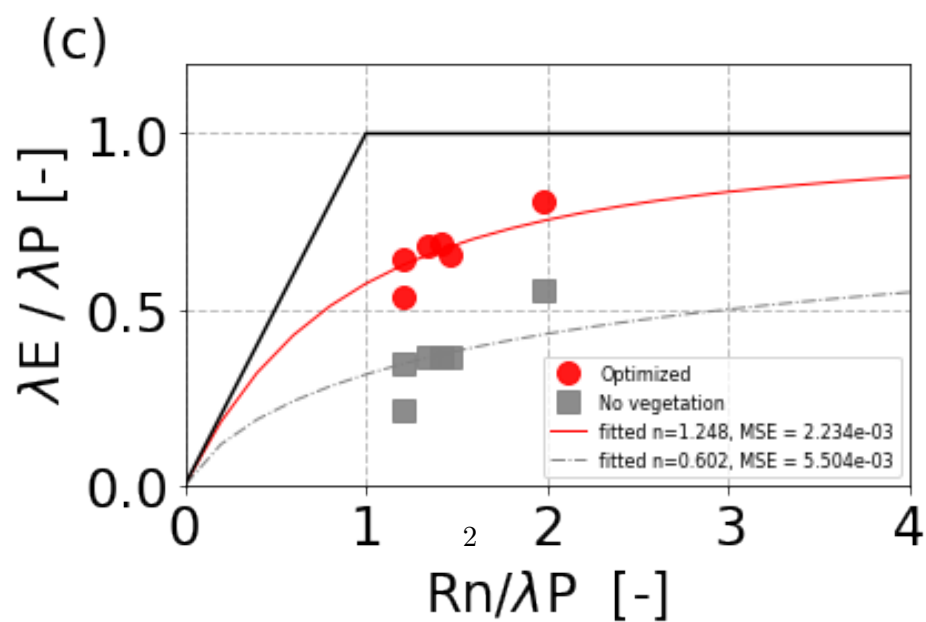
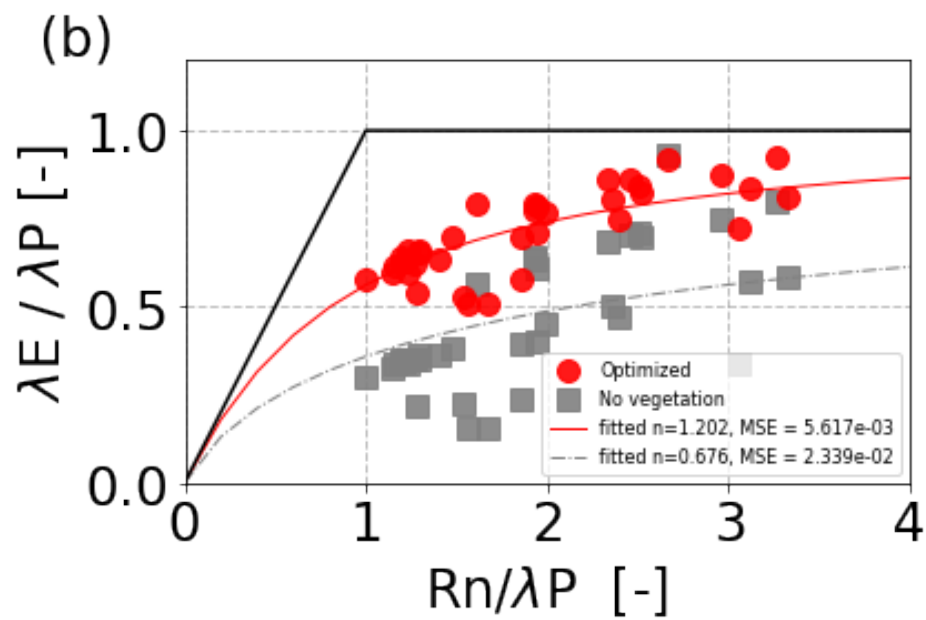
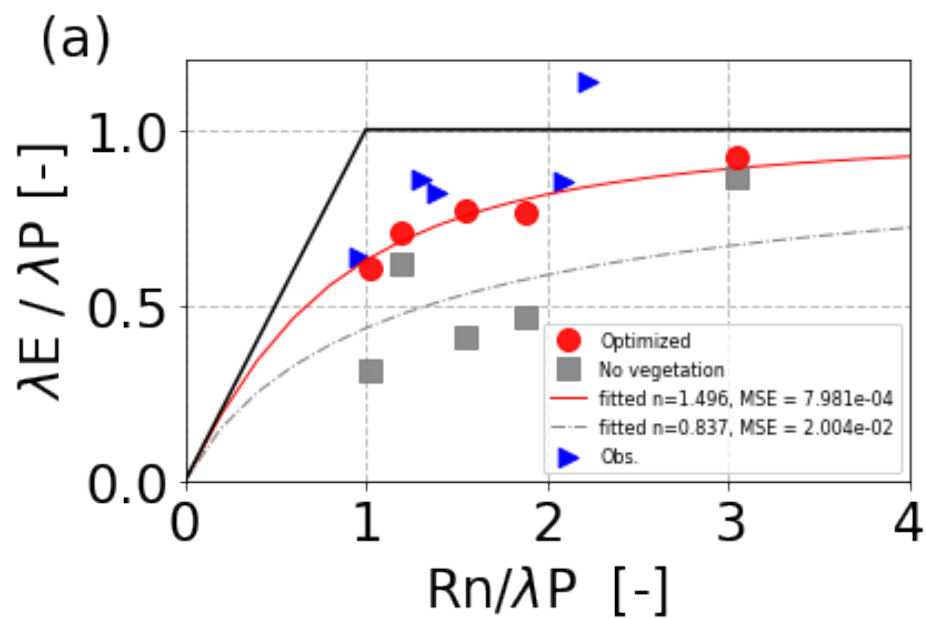


