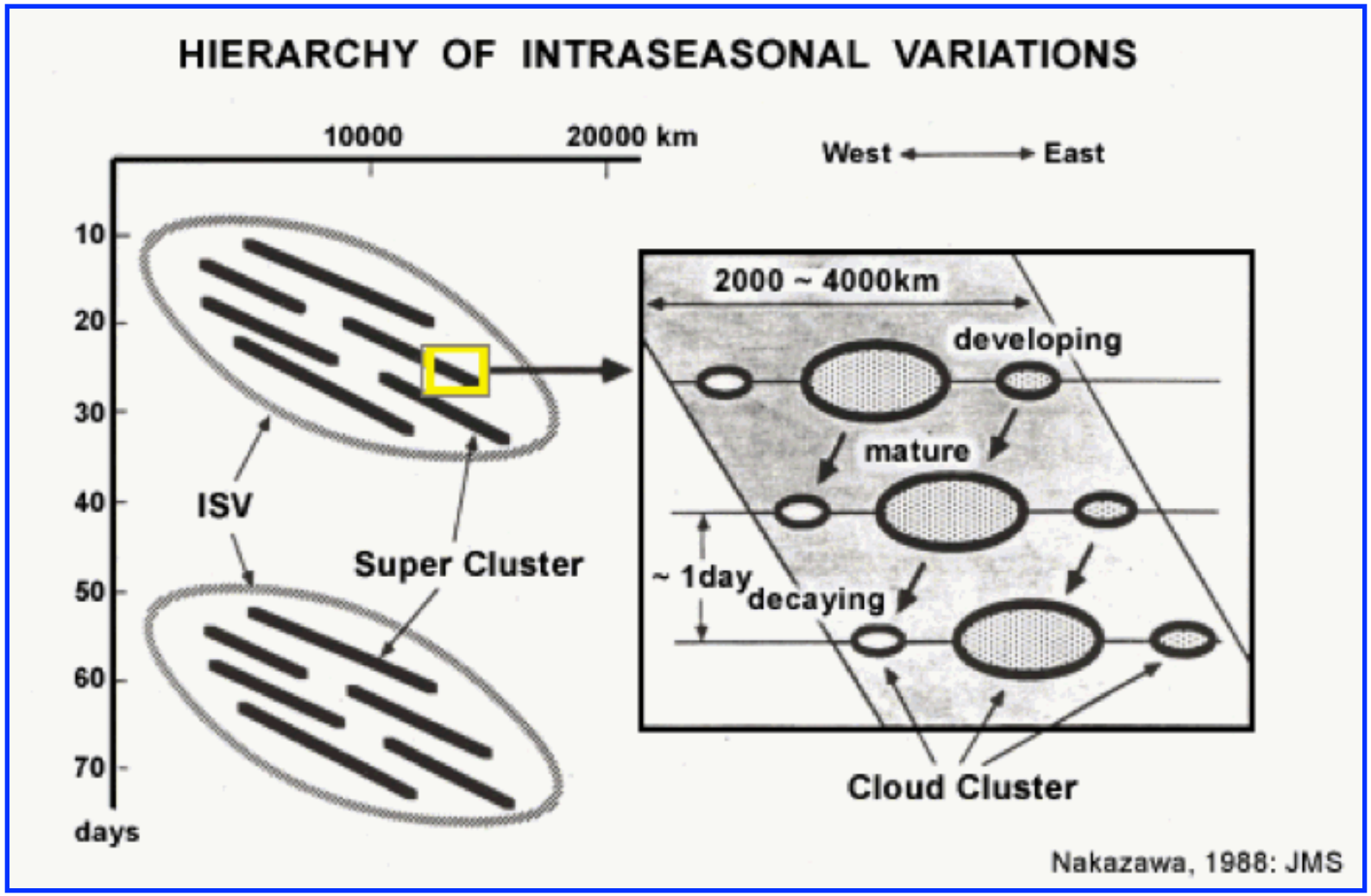
- The Madden-Julian Oscillation (MJO)

Goal: Understand the principal features of the MJO

Chapter 5, Comet Textbook

Intraseasonal variability: timescales < ~ a season



Madden-Julian Oscillation: Overview

- The Madden-Julian Oscillation (MJO) is a coupled-ocean atmosphere phenomenon first identified and document in the early 1970s.
- The MJO's atmospheric component consists of an equatorial oscillation propagating eastward from the Maritime Continent at ~5 ms^{-1} [periods of 30-60 days] with a spatial scale of $12x10^3$ - $20x10^3$ km.
- The atmospheric signatures are evident in surface pressure, lower and upper level winds, and fields tied to deep convection. Seasonally, the MJO is strongest in austral (Southern Hemisphere) summer
- The MJO's oceanic component has slightly longer periods and is evident in SST, mixed layer depth, latent heat flux, and surface stress.

