Supplement of

Convective Organization and 3D Structure of Tropical Cloud Systems deduced from Synergetic A-Train Observations and Machine Learning

Claudia J. Stubenrauch[1], Giulio Mandorli[1], Elisabeth Lemaitre[1]

[1]Laboratoire de Météorologie Dynamique / Institut Pierre-Simon Laplace, (LMD/IPSL), Sorbonne Université, Ecole Polytechnique, CNRS, Paris, France

Correspondence to: Claudia J. Stubenrauch (claudia.stubenrauch@lmd.ipsl.fr)

Artificial Neural Network predictions and evaluation

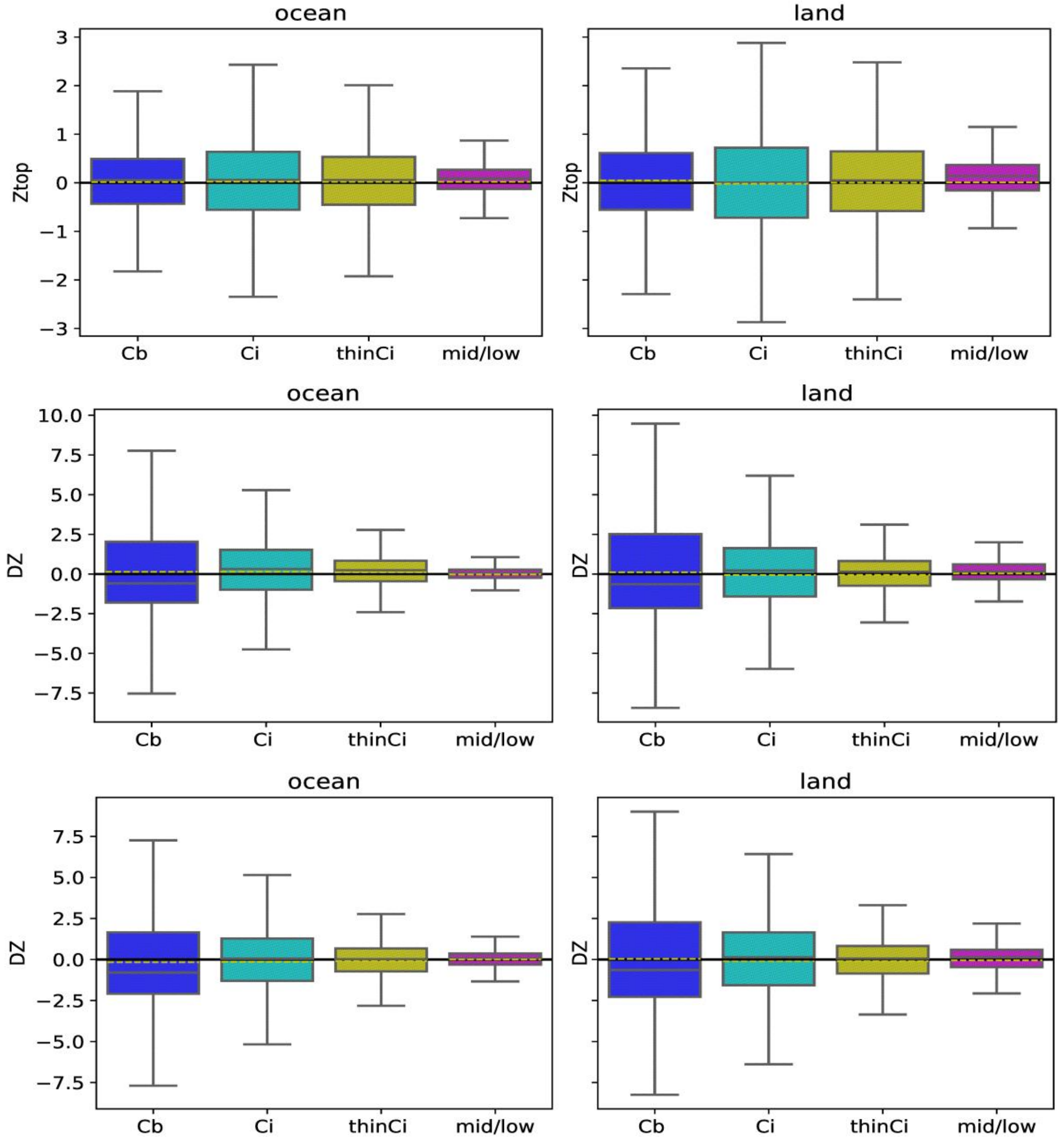

Figure S1: Box-and-whisker plots of Ztop(predicted) – Ztop(observed) and DZ(predicted) – DZ(observed) in km, for Cb, Ci, thin Ci, mid- and lowlevel clouds separately over ocean (left) and over land (right). The DZ results are shown for two developed models: The first model includes the predicted Ztop as input parameter (middle panels), the second does not (bottom panels). The boxes show the quartiles of the data while the whiskers extend to show the rest of the distribution.

