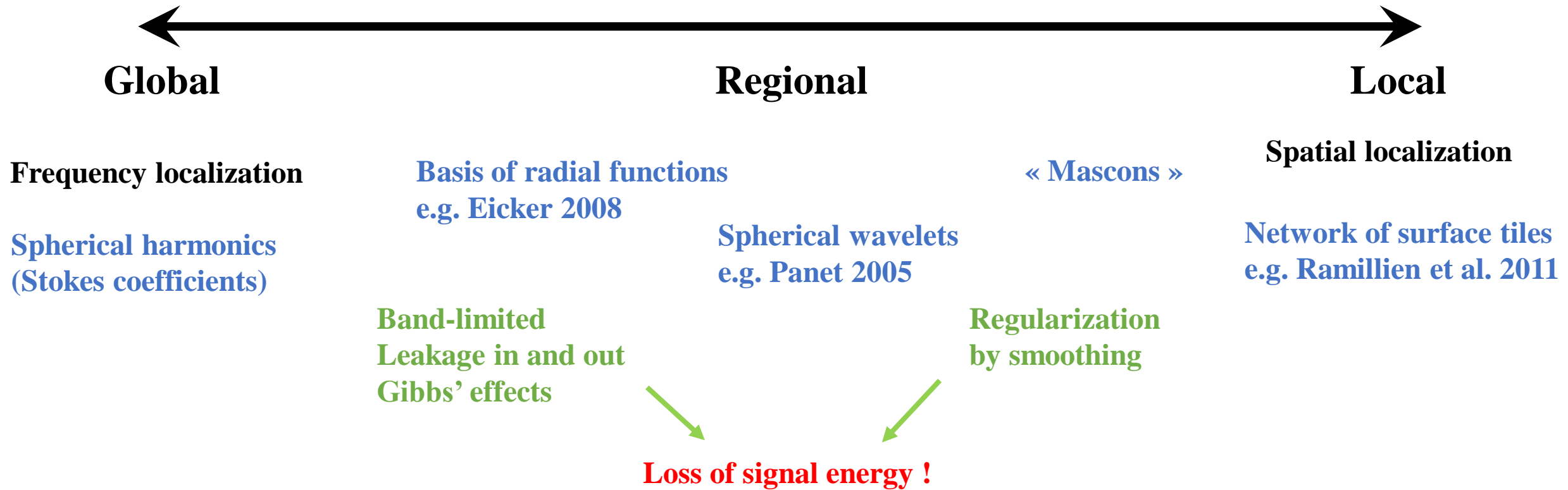# Fast determination of surface water mass changes using regional orthogonal functions

Guillaume Ramillien (1, 3, 4), Lucia Seoane (2, 3, 4) and José Darrozes (2, 3, 4)

Guillaume.Ramillien@get.omp.eu; Lucia.Seoane@get.omp.eu

1. Centre National de la Recherche Scientifique (CNRS)
2. Université Paul Sabatier (UPS)
3. Géosciences Environnement Toulouse (GET)
4. Observatoire Midi-Pyrénées (OMP)

EGU2020 – 2692 – PICO G1.2

Spatial scales of GRACE signal representation (*)

← →

Global   **Regional**   **Local**

Frequency localization   **Basis of radial functions**   **« Mascons »**   **Spatial localization**
                                   e.g. Eicker 2008

Spherical harmonics   **Spherical wavelets**   **Network of surface tiles**
(Stokes coefficients)   **e.g. Panet 2005**   **e.g. Ramillien et al. 2011**

                  Band-limited   **Regularization**
                  Leakage in and out   **by smoothing**
                  Gibbs' effects

