

# Measurements of light alkanes (C<sub>2</sub>-C<sub>4</sub>) in firn air at Summit, Greenland (2006) and West Antarctic Ice Sheet Divide, Antarctica (2005): Is there evidence for a recent decline in polar tropospheric levels?

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Blake-Rowland Lab. (UCI) – surface flask data  
E. Atlas (U. of Miami) – firn data  
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ICDS – drilling support

# NMHC's – light alkanes ( $C_2H_6$ , $C_3H_8$ , n- $C_4H_{10}$ )

Precursors of  $O_3$  and CO and a removal mechanism for OH

Summer OH lifetimes:  $\tau_{ethane}=1-2$  months,  $\tau_{propane}=8-20$  days,  $\tau_{butane}=2-10$  days

## Anthropogenic sources

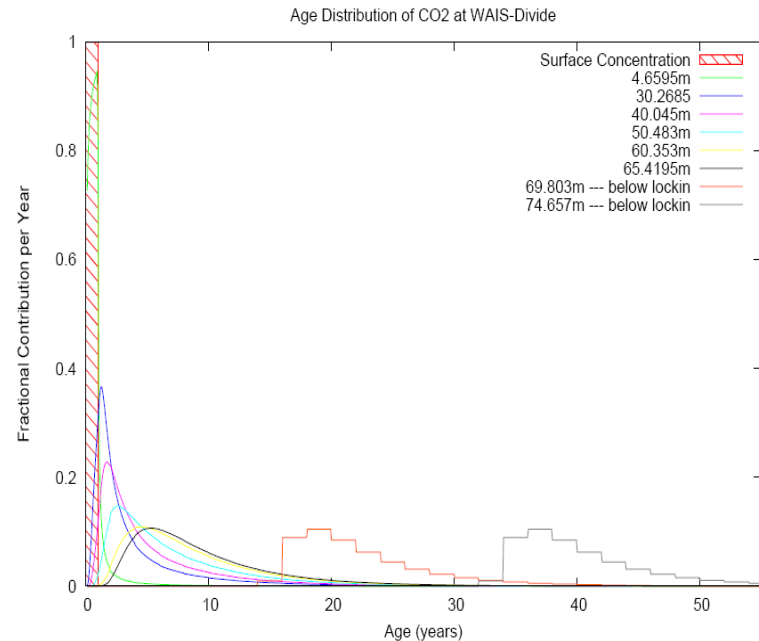
natural gas and oil leaks  
Automotive, biomass burning

## Natural sources

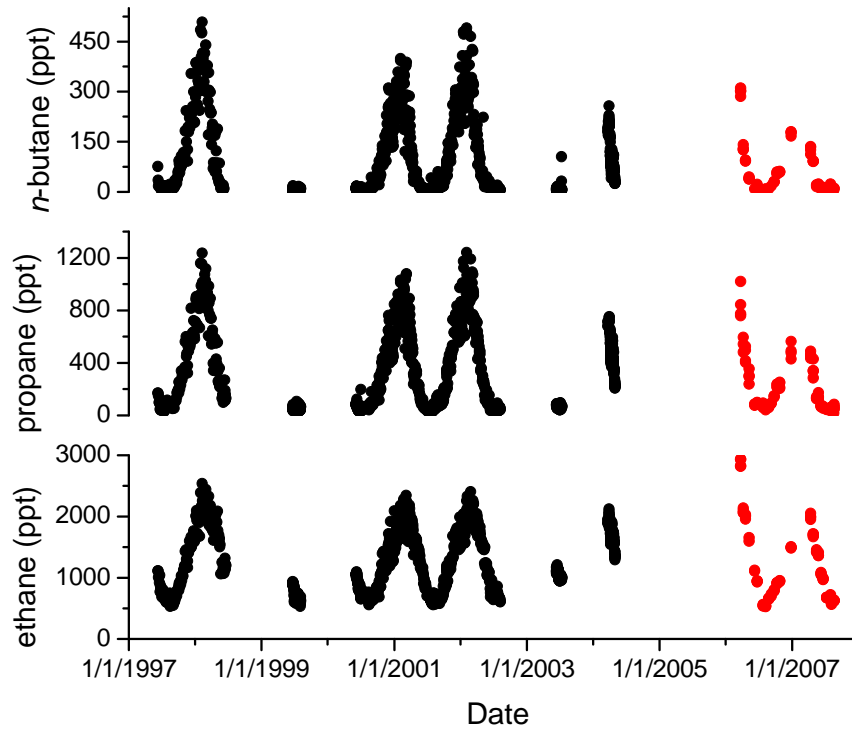
biomass burning  
oceanic, vegetative, soil emissions (smaller)

## Firn air records and modeling

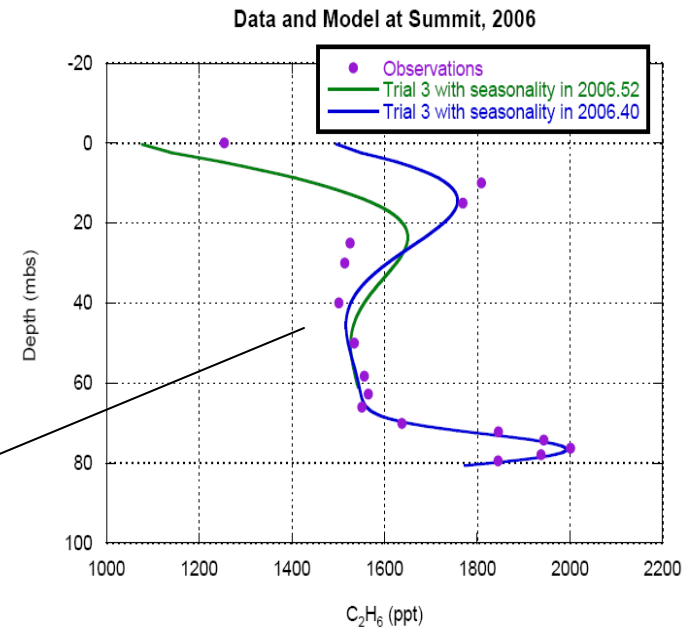
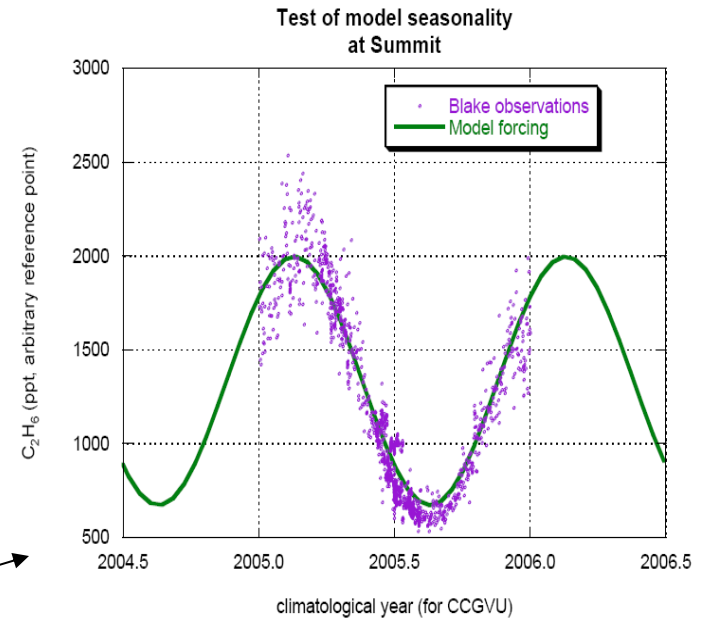
- Smoothed (low-pass filter) records
- Site characteristics impact smoothing
- Exact age calculation impossible
- All ages ( $CO_2$ , CFC-12, mean) represent an integrated average
- Summit and WAIS-D firn modeling with diffusivity tuning using  $CO_2$  and CFC-12.



