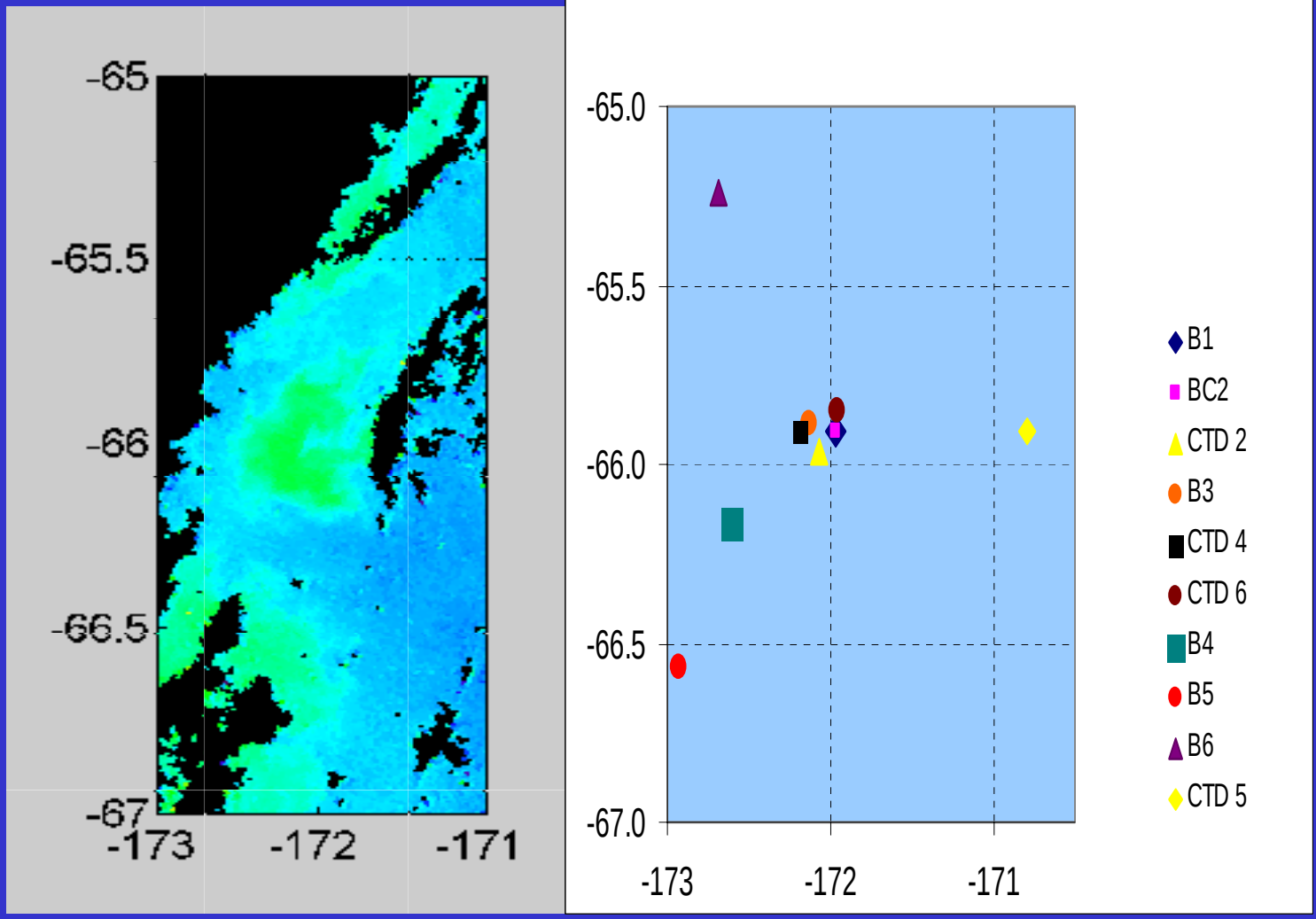
USCG Polar Star overview
&
Particle export during SOFeX