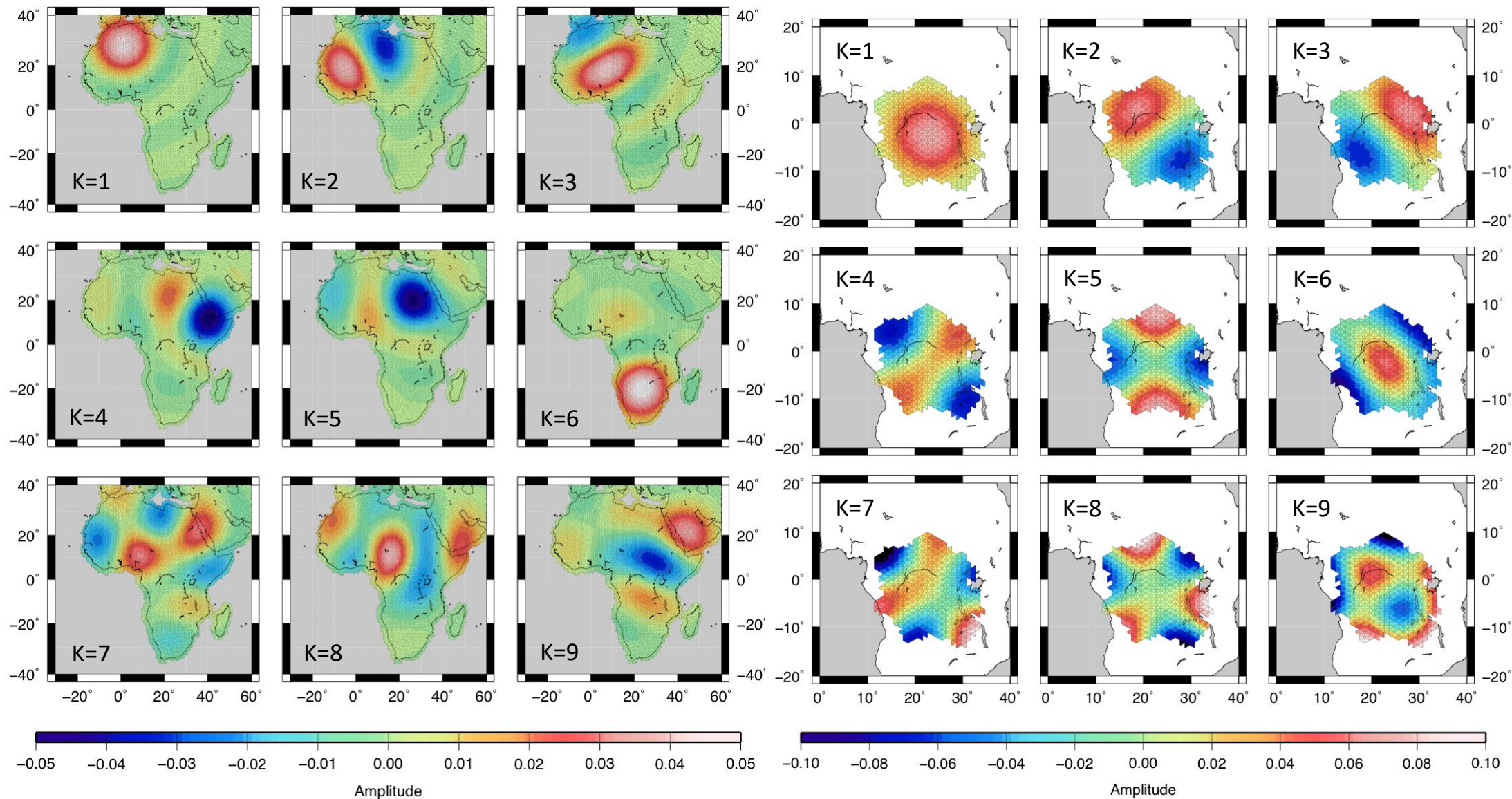   **Loss of signal energy !**

> We propose a representation method that maximize the information inside a domain
