Preliminary Observational Results from the Third Tibetan Plateau Atmospheric Scientific Experiment (TIPEX-III)

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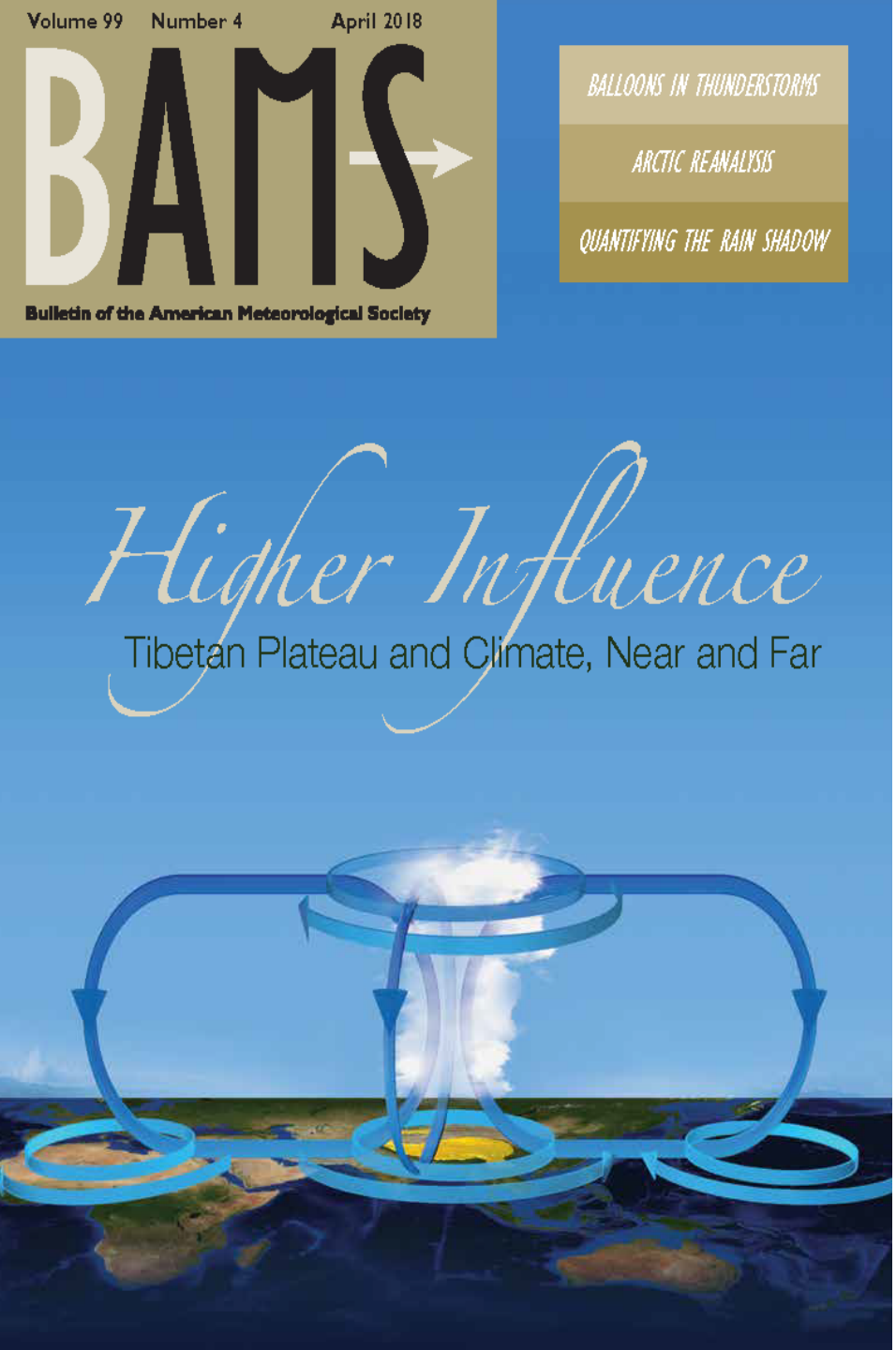
Chinese Academy of Meteorological Sciences

International Workshop of First Phase of GEWEX/GASS ILSTSS2S Initiative and TPEMIP
Washington D.C., December 2018



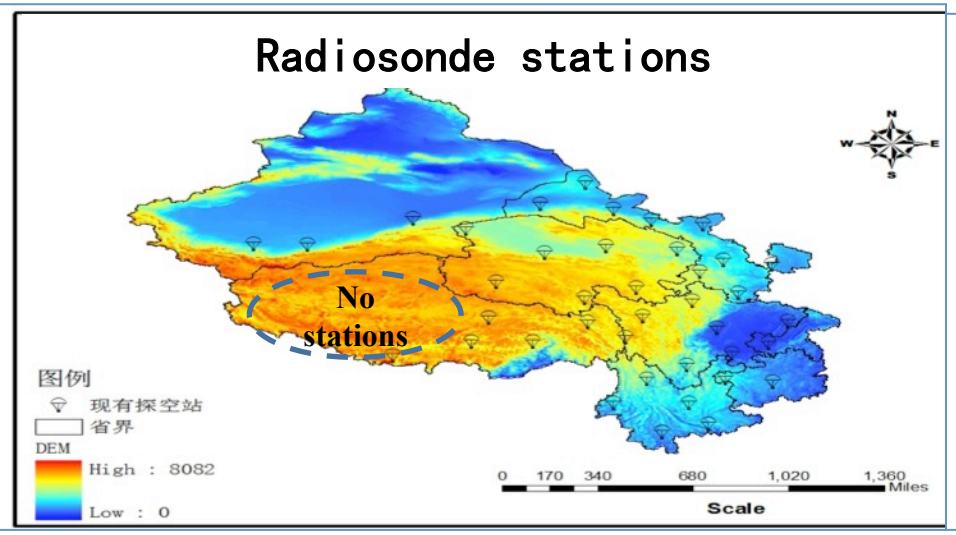
- Zhao et al., 2018: The Third Atmospheric Scientific Experiment for Understanding the Earth-Atmosphere Coupled System over the Tibetan Plateau and Its Effects. *BAMS*, 99, 757-776, DOI: 10.1175/BAMS-D-16-0050.1.

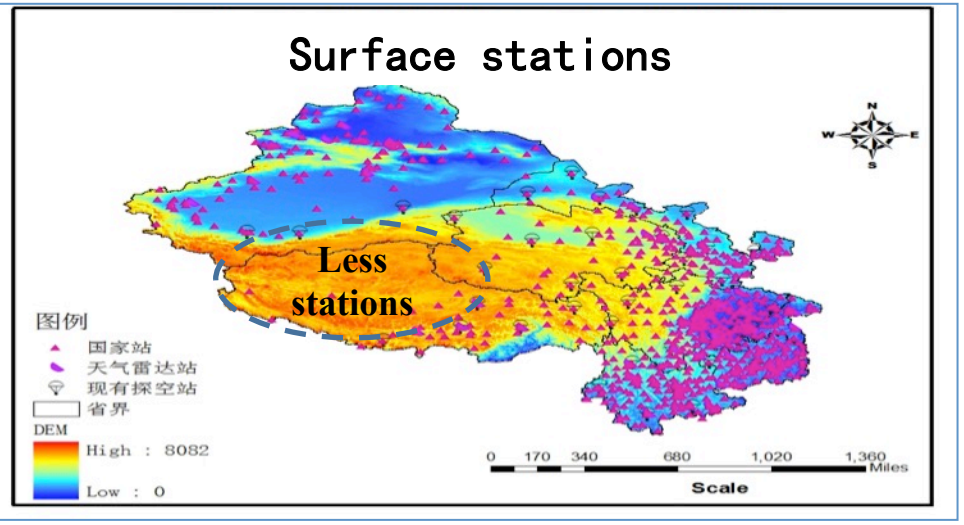
Outline

1. Background of TIPEX-III
2. Integrated Observations of TIPEX-III
3. Preliminary results from TIPEX-III observations
4. Summary

