

Supplementary information for

Aquifer conditions, not irradiance determine the potential of photovoltaic energy for groundwater pumping across Africa

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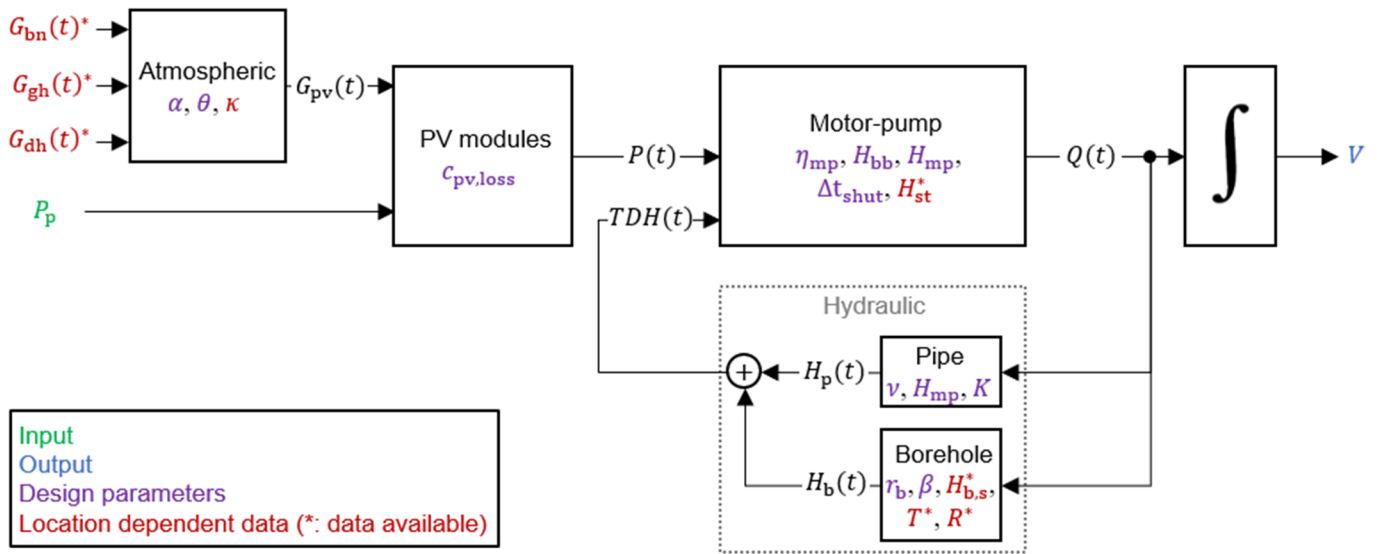
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Supplementary Figure 1 – Block diagram of the model

α : azimuth of the photovoltaic (PV) modules, β : borehole losses coefficient, $c_{pv,loss}$: PV modules loss coefficient,

Δt_{shut} : minimum shutdown time of the motor-pump before attempting to restart, η_{mp} : motor-pump efficiency,

G_{bn} : beam normal irradiance, G_{gh} : global horizontal irradiance, G_{dh} : diffuse horizontal irradiance,

