



EGU 2020, 7th May 2020

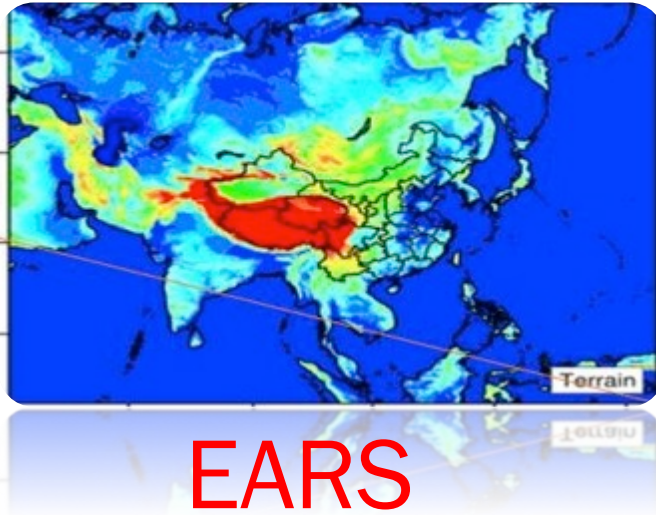


East Asia Reanalysis System of CMA

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Chinese Academy of Meteorological Sciences (CAMS), Beijing, China**

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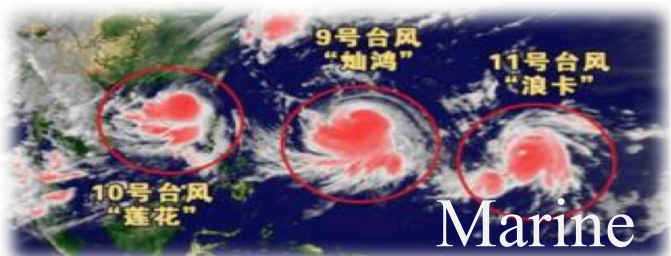
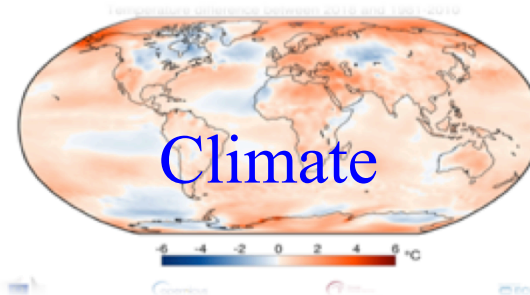
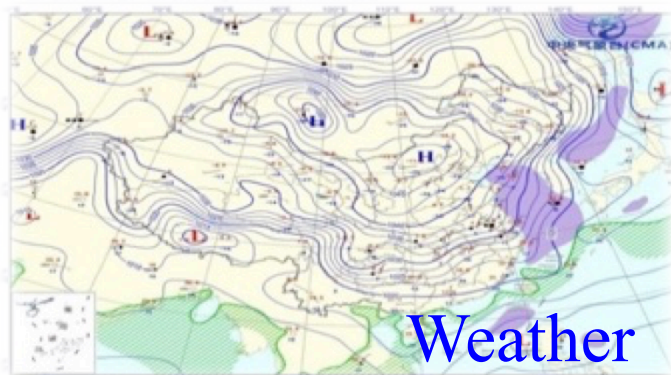


East Asia Reanalysis System

- Motivation and Goals
- East Asia Reanalysis System (EARS)
- Data for EARS
- Preliminary results
- Summary

Motivation and Goals

Reanalysis data has been widely utilized in different fields.

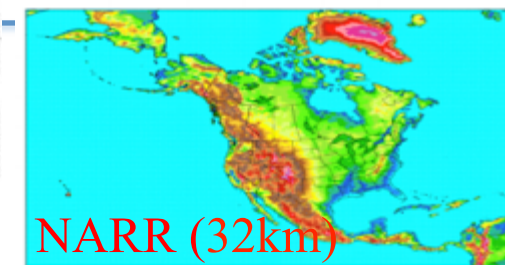
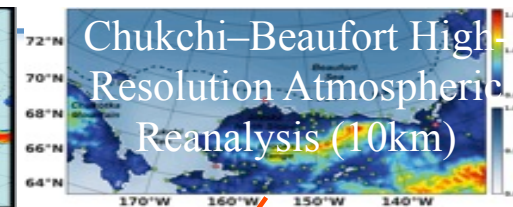
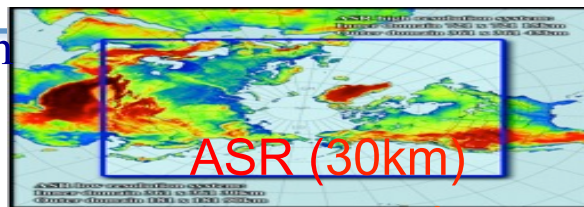
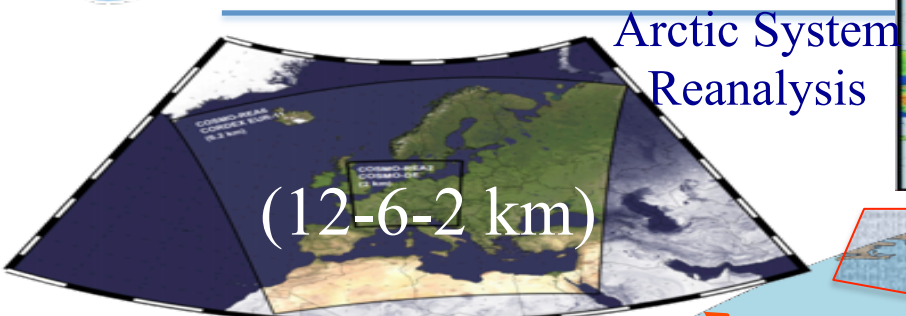


Reanalysis
Data

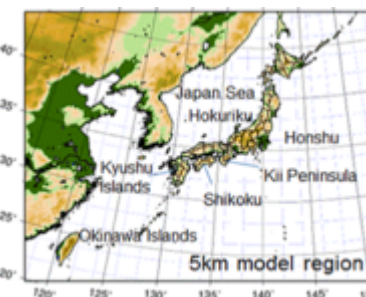




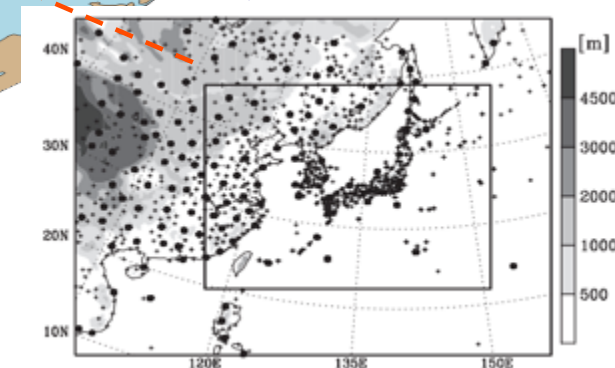
Motivation and Goals



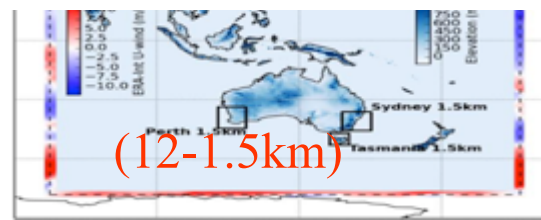
North American Regional Reanalysis



NHM-LETKF

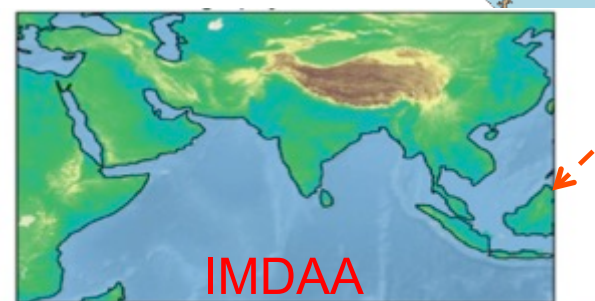
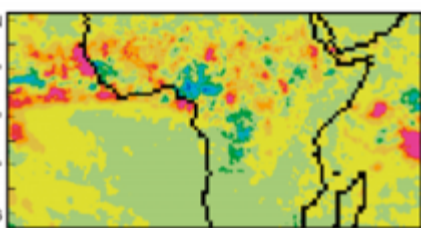


Bureau of Meteorology Atmospheric high resolution Regional Reanalysis for Australia



High-resolution Regional Reanalysis for the European CORDEX

EARS (East Asian Reanalysis System)



Indian subcontinent

Goals

- Develop East Asia Reanalysis System (EARS) which can assimilate high density observations over East Asia.
- Establish high-resolution reanalysis data for regional weather and climate studies.
- Generate finer reanalysis data (~ 3 km) for special areas, such as the Tibetan Plateau.

Summary of the project

Launched by the China Meteorological Administration (CMA), supported by the National Department Public Benefit Research Foundation

Supported by the National Key Research and Development Program of China

Ten-year (2008-2017) datasets version 1

Ten-year (2008-2017) datasets version 2 with radar data used, and finer domain nested

