

# *Why does NOAA/ESRL consider Summit a key Arctic site?*

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*State of the Arctic Conference  
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## Summit Facts

- Original site for the GISP2 bore hole (reached bedrock in 1993)
- Summit of the Greenlandic Ice Sheet (very near)  
(72° N, 38° W, 3200 meters a.s.l.)
- Highest elevation station located north of the Arctic Circle
- In the remote free troposphere
- Year round staff
- Managed by CH2MHill Polar Services for NSF/Office of Polar Programs
- Co-located research including snow-atmosphere chemical transfer studies, long term climate records from deep ice cores, etc.



## *The NOAA Baseline Observatory Perspective*

**Mission:** Acquire and make freely available accurate, long-term records of atmospheric **gases, aerosols and solar radiation** which affect ***climate, the ozone layer and baseline air quality.***

**How we do it:** Operate six staffed remote atmospheric **baseline observatories** that are relatively free of regional anthropogenic effluents. Maintain traceable calibrations so that data are comparable for the duration of the measurement series (century or more?).

**Outcome:** Some of the longest and best calibrated **long-term data sets** on the composition and radiative properties of the global atmosphere.

**Mantra:** "*Stay the course.*" Established MLO, SPO (1956-57); BRW, SMO (1972-73); TDH (2001); SUM (2005).  
MLO now makes ~250 different measurements.



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## Summit Station – NOAA “Emerging” Baseline Observatory

Pt. Barrow, Alaska



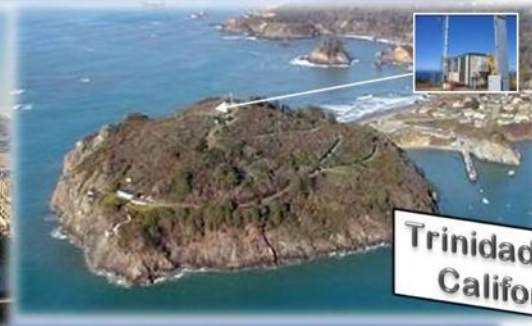
Summit, Greenland



Mauna Loa, Hawaii



Trinidad Head, California



Cape Matatula, American Samoa



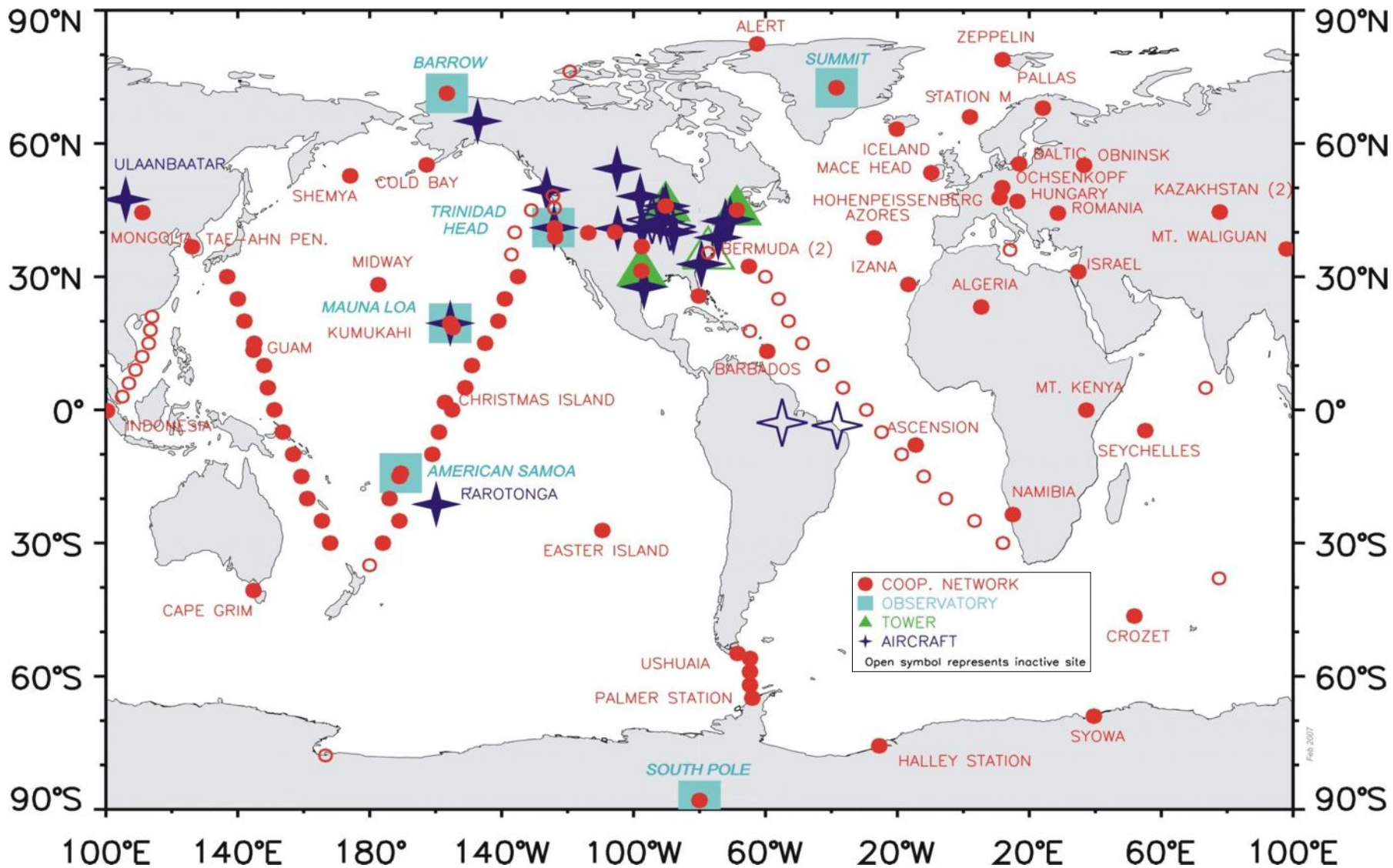
South Pole, Antarctica



- *Summit Measurements Fit into the NOAA Strategic Plan under the Climate Mission Goal and Climate Observation and Monitoring Program*



# NOAA ESRL Global Carbon Cycle Measurement Program



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# *International Arctic Systems for Observing the Atmosphere (IASOA)*

[Abisko, Sweden \(68.35 N, 18.82 E\)](#)

[Alert, Canada \(82.5017 N, 62.3297 W\)](#)

[Barrow, USA \(71.323 N, 156.609 W\)](#)

[Cherskii, Russia \(69 N, 161 E\)](#)

[Eureka, Canada \(80.050 N, 86.417 W\)](#)

[Ny-Aalesund, Norway \(78.908 N, 11.881 E\)](#)

[Pallas, Finland \(67.974 N, 24.116 E\)](#)

