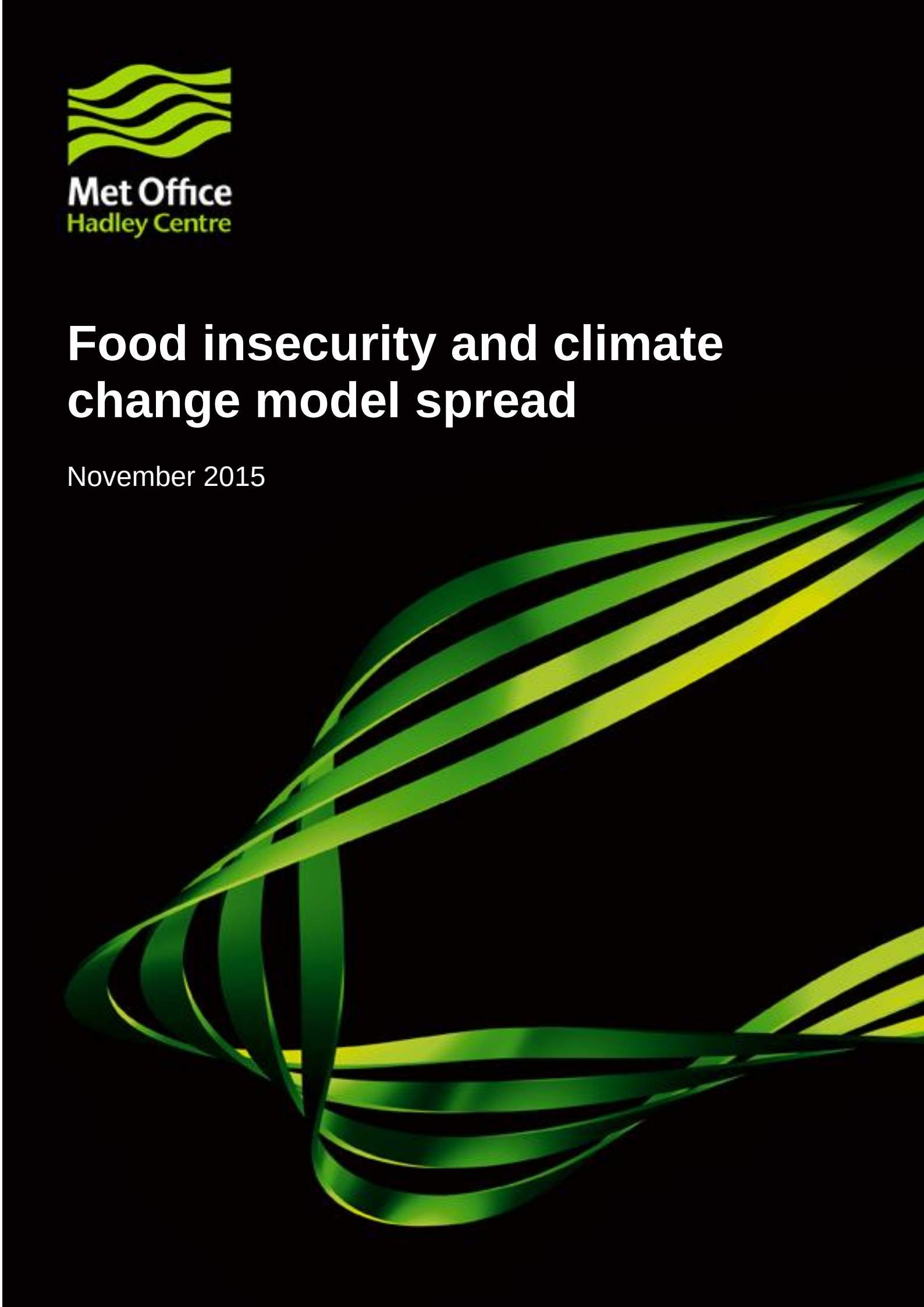
Met Office
Hadley Centre

Food insecurity and climate change model spread

November 2015



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Contents

1 Introduction

The Food Insecurity & Climate Change website (www.wfp.org/climate-food-insecurity-index or www.metoffice.gov.uk/food-insecurity-index) showcases an interactive climate and food insecurity index which allows the user to explore policy outcomes for vulnerability to food insecurity. The website shows a present-day measure of vulnerability of the food system to climate-related hazards, and future projections of the index for a range of scenarios of different future global greenhouse gas emissions and adaptation levels.

The climate and food insecurity index is a measure of vulnerability of the food system to climate-related hazards. Vulnerability is computed at a country level and is comprised of three components:

- ***Exposure*** to climate-related hazards,
- ***Sensitivity*** of national agricultural production to climate-related hazards,
- ***Adaptive capacity*** – a measure of capacity to cope with climate-related food shocks.

Future projections of the climate and food insecurity index were computed for a range of scenarios of different future global greenhouse gas emissions and adaptation levels. These are available to view on the website, and further detail about the index calculation and future projections can be found in the Food Insecurity & Climate Change Technical Report, available to download from the website.

There are three greenhouse gas emission scenarios (low, medium and high emissions), which correspond to future projections of the exposure component of the index using climate model projections. There are also three scenarios of adaption investment (high, low and no adaptation), which correspond to changes in the sensitivity and adaptive capacity components of the index. Further detail about the emissions and adaptation scenarios is available in the Food Insecurity & Climate Change Technical Report.

The future projections of the exposure component of the index were computed for 12 climate models from the Coupled Model Intercomparison Project Phase 5 (CMIP5; Taylor *et al.*, 2012) multi-model ensemble, used to inform the latest Inter-Governmental Panel on Climate Change 5th Assessment Report (IPCC AR5; IPCC, 2013). The twelve models are those that were available for commercial use at the time of study, and have a resolution of 90 latitude grid cells x 144 longitude grid cells or more. The models have a good representation of the range of global average temperature projections from the CMIP5 ensemble. The models and their resolutions are listed in Table 1.

The future exposure components were calculated using projections of daily precipitation from each of the twelve climate models in Table 1. The future climate and food insecurity index for each combination of emissions and adaptation scenarios was then calculated using exposure component from each of the twelve climate models. The ensemble mean was calculated by taking the average value of the index for each country across the models, and it is this that is shown on the website.

This report presents the spread of results across the climate models for each of the emissions and adaptation scenarios. Maps of the climate and food insecurity index for each of twelve models, along with the minimum, mean and maximum values per country, are shown for each combination of emissions and adaptation scenarios.

Table 1 – The 12 CMIP5 models used for the future climate projections, and their resolutions.

Model name	Modelling centre	Number of latitude grid cells	Number of longitude grid cells
BCC-CSM1-1-M	Beijing Climate Center, China Meteorological Administration	160	320
CCSM4	National Center for Atmospheric Research	192	288
CESM1-CAM5	Community Earth System Model Contributers	288	288
CNRM-CM5	Centre National de Recherches Météorologiques / Centre Européen de Recherche et Formation Avancée en Calcul Scientifique	128	256
GFDL-CM3	NOAA Geophysical Fluid Dynamics Laboratory	90	144
GFDL-ESM2G	NOAA Geophysical Fluid Dynamics Laboratory	90	144
GFDL-ESM2M	NOAA Geophysical Fluid Dynamics Laboratory	90	144
HadGEM2-ES	Met Office Hadley Centre	145	192
IPSL-CM5A-MR	Institut Pierre-Simon Laplace	143	144
MPI-ESM-LR	Max-Planck-Institut für Meteorologie	96	192
MPI-ESM-MR	Max-Planck-Institut für Meteorologie	96	192
NorESM1-M	Norwegian Climate Centre	96	144

In some cases, the climate model projections do not have the required criteria to define a drought in some countries, and therefore there is no exposure component. This only occurs in a few countries and models, and is resolved by excluding these countries from the index calculation for the models in question, resulting in the ensemble mean being based on 11 models as opposed to 12 models for that particular country. The specific models and countries are:

- Egypt in MRI-EMS-MR
- Eritrea in IPSL-CM5A-MR
- Yemen in IPSL-CM5A-MR

In these cases where a country has no exposure component, the country is coloured grey in the maps in this report.

2 Climate and food insecurity index model spread

2.1 Low emissions, no adaptation

The climate and food insecurity index is mapped for each of the 12 models used in this study for the low emissions and no adaptation scenario in Figure 1 for the 2050s, and in Figure 2 for the 2080s. The minimum, mean and maximum values per country across the ensemble of models are mapped in the bottom row of each figure. It is the ensemble mean that is displayed on the website.

