The Coniacian-Santonian Oceanic Anoxic Event OAE3 - global correlation of subevents

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Earth system changes during the cooling greenhouse phase of the Late Cretaceous: Coniacian-Santonian OAE3 subevents and fundamental variations in organic carbon deposition

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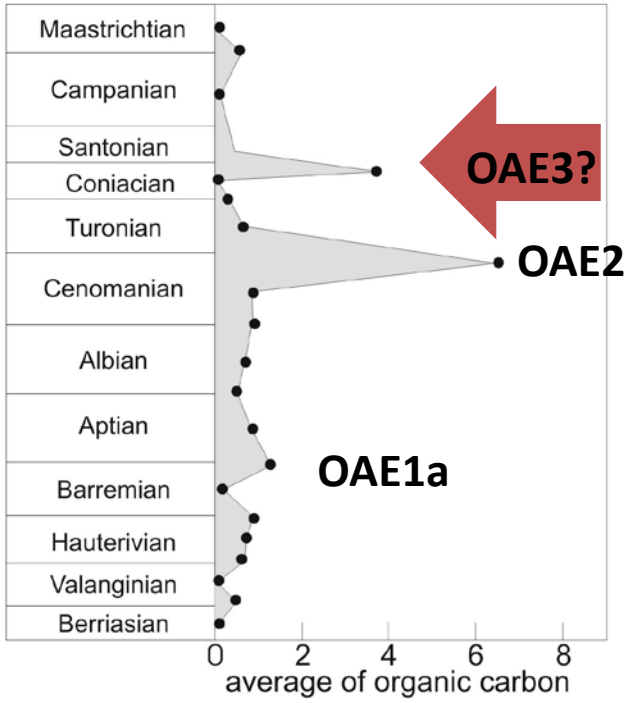
OAE3 – Oceanic Anoxic Event 3



Average values of organic carbon plotted by stage from DSDP Legs 1 - 48 in the North Atlantic Ocean. Arthur & Schlanger, 1979, AAPG Bull 63, 870-885

Arthur & Schlanger, 1979: "*A third and less widespread oceanic anoxic event of Coniacian-Santonian age, which affected mainly the southern North Atlantic, Caribbean and South Atlantic regions,…*"

[Jenkyns, 1980; Arthur et al, 1990; Wagreich, 2009, 2012]

Arthur & Schlanger, 1979

Compilation of Coniacian-Santonian sites

Compilation of geochemical and isotope proxy data of more than 95 study sites

A. Mansour and M. Wagreich

Table 1
Localities that contain a Coniacian-Santonian stratigraphic succession used to conduct this study and their associated data sources. Numbers of the compiled study areas refer to their location in the C/S paleogeographic map of Fig. 1.

