Detecting clouds and cloud shadows in Landsat data used for marine applications

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Satellite remote sensing provides a wealth of information on Suspended Particulate Matter (SPM) distribution and dynamics. This information is used, often in conjunction with *in situ* measurements or transport models, to better understand coastal sediment transport or to assess environmental impacts associated with offshore construction. The very large datasets now available from multiple satellites necessitates automated processing and quality control. However, current quality control algorithms have a critical weakness associated with the difficulty of automatically identifying cloud shadows over water. As a result erroneous data for SPM may pass the quality control and be used in applications, giving false information. In this paper we tackle this issue and develop an automated method of reliably detecting and removing cloud and cloud shadows from remotely sensed data obtained by the Operational Land Imager (OLI) aboard Landsat 8.

Previous methods for cloud and cloud shadow detection have been derived for Landsat imagery, including Landsat 8. However, these methods have not considered the possibilities of marine applications and the difficulties of identifying cloud shadow over water. Thus, much of the useful information has either been discarded or not correctly identified as cloud shadow. We attempt to refine and adapt the current cloud and cloud-shadow detection methods in order to obtain useful information for the study of the marine environment.

We select a variety of Landsat 8 scenes to perform and assess the methods. These scenes represent the different land, cloud and water combinations that may occur. We apply a cloud masking algorithm in two steps. The first uses spectral data to identify potential cloud pixels and the second uses scene specific information to prevent over commission of cloud pixels to produce a cloud layer mask. The sun zenith and sun azimuth angles in combination with estimated cloud height for each cloud object are used to identify pixels which may fall in the shadow of the cloud. Darker pixels in the near infrared band (NIR) are identified separately for water and land and those which fall in the possible cloud shadow are identified and masked as cloud shadows.

We summarize the results of the methods using qualitative images, showing good results. Cloud pixels are detected well using the methods. Cloud shadow detection improves over water for many scenes. However, cloud shadow identification still proves to be a difficult task to automate. This study additionally helps to identify the cases in which cloud shadow identification is more difficult and to provide useful information for further studies.

References

Vanhellemont Q. and K. Ruddick. 2014. Turbid wakes associated with offshore wind turbines observed with Landsat 8. Remote Sensing of Environment 145:105-115.

Zhu Z. and C.E. Woodcock. 2012. Object-based cloud and cloud shadow detection in Landsat imagery. Remote Sensing of Environment 118:83-94.