# Partitioning a vertical profile of phytoplankton biomass into contributions from two communities: A conceptual approach

Bob Brewin (r.brewin@exeter.ac.uk), Giorgio Dall'Olmo , John Gittings, Xuerong Sun, Priscila Lange, Dionysios Raitsos, Heather Bouman, Ibrahim Hoteit, Jim Aiken, Shubha Sathyendranath

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BICEP
Biological Pump and Carbon Exchange Processes

PML Plymouth Marine Laboratory

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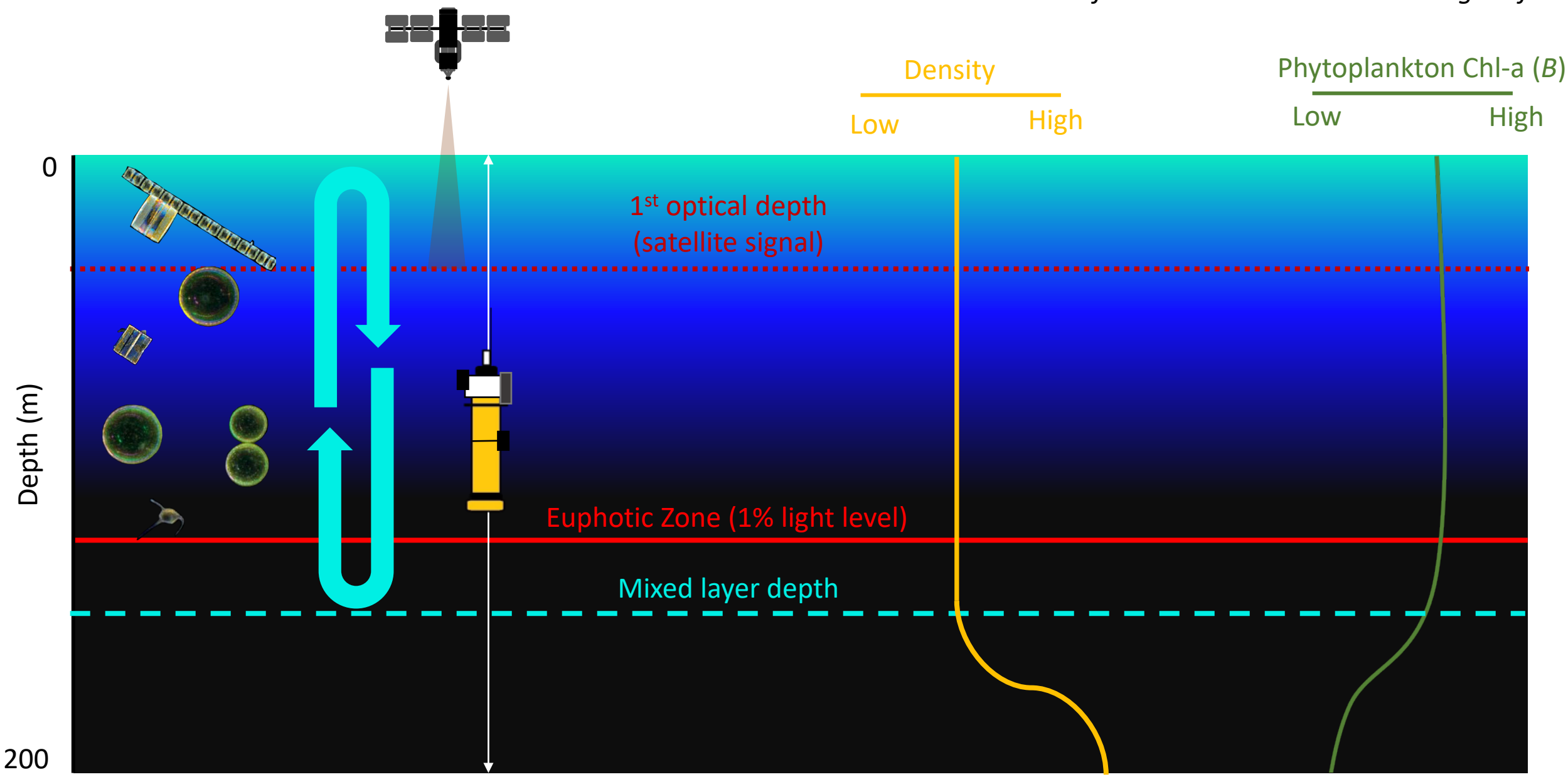
National and Kapodistrian UNIVERSITY OF ATHENS

UNIVERSITY OF OXFORD

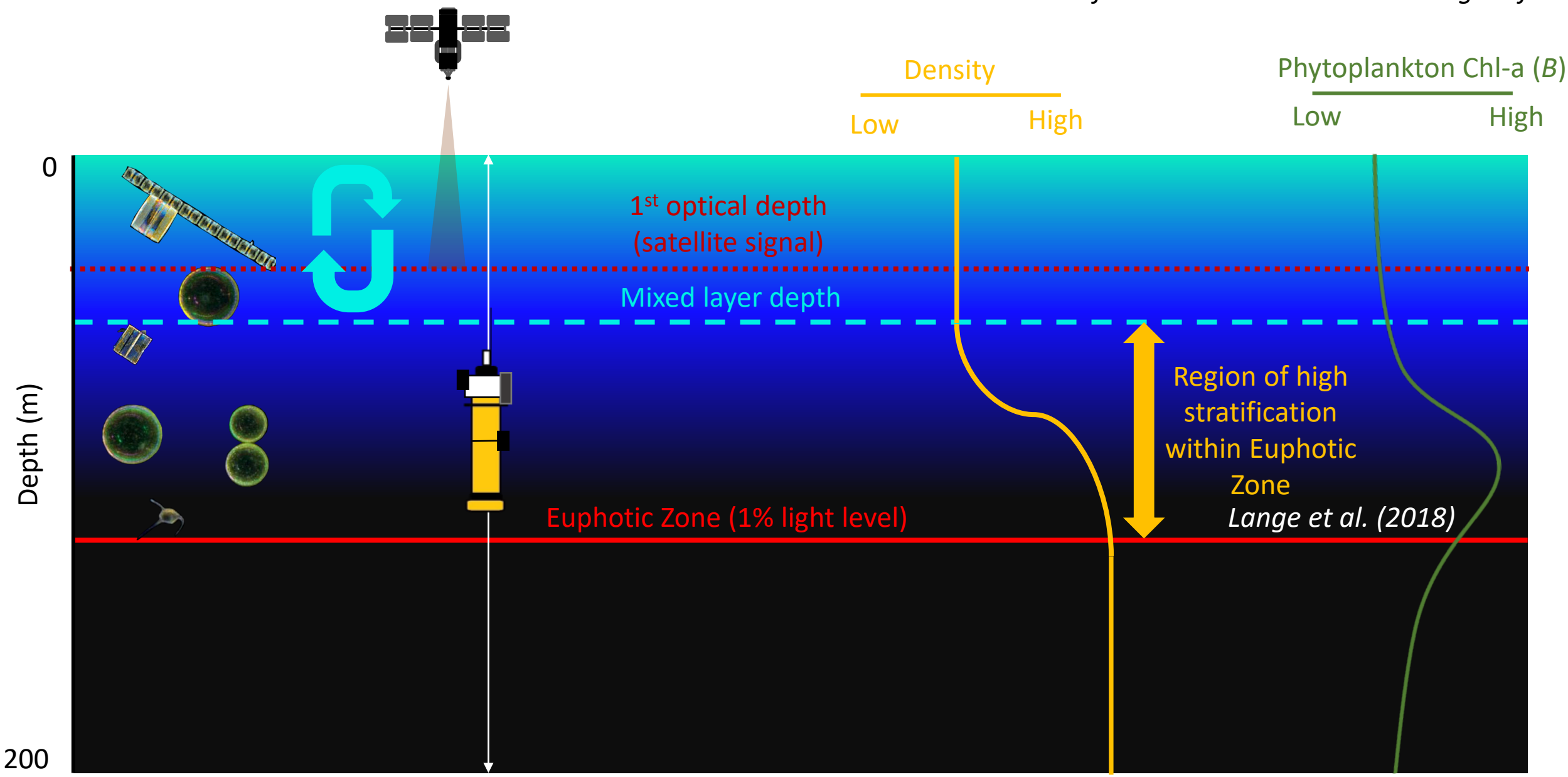
*'Plankton' from the Greek words meaning 'drifter'*




Phytoplankton community = a group of species that occur together in space and time

*Begon et al. (1990) Ecology: Individuals, populations, and communities. Blackwell Science Inc.*