[Sodankyla, Finland \(67.37 N, 26.65 E\)](#)

[Summit, Greenland \(72.58 N, 38.48 W\)](#)

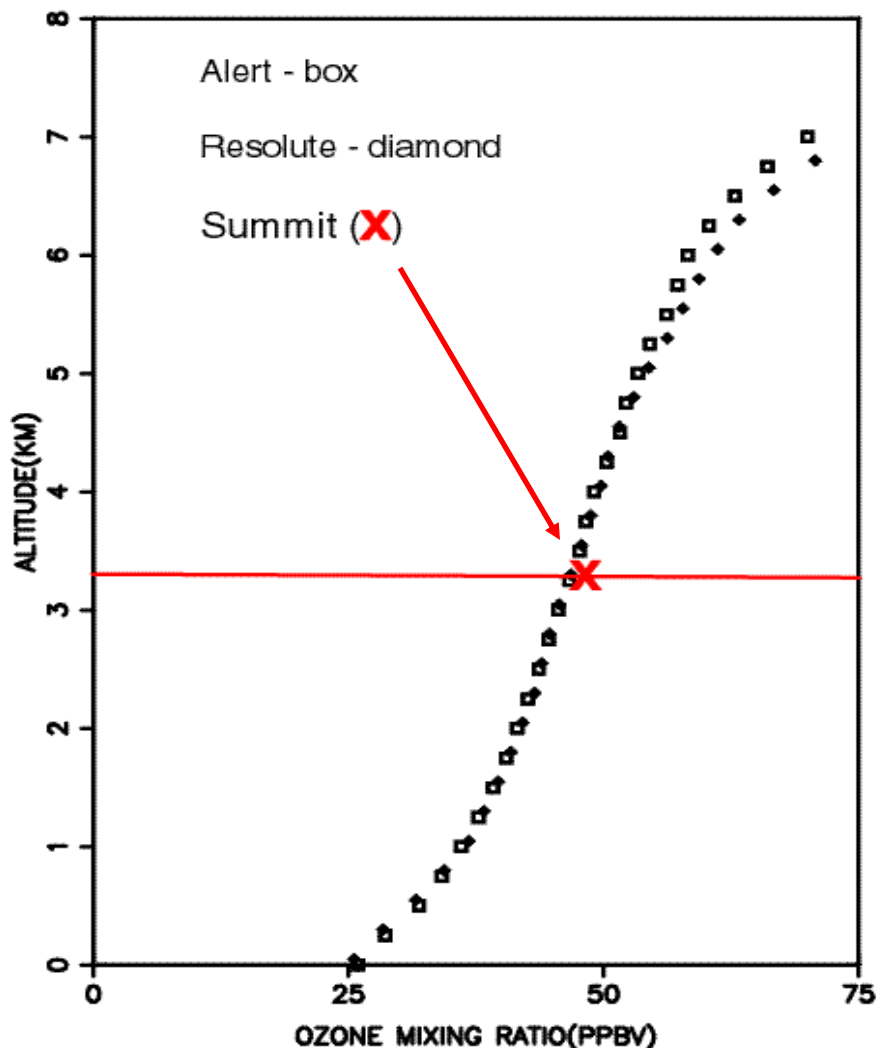
[Tiksi, Russia \(71.58 N, 128.92 E\)](#)



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## Summit Surface Ozone is Representative of Free Arctic Tropospheric Ozone



Annual mean ozone profiles at Alert and Resolute with average annual mean Summit surface ozone (X).

Surface ozone values at Summit are representative of the free troposphere.

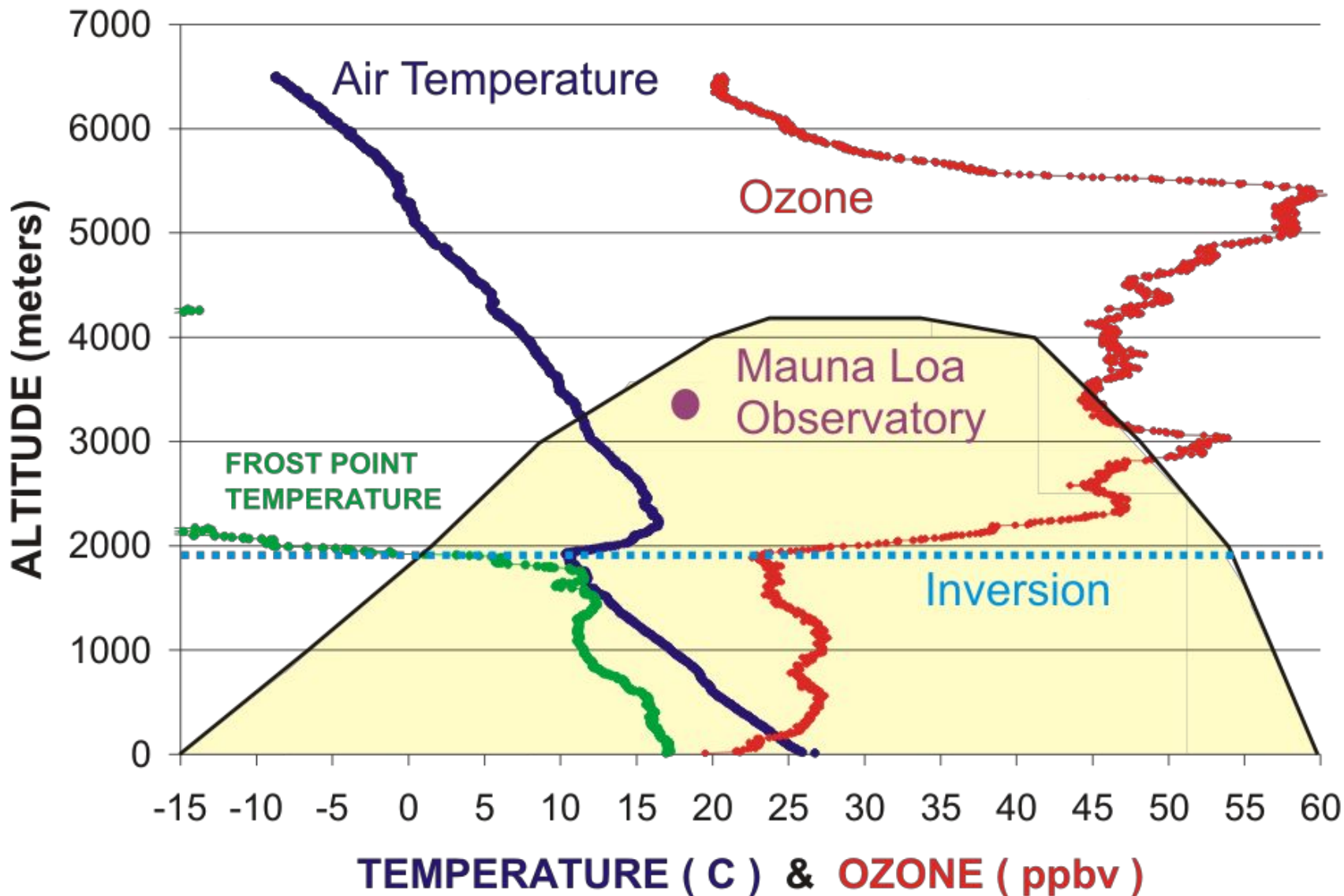
This is important for measuring climate forcing gases and is similar to Mauna Loa. *There are very few locations on earth where free troposphere gases can be measured from a surface site.*



