Mountain Research: testing the future ahead of us

Manuel Villar Argaiz, mvillar@ugr.es

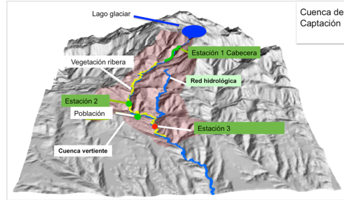
Session 5 Artic and Alpine ecosistems in face of climate change

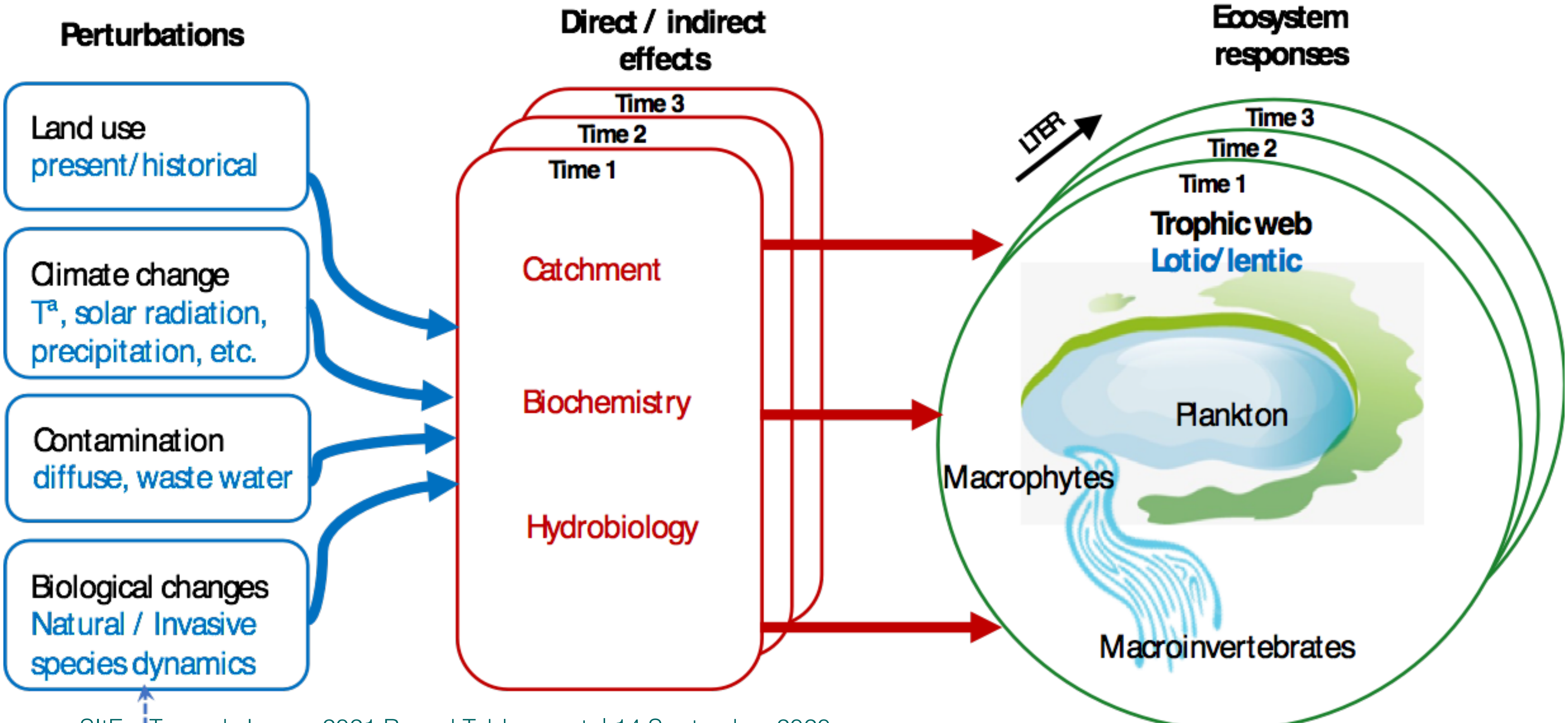
UNIVERSIDAD DE GRANADA

Why are mountains ideal scenarios for testing the future ahead of us ?

Global sciences need global approaches:

A “Hubbard Brook” ecosystem approach





CLIMATE CHANGE

Sentinels of Change

Craig E. Williamson,[1] Jasmine E. Saros,[2] David W. Schindler[3]

www.sciencemag.org SCIENCE VOL 323 13 FEBRUARY 2009

Lakes and reservoirs provide key insights into the effects and mechanisms of climate change.

Limnol. Oceanogr., 54(6, part 2), 2009, 2283–2297

Lakes as sentinels of climate change

Rita Adrian,[a,*] Catherine M. O'Reilly,[b] Horacio Zagarese,[c] Stephen B. Baines,[d] Dag O. Hessen,[e]
... Livingstone,[g] Ruben Sommaruga,[h] Dietmar Straile,[i] Ellen Van Donk,[j]
... Monika Winder[l]

AEET Asociación Española de Ecología Terrestre
ecosistemas REVISTA DE ECOLOGÍA Y MEDIO AMBIENTE
Año X, Nº3 / 2001 Septiembre - Diciembre

Investigación

Ecosistemas de alta montaña, las atalayas de la troposfera

La troposfera es el fluido en el que vivimos los organismos terrestres. La dinámica de este fluido hace posible el funcionamiento de los ecosistemas

Rafael Morales Baquero, Carmen Pérez Martínez e Isabel Reche
Instituto del Agua, Universidad de Granada

Limnetica, 25(1-2): 551-584 (2006)

High mountain lakes: extreme habitats and witnesses of environmental changes

Jordi Catalan[1,5], Lluís Camarero[1,5], Marisol Felip[2,5], Sergi Pla[3], Marc Ventura[4], Teresa Buchaca[4], Frederic Bartumeus[1,5], Guillermo de Mendoza[1,5], Alexandre Miró[5], Emilio O. Casamayor[1,5], Juan Manuel Medina-Sánchez[1,5,6], Montserrat Bacardit[1,5], Maddi Altuna[1,5], Mireia Bartrons[1,5], Daniel Díaz de Quijano[1,5]

