Flight Plans for IPY 2008: Aerosol, Radiation, and Cloud Processes affecting Arctic Climate (ARCPAC)

NOAA WP-3D flights from Denver and Fairbanks

Plans from discussions with Dan M., Michael T., Karen R., Owen C., Jerome B., Tom R., others

Looking for your ideas and input

- Digest a while
- Get back to me or Dan with suggestions
- Major points today o.k.

Will post modified plans on the ARCPAC web site

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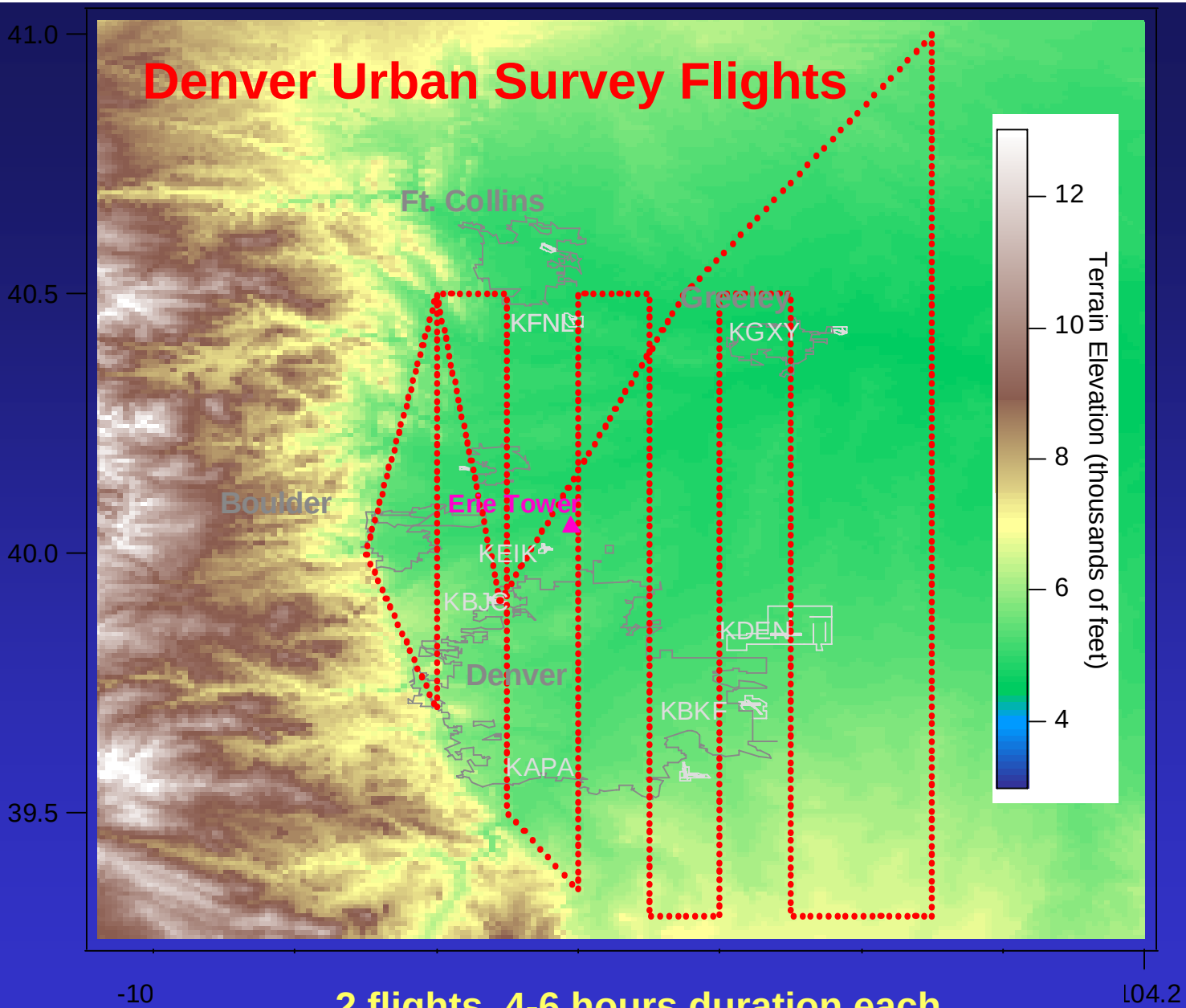
Transit/Science Flight from Tampa-Denver ~6.5 hrs

(Still working details)

Some low altitude straight-line sampling, probably over the Deep South states and approaching Denver

Regional distribution and characteristics of biogenic gases, organic particles, urban pollution

En-route step climb centered over ARM Southern Great Plains site (northern OK) for aerosol optical properties/radiation measurement comparison



2 flights, 4-6 hours duration each
Long crosswind transects at minimum safe altitude
Short profiles to 9000’-12000’ MSL and return

Flight Plans for IPY 2008: Aerosol, Radiation, and Cloud Processes affecting Arctic Climate (ARCPAC)

Transit/Science Flight from Denver-Tampa ~9 hrs

Route and altitude driven by aircraft considerations (direct route or whatever works for them)

No low-altitude science

No profiles, no science-driven stepped legs

Maximum efficiency transit (we'll make measurements regardless)

