Synthesis template for new/upgraded Research Infrastructure (RI) of pan-European relevance to be sent by the ESFRI delegations to the Executive Board for consideration

1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)

Svalbard Integrated Arctic Earth Observing System (SIAEOS)
Submitted by the Norwegian delegation in cooperation with the University Centre in Svalbard, the Norwegian Polar Institute and the Norwegian Research Council.

2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use. Add links to relevant data/web pages (half page max)

IPCC, ACIA and UNEP all point towards the High Arctic as a key region in global environmental change. The impact of climate change, pollution and other pressures on the environment appear sooner and with more severe consequences in the High Arctic compared to regions at lower latitudes closer to the pollution sources and population centres. This makes the High Arctic an early warning region for global warming.

Due to its geographical location and extensive research infrastructure as well as easy access and good living conditions, Svalbard is uniquely suited as the European hub in High Arctic research and as a node in the planned Sustained Arctic Observing Network (SAON): (1) Svalbard provides excellent opportunities for studies of ecosystem changes following global environmental change. (2) Oceanic and atmospheric transport patterns prevail in the Svalbard region, allowing for studies of environmental pollution as well as its effects on the food chain. (3) Svalbard is well positioned to observe and analyse the Changing Arctic ice cover as well as its albedo. (4) Svalbard's position underneath the magnetospheric cusp allows for unique studies of the energy balance between the layers of the atmosphere, from the borders of space to the surface. (5) The location of Svalbard and the High Arctic provides for dense satellite monitoring.

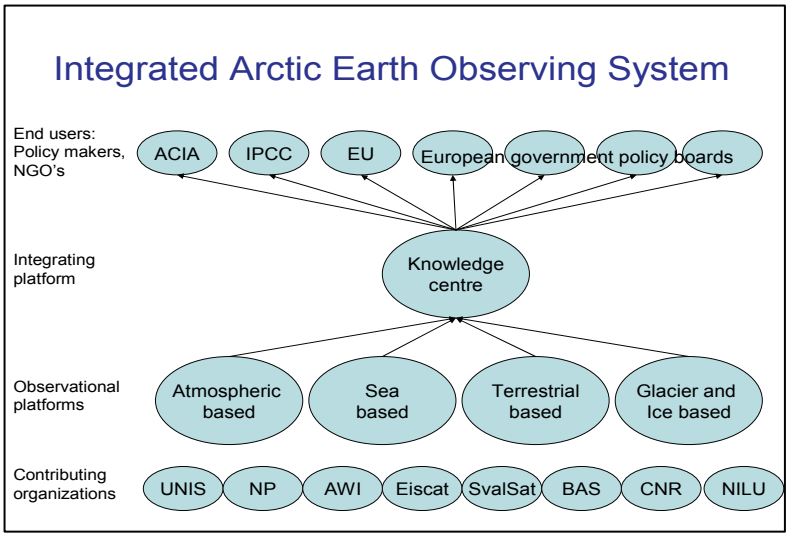
The research infrastructure in Svalbard is extensive: (1) Research organizations from 20 countries are present on a regular basis, operating a wide variety of advanced facilities, ranging from large scale radars to numerous field stations and a variety of research vessels. (2) Norway has established an international university in Longyearbyen (UNIS) with students and staff from 25 countries. (3) Ny-Ålesund has been developed into an international, high standard field station focusing on environmental and climate research. (4) Svalbard is accessible all year round because of its advanced community infrastructure and its relatively mild climate. (5) Svalbard has the highest available data bandwidth in the High Arctic.

It is the goal of this proposal to establish an Arctic Earth Observing System in and around Svalbard that integrates the studies of geophysical, chemical and biological processes from all research and monitoring platforms. This will be done through:

(1) Organize all infrastructure and all research and monitoring activities into four observation platforms being land-based, sea-based, glacier/ice-based and space/air-based.

(2) Assess the present infrastructure and activities to identify gaps and weaknesses in the system. Invest in additional infrastructure and activities to close these gaps.

(3) Establish a Knowledge Centre in Longyearbyen for data assessment, storage and delivery, education and outreach, cooperative efforts, and input to Earth System modeling.



(4) Take actions to coordinate the SIAEOS initiative with complementary ESFRI efforts as well as other Earth Observation Systems and related modelling efforts.

3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).

The EC Northern Dimension Action Plan (http://ec.europa.eu/external_relations/north_dim) addresses the economic, social and environmental impacts caused by climate variability and change and promotes the coordination of European and international research and technology development. The European Arctic is especially sensitive to these changes with average temperatures rising almost twice the rate of the rest of the world, and should be at the forefront of cooperative efforts. The extraordinary changes are documented by the ACIA 2004 report (www.acia.uaf.edu) and demonstrated by the decrease in arctic sea ice extent and thickness, permafrost thawing, more intense melting of Arctic glaciers and ice-sheets during summer, as well as in altered distribution and abundance of species. Amplified by feedback mechanisms and the projected increase in greenhouse gases, these trends are expected to accelerate during the next century (IPCC, 2007).

Although natural changes, interaction and feedback mechanisms between the interdependent parts of the earth climate system, cause large climate variability on timescales from seasons to ice-ages, the strength and rates of recent environmental change indicate significant human influence, due to the emission of greenhouse gases, dust particles and organic pollutants. The interconnectedness of physical, biological, chemical, and human components, together with the high amplitude of projected changes, make a compelling argument for an improved observation infrastructure that delivers a coherent set of pan-arctic, long-term, multidisciplinary observations.

