

資料 2

日本北極海会議 2011年7月26日

国際極年から北極温暖化研究最前線へ — 国際情勢と北極科学研究の連環 —

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- ・北極探検
- ・環北極観測の開始: IPY、IPY-2、IGY、IPY 2007-2008
- ・冷戦構造の崩壊: 北極観測の活発化: IASC、北極センター
- ・北極急変とオールジャパンでの北極研究 スパールバル・ニーオルスン

北極航路

15世紀、アジアへの北方迂回路を求めたイギリス、オランダは北極探検を開始。17世紀に入るとスペイン衰退に伴い必要がなくなる。しかし18世紀末から再び活発化。



北西航路

1903 ~ 06年、アムンセン
初通過(ユア号)



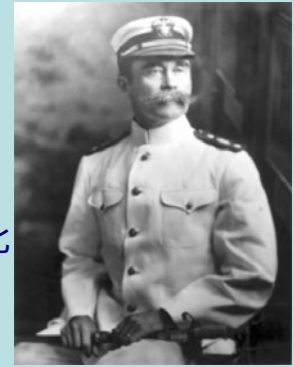
北東航路

1878 ~ 79年、ノルデンショルド初
通過(ウェガ号)

北極点到達



1909年4月6日、ピアリーが北極点に建てた旗



Robert E. Peary
(1856 - 1920)

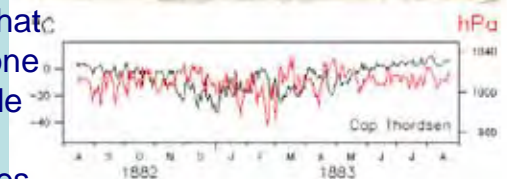


北極点横断飛行船
ノルゲ号、アムンセン
1926年



国際極年 International Polar Year (IPY) 1882-83

First International Polar Year (1882-1883): The idea of International Polar Years was the inspiration of the Austrian explorer and naval officer Lt. Karl Weyprecht who was a scientist and co-commander of the Austro-Hungarian Polar Expedition of 1872-74. From his experiences in the polar regions Weyprecht became aware that solutions to the fundamental problems of meteorology and geophysics were most likely to be found near the Earth's poles. The key concept of the first IPY was that geophysical phenomena could not be surveyed by one nation alone; rather, an undertaking of this magnitude would require a coordinated international effort. 12 countries participated, and 15 expeditions to the poles were completed (13 to the Arctic, and 2 to the Antarctic). Beyond the advances to science and geographical exploration, a principal legacy of the First IPY was setting a precedent for international science cooperation. Unfortunately Weyprecht did not live to see his idea come to fruition. (www.arctic.noaa.gov/aro/ipy-1/)



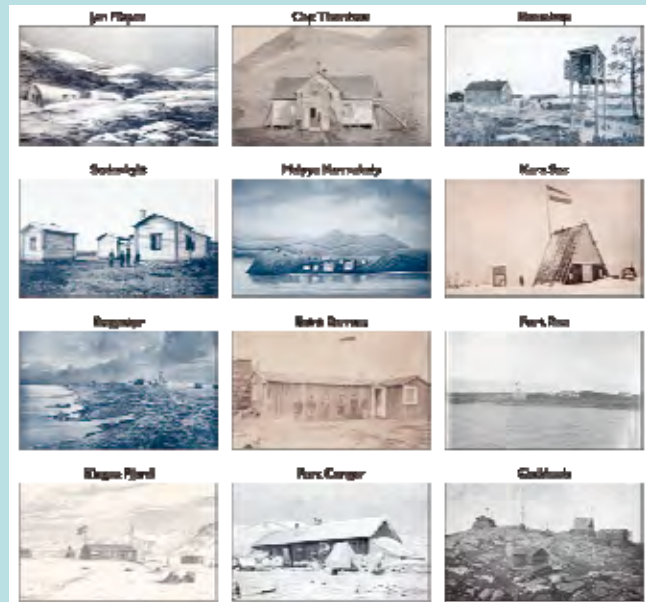
Weather station and meteorological data recorded at Cap Thorsden, Spitzbergen, during the first IPY.

International Polar Year (IPY) 1882-83

12 Principal research stations established in the Arctic during the first IPY, 1881-84.



Map of 12 stations



12 stations

IPY-2 1932-33 第2回国際極年

Second International Polar Year (1932-1933): The International Meteorological Organization proposed and promoted the Second IPY (1932–1933) as an effort to investigate the global implications of the newly discovered “Jet Stream.” 40 nations participated in the Second IPY, and it heralded advances in meteorology, magnetism, atmospheric science, and in the “mapping” of ionospheric phenomena that advanced radioscience and technology. Forty permanent observation stations were established in the Arctic, creating a step-function expansion in ongoing scientific Arctic research. In Antarctica, the U.S. contribution was the second Byrd Antarctic expedition, which established a winter-long meteorological station approximately 125 miles south of Little America Station on the Ross Ice Shelf at the southern end of Roosevelt Island. This was the first research station inland from Antarctica’s coast. (www.arctic.noaa.gov/aro/ipy-1/)

1933 - 35、バード、リトル・アメリカ基地越冬(33年の5ヶ月間1人越冬)
 なお、1929年11月29日、航空機にて南極点到達(上空)

IPY-2 (1932-33)

Drifting Station North Pole (USSR/Russia) 1937~
海水漂流基地、以後現在まで続く



(a)



(b)

Figure 1.2. (a) The ship Cheladzin is beached in the ice of the Chukchi Sea in 1933; (b) ice camp and crew of the Cheladzin in March 1934.
(a) Photo by Yu. Galst. (b) Photo by P. Sosolov.