Seventy-year (1950-2020) datasets with conventional data used

2015

2017

2019

2020

2021

PI



Chinese Academy of Meteorological Sciences (CAMS), CMA



National Meteorological Information Center, CMA



Guangdong Ocean University



Institute of Atmospheric Physics, CAS



Jiangsu Institute of Meteorological Sciences

Participants



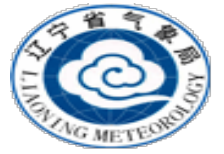
CMA Meteorological Observation Centre



National Satellite Meteorological Centre



Lanzhou University

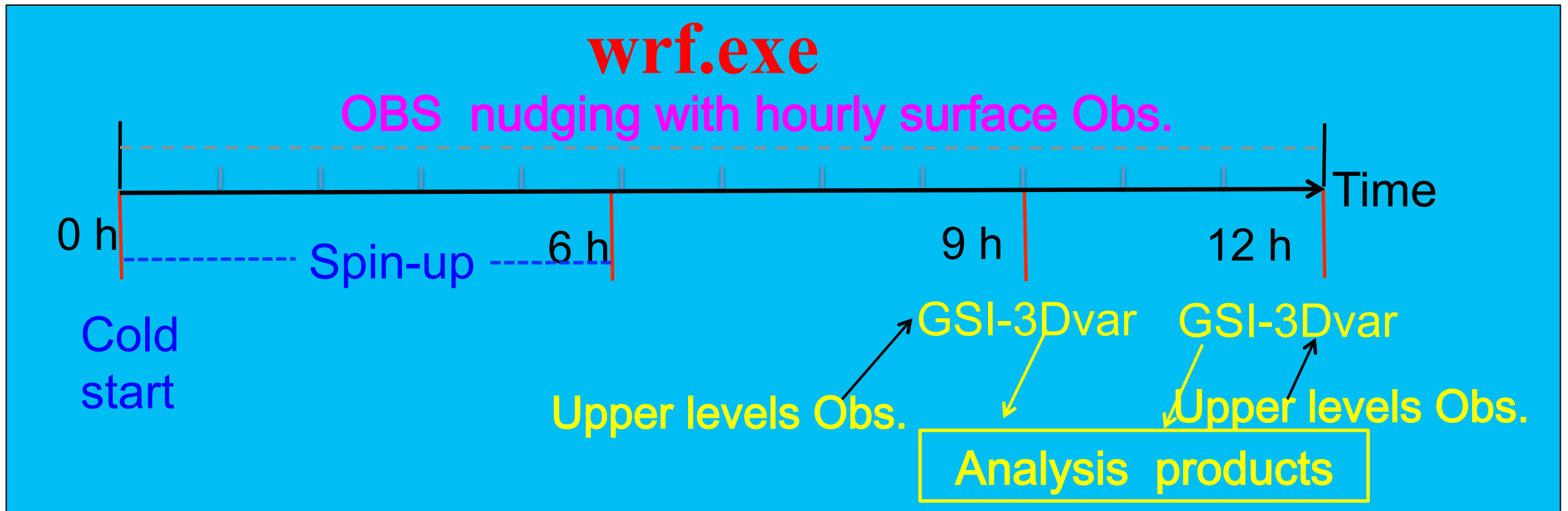


Institute of Atmospheric Environment, CMA, Shenyang

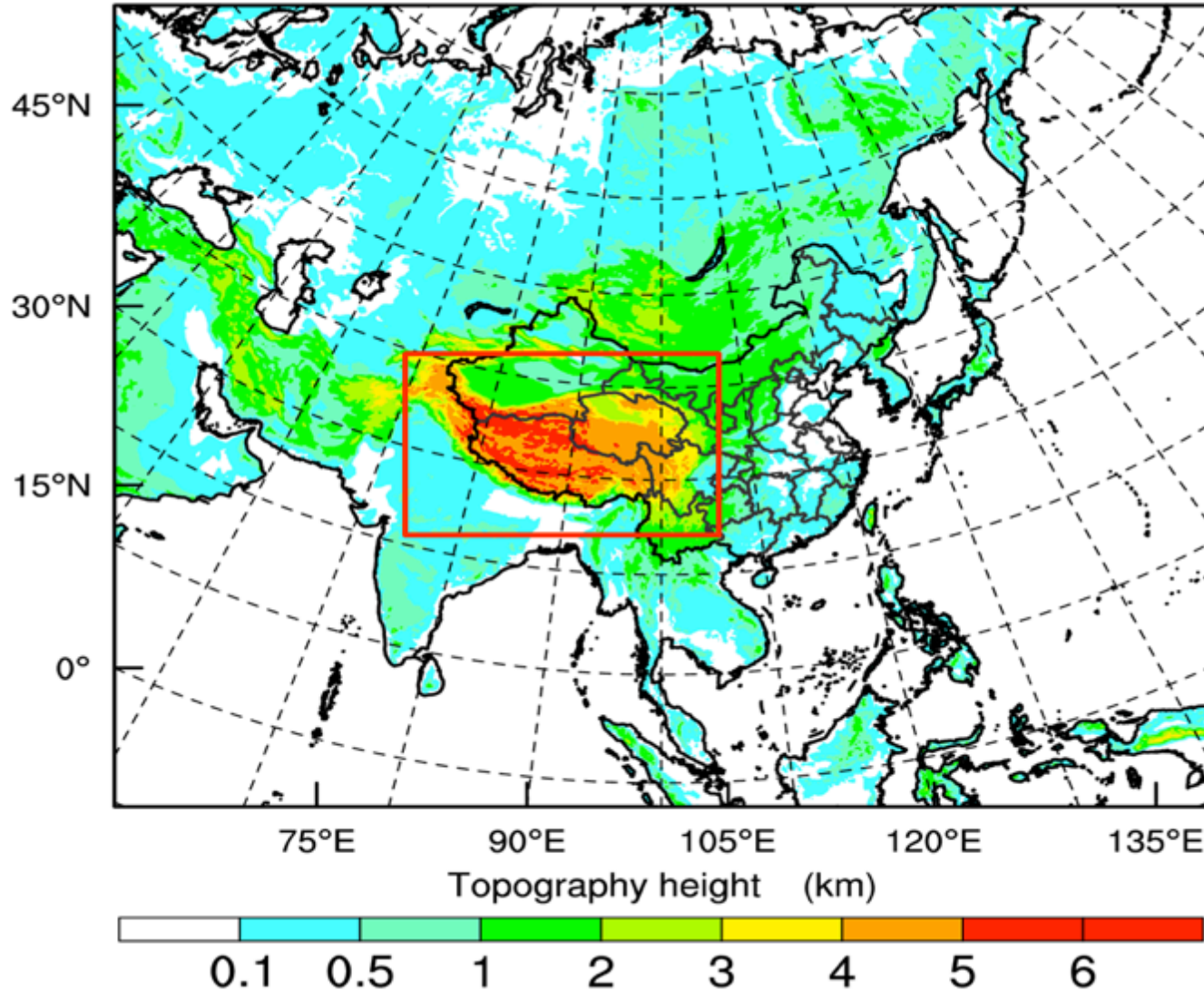
WRF Model

GSI System

Postprocesses



Flow chart of the EARS



The domain of EARS

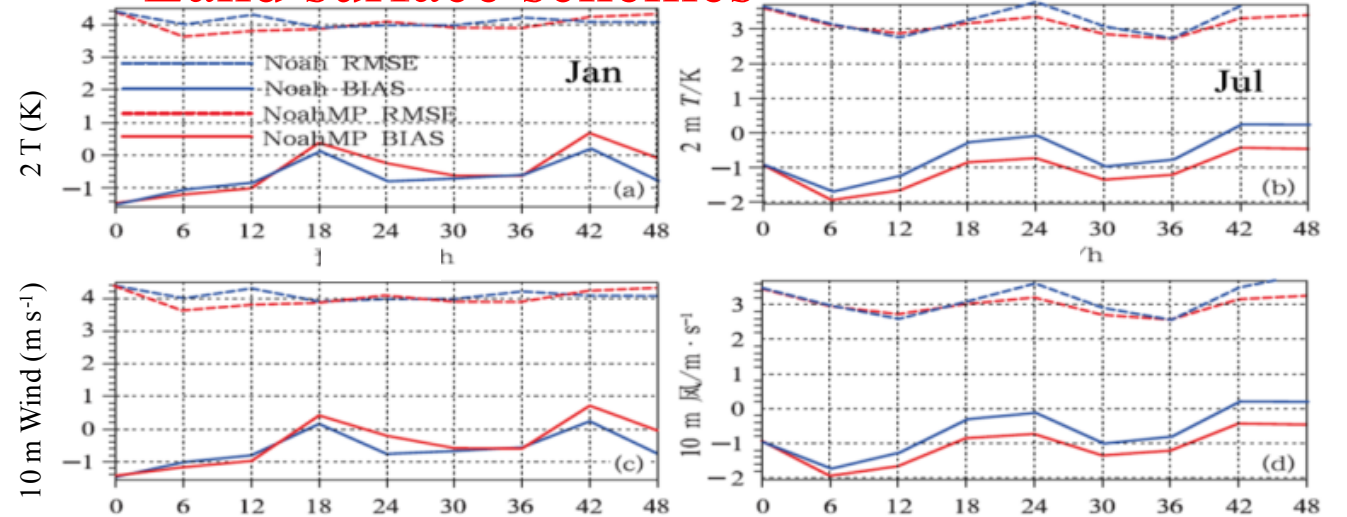
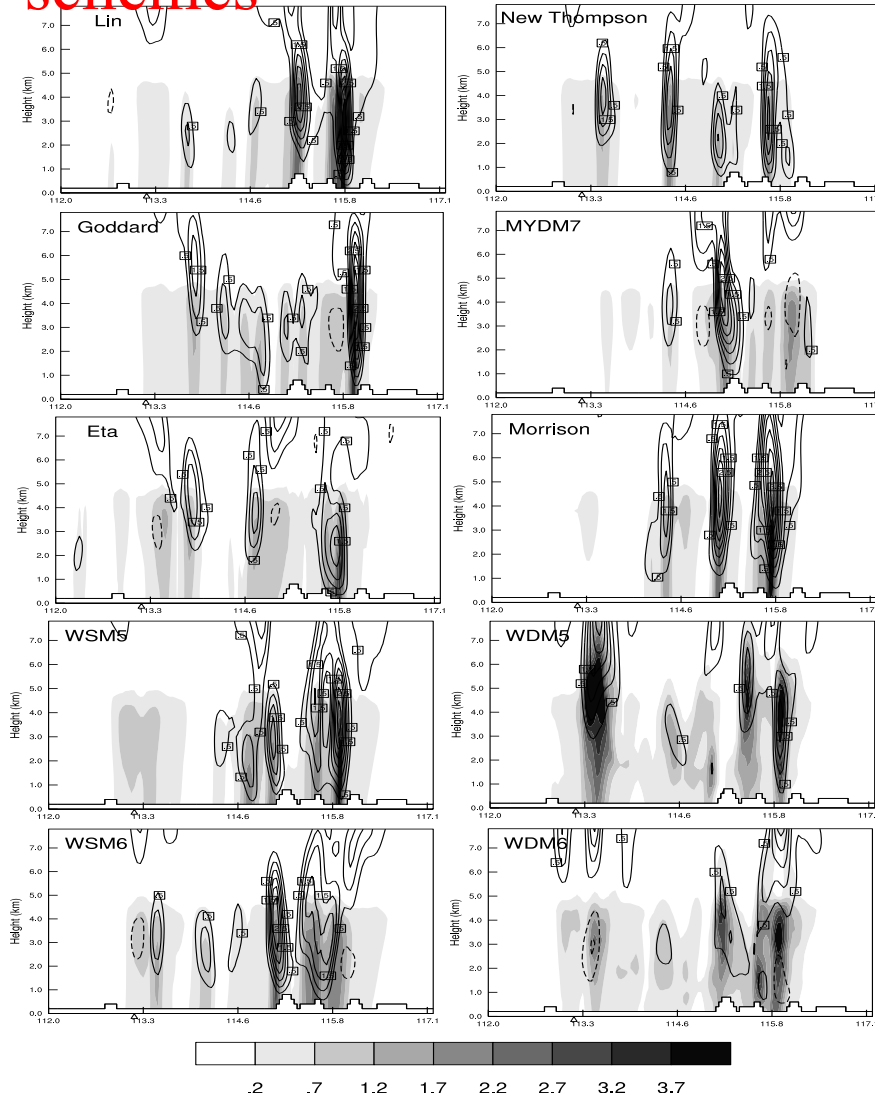
East Asia Reanalysis System (EARS)

- WRF(v3.9.1) + GSI(v3.5)
- 3Dvar ± 0.5 h
- Nx (900) \times Ny(760) \times 74 lev
- Dx 12 km
- Model top 10 hPa
- ERA-Interim (Model level)
- 3-hour reanalysis
- Thompson microphysics scheme
- Kain-Fritsch (new Eta) scheme
- Yonsei University PBL scheme
- Rapid radiative transfer model
- NOAH-MP land-surface scheme
- MM5 M-O surface layer scheme
- 21-class MODIS land use
- USGS GMTED2010 terrain

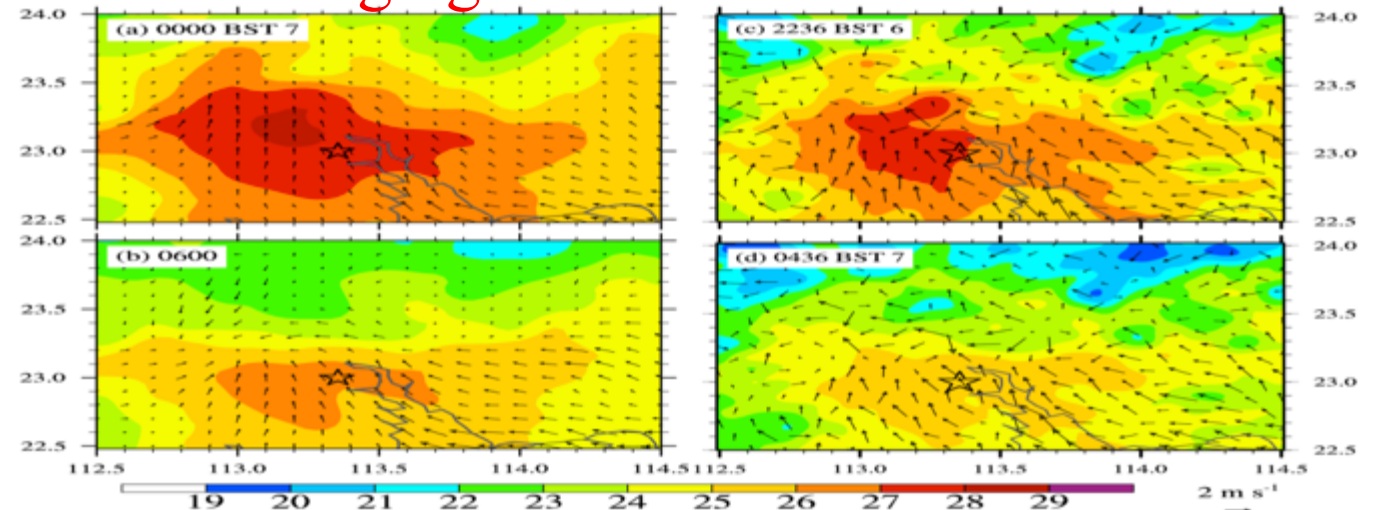
Physic schemes were chosen and tuned based sensitive experiments