*'Plankton' from the Greek words meaning 'drifter'*

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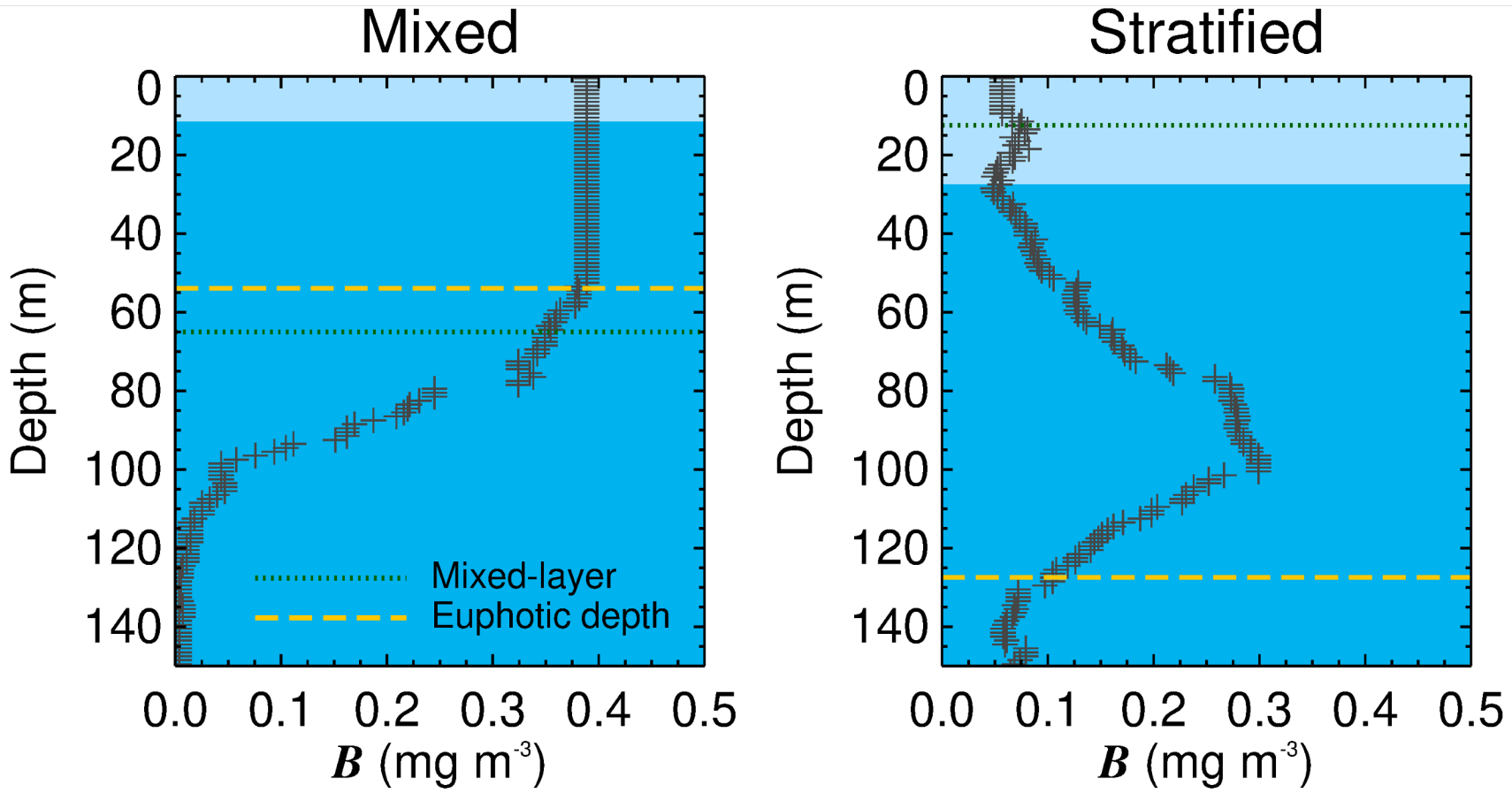
Seen from satellite

Hidden from satellite



Seen from satellite

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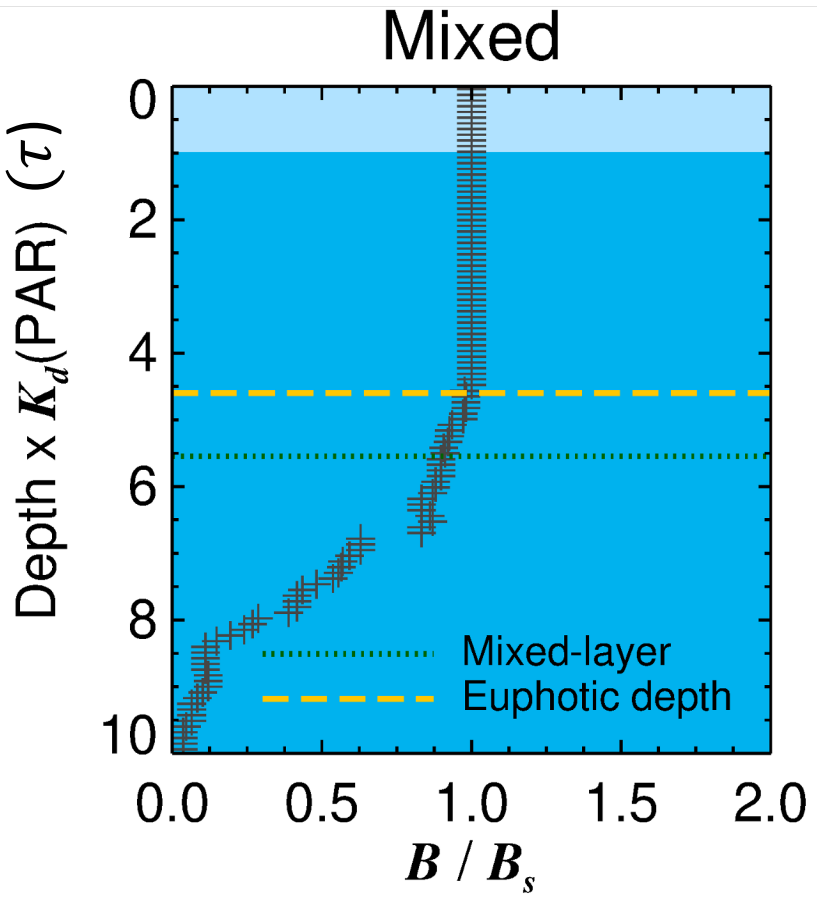


