Aetiology-specific projections of temperature-attributable mortality due to enteric infections

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Background and objective

- Enteric infections cause significant burden of morbidities (e.g. diarrhoea) and mortality in children and elderly in low- and middle-income countries (LMICs)
- They are indirectly affected by ambient temperature via water- or environmental-related pathways
- Enteric infection pathogen have varying temperature-sensitivity, not been considered in previous projections
- This study did aetiology-specific approach in projecting temperature-related mortality due to enteric infections in a global-level

Methods

- 10 enteric infection aetiologies modelled by IHME-GBD
  - non-typhoidal salmonellosis, shigellosis, campylobacteriosis, cholera, enteropathogenic *E. coli* enteritis (EPEC), enterotoxigenic *E. coli* enteritis (ETEC), typhoid, rotavirus, norovirus, and cryptosporidiosis
  - 85% of overall enteric infections (Troeger et al 2017)
- Forecasted annual aetiology-specific deaths (D) without temperature change (Foreman et al 2018)
  - Linear mixed model with:
    - Sociodemographic index (SDI), trend (T), and scalar of risk factors (S) as fixed effects
    - Aetiology (r), country (l), age (a) as random effects

$$ln[E(D_{r,l,a,t})] = \alpha_{r,l,a} + \beta_0 SDI_{<0{\cdot}8,l,t} + \beta_1 SDI_{\geq 0{\cdot}8,l,t} + \theta_a T + ln(S_{l,a,t})$$

  - SDI categorised by: (IIASA/WCD)
    - SSP 1-3 only
  - Scalar of risk factors by: (IHME-GBD)
    - Baseline, additional, and low health investments (non SSP)

Methods

- Projections of annual aetiology-specific enteric infections (d)
  - Derived from temperature anomalies (T) and aetiology-specific temperature sensitivity (β)

$$d_{r,l,t} = D_{r,l,a,t} \times P_{l,a,t} \times \frac{e^{[\beta r \times (T_{projected} - T_{baseline})]} - 1}{e^{[\beta r \times (T_{projected} - T_{baseline})]}}$$