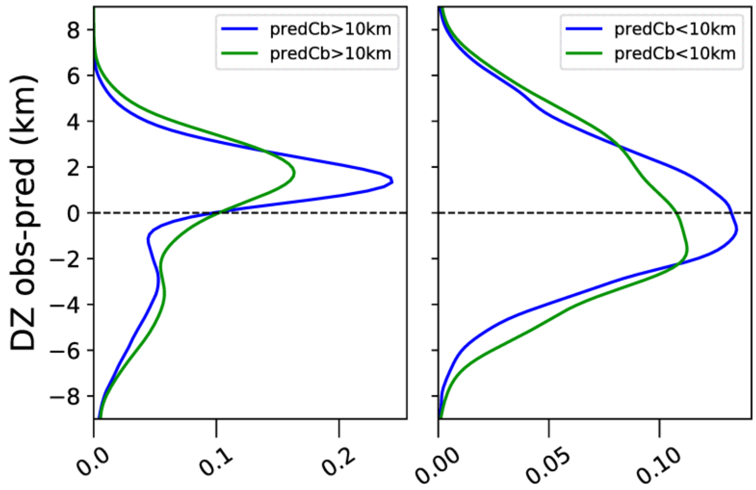

Figure S2: Normalized distributions of DZ(predicted) – DZ(observed), for Cb over ocean and over land. Compared are Cbs for which DZ > 10 km is predicted (left) and those for which DZ < 10 km is predicted. The prediction models have been applied to 20% of the collocated data and are compared with the results derived from CloudSat-lidar 2B GEOPROF data.

