IPY-THORPEX Science Implementation Plan

Written by Thor Erik Nordeng
(February 2007)

Preface

The scientific community was invited to submit to the IPY International Programme Office (IPO), by 14 January 2005, brief expressions of intent for IPY activities. The Joint Committee assessed all the EOI's at its 7-9 March 2005 meeting, and from this assessment identified a number of potential IPY topics (or missions) that can be linked back to the original six IPY themes. EOI #294 Polar Thorpex, submitted from the Norwegian Meteorological Institute, was suggested as a potential lead project for THORPEX 30 June 2005 deadline. The Norwegian Meteorological Institute therefore invited these EOI's to join a so-called "full proposal" (also called "cluster proposal") for the 30 June 2005 deadline and most of the identified EOI's agreed to submit a joint "full proposal", named THORPEX-IPY.

The ICSU/WMO Joint Committee for the International Polar Year 2007-2008 endorsed the THORPEX-IPY cluster proposal as an IPY activity (a conditional endorsement by 24 August 2005; a full endorsement by 30 November 2005).

In order to develop a Science Implementation Plan and to coordinate the work within the cluster, cluster participants were invited to a workshop in Oslo, Norway. Lead scientists from 8 projects together with representatives from WMO/THORPEX and EUMETNET/EUCOS participated and jointly formed this document. The workshop also decided to change the name to IPY-THORPEX in order to demonstrate that focus is on the International Polar Year. A previous draft of this document was sent to all those EOI's that formed the original cluster and they were invited to join.

This document describes the IPY-THORPEX objectives and how they are related to the THORPEX themes. It then consists of several tables where main characteristics of each of the main projects are outlined together with interdisciplinary to other projects.

1. THORPEX and IPY

The THORPEX International Research Implementation Plan (Version I, 2005) establishes a roadmap for all THORPEX activities. Section 13.1 covers activities related to the International Polar Year. In particular, under the International Polar Year, THORPEX will

a) address two-way interactions between polar and sub-polar weather regimes.

b) assess and seek to improve the quality of operational analyses and research reanalyses products in the Polar Regions.

c) address improving data assimilation techniques for Polar Regions.

d) assess the skill in the prediction of polar to global high impact weather events for different observing strategies in higher latitudes.

e) demonstrate the utility of improved utilization of ensemble weather forecast products for high impact weather events and for IPY operations, when applicable.

f) result in recommendations on the design of the Global Observing System in polar regions for weather prediction.

g) To assist in accomplishing these research goals, THORPEX/IPY will conduct field campaigns during the IPY intensive observing period

Much of the research outlined in this paper aligns with the THORPEX focus on "Global-to-regional influences on the evolution and predictability of weather system" and the IPY objective of "understanding polar-global teleconnections on all scales, and the processes controlling these interactions". IPY-THORPEX will address high-impact weather forecasts, the predictability, and increased knowledge of related physical and dynamical processes associated with polar and sub-polar interactions. Examples of research investigations include the role of Greenland's orography on European and African cyclonic storm systems, the interactions between tropical, middle latitude and polar processes that occur off the coast of Asian are so poorly predicted that hemispheric drops in forecast skill can be routinely observed, Rossby wave trains by intense cyclogenesis off the coast of Asia and whether anomalous open water in the vicinity of the Arctic and Antarctic lead to modifications in storm tracks, storm intensity, and the Ferrel/Walker circulations.

The IPY-THORPEX will also address other core THORPEX goals such as to "Contribute to the development of advanced data assimilation and ensemble prediction systems" and "Contribute to the design and demonstration of interactive forecasting systems". These efforts include a focused campaign over Antarctic aimed at evaluating and improving satellite data assimilation techniques, which will contribute to the IPY core objective of "To determine the present environmental status of the polar regions by quantifying their spatial and temporal variability". The improvement in satellite assimilation over the poles afforded by this study will be an observational legacy of IPY improving our ability to predict polar weather system, the interactions of polar processes with lower latitudes and our ability to monitor the climate over the poles.

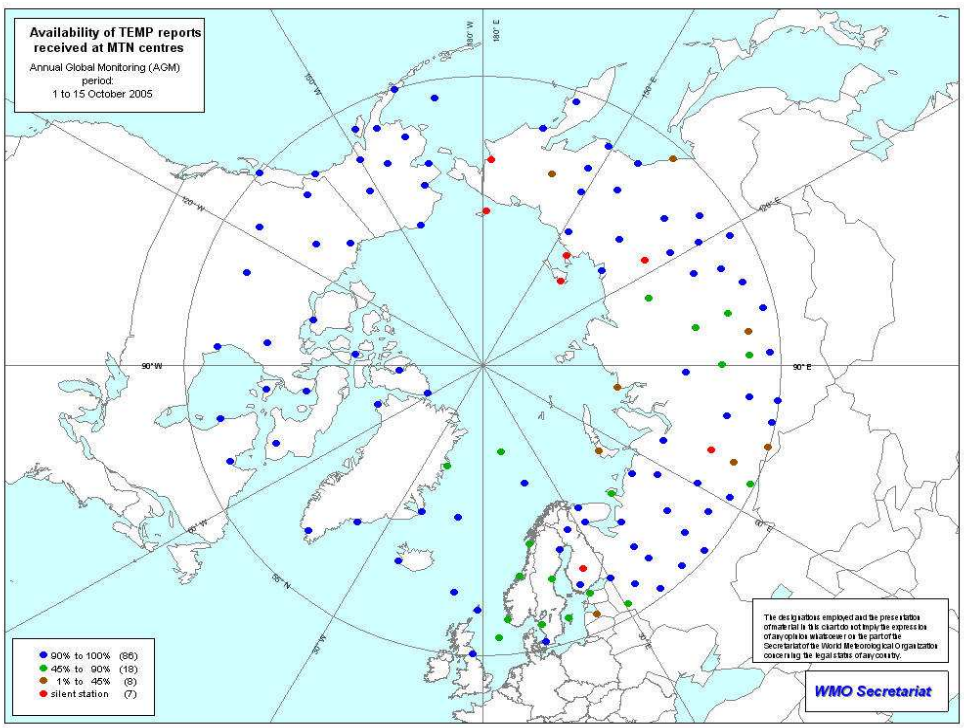
The impact of THORPEX activities on climate, is evidence that THORPEX's main focus is on weather prediction, but it has also a strong linkage to climate research. Chapter 9 of the THORPEX International Research Implementation Plan (Version I, 2005) describes this relationship:

> *It is anticipated that within a decade, the largely artificial distinction between climate and weather prediction will give way in favour of a unified weather-climate forecast approach, leading to a so-called seamless suite of forecast products applicable on all relevant decision making time and space scales. For this to happen, the weather and climate forecast communities will need to attain a level of collaboration not seen before. The main goal of THORPEX is to improve 1-14 day weather forecasts, while the focus of the climate forecast community is on the seasonal and interannual time scales. THORPEX will play a major role in partnering with the climate forecast community to bridge the gap between weather and climate forecasting, leading to better understanding, improved forecast techniques, and more skilful forecasts for the often neglected, 10-60 day range between the weather and climate time scales.*

