

Eleven years Ukraine Antarctic research in connection to climate change

Gennadi Milinevsky

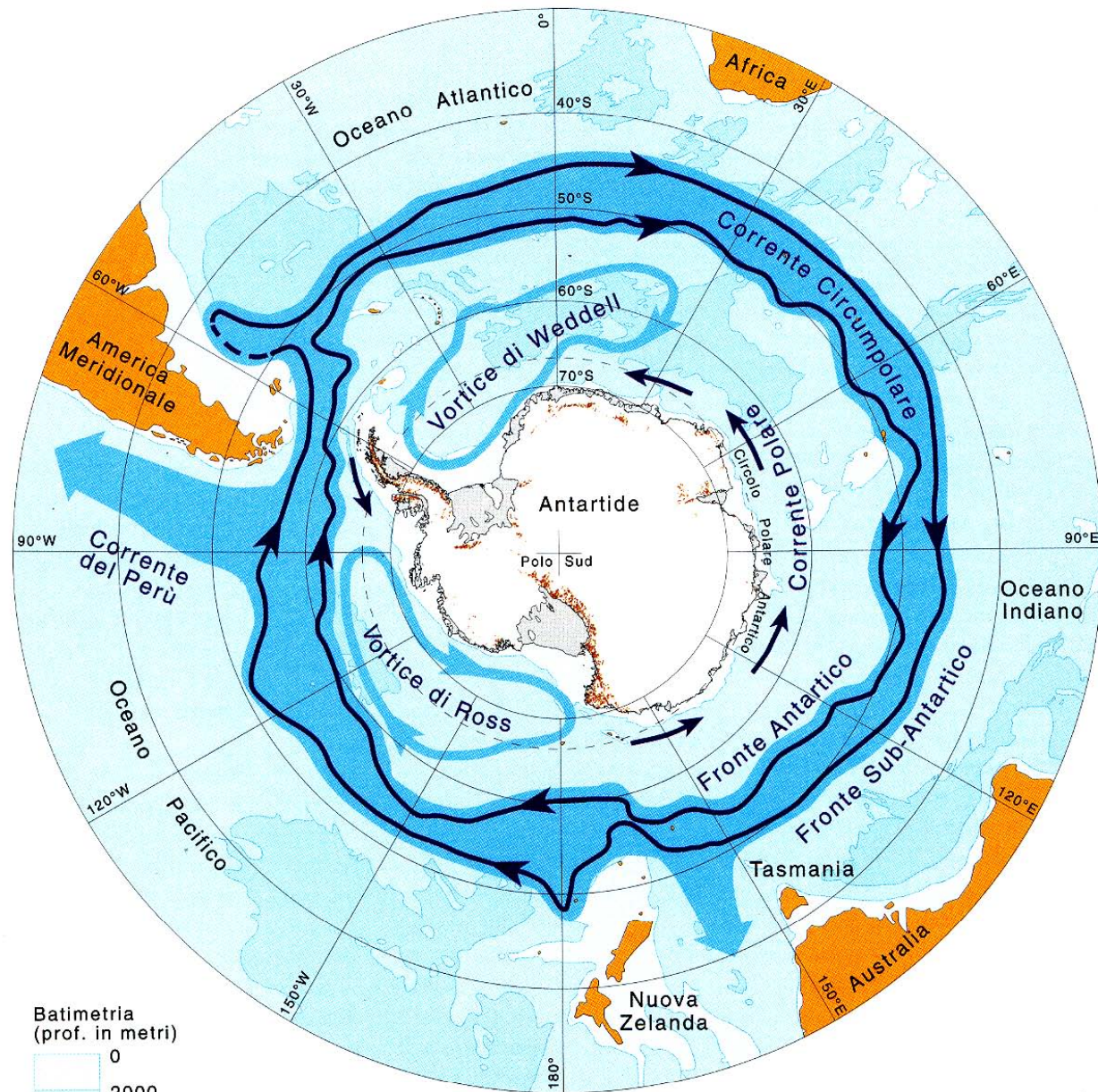
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Summer school “Atmosphere researches. Challenge for Ukraine”,
Kyiv, 15-17 September 2008 (17 Sep, Wed 11.00-11.45)

© Photo Rory O'Connor





**Roaring Forties
Furious Fifties**

**Circumpolar
current:
135 millions m³/s
(135 x flow of
world's rivers)**

**Vortex – Ross,
Weddell**

Terra Australis

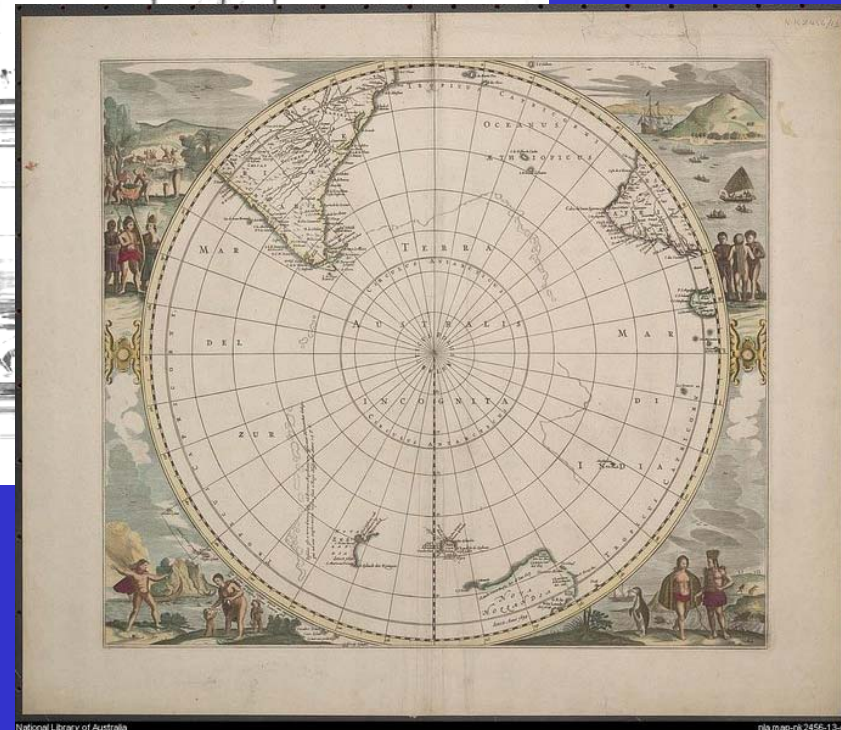
Discovery

**James Cook ?
1773-1775**

**Bellingshausen
1820, 16 Jan**

**Palmer
1820, 16 Nov**

**Bransfield
1920**





Amundsen 14 Dec 1911

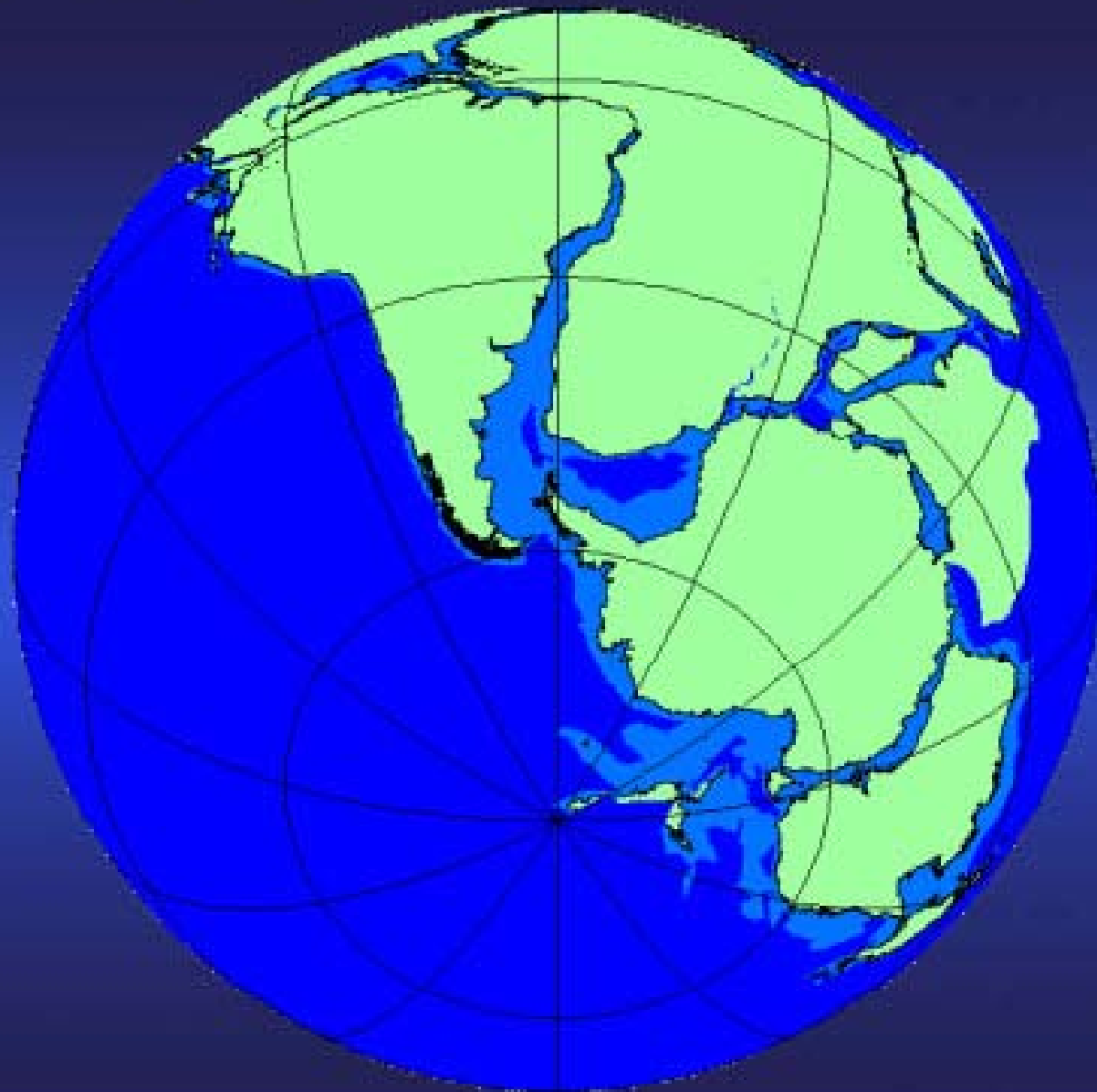


Scott 17 Jan 1912



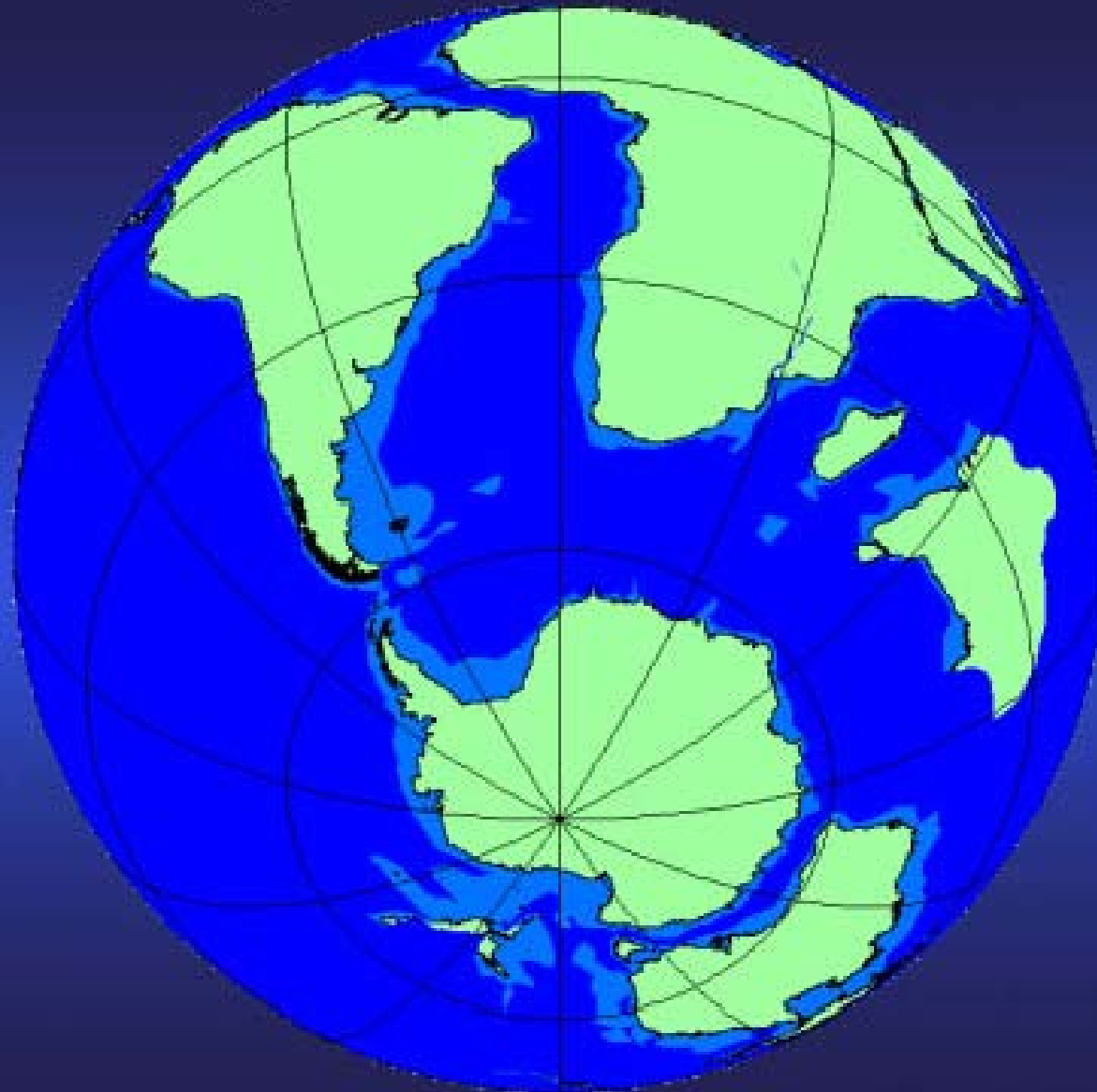
Shackleton, 21 Oct 1915

~180 Million years ago



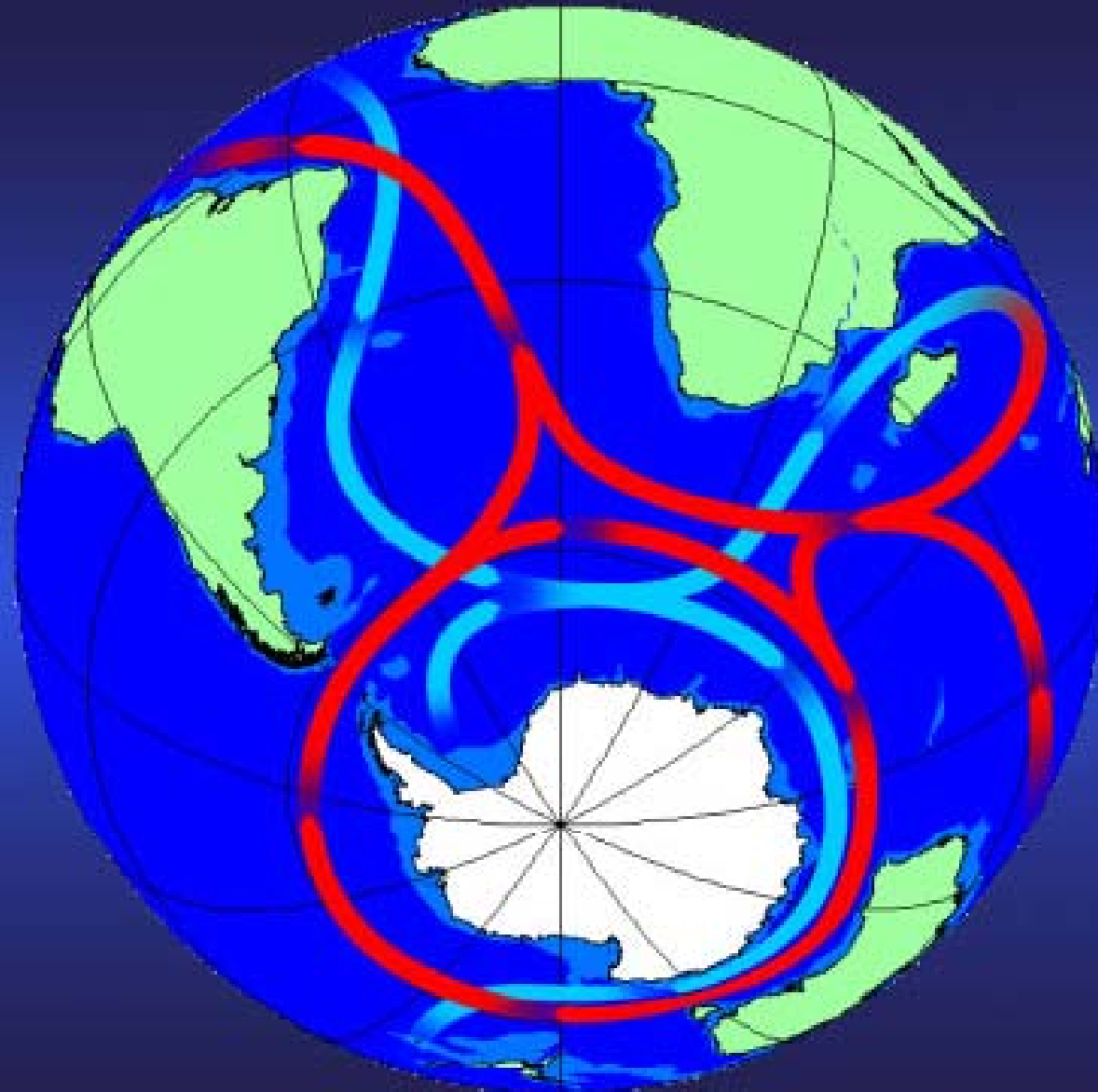
SCAR

~90 Million years ago



SCAR

~30 Million years ago



SCAR

Antarctic Science – why it important?



SCAR

The main Antarctic science issues:

Evolution of the Antarctic Continent

Genomics as a
tool for biological
investigation

Sun-Earth
connections

SCAR



The Antarctic
Ozone Hole

Evolving global
atmosphere and
climate

Antarctica as indicator of climate change

Where and what research Ukraine provides in Antarctica?

Vernadsky (former Faraday) station, West Antarctic Peninsula

Task 1. Climate change at Antarctic Peninsula

Task 2. Antarctic ozone hole, ozone hole dynamics

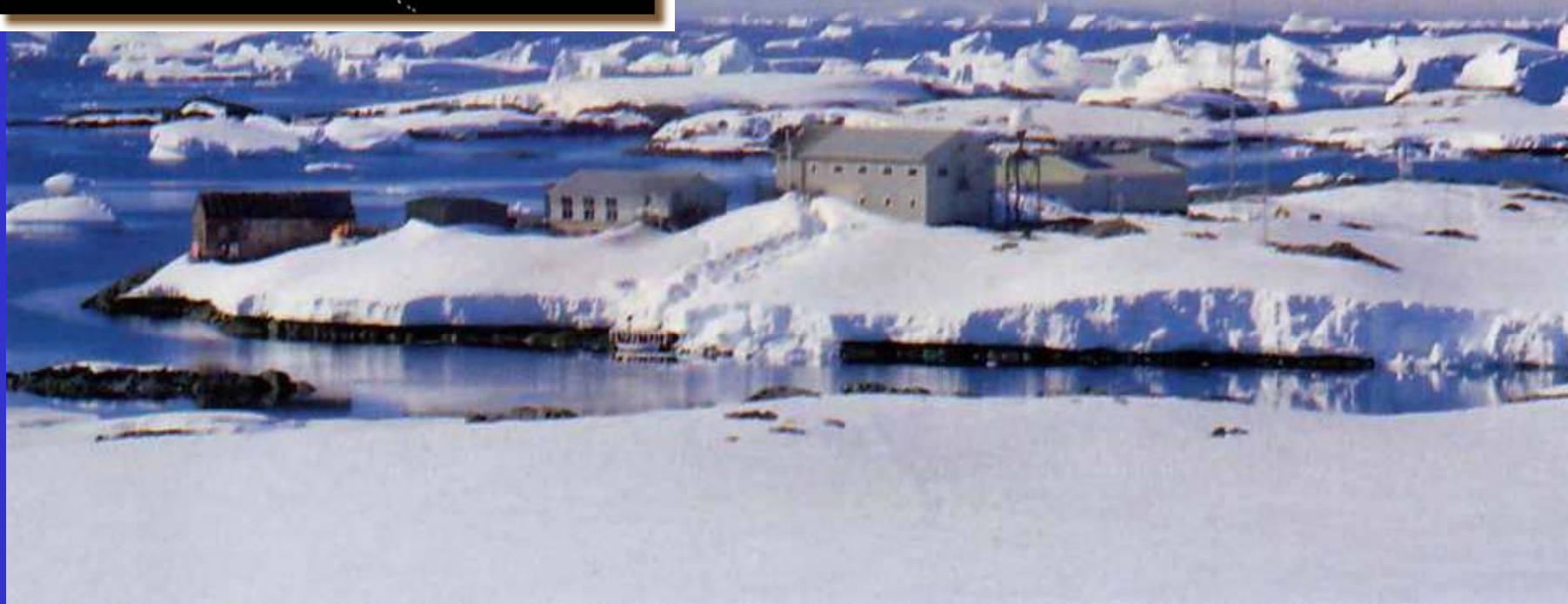
Task 3. Upper atmosphere, space weather

Task 4. Biology, human biology



**Station:
Vernadsky
(former Faraday, UK, BAS)**

65° 15' S 64° 15' W



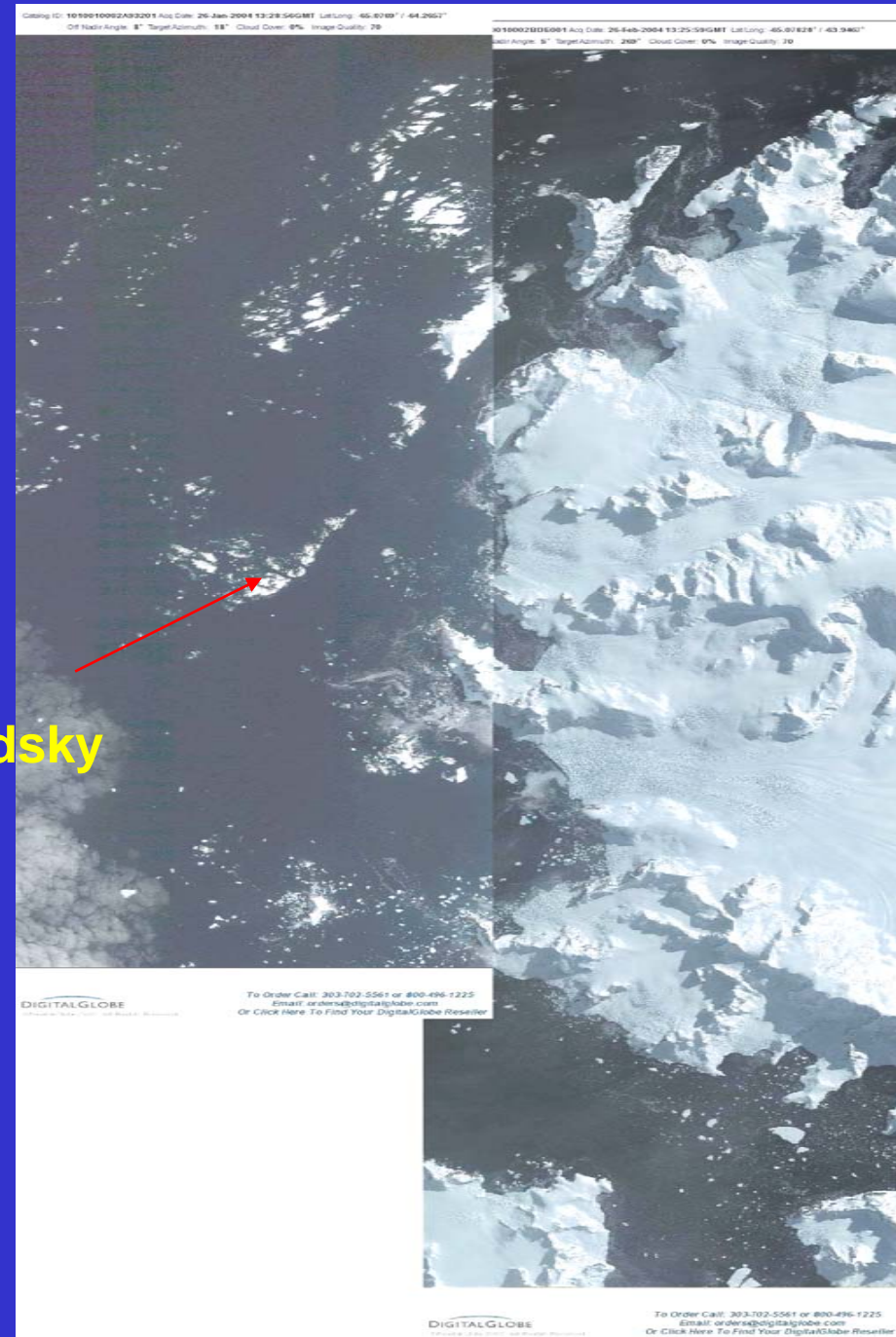
Vernadsky station region

Argentine Islands

65°15' S, 64°15' W

Vernadsky

QuickBird satellite picture, 2004





Memorandum on transfer Faraday British Antarctic Survey (BAS) Base to Ukraine has been signed July 20, 1995

