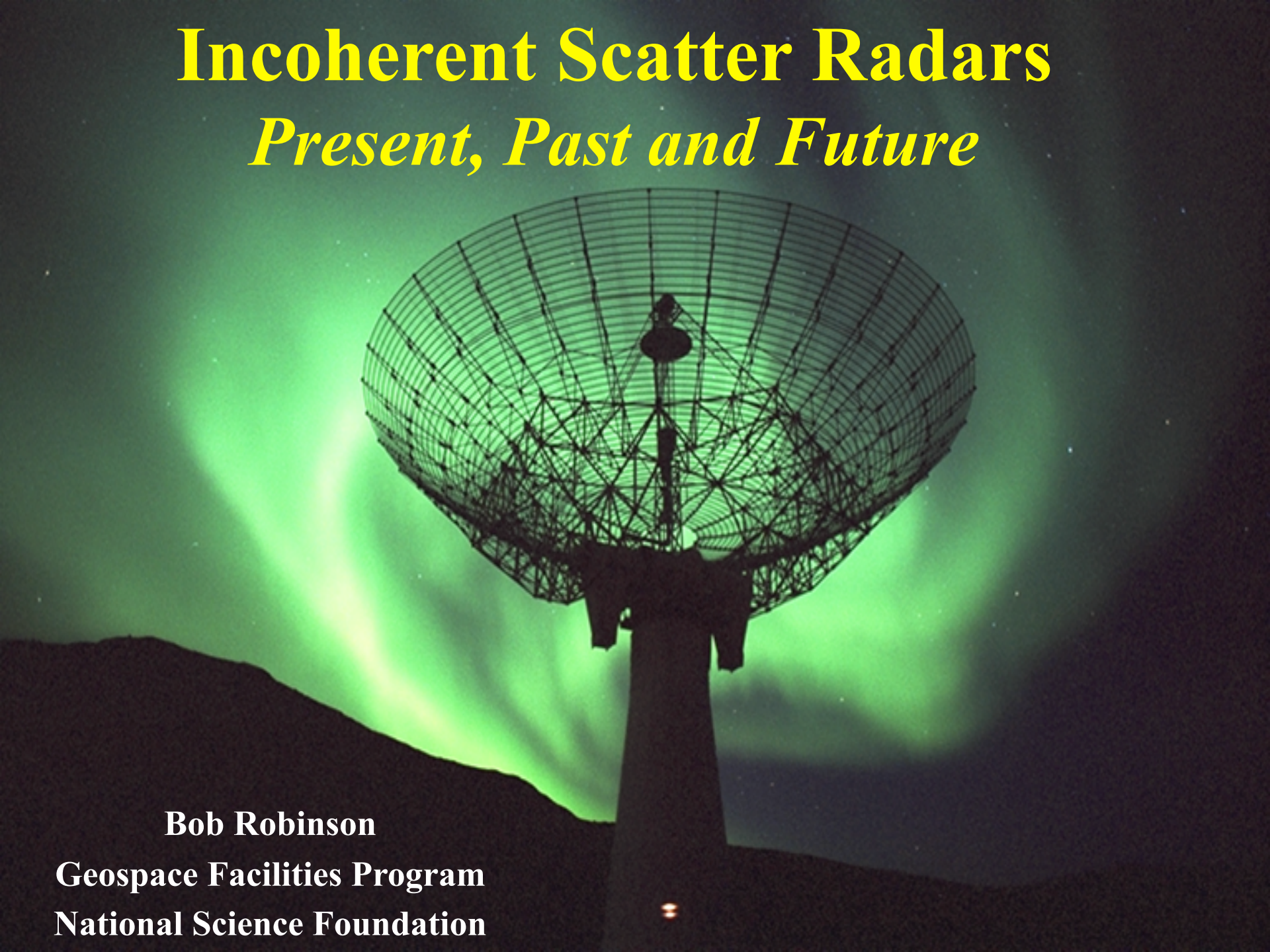
Incoherent Scatter Radars

Present, Past and Future



Bob Robinson

Geospace Facilities Program

National Science Foundation

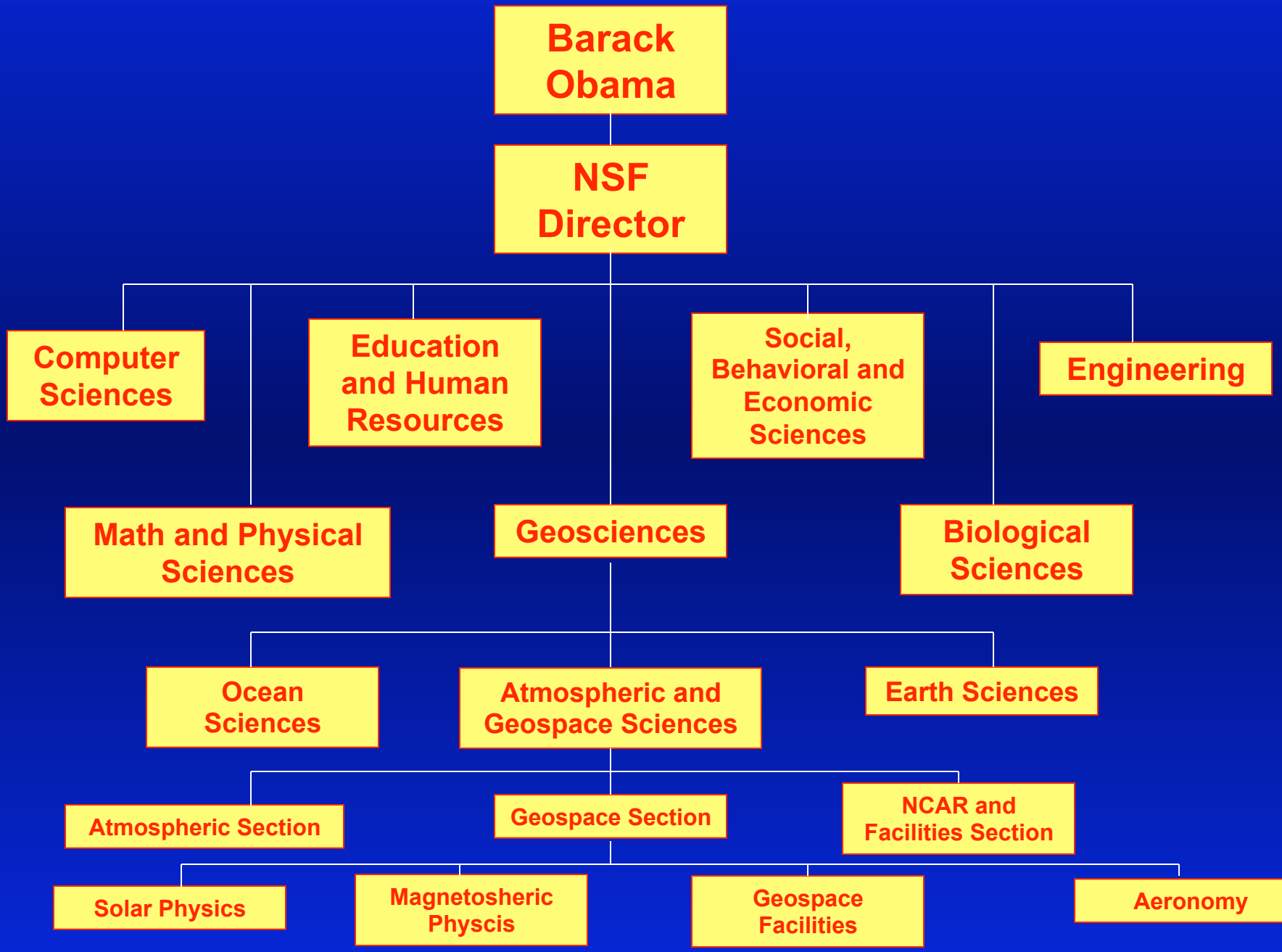
3. It is difficult to imagine an area of space science research that does not benefit from the data provided by the incoherent scatter radars.

2. Because the incoherent scatter radars are able to measure height profiles of the most fundamental ionospheric properties, data from these instruments are used for a broad range of research studies pertaining to the upper atmosphere, ionosphere, and magnetosphere.

1. The Geospace Facilities (GF) Program in the Division of Atmospheric and Geospace Sciences at the National Science Foundation (NSF) was created in 1983 to oversee the scientific operation of a network of incoherent scatter radars used to probe the upper atmosphere and ionosphere.

