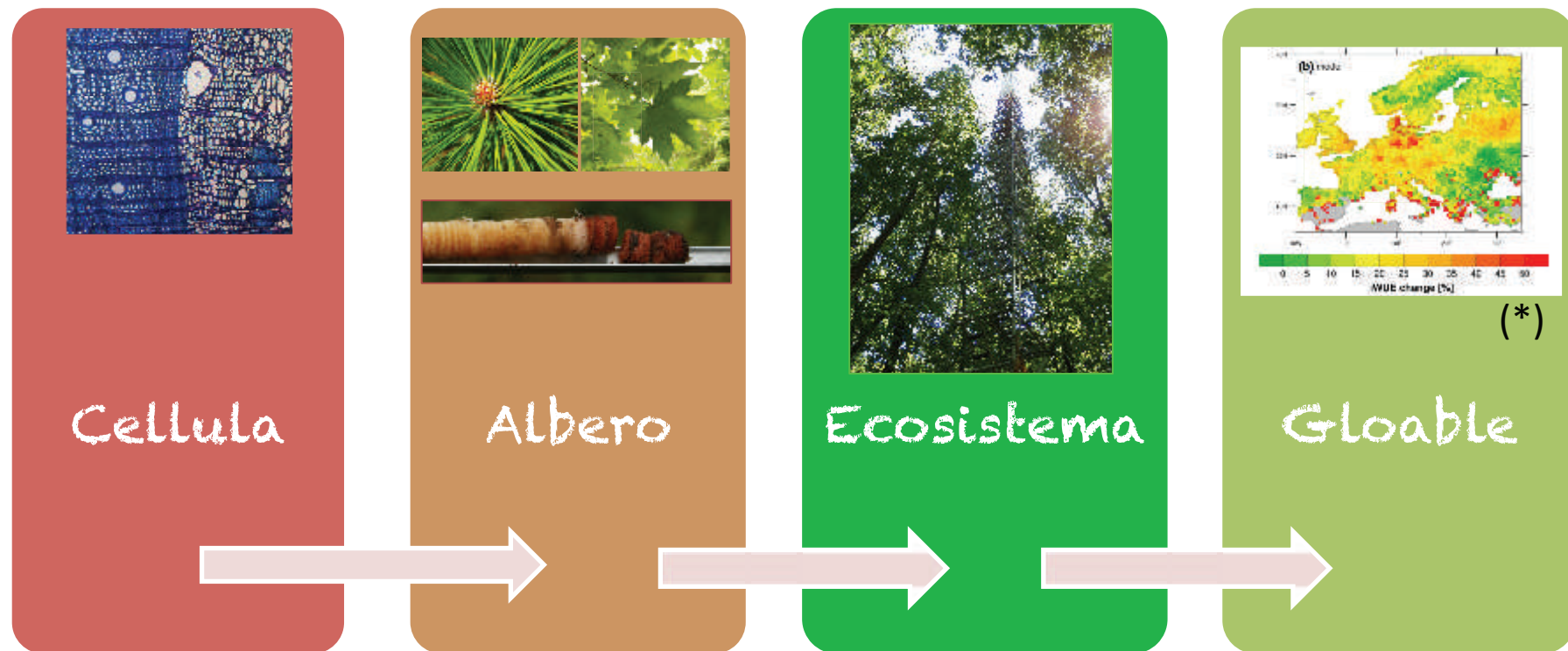


## L'ecosistema delle foreste come vittima e salvezza del clima

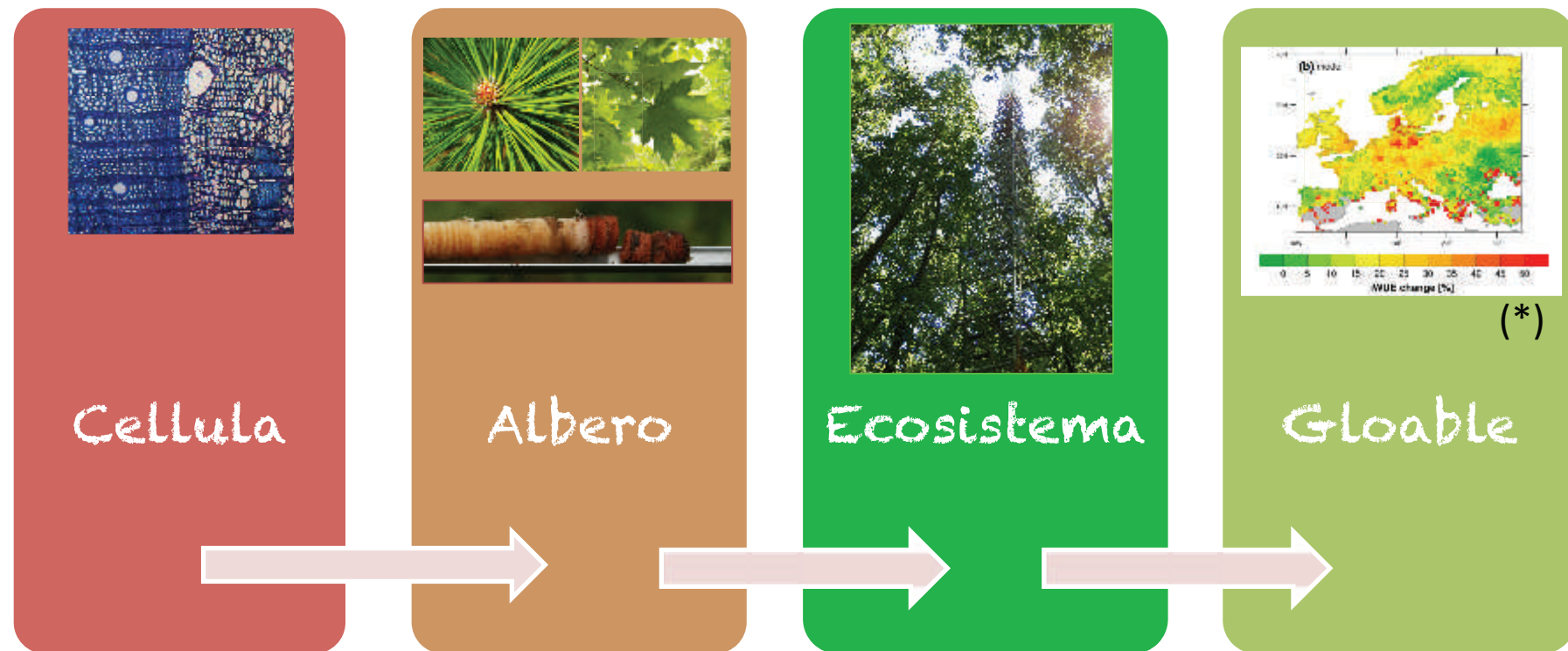
Dobbiaco, 28 Settembre 2019

# Premessa

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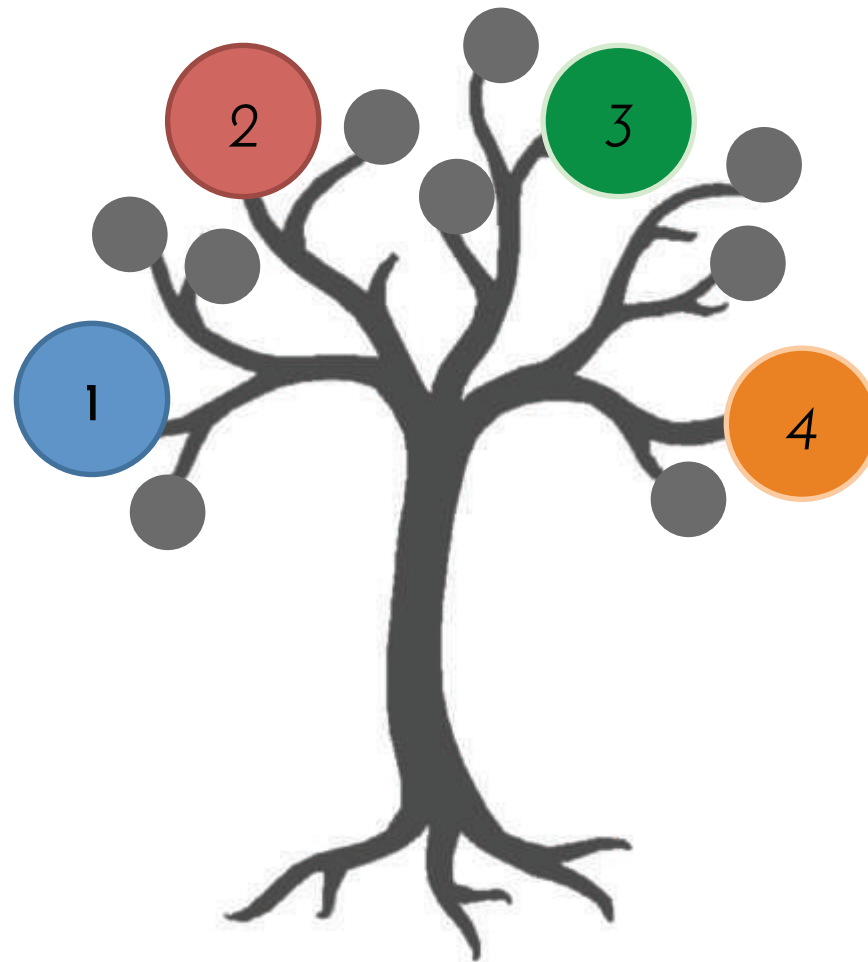


# Premessa



# Di che cosa parleremo

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# Di che cosa parleremo

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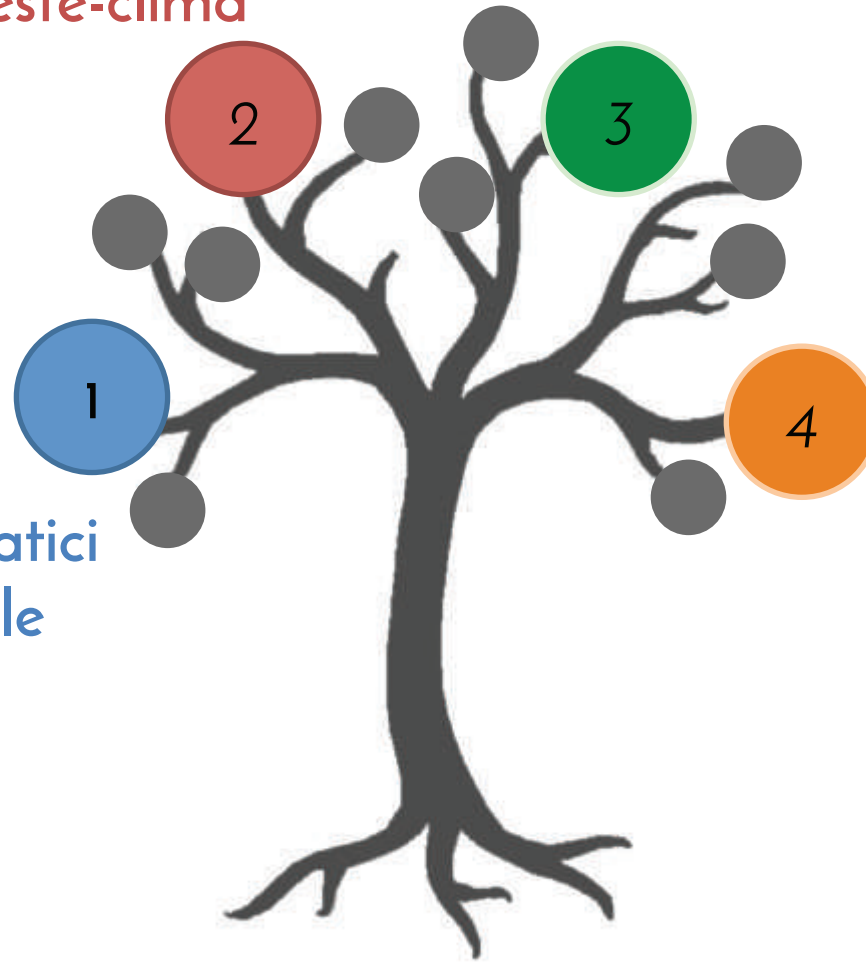


