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Subseasonal prediction of springtime Pacific-North American transport using upper-level wind forecasts

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Mass transport is important to many aspects of Pacific-North American climate, including stratosphere-to-troposphere transport of ozone to the planetary boundary layer, which has negative impacts on human health, and water vapor transport, which contributes to precipitation variability. Here, subseasonal forecasts (forecasts 3-6 weeks into the future) of Pacific jet variability are used to predict stratosphere-to-troposphere transport (STT) and tropical-to-extratropical moisture exports (TME) during boreal spring over the Pacific-North American region. To do this, we consider a very simple conditional probability: if 200 hPa zonal winds have a high (positive or negative) loading on a particular 200 hPa Pacific basin zonal wind pattern, then what will the corresponding shift in the probability of STT or TME be during those time periods? We first answer this question in the context of a retrospective analysis, which allows us to understand the regionality of STT and TME for different jet patterns. Then, using the retrospective results as a guide, we utilize zonal wind hindcasts from the European Centre for Medium-Range Weather Forecasts Integrated Forecasting System (taken from the S2S Prediction Project) to test whether STT and TME over specific geographic regions may be predictable for subseasonal forecast leads (weeks 3-6). For both analyses, STT and TME are taken from the ETH-Zürich Feature-based climatology database, which allows us to apply a single, self-consistent measure of transport for both the retrospective (1979-2016) and hindcast (1997-2016) analysis periods.

We find that large anomalies in STT to the mid-troposphere over the North Pacific, TME to the west coast of the United States, and TME over Japan are found to have the best potential for subseasonal predictability using upper-level wind forecasts. STT to the planetary boundary layer over the intermountain west of the United States is also potentially predictable for subseasonal leads, but likely only in the context of shifts in the probability of extreme events. While STT and TME forecasts match verifications quite well in terms of spatial structure and anomaly sign, the number of anomalous transport days is underestimated compared to observations. The underestimation of the number of anomalous transport days exhibits a strong seasonal cycle, which becomes progressively worse as spring progresses into summer.