Kilometer-Grid Cloud-Resolving Modeling of a TWP-ICE case

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

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CMMAP
Reach for the sky.

CMMAP Team Meeting
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NSF

Benchmark: LES of the Tropical Warm Pool–International Cloud Experiment (TWP-ICE)

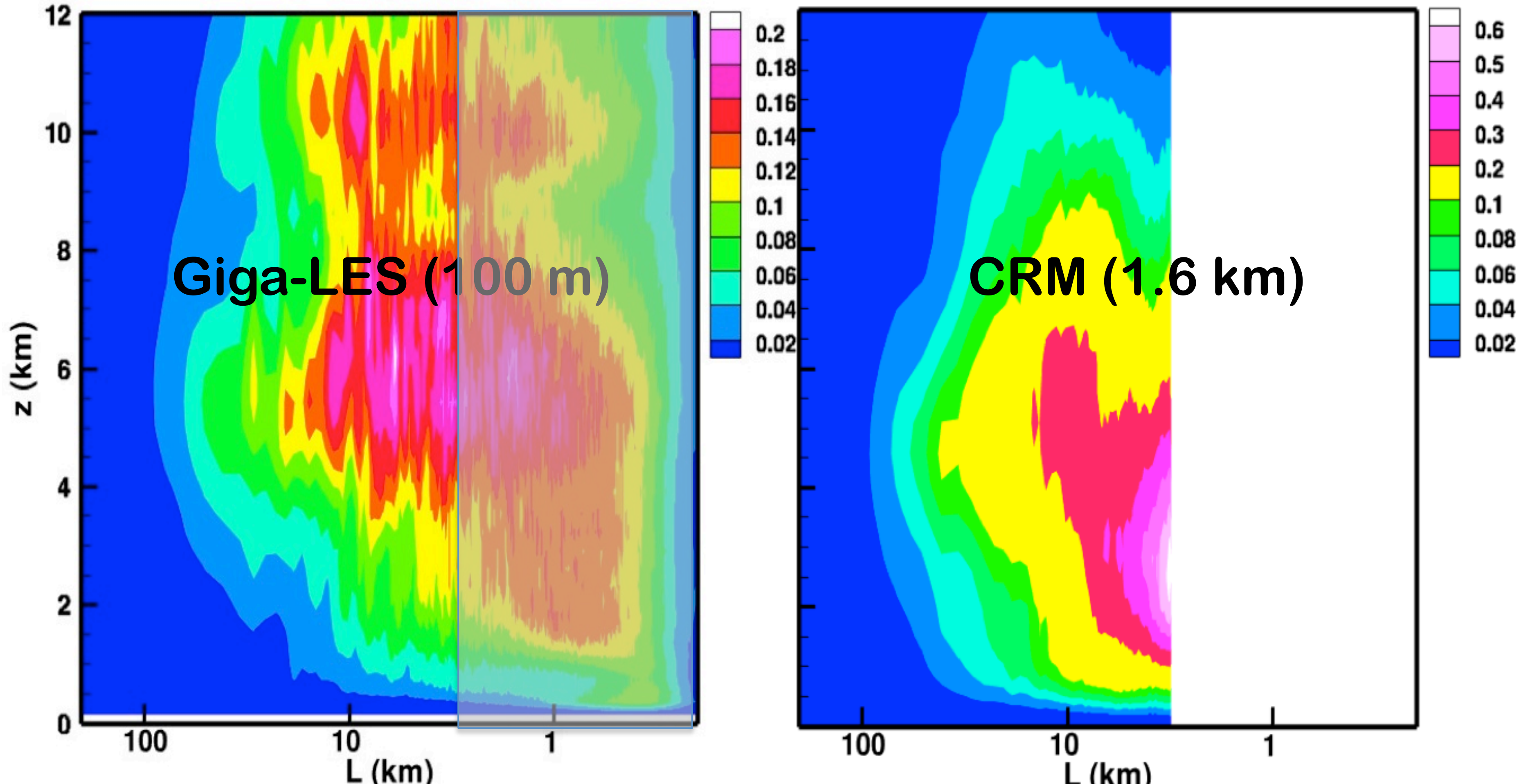
- LES version of SAM
- Horizontal grid size 100 m
- Time interval 2 s
- Domain 204.8 km x 204.8 km x 27 km
- Simulation period: 1/18/06 →
- Time varying LS forcing from field data

	GigaLES 1	GigaLES 2
Large Scale Forcing	GATE (IDEAL) - steady	TWP-ICE - time-varying
Radiation	Prescribed steady	RRTM interactive
Microphysics	Single Moment	Two-moment Morrison 2005
Scalar Advection	MPDATA	Ultimate Macho - 5th order
Duration	24 hours	5 days (and continuing)

