MARSPEC: ocean climate layers for marine spatial ecology

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Abstract. Ecological niche models are widely used in terrestrial studies to address critical ecological and evolutionary questions related to past and future climate change, local adaptation and speciation, the discovery of rare endemics, and biological invasions. However the application of niche models to similar questions in marine ecosystems has lagged behind, in part due to the lack of a centralized high-resolution spatial data set representing both benthic and pelagic marine environments. Here we describe the creation of MARSPEC, a high-resolution GIS database of ocean climate layers intended for marine ecological niche modeling and other applications in marine spatial ecology. MARSPEC combines information related to topographic complexity of the seafloor with bioclimatic measures of sea surface temperature and salinity for the world ocean. We derived seven geophysical variables from a high-resolution raster grid representing depth of the seafloor (bathymetry) to characterize six facets of topographic complexity (east–west and north–south components of aspect, slope, concavity of the seafloor, and plan and profile curvature) and distance from shore. We further derived 10 bioclimatic variables describing the annual mean, range, variance, and extreme values for temperature and salinity from long-term monthly climatological means obtained from remotely sensed and in situ oceanographic observations. All variables were clipped to a common land mask, interpolated to a nominal 1-km (30 arc-second) grid, and converted to an ESRI raster grid file format compatible with popular GIS programs. MARSPEC is a 10-fold improvement in spatial resolution over the next-best data set (Bio-ORACLE) and is the only high-resolution global marine data set to combine variables from the benthic and pelagic environments into a single database. Additionally, we provide the monthly climatological layers used to derive the bioclimatic variables, allowing users to calculate equivalent MARSPEC variables from anomaly data for past and future climate scenarios. A detailed description of GIS processing steps required to calculate the MARSPEC variables can be found in the metadata.

Key words: climate change; ecological niche modeling; GIS; marine spatial ecology; ocean climate; salinity; sea surface temperature; species distribution modeling.