Drivers of Global and Regional Fire activity
What we know from the different GCD syntheses

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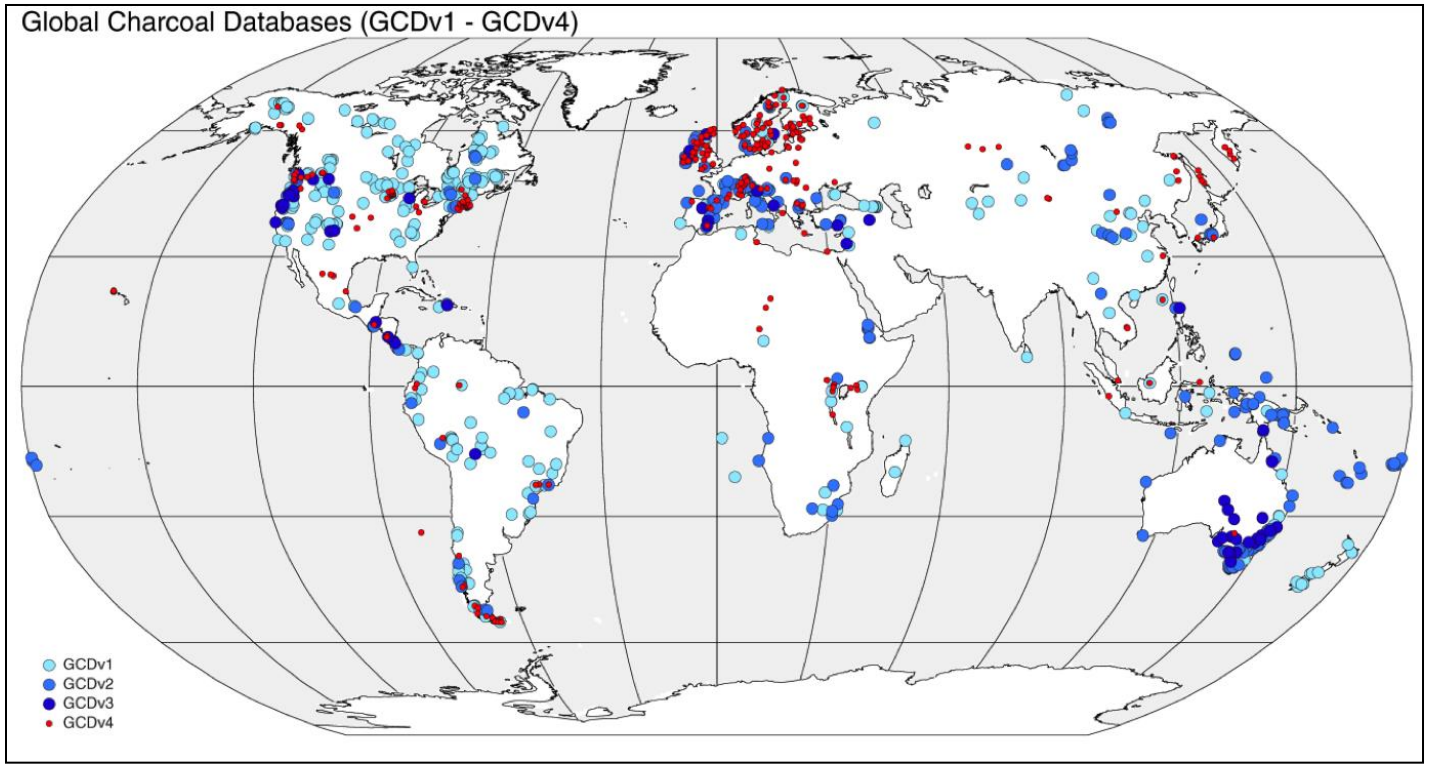
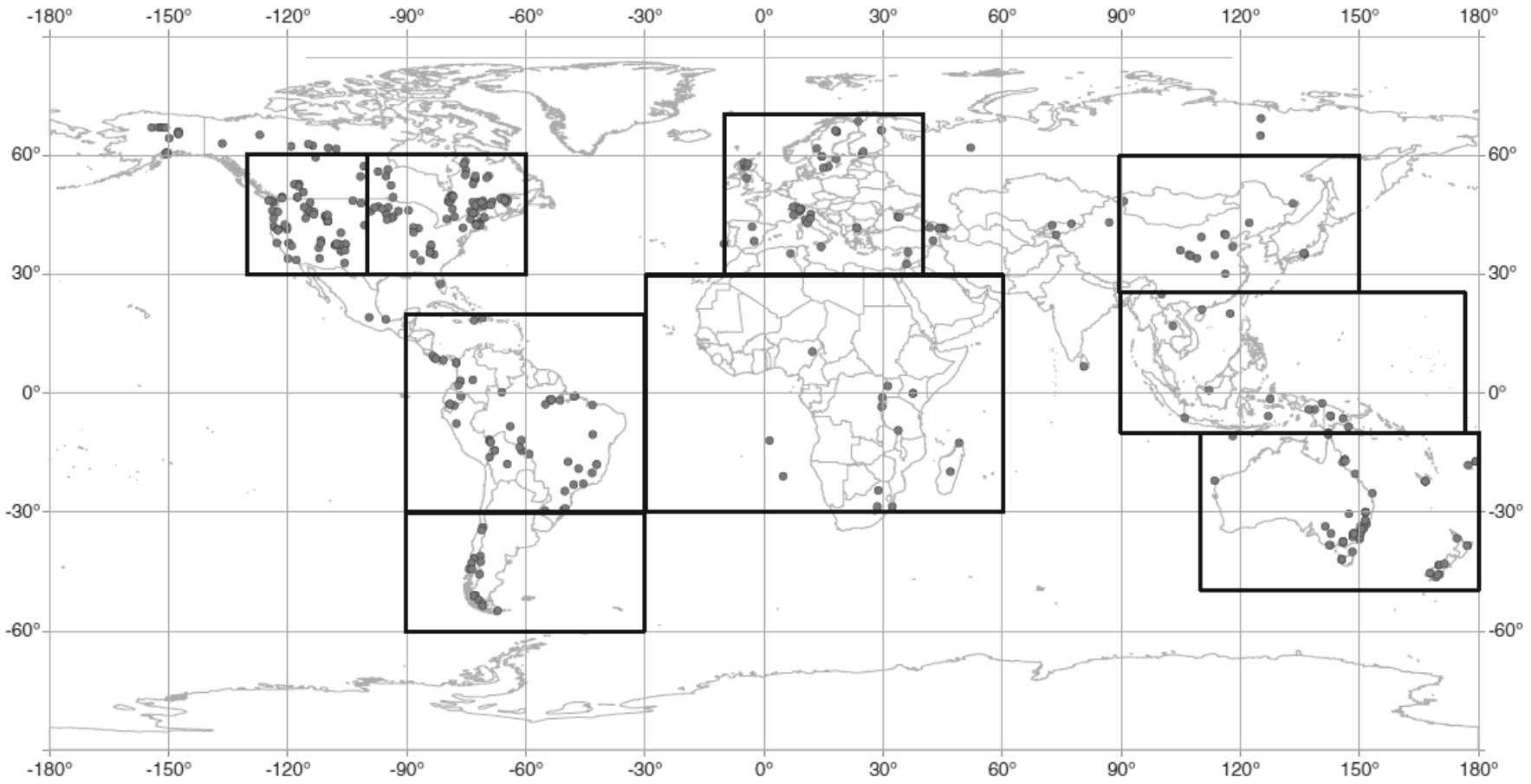


Results from GCD version 1

Power and 83 collaborators, 2008 Climate Dynamics

Changes in fire regimes since the Last Glacial Maximum: an assessment based on a global synthesis and analysis of charcoal data

