EGU, April 05, 2011, HS 6.1

"Energy and matter exchange in the convective boundary layer above the Tibetan Plateau at Nam Co Lake"

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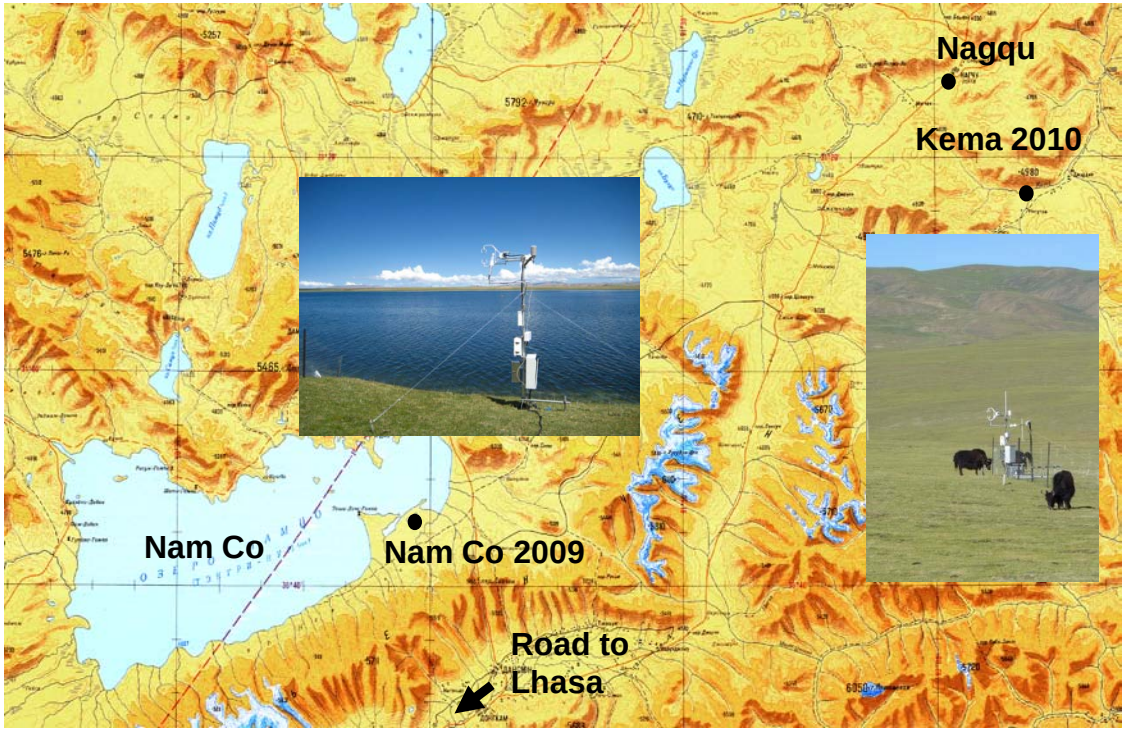
Content

- Flux measurements on Tibetan Plateau
- Validation of lake and land surface models on Tibetan Plateau
- Free Convection from the ground
- Modeling of the generation of convective clouds

Importance of Flux Measurements

- Low amount of data at high altitudes (high potential temperature, convective situations)
- Validation of model outputs
- Forcing parameters for the investigation of convective processes
- Investigation of important questions of the atmosphere – biosphere interaction

