ARM

Atmospheric Radiation Measurement

North Slope of Alaska Program

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The United States Department of Energy

Status of ARCS Development, Site Development, Operations, And Educational Program

Three Primary ARM Sites

ARM Program Components

PROGRAM COMPONENTS:

***Three primary regions**

***Global climate modeling**

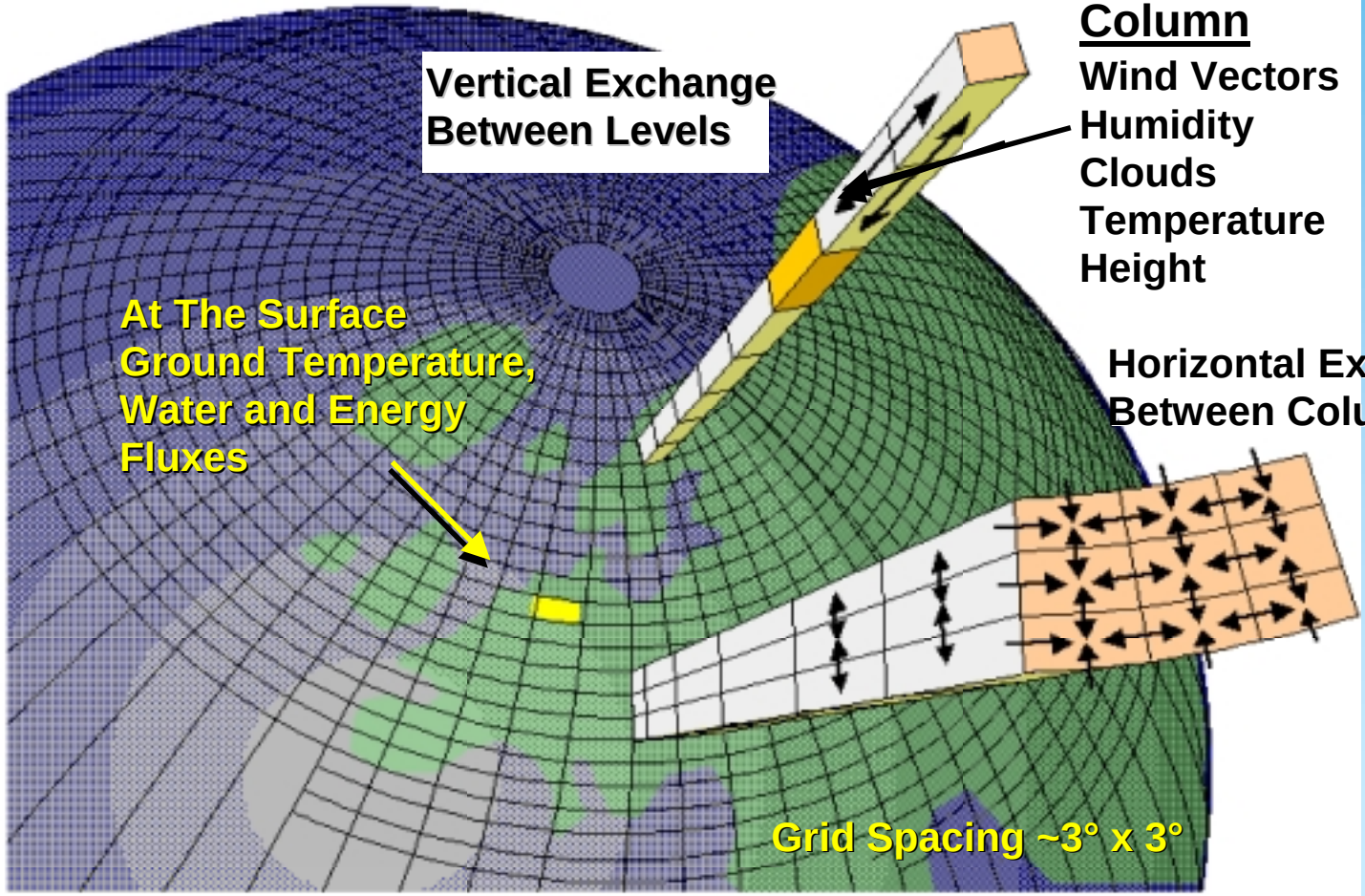
***Instrument development**

General Goal of ARM

Improve the performance of general circulation and related models of the atmosphere as tools for predicting global and regional climate change.

Global Climate Models (GCMs)

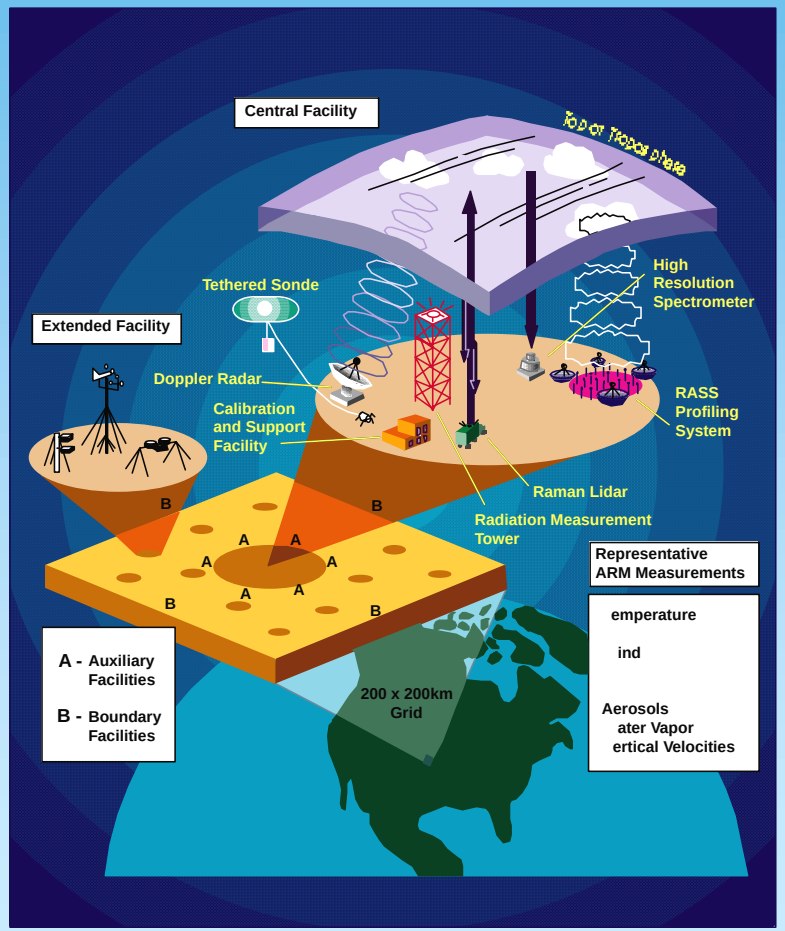
(GCMs) calculate atmospheric conditions inside each box all over the Earth and up into the atmosphere



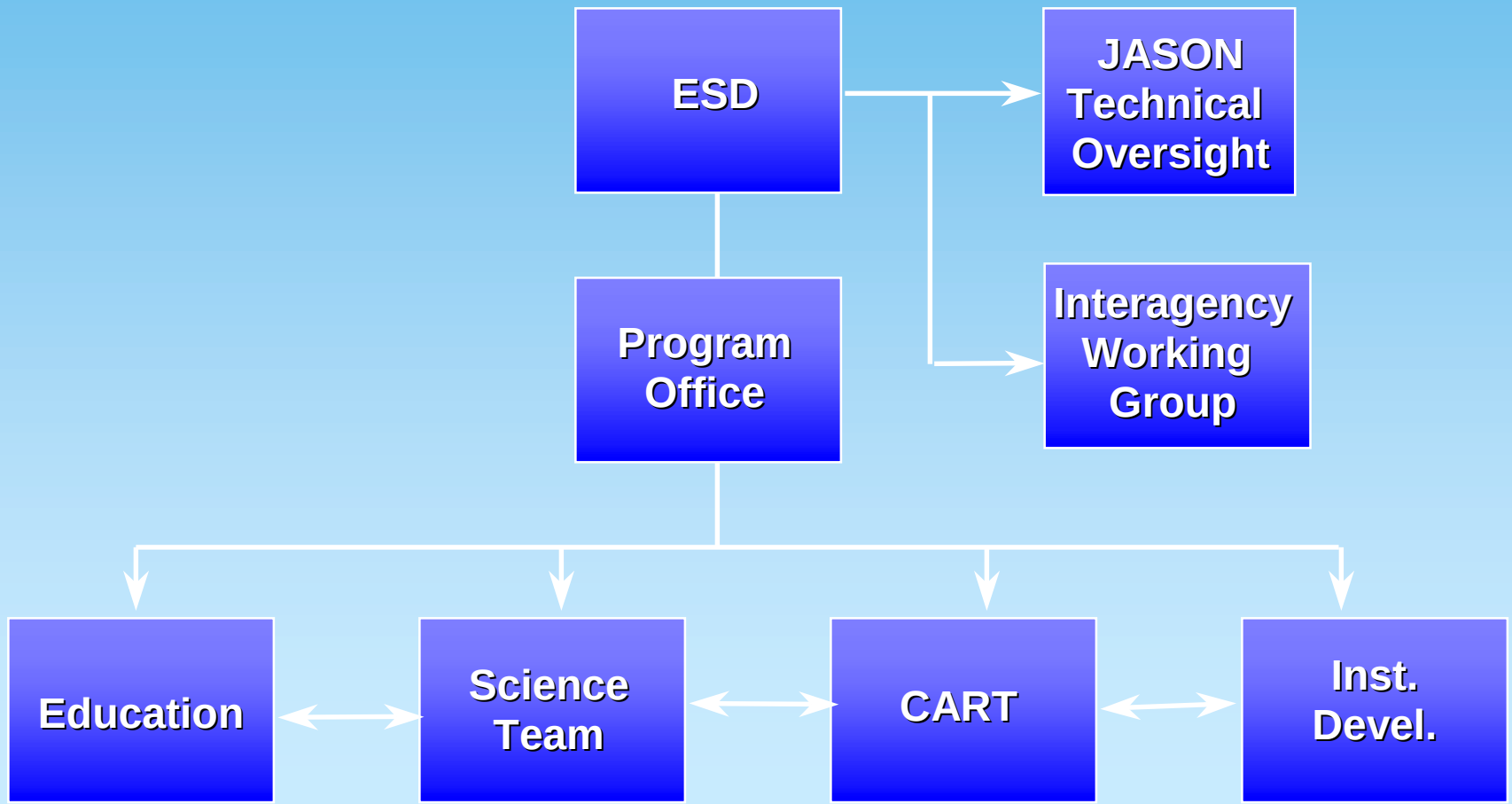
Time Step ~30 Minutes. Each grid cell is about 200 km x 200 km

Specific Goals of ARM

- Improve GCMs as tools for predicting global and regional climate change
- Improve the treatment of radiative transfer in GCMs under all conditions
- Improve the parameterization of cloud properties and cloud formation in GCMs