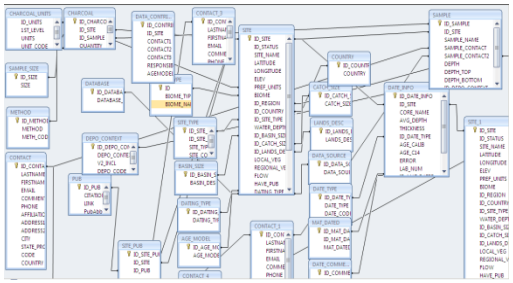
405 sites



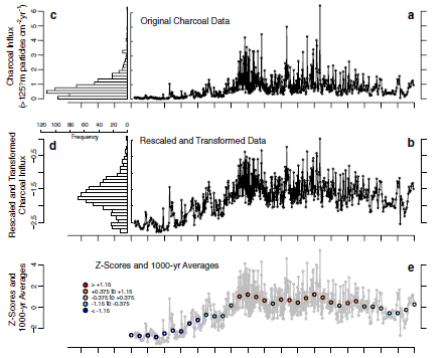
(Power et al. 2008 Clim Dyn)

Data treatment

Extraction of raw data from the database

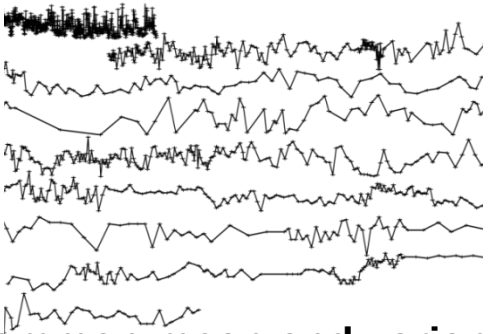


Individual record standardisation



- ✓ Box–Cox transformation
- ✓ Z-scores rescaling

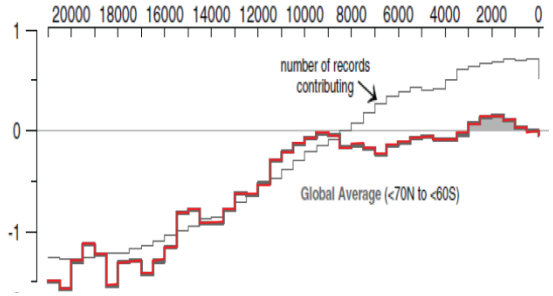
Z-scores by site



Common mean and variance for all sites

Smoothing step

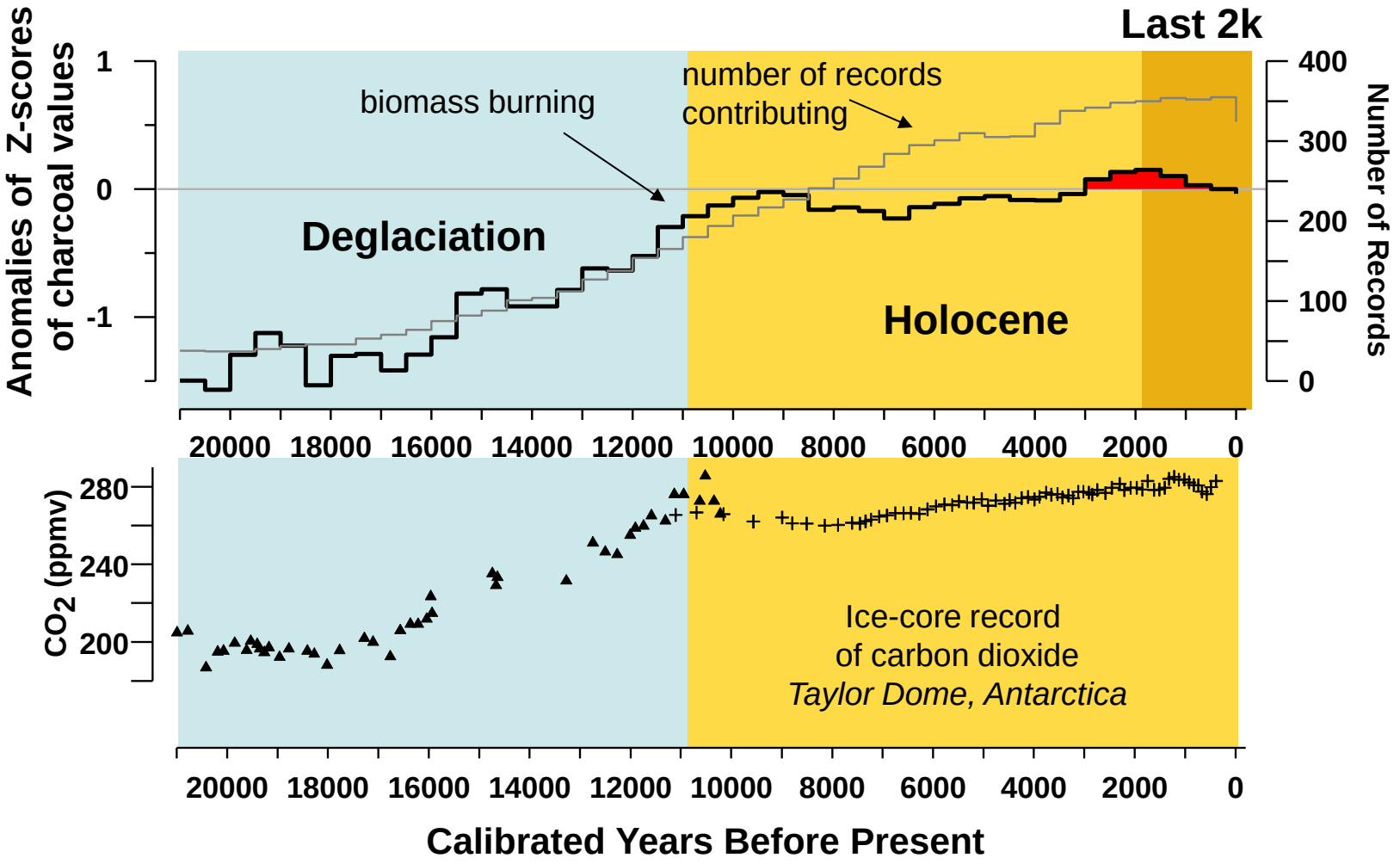
Composite curve



- ✓ Lowess curve fitted to the pooled transformed data

(Protocol in Marlon et al. 2008; Power et al. 2010)

Results from GCD version 1



Transition from cold glacial to warm Holocene climates was marked by a global increase in fire
- climate controls via temperature and biomass level -

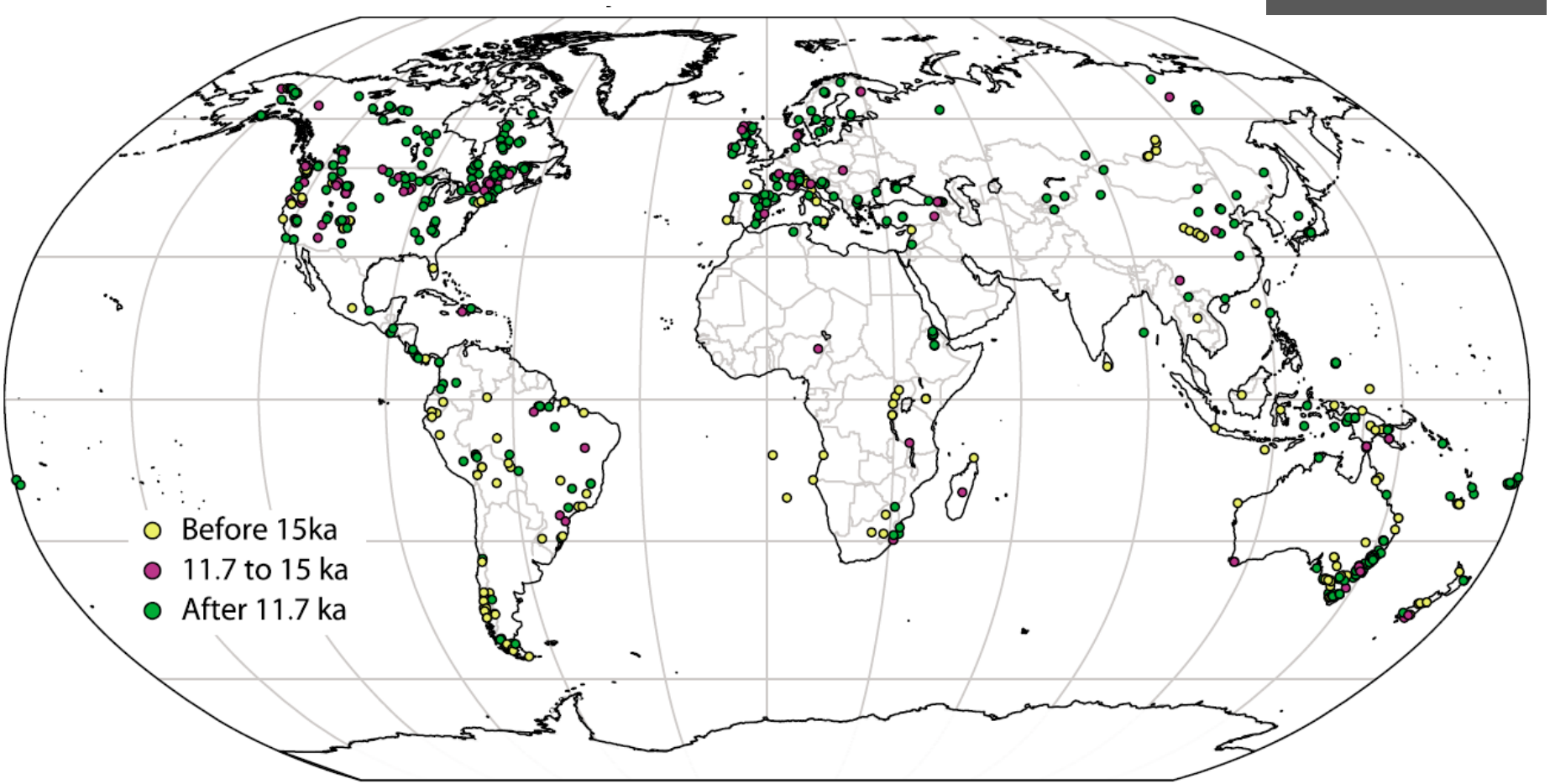
(Power et al. 2008 Clim Dyn)

