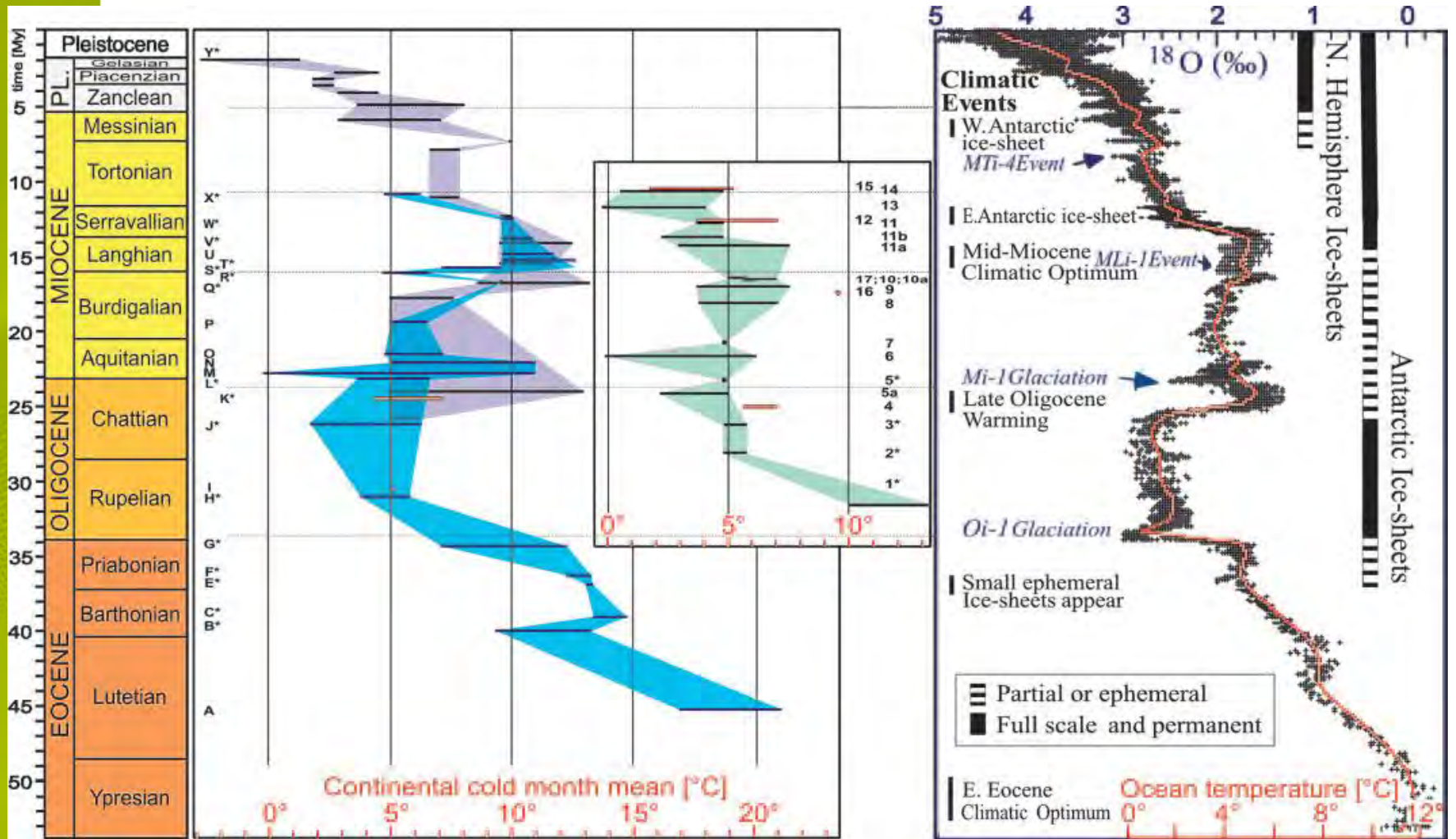


Transition entre modes climatiques

Les leçons des âges glaciaires du passé
géologique

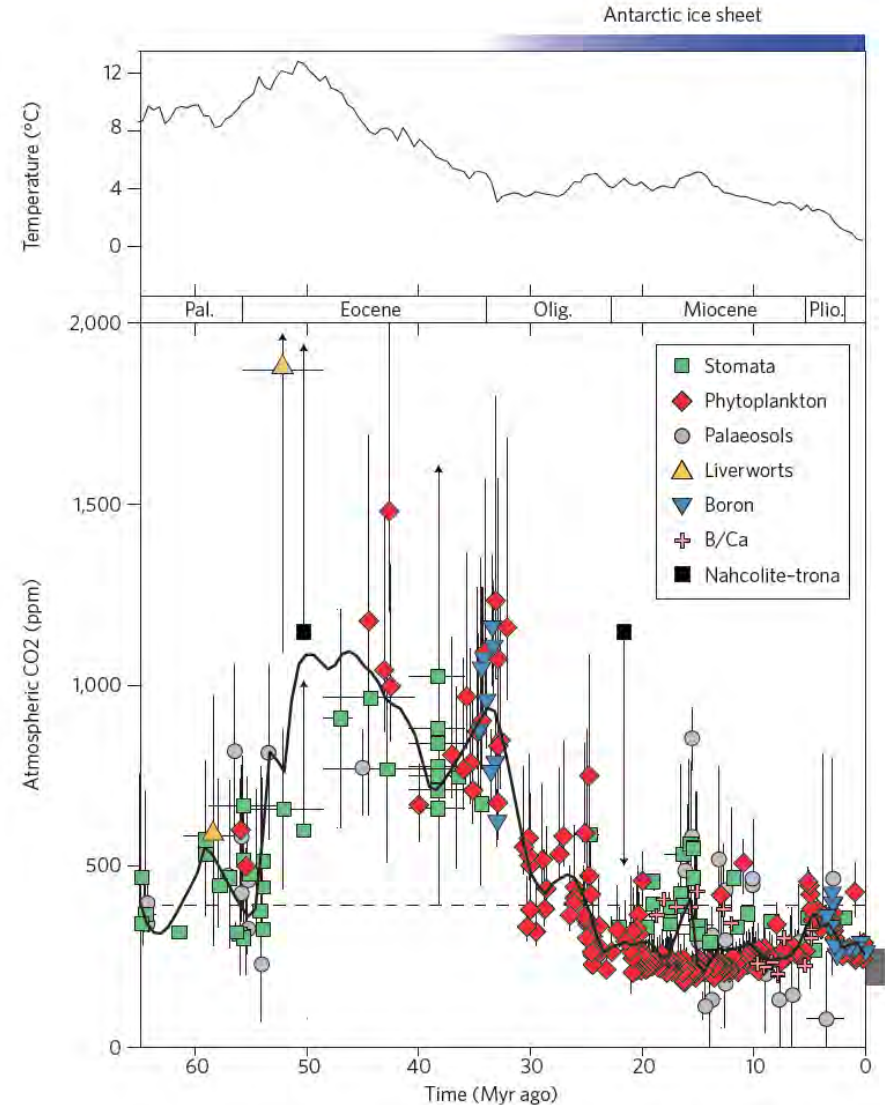
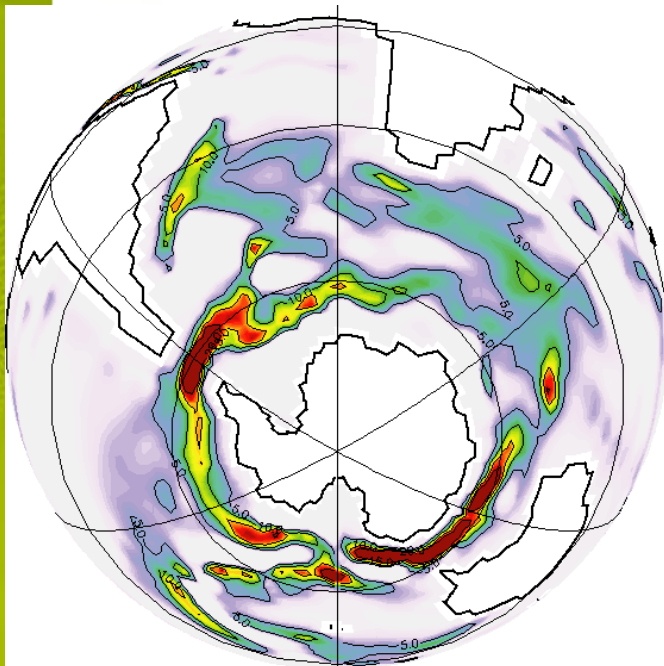
Contexte du projet COLORS – Evolution du climat au Cénozoïque