# Supplement S4

February 14, 2022

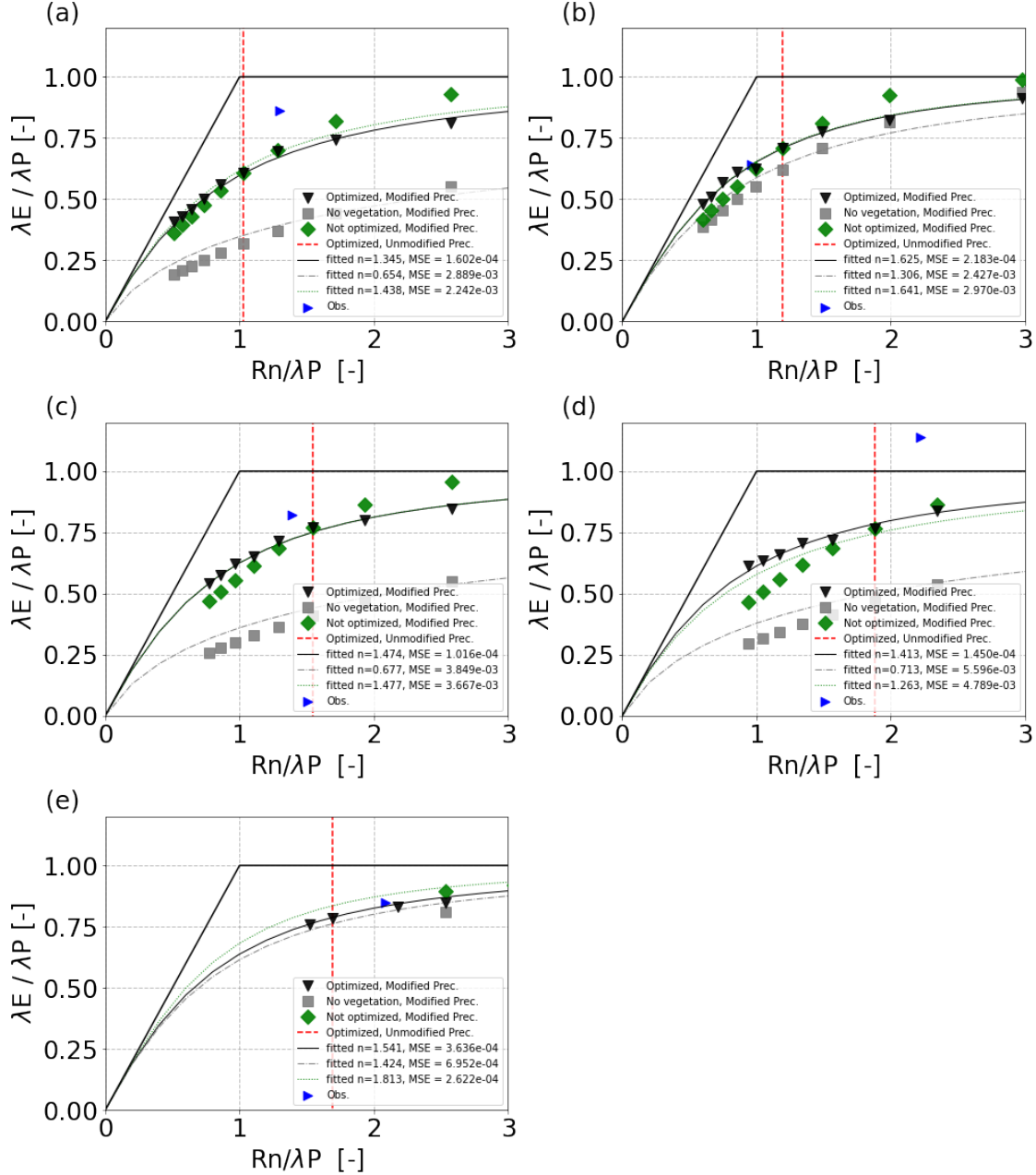
## **1 The Budyko framework based on a dryness index**