ARM Project Organization



ARM Web Site

www.arm.gov

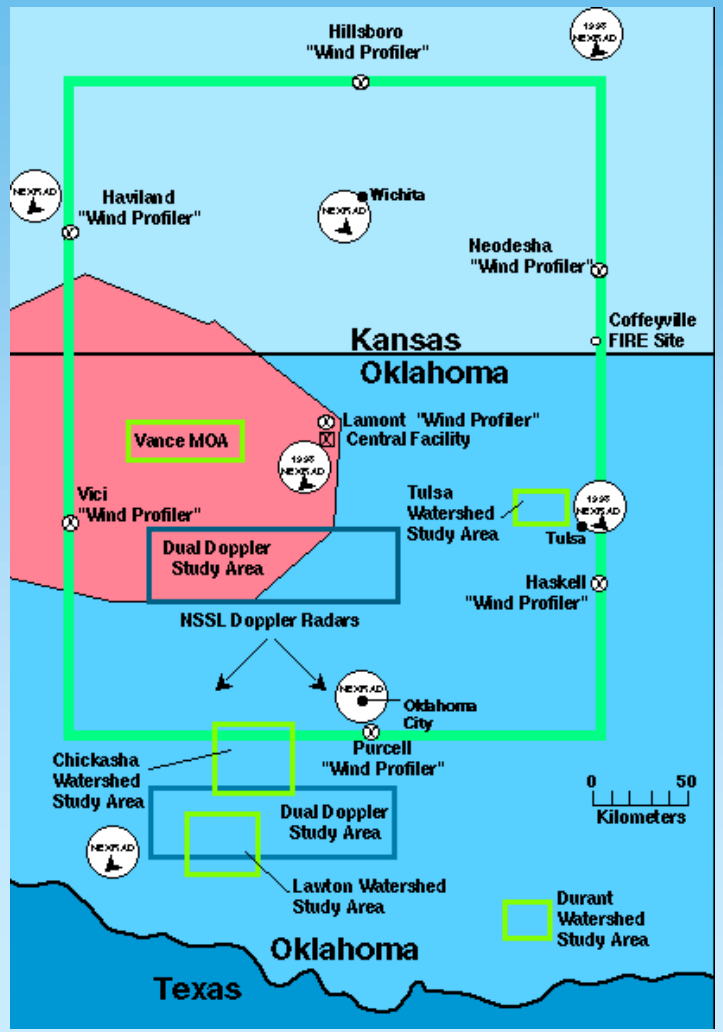
The ARM Program:

- *Is addressing its goals through a balanced program of modeling and measurement*
- *Is instrumenting three primary locales for obtaining data*
- *Will operate each site for at least 10 years*
- *Is establishing education enrichment programs at each site*

Locale Development Status

- **Southern Great Plains (SGP)**
  - Operational
  - Data delivery since May, 1992
  - Regular data stream + intensive periods
- **Tropical Western Pacific (TWP)**
  - Modular (containerized) facility
  - Island-based initially
  - First site operational (Oct 96)
- **North Slope of Alaska (NSA)**
  - Modular facility
  - First site (Barrow) operational (July 1997
  - Second site (Atqasuk) operational (Summer 1999)

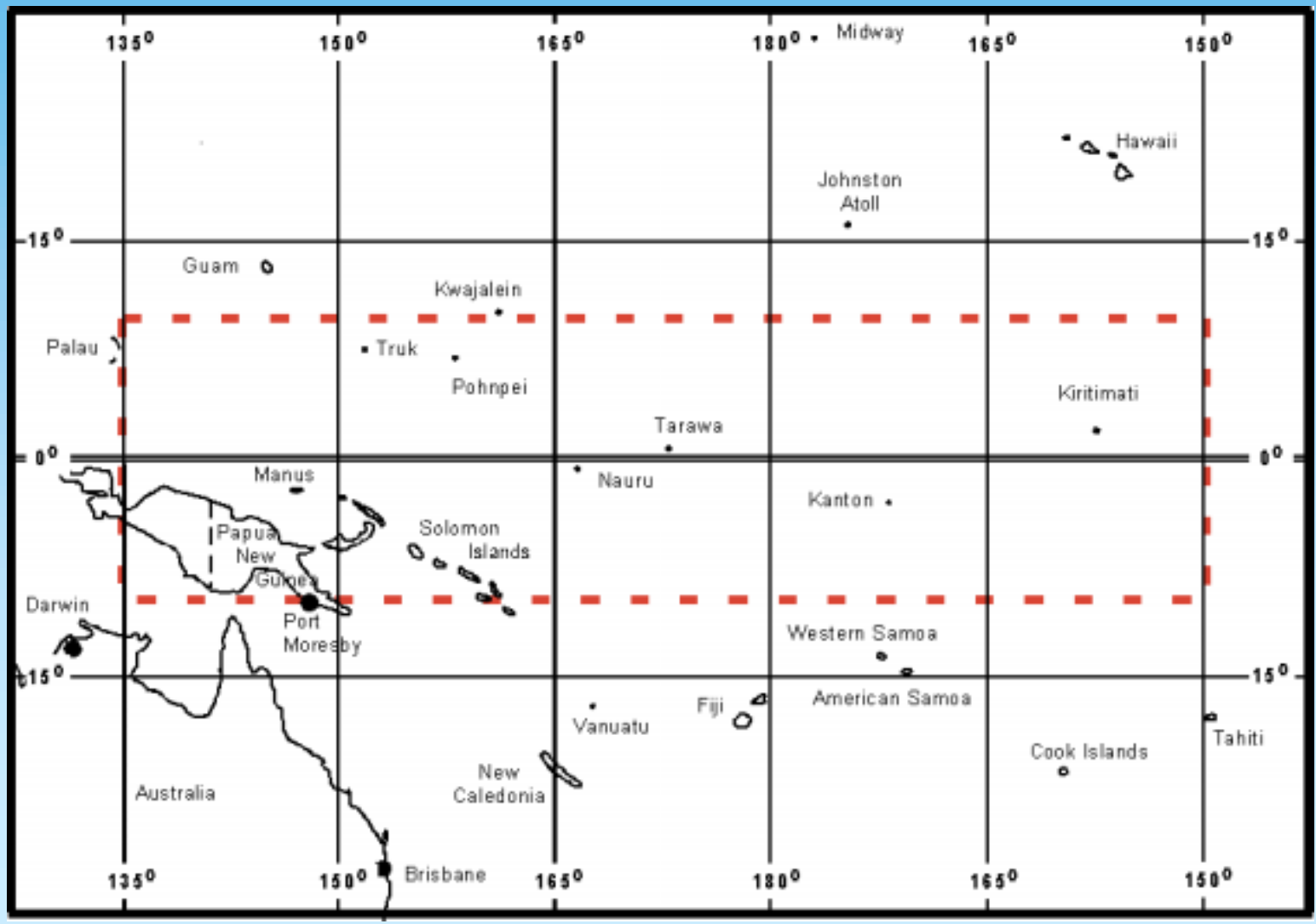
Southern Great Plains Site



SGP Central Facility

SGP Central Facility

Tropical West Pacific Sites


135°
150°
165°
180°
Midway
165°
150°
Hawaii
Johnston Atoll
15°
Guam
Kwajalein
Palau
Truk
Pohnpei
Kiritimati
Tarawa
0°
Manus
Nauru
Kanton
Papua New Guinea
Solomon Islands
Darwin
Port Moresby
Western Samoa
15°
American Samoa
Fiji
Vanuatu
Tahiti
Cook Islands
New Caledonia
Australia
Brisbane

Nauru Site View

Momote Site, Manus Island(ARCS-1)