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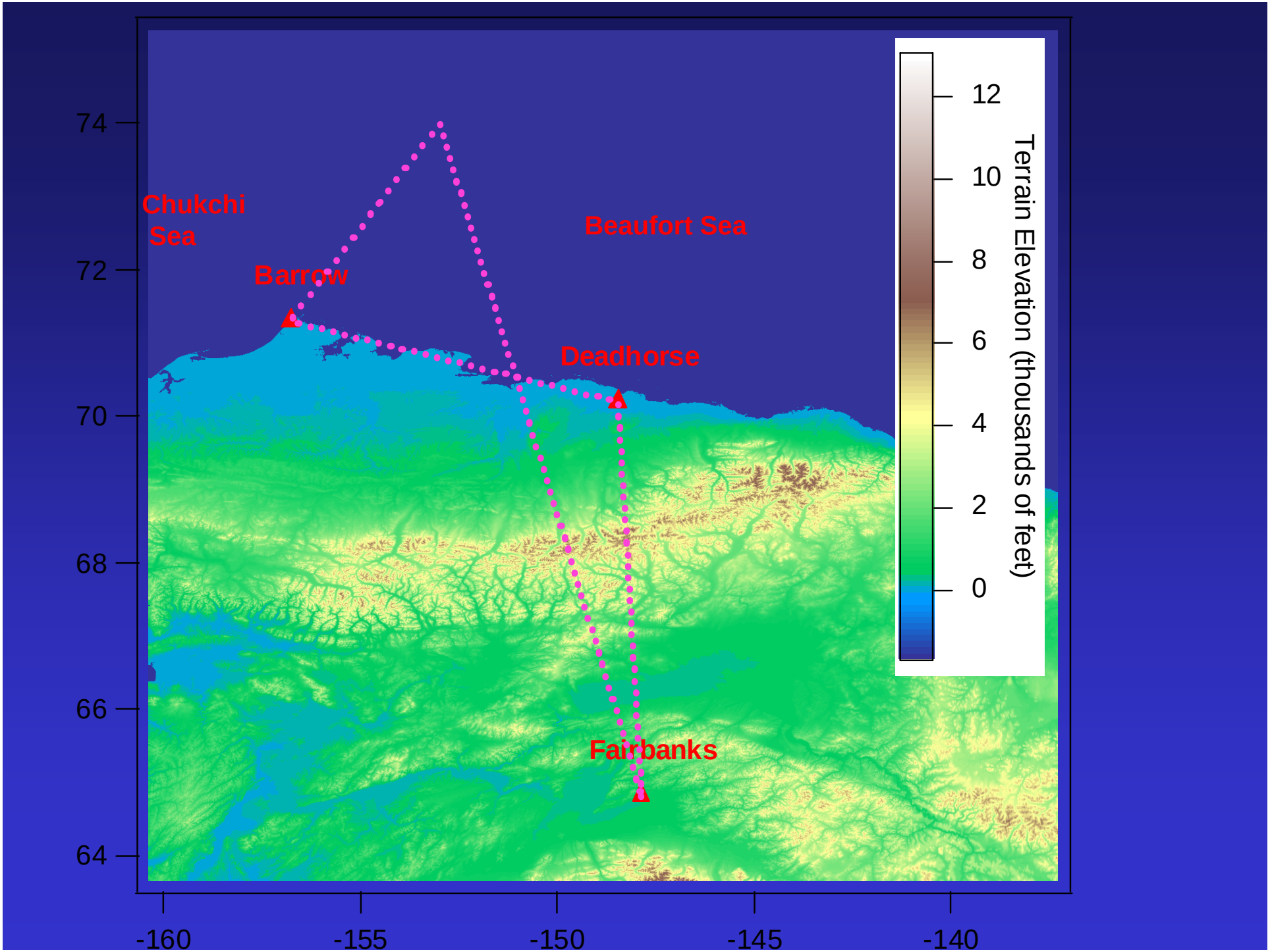
NOAA WP-3D flights from Fairbanks

Flight Modules

- **Each lasts 1-4 hours**
- **Are combined during pre-flight planning using available met, model, and satellite data to make a complete 8-hour flight. Adjustments during flight.**

Typical flight might be transit, flight module 1, transit, flight module 2, return.

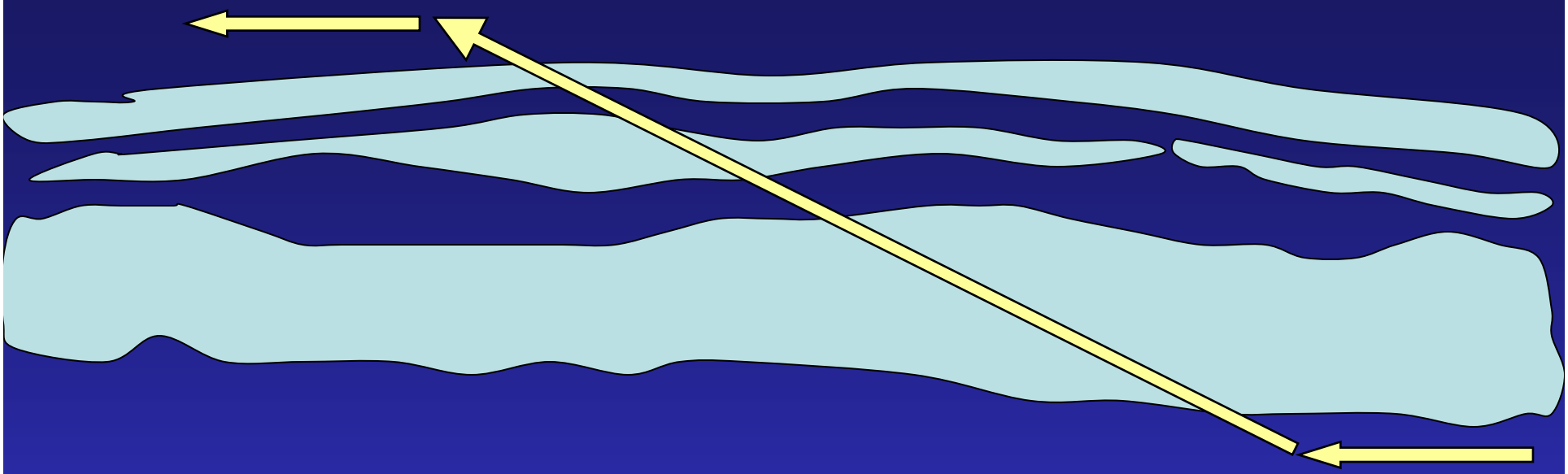

Chukchi Sea
Beaufort Sea
Barrow
Deadhorse
Fairbanks
74
72
70
68
66
64
-160
-155
-150
-145
-140
12
10
8
6
4
2
0
Terrain Elevation (thousands of feet)

Module 1: Haze mapping, sampling, profiling

Goals: Find layers of pollution in the Arctic air mass based on model projections, satellite observations, surface remote sensing at Barrow, and reports from other research aircraft. Map spatial extent, vertical distribution, particle and gas-phase properties, radiative heating rate.