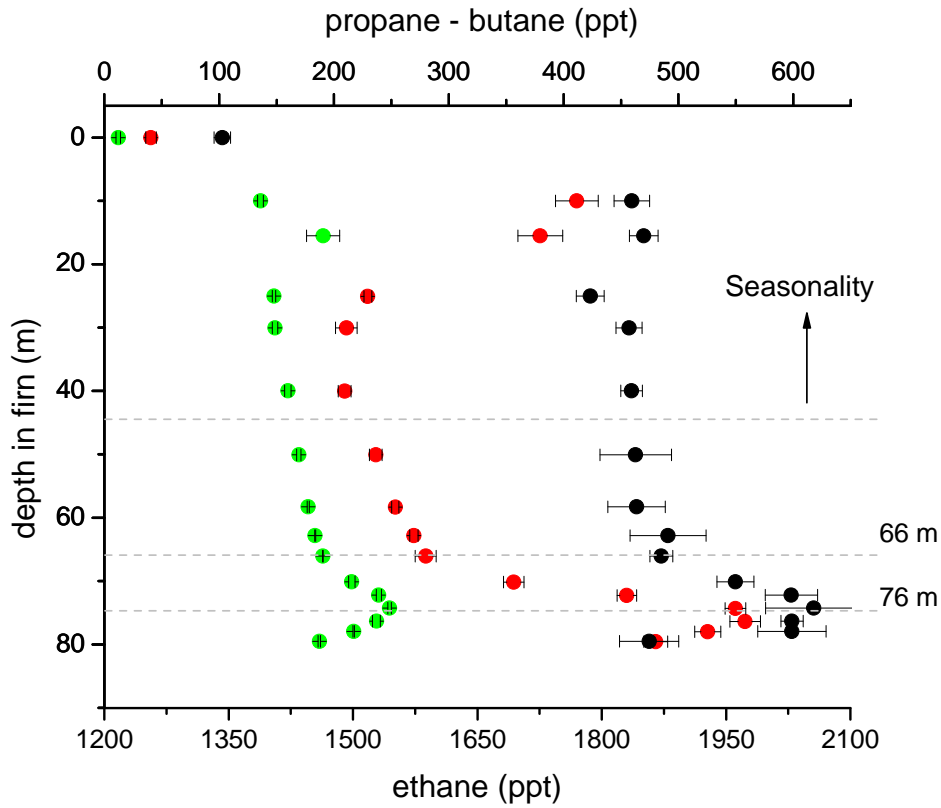
# Summit surface measurements 1997-2007 and seasonality in Summit firn (Blake-Rowland and UCI)



- No clear long-term trend
- Mean levels
  - ethane: 1250-1500 ppt
  - propane: 400-600 ppt
  - *n*-butane: 150-250 ppt
- Annual mean signal observed in firn below 40 m

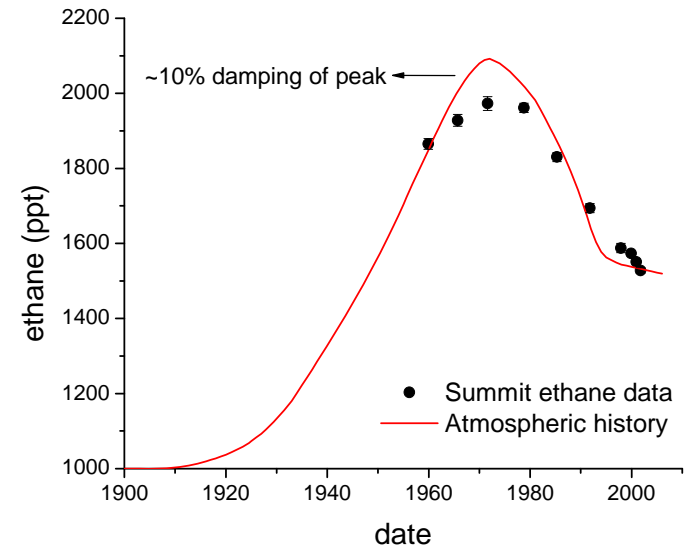


# Summit UCI firn data (ethane, propane, *n*-butane)



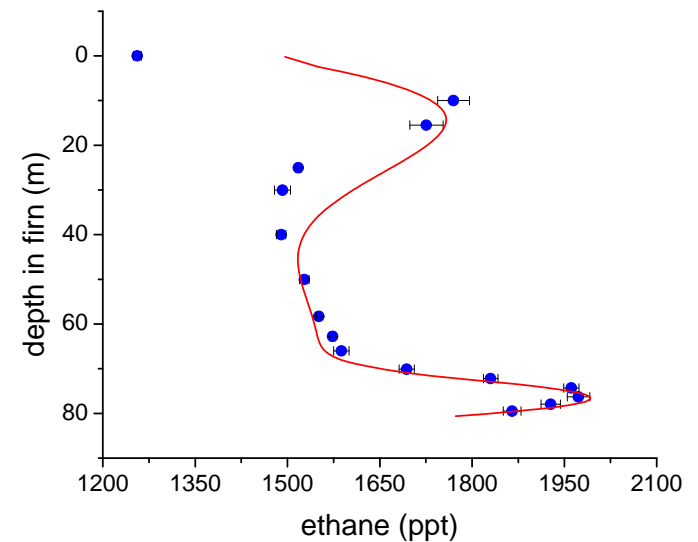
## Change in alkanes 1970-1990

	$C_2H_6$	$C_3H_8$	$n-C_4H_{10}$
Rate	29 ppt/y	9 ppt/y	4 ppt/y
Overall	27%	27%	28%

