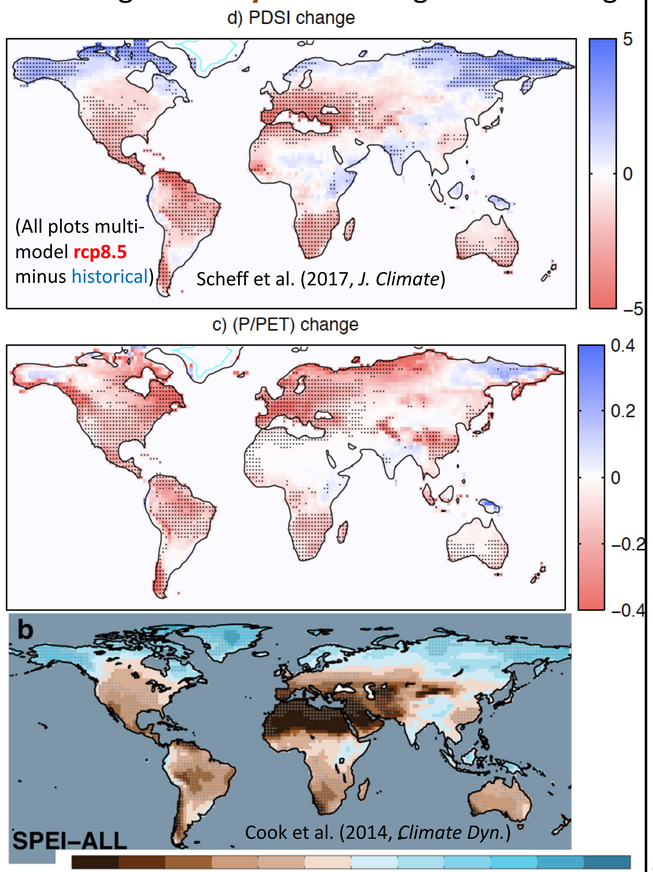
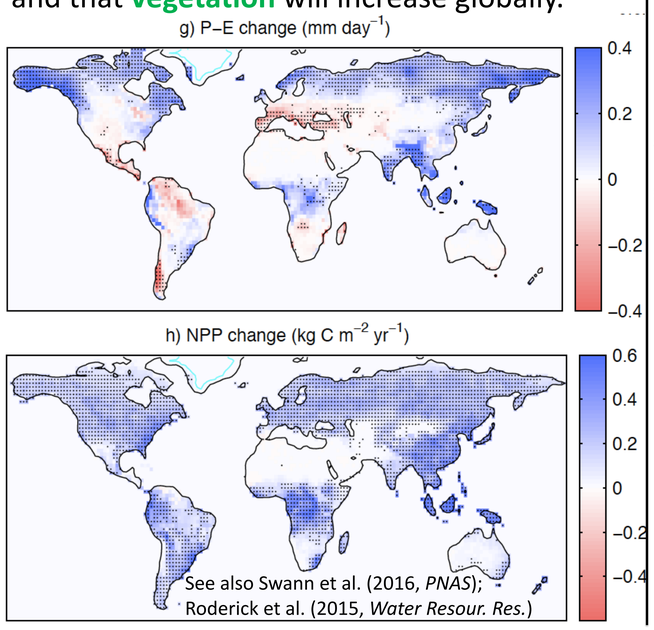
Drought *indices* overpredict the drought *impacts* of warming – in models and in reality

Jacob Scheff, Geography & Earth Sciences, University of North Carolina Charlotte (*Curr. Climate Change Rep.*, 2018)

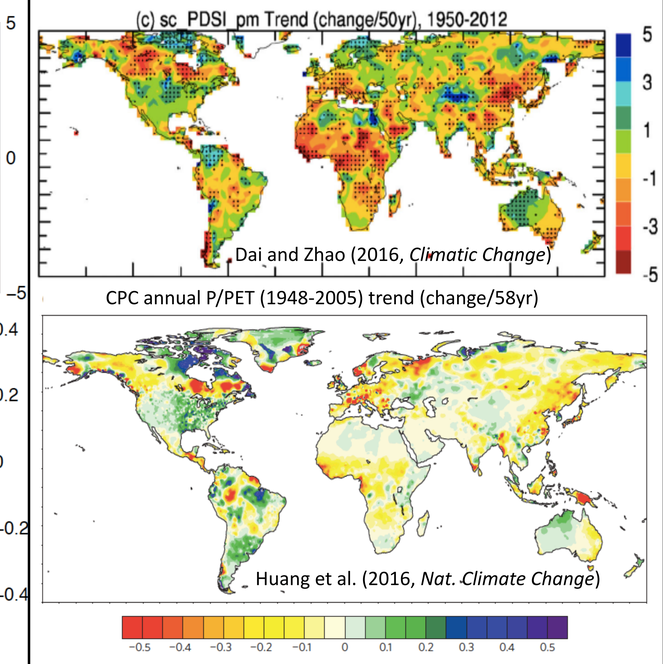
Earth System Models project that PDSI, SPEI, and Aridity Index (P/PET) will all trend strongly toward global **"dryness"** with global warming.