Results from GCD version 2

Daniau and 61 collaborators, 2012 Global Biogeochemical Cycle

Predictability of biomass burning in response to climate changes

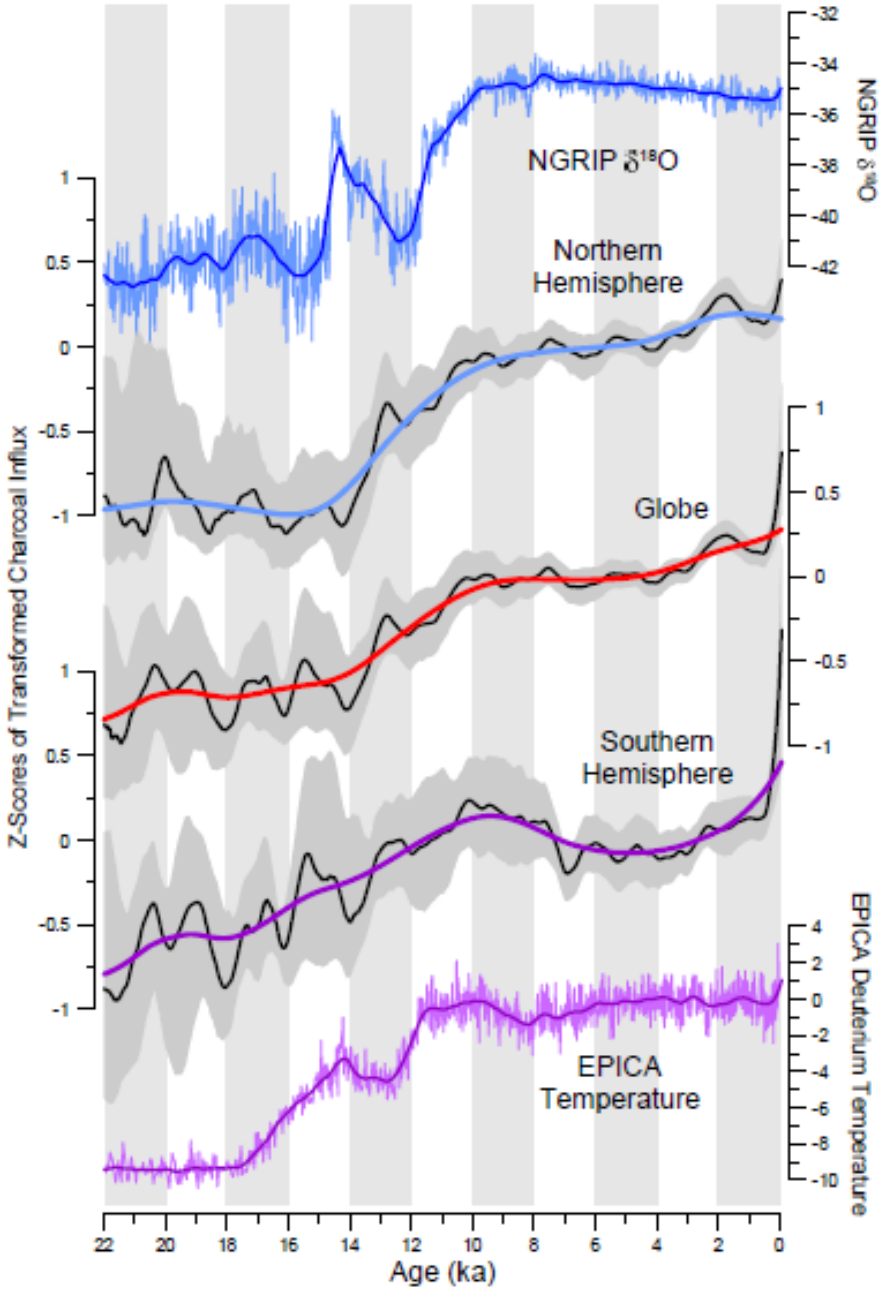
V1+ 274 sites
679 sites

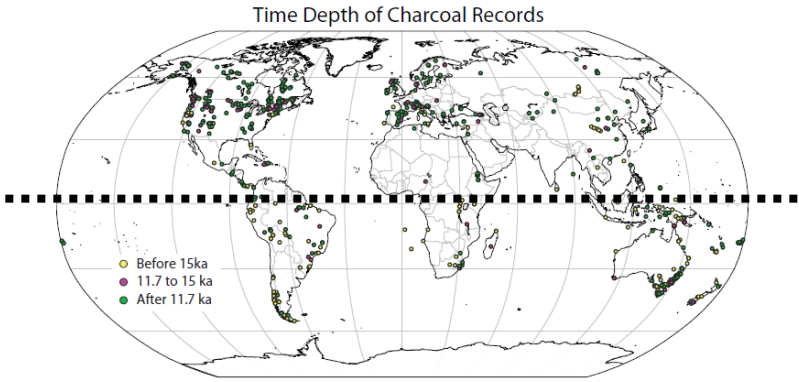


(Daniau et al. 2012, GBC)

