Center report From JMA

Numerical Prediction Division,
Japan Meteorological Agency

Recent upgrades of JMA's NWP system

- Upgrade of GSM (Mar. 2023)
  - Increase of horizontal resolution to TL959(20km) ➔ TQ959(13km)
  - Physics upgrade, incl. parametrized surface drag
  - Upgrade of orography ancillaries
- Upgrades of the regional NWPs which contribute to improving representation of MCS (Mesoscale Convective Systems) (Mar.2023)
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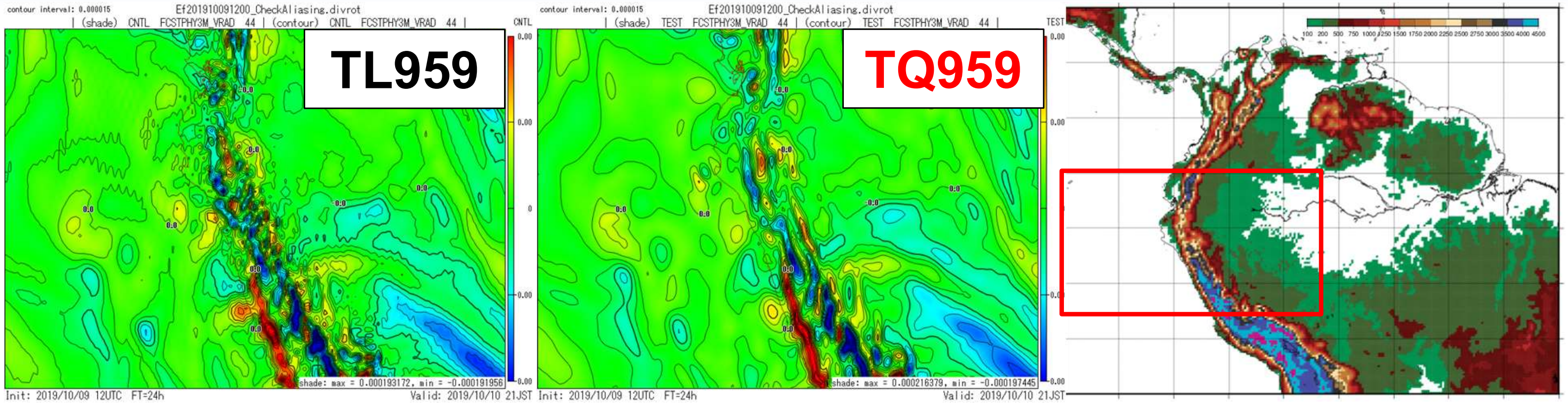
    - TOFD: Turbulent Orographic Form Drag
  - Assimilation of screen level humidity in Mesoscale and Local Analysis

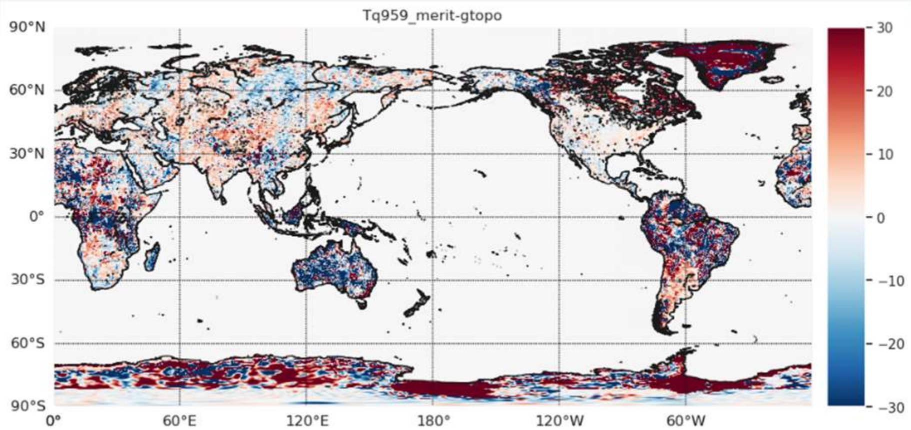
New grid in GSM:
Quadratic grid and resolution increase in grid-point space