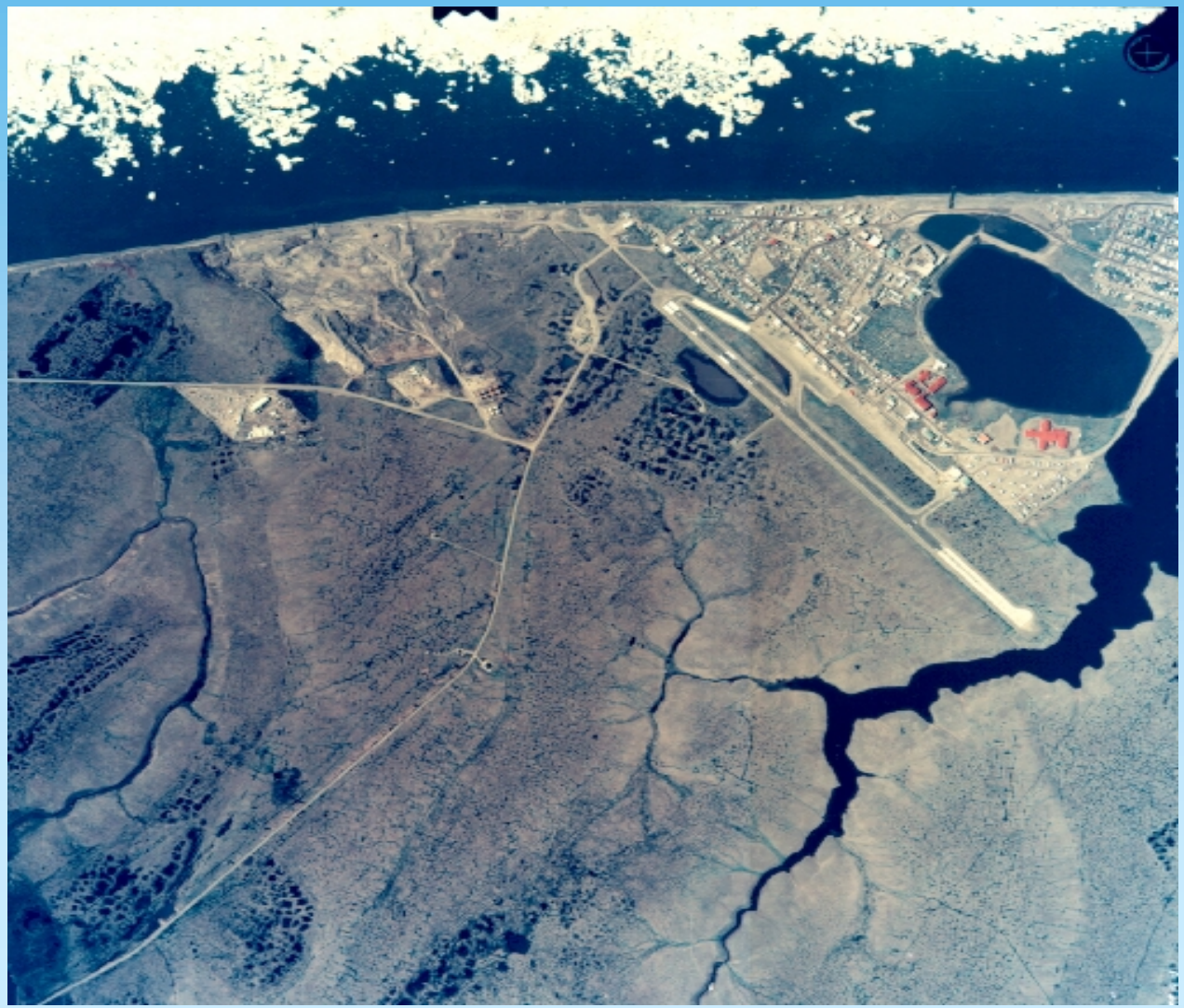
North Slope of Alaska Sites

North Slope of Alaska
Site Detail Map

North Slope of Alaska Site Map

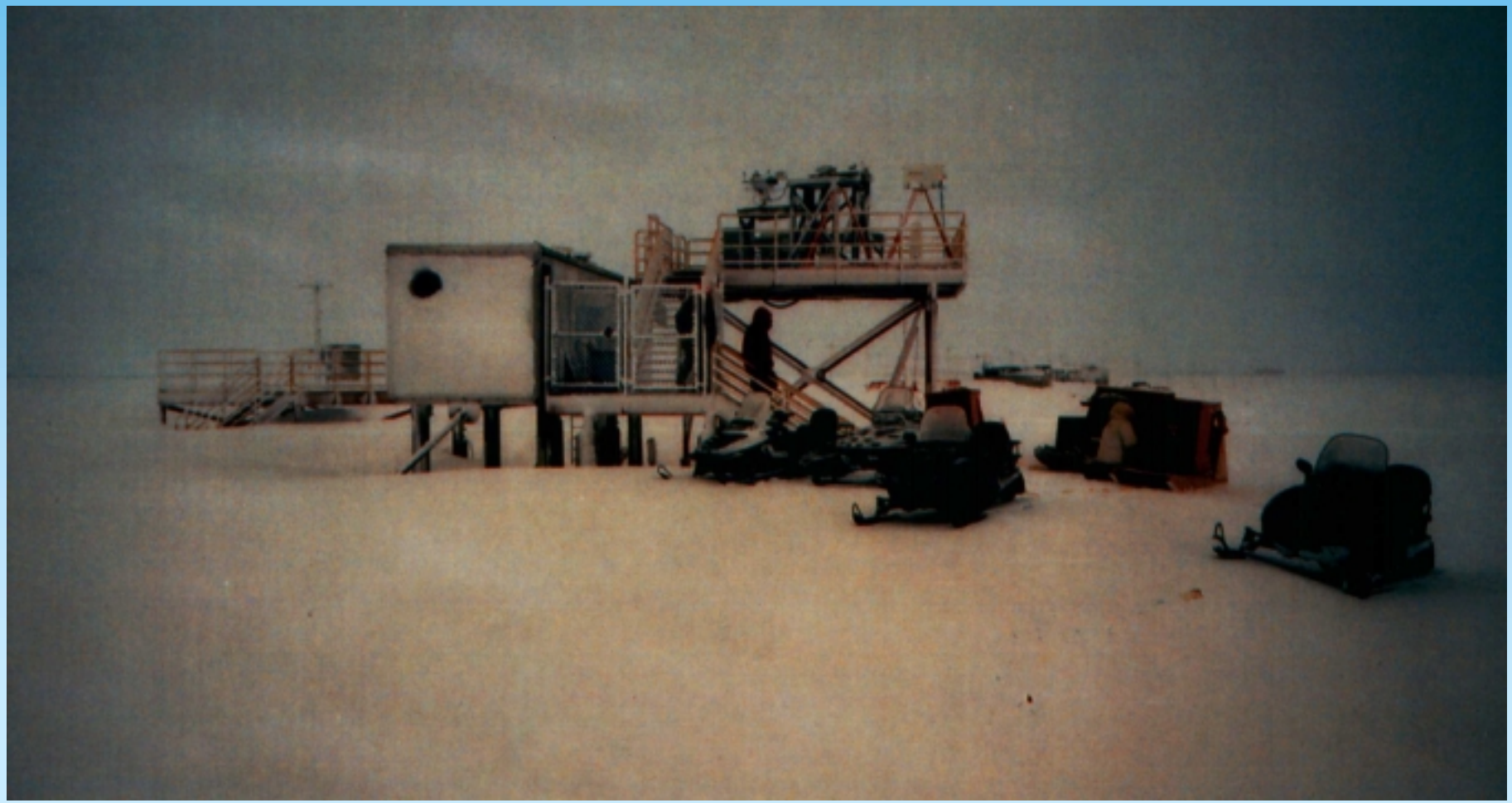
Barrow ARM Site

Townsite, Barrow, Alaska

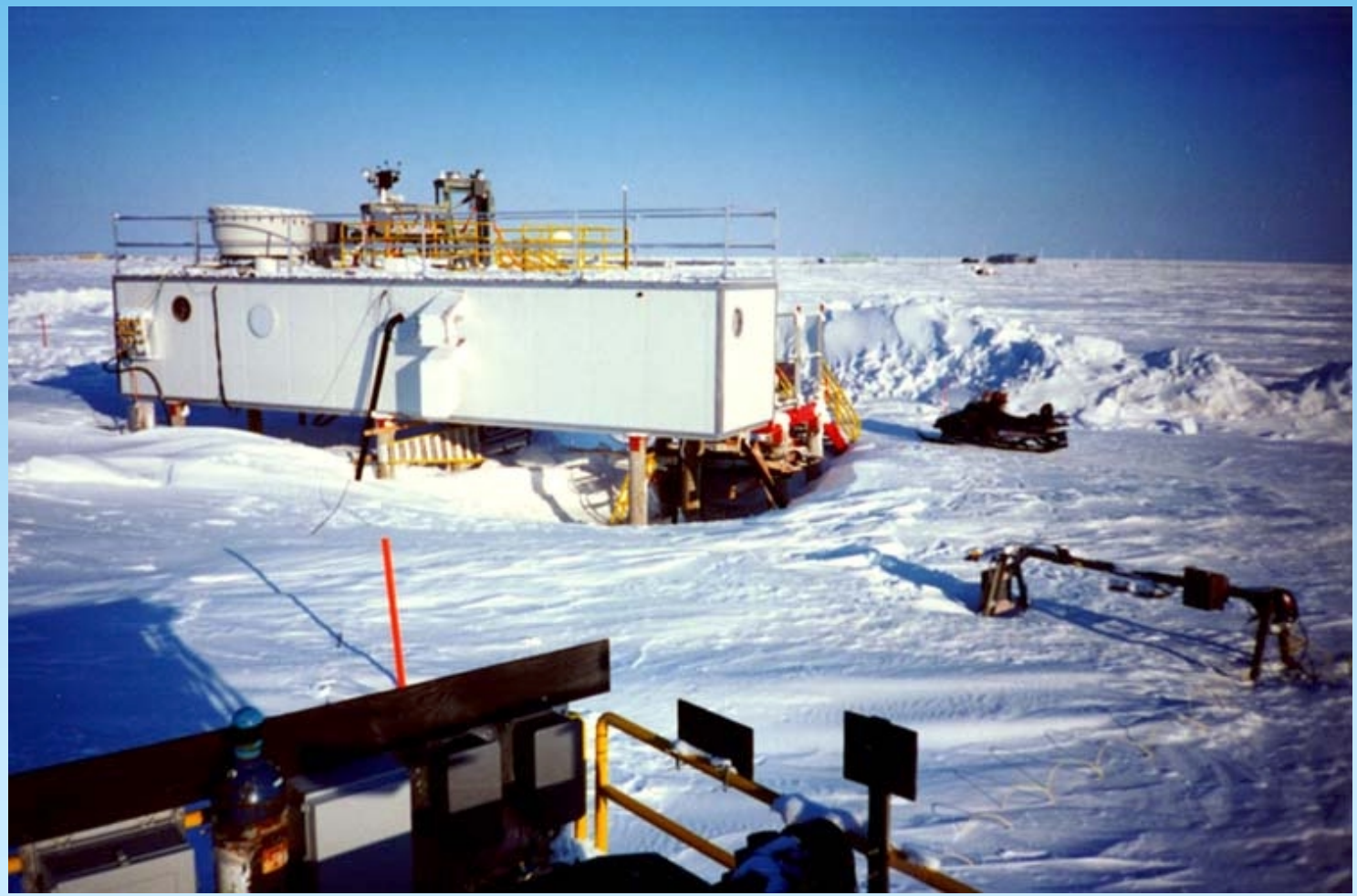


Point Barrow

Barrow ARM Site



“Great White” - The Barrow Instrumentation Facility



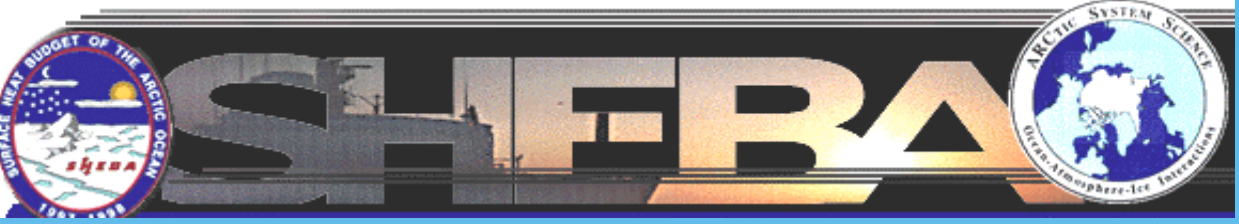
Great White in the Summer

Atqasuk Site Location

Aerial View of Atqasuk

Atqasuk Instrument Shelter

Atqasuk Instrument Sky Stand



http://sheba.apl.washington.edu/

ARM

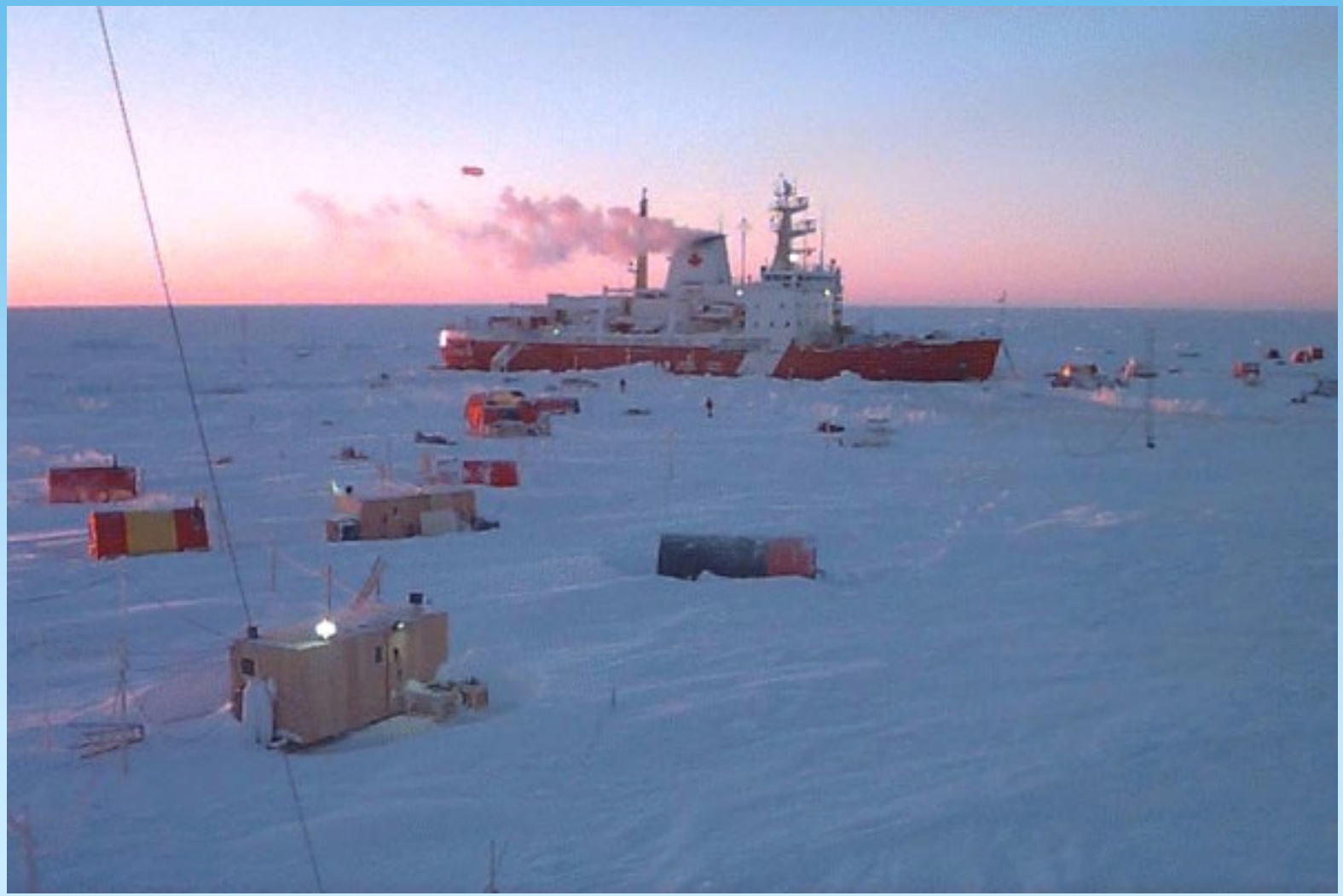
SHEBA -- a coordinated project to investigate the role of arctic climate in global change.

