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Impact of initial conditions with respect to external forcing in the decadal predictions: a sensitivity experiment

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Sensitivity experiments have been performed to isolate the impact of the initial conditions from the impact of external forcing in decadal predictions. They consist of four 10-year long multi-model ensemble hindcasts (SWAP experiments): two control integrations initialised with estimates of the 1965 and 1995 climate states and external forcing such as, aerosols, solar activity and greenhouse gases of 1965-1975 and 1995-2005 decades; two sensitivity hindcasts starting the same dates as control but swapping forcing and initial conditions, i.e. the integrations are initialised in 1965 and 1995, but using the external forcing of 1995-2005 and 1965-1975 respectively. By comparing control and sensitivity integrations we estimate the impact of external forcing versus initial conditions on the predictability over multi-annual time scale. To give a quantitative measure of these two relative contributions a crossover time is defined as the forecast time range when information from initial condition and forcing are equal. We focus on the impact of initial conditions vs. external forcing on the predictability of sea surface (and sub-surface) temperature and the Atlantic branch of the meridional overturning circulation (AMOC).
We show that over time scales longer than about 1 year predictability of SSTs on a global domain arises mainly from the forcing. The correct initialisation seems to have a longer impact on SST predictability over selected regions such as North Atlantic, North-West Pacific and Southern Ocean. The impact of initialisation is longer and extends to wider regions when under-surface ocean variables are considered. Over the Tropical Atlantic the impact of initialisation for the 700 m heat content extends to as much as 10 years for one of the models considered. In all models considered the impact of initial conditions on the predictability of the AMOC is dominant for the first 5 years. In some models the influence of initial conditions is apparent up to 9-year lead time. These results have to be tempered by the fact that the band of uncertainty associated with the natural variability, estimated here using the ensemble spread, is not negligible.