Ken O. Buesseler

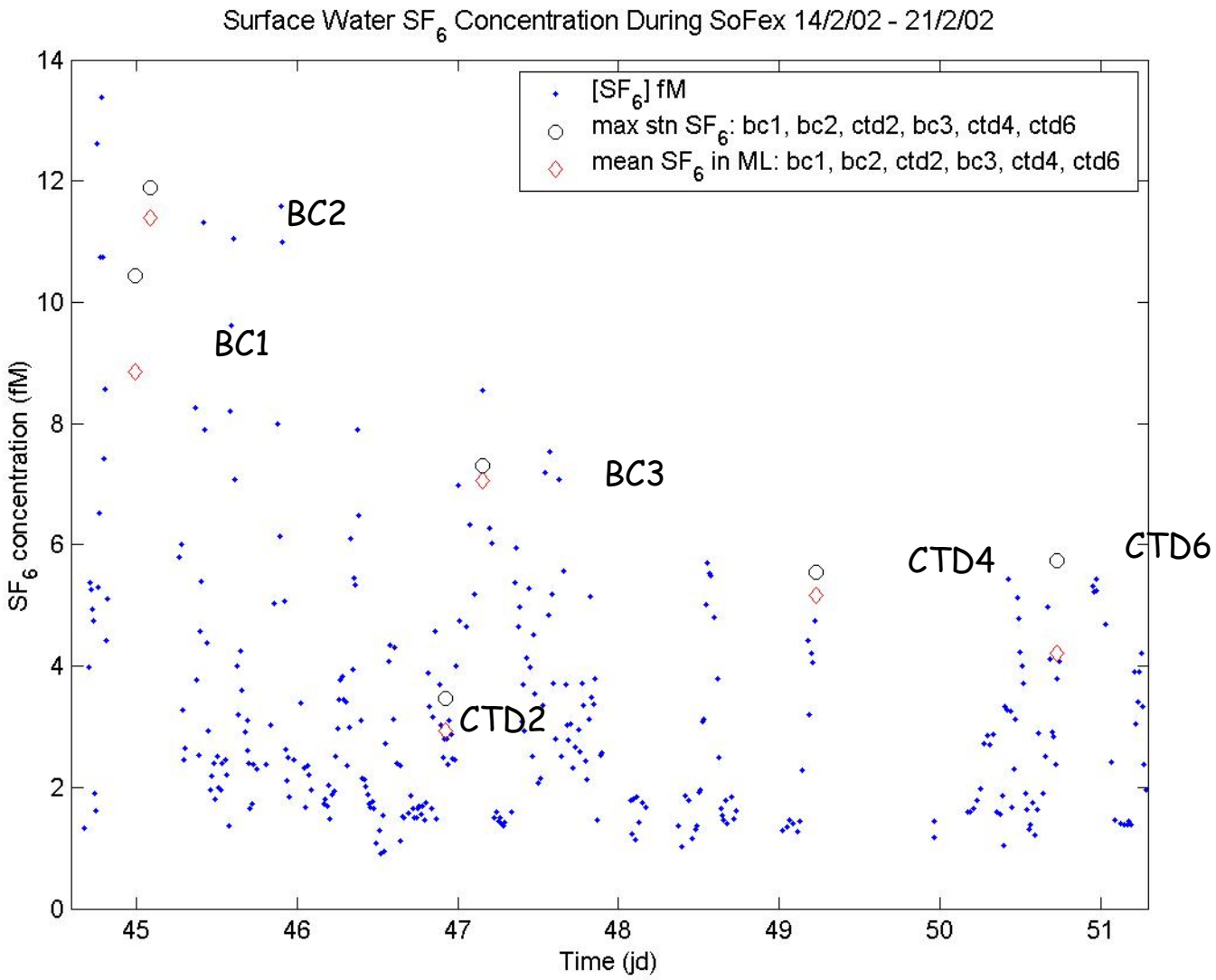
Polar Star Science team

Operation	personnel, etc.
Export- 234Th	WHOI w/on board detectors- K. Buesseler & S. Pike
SF6	WHOI/UEA UK (J. Ledwell, A. Watson)- L. Houghton & L. Goldson
surf. water pCO2	AOML install prior to departure in Seattle (R. Wanninkhof)
Major Nutrients	To collect & freeze for later analyses (ancillary team- C. Herbold, K. Mahoney, J. Tegeder, M. Coggeshall)
Particles, small volume- POC/PON/bSi & pigments	WHOI to collect for CHN & bSi (M. Brzezinski- UCSB); pigments (frozen for R. Bidigare, U. Hawaii); C/N isotopes (for M. Altabet)- Ancillary team
Particles, large volume- 234Th, C/N isotopes	share between Buesseler & Altabet for 234Th & stable C/N work- K. Buesseler & S. Pike
DIC/DOC	Collect & return for on shore analyses (F. Millero- U Miami/J. Bauer-VIMS)- R. Daniels
Iron	Fe dissolved, total & speciation from Kevlar/bottles & towed fish (P. Croot- IfM & R. Frew- U. Otago, NZ)
Production- primary & bacterial	14C and 3H- (W. Smith-VIMS/R. Barber- Duke and H. Ducklow- VIMS)- C. van Hilst, R. Daniels
Biological Fe stress	Fv/Fm- P. Boyd & E. Abraham (NZ)
others	salinity, radium (Herbold), bio (chl-C. van Hilst)

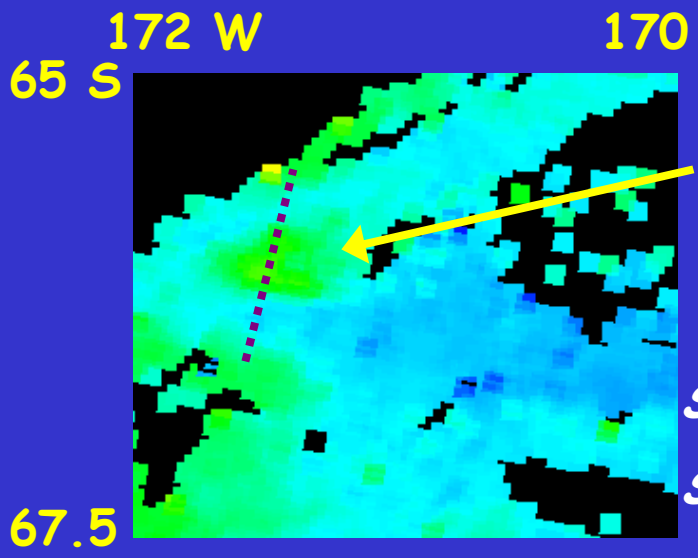


Polar Star cruise- 10 profile stations; 6 In, 4 Out

6 "In" profiles- 5 at highest SF6; 1 shoulder sta.



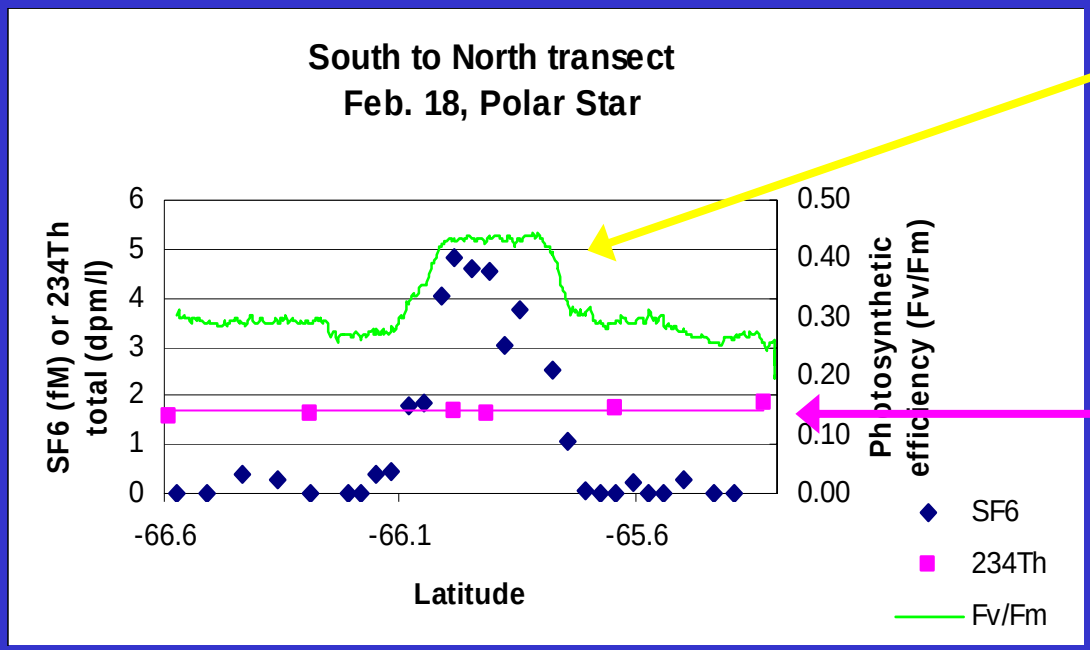
SF6
Goldson et al.



