Evaluation of atmospheric attraction effect using local-scale objective analysis (LANAL)

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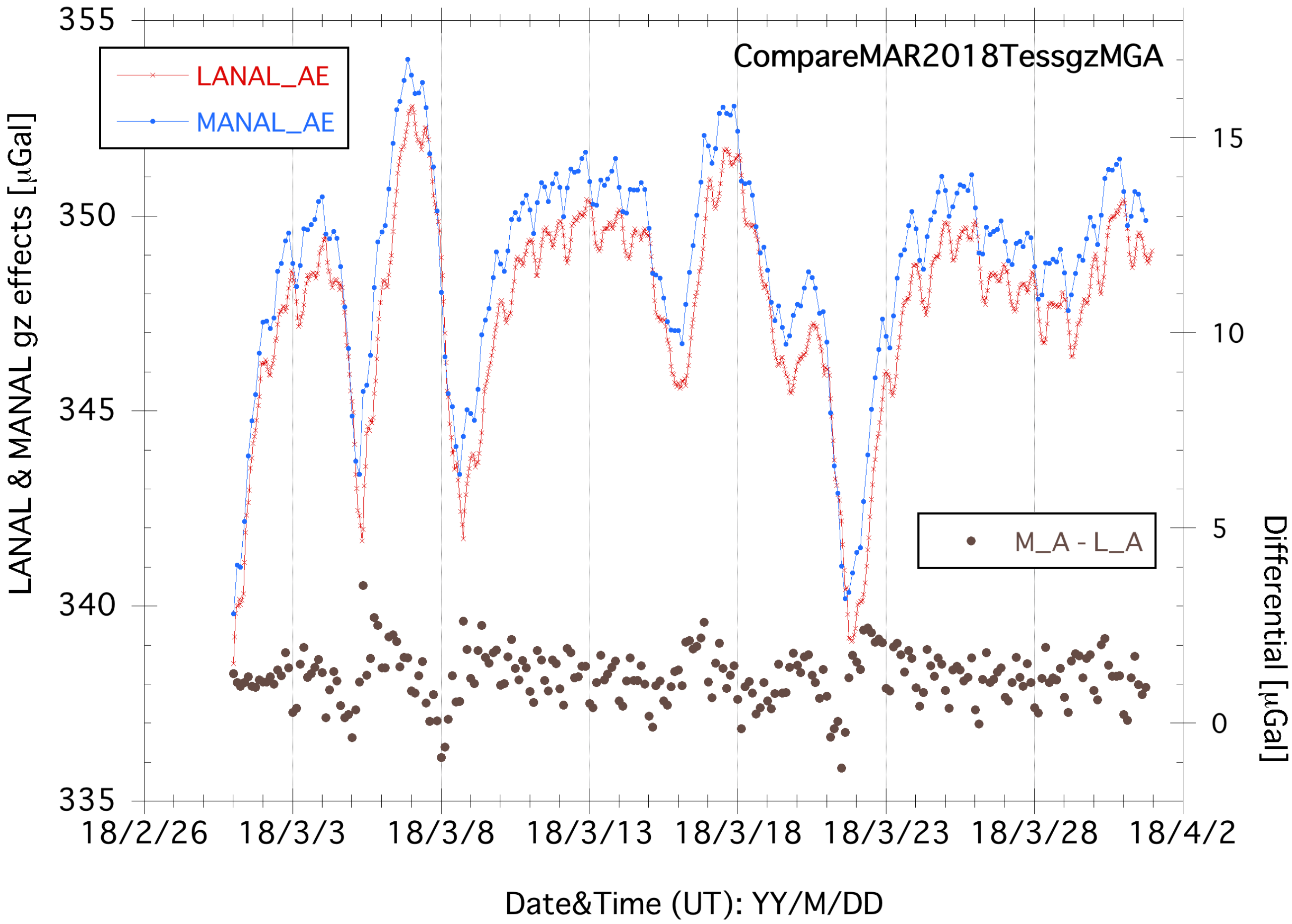
Tono Research Institute of Earthquake Science (TRIES) has been conducting continuous gravity observations both above the ground and below the ground of Mizunami Underground Research Institute in order to monitor the underground mass fluctuation including groundwater (Tanaka and Honda, 2018, doi: 10.1002 / 2017EA000311). The mass fluctuation between these two gravimeters can be evaluated from the difference between the two gravimeter values. Also, the sum of the two gravimeter values reflects the gravitational effects both from above the ground gravimeter position and from the below the underground gravimeter position. In order to extract the gravity fluctuation related to earthquake phenomena, that is, the gravitational effect only from below the subsurface gravimeter position, it is necessary to correct the atmospheric attraction effects above the ground gravimeter. Here, for the sake of simplicity, it is assumed that the atmospheric loading deformation effects and the existence of high altitude near the observation point are negligible. TRIES has been used the meso-scale objective analysis (MANAL) to calculate the atmospheric attraction effect in the range of 10 °×10 °×100 hPa–surf (approximately, 900 km in latitudinal direction ×1100 km in longitudinal direction ×16 km in altitudinal direction) centered on a gravity observation point before now. This attraction effect accounts for approximately 60% of the time-variating amplitude of the global summation. Local-scale objective analysis (LANAL) began publishing since 2018. The lattice spacing was 5 km, the same as MANAL, but LANAL increased the number of isobaric surfaces by 1 (975 hPa surface) from MANAL. This increase improved the spatial resolution of the altitude close to the observation point. Moreover, the time resolution improved as time interval changed from three hours of MANAL to one hour. Therefore, the updating from MANAL to LANAL to calculate the atmospheric attraction effect have to been evaluated quantitatively. Like other objective analysis data, LANAL is also offered in GRIB 2 format. We accessed LANAL using the GrADS software (http://cola.gmu.edu/grads/), but as it was seen in MANAL, it was not possible to display correctly with the control file generated by the g2clt or alt_g2ctl commands. In the PDEF line of the control file, you need to change the jref variable set to 1 to the value of the jsize variable. Also, from the necessity both of atmospheric density calculation on the topographic surface and comparison between isobaric surfaces and a topographic altitude, we use the enclosed terrain data (4-byte real binary). This feature is also the same specification as MANAL, and the GrADS draws the North-South direction reversed figure. In order to correct this problem, the data stored with the northwest end as the starting point was restored as the start point at the southwest end (byte swapping is necessary depending on the processing system). After that, the atmospheric attraction effect was calculated according to the procedure developed for MANAL. At the time of this writing, it was an evaluation for only one month in March 2018. The standard deviation of the difference of simultaneous numerical values between MANAL and LANAL was 0.66 microGal, and the maximum difference of instantaneous values was 2.4 microGal. It turned out that there was a significant difference. In the future, we would like to evaluate the difference from using MANAL by applying to gravity observation data.

Keywords: gravity, local-scale objective analysis, atmosphere


CompareMAR2018TessgzMGA
LANAL_AE
MANAL_AE
M_A - L_A
LANAL & MANAL gz effects [μGal]
Differential [μGal]
Date&Time (UT): YY/M/DD
355
350
345
340
335
15
10
5
0
18/2/26
18/3/3
18/3/8
18/3/13
18/3/18
18/3/23
18/3/28
18/4/2