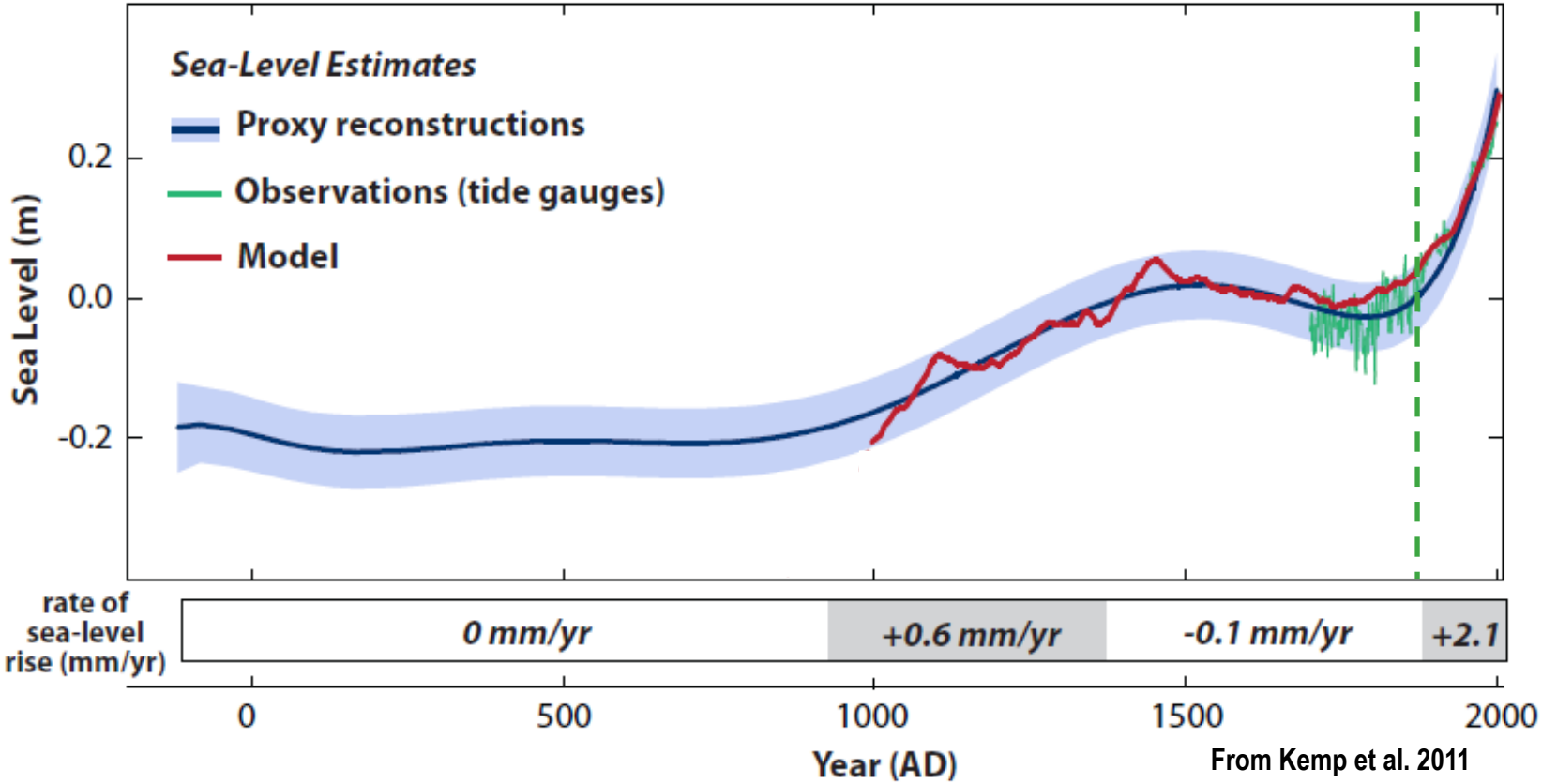
Les variations du niveau de la mer actuelles et futures en réponse au changement climatique

