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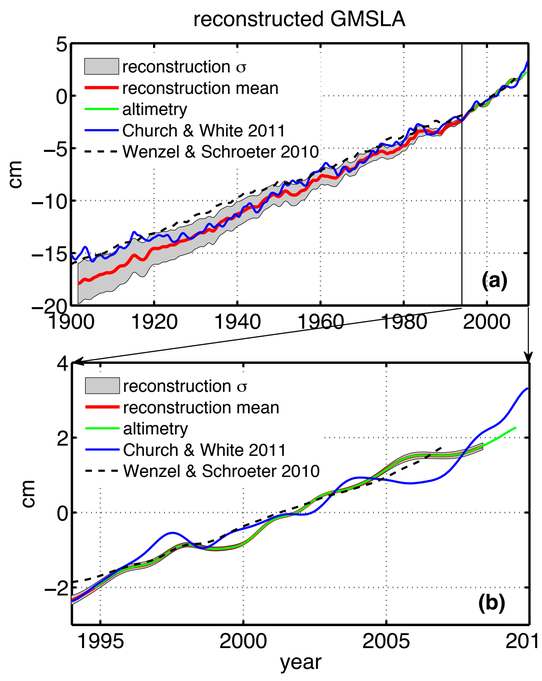
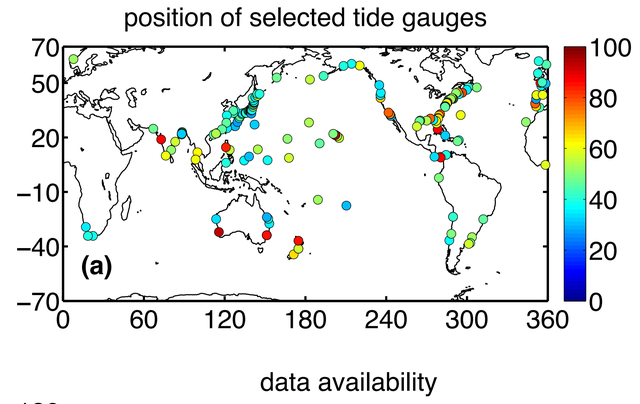
Sea level variations since 1900 derived from altimertry and tide gauges

Sea level change prior to 1993 is described by time varying amplitudes of spatial expansion functions, in analogy to Church and White by EOFs.
The amplitudes, denoted principle components (PC) are estimating by analysing historic tide gauge records.
We complement the suite of studies inspired by Church and White study with alternative methods. In a first step gaps in 178 records of sea level change are filled using the pattern recognition capabilities of artificial neural networks. Afterwards satellite altimetry is used to extrapolate local sea level change to global fields. In contrast to prior studies we do not try to reconstruct sea level at tide gauges. Instead we estimate the PCs from the tide gauge observations directly.





GOAL: SLA=H(x,y,t) for t=1900:2009

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measured altimetry $H_M = U_M(x,y)\alpha(t)$ EOF decomposition

reconstructed $H_R = U_M(x,y).\alpha_R(t)$ EOF expansion

Least Sq. Fit **in the space of principal components (differences)**

$$S(M) = \left\| (H^0 + \varepsilon) * M - \alpha(t) \right\| + w \left\| M \right\|$$

$\alpha_R(t) = M * H^0(t)$ unknown amplitudes

Least Sq. Fit **in the space of tide gauge observation (differences)**

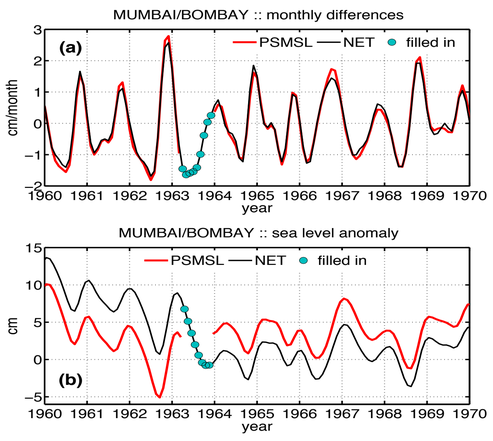
Church, Meyssignac, ...

