Inter-model diversity in aerosol-sensitive regions

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Anthropogenic aerosols have been shown to have an influence on global- and hemispheric-scale temperature [1], and on regional circulation patterns [2,3]. We identify regions that CMIP5 models suggest are likely to be sensitive to forcing due to anthropogenic aerosol changes, and attempt to quantify the aerosol contribution to temporal changes in climate variables in these regions.

Identification of aerosol-sensitive regions

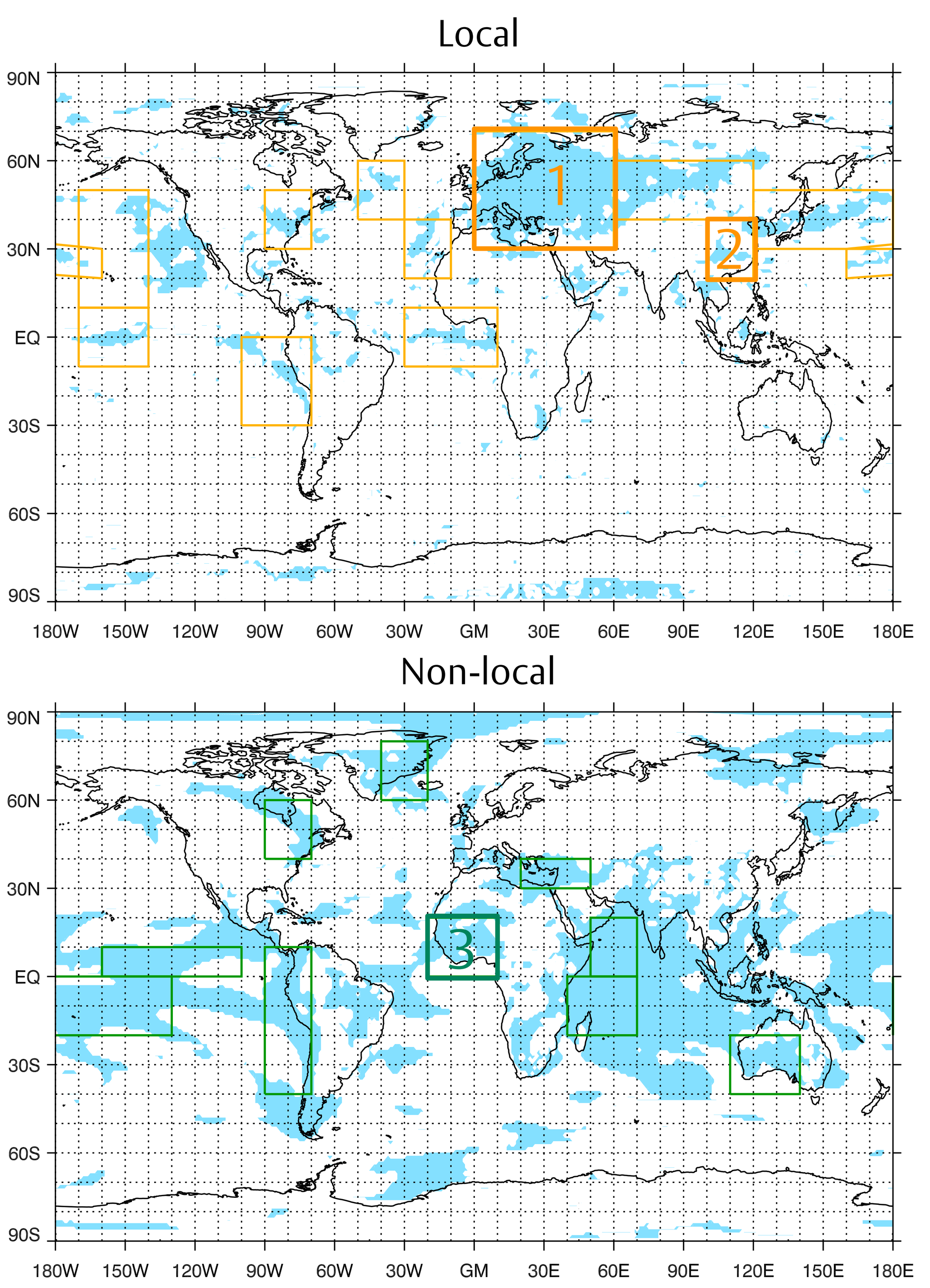

Figure 1: *Masks showing regions that may be particularly sensitive to anthropogenic aerosol forcing. The local mask is derived from the response of fluxes to aerosol changes. The non-local mask is derived from the temperature response. Focus regions for the remainder of the poster are numbered.*