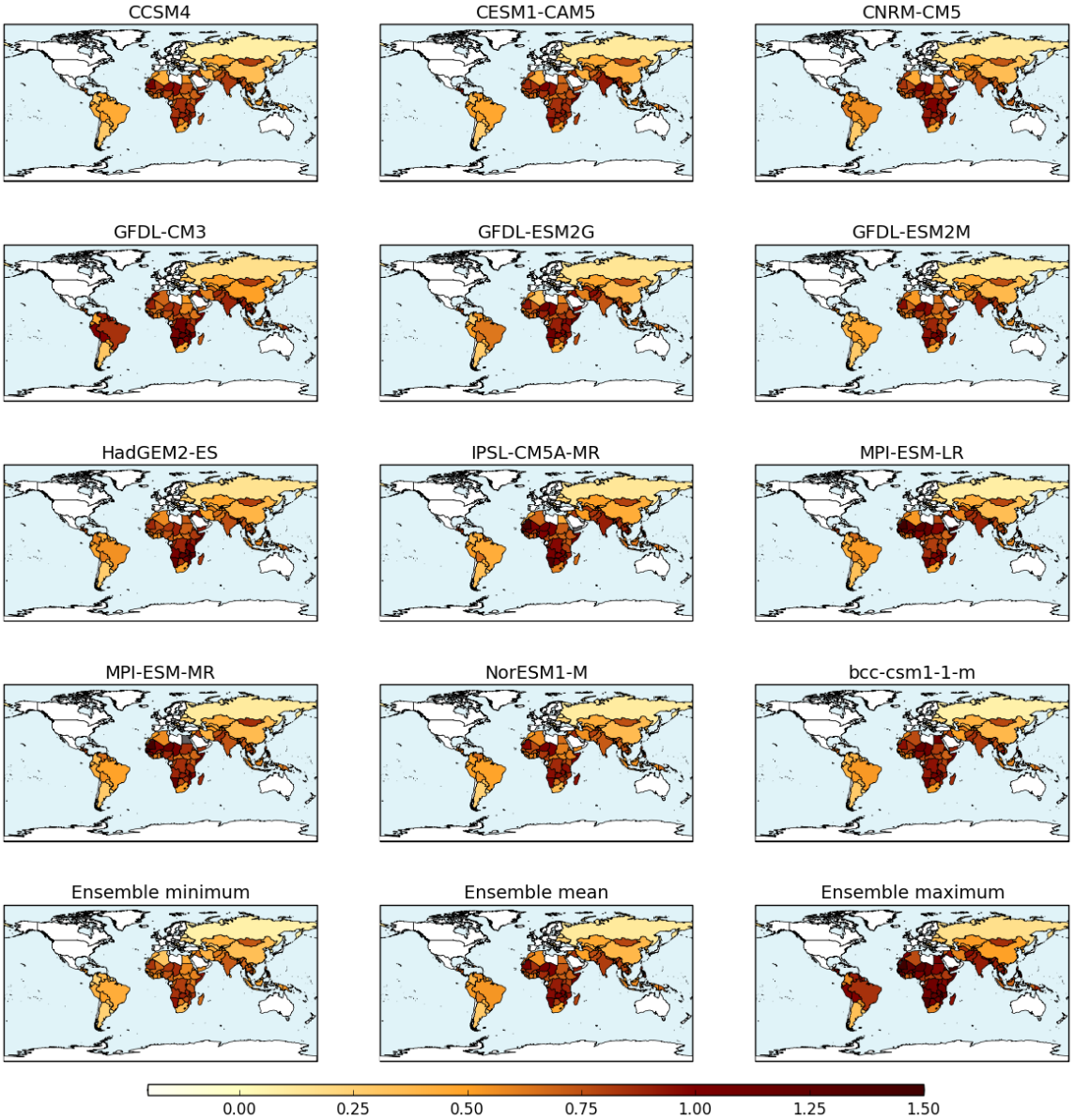

Figure 1 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the low emissions and no adaptation scenario in the 2050s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

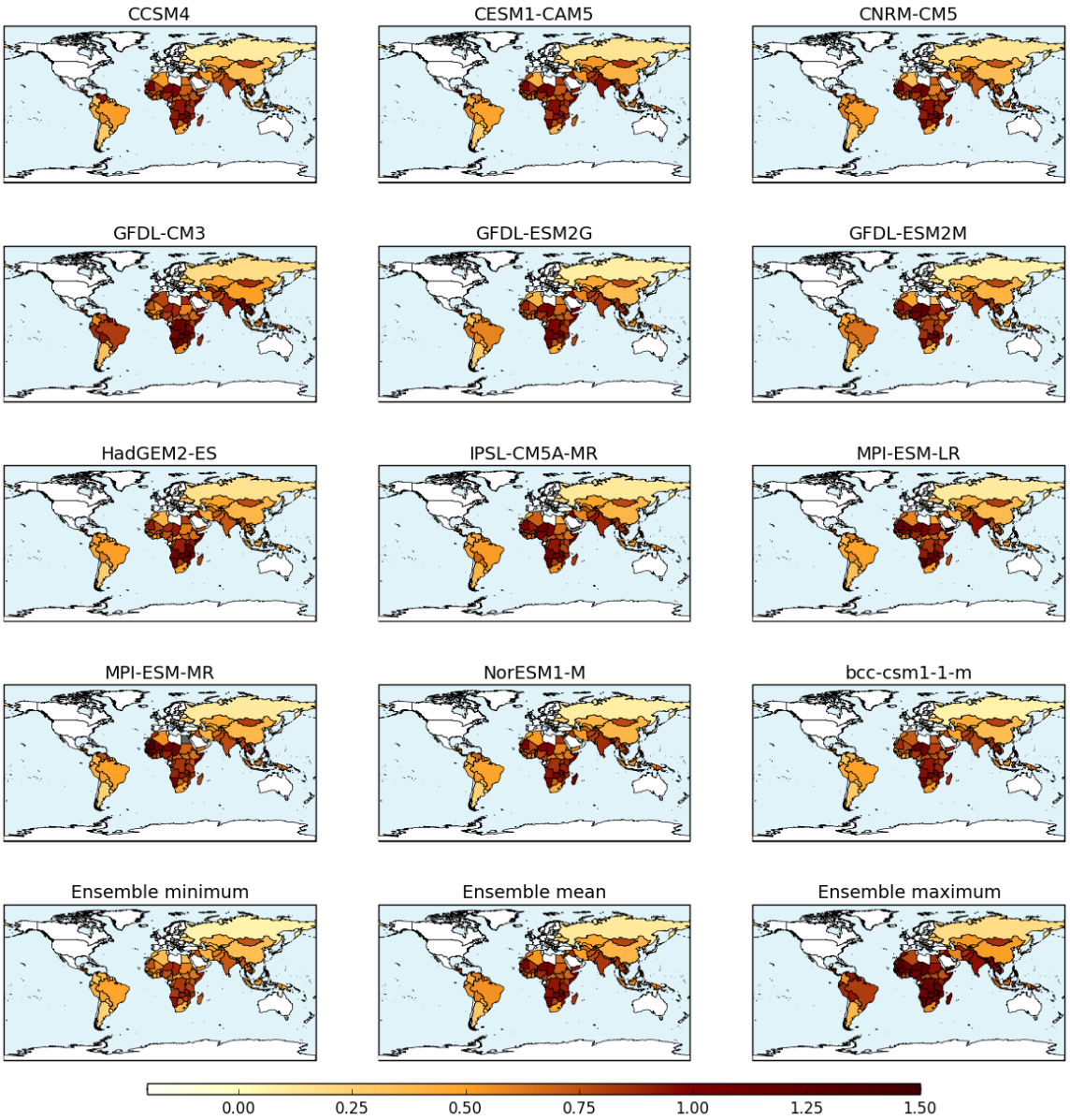

Figure 2 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the low emissions and no adaptation scenario in the 2080s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

2.2 Low emissions, low adaptation

The climate and food insecurity index is mapped for each of the 12 models used in this study for the low emissions and low adaptation scenario in Figure 3 for the 2050s, and in Figure 4 for the 2080s. The minimum, mean and maximum values per country across the ensemble of models are mapped in the bottom row of each figure. It is the ensemble mean that is displayed on the website.

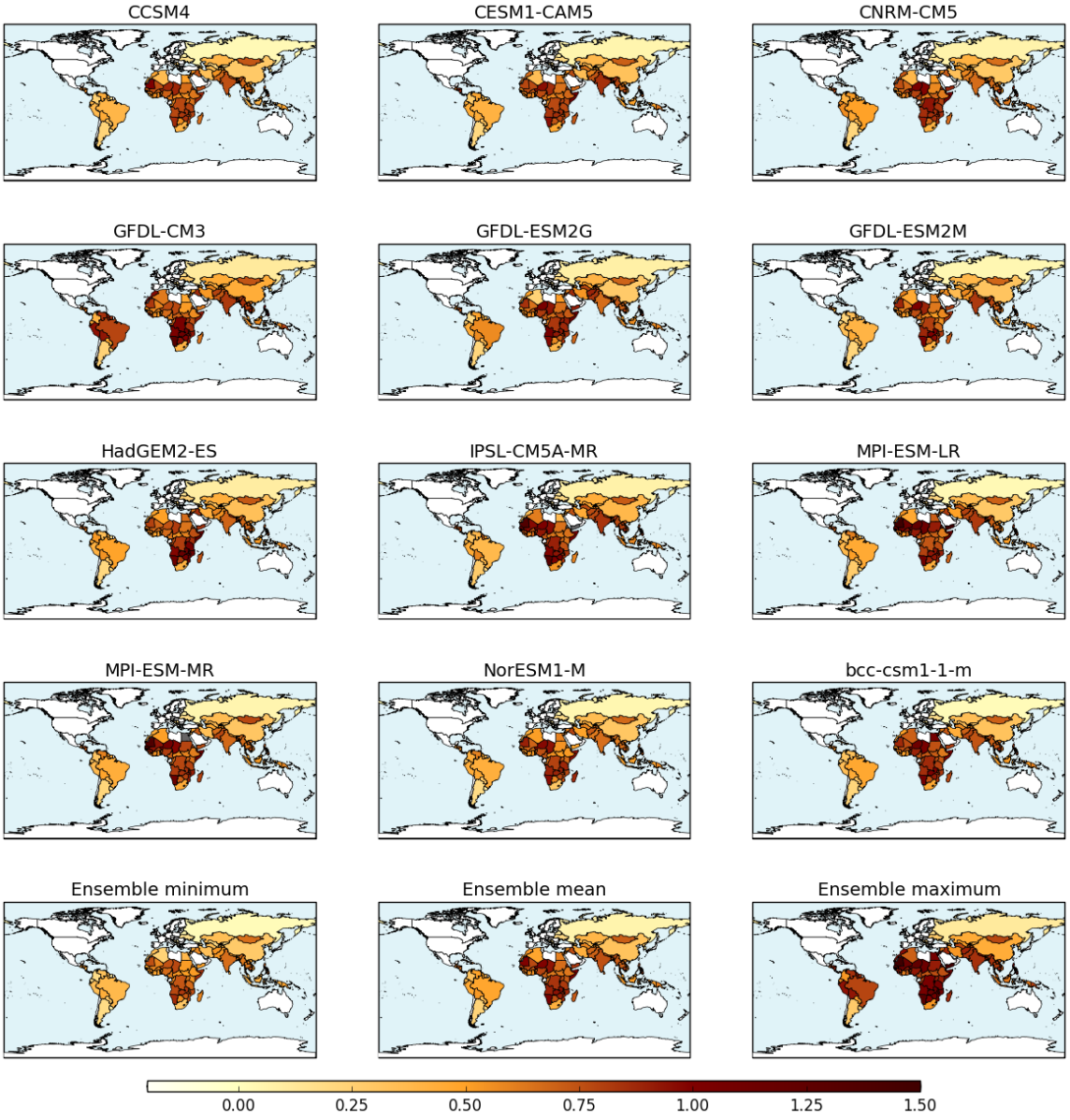

Figure 3 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the low emissions and low adaptation scenario in the 2050s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

