Large-Eddy Simulation of the VOCALS RF06 Pocket of Open Cells:

Dynamics, Maintenance Timescale for Microphysical Gradients, and Entrainment

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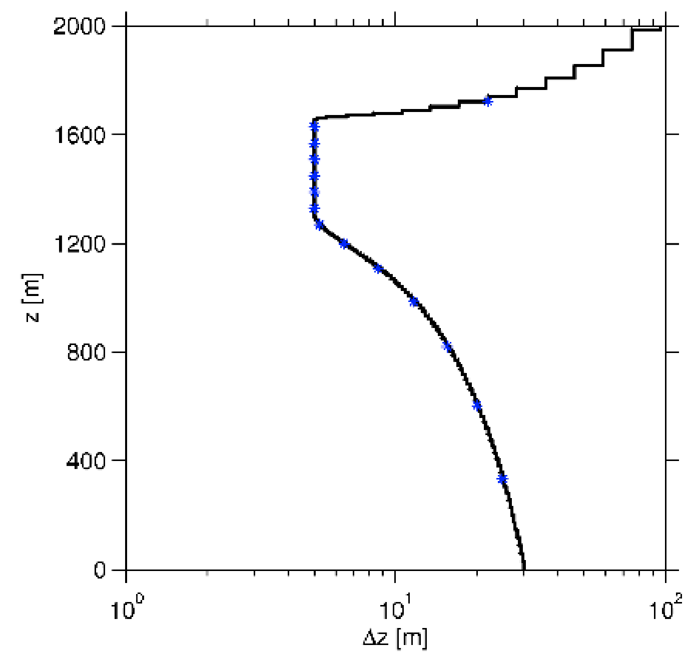
Modeling Objectives

- Effects of N_c treatment
  - Evaluate the sensitivity of the simulation to the choice of fixed or advected N_c distribution
- Comparison to Observations
  - See if LES can capture the character of the observed boundary layer when initialized from observations
- Entrainment
  - Investigate differences in entrainment between the overcast (OVC), open-cellular (POC), and transition (TRANS) regions

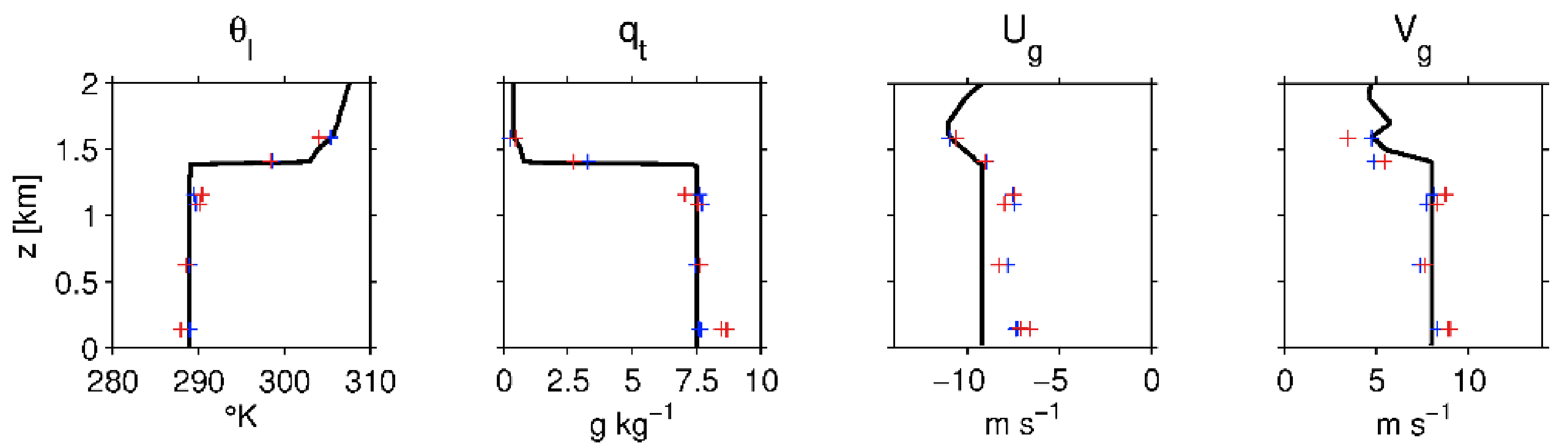
Model and Simulation Configuration



- SAM v6.7 LES
  - Anelastic dynamical formulation
  - Morrison 2005 microphysics
    - Advected or fixed N_c
  - CAM3 radiation
- Simulation
  - Bowling alley domain, 192 km x 24km in horizontal, x direction oriented perpendicular to mean PBL wind
  - 125m Δx and Δy, varying Δz of 30m near surface, 5m near inversion, stretched to grid top at 30km for radiation
  - Total of 192x192x1536 gridpoints

