Combining datasets of satellite retrieved products
Closure of the terrestrial water budget over Mississippi

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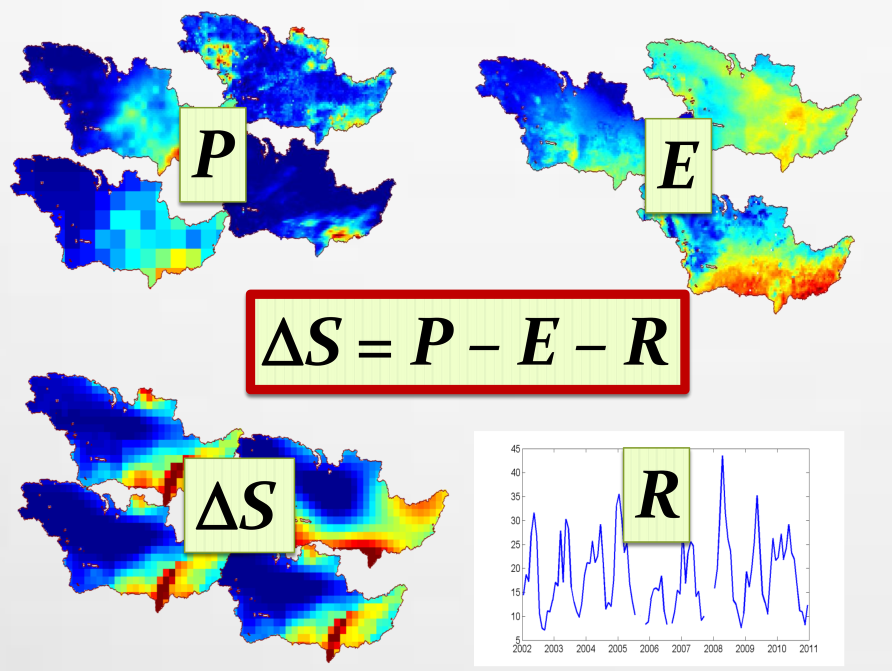
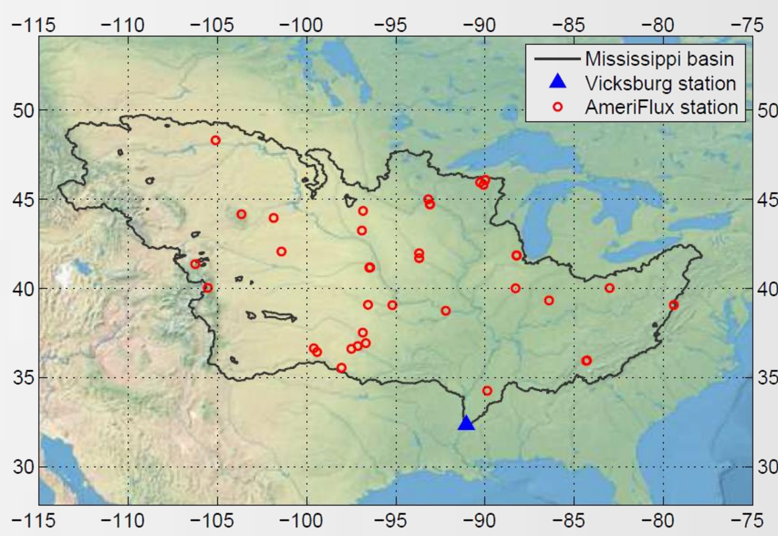
1. Introduction

This study addresses the problem of the optimal combination of multiple observation datasets to obtain a coherent dataset of four water cycle key components at the basin scale: precipitation (***P***), evapotranspiration (***E***), runoff (***R***) and terrestrial water storage change (**Δ*S***). All the datasets are combined in a two-step process: Simple Weighting integration and closure Post-Filtering (Aires, 2014). Results are validated against in situ data over the Mississippi basin. A Closure Correction Model is further derived, which allows to correct each dataset independently with interesting applications such as the reconstruction of missing values.



