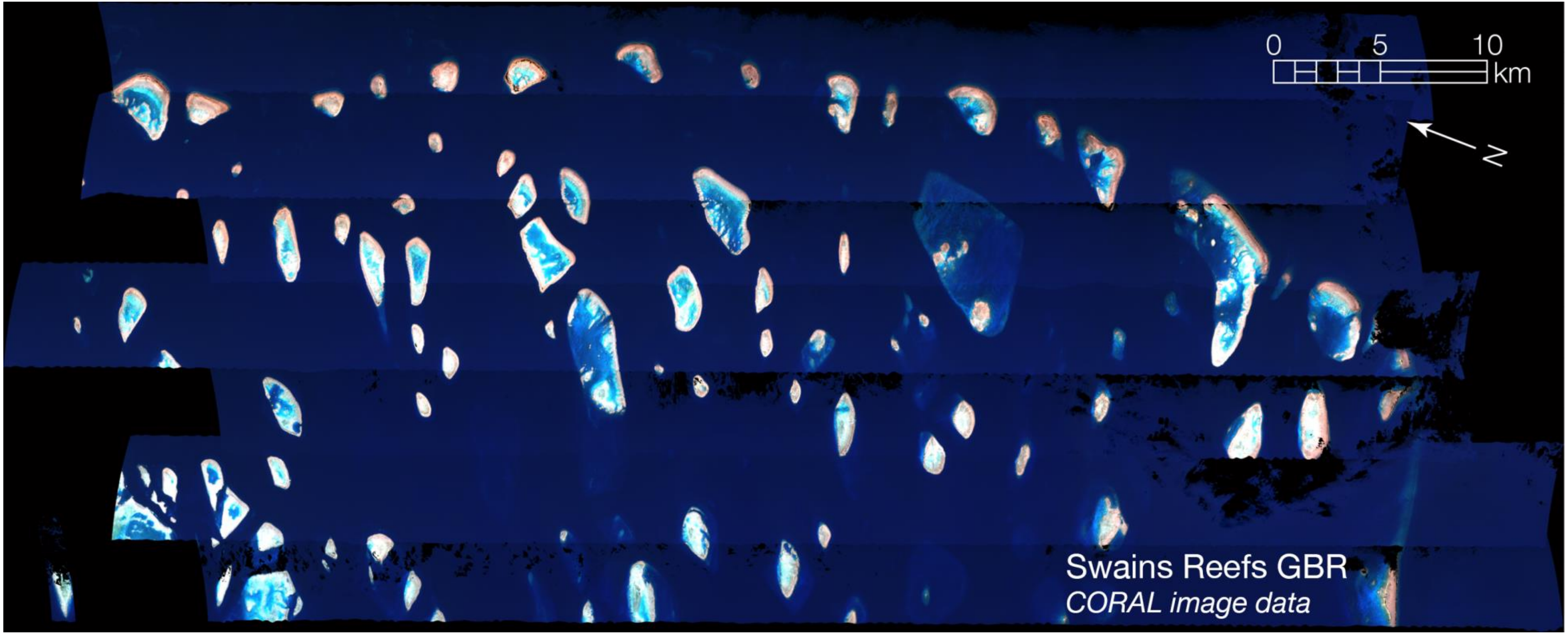
(Very) Select Topics in Coral Reef Remote Sensing