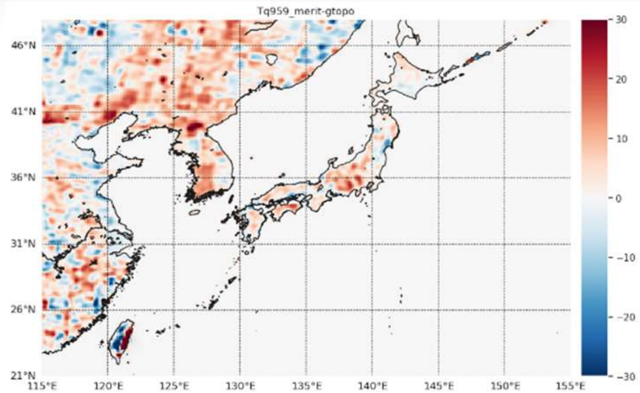


vorticity on 44th level（201910091200 init., T+24）

- Removing aliasing from quadratic terms and alleviation of aliasing from non-linear terms by using quadratic grid
- Increasing resolution in grid-point space from approx. 20km to 13km
- Refining of numerical diffusion in the model and filters for mean orography

New source data set for orographic ancillary files





- Accurate lower boundary conditions necessary for accurate weather predictions
- MERIT DEM+RAMP2 replacing GTOPO30 as a source data set for orographic ancillary files
- MEIRT DEM (Yamazaki et al. 2017): bias removed SRTM based DEMs, available on 90m grid (10-times higher than GTOPO30) !
- No spurious mountains in Venezuela, large differences in the Tropics, Greenland and the Antarctic
- Combined with RAMP2 for the Antarctica as MERIT DEM contains N90−S60

Rebalancing orographic drag

(as reported at WGNE-36 and WGNE Bluebook 2022)

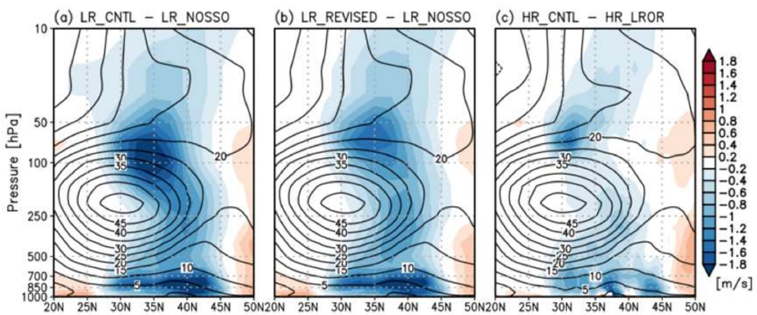


Fig. 1 Latitude-height cross section showing impacts of SSO drag on zonal wind [m/s] averaged over the Middle East (28 – 68°E). (a) LR_CNTL minus LR_NOSSO; (b) LR_REVISED minus LR_NOSSO; (c) HR_CNTL minus HR_LROR. Contours represent mean zonal wind in each experiment.

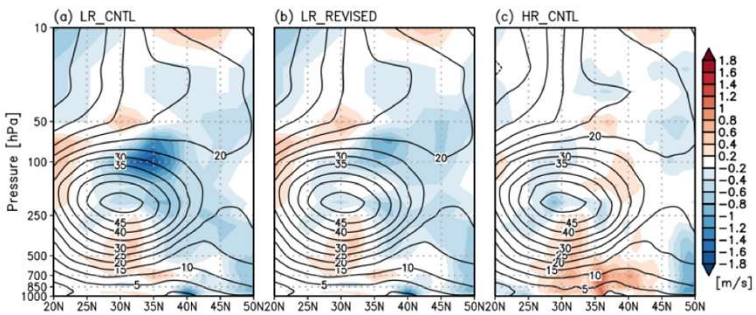


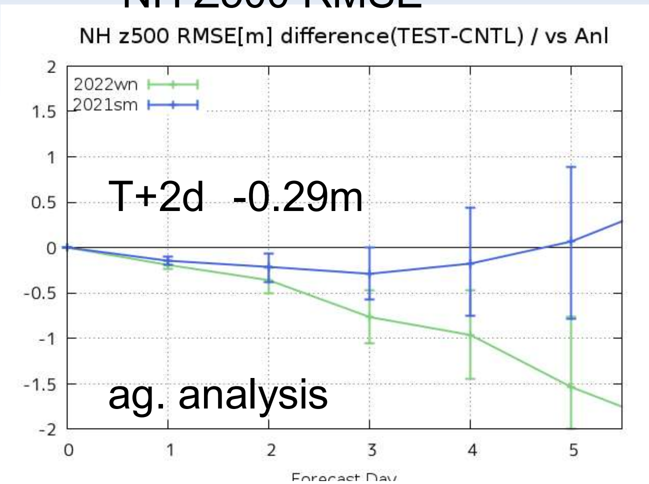
Fig. 2 Latitude-height cross section of zonal wind mean error against analysis [m/s] averaged over the Middle East region (28 – 68°E). (a) LR_CNTL; (b) LR_REVISED; (c) HR_CNTL. Contours represent mean zonal wind in each experiment.

