Observing Pole to Pole – A virtual observing system

Global Inter-agency IPY Polar Snapshot Year (GIIPSY)
WMO Space Task Group

Participating International Agencies: ASI, CSA, CMA, CNES, DLR, ESA, EUMETSAT, INPE, JAXA, NASA, NOAA, ROSHYDROMET, WMO, WCRP-CLiC
Climate Change and the IPY 2007-2008

- The IPY provided an international framework for understanding polar processes and high-latitude climate.
- Spaceborne technology offered unique capabilities for obtaining essential data for predictive models.
- IPY era spaceborne instrumentation represented a technological leap beyond the capabilities of the IGY.
Collecting satellite polar snapshots

Aircraft and in-situ Sounders and GPR Systems

DMSP
SSML
Aqua & Terra
AMSR-E
MODIS / ASTER
ASCAT
AVHRR
ADM-Aeolus

GRACE
GOCE

SMOS
ERS-2
RADARSAT-2
ALOS
PALSAR
PRISM / AVNIR-2

IceSat

SWIR / VGT

SPOT-4

HRVIR / VGT

Metop

GOCE

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GIIPSY

The 1957 IGY began the rigorous scientific investigation of the Polar Regions.

The 2007-08 IPY goes beyond the IGY through the numbers and capabilities of earth observing satellites. These systems can routinely observe the poles and cast polar processes within the context of the global environment.

In November 2005, the Global Interagency Polar Snapshot Year (GIIPSY) project was established to develop consensus requirements on polar science objectives that could best and perhaps only be met with Earth observing satellites.
GIIPSY Strategy

• Work with the science community to compile IPY science data requirements

• Identify those requirements which will be satisfied through routine operations (eg MODIS, MERIS)

• For routine observations, work with flight agencies to assure that data are available/archived in some standardized fashion

• Identify those requirements that can only be satisfied by non-routine tasking, processing and distribution. Work with the flight agencies to acquire these data in a fashion that distributes the operational load.

• Following selection of projects through the national A.O.’s, identify whether any legacy data sets are absent from the acquisition plans. Make necessary requests.

• GIIPSY science requirements and related documentation are posted at www.bprc.osu.edu/rsl/GIIPSY
WMO IPY Space Task Group (STG)

The STG is the body convened by the WMO tasked with addressing how to meet the IPY space observation requirements developed by GIIPSY.

The STG was established to coordinate agency planning, processing and archiving of IPY Earth observation legacy data sets.

It is comprised of nominated representatives from Brazil, Canada, China, France, Germany, Italy, Japan, Russian Federation, United Kingdom, United States, and both the European Space Agency and The European Organization for the Exploitation of Meteorological Satellites, the later two of which alone represent 26 nations.

STG coordinates across CEOS and CGMS Agencies.
STG Strategy

• Satisfy GIIPSY science requirements in a fashion that distributes the acquisition and processing loads across agencies
• Select projects that are compatible with the operational mandates of individual agencies and commercial partners
• Encourage participation of other nations as additional polar observation capabilities are developed
• Identify a limited number of the most important scientific objectives achievable within the STG framework and within the IPY time period.

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STG Goals

The STG initially accepted 4, primary objectives based on the GIIPSY requirements. Polar meteorology and atmospheric chemistry goals were later added.

- Pole to coast multi-frequency InSAR measurements of ice-sheet surface velocity.
- Repeat fine-resolution SAR mapping of the entire Southern Ocean sea ice cover for sea ice motion.
- One complete high resolution visible and thermal IR (Vis/IR) snapshot of circumpolar permafrost.
- Pan-Arctic high and moderate resolution Vis/IR snapshots of freshwater (lake and river) freeze-up and break-up.
Ice Sheets
Multisensor data provide new views of the polar ice sheets

RADARSAT 2 Multi-pol color composite of Antarctic outlet glaciers HH, HV, HH-HV

SPOT stereo digital elevation model from CNES SPIRIT project. Hoffsjökull Ice Cap, Iceland
Greenland ice-sheet dynamics & change

Courtesy Joughin et al

Courtesy Jezek et al

Courtesy Johannessen et al
Greenland ice-streams

JERS-1
Oct. 4, 1994

PALSAR
Aug. 3, 2007

TerraSAR-X
June, ‘08

ASAR Browse
Sep. 18, 2008

Jakobshavn Isbrae

TerraSAR Sites

Fast
Monitoring Antarctic changes

Cycle 08: 2006/12/5 ~ 2007/1/19
Cycle 14: 2007/9/7 ~ 2007/10/22
Cycle 16: 2007/12/8 ~ 2008/1/22

Courtesy ESA

Atka Bay

JAXA Japan Aerospace Exploration Agency

Envisat ASAR ESA 2007

Lambert Glacier, East Antarctica
Ice-sheet change in Antarctica

Altimeter – Topographic Change

SAR – Ice Flow Dynamics

Rate of change of elevation (mm/yr)

Courtesy Wingham et al

Courtesy Rignot et al
Wilkins Ice Shelf disintegration

2009-09-04 HR
ASI Cosmos Skymed

Charcot Island Antarctic

Latady Island
For the first time, pole to coast multi-frequency InSAR measurements of ice-sheet surface velocity
Greenland Ice Mapping Project