No.	Locality		References
1	BED2-3 well, Abu Gharadig Basin, Egypt	Southern Tethys	Mansour et al. (2020)
2	Negev, Israel		Soudry et al. (2006)
3	Asterisk, Zagros Basin, Iran		Navidtalab et al. (2016)
4	Shahneshin section, Zagros Basin, Iran	Eastern Tethys	Razmjooei et al. (2020)
5	Gura, Tibet		Wendler et al. (2011)
6	Tingri, Tibet		Wendler et al. (2009)
7	Chuangde, Tibet		Wang et al. (2005)
8	Gongzha, Tibet	Southeastern Tethys, Tibet	Li et al. (2006); Wendler et al. (2009)
9	Gyangze, Tibet		Hu (2002)
10	TDP Site 39, Ruvuma Basin, SE Tanzania		Petrizzo et al. (2017)
11	Exmouth Plateau, ODP Site 762C		Clarke and Jenkyns (1999); Falzoni et al. (2013, 2016)
12	Exmouth Plateau, ODP Site 763		Clarke and Jenkyns (1999)
13	Exmouth Plateau, ODP Site 766		Robinson et al. (2010); Clarke and Jenkyns (1999)
14	Kerguelen Plateau, ODP Site 1138	Indian Ocean	Murphy and Thomas (2012); O'Connor et al. (2019)
15	Kerguelen Plateau, ODP Site 1135		O'Connor et al. (2019)
16	Naturaliste Plateau, DSDP Site 258		Huber et al. (1995, 2018)
17	IODP U1512, Bight Basin	Australo-	MacLeod et al. (2020)
18	Voluta-1 well, Otway Basin	Antarctica Gulf	Gallagher et al. (2005)
19	X1–4 borehole, Songliao Basin		Xi et al. (2018)
20	SK1-S core, Songliao Basin	Extreme east Asia, NE China	Chamberlain et al. (2013); Hu et al. (2015); Wang et al. (2016); Jones et al. (2018)
21	SK-1n core, Songliao Basin		
22	Crimean Mountains, Russia		
23	Mangyshlak Peninsula, Russia		Kopaevich et al. (2007)
24	NE Caucasus, Madzhalis		Tur and Wagreich (2005)
25	Bottaccione, Scaglia Rossa, Italy	Northern Tethys	Arthur and Fischer (1977); Jenkyns et al. (1994); Sprovieri et al. (2013)
26	Contessa Quarry, near Gubbio, Italy		Stoll and Schrag (2000)
27	Apennine Carbonate Platform, Italy — Mt. Varchera		
28	Mt. Coccovello		Frijia et al. (2015)
29	Trentinara		
30	Katafito, Pindos Basin, Greece		Neumann and Wagreich (2009)
31	Dubovcy section, western Ukraine		Remin et al. (2016)
32	Lipnik-Kije section, Poland		
33	Outer Western Carpathians, Czech		Skupien et al. (2009)
34	Northern Calcareous Alps (NCA) active margin, Flysch Zone, and Helvetic-Ultrahelvetic sections, Austria	Northern Tethys	Wagreich et al. (2009)
35	NCA, Upper Gosau subgroup, Austria		Wagreich and Krenmayr (2005)
36	Rehkogelgraben section, Austria		Neumann and Wagreich (2009)
37	Subbetic Zone, Spain		Vera et al. (1982)
38	near Caravaca, Santa Ines, Spain		Stoll and Schrag (2000)
39	Olazagutia, Spain		Lamolda and Paul (2007)
40	NCA, Dalsenalm, Germany		Wagreich et al. (2009)
41	Lägerdorf-Kronsmoor-Hemmoor	Boreal Realm	Voigt et al. (2010)

Table 1 (*continued*)

No.	Locality		References
42	White Chalk, Shearwater, North Sea		Eldrett et al. (
43	English Chalk, Seaford Head		Jenkyns et al.
44	English Chalk, East Kent		Jarvis et al. (2 Thibault et al.
45	Nuussuaq Basin, Umiivik-1 well	West Greenland	Dam et al. (1
46	Hoodoo Dome, Sverdrup Basin		Pugh et al. (2
47	Sawtooth Range, Sverdrup Basin	Arctic Canada	Davies et al. (
48	Slidre Fiord, Sverdrup Basin		
49	Cold Lake	Canadian Western Interior Seaway	Schröder Ada (2012)
50	16-4-22-15 W4 Core		Tessin et al. (
51	Aristocrat Angus 12-8		Locklair and (2008); Joo a (2014)
52	Berthoud State Core #3		Pratt et al. (1
53	Libsack 43-27	American Western Interior Seaway	Locklair and (2008)
54	USGS#1 Portland		Locklair et al. Tessin et al. (
55	Austin Chalk, near Dallas, Texas		Gale et al. (2
56	Blake Nose, ODP Site 1050	North Atlantic	Huber et al. (
57	Hatteras Rise, DSDP Site 603		De Graciansky Stein et al. (1
58	Bermuda Rise, DSDP Site 386		Robinson and
59	Newfoundland Basin, ODP Site 1276		Tucholke et a Robinson and
60	Irelanda, Goban Spur, DSDP Site 549	North Atlantic	Linnert et al. de Souza et al
61	Off Galicia Bank, ODP Site 398, Portugal		
62	Gibraltar, DSDP Site 136		De Graciansky
63	DSDP Site 369		
64	Sondge 1–2, Tarfaya Basin, Off west Africa		Sachse et al. (
65	S-13, S-75, Tarfaya Basin, Off west Africa		Prauss (2015)
66	SN 1–4, Tarfaya Basin, Off west Africa,	Eastern Equatorial	Aquit et al. (2
67	DSDP Site 367, Cape Verde	Atlantic	De Graciansky
68	DSDP Site 368, Cape Verde		Martin et al. (
69	Site 959, DIB, Off Ivory Coast and Ghana		Wagner et al. Hofmann and (2011); Beckn (2005a)
70	DSDP Site 364, Angola Basin		
71	DSDP Site 530, Walvis Ridge		Jacquin and d (1988)
72	DSDP Site 363, Walvis Ridge		
73	DSDP Site 361, Cape Basin		
74	DSDP Hole 690C, Maud Rise		
75	DSDP Site 511, Falkland Plateau		Jacquin and d (1988); Huber 2018)
76	DSDP Hole 327A, Falkland Plateau	South Atlantic	
77	ODP Site 700, East Georgia Basin		Moiroud et al
78	DSDP Site 516, Rio Grand Rise		
79	DSDP Site 357, Rio Grand Rise		Jacquin and d (1988)
80	DSDP Site 356, Rio Grand Rise		
81	ODP Site 1257, Demerara Rise		
82	ODP Site 1258, Demerara Rise		Böttcher et al. et al. (2006)
83	ODP Site 1259, Demerara Rise	Western Equatorial Atlantic	Friedrich et al Junium et al.
84	ODP Site 1260, Demerara Rise		Böttcher et al. (2006)
85	ODP Site 1261, Demerara Rise		Böttcher et al. (2006); Flögel et al. (2008); Beckmann et al. (2008); März et al. (2009)