Benoit Meyssignac, LEGOS, CNES

Gulf of Maine October 2014

LES OBSERVATIONS DU NIVEAU DE LA MER

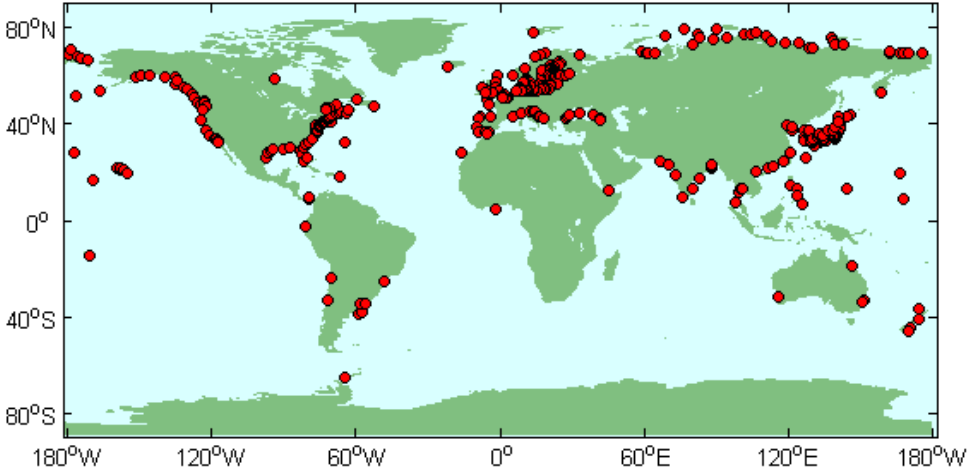
LE NIVEAU DE LA MER DANS LE PASSE



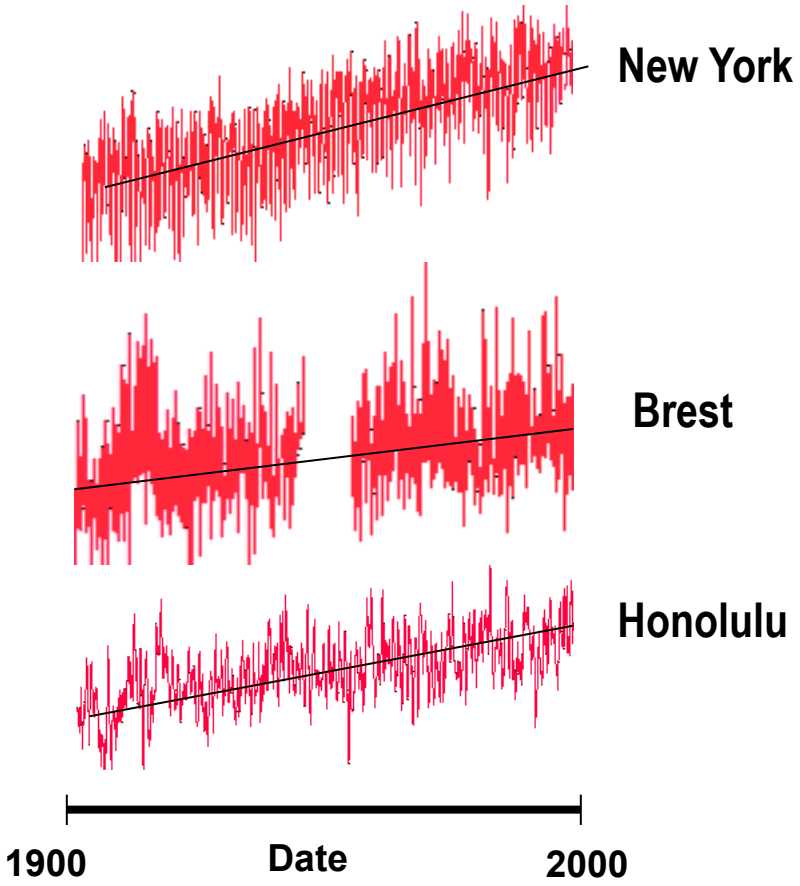
From Kemp et al. 2011

LE NIVEAU DE LA MER DANS LE PASSE

Tide gauge distribution with records > 40 years

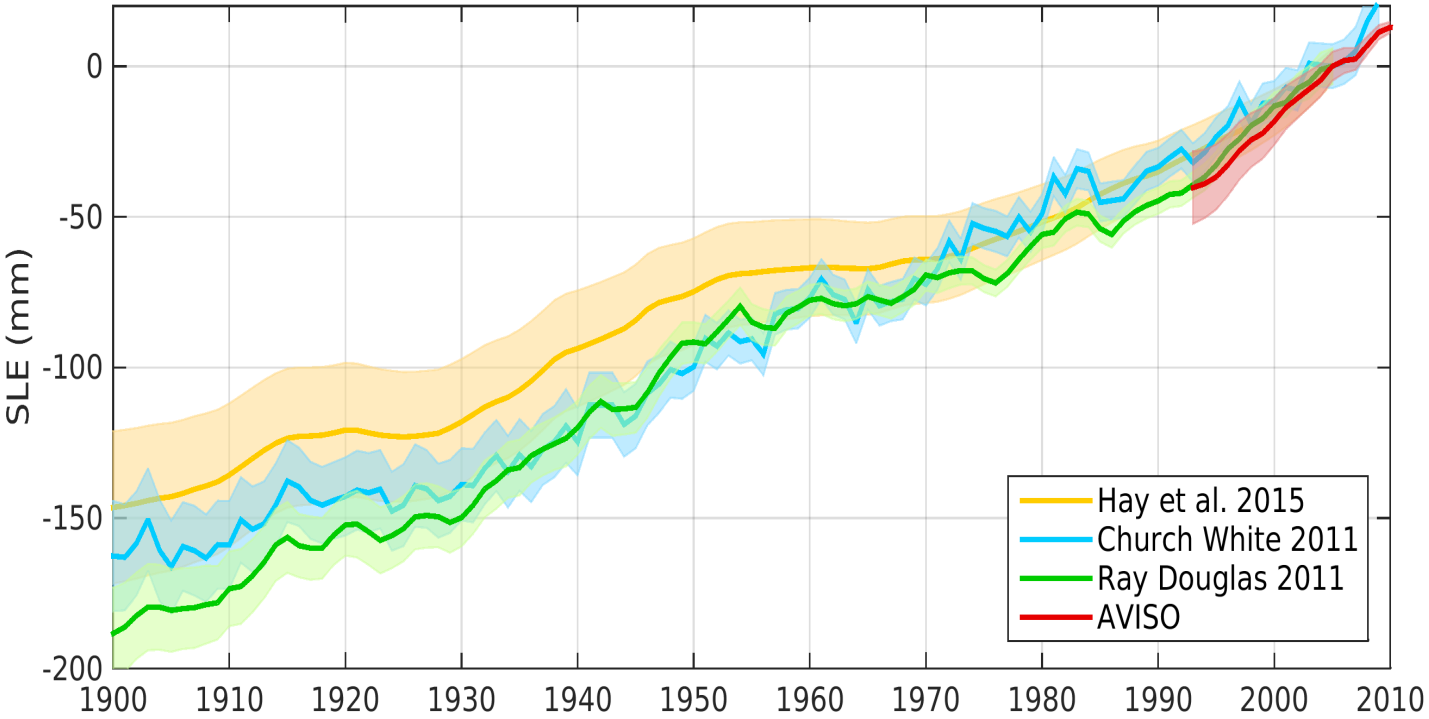


Tide gauge



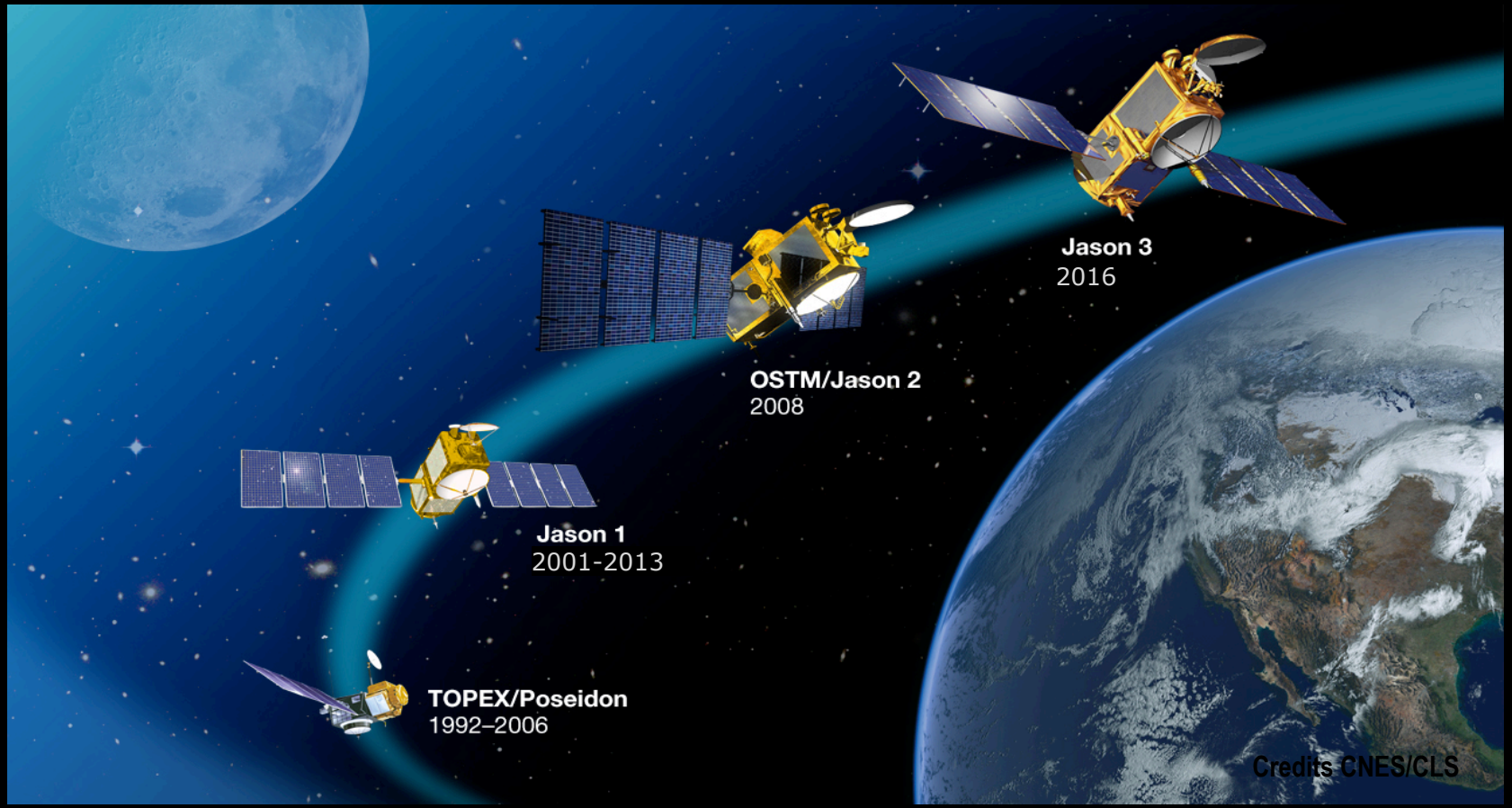
From Church et al. 2013

LE NIVEAU DE LA MER DANS LE PASSE

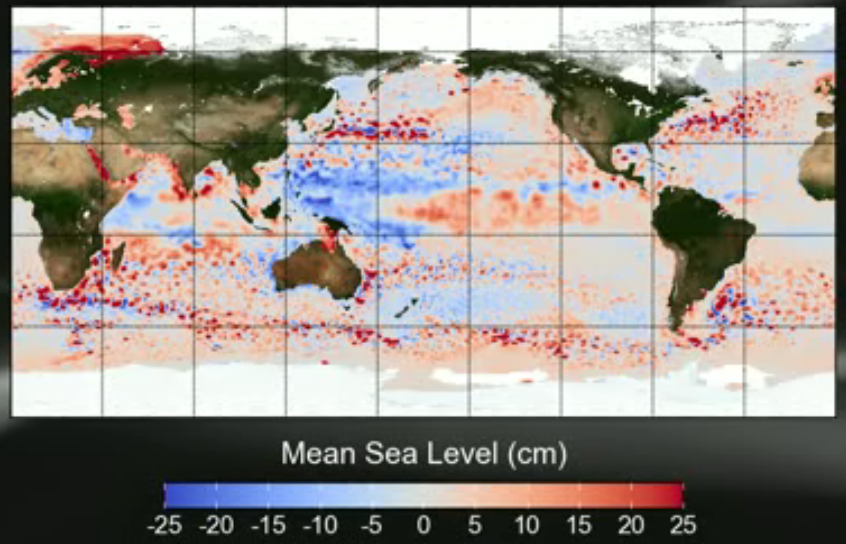


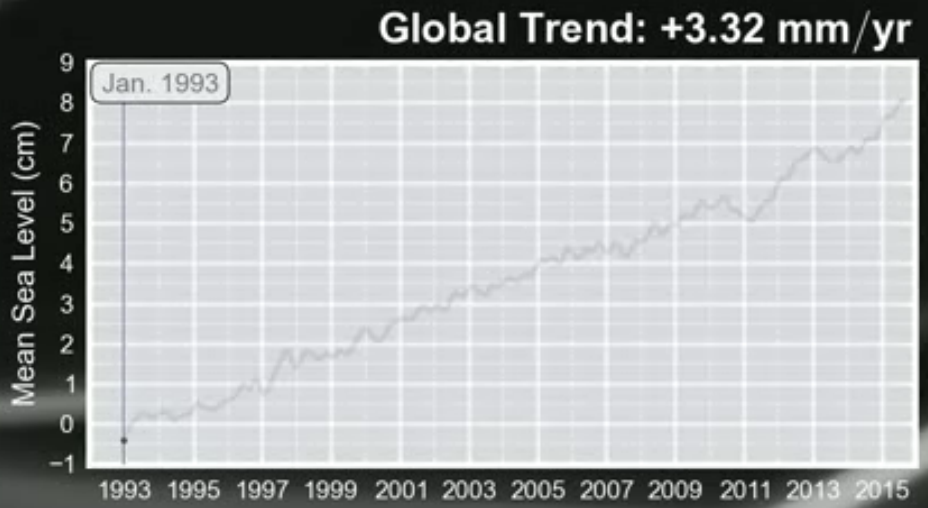
Hausse du niveau de la mer sur le 20ème siècle : 1.5 +/- 0.3 mm/yr

LE NIVEAU DE LA MER ACTUEL



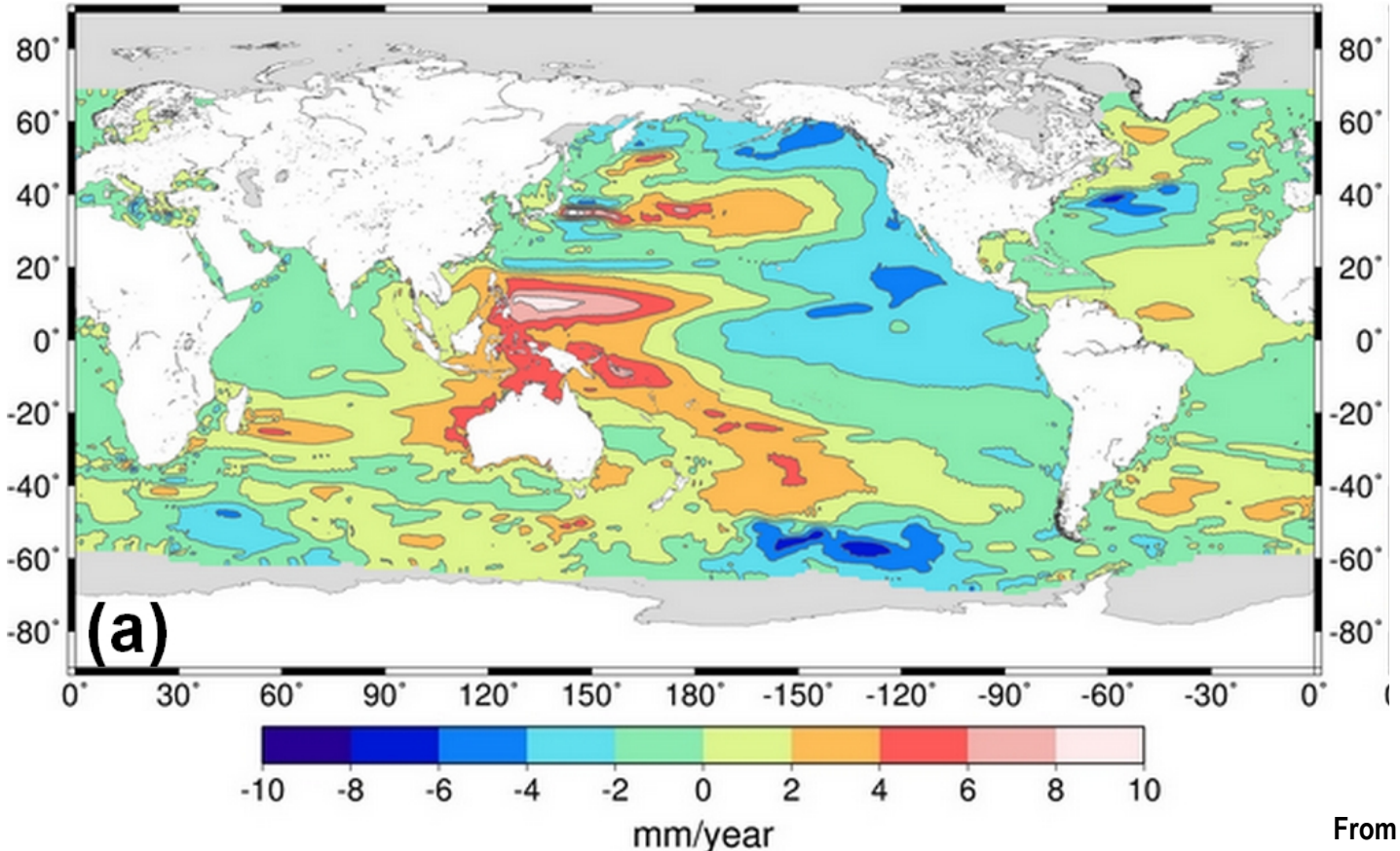
LE NIVEAU DE LA MER ACTUEL





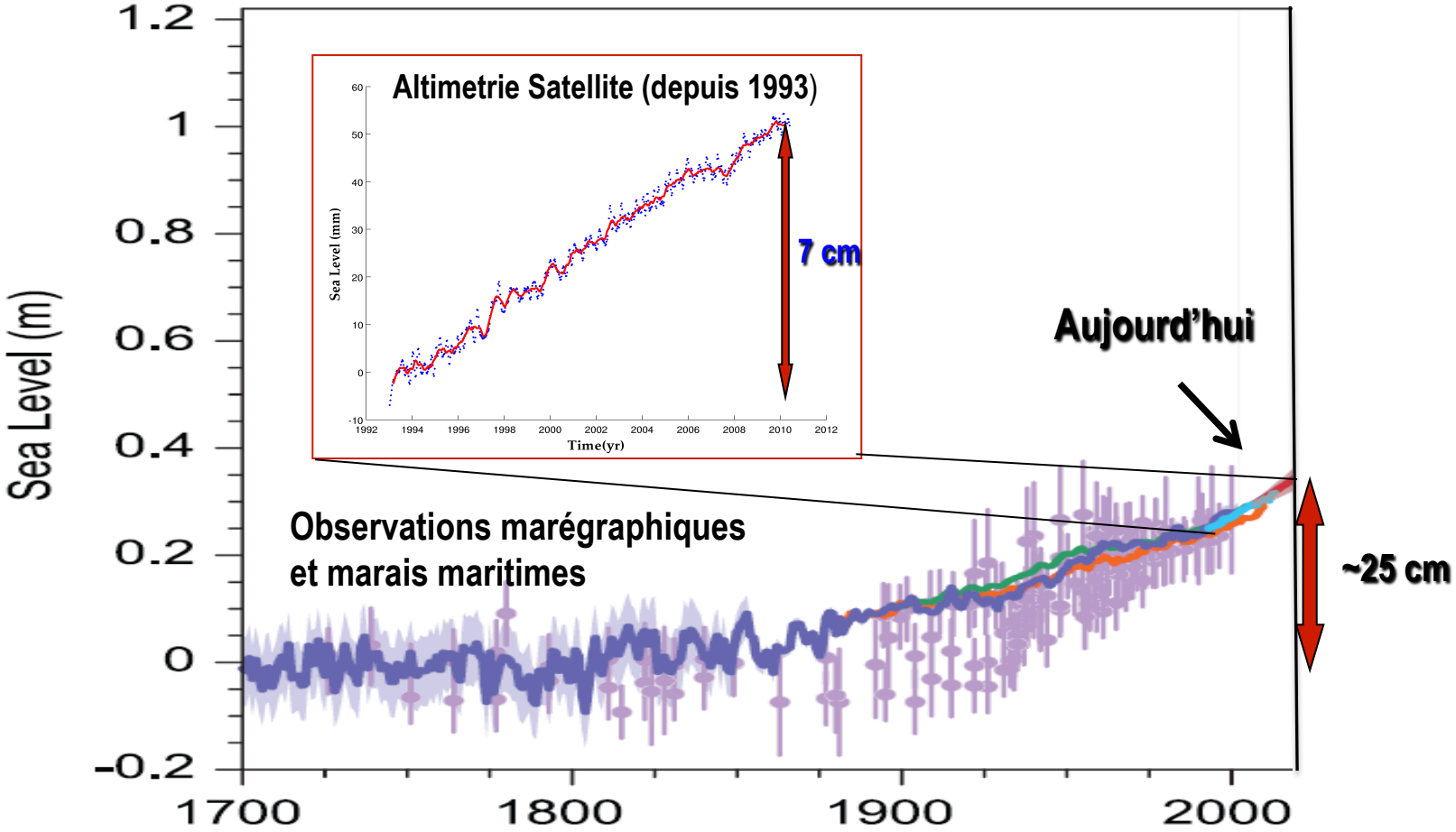
Hausse du niveau depuis 1993:
3.0 +/- 0.4 mm/yr

