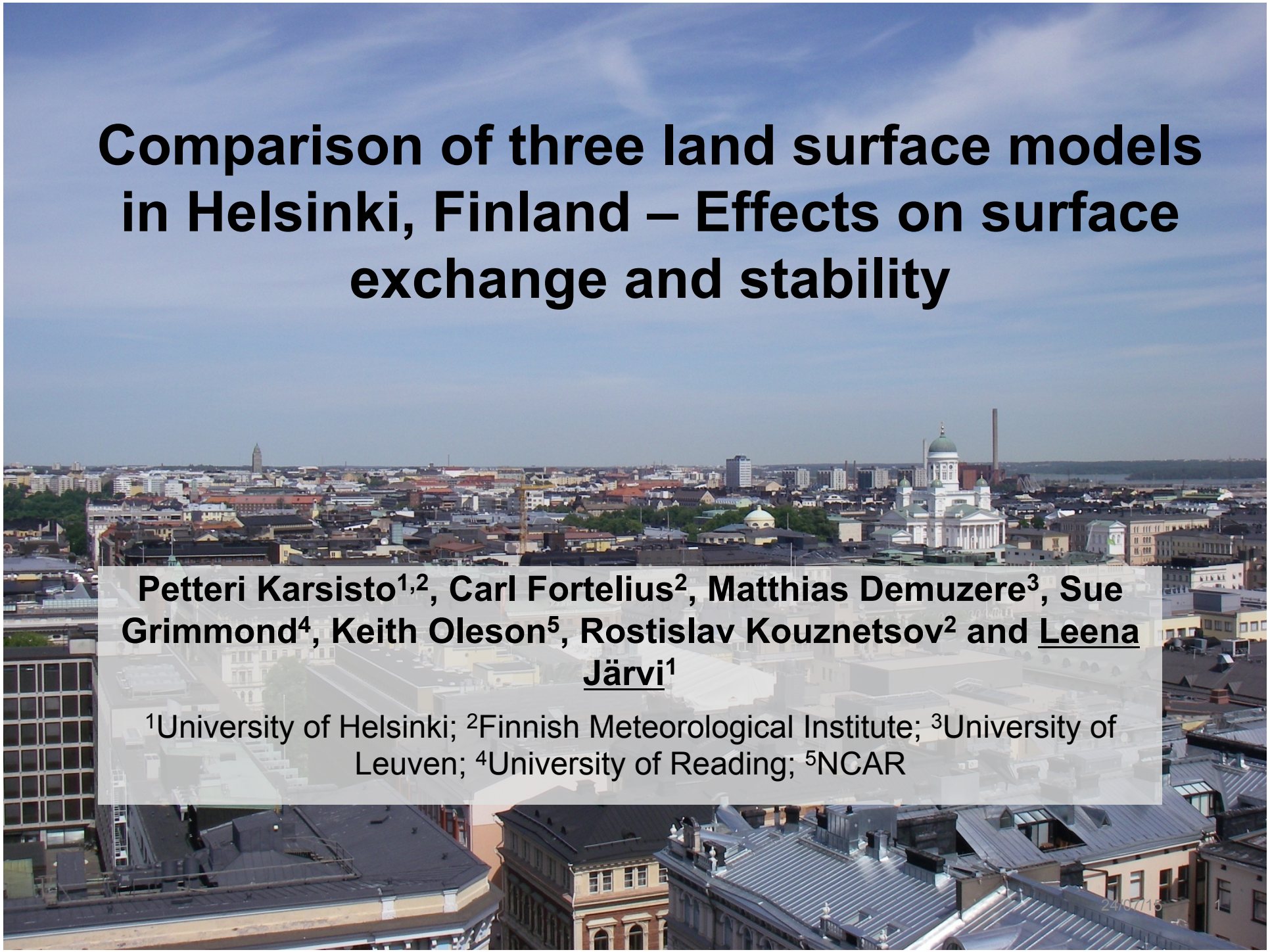
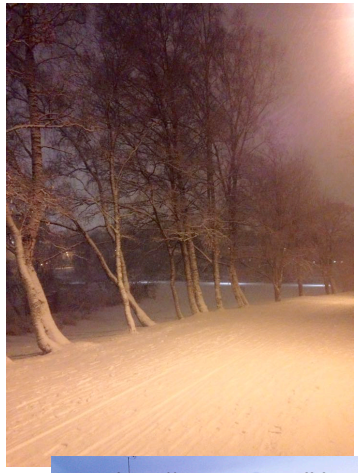


