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Spatiotemporal evolution of large-scale thermal anomalies in the Pacific Mantle: Leveraging geologic records of lithosphere subsidence within a Bayesian framework

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The oceanic lithosphere of the west-central Pacific displays two prominent features: (1) shallower bathymetry than expected for its age, also called the "Pacific Superswell", and (2) several atolls and guyots which formed as oceanic islands subsided; the associated geologic record suggests subsidence of these islands at uncharacteristic rates. Previously, the "Darwin Rise", a large-scale thermal upwelling in the equatorial Pacific mantle has been considered to have contributed to the uplift of the oceanic lithosphere in the Cretaceous. Subsequently, as the oceanic plate moved away from the region of thermal upwelling and/or as the upwelling waned, the oceanic lithosphere cooled and subsided. The process of *lithosphere re-heating*, correlated with unusually hot mantle which perturbs the thermal state of the overlying lithosphere, can plausibly explain these paleo-vertical motions. Recent plate reconstructions suggest the formation Cretaceous LIPs—present-day Ontong Java, Manihiki and Hikurangi Plateaus, on the Pacific seafloor. These features, linked with mantle plumes, bolster the hypothesis that the "Darwin Rise" perturbed the thermal structure of the oceanic lithosphere. Although existence of a mantle upwelling in the central Pacific is agreed upon, its space-time evolution as reflected in Pacific geology is poorly understood, which motivates this study.

Using a data-driven approach in an integrative Bayesian framework to recover the spatial and temporal characteristics of thermal anomalies in the Pacific mantle, we use several geologic datasets such as temporally rich subsidence information from guyots, atolls, and carbonate compensation paleo-depths and spatially rich present-day bathymetry. We incorporate most recent plate reconstructions and do not assume a lithosphere cooling model, such as the half-space or plate-cooling models. In addition to the space-time attributes, we use our join-inversion scheme to constrain (1) the additional heat supplied to the lithosphere by these unusually hot mantle features, (2) the subsidence intrinsic to the conductively cooling oceanic plate, (3) the extent to which such reheating processes can explain the regional uplift and subsidence of oceanic lithosphere, and (4) how the vertical motions associated with mantle processes are manifested in the geologic records.