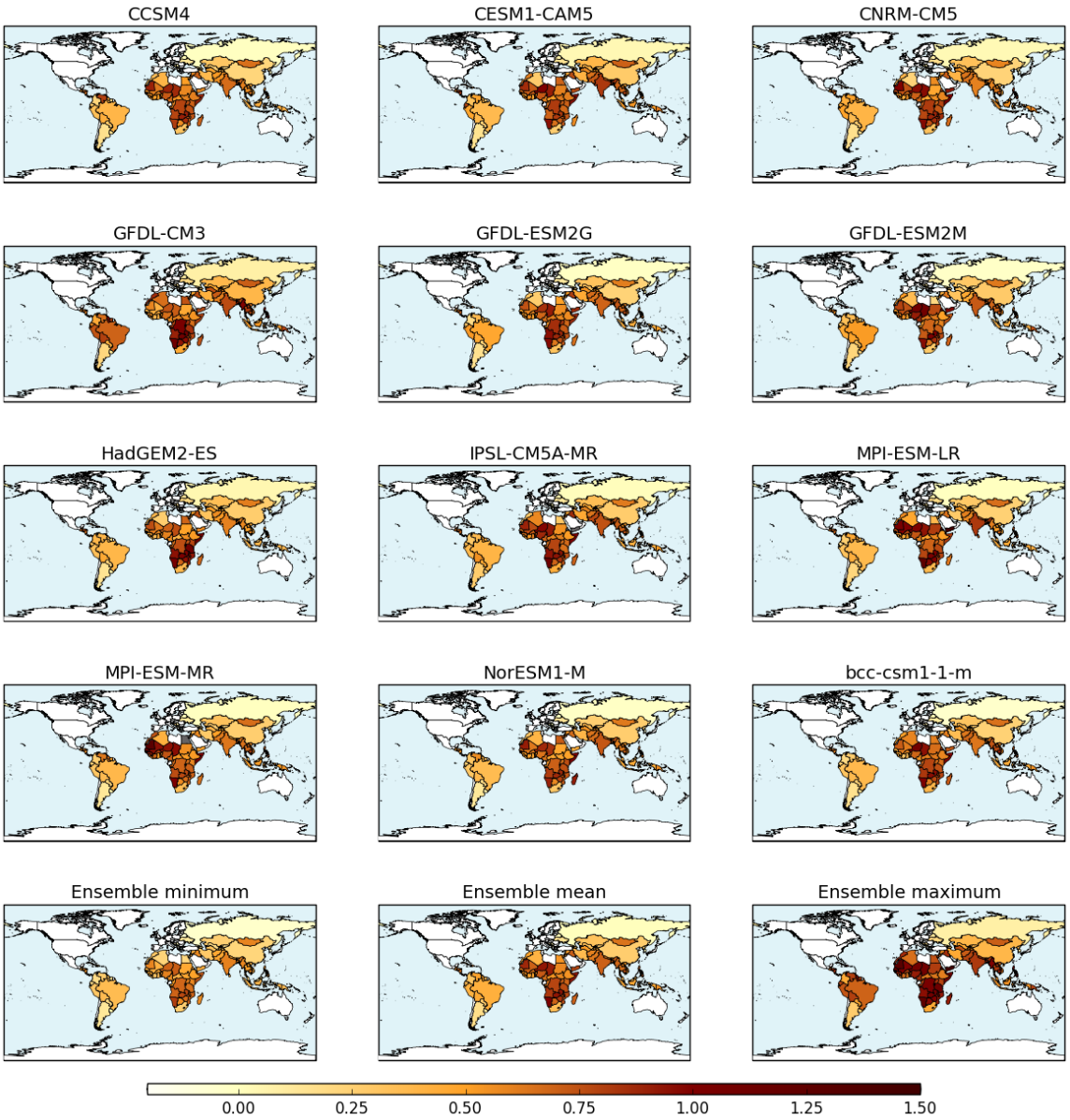

Figure 4 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the low emissions and low adaptation scenario in the 2080s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

2.3 Low emissions, high adaptation

The climate and food insecurity index is mapped for each of the 12 models used in this study for the low emissions and high adaptation scenario in Figure 5 for the 2050s, and in Figure 6 for the 2080s. The minimum, mean and maximum values per country across the ensemble of models are mapped in the bottom row of each figure. It is the ensemble mean that is displayed on the website.

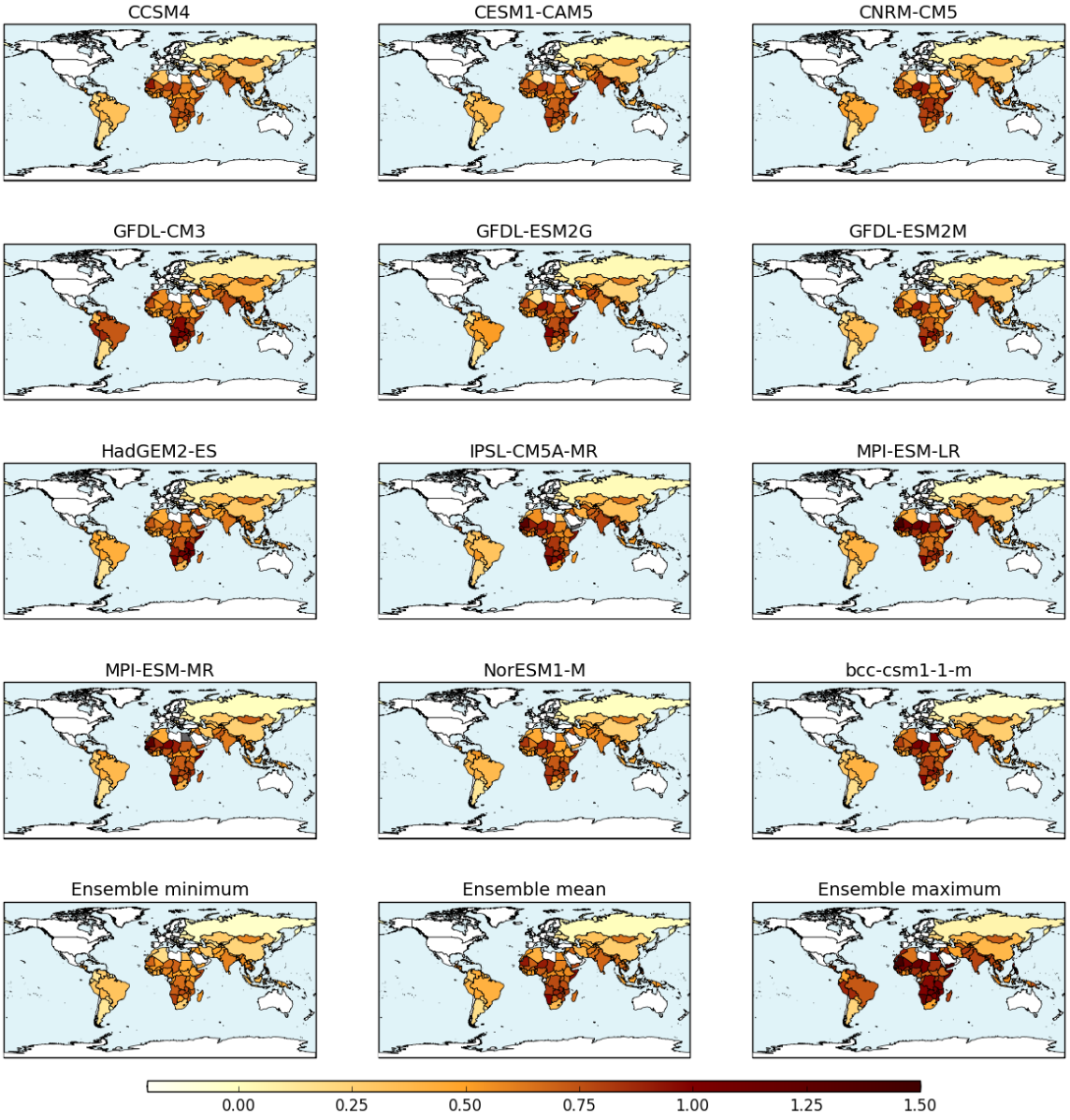

Figure 5 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the low emissions and high adaptation scenario in the 2050s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

