Drivers and climatic impact of organic carbon burial: comparing OAE2 and the PETM

Nina M. Papadomanolaki[1*], Richard E. Zeebe[2], Appy Sluijs[1] and Caroline P. Slomp[1]

*e-mail: n.papadomanolaki@uu.nl

[1]Department of Earth Sciences, Utrecht University, The Netherlands [2]Department of Oceanography, University of Hawaii at Manoa, USA

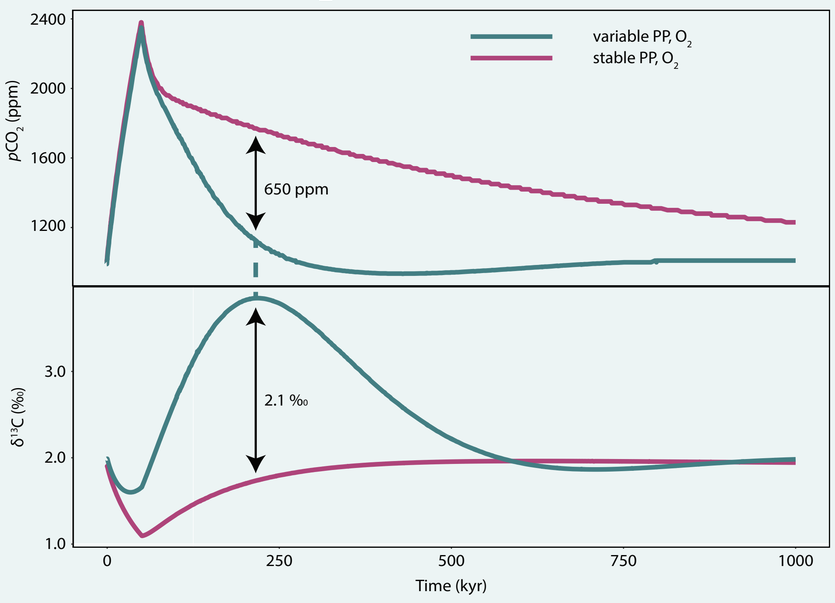
INTRODUCTION

The **positive d^{13}C** excursion and ***p*CO$_2$ decrease** during **OAE2**, including the **Plenus Cold Event**[1-2], and the initially rapid **δ^{13}C recovery** during the termination of the **PETM**[3-4] are hypothesized to be the result of enhanced **organic C** (C_{org}) **burial**[5-6].

In this study, we present results from carbon-cycle box **models**, LOSCAR and a new C-O_2-P model (NMP_UU), which includes coastal marine environments, to assess the potential **drivers of enhanced C_{org} burial** and their **impact** on the **carbon cycle** during OAE2 and the PETM. We focus on the role of eutrophication, deoxygenation and redox-dependent P recycling and also present a data compilation for the PETM.

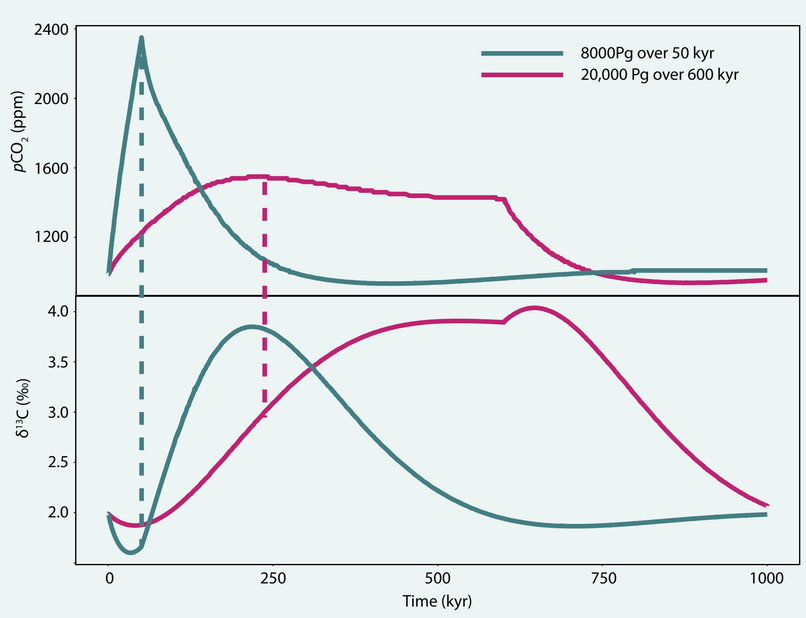
RESULTS: OAE2

pCO_2 and δ^{13}C with/without O_2 feedback (LOSCAR)