(a)



(b)

Figure 1.6. (a) Aerologists Vasily Kanaki (on the left) and Igor Tsigel'nitsky prepare for launching a radiosonde at the 'North Pole-3' drifting station (1954); (b) general view of the construction of the 'NP-3' drifting station (April 1954).
(a) Photo from V. Savvitanov. (b) Photo from the RGMMA archives.

International Geophysical Year IGY 国際地球観測年

The International Geophysical Year (1957-58): The International Geophysical Year (IGY), 1 July 1957 to 31 December 1958, celebrated the 75th and 25th anniversaries of the First and Second IPYs. The IGY was conceived by a number of post-WWII eminent physicists, including Sydney Chapman, James Van Allen, and Lloyd Berkner, at an informal gathering in Washington, DC in 1950. These individuals realized the potential of the technology developed during WWII (for example, rockets and radar), and they hoped to redirect the technology and scientific momentum towards advances in research, particularly in the upper atmosphere.

(www.arctic.noaa.gov/aro/ipy-1/)

IASC

International Arctic Science Committee

国際北極科学委員会

1990年に北極圏8カ国で設立、非北極圏国も加わり現在18カ国

(カナダ、デンマーク、フィンランド、アイスランド、ノルウェー、ロシア、スウェーデン、アメリカ、中国、フランス、ドイツ、イタリア、日本、オランダ、ポーランド、韓国、スイス、イギリス)

ICSUの”International Associate”准会員

IASC Council ; IASC Regional Board (8 Arctic countries)

ISIRA (International Science Initiative in the Russian Arctic)

ICARP-II: 12 Science Plans; AESD, IPCA, ACP, DCBAO, AMG, ASS, TCHPS, TFBB, MPAWC, RPSRCRVSESA, ASPI, Contaminants

IASC Projects: 8 (2007); ACBio, ACD, CARMA, CEON, CHHA, WAG, TTI, MT

ACIA (Arctic Climate Impact Assessment): <-- IASC + Arctic Council

Arctic Council: high-level forum for cooperation, coordination and interaction between 8 Arctic states

FARO (Forum of Arctic Research Operators): 17 Arctic research operators

Ny-Alesund, Svalbard International Research Site



Established in 1990s by Norwegian Polar Institute (NP) and operated by Kings Bay AS (originally, KBKC).

Germany (AWI), China (CAAA), Italy (CNR), France (IPEV), Korea (KOPRI), Japan (NIPR), UK (NERC), Norway (NILU, NMA, NP, NSC, UNIS, UiT), Sweden (SU), Netherland (UoG), India (NCOAR)

北極観測の活発化<---- 冷戦構造の崩壊(ゴルバチョフ宣言1989)
我が国も観測基地設置(1991) Svalbad Treaty (1920) 第一次大戦後

MySMAC: Ny-Alesund Science Managers Committee, 1994~



(78° 55' N, 11° 56' E)

Coal mining was started at Ny-Alesund

In 1926, R. Amundsen launched airship "Norge" from NA to the North Pole

日本ニーオルスン観測基地(極地研施設)



観測基地は高速のインターネットシステムでデータ送信、メールが可能な研究室、実験室、寝室(ベッド数7)、キッチン、シャワー室、倉庫などが整備されている。



気象観測施設



スパールバル、ニーオルスン国際観測村

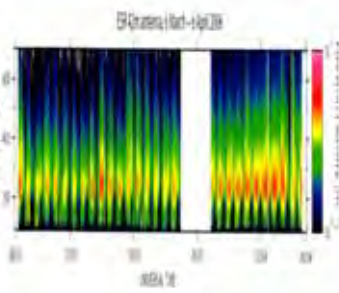
北極域における主な観測施設(極地研主導)

スパールバルの観測施設 ロングイヤーピン

EISCAT レーダー



ヨーロッパ非干渉散乱(IS)レーダー観測(EISCAT)



EISCATで観測された電子密度

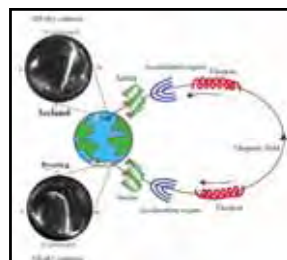


NIPR
オフィス



スパールバル大学 (UNIS)