Flight conditions: cloud-free
Flight location: Likely north of Brooks Range, over tundra, sea ice

Module 1: Haze mapping, sampling, profiling

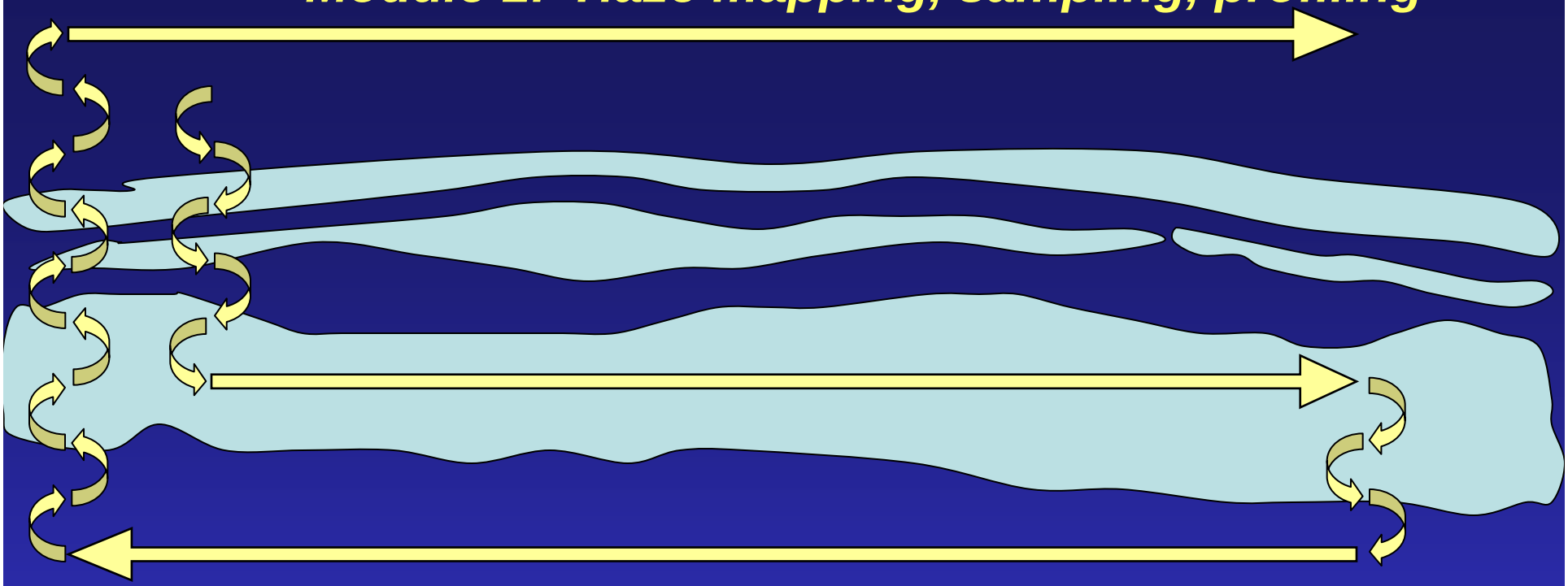


Flight patterns:

1. Level legs and en route climbs or descents through haze layers to map horizontal and vertical distribution.

2. Identify maximum in layers

Module 1: Haze mapping, sampling, profiling



Flight patterns:

1. Level legs and en route climbs through haze layers to map horizontal and vertical distribution.
2. Identify maximum in layers
3. Horizontal legs through thickest portion of layers (~10 minutes)
4. Horizontal legs below layers, if possible (~10 minutes)
5. Parking garage ascent up through layers
6. Reverse course and repeat (4) above top of layers (~10 minutes)

repeat (3-6) as needed

Module 2: Stratiform cloud sampling

Goals:

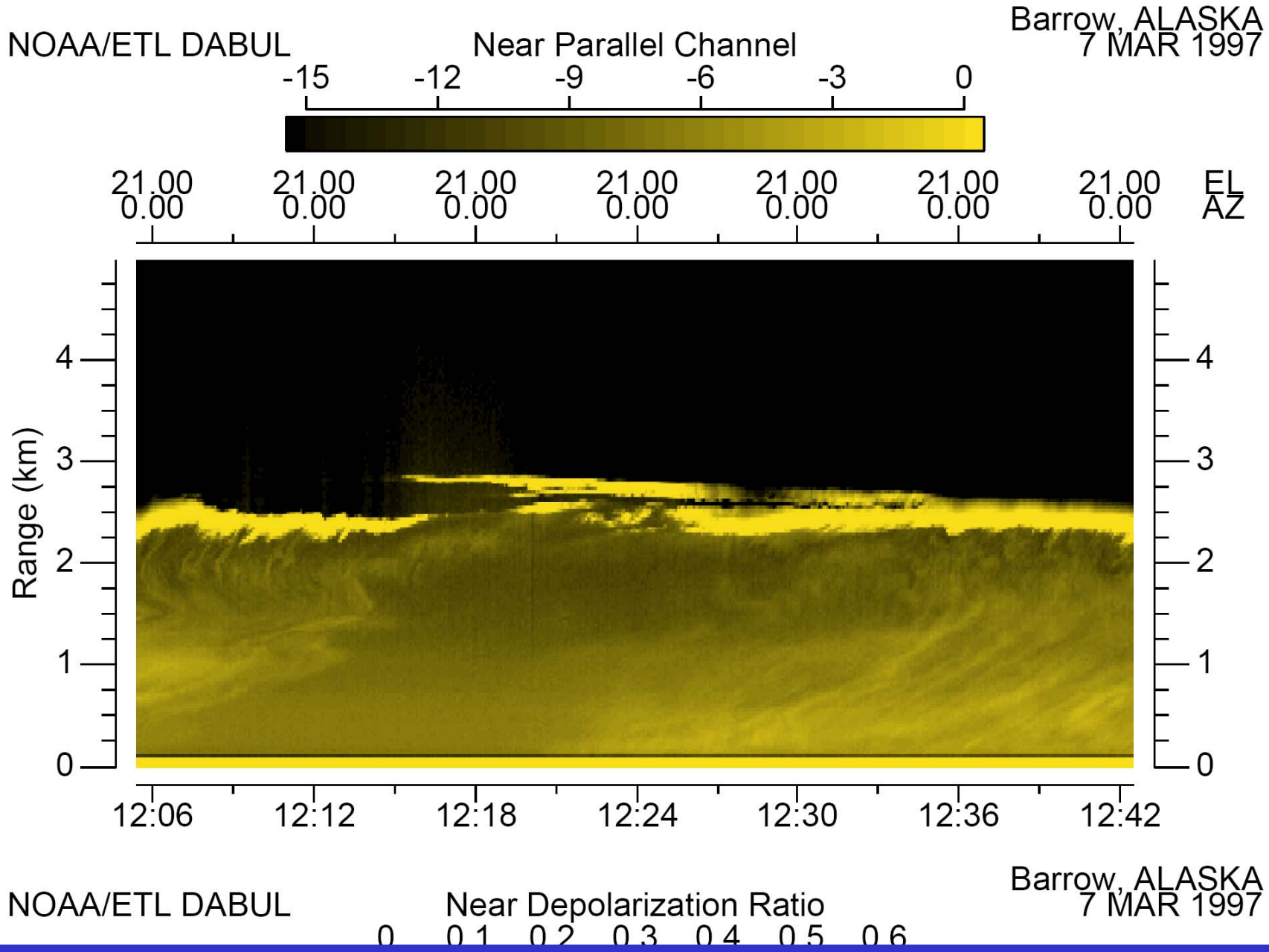
a) Determine microphysical and radiative properties of low-altitude stratiform clouds, especially optically thin clouds