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## Mauna Loa Observatory & the Marine Boundary Layer

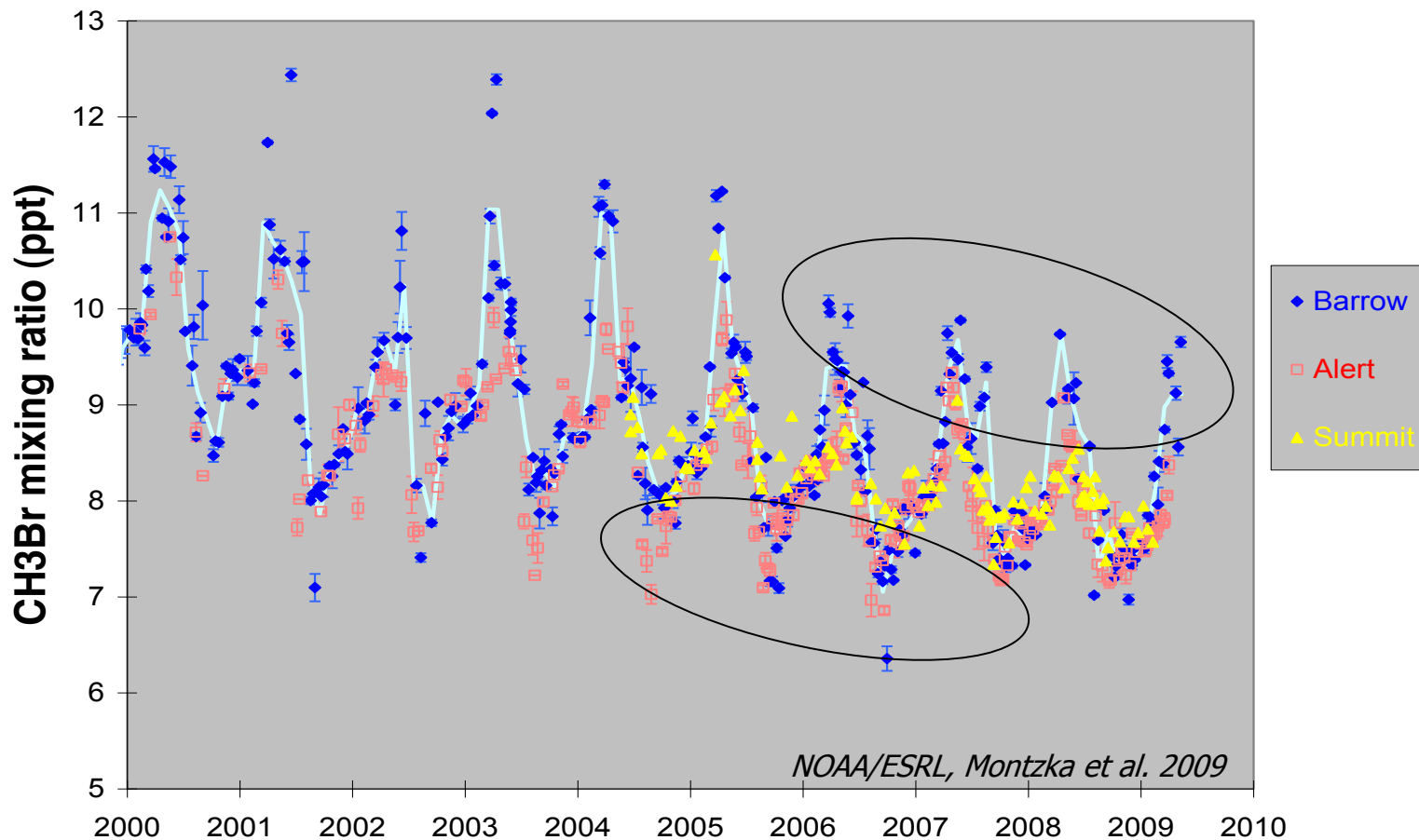


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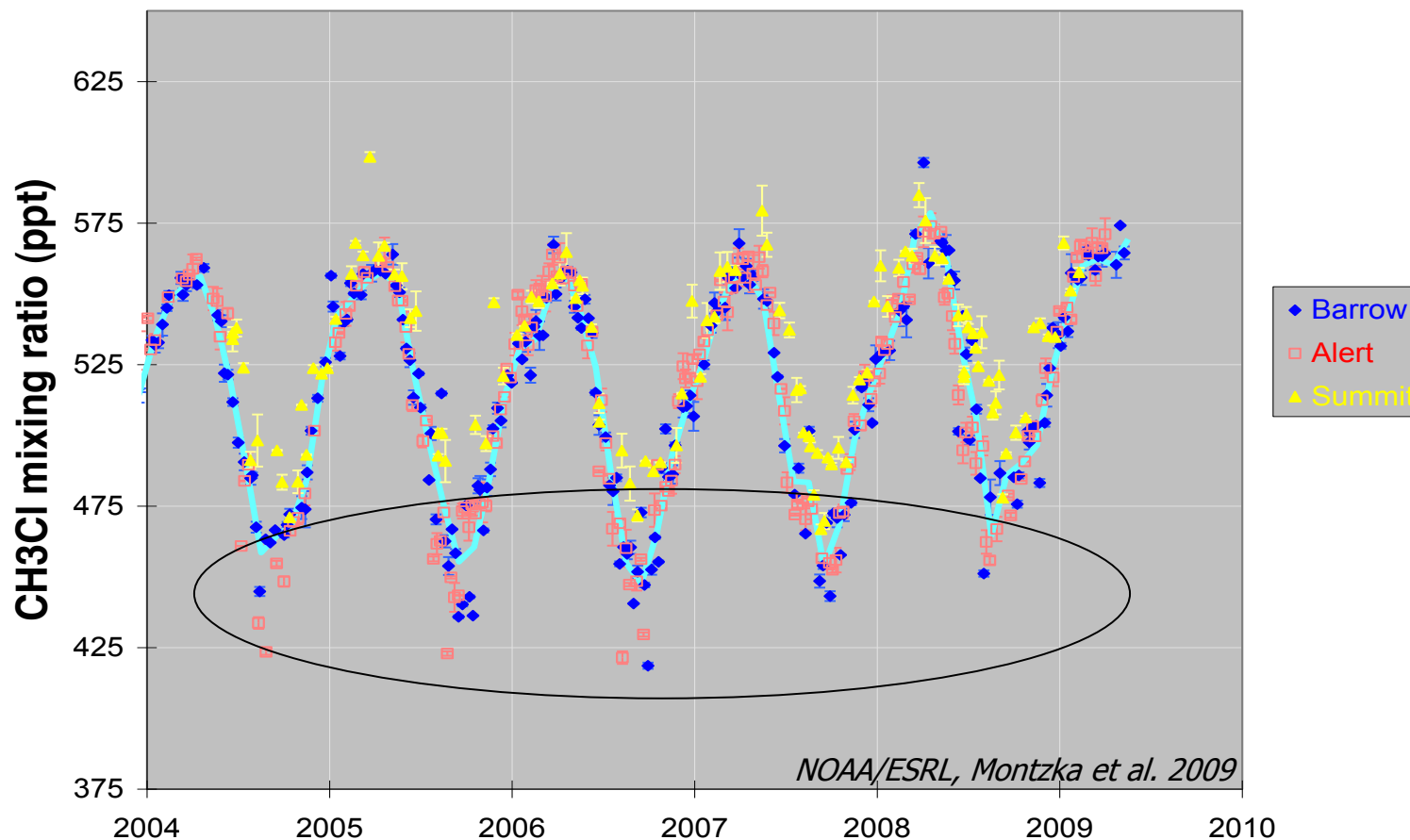
## Methyl Bromide at Summit vs. Barrow & Alert