# Di che cosa parleremo

---

Processi che regolano  
interazione foreste-clima

Cambiamenti climatici  
e ruolo svolto dalle  
foreste

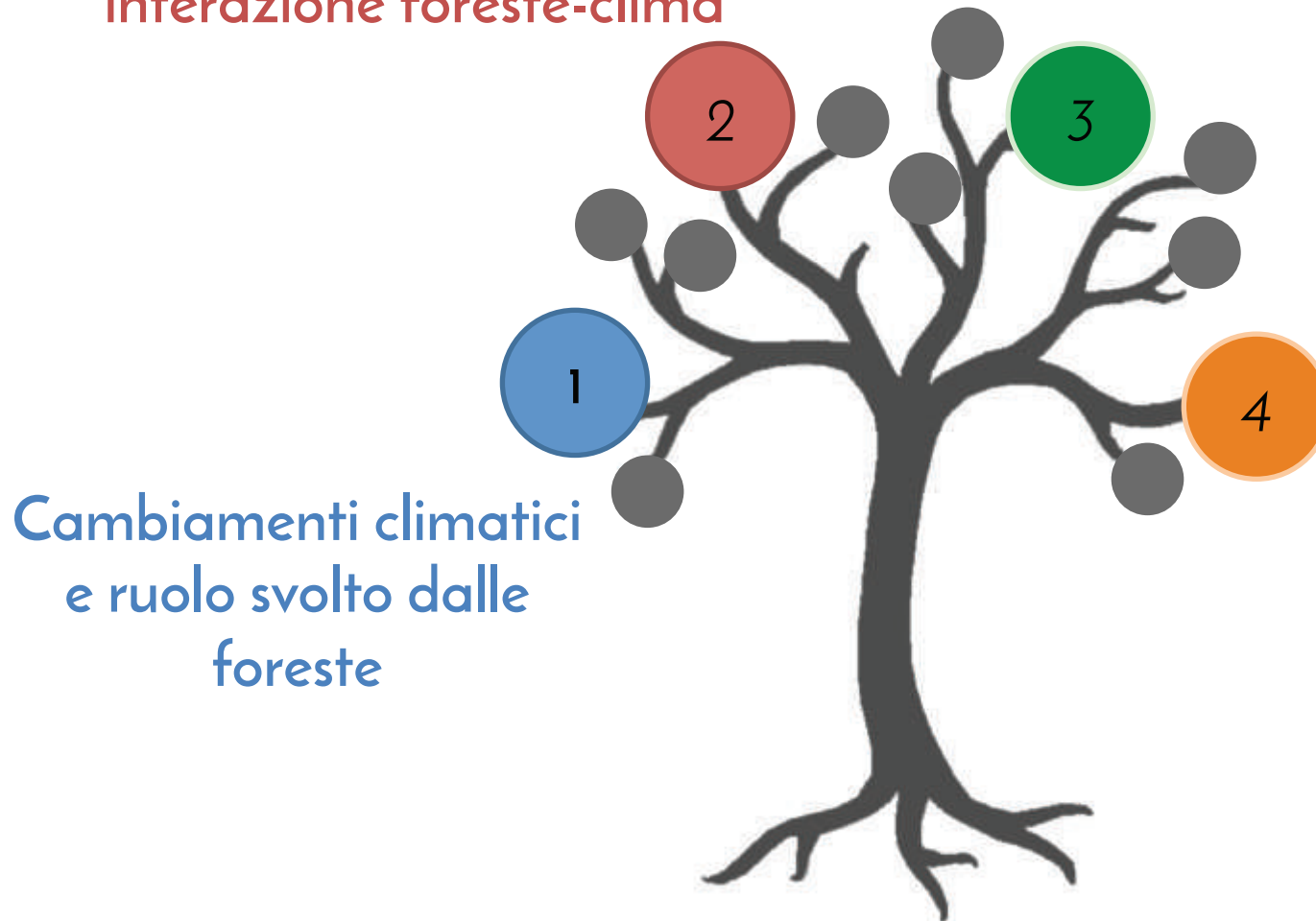


# Di che cosa parleremo

---

Processi che regolano  
interazione foreste-clima

Le sfide per le nostre foreste





# Di che cosa parleremo

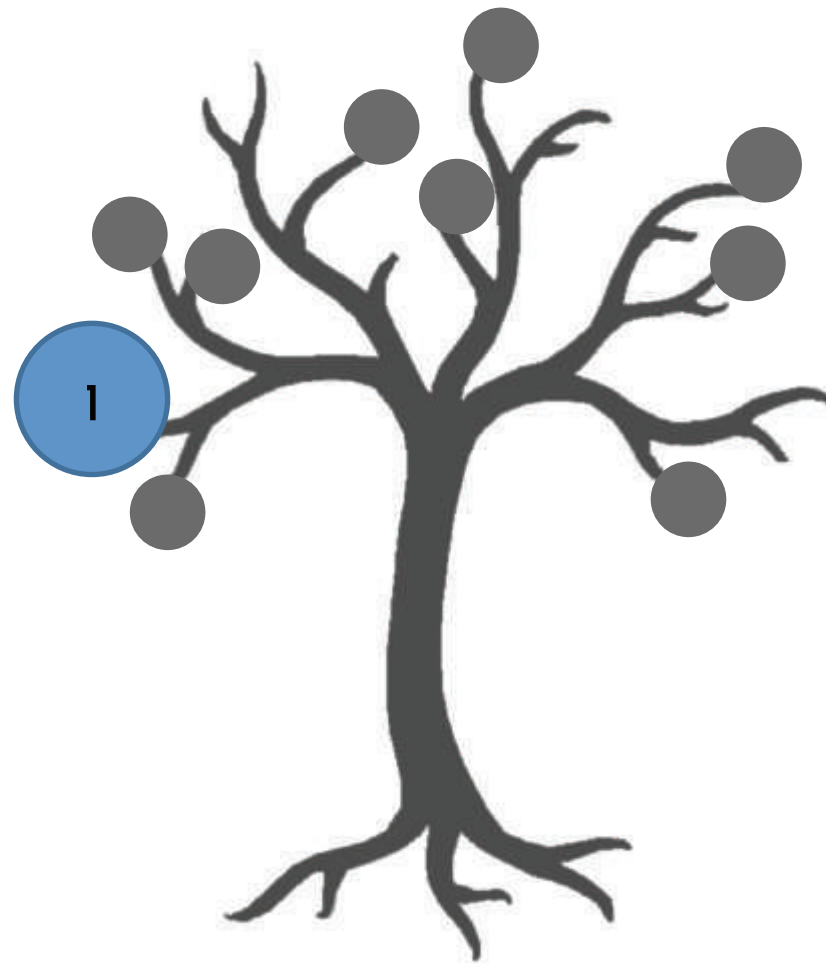
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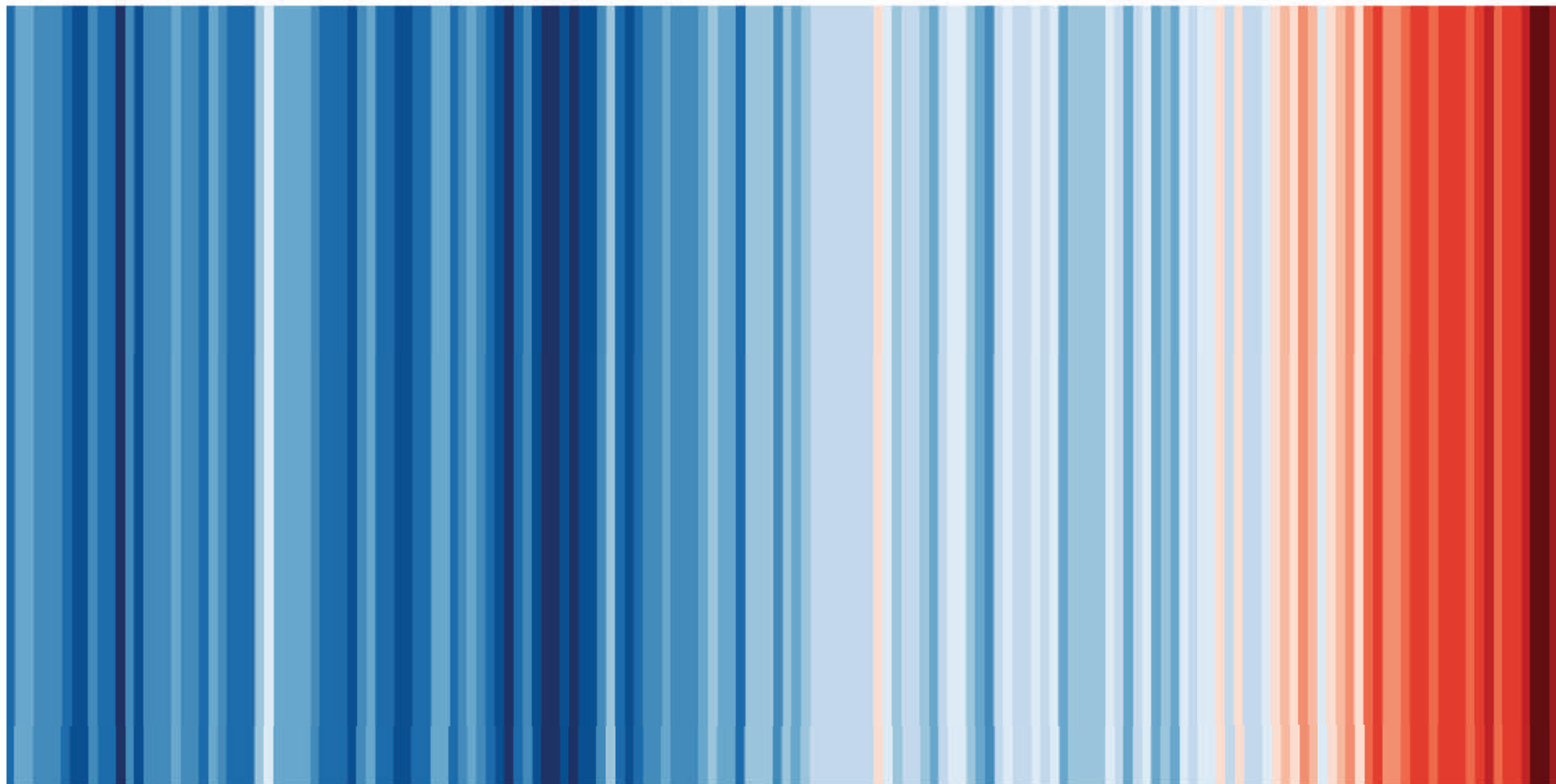




# Cambiamenti climatici e ruolo svolto dalle foreste

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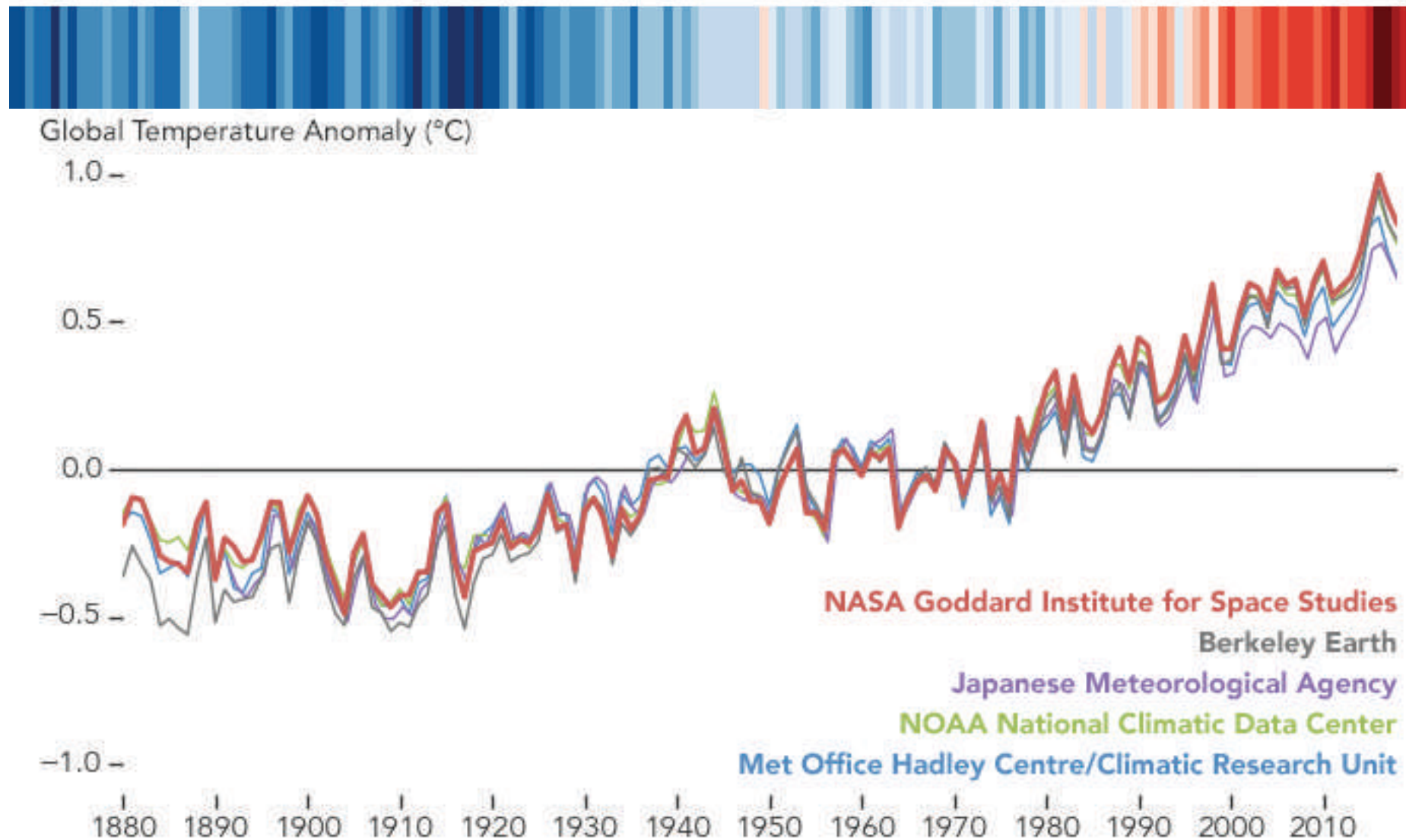


Ed. Hawkins, *Temperatura media annuale a scala globale (1850-2017)*

Origine dati: Berkeley Earth, NOAA, UK Met Office, MeteoSwiss, DWD

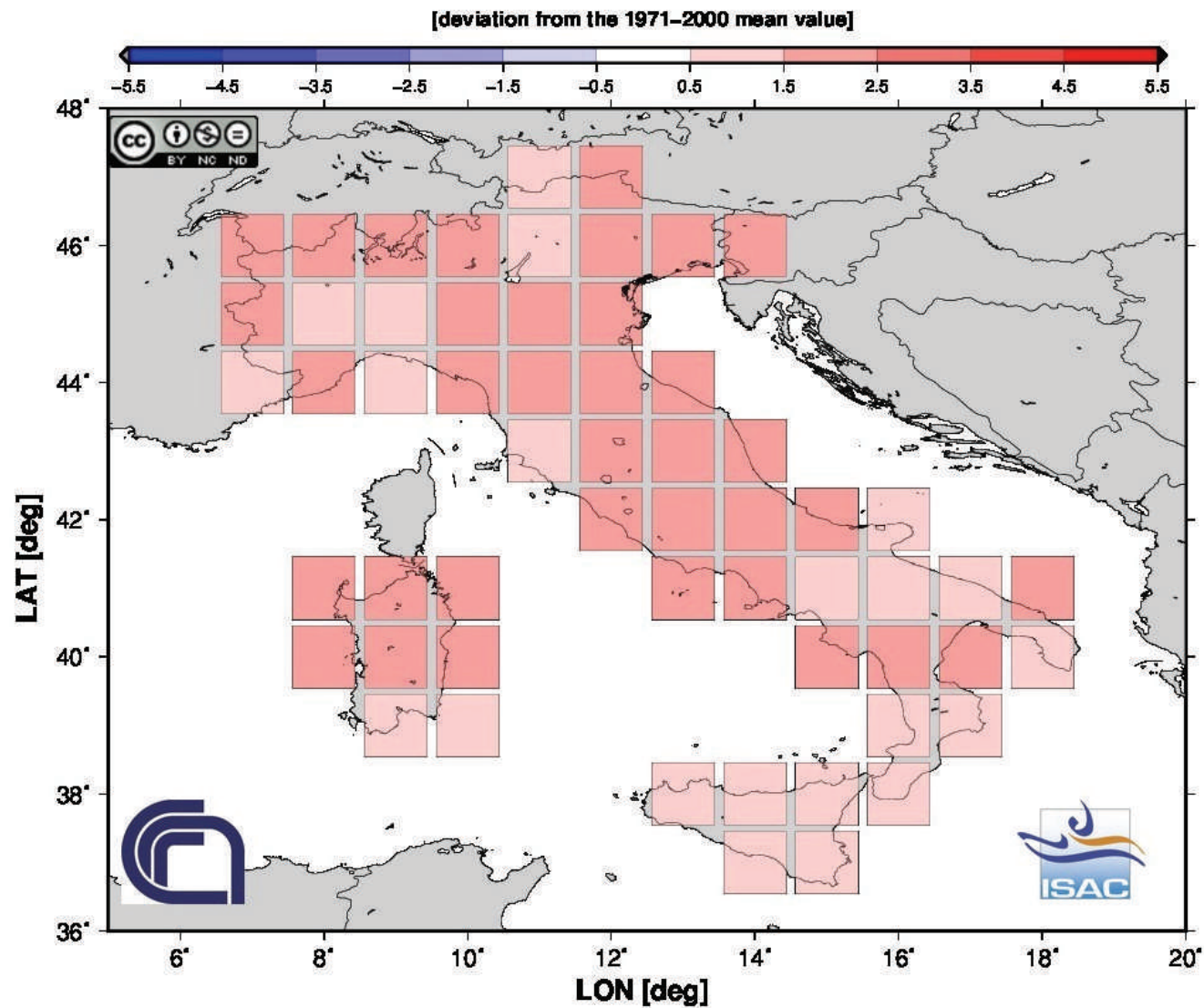
# Consenso scientifico sull'aumento della temperatura

1



# Anomalie 2018: temperatura fino a 2.5 °C piu' alta in Italia

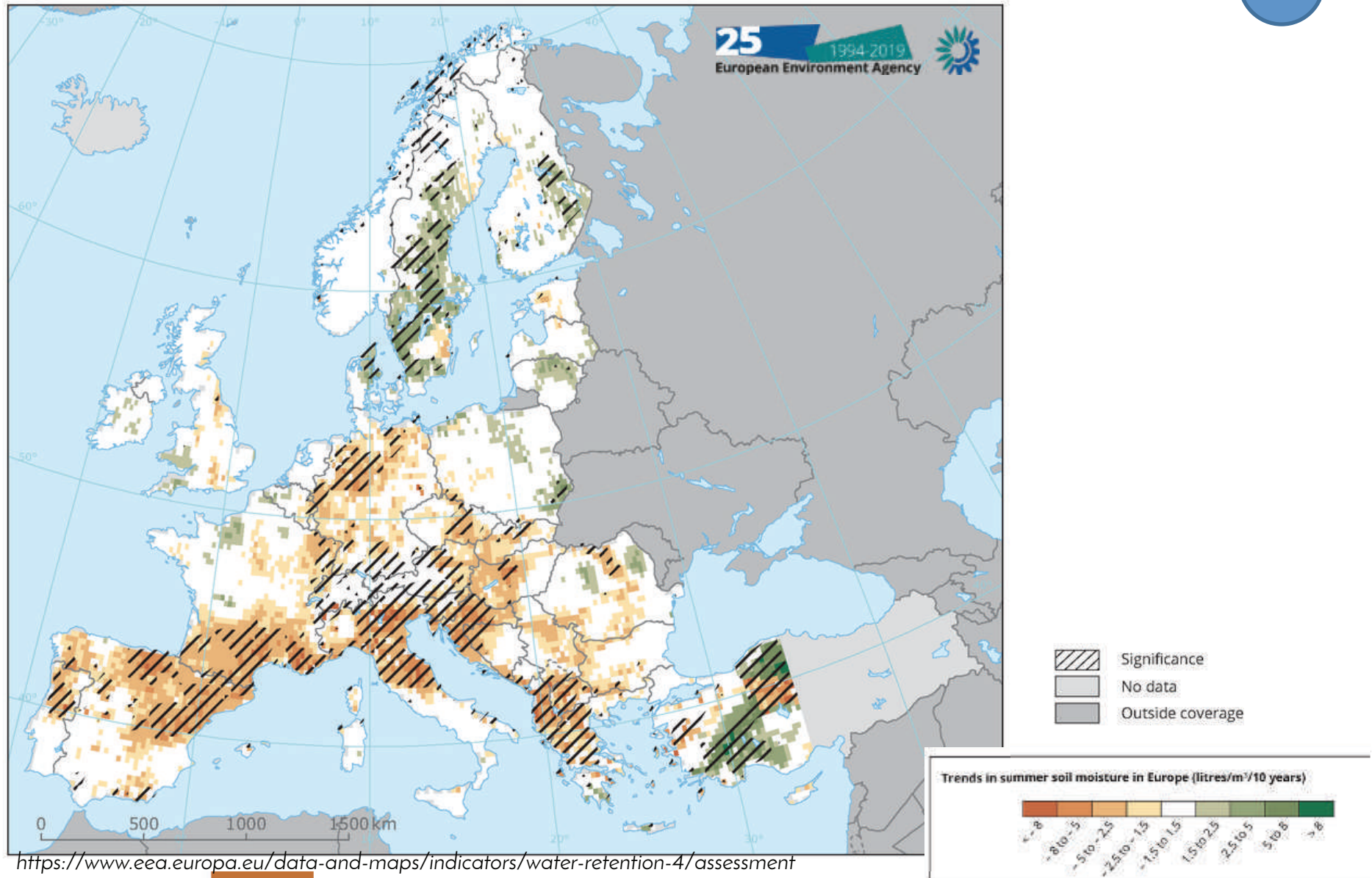
1



[http://www.isac.cnr.it/climstor/climate\\_news.html](http://www.isac.cnr.it/climstor/climate_news.html)

