A Problem with Processing TOVS Data

Introduction

CDAS/Reanalysis uses satellite temperature retrievals (VTPR, TOVS, RTOVS) to help determine the tropospheric and stratospheric temperatures. This is an important source of temperature data over the oceans and in the stratosphere. However, this data is of low accuracy and the forecasts/analyses would be degraded if this data were used everywhere. Consequently a few rules were used to limit the use of the retrieval to where it would be helpful. (This is a tiny part of the QC process.)

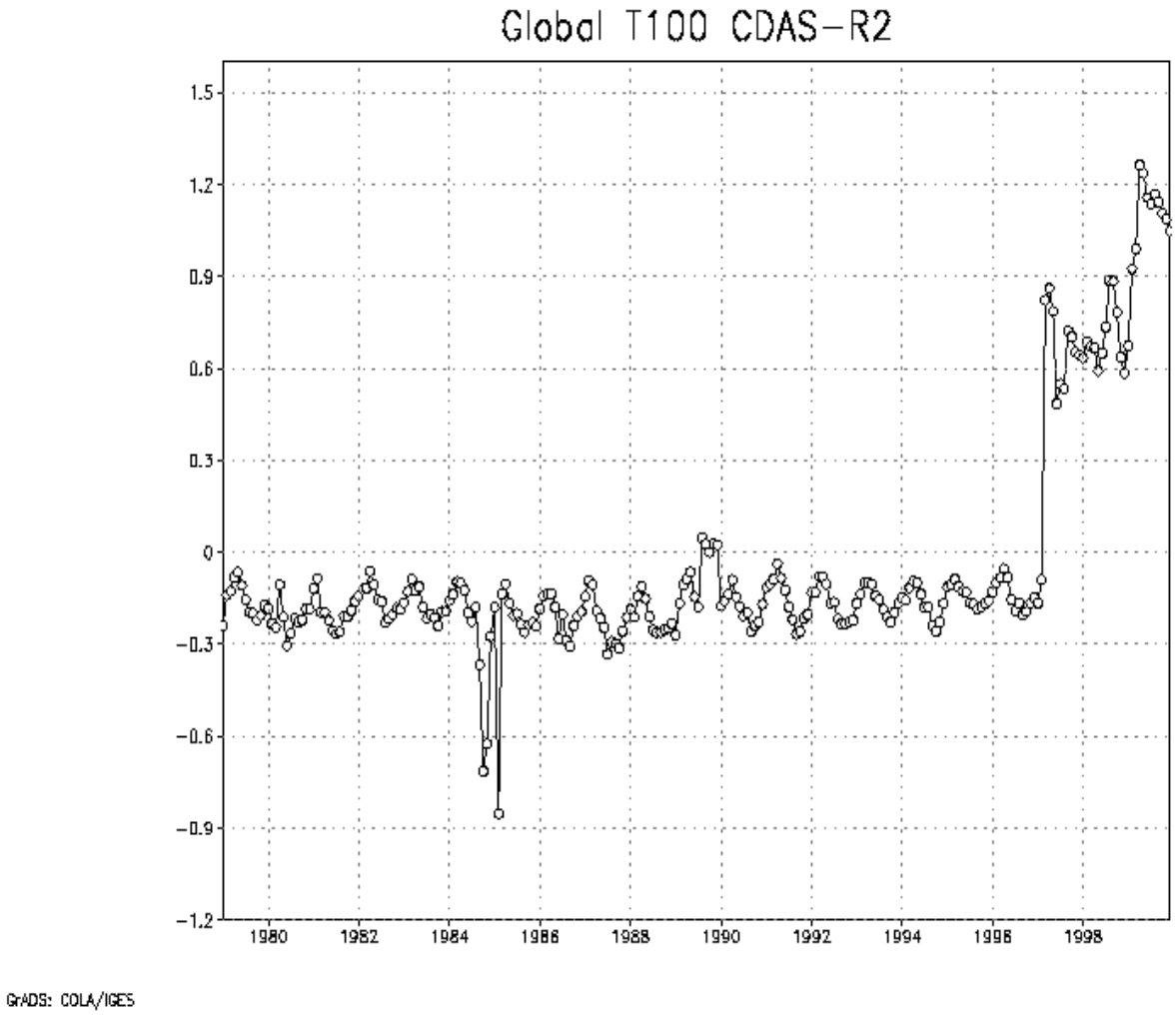
1. cloud-free and cloudy retrievals were ignored if over land and prs .ge. 100 mb and lat .ge. -60 (ie north of 60S)
2. cloudy retrievals were ignored if over land and prs .gt. 100 mb and lat .lt. -60 (ie south of 60S)
3. retrieval was ignored if subsurface (caught by other tests?)

