How does the Land-Ocean distribution affect atmospheric circulation on the planet? Evidence from eolian dune records on Earth, Mars, and Titan

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Existence of water and Land-Ocean distribution on the planet’ s surface are thought to amplify the seasonal changes in interhemispheric temperature gradient, and thus affect the pattern of atmospheric circulation. However, relationships between Land-Ocean distribution and atmospheric circulation pattern has not been tested due to the lack of appropriate data-sets based on reliable proxy. Eolian dunes are particularly suited for comprehensive planetary studies because they are generally present on terrestrial planets and moons (e.g., Earth, Mars, and Titan). The distribution, orientation, and morphology of eolian dunes are thought to record surface wind patterns and atmospheric circulation system on the planets and moons (Hasegawa, 2012). In order to discuss the role of Land-Ocean distribution against atmospheric circulation pattern on the planets, we compared the eolian dune records and wind circulation pattern reconstructed by general circulation models (GCM) of the present and past Earth, present and past Mars, and present Titan.

As a result, we find marked relationships between Land-Ocean distribution and atmospheric circulation pattern as follows. In the Ocean Planet-type with dispersed continents (e.g., present Earth), zonal and symmetrical atmospheric circulation pattern is developed because interhemispheric temperature gradient is relatively small. On the other hand, cross-equatorial and asymmetrical atmospheric circulation is gradually dominant in response to the increase in Land area distribution, such as Ocean Planet-type with aggregated continents (e.g. Pangaean Earth), Lake Planet-type (e.g. Titan), and Land Planet-type (e.g. present Mars). However, we also noted the exceptions of the predominance of cross-equatorial and asymmetrical monsoonal circulation in Ocean Planet-type with aggregated continents in one side of the hemisphere (e.g. Rodinian Earth and past Mars).

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