RADARSAT data provided by CSA, archived and distributed through ASF, and processed by the University of Washington under contract to NASA.
Northern Greenland Glacier Speed Change – 2000 to 2006

2006 Flow Speed

Change from 2000 to 2006

Courtesy I. Joughin
Recovery Glacier – T-SAR-X
ALOS data provided by JAXA & MIDI
Velocity processed by U. Wash. with NASA support
MODIS data mosaicked by NSIDC with NASA support

Antarctic Peninsula Velocities produced from ALOS 2007-2008 ALOS Data
Sea Ice
Arctic sea ice changes

A comparison of ice age in September 2007 (left) and September 2008 (right) shows the increase in thin first-year ice (red) and the decline in thick multi-year ice (orange and yellow). White indicates areas of ice concentration below ~50 percent, for which ice age cannot be determined. AVHRR, SMMR SSM/I, and IABP buoy data were used.
New Ice Products from AVHRR, MODIS, SEVERI

Sea Ice Concentration

Sea Ice Thickness

SIC from MODIS/Aqua visible band

03/2003 0400 LST, NOAA
Arctic Sea-Ice Thickness Change

ERS-1/2: 1993-2002

Envisat: 2008 ice anomaly

2007: lowest minimum
2008: second lowest minimum
Arctic Sea-Ice Drift

2-day ice drift: April 30, 2008 → May 02, 2008

http://www.seaice.dk/test.N/
For the first time, repeat fine-resolution SAR mapping of the entire Southern Ocean sea-ice cover for sea ice motion
Global Monitoring Mode (GMM) – 1km resolution

Antarctica monthly sea ice extent

APRIL 2004
Envisat ASAR 3-day sea ice drift

4-7 July, 2008

http://www.seaice.dk/polarview/google.s/latest.GMMdrift.kml
Routine Antarctic Sea ice Drift

Courtesy DTU – PolarView

http://www.seaice.dk/test.S/
For the first time, one complete Bipolar high & moderate resolution visible and thermal IR and SAR snapshot - for ice sheet, circumpolar snowcover and permafrost applications
Visible/IR Image Mosaics of the Poles

SPOT VGT 1km daily mosaics (courtesy CNES)

esa
Circumpolar Clear Sky Composites

Spring thaw – Siberian Thermokarst

Winter snow pack

MODIS Mosaic - Courtesy NRCan & NASA
River and Lake Ice
For the first time, Pan-Arctic high resolution Vis/IR and SAR snapshots - for lake and river freeze-up and break-up and other applications
ALOS: AVNIR-2 (10m) & PRISM (2.5m)
Arctic Optical Coverage

Envisat MERIS Data Viewer
See MERAVI:
http://miravi.eo.esa.int

Pechora River, Russia

Envisat - MERIS – 300m optical image of Arctic tundra
Daily Optical (Visible/InfraRed)

SPOT VGT 1km daily mosaics (courtesy CNES)
NRCan VGT mosaics

Corrected for BRDF & cloud effects (courtesy, Government of Canada, Natural Resources Canada, Earth Sciences Sector and Canadian Space Agency)
River Ice monitoring - Porcupine River, YK

May 15, 2008
Envisat ASAR VV - IS6 – Desc.
Lake Ice Monitoring

Ice Status: Initial Ice Break-up
Percent Area Frozen: 25 - 50%

http://www.polarview.org/services/lim.htm
River Ice & Ice Jam Monitoring

Alternating polarisation mode ASAR data

Exploits River - Canada

January 11, 2008

http://www.polarview.org/services/rim.htm

Courtesy PolarView
Atmosphere
Cloud tracking: Upper atmosphere Winds

Polar Winds (courtesy NOAA/NESDIS)
Direct Broadcast (Readout) MODIS and AVHRR Winds

- Aqua, Terra, AVHRR winds are generated separately
- Data source is direct readout (broadcast)
- 1 km MODIS and AVHRR remapped to 2 km.
- Cloud-track and water vapor (MODIS) winds
- NCEP’s GFS is used as the background.
- Pros: Low latency; high resolution.
- Cons: Incomplete polar coverage.
Atmospheric composition measurements, e.g. Bromium Monoxide (BrO)

Courtesy S. Kern
Continued atmospheric composition measurements, e.g., ozone (O3) and bromium monoxide (BrO)
Summary

• The STG has contributed fundamentally to IPY by ensuring inter-Agency coordination needed to acquire a critical 21st century climate benchmark dataset necessary to meet IPY Science goals.

• IPY satellite Legacy dataset is multi-dimensional and spans data from 14 space agencies.

• The Space Task Group mechanism is itself a legacy for organizing future coordinate earth observing campaign as appropriate.
What Next?

Establish a path for securing future collections of spaceborne snapshots of the poles through development of a virtual constellation.

The WMO Global Cryosphere Watch could be a vehicle for achieving that objective.

How would a reconstituted STG operate in a new framework? Would there be expanded scientific objectives? What would be the extent of the planning window?

What would be the new functional link to the science community.

GIIPSY/STG:
A legacy of IPY

A component of WIGOS

A legacy of WCRP/CliC in the area of observations

A contribution to GEOSS
GIIPSY/STG Related Publications