MONITORING SATELLITE WINDS AT ECMWF

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ABSTRACT

Although most of the satellite wind monitoring information is now part of the joint UKMO-ECMWF participation in the NWP-SAF presented by Butterworth et al., some monitoring information is not part of this initiative. Information on data availability that is presented is kept updated daily on ECMWF web site with public access. It is also shown that aircraft data that are now available in increasing numbers are confirming the longstanding issue of satellite winds underestimation first revealed by radiosonde collocations. This bias puts a major limitation on the real impact of satellite winds in the jet areas. It is therefore suggested that bias correction methods are tested that would allow numerical models to use this information were it could be of crucial importance for the timely forecast of extratropical developments.

1. Introduction

The main changes in the monitoring activities of ECMWF in recent years have been related to slowly bringing the information to the users (data providers and forecast users) in a more friendly way using our Web server (http://www.ecmwf.int). Although most of this effort has been shared with the UK Met. Office as part of the NWP SAF initiative (see the co-signed contribution Butterworth et al. in the same volume), some types of useful information do not fit in this framework. They are mainly related to data availability and coverage and to intercomparison with independent sources of observation. Recent findings derived from these diagnostics will therefore be summarised in this contribution, together with some discussion on the impact of satellite winds on the model description of the atmospheric state and on plans for future developments.

2. Data monitoring information made available on ECMWF WEB server

This information is publicly available at the following address:

http://www.ecmwf.int/services/dcover/index.html

It includes data coverage maps over the last 24h (four assimilation cycles) and time series showing the amount of data received over the last 30 days. In contrast with comments made at the last Winds Workshop (Lalaurette et al., 1998), only minor problems could be found in recent months. The flow of data was mostly uninterrupted, and one of the only disruptions is visible in Figure 1 when data were missed for a few days when Meteosat7 went through its decontamination program.