- 6 CMIP5 models providing aerosol-only (AA) simulations
- Interpolate to a 1°x1° grid
- Find the correlation between the all forcing and AA simulations at each grid point
- Identify locations where the Pearson correlation coefficient is greater than 0.3
- Sensitive regions are defined when 4 out of 6 models agree on these locations

Diversity in aerosol load and distribution

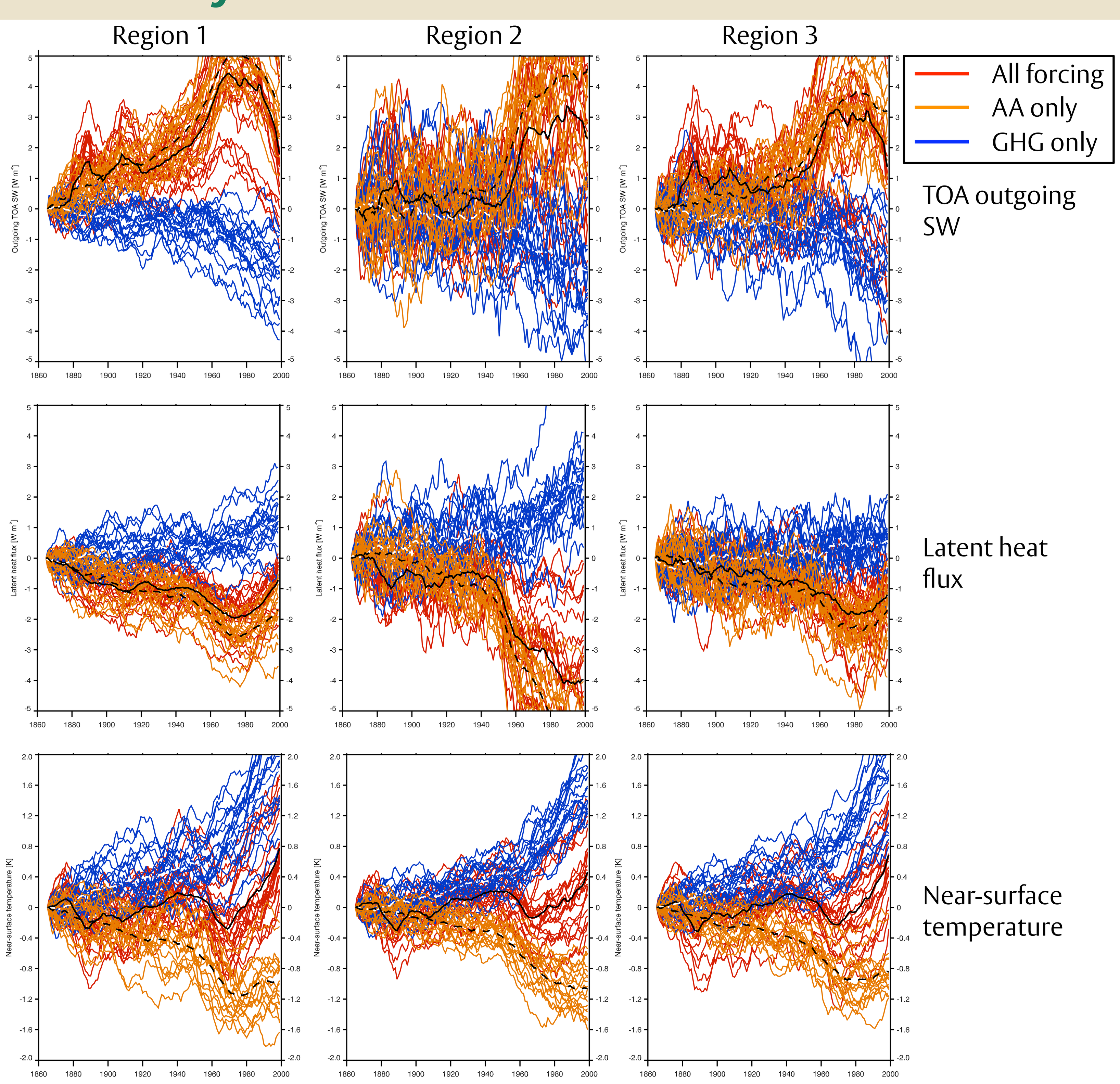

Figure 2: *Individual model timeseries (colours) of TOA outgoing shortwave (SW), latent heat flux, and near-surface temperature for three aerosol-sensitive regions. The multi-model means are shown by the black solid line (All), black dashed line (AA), and white dashed line (GHG). All timeseries are 11-year running means.*

- Individual model timeseries are noisy, with considerable inter-model spread
- An anthropogenic aerosol influence can be seen on the all forcing timeseries in all cases