>
> by construction of a finite set of regional orthogonal functions known as *Slepian* functions (Simons 2009)
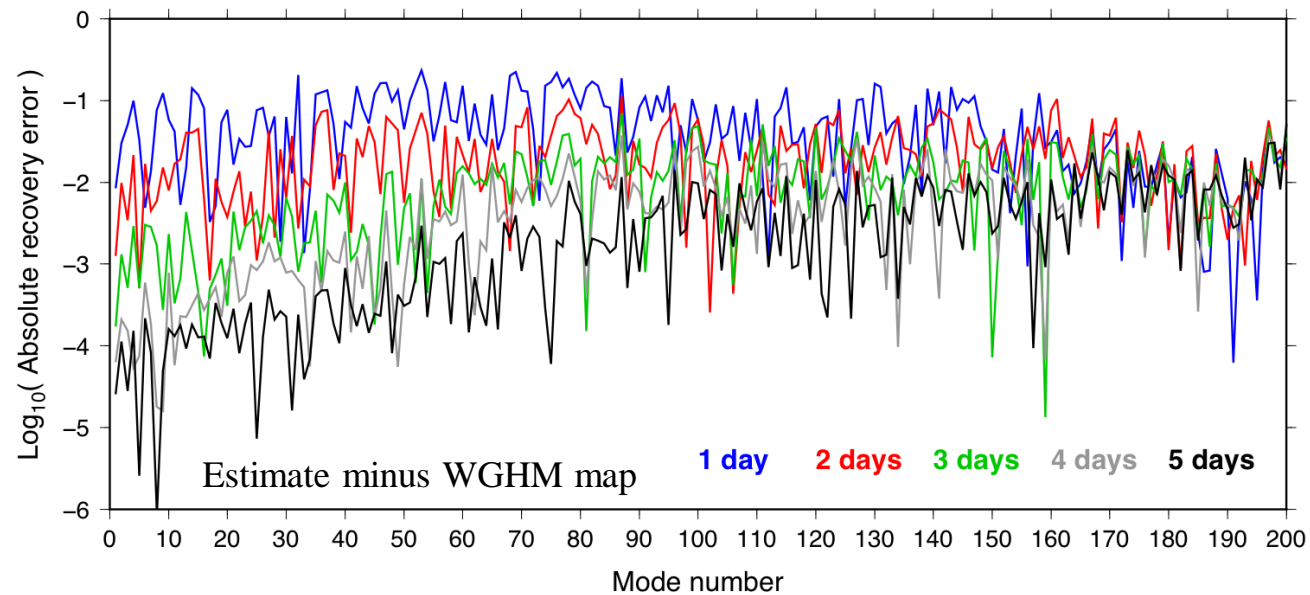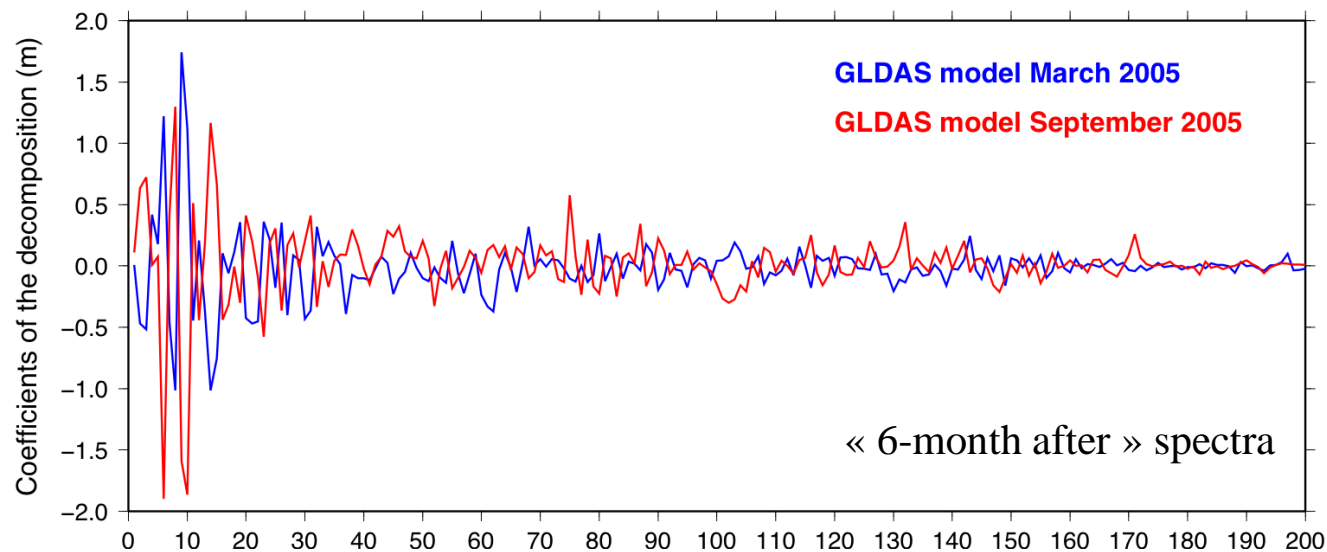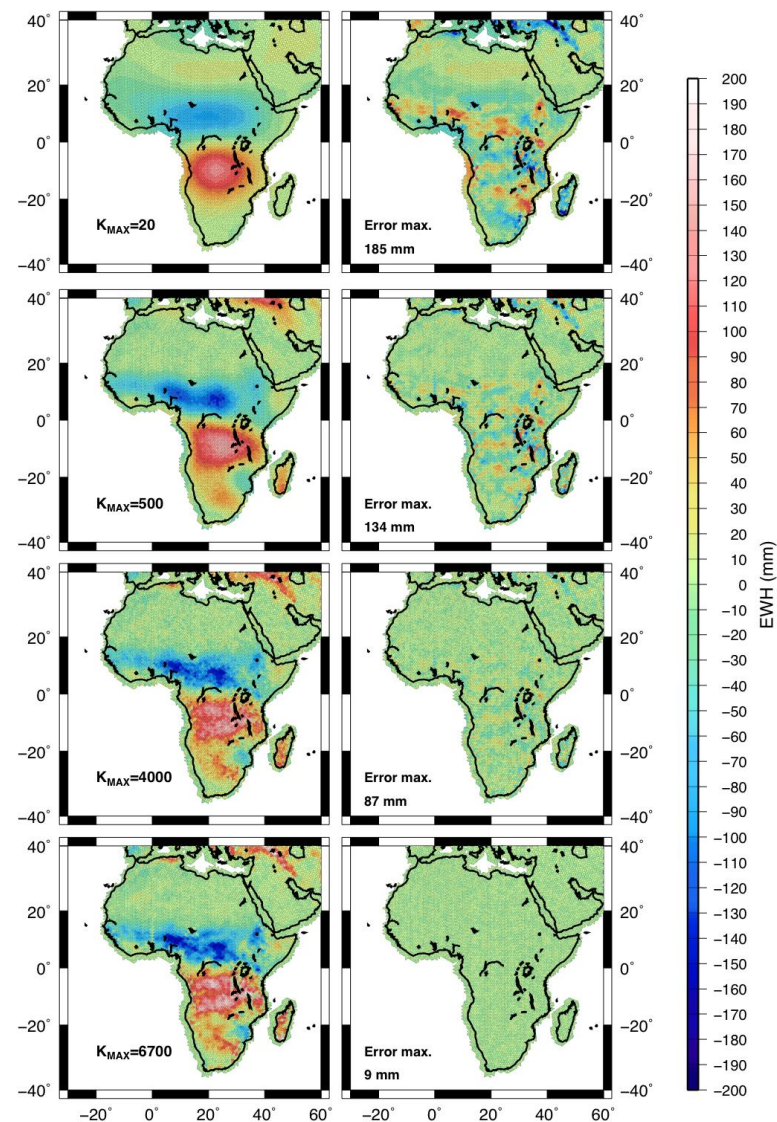
(*) modified from Freeden & Schreiner 2008