**Ceremony of
Faraday Base
transfer and
renaming into
Vernadsky**

February 6, 1996

Galindez Island

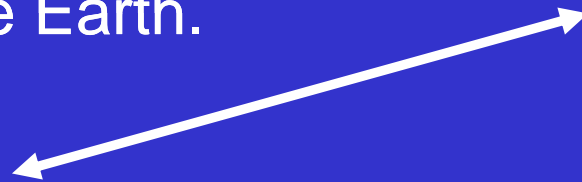
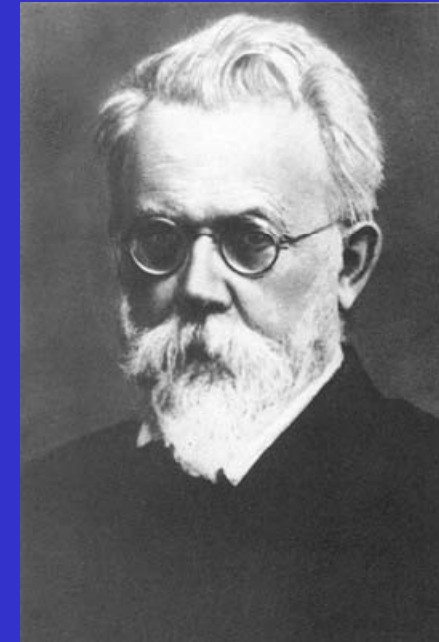


Volodymyr Vernadsky

Ukrainian scientist Vernadsky's name was given to the station

He was the first president of Ukraine Academy of Sciences (1918)

He proposed idea of biosphere and noosphere of the Earth.



Michael Faraday, physicist who contributed significantly to the field of electromagnetism



Main building, generator shed, fuel tanks, Sat tower

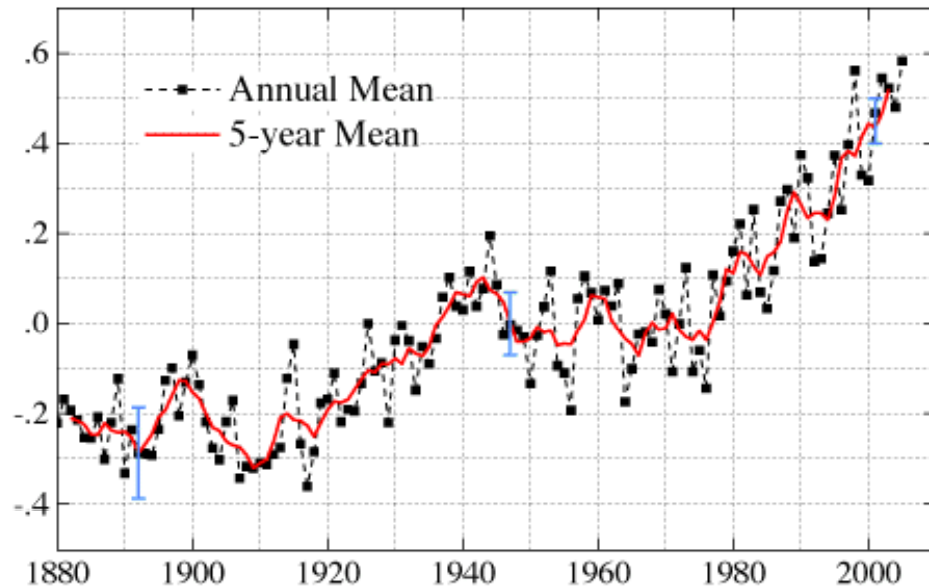


Task 1:

**Climate change in Antarctic
Peninsula**

The monitoring of global warming

Change in global mean surface temperature (°C)

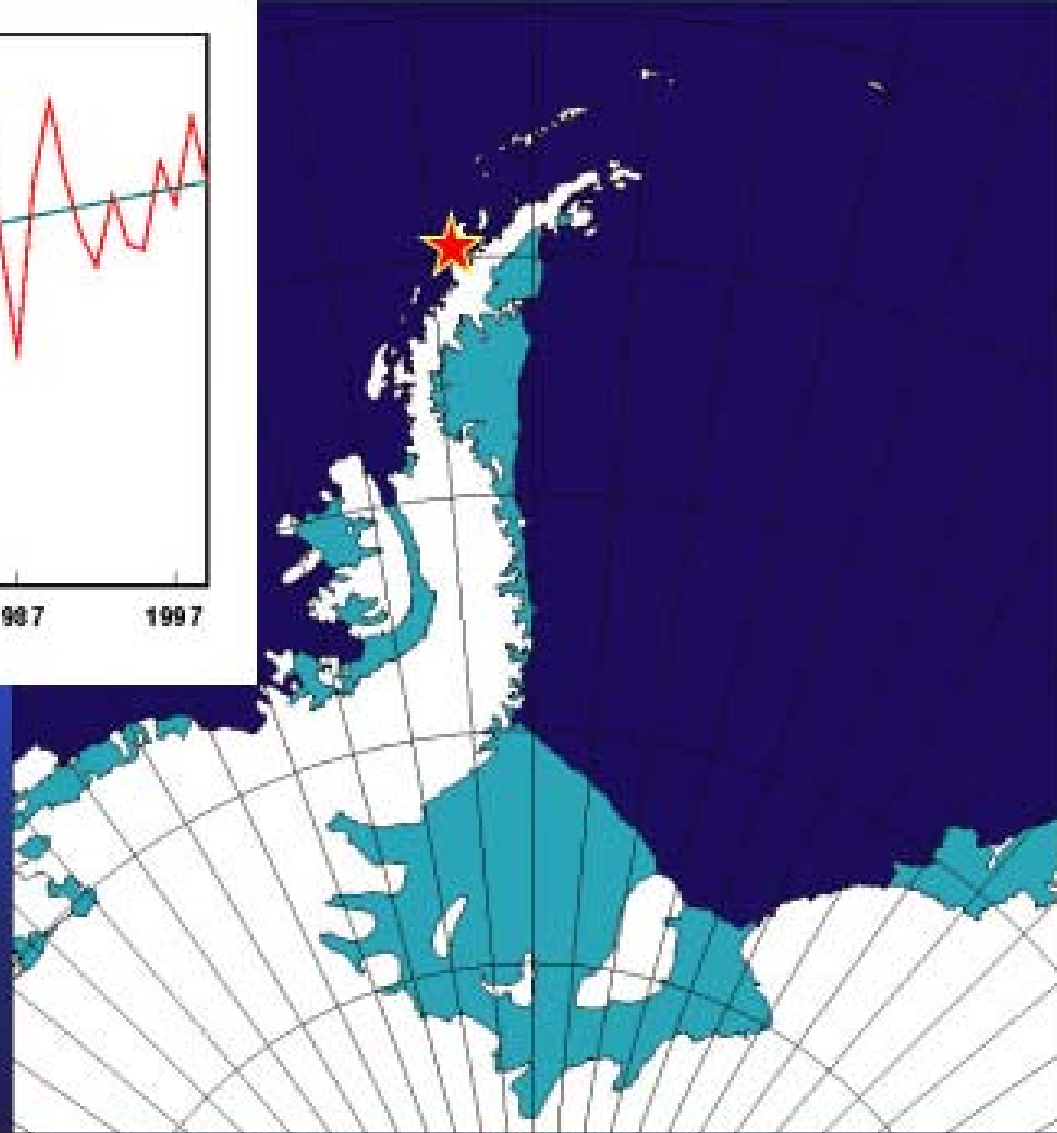
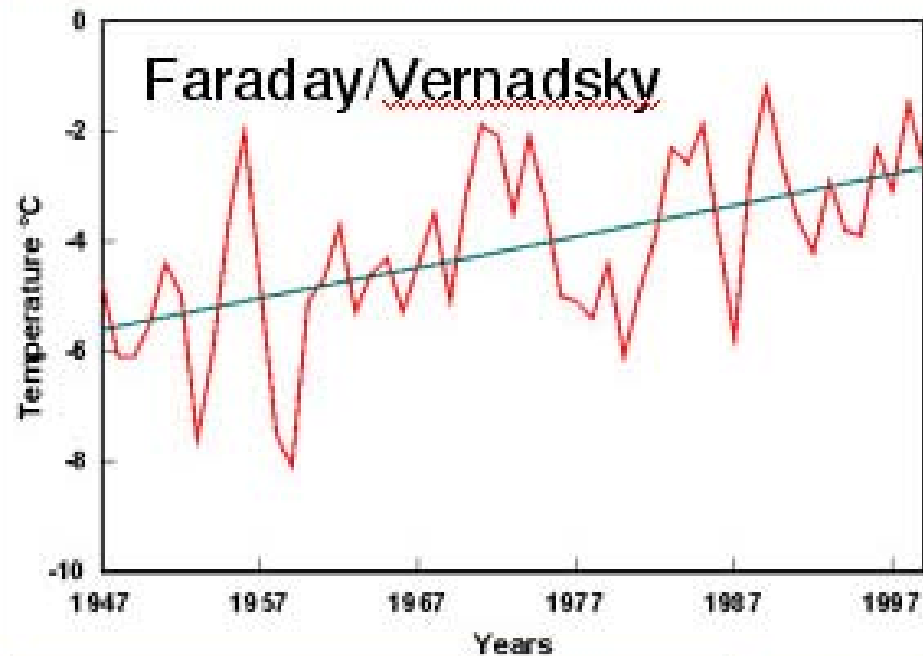


+0.6°C since the 1960s

+0.8°C since the 1880s



Warming on the Antarctic Peninsula

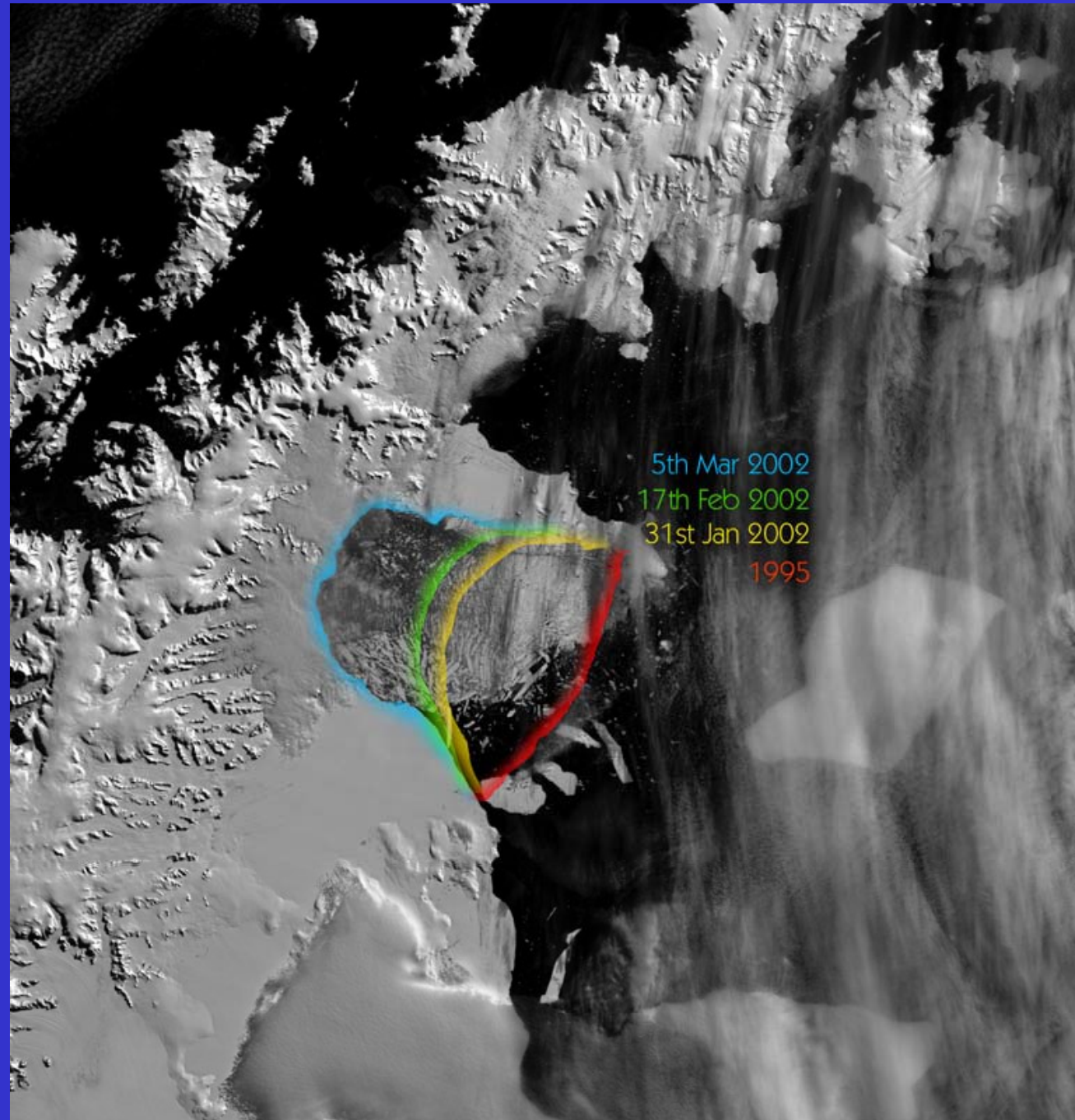


SCAR

Antarctic Peninsula ice shelves disintegration

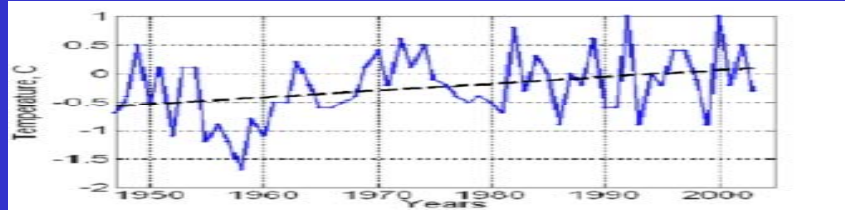
Break-up Larsen B Ice Shelf in 2002

BAS

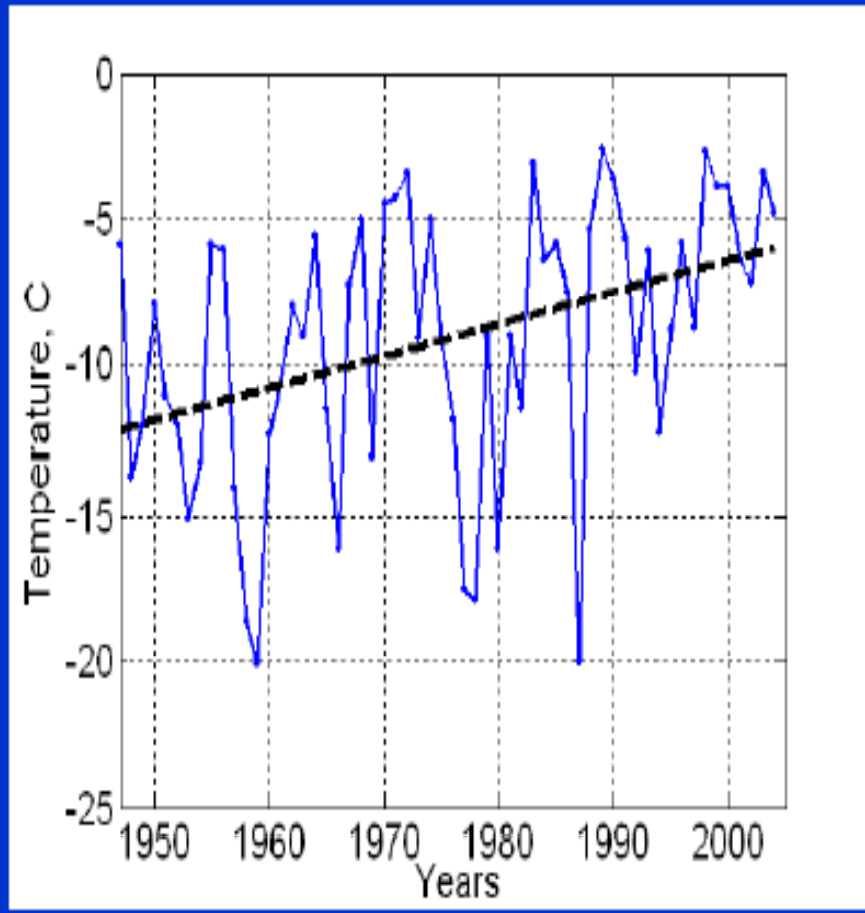


Faraday/Vernadsky temperature:

summer



winter



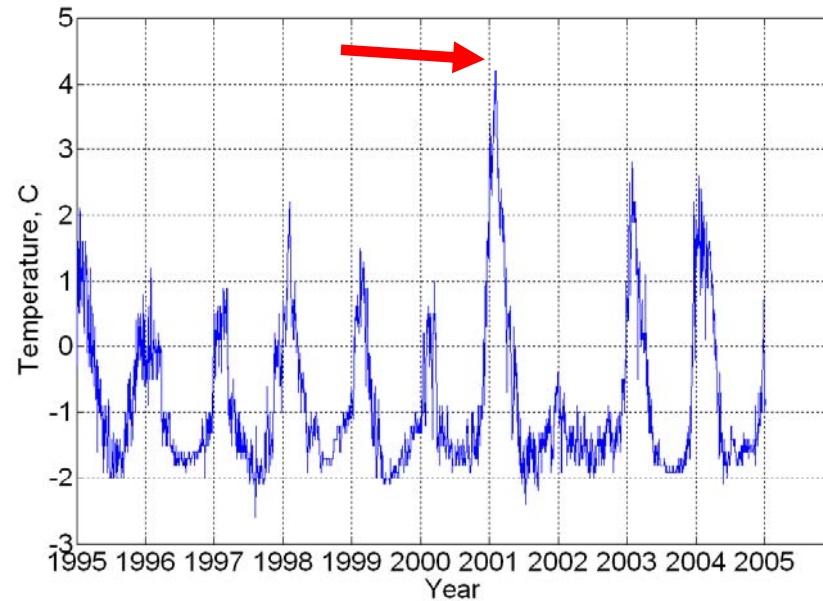
Trend:

Dec 1947–2005 +0.7°C

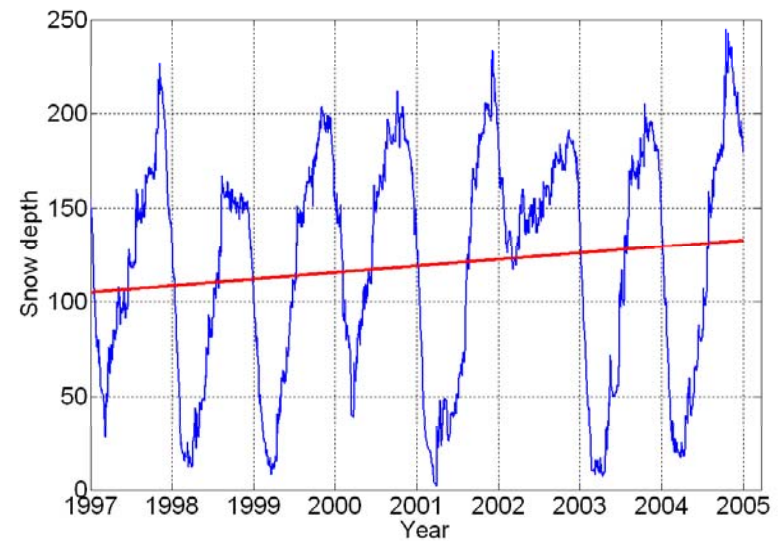
July 1947 –2005 +5.1°C

Warming trend most evident in winter temperatures accompanied by loss of snow, retreat of glaciers and collapse of ice shelves and changes in precipitation

Meteorology parameters trend at Far/Vern Base



Sea water temperature



Snow depth

Antarctic Peninsula climate changes – impact on ecosystem

Met Records:

