GNSS Observations of Convective Timescales

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OUTLINE

- Shallow-to-Deep Transition in Tropical Continental Convection
- Development of Water Vapor Convergence Timescale using GNSS/GPS
- GNSS Climatology of Deep Convective Events in Manaus
- Diurnal Cycle of PWV in Belem during GPM-CHUVA (June 2011)

Shallow-to-Deep Convective Transition in Tropics

Models do not replicate well, often skip shallow-to-deep transition entirely (Betts and Jakob 2002; Wu et al. 2009)

What controls shallow-to-deep transition?
Different Authors, Different Arguments

- Kuang and Bretherton (2006) Dry mid-troposphere impedes transition to deep convection, must have moist mid-troposphere

- Chaboreau et al. (2004) Shallow Cumulus must moisten just above boundary layer for transition to deep convection



Shallow-to-Deep Convective Transition in Tropics (cont.)

- Khairoutdinov and Randall (2006); Make clouds larger so entrainment is less important. Congestus cold pools create convergence zone leading to deeper convection and so on…

- Wu et al. (2009) Critical lapse rate above boundary layer needed for transition to deep convection to occur



Which argument is correct? Difficult to say given lack of observations.
One way to tackle this difficulty is through timescale analysis (Hohenegger and Stevens 2013).

- Physical processes responsible for convective activity must have the proper time scale to jibe with observations

- **BUT**, these above and nearly all other studies are ***Modeling Studies*** and subject to all of their uncertainties in representing deep convection

- We need long-term, high-spatial/temporal resolution**, all-weather** observations to carry out time scale analysis

- GNSS/GPS Meteorology can help

Adams, Gutman, Holub, and Pereira, (GRL 2013)

Developed Criteria for Water Vapor Convergence Timescale

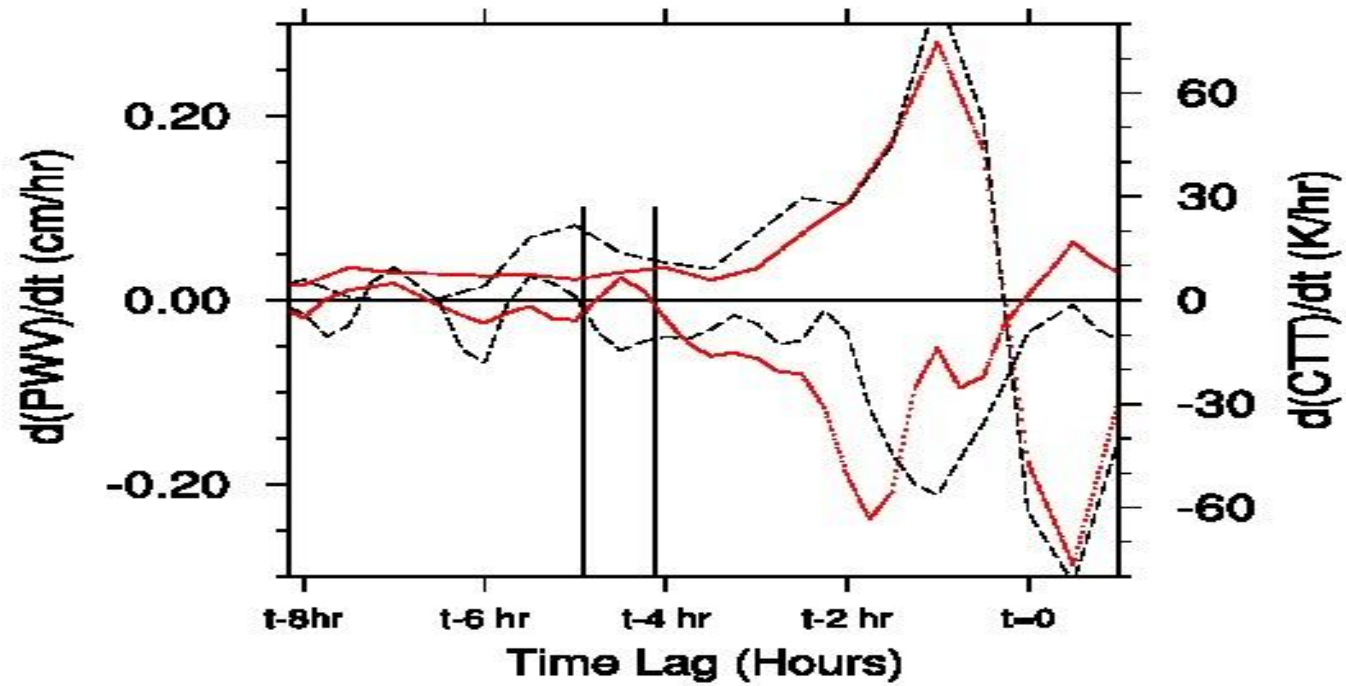
$$|\frac{\partial}{\partial t}(PWV)| \sim |\nabla \cdot \frac{1}{\rho_w} \int q\vec{V}\frac{dp}{g}|$$

