

How accurate is accurate enough?

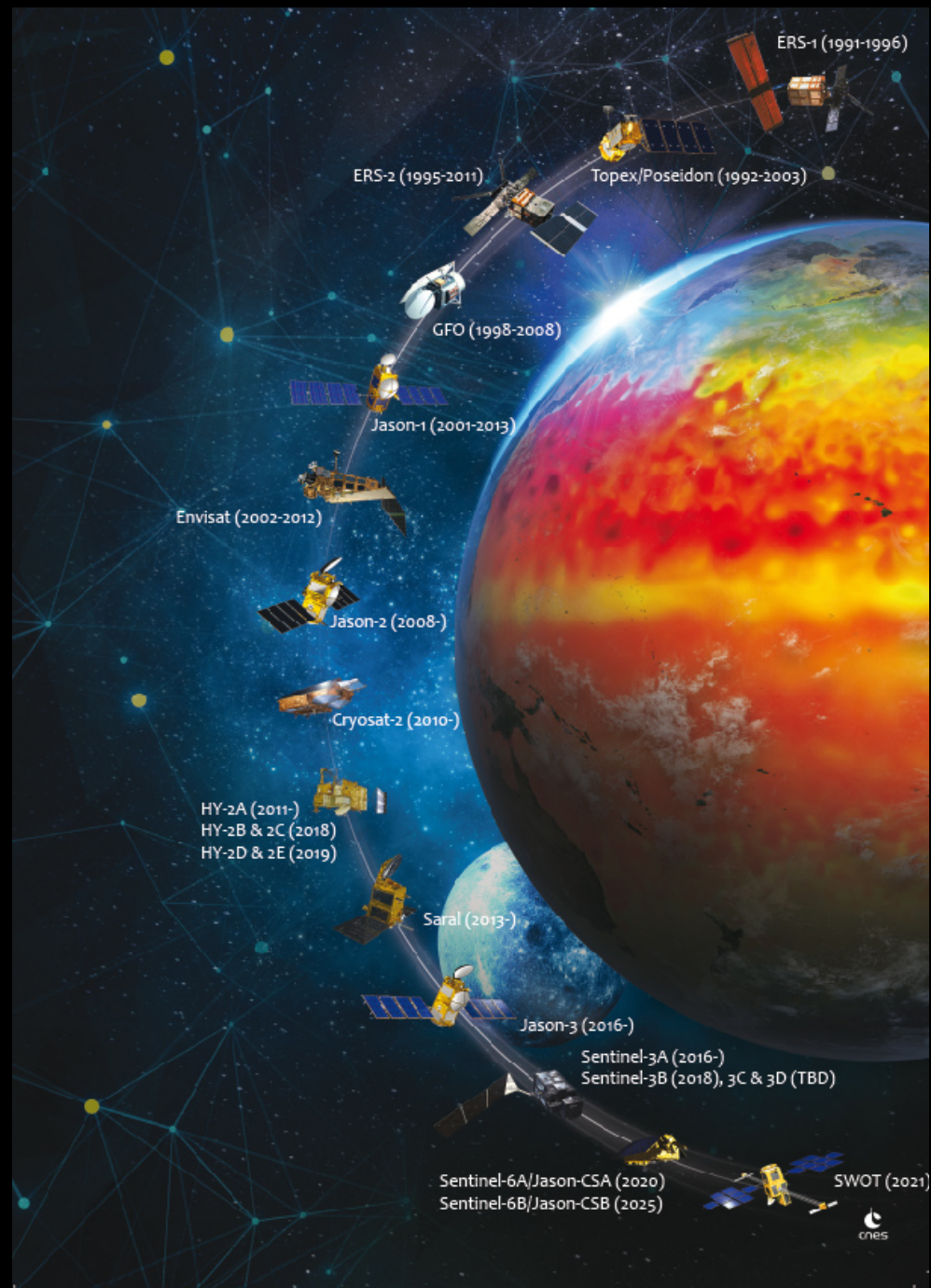
Benoit Meyssignac^{1,2}

Motivated by discussions with P.Bonnefond, J.Willis and C.Watson.

with inputs from R.de Conto, A.Ribes, A.Slangen, K.Richter, M.Ablain, P.Prandi, R.Jugier, A.Guerou, A.Blazquez, S.Labroue, T.Guinle, N.Picot, J.Benveniste, E.Obligis

