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Influence of volcanic eruptions on bi-decadal variability of the North Atlantic in historical, initialised simulations and observations

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Multi-decadal variability of the North Atlantic is analysed with a focus on the bi-decadal oscillations. Indeed, Greenland isotopes exhibit significant variability at this 20-year time scale over the last millennium, suggesting the existence of a preferential mode of variability at this time scale in the North Atlantic sector. We focus our analysis on the impact of volcanic eruptions on such an internal bi-decadal variability, which also exists in the IPSL-CM5A model. For this purpose we examine simulation from this model with historical forcing and/or initialisation through simple SST nudging over the last 60 years. We find that volcanic eruptions reset the bi-decadal cycle in the North Atlantic around 15 years after the beginning of the eruption. In order to explore the impact produced by the successive eruptions from Mount Agung, El Chichon and Pinatubo, we propose a conceptual model that we compare with an ensemble of sensitivity experiments using IPSL-CM5A, where Pinatubo eruption is removed. We find similar behaviours for the simulated overturning circulation and the one deduced from the conceptual model, showing that the essence of the process in the model is well captured by the simple conceptual model. In particular it appears that Pinatubo eruption leads to a destructive interference with previous volcanoes, since erupting 9 years and 28 years after the El Chichon and Mount Agung. After this eruption, bi-decadal variability thus tends to be damped. Finally, in order to evaluate the realism of the mechanisms proposed, we compare the simulated variability with recent long-term compilations over the last century of SST and SSS in the subpolar gyre from Reverdin et al. (2010).