Unfortunately when the BUFR/QC processing was ported moved from the HDS to the CRAY (history), these filters were lost in the port. This problem was not found earlier because the rejection rate of the satellite temperatures remained reasonable. (The other QC tests rejected more data.)

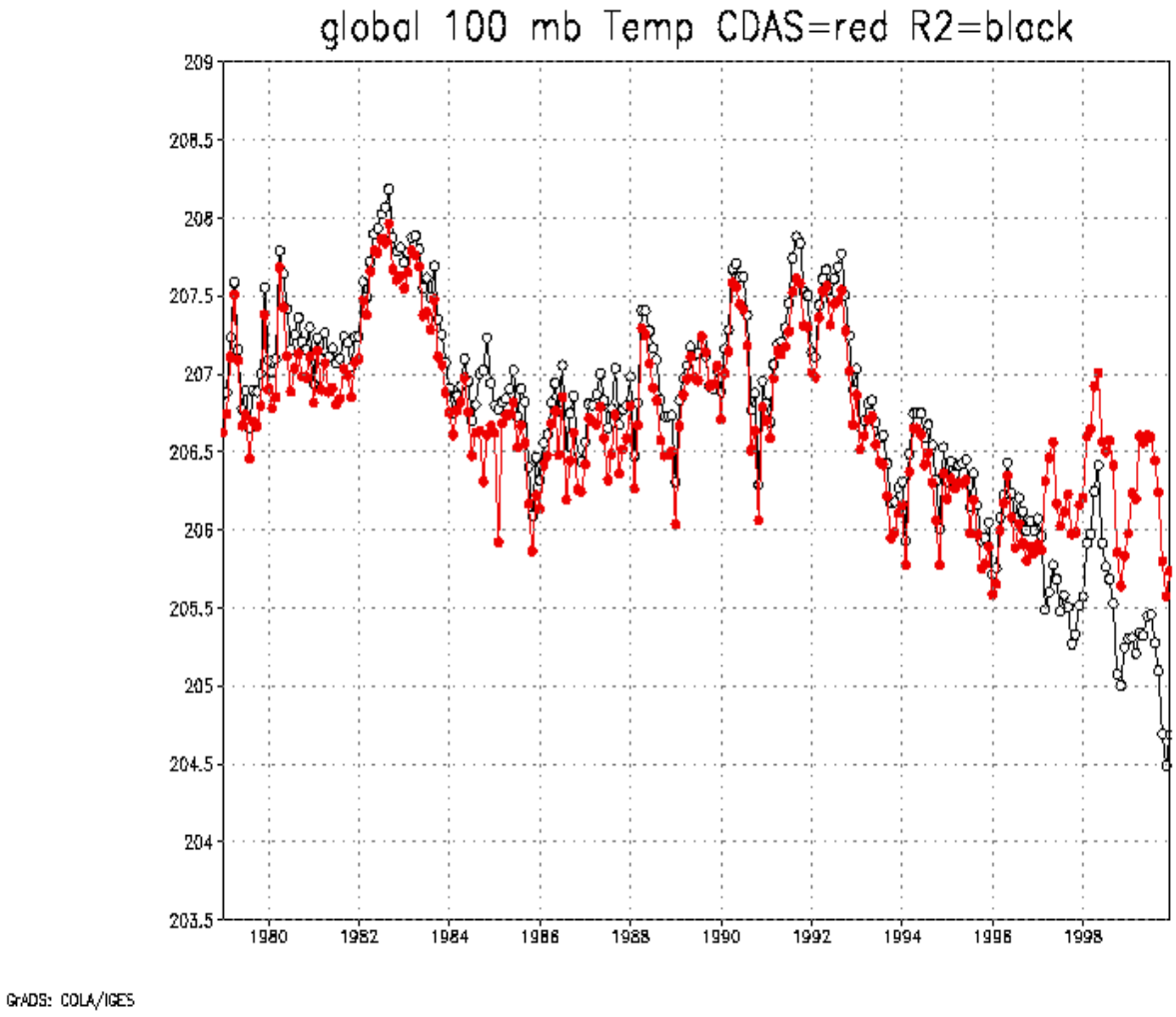
Consequences of Accepting Retrievals over Land

