Overview of GEWEX Atmospheric Boundary Layer Study (GABLS)

Bert Holtslag

Thanks to Bob Beare, Joan Cuxart, Gunilla Svensson and many others...

Towards a better ABL representation for Weather, Air Quality, Climate, and Earth System Studies

Thanks to all the participating scientists!

Overview

Background

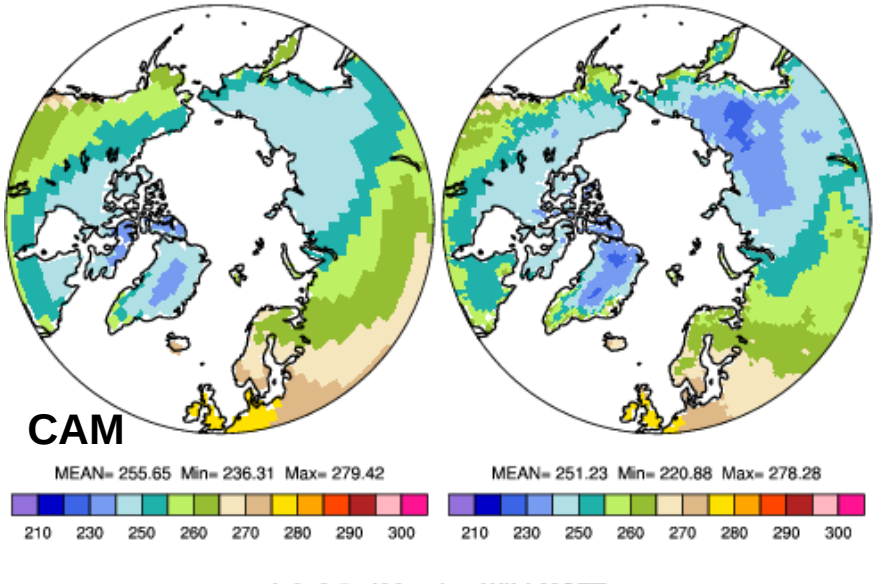
Some further findings of GABLS1

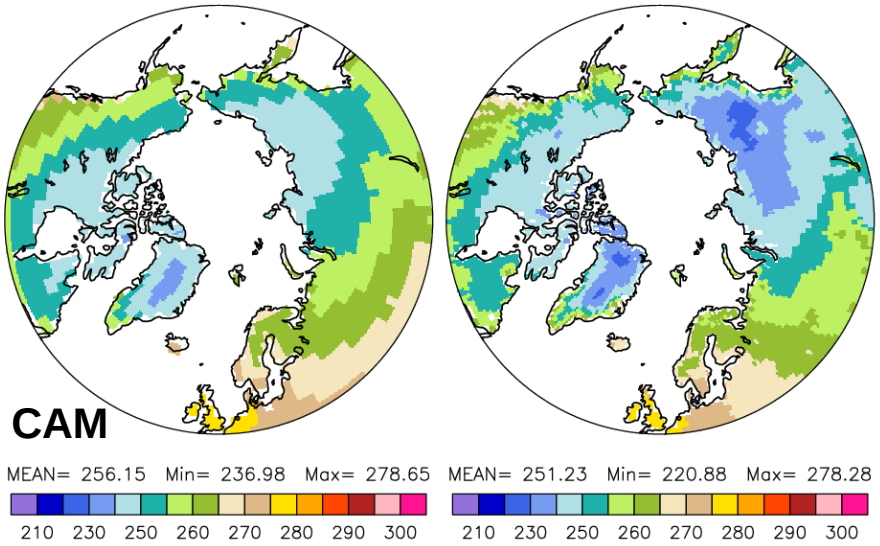
Set-up and findings of GABLS2 (Gunilla Svensson)

How to proceed (To be discussed this week)?

