



エアロゾンデによる海面水温の連続観測

— 北極海への応用 —

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地球温暖化情報観測研究プログラム

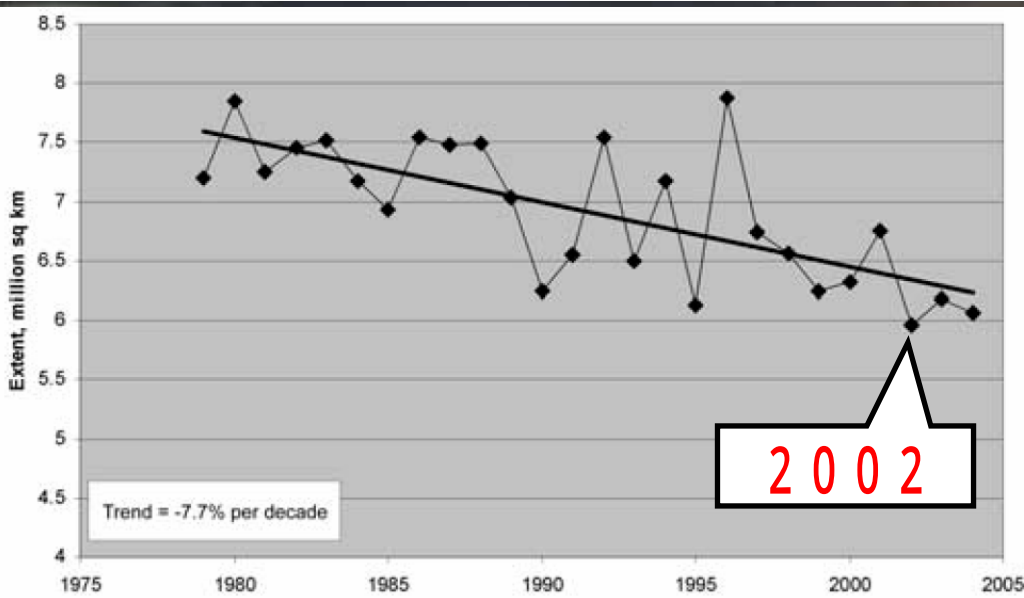
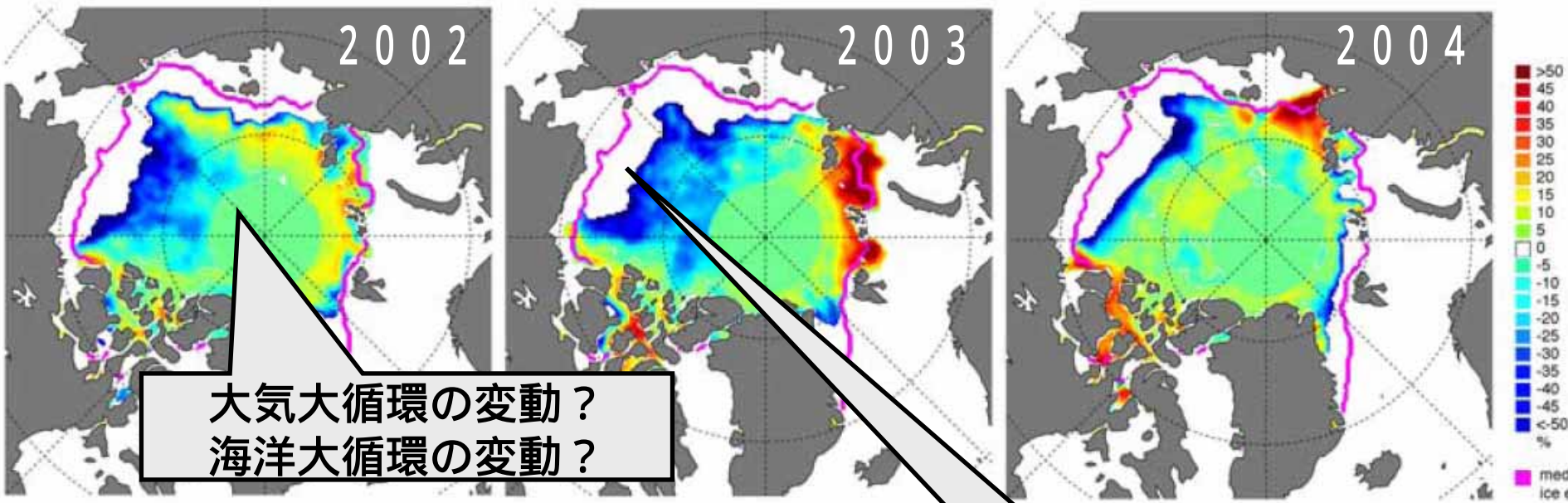
Reference:

Inoue, J. and J. A. Curry, 2004: Application of Aerosondes to high-resolution observations of sea surface temperature over Barrow Canyon, *Geophys. Res. Lett.*, **31**, L14312.
(selected as AGU Journal Highlight)

