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The role of baroclinic activity in shaping Earth's albedo in present and future climates

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Atmospheric albedo is one of the most influential properties of Earth's climate. Specifically, the midlatitude planetary albedo plays a vital role in shaping the Earth's albedo. Although, there is no one theory to connect midlatitude atmospheric albedo to the midlatitude climate. This study investigates the connection between baroclinic activity, which dominates the midlatitude climate, and cloud cover. We show that EKE and atmospheric albedo are highly correlated on the climatological level. Then, we show that, from a Lagrangian perspective, the positive correlation translates into a high correlation between cyclone and anticyclone strength and cloud cover at all levels. Observing the strength-cloud cover relation across various systems strengths, we see that this coupling is robust and saturates for intense cyclones. Using these insights, we reflect on two aspects of the Earth radiation budget: the Earth hemispheric symmetry in planetary albedo and future changes in Earth atmospheric albedo. Observing the relationship between the storms, mean cloudiness, strength, and spatial distribution, we find that the difference in eddy population between hemispheres can explain the difference in cloud-cover, which counter-balance the higher surface albedo at the NH. Finally, we use the relation between baroclinic activity and midlatitude cloudiness to understand the projected change in cloud patterns in a warmer climate. We show a high correlation between climatological baroclinic activity response and cloud response. We also suggest that the discrepancy between baroclinic activity and clouds response over the SH is due to the saturating nature of the strength-cloudiness curve.