Results: Tropical convective organization

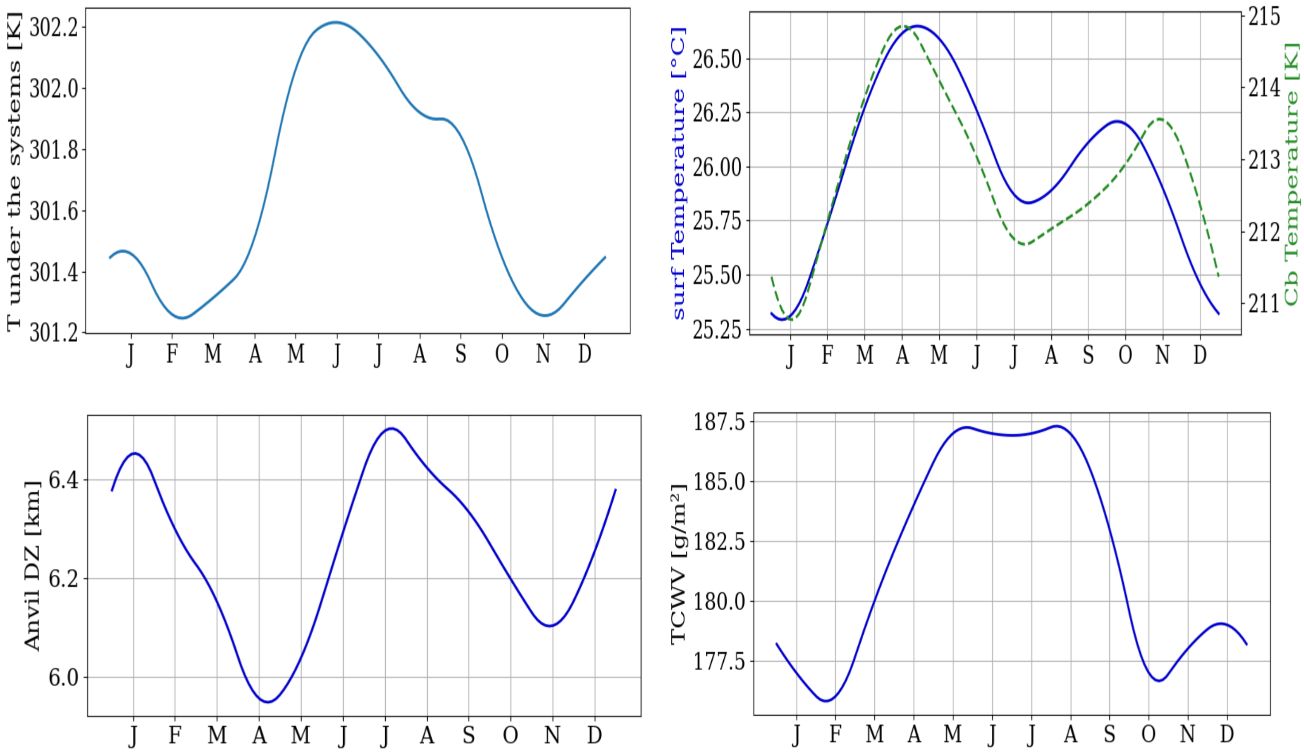

Figure S3: right: Annual cycle of surface temperature underneath the MCSs , tropical mean surface temperature and convective core temperature, anvil vertical extent and UT humidity. Monthly statistics averaged over four observation times from 2008 to 2018.

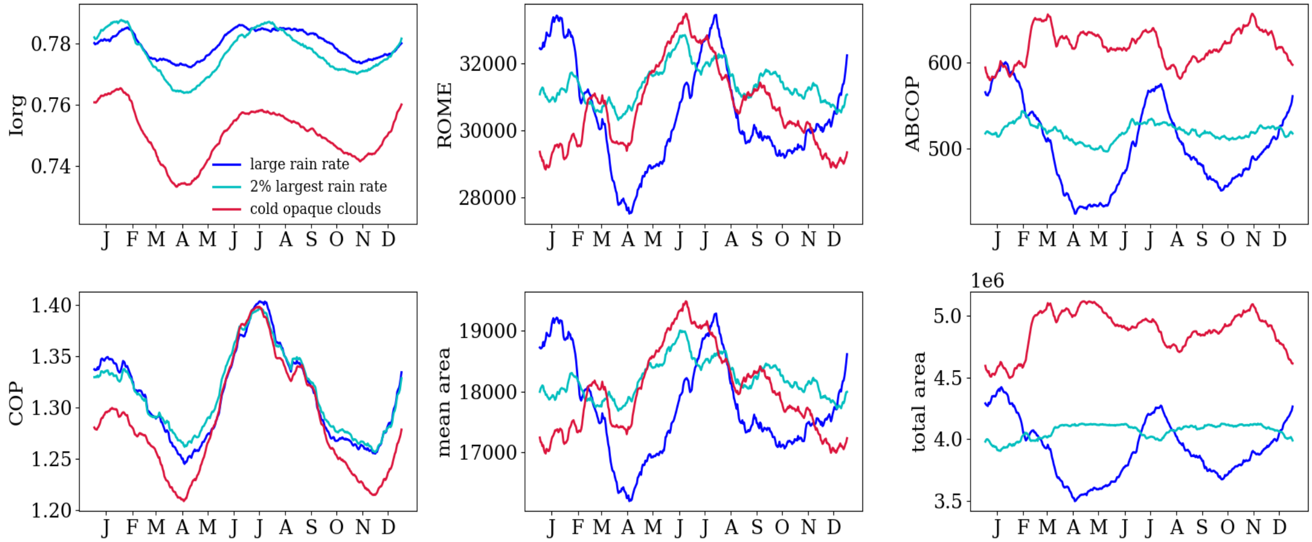

Figure S4: Annual cycle of I_{org}, ROME, ABCOP, COP, mean area and total area estimated from convective areas defined by different variables. These areas are built from grid cells covered by at least 90% UT clouds, with rain rate indicator > 2, $T_{cld} < 230$ K & $\varepsilon_{cld} > 0.95$, or using the 2% largest rain rate indicator. The latter leads to a constant total area of convection. Monthly statistics of UT clouds averaged over four observation times from 2008 to 2018.