The Budyko-framework can be used and plotted by using a dryness index or wetness index as the independent variable. Here, we assess if the outcomes changes by using a wetness index as the independent variable in the framework.



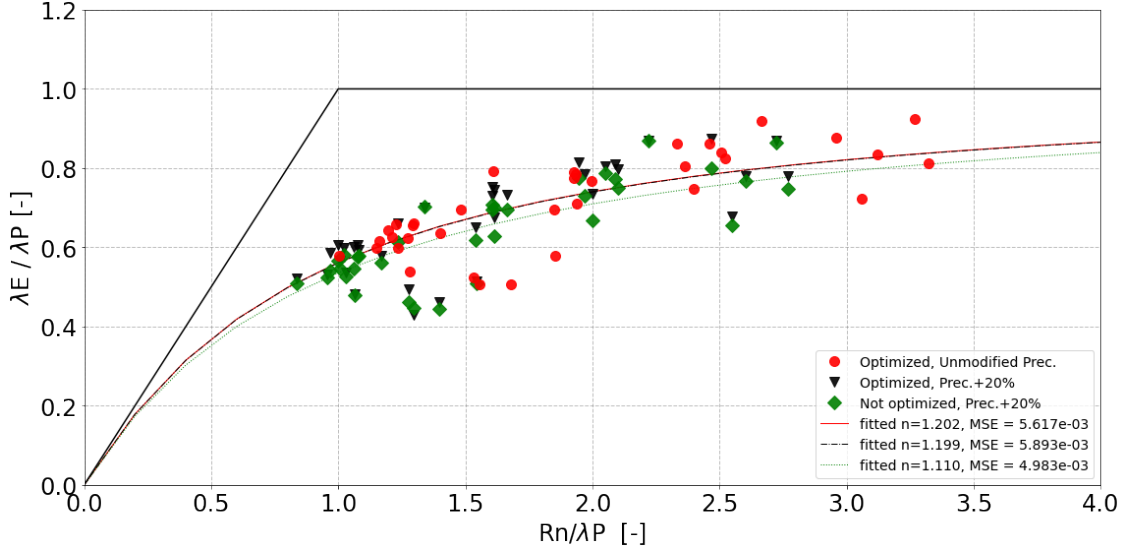
**Fig. S4.1** *Budyko curves based on a dryness index for sites along the NATT, based on VOM-results, for a) flux tower sites, b) 36 additional locations, c) six Australian catchments. Model runs that are fully optimized are shown in red, whereas model runs that use no vegetation parameters are shown in gray.*

Similar as for a Budyko-curve with a dryness index, the curves without vegetation plot much lower and have lower n-values.