Comparison of three land surface models in Helsinki, Finland – Effects on surface exchange and stability

Petteri Karsisto[1,2], Carl Fortelius[2], Matthias Demuzere[3], Sue Grimmond[4], Keith Oleson[5], Rostislav Kouznetsov[2] and Leena Järvi[1]

[1]University of Helsinki; [2]Finnish Meteorological Institute; [3]University of Leuven; [4]University of Reading; [5]NCAR

Outline

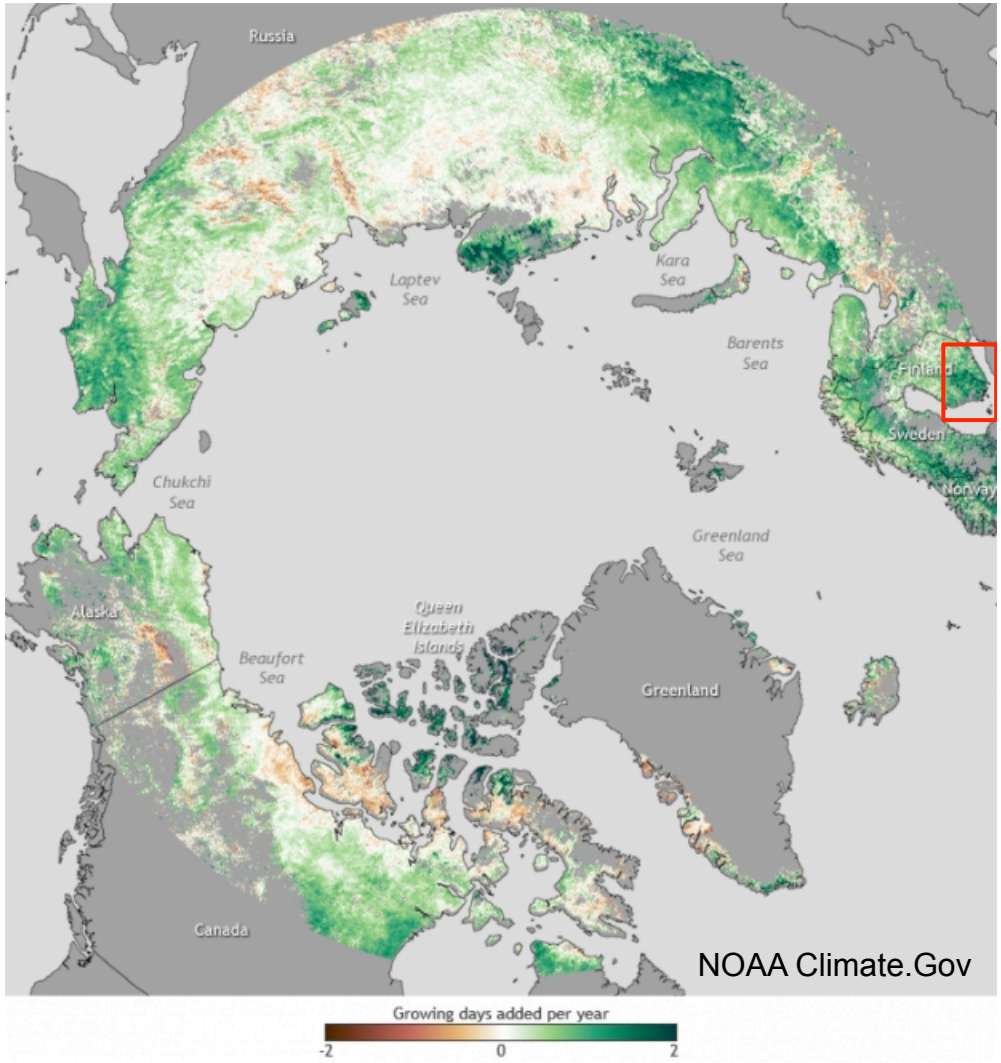


- Motivation
- Used models and study sites
- What are we going to learn?
  - For *Q**, description of snow cover and its fraction important
  - Dense city center more problematic to simulate than suburban area
  - Revision on high-latitude thermal and radiative parameters needed
  - Irrigation important only at the suburban area

Motivation –
Why high-latitude cities?