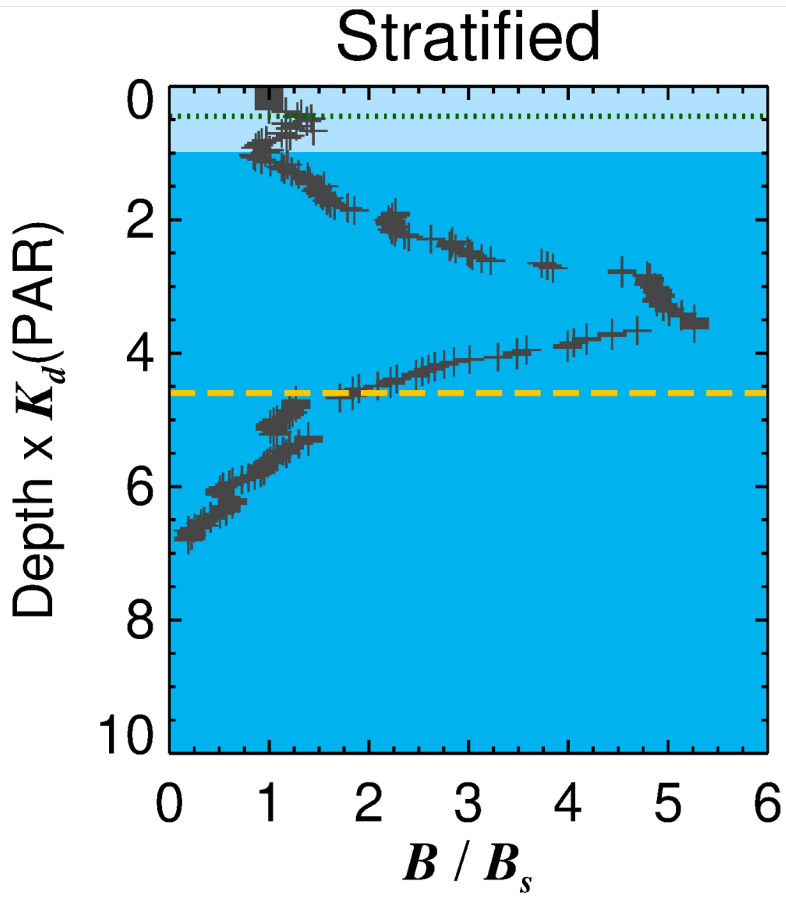


*Morel & Berthon (1989)*

*Uitz et al. (2006)*

*Brewin et al. (2017)*

Seen from satellite

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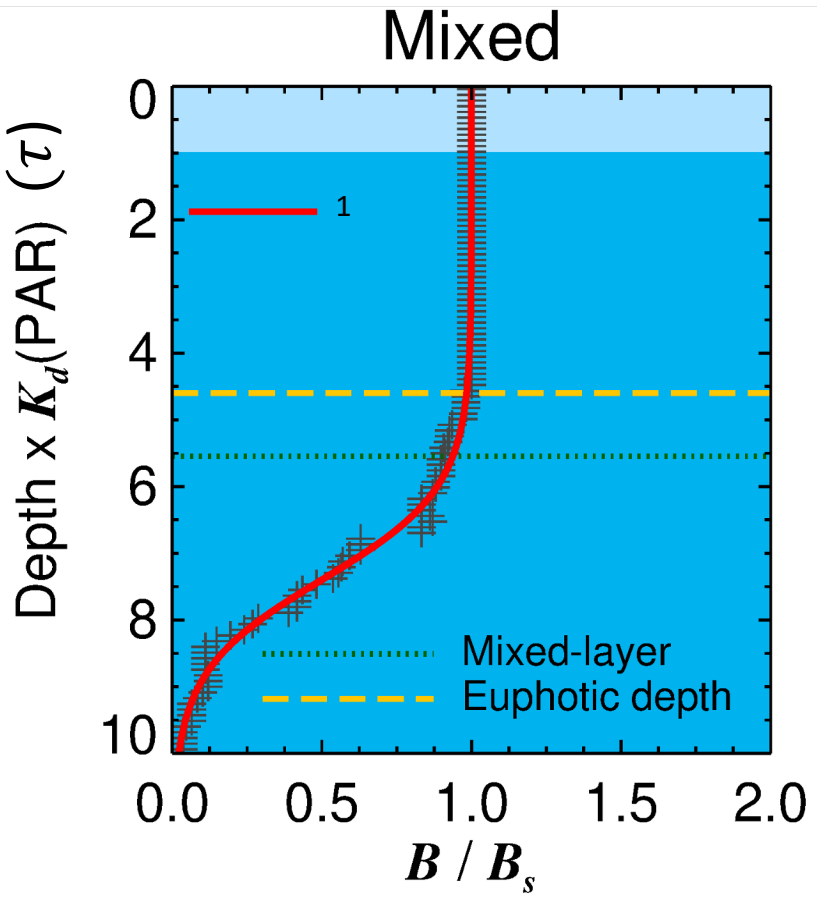
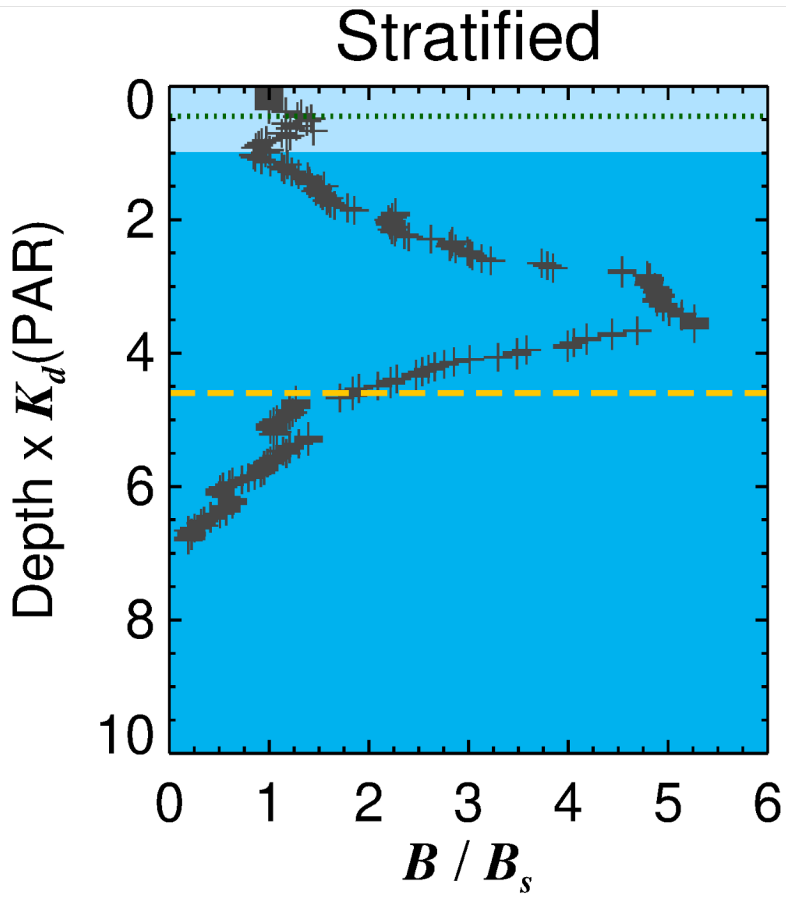