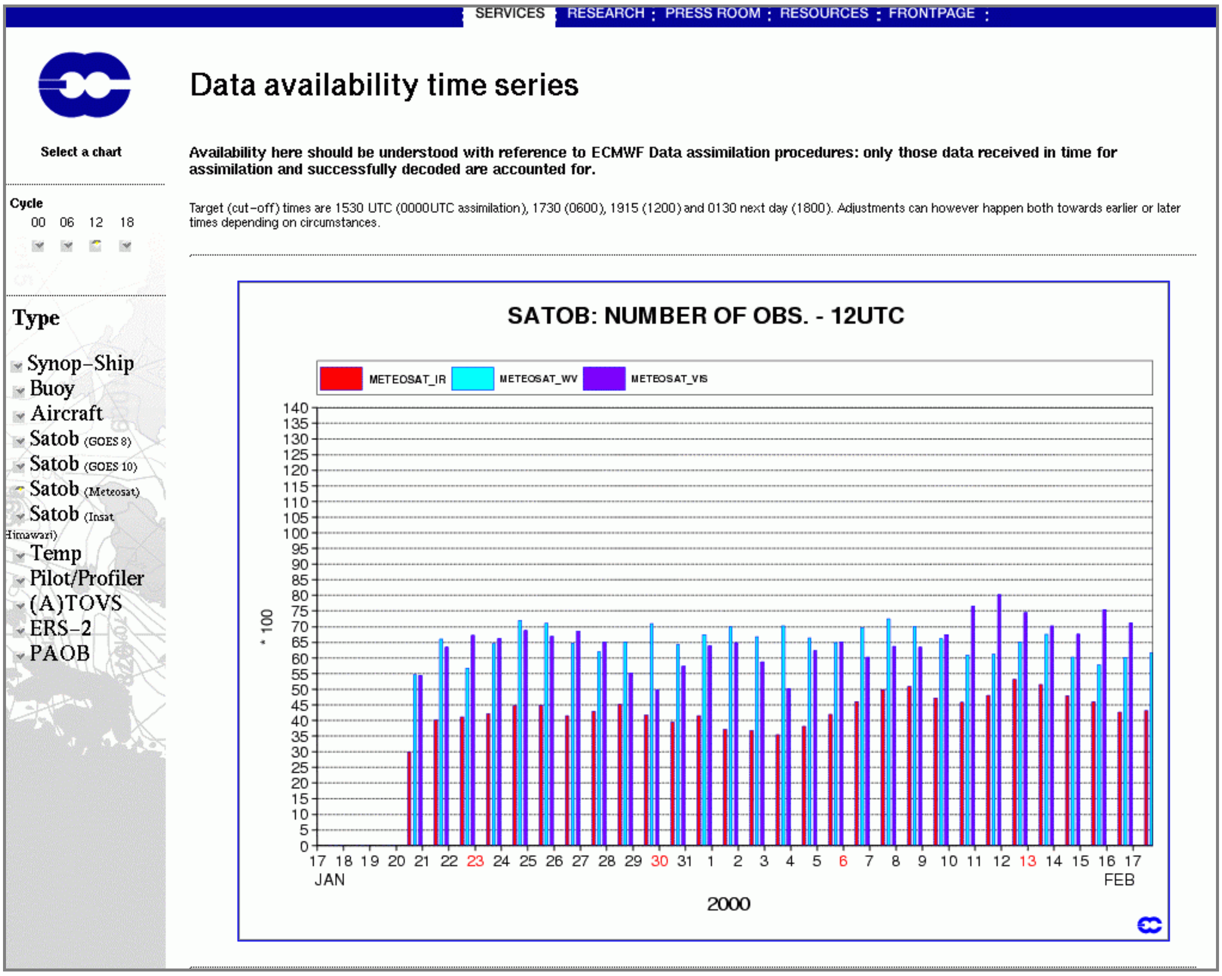

Figure 1. Time series of Meteosat-7 winds available at ECMWF from 18 January to 17 February 2000 (9-15UTC). No data selection or thinning is applied at this stage. The information is shown as available from ECMWF Web site.

Since the quality control decisions are now delayed to the data assimilation stage in the case of METEOSAT winds processed in BUFR format together with their Quality Indicator, the coverage can be seen to have increased again (Figure 2). This service is currently under development. More information on the data monitoring (satellite radiance should be the first step) and daily information on the data active and/or rejected should also be added. These although are likely to be given limited access by ECMWF Member States except when data providers have given permission to issue such information – as is the case with NESDIS and EUMETSAT for raw radiance.

