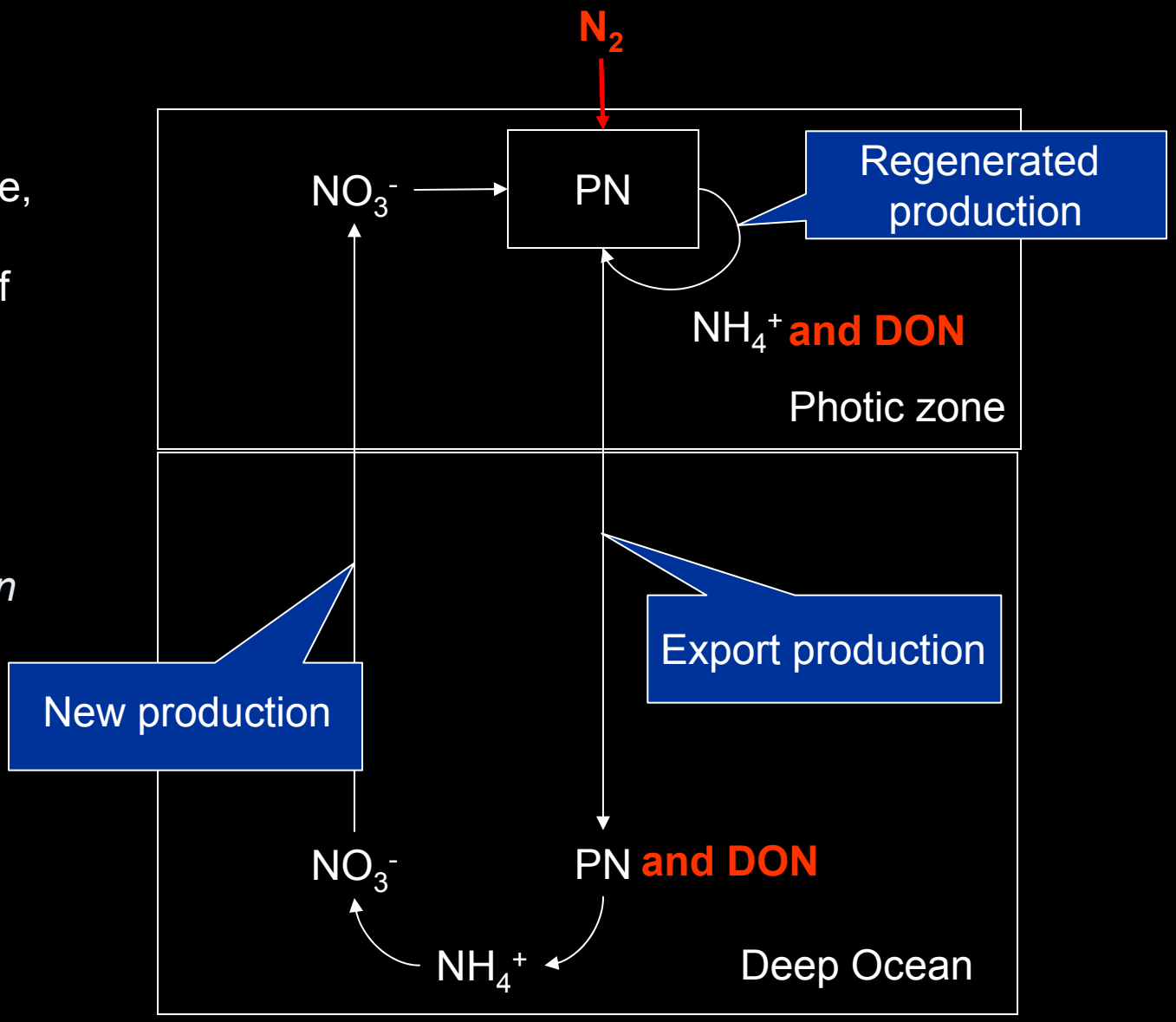
The new production paradigm

"Over appropriate space and time scale, the upward flux of nitrate, the uptake of nitrate and the downward flux of particulate N should be in balance"

Eppley and Peterson [1979] Nature, 282



New production assessment

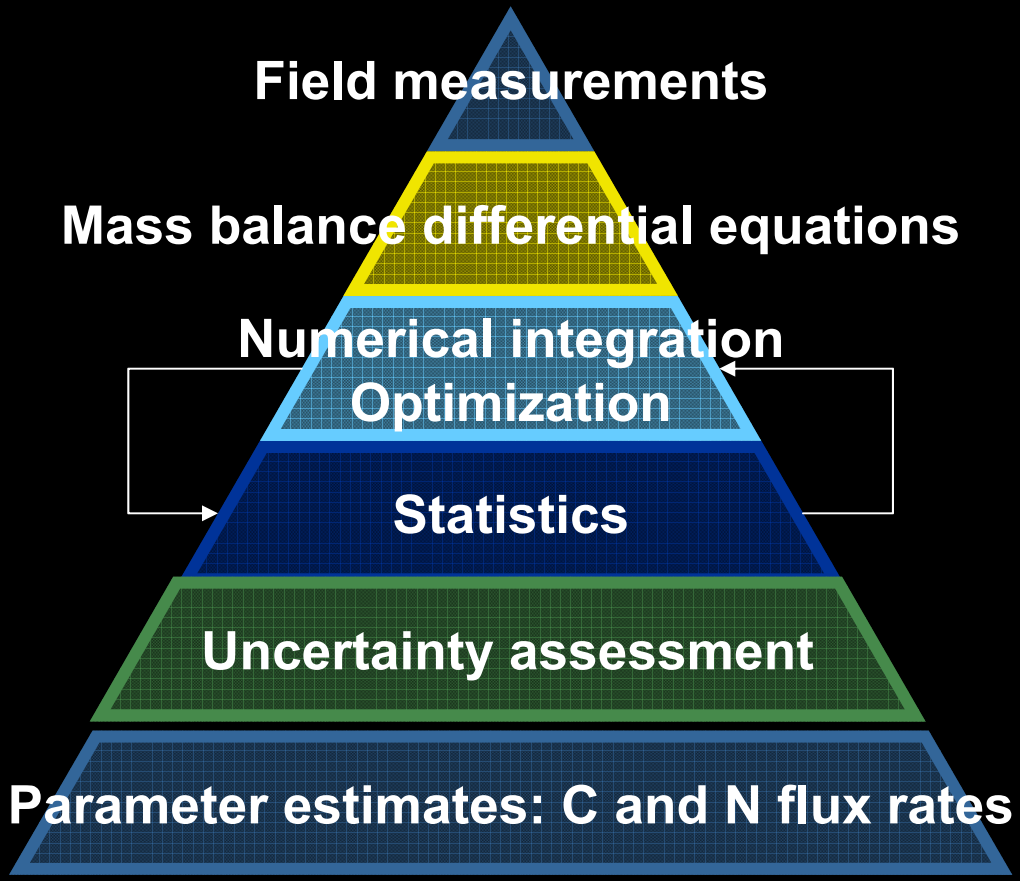
- Use of stable isotope techniques to determine:
  - Primary production PP (^{13}C)
  - *f*-ratio (^{15}N)

$$\begin{cases} f-ratio = \dfrac{Uptk_{NO_3} + Uptk_{N_2}}{\sum Uptk_{DIN}} \\ \sum Uptk_{DIN} = Uptk\left(NH_4 + NO_3 + NO_2 + N_2\right) \end{cases}$$