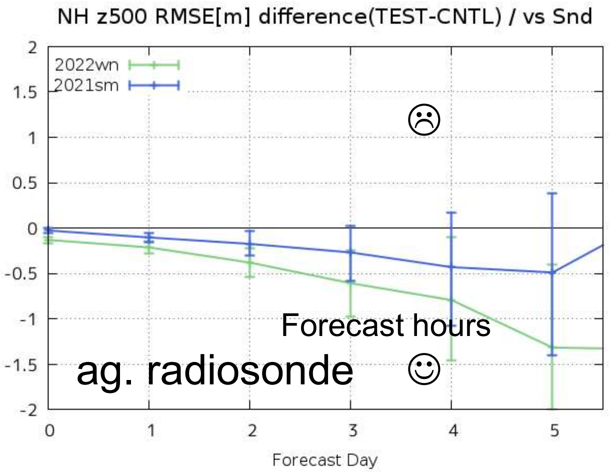
- Too strong orographic drag also leading to too weak zonal wind bias in upper Trop. to lower Strat. (pointed out in the COORDE project paper Van Nierkerk et al. (2020))
- Rebalancing orographic drag in GSM using COORDE experiments
- Reducing gravity wave drag and enhancing turbulent orographic form drag
- Successfully mitigating the bias!
- Matsukawa et al. (2022, WGNE Bluebook)

WGNE 36: https://wgne.net/wp-content/uploads/2021/11/WGNE36_Ujiie_JMA_report.pdf

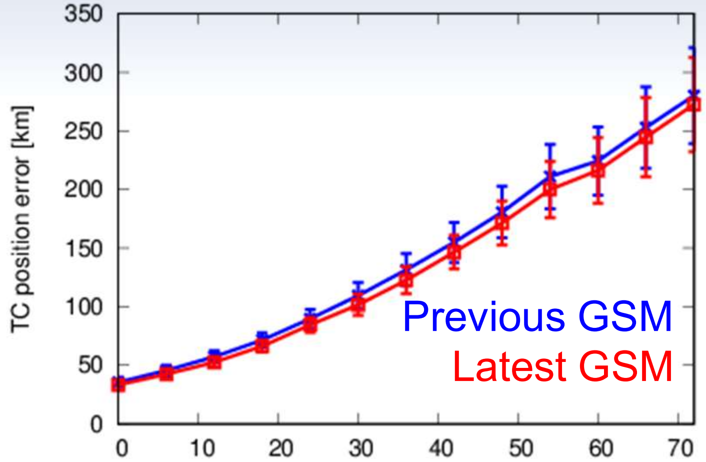
Headline scores

NH Z500 RMSE

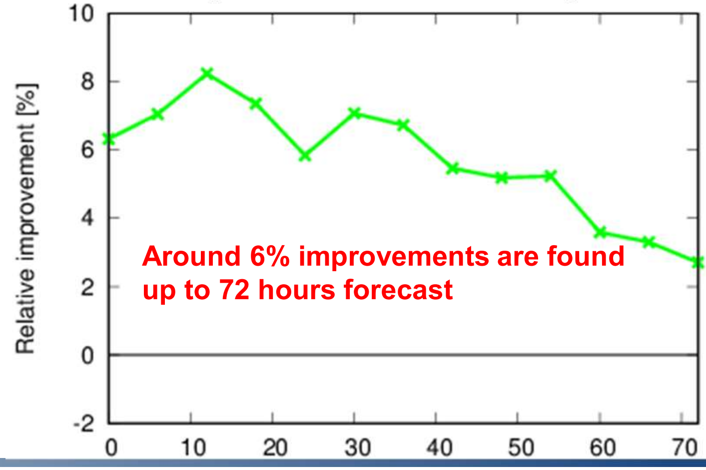




Mean TC position error [km]



Relative improvements on TC position error [%]



