Japanese Sardine and North Pacific Ocean/Climate Variability

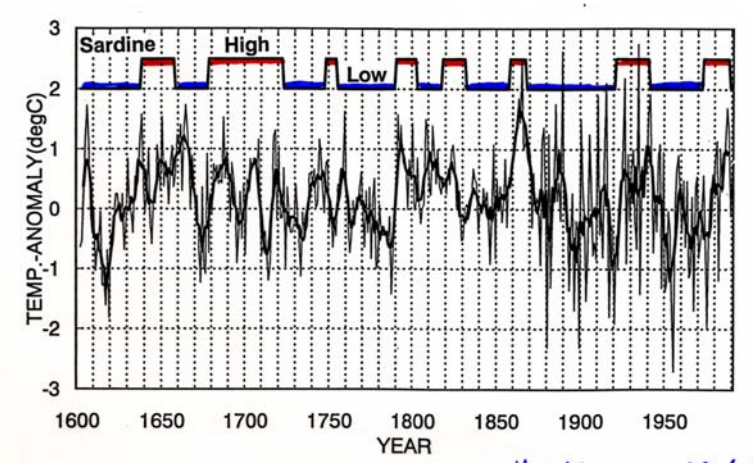
Ichiro Yasuda

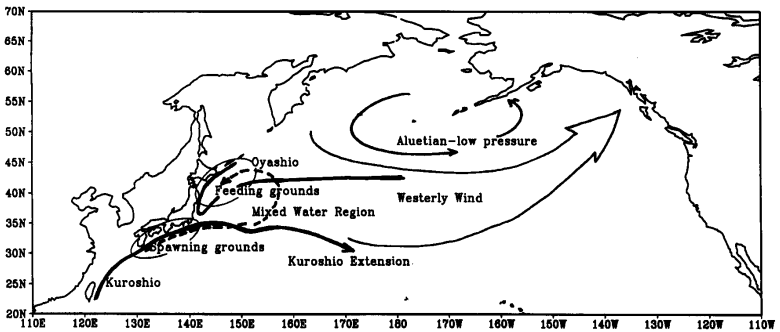
(Univ. of Tokyo)

Downscaling discussion in order to seek underlying mechanisms to control the large stock changes