Mosbrugger et al., 2005

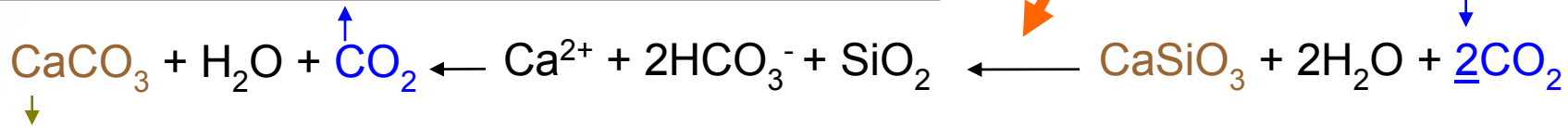
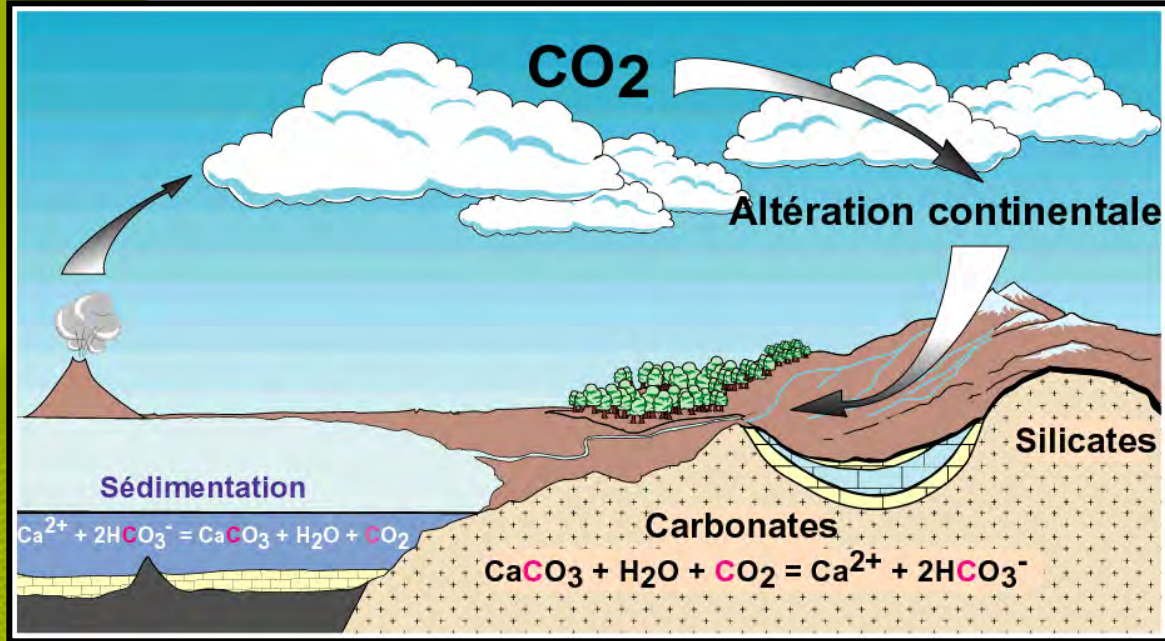
Contexte du projet COLORS – Transition E-O, quels mécanismes ?

- 2 théories : - Baisse du CO₂
- Initiation du Courant Circumpolaire Antarctique (ACC)

