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Dual-polarimetric Sentinel-1 backscattering from coastal macroalgae

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INTRODUCTION

Coastal macroalgae blooms have a profound influence on marine ecosystem balance, tourism, and aquaculture. Since 2008, the western coasts of the Yellow Sea have been damaged every summer by a macroalgae bloom, i.e., green tide, caused by the overgrowth of green algae, mainly *ulva prolifera*. Remotely sensed optical radiation has been exploited to detect algae and to track them over time [1,2]. Recently, the all-day and almost all-weather observation ability provided by measurements remotely sensed by synthetic aperture radar (SAR) has been investigated to monitor the green tide. Mostly, phenological studies have been carried out that look at the gray-tone SAR image without any physical characterization of the mechanisms that generate unique algae signature in the SAR image plane [3].

OBJECTIVE

- Understand the scattering mechanisms of green algae based on C-band Sentinel-1 imagery from electromagnetic perspective.
- Clarify the scattering types based on the binary algea map.

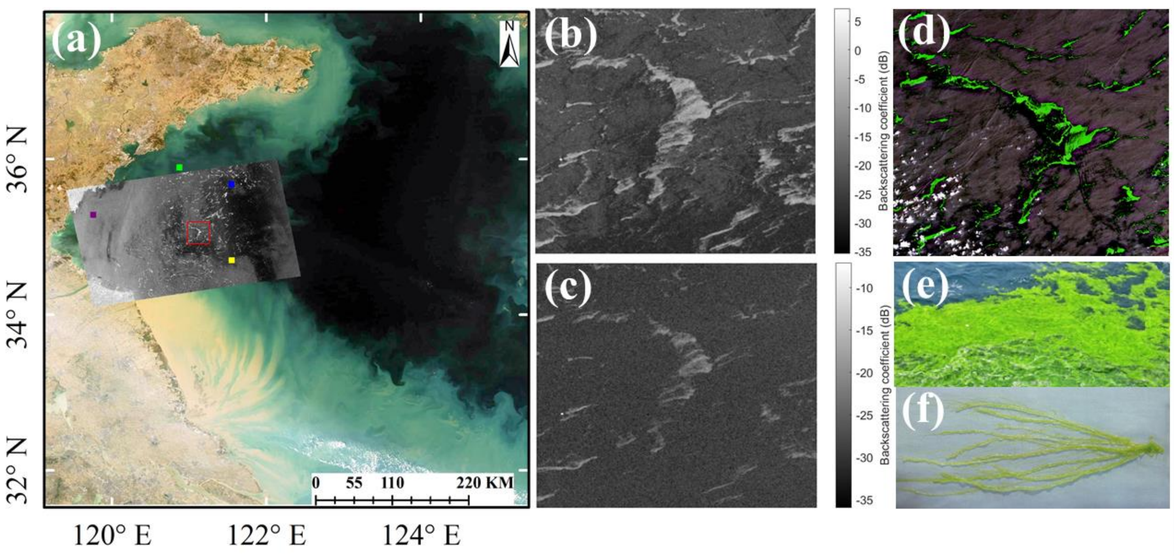

Figure 1. Research area (a) and green algae on Sentinel-1 SAR (b,c) and Sentinel-2 optical imagery (d). (e) and (f) are photos of green algae patches, plant respectively.

SCATTERING THEORY & METHODOLOGY

- Extract binary algae map using the deep learning (DL) model GA-Net [3].
- Analyze the scattering mechanism of green algae using degree of polarization (DoP).
- Propose a new indicator to represent DoP to reduce computational stress.
- Update the binary algae map using our proposed indicator.