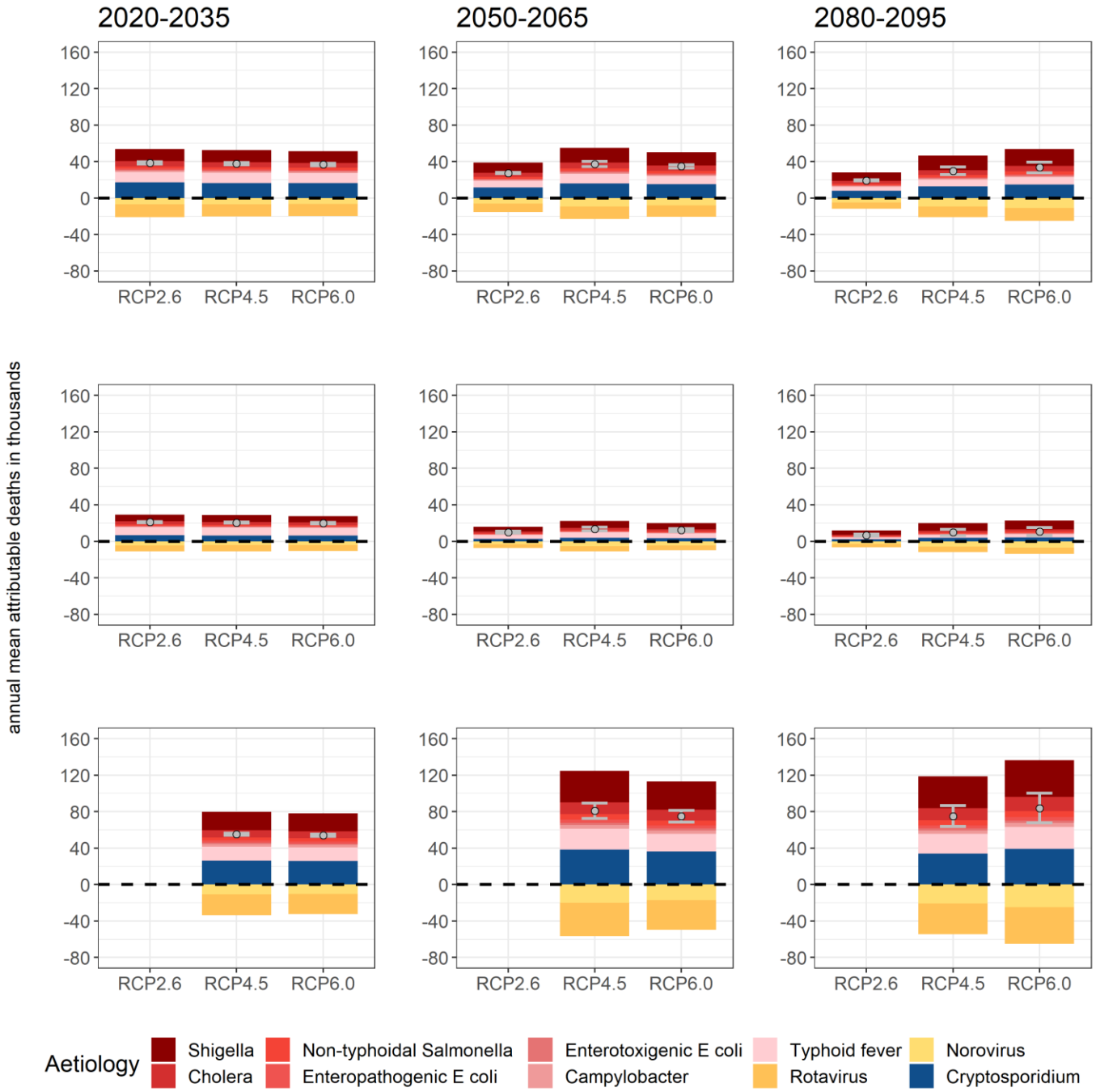
  - Temperature change (reference is 1976-2005) by:
    - RCP 2.6, 4.5, and 6.0 only (ISIMIP2b tasAdjust)
  - Assumed temperature-morbidity associations are same with temperature-mortality
- Scenarios
  - SSP 2 + Baseline Health Investments (BHI) & all RCPs *(mid)*
  - SSP 1 + Additional Health Investments (AHI) & all RCPs *(better)*
  - SSP 3 + Low Health Investments (LHI) & RCP 4.5 and 6.0 *(worse)*

GCM-ensemble estimates of global temperature-attributable enteric infection deaths

