Key Ocean Variables Mapped with Consideration of CMIP5 Climate Change Data

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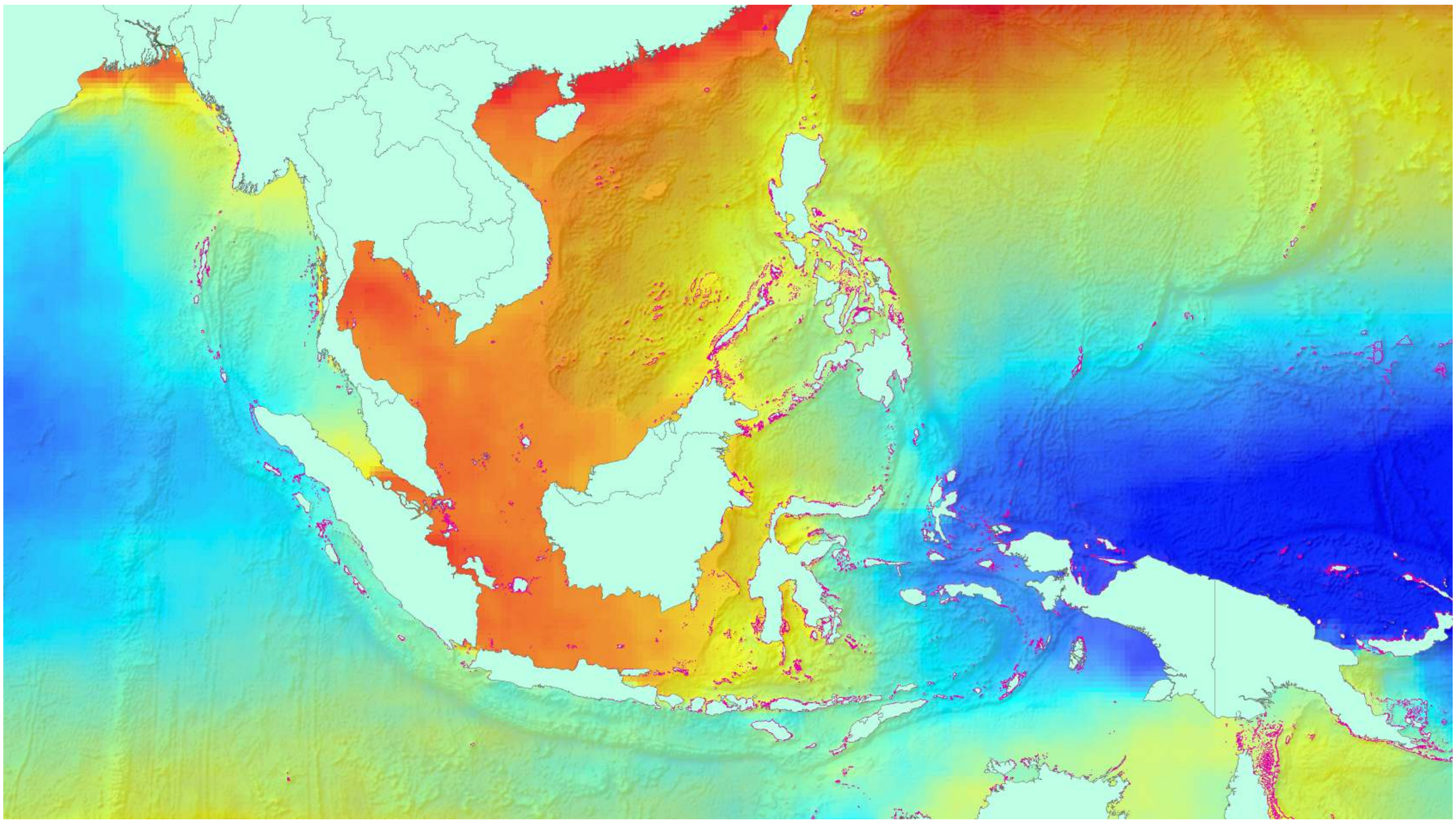
SimCLIM
for ArcGIS / Marine



About a third of the CO_2 released in the atmosphere dissolves in the oceans, where it slightly lowers the pH. This effect is known as ocean acidification.