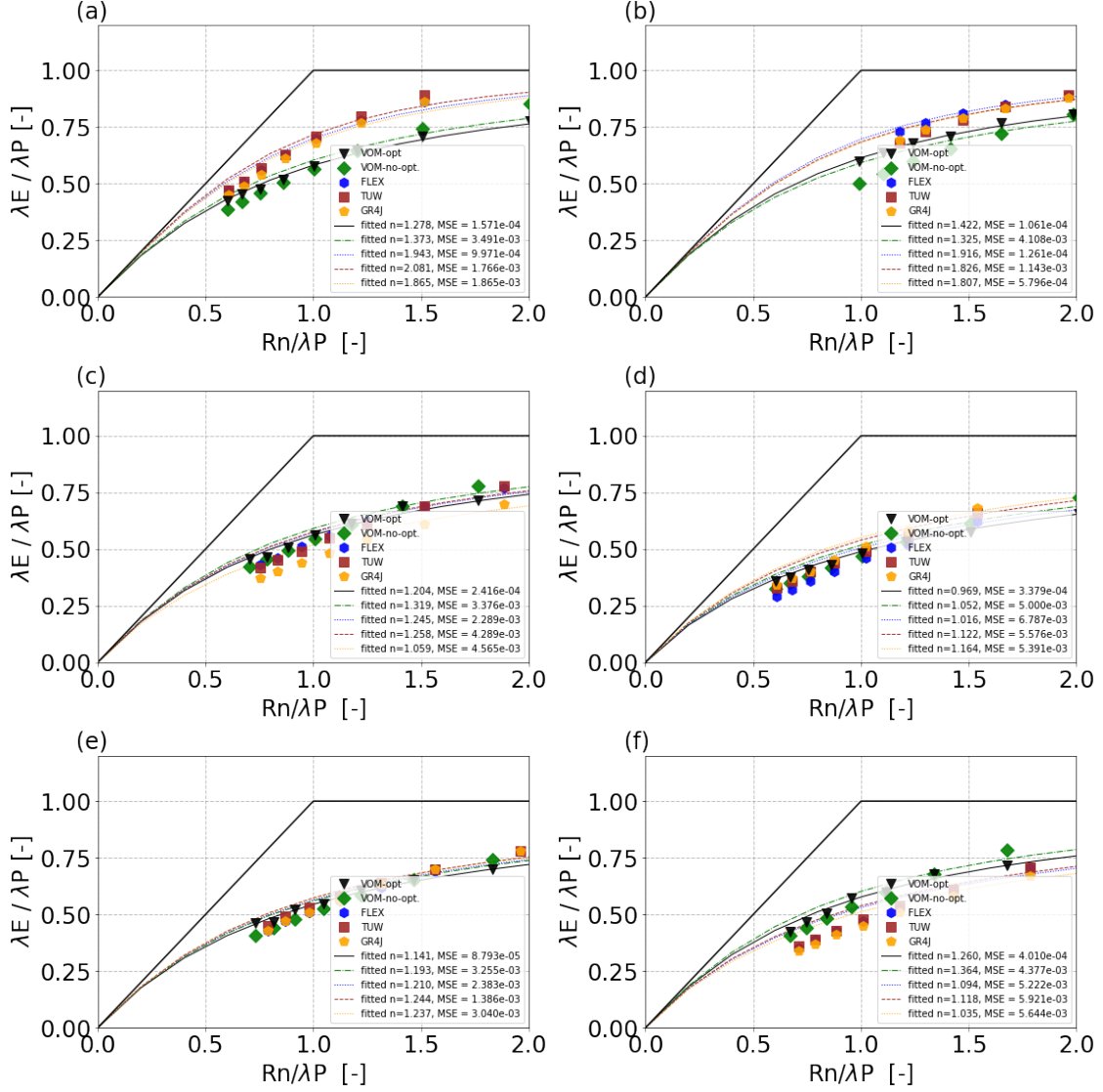
**Fig. S4.2.** *Budyko curves based on a dryness index for sites along the NATT, based on VOM-results, for a) Howard Springs, b) Adelaide River, c) Daly Uncleared, d) Dry River and e) Sturt Plains. Model runs that are re-optimized for increased precipitation values are shown in black triangles, whereas model runs that use vegetation parameters based on the benchmark situation (red point) are shown in green.*

The resulting  $n$ -values slightly differ from the values obtained for the curves in Budyko-space with a dryness index, but the still change in similar ways. The best fits are still obtained for the optimized VOM and the  $n$ -values increase for the VOM without optimization.



