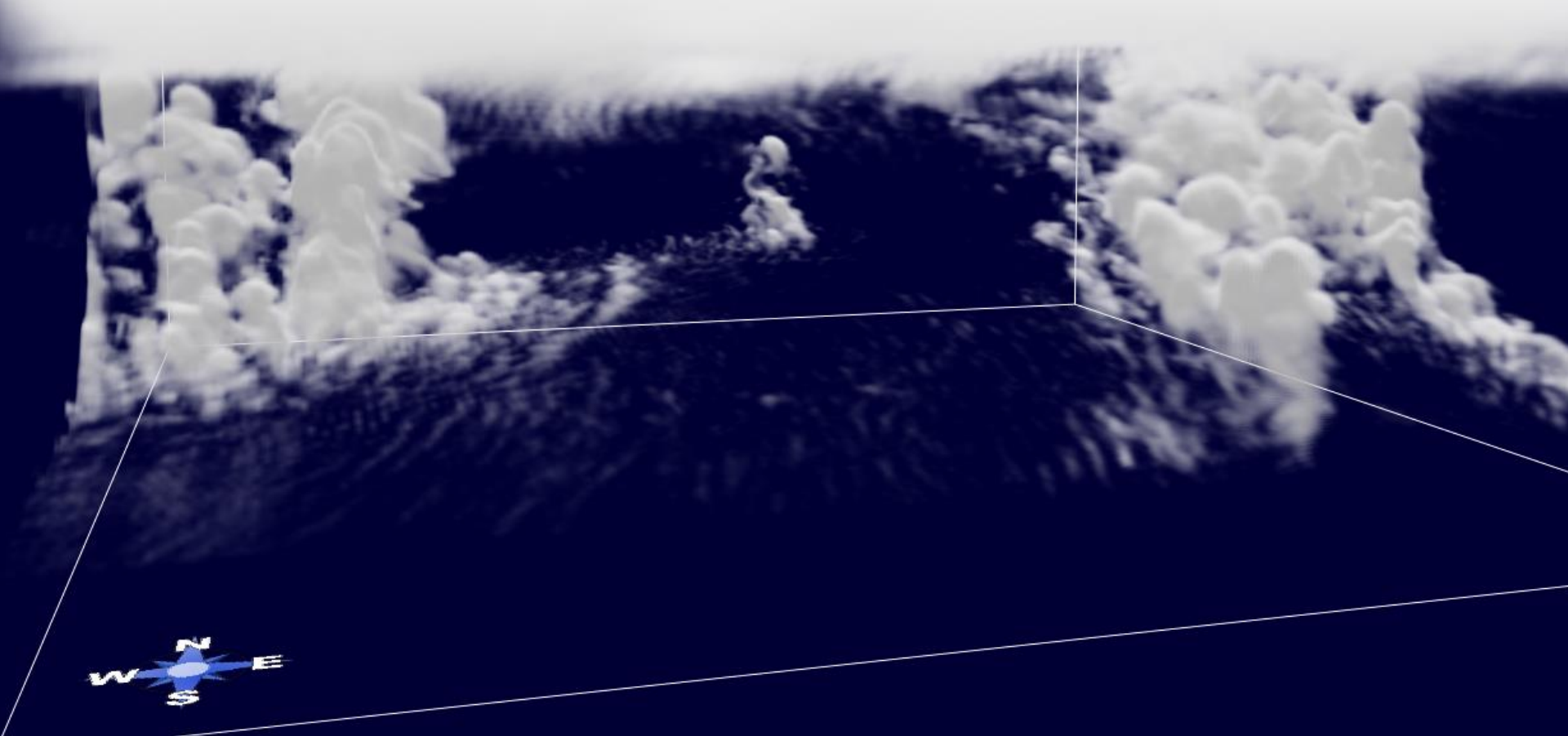


Turbulent Scales in the Boundary Layer: *A Year-Long Large-Eddy Simulation*

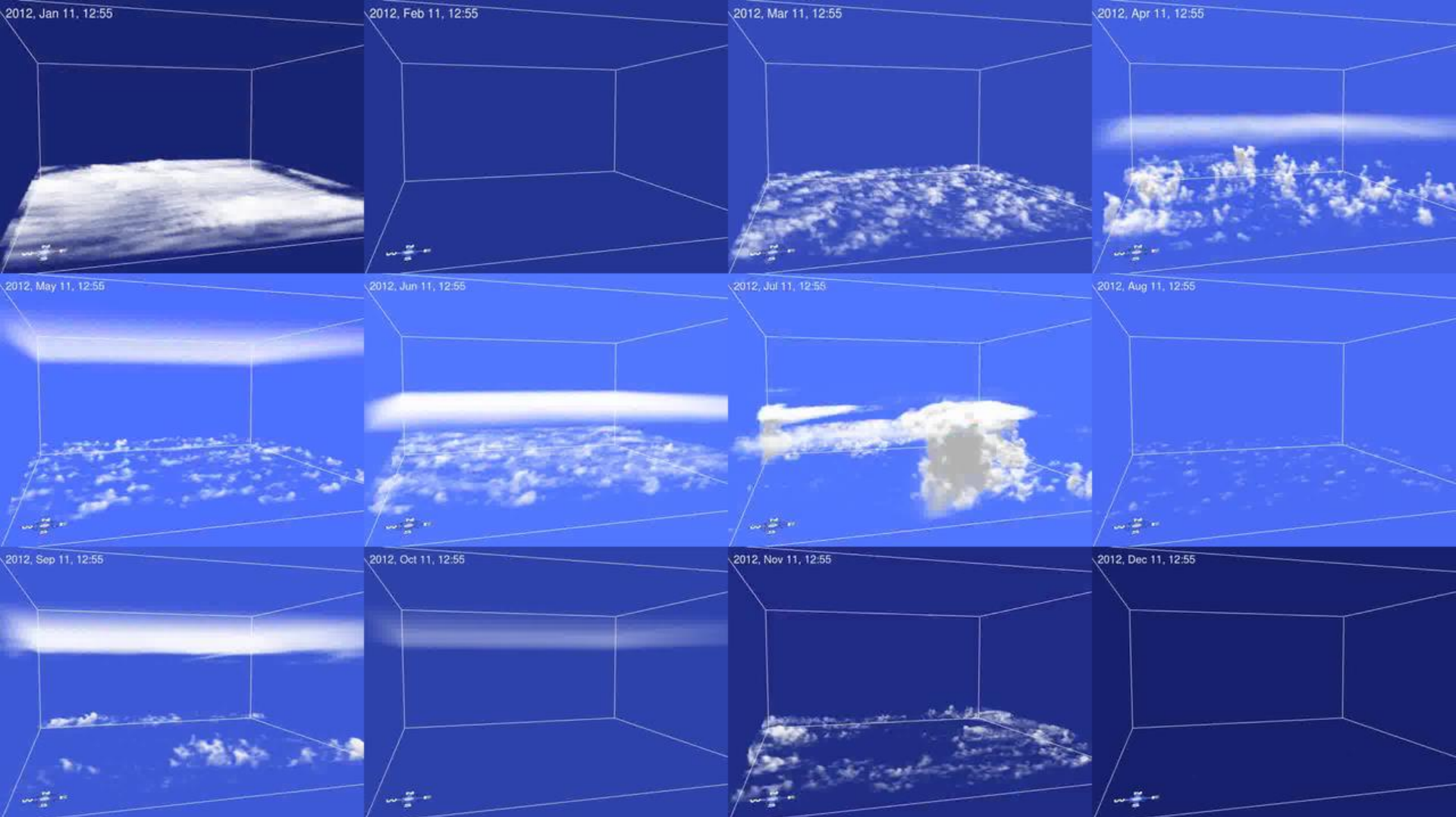
Jerôme Schalkwijk, Harm Jonker, Pier Siebesma



