5A.2

COMPREHENSIVE AUTOMATED QUALITY ASSURANCE OF DAILY SURFACE OBSERVATIONS: THE GHCN-DAILY EXAMPLE

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1. Introduction

This presentation will describe a comprehensive set of fully automated quality assurance (QA) procedures for observations of daily maximum and minimum surface air temperature, precipitation, snowfall, and snow depth. The QA procedures are being applied operationally to the daily Global Historical Climatology Network (GHCN) – Daily data set developed and maintained at the National Oceanic and Atmospheric Administration's National Climatic Data Center (NCDC). Since these data are used for analyzing and monitoring variations in extremes (e.g., Alexander et al. 2006), the QA system is designed to detect as many errors as possible while maintaining a low probability of falsely identifying true meteorological events as erroneous.

2. System Components

The system, which is described in detail in Durre et al. (submitted), consists of a comprehensive set of procedures, each of which detects a type of error known to be present in the data. Examples of such errors include values that are physically impossible or climatologically implausible for the location and time of year; inconsistencies with observations on adjacent days, with current observations of other variables, or with observations at neighboring stations; and values that are repeated for a period of days or duplicated for months or years. Specifically, the tests in the GHCN-Daily system can be grouped into five general categories which are executed in the following order: basic integrity checks, outlier tests, internal and temporal consistency checks, spatial consistency checks, and "megaconsistency" checks. The basic integrity checks identify cases of data duplication as well as physically implausible values. The outlier checks identify excessive gaps in the distributions of data values as well as observations that deviate excessively from station-specific climatological parameters. The internal, temporal, and spatial consistency checks identify values that deviate significantly from "adjacent" observations in time and space. Finally, the "megaconsistency" checks verify the integrity of all remaining unflagged observations. Given the large variability in record length and station density in GHCN-Daily and differences in the data requirements of the various procedures, this sequence maximizes the number of observations that can be checked with at least one QA procedure.

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3. System Evaluation

Unlike many other QA approaches, the GHCN-Daily QA system is fully automated but has been manually validated using the strategies of Durre et al. (2008) to ensure satisfactory performance. Full automation is essential in the case of GHCN-Daily whose more than 1,500,000,000 observations at over 40,000 land-based stations must be reprocessed on a regular basis to incorporate the latest versions of historical and real-time data. In the past, automated procedures have often yielded a significant number of "false positives," i.e., valid observations erroneously identified as invalid (Guttman and Quayle 1990; Kunkel et al. 2005). To limit the false positive rate of the GHCN-Daily QA system, each test is applied in a preliminary fashion to the entire GHCN-Daily data set, and samples of flagged values are then manually inspected for a range of plausible test thresholds. Based on the resulting estimated fraction of false positives in each sample, the threshold yielding the highest error detection rate without exceeding a 20% false-positive rate is chosen for each QA check. In other words, sampling variability and evaluator subjectivity notwithstanding, no more than one in five values flagged by any one check is allowed to be a false positive.

4. Conclusion

In the end, however, many of the procedures turn out to incur a far smaller fraction of false positives among the values they flag. The system as a whole flags 0.24% of the observations, and only 1-2% of the flag values are estimated to be false positives. The low false-positive rate combined with the ability to detect a variety of typical data errors implies that the system can be effectively employed on an operational basis without manual intervention.

5. References

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