

Les variations du niveau de la mer actuelles et futures en réponse au changement climatique

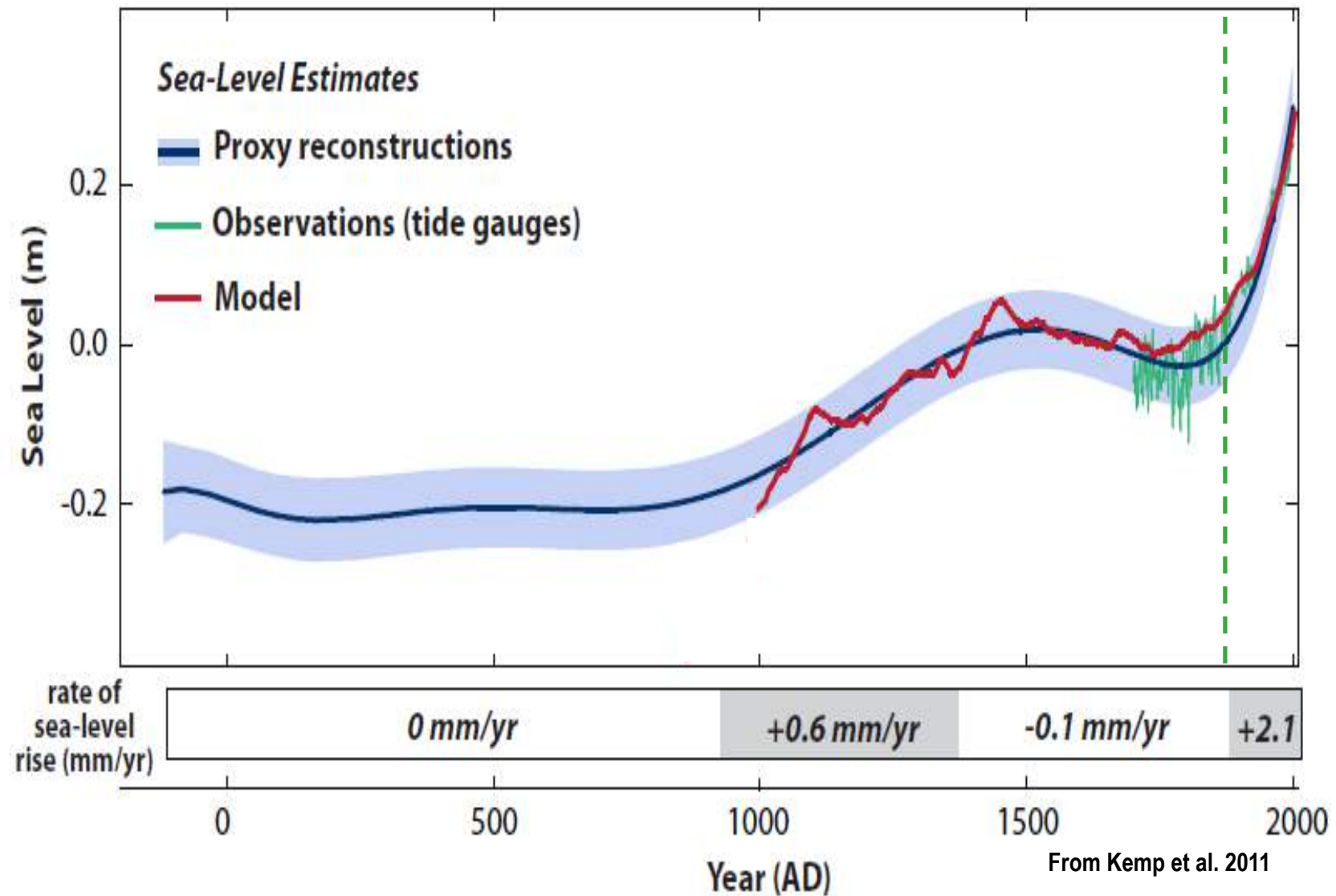
Benoit Meyssignac, LEGOS, CNES



Gulf of Maine October 2014

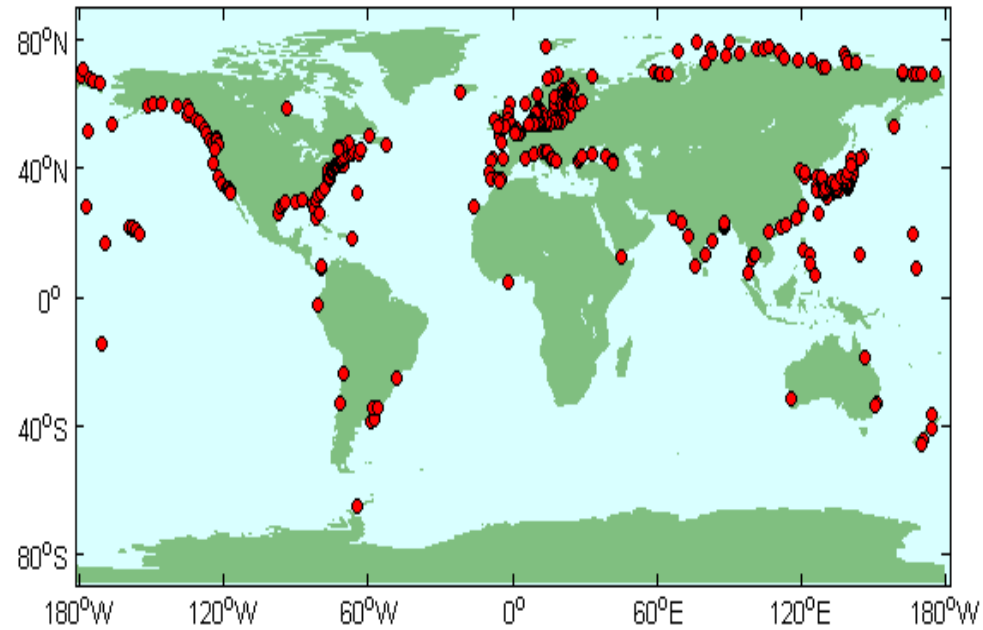
LES OBSERVATIONS DU NIVEAU DE LA MER

LE NIVEAU DE LA MER DANS LE PASSE



LE NIVEAU DE LA MER DANS LE PASSE

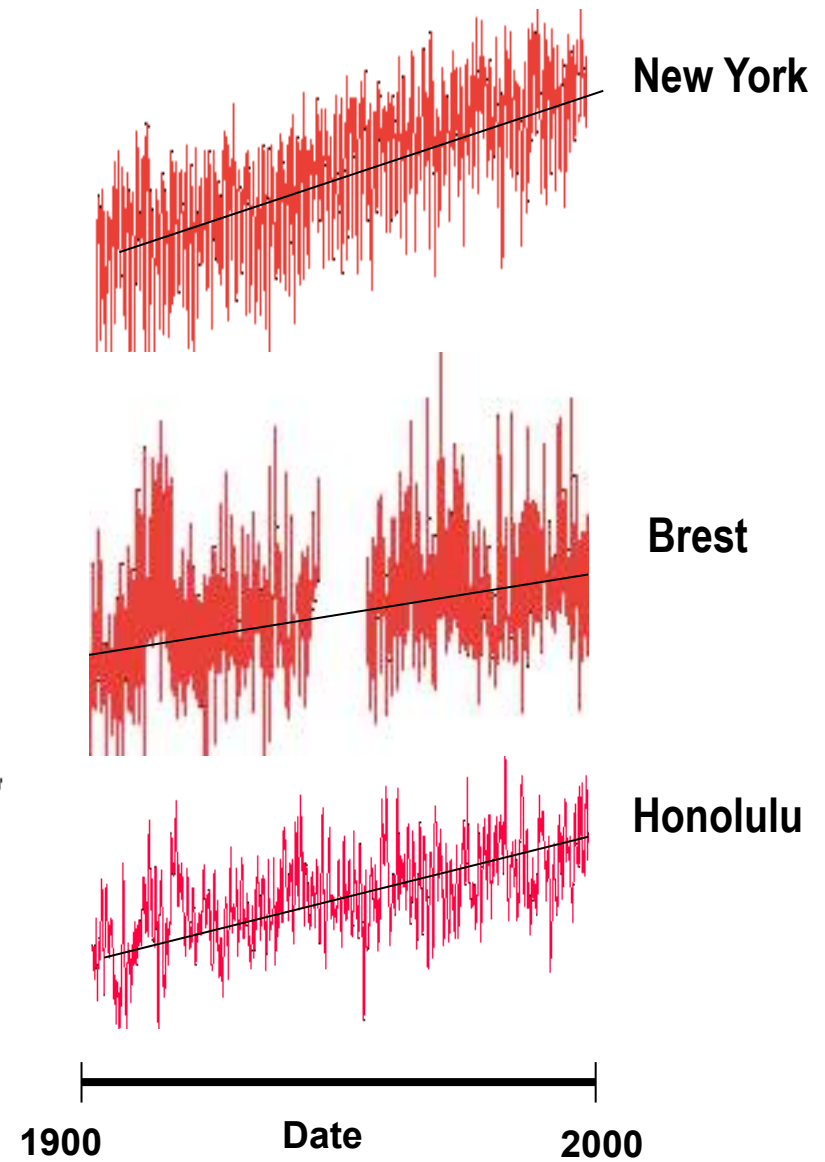
Tide gauge distribution with records > 40 years