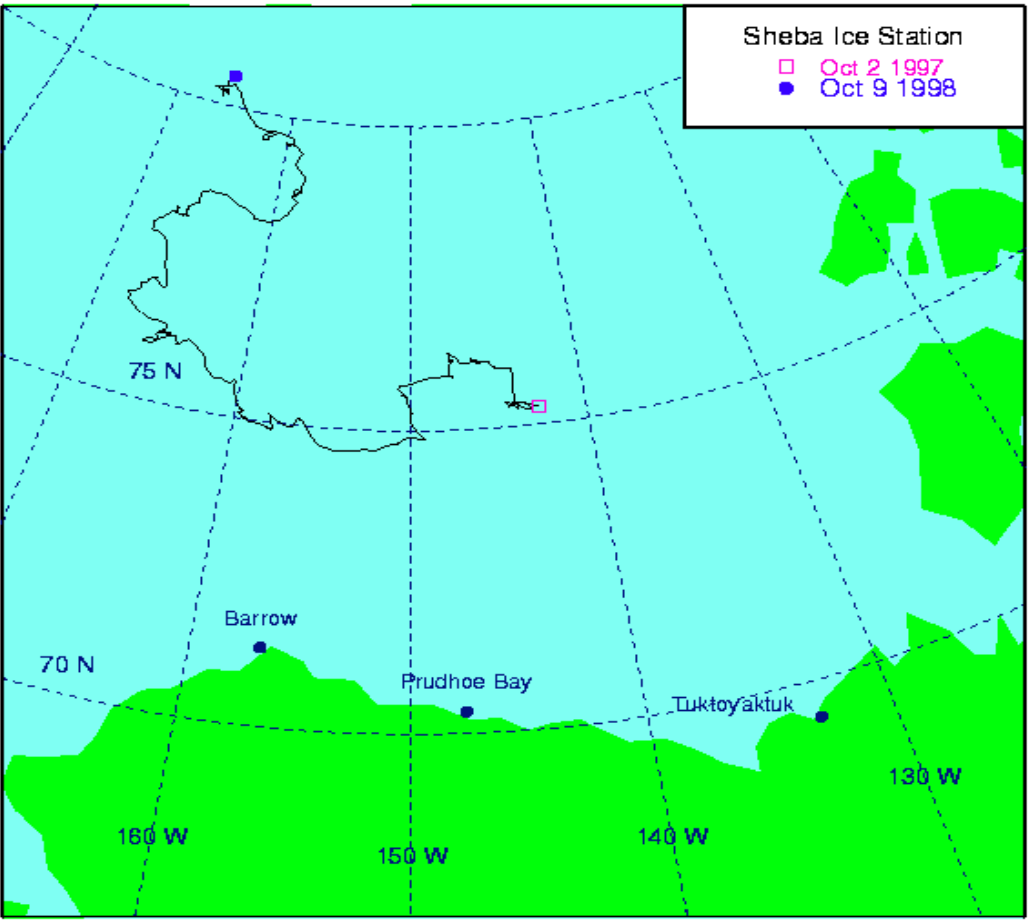
GOALS ---

1.To determine the ocean-ice-atmosphere processes that control the surface albedo and cloud-radiation feedback mechanisms over arctic pack ice,

2. Improve models for the simulation of present day arctic climate, including its variability, utilizing coupled global climate models.

SHEBA Ice Camp





SHEBA Ice Station Drift Tracks

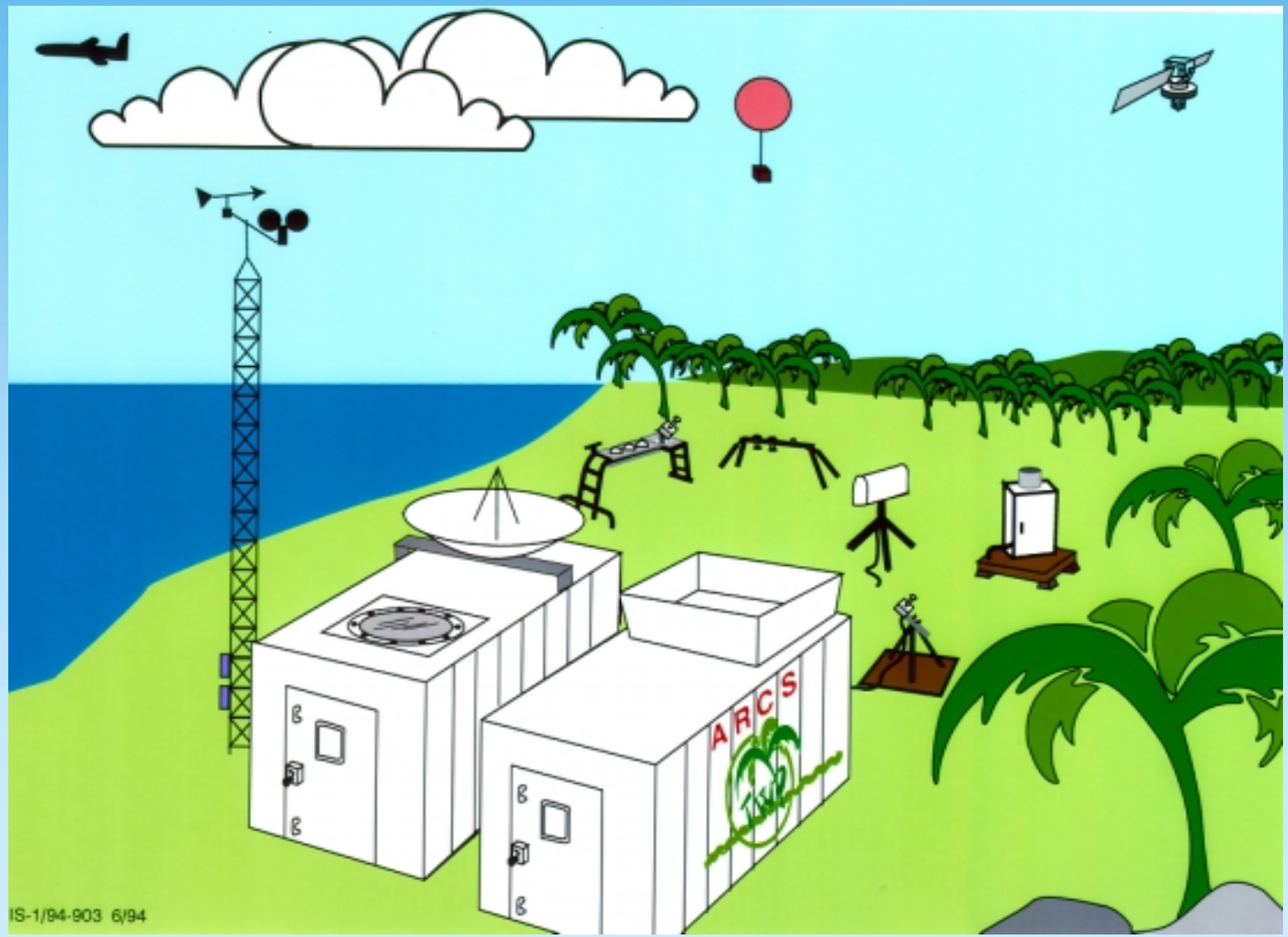
Installation of Ice Station

Releasing Weather Balloon

Atmospheric, Radiation, and Cloud Station (ARCS) Concept

- Instruments that measure radiation, cloud, and meteorological properties
- Data computers, communication and support systems
- Housed in four ocean cargo containers
- Minimal maintenance, movable, flexible
- Phased installation schedule

Atmospheric Radiation and Cloud Station (ARCS) Concept



Installing and Operating Sites and Instruments in Remote Locations

- Both NSA and TWP depend on an “ARCS” concept -- semiautonomous laboratories that are designed, developed and tested before installing at the remote site.
- Remote sites are operated in collaboration with local or regional assistance.
- Similar instruments are used throughout ARM to ensure consistency in data flows and high quality data.

ARCS Measurements

- Surface meteorology
- Surface radiation balance
- Vertical structure of atmosphere
- Column water
- Cloud properties
- Aerosol optical depth

ARCS Measurements

MEASUREMENTS	INSTRUMENTS
Cloud Properties	Whole sky imager* 905 nm ceilometer 523 nm vertical pointing lidar 35 GHz vertical pointing cloud radar*
Surface level solar and terrestrial radiation properties	Up- and down-looking pyranometers, pyrgeometers, and narrow field of view 10 micron radiometers Normal incidence tracking pyrheliometer Shaded pyranometer and pyrgeometer on solar tracker Net radiometer UVB radiometer Multifilter rotating shadowband radiometer
Aerosol optical depth	Multifilter rotating shadowband radiometer
Column water vapor and liquid water	Microwave radiometer
Vertical profiles of wind, temperature and humidity	GPS rawinsonde
Surface meteorology	Meteorology station with 10-meter mast: temperature, humidity, precipitation, pressure, wind speed and direction
Boundary layer structure	915 MHz wind profiler with radar-acoustic sounding system for temperatures (operated in collaboration with NOAA's Aeronomy Lab)
* to be added in 1997	

ARCS Integration Site - Albuquerque, New Mexico

ARCS Data Facilities

ARM Education in NSA

Capacity Building

Public Relations

Community Outreach

Teacher Support

Student Enrichment

Capacity Building

Arm is an environmentally aware project, dedicated to understanding our climate and its changes. We are committed to excellence in education and working with cultural concerns. We intend to ensure the availability of open communication and information for all who are interested. Community, teachers, and students will all work together toward a common goal of ultimately predicting our planet's future.

Public Relations Activities

- Interpretive sign for the site
- Local public relations, including site tours
- Public information packages
- Newsletter and progress sheets
- Radio/TV updates
- Public meetings to give updates on ARM education program

Community Outreach

- Community workshops focusing on cultural understanding of current and historic climate change in the North Slope.
- Public meetings discussing ongoing ARM Education programs.
- Discussions and interviews with community members about climate change.
- Follow-up discussions and put-to-practice use of cultural views in the North Slope Climate Change Curriculum.
- Development in conjunction with Ron Brower on ARM Climate Change interactive kiosk for the Iñupiat Heritage Center.

Teacher Support

- In-service training on climate change for all grades.
- Field trips for teachers and students to ARM sites.
- Curriculum development with the North Slope School District Science Curriculum.
- Lesson plans available through ARM education web site.
- Teacher enrichment grants through Ilisaguk College.
- Teacher workshops and evaluations.

Student Enrichment

- Student to student teaching and mentoring.
- Job shadowing of ARM technicians at ARM sites.
- Internet data and project exchange.
- Radio interviews.

Atmospheric Radiation Measurement Program

EDUCATION PROGRAM

ARM Education Program

- ARM Program mandates an education outreach program for each site.
- Education outreach must be relevant to the needs of the local and regional communities.
- Content and management of the program has been determined by the Site Project Manager.
- Starting in FY2000, the Education Outreach Program was integrated across all 3 sites.