Forecast hours

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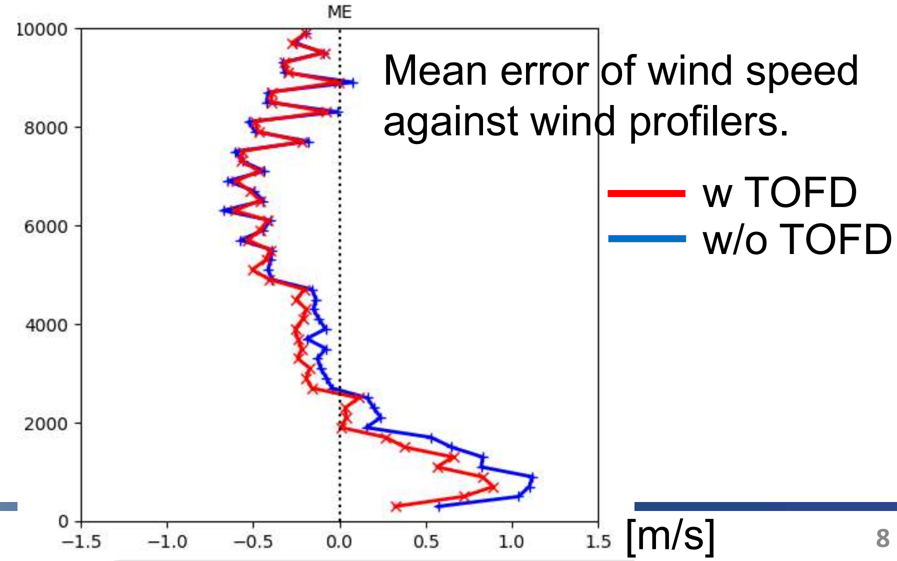
Introduction of TOFD

- Effects of subgrid orography had not been considered in LFM (dx: 2km)
  - Gravity wave drag and blocked flow drag are partially resolved in LFM, however, turbulent orographic form drag (TOFD) is not.
  - One of possible reasons for low-level strong wind bias in LFM
- TOFD based on Beljaars et al. (2004) was introduced into LFM
  - parameters related to subgrid orography are computed from MERIT DEM.

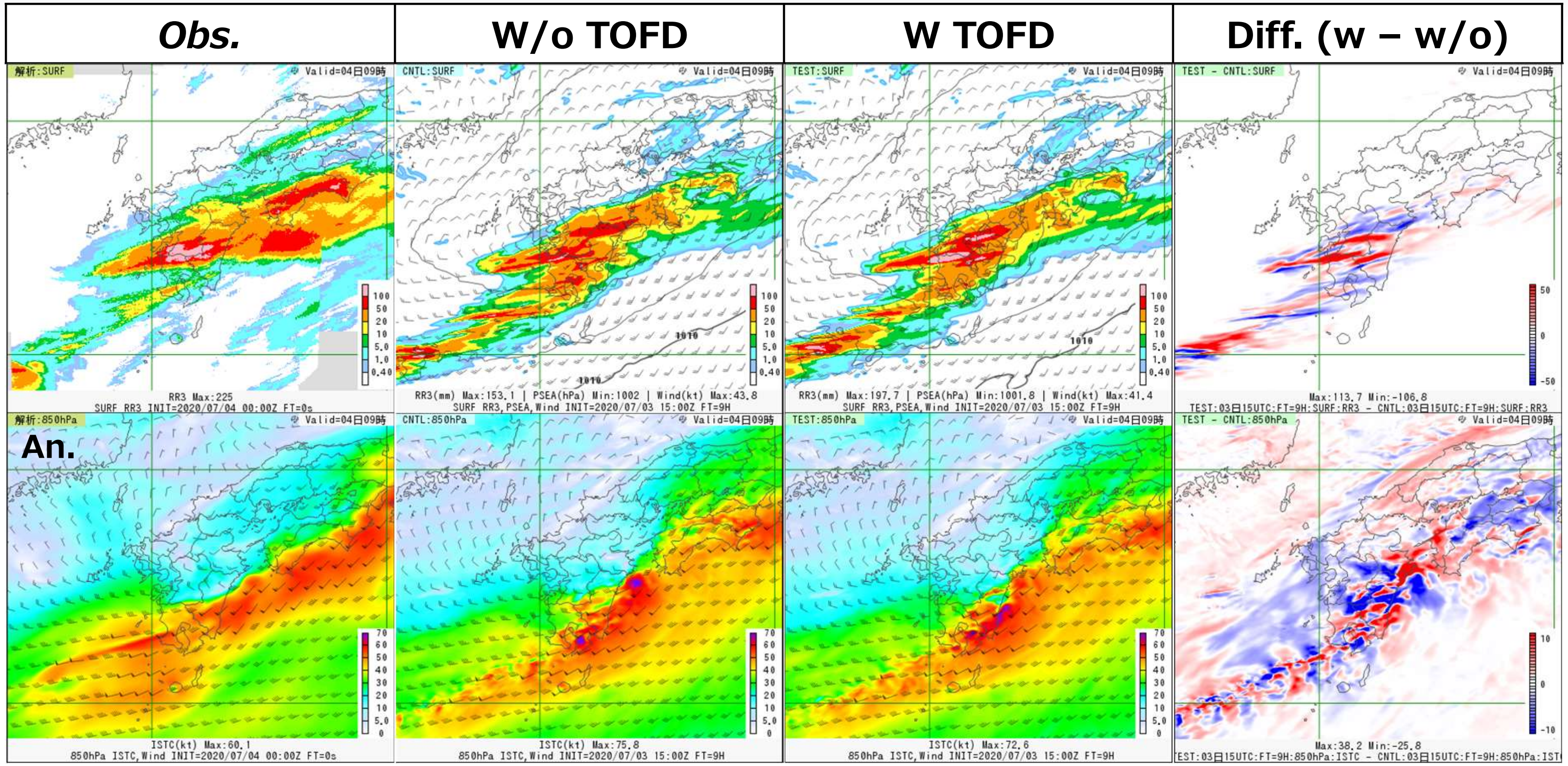
$$\frac{\partial \boldsymbol{U}}{\partial t} = \frac{\partial}{\partial z}\frac{\boldsymbol{\tau_o}}{\rho}$$

