Biochar and Albedo: facts and perspectives

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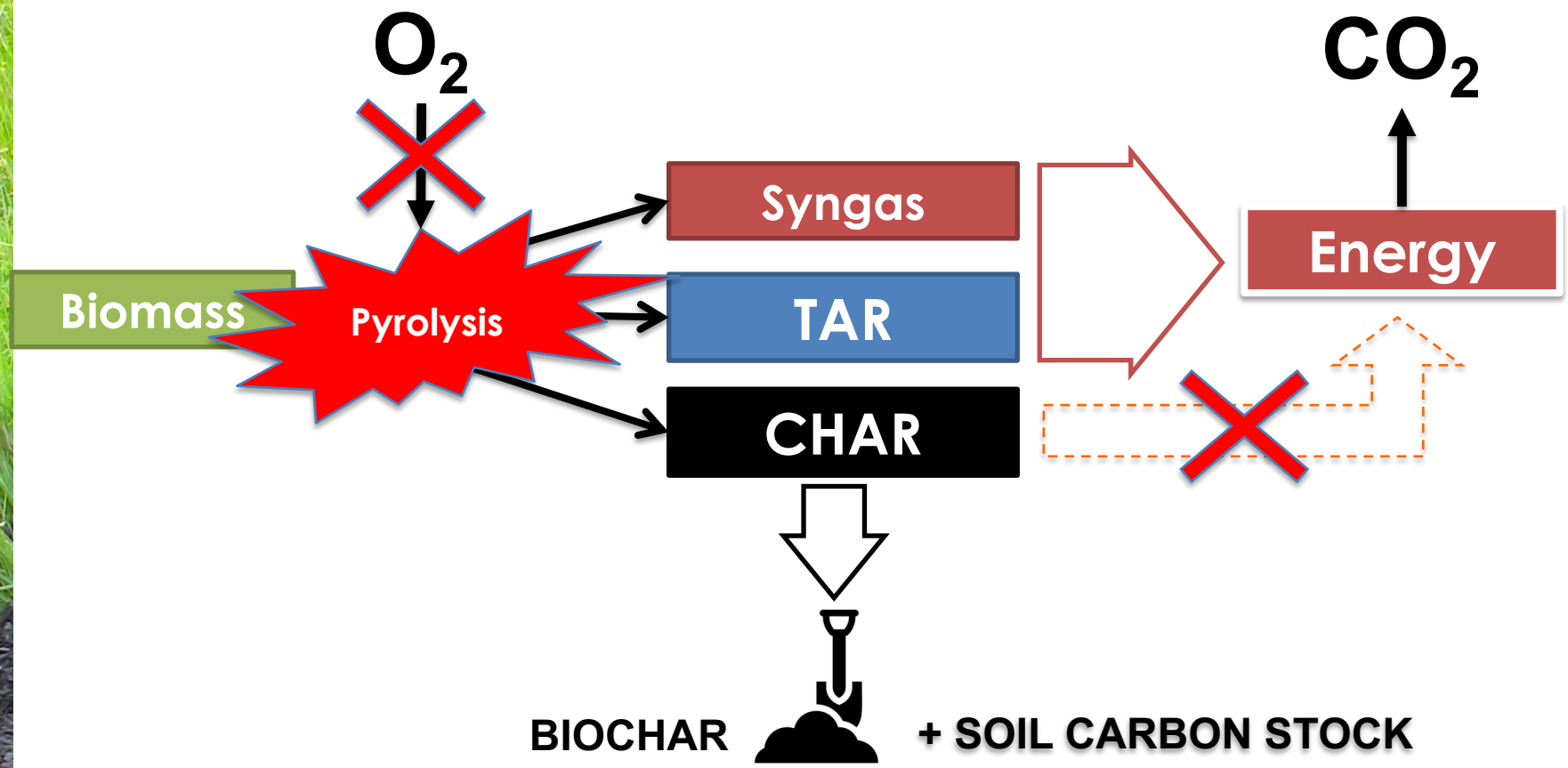
Biochar in WoS
2006 : 3 papers
2020: >15'000 papers

Consiglio Nazionale delle Ricerche

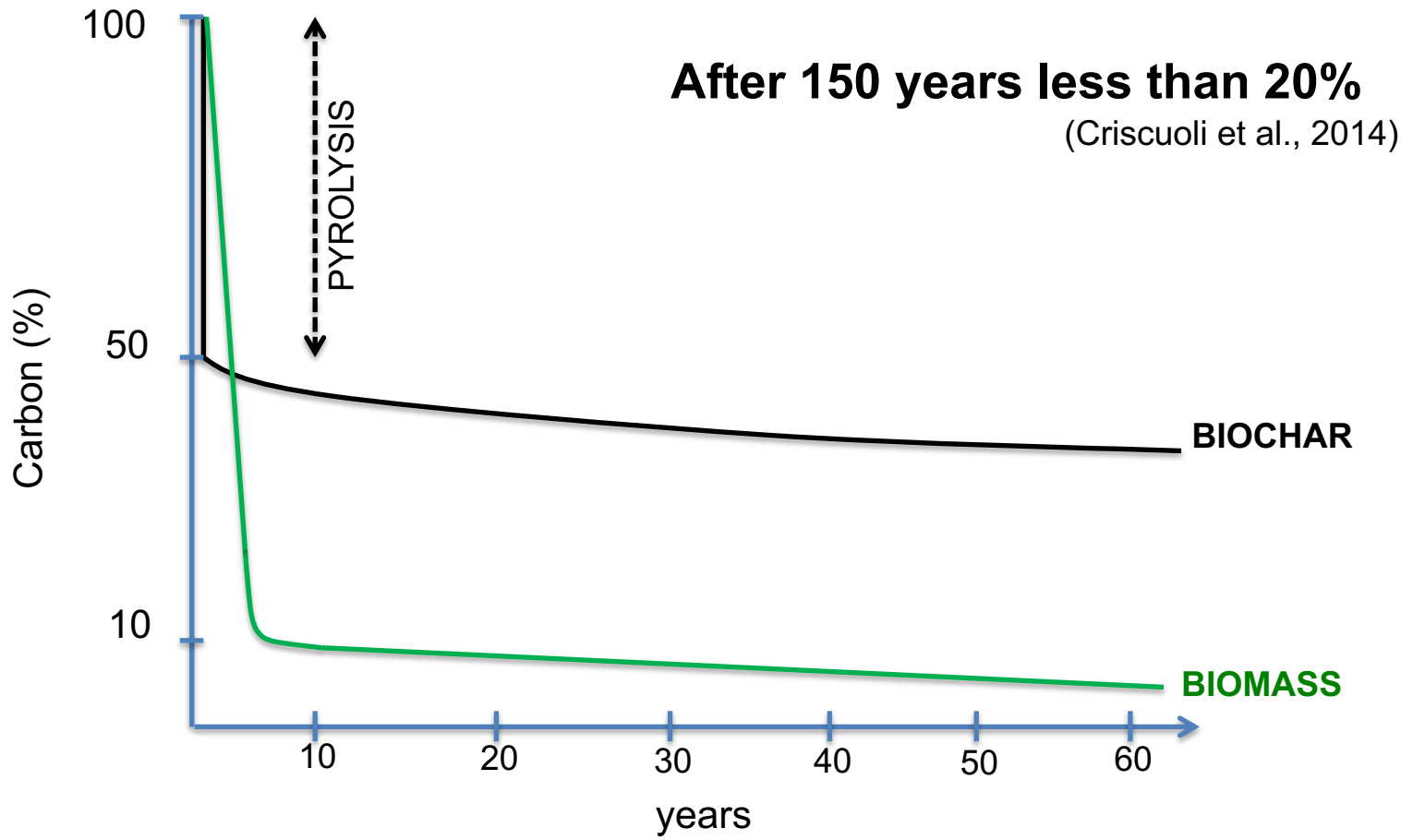
From Biomass to Biochar



Biochar is the solid by-product of ***biomass pyrolysis*** *which is specifically produced for applications into soil for* ***agronomic*** *or* ***environmental purposes****.*