Same for km-grid CRM runs

Courtesy: Don Dazlich

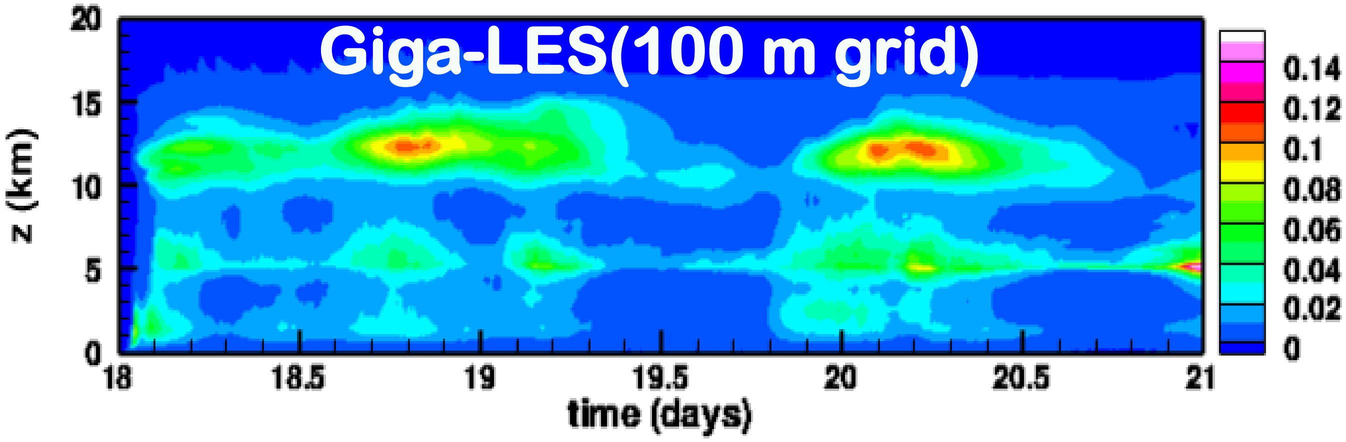
Vertical-velocity power spectra (wet period)

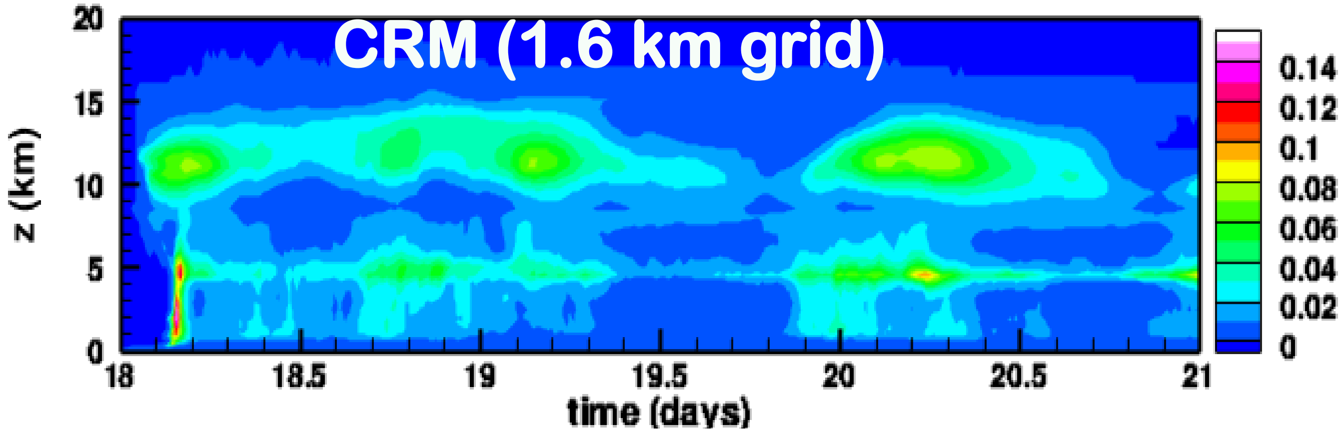


How does a km-grid CRM with a poorly resolved w field perform?