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



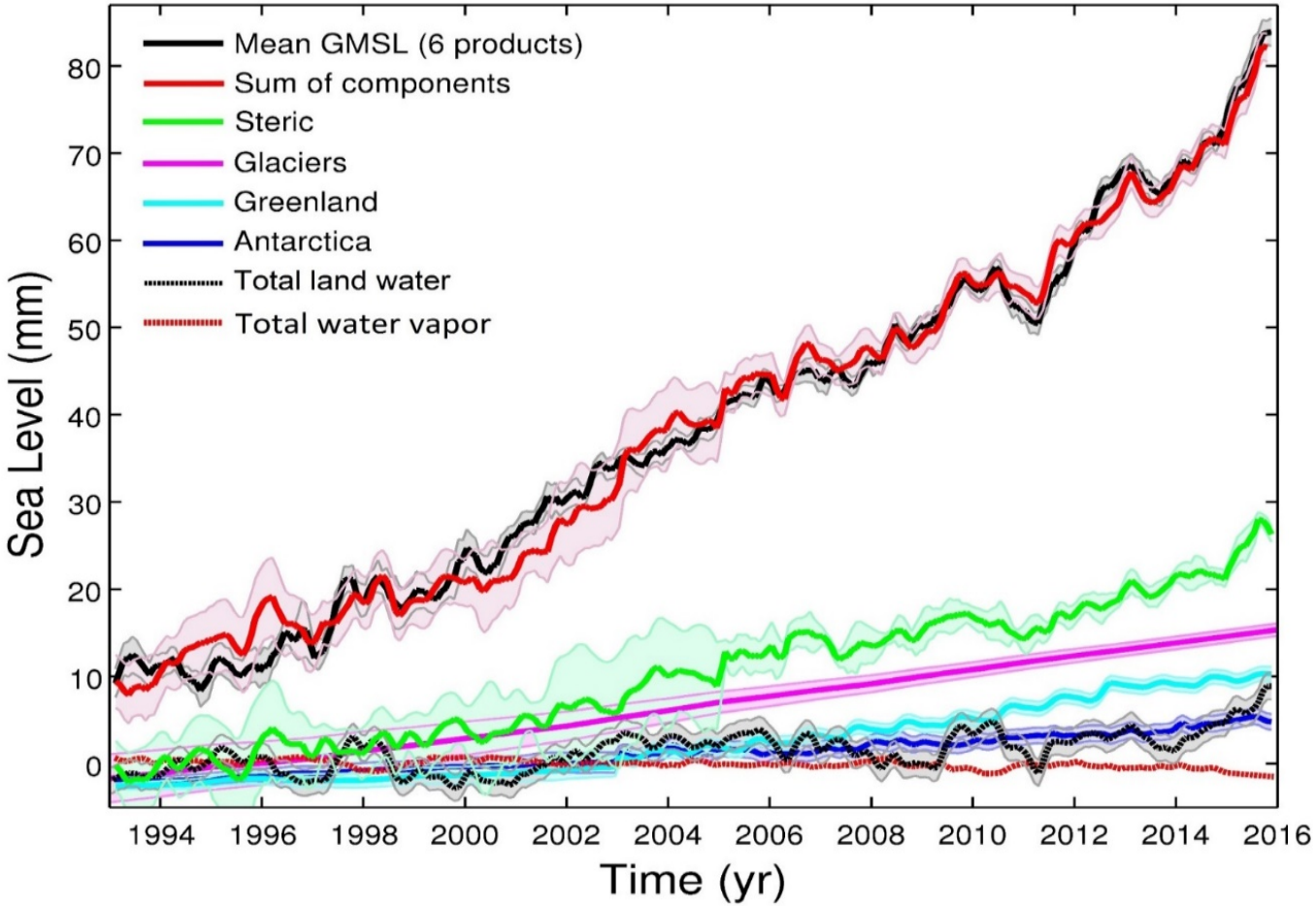
From Meyssignac et al. 2016

LE NIVEAU DE LA MER DEPUIS 1700

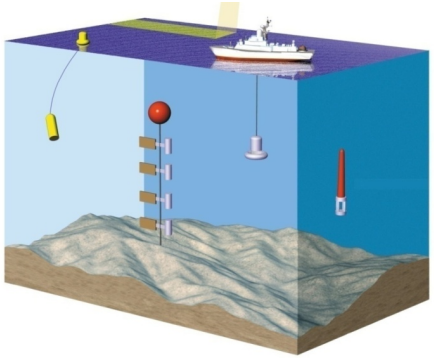


LES CAUSES DES VARIATIONS DU NIVEAU DE LA MER

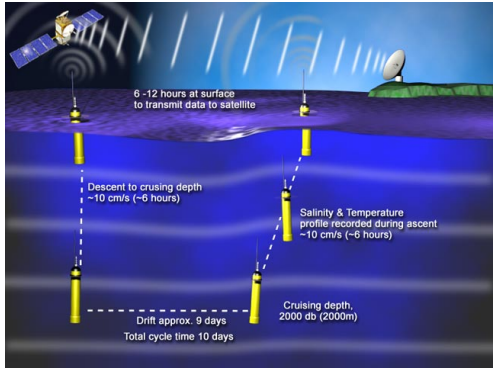
CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



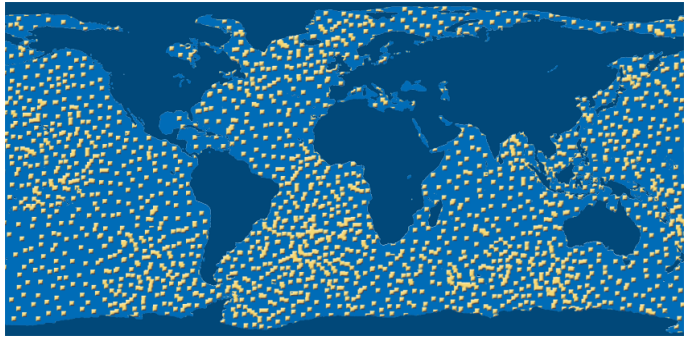
L'EXPANSION THERMIQUE DE L'OCEAN



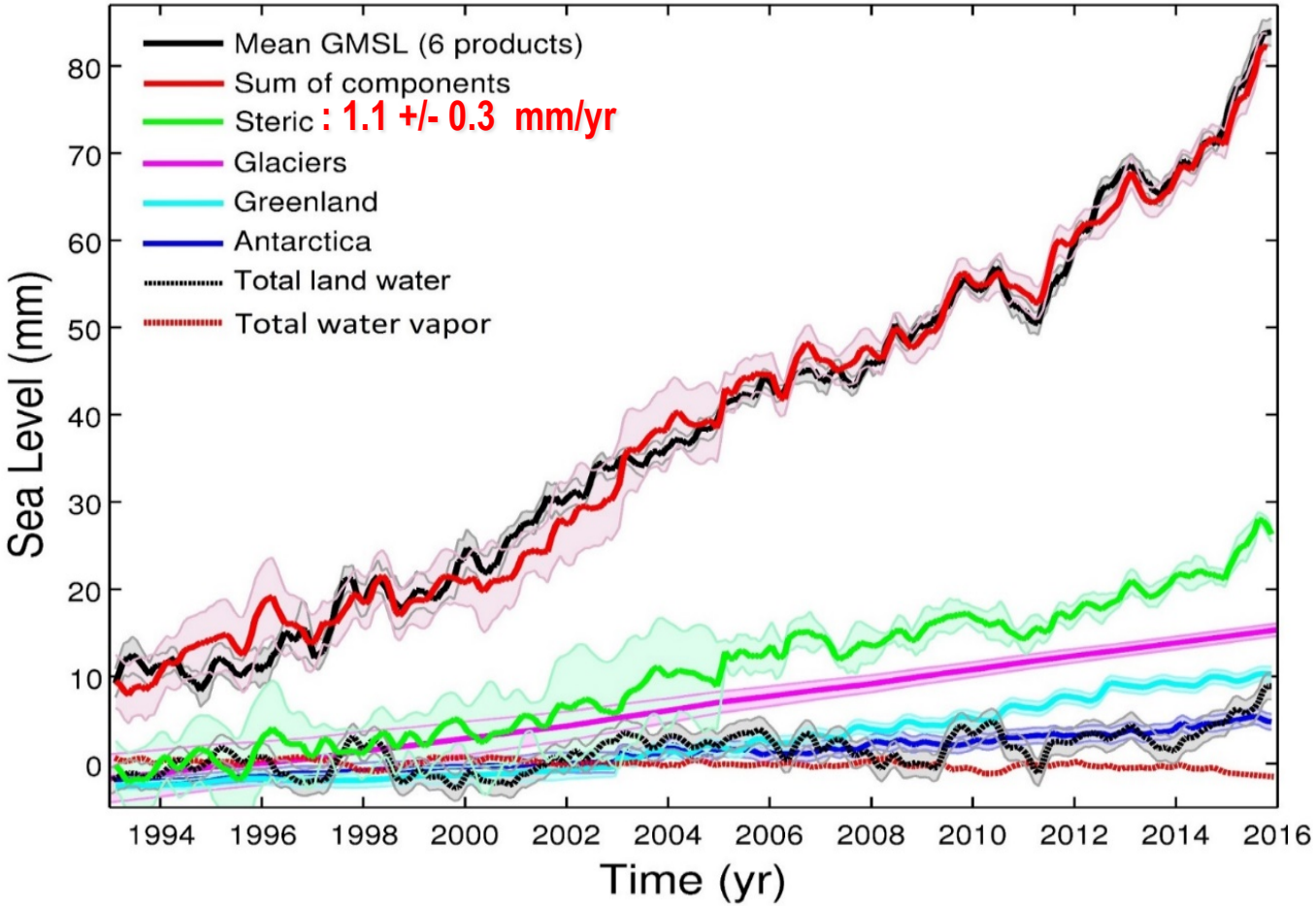
Past few decades:
coverage mainly
along commercial roads



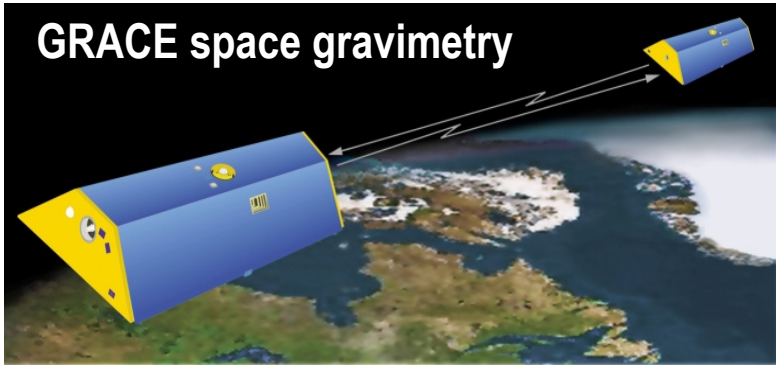
Since about 2003 →
'Argo' profiling floats



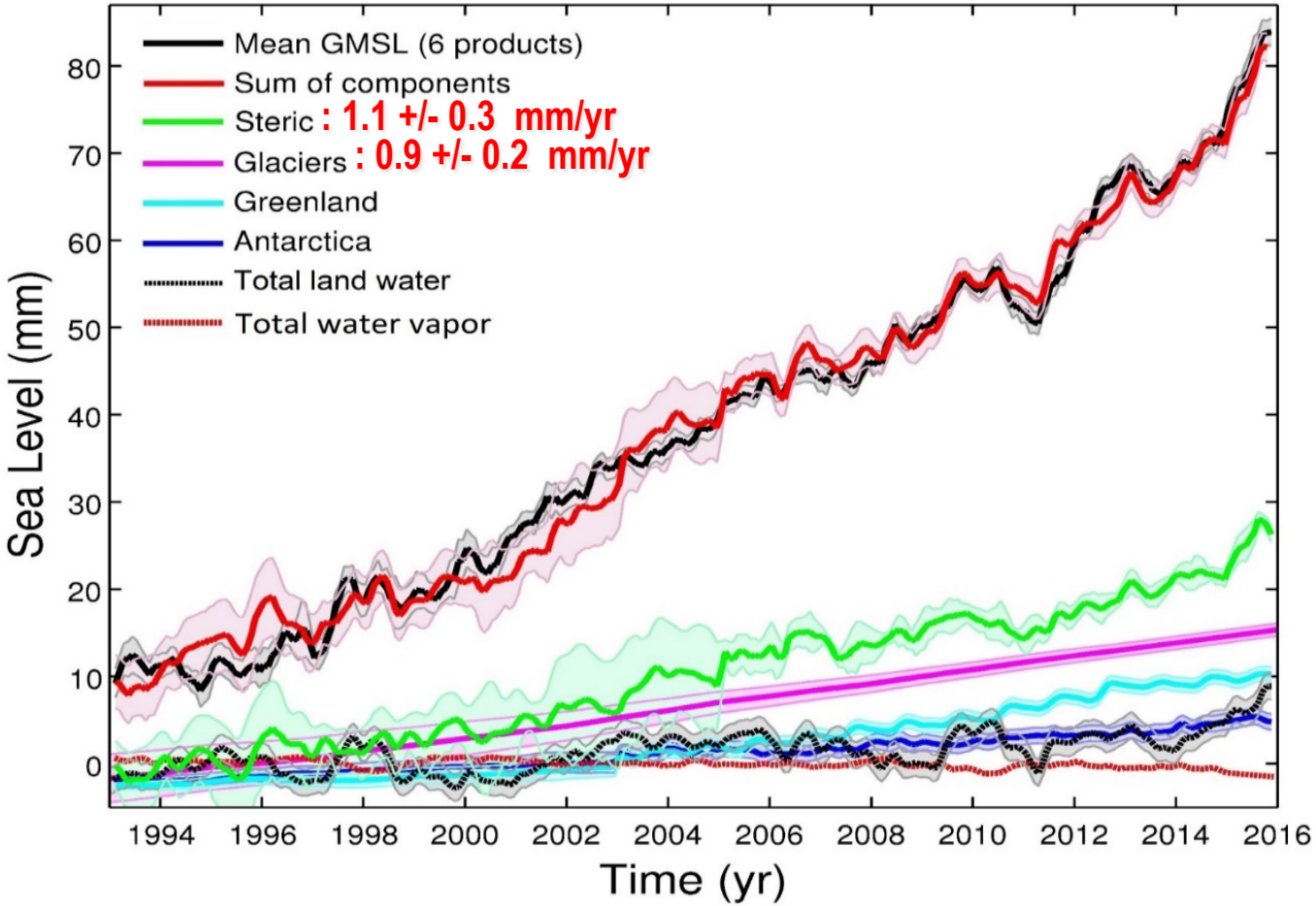
CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



