

# **Is ENSO a cycle or a series of events?**

**William S. Kessler**

**NOAA / Pacific Marine Environmental Laboratory, Seattle**

---

**Early ideas (Wyrтки) saw El Niño as an isolated disturbance.**

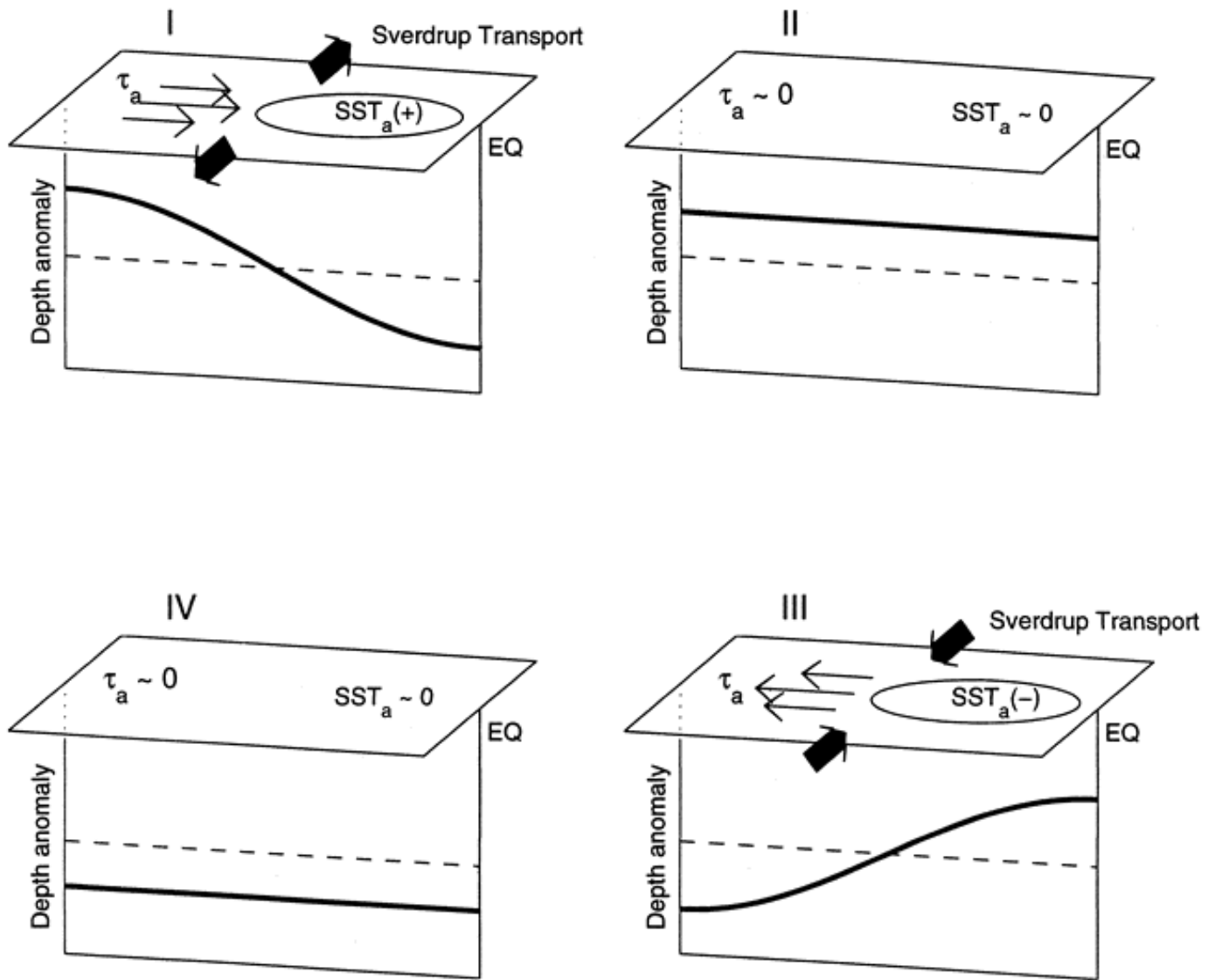
**The advent of simple and intermediate coupled models suggested a cyclic phenomenon, with each phase leading to the next in a self-sustained oscillation.**