MP schemes

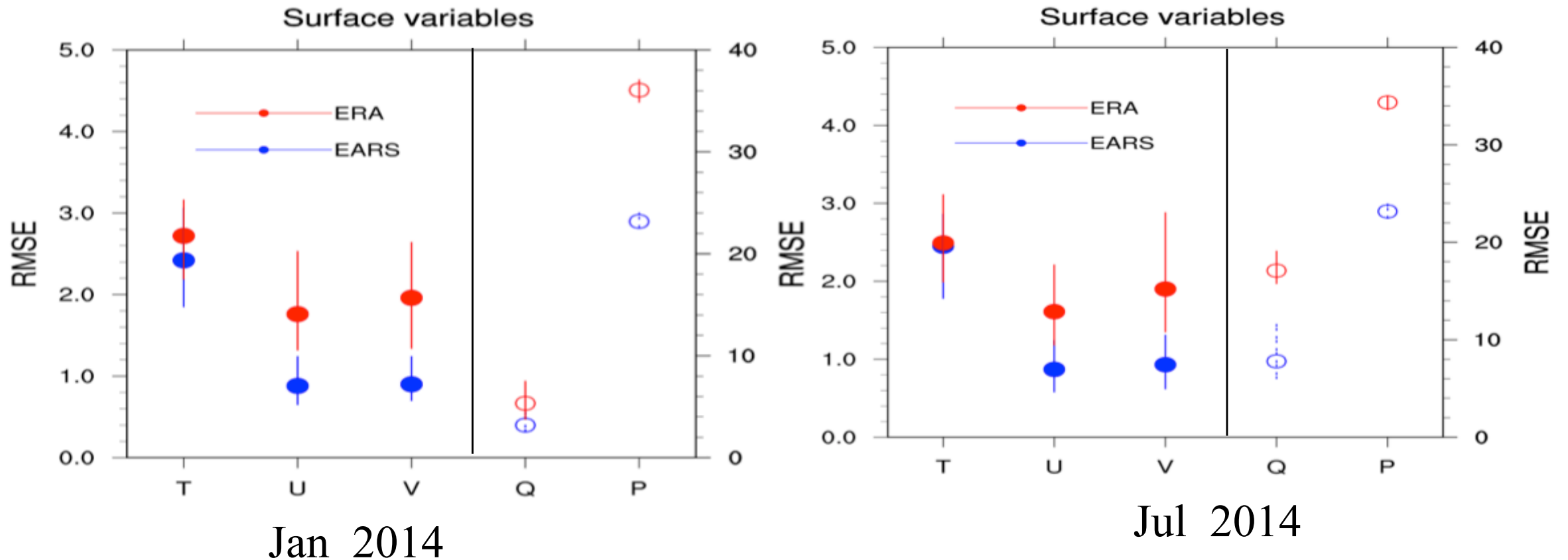
Land surface schemes



OBS nudging with surface Obs.



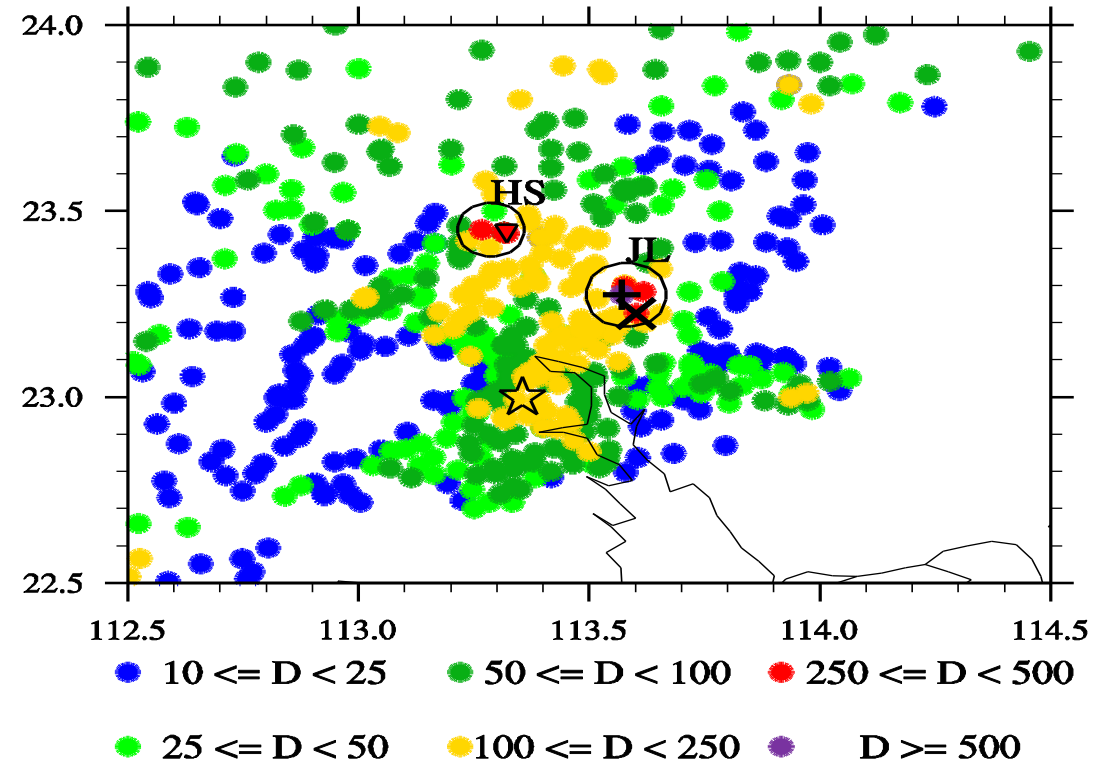
Comparisons of the RMSE between model output (downscaling only) with ERA-Interim(ERA) for Jan and July of 2014.



Nudging method for surface observations

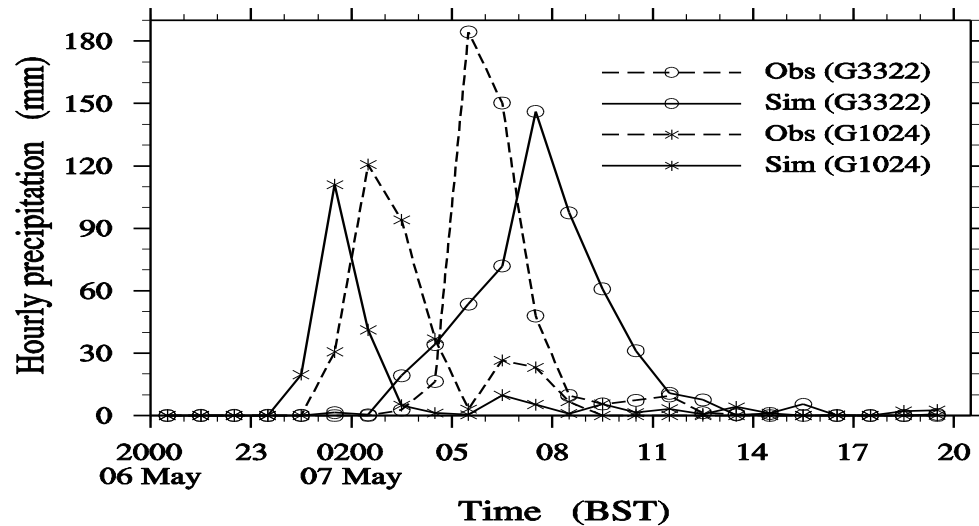
Test for a rainfall case on
7 May 2017, GuanZhou

Yin Jinfang, Dalin Zhang, et al., 2020,
Mon. Wea. Rev., 148(3), 955–979.



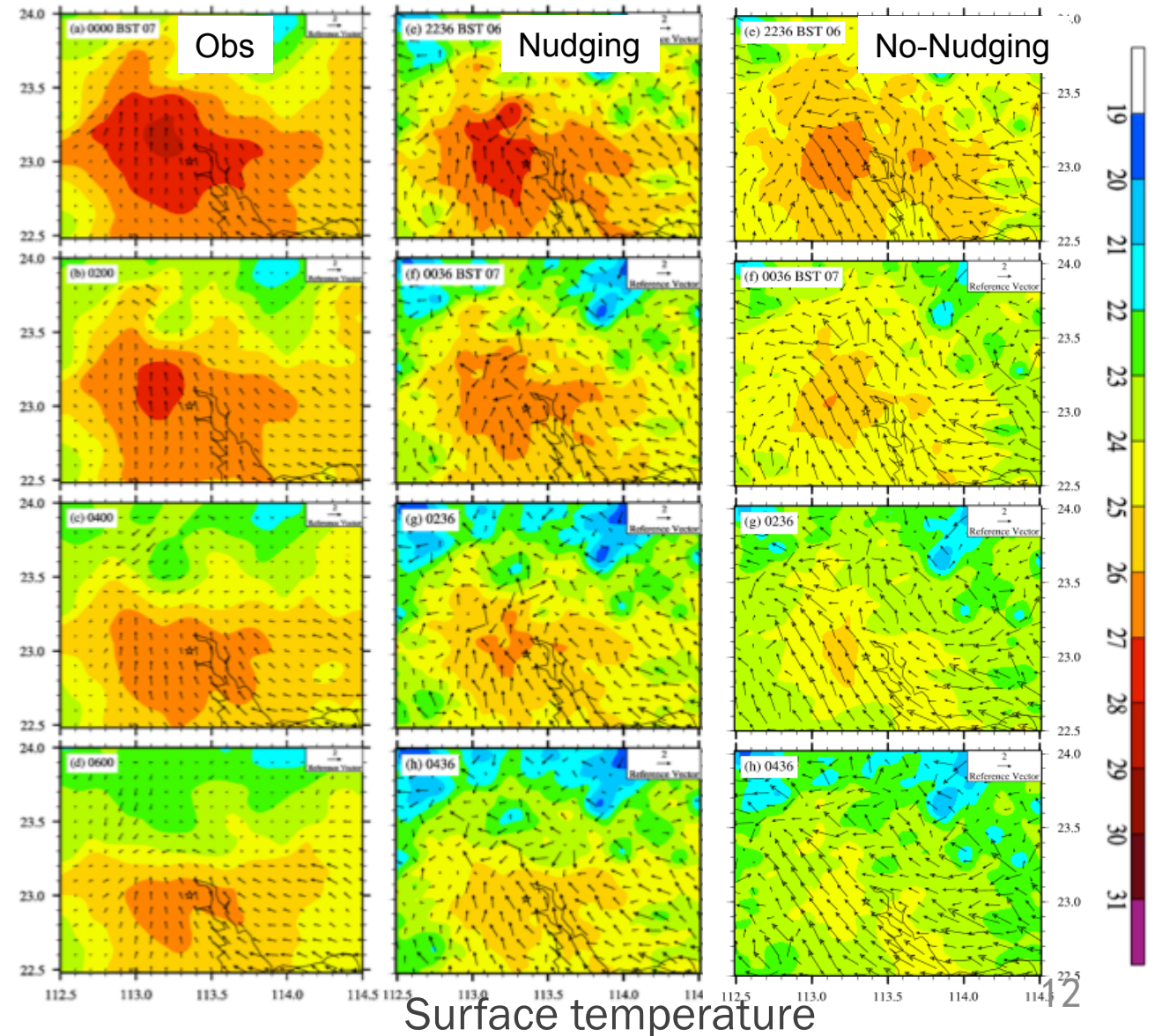
Accumulated precipitation records:
524 mm/24h, 382 mm/3h, 184 mm/1h

Nudging method for surface observations



Observed and simulated rainfall of two stations

Assimilating surface observation using Nudging captured the characteristic of the urban heat island and corresponding rainfall pattern.