Geospace Facilities Program

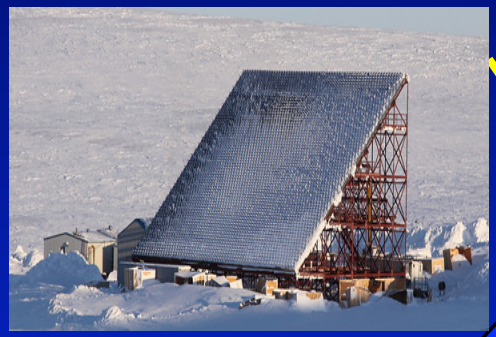
NSF Hierarchy



Goals of the GF Program

- To ensure that the science undertaken at the GF-sponsored facilities is of the highest quality and is coordinated with the university community to produce a synergistic effect in the advancement of upper atmospheric science; and
- To ensure that the facilities are maintained as state-of-the-art, cost-effective research tools available to all qualified scientists, and that the data and services provided by the facilities are adequate to meet the community's short- and long-range scientific objectives;
- To educate the next generation of space scientists in the development, operation, and use of multi-user facilities, leading to the maintenance of a diverse, highly-qualified user base for upper atmospheric research data.

NSF-supported ISRs--2011



AMISR- Resolute Bay (RISR)

Sondrestrom (SRF)

AMISR- Poker Flat (PFISR)

Millstone Hill (MH)

Jicamarca (JRO)

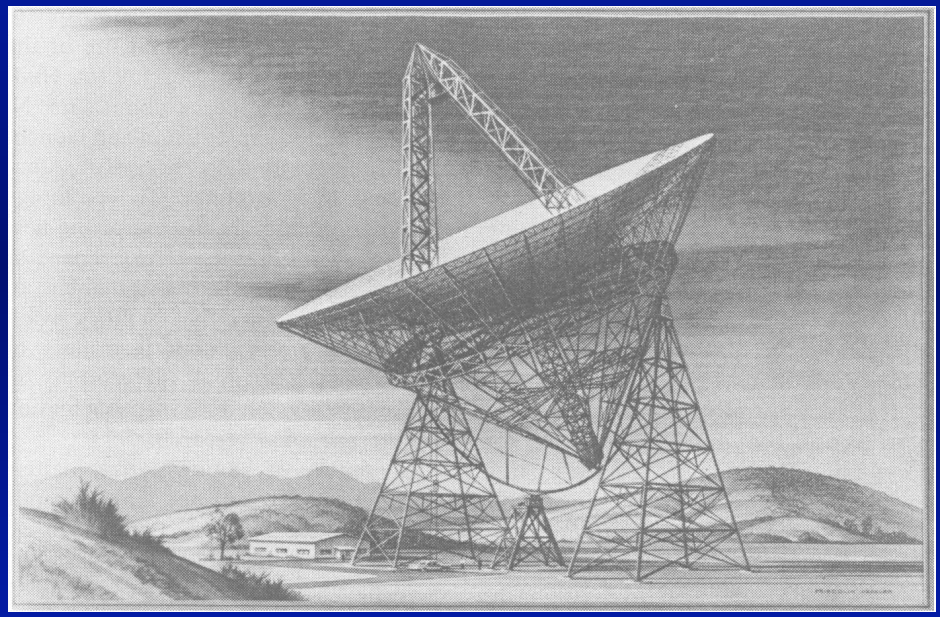
Arecibo (AO)

B
cc
i
Millstone
by MIT Lincoln
Lab
scatter
DNA
built
SR at
Stanford
NSF
over Arecibo
from DoD to
Chatanika
Stanford
NSF takes
over
Jicamarca
from NOAA
Chatanika
Radar moved
to Greenland
EISCAT
HF radar
Built
EISCAT
Svalbard
Radar built
A
AMISR is
built in
Canada

