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Heavy winter precipitation events with extratropical cyclone diagnosed by GPM products and trajectory analysis

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In Japan, Extratropical cyclone sometimes causes sporadic heavy snow in the coastal cites or heavy rains on snow covers in mountainous areas. Ando and Ueno (2015) identified that heavy precipitation events tend to occur with occluding cyclones. However, three-dimensional structure of precipitation system embedded in the cyclone system are difficult to capture by surface observation network over Japanese archipelago that are composed of complex coastal lines and mountains. This study identified heavy precipitation events during the cold seasons of 2014-2019 by two-day accumulated precipitation data at 137 stations of the Japan Meteorological Agency. The mechanisms for producing heavy precipitation in relation to the structure of an occluding extratropical cyclone were analyzed with the aid of the products of the Dual-frequency Precipitation Radar onboard the Global Precipitation Measurement (GPM) core satellite and trajectory analysis on European Centre for Medium-range Weather Forecasts atmospheric reanalysis data. Upper-ranked events with heavy precipitation were mostly due to extratropical cyclones, and many of them were in mature stages. In the top 50 ranked events, three south-coast cyclones were nominated, and relationships between the development of the mesoscale precipitation system and airstreams were intensively diagnosed. Hourly precipitation changes at stations that recorded heavy precipitation were primary affected by a combination of the warm conveyor belt (WCB), the cold conveyor belt (CCB) and the dry intrusion (DI). Wide-ranging stratiform precipitation in the east of cyclone center was composed of low-level WCB over the CCB and the upper WCB, and convective clouds around the cyclone center was associated with the upper DI over the WCB that provided an extreme precipitation rate at the surface, including formation of a band-shaped precipitation system. The convective cloud activities also contributed to moist air advection over the stationary stratiform precipitation areas recognized as the upper WCB. DPR products also identified deep stratiform precipitation in the cloud-head area behind the cyclone center with mid-level (near-surface) latent heat release (absorption) with increased potential vorticity along the CCB that was made feed-back intensification of the cyclone possible. (This study will be published in GPM special issue of JMSJ)