DEVELOPMENT OF A SATELLITE LAND AND ATMOSPHERE COUPLED DATA ASSIMILATION SYSTEM (CALDAS)

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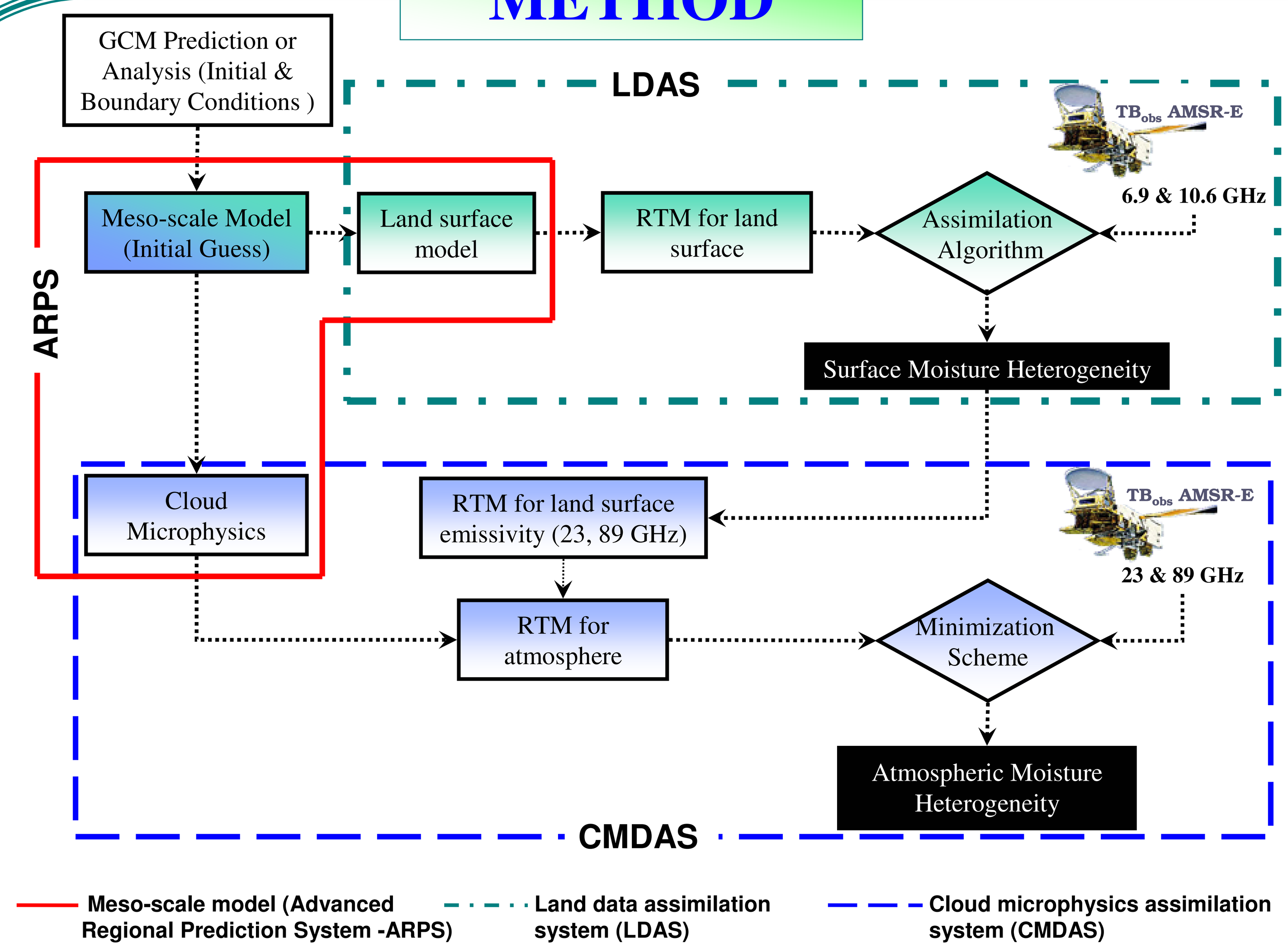
ABSTRACT

Accurate amount of soil moisture is crucial for reliable estimation of land-atmosphere interactions and their feedbacks on global/regional water and energy budgets. To physically introduce existing soil moisture conditions into a mesoscale model, a passive microwave Land Data Assimilation System was coupled with a mesoscale model (LDAS-A) and was applied in the Tibetan Plateau.

