Stable Isotopes in Atmospheric Gases: the INSTAAR NOAA Collaboration

- CO_2: $\delta^{13}C$ and $\delta^{18}O$
- CH_4: $\delta^{13}C$ and δD
- CO: $\delta^{13}C$

This talk: $\delta^{18}O$ (and advertisement for $\delta^{13}C$ of CO_2)…Colin Allison and Roger Francey

Bruce Vaughn: $\delta^{13}C$ and δD of CH_4, ICPs and calibrations

New Approaches to $\delta^{13}C$ of CO_2

- $\delta^{13}C$ has proven useful in separating land and ocean carbon fluxes on large scales
- Gold left to be mined
- As independent flux estimates of ocean and land improve, and as regional networks become more dense (e.g. North America)…
- Use $\delta^{13}C$ to focus in on
  - Disequilibrium: balance between photosynthesis and respiration
  - Fractionation during photosynthesis: water use and carbon

Caroline Alden: PhD Thesis (see her talk next week!)

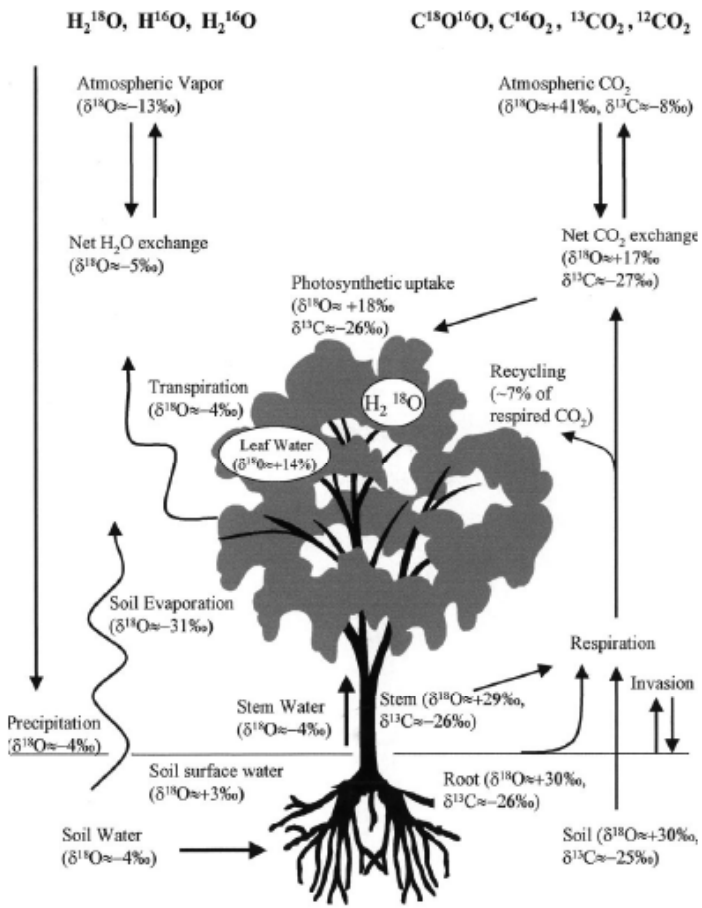
$\delta^{18}O$ of CO_2

Candice Evans: MS Thesis and article in preparation

Why $\delta^{18}O$ of CO_2?

Controlled by:

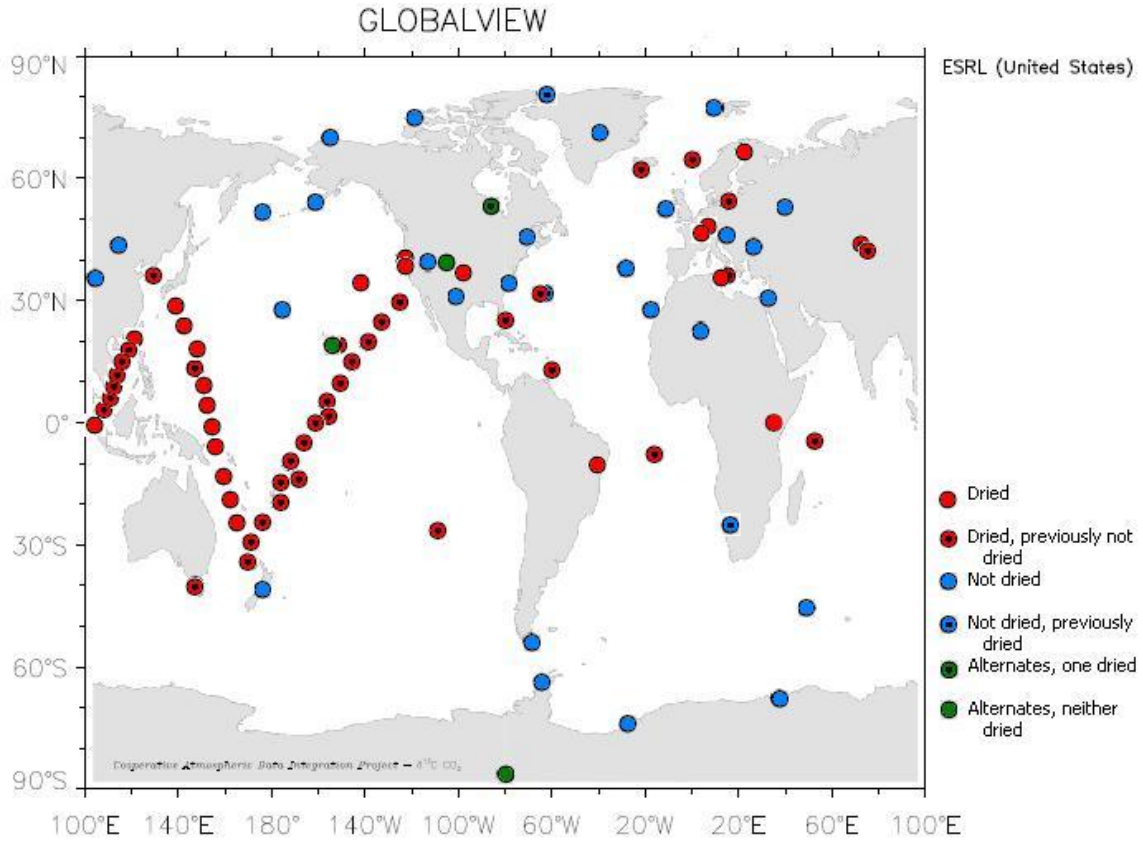
- Photosynthesis (leaf water exchange)
- Respiration (soil water exchange)
- Climate (spatial distribution of $\delta^{18}O$ of water)