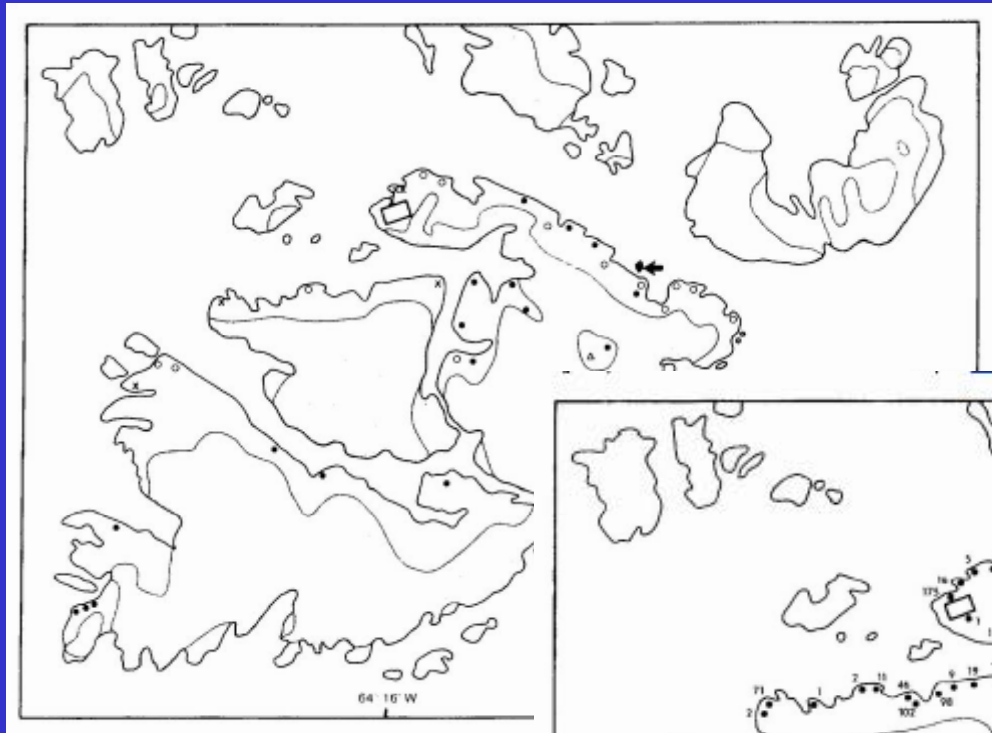
- Minimum temperature
- 43.3 °C 1958
- Maximum temperature
+11.8 °C 1985
- Maximum gust
78 knots 1991



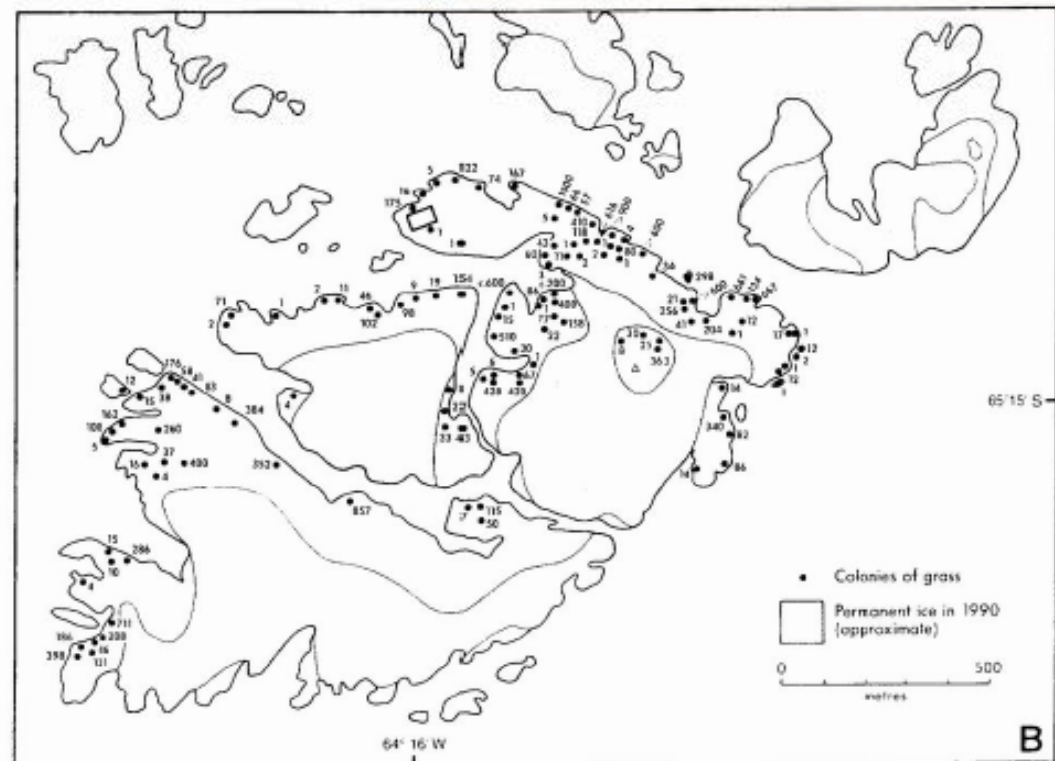
Grows of area *Deschamperia antarctica*, *Colobanthus*

Grows of *Deschampsia antarctica* area at Faraday/Vernadsky region

(J.Fowbert et al, 1994)

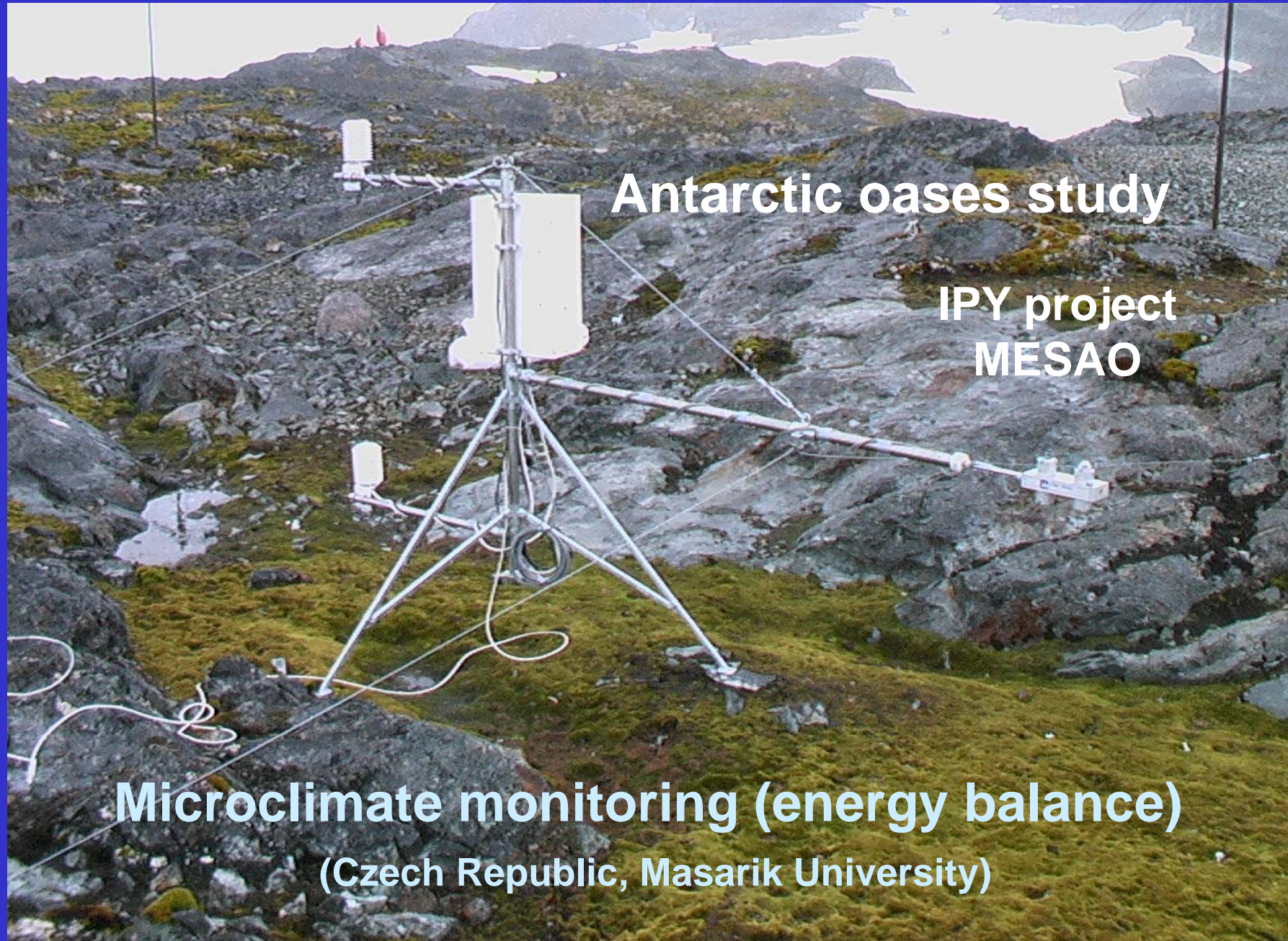


1964



1990

2008 ?



Antarctic oases study

**IPY project
MESAO**

Microclimate monitoring (energy balance)

(Czech Republic, Masarik University)

Antarctic oases study



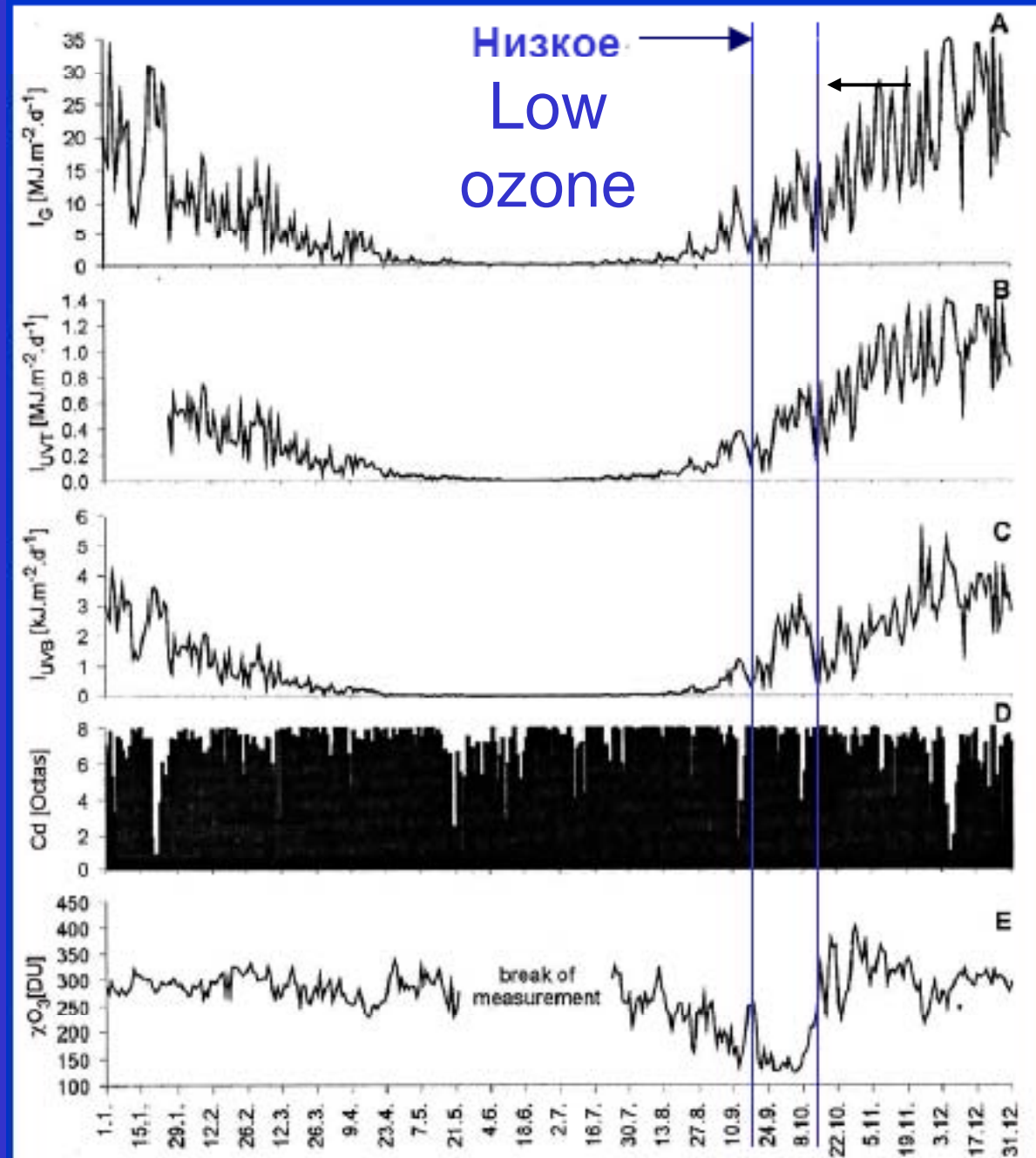
UV-A and UV-B measurements (2005)



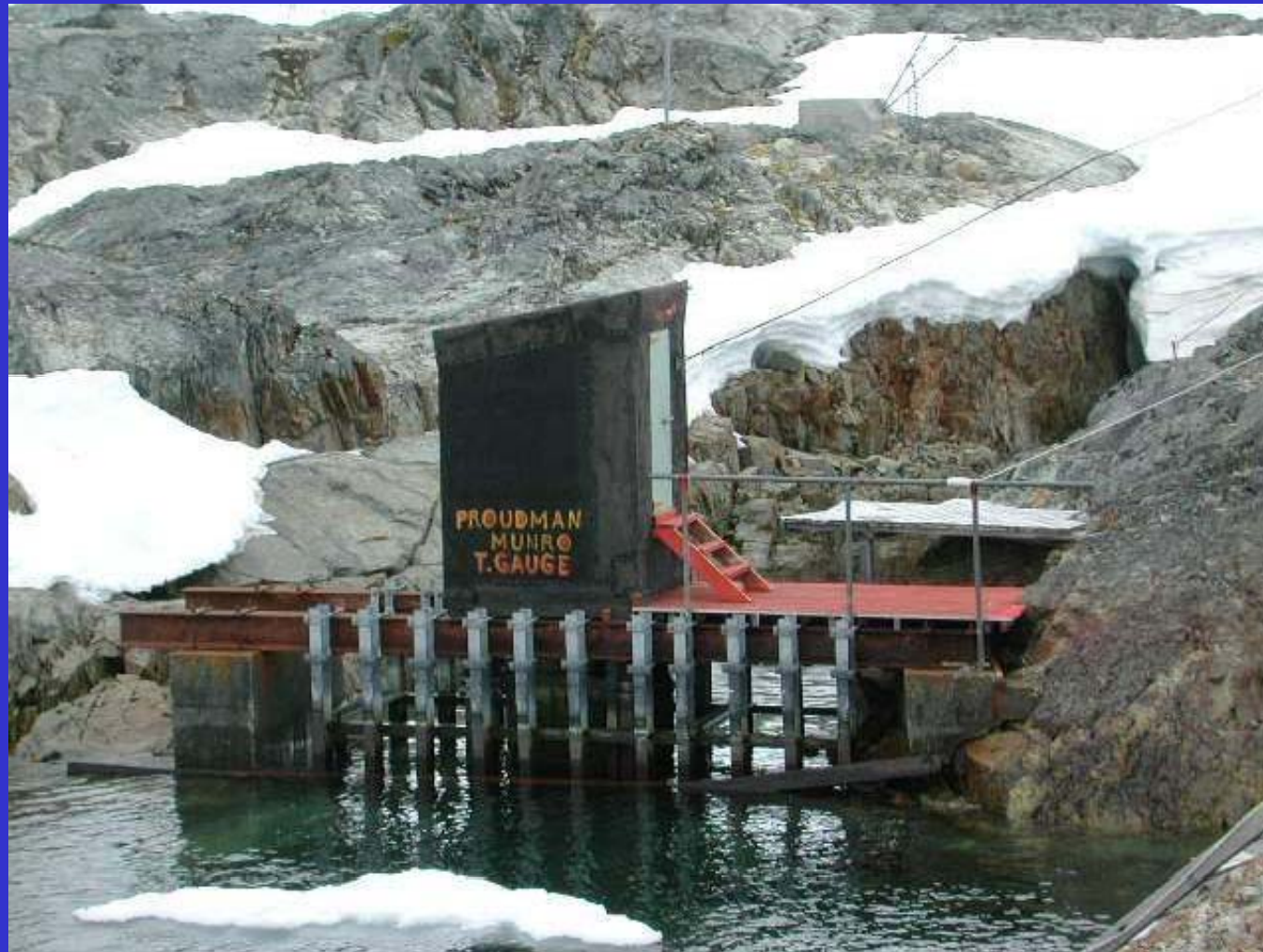
Ozone, clouds, UV-B radiation

Low ozone –
high UV

High clouds
cover – low UV

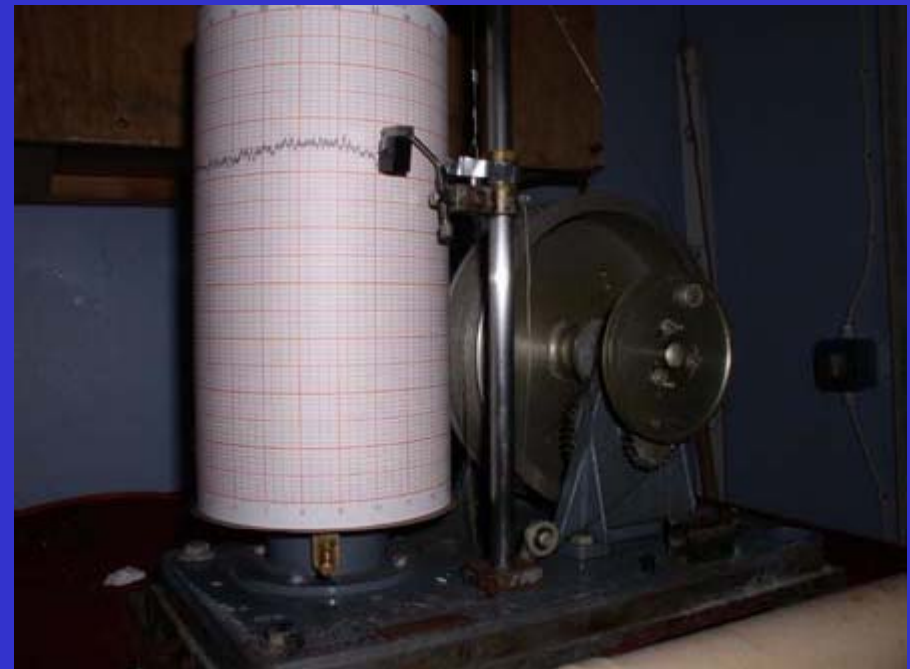


The tide gauge for sea level measurements

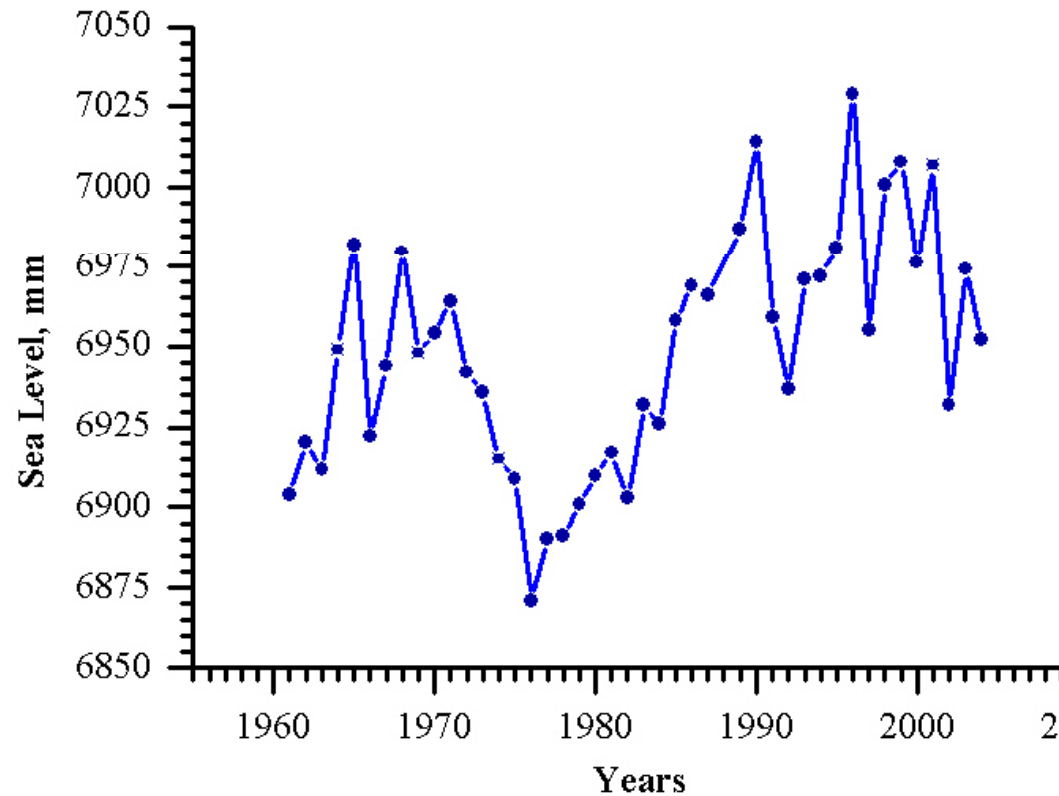




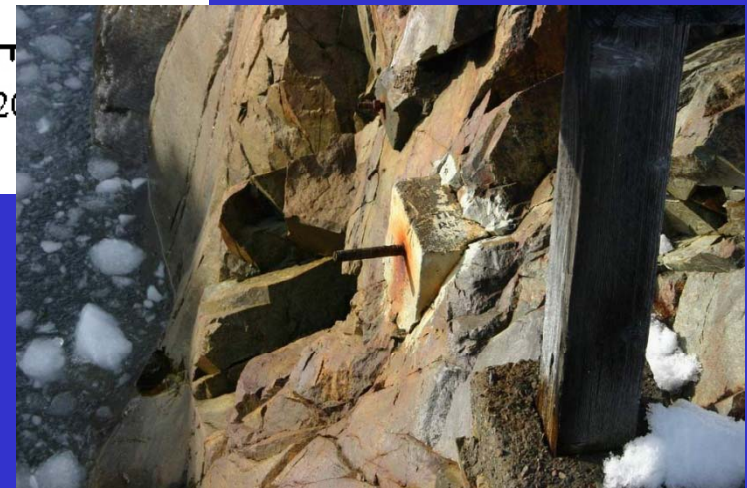
**Tide gauge site in winter
2003, 11 September**



