Global Coupled Energy and Water cycle 2001-2011 from satellite data

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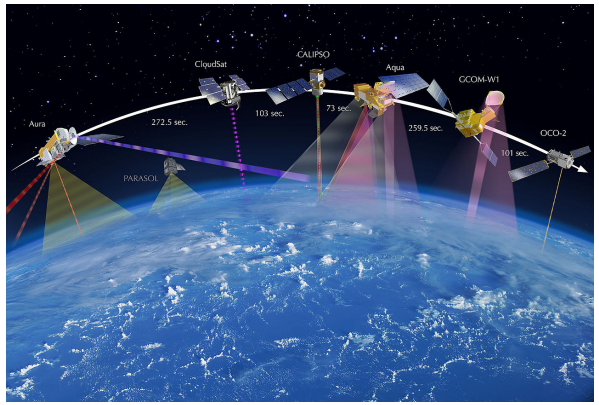
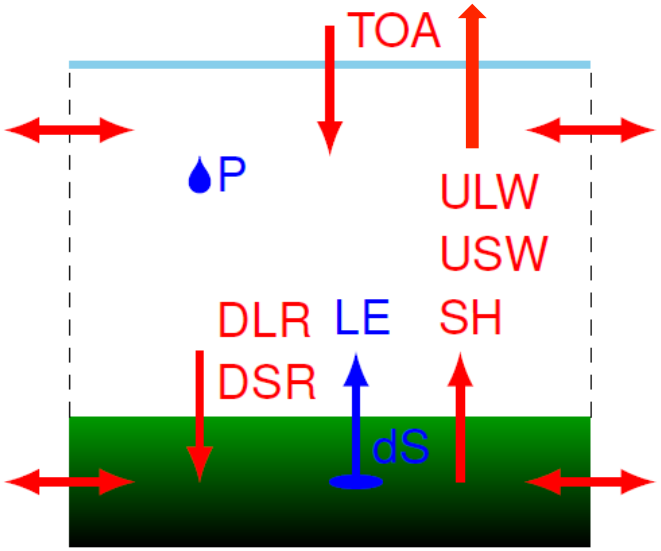
Regional Energy + Water Inverse model

Satellite-based Monthly Global Energy and Water flux Products





Based on NASA NEWS2015 Analysis
L'Ecuyer et al (2015), Rodell et al (2015) J. Climate

$$J(\mathbf{F}) = \frac{1}{2}[\mathbf{F}-\mathbf{F}_{\text{obs}}]^{\text{T}}\mathbf{R}_{\text{obs}}^{-1}[\mathbf{F}-\mathbf{F}_{\text{obs}}] + S(\mathbf{F}) + H(\mathbf{F})$$

$$\mathrm{DLR}_r + \mathrm{DSR}_r - \mathrm{ULW}_r - \mathrm{USW}_r - \mathrm{SH}_r - \mathrm{LE}_r + \mathrm{SEC}_r = b_r \pm \sigma_r \,\forall r,$$

