IGOS Cryosphere Theme, background and present status

Based on information from V. Ryabinin and Jeff Key

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Background

IGOS-P10bis Colorado Springs, November 2003

Initiators: Exec. Dir. of SCAR (inspired by IGOS-P) and the leadership of the WCRP CliC Project.

Writing team and those who commented: experts from GOOS, SCAR, WCRP/CliC, WMO, the Canadian Meteorological Service, ESA, the Geological Survey of Canada, the International Permafrost Association, the Finnish Institute of Marine Research, and Ohio State University.

Expressions of interest from:
JAXA, NOAA, NERSC, and GMES-ICEMON.

Cryosphere

Snow

- SWE, depth, extent, state, density, snowfall, solid precipitation, albedo
- in-situ climate & synoptic (manual, auto), weather radar, remote sensing

Lake and River Ice

- FU/BU, thickness, snow on ice
- in-situ (shore based), remote sensing

Sea Ice

- extent, concentration, open water, type, thickness, motion, icebergs, snow on ice
- landfast (manual), ship-based & aerial reconnaissance, satellite & airborne reconnaissance

Glaciers, Ice Caps, Ice sheets

- mass balance (accumulation/ablation), thickness, area, length (geometry), firn temperature, snowline/equilibrium line, snow on ice
- ground-based (in-situ), remote sensing