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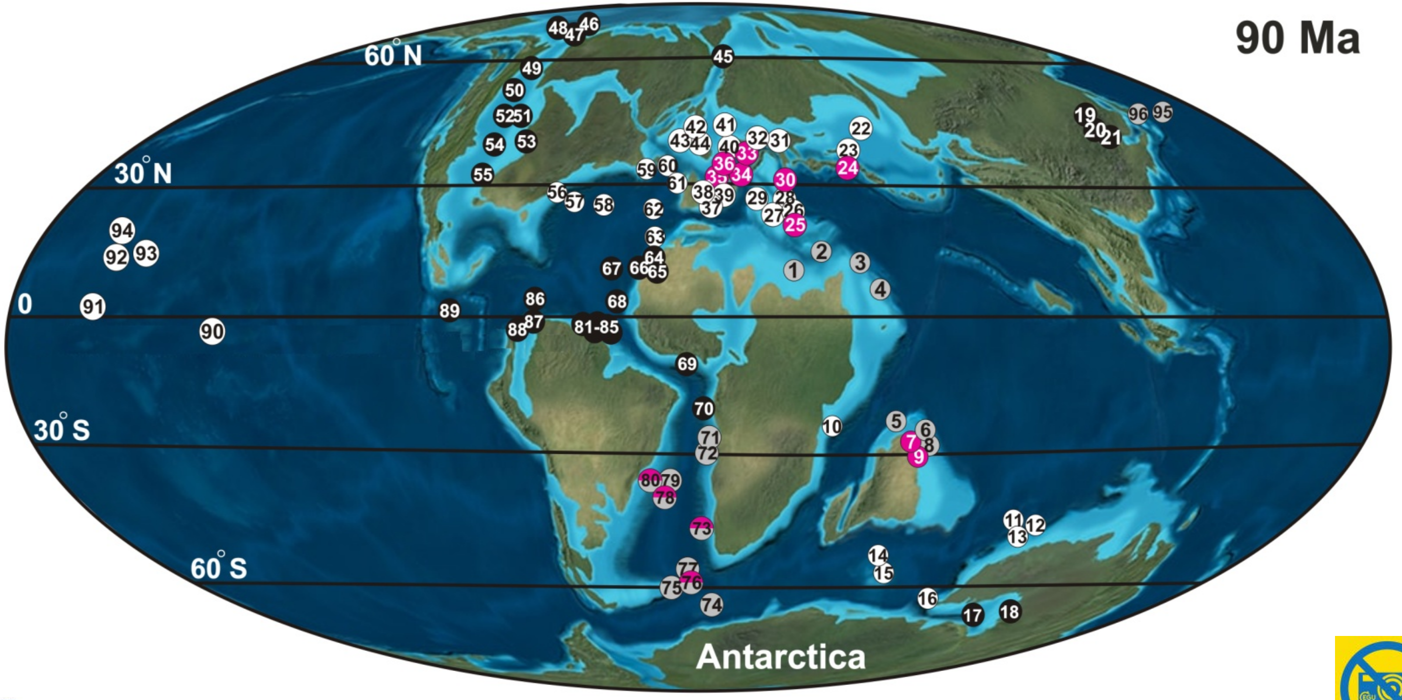