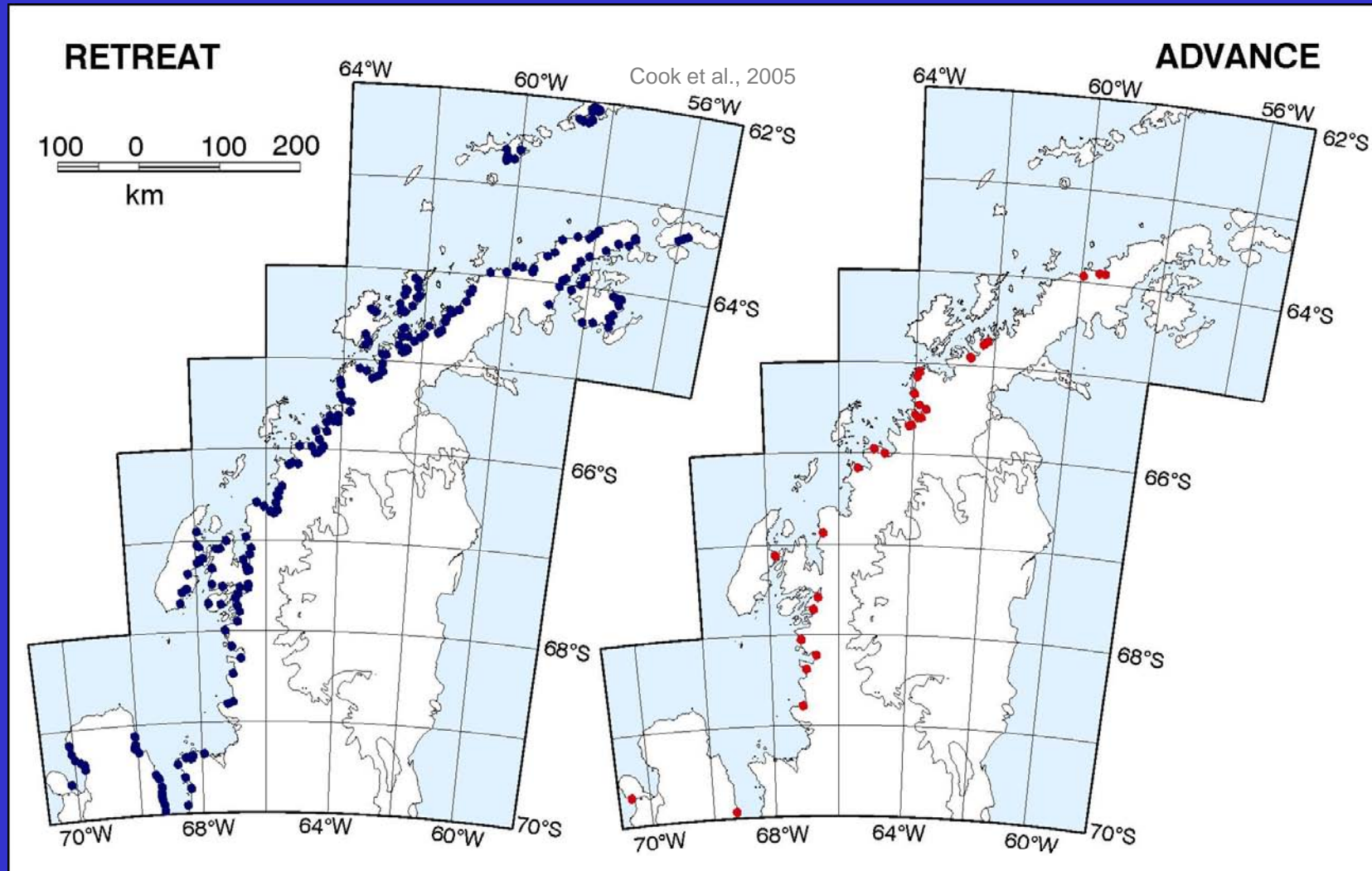
Faraday/Vernadsky sea level 1960-2005



Faraday/Vernadsky benchmark



Antarctic Peninsula Glacier Responses



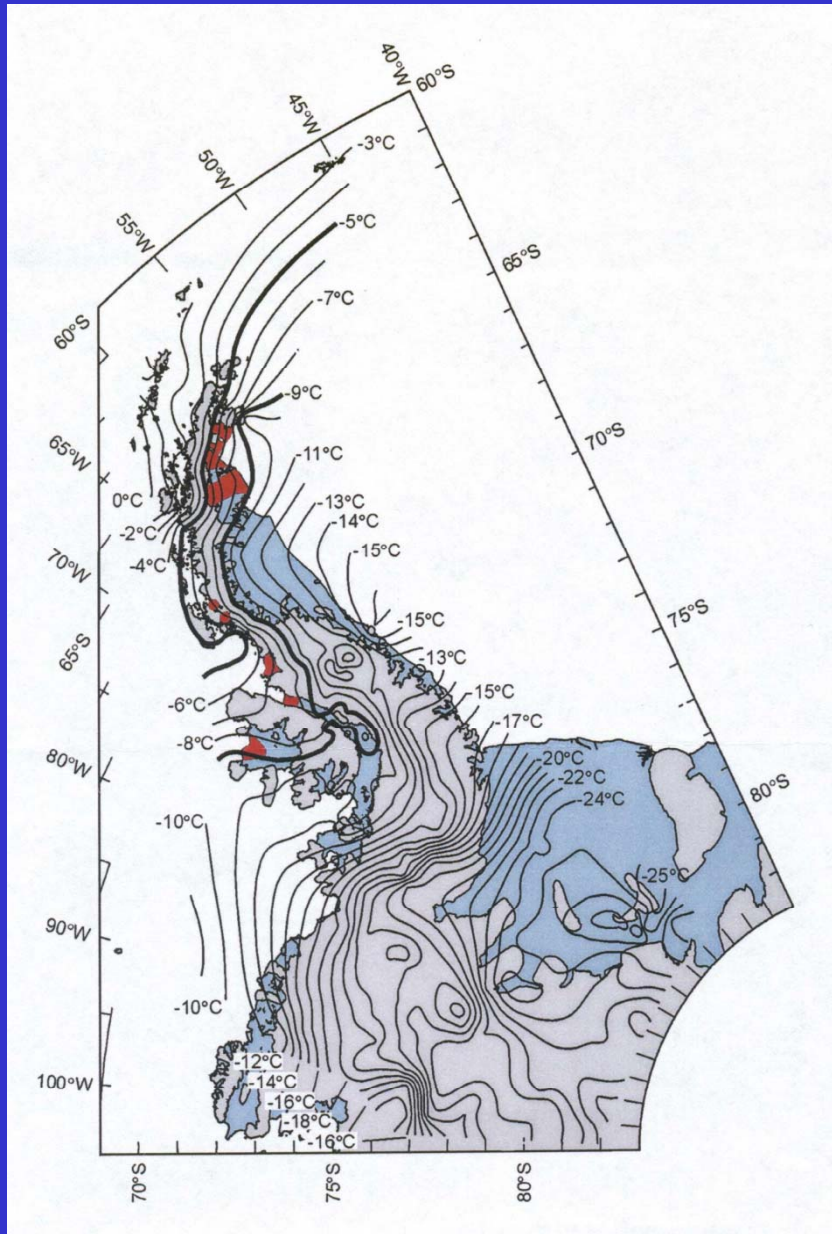
244 glaciers : 87% have retreated over last 50y

Antarctic Peninsula ice shelves (ice caps) disintegration

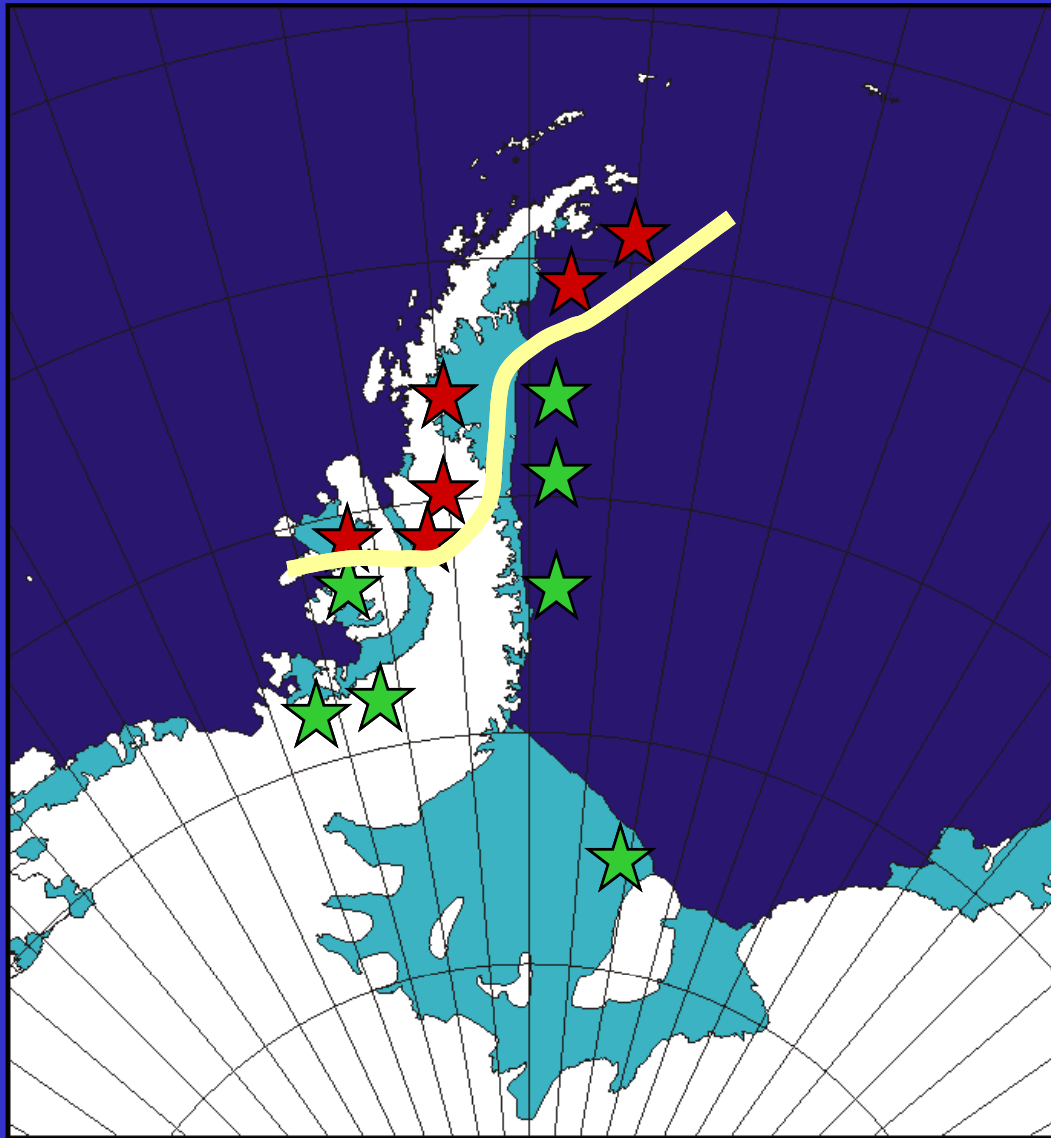
(Morris, E.M., Vaughan, D.G., 2003)

- Modern ice shelves - connection of the snow and ice cover extent with average annual temperature

All ice shelf between -5°C and -9°C isotherms have to disintegrate during last century



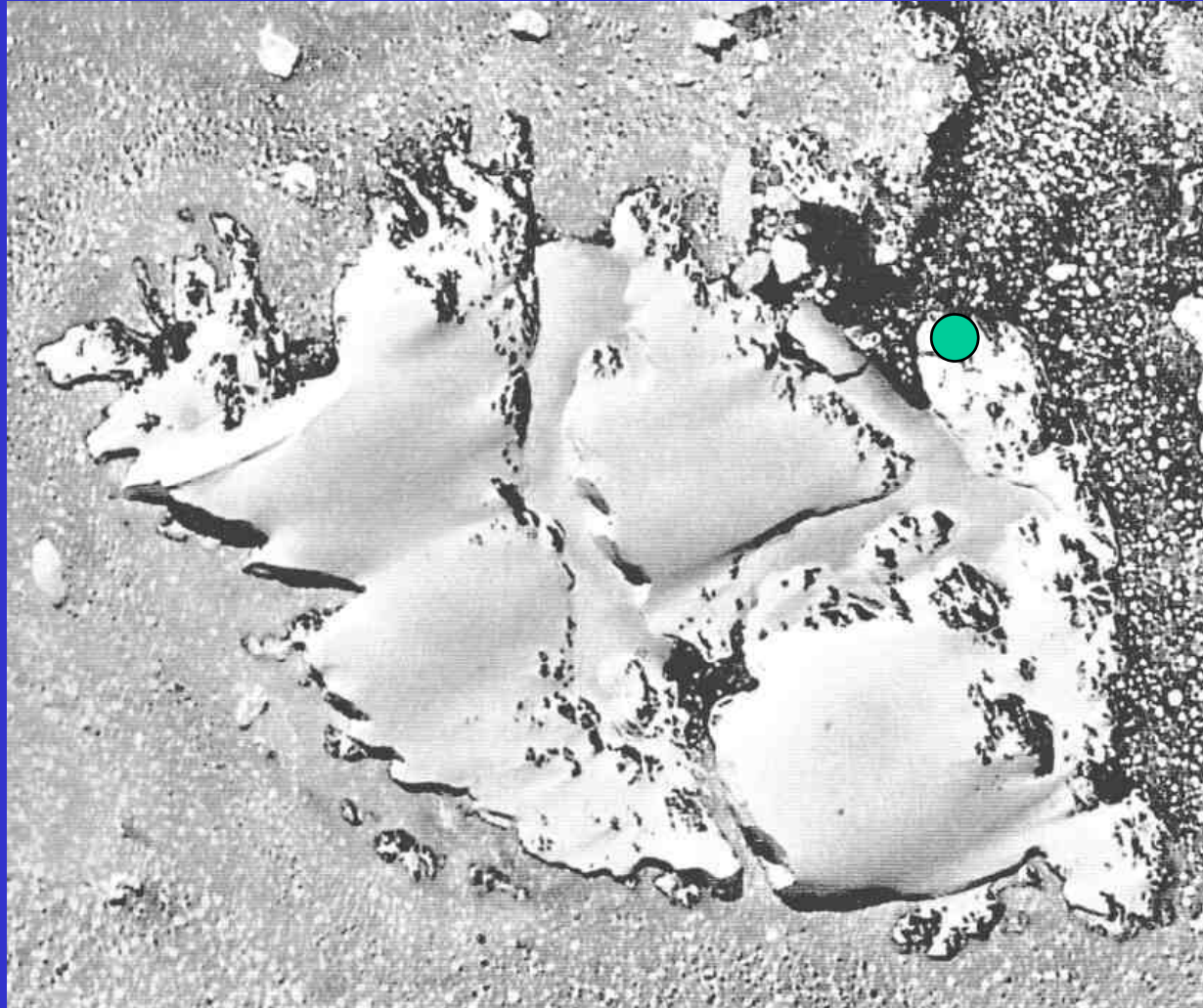
Antarctic Peninsula Ice Shelf Disintegrations



- Summer surface melting
- Northern ones absent 3-5ky ago

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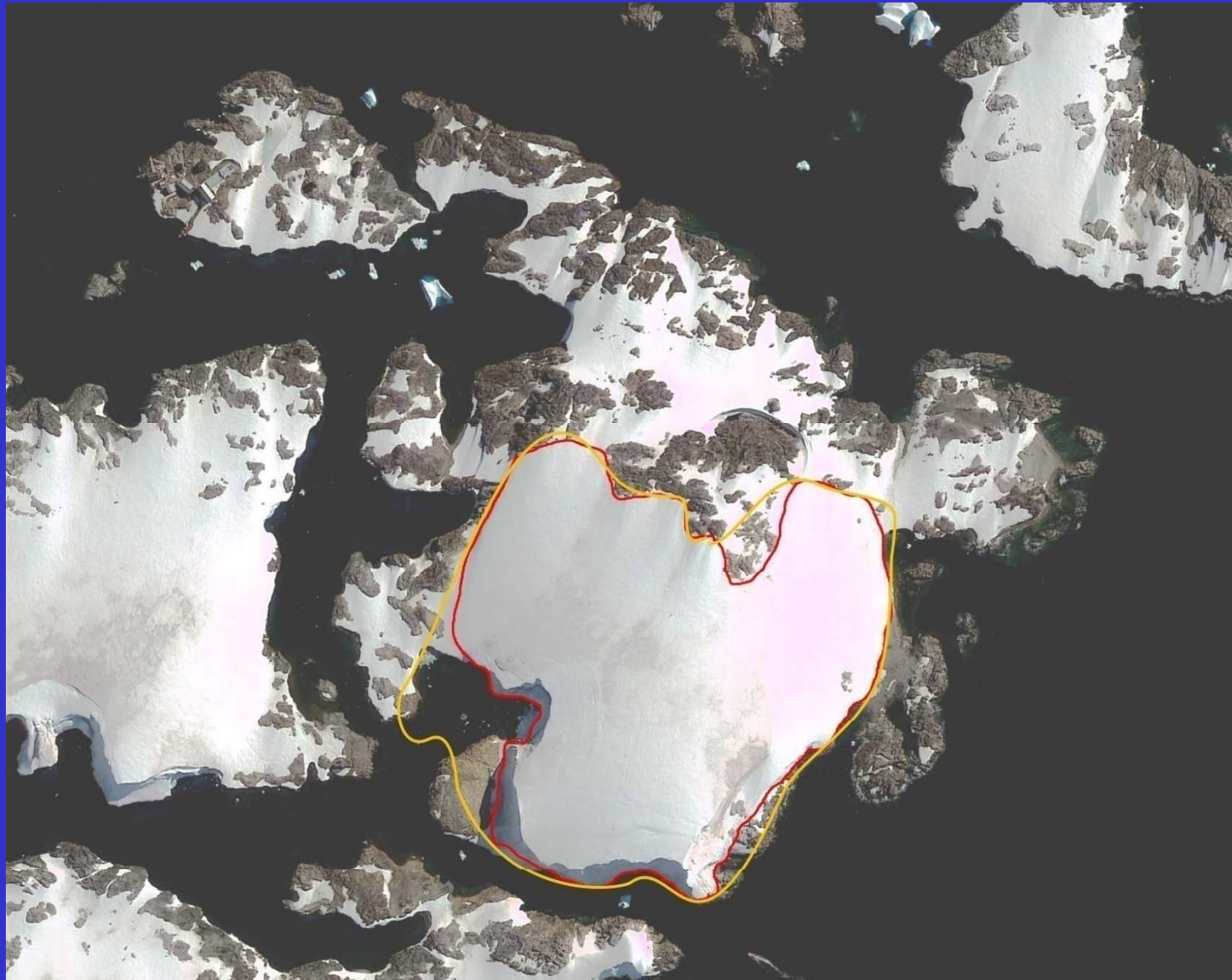
Ice caps dynamics in Antarctic Peninsula climate change conditions



Galindez Island aerial photograph, December 1956

(BAS, R.Thomas, 1963)

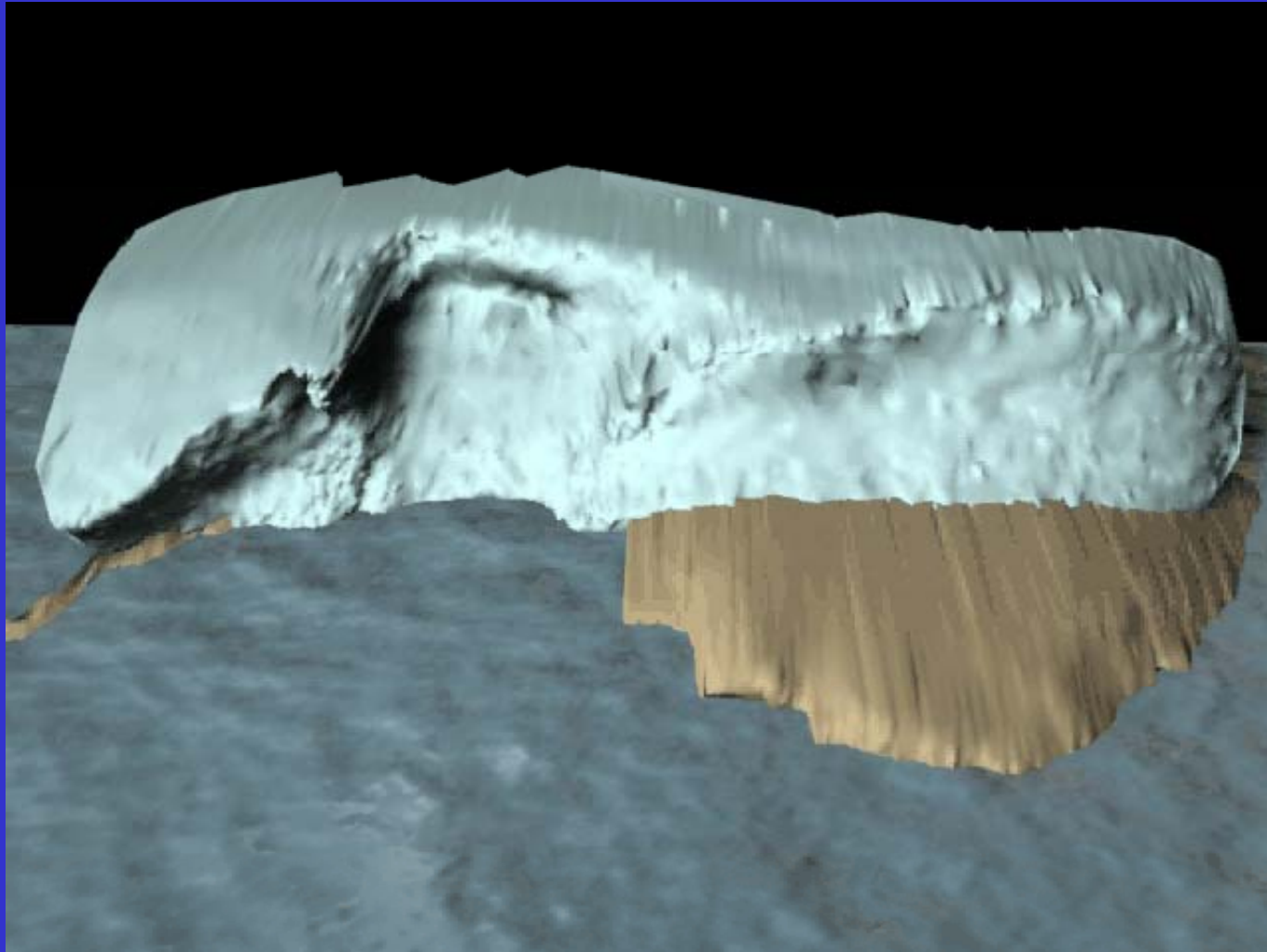
— 1956
— 2004



Galindez ice cap boundaries: Dec 1956 and Jan 2004

Since 1956 the Galindez ice cap area has decreased significantly

Shape changes of the west part during 2002-2004



The photogrammetry shows considerable reducing of the ice cap west part between 2002 and 2004.