# Riduzione piogge => minore umidità' del suolo (1950-2012)

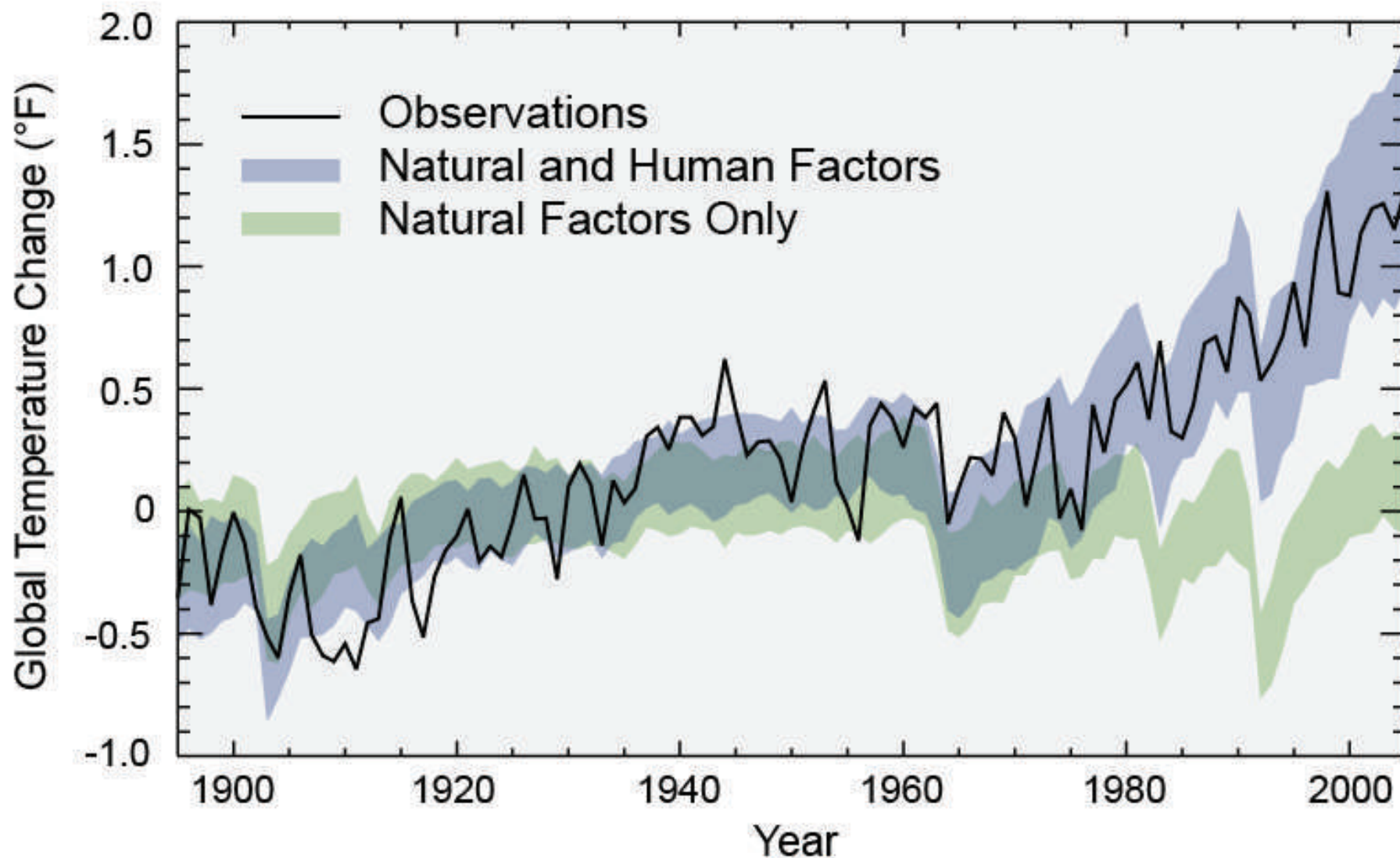
1





# Fattori antropogenici come principale causa del cc

1



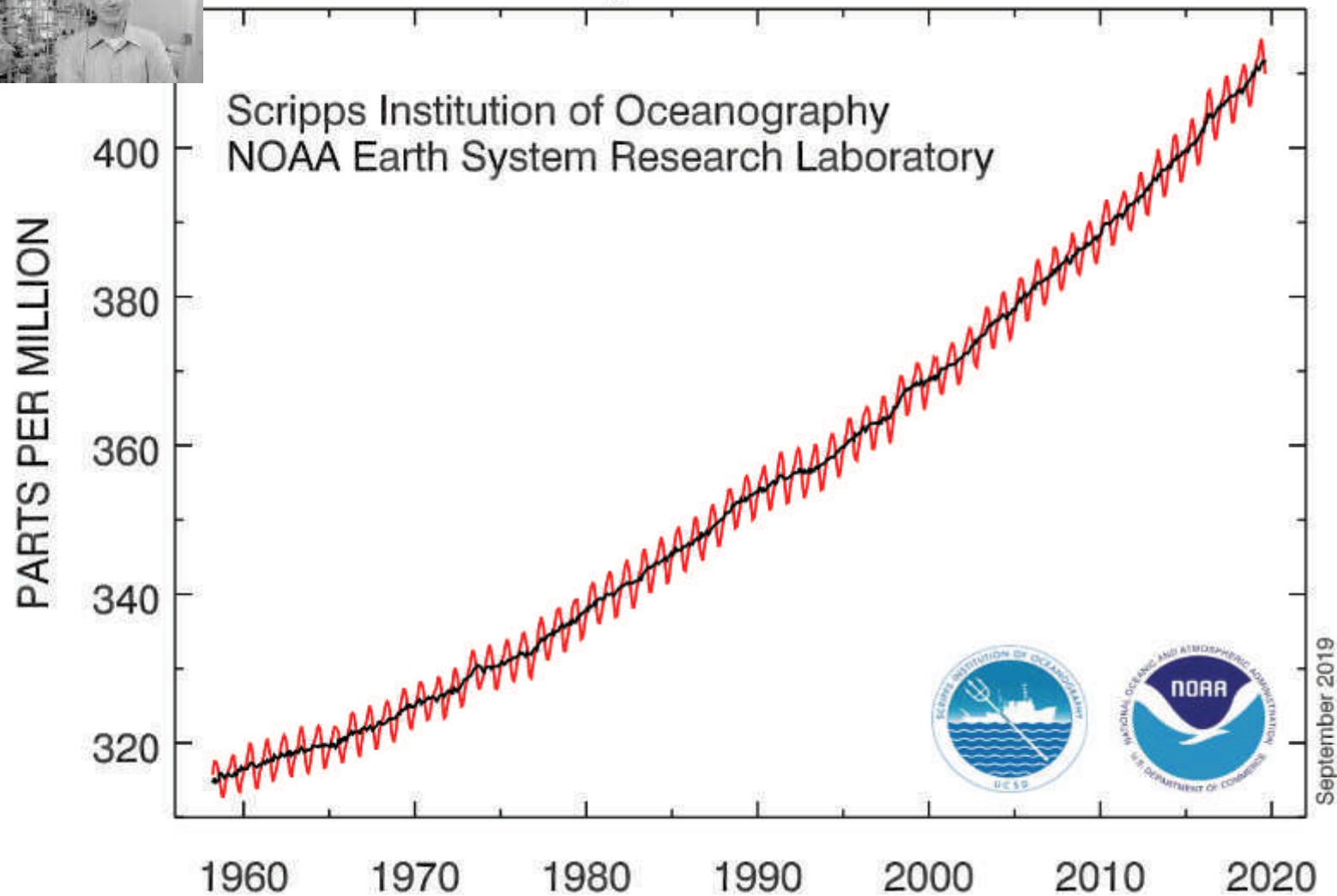
[https://19january2017snapshot.epa.gov/climate-change-science/causes-climate-change\\_.html](https://19january2017snapshot.epa.gov/climate-change-science/causes-climate-change_.html)

# Aumento di uno dei tre principali gas serra: CO<sub>2</sub>.....

1



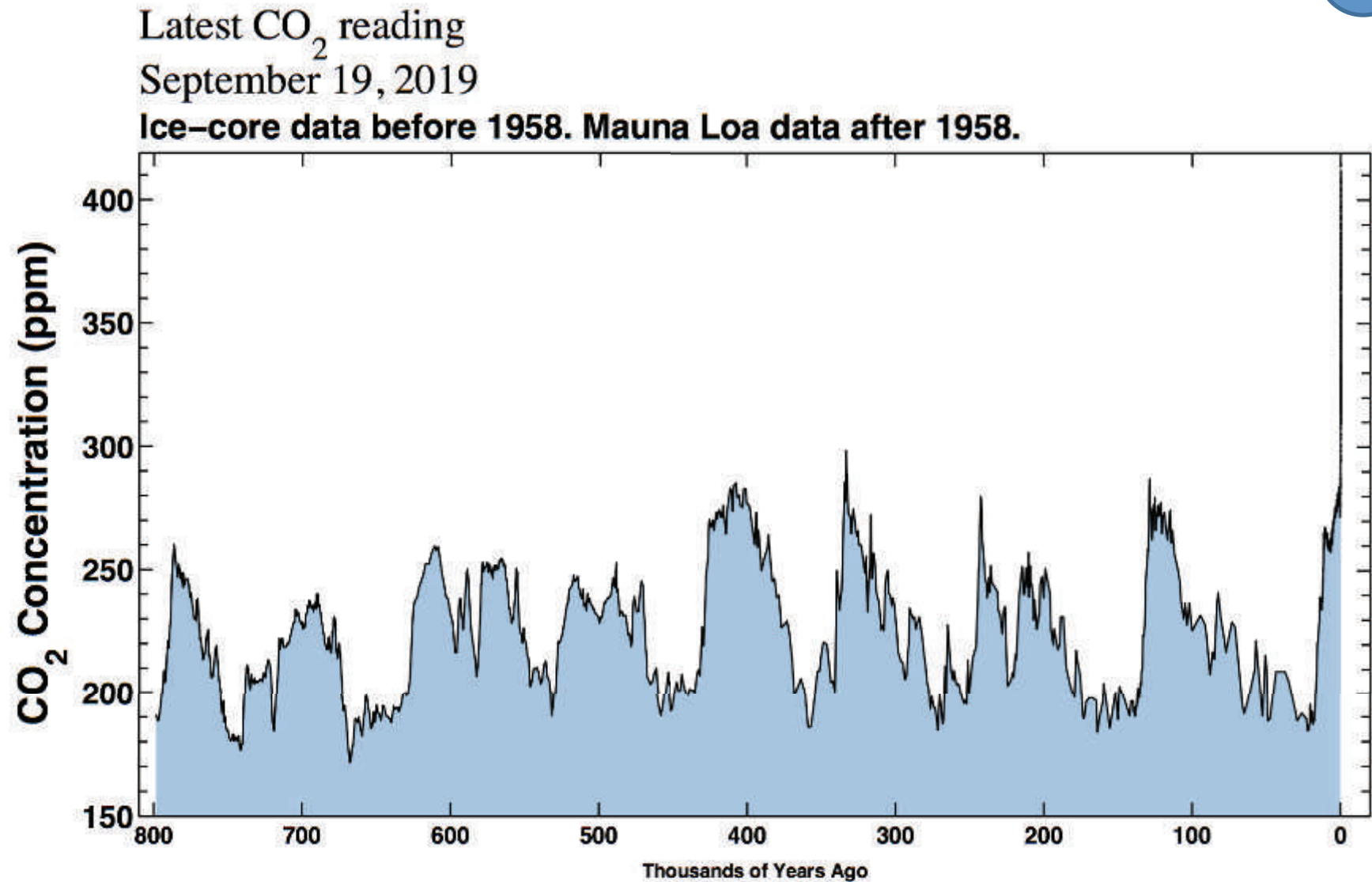
## Atmospheric CO<sub>2</sub> at Mauna Loa Observatory





..... senza precedenti nella storia dell'umanità'

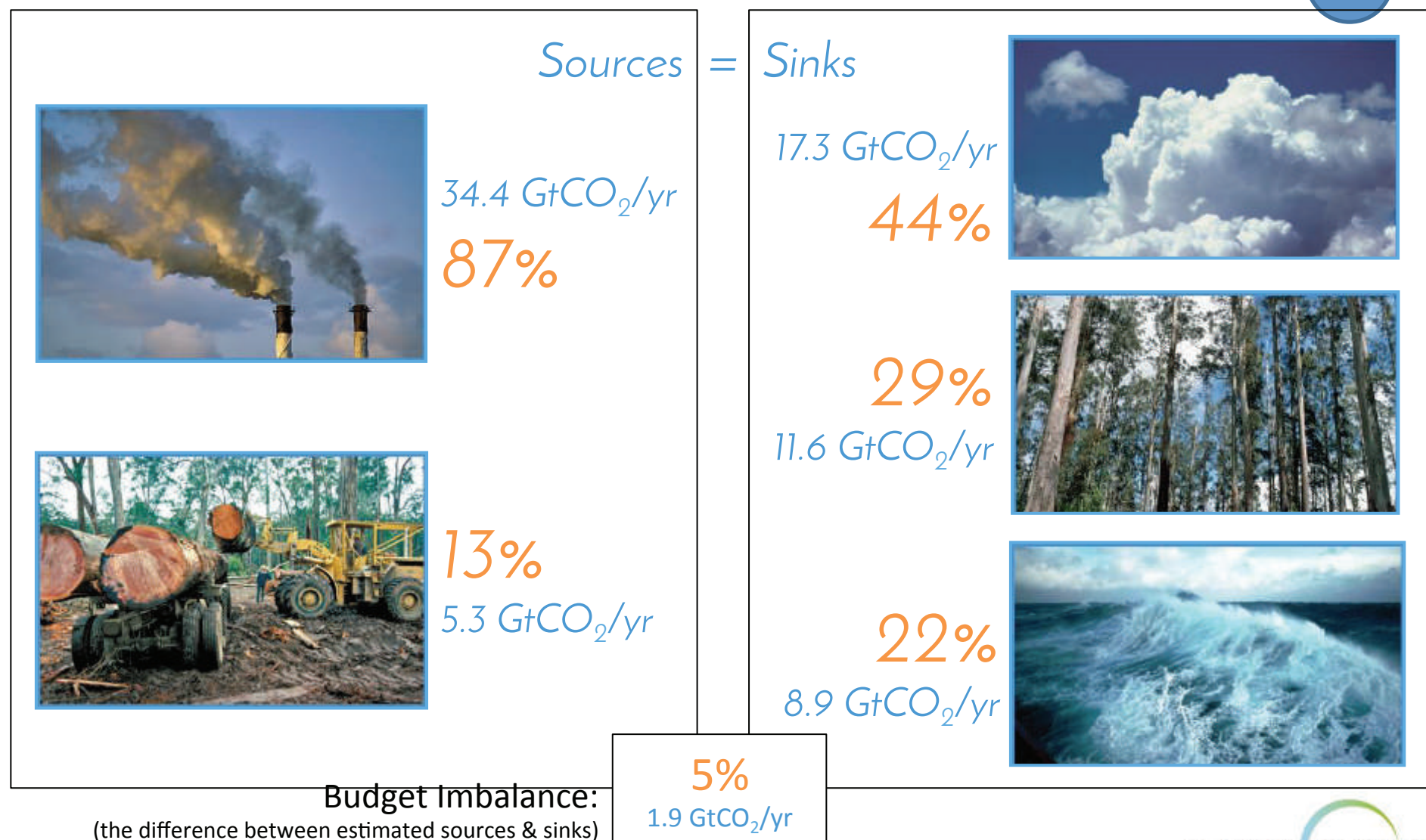
1



Scripps Institution of Oceanography

# I principali serbatoi della CO<sub>2</sub> antropogenica

1

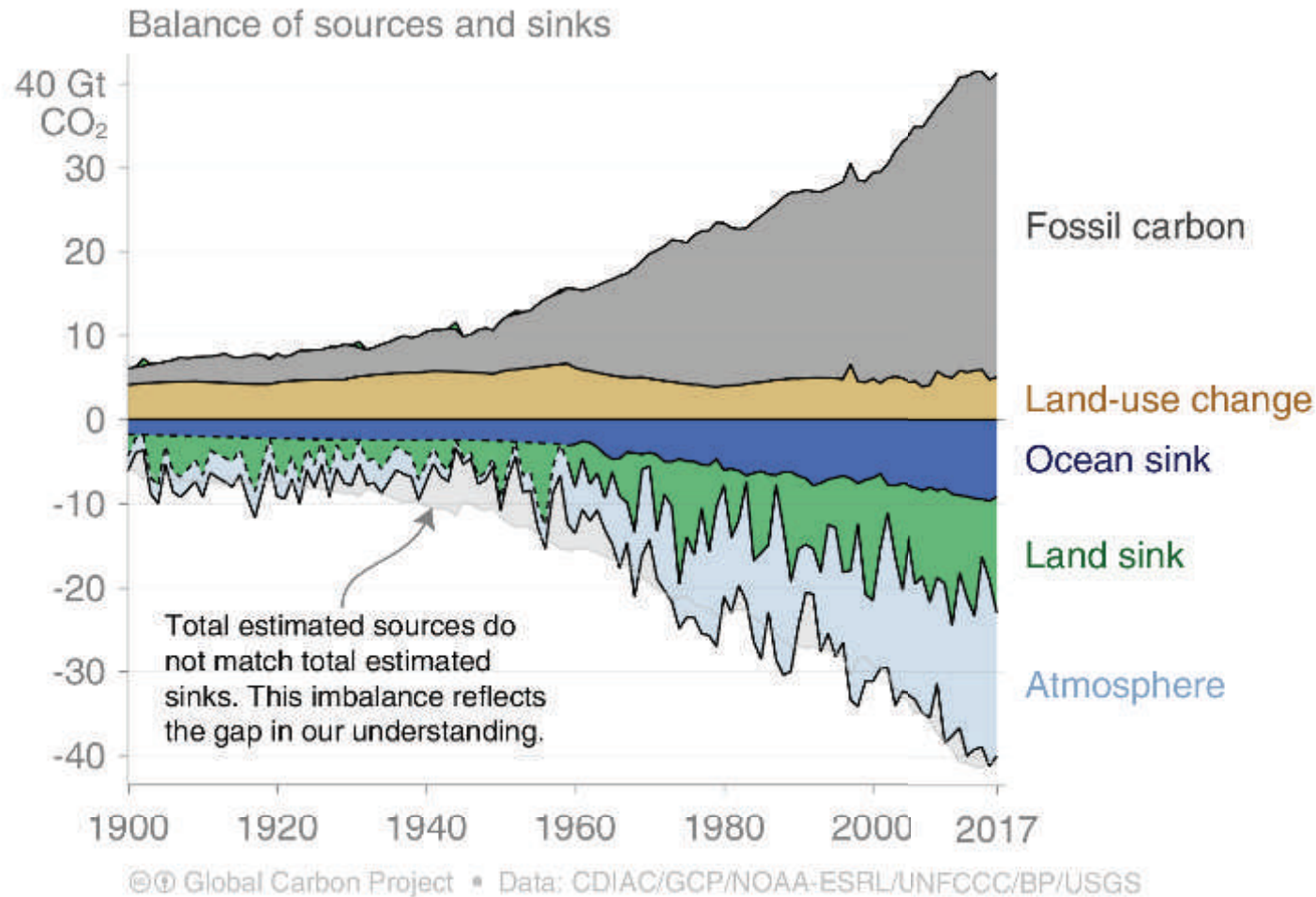


Fonte: [CDIAC](#); [NOAA-ESRL](#); [Houghton and Nassikas 2017](#); [Hansis et al 2015](#); [Le Quéré et al 2018](#); [Global Carbon Budget 2018](#)



