# Possible Big-ticket Items

- **Model Development:** Earth System Models have developed significantly since the AR5, by increases in model resolution, improvements in physical parameterizations (e.g. clouds), and inclusion of additional Earth System processes (e.g. N-limits on the terrestrial carbon cycle, Fe-limits on marine productivity). These additional ES processes are needed to represent key feedbacks on climate change, but are also likely increase the climate projection spread, in the absence of more comprehensive model evaluation. ***We therefore recommend a tighter coupling between model development and model evaluation, by exploiting new observations and evaluation tools.***

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- **Model Evaluation:** a major advance for the IPCC AR5 was the much improved availability of outputs from ESMs. For AR6 we will have in addition access to routine model evaluation packages (such as ESMvalTool and PMP). We anticipate that this new capability to assess models against observations more quickly and easily, will accelerate model development especially concerning long-standing systematic biases. ***We recommend the clear prioritization of metrics related to the key biases and processes that need most attention.*** Despite improved in certain domains (especially from remote-sensing), ***some domains of the Earth System desperately need better data coverage (e.g. ocean, biosphere).***

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- **Model Weighting:** we have a deeper understanding that defining "good" and "bad" models is difficult and depends fundamentally on the application, because different models agree with different aspects of the observations. When using ESMs for ensemble projections, it is important to account for the fact that ESMs are not independent (as many share components), and that they often do not evenly span the range of possible futures. Recent advances have been made in dealing with both of these issues. ***Understanding the implications of different approaches to model weighting is now urgent, alongside extension of weighting metrics to include variability (especially where this relates to emergent constraints).***

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- **Emergent Constraints:** are relationships between an observable variation (trend, variability, trend in variability) and some aspect of the future climate, that *in principle* allow the range of future projections to be reduced. Many ECs have been 'proposed' since the AR5, but few have been 'confirmed' – which involves both identifying a plausible mechanism for the EC, and also validation against independent models that were not used to define the original relationship. Nevertheless, we anticipate ECs will become more prevalent over the next decade. To mitigate the risk of spurious ECs, that could for example be found through blind data-mining, ***there is a need to develop and apply 'best practices' for the identification and application of ECs.***