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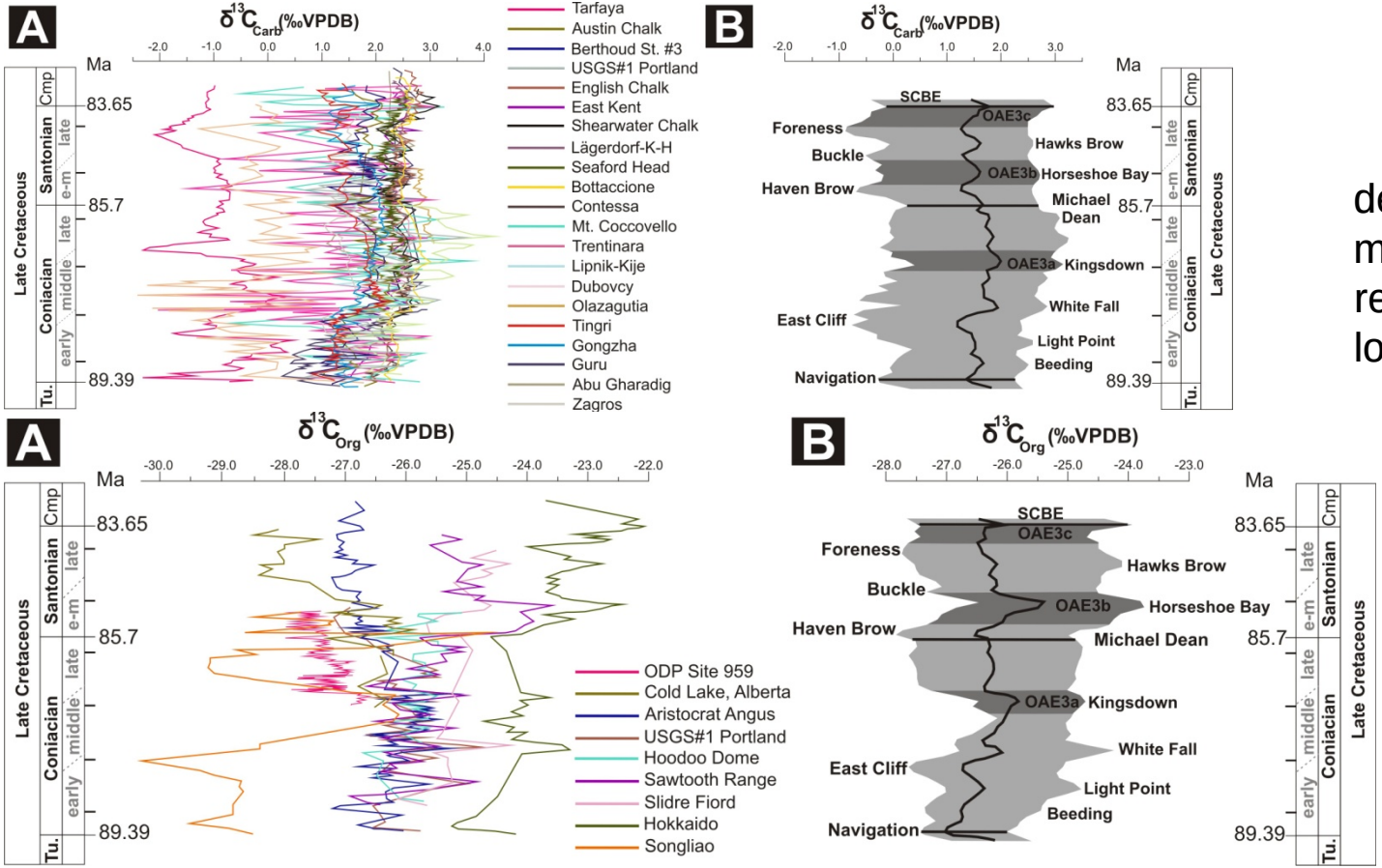
Carbon isotope stack for Coniacian-Santonian