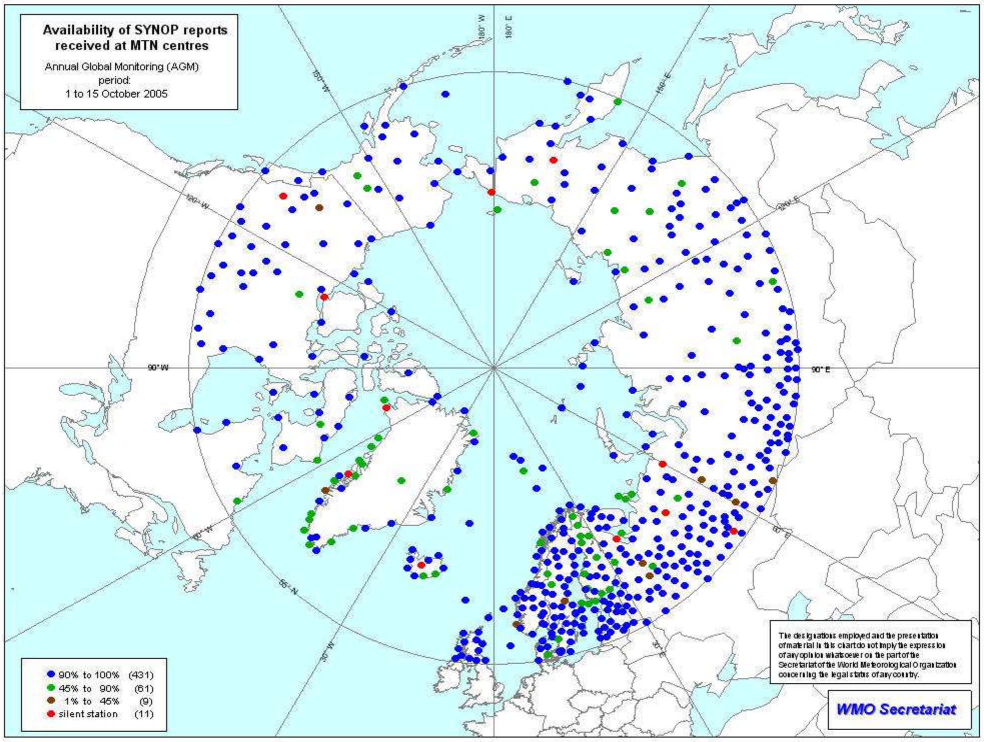
IPY-THORPEX focuses on improved weather forecasting <u>and</u> climate with a strong emphasis on improving and understanding processes that will gain both weather forecasting models and climate models. THORPEX Core Research Objective 3.7 says: *Coordinate THORPEX* *research with the World Climate Research Programme Coordinated Observation and Prediction of the Earth System (WCRP/COPES) and the mesoscale/microscale community to address the observational and modelling requirements for the prediction of weather and climate for two weeks and beyond.*

2. Examples of Polar Research Issues

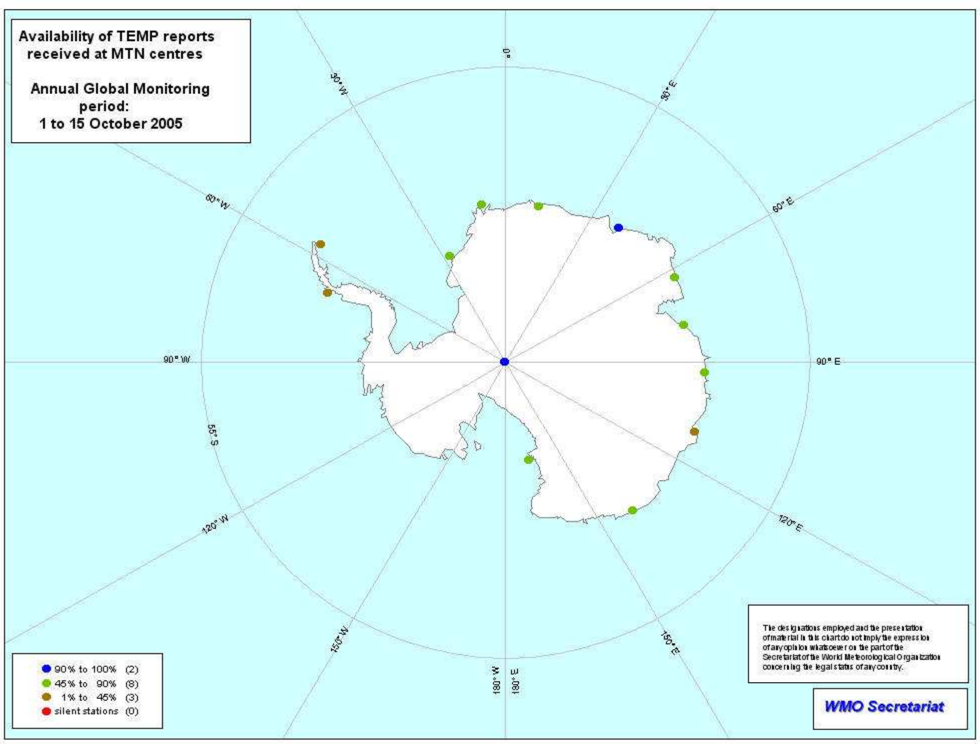
So, what is special about polar regions? First of all, in terms of conventional observations the area is data sparse making numerical weather prediction a difficult task. Fig. 1a,b below, shows synop and radiosonde coverage for the Arctic region. There are in addition only a few surface observations based on buoys and in order to initialise NWP models properly, one needs to rely on satellite observations. While the lack of routine in-situ observations over the Arctic is easily demonstrated, the lack of in-situ observations over the Antarctic, coupled with the general lack of such measurements in the Southern Hemisphere means that the satellite observations are even more critical to observing conditions over Antarctica (Fig. 1c,d). Unfortunately, satellite data assimilation presents unique challenges over polar regions. In particular, the orography over Greenland and Antarctica, the varying surface properties (e.g., old and new ice, open leads), stable atmospheres and low clouds all make the determination of the surface emissivity difficult which limits the use of satellite remote sensing over polar regions. Thus, the analyses used in weather prediction and climate studies are among the most data sparse regions over the globe,



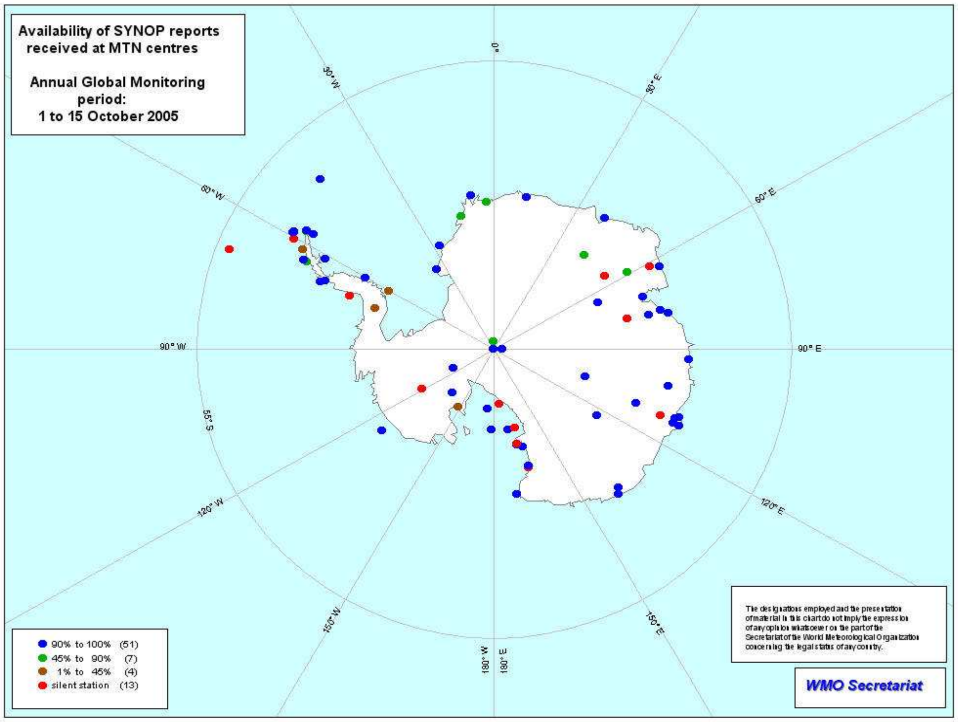
(a)


Availability of SYNOP reports received at MTN centres
Annual Global Monitoring (AGM) period:
1 to 15 October 2005
90% to 100% (431)
45% to 90% (61)
1% to 45% (9)
silent station (11)
The designations employed and the presentation of material in this chart do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country.
WMO Secretariat

(b)


Availability of TEMP reports received at MTN centres
Annual Global Monitoring period:
1 to 15 October 2005
0°
30° W
30° E
60° W
60° E
90° W
90° E
120° W
120° E
150° W
150° E
180° W
180° E
55° S
90% to 100% (2)
45% to 90% (8)
1% to 45% (3)
silent stations (0)
The designations employed and the presentation of material in this chart do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country.
WMO Secretariat

(c)



(d)

Figure 1. Availability of radiosonde reports (a and c) and synop reports (b and d) north (south) of 55 N (55 S) between 1 and 15 October 2005 (by courtesy of WMO).