b) Measure aerosol particles just above and below cloud to determine aerosol-cloud interactions

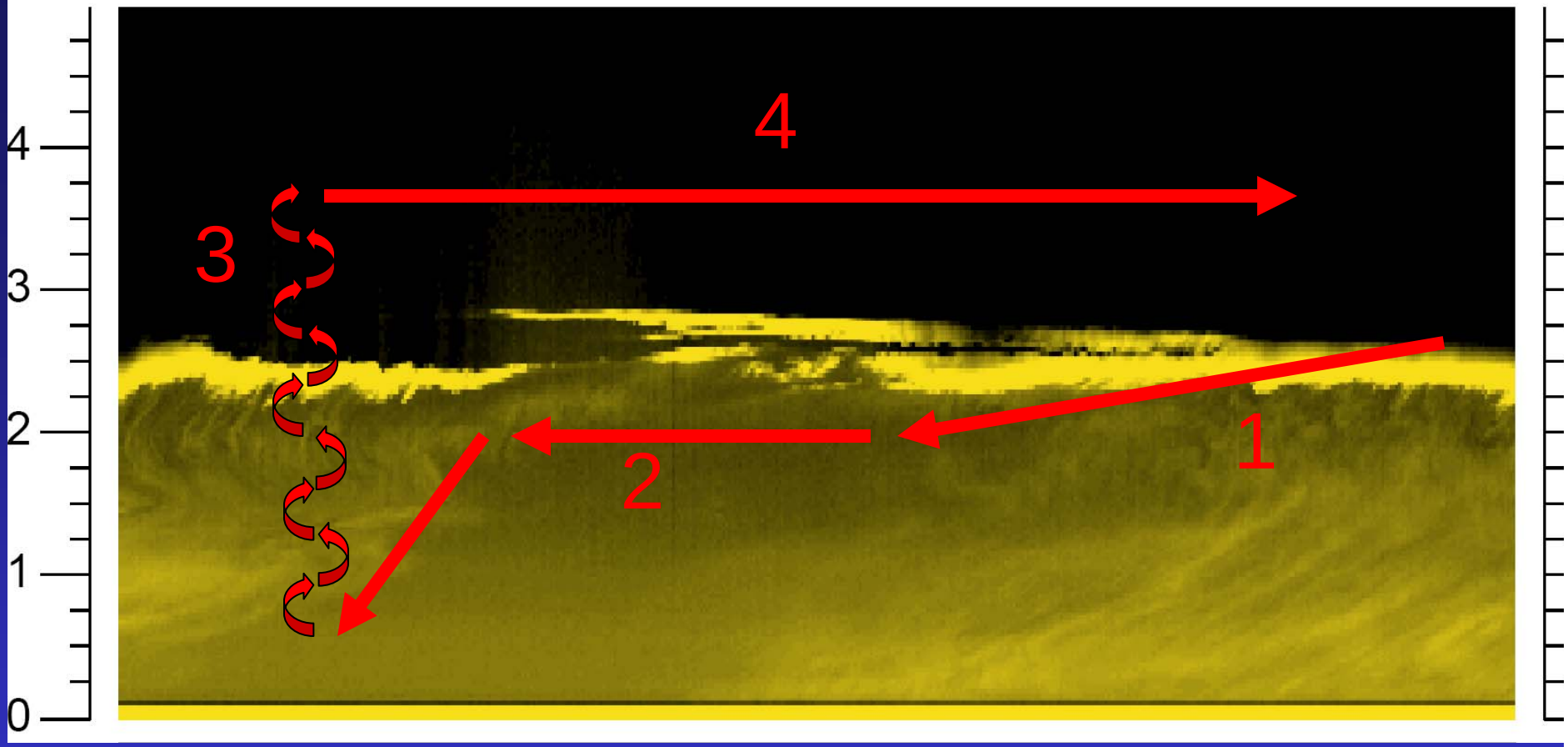
c) Look for evidence of aerosol scavenging in snow precipitation below cloud