Most dramatic climate change expected at high-latitudes

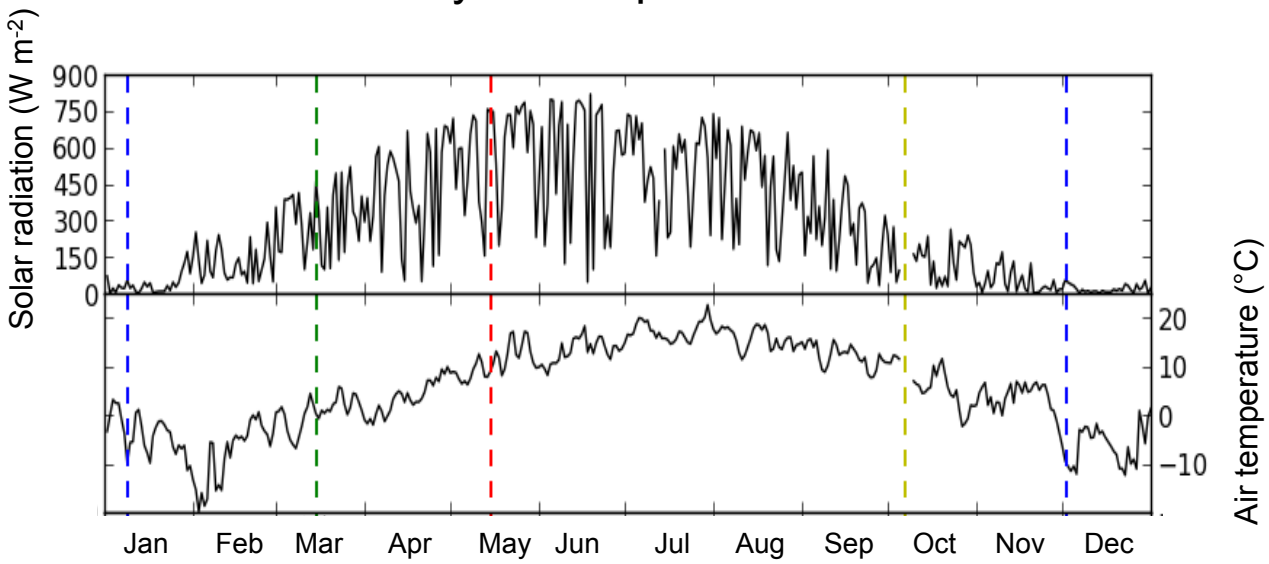
Tools needed to examine and predict the atmosphere in these areas



Motivation - Large **seasonal variation** in **radiation** and **temperature** and **snow** a common sight

Thermal seasons marked with dashed lines: winter, spring, summer and fall

Daily daytime (10:00 – 14:00) solar radiation and daily air temperature in 2012



Comparison of three urban land surface schemes with default parameterizations

Simulation:

- July 2011 – Dec 2012
- 2012 used in evaluation
- 60-min time step
- Same forcing + surface cover characteristics (Lidar, Nordbo et al. 2015)

	CLM	SURFEX	SUEWS
Version	4.0	7.2	2014b
Urban tile	CLM-URB	TEB	Integrated
Q_H	Resistance	Resistance	Energy balance residual
Q_E	Resistance	Resistance	Penman-Monteith
ΔQ_S	EB residual	EB residual	OHM
Q_F	Building heating	Building heating, traffic, industry	Building heating & cooling, traffic
$T_{min,build}$	19.0°C	19.0°C	18.2°C*
Surface parameters	Jackson et al. (2000)	ECOCLIMAP (Masson et al.2003)	Own parameters, Järvi et al. (2014)

OHM = objective hysteresis model

$T_{min,build}$ = internal minimum building temperature (*outdoor)

Two simulated areas with comparisons to eddy covariance measurements of Q_H and Q_E

Kumpula
- Metek + LI7000
- z_m = 31 m
- Meteorological forcing, Q^*
- z_h = 11 m
- Over 50% of vegetation
- LCZ 6

