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Visualizing projected Climate Changes - the CMIP5 Multi-Model Ensemble

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Large ensembles add an additional dimension to climate model simulations. Internal variability of the climate system can be assessed for example by multiple climate model simulations with small variations in the initial conditions or by analyzing the spread in large ensembles made by multiple climate models under common protocols. This spread is often used as a measure of uncertainty in climate projections. In the context of the fifth phase of the WCRP's Coupled Model Intercomparison Project (CMIP5), more than 40 different coupled climate models were employed to carry out a coordinated set of experiments. Time series of the development of integral quantities such as the global mean temperature change for all models visualize the spread in the multi-model ensemble. A similar approach can be applied to 2D-visualizations of projected climate changes such as latitude-longitude maps showing the multi-model mean of the ensemble by adding a graphical representation of the uncertainty information. This has been demonstrated for example with static figures in chapter 12 of the last IPCC report (AR5) using different so-called stippling and hatching techniques.

In this work, we focus on animated visualizations of multi-model ensemble climate projections carried out within CMIP5 as a way of communicating climate change results to the scientific community as well as to the public. We take a closer look at measures of robustness or uncertainty used in recent publications suitable for animated visualizations. Specifically, we use the ESMValTool [1] to process and prepare the CMIP5 multi-model data in combination with standard visualization tools such as NCL and the commercial 3D visualization software Avizo to create the animations. We compare different visualization techniques such as height fields or shading with transparency for creating animated visualization of ensemble mean changes in temperature and precipitation including corresponding robustness measures.

[1] Eyring, V., Righi, M., Lauer, A., Evaldsson, M., Wenzel, S., Jones, C., Anav, A., Andrews, O., Cionni, I., Davin, E. L., Deser, C., Ehbrecht, C., Friedlingstein, P., Gleckler, P., Gottschaldt, K.-D., Hagemann, S., Juckes, M., Kindermann, S., Krasting, J., Kunert, D., Levine, R., Loew, A., Mäkelä, J., Martin, G., Mason, E., Phillips, A. S., Read, S., Rio, C., Roehrig, R., Senftleben, D., Sterl, A., van Ulft, L. H., Walton, J., Wang, S., and Williams, K. D.: ESMValTool (v1.0) – a community diagnostic and performance metrics tool for routine evaluation of Earth system models in CMIP, Geosci. Model Dev., 9, 1747-1802, doi:10.5194/gmd-9-1747-2016, 2016.