(Lehmann and Joseph, 2015)

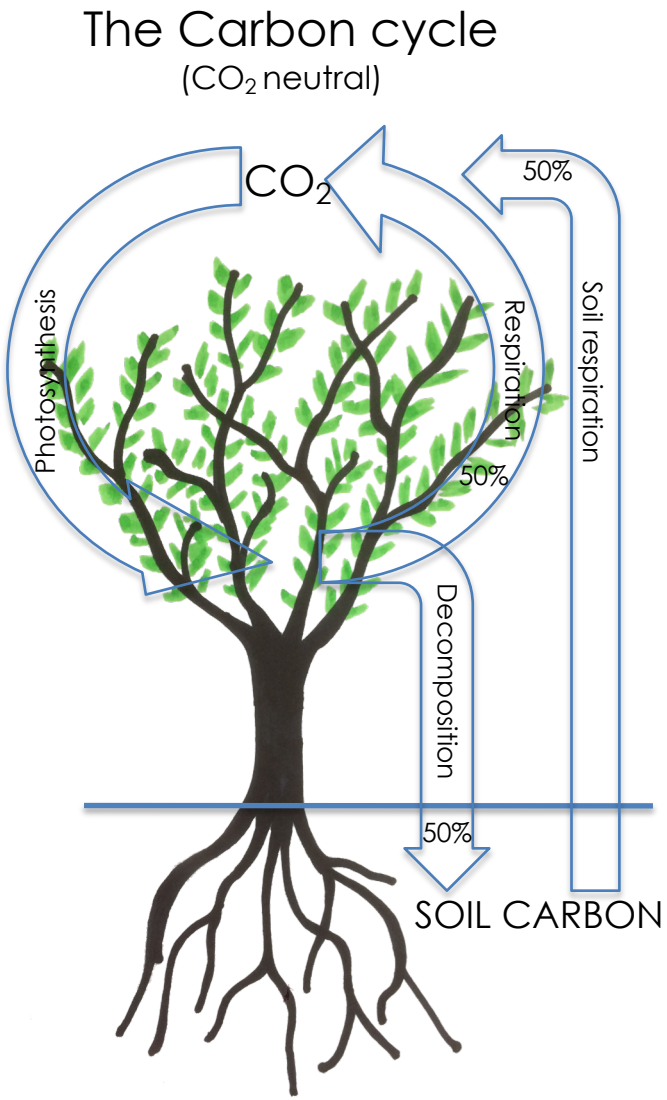
Stability of char in soils

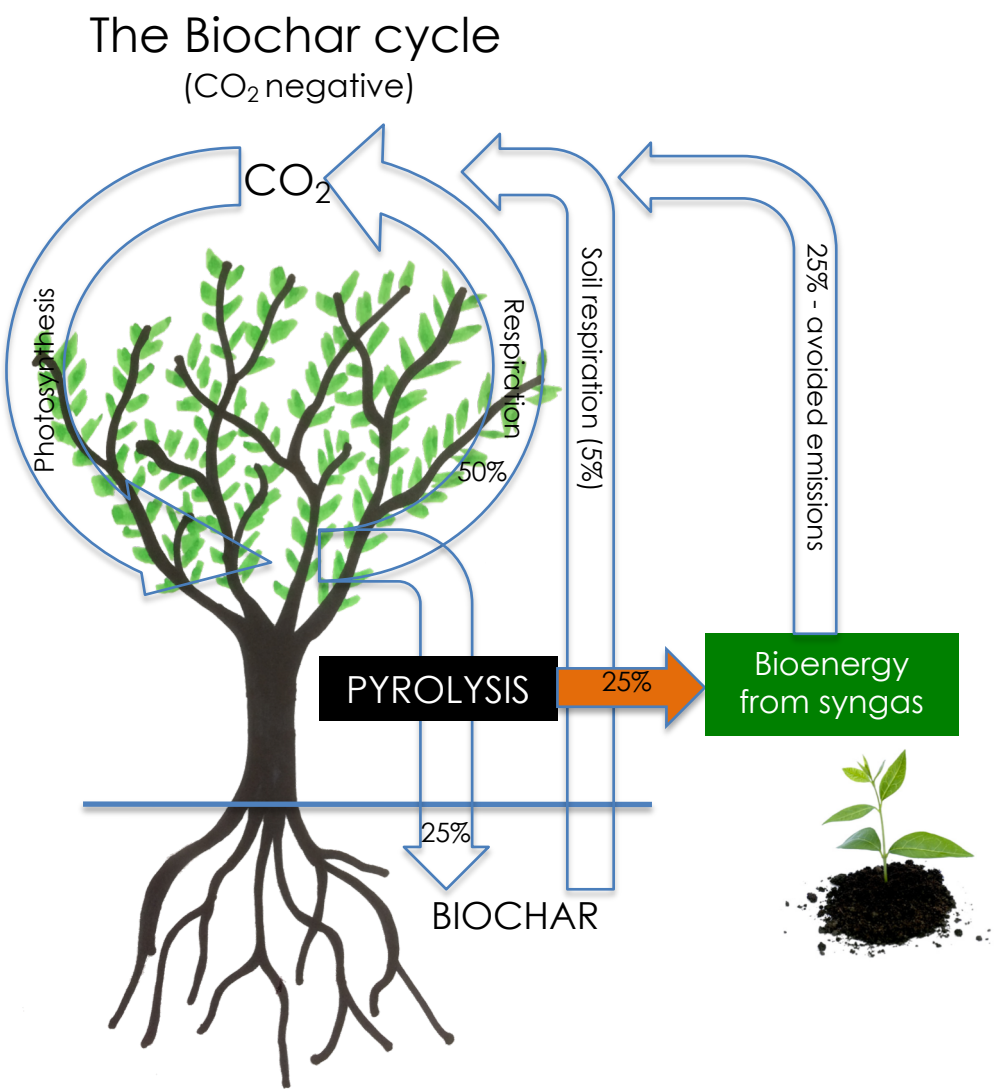


Biochar has high content of stable carbon, typically 50–85%, which resists decaying and remains in soils for long time

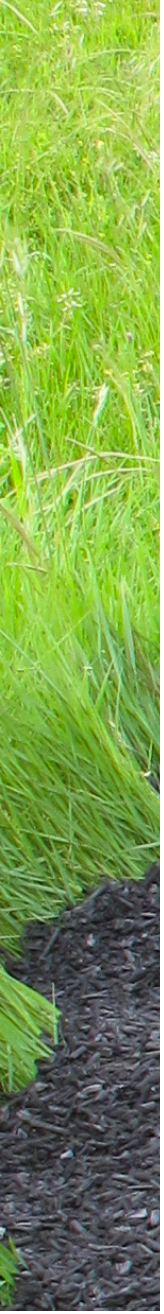
(Hammond et al., 2011)