MJO: Vertical structure

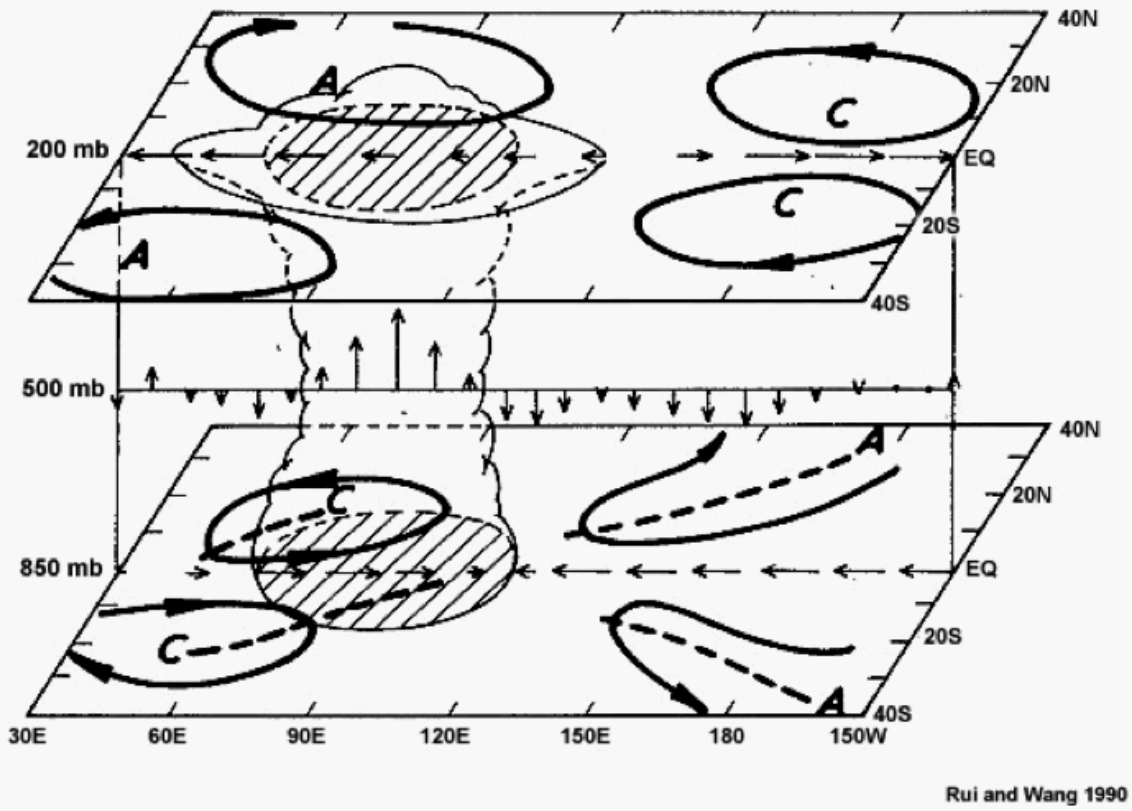
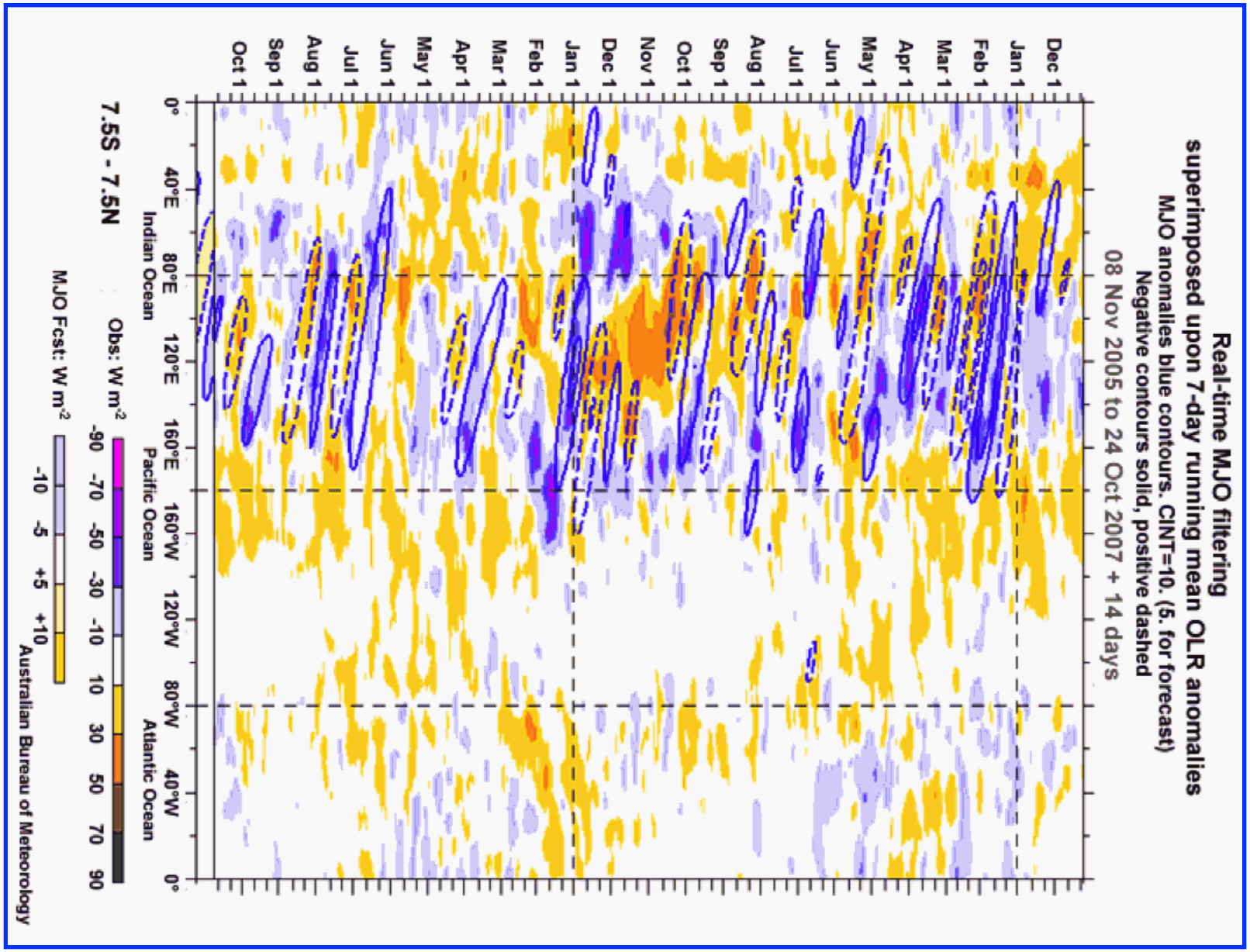