SOFeX patch as seen from space 4 weeks after iron fertilization

SeaWiFS ocean color

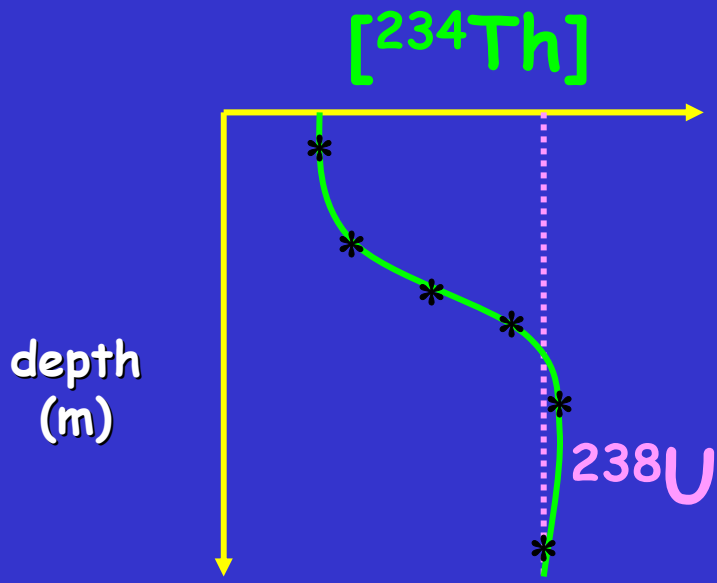
Satellite image- Feb. 12, 2002, F. Chavez et al.



SOFeX patch seen as SF6 peak & Fv/Fm peak

Thorium-234 indicates similar particle flux in & out of patch (C flux may be elevated, but didn't see diatom crash)

Thorium-234 approach for estimating particle export



half-life = 24.1 days

source = ^{238}U parent is conservative

sinks = attachment to sinking particles and decay

Calculate ^{234}Th flux from the measured ^{234}Th activities

Low ^{234}Th = High flux

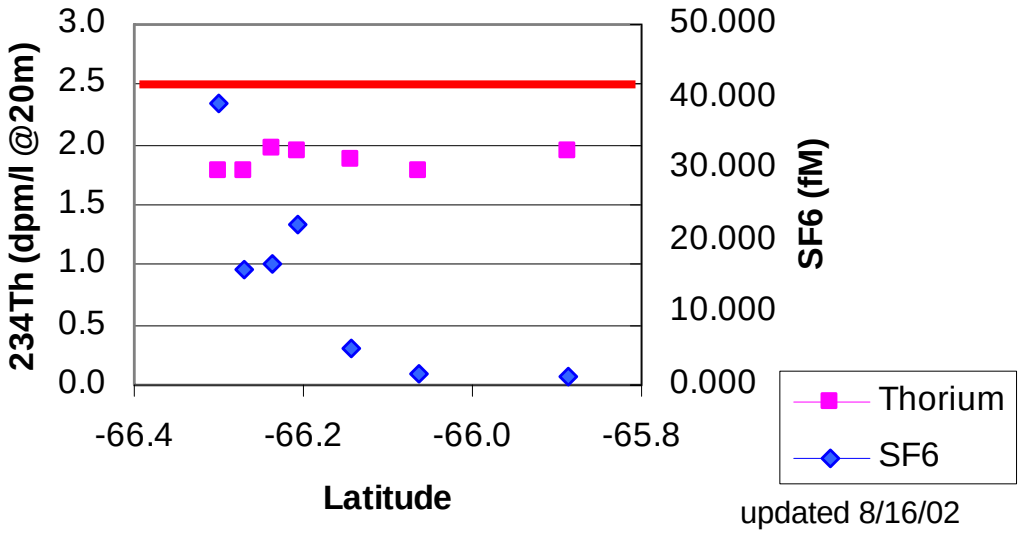
Prior Fe Fertilization export data:

FeEX-II: 6 surface samples

SOIREE: 1 5pt profile and & time-series integrals

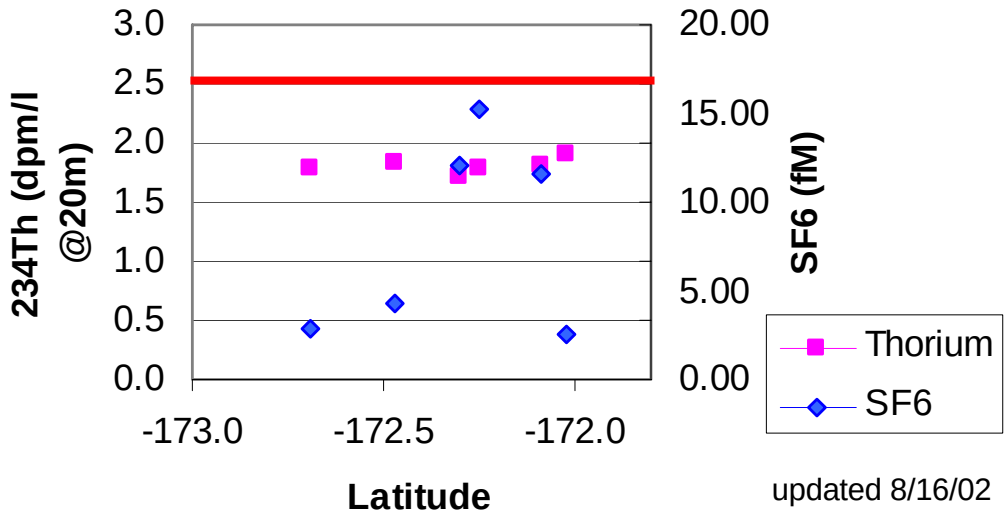
(better coverage for EISENEX & SERIES?)