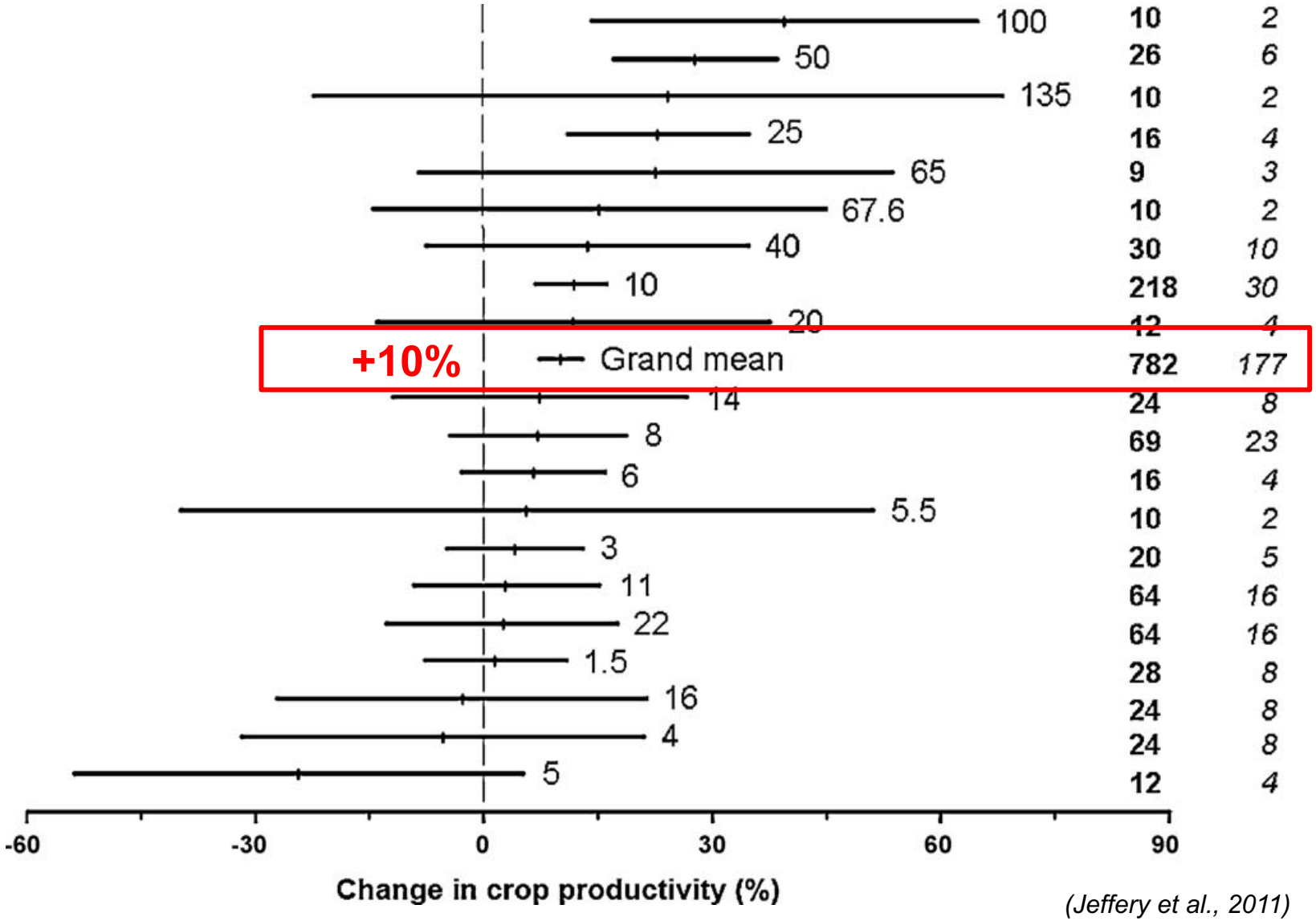
Toward a Carbon negative agriculture





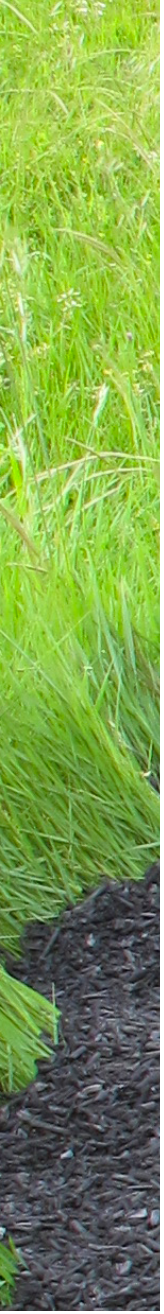
Biochar = increase in yields?

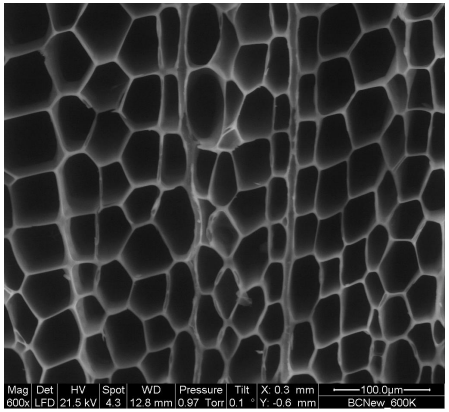


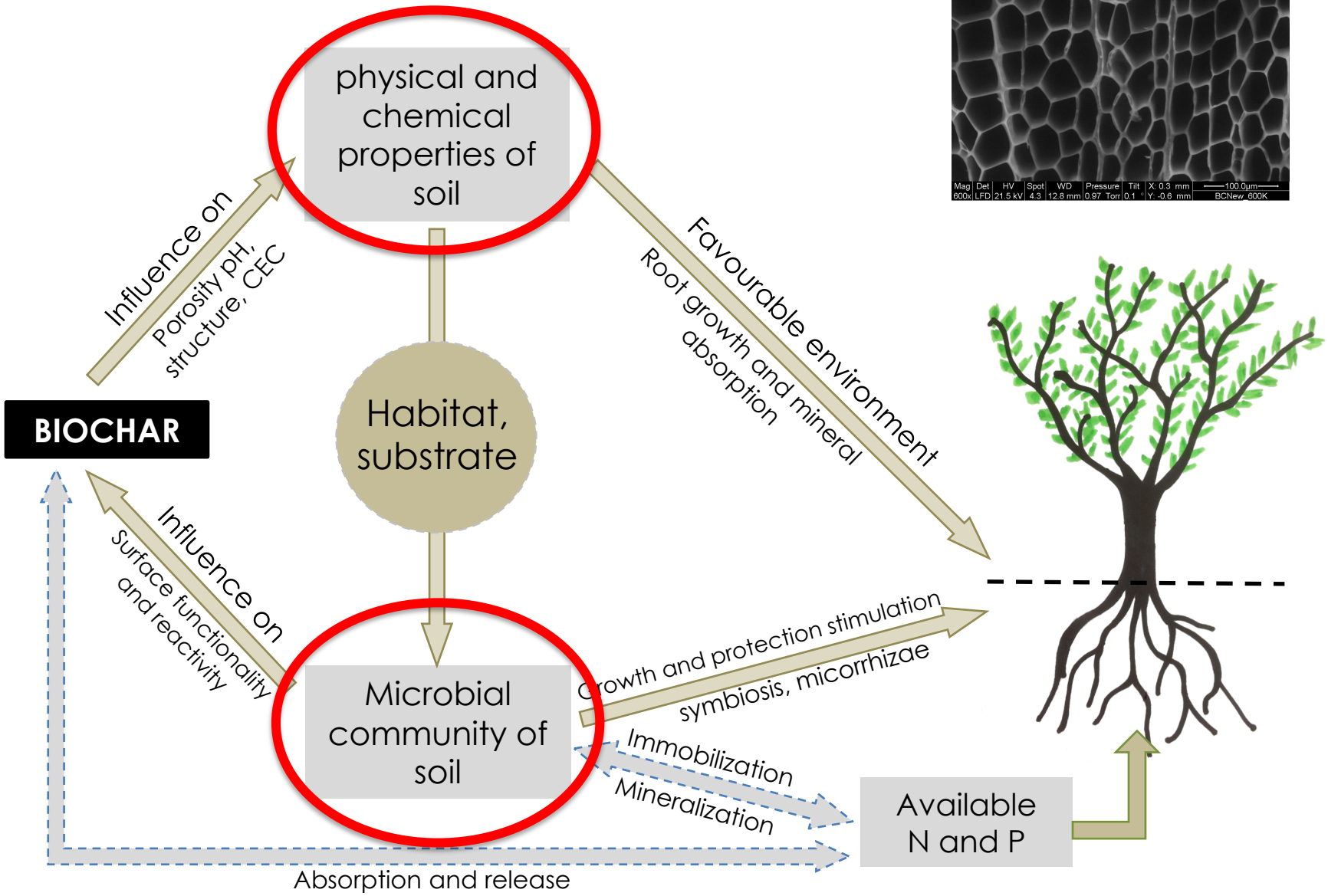


(Jeffery et al., 2011)

