Some thoughts on Daily SCM/LES

within the context of Test Beds

Current DOE Sponsored Test Beds

- Aerosol (Jerome Fast)
- Clouds (Steve Klein)
- Fast Physics (Yangang Liu)

CONTINUOUS SINGLE-COLUMN MODEL EVALUATION AT A PERMANENT METEOROLOGICAL SUPERSITE

BY R. A. J. NEGGERS, A. P. SIEBESMA, AND T. HEUS

BAMS, September 2012

Constraining a system of interacting parameterizations through multiple-parameter evaluation: Tracing a compensating error between cloud vertical structure and cloud overlap

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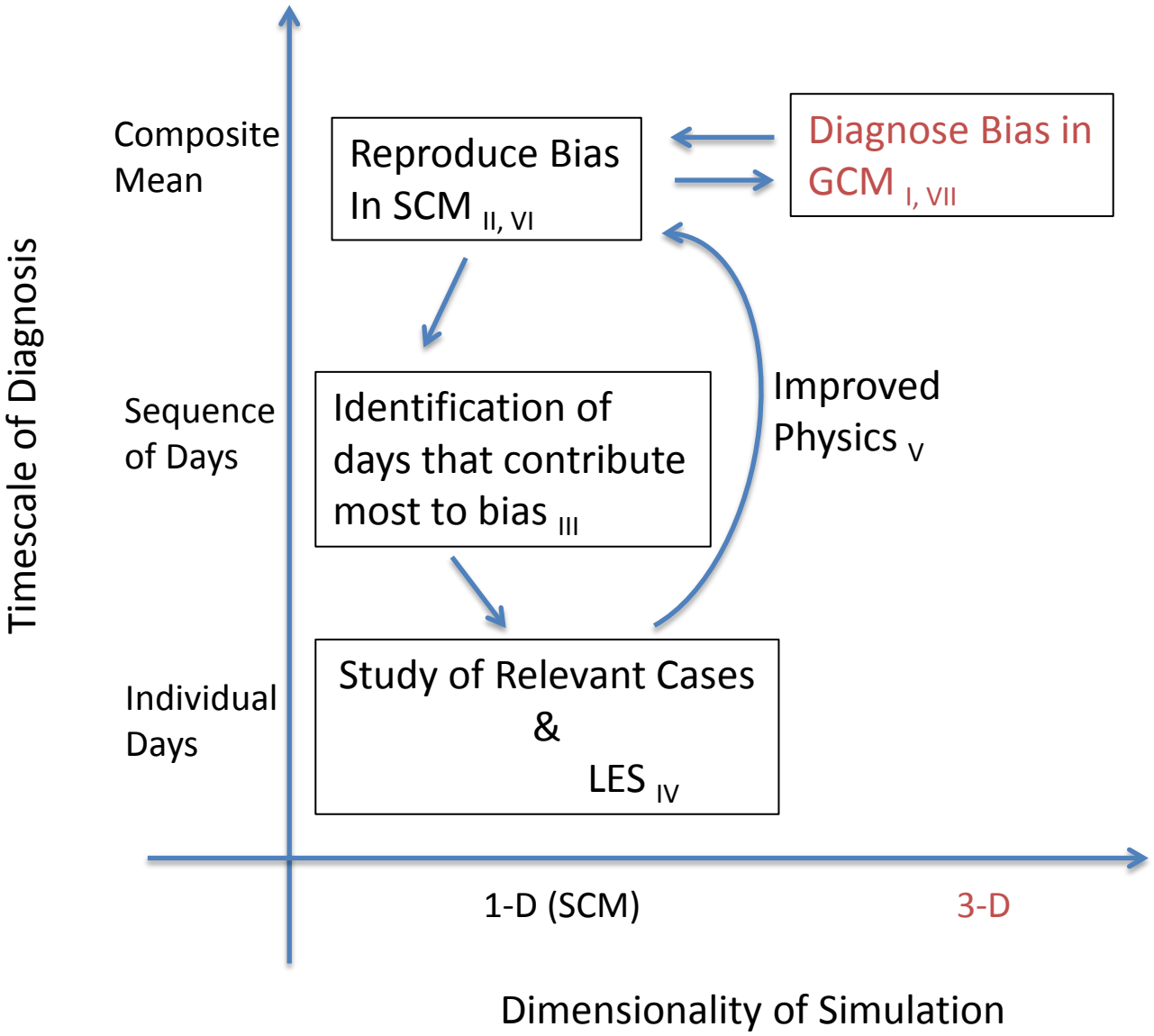
http://www.knmi.nl/~neggers/KPT