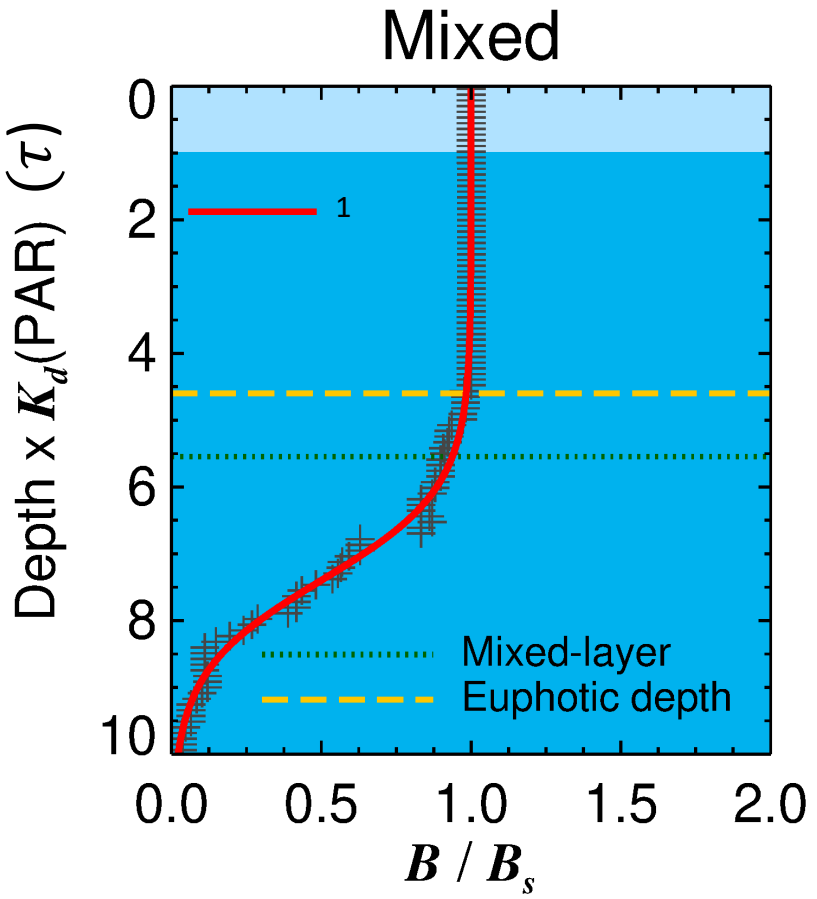

$$\frac{B}{B_s}(\tau) = 1 - \left\{\frac{1}{1+\exp[-S_1(\tau-\tau_1)]}\right\}$$

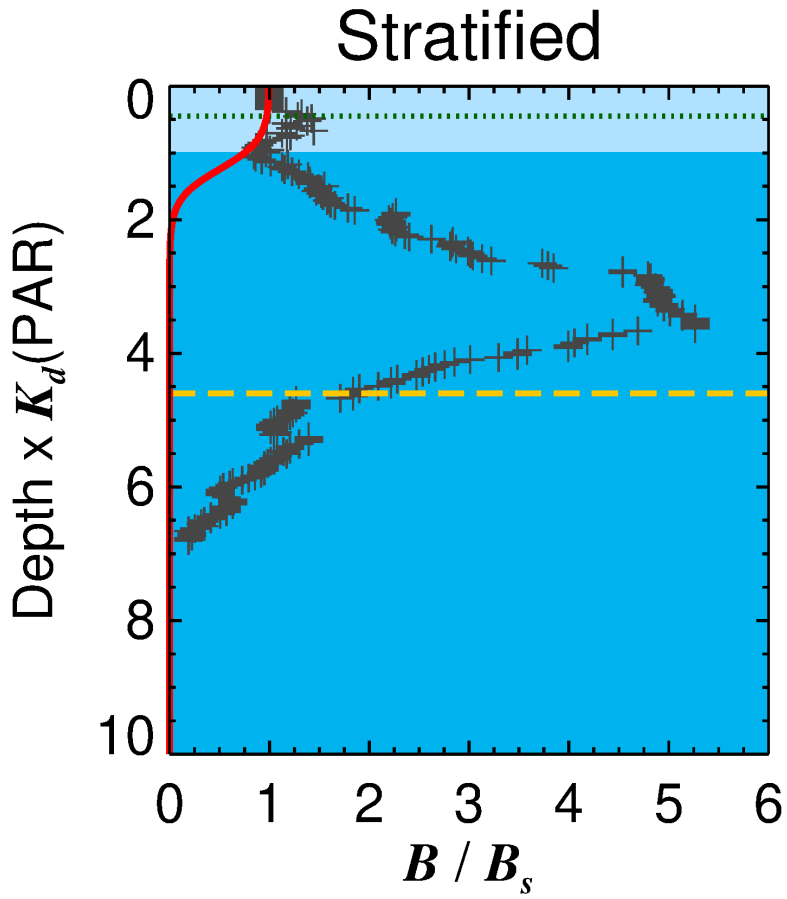
Community 1

*Mingot et al. (2011)*

Seen from satellite

Hidden from satellite

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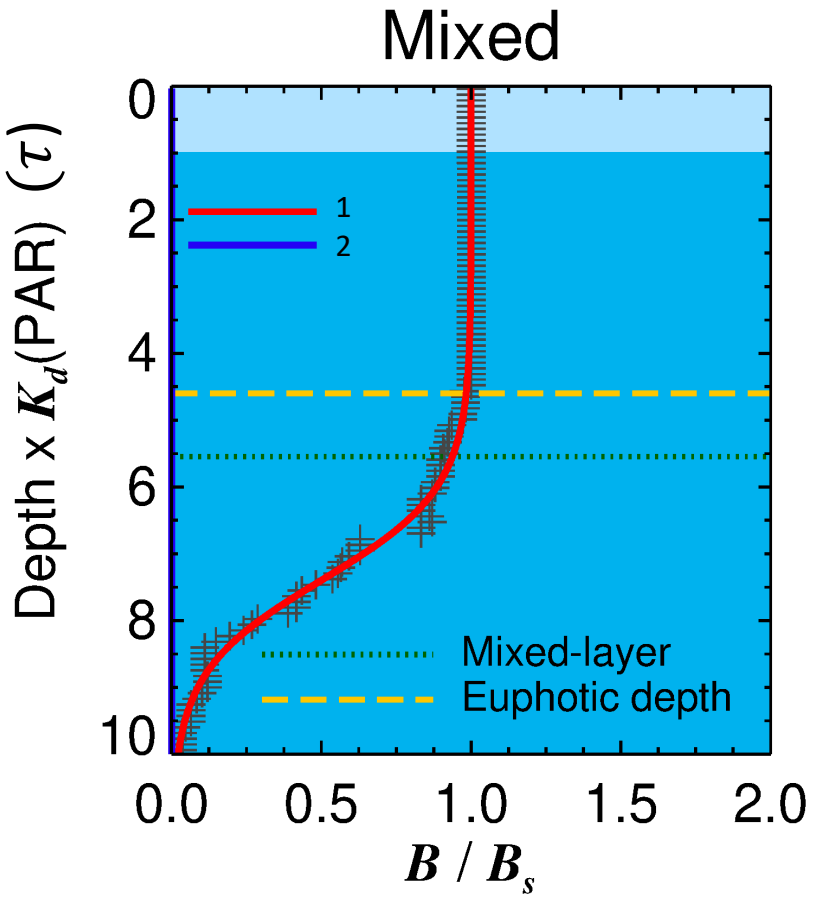
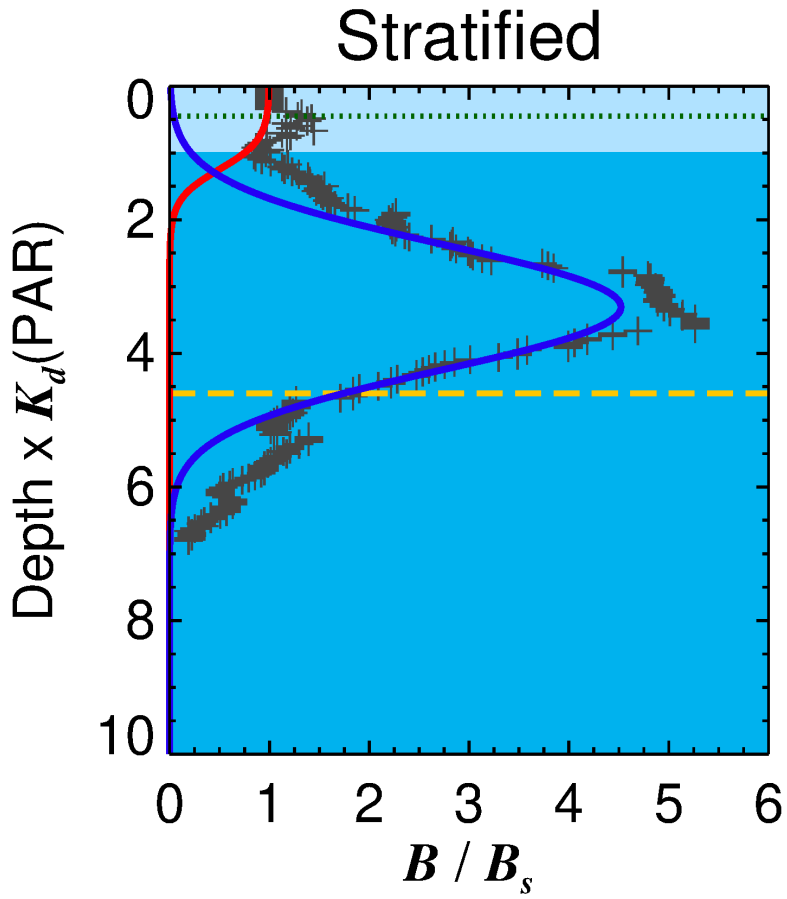
Community 1

Seen from satellite

Hidden from satellite



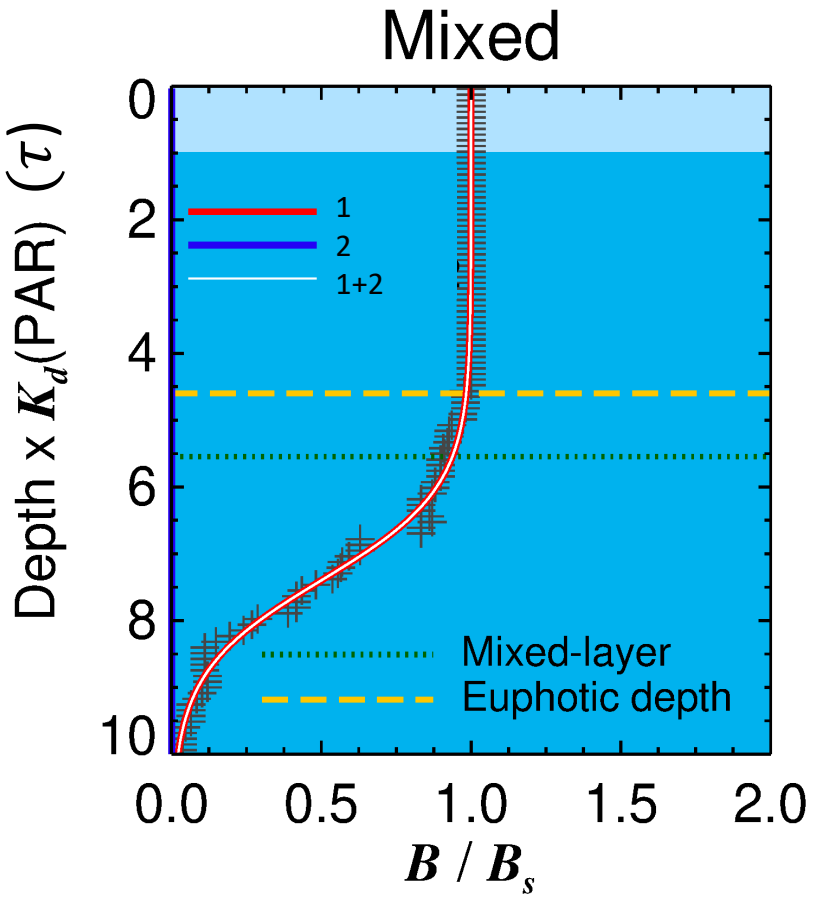

$$\frac{B}{B_s}(\tau) = 1 - \left\{\frac{1}{1+\exp[-S_1(\tau-\tau_1)]}\right\} + B_2^{B_s}\exp\left[-\left(\frac{\tau-\tau_2}{\sigma}\right)^2\right]$$