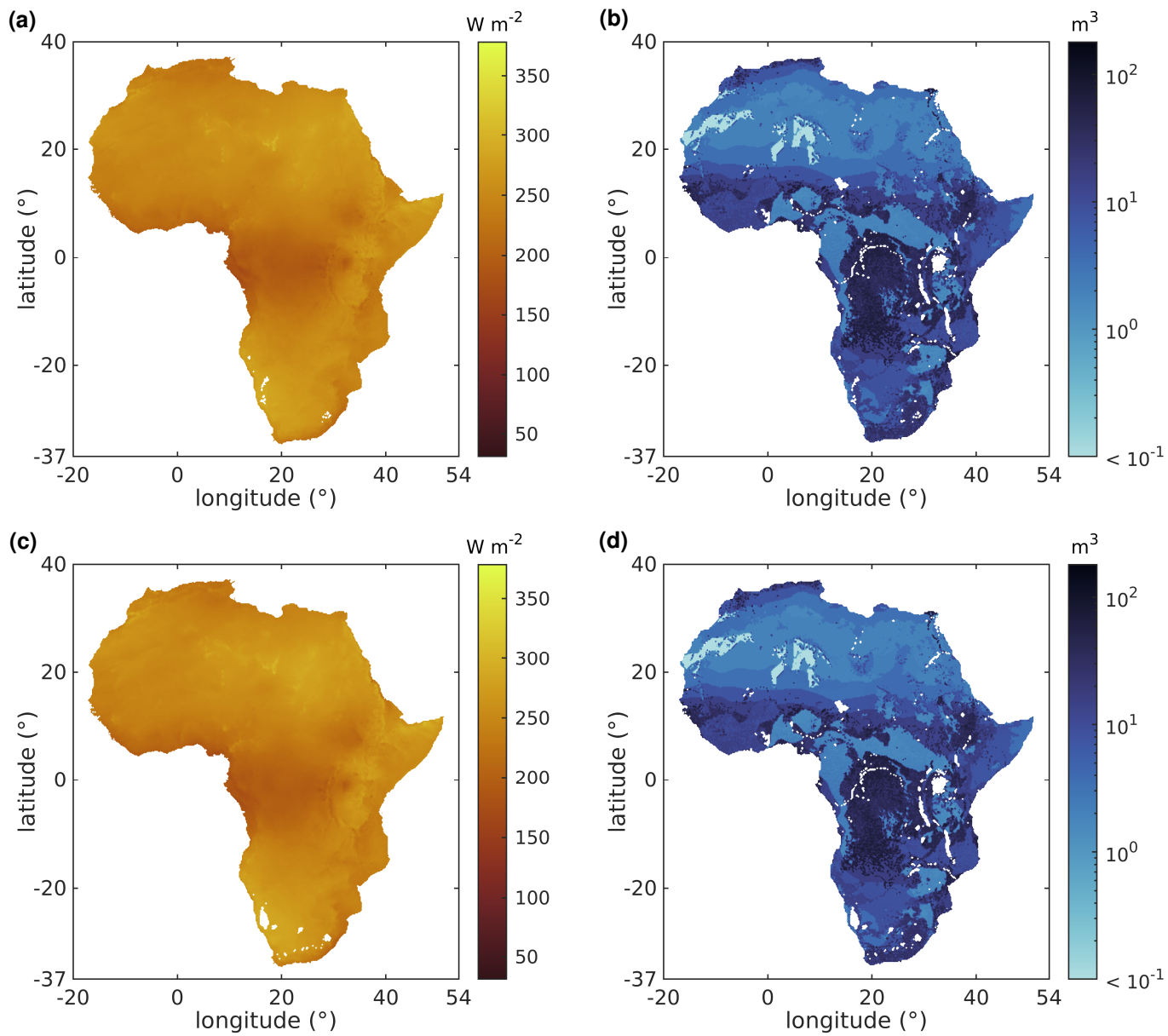
G_{pv} : irradiance on the plane of the PV modules, $H_{b,s}$: static water depth, H_{st} : aquifer saturated thickness, H_b : water depth in the borehole,

H_p : head due to pipe losses, H_{bb} : borehole depth, H_{mp} : motor-pump depth, K : junction losses coefficient,