# Variabilita' annual nella funzione sink delle foreste

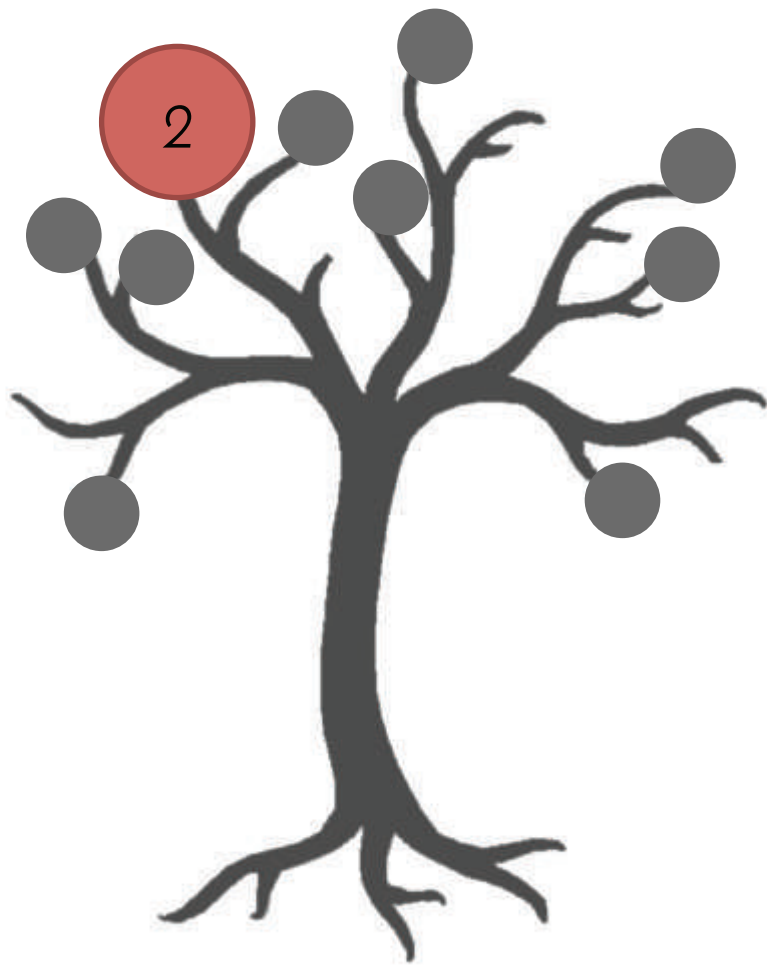
1



Fonte: [CDIAC](#); [NOAA-ESRL](#); [Houghton and Nassikas 2017](#); [Hansis et al 2015](#); [Le Quéré et al 2018](#); [Global Carbon Budget 2018](#)



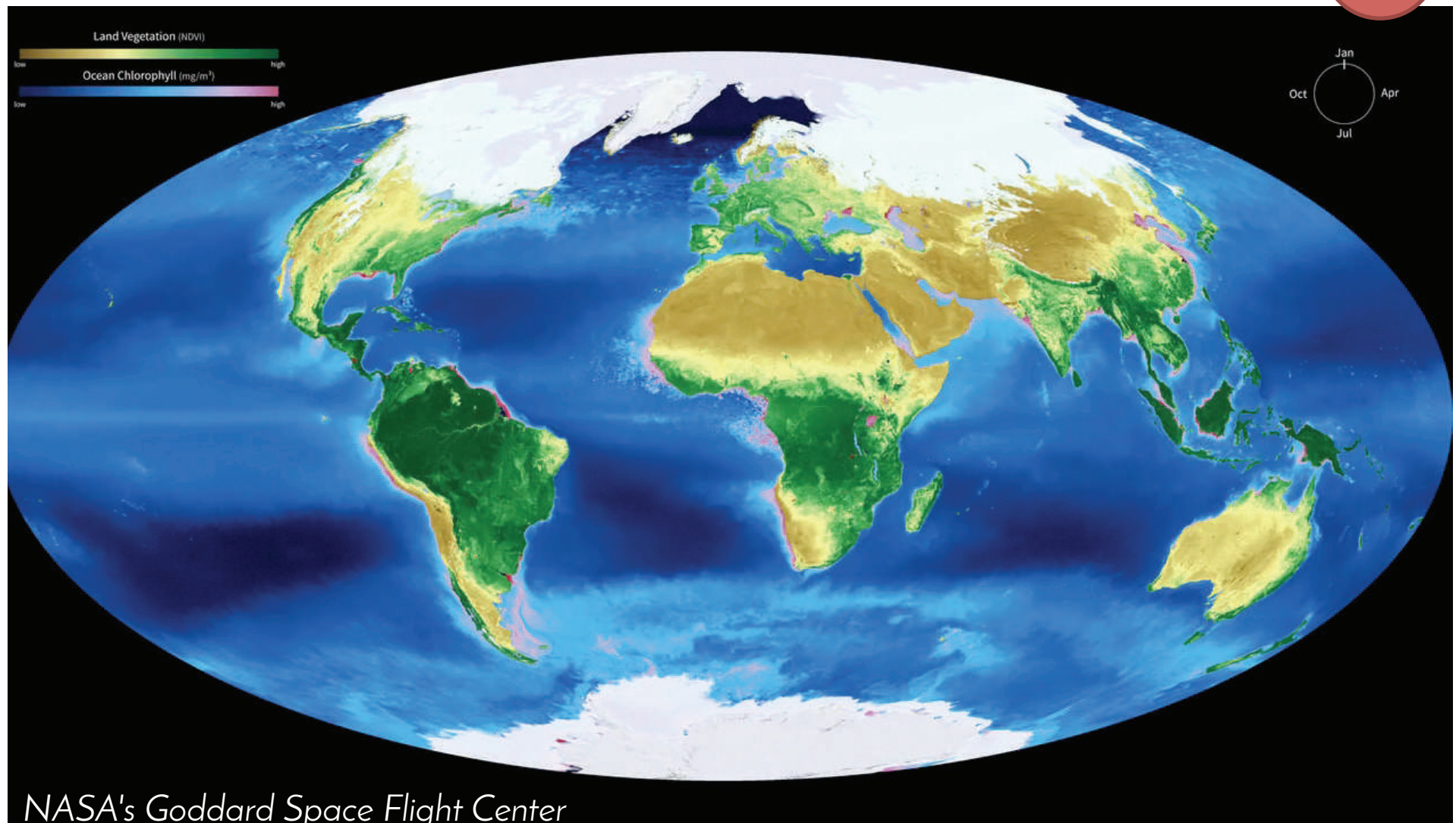
## Processi che regolano interazione foreste-clima



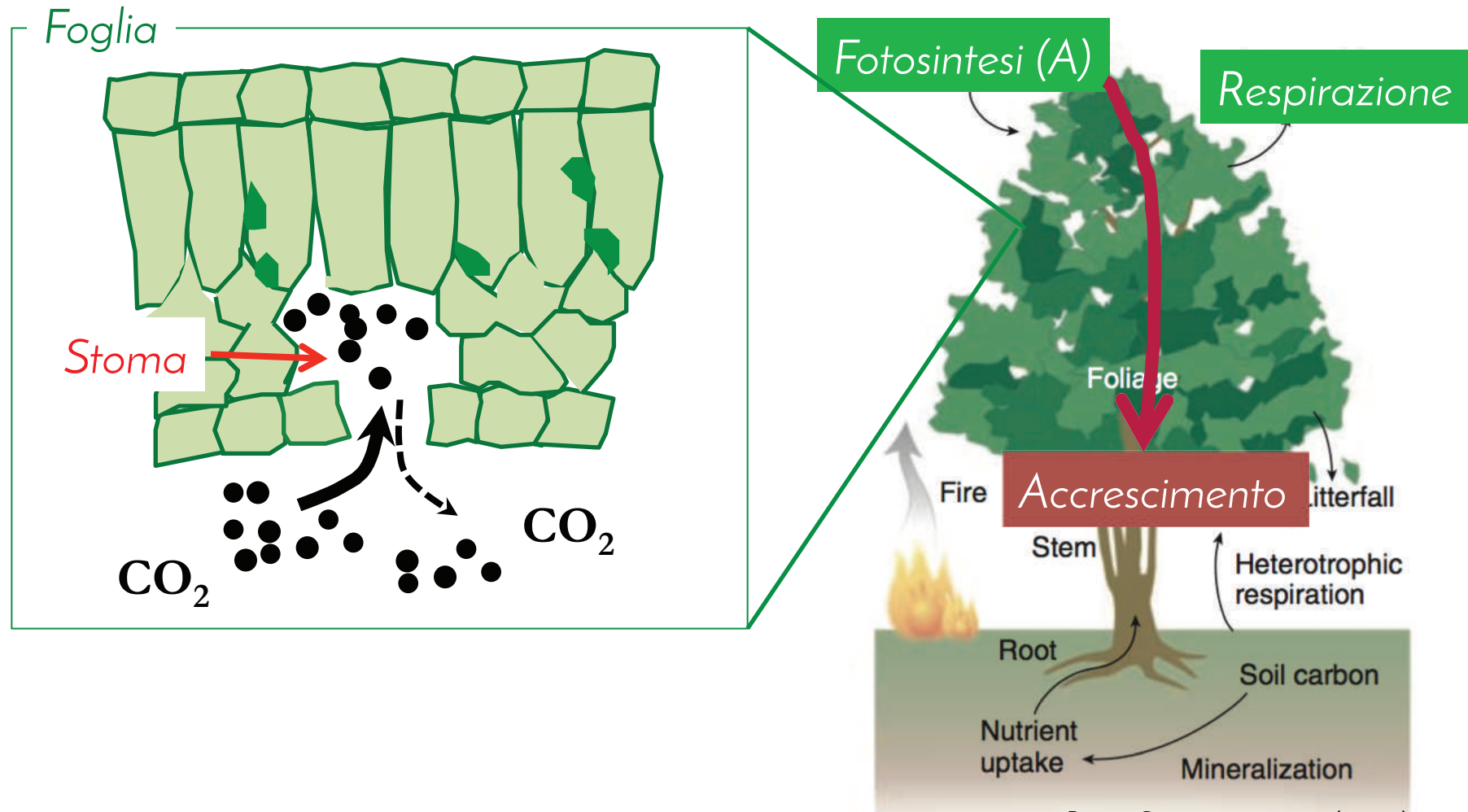


# Le foreste sono dinamiche!

2

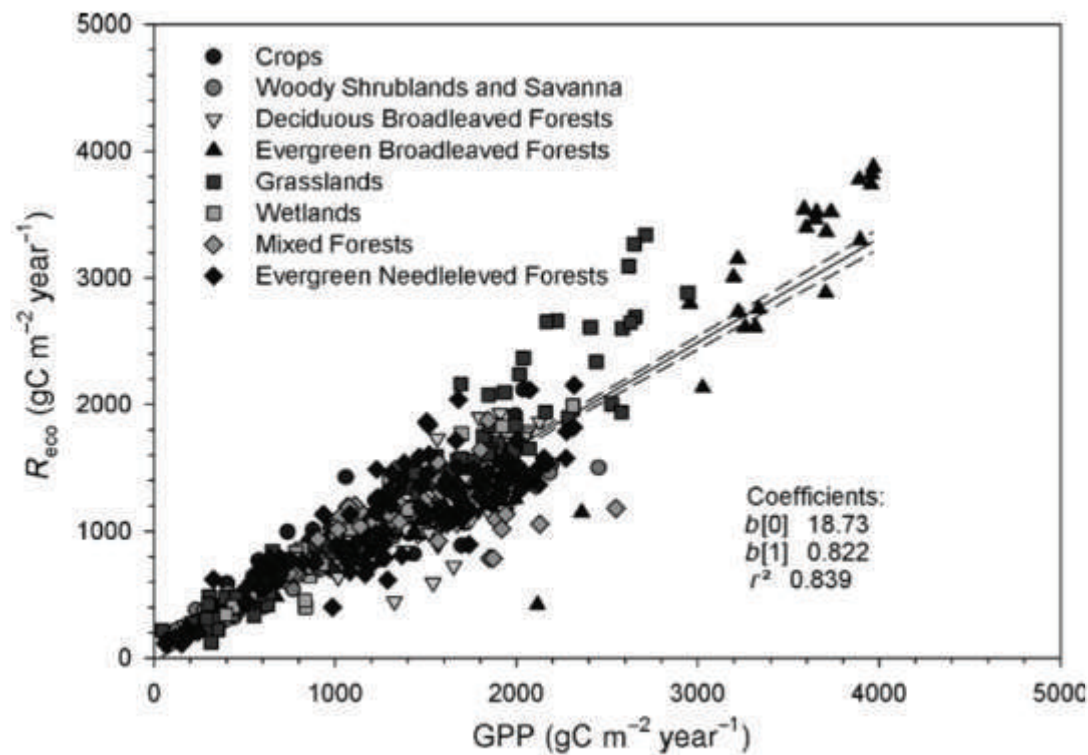


30.6 % del pianeta ricoperto da foreste - 23% in aree montuose (FAO)

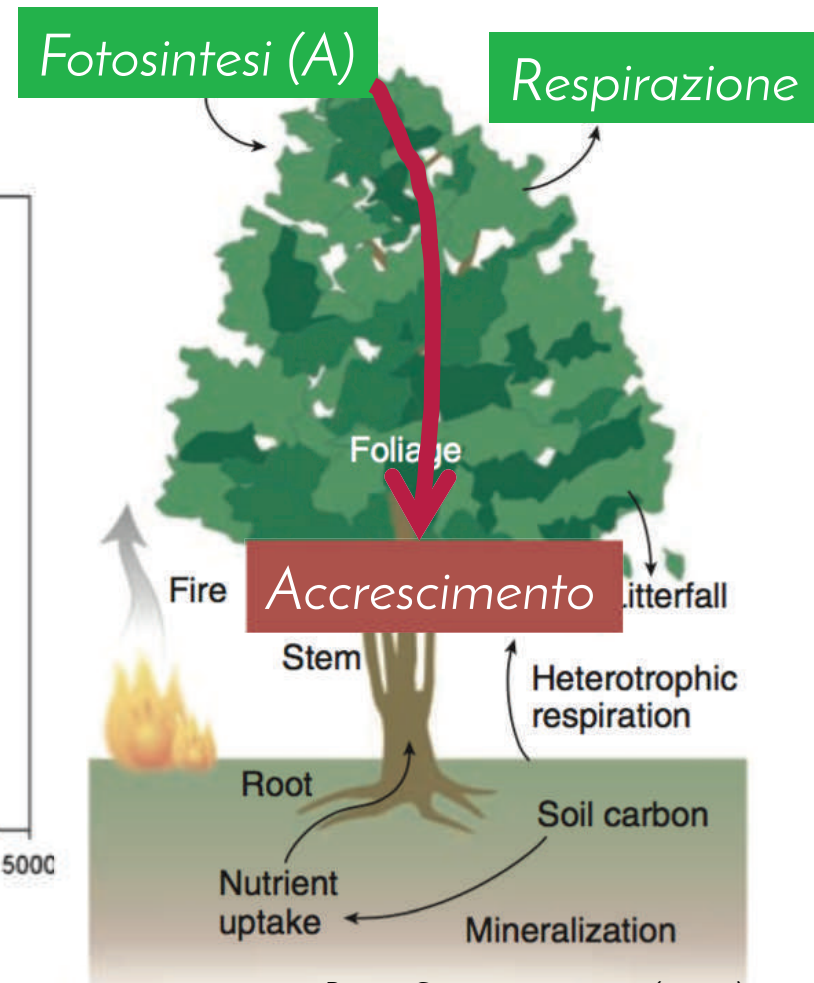


Bonan Science 320, 1444 (2008)