**Will use the Jin (97) recharge oscillator as a paradigm for this type of behavior (the delayed oscillator would do as well).**

**Examine observed ENSO evolution since 1980: Does each phase provide the impetus to advance to the next phase? (Will find a fundamental asymmetry and break in the cycle).**

**The results suggest that El Niños are event-like, requiring an initiating impulse not contained in the dynamics of the cycle itself.**

# Schematic of the Jin (1997) Recharge-Discharge mode:



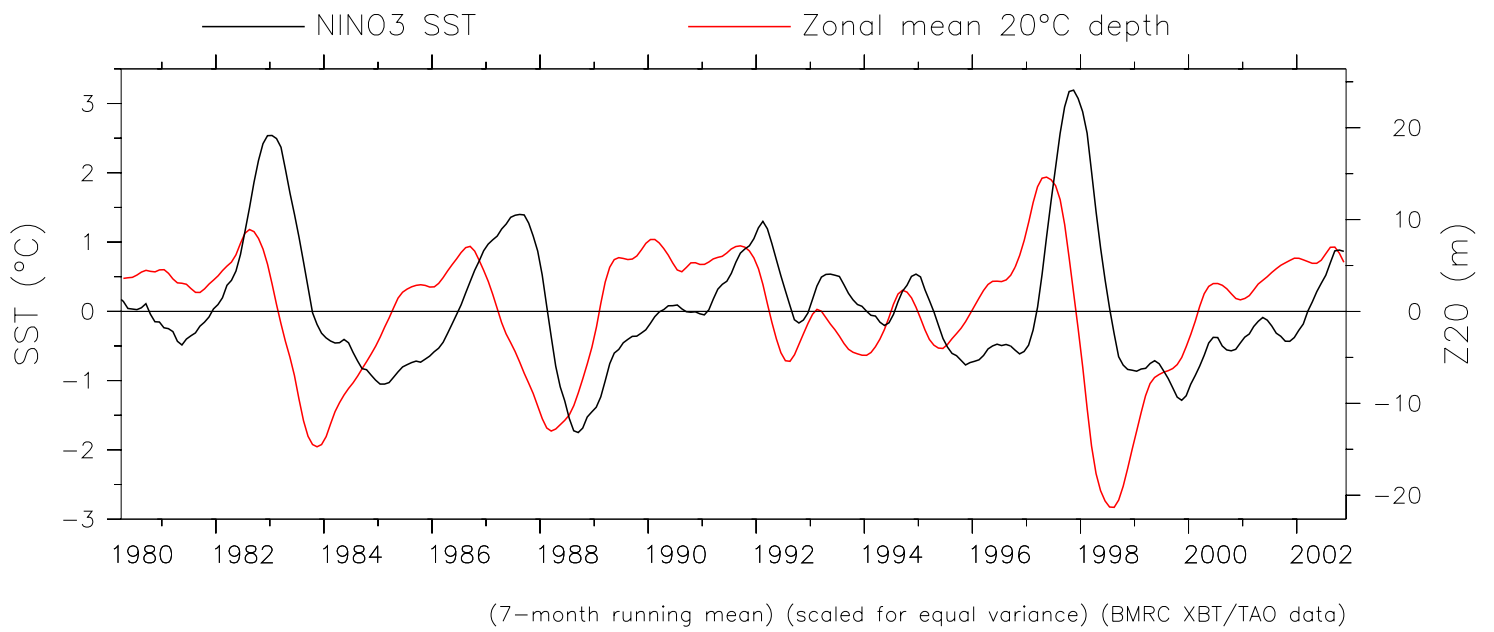
(After Meinen and McPhaden (2000))