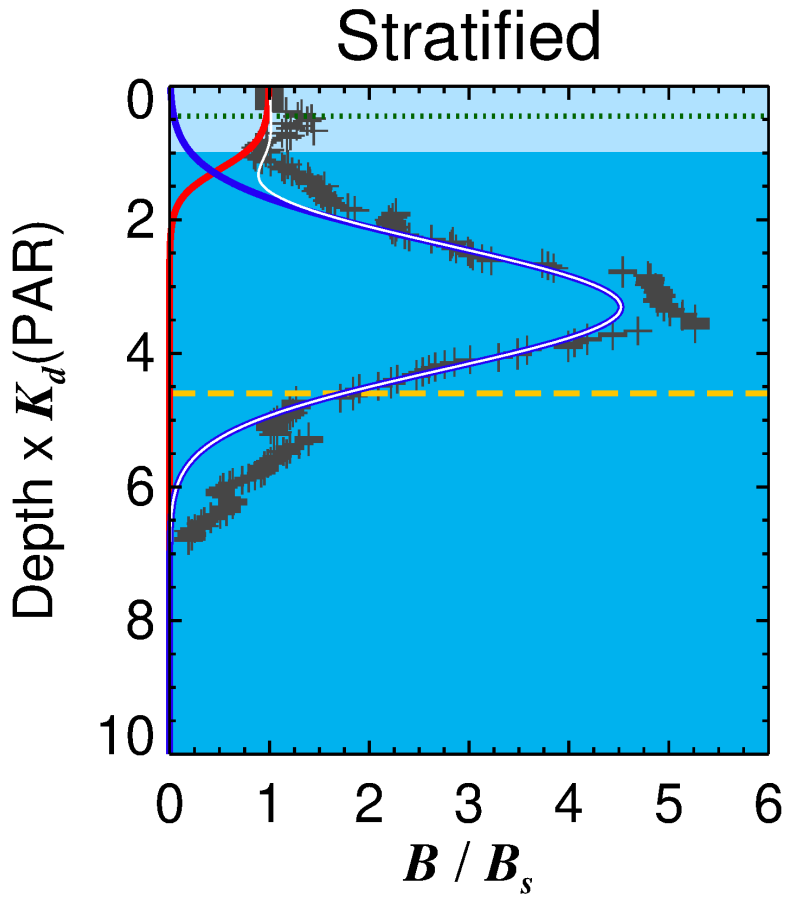
Community 1 Community 2

*Platt & Sathyendranath (1988)*

Seen from satellite

Hidden from satellite

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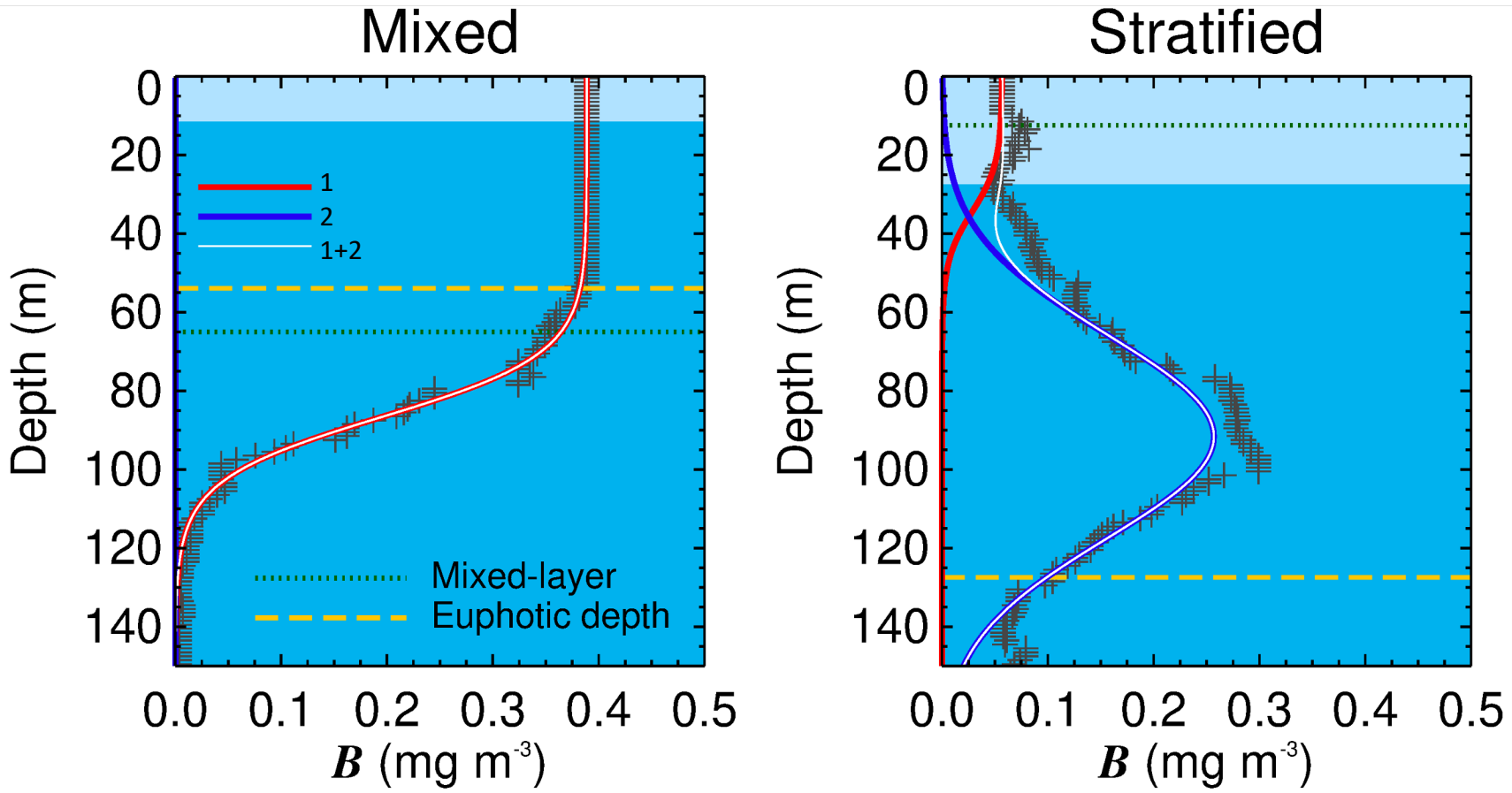
Community 1