SAM-CRM with horizontal grid = 1.6 km

Horizontally averaged cloud water mixing ratio

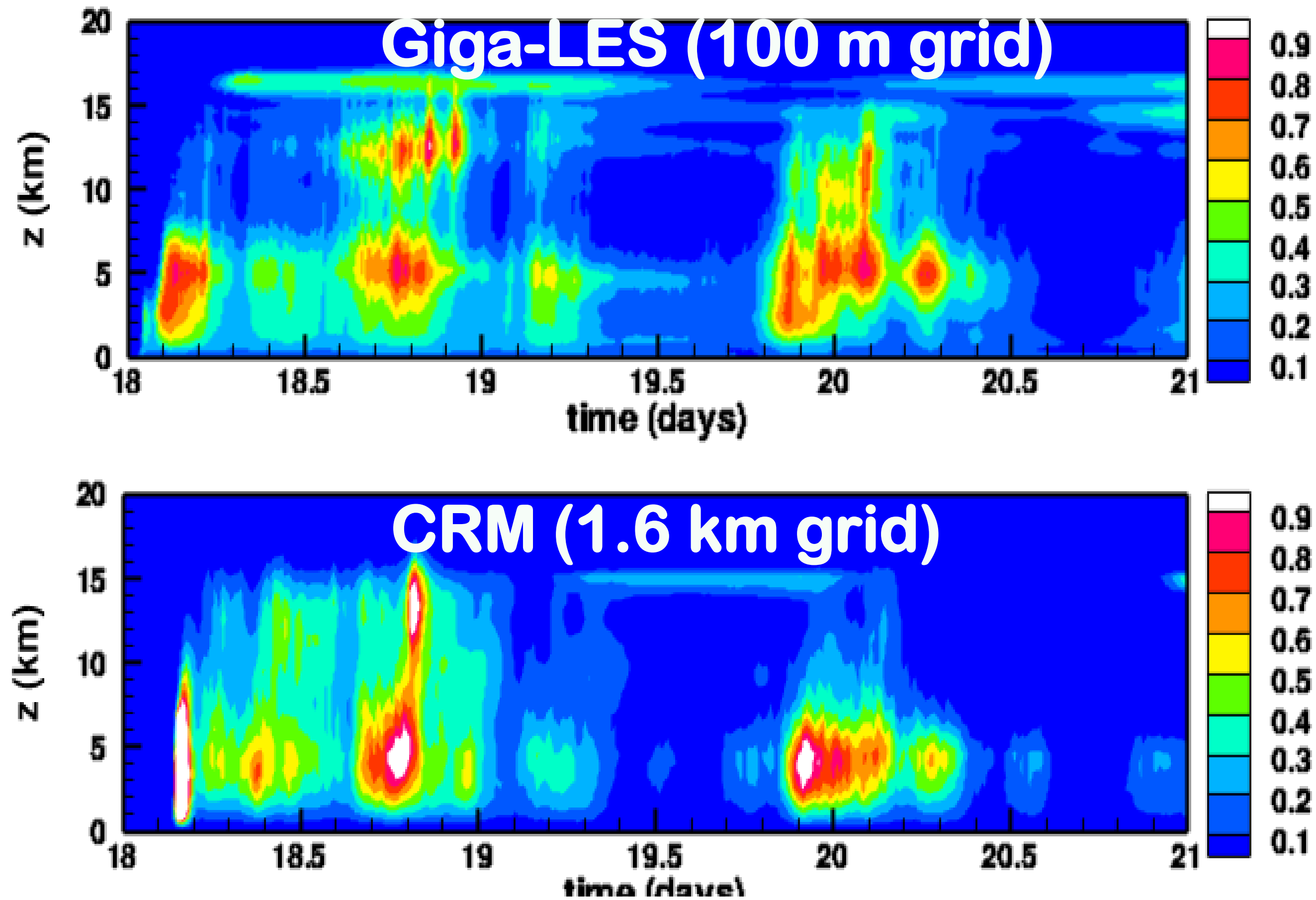




The time evolution of the mean cloud amount is reasonably simulated by the SAM's 1.6 km CRM.

SAM-CRM with horizontal grid = 1.6 km

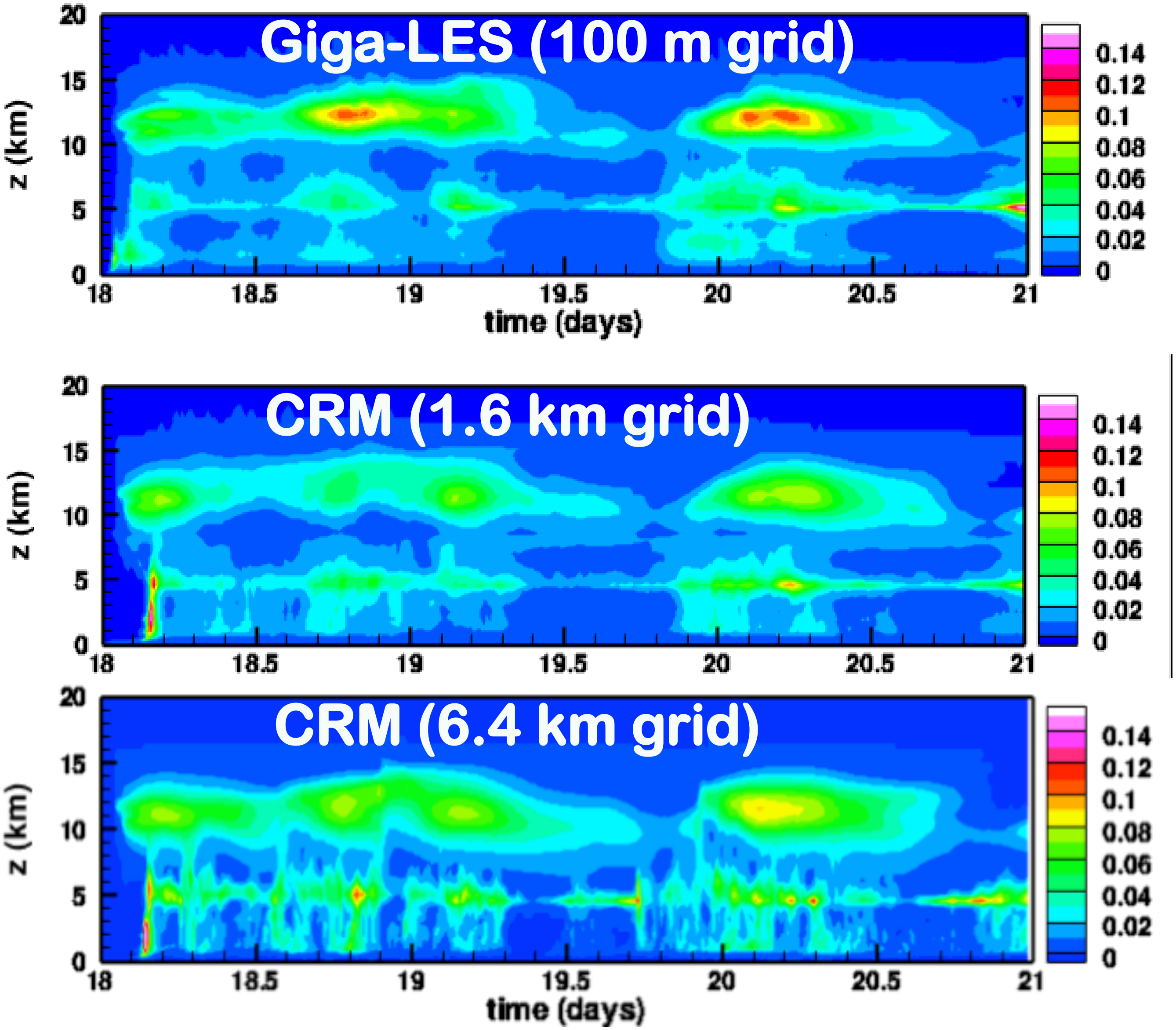
Resolvable-scale vertical-velocity variances