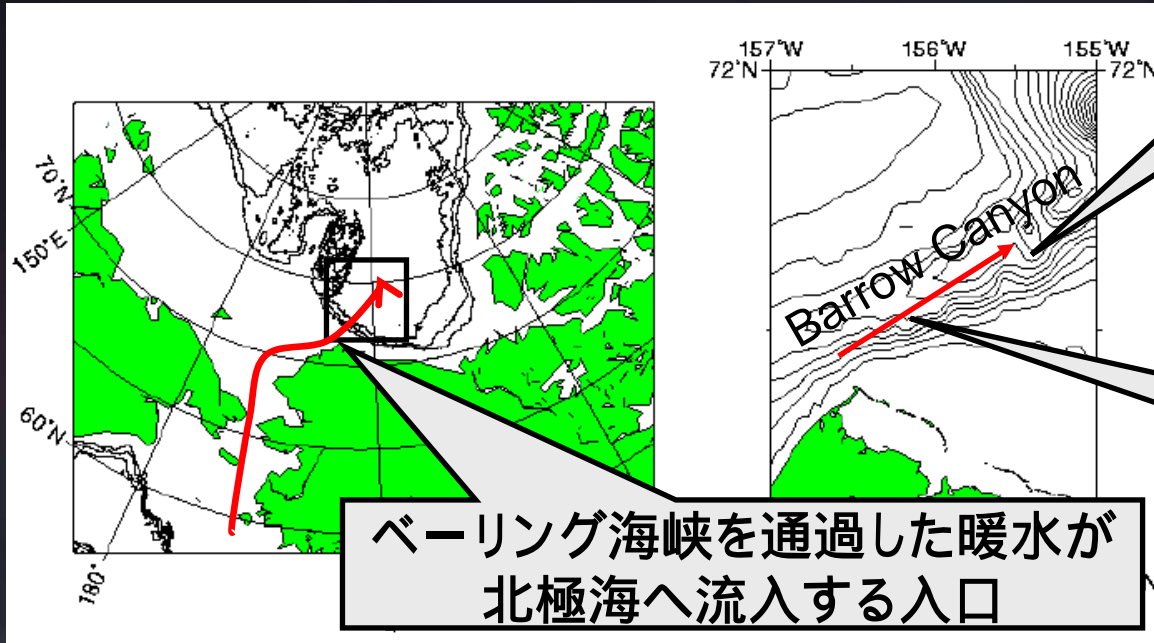


はじめに

近年の北極海における海氷の減少

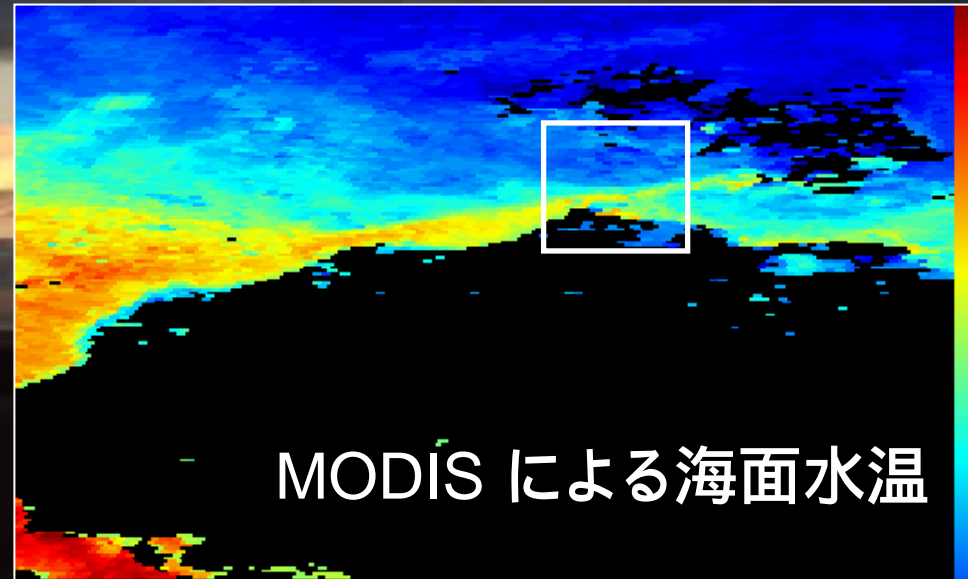


Barrow Canyon



海洋観測が困難な領域

- ADCP & CTD 船が必要
- 人工衛星 時間空間分解や雲が障害
- 上記を補うための観測が必要



Aerosonde (エアロゾンデ)

TABLE 1. Technical specifications for the Mark 3 Aerosonde.

SPECIFICATIONS	
WEIGHT	13.5 kg
WING SPAN	2.9 m
ENGINE	24 cc, fuel injected, premium unleaded petrol
NAVIGATION	GPS
PERFORMANCE	
SPEED/CLIMB	18 – 32 m s ⁻¹ /2.5 m s ⁻¹ (at sea level)
RANGE/ENDURANCE	>30 h/>3000 km
ALTITUDE RANGE	Up to 7 km (medium weight)
PAYLOAD	Maximum 2 kg with full fuel load



Curry et al. , 2004:
Applications of Aerosonde in
the Arctic, *Bull. Amer. Meteor.
Soc.*, **85(12)**, 1855-1861.

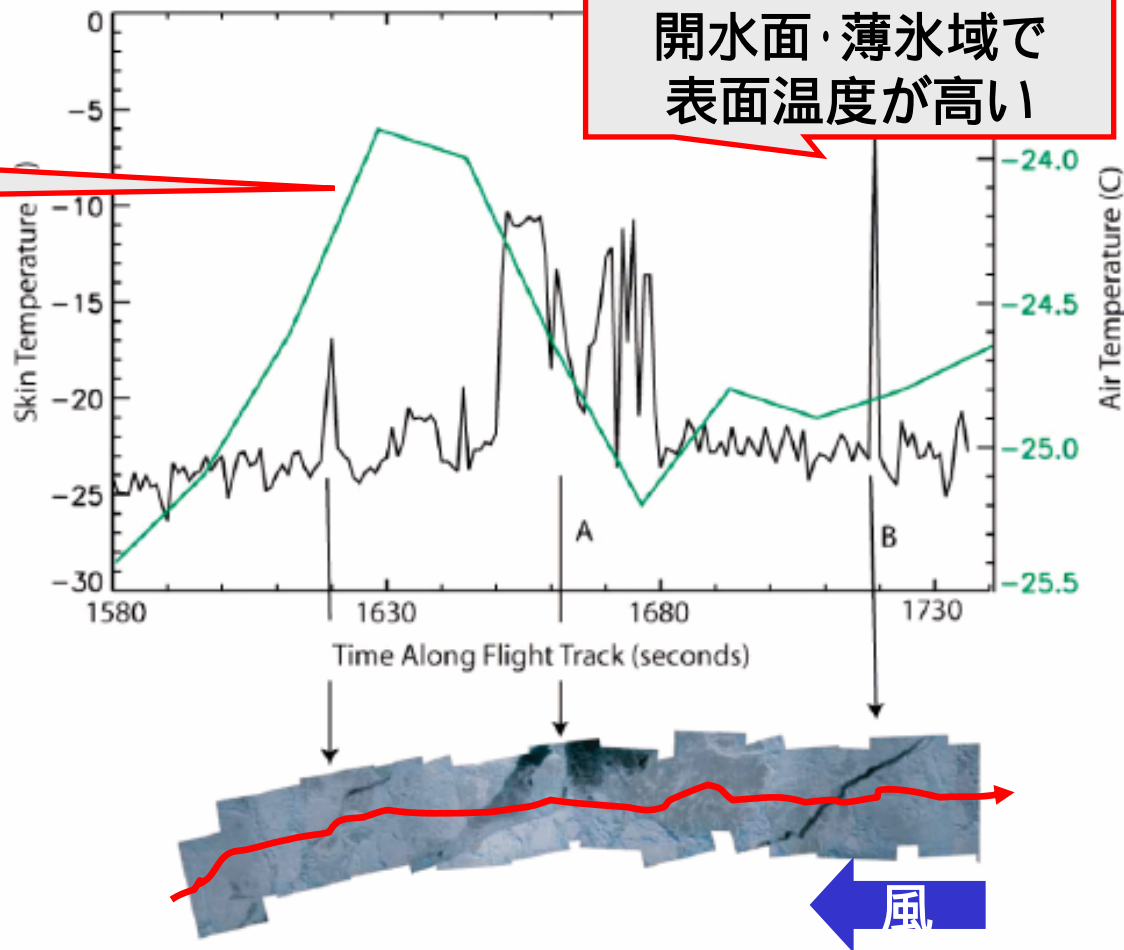
TABLE 2. Aerosonde meteorological and environmental instruments.