Results obtained during dry period showed that LDAS-A is capable of improving land surface variables and land-atmosphere interactions. However, results obtained during rainy days showed that assimilated land surface conditions suffered substantial errors owing to predicted model forcing (e.g., rainfall and solar radiation) and consequently affect land-atmosphere feedback mechanism.

To overcome this operational pitfall, a Coupled Atmosphere and Land Data Assimilation System (CALDAS) was developed incorporating a passive microwave cloud data assimilation with LDAS-A and presented.

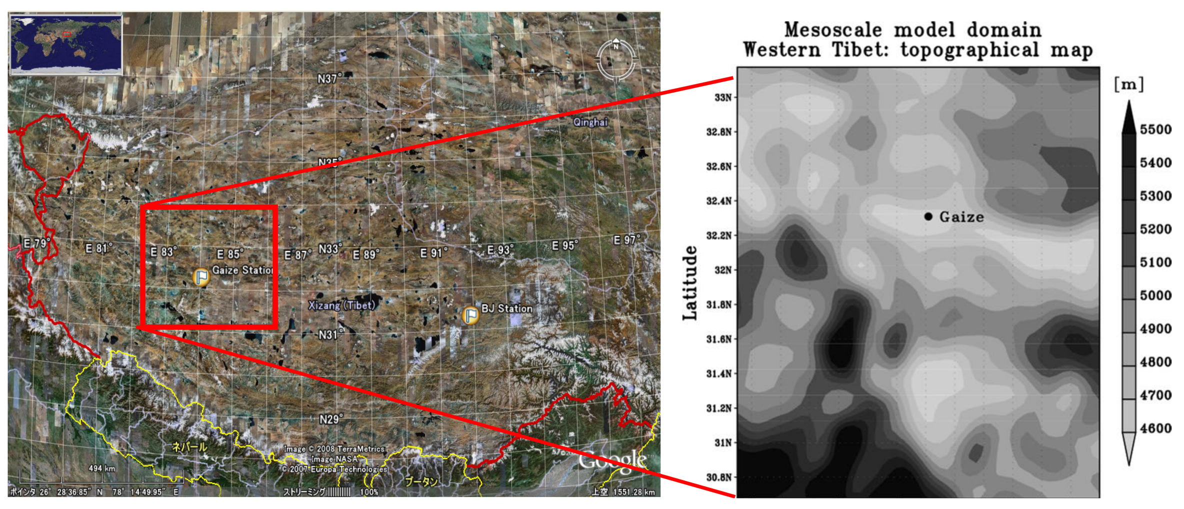
METHOD



Schematic diagram of Coupled Atmosphere and Land Data Assimilation System (CALDAS) and its principal components

- As in the figure, ARPS was set up using initial and boundary conditions from NCEP FNL data and land surface model was integrated for ensemble (50 no.) of soil moisture profiles.
- At times when AMSR-E observations were available, the brightness temperature (T_b) at vertical polarizations of 6.9 and 10.65 GHz were assimilated for soil moisture using a forward microwave Radiative Transfer Model (RTM) and Ensamble Kalman Filter (EnKF) method.
- As soon as the LDAS finished the assimilations, the CMDAS was activated to assimilate *Tb* at 23.8 and 89 GHz for cloud condensate.
- 4-stream fast model used to calculate *Tb* at satellite level. Land surface emissivity at lower boundary was calculated using assimilated soil moisture. Shuffle Complex Evolution (SCE) method was used as assimilation scheme and Lin's ice scheme was used as model operator.
- With improve land and atmospheric conditions, ARPS integrated forward in time to predict land and atmospheric evolutions. *(Submitted to TGRS/IEEE)*

EXPERIMENTAL DESCRIPTIONS



- A meso-scale area (82.7E-85.2E, 30.7N-33.2N) located in the Western Tibetan Plateau was considered.

