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IMPACTS ON TROPICAL SOUTH AMERICAN RAINFALL DUE TO CHANGES IN GLOBAL CIRCULATION

T.-C. (Mike) Chen[1], E. S. Takle, J.-H. Yoon, K. J. St. Croix, and P. Hsieh.
Iowa State University, Ames, Iowa

1. INTRODCTION

Three seperate data sets including the Global Historical Climatological Network (GHCN, Easterling et al. 1996), NOAA outgoing longwave radiation (OLR), and the NCEP/NCAR reanalysis data (Kalnay et al. 1996), were used to explore rainfall and intensity of the hydrological cycle over tropical South America for the past four decades. A clear increasing trend in these hydrological variables emerges from our analysis (Chen et al. 2001). The purpose of this study is to report out findings in three aspects: a) interdecadal trend, b) suppression impacts of Amazonian deforestation, and c) impacts on the interannual rainfall variation caused by ENSO.

2. INTERDECADAL TREND

The geography-orography in tropical South America including the GHCN precipitation stations (denoted by open circles) with their elevations below 200m around the Amazon River is shown in Fig.1. The GHCN station precipitation reaches the criterion [RMS(ΔP)$\geq$0.5mmday^{-1}] is marked by an "x". Seasonal value of ΔOLR [=$\overline{\text{OLR}}$-OLR, $\overline{(\ \ )}$ multi summer-mean OLR]; P(CMAP) (Xie and Arkin 1997), P(selected GHCN stations), precipitable water (W), convergence of water vapor flux ($-\nabla \bullet Q$) averaged over the rectangular domain in Fig. 1 for the past four decades are graphed in Fig.2. The interdecadal trend of all variables is determined by a least square fit with a statistical scheme of Chen et al. (1996). Rainfall and convection (ΔOLR) exhibit an increasing trend. The [W] trend indicates that the basin became more moist, and the atmospheric hydrological cycle has intensified.

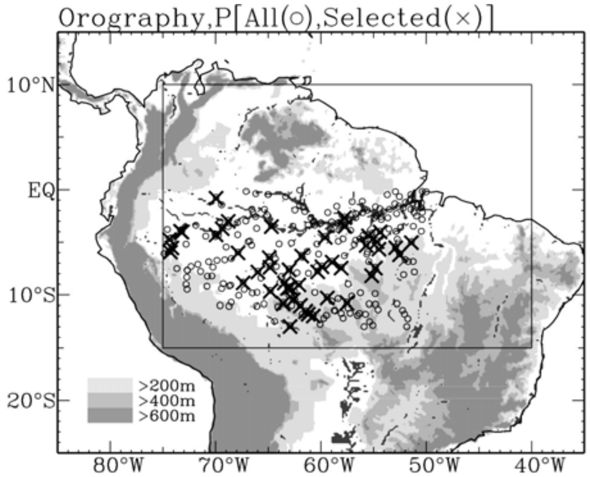

Fig.1 The geography–orography of northern South America and Global Historical Climatological Network (GHCN) stations (open circle) below the elevation of 200m. The selected GHCN stations meeting the criterion [RMS(ΔP)$\geqq$0.5mm day^{-1}] are denoted by a cross. The rectangular box is the analysis domain

3. SUPPRESION IMPACTS OF AMAZONIA DEFORESTATION

The interdecadal change $\Delta\chi_Q$ pattern (Fig.3a) with a positive center located over the Amazon Basin indicates that water vapor converges toward this basin to maintain the increasing trends of [P] and [W]. In other words, interdecadal increasing trends of [P] and [W] in the Amazon Basin may be a response of the regional hydrological cycle in this basin to the interdecadal change in the global divergent circulation. All global and regional-scale numerical studies that overlook influences of interdecadal global convergence change indicated deforestation reduces rainfall and evaporation. Observed trends contrary to these numerical results suggest that the interdecadal increase of moisture convergence is of sufficient magnitude to more than compensate for mesoscale drying due to deforestation.

