Assimilation of surface pressure in METAR

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1. Introduction

Observation data reported in METAR format (e.g., those relating to pressure, temperature and wind) are useful information for NWP. The Japan Meteorological Agency (JMA) began assimilating surface pressure data in METAR into its global NWP system in October 2015. This report outlines the usage of surface pressure data in METAR and related impacts on the global NWP system.

2. Overview of METAR and quality control procedure for surface pressure data

Figure 1 shows the worldwide coverage of stations reporting METAR, which number around 4,000. Approximately half of these stations also report SYNOP or are collocated with SYNOP-reporting stations. METAR-reporting stations have a tendency of concentration in the USA (in contrast to the situation with SYNOP-reporting stations), but are also found on the African Continent and Pacific islands where SYNOP-reporting stations are scarce. Since METAR observation data provide valuable information from these areas, it is beneficial to improve the quality of analysis fields by assimilating observation data in METAR.

The METAR surface pressure data assimilated into JMA's global NWP system is QNH, which is defined as mean sea level pressure corrected using the ICAO (International Civil Aviation Organization) standard atmospheric profile. QNH is generally rounded down to the nearest whole hPa for METAR reports. In addition, stations in some countries (e.g., Japan, the USA and Canada) also report QNH in hundreds of inches of mercury with a precision of 0.01 inHg (approx. 0.3386 hPa).

The quality control (QC) procedure for surface pressure in METAR is based on Ingleby (2014). Since the reporting of QNH in hundreds of inches of mercury is more precise than that in whole hPa, such QNH reports are assimilated into the analysis prior to those in whole hPa. For QNH reports in whole hPa, which are rounded down for METAR reports, 0.5 hPa is added to avoid systematic errors. The Blacklist check, the climatological check, the inter-element consistency check, the gross error check and the spatial consistency check are applied for QC (see JMA (2013)). When observed surface pressure is assimilated, values generally need to be converted to model surface height equivalents for comparison with first-guess field variables. This is achieved by first converting QNH to station-level pressure using the ICAO standard atmospheric profile, then converting this to model surface height pressure using the atmospheric profile applicable at the time of observation.

Figure 2 shows histograms of the first-guess (FG) departure of pressure at model surface height. Normal distribution is seen for both METAR and SYNOP. The average and standard deviation of FG departure for METAR are similar to those for SYNOP. These results are consistent with those of Ingleby (2014), which showed that the quality of surface pressure data in METAR is comparable to that in SYNOP.

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3. Impacts on the global NWP system

Observing system experiments were performed for the two months of August 2014 and January 2014 to evaluate the impacts of METAR assimilation. The control experiment (CNTL) had the same configuration as the operational global NWP system of September 2014, and surface pressure data in METAR were additionally assimilated in the test (TEST) experiment. Figure 3 shows the normalized difference (TEST-CNTL) of standard deviation in analysis (AN) departure for surface pressure in SYNOP. Standard deviation in AN departure for the TEST experiment was smaller than that for the CNTL experiment, indicating improved analysis field quality. Impacts on the forecast score were almost neutral.

References

Ingleby, B., 2014: Global assimilation of air temperature, humidity, wind and pressure from surface stations. *Quart. J. Roy. Meteor. Soc.*, doi: 10.1002/qj.2372

JMA, 2013: Data Assimilation Systems. *Outline of the operational numerical weather prediction at the Japan Meteorological Agency. Appendix to WMO Technical Progress Report on the Global Data-processing and Forecasting System,* Japan Meteorological Agency, Tokyo, Japan, 10-40.

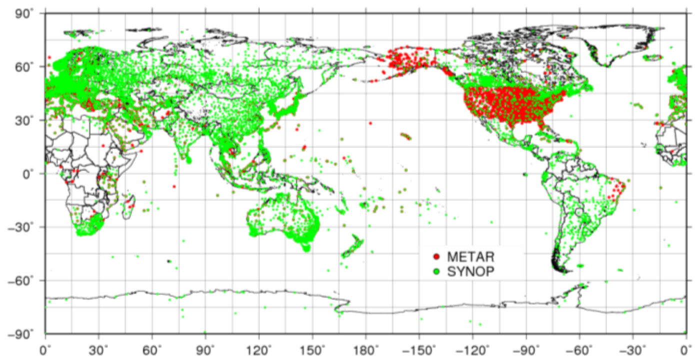

Figure 1: Stations reporting METAR (red dots) and SYNOP (green dots)

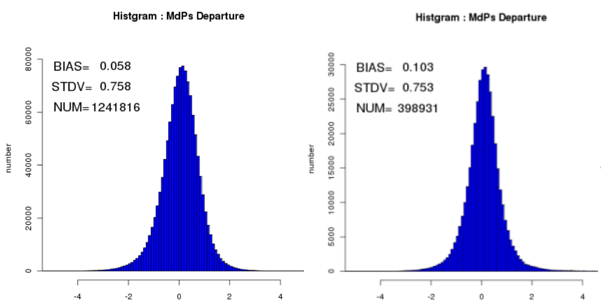

Figure 2: Histograms of FG departure [hPa] for pressure at model surface height
Left: METAR; right: SYNOP

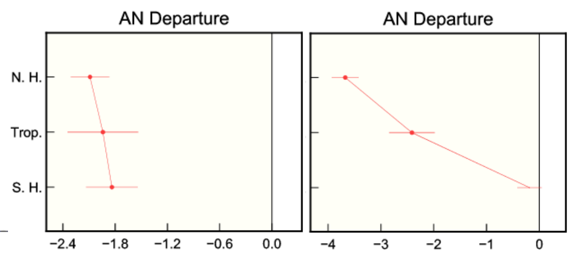

Figure 3: Normalized difference (TEST – CNTL [%]) of standard deviation in AN departure for surface pressure in SYNOP. N.H., Trop and S.H. indicate the Northern Hemisphere, the tropics and the Southern Hemisphere, respectively. Red dots indicate a statistically significant difference.
Left: Aug. 2014; right: Jan. 2014