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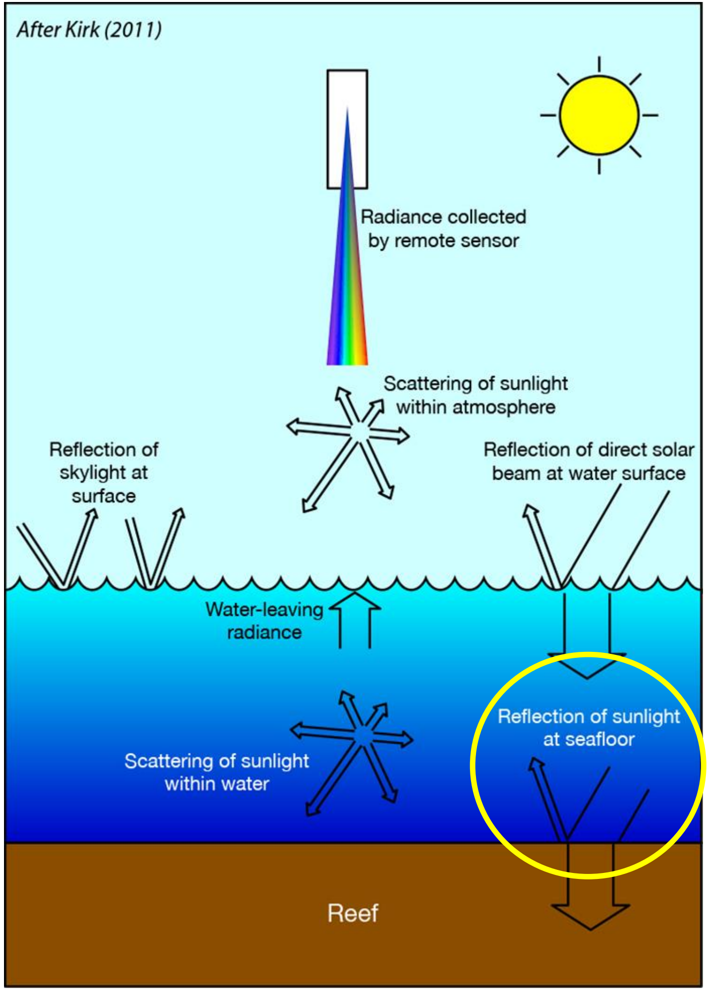
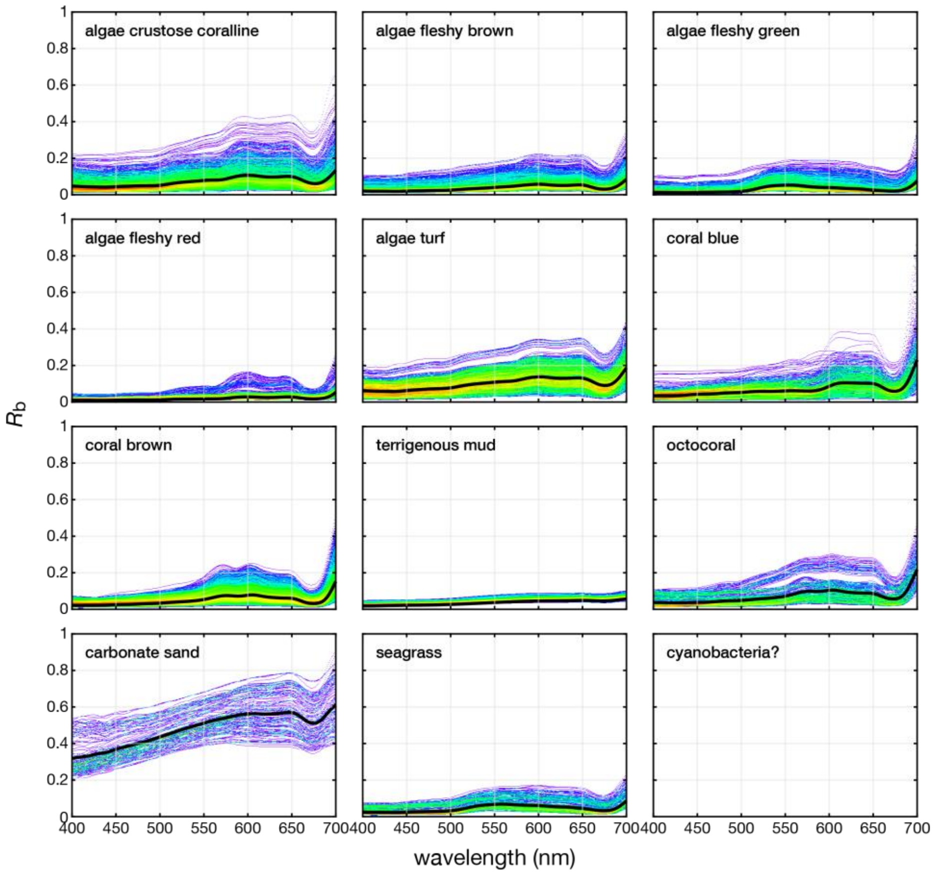
IOCS, 10 April 2019, Busan