Owing to a high elevation and a naturally harsh environmental condition, there are few meteorological operational stations over the Tibetan Plateau

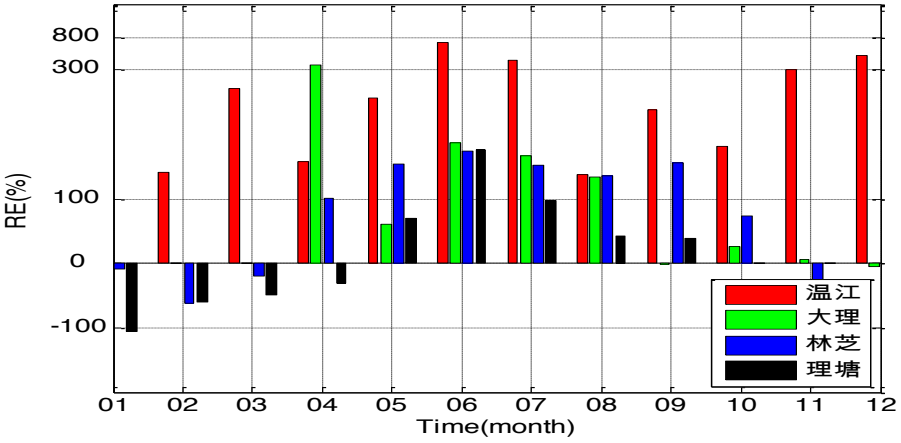
Lack of routine operational meteorological observations



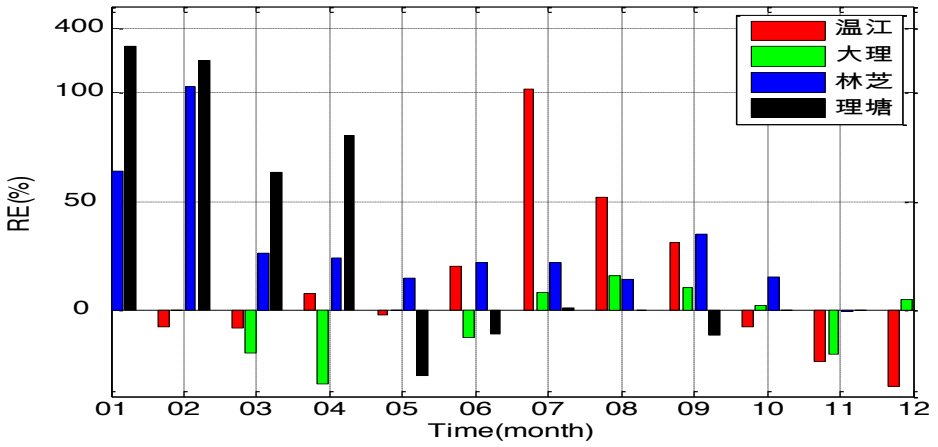


WRF model: large errors of modeling surface heat fluxes over Tibet

Sensible heat (relative error)

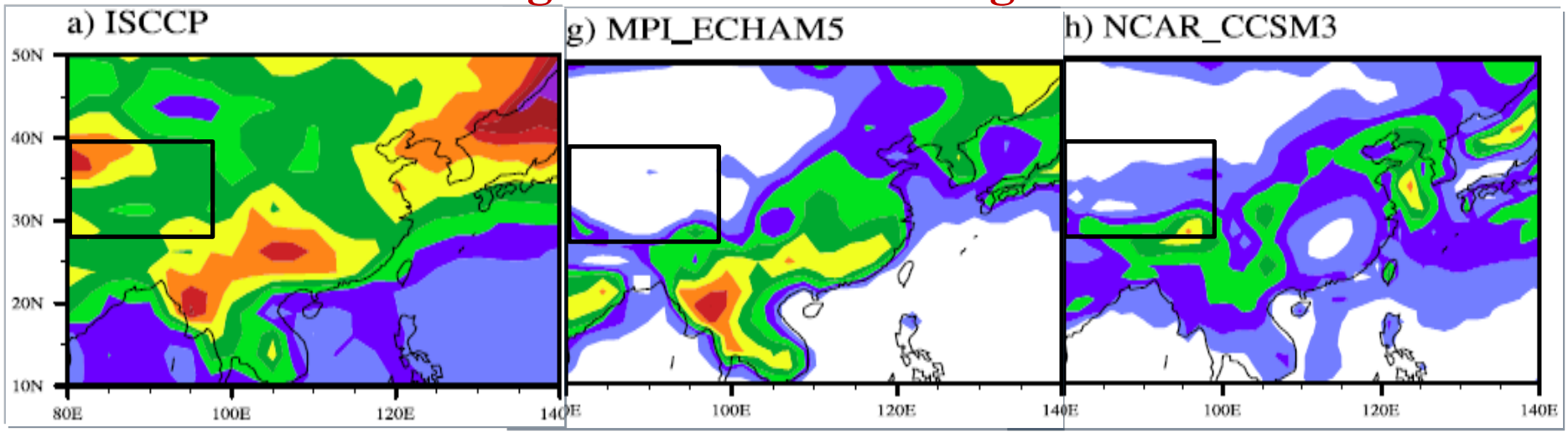


Latent heat (relative error)



（From Xu Xiangde）

Climate models: large errors of modeling cloudiness over Tibet



（Wu and Zhou, 2011）

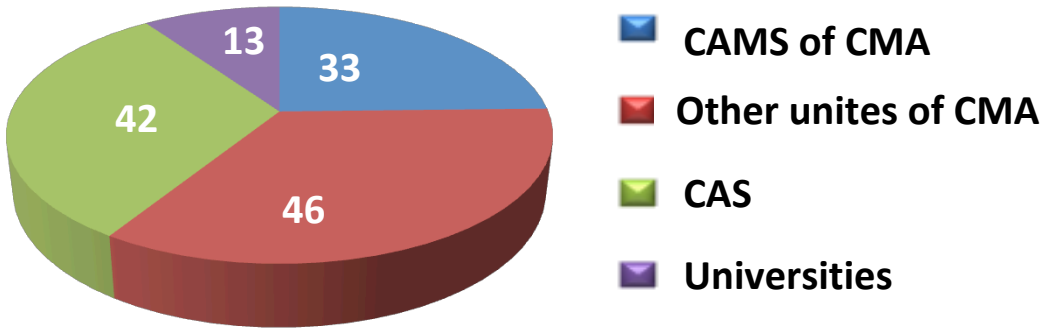
- **To increase data and improve the models' ability, CMA, CAS, and NSFC jointly initiated the TIPEX-III.**
- **The objective of TIPEX-III**

- To construct a 3D observation system of land surface, planetary boundary layer (PBL), troposphere, and stratosphere for understanding the earth-atmosphere coupled system over Tibet
- To provide new datasets for basic scientific research