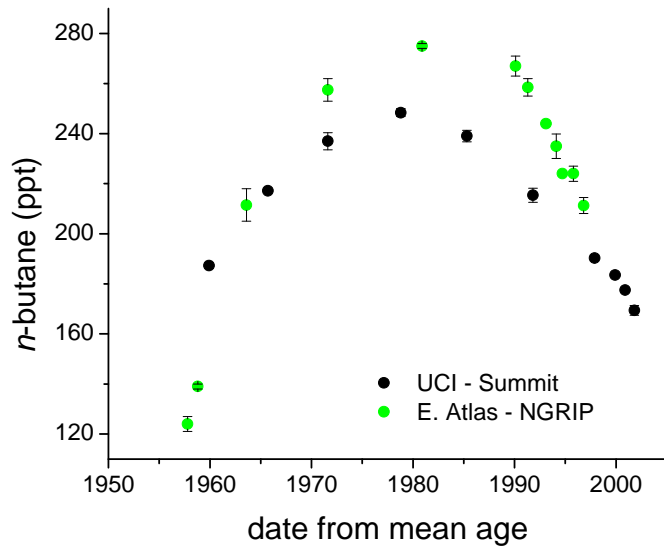
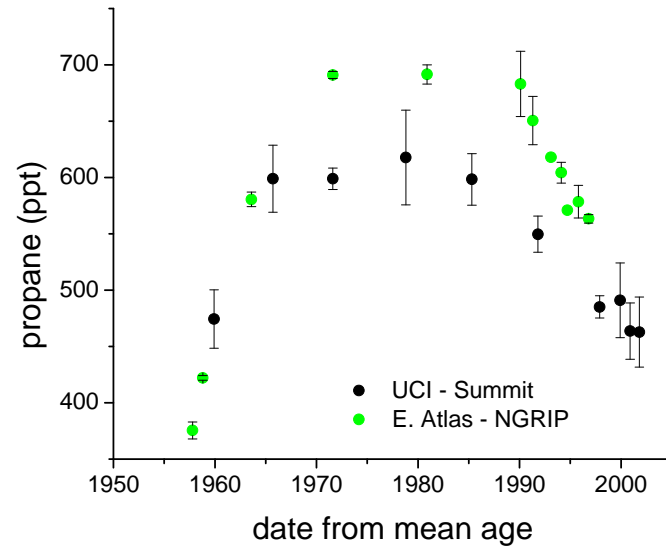
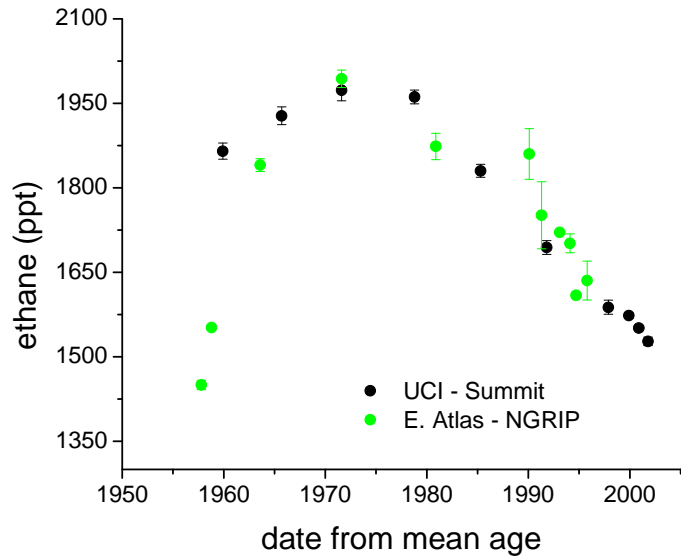


Incorporation of atmospheric signal into firn

↓



# Summit (UCI) and NGRIP (E. Atlas), Greenland data (depths > 40 m)



Similar trends at both sites:

1970s peak, decrease during 1980s and on

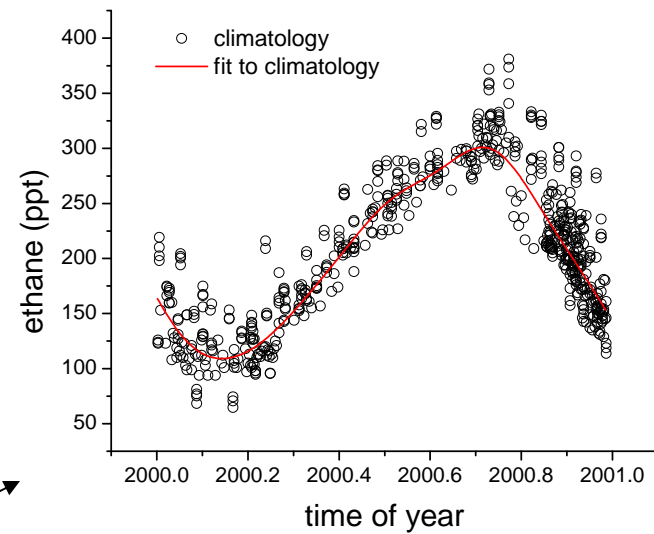
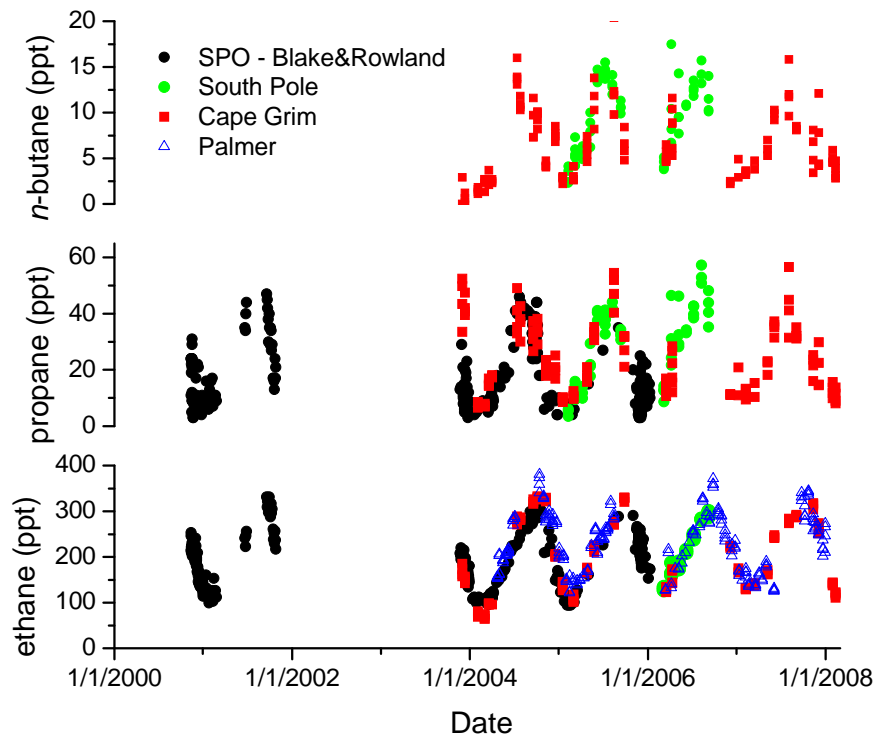
Apparent disagreement