  - All timeseries closely follows AA for TOA outgoing SW, and latent heat flux
  - AA influences multi-decadal variability in near-surface temperature

[1] Wilcox et al., (2013). *Environmental Research Letters*, **8**, 024033.
[2] Dong et al., (2014). *Journal of Climate*, **27**, 7000-7017.
[3] Polson et al., (2014). *Geophysical Research Letters*, **41**, 6023-6029.

Attribution of temporal structure

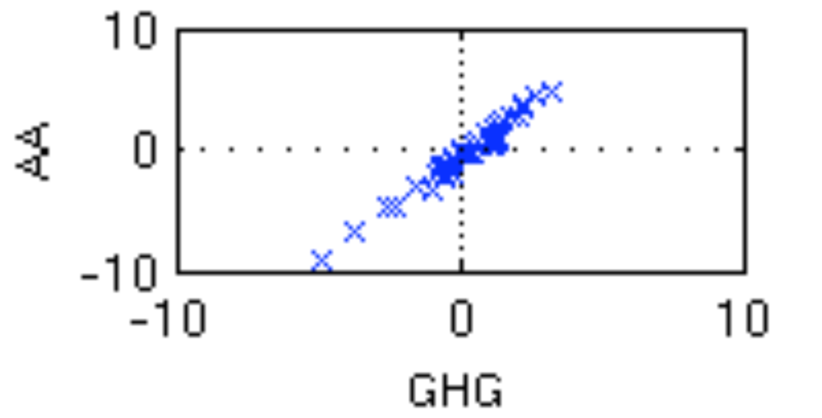

Figure 3: *'Perfect model' scaling factors for GHG and AA (5th percentile) for a sample region.*

- AA and GHG timeseries are covariant, with trends of opposite sign -> degenerate result

- Traditional detection and attribution may not be a suitable tool in this case
  - Investigate other techniques for quantifying the relative roles of AA and GHG
- Figure 2 suggests that quantifying how closely two timeseries follow each other and similarities in local trends may be informative