Field measurements of the University of Bayreuth in Tibet



Nam Co 2009

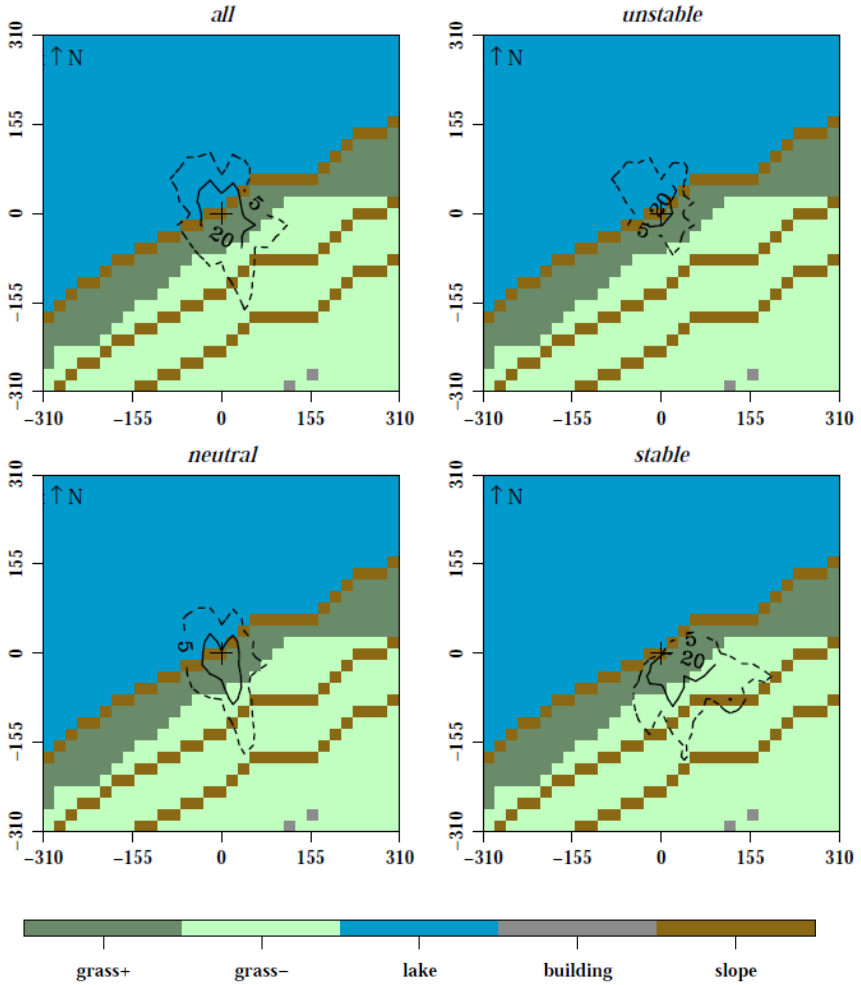
- Turbulent flux measurements at land-lake interface
  - →Investigations into energy balance closure
  - →successful application of land surface and hydrodynamic model
  - → data for upscaling and investigation of mesoscale circulations

Kema 2010

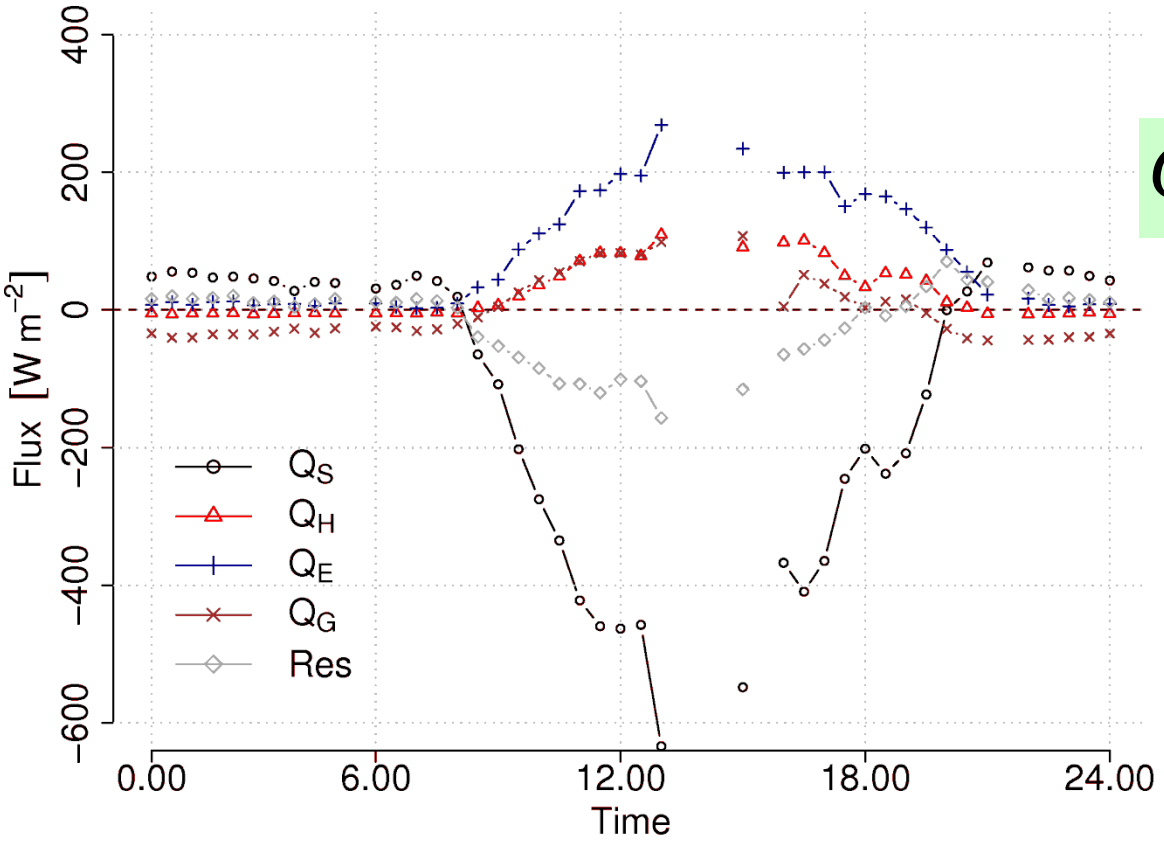
- Joint *Kobresia* ecosystem expedition
- Flux measurements under grazed and ungrazed conditions

