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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.

E. Campmany et al.

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1. 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 reviewer might be right and so we had pointed that issue in different parts of the paper (Figure 3, section 3.1). However, as it is said in the manuscript, the global distribution of ship tracks, as well as its latitudinal distribution, cannot be considered as a random noise since shows a good resemblance to the ships emission distribution.

2. 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

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clouds become opaque, making the radiances less susceptible to variations in liquid water amount than those at 1.6 microns.

The reviewer is right, the 3.7 micrometer channel has a better intensity contrast. Unfortunately the ATSR2 has such channel switch off above ocean. The AATSR however does have operative the 3.7 micrometer channel all the time and will be used in future studies.

3. 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 algorithm indeed has many false detections caused by dynamics within marine boundary layer that could be screened using different approaches. As pointed out in the conclusions, the use of the microphysical properties retrieved by the GRAPE algorithm as new conditions for the detection would reduce the failure rate. The location of the head of the track could certainly be another good improvement. All these approaches are being studied and will be used in future works.

4. 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

ACPD

8, S8500–S8503, 2008

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.

The reviewer is right in saying that many ship tracks are missed in RGB at visible wavelengths from MODIS, however that does not imply a higher failure rate of the algorithm, but a lower one. It implies that the algorithm detects ship tracks which are not obvious in the visible MODIS imagery and also that the comparison to such imagery is a poor method of validation. Our reported frequency of 100 tracks per month is much more in line with the accepted value of Segrin at al. J. Atmos. Sci., 64, 4330 (2007). This probably also explains why with a 90% false detection our results do not look like random noise

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

Answered in 1) and 2)

6. 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.

Section 1 has been rewritten focusing on this study.

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8, S8500–S8503, 2008

Interactive Comment

7. 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.

The algorithm has been applied to the 1.6 micron reflectances stored in the 3 x 4 km Level2 GRAPE products as indicated in page 14821 line 14.

8. 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.

The criteria to indicate whether or not the track can be a candidate for a real ship tracks was a minimum track length of 20 ridgelets . This parameter was varied to tune it on confirmed ship track scenes. This information has been added to the text (new subsection 2.4)

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 14819, 2008.