Progress in Calculating Tropical Cyclone Surface Wind Inflow → Upflow → Outflow from OVW Observations

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Force Emanuel "Carnot Cycle" With SAR-derived PBL Solution

- Input data: Katrina, 27 Aug, 2005 11:30
 - OVW (SAR, RadarSAT-1, 1km)
 - SST (MW+IR, from RSS, 9km)
- Foster (2009, 2017) PBL solution (from SAR) generates lower BC to Emanuel (1986)
 - Primarily W along PBL top
 - ("Ring the troposphere's bell")
- Calculate tropospheric (U,V,W)
- First Goal: Can I get correct order of magnitude?

(skip)

- 1. Derive Sea-Level Pressure (*SLP*) from Satellite OVW (Foster, 2017)
- 2. Derive Gradient Wind at the PBL-Top (*h*) from SLP
- 3. Derive PBL (U,V,W) from SLP and OVW using Foster (2009)
- 4. Emanuel (1986) "Carnot" Cycle:
 - 1. TC troposphere is neutral to Slant-wise convection \leftrightarrow
 - 2. Angular Momentum (M) surfaces are parallel to Saturated, equivalent Potential Temperature (θ_e^{*})
 - 3. Overturning Secondary Circulation Stream function (ψ) is parallel to M
- 5. Use SLP & Sea-Surface Temperature (*SST*) to find θ_e^* as function of Height (z)
- 6. Find (R,z) profile of M at RMW(T(z))
- 7. Moon and Nolan (2010): V(troposphere) is self-similar to V(h)
- 8. Calculate *M*(*troposphere*) from *V*(*troposphere*)
- 9. Calculate $\psi(h)$ from PBL solution $(\frac{\partial \psi}{\partial r} = rw, -\frac{\partial \psi}{\partial z} = ru)$ 10.Interpolate ψ into troposphere knowing M(h)11.Calculate (*U*,*W*) in Troposphere















Gray, 1979 Composited Observations



Frank, 1977





Summary

- First estimate of TC Tropospheric winds from OVW and SST alone
- First cut at coupling Non-linear PBL model to Emanuel (1986) TC model
- Results are lower than, but within order-ofmagnitude of, composite observations
- Year 3: PBL model improvements in-progress
- Year 3: More complete coupling planned
- Year 4: Compare to Global Hawk Observations