$$P_r - \mathrm{LE}_r + \mathrm{SWC}_r = dS_r \,\forall r.$$

Thomas et al 2019 J. Climate

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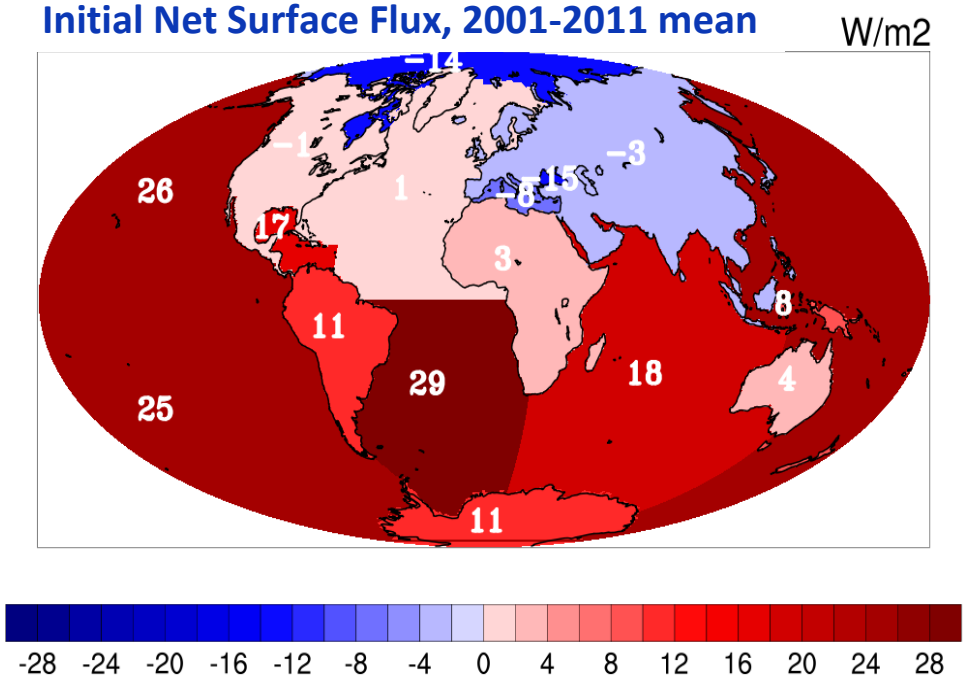
Energy/Water Data Sets

Monthly Input Data (2001-2011)

- CERES Radiation, TOA and Surface (v4.0/4.1)
- Precipitation GPCP2.3
- JOFUROv3 Ocean Turb. Fluxes (Tomita et al. 2019)
- FLUXCOM Land Turb. Fluxes (Jung et al. 2019)
  Runoff GRUNv1 (Ghiggi et al 2019)
- GRACE Land Surface water storage (MASCONv02)
- Atmos. water storage ERA5

Uncertainties taken from NEWS2015

Initial Net Surface Flux, 2001-2011 mean



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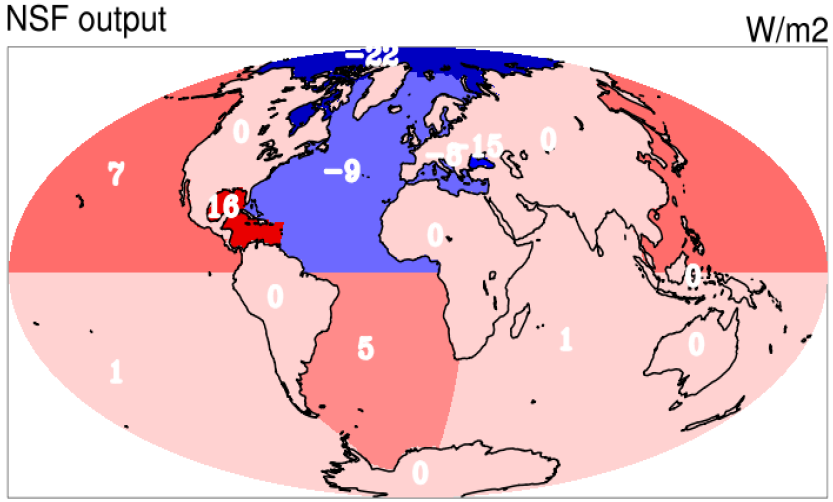
Two step Interannual solution method

1. Time mean solution :
   - Fully coupled global and regional energy and water budgets
   - Inter-continental/basin spatial error covariance
   - Final Uncertainties all self-consistent



2. Interannual solution
   - Monthly energy and water budget constraints:
   - GRACE Water storage; DEEPC net surface energy flux (Liu et al 2015)
   - Time mean solutions constrained to step 1