Model domain including the Gaize station

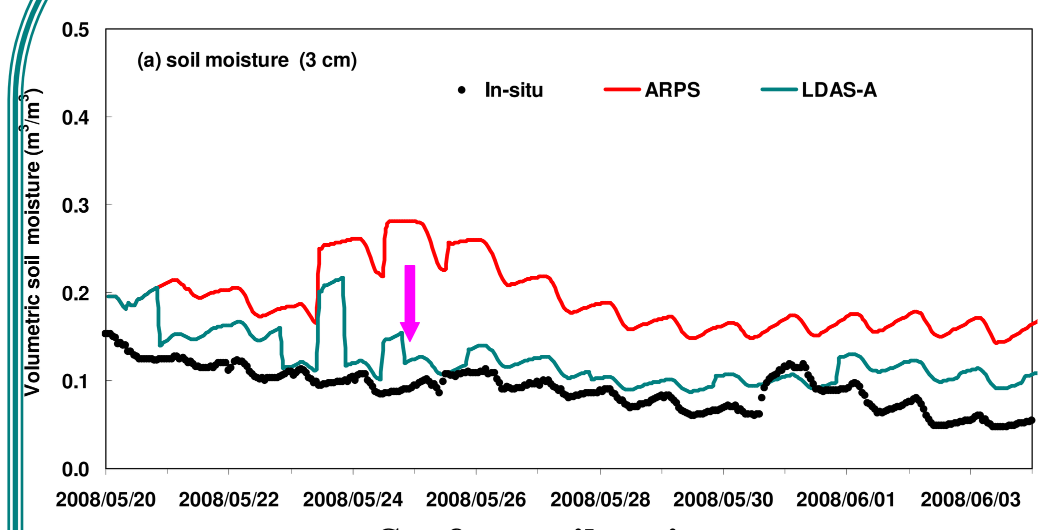
- Heterogeneous soil moisture distribution is favorable for the study of land atmosphere interactions.
- Sparse vegetation without intense human activity ensured the applicability of microwave RTM and AMSR-E observations in this region.

Three sets of simulations for system evaluation:

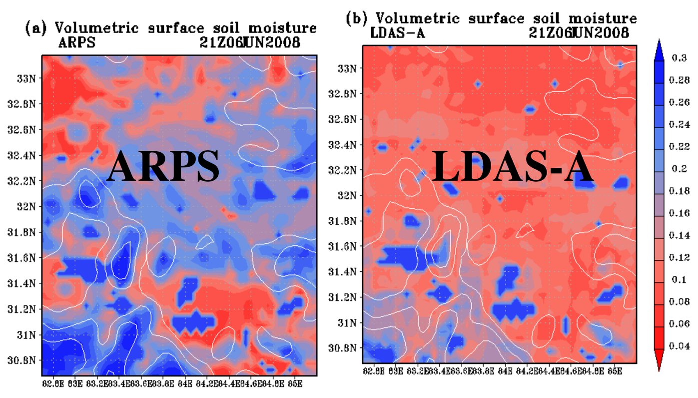
- ✓ *ARPS run, which employed a mesoscale model without any assimilation.*
- ✓ *LDAS-A run - ARPS run was accompanied by sequential land data assimilation.*
- ✓ *CALDAS run - LDAS-A run was accompanied by a cloud microphysics data assimilation.*