  - New production NP = *f*-ratio x PP

Data Analysis

A model comparison approach*



Elskens et al. [2005] Global Biogeochemical Cycles, 19

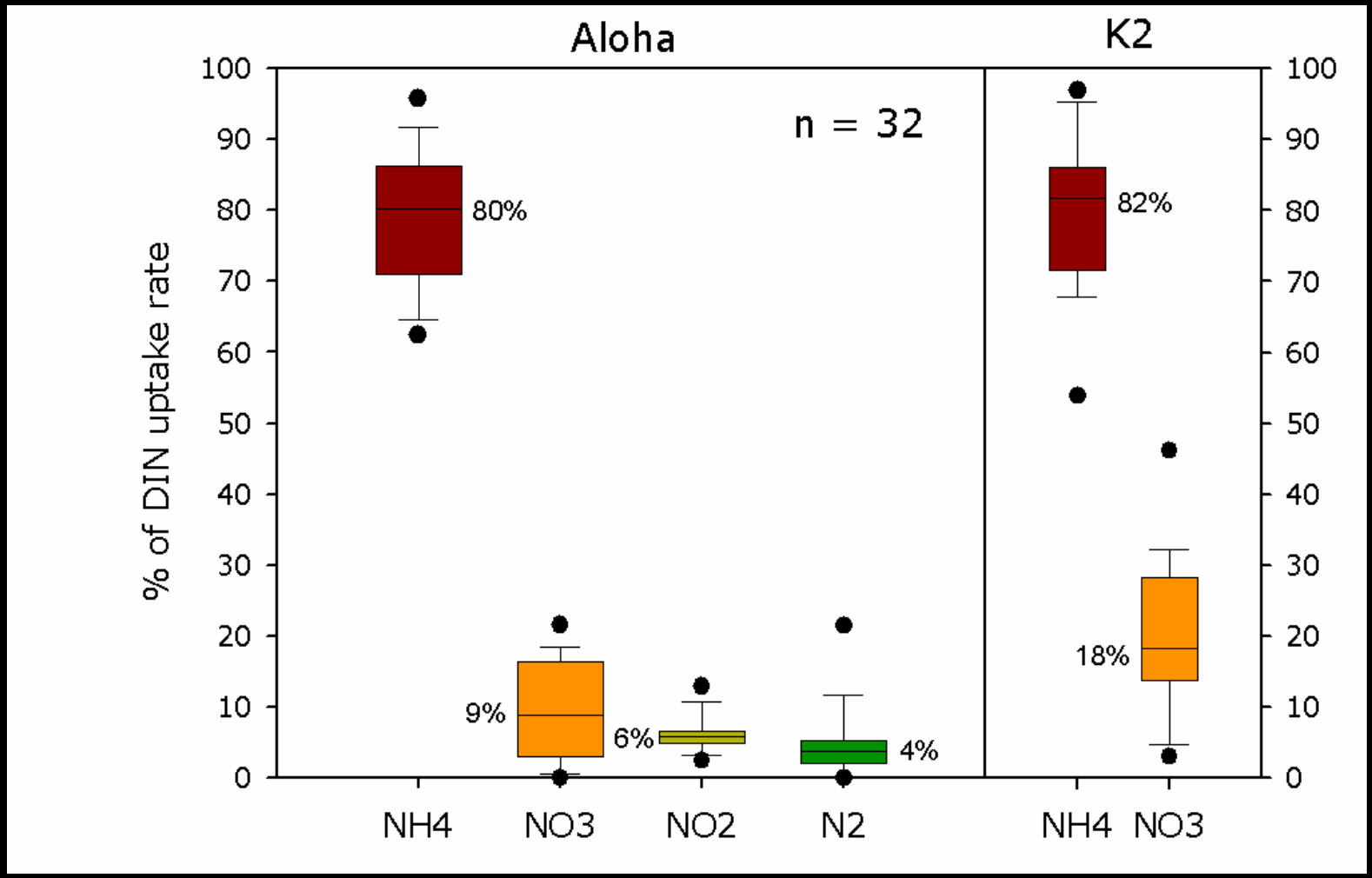
Methodological constraints during Aloha

- DIN concentrations below the limit of detection
  ⇒Simple statistical methods for analyzing the mean and variance of this censored data set
    ⇒RSD% on initial enrichment up to 50%
      ⇒Large uncertainty on uptake rate estimates

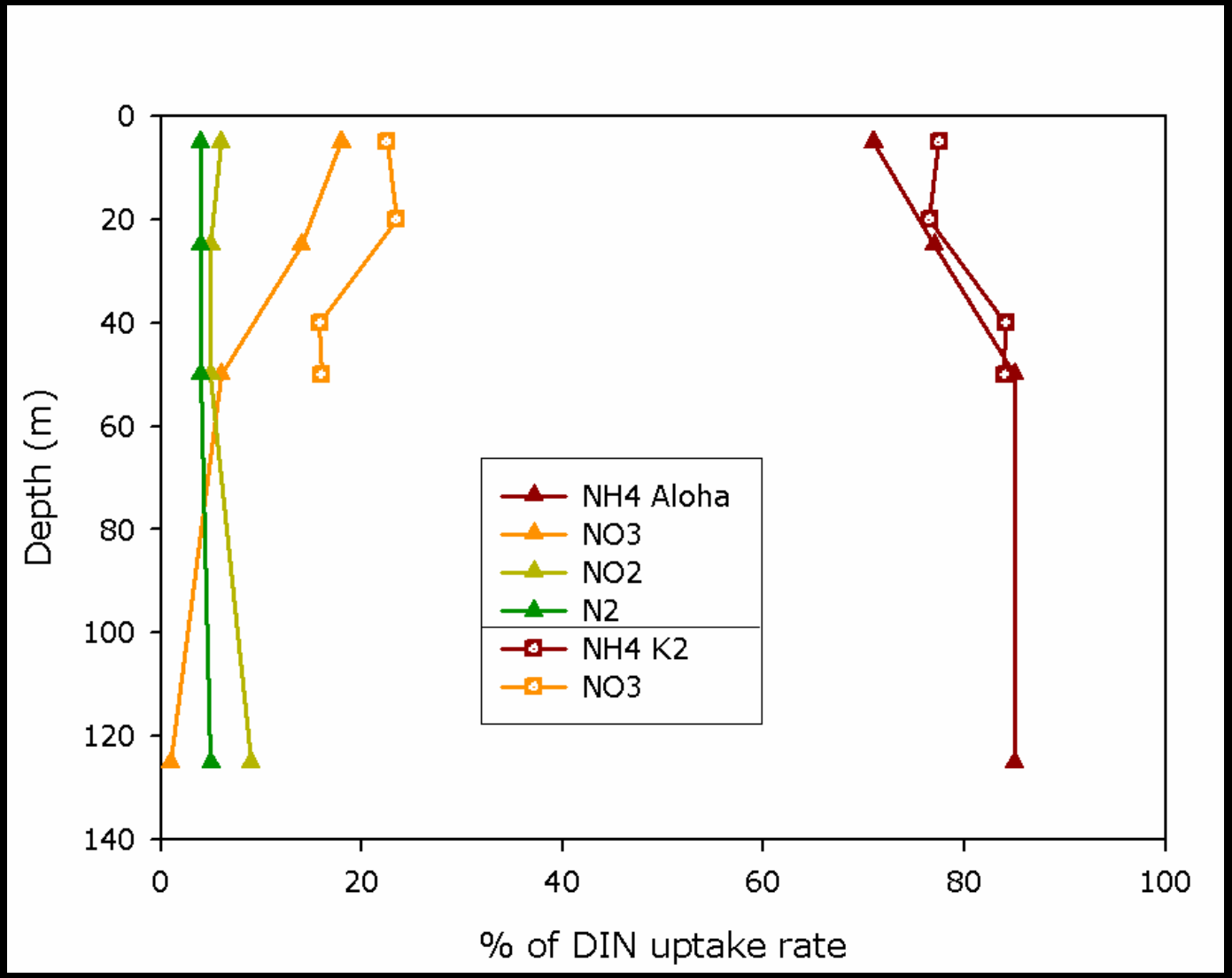
- ^{15}N tracer additions >> ambient DIN level
  ⇒A correction is need for estimating ambient uptake rates
    ⇒Adjusted uptake rates based on first order kinetic*