The consequences will be illustrated by comparing the CDAS/Reanalysis (R1) with NCEP/DOE Reanalysis (R2). R2, like R1, had to run the HDS QC codes on a cray computer. The R1 project used the operational codes with CDAS options because the NCEP infrastructure could then be used to maintain the codes. R2, on the other hand, was designed to be portable so they ported the HDS QC codes.

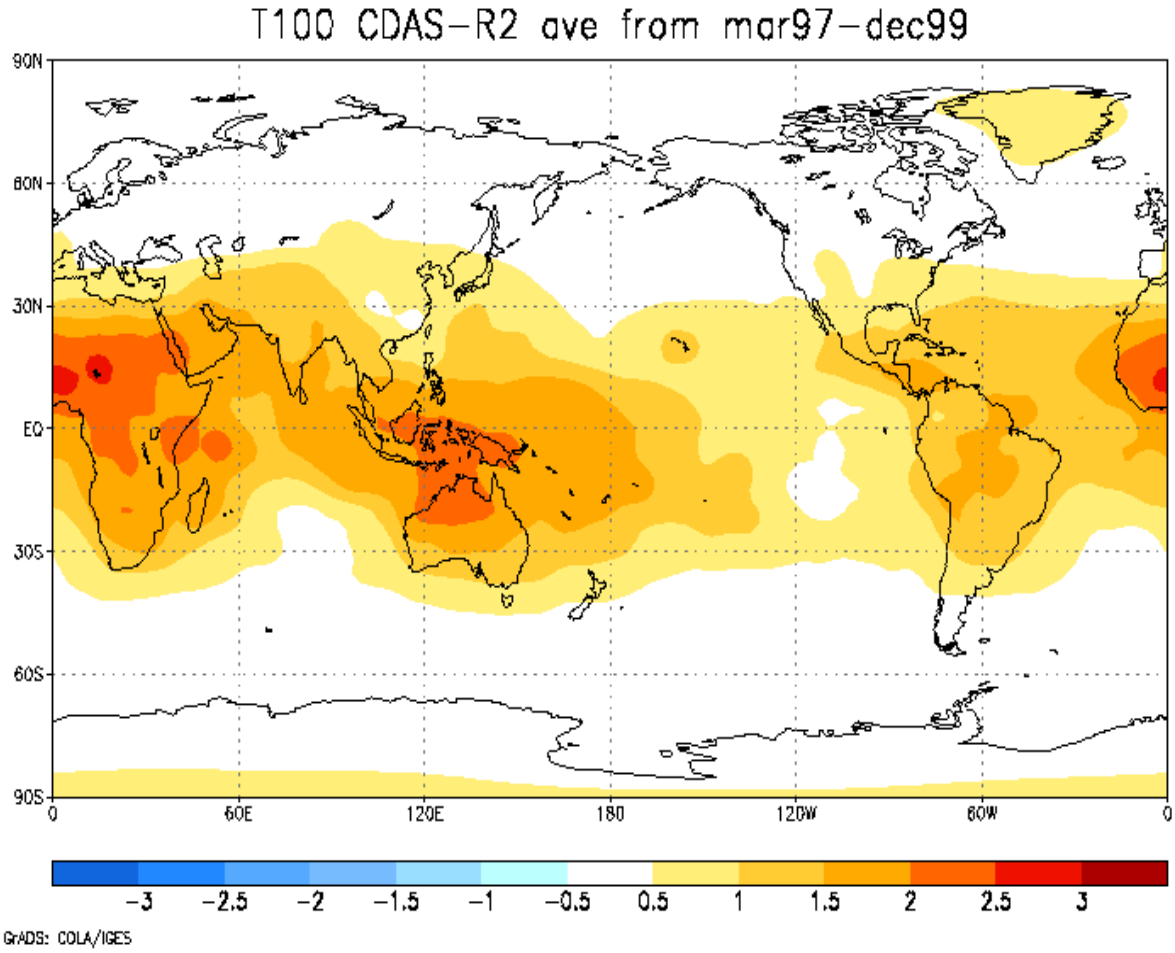
A problem with R1 was discovered by looking at the differences in monthly temperatures. A particularly problematical level is at 100 mb. The following plot shows the difference in the global 100 mb temperature between R1 and R2. As seen in the plot, R1 shows a sudden relative warming in March 1997 which corresponds to the start of processing the BUFR data on the Cray. By the way, the blips in 1985 and 1989 may be caused by R2 having more input data than R1.