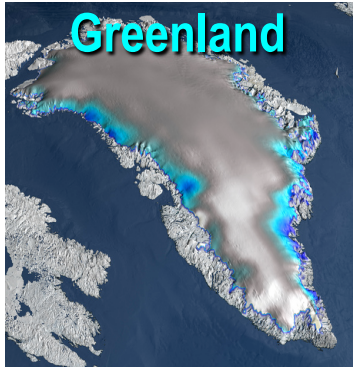
FONTE DES GLACIERS DE MONTAGNE

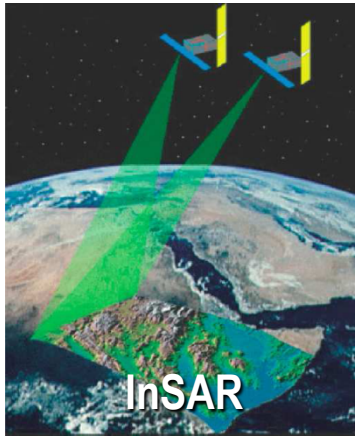


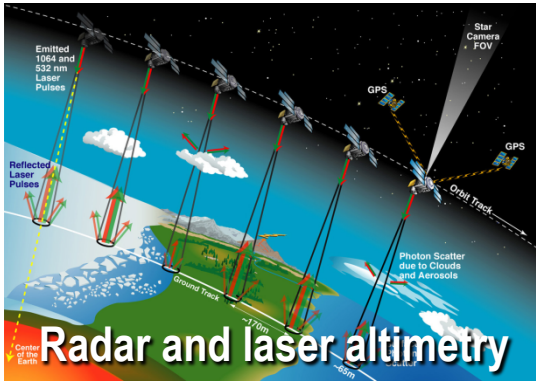
CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



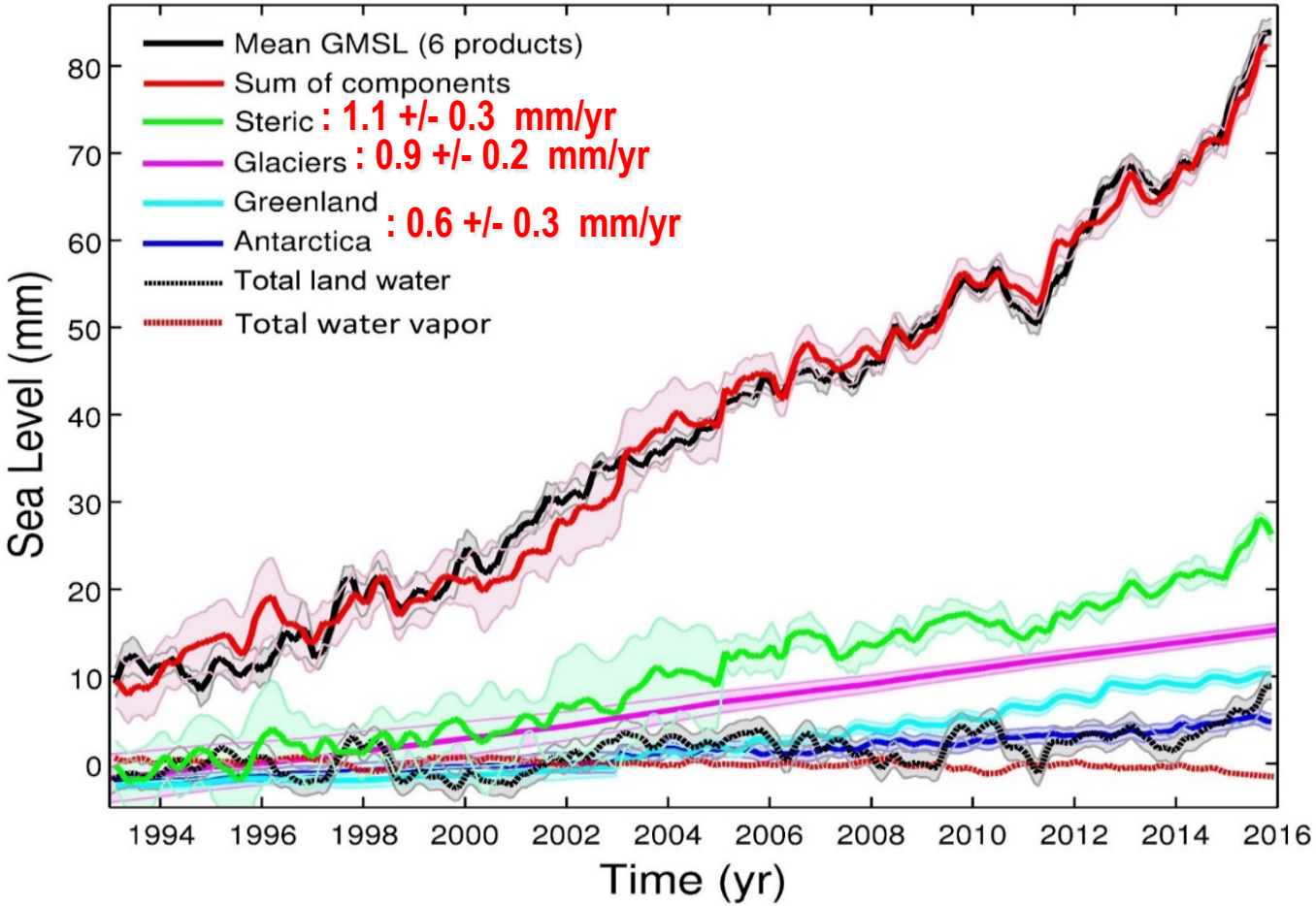
FONTE DES CALOTTES POLAIRES







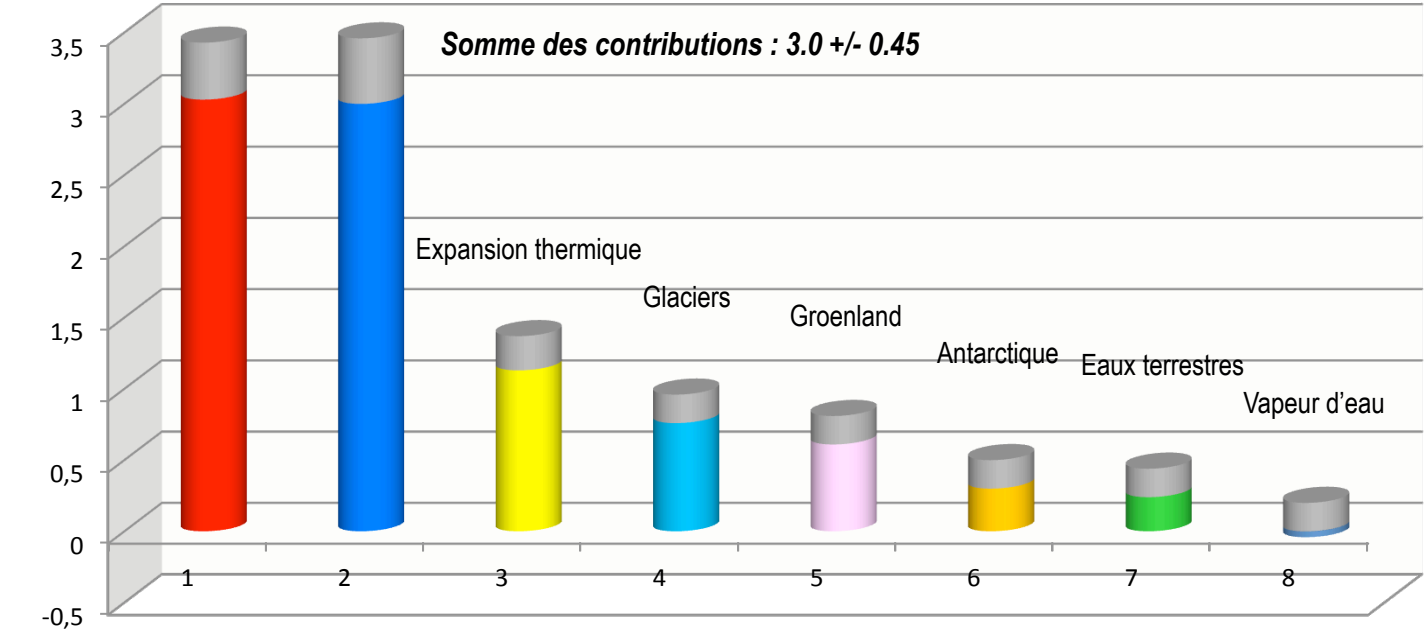
CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



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

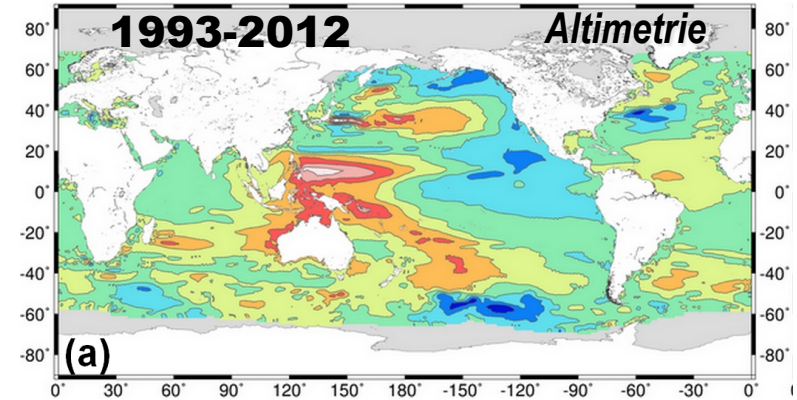
(dérive Topex A corrigée)

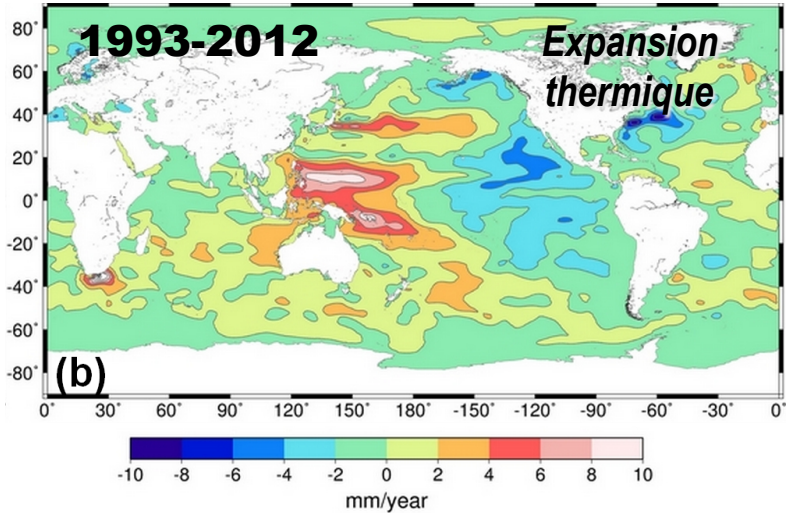
Hausse de la mer altimétrique: 3.0 +/- 0.4



From Dieng et al., 2017

CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER

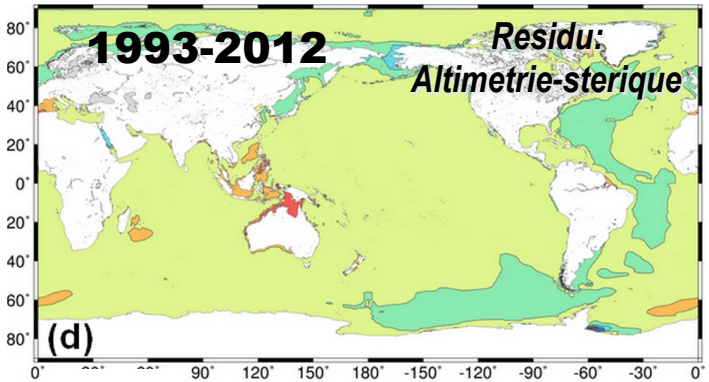




→Sea level rise is not uniform. It is mostly due to non uniform thermal expansion