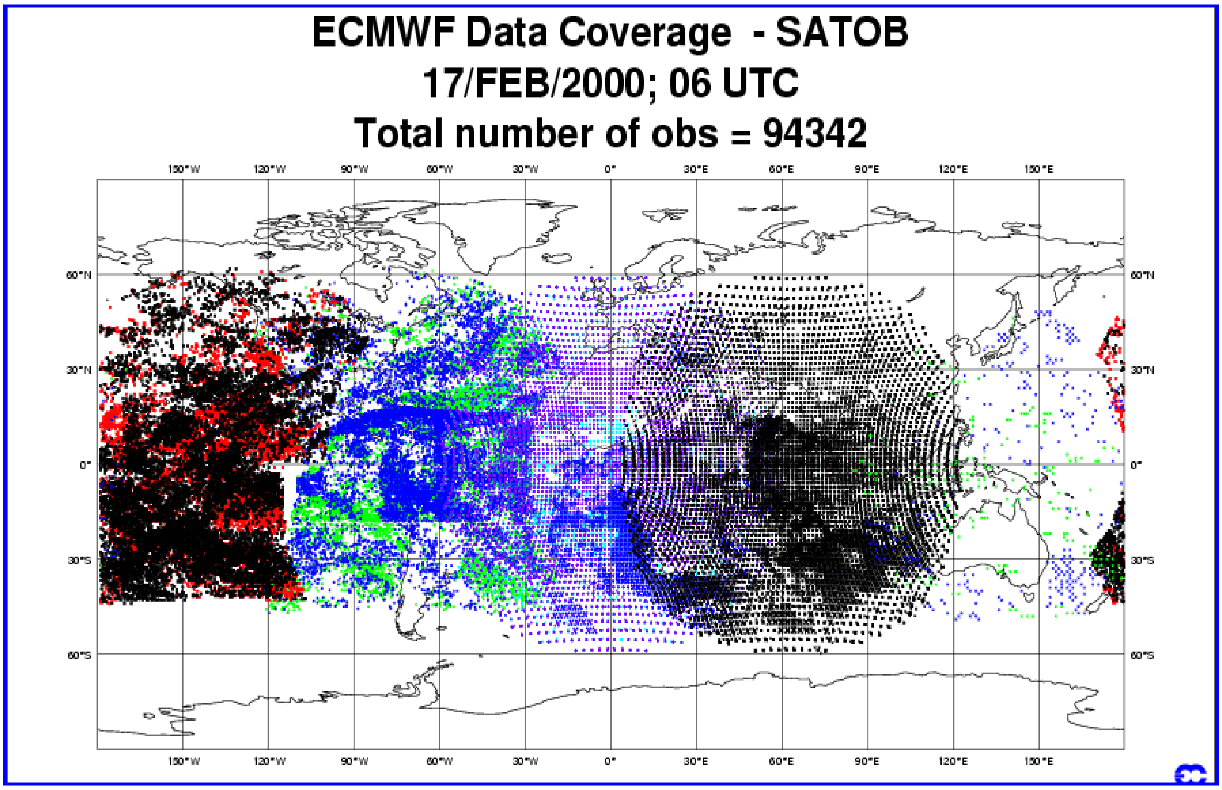

Figure 2. Data coverage given by all satellite winds dated 17 February 2000 between 03 and 09UTC and processed at ECMWF. No data selection or thinning is applied at this stage. The information is shown as available from ECMWF Web site.

3. Collocation statistics (aircraft and radiosondes)

Although model performance is steadily improving with time, the fit of satellite winds to the model cannot be taken as an absolute reference, the last reason not being that the quality of these observed data is also due to improve following refinements in both instrumentation and wind retrieval techniques. This is why in complement to statistics based on model comparisons (Butterworth et al.) statistics are gathered when satellite winds are collocated with other sources of observations. Although most of the emphasis is usually put on the comparison to radiosondes, there is an increasing benefit to be taken from a comparison to aircraft measurements. The reasons for this are:

1) the large improvement in quality that has followed the automation of most reports and
2) the increased coverage of data that followed the efforts paid by several Meteorological Agencies to collect these data from their national airlines for the common benefit of the meteorological community (Figure 3)

As a result, it can probably be safely argued that the total number of in-situ data has increased very significantly in recent years, at least for those atmospheric layers where most commercial air traffic occurs (400-200 hPa). Aircraft data have the further advantage of covering some oceanic areas where radiosondes are usually not available.