Examples of regional *Slepian* functions : cases of Africa & Congo basin

Recovery of WaterGap Global Hydrology Model (WGHM) maps by Kalman Filtering estimation

$$s(\theta, \lambda) = \sum_{K=1}^{K\_max} slepian(\theta, \lambda)^{(k)} a^{(k)}$$

$K_{MAX}=20$
Error max. 185 mm

$K_{MAX}=500$
Error max. 134 mm

$K_{MAX}=4000$
Error max. 87 mm

$K_{MAX}=6700$
Error max. 9 mm

EWH (mm)

GLDAS model March 2005
GLDAS model September 2005

« 6-month after » spectra

Coefficients of the decomposition (m)

$\mathrm{Log}_{10}($ Absolute recovery error $)$

Estimate minus WGHM map

1 day **2 days** **3 days** **4 days** **5 days**

Mode number

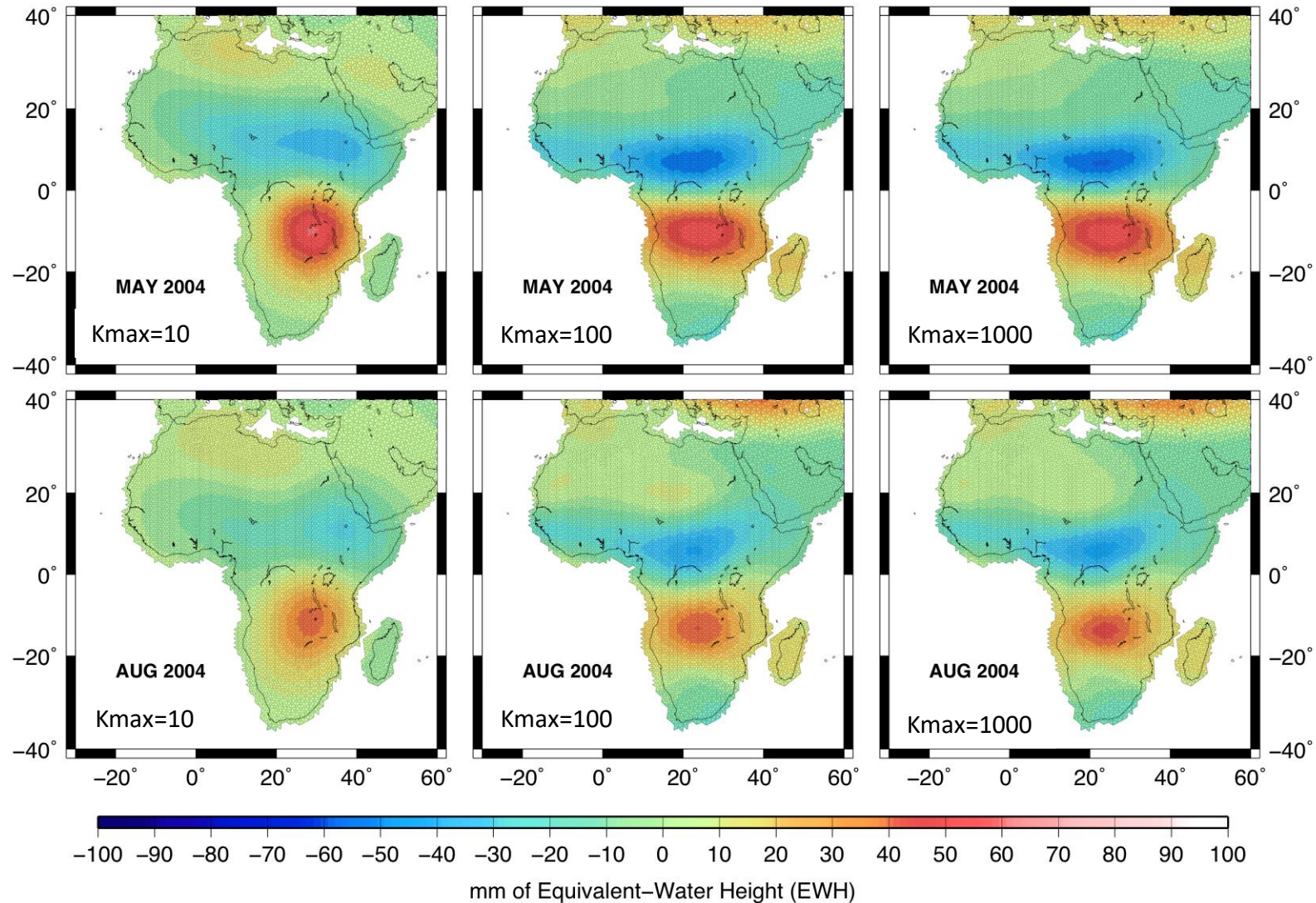**Inversion of <u>real GRACE data</u> – First resutlts (1/2)**

