Validation of MODIS Aerosol Optical Thickness (AOT) over the Indian Ocean with Field Observations

Gad Levy[1] Andrew Geiss[1] DanLing Tang[2] Qinyang Sun[2] Jingrou Lin[2*] Wang Sufen[2] Nicole Colasacco-Thumm[1] Chidong Zhang[1] Chu-Chun Huang[3]

ABSTRACT

The Moderate Resolution Imaging Spectroradiometer (MODIS) instrument measures the aerosol optical thickness (AOT) from satellites. The MODIS aerosol product monitors the ambient aerosol optical thickness, a major source of uncertainty in climate modeling, over the oceans globally and over a portion of the continents. Because of assumptions on the general structure of the size distribution required in the inversion of MODIS data, and instrumental degradation and calibration drift, it is important to regularly validate data provided by satellite remote sensing instruments. We have deployed a hand-held sun photometer on board research ships in three recent field campaigns in the Indian Ocean in 2011 and 2012. The field data collected are used to validate AOT observations from the MODIS-AQUA following spatial-temporal matching.

DATA

Microtops II SunPhotometer – We deployed a hand-held photometer on three research cruises in the Indian Ocean during 2011 and 2012. The photometer measures aerosol optical thickness, solar irradiance and water vapor column at eight wavelengths. 500nm wavelength aerosol optical thickness was used for comparison to MODIS AOT. The hand-held instrument also records elevation, location (using GPS) and pressure.

MODIS-Aqua – Field measurements of AOT were compared to 550nm ocean AOT measured by MODIS-Aqua. MODIS-Aqua produces daily global AOT data over the world's oceans. For direct comparison to field data, MODIS data were spatially interpolated to determine approximate AOT over the location of the hand-held instrument.

METHODS

Quality Control

The hand-held photometer that was used is susceptible to error introduced by the user and the environment. To take an accurate reading the device must be pointed directly towards the sun, using a viewfinder with a 2.5 degree field of view. Failure to do so results in erroneously high AOT values. Readings taken under cloud cover result in similarly high AOT values. As a result, a substantial amount of quality control was done to remove these values. Firstly, all AOT values above 3 were removed which accounts for the majority of the user error. Secondly, data recorded during inclement weather or under heavy cloud cover were removed. Lastly, remaining data that were not within two standard deviations of the mean AOT were marked as outliers.

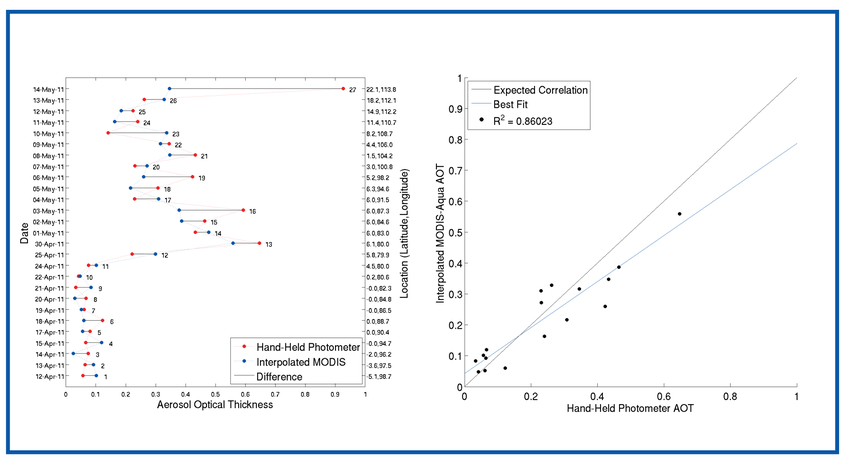
Comparison to MODIS

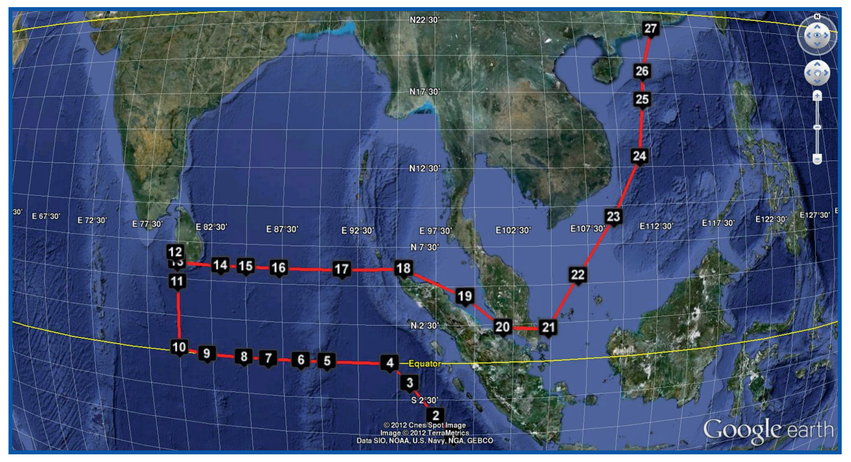
Because of the limited resolution and swath size of MODIS-Aqua. Remote sensing AOT data were not always available directly over the location of the vessel. For comparison to ground based AOT measurements, MODIS data were interpolated to approximate a corresponding space based AOT measurement. For each ground based measurement, AOT data over the location were spatially interpolated from the most recent MODIS-Aqua AOT field. The interpolation scheme used a k-nearest neighbor algorithm (k=8). Each sampled AOT value was weighted using normalized inverse distance squared. Due to limited MODIS coverage at low latitudes, occasionally interpolation was carried out over a very large distance. A threshold distance of 250km was used to identify outliers caused by interpolation error.