表面温度観測

PAYLOAD TYPE	MISSION	STATUS
Heitronics KT11 infrared pyrometer	Surface temperature	Operational
Still camera (Olympus)	Surface imaging	Operational
Video camera (Various)	Surface imaging	Operational
Sulfur and carbon compounds, NASA JPL	Volcanic plume and atmospheric chemistry	Instrument flight tested
Cloud particle image, NCAR	Cloud physics, icing	Unit complete and at integration stage
Micro Synthetic Aperture Radar, Brigham Young Univ.	Surface imaging	Unit complete and at integration stage

開水面の風下で
気温が高い

測器の組み合わせで海面・海氷面・陸面の観測を効率的に行うことができる場合もある



開水面・薄氷域で
表面温度が高い

FIG. 7. Surface temperatures (black line), air temperatures (at 200-m altitude; green line) and aerial photographs acquired along a flight-track segment within pack ice on 16 March 2003. Winds were from the east, with the aircraft flying from west to east (left to right along the x-axis). Increases in surface temperature correspond to leads visible in the photo mosaic. New and young ice in leads, as indicated at locations A and B, are associated with the darker areas in the image mosaic.

観測サイト



観測準備



Aerosonde crews



launch system



calibration



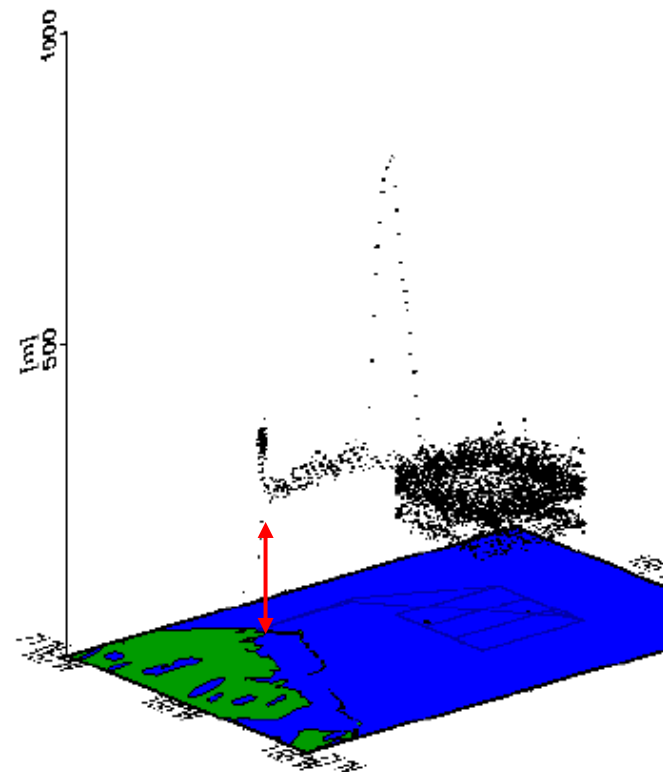
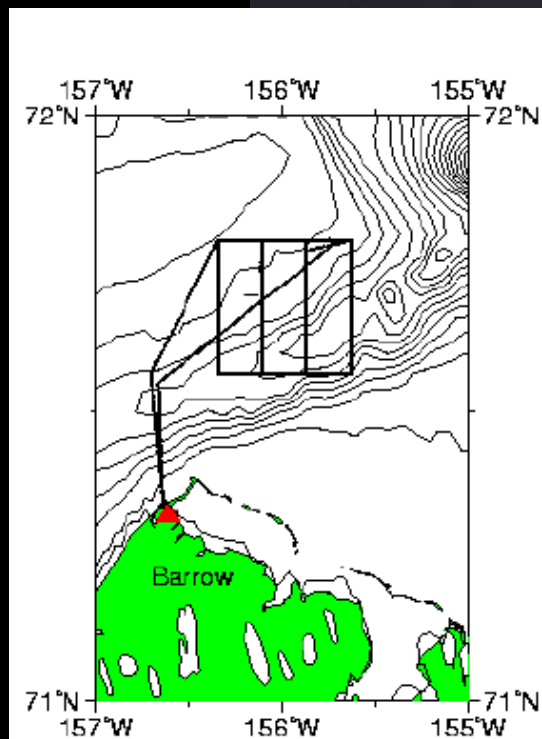
takeoff