¹ LEGOS, ² CNES

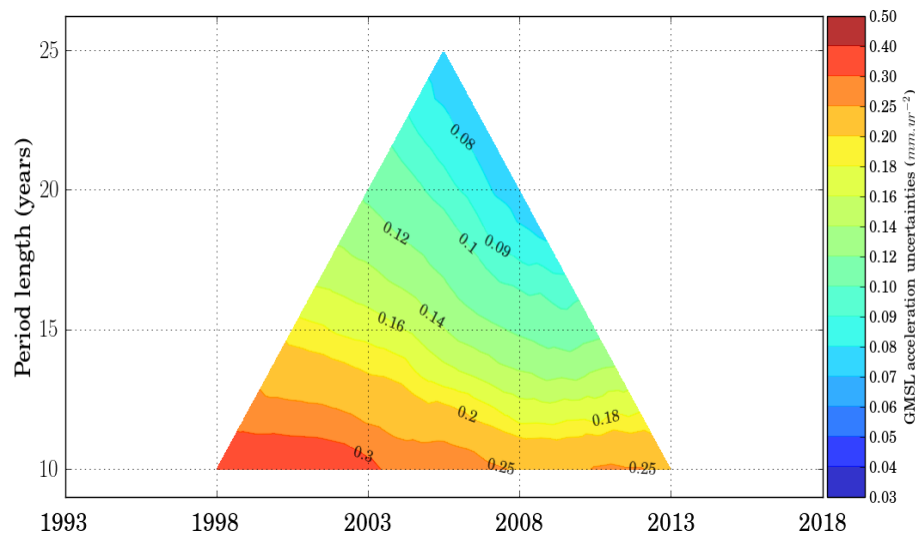
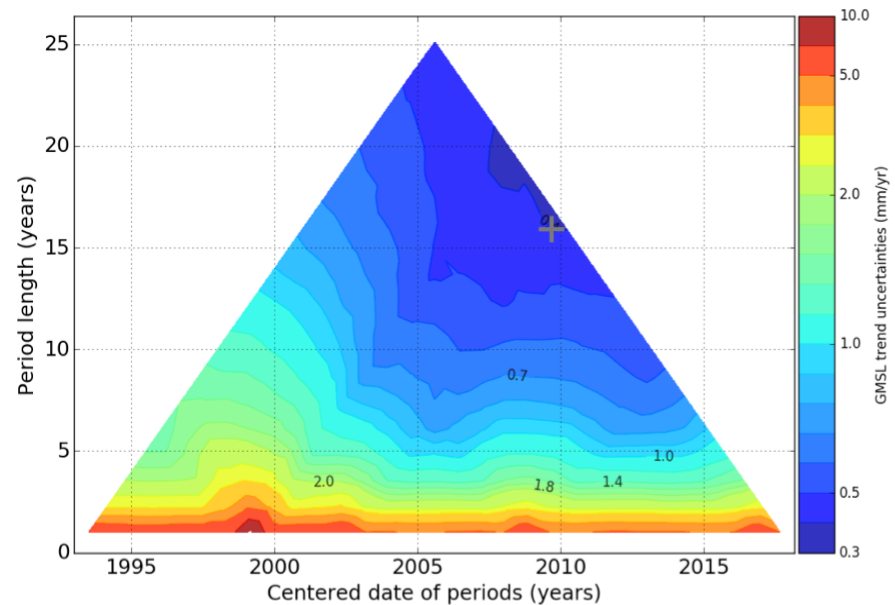
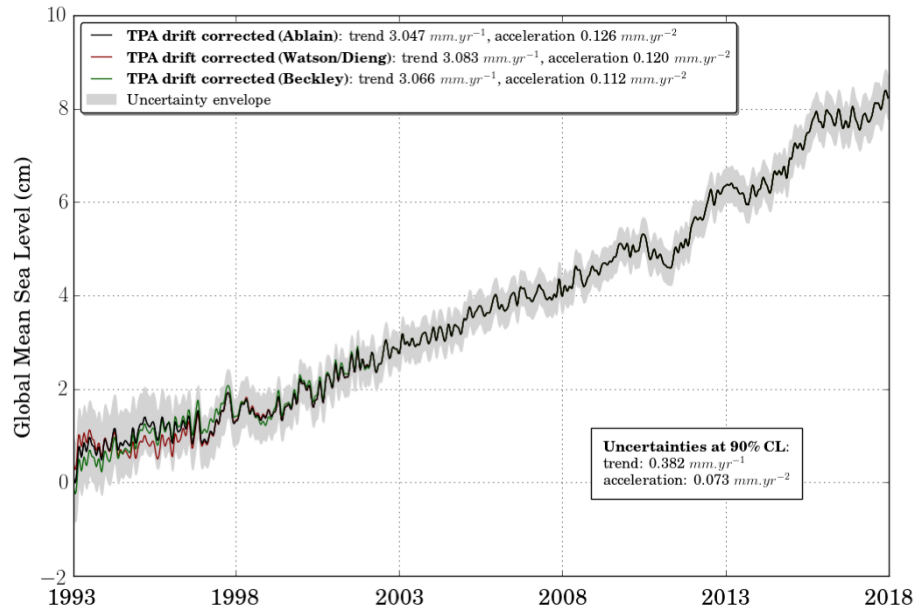
benoit.meyssignac@legos.obs-mip.fr



Maturity of the sea level record

- Quasi global coverage
- Very low ratio of missing or corrupted data: $<4\%$ in open ocean
- High stability: $<\pm 0.3$ mm/yr of drift over 20yr and longer time scales
- Robust validation against tide gauges and through the sea level budget
- Advance estimate of the associated uncertainty including time correlation in errors

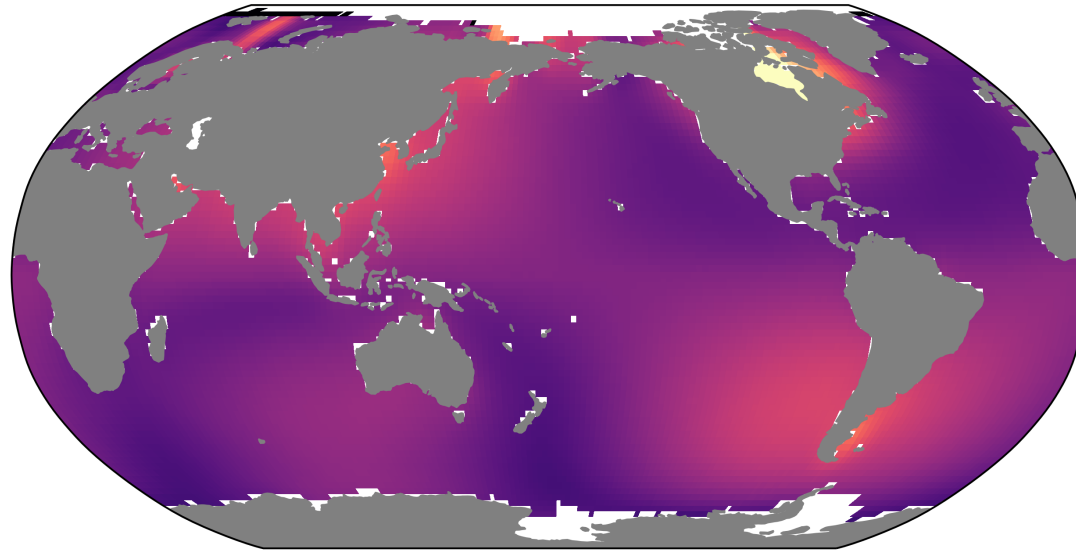
Accuracy of the sea level record



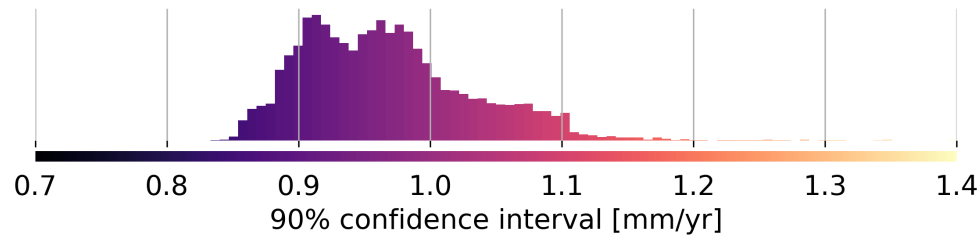
Uncertainty in sea level change, trend and acceleration from satellite altimetry (1.65σ)