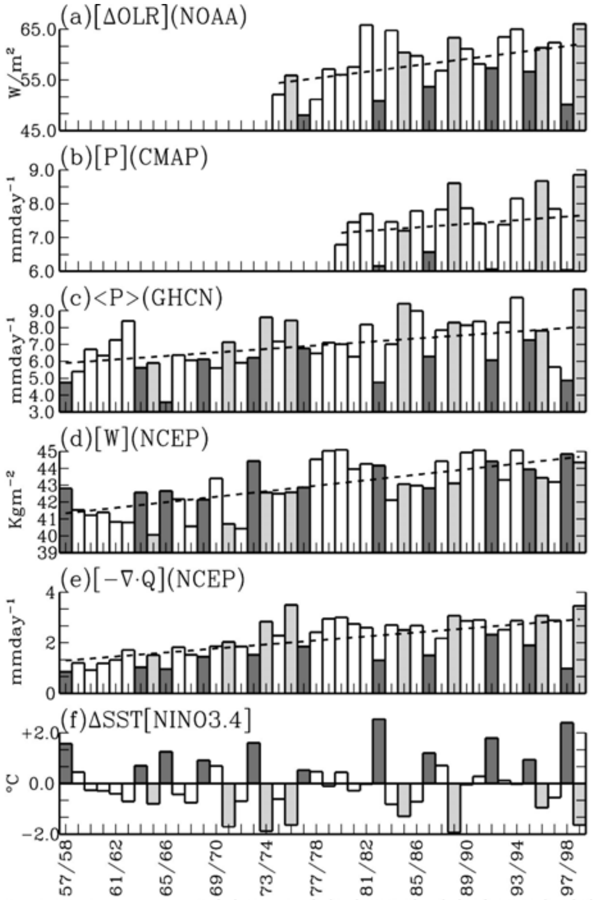

Fig.2 Histograms of (a)ΔOLR, (b)P(CMAP), (c)P(GHCN), (d) W, (e)$-\nabla\cdot$Q, and (f)ΔSST(NINO3.4). The symbols < > and [ ] denote the alegbraical average over all selected stations indicated in Fig.1 and the area average over the rectangular domain in Fig.1, respectively.

4. IMPACTS ON THE INTERANNUAL RAINFALL VARIATION CAUSED BY ENSO

Compared to ΔSST (NINO3.4) (Fig.2f), convection (Fig. 2), and

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[1] Corresponding author address: T.-C.(Mike) Chen, Iowa State University, Department of Geological and Atmosphic Sciences, 3010 Agronomy Hall, Ames, IA, 50011, e-mail: tmchen@iastate.edu

rainfall (Fig. 2b, and c) in the Amazon basin are enhanced (reduced) during cold (warm) ENSO events and the basin becomes drier (wetter) (Fig.2d), accordingly. This enhancement (reduction) of the basin's convection and rainfall is maintained by that of water vapor flux convergence ($-\nabla \bullet Q$) (Fig.2e) coupled with the intensification (weakening) of the lower-tropospheric convergent circulation over this basin (Fig.3b and c). The interdecadal trend of global-scale divergence enhances (reduces) convergence of water vapor flux toward tropical South America during cold (warm) ENSO phases with concurrent enhancement (reduction) of summer rainfall. The contrast of summer rainfall in the Amazon Basin between the two extreme ENSO phases is not altered, but the interdecadal increasing trend of water vapor flux convergence in to this region enhances rainfall during both cold and warm ENSO phases.

5. REMARKS

Our results suggest that future simulations of the impacts of basin-scale deforestation, the regional hydrological cycle, and the forcing of regional climate of Amazonia must include mechanisms describing both land-surface processes and Interdecadal changes of the global divergent circulation.

