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Surface-Atmosphere Interactions: Boundary Layer Clouds and Mesoscale Circulations at Nam Co Lake

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1) Modeled Surface Fluxes

- Almost daily Lake Breeze regime at Nam Co Lake
- Caused by differential heating between Land and Lake
- Good Comparison between Surface Model and Observations
- 5 + 6 Aug. 2009 similar surface conditions and fluxes, but different circulation regime (no lake breeze on 6-Aug)

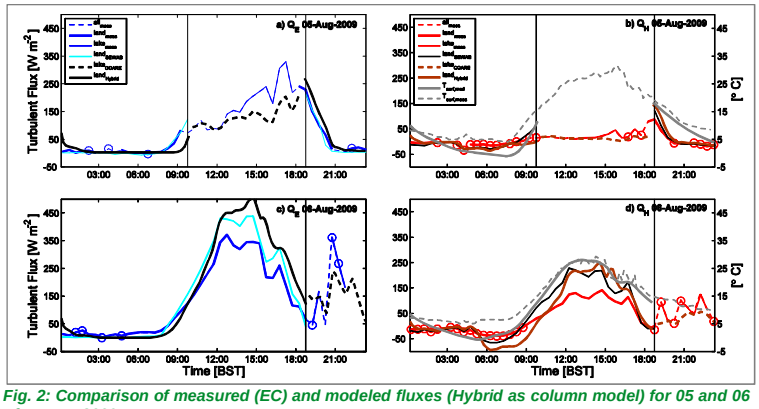

Fig. 2: Comparison of measured (EC) and modeled fluxes (Hybrid as column model) for 05 and 06 of August 2009

2) Atmospheric Conditions

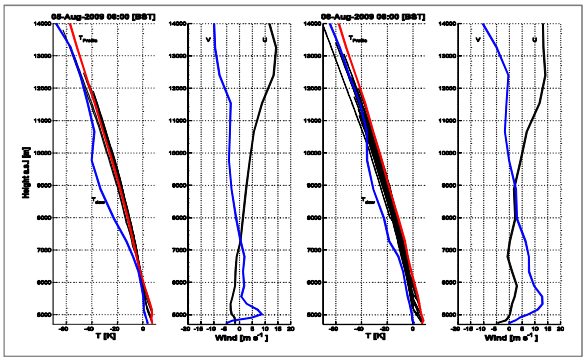

Fig. 2: Initial Profiles for 05 and 06 of August 2009 06:00 BST. Temperature Profile (red), Dewpoint T (blue), parcel temperatures for parcels lifted adiabatically (black lines) and U + W wind-speed

5-Aug: Conditional Instability between 6.5 and 12 km a.s.l.; high RH, shallow band of off-shore wind

6-Aug: No initial conditional Instability; lower RH, deep band of off-shore wind, strong cross-shore wind

3) Overestimated Vertical Instability from Reanalysis data/ WRF profile

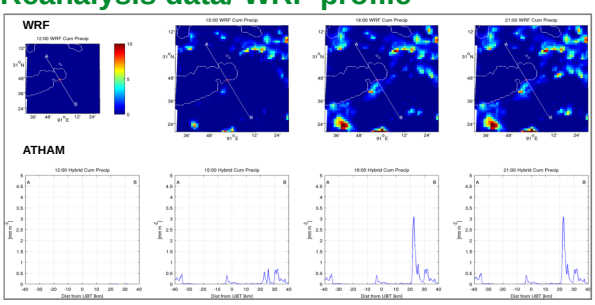

Fig. 3: Cumulative Precipitation from WRF and ATHAM simulation for 05 Aug 2009 (No observed precipitation).

- Lack of resolution or quality in atmospheric data
- Errors in Reanalysis Data in remote regions will cause false weather and hence surface processes

At Nam Co Lake 4730 m a.s.l. on the Tibetan Plateau local and regional circulation is influenced by the large water body, the SW-NE oriented *Nyenchen Tanglha* mountain range and the large land surface fluxes We investigate those processes at Nam Co Lake.