Tide gauge

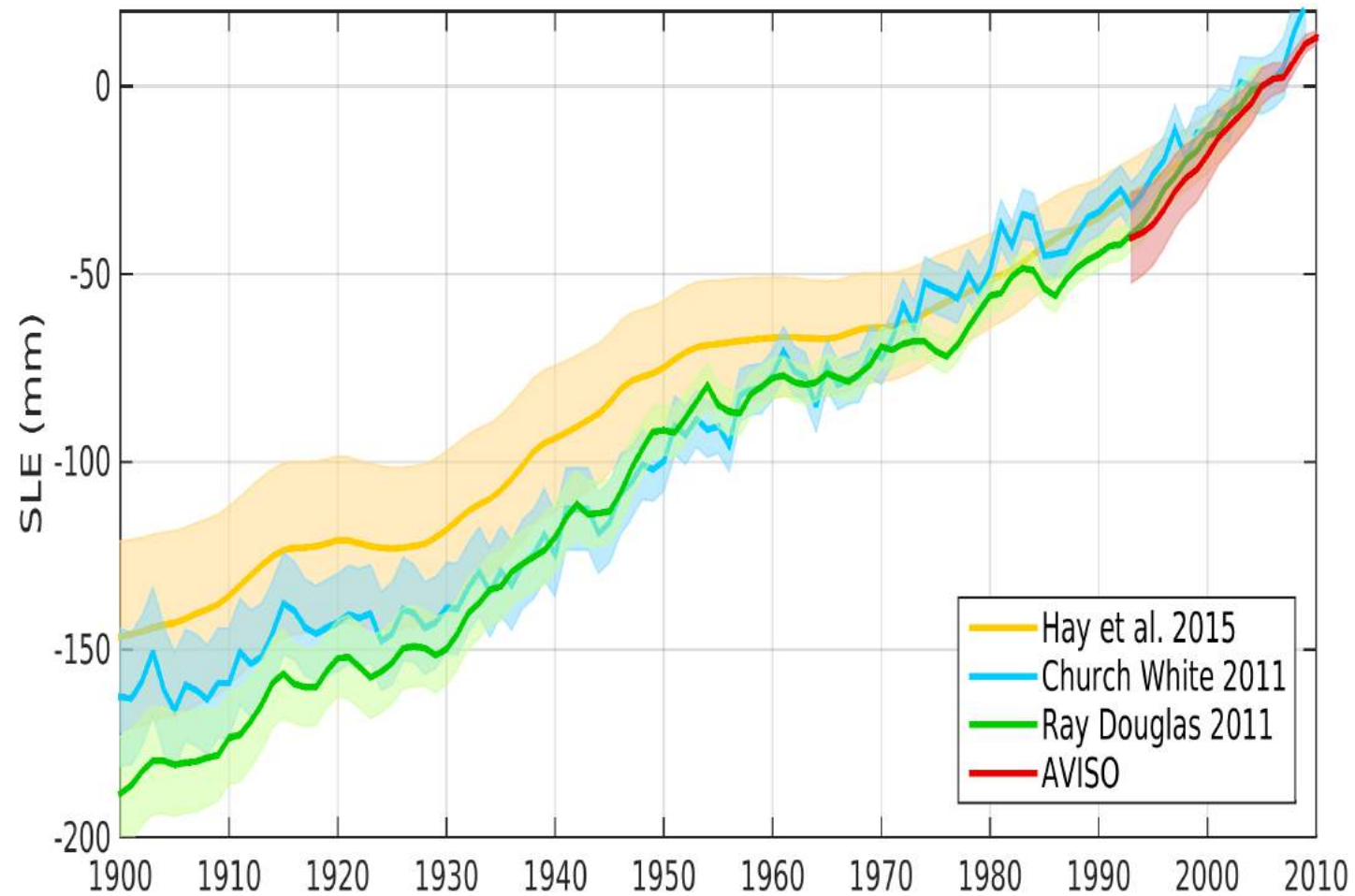


20 cm



From Church et al. 2013

LE NIVEAU DE LA MER DANS LE PASSE

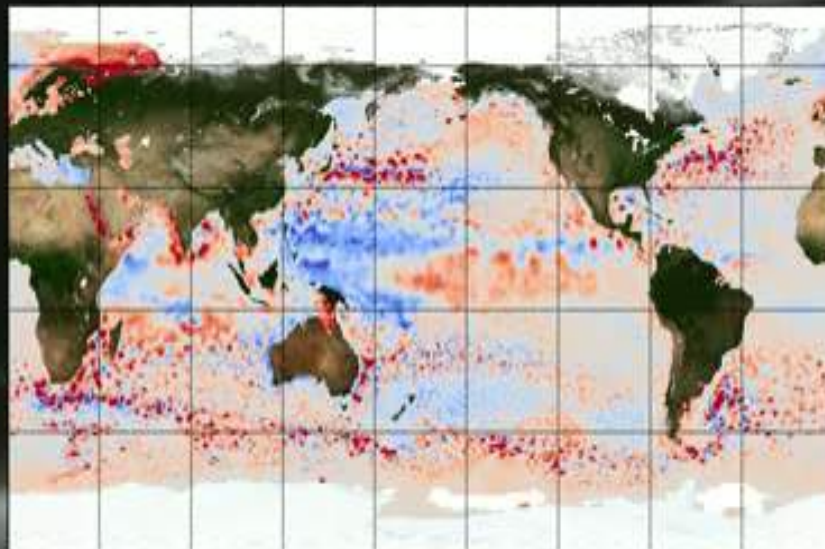


Hausse du niveau de la mer sur le 20^{ème} siècle : 1.5 ± 0.3 mm/yr

LE NIVEAU DE LA MER ACTUEL



LE NIVEAU DE LA MER ACTUEL



Hausse du niveau depuis 1993:
3.0 +/- 0.4 mm/yr

Global Trend: +3.32 mm/yr

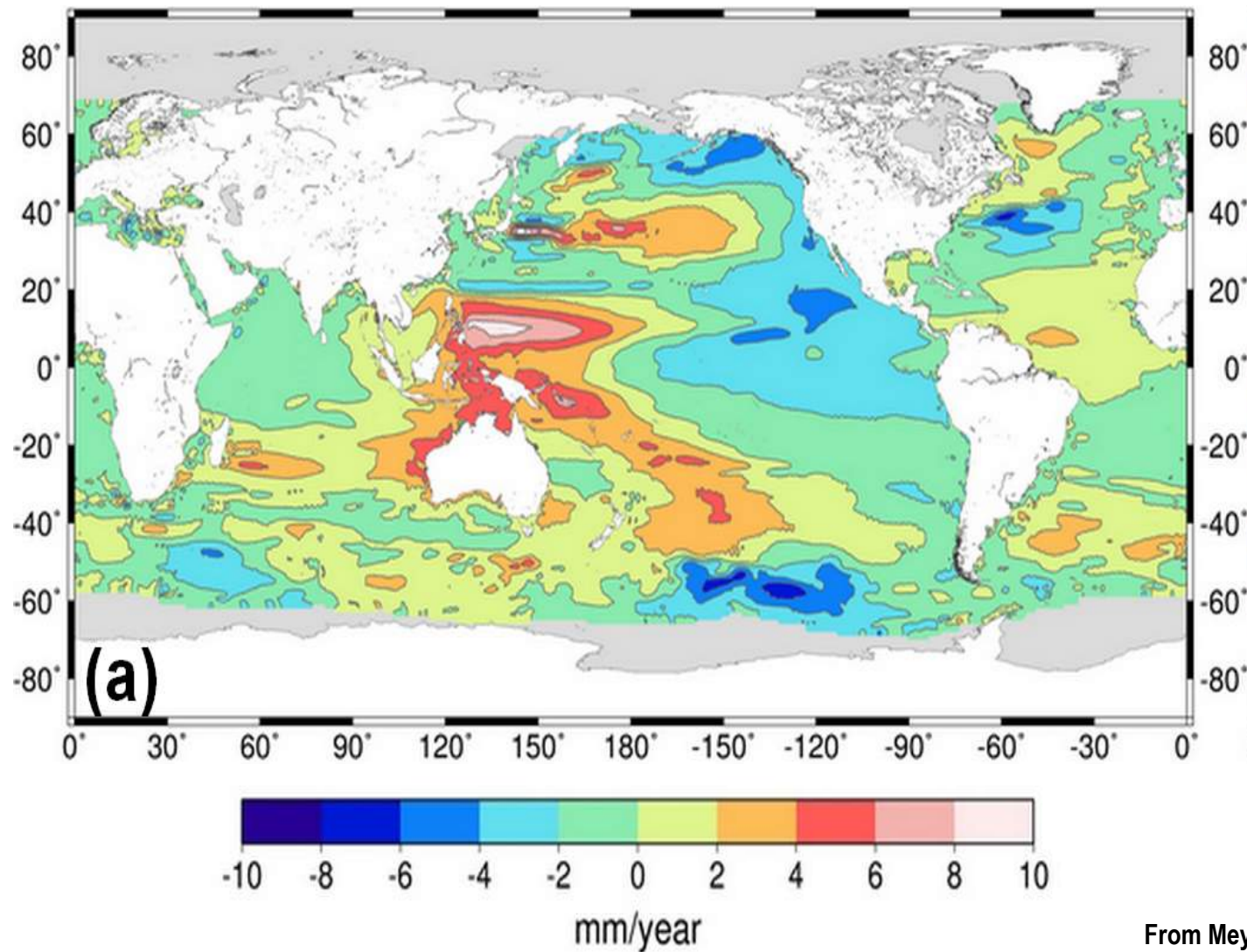


© EU Copernicus Marine Service, CNES, LEGOS, CLS



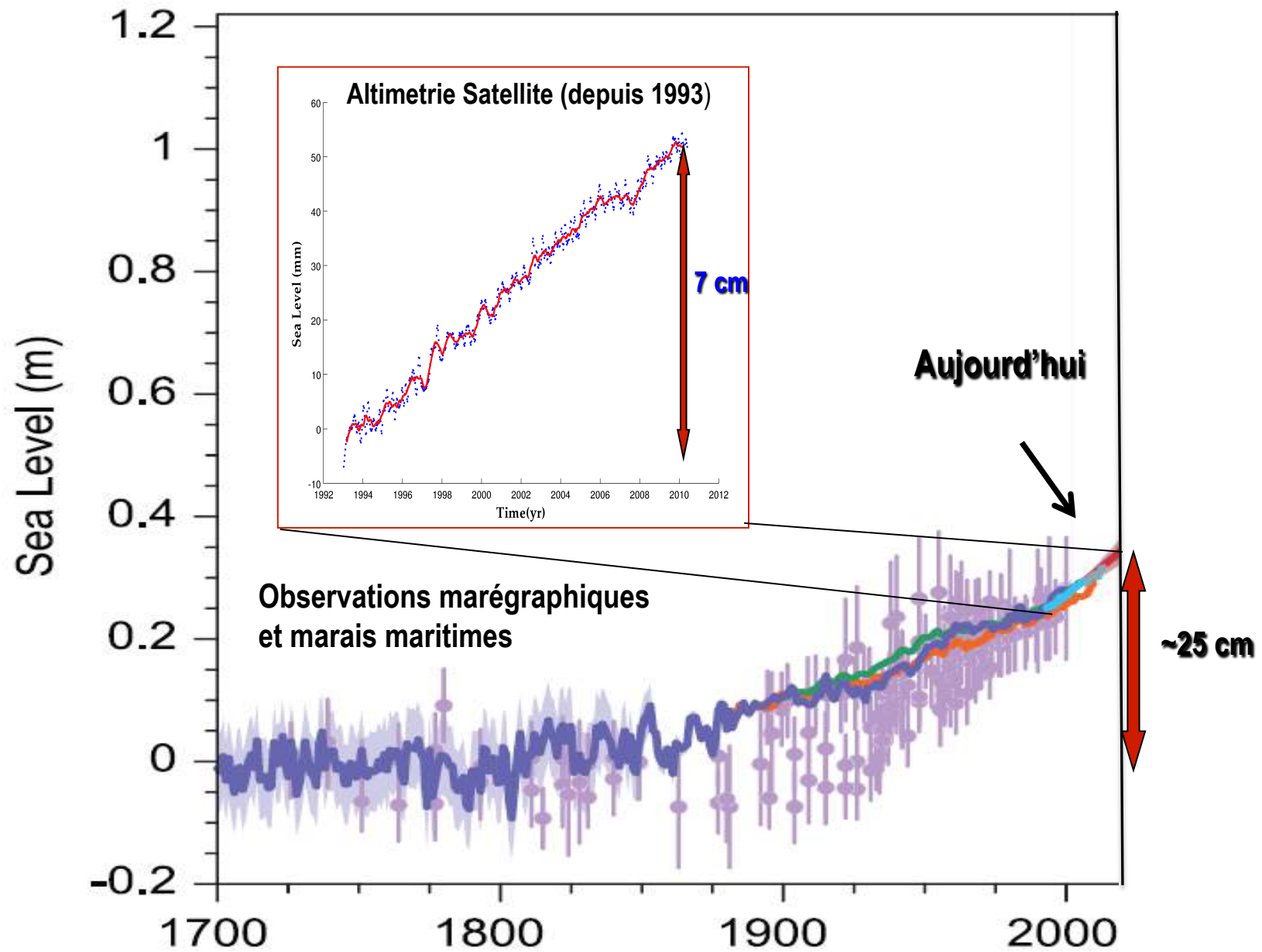
LE NIVEAU DE LA MER ACTUEL

Tendances du niveau de la mer observées par altimétrie 1993-2015 (la moyenne globale 3.4 mm/yr retirée)



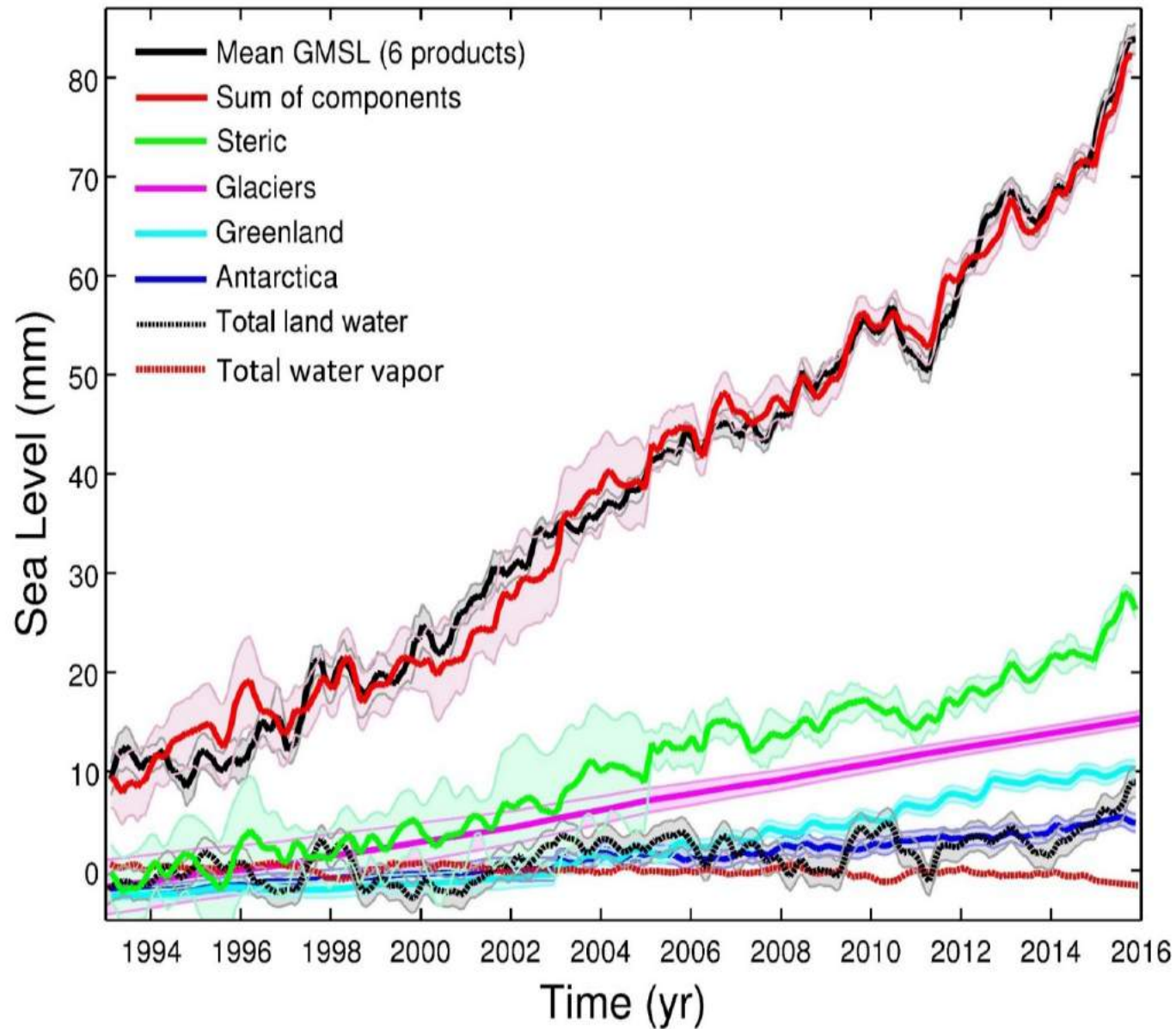
From Meyssignac et al. 2016

LE NIVEAU DE LA MER DEPUIS 1700

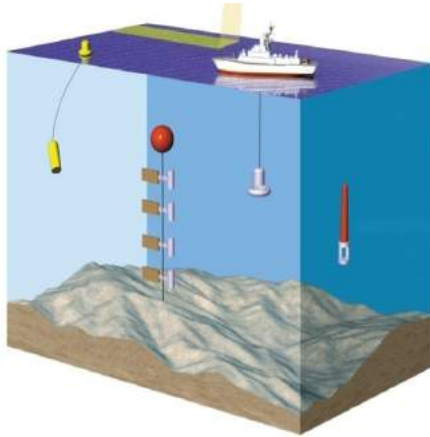


LES CAUSES DES VARIATIONS DU NIVEAU DE LA MER

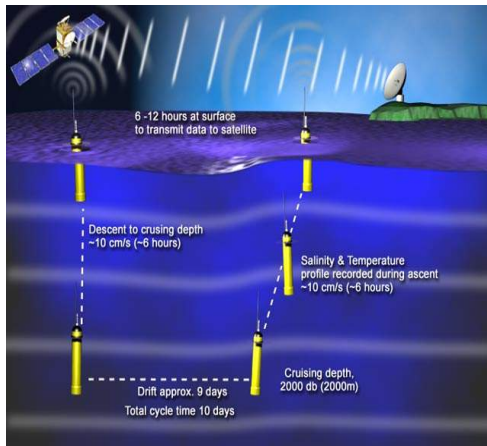
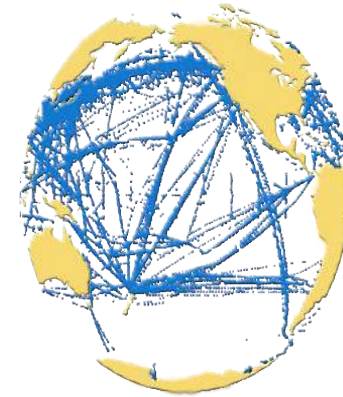
CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