Results from GCD version 2

Biomass burning



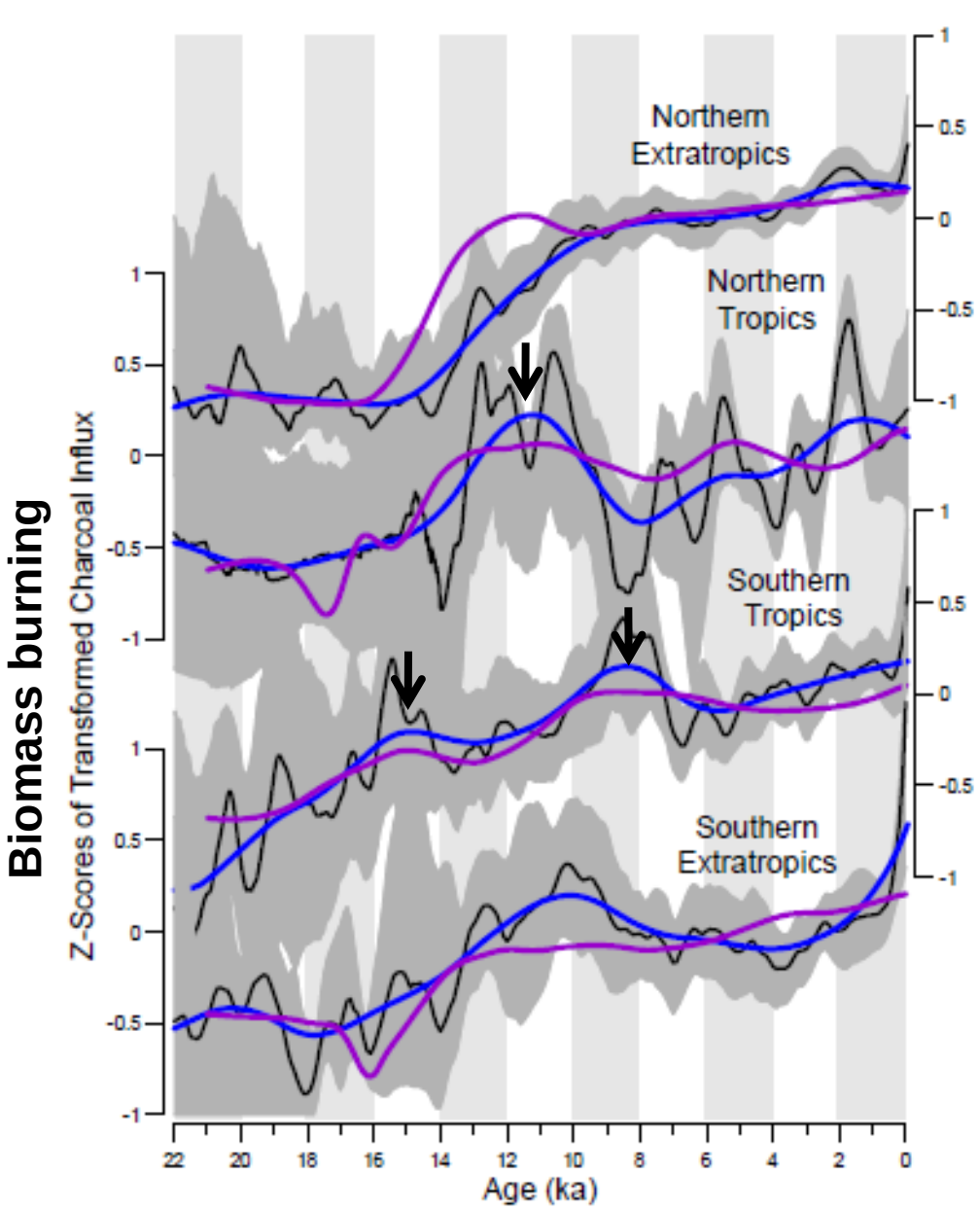


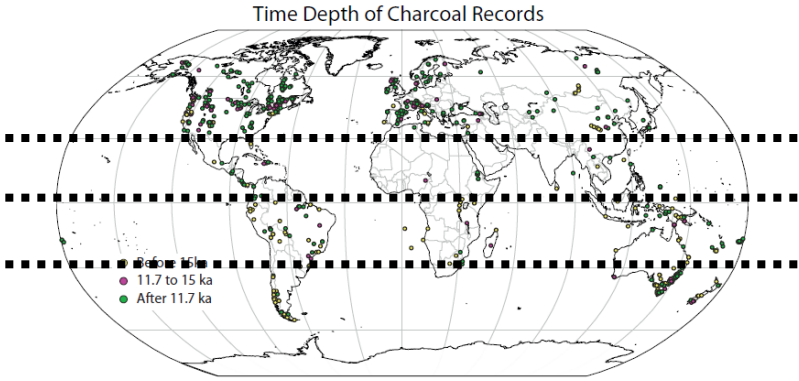
Increase in global biomass burning from glacial to interglacial

Different trends in biomass burning between northern and southern hemispheres

(Daniau et al. 2012, GBC)

Results from GCD version 2





Different trends between northern and southern hemispheres ….

And also between northern and southern tropics and extratropics

→ How to explain these different latitudinal trends in fire and what are the drivers?

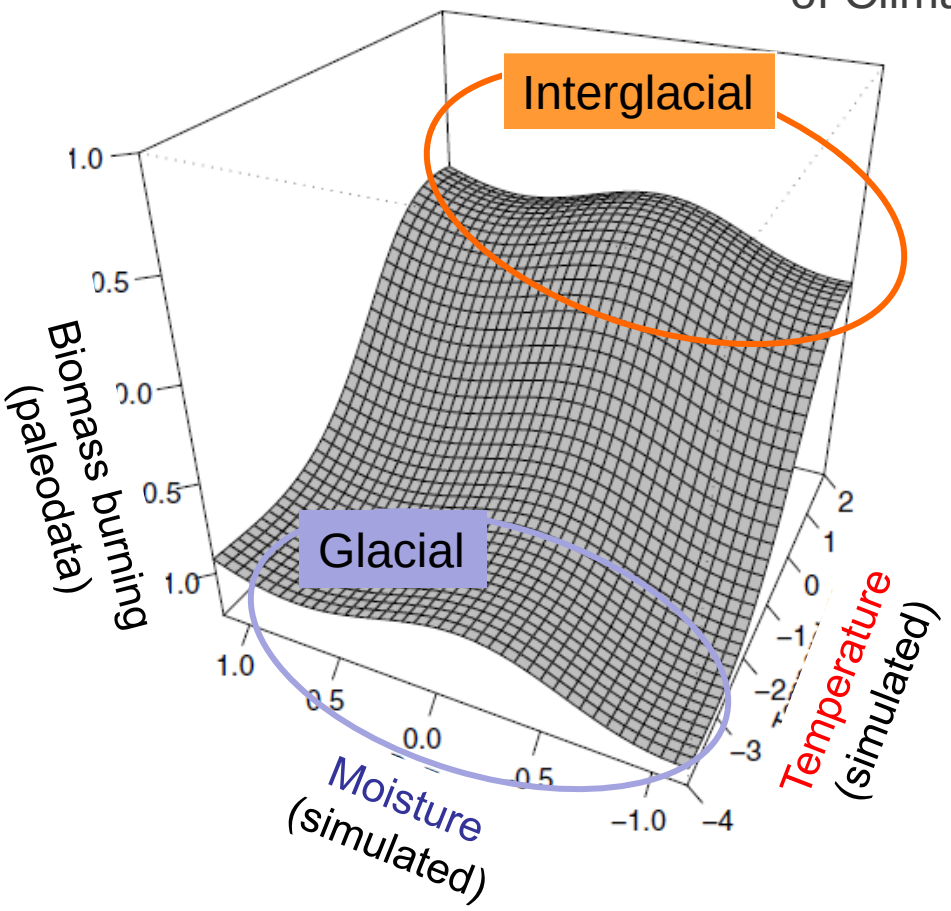
(Daniau et al. 2012, GBC)

Results from GCD version 2

Statistical regression model between biomass burning and simulated climatic variables

- Mean annual temperature
- Precipitation minus Evaporation (moisture index)

→ Simulations obtained from the ECBILT-CLIO model v3 run by changing orbital forcing, ice sheet, topography and greenhouse gas concentrations (Timm and Timmermann, 2007 J. of Climate)



66% of the variance in biomass burning is explained by a single global function of simulated temperature and moisture