$$\tau = h_E - h_W, \quad \tau = bT_E$$

$$\frac{dh_W}{dt} = -rh_w - \alpha bT_E,$$

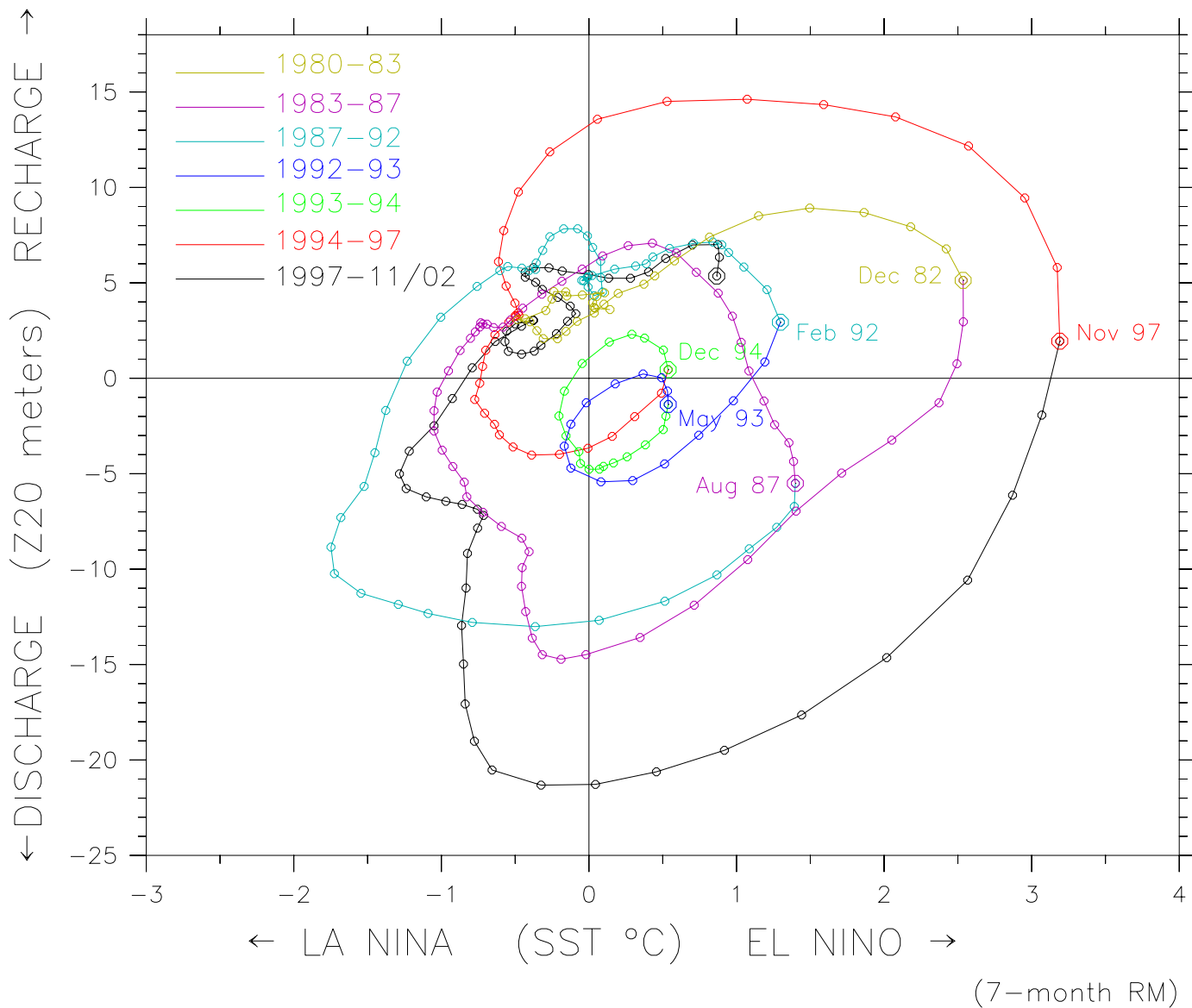
$$\frac{dT_E}{dt} = RT_E + \gamma h_W$$

# NINO3 SST and Warm Water Volume

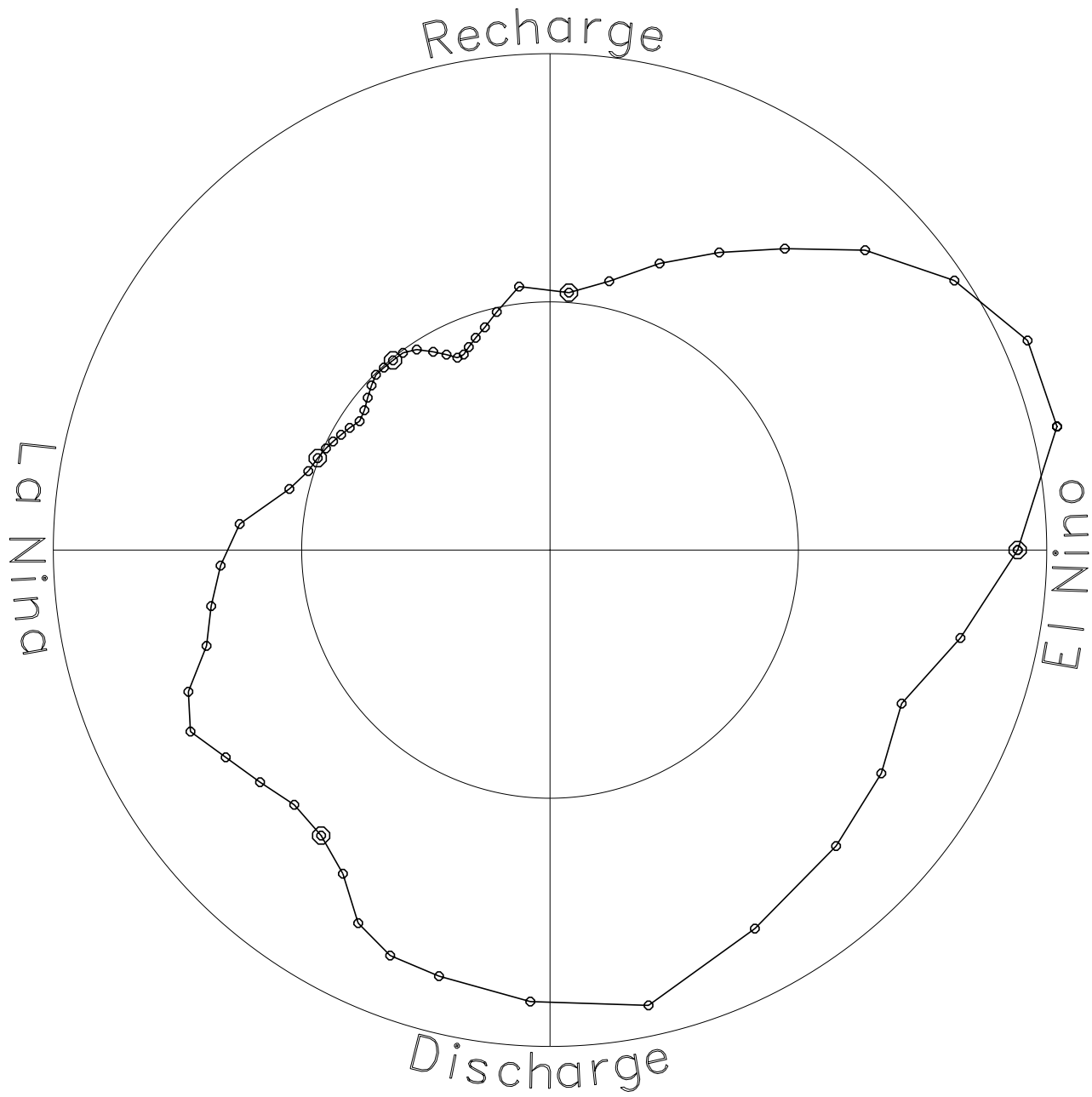


# Nino3 SST and Upper Layer Thickness phase ellipses

ULT is 5°S–5°S, 130°E–80°W average Z20 (BMRC XBT/TAO). Circulation is clockwise