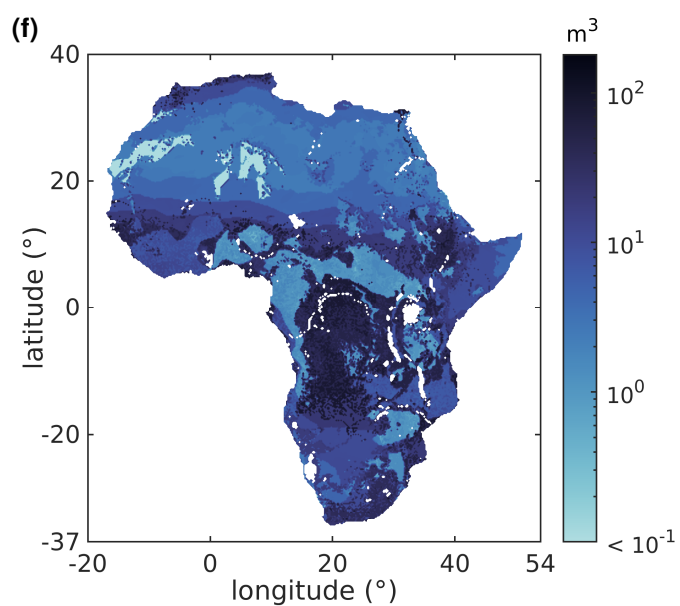
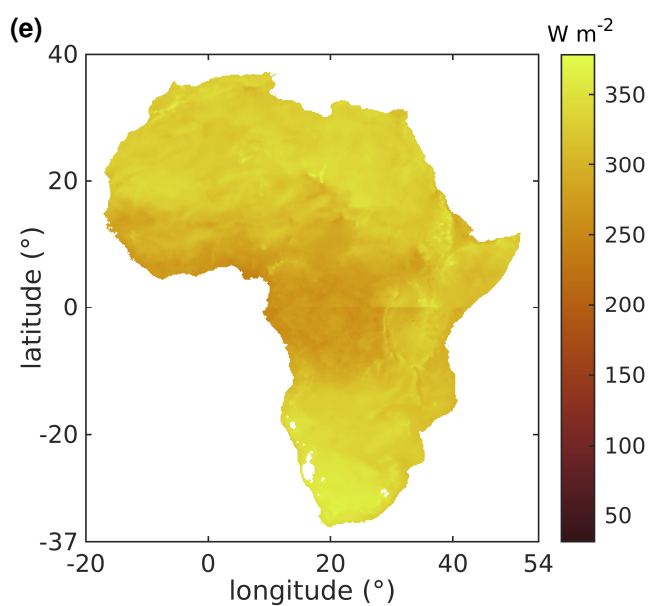
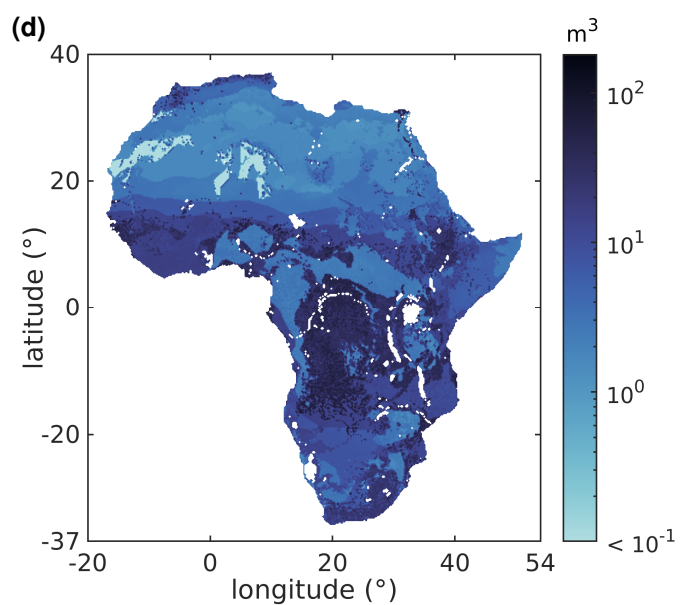
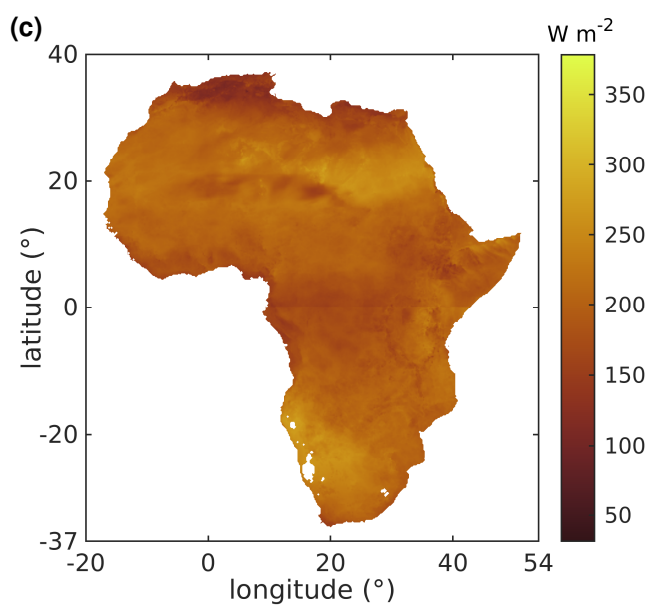