Coral Reef Problem and Remote Sensing



Spectral Discrimination of Benthic Types



Predicted Class \ Actual Class	algae crustise coralline	algae feshy brown	algae fleshy green	algae fleshy red	algae turf	coral blue	coral brown	terrigenous mud	octocoral	carbonate sand	seagrass	
algae crustose coralline	820	6	0	3	20	10	0	0	0	0	0	95.5%
algae fleshy brown	14	1176	0	2	5	0	2	0	0	0	0	98.1%
algae fleshy green	0	0	851	0	3	0	0	0	0	0	3	99.3%
algae fleshy red	7	0	0	833	4	0	0	0	0	0	0	98.7%
algae turf	78	13	25	9	1094	7	0	0	0	0	15	88.2%
coral blue	6	0	0	0	0	542	0	0	1	0	0	98.7%
coral brown	0	4	0	0	3	14	2516	0	7	0	0	98.9%
terrigenous mud	0	0	0	0	0	0	0	887	0	0	0	100%
octocoral	0	0	0	0	0	1	1	0	273	0	0	99.3%
carbonate sand	0	0	0	0	0	0	0	0	0	132	0	100%
seagrass	0	0	5	0	0	0	0	2	0	0	266	97.4%
	88.6%	98.1%	96.6%	98.3%	96.9%	94.4%	99.9%	99.8%	97.2%	100%	93.7%	97.2%

Shallow Water Reflectance
Complex Parameterization of Water OPs

20 June 1999 / Vol. 38, No. 18 / APPLIED OPTICS 3831

Hyperspectral remote sensing for shallow waters: 2. Deriving bottom depths and water properties by optimization

Zhongping Lee, Kendall L. Carder, Curtis D. Mobley, Robert G. Steward, and Jennifer S. Patch

$$r_{rs} \approx r_{rs}{}^{dp}\left(1 - \exp\left\{-\left[\frac{1}{\cos(\theta_w)} + \frac{D_u{}^C}{\cos(\theta)}\right]\kappa H\right\}\right) + \frac{1}{\pi}\rho \exp\left\{-\left[\frac{1}{\cos(\theta_w)} + \frac{D_u{}^B}{\cos(\theta)}\right]\kappa H\right\}, \quad (9)$$

$$r_{rs}{}^{dp} \approx (0.084 + 0.170u)u. \quad (4)$$

$$D_u{}^C \approx 1.03(1 + 2.4u)^{0.5}, \qquad D_u{}^B \approx 1.04(1 + 5.4u)^{0.5} \quad (5)$$

$$u = b_b/(a + b_b), \qquad \kappa = a + b_b, \quad (6)$$

$$a = a_w + a_\phi + a_g. \quad (8)$$

$$a_\phi(\lambda) = [a_0(\lambda) + a_1(\lambda)\ln(P)]P, \quad (16)$$

$$a_g(\lambda) = G \exp[-S(\lambda - 440)], \quad (17)$$

$$b_b{}'(\lambda) = b_{bw}(\lambda) + b_{bp}{}'(\lambda) \quad (18)$$

$$b_{bp}{}' = X\left(\frac{400}{\lambda}\right)^Y, \quad (19)$$

$$Y \approx 3.44[1 - 3.17 \exp(-2.01\chi)], \quad (20)$$

$$\rho(\lambda) = B\rho_{sd}(\lambda), \quad (22)$$

$$R_{rs}{}^{raw}(\lambda) \approx R_{rs}(\lambda) + \Delta. \quad (15)$$

$$P^{in} = 0.072[R_{rs}{}^{in}(440)/R_{rs}{}^{in}(550)]^{-1.62} \text{ (Ref. 33)},$$