Surface temperature

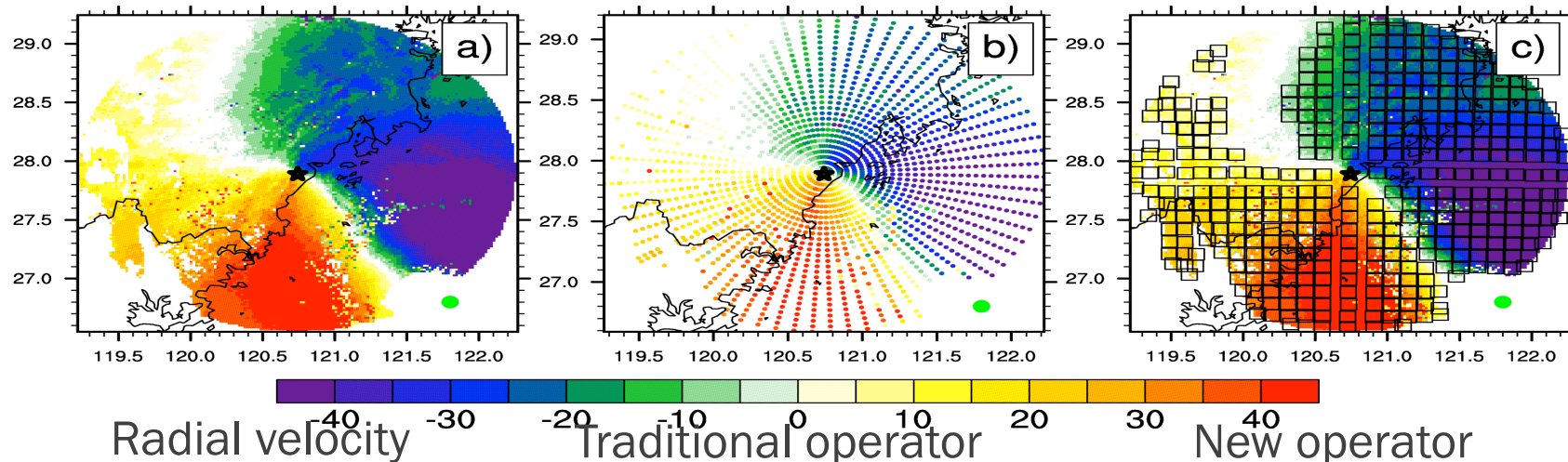
Org: $V_r^* = u \cos \theta \cos \varphi + v \sin \theta \cos \varphi + w \sin \varphi$

New:

$$\begin{cases} \frac{\sum_{\Omega} V_r \cos \theta}{\sum_{\Omega} \cos^2 \theta} = \bar{u} \frac{\sum_{\Omega} \sin \theta \cos \theta}{\sum_{\Omega} \cos^2 \theta} + \bar{v} \\ \frac{\sum_{\Omega} V_r \sin \theta}{\sum_{\Omega} \sin^2 \theta} = \bar{u} + \bar{v} \frac{\sum_{\Omega} \sin \theta \cos \theta}{\sum_{\Omega} \sin^2 \theta} \end{cases}$$

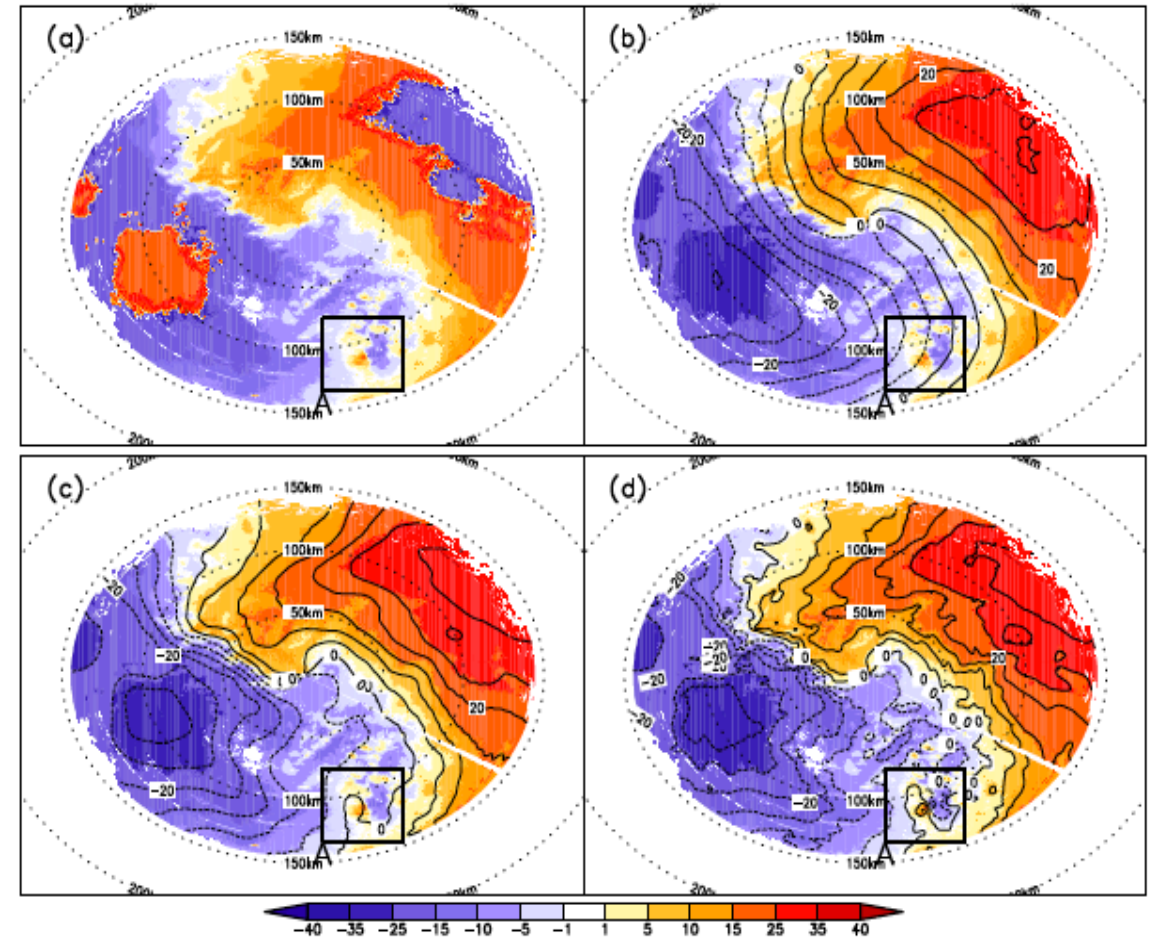
An improved observation operator for Doppler radar radial velocity assimilation was proposed and coupled into the GSI.

Chen Feng, Liang Xudong et al., 2017, *Mon. Wea. Rev.*, 145, 4187-4203.



An IVAP-Based Dealiasing Method for Radar Velocity Data Quality Control was developed

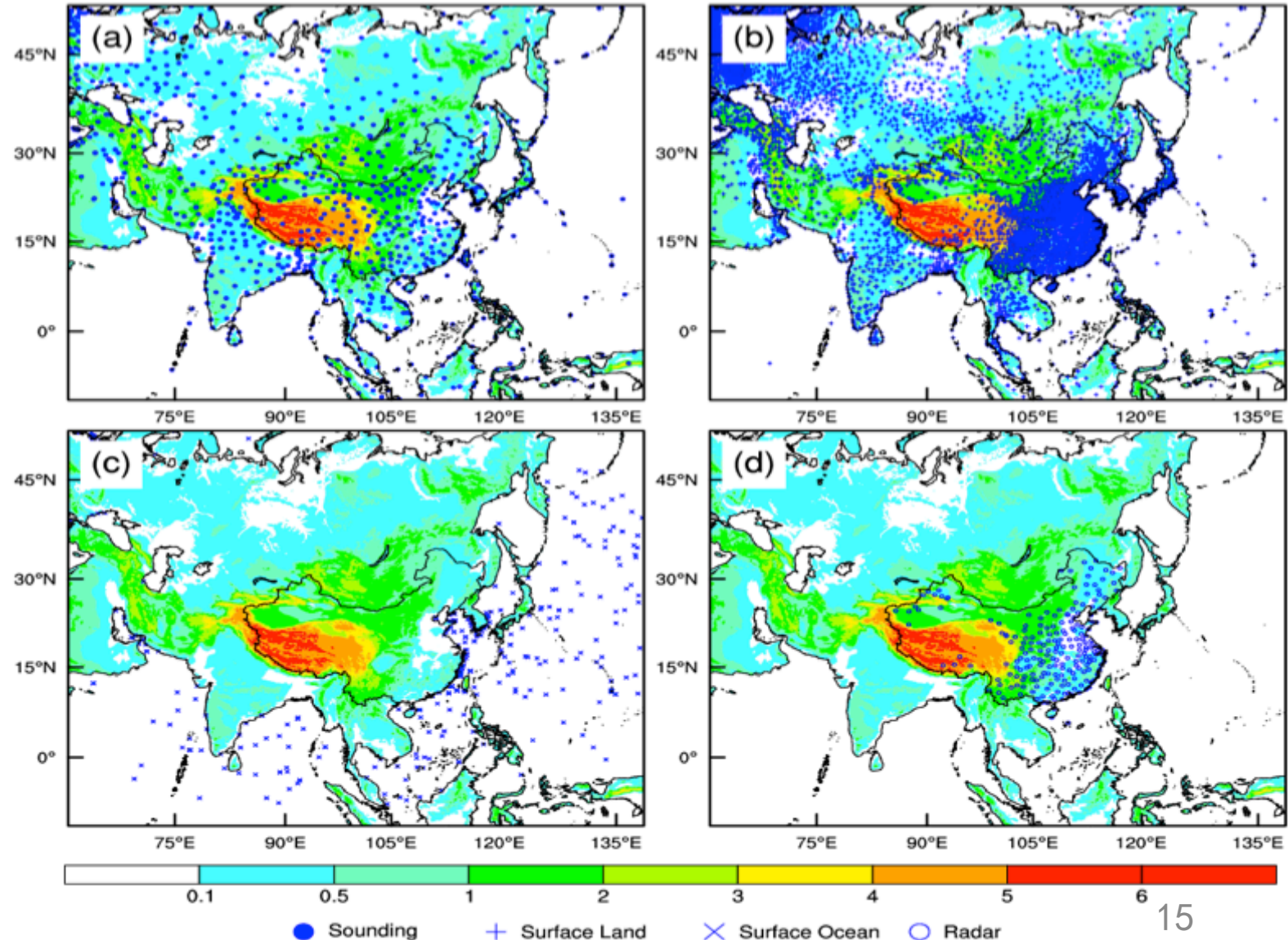
Liang Xudong, Yanxin Xie, Jinfang Yin et.al., 2019, *J. Atmos. Oceanic Technol.*, 36, 2069 - 2085.