- **TIPEX-III started in 2014 and will end in 2023.**

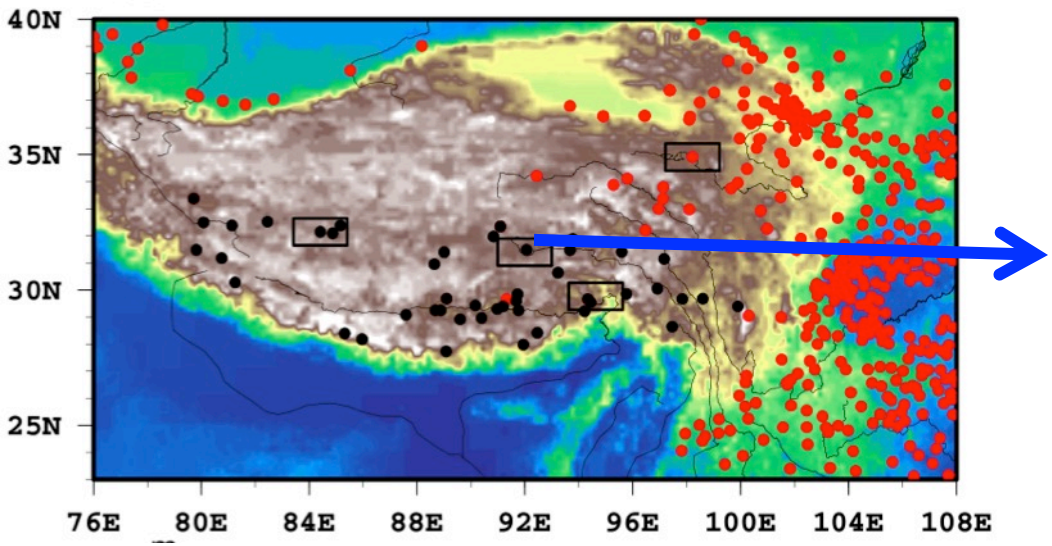
Participants of TIPEX-III

- **30 units from CMA, CAS, and Chinese universities.**
- **More than 130 persons (scientists, and meteorologists)**

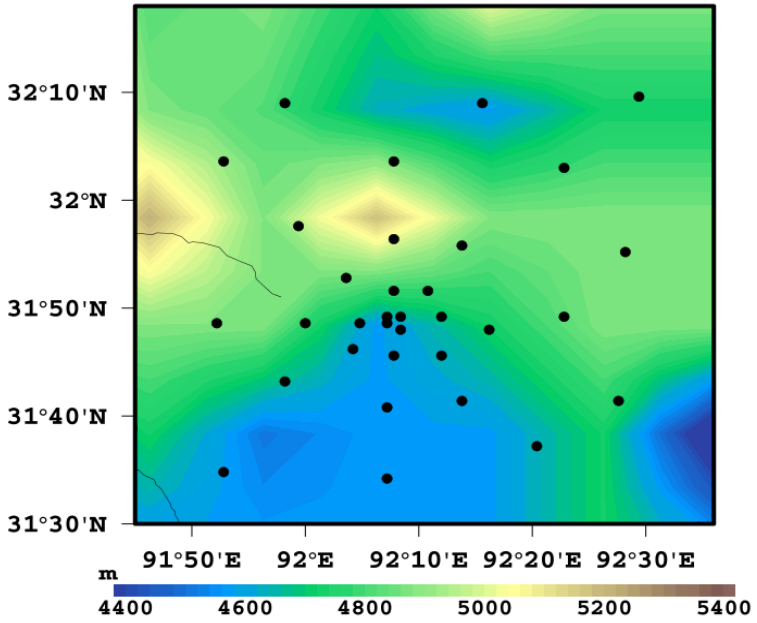


➢ Multi-scale land and boundary-layer observational networks

Soil Temperature & Moisture Observations



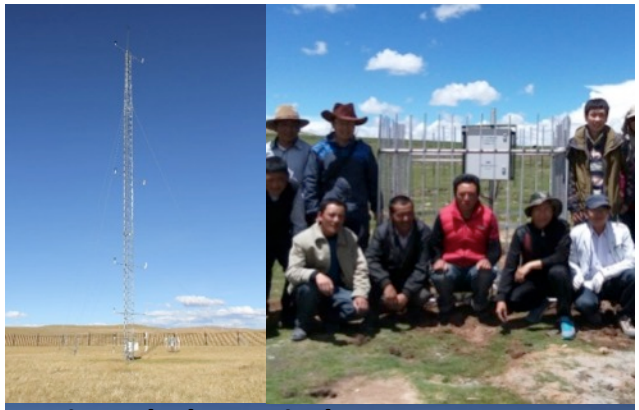
- Red：operational observations
- Black：newly-established sites
- Box: regional intensive network

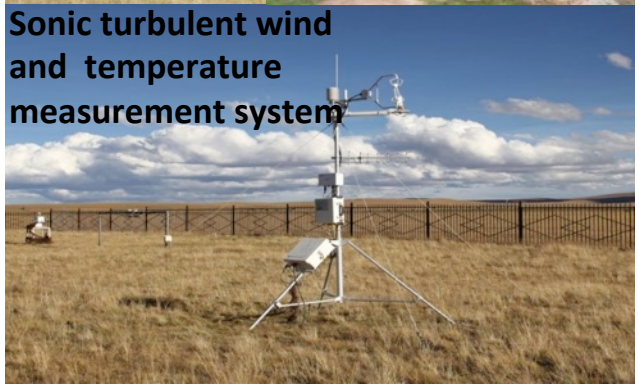


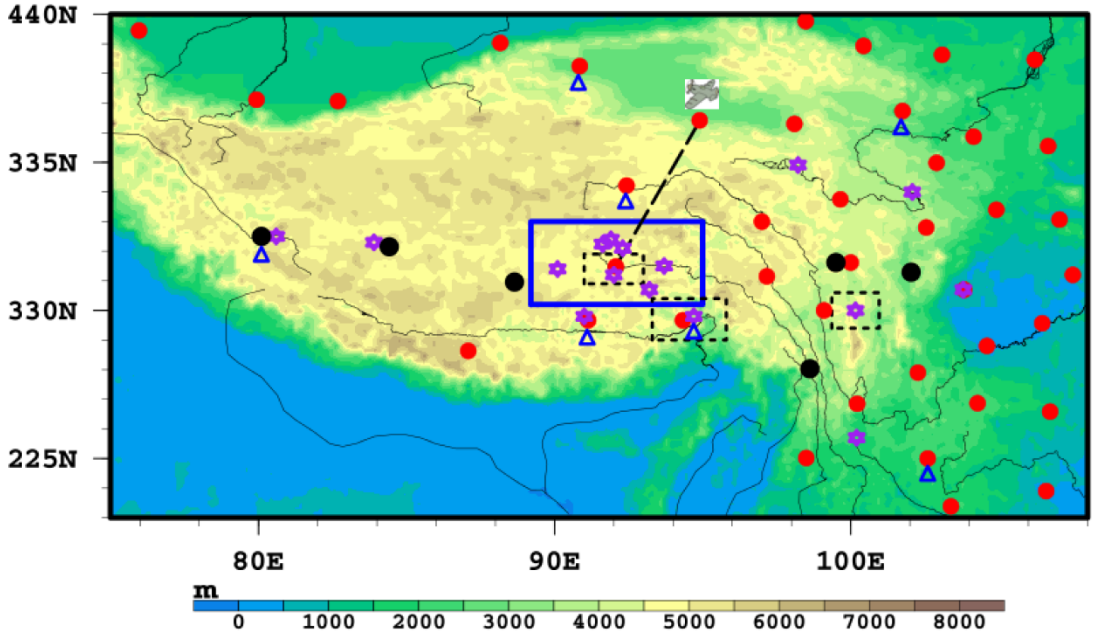
- Intensive observation in Naqu

- Designing a plateau-scale observation network and 4 regional-scale intensive networks
- The plateau-scale network: 46 sites; built in September, 2015
- The regional-scale network in Naqu: 33 sites; built in August, 2015
- The other three regional-scale networks: in the subsequent years