Significant weather is not unusual in polar regions. The low troposphere and quite often small static stability cause rapid small scale developments (polar lows). There are strong contrasts in stability and temperature with ample possibilities for shallow low level baroclinic zones to develop. Simple baroclinic theory may be used to show that critical wavelengths for baroclinic growth may occur at wave lengths significantly shorter than for middle latitudes. In addition, release of latent heat by convection plays an important role developing these small scale systems. Fig.2 is a high resolution forecast (horizontal resolution 4 km) of a polar low in the Barents Sea north of North Cape in Norway. The small scale of the low is evident.

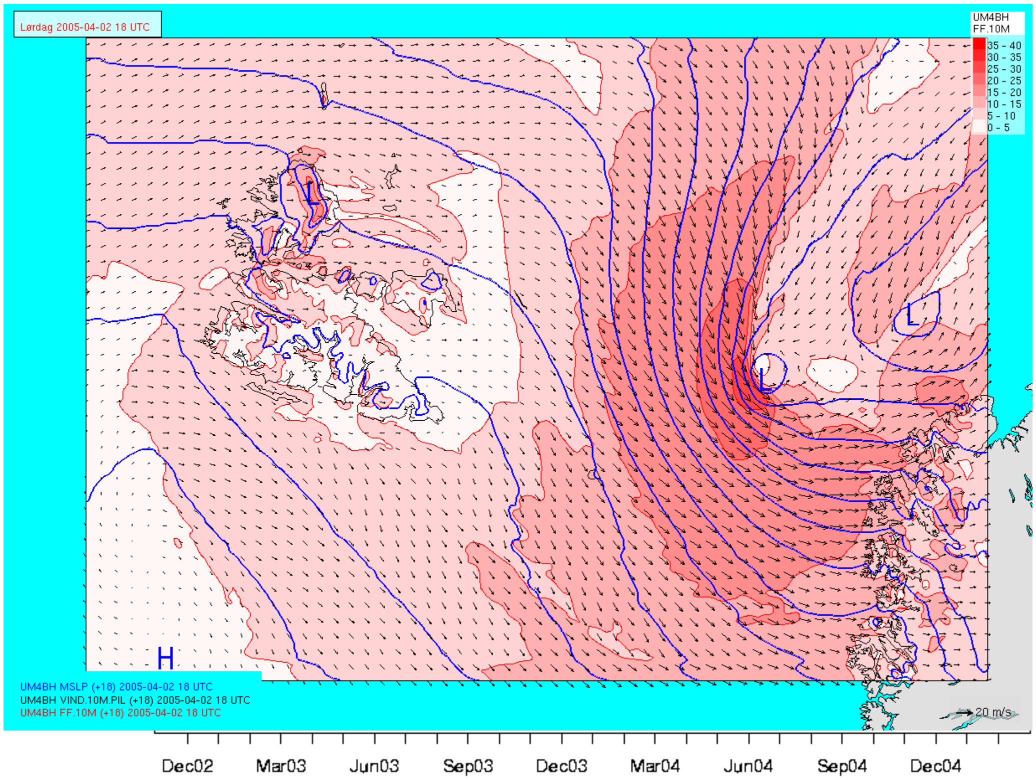


Figure 2. Forecast of a polar low in the Barents Sea with the Norwegian Meteorological Institute's mesoscale weather prediction model (horizontal resolution 4 km)

Unfortunately, these events are often poorly predicted in regions that are of significant importance to society. Verification results from the Norwegian Meteorological Institutes operational limited area numerical model system show that the model scores significantly better in the North Sea than in the Barents Sea (Fig. 3). This may cause worries for future activities in the area. In addition to being one of the richest fishing areas of the Northern Atlantic, the Barents Sea will be an important area for gas and oil exploitation in the next decade.

Another example is the impact of polar processes on middle latitude populated regions as Greenland with its high topography has a significant effect on a number of weather phenomena at high latitudes in Europe. The combination of Greenland's high topography and the data sparse area of Northern Canada make the area important as an initiation place for surprise developments hitting Europe with a relatively short lead time. Klinker and Ferrant (2000) investigated the poor performance of the ECMWF model for the summer of 1998 as compared to the 1999 summer, and showed that analysis errors in the polar area can have a detrimental impact on forecast skill over Europe. The result is likely to be dependent on the flow conditions. For the period they considered, a strong baroclinic flow extended from Greenland over the North Atlantic into Europe. The flow in the vicinity of Greenland is also important for climate studies as the strong winds impact the ocean dynamics and may effect the climate and other aspects of the Earth System through affecting the thermohaline circulations.

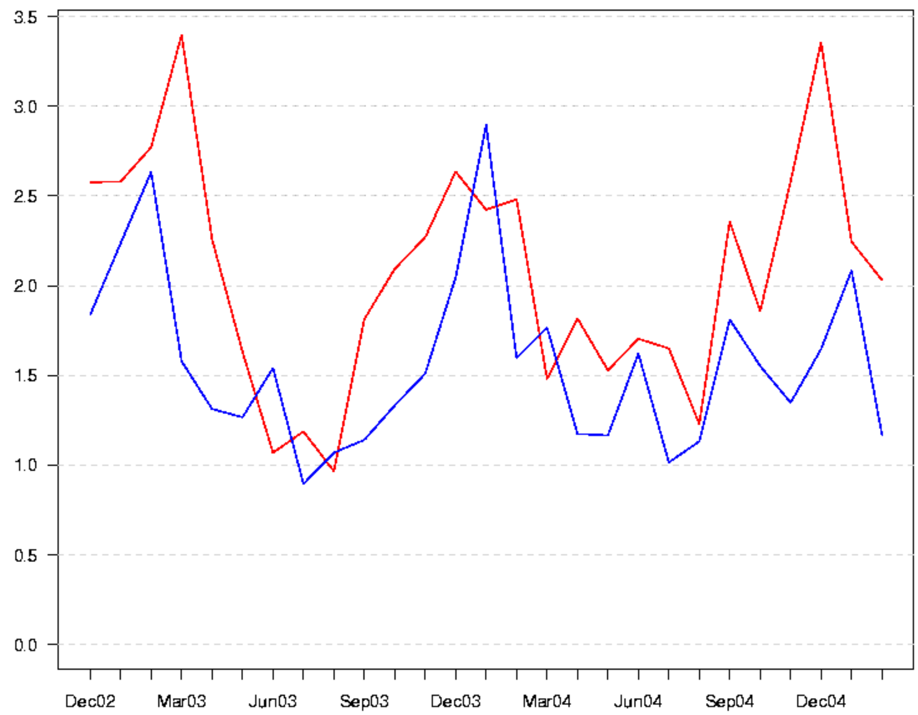


Figure 3. RMS error of mslp from the Norwegian Meteorological Institute's operational numerical weather prediction model from December 2002 to February 2005 for the Barents Sea (red) and the North Sea (blue).