YOGA: A Year-Long Large-Eddy Simulation

Jerôme Schalkwijk (1), Harm Jonker (1), Pier Siebesma (1,2)

1) Delft University of Technology; 2) KNMI (Royal Netherlands Meteorological Institute)



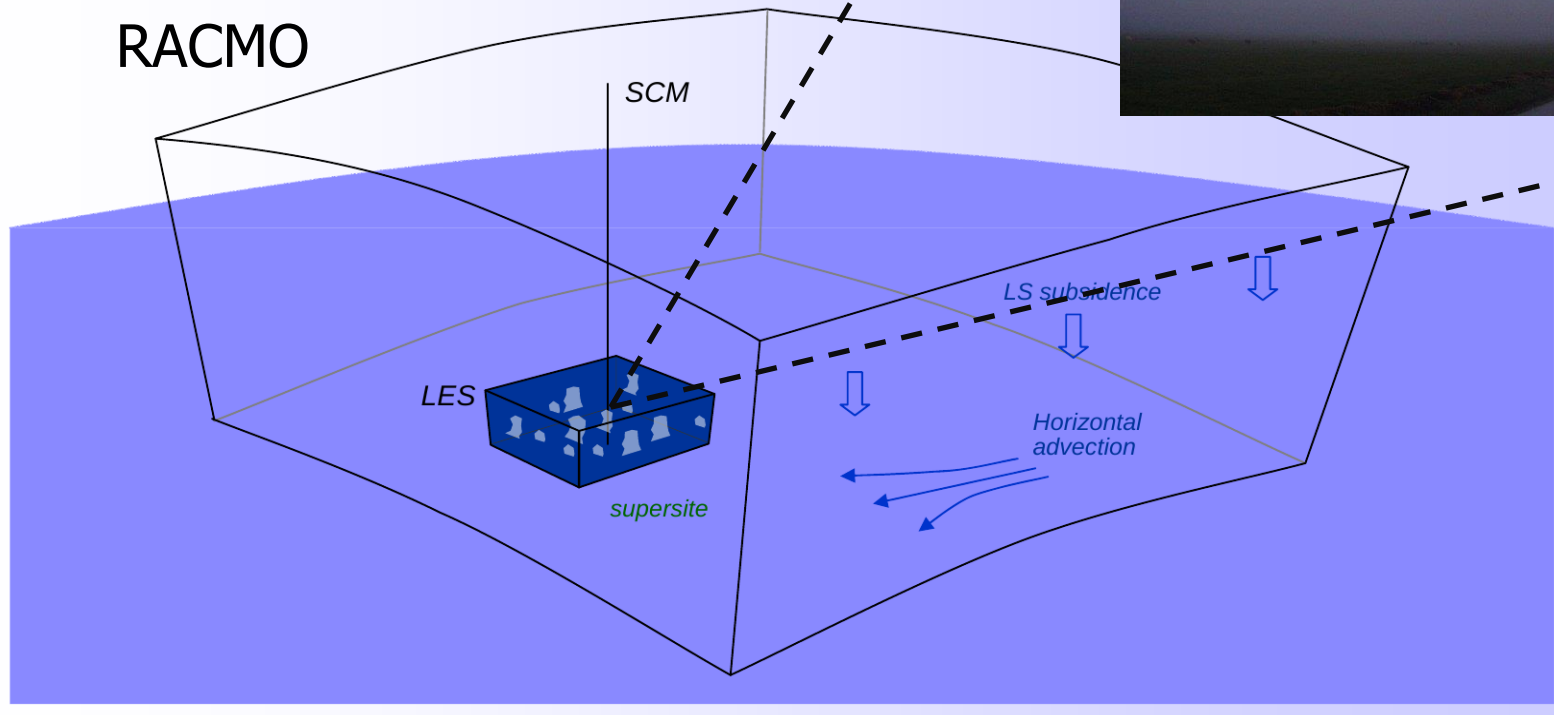
Topics

- Year of GALES (YOGA)
 - Set-up
Driven by regional model
 - Computational aspects
Continuous year-long simulation using GPU Acceleration
- Turbulence Spectra
Do we see a spectral gap?

