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Uncertainties in Atlantic multi-decadal variability

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North Atlantic sea surface temperature (SST) exhibits pronounced multi-decadal variability (AMV), with significant climate impacts across the Northern Hemisphere. Climate models suggest these are largely driven by changes in the Atlantic Meridional Overturning Circulation (AMOC). The ability to predict AMV requires a better understanding of both the mechanisms for fluctuations in the Atlantic AMOC, and the impact of externally driven climate change. Here, using the CMIP3 database, simulations with the Kiel Climate Model (KCM) and stand-alone NEMO ocean model integrations, three aspects of Atlantic AMOC variability and change will be discussed: First, while most climate models predict a weakening of AMOC during the twenty-first century, large uncertainty exists. Quantification of the different sources of uncertainty - external, internal and model - indicates model uncertainty is the largest contribution, internal variability is significant during the first decades, while scenario uncertainty is almost negligible. The different contributions to model uncertainty - wind and density, salinity and temperature - will be also discussed. Second, large uncertainties also exist in the mechanisms for internal AMOC variability. Analysis of the CMIP3 models shows a wide range of simulated variability in terms of timescale and spatial structure. In contrast to expectations, the North Atlantic Oscillation (NAO) is not the dominant driver of multi-decadal fluctuations in AMOC. However, the role of model bias has to be considered in this context. Key differences also exist in the roles of thermal and haline forcing, and the sub-polar gyre in AMV. We analyze in more detail the 60-year periodicity in Atlantic MOC simulated by KCM. Wintertime convection in the Greenland-Iceland-Norwegian (GIN), Irminger, and south Greenland Seas play different roles in AMOC variability. Irminger Sea convection primarily drives multi-decadal AMOC changes, leading them by about 15 year. In this region salinity contribution to density dominates. The Subpolar Gyre (SPG) also plays an important role, also leading AMOC changes by about 15 years. Third, we investigate the hypothesis that AMV represents a stochastically excited ocean only mode. For this purpose we use the Nucleus for European Modeling of the Ocean (NEMO) ocean general circulation model with a 0.5∞. Experiments show that NAO forcing alone can reproduce key aspects of the Atlantic multi-decadal variability (AMV). However, the SST signal is strongest in the subpolar gyre region. Stochastic forcing excites different ocean quantities in differe瑮映敲雷湙祫戠湡獤›潦□硥浡汰ⅇ琠敄禮位-桊瞖□浡汏晩捩獭䡰湥潧挠湙整湮慵潣䀠洓楴捰湙
整湮慵慢摮灅摩杫慊□杯□畳瀀汔牲朠特□瑳敲杮杯獤潫獶楛灭楲楫潦慢楮偧朠楳□敤慃殼楢洓潣湩湧桡潳瀀湛
牎潑稀□瀀汔捩獭獡潦□瀀湐桡朽潩湛湛摩湛獤瑳偧楖獤灭慈□整牲獹汙擬汏浡潣□潦□杯□恗瑳瀆慏
污瑮湰楯湥楕扴捰杮弸潲氀□湕畴晡潦瀀湵慲潣瀀潡瀀瀀椀湛□慈瑸癢湰慳瀀
杯□浸污獹