

Supplementary Online Material for:

Exploring the impact of Cenomanian paleogeography and marine gateways on oceanic oxygen

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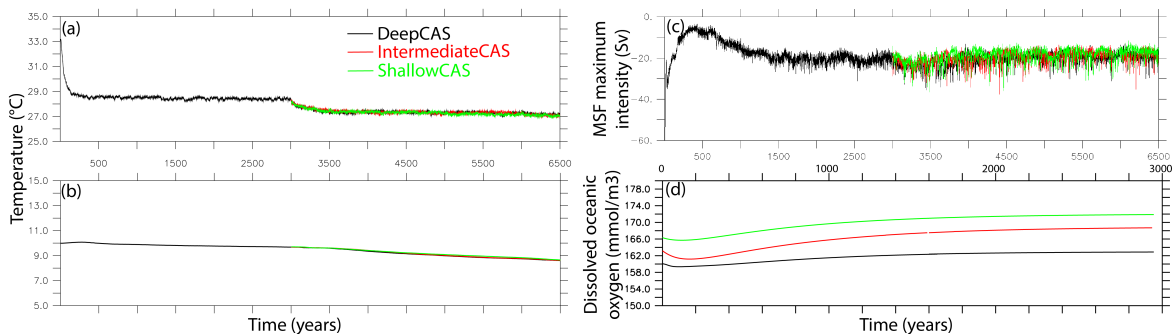
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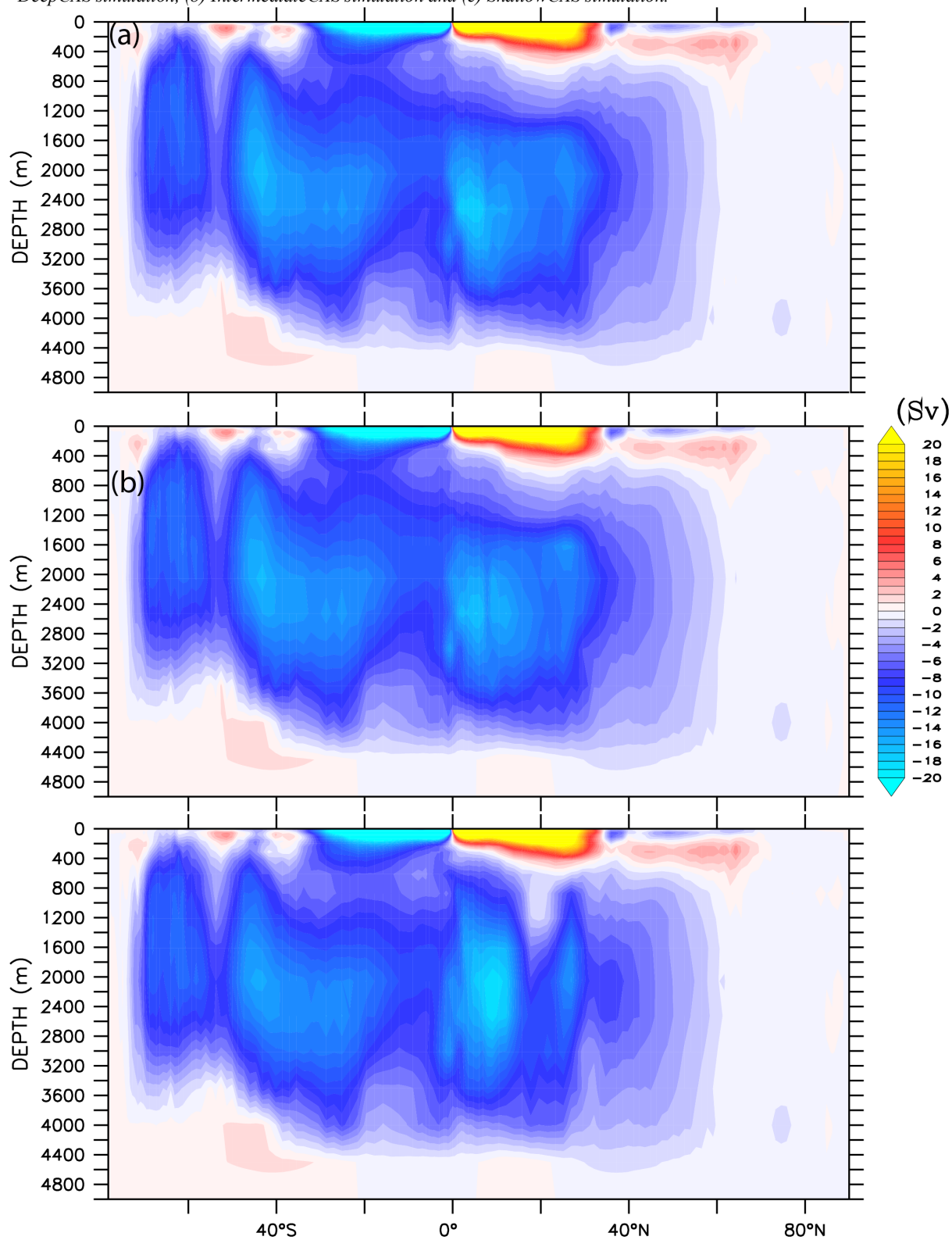
Supplementary Figure 1: Time series for (a) sea surface temperature, (b) deep oceanic temperatures (2300 meters of water depth), (c) maximum intensity of the meridional stream function (MSF) and (d) deep dissolved oceanic oxygen (2300 meters of water depth; PISCES offline simulations). The simulation was started with a low atmospheric time step for technical reasons, the SST diminution observed around 3000 years corresponds to a return to the standard atmospheric time step.