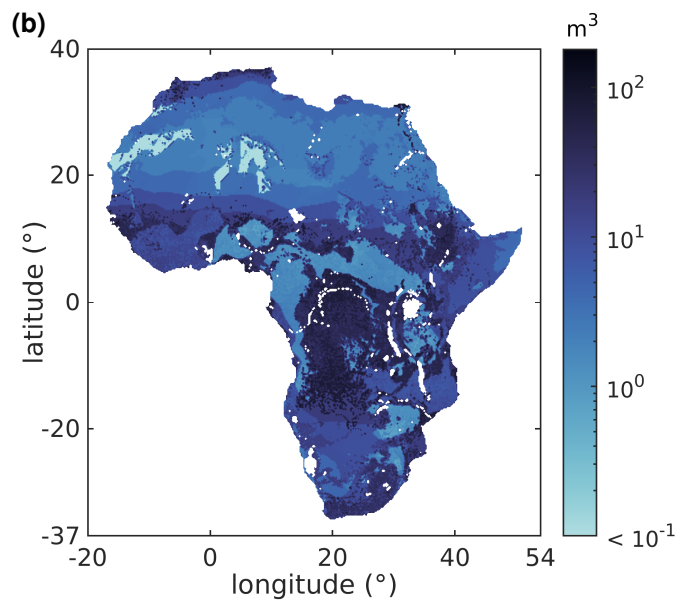
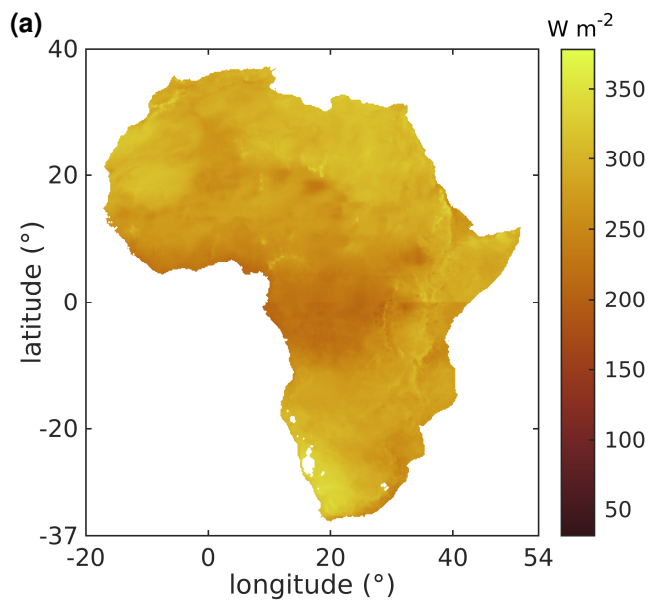
κ : albedo of the surrounding environment, ν : linear pipe losses coefficient, P : power produced by the PV modules,