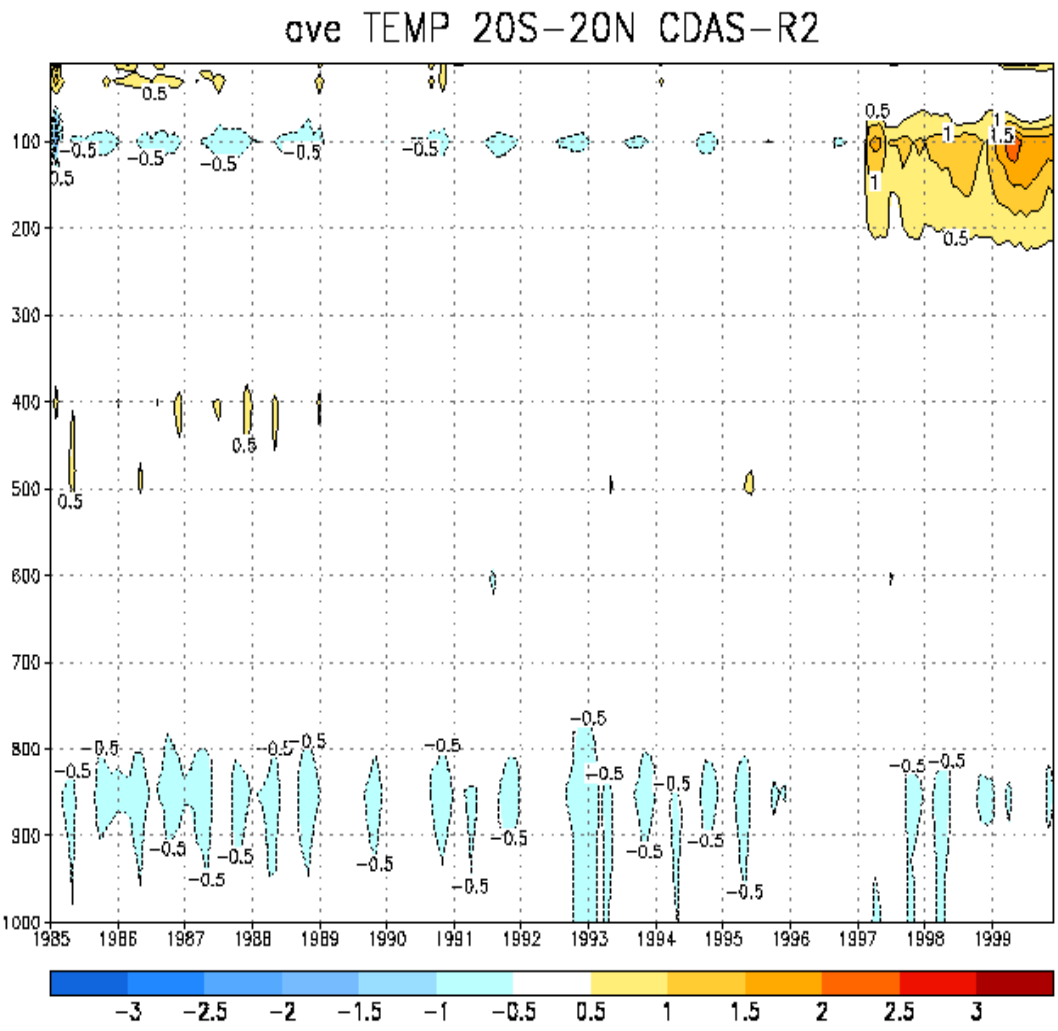
The following plot shows that since March 1997, R2 continued the cooling trend started in 1992 whereas the cooling trend levels off in R1.