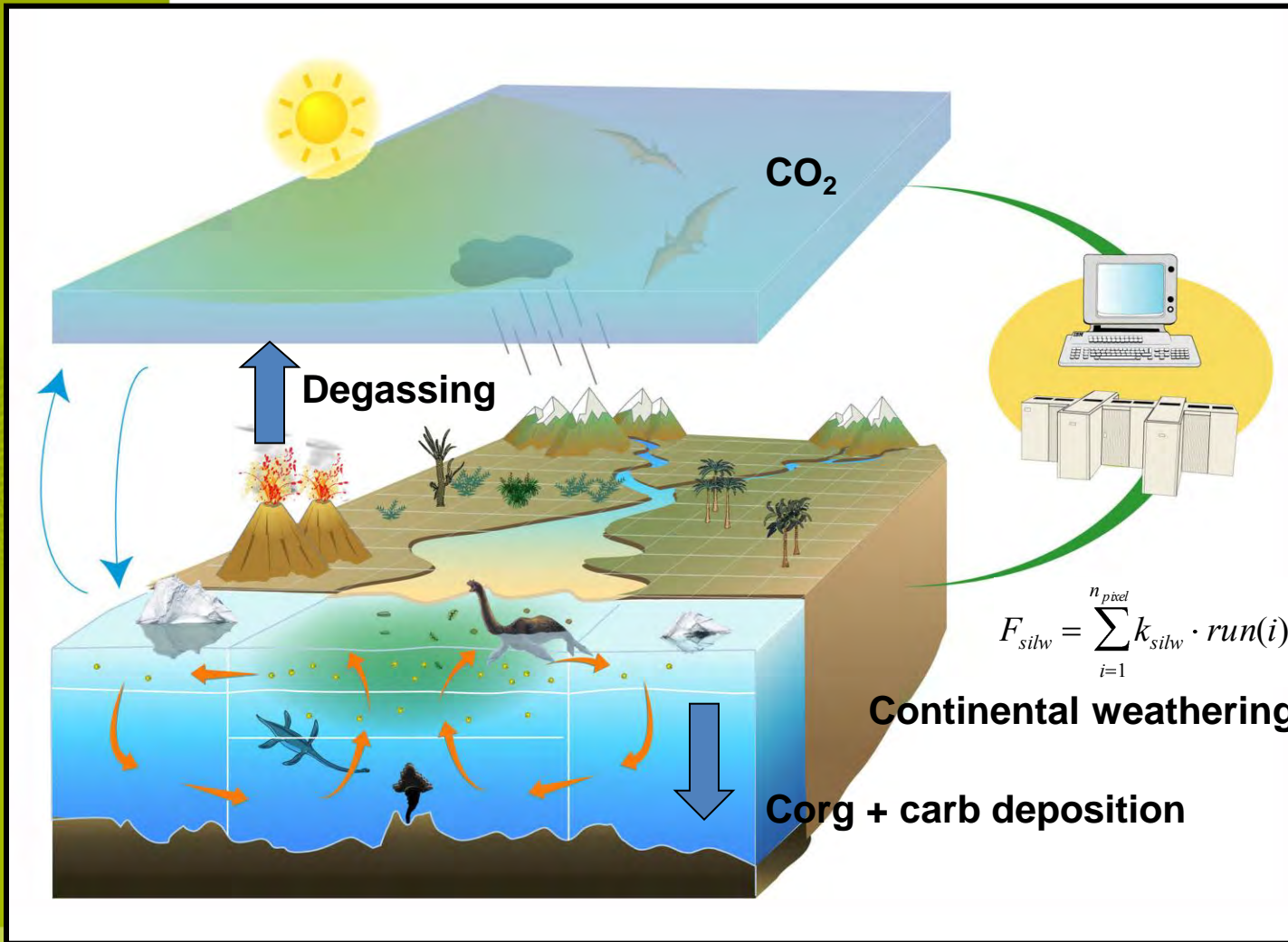


Beerling & Royer, 2011

Le cycle du carbone à long terme ... C'est quoi ?



A l'échelle de quelques centaines de milliers d'années, la teneur en CO₂ est liée à l'équilibre s'opérant entre une source (le dégazage) et un puits (l'altération des roches silicatées)



FOAM GCM
4.5 x7.5

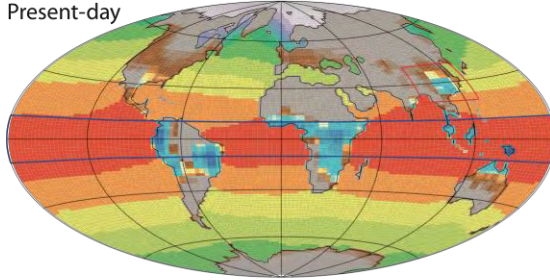
$$F_{silw} = \sum_{i=1}^{n_{pixel}} k_{silw} \cdot run(i) \cdot area(i) \cdot \exp\left[\frac{E_a^{silw}}{R} \left(\frac{1}{T} - \frac{1}{T_0}\right)\right]$$

Continental weathering

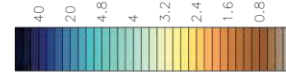
Corg + carb deposition

Effet de la paléogéographie

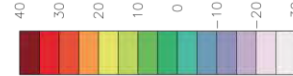
Present-day



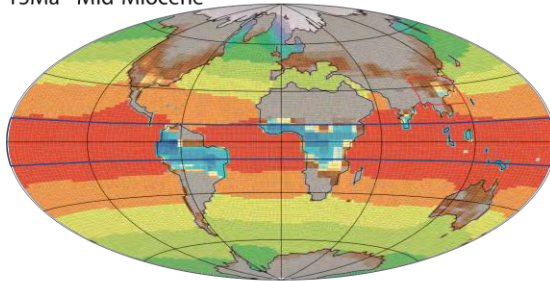
Silicate weathering rate (10^9 mol.yr^{-1})



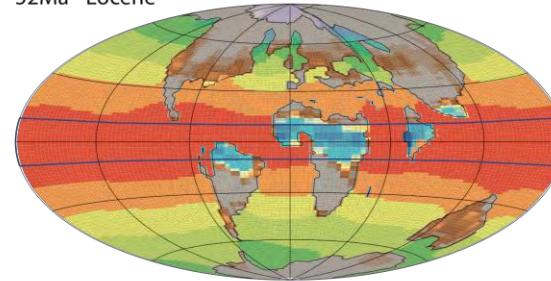
Surface Air Temperature ($^{\circ}\text{C}$)