アイスランドにおける昭和基地とのオーロラの南北半球比較観測



Study sites by National Institute of Polar Research

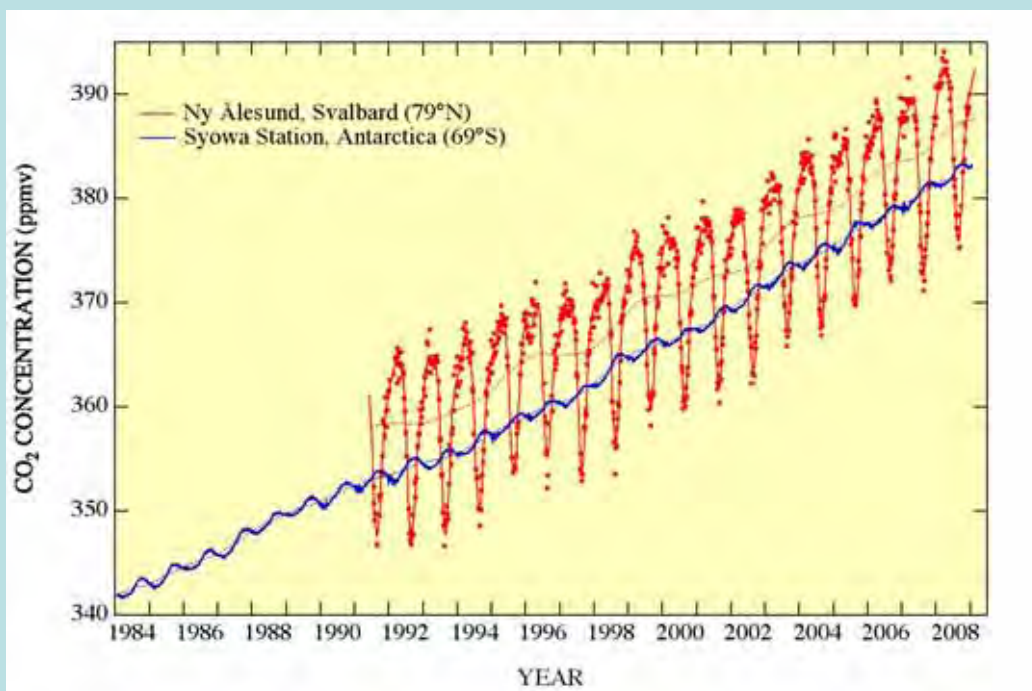
atmospheric observation
ice core drilling
terrestrial biological study
oceanographic observation
upper atmospheric observation

Trans Arctic Flight Observation

EISCAT Svalbard Radar

Rabben station at Ny-Alesund

CO₂ concentration in the Arctic and Antarctic



North-south
 difference of
 amplitude of
 seasonal
 variation

Annual increase
 rate (~1.5 ppmv/
 a)

North-south
 difference of
 inter annual
 variation

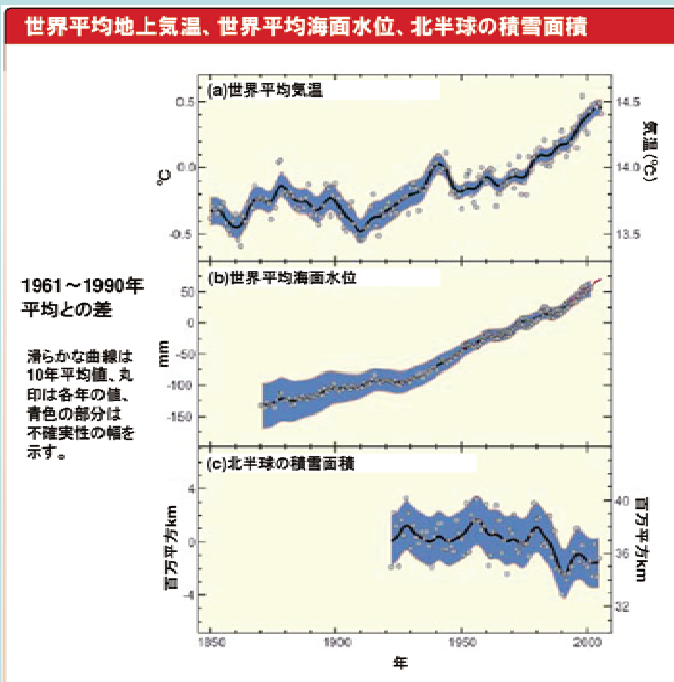
North-south
 difference of
 absolute amount

Comparison of CO₂ concentration at Ny-Alesund, Svalbard (red) and Syowa, Antarctica (blue)

IPY 2007-2008 (ICSU-WMO) International Polar Year 国際極年

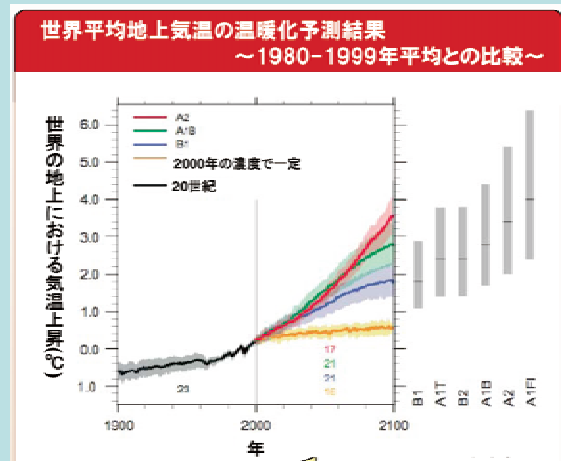
- ・IPY concept: International coordinated, interdisciplinary, scientific research and observations focused on the Earth's polar regions
- ・IPY themes: Status, Change, Global linkages, New frontiers, Vantage point, Human dimension
- ・“Scope of Science” (2007), “Edinburgh Declaration” (2006)
- ・GではなくPを選んだ(極域の重要性、生物圏の寄与大)
- ・IGYが4つに分離
 International Polar Year (IPY)国際極年 ICSU-WMO
 International Heliophysical Year (IHY)国際太陽系観測 UN/ESA/NASA
 International Year of Planet Earth (IYPE)国際惑星地球年 IUGS
 International electronic Geophysical Year (eGY)国際デジタル地球年
- ・成熟した極域科学? ———予算が取れない

