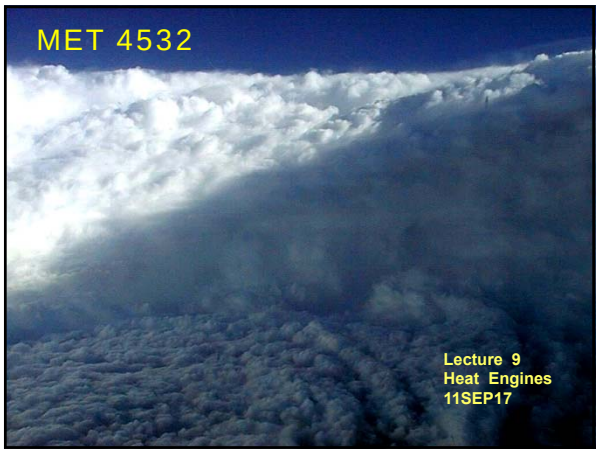
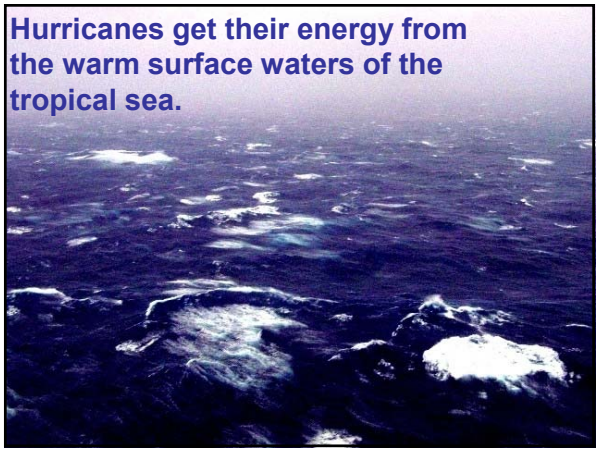
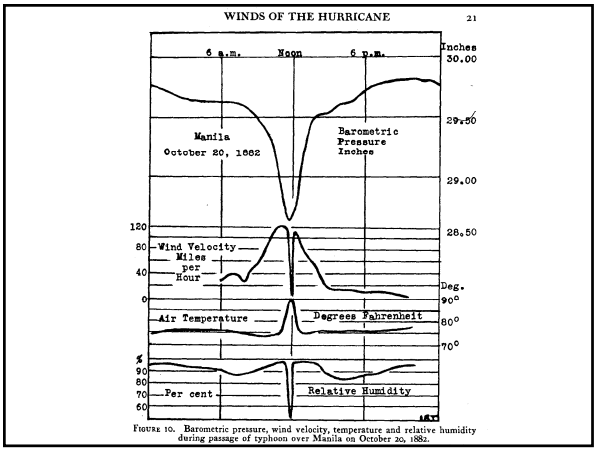


Important Dates and Events

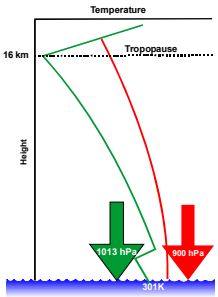
- **Paper assignment**
  - **Length 1500-2000 words, at least 5 references**
  - **See written assignment for details**
  - **Preliminary draft to Turnitin 08November**
  - **Final hard-copy Wednesday 15 November 2017**
- **Paper topics due Monday 18SEP17**
- **Monday 27 September Lecture 17, EXAM REVIEW. Lectures 1-16**
- **Wednesday 2 October, Lecture 18 EXAM # 1**





Thermodynamic Equilibrium

- Tropical atmosphere is not in equilibrium with the sea surface
- Warming the air and evaporating some water will bring it to equilibrium
- Mix to tropopause
- Lower hydrostatic pressure
- By about 10%
- Equivalent to a CAT5 hurricane