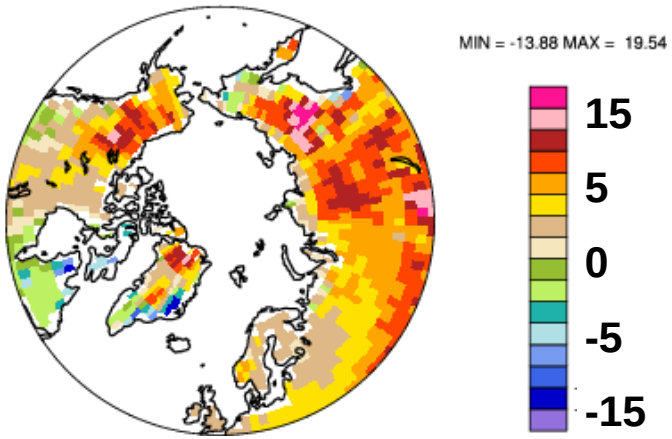
NCAR CAM - 2 different PBL schemes

DJF 2-m temperature compared with surface observations

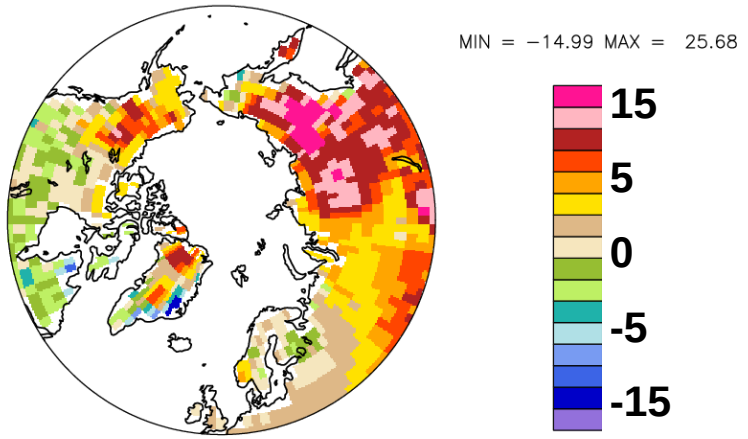




CAM – Observations

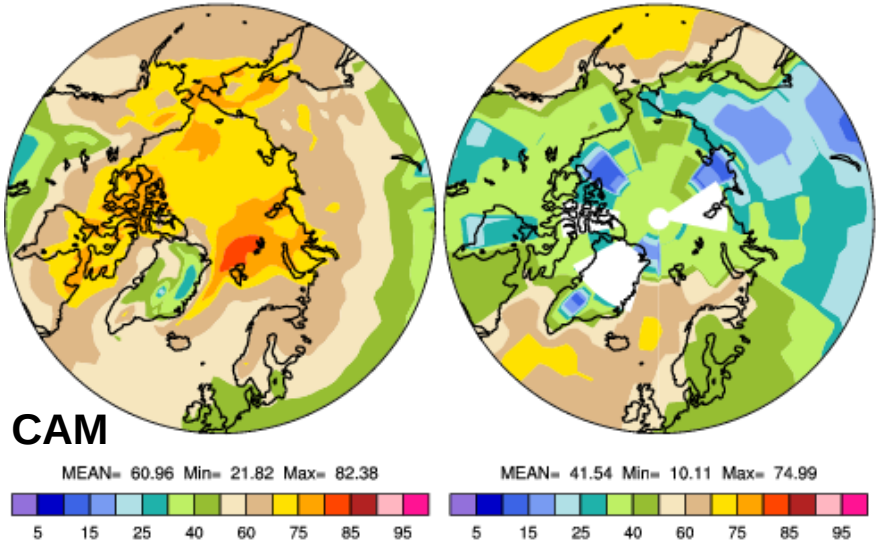


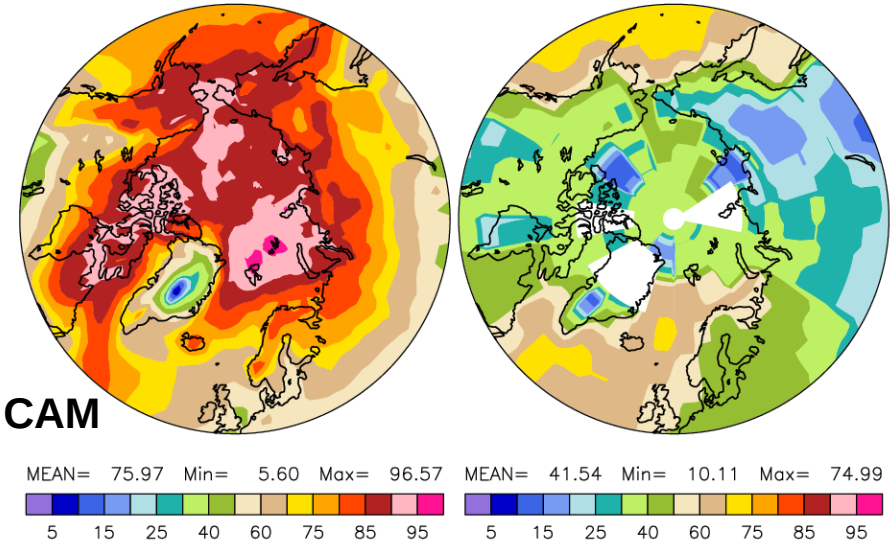
CAM – Observations



NCAR CAM - 2 different PBL schemes

ANNUAL low-level cloud cover compared with surface observations





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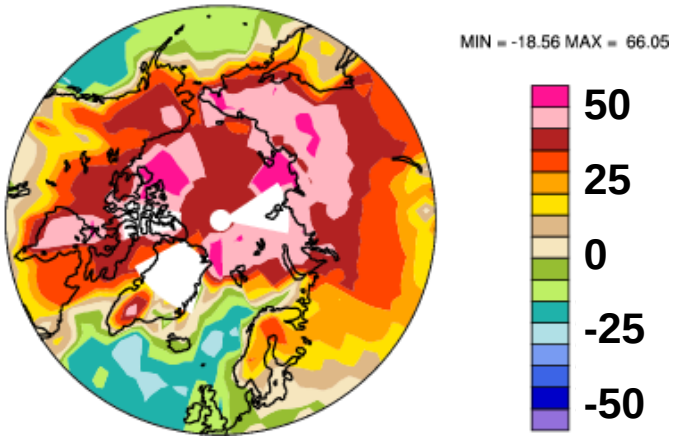

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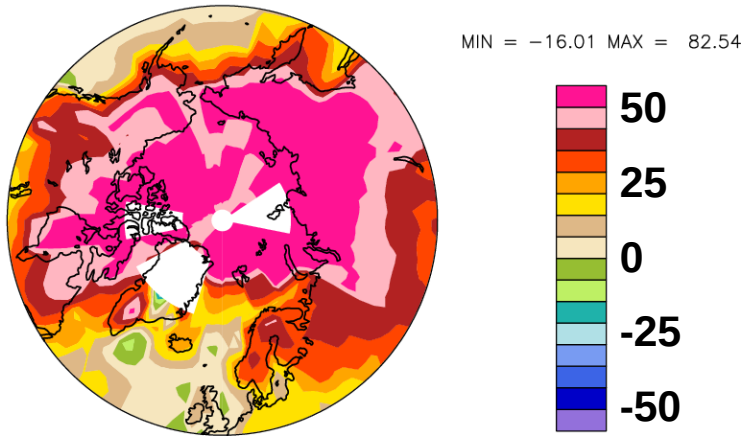
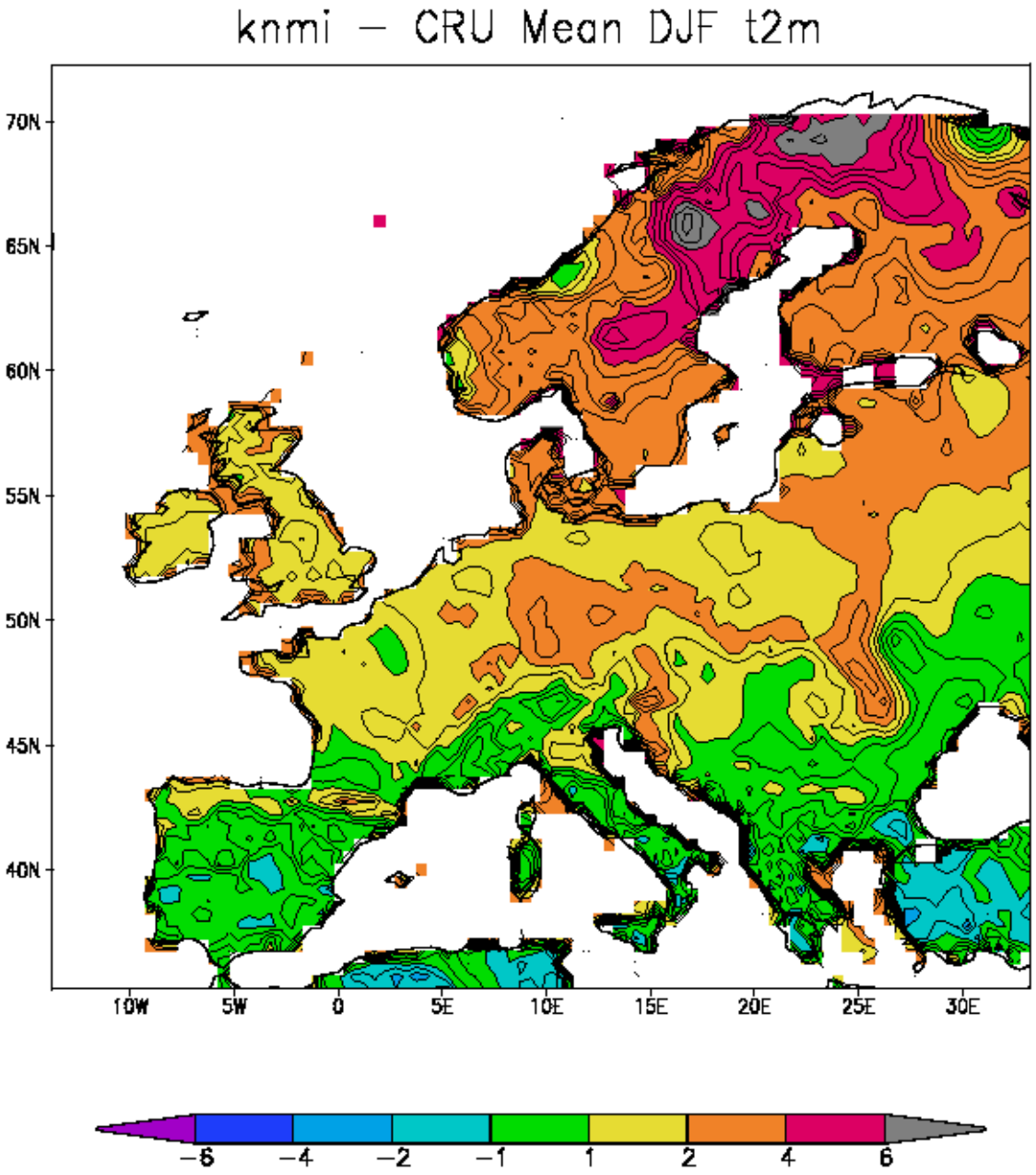
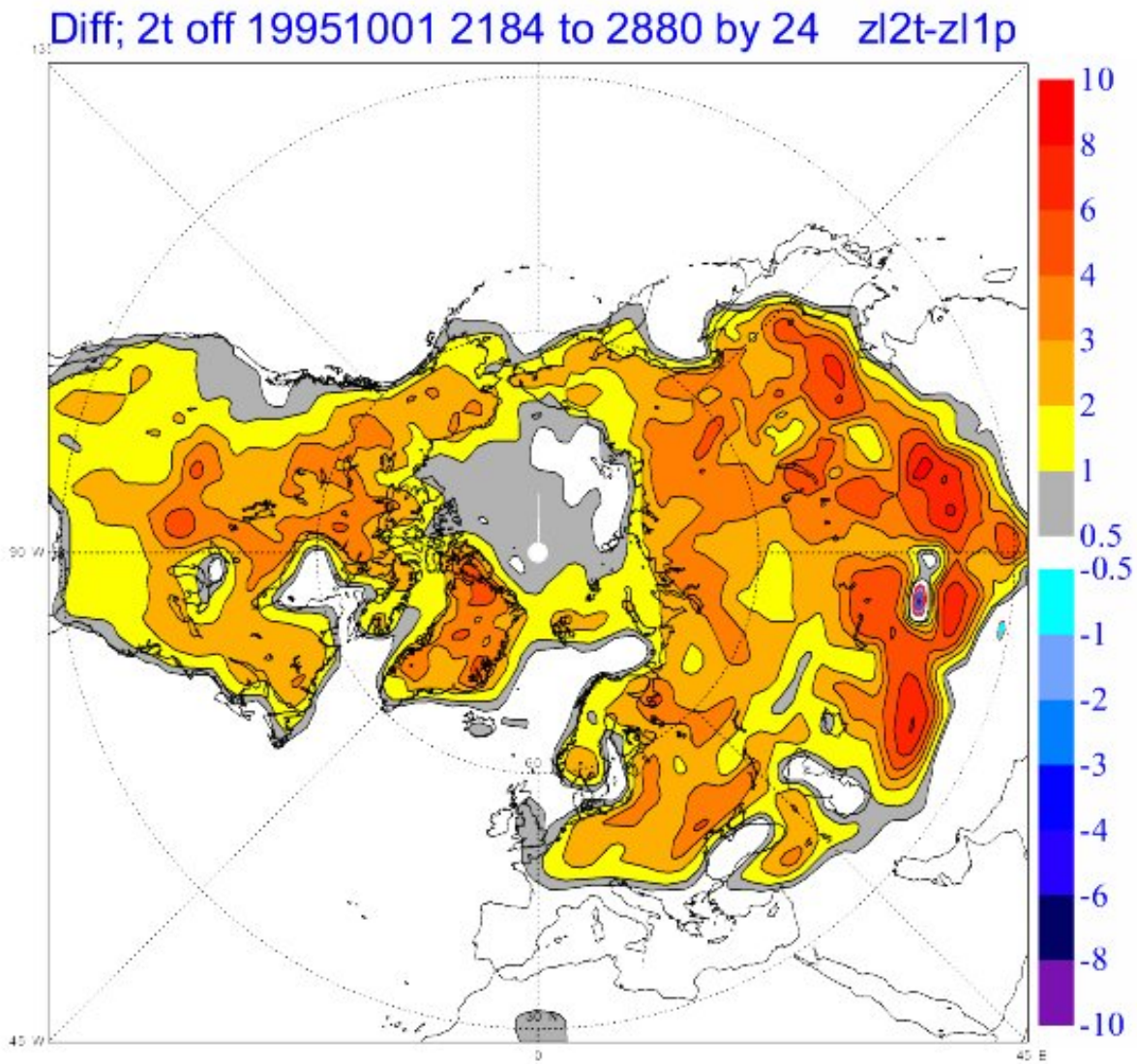