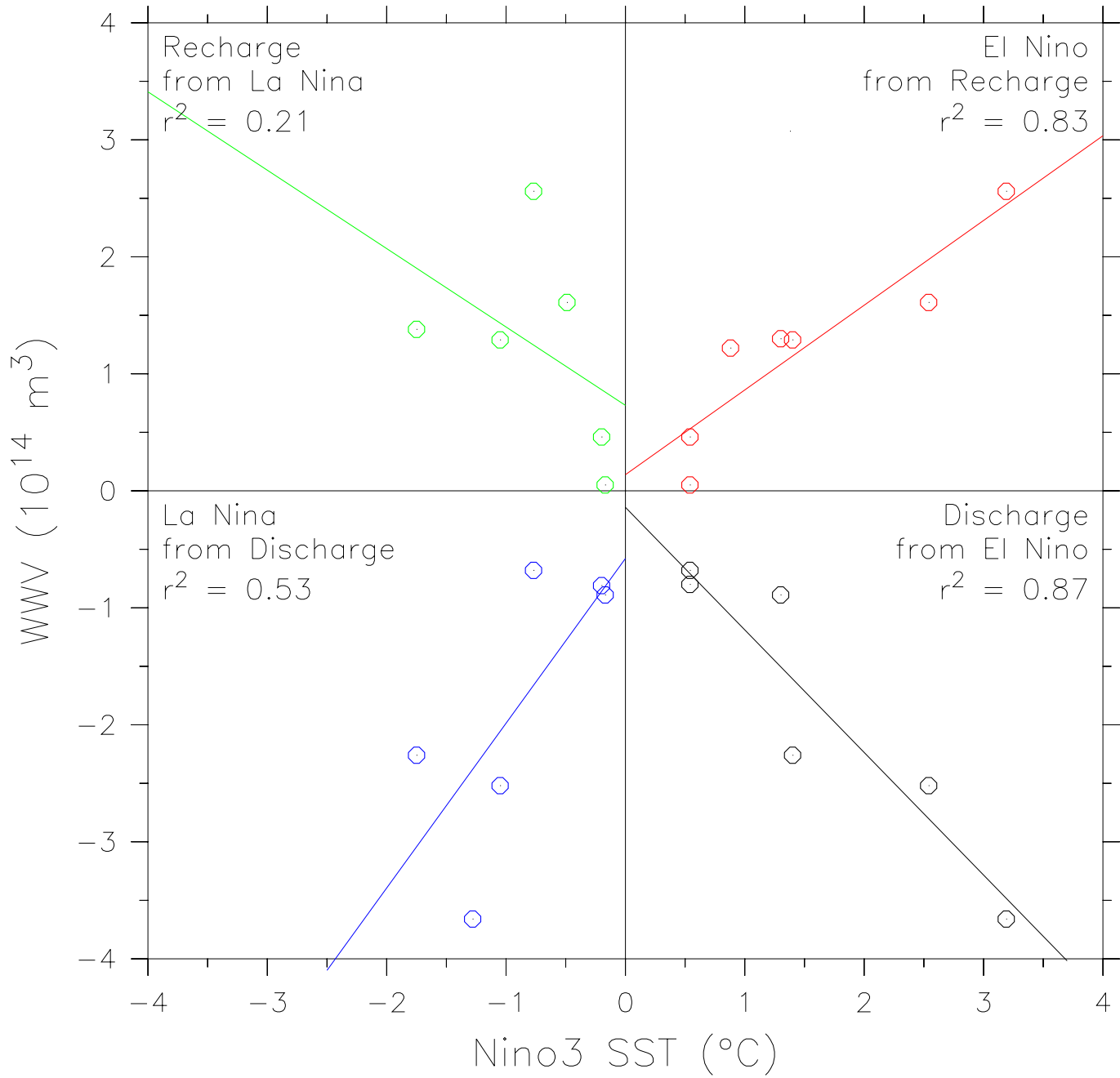


# Average ENSO cycle (Nino3 SST vs WWV)



Observed mean amplitude and angular speed. Monthly and yearly tics  
Mean cycle length is 4.75 years. Circles are 1 and 2 Std Dev

Predictability of amplitude of each ENSO phase  
from maximum of previous phase



Nino3 SST vs BMRC Warm Water Volume

# **Conclude:**

**Wyrtki was right! (well, not quite ....)**

**Observations suggest that an El Niño event leaves the system in a cool state with slightly increased warm water volume, and this state can persist for years, losing memory of previous conditions. ENSO is not a self-sustained oscillation.**