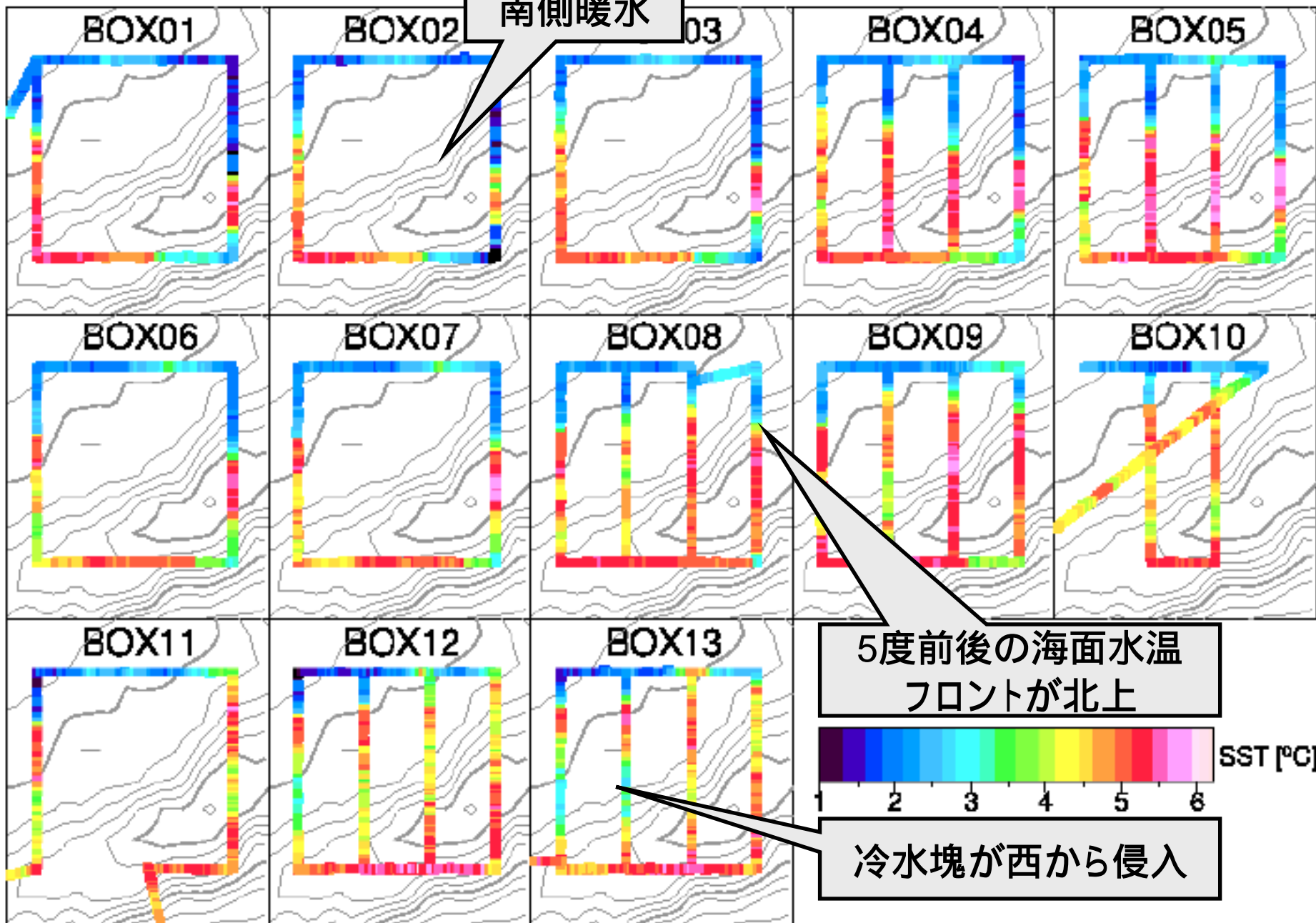
fuel-up

観測

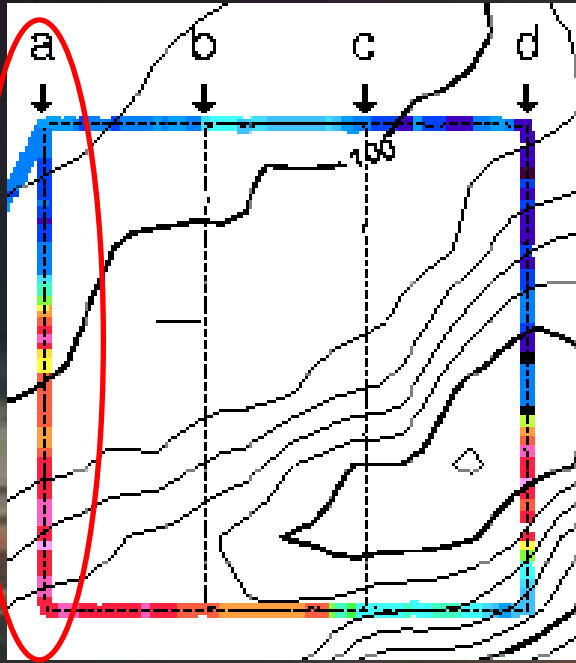
- 2002年9月20 - 21日 (27時間)
- Barrow Canyon上
- Box パターン (計13個)
 - large box (25x25 km)
 - small box (25x8.3 km)
- 1box 1.5 - 2時間
- 飛行高度: 150-250 m
(雲底下を観測)



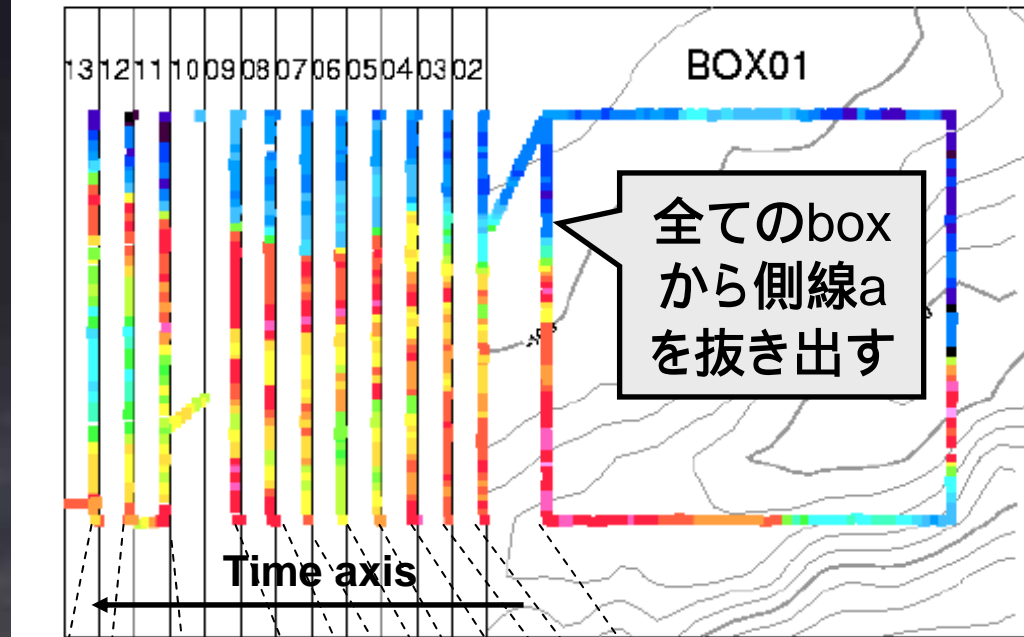
観測結果



表層の流れの見積もり (時間-緯度断面の作成) (側線aの例)