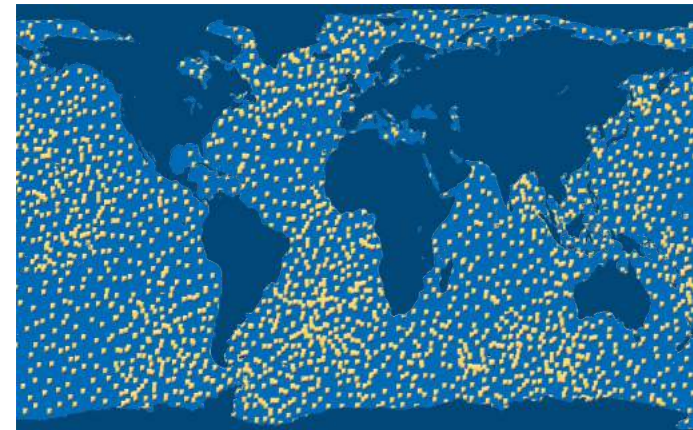
L'EXPANSION THERMIQUE DE L'OCEAN



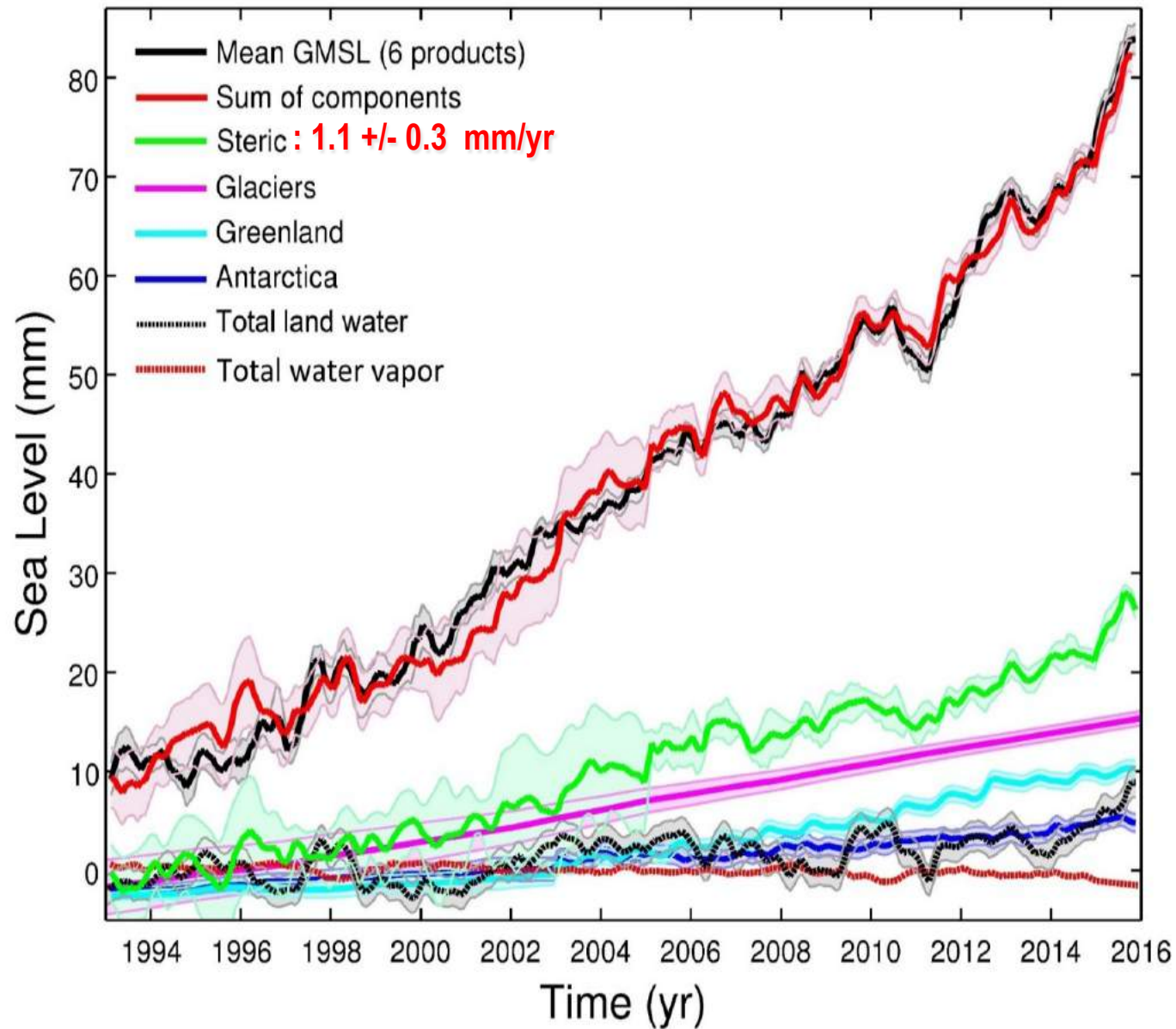
Past few decades:
coverage mainly
along commercial roads



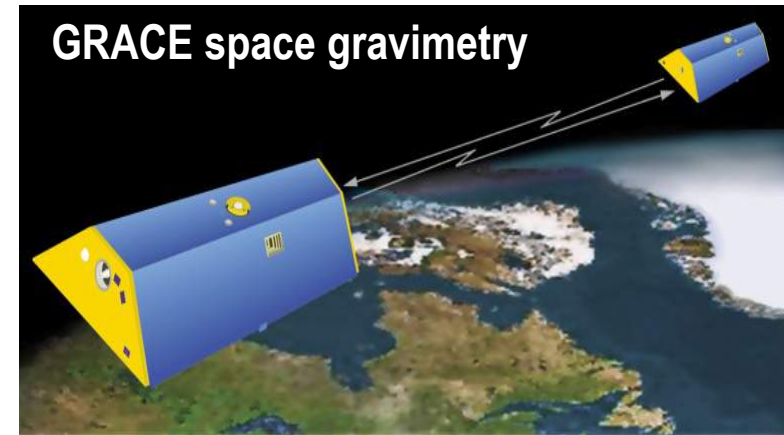
Since about 2003 →
'Argo' profiling floats



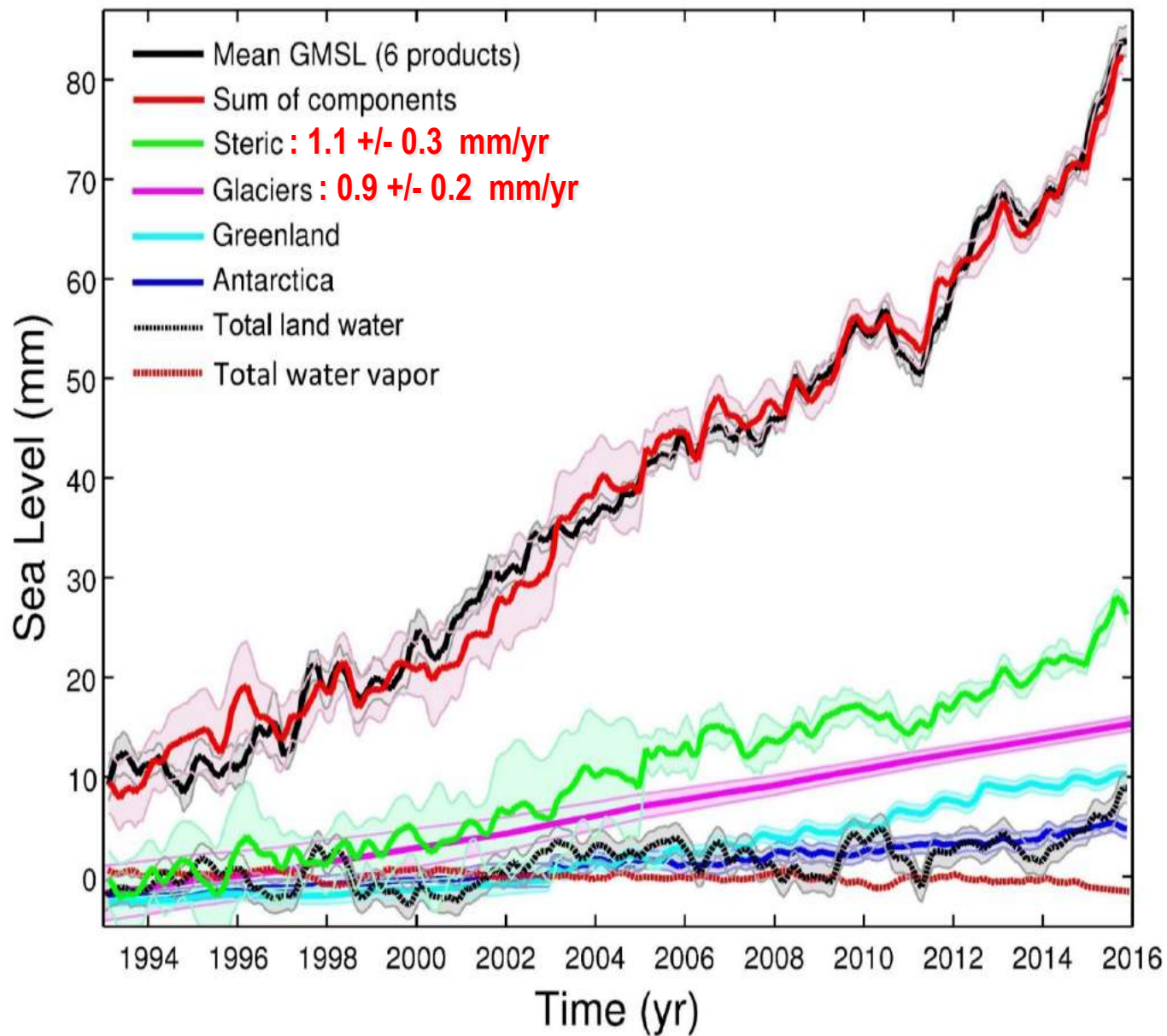
CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



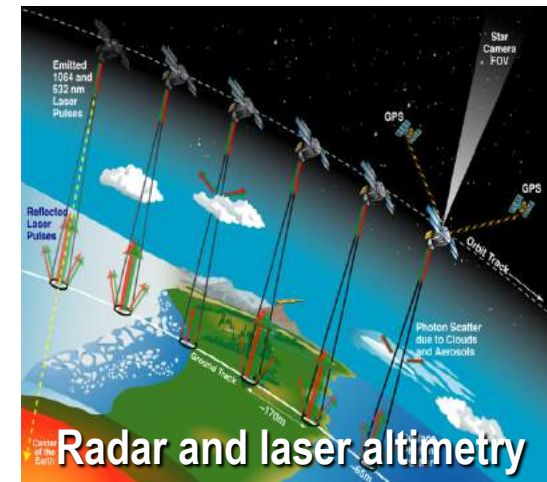
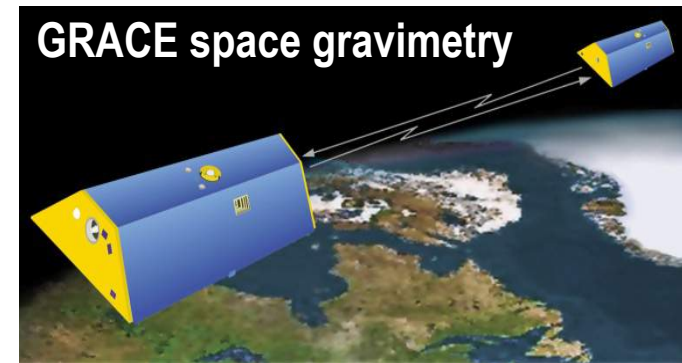
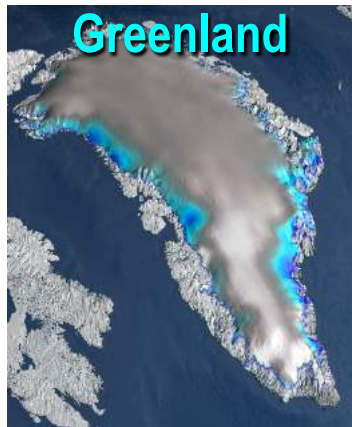
FONTE DES GLACIERS DE MONTAGNE



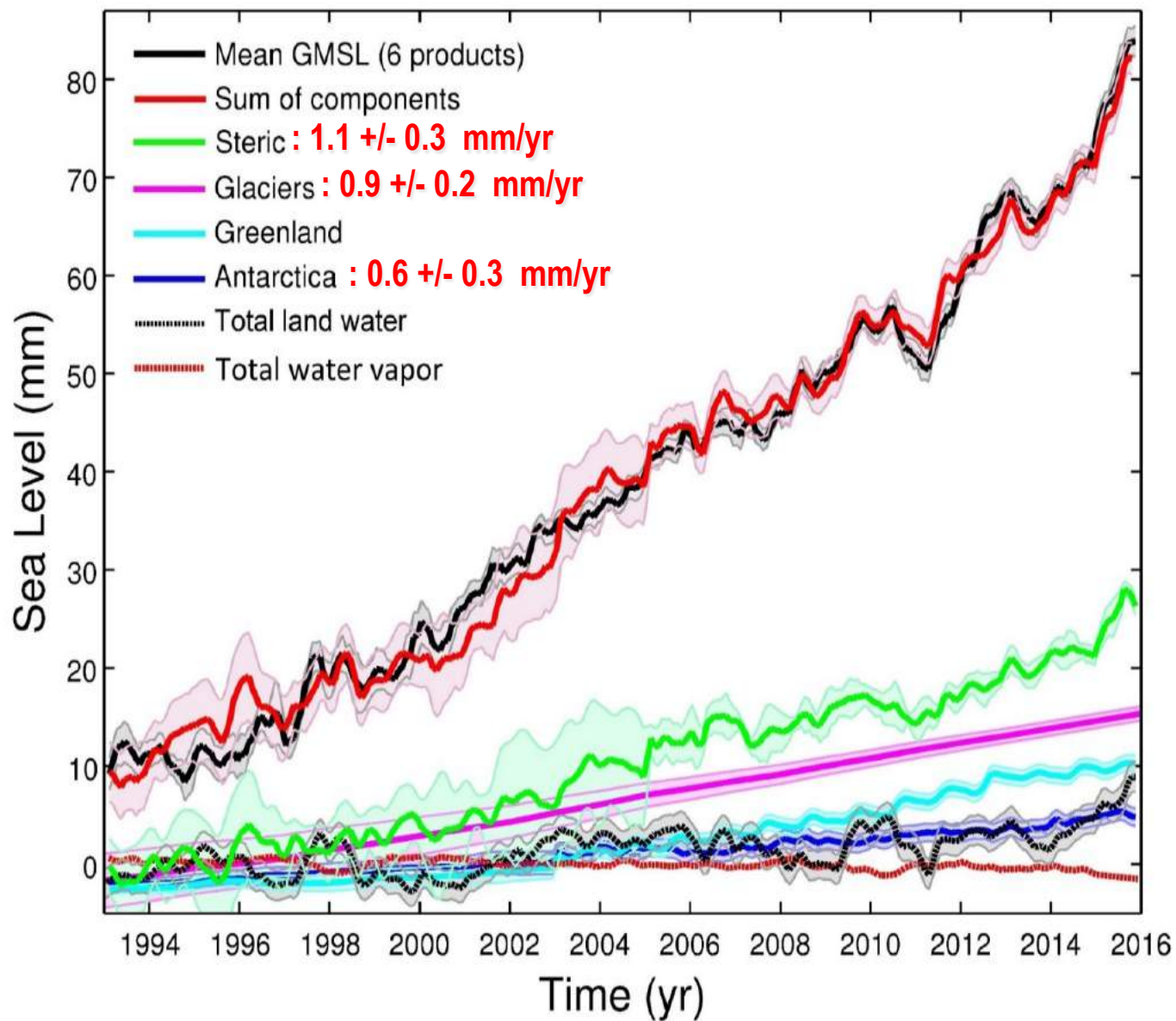
CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