Education Program Plan

- Focus on basic science, climate, climate change, and effects relevant to the region.
- Enrich primary, secondary and college science programs in the region.
- Collaborate in the development and implementation of a regional science curriculum.

Education Program Elements

- Visits to Schools
- Newsletters, TV and radio interviews, videos
- Web sites
- Classroom Activity Guides
- Curriculum Development
- Teacher Workshops for curriculum implementation
- ***INTEGRATION ACROSS ALL SITES*** for increased resources and opportunities for teachers and schools

Atqasuk classroom visits

NSA Classroom visits - Oct 2000

ARM Program's

EDUCATION CENTER

http://www.arm.gov/docs/education/

ARM

Hey Kids...
Meet
PROFESSOR POLARBEAR!

Developed for
KIDS
and
TEACHERS!

Check out our Scavenger Hunt !!

About ARM
Take a look at who we are and what we do.

Global Warming
The facts for beginners or brainers

Ask a Scientist
Got big questions? We've got big answers.

Question of the Week
Professor Polarbear's pick of the week

Lesson Plans
A little help for teachers.

Try Our Quiz!
Global warming
What do you know?

Cool Sites!!!
Lesson plans & tools
Cool education links

Related News
Global news
Great reports

Outreach Sites
Take a trip to one of our education sites!

GLOBAL WARMING

http://www.arm.gov/docs/education/warming/

ARM

Causes of climate change and effects of carbon dioxide on the environment.

Global Beginners

If you are not sure what global warming means, this is the place to start.

Global Thinkers

You have given global warming some thought and would like to know more -- this section is for you.

Global Experts

This section is for those who have spent considerable time studying global warming.

Lesson Plans

http://www.arm.gov/docs/education/tlessons/

The following lessons were first printed as part of the ***Curriculum Modules for the Pacific Schools*** - Climate Change and Sea Level.

Most materials [links are highlighted] are aimed at the **middle school grade level**, but many can be modified by the teacher to be more or less difficult, as desired.
The lessons typically require some background information which is also included. The lessons contain the **objective**, **materials** needed, **important points** to understand, **preparation** steps, and **procedures**.

The lessons will give students:
1. A basic understanding of the composition and structure of the atmosphere.
2. An understanding of the role played by atmospheric pressure and temperature.
3. An understanding of the natural and enhanced greenhouse effects and their implications.

Examples of topics: Air Density and Temperature, Air Pressure, Winds, etc…

NSA/AAO Educational Outreach

- **The ASET/Silakun Project**
- **ASET/Silakun and the Teacher Small Contracts Program**

Http://www.arm.gov/docs/sites/nsa/educate/

Web sites for education

- Atmospheric Radiation Monitoring (ARM) site:
  http://www.arm.gov/
- North Slope of Alaska (NSA) site:
  http://www.arm.gov/docs/sites/nsa/nsaaao.html
- Southern Great Plains (SGP) site:
  http://www.arm.gov/docs/sites/sgp.html
- Tropical Western Pacific (TWP) site:
  http://www.arm.gov/docs/sites/twp.html

Curriculum Workshops…

Nauru

Nov. 98

PNG - May 99

- *Port Moresby*
- *Manus*

Tropical Western Pacific Education Program

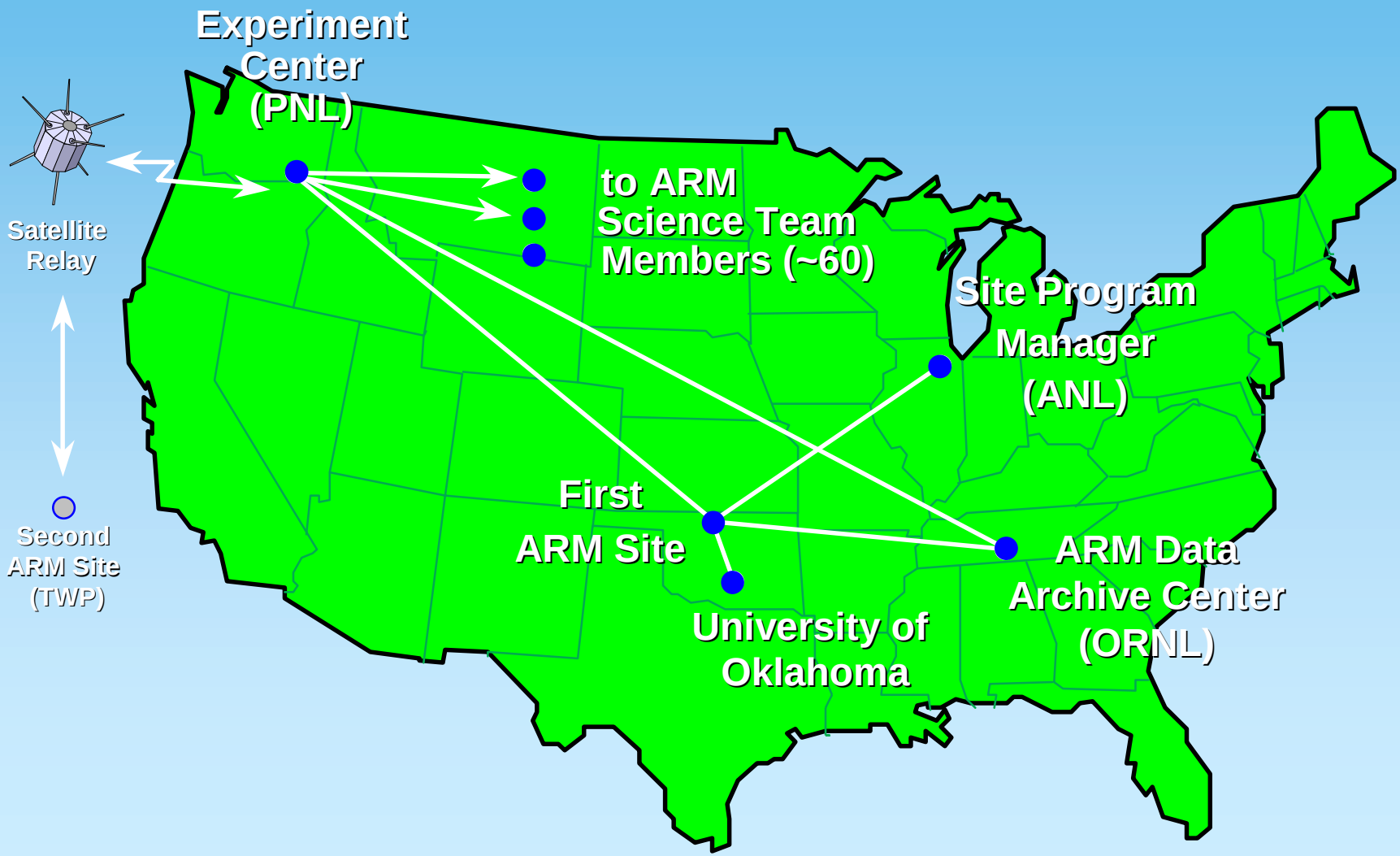
Education Activities

- **Papua New Guinea**
- **Nauru**
- **Regional**
- **SPREP**
- **Future Plans**

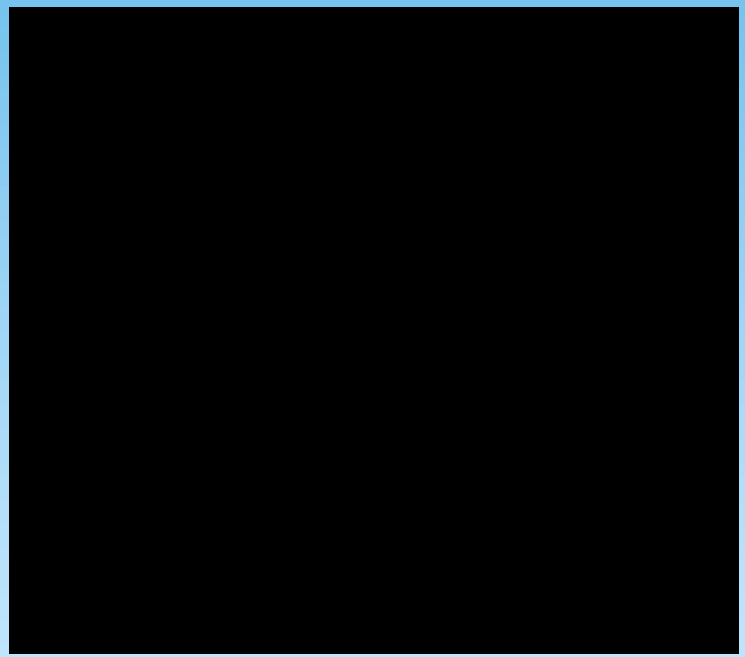
Fairley Barnes, ARM Education Director with Herman Poyasei, Deputy Headmaster of Bundrahei High School, and Ken Zorika, Associate Director, Papua New Guinea National Weather Service.

