Satellite Views of the Tropical Cyclone Lifecycle

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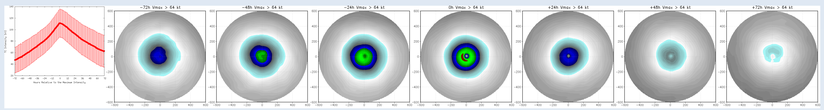
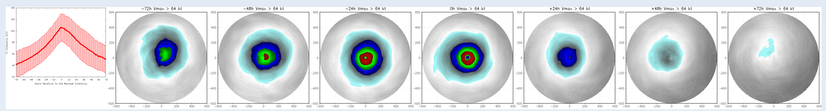
Lifecycle in Infrared (IR) Imagery

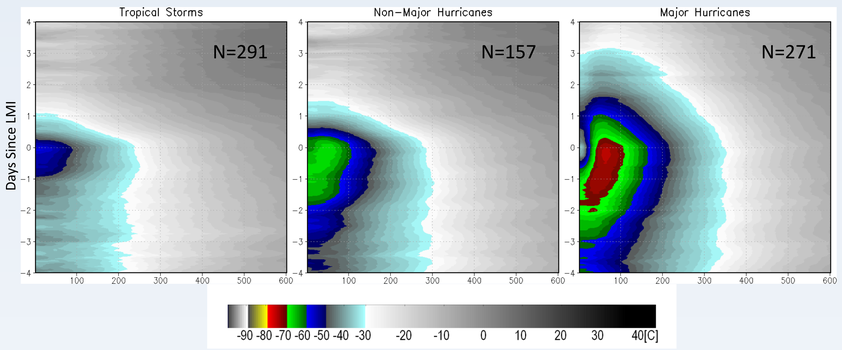
Northern Hemisphere



Southern Hemisphere



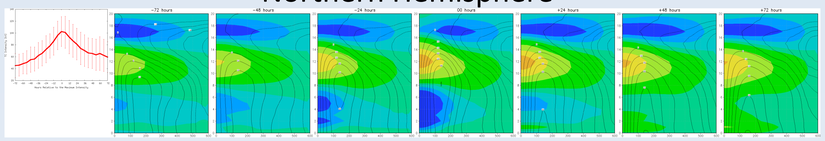
Caption: Homogeneous storm-center, direction relative (upward) composites of IR images associated with hurricane-strength TCs. Northern Hemisphere (top, N=264) and Southern Hemisphere (bottom, N=72) are show with the mean intensity and standard deviation of intensity at each time is shown on the left.



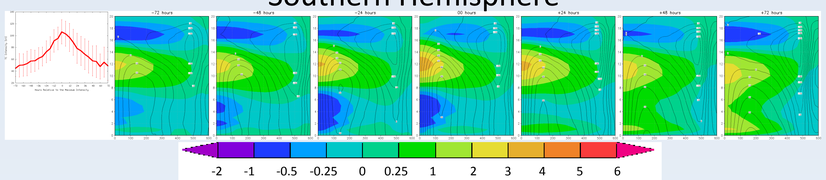
Caption: Inhomogeneous storm-center azimuthally averaged IR brightness temperatures with respect to the first lifetime maximum intensity (LMI, 0 days) and stratified by LMI intensities.