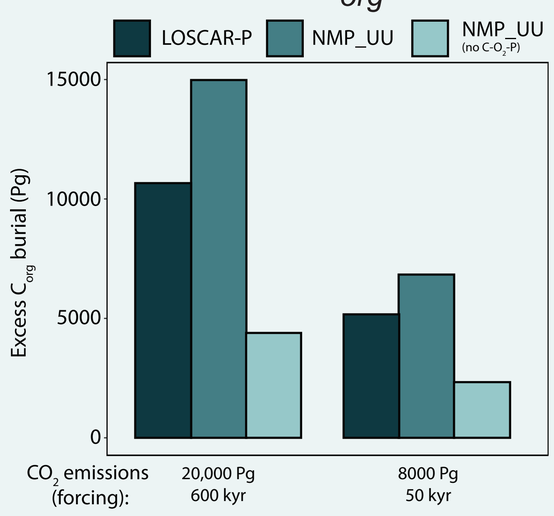
Using an emission scenario of **8000Pg/50kyr** in LOSCAR-P we show that the ***p*CO$_2$ decrease and d^{13}C increase** can be attributed to **enhanced C_{org} burial** through eutrophication and ocean deoxygenation.

pCO_2 and δ^{13}C per CO_2 emission scenario (LOSCAR)



By comparing **long emission scenarios**[9] in LOSCAR with **short** ones we show that only the **latter** produces the simultaneous **drop in *p*CO$_2$** and **increase in δ^{13}C**, which is seen in data[4].

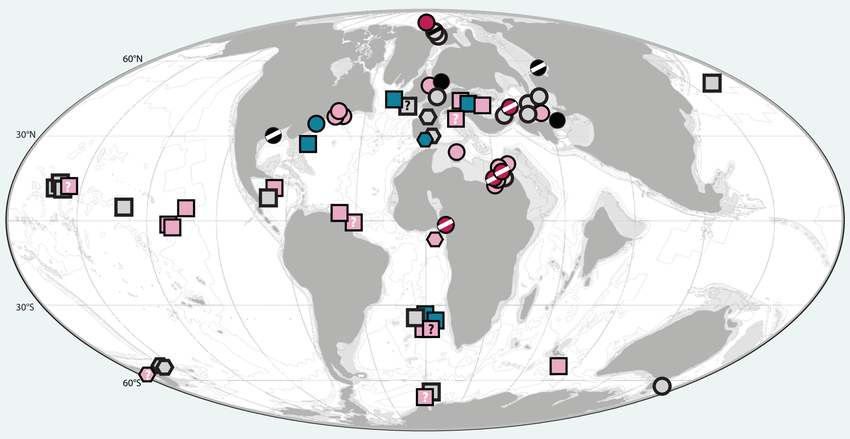
Excess C_{org} burial



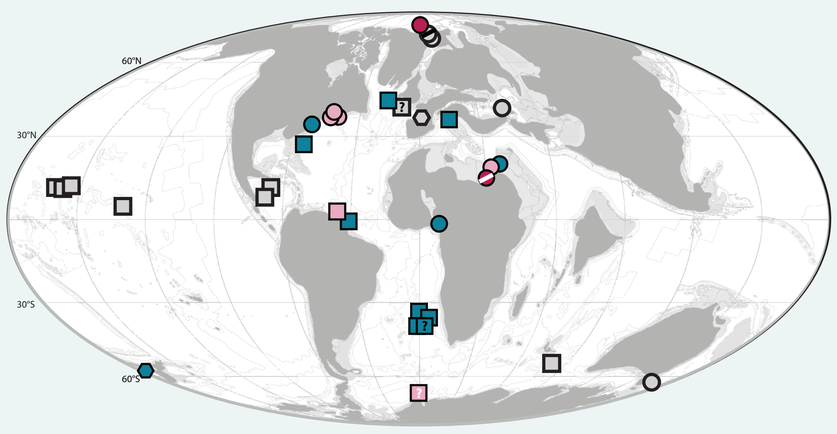
Increased **external P** together **with redox-driven P recycling** are required to simulate the **required C_{org} burial** for CO_2 drawdown in NMP_UU.