Biochar and soil fertility

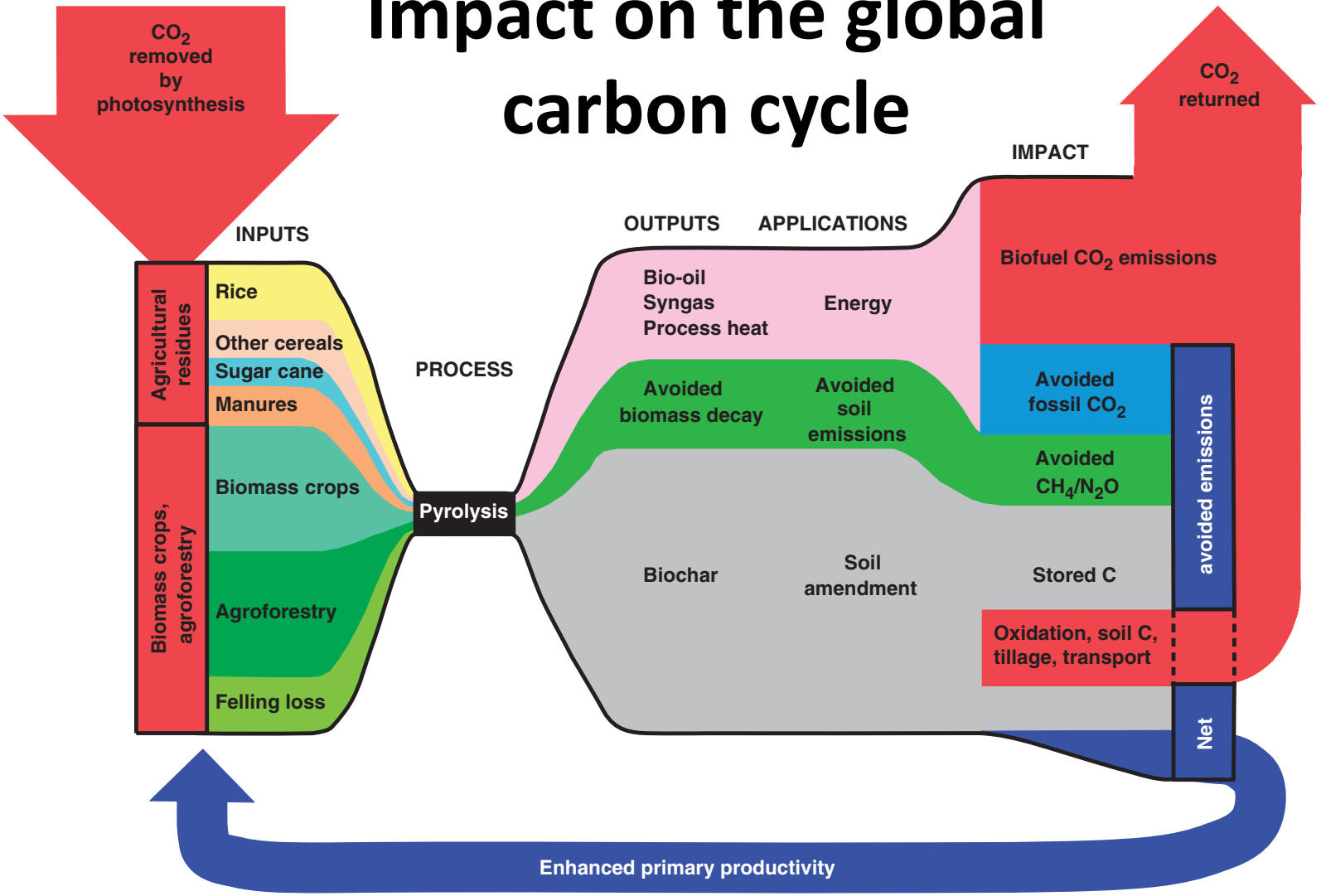






(modified from Gul & Whalen, 2016)

Impact on the global carbon cycle



MSTP = 1.8 Pg CO_2-C_e per year = 12% anthropogenic emissions

"..without endangering food security, habitat or soil conservation."

(Woolf et al., 2010)

Potential drawbacks

Environmental Research Letters
IOP Publishing Environ. Res. Lett. 10 (2015) 084014 doi:10.1088/1748-9326/10/8/084014

LETTER

Mimicking biochar-albedo feedback in complex Mediterranean agricultural landscapes

E Bozzi[1,2,5], L Genesio[1,2,5], P Toscano[2], M Pieri[2,3] and F Miglietta[1,2,4]

Global Change Biology
Global Change Biology (2016), doi: 10.1111/gcb.13254

LETTER TO EDITOR

Black carbon aerosol from biochar threats its negative emission potential

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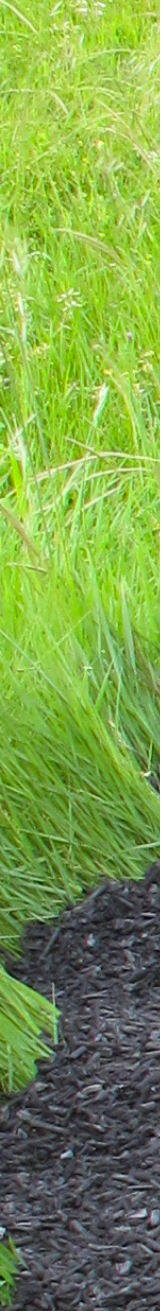
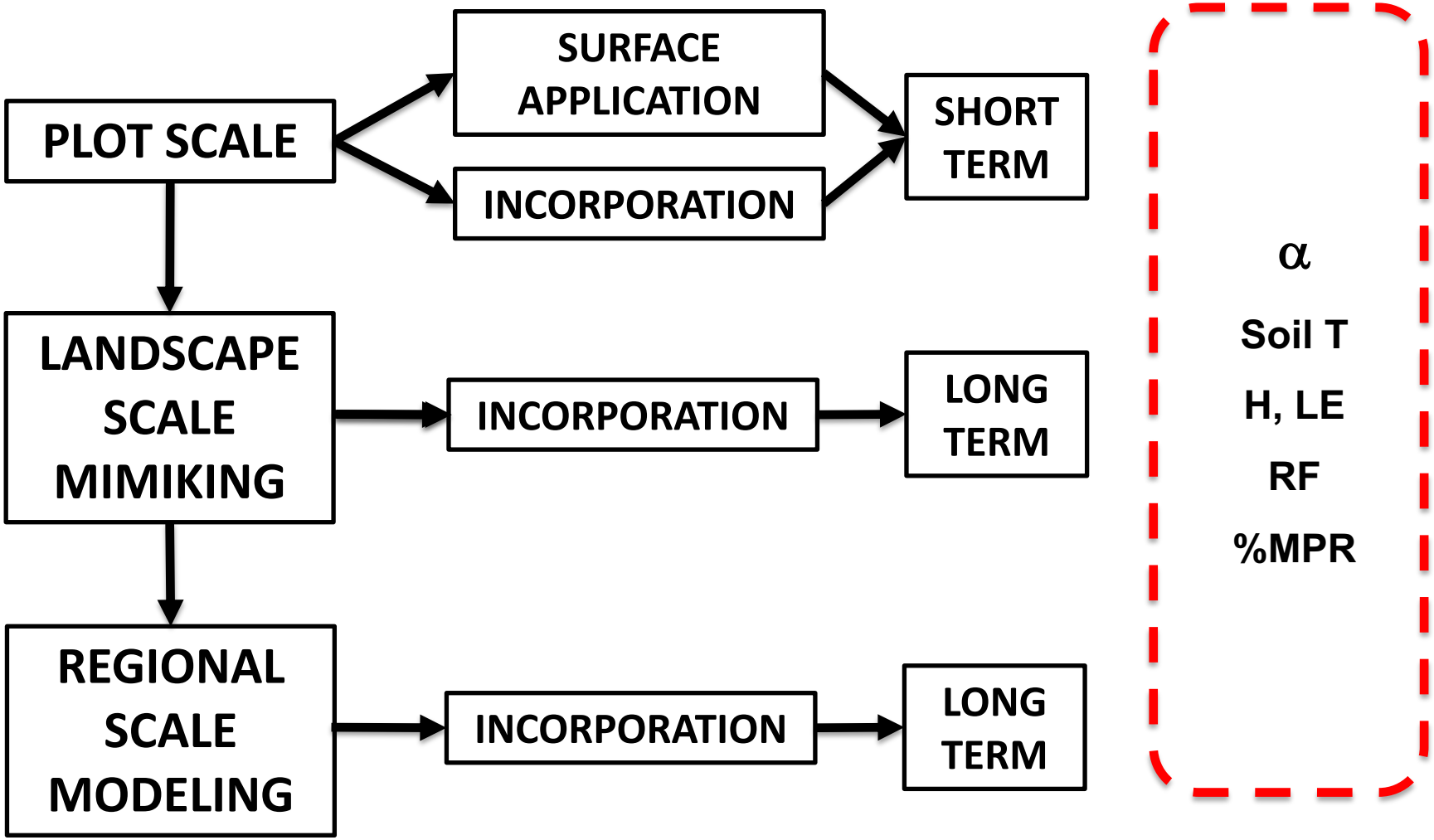
Changes in Surface Albedo

