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Surface-atmosphere interactions and convection triggering at Nam Co Lake, Tibetan Plateau: Influence of soil moisture and wind direction

T. GERKEN[1,2], T. BIERMANN[2], W. BABEL[2], M.HERZOG[1], Y. MA[3], T. FOKEN[2] and H-F. GRAF[1]

[1] University of Cambridge, Centre for Atmospheric Science, UK
[2] University of Bayreuth, Micrometeorology, GERMANY
[3] Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing, CHINA

1) Motivation

- The Tibetan Plateau **(Fig. 1)** is the world's largest mountain highland.
- Water resources, glacier mass balance etc. are dependent on interaction between synoptic scale and local scale processes.
- Local scale processes are not resolved in conventional mesoscale models.
- Therefore, high-resolution modeling approaches are needed to study processes.

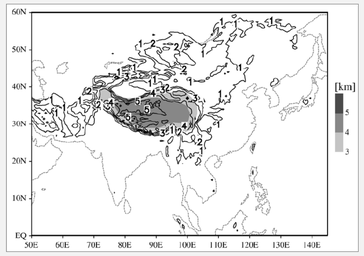


Fig. 1: Tibetan Plateau (Cui et al., 2006)

2) Research Questions

- The Nam Co Lake system **(Fig. 2)** is used as a test system due to its complex interaction of small-scale processes **(Fig. 3)**.
- How is convection triggered in this basin with respect to wind and interaction with topography? → **Point 3)**
- What is the impact on locally generated convective precipitation?
- How does soil moisture influence convection development? → **Point 4)**
- What is its impact on the surface energy balance? → **Point 5)**
- How does this impact the Tibetan Plateau and regional climate?

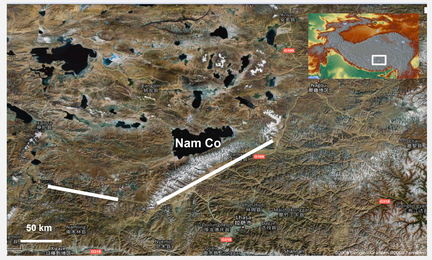


Fig. 2: Nam Co Lake (google maps, wikimedia)

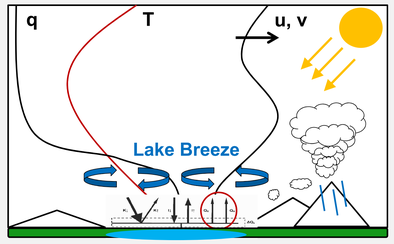


Fig. 3: Surface-atmosphere system at Nam Co

3) Convection Triggering and Precipitation Location

→ Interaction of local and large-scale wind determine location of convection triggering. .
→ Influence on the water cycle through location of precipitation.
→Precipitation will either fall within the basin or exported

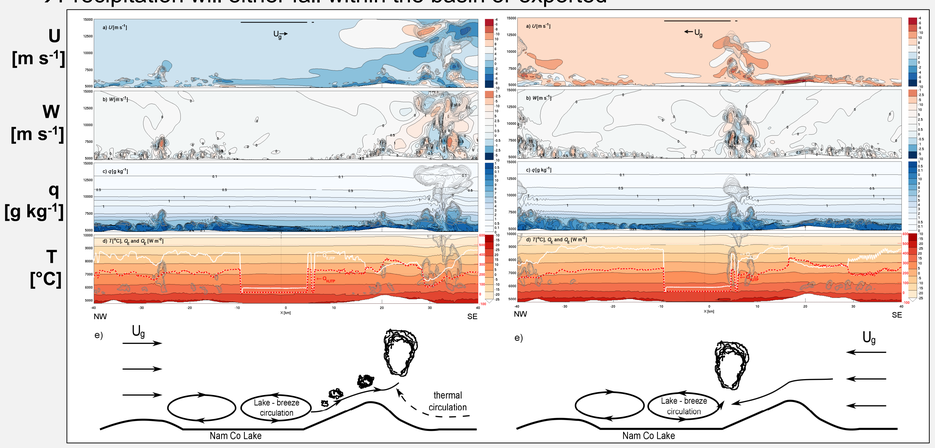


Fig. 4: Simulated convection triggering at Nam Co Lake and dependence on geostrophic wind direction (Gerken et al., 2013)

4) Influence of Soil Moisture on Convection Development

→ ATHAM is initialized with soil moistures ranging from wilting point to double field capacity **(Fig. 5)**. This corresponds to a realistic range.
→ Cloud-net radiation feedback leads to decreased evapotranspiration (both actual and potential) for moistest cases.
→Evaporation from lake is smaller than evapotranspiration at wilting point
→Intermediated soil moisture runs are the only runs that create strong and deep convection **(Fig. 6)**.
→Convective dynamics introduce radiative and dynamic feedbacks.