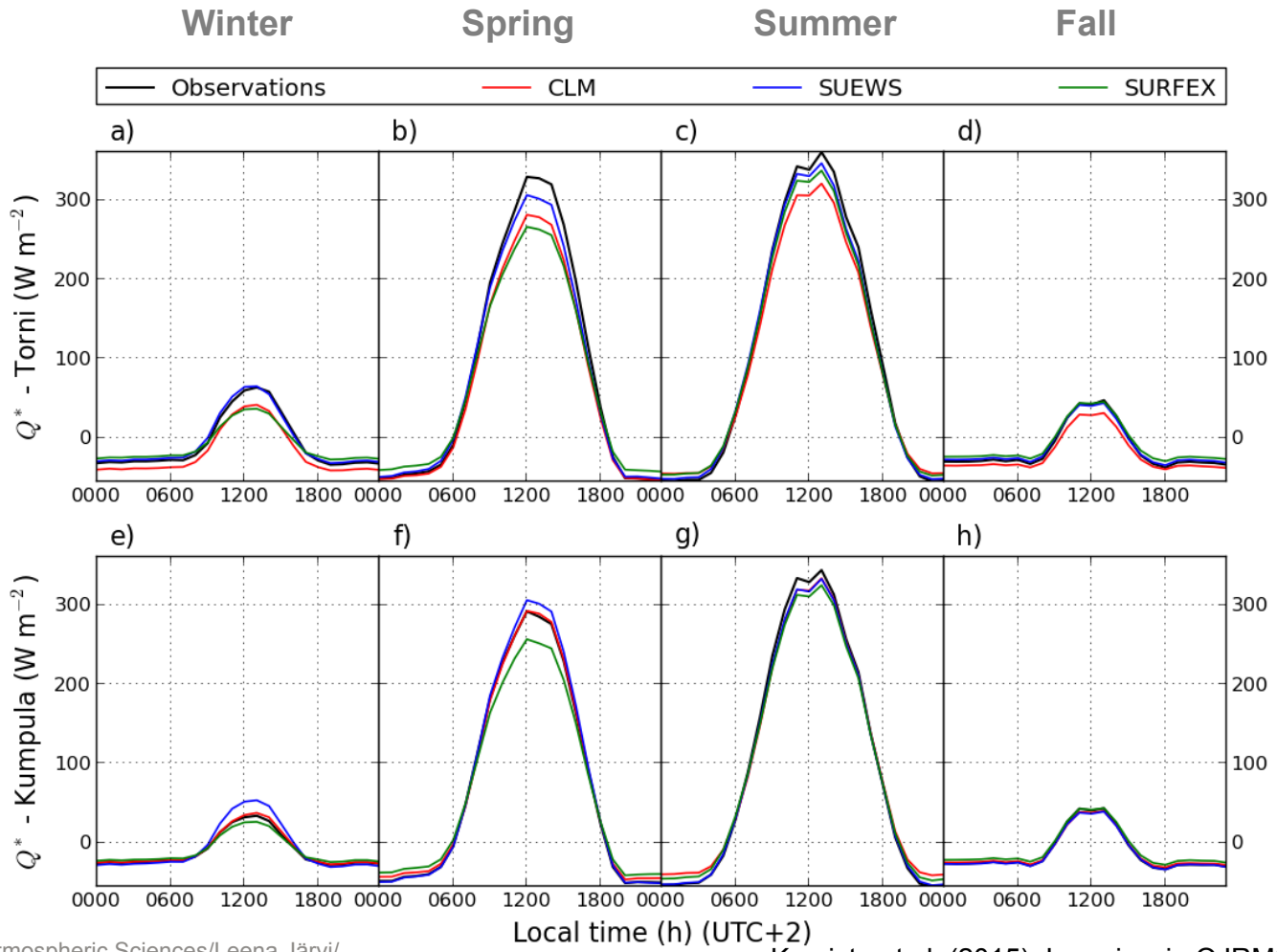
Hotel Torni
- Metek + LI7200
- z_m = 60 m
- T_{air}, Q^*
- z_h = 11 m
- 22% of vegetation
- LCZ 2

Nordbo et al. (2013), BL Met

Diurnal behavior of **net all-wave radiation** by season and site

RMSE: 5 - 44 W m^{-2}
r > 0.97

Spring problematic and affected by
- Snow fraction (depends on snow depth)
- Change in LAI