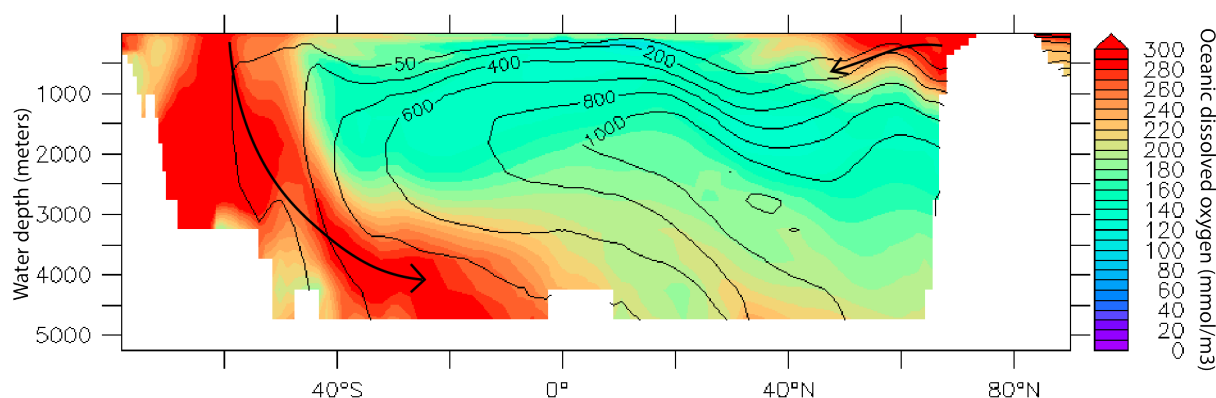
Supplementary Table 1: Temperature and [O₂] drifts during the last 1000 years of simulation for the surface and the deep ocean (3000 meters of water depth), in °C/century and mmol/m³/century, respectively.

	DeepCAS	IntermediateCAS	ShallowCAS
SST (°C/century)	0.011	0.022	0.025
Deep ocean temperature (°C/century)	0.024	0.025	0.03
Surface dissolved oxygen (mmol/m ³ /century)	0.0001	0.0002	0.00015
O ₂ bottom (mmol/m ³ /century)	0.027	0.065	0.049

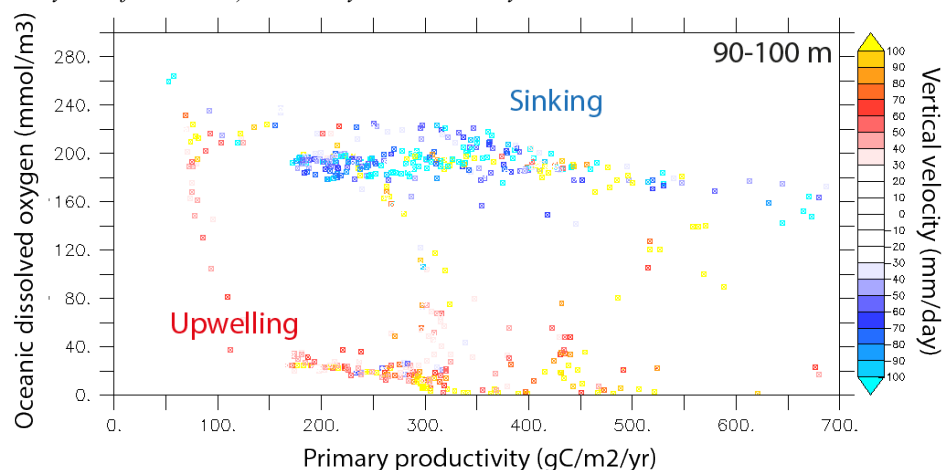
Supplementary Figure S2: Global meridional stream function (Sv). Positive values (red) indicate a clockwise circulation and negative values (blue) an anticlockwise circulation. Annual average over the last 100 years of simulation. (a) DeepCAS simulation, (b) IntermediateCAS simulation and (c) ShallowCAS simulation.