Results of the Kema experiment will be shown on the 3rd iLEAPS conference in Sept. 2011, Garmisch-Partenkirchen

Flux measurements and footprints at Nam Co



Daily cycle of energy fluxes – Energy balance closure

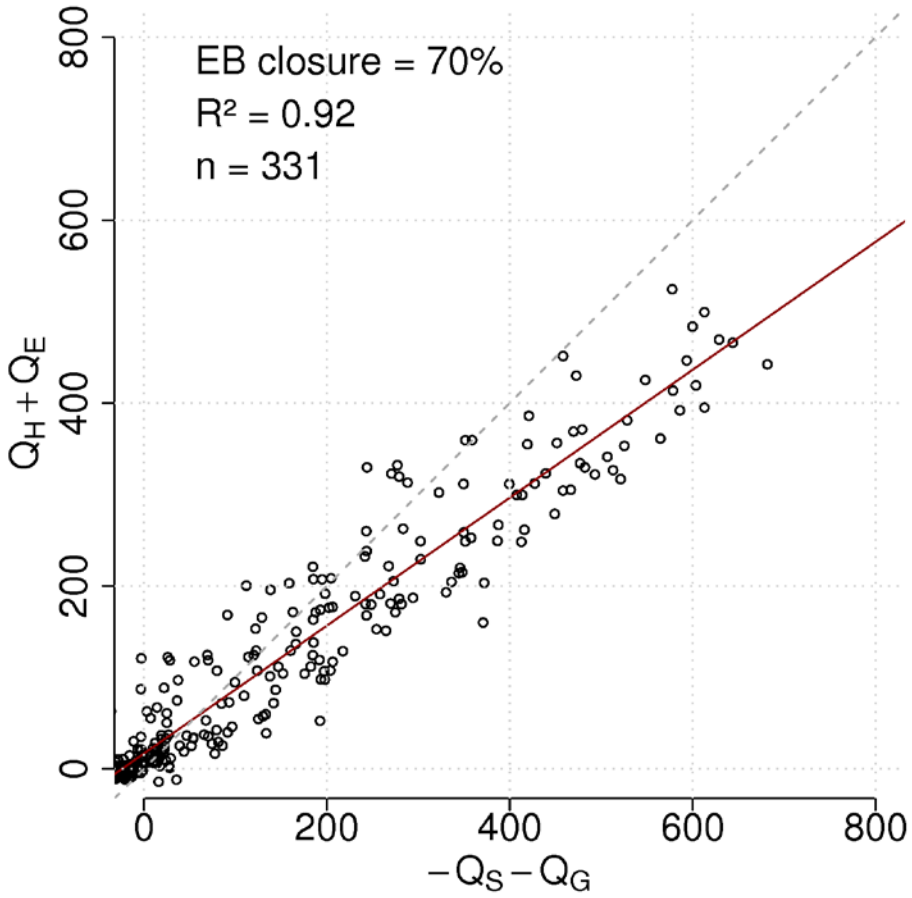


$$Q_s^* \geq Q_G + Q_H + Q_E$$

Nam Co 2009
Fluxes above grass

Foken (2008)

Daily cycle of energy fluxes – Energy balance closure



$$Q_s^* \geq Q_G + Q_H + Q_E$$

Nam Co 2009
Fluxes above grass

Applied models

Lake

- Hydrodynamic multilayer (HM) model by Foken (1986).

