Supplementary materials of: "General Circulation Models evaluation at different time scales over tropical region using ESA-CCI satellite data records: a case study of water vapour and cloud cover"

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1 Appendix

The factors $\mathbf{S_n}$ and $\mathbf{D_i}$ are given by :

$$\mathbf{S_n} = \sum_{\mathbf{k}=-\infty}^{+\infty} \mathbf{C_{nk}} \mathbf{\Phi_{n,k}}(\mathbf{t}) \tag{1}$$

$$\mathbf{D_i} = \sum_{\mathbf{k}=-\infty}^{+\infty} \mathbf{d_{ik}} \mathbf{\Psi_{i,k}}(\mathbf{t}) \tag{2}$$

(Oh et al., 2003)

where $\mathbf{C_{nk}}$ represent the lowest frequency smooth component and $\mathbf{d_{ik}}$, coefficients delivering informations about the behavior of the signal. $\mathbf{\Phi_{n,k}}$ is the scaling function also knwon as the father wavelet and $\mathbf{\Psi_{i,k}}$ the mother wavelet Gallegati (2022). $\mathbf{\Phi_{n,k}}$ and $\mathbf{\Psi_{i,k}}$ are given by :

$$\mathbf{\Phi_{n,k}}(\mathbf{t}) = \mathbf{2^{-\frac{n}{2}}} \mathbf{\Phi} \left(\frac{\mathbf{t - 2^n * k}}{\mathbf{2^n}} \right) \tag{3}$$

$$\mathbf{\Psi_{i,k}}(\mathbf{t}) = \mathbf{2^{-\frac{i}{2}}} \mathbf{\Psi} \left(\frac{\mathbf{t - 2^i * k}}{\mathbf{i}} \right) \tag{4}$$

(Gallegati, 2022)

References

Gallegati, M.: Multiscale evaluation of CMIP5 models using wavelet-based descriptive and diagnostic techniques, Climatic Change, 170, 41, 2022.

Oh, H.-S., Ammann, C. M., Naveau, P., Nychka, D., and Otto-Bliesner, B. L.: Multi-resolution time series analysis applied to solar irradiance and climate reconstructions, Journal of Atmospheric and Solar-Terrestrial Physics, 65, 191–201, 2003.