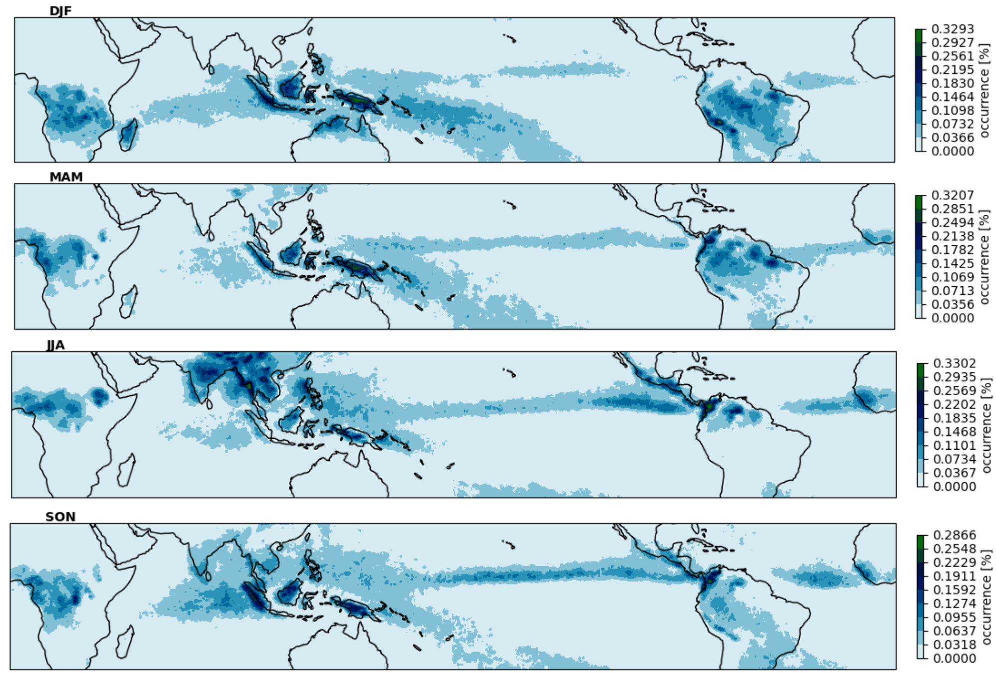

Figure S5: Geographical maps of intense precipitation (indicated by rain rate indicator > 2) occurrence, separately for the four seasons of boreal winter, spring, summer and autumn. Monthly statistics averaged over four observation times from 2008 to 2018.

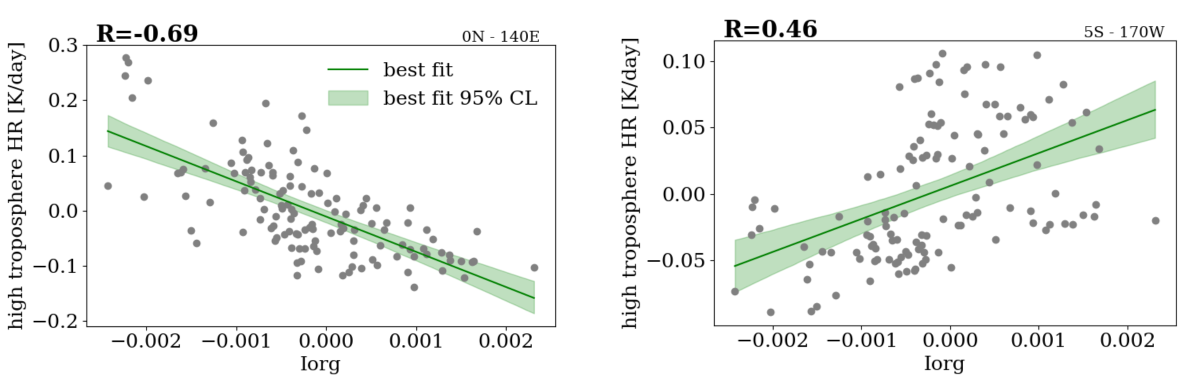

Figure S6: Scatter distributions of the 12 month running mean anomaly of upper troposphere radiative heating rate and of I_{org} obtained using intense precipitation as proxy to define convective areas, for two locations in the tropics: 0N-140E (Warm Pool, left) and 5S-170W (Central Pacific, right). Linear regression fits are also shown, with correlation coefficients. Monthly statistics of UT clouds averaged over four observation times from 2008 to 2018.

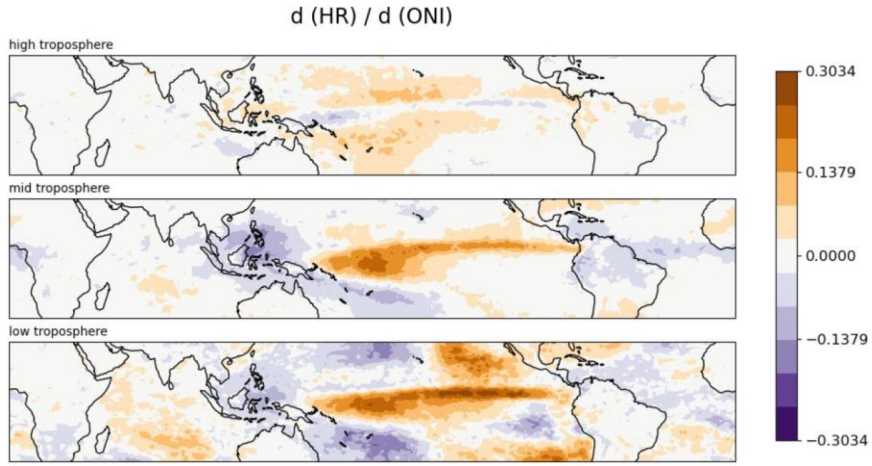

Figure S7: Change in radiative heating rates with Oceanic Niño index (ONI). The troposphere is divided into three layers: upper troposphere (100-200 hPa), mid troposphere (200-600 hPa), and low troposphere (600-900 hPa). Monthly statistics from 2008 to 2018.