Japanese sardine catch and climate variations since the 17th century

Yasuda et al. 1999 FO



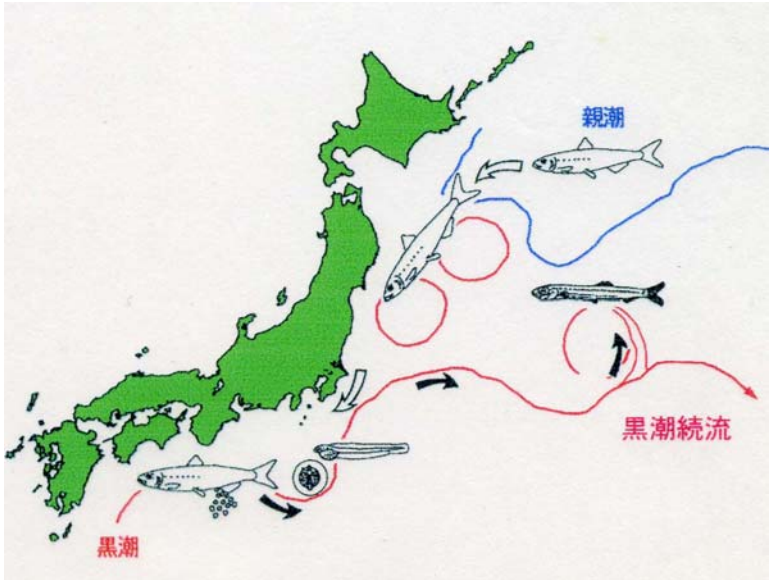


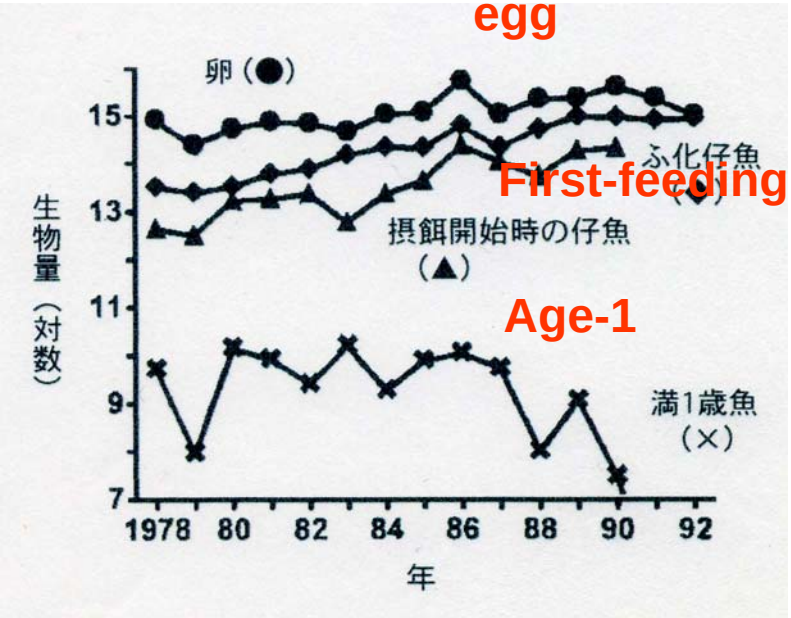
- Repeat good/bad in 50-70years cycle (Tsuboi 1987: old documents)
- Significant NW-US Air-temperature difference between good and bad periods (from tree-ring)
- High Tair in NW-US:

low-SST east of Japan and High catches

Aleutian Low links the two distant places

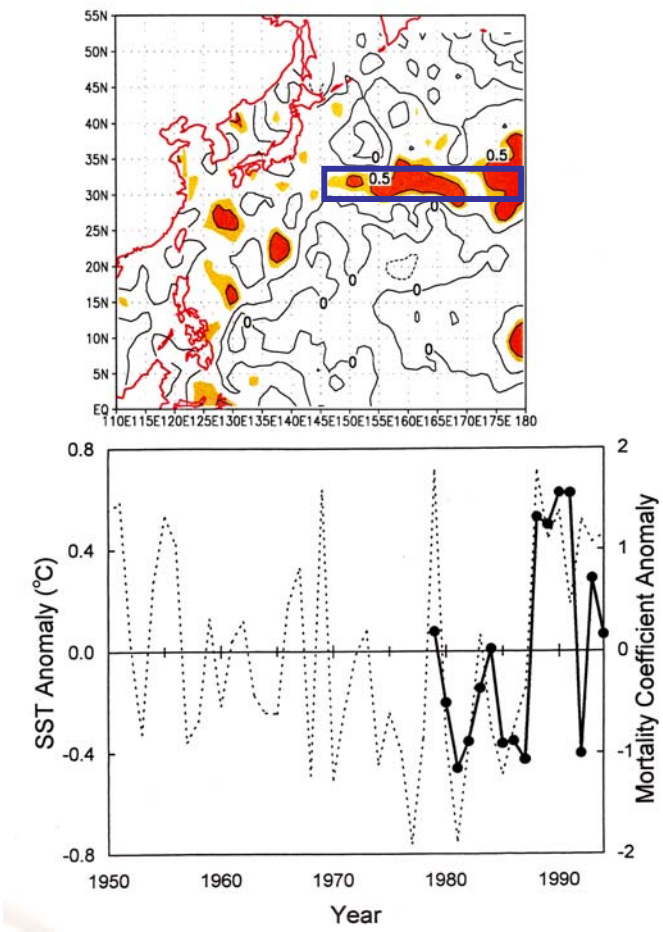
Sardine egg/larvae and Age-1 relationship
Watanabe et al. (1995CJFAS)