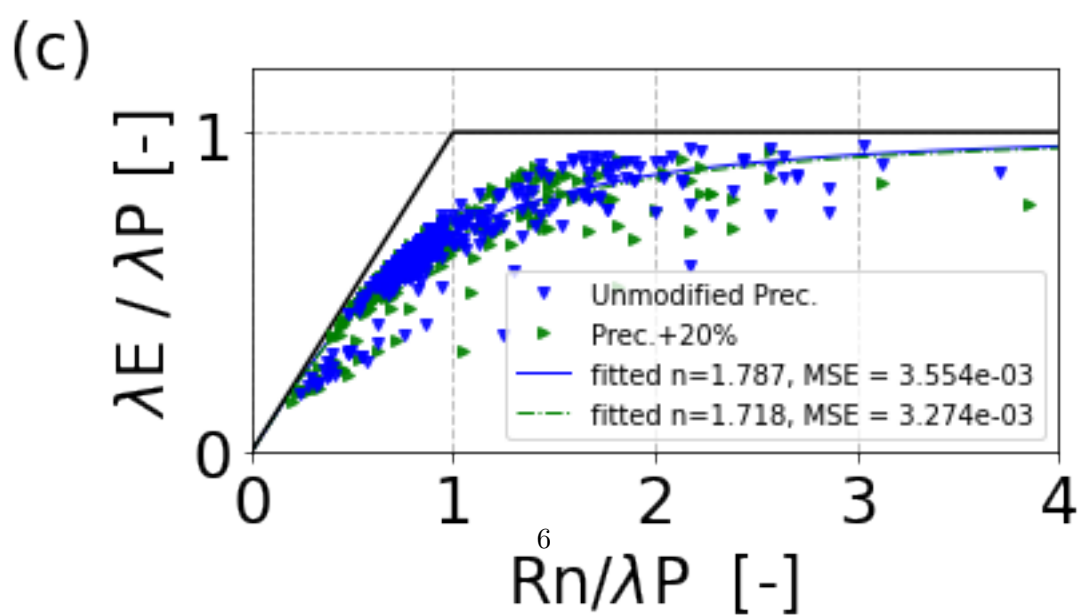
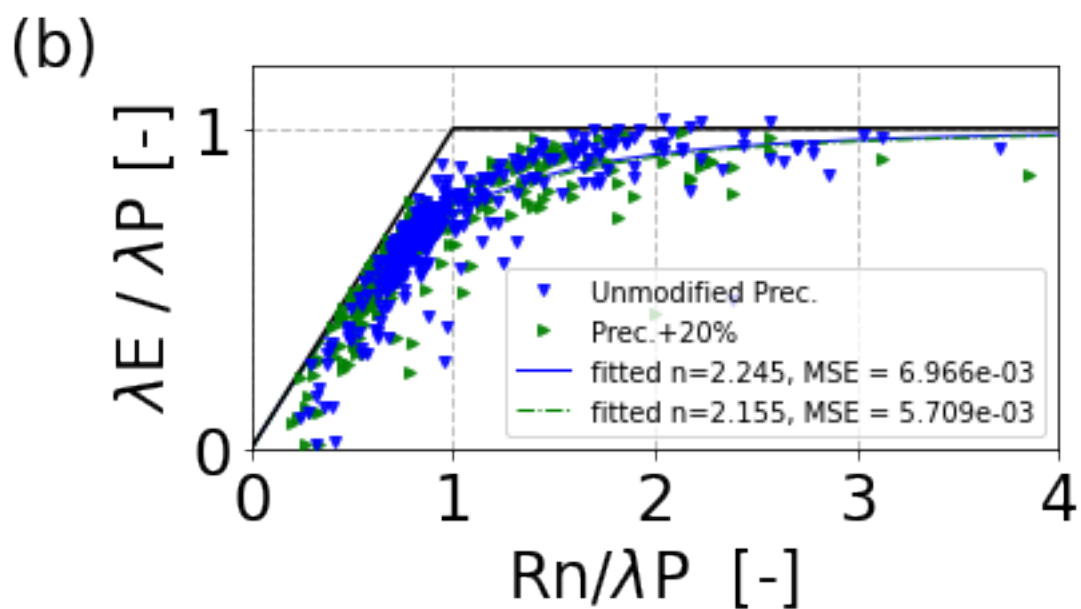
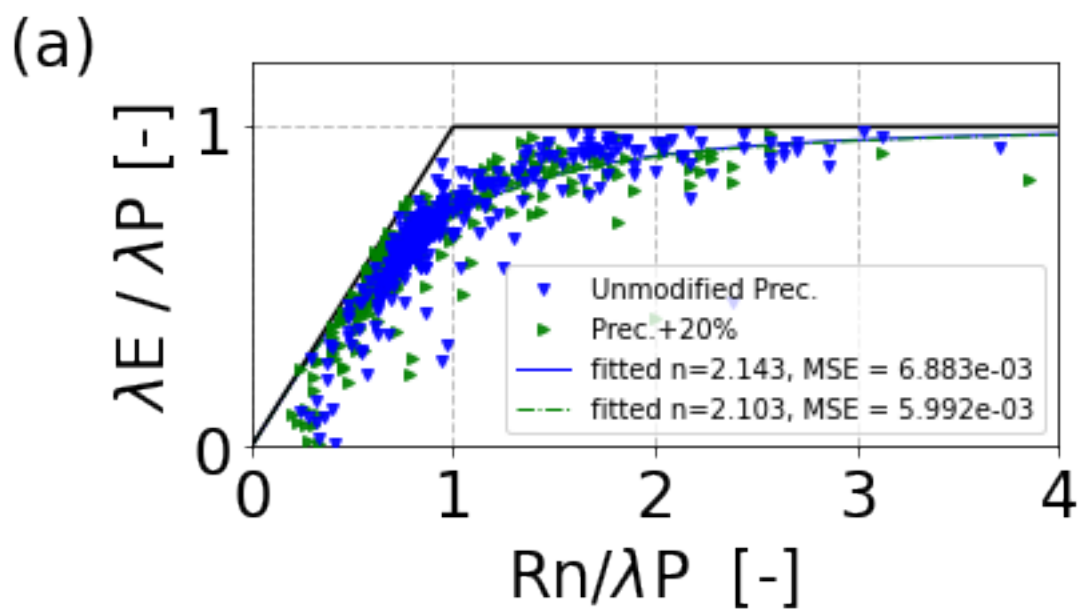
**Fig.S4.3.** *Results of the VOM applied to additional virtual points in the Budyko-framework based on a dryness index. Original (unmodified precipitation) results are shown in red, results with increased precipitation and the same vegetation parameters in green, and results with increased precipitation and re-optimized vegetation in black triangles.*

Similar as for the results in Budyko-space with a dryness index, the VOM without optimization and increased rainfall has a lower  $n$ -values. The optimized VOM with increased precipitation returns to a similar value as initially.



**Fig.S4.4.** Results of three hydrological models (Flex, TUWmodel and GR4J) in the Budyko-framework based on a dryness index for a) Adelaide River, b) Dry River, c) Fergusson River, d) Magela Creek, e) Seventeen Mile Creek and f) South Alligator River.

The results here, in a Budyko-space with a wetness index as independent variable, remain similar as for a Budyko-space with a dryness index. The best fits, with lower variance  $\sigma$  are still obtained by the optimized VOM.



**Fig.S4.5.** Results of three hydrological models, a) Flex, b) TUWmodel and c) GR4J) in the Budyko-framework for the Camels-data, with in blue the benchmark runs, and in green the the same runs with increased precipitation.