The need for a well coordinated and sustained Arctic Observing Network (AON) that meets scientific and societal needs has been identified in numerous high profile reports and at a variety of conferences (NAP, 2006; http://www.nap.edu/catalog/11607.html). The Arctic Council Salekhard Declaration 2006 (http://arctic-council.org/filearchive/salekhard_ac_declaration_2006.pdf), with ministers representing the eight Arctic States, have agreed to "urge member states and other entities to strengthen monitoring and research efforts needed to comprehensively address Arctic change and to promote the establishment of a circumpolar Arctic observing network of monitoring stations with coordinated data handling and information exchange for scientific data, statistics and traditional knowledge as a lasting legacy of the IPY (and as the evolving Arctic component of the Global Earth Observation System of Systems, GEOSS)". The goal of developing an Arctic Observing Network as a legacy of IPY (www.ipy.org) was endorsed by the WMO XV Congress in May 2007 (WMO/ICSU, 2007).

Svalbard is a hotspot both for contemporary Arctic change and for European Arctic research (RTD-Info, 2005; Cordis Focus, 2007; European Commission, 2007-1,2). Long time series in the fields of troposphere, upper atmosphere, oceanography and glaciology, as well as terrestrial and marine biology; have been established at several sites and by many nations. SIAEOS will enable the many research organisations and national research programs of different nationalities to work together towards common goals, adding value to each others programs, facilitating closer cooperation, coordination of activities, more cost effective use of scientific equipment and better integrating functions. The new infrastructure will represent a major structuring and strengthening effect on the rather fragmented nature of European national and institutional strategies within Arctic research, which is necessary to achieve the best effectiveness of research and the best available advice for policy decisions in Europe.

During the past decade, great progress has been made with regards to Earth System modelling. Designing and building observation systems with a deliberate Earth System Science focus has not received the same systematic approach. Integrated Earth System Studies require Arctic information input, and SIAEOS will represent a major European Arctic building block in the pan-Arctic Sustainable Arctic Observing System (SAON, http://arcticportal.org/iasc/science-development/saon), spanning from Greenland to the Russian arctic islands, Canada and Alaska. The new research infrastructure will build on the extensive research and observation activities already established. With Svalbard as the hub, this can be done from space, in the atmosphere, in the sea and on land:

The atmosphere and geo-space: The combination of Svalbard's location under the polar cusp and the presence of a multitude of research facilities, including optical, radar and radio wave instruments, enable researchers to study the energy budget and dissipation of solar wind energy in the circumpolar regions and its effects on the vertical column between ground level and the magnetopause. Time series related to greenhouse gases and the transportation of pollutants are also crucial.

The sea: A Svalbard marine observatory system based on mooring networks and long term hydrography,

zooplankton and benthos data series enable researchers to set a baseline for future monitoring programs with respect to mega faunal communities and food web structures and to identify thresholds that can change arctic marine food webs and energy transfer. It can also enable researchers to monitor geophysical processes like sea currents and deep water formations, which is crucial for heat transport into the Arctic.

The ice: Many research groups from many nations have been monitoring the volumes of glaciers and sea ice in the High Arctic. This has been done from a variety of field stations and sea based platforms. The accelerating melting processes require an increased and more systematic effort in these fields. The complexities and costs of the efforts make closer cooperation the obvious choice.

On land: The wildlife of the High Arctic is vulnerable to climate change. Some may adept well while others will disappear. High Arctic plants as well as mammals of the region have developed amazing strategies of survival that may not be beneficial in a warmer climate. Terrestrial biologist work all over Svalbard to understand the dynamics of the populations and their adoption to change. Svalbard is also a site where extensive work is being done within the fields of geology to understand climate variability of previous times.

Long term measuring series are crucial in all fields. Parameters of change can only be understood, however, if a sufficiently accurate and representative knowledge of the current state is available. The IPY and earlier efforts provide a good foundation, but will only be worthwhile if the sampling is extended and in some areas expanded over time. It is an important aspect of this proposal to build on the heritage of the IPY, so that the IPY is not an event that ends in 2009 but the beginning of a more systematic approach.

The SIAEOS will be well coordinated with complementary ESFRI efforts like the Aurora Borealis, EMSO, Lifewatch and the ICOS projects, as well with other Earth Observation Systems and related modelling efforts. As such, the SIAEOS will contribute also to other European efforts for structuring European Arctic research under the FP7 Capacities Research Infrastructure programs (INFRAPOLAR). Together, these should enable Europe to greatly improve its knowledge base and research and monitoring abilities.

4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies (half page, list references/links).

The SIAEOS facilities described in this application are designed to be a major building block of a Sustained Arctic Observing System (SAON, http://arcticportal.org/iasc/science-development/saon), building on the recommendations put forward by AON (http://www.nap.edu/catalog/11607.html). A large number of research and monitoring facilities in Longyearbyen, Ny-Ålesund, Barentsburg, Hornsund, Svea, Bear Island and Hopen, as well as a number of research vessels, are already in place. (Appendix 1)

The preparatory phase of this proposal will be dedicated to design and establish the Knowledge Centre in Longyearbyen – the centre peace of SIAEOS, organizing the infrastructure and research and monitoring activities in Svalbard into four observation platforms and to identify gaps and weaknesses in this system. *This work is given high priority in Norway and will start early in 2008 under the framework of the national Norwegian roadmap.* All research organizations in Svalbard will be invited to take part in these efforts.

35 IPY projects are being conducted in Svalbard or its nearby waters during the IPY 2007-2008. The projects range widely in science fields and countries involved, but they all have Svalbard as one major research area and they all involve logistical instalments at the archipelago; from the University Centre to optical and radar installations, meteorological stations, ships, helicopters, laboratory facilities and field stations. There is a great potential in extending these projects beyond the IPY. (Appendix 2)

A High Arctic Earth Observing System based