From Ablain et al. 2019

Accuracy of the sea level record



mean: 0.97, std= 0.08



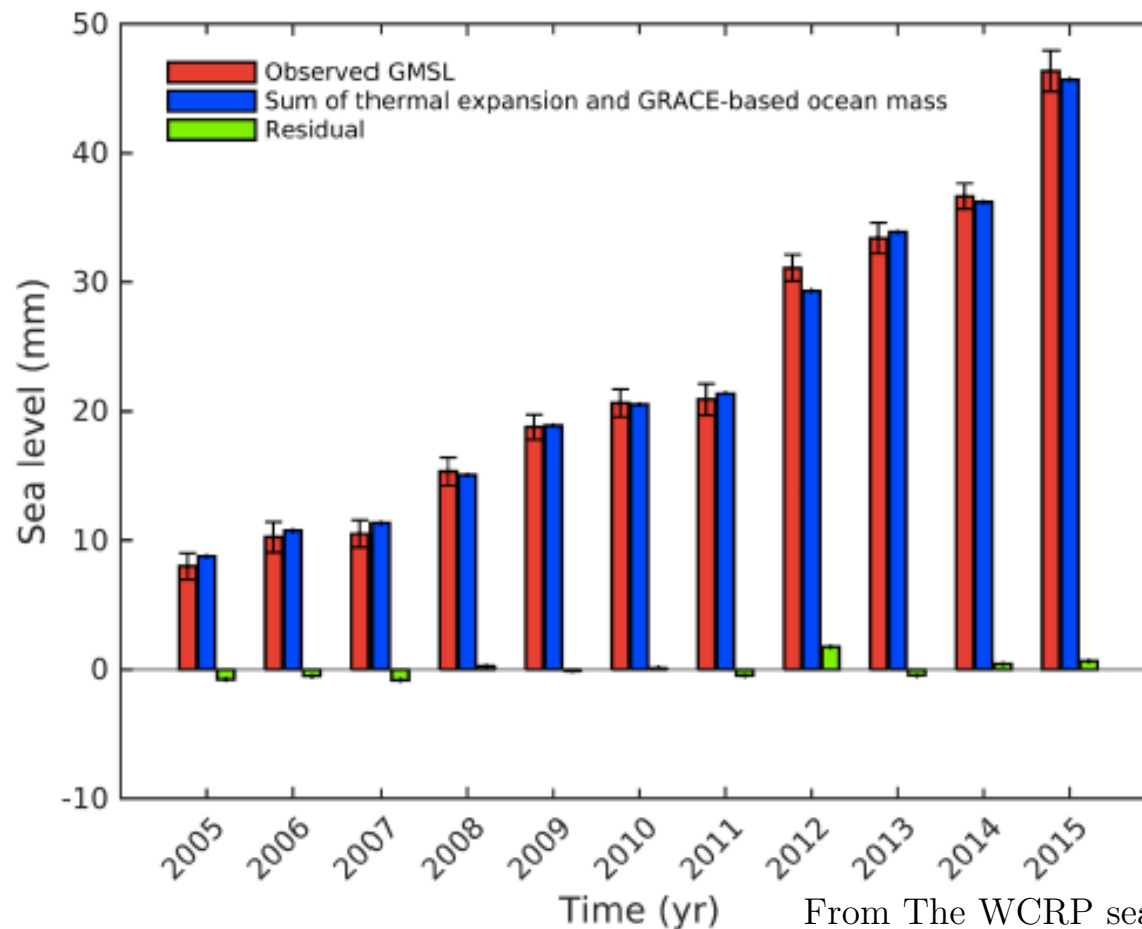
Uncertainty in regional sea level trend from satellite altimetry
over 1993-2018 (90%CL)

From Prandi et al. in prep.

Is the sea level record accurate enough to address the current scientific questions?

- Closing the sea level budget and identifying the uncertain contributions to sea level rise (globally, regionally and at the coast)
- Constraining projections of future sea level rise and its contributions
- Estimating the Earth energy imbalance and constraint the energy budget of the Earth