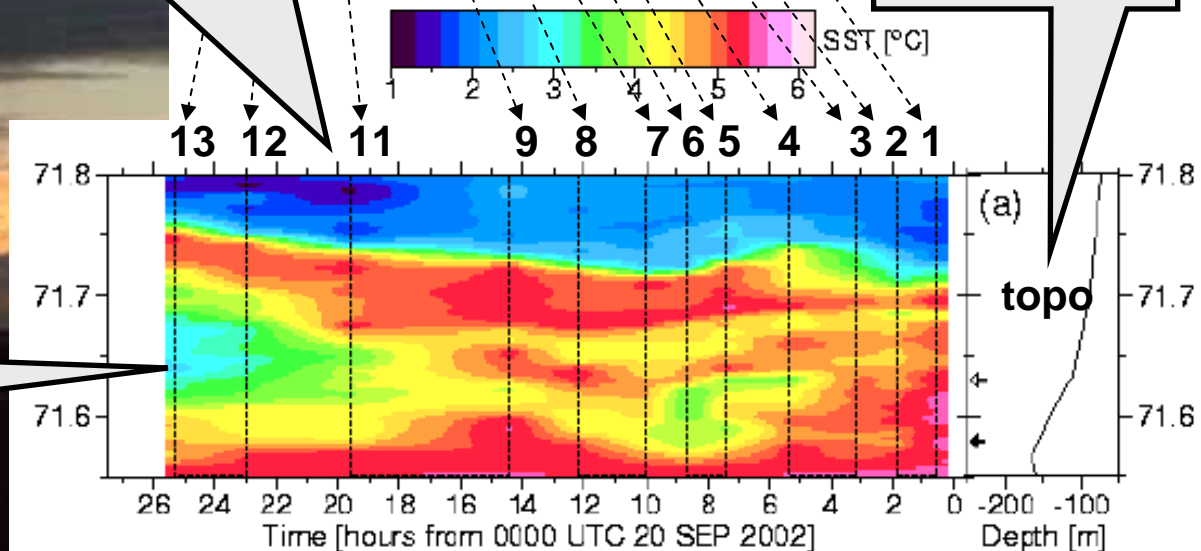


この図を各側線
(a,b,c,d)に関して作成

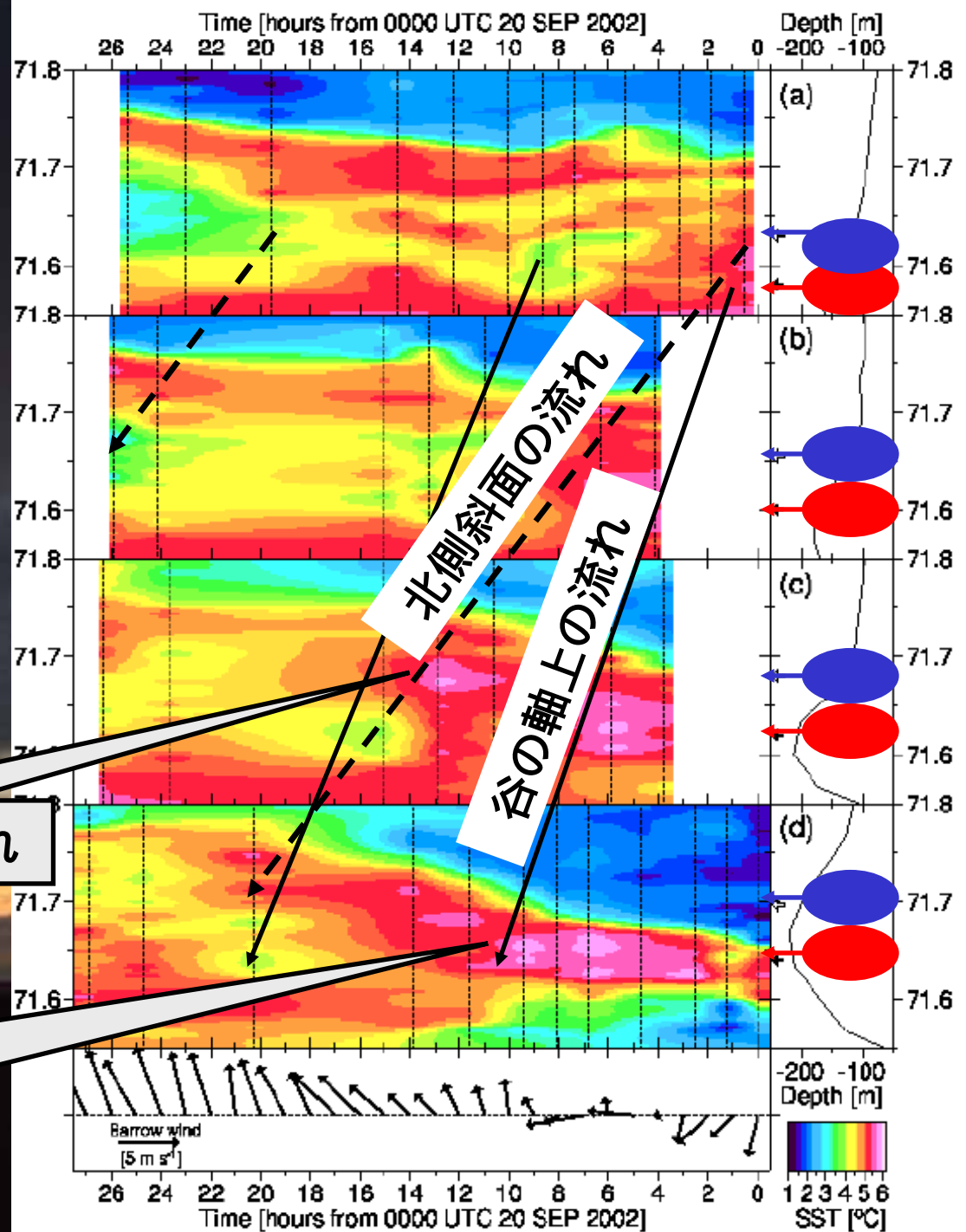
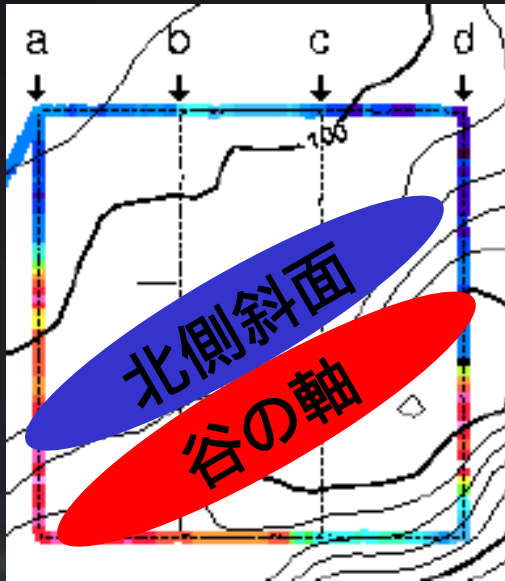


