Error Analysis of SSM/I F08 Antenna Temperatures to Produce an Extended Record of Observations for Climate Applications

Dustin Snare[1], Wesley Berg[2], Mathew Sapiano[2], Christian Kummerow[2]

INTRODUCTION

The Special Sensor Microwave/Imager (SSM/I) was a conically scanning window channel microwave radiometer that was flown aboard the Defense Meteorological Satellite Program (DMSP) satellites. The series of satellites forms the longest record of microwave measurements starting in 1987 and continuing through to the present with the Special Sensor Microwave Imager/Sounder (SSMIS) with dual coverage for much of the record. The first sensor flew aboard the F08 satellite that was launched in June 1987 and flew until December of 1991. During this time, this was the only SSM/I flown making these data a crucial part of the climate record. However, many errors existed in this early data from F08 and correction of these errors is essential for the use of these data in long-term climate studies.

Several Quality Control (QC) checks are already applied including checks against climatology and checks based on comparison of original and calculated geolocation. However, significant problems still exist and a further QC check is required to identify bad scans. In this study, we identified cases where additional QC is required and developed a new procedure that was added to existing procedures and makes F08 data a viable part of the climate record.

METHODS

It was found that the time tag for some scans for F08 was incorrect, so that the brightness temperature (TB) values were mis-located in both the original and calculated geolocation. This problem lead to land being mis-located over ocean and vice versa and affected a large number of scans in a row in some swaths.

•A procedure was developed whereby erroneous TBs were identified using a climatology check. A moving data window was used to seek long sequences of scans where this behavior was detected

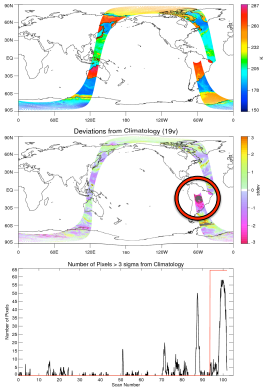
•Three parameters are used in the QC check:

1. Number of pixels in a scan that are more than three standard deviations from the climatological mean
2. Number of scans in the data window exceeding this threshold
3. Width of the data window

•The three parameters must be chosen with great care so as to avoid incorrectly flagging "extreme" weather phenomena that fall outside the climatology check as bad scans

•A large number of cases were studied in order to ensure that the new QC check worked appropriately

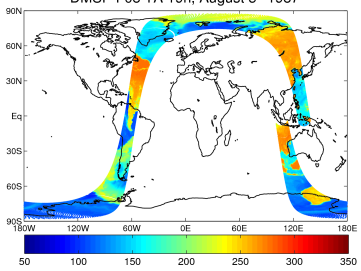
DMSP F08 TA 19v, August 1st, 1987



ANALYSIS

PROBLEM 1: TIME GEOLOCATION ERROR

DMSP F08 TA 19h, August 5th 1987



•The plot on the left shows the incorrectly geolocated data that affected around half of the swath in this example

•The geolocation was determined to be correct for the time values given in the original data file, however, the time and TB values in the file did not match so that the data are incorrectly geolocated

•The window argument was carefully chosen to ensure that the bad scans were removed

•The window needed to be long enough to span areas where ocean TB values were incorrectly placed over ocean (the wrong ocean) and passed the climatology check but were actually erroneous

•Same was true for land pixels

PROBLEM 2: ALTERNATING SCAN ERROR

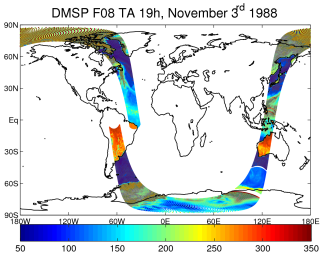
•Some swaths contained good scans that were interleaved with bad (presumably mis-located) scans

•These "good" scans caused the QC check to miss the bad scans when the bad scans occured in smaller chunks

•A wider time window was used to ensure that these scans were flagged

•The plot on the right shows an example of a case of interleaved good/bad data

DMSP F08 TA 19h, November 3rd 1988



PROBLEM 3: CLIMATOLOGY

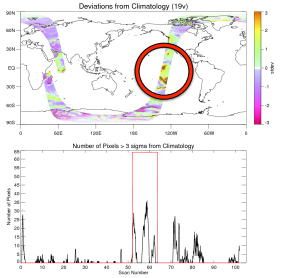
•One of the biggest dangers of implementing this type of QC check is the potential for incorrectly identifying weather phenomena as bad pixels

•A climatology check of three standard deviations was used, so that TBs showing large weather variations are routinely identified as bad in two main categories

1. Significant weather phenomena over oceans (right) and land (left)
2. Sea ice over the Arctic Southern Oceans and Antarctica snow cover

•Again, case studies where used to ensure that the QC check does not identify such cases as bad. This was solved by using a window that was long enough to span over such weather/surface phenomena

DMSP F08 Climatology Check 19v, August 9th, 1987
Data Window = 428 Scans



RESULTS

•The new screening procedure for removing bad scans due to mis-matched time data was tested an implemented for F08

•Testing was conducted to ensure that the screening procedure did not remove large weather events that were outside the three sigma climatology

•This testing mainly focused on what size window was required to effectively pass over these extreme weather events

•The final QC check was implemented with the following settings:

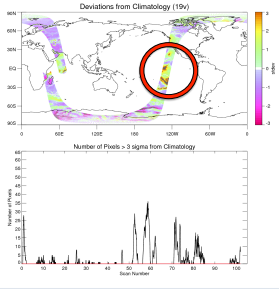
1. If 30 pixels in a scan fail the three sigma climatology check, that scan is potentially bad
2. If the percentage of potentially bad scans within a window was greater than 30%, those scans were flagged as actually bad
3. The final window size was chosen to be 1500 scans (~100 minutes)

•A further test of the technique was done by applying the procedure to F13, which is known not to have this problem

•It was found that the window of 1500 scans did not exclude genuine weather events for F13, but did exclude erroneous pixels for F08

•The procedure was applied to F08, F10 and F11

DMSP F08 Climatology Check 19v, August 9th, 1987
Data Window = 1500 Scans



SUMMARY

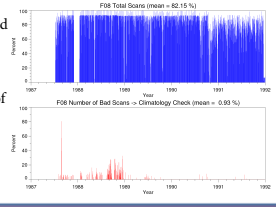
•Adequate quality control of the F08 SSM/I data is of great importance to the longer SSM/I climate record since this one sensor extends the series by around five years

•Substantial errors exist in the raw F08 temperature data record that preclude their use for climate studies without the application of QC procedures

•A QC procedure has been developed and implemented for F08 that removes a significant number of bad scans

•The plot shows the number of good scans (blue) and flagged bad scans (red) for F08 over time

•The QC issues were a larger problem than the intercalibration of the satellites and thus applying the QC checks has lead to a large improvement in the climate data record



This work has been supported by the National Science Foundation Science and Technology Center for Multi- Scale Modeling of Atmospheric Processes, managed by Colorado State University under cooperative agreement No. ATM-0425247.

[1] Department of Earth Sciences-Meteorology, California University of Pennsylvania, California, PA
[2] Department of Atmospheric Sciences, Colorado State University, Fort Collins, CO
Contact info: Dustin Snare, California University of Pennsylvania, California, PA; email: sna9349@calu.edu