Warmer temperatures and intermediate P-E increase fire

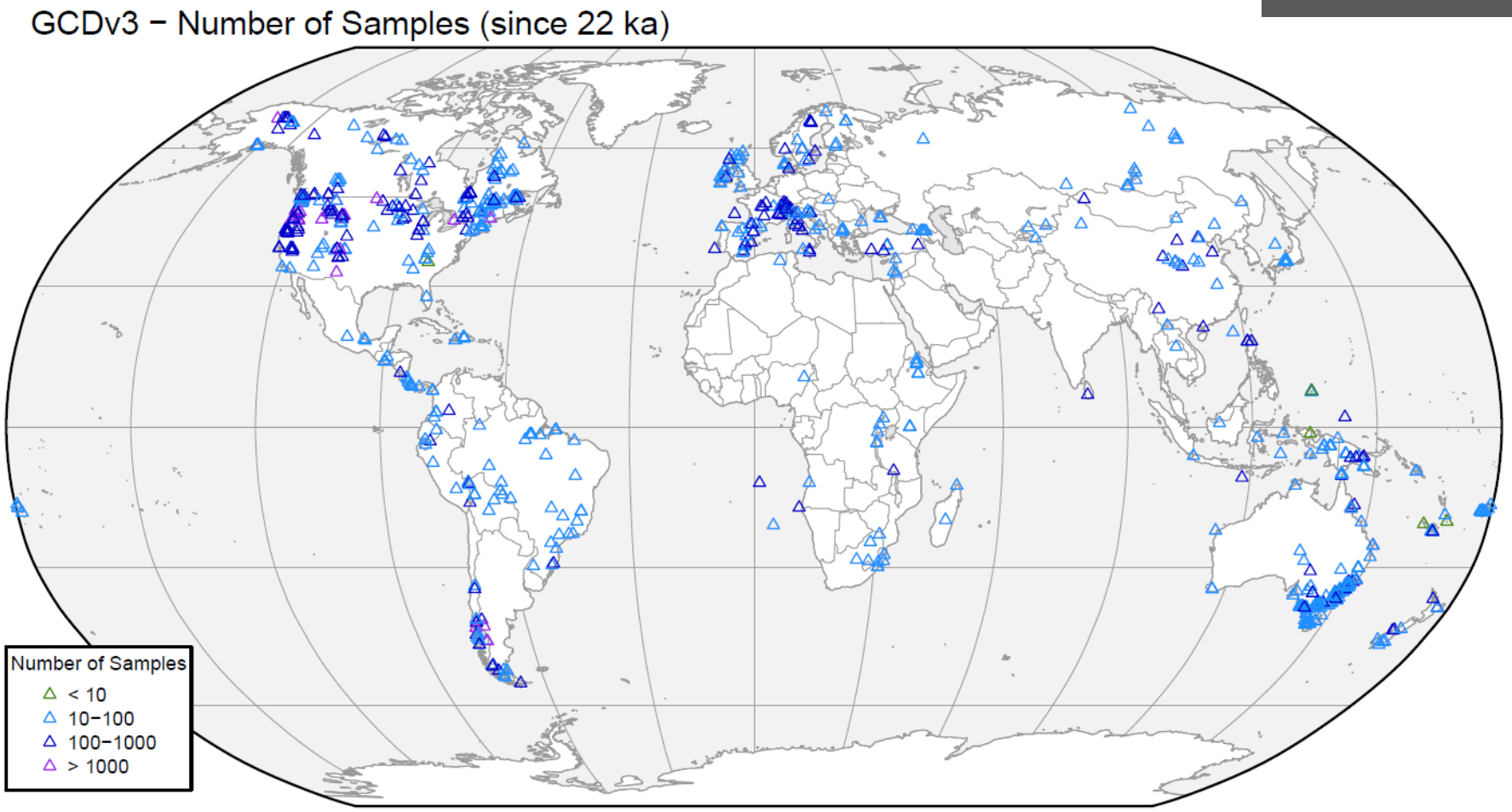
(Daniau et al. 2012, GBC)

Results from GCD version 3

Marlon and 16 collaborators, submitted to Biogeosciences

Reconstructions of biomass burning from sediment charcoal records to improve data-model comparisons

V2 + 56 sites
736 sites



(Marlon et al. submitted)

Results from GCD version 3

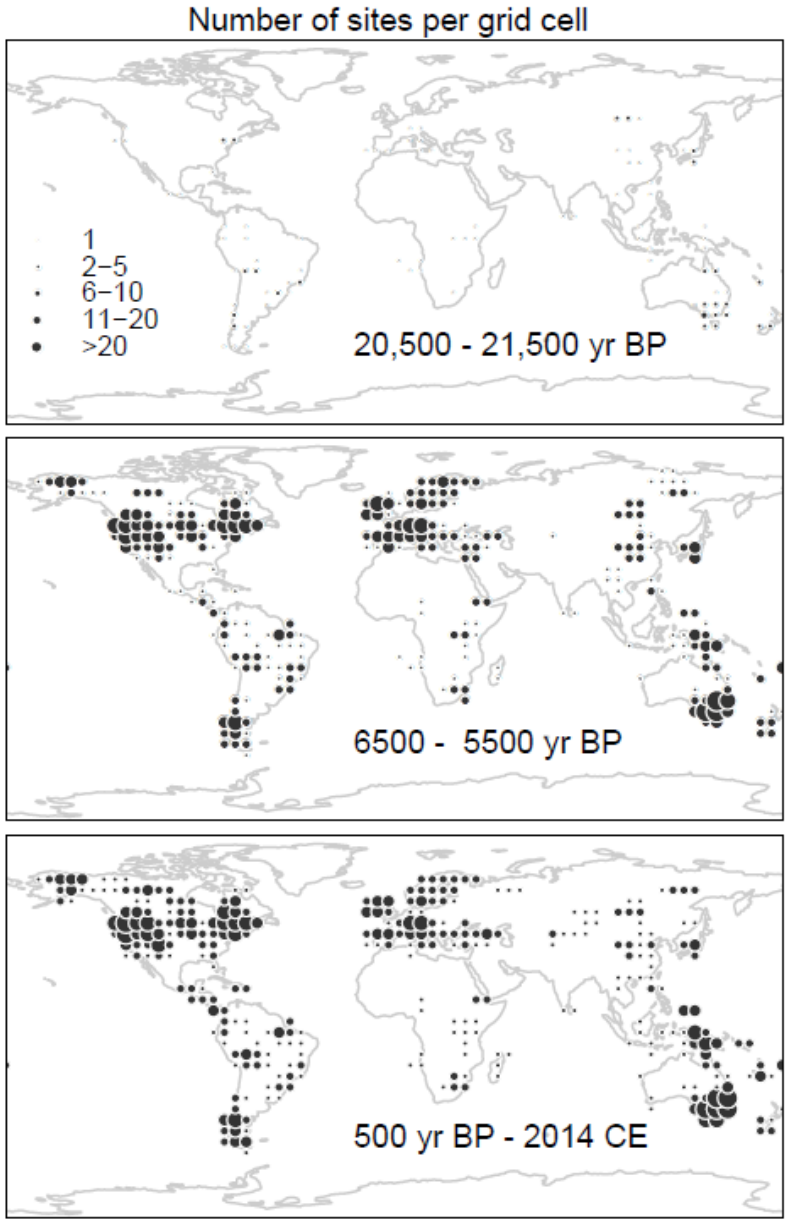
Product:

Spatially gridded version of GCDv3 using dot maps

- Each dot on the map represents a composite charcoal series constructed from all records within a fixed distance of the dot

- All GCD sites contribute to at least one dot -- radius used to identify sites contributing to a dot as half the distance between diagonally adjacent dots at the equator (e.g., ~395 km for a 5° x 5° grid)

