Inundation prediction in tropical wetlands

Hydro-JULES

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- Wetlands play a key role in hydrological and biogeochemical cycles and provide enormous value to human society in the form of multiple ecosystem services.

- Despite the importance of these inundated areas, reliable data on their extent remain surprisingly uncertain.

- We took a leading global data product on inundation extents (*GIEMS-2*, Prigent *et al*. 2020) and matched it against predictions from a leading global hydrodynamic model (*CaMa-Flood*, Yamazaki *et al*. 2011) driven by runoff data generated from the *JULES* land surface model (Best *et al*. 2011, Clark *et al*. 2011) using meteorological data from the *eartH2Observe* project (Marthews *et al*. 2020).

Globally, wetlands may be divided into groundwater-maintained wetlands, where the effects of groundwater dominate over other processes (e.g. fens), and fluvial inundation-maintained wetlands, where their existence depends primarily on their proximity to a water course that regularly overtops its banks (e.g. igapó and várzea forests). Seasonally-varying levels of inundation are dependent on upstream precipitation and how this translates into these two forms of inflow, as well as on the ambient rates of evaporation and infiltration.

The Sudd wetland, South Sudan

The Pantanal, Brazil, Bolivia & Paraguay

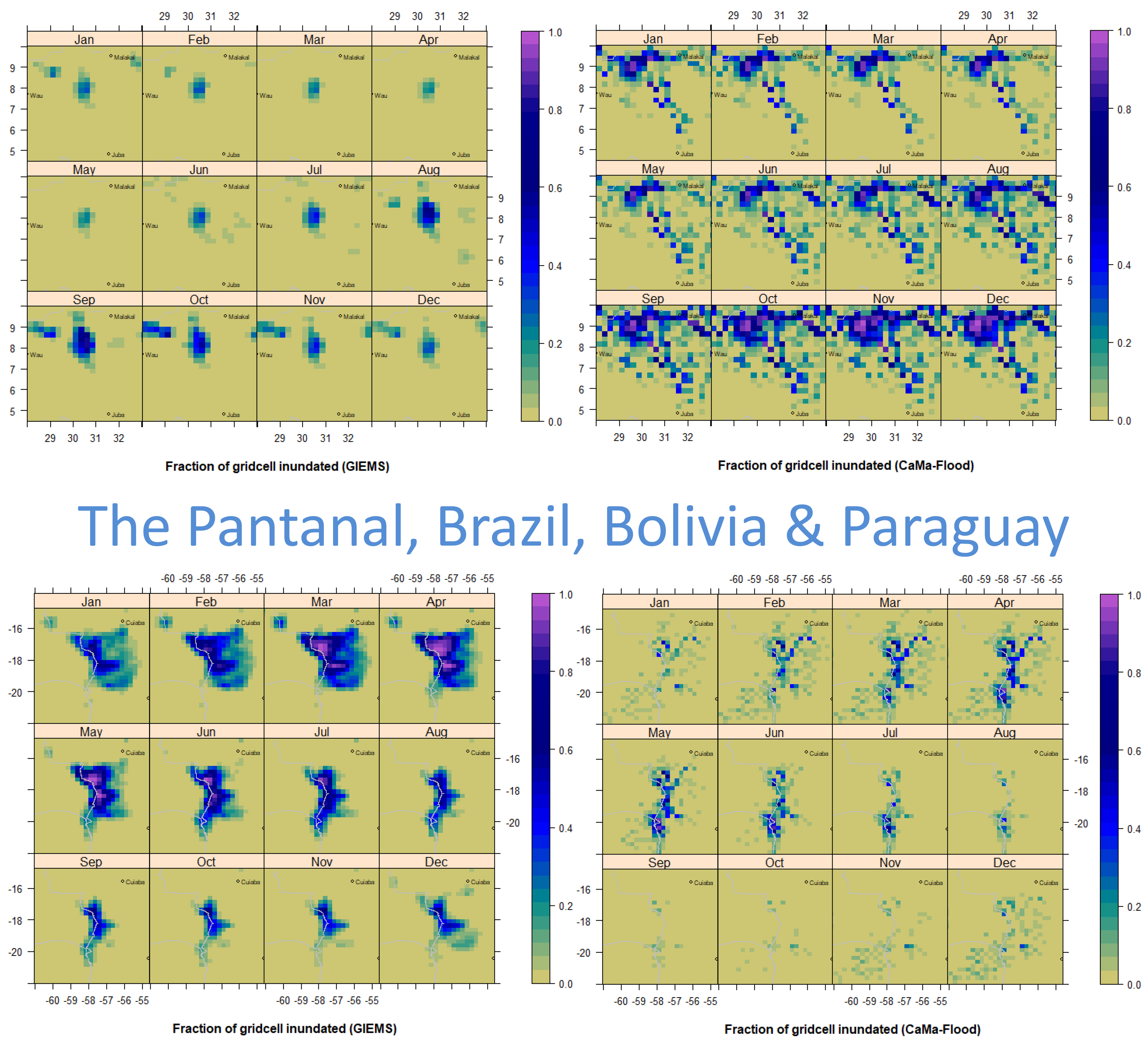

Fig. 1: Fraction of gridcell inundated (in addition to water contained in channels and watercourses, which are not shown) in the Sudd (upper) and Pantanal (lower) wetlands. Resolution is 0.25° in both latitude and longitude. Data shown are an average for 1992-2014 from *GIEMS* observations (left) and equivalent *JULES-CaMa-Flood* simulations (right).