3.5 year Study from Manaus GPS Meteorology Station

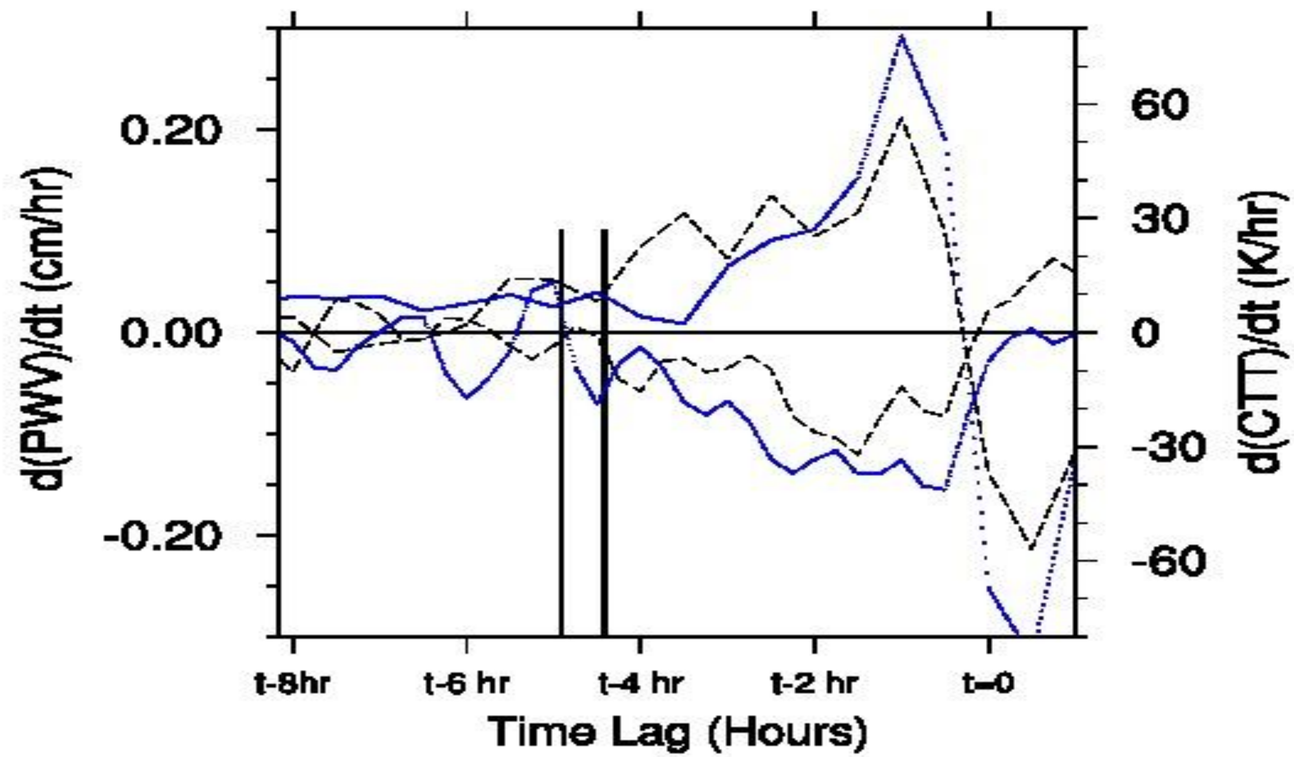
Deep Convective Climatology Developed

Shallow-to-Deep Convective Time scales examined

Approximately 4 hour shallow-to-deep water vapor convergence timescale observed for high vs. low PWV