$$G^{in} = P^{in},$$

$$X^{in} = 30a_w(640)R_{rs}{}^{in}(640),$$

$$B^{in} = 0.2 \text{ [equivalent to } \rho(550) = 0.2\text{]},$$

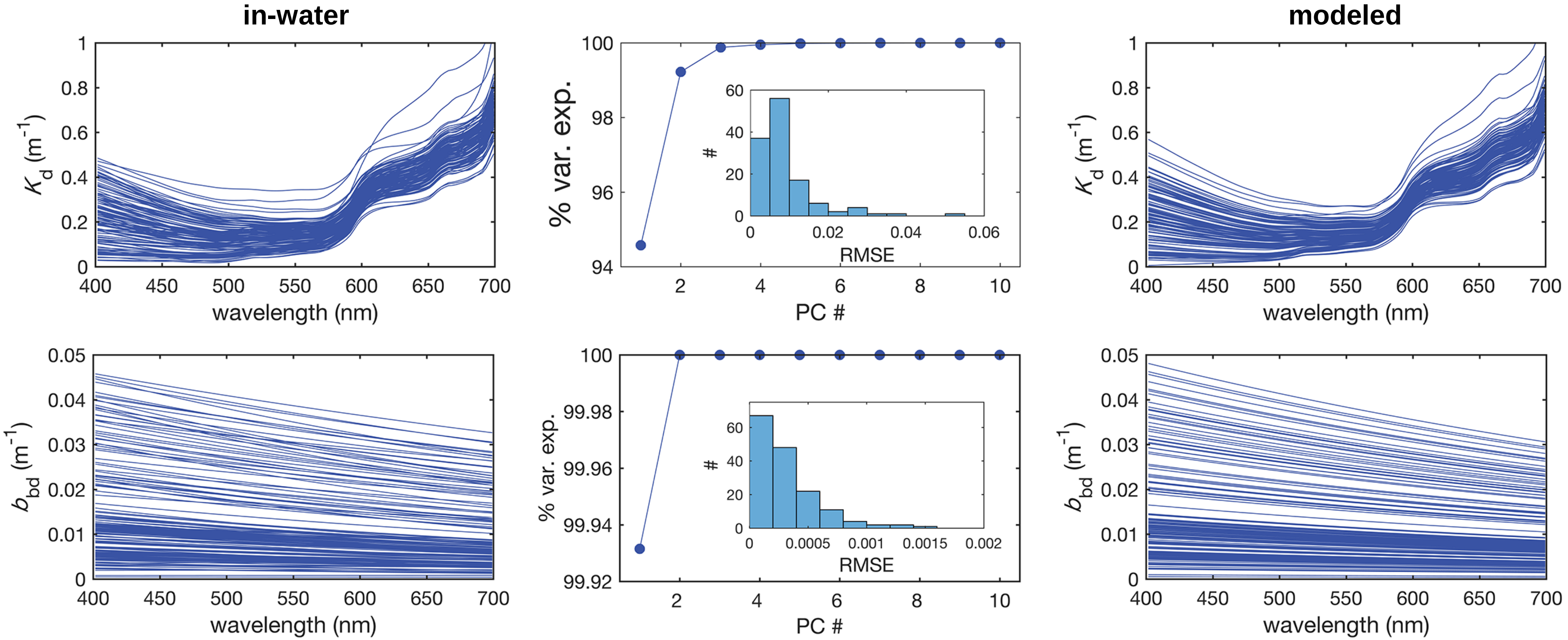
$$H^{in} = 10.0,$$

$$\Delta^{in} = R_{rs}{}^{raw}(750).$$

Shallow Water Reflectance
Simplified Parameterization

$$R_w = \frac{b_{bd}}{K_d + \kappa} + \left(R_b - \frac{b_{bd}}{K_d + \kappa}\right) e^{(K_d + \kappa)H}$$

$$R_w = \frac{b_{bd}}{2K} + \left(R_b - \frac{b_{bd}}{2K}\right) e^{2KH}$$



Simple Shallow Water Reflectance
AOP Retrieval

Remote Sensing of Environment 200 (2017) 18–30

Airborne mapping of benthic reflectance spectra with Bayesian linear mixtures

David R. Thompson[a,*], Eric J. Hochberg[b], Gregory P. Asner[c], Robert O. Green[a], David E. Knapp[c], Bo-Cai Gao[d], Rodrigo Garcia[e], Michelle Gierach[a], Zhongping Lee[e], Stephane Maritorena[f], Ronald Fick[g]