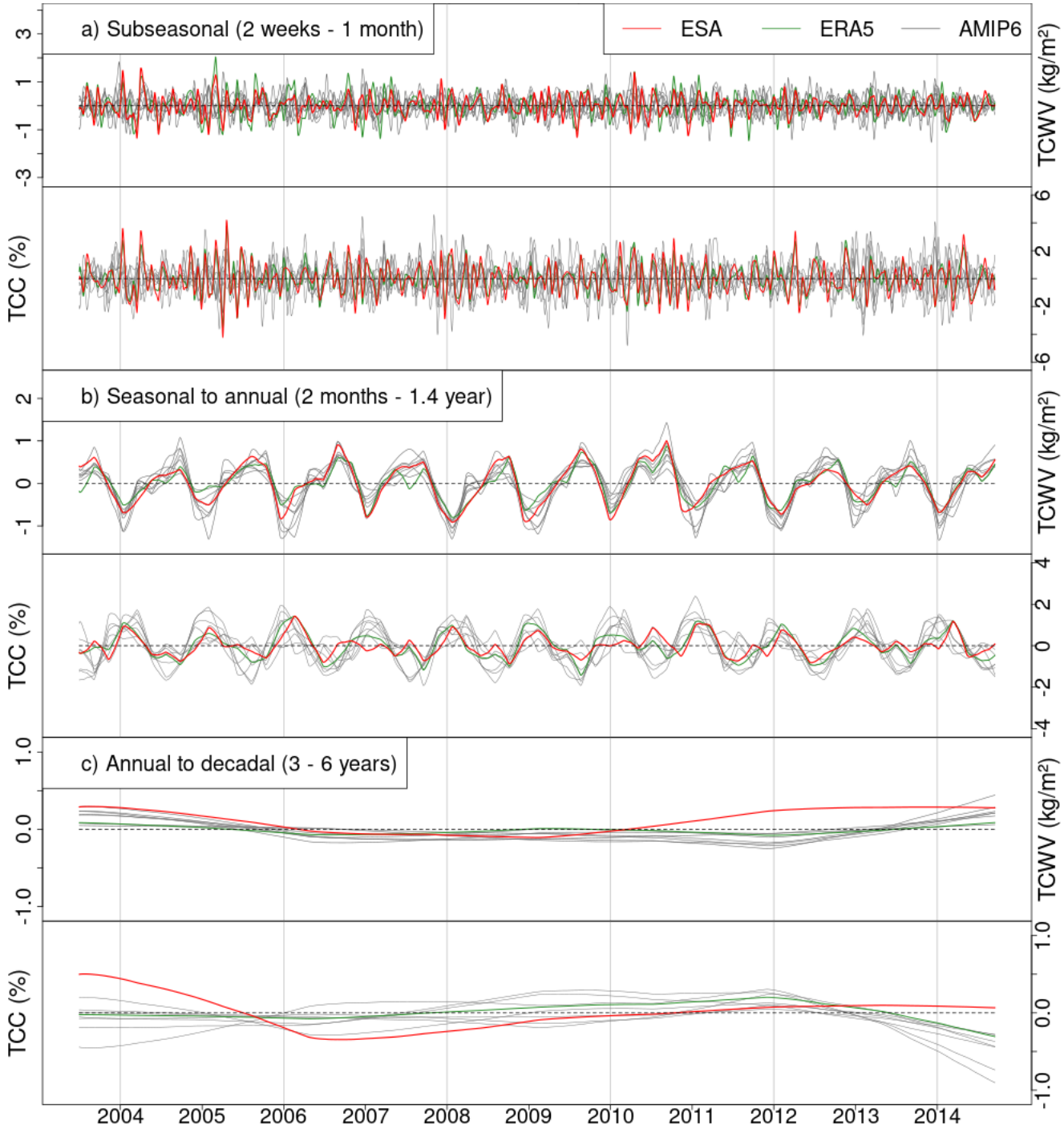


Figure S1. MRA decomposition of TCWV and TCC signals over the tropical lands during the observed period. The decomposition is applied on 12 levels of resolution and the results are grouped in three time frequencies : **(a)** subseasonal, **(b)** seasonal to annual and **(c)** annual to decadal. The red, green and gray curves represent ESA-CCI, ERA5 and CMIP6. The Y-axis represent TCWV in kg/m^2 and TCC in %. The X-axis indicates the time.