*Fotosintesi > Respirazione*



Baldocchi & Penuelas (2019) *Glob Change Biol.* 25:1191-1197



Bonan Science 320, 1444 (2008)



# Foreste tropicali come maggiore sink di carbonio

2



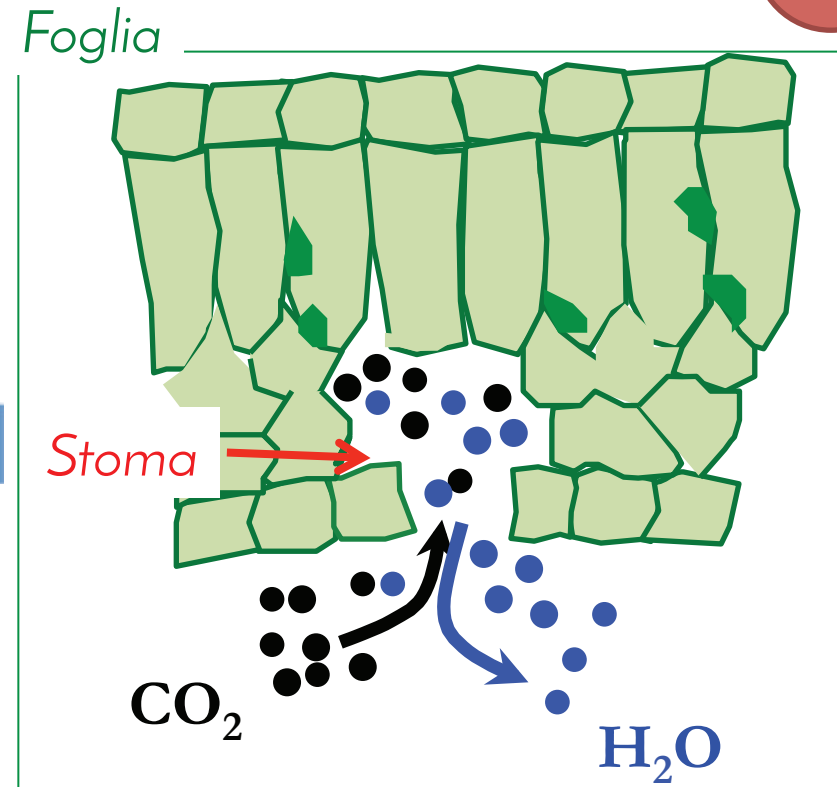
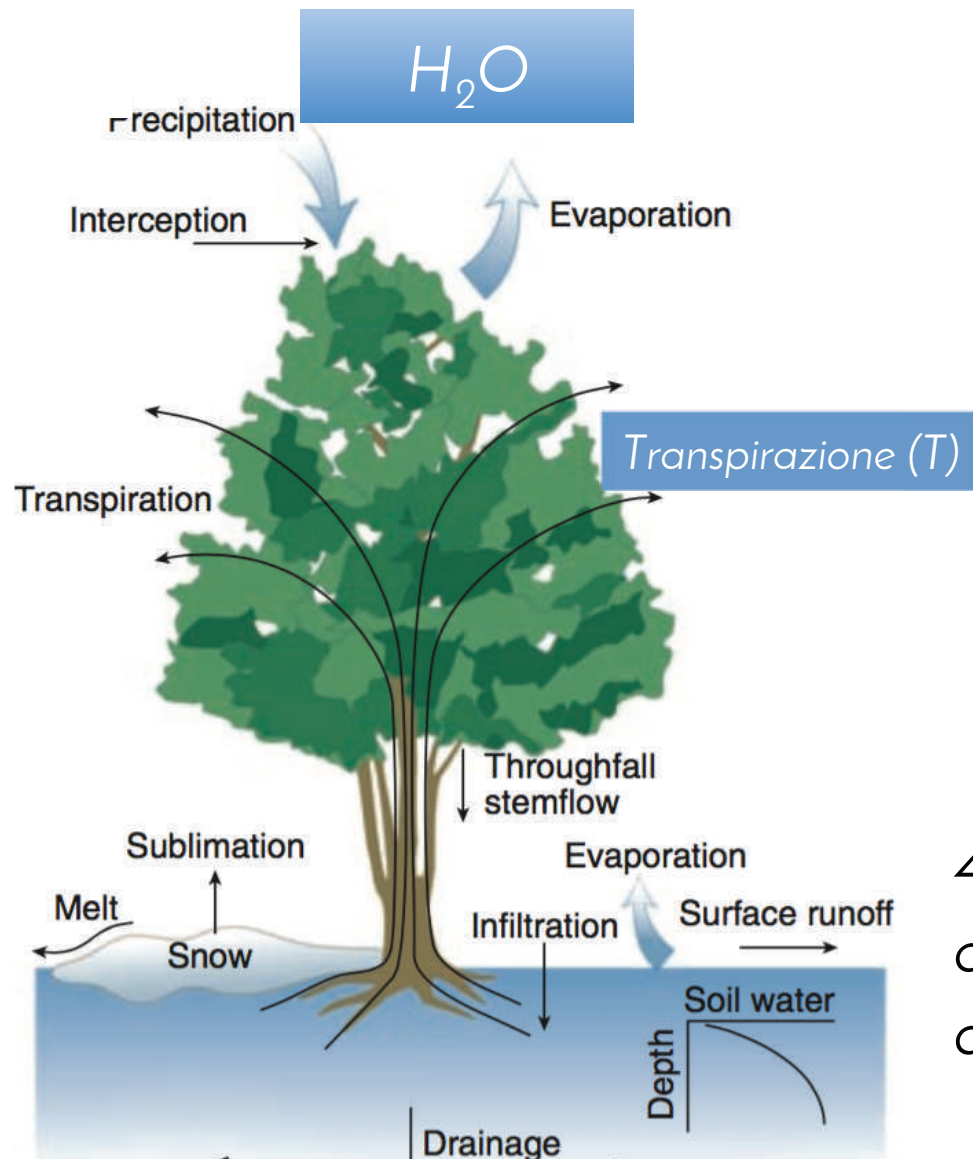
*Madre de Dios, Peru*

*Autore: Jakey Bryant*



# La traspirazione ha effetti sul clima

2



40% delle piogge ritorna in atmosfera mediante traspirazione delle foreste

Schlesinger, & Jasechko (2013) Agricultural and Forest Meteorology 189–190: 115–117

# Piogge generate dalla foresta pluviale Amazzonica

2



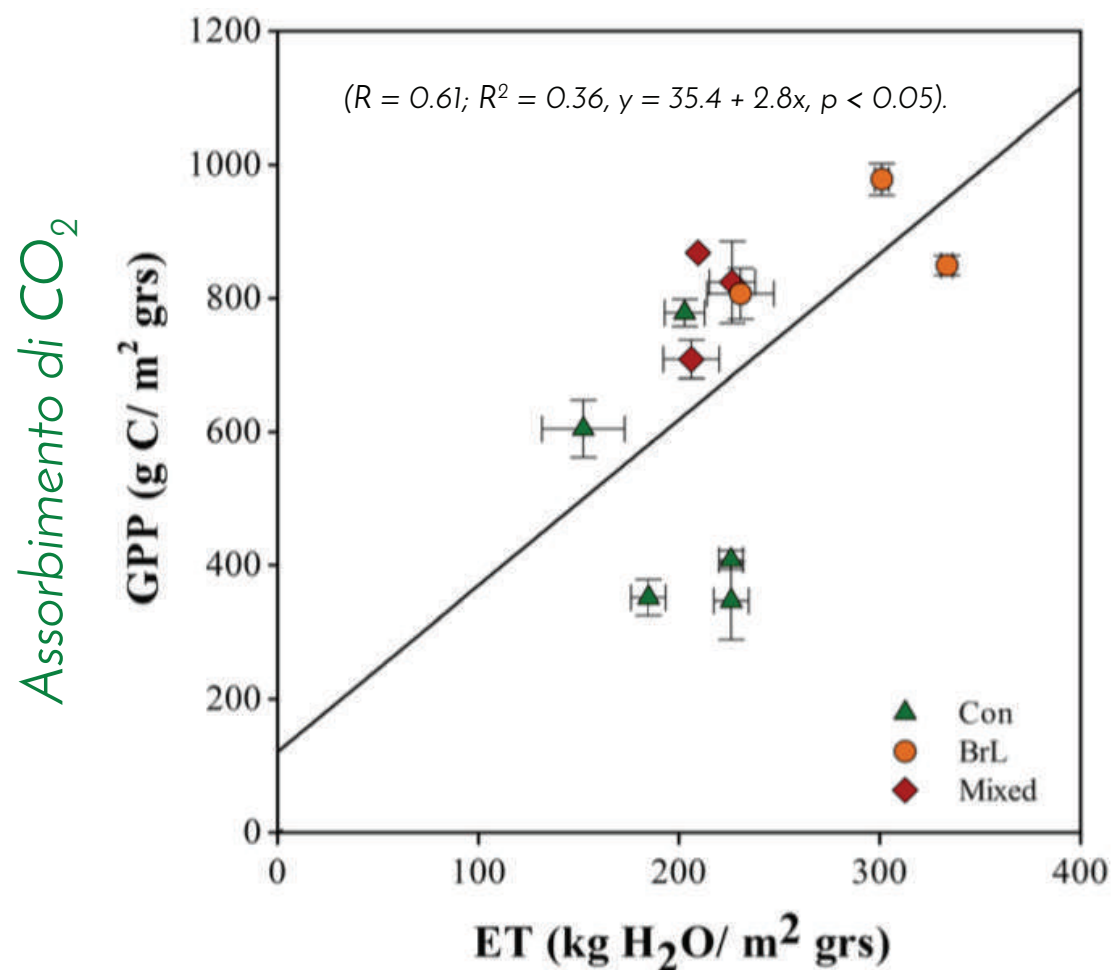
*The Amazon rainforest. Credit: Center for International Forestry Research*

*Wright et al PNAS August 8, 2017 114 (32) 8481-8486*





*Faggeta in Catalunya*



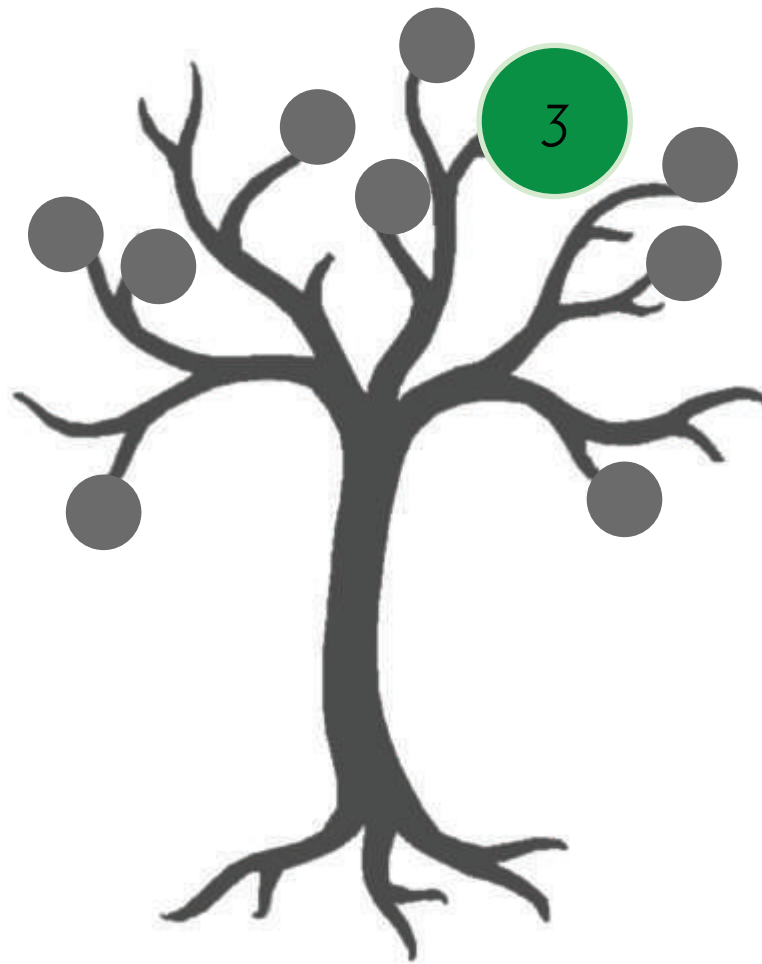
Efficienza d'uso dell'acqua  
come tratto funzionale chiave  
nella risposta al cc



Guerrieri et al. 2016 JGR Biogeosciences 121, 2610–2629

# Le sfide per le *nostre* foreste

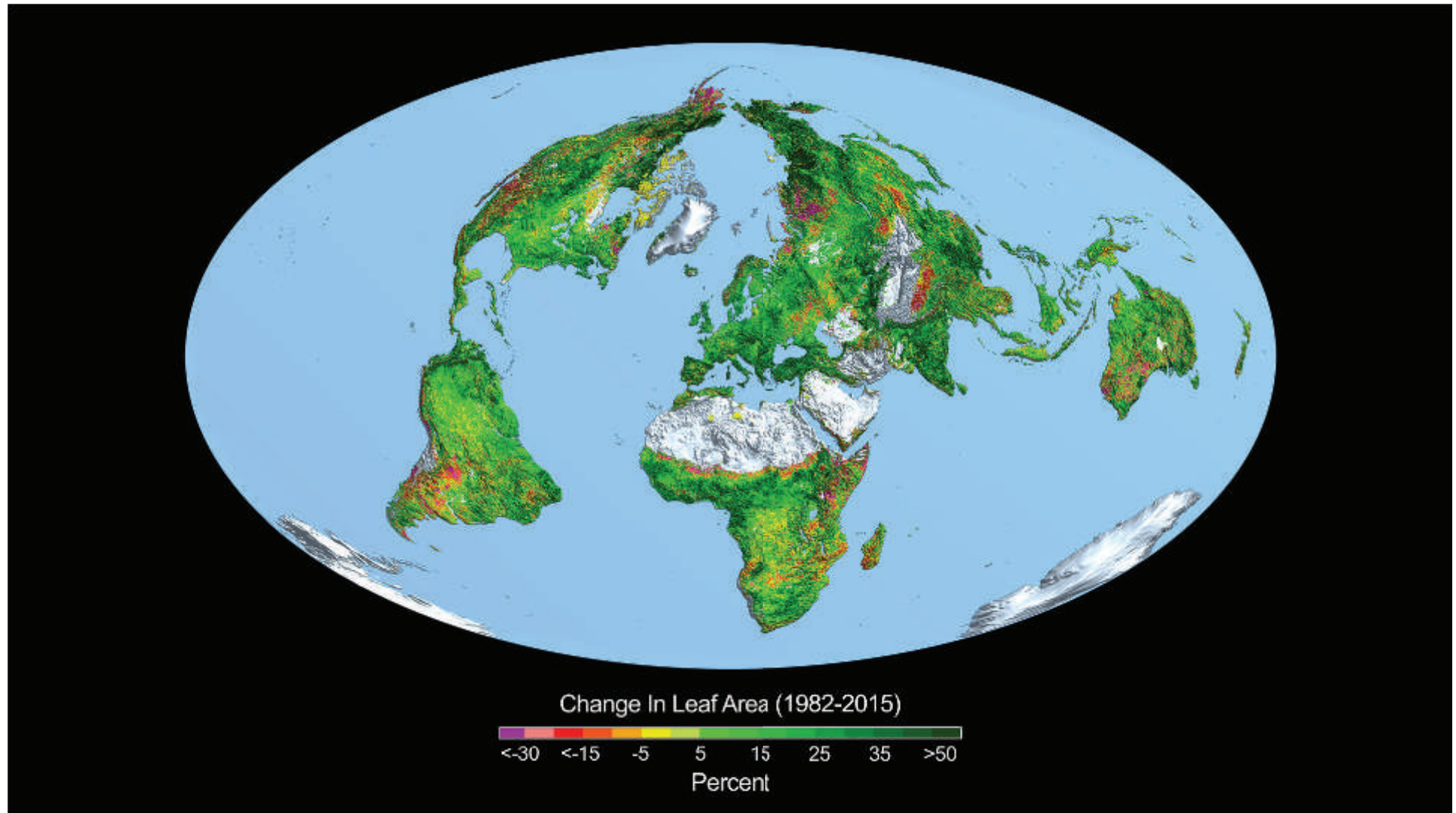
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## + CO<sub>2</sub> e temperatura: aumento della copertura vegetale (+7% relativo al 1982)

3



Zhu et al. (2016) Nature Climate Change

Credits: Boston University/R. Myneni



# LETTER

doi:10.1038/nature12291

## Increase in forest water-use efficiency as atmospheric carbon dioxide concentrations rise

Trevor F. Keenan<sup>1</sup>, David Y. Hollinger<sup>2</sup>, Gil Bohrer<sup>3</sup>, Danilo Dragoni<sup>4</sup>, J. William Munger<sup>5</sup>, Hans Peter Schmid<sup>6</sup> & Andrew D. Richardson<sup>1</sup>