SSP 2 + Baseline Health Investments

SSP 1 + Additional Health Investments

SSP 3 + Low Health Investments

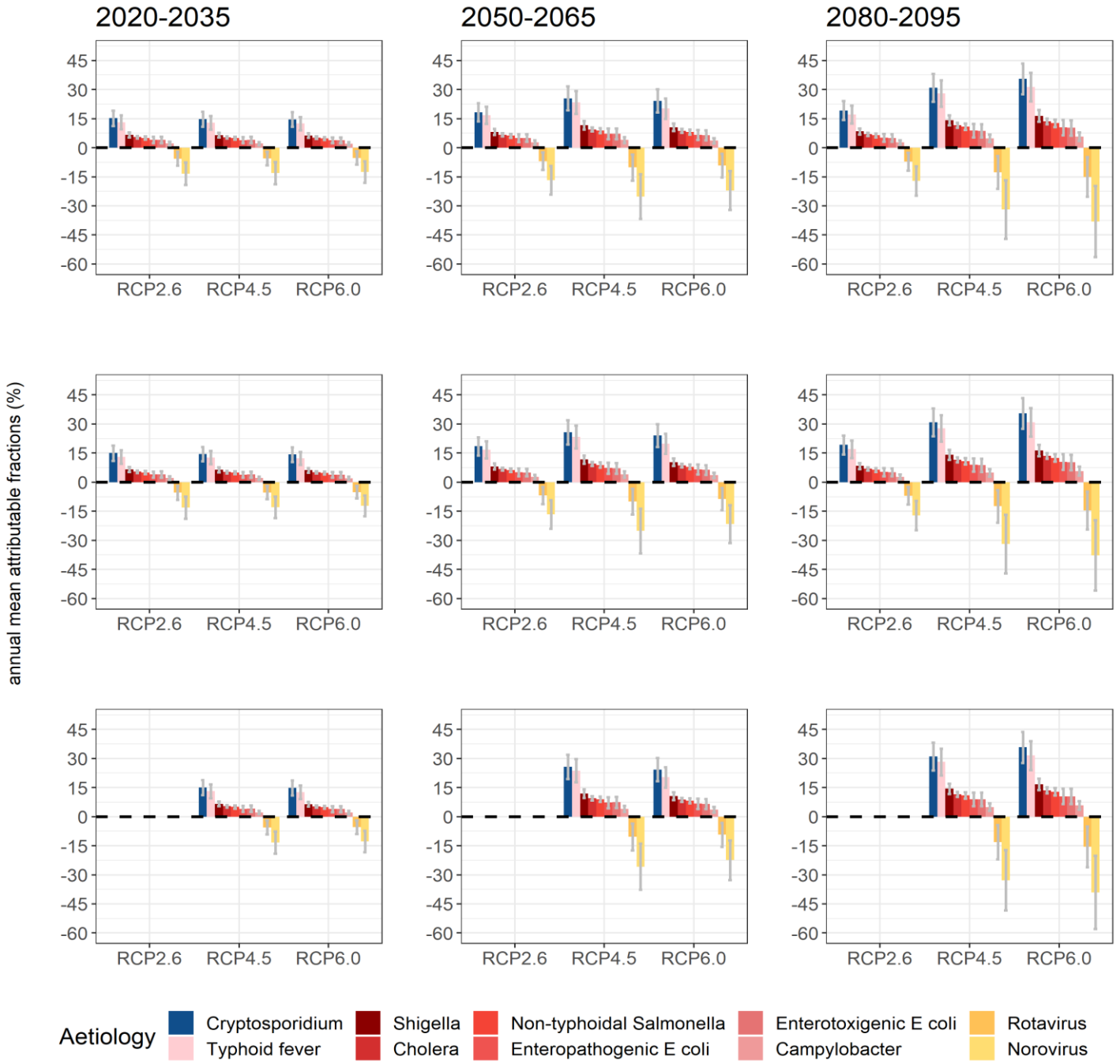


GCM-ensemble estimates of global temperature-attributable fractions of enteric infection deaths