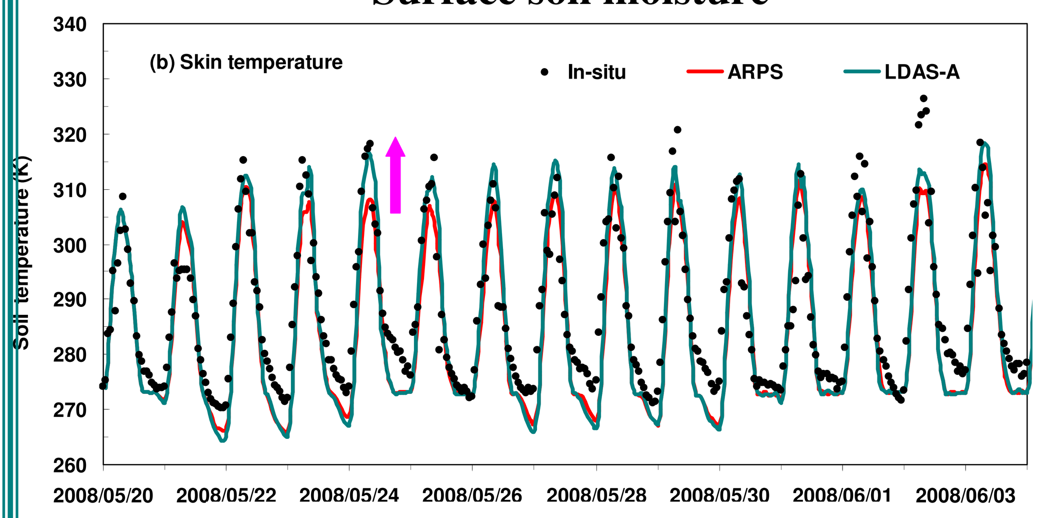
RESULTS

(a) LDAS-A: Dry Period

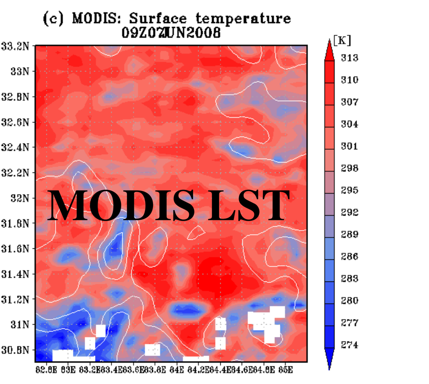


Surface soil moisture

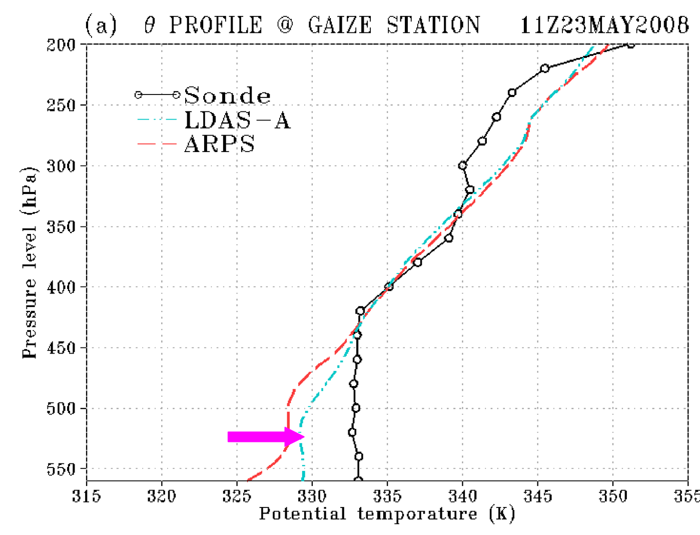




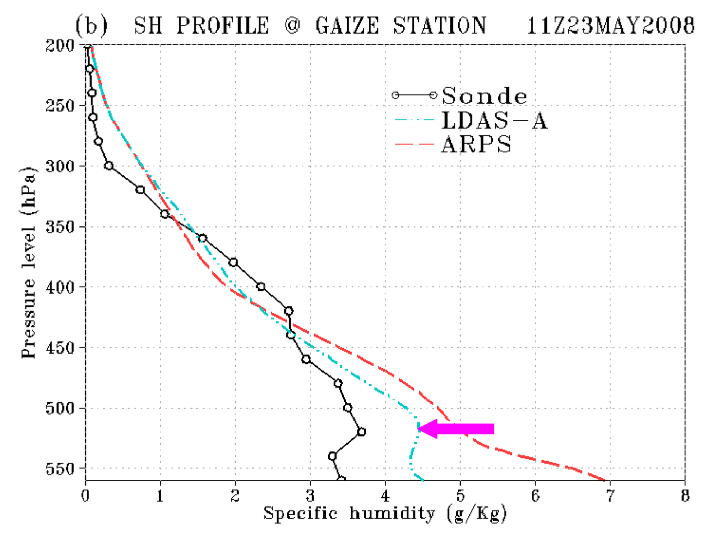
Skin temperature



Soil moisture and MODIS LST



