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The composite precipitation results for pure NAO(+) and pure NAO(-) show an east-west dipole in the equatorial Pacific. The position of this dipole is orthogonal to the counterpart of the pure ENSO mode. In specifically, the zero line is collocated with the maximum center of the precipitation anomalies in the composite pure ENSO mode. This may be related to the second or higher order of the SST variability in the equatorial pacific. In specific, although we eliminate the first EOF mode, but it gives more opportunity to pull in the higher order of the EOF modes . In this sense, the EOF analysis may not be a good way to define the ENSO index. Because it is hard to be guaranteed to eliminate higher order modes which may also be related to the ENSO variability in the way of shifting the SST variability eastward or westward. Given these consideration, we use area averaged SST anomalies over the NINO 3 region as the ENSO index, which is consistent with the Andrew(?). The standard deviation of the SST also shows that the SST variability tends to be strongest in this region.

North Pacific: NAO(+),NAO(-) 🡪 El Nino

Now let’s focus on the North Pacific session, and find out the different impact in the North Pacific by the different phase of NAO when both are combined with El Nino events. Negative and positive anomalies of geopotenial height at 500hPa in the North Pacific are associated with the positive and negative phase of pure ENSO, respectively. For the pure NAO events, there are notable anomalies in the North Pacific besides the north-south dipole in the North Atlantic. The polarity of the anomaly in the North Pacific is the same as that in the North Atlantic, which makes the NAO pattern more global in the North Hemisphere. This third center in the North Pacific superimposed with the anomaly associated with the pure El Nino mode make the geopotential height in the North Pacific quite different in the combination modes between El Nino plus NAO (+) and El Nino plus NAO (-). Specifically, in the combination of El Nino and NAO(-), the negative anomaly is reinforced in the North Pacific, and extended eastward. Thus the negative anomalies are around the subtropical latitude circle. The stronger height gradient compared with that associated with the combination of El Nino and NAO(-) results in the stronger upper level westerlies. So that storm track tends to be more frequent and stronger in the strengthened mean flow, and more precipitations are expected to occur in the westerlies in the former case. The maximum precipitation anomalies in the western coast of the United States are 6 in the former case compared with 4 in the later case.

The sea level pressure are in phase with the geopetential height at 500hPa, indicating the equivalent barotropical characteristics in the North Pacific. The negative anomalies in the North Pacific are more dominant in the former case. The southly winds the eastern flank of the deep Aleutian low advect warmer and moister air along the west coast of North American, so that SST increase more along the west coast of North America, as well as changes in the coastal rainfall.

In summary, when El Nino events are combined with NAO+(NAO-), the signal in the North Pacific are somewhat cancelled(reinforced) with each other, and get a wavy (annular) pattern in the geopential field in 500hPa. In the latter case, the westerlies are we strengthened in almost the whole latitude circle, so that the storm track are more and frequent, giving rise to more precipitation around the jet stream. So that we can see the rainbelt starting from western coast of the United States extend eastward to the inland of the Europe. However, in the former case, the enhanced precipitation in the western coast of the United States is not as strong as that in the latter case. The much warmer and wetter in the western coast of the United States are also associated with stronger southly surface winds, which advect warmer and moister air along the west of North American.

North Atlantic: ENSO(+), ENSO(-) 🡪 NAO(+)

I am not sure if I should take a look at the NAO in the spring season.

Because El Nino has very weak impact in the North Atlantic region, only weak positive anomalies appear in the eastern subtropical Atlantic. Thus when El Nino events are combined with NAO(+), the south dipole of the NAO is eastward shift. However, when El Nino events are combined with NAO(-), it shows the tripole pattern in the North Atlantic.

Changes in the surface temperature and rainfall in the North Atlantic are related to the polarity of the NAO, because El Nino has very weak influence in the North Atlantic. The

plot

1. SD of SST(DJF)
2. Polar stereo projection and 20-90N