Melville Feb 3 transect



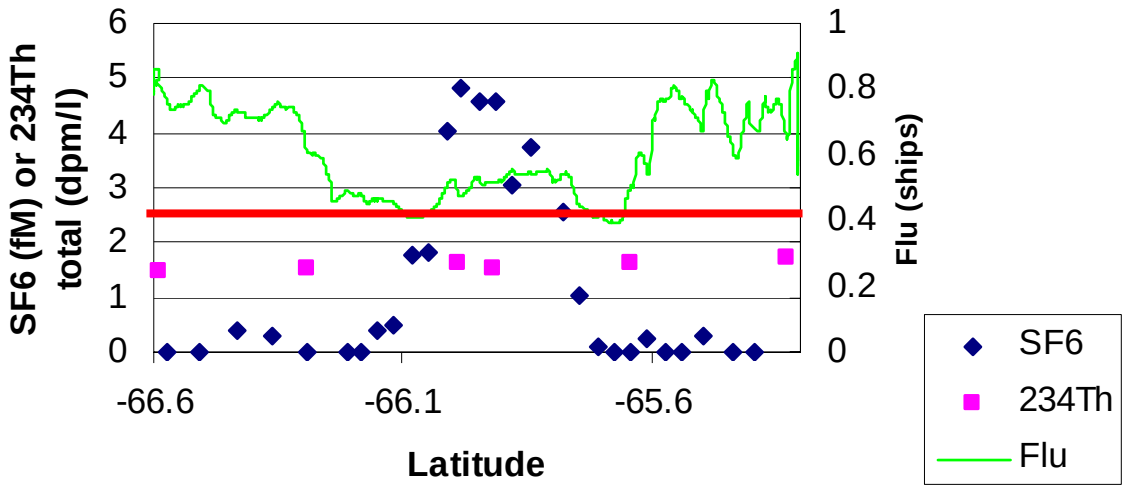
updated 8/16/02

Melville Feb 13/14 transect



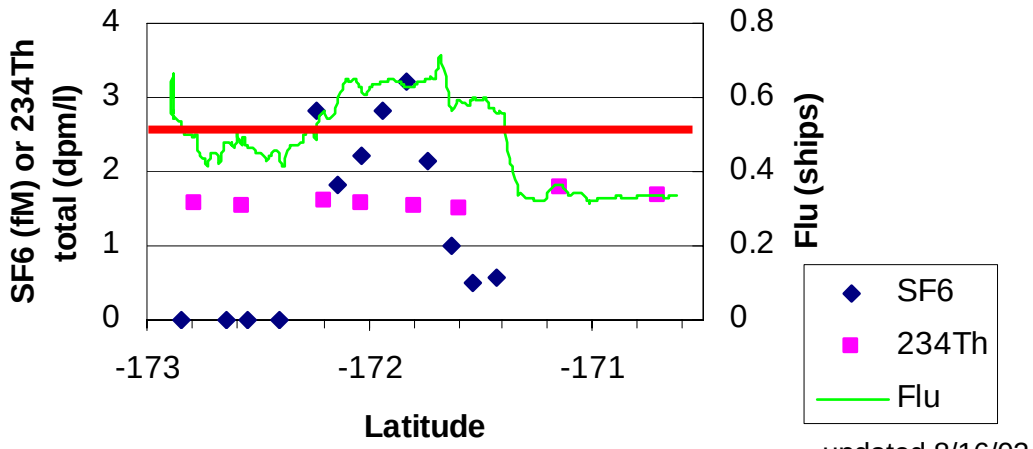
updated 8/16/02

South to North transect
Feb. 18, Polar Star



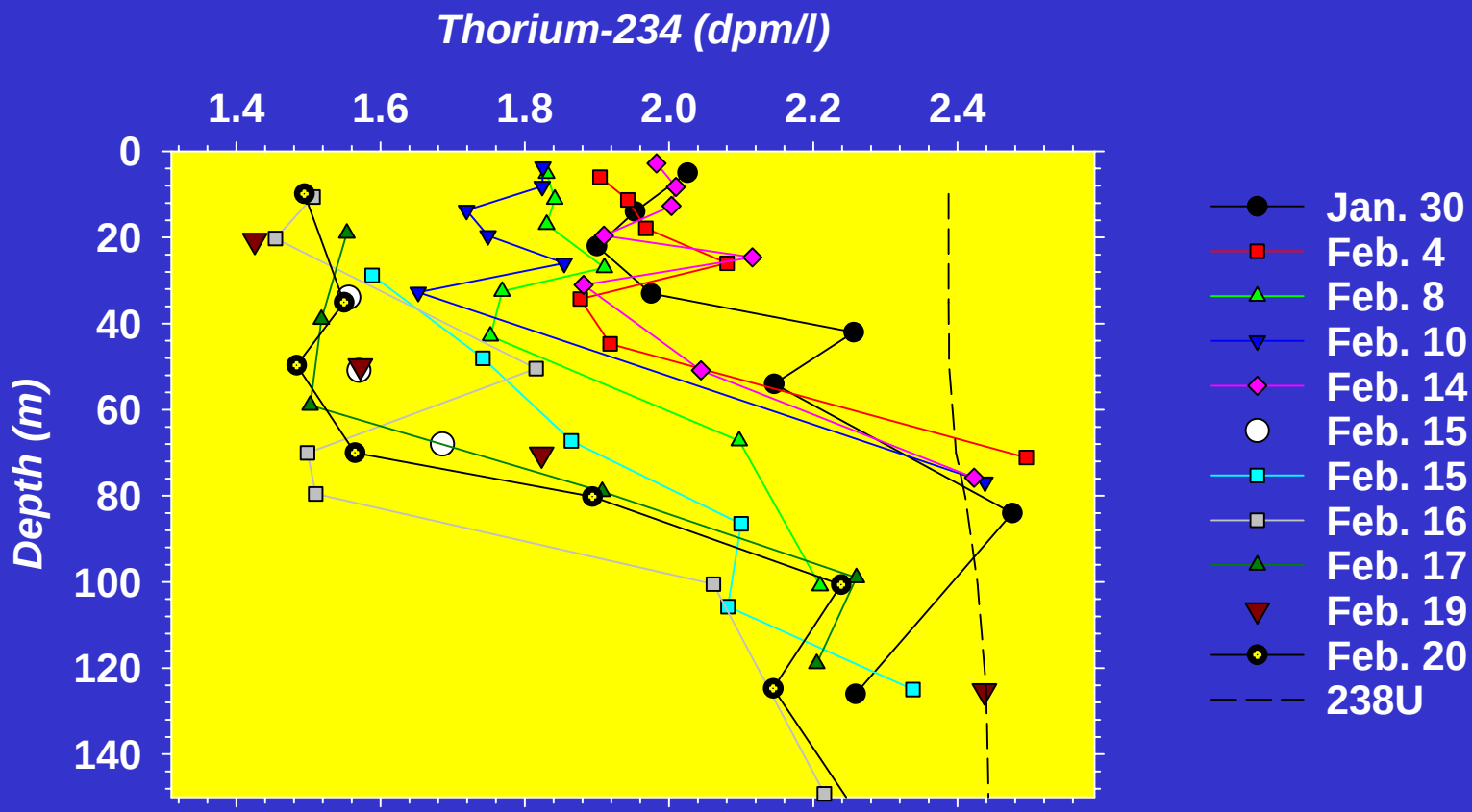
updated 8/16/02

West to East transect