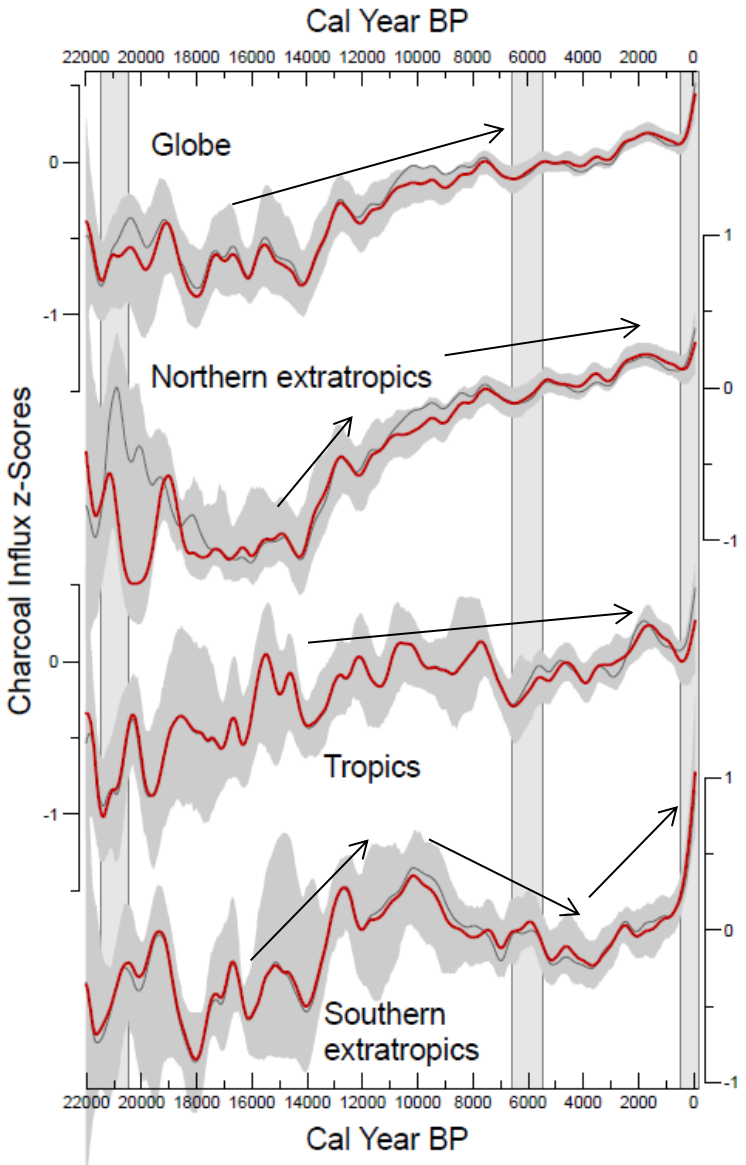
- Gridding approach prevents interpolation into areas that are not represented in the GCD, which is desirable given the great spatial heterogeneity of fire regimes

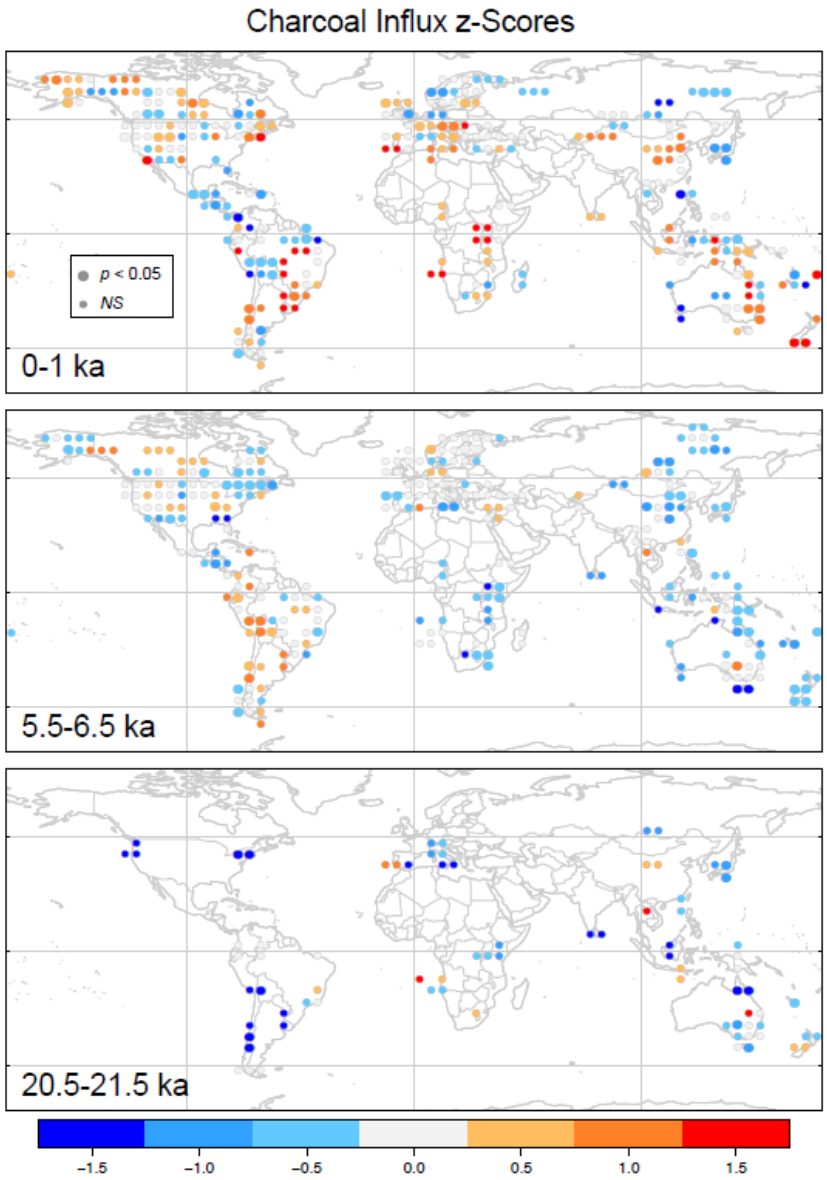


(Marlon et al. submitted)

Results from GCD version 3

(Plotted on a 5° grid, e.g., ~395 km)

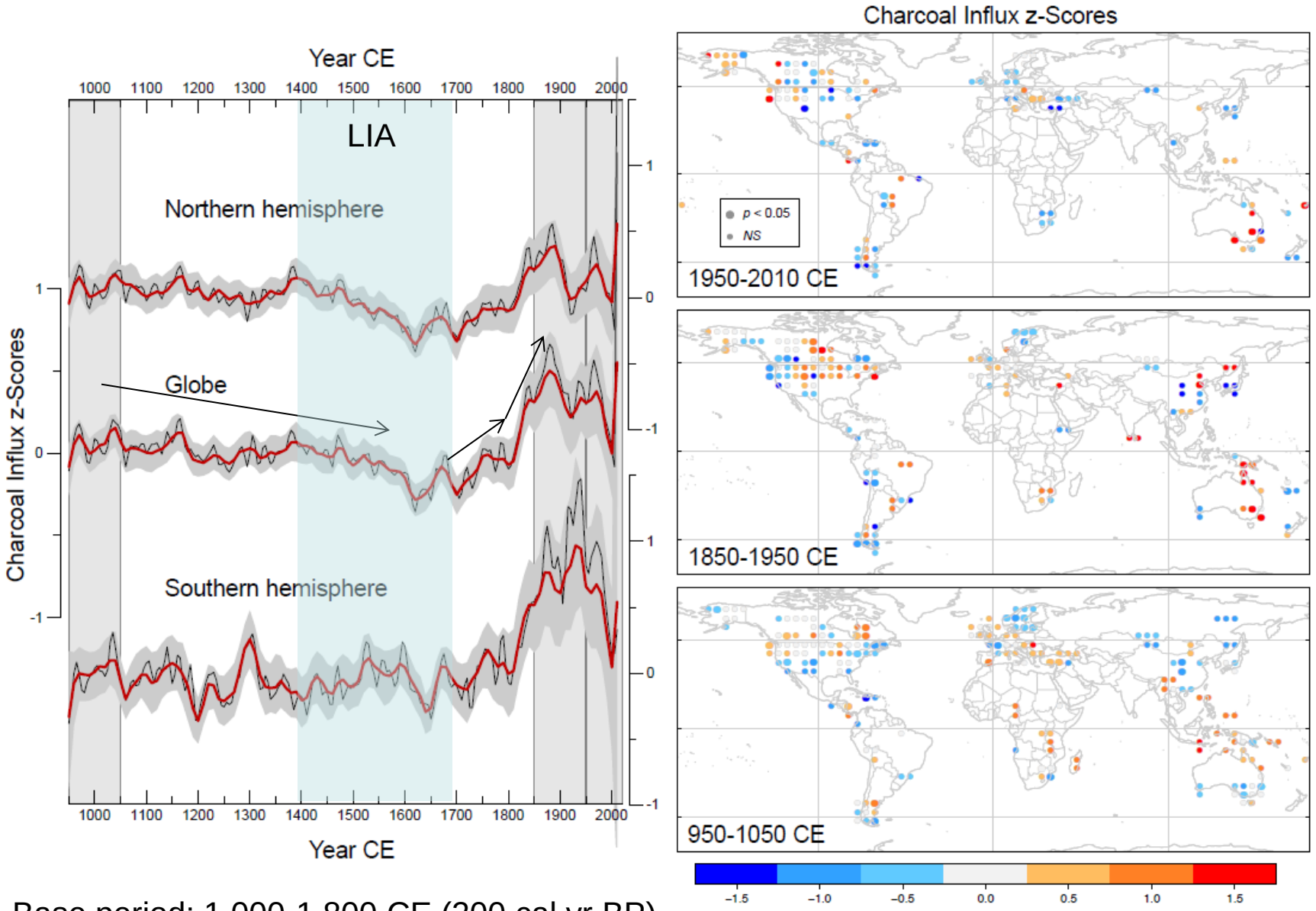




Base period: 21,000-200 cal yr BP

(Marlon et al. submitted)