Adapted from Neggers et al., BAMS 2012



I. Statistically identify a problem in a GCM or RCM (based on longterm GCM statistics)
II. Assess if problem is reproduced by SCM; *Does it match GCM stats (monthly/yearly means)?*
III. If so, identify days contributing most to error *(Selected individual days are guaranteed to matter)*
IV. Study those days in great detail
V. Identify/understand cause, and find solution
VI. Re-simulate/evaluate modified SCM
VII. Rerun GCM/RCM including improved physics

GUI: Model Output, Data

http://www.knmi.nl/~neggers/KPT

Daily SCM and LES

- Host model (NWP)
  - provides prescribed advective forcing and continuous nudging
- LES can be interpreted as a “downscaling” of the host model state at high spatial and temporal resolutions
- LES provides turbulence, microphysical structure
- Compare with archived observations

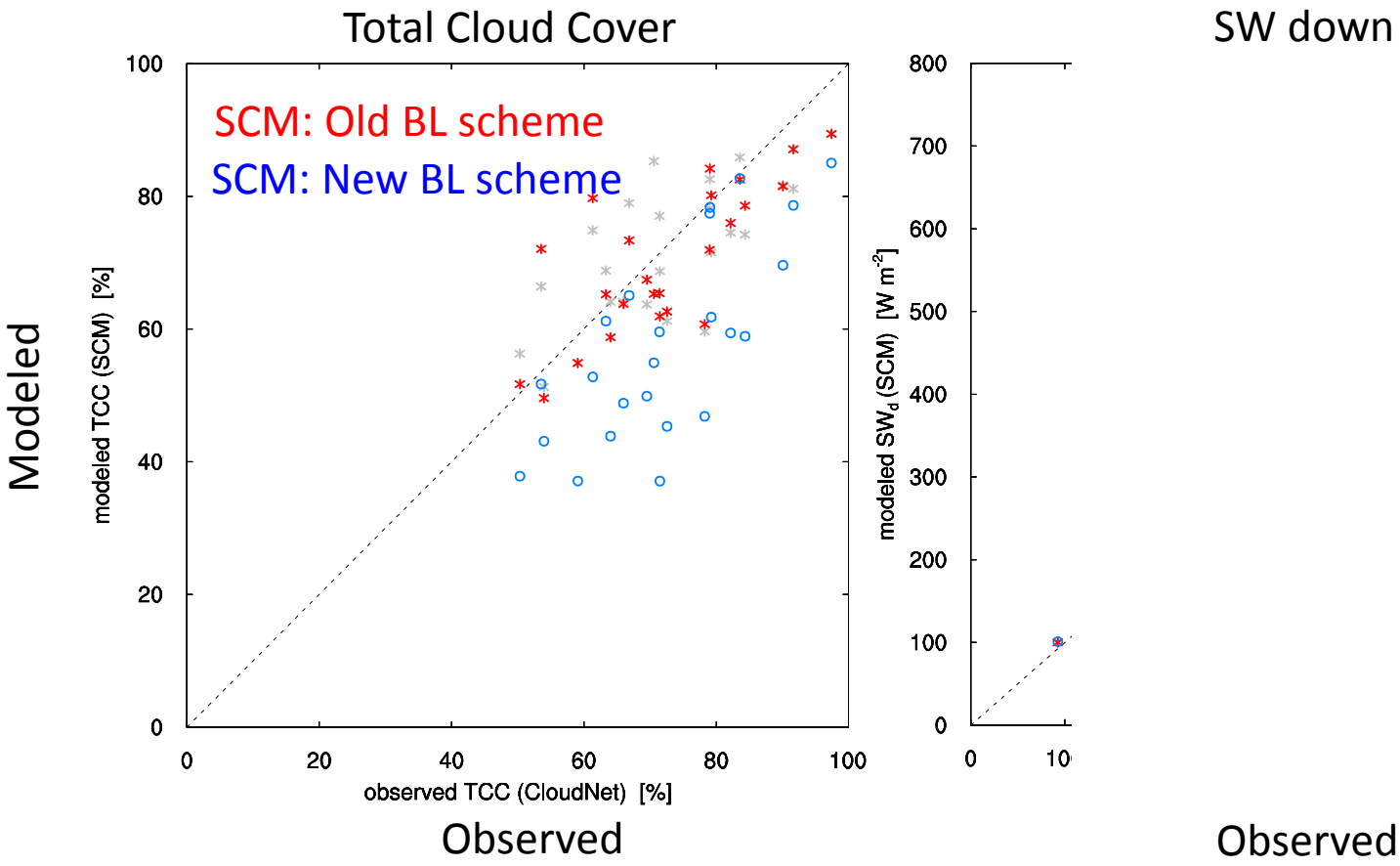
Problems that are appropriate to address:

- Time and length scales of a phenomenon need to be much smaller than the circulation in which it is embedded;

- Phenomenon is sufficiently locally forced that it can be studied in the absence of larger scale forcing

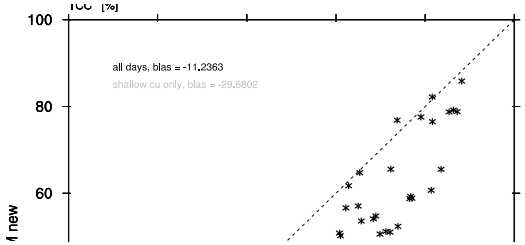
Example of Diagnosis of SCM Model Bias using observations and LES

Identify Problem in Cloud Cover and SWd



Add other variables to this set of checks (e.g., surface fluxes, surface T)

Trace Problem to Shallow Cu



Total Cloud Cover

SCM: New BL scheme

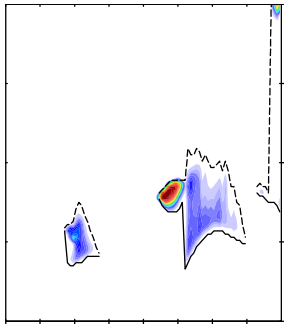
Grey points: Shallow Cu

SW down

SCM: Old BL scheme

Compare to LES for same Days