Planetary Boundary Layer Observation





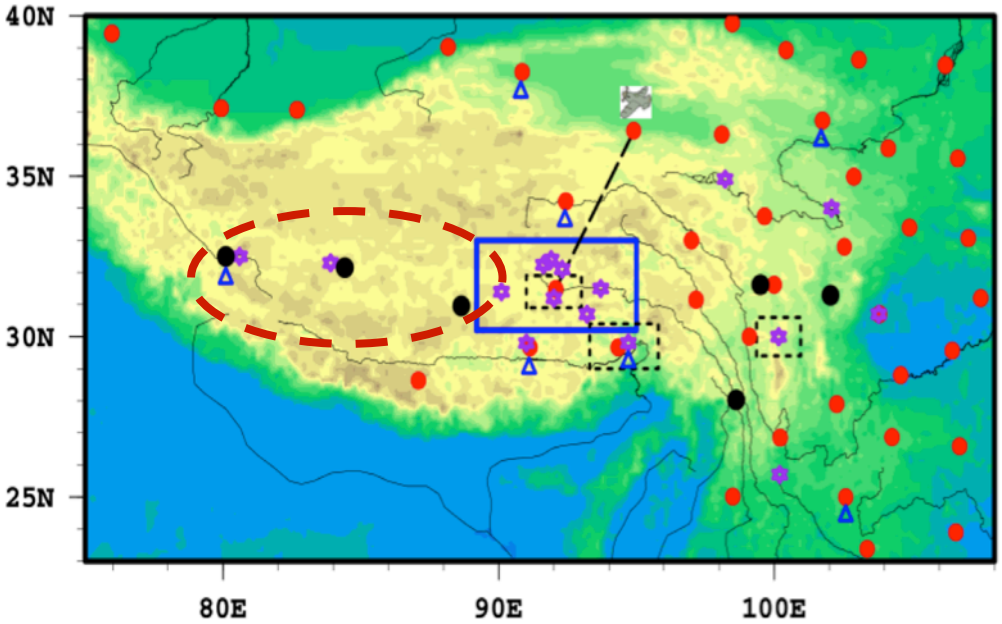


- Purple: plateau-scale PBL observation sites
- Blue square: PBL Observation Network in Naqu

- Designing a plateau-scale network with distance of approximately 500 km between two sites and a regional-scale network near Naqu (with distance of ～200 km).
- These networks consist of 16 sites.
- Building 13 sites in July, 2014 and one site in August, 2015

➢ Intensive radiosonde observation

Automatic radiosonde stations over western Tibet



- Red: operational stations
- Black: newly-established sites

GPZ1 Auto Sounding

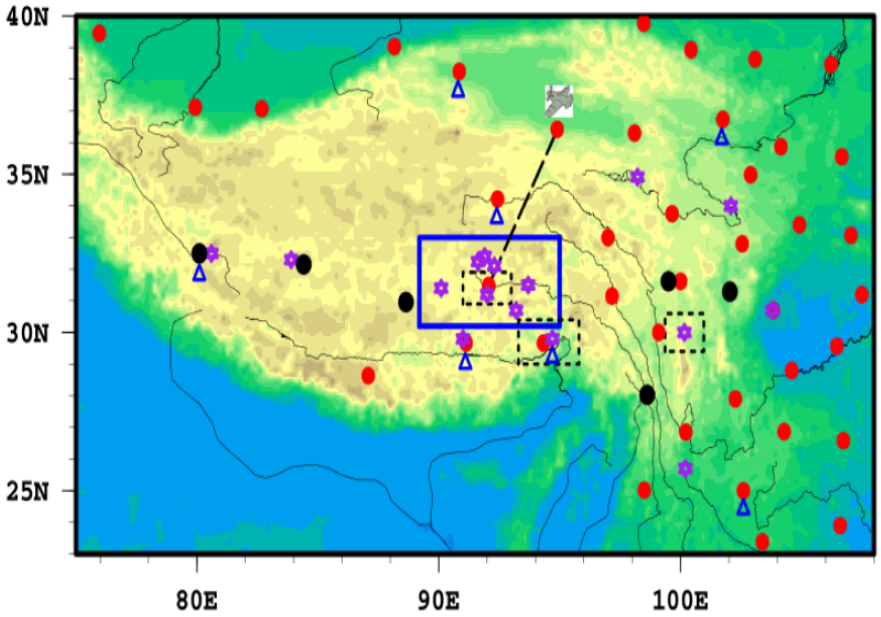
XGP-3GZ Data Tracker

QDQ2-1 Hydrogen Generator

- Building 3 radiosonde observational systems at Shiquanhe, Gaize, and Shenzha of western Tibet
- Starting observation in November, 2014; twice each day.

➢ Cloud-precipitation physical process observation

Ground-based radar observations



- Black box: Intensive cloud-precipitation observation Area

- Using ground-based radars for observing cloud and raindrop properties in the central and eastern parts of the Tibetan Plateau near Naqu, Lingzhi, and Litang.
- Conducting observations at Naqu in July and August, 2014 and at Naqu and Lingzhi in July and August, 2015.