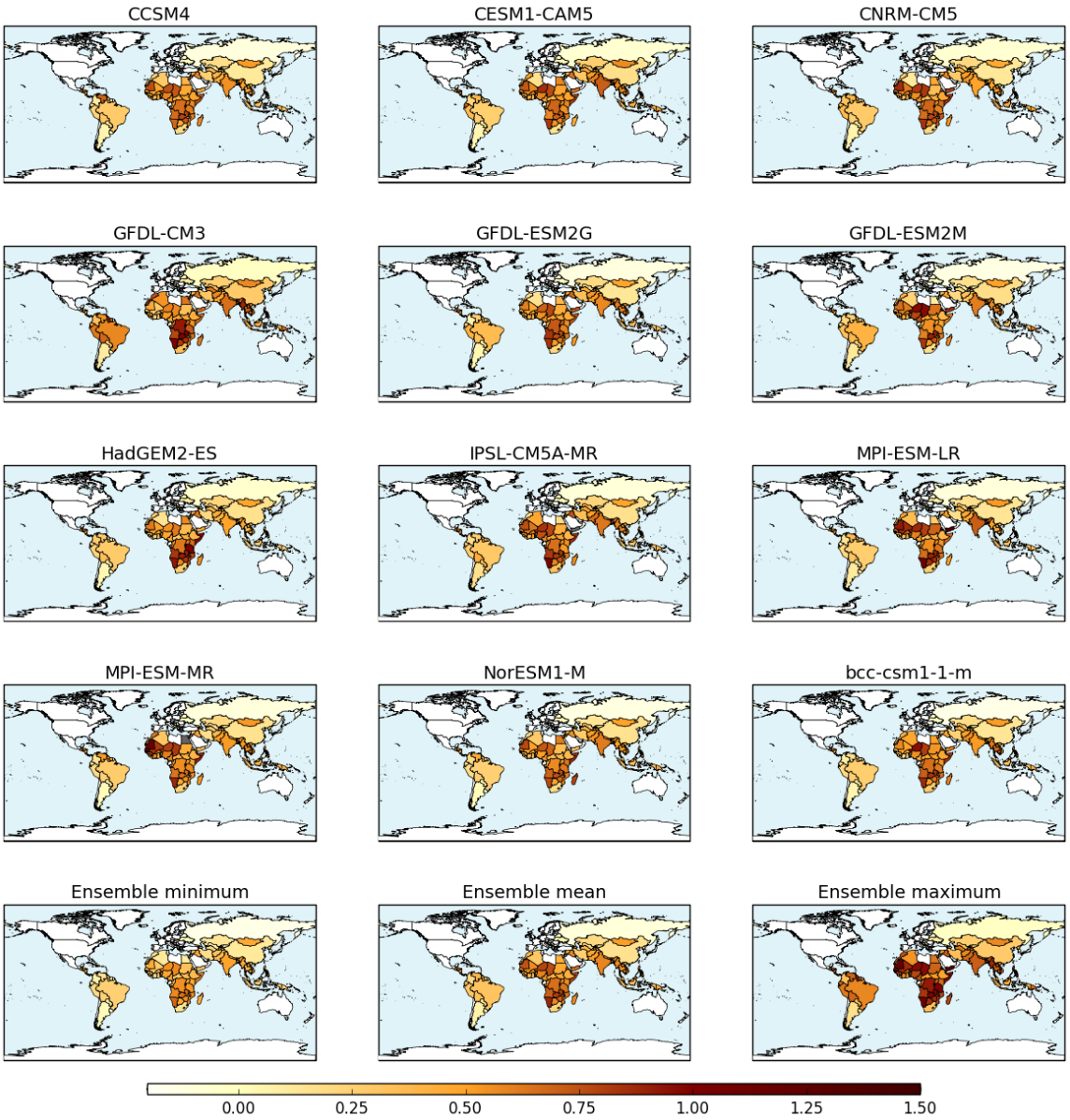

Figure 6 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the low emissions and high adaptation scenario in the 2080s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

2.4 Medium emissions, no adaptation

The climate and food insecurity index is mapped for each of the 12 models used in this study for the medium emissions and no adaptation scenario in Figure 7 for the 2050s, and in Figure 8 for the 2080s. The minimum, mean and maximum values per country across the ensemble of models are mapped in the bottom row of each figure. It is the ensemble mean that is displayed on the website.

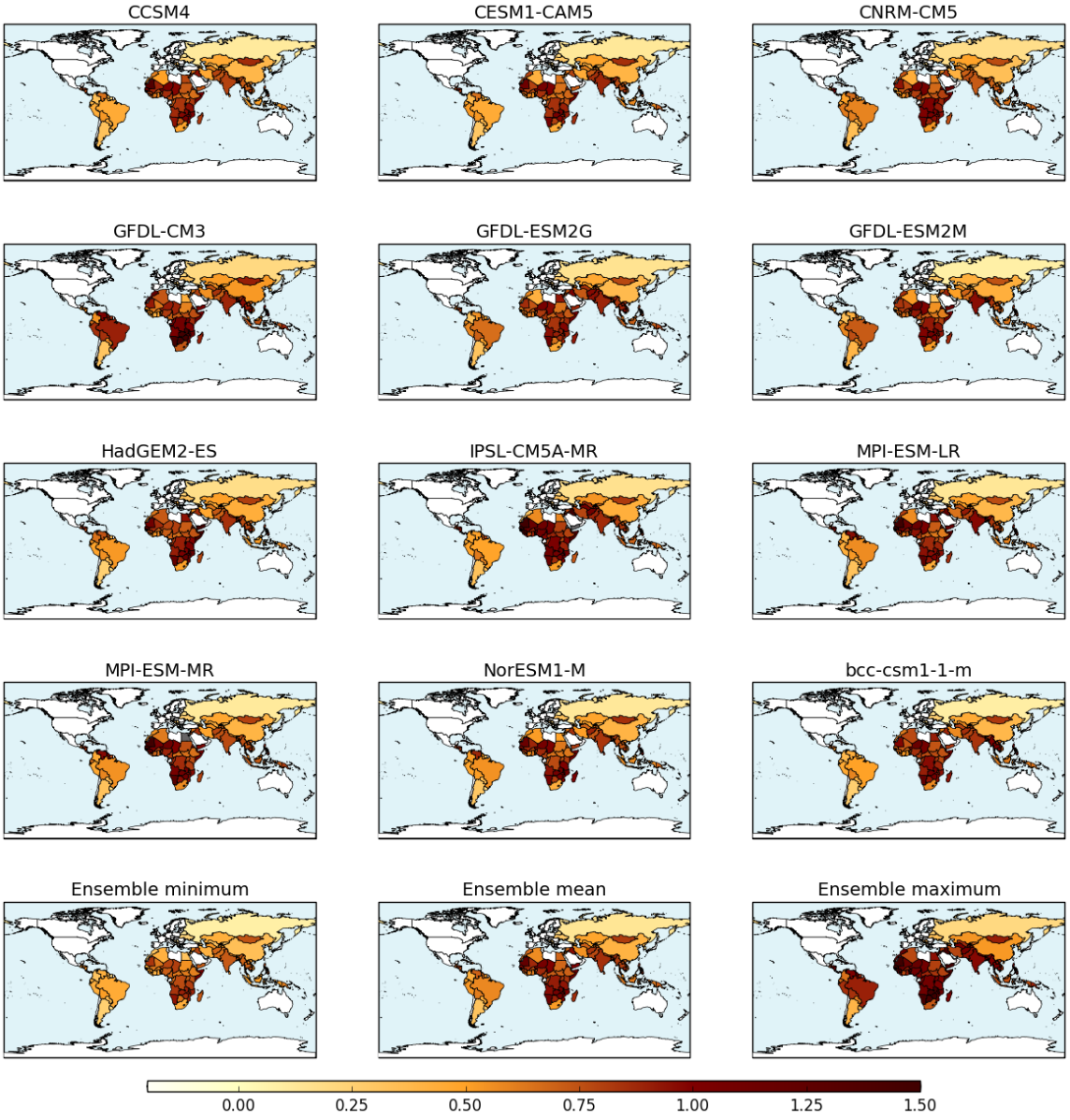

Figure 7 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the medium emissions and no adaptation scenario in the 2050s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

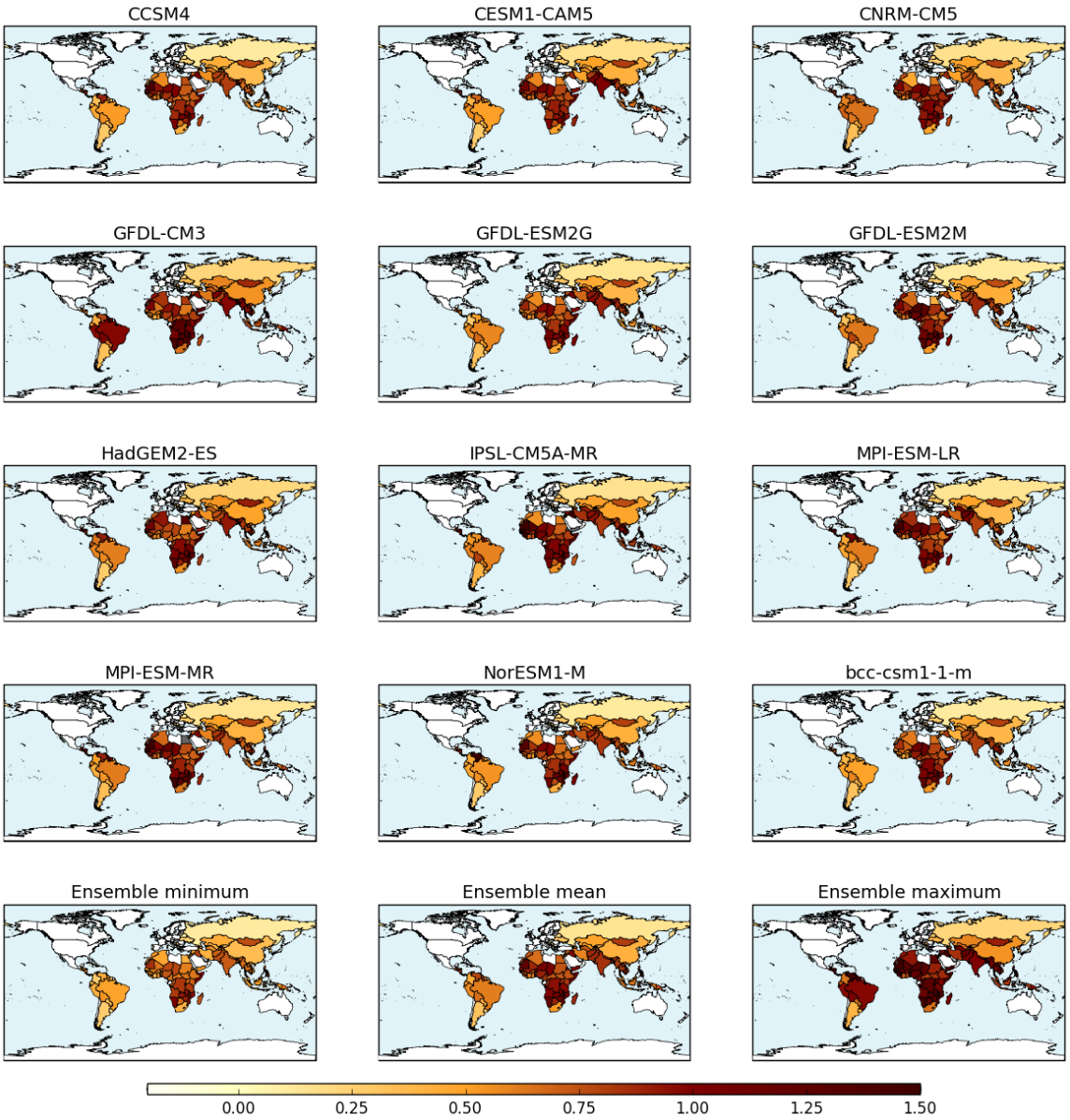

Figure 8 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the medium emissions and no adaptation scenario in the 2080s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

2.5 Medium emissions, low adaptation

The climate and food insecurity index is mapped for each of the 12 models used in this study for the medium emissions and low adaptation scenario in Figure 9Figure 1 for the 2050s, and in Figure 10 for the 2080s. The minimum, mean and maximum values per country across the ensemble of models are mapped in the bottom row of each figure. It is the ensemble mean that is displayed on the website.