Argentina Islands ice caps: forecast for the future

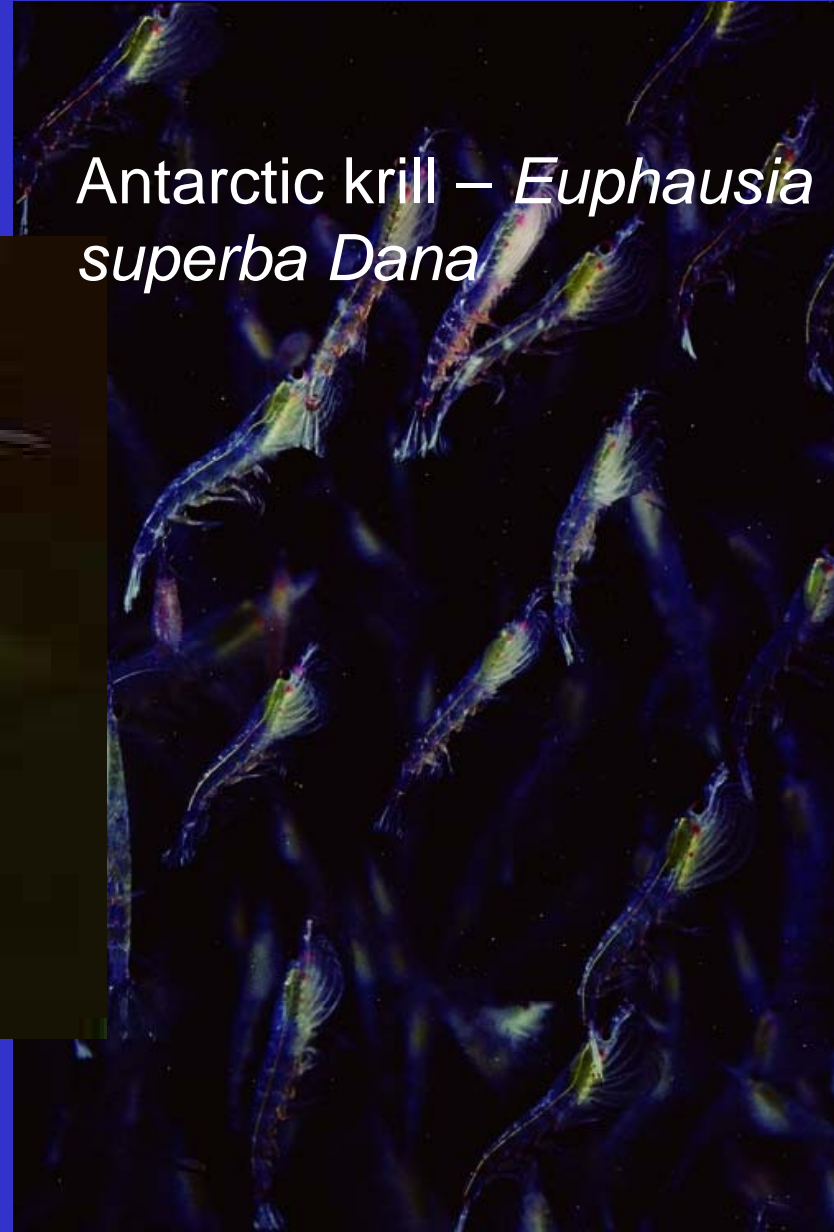
If the temperature trend left constant that the ice cap could be discharging within century

This process could be increased due to unique water temperature anomaly observed last years (up to + 4°C)

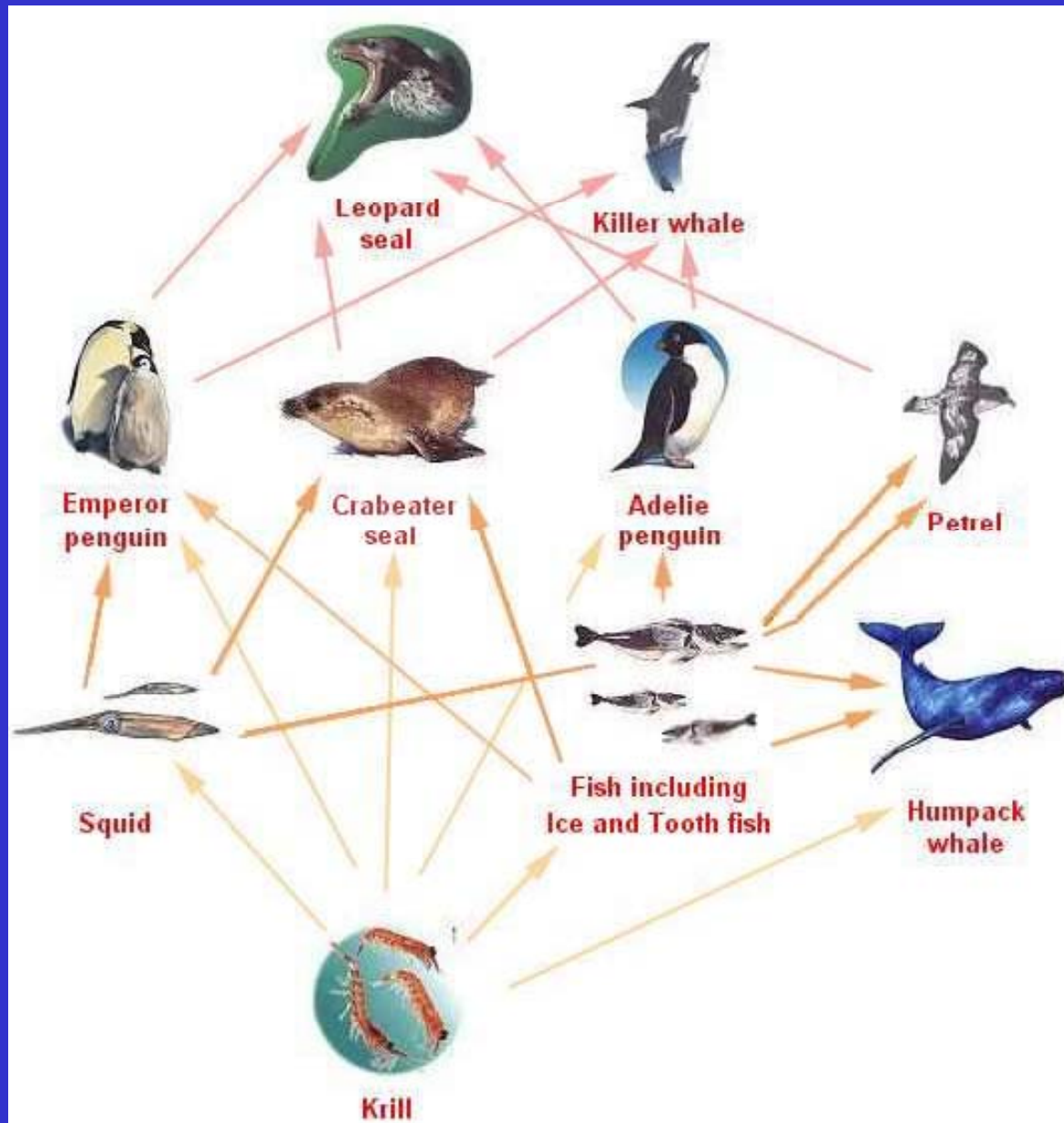
Impact of Climate Warming (example – krill)

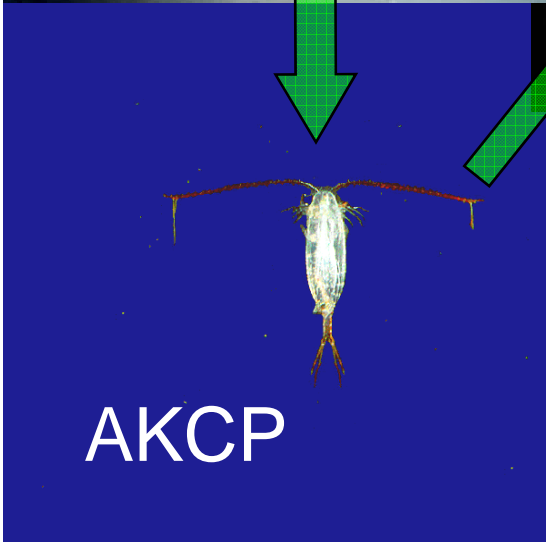
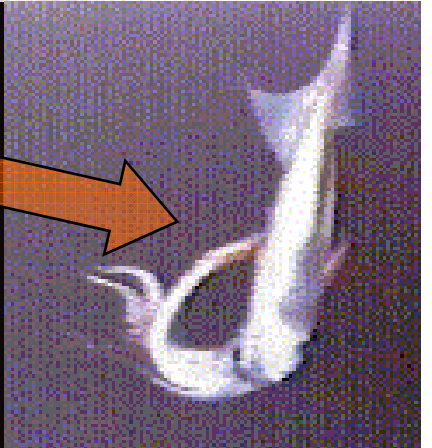
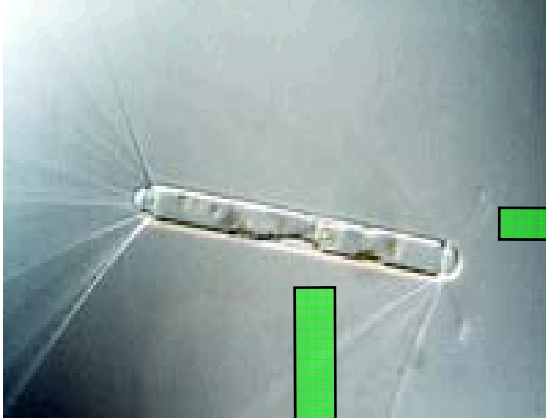
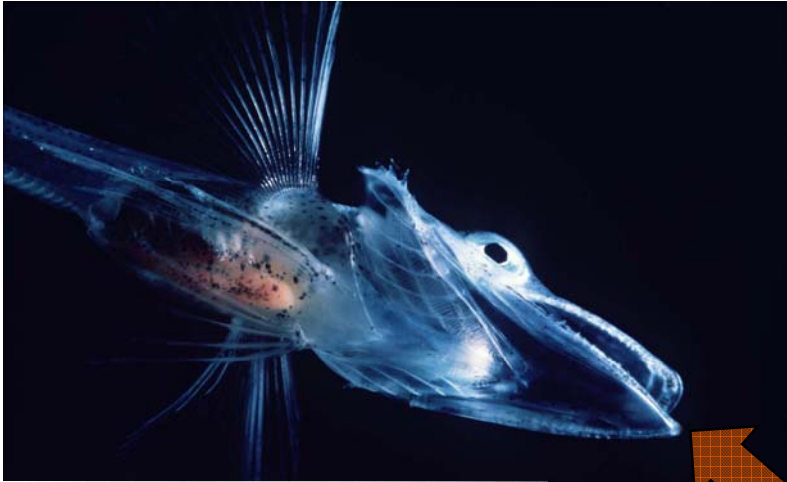
Krill:

Antarctic krill – *Euphausia
superba* Dana

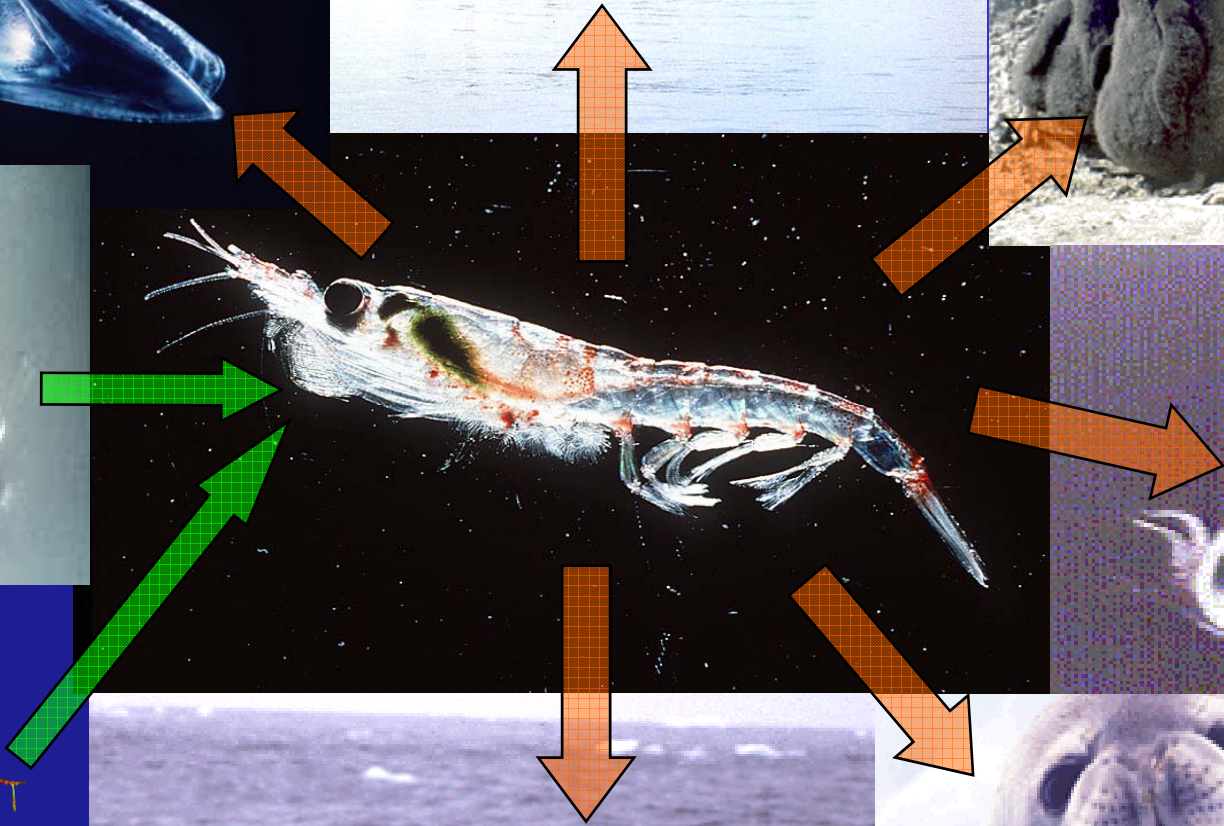
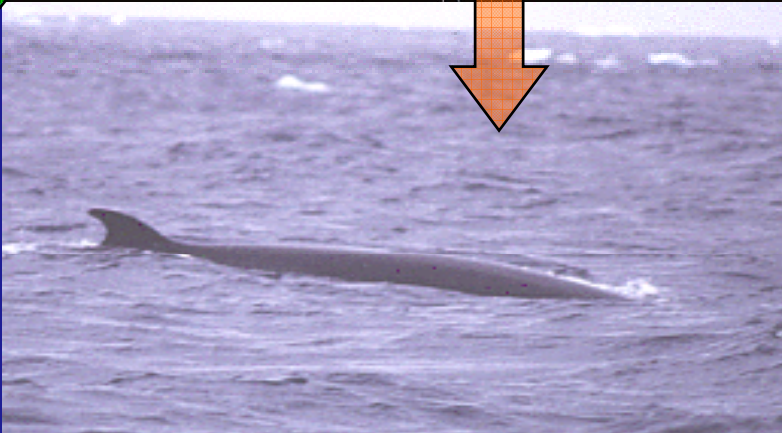


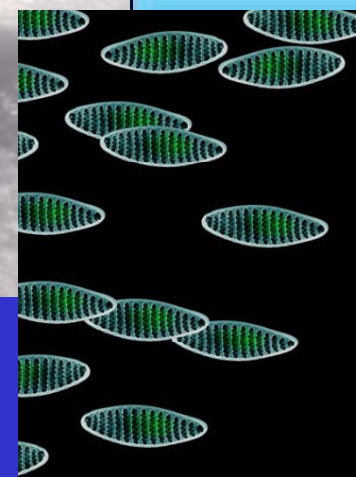
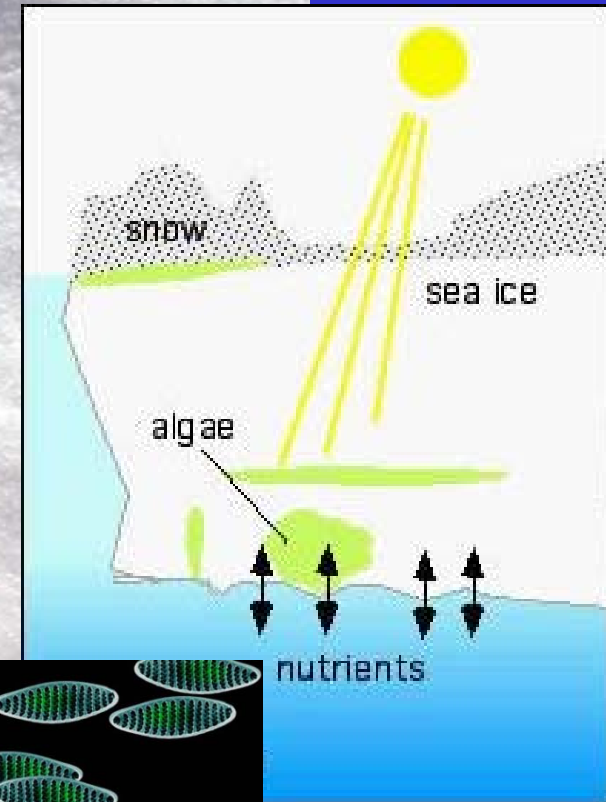
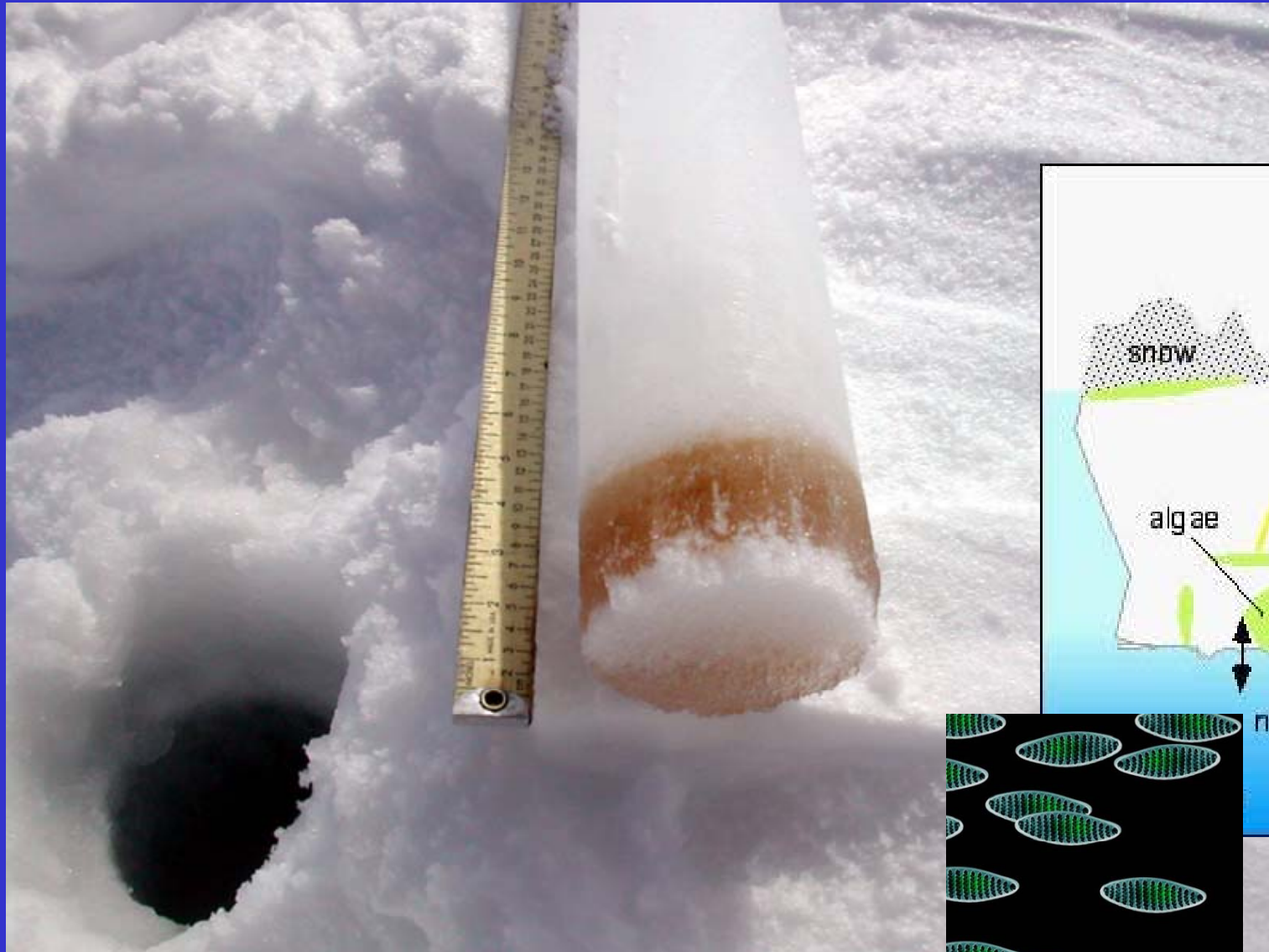
Antarctic food web





AKCP





**Krill nursing and feeding
under sea ice**

AKCP



Gentoo and chinstrap penguins are shifting south.

Adelies are being forced further south because of change in sea ice

Higher temperatures have already forced penguin populations to migrate south and may reduce the availability of krill

How about ozone change impact?