## Disentangling the role of photosynthesis and stomatal conductance on rising forest water-use efficiency

Rossella Guerrieri<sup>a,b,1</sup>, Soumaya Belmecheri<sup>c</sup>, Scott V. Ollinger<sup>a</sup>, Heidi Asbjornsen<sup>a</sup>, Katie Jennings<sup>a</sup>, Jingfeng Xiao<sup>a</sup>, Benjamin D. Stocker<sup>b</sup>, Mary Martin<sup>a</sup>, David Y. Hollinger<sup>d</sup>, Rosvel Bracho-Garrillo<sup>e</sup>, Kenneth Clark<sup>f</sup>, Sabina Dore<sup>g</sup>, Thomas Kolb<sup>g</sup>, J. William Munger<sup>h</sup>, Kimberly Novick<sup>i</sup>, and Andrew D. Richardson<sup>j,k</sup>

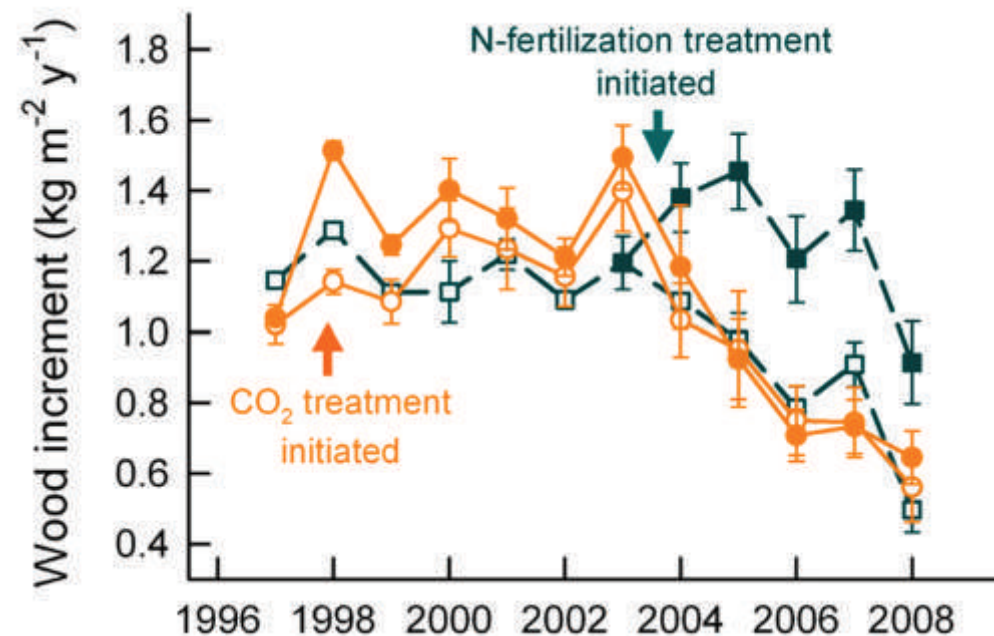
<sup>a</sup>Earth Systems Research Center, University of New Hampshire, Durham, NH 03824; <sup>b</sup>Centre for Ecological Research and Forestry Applications, c/o Universidad Autonoma de Barcelona, 08290 Cerdanyola, Barcelona, Spain; <sup>c</sup>Laboratory of Tree-Ring Research, University of Arizona, Tucson, AZ 85721; <sup>d</sup>Northern Research Station, US Department of Agriculture Forest Service, Durham, NH 03824; <sup>e</sup>School of Forest Resources and Conservation, University of Florida, Gainesville, FL 32611; <sup>f</sup>Silas Little Experimental Forest, Northern Research Station, US Department of Agriculture Forest Service, New Lisbon, NJ 08064; <sup>g</sup>School of Forestry, Northern Arizona University, Flagstaff, AZ 86011; <sup>h</sup>School of Engineering and Applied Sciences, Harvard University, Cambridge, MA 02138; <sup>i</sup>School of Public and Environmental Affairs, Indiana University, Bloomington, IN 47405; <sup>j</sup>Center for Ecosystem Science and Society, Northern Arizona University, Flagstaff, AZ 86011; and <sup>k</sup>School of Informatics, Computing and Cyber Systems, Northern Arizona University, Flagstaff, AZ 86011





Esperimento FACE – Duke, USA  
(Free-air CO<sub>2</sub> enrichment)

*Aumento della crescita con  
+ CO<sub>2</sub> se azoto disponibile  
(Foreste temperate e boreali)*



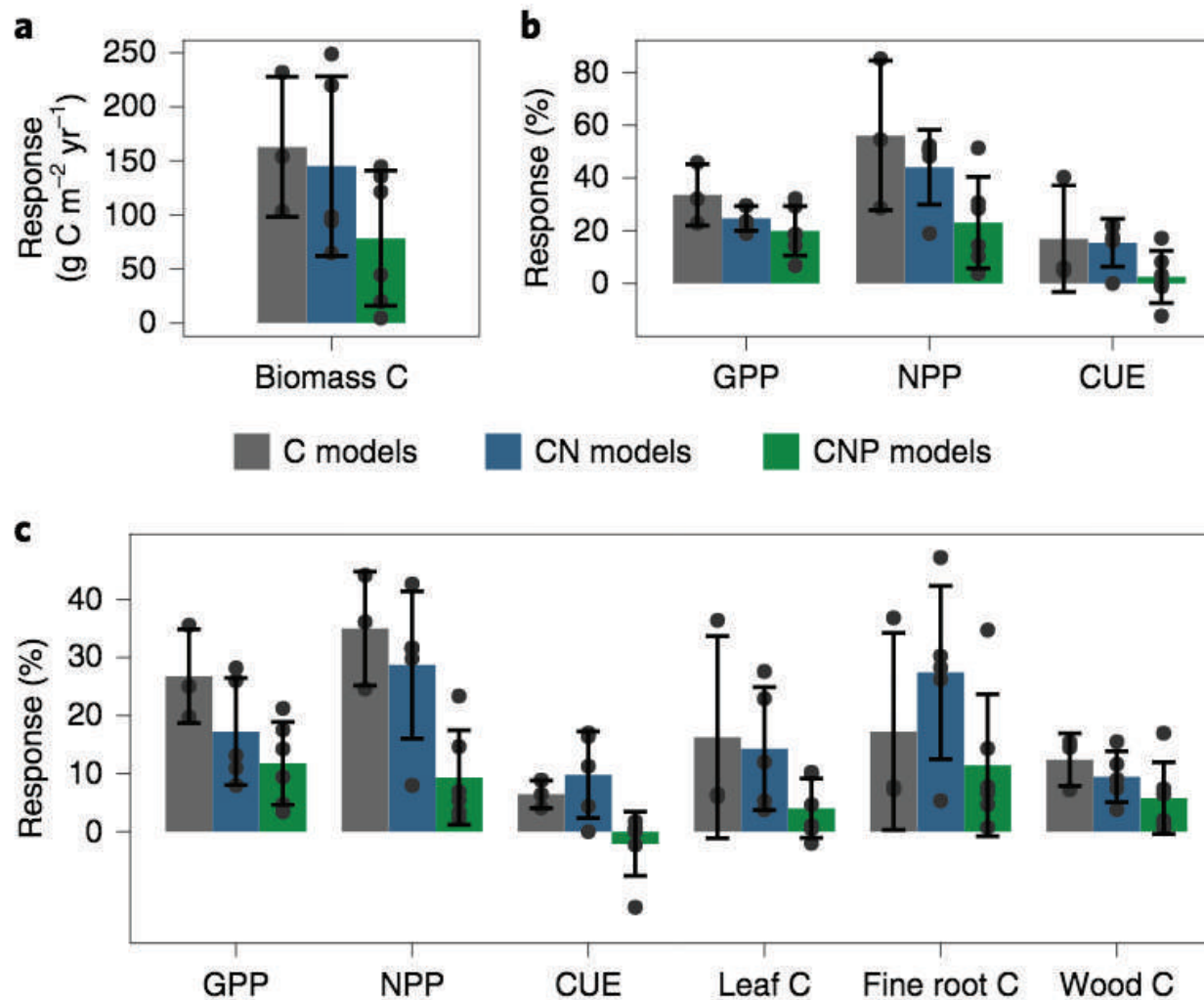
Norby et al. 2010 (PNAS), vol. 107 (45): 19368-19373



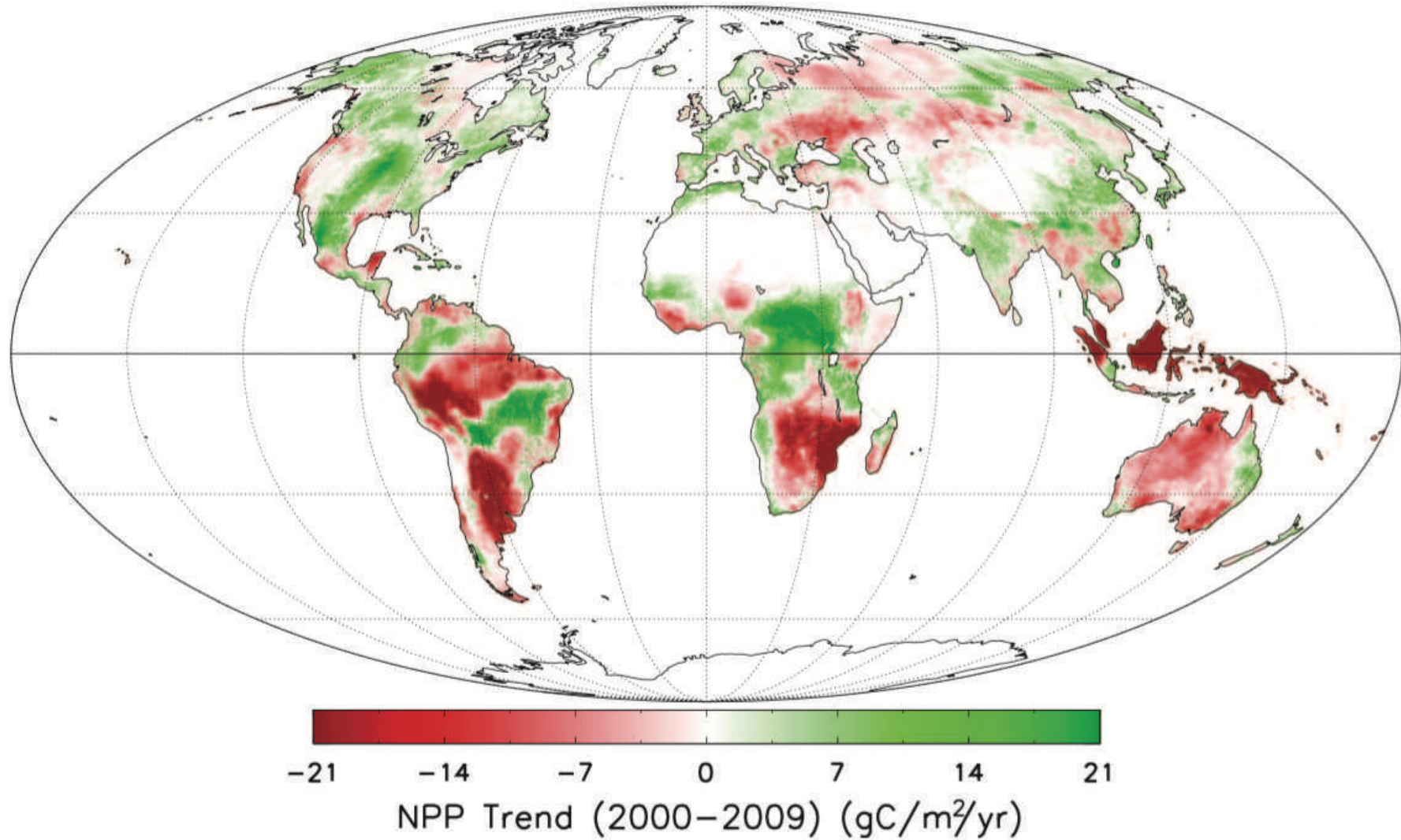
# Effetto + della CO<sub>2</sub> contrastata dalla limitazione di nutrienti

3

*Il fosforo limita la capacita' sink delle foreste tropicali*



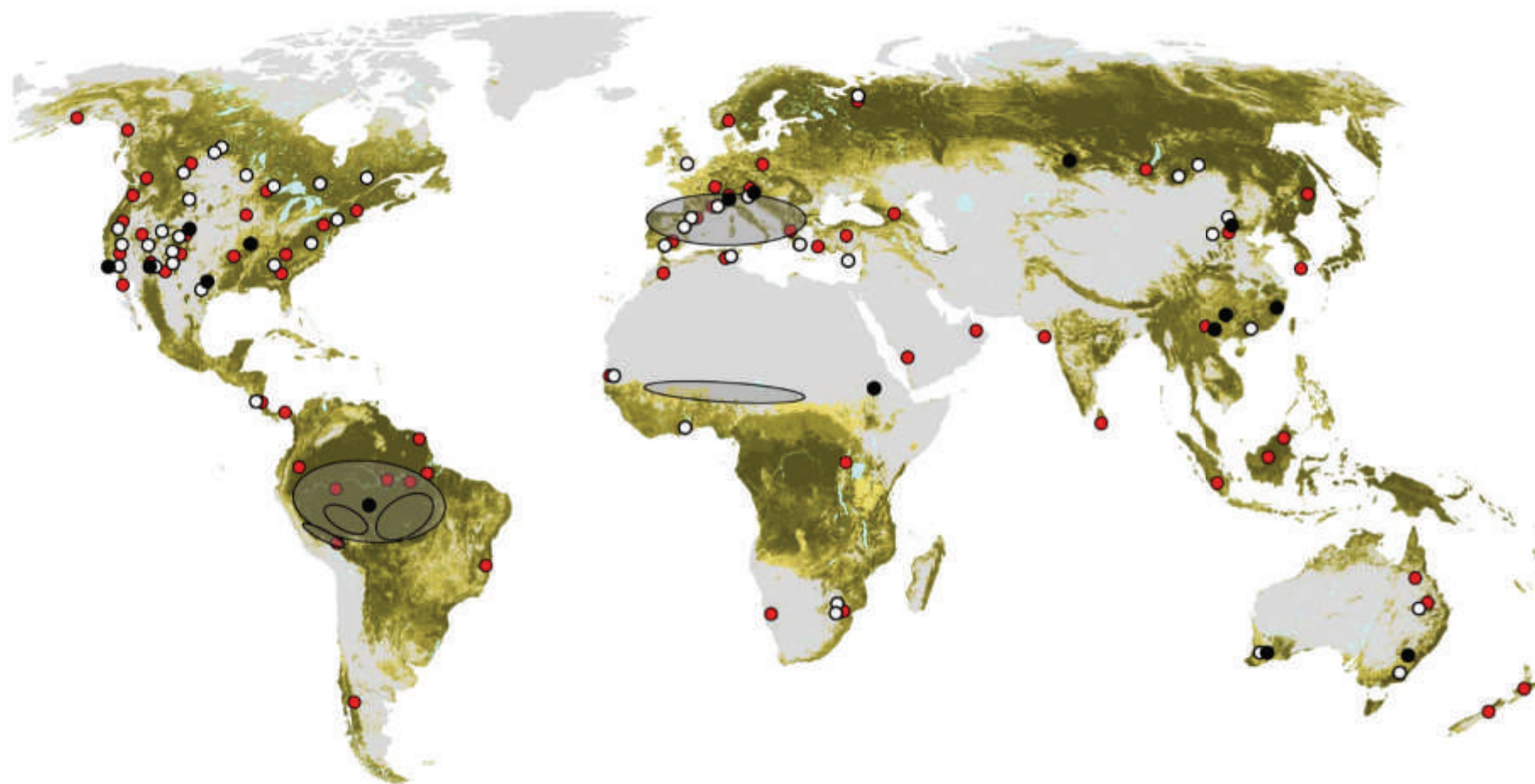
Fleischer et al. (2019) Nature Geoscience 12:736-741