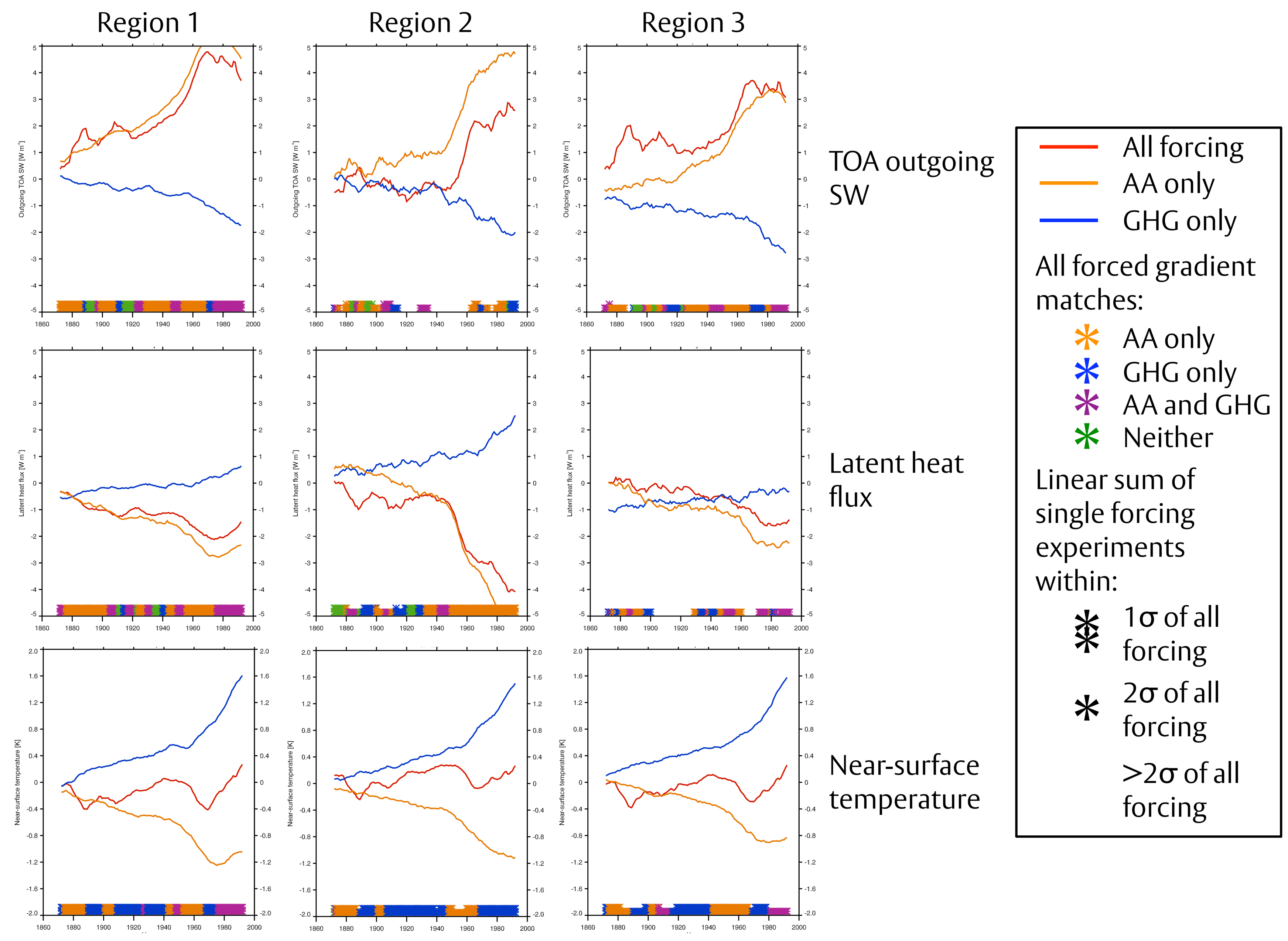

Figure 4: *Multi-model mean timeseries (colours) of TOA outgoing SW, latent heat flux, and near-surface temperature for three aerosol-sensitive regions. Coloured stars indicate which forcing component is likely to be the main driver of the all forcing trend in a given period.*

- When the linear sum of AA and GG is a good approximation to All, the main driver of the All trend can be identified
- The assumption of linearity is not valid in all regions for all variables. Where it is valid:
  - AA typically drives trends in fluxes during the historical period
  - GHG typically drives temperature trends, with multi-decadal scale contributions from AA