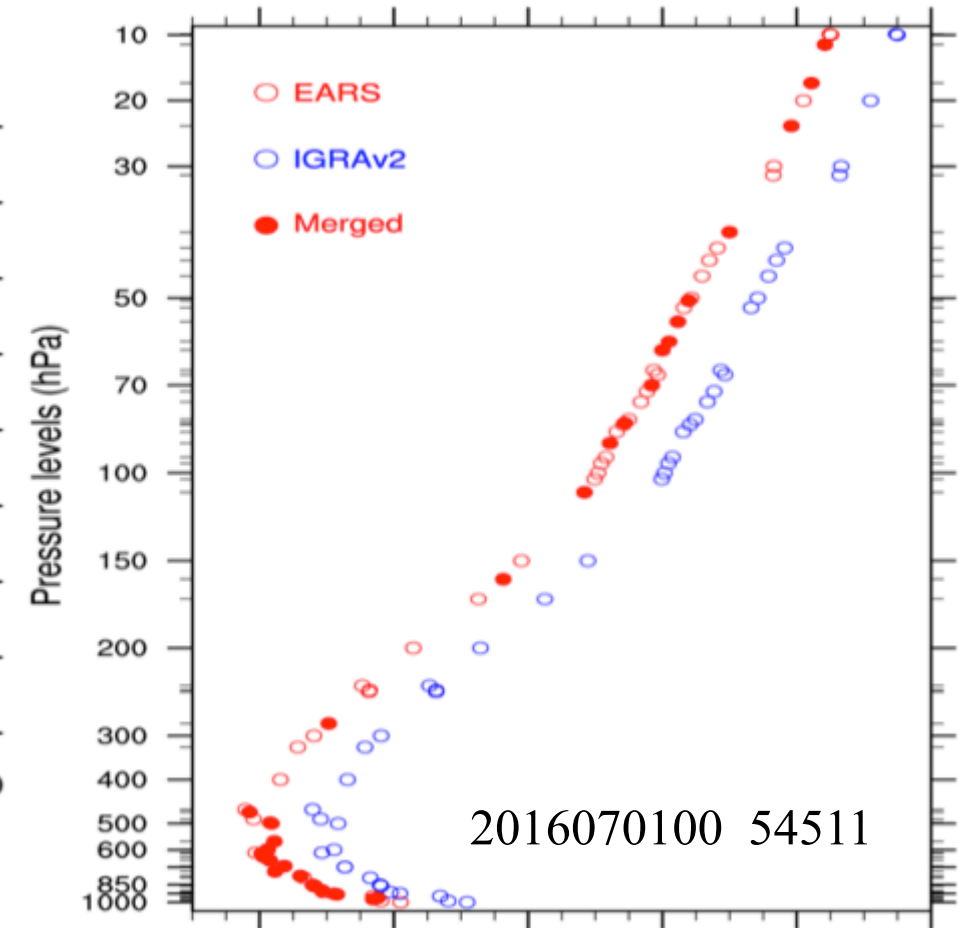
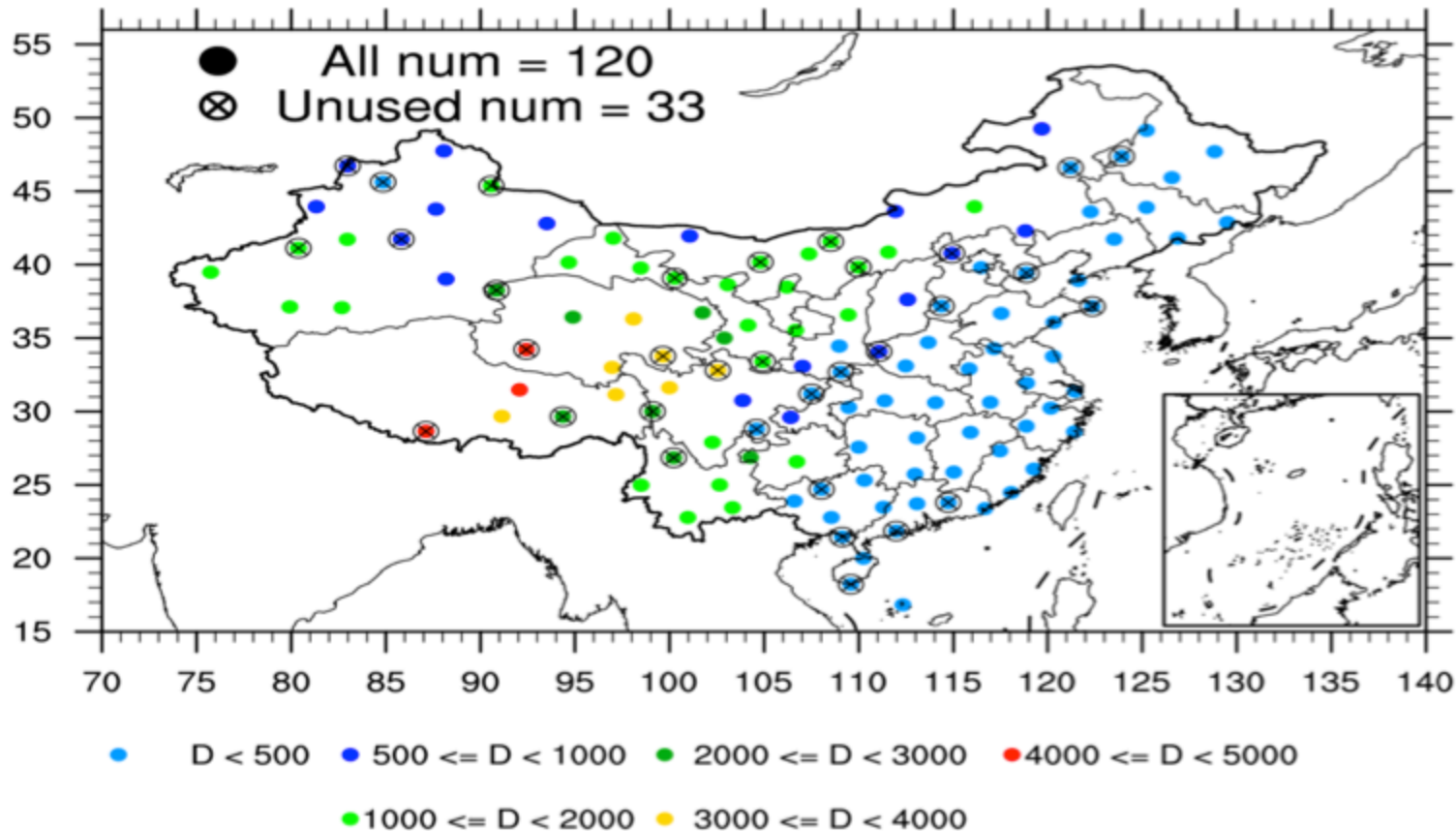
(a) Raw and (b) – (d) dealiased radar radial velocites

Background & observations

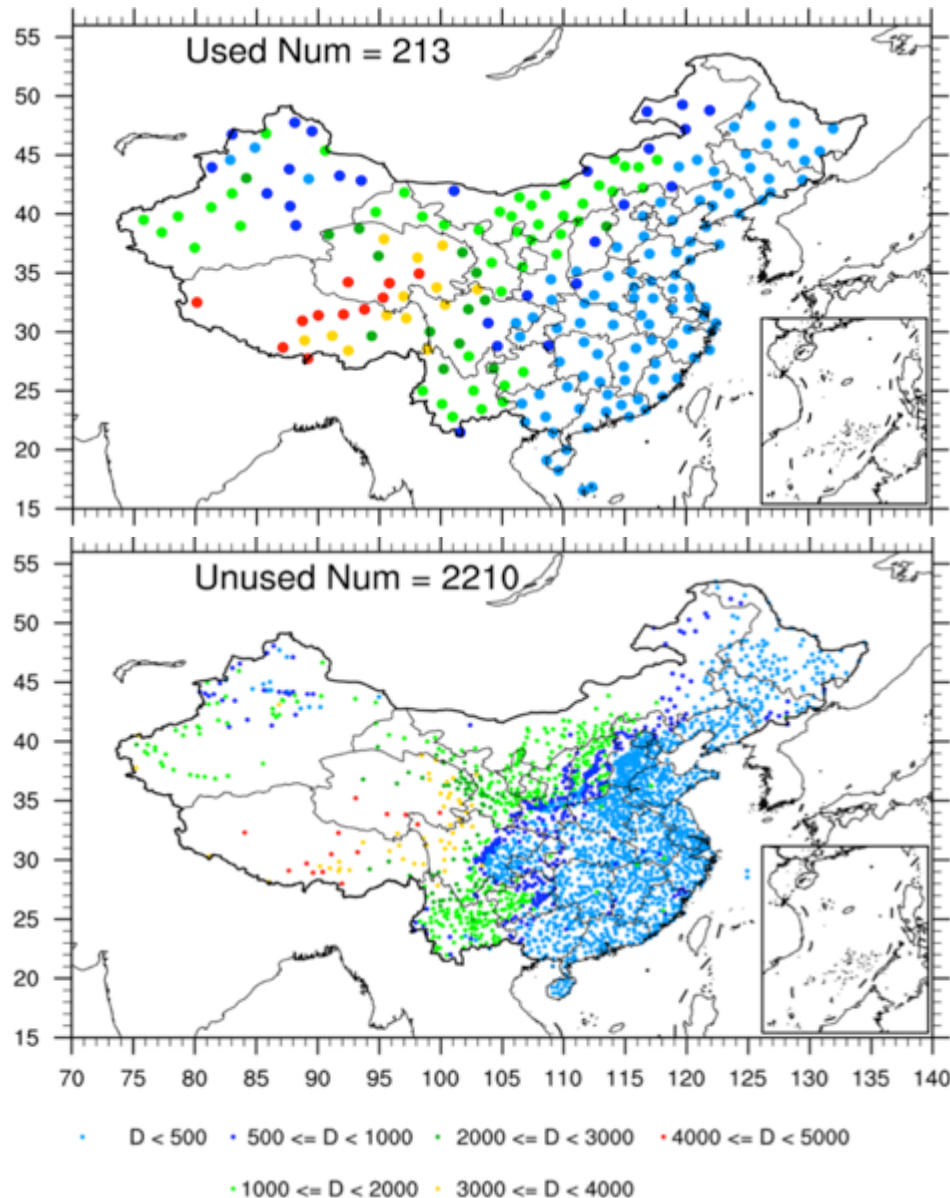
- The ERA-Interim (ERA) 0.79-degree analysis data at 6-h intervals are utilized as initial and boundary conditions for the cold run.
- Surface observations -> OBS nudging
- Radiosonde observations -> 3D-Var
- Aircraft observations -> 3D-Var
- Radar radial wind -> 3D-Var
- Radar reflectivity -> Cloud analysis



Radiosonde data collection and quality control



Based on the Integrated Global Radiosonde Archive (IGRA) Version 2, 120 radiosonde stations in China were used with more than 100 vertical levels.

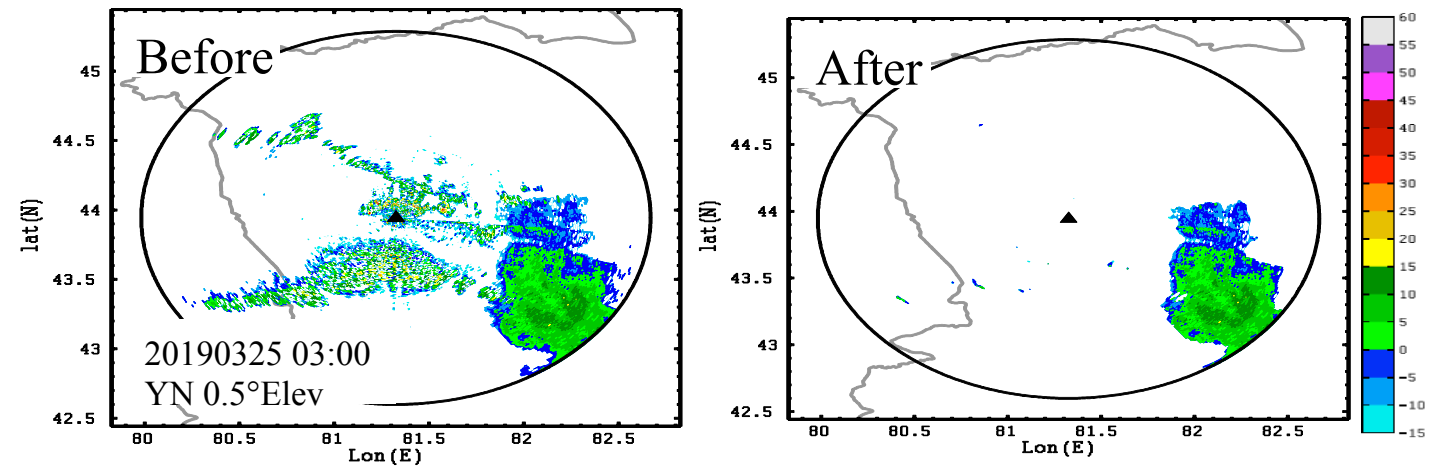
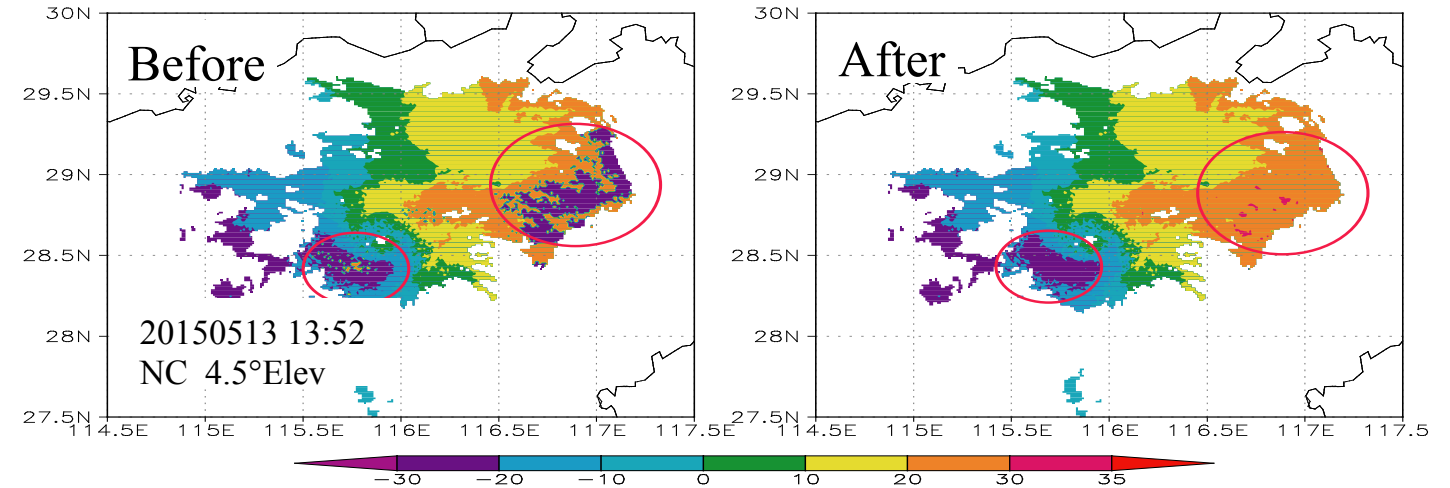
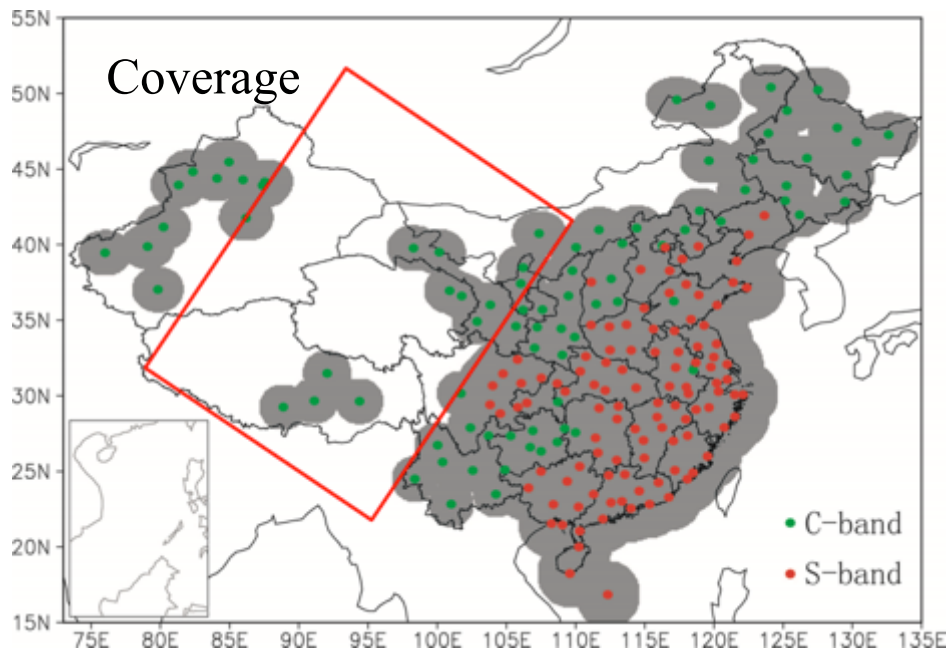