http://www.arm.gov/docs/sites/twp/education/t_educ/

ARM Data Distribution



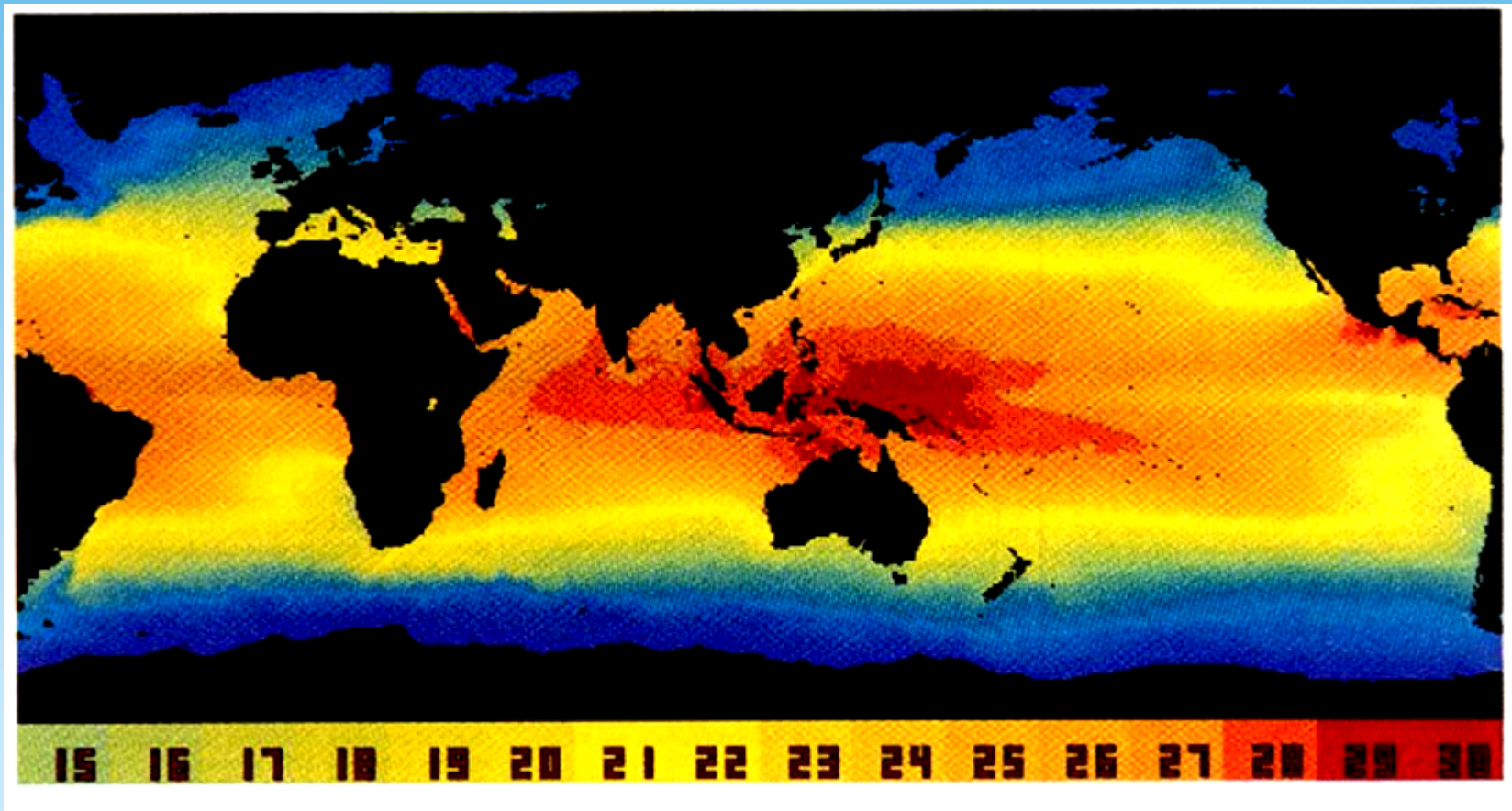
Collaboration with SPREP



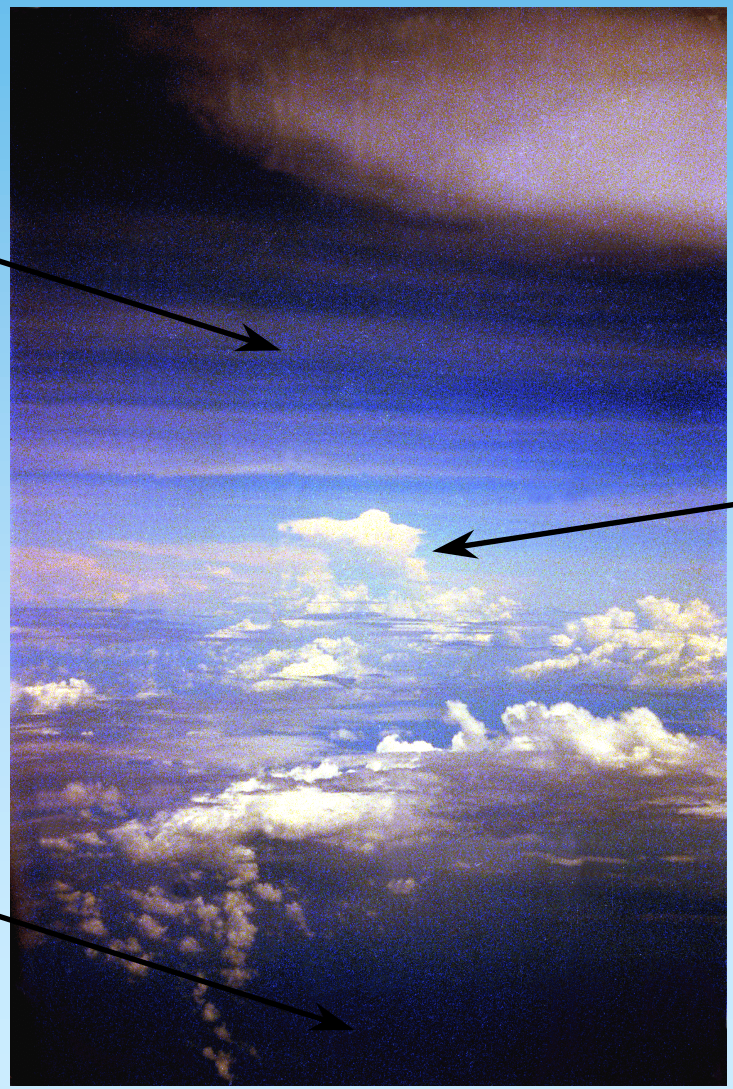
All ARM activities in the Tropical Western Pacific are undertaken in collaboration with the South Pacific Regional Environment Programme (SPREP)

Mr. Penehuro Lefale
SPREP ARM/TWP Program Coordinator

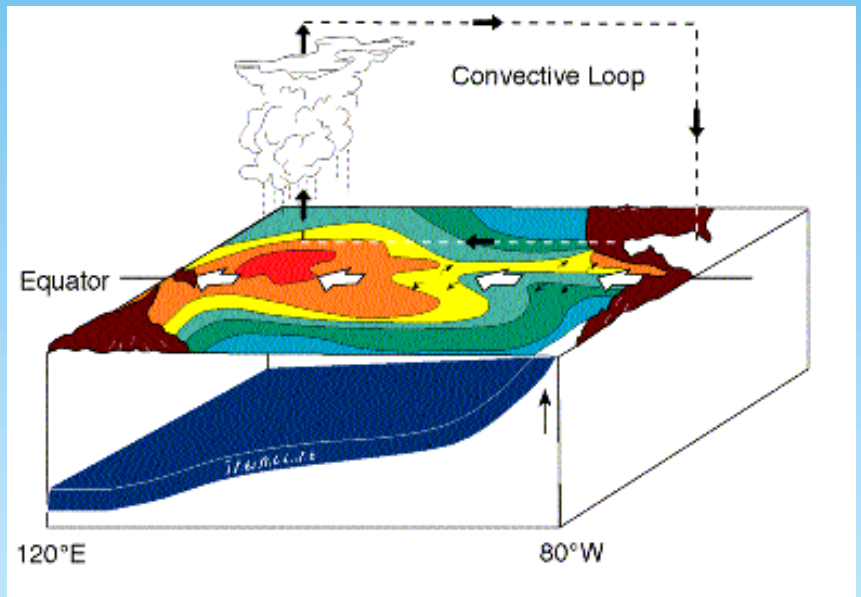
Pacific Warm Pool



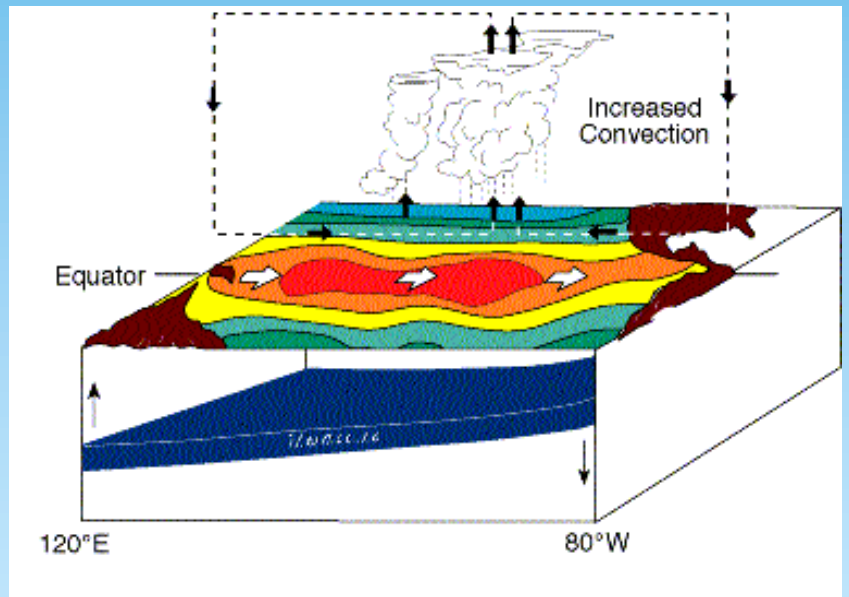
Deep Convection



El Niño



Normal Conditions



El Niño Conditions

Source: www.pmel.noaa.gov/toga-tao/el-nino-story.html

Met Tower

Optical Rain Gage

Remote Balloon Launcher (RBL)

Remote Balloon Launch

Sky Radiation Instruments (SKYRAD)