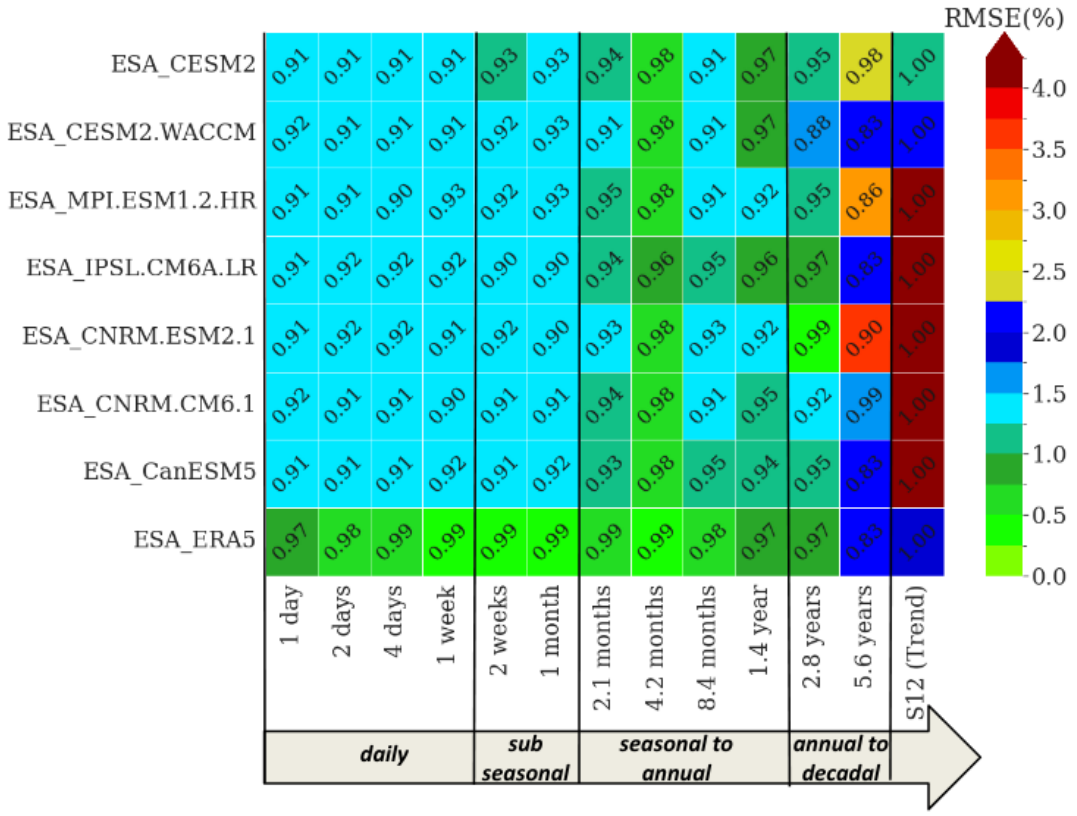
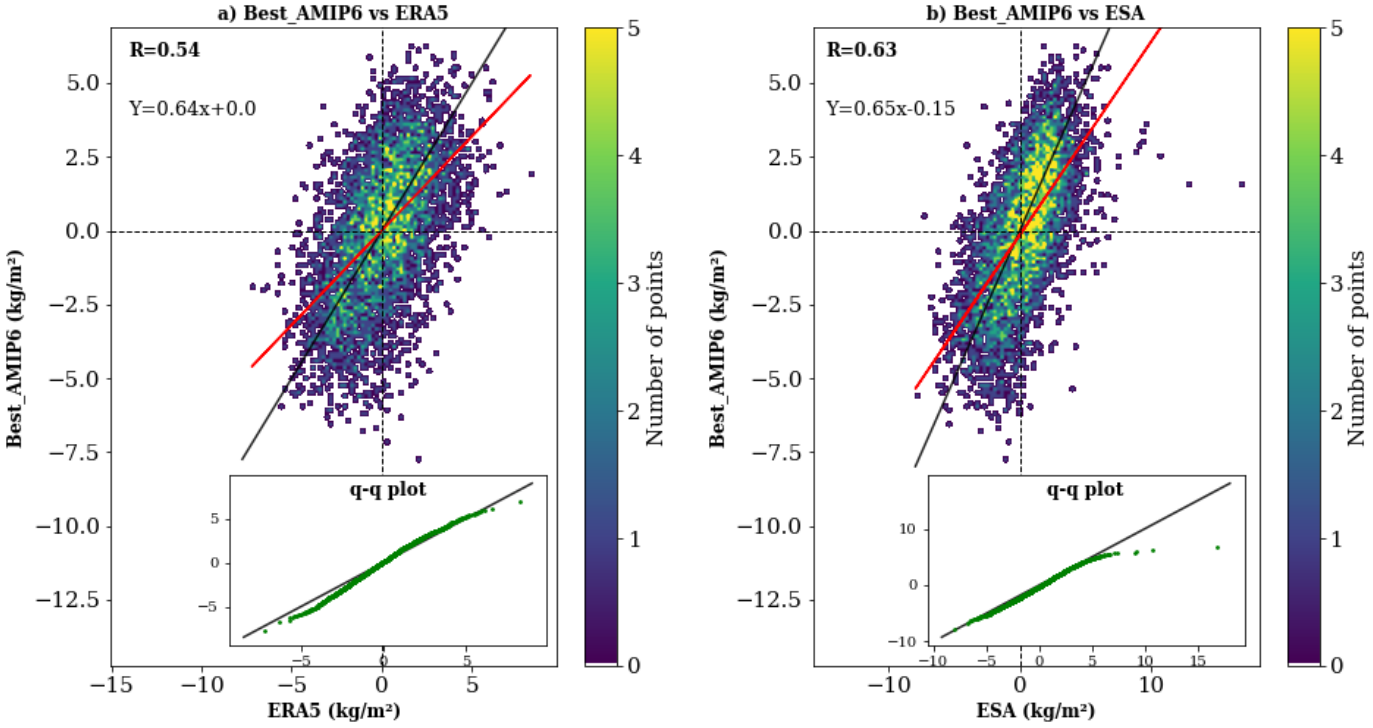