RESEARCH ARTICLE

SUSTAINABILITY

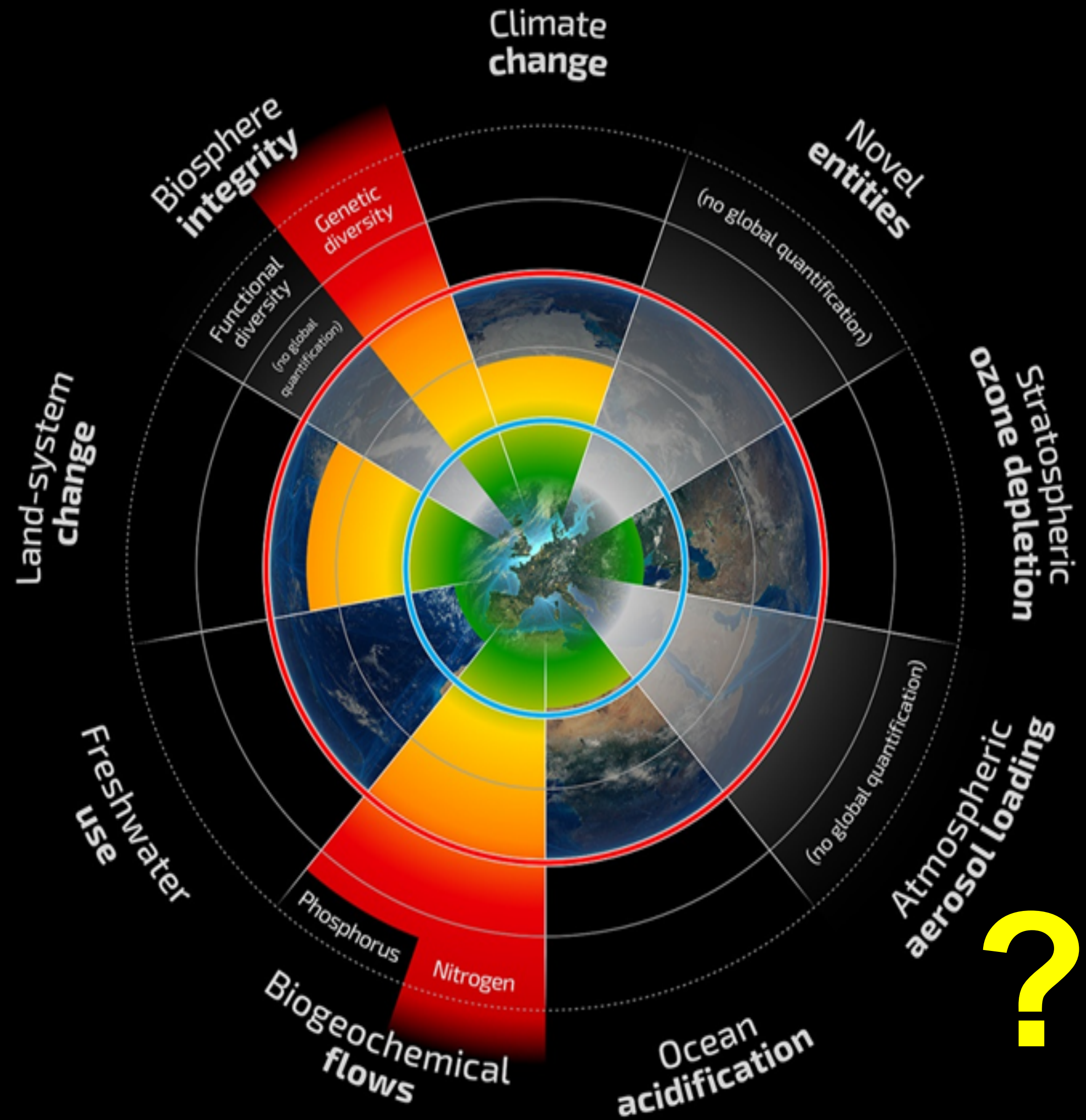
Planetary boundaries: Guiding human development on a changing planet

Will Steffen,[1,2]* Katherine Richardson,[3] Johan Rockström,[1] Sarah E. Cornell,[1]

Steffen et al. 2015 Science

Planetary Boundaries
The main threats

- Beyond zone of uncertainty (high risk)
- In zone of uncertainty (increasing risk)
- Below boundary (safe)
- Boundary not yet quantified



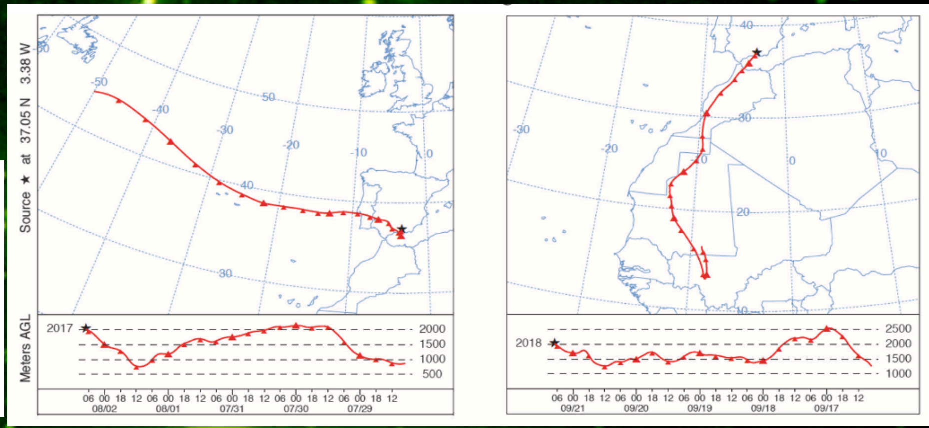
Bacteria / Virus

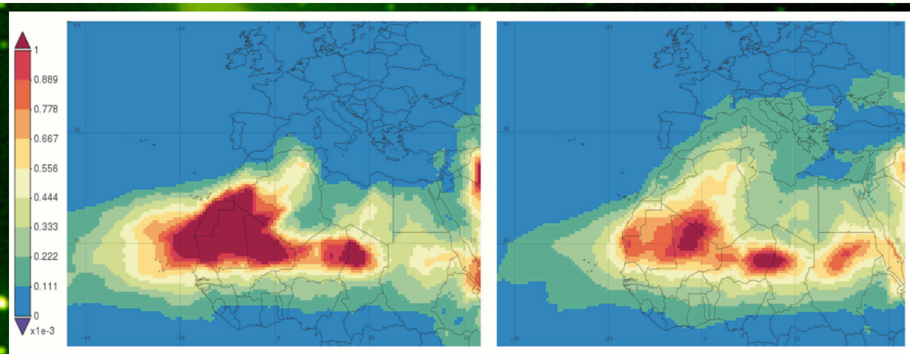
The ISME Journal
https://doi.org/10.1038/s41396-017-0042-4