Airborne observations

King Air 350ER

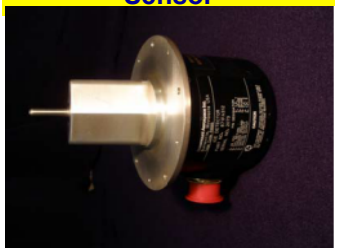
3V-CPI Cloud Particles Observation

AIMMS-20

HVPS-3 Distrometer

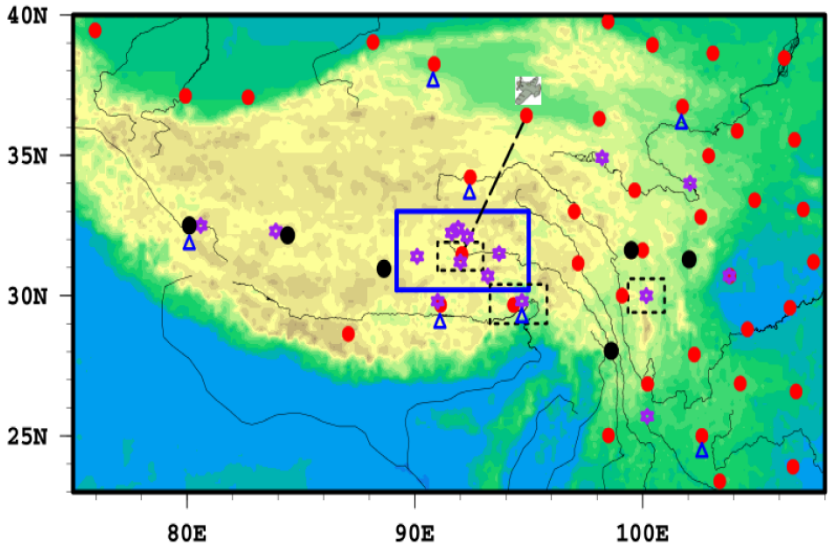
Goodrich Temperature Sensor

Goodrich Freezing Sensor



Cloud Particles Detector

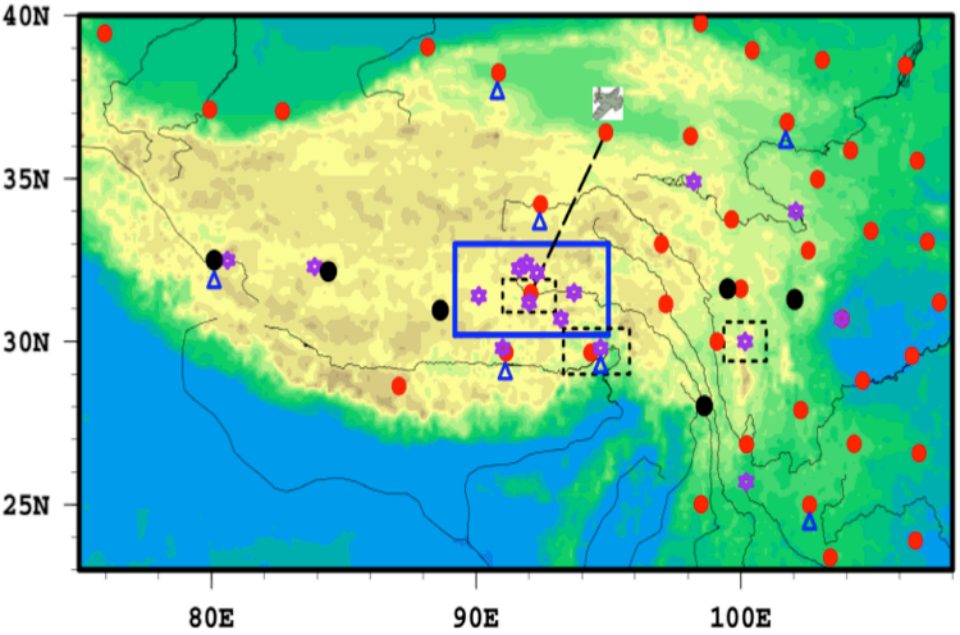
Liquid Water/Total Water Measurement



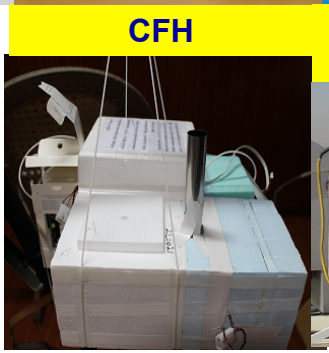
- Dashed line：the route of air plane

- Using aircraft campaigns for measuring cloud and raindrop properties near Naqu
- Aircraft flights took off from Golmud of the northeastern TP and conducted measurements over Naqu in July, 2014

➢ Ozone, aerosol, and water vapor observations in troposphere and stratosphere

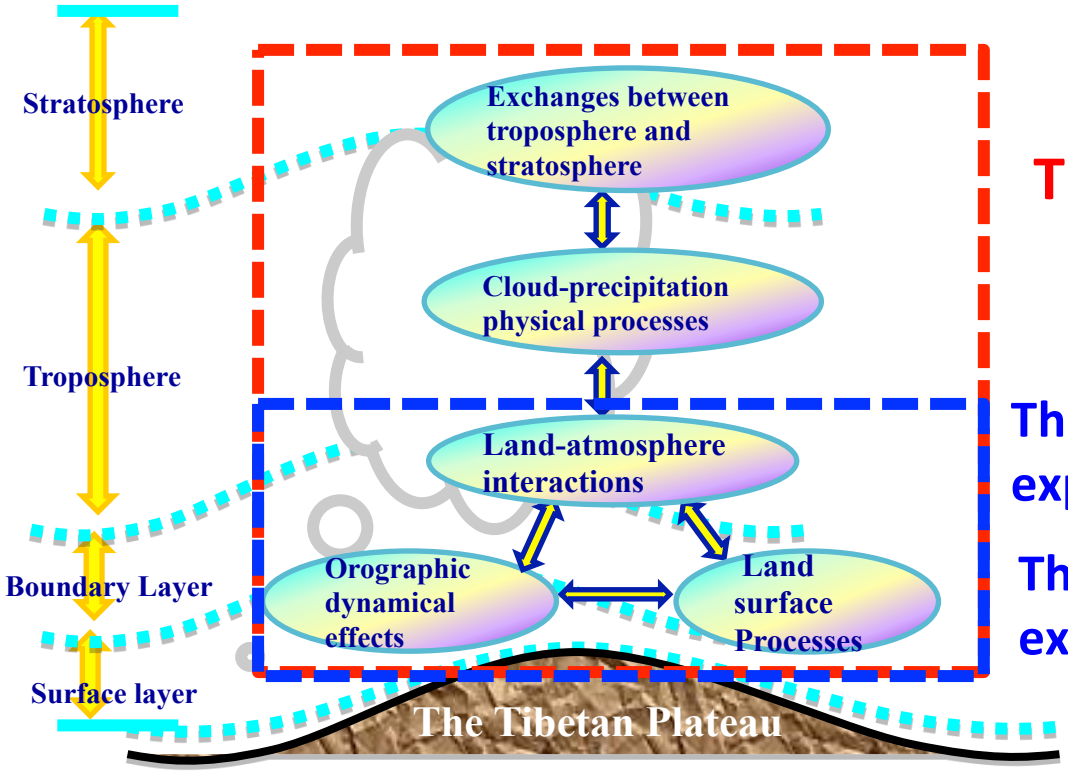


- Triangle: for atmospheric component



- Designing a monitoring network at Shiquanhe, Lhasa, Linzhi, Kunming, Mangya, Tuotuohe, and Xining
- Conducting the observation at Linzhi in June-July, 2014, and at Shiquanhe, Lhasa, Kunming, and Xining in May-September, 2016.

➢ Comparisons between TIPEX-III and previous experiments



TIPEX-III

The First Atmospheric scientific experiment (in May-August, 1979)

The Second Atmospheric scientific experiment (in May-August, 1998)

Land-atmosphere physical processes over Tibet

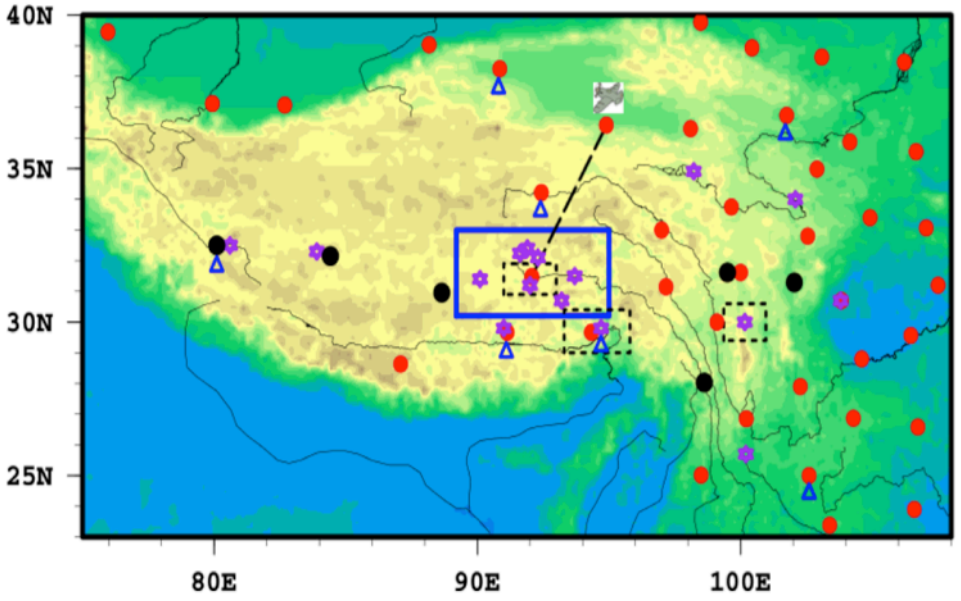
- The first and second experiments over Tibet：short in the 1979 and 1998 summers；and focusing on land and boundary player processes.
- TIPEX-III：a longer time (10 years)；and extending from the land surface process to the tropospheric and stratospheric physical processes by new observational tools.