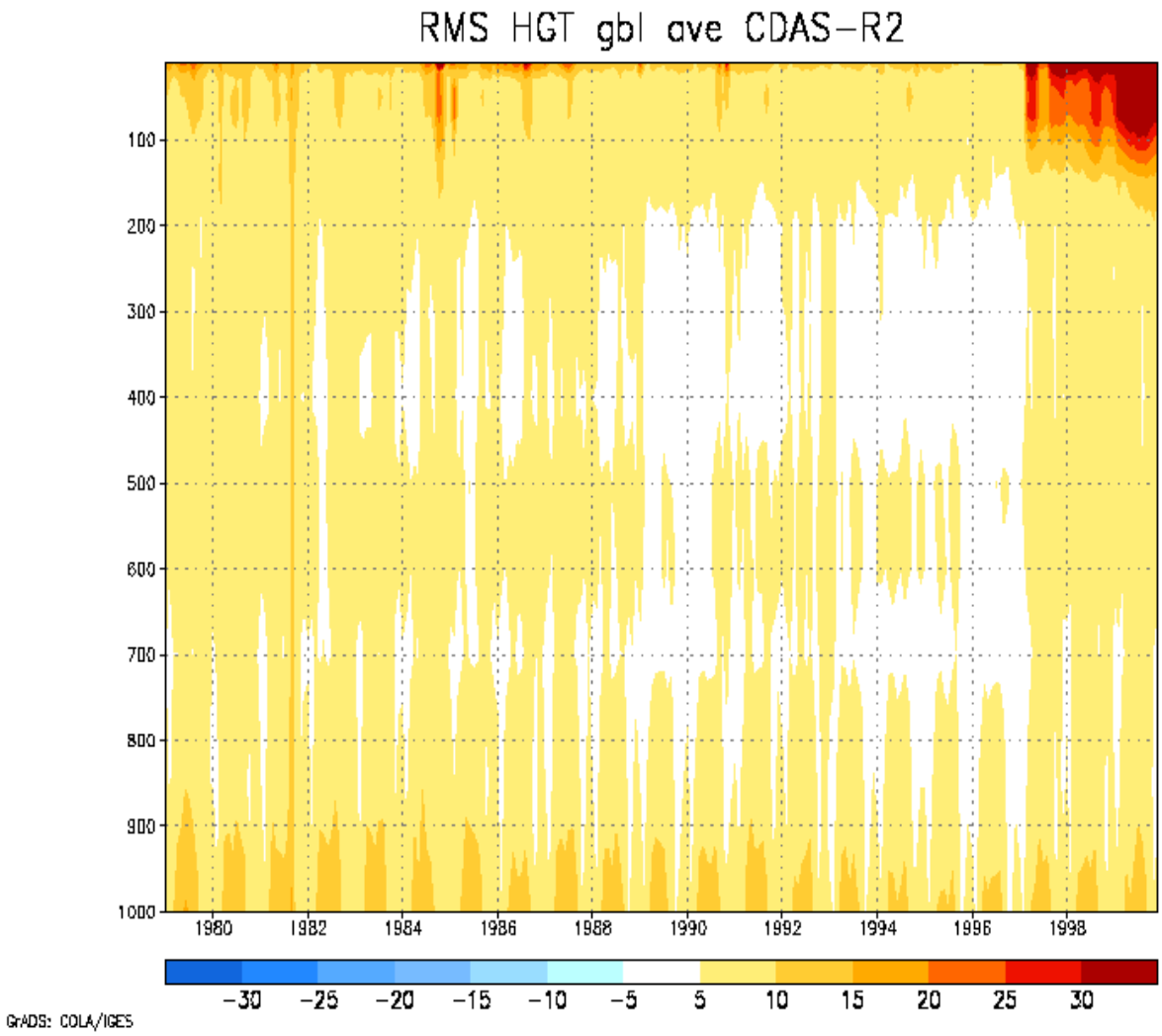
In the following plot, one sees the effect of the on the T100 is concentrated over the 30S-30N land masses and to a lessor extent over the 30S-30N oceans.



