Variability of Optical Properties in perialpine lakes

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Vincent Nouchi[†], Daniel Odermatt[‡], Damien Bouffard[†], Jaime Pitarch[§], Peter Hunter[℘] and Alfred Johny Wüest[†]

[‡]Odermatt & Brockmann GmbH, Switzerland
[§]National Research Council, Italy
[℘]Stirling University, UK

[†]Ecole Polytechnique Fédéral de Lausanne (EPFL), Switzerland

1. Introduction

Necessity for remote observation interpretation in complex waters

- Focus on 5 perialpine lakes: L. Geneva, L. Biel, L. Greifen, L. Brienz and L. Morat (Figure 1)
- Oligotrophic to mesotrophic situations
- New vertically resolved (S)IOPs measurements
- Influence of stratification levels
- We present here results for L. Geneva

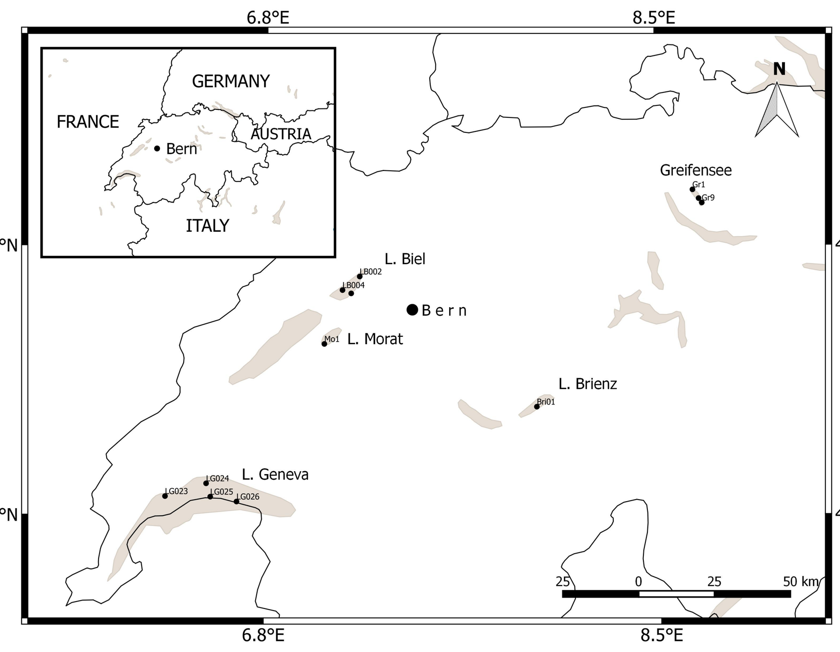

Figure 1: *Study site.*

2. Motivation

The aim of the study is to answer the following questions:

- How variable are the spectral shapes of (S)IOPs in perialpine lakes?
- How do IOPs vary with depth?
- What is these variations' contribution to the water-leaving reflectance signals, and at what IOP levels are stratification effects dominant?
- Which existing retrieval techniques are technically suitable to account for the vertical variability?

3. Method

Field measurements

- R^+_{rs} from Ramses in-water profiles and WISP-3 E^+_d
- b_p, a_t, a_g from AC-S
- $b_{b,p}$ from ECO-VSF
- a_{phy}, a_d, a_g from water sampling
- Chl-a, TSM from water sampling and in-situ fluoro-probe/transmissiometer

