

## Updates to TMI V04 Ocean Products

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### Introduction

A major update to the TMI dataset has been implemented. TMI Version 3 (V03) has been updated to Version 4 (V04). The major objectives of the update was to:

1. Implement a much-improved cloud and rain rate algorithm.
2. Achieve better consistency between TMI retrievals and 7 other satellite platforms (i.e, 6 SSM/I and AMSR-E).
3. Make minor improvements in other retrievals, namely SST and vapor.

### Algorithm Improvements for TMI

1. The generation of a CDR for TMI is particularly challenging due to the following:
  - a. The vapor-deposited aluminum (VDA) on the TMI antenna oxidized and/or cracked. As a result the antenna has an emissivity of graphite, which is 3 to 4%.
  - b. The solar environment for TMI is constantly changing due to its near-equatorial orbit drifting through the diurnal cycle. Furthermore, the solar environment changes radically every month or so when a 180° yaw maneuver is completed.
  - c. In September 2001, the TMI orbit was boosted from an altitude of 350 km to 400 km.
  - d. There are small errors in the knowledge of the satellite roll and pitch, particularly right after the 2001 orbit boost.

Our new calibration algorithms attempt to correct for all these effects. We found that the algorithm used to correct roll and pitch errors was introducing a small along-scan error in the SST and wind retrievals. This problem has been fixed in V04. We also found small systematic biases in the SST, wind, and vapor retrievals that were correlated with the yaw state (either 0° or 180°). Finally, we found small systematic biases in wind and vapor for the time period before the boost as compared to the time period after the boost. Both these biases have been removed in V04 products.

2. A much improved rain algorithm has been implemented. More realistic freezing level heights and beam-filling corrections are used. We rederived the relationship between rain column height and sea surface temperature (Reynold's SST) using NCEP freezing level heights in raining conditions. The new relationship produces freezing level heights that are more realistic and spatially representative. In addition, we have made two major changes to the beamfilling correction. A) Previously, we allowed the correction to "max-out" when the radiometer saturated. The new correction produces more realistic corrections when saturation occurs. B) We now incorporate footprint size into the beamfilling correction in order to bring SSM/I, AMSR-E and TMI rain rates into better agreement. As a result, the cloud water and rain rates retrievals are very consistent across all 8 satellite platforms (i.e, 6 SSM/I, TMI, and AMSR-E). This consistency is also a result of using the same method of  $T_A$  resampling for all satellites (see next item).

3. Corrections to  $T_A$  resampling have been implemented. The geophysical retrieval algorithms require that the  $T_A$  measurements from different frequencies all be resampled to a common spatial resolution. TMI had been using a precise  $T_A$  resampling method to optimally interpolate the  $T_A$  observations to a common footprint (the same type of  $T_A$  resampling as we use for AMSR-E.) However, the TMI V03  $T_A$  resampling was not correctly taking into account the change in geometry that occurs when TMI goes through a  $180^\circ$  yaw maneuver. The resampling weights were correct for  $180^\circ$  yaw orientation but were incorrect for the  $0^\circ$  yaw orientation. This error led to a distortion near the swath edges and produced a positive bias in cloud water and rain rate at the swath edges. We have corrected this problem; now TMI V04 uses 4 separate sets of resampling weights: yaw  $0^\circ$ -preboost, : yaw  $180^\circ$ -preboost, yaw  $0^\circ$ -postboost, : yaw  $180^\circ$ -postboost. Use of the new weights makes little impact on SST, wind speed, or columnar water vapor, but does significantly affect cloud water and rain rate.

4. The geophysical retrieval algorithms and data processing systems have been modified and restructured to bring a higher degree of commonality to the SSM/I, TMI, and AMSR-E. Essentially the same set of algorithms is now used to process all three types of satellite microwave radiometers. This will help to ensure greater consistency among the extended suite of satellite microwave radiometers.