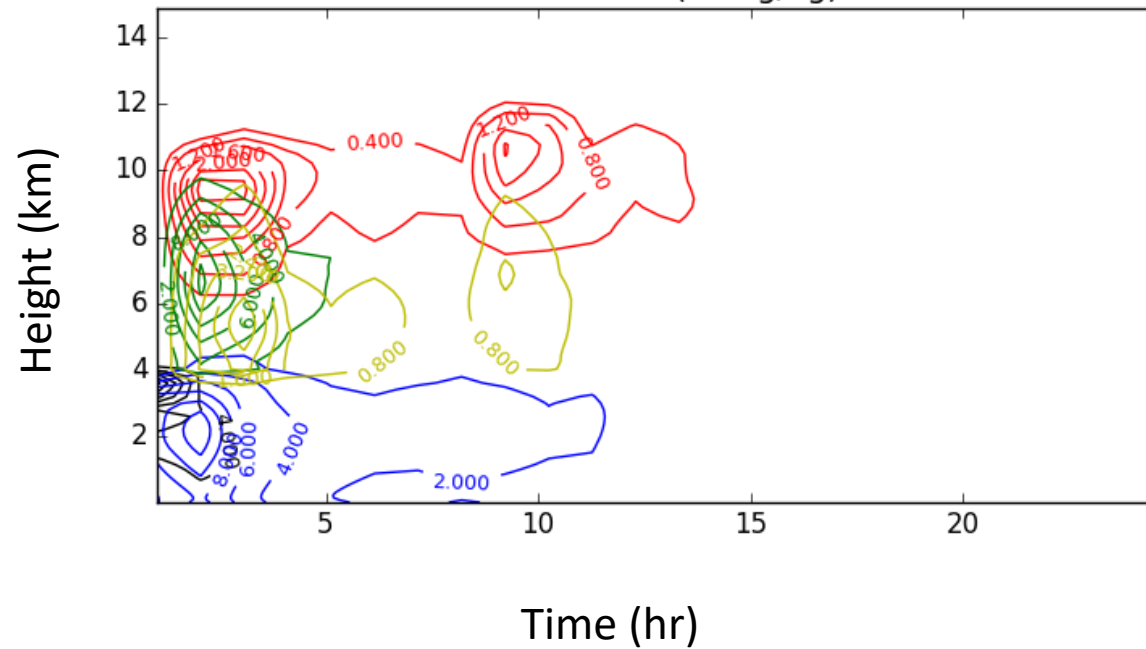
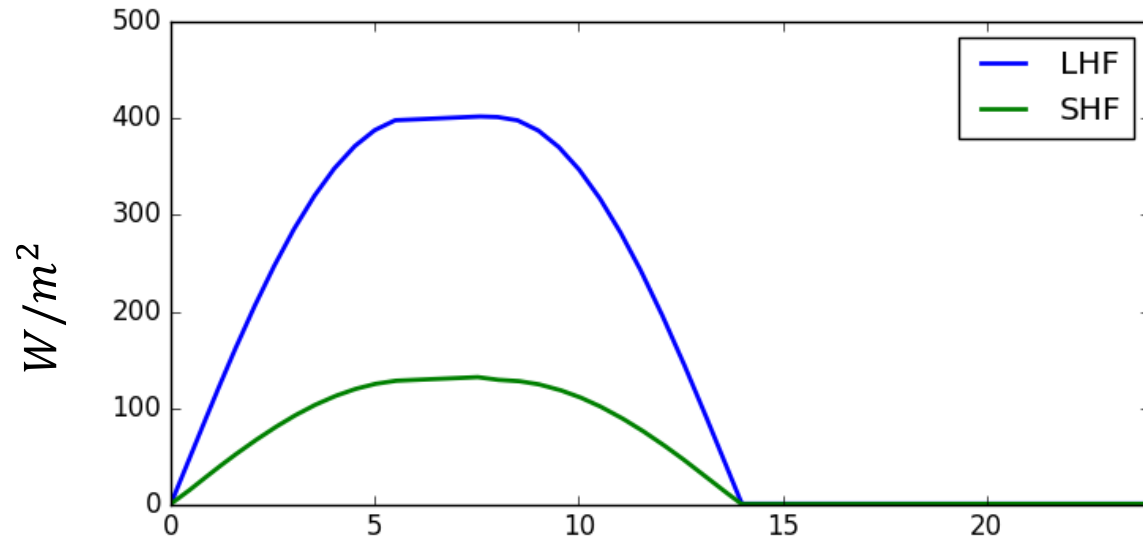
$\langle w'\theta' \rangle$ (K m/s) Day 2

$\langle w'\theta' \rangle$ (K m/s) Day 3

Clou



Evolution of condensate: day 1



- Liquid water mass *100000
- Ice mass *100000
- Rain mass *100000
- Snow mass *100000
- Graupel mass *100000

Other time series