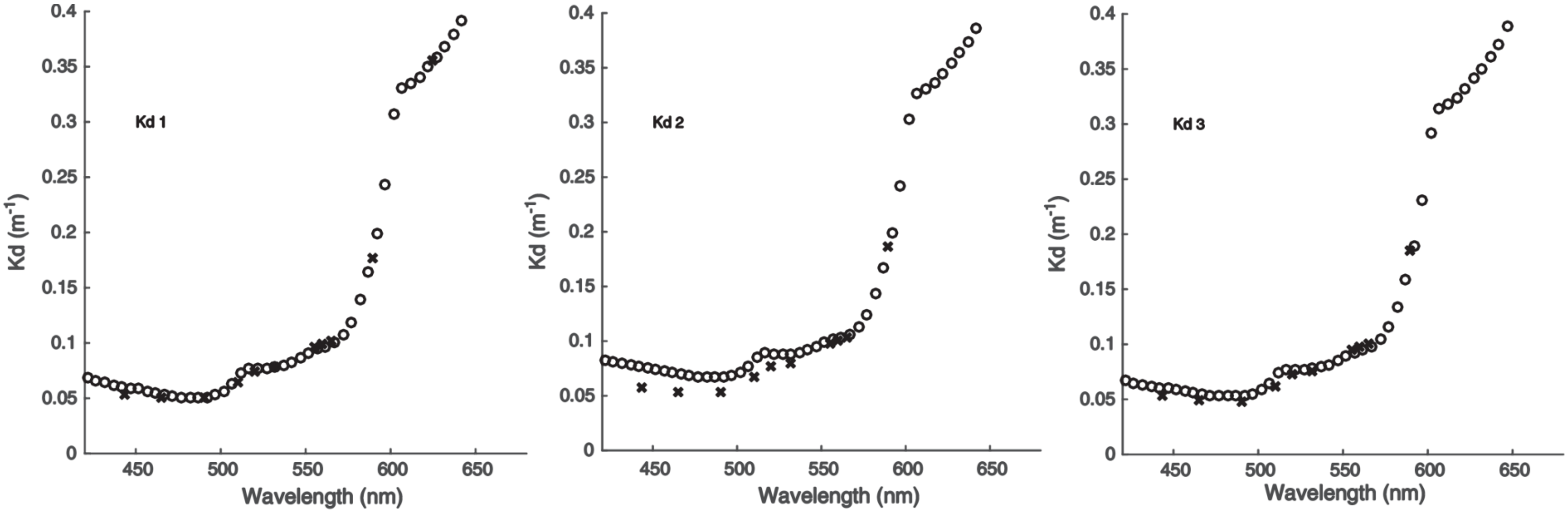
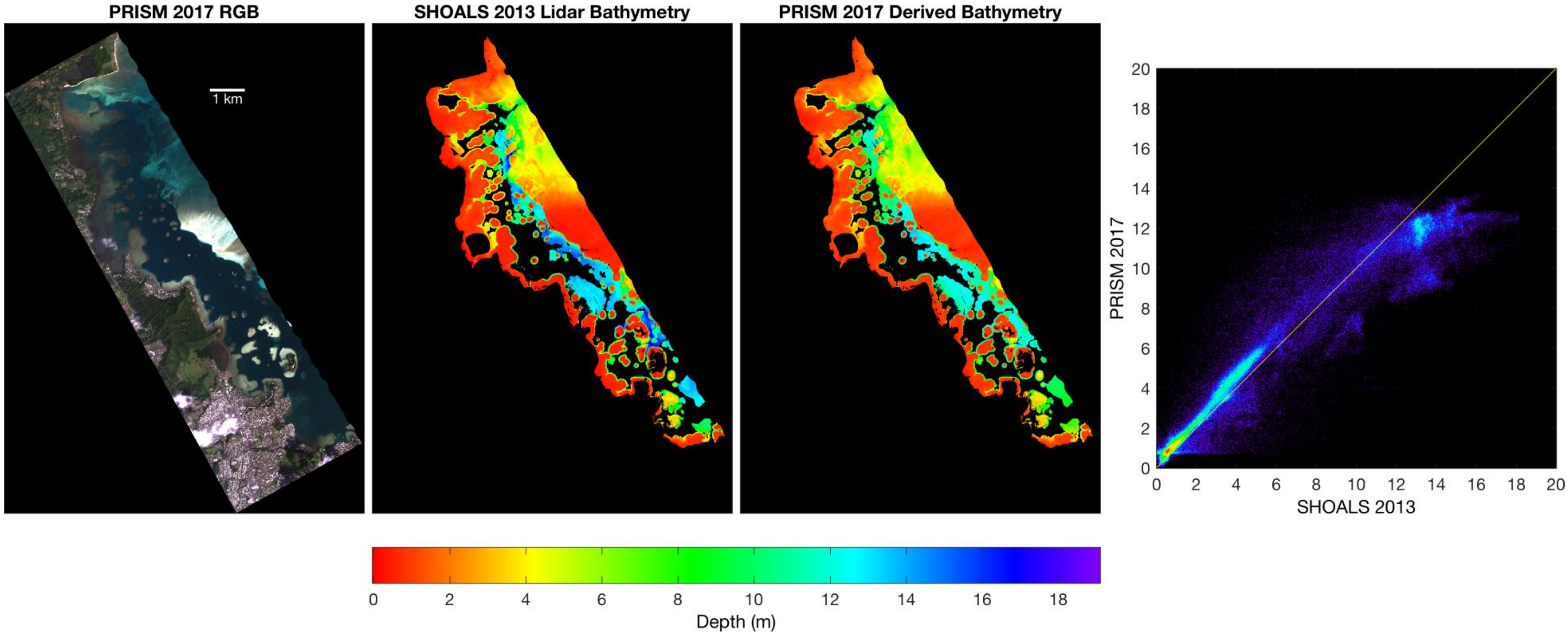