YOGA set-up (1)

Embedment in
Large-Scale Weather model

CESAR
observational
supersite

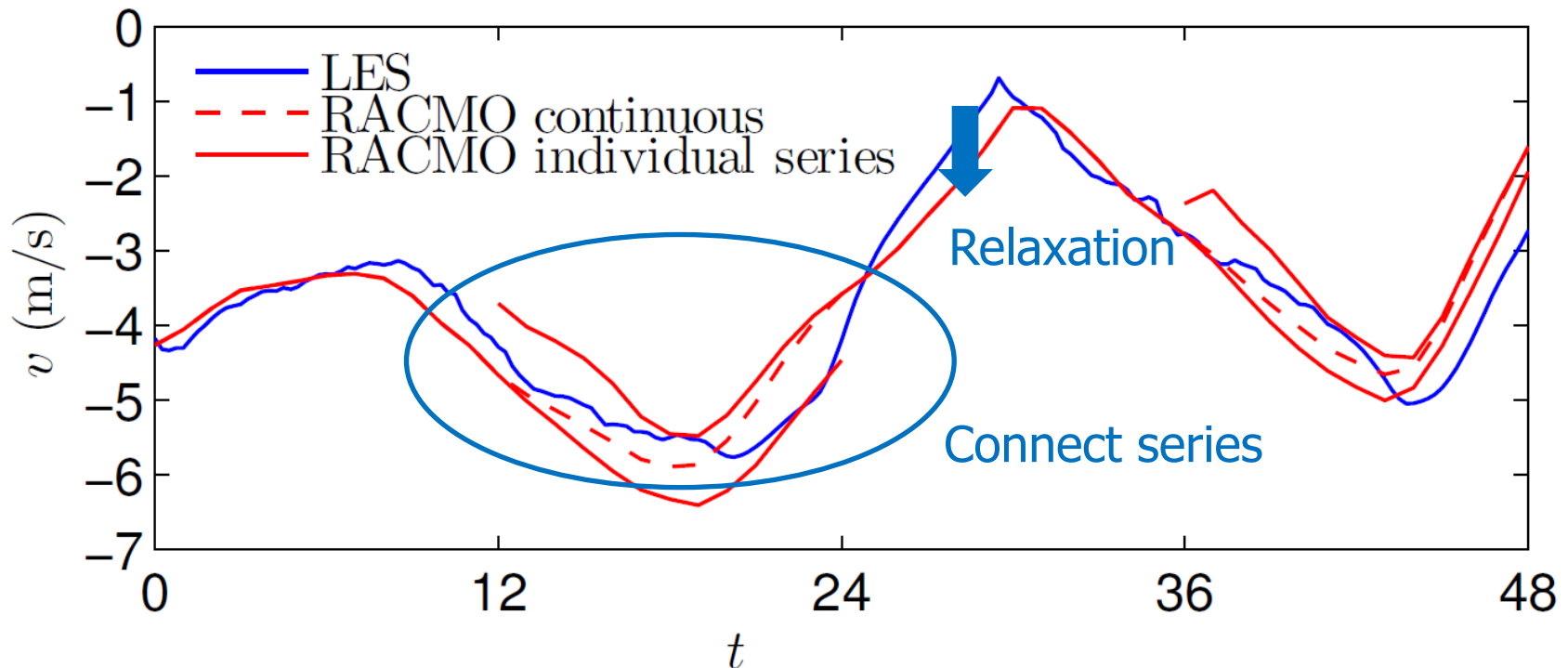


- *Roel Neggers, Pier Siebesma and T. Heus, BAMS, sept 2012*

YOGA set-up (2)

Continuous (un-interrupted) LES run

Jan 1 – Dec 31; 2012,
Cabauw, the Netherlands.

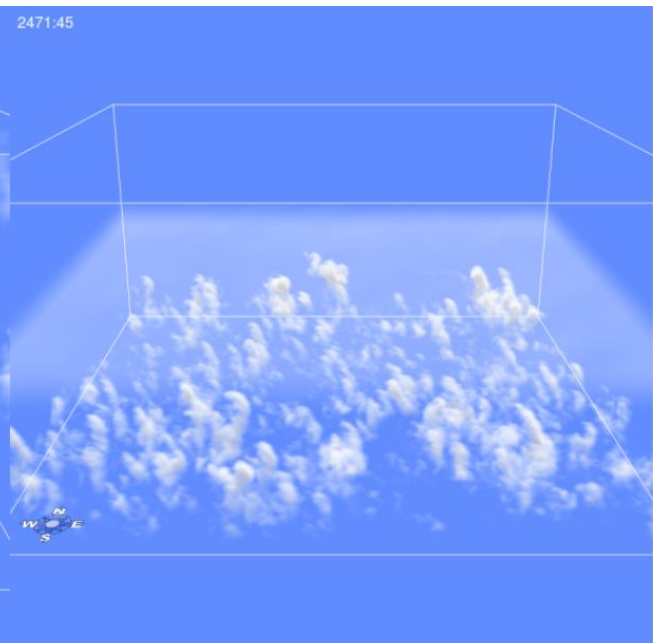
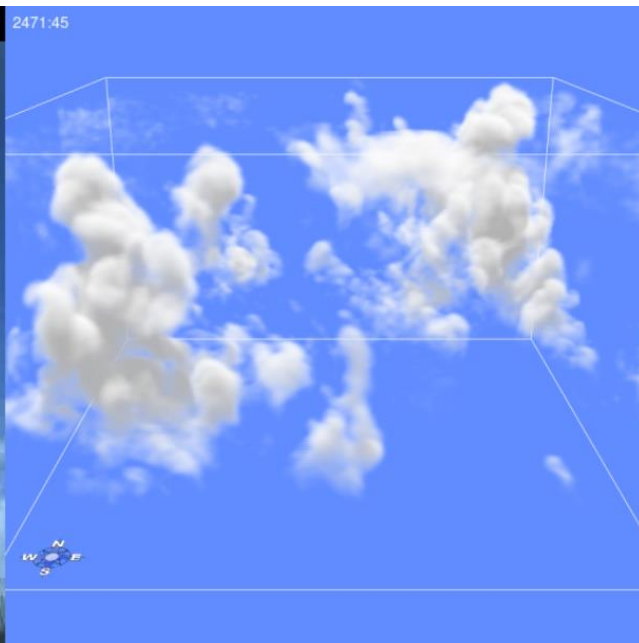