正確な時間軸に内挿

海底地形も



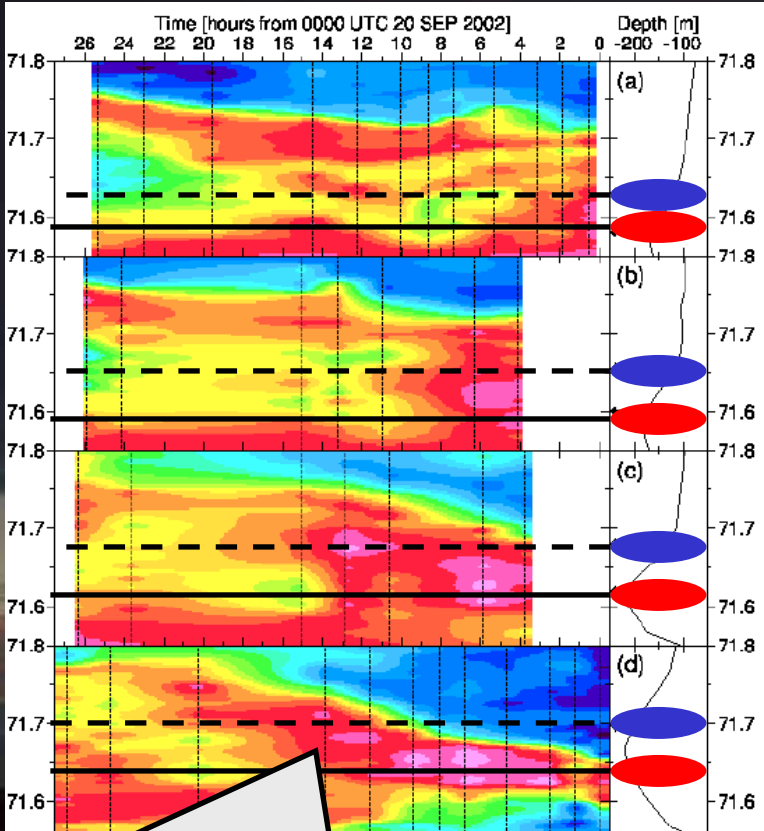
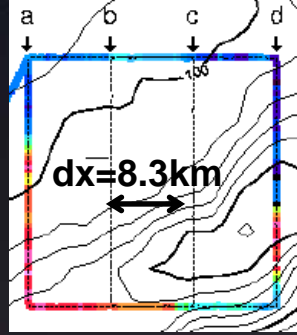
(全側線)