$C_2H_6$ : bottom of the firn

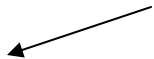
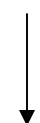
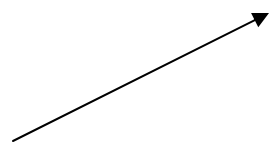
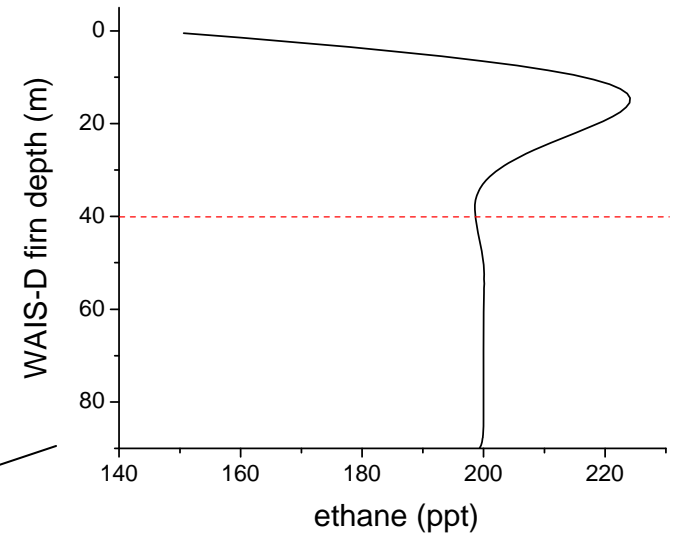
$C_3H_8$ : shallow firn

$n-C_4H_{10}$ : shallow firn

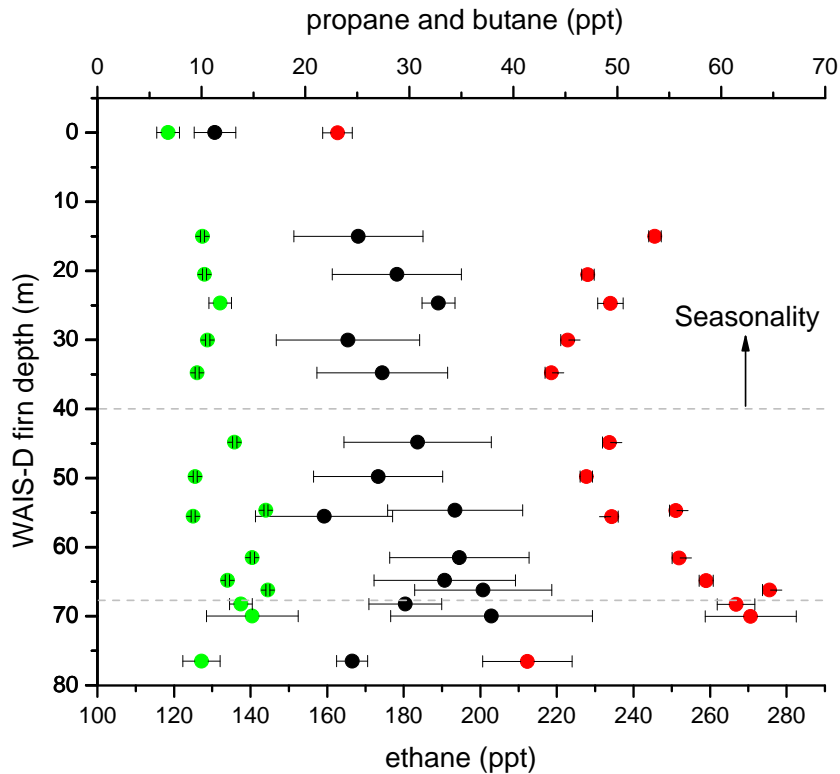
# SH surface measurements 2000-2007 and seasonality in WAIS-D firn (Blake-Rowland and UCI)



- No spatial variability, no clear long-term trend
- Mean levels
  - $C_2H_6$ : ~200 ppt
  - $C_3H_8$ : ~25 ppt
  - $n-C_4H_{10}$ : ~8 ppt
- Annual mean below 40 m at WAIS-D (similar to Summit)



# WAIS-D UCI firn data ( $C_2H_6$ , $C_3H_8$ , $n-C_4H_{10}$ )

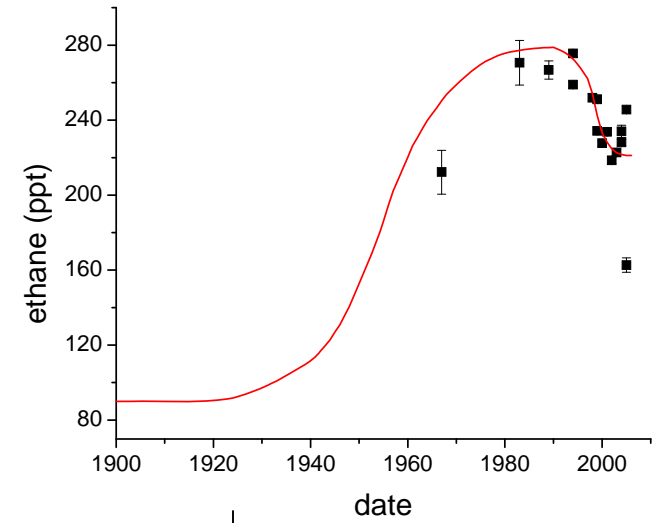


## WAIS-D ethane

- stabilization in 1980s
- drop in 1990s (~30%)

