Dynamic coupling of Mauna Loa and Kilauea, Hawaii

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The neighboring Hawaiian volcanoes, Kilauea and Mauna Loa have long been recognized as having anti-correlated periods of eruptive activity, thought to reflect a competition for the same magma supply. Yet recent observations also show correlated inflationary episodes. Furthermore, magmas erupted at both volcanoes are isotopically distinct, indicating that each volcano has a separate magmatic plumbing system and is supplied with melt by different parts of the same mantle source. We present a model, which illustrates the feasibility that both volcanoes are connected through a shared asthenospheric partial melt zone, which facilitates dynamic stress transfer between both volcanoes through pore pressure diffusion. If pressure changes can be transmitted effectively between this deep partial melt zone and shallow storage reservoirs, perhaps through an open magma-filled lithospheric plumbing system, a likely possibility given the persistent long-lived eruptive activity at Kilauea and to a lesser extent at Mauna Loa, then stress changes can be transmitted from one volcano to the other. For example, an increase in the deep magma supply can cause a pressure rise in the partial melt zone and eventually simultaneous inflation of both Kilauea and Mauna Loa. By the same token, eruptive activity at one volcano may inhibit eruptions of the adjacent volcano, if there is no concurrent increase in deep magma supply. We model surface deformation at both Kilauea and Mauna Loa during the past decade, when a surge in asthenospheric melt supply resulted in simultaneous inflation at both volcanoes. Our model couples porous melt flow in a hypothetical partial melt zone with magma flux to and from magma storage reservoirs, and predicts geodetic observations of surface deformation at both volcanoes, as well as observed gas emissions at Kilauea. We find that despite the changes in pore pressure, and diffusion thereof within the partial melt zone, each volcano persistently captures a different part of this partial melt region, consistent with the long-lived isotopic differences in erupted magmas at each volcano.