** Eppley et al. [1977] Marine Biology, 39*

DIN uptake rates

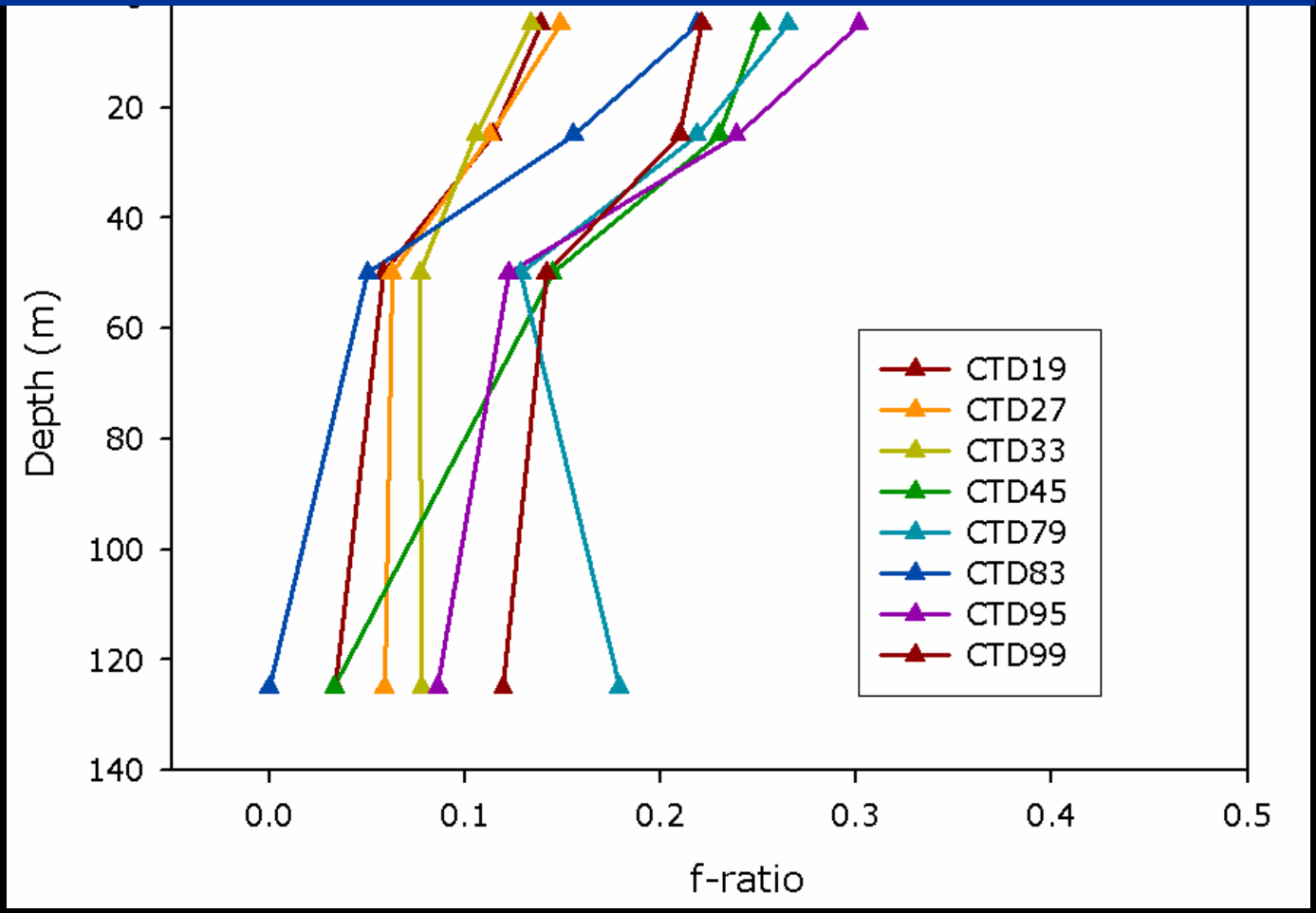


Utilization of N substrates *vs* depth



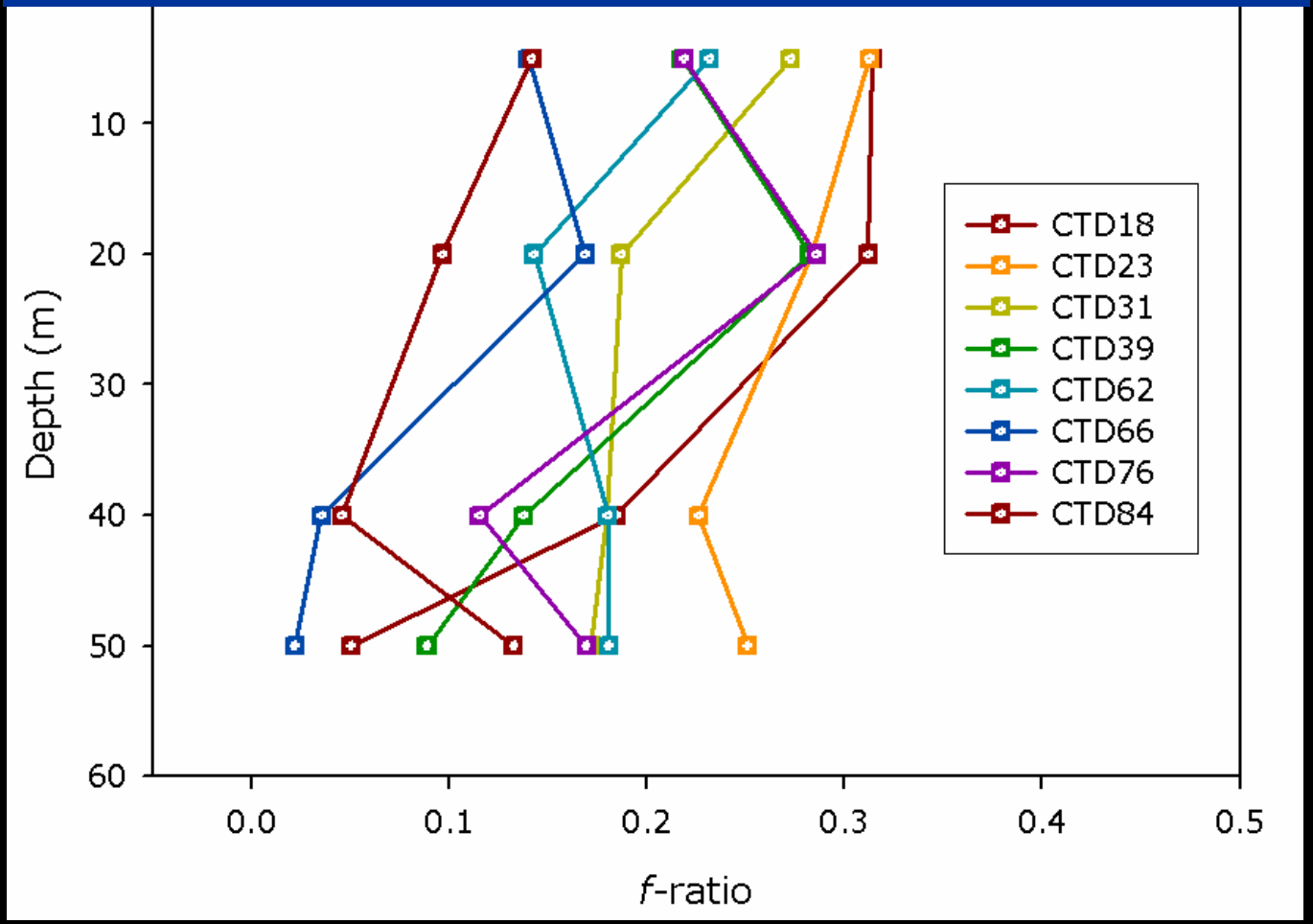
Vertical profiles of *f*-ratio at Aloha

Integrated *f*-ratio	0.12 ± 0.05
Range (min-max)	0.07 – 0.20



Vertical profiles of *f*-ratio at K2

Integrated *f*-ratio	0.17 ± 0.05
Range (min-max)	0.10 – 0.24



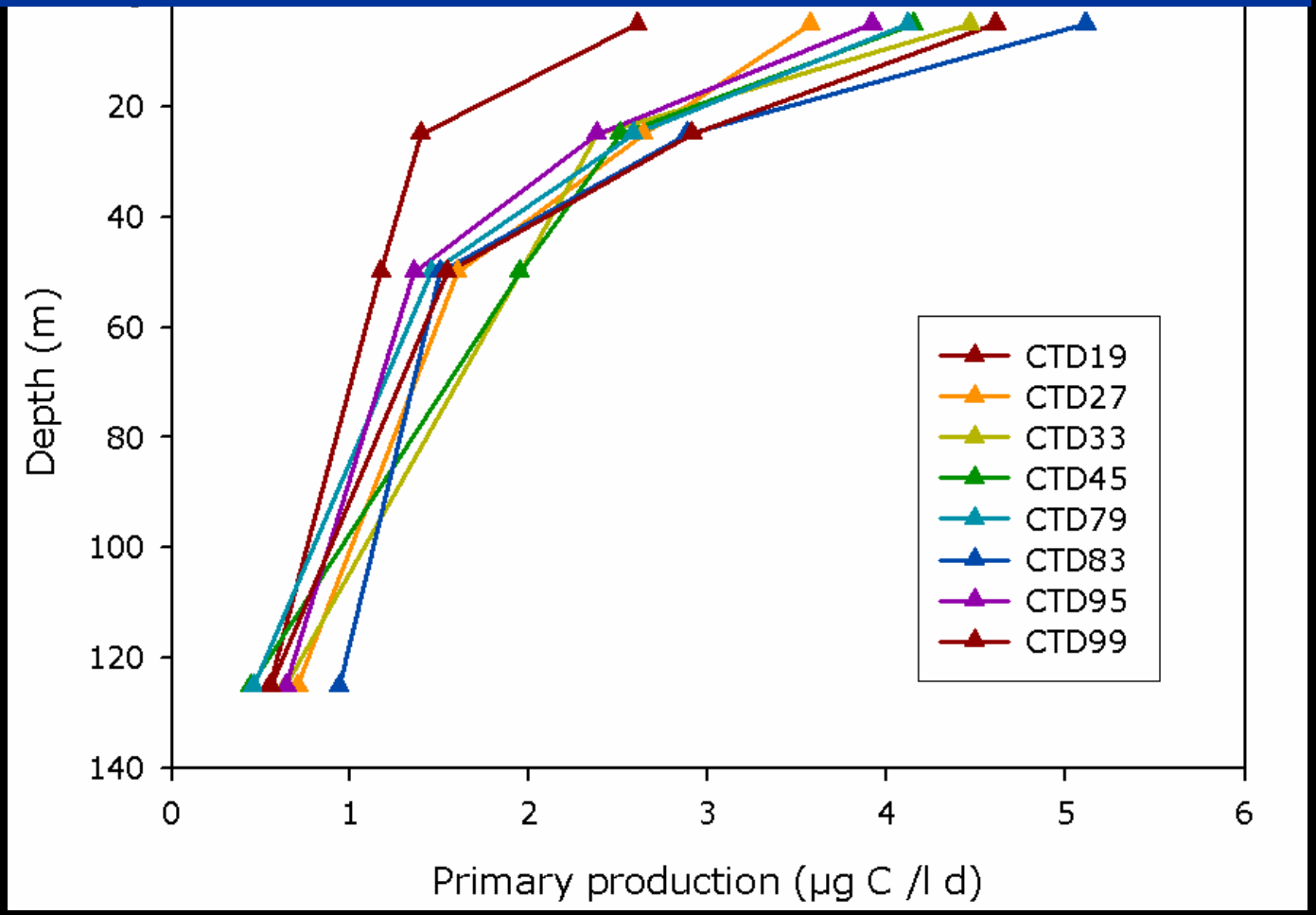
Representative value of surface nitrate specific uptake rates and *f*-ratio

Region	Specific UNO3 d^{-1}	f-ratio %
Eutrophic* Peru, Baja Calif…	0.28 – 0.84	57 – 84
Oligotrophic* Sargasso sea, Mediterranean sea…	0.006 – 0.011	3 - 21
Aloha	0.002 – 0.006	7 - 20
HNLC* Antarctic, Northeast Pacific…	0.03 – 0.06	36 - 48
K2	0.02 – 0.06	10 - 24

Compilation of data from Dugdale and Wikerson, [1992]. Environmental Science Research, 4