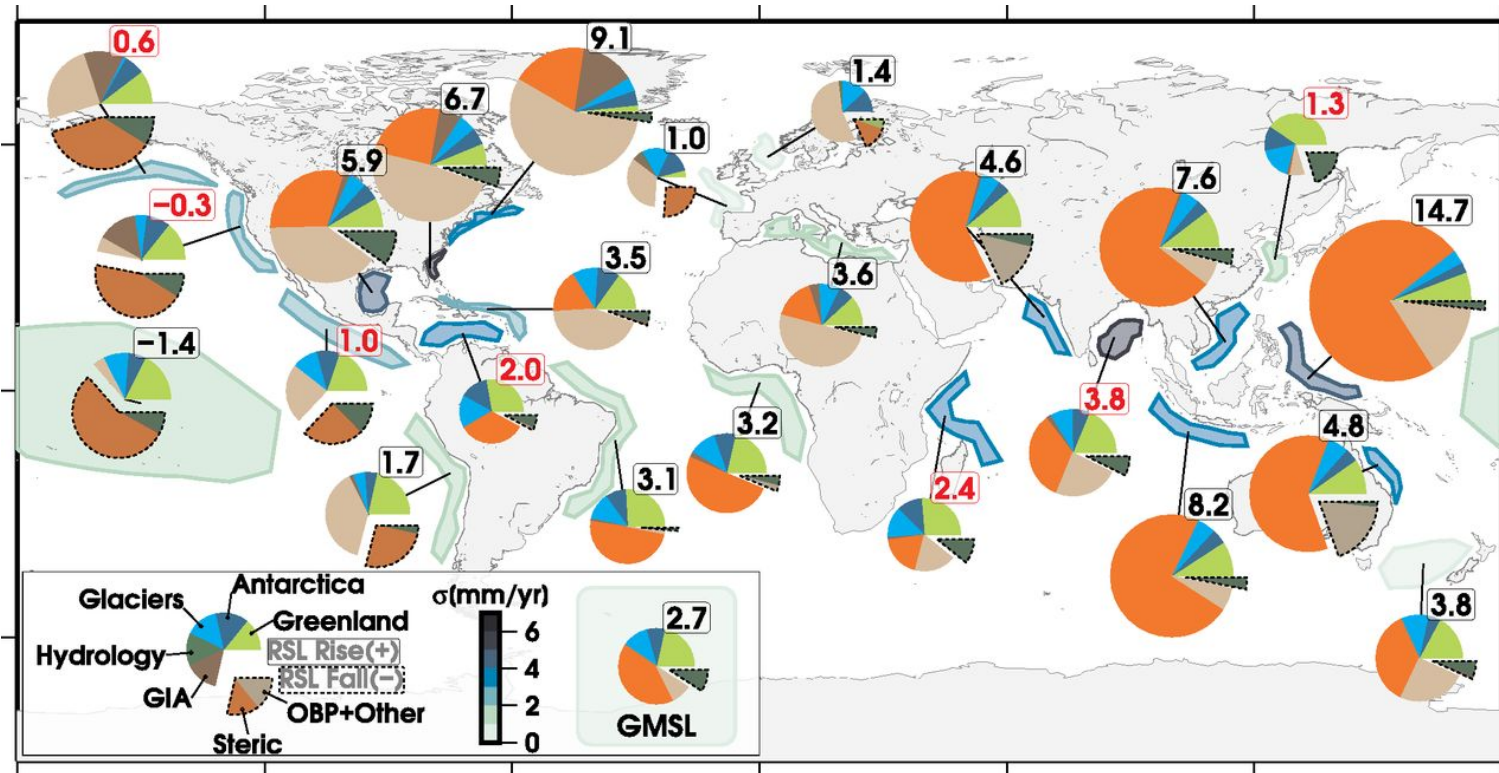
Closing the sea level budget



$<\pm 0.3$ mm/yr to close the sea level budget and estimate the uncertain contributions to sea level from land water changes

$<\pm 0.1$ mm/yr to estimate the deep ocean warming and smaller contributions like the permafrost thawing...

Closing the sea level budget



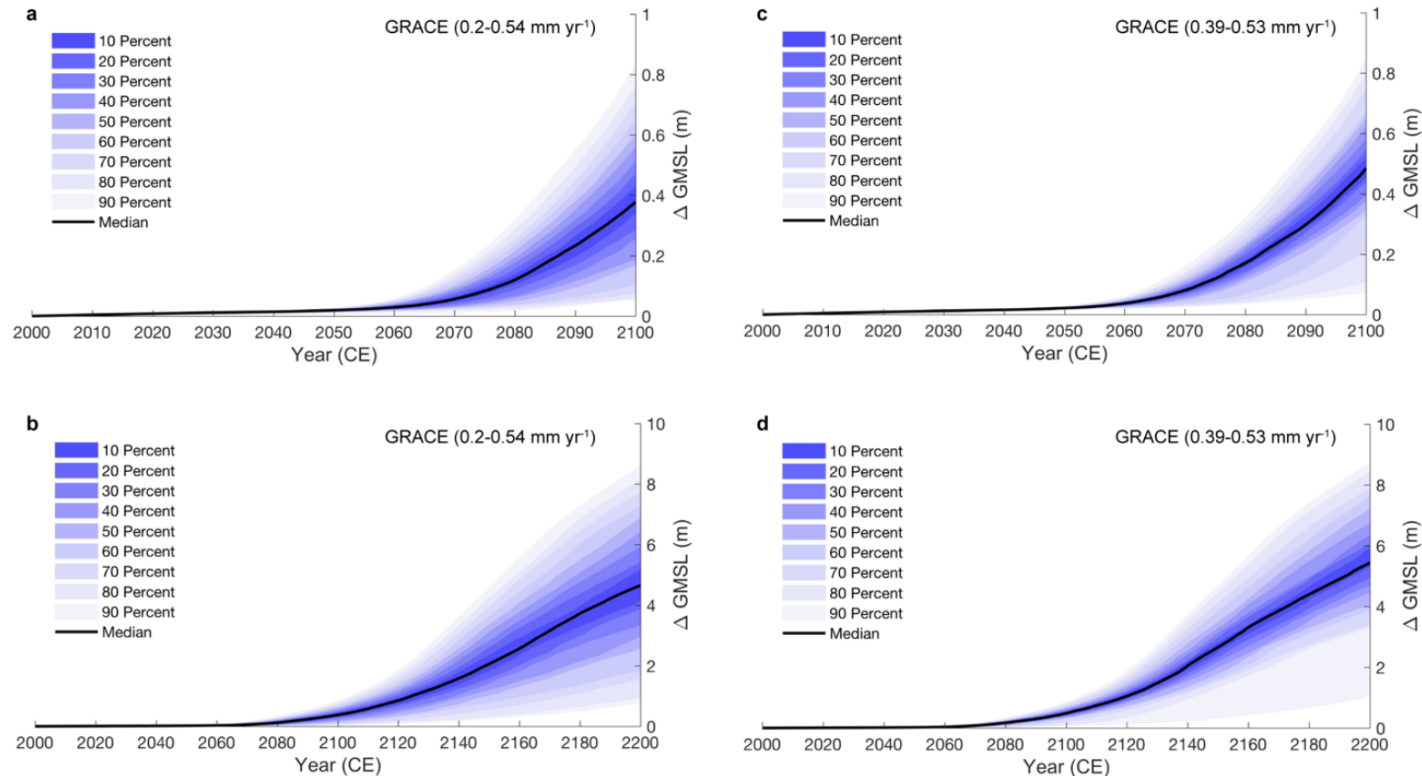
From Rietbroek et al. 2016

$< \pm 1$ mm/yr to close the regional sea level budget and explain the regional sea level rise for impact studies

Is the sea level record accurate enough to address the current scientific questions?