Research Questions

- What is the relationship and the feedbacks between solar radiation, turbulent heat fluxes and boundary layer clouds?
- Process studies of mesoscale circulation development with complex terrain
- Under which conditions (vertical profiles) do these circulations develop?
- Quantify the contributions of such circulations to transport of energy and moisture from the lake to the surrounding mountains.
- Further development of Active Tracer High-resolution Model

The Model

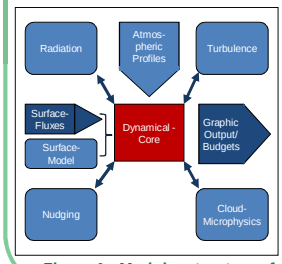

Figure 1: Modular structure of ATHAM (Herzog et al., 98 ; Oberhuber et al., 2008)

The cloud resolving Active Tracer High Resolution Atmospheric Model (ATHAM - Fig.2):

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

5) Interactive Surface Atmosphere System: Lake Breeze Development and Convection Triggering

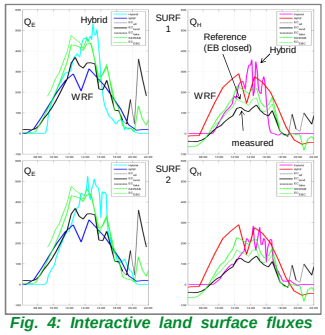

Fig. 4: Interactive land surface fluxes for two realistic surface conditions at Nam Co for 06-Aug 2009

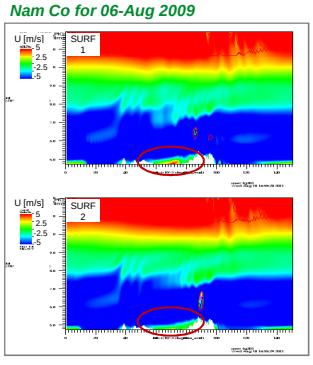

Fig. 5: Modeled Lake Breeze development at 13:00 BST for fluxes as in Fig 6.

- Nam Co is high sensitivity system
- 2 realistic surface configurations with similar fluxes cause large differences in resulting circulation system
- Circulation feeds back on weather and fluxes

Lake Breeze System

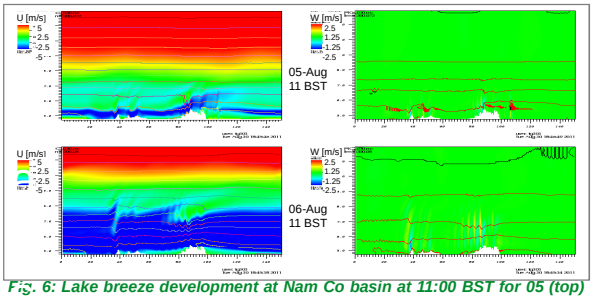

Fig. 6: Lake breeze development at Nam Co basin at 11:00 BST for 05 (top) and 06 of August 2009. Left: u and θ. Right: w and water vapor mixing ratio

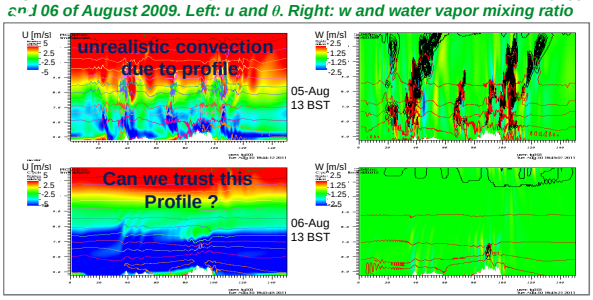

Fig. 7: As Fig. 4, but for 13:00 BST

Conclusions

- Very much a work in progress !
- The high resolution modeling approach is suitable, but requires careful initialization.
- Next step will be the extension to 3D and the further exploration of the system
- Development of system is strongly influenced by local conditions
- Model results are in line with expectations, but do not necessary resemble observations due to lack of data.
- It cannot be about modeling specific days or exact structures due to lack of observations, but about exploration about the sensitivities of such a system
- More observations are needed in order to assess the influence of the modeled processes on the larger scale and their contribution to energy and water budgets

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