Flight conditions: cloudy and in light snow

Flight location: North of Brooks Range, over tundra, sea ice

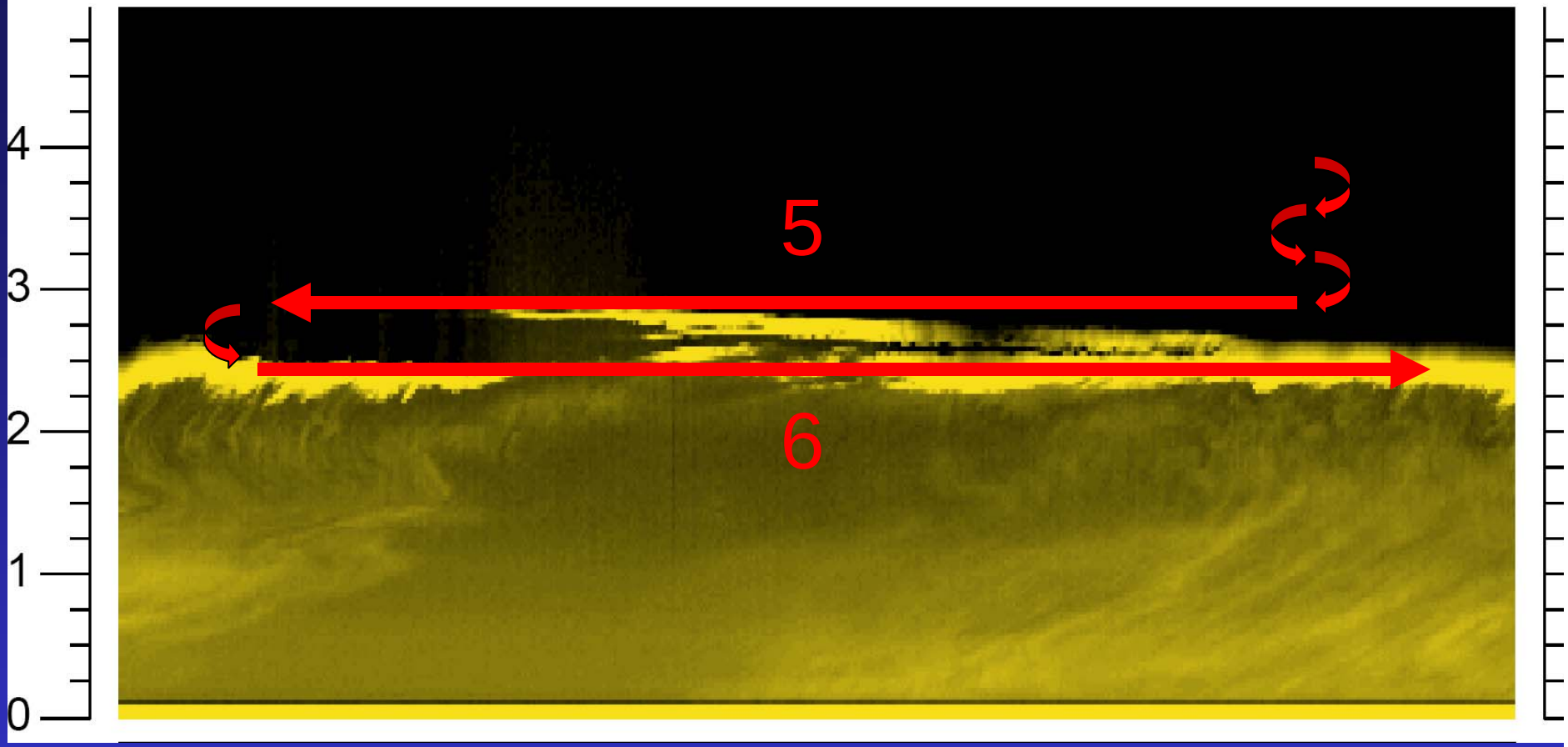

NOAA/ETL DABUL
Near Parallel Channel
Barrow, ALASKA
7 MAR 1997
-15
-12
-9
-6
-3
0
21.00
0.00
EL
AZ
Range (km)
0
1
2
3
4
12:06
12:12
12:18
12:24
12:30
12:36
12:42
NOAA/ETL DABUL
Near Depolarization Ratio
Barrow, ALASKA
7 MAR 1997
0
0.1
0.2
0.3
0.4
0.5
0.6

Module 2: Stratiform cloud sampling



1. **Determine cloud base (expect about 1000-2000’) in descent**
2. **Horizontal leg (~5 min) below cloud base for aerosol and radiation measurement; end with descent to min. alt.**
3. **Ascending vertical profile through cloud to cloud top**
4. **Reverse course, horizontal leg 1000’ above cloud top for radiation measurement**

Module 2: Stratiform cloud sampling



5. Reverse course and perform horizontal leg at cloud top for aerosol measurement

6. Reverse course and perform horizontal leg through middle of cloud (limited by aircraft/instrument icing)

Module 3: Profiles over or near Barrow ARM/GMD site

Goals: Compare ground site aerosol and radiation observations with aircraft data.

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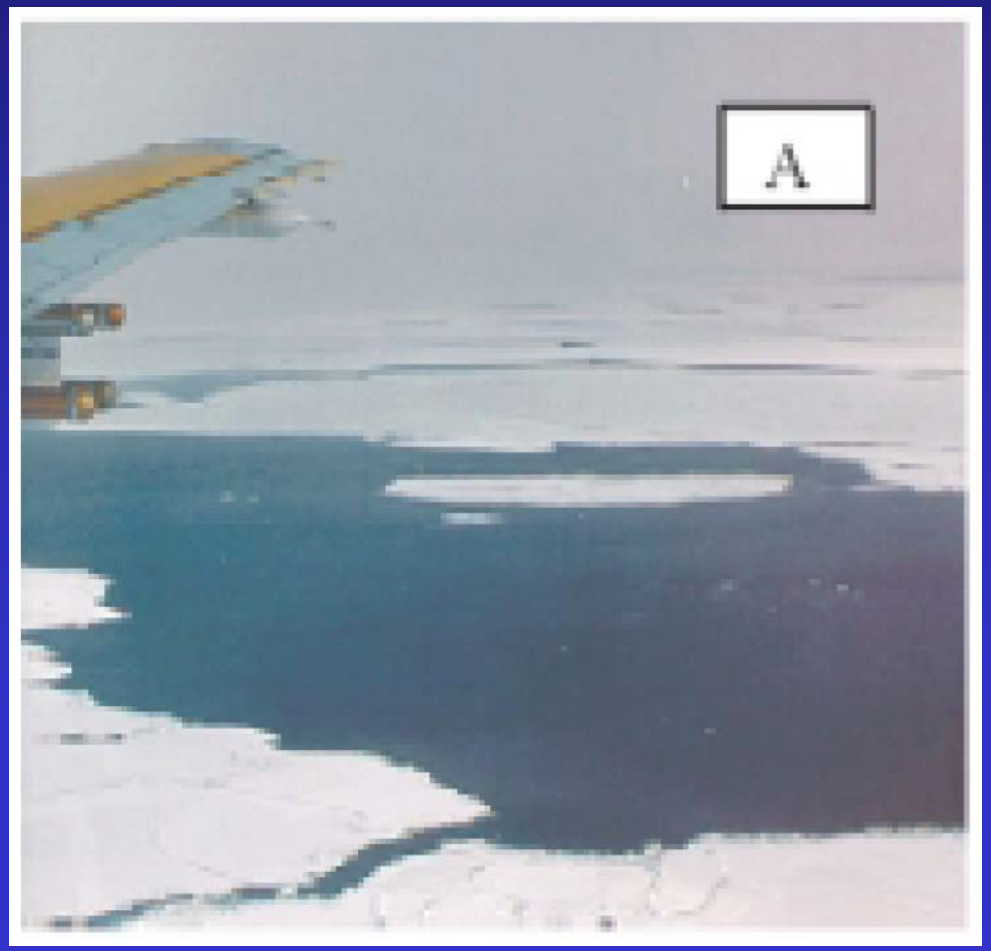
Flight patterns:

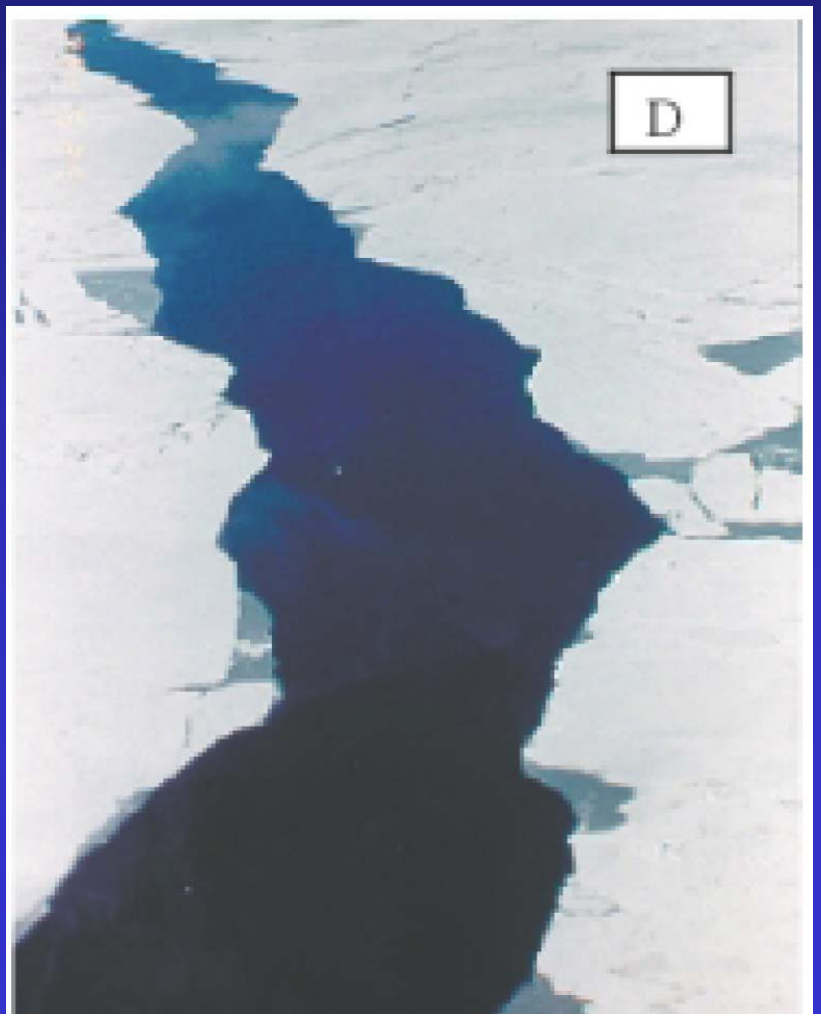
1. **Transit to Barrow**
2. **Perform "parking garage" profile over Barrow ground site.**
3. **Missed approach at Barrow airport to reach min. alt.**

Flight conditions: cloud-free
Flight location: Barrow
Issues: Whale hunting west of Barrow

Module 4: Cloud formation and mixing from leads and polynyas (large, non-linear open water areas)

Goals: Examine cloud-aerosol interaction over open-water polynas. Examine halogen chemistry in well-mixed air with surface contact.