- Supplemented with a shallow water correction term by Panin et al. (2006)
→ increased turbulent fluxes

$$Q_{E,H}^{L\ a} = {}^{k}Q_{E,H}^{eO\ c} \cdot \left(1 + \frac{2h}{H}\right)^{e\ a\ n}$$

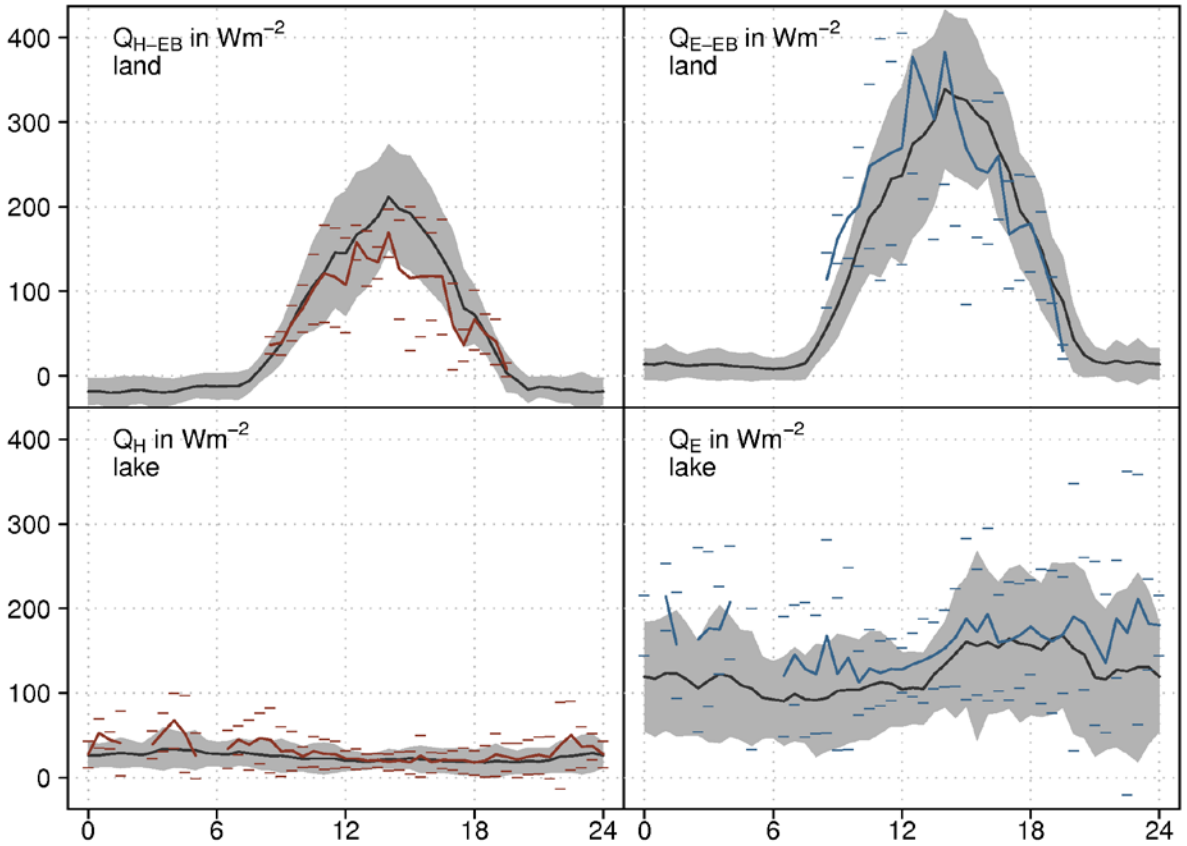
Land

- Surface Energy and Water Balance (SEWAB) by Mengelkamp et al. (1999), energy balance closed.

- Parameter estimation by in situ measurements, laboratory investigation of soil characteristics and literature values

Both models were forced with standard meteorological in-situ measurements.