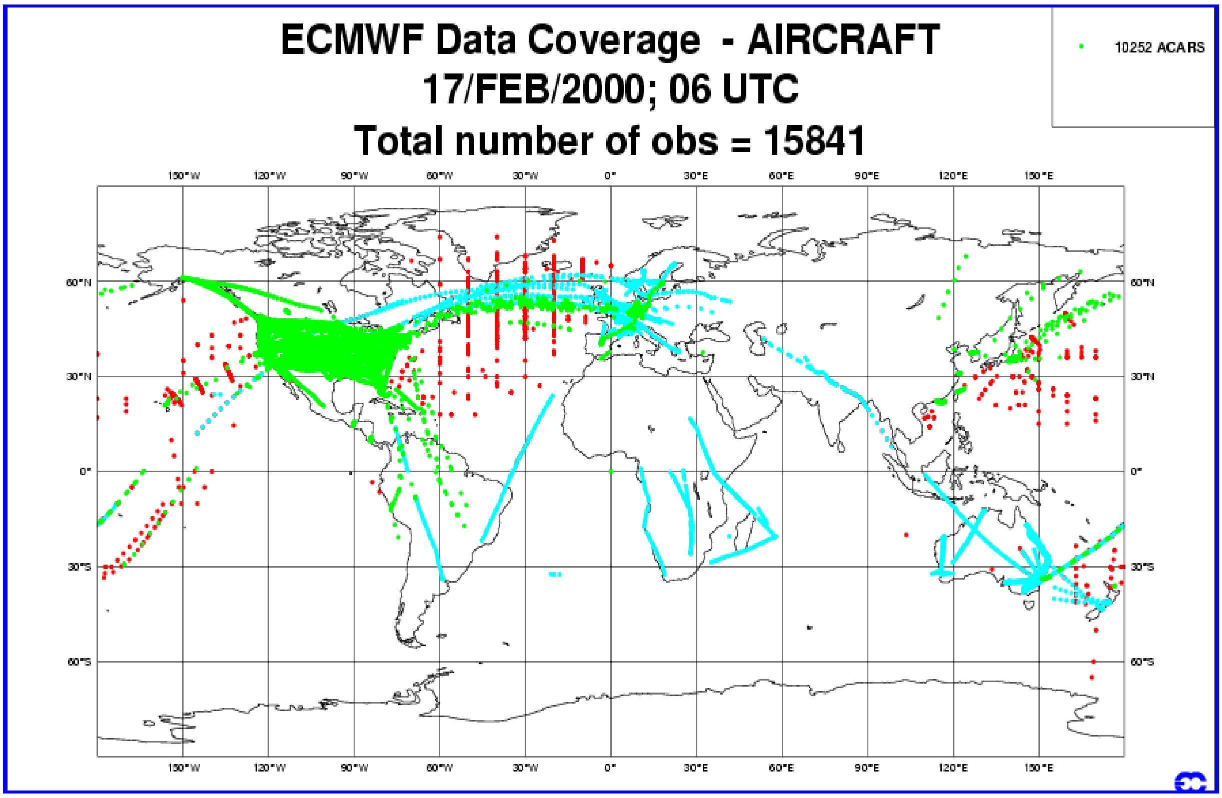

Figure 3. Data coverage given by all aircraft reports dated 17 February 2000 between 03 and 09UTC and processed at ECMWF. No data selection or thinning is applied at this stage. The information is shown as available from ECMWF Web site.

Collocation statistics usually point to the same conclusions whether satellite winds are compared to aircraft or radiosonde data, except by the end of the distribution when data are not available in large enough numbers to retrieve stable statistics (Figure 4). METEOSAT and HIMAWARI show similar signatures: an increasing underestimation for increasing values of the satellite wind, by about 10% in the case of METEOSAT, almost 20% for HIMAWARI. The bias for high-level GOES winds is almost independent of the wind speed, and point to an underestimation by about 2-3 $m.s^{-1}$ in the range 10 to 60 $m.s^{-1}$. That there is no dependence on the observed range of wind speed shows that the linear correction applied by the data providers is correct, a procedure that is not applied to METEOSAT and HIMAWARI data. It cannot however from these figures be deducted whether the bias is related to an underestimation of the wind by the target displacements, or to height assignment errors. A remarkable feature of GOES winds on the other hand is that the fit to the model is better than to in-situ observations (at least for ranges below 45 $m.s^{-1}$). This could be the result of the recursive filters applied to the GOES winds before dissemination that transform the data into winds that are more representative of the scales observed by the model (50-100km) than in-situ measurements by aircraft and radiosondes.

