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Modeling the climate impacts of the messinian desiccation

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The Messinian desiccation is the only known event when a substantial region of dry ground existed at such great depths below sea level. Since there is no good present analog, geologists cannot expect to estimate its climate implications by comparison with or extrapolation from current features. Thus the desiccation presents a good opportunity for progress using sophisticated modeling tools. Climate questions amenable to modeling can be placed in two groups. The first group concerns the climate of the exposed basin itself, and how climate change forced by reduction in sea level may have interacted with the desiccation process. How did the desiccation proceed, against the increasing difficulty of removing water from an ever deeper basin? The second group concerns the impact of a large sub-sea level depression on the flow of the atmosphere, and resulting changes in cloudiness, precipitation and dustiness.

To investigate these questions we are using a range of models, from single column models through dry stationary wave response models and regional climate models to general circulation models. Here we present results from single column experiments, and from a simple GCM.

Preliminary work with a single column model using the Emanuel (1991) convection scheme and Chou (1994) radiation scheme demonstrate that the temperature at a lowered sea level depends strongly on the strength and nature of the coupling between the atmosphere over the basin and the surrounding atmosphere. Increased sea level pressure alone has very little impact on surface temperature for spring conditions, yielding instead a reduction in tropopause height. However, an assumption that temperatures in the free troposphere above the deep basin would be dynamically linked to temperatures outside the basin produces a much warmer surface temperatureÑan increase well approximated by extrapolation by a moist adiabat from the 1000 mb to the 1200 mb level.

Two experimental model simulations, using the Planet Simulator GCM, demonstrate the effects of the Mediterranean drawdown. In the first simulation, the surface of the Mediterranean is lowered, leaving standing water in the bottom of the basin. In the second simulation, basin is emptied, representing the completely desiccated basin. Both experiments are compared to a control simulation, where the Mediterranean remains unchanged.

Results from these simulations show the strongest changes during the summer months of June, July, and August. Surface temperatures show a decrease of up to 10 K in the Mediterranean region for the lowered water level simulation, while the desiccated basin shows an increase of up to 15 K. Shifts in upper and lower wind patterns, surface pressure, and precipitation patterns were also observed. The findings indicate that the Messinian Salinity Crisis had a considerable effect on the regional climate.