YOGA runs

Model grid

Turbulence

Large scales



Webcam

YOGA-HR
 $\sim(5 \text{ km})^2 \times 3 \text{ km}$
25m x 25m x $\sim 10\text{m}$

YOGA
 $\sim(25 \text{ km})^2 \times 25 \text{ km}$
100m x 100m x $\sim 30\text{m}$

YOGA : Computational Numbers

Year of GALES & Year of GALES - HR

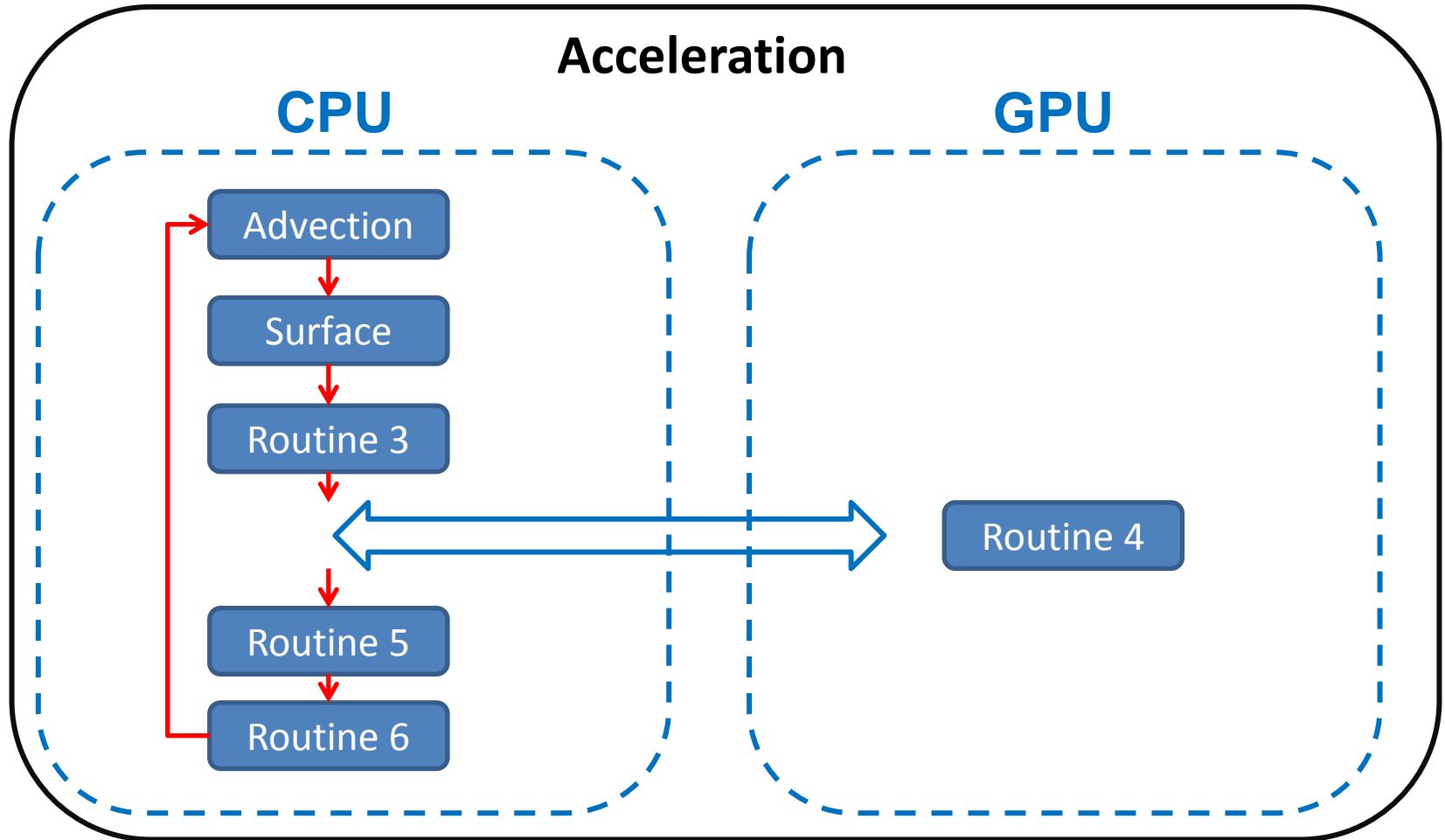
- 2 Non-stop year-long runs

	YOGA	YOGA-HR
Grid cells	256 ³ (16M)	194 ³ (7M)
Time steps	7M	16M
3D fields (if stored)	~2.5 PetaByte	
Wall clock time	?????	

- How?