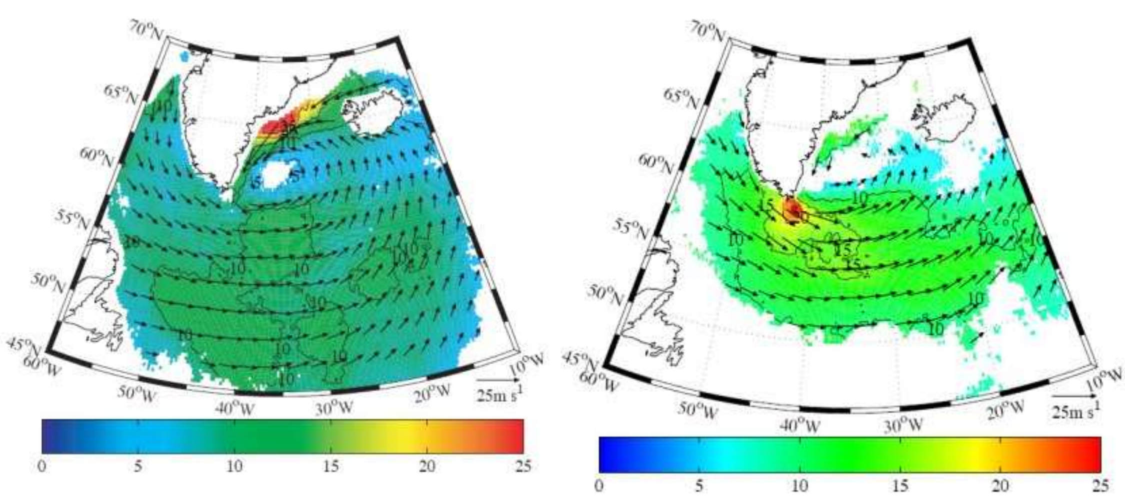


Figure 4. Meteorological phenomena local to Greenland, barrier jets (left panel) and tip jets (right panel); by courtesy of Ian Renfrew.

Another importance region of the atmosphere that relates to polar circulations occurs over the western North Pacific and eastern Asia. One aspect of the circulations over this region (Fig. 5), is the movement of tropical cyclones in this region northward into the middle latitudes where intense cyclogenesis occurs as these systems become so-called extratropical transition (ET) storms. The evolution of the ET events is sensitive to tropical to polar circulations.

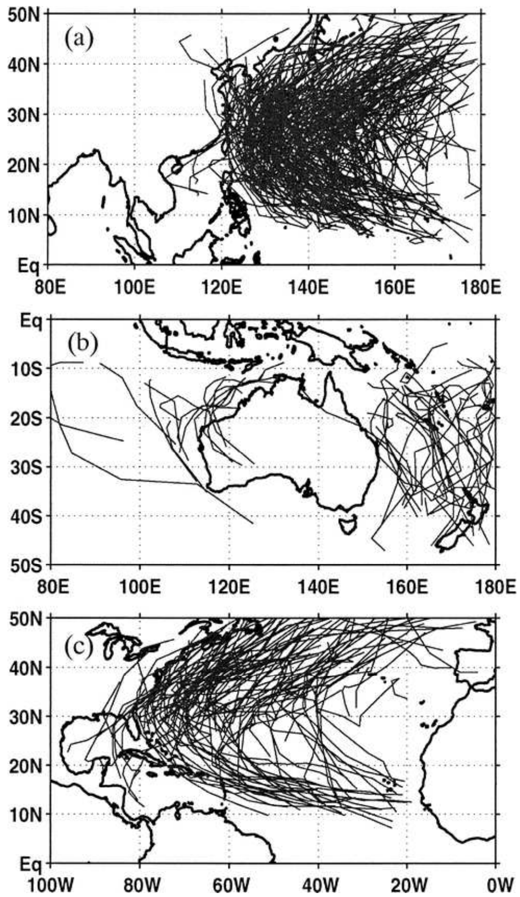


Figure 5: Tracks of tropical cyclones that become ET systems. The region of East Asia and the North Pacific has more of these events than elsewhere on the planet. From Jones et al. (2003).

These system directly impact the Arctic regions as they move into polar latitudes generating strong waves along the coast line and high impact weather over the Alaska and northwestern Canada. These storms in the Arctic can impact the traditional activities of the native population, general safety of all populations and economic activities such as transportation, energy production, and fisheries. Climate change can modify these high impact weather events in a number of ways. The loss of permafrost along the Arctic coast from high waves generated by the storm's, for example, means that wave erosion has become a significant problem with native villages repeatedly displaced (Fig. 6). The intense cyclogenesis events associated with ET storms also have global implications through triggering new Rossby wave trains or intensifying existing events that are associated with a hemispheric reduction in predictive skill (Fig. 7) that can be traced to uncertainty in the treatment of the Rossby wave responses. These wave trains have significant societal impacts as and generate subsequent high impact weather downstream and, in addition, modify the circulation on time-scales beyond those of numerical weather prediction. Predictions over portions of the Arctic are quite sensitive to an accurate portrayal of initial condition, specifically, in the vicinity of these ET storms, and, in general, to the region of the western North Pacific and East Asia.

Figure 6: A residence in the native village of Shishmaref in Alaska showing the impact of wave action from the ET of Super Typhoon Tokage on a coast line that has lost permafrost. The buildings of the village have been relocated several times from such events. Courtesy of James Partain (NOAA Alaskan Region of the National Weather Service).

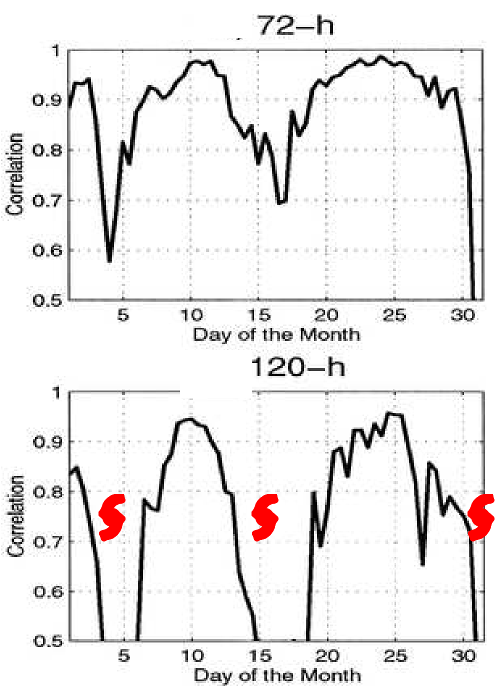


Figure 7: Northern hemispheric skill in the 500 hPa correlation coefficient showing the 72 and 120-h skill drops associated with ET events over western North Pacific. From Jones et al. (2003).