ANALYSIS & RESULTS

Cruise 1
South China Sea Institute of Oceanology (SCSIO)
12 April 2011 – 14 May 2011
Qinyang Sun

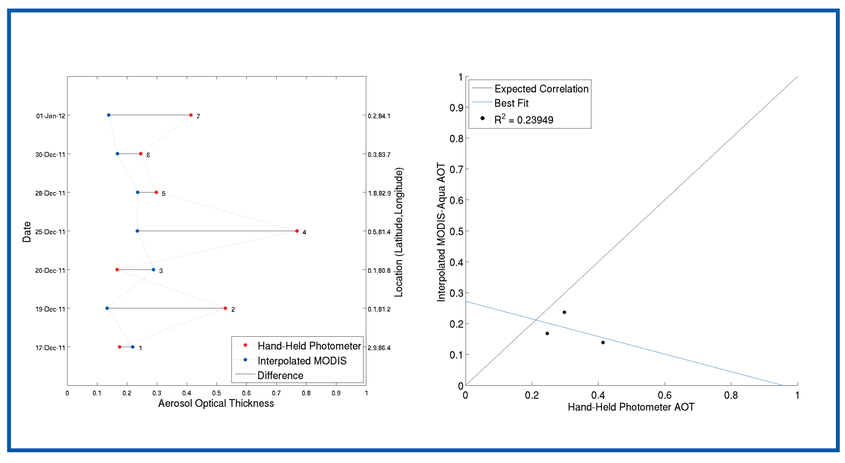
Cruise 1 resulted in data with high correlation to MODIS. Of note is the sudden and consistent increase in AOT after moving into the northern hemisphere (11+).

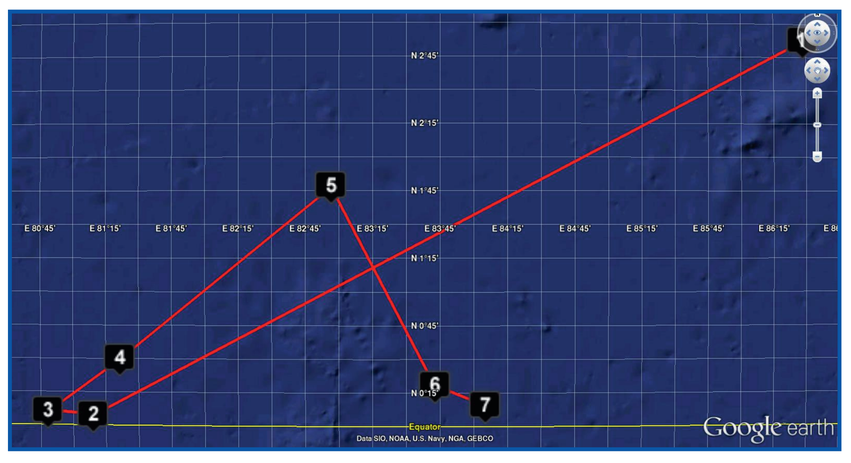




Cruise 2
DYNAMO Project
28 Nov 2011 – 1 Jan 2012
Nicole Colasacco-Thumm
Chu-Chun Huang

Cruise 2 yielded limited data and poor correlation with interpolated MODIS AOT. This was likely due to cloud cover.
Cruise 2 measurements were carried out on leg four of the DYNAmics of the Madden-Julian Oscillation (DYNAMO) project.





Cruise 3
SCSIO
25 Feb 2012 – 19 April 2012
Jingrou Lin

Cruise 3 resulted in a large amount of good data from the hand-held instrument, however, there was poor correlation with MODIS. Hand-held AOT data were not strictly larger than MODIS AOT, which means that the error may stem from interpolation. Additionally, several of the hand-held readings were taken under cloud cover, which artificially increases AOT values.