Zhao & Running (2010) Science 329

# Mortalita' diffusa a causa di siccita' e elevate temperature

3

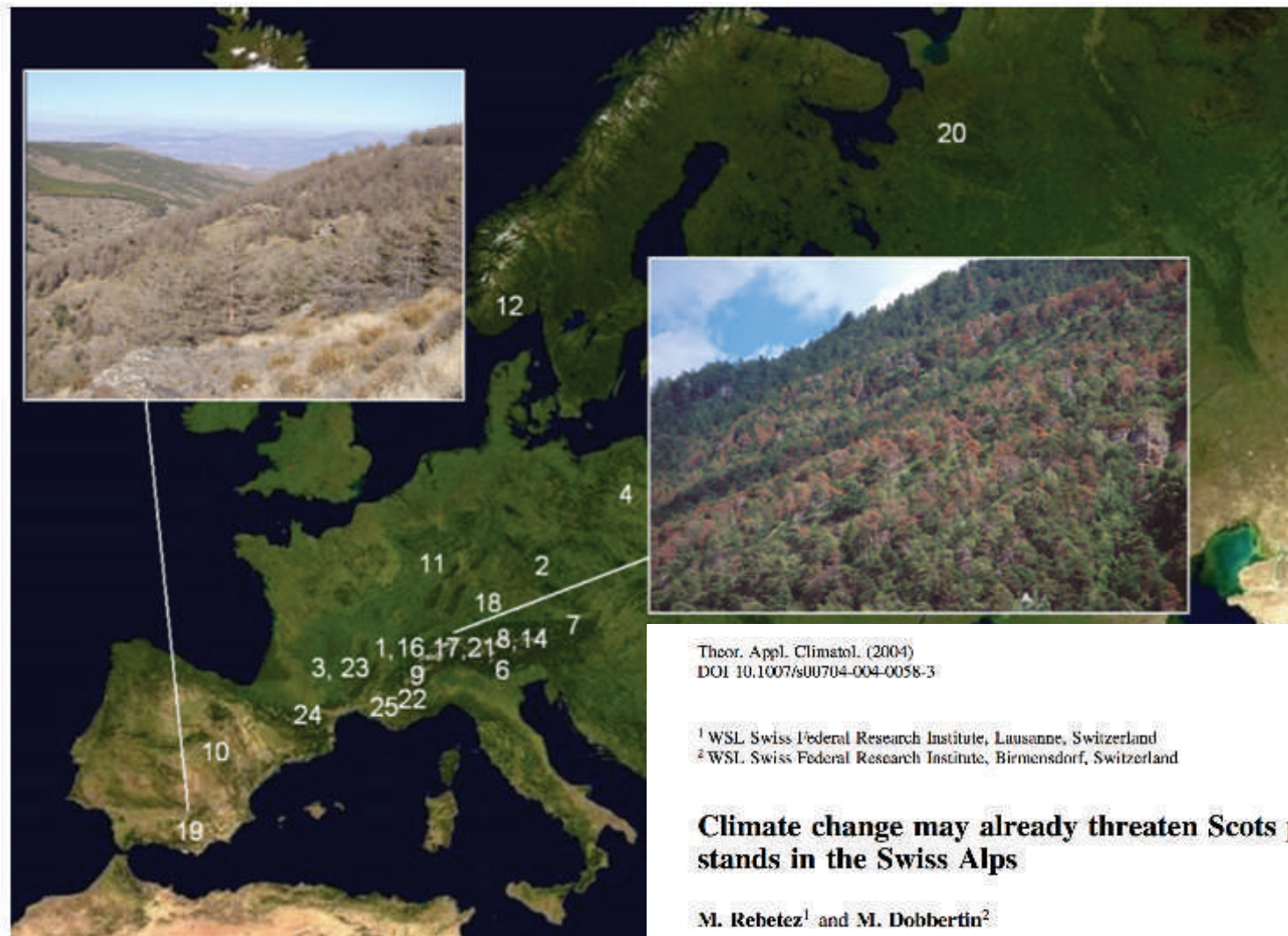


Allen et al. 2015. *Ecosphere* Volume 6(8) Article 129



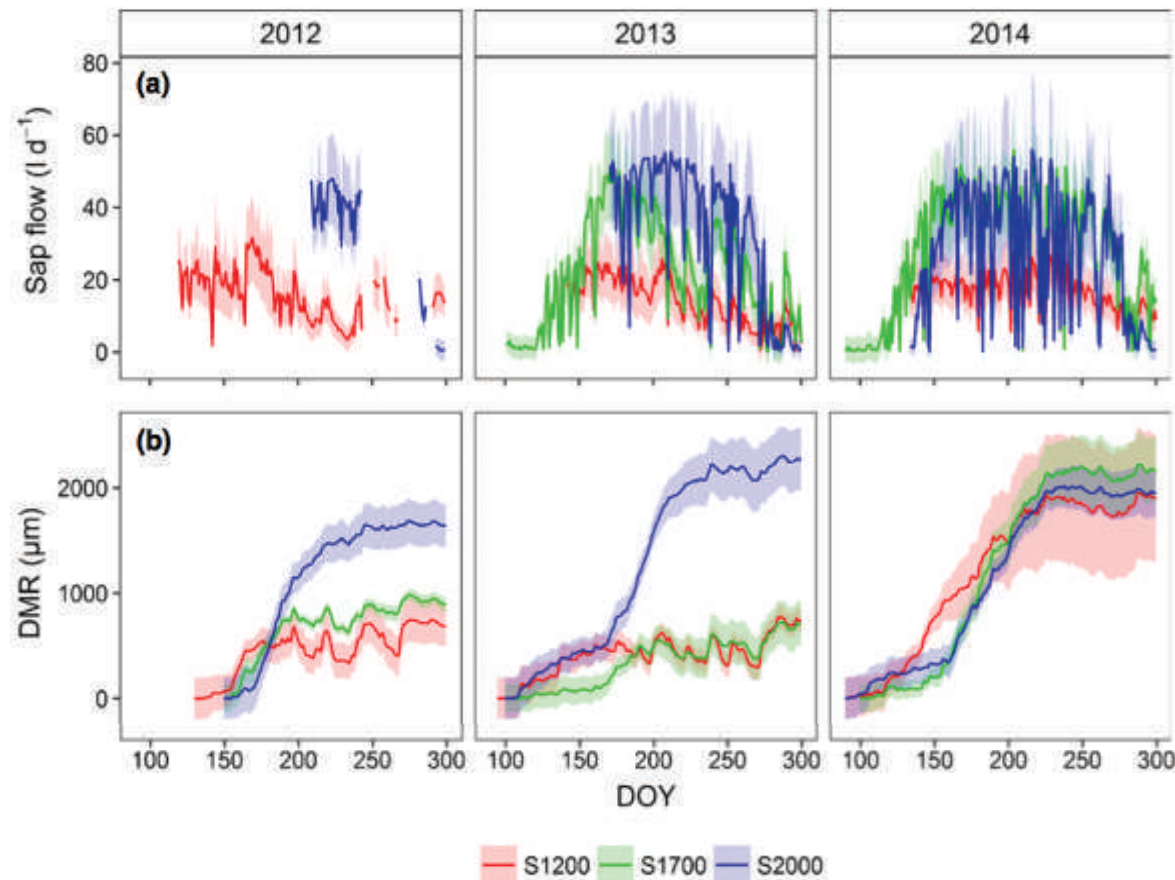
# Mortalita' diffusa a causa di siccita' e elevate temperature

3





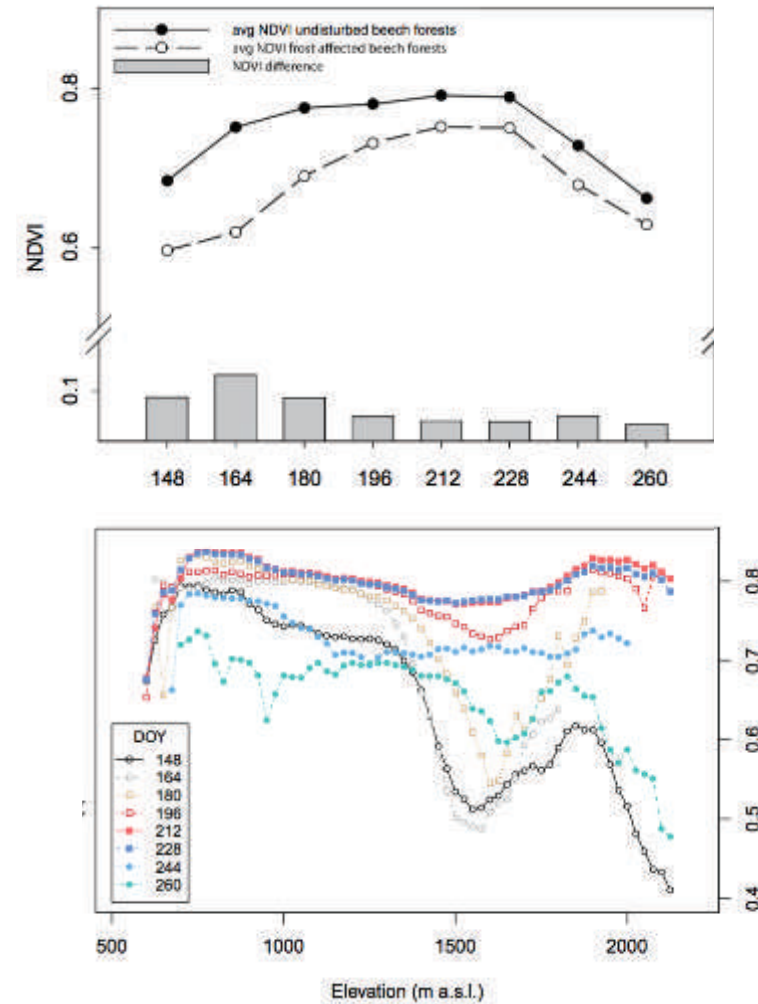
*Alberi di Larix decidua in Val Venosta lungo un gradiente altitudinale*



Obojes et al. (2018) *New Phytologist* doi: 10.1111/nph.15348

# Gelate tardive - riduzione della copertura fogliare

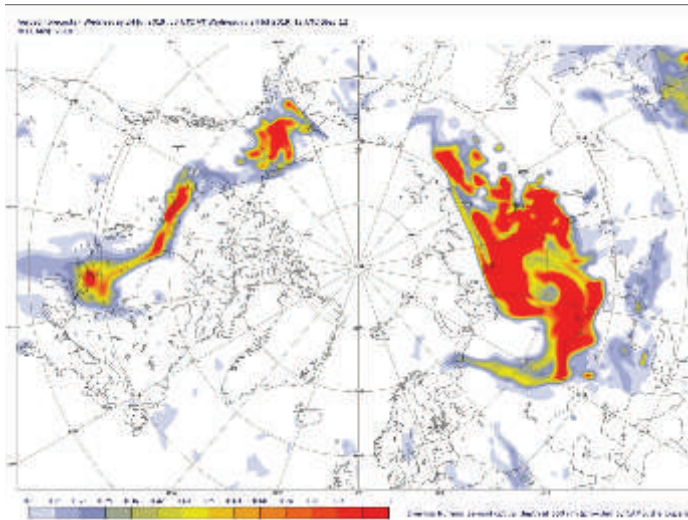
3



Nolé et al. *Annals of Forest Science* (2018) 75: 83

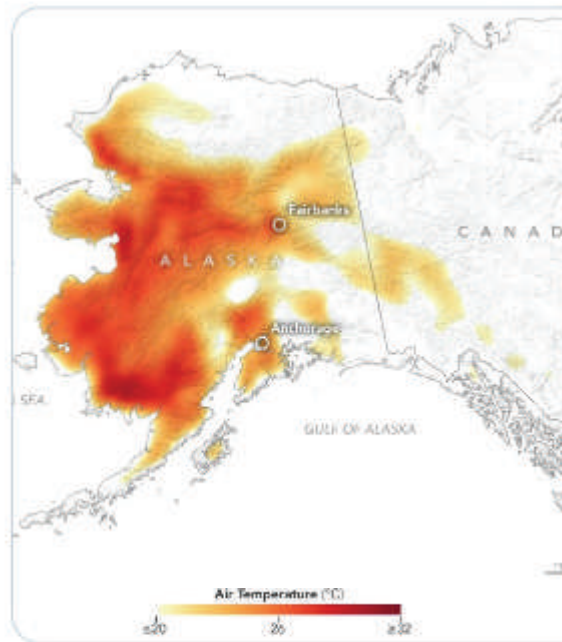


## Foreste boreali



NASA Earth  
@NASAEarth

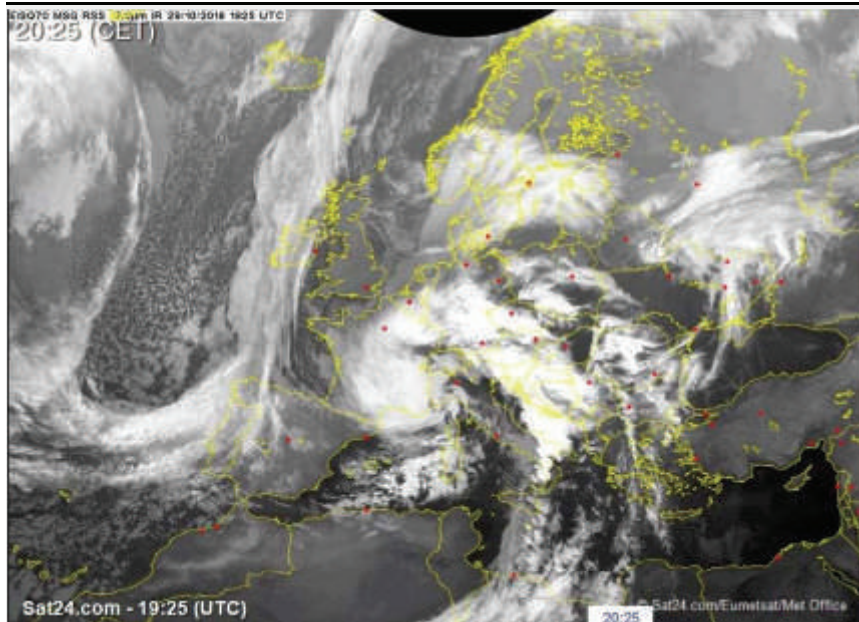
Record-breaking heat in [#Alaska](#) has exacerbated clusters of wildfires burning throughout the state. [earthobservatory.nasa.gov/images/145294/...](https://earthobservatory.nasa.gov/images/145294/) [#NASA](#) [#MODIS](#) [#fire](#)



11:44 PM · Jul 11, 2019 · Twitter Web Client

# Intensificazione fattori di disturbo naturali - vento

3



*Tempesta VAIA  
(che non e' stata la piu' violenta nella storia!)*

*Foto da SAPR in Provincia di Bolzano*



*Chirici et al. (2019) Forest@ 16: 3-9*



Fonte: Motta et al. (2018) Forest@ 15: 94-98

**Tab. 1** - Esempi di impatto sulle foreste europee di alcune tempeste verificatesi nelle foreste europee negli ultimi 30 anni.

Tempesta	Anno	Nazioni colpite	Decessi	Milioni di m <sup>3</sup> di legno atterrati	Massima velocità vento misurata (km h <sup>-1</sup> )
Viviane	1990	Germania, Gran Bretagna, Irlanda, Francia, Olanda, Belgio, Svizzera (Italia nord-ovest in modo marginale)	64	60-70	>200
Lothar & Martin	1999	Francia, Belgio, Germania	140	240	259
Gudrun	2005	Irlanda, Gran Bretagna, Danimarca, Norvegia, Svezia, Russia	7	75	>180
Kyrill	2007	Irlanda, Francia, Belgio, Olanda, Danimarca, Svezia, Austria, Germania, Repubblica Ceca, Slovacchia, Svizzera e Polonia	47	66	>250
Vaia	2018	Italia	>14	6-8	>200



Chirici et al. (2019) Forest@ 16: 3-9



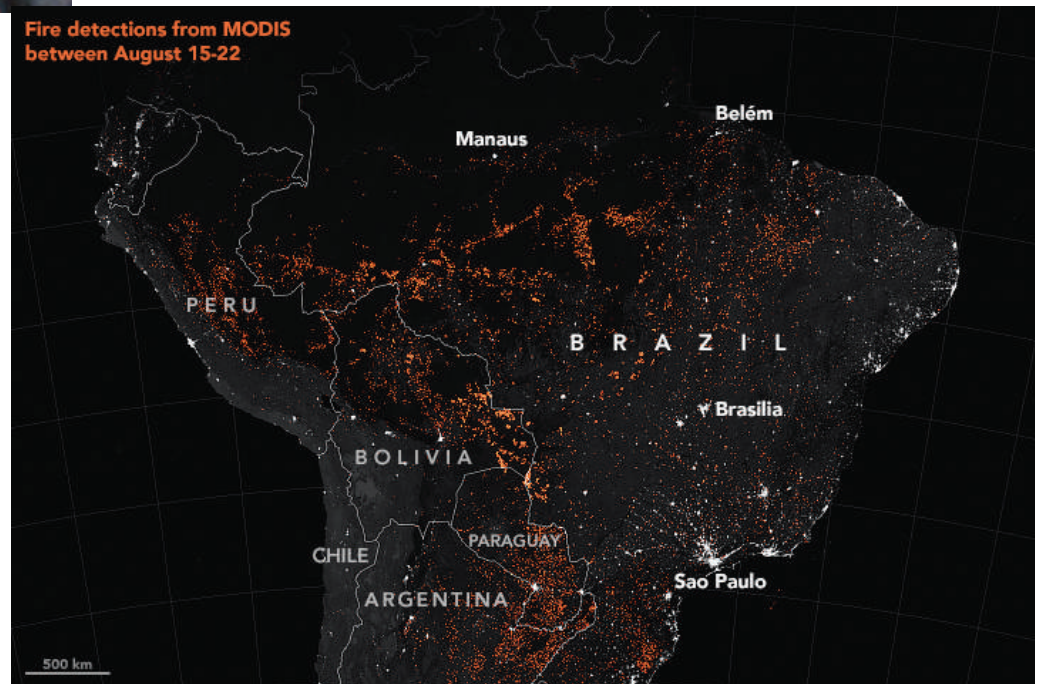
*Incendi legati a deforestazione*

*Foresta Amazzonia  
(Agosto 2019)*

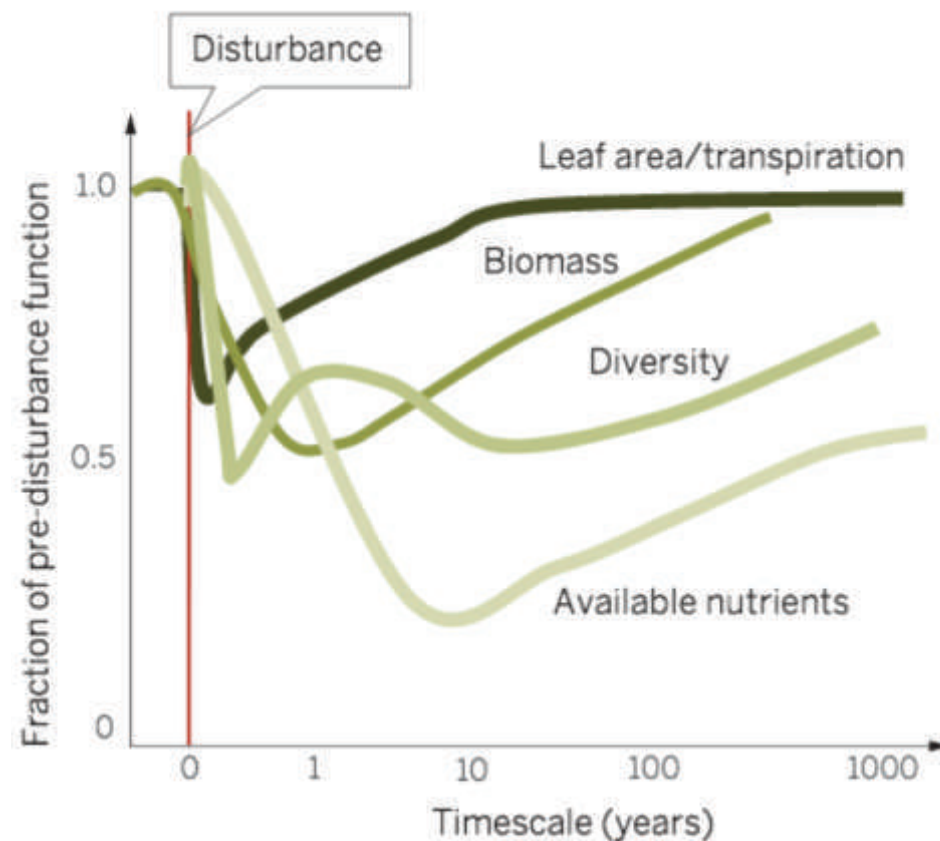
Fonte: Amnesty International. <https://www.bbc.com/news/world-latin-america-49433767>