IOP approximation models

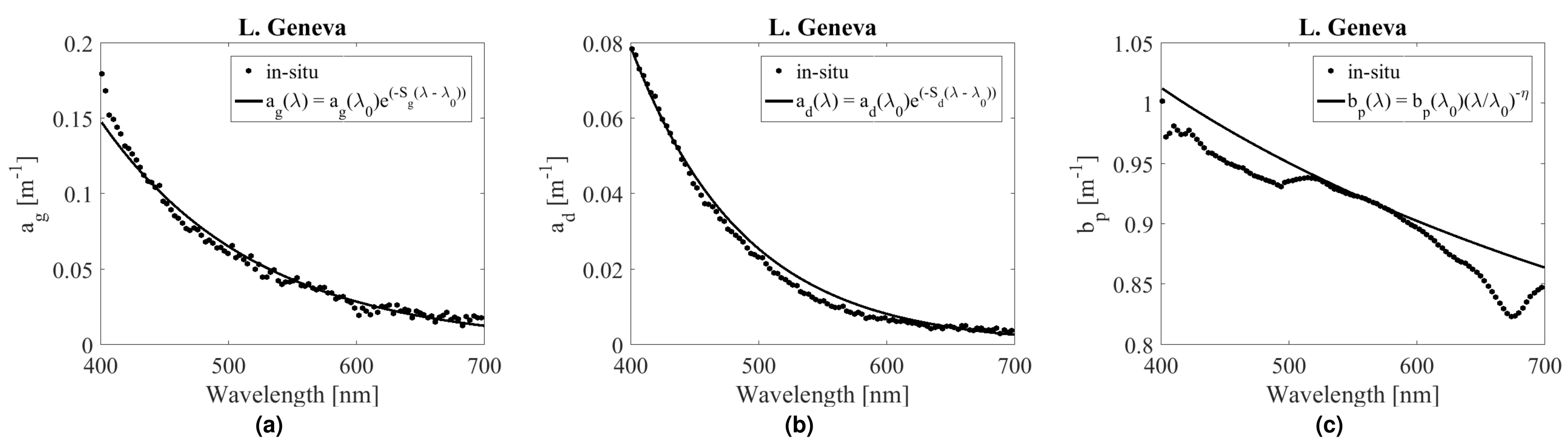

Figure 2: *(a) an exponential relation is used to model a_g ([1] Bricaud, 1981), (b) an exponential relation was used for a_d, and (c) an power law to model b_p.*

Spectral similarity indicators

- Percent difference
- Correlation coefficient from least-square regression
- Focus on 9 wavebands of OLCI sensor (ESA) in the visible domain

4. Results

SIOPs variability

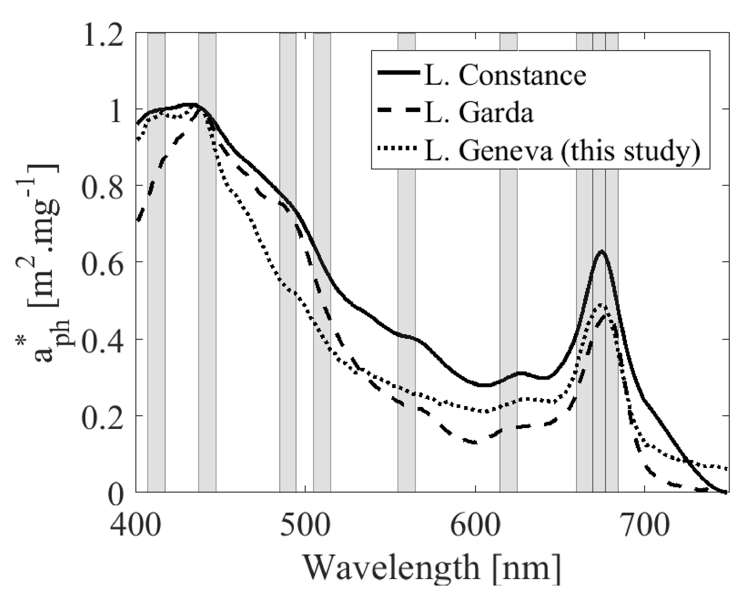

Figure 3: *Specific phytoplankton absorption from literature in L. Constance ([2] Gege, 1997) and L. Garda ([3] Giardino, 2014) and from this study in L. Geneva.*

PD (%)	412	442	490	510	560	620	665	674	681
C vs Gva	1.7	1.7	35	37	42	27	20	24	25
G vs Gva	17	1.6	31	21	17	31	20	9	3
C vs G	19	0.1	3	17	57	57	40	34	21