➢ Spatial heterogeneity in surface sensible and latent heat fluxes

Median value of bulk transfer coefficients for 11 sites

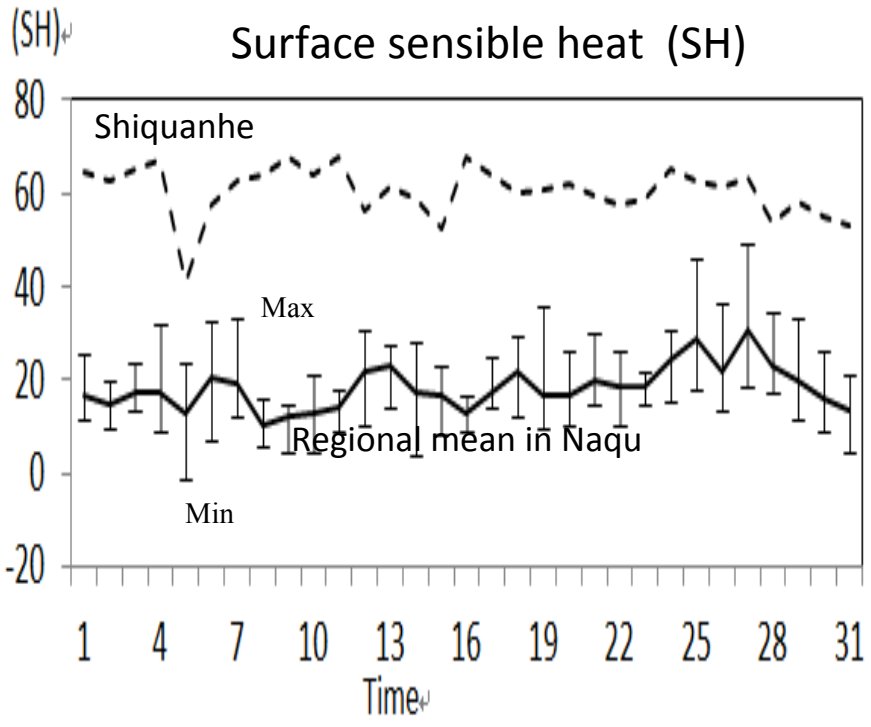
Sites	Seng-ge Kambab	Baingoin	Namco	Amdo	Nagqu	Nyainrong	Lhari	Biru	Nyingchi	Dali	Wenjiang
C_D	0.0096	0.0034	0.0038	0.0029	0.0044	0.0038	0.0105	0.0101	0.0080	0.0116	0.0126
C_H	0.0024	0.0027	0.0022	0.0024	0.0028	0.0032	0.0038	0.0034	0.0060	0.0045	0.0047

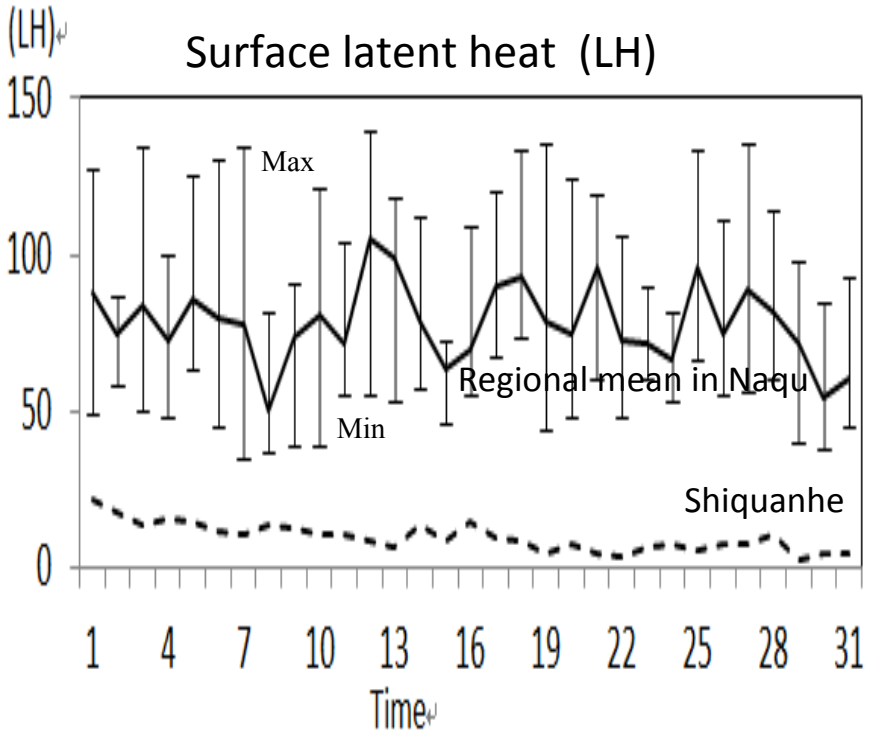
- Bulk transfer coefficient of surface sensible heat flux (C_h) : 2.4×10^{-3} in western Tibet, $2.2\text{-}3.8\times10^{-3}$ in central Tibet, 6.0×10^{-3} in southeastern Tibet, and $4\text{-}5\times10^{-3}$ to the east of Tibet.



(Wang and Xu et al., JGR)