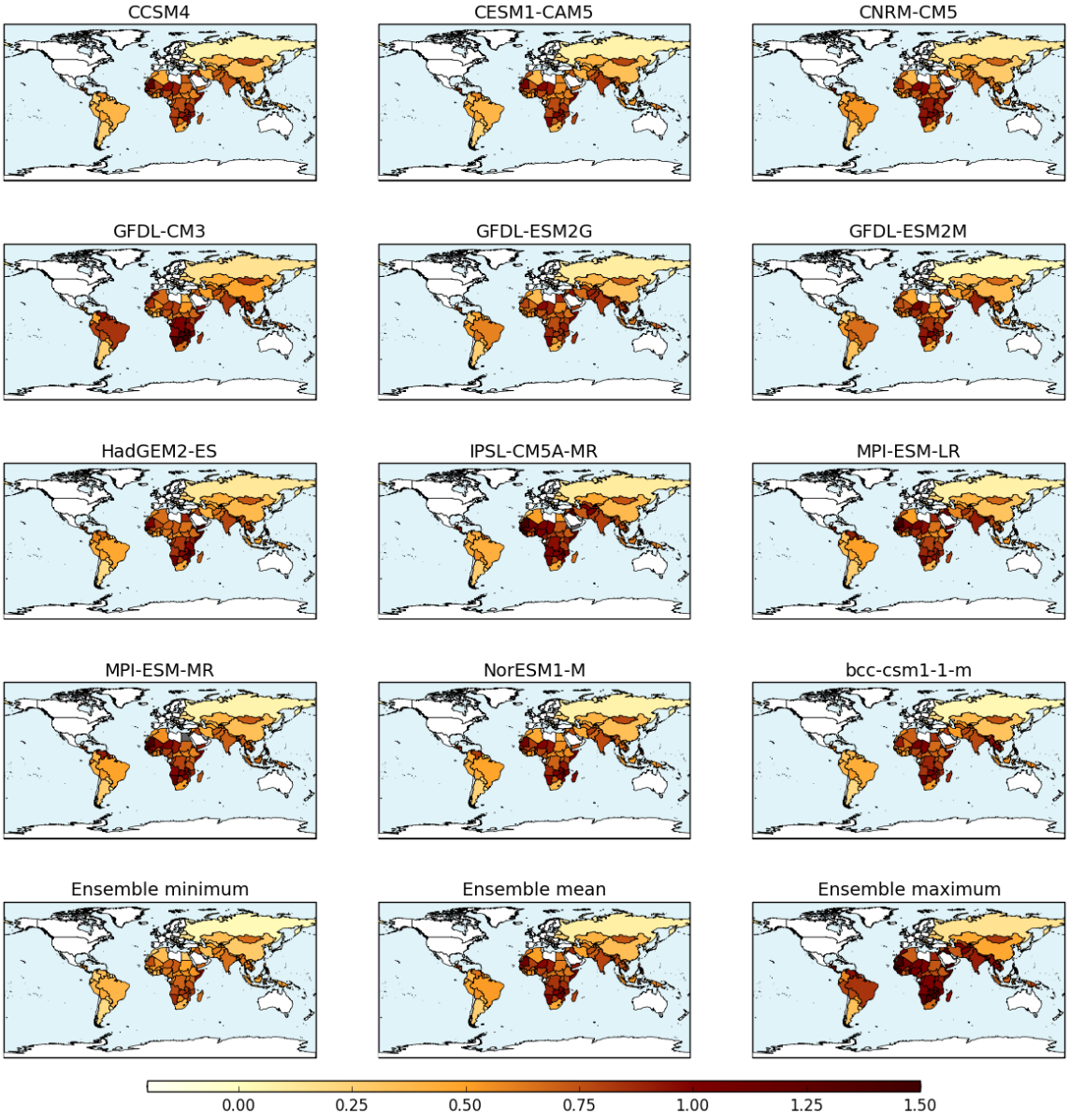

Figure 9 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the medium emissions and low adaptation scenario in the 2050s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

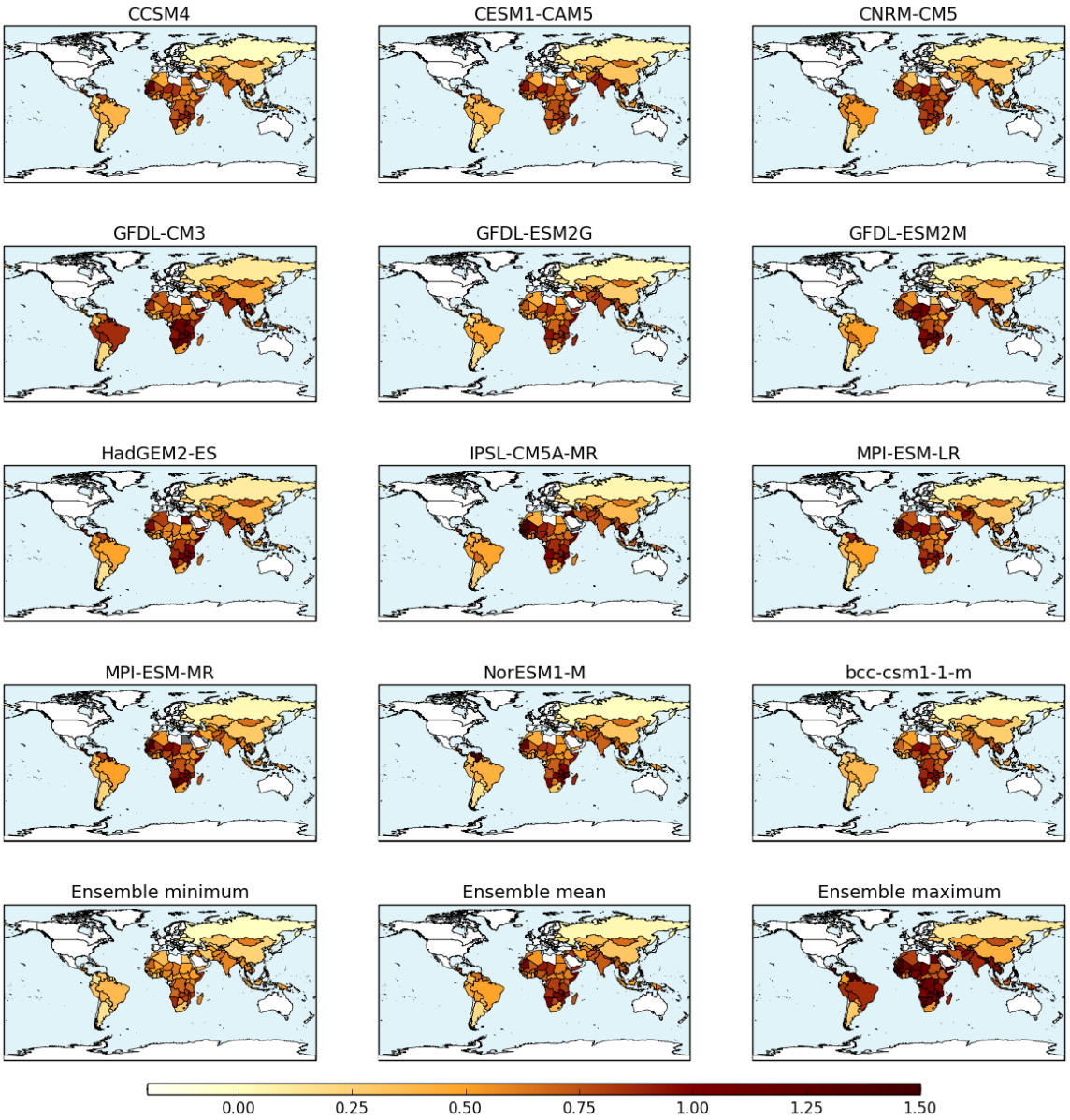

Figure 10 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the medium emissions and low adaptation scenario in the 2080s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

2.6 Medium emissions, high adaptation

The climate and food insecurity index is mapped for each of the 12 models used in this study for the medium emissions and high adaptation scenario in Figure 11 for the 2050s, and in Figure 12 for the 2080s. The minimum, mean and maximum values per country across the ensemble of models are mapped in the bottom row of each figure. It is the ensemble mean that is displayed on the website.