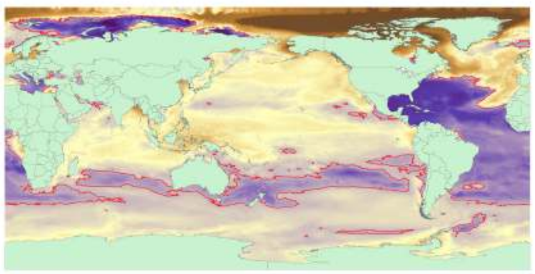
Ocean acidification is of great concern: small changes in pH impact the $CaCO_3$-CO_2 equilibrium thus slowing coral growth and weakening the coral that does grow under such conditions.

The image shows the result from 12 models from the CMIP5 data for changes in pH. Because pH is a log-scale unit, the ratio of pH for 1995 and 2035 is presented. The redder colour shows a stronger change. This is mostly occurring in shallower areas, as there is an effect from temperature as well. As the model-data (using grid-cells of 0.5°x0.5°) does not cover partial cells close to the coastline, the FILTER function of ArcGIS was used to fill in the gaps.

The pH-information is combined with other data:

- country data (grey land and black boarders)
- coral reef locations (purple)
- ocean bathymetry (from ETOPO1, through ArcGIS-online) (this layer is visible because the pH layer has been made 25% transparent)

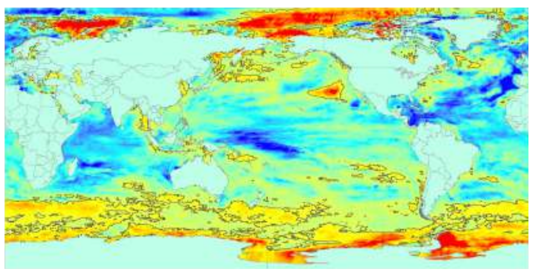
The image is a beautiful example of how a toolbar (the CLIMsystems "Marine" toolbar, which was newly developed in addition to the "Climate" toolbar), combines perfectly with the functionality of ArcGIS.



Change in Alkalinity

The image shows the distribution of the relative change in total alkalinity: purple areas increase, brown areas decrease, with the contour lines separating the areas.

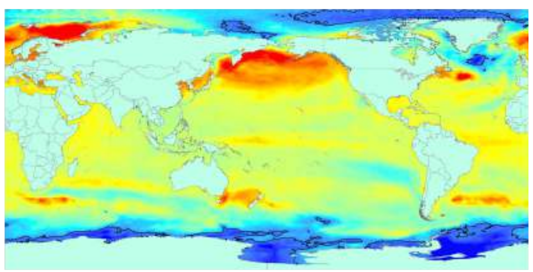
The total alkalinity is (by definition) NOT affected by temperature, pressure, or pH. As in most natural waters, all ions except HCO_3^- and CO_3^{-2} have low concentrations, the total alkalinity is approximately equal to carbonate alkalinity, which is equal to $mHCO_3^- + 2mCO_3^{-2}$.



Change in net primary production

Changes in the surface chemistry and temperature of the oceans because of climate change, impact the primary production from phytoplankton. The image shows the distribution of the relative change in net primary production. In the blue areas the production decreases, and the yellow/red areas it increases (more than a factor of 2, by 2100 under the RCP8.5 emission pathway). The contour lines separate the areas of increase from those decreasing.

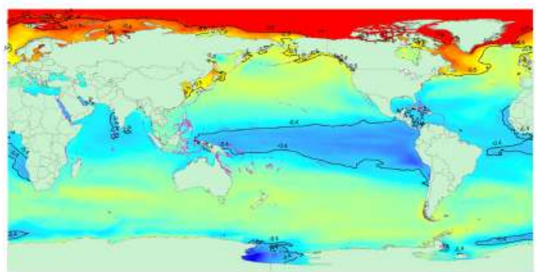
The increase is mostly situated in the colder regions, while the decrease is primarily in the areas that are already warmer. i.e. the Gulf Stream from the Gulf of Mexico to Europe is clearly visible.



Change in oxygen concentration

Changes in surface oxygen concentrations have complex origins. Temperature increase and changes in nutrients alter primary production which impacts the oxygen concentration, but temperature also determines the oxygen saturation levels.

The image shows the distribution of the relative change of the surface oxygen concentration: blue areas increase, yellow/red areas decrease, with the contour line depicting the boundary between increase and decrease.



Change in pH

The image shows the global shift in pH under the most extreme scenario (RCP8.5, by the year 2100). Although acidification is "smallest" in the areas with coral reefs (purple), the shift is many times more than these reefs are likely to survive.

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