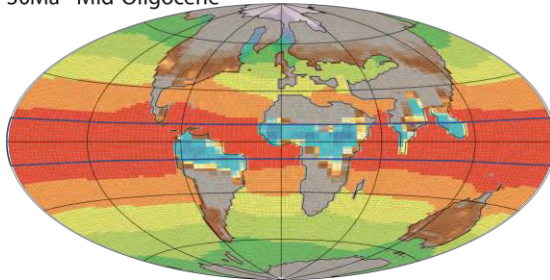
15Ma - Mid-Miocene



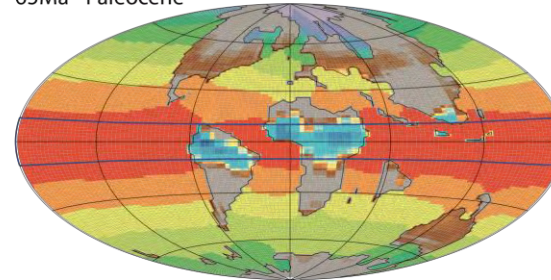
52Ma - Eocene



30Ma - Mid-Oligocene

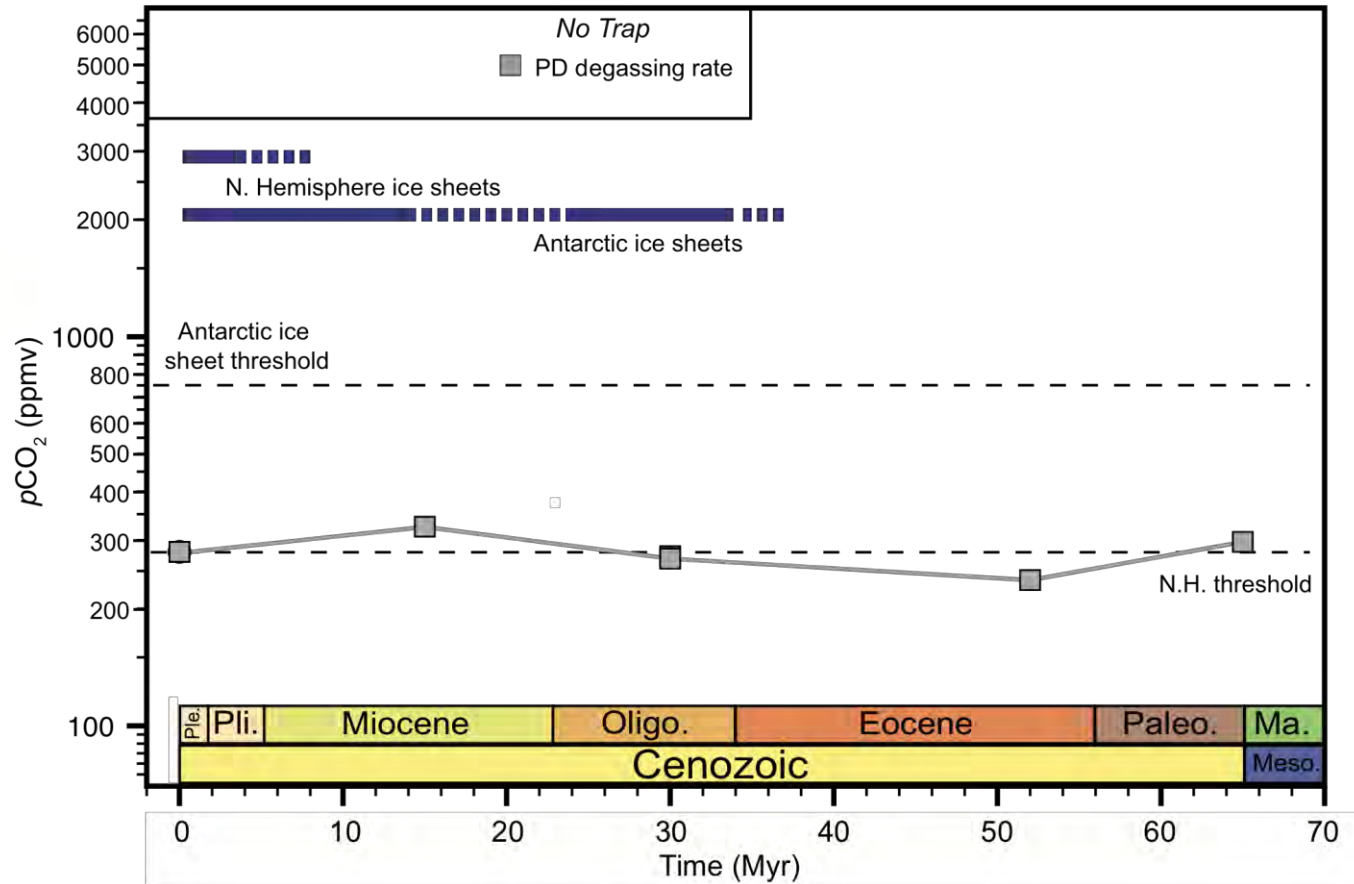


65Ma - Paleocene

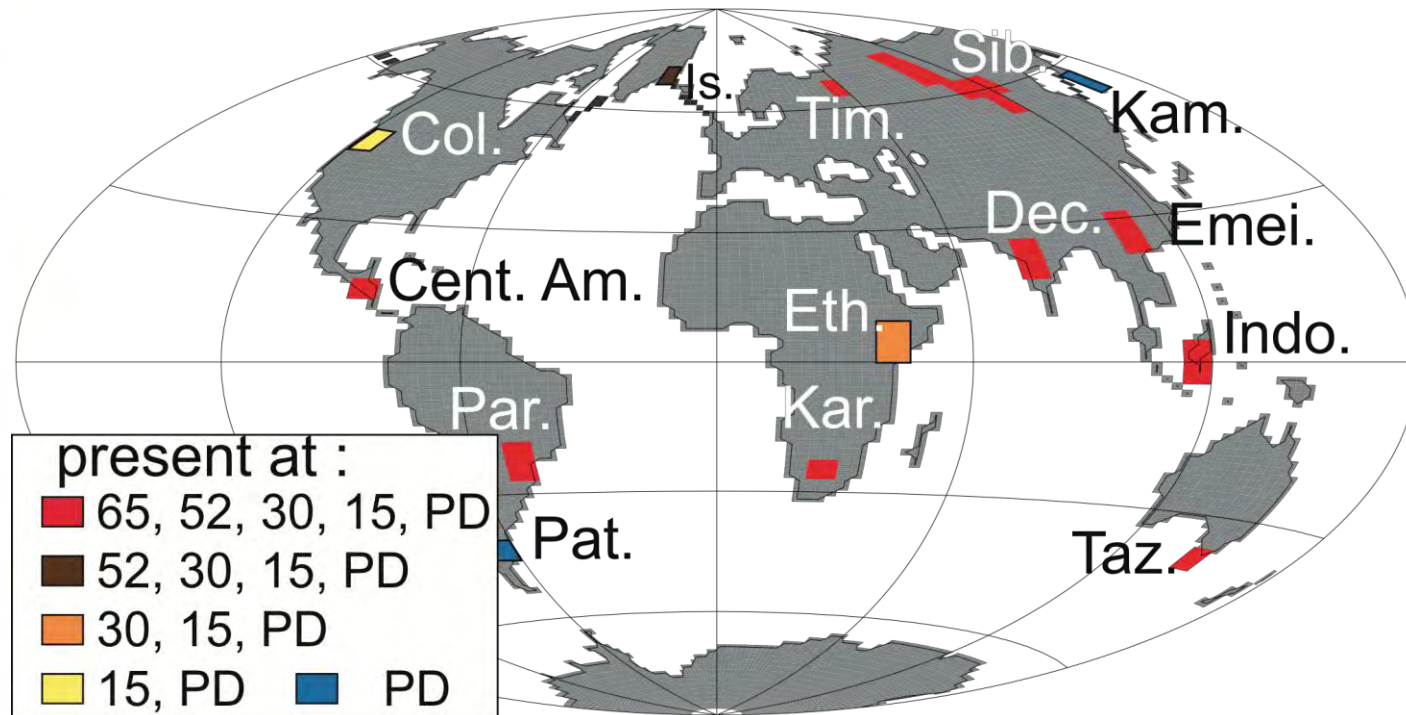


4 reconstructions continentales pour forcer le modèle GEOCLIM

Effet de la paléogéographie



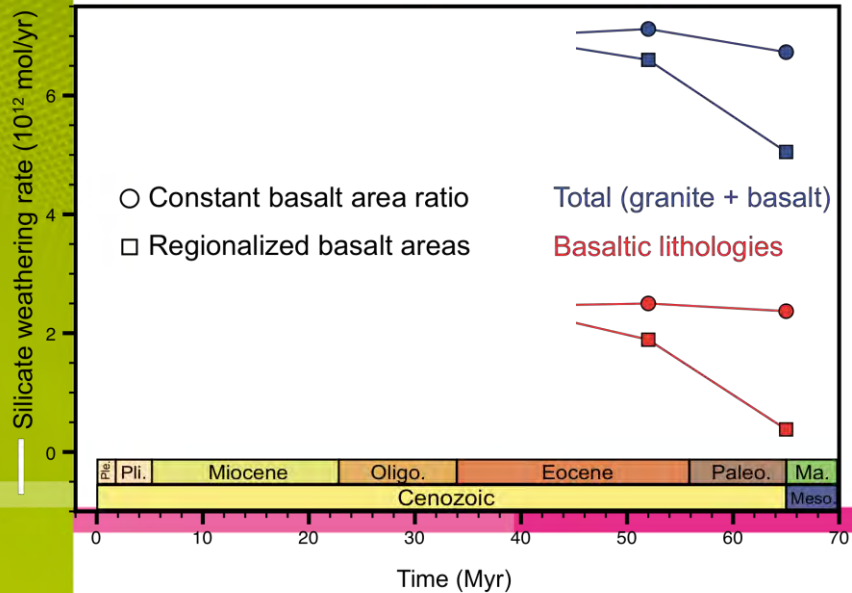
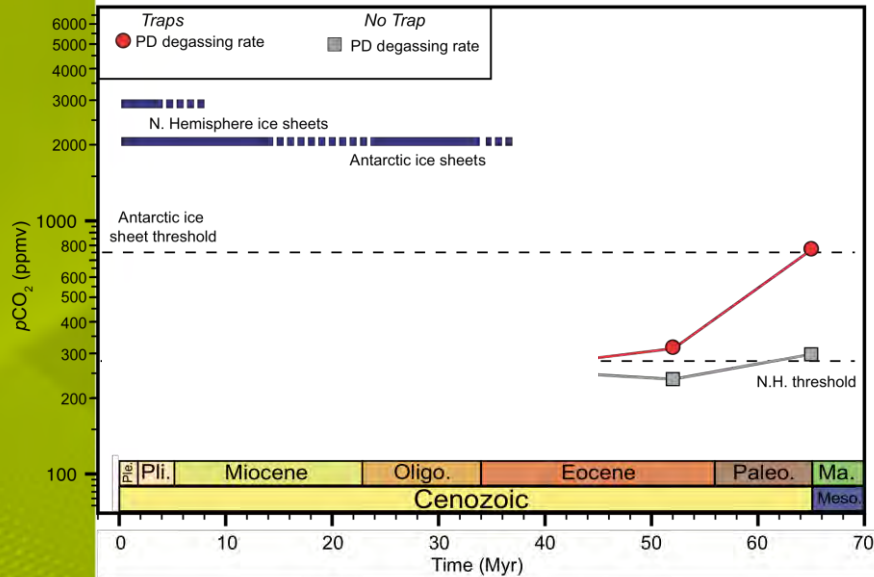
Effet des grandes provinces basaltiques



