Remote detection of pollen aggregations in the Baltic Sea: Implications for satellite monitoring of marine litter

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1. BACKGROUND

- Each pine pollen tree can produce several kilograms of pollen during pollination season (Fig. 1 top)
- Field and airborne photos show pollen aggregations in lakes and coastal waters (Fig. 1 bottom)
- The Baltic Sea is surrounded by conifers including pine trees.

Fig. 1. "Pollen cloud" from pine trees (top) and pollen aggregations in lake and coastal water of the Baltic Sea (bottom).

2. OBJECTIVES

- What are the spectral characteristics of pollen grains?
- Where and when can pollen grains be found in the Baltic Sea?
- What are the implications on remote detection of marine litter?

3. DATA & METHOD

Laboratory experiments were used to measure spectral reflectance of pine pollen grains on water (Fig. 2).

Multi-sensor images, including VIIRS, MODIS, MERIS, OLCI, and MSI, were used to infer floating matter types by through spectral diagnostic analysis.

Pollen-rich water areas were manually delineated and pollen density in each pixel was estimated using a spectral unmixing scheme.

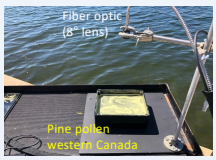


Fig. 2. Experiments to measure pollen reflectance.

4. RESULTS

- Pollen-on-water shows unique reflectance spectral shapes (Fig. 3).
- Multi-sensor image features shows similar spectral shapes (Figs. 4, 5, 6).
- These features are extensive in the Baltic Sea between May 10 and June 16 (Figs. 6, 7).

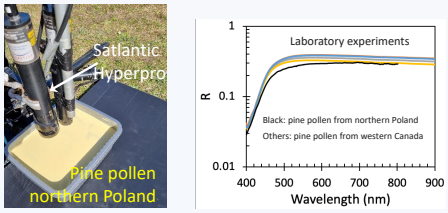


Fig. 3. Spectral characteristics of pollen on water.

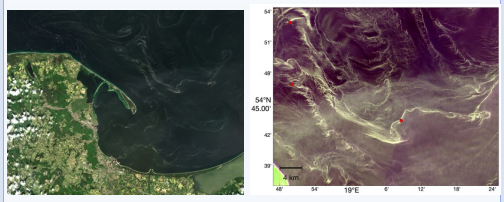


Fig. 4. Left: pollen aggregations captured in MSI image of 16 May 2018, southern Baltic Sea off Poland. Right: same image but colors are stretched to enhance the image features.

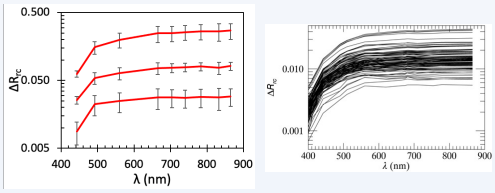


Fig. 5. Left: MSI spectra of pollen pixels (Fig. 4). Right: OLCI spectra of pollen pixels (Fig. 6).

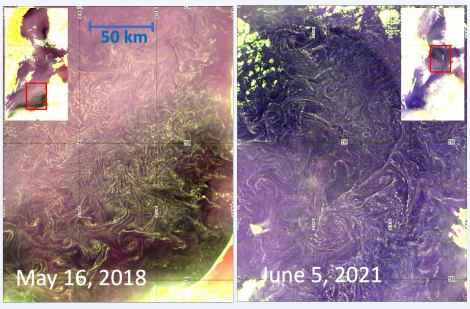


Fig. 6. VIIRS images showing pollen features.

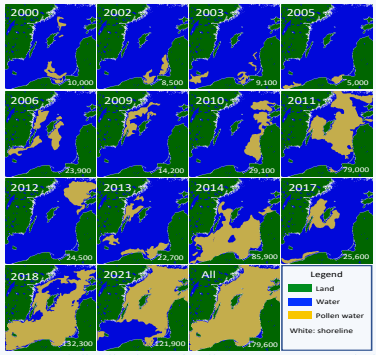
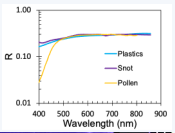


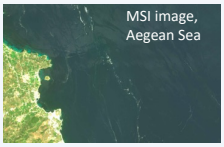
Fig. 7. Annual distributions of pollen on water. Areas in km² are annotated. Certain years show no pollen features.

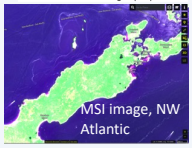
5. IMPLICATIONS

Many image features are similar in both spectral shapes and spatial morphology, making it difficult to discriminate debris from others (Fig. 8).

Fig. 8. Pollen spectra are similar to others (right). Pollen features in the Aegean Sea and NW Atlantic Ocean (bottom).







6. SUMMARY

- Pollen on water is often extensive in the Baltic Sea during the pollination season, and the coverage appears to have increased recently.
- Similar pollen features are also found from other coastal, inland, and open waters.
- Pollen spectra are similar to plastics, making them difficult to separate.

REFERENCE

Hu, C., L. Qi, D. C. English, M. Wang, et al. (2023). Pollen in the Baltic Sea as viewed from space. Remote Sens. Environ., 10.1016/j.rse.2022.113337

ACKNOWLEDGEMENT

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