Feb. 21, Polar Star



updated 8/16/02

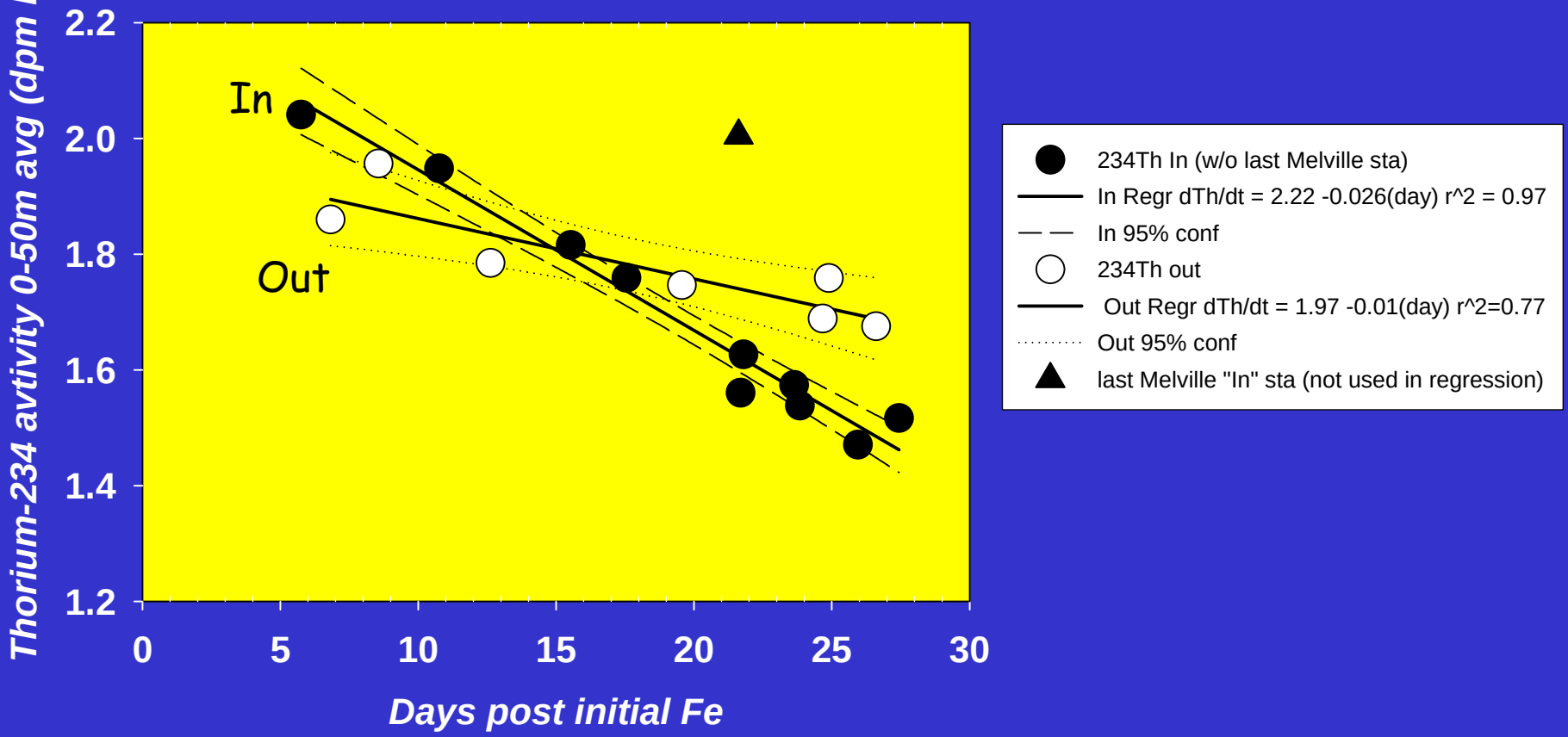
SOFeX time-series progression S-patch "In" stations



Highest resolution thorium-234 data set

See progression to lower Thorium-234 on average during course of SOFeX "In" patch (and "Out" stations also)