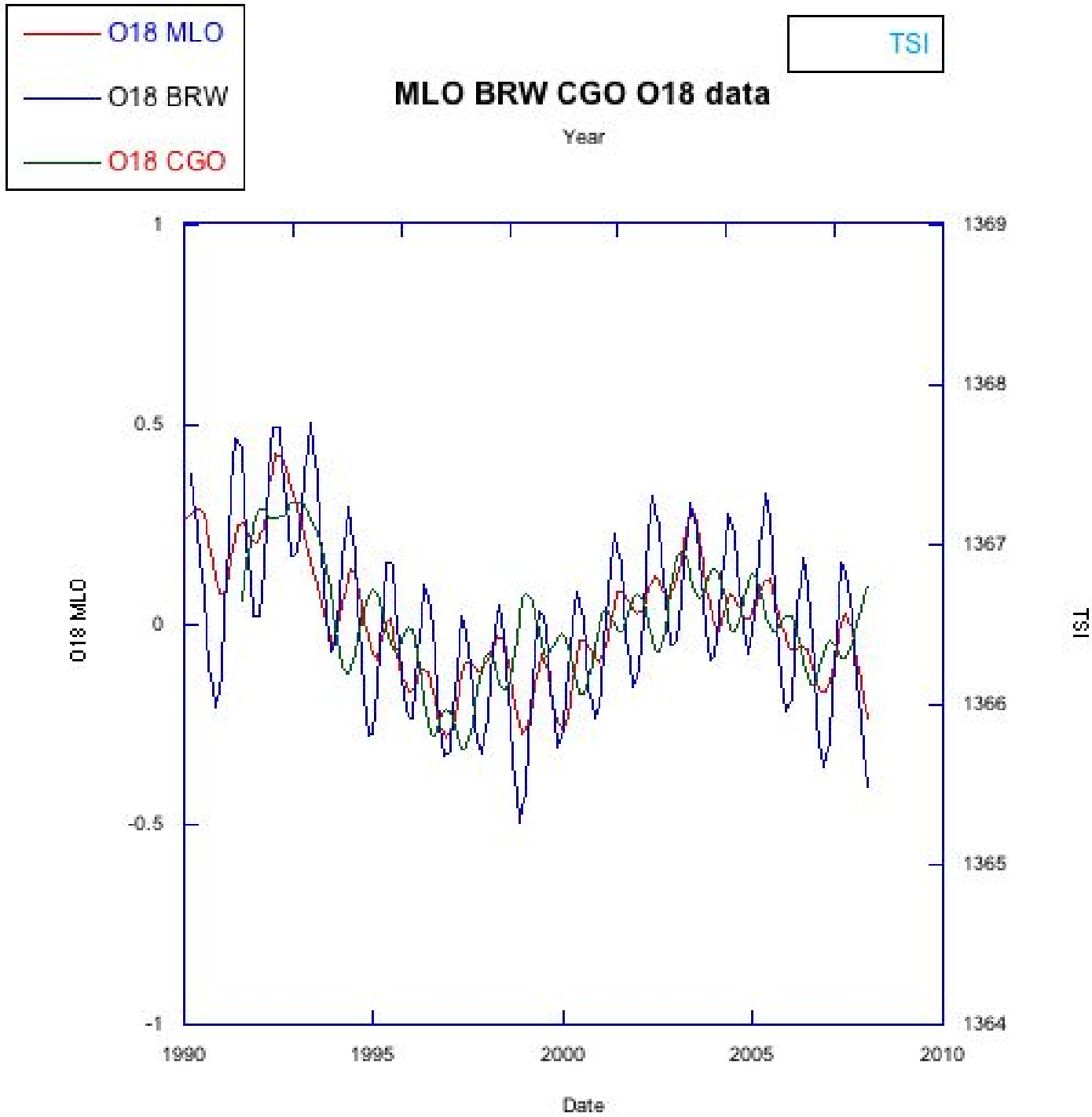
From Yakir and Sternberg, 2000

The problem: Some air samples collected without drying…

CO_2 and H_2O can exchange oxygen in flask: Gemery et al, 1996, JGR



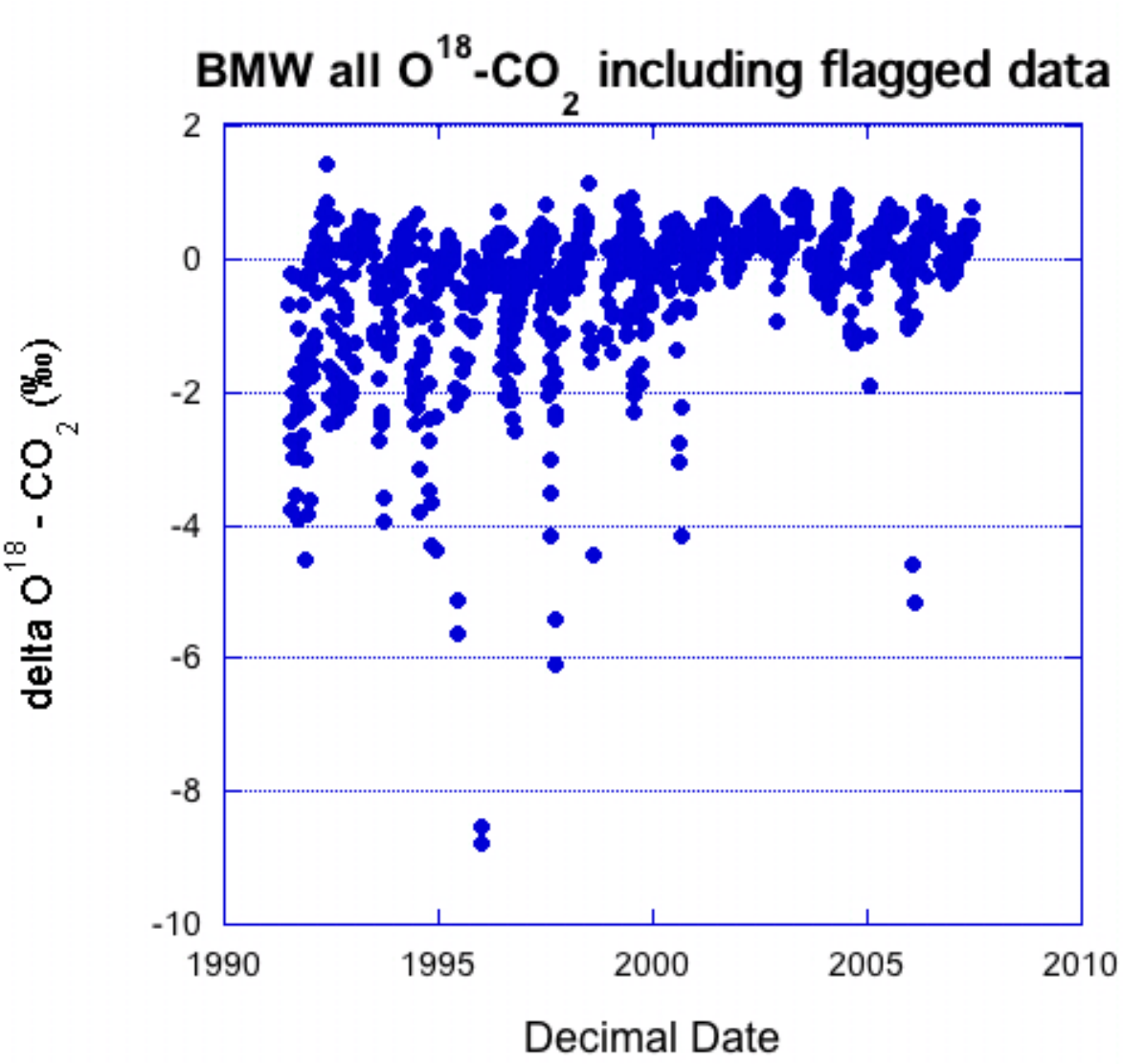
The signal…


O18 MLO
O18 BRW
O18 CGO
TSI
MLO BRW CGO O18 data
Year
O18 MLO
TSI
Date
1
0.5
0
-0.5
-1
1369
1368
1367
1366
1365
1364
1990
1995
2000
2005
2010

The noise…

CO_2 exchange with H_2O causes abnormally light values

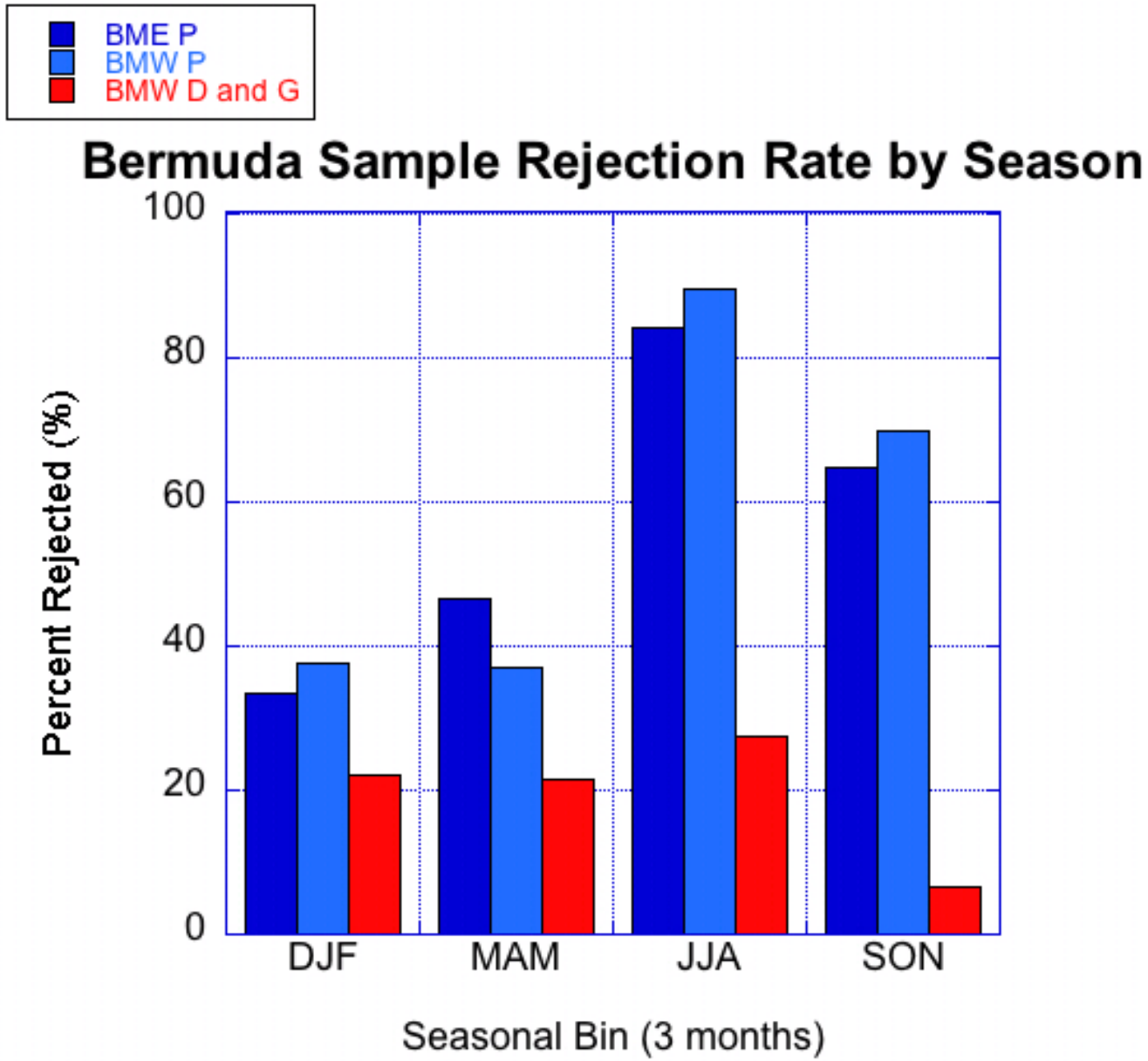
Past strategy has been to warn users away from all data 30N to 30S… but can we do better than this?



