Climate dynamics referenced to coastline: a restrospective

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Coexistence of land and sea is essential to make Earth’ s climate have periodicities due to revolution and rotation. Because of the quick rotation, the atmosphere has rather zonally symmetric structure, and its dynamics is described usually by coordinates referenced to the rotating earth, except for mesoscale or smaller. However, Ogino et al. (2016, 2017) show from 13-year TRMM observation and 30-year JMA reanalysis that the global rainfall distribution is a function of the distance from coastline (DFC) with has a strong peak at tropical coastline, which plays a role of dehydrator in the global atmospheric water circulation. A coastal region is with DFC smaller than few hundreds of kilometers. This rainfall peak may be associated mainly with the annual-cycle monsoon and the diurnal-cycle sea-land breeze circulation forced by the thermal contrast along the coastline. Therefore we need to consider atmospheric dynamics referenced to coastline even for larger scales, resembling the ocean dynamics. As the simplest case, a spherical coordinate system with a pole at the center of a circular land with the small-circular coastline is introduced. When the land is an “Arctic” continent with the North (Arctic) pole, the coastline becomes a (co-)latitude circle, and if the continental radius is smaller than the Arctic circle (33 deg co-latitude or 3,700 km) just as the actual Antarctica, the annual and diurnal variabilities of climate are not separated. If the continent radius becomes 90º co-latitude or 10,000 km, the equator becomes the coastline between the land and water hemispheres, which become also summer/winter hemispheres alternately with the annual cycle. This is often used as an extreme model of the Indian monsoon. Another simplest case is a sea-land breeze circulation around an island small enough to neglect the Coriolis force. In these extreme cases, the aspect ratios of the trans-coastal circulations are basically dependent on structures (dispersion relationships) of equatorial and gravity waves. Some intermediate cases will be shown, considering the large islands of the Indonesian maritime continent (Yamanaka, 2016; Yamanaka et al., 2018), to lead a basic explanation of the horizontal scale of the coastal region.

References

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