- Closing the sea level budget and identifying the missing contributions $< \pm 0.3$ to ± 0.1 mm/yr globally, $< \pm 1$ mm/yr at the coast ($>$ decadal time scales)
- Constraining projections of future sea level rise and its contributions
- Estimating the Earth energy imbalance and constraint the energy budget of the Earth

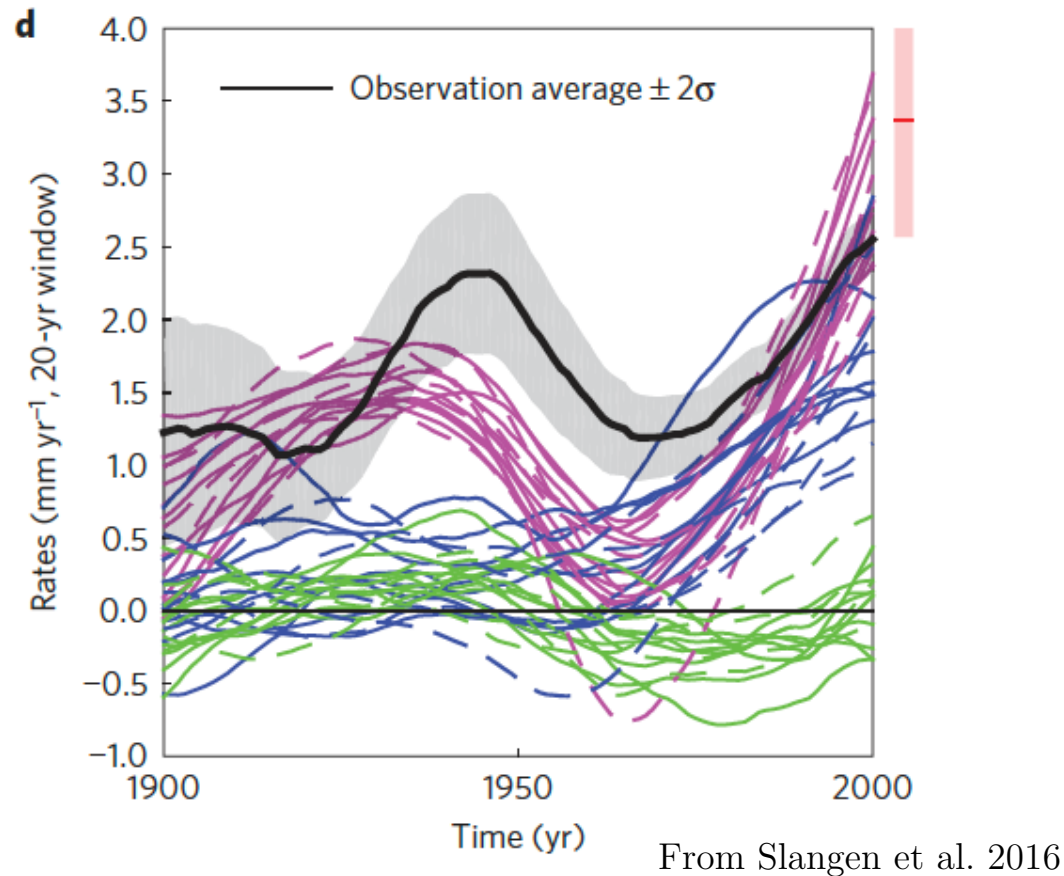
Constraining projections of future sea level rise and its contributions



From de Conto et al. in revision

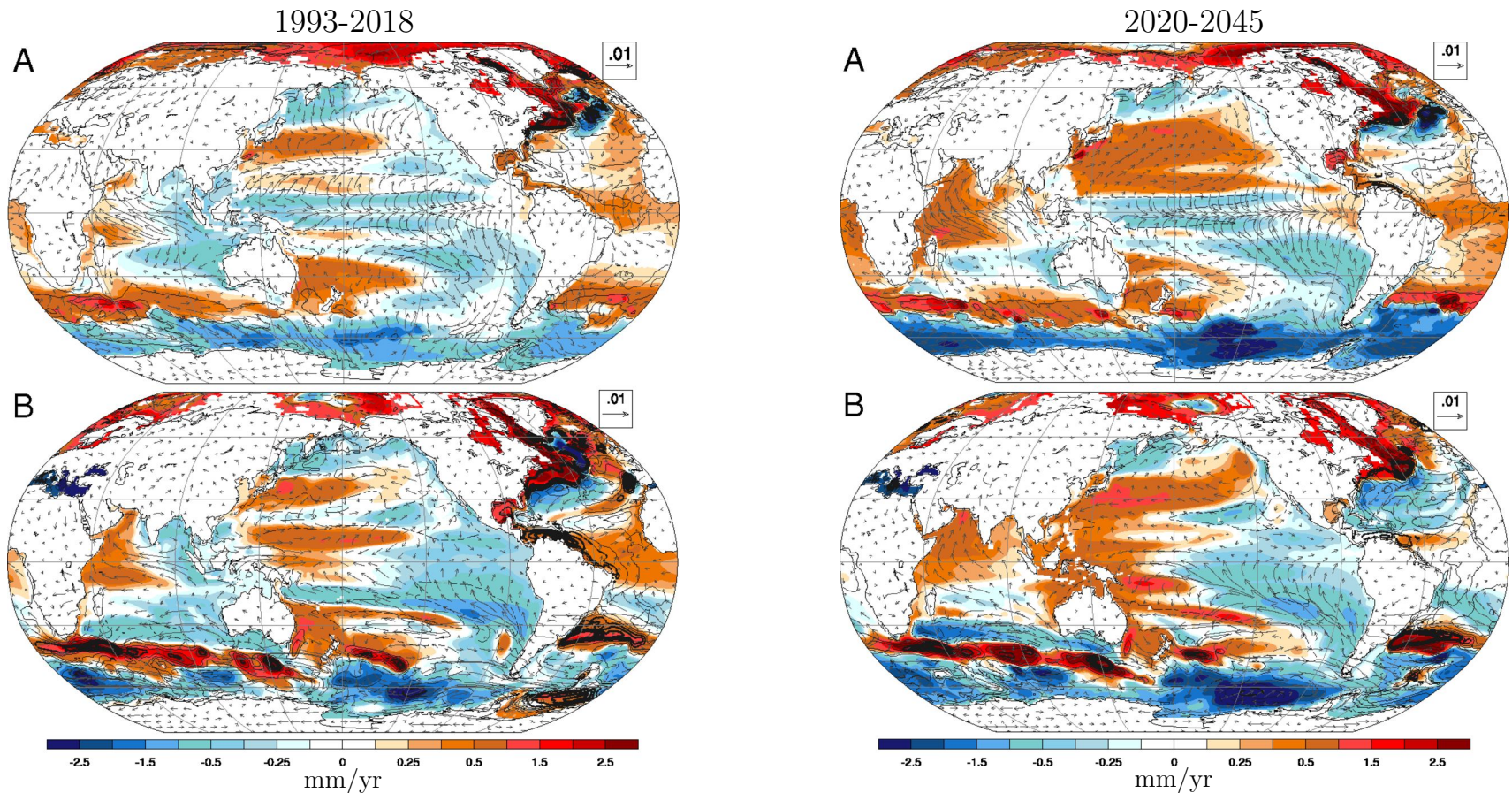
$< \pm 0.2$ mm/yr to constraint futur Antarctica contribution to sea level rise