ARTICLE

Deposition rates of viruses and bacteria above the atmospheric boundary layer

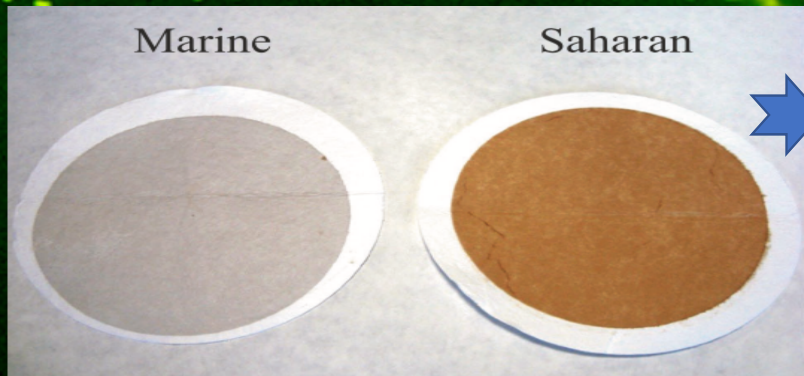
Isabel Reche[1] · Gaetano D'Orta[1] · Natalie Mladenov[2] · Danielle M. Winget[3] · Curtis A. Suttle[3]

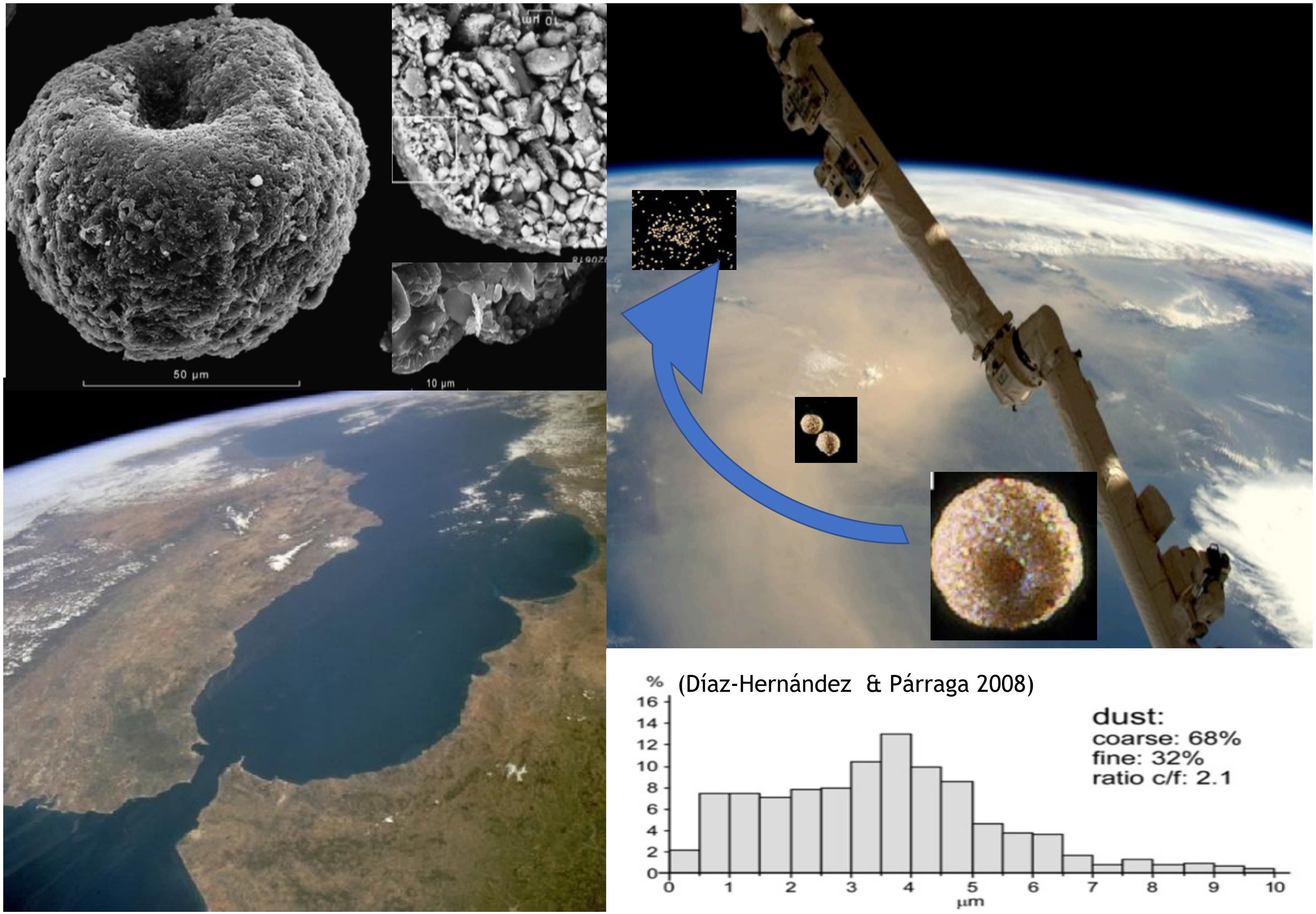


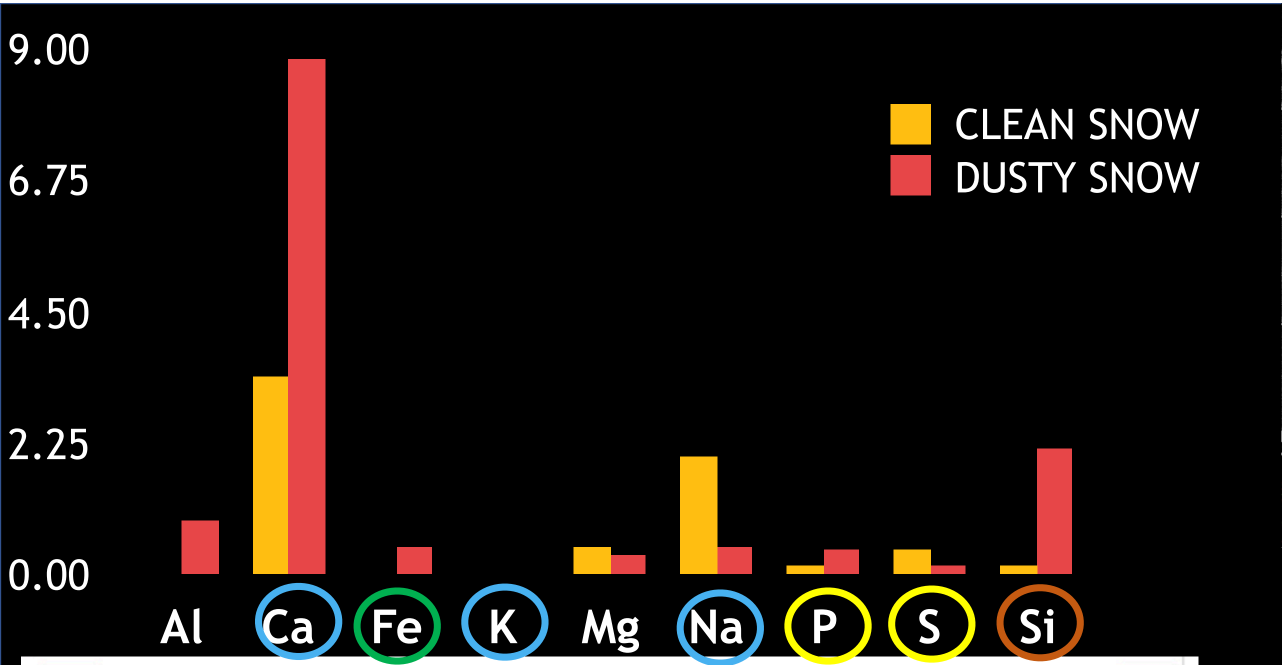


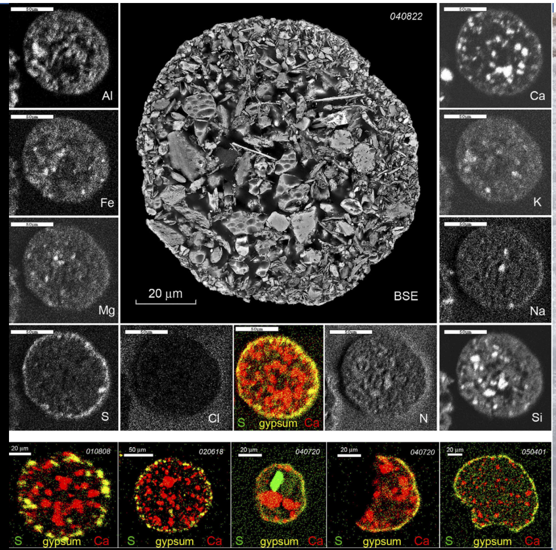
7×10^{9} $m^{-2}\,d^{-1}$

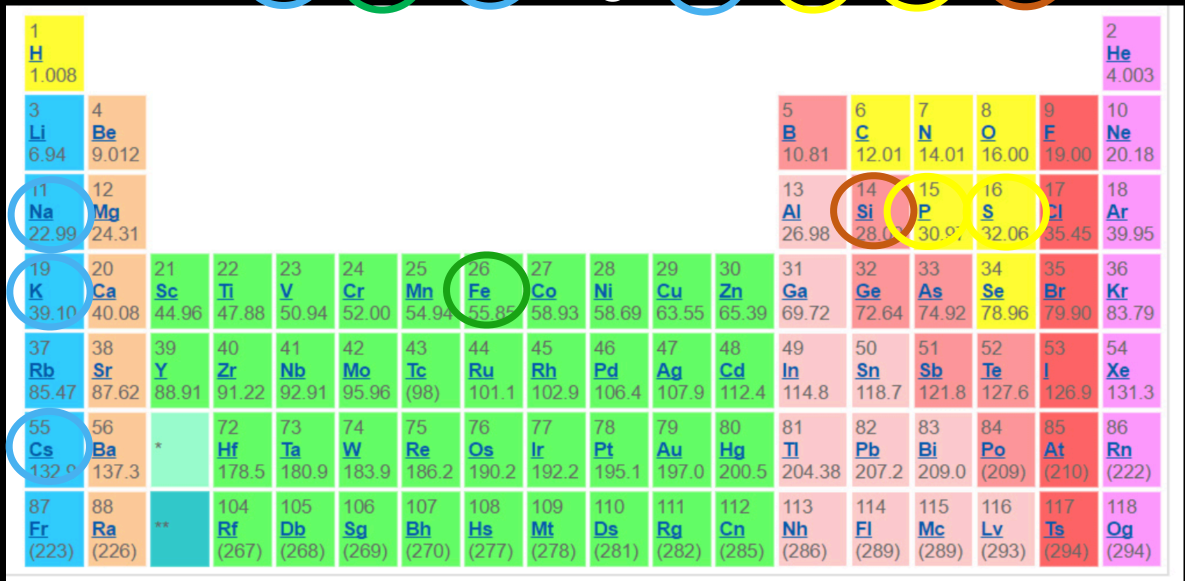
8×10^{7} $m^{-2}\,d^{-1}$

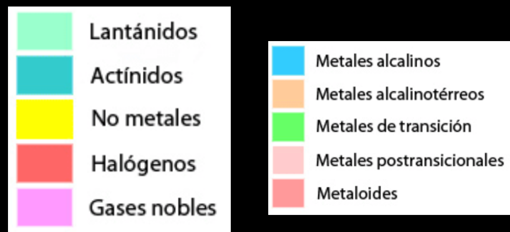


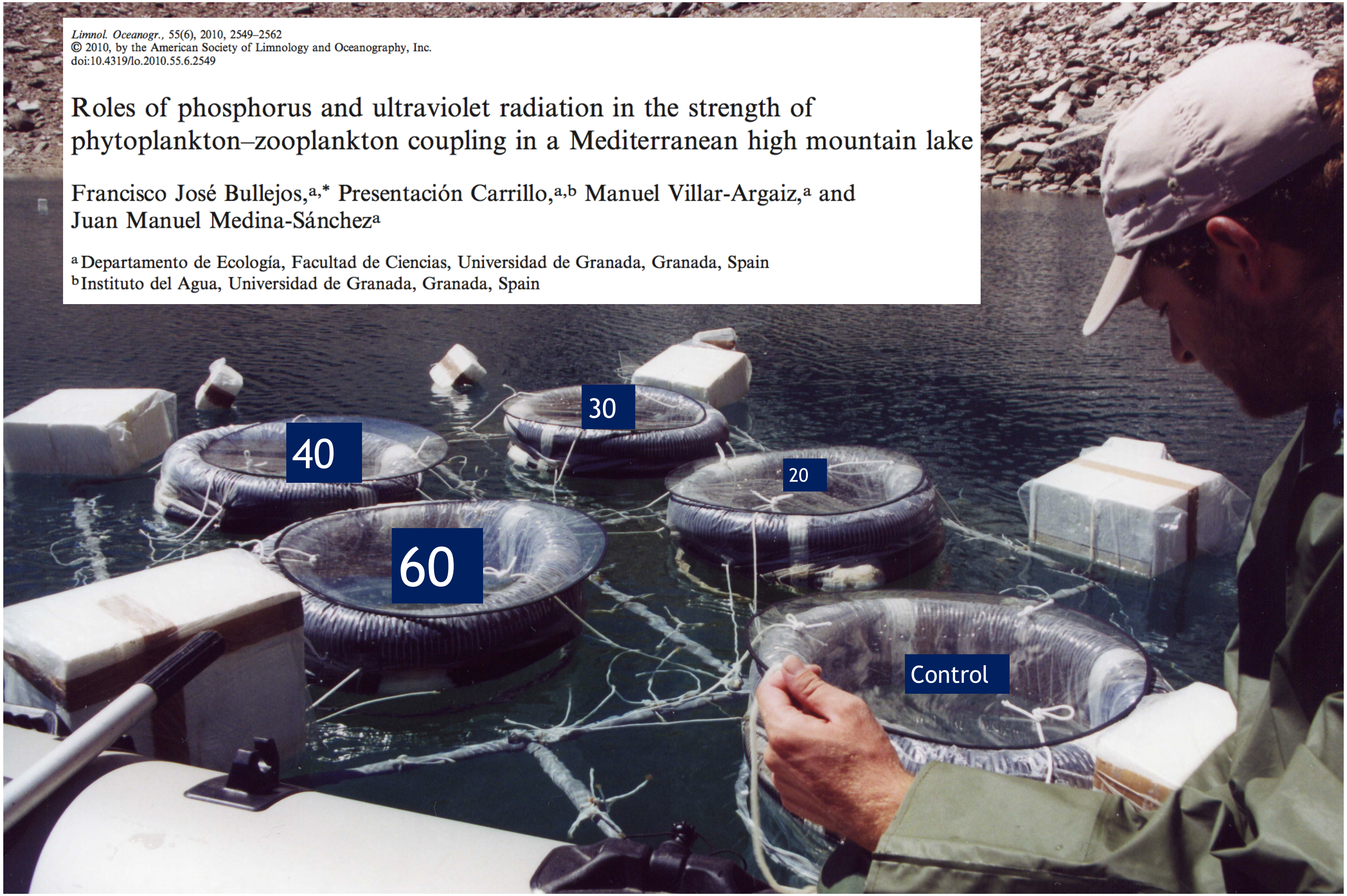

50 µm
10 µm
% (Díaz-Hernández & Párraga 2008)
dust:
coarse: 68%
fine: 32%
ratio c/f: 2.1
µm


9.00
6.75
4.50
2.25
0.00
CLEAN SNOW