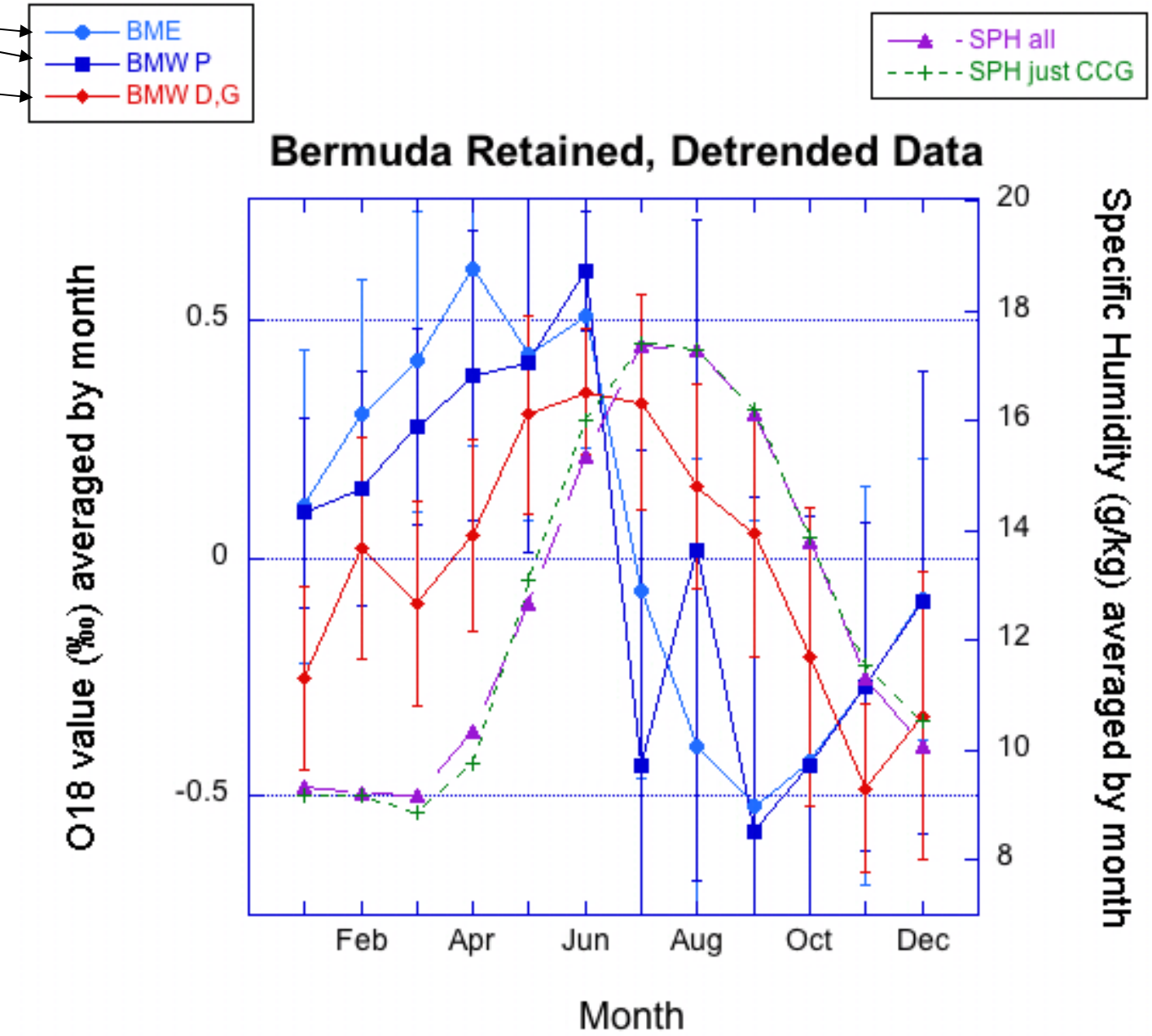
Recap from 2007: Pair rejection Problem

P: sampled “wet”

D and G are both sampled “dry”



Wet:
Dry:

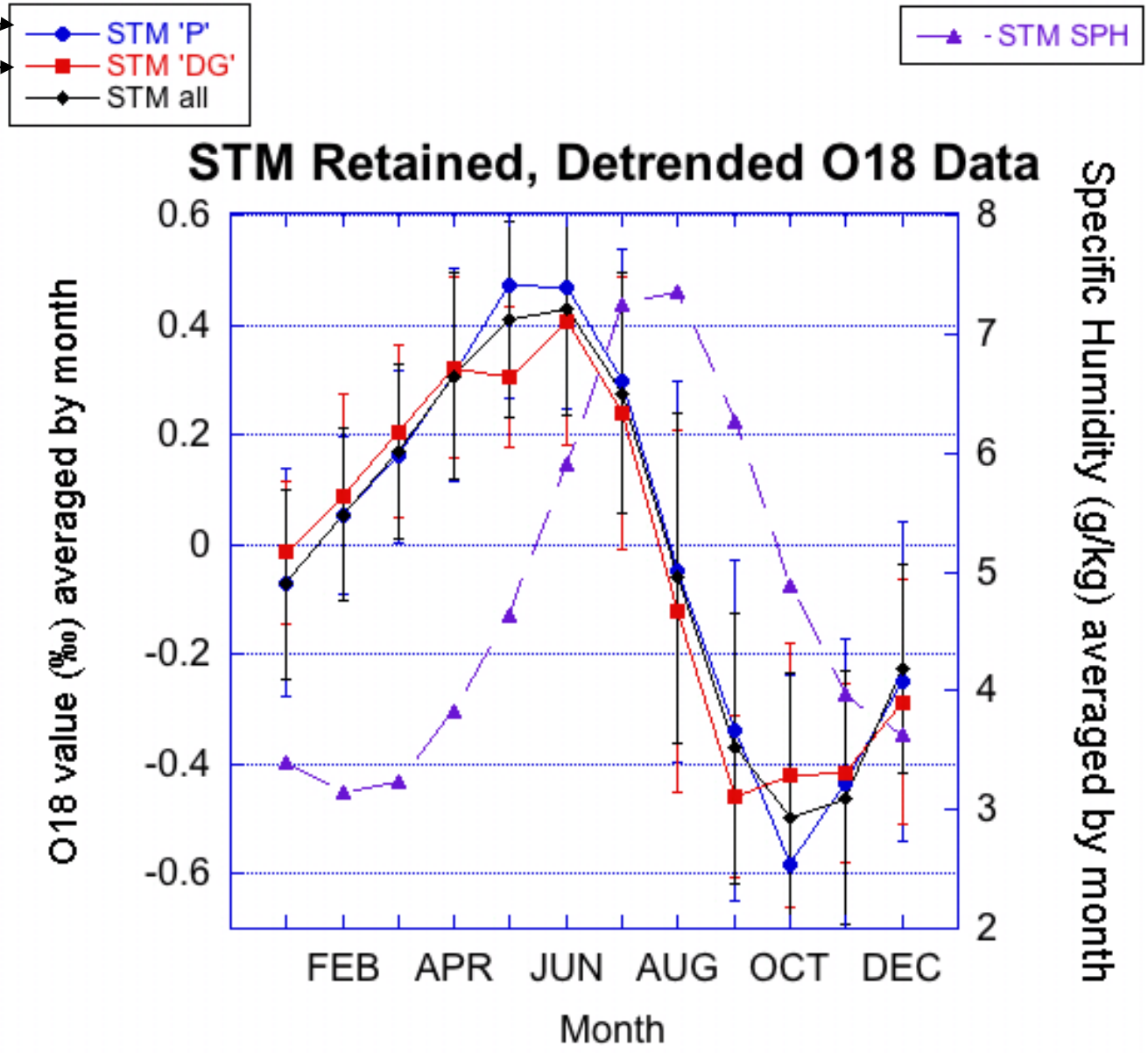


Not just a pair rejection problem…

problem data survives data QA/QC controls

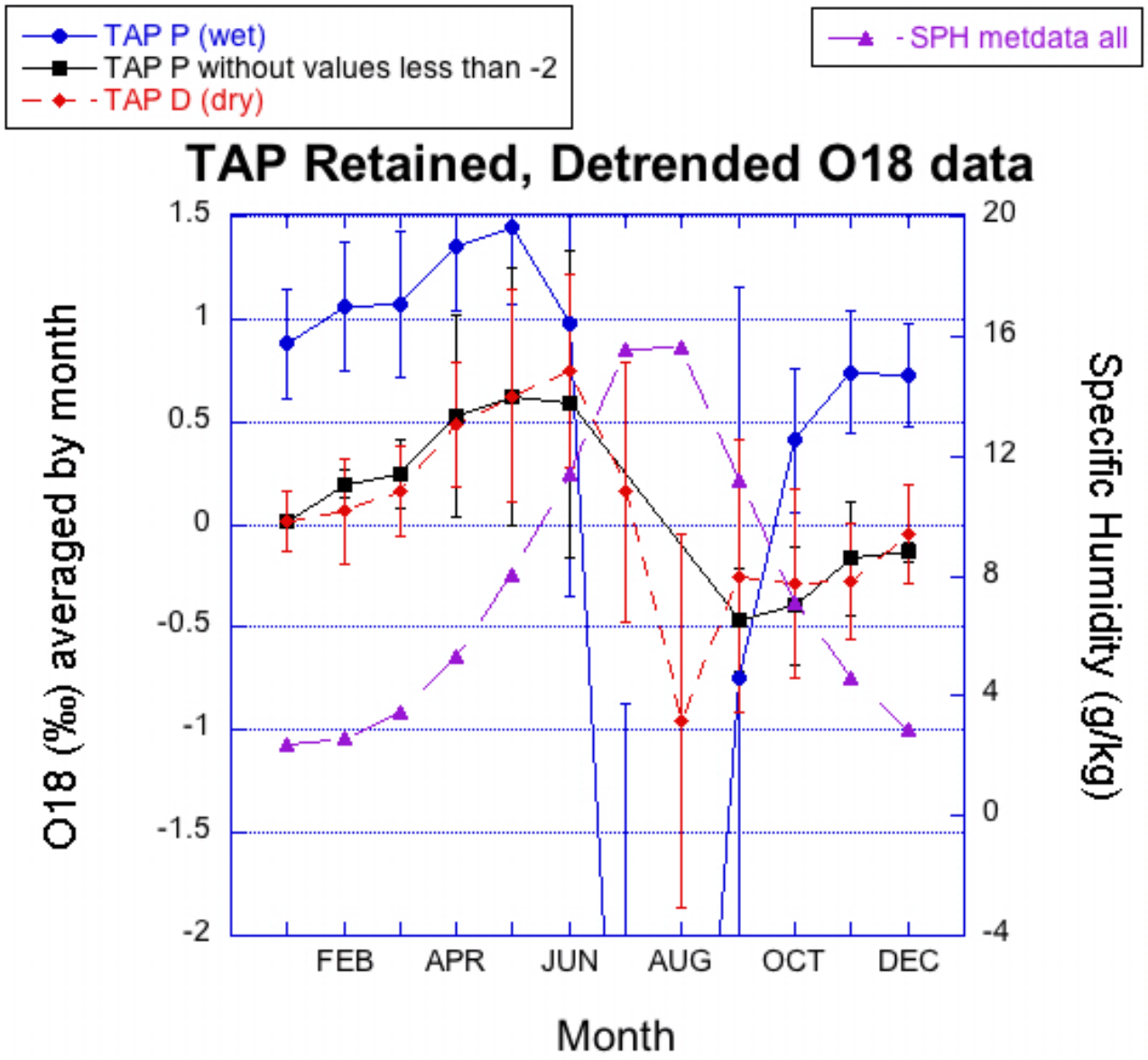
Wet:

Dry:

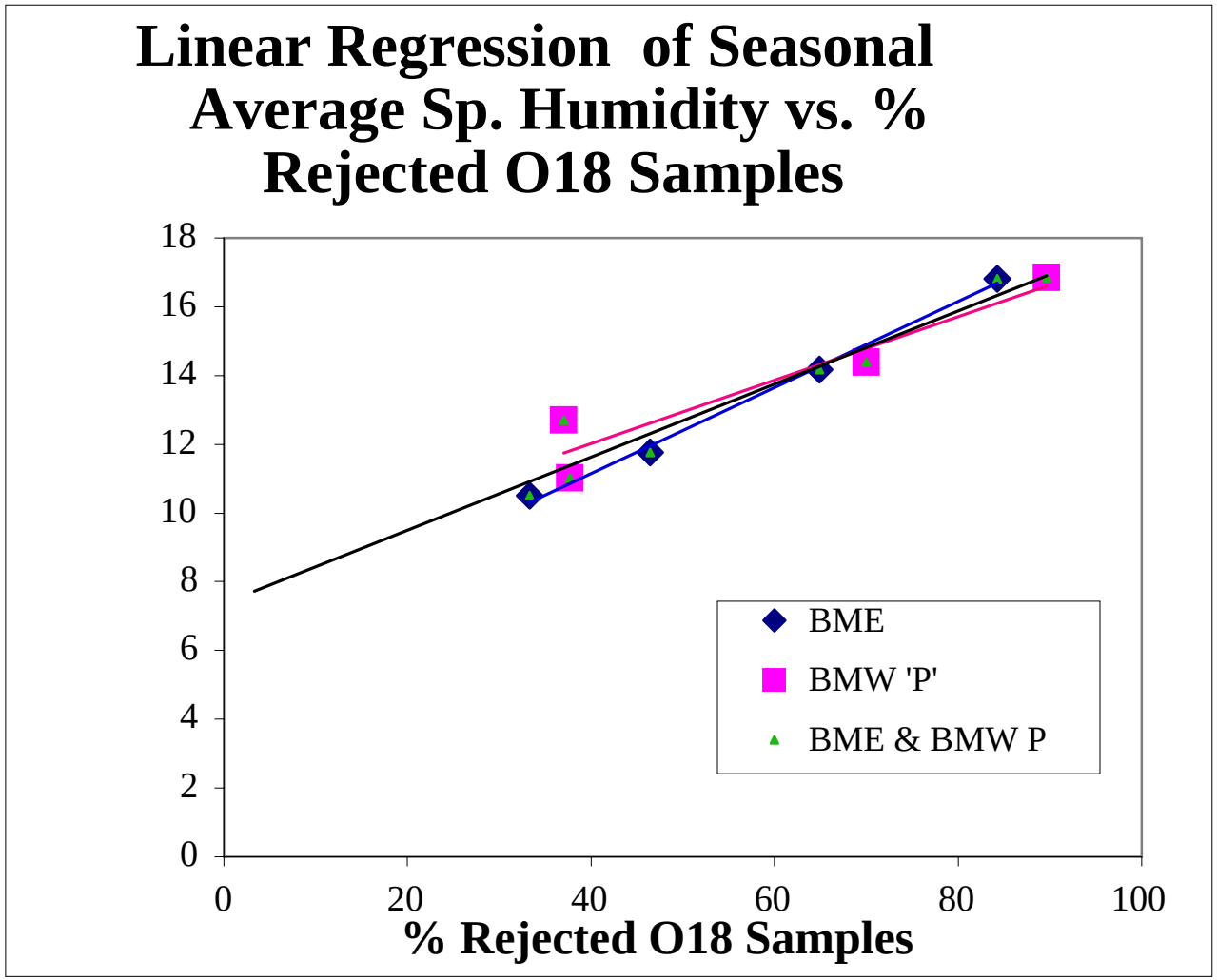


Drier sites seem to not have this problem… Station M in Norwegian Sea

Some sites look good in the winter, but not the summer… seasonal humidity changes



Is there a lower limit of humidity below which we are safe?