Constraining projections of future sea level rise and its contributions



$<1.5 \text{ mm/yr}$ to detect and attribute present day global sea level rise

Constraining projections of future sea level rise and its contributions



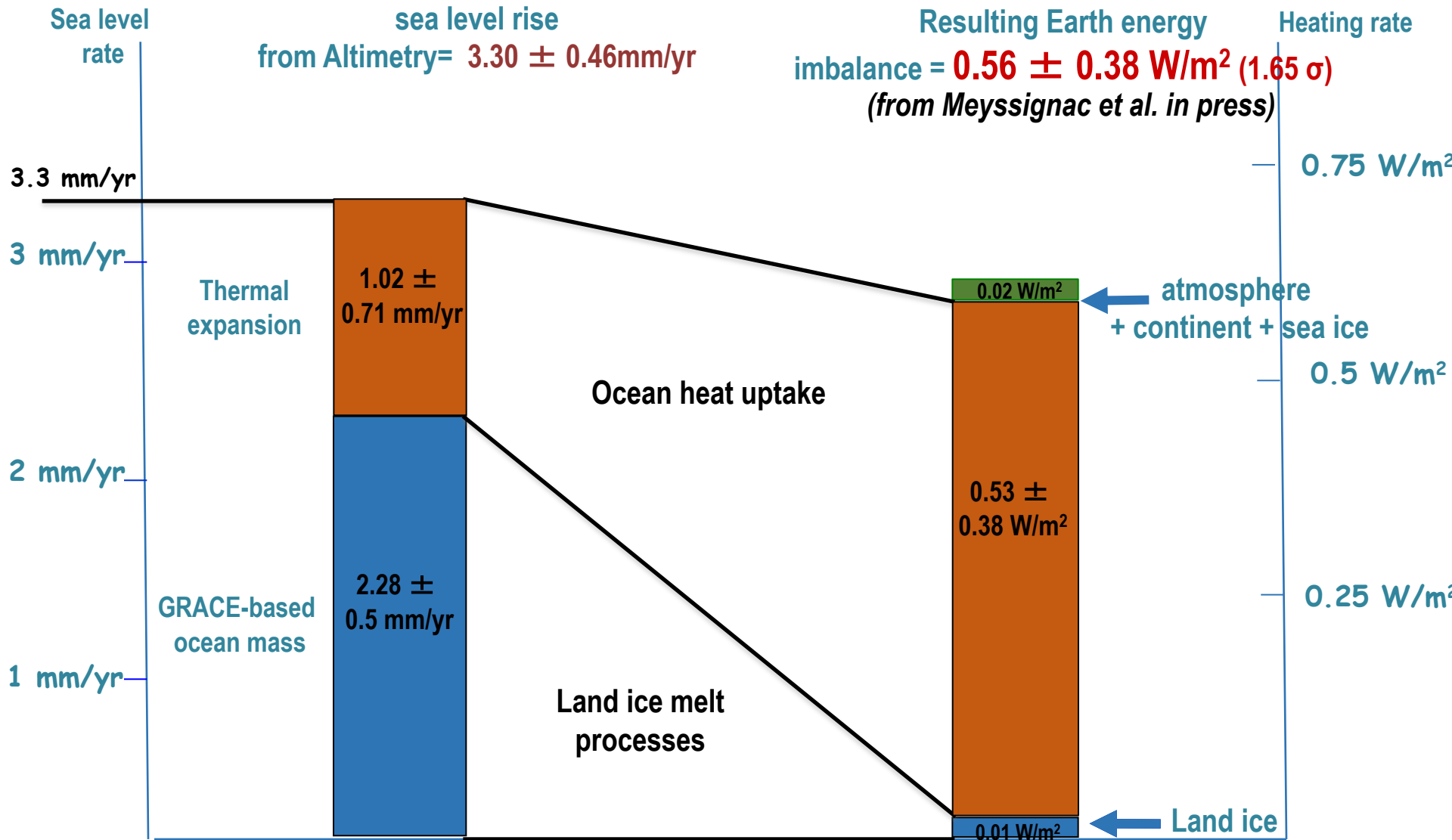
From Fasullo and Nerem 2018

$< \pm 0.5 \text{ mm/yr}$ to detect and attribute present day local sea level rise

Is the sea level record accurate enough to address the current scientific questions?

- Closing the sea level budget and identifying the missing contributions $< \pm 0.3$ to ± 0.1 mm/yr globally, $< \pm 1$ mm/yr at the coast ($>$ decadal time scales)
- Constraining projections of future sea level rise and its contributions $< \pm 0.2$ mm/yr globally, $< \pm 0.5$ mm/yr locally ($>$ decadal time scales)
- Estimating the Earth energy imbalance and constraint the energy budget of the Earth