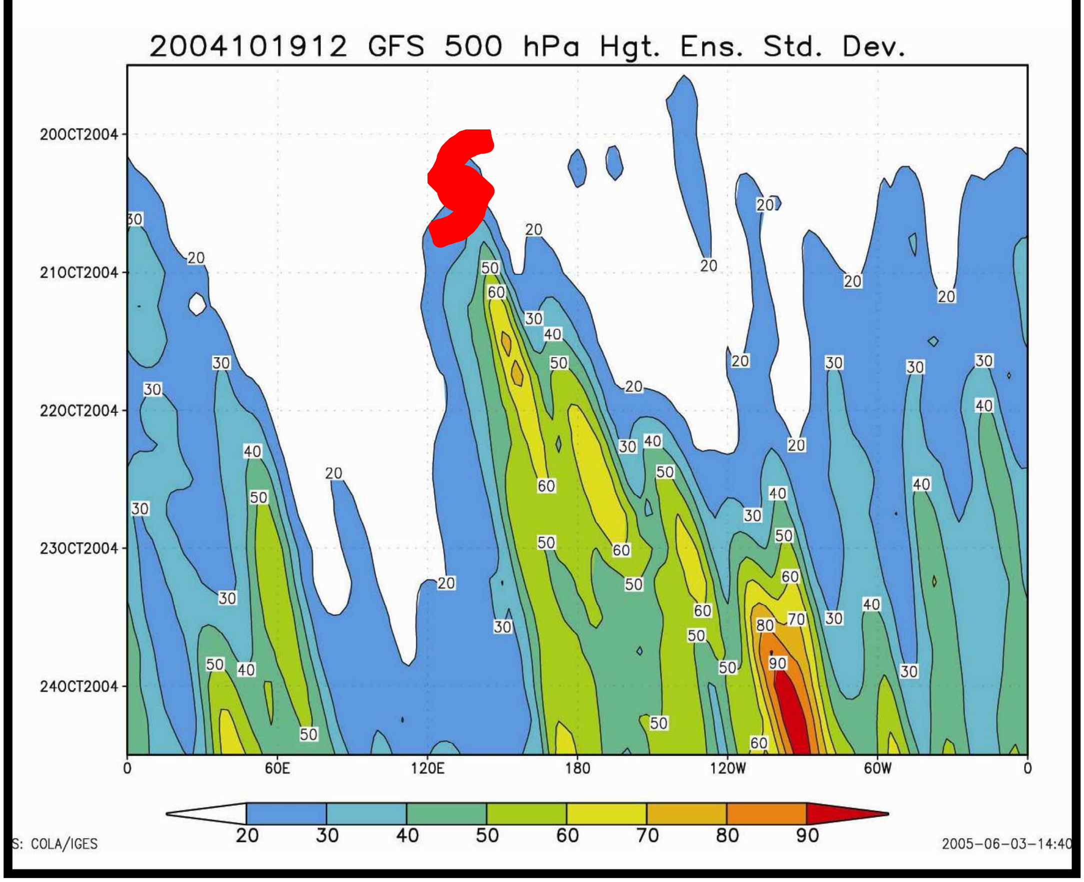


Figure 8; A hovmueller diagram showing the variance in the ensemble predictions in the Global Forecast System of NOAA downstream of the ET of Super Typhoon Tokage. Note both the obvious downstream uncertainty and the embedded signal of Rossby wave propagation.

Cloud physics at high latitudes is an area where climate as well as NWP model needs to be improved. Low clouds are an important factor for the Arctic climate. At low latitudes low clouds have a cooling effect. At high latitudes, however, when low clouds appear over snow- or ice covered surfaces with high albedo, their effect can be different. In addition, special radiation properties alter their role as compared to low latitudes. Parameterisation of clouds is difficult in general. In the Arctic there are additional problems: The poor description/understanding of the boundary layer causes wrong heat- and humidity fluxes and this have effects on the parameterisation of clouds. Low temperatures, low absolute humidity and stable conditions give conditions which current parameterisation schemes are not tuned for. It is therefore a need for observations/measurements to improve and test parameterisation schemes. Fig. 9 shows modelled PBL behaviour (here the ECMWF model) as compared to SHEBA observations. The model has clearly problems in capturing correct magnitude and even correct sign of surface fluxes of sensible heat (Fig. 9a) and this is apparently related to wrong stability (Fig. 9b). Fig. 10 shows measured and modelled fraction liquid water in Arctic clouds. It is clear that the model strongly underestimates the fraction of liquid water in these cold clouds.

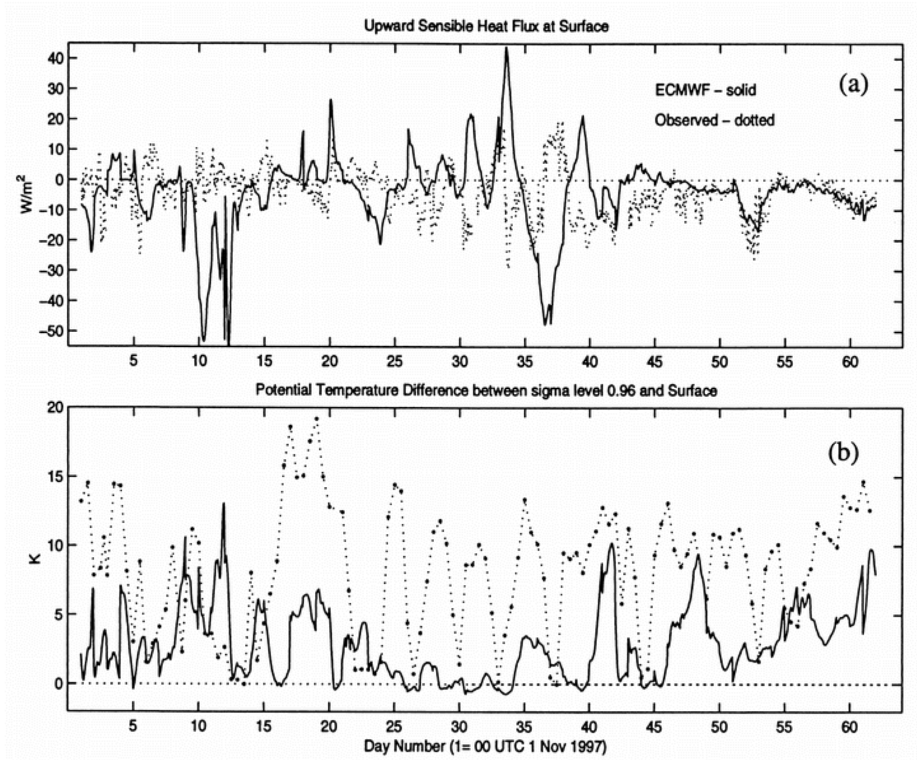


Figure 9. Measured and modelled upward sensible heat flux and stratification at the SHEBA. Sensible heat flux observations in Fig. 9a are hourly averages computed using the eddy correlation method. Stratification (Fig. 9b) is defined here as the difference in potential temperature between the height of the second lowest model level and 2 m.

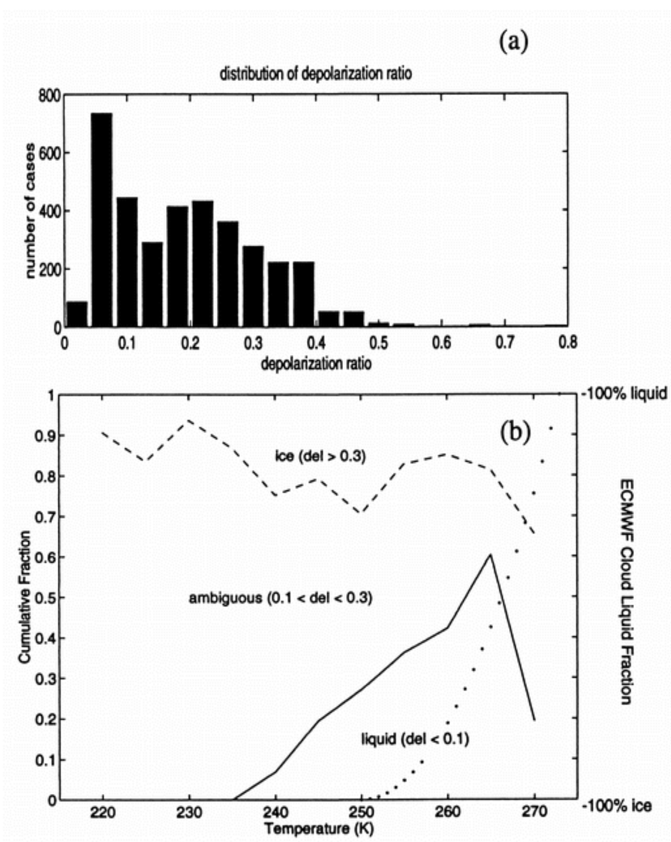


Figure 10. Depolarization ratio statistics for lidar measurements during November and December 1997. (a) The depolarization ratio frequency distribution and (b) the relationship between cloud base temperature and condensate phase as inferred from the depolarization ratio ("del"). Reading vertically from a given temperature on the horizontal axis, the distance to the solid line is the fraction of clouds that are liquid, the distance between the solid line and the dashed line is the fraction of clouds whose phase is ambiguous, and the remainder are ice clouds. The dotted line in Figure 10b represents how cloud condensate is partitioned between liquid and ice as a function of temperature in the ECMWF model (scale on right). From Beesley et al., 2000.