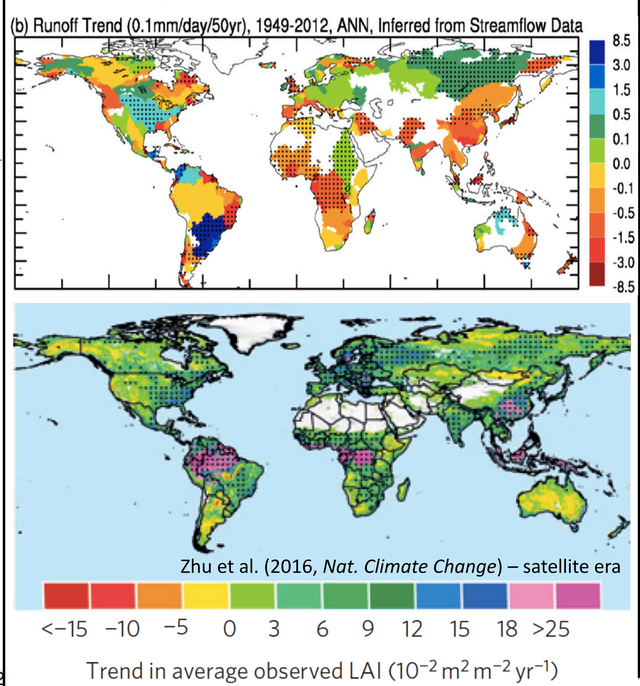
Yet the exact same models also project that **runoff** will variously increase and decrease – and that **vegetation** will increase globally.



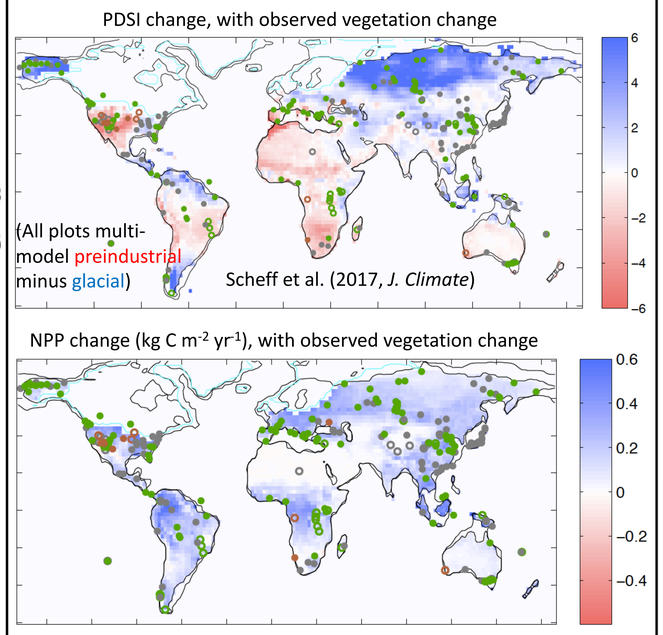
Is this **believable?** **Yes** – in fact it **already seems to be happening**: PDSI and P/PET are trending toward **"dryness"** globally…