But the w-variance is not so good; overestimate at mid and low cld layer

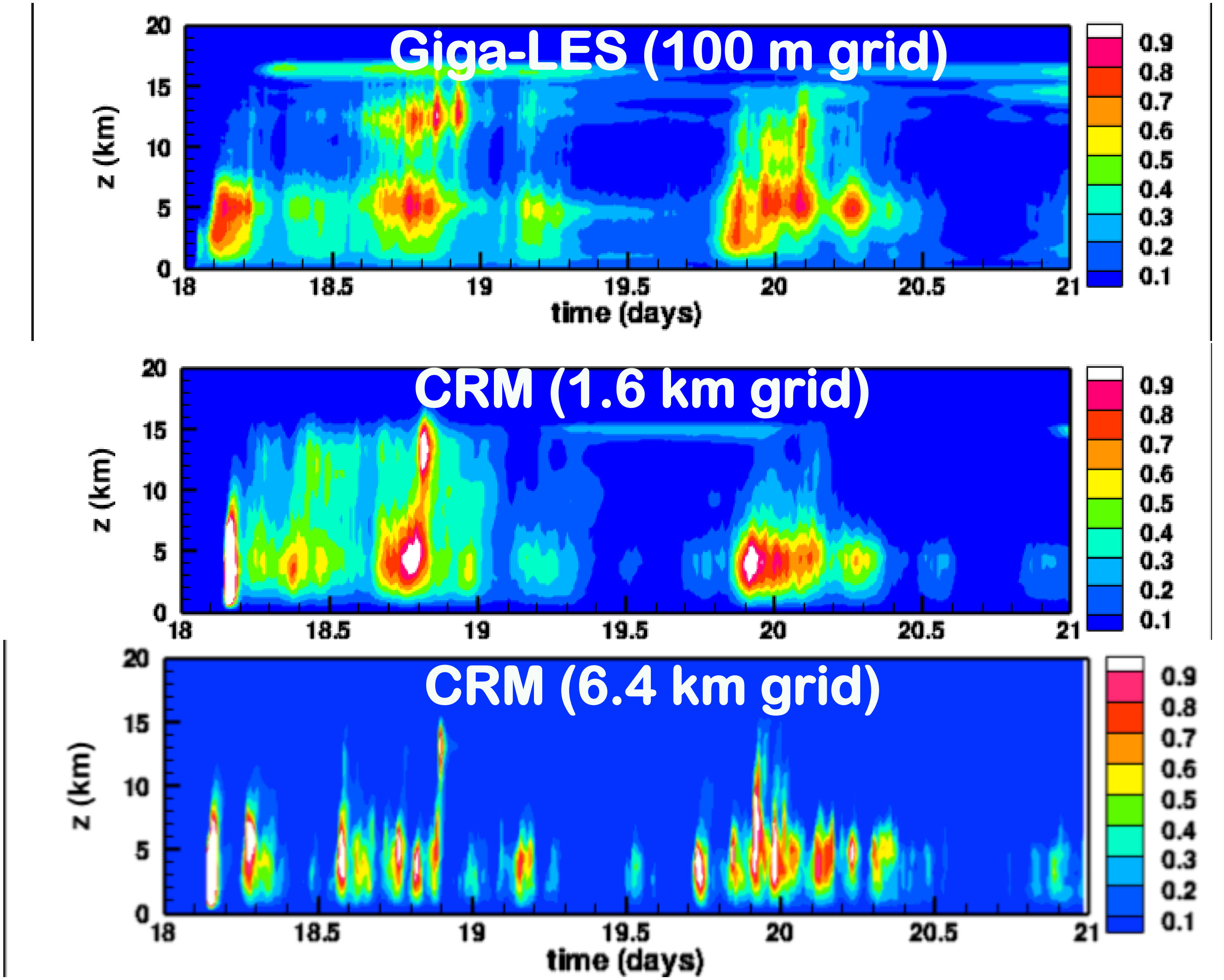
Sensitive to grid spacing?