Example:
Mean model bias for the 2 meter temperature in present winter climate (30 years)

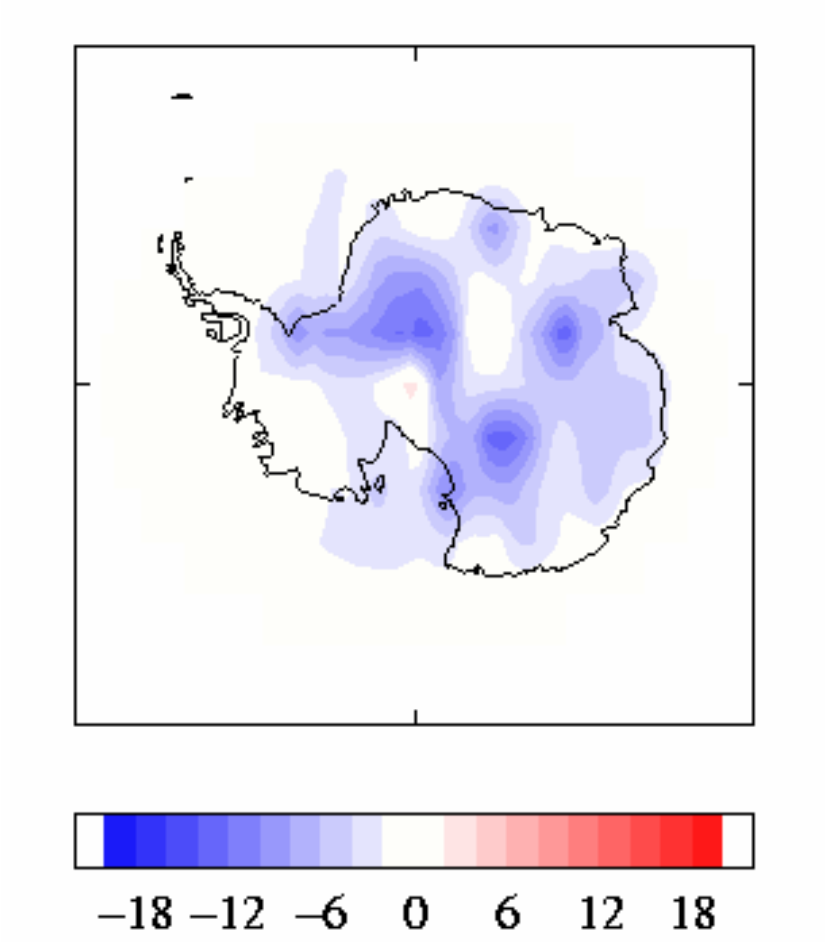
Courtesy,
Geert Lenderink,
KNMI and
PRUDENCE partners

Also:
Magnitude diurnal cycle is underestimated



Mean model difference in 2 meter temperature for January 1996 using two different stabilty functions in ECMWF model (Courtesy A. Beljaars)

Sensitivity to SBL parameterization in Hadley Centre Climate Model, over Antarctic



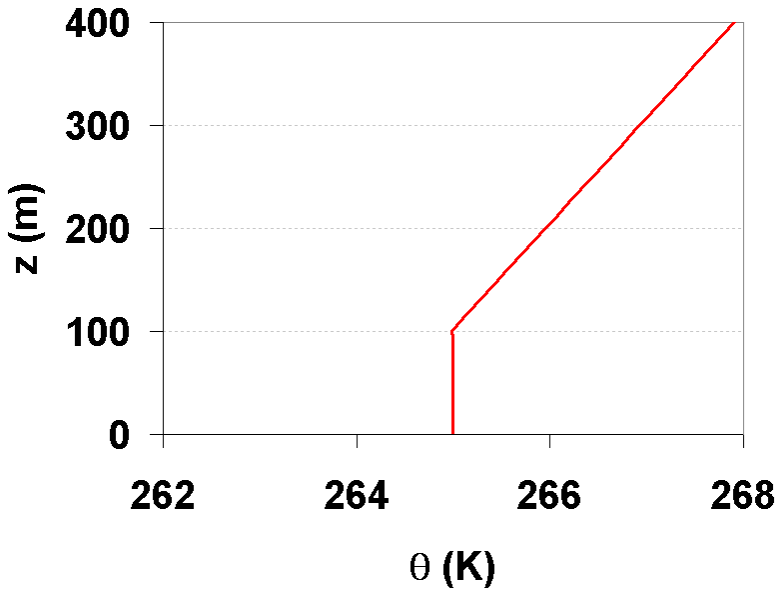
Difference between new
(2nd order closure)
and current scheme
(1st order closure)
for 1.5m Temperature (K),
JJA season, 5 year mean
(King et al. 2001, QJRMS)

GABLS *first model inter-comparison case*

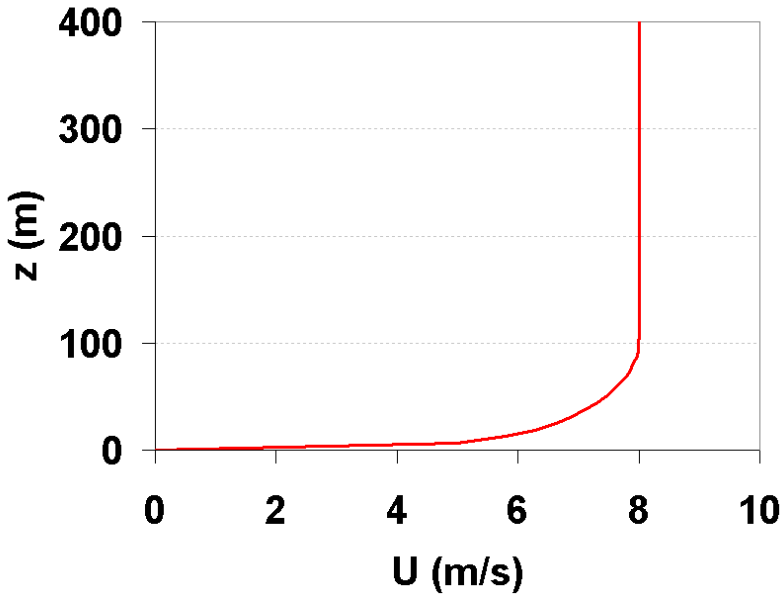
Simple shear driven case for a stable boundary layer over ice

(after Kosovic and Curry, 2000)