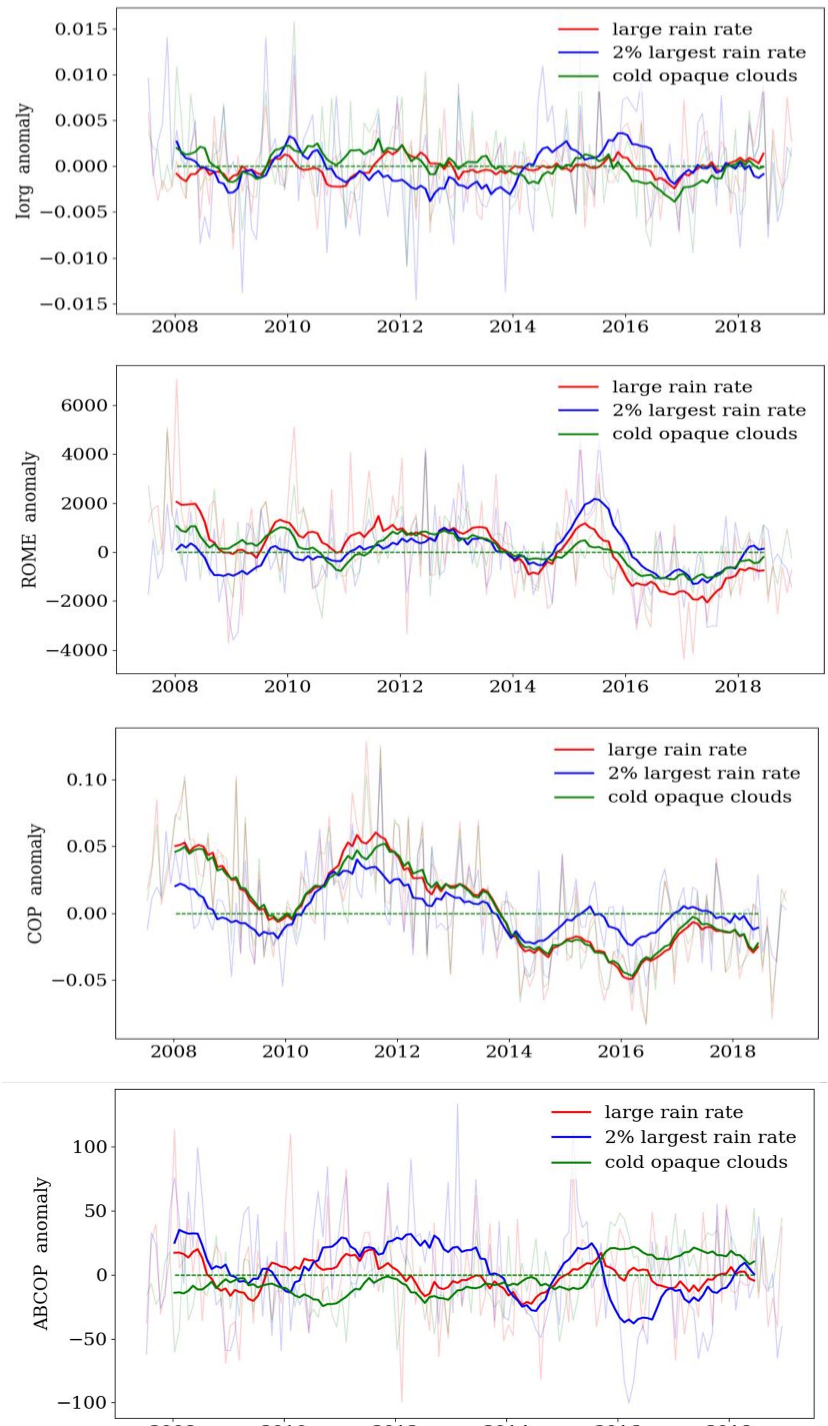

Figure S8: Time series of deseasonalized monthly anomalies of I_{org}, ROME, COP and ABCOP, using different proxies to define the convective areas. The deseasonalization was done by computing 12-month running means. The monthly anomalies are shown in light grey.