Considered datasets

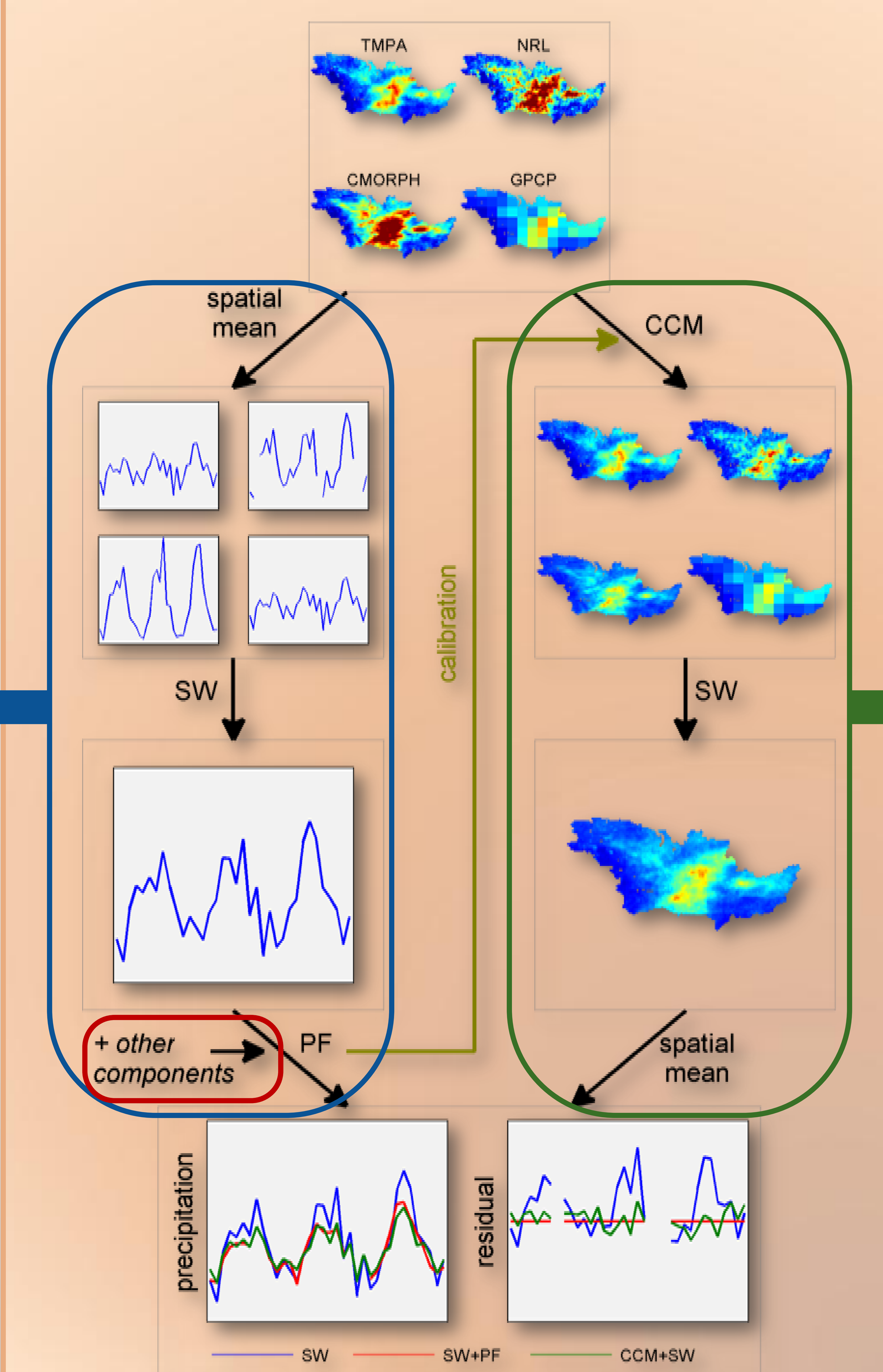
- ***P*** GPCP, TMPA, NRL, CMORPH
- ***E*** GLEAM, MOD16, NTSG
- **Δ*S*** (GRACE) CSR, JPL, GFZ, GRGS
- ***R*** GRDC (Vickburg)



The Mississippi Basin at Vicksburg and location of AmeriFlux stations used for validation