Higher and lower mixing ratios observed at BRW and ALT because of local influences. Results from Summit are free of these influences and, therefore, allow for a better characterization of atmospheric changes on large scales.



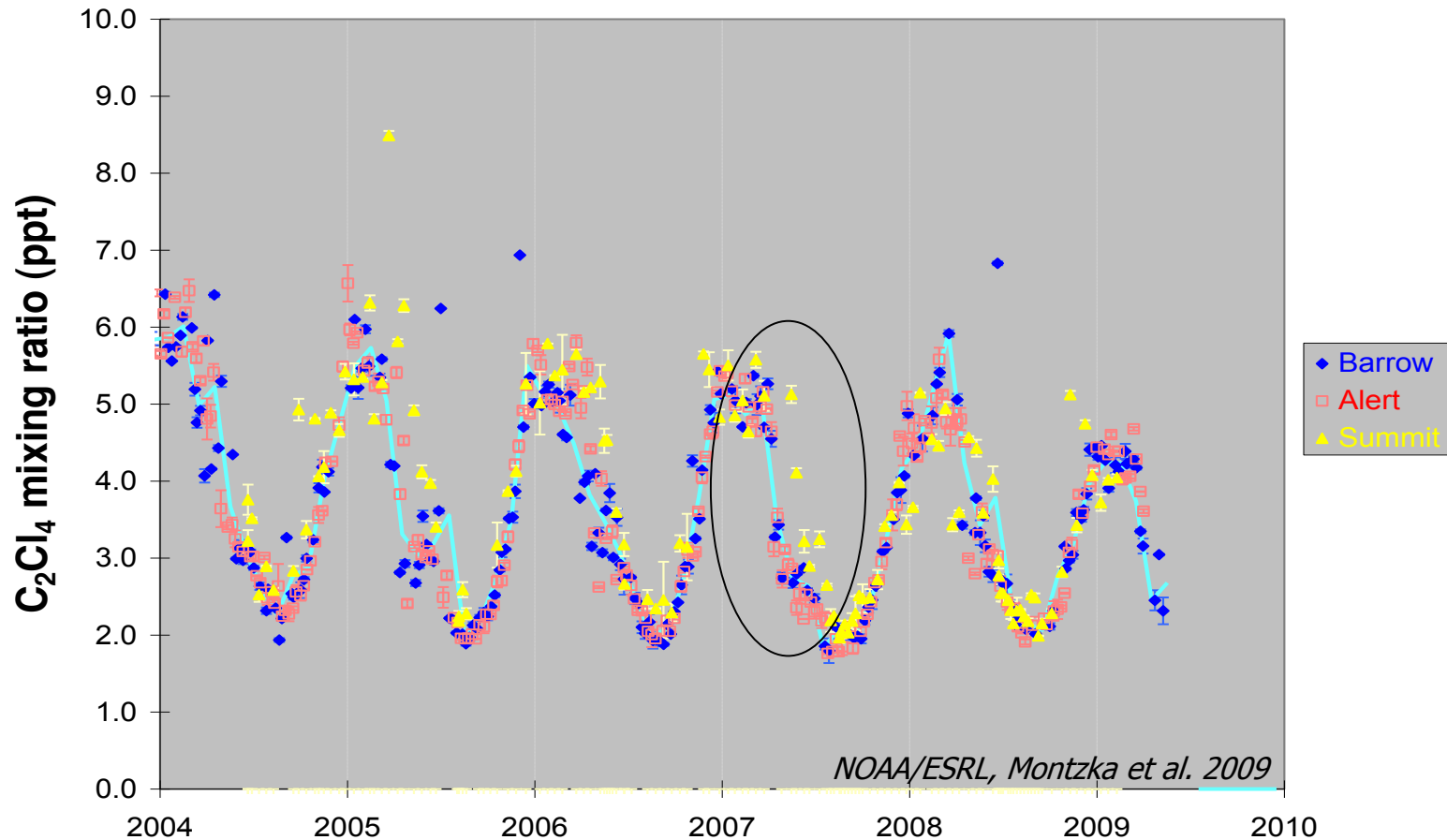
## Methyl Chloride at Summit vs. Barrow & Alert



Results for CH<sub>3</sub>Cl at Summit are not as low during summer as is observed at BRW and ALT; suggesting the presence of a broad-scale persistent vertical gradient for CH<sub>3</sub>Cl ONLY during summer, probably arising from enhanced seasonal uptake by soils.