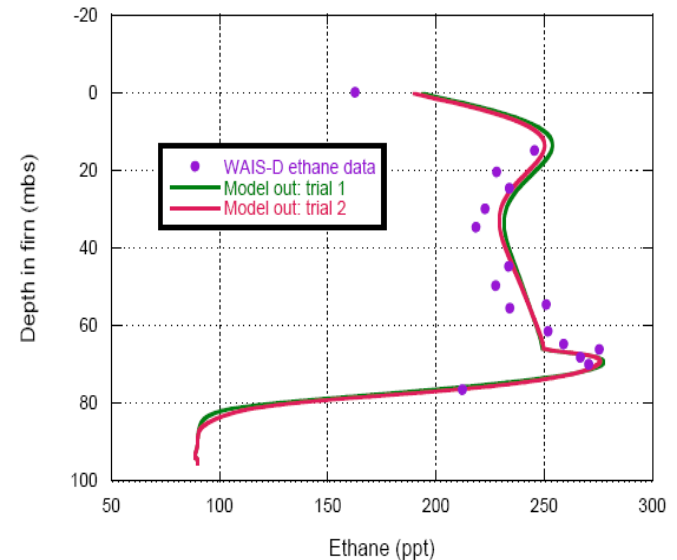
## WAIS-D propane and *n*-butane

- More noise
- May be a similar drop in propane

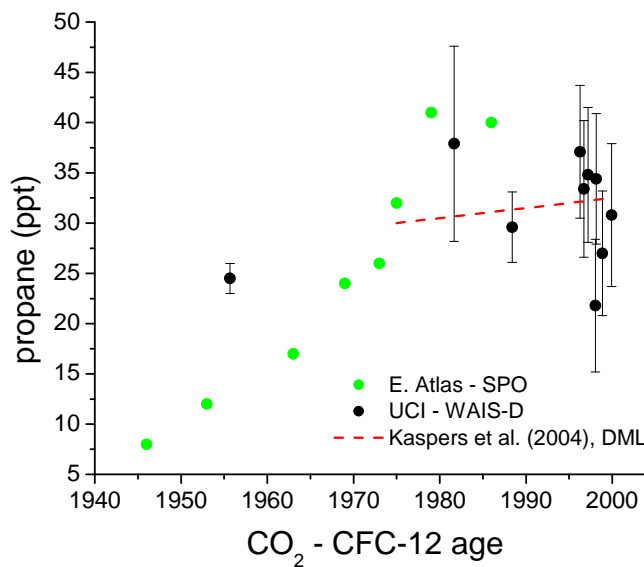
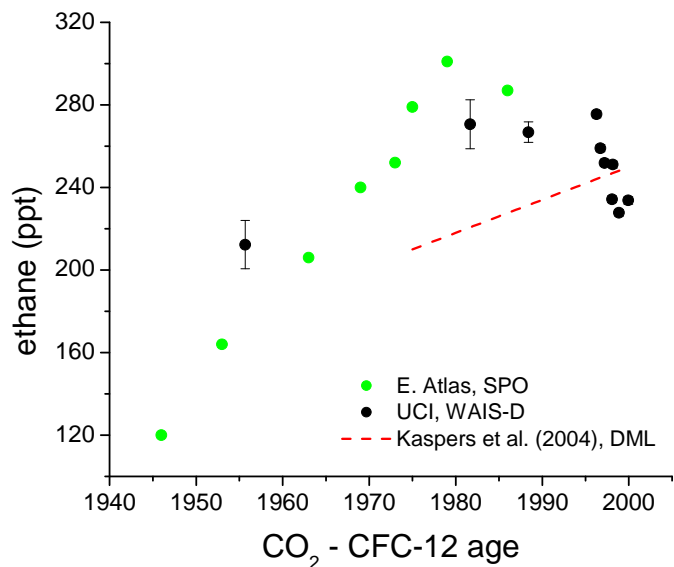


Incorporation of atmospheric signal into firn

Ethane at WAIS-D (2005)



## WAIS-D (UCI) and South Pole (E. Atlas) data (depths > 40 m)



- WAIS-D and SPO agree, trends from DML don't (more/better data from Antarctica)
- SPO and WAIS-D data together suggest a ~30% decline in ethane
  - Roughly synchronous with changes at Summit, Greenland
- Fidelity of firn record still a question