Surface data collection and quality control

Based on the Integrated Surface Database (ISD) and Global Data Assimilation System (GDAS), more than 2200 surface stations were used at present. In the future, datasets from the intensified automatic surface weather system (over 60, 000) will be introduced.

Radar data collection and quality control

Observations of about 200 (different in each year) Doppler radars were employed.



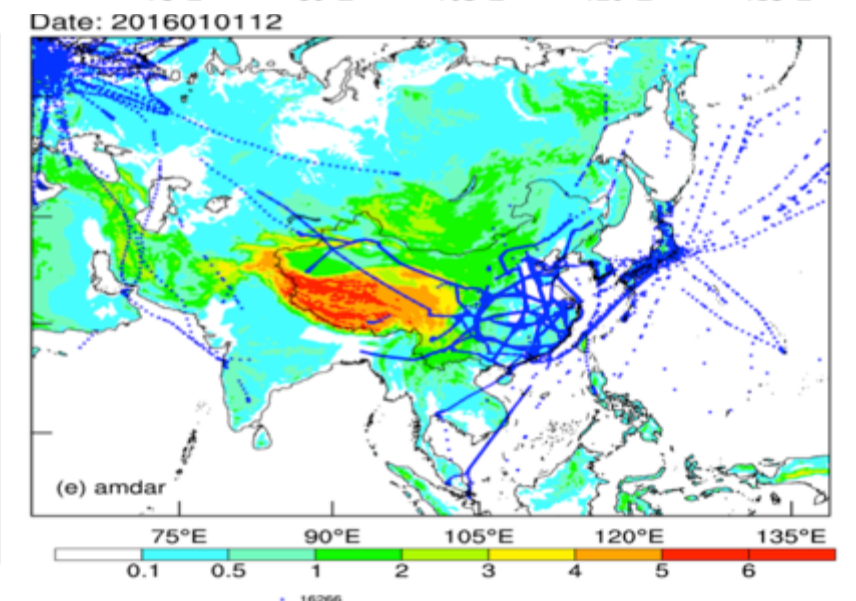
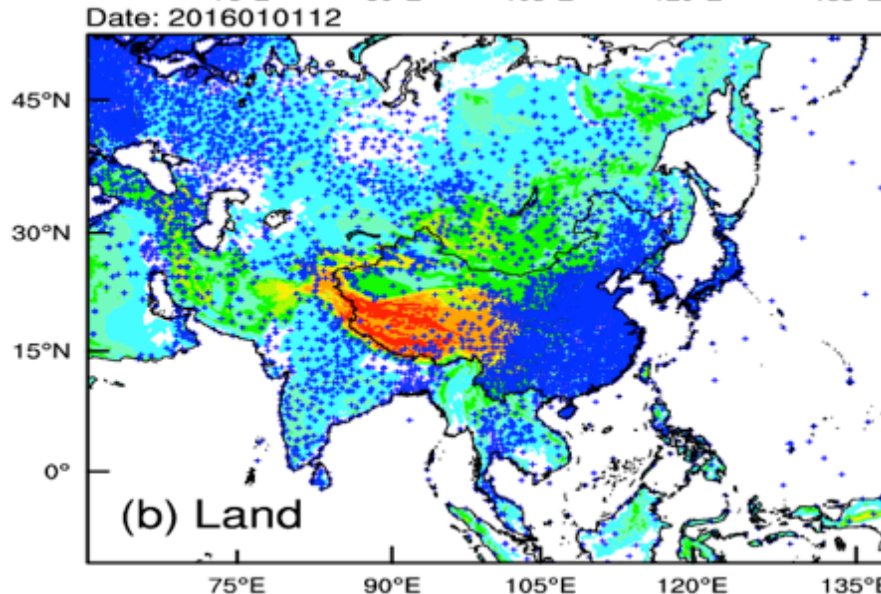
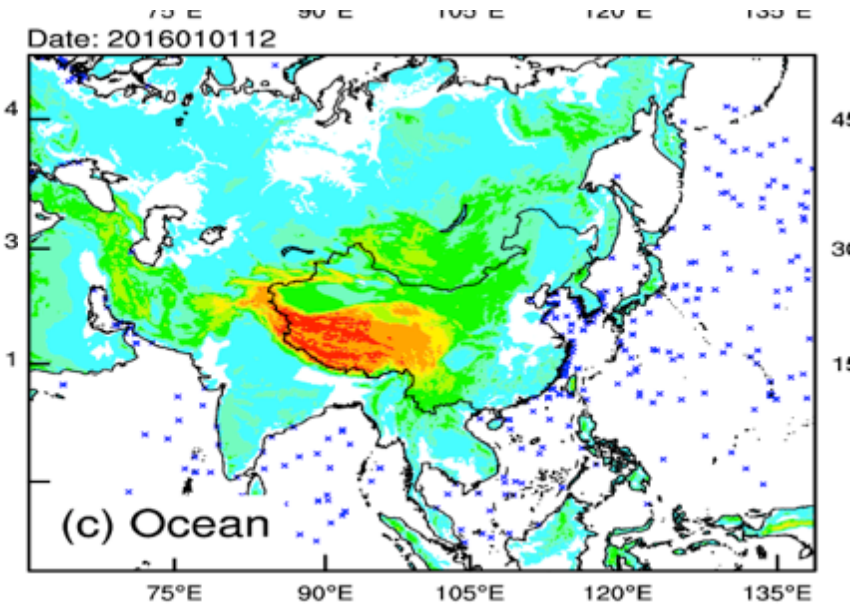
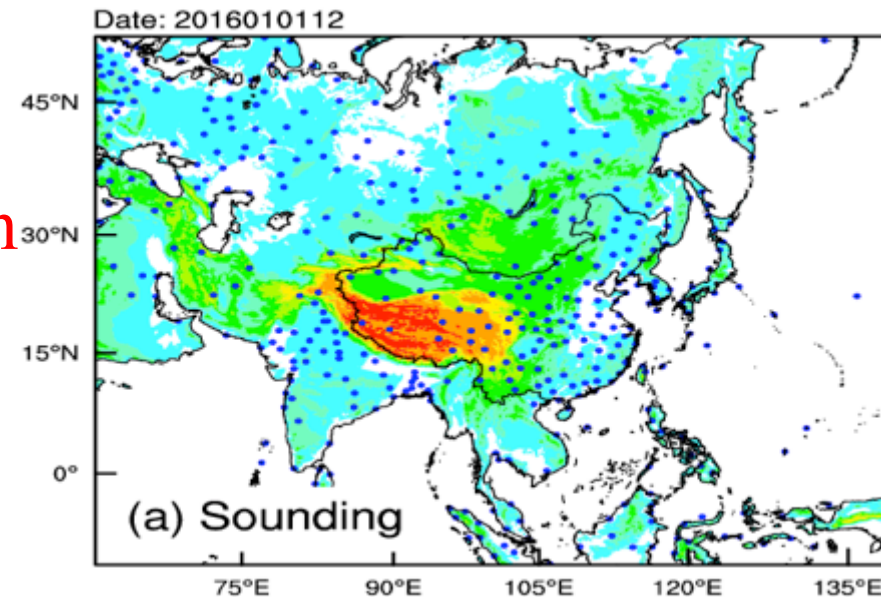
Examples of data quality control

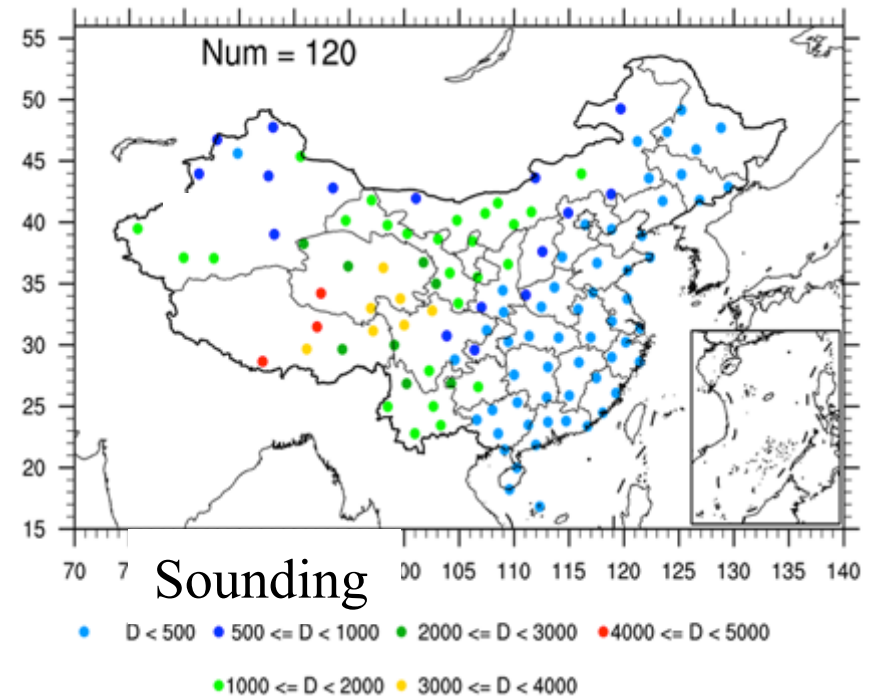
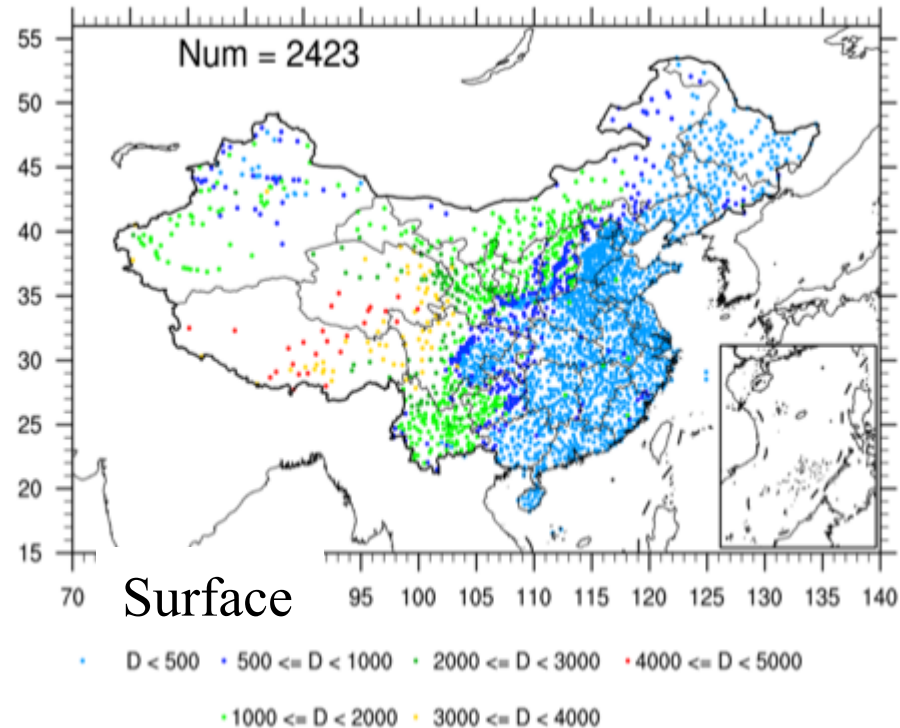
10 years (2008 - 2017)
reanalysis data has been
developed.