Results from GCD version 3

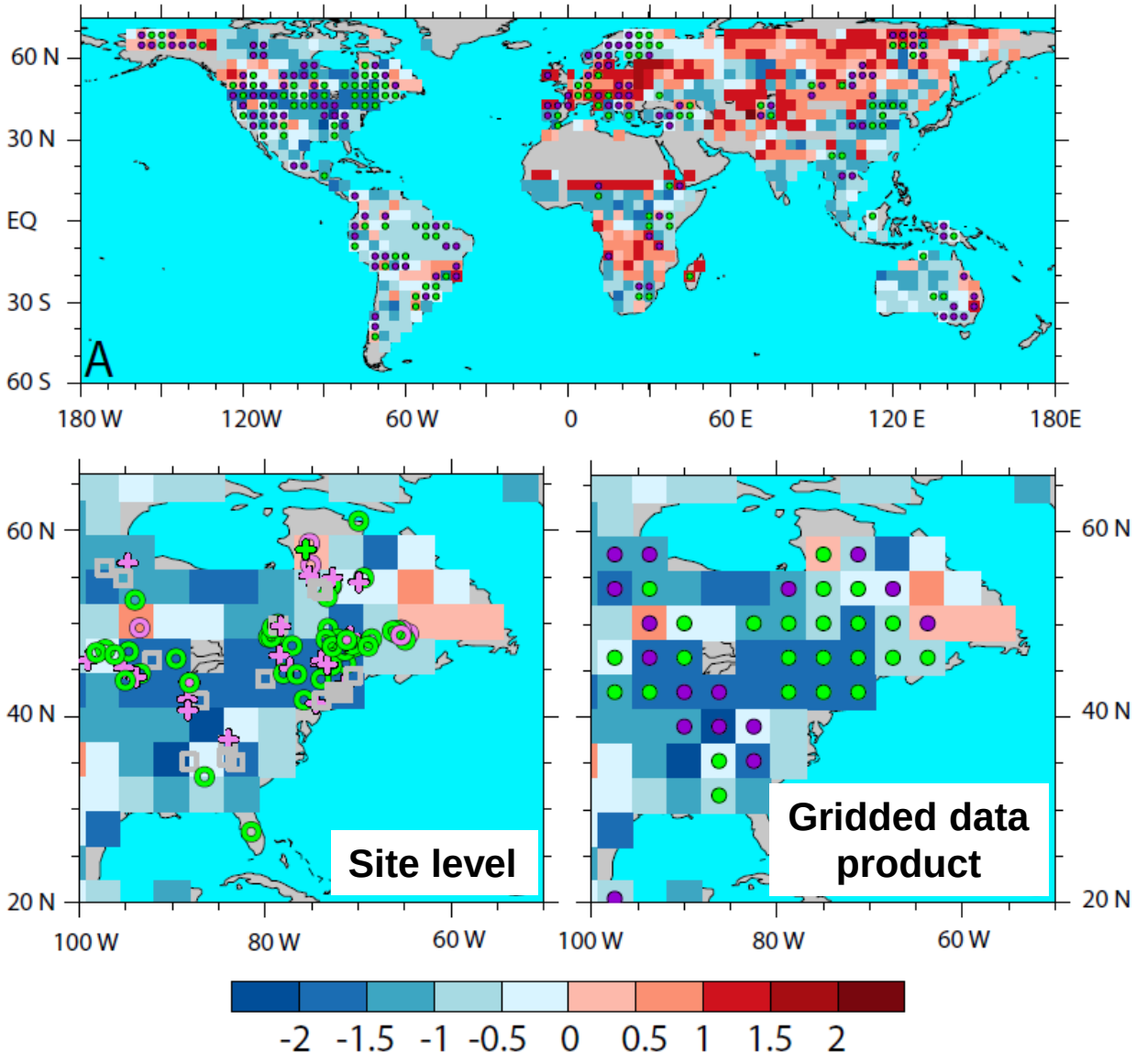


Base period: 1,000-1,800 CE (200 cal yr BP)

(Marlon et al. submitted)

Results from GCD version 3

Example: Gridded-map of simulated area-burned and charcoal anomalies (6ky – 0 BP)



Data and Model:

Agree

Disagree

Simulated area-burned from CLIMBA model (Brücher et al. 2014)

(Marlon et al. submitted)