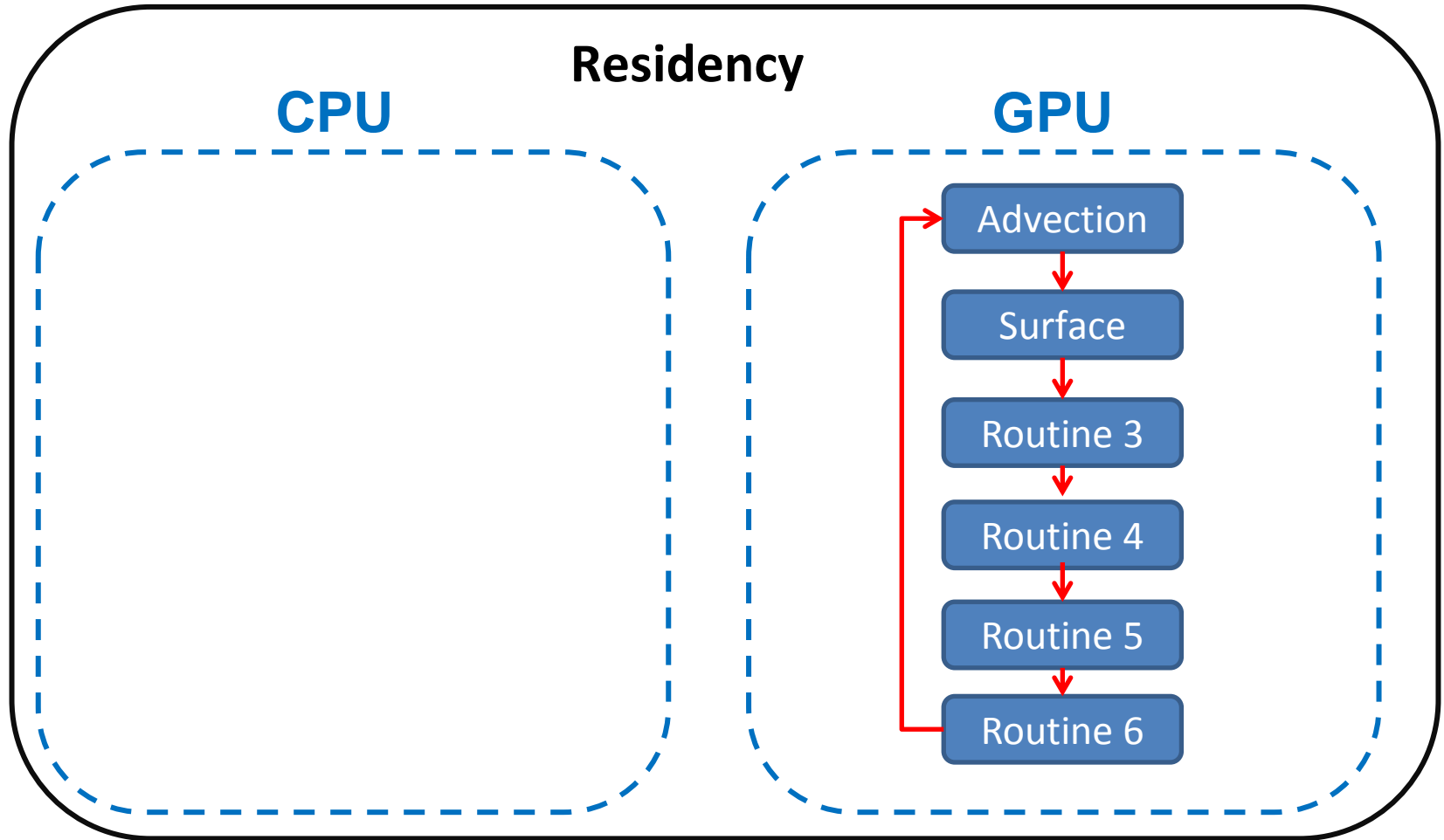
GALES

GPU-**resident** Atmospheric Large-Eddy Simulation



GALES

GPU-**resident** Atmospheric Large-Eddy Simulation



Volume 93 Number 3 March 2012

BAMS

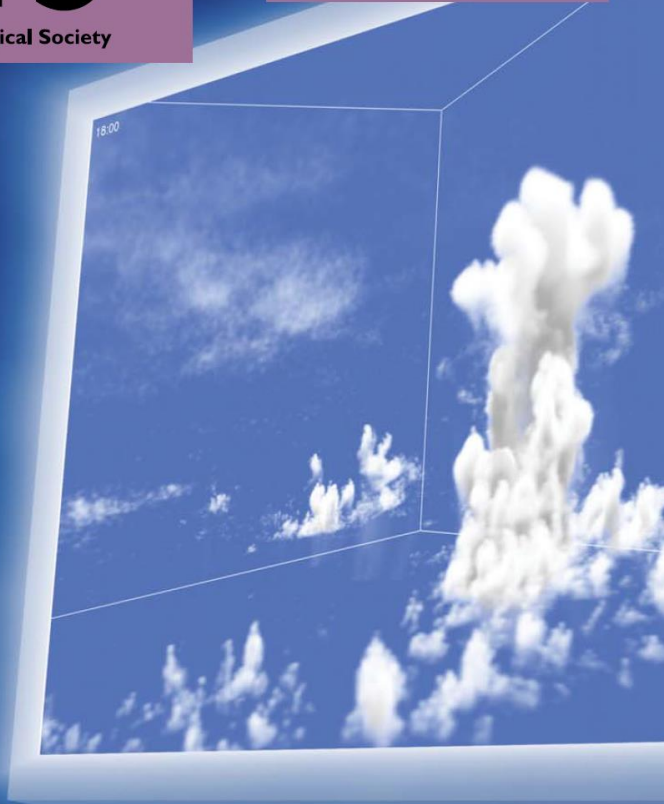


Bulletin of the American Meteorological Society

DEVELOPING SOUNDING DATASETS

THE PEER REVIEW WORKLOAD

IASI's HYPERSPECTRAL OBSERVING



LOUDS ON A DESKTOP

High-Performance Simulations with Graphics Cards

High-Performance Simulations of Turbulent Clouds on a Desktop PC: *Exploiting the GPU*

Schalkwijk, Griffith, Post & Jonker

March 2012

Result:

Time per time-step at 256^3

24 CPUs: 2.6s

48 CPUs: 1.9s

1 GPU: 0.8s

YOGA : Computational Numbers

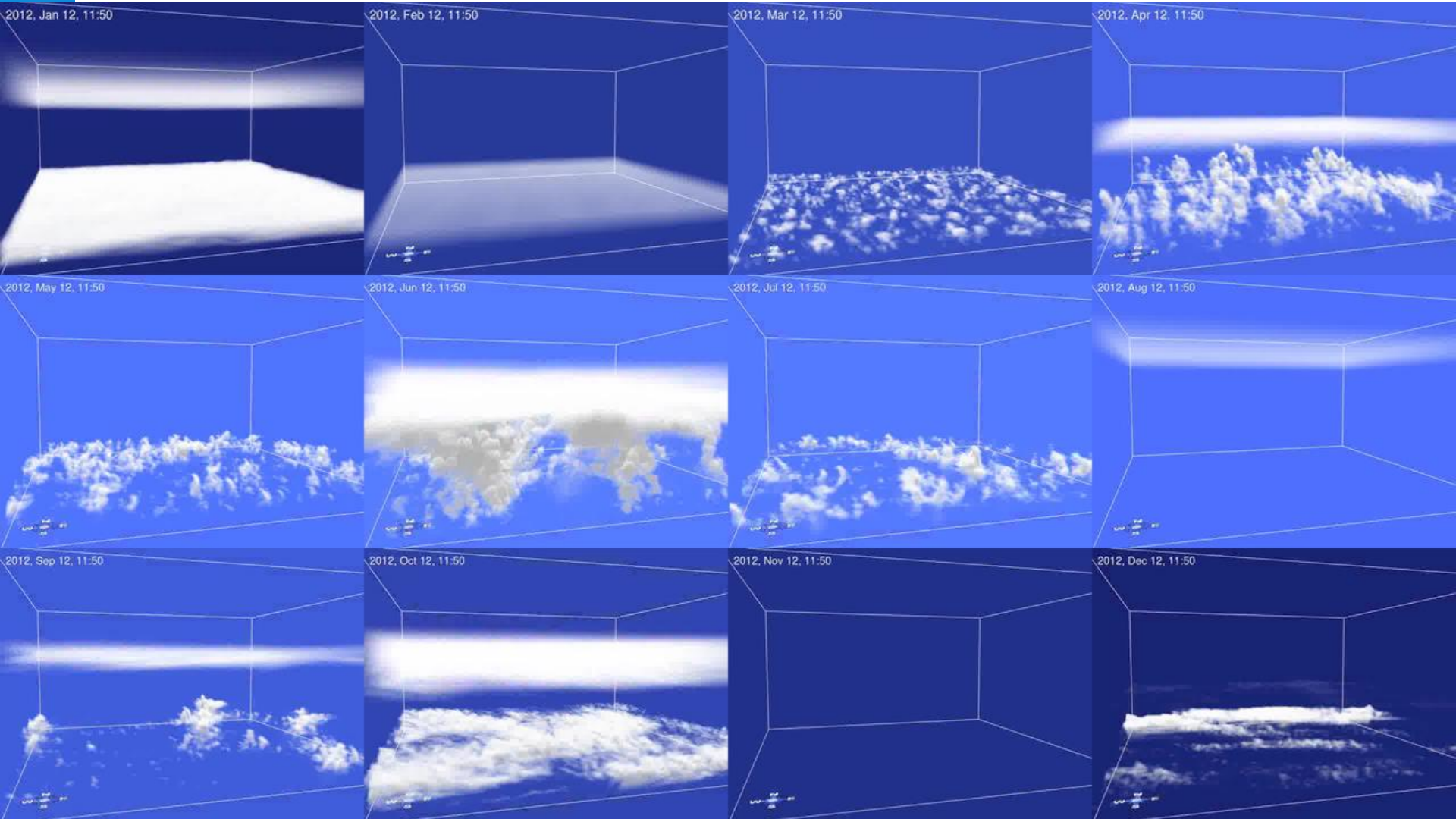
Year of GALES & Year of GALES - HR

- 2 Non-stop runs of *GPU-resident Atmospheric Large-Eddy Simulation*

	YOGA	YOGA-HR
Grid cells	256 ³ (16M)	194 ³ (7M)
Time steps	7M	16M
3D fields (if stored)	~2.5 PetaByte	
Wall clock time	5M seconds (~ 2 months)	