地球規模気候の温暖化 IPCC (気候変動に関する政府間パネル) 報告

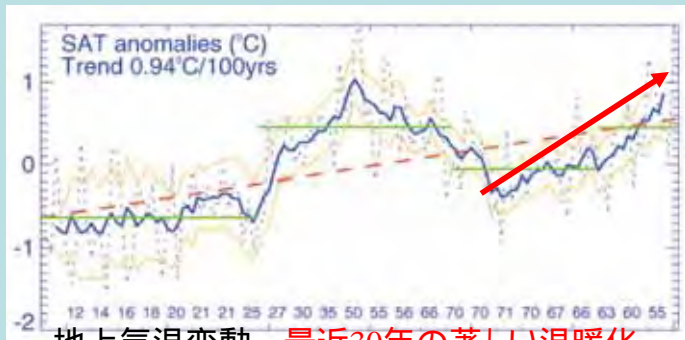


温暖化による極地の変化

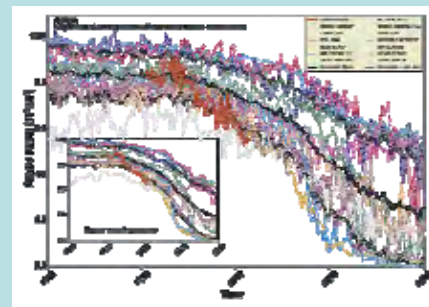
- ・北極海氷の減少
- ・グリーンランド氷床の融解



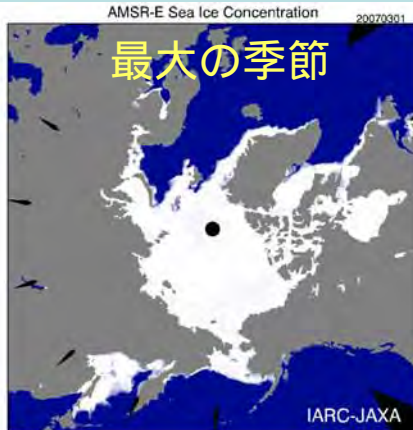
北極温暖化と海氷域の急減



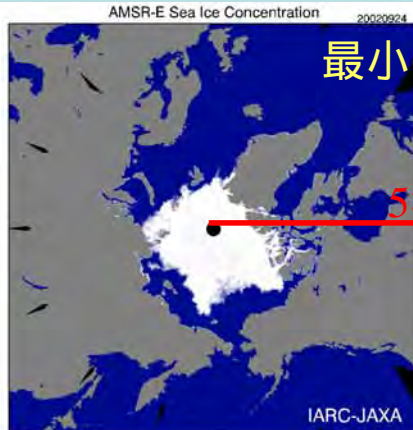
地上気温変動—最近30年の著しい温暖化



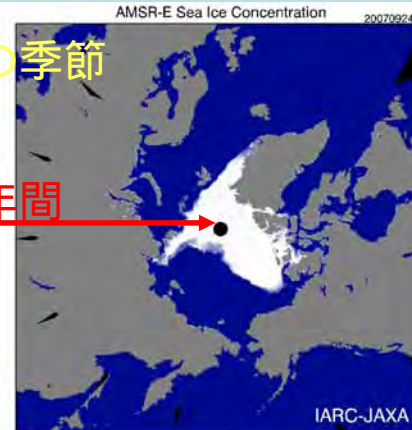
モデル予測よりはるかに早い海氷減少



2007年3月1日



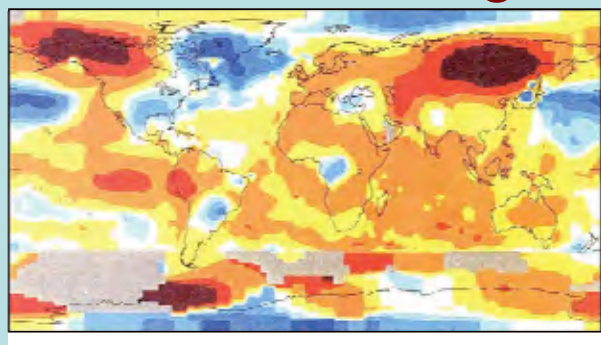
2002年9月24日



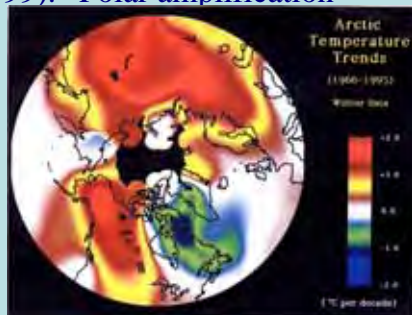
2007年9月24日

衛星からみた北極海氷の広がり、2007年9月24日、最大規模に縮小

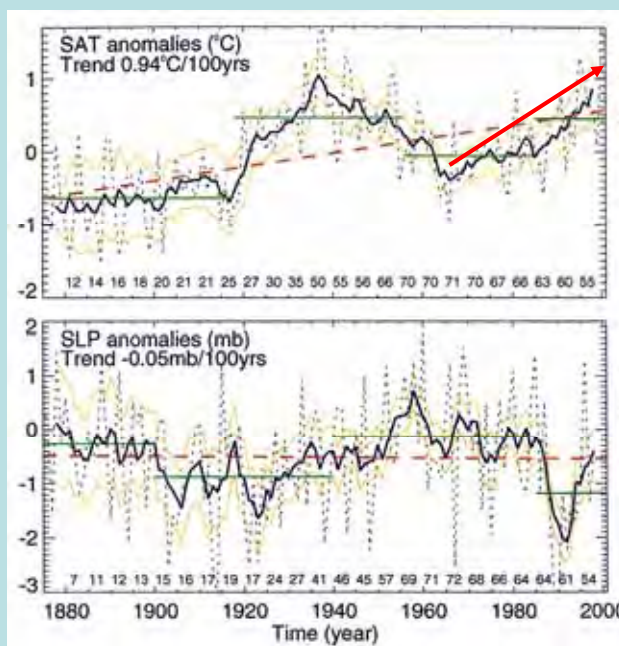
Arctic change - temperature rise