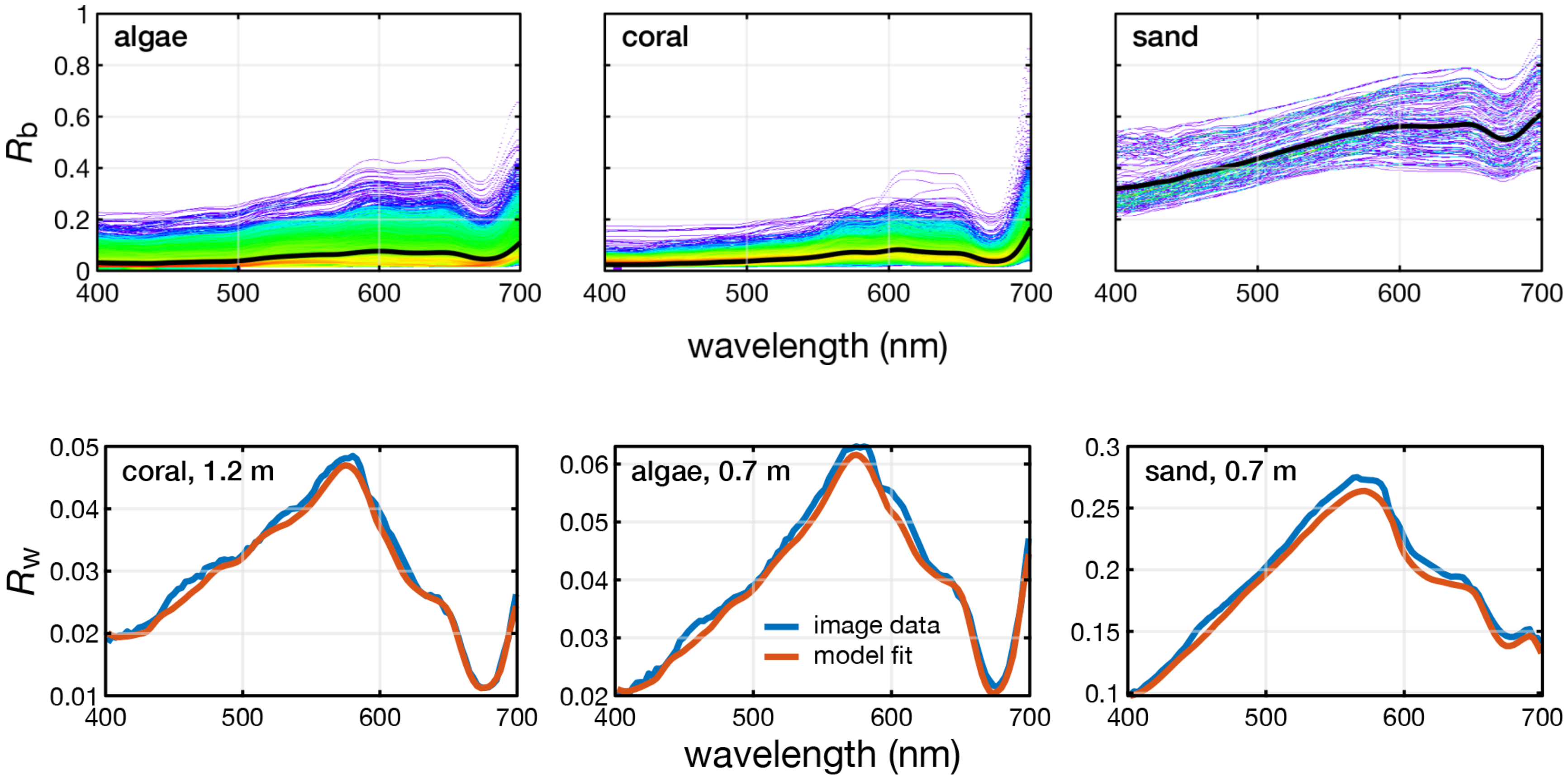
Fig. 13. Comparison of remote and *in situ* measurements of K_d. The dashed line indicates a slope of unity. The first three *in situ* measurement sites appear as dark 'x' symbols. Remote retrievals are averages of 2 scenes for the center and right panels, where multiple overpasses were available.