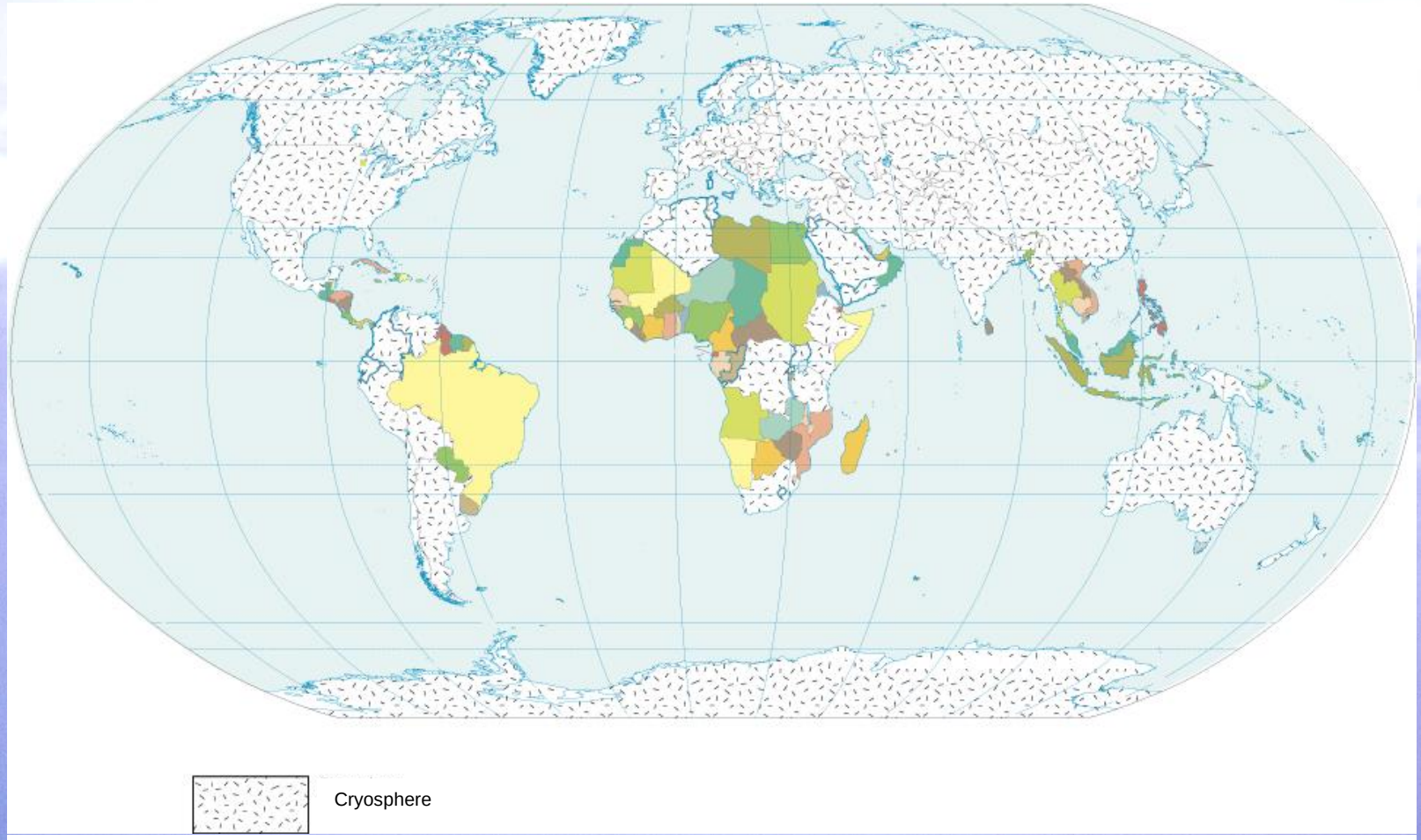
Frozen Ground/Permafrost

- soil temperature/thermal state, active layer thickness, borehole temperature, extent, snow cover
- in-situ (manual, auto), remote sensing (new)

Countries Where Cryosphere Occurs

95 countries identified with cryospheric components

Cryosphere is global



THE VANCOUVER SUN

February 5, 2003

Warm winter disrupting B.C. wildlife:

Unseasonal weather has halved snowpacks,
kept bears from hibernating and prolonged insects' lives

Disappearing glaciers!

USA TODAY

Warmer world driving weather

Arctic communities face major changes in climate:
Northern residents grapple with unpredictable weather

Extreme weather should continue!

Swiss scientist warn on Global Warming

Los Angeles Times

January 19, 2003

Melting Ice, Winds of Change

Extreme rain/snow

The New York Times ON THE WEB

24 November 2002

Disappearing Glaciers Menace Water Supplies

Chacaltaya Mountain, Bolivia. – Great slices of snow and ice vanish every year in the Andes, from Venezueal to Bolivia

Western farmers worried about absence of snow this winter

Warming trend keeps animals from their winter ice habit

The Arctic Perennial Sea Ice Could be gone by end of the Century (NASA press release - Jan 2003)

Some examples showing the importance of knowing the state of the cryosphere:

- Through several feedbacks (e.g. ice-albedo one) it has a large effect on the predictability/variability of weather and climate, and knowledge of the cryosphere is therefore vital at many levels of decision-making and in many applications.
- It plays an important role in generating and mediating the conditions for a possible abrupt climate change.
- It is one of the factors of largest uncertainty among contributors to mean sea level rise.
- It is an important source for fresh water resources for many countries.
- Future of the sea-ice is a challenging scientific problem. In polar regions sea-ice critically affects the pathways and hence patterns of world sea-borne trade, and strongly influences fishing activity.
- The cryosphere provides many of the most useful indicators of long-term climate change.

Importance of cryospheric observations is recognised at/by:

Earth Observation Summit (July 2003) – Group on Earth Observations

WMO Statements of Guidance regarding how well satellite capabilities meet WMO user requirements

Second Report on the Adequacy of the Global Observing Systems for Climate in support of the UNFCCC & GCOS Implementation Plan

WCRP Climate & Cryosphere Project Sci. Plan

Status: snow cover

WWW/GOS Synoptic Network.
National Networks (depth and snow water equivalent).

Synoptic and national networks have significant gaps and are ALL contracting.
Southern Hemisphere not monitored operationally for extent and duration.

Solid precipitation observation network – requires maintenance, support and development, huge gaps

Status: permafrost and frozen ground

Global Terrestrial Network for Permafrost (GTN-P) under IPA co-ordinates National Monitoring Networks.

Major geographical gaps.

Partially declining.

International Standards under development.

Status:
glaciers and ice caps

Global Terrestrial Network for Glaciers (GTN-G) co-ordinates national monitoring networks.

Major gaps geographically.

Number of glacier mass balance measurements inadequate.

Status:
Antarctic and Greenland Ice Sheets

Research mode only, continuation of laser altimetry and modern gravimetry desirable.

Status: sea ice

Under JCOMM and Ice Charting WG.
Aerial reconnaissance declining.
Major problems in measuring the thickness.
No adequate DAS.
Relatively weak links to climate requirements.
Measurements under sea ice are a problem.

Status: lake- and river- ice

It is not recognised as an essential climate variable.

Intermediate conclusion:

Cryosphere is significantly undersampled, in general.
Some networks are declining.
Poor observations of the cryosphere may potentially make it difficult to gain expected benefits from having other types of observations better developed, e.g. the oceanographic observations.
Coordination of cryospheric observations needs improvement.
Profile of cryospheric observations should be elevated.

Theme Goals:

to create a framework for improved coordination of cryospheric observations conducted by research, long-term scientific monitoring, and operational programmes;

to achieve better availability and accessibility of data and information needed for both operational services and research;

to strengthen national and international institutional structures responsible for cryospheric observations;

to increase resources for ensuring the transition of research-based cryosphere observing projects to sustained observations.