Solar Tracker Instruments

Ground Radiation Instruments

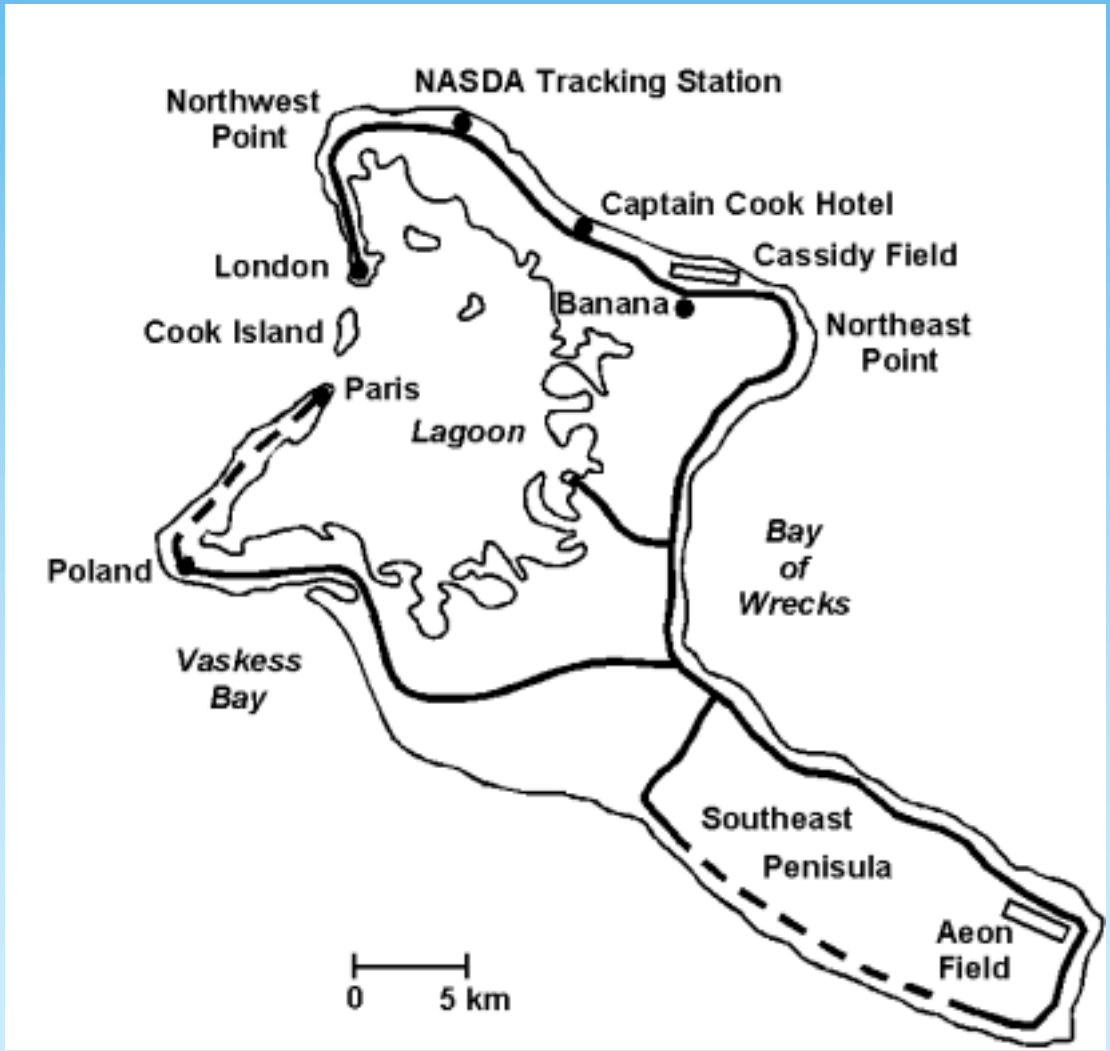
Ceilometer

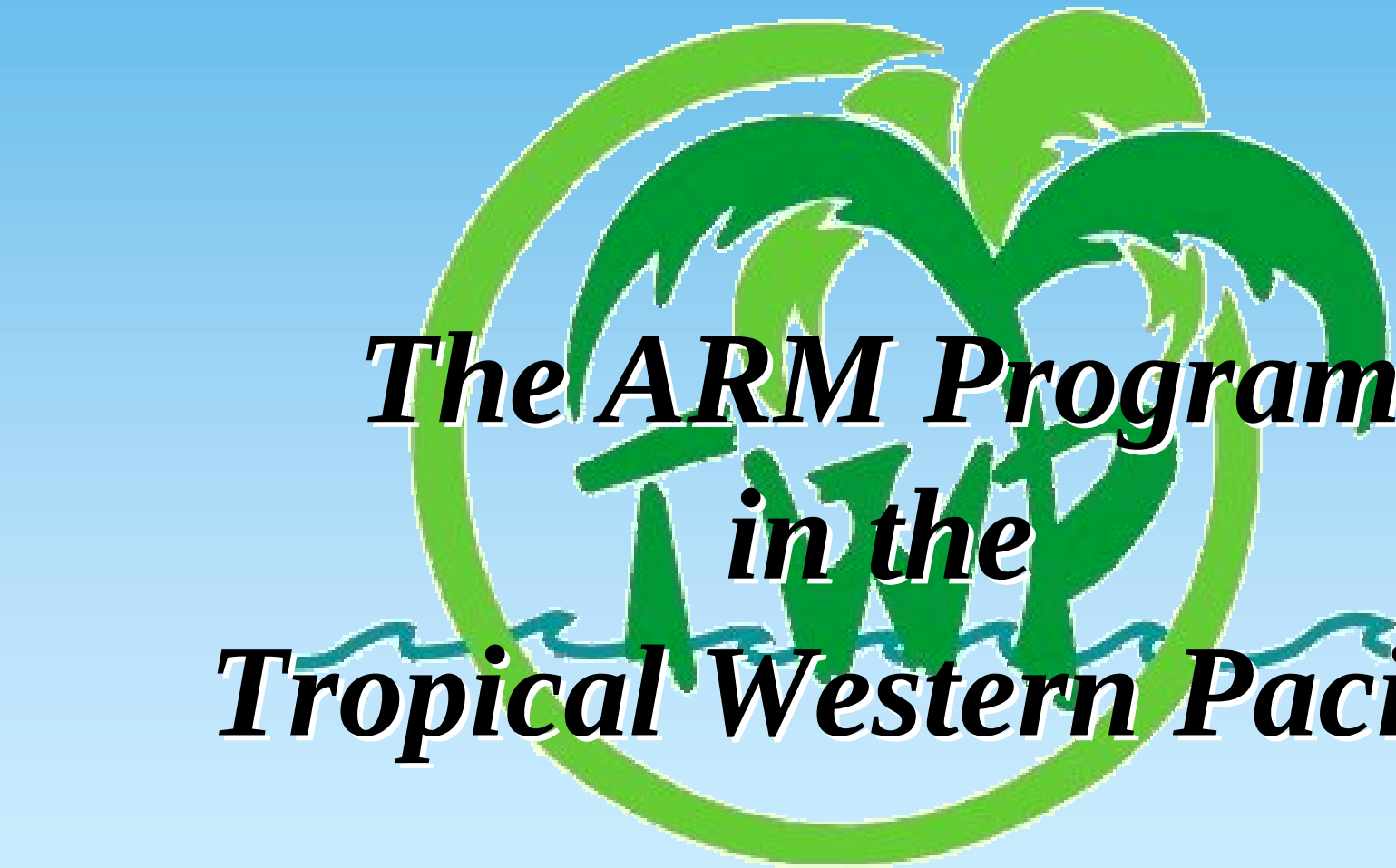
Cloud Lidar

Cloud Radar

Whole Sky Imager (WSI)

