Global Calibration of the JASON Microwave Radiometer (JMR) with AIRS Data

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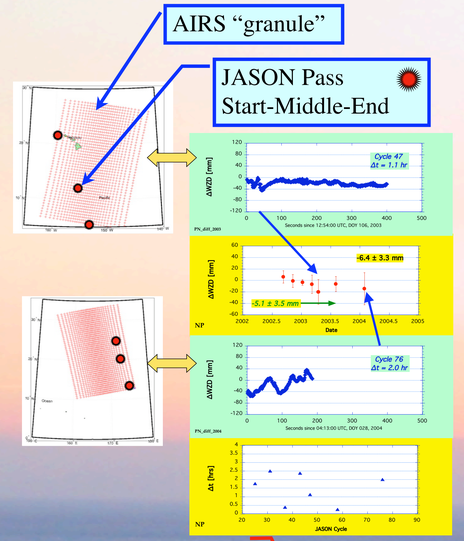
Abstract

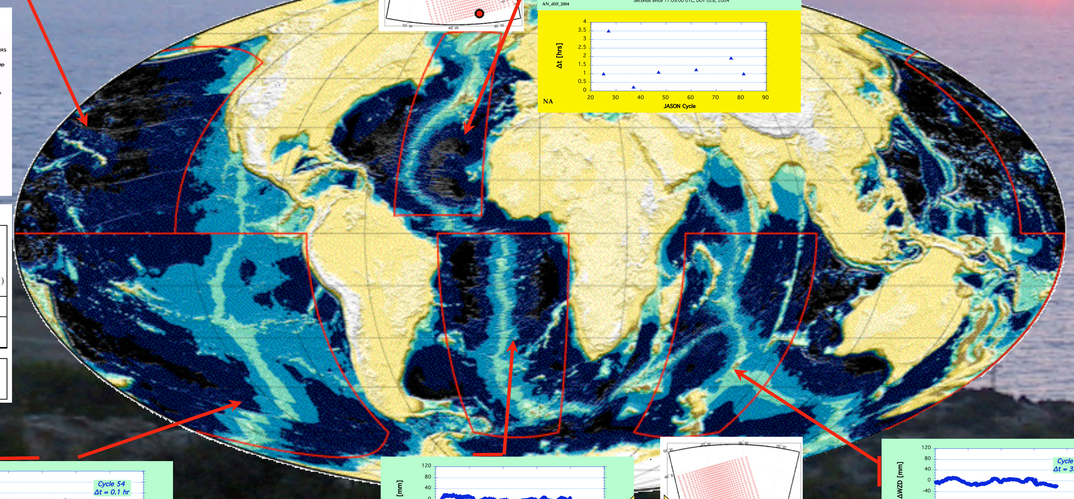
A new approach for the calibration as well as the operational validation of the atmospheric delay derived from JMR measurements is presented. The Atmospheric Infra-Red Sounder (AIRS) aboard NASA's satellite mission AQUA, is able to measure twice daily a number of environmental parameters of Earth's atmosphere in the form of atmospheric profiles (Aumann et al., 2003). AIRS data comes in the form of a granule, which contains 30 cross-track points in each of 45 along-track scan-lines. Each measurement point has a spatial resolution of approximately 50 km and there are a total of 1350 (=45x30) such points per granule. The vertical resolution is 28 pressure levels extending from the surface up to 0.01 mb, pressure being "ancillary" data from ECMWF fields. We make use of the global fields produced by the AIRS instrument during concurrent JASON passes over five areas covering the North and South Atlantic and Pacific oceans, as well as the Indian ocean. AIRS granules that were chosen here cover the appropriate JMR tracks spatially and temporally, with varying lag-time, from minutes to three hours maximum. In addition to AIRS data, we also have available from another AQUA instrument, the Advanced Microwave Sounding Unit (AMSU), brightness temperatures to be compared with those from JMR measurements. The spectral range includes 13 channels from 50-90 GHz and 2 channels from 23-32 GHz. We have looked at channel 1 (23.8 GHz) and channel 2 (31.4 GHz), the two closest to those used by JMR. JMR measures sea surface microwave brightness temperatures at three frequencies, 18.7 GHz, 23.8 GHz and 34.0 GHz. The 23.8 GHz channel is used for water-vapor measurement, the 18.7 GHz channel provides corrections for wind-induced effects in the sea surface background emissions, and the 34.0 GHz channel provides a correction for cloud liquid water. All these measurements are combined to provide the range correction for the wet path delay due to water vapor in the atmosphere. Our present comparison between the two systems covers the globe, focusing on five regions that are exclusively over open seas. We are in the process of examining areas that are close to the coast, so that we can discriminate between the variable performance of JMR as it was discussed during the November 2003 Science Working Team meeting and in (Scharroo et al., 2004). This work is an extension of the comparisons we presented for our two Mediterranean campaigns as described in (Pavlis et al., 2004). The results of the global analysis indicate a close agreement of JMR and AIRS measurements in 2002 (mm-level agreement), slowly degrading through 2003 and 2004 (cm-level discrepancies).

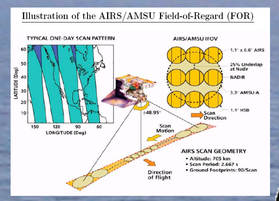
Aumann, H. H., M. T. Chahine, C. Gautier, M. D. Goldberg, E. Kalnay, L. M. McMillin, H. Revercomb, P. W. Rosenkranz, W. L. Smith, D. H. Staelin, L. L. Strow, and J. Susskind. 2003. AIRS/AMSU/HSB on the Aqua Mission: Design, Science Objectives, Data Products, and Processing Systems. *IEEE Transactions on Geoscience and Remote Sensing*, 41(2):253-264.