Annual surface temperature trends for 1950 to 1998 (Turner et al., 2007; after Hansen et al., 1999). “Polar amplification”



Distribution of Arctic temperature rise (Serreze et al., 2000)



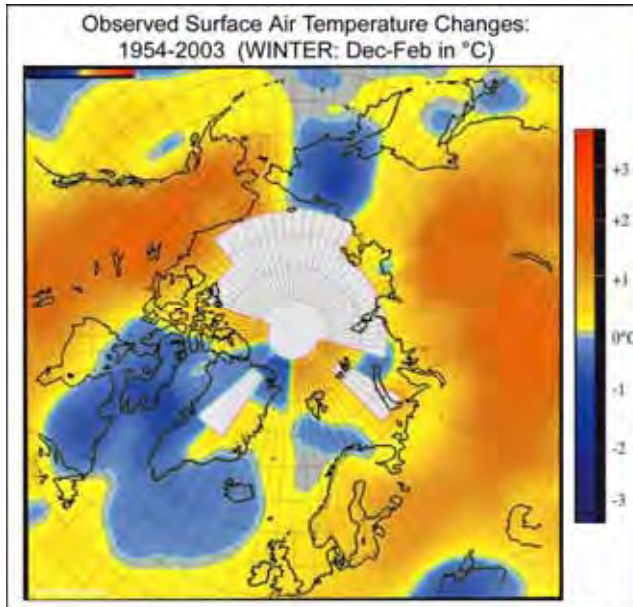
Surface air temperature in the Arctic (Polyakov et al., 2003).

1920s - 40 warming and 1940 - 60 cooling!

観測とモデル比較

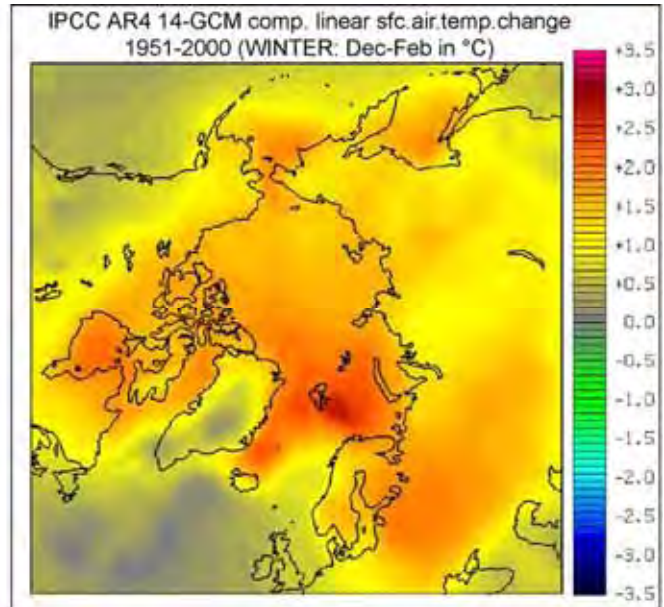
Global Warming Pattern

Observation



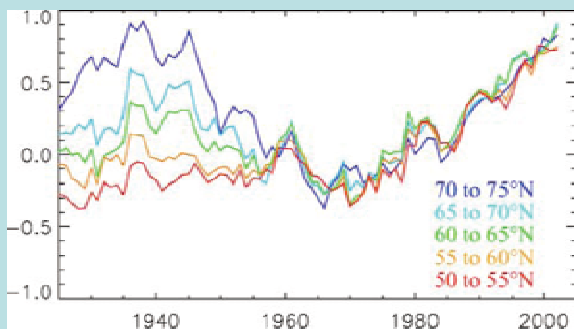
北極振動パターン(AO)

IPCC AR4 model

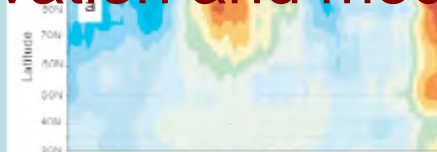


(田中博氏提供)