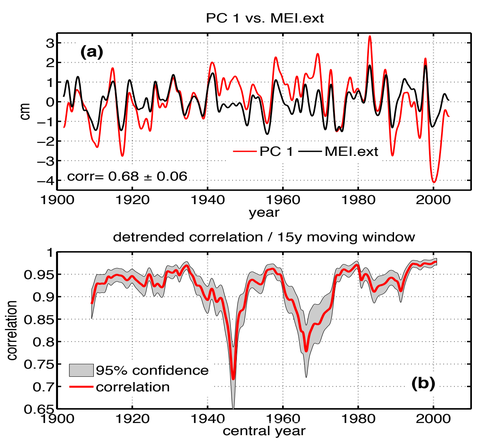
$$S(\alpha) = \left\| \; (PU_M\alpha - H^0)^T R^{-1} (PU_M\alpha - H^0) \; \right\| + \left\| \; \alpha^T \Lambda^{-1} \alpha \; \right\|$$

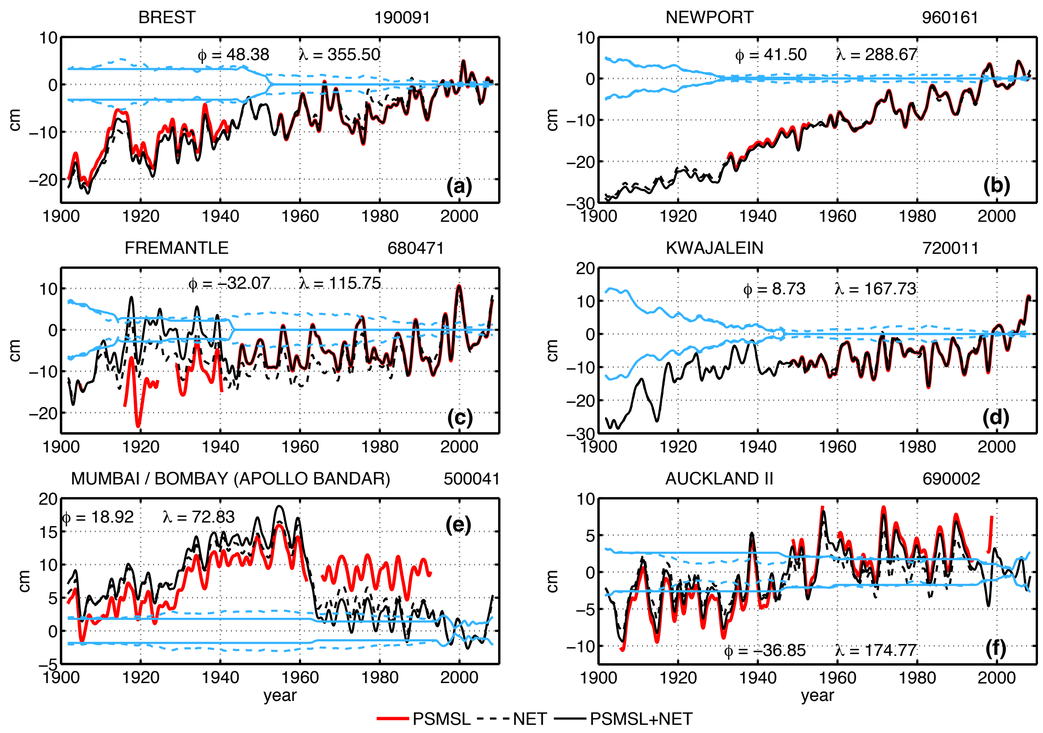
$$\alpha_R(t) = M * H^0(t)$$

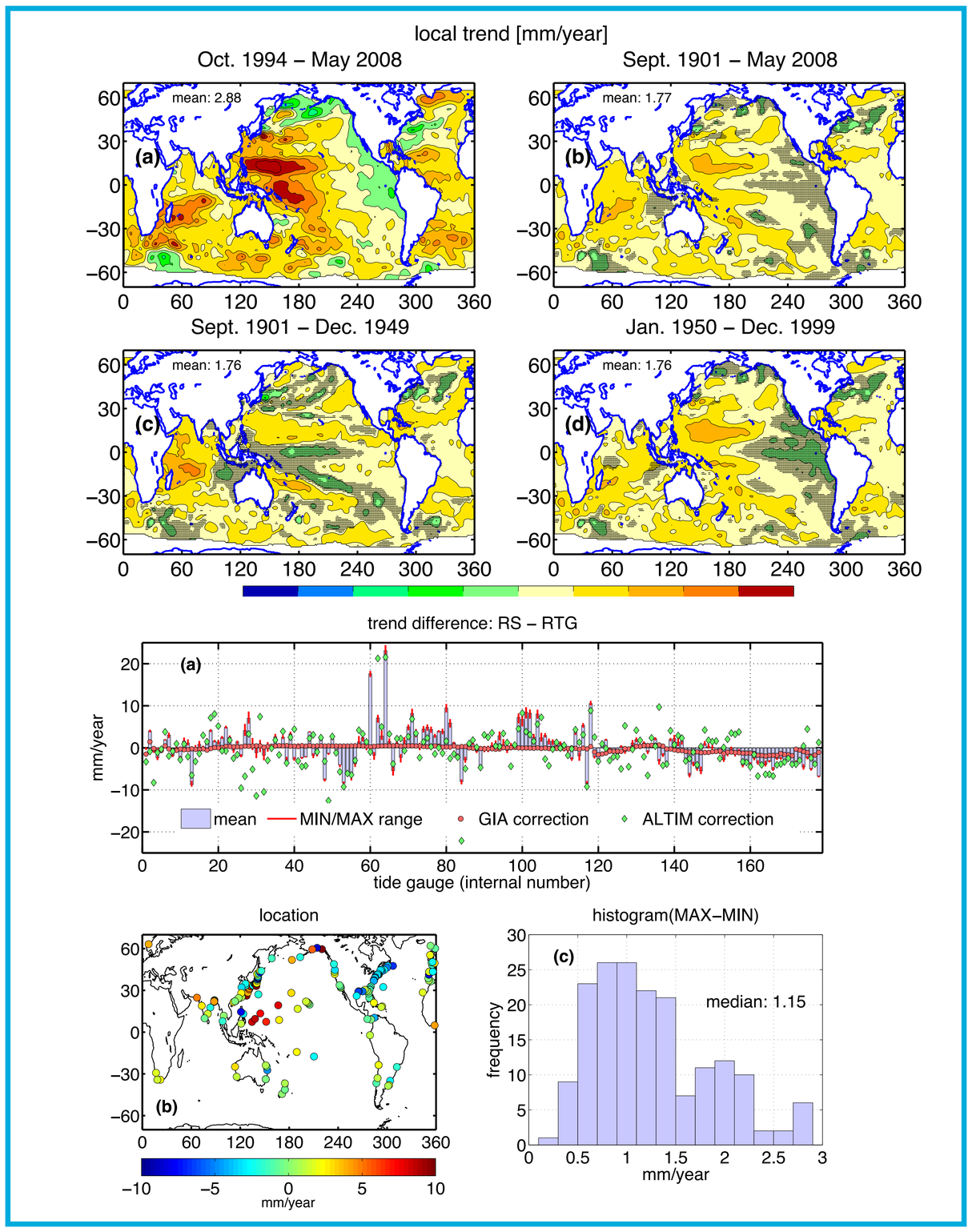
$$M = (U_M^T P^T R^{-1} P U_M + \Lambda^{-1})^{-1} U_M^T P^T R^{-1}$$

Global mean sea level change since 1900 is found to be 1.77 ± 0.19 mm/year on average. Local trends are essentially positive with the highest values found in the western tropical Pacific. Regions with negative trends are spotty with a minimum value of about −2 mm/year south of the Aleutian Islands.
All uncertainties are estimated using a Monte Carlo method (72 members).
The acceleration found for the global mean is +0.0042±0.0.0046 mm/year**2. Local values range from −0.1 mm/year**2 in the central Indian Ocean to +0.1 mm/year**2 in the western tropical Pacific and east of Japan. These extrema are associated with patterns of sea level change that differ significantly from the first half of the analyzed period (i.e. 1900 to 1950) to the second half (1950 to 2000). We take this as an indication of long period oceanic processes that are superimposed to the general sea level rise.









References
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