**Information about Level 3 – MSE variance diagnostics**

At this level the code calculates terms of MSE variance/covariance diagnostics.

To select this level set the parameter ENSO\_MSE\_VAR = 1 in ~/diagnostics/ENSO\_MSE/settings.jsonc file.

The necessary input data are already estimated in **Level 2** and **Level 1.**

**Level 3** diagnostics are estimated as:

Where *x* can be any one of the following MSE budget term:

moist advection:

MSE vertical advection:

net shortwave flux:

net longwave flux:

sensible heat flux:

latent heat flux:

The column MSE is, where *Cp* is specific heat at constant pressure, *T* is temperature, *g* is the gravitational acceleration*, z* is geopotential height, *L* is latent heat of vaporization, and *q* is specific humidity. represents area averages.

There are two default and one custom selected areas for averaging the MSE variances:

a) Equatorial Central Pacific (180o–200oE; 10oS – 5oN)

b) Equatorial Eastern Pacific (220o–280oE; 5oS – 5oN)

c) user prescribed area defined by environmental variables **slon1, slon2 , slat1** and **slat2** (longitudes, latitudes) in ~/diagnostics/ENSO\_MSE/settings.jsonc file.

Final output directories:

The output data are saved in

~/diagnostics/wkdir/MDTF\_$model\_$first\_year\_$last\_year/ENSO\_MSE/

$diag\_name/model/netCDF .

Graphical output is in : ~/diagnostics/wkdir/MDTF\_$model\_$first\_year\_$last\_year/ENSO\_MSE/model

(e.g., $model = CESM1, $fist\_year= 1950, $last\_year = 2005, $diag\_name = MSE\_VAR)

The calculated co-variances are scaled by MSE variance and plotted as a bar chart.