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

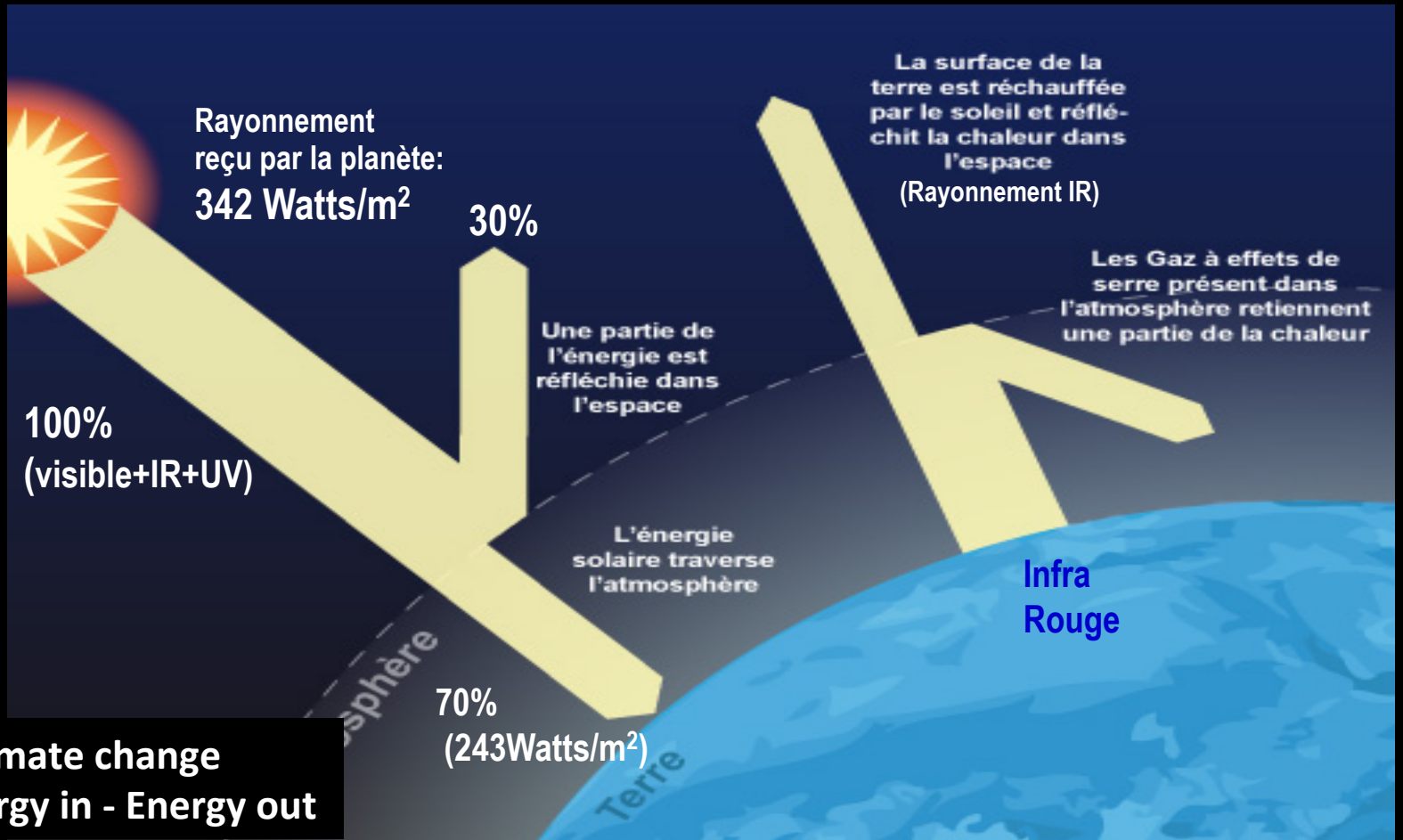
Niveau de la mer moins expansion thermique 1993-2012



From Meyssignac et al. 2016

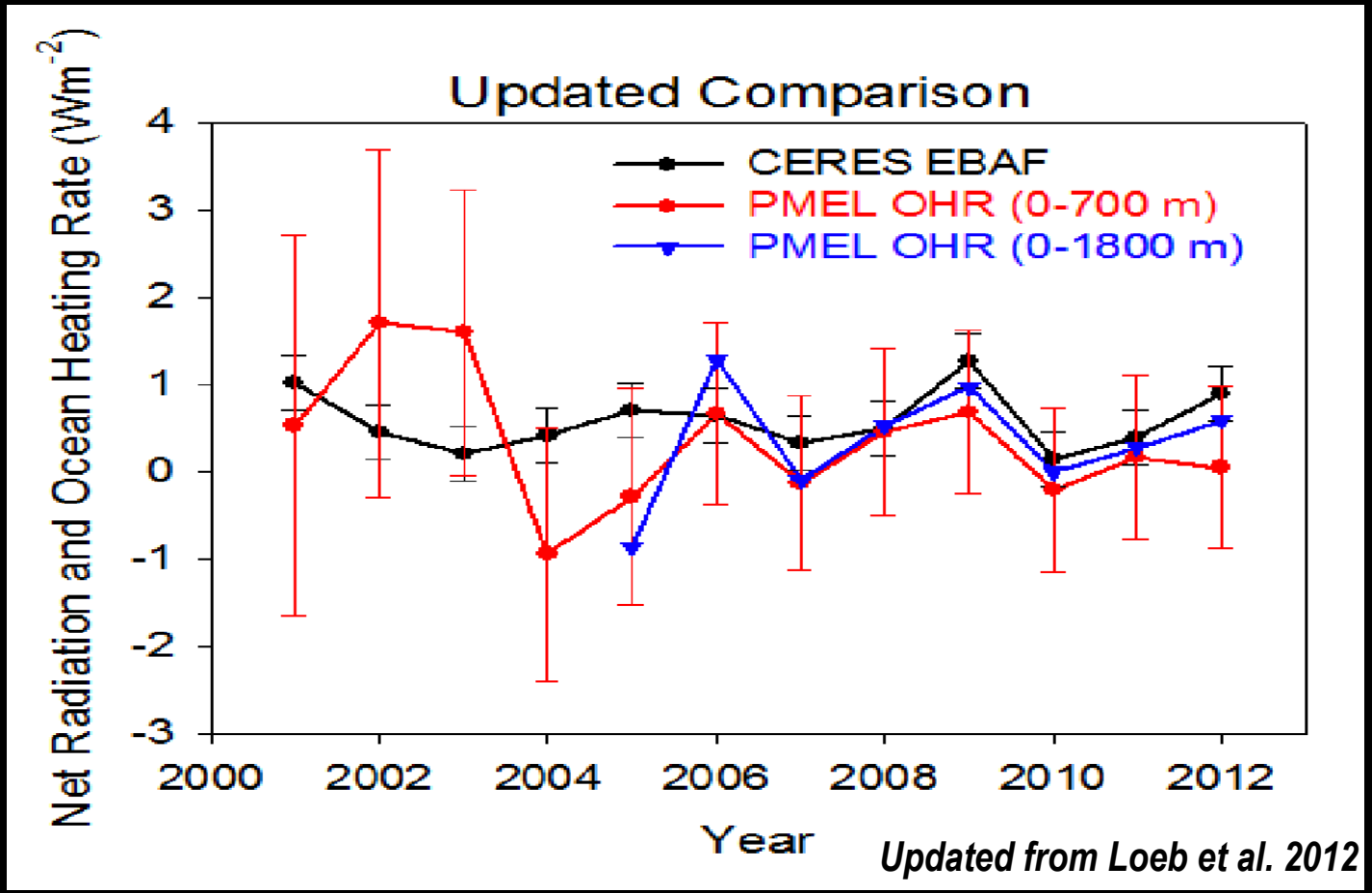
LES VARIATIONS DU NIVEAU DE LA MER EN REPONSE AU CHANGEMENT CLIMATIQUE

LE NIVEAU DE LA MER EN REPONSE AU CHANGEMENT CLIMATIQUE



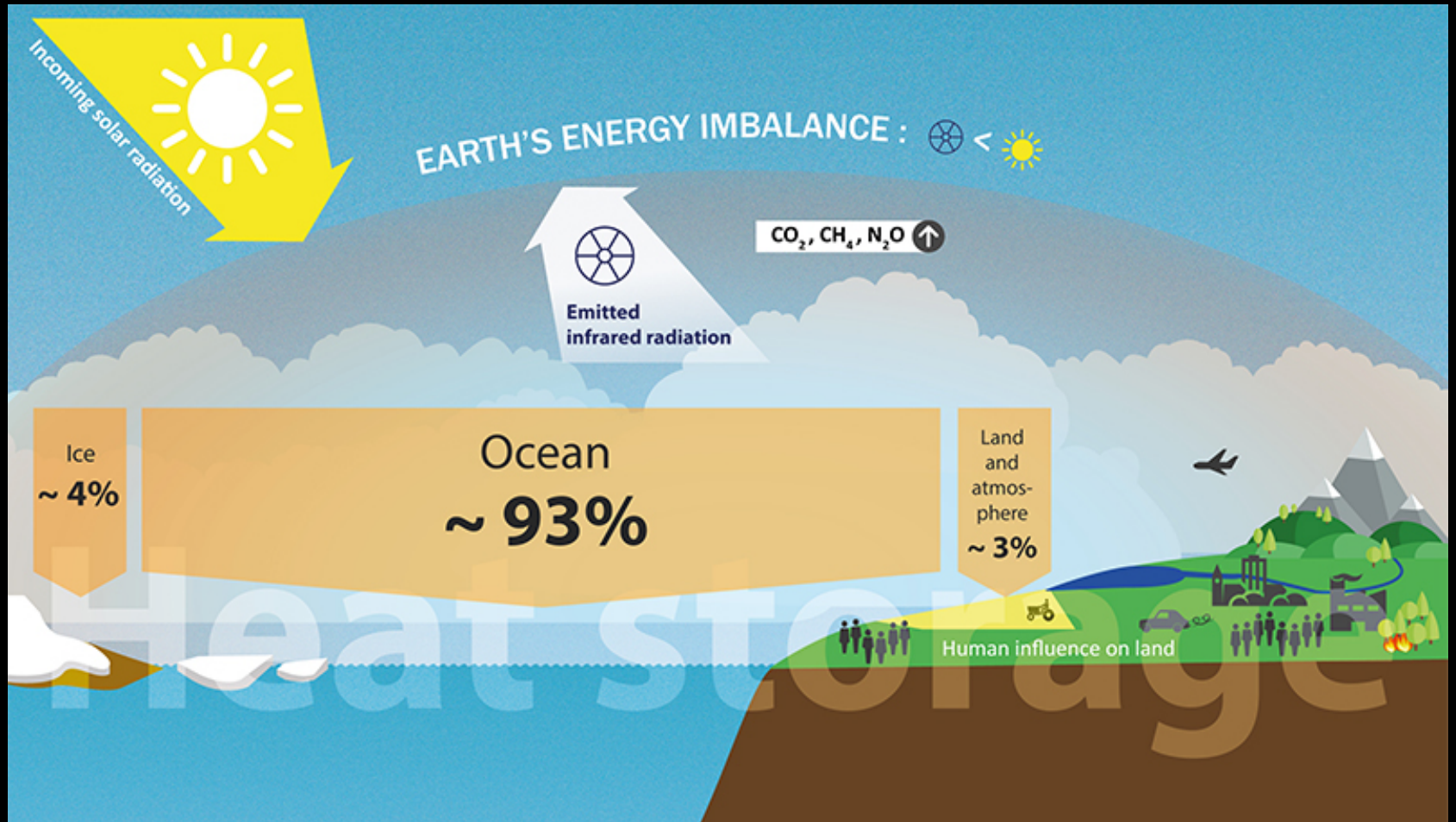
Under climate change
Net =Energy in - Energy out