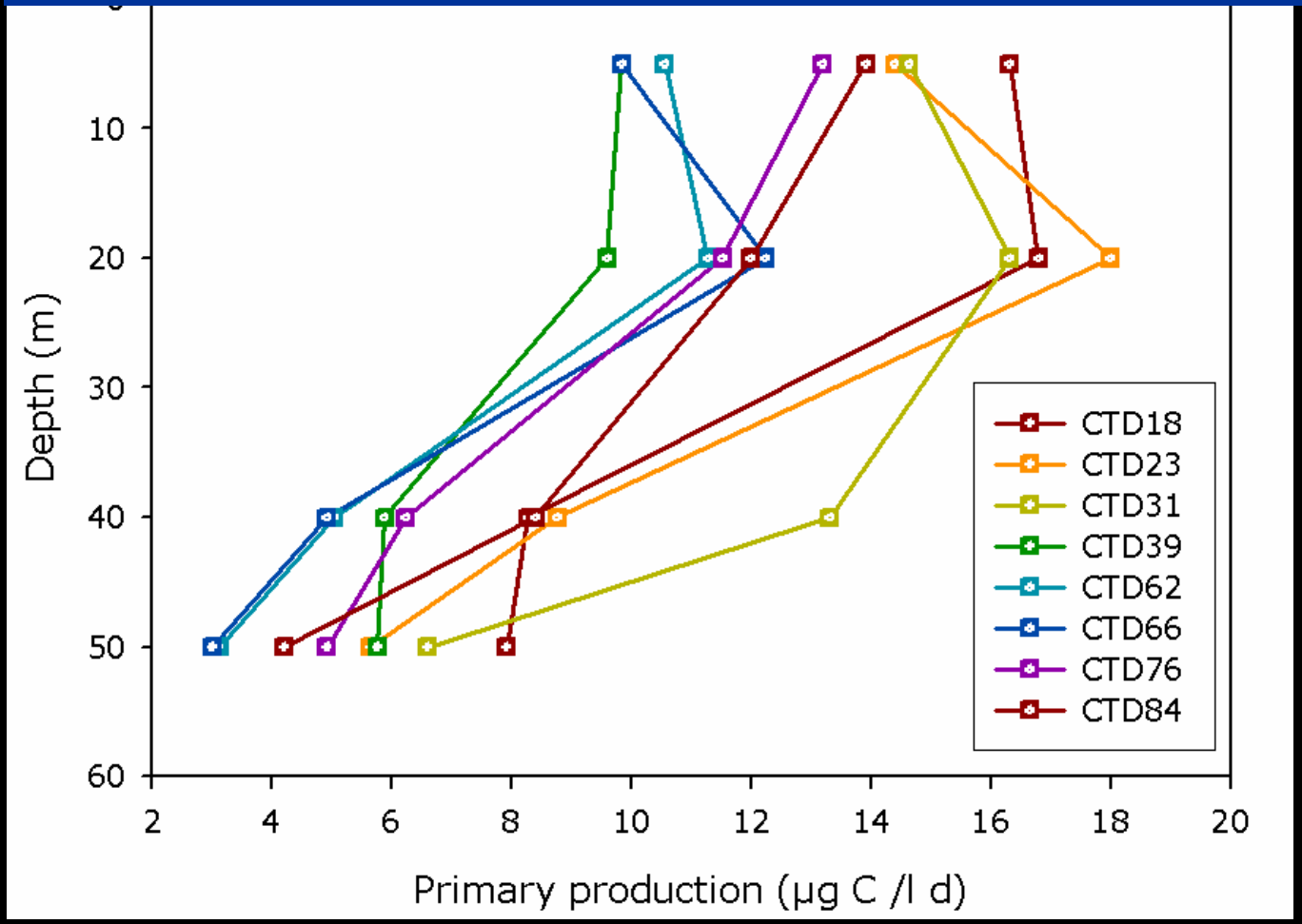
Vertical profiles of primary production (^{13}C) at Aloha