Fig. 5.5. Schematic depiction of the large-scale wind structure of the MJO. The cloud symbol indicates the convective center. Arrows represent anomalous winds at 850 and 200 hPa and the vertical motions at 500 hPa. "A" and "C" mark the anticyclonic and cyclonic circulation centers, respectively. Dashed lines mark troughs and ridges (from Rui and Wang 1990[10]).

MJO: OLR timeseries



MJO: Formation and maintenance

- *Initially*: latent heat release by convection, forcing Kelvin waves, but strictly speaking Kelvin waves propagate too quickly
- External forcing theories: MJO owes its existence to external phenomena
  - Intraseasonal fluctuations from the Asian monsoon
  - "stochastic" convective forcing
  - Midlatitude interactions
- Internal forcing theories: MJO creates its own energy source through feedback processes
  - Wave conditional instability of the second kind [CISK]: ABL moisture convergence in low pressure areas forces mesoscale convective organization; moisture convergence also linked to forcing of Kelvin waves
  - Wind induced surface heat exchange [WISHE]: evaporation is the source of MJO instability

We will discuss these further in the study of tropical cyclones.

MJO: Implications

- Modulation of continental precipitation
- Modulation of Asian, Australian, and African monsoons
- Linkages to tropical cyclones and mesoscale convective systems
- Contributions to ENSO variability
- Rossby wave “trains” to higher latitudes

West Coast Pineapple Expresses