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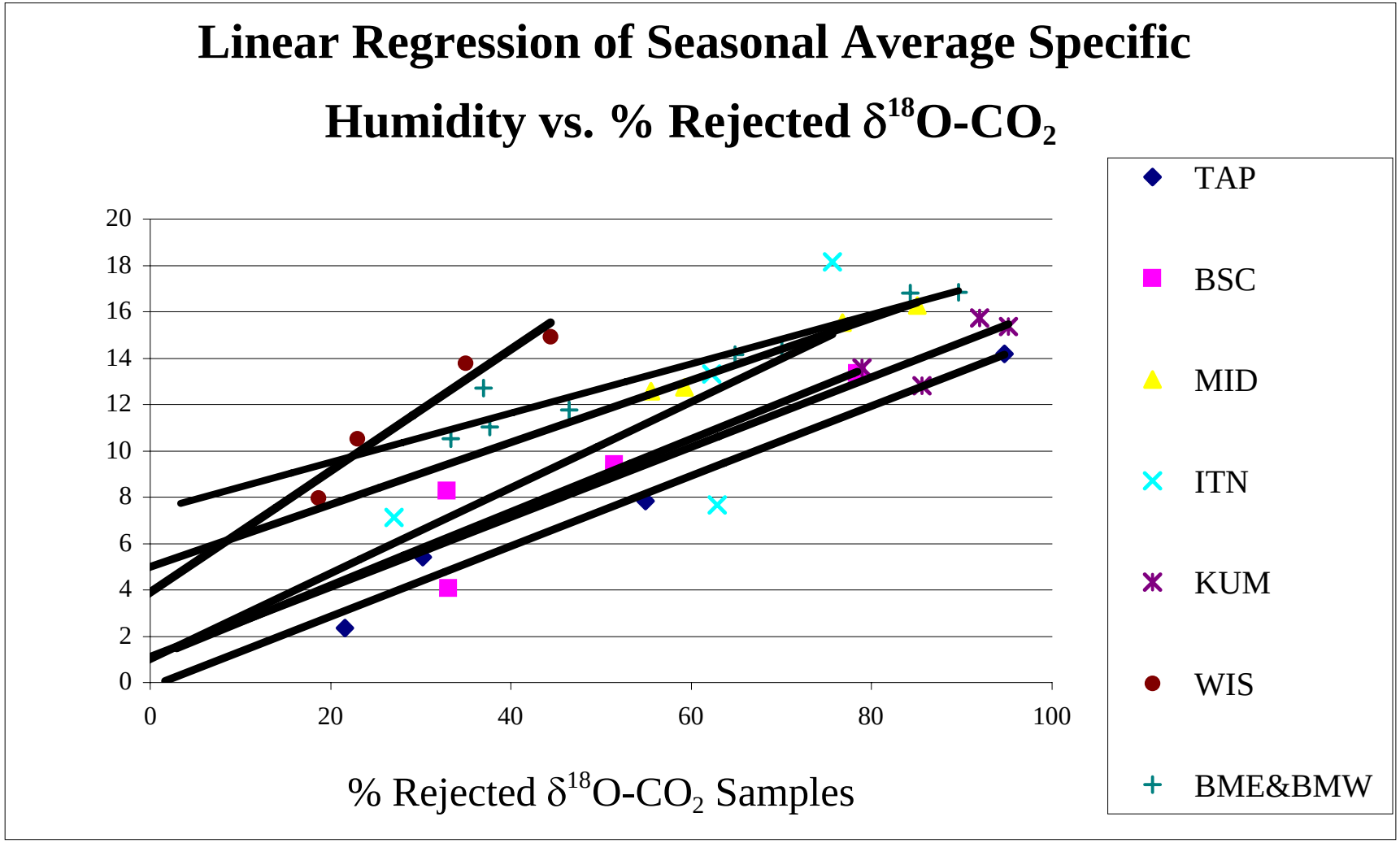
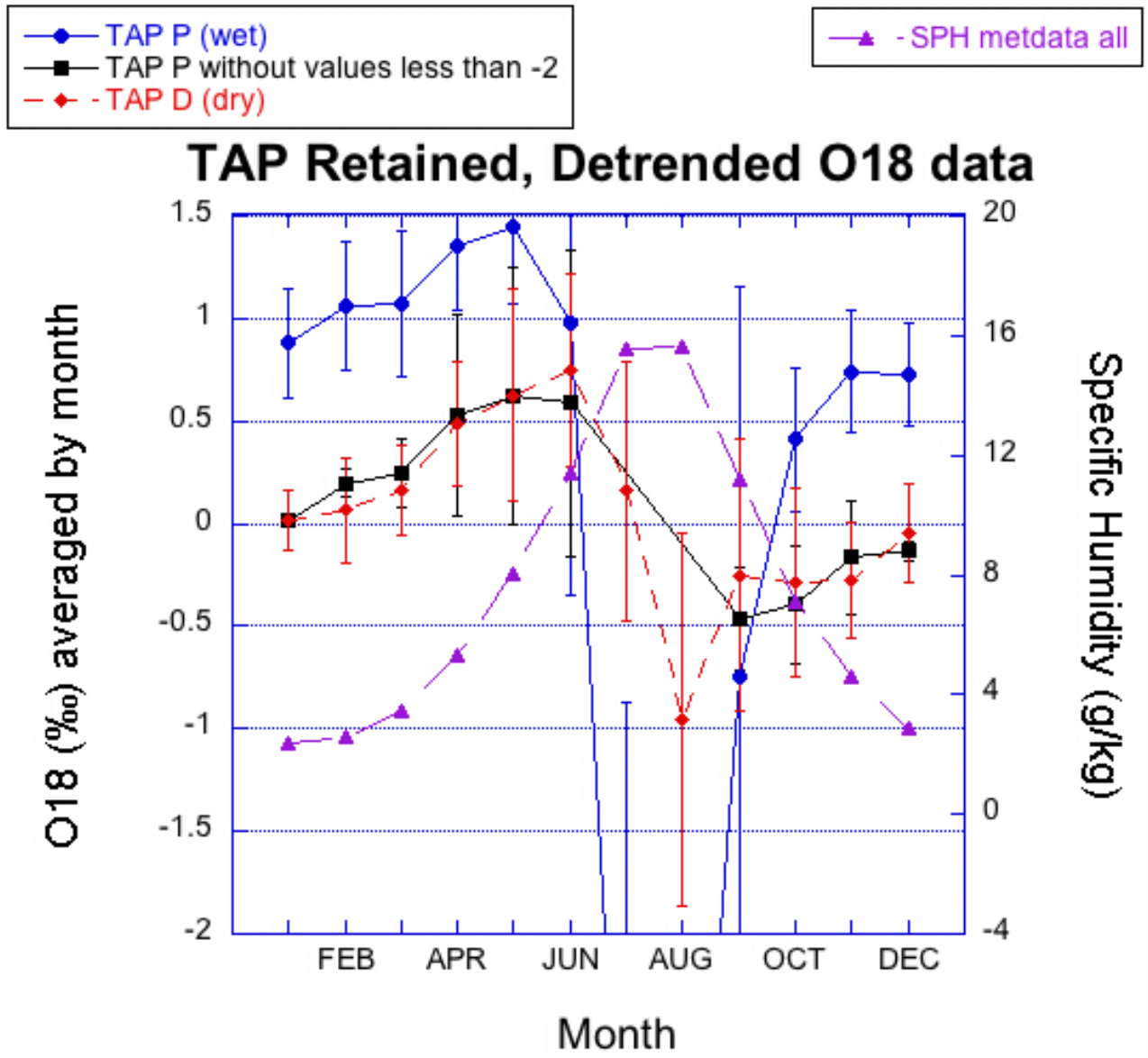
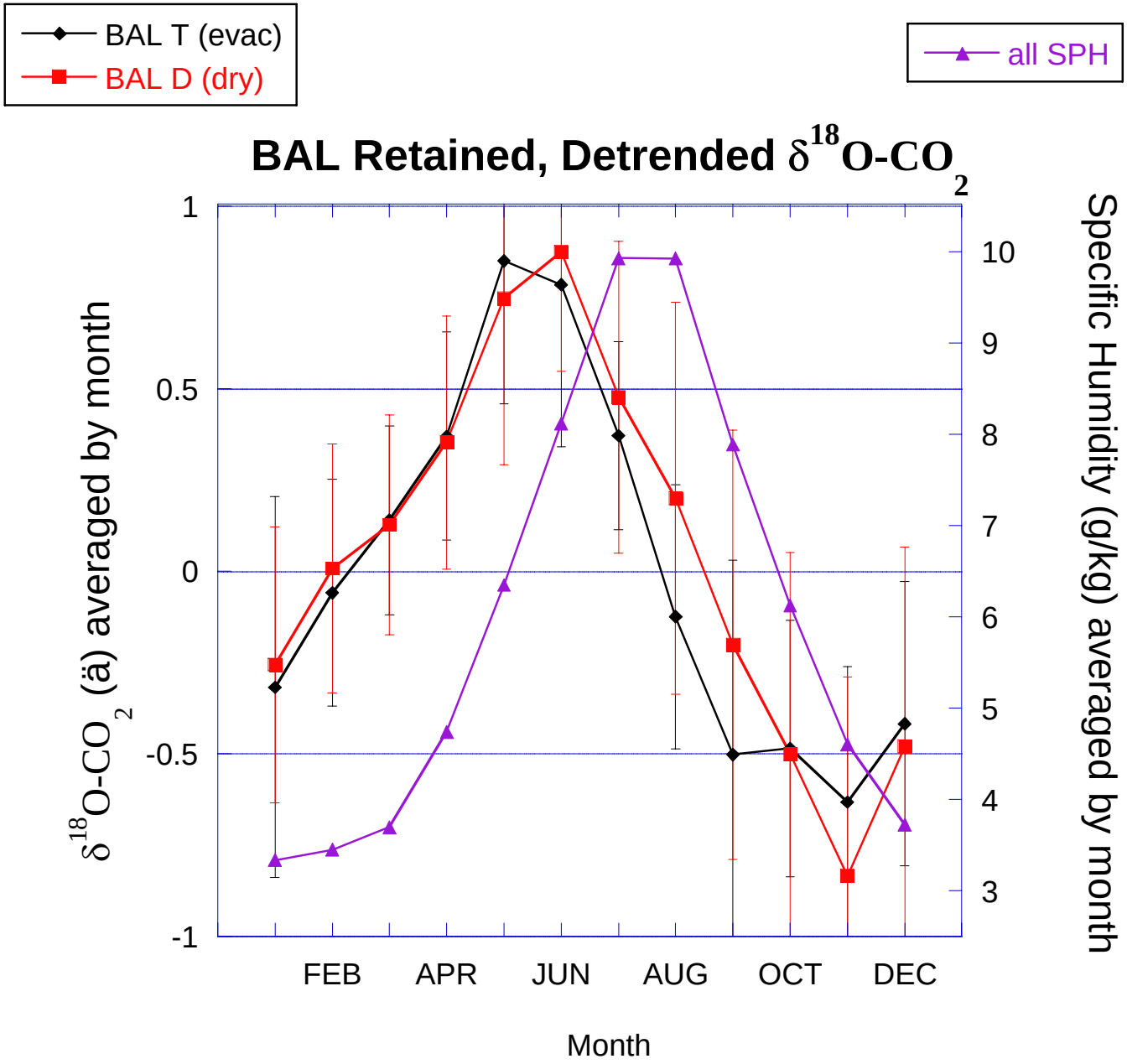