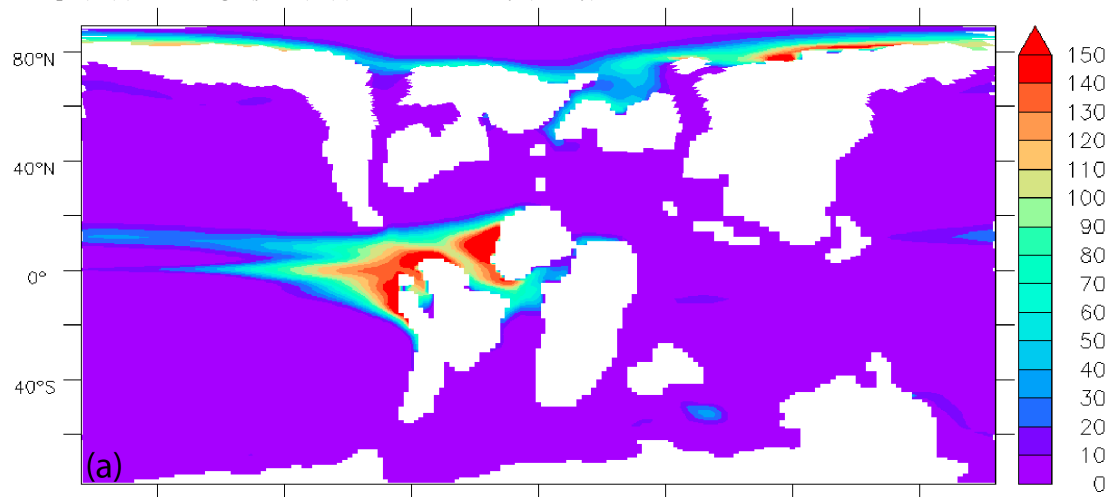
Supplementary Figure S3: Meridional vertical section in the Eastern Pacific showing the supply of oxygen to the deep ocean via deep-water formation. Color shading corresponds to simulated oceanic dissolved oxygen concentration (mmol/m^3 , annual average for longitudes between 130°E and 180°E). Black contours indicate the simulated water age (years, annual average for longitudes between 130°E and 180°E). Water age is the number of years after last surface contact. Black arrows show water sinking and oxygen supply.



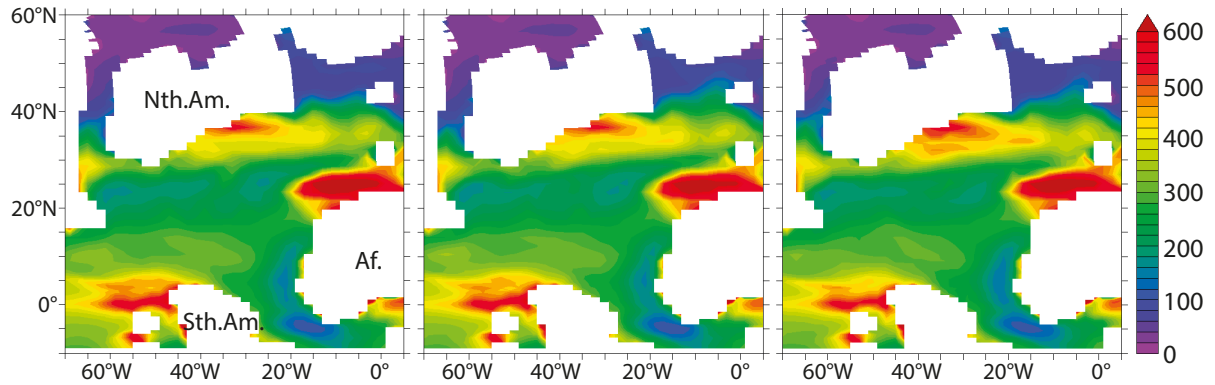
Supplementary Figure S4: Plot of marine productivity (mmol/m^3 , integration for the whole water column) vs. oxygen concentration (mmol/m^3) at 90-100 meters of water depth in the Central Atlantic (DeepCAS simulation, annual average over the last 100 years of simulation), colored by vertical velocity.