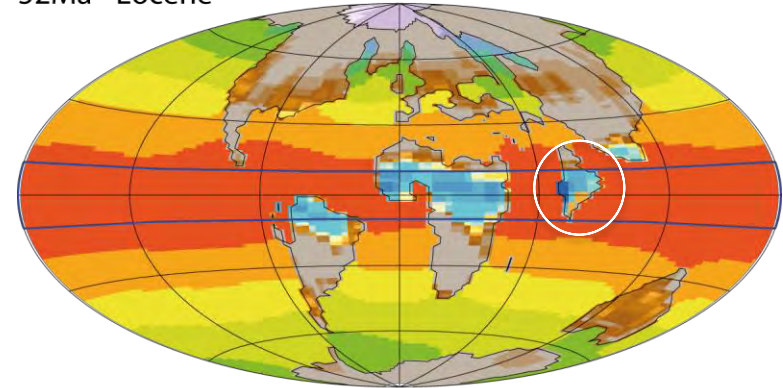
Sur chaque géographie, localisation des trapps (provinces basaltiques) en fonction de leur âge.

L'altération des roches basaltiques consomment 8 fois plus de CO_2 que l'altération des roches granitiques

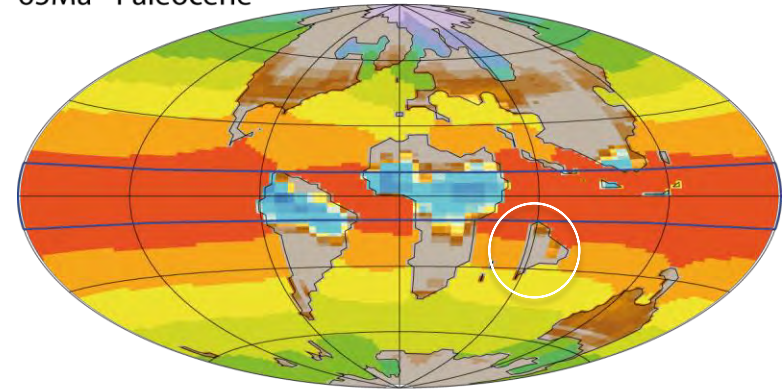
Passage des traps du Deccan à travers l'ITCZ



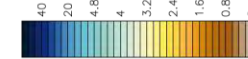
52Ma - Eocene



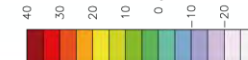
65Ma - Paleocene



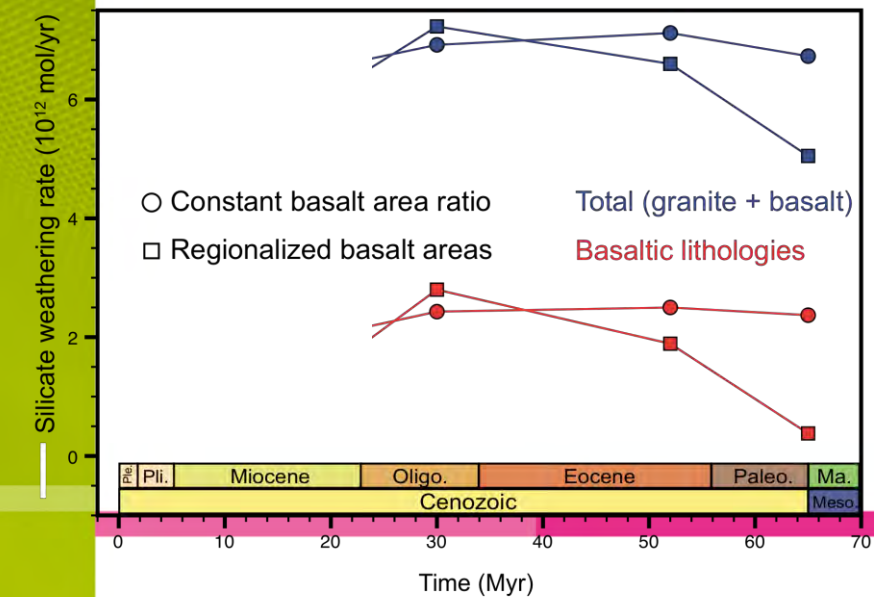
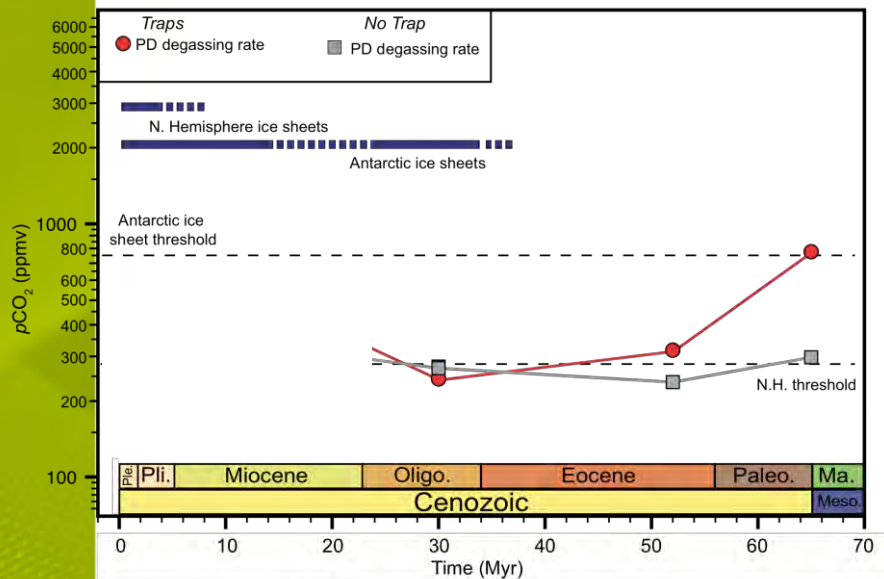
Silicate weathering rate (10^9 mol.yr^{-1})



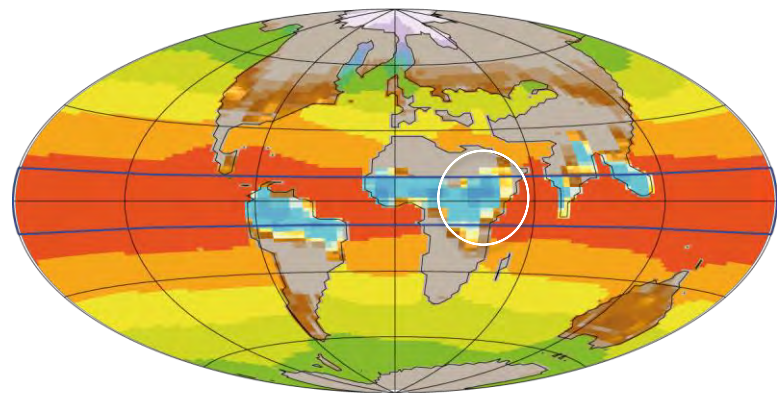
Surface Air Temperature ($^{\circ}\text{C}$)