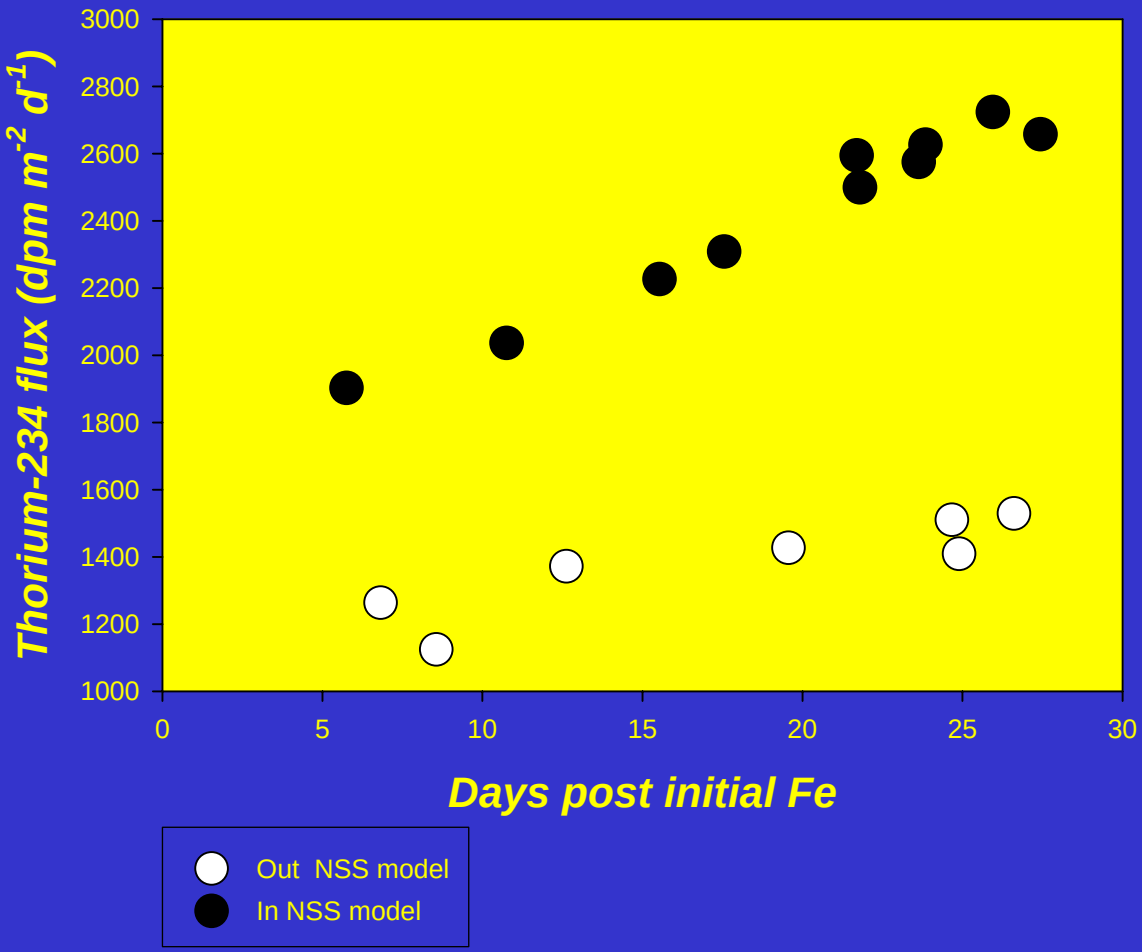
Southern Patch time-series average 0-50m Thorium activity



$$\delta^{234}Th/\delta t = (^{238}U - {}^{234}Th) * \lambda - P_{Th} + V$$

where λ = decay rate; P_{Th} = ^{234}Th export flux; V = sum of advection & diffusion

Southern Patch time-series Thorium flux



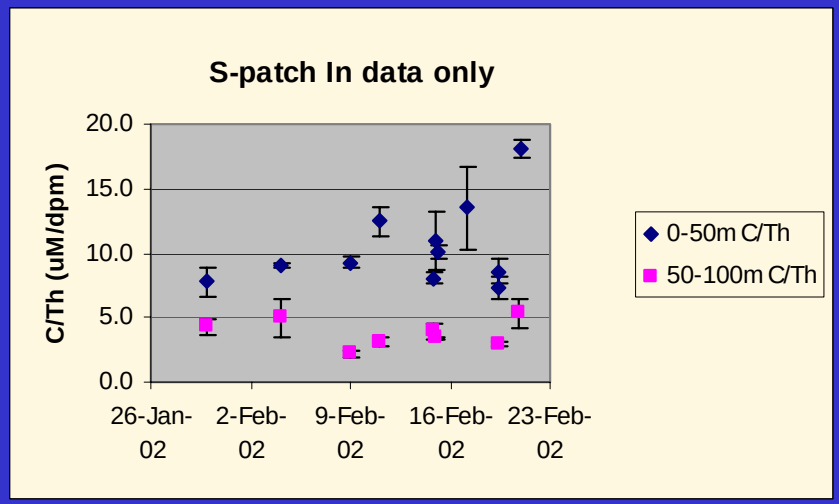
Thorium-234 flux increasing both "In" and "Out", but significantly larger increased particle flux in Fe fertilized patch

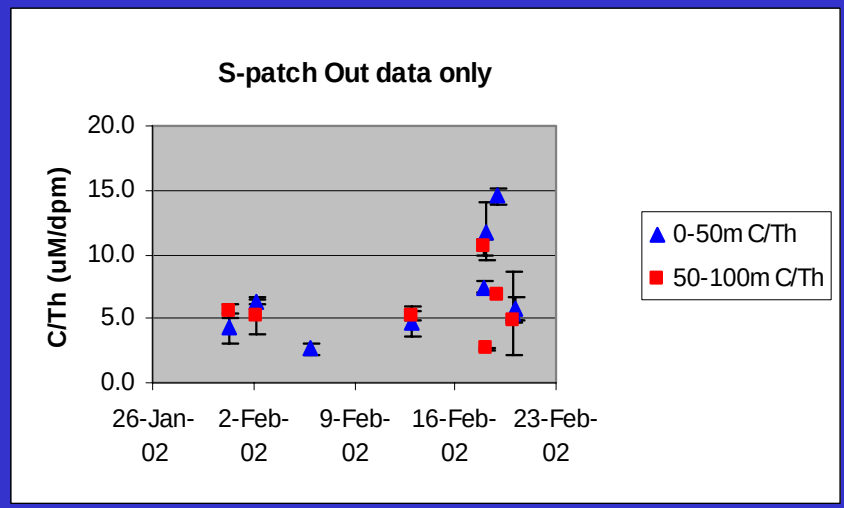
- first time that we see So. Ocean export response to Fe!