Task 3:

**Upper atmosphere,
troposphere-ionosphere
energy transfer,
space weather**

Solar-Terrestrial Interactions



Polar aurora over Halley base, Antarctica

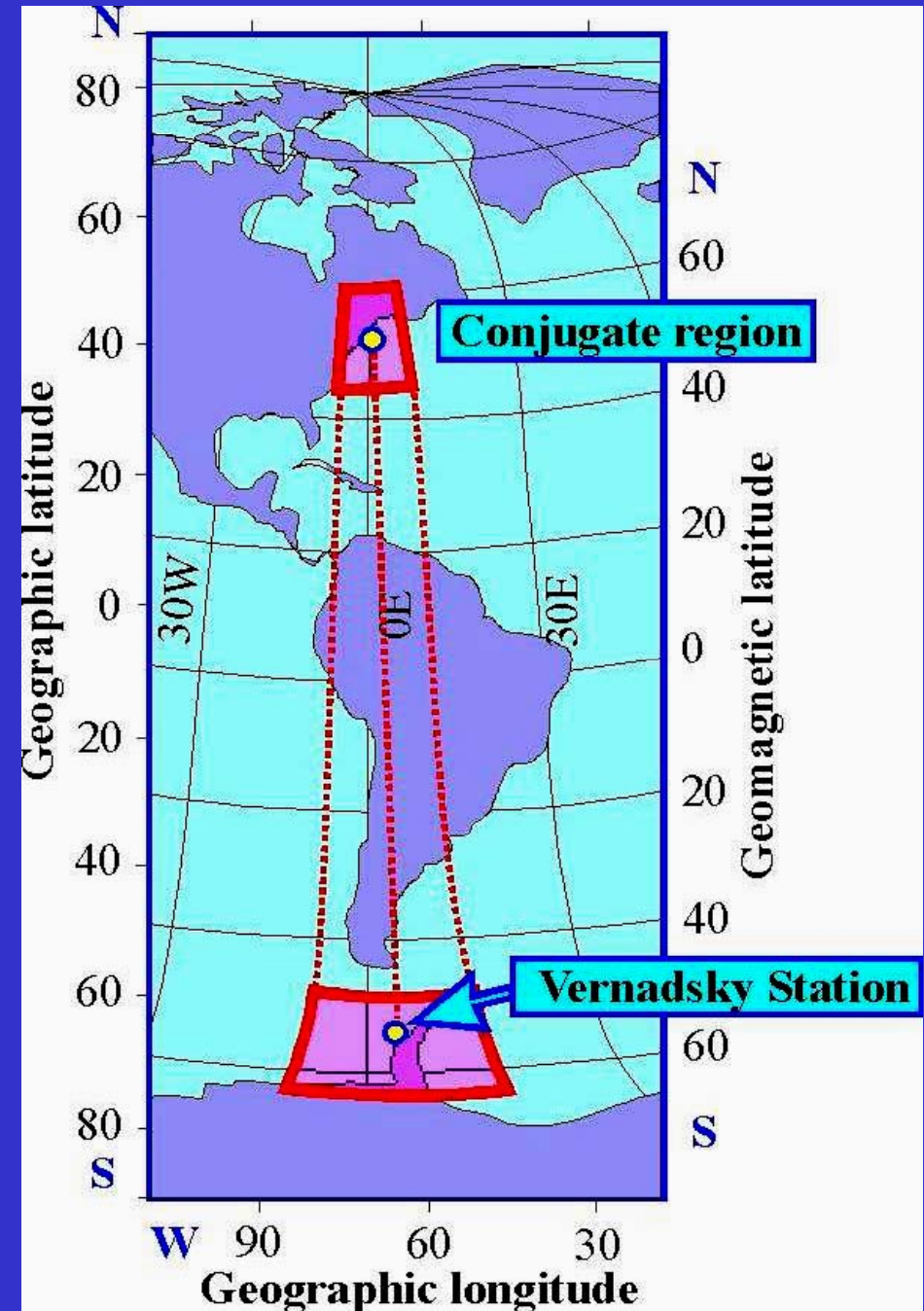


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Idea – study energy exchange between hemispheres

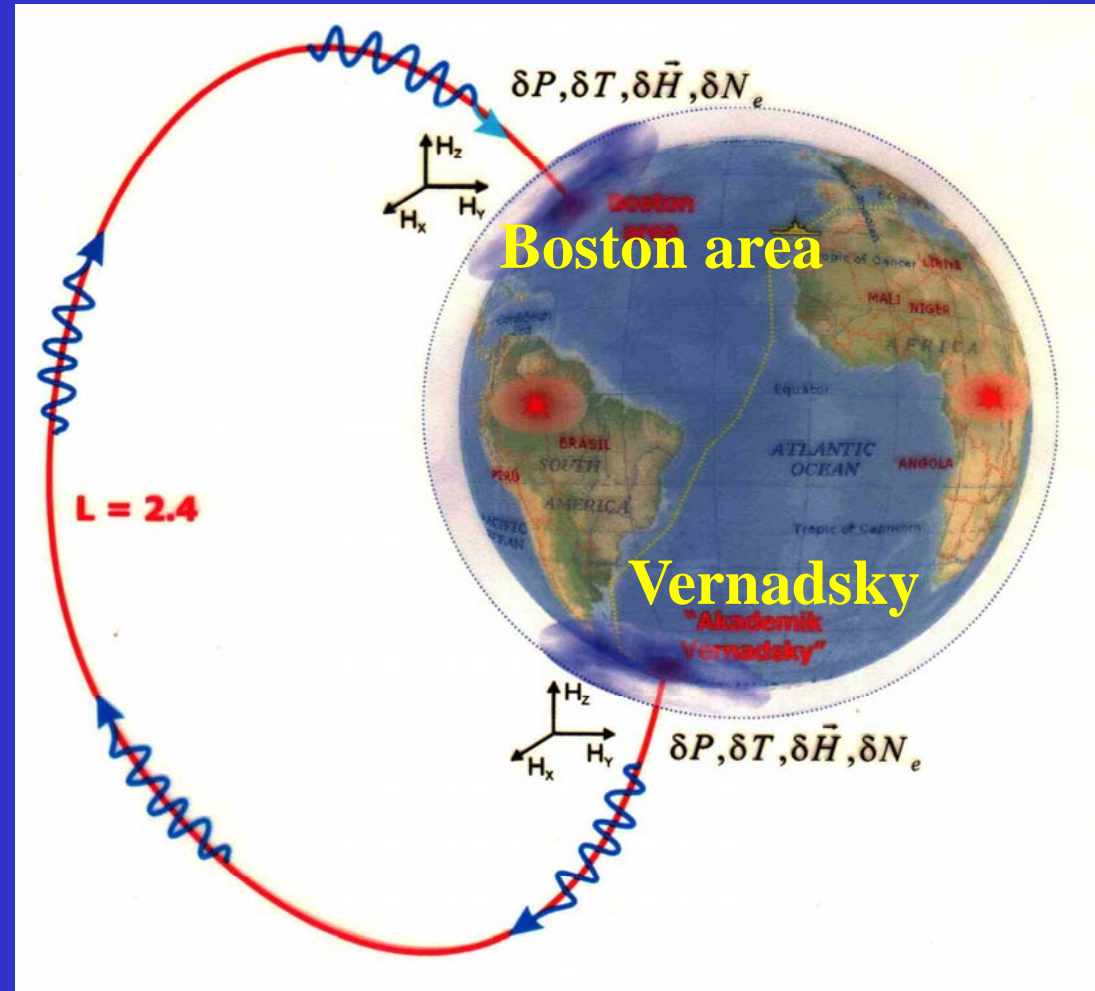
EM-energy flow from industrial region (USA) to Antarctica

Antarctic Peninsula is only the place in Antarctica magnetically conjugated to industrial region



Geomagnetic conjugate regions: Vernadsky – USA East Coast

Channel for
energy transfer
from
N-hemisphere to
S-hemisphere



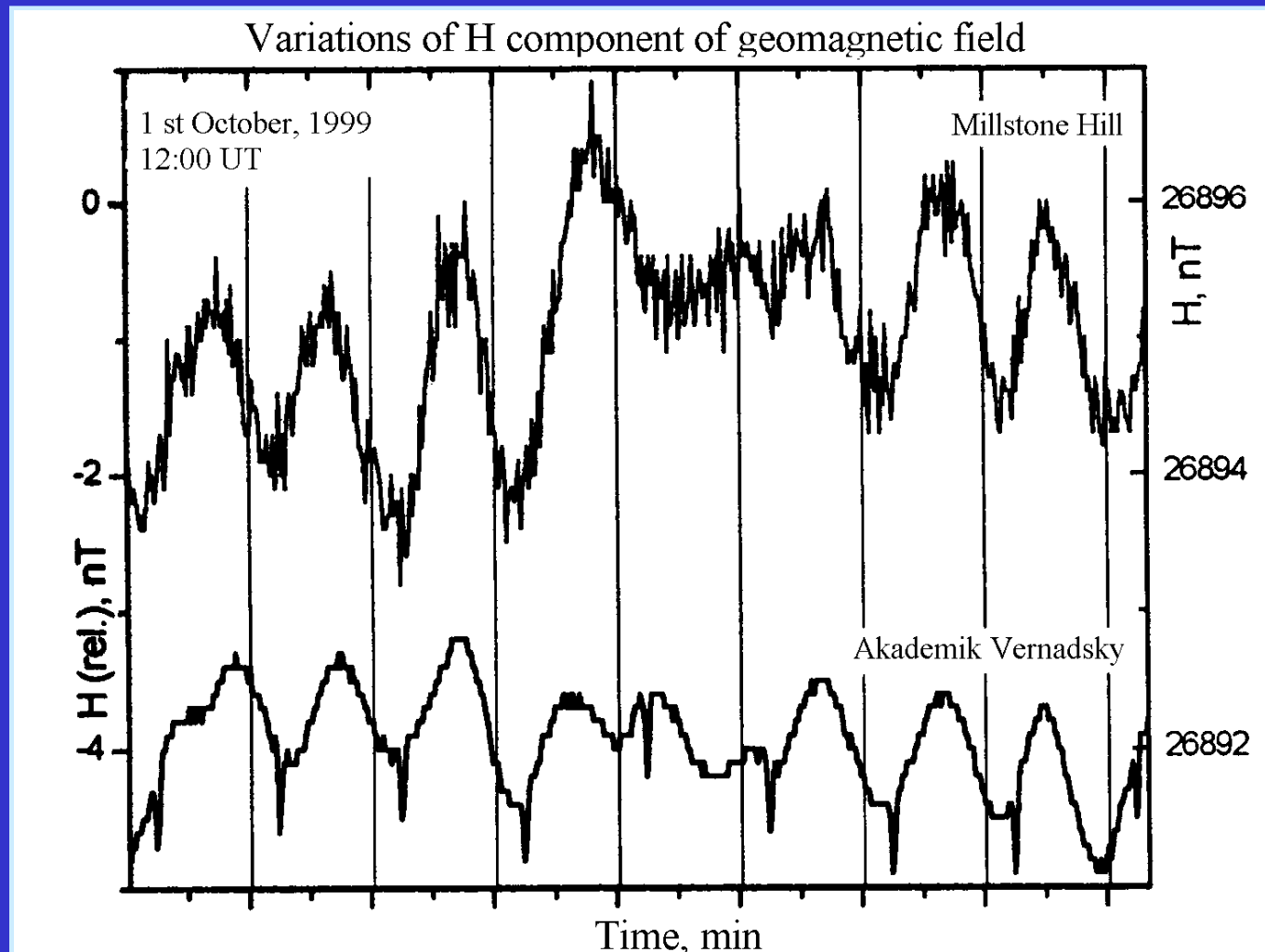
Three magnetosphere
resonance

Magnetosphere resonance (mictopulsations)

Schumann resonance 8, 14, 20... Hz

Alfven resonance 0.6, 0.8... Hz

The geomagnetic micropulsations Pc3 observed simultaneously at Vernadsky and Boston area



**Troposphere
Weather –**

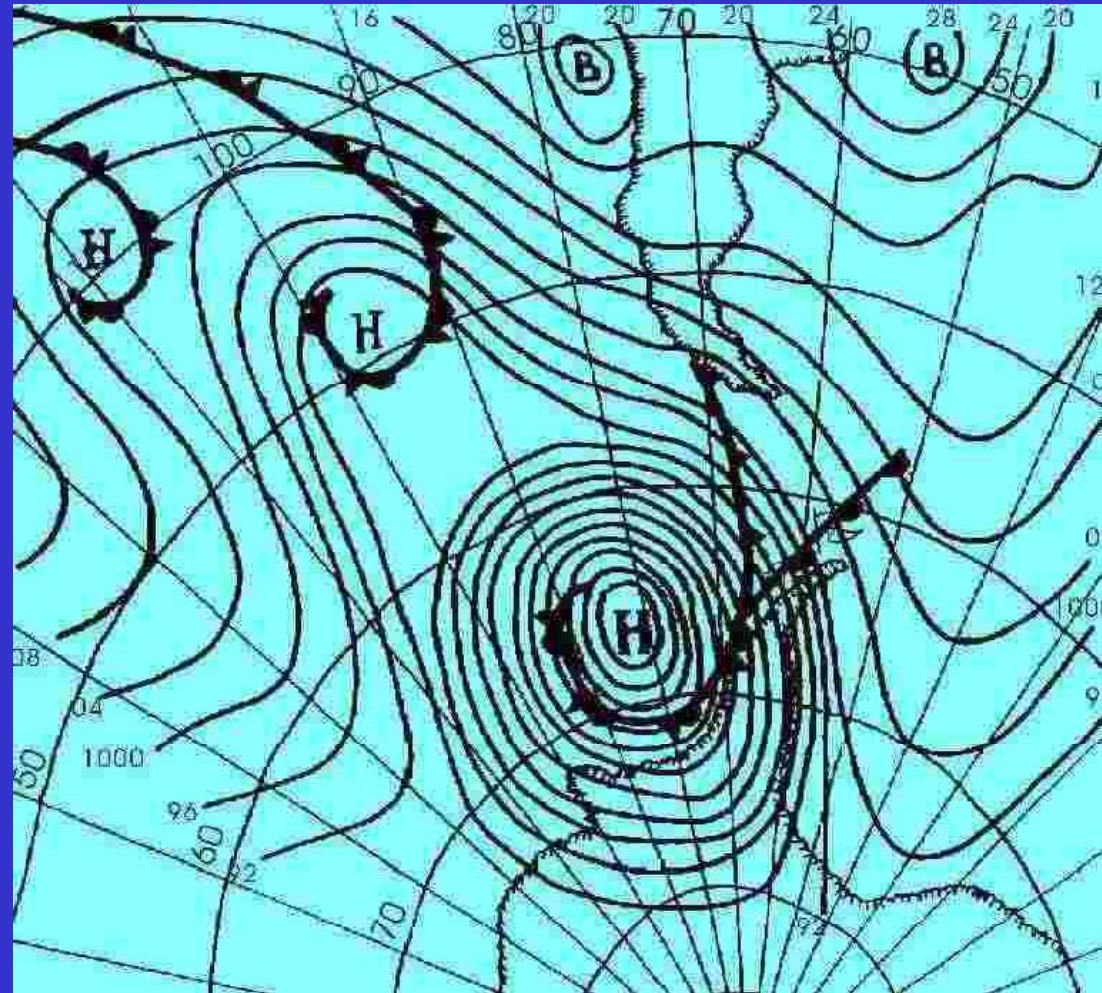
Space Weather

**Drake Passage and
Antarctic Peninsula
–place for cyclones**

**~ 50 powerful
cyclones annually**

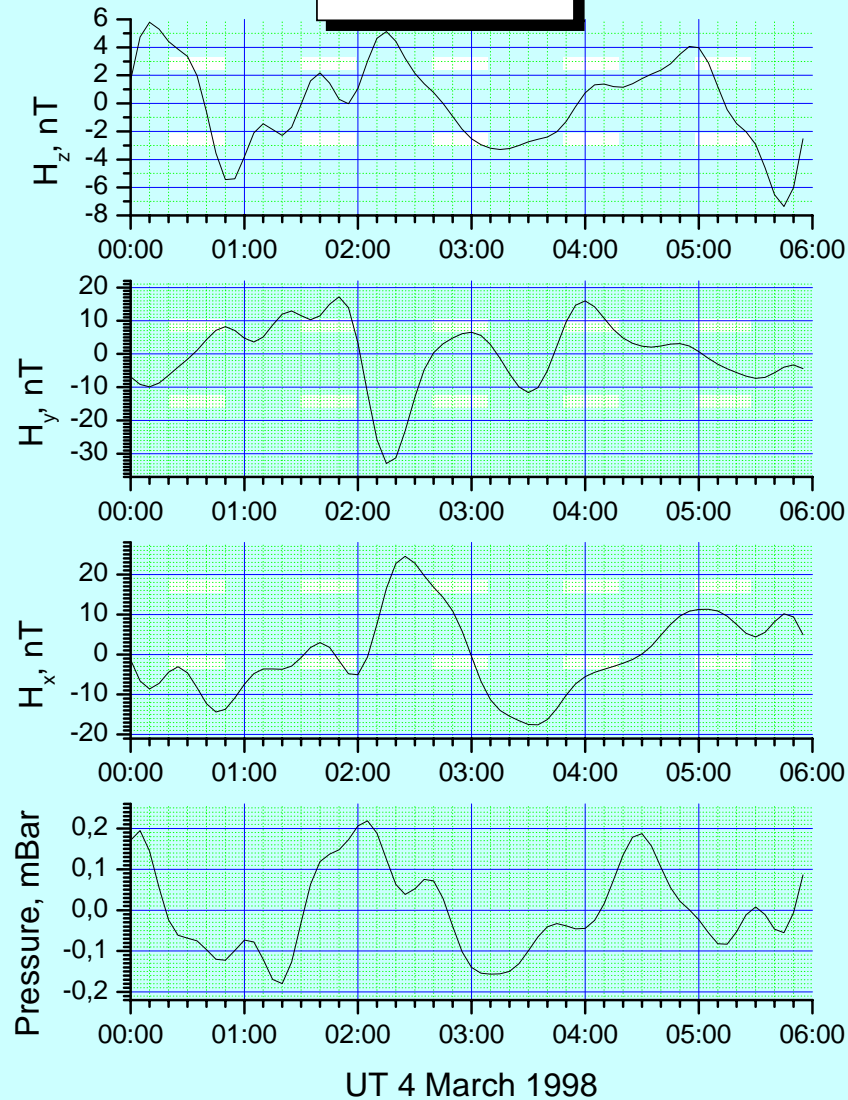
**Study energy
propagation
from surface to
ionosphere**

**Cyclon
April 1, 1998**



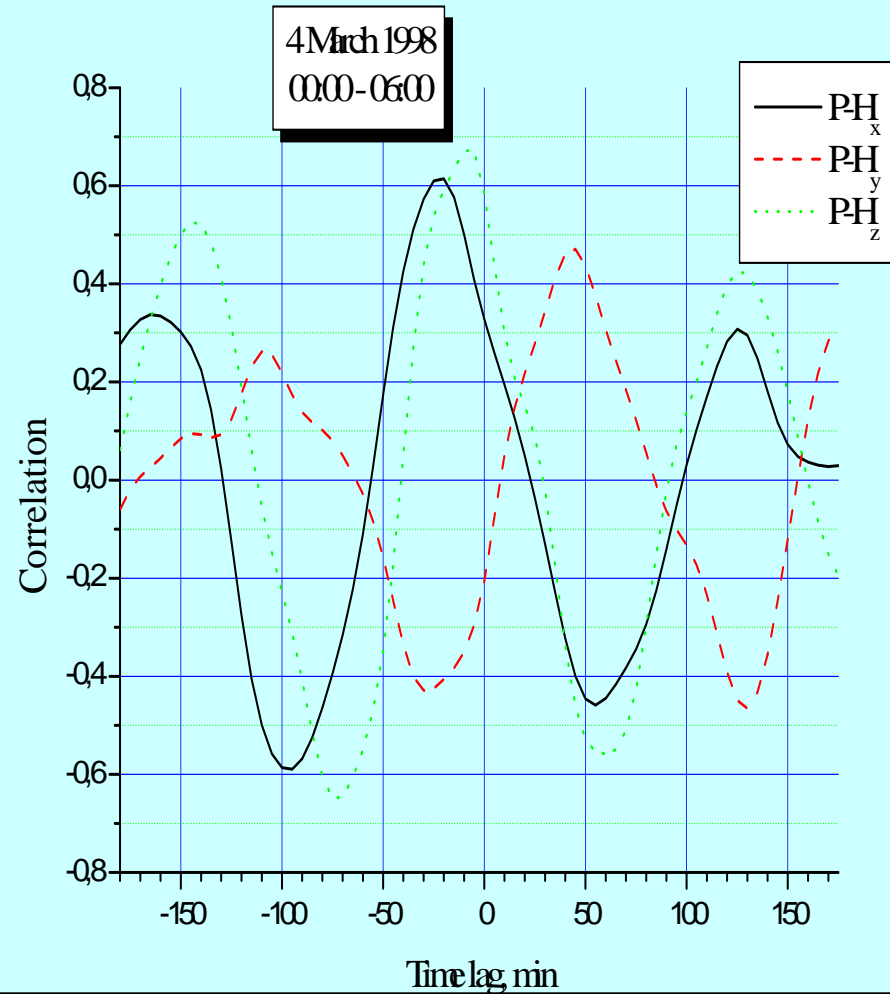
Magnetic field and pressure at Vernadsky

4 March 1998
"Academic Vernadski"
Filtered from 3^h to 30^m



AGW

Correlation



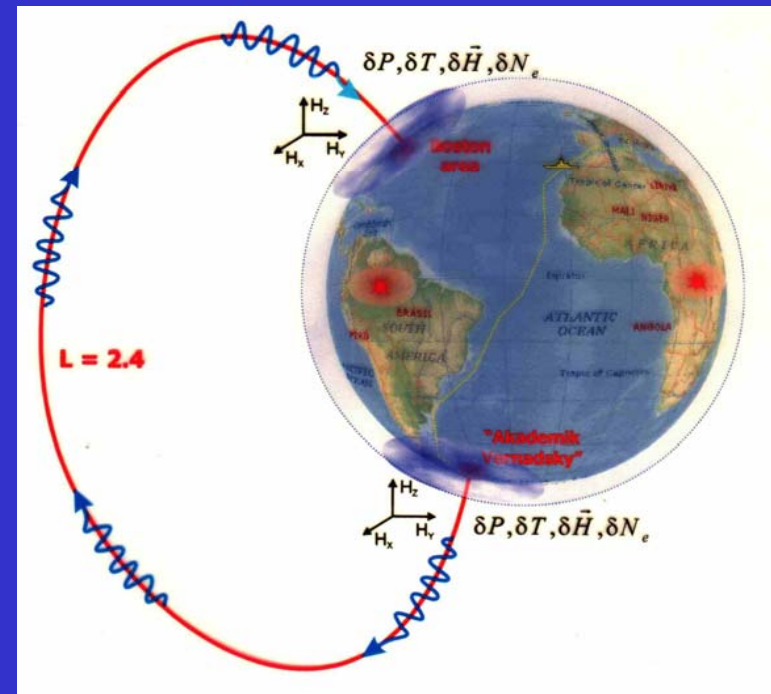
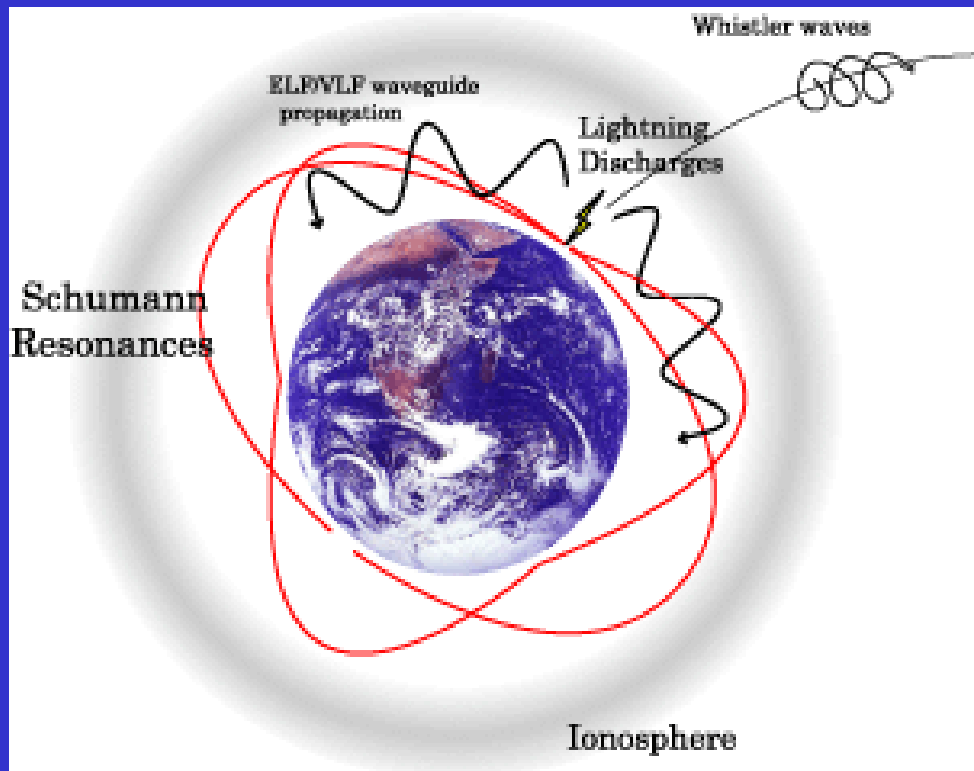
Automatic Meteo-Magnetic Station (AMMS) installation in 2005



Schumann resonance 8, 14, 20... Hz

LEMI-112a induction magnetometer

- ELF receiver: two orthogonal search-coil magnetometers
- frequency band 0,1 - 300 Hz

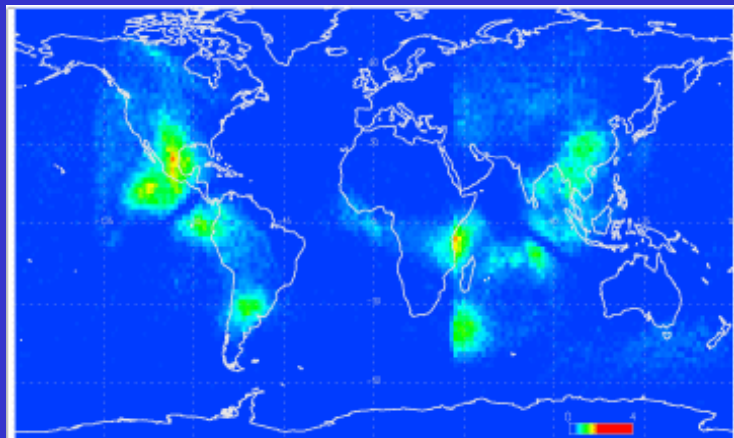


ELF data Q-burst events and optical satellite data of lightning

Vernadsky – Syowa - Onagawa

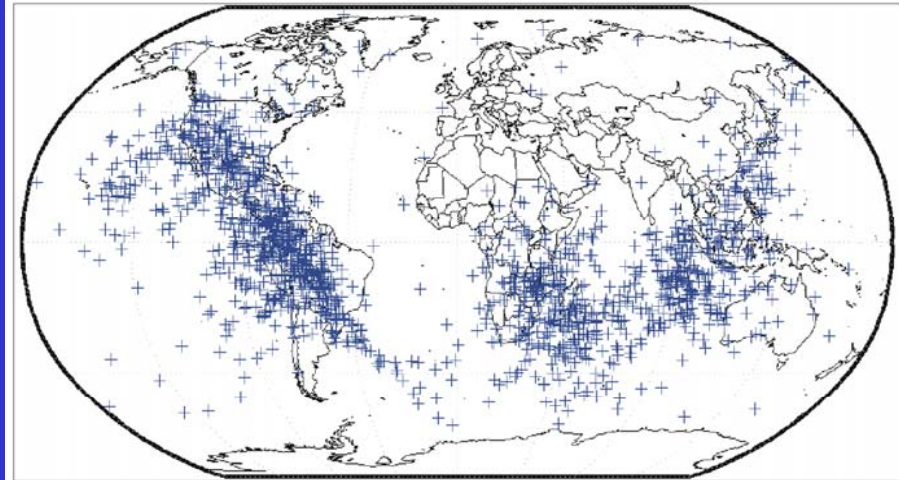
Monitoring of global thunderstorm activity – “Global thermometer”- Positive feedback!

