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Impact of climate change on surface wind regime over the Peru-Chile upwelling region

K. Goubanova (1,2), V. Echevin (2), B. Dewitte (1), R. Garreaud (3), P. Terray (2), and M. Vrac (4)

(1) LEGOS/CNRS, Toulouse, France (kglmd@lmd.jussieu.fr), (2) LOCEAN/IRD, Paris, France, (3) Department of Geophysics, Universidad de Chile, Santiago, Chile, (4) LSCE/CNRS, Gif-sur-Yvette, France

The ocean region off the Chile-Peru coast is characterized by upwelling of cold, nutrient-rich waters, which drives an exceptionally high biological productivity. This upwelling is induced by the persistent southerly winds along the coast that exhibit a coastal jet structure at intraseasonal scales. Recent climate change studies based on the coupled atmosphere-ocean general circulation models (AOGCM) show a strengthening of the large-scale southerlies along the subtropical coast that could lead to an increase in coastal upwelling. However the coastal jet events which represent a considerable source of the synoptic variability of the alongshore winds are characterized by horizontal scale comparable to a AOGCM grid cell size, and cannot be therefore explicitly resolved by the AOGCMs.

In order to provide a regional estimate of the winds as predicted by the coarse-resolution AOGCMs, a statistical downscaling method based on multiple linear regression is proposed. Large-scale wind at 10 m and sea level pressure are chosen as the predictor variables for regional 10 m wind. The validation is performed in two steps. First, QuikSCAT and ERS satellite products and NCEP reanalysis for the period 1992-2006 are used to build and validate the statistical model for the present climate. Second, the model is validated under a warmer climate: it is applied to large-scale predictors extracted from HadCM3 AOGCM simulations for the A2 and B2 SRES scenarios (2071-2100); the downscaled wind is then compared with outputs of the PRECIS regional climate model, forced at its boundaries by the same HadCM3 scenarios.

To assess climate change impact on the along-shore wind, the statistical downscaling is applied to two contrasted SRES scenarios, namely the so-called preindustrial and CO2 quadrupling. The outputs of the IPSL-CM4 AOGCM are used as predictors. Evolution of the along-shore wind regime with a focus on the change of the coastal jet characteristics is discussed. For this particular AOGCM, we show a decrease of coastal jet activity in terms of mean and variability due to decreasing activity of anticyclone of the Southwest Pacific.

At last, the impact of the change in wind regime on the coastal upwelling is assessed using a regional ocean model (ROMS) forced by the downscaled high-resolution wind field.