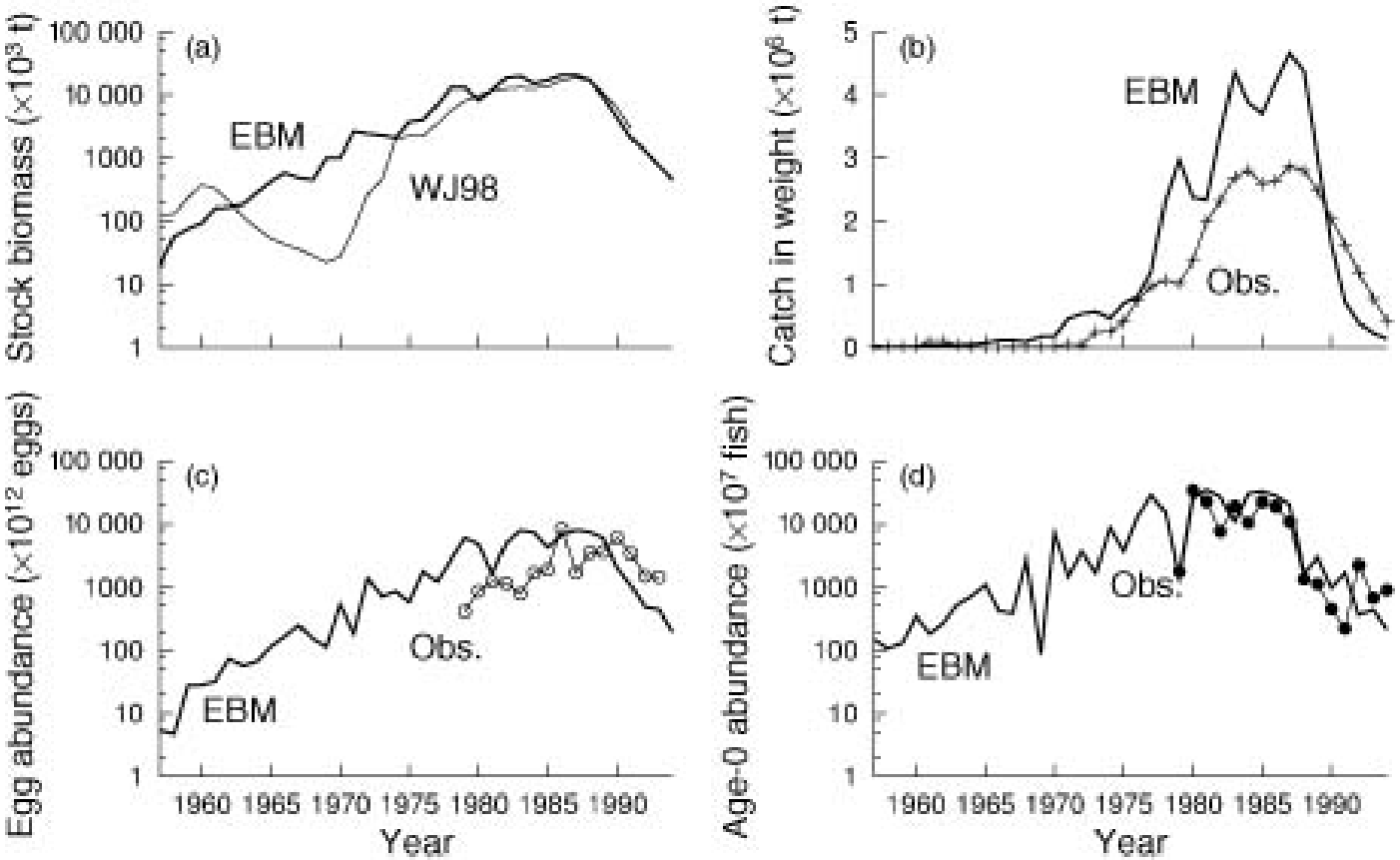
Age-1 abundance declined since 1988; No correlation between Egg/First feeding larvae abundance and Age-1
Large fluctuation of sardine population is possibly controlled after First feeding larval stage to Age-1

Survival rate and winter-spring SST in the Kuroshio Extension and southern recirculation areas (Noto & Yasuda 1999 CJFAS)



- Mortality coefficient from post-larvae to age-1 co-varied with winter-spring SST in the Kuroshio Extension and southern recirculation regions (KESA: 145-180E, 30-35N) on a year-to-year basis.
- High SST: high-mortality
  Low SST: low-mortality
- SST-jump in 1988 and successive warm-SST may lead to sardine collapse
- Low-SST from 1970 to 1987 may lead to large peak.