Community 2

Seen from satellite

Hidden from satellite

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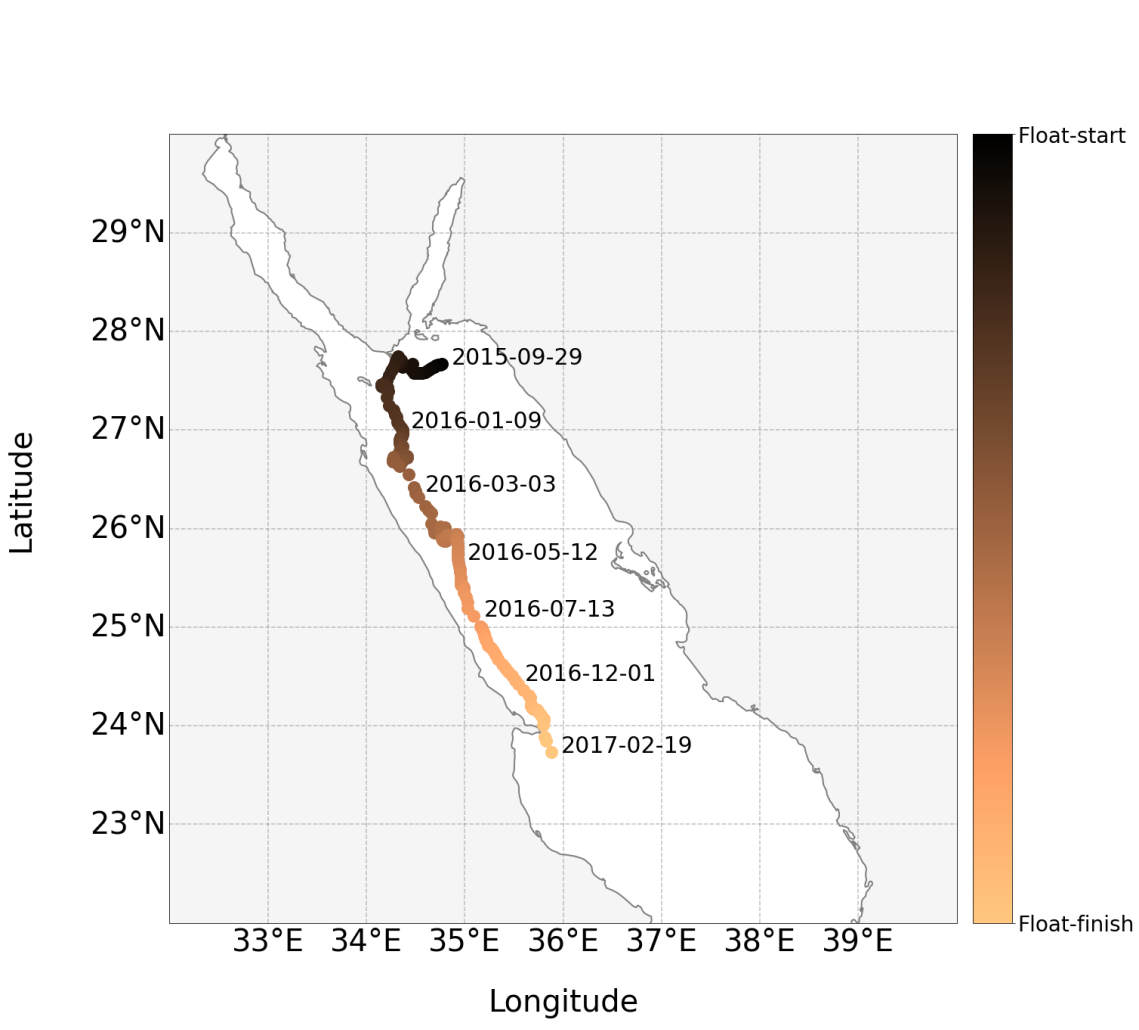
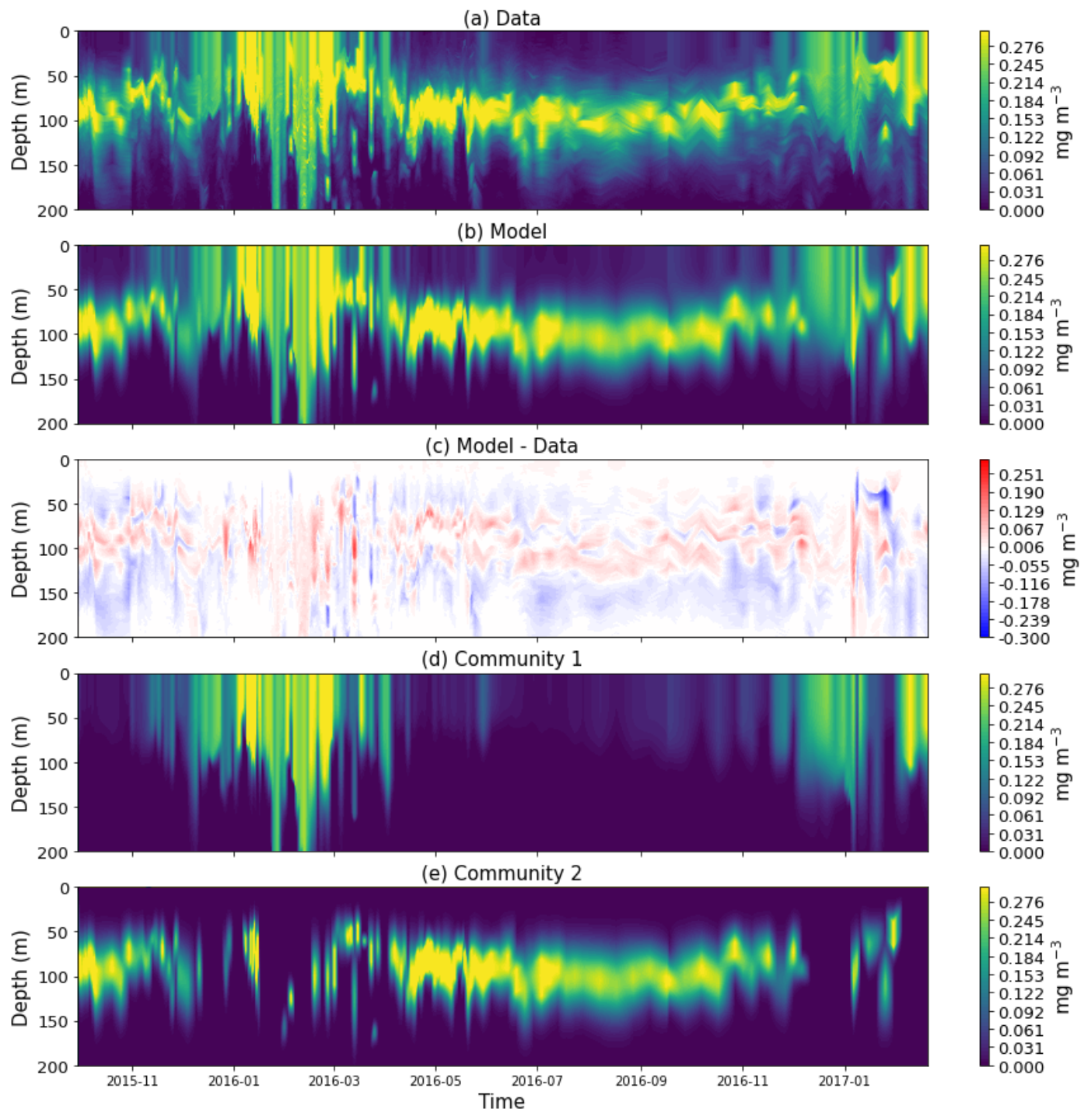
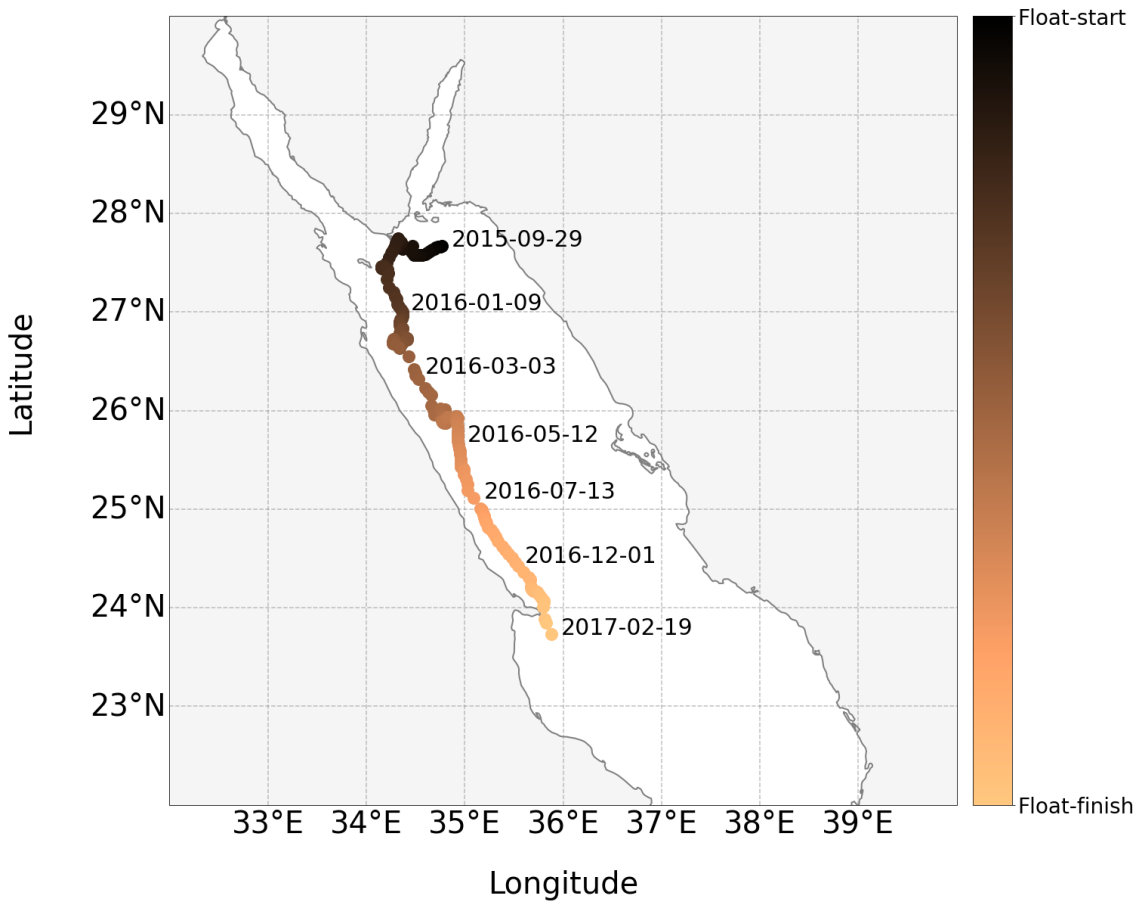
Community 1 Community 2