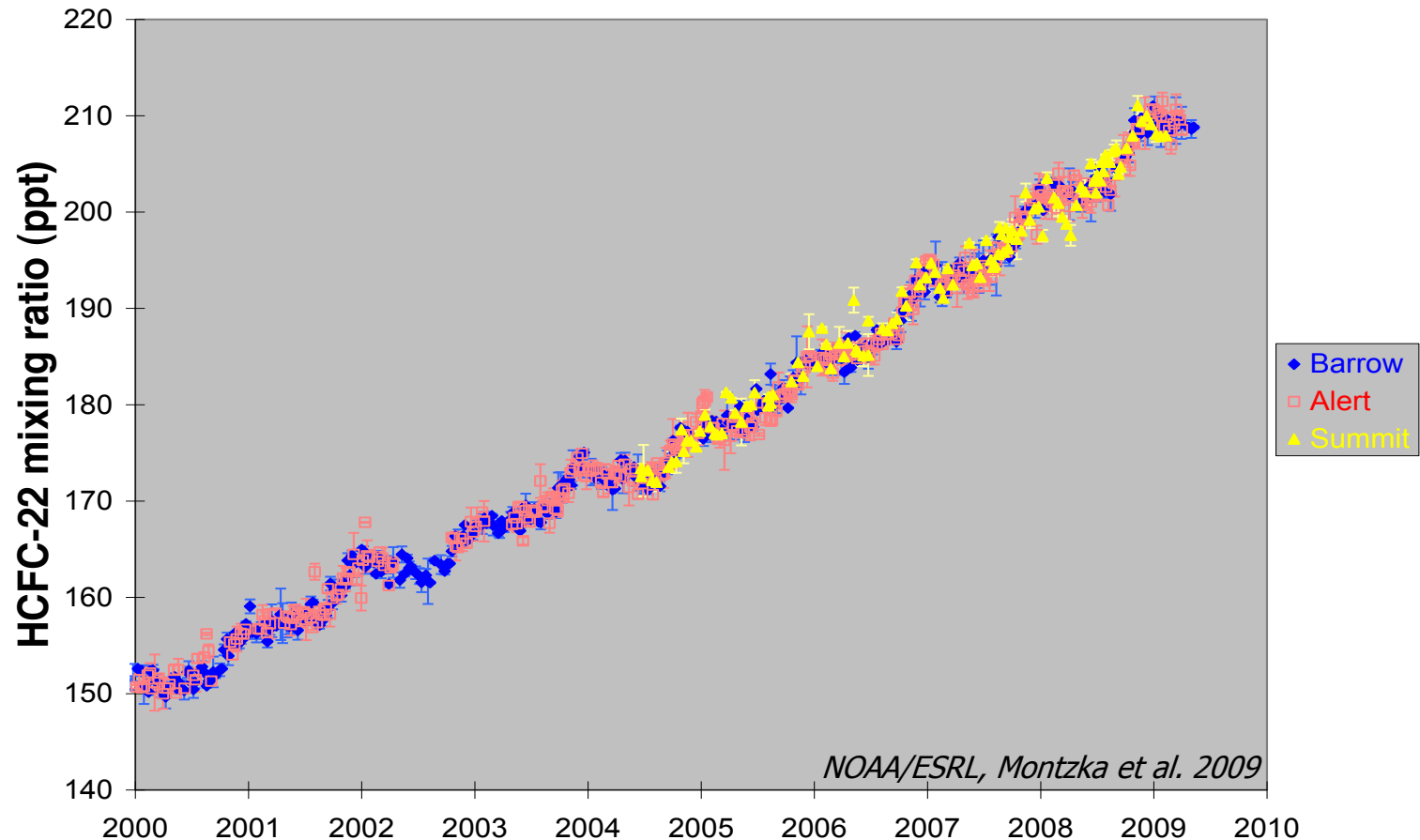
## Tetrachloroethylene at Summit vs. Barrow & Alert



Springtime decline of C<sub>2</sub>Cl<sub>4</sub> can be “slower” (delayed) in some years at Summit relative to BRW and ALT... likely because of local halogen (Cl-derived) oxidation of C<sub>2</sub>Cl<sub>4</sub> within the marine boundary layer during springtime ozone-depletion events that don’t significantly influence air reaching Summit.



## HCFC-22 at Summit vs. Barrow & Alert



Summit helps to complete our characterization of the atmosphere by providing results from a high altitude site in the high northern latitudes. Consistent results are observed at these three sites only for compounds that don't have local sources and sinks influencing their atmospheric abundance at the marine boundary layer sites (BRW and SUM).



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## Why is there interest in launching ozonesondes from Summit?



### Summit Station, Greenland

**72.58 ° North**  
**38.48 ° West**

**Elevation:**  
**3,238 Meters**



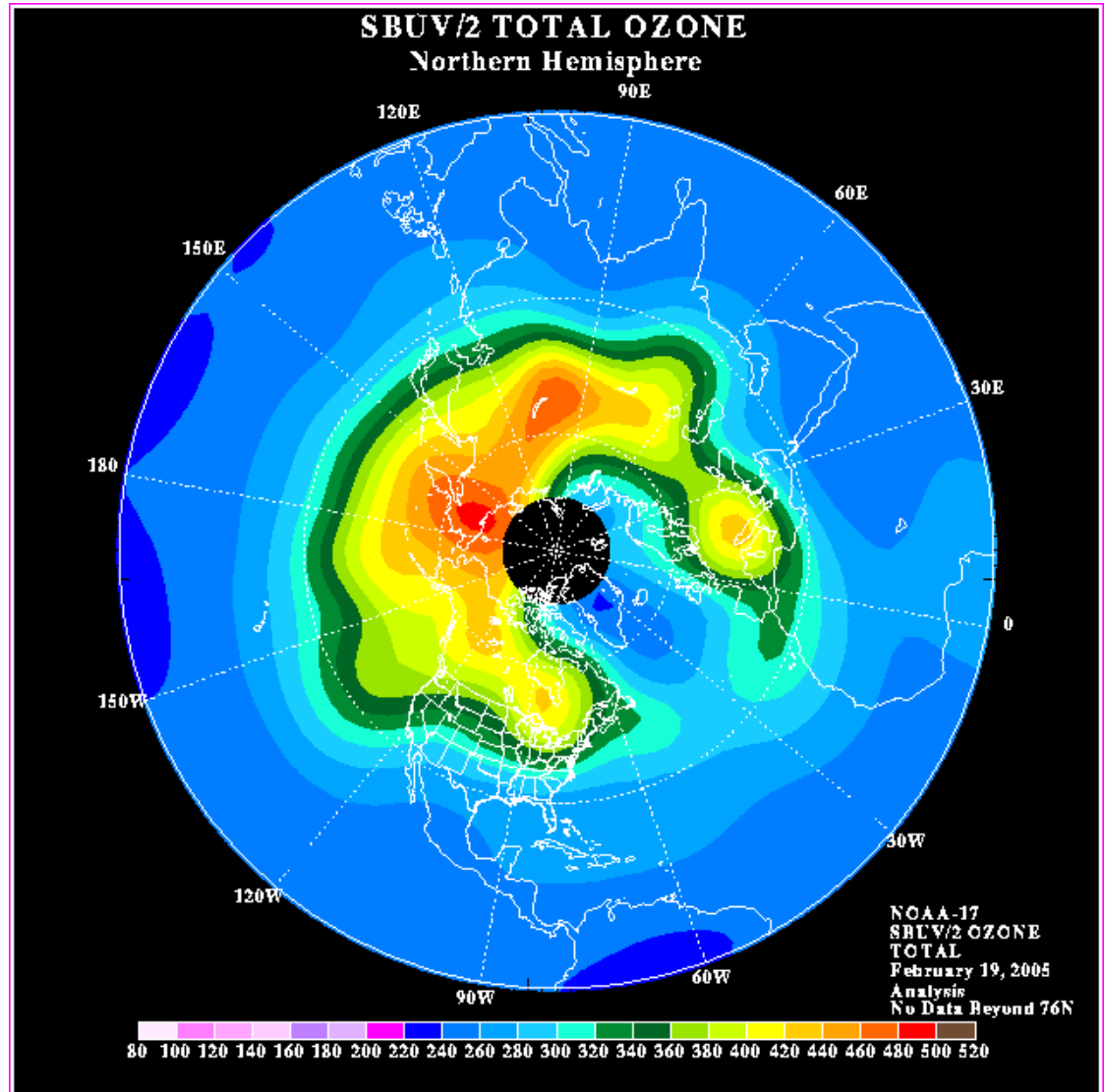
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*...great location to monitor springtime stratospheric Arctic ozone depletion*