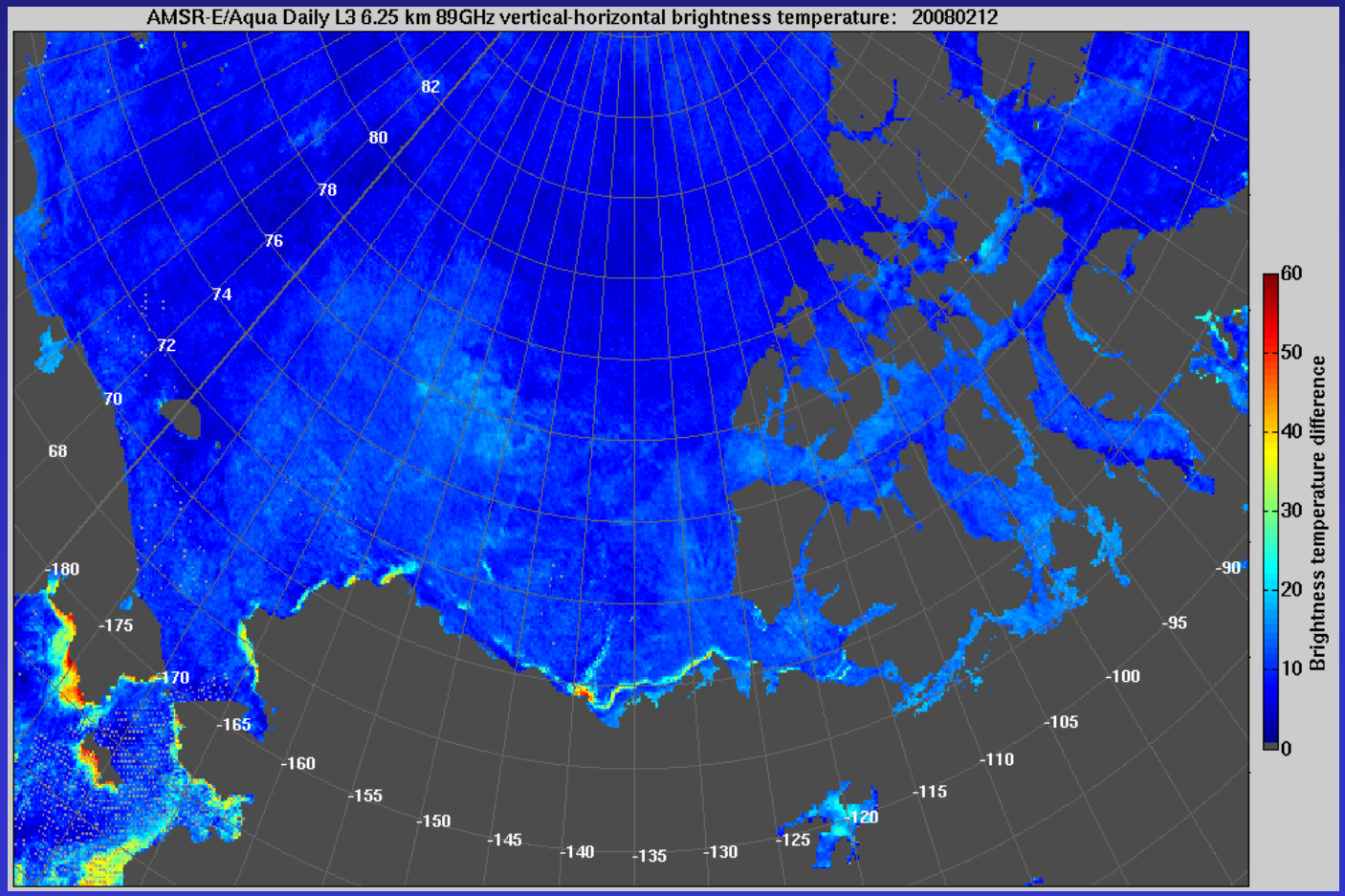




Module 4: Cloud formation and mixing from leads & polynyas

Flight patterns:

1. Transit to region of open water identified from satellite observations.



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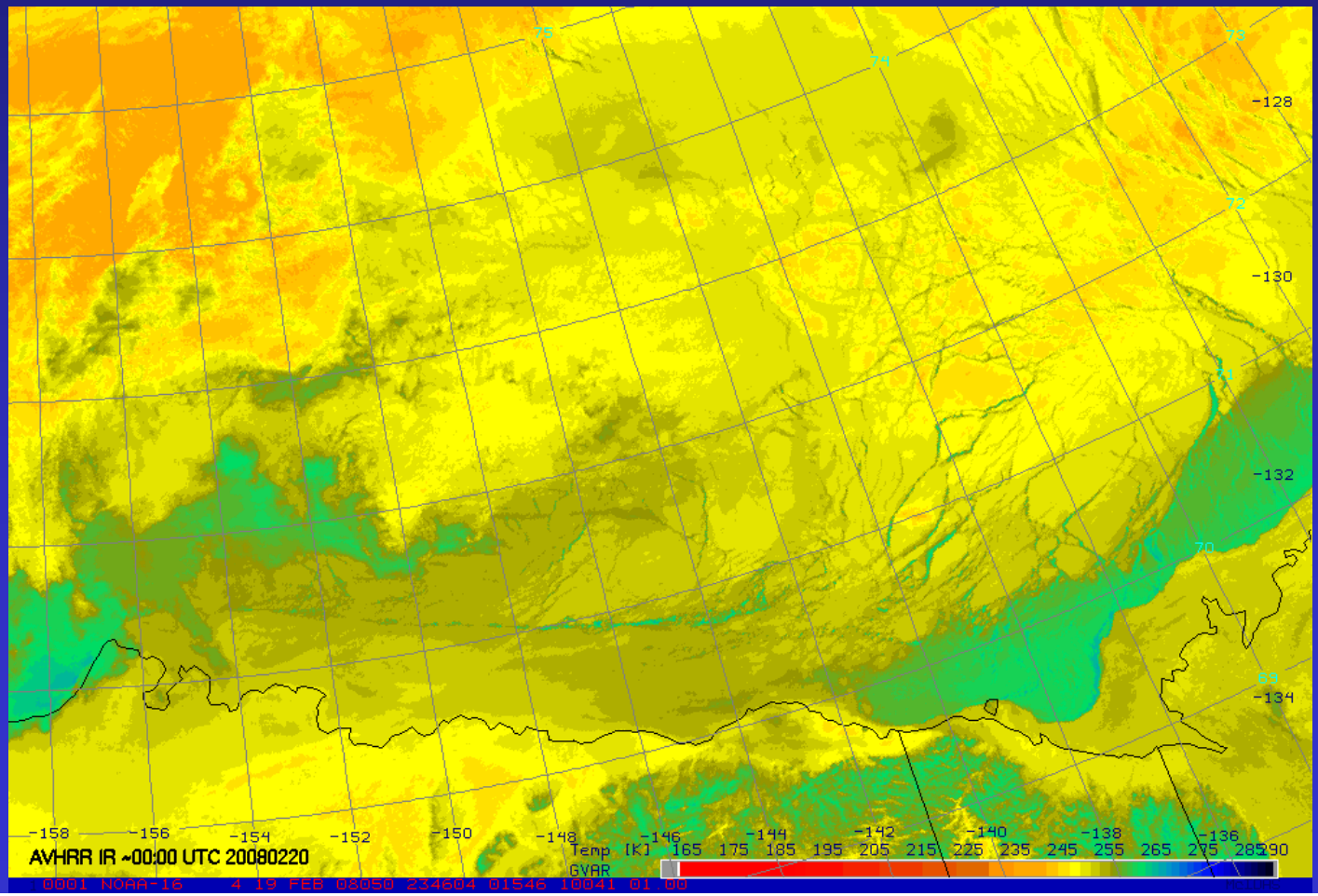
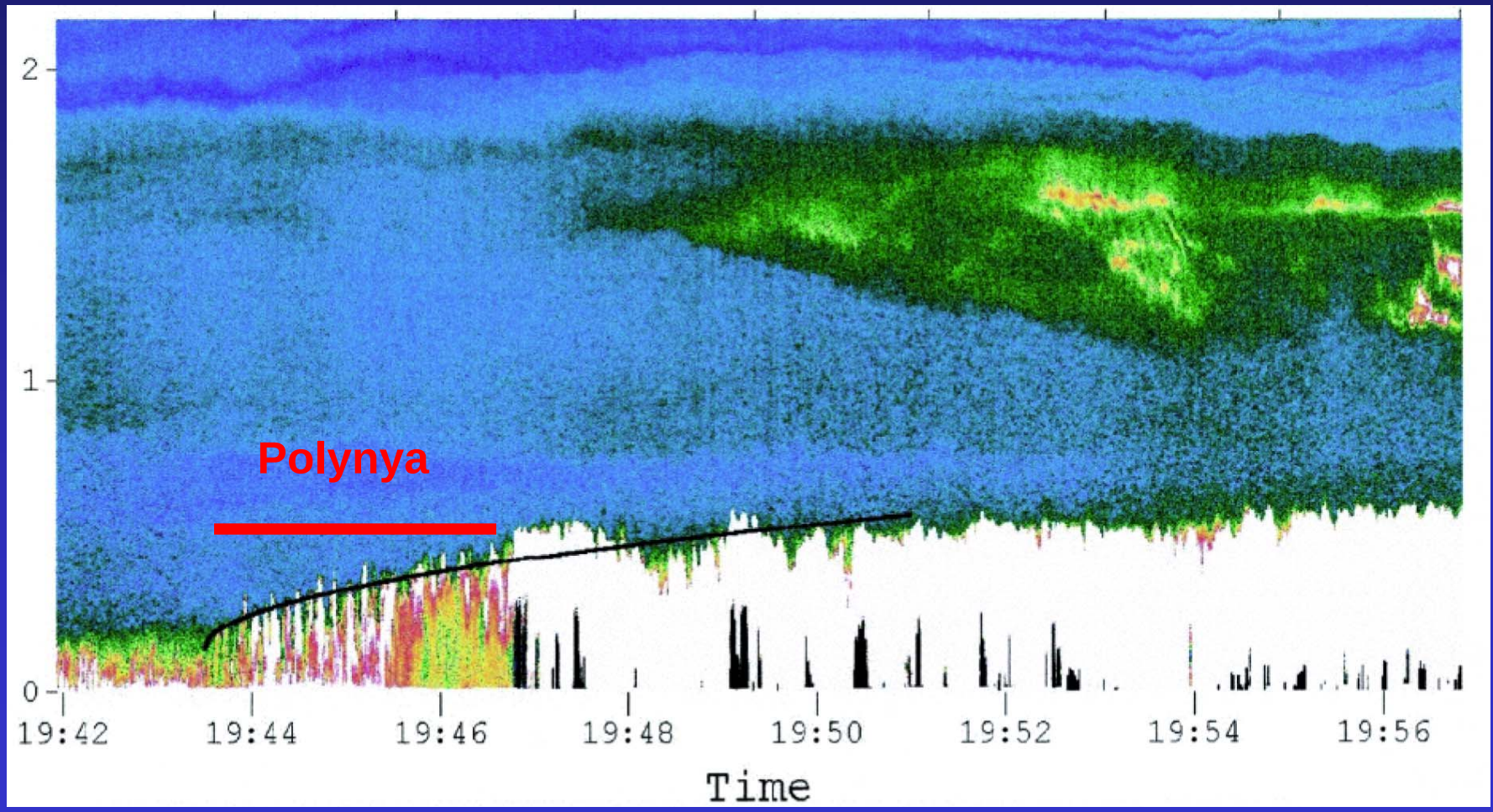