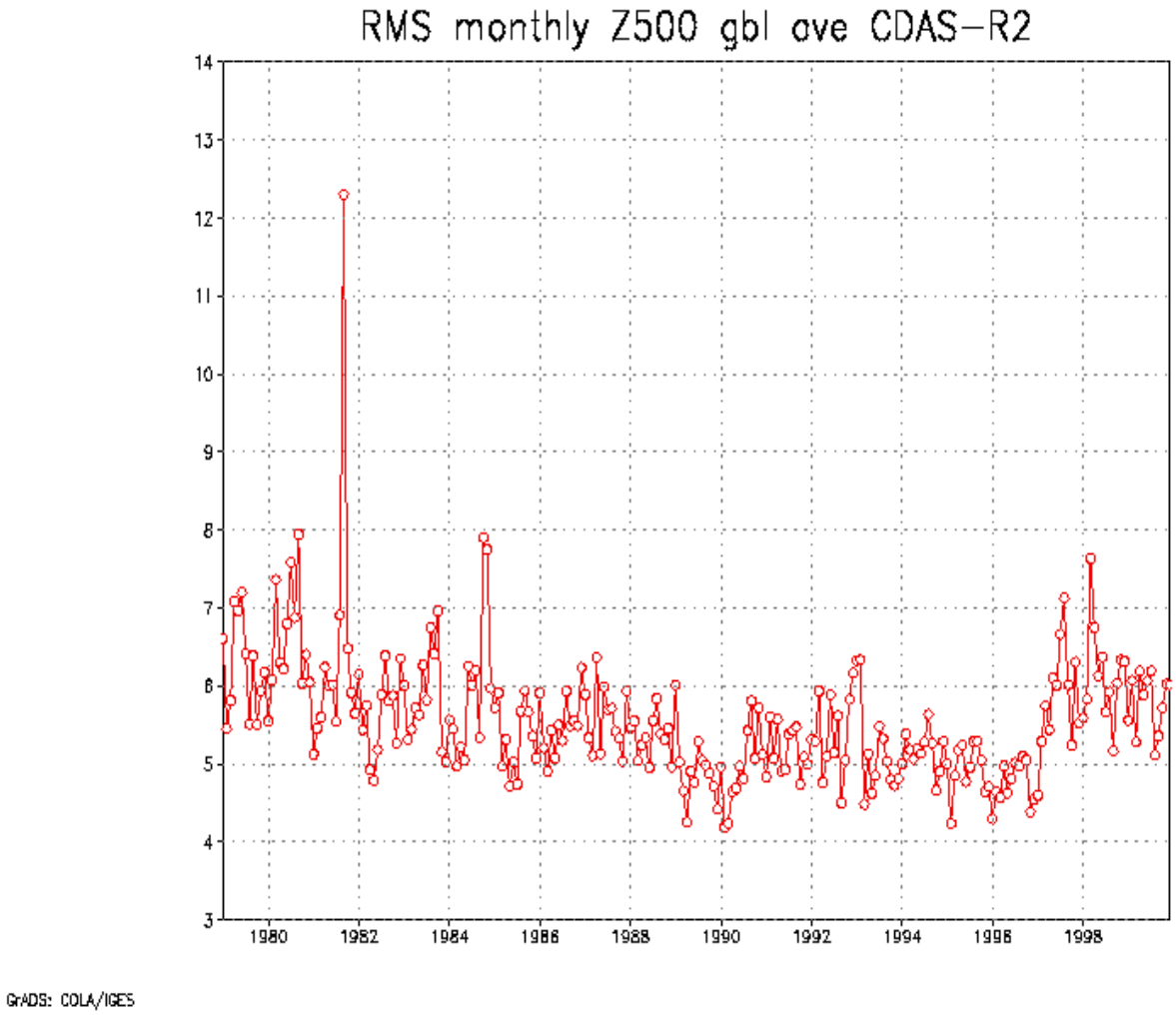
In the following plot, the CDAS-R2 tropical (20S-20N) temperature is plotted as a function of time and pressure. As seen, the problem is most severe between 100 and 150 mb. Above 100 mb, the problem doesn't appear (the filter did not affect temperature retrievals above 100 mb).