**Summit is typically within the Arctic polar vortex region that forms during the winter.**

- **cold stratospheric temperatures**
- **formation of polar stratospheric clouds**
- **chlorine activation**
- **ozone chemical destruction**



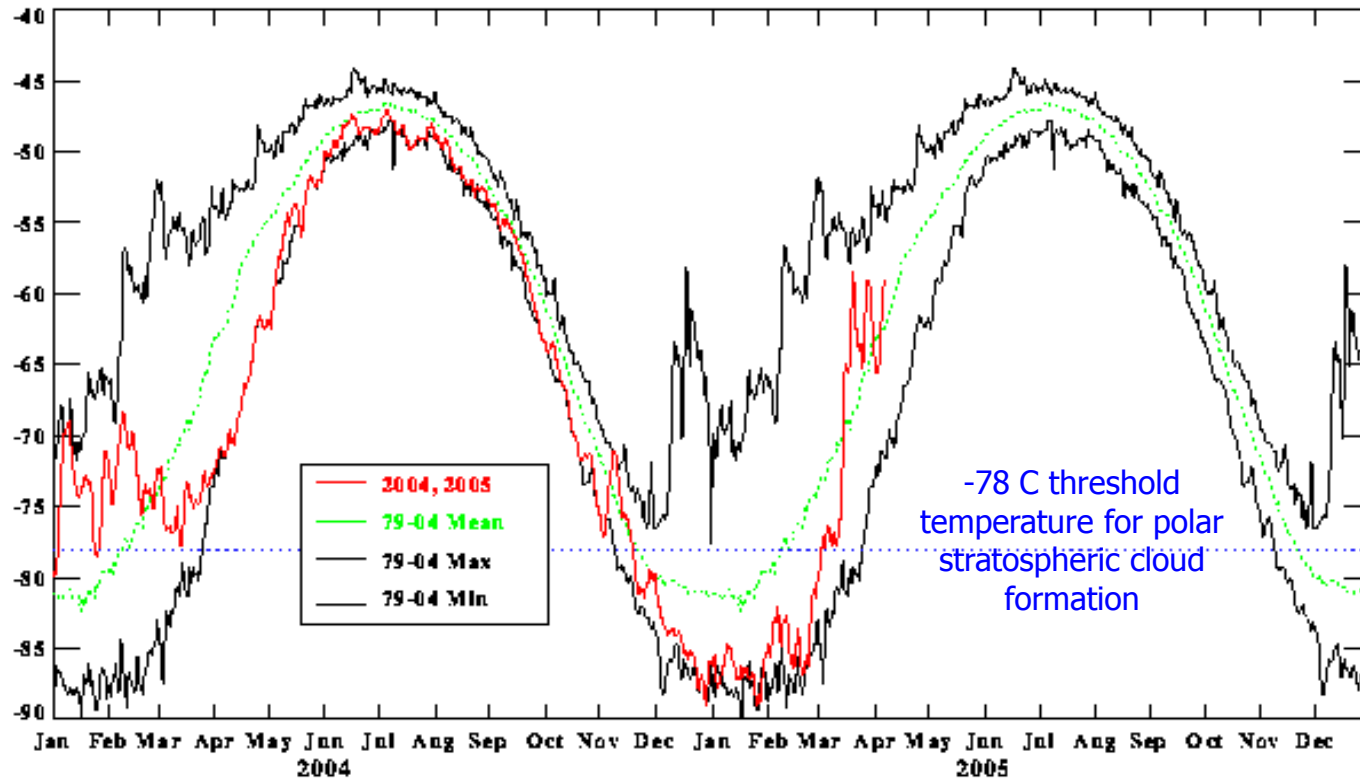
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## Stratospheric Temperatures above Greenland