Daily mean of surface heat fluxes (W m^{-2}) from August 1 to 31, 2014

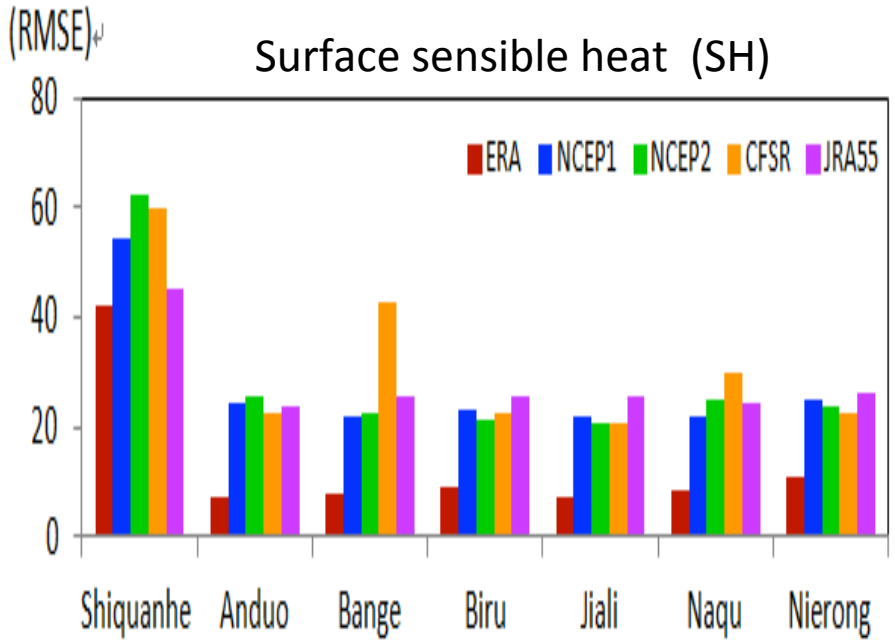


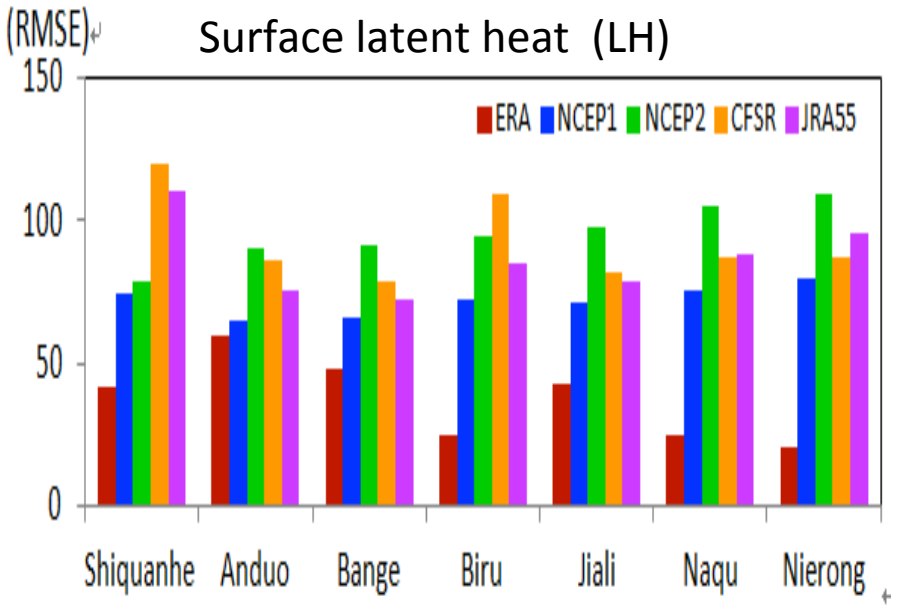


- There is a significant difference between western and central parts of Tibet, and relatively small difference within six sites of central Tibet .
- SH is larger in western Tibet than in central Tibet, but LH is much lower in western Tibet than in central Tibet.

(Zhao et al., BAMS, under review)

Daily RMSE (W m^{-2}) between observation and reanalysis

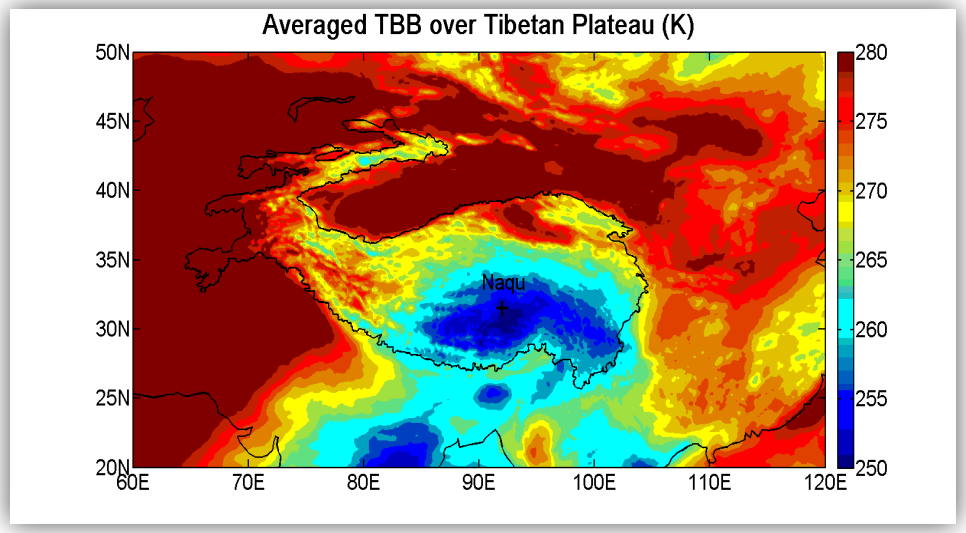




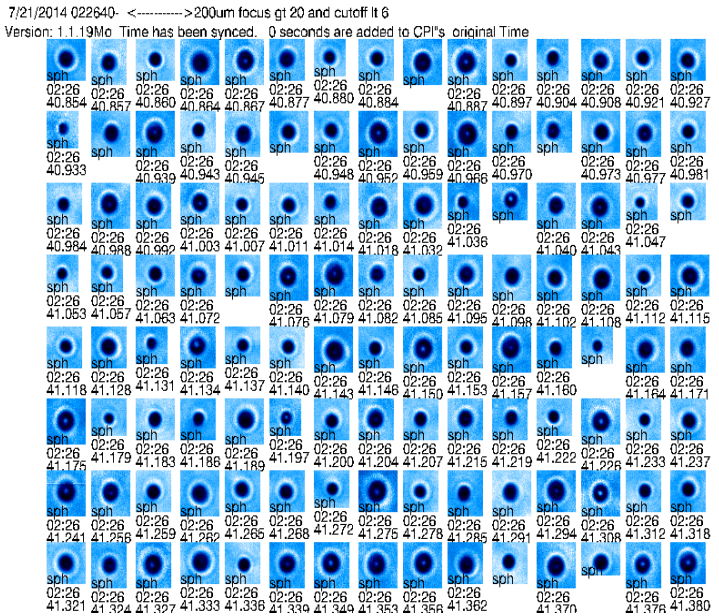
- For *SH*, there are larger root-mean-square error (RMSE) over western Tibet than over central Tibet.
- Compared to *SH*, *LH* generally has larger errors.
- The ERA-Interim dataset has the lowest RMSE compared to other four reanalysis datasets.

➢ Summer cloud physical features over Naqu

Mean TBB in July-August, 2014



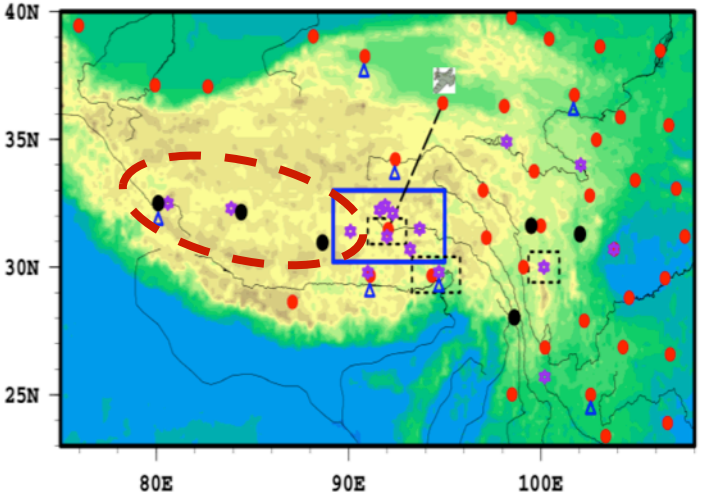
Airborne cloud particle images at Naqu on July 21, 2014