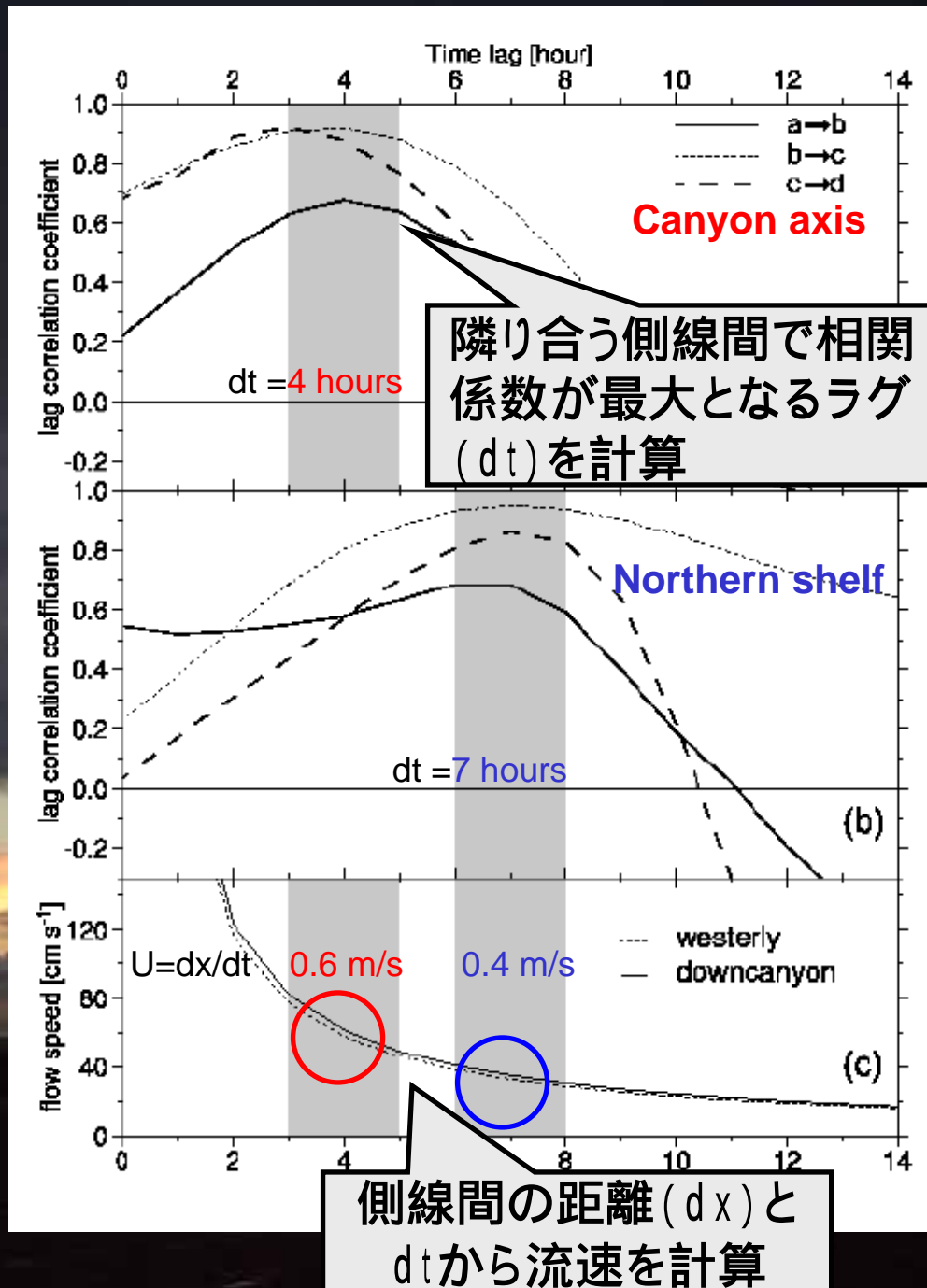
北側の斜面では遅い流れ

谷の軸に沿って暖水塊・冷水塊が西から東の側線へ移動

流速の見積もり (ラグ相関)



時間緯度断面図から北側斜面と谷の軸に関してSSTの1時間値を作成

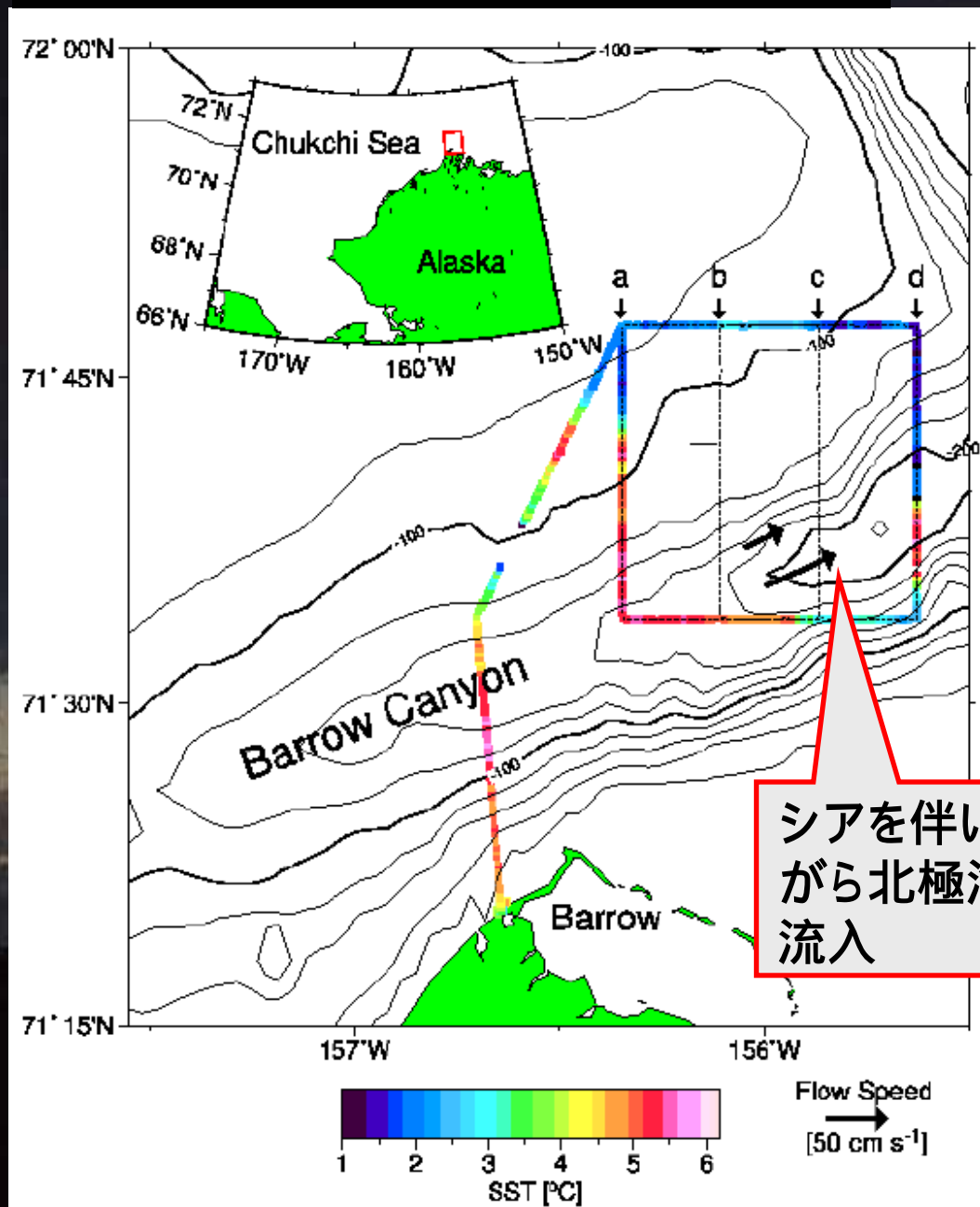


Barrow Canyon での流れの特徴

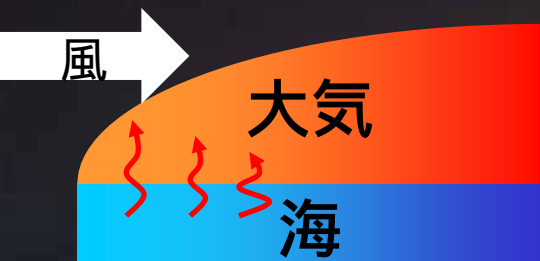
過去の研究との比較

- Aggaard and Roach (1990)
Ave. 0.1-0.2 m/s; max. 0.9 m/s
- Munchow and Carmack (1997)
> 0.7 m/s
- Weingartner et al. (1998)
Max. < 1.0 m/s