Release of BCa

Biochar-albedo impact



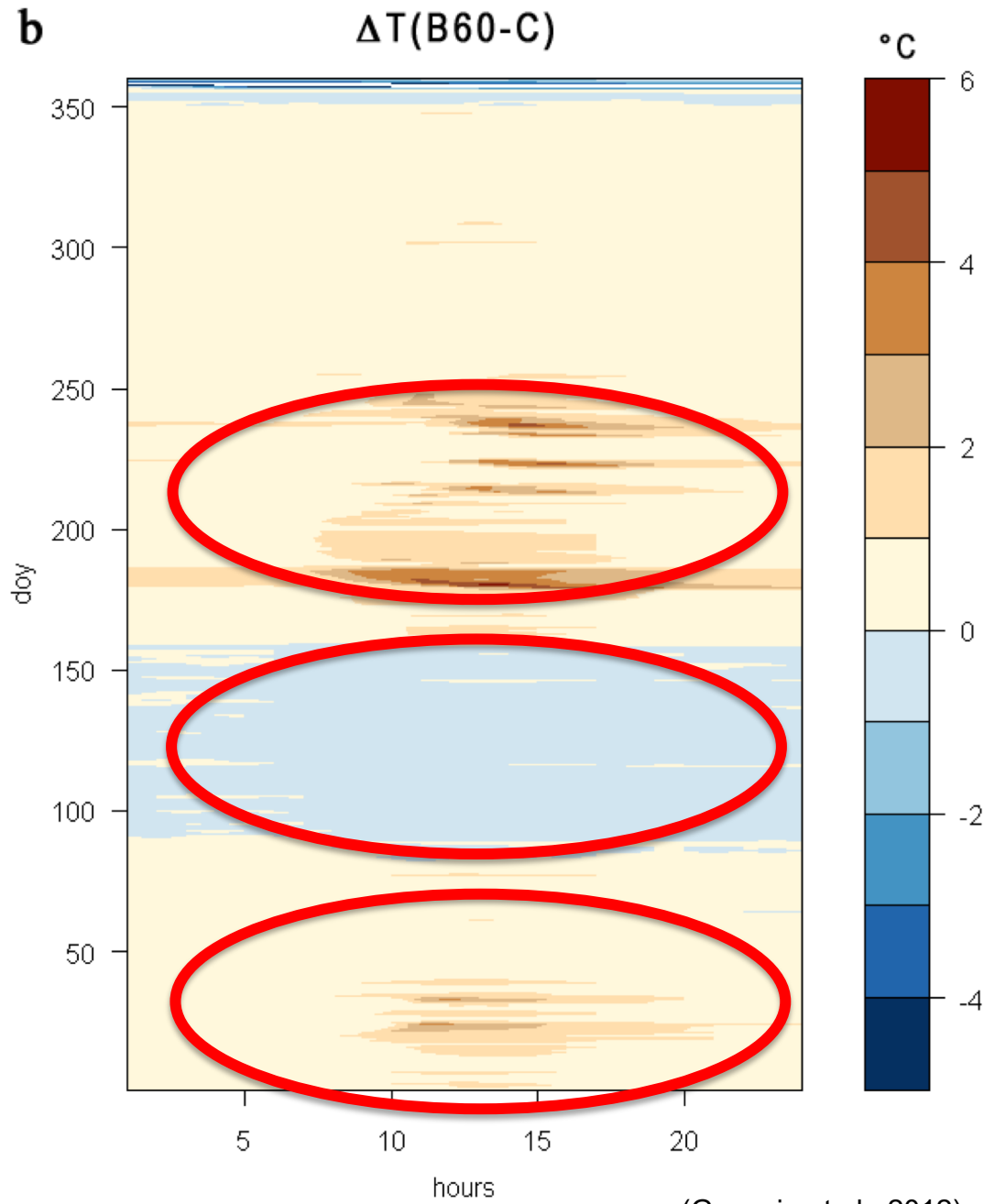


Plot Scale

- 40% albedo changes (yearly mean 0.08-0.12 for 30-60t ha^{-1})
- Anomaly in surface temperature (seasonal mode)
- Increased evapotranspiration
- Changes in energy partitioning

Implications

- Accelerated germination
- Reduction of mitigation benefit of biochar

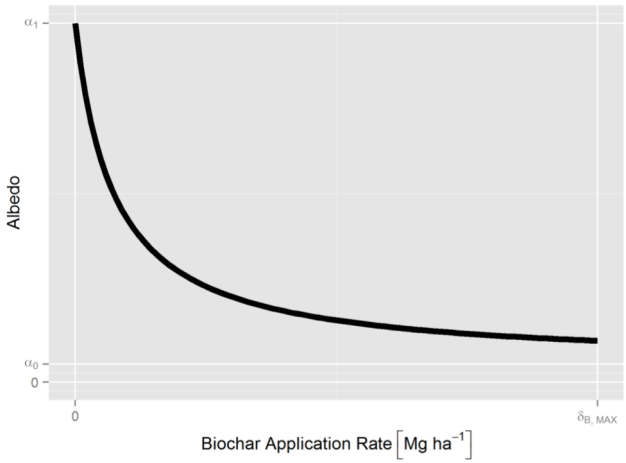


(Genesio et al., 2012)