*Gittings et al. (2019)*

*Kheireddine et al. (2020)*



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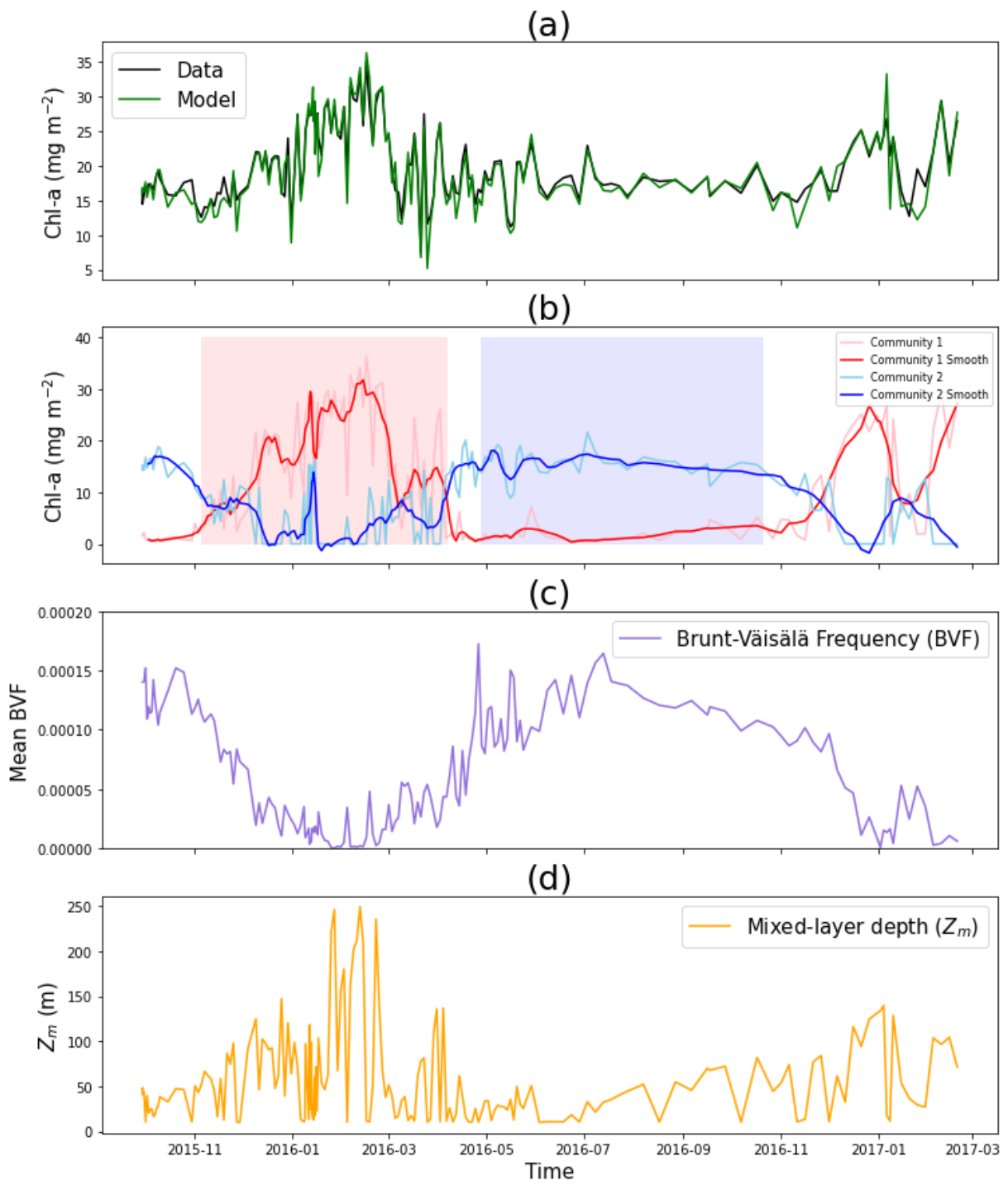
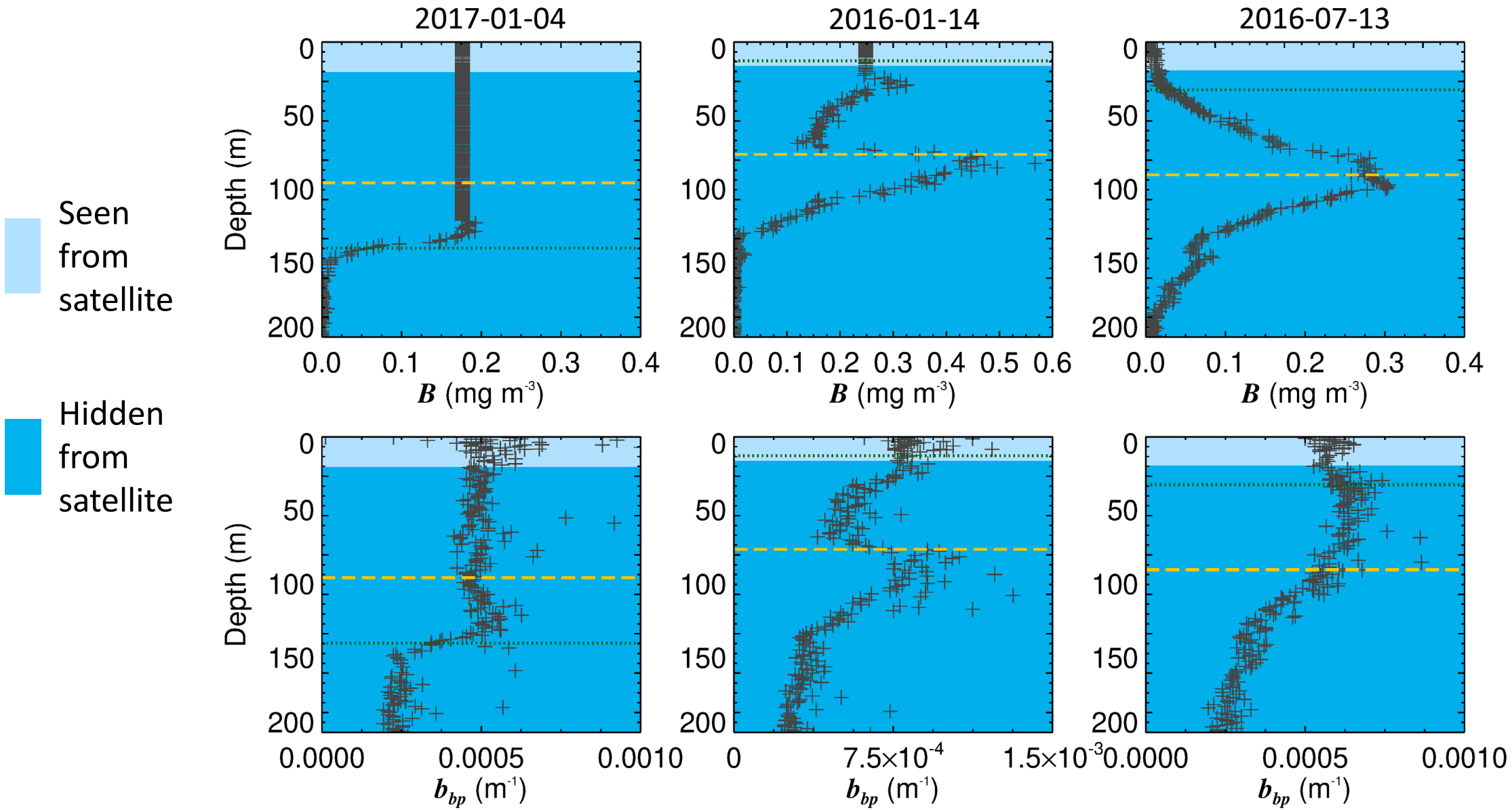
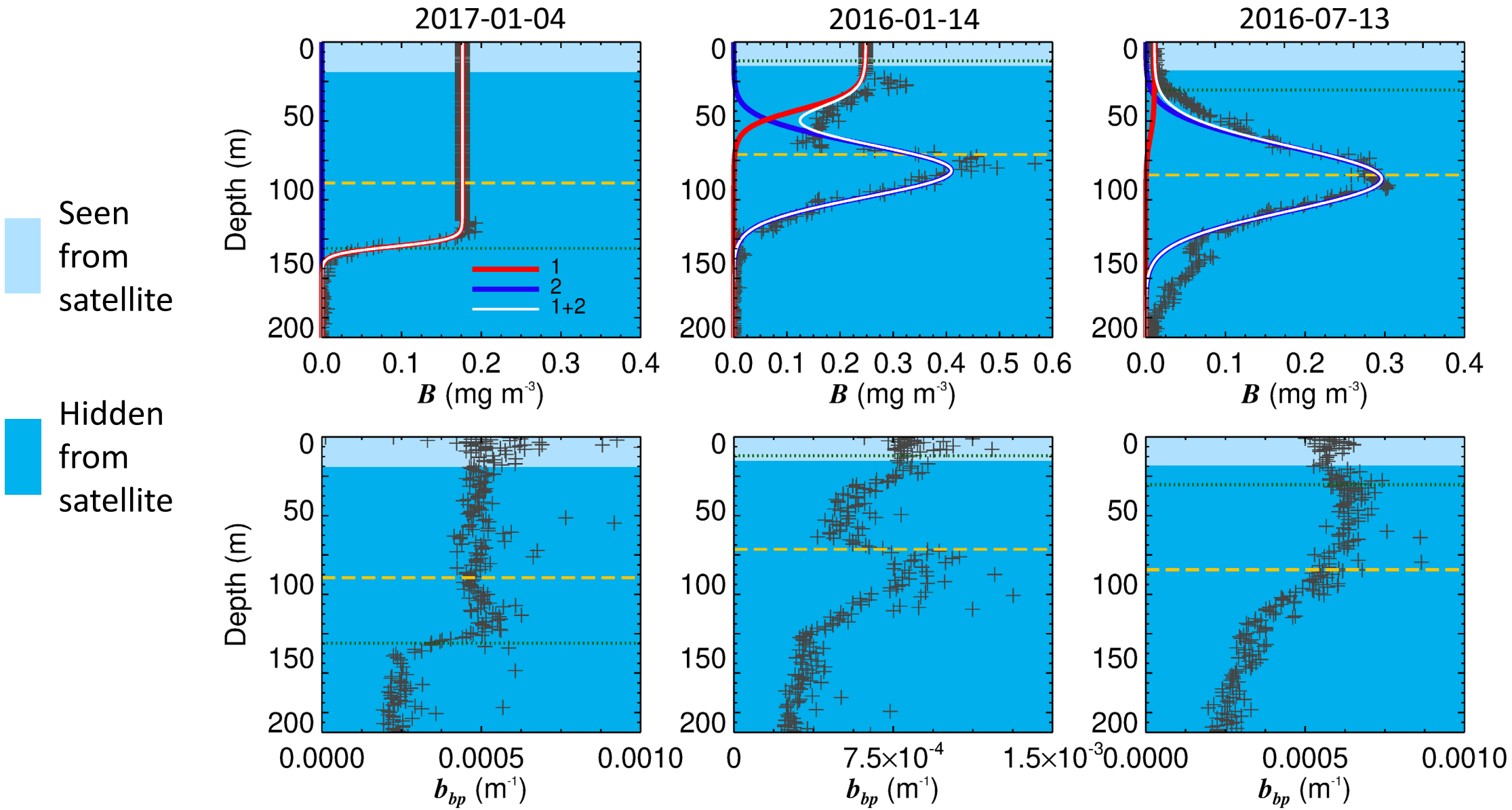
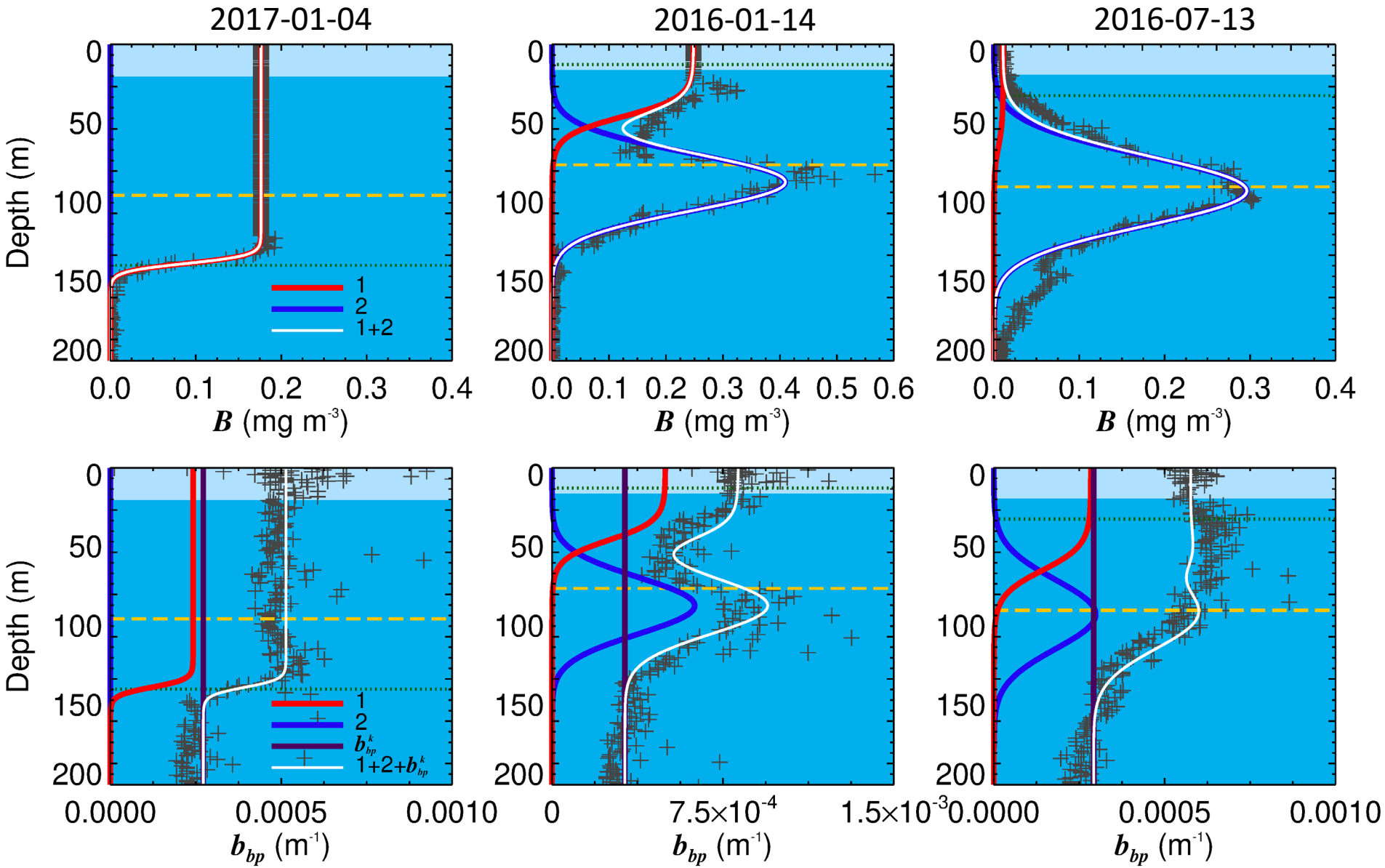