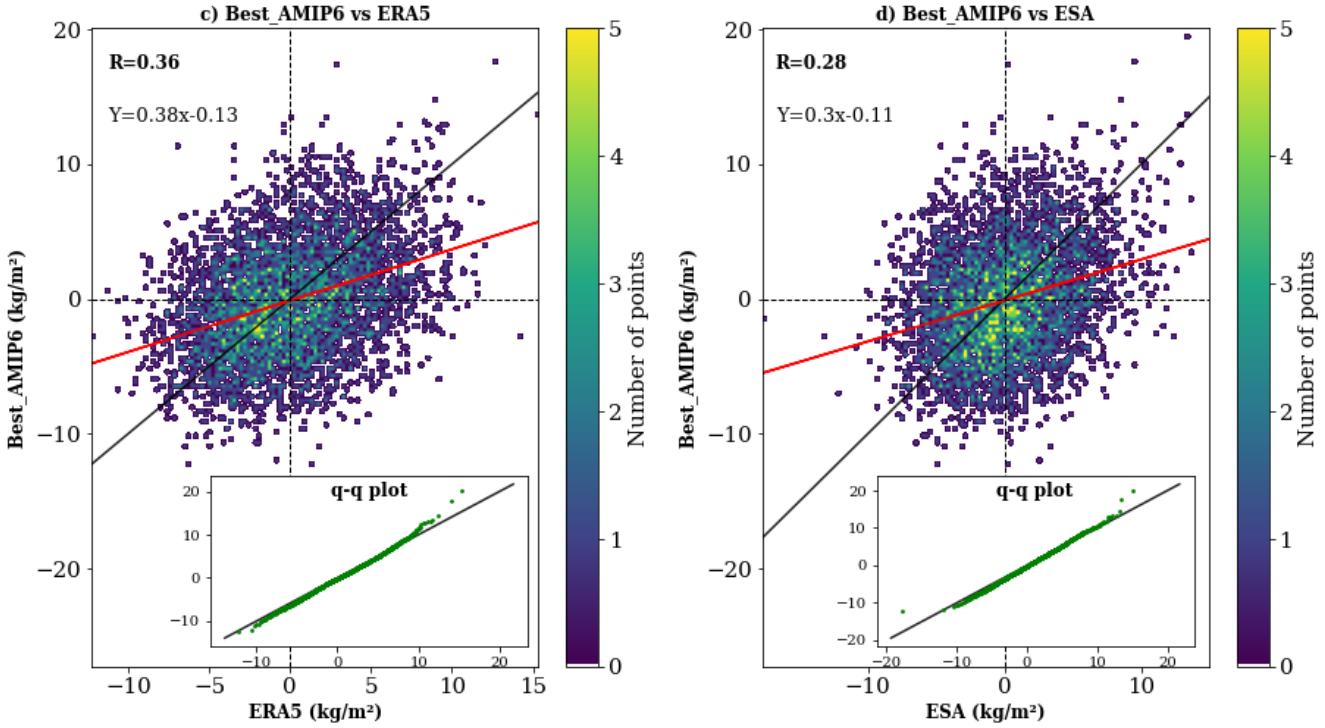