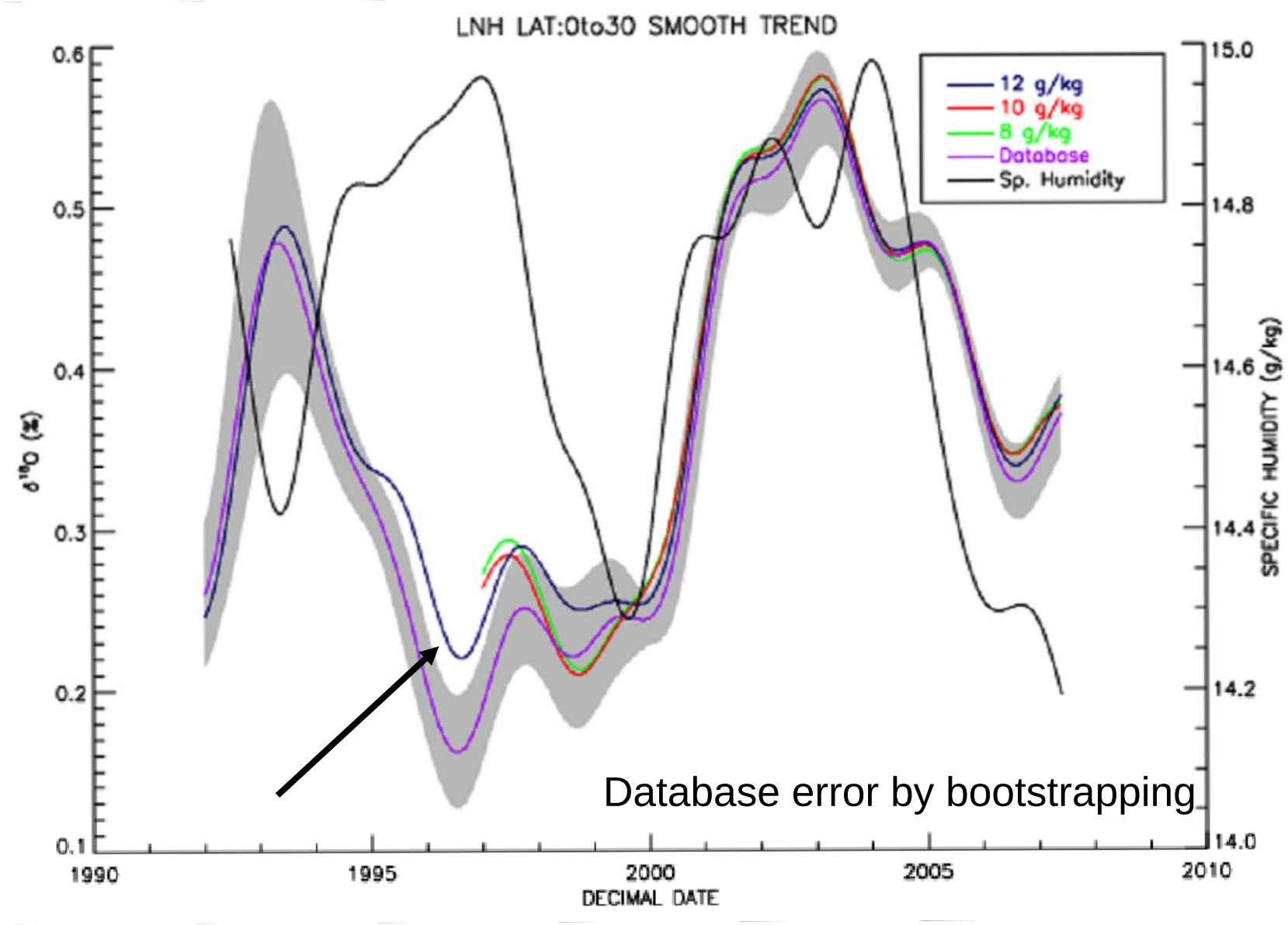
Problems do appear to start in earnest when SH>10 to 12 g/kg



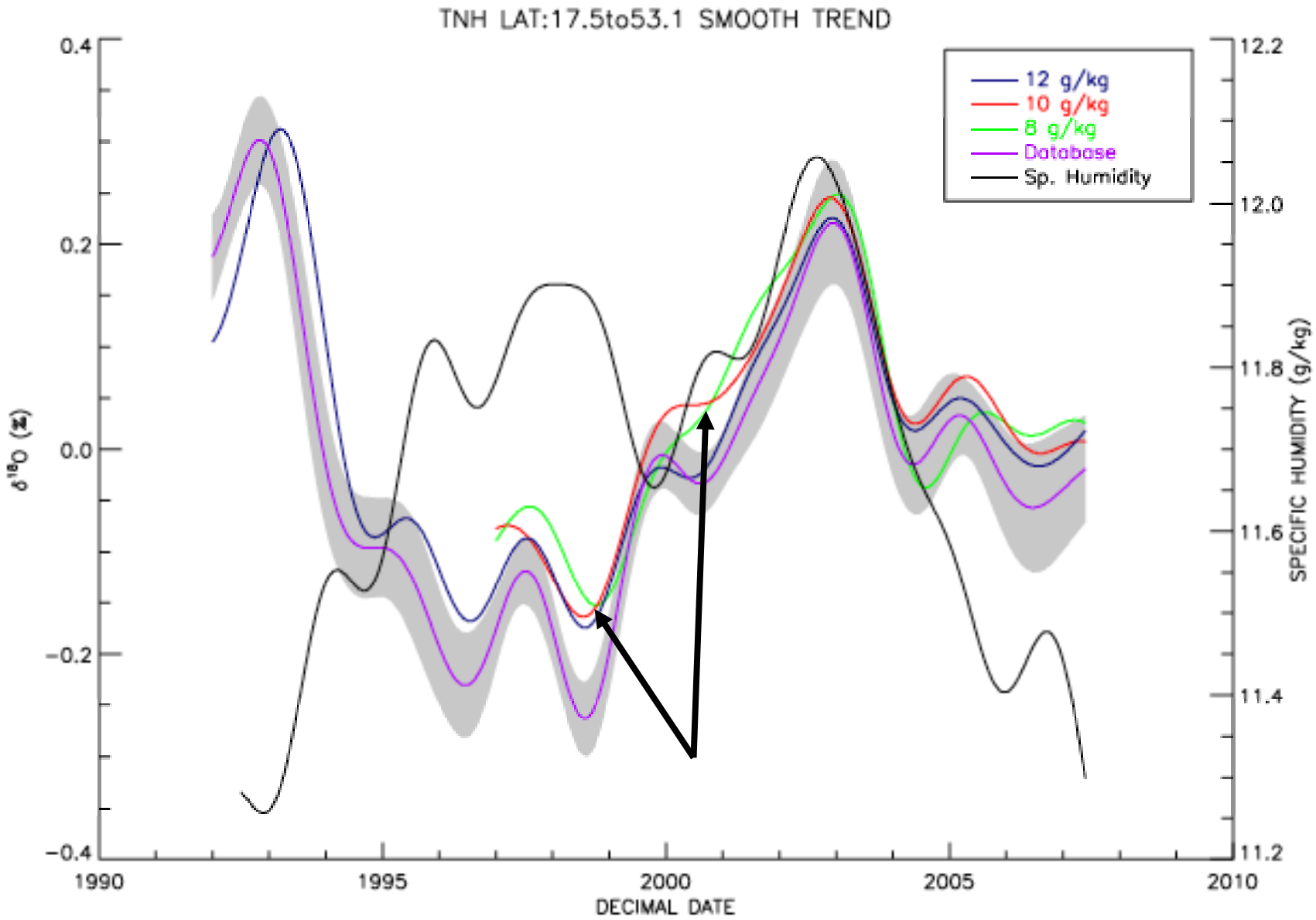
And below 10 g/kg, all generally looks ok…



