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Regional variability and turbulent characteristics of the satellite-sensed submesoscale surface chlorophyll

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Regional variability and turbulent characteristics of submesoscale surface chlorophyll concentrations are examined with hourly maps of geostationary ocean color imagery-derived chlorophyll concentration maps at a 0.5-km resolution for a period of five years (2011 to 2015) off the East/Japan Sea and concurrent mesoscale and submesoscale observations. There are (1) two seasonal blooms in spring and fall within 250 km from the coast associated with constructive combinations of light exposure, nutrients, and vertical stratification and (2) a bloom in summer closely related to the regional wind-driven upwelling events. The spring and fall blooms occur more significantly near the coast (within 40 km from the coast) than offshore because of more energetic submesoscale horizontal shear and vortical phenomena onshore and their propagations in the cross-shore direction, which can lead to enhanced vertical mixing due to frontal-scale secondary circulation and physio-biological interactions. In addition, the regional spring bloom starts offshore and migrate onshore with one month time delay, which may result from the onshore propagating geostrophic currents, the deepening of the mixed layer, and favorable nutrient fluxes from the subsurface. The wavenumber domain energy spectra of the chlorophyll concentrations exhibit anisotropy reflecting bathymetric effects and regional circulation, and their decay slopes change from $k^{-5/3}$ to k^{-1} at $O(10)$ km scales and from k^{-1} to k^{-3} at $O(1)$ km scales and have weak seasonality, which is consistent with the two-dimensional quasi-geostrophic turbulence theory and can be interpreted with the baroclinic instability in the weak seasonal mixed layer and non-seasonal regional circulations.