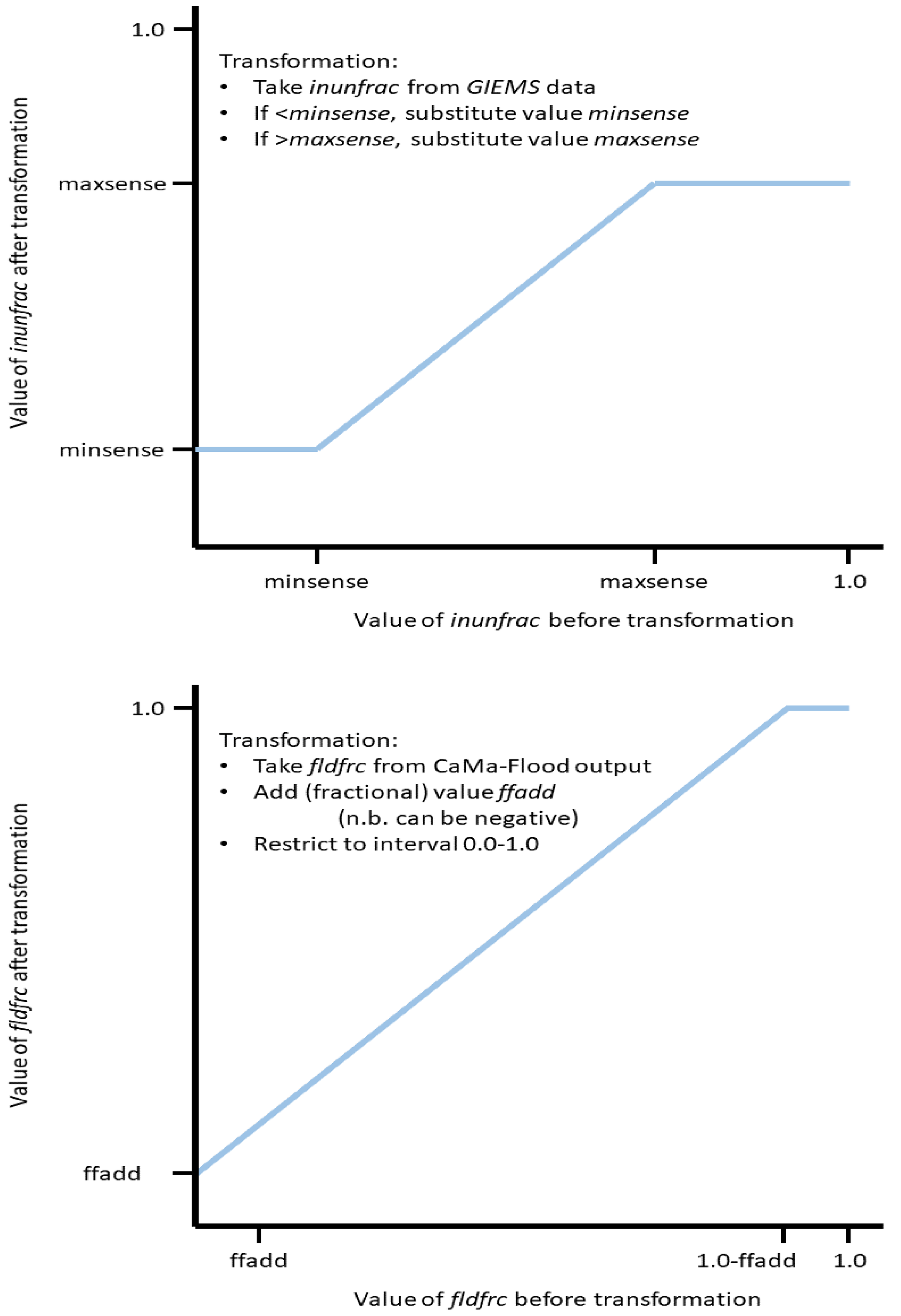

Fig. 2: Transforming the *GIEMS* inundated fraction (*inunfrac*) data (left) and *CaMa-Flood* output flooded fraction (*fldfrc*) variable (right). Note that values *minsense* = *ffadd* =0.0 and *maxsense* =1.0 are equivalent to no modification..

In the Sudd wetland, our model appears to over-predict inundation (Fig. 1, upper). Conversely, in the Pantanal it appears to under-predict (Fig. 1, lower). Can we explain this difference? Is the observed data always correct? We applied simple transformations to our data in order to elucidate the causes of these over- and under-estimations (Fig. 2), and the optimal values we found for each wetland of the three parameters *minsense* (a minimum level of inundation fraction below which *GIEMS* always returns zero), *maxsense* (a maximum inundated fraction above which *GIEMS* loses its sensitivity) and *ffadd* (a fraction added to all *CaMa-Flood* outputs to test for bias) provide a possible explanation for observable differences.