Warmer – more humidity, more thunderstorms, and lightning warmed atmosphere



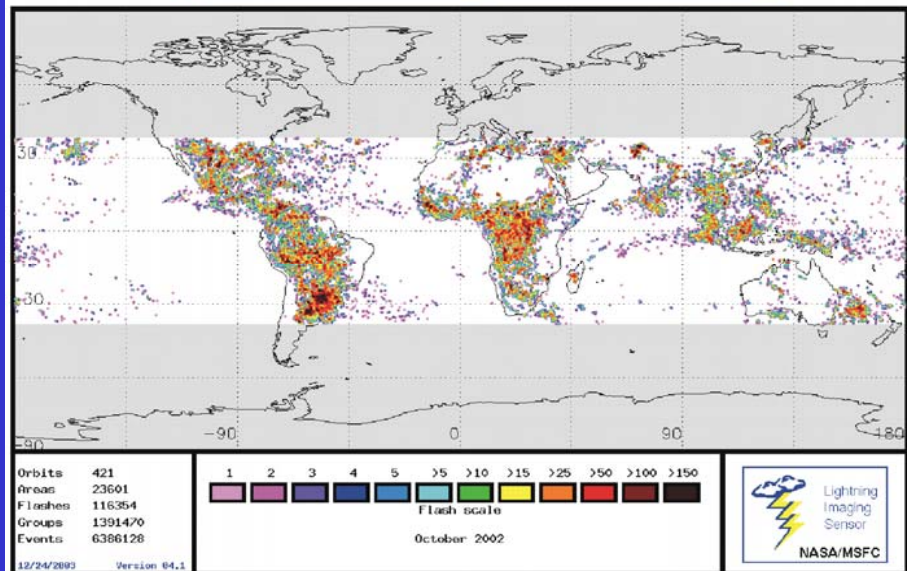
Sprites in summer

27-30 October, 2002
ELF waveband, Q-type burst sources restoration,
Akademic Vernadsky (Ukraine), Syowa, Onagawa (Japan)



ELF data from Syowa and Onagawa were obtained by Dr. M.Sato,
Department of Geophysics, Tohoku University

October, 2002,
Lightning flashes, optical waveband, LIS (Lightning Imaging Sensor) Data,
(<http://thunder.msfc.nasa.gov/data/lisbrowse.html>)



Ionosphere sounding

Ionosonde ISP-42

Ionosphere sounder - radar

Height: 0-800 km

Frequency:

1.0-22.6 MHz



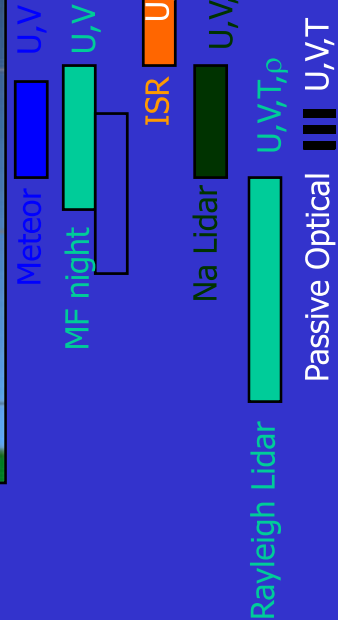
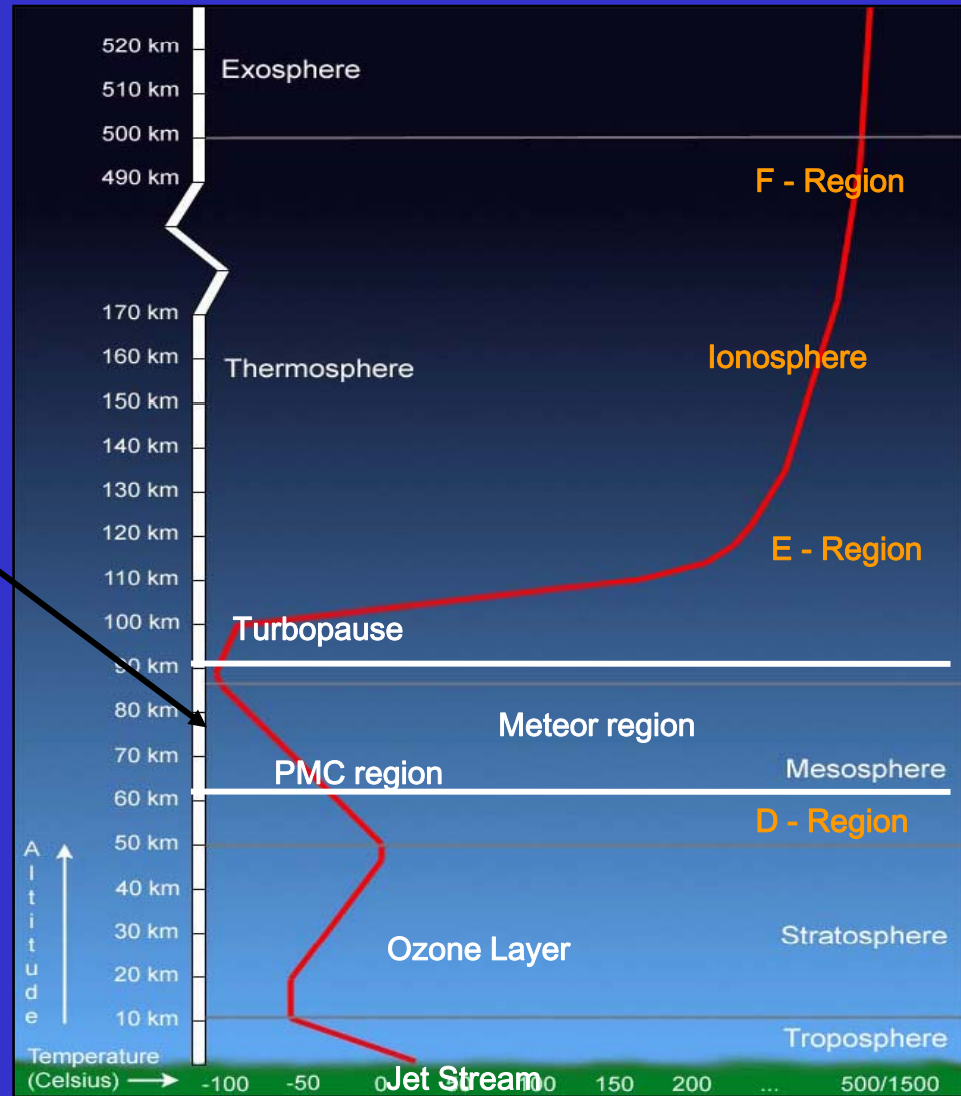
Atmosphere structure

The mesopause, coldest place on earth - 130K in polar summer, due to dynamical cooling (gravity waves)

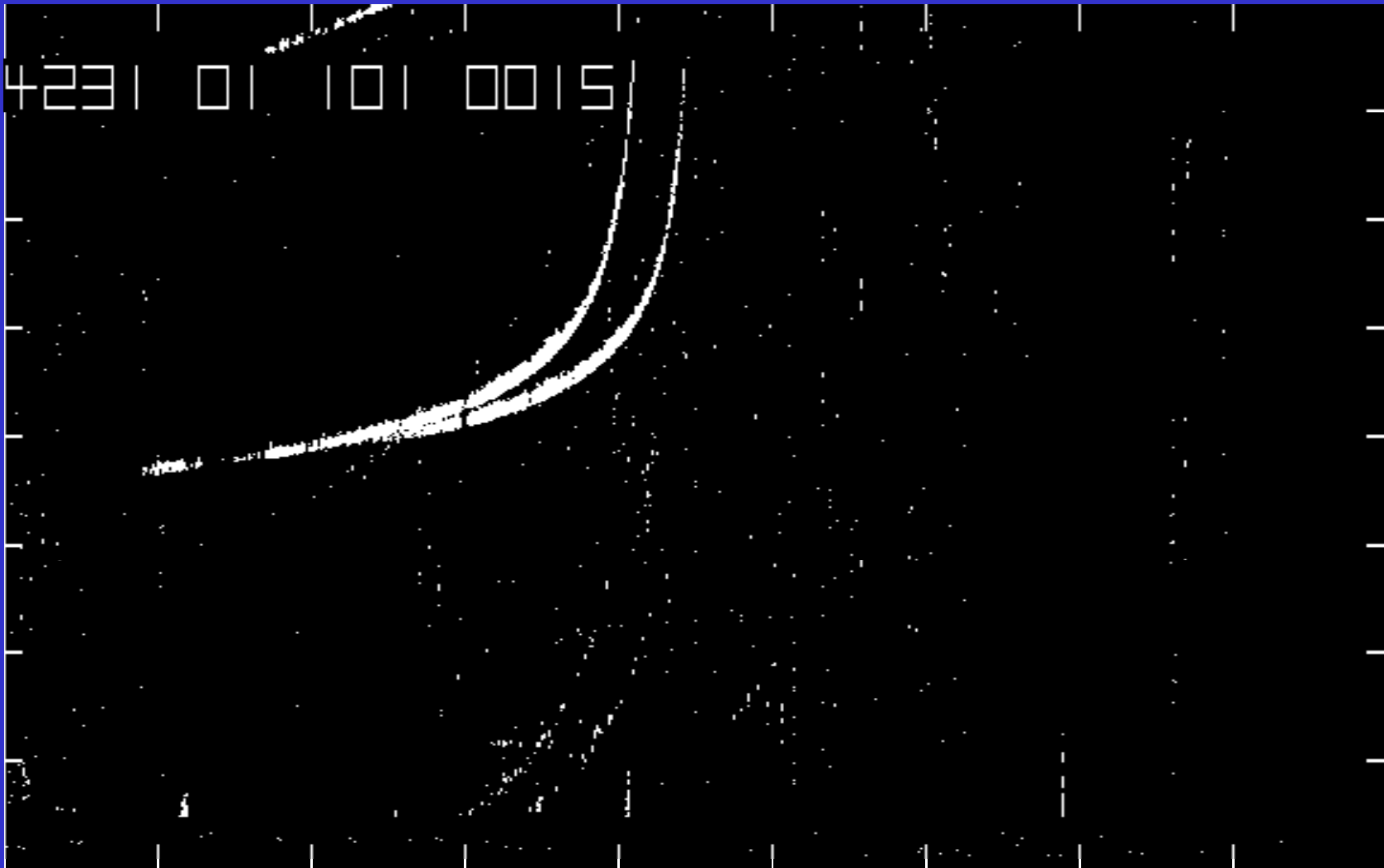
0.00063 mb

0.79 mb

1000 mb



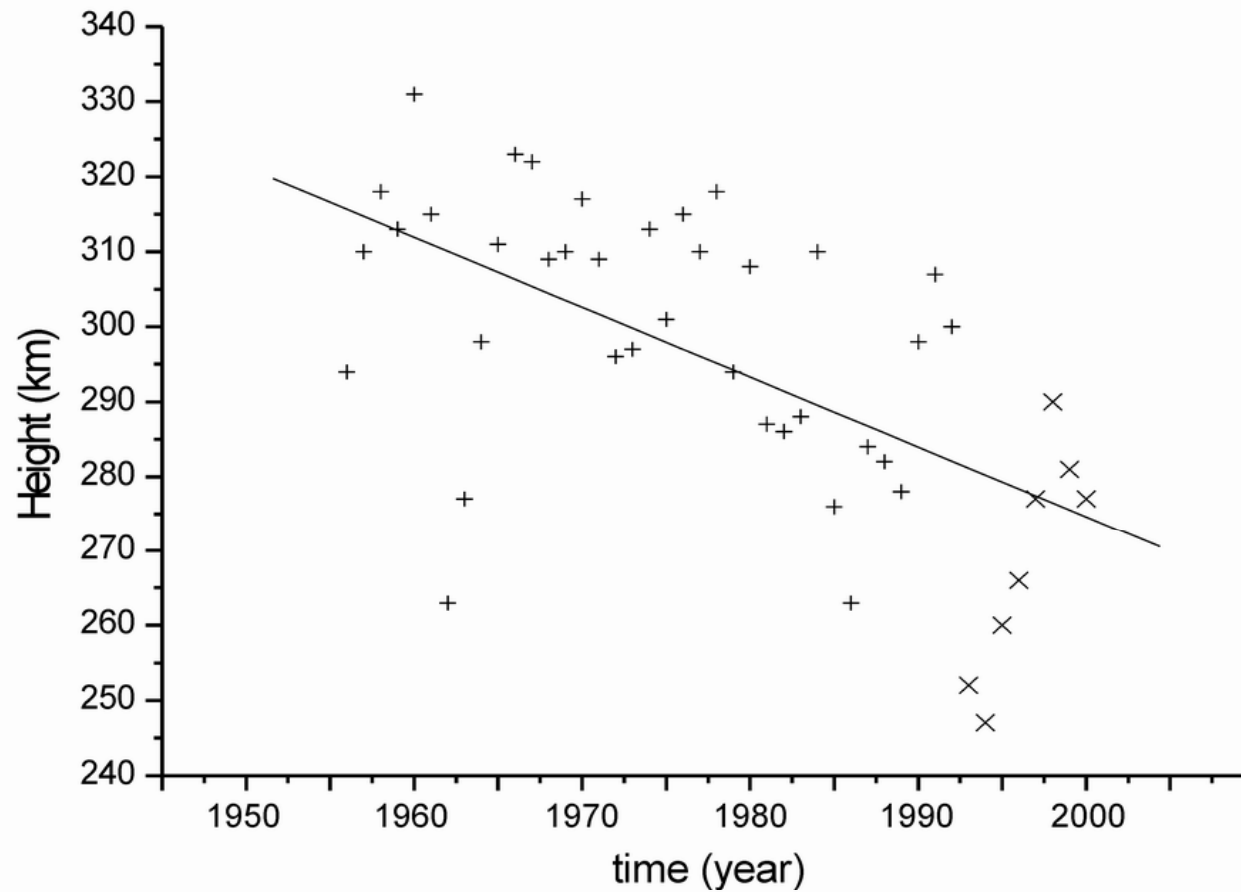
Files of digital ionogram images

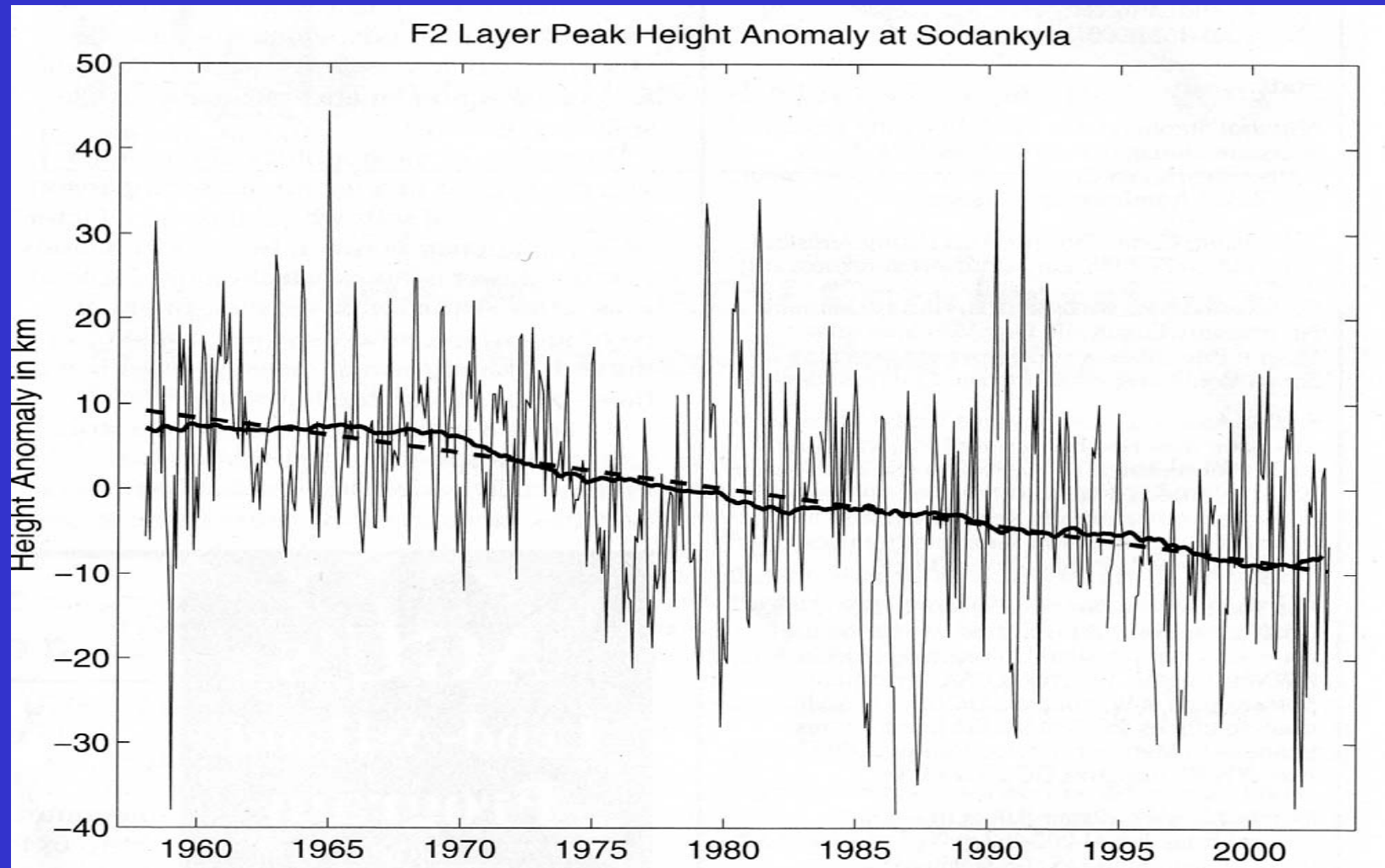


Geomagnetic storm, April 11-13, 2001

Greenhouse effect - cooling

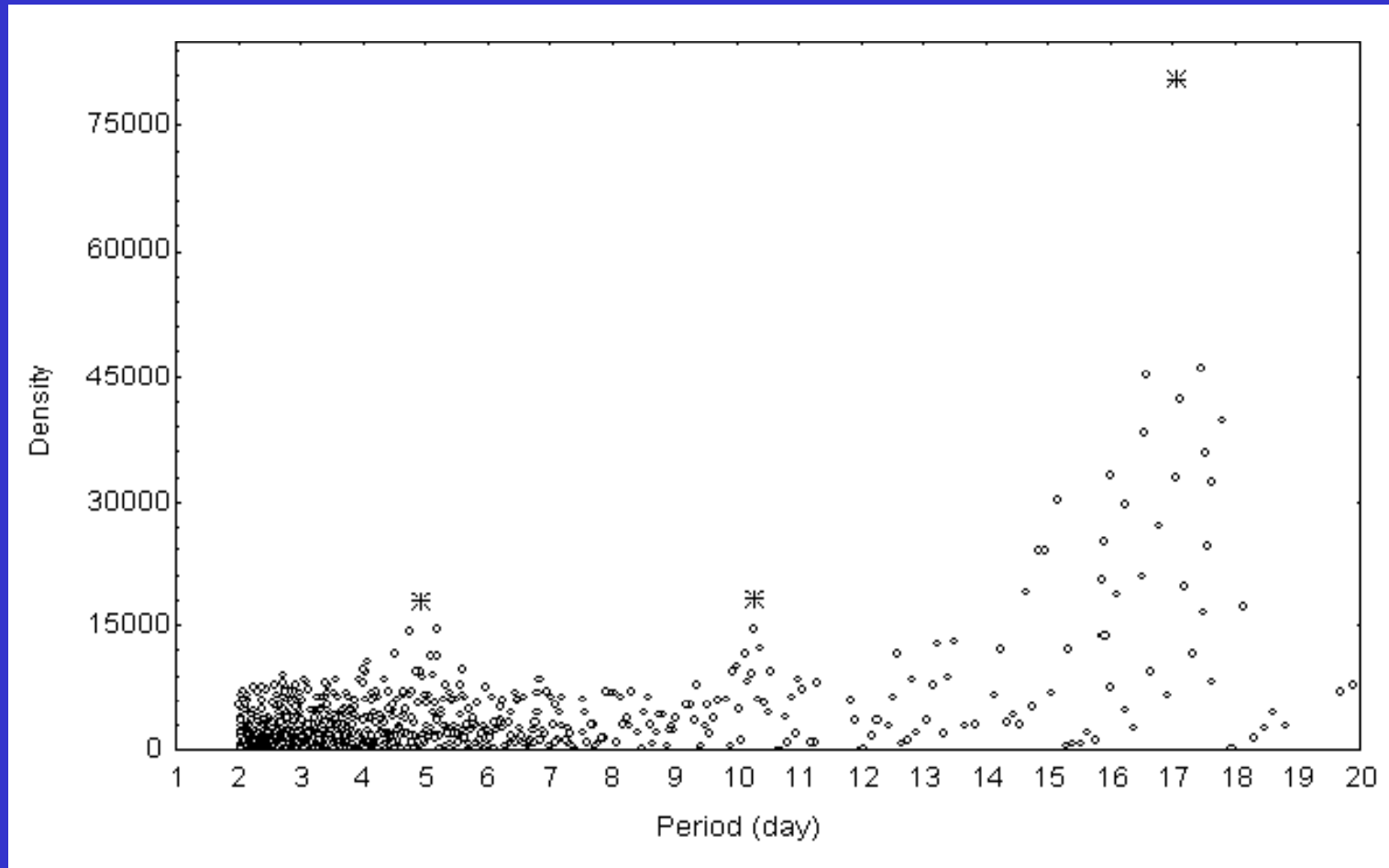
Ionosphere layer F2 height: Faraday/Vernadsky data