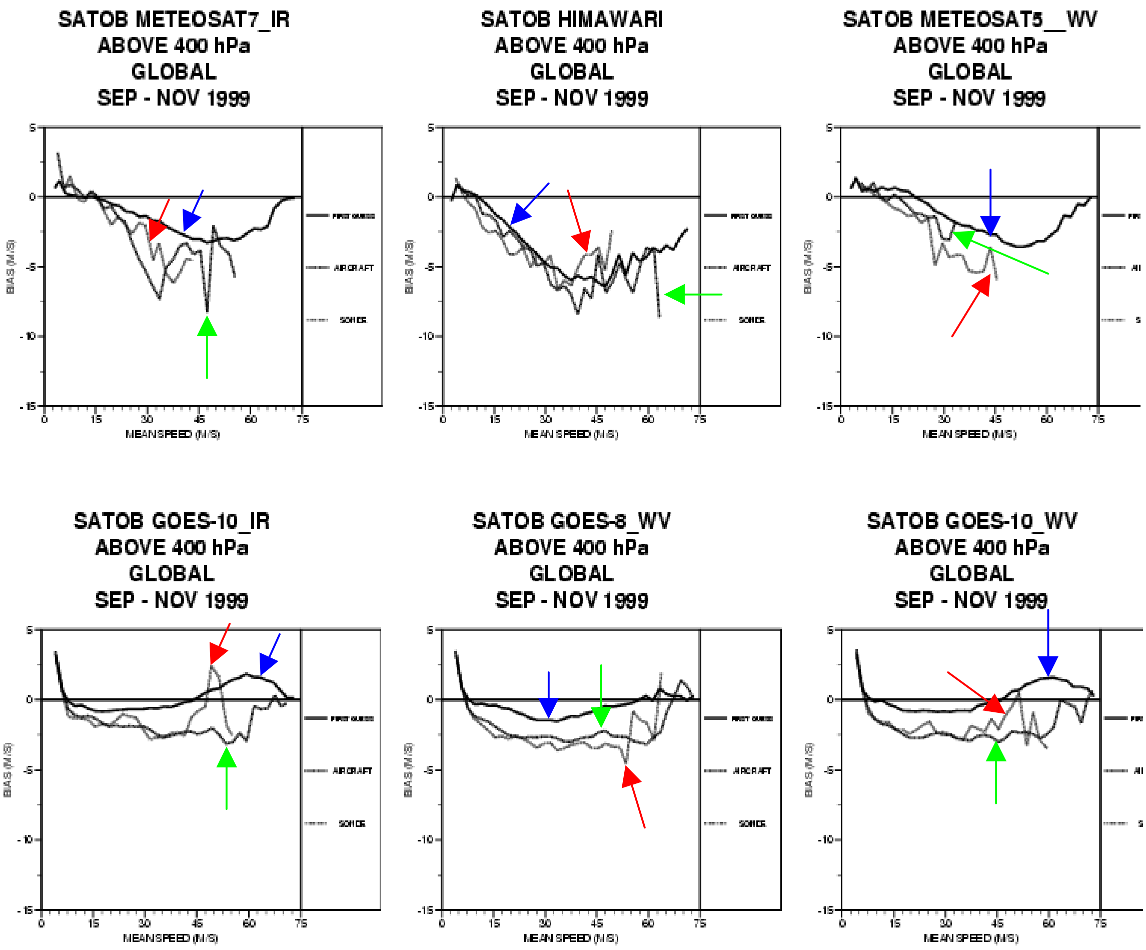

Figure 4. Comparison of high level (P<400hPa) satellite winds with collocated model winds (blue) and winds measured from radiosondes (red) and aircraft (green). Horizontal axis is labelled according to the satellite wind speed, vertical axis is the mean bias (collocated – satellite).