FONTE DES CALOTTES POLAIRES



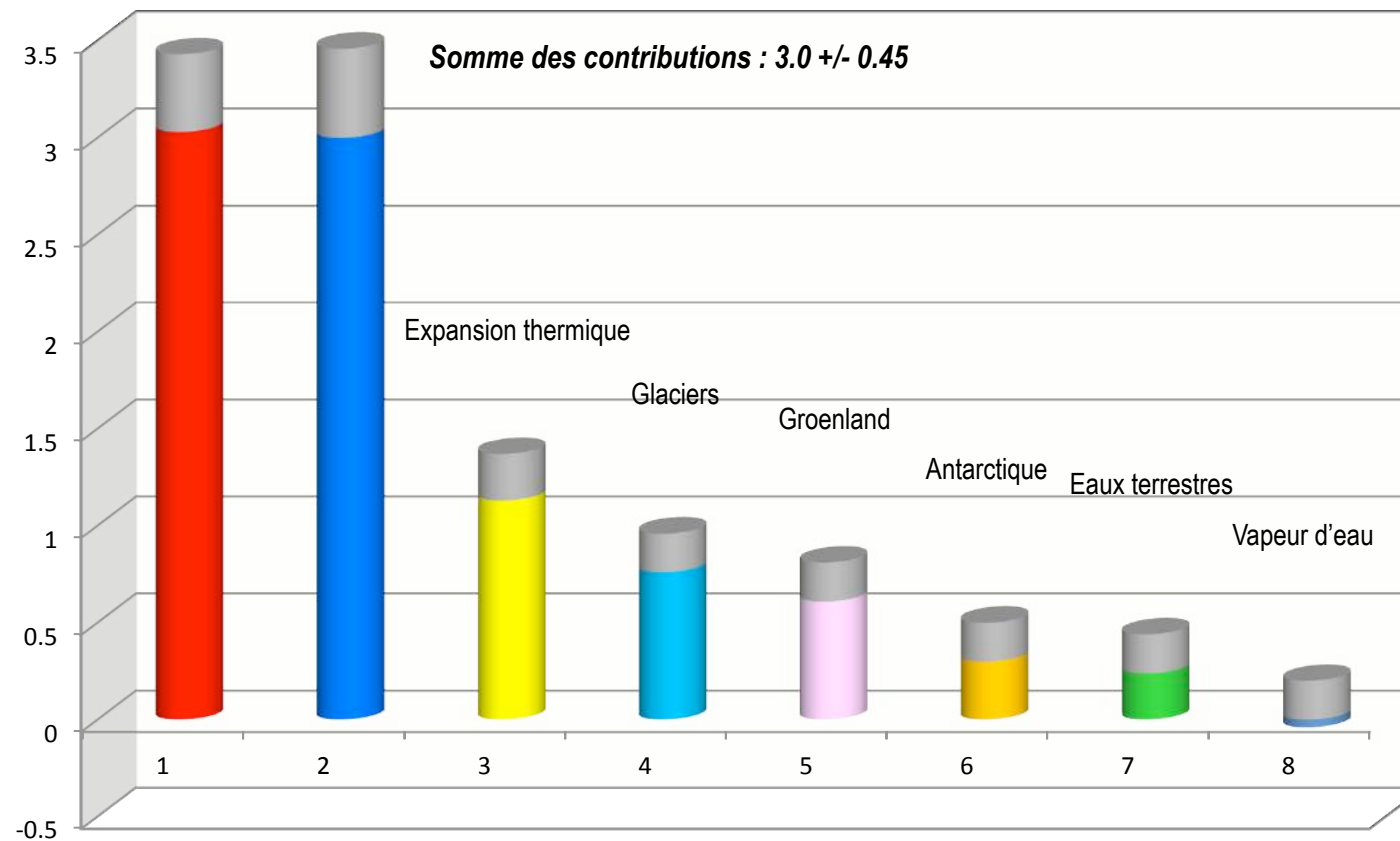
CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



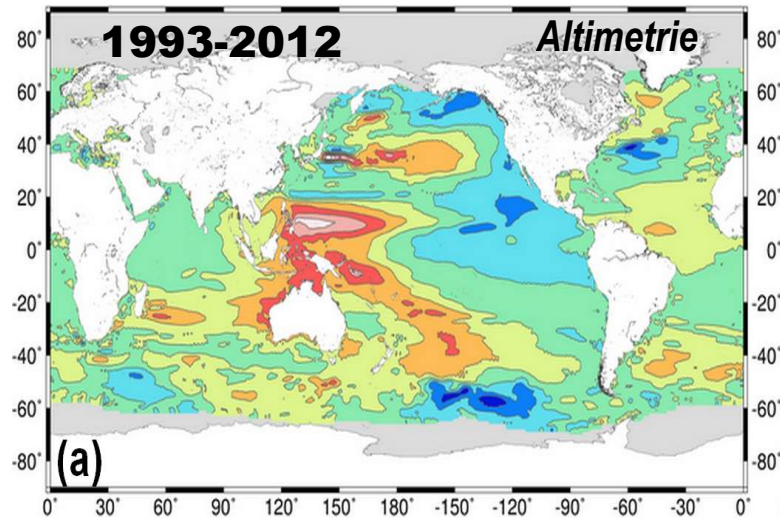
CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER

Bilan du niveau de la mer: tendances sur 1993-2016 (mm/an) (dérive Topex A corrigée)

Hausse de la mer altimétrique: 3.0 ± 0.4

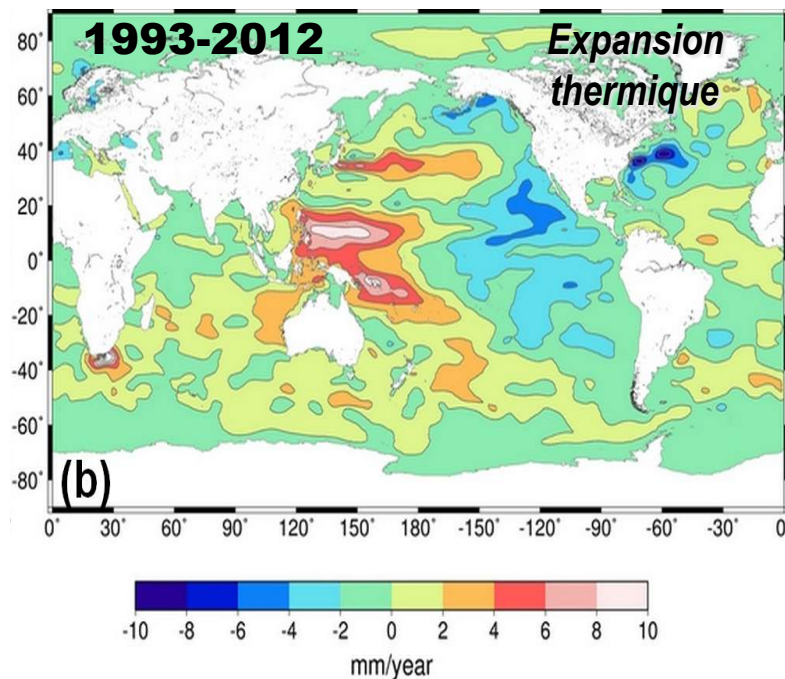


CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER

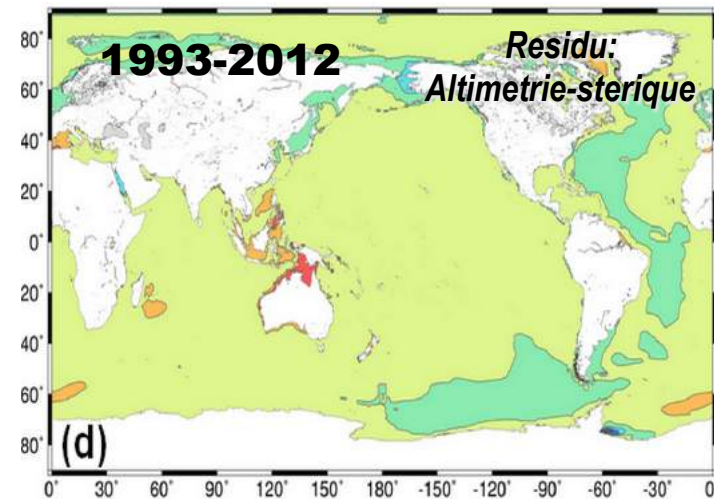


→ Sea level rise is not uniform. It is mostly due to non uniform thermal expansion

Lombard et al. 2009, Kohl & Stammer 2008,
Wunsch et al. 2007, Fukumori et Wang 2013,
Forget and Ponte 2015, Meyssignac et al. 2016



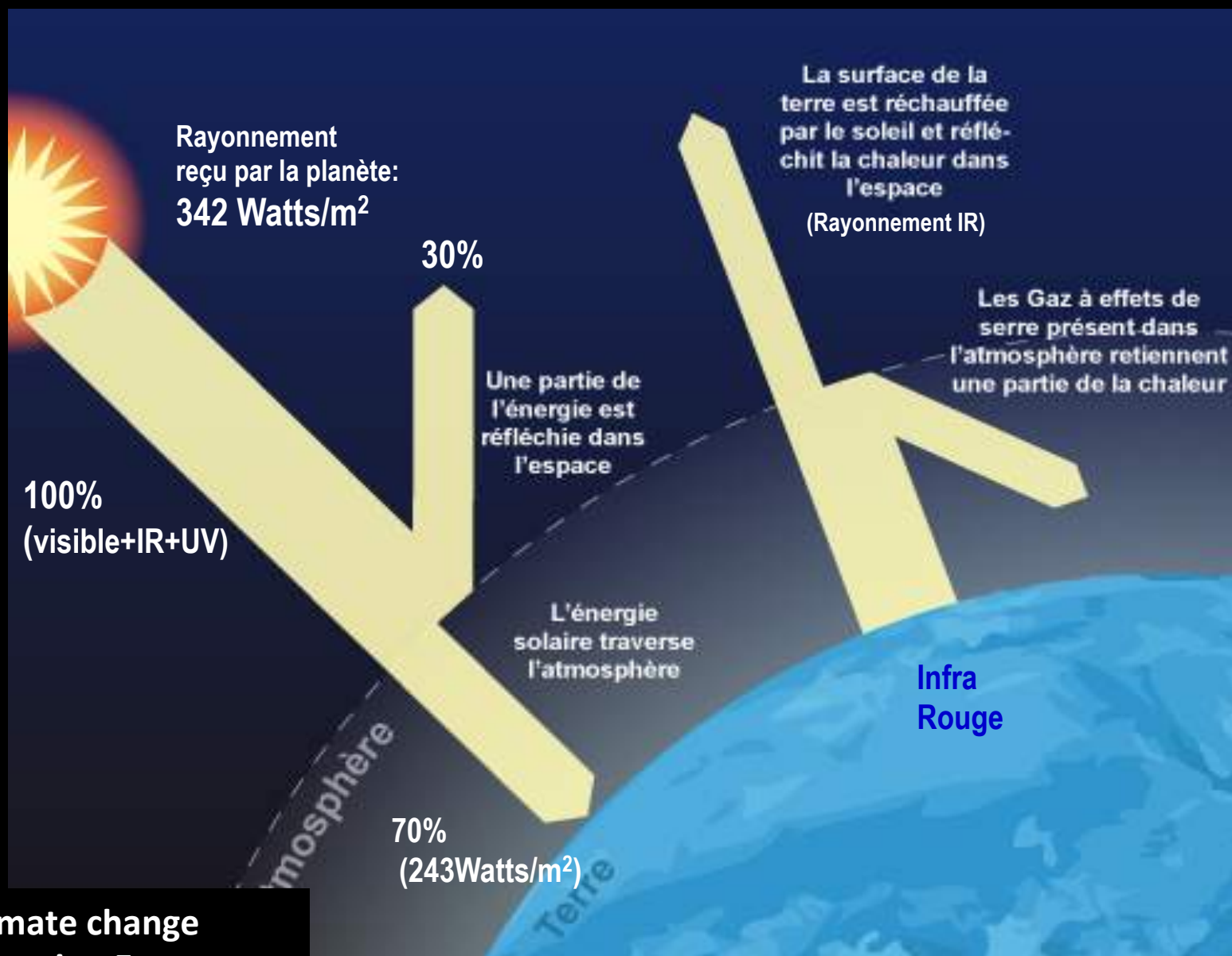
Niveau de la mer moins expansion thermique
1993-2012