LES

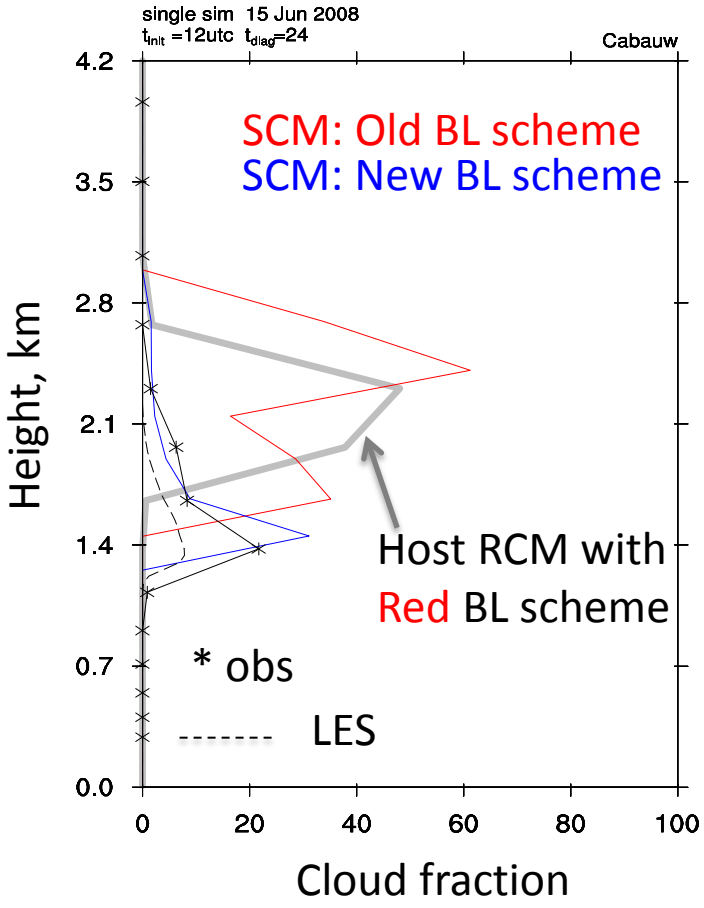


SCM: Old BL scheme

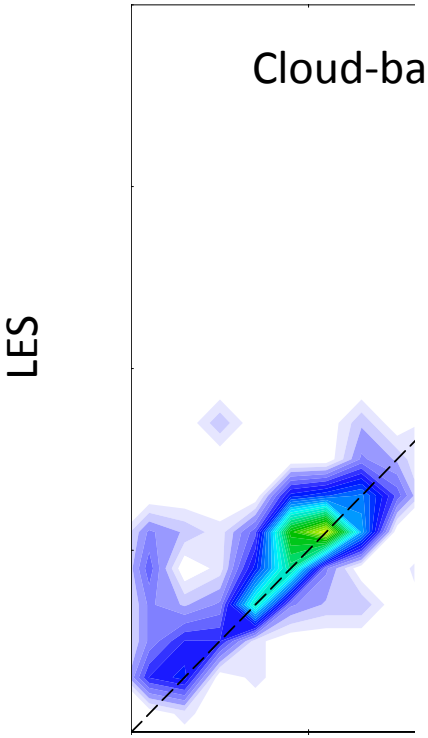
SCM: New BL scheme

Compare to Observations and LES

Single day



Month of June at Cabauw



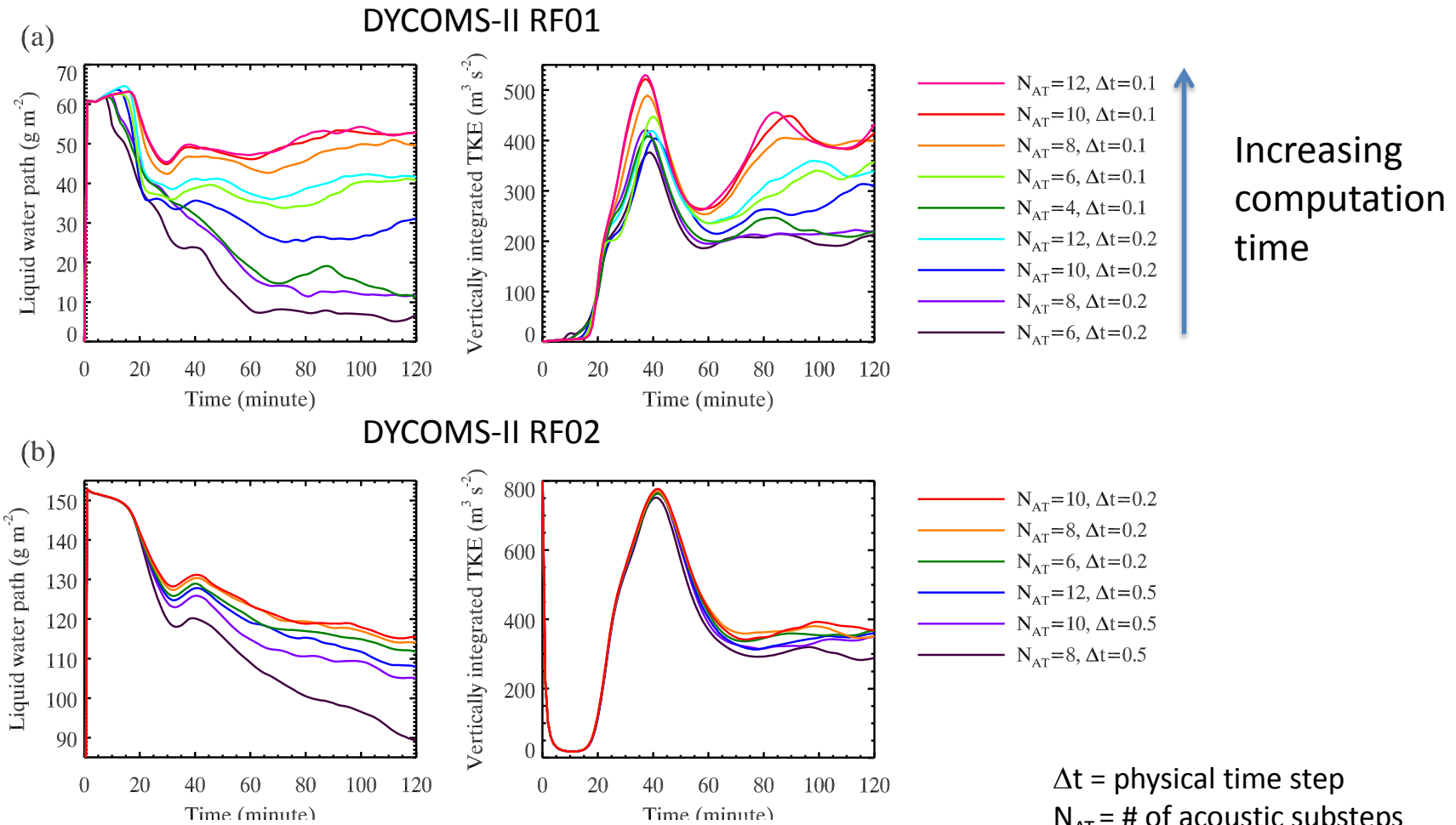
Solution to Problem

- Problem Traced to Treatment of Overlap Function
- New BL parameterization actually performs better

DOE Community Issues

- DOE tends to favour WRF
  - Concerns about WRF as LES (fine time-stepping requirements; Yamaguchi and Feingold 2012)
  - Convergence criteria change from case to case, and grid size
  - Can be 10x slower than incompressible LES