Early 20th C warming concentrated in high latitude: observation and model



Annual mean SAT anomalies (), data from Jones et al. (2003), Serreze and Francis (2006)



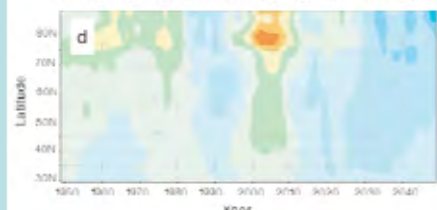
Obs. AARI data, Alekseev et al. (1999) + a



Modelled, GHGs only



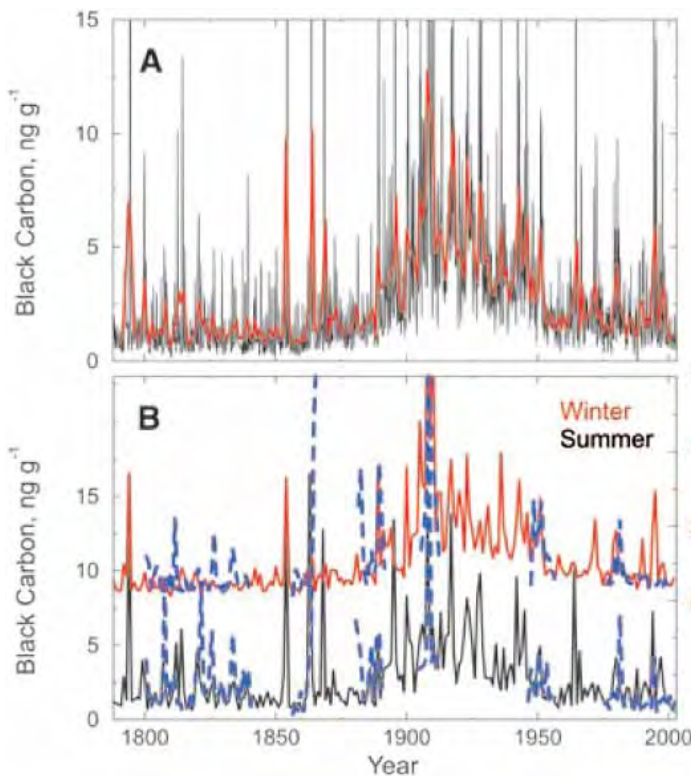
Modelled, GHGs+sulfate aerosols



Modelled control run, variability
Johannessen et al. (2004)



Black carbon from Greenland ice core

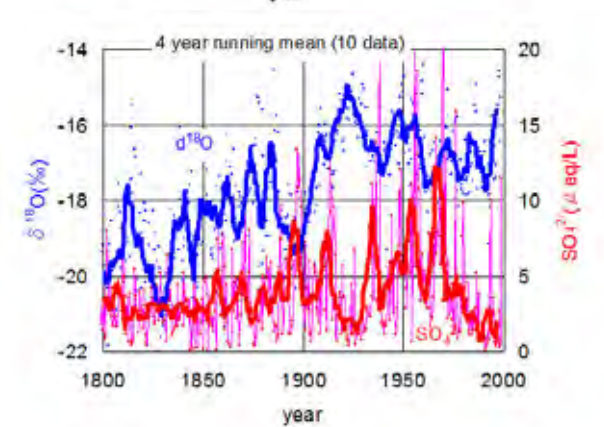
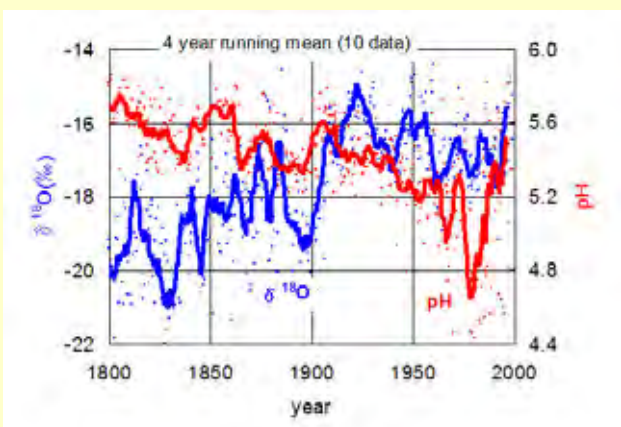
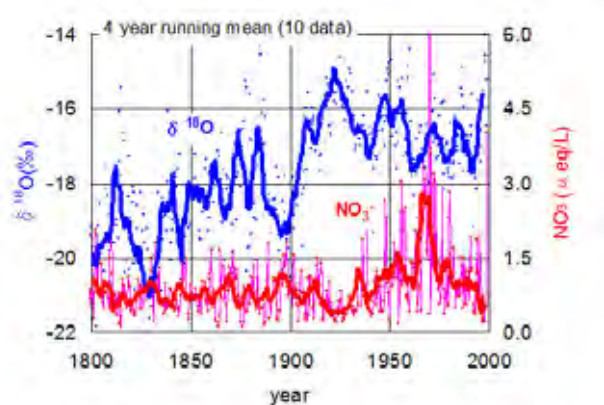


Monthly (black) and annual (red) black carbon (BC) concentrations from 1788 through 2002 measured in the Greenland D4 ice core.