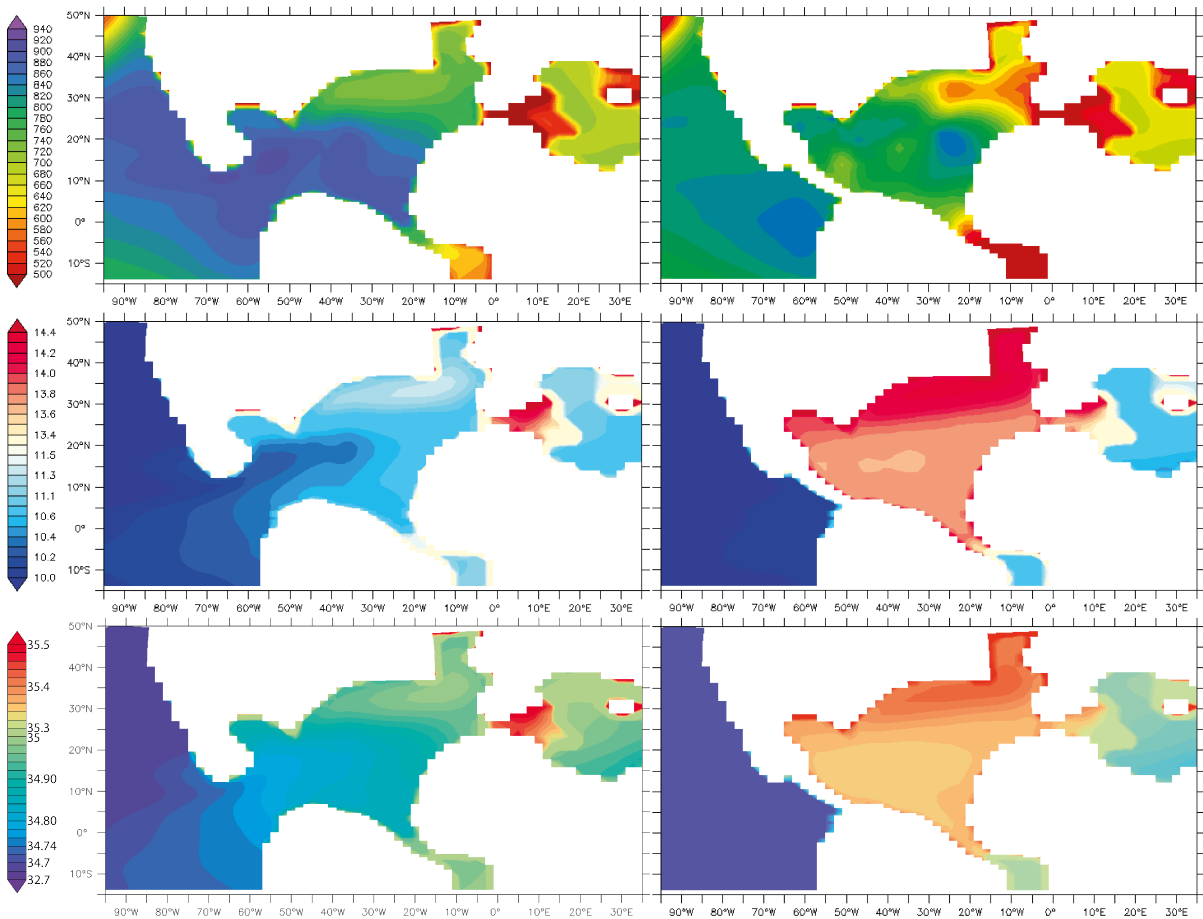
Supplementary Figure S5: Surface oceanic trends for the Deep CAS simulations (Annual average for 1 to 100 meters of water depth). (a) Water age (years). (b) Vertical velocity (m/day).