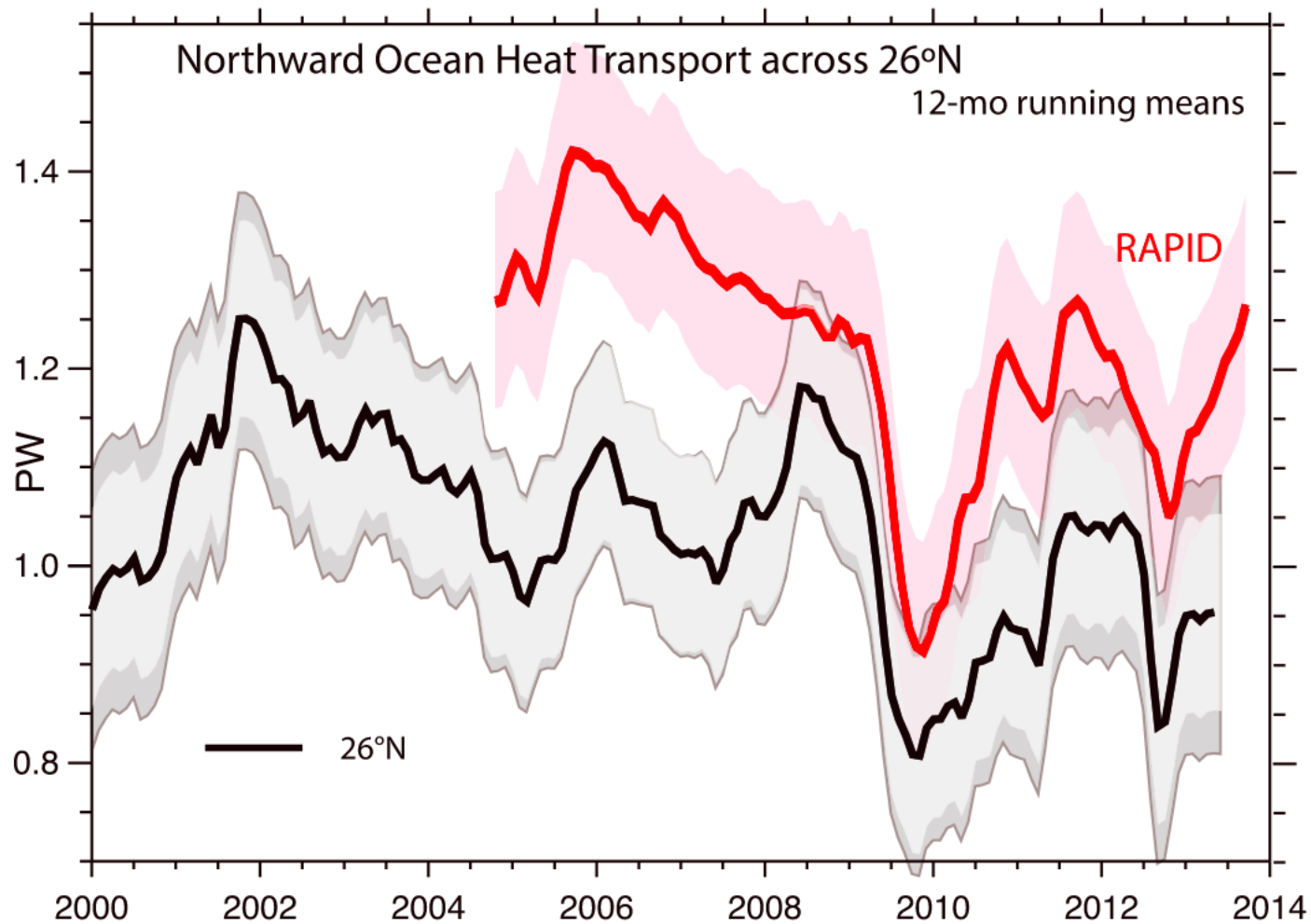
Estimating The Earth energy imbalance (2006-2015)



From Meyssignac et al. 2019

$<0.1 \text{ mm/yr}$ to estimate the Earth energy imbalance on decadal time scales

Constraining regional energy budget



From Trenberth and Fasullo 2017

$< \pm 0.5$ mm/yr to derive regional energy budgets

Is the sea level record accurate enough to address the current scientific questions?

- Closing the sea level budget and identifying the missing contributions
< ± 0.3 to ± 0.1 mm/yr globally, < ± 1 mm/yr at the coast (> decadal time scales)
- Constraining projections of future sea level rise and its contributions
< ± 0.2 mm/yr globally, < ± 0.5 mm/yr locally (> decadal time scales)
- Estimating the Earth energy imbalance and constraint the energy budget of the Earth
< ± 0.1 mm/yr globally , < ± 0.5 mm/yr regionnally (> decadal time scales)

Conclusion

- Is the sea level record accurate enough?

No. Improving the accuracy of the record will enable to tackle major climate science questions (priorities of the WCRP)

- Then, how accurate is accurate enough?

Each scientific question requires a specific level of accuracy on specific time scales and specific spatial scales

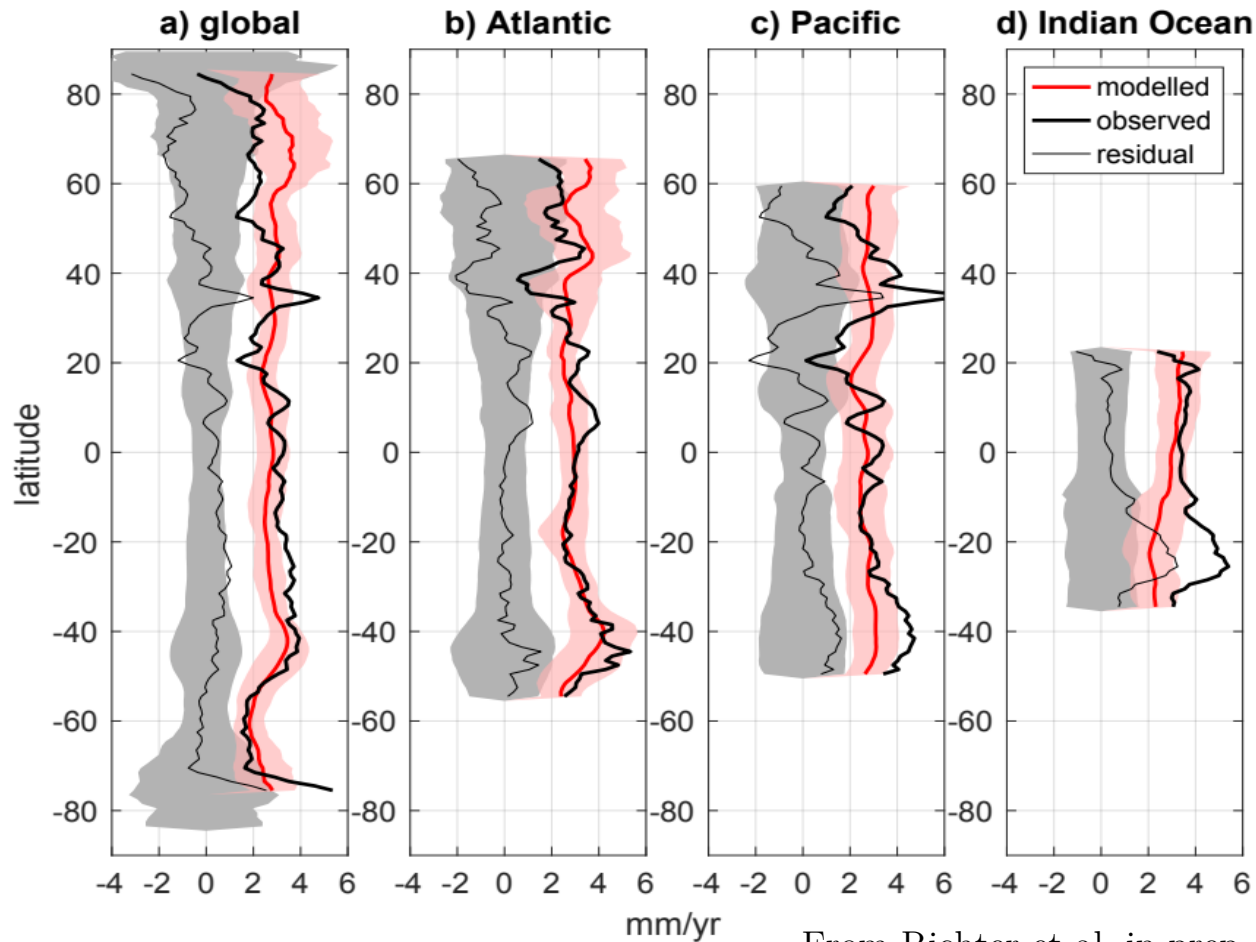
- Robust and comprehensive estimate of the uncertainty to derive uncertainty consistently for any metrics based on sea level