IOPs variation with depth

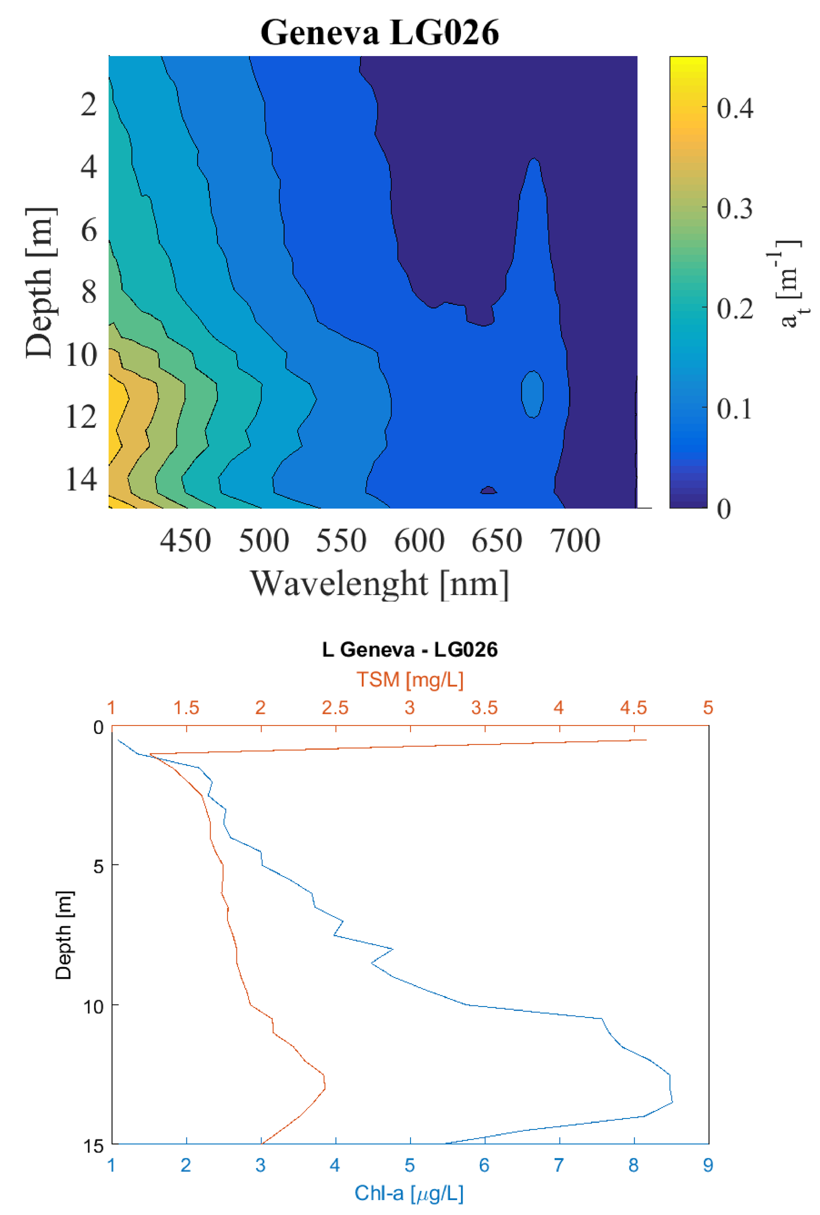

Figure 4: *vertical profile of non-water total absorption (top) and concurrent biogeochemical vertical profile at this station (bottom).*

Optical closure – homogeneous vertical profile

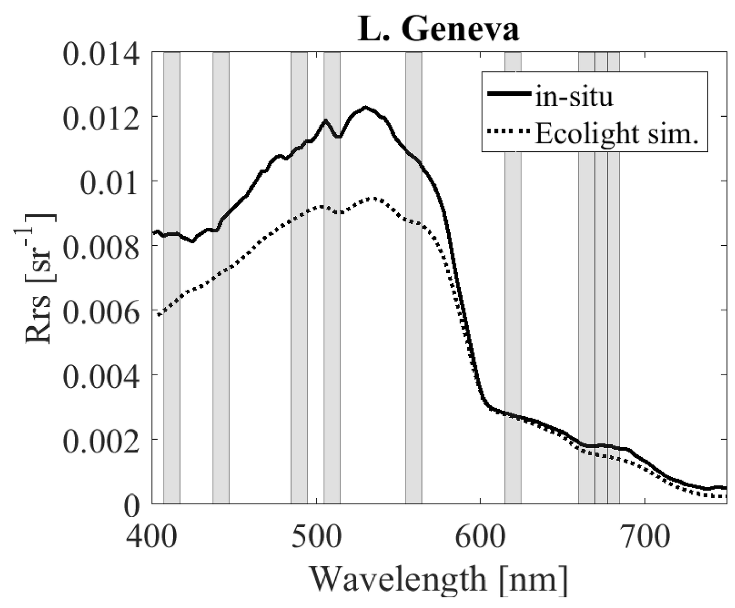

Figure 5: *Comparison between in-situ R_{rs} and Ecolight simulation using homogeneous vertical profile as input.*

PD (%)	412	442	490	510	560	620	665	674	681
in-situ vs Ecolight	30	20	21	24	21	2	12	19	21

Test differences with:

- **Vertical approximation model**
- **In-situ IOP profile**

References

[1] Bricaud, A., Morel, A., and Prieur, L. (1981). *Absorption by dissolved organic matter of the sea (yellow substance) in the UV and visible domains.* Limnol. Oceanogr. 26, pp. 43-53.

[2] Gege, P. (1997). *Classification of phytoplankton in Lake Constance by modeling the albedo.* In Ocean Optics XIII, (Halifax, Nova Scotia, Canada ET – 1 OP – Ja:SPIE), p423.

[3] Giardino, C., Bresciani, M., Cazzaniga, I., Schenl, K., Rieger, P., Braga, F., Matta, E., and Brando, V.E. (2014). *Evaluation of Multi-Resolution Satellite Sensors for Assessing Water Quality and Bottom Depth of Lake Garda.* Sensors 14, 24116.

5. Outlook

- Is the influence of the IOPs spectral shape generally overrated in comparison to vertical variability in clear waters?
- How can existing retrieval techniques be modified to account for vertical variability?