Pavlis, E. C., S. P. Mertikas and the GAVDOS Team. 2004. The GAVDOS Mean Sea Level and Altimeter Calibration Facility: Results for Jason-1, accepted for publication in the 3rd Jason special issue of *Mar. Geod.*.

Scharroo, R., J. L. Lilibridge, W. H. Smith, and E. J. O. Schrama. 2004. Cross-calibration and long-term monitoring of the microwave radiometers of ERS, TOPEX, GFO, Jason, and Envisat. *Mar. Geod.*, in press.





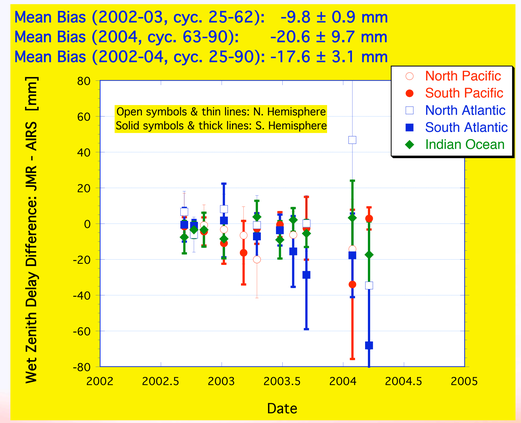


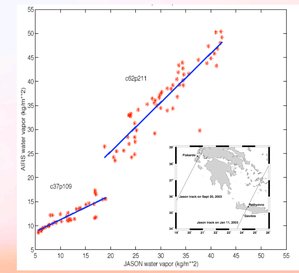
Summary of Geophysical Products

$T(p)$	vertical temperature profile
$q(p)$	vertical water vapor profile ($\approx$ 8 g/kg @ surface)
$L(p)$	vertical liquid water profile (f/ AMSU/HSB)
$O_3(p)$	vertical ozone profile ($\approx$ 8 ppmv @ 6 mb)
T_s	surface temperature
$\epsilon(\nu)$	spectral surface emissivity, (*e.g.*, 0.95 @ 800 cm^{-1})
$\rho_r(\nu)$	spectral surface reflectivity of solar radiation
P_{cld}	cloud top pressure for $\leq$ 2 cloud levels
$\alpha_{cld,\delta\nu}$	cloud fraction for $\leq$ 2 cloud levels and 9 FOV's
CO_2	total column carbon dioxide ($\approx$ 363 ppmv)
$CH_4(p)$	methane profile ($\approx$ 1.65 ppmv)
$CO(p)$	carbon monoxide profile ($\approx$ 0.11 ppmv)

Ancillary Information Needed for Retrieval

P_s	surface pressure (f/ forecast)
θ	satellite zenith angle
$\theta_\odot$	solar zenith angle
$\epsilon_{cld,\nu}$	spectral cloud emissivity for $\leq$ 2 cloud levels





Multiple System Comparisons at two Eastern Mediterranean Sites

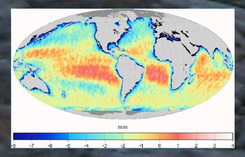
System	Fiskardo, Kefalonia September 2003, Cycle 62	Rethimno, Crete January 2003, Cycle 37
JMR	132.4 mm	71.6 mm
GEMOSS	134.0	70.4
WVR2000	138.9	----
AIRS	130.3	72.6
JMR - GEMOSS	-1.6	1.2
JMR - WVR2000	-6.5	----
JMR - AIRS	2.1	-1.0

GEMOSS & WVR measurements by ETHZ GAVDOS partners

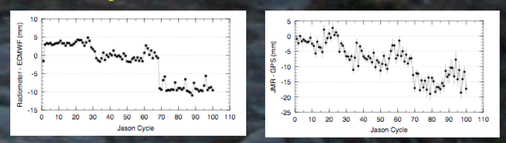
Summary

- We have used AIRS total wet zenith delay retrievals during the period 2002 – 2004, over five open ocean areas to perform comparisons with the corresponding JMR observations.
- The periods we selected correspond to various time intervals when sudden changes in the JMR observations had been observed, in comparison to other (independent) observations (e.g. ECMWF and GPS).
- Due to the different orbits between AQUA and JASON, we restricted our comparisons to cases when the temporal difference was less than 4 hours, (in most cases we are < 3 hours apart).
- Our comparisons agree in general with the observed increased bias in the time frame following cycle 70.
- **For the entire period examined (cycles 25-90), we obtain a bias of -17.6 ± 3.1 mm. If we restrict the period to cycles 25-62, then the bias is: -9.8 ± 0.9 mm, while it grows to -20.6 ± 9.7 for the 2004 period, cycles 63 to 90. The scatter increases also by an order of magnitude between the early and late estimates.**

JMR-TMR over Cycles 1-21
From CAL/VAL Summary at Arles SWT



JMR Comparisons to ECMWF and GPS-derived WZD*



*MacMillan, D.S., B. Beckley, and P. Fang, "Monitoring the TOPEXand Jason-1 Microwave Radiometers with GPS and VLBI Wet ZenithPath Delays, Mar. Geod., 2004.

Ocean Surface Topography Science Team Meeting
November 4-6, 2004
St. Petersburg, Florida, USA