Data from aircraft are now coming in numbers large enough to allow scatter diagrams to be drawn that will avoid some of the problem that may affect the bias curves such as shown in Figure 4 when dealing with one-sided distributions. Such scatter diagrams are shown in Figure 5. They very clearly confirm the overall underestimation of the winds provided by both METEOSAT and HIMAWARI. They also show that there is little information to be taken from the mean bias values, as the bias exhibits roughly a linear dependency with observed winds. The mean bias is likely to largely underestimate the underestimation problem as strong winds are outnumbered by slow winds in the global statistics.

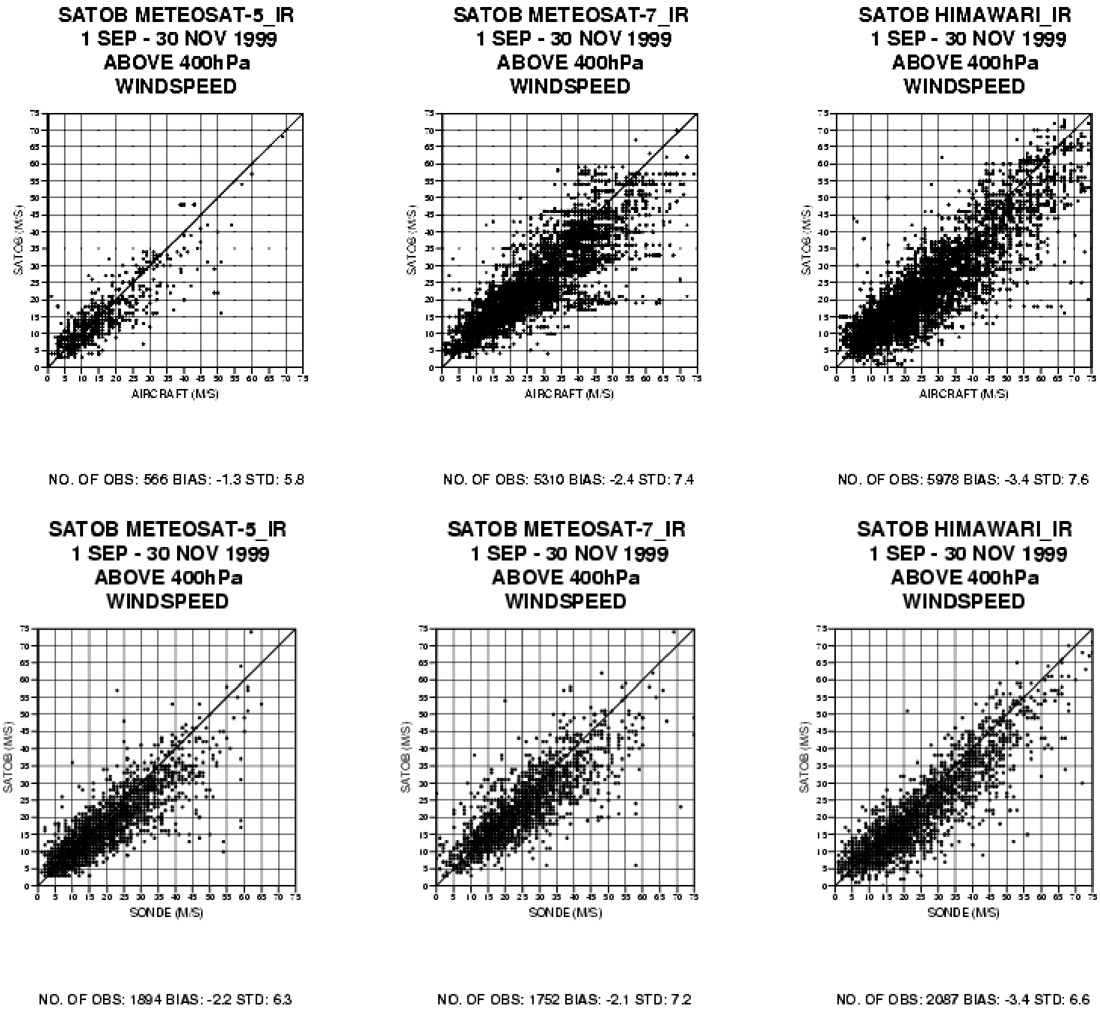

Figure 5: Scatter diagrams showing satellites winds (vertical axis) compared to collocated measures from aircraft (upper row) and radiosondes (lower row).