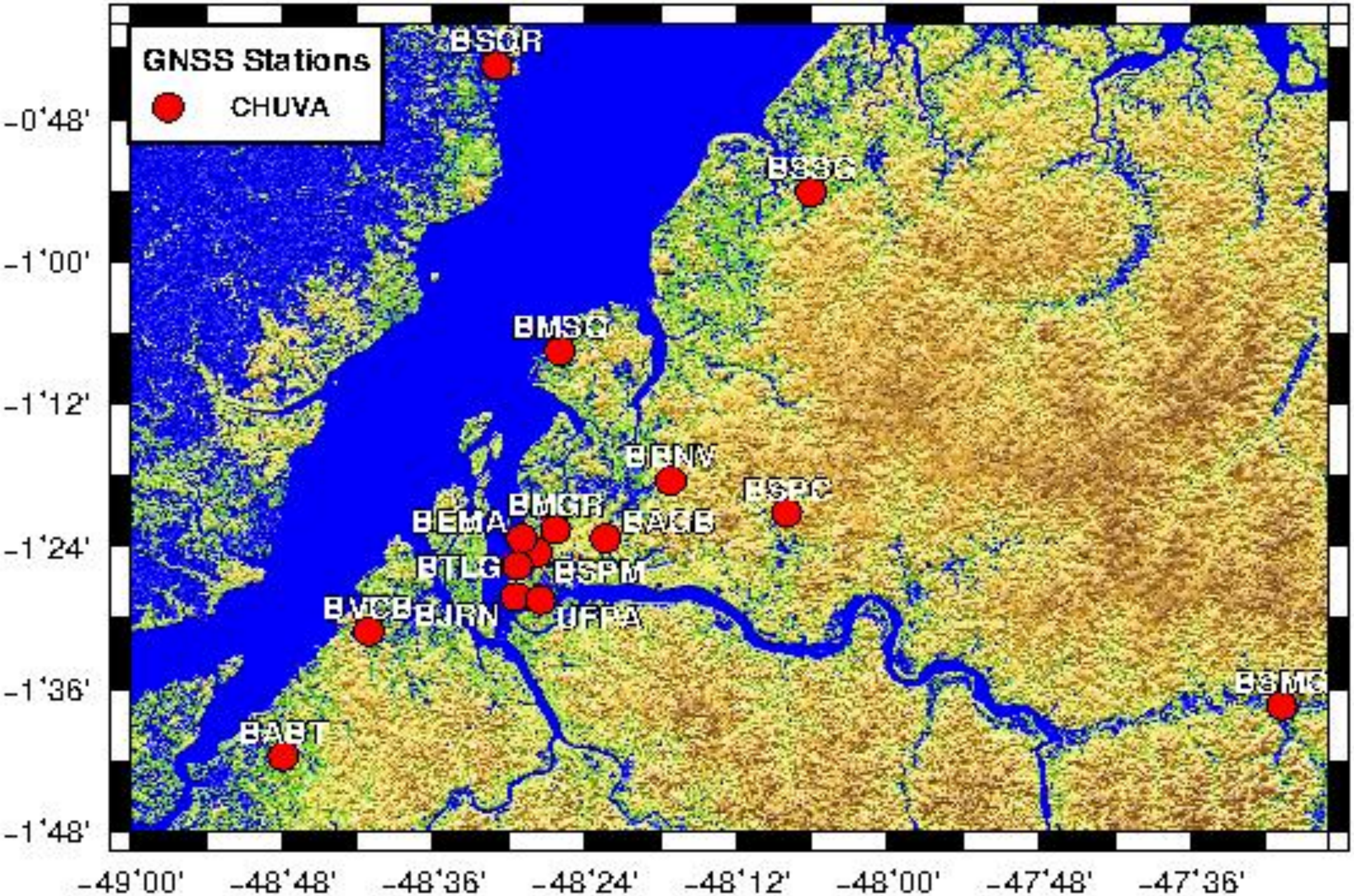


Approximately 4 hour shallow-to-deep wv convergence timescale observed for intense vs. weak deep convection