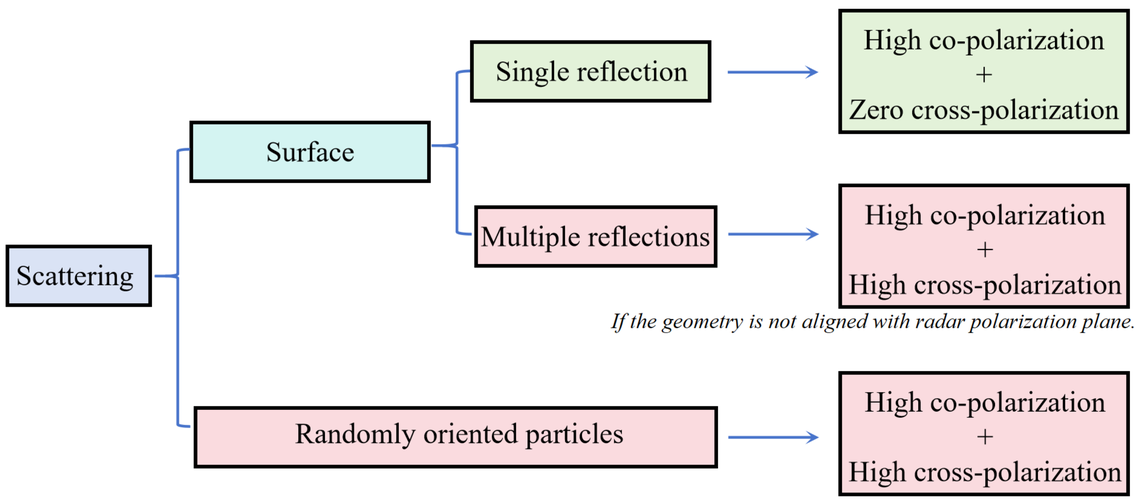

Figure 2. Scattering theory of green algae.