Winter and summer BC concentrations show that long-term changes in BC were greater in winter (red) than in summer (black) during the late 19th and 20th centuries.

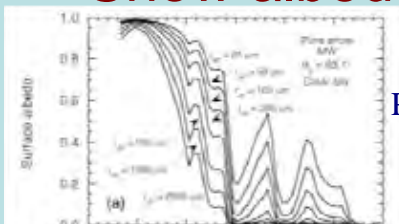
McConnell et al. (2007), Sci.

Ice core drilling in Svalbard

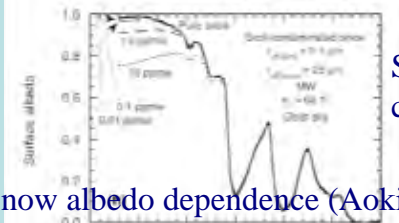


→ Join The Greenland Eemian Ice Drilling (NEEM) project

Amplification of aerosol radiative forcing Snow albedo increase by **black carbon**

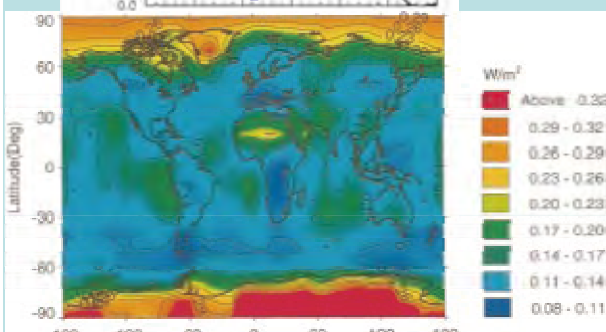


Particle size

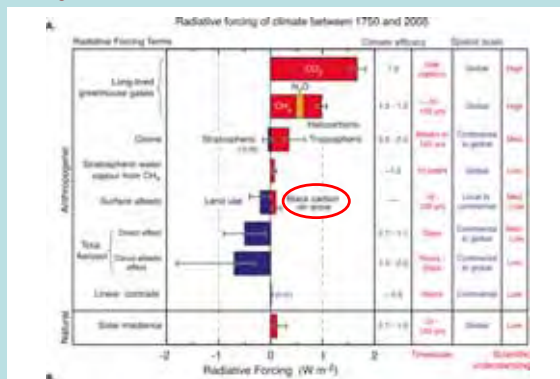


Soot contamination

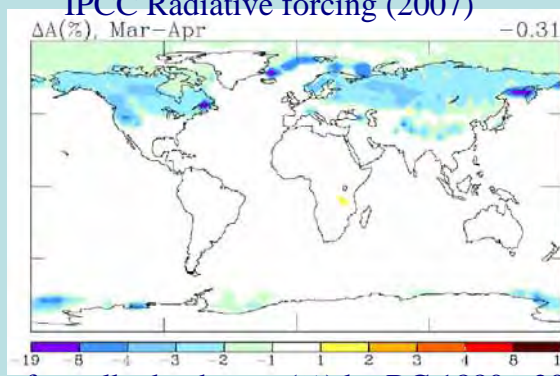
Snow albedo dependence (Aoki, 2007)



Radiative forcing due to soot aerosols (Myhre et al., 1998, Tellus)

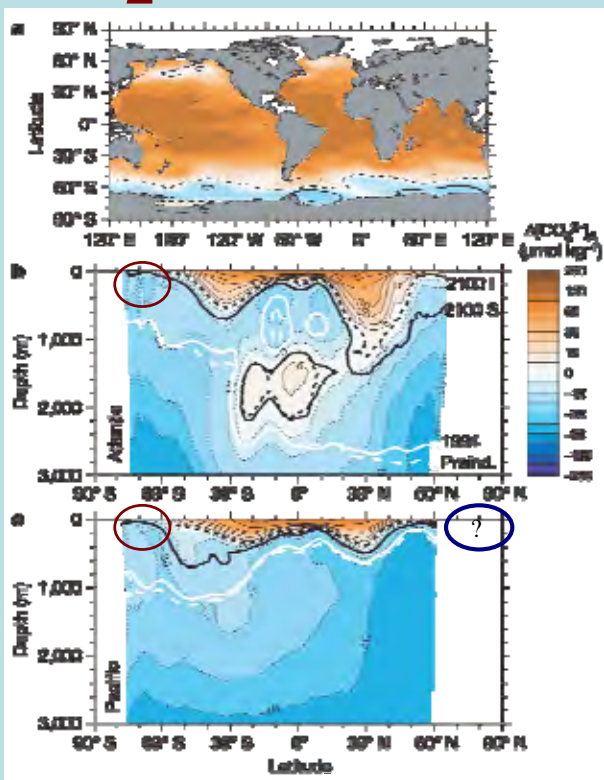


IPCC Radiative forcing (2007)