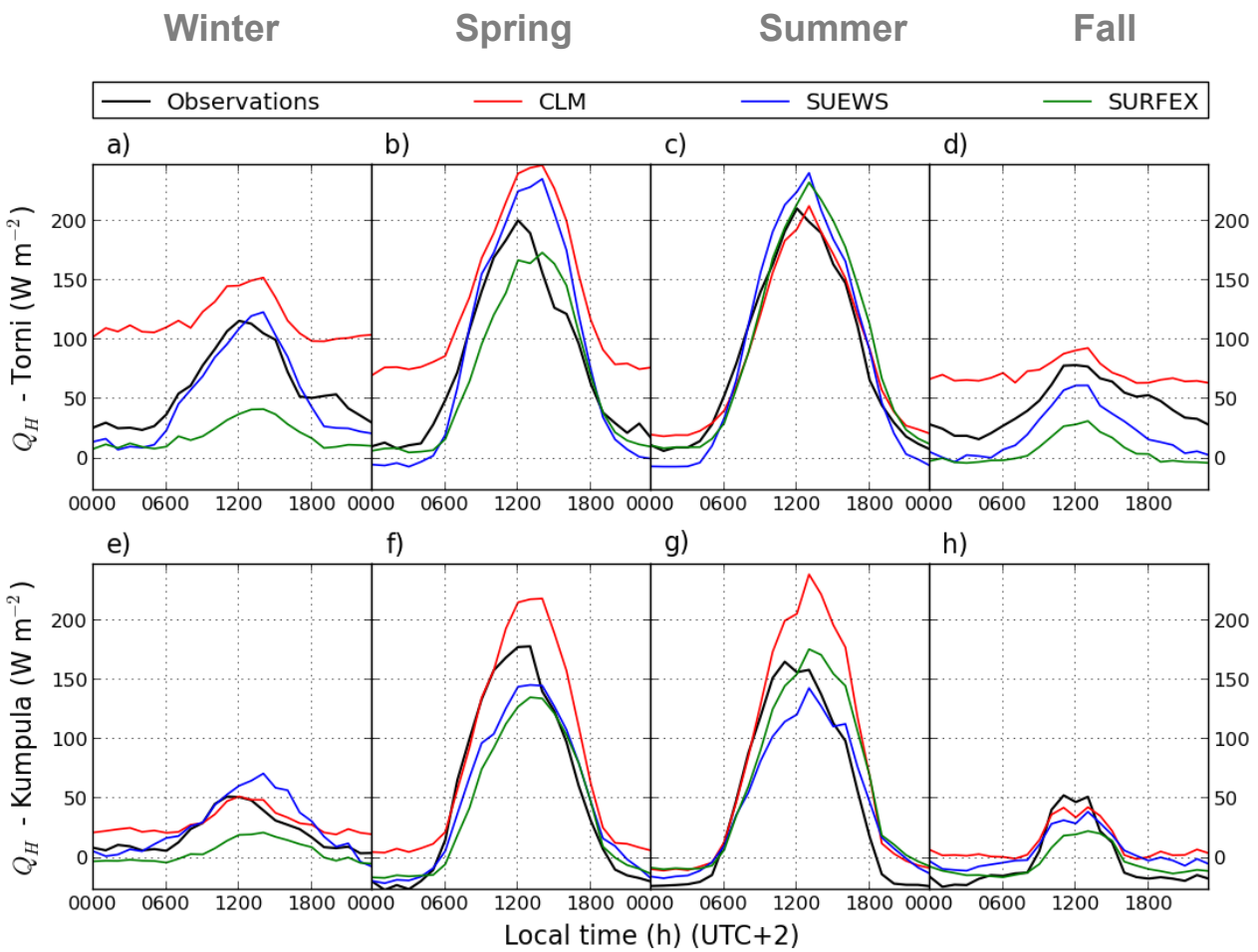


Karsisto et al. (2015), In review in QJRMS

Diurnal behavior of **sensible heat flux** by season and site

Spatial difference between the sites (half at Kumpula in winter)