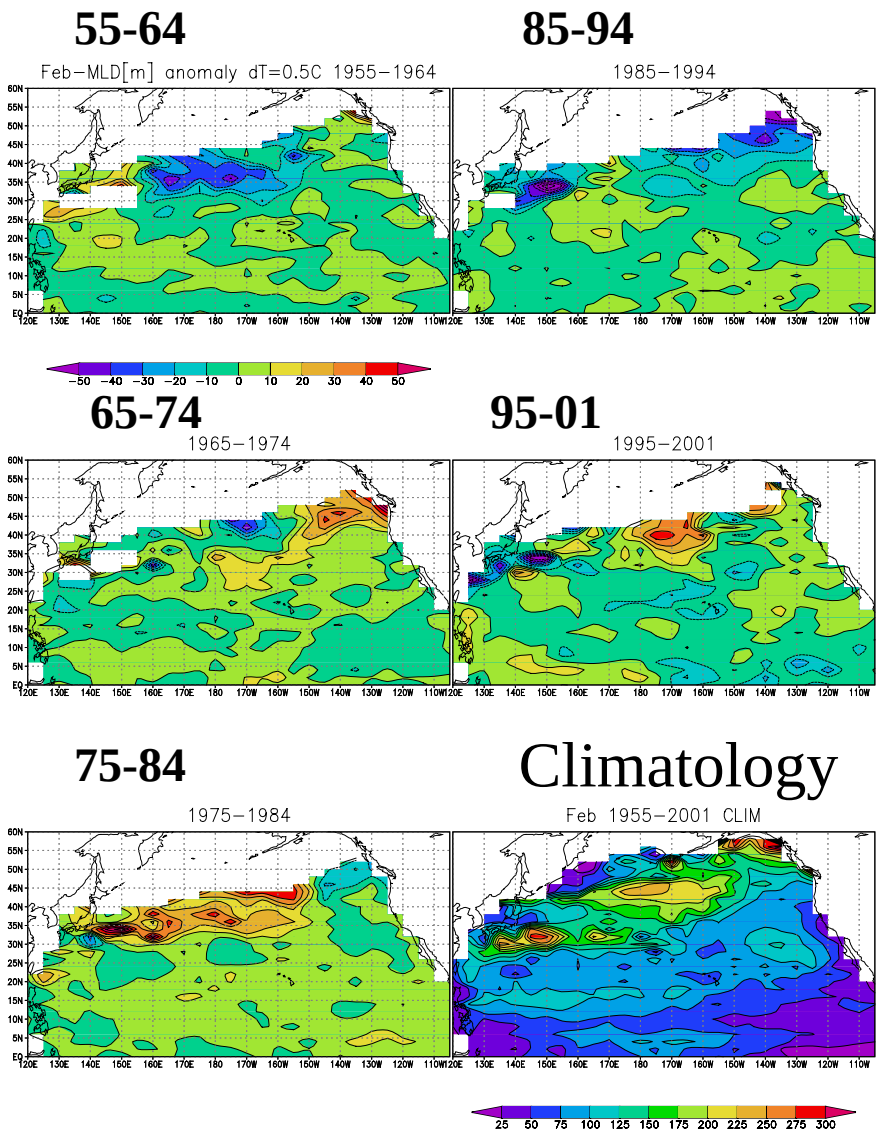
Empirical Biomass model using relation between mortality and SST (Noto & Yasuda 2003 FO)