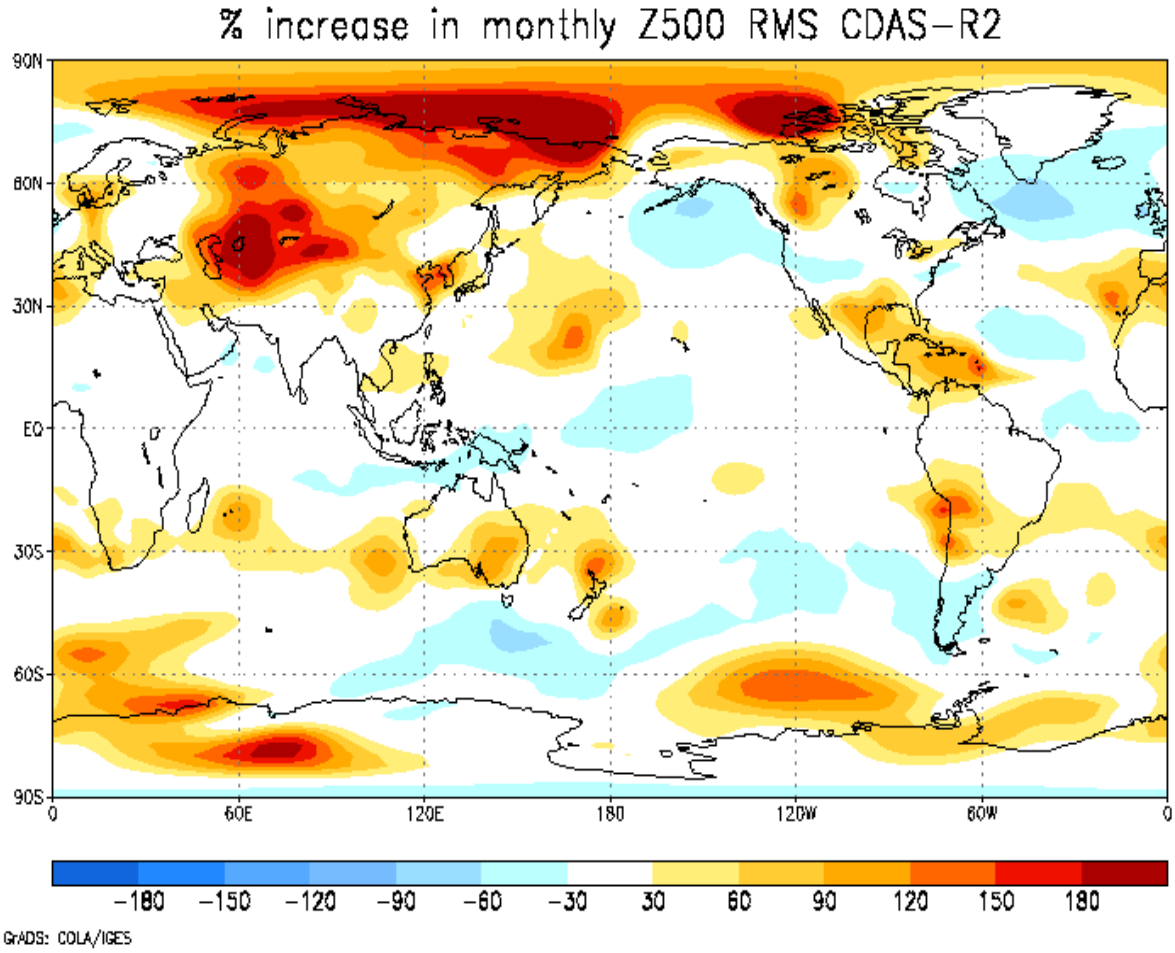
This problem apparently affected the global RMS difference of the CDAS and R2 monthly mean heights. There are large deviations between CDAS and R2 above 150 mb as one would expect. However, even in the troposphere, the variance appears to increase after March 1997.