2. Methodology

Example of the precipitation component



3. Integration and closure filtering

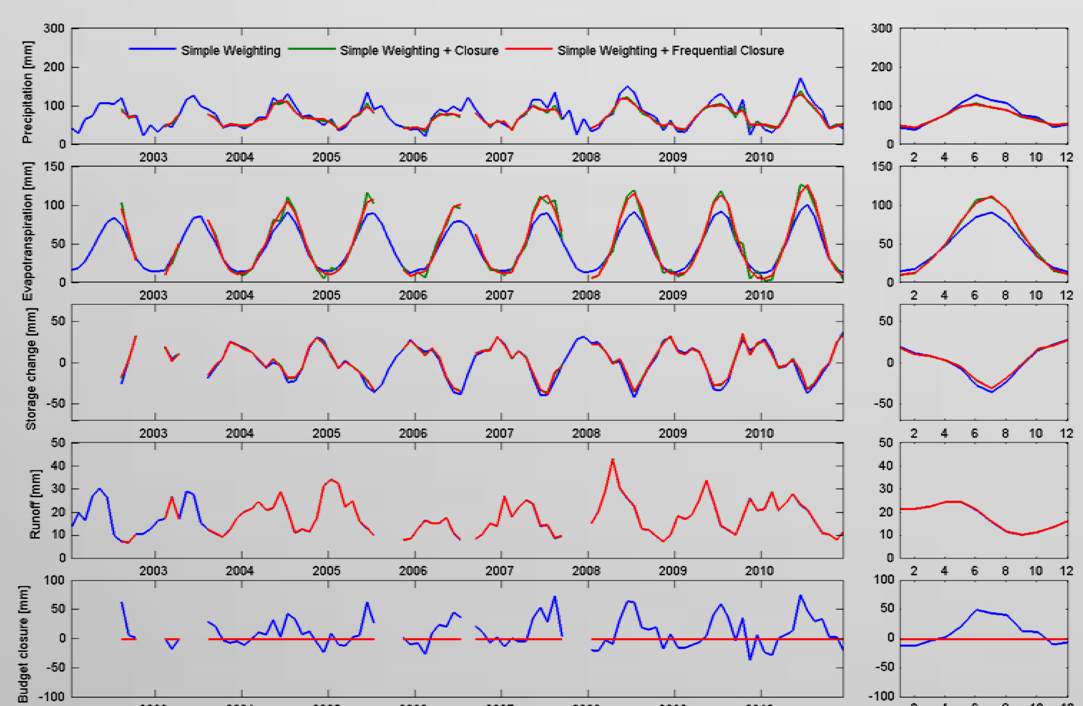
Bias correction pre-processing: based on the seasonal average

Simple Weighting integration **(SW)**: each component obtained from a linear combination of the unbiased datasets; datasets are weighted depending on their respective uncertainties

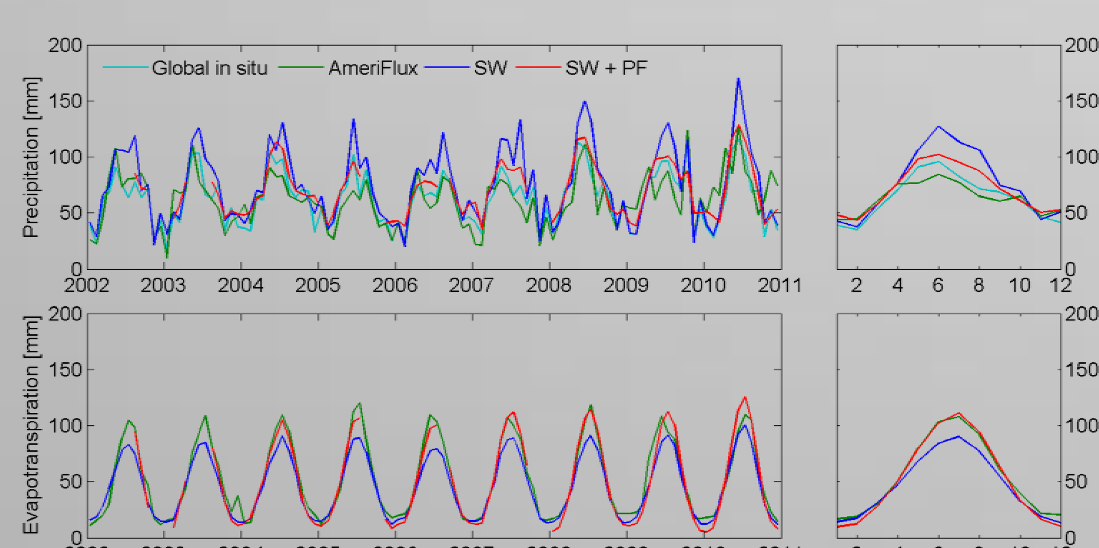
Closure Post-Filtering **(PF)**: budget residual (***P-E-R-ΔS***) distributed among the components depending on their respective uncertainties