POC export = ^{234}Th flux · [POC/^{234}Th]$_{sinking\ particles}$

See references by:

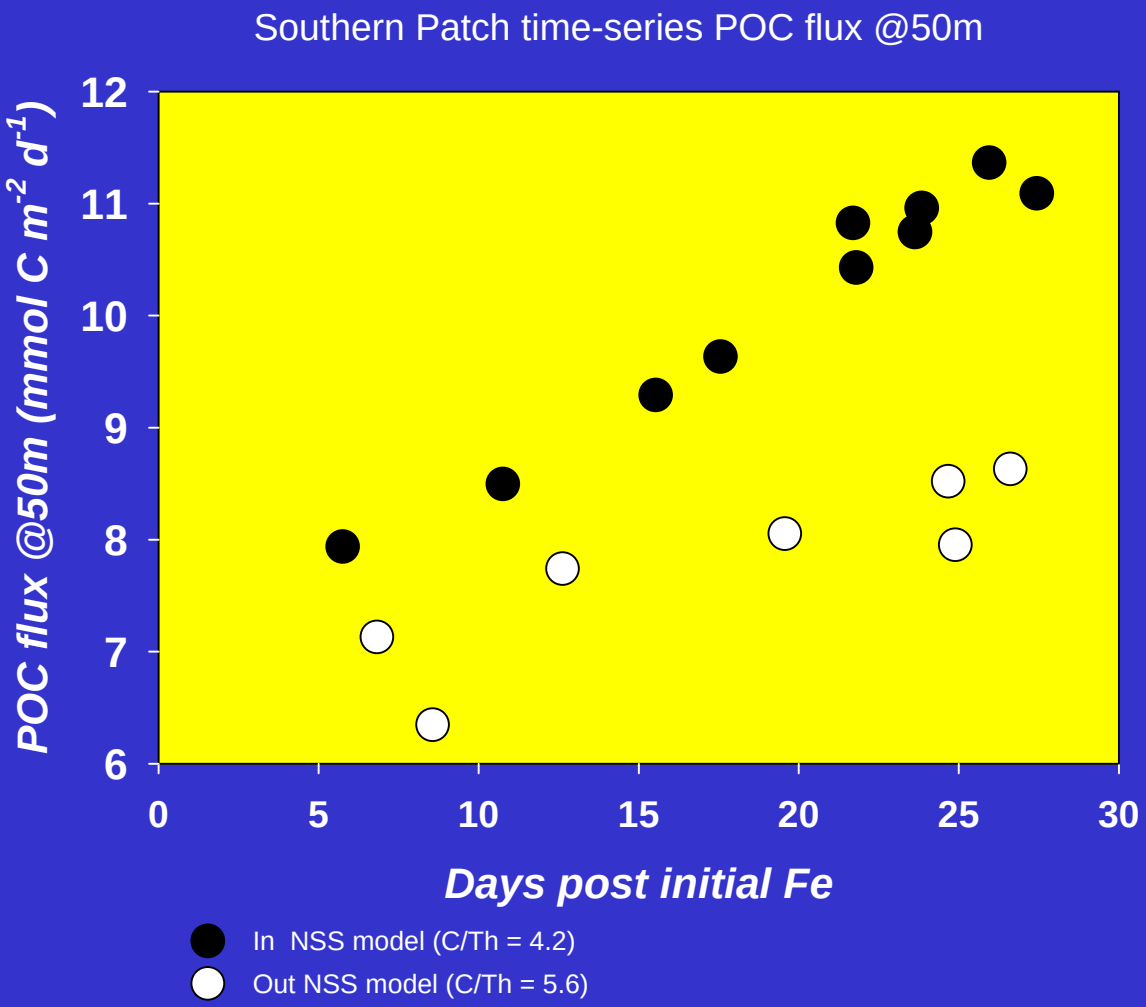
Buesseler, Bacon, Benitez-Nelson, Cai, Charette, Cochran, Coppola, Dunne, Guo, Gustafsson, Hall, Langone, Miller, Moran, Murray, Pates, Roy-Barman, Rutgers vd Loeff, Santschi, Sarin, Shimmield, Smith, Wei & more …..





>53um particles: C/Th below 50m relatively constant
- used in POC flux calculations

Some evidence of increase C/Th "In" stations 0-50m
- growth of phyto?



POC flux "In" increased from 7-8 to 11 mmol C m-2 d-1
- calculated at 50m

Did not see "crash" of Fe induced bloom
- flux still increasing; high Fv/Fm; still Fe….

Does iron fertilization lead to carbon sequestration into the deep ocean via sinking particles?

FeExII- significant C flux (12 days)

SOIREE- little/no C flux (13 days & satellite 55 days)

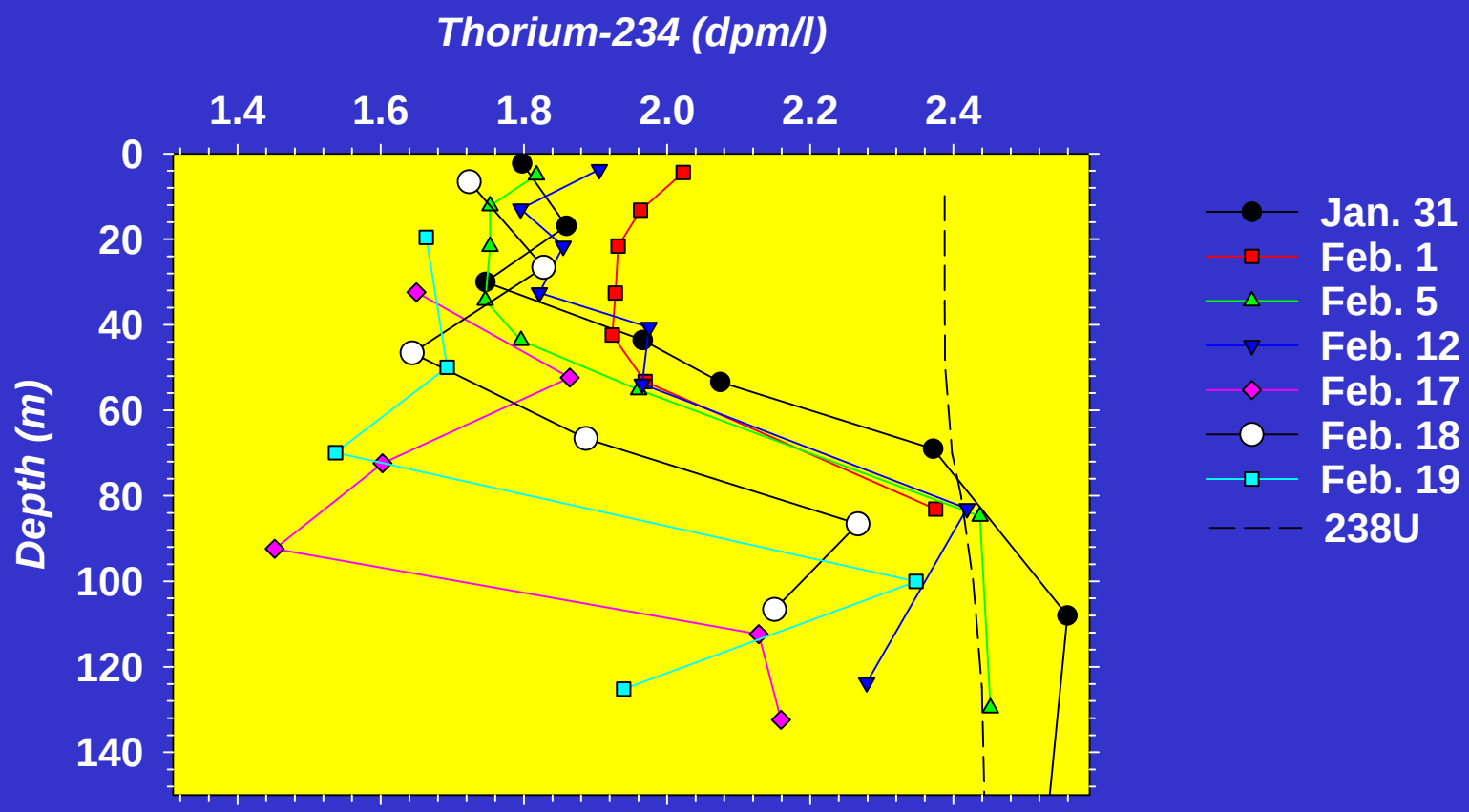
EisenEx – little/no "C flux" (22 days)