Mean cloud field for dx = 1.6 km & 6.4 km

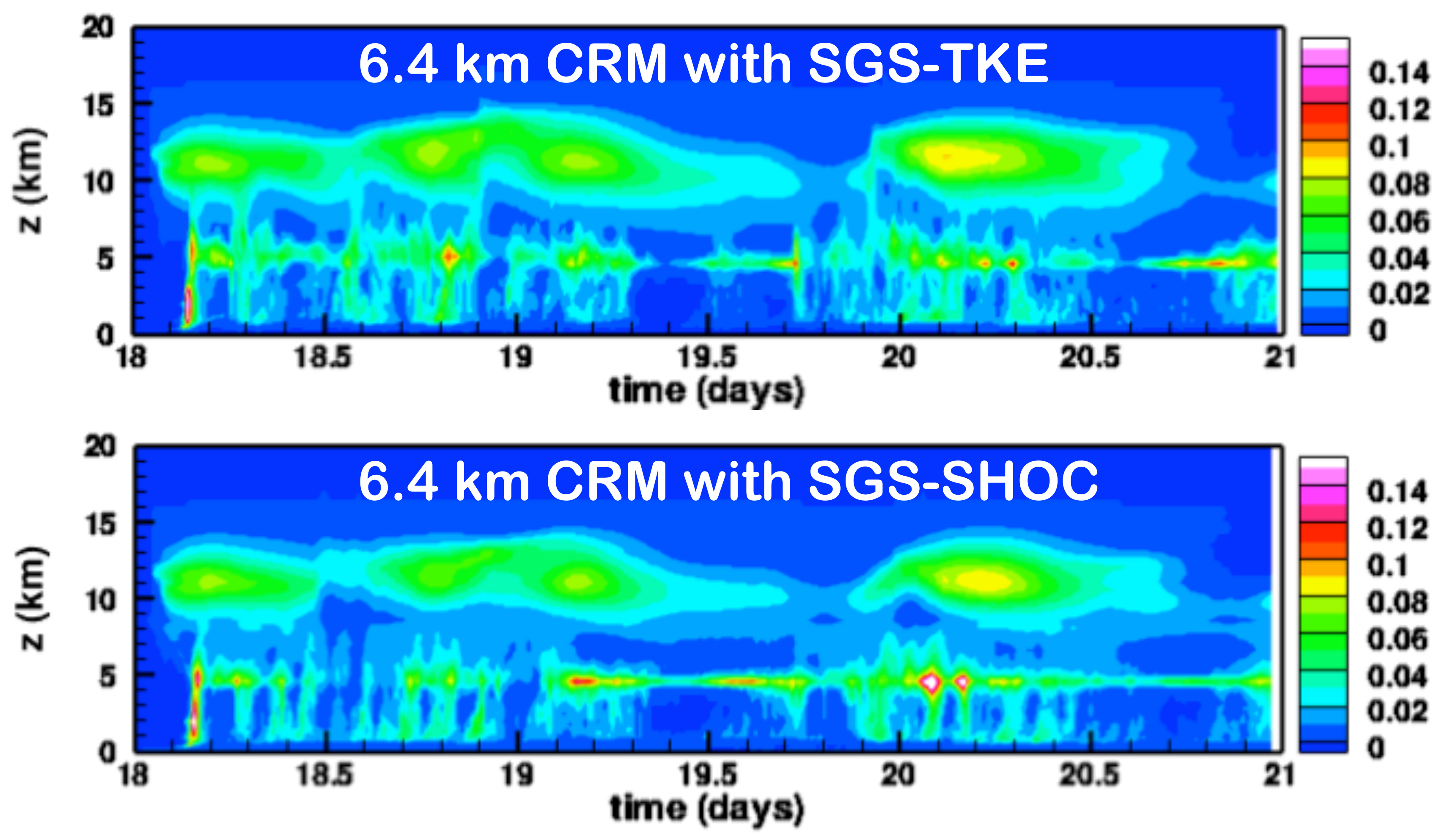


Due to the poor w-velocity field?

w-variance for dx = 1.6 km & 6.4 km



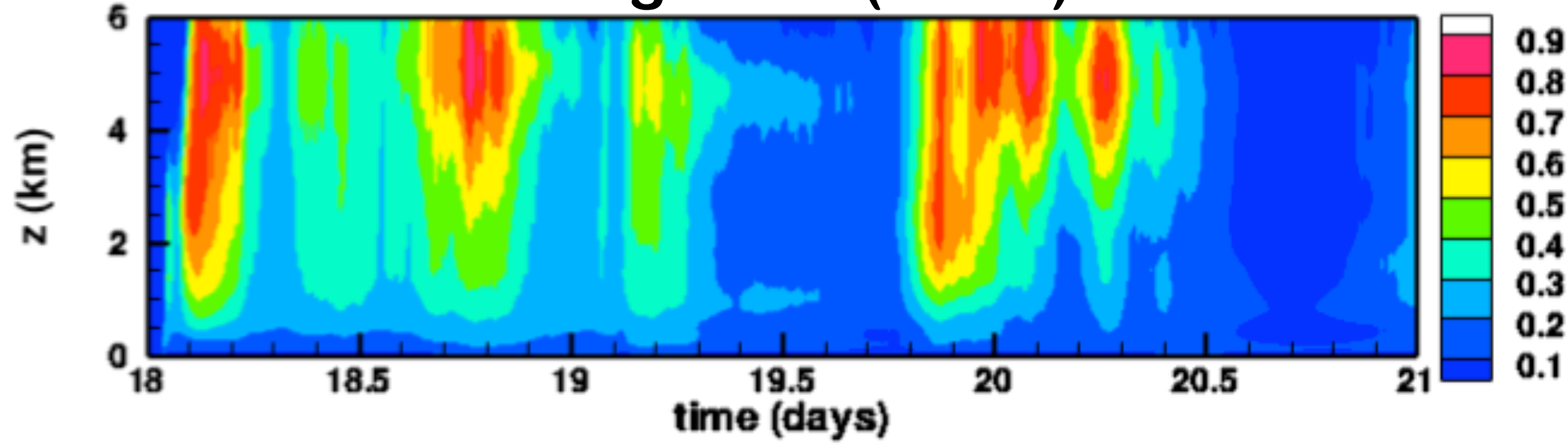
What about the SGS-SHOC scheme?



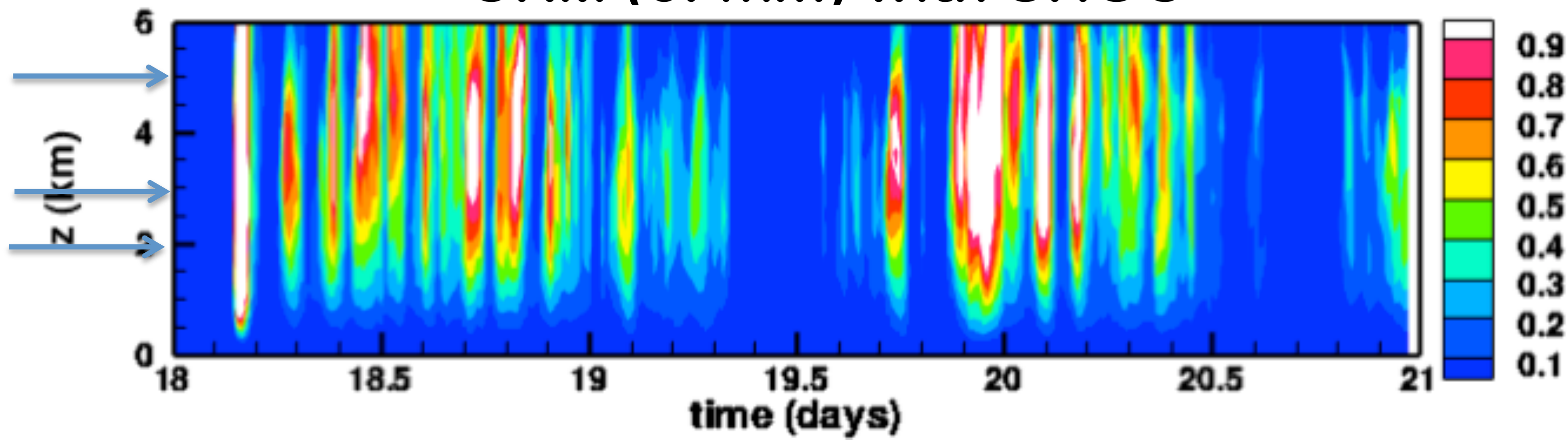
Mean cloud amounts (and w-var.) from these two 6.4 km-CRM runs are similar.