Sardine life-history (7years life; adult-egg & mortality-SST relations; density effects) successfully reproduced biomass/catch/egg & Age-0 abundance→ persistent (>7 years) SST anomaly produces sardine cycle

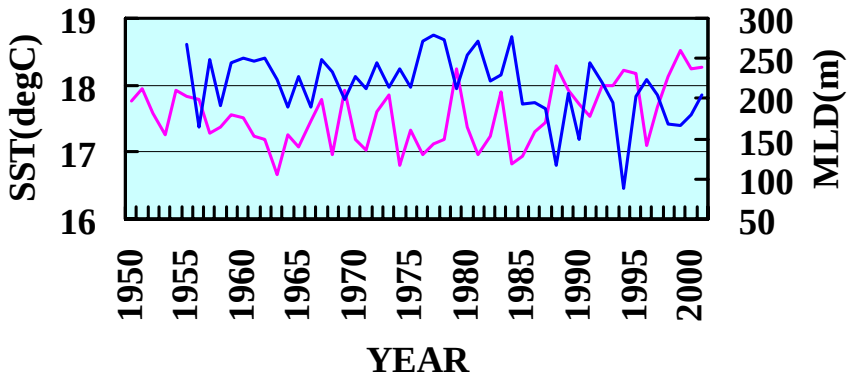
Seek more direct cause other than SST

North Pacific Feb-MLD 10-year mean



Time-series of Feb-KE SST and MLD

Feb-SST and MLD

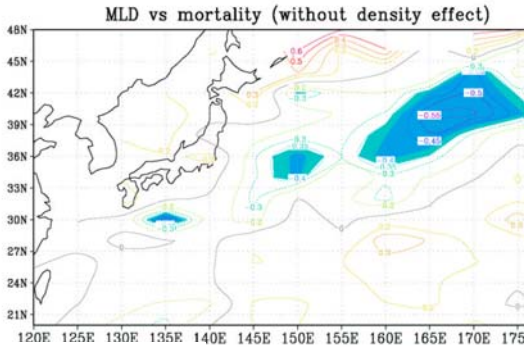


KE-MLD:1975-84Thick
Thin after 1985
Proceed SST-jump in 1988

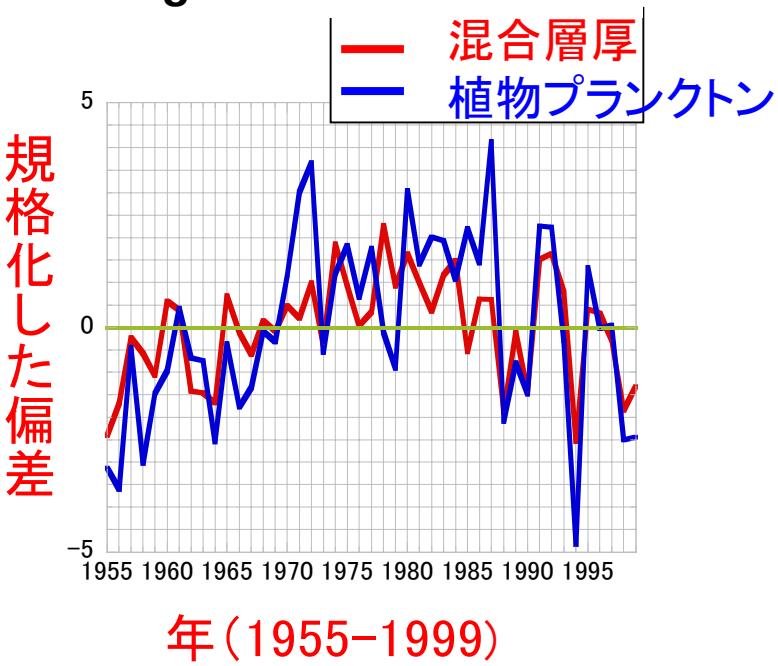
Why KE-SST & MLD change?

Yasuda et al. 2000 Progress in Oceanogr.