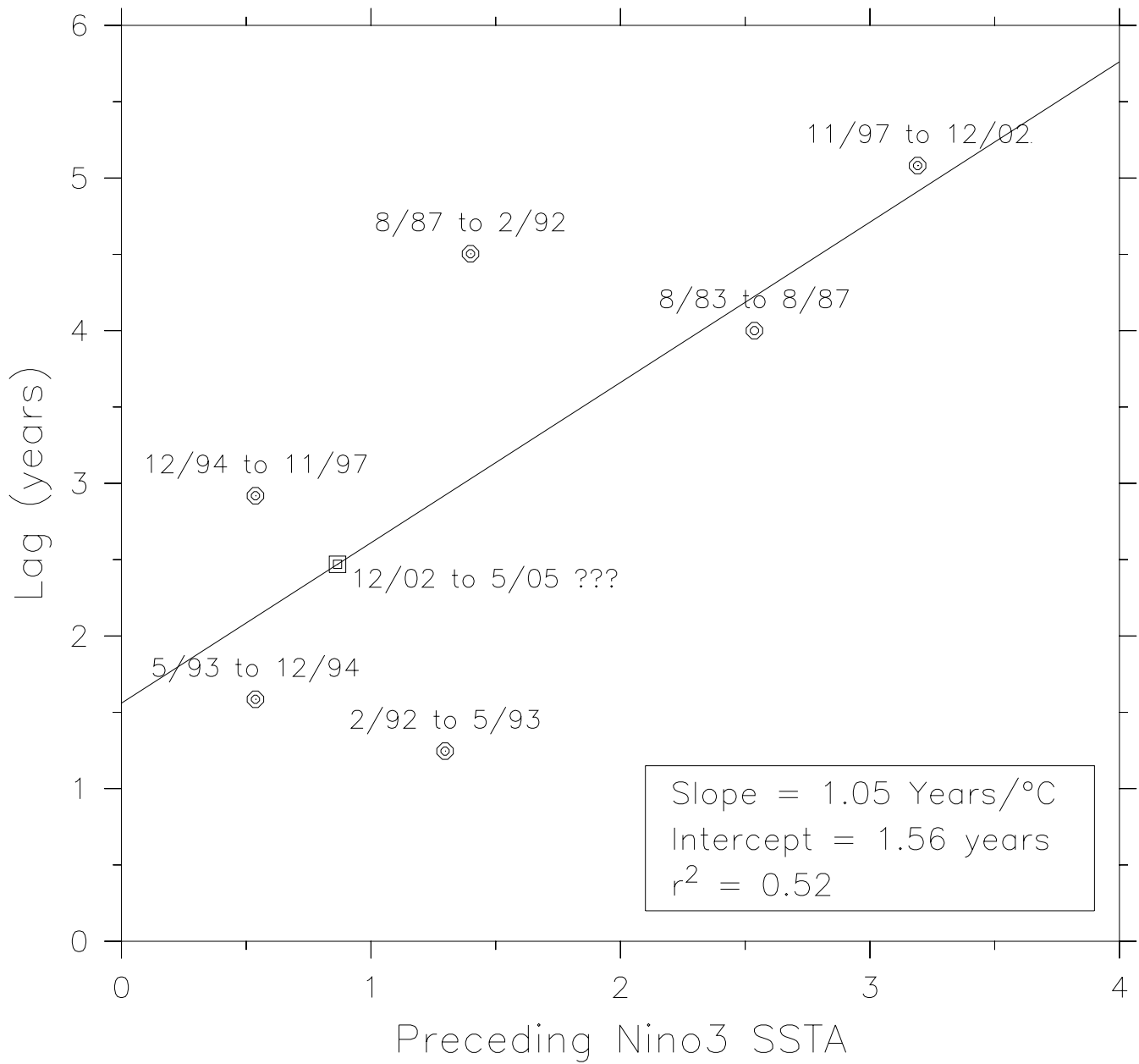
**The evolution of ENSO since 1980 appears consistent with the idea that the basic state is stable or nearly so, and warm events are produced by (stochastic?) forcing external to the cycle itself.**

**All figures from this talk are available at:**

**<http://www.pmel.noaa.gov/~kessler/> → Latest talk**

**(Kessler, 2002: *Geophys. Res. Lett.*, 29(23), 2125.)**

# Lag between El Ninos as a function of previous El Nino SSTA





**Extra slides .....**

# Frequency distribution in observed Recharge Oscillator

Nino3 SST vs Warm Water Volume ( $\iint Z20 \text{ dx dy}$ )

Number of months in each 10° of the cycle (of 263 months 4/80–1/02)