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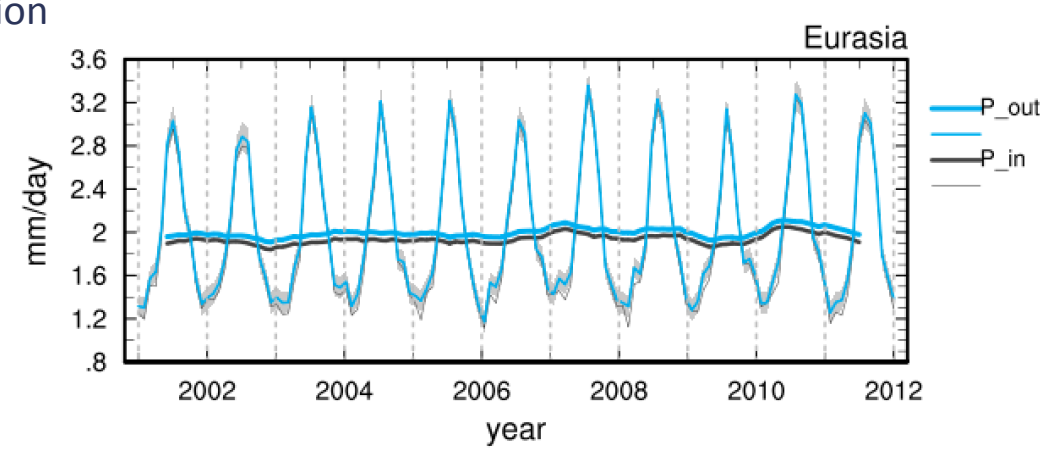
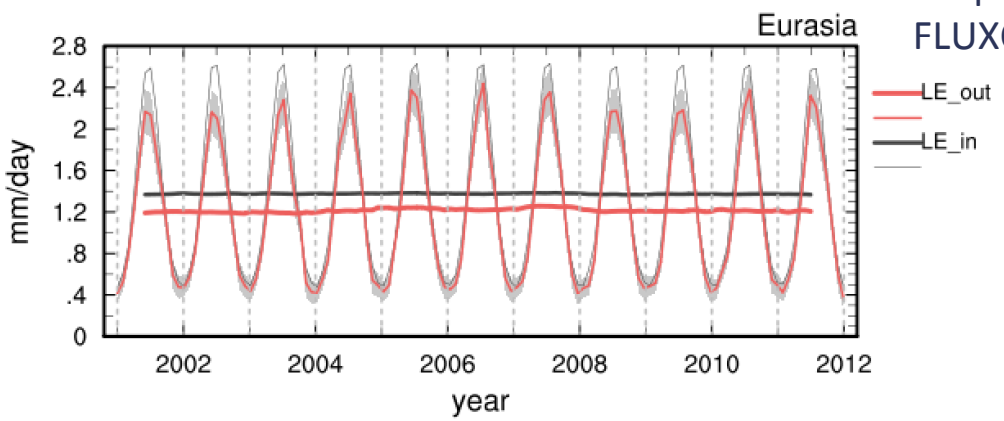
Eurasia water cycle