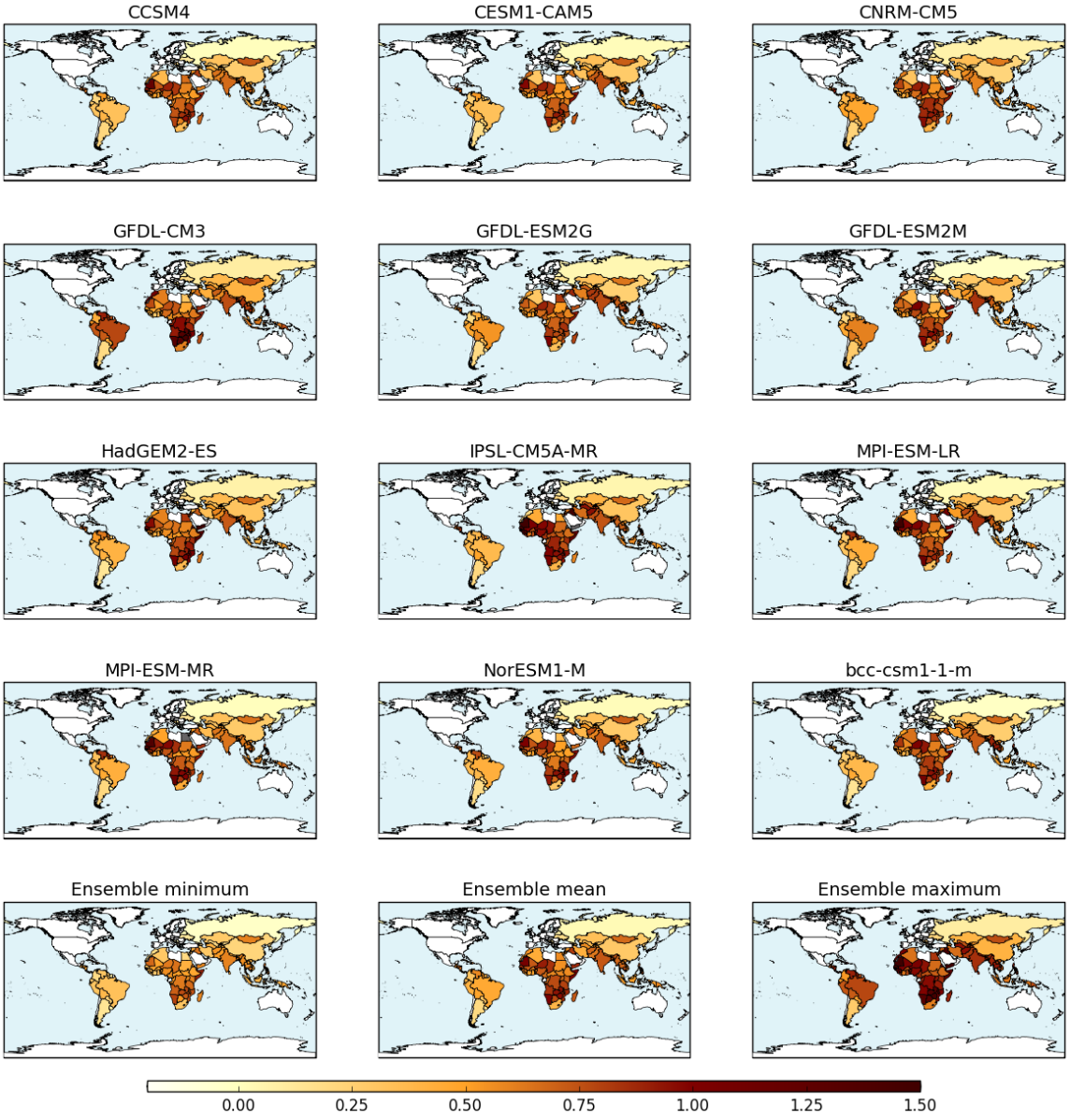

Figure 11 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the medium emissions and high adaptation scenario in the 2050s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

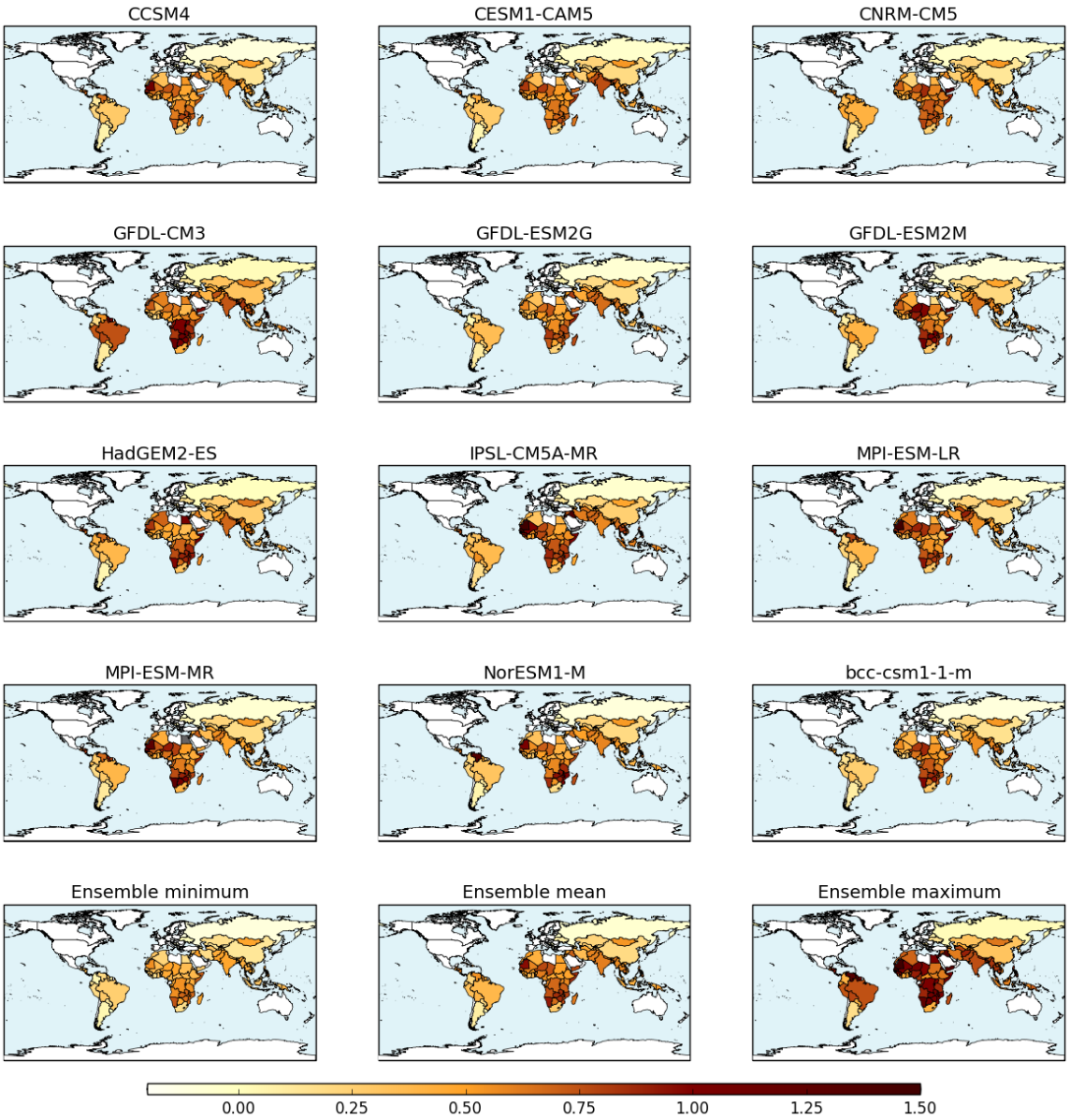

Figure 12 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the medium emissions and high adaptation scenario in the 2080s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

2.7 High emissions, no adaptation

The climate and food insecurity index is mapped for each of the 12 models used in this study for the high emissions and no adaptation scenario in Figure 13 for the 2050s, and in Figure 14 for the 2080s. The minimum, mean and maximum values per country across the ensemble of models are mapped in the bottom row of each figure. It is the ensemble mean that is displayed on the website.

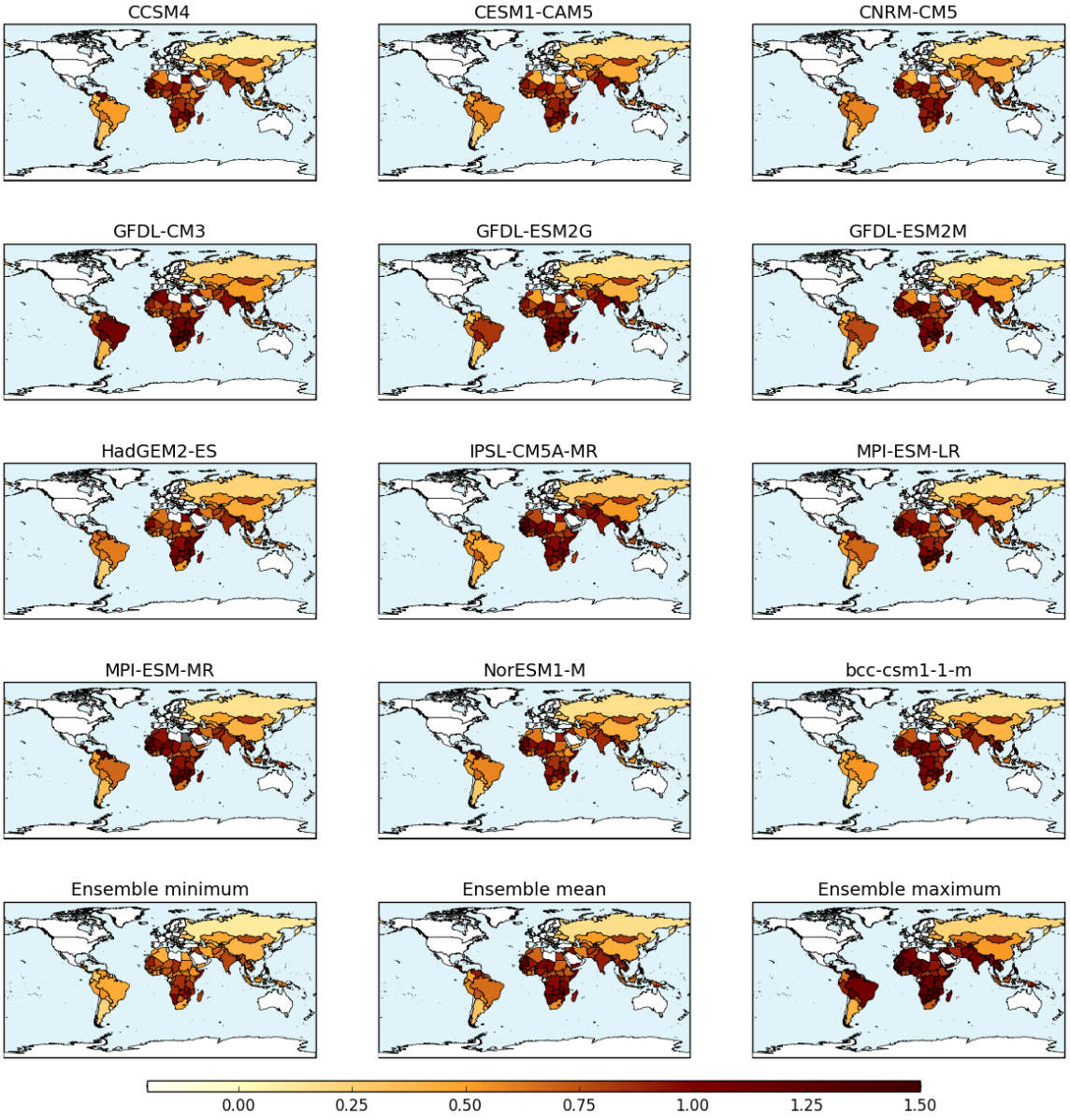

Figure 13 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the high emissions and no adaptation scenario in the 2050s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