Potential temperature profile



Specific humidity profile

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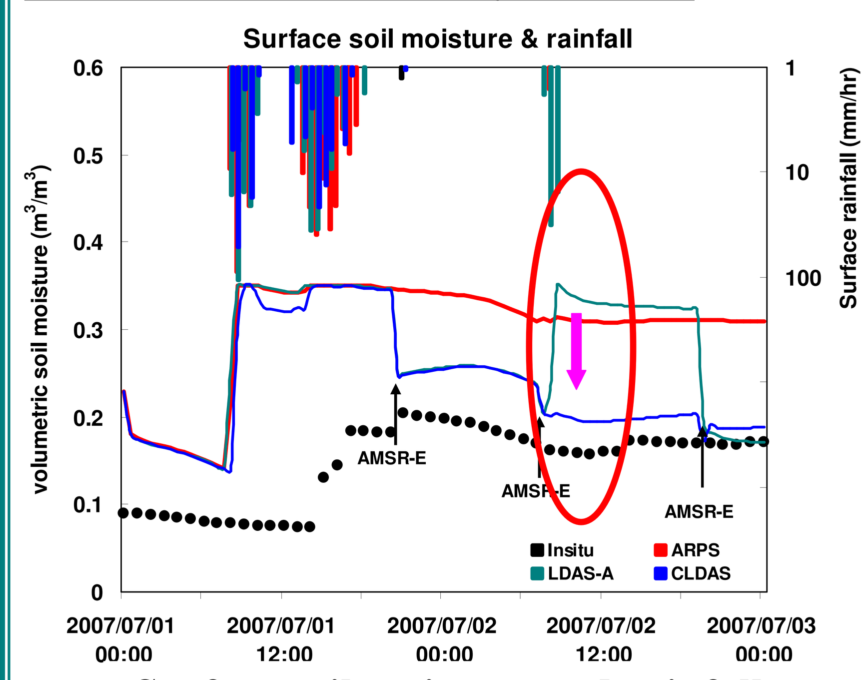
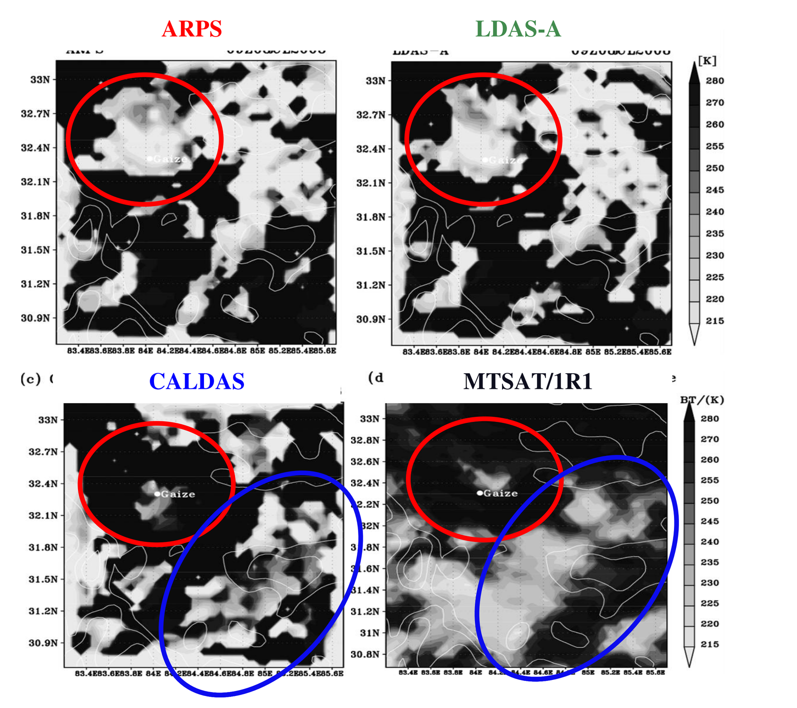
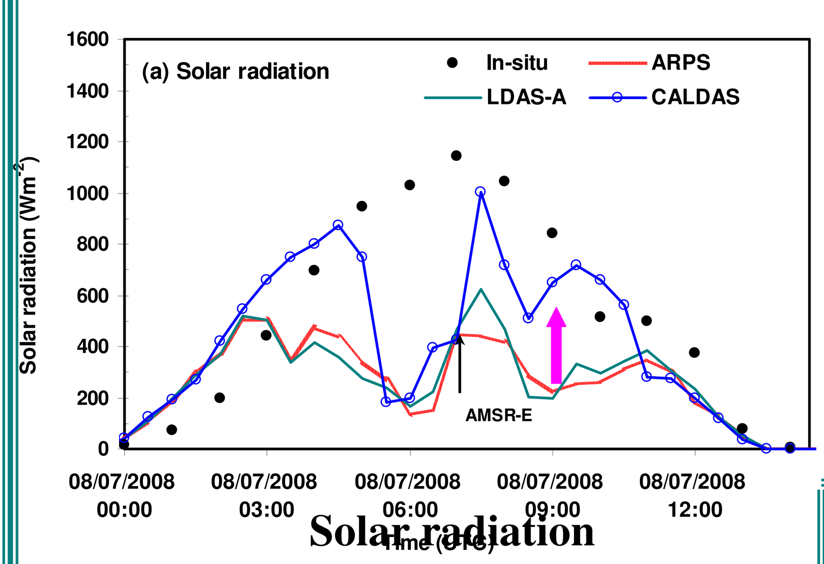
(b) CALDAS: Rainy Period