Frequential closure: low- and high-frequencies PF to remove HF in ***E***

Chosen uncertainties: 10, 10, 5 and 1 mm/month for ***P***, ***E***, **Δ*S*** and ***R***, respectively (empirical values based on various studies about the different datasets)



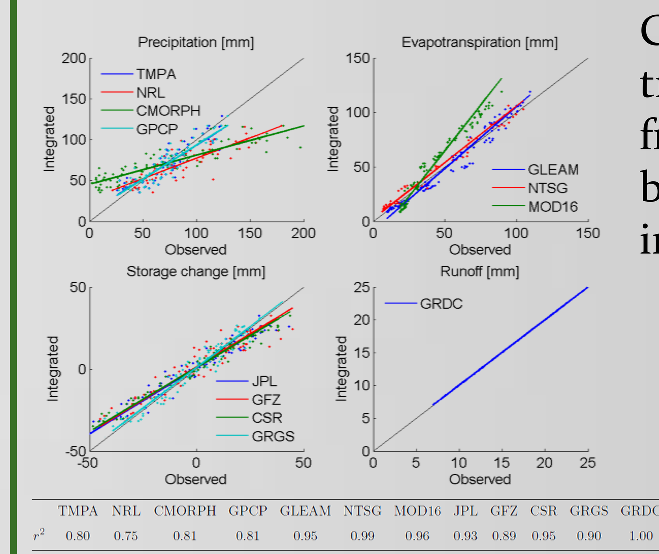
Comparison of SW, SW+PF and SW+frequential PF



Evaluation of the integration process: comparison with in situ data from gridded datasets (GPCC, CRU, WM) and AmerifFux database

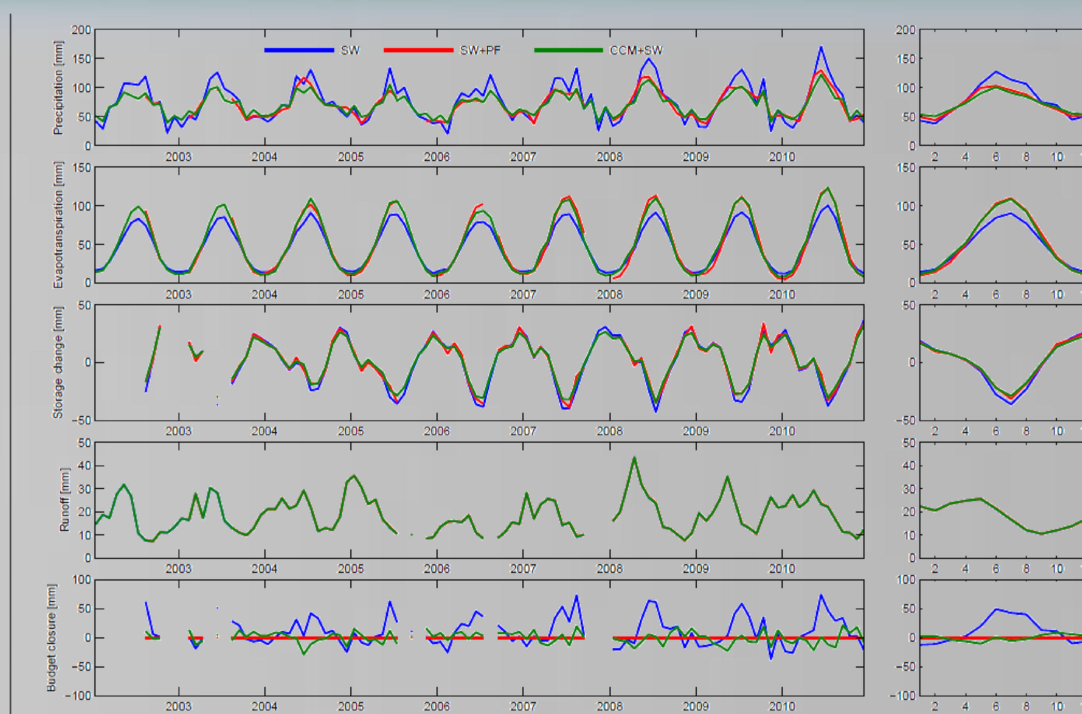
4. Closure Correction Model (CCM)

A closure correction model (CCM) is designed to correct each dataset of each component independently toward the integrated product.



