Abstract:

The mechanisms of poleward propagation of tropical intraseasonal oscillations (ISOs) are not well-understood. In this thesis, we investigate this issue for two such tropical ISOs over the Indian Ocean, namely, the Boreal Summer Intraseasonal Oscillation (BSISO) during boreal summer which propagates northward from the equator, and the quasi-biweekly oscillation (QBWO) during boreal winter which propagates south-westward from the equator.

We start with the BSISO and show that northward propagation occurs in multiple stages after convection is initiated over the EIO. First, convection moves into the southern Arabian Sea (AS) due to moistening of the free troposphere via horizontal BSISO anomalous winds acting on the background moisture distribution and forms a northwest-southeast (NW-SE) oriented convection band. Subsequently, in the presence of background easterly vertical shear of monsoon winds and meridional gradient of anomalous vertical velocity, a NW-SE oriented tilting term is generated that results in a tilted gyre north of the existing convective anomaly. As a result, BSISO winds over the South Asian landmass become south-easterly. In the second stage, these winds tap the ambient north-westward moisture gradient and help move convection further north over the landmass. Moreover, background winds advect anomalous moisture to initiate convection over the Bay of Bengal. In all, free-tropospheric moisture advection and vortex tilting due to the background vertical shear work together for robust northward propagation of the BSISO.

Moving to the winter season, an analysis of outgoing longwave radiation (OLR) and winds over the South-West Indian Ocean (SWIO) yields regular, poleward propagating, large-scale, convectively coupled systems of alternating cyclonic and anticyclonic circulation with a quasi-biweekly period. Composites show well-formed rotational gyres in the lower troposphere that can be tracked from near the equator to almost 30S appearing west of Sumatra and propagating towards Madagascar, i.e., with mean southwest propagation. The scale of the gyres is about 30-35 degrees, their period is 14-18 days, and they have a westward phase speed of approximately 3.5 m/s . In early stages, the gyres are associated with weak convection, but when they move poleward, convective coupling is enhanced. Velocity fields and OLR indicate that the maximum of moist convective activity lies in the eastern sector of the gyres and a coherence between column-integrated moisture and OLR anomalies points to the applicability of the moisture mode framework. In fact, moistening is mainly due to northerlies in the eastern sector of the cyclonic gyre acting on the meridional gradient of background moisture. This moistening process continues up to 30S while the gyres traverse south-westward. Subsequently, background easterlies advect

anomalous moisture and along with moistening via so-called ’column-processes’, convection is observed to extend inside the gyre from the eastern side. A vorticity budget reveals that the beta effect plays a leading role in the south-westward propagation, horizontal advection assists the westward movement of vorticity anomalies due to prevailing easterlies and moist coupling is important in reducing the speed of propagation of this mode.