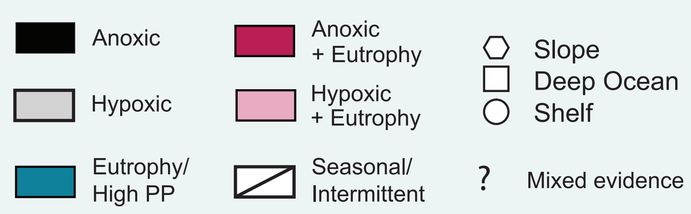
RESULTS: PETM

Whole event (all available data)



Termination

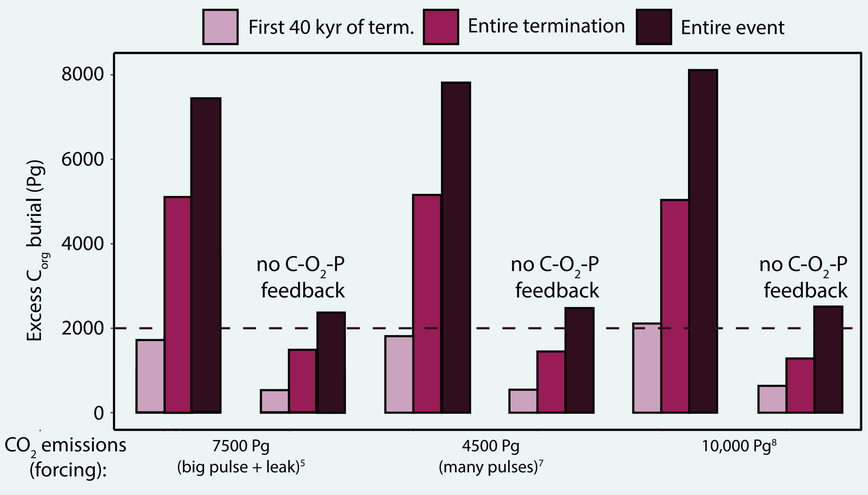




Our data compilation shows widespread **eutrophication** and **ocean deoxygenation** across the open and coastal ocean, with signs of recovery during the **termination**. However, model results (not shown here) suggest **recovery** of **P burial is slow** and may have facilitated **ongoing C_{org} production and burial** during the termination.

Using emission scenarios from literature, we show with NMP_UU that, besides increased external P input, redox-dependent **P recycling** is **required** to cause **excess** burial of **~2000 Pg C**[3-4] during the termination of the PETM. **Shelf** burial generally accounts for more than **70%** of burial.

Excess C_{org} burial



CONCLUSIONS

1. Increased C_{org} burial, coincident with a break or drop in CO_2 emissions, is key for reconstructing **OAE2** ***p*CO$_2$** and δ^{13}C trends.

2. Deoxygenation and reduced P burial are required for 2000+ Pg excess C_{org} burial during **PETM**.

1 Jenkyns (2010) G^3 2 Jarvis et al. (2011) *Paleoc. Paleocl.* 3 Bowen and Zachos (2010) *Nature* 4 John et al. (2008) *Paleoc. Paleocl.* 5 Komar and Zeebe (2017) *EPSL* 6 Ruvalcaba Baroni et al. (2014) *Biogeosciences* 7 Frieling et al. (2016) *PNAS* 8 Gutjahr et al. (2017) Nature 9 Du Vivier et al. (2015) *EPSL*

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Utrecht University