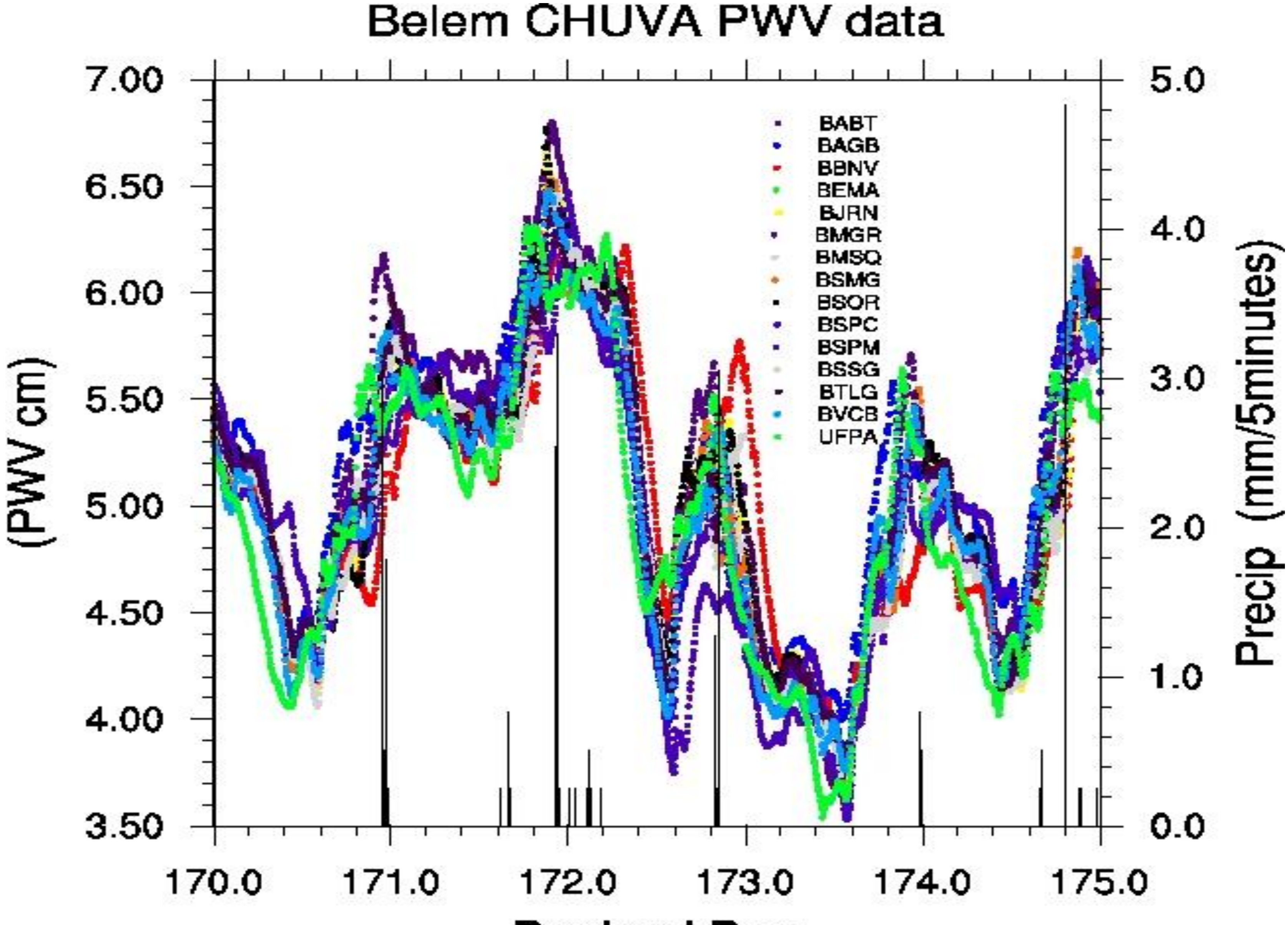


Belem Dense Network (GPM-CHUVA)