Calibration of the CCM based on linear regressions between the original and the integrated datasets

CCM is based on affine transformations calibrated from linear regressions between observed and integrated datasets.

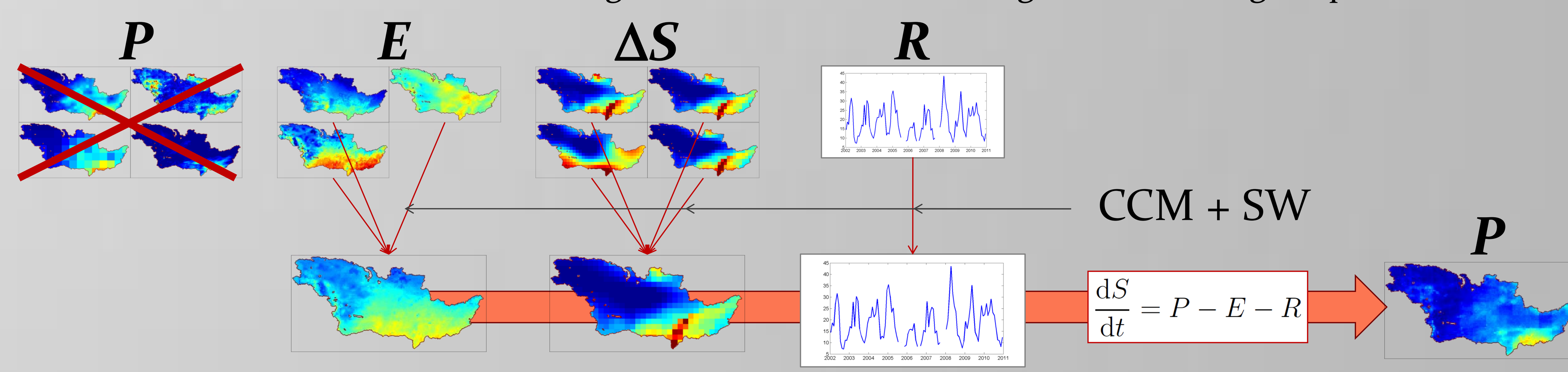


Evaluation of CCM against SW+PF for the four components and budget residual

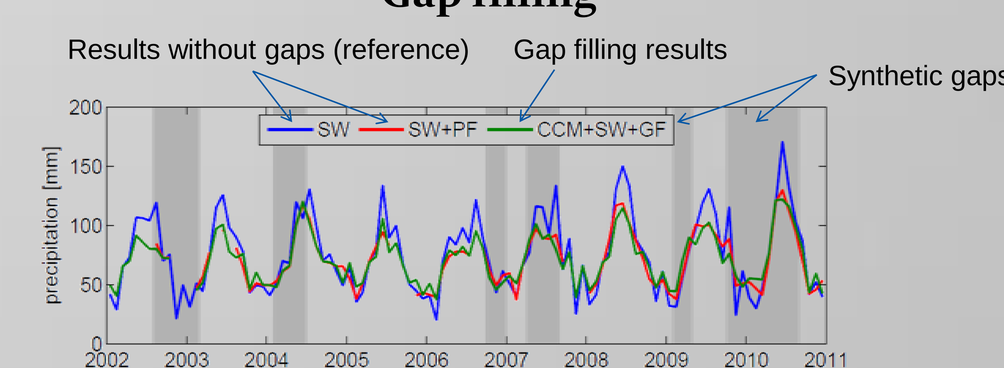
The CCM product compares well with the integrated one (SW+PF). The budget is not closed but the residual is highly reduced compared with SW.

5. CCM applications: reconstruction of missing values

If one component is missing: PF is not applicable, leading to missing values for the four components.
CCM can be applied on the three other components
the missing one can be estimated using the water budget equation



Gap filling



Exemple of gap filling with synthetic gaps in P. Comparison between gap filling results with CCM and theoretical results with SW+PF (without gaps)

Monte Carlo experiment to test the robustness of the gap filling method for each component.