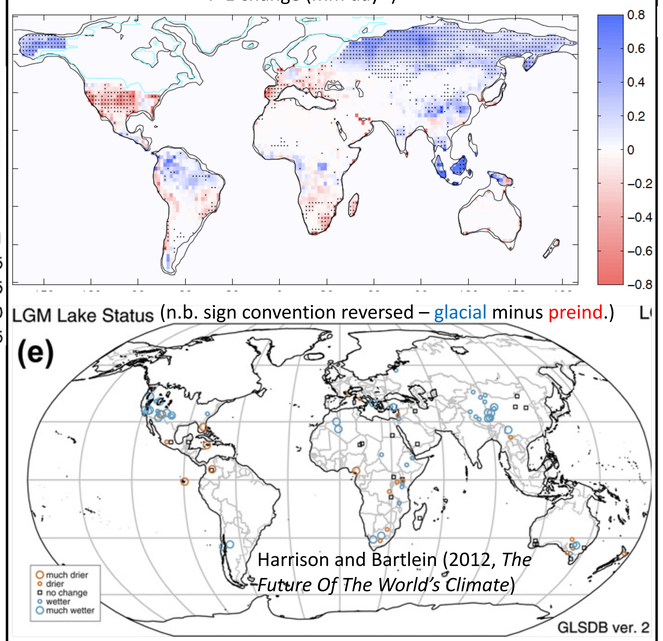
…while **runoff** is variously increasing and decreasing with no preferred polarity, and **vegetation** is increasing over many areas but decreasing almost nowhere.



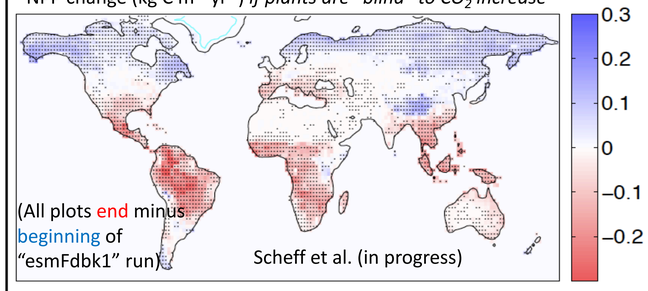
And it **happened** going out of the last glacial: Earth warmed with CO_2; **vegetation density** (dots - from pollen) followed model **NPP** (increasing) rather than **PDSI** (declining)…



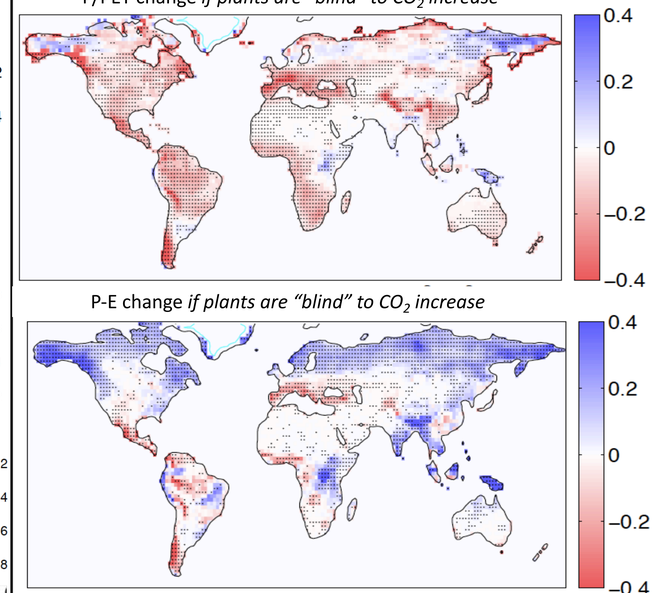
and **runoff** (from paleolake data) followed model P-E projections, validating them:



Why is this? Direct CO_2 effects on vegetation are often cited (e.g. Roderick et al. 2015 *WRR*, Swann et al. 2016 *PNAS*, Milly and Dunne 2016 *Nat. Climate Change*.) Indeed, CO_2 totally explains the **NPP/veg increase**:



But, CO_2 **fails** to explain why the dryness indices don't predict the **runoff** response.



So the mismatch between index-based drying and lack of actual runoff drying must be due to **something other than CO_2-plant effects**! Candidates include:

-increased VPD closing leaf stomata (Novick et al. 2016 *Nat. Climate Change*)
-increased precipitation intensity (e.g. Dai et al 2018 *Curr. Climate Change Rep.*) and/or seasonality (Chou et al. 2013 *Nat. Geosci.*)
-Penman PET formulation itself flawed (Milly and Dunne 2016 *Nat. Climate Change*)
… ???

So, CO_2 warming **does** indeed seem to be characterized by **index-based drying** with **greening vegetation** and **varied runoff response**. **Drought indices ≠ drought impacts.**