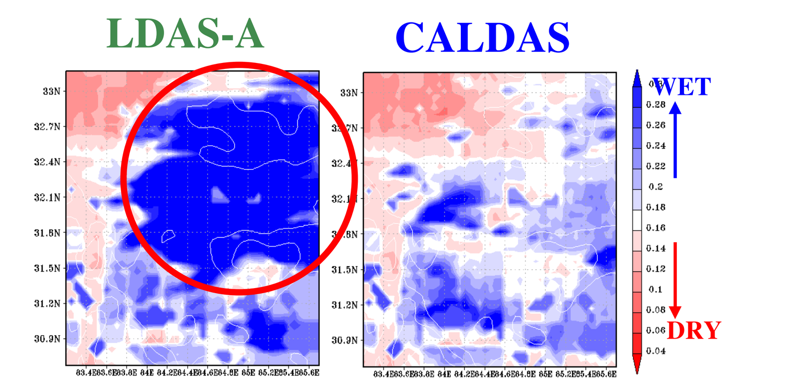
Surface soil moisture and rainfall



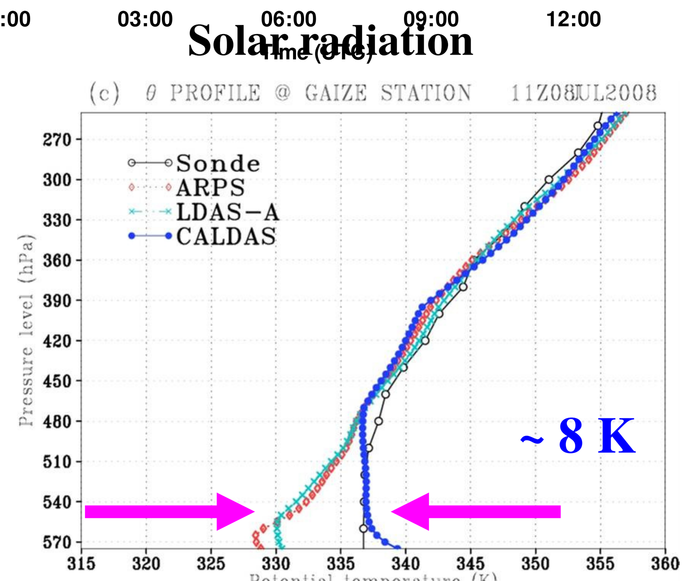
cloud condensate against satellite IR obs.



Solar radiation



Effect of rainfall on surface soil moisture



Potential temperature profile

CONCLUSIONS

Unrealistic model forcing (e.g. rainfall) affects land surface states.

Therefore, LDAS-A is alone inadequate.

CALDAS is a valuable tool to improve model forcing and thus land-atmosphere interactions

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REFERENCE

Rasmy, M., T. Koike, S. Boussetta, H. Lu, and X. Li, 2011: Development of a Satellite Land Data Assimilation System Coupled With a Mesoscale Model in the Tibetan Plateau, IEEE Transactions on Geosciences and Remote Sensing, Vol. 49(8), pp. 2847-2862. DOI:10.1109/TGRS.2011.2112667

Rasmy, M., T. Koike, D. N. Kuria, C. R. MIRZA, S. Boussetta, H. Lu, and X. Li, 2011: Development of a satellite land and atmosphere coupled data assimilation system in Tibetan Plateau, IEEE Transactions on Geosciences and Remote Sensing, Submitted.