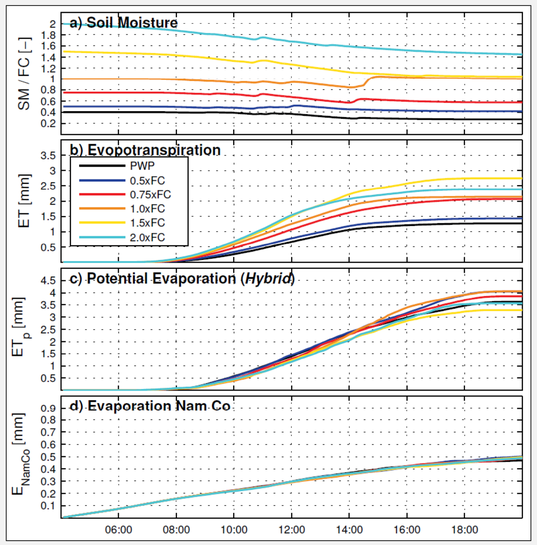


Fig. 5: Soil moisture (in terms of field capacity), actual and potential evaporation for the grass surface and the lake for simulations initialized with different soil moistures

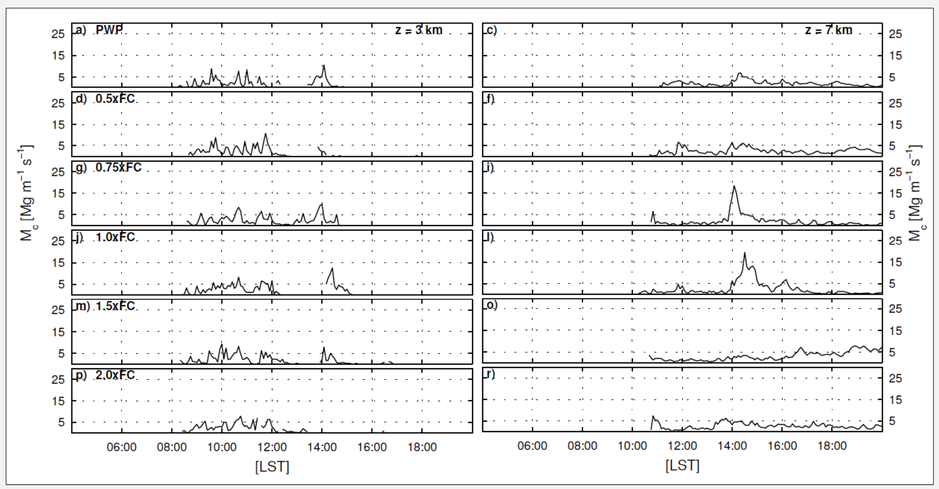
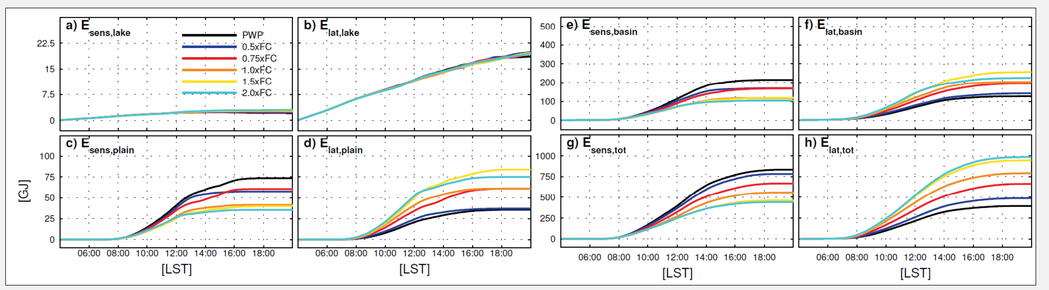


Fig. 6: Convective mass-flux (M_c) for simulations with different soil moistures from permanent wilting point (PWP) to double field capacity (2.0xFC)

→ Differences in convective activity translate into changes in the surface energy balance that cannot be attributed to Bowen-ratio alone **(Fig. 7)**.
→ How does this influence plateau-scale heating?

Fig. 7: Simulated cumulative surface energy balance for sensible and latent heat, spatially integrated for a+b) lake area; c+d) vegetated plain around lake; e+f) lake basin and g+h) total domain for different initial soil moistures

5) Impact on surface energy balance



6) Conclusions

→ **"Normal" mesoscale models are too coarse to resolve topography, local circulations or clouds and use uncertain input data.**
→ **This may lead to systematic errors in simulated surface energy balance and weather, which needs to be investigated.**
→ **High-resolution modeling approaches are a valuable tool for exploring the interaction of surface-atmosphere processes.**
→ **Convection triggering mechanism at Nam Co Lake determines location of precipitation and thus influences the water cycle on a larger scale.**
→ **Non-trivial relationship between surface moisture and convection development, due to interaction of surface heating and available moisture.**

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tobias.gerken@uni-bayreuth.de
www.bayceer.uni-bayreuth.de/TiP-AEG

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