Initial temperature profile GABLS case study



Initial wind profile GABLS case study



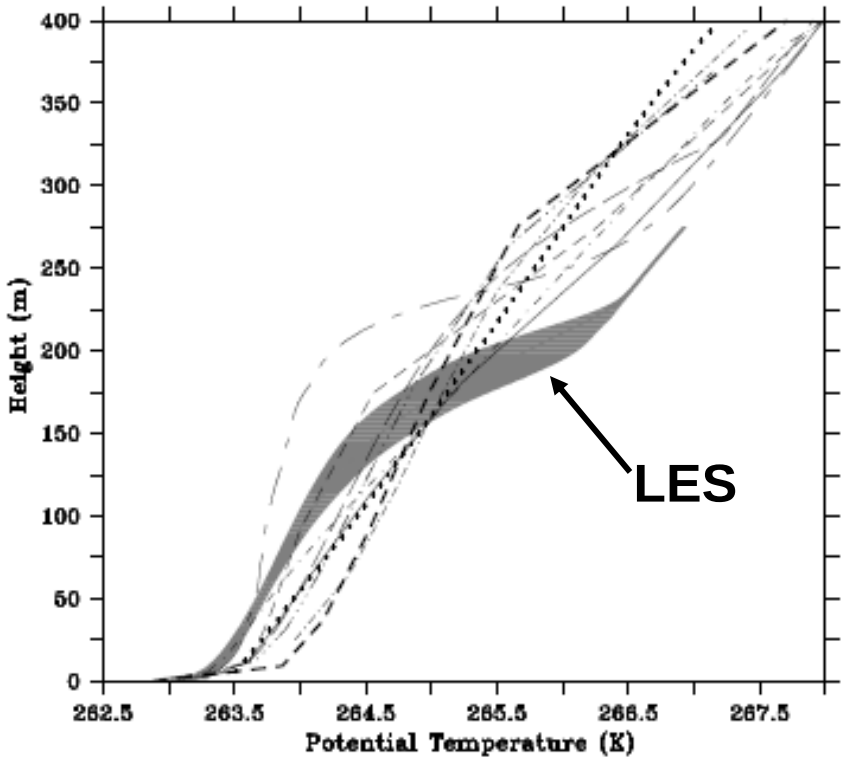
Prescribed surface cooling 0.25 K/h for 9 hours to quasi- equilibrium; no surface and radiation scheme

Geostrophic wind 8 m/s, latitude 73N

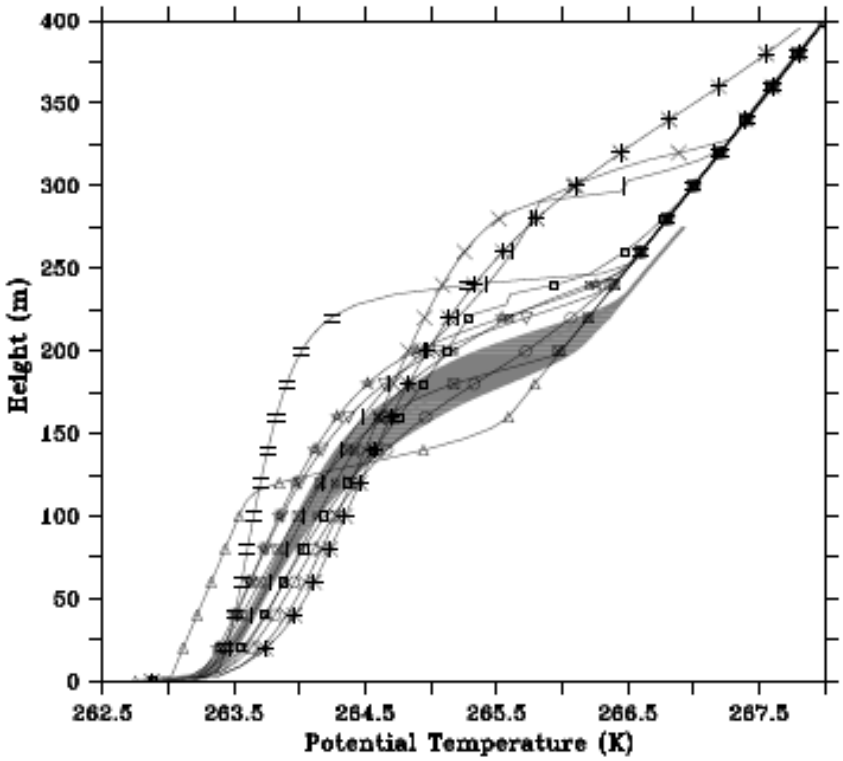
Participating models

Model	Use	Type	Ref
ECMWF	operational	1st order	Beljaars and Viterbo, 1998
ECMWF-MO	operational-test	1st order	
NOAA-NCEP	operational	1st order	Hong and Pan, 1996
MeteoFrance	operational	1st order	Louis et al., 1982
JMA	operational	1st order	Mellor and Yamada, 1974
Met Office	operational	1st order	Louis, 1979
Met Office res	research	1st order	Williams, 2002
Wageningen U	research	1st order	Duynkerke, 1991
Sandia Labs	research	ODT	Kerstein et al., 2001
MSC	operational	$e-l$	Belair et al., 1999
KNMI-RACMO	operational	$e-l$	Lenderink and Holtslag, 2004
UIB-UPC	research mesoscale model	$e-l$	Cuxart et al., 2000
NASA	research mesoscale model	$e-l$	Xue et al, 2000
WVU	research	$e-l$	Sykes and Henn, 1989
York U.	research	$e-l$	Weng and Taylor, 2003
Louvain U-L	research	$e-l$	Therry and Lacarrère, 1983
Louvain U-eps	research	$e-\epsilon$	Duynkerke, 1988
Swedish MS	research	$e-\epsilon$	
Stockholm U	research	$e-l$	Andren, 1990
Stock.U-sim	research	$e-\theta^2$	Mauritsen et al., 2004