DUSTY SNOW
Al
Ca
Fe
K
Mg
Na
P
S
Si


040822
20 µm
BSE
Al
Fe
Mg
Ca
K
Na
S
Cl
N
Si
gypsum
010808
020618
040720
040720
050401


1 H 1.008
2 He 4.003
3 Li 6.94
4 Be 9.012
5 B 10.81
6 C 12.01
7 N 14.01
8 O 16.00
9 F 19.00
10 Ne 20.18
11 Na 22.99
12 Mg 24.31
13 Al 26.98
14 Si 28.0
15 P 30.9
16 S 32.06
17 Cl 35.45
18 Ar 39.95
19 K 39.10
20 Ca 40.08
21 Sc 44.96
22 Ti 47.88
23 V 50.94
24 Cr 52.00
25 Mn 54.94
26 Fe 55.85
27 Co 58.93
28 Ni 58.69
29 Cu 63.55
30 Zn 65.39
31 Ga 69.72
32 Ge 72.64
33 As 74.92
34 Se 78.96
35 Br 79.90
36 Kr 83.79
37 Rb 85.47
38 Sr 87.62
39 Y 88.91
40 Zr 91.22
41 Nb 92.91
42 Mo 95.96
43 Tc (98)
44 Ru 101.1
45 Rh 102.9
46 Pd 106.4
47 Ag 107.9
48 Cd 112.4
49 In 114.8
50 Sn 118.7
51 Sb 121.8
52 Te 127.6
53 I 126.9
54 Xe 131.3
55 Cs 132.9
56 Ba 137.3
*
72 Hf 178.5
73 Ta 180.9
74 W 183.9
75 Re 186.2
76 Os 190.2
77 Ir 192.2
78 Pt 195.1
79 Au 197.0
80 Hg 200.5
81 Tl 204.38
82 Pb 207.2
83 Bi 209.0
84 Po (209)
85 At (210)
86 Rn (222)
87 Fr (223)
88 Ra (226)
**
104 Rf (267)
105 Db (268)
106 Sg (269)
107 Bh (270)
108 Hs (277)
109 Mt (278)
110 Ds (281)
111 Rg (282)
112 Cn (285)
113 Nh (286)
114 Fl (289)
115 Mc (289)
116 Lv (293)
117 Ts (294)
118 Og (294)


Lantánidos
Actínidos
No metales
Halógenos
Gases nobles
Metales alcalinos
Metales alcalinotérreos
Metales de transición
Metales postransicionales
Metaloides