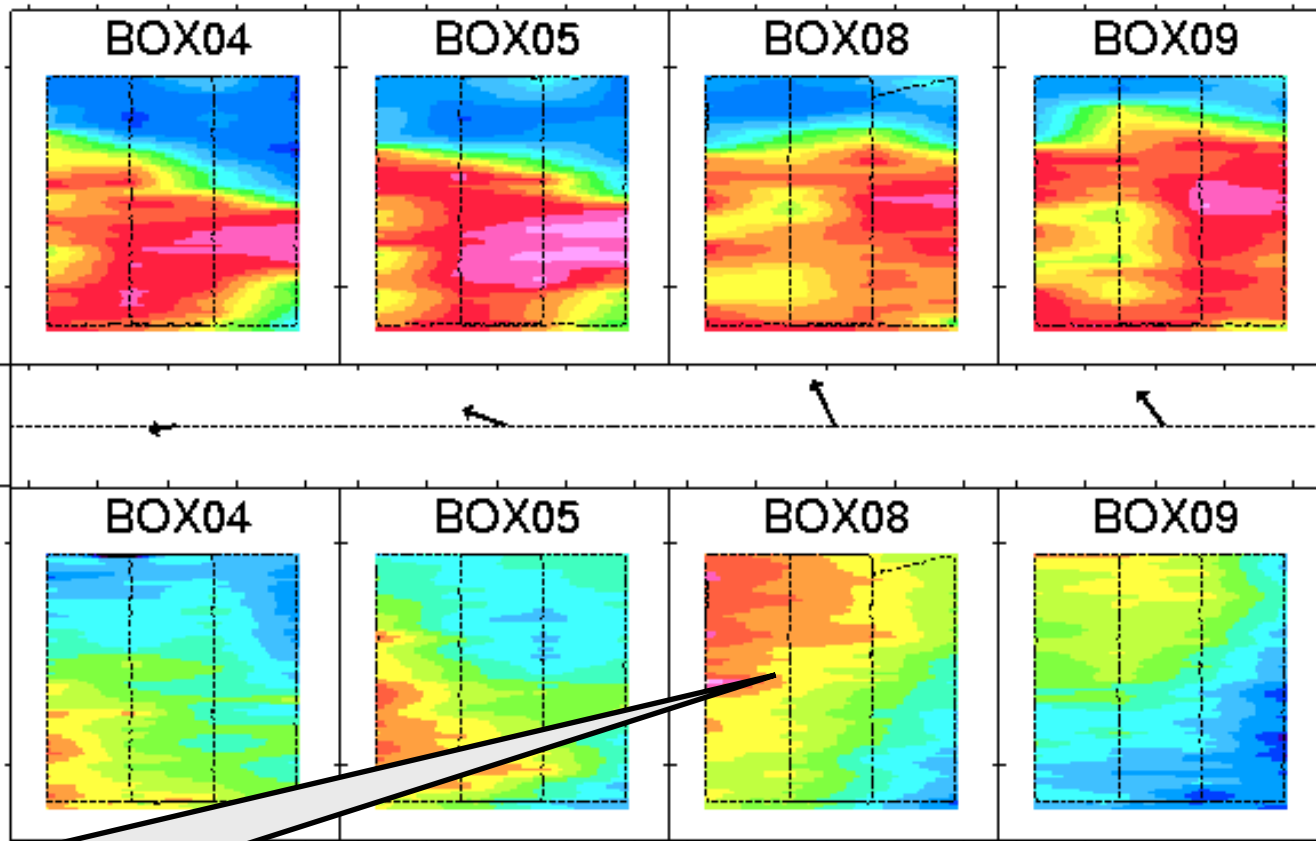
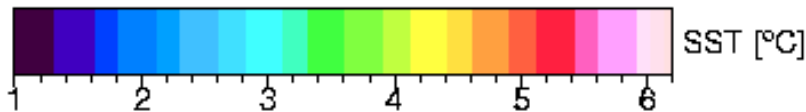
シアを伴いながら北極海へ流入



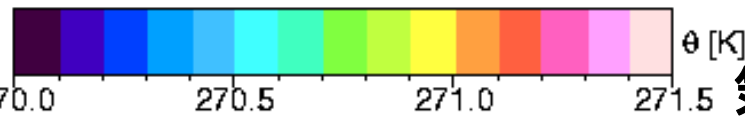
風向の変化に対する大気の応答



海面水温



風下の気温(温位)が増加
(海から熱を受け取り空気塊が加熱)



気温(温位)

Barrow wind
→
[10 m s⁻¹]

TABLE 3. Instrumentation under consideration for the Aerosonde.

PAYLOAD TYPE	MISSION
Laser altimeter	Environmental surveillance, ice mapping, ocean waves, enable low-altitude flights
Microwave radiometer	Ice and snow age, cloud water content
Short- and long-wave radiometers (down and up)	Energy balance and albedo
Infrared camera	Ice conditions at night, biological, and search and rescue

まとめ・課題

- 北極海への水塊の流入過程をエアロゾンデによって確認 (UAVの海洋観測への応用例)
- 利用者(研究者)側として興味:
気象観測以外にオプションとしてどのような観測ができるのか?
(UAVに搭載できる測器の自由度)
- その他の観測プロジェクトとの相性 (効果的なUAVの活用法)

For Further Reading:

- Inoue, J. and J. A. Curry, 2004: Application of Aerosondes to high-resolution observations of sea surface temperature over Barrow Canyon, *Geophys. Res. Lett.*, **31**, L14312.
- Curry, J. A., J. Maslanik, G. Holland, and J. Pinto, 2004: Applications of Aerosondes in the Arctic, *Bull. Amer. Meteor. Soc.*, 85 (12), 1855-1861.