Integrated PP	209 ± 30 mg C m^{-2} d^{-1}
Range (min-max)	143 – 240

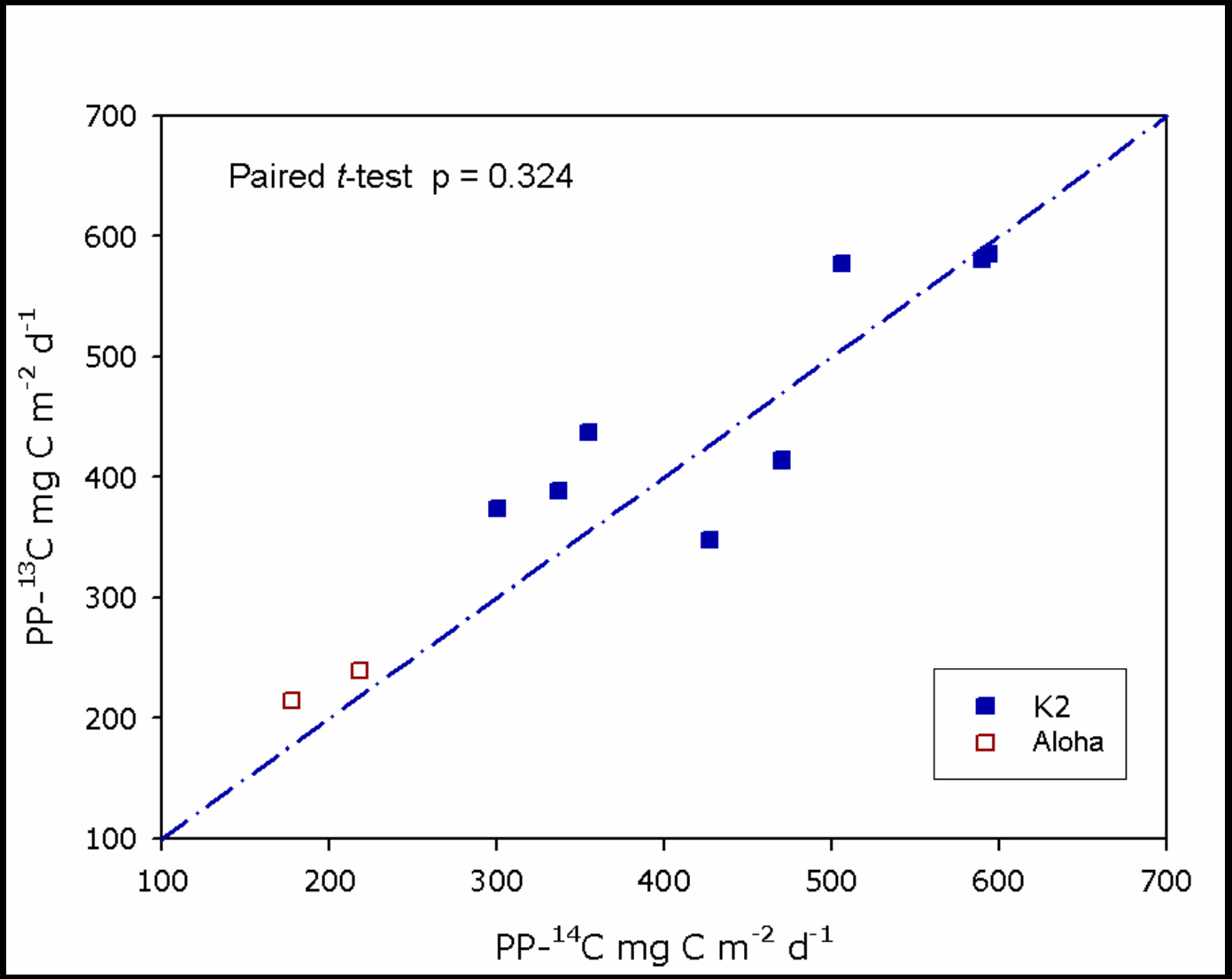


Vertical profiles of primary production (^{13}C) at K2

Integrated PP	470 ± 107 mg C m^{-2} d^{-1}
Range (min-max)	348 – 585

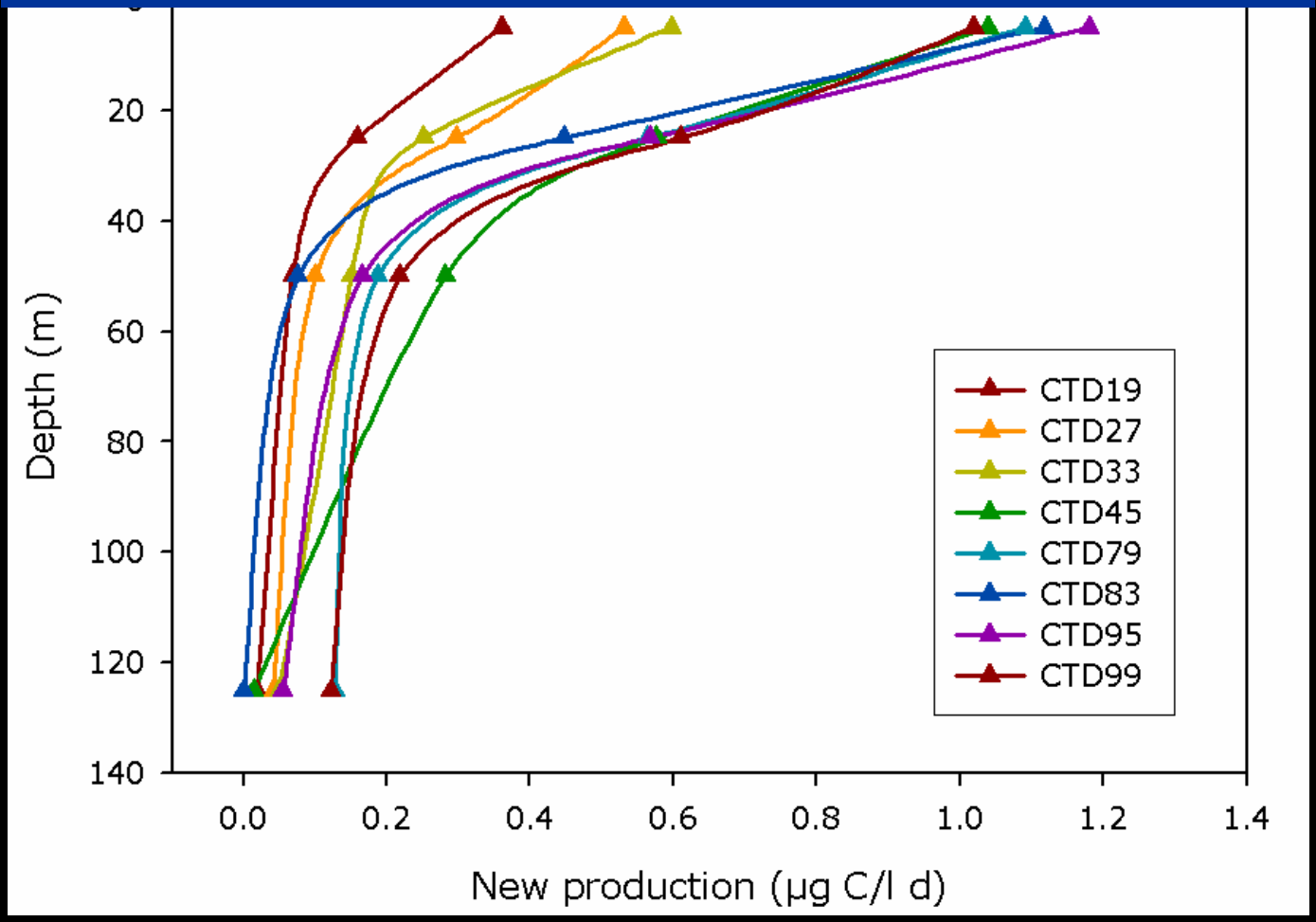


Comparison between ^{13}C and ^{14}C PP estimates



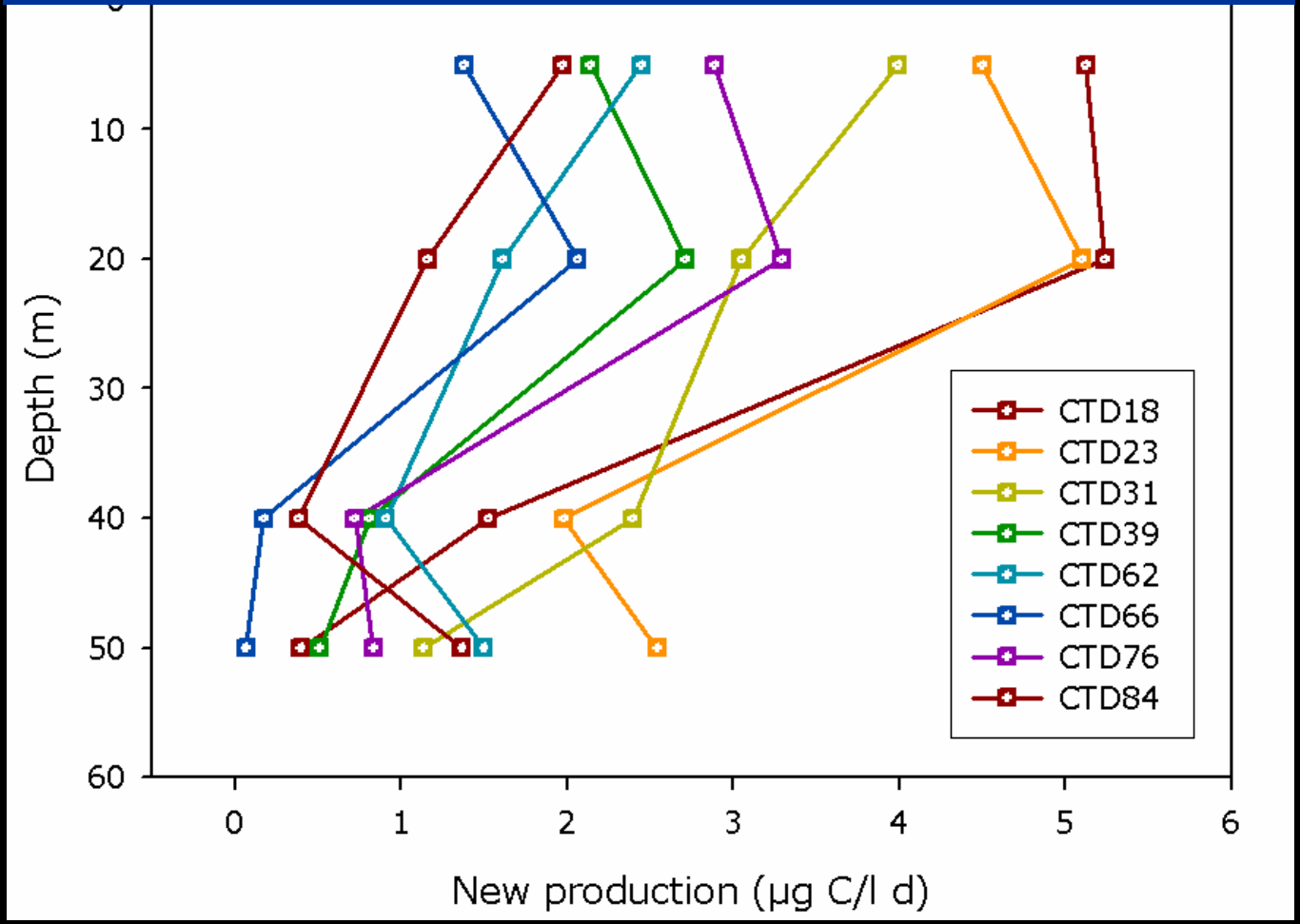
Vertical profiles of new production at Aloha