Approach:

update user requirements,

study of how they are met by current, planned and prospective *in situ* and remotely sensed observations,

propose the way forward trying to build on adequate mix of satellite and in-situ observations.

Three major streams of cryospheric data applications

- GCOS/GTOS: GSN, GTN-P, CALM, etc.
- ARCTIC-HYCOS, GTN-H, etc.
- AOOS
- SO OS
- GOOS and JCOMM sea-ice compartments
- GTN-G, WGMS, GLIMS

Ocean

Marine Cryosphere

Land

Combined system for observations of soil, meeting requirements of hydrology, geocryology, climate and biogeochemical modelling

Mountains

Alpine Cryosphere

Partners in the Theme

- Leads: WCRP through CliC, ICSU through SCAR, (etc. ?)
- Participants from Partners: who, almost all?
- “External” participants: GTNs, OOPC, TOPC, IPA, various institutes, agencies, services, universities, etc.

IPY

Much more certainty in this will be achieved in the near future.

Resources

Existing:

CliC and its Observations Product Panel

Very modest funds for a CliC OPP meeting

WCRP, SCAR, JCOMM resources – very small amounts

Expressions of interest from several organisations

Offer by the Canadian Space Agency and Environment Canada to host first meeting

Resources

Required:

2 or more workshops outside N. America (Europe?, Japan?)

Manpower

Contact persons from interested IGOS-P members – Commitment, contributon to work by participating members,

More commitments?

Climate & Cryosphere, Goal and Objectives

Tokyo, March 2000, a new WCRP core project, sunset in 2015

Principal Goal:

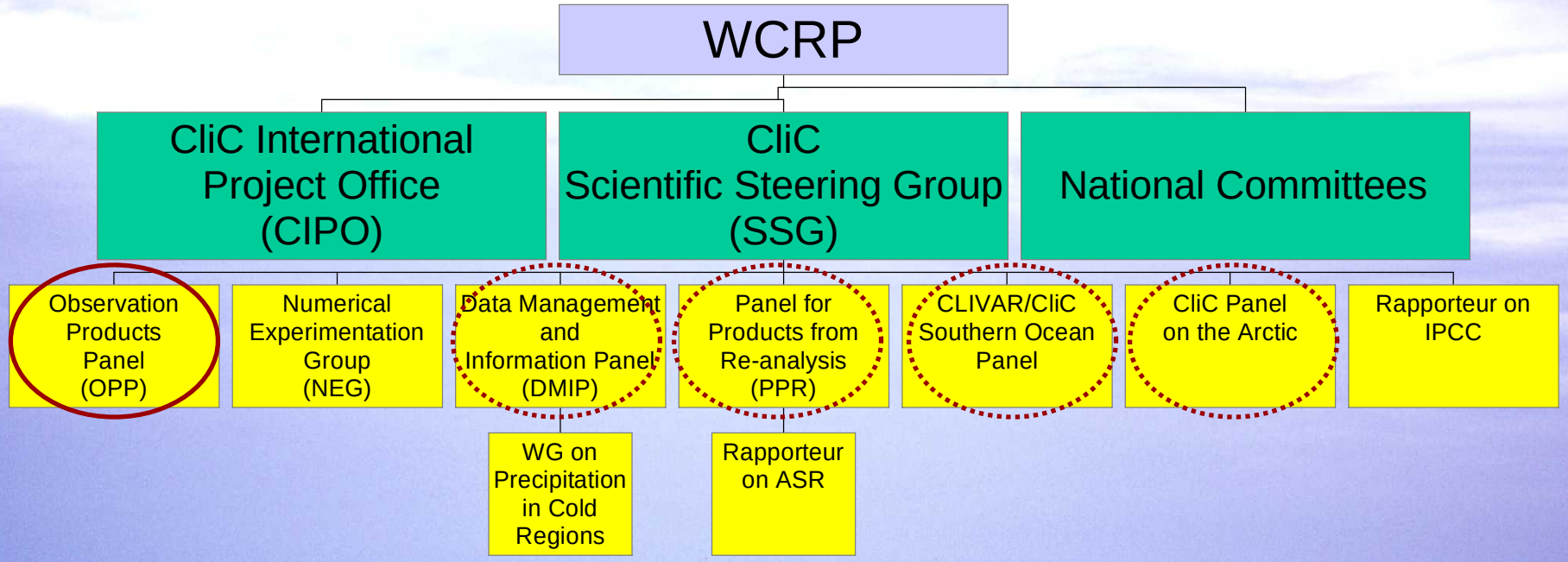
To develop and contribute the knowledge of cryosphere into WCRP climate observing, research, modeling, assessment, prediction process and to determine the stability of the global cryosphere in changing climate