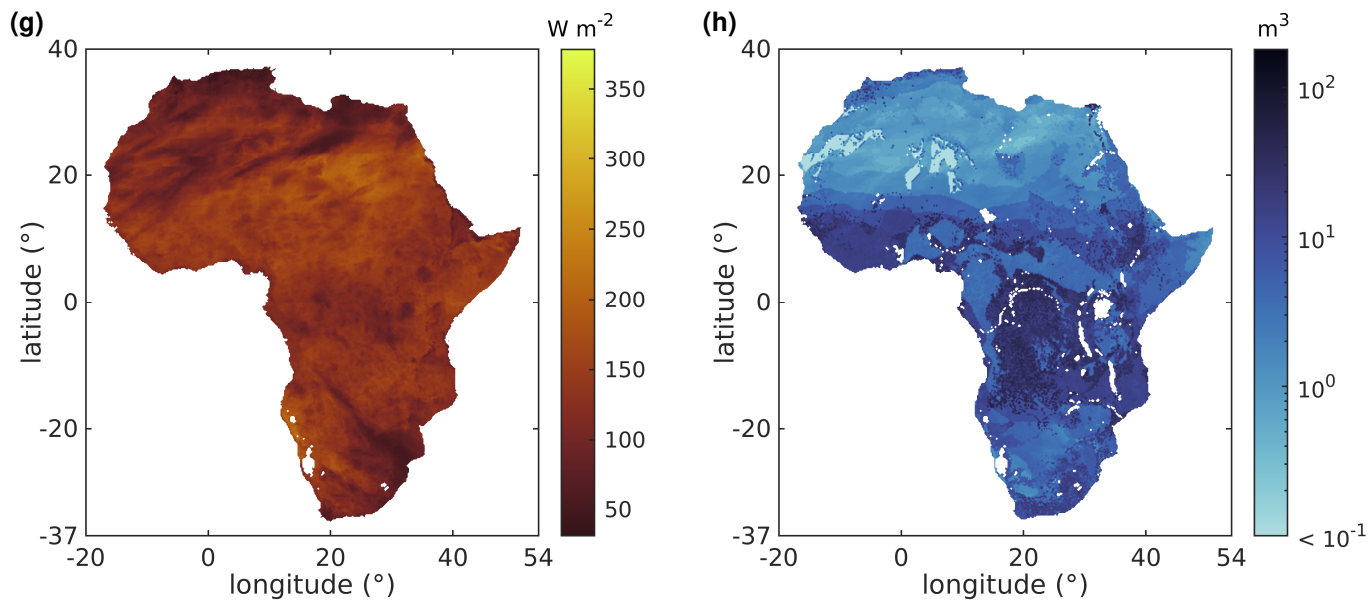
P_p : peak power of the PV modules, Q : pumped flow rate, R : groundwater recharge, r_b : borehole radius, T : aquifer transmissivity,