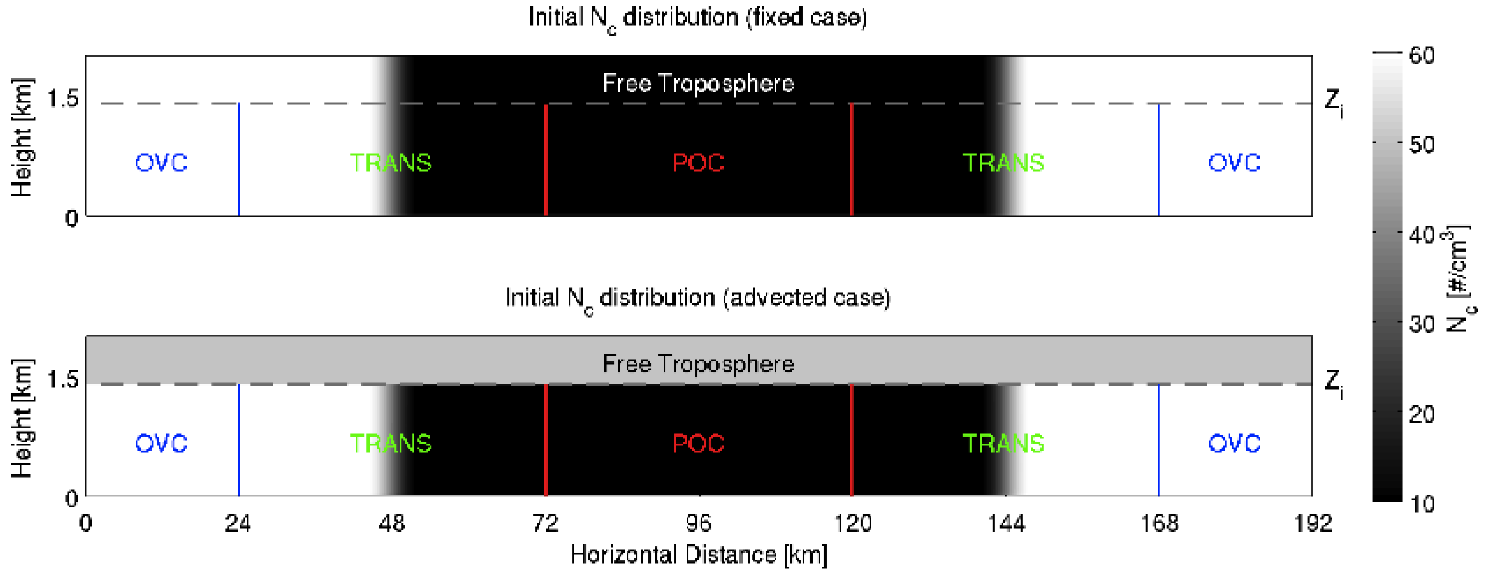
Initialization

- Thermodynamic and Wind Profiles
  - Basic profile assembled from RF06 legs P2d, P4u, and NCEP reanalysis
  - Wind profile tweaked such that mean boundary layer wind spins up with geostrophic forcing to profile similar to obs