4. Summary: Can we make a better use if satellite winds?

Current data assimilation methods can handle random observation or representativity errors, but not systematic (biased) ones. This is why bias correction methods have to be applied before the data are provided to the model assimilation software, which is a common calibration process applied to data as different as scatterometer data, radiosonde temperatures or satellite brightness temperatures. Such calibrations are currently not applied to satellite winds, on the basis that the tracking techniques do identify motion vectors directly – and not through a quantity that is only indirectly related. An example of the latter type of winds are scatterometer winds that are related to the electromagnetic signal backscattered to space through the sea surface properties, which in turn are well related to the surface wind. However whatever the physical interpretation, results like seen on Figure 4 and Figure 5 confirm that satellite winds cannot be used as any other winds by the data assimilation system, as they will systematically slow down the most active jet streams.

The present solution used to overcome this problem is to introduce an asymmetric check on satellite winds. This check gives more confidence to slow winds than to fast ones, with the effect that any satellite wind slower than the model forecast by more than $4ms^{-1}$ for ranges beyond $60ms^{-1}$ will be rejected. This results in satellite winds being not used in those areas where they should be of crucial importance to early detect jet streams perturbations or jet streaks. A typical such rejection map is shown in Figure 6.

In order to let satellite winds bring their full information in situation that really matters, it is therefore suggested that the bias problem identified in section 3 is addressed with a high priority. This calibration should never be applied blindly and overwrite the basic displacement information provided by the automated tracking software. Whether the problem is solved by refining the height assignment procedures or by applying the bias correction to the wind value is a matter for careful studies.

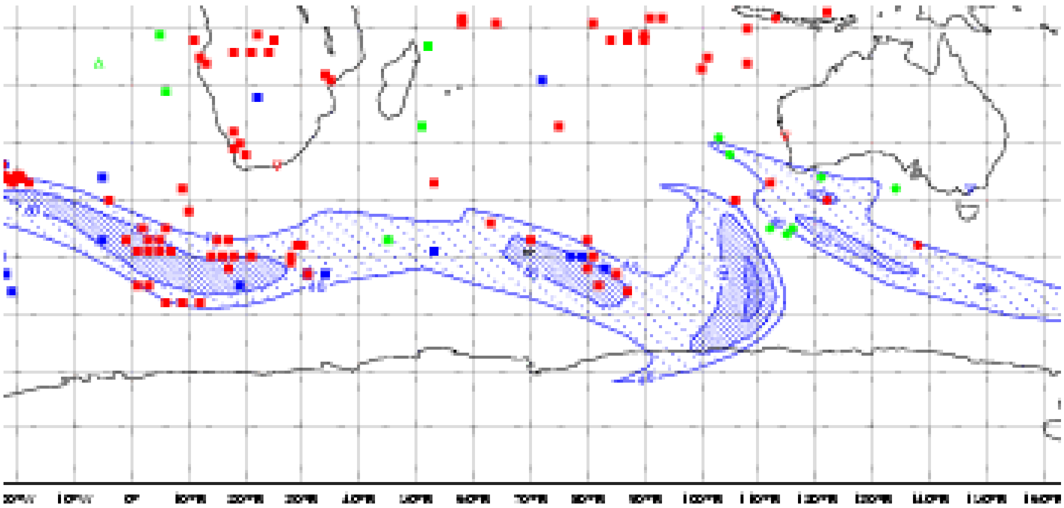

Figure 6. Rejection map (17 Feb. 2000 12UTC) showing the collocation of rejected data with the jet stream (shaded blue).

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