YOGA

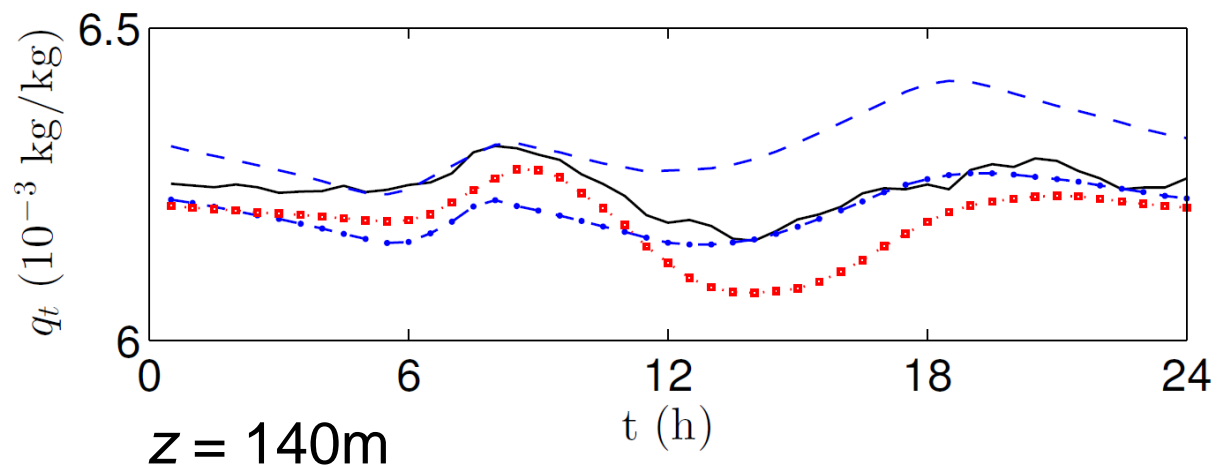
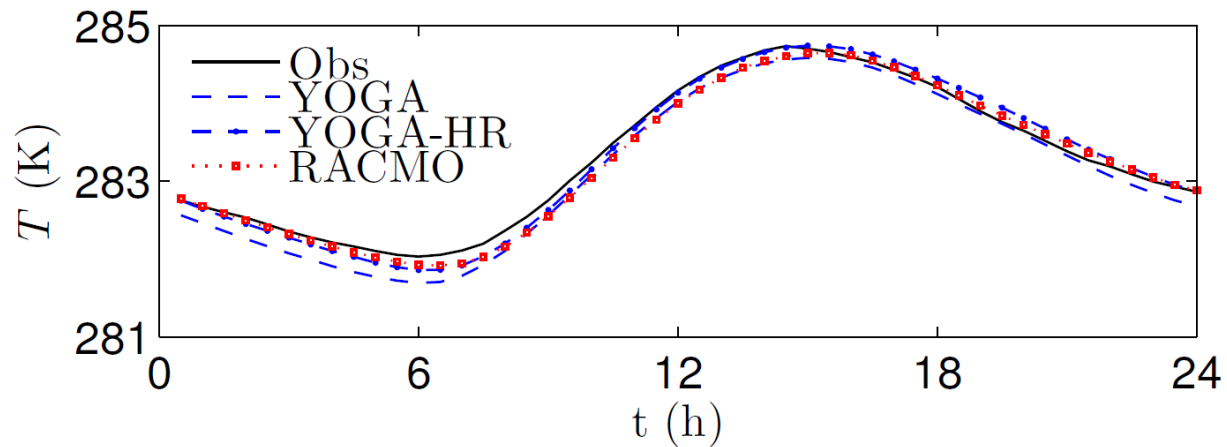
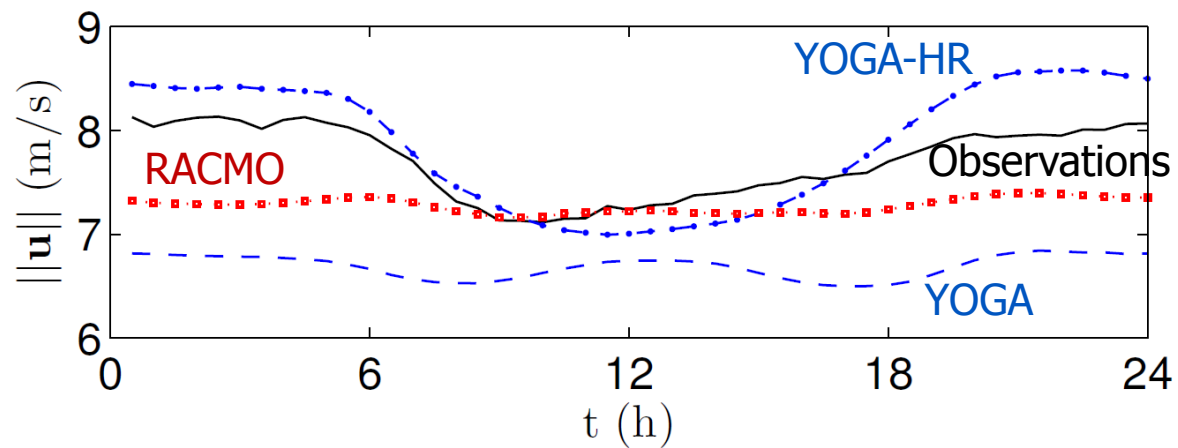
Year of GALES & Year of GALES - HR