δ13C carbonate

Summing up deviations from local mean values due to regional differences and local factors

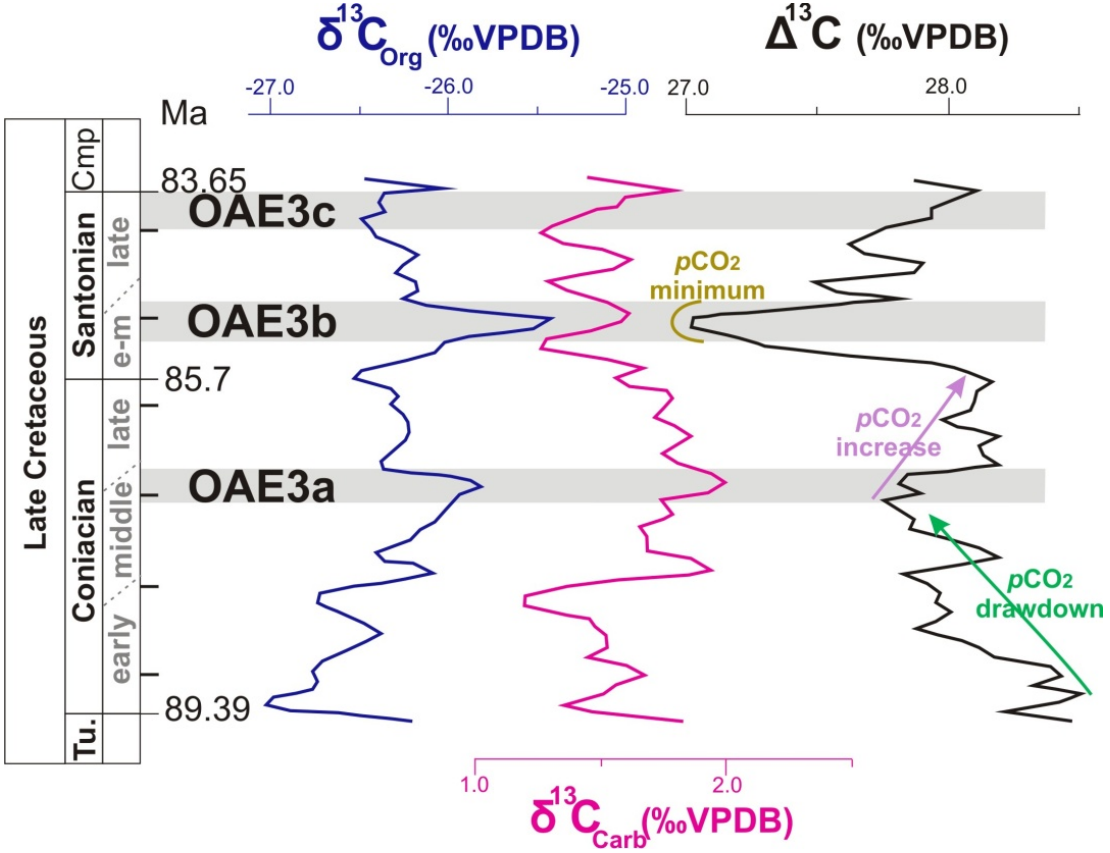
δ13C organic carbon

OAE3 subevents

Summary of mean peak magnitudes, age of mean peak, maximum age range and duration of the OAE3 subevents. Mean peak magnitude is the difference between single lowest and highest $\delta^{13}C_{org}$ or $\delta^{13}C_{carb}$ values of an excursion event.