TDH : total dynamic head, θ : tilt of the PV modules, V : average daily pumped volume



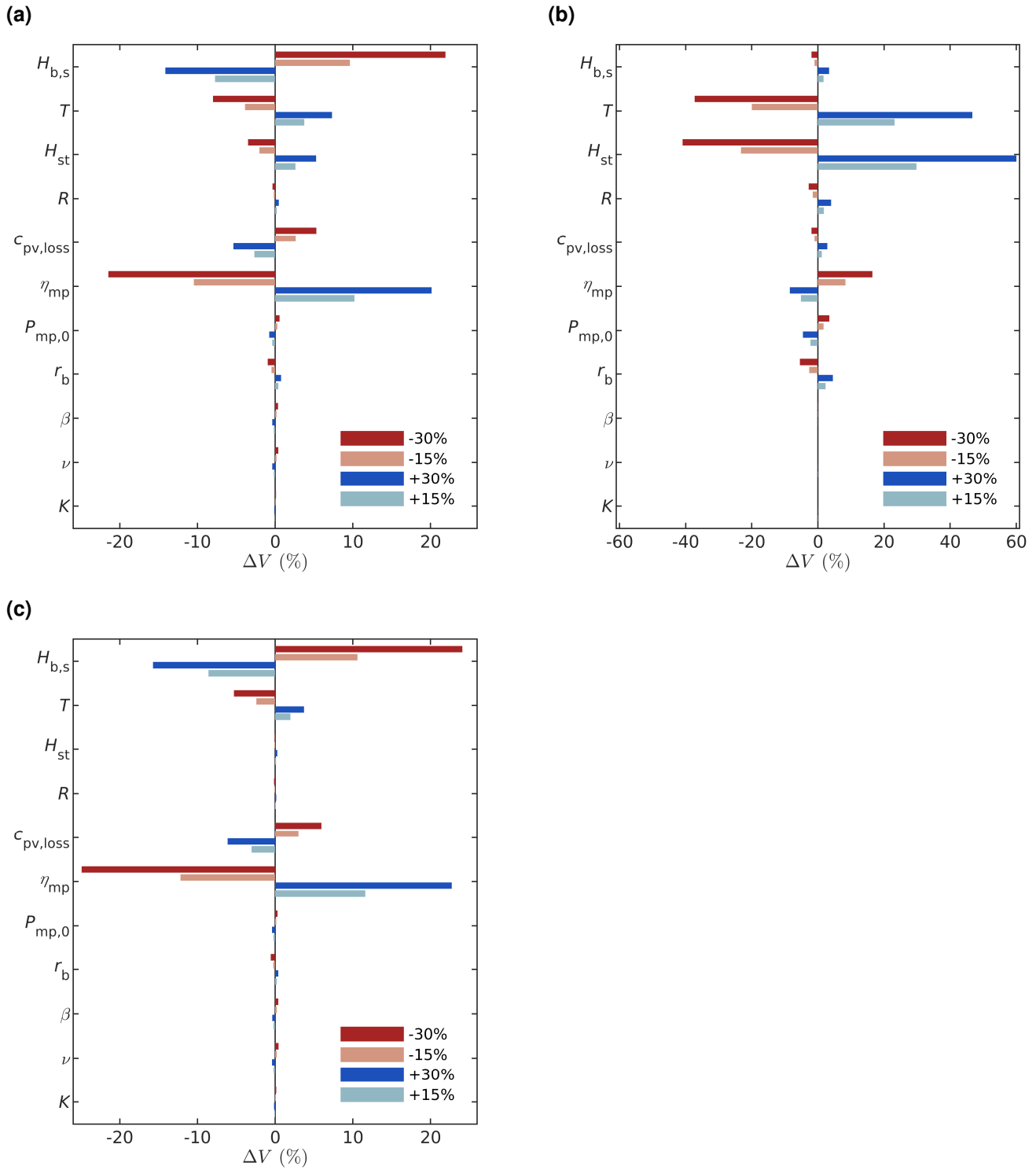
Supplementary Figure 2 – Irradiance G_{pV} on optimally tilted PV modules (average over the year) for (a) 2014 and (c) 2017. Average daily pumped volume V for a PVWPS of size $P_p = 1000 W_p$ for (b) 2014 and (d) 2017.





Supplementary Figure 3 - Irradiance G_{pv} on optimally tilted PV modules for (a) the most irradiated month and (c) the least irradiated month (average over the month). Average daily pumped volume V for a PVWPS of size $1000 W_p$ for (b) the most irradiated month and (d) the least irradiated month.

Irradiance G_{pv} on optimally tilted PV modules for (e) the most irradiated 3 days and (g) the least 3 days (average over the 3 days). Average daily pumped volume V for a PVWPS of size $1000 W_p$ for (f) the most irradiated 3 days and (h) the least irradiated 3 days. Results for 2020.



Supplementary Figure 4 - Influence of input groundwater data and design parameters on the pumped volume V .

(a) Average results for 100 random locations and PVWPS of 100 W_p, 1000 W_p and 3000 W_p for 2020.

In (b) we only considered the locations amongst the 100 where the largest system does not yield the highest pumped volume and in (c) only the locations where it does.