3. Objectives

The aim of this cluster proposal is to improve numerical weather prediction and climate models by utilizing remotely sensed and in situ observations taken during the IPY and to study and advance our knowledge of meteorological, surface and ocean phenomena typical for the region. The investigations will also improve our understanding and modelling of polar-global interactions. The scope ranges from high-resolution numerical weather prediction to climate and regional ocean modelling. The motivation comes from several applications: 1) Regional weather forecasting: In polar areas there are strong needs for accurate weather forecasts. Further model-based ocean, ice and wave forecasting need accurate forcing fields. 2) Medium range (global) weather forecasting: Improved model quality in polar areas influences forecasts at mid and high latitudes. 3) Climate studies and the related general improvement in the ability to simulate the Earth

The project has four main objectives:

The first objective is to improve numerical forecast systems, e.g. through optimal use of satellite data, the in-situ observational network, and targeted observations; with an emphasis on high impact weather events. These studies will not be limited to forecasting conditions over the poles, but will also address polar-global interactions. They will provide insight into the design of the global observing system and into the potential impact of any IPY legacy measurement sites. New satellite technologies will be used to develop products that can potentially improve weather forecasts. IPY-THORPEX will cooperate with EUCOS. Several projects will use the Internet facilities for predicting sensitive areas and piloting adaptive observations currently developed by ECMWF for EUCOS/PREVIEW. A legacy of these efforts will be improved models and improved analysis for weather and climate.

The second objective is to advance knowledge of physical and dynamical processes with a specific emphasis on interaction with topography and the underlying surface properties, the microphysical properties of clouds and aerosols; one aim being to improve parameterisation schemes in NWP and climate models. The spatial variations in surface characteristics, stable lapse rates and extreme seasonal variations in solar radiation make the polar environment unique and a challenge for parameterizations. The work under this objective includes investigations of the flow distortion over Greenland and how it impacts the mesoscale thermohaline circulation plus improved understanding of tropical to polar interactions through the THORPEX Pacific Asian Regional Campaign (T-PARC). In some cases the higher resolution modelling capability will remain in place as a legacy of IPY-THORPEX activities.

The third objective is to advance knowledge of polar climate processes, variability and feedbacks within the coupled climate system, in particular in the Arctic.

Taken together the research results from the first three objectives will have the potential to improve future predictions of the weather and climate over the polar regions. Improvement in the initial state means an improved time series of operational and research analyses for climate change research.

The fourth and final objective is to utilize improved forecast systems to benefit society, economy and environment.

High-impact weather events in polar regions include spring thaws, sea ice movement, and severe winter cyclones resulting in strong winds, high seas, and heavy precipitation as defined by their impact on public safety, fisheries and fishery management, activities of the indigenous arctic populations, wildlife, energy production and transportation. These problems are not local to the poles as the intrusion of polar air masses into higher latitudes also has dramatic impacts and many of the polar events are linked to wave trains that are initiated at lower latitudes. During IPY, the major operational forecast centres of the world will co-operate to form a THORPEX Interactive Grand Global Ensemble (TIGGE) that will form the basis for research on ensemble prediction and on improving society's ability to utilize forecast information. TIGGE will also be made available for IPY field operations.

Table: Objectives in relation to THORPEX themes

IPY-THORPEX cluster objectives \ THORPEX Themes	Objective 1: improve forecasting through optimal use of satellite data, the in-situ observational network, and targeted observations; with an emphasis on high impact weather events	Objective 2: advance knowledge of physical and dynamical processes with a specific emphasis on interaction with topography and the underlying surface properties, the microphysical properties of clouds and aerosols; one aim being to improve parameterisation schemes in NWP and climate models.	Objective 3: advance knowledge of polar climate processes, variability and feedbacks within the coupled climate system, in particular in the Arctic.	Objective 4: utilize improved forecast systems to benefit society, economy and environment.
a) Two-way interactions		x	x	
b) Improved analyses	x		x	X
c) Improved assimilation	x		X	
d) High impact weather forecasts - assess observing strategies	x	x		X
e) Ensemble forecasting products- demonstrate utility			X	X
f) Recommend design of Global Observing System	x			
g) Conduct field experiments	x	x	X	x

4. Organisation

IPY-THORPEX consists of the following projects:

1. Greenland Flow Distortion experiment GFDex (project coordinator Dr. Ian Renfrew, UK)

2. Storm Studies of the Arctic STAR (project coordinator Dr. John Hanesiak, Canada)
3. Concordiasi (project coordinator Dr. Florence Rabier, France)
4. Norwegian IPY-THORPEX (project coordinator Dr. Jon Egill Kristjansson, Norway)
5. TAWEPI (project coordinator Dr. Gilbert Brunet, Canada)
6. Greenland Jets (project coordinator Dr. Andreas Dörnbrack; Germany)
7. GREENEX (project coordinator Dr. Haraldur Ólafsson, Iceland)
8. Arctic Regional Climate Model Intercomparison project
   ARCMIP & CARCMIP (project coordinator Dr. Klaus Dethloff, Germany)
9. Impacts of Surface Fluxes on Severe Arctic Storms, Climate Change and Arctic Coastal Oceanographic Processes (project coordinator Dr. Will Perrie, Canada)
10. THORPEX Pacific Asian Regional Campaign (T-PARC) (project coordinatorDavid Parsons, NCAR)
11. **High resolution data assimilation, modelling and reanalysis for the Arctic** (A reanalysis of the IPY) (project coordinator Dr Per Kållberg, Sweden)

A project steering committee consisting of the IPY-THORPEX international coordinator (Dr. Thor Erik Nordeng[1]) and the project leaders of the individual projects of IPY-THORPEX will be established. A representative of THORPEX steering committee/secretariat is invited to the IPY-THORPEX steering committee.

The international coordination is mainly to make sure there is good exchange of information among IPY-THORPEX projects; interaction with IPY JC on "generic issues", organizing IPY-THORPEX-meetings, easy and quick access to data, and identify possible joint actions (e.g. available space for observations for other projects at additional costs)

Generic services in IPY

The ECMWF view is that the national authorities in countries that "own" individual IPY-projects should take the responsibility for operational services. IPY-THORPEX shares this opinion. IPY-THORPEX needs as a minimum to make sure that there is a web page listing the operational services available in different countries including ECMWF, NCEP etc relevant for IPY field purposes.

A web-page will be set up by the host institute of the international coordinator for exchange of information including the issue raised above.

[1] Thor Erik Nordeng is the IPY-THORPEX international coordinator.

Time-table:

2007 2008 2009

	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1
1. GFDex		x	x																						
2. STAR									x	x															
3. CONCORDIASI																					x	x	x	x	x
4. Norway IPY-THORPEX	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
5. TAWEPI	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
6. Greenland Jets																									
7. Greenex																									
8. ARCMIP & CARCMIP			x	x	x	x	x																		
9. Arctic surface fluxes	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
10 T-PARC field phase																				x	x	x	x	x	
11 IPY reanalysis													x	x	x	x	x	x	x	x	x	x	x	x	

4. Status for the individual projects
As a majority of the IPY-THORPEX international participants have deadlines for application for funding from their respective science foundations in 2006, a limited number of projects has committed funding so far. Brief descriptions of the individual projects of IPY-THORPEX (including status with regard to funding) are found in Appendix:

5. References.

Beesley, A., C. S. Bretherton, C. Jakob, E. L Andreas, J. M. Intrieri and T. A. Uttal, 2000: A comparison of cloud and boundary layer variables in the ECMWF forecast model with observations at Surface Heat Budget of the Arctic Ocean (SHEBA) ice camp. J. Geo. Res., Vol. 105, Number D10, Page(s) 12337-12349, 2000

Klinker, E., and Ferranti, L., 2000: Forecasting system performance in summer 1999. Part 1 – Diagnostics related to the forecast performance during spring and summer 1999. Technical Memorandum, No. 321. September 2000. European Centre for medium Range Weather Forecasts.