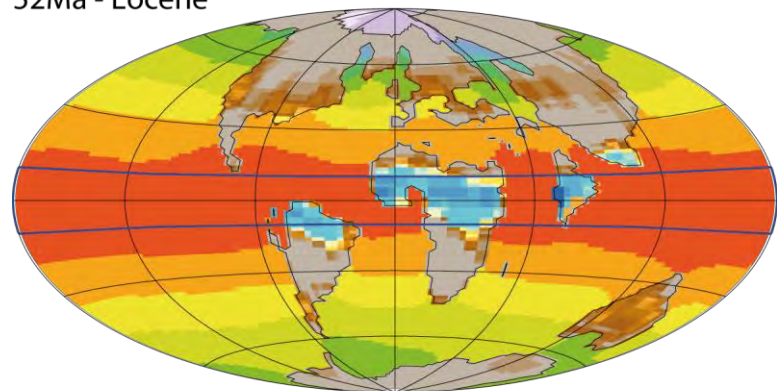
Mise en place des traps d'Ethiopie



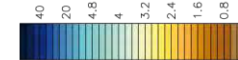
30Ma - Mid-Oligocene



52Ma - Eocene



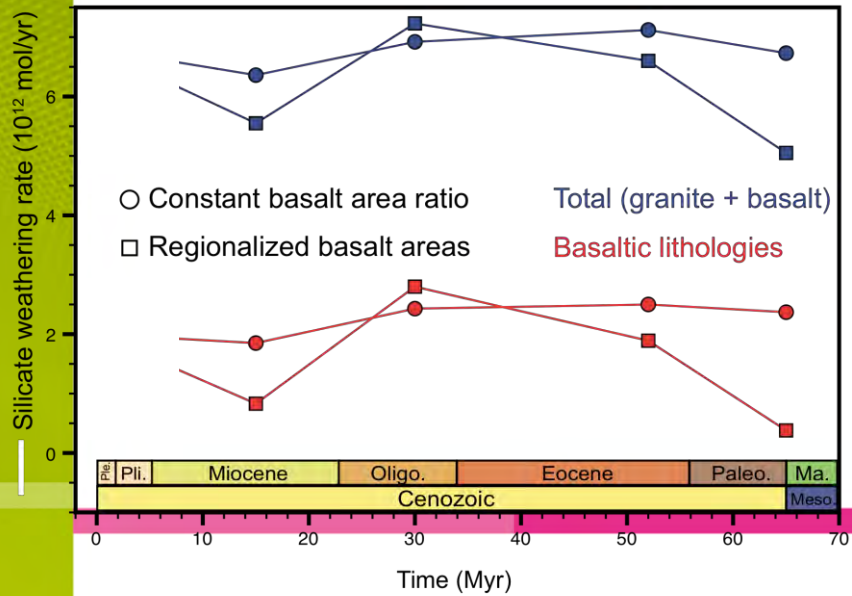
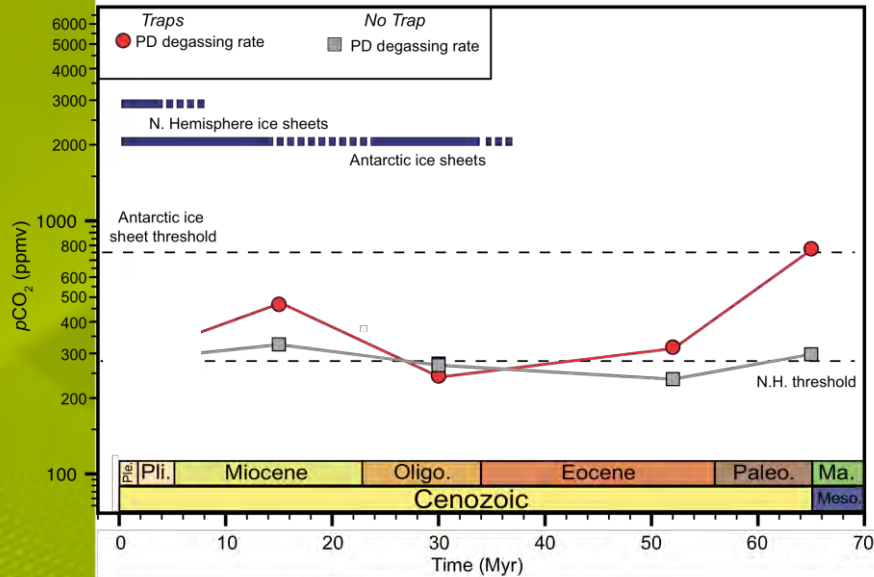
Silicate weathering rate (10^9 mol.yr⁻¹)



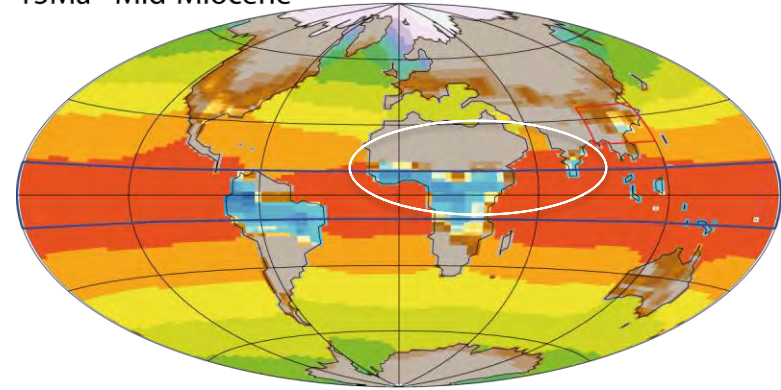
Surface Air Temperature (°C)