The effect on globally averaged monthly Z500 RMS difference was approximately 1 m which is noticeable but not huge (RMS about climatology is on the order of 30 m). BTW the huge spike on September 1981 corresponds to a huge anomaly over the poorly observed Southern ocean.



However, a global average can hide many sins; the tropics normally has a low Z500 variance and the missing filter would not directly affect the oceanic regions. Below is a plot of the percentage increase in the Z500 monthly RMS. (Details: used the 1/98-12/99 period to be representative of the post-mistake RMS and the 1/87-12/96 period to be representative of the pre-mistake RMS.) As can be seen, central Asia, the Arctic and parts of Antarctica showed doubling of the RMS (peak value=497%). Much of the mid-latitude continental regions showed greater than 30% increase in the monthly RMS.



Rerun

The consequences of accepting the TOVS data over land has some significant impacts. The 500 mb height is one of the better analyzed fields. Even the monthly Z500 was affected. (We very strongly suspect the impact was adverse because of earlier satellite impact tests. It is also suspicious the Reanalysis forecast skill went down while the operational skill went up.) In addition, the effects of no TOVS-Land filter is very significant in the lower stratosphere temperatures and the stratospheric heights. Considering that climate monitoring is an important duty for CDAS; we need to rerun the affected period.

The affected period is from March 1997 to February 2001. For the convenience of the data distribution centers, we will rerun starting from January 1997. We expect the rerun to take from four to six months. During this period, we will continue to rerun the real-time CDAS. The rerun will eventually get to real-time and then the rerun system will take over.

The rerun will have a process ID of 181 in the GRIB header (vs 180 of the current version) so that one can easily determine the CDAS "version".

Details on the distribution of the revised CD-ROMs have not been finalized. Of course, the 2000 CD-ROM will be delayed until the 2000 has been rerun.

We regret the inconvenience that our mistake will cause the Reanalysis users. Mistakes will occur in large software projects and unfortunately our monitoring tool (global/regional data rejection rates) didn't indicate any problems. The problem could only be diagnosed by plotting the BUFR data, and unfortunately our tools were, at that time, was not as well developed.

History

Development of The CDAS/Reanalysis was started in 1991. As one would expect, CDAS/Reanalysis has been forced to port the code as old computers have been retired. Here is a brief table of the major system changes:

Date	Model (MRF), Assimilation (SSI)	BUFR production, quality control	comments
5/1994	CRAY YMP/8 (UNIX)	HDS (s370 clone, MVS)	original configuration, BUFR and QC codes based on operational and modified for older data types
?/1995	CRAY J/16 (UNIX)	HDS (s370 clone, MVS)	changes for performance
3/1997	CRAY J/16 (UNIX)	CRAY C90 and J/16 (UNIX)	moved to operational BUFR and QC codes with CDAS options
5/2000	IBM SP/2 (UNIX)	IBM SP/2 (UNIX)	major port, used operational BUFR and QC codes with CDAS options

Acknowledgements

Dennis Keyser, Bob Kistler and Jack Woollen were key players in solving this problem. Suru Saha wrote for us the code used to convert the BUFR TOVS files to GrADS format.

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