Avaraged daily cycle of turbulent fluxes, Nam Co, June/July 2009



land

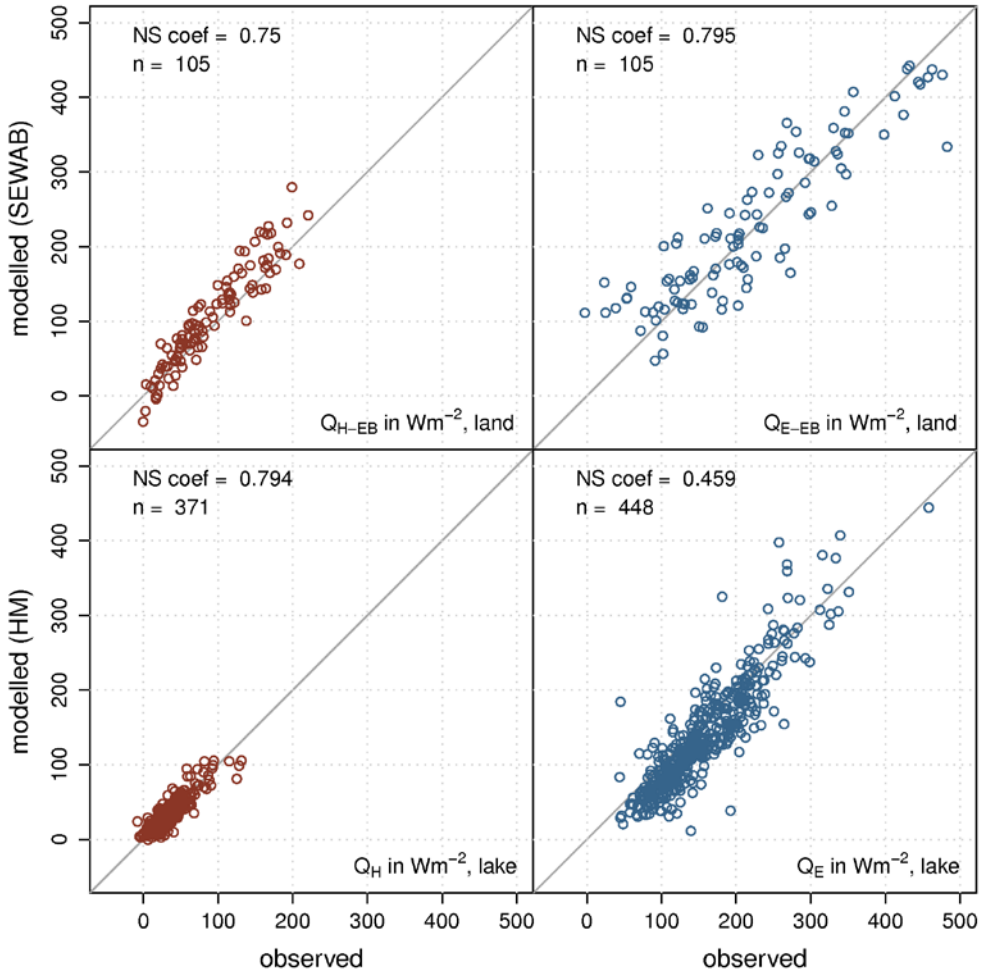
lake

Latent heat flux
Sensible heat flux
Model results

Sensible heat flux

Latent heat flux

Comparison of measured and modeled fluxes



Land
(Observation with EBC according to the Bowen ratio, Twine et al. 2000)