Recovery of the first modes from GRACE-based geopotential differences

First modes versus time by KF estimation
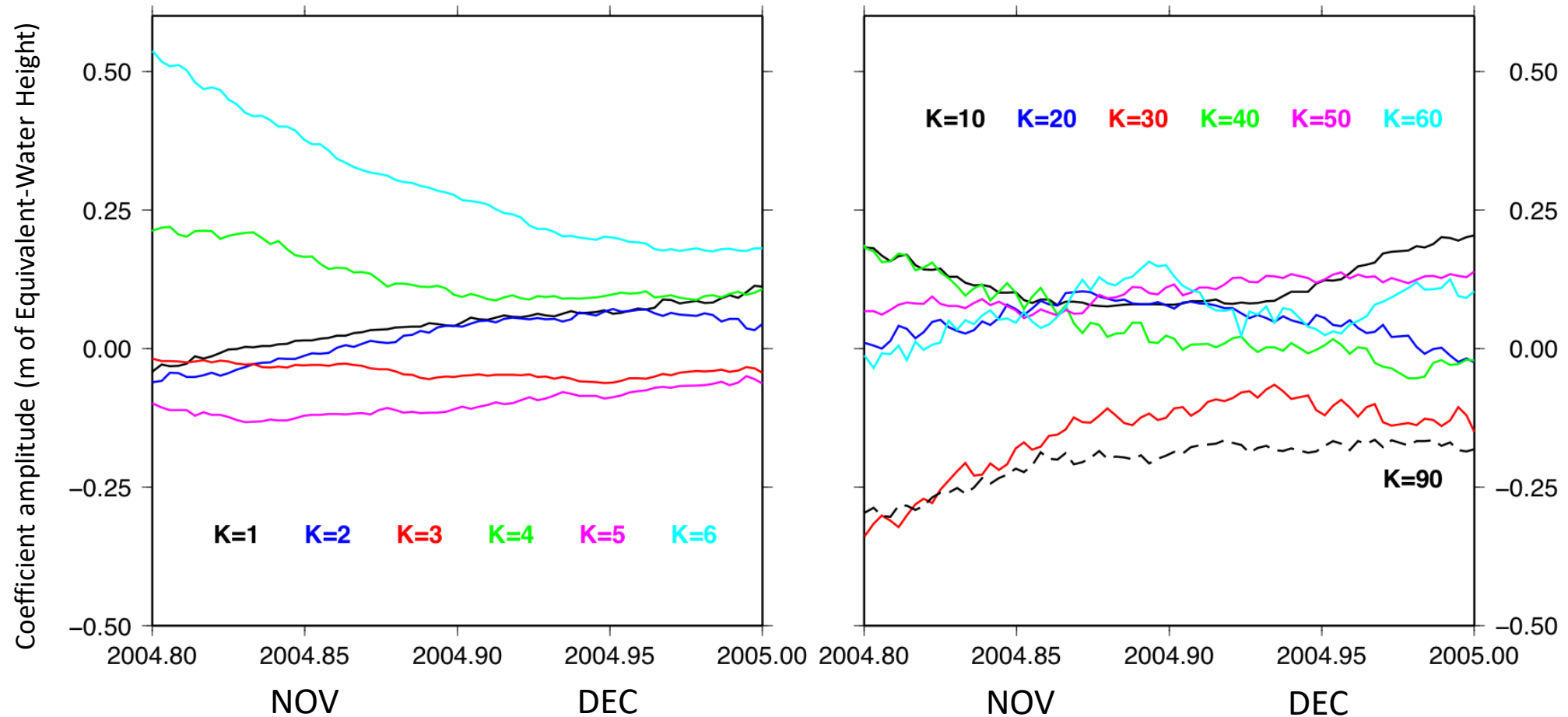
Inversion of **real GRACE data** – First resutlts (2/2)

Recovery of the first modes from GRACE-based geopotential differences

Highlights

A promising approach based on orthogonal *Slepian* functions has been successfully developed to

   invert GRACE satellite geopotential difference data and map continental water storage changes.

It is possible to follow the evolution of the GRACE *Slepian* coefficients adjusted by Kalman Filtering (KF).

Perspectives

Numerical optimization of the computation of *Slepian* coefficients of higher orders ($K \sim 7000$)

   would permit to reach better spatial resolutions in continental hydrology.

Multi-year series of coefficients estimated from real GRACE (-FO) data would enable

   spatio-temporal analysis and characterization of water mass processes.