Landscape scale

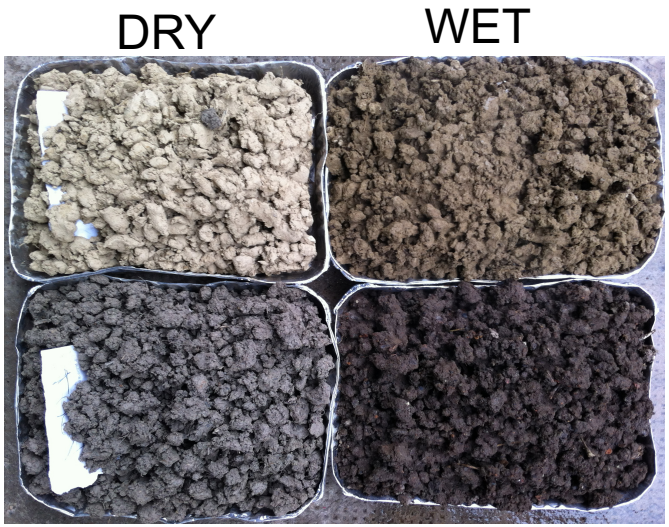
- Fragmentation
- Crop choices

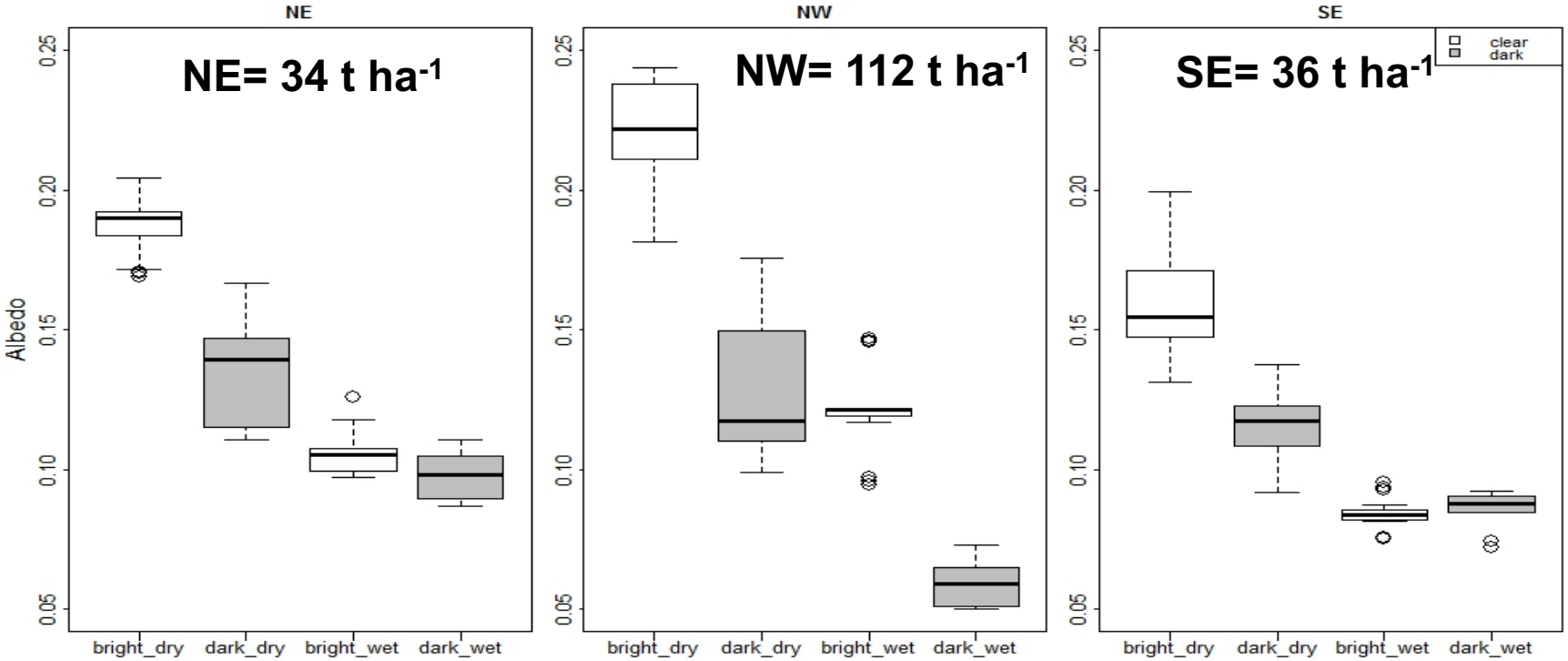
Biochar Application Rate (BAR)



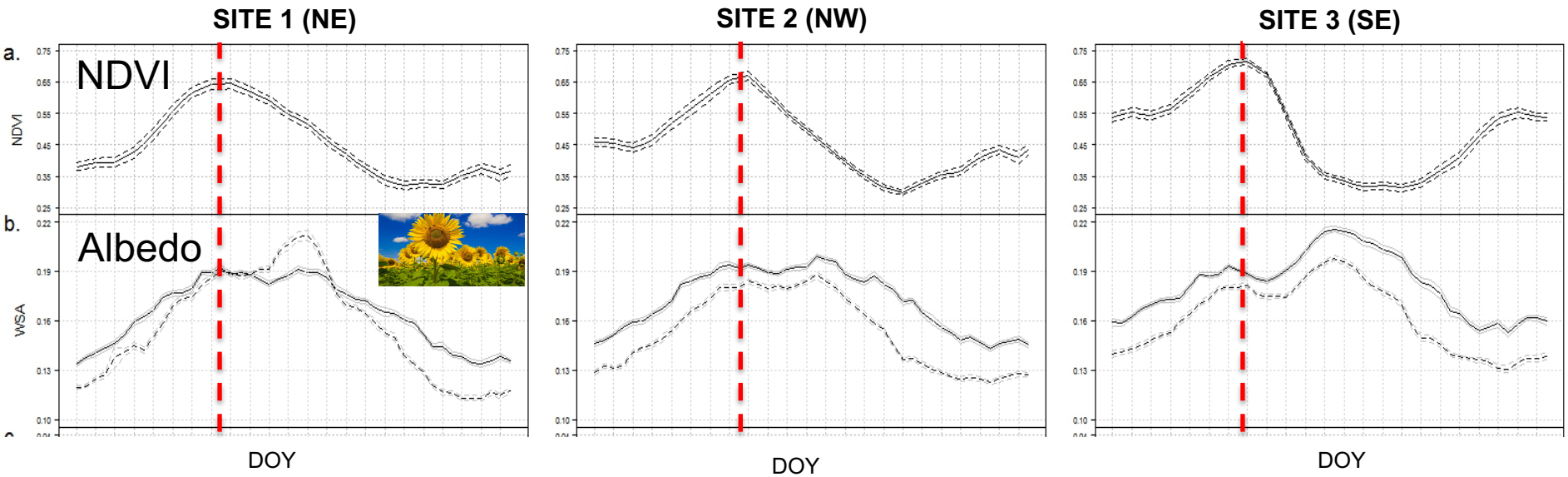
SOIL STF2

SOIL CLT1





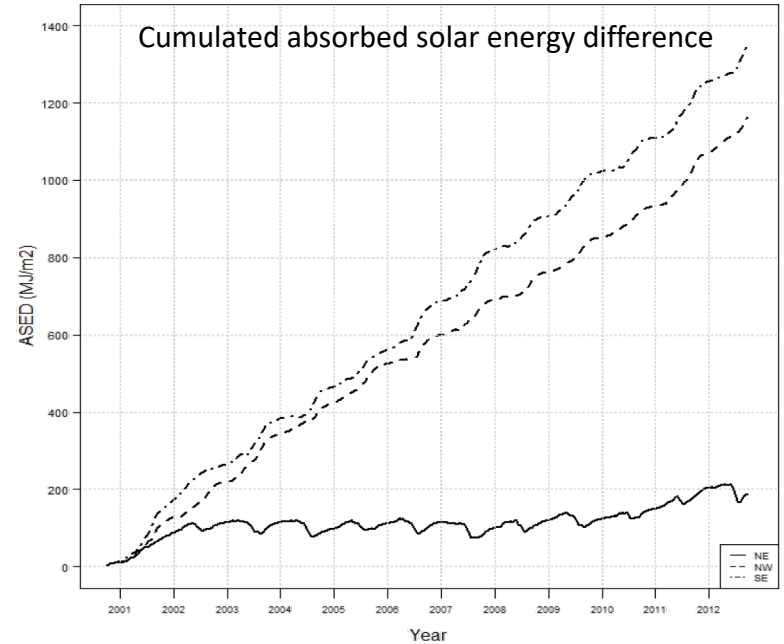
Results from a 12 years MODIS time series



(Bozzi et al., 2015)