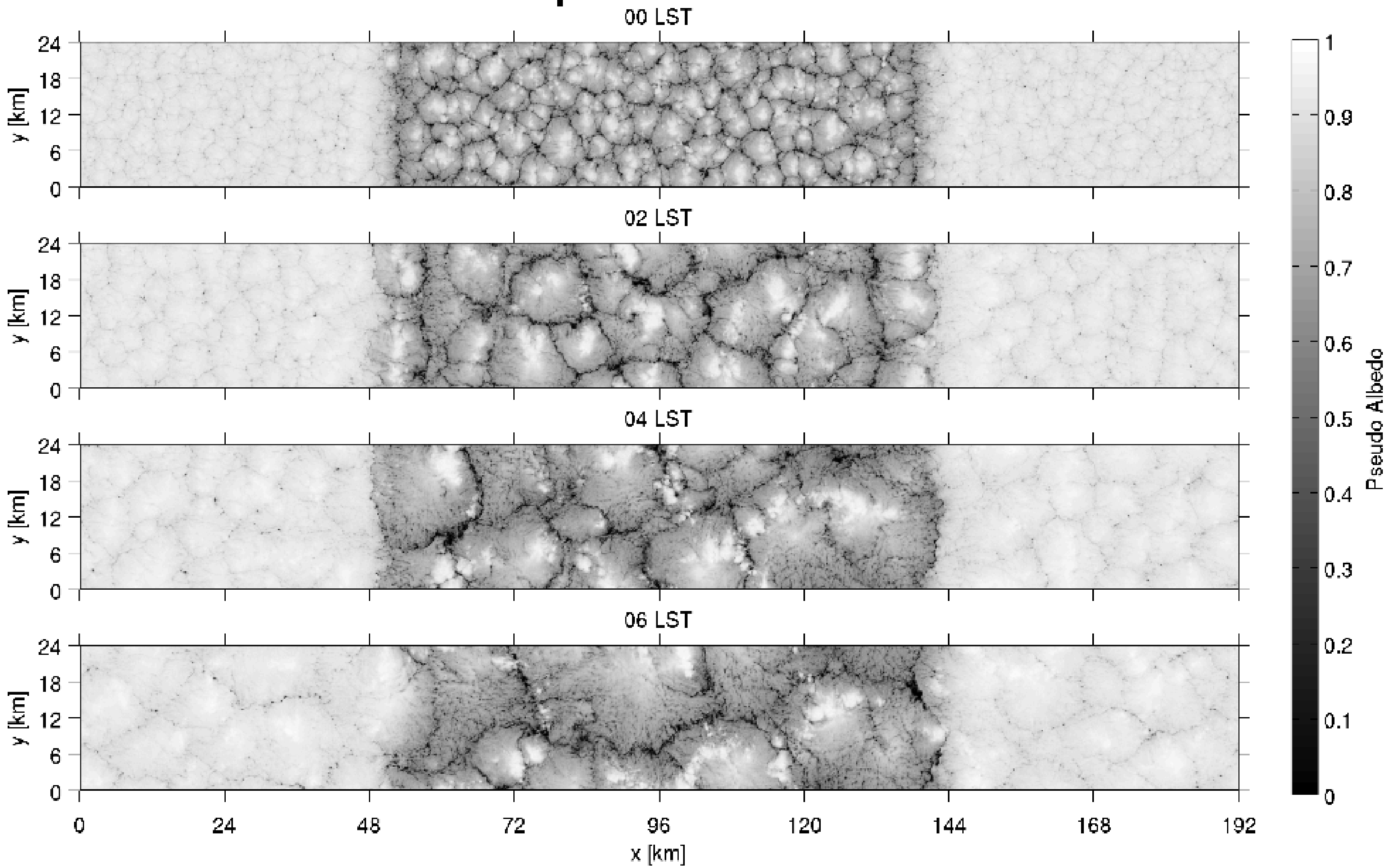
Initialization (2)

- Microphysics
  - Varying N_c specified across x direction
    - N_c of 60 cm^{-3} in overcast region (88 km)
    - N_c of 10 cm^{-3} in POC region (88 km)
    - 8 km half sine wave transitions between regions