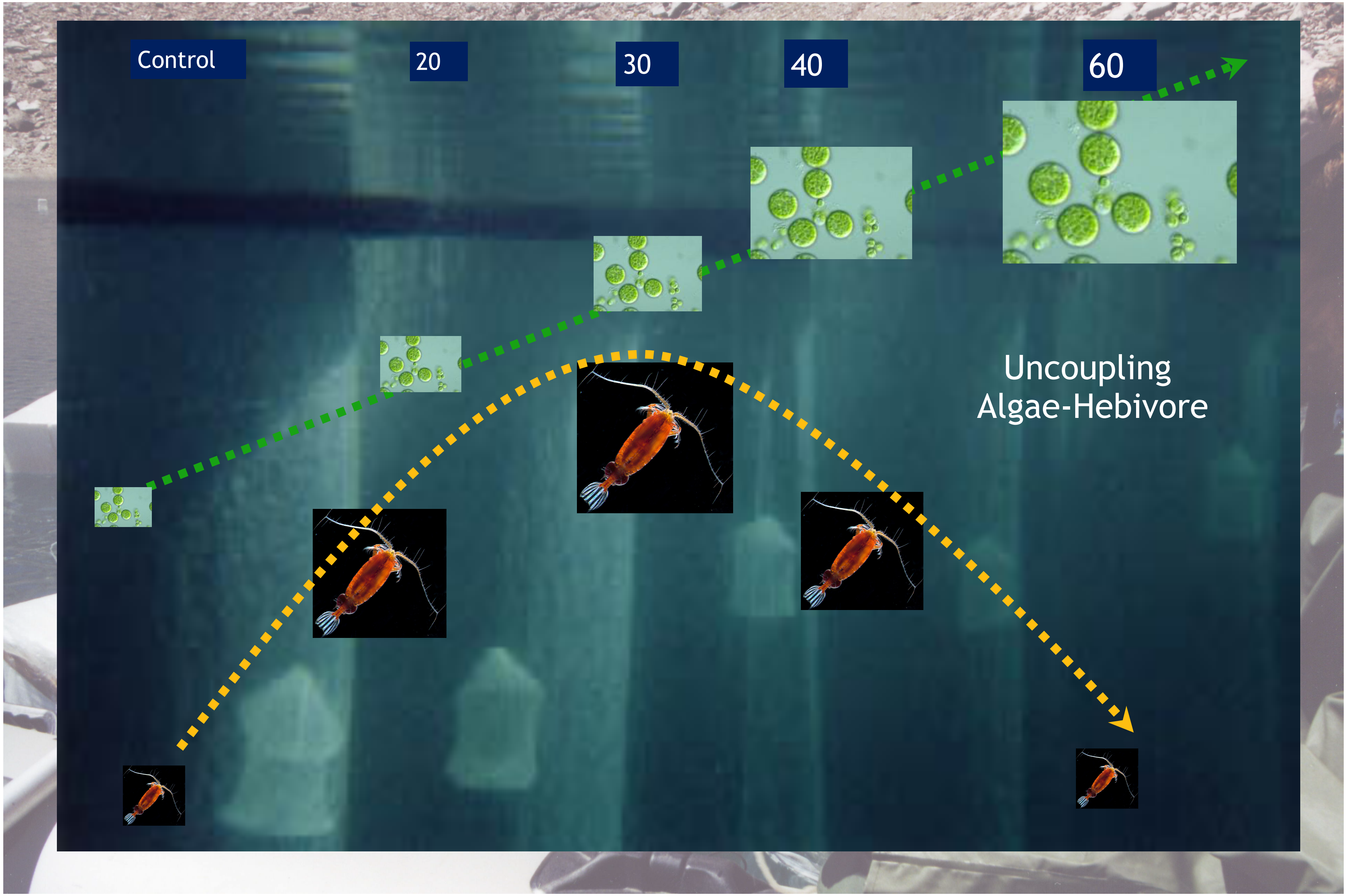
Limnol. Oceanogr., 55(6), 2010, 2549–2562

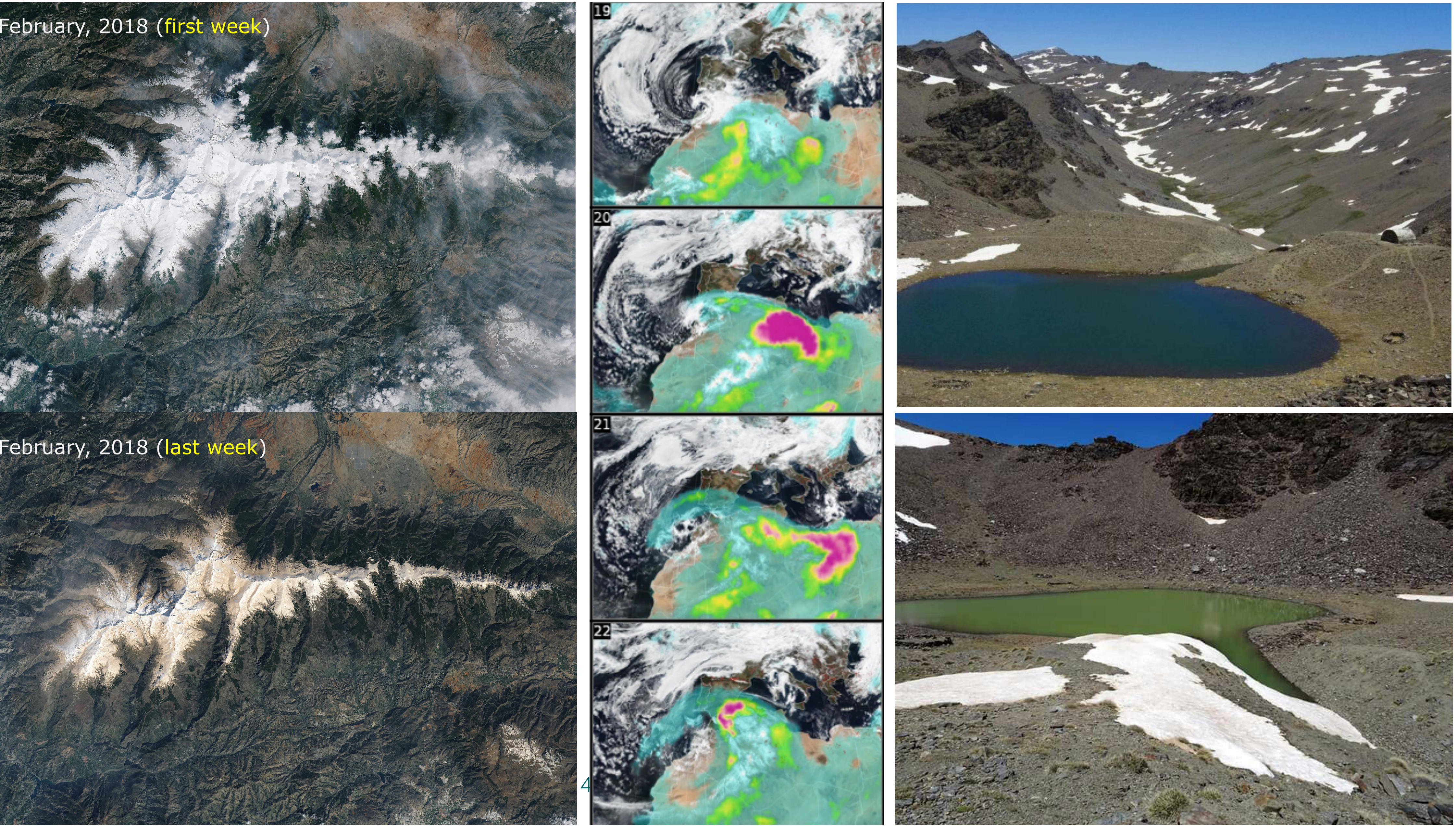
doi:10.4319/lo.2010.55.6.2549

Roles of phosphorus and ultraviolet radiation in the strength of phytoplankton–zooplankton coupling in a Mediterranean high mountain lake