1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010

ISR Starts and Stops

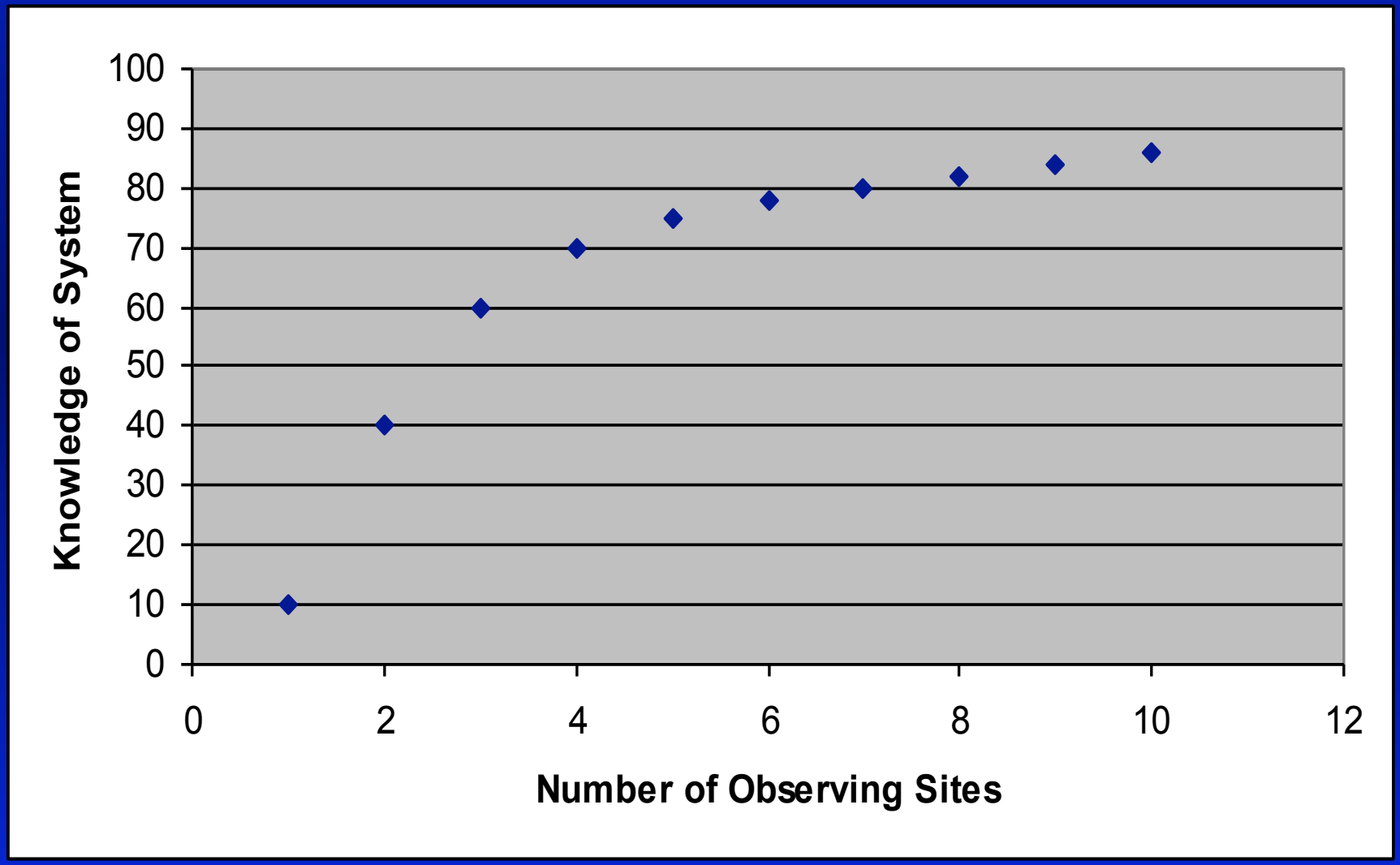
- **France: St. Santin, (multi-static) 1963-1987**
- **UK: Malvern, (multi-static) 1968-1975**
- **MISCAT, Aberystwyth, UK, 1972 (multi-static--first ISR to measure three-dimensional drift velocities)**
- **The Upper Atmosphere Observatory (U. S.), planned 1969-1975**
- **The Polar Cap Observatory (Canada), planned 1987-1997**



ISR Deployment Strategies for the future

- Global coverage
- Ease and cost-effectiveness in ISR operation
- Interoperability and commonality in ISR scheduling, operating modes, and data access
- Global leveraging and coordination