lake

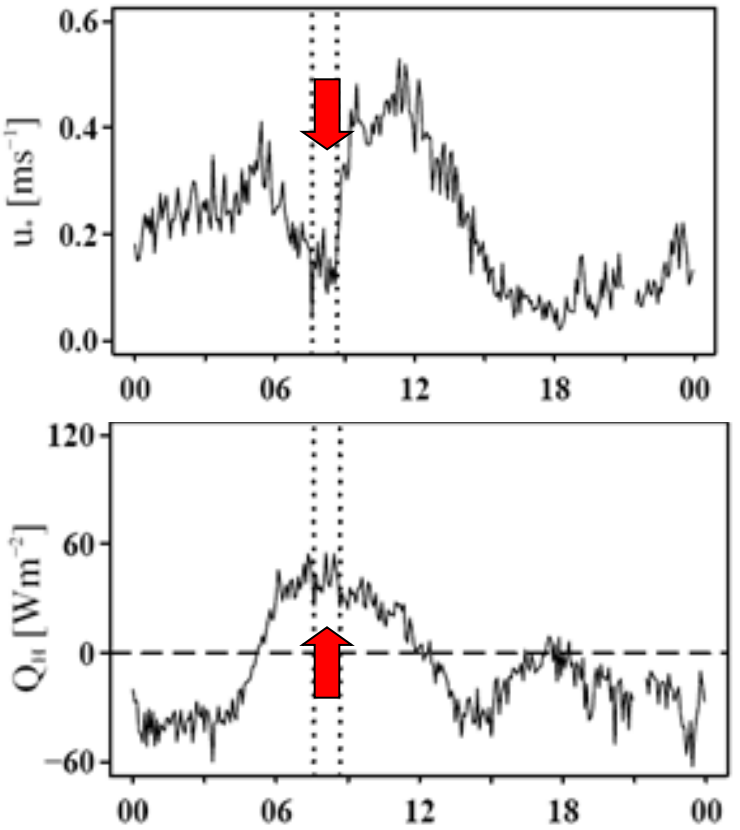
Sensible heat flux

Latent heat flux

Generation of free convection from the ground

- Free convection: buoyancy forces > shear forces ➡ $\zeta < -1$
- Stability parameter: $\zeta = \frac{z}{L} = -\frac{z \cdot \kappa \cdot g \cdot \left(\overline{w'\theta_v'}\right)_0}{\overline{\theta_v} \cdot u_*^3} < -1$
- Requirements:
  - ⬇ u_*

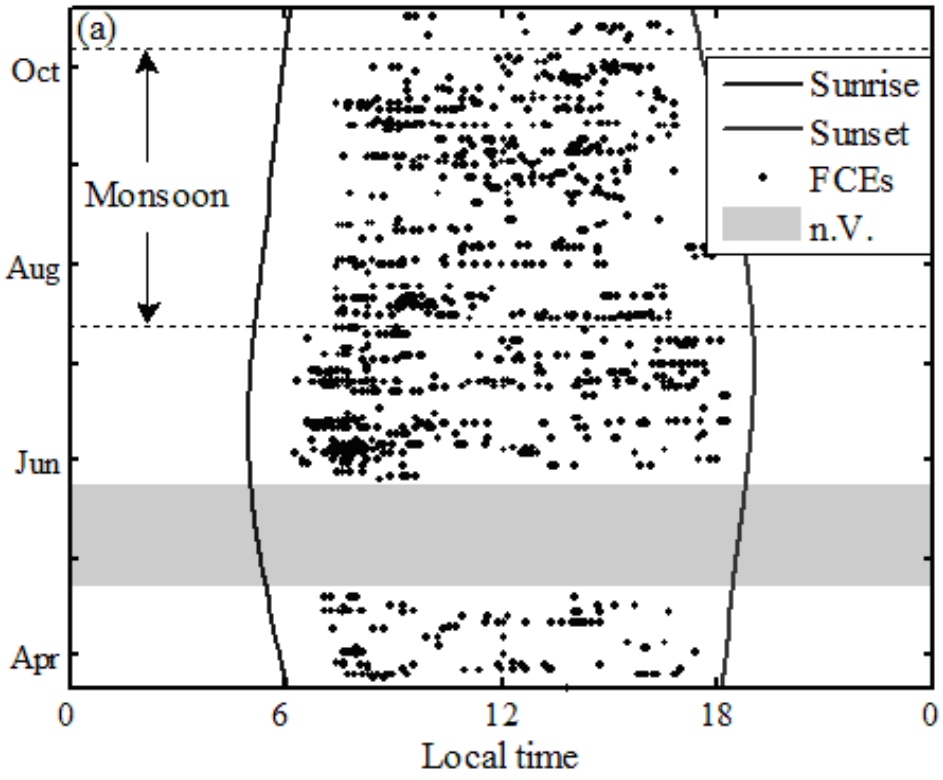
    During wind direction change!
  - ⬆ $\left(\overline{w'\theta_v'}\right)_0$



(Eigenmann et al., 2009)