Impact on fragmented landscape

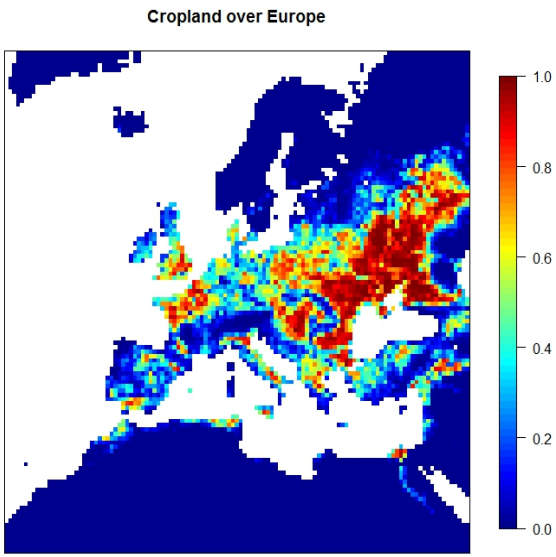
- Soil backgroud colour has an impact on surface radiation balance also in high canopy cover conditions
- mitigation potential reduction is lower at high biochar doses (albedo saturation)
- Crop choice has a substantial impact on RF
- MPR=12.8%

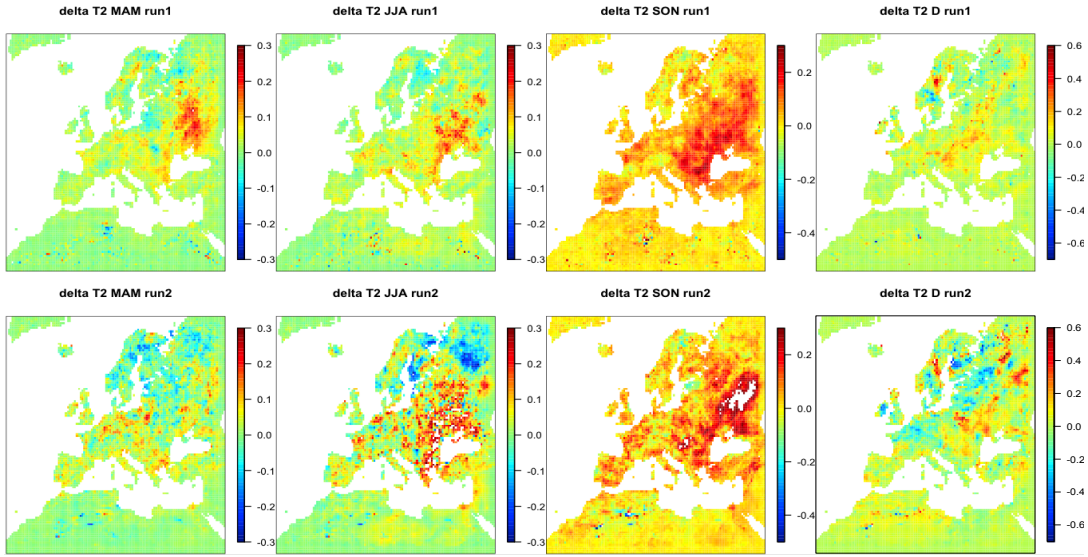


BAR	Land use	IRF annual mean (Wm^{-2})	MPR (%) incorporated	MPR (%) superficial	Scale/type of analysis	Source
120 Mg ha^{-1}	grasslands	0.027 – 0.055	11	23	Global, modeled from BAR laboratory experiment	Verheijen *et al* 2013
	croplands	0.017 – 0.035	5	11		
10 Mg ha^{-1}	grasslands		44	94		
	croplands		13	28		
31.5 Mg ha^{-1}	croplands	2.6-3.1	13-22	-	Field scale (mt), modeled from BAR laboratory experiment and modeled vegetation	Meyer *et al* 2012
112 Mg ha^{-1}	croplands (NW)	1.75	7.6	-	Landscape scale (km), observed from MODIS albedo, and BAR laboratory experiment.	(Bozzi et al., 2015)
34 Mg ha^{-1}	croplands (NE)	0.16	2.4	-		
36 Mg ha^{-1}	croplands (SE)	2.13	28.4	-		

Regional modeling of biochar application

- perturbing the arable land albedo scheme in WRF model (1 year)
- significant impact on surface temperature in Eastern Europe





Further questions?

- Long-term impact
- Accounting for
  - Enhanced SWC
  - Increased crop yield

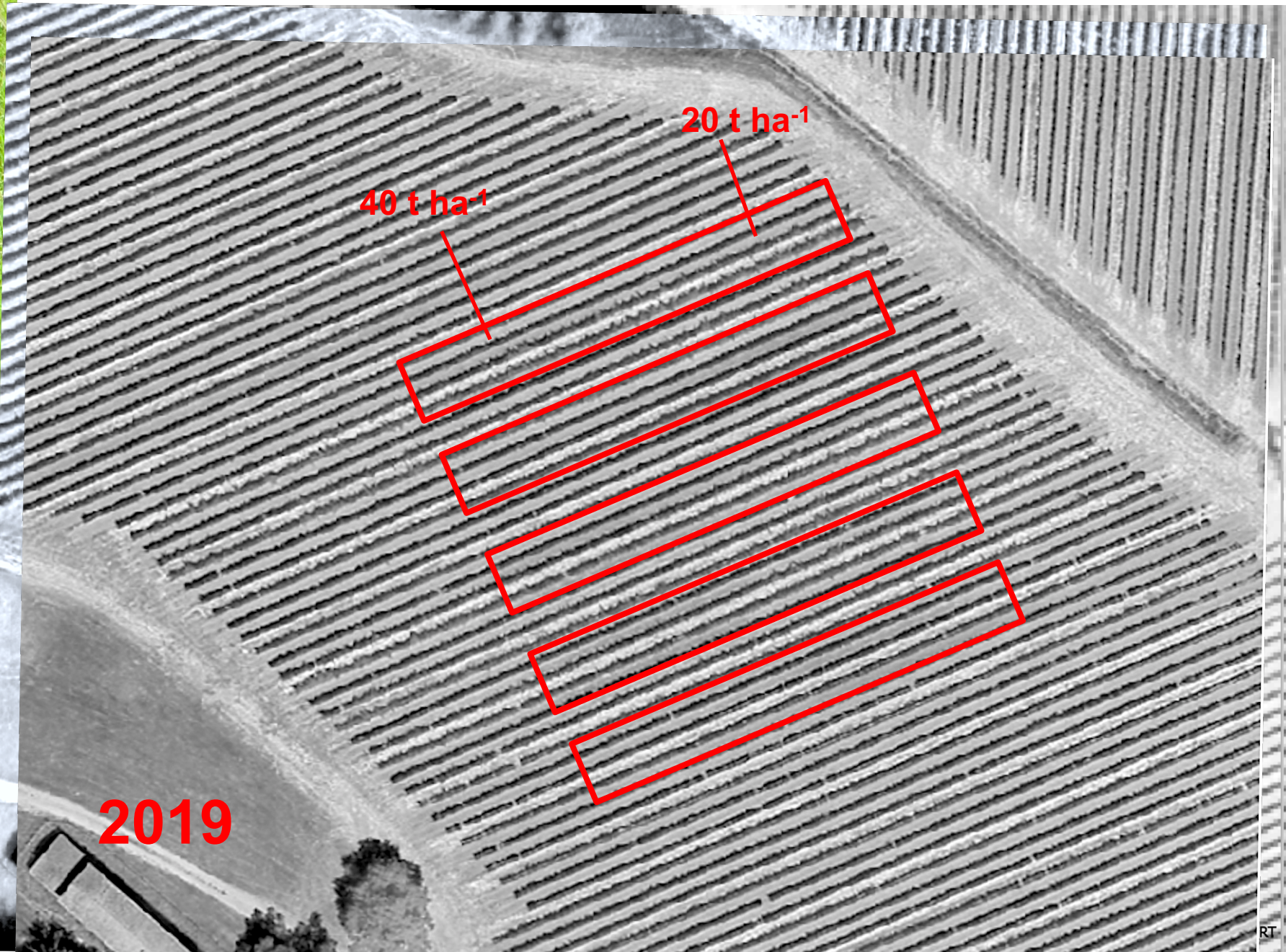
Recommedations?