Integrated PNEW	30 ± 11 mg C m-2 d-1
Range (min-max)	12 – 42



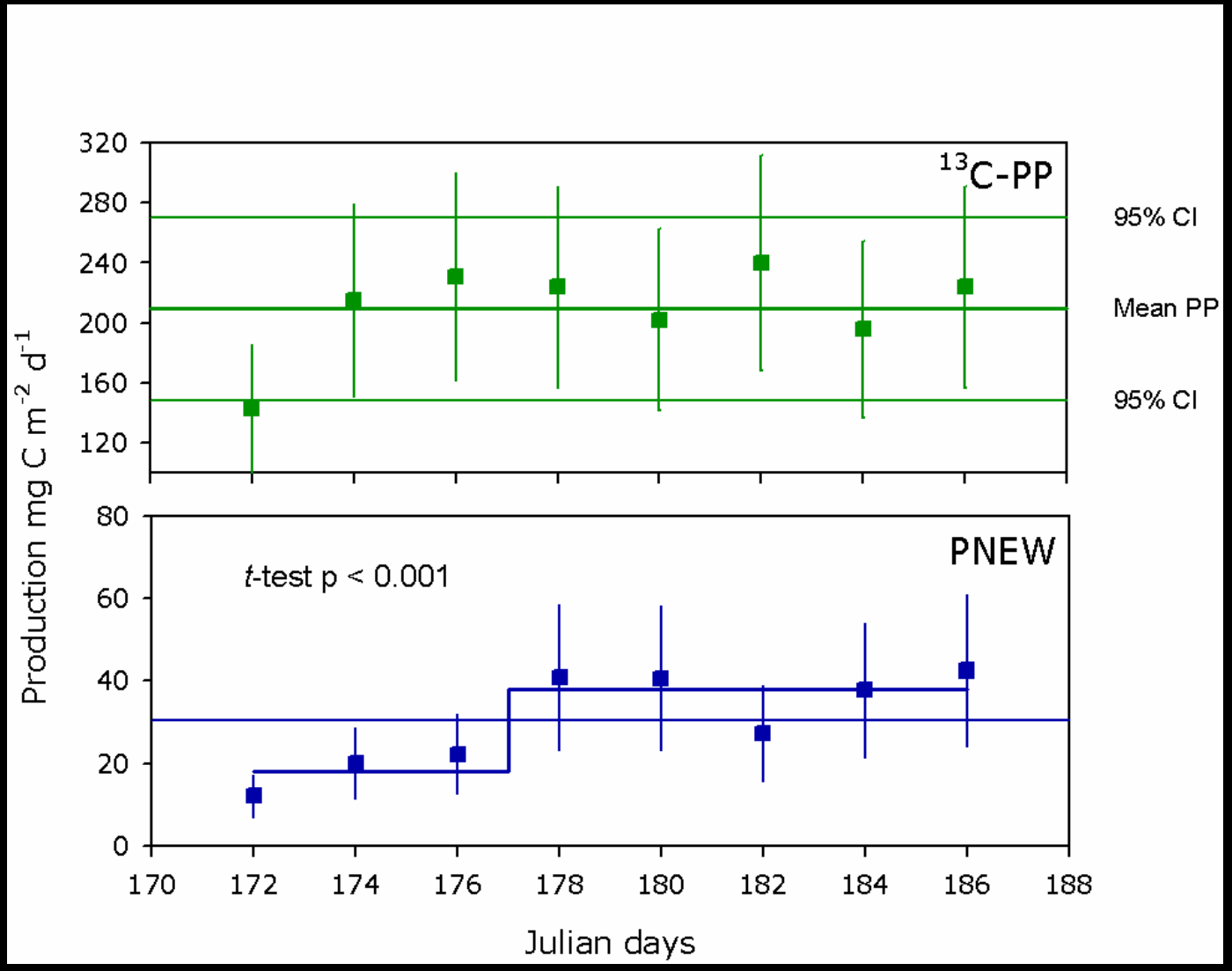
Vertical profiles of new production at K2