Potential temperature



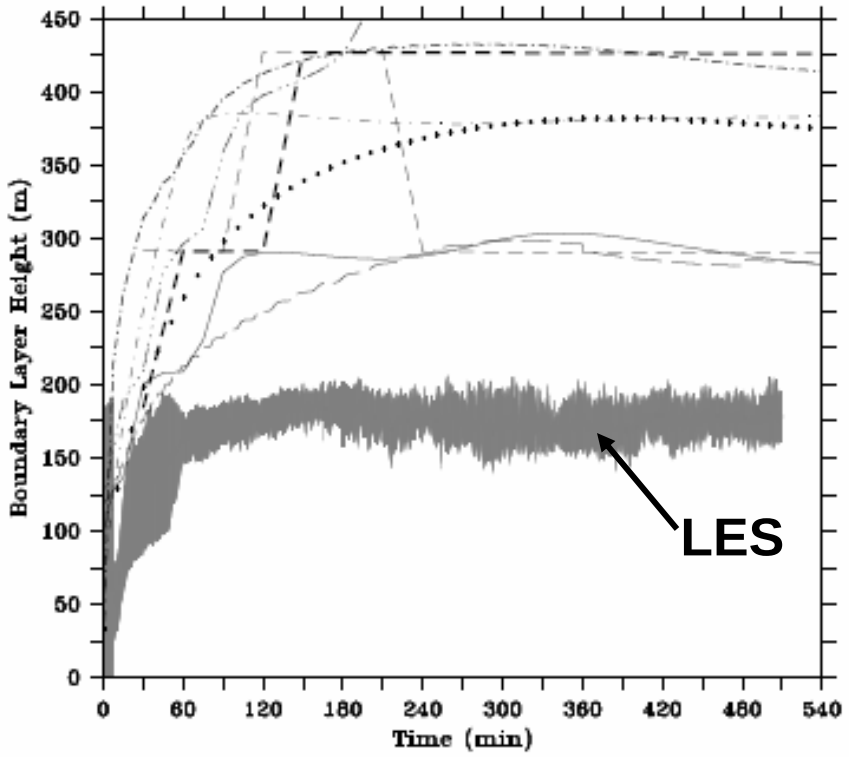
Operational



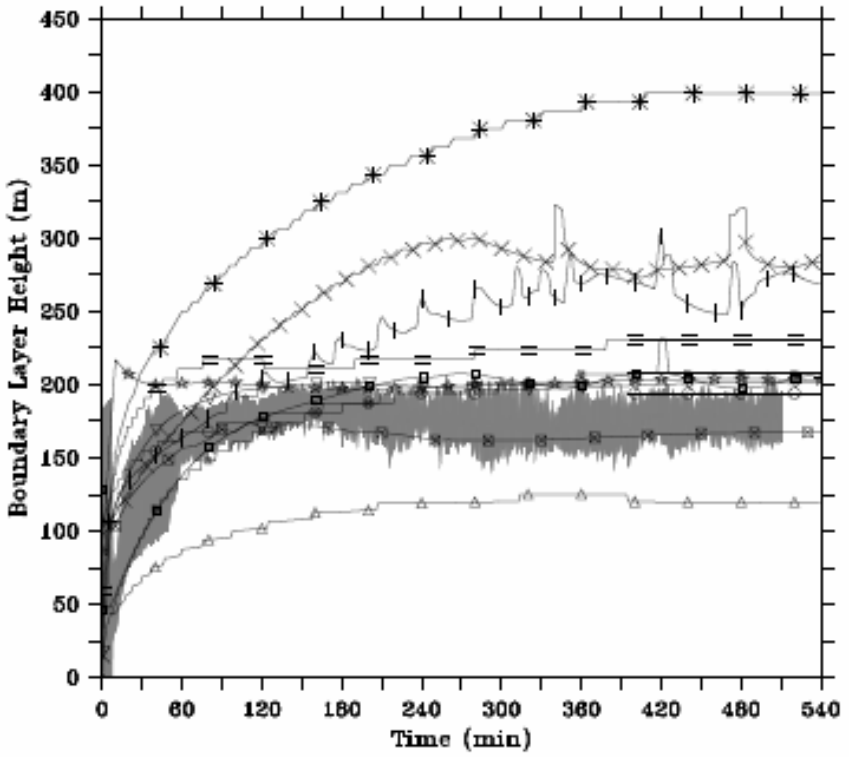
Research

Comparison of Single-Column Models with Large Eddy Simulations (LES)
(Beare et al, 2006; Cuxart et al, 2006)

Boundary-Layer Height



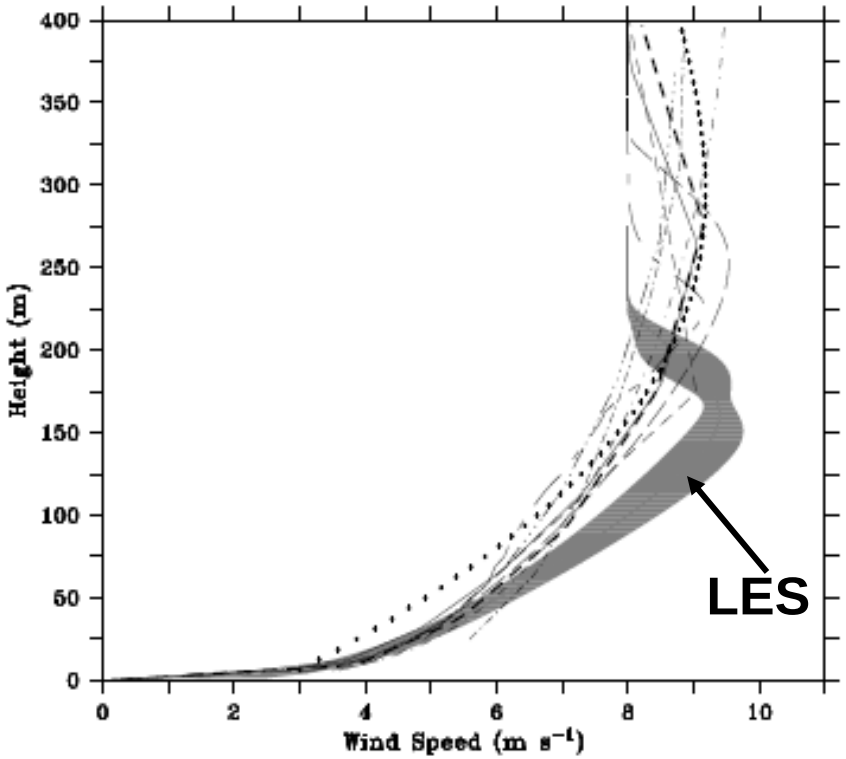
Operational



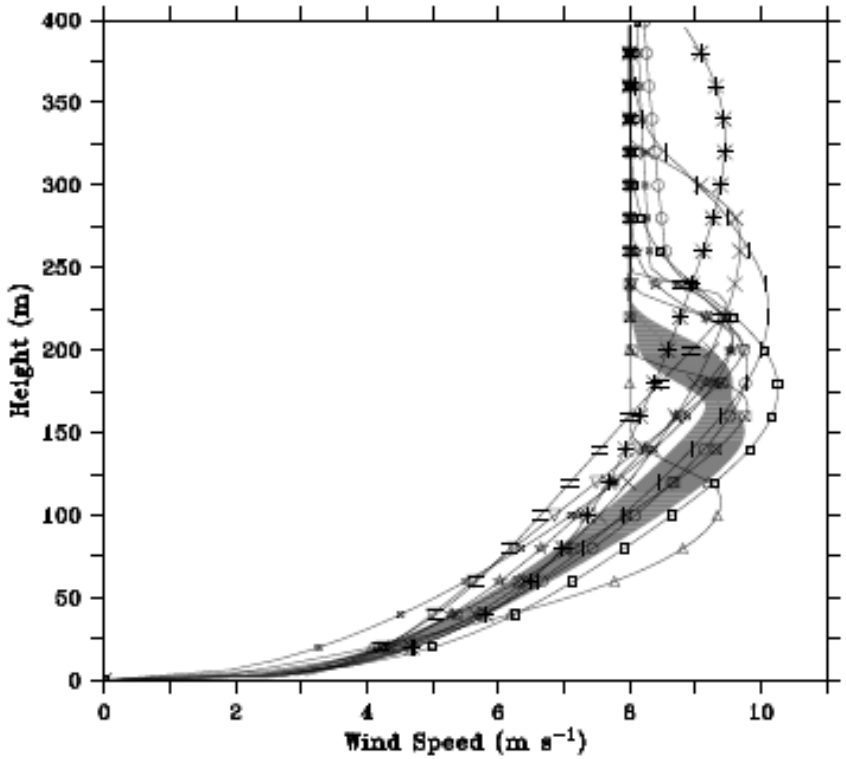
Research

Resolution (most) operational models is set to 6.25 m!