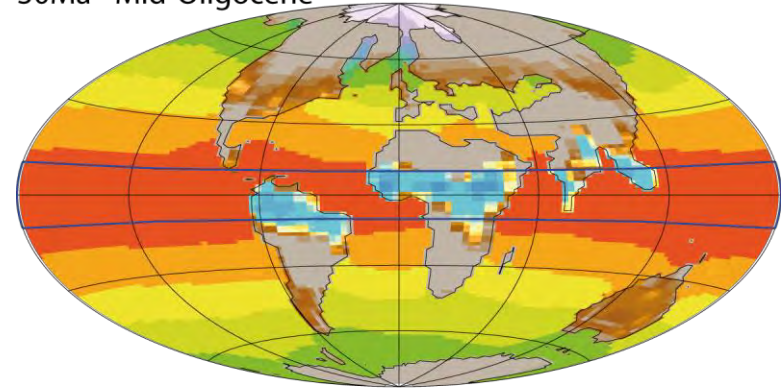
Remontée de l'Afrique et de l'Inde



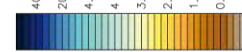
15Ma - Mid-Miocene



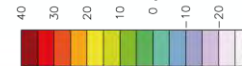
30Ma - Mid-Oligocene



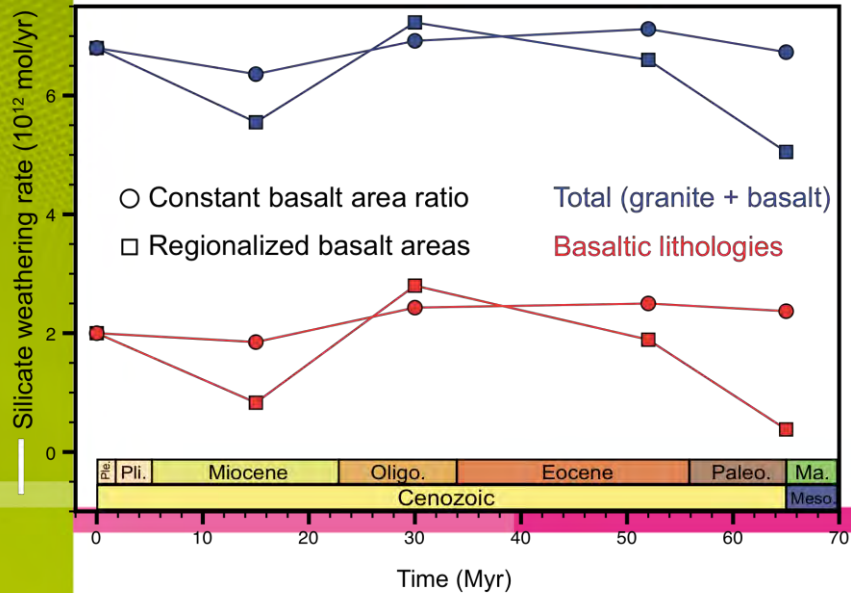
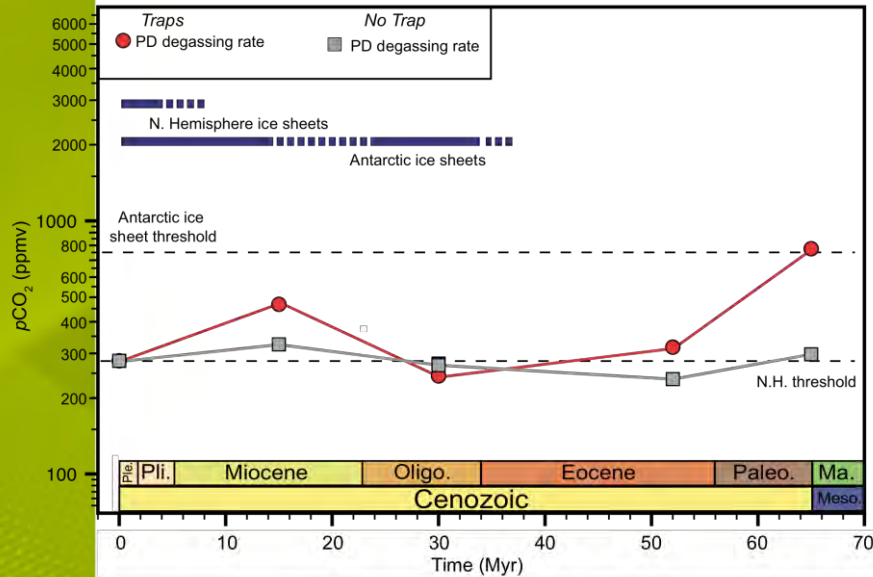
Silicate weathering rate (10^9 mol.yr⁻¹)



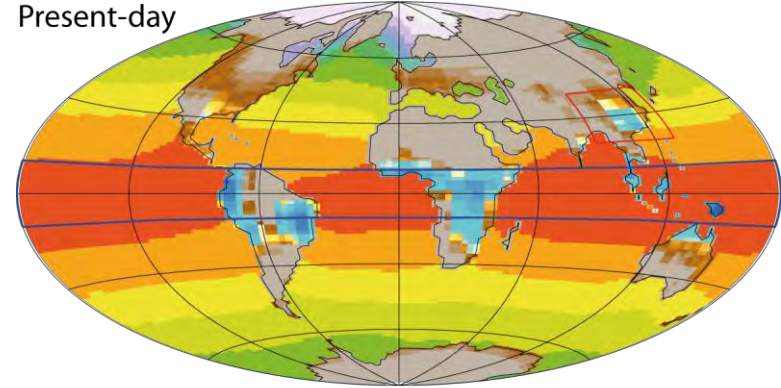
Surface Air Temperature (°C)



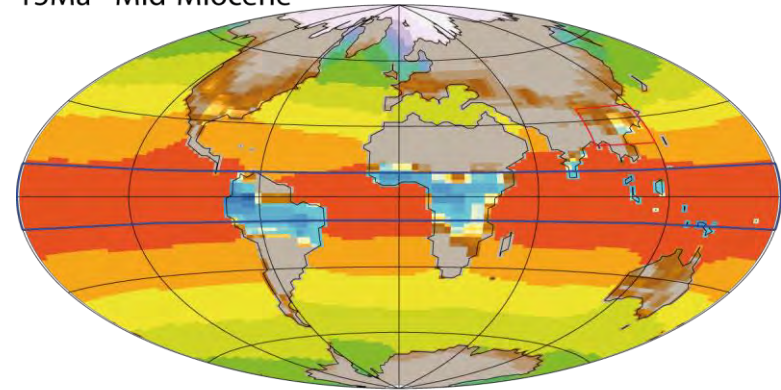
Mise en place de la mousson du Sud-Est asiatique