Thanks to GCD data contributors

Absy Maria Lucia
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Behling Herman
Bennett Keith
Blarquez Olivier
Bradshaw Richard
Bremond Laurent
Briles Christy
Brown Kendrick
Brownlie Katherine
Brunelle Andrea
Buckman Solomon
Burney David
Camill Phil
Carcaillet Christopher
Carrion José S.
Chu GQ
Clark Jim
Colhoun Eric
Connor Simon
Cordova Carlos
Cupper Matthew
Daniau Anne-Laure
Daniels Mark
Davis Basil
D'Costa Donna
Dodson John
Donders Timme
Doughty E
Dull Robert
Dupont Lydie
Edwards Mary
Eshetu Zewdu
ECD-UK
Foster David
Frechette JD
Gaillard-Lemdahl Marie-Jose
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Gebru Tsige
Gerasimenko Natalia
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Hallett Douglas J.
Harle Katherine J.
Harrison Sandy
Higuera Phil
Hope Geoff
Impagliazzo Stafania
IMPD
Inoue Jun
Jones Claire
Kaal Joeri
Kaltenrieder Petra
Kennedy Lisa
Kenyon Christine
Kershaw Peter
Kong ZC
Krivonogov Sergey
Inoue Jun
Jones Claire
Kaal Joeri
Kaltenrieder Petra
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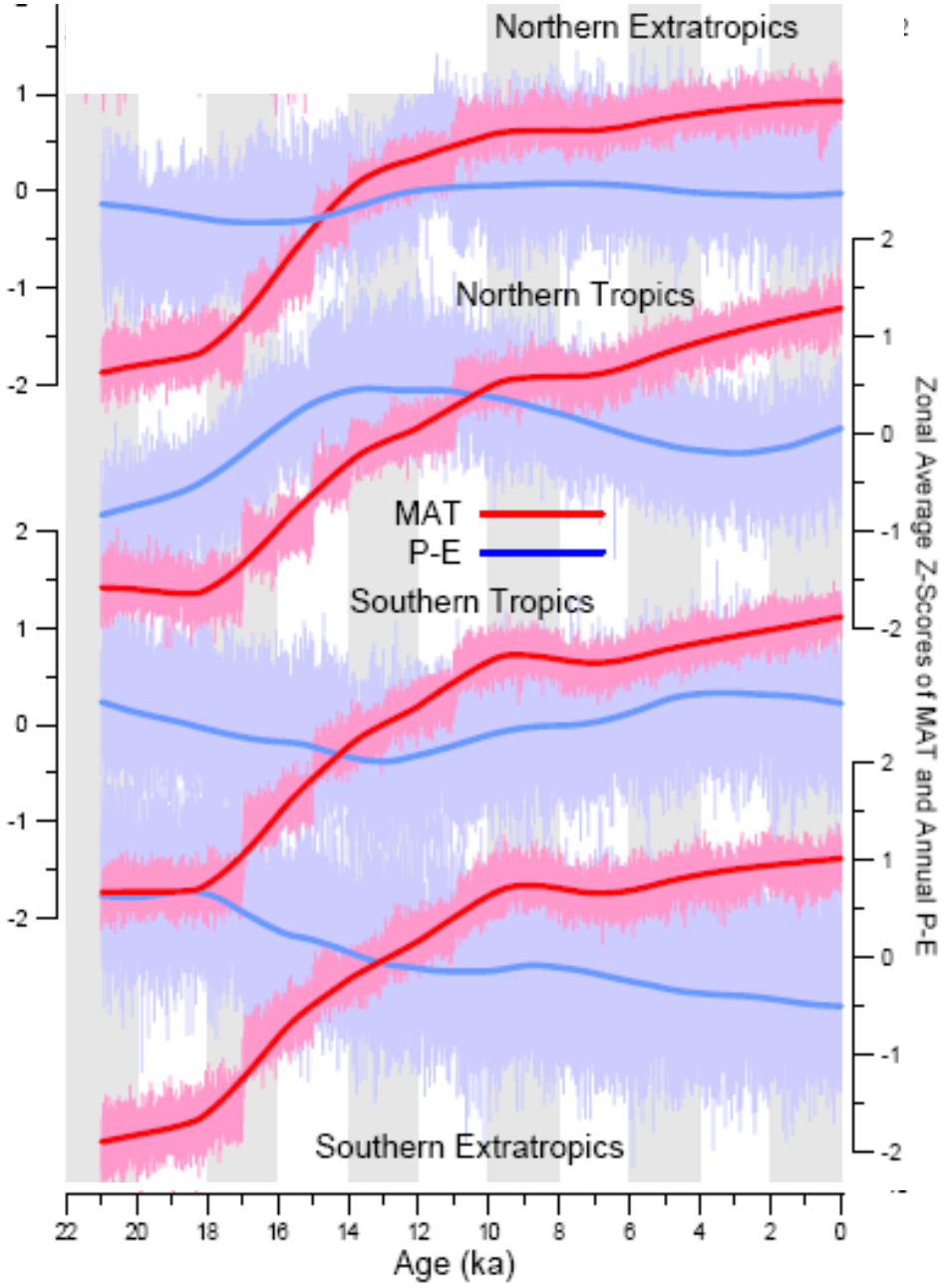
Kenyon Christine
Kershaw Peter
Kong ZC
Krivonogov Sergey
Lane Chad
Lerner Jon
Lindbladh Matts
Long Colin
Lumley Susie
Lynch Beth
Lynch Jason
Magri Donatella
Manabe Tomoko
Marchant Rob
Marinova Elena
Marlon Jennifer
Mayle Francis
McGlone Matt
McKenzie G. Merna
Meeks Scott
Meyer Grant
Minckley Thomas
Miyake Nao
Mohr Jerry
Molinari Chiara
Mooney Scott
Moreno Patricio
Moss Patrick
Nelson David
Neumann Frank Harald
New J
Newnham Rewi
Niinemets Eve
Norstrom Elin
Noti Roland
Ogura Akira
Olsson Fredrik
Oswald Wyatt
Pierce Jen
Poska Anneli
Power Mitchell
Prentice Colin
Richard Pierre
Rius Damien
Roberts Neil
Robinson Guy
Rösch Manfred
Rowe Cassandra
Sasaki Naoko
Scharf Elizabeth
Shuman Bryan
Simard Isabella
Stevenson Janelle
Takahara Hikaru
Taylor Zack
Terwilliger Valery
Tierney Jessica
Toney Jaime
Turner Rebecca
Turney Chris
Umbanhowar Charles
Urrego Dunia
Valsecchi Verushka
Vandergoes Marcus
Vannière Boris
Vedrova Estella
Vescovi Elisa
Walsh Megan
Wang Xuan
Whitlock Cathy
Wick Lucia
Williams Nicola
Wilmshurst Janet
Yu Shiyong
Zewdu Eshetu
Zhang Jiahua H
Zhang Yun
Zhao Yan
Zong Yongqiang

Results from GCD version 2



Simulated climatic variables obtained from Timm and Timmermann (2007, J. of Climate)

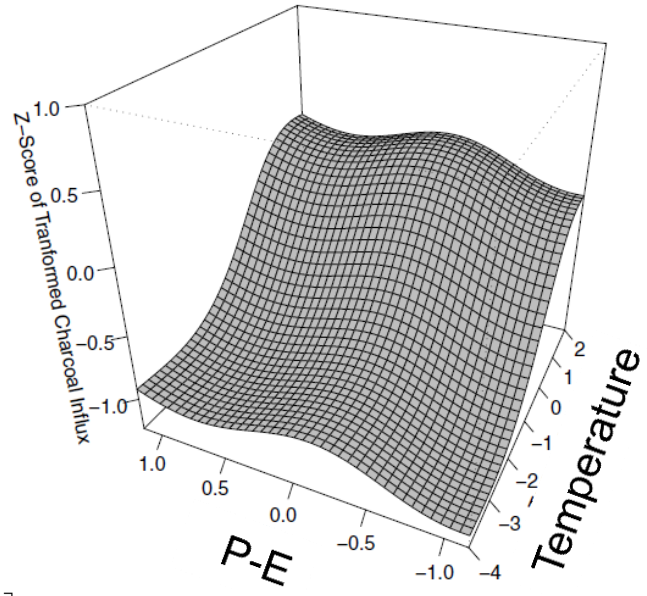
- Mean annual temperature
- Precipitation minus Evaporation

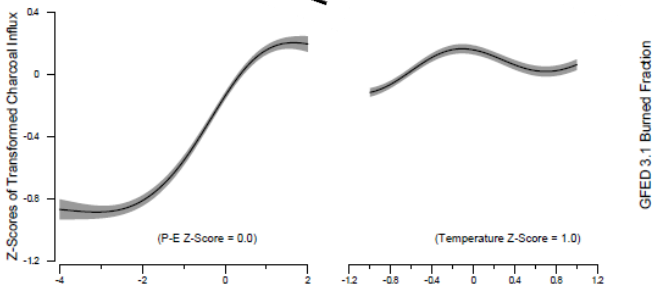
Results from GCD version 2

Paleo GAM

Charcoal vs. EcBilt Transient Data

21 – 0 kya





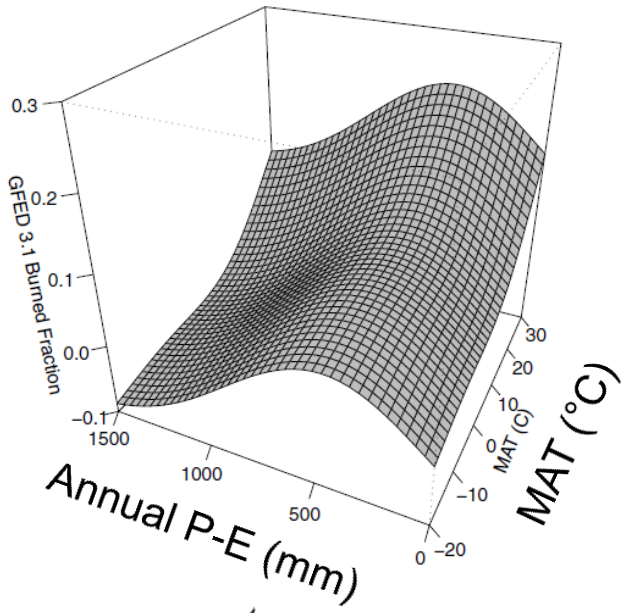
MAT Anomalies P-E Anomalies

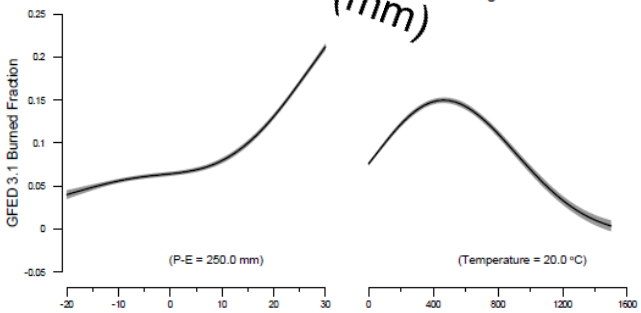
Warmer temperatures and intermediate P-E increase fire

Modern GAM

GFED Area burned vs. CRU Data

1996-2009 1961-1990





MAT (°C) Annual P-E (mm)

(Daniau et al. 2012, GBC)

(EcBilt - Timm & Timmermann, 2007; GFEDv3 - van der Werf et al. 2010; CRU - New et al. 2002)