Wind speed

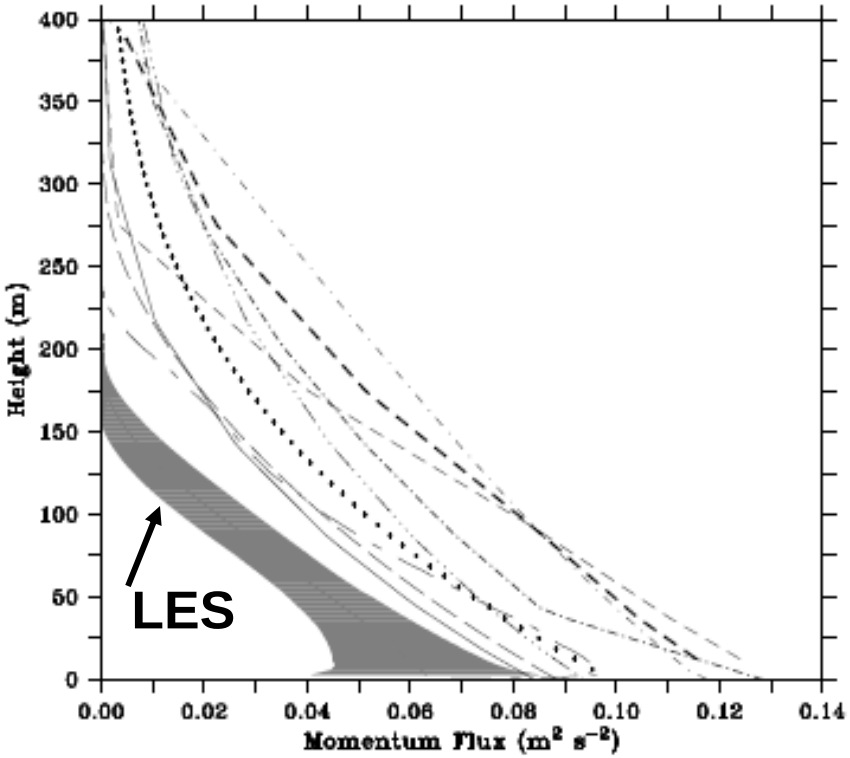


Operational

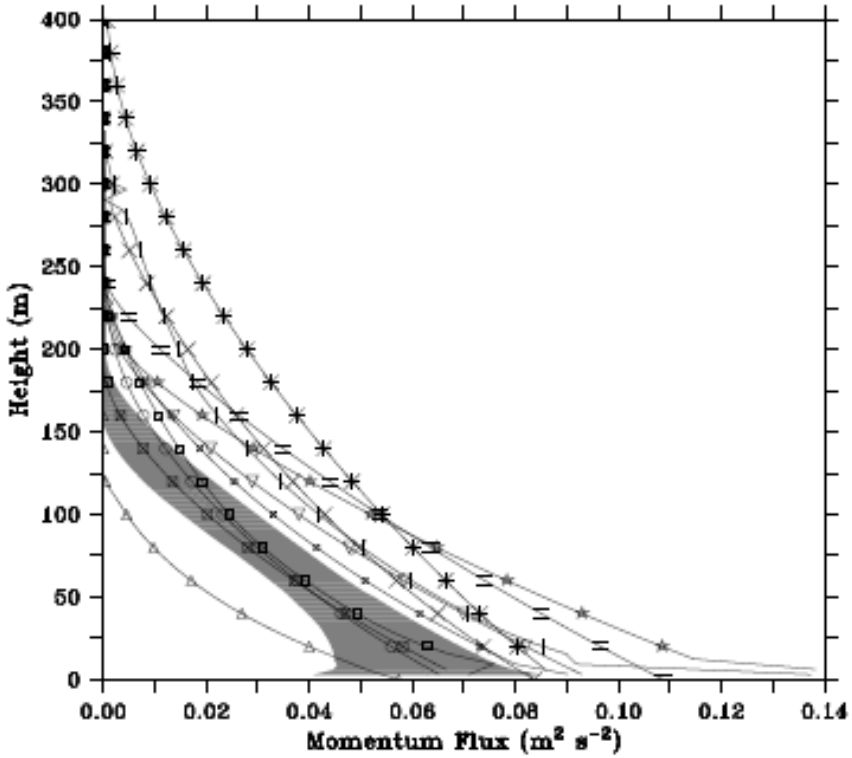


Research

Momentum flux

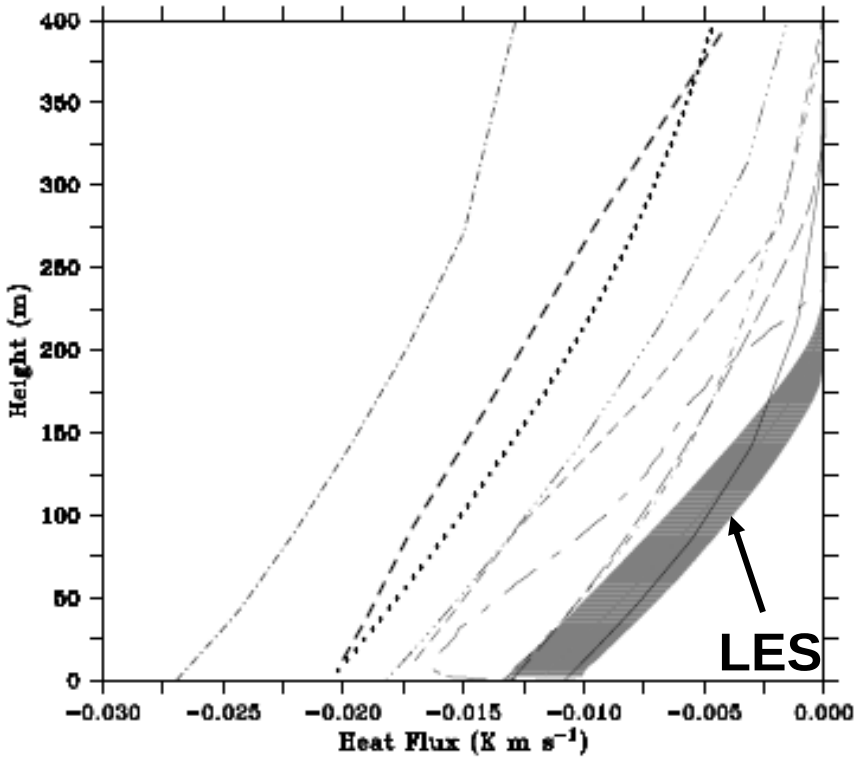


Operational

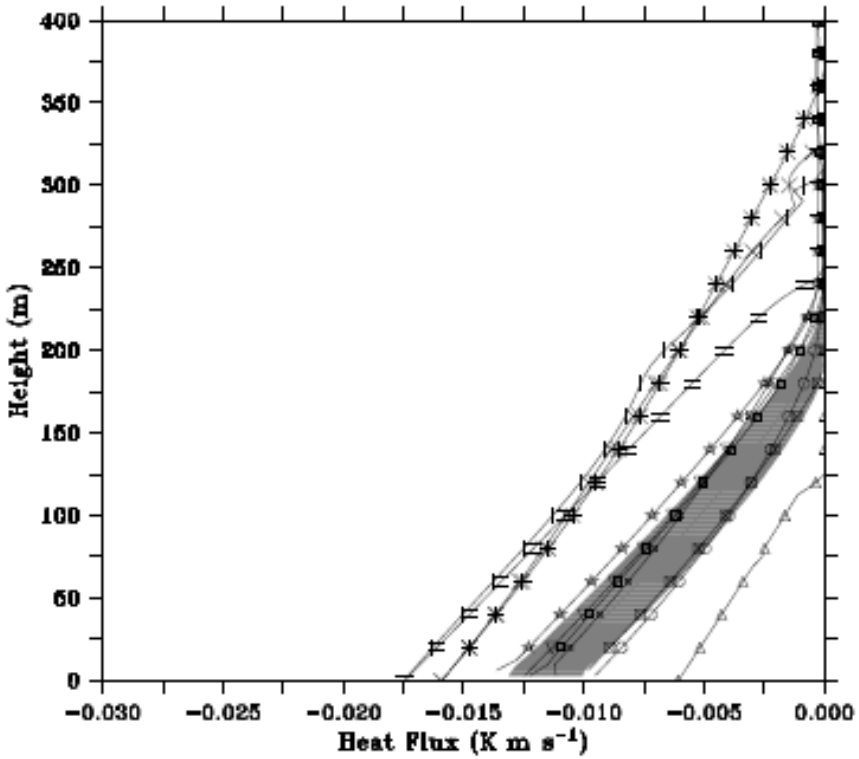


Research

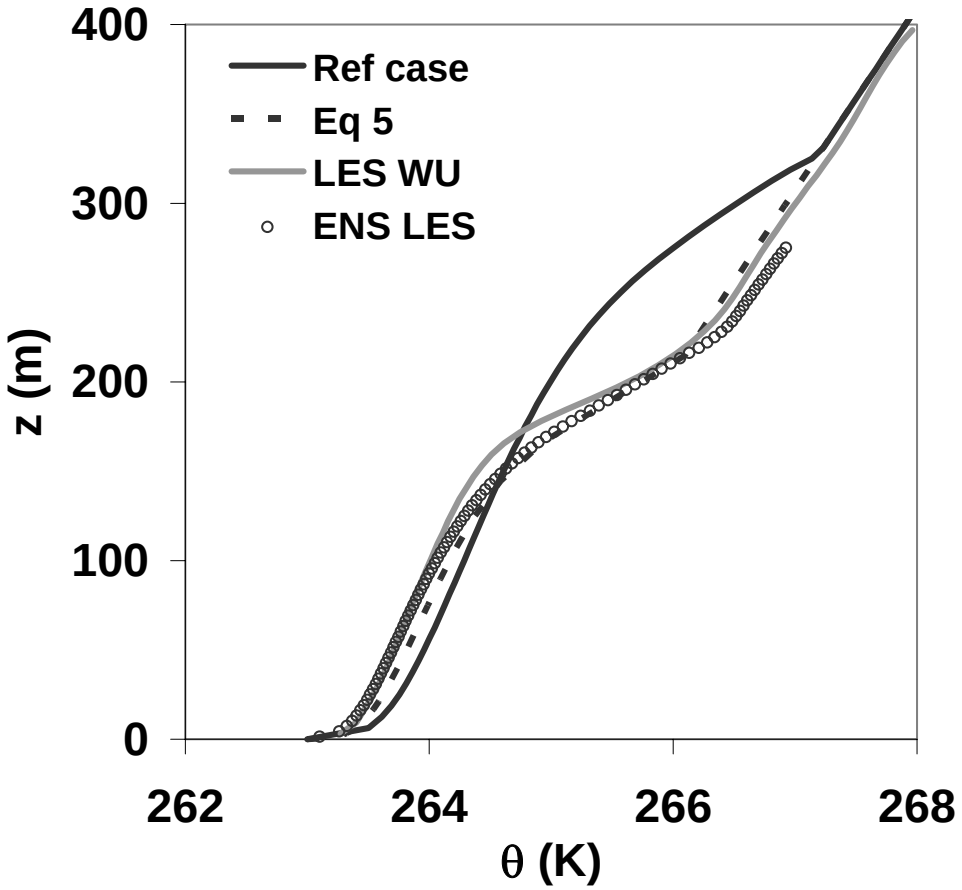