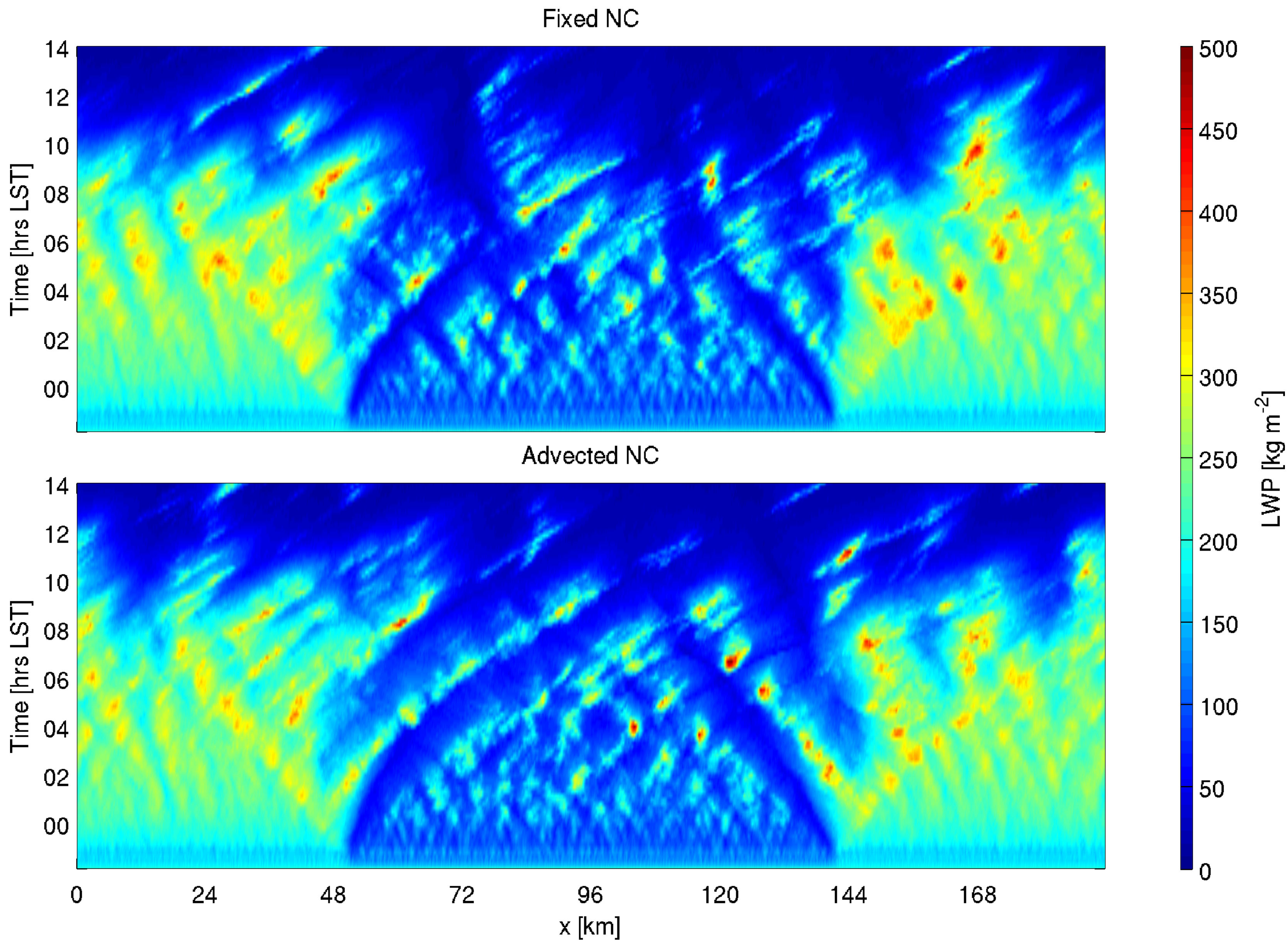


Cloud Field Evolution

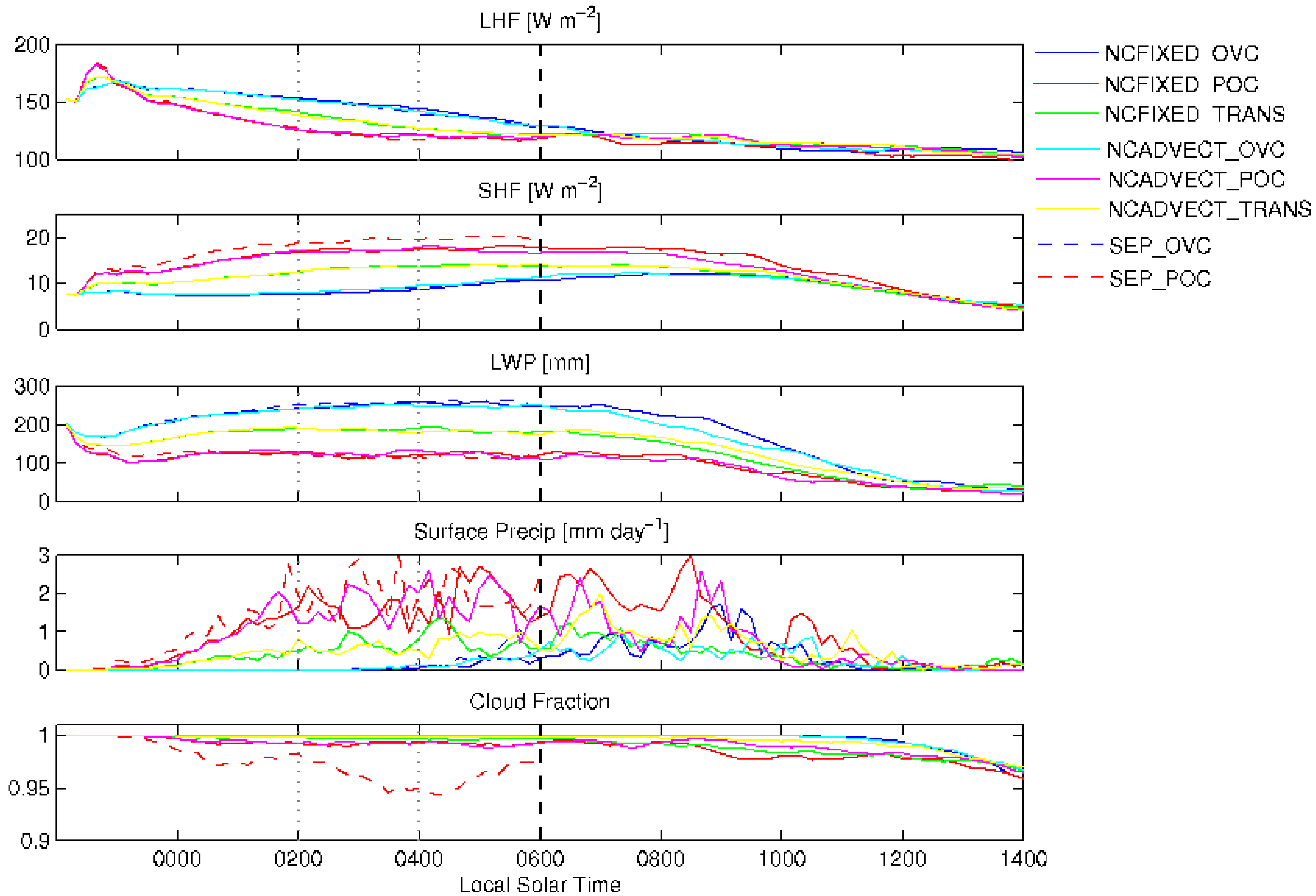
- Pseudo-albedo snapshots



Effects of N_c Advection