Figure S2. Evaluation of AMIP6 models and ERA5 with respect to ESA at different frequency for TCC over the tropical lands during the observed period. The Y-axis represents the different "$\mathbf{ESA\_GCM_j}$" and the X-axis the levels of decomposition or time scales. The numbers in the box indicate the correlation coefficient, while the color represents the RMSE.


a) Best_AMIP6 vs ERA5
R=0.54
Y=0.64x+0.0
q-q plot
Best_AMIP6 (kg/m²)
ERA5 (kg/m²)
Number of points
b) Best_AMIP6 vs ESA
R=0.63
Y=0.65x-0.15
q-q plot
Best_AMIP6 (kg/m²)
ESA (kg/m²)
Number of points

(i)



(ii)

Figure S3. Analysis of the correlation between the Best_CMIP6, ERA5 and ESA-CCI over the tropical lands during the observed period for : **(i) TCWV** and **(ii) TCC**. The small integrated plots represent the quantile quantile plots. The black and red curves represent the identity line and the regression line respectively. The colorbar indicates the distribution of the points in the scatter plot. The Y-axis represents the anomalies of TCWV/TCC using the Best_AMIP6 and the X-axis, the anomalies of TCWV/TCC using ERA5 reanalysis or ESA-CCI. The anomalies are computed by removing the climatology in the evolution of signals. "R" indicates the pearson correlation coefficient and "Y" the equation of the regression line.