Heat flux



Operational



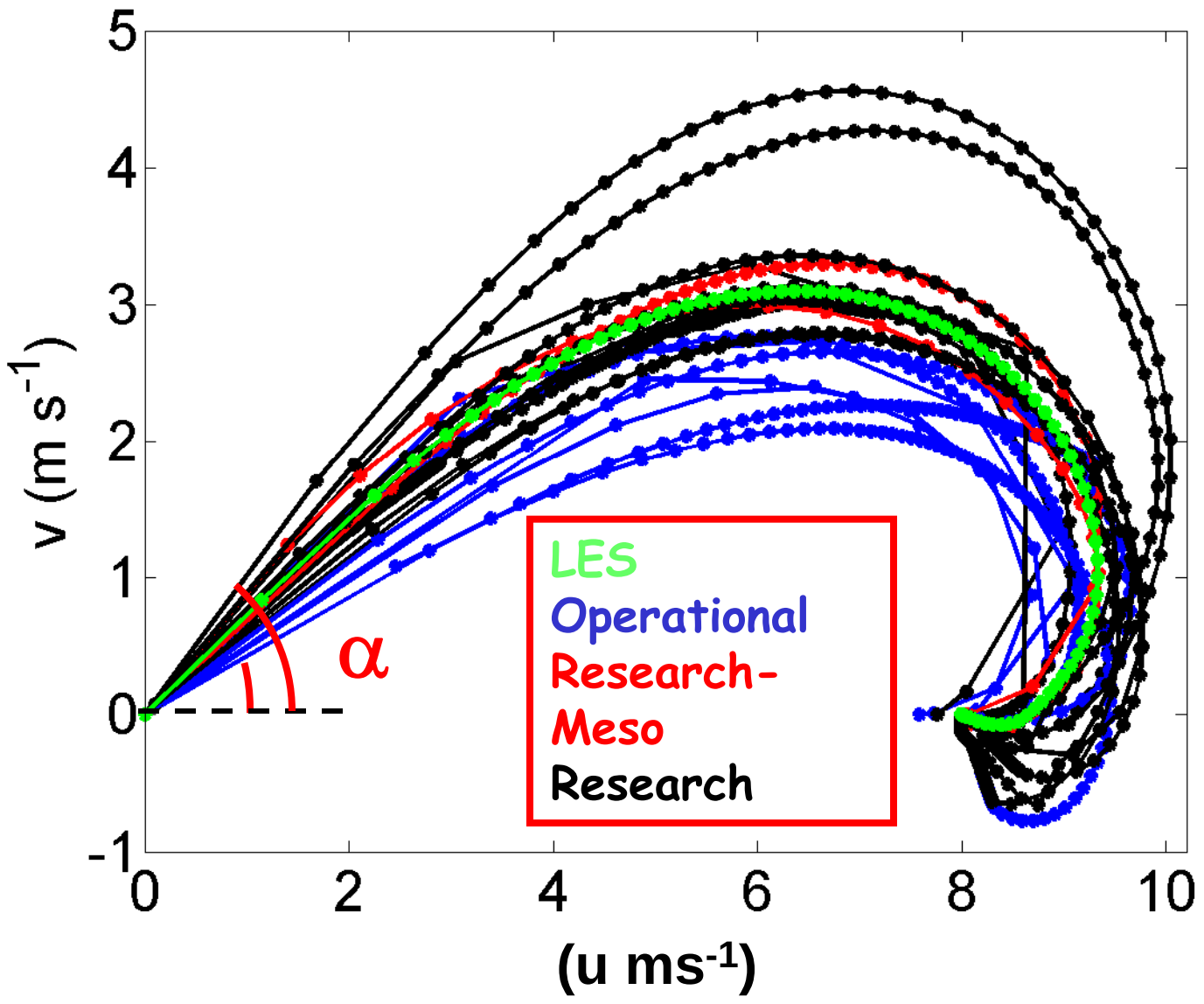
Research



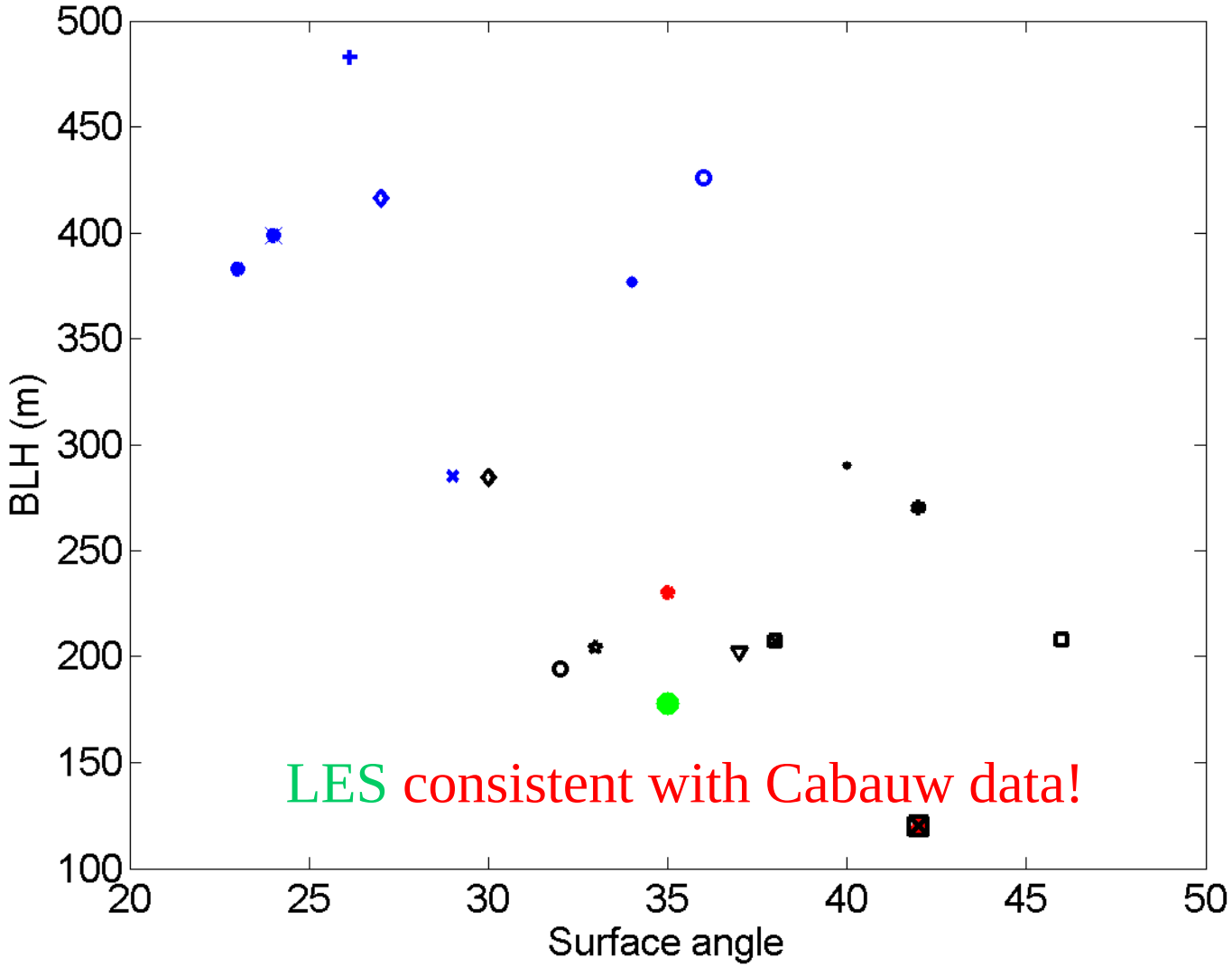
Note:
Models can represent main LES results after adjusting parameters in turbulence scheme

Steeneveld, Van de Wiel, Holtslag, 2006 (BLM)