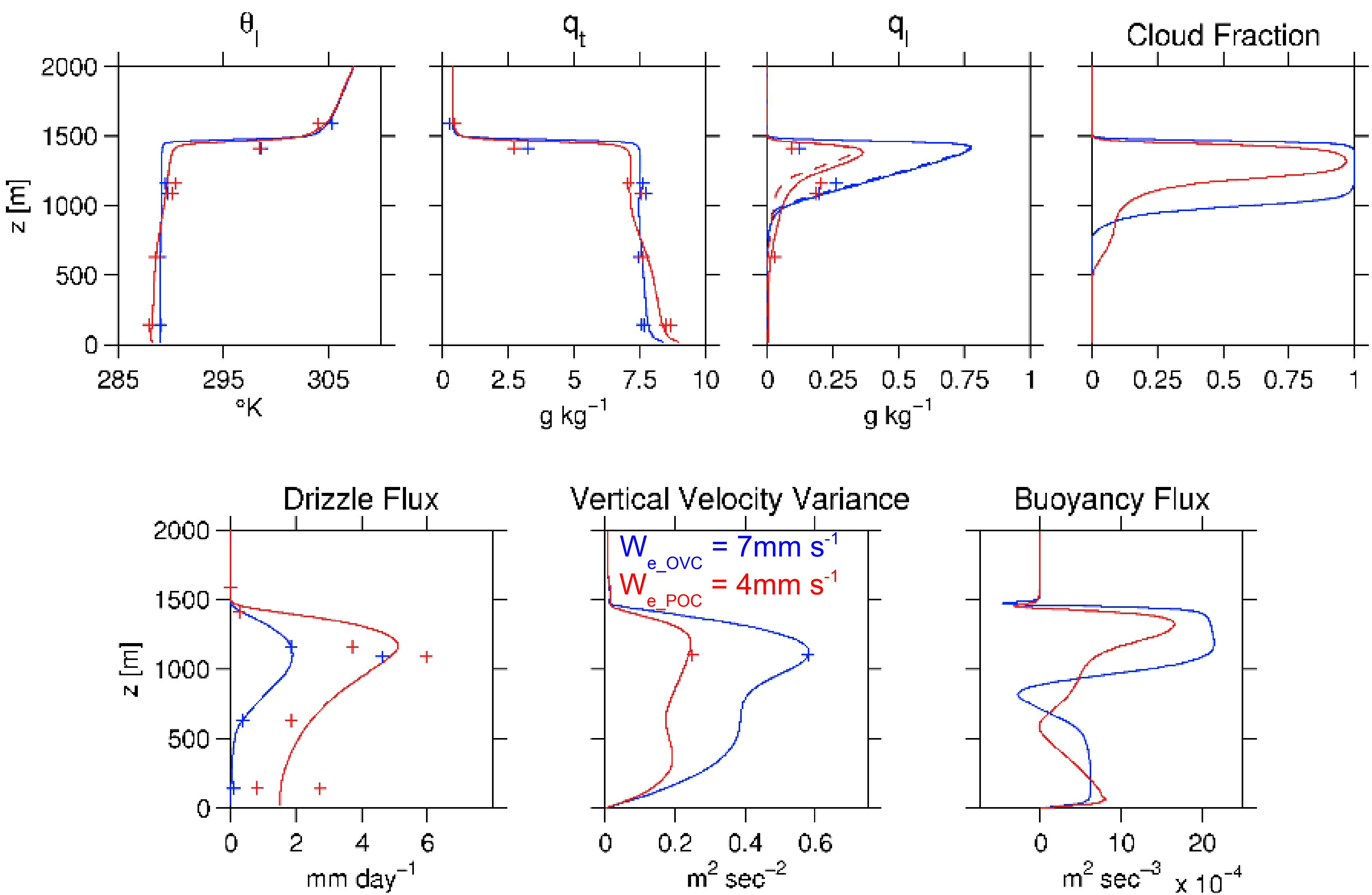


Time Series

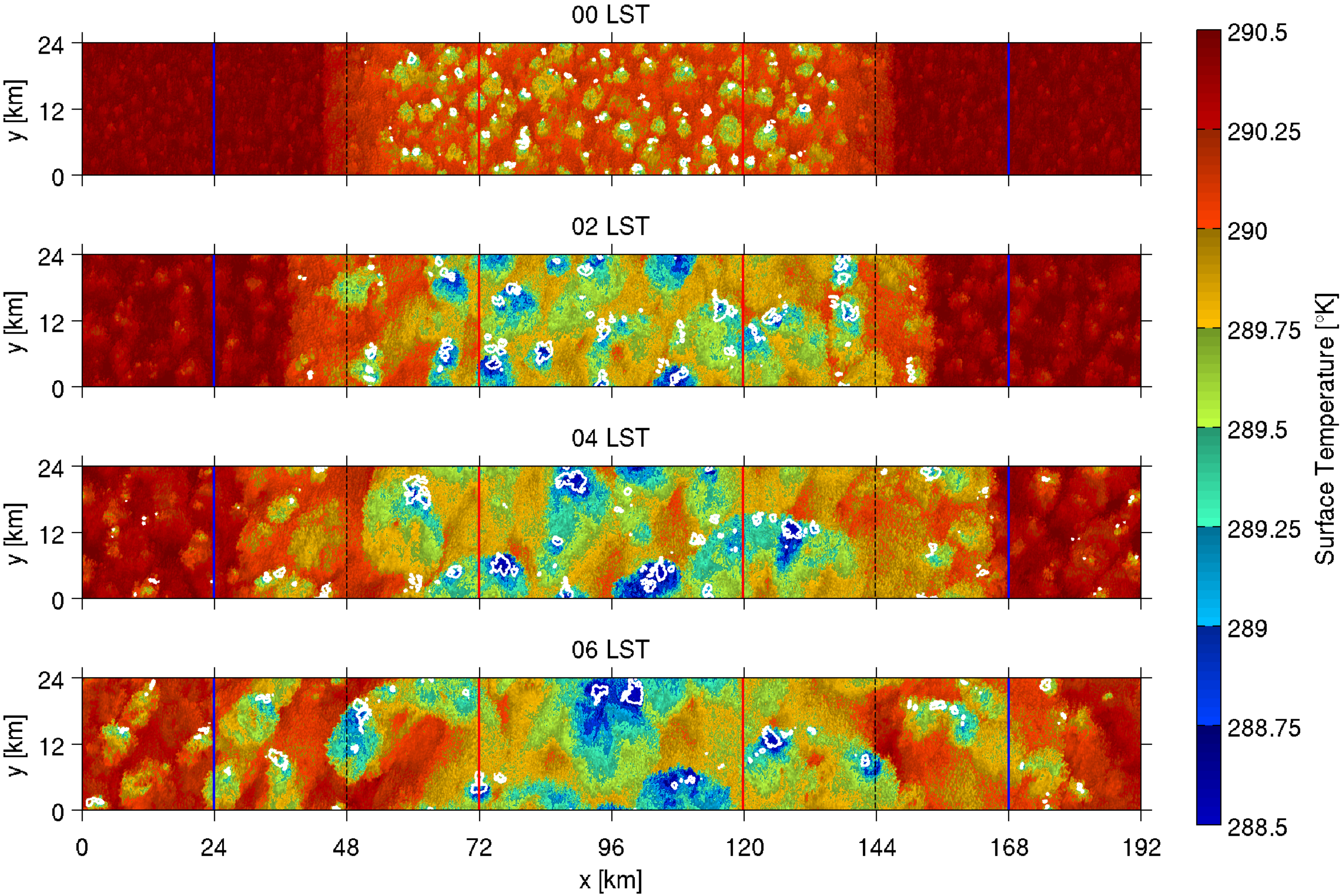


LHF [W m^{-2}]
SHF [W m^{-2}]
LWP [mm]
Surface Precip [mm day^{-1}]
Cloud Fraction
200
150
100
20
10
0
300
200
100
0
3
2
1
0
1
0.95
0.9
0000
0200
0400
0600
0800
1000
1200
1400
Local Solar Time
NCFIXED OVC
NCFIXED POC
NCFIXED TRANS
NCADVECT_OVC
NCADVECT_POC
NCADVECT_TRANS
SEP_OVC
SEP_POC