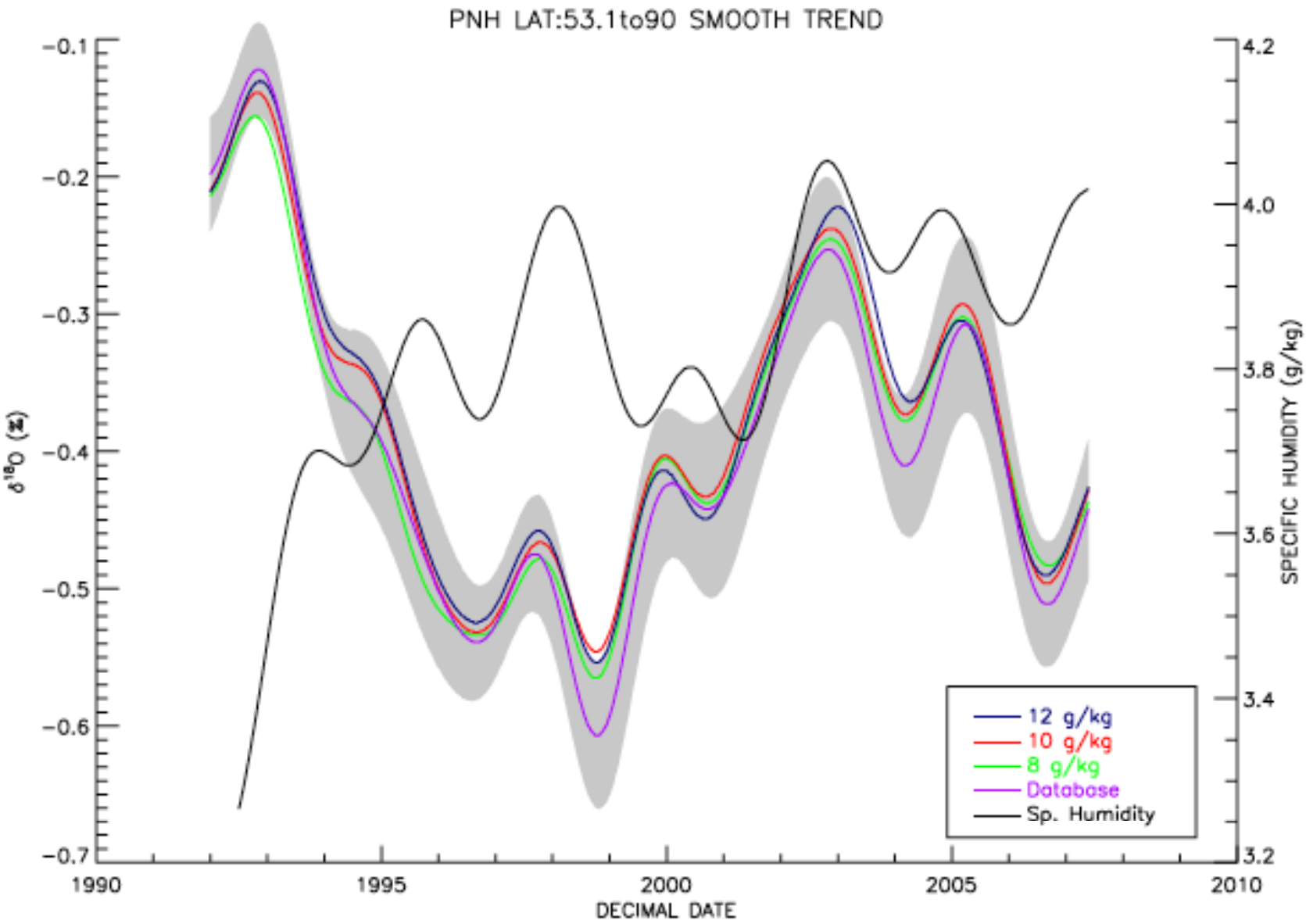
Mostly Wet sites



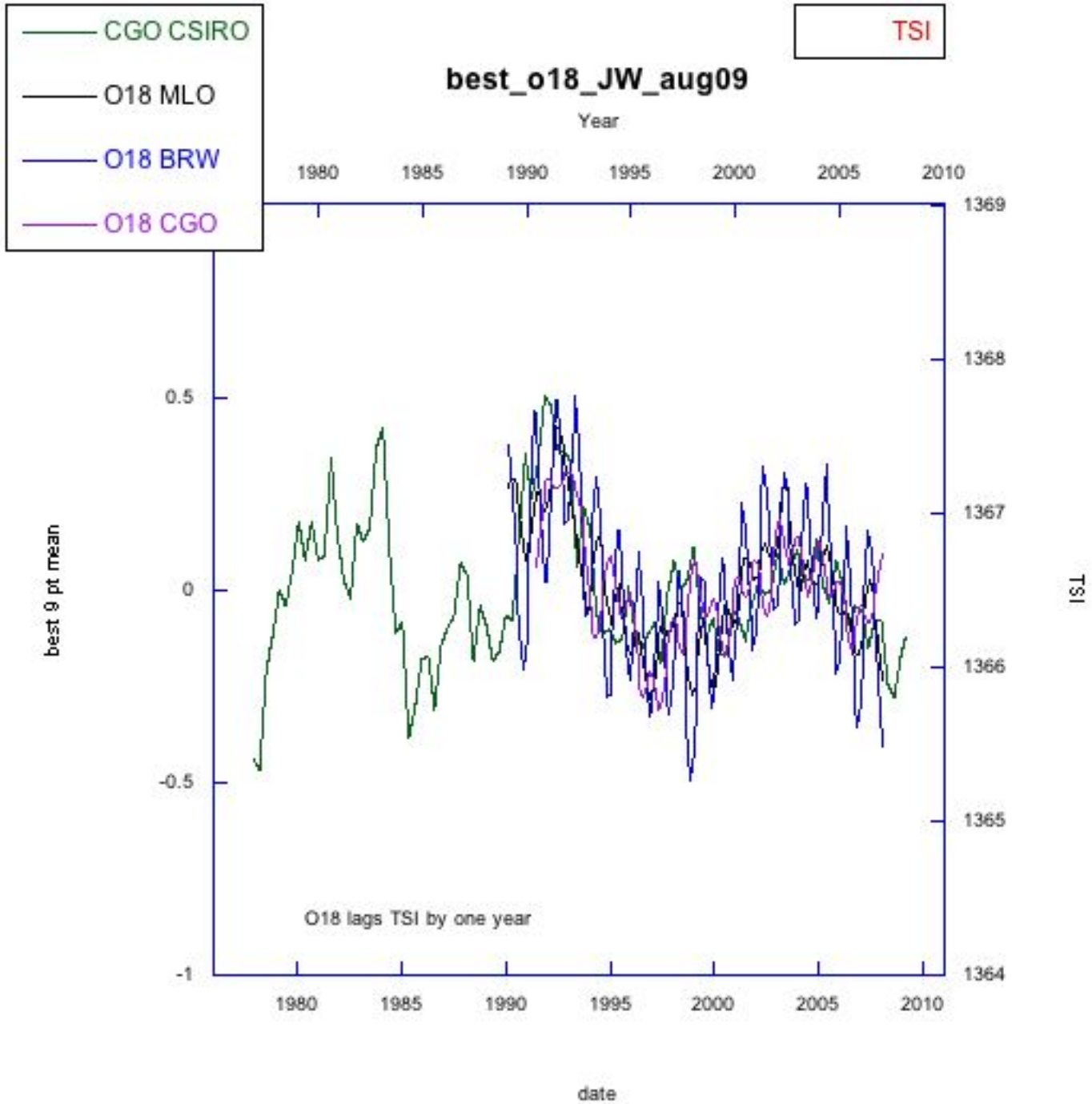
Generally Dry Sites



All Dry Sites



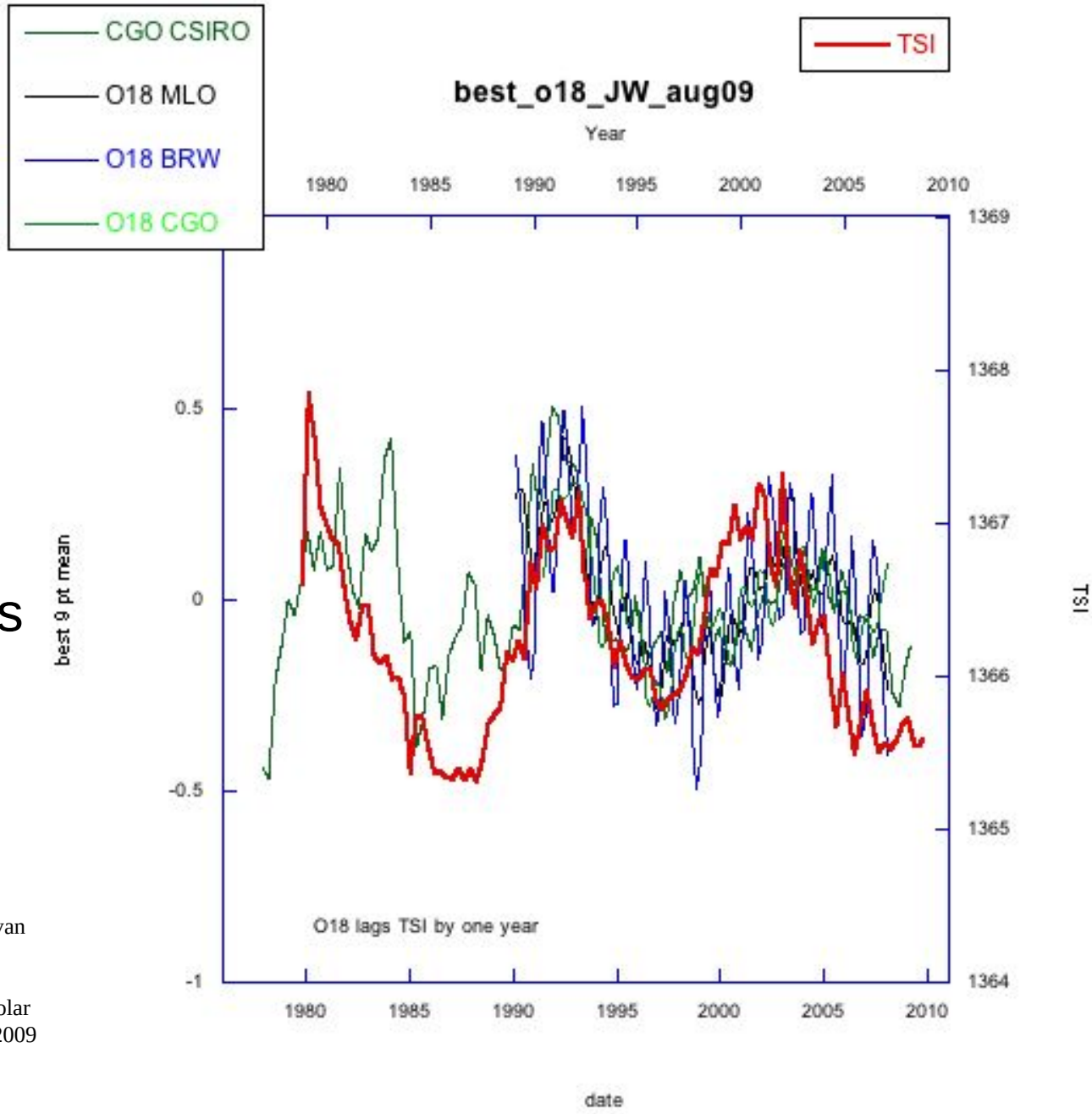
The long time record



Does insolation pace $\delta^{18}O$ of CO_2?