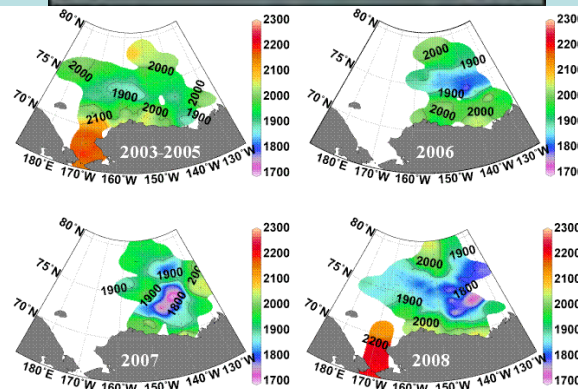
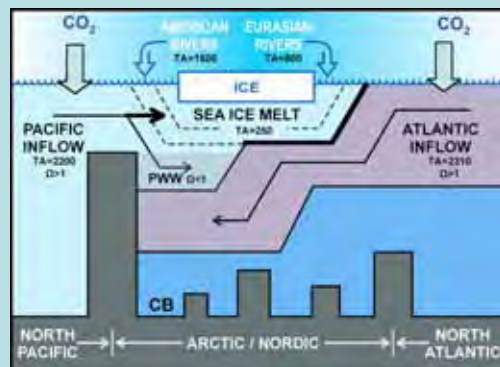


Surface albedo change (%) by BC 1880 - 2002 (Hansen et al., 2005, JGR)

CO₂ increase to ocean acidification



Saturation state in 2100 $\Delta[\text{CO}_3^{2-}]_A$ (Orr et al., 2005, Nature)



Total Alkalinity in surfaces waters of the Canada Basin (Yamamoto-Kawai, 2009)

New Interdisciplinary Research Project of the Arctic, "Arctic Change - Past, Present and Future"

(Proposal for 2009 - 2013; failed!)

Major questions:

- What was the early 20th C Arctic warming? - Black Carbon?
- Abrupt decrease of sea ice and energy exchange?
- Ocean circulation and acidification?
- Methane, carbon cycle land and ecosystem change?
- Large scale atmospheric circulation and hydrology?

First time we consolidate various Arctic research groups across institutions in Japan including NIPR, JAMSTEC, JMA/MRI, NIES, CCSR and universities under one umbrella for Arctic observations and modelling



北極域の利用可能性の高まり



< A. Walther 2010より >

Energy Resources in the Arctic

30% of the world's undiscovered natural gas and 13% of the world's undiscovered oil in the Arctic (source: USGS)



1. South Kara Sea
2. North Kara Sea
3. Laptev Sea
4. East Siberian Sea
5. Chukchi Sea
6. Alaska North Slope
7. East Greenland
8. Barents Sea

Northern Route reduces sailing distance from Yokohama to Rotterdam by 40%

UNCLOS 国連海洋法条約
(UN Convention on the Law of the Sea)
150カ国以上が批准 (米未加入)
沿岸国に大陸棚の主権を認める
(天然資源開発の排他的権利を含む)
200海里を越えて拡張申請の道

風雲急の北極ーロシア



海水が減少したことにより様々な活動が現実化



2007年8月、北極点水深4000 mに潜水艇ミールよりロシア国旗を立てた (Nature 2008) 国際的緊張

「北極条約」を待望？

国連海洋法条約(UNCLOS)に基づき、大陸棚の自然延長として排他的経済水域の200マイルを越えて延長申請(世界中で2009年5月締め切り)(太田2007)



ARCTIC COUNCIL

1996年

北極評議会 (Arctic Council)

北極圏8カ国(カナダ、デンマーク、フィンランド、アイスランド、ノルウェー、スウェーデン、ロシア、アメリカ)および先住民族(indigenous representatives)の6常任参加者からなる会議で、常任オブザーバの枠組みがあり、現在フランス、ドイツ、ポーランド、スペイン、オランダ、イギリスがその立場にある。イタリア、EUの他、中国、韓国も既にオブザーバ申請中であるところ、日本も2009年7月に申請を提出。

Only circum polar organization
Policy shaping - not decision making

さらなる動き

北極海に面した
「北極5カ国」

The "Arctic Five"



Norway
Russia
USA
Canada
Denmark

北極をめぐる状況

北極の変化: 温暖化、海氷急減、氷河崩壊、永久凍土の融解

科学的、社会的注目—海底資源、北極航路の可能性
国際的に大きな課題

わが国の北極評議会 (Arctic Council) へのオブザーバ参加申請
(2009年7月)

内外ともに北極に関心が高まっている

これからの北極観測・研究のあり方

環北極観測網の構築—国際極年 (IPY 2007-2008) が終わって:

IASCの新しい体制へ

SAON (Sustaining Arctic Observing Networks)

IASOA (International Arctic Systems for Observing the Atmosphere)

外交の進展による科学の発展; 科学による外交のサポート

南極から学ぶScience-Diplomacyを北極へ

国内体制の整備:

オールジャパン「北極研究コンソーシアム」(仮称)の構築

連携拠点(事務局)の設置—極地研とJAMSTEC(連携協定?)

北極観測センターの充実、新しい観測・研究プロジェクト構想

環北極観測網の維持・拡充



まとめ

北極・南極探検(ナショナリズムの高揚)

———> 科学観測—国際協力の必要性

国際極年

冷戦の終焉 —————> 北極国際協同観測の実現

IASC、極地研北極センター

北極急変(強温暖化、海水急減)——> 北極をめぐる国際環境変化

新しい北極研究体制