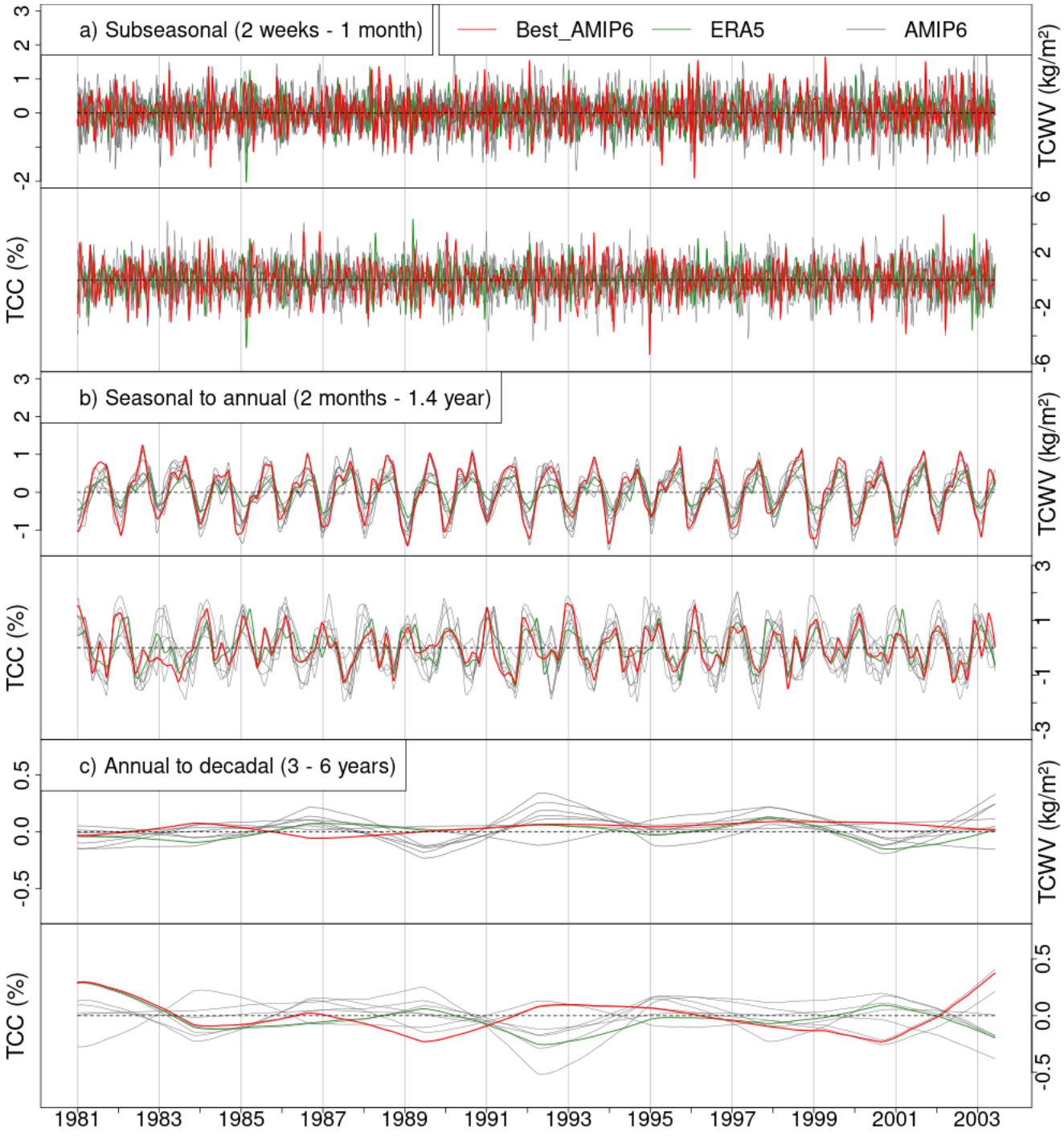


Figure S4. MRA decomposition of TCWV and TCC signals over the tropical lands during the pre-ESA period. The decomposition is applied on 12 levels of resolution and the results are grouped in three time frequencies : **(a)** subseasonal, **(b)** seasonal to annual and **(c)** annual to decadal. The red, green and gray curves represent ESA-CCI, ERA5 and CMIP6. The Y-axis represent TCWV in kg/m^2 and TCC in %. The X-axis indicates the time.

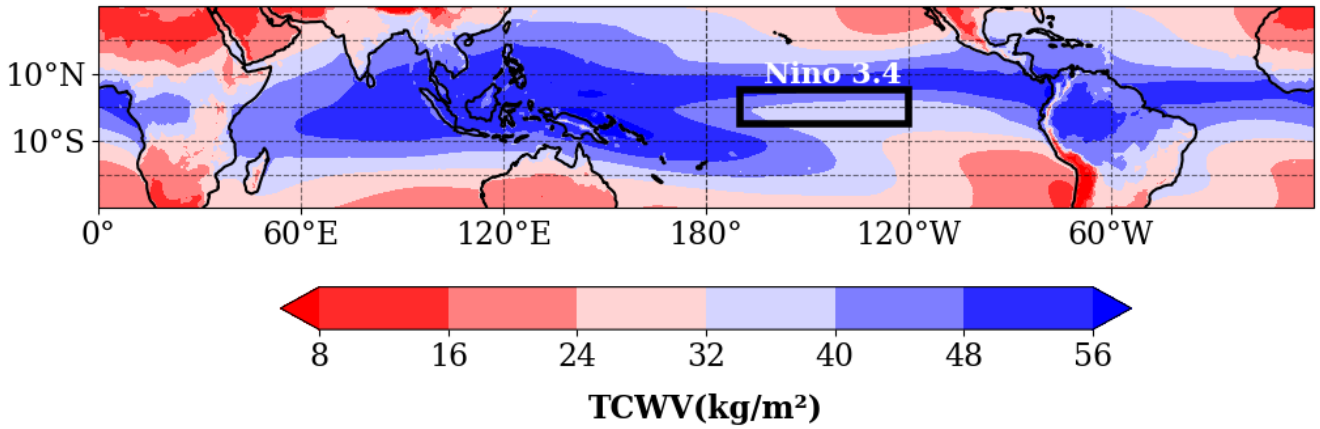


Figure S5. Climatological mean of TCWV over the tropical region during the period 2004-2014 using WV_cci data records. The color bar indicates the intensity of TCWV in kg/m^2 and the black box shows the $Niño$ 3.4 region over the Pacific ocean. The Y and X axes represent the latitude and longitude in degrees respectively.