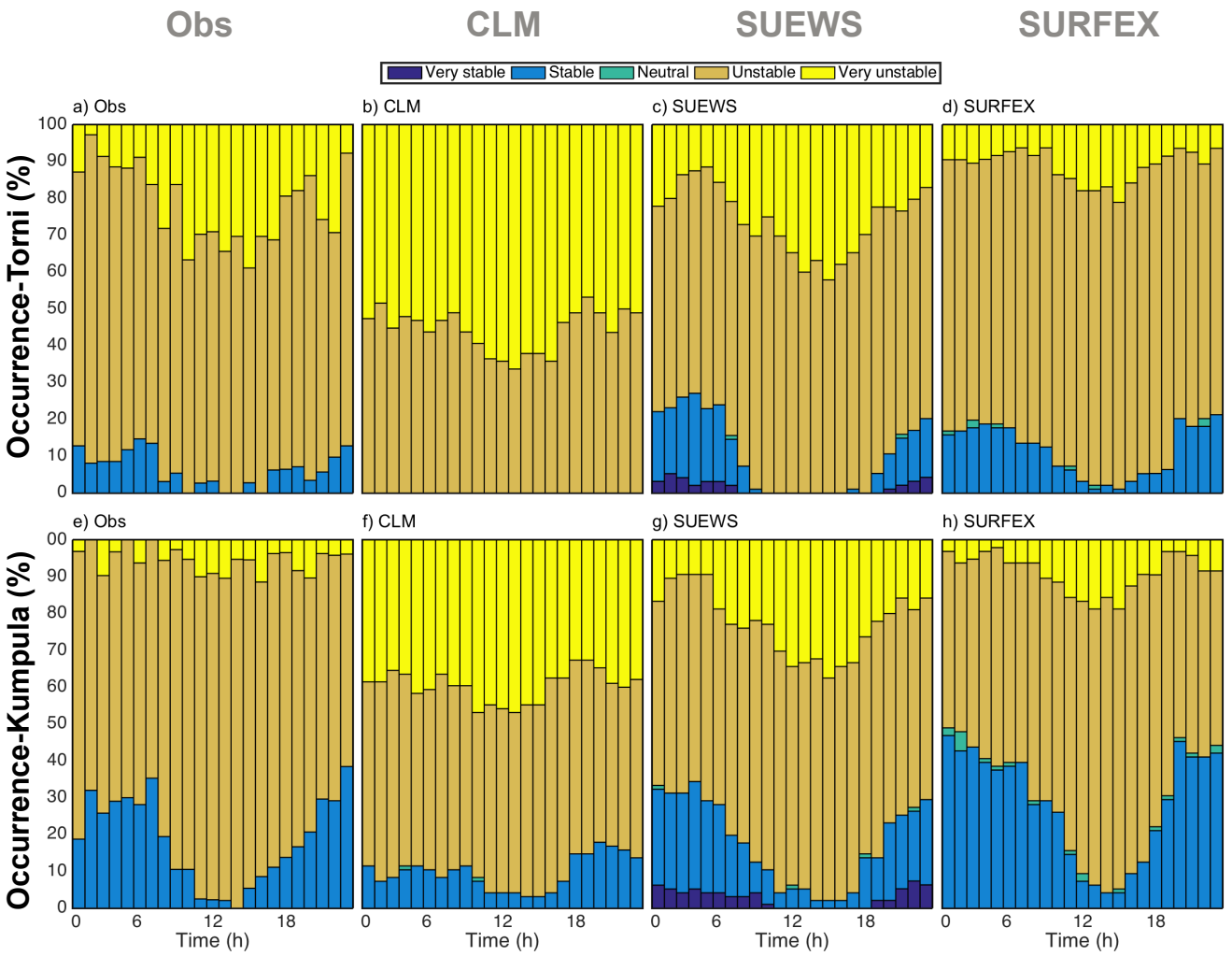
CLM overestimation at Torni in cold periods caused by thermal and radiative parameters



Karsisto et al. (2015), In review in QJRMS

Most of the time **models** give correct behavior of **winter** time **near-surface stability**