Perspective: where can we make progress?

- Wet tropospheric correction? Consistent with FCDR on long time scales? Spatial structure of the uncertainty?
- Orbit correction? Can we get an idea of the spatial structure of the uncertainty? The temporal structure (when GRACE is available and when it is not)?
- Improve the estimate of sea level in the leads and along the coast: retracking? Tides? DAC? Wet tropospheric correction?
- Correcting Sentinel-3 drift: SAR mode drift and PTR drift?
- Improving the accuracy has a cost that should be evaluated and should be compared with the benefit of the corresponding scientific achievements. This is particularly important for operational missions

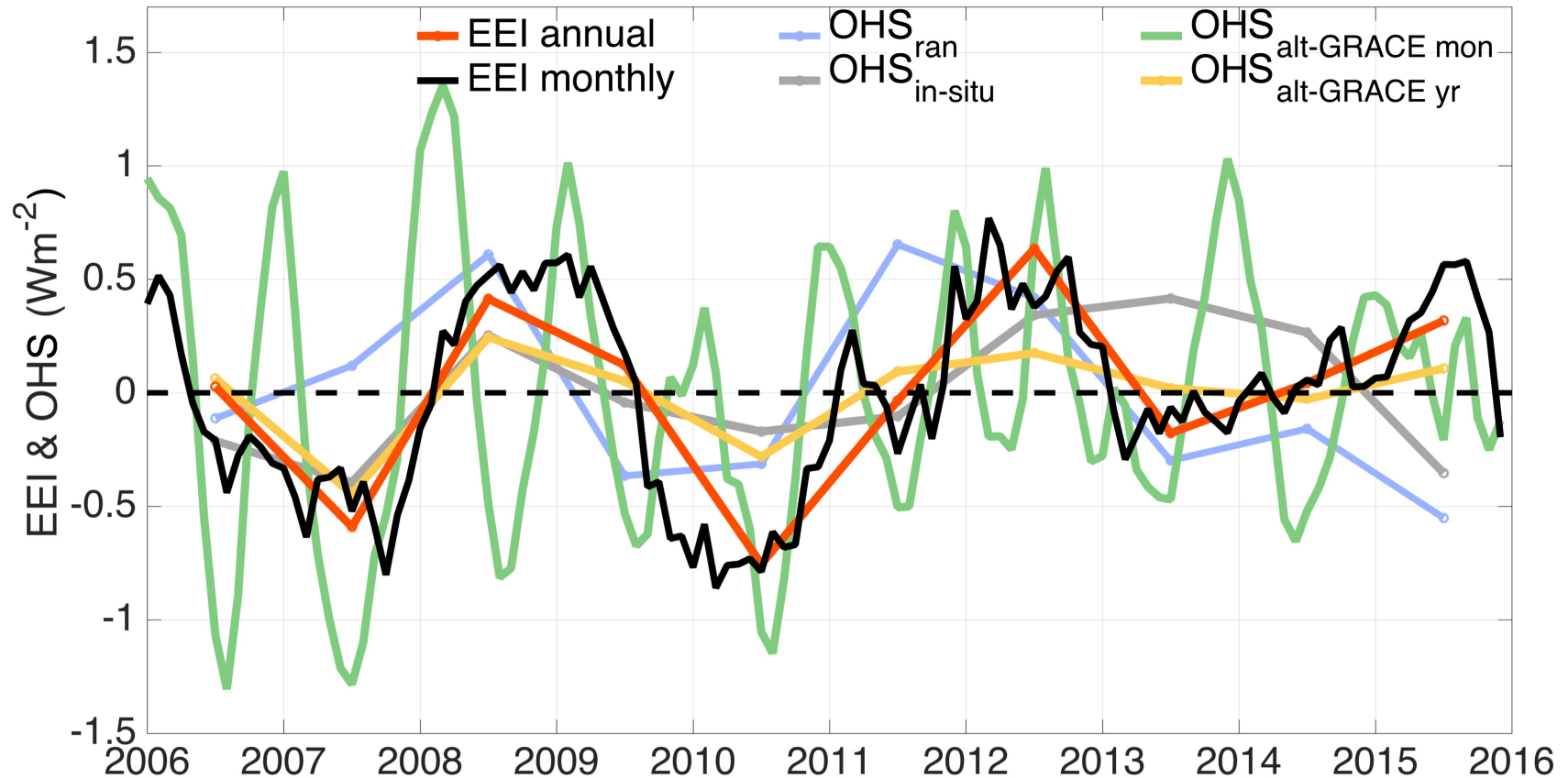
Extra Slides

Constraining projections of future sea level rise and its contributions



<1mm/yr to detect and attribute present day zonal sea level rise

Estimating The Earth energy imbalance



From Meyssignac et al. 2019

<1 mm/yr to estimate the Earth energy imbalance at monthly time scales