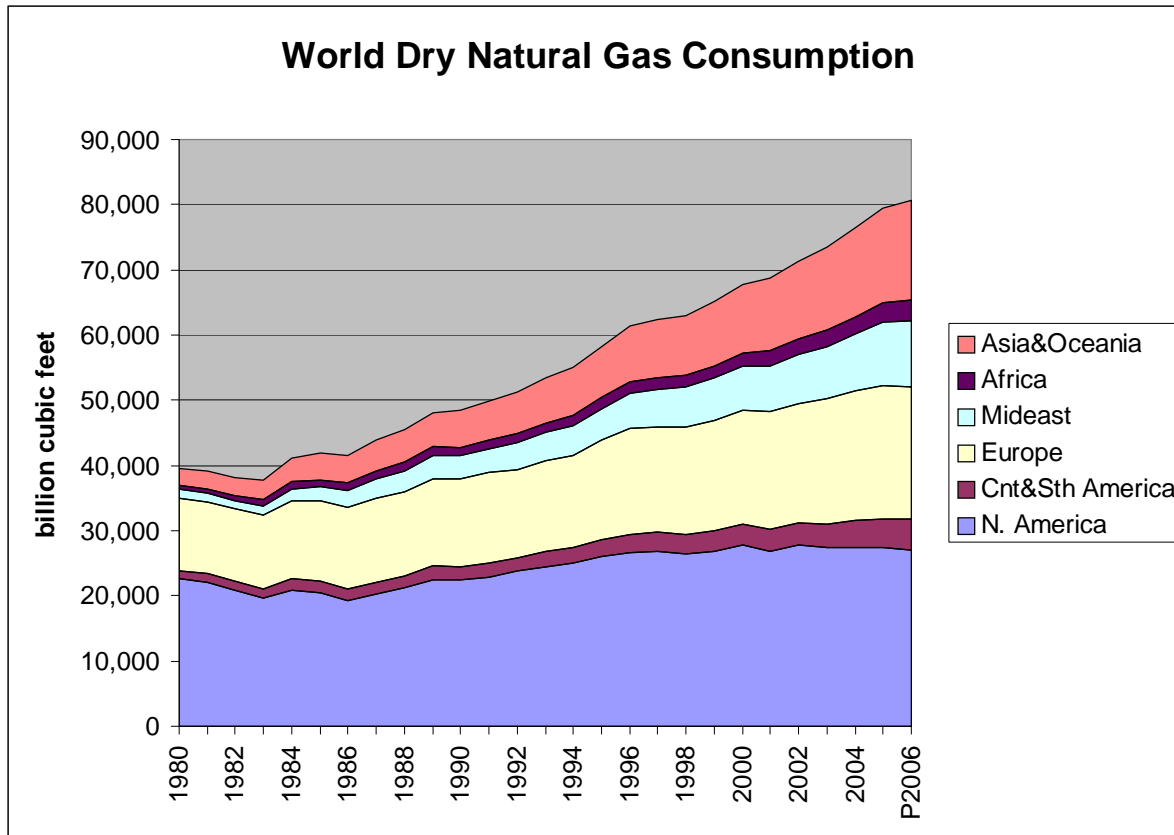


# WHY are NMHC's decreasing at polar latitudes? (possibly globally!)

Sources: Fossil fuel consumption

Sink: OH, Cl

Sources: Hydrocarbon fuel use efficiency must have improved dramatically?



- Consumption/production going up
- Short lifetimes imply source loading must be continually dropping
- Both hemispheres (may be)

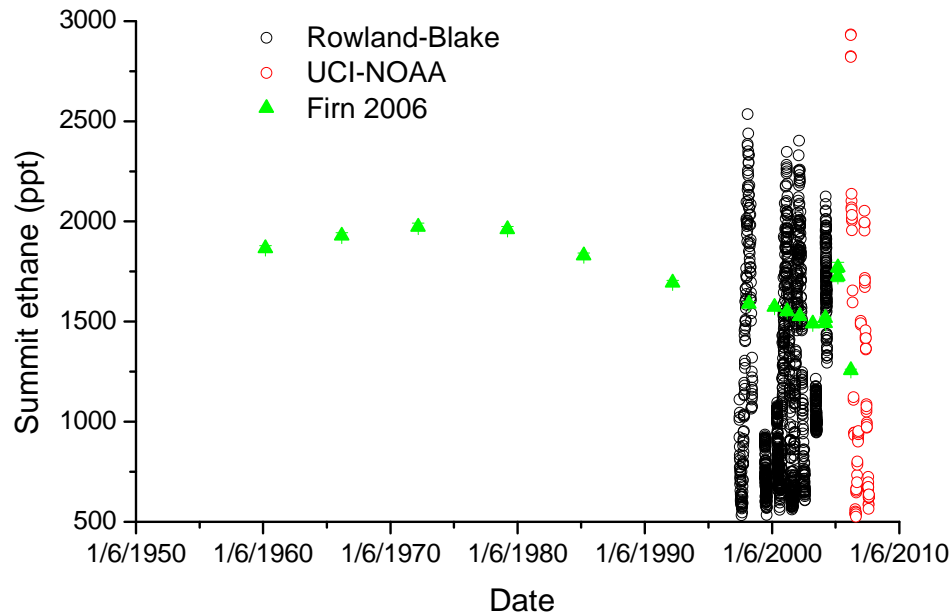
# Can we trust the fidelity of the firn record?