Lifecycle in AMSU Retrievals

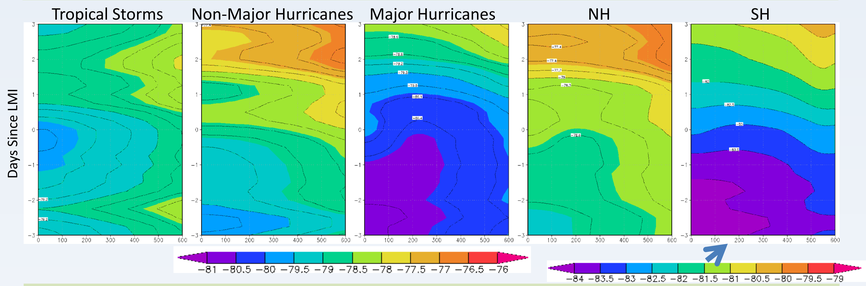
Northern Hemisphere



Southern Hemisphere

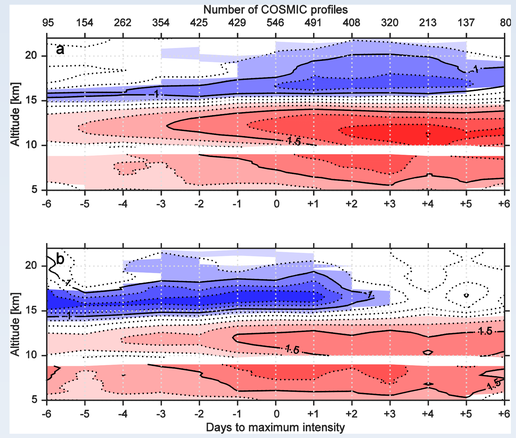


Caption: Inhomogeneous composites of TCs with LMI > 64 knots at different times relative to the time of the LMI. . Temperature anomalies relative to the temperature at r=600 km (shaded) and tangential winds [m s^{-1}] based on 1-D gradient balance (contours). The left most panel shows the mean and standard deviation associated with the TCs in these 6-hourly composites. The number of cases at LMI for northern and southern hemispheres was 158 and 53, respectively.

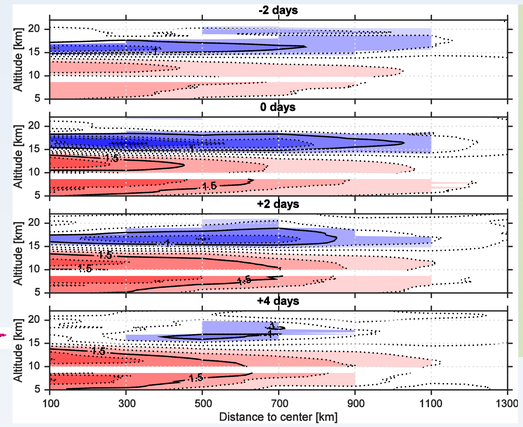


Caption: Inhomogeneous composites of 17km (i.e., tropopause) temperatures from the AMSU-based temperature retrievals from 3 days prior to LMI to 3 days after LMI. The number of cases at LMI was 219, 110, 125, 158, and 53 going left to right.

Lifecycle in COSMIC Retrievals



Caption: Temperature anomaly within 500 km of TC with LMI > 65 kt contoured as a function of time relative to first LMI and altitude. Anomalies that exceed the t-test 95% significance level are shaded. Anomalies in a) are relative to the local climatology, b) are relative to the area average between 1300-1500 km away from storm center. The white horizontal band under 10 km marks the separation between dry and wet COSMIC retrievals.



Caption: Temperature anomaly contoured as a function of the distance to the center of storms and altitude. Anomalies that exceed the t-test 95% significance level are shaded. Anomalies are defined with respect to the area average between 1300 and 1500 km away from storm center. Only TC tracks from -2 to +4 days are used.

Findings/Observations:
- Intensity variations are relatively symmetric about LMI
- Deep convection, on the other hand ,is asymmetric about the LMI.
- Southern hemisphere cyclones have colder tops due to lower latitudes and colder tropopause November – March
- Eye features last a couple days after LMI, longer in the NH
- Major hurricanes have much colder convection that is sustained throughout the entire intensification period.

Findings/Observations:
- Upper tropospheric temperature anomalies and intensities are relatively symmetric about the LMI
- Tropopause (17 km) temperatures are asymmetric about the LMI.
- SH cyclones have colder tropopause due to the seasonal November – March cold point tropopauses
- Eye warming features are evident near LMI in major hurricanes, NH and SH composites

Findings/Observations:
- TC circulations are transporting warm tropospheric and cold tropopause air poleward into their surrounding environments
- Upper tropospheric temperature anomalies are relatively symmetric about the LMI and are related to intensity
- Tropopause/17 km temperature anomalies are asymmetric about the LMI
- At later times, the cool anomalies over the TC center abate, but the cold anomalies near the outflow-environment interface (300 – 700 km) remain

These combined observations suggest:

1. **Deep convection near the TC center** appears to **cool the tropopause and outflow temperatures** during the formative stages and during intensification; **priming the atmosphere to higher potential intensities**.
2. Post LMI**, the deep convection and tropopause cooling abates near the TC center**, but **cold temperature anomalies remain** and/or are advected to the region **where the outflow interfaces with the environment**, dropping the central pressure and raising the environmental pressure. This **increase in the horizontal pressure gradient** may **help maintain TCs in the absence of central deep convection**.
3. TCs are transporting both warmer tropospheric and colder tropopause temperatures horizontally. **Horizontal transport in TCs moistens and warms (dries and cools) the mid-latitude troposphere (lower stratosphere).** For more details on this aspect see the presentation entitled “Evolution of the Vertical Temperature Structure in Tropical Cyclones Inferred from GPS Radio Occultation Measurements” by Louis Rivoire, 18A.2, Friday at 11:15am.