YOGA

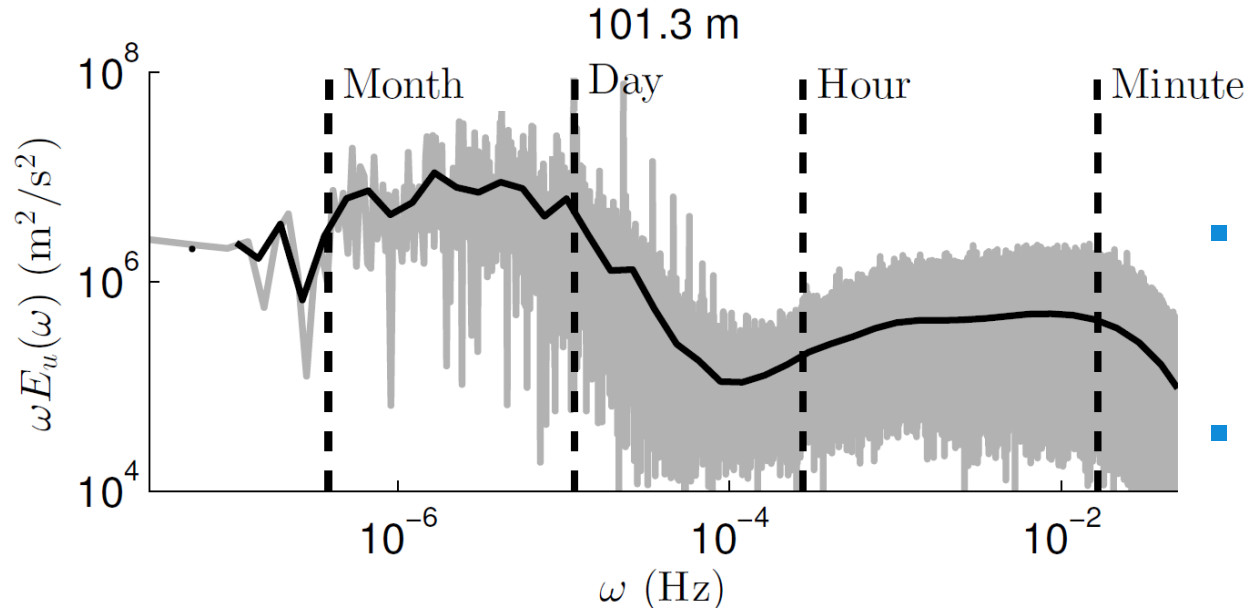
Year-averaged time-series

- Good agreement
- YOGA-HR better resolves diurnal cycle of u



Van der Hoven Energy Spectrum

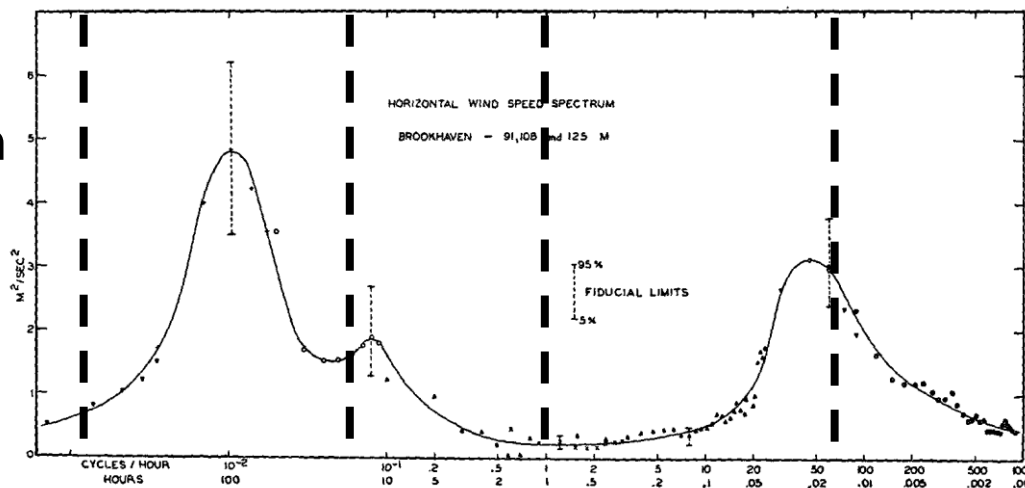
Power spectrum of variance in 100m wind



- Qualitative correspondence

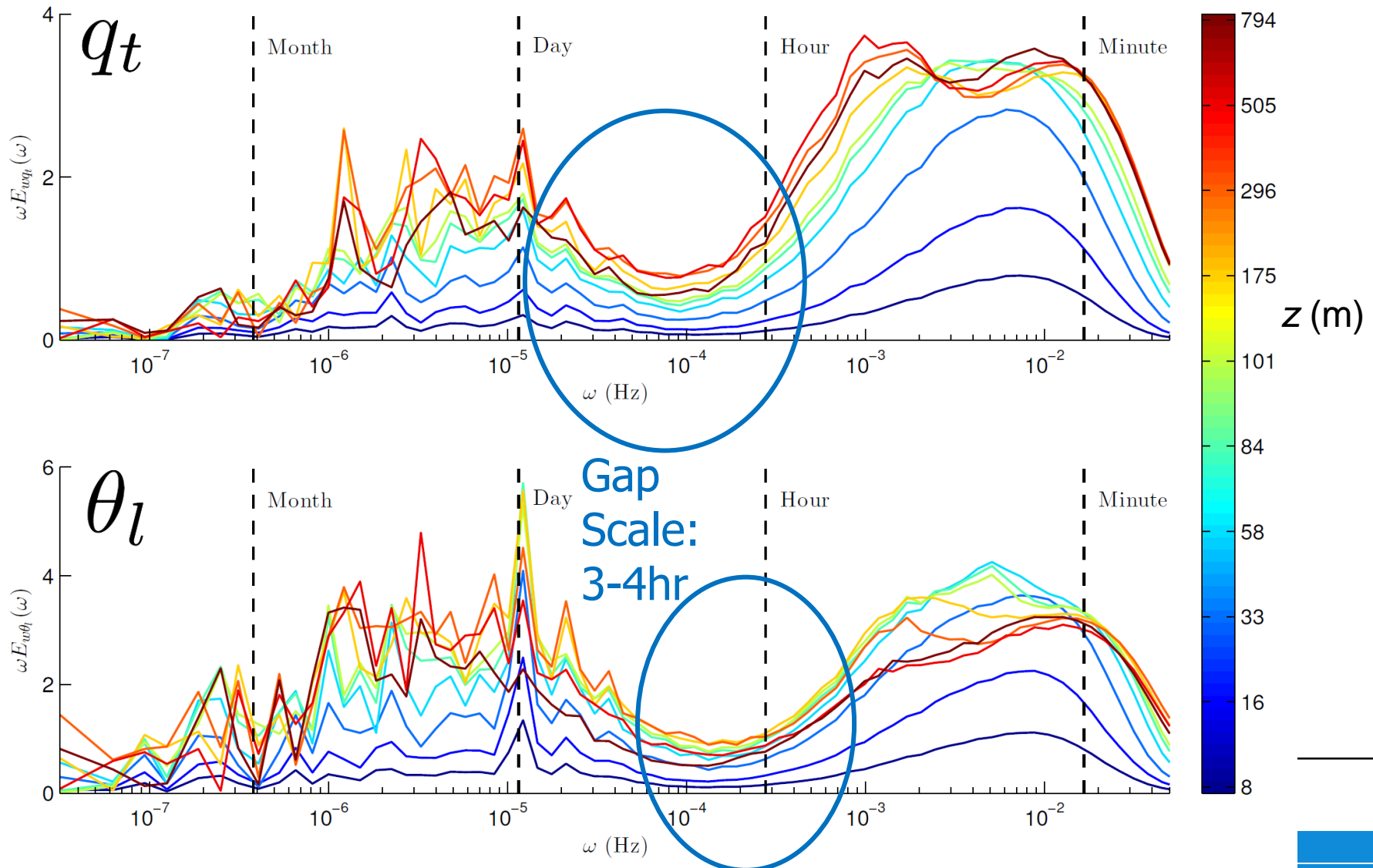
- Spectral gap is visible!
But less pronounced and narrower

Van der Hoven (1957)



Power Co-Spectra

Energy spectrum of turbulent transport



Concluding remarks

- It is now computationally feasible to perform >year LES runs
Statistics vs case studies.
- LES is capable of handling extremely diverse situations
From stable boundary layer to deep convection in 1 run
- Qualitative spectrum of *van der Hoven (1957)* can be reproduced
Including presence of “spectral gap”
- Spectral gap is also present in temperature/humidity co-spectra
But is very large (~4hrs)
- YOGA dataset will be made available

Thank you for your attention
Questions?