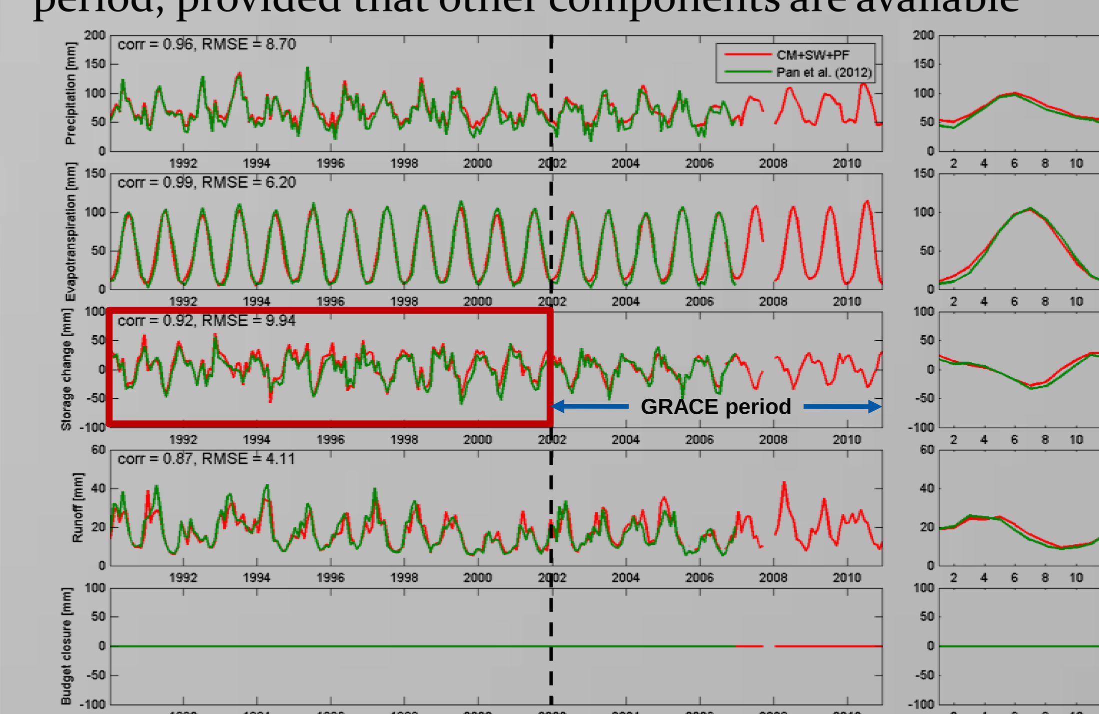
Comparison with two simple gap filling methods: linear interpolation (LI) and seasonal regression (SR)
-CCM provides best results for ***P*** and **Δ*S***
-Good results for ***E*** from CCM, but better with SR (high seasonality of ***E***)
-Bad results for ***R*** (variability of the same order as budget residual)

RMSE	*P*	*E*	Δ*S*	*R*
Linear interpolation	13.06	19.04	15.11	6.87
Seasonal regression	8.42	1.43	9.15	7.87
CCM + closure	5.41	5.01	8.94	10.85

RMSE of 3 gap filling methods compared with SW+PF (without gaps). Only gap periods are considered.

Reconstruction of past water storage change

Same methodology to reconstruct **Δ*S*** prior to the GRACE period, provided that other components are available



Reconstruction of **Δ*S*** using CCM + water budget equation (red square) and comparison with results from Pan et al. (2012)

6. Conclusion and perspectives

The integration procedure (SW+PF) developed by Aires (2014) is applied successfully with real observation datasets.
A closure correction model (CCM) is derived, which allows to correct each dataset independently toward a more coherent product. CCM can be used to reconstruct missing values, with a demonstrated efficiency.
Since CCM can be applied pixel-wise, we envisage to develop an integrated product at the global scale. The method will be applied on various basins around the globe to analyze the spatial consistency of the regression coefficients. Dependencies on various hydro-meteorological characteristics will also be analyzed.

References

Aires, F. (2014), Combining datasets of satellite retrieved products. Part I: Methodology and water budget closure, *Journal of Hydrometeorology*, accepted, 14pp.

Munier, S., F. Aires, S. Schlaffer, C. Prigent, F. Papa, P. Maisongrande, M. Pan (2014), Combining datasets of satellite retrieved products. Part II: Evaluation on the Mississippi Basin and closure correction model, *Journal of Geophysical Research*, submitted.

Pan, M., A. K. Sahoo, T. J. Troy, R. K. Vinukollu, J. Sheffield, and E. F. Wood (2012), Multisource Estimation of Long-Term Terrestrial Water Budget for Major Global River Basins, *Journal of Climate*, 25 (9), 3191-3206.