Irrigation vs. global warming

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Present-day irrigation extent

(Adapted from Siebert et al., 2005 HESS)
$T_{2m}$

$TXx$

(Thiery et al., 2017 JGR)
MED - irrigated land

SAS - irrigated land

(Thiery et al., 2017 JGR)
Relation to global warming?
20\textsuperscript{th}C change in daytime temperature during hottest month (CRU)

(See also: van Oldenborgh et al., 2018 HESS for India + recent period)
Simulation set-up

- 4 x 5 member ensemble
  - 1901-1930: CTL & IRR
  - 1981-2010: CTL & IRR

- CESM1.2.2 - CLM4.0 (SP)
- HadIO SST & Sea ice fraction
- 0.9° x 1.25°
- Parameterized irrigation

(adapted from Siebert et al., 2015 HESS)
Irrigation-induced cooling?

(Thiery et al., 2020 Nat. Comm.)
Correlation vs. causality
Early 20th Century

\[ T \]

Big box:

\[ \delta T_{\text{tot}} = \beta_0 + \beta_1 \times \delta f_{\text{irr}} + \beta_2 \times \text{lat} + \beta_3 \times \text{lon} + \beta_4 \times \text{elev} \]

Center pixel:

\[ \delta T_{\text{irr}} = \beta_1 \times \delta f_{\text{irr}} \]

Present-day

\[ T + \delta T_{\text{GHG}} \]

(Adapted from Kumar et al., 2013 JGR; Lejeune et al., 2018 Nature CC)
Irrigation-induced cooling!

CRU TS v3.22

(Thiery et al., 2020 Nat. Comm.)
Irrigation-induced cooling!

CRU TS v4.02

(Thiery et al., 2020 Nat. Comm.)
Probability ratio (PR)

\[ PR = \frac{P_{\text{new}}}{P_{\text{ref}}} = \frac{0.5}{0.1} = 5 \]

\( P_{\text{new}} \): event probability in the new situation
\( P_{\text{ref}} \): event probability in the reference situation

(Fischer and Knutti, 2015 Nature CC)
Hot extremes become less likely

Hot extremes become more likely

All forcings except irrigation

Irrigation expansion

All forcings

(Thiery et al., 2020 Nat. Comm.)
Change in probability

(Thiery et al., 2020 Nat. Comm.)
~5 % of all land

~3 % of all land

(Thiery et al., 2020 Nat. Comm.)
0.79 – 1.29 Billion people less exposed to hot extremes (≠ heat stress)
Thanks! Questions?