$$= -\alpha\beta C_{md} C_{corr} |\boldsymbol{U}(z)| \boldsymbol{U}(z) 2.109 e^{-\left(\frac{z}{1500}\right)^{1.5}} a_2 z^{-1.2}$$



Impacts of TOFD on MCS

Valid 00UTC 4 Jul. 2020 T+9



- TOFD influences positions and strength of MCS through representation of low-level winds

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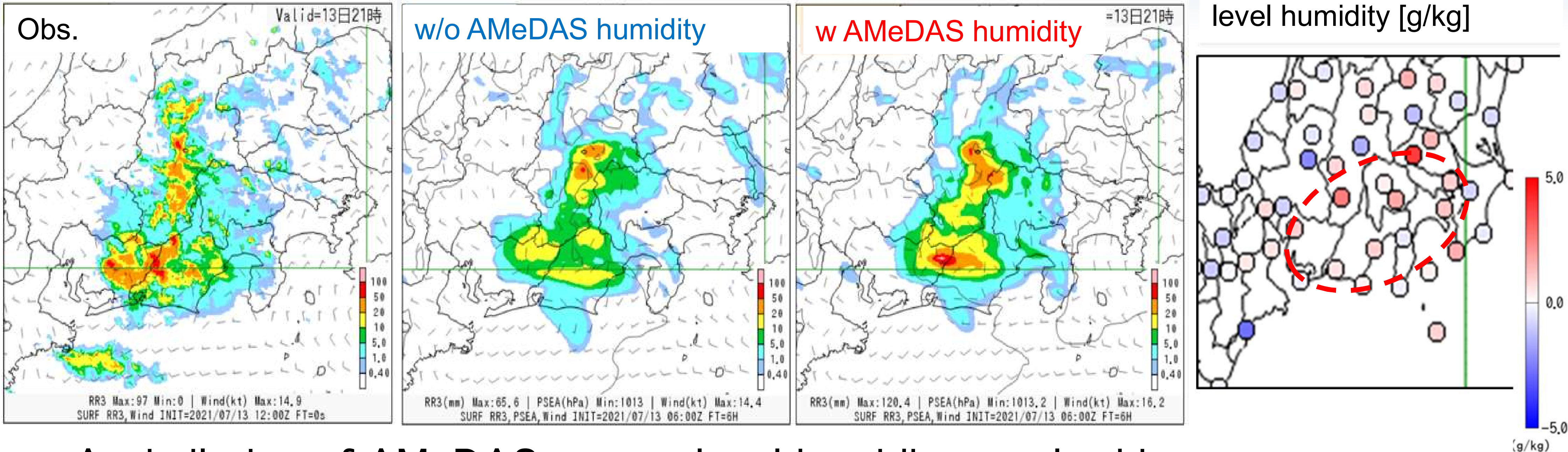
Impact of assimilating screen level humidity on a shower case

Valid: 12UTC (21LST) 13 Jul. 2021



- Assimilation of AMeDAS screen level humidity resulted in more accurate precipitation forecasts
- AMeDAS: The Automated Meteorological Data Acquisition System, a collection of Automatic Weather Stations (AWSs) operated over Japan by JMA.