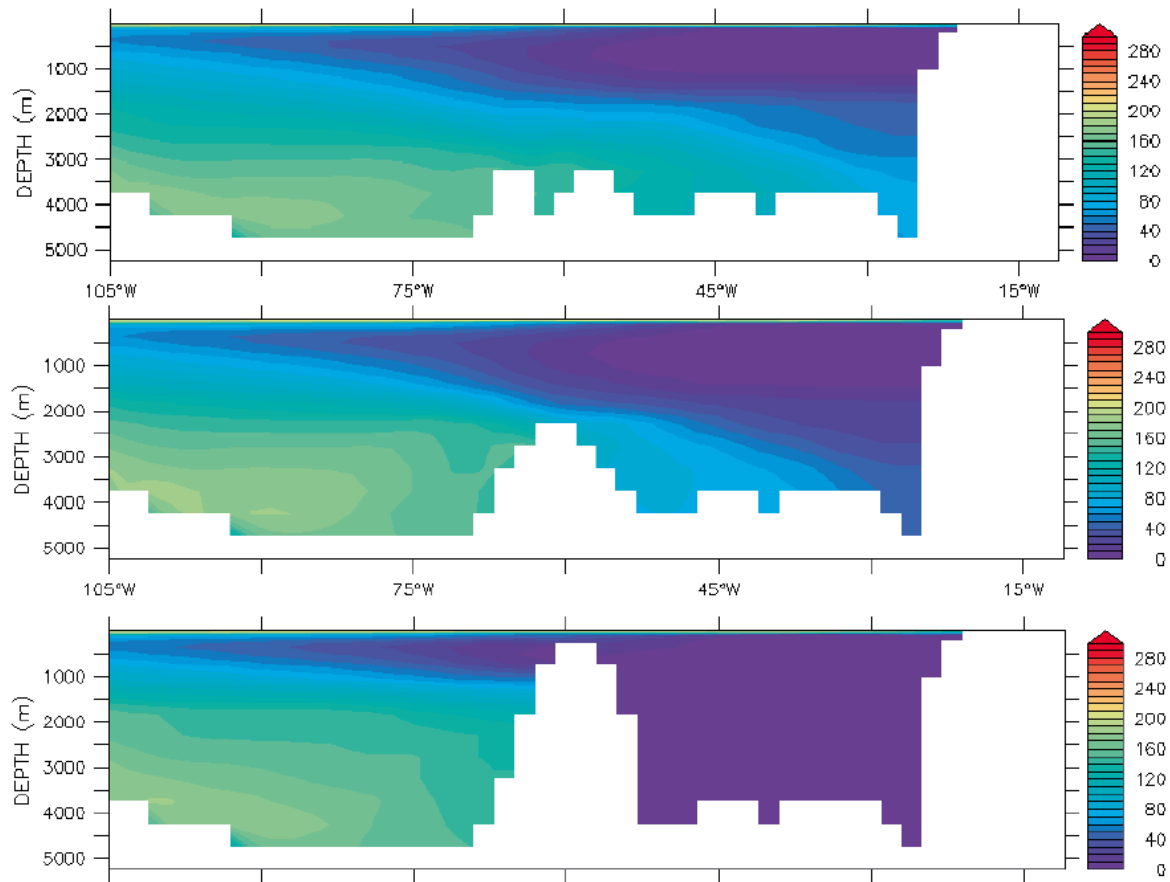
Supplementary Figure S6: Marine productivity ($\text{gC/m}^2/\text{year}$) for Deep, Intermediate and Shallow CAs simulations (Integrated over the whole water column, Annual average over the last 1000 years of simulation). Nth.Am.: North America, Sth.Am.: South America, Af.: Africa.



Supplementary Figure S7: Oceanic trends for intermediate waters (Annual average between 600 and 1600 meters of water depth over the last 100 years of simulation for DeepCAS simulation (left) and ShallowCAS simulation (right). From top to bottom: Water age (years), Water temperature ($^{\circ}\text{C}$), Water salinity (psu).



Supplementary Figure S8: Vertical sections of $[O_2]$ ($mmol/m^3$, Annual average over the last 100 years of simulation) through the CAS (latitude of $7^\circ N$) for (a) DeepCAS, (b) IntermediateCAS and (c) ShallowCAS simulations.



Supplementary Figure S9: Seafloor dissolved oxygen concentration (mmol/m^3 , Annual average over the last 100 years of simulation and comparison with redox data for (a) IntermediateCAS simulation / pre-OAE2 data, (b) IntermediateCAS simulation / OAE2 data, (c) ShallowCAS simulation / pre-OAE2 data and (d) ShallowCAS simulation / OAE2 data. The black and red lines indicate the limits of anoxia and dysoxia, respectively.