Module 4: Cloud formation and mixing from leads & polynyas

Lidar Image from Canadian Convair, April 1998



75 km

Module 4: Cloud formation and mixing from leads & polynyas

Flight patterns:

1. Transit to region of open water identified from satellite observations.

2. Perform stacked crosswind legs upwind of open water perpendicular to wind from lowest safe altitude to height above polyna cloud or mixing level.

3. Perform stacked crosswind legs over polynya from lowest safe altitude to height above polyna cloud.

4. Perform crosswind legs every few km downwind of polyna (distance depends on scale of polyna mixing region).

Module 5: Low altitude sampling for halogen chemistry

Goal: Examine chemistry of ozone depletion events associated with halogens and the spatial scale of the phenomenon.

Flight patterns:

1. **Transit to region of observed or modeled halogen-induced ozone depletion**
2. **Perform transect across the region at lowest safe altitude**
3. **Perform spiral profile up to top of chemically active layer**
4. **Perform second transect across the region at lowest safe altitude**

Flight conditions: cloud-free
Flight location: Beaufort Sea

Module 6: Emissions from Prudhoe Bay & extraction facilities

Goal: Determine emission ratios and evolution of trace gases and aerosol particles from industrial and extraction facilities in vicinity of Prudhoe Bay.

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Flight patterns:

1. **Fly upwind transect at lowest safe altitude.**
2. **Fly downwind transects at multiple altitudes to determine height of maximum plume concentrations.**
3. **Fly downwind transects in plume at this altitude, leg spacing TBD.**
4. **Perform missed approach to lowest safe altitude at Deadhorse airport.**

Flight conditions: cloud-free
Flight location: Over tundra, Prudhoe Bay facilities, sea ice

Module 7: Comparisons with NASA DC-8 and P3B and Environment Canada Convair 580

Goal: Compare scientific instruments on different platforms to identify poorly performing instruments and to determine the extent to which datasets from different sources may be analyzed together.

Flight patterns:

1. **Wingtip-to-wingtip level legs, climbs through pollution**
2. **Comparisons between only two aircraft at one time**
3. **Scripted legs or instrument approaches with DC-8 and Convair for cloudy conditions**

Flight conditions: cloud-free (DC-8, P-3, Convair), cloudy (P-3 and Convair only)

Flight location: En route between Fairbanks & North Slope, over North Slope, Beaufort Sea

Module 8: Coordinated radiative flux measurements with NASA P-3 (module 1 + NASA P-3)

Goal: Determine instantaneous radiative heating rate in region with layers of absorbing aerosol. Obtain profiles of aerosol optical properties for comparison with radiative transfer models. Only flown if conditions/science warrant.

Flight patterns:

1. Wingtip-to-wingtip instrument comparison with NASA P-3
2. NOAA P-3 flies upper leg above polluted layers (~5 km), NASA P-3 flies lower leg at set low altitude.
3. Reverse course and repeat leg
4. Each aircraft performs offset parking garage profile
5. NOAA P-3 flies upper leg above polluted layers (~5 km), NASA P-3 flies lower leg at set low altitude

Flight conditions: cloud-free, over sea ice

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