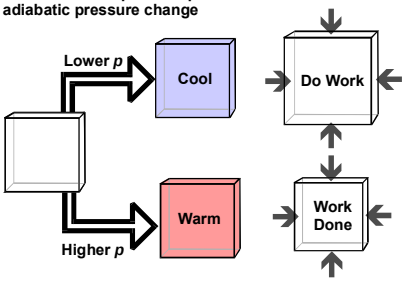


Effects of heating a parcel of air

- Add heat:
  - Raise the temperature
  - Air expands, doing work on surroundings
  - Evaporate condensed water (if any)
- Remove heat:
  - Lower temperature
  - Air contracts, surroundings do work on it
  - Water condenses (if saturated)
- Adiabatic
  - No heat added or removed
  - Air warms (moisture may evaporate) when work is done on it
  - Air cools (moisture may condense) when air does work

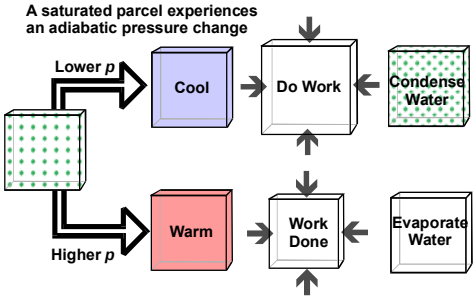
Dry Adiabatic Process

An unsaturated parcel experiences an adiabatic pressure change



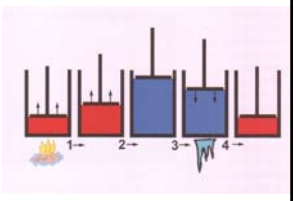
Moist Adiabatic Process

A saturated parcel experiences an adiabatic pressure change

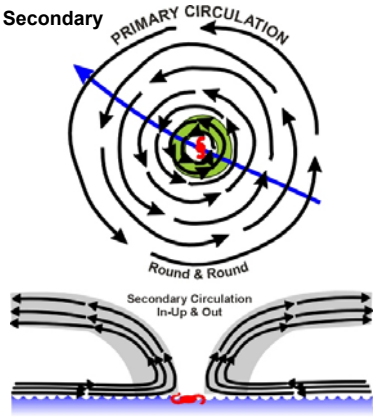


Carnot Engine

- Runs between warm and cold reservoirs
- Heat input Q
- At temperatures T_w and T_c
- Heat the cylinder →Isothermal Expansion
- After heating stops →Adiabatic expansion
- Cool the cylinder → Isothermal compression
- After cooling stops → Adiabatic compression
- Useful work = $Q(T_w\text{-}T_c)/T_w$
- Entropy, related to the "wasted" heat, always increases in real heat engines