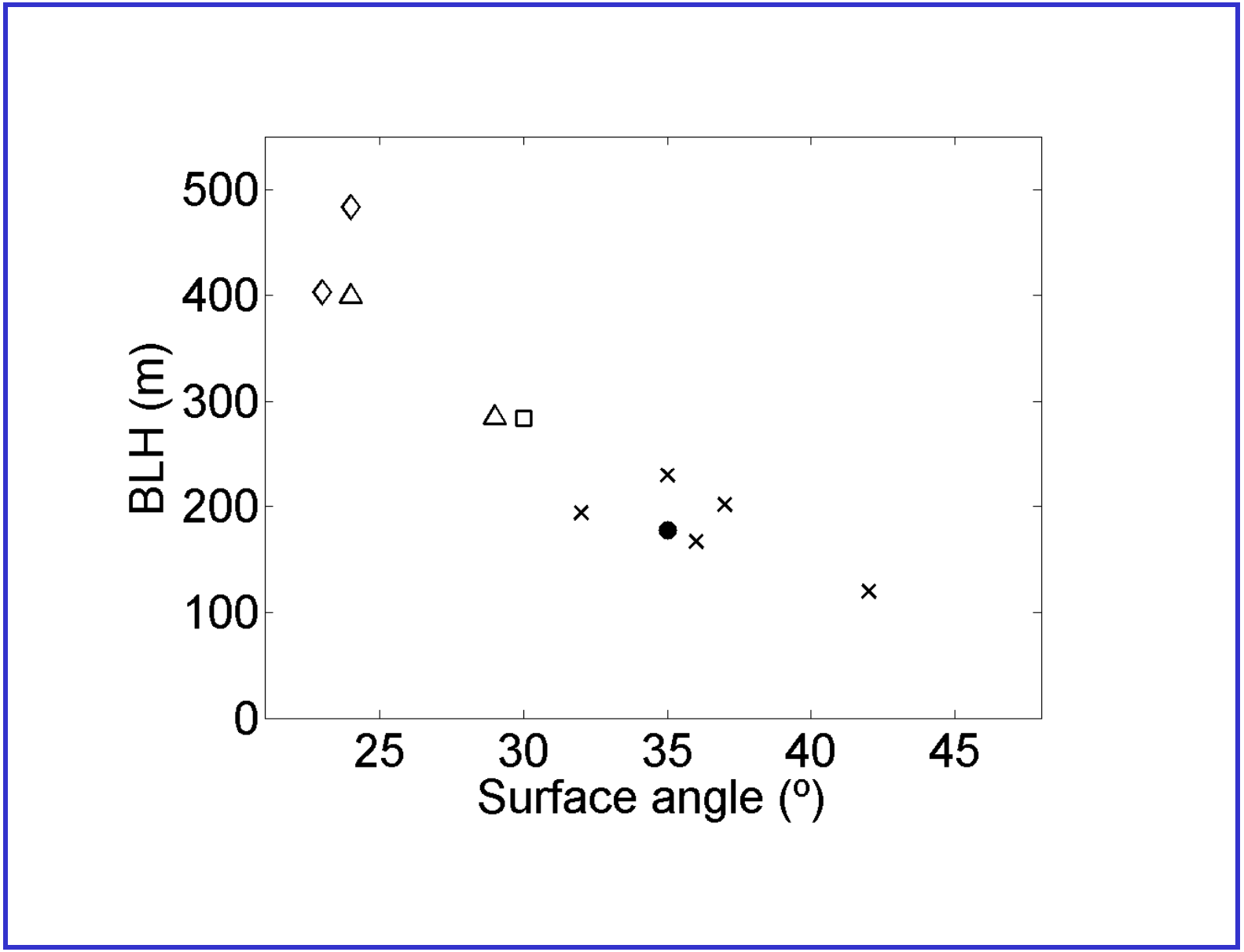
'Ekman spirals' (Svensson+Holtslag, 2006)



Boundary-layer height and surface angle



Models with surface problems removed



Summary

First GABLS model intercomparison on stable boundary layers

Large variation among 1D models,
but all operational models show too strong mixing!

Results of LES models in good agreement with observations in relatively homogeneous cases

Eight papers in special GABLS issue of Boundary Layer Meteorology, Feb. 2006

Why do Operational Models need Enhanced Mixing in Stable Cases?

To prevent unrealistic ‘runaway’ surface cooling

To have sufficient ‘Ekman pumping’

To compensate for model errors?

Do we overlook an atmospheric process?

What is relation with surface heterogeneity?

Second GABLS model intercomparison experiment on diurnal cycle over land

Coordinated by

Gunilla Svensson

Department of meteorology,

Stockholm university

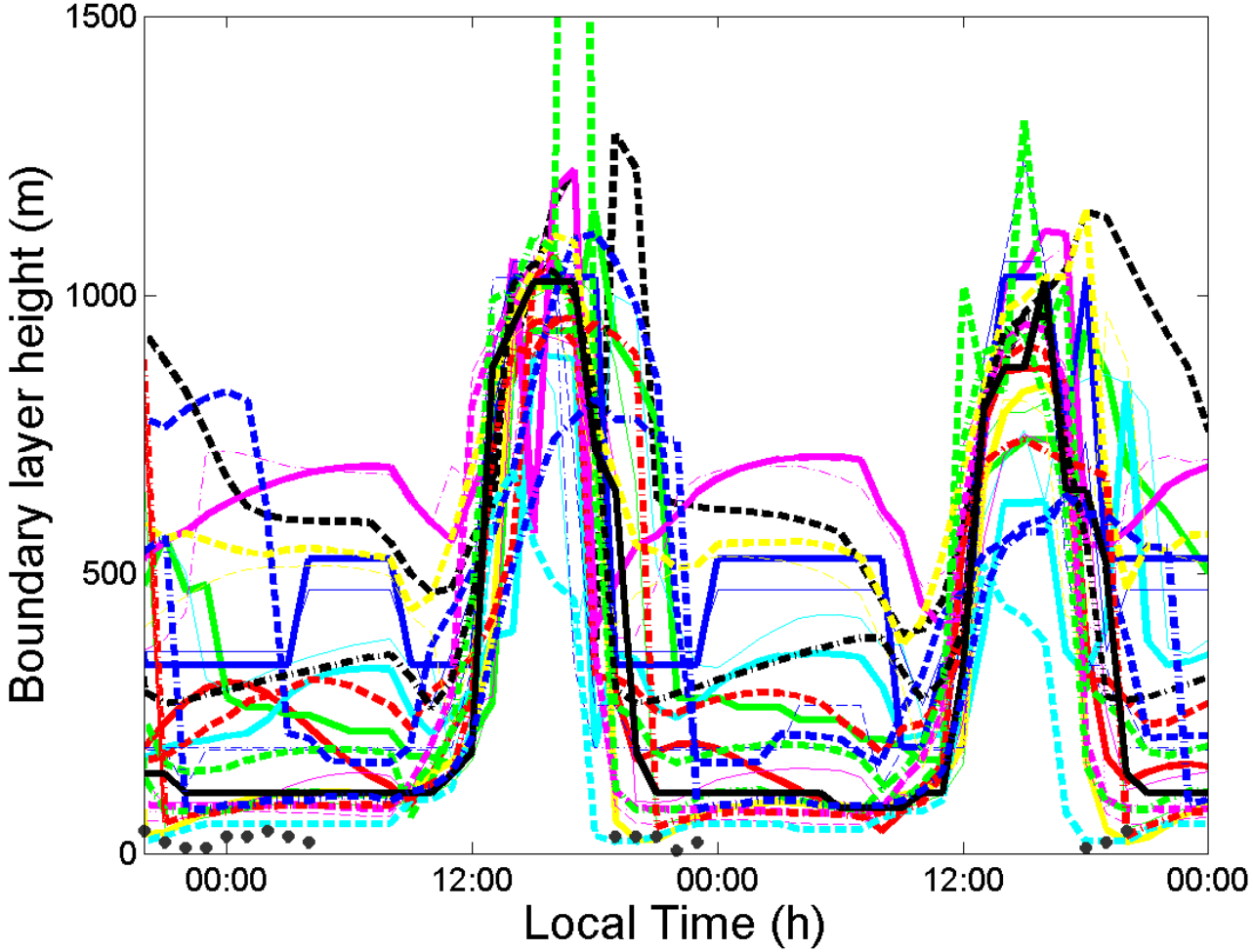
(after preparation and analysis of CASES99-observations by

Steeneveld, Van de Wiel, Holtslag, 2006, JAS)

WAGENINGEN UNIVERSITY

METEOROLOGY AND AIR QUALITY

Boundary-layer Art



Preliminary Results!

Activities
Second GABLS model intercomparison

Further analysis and intercomparison of the 1D models with observations of CASES99 (2.5 days)

Also comparison of this case with Large Eddy Simulations in progress

Comparison of Mesoscale models

Impact on mixing of scalars?

Exploring observations at Cabauw (KNMI) and Lindenberg (DWD)

Courtesy Fred Bosveld, Frank Beyrich and Colleagues