Simple Shallow Water Reflectance
Depth Retrieval



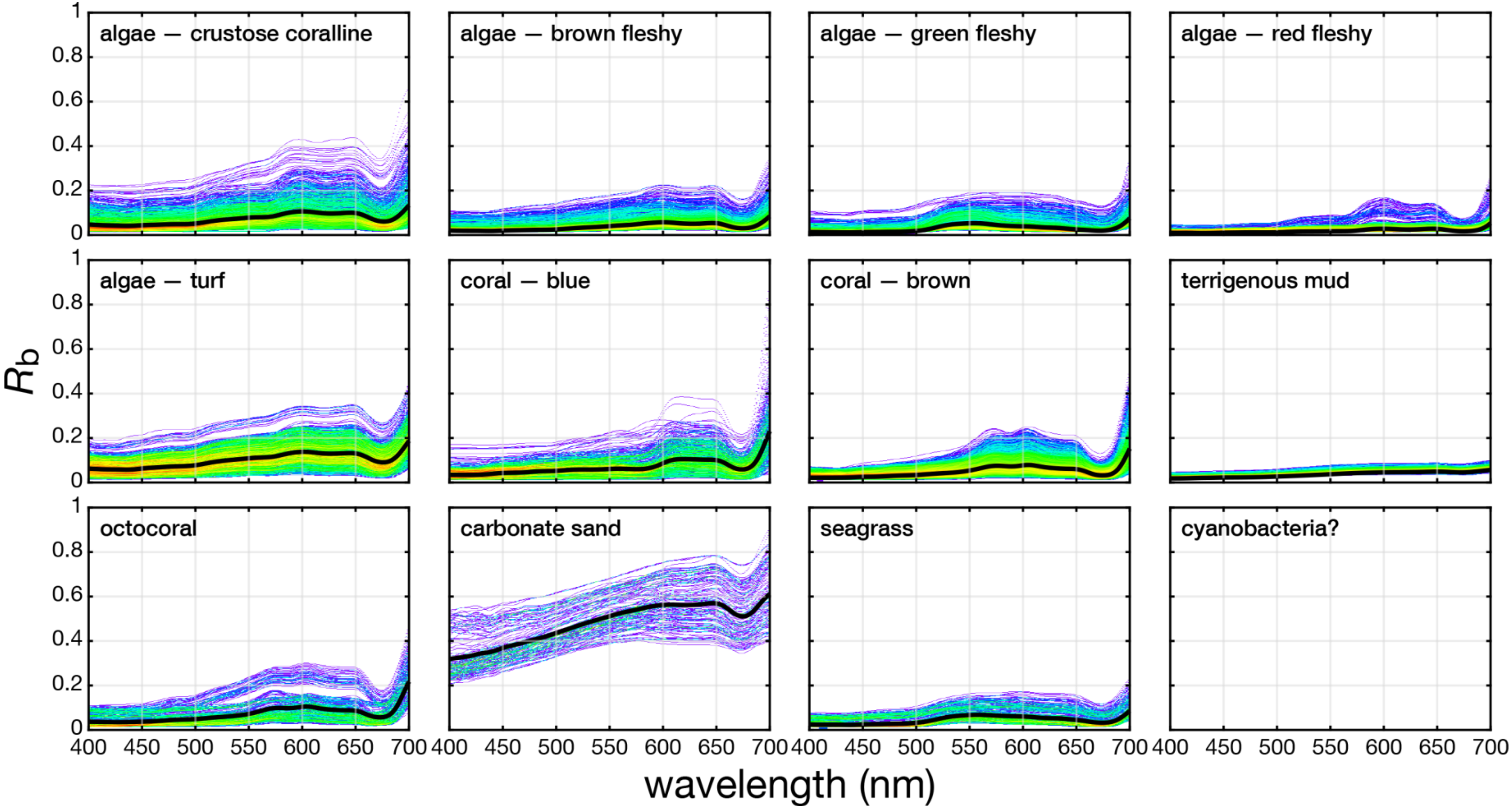
Simple Shallow Water Reflectance

CORAL R_b *Parameterization → Overall close, but not perfect, R_w fit*



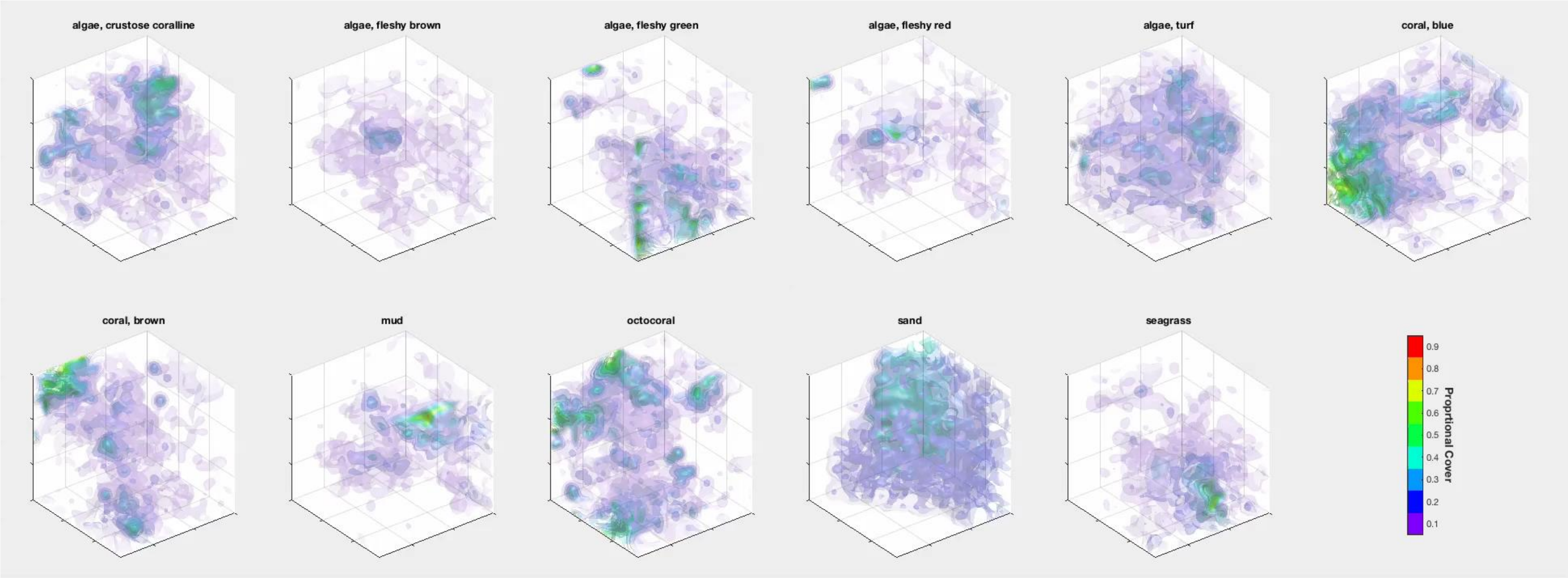
Simple Shallow Water Reflectance

Actual R_b — Intraclass and Interclass Variability



Simple Shallow Water Reflectance

Actual R_b Variability



Self-organizing map based on 757,660 spectral mixtures highlights difficulty of dimension reduction