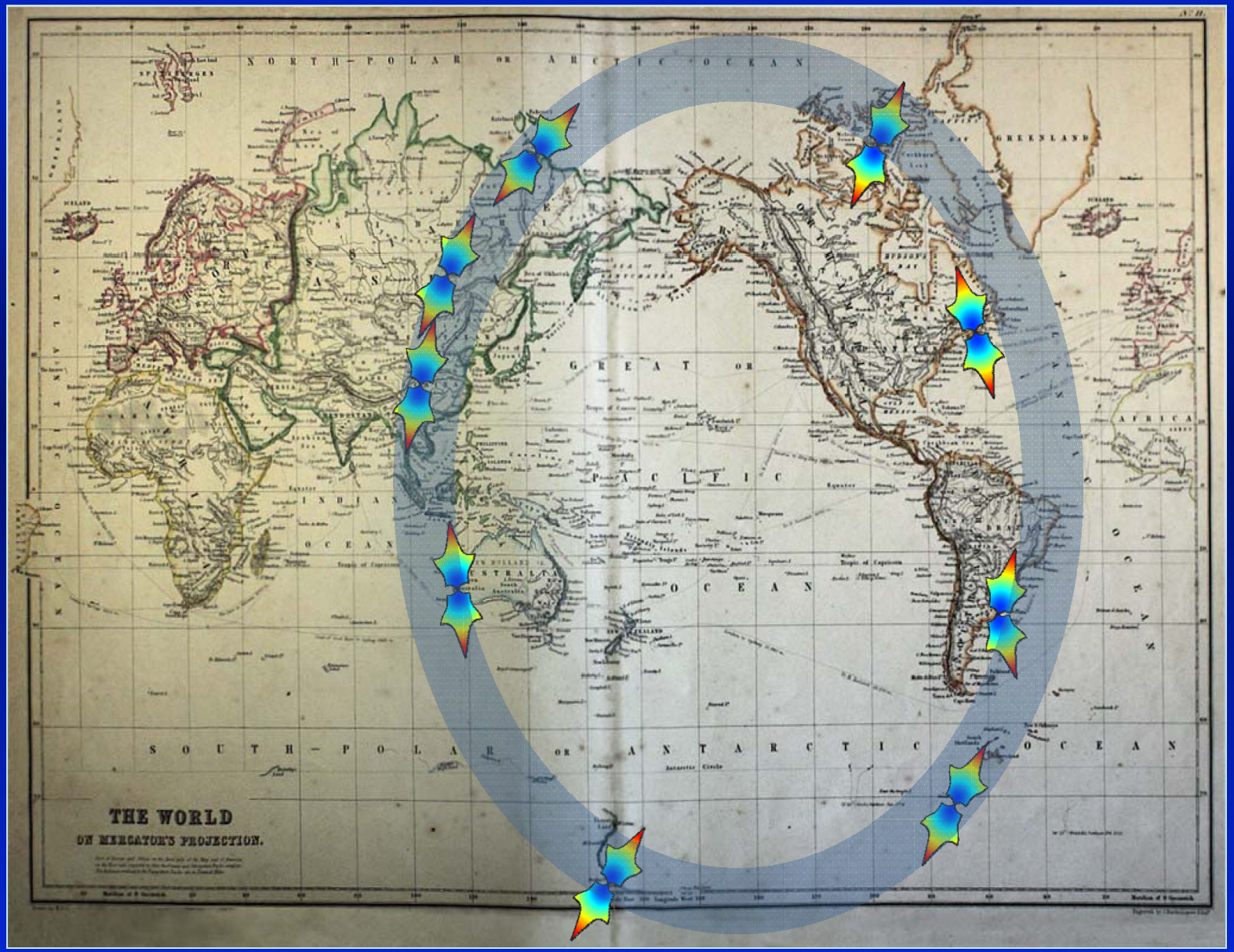
How do we know how many observatories are enough?



Where do we need ISRs?

- Within the polar cap (Resolute Bay)
- Around the auroral oval (Poker Flat, Sondrestrom, Tromso, Svalbard)
- Sub-auroral zone (none)
- Mid-latitude (Millstone, Kharkov)
- Low latitude (Arecibo)
- Equator (Jicamarca+one more)
- Low latitude southern hemisphere (Argentina)
- Auroral latitude southern hemisphere (McMurdo)

Meridian Ring of AMISRs



ISR Global Operating Modes

	Northern Hemisphere Science Mode	Southern Hemisphere Science Mode	Conjugate Science Mode	Equatorial Science Mode	Meridional Science Mode	Auroral Science Mode
Resolute-N	128		64		64	
Resolute-S	64	128	64	128	64	
Sondrestrom						
EISCAT Svalbard						
Other Canada	64		64		64	128
Poker Flat	128					96
EISCAT Tromso						
Millstone						
Arecibo						
Jicamarca	7	7	7	32	7	7
Brazil		32		128	32	
La Plata	16	64	32	128	64	16
Antarctic Peninsula		64	96		64	64
Antarctic Auroral		64				96
McMurdo		64	96		64	
Total Panels	407	423	423	416	423	407

What is the future of ISR?

Question

- **What is the most important aspect of incoherent scatter radars that have kept them at the forefront of ionospheric and atmospheric research?**