RESULTS

◆DoP and the proposed indicator

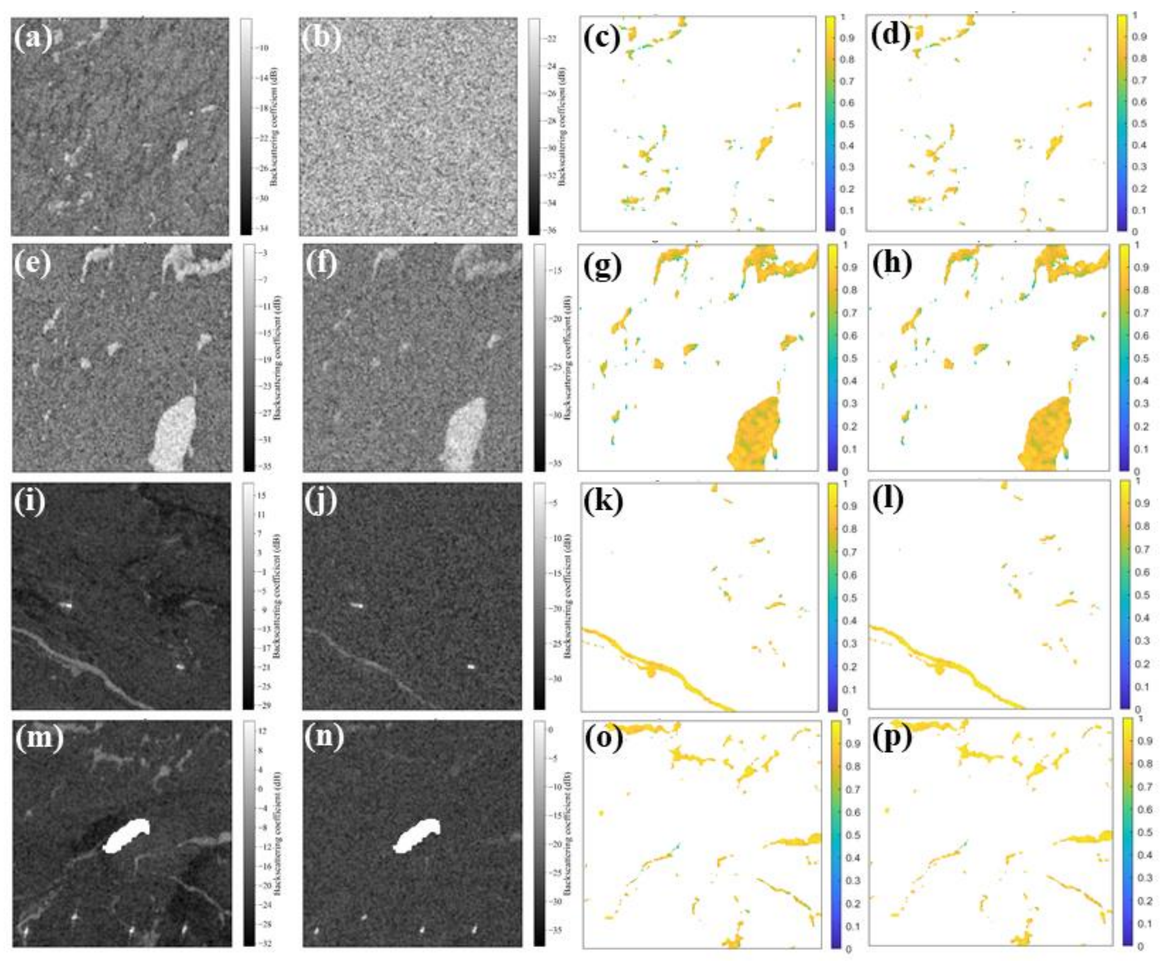

Figure 3. DoP and our proposed indicator on 4 typical cases. Case 1(row 1): algae only appears on VV channels. Case 2 (row 2): algae appeared on VV and VH channels are almost fully overlapped. Case 3 (row 3): algae appear on both VV and VH channels, and most appeared algae on VH channel are above noise floor. Case 4 (row 4): algae appear on both VV and VH channels, but some appeared algae on VH channel are below noise floor. Each column represents VV channel, VH channel, DoP, and the proposed indicator from left to right.

◆Updated algae map

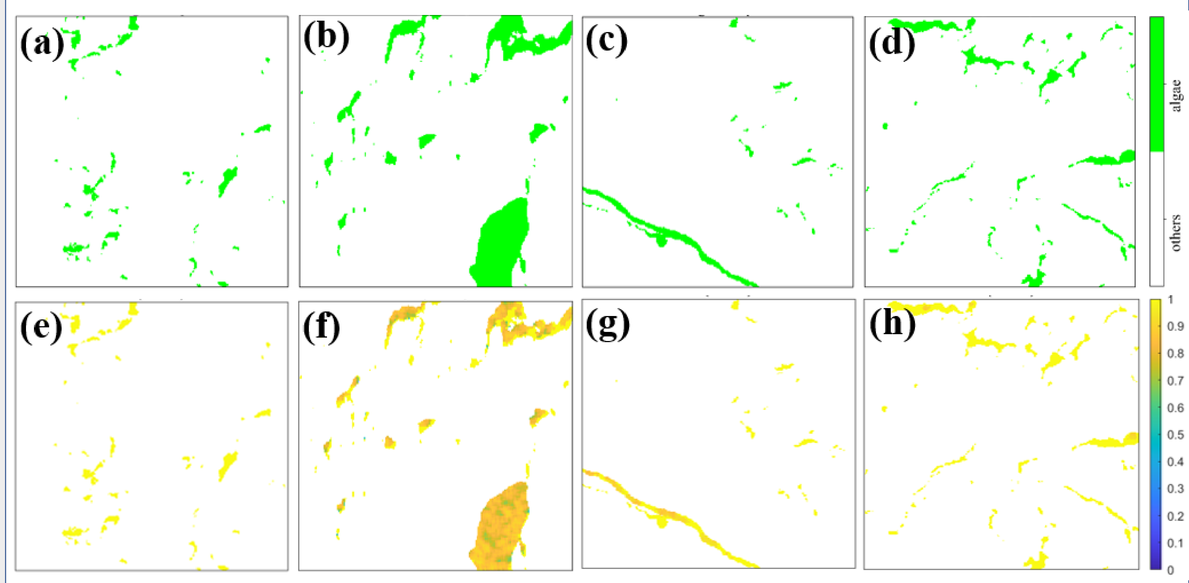

Figure 4. Binary (a-d) and updated (e-h) algae maps. Each column represents case 1-4 from left to right.

CONCLUSIONS

- ✓ Algae are mostly dominated by surface scattering with a residual cross-pol component that may be related to either misaligned multiple reflection or volumetric scattering at C-band.
- ✓ The proposed indicator can provide comparable information to DoP, but requires only amplitude information (GRD data).

REFERENCES

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