Francisco José Bullejos,[a,*] Presentación Carrillo,[a,b] Manuel Villar-Argaiz,[a] and Juan Manuel Medina-Sánchez[a]

[a] Departamento de Ecología, Facultad de Ciencias, Universidad de Granada, Granada, Spain
[b] Instituto del Agua, Universidad de Granada, Granada, Spain


Control
20
30
40
60
Uncoupling
Algae-Hebivore


February, 2018 (first week)
February, 2018 (last week)
19
20
21
22

Global Change Scenario

Traditional approach

- Studies with **single** global-change drivers
- Under **controlled/lab** conditions

vs.

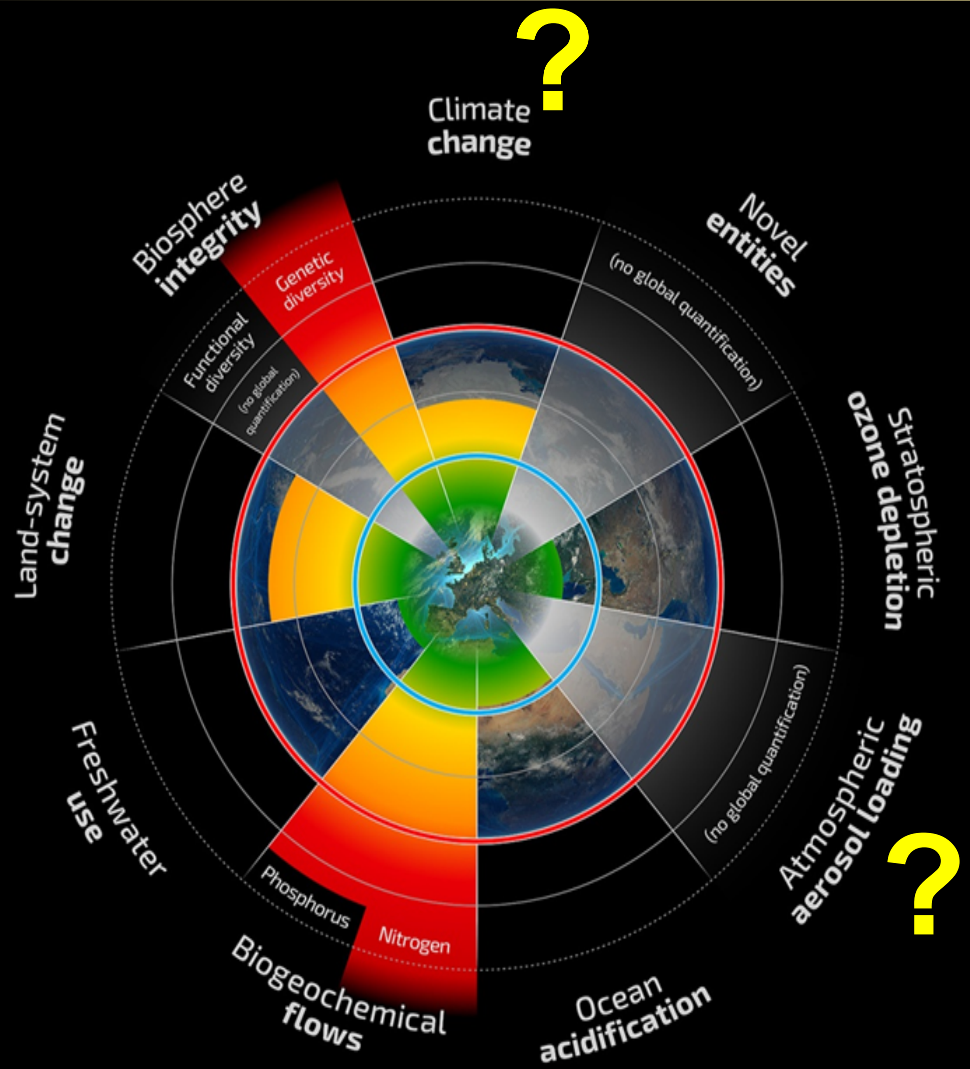
Current approach

- Studies with **multiple** global-change drivers
- Under **realistic/ natural** conditions

Simplicity Complexity

Interactive effects?

Planetary Boundaries



CO2 x Aerosol interaction

- Beyond zone of uncertainty (high risk)
- In zone of uncertainty (increasing risk)
- Below boundary (safe)
- Boundary not yet quantified