~ 23 km = 30-hPa Zonal Minimum Temperature for 2004 & 2005

90N to 65N



### NOAA CLIMATE PREDICTION CENTER (CPC)

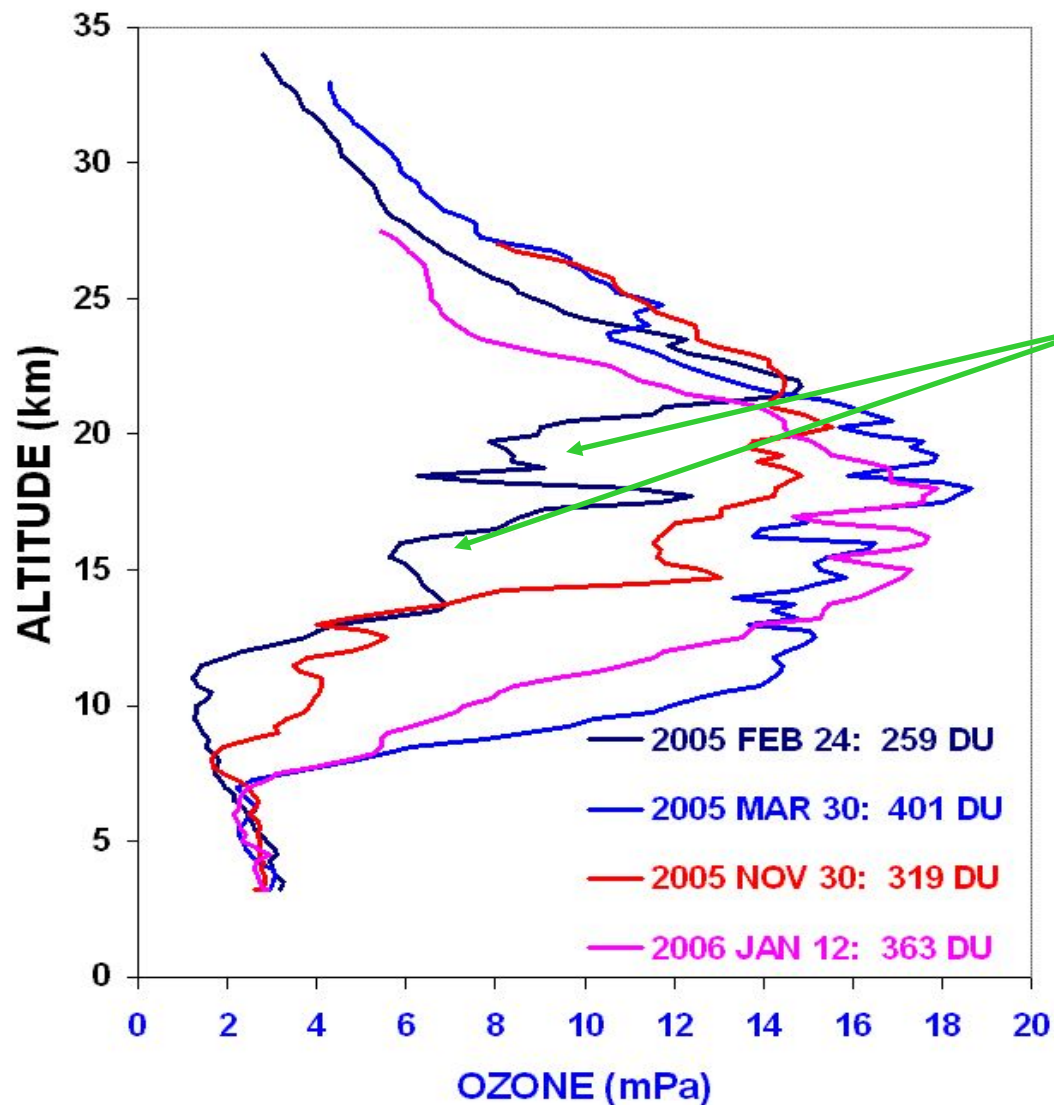
Temperatures derived from NESDIS retrieval soundings of the Advanced Microwave Sounding Unit (AMSU) on board the NOAA Polar Orbiting Environmental Satellites.



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## Winter Ozonesonde Profiles from Summit

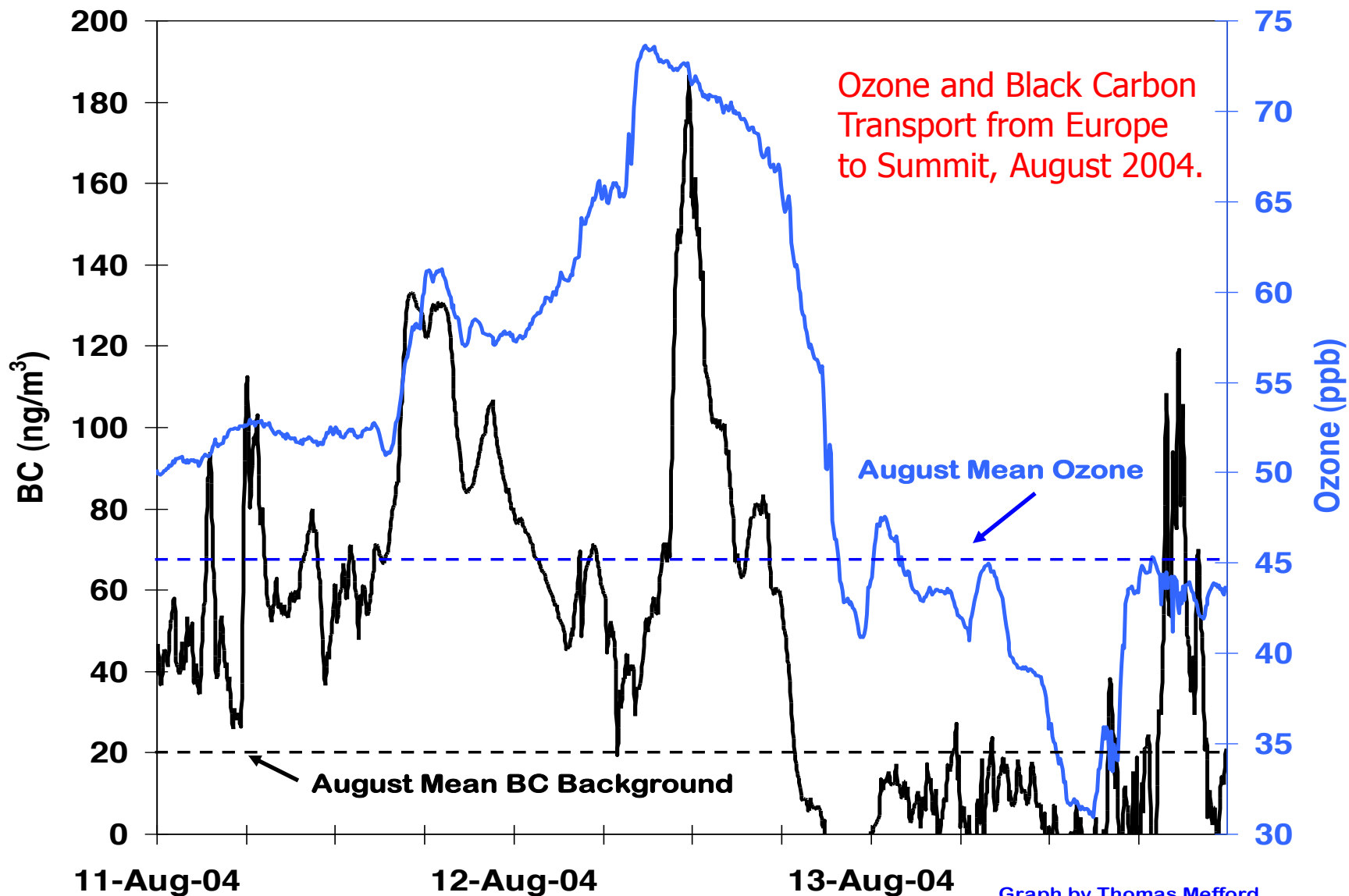


Probable  
stratospheric ozone  
depletion related to  
chlorine and bromine  
compounds