LE NIVEAU DE LA MER EN REPONSE AU CHANGEMENT CLIMATIQUE

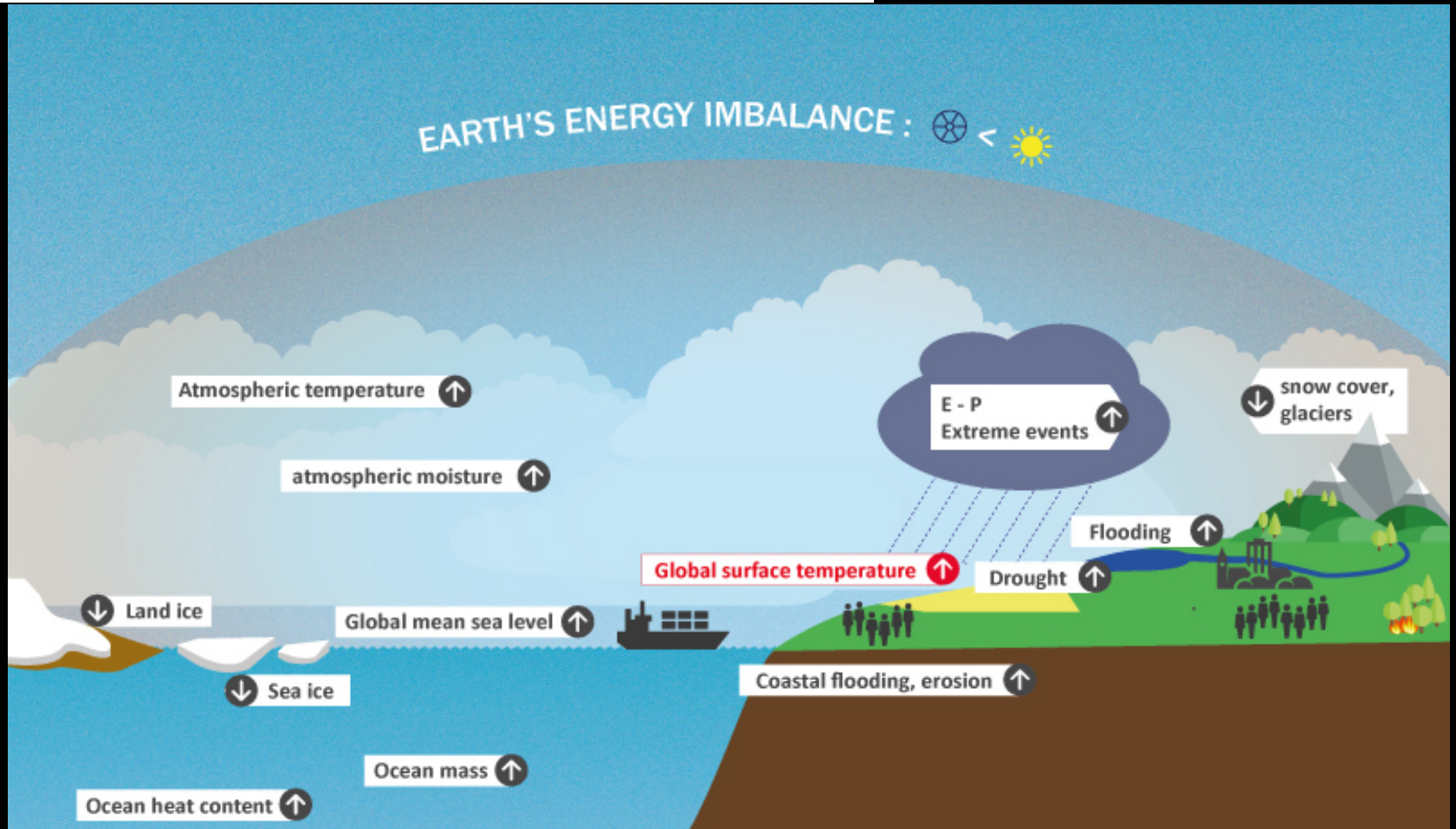


Updated from Loeb et al. 2012

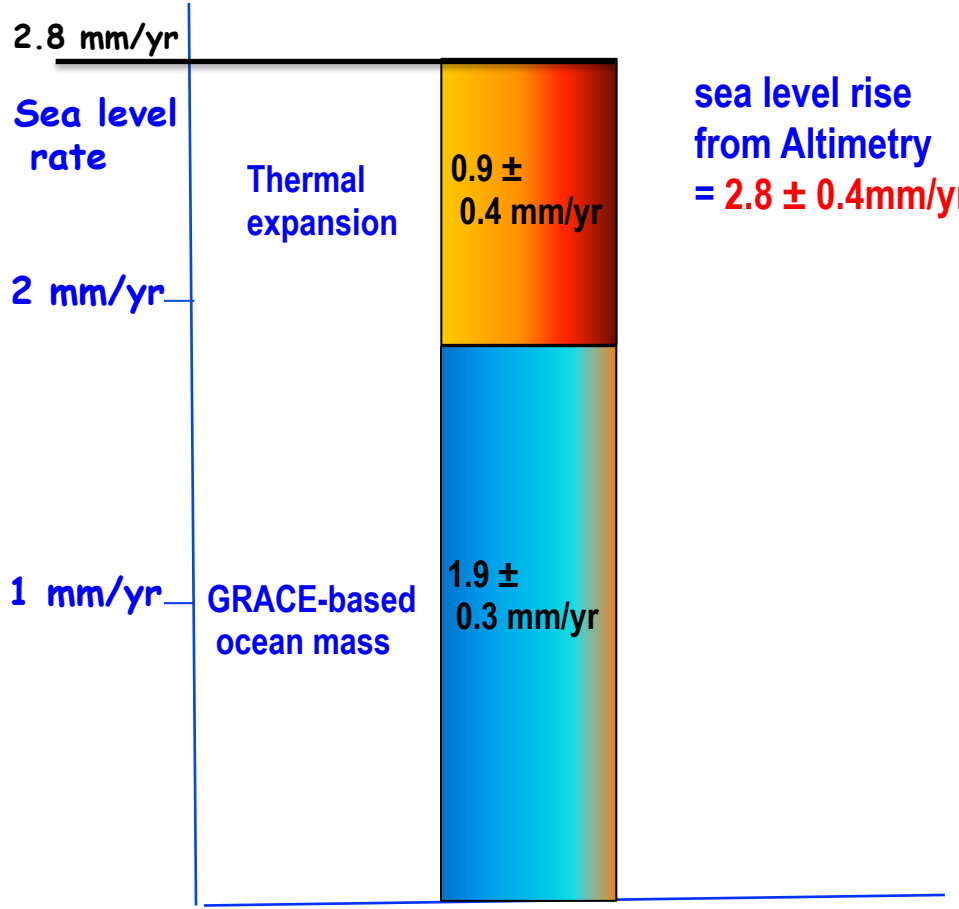
LE NIVEAU DE LA MER EN REPONSE AU CHANGEMENT CLIMATIQUE



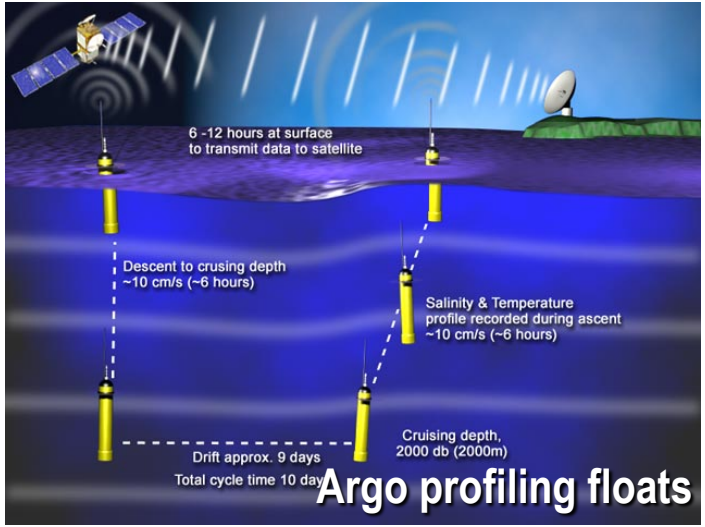
LE NIVEAU DE LA MER EN REPONSE AU CHANGEMENT CLIMATIQUE

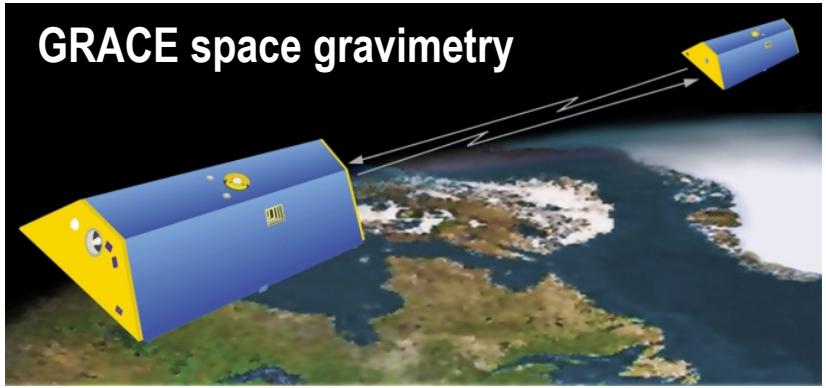


CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



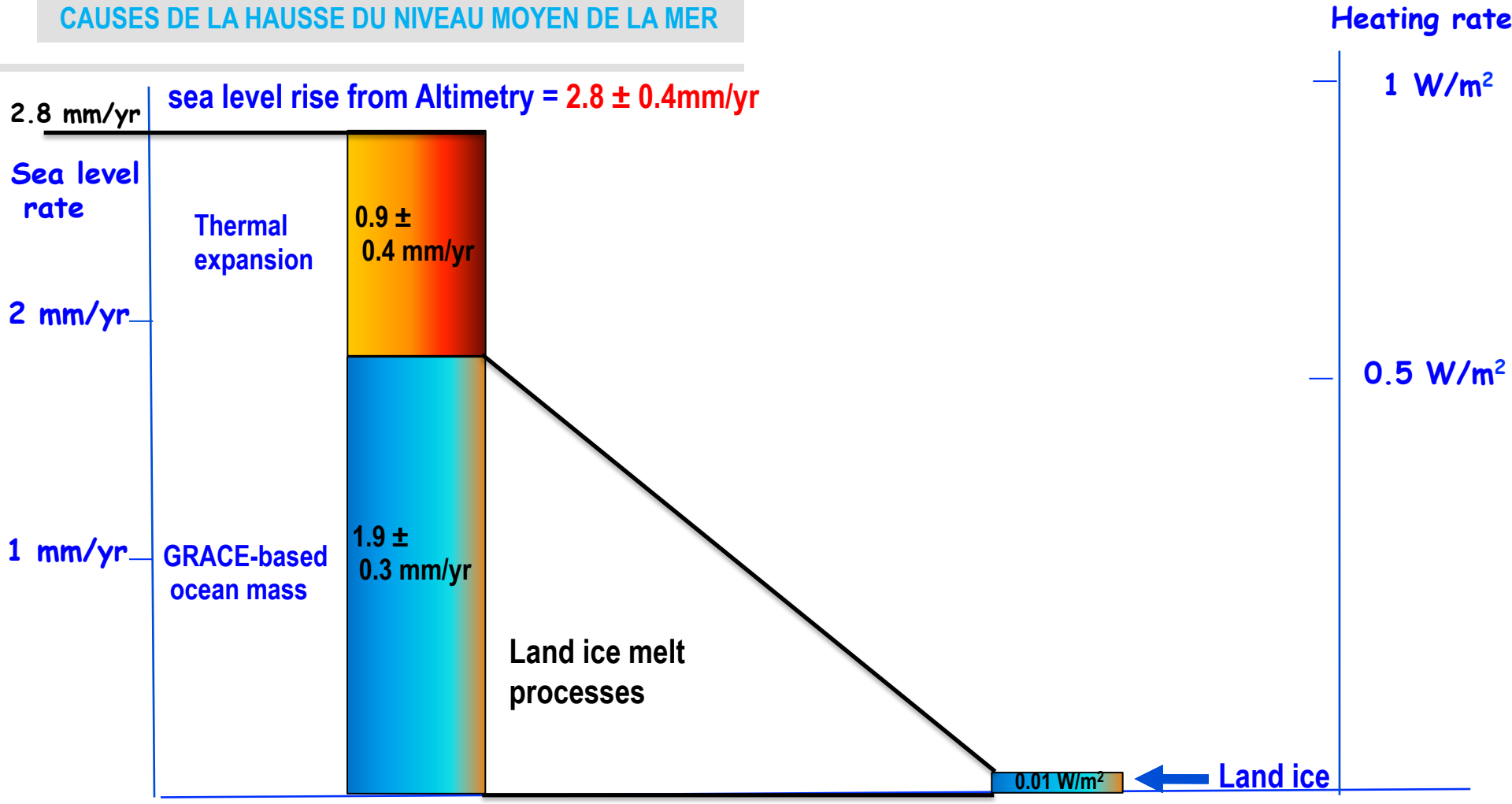
sea level rise from Altimetry = 2.8 ± 0.4mm/yr





(from Dieng et al. 2015)

CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



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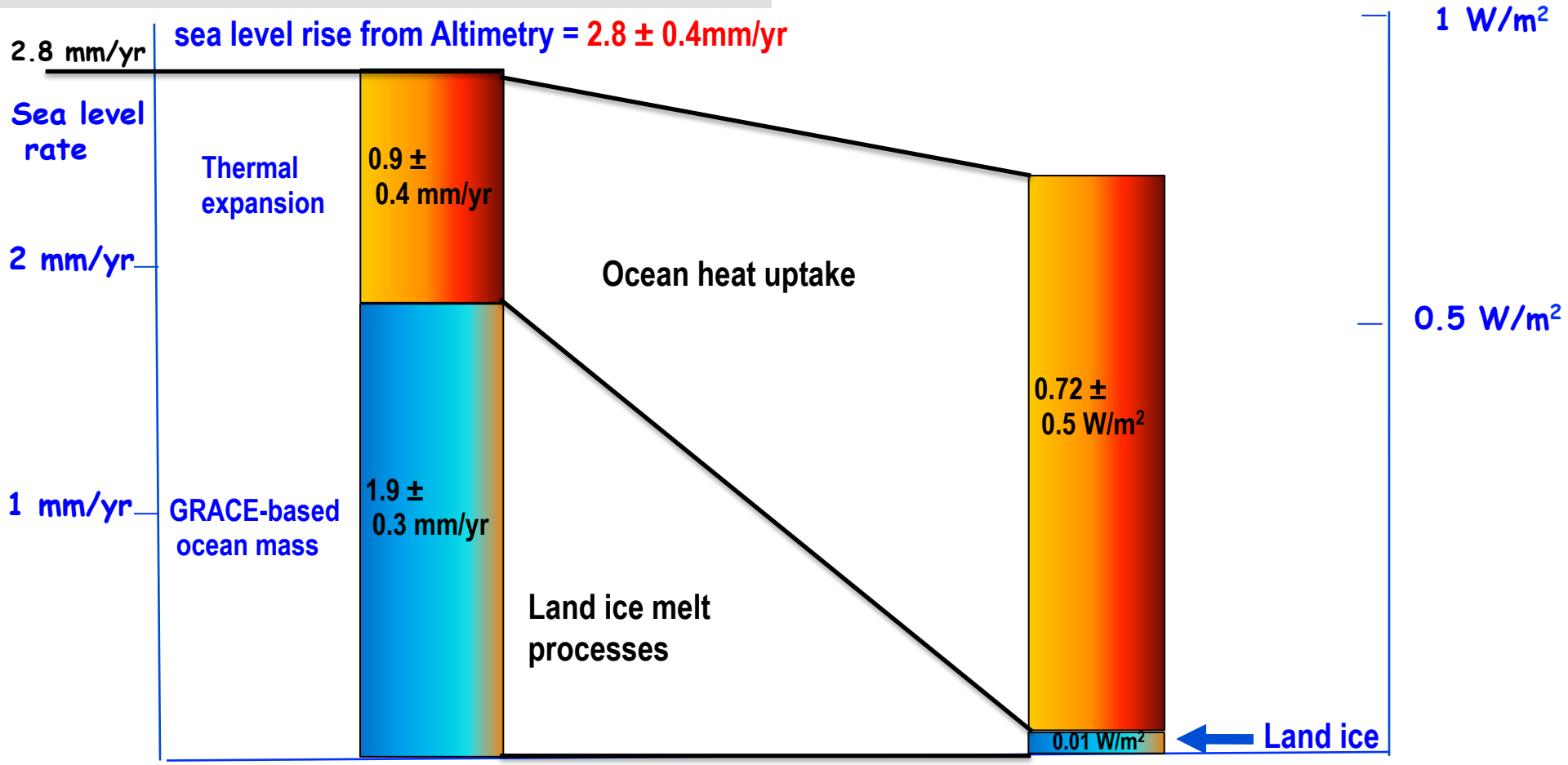
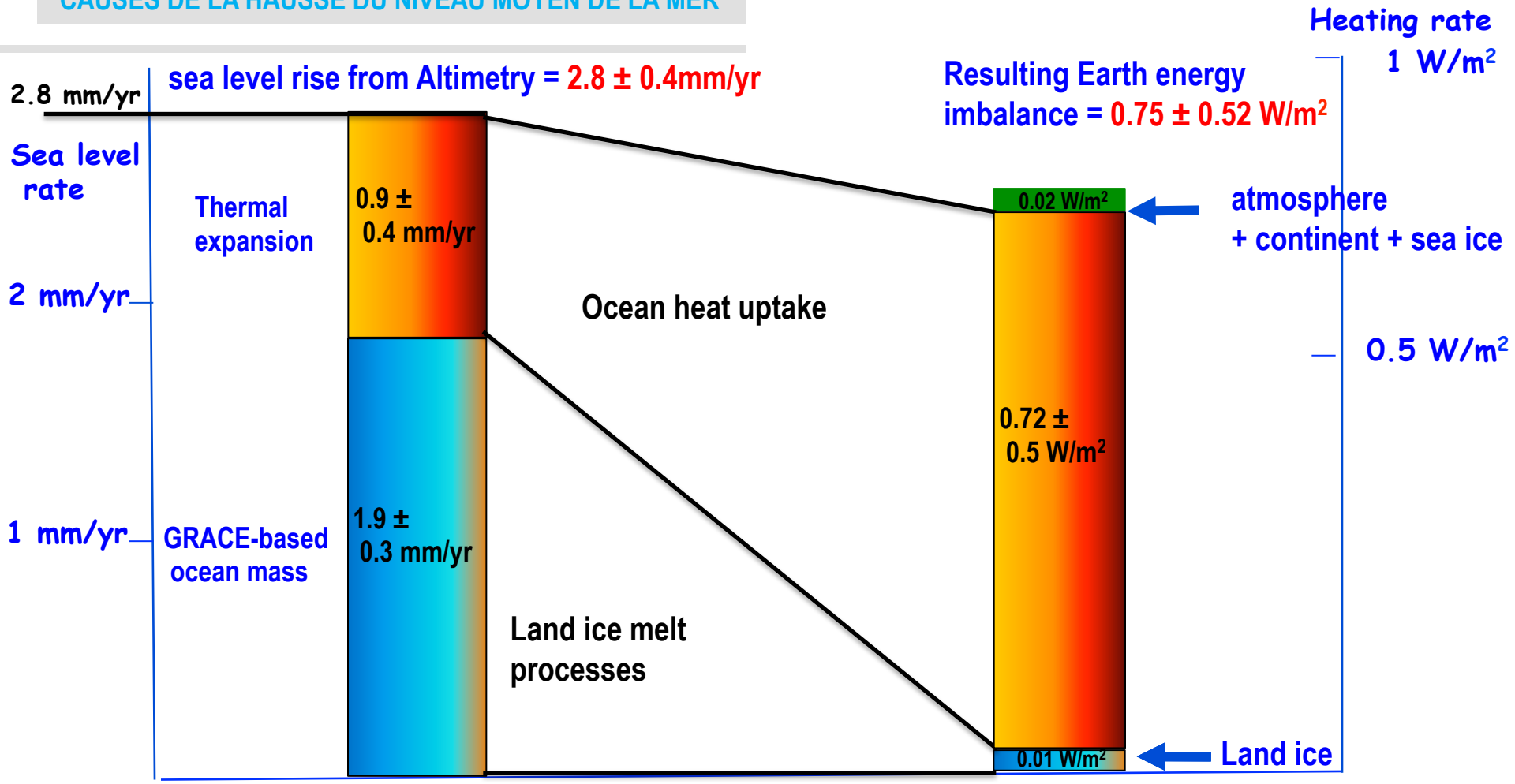
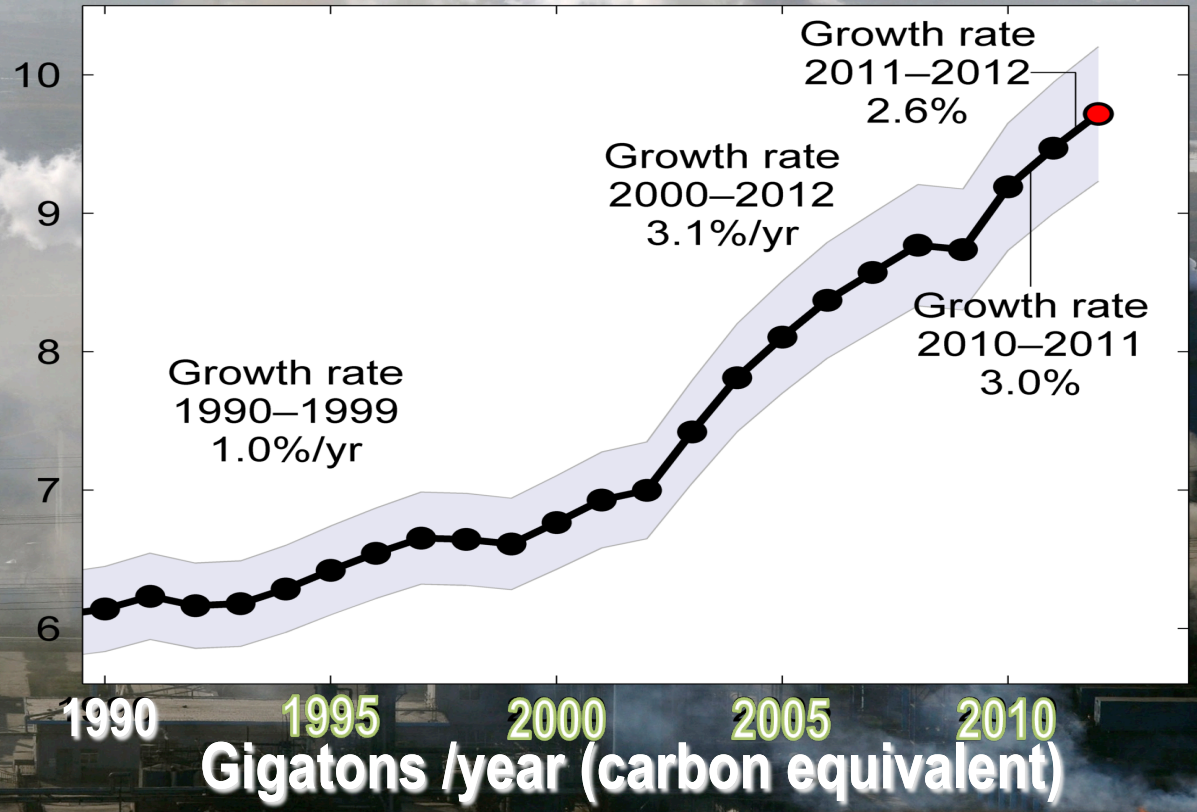


CAUSES DE LA HAUSSE DU NIVEAU MOYEN DE LA MER



LES PROJECTIONS DU NIVEAU DE LA MER

Emissions de Gaz à Effet de Serre



From Le Quéré et al. 2012

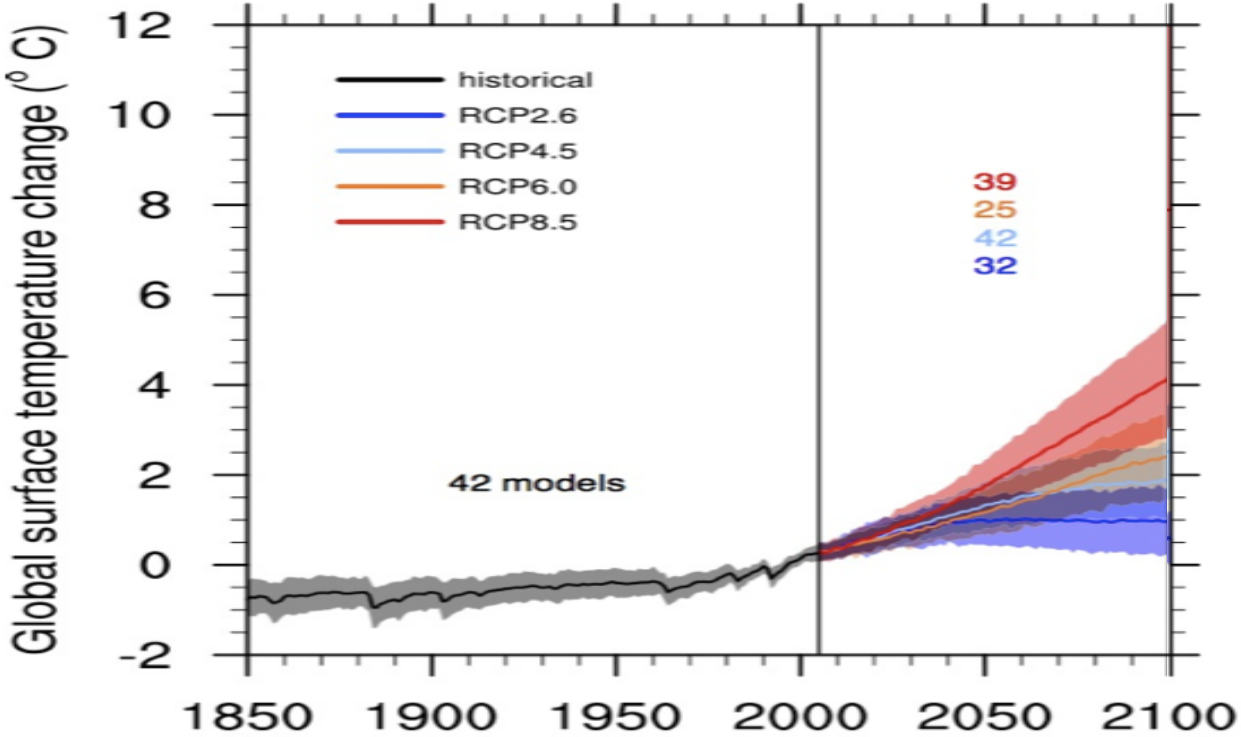
Warming scenarios considered by IPCC AR5

→ Representative Concentration Pathways (RCPs)

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

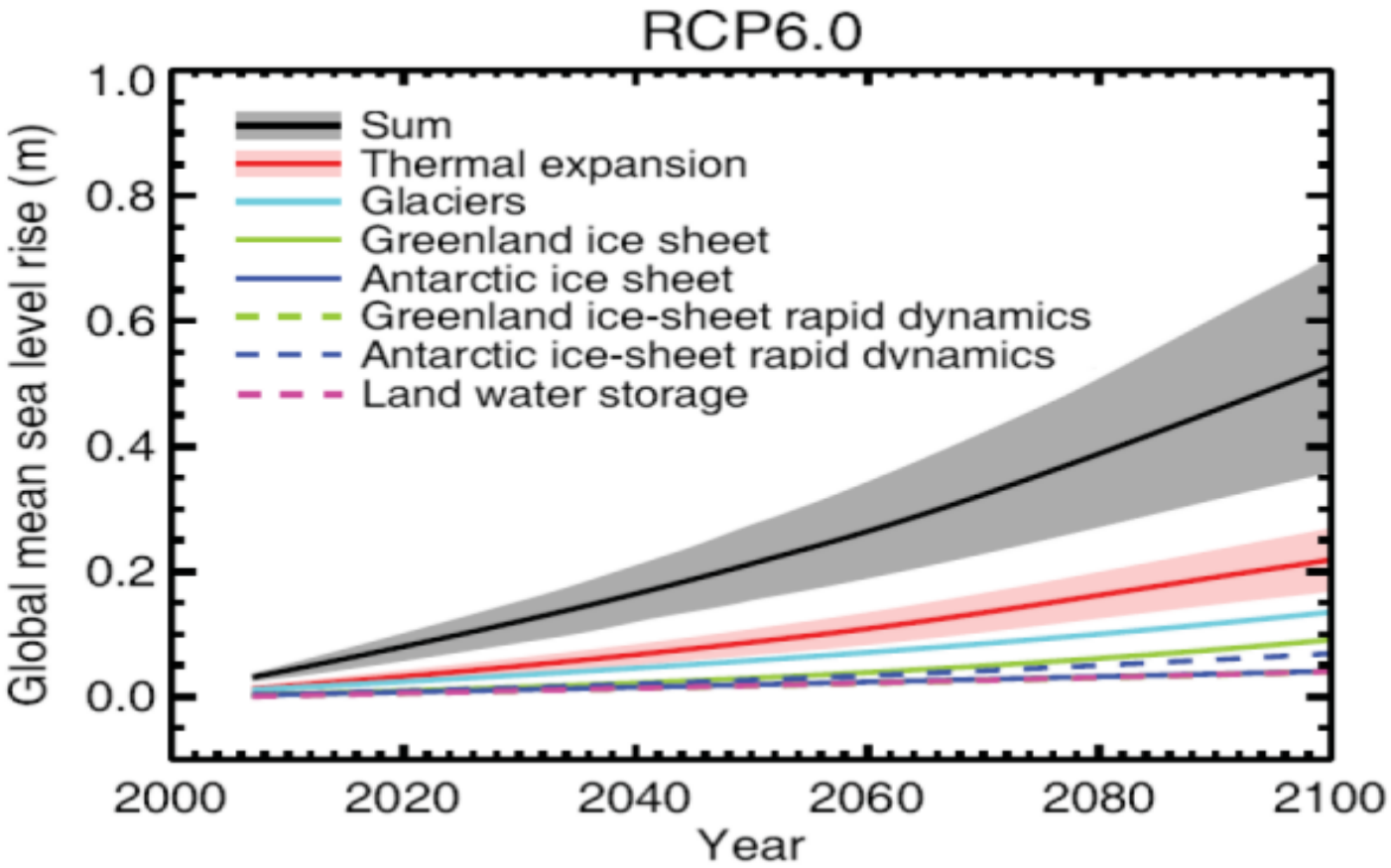
- RCP2.6 (2.6 Wm^{-2})
- RCP4.5 (4.5 Wm^{-2})
- RCP6.0 (6.0 Wm^{-2})
- RCP8.5 (8.5 Wm^{-2})