Steffen et al. 2015 Science

Science of the Total Environment 639 (2018) 118–128

Contents lists available at ScienceDirect

Science of the Total Environment

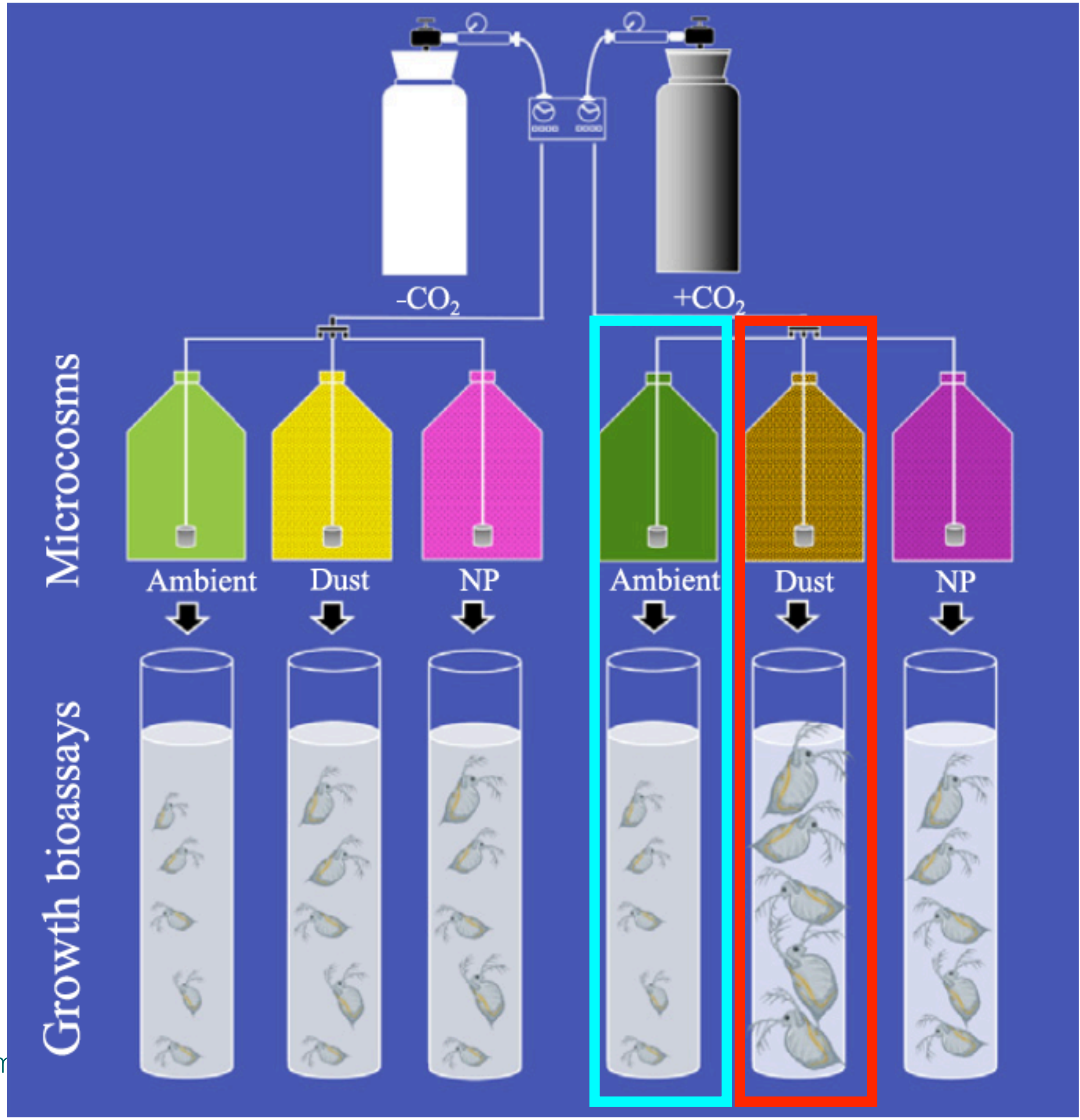
journal homepage: www.elsevier.com/locate/scitotenv

Growth impacts of Saharan dust, mineral nutrients, and CO_2 on a planktonic herbivore in southern Mediterranean lakes

Manuel Villar-Argaiz [a,*], Marco J. Cabrerizo [b], Juan Manuel González-Olalla [b], Macarena S. Valiñas [c], Sanja Rajic [b], Presentación Carrillo [b]

- No single effect of rising CO_2 was detected unless supplemented with Saharan dust or inorganic nutrients.

- CO_2 effects on herbivores are expected to intensify as the Mediterranean region becomes dustier.



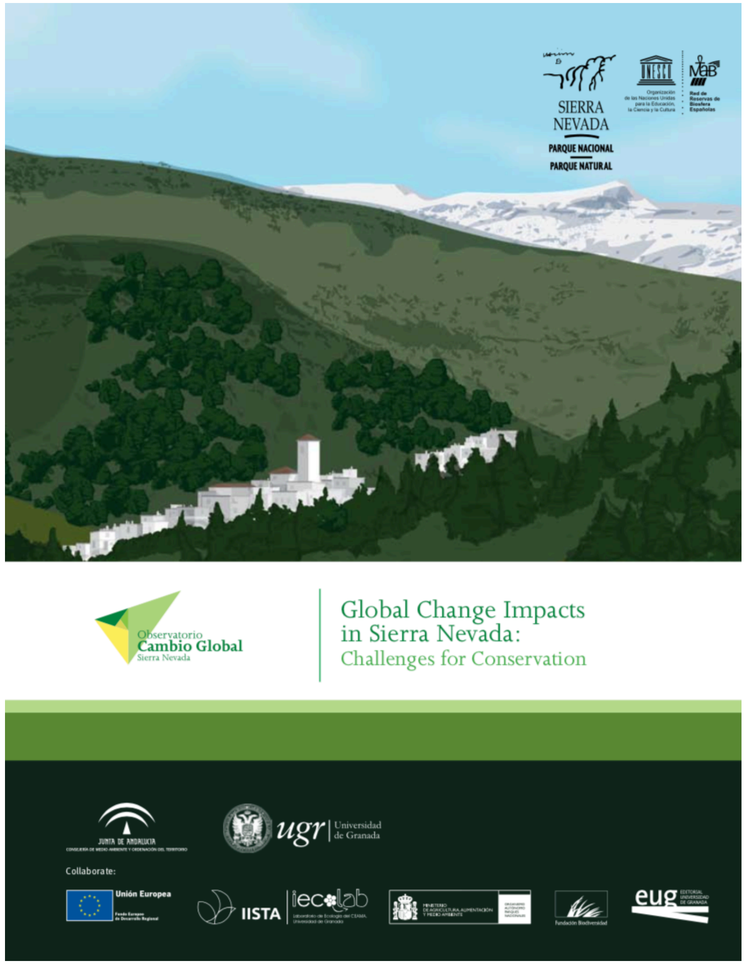
A guide-like publication achivement

40 thematic chapters

Climate (2)
Cryosphere (4)
The role of history (6)
Aquatic ecosystems (5)
Population trends (7)
Phenology (3)
Carbon fluxes and NPP (2)
Socieconomic services (2)
Forest management (6)
S. Nevada as global observatory (3)

69 authors from 11 institutions

Univeridad de Granada
Universidad Autónoma de Madrid
Universitat Autònoma de Barcelona
Oslo University
Lancaster University
Andalusian Regional Government
Spanish National Research Council (CSIC)
…



https://www.researchgate.net/publication/308986359_Global_Change_Impacts_in_Sierra_Nevada_Challenges_for_Conservation

…testing the future ahead of us

- MOUNTAINS (aquatic ecosystems) offer unique sites for research: they are CRISTAL BALLS (natural observatories) where to look for future changes ahead of us

- THINGS ARE NOT SIMPLE !
we need to search for interactive effects if we wish to have an accurate idea for how species and ecosystems are changing