Resolution: 12-km

Observations:

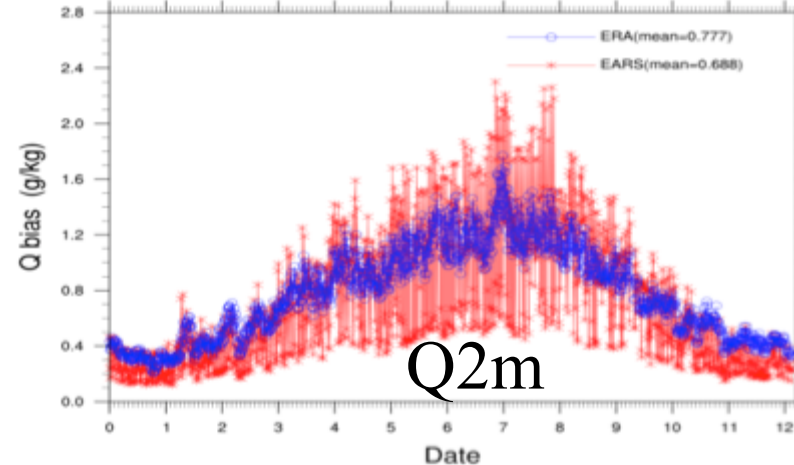
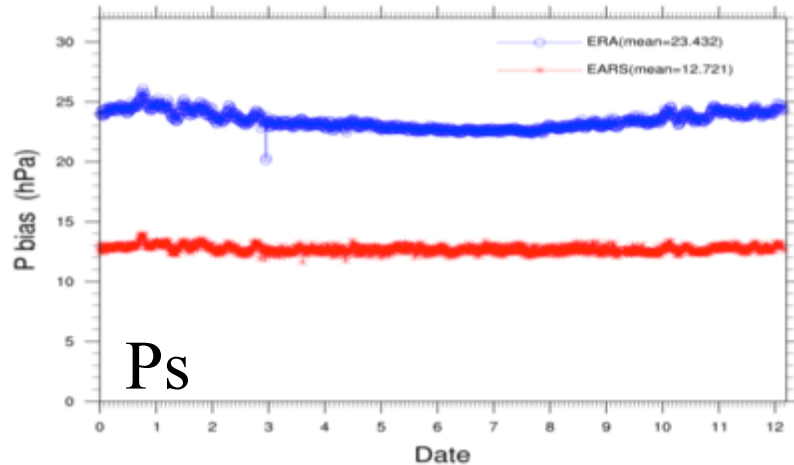
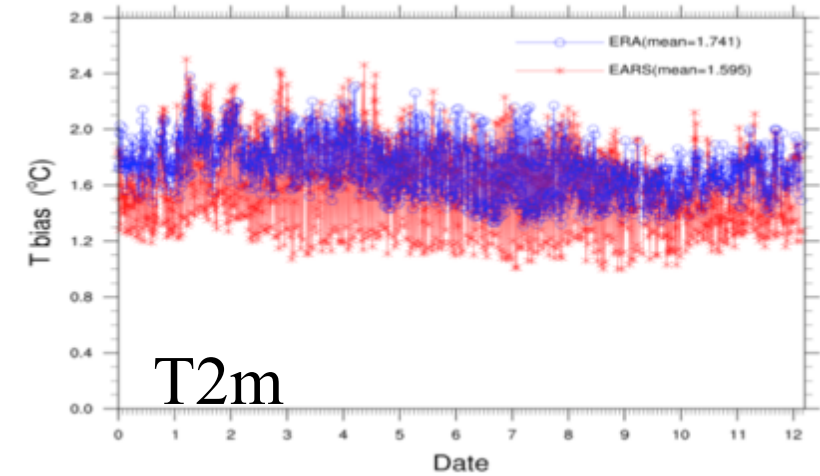
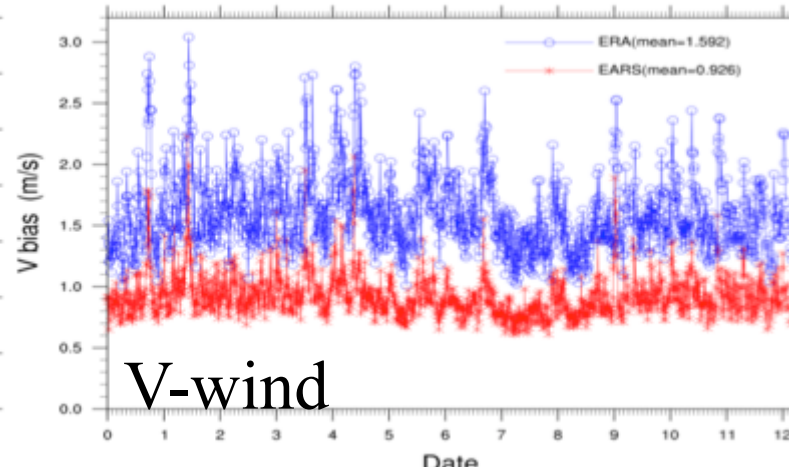
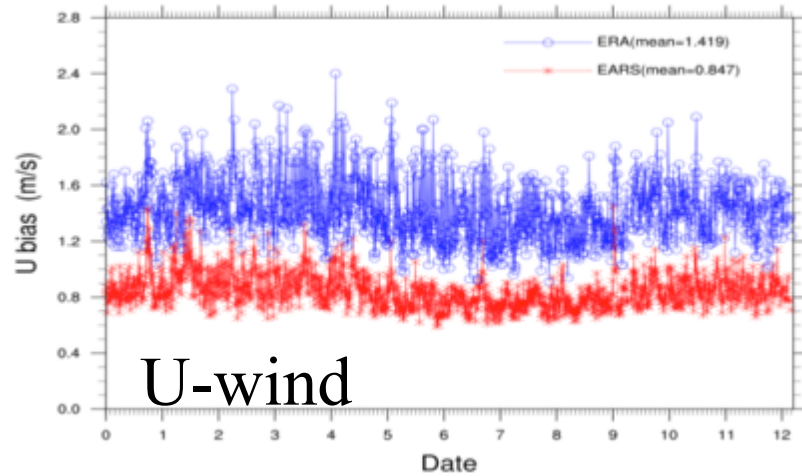
- surface observation
- radiosonde
- air plan report





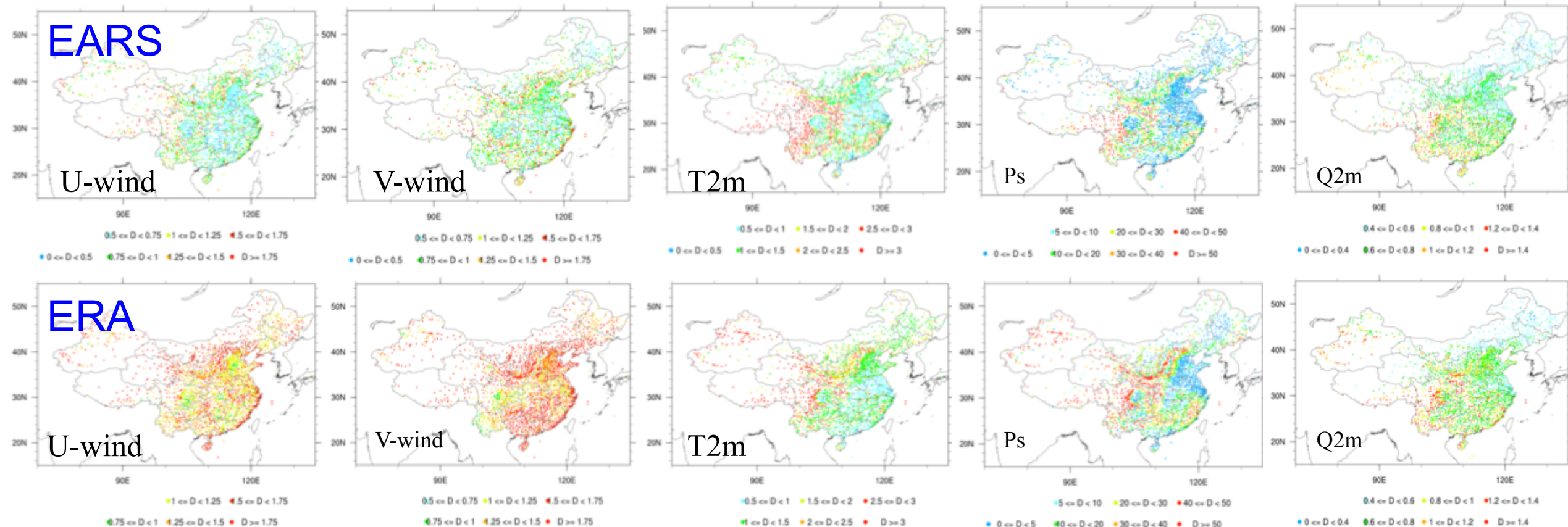
The EARS data are verifying with surface and radiosonde observations in term of absolute error (AE) and root mean square error (RMSE).

Comparing ERA-Interim (ERA) and East Asia Reanalysis System (EARS) in terms of absolute bias for 2016.