Integrated PP	101 ± 50 mg C m^{-2} d^{-1}
Range (min-max)	50 – 171



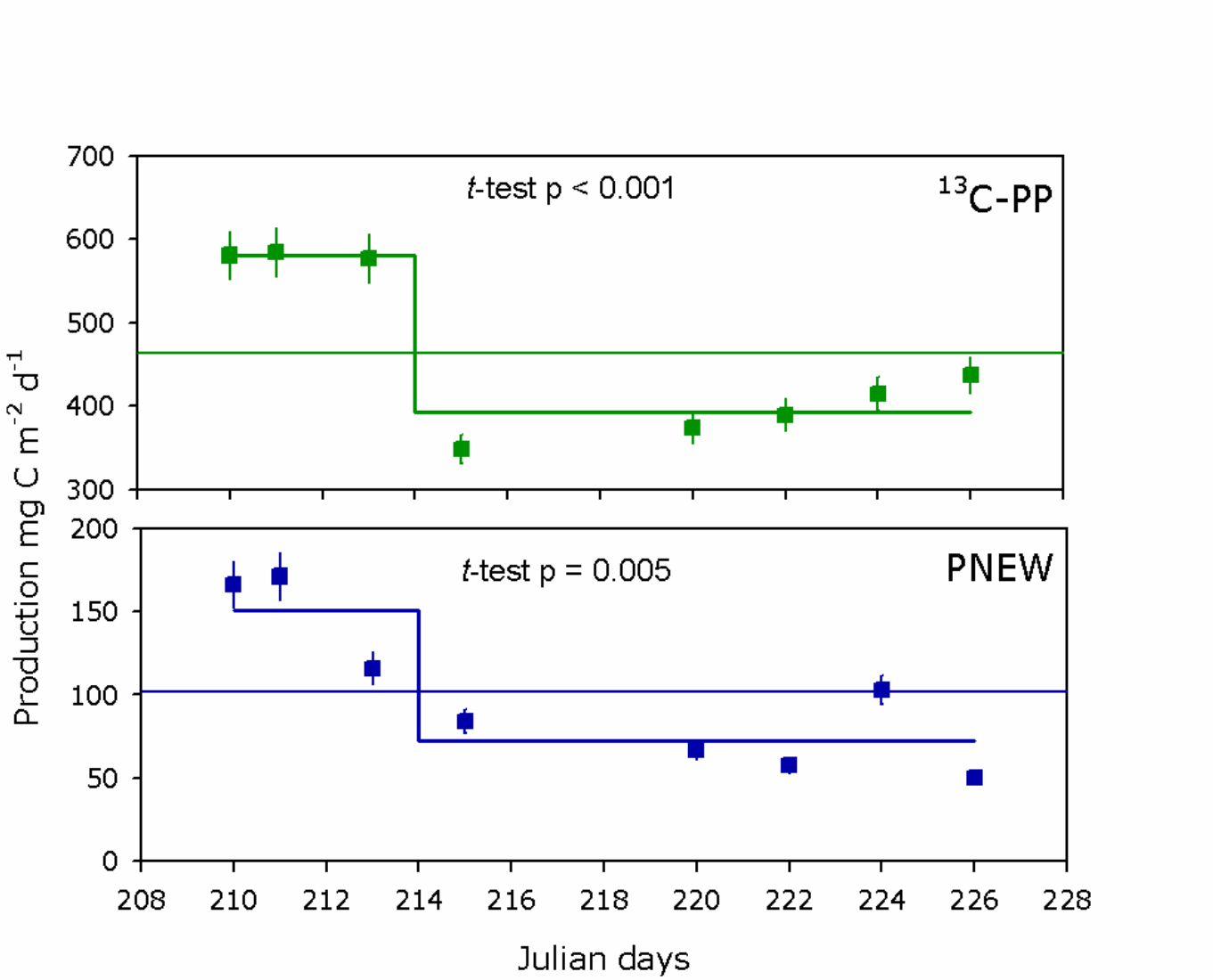
Primary and new production variability at Aloha

Detecting process changes with a CUSUM technique



Primary and new production variability at K2

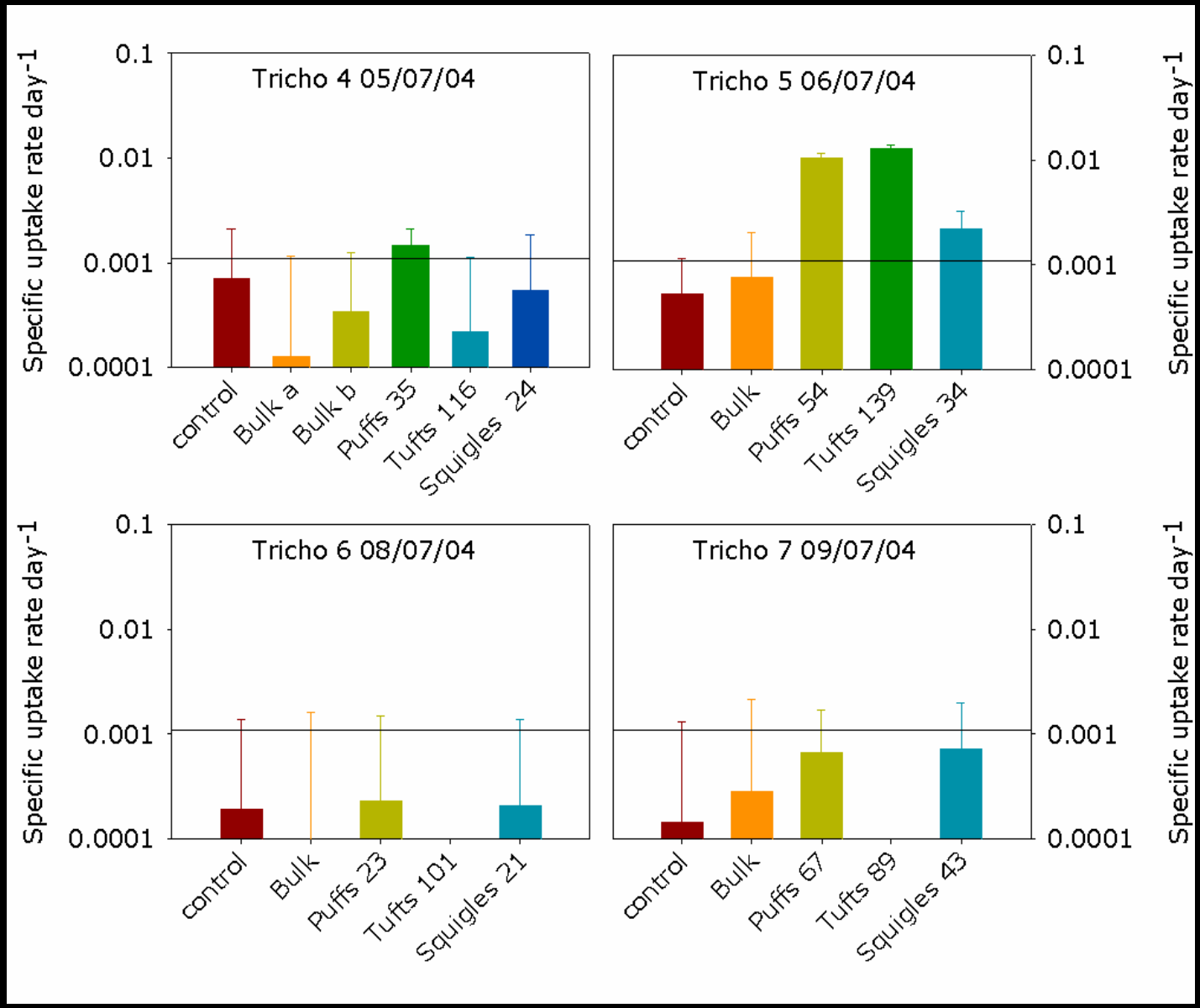
Detecting process changes with a CUSUM technique



Primary and new production: a summary

Station	PP mg C m^{-2} d^{-1}	PNEW mg C m^{-2} d^{-1}
Aloha		
23/06 – 27/06/04	209 ± 30	18 ± 5
29/06 – 07/07/04		38 ± 6
Ratio to POC flux at 150m (NBST)	10 - 12	0.8 - 1
K2		
31/07 – 04/08/05	581 ± 4	151 ± 30
06/08 – 17/08/05	392 ± 35	72 ± 21
Ratio to POC flux at 150m (NBST)	10 - 17	2 - 3

Trichodesmium: specific uptake rate day^{-1}



Trichodesmium: Absolute uptake rate μM day^{-1}