Zoom-in: <w^2> below 6 km

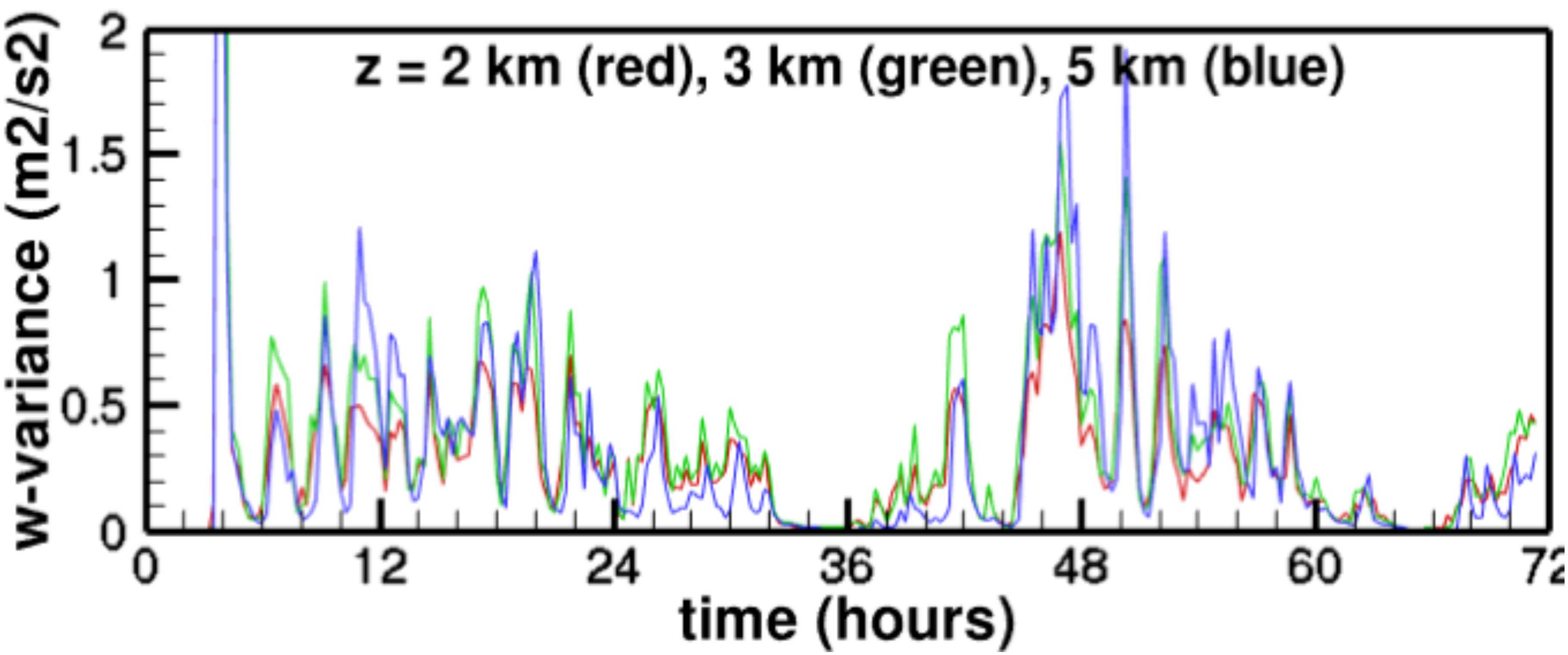
Giga-LES (100m)