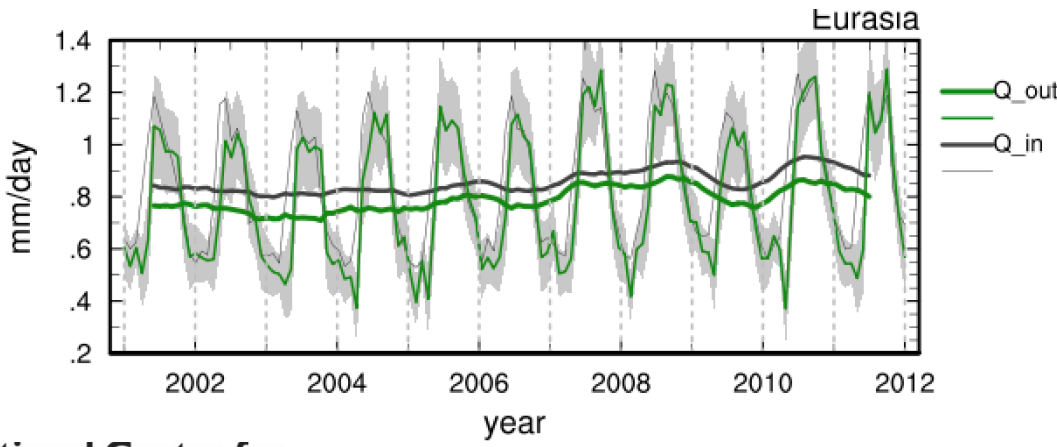
Precipitation
GPCP2.3



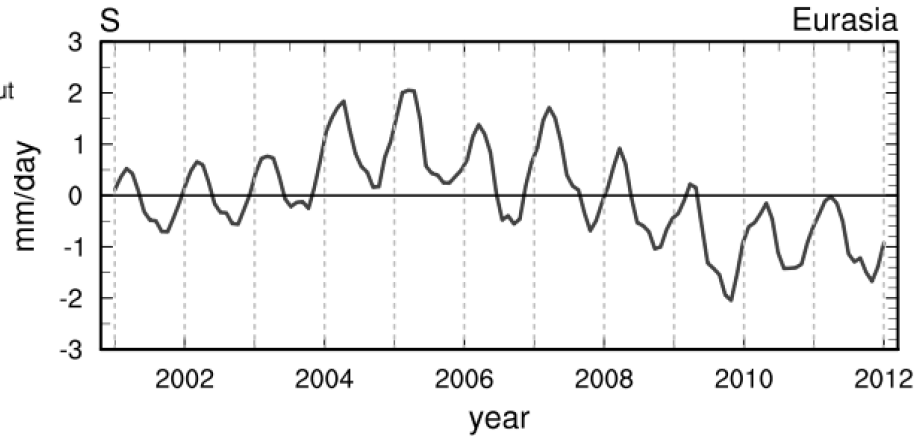
Evapotranspiration
FLUXCOM



Runoff
GRUNv1



Water Storage
GRACE



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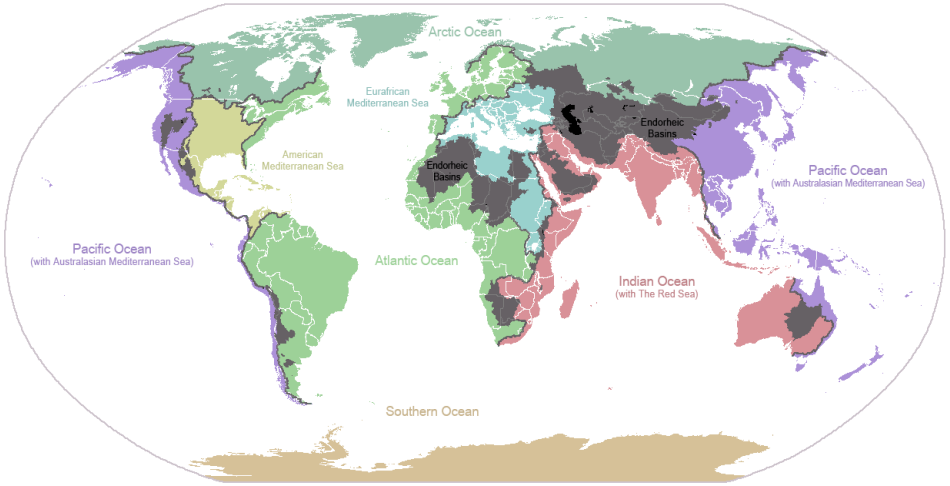
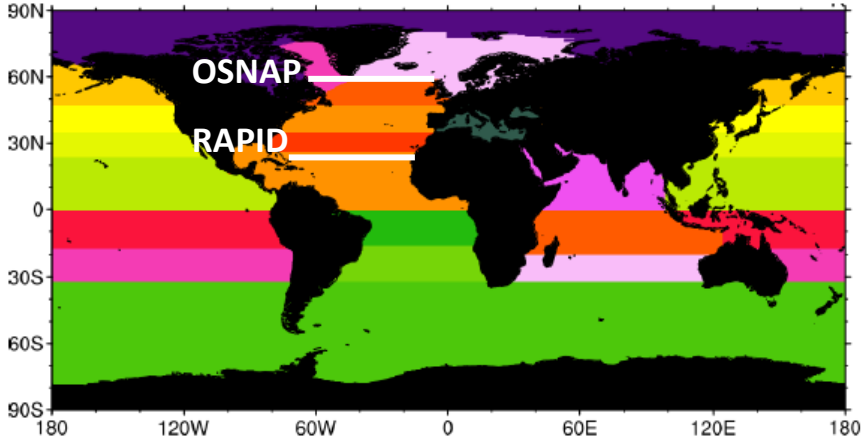
Future work

- New EO data sets: Land Surface T=> Monthly energy-water coupling, Other ESA-CCI datasets, …
- Extend time period (more recent data inc. 2016 ENSO)
- Increase spatial resolution
  - Large Hydrological catchments over Land
  - Ocean Hydrographic section constraints





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