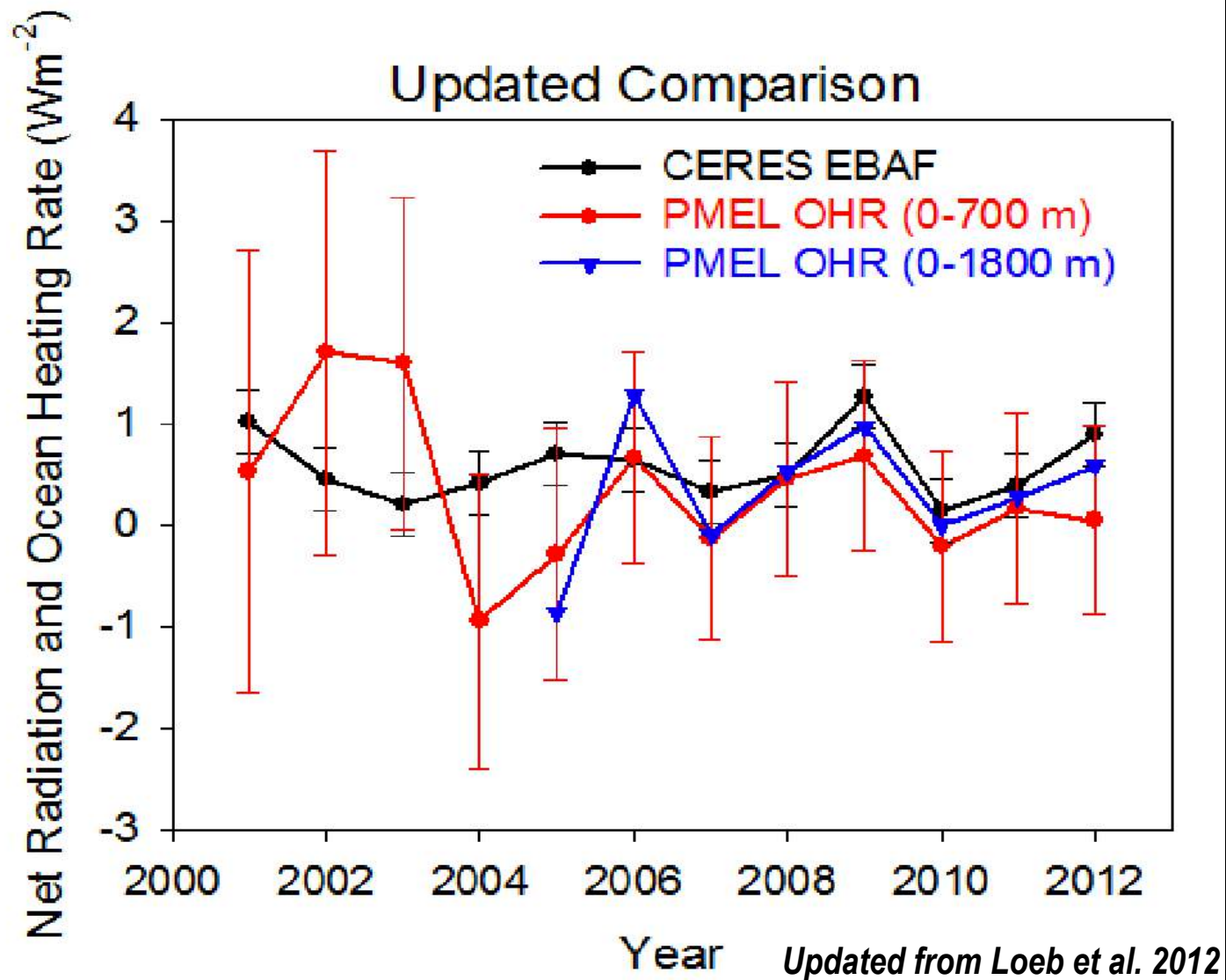
From Meyssignac et al. 2016

LES VARIATIONS DU NIVEAU DE LA MER EN REPONSE AU CHANGEMENT CLIMATIQUE

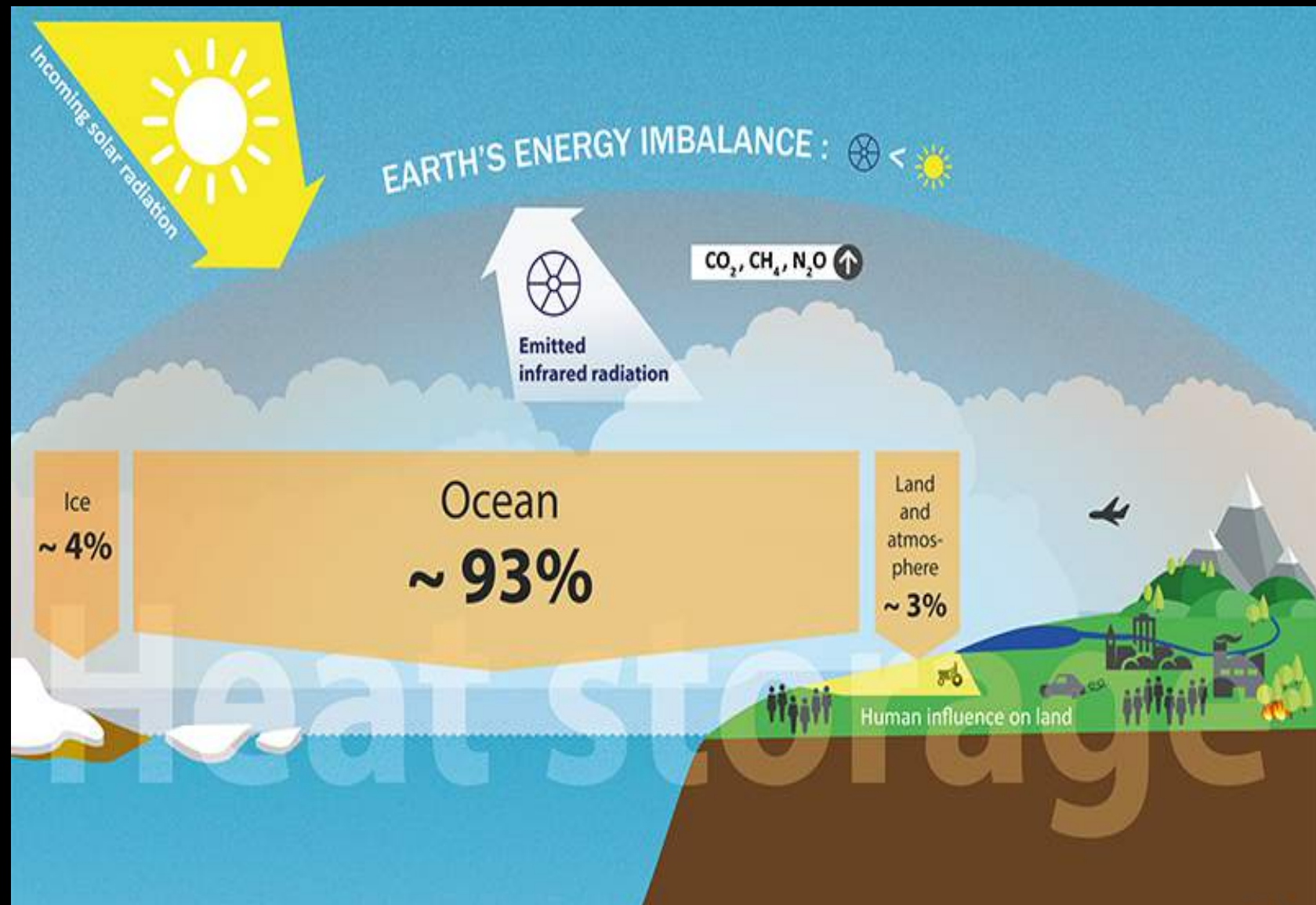
LE NIVEAU DE LA MER EN REPONSE AU CHANGEMENT CLIMATIQUE



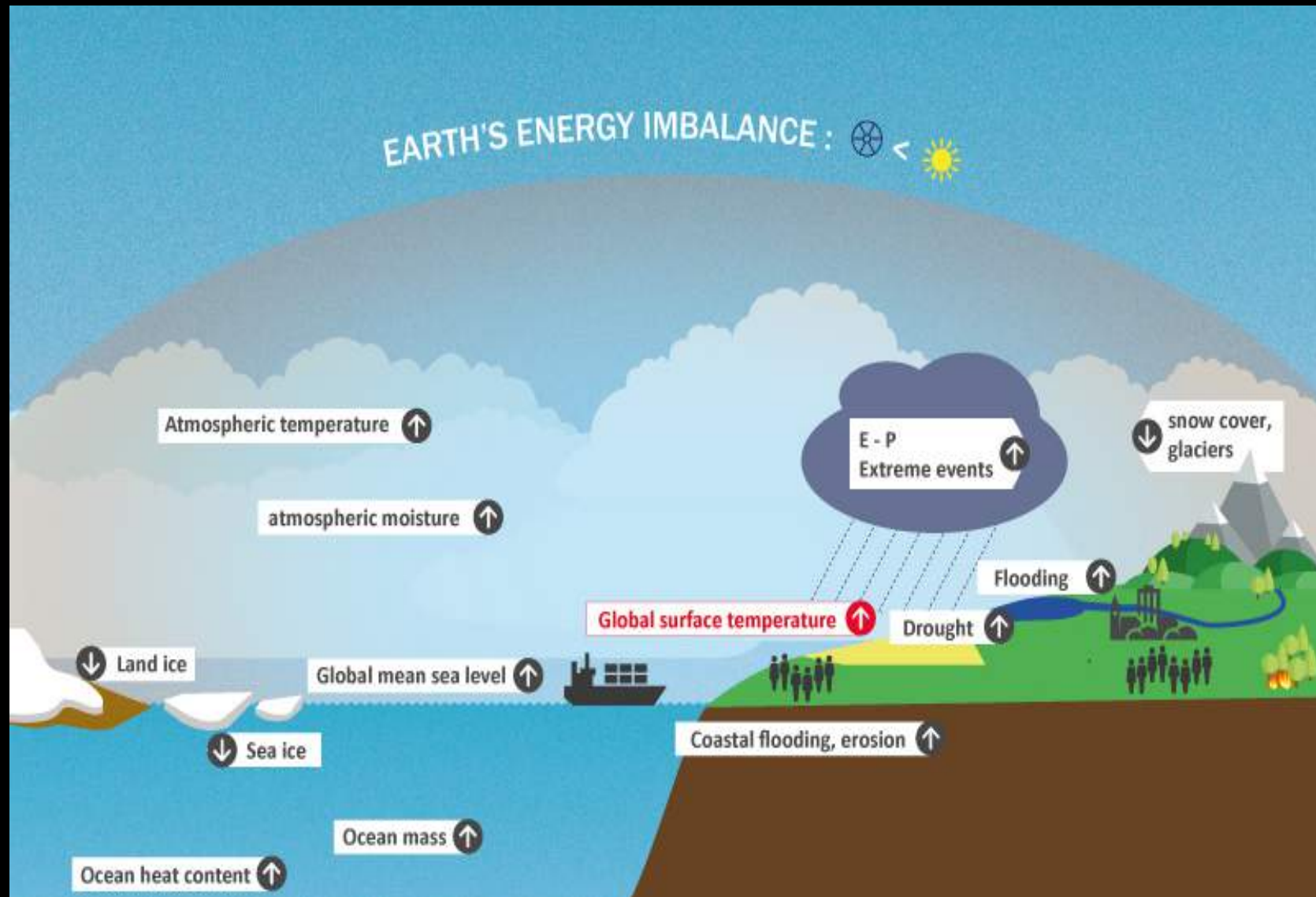
Under climate change
Net = Energy in - Energy out



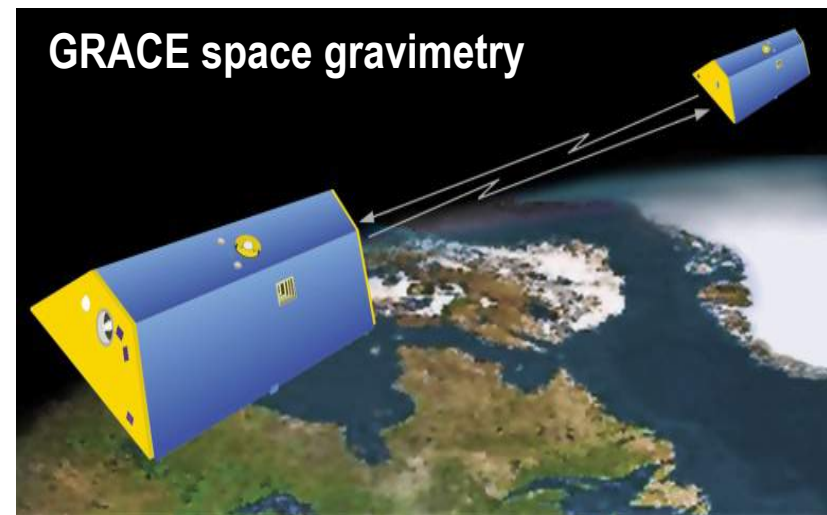
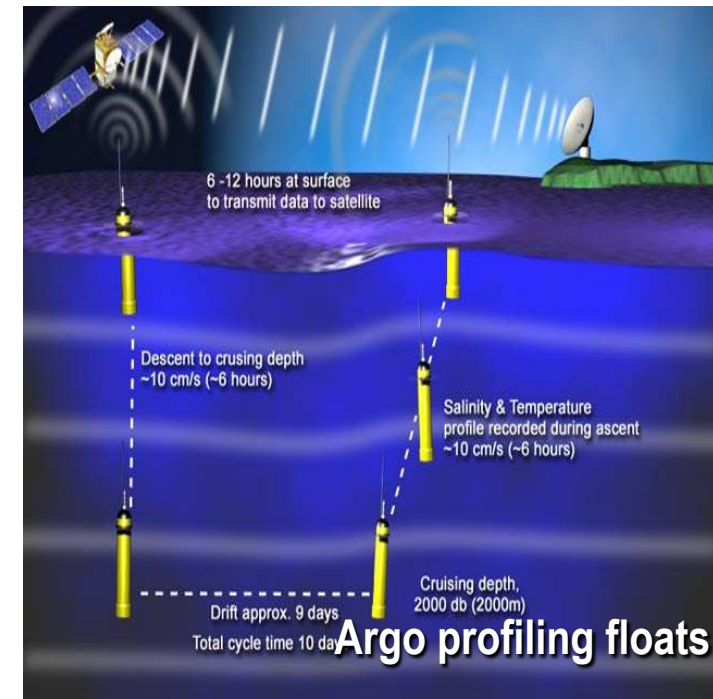
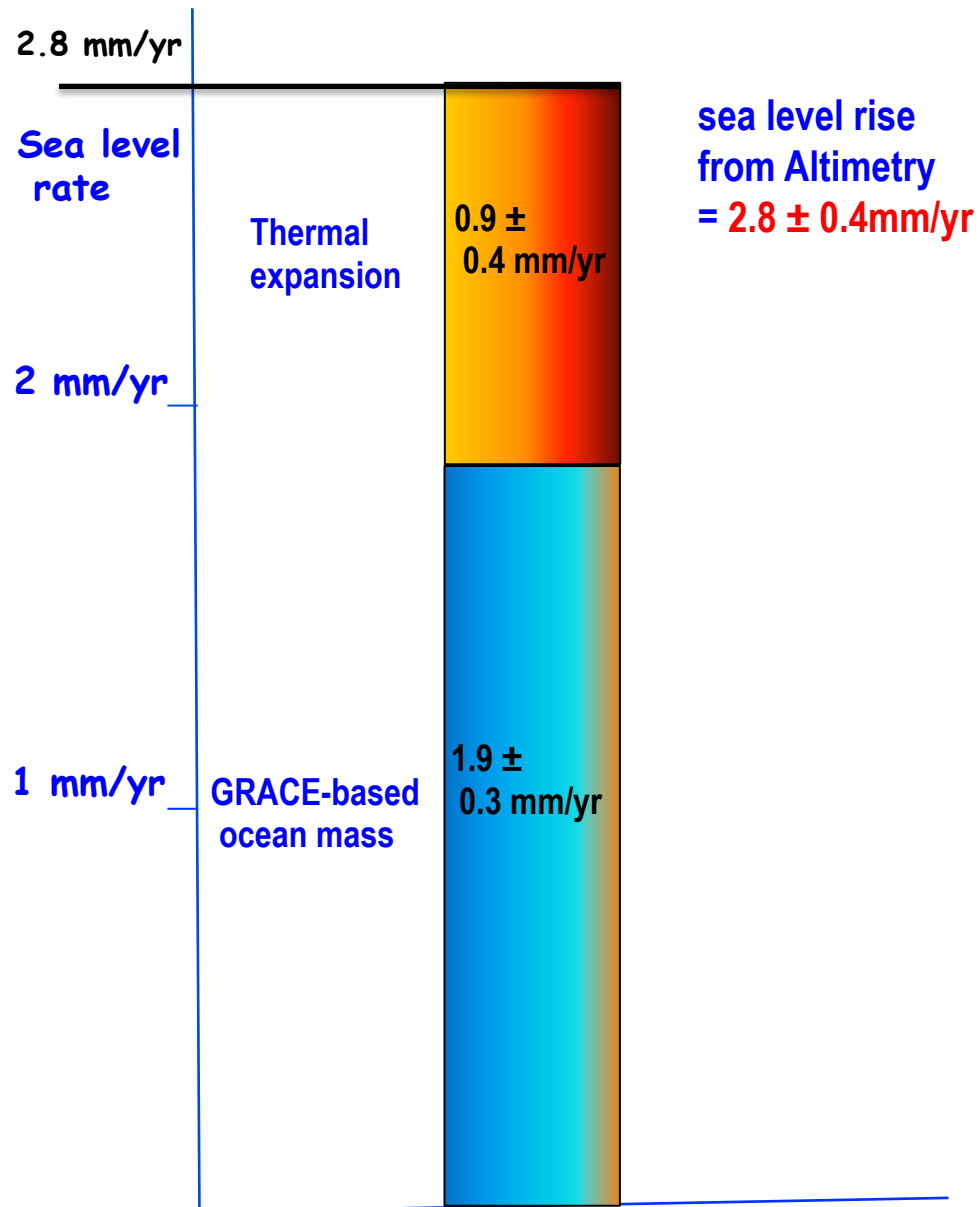
LE NIVEAU DE LA MER EN REPONSE AU CHANGEMENT CLIMATIQUE