Stability = 1/*L*

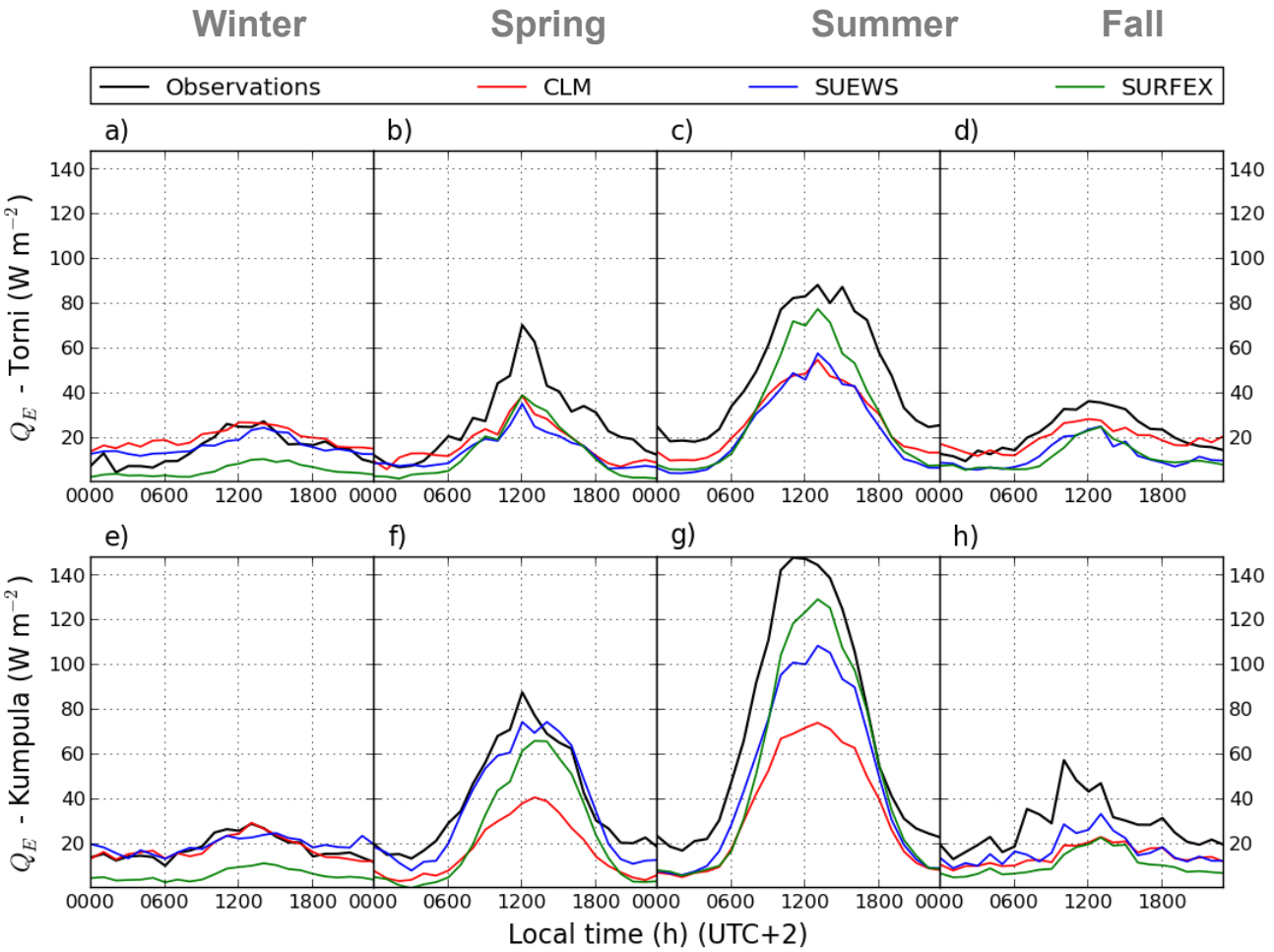


Karsisto et al. (2014),
In review in QJRMS

Diurnal behavior of **latent heat flux** by season and site

Underestimation of Q_E in spring and summer

SUEWS only model with default irrigation. If switched off:
Kumpula: RMSE 47 ➔ 58 W m^{-2}
Torni: RMSE 49 ➔ 38 W m^{-2}



Karsisto et al. (2015), In review in QJRMS

Conclusions

- Three urban land surface schemes were compared against EC measurements of turbulent fluxes in Helsinki
- Two study sites representative for dense urban center and suburban area
- Dense urban center more problematic to simulate
- Snow cover fraction important for net all-wave radiation
- CLM high-latitude radiative and thermal parameters (Jackson et al. 2010) need to be updated
- Irrigation important at the less dense site

Thank you!

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