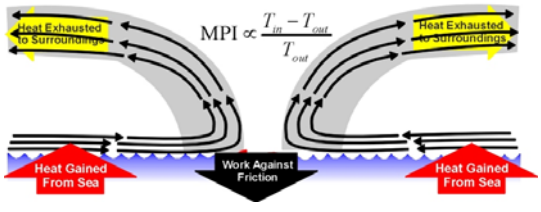


Primary and Secondary Circulations



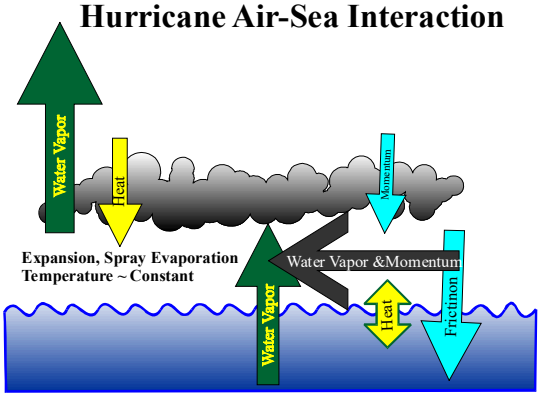
Emanuel Cycle

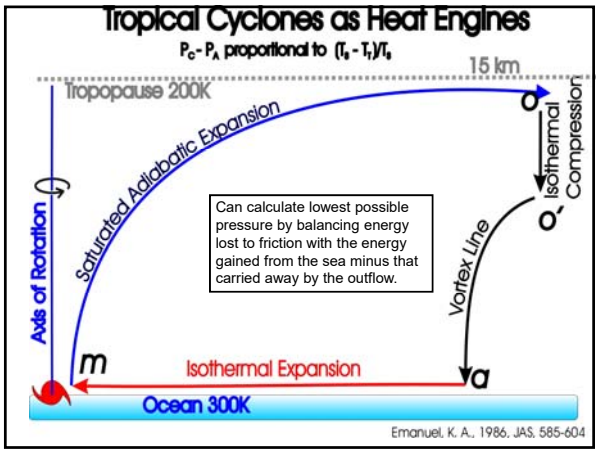
Heat Gained = Work + Heat Exhausted

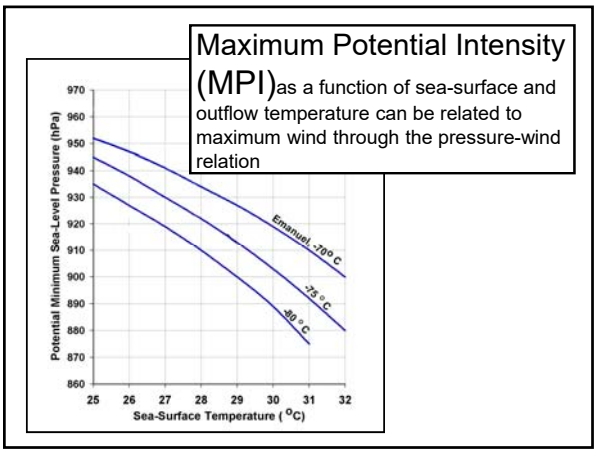


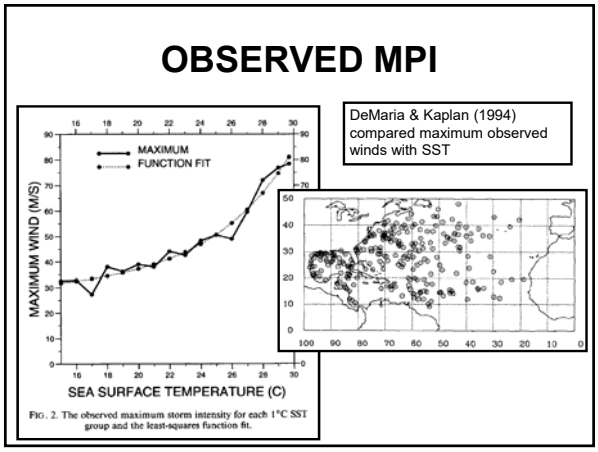
MPI is the lowest central pressure or strongest windspeed possible for given sea-surface and outflow temperatures.

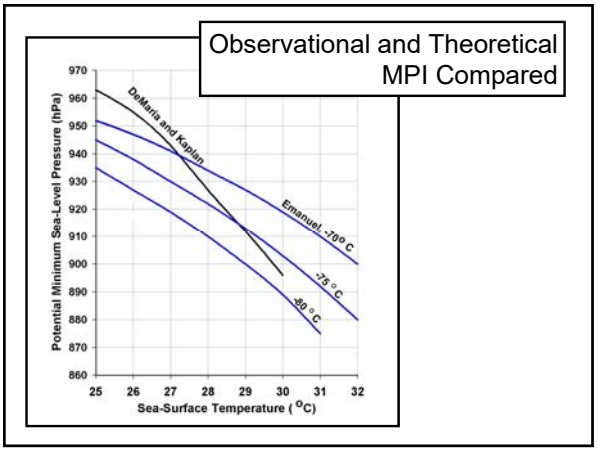
Hurricane Air-Sea Interaction











SUMMARY

- TC low central pressure due to warm vortex core
- Swirling wind in gradient balance with low pressure
- Energy drawn from sea balanced by
  - Loss to frictional work
  - Heat carried away by exhaust
- Energy is released through moist adiabatic expansion that changes stored latent heat into sensible heat
- Like the Carnot Cycle in steam engines
- Defines Maximum Potential Intensity (MPI)
- Reasonable agreement between theory and observations
- FOR NEXT TIME: Emanuel Ch. 12 Intensity (pp.72-81)