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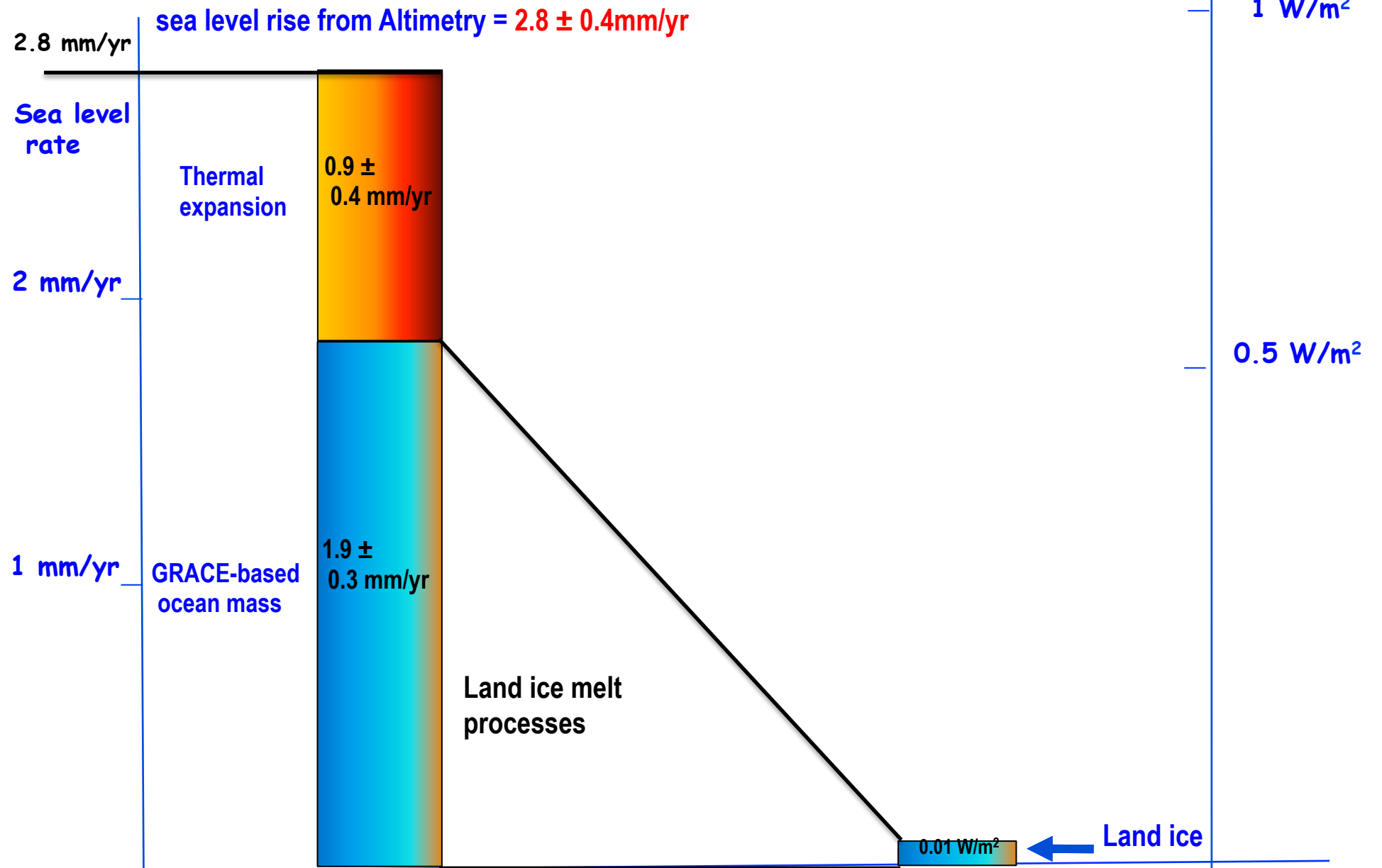


CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER

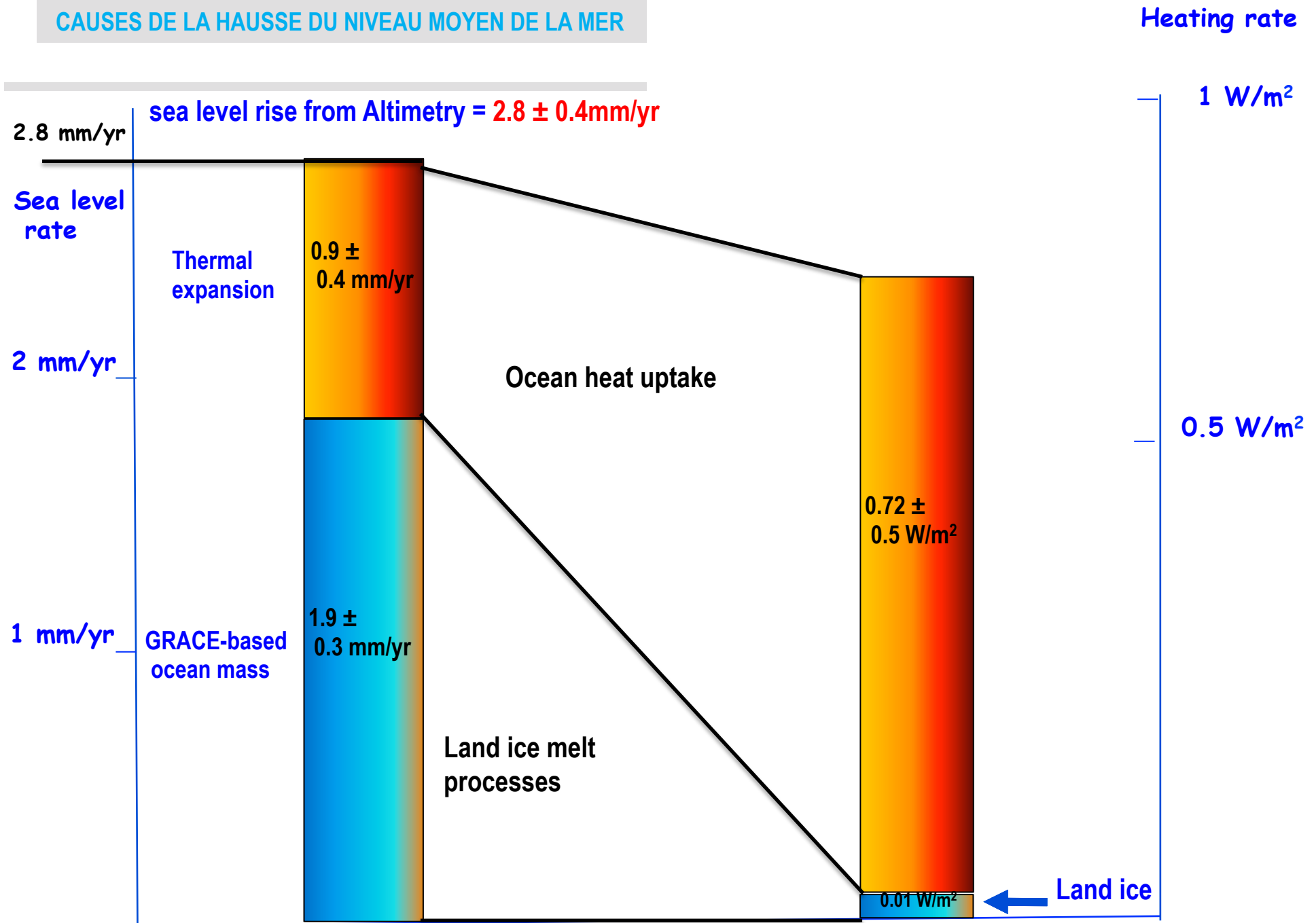


(from Dieng et al. 2015)

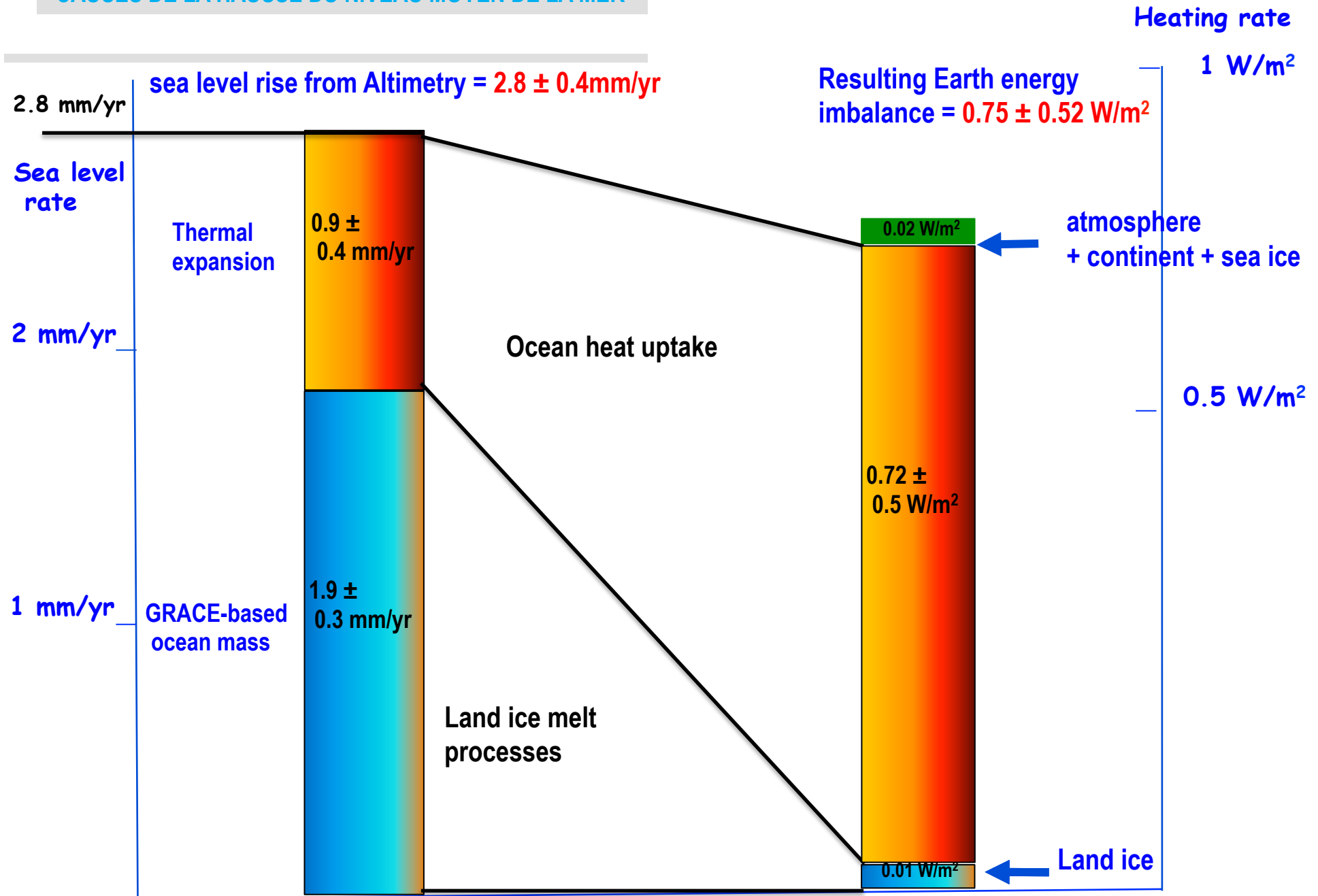
CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



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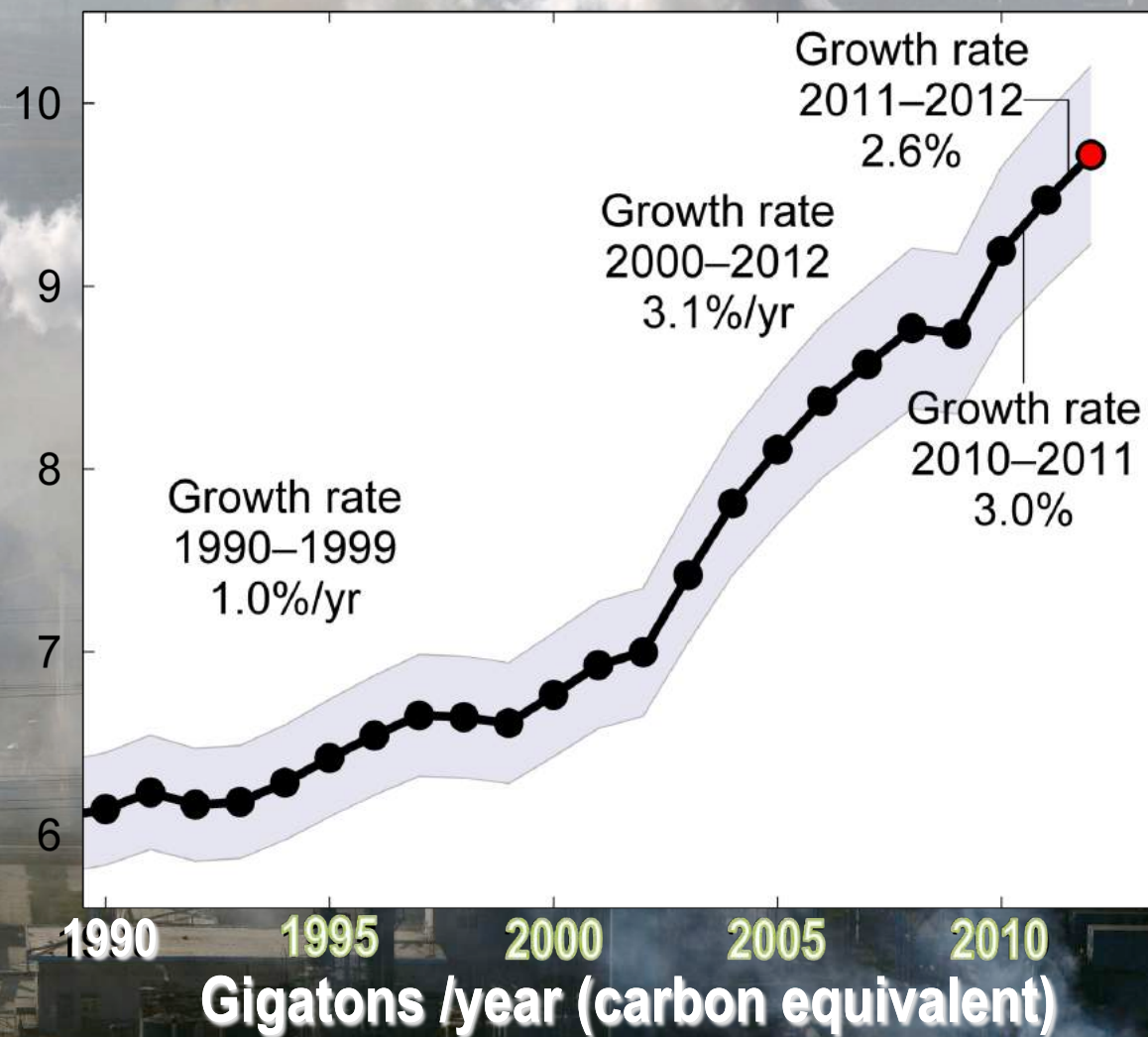


CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



LES PROJECTIONS DU NIVEAU DE LA MER

Emissions de Gaz à Effet de Serre



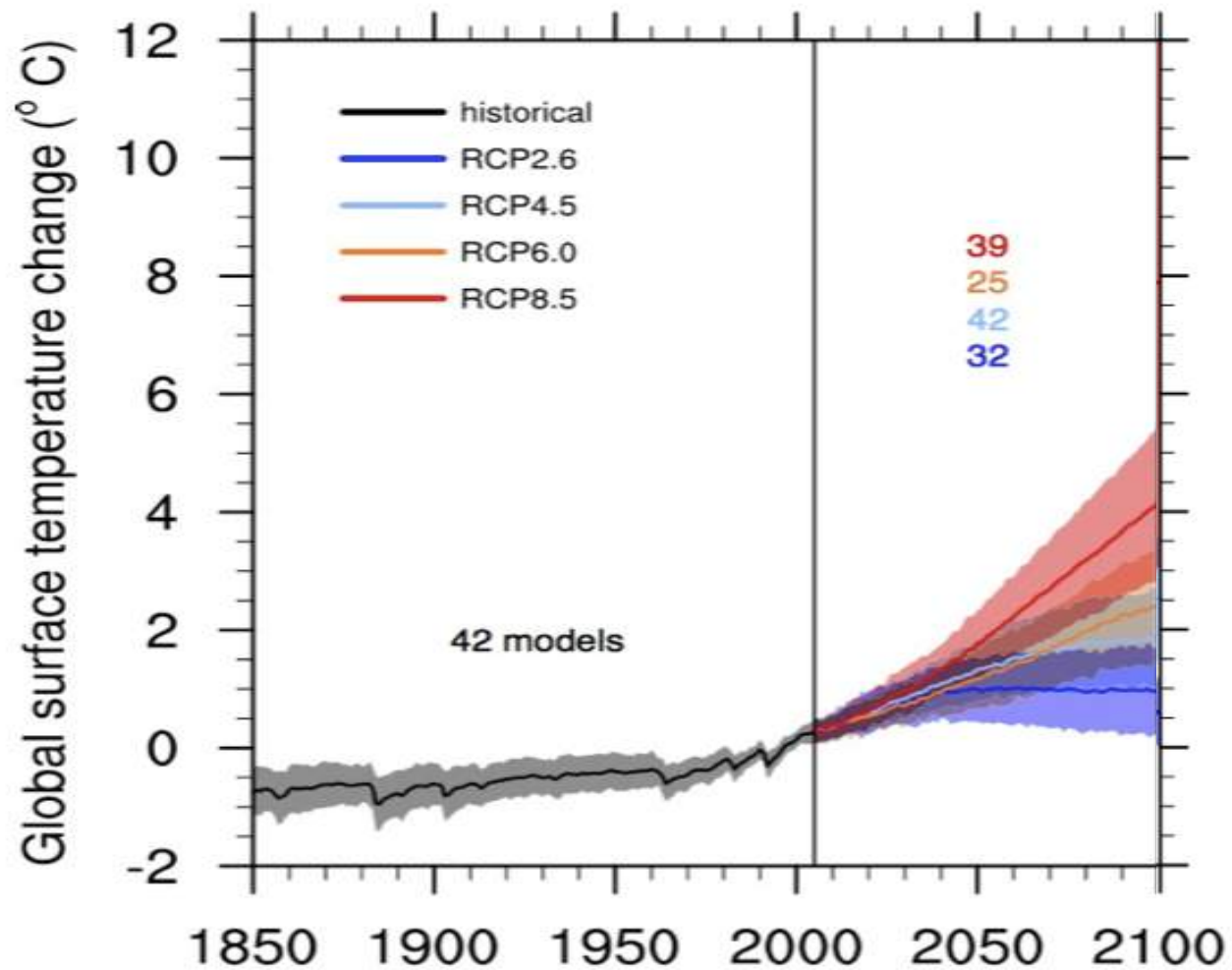
Warming scenarios considered by IPCC AR5

→ Representative Concentration Pathways (RCPs)

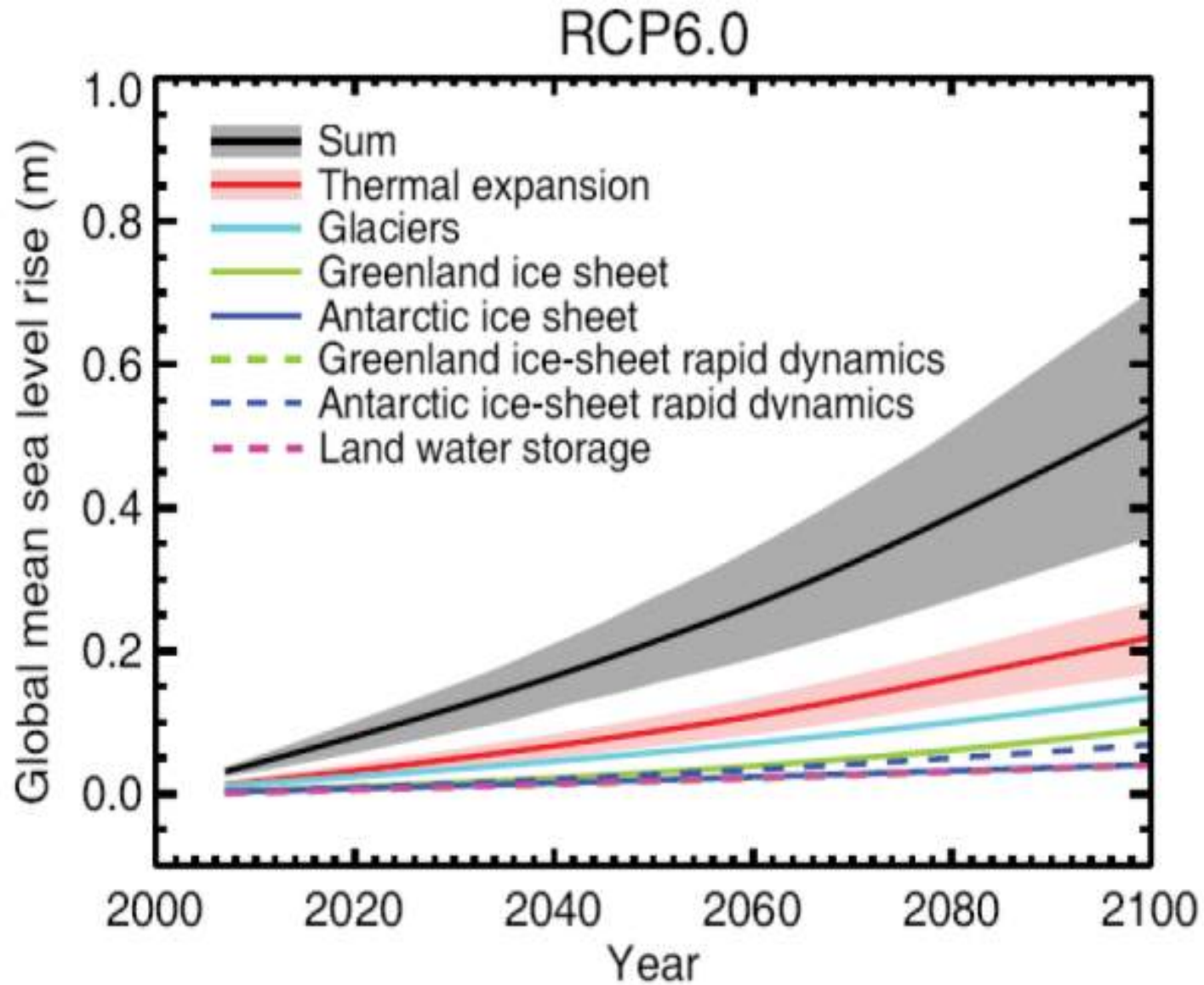
→ 4 RCP scenarios defined by their total radiative forcing by 2100:

- RCP2.6 (2.6 Wm^{-2})
- RCP4.5 (4.5 Wm^{-2})
- RCP6.0 (6.0 Wm^{-2})
- RCP8.5 (8.5 Wm^{-2})

Earth surface mean temperature projections

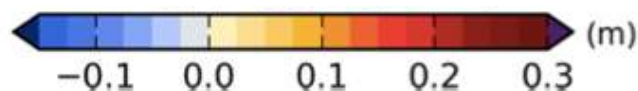
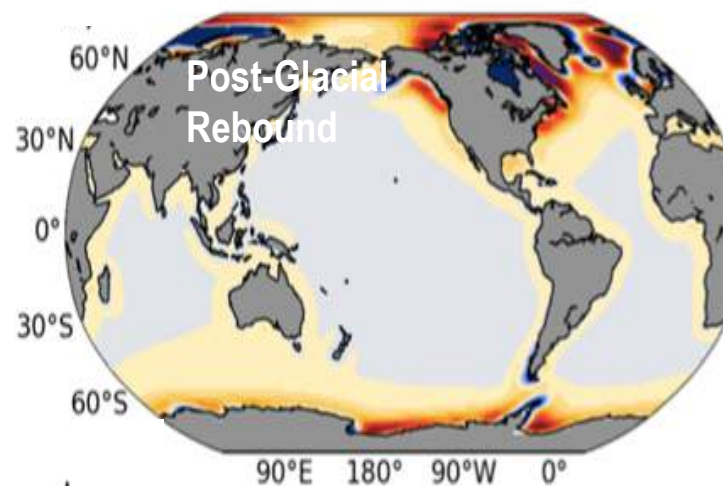
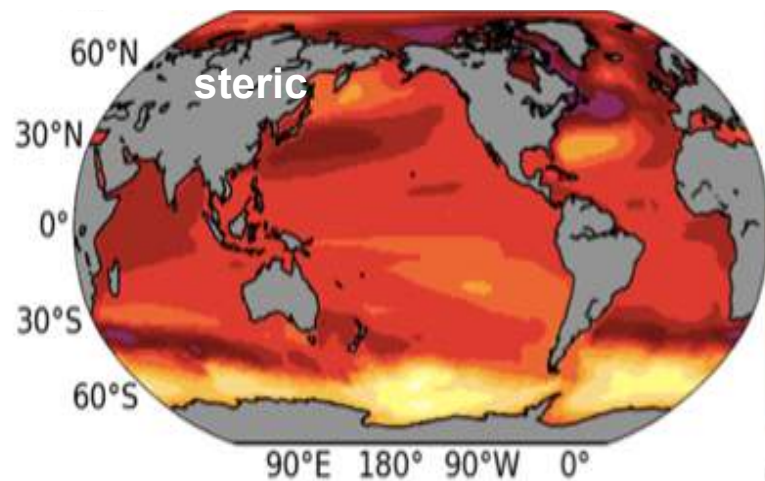
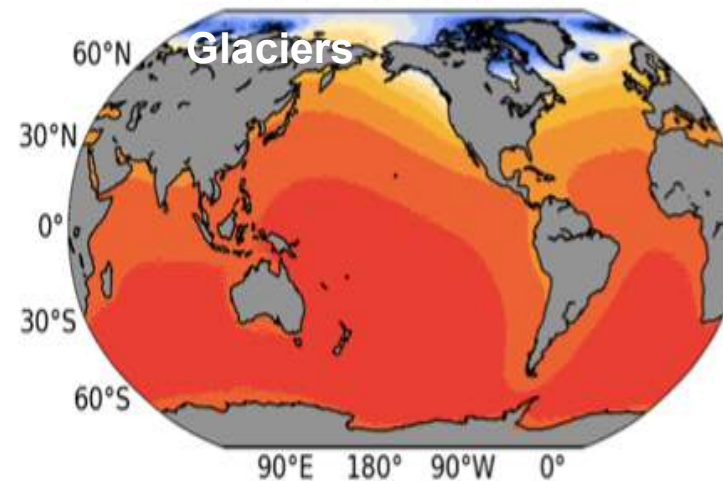
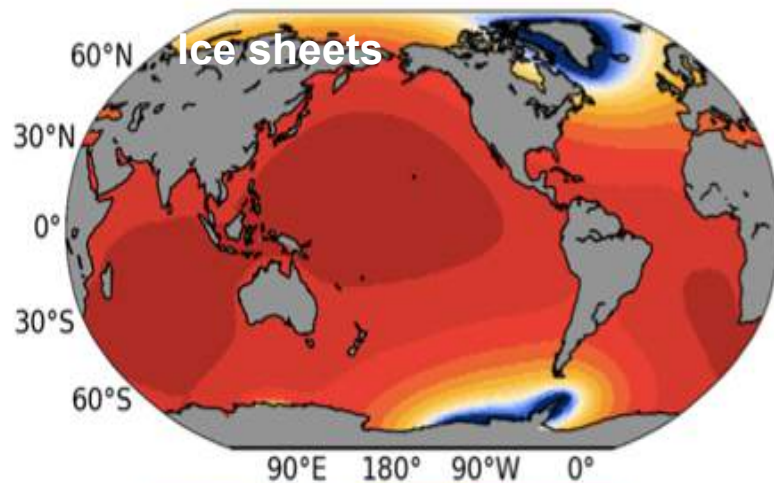