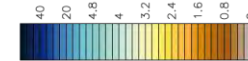
Present-day



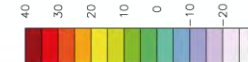
15Ma - Mid-Miocene



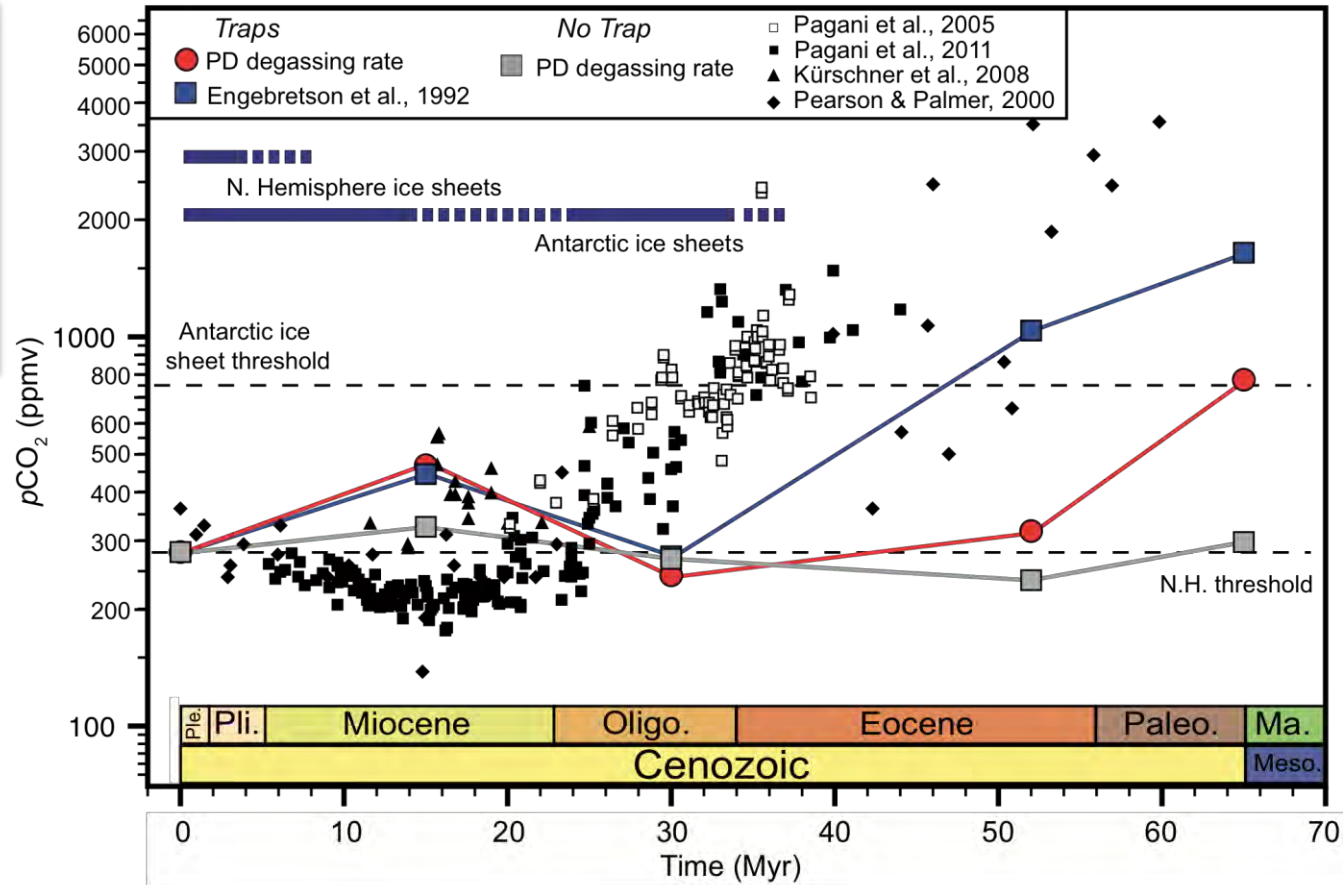
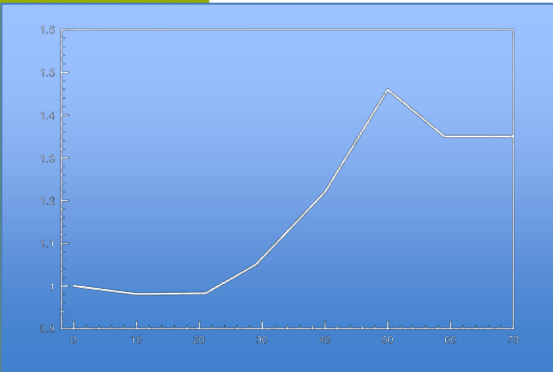
Silicate weathering rate (10^9 mol.yr⁻¹)



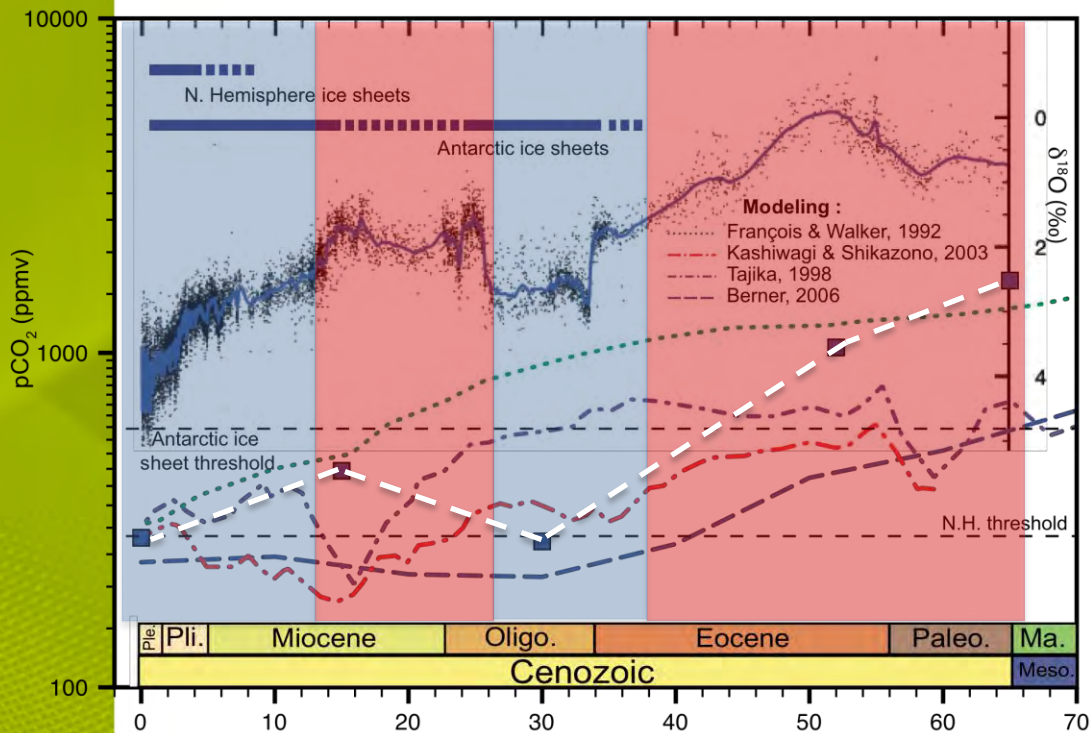
Surface Air Temperature (°C)



Effet du dégazage variable



Conclusions



- 1) Climat chaud de l'Eocène nécessite un **dégazage très intense** (carbonates de la Téthys ?)
- 2) **Le forçage paléogéographique** permet d'expliquer la tendance Oligocène – actuelle.
- 3) Amélioration de la modélisation du cycle du carbone / aux études précédentes grâce à **l'innovation du modèle GEOCLIM** (couplage géochimie – GCM)

Autres résultats en cours: en utilisant des CO₂ typique de l'Eocène (1120 – 840 ppm) et en retirant la calotte de glace Antarctique, l'ouverture des passages de Drake et de Tasmanie ne conduit pas à la mise en place du courant circumpolaire Antarctique = passages marins constituent une rétroaction du système plus qu'un forçage.

Difficulté pour les projets futurs: portabilité du modèle de climat FOAM impossible sur la prochaine génération de calculateurs (Mai 2013). Des essais d'utilisation du modèle IPSL se sont révélés infructueux du fait d'une infrastructure inadapté à nos thématiques de recherche.

Autres résultats associant des participants du projet COLORS

- 1) E. Nardin, **Y. Godd ris**, **Y. Donnadi u**, G. Lehir, R.C. Blakey, E. Puc at and M. Aretz, Modeling the early Paleozoic long-term climatic trend, *Geological Society America Bulletin*, doi: 10.1130/B30364.1, 2011
- 2) G. Lehir, **Y. Donnadi u**, **Y. Godd ris**, B. Meyer-Berthaud, **G. Ramstein** and R. Blakey, The climate change caused by the land-plant invasion, *Earth and Planetary Science Letters*, **310**, 203-221, 2011
- 3) N. Hamon, P. Sepulchre, **Y. Donnadi u**, A.-J. Henrot, L. Fran ois, J.-J. Jaeger, **G. Ramstein**, 2012. Growth of sub-tropical forests in middle Miocene Europe: The role of Carbon dioxide and Antarctic ice volume. *Geology*, in press.

Un lien entre CO₂ et effet des passages marins austraux