Kiritimati Island

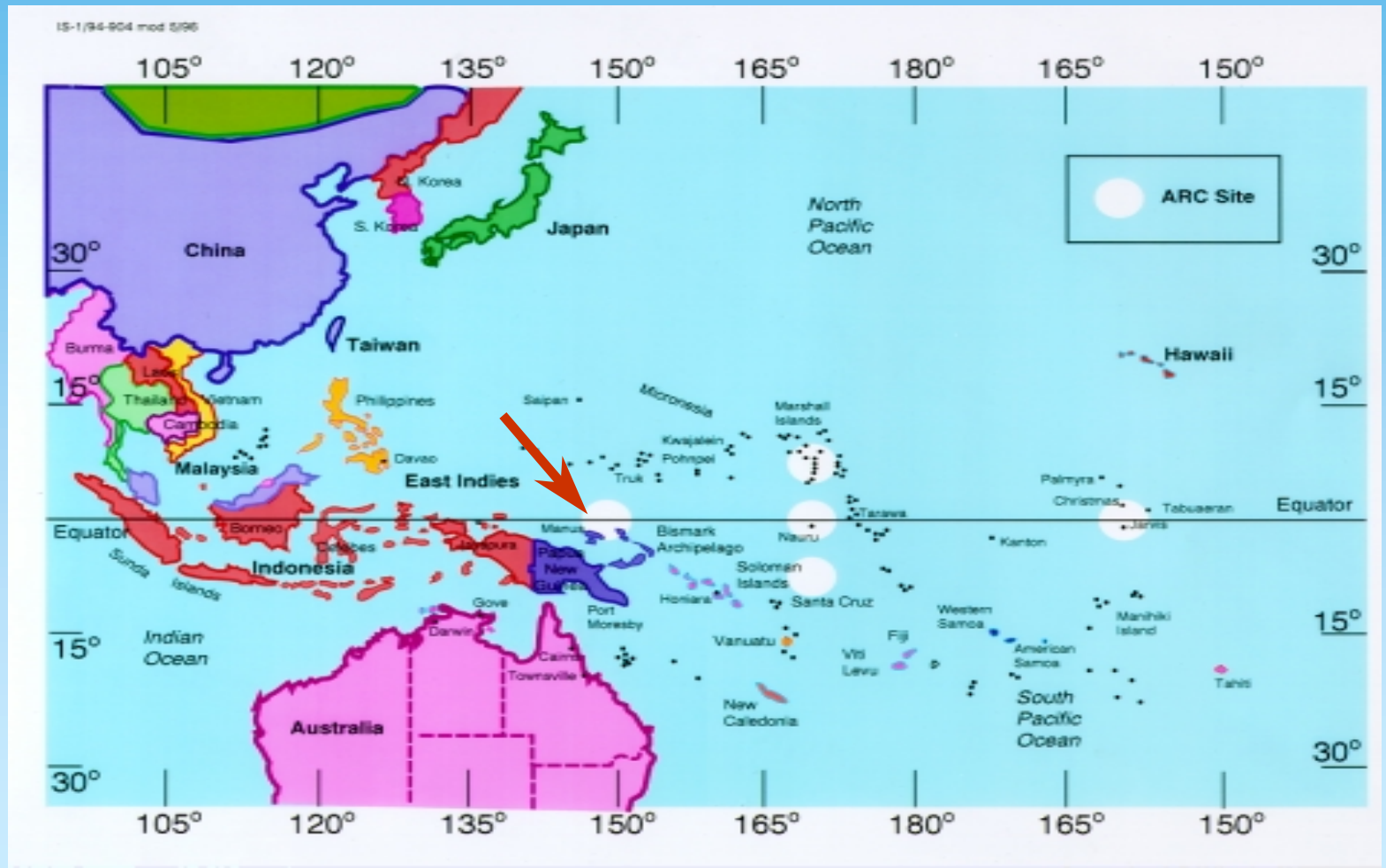




The ARM Program in the Tropical Western Pacific

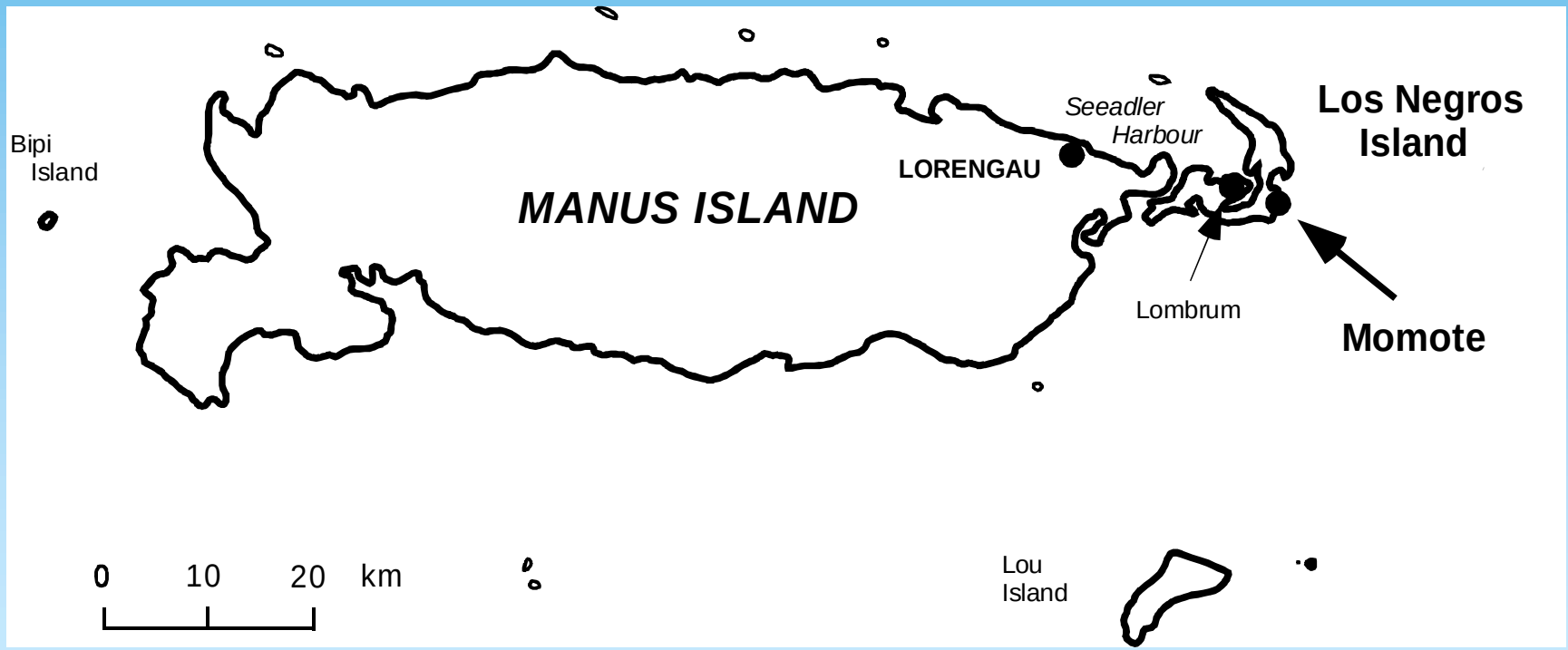
Manus Island, PNG

The Site for ARCS-1



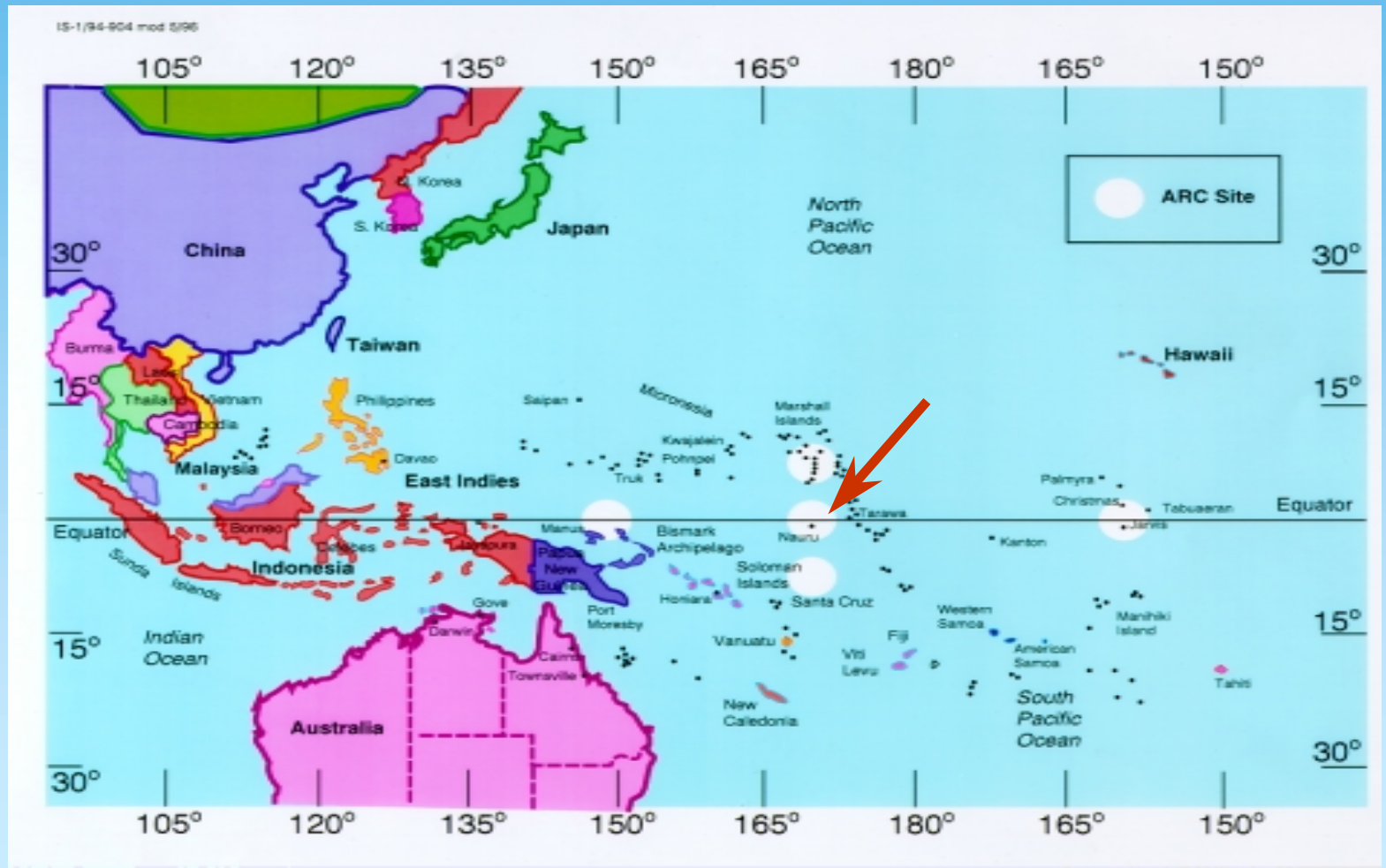
In operation since October 1996 in Collaboration with the PNG National Weather Service.

Manus Island



Republic of Nauru

The Site for ARCS-2



Operations began in November 1998 in collaboration with the Nauruan Department of Island Development and Industry (IDI).

Nauru Island

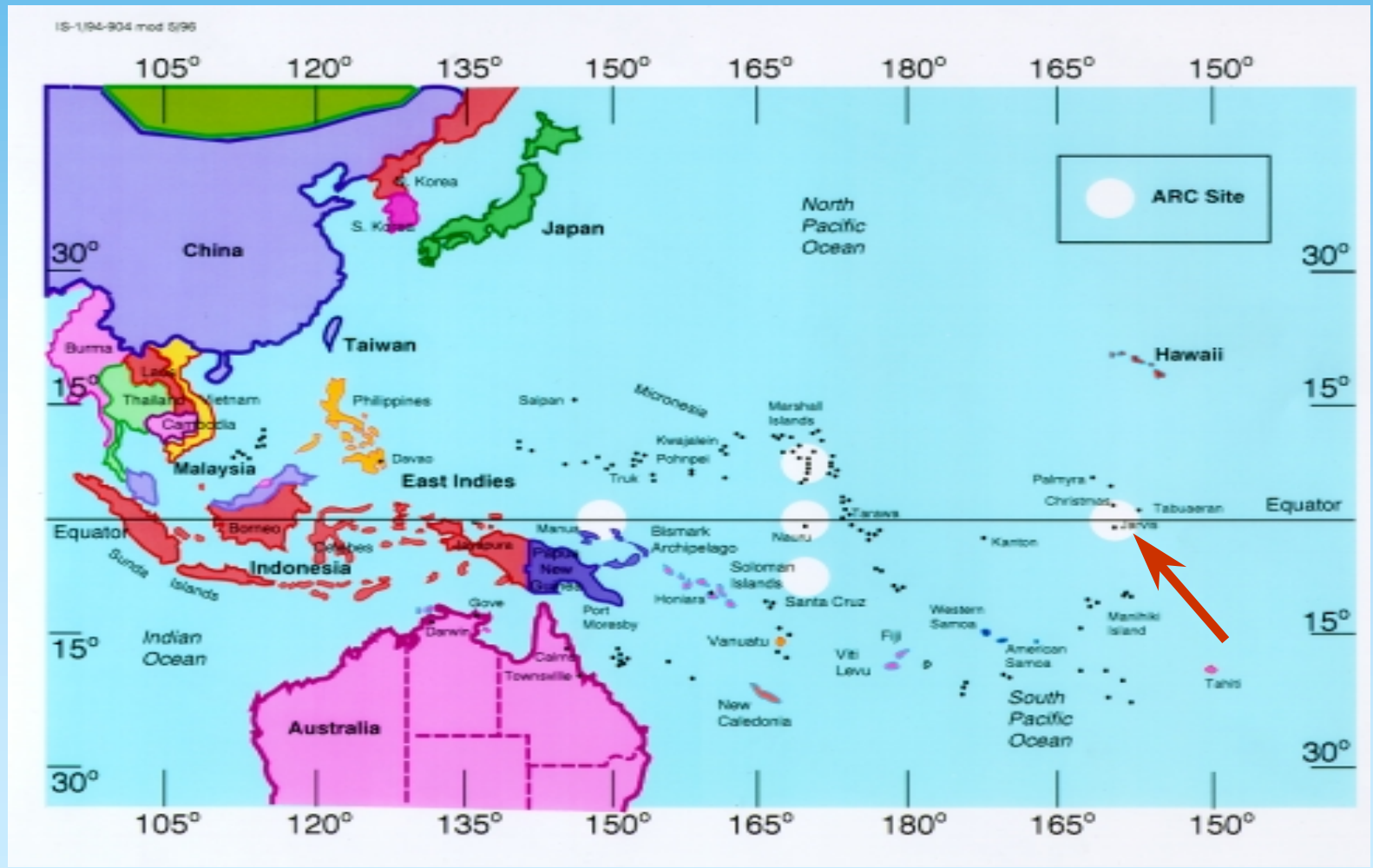
Nauru Site Installation

Nauru Site Opening

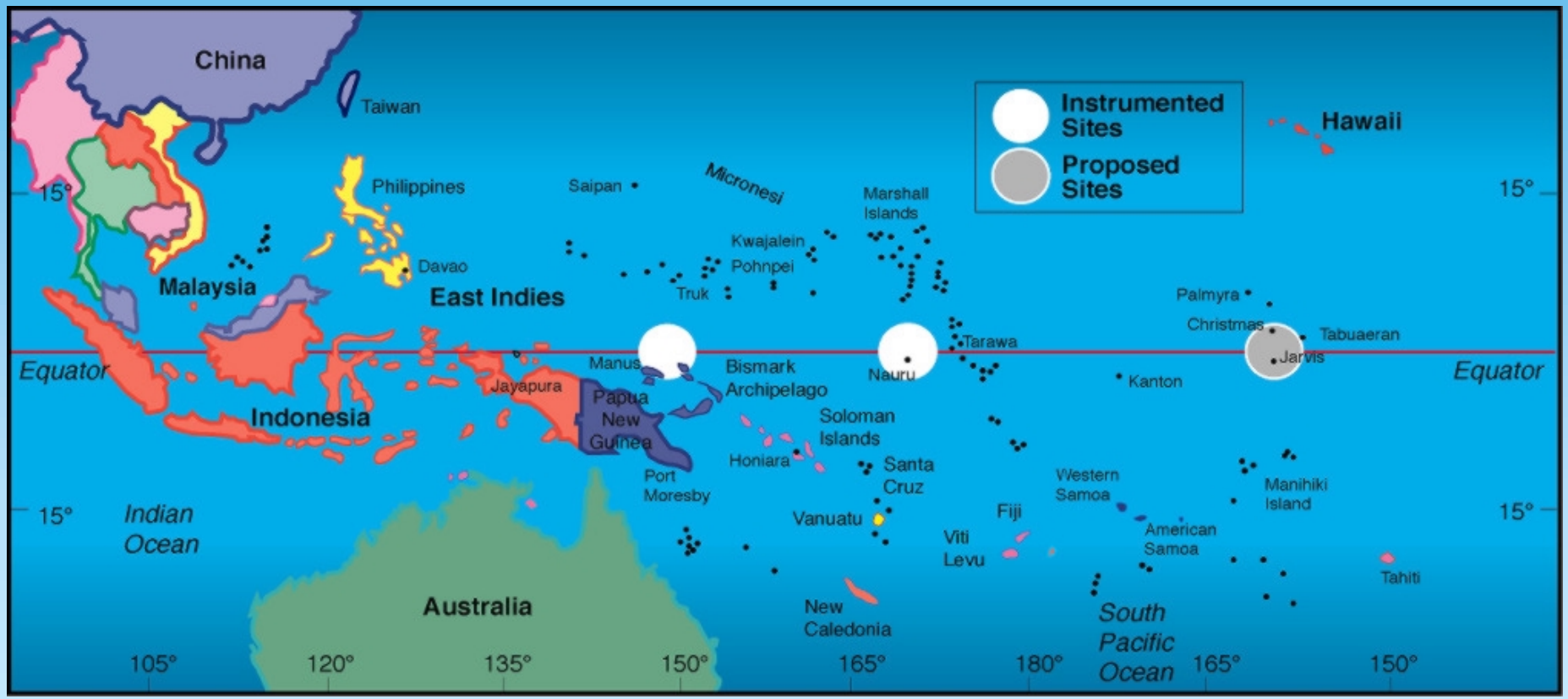
The Nauru Site officially began its operations with the opening ceremony on 20 November 1998. Dr. Wanda Ferrell, DOE/OBER, and His Excellency Derog Gioura, acting president of Nauru, released two connected weather balloons symbolizing the joint effort of ARM and Nauru in establishing and operating the site.

Kiritimati Island

Proposed ARCS-3 Site for 2000



TWP Siting Strategy



Schedule and Status

1	Manus	1996	In operation
2	Nauru	1998	November 98
3	Kiritimati	2000	Proposed
4	Off Equator	TBD	No site selected
5	Off Equator	TBD	No site selected

Tropical Western Pacific (TWP) Program Office

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United States Department of Energy