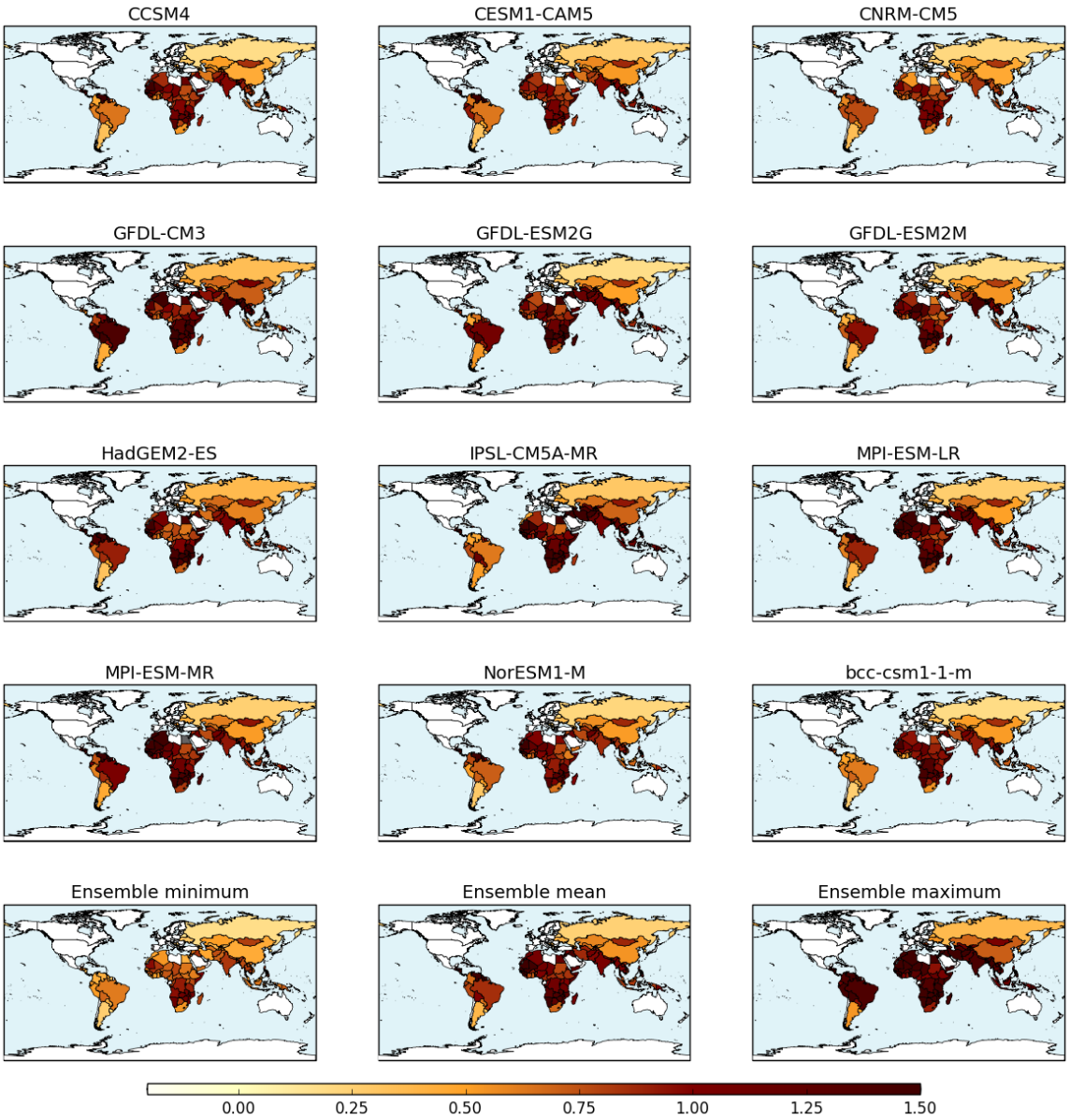

Figure 14 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the high emissions and no adaptation scenario in the 2080s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

2.8 High emissions, low adaptation

The climate and food insecurity index is mapped for each of the 12 models used in this study for the high emissions and low adaptation scenario in Figure 15 for the 2050s, and in Figure 16 for the 2080s. The minimum, mean and maximum values per country across the ensemble of models are mapped in the bottom row of each figure. It is the ensemble mean that is displayed on the website.

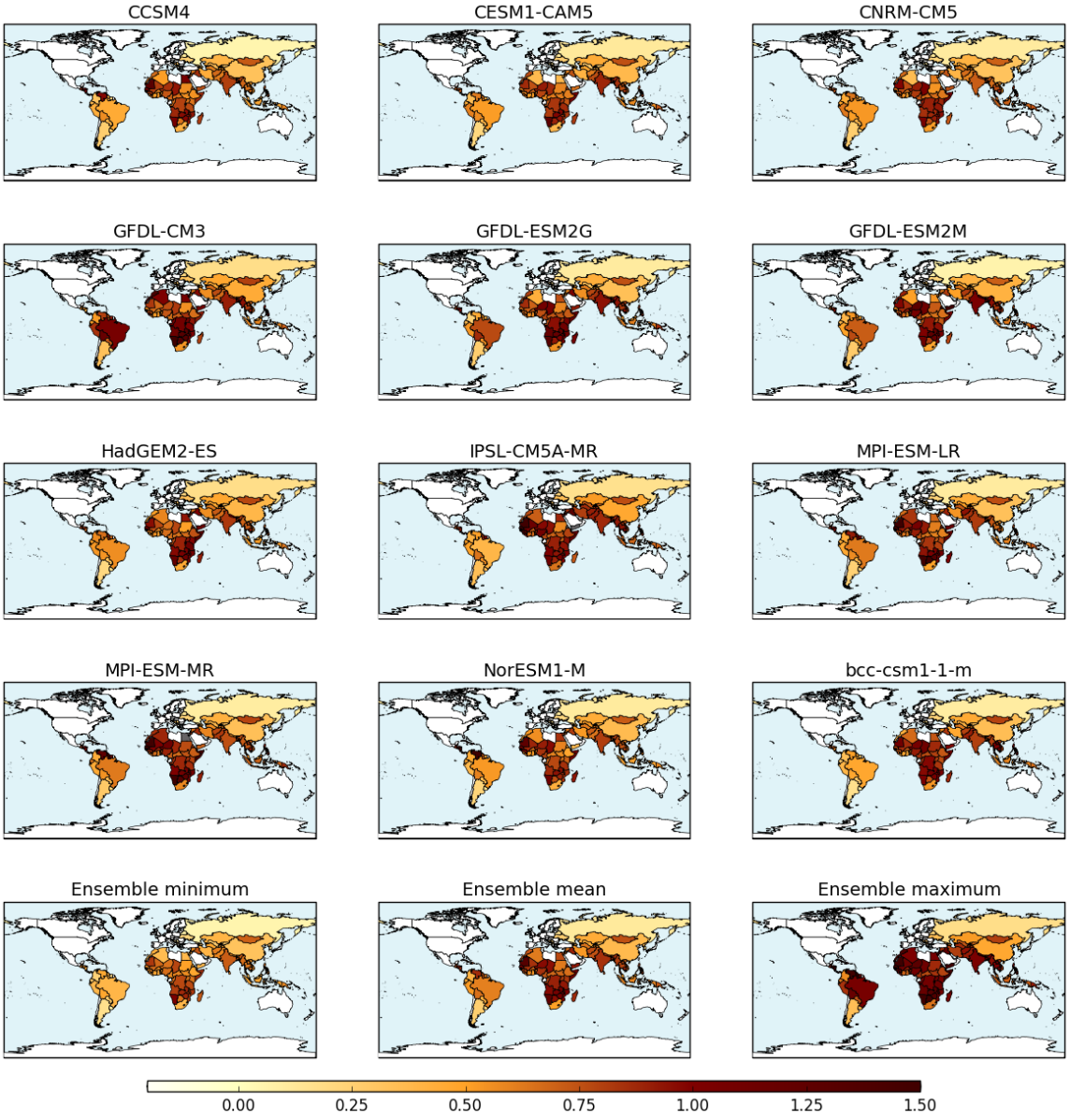

Figure 15 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the high emissions and low adaptation scenario in the 2050s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