6. ACKNOWLEDGEMENT

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7. REFERENCES

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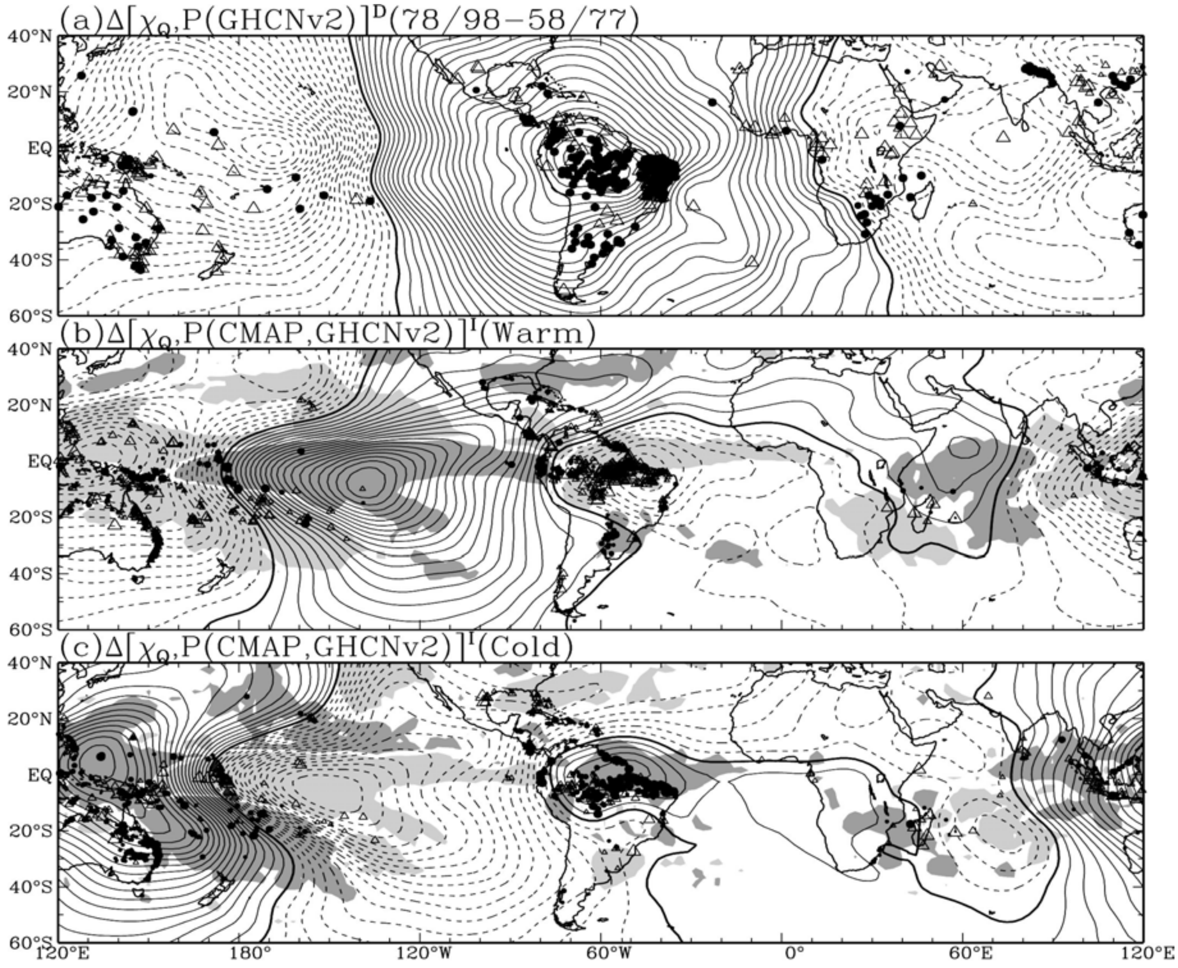

(a) $\Delta[\chi_Q, P(\text{GHCNv2})]^D(78/98-58/77)$

(b) $\Delta[\chi_Q, P(\text{CMAP,GHCNv2})]^I(\text{Warm})$

(c) $\Delta[\chi_Q, P(\text{CMAP,GHCNv2})]^I(\text{Cold})$

Fig.3 (a) Interdecadal changes [differences between (1978−98) and(1958−77)] of (χ_Q,Q,P), and composite of (χ_Q,Q,P) departures from the long−term winter−mean values for (b)Cold and (c)Warm ENSO events. Station precipitation departures $\Delta P \geq 0$(≤ 0) are represented by different signs of dots (open triangle). The contour interval of $\Delta\chi_Q$is $5\text{x}10^6 \text{kgm}^2\text{s}^{-1}$. The ΔP(CMAP)(stip−pled areas) anomalies are superimposed by ΔP(GHCN) (dots and open triangles).