Recent papers postulate a link:

- More sun
- more evap in tropics
- More humidity
- More ppt



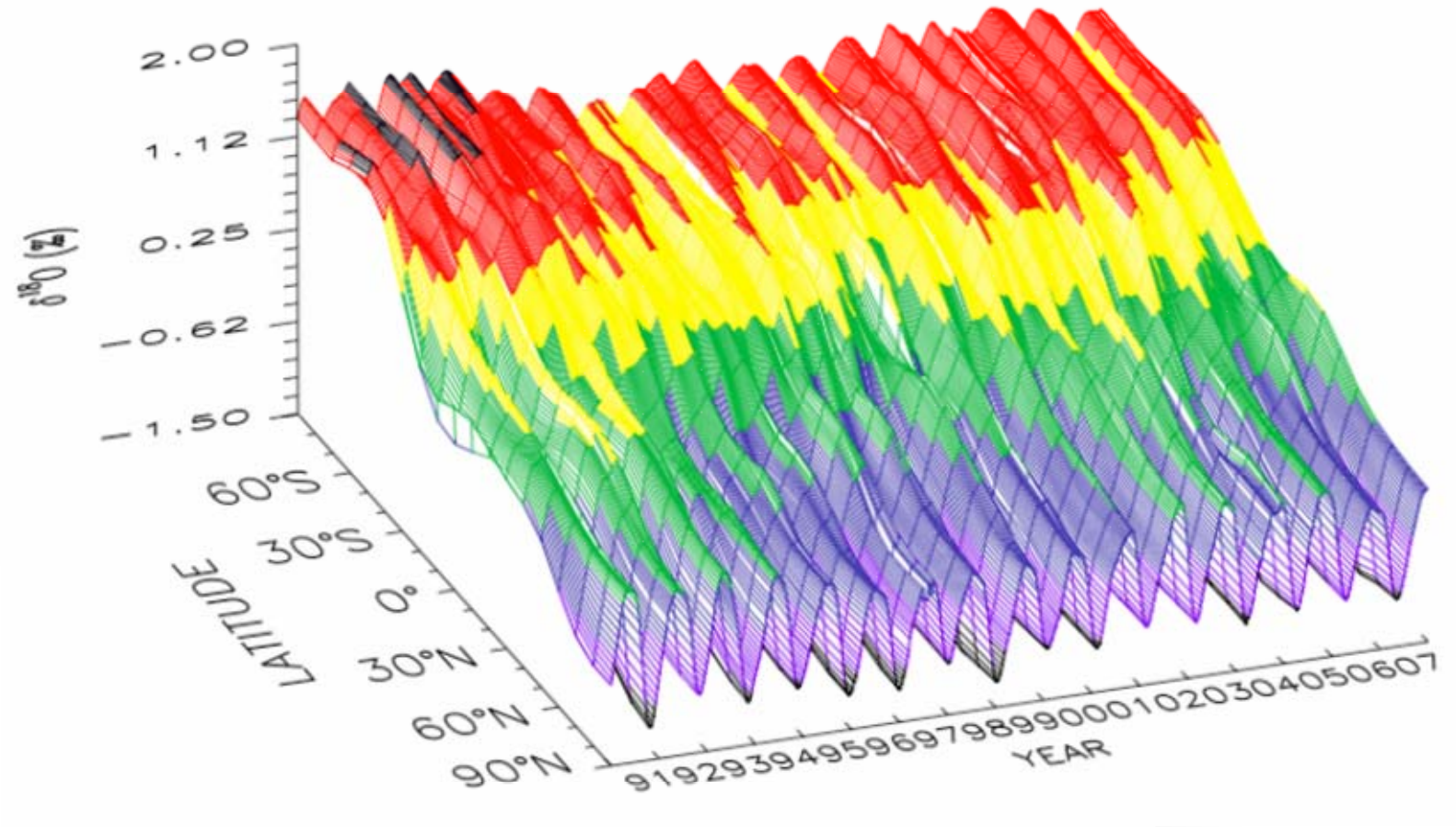
A decadal solar effect in the tropics in July–August, van Loon Meehl and Arblaster, 2004

A Lagged Warm Event–Like Response to Peaks in Solar Forcing in the Pacific Region, Meehl and Arblaster, 2009

Where next?

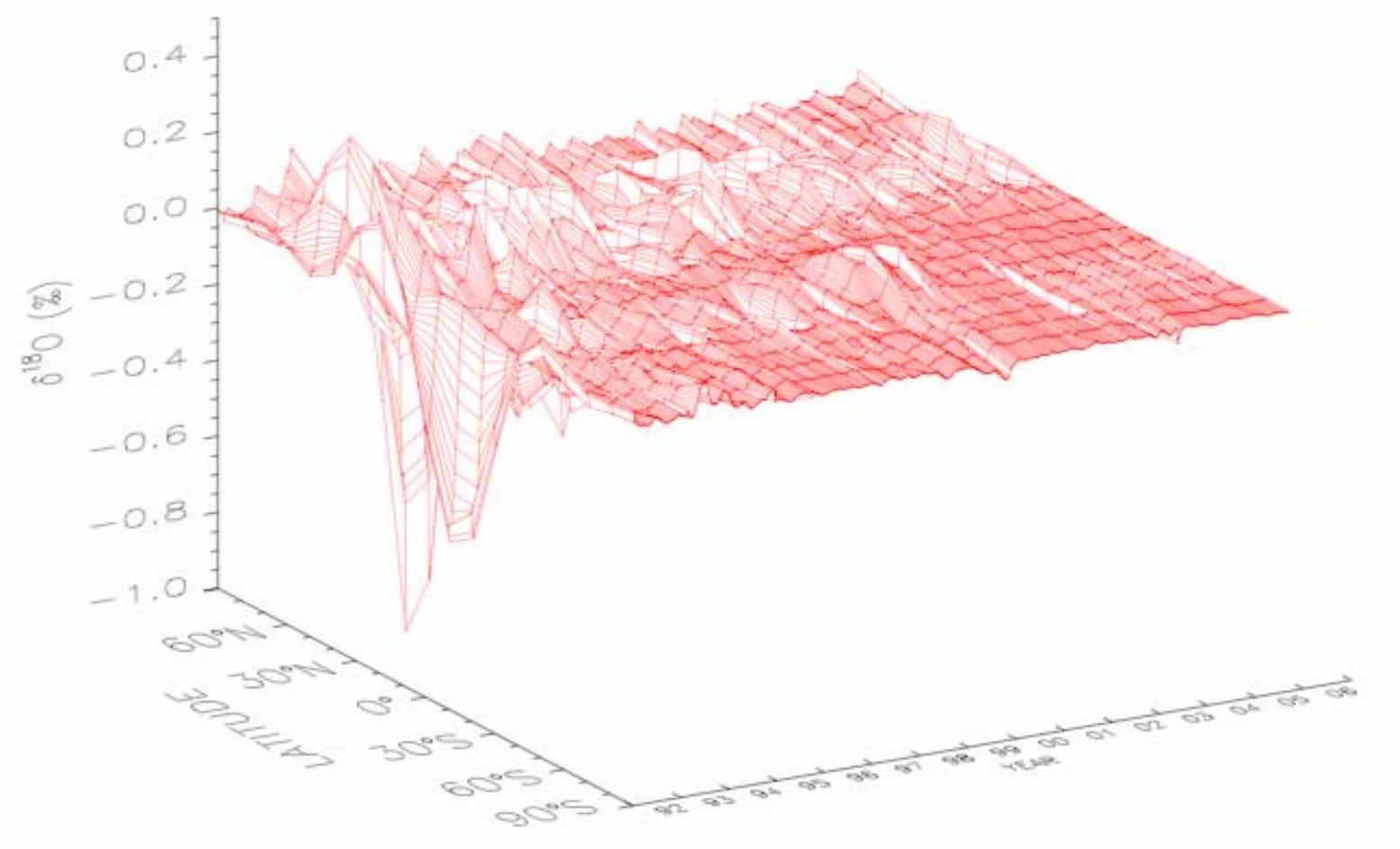
- New data release with flags for different filters
- New filtering strategy:
  - Normal filters (pair, etc.)
  - Specific humidity filter… metrological data needed for all flasks, included as in data release

The rug plot: All data that passes normal quality controls



Apply SH filters (8,10 and 12 g/kg): Examine Impact on database

Impact on database: Existing database minus12 g/kg filter



Impact on database: 8 g/kg filter