- lack of in/out differences (thorium-234)

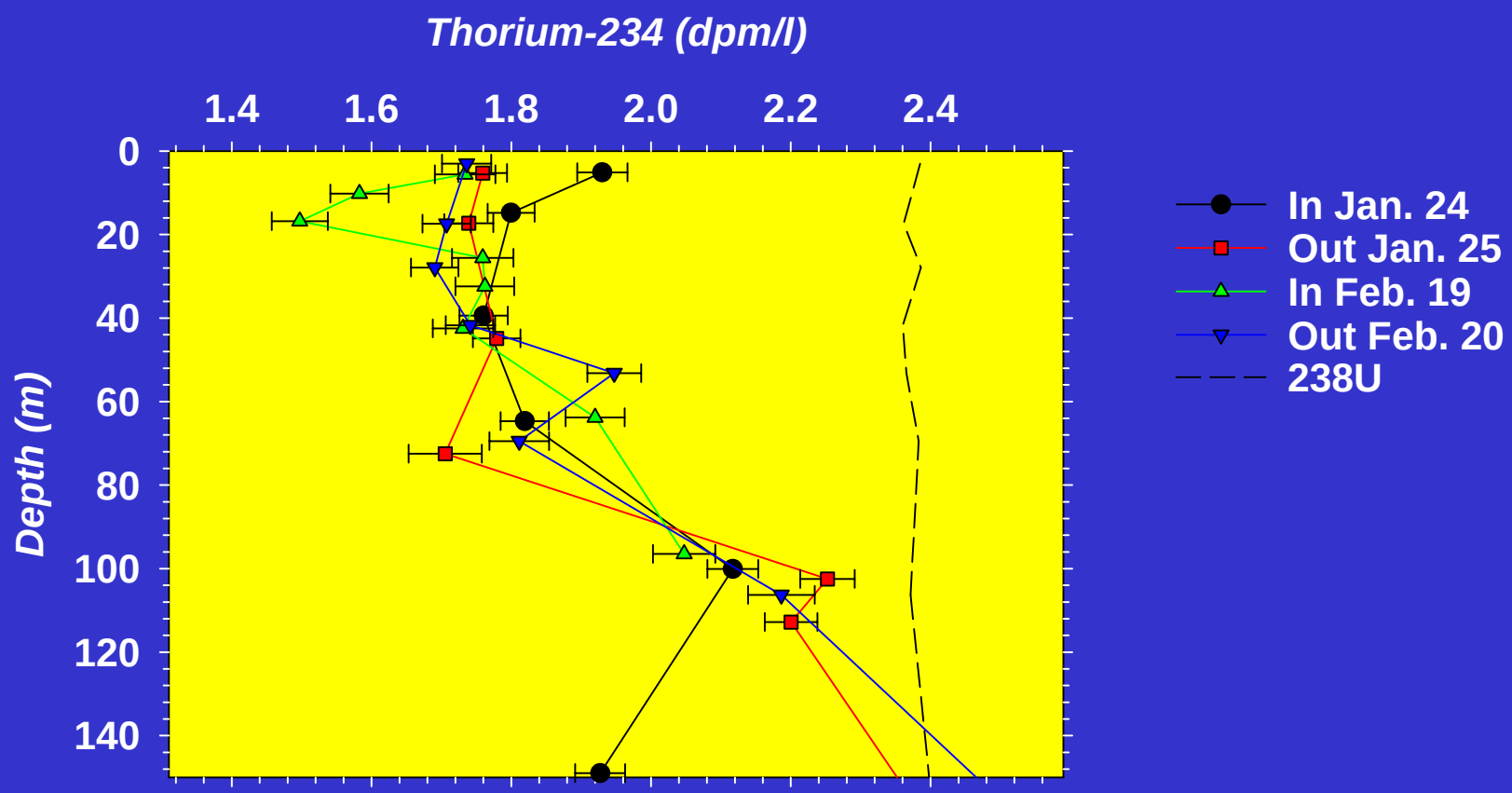
SOFeX- small C flux increase (27.5 days since t^0)

- enhanced export "in" vs "out" (subtle changes)
- did not see crash of Fe induced (or natural) bloom
- maintained high photosynthetic efficiency
- low loss terms imply efficient recycling of iron

SOFeX time-series progression S-patch "Out" stations



SOFeX time-series progression N-patch "In & Out" stations



N-patch: see no clear in vs. out or time-series trend

? hint at 10-20m on Feb. 19th

? late station with lower PProd & Chl than Revelle