*! Riduzione funzione  
sink di CO<sub>2</sub> e  
raffreddamento ;  
perdita biodiversita' !*

<https://earthobservatory.nasa.gov/images/145498/uptick-in-amazon-fire-activity-in-2019>







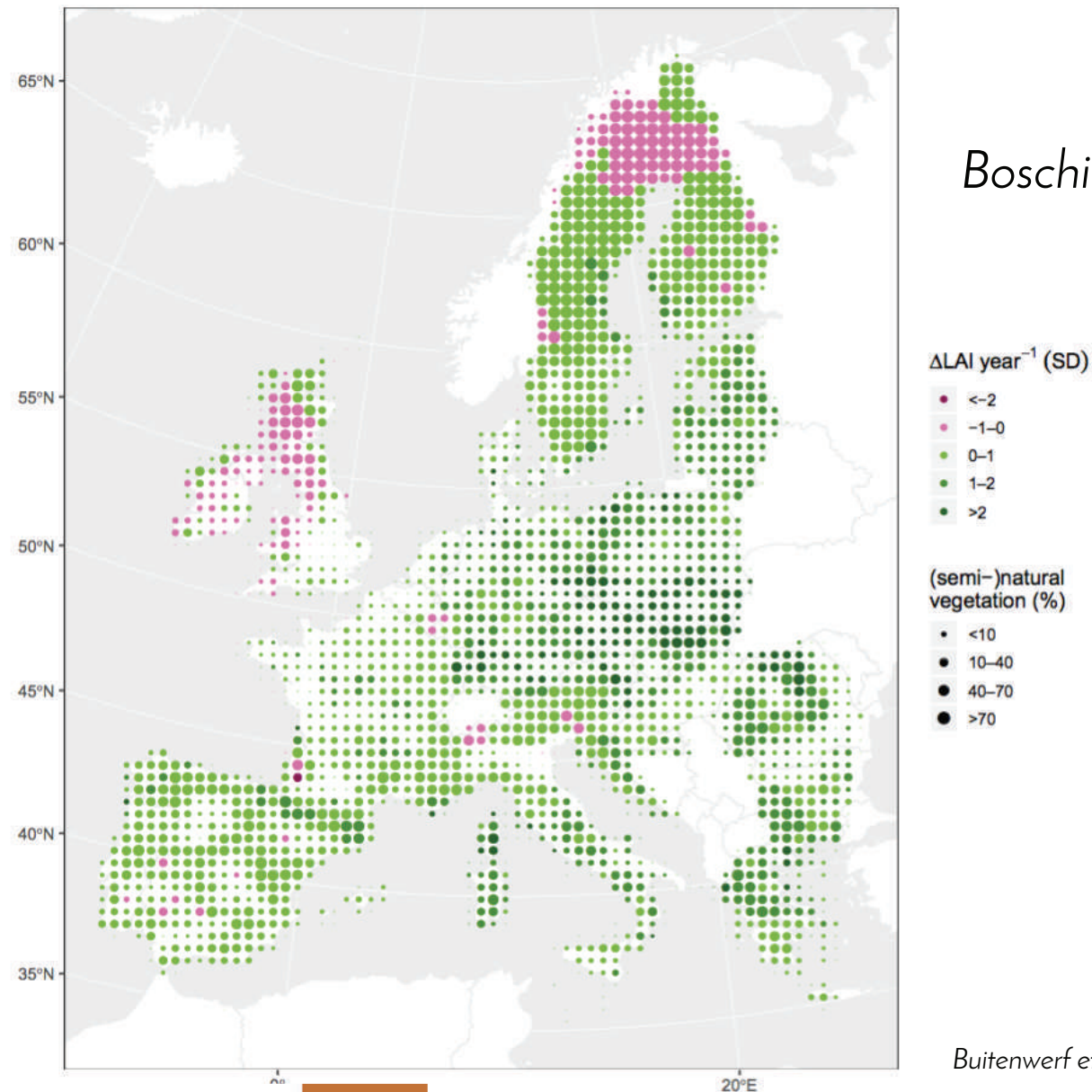
**Fig. 2. Time scales of recovery for different forest functions after a disturbance.** Disturbances, such as deforestation or fire, are followed by erosion and forest regrowth. Whereas functions associated with leaf area, such as photosynthesis and transpiration, recover within a decade, biomass (and therefore carbon storage) recovers more slowly, with mineral nutrients recovering most slowly of all.

Trumbore et al. (2015) *Science* 349 (6250):814-818



# Dove l'uomo scompare, le foreste avanzano

3

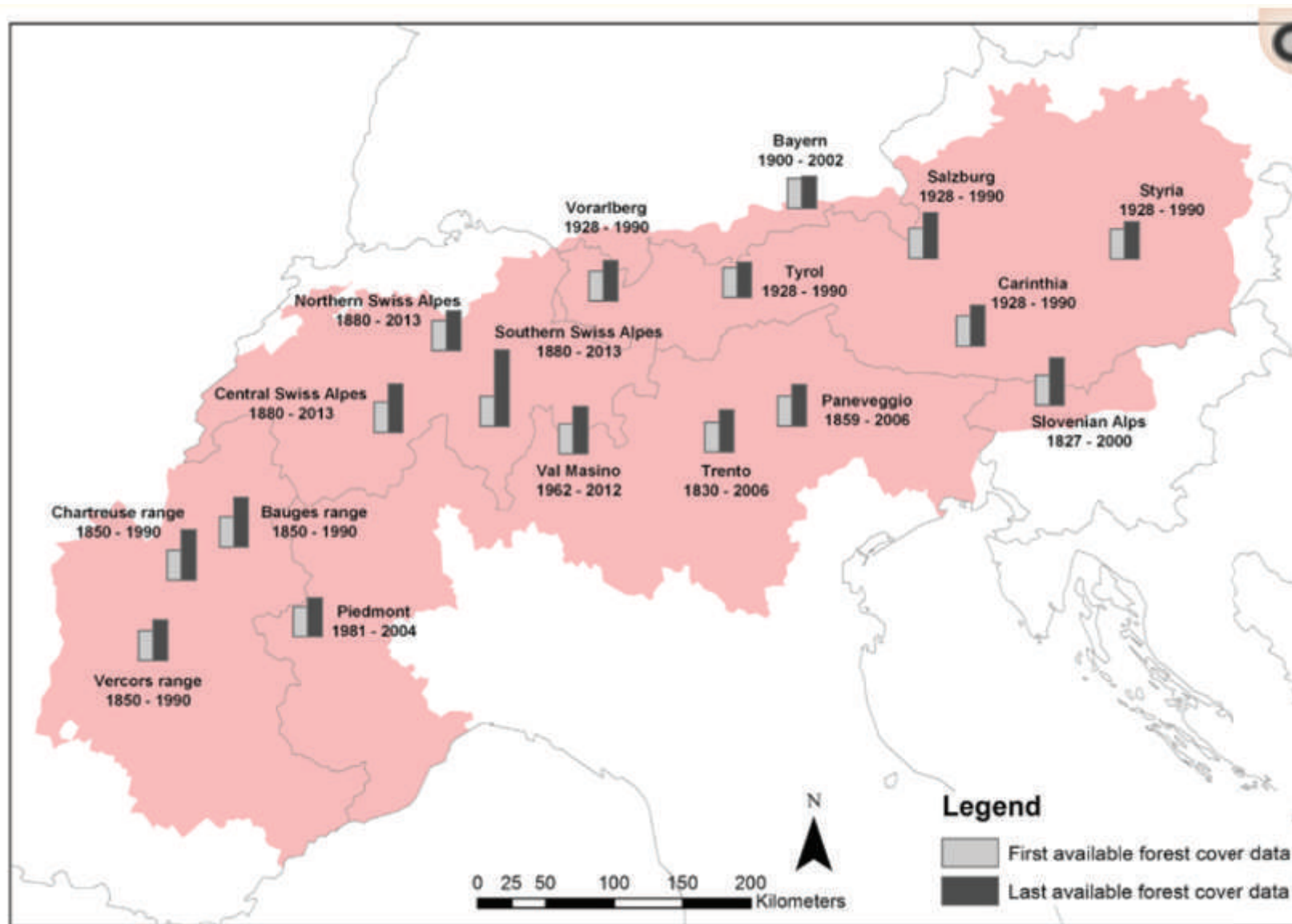


*Boschi di neoformazione in Europa*

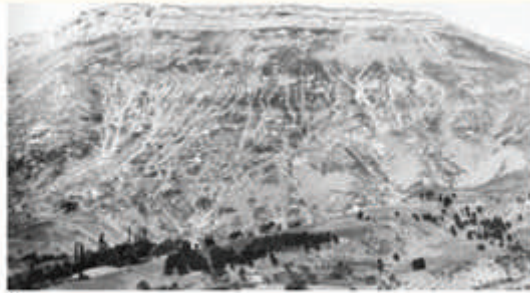
Buitenwerf et al. 2018 *Glob Change Biol.* 2018;24:5789-5801.

# Foreste che avanzano

3



Bebi et al. (2017) *For Ecol Manage.* 388: 43-56



A



B



C



D



E



F

(A and B): Ceüse, southern French Alps, at the end of the 19th century (A) at the beginning of the 21st century after so-called RTM (mountain terrains rehabilitation) works (B)

(C and D): Davos (Central Swiss Alps) in 1900 (C) and 2010 (D)

(E and F): Vermiglio (Trentino, Italian Alps) in 1915 (E) and 2000 (F).

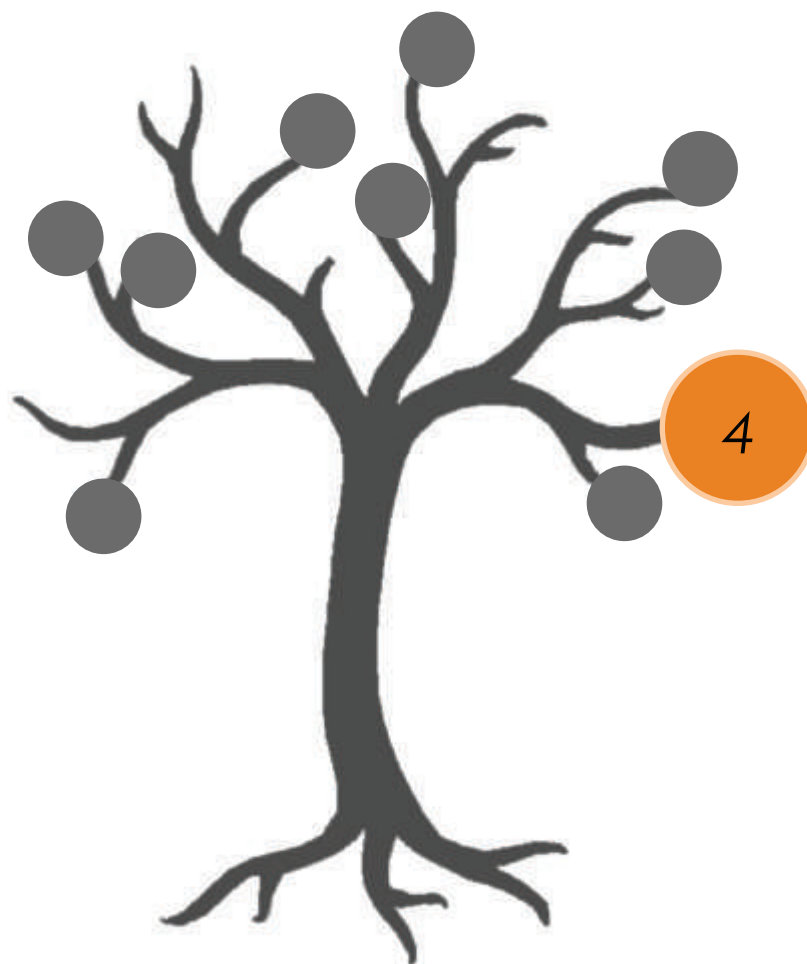
Source: Trento Autonomous Province archive.

Bebi et al. For Ecol Manage. 2017 Mar 15; 388: 43-56



# Riflessioni finali

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### **Ruolo delle foreste come serbatoio della CO<sub>2</sub> dipende da...**

*Adattamento, resistenza e resilienza => ecosistema e non singolo albero*

*Disponibilita' di risorse (acqua, nutrienti)*

*Interazione con altri fattori antropogenici (deposizioni di azoto, inquinamento)*

### **Ruolo delle foreste come serbatoio della CO<sub>2</sub> dipende da...**

*Adattamento, resistenza e resilienza => ecosistema e non singolo albero*

*Disponibilita' di risorse (acqua, nutrienti)*

*Interazione con altri fattori antropogenici (deposizioni di azoto, inquinamento)*

### **Oltre all'assorbimento di CO<sub>2</sub>, c'è la traspirazione**

*Contributo alla generazione di pioggia e al raffreddamento*

*Vapore acqueo è un GHG!*



### **Ruolo delle foreste come serbatoio della CO<sub>2</sub> dipende da...**

*Adattamento, resistenza e resilienza => ecosistema e non singolo albero*

*Disponibilita' di risorse (acqua, nutrienti)*

*Interazione con altri fattori antropogenici (deposizioni di azoto, inquinamento)*

### **Oltre all'assorbimento di CO<sub>2</sub>, c'è la traspirazione**

*Contributo alla generazione di pioggia e al raffreddamento*

*Vapore acqueo è un GHG!*

### **Prima di piantare....**

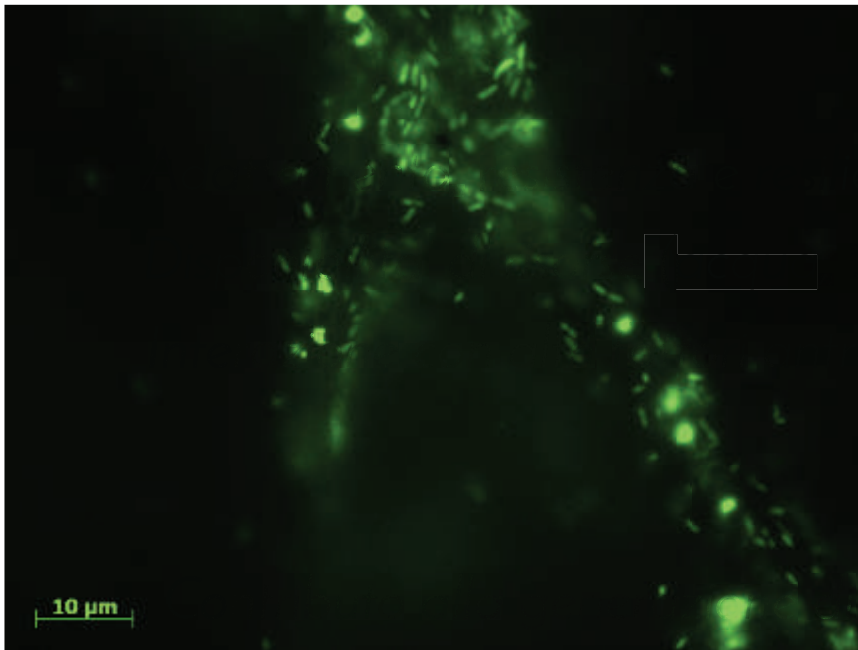
*Ridurre le emissioni è la prima cosa da fare*

*Proteggere le foreste esistenti e 'restaurare' quelle danneggiate*

*Guardare alle foreste con una visione olistica*

## Conclusioni – spunti di riflessione

3



*Vapore acqueo e' un GHG!*

**Prima di piantare....**

*Ridurre le emissioni e' la prima cosa da fare*

*Proteggere le foreste esistenti e 'restaurare' quelle degradate*

**Guardare alle foreste con una visione olistica**



**ANKE! GRAZIE!**

tatto: [rossellaguerrieri@gmail.com](mailto:rossellaguerrieri@gmail.com)