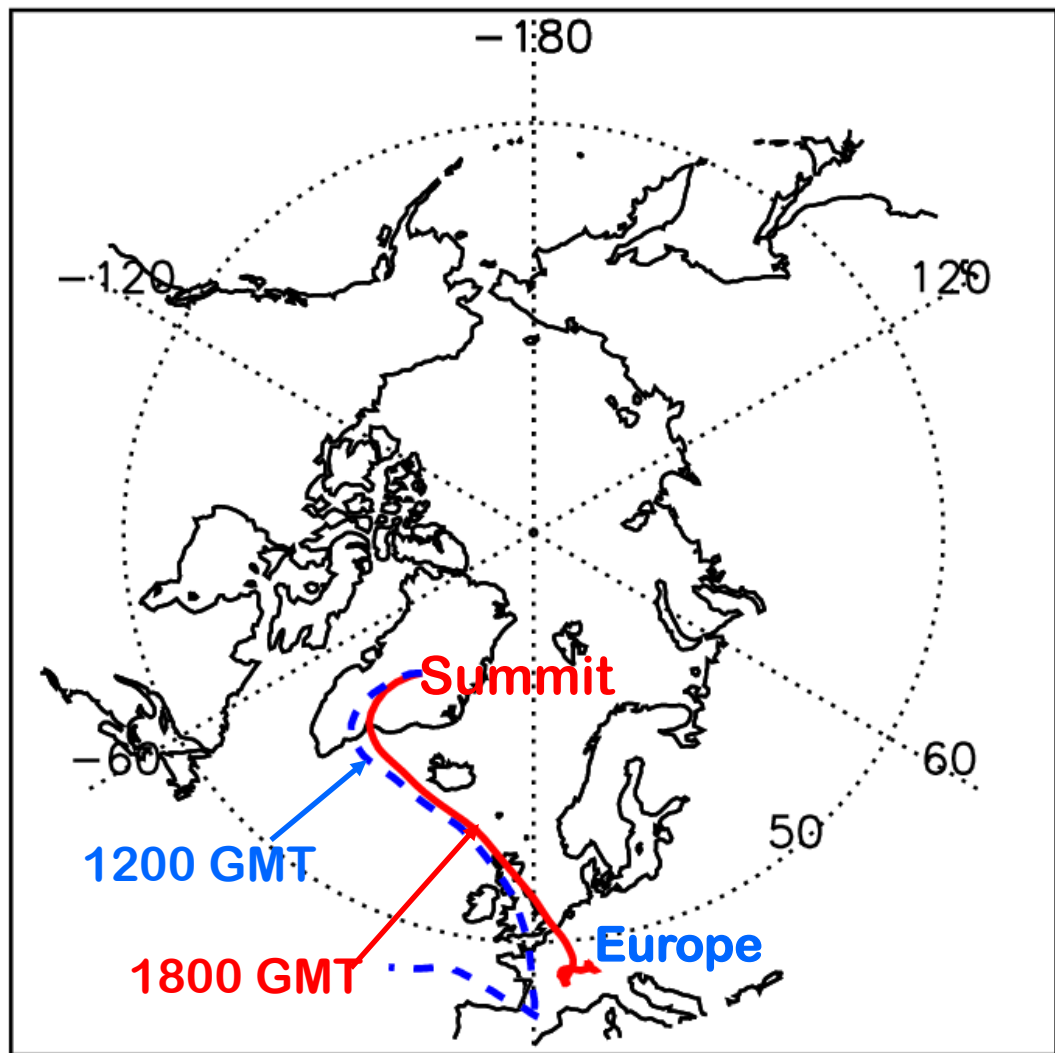
## Pollution events into the Arctic



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## Back trajectories for pollution source



**Back trajectories to Summit:  
12 August 2004**

**1200 GMT (dashed blue line)  
1800 GMT (solid red line)**

**The air mass flowed over the  
NOAA ozone monitor on the  
Westman Islands in southern  
Iceland enroute to Summit.**



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# NOAA data available at Summit to all research groups – 2010 season

Program/Measurement	Instrument	Sampling Frequency	Measurement Start Date
<b><u>Gases</u></b>			
CO <sub>2</sub> , CH <sub>4</sub> , CO, H <sub>2</sub> , N <sub>2</sub> O, SF <sub>6</sub> , <sup>13</sup> C/ <sup>12</sup> C of CH <sub>4</sub> , <sup>13</sup> C/ <sup>12</sup> C and <sup>18</sup> O/ <sup>16</sup> O of CO <sub>2</sub> , CH <sub>3</sub> Cl, C <sub>6</sub> H <sub>6</sub> , C <sub>7</sub> H <sub>8</sub> , C <sub>2</sub> H <sub>6</sub> , C <sub>2</sub> H <sub>4</sub> , C <sub>3</sub> H <sub>8</sub> , C <sub>3</sub> H <sub>6</sub> , i-C <sub>4</sub> H <sub>10</sub> , n-C <sub>4</sub> H <sub>10</sub> , i-C <sub>5</sub> H <sub>12</sub> , n-C <sub>5</sub> H <sub>12</sub> , n-C <sub>6</sub> H <sub>14</sub> , C <sub>5</sub> H <sub>8</sub>	2.5-L glass flasks (MAKS or PSU)	1 pair/week	Began summer '97-'98, again '00-'02, then cont. since 2003
Surface Ozone (O <sub>3</sub> )	TEI surface ozone analyser	Continuous	Sampling began 6/2004
Ozone vertical profiles	Balloon borne ECC ozone sonde	~1 week, with additional in Spring when conditions warrant	Sampling began 2/2005
Water-vapor vertical profiles	Balloon borne water vapor sonde	only when conditions warrant	Sampling began 2/2005
CFC-11, CFC-12, CFC-113, CS <sub>2</sub> , COS, HCFC-22, HCFC-141b, HCFC-142b, HFC-134a, HFC-152a, H-1211, H-1301, H-2402, CH <sub>3</sub> Cl, CH <sub>2</sub> Cl <sub>2</sub> , CHCl <sub>3</sub> , CCl <sub>4</sub> , CH <sub>3</sub> CCl <sub>3</sub> , C <sub>2</sub> Cl <sub>4</sub> , CH <sub>3</sub> Br, CH <sub>2</sub> Br <sub>2</sub> , CHBr <sub>3</sub> , CH <sub>3</sub> I, N <sub>2</sub> O, SF <sub>6</sub> , C <sub>6</sub> H <sub>6</sub>	2.5-L, glass flasks (HATS)	2 pair/month (~8th & 23rd)	Sampling began 06/2004
CFC-11, CFC-12, CFC-113, N <sub>2</sub> O, SF <sub>6</sub> , H-1211, CCl <sub>4</sub> , CH <sub>3</sub> CCl <sub>3</sub>	Automated CATS GC (HATS)	1 sample/hour	Sampling began 07/2007
<b><u>Aerosols</u></b>			
Black Carbon	Aethalometer	Continuous	Sampling began 08/2008
<b><u>Meteorology</u></b>			
Air temperature (2m and 10m heights)	Vaisala Resistance probes & Logan RTDs	Continuous	Sampling began 08/2005
Pressure (2m, primary and secondary)	Honeywell pressure transducer Setra pressure transducer	Continuous	Sampling began 08/2005
Wind (10m, speed and direction)	R.M. Young wind monitor	Continuous	Sampling began 08/2005
Dew point temperature (2m)	Vaisala humidity probe	Continuous	Sampling began 08/2005



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*Thanks!*



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