Earth surface mean temperature projections



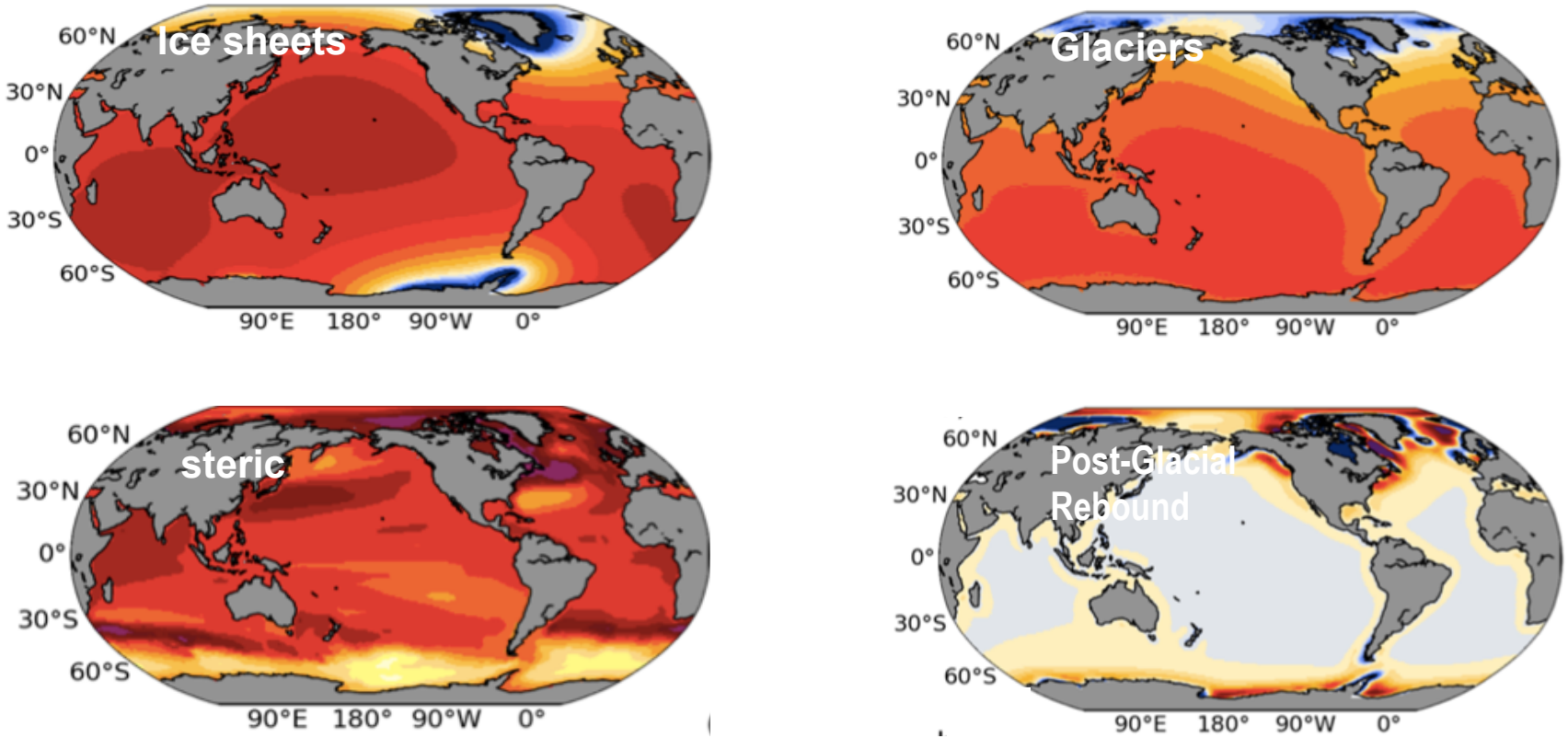
From IPCC AR5,2013

PROJECTIONS DU NIVEAU DE LA MER



From IPCC AR5,2013

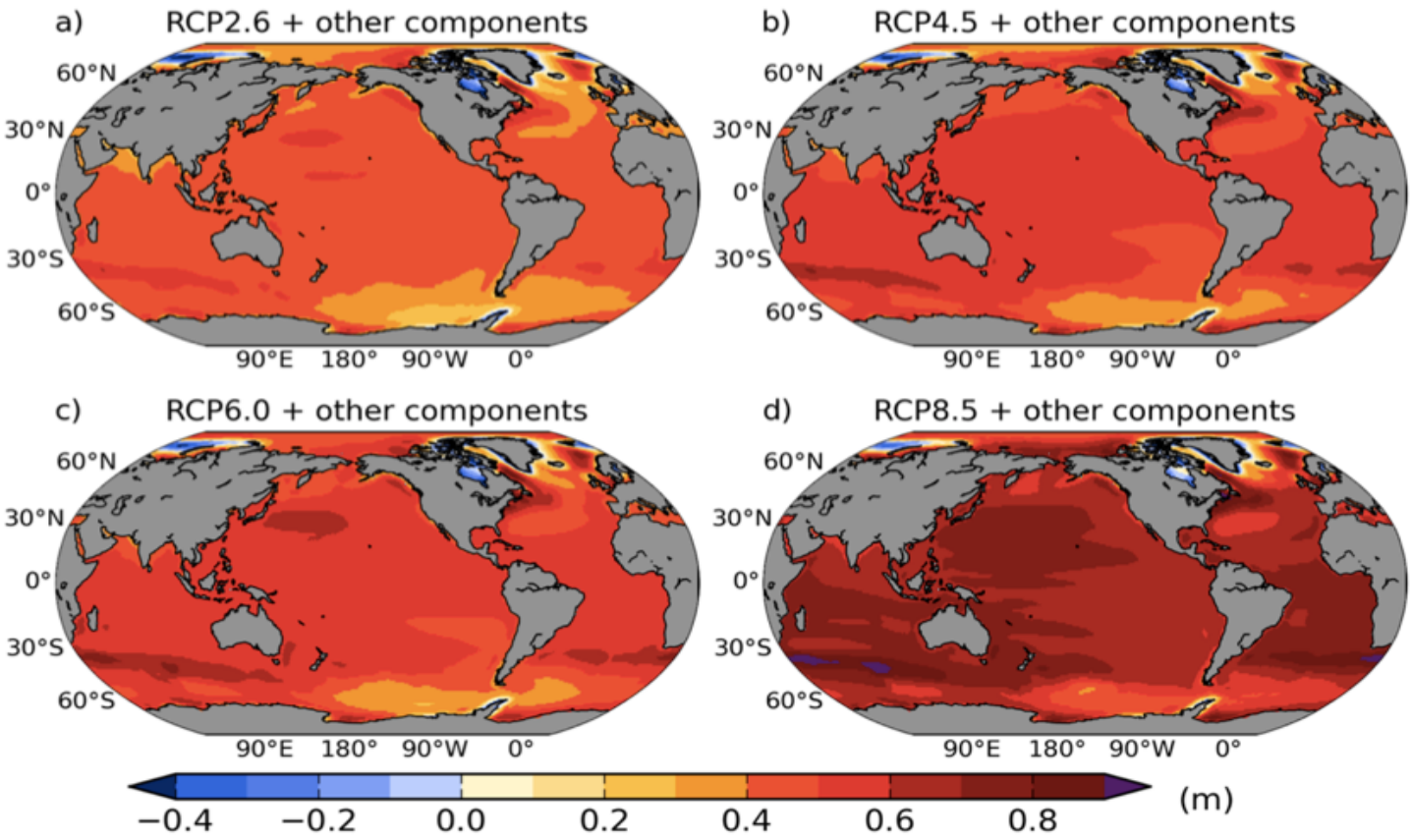
Regional variability in relative sea level in 2080-2100 (*RCP 6.0*)



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

From IPCC AR5,2013

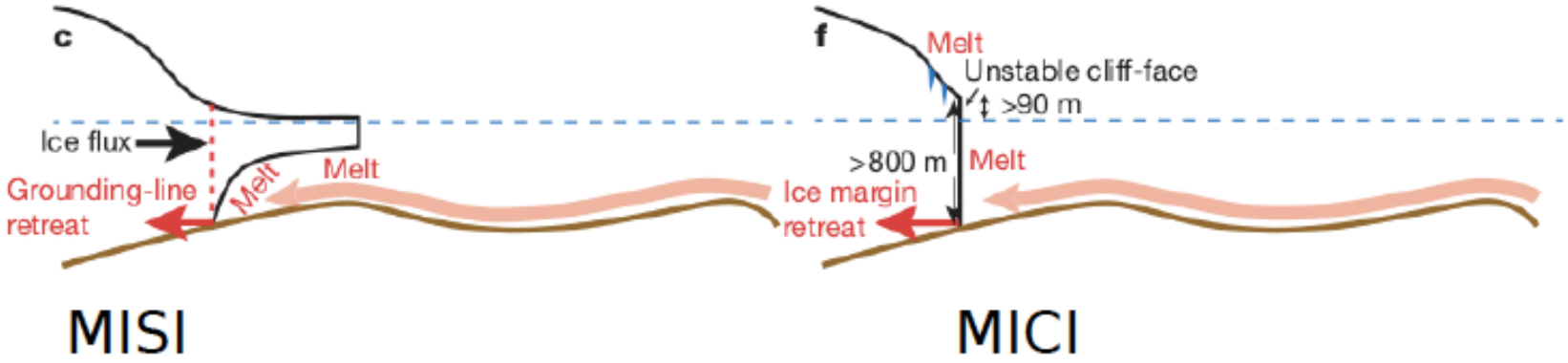
Regional variability in relative sea level in 2080-2100



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

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**

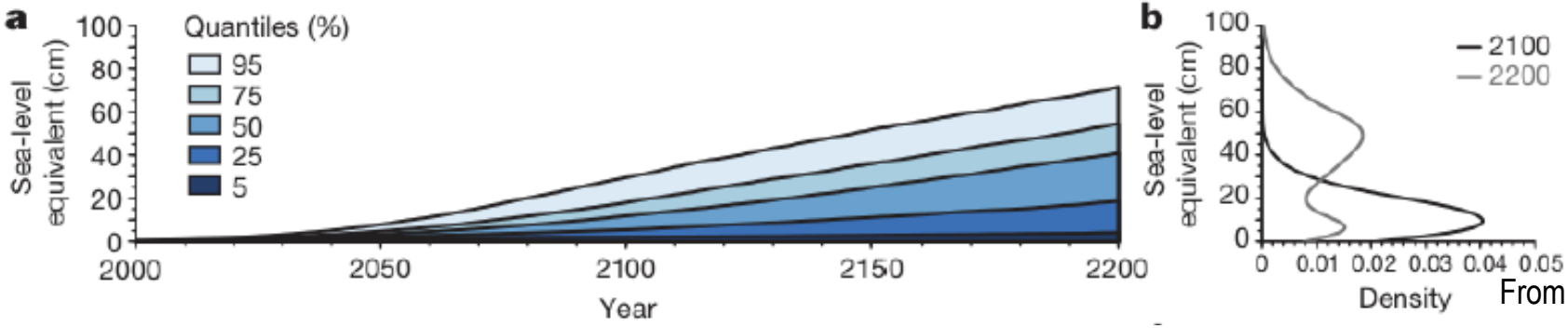
Marine Ice Cliff Instability:

- **Débattu**
- **Non observé en Antarctique**

From DeConto and Pollard 2016

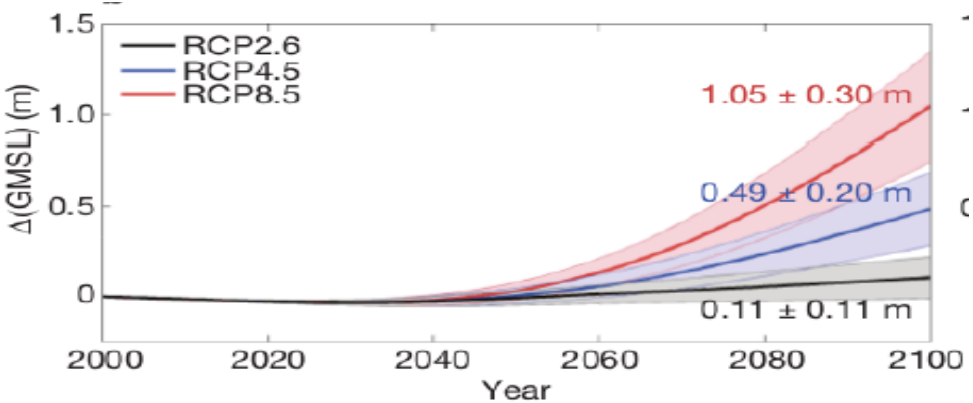
Instabilités dynamique des calottes polaires: simulations avec méthode d'ensemble

Marine Ice Sheet Instability:



From Ritz et al. 2015

Marine Ice Sheet +Marine Ice Cliff Instability:



From DeConto and Pollard 2016

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 du aux gaz à effet de serre!! Notre compréhension du phénomène est robuste

- Dans le futur le niveau de la mer augmentera entre 40±14cm et 62±19cm en 2100 en fonction du scenario d'émission de GES avec une variabilité régionale de ±30% autour de la moyenne

- Cette estimation ne prend pas en compte la perte de masse des calottes polaire par instabilité dynamique. Cette contribution pourrait atteindre 60cm à 1m en 2100


MERCI POUR VOTRE ATTENTION
SI VOUS AVEZ DES QUESTIONS…