Free convection near the ground on Tibetan Plateau

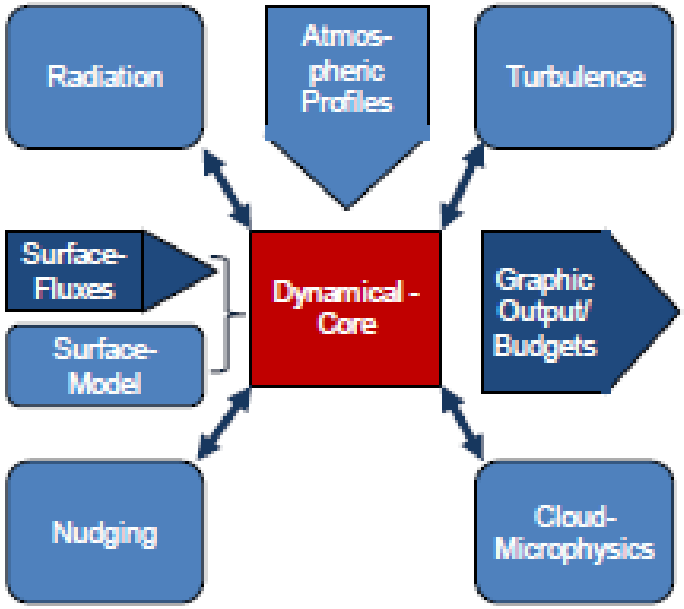
- due to the reversal the land-lake circulation system in the morning
- due to the adaption of circulation system to cloud cover periods during the whole daytime



Nam Co 2007

(Zhou et al., 2011)

The ATHAM-Model

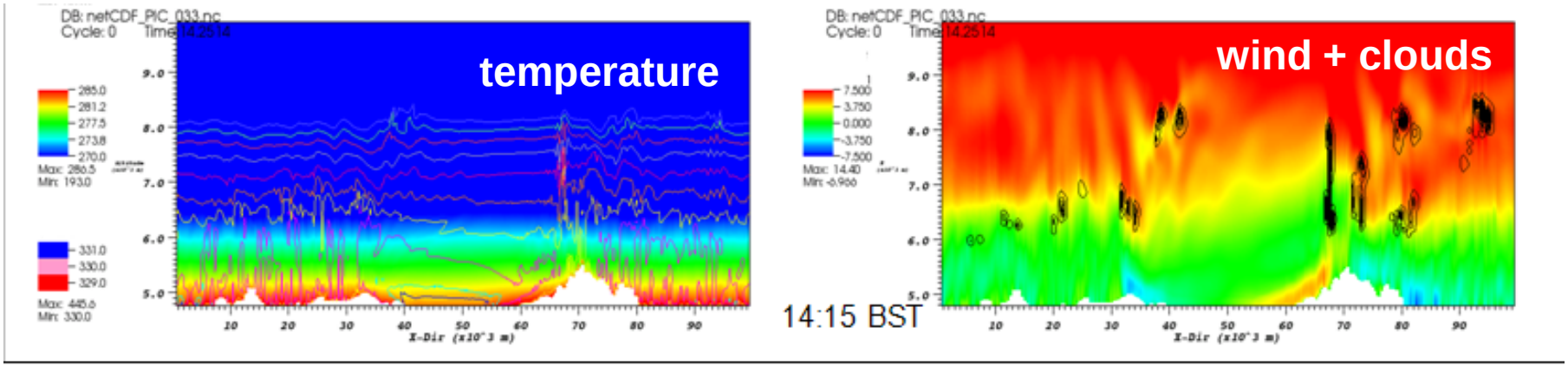


The cloud resolving Active Tracer High Resolution Atmospheric Model (ATHAM) developed by the University of Cambridge has the following features:

- **2D/3D stretched Cartesian grid**
- **Transport of passive and active tracer (atmospheric trace gases, water vapor, ice and water particles)**
- **Modules for turbulence, Cloud Micro-physics (Kessler), LW and SW radiation.**
- **Very high resolutions in space and time possible (i.e. 100 m).**
- **Surface-model for interactive surface-fluxes: Hybrid (Friend & Kiang, 1995)**

See Poster A337 by Gerken et al.