PROJECTIONS DU NIVEAU DE LA MER



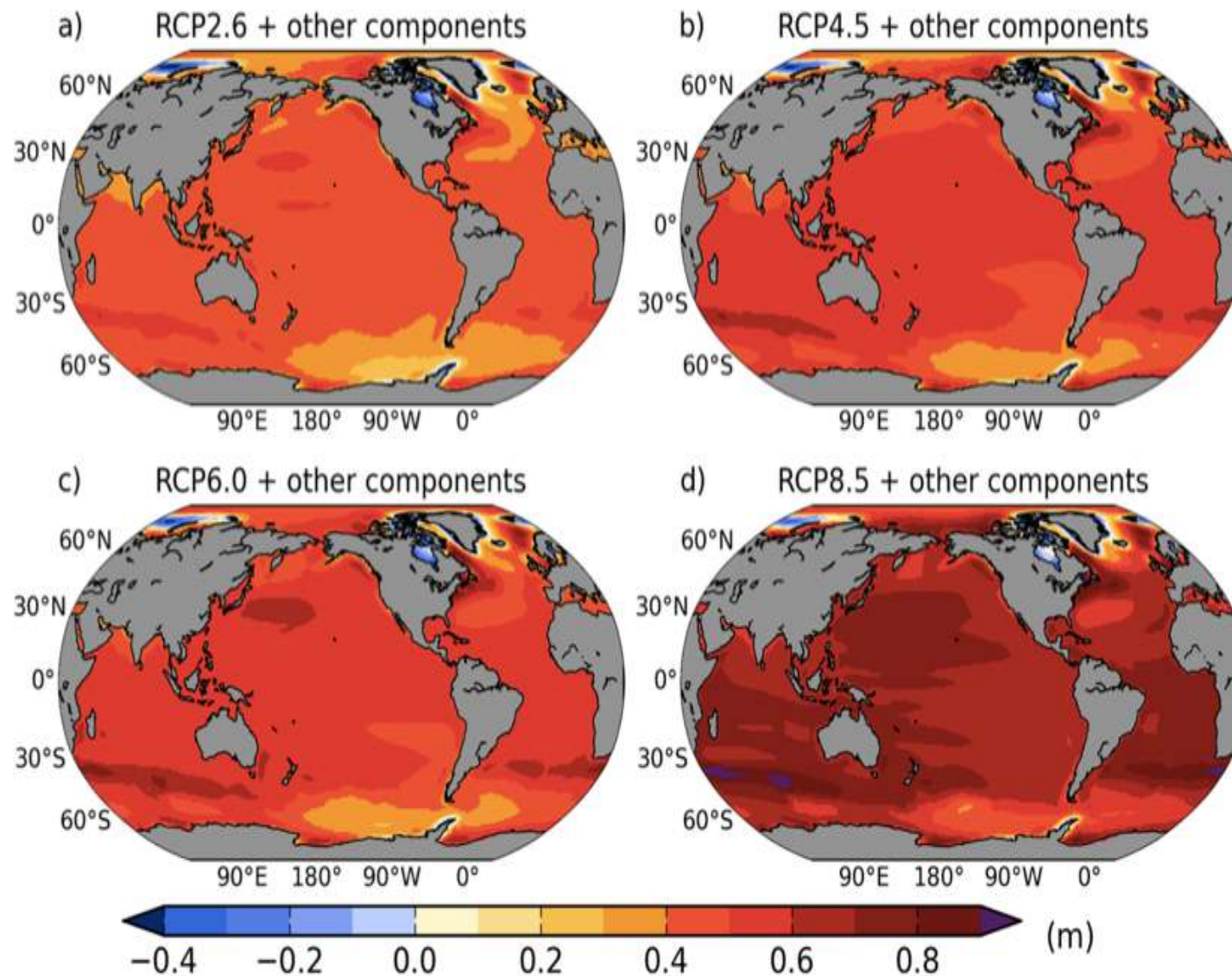
From IPCC AR5, 2013

Regional variability in relative sea level in 2080-2100 (*RCP 6.0*)



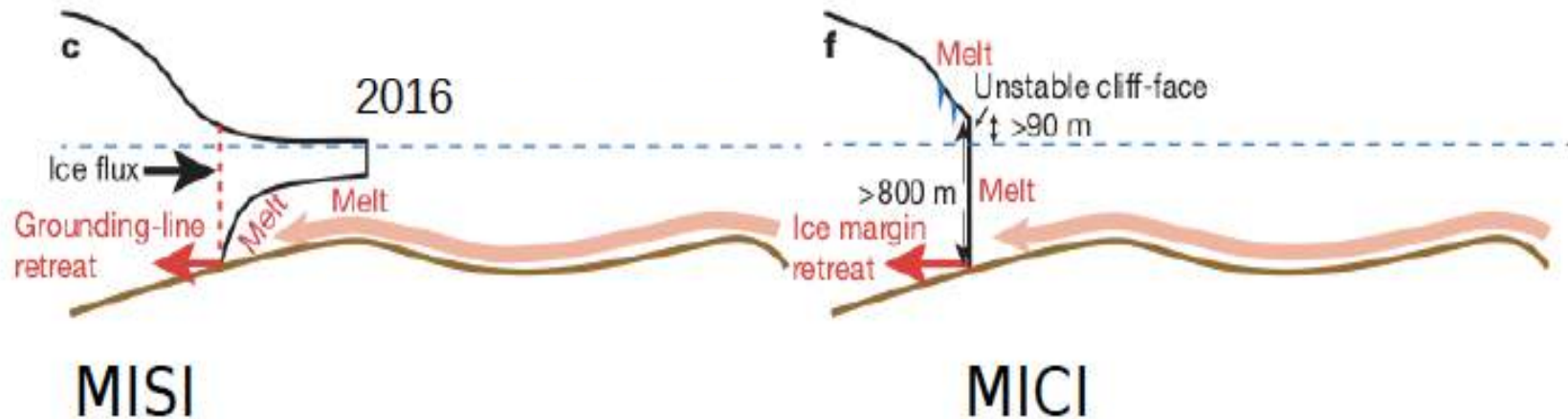
**Sea level change (m)
wrt present-day sea level**

Regional variability in relative sea level in 2080-2100



From IPCC AR5, 2013

Instabilités dynamique des calottes polaires



Marine Ice Sheet Instability:

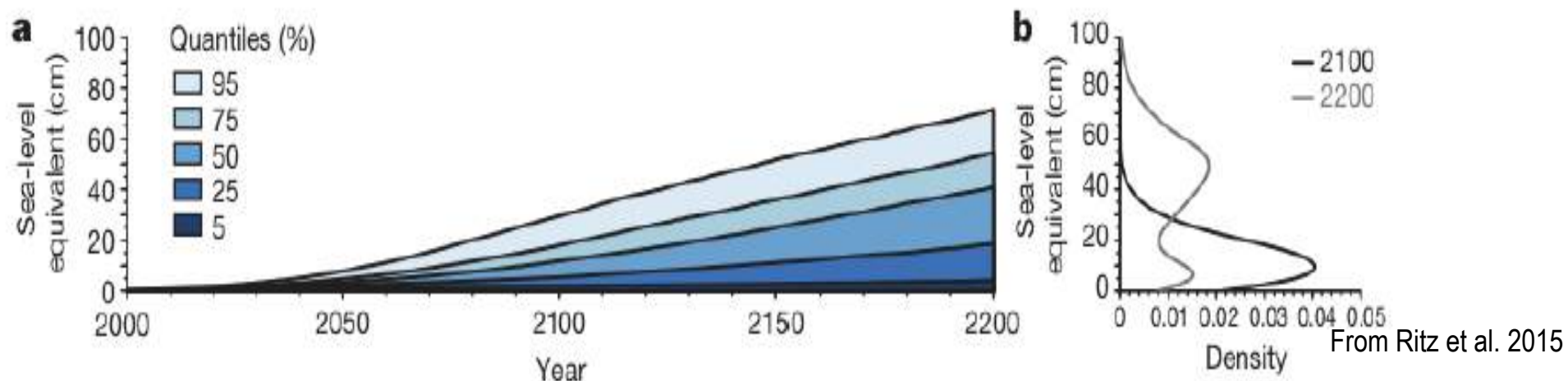
- Consensus
- Observé en Antarctique et au Groenland
- Soulève des questions sur la qualité des modèles

Marine Ice Cliff Instability:

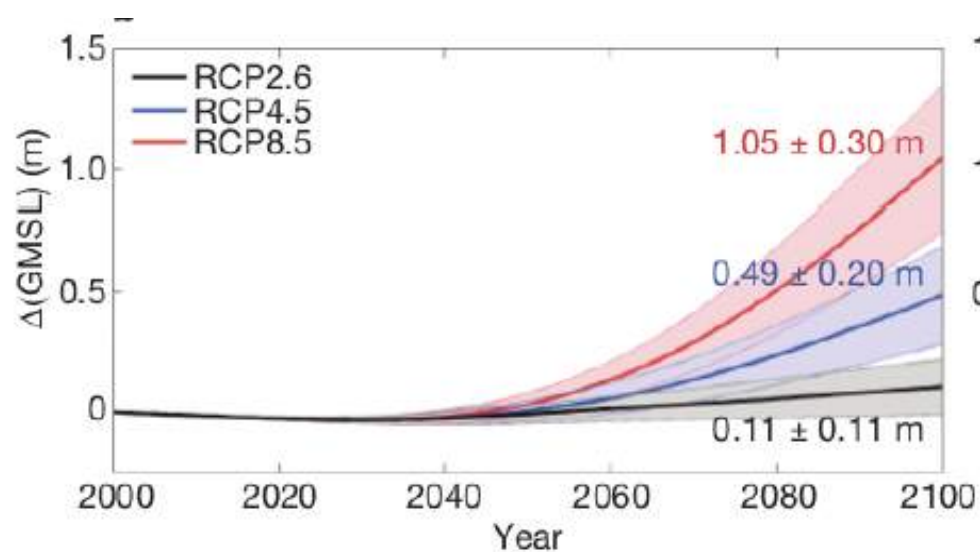
- Débattu
- Non observé en Antarctique

Instabilités dynamique des calottes polaires: simulations avec méthode d'ensemble

Marine Ice Sheet Instability:



Marine Ice Sheet + Marine Ice Cliff Instability:



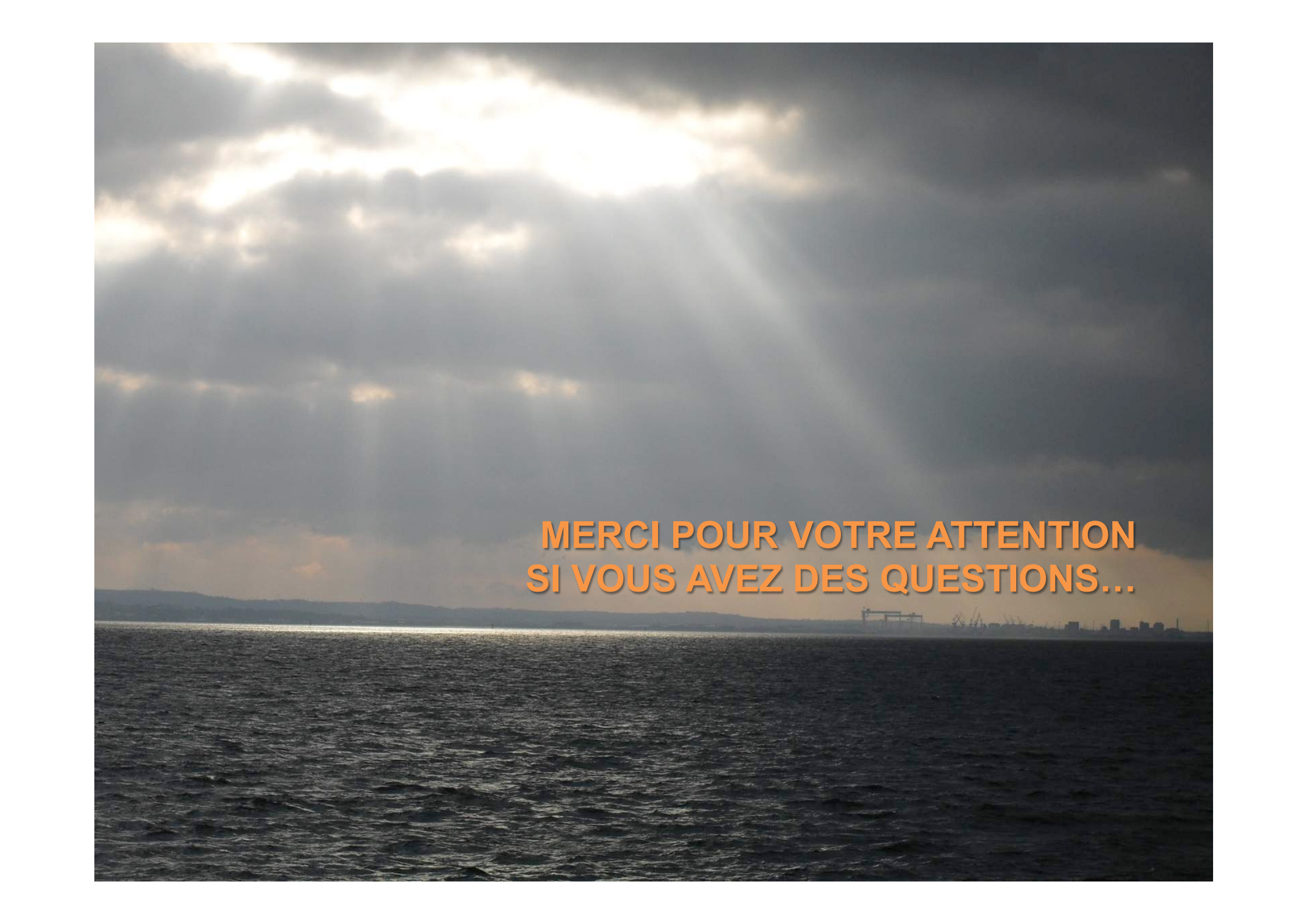
From DeConto and Pollard 2016

Submersion permanente dans la baie de St Brieuc: 2m de hausse de niveau de la mer



Conclusions

- Le niveau de la mer actuel augmente rapidement comparé aux millénaires précédents et menace les populations cotières
- Il augmente en réponse au réchauffement de l'océan et à la fonte des glaces continentales
- La hausse du niveau de la mer est cohérente avec le déséquilibre énergétique de la Terre due aux gaz à effet de serre!! Notre compréhension du phénomène est robuste
- Dans le futur le niveau de la mer augmentera entre 40 ± 14 cm et 62 ± 19 cm en 2100 en fonction du scénario d'émission de GES avec une variabilité régionale de $\pm 30\%$ autour de la moyenne
- Cette estimation ne prend pas en compte la perte de masse des calottes polaires par instabilité dynamique. Cette contribution pourrait atteindre 60 cm à 1 m en 2100



**MERCI POUR VOTRE ATTENTION
SI VOUS AVEZ DES QUESTIONS...**