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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Detection of ship tracks in ATSR2 satellite imagery" *by* E. Campmany et al.

Anonymous Referee #2

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General Comment

The paper describes an approach to automating the identification of ship tracks using the 1.6-micron reflectances obtained with the ATSR2. The automated detection of ship tracks is a challenging problem and of the tracks automatically identified only 10% agreed with tracks identified through the visual inspection. Nonetheless, the automated scheme was applied to two years of ATSR2 radiances yielding the result that the tracks appeared where shipping is dense, the shipping routes in the northern hemisphere.

Specific Comments

The conclusion that the algorithm, despite its 90% failure rate, is using ship tracks to locate the shipping lanes does not seem to follow from the evidence provided. The algorithm, for example, may be identifying structures in northern hemisphere, low-level marine clouds not common to those in the southern hemisphere.

The method devised for identifying tracks should be applied to the ATSR2 3.7-micron radiances instead of the 1.6-micron radiances. Platnick et al., J. Atmos. Sci. 57, 2607 (2000) showed that the additional absorption by water droplets at 3.7 microns increases the contrast that arises through changes in droplet radii. In addition, at 3.7 microns the clouds become opaque, making the radiances less susceptible to variations in liquid water amount than those at 1.6 microns.

Much of the variability in the near infrared reflectances picked up by the algorithm in this study may result from variability in liquid water amount, not droplet radius. Nonetheless, even droplet radii can be affected in conjunction with variations in liquid water amount. Coakley and Walsh (2002) chose to visually identify ships, as opposed to developing a completely automated strategy, because even at the 3.7-micron wavelength, they found curvilinear features in the images that might have been ship tracks, but they might also have been the result of gravity waves propagating through the marine boundary layer. To ensure that a ship track as opposed to a structure attributable to boundary layer dynamics had been identified, they required ship tracks to have a discernible head–the location nearest the underlying ship. No such strategy appears to be employed in the current study to distinguish between ship tracks and other structures that might be attributable to dynamics within the marine boundary layer.

The method of "validation" appears to have been through the visual inspection of the output with RGB imagery at visible wavelengths from MODIS, e.g., Figs. 3 and 4 and the text. If so, many ship tracks were missed. Many tracks that fail to appear at visible wavelengths, because they are imbedded in extensive regions overcast by marine stratus, reveal themselves at the near infrared wavelengths. The algorithmic failure rate is probably worse than claimed. Indeed, Segrin et al., J. Atmos. Sci., 64, 4330 (2007) report finding on average 150-200 ship tracks per month off the west coast of the U.S. compared with the 100 tracks found for one month in a global survey with the ATSR2.

In conclusion, what the algorithm has picked out is unclear. The algorithm might have

ACPD

8, S6840–S6843, 2008

Interactive Comment

achieved a higher rate of success if it had been applied to the 3.7-micron radiances, as opposed to the 1.6-micron reflectances. Then again, clouds can exhibit many curvilinear structures that look like ship tracks, but are probably caused by circulations within the boundary layer. Developing an automated procedure that would distinguish between ship tracks and other curvilinear features would be a daunting challenge.

Technical Issues

In addition to the above comments, there are areas of the manuscript that need attention.

1. Much of the development in Section 1, e.g., eq. (1)-(5) is irrelevant. The results of this development are not used in the study. Given the wealth of literature on the aerosol indirect radiative forcing and even on the role of ship tracks in assessments of the aerosol indirect radiative forcing, Section 1 should be rewritten to better focus on what this study offers.

2. The text needs to clearly state that the analysis is being applied to 1-km reflectances, as opposed to the 3 x 4 pixel arrays that GRAPE uses to summarize retrieved products. Incidentally, the use of the GRAPE products to study ship tracks does not seem promising as contrasts between the polluted and nearby unpolluted clouds will be somewhat compromised at the coarser resolution.

3. The text needs to add a description of any procedures used for accepting "legitimate" tracks–a minimum number of connected ridgelets, or a minimum length to width aspect ratio, etc. If there are none, the text should also say there are none.

4. When discussing a phenomenon like ship tracks, particularly as is done here–the tracks are in the northern hemisphere, not the southern hemisphere, one wonders whether a further normalization is warranted. For example, of the clouds common to both the northern and southern hemisphere, what fraction seem to be affected by ships?

ACPD

8, S6840–S6843, 2008

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8, S6840–S6843, 2008

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