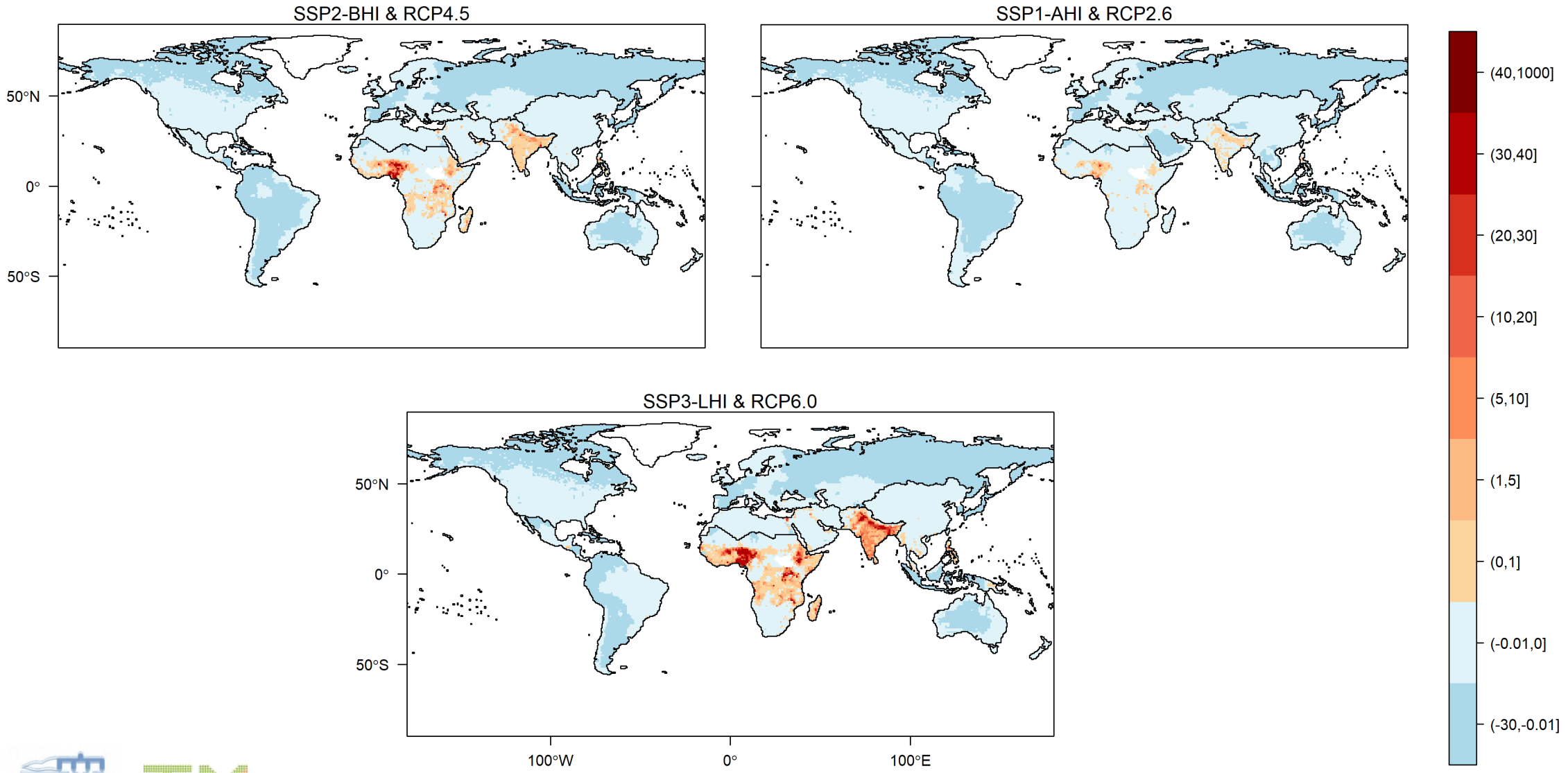
SSP 2 + Baseline Health Investments

SSP 1 + Additional Health Investments

SSP 3 + Low Health Investments



GCM-ensemble estimates of mean temperature-attributable enteric infection deaths under various scenarios in 2080–2095 by 0.5°×0.5° grids



Discussion points

- Future with a warmer climate and worse sociodemographic scenarios may have higher enteric infections (6-10% increase by 2080-2095)
  - Majority in Sub-Saharan Africa (~70%) and South Asia (~20%)
  - Dominated by deaths due to *Shigella*, *Cryptosporidium*, and *Salmonella typhi* (~50%)
  - Reduction of deaths due to rotavirus and norovirus (~-30%)
    - Net reductions in East Asia & Pacific and Latin America and the Caribbean
- Mechanistic models and incorporation of other climate/environmental factors
- Limitations
  - Modelled aetiology-specific mortality (IHME-GBD)
  - Short-term temperature-diarrhoea associations may not apply in annual-level and mortality
  - Other climate factors not considered

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Thank you!

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