I. Motivation and Goals

Superclusters on the synoptic scale containing mesoscale systems are frequently organized by convectively coupled equatorial waves (CCEWs). One specific example is convectively coupled Kelvin waves (CCKWs). The mesoscale equatorial synoptic dynamics (MESD) model, originally derived by Majda (2007), is used here. The MESD model gives theoretical predictions about all eddy terms.

Goal 1: assessing upscale impact of mesoscale disturbances propagating at various tilt angles and speeds on CCKW.

Goal 2: theoretically predicting the upscale impact of mesoscale disturbances.

Goal 3: measuring mesoscale disturbances propagating at various tilt angles and speeds on CCKW.

II. A Multi-Scale Asymptotic Model

The mesoscale equatorial synoptic dynamics (MESD) model, originally derived by Majda (2007), is used here.

Large-scale dynamics for CCEWs

\[ U_\theta - YV = -p_x - dU - (\overline{wv}) \]
\[ V_\theta + UAV = -p_y - dV - (\overline{wu}) \]
\[ \Theta_\theta + W = - (\overline{w\theta}) + S_\theta \]
\[ P_\theta = \Theta_\theta \]
\[ U\dot{X} + Y\dot{Y} + W = 0 \]

Small-scale dynamics for mesoscale disturbances

\[ u_x = -p_x \]
\[ v_x = -p_y \]
\[ \theta_x + w = \Theta_\theta \]
\[ p_x = \Theta_\theta \]
\[ u_y + v_y + w_x = 0 \]

where \( s_\theta \) is mesoscale heating and the spatial and temporal mean of these mesoscale fluctuation variables vanish.

III. Two-Dimensional Scenario

Here the MESD model is reduced into its 2D version and compared directly with CRM from Grabowski and Moncrieff (2001) under the similar model setup.

IV. Three-Dimensional Scenario

The essential difference in 3D scenario is that mesoscale disturbances are allowed to propagate at various directions and speeds as shown by a conceptual diagram below.