Jones, S. C., et al., 2003: The extratropical transition of tropical cyclones: Forecast challenges, current understanding, and future directions. *Wea. Forecasting,* **18**, 1052-1092.

APPENDIX

Table: Status of individual projects

Project name →	**1. Greenland Flow Distortion experiment GFDex**	**2. Storm Studies of the Arctic STAR**	**3. Concordiasi**
Objectives 1 Improved forecasting ... 2 Improved physical and dynamical understanding 3 Improved polar climate understanding 4 Improved societal benefits	1. Targeted observations in vicinity of Iceland 2. In particular Greenland tip jets, barrier winds & mesoscale cyclones 3. Via air-sea interactions in Greenland & Irminger Seas 4. Over Iceland and downstream over Europe	1. Enhanced surface, radar, upper-air observations in eastern Canadian Arctic 2. Gap flow, Interaction of cyclones with topography and air-sea-ice interactions. 3. Air-sea-ice interactions, orographic precipitation and ice cores. 4. Over the eastern Canadian Arctic and adjoining seas. Will work with Inuit to incorporate findings for use by local communities.	1- IASI assimilation Antarctica. 2- multi-resolution forecast (meteorolgy and atm. Chemistry) - polar processes (stable boundary layers, polar clouds, precipitation, snowdrift) -circumpolar vortex, ozone dynamics, role of aerosols on SPCs. 3- future analyses over Antarctica using IASI data for climate monitoring 4- Contribution to GOS/GEOSS
Institution coordinating	University of East Anglia, UK	University of Manitoba, Canada	Consortium CNRM, LMD, LGGE
Contact person email	Ian Renfrew i.renfrew@uea.ac.uk	John Hanesiak john_hanesiak@umanitoba.ca	Florence.Rabier@meteo.fr
observations to be carried out long-term observations field experiment type observations use of other observational infrastructure	Aircraft-based field campaign, from Iceland, Feb-Mar 2007; flight-level meteorology, cloud physics, broadband radiation, turbulence plus profiles from dropsondes	Aircraft, surface and ship-based field campaign in southern Baffin Island; September-October 2007. Flight-level meteorology, cloud physics, broadband radiation, turbulence as well as profiles from dropsondes. Surface Mesonet (network og automatic weather stations) in southern Baffin Island. Two additional upper-air sounding sites in southern Baffin Island. Icebreaker Amundsen will be deployed in region with surface meteorology package as well as deployable ice buoys. Portable (5cm) Doppler radar will be deployed.	1- IASI , GOME2, AIRS 2- Radio-soundings. Driftsondes launching dropsondes, incl stratosphere microphysics measurements Surface observations (inc. hydrometeors) – Sept 2008 to January 2009 3 –Concordia and McMurdo
modelling and data assimilation - development - application - operationality	NWP and cloud-resolving modelling of case studies using UM, WRF, MM5, CReSS,	NWP and cloud-resolving modelling of case studies using WRF, MM5, CReSS. Operational run of GEM-LAM model.	1 - IASI 4D-Var assimilation with ARPEGE and IFS. IASI 3D-Var HR assimilation with AROME. Parametrisation improvement of ARPEGE, AROME and MAR 3D-Var FGAT or 4D-Var assimilation of IASI and GOME 2 O3 observation by MOCAGE 2- ARPEGE, AROME and

			MAR simulation of meteorological cases over the Plateau MOCAGE simulation of 03 hole 3- AROME (on request) MOCAGE on global domain
observational geographical domain	Greenland, Iceland and surrounding seas	Southern Baffin Island and adjoining seas	Antarctic plateau
special data requirements (additional to routine data)	Enhanced upper air data, sensitive-area-predictions (UKMO, ECMWF), SAR imagery (ASAR), CloudSAT data, AVHRR (Dundee SRS) Access to TIGGE Data Base Access to ECMWF Internet facilities for adaptive observations	Enhanced upper-air data, SAR (ASAR), CloudSAT/Calipso, AVHRR (MSC).	Other Antarctica RS and in situ obs. Other available satellite data
data management	aircraft data archived by British Atmospheric Data Centre (www.badc.ac.uk); dropsonde data on GTS	Data will be archived by STAR team. Accessible TBD.	Data Basis by the Consortium Open for research, RSs by GTS
outreach	Media activities in Iceland; website	Schools in region will be provided with miniature weather stations. Outreach with Inuit community.	No specific action
education and training	6 PhD students; 2 Postdoctoral fellows	10 PhD student; 5 Postdoctoral fellows	No specific action
legacy	Improved forecasts and scientific understanding	Improved forecasts and scientific understanding	Contribution to GOS/GEOSS
status of funding	UK, Canadian and EUFAR and EUCOS components funded	Canadian Academic component fully funded. Funding for Canadian Government component has been applied for.	Concordia RS, driftsondes, HPC, Concordia logistics secured, McMurdo logistics, dropsondes, airborne aerosols sensor in discussion
coordination/cooperation needs	International GFDex group established; UK Met Office and ECMWF are project partners		CNES, IPEV, NCAR, Univ of Wyoming, McMurdo, ENEA, PNRA, ECMWF
project interdependencies	Providing data to TAWPEI, and Norwegian project. Close science links to Greenland Jets and Greenex projects	TAWEPI	RIME, COMPASS, ORACLE-O3

(table contd.)

Project name →	**4. Norwegian IPY-THORPEX**	**5. TAWEPI**	**6. Greenland Jets**
Objectives 1 Data assimilation 2 Process understanding + 3 Climate 4 Social impacts	Optimization of new sat data Improved modelling of latent heat cycle Extreme weather pdf, present and future Improved operational NWP ensemble	1) The primary objective of TAWEPI is to develop a regional Numerical Weather Prediction (NWP) system, Polar-GEM, at 10-15km horizontal resolution, over the Arctic. This initiative will also include data assimilation	Targeted observations in the vicinity of Iceland and Greenland. Mesoscale flows, including orographic disturbances, mesocyclones and surface fluxes. Over the N-Atlantic and Europe.

		experiments. 2) This initiative will include various field campaigns, model development and process studies. 3) Development of new physics, sea-ice and land-surface packages for the next generation Regional Climate Model. 4) Joint research with local communities that will utilize both scientific and traditional knowledge.	
Institution coordinating	University of Oslo	Environment Canada	DLR, Germany
Contact person email	j.e.kristjansson@geo.uio.no	Gilbert Brunet Gilbert.brunet@ec.gc.ca	Andreas Dörnbrack andreas.doernbrack@dlr.de
observations to be carried out 1. long-term observations 2. field experiment type observations 3. use of other observational infrastructure	1. Flux Tower, Svalbard. 2. Radar Andøya. Research Aircraft, radiosondes 3. Extra radiosondes, Bjørnøya, Kola, Svalbard F.Josefs land, EUCOS Time period winter 2007 (pilot study) and winter 2008 (main field campaign)	-Remote Sensing of Arctic Cloud Properties and Precipitation Characteristics from Space (field experiments, Eureka observation site and long-term observations) -Collaboration, participation, and support to The Greenland Flow Distortion Experiment (GFDex) and The Storm Studies in the Arctic (STAR) Time period 2007-2008	Aircraft-based field campaign from Iceland in Feb 2008. Flight level observations, dropsondes and lidar observations
modelling - development - application - operationality	- Air/sea- Cloud-Convection parametrisation - HIRLAM, WAM, WRF, UM - Operational lam-eps for Arctic	-Development of the regional Polar-GEM model -Development of the local Polar-GEM LAM windows -Development of the Polar-GEM sea-ice and snow models -Sensitivity of weather forecasts in the mid-latitude (Arctic) due to analysis error over the Arctic (mid-latiude) -Ice analysis -Stratospheric analyses -Coupling Polar-GEM to a high-resolution land surface model and hydrological prediction system for the Canadian Arctic hydrographic basin and archipelago -Parameterization of Arctic Clouds for Weather and Climate Prediction. - Weather Hazards to Aviation in the Arctic	High-resolution NWP modelling of cases. MM5 WRF