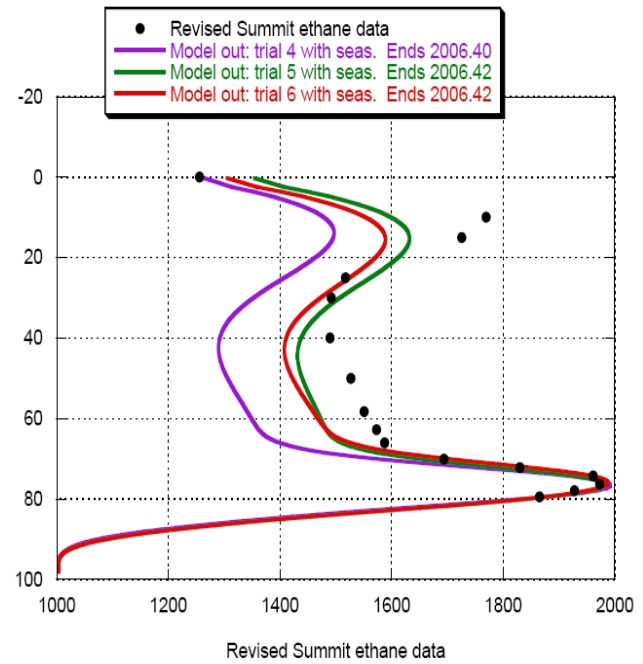
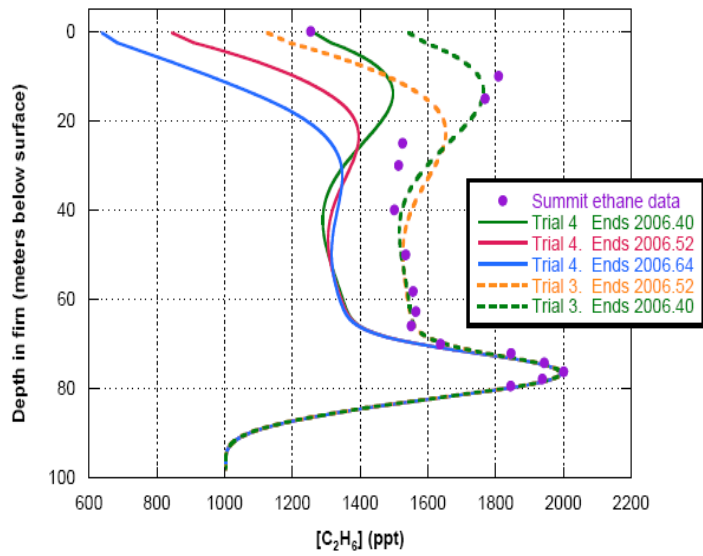
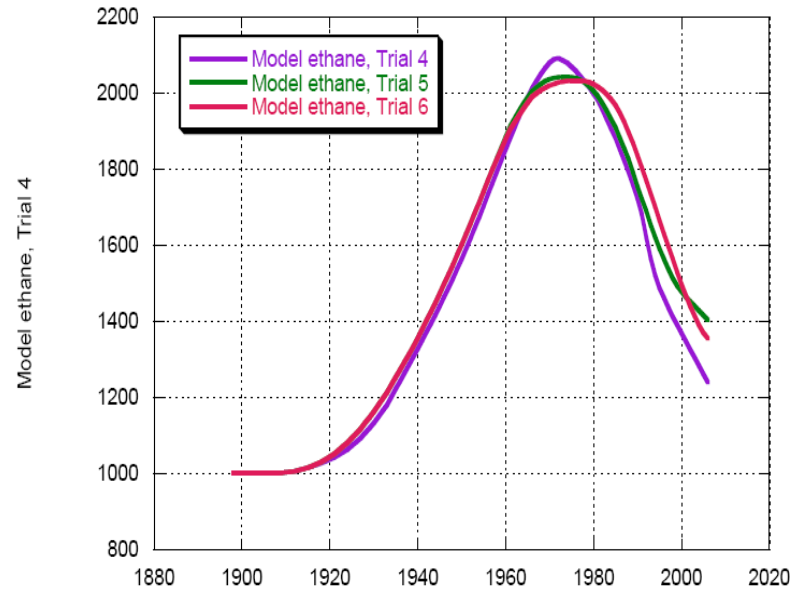
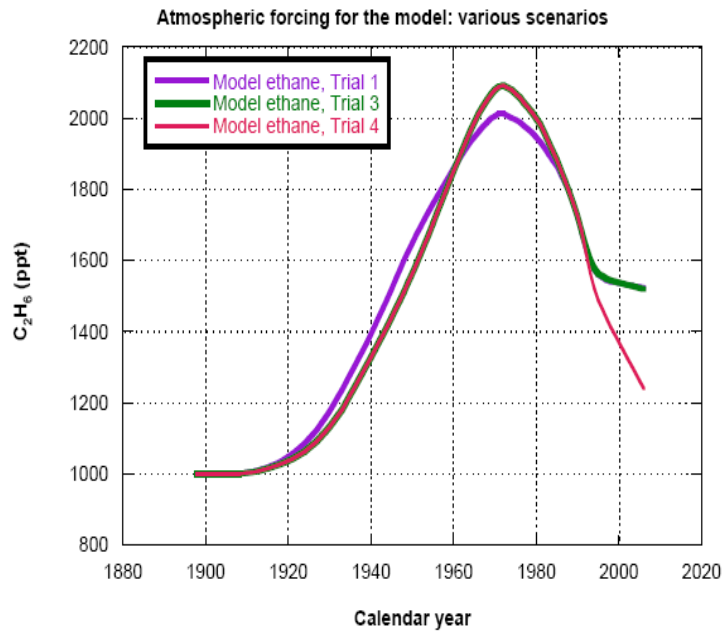
## Surface air analysis:

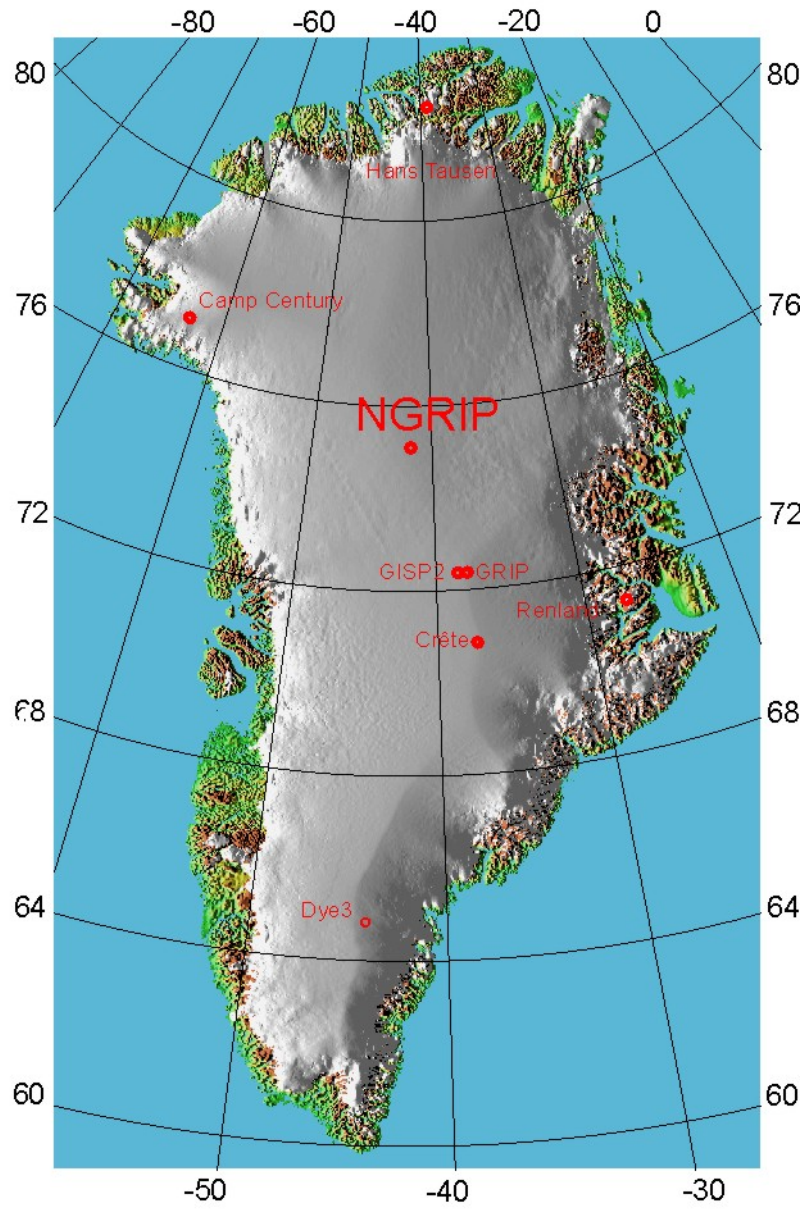
- Ongoing at UCI with NOAA flasks

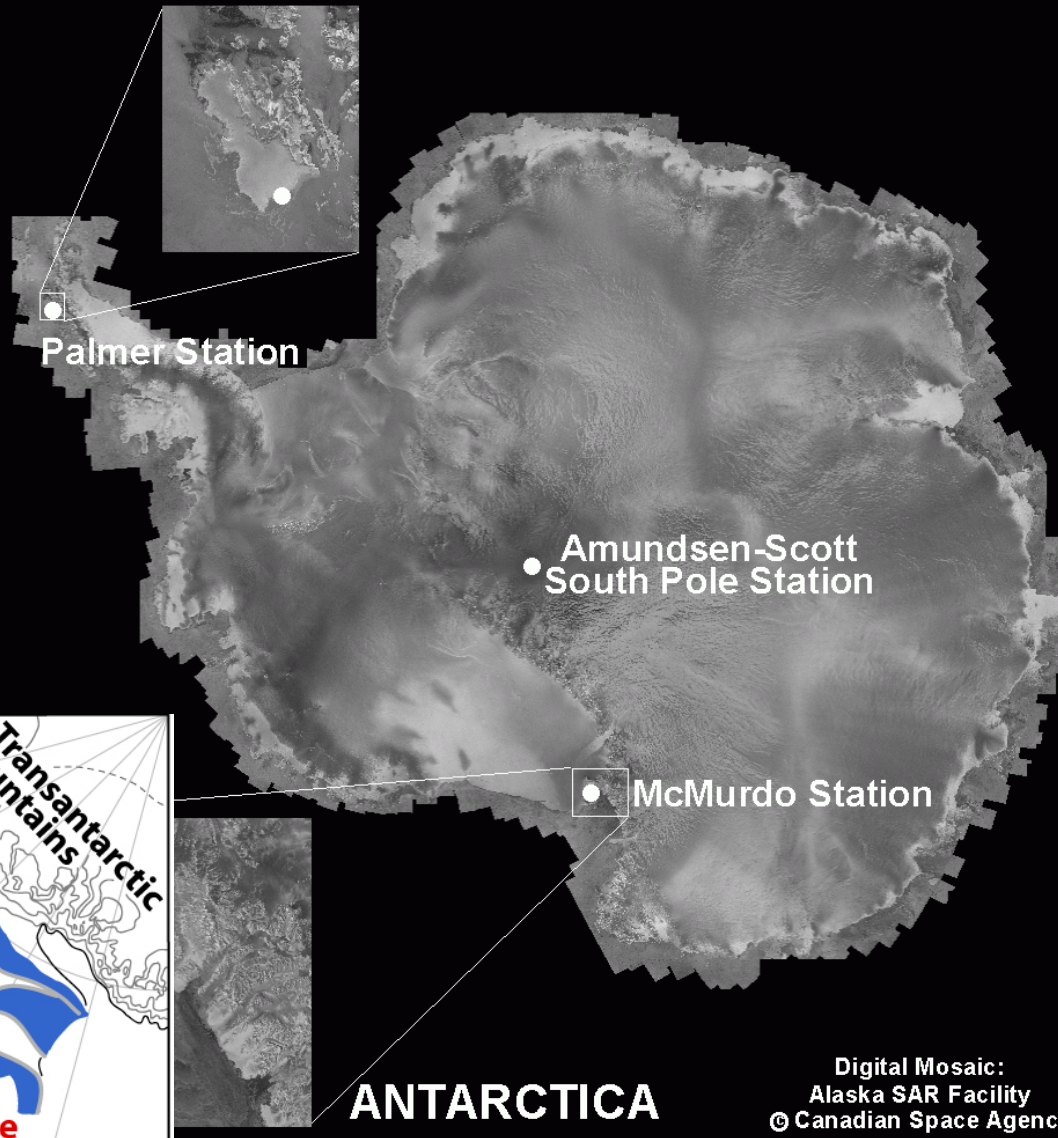
## Firn air data – firn modeling:

- back to Summit in 2008
- new SPO firn sampling in 08-09

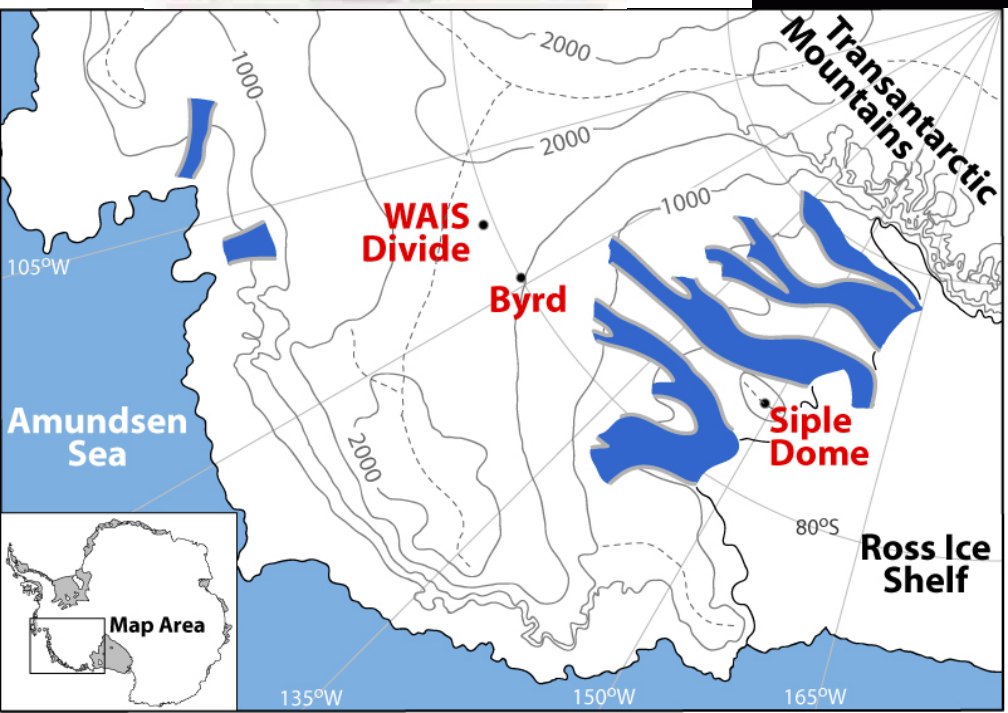








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# Ice Cores