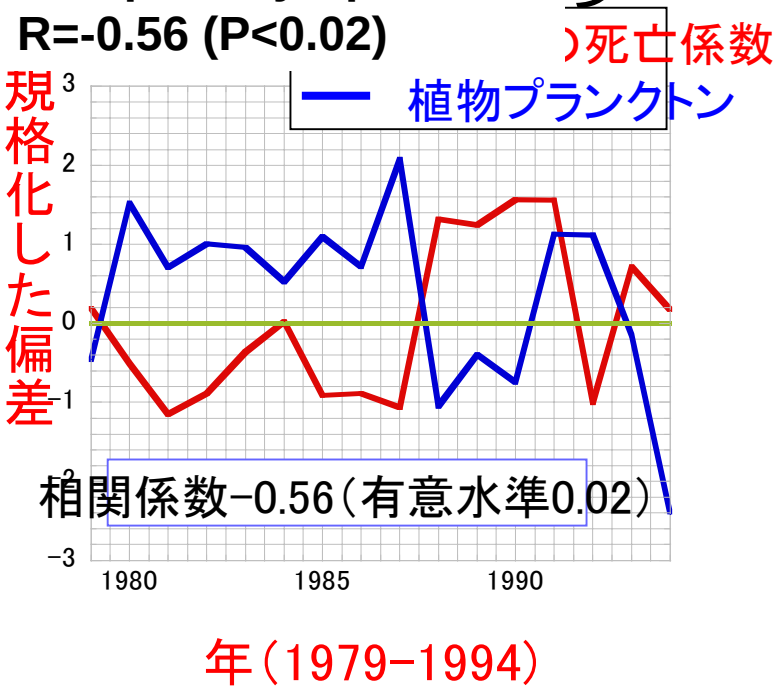
Survival of Japanese sardine and MLD-PP variations (Nishikawa/Yasuda)



March-MLD vs April P.P.
Using NEMURO model



Sardine Morality coeff.
Vs April Phytoplankton
R=-0.56 (P<0.02)



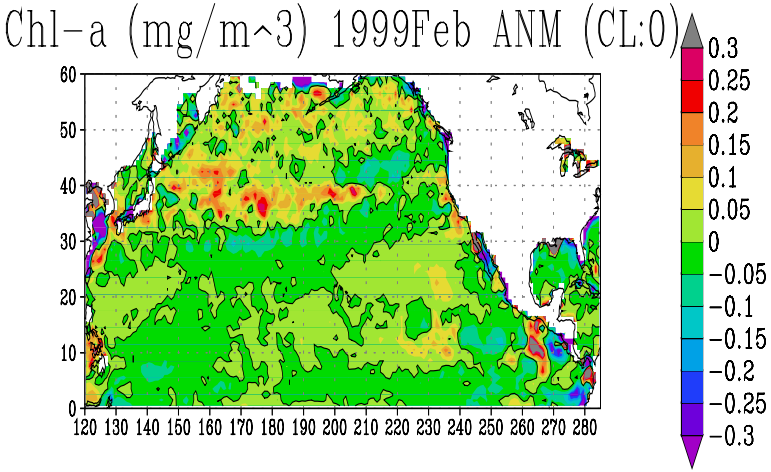
Japanese sardine stock and survival:

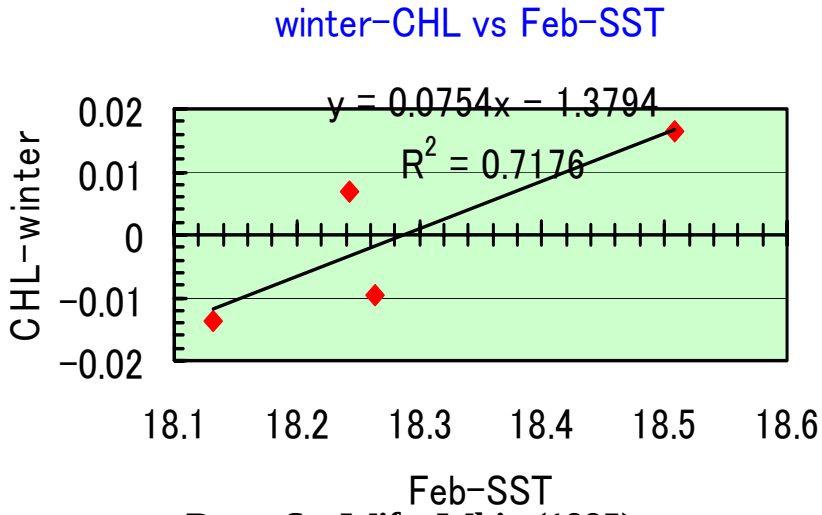
is determined in the period from post-larval stage to Age-1 possibly from winter to spring environmental conditions in the Kuroshio-Kuroshio Extension

Long-term SST variations and 7-years life time cause long-term smooth catch variations

Japanese sardine favorites
deep winter-MLD & cold winter SST---
spring high productivity

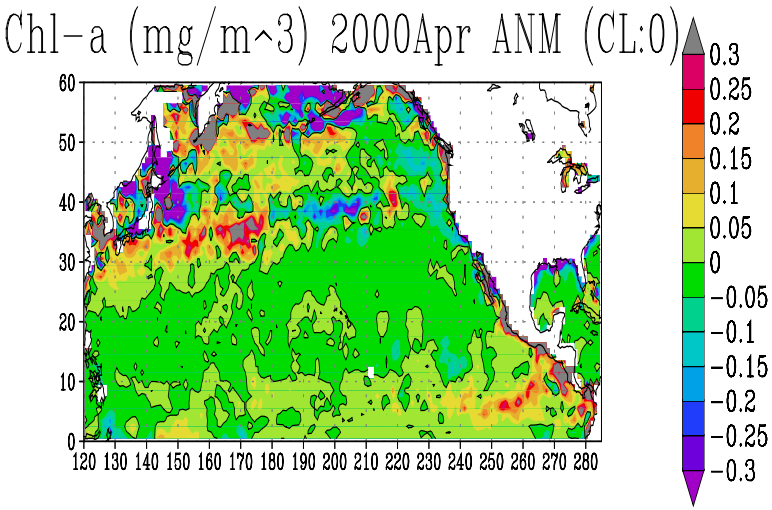
Chl-a from SeaWiFS image and SST/MLD in KE (98-01)

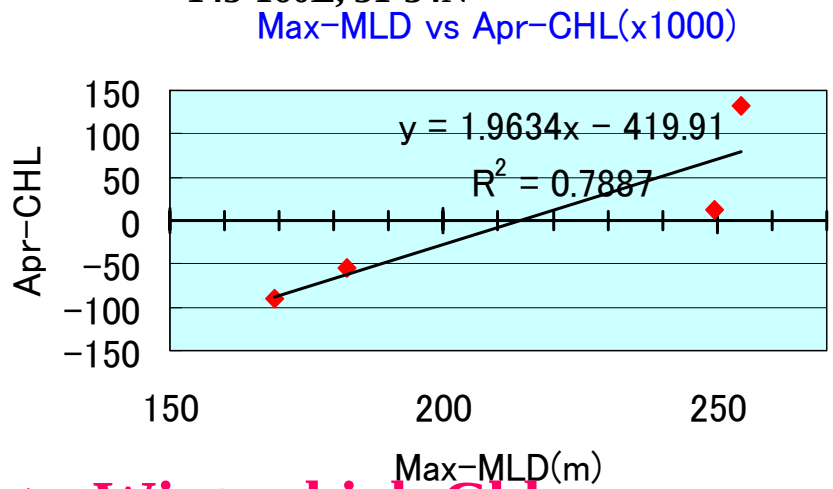




Data: SeaWifs; White(1995)

145-160E, 31-34N





Winter-warm SST ---> Winter high Chl-a

Winter deep MLD ---> Spring high Chl-a