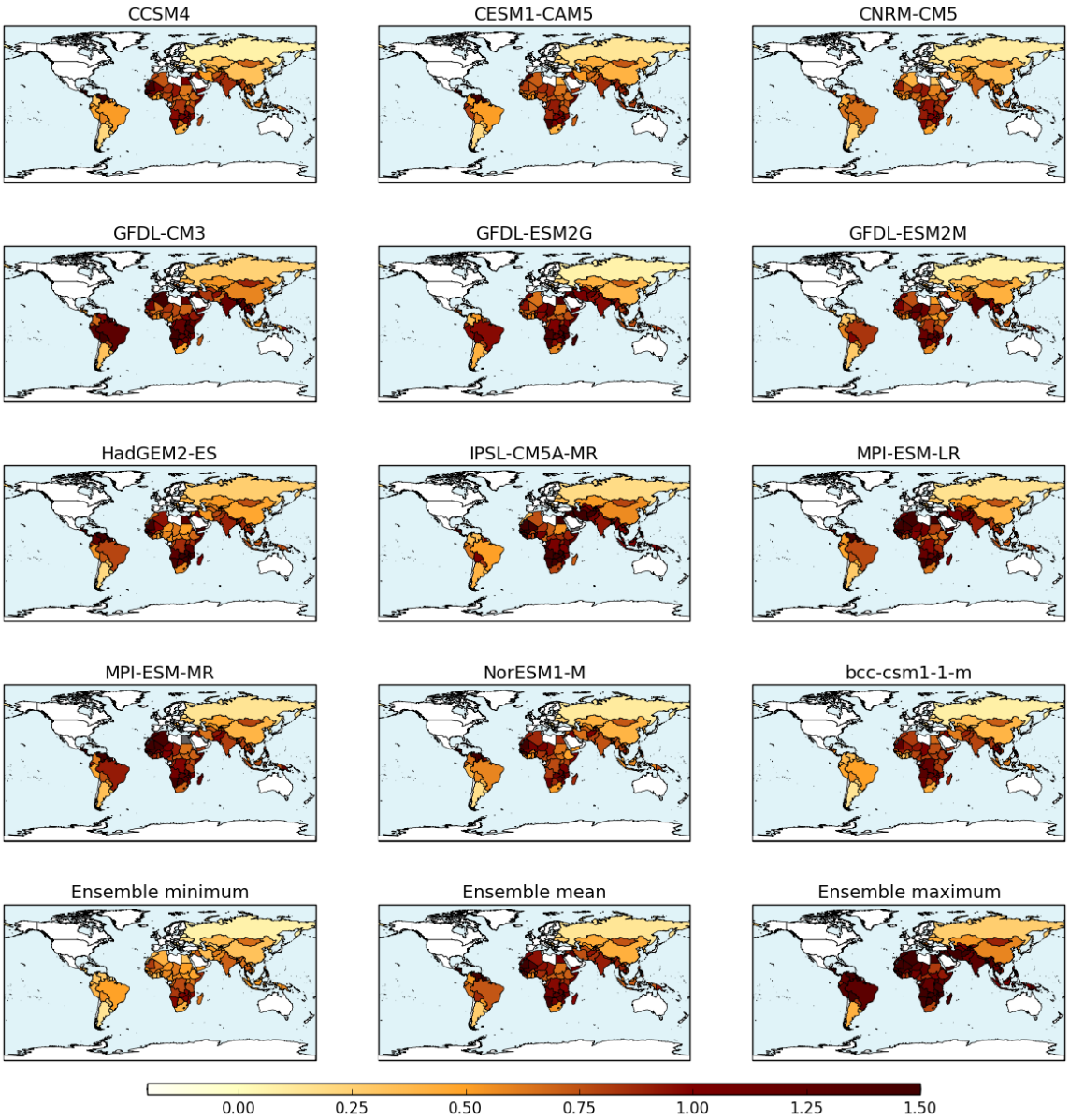

Figure 16 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the high emissions and low adaptation scenario in the 2080s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

2.9 High emissions, high adaptation

The climate and food insecurity index is mapped for each of the 12 models used in this study for the high emissions and high adaptation scenario in Figure 17 for the 2050s, and in Figure 18 for the 2080s. The minimum, mean and maximum values per country across the ensemble of models are mapped in the bottom row of each figure. It is the ensemble mean that is displayed on the website.

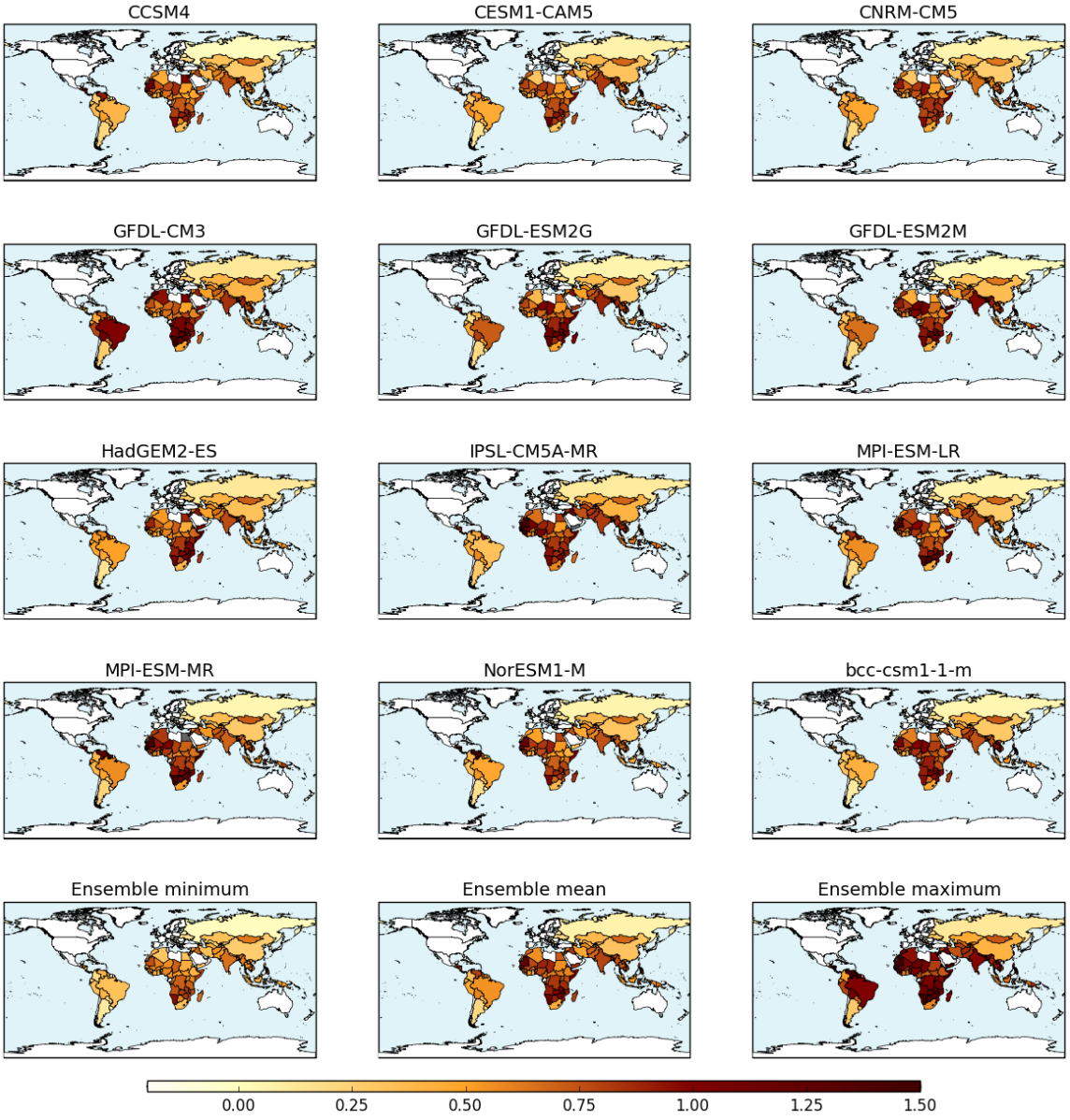

Figure 17 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the high emissions and high adaptation scenario in the 2050s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

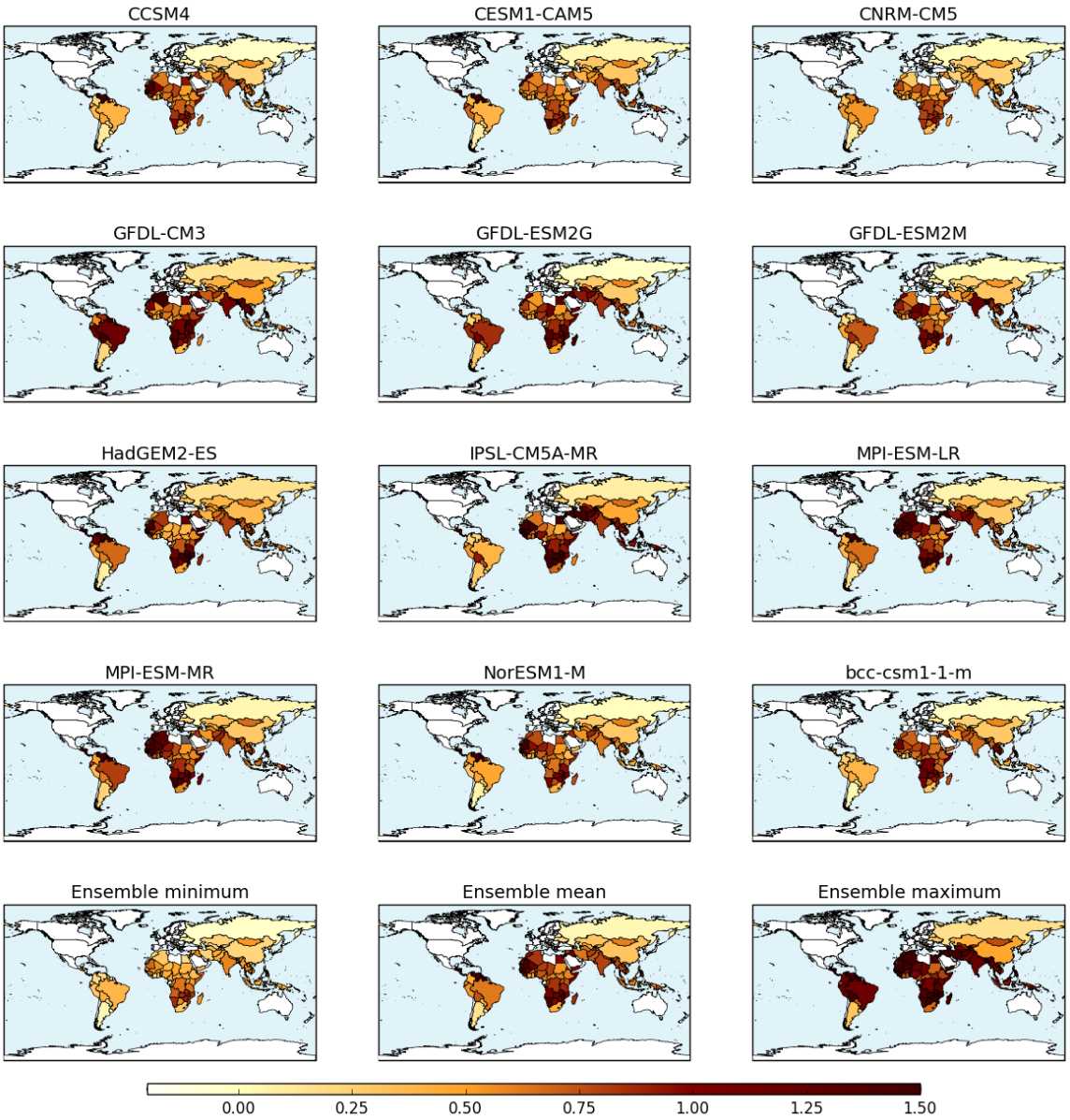

Figure 18 – Climate and food insecurity index for the 12 CMIP5 climate models used in this study for the high emissions and high adaptation scenario in the 2080s. The minimum, mean and maximum values per country are mapped in the bottom row. Countries excluded from the index are white, and those which do not have an exposure component are coloured grey.

3 References

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Taylor, K.E., R.J. Stouffer, and G.A. Meehl, 2012: An Overview of CMIP5 and the experiment design." Bull. Amer. Meteor. Soc., 93, 485-498, doi:10.1175/BAMS-D-11-00094.1.