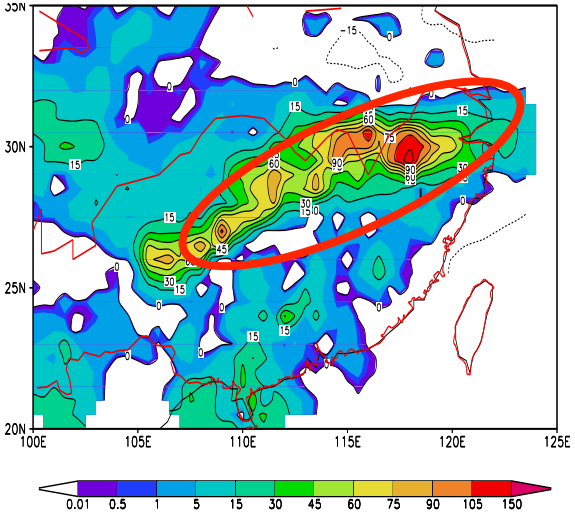
- The lowest TBB appears near Naqu.
- The dominant cloud particles were raindrop-size supercooled water, and there are less ice particles
- This result indicates that these clouds in this process were mainly produced by a warm-cloud process instead of an ice-cloud process.

（Chang and Guo, 2016, Chinese Science Bulletin）

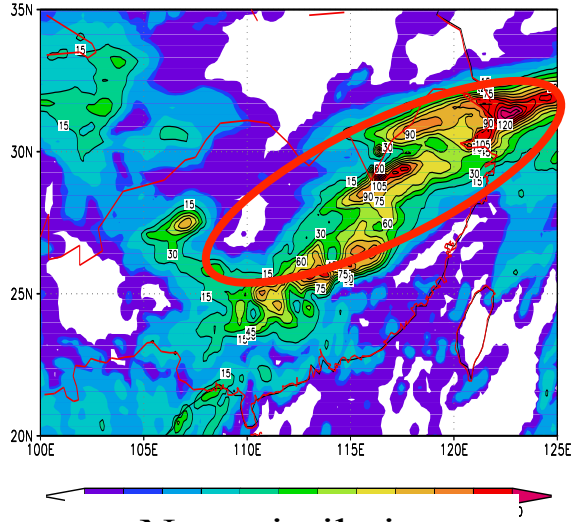
➢ Contribution of intensive radiosonde data over western Tibet to enhancing precipitation forecast



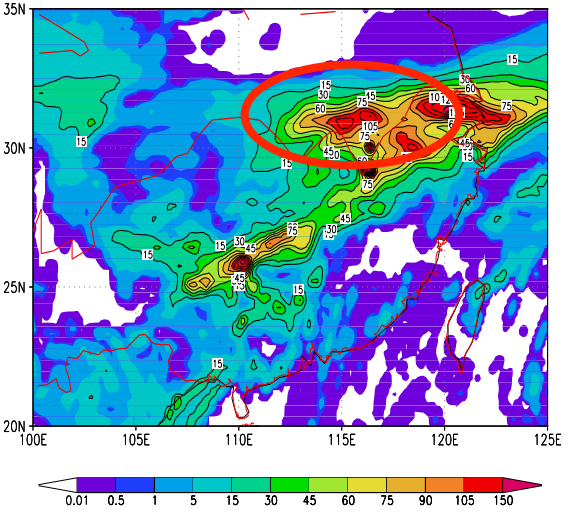
Observed rainfall
(from 08:00 on Jun 7-8, 2015)



With assimilation

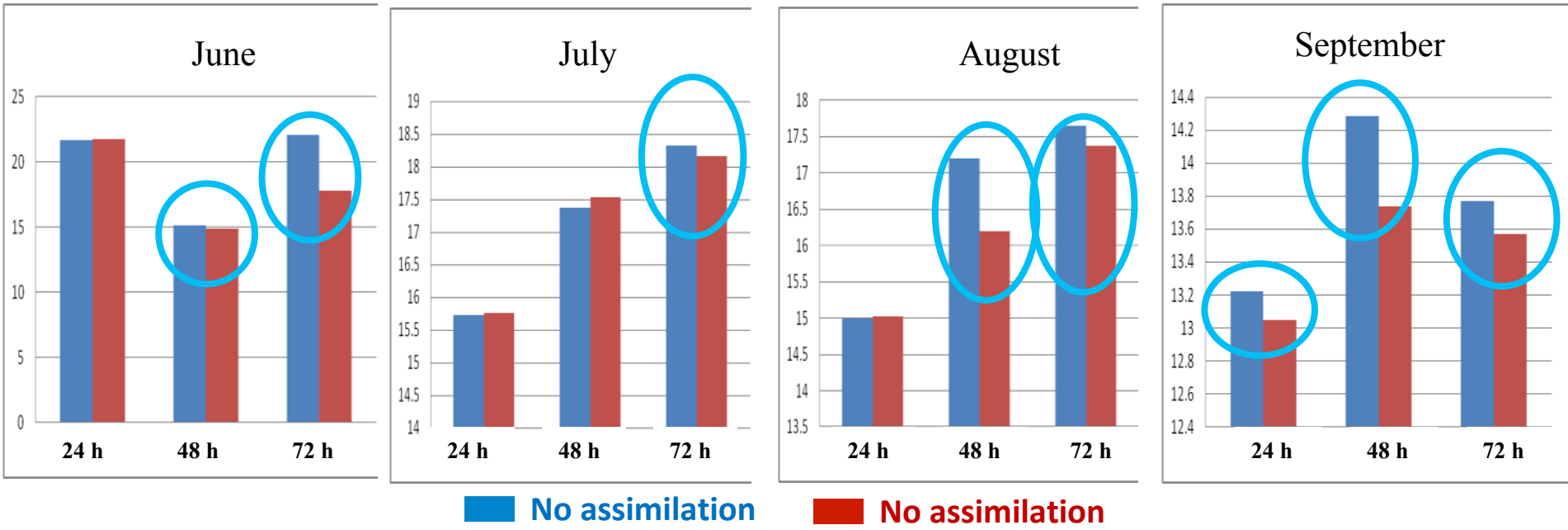


No assimilation



- Using the WRF model system with three-dimensional variational data assimilation (3DVAR), we examine the impact of intensive radiosonde data at Shiquanhe, Gaize, and Shenzha on precipitation forecast.
- When the intensive data are assimilated, the 24-hr rainfall forecast is remarkably improved.

RMSE of 24-hr, 48-hr, and 72-hr rainfall forecasts over the Yangtze River for June, July, August, and September in 2015



- When the intensive data are assimilated, the 48-hr and 72-hr rainfall forecasts over the Yangtze River are improved to some extent, especially for June, August, and September.

- **TIPEX-III was initiated jointly by CMA, CAS, and NSFC, and was designed to conduct a long-term integrated observation by coordinating ground- and air-based measurement facilities.**
- **TIPEX-III have established multiscale land-surface and PBL observation networks over Tibet and a tropospheric radiosonde network over western Tibet, and executed an integrated observation mission for cloud-precipitation physical features and an observation task for atmospheric ozone, aerosol, and water vapor.**
- **Some TIPEX-III data have been applied to analyze the features of surface heat fluxes, cloud particle properties, and to improve the precipitation forecast skill.**

Data share policy

- **The validated TIPEX-III data will be open to the domestic and international scientific communities.**

- **When meteorologists complete the quality control of observation data and the product generation, the TIPEX-III data will be released after a data-protection period of 1 year.**

- **http://data.cma.cn/tipex; Email: tipex3@camscma.cn**


Thank you!