CRM (6.4km) with SHOC

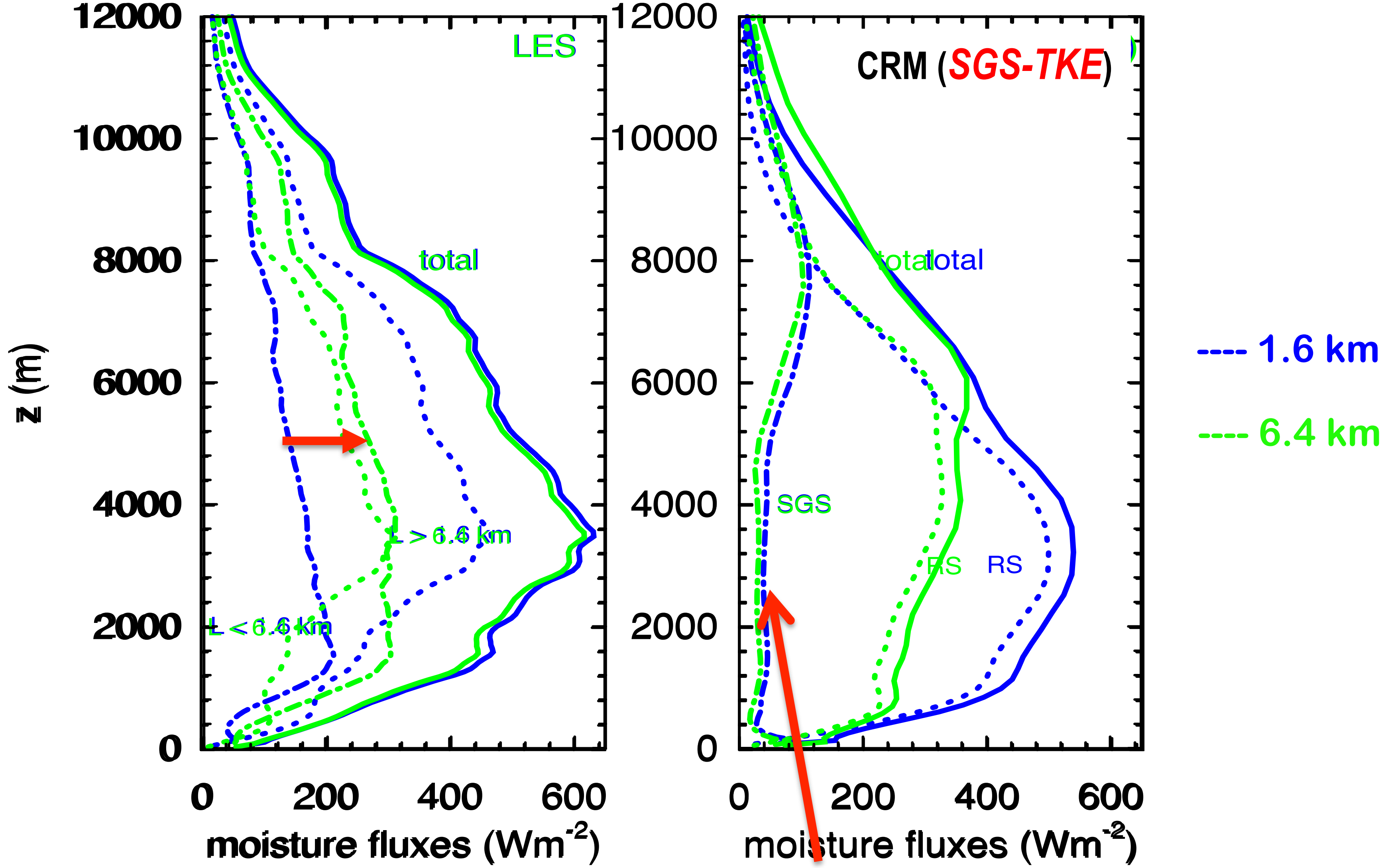


- Frequency ~ 2 hours?
- Coherent in the vertical?



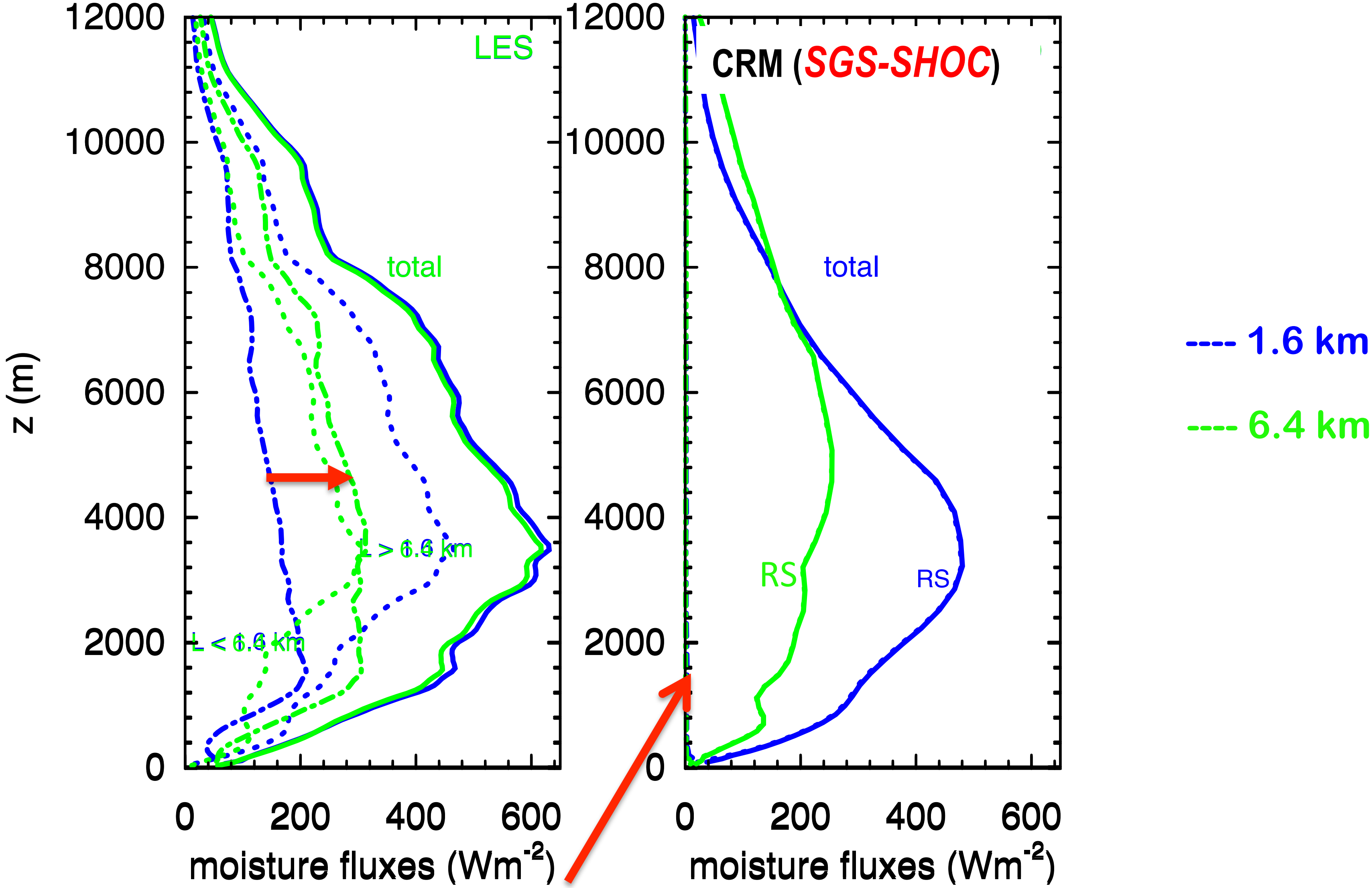
Is there a way to get rid of this spurious w ?