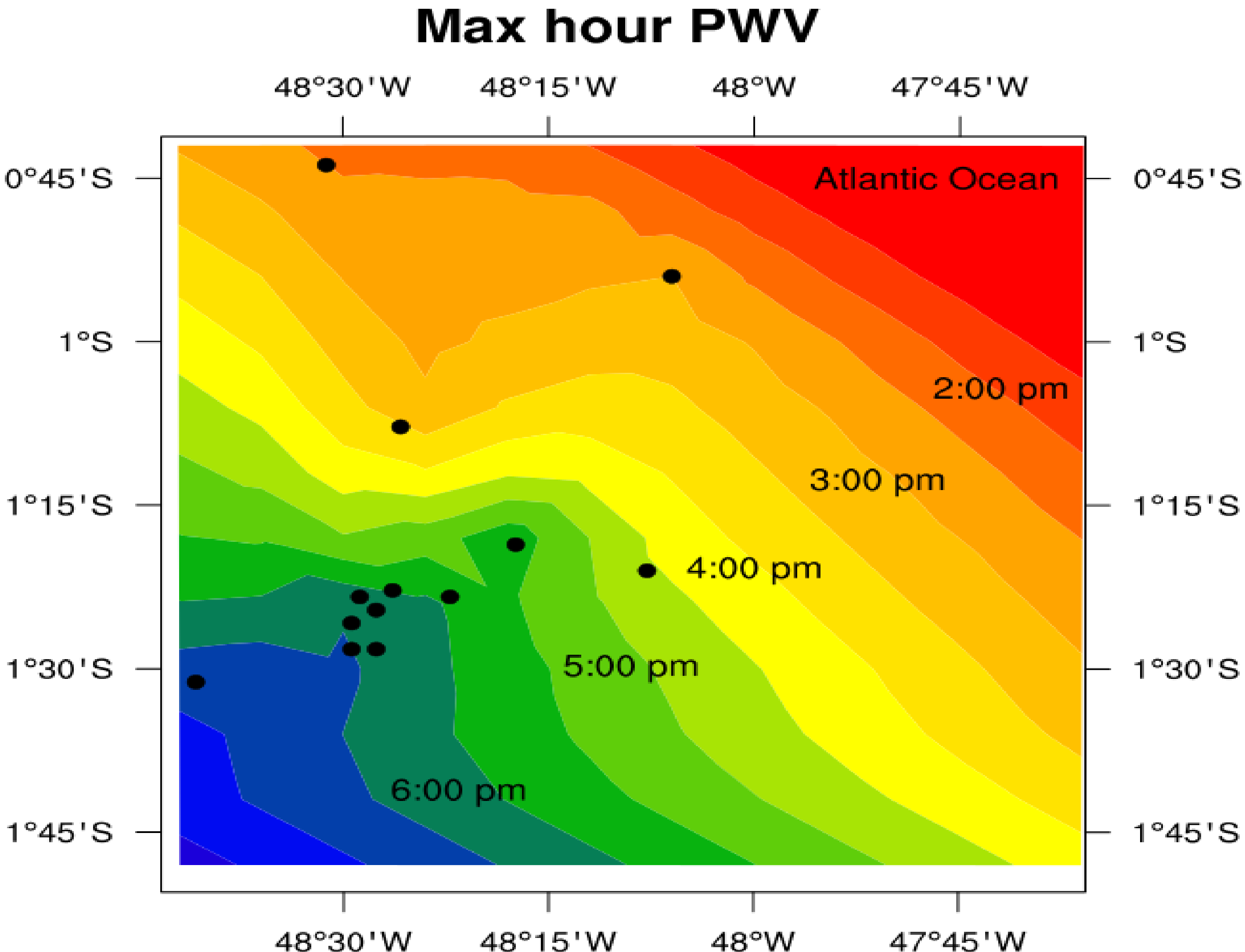
June 2011

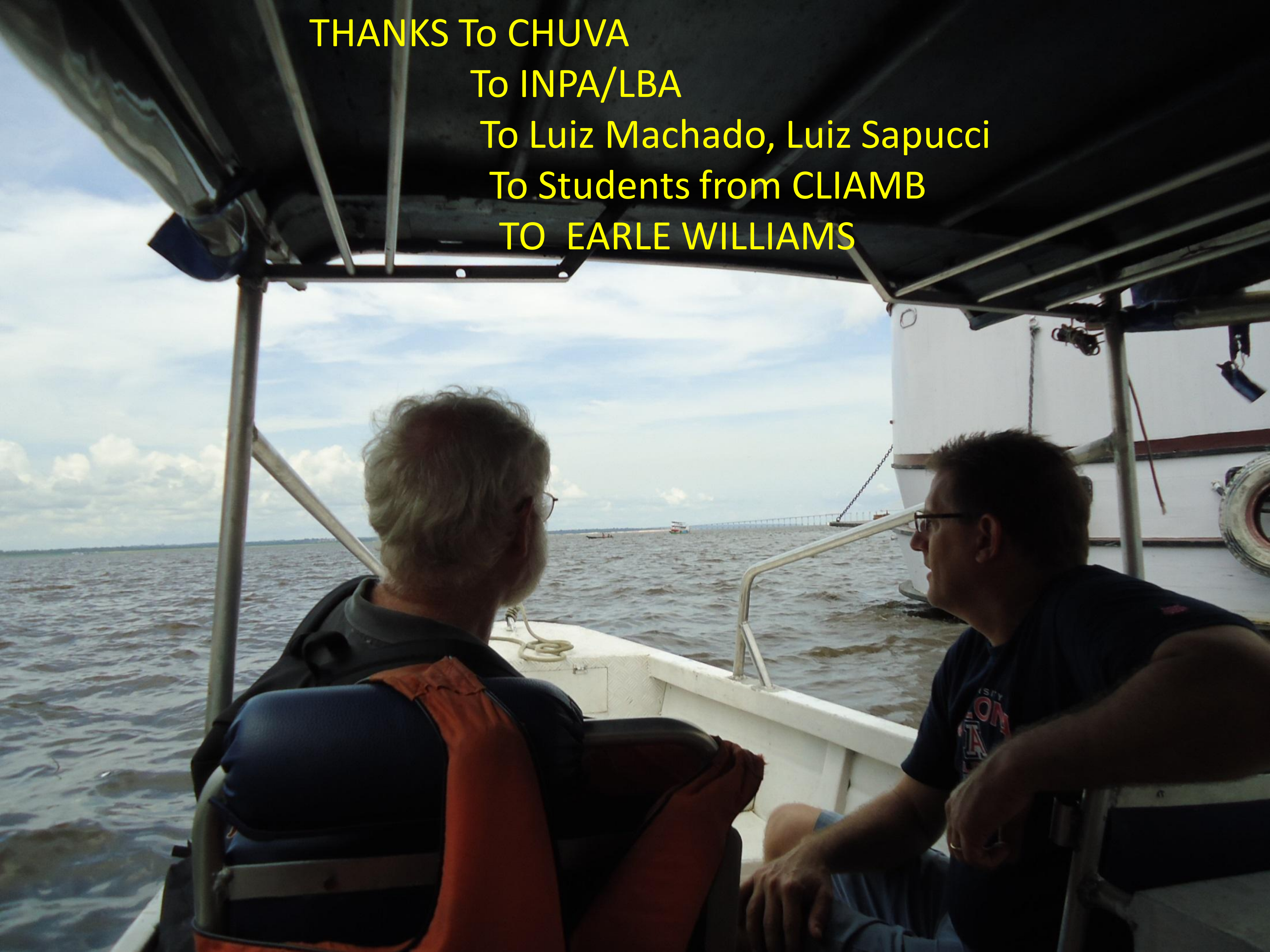


Sea-Breeze Convection Belem



Diurnal Cycle of Maximum PWV CHUVA BELEM

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