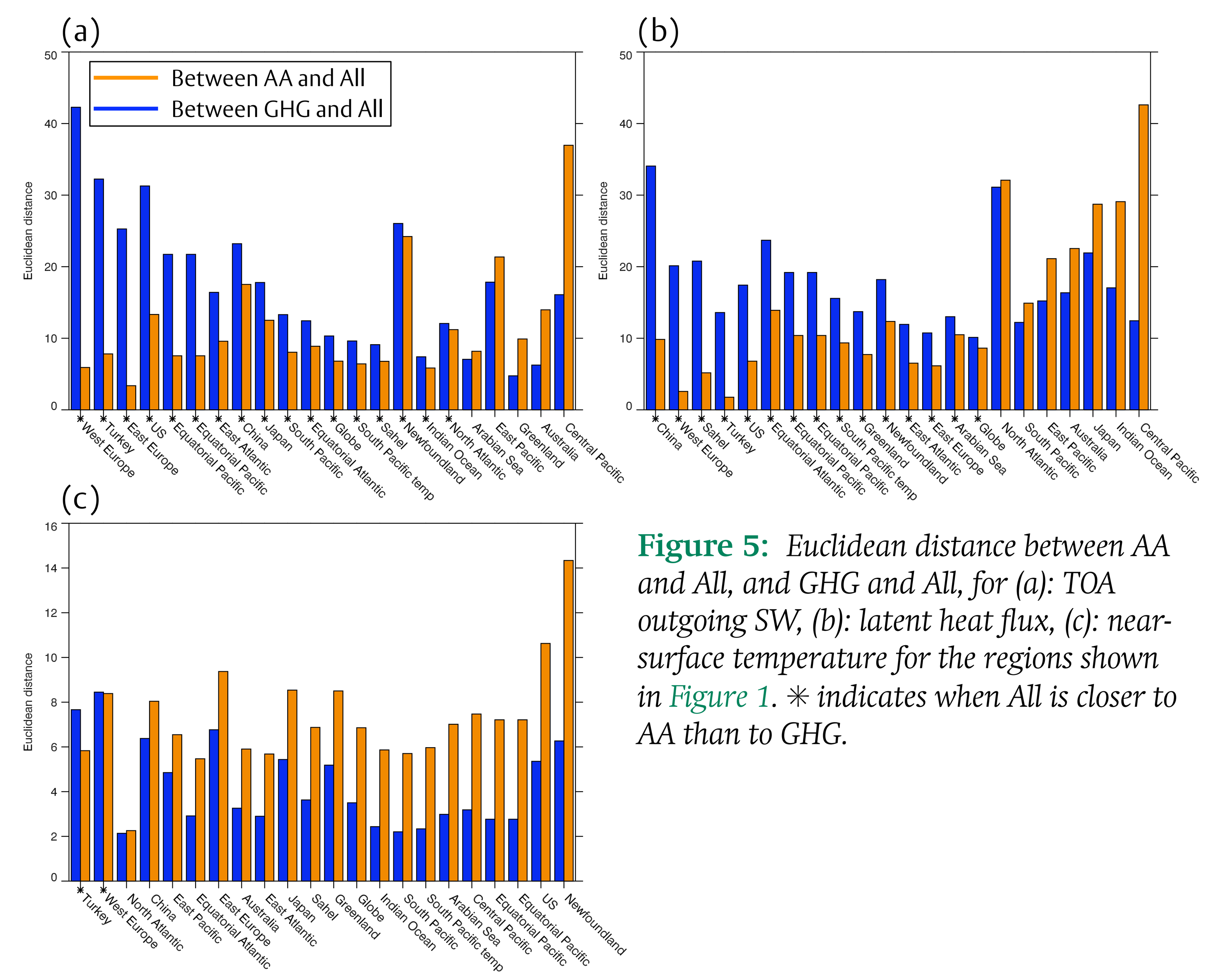

Figure 5: *Euclidean distance between AA and All, and GHG and All, for (a): TOA outgoing SW, (b): latent heat flux, (c): near-surface temperature for the regions shown in Figure 1. ∗ indicates when All is closer to AA than to GHG.*

- All closely follows AA for fluxes directly influenced by aerosol, with weaker relationships for temperature, as seen in Figure 1

Next steps:
- Use our knowledge of inter-model differences to explain inter-model diversity on a regional scale.
  - Likely to be limited be internal variability and small ensemble sizes