Wetlands exist as a balance between water input and water output (Fig. 3). The optimal parameter value derived in this study *ffadd_opt* may be understood as an index unique to each wetland that estimates the amount that is missing / underestimated in the overall wetland water balance (Fig. 3). We conclude that for the Pantanal wetland the JULES-CaMa-Flood predictions underestimate river and groundwater inflow (and perhaps also underestimate infiltration and evaporation), whereas in the Sudd the *JULES-CaMa-Flood* predictions underestimate infiltration and evaporation (and perhaps also overestimate river and groundwater inflow).

Identifying these discrepancies and their causes is important because it allows us to improve our modelling predictive capability and therefore the reliability of the model to predict the hydrology of global wetlands reliably in the future.

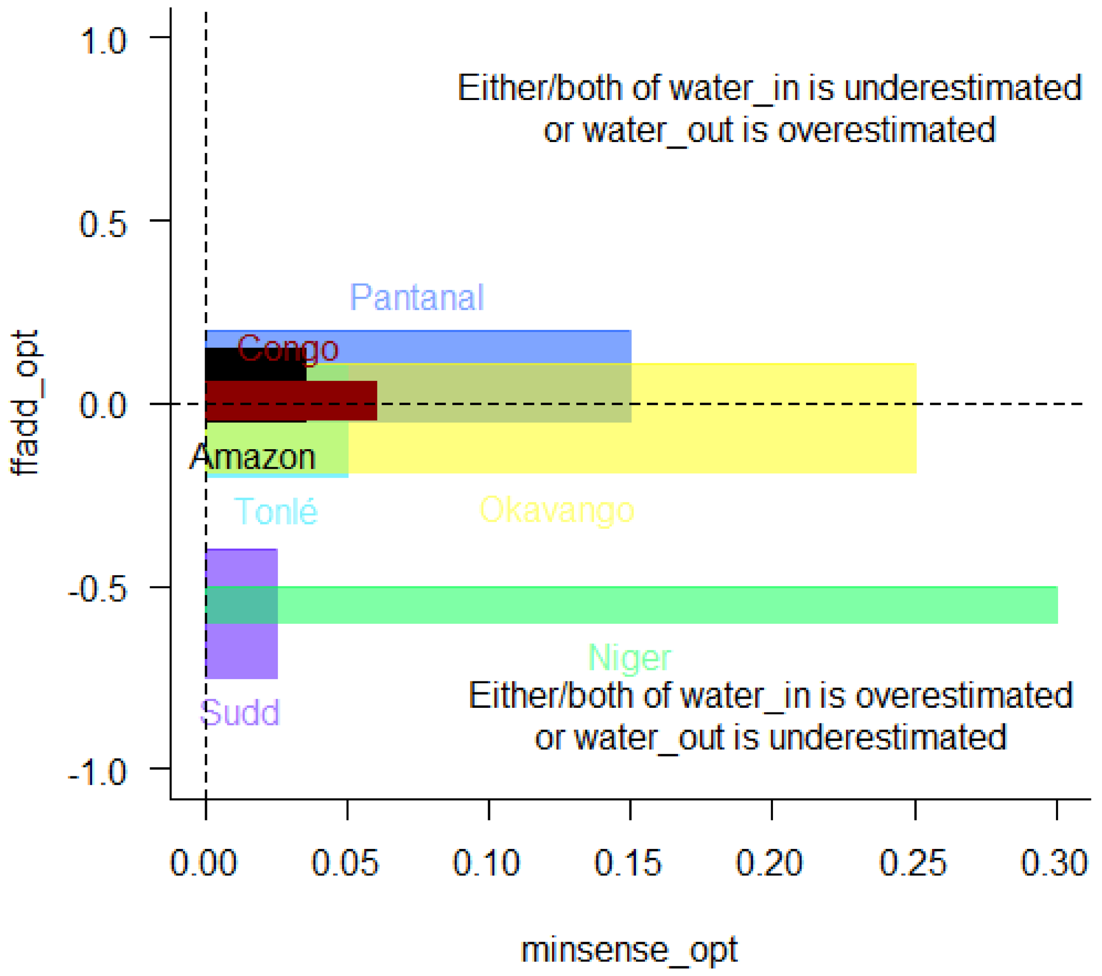

Fig. 3: Values of *ffadd_opt* and *minsense_opt* (i.e. optimal in the sense of a best fit between observations and model predictions). We define *water_in* = (channel + surface + subsurface inflow) and *water_out* = (infiltration + evaporation).

Best *et al.* (2011) *GMD* 4; Clark *et al.* (2011) *GMD* 4; Marthews *et al.* (2020) *HESS* 24; Prigent *et al.* (2020) *JGR Atmos* 125; Yamazaki *et al.* (2011) *WRR* 47.

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