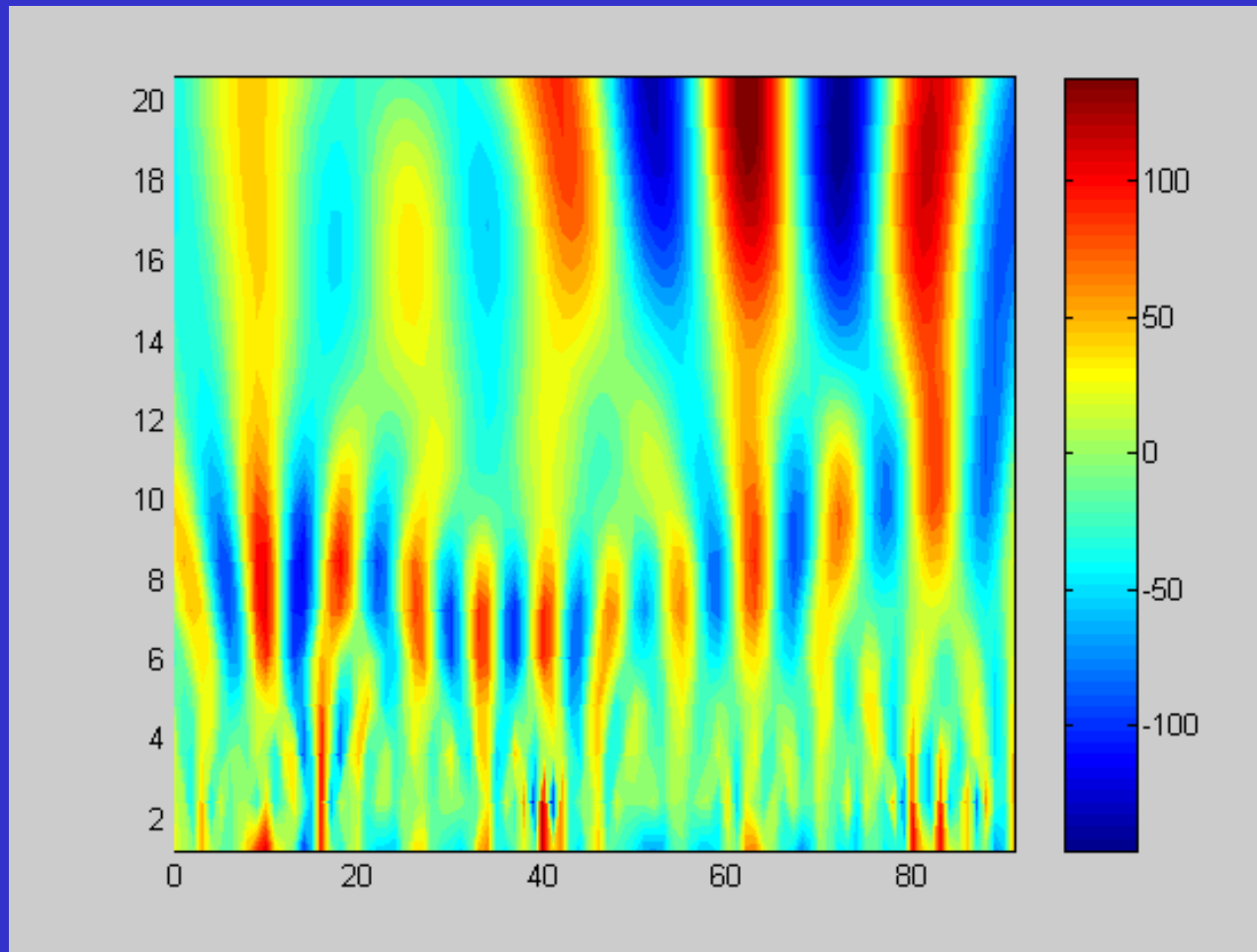


Lowering of F2 layer ionosphere by Sodankyla,
Finland in 1957-2005

Troposphere-ionosphere interaction – search of planetary wave propagation to ionosphere heights



Planetary waves in F2 height variations



Wavelet analysis of F2 layer variations
January-March 1999 (Vernadsky Station)



Task 4

**Biology, human biology,
adaptation**

Biology at Faraday (Petermann Island)



BAS

The toxicant XRF-analysis of gentoo penguin feather of Petermann Island colony, Antarctic Peninsula



Petermann Island represents the southernmost breeding population of gentoo penguin

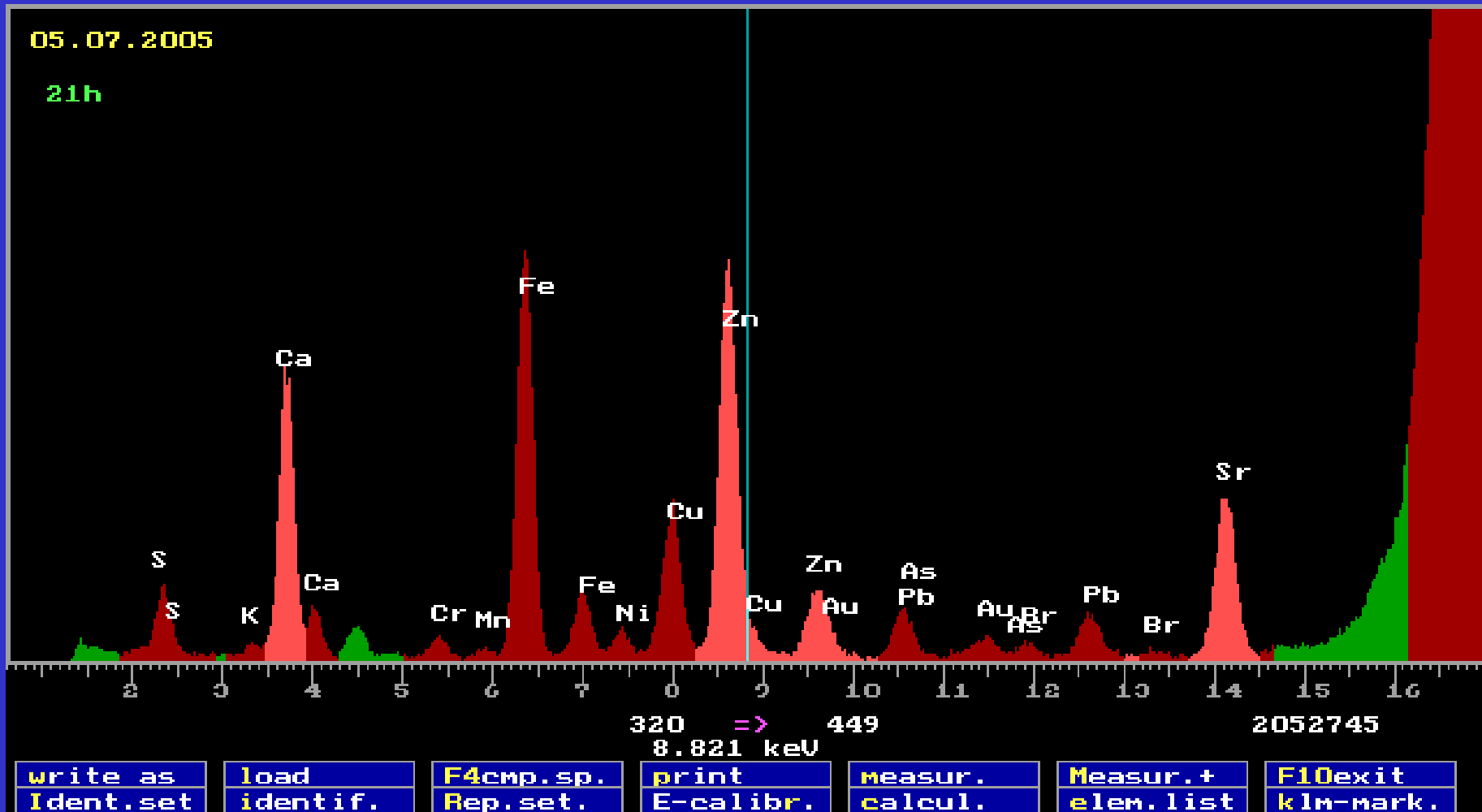


High resolution spectrometer for micro-volume analysis



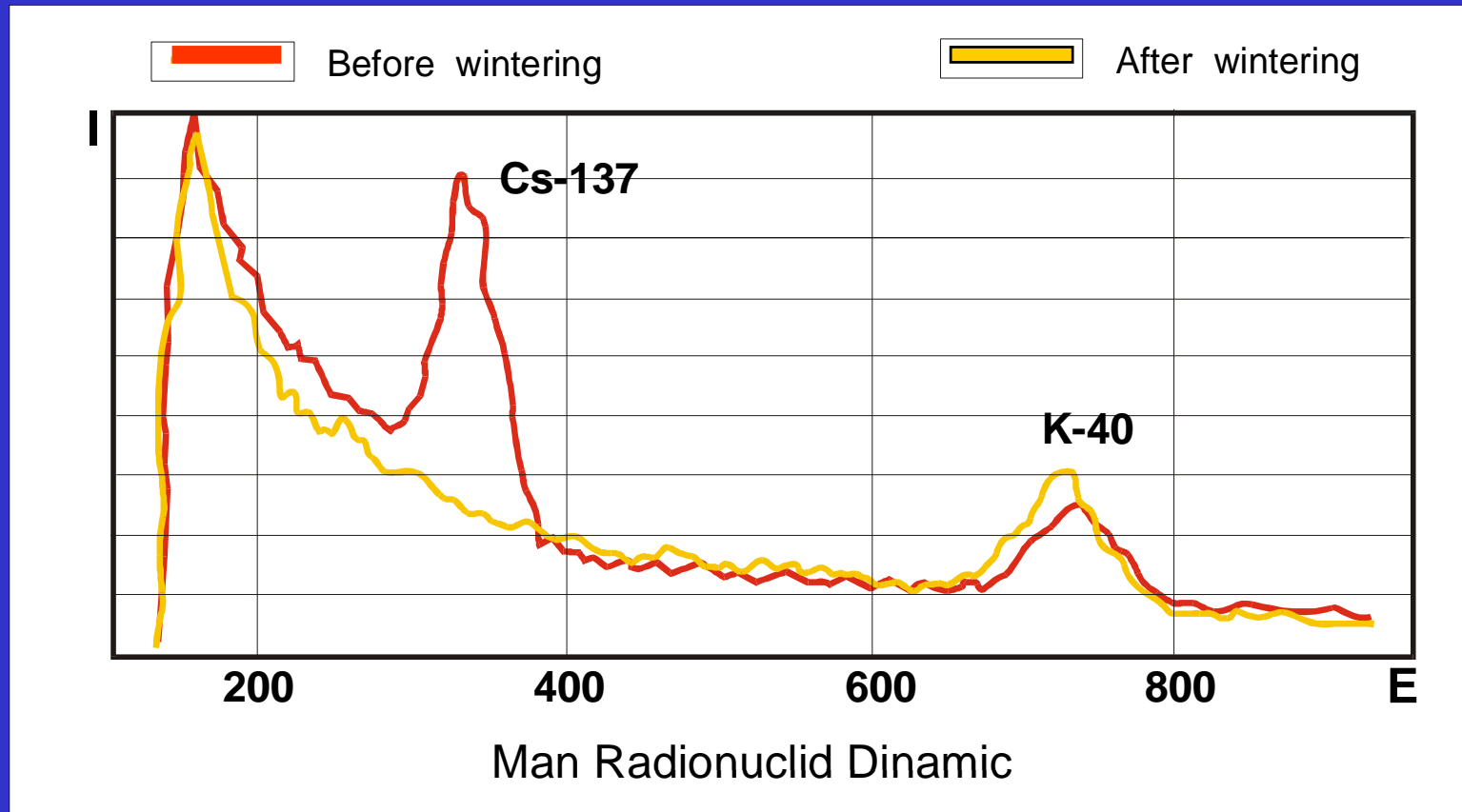
05.07.2005

21h



Feather head XRF-spectrum contained Au

Ukrainian winterers have usually increased amount of Cs-137 in body

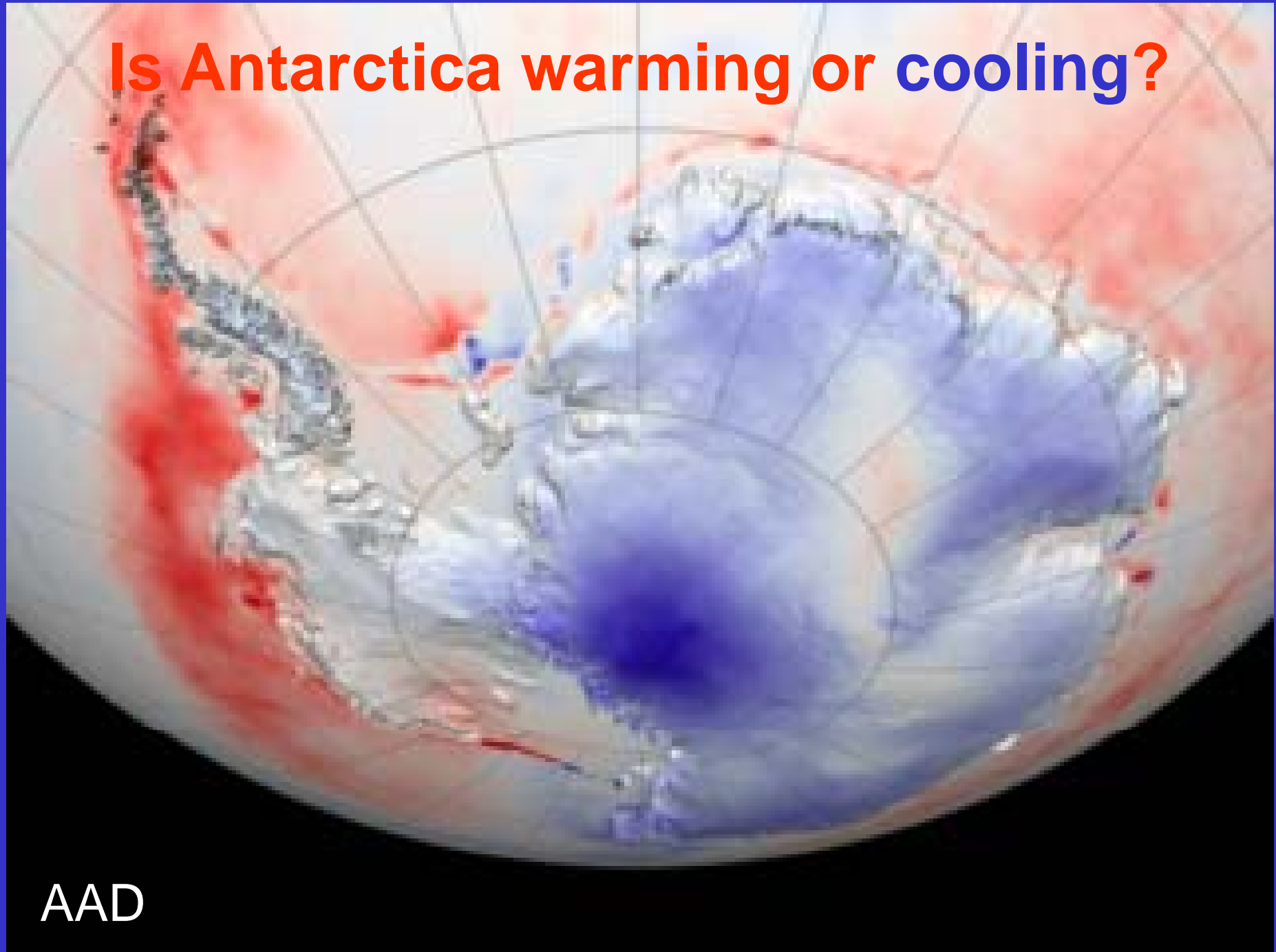


After winter the Cs amount in body essentially decreased

Conclusion: Priorities of research for IPY
2007/8 activity

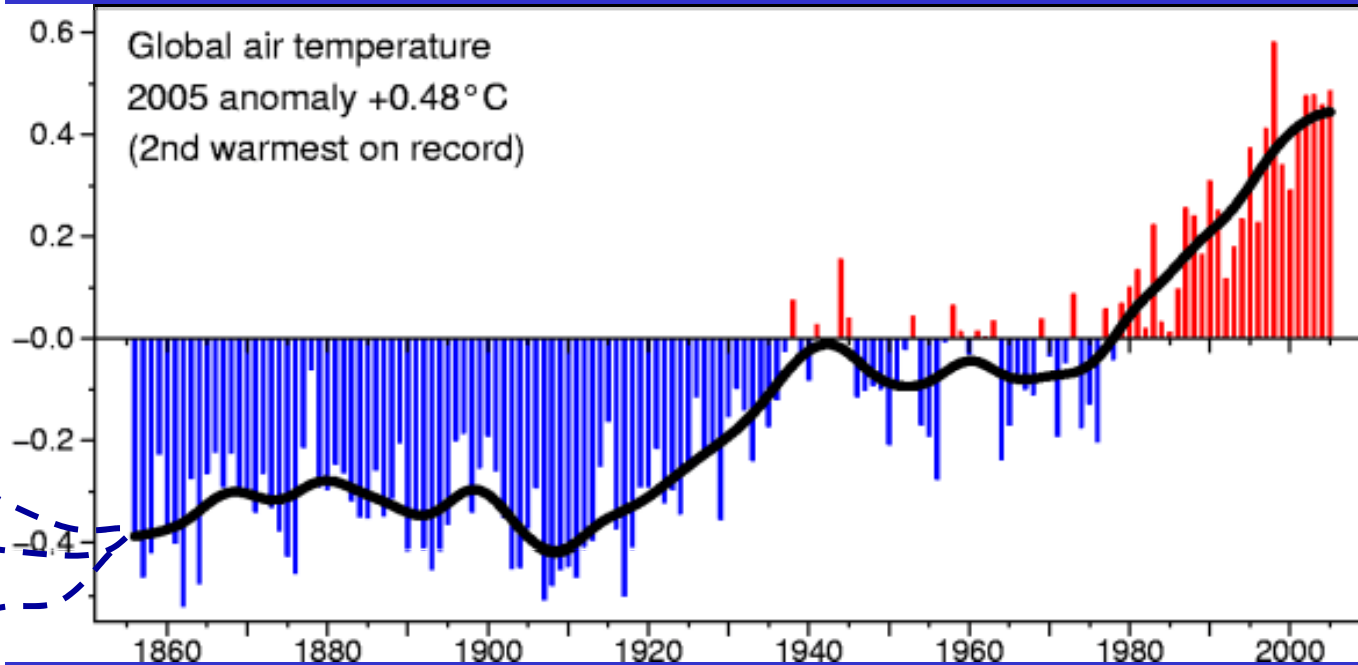
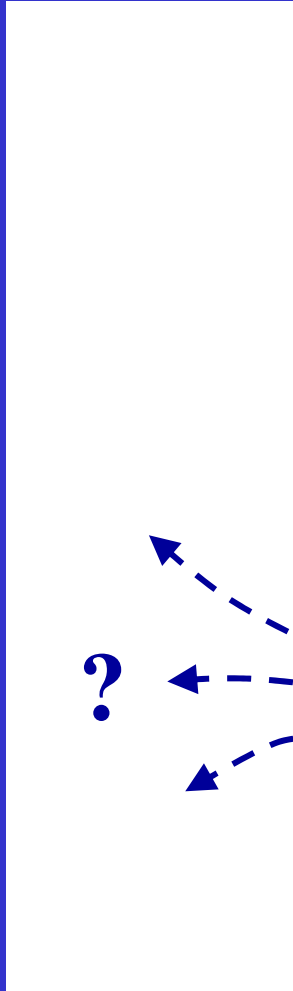
- **Climate variability study (CLICOPEN)**
- **Ozone hole dynamics (ORACLE-O3)**
- **Upper atmosphere (ICESTAR/IHY)**
- **Climate change impact on ecosystem**

Is Antarctica warming or cooling?



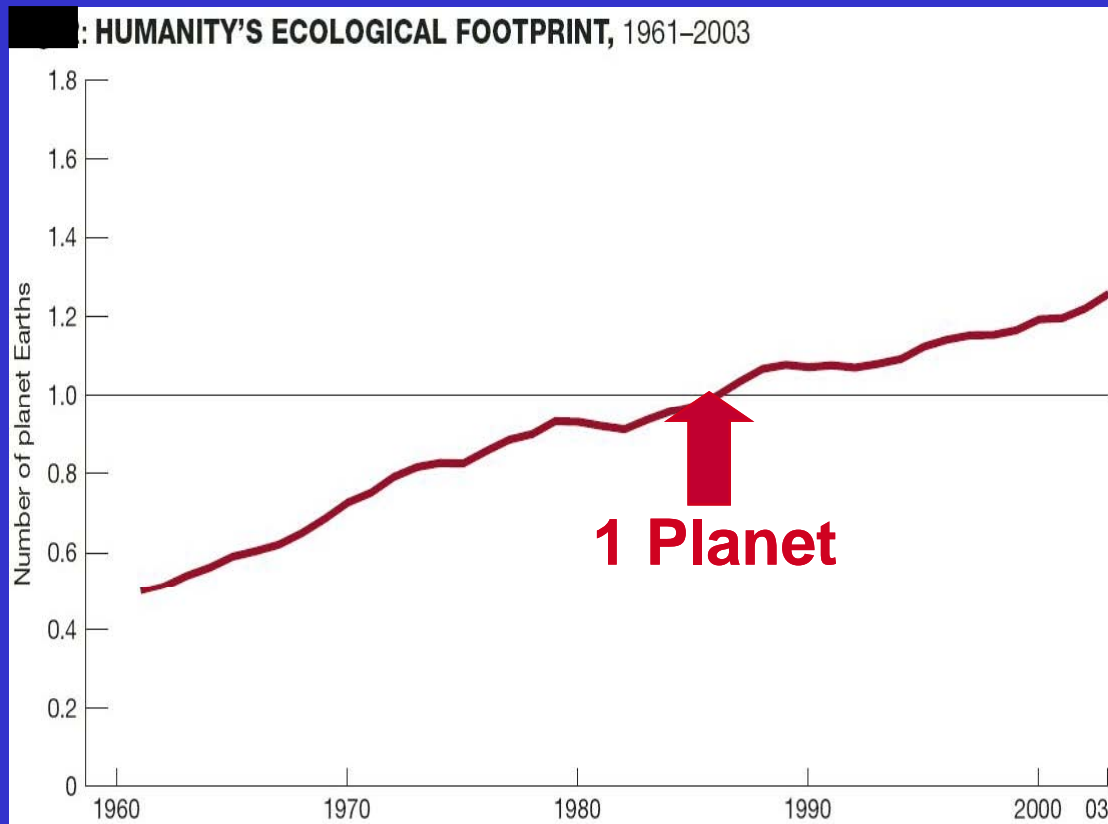
AAD

Future temperatures?



Source: Hadley Centre, UK Met. Office.

Human footprint



Human Ecological Footprint

Area of biologically productive land and water needed to provide ecological resources and services used by humanity

Very similar we saw...



Wikipedia

New Orleans Sept 2005

What to find to eat?