Model results



- **Development of a thermal lake breeze/mountain wind that develops through interaction of solar irradiation, turbulent fluxes and boundary layer clouds**
- **Investigation of feedbacks in system and importance for energy and moisture transport at Nam Co lake**

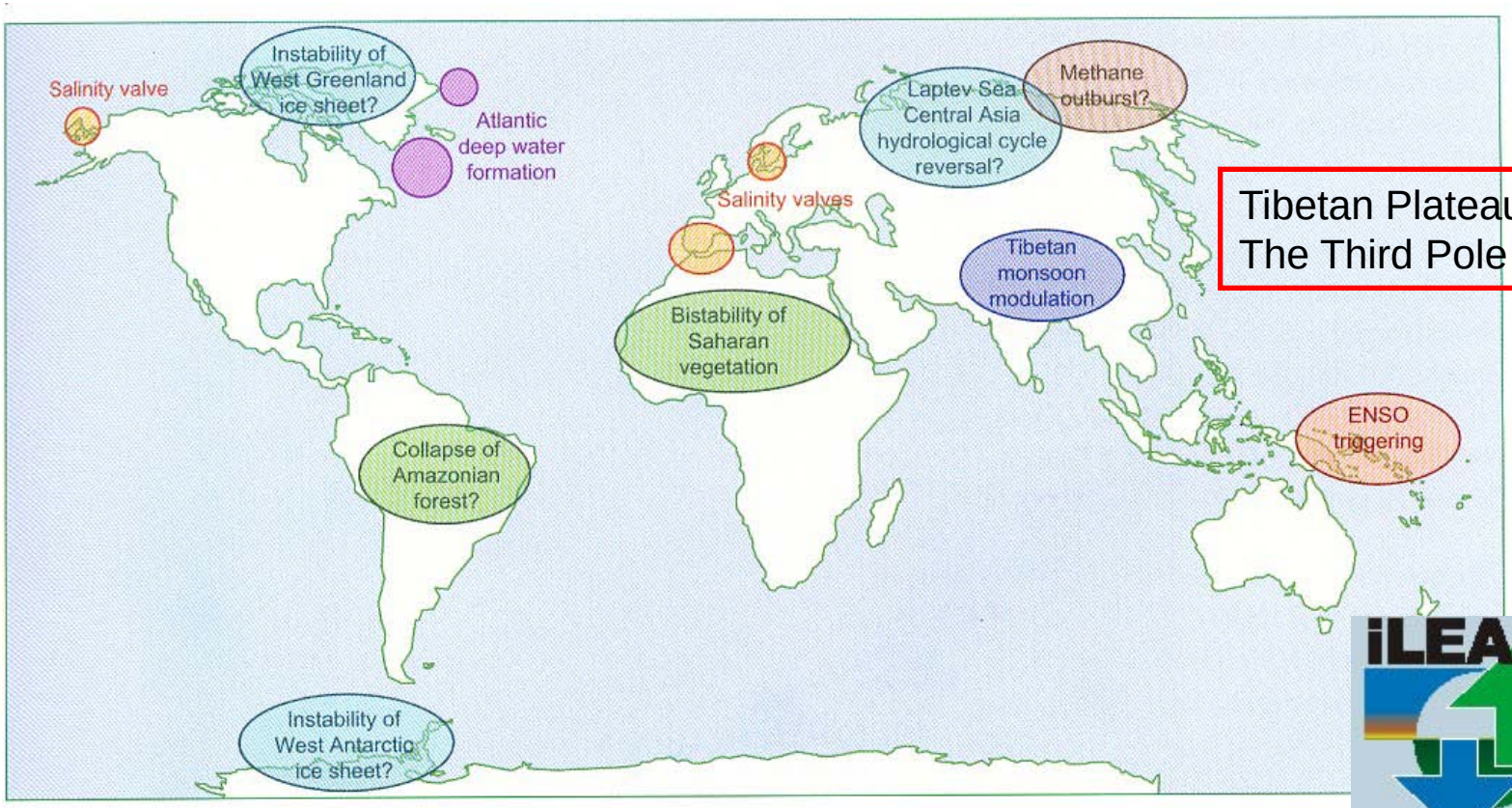
See Poster A337 by Gerken et al.

Conclusions

- **Turbulent energy fluxes can be measured and modeled with high accuracy also on high altitudes on Tibetan Plateau (except winter conditions, in preparation for publication)**
- **Strong convection events can be found even in surface fluxes.**
- **The generation of convective clouds can be modeled with high resolution models (grid size about 100 m)**
- **Upscaling of turbulent fluxes on pixel/grid size is possible with a combination of footprint and SVAT modeling (not shown, will be soon submitted for publication in HESS)**

A good basis is given for calibration also of mesoscale models or remote sensing data. But therefore a good available data base is necessary.

Contribution to one of the most important places of climate change



Tibetan Plateau
The Third Pole

iLEAPS