Seen from satellite
Hidden from satellite
2017-01-04
2016-01-14
2016-07-13
Depth (m)
0
50
100
150
200
0.0 0.1 0.2 0.3 0.4
0.0 0.1 0.2 0.3 0.4 0.5 0.6
B (mg m-3)
0.0000 0.0005 0.0010
0 7.5×10-4 1.5×10-3
bbp (m-1)


Seen from satellite
Hidden from satellite
2017-01-04
2016-01-14
2016-07-13
Depth (m)
0
50
100
150
200
1
2
1+2
0.0 0.1 0.2 0.3 0.4
0.0 0.1 0.2 0.3 0.4 0.5 0.6
B (mg m-3)
0.0000 0.0005 0.0010
0 7.5×10-4 1.5×10-3
bbp (m-1)

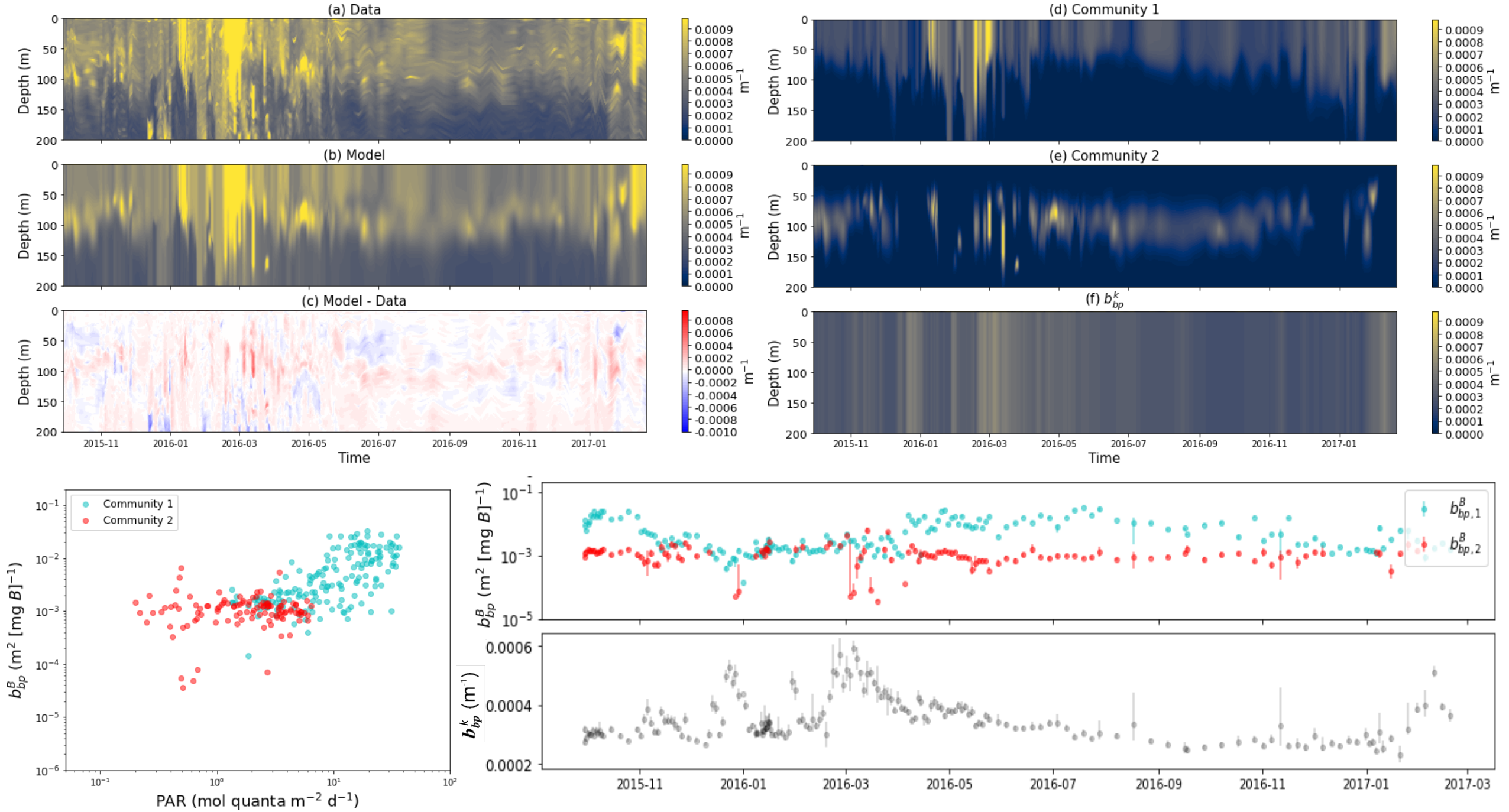
Seen from satellite

Hidden from satellite




$$b_{bp} = b^{B}_{bp,1} B_1 + b^{B}_{bp,2} B_2 + b^{K}_{bp}$$


Brewin et al. (2012) https://doi.org/10.1364/oe.20.017632
Bellacicco et al. (2019) https://doi.org/10.1029/2019GL084078
Kheireddine et al. (2021) https://doi.org/10.1029/2020JC016610


(a) Data
(b) Model
(c) Model - Data
(d) Community 1
(e) Community 2
(f) $b_{bp}^{k}$
Depth (m)
Time
m$^{-1}$
Community 1
Community 2
PAR (mol quanta m$^{-2}$ d$^{-1}$)
$b_{bp}^{B}$ (m$^{2}$ [mg $B$]$^{-1}$)
$b_{bp}^{B}$ (m$^{2}$ [mg $B$]$^{-1}$)
$b_{bp}^{k}$ (m$^{-1}$)
$b_{bp,1}^{B}$
$b_{bp,2}^{B}$

https://doi.org/10.1029/2021JC018195

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April 2022 · Volume 127 · Issue 4


# A Conceptual Approach to Partitioning a Vertical Profile of Phytoplankton Biomass Into Contributions From Two Communities

**Robert J. W. Brewin[1], Giorgio Dall'Olmo[2,3], John Gittings[4,5], Xuerong Sun[1,6], Priscila K. Lange[7,8], Dionysios E. Raitsos[5], Heather A. Bouman[9], Ibrahim Hoteit[4], Jim Aiken[2], and Shubha Sathyendranath[2,3]**

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**Abstract** We describe an approach to partition a vertical profile of chlorophyll-a concentration into contributions from two communities of phytoplankton: one (community 1) that resides principally in the turbulent mixed-layer of the upper ocean and is observable through satellite visible radiometry; the other (community 2) residing below the mixed-layer, in a stably stratified environment, hidden from the eyes of the satellite. The approach is tuned to a time-series of profiles from a Biogeochemical-Argo float in the northern Red Sea, selected as its location transitions from a deep mixed layer in winter (characteristic of vertically well-mixed systems) to a shallow mixed layer in the summer with a deep chlorophyll-a maximum (characteristic of vertically stratified systems). The approach is extended to reproduce profiles of particle backscattering, by deriving the chlorophyll-specific backscattering coefficients of the two communities and a background coefficient assumed to be dominated by non-algal particles in the region. Analysis of the float data reveals contrasting phenology of the two communities, with community 1 blooming in winter and 2 in

Your interest in BGC-Argo (the good and the bad): Natural synergy between satellite and BGC-Argo. Surface focus. Continued investment in QC & consideration of environmental impacts.

Its complementarity with your work: Yes

Next steps for BGC-Argo deployment: Larger array please

The impact on your work in case the size of BGC-ARGO array is reduced: Devastating!

Additional variables: Hyperspectral $K_d$ (Organelli et al 2021 https://doi.org/10.5670/oceanog.2021.supplement.02-33), better Chl-a and $b_{bp}$ sensors, PSD data (UVP)

Specific regions where to deploy BGC-Argo: Global (focus on underrepresented). Need to link to other autonomous networks (e.g. gliders, seals) better suited to coastal / shelf water.

Perspectives on the synergistic use of BGC-Argo, satellites and models: The future of biological oceanography! But let's not forget the importance of ship-based *in situ* measurements!