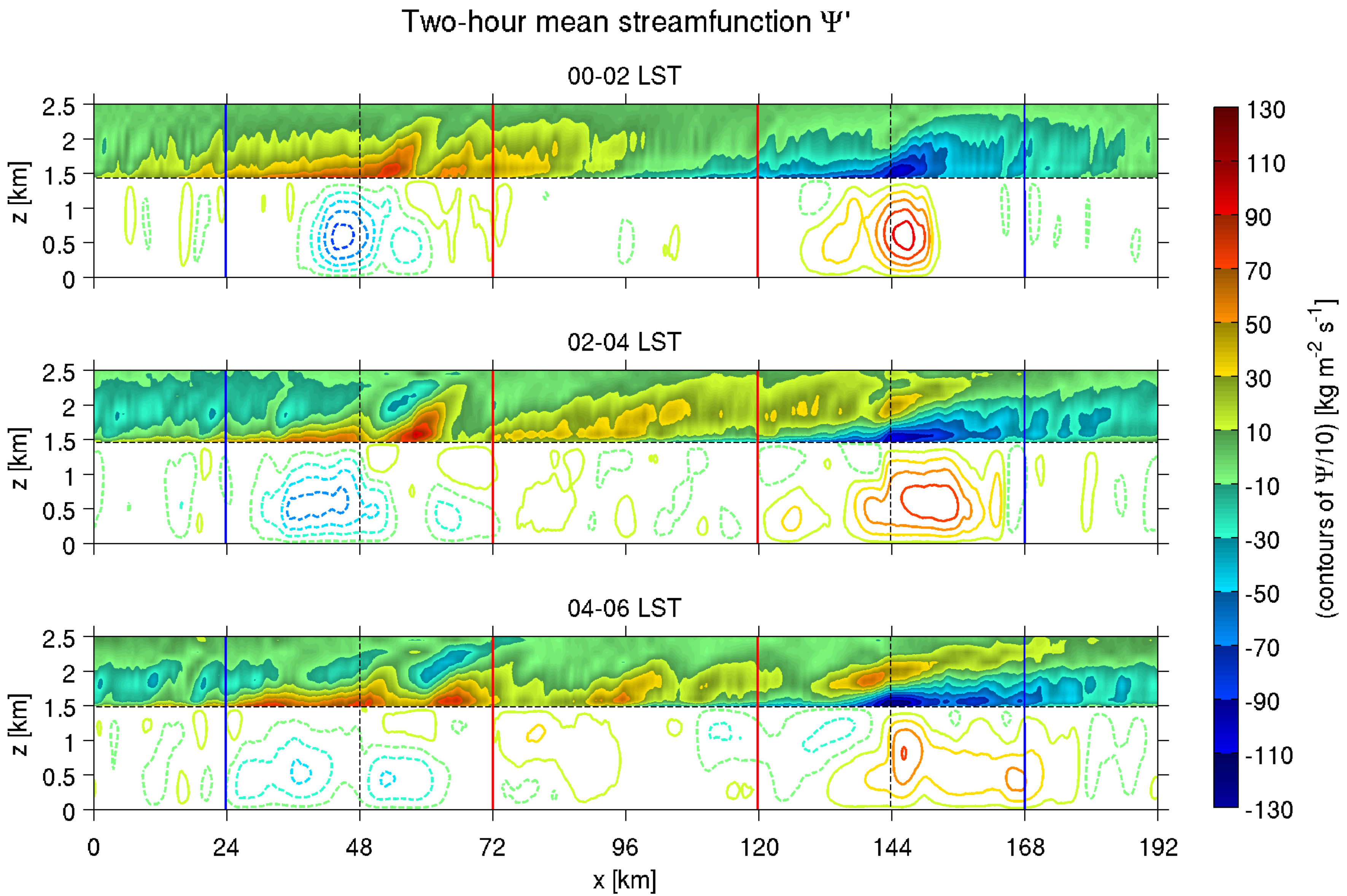
Profiles: 02-04 LST



Cold Pooling

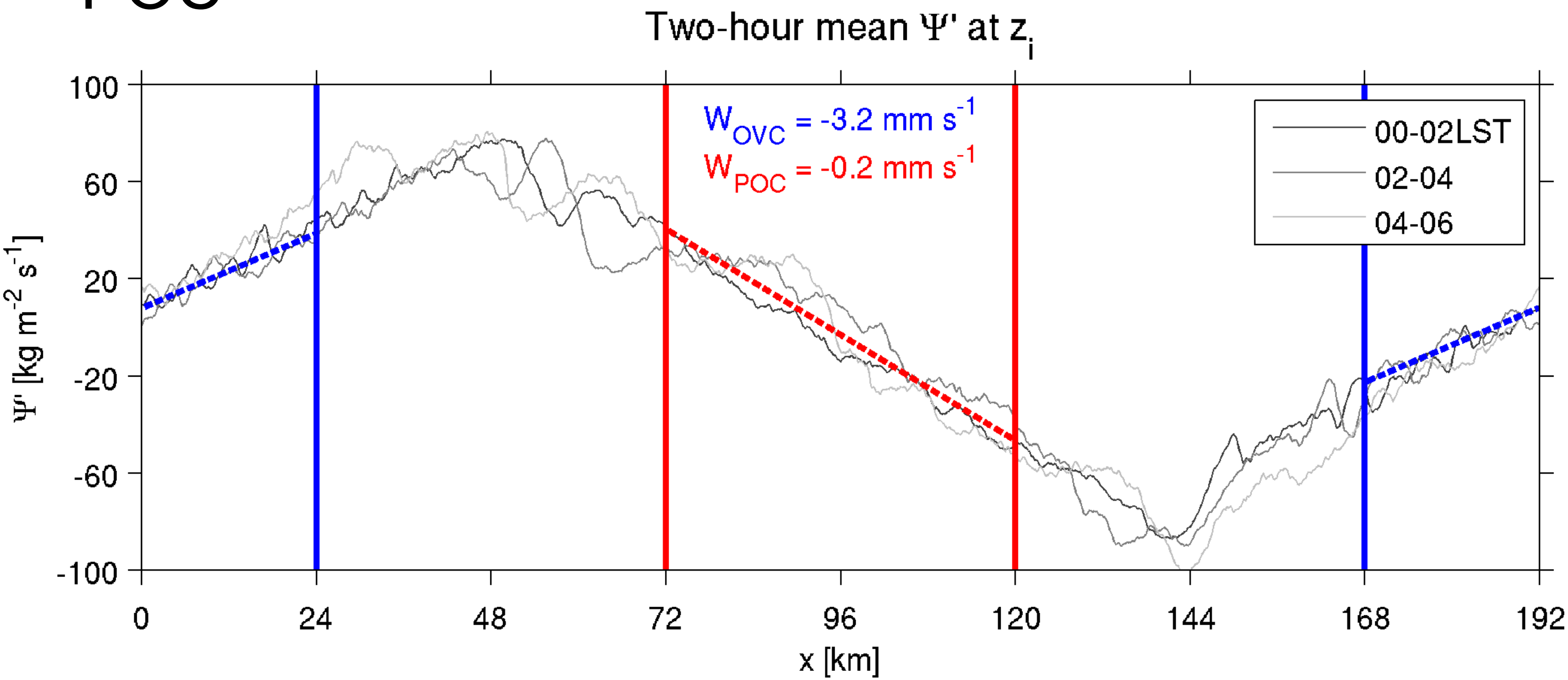


Mesoscale Circulation



Entrainment

- Analysis of streamfunction at level of inversion suggests diminished effective subsidence over POC



Conclusions

- LES initialized from observations captures the basic behavior of the boundary layer fairly well
- Too much cloud in the POC; less simplistic microphysical scheme necessary?
- Entrainment differential across between POC and surrounding overcast compensated by mesoscale circulation in order to keep the inversion level

Thanks for listening!
Questions?

Entrainment Time Series