- Amendment strategies
- Locations
- Mixing strategies with other LRM

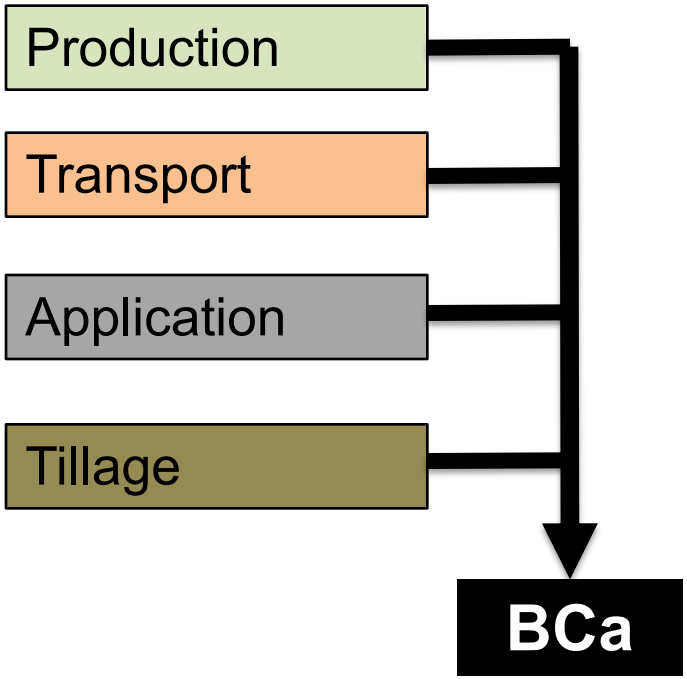
Irreversible changes?

Biochar-Kaolin mixing (% in weight)

Permanency of biochar impact on surface albedo?



Biochar and the earth radiative balance: Increase of atmospheric Black Carbon aerosols



Major, 2010

Bca= <2.5µm particles of a refractory, water-insoluble carbonaceous material strongly absorbing visible light at a lenght of 550nm (Bond et al., 2013)

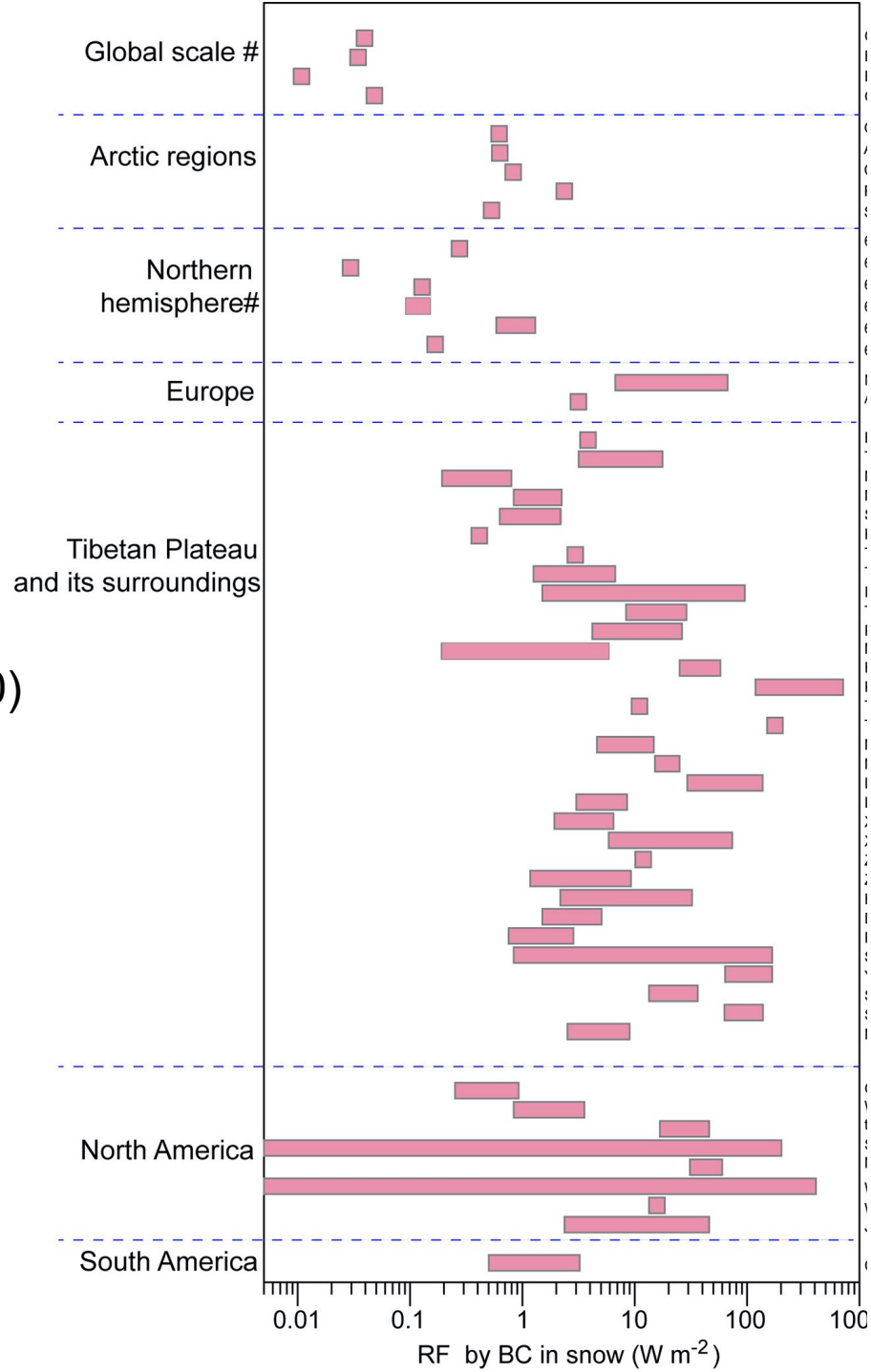
In a scenario of global biochar application, if all Bca contained in biochar would be released in atmoshpere its RF would be in the range of 0.77 to 1.44 W m^{-2}

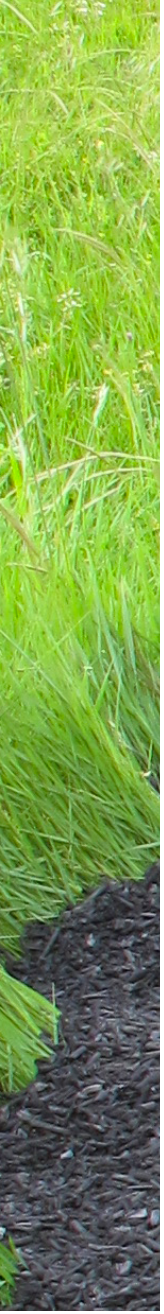
Genesio et al 2016

BCa deposition

20% of total glacier melting

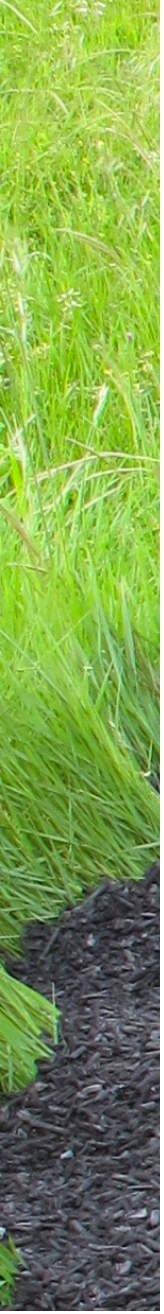
(Kang et al.,2020)





FACTS

- Biochar is effective for CC mitigation
- Biochar modifies soil albedo on the long term
- Biochar production and application may increase the release of BCa



RECOMMENDATIONS

- Biochar application with Cover Crops and residue management
- Optimize agronomic practices and choose the appropriate locations (dark soils YES, bright soils NO).
- Avoid Bca relase during production and application

Thank you