Supporting Objectives:

- **Enhance the observation & monitoring of the cryosphere in support of process studies, model evaluation and change detection**
- **Improve understanding of the physical processes and feedbacks through which the cryosphere interacts within the climate system**
- **Improve the representation of cryospheric processes in models to reduce uncertainties in simulation of climate and predictions of climate change**

CliC structure

http://clic.npolar.no



THEME TEAM

NameRoleSpecializationInstitute/AgencyCountry

- Jeff Key Chair Satellite remote sensing of clouds, snow/ice (vis/IR)NOAA/NESDISUSA
- Mark Drinkwater Vice-chair Satellite remote sensing of snow/ice (microwave)ESANetherlands
- Colin Summerhayes Core SCAR (ICSU)UK
- Vladimir Ryabinin Core WMOSwitzerland
- Barry Goodison Core Snow/ice generalMSC; CliCCanada
- Chad Dick Core CliC Project OfficeNorway
- Don Hinsman Liaison to IGOS WMO

- Helmut Rott Remote sensing of snow cover, ice sheets, glaciers; snow hydrologyUniversitaet InnsbruckAustria
- Ken Jezek Ice sheets and sea ice processes, remote sensingOhio State UniversityUSA
- Stein Sandven Arctic sea ice, altimeterNansen Environmental and Remote Sensing CenterNorway
- Konrad Steffen Ice sheets (Greenland); sea iceUniversity of Colorado; CliCUSA
- David Vaughan Glaciology, AntarcticaBritish Antarctic SurveyUK
- Xiao Cunde GlaciologyChinese Academy of Meterological Sciences, CMA; Chinese CliCChina
- Sharon Smith PermafrostGeological Survey of CanadaCanada
- Jerry Brown PermafrostInternational Permafrost AssociationUSA
- Tingjun Zhang Frozen groundNational Snow and Ice Data CenterUSA
- Anne Walker Remote sensing of snow cover, sea ice, lake ice (passive microwave)Meteorological Service of CanadaCanada
- Georg Heygster Remote sensing of sea ice (passive and active microwave)University of BremenGermany
- Fumihiko Nishio or representative Antarctica, sea iceJapanese CliC; Chiba UniversityJapan
- Pierre-Philippe Mathieu Modeling; remote sensing of sea ice (microwave and optical)ESAItaly
- John Falkingham Sea ice monitoring and forecastingCanadian Ice ServiceCanada
- Roger Barry Arctic climate, sea iceUniversity of ColoradoUSA
- Ola Johannessen Arctic climateNansen Environmental and Remote Sensing CenterNorway
- Ian Allison Ocean-ice-atmos interaction; ice sheet processes; southern hemisphereDepartment of the Environment and HeritageAustralia
- Timo Vihma Polar and boundary-layer meteor., sea ice thermodynamicsFinnish Institute of Marine ResearchFinland
- Tom Carroll Operational snow cover, precipitationNational Operational Hydrologic Remote Sensing Center, NOAA/NWSUSA
- Florence Fetterer Sea ice observationsNational Snow and Ice Data CenterUSA
- Dorothy Hall Snow and ice cover; satellite remote sensingNASA Goddard Space Flight CenterUSA
- Dave Robinson Snow and coverRutgers UniversityUSA
- Georg Kaser Snow, ice generalUniversity of InnsbruckAustria

Expected schedule

Theme team forms: summer 2004 + later additions – then we will know exactly who does what

Input: Nov., 2004, IGOS-P-11, CEOS-SIT

Draft report & initial implementation plan:

March 2-4、2005、

First Cryosphere Theme workshop, Kananaskis, Alberta.

CliC science conference: April 11-152005, Beijing:

additional inputs, help to identify peer reviewers

Second draft: May-August 2005 followed by a peer review

IGOS-P-12: May, 2005: 2nd Draft submission

Theme document: IGOS-P-12bis, end October 2005

Fall-back position:

submission to IGOS-P-13: May 2006

CliC First Science Conference

Cryosphere - The "Frozen" Frontier of Climate Science: Theory, Observations, and Practical Applications

11-15 April 2005

CMA, Beijing, China

Current Sponsors

- World Climate Research Program (WCRP)
- China Meteorological Administration (CMA)
- Chinese Academy of Sciences (CAS)
- Chinese Arctic and Antarctic Administration (CAAA)
- Natural Science Foundation of China (NSFC)
- Norwegian Polar Institute (NPI)
- CliC International Project Office (CIPO)
- ?