geographical domain	Atlantic Sector and Barents sea. Greenland	Arctic	Greenland, Iceland and surrounding waters
data requirements	Satellite data (specify!), operational analyses, Re-analyses	NA	Additional upper-air observations. Predictions of sensitive areas. Access to TIGGE Data Base Access to ECMWF Internet facilities for adaptive observations
data management	met.no	-Data produced or used by the GEM model will be managed at the Canadian Meteorological Center	Data managed by the DLR, Germany
outreach	Web - TV-documentary – peer review – popular – newspaper		Media in Iceland and elsewhere in Europe.
education	MSc- PhD- E-learning tool for primary schools		4 PhD students
legacy	Improved weather forecasting Reduced risk in marine operations, Safeguarding of environmental interests	<u>In relation to the IPY themes, the following advances are anticipated from TAWEPI</u>: -TAWEPI will generate all the meteorological, hydrological and ice information needed to continuously monitor and forecast the Arctic -TAWEPI will improve weather and environmental forecasts for Arctic communities - Advance our scientific knowledge of the polar regions. -TAWEPI will evaluate/use the surface and space-base observations system <u>Regarding TAWEPI's legacy of infrastructure:</u> -The Polar-GEM model will be made operational on a permanent basis for the Canadian and international Arctic communities after the IPY. -TAWEPI will assist in the establishment of the Clyde River Research Center for traditional and meteorological knowledge of high latitude weather. -Automatic weather stations deployed as part of TAWEPI related field projects will remain in northern	Improved forecasts and knowledge of mesoscale flows

		communities	
status of funding	Application RCN (pending)	Funding decision expected in Fall 2006	EUFAR, Germany, Iceland (pending)
coordination/cooperation needs	DLR, IAP N.Novgorod, IPA (Institute of Physics of the Atmosphere) Moscow, AARI St. Petersburg, Hydromet Moscow	-All the modeling components of this proposal will use Polar-GEM as the main platform for model development and atmosphere-hydrology-sea-ice coupling. We will collaborate and coordinate with ongoing model development activities within Environment Canada (EC), Department of Fishery and Ocean (DFO), Department of National Defense and the university community. - TAWEPI has established an agreement to share data and expertise with the US project "Hydrological Impacts of Arctic Aerosols" (PI: Judith Curry). -The proposed THORPEX Pacific Asian regional campaign (T-PARC 2008). -SPARC-IPY proposal (Norm McFarlane). -The Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka (James Drummond). -TAWEPI will collaborate with the Clyde River Hunters and Trappers Association to establish a Research Center in the community. -Regional Climate Modelling within the Arctic Ocean	ECMWF for sensitivity calculations. VI for weather support
project interdependencies	GFD experiment, DLR, TAWEPI		Closely related to GFDex

(table contd.)

Project name →	7. GREENEX	8. Arctic Regional Climate Model Intercomparison project ARCMIP & CARCMIP	9. Impacts of Surface Fluxes on Severe Arctic Storms, Climate Change and Arctic Coastal Oceanographic Processes
		Targeted observations on North Pole station over the Arctic Ocean Feedbacks between PBL and meso-scale cyclones Climate processes and feedbacks within the coupled Arctic climate system Improved climate feedbacks and more reliable scenarios	a) Studies of storm activitiy in the western Arctic in the context of surface fluxes from changing ice, ocean and land surface conditions. b) Studies on coastal ocean processes including sediment transport, for extreme storms, and seasonal to decadal times. c) Assess severe weather and climate factors that can impact human communities in this the western Arctic coastal areas.
Objectives 1 Improved forecasting ... 2 Improved physical and dynamical understanding 3 Improved polar climate understanding 4 Improved societal benefits	1. Conceptual model of atmosperic response to orography leading to downstream development. Forecasting of small-scale weather phenomena, inlcuding extremes. 3. Meso- and fine-scale flows in vicinity of orography and sea ice and downstream weather development. Scale interactions. 4. Over the N-Atlantic , Europe and globally.	Alfred-Wegener Institute for Polar and Marine Research Research Unit Potsdam	Bedford Institute of Oceanography, Canada
Institution coordinating	University of Iceland		
Contact person email	Haraldur Ólafsson haraldur@vedur.is	Klaus Dethloff dethloff@awi-potsdam.de	Will Perrie; perriew@dfo-mpo.gc.ca
observations to be carried out • long-term observations • field experiment type observations • use of other observational infrastructure	Automatic meteorological high-temporal resolution ground observations in Iceland. Flights associated with DLR, Germany and Univ. East Anglia, UK.	Tethered balloon and radiosonde measurements on NP 34 March-July 2007 PBL structure and free atmospheric structure	1) *in situ* winds, waves and currents, will be collected through iAOOS, CANCO, Arctic SOLAS, Arctic Hydra, TAWEPI, and COME field programs. 2) Remotely sensed wind and ice edge data from RADARSAT 1/2, and related satellite programs
modelling - development - application - operationality	NWP with MM5, WRF, HIRHAM	Simulations with atmosphere only HIRHAM and coupled HIRHAM-NAOSIM	Dynamical coupling of atmosphere-ocean-icea-waves, surface fluxes using MM5, CRCM, POM, Wavewatch3, sea spray, blowing snow modules.
observational geographical domain	Greenland, Iceland and surrounding seas	Arctic Ocean and pan-Arctic integration domain	Western Canadian Arctic, Beaufort and Chucki Seas
special data requirements (additional to routine data)	Data from GFDex and Greenland Jets	Satellite data on sea-ice and clouds ECMWF, HIRLAM (and	Envisat SAR (ASAR).

		Russian) forecast products Polar-GEM products	
data management	University of Iceland, Icelandic Met. Off., Inst. Meteorol. Res., Iceland	Data archived by AWI Adher to IPY and THORPEX data policies	Data will be archived by the team. Accessible TBD.
outreach	Media activities in Iceland. Close collaboration with IPY national committee	Media activities via the German IPY committee	Outreach with Inuit community through the coodinated Department of Fisheries and Oceans Canada programs
education and training	2 PhD students; 1 Postdoctoral fellow	1 PhD student, 1 Postdoc	5 PhD student; 5 Postdoctoral fellows
legacy	Improved fine-scale forecasts, conceptual model of conditions for development downstream of orography. Assessment of severe mesoscale weather events in a future climate in the Iceland-Greenland region.	Advance in knowledge of Arctic climate processes	Improved forecasts and scientific understanding
status of funding	EUFAR, Iceland (pending)	AWI money, Deutsche Forschungs Gemeinschaft proposal (deadline for submitting 30 June 2006)	Canadian Academic and Canadian Government funding components were applied for.
coordination/cooperation needs	International GFDex group and Greenland Jets (observations) DMI (climate modeling)	ARCMIP and CARCMIP groups established	
project interdependencies	Closely related to GFDex and Greenland Jets	Cooperation with Polar-GEM	iAOOS, CANCO, Arctic SOLAS, Arctic Hydra, TAWEPI, and COME programs.