Event		Mean peak magnitude (‰)	Age of mean peak (Ma)	Event age range (Ma)	Duration (Ma)
OAE3a (Kingsdown event)	$\delta^{13}C_{carb}$	0.32	86.84	87.04 to 86.60	0.44
	$\delta^{13}C_{org}$	0.60	86.89	87.10 to 86.64	0.46
OAE3b (Horseshoe Bay event)	$\delta^{13}C_{carb}$	0.42	84.94	85.27 to 84.66	0.61
	$\delta^{13}C_{org}$	1.18	84.97	85.48 to 84.78	0.70
OAE3c	$\delta^{13}C_{carb}$	0.61	83.55	84.00 to 83.47	0.53
	$\delta^{13}C_{org}$	0.61	83.53	83.94 to 83.45	0.49

Differences of carbonate/organic carbon isotopes



Assess pCO_2 trends:

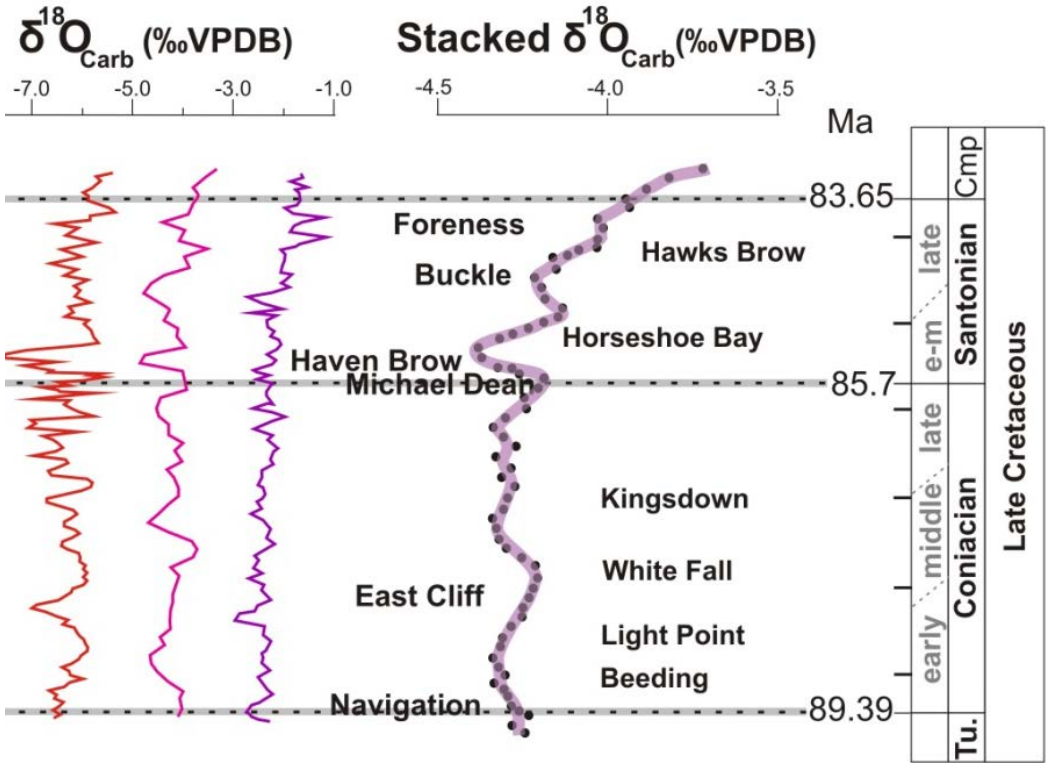
pCO_2 increase

pCO_2 minimum

pCO_2 increase

pCO_2 drawdown

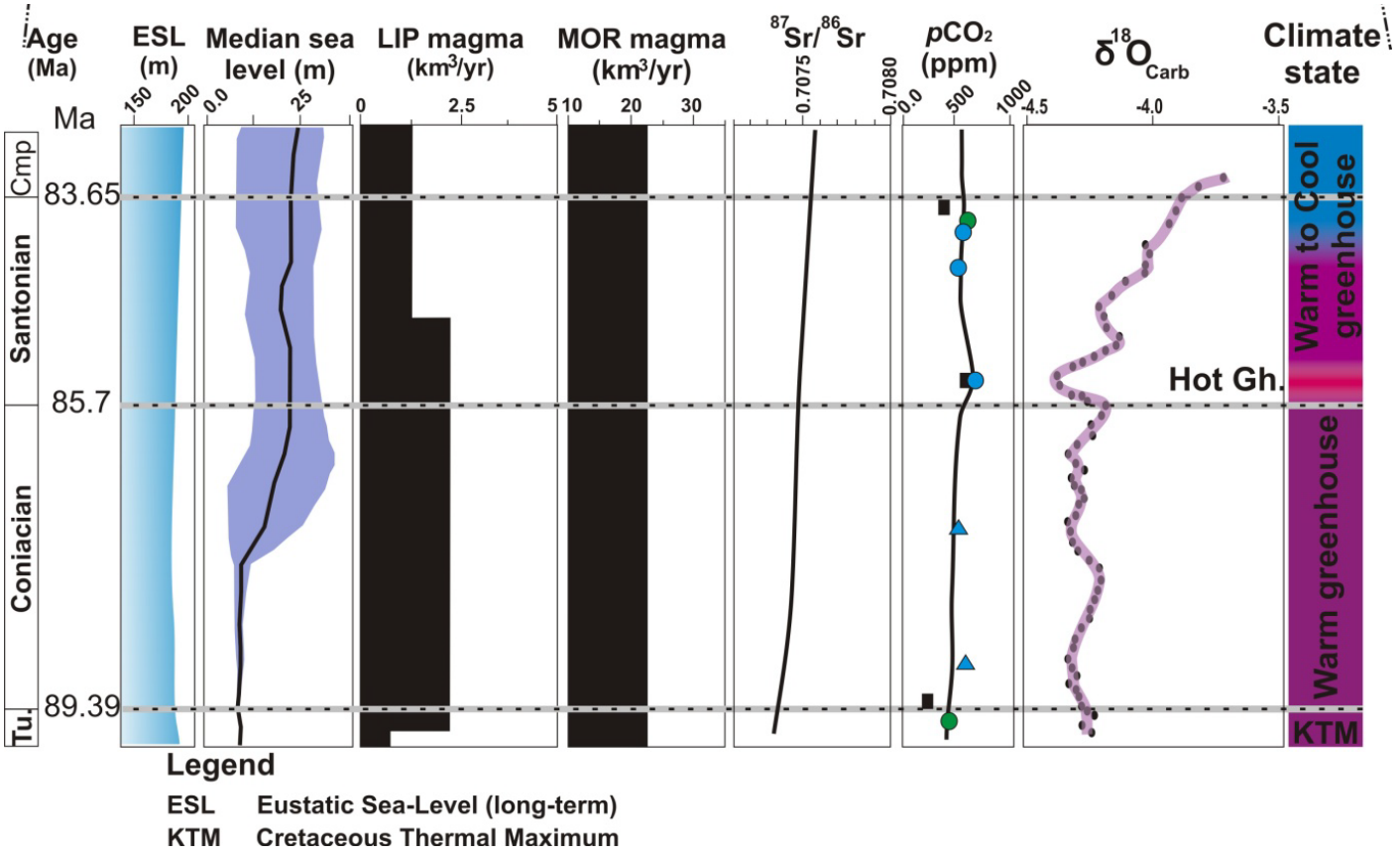
Oxygen isotope stack for Coniacian-Santonian



δ18O stack

Summing up deviations from local mean values due to regional differences and local factors

Major Drivers?



Conclusions

3 OAE3 subevents:

- OAE3a - late mid-Coniacian, ca. 86.9 Ma, Kingsdown Event, positive δ13C excursion of ca. 0.4 ‰
- OAE3b - late mid-Santonian, ca. 85.0 Ma, Horseshoe Bay Event, ca. 0.4 ‰, after hot greenhouse event
- OAE3c - late Santonian to Santonian-Campanian Boundary Event, ca. 83.5 Ma, regional long-term $\delta^{13}C$ positive excursion of 0.6-1 ‰

- equatorial Atlantic and adjoining epicontinental seas show enhanced OC and sulfur accumulation, high contents of redox-sensitive trace elements such as Mo, V, Cr, Zn, Cd, benthic foraminifera regional extinctions and turnover

- OC-poor sediments such as CORBs, chalk, grey colored shales and limestones, in Boreal, Tethys, Indian and Pacific oceans