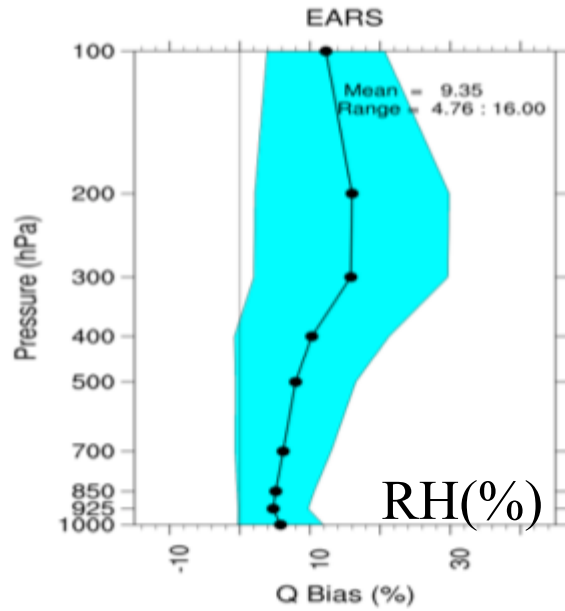
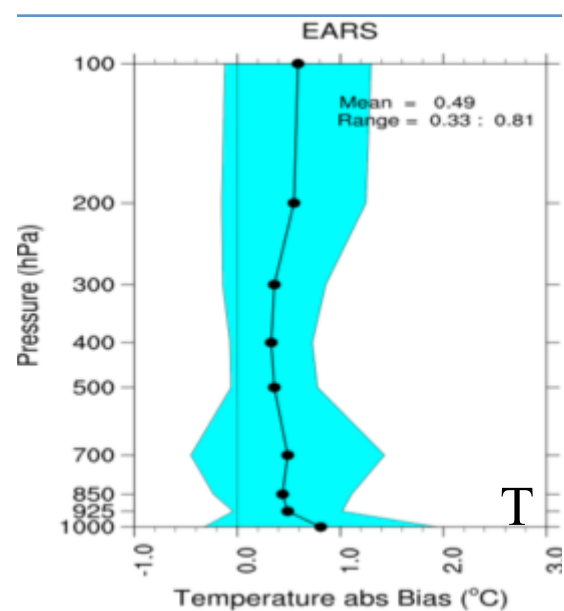
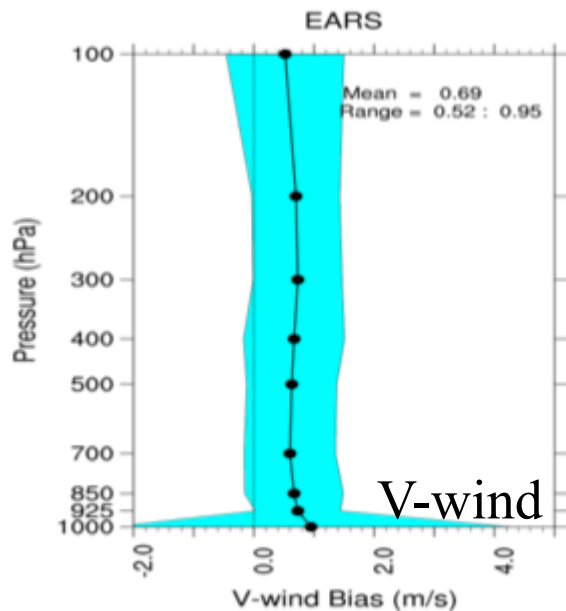
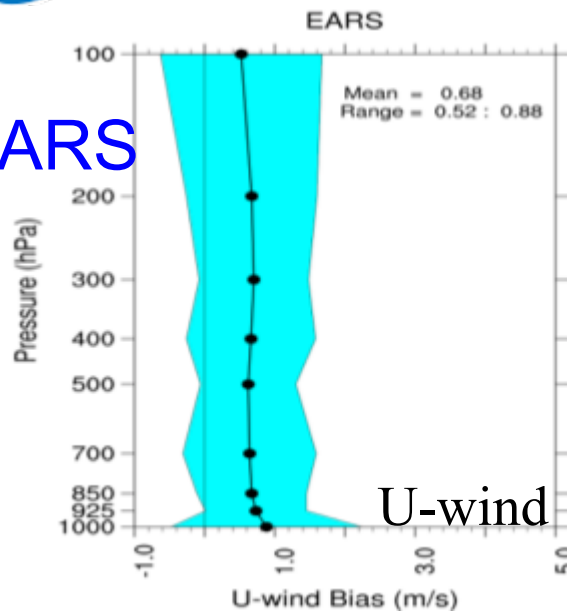
Generally speaking, the ERAS has a less bias than the ERA-Interim over East Asia, especially in surface wind and pressure.

Comparing ERA-Interim (ERA) and East Asia Reanalysis System (EARS) in terms of absolute bias for 2016.

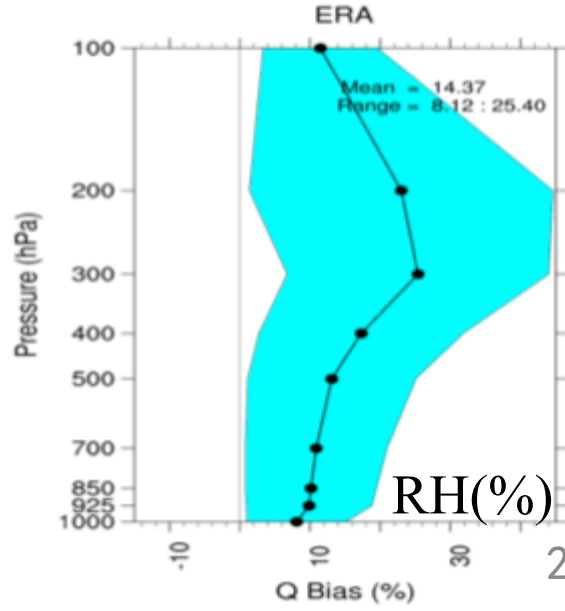
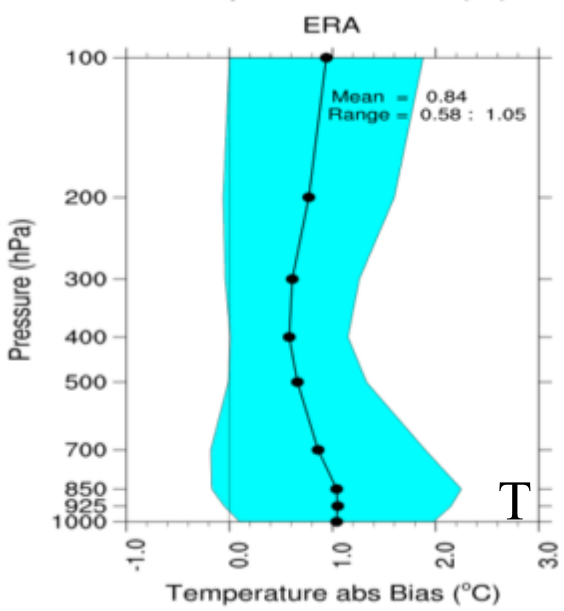
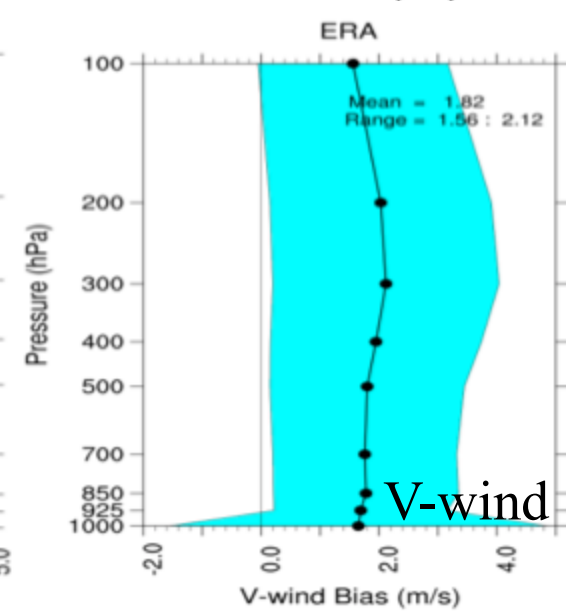
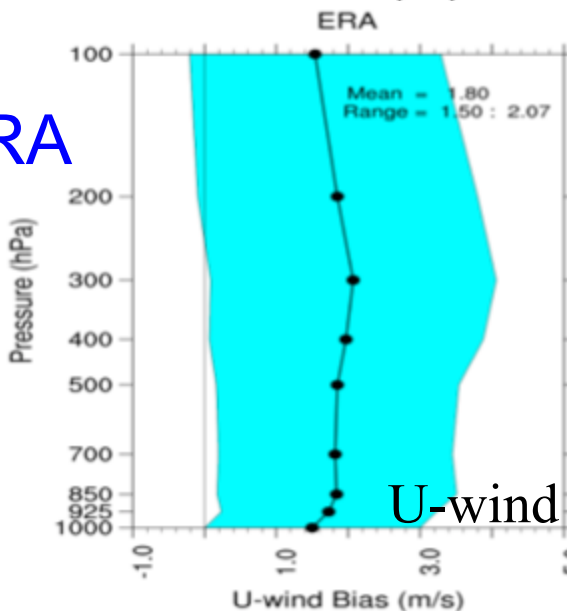


Preliminary results

EARS



ERA

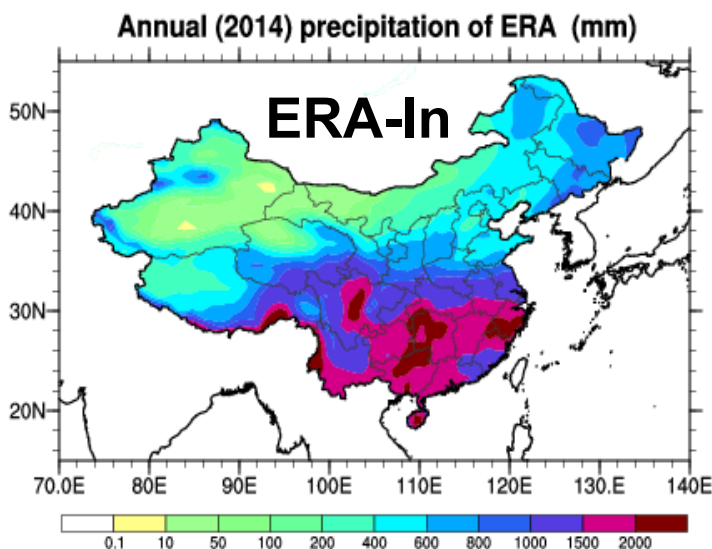
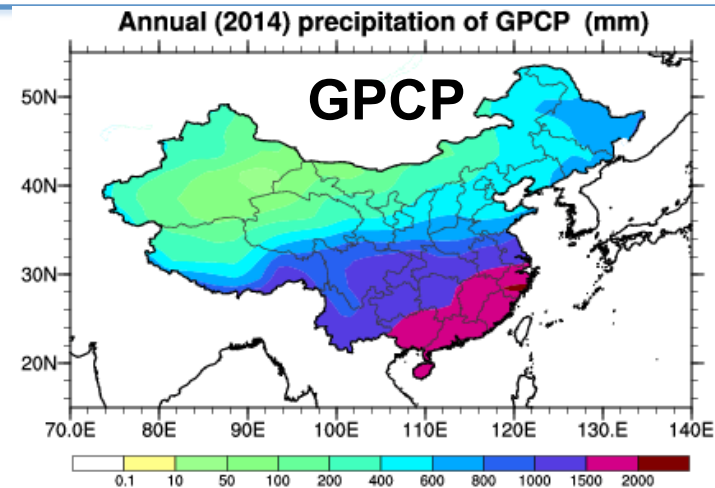


One-year cycling run results

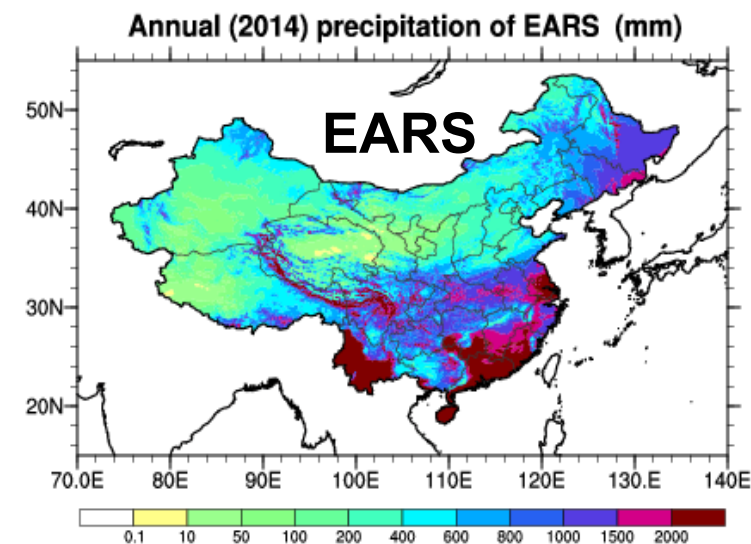
Precipitation

(Yearly Total in 2014, mm)

Global Precipitation
Analysis NASA
2.5°*2.5°



ERA-Interim 0.75°



EARS 12 km

- The East Asia Reanalysis System (EARS) was established based on the Advance Research Weather Research and Forecasting (WRF-ARW) model and the Gridpoint Statistical Interpolation (GSI) data assimilation system.
- The 10 years (2008-2017) reanalysis data has been carried out. The results are encouraging.
- Based on the EARS results and improvement of the system, our team will rerun the EARS with radar observations, and finer domains will be nested for some regions.

Thank you for your attention!