Convergence: WRF in LES mode



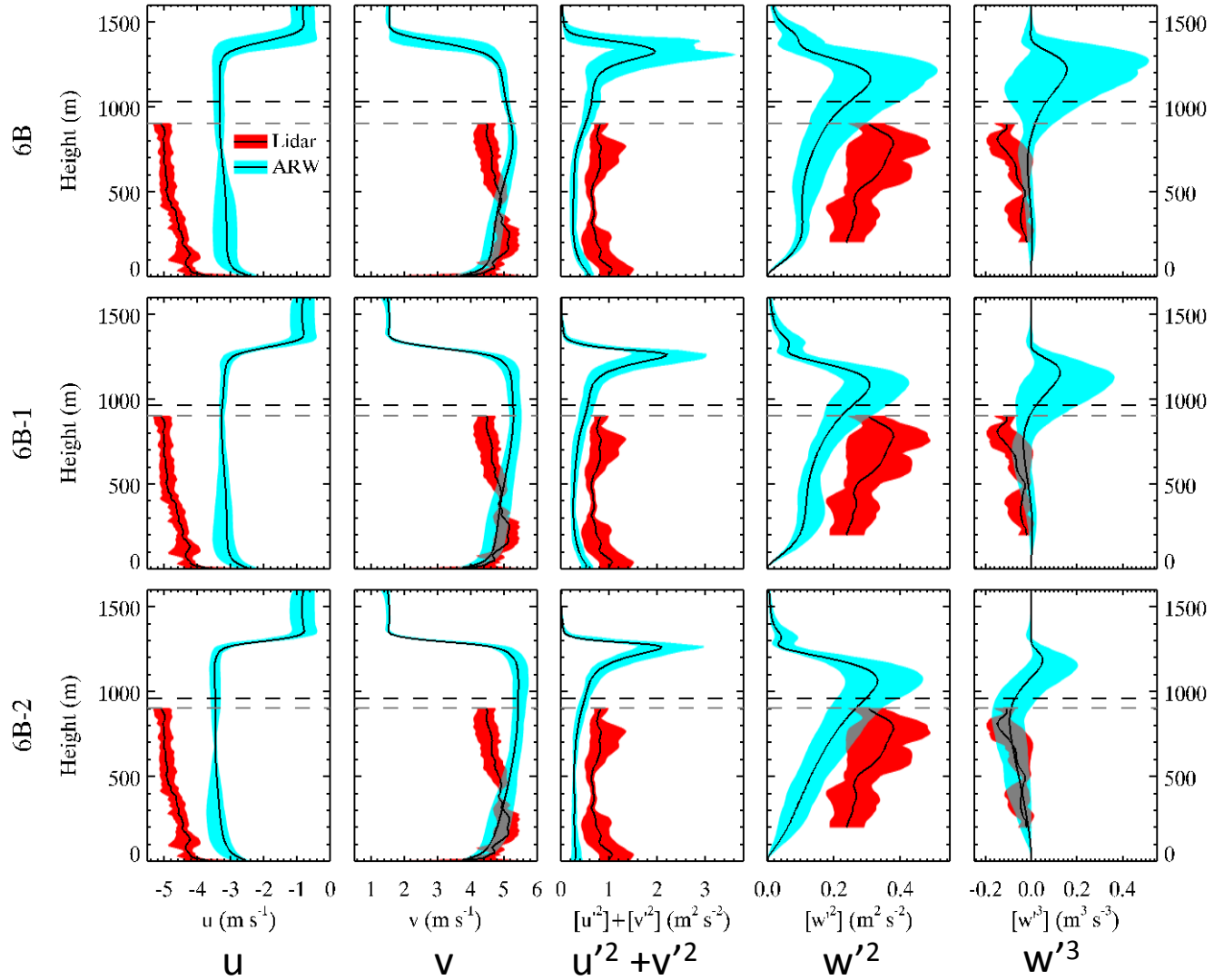
Δt = physical time step

N_{AT} = # of acoustic substeps

Yamaguchi and Feingold 2012

Doppler velocity comparison: single case

dependence on different grid and domain sizes, physics, etc



WRF-LES

Lidar

Yamaguchi et al. 2013 JAS

DOE Community Issues

- DOE tends to favour WRF
  - Concerns about WRF as LES (fine time-stepping requirements; Yamaguchi and Feingold 2012)
  - Convergence criteria change from case to case
  - Can be 10x slower than incompressible LES
- Would be better off using SAM (or similar)
  - Unencumbered by huge array of options
  - SAM does have a range of microphysical packages
  - Stats package (now also in WRF; Yamaguchi and Feingold 2012)

Where?!

- SGP
  - Longest, most comprehensive data sets
  - Range of cloud/BL regimes (advantage and disadvantage)
  - Seasonal land-surface changes
- Azores
  - Fewer issues with land surface changes
  - Smaller range of conditions but still highly variable meteorology
- Ideally, do this exercise in a “stable” meteorological regime

Technicalities: Fortran vs. C++; CPU vs GPU

- C++ runs on GPU (~ order of magnitude speed-up)
- Fortran code traditionally run on CPUs but now appear to run on GPUs
  (e.g. PG compiler)
- Effort of converting codes to C++ does not seem warranted
  - Throw a little more computing power at the problem rather than get bogged down in model development

Decisions

- Is the effort warranted?
- It will require significant resources
- Candidate model(s)
- Technology transfer from KNMI (e.g., GUI interface)

Overlap with Proposed Observationally-Based Assessment of Aerosol-Cloud Radiative Forcing