How does SGS vertical transport depend on grid spacing?



<SGS q-fluxes> unchange with grid size.

How does SGS vertical transport depend on grid spacing with the SHOC scheme?



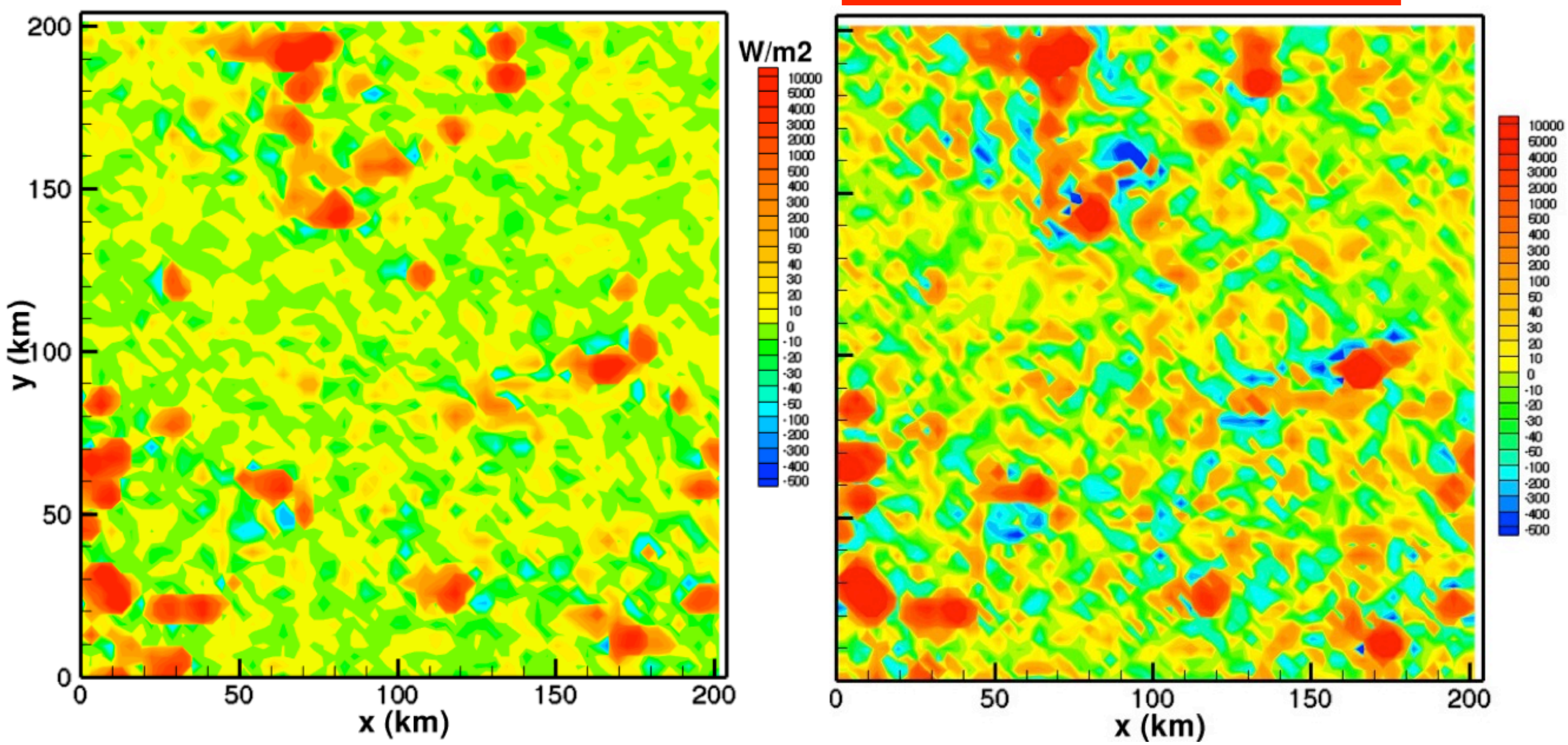
<SGS q-fluxes> in SHOC negligibly small!

Can adding this part of SGS fluxes help??

Analysis from Giga-LES shows:

(Moeng, MWR, 2013)

SGS vertical flux of q $\approx$ $\Delta_x \widetilde{w} \bullet \Delta_x \widetilde{q} + \Delta_y \widetilde{w} \bullet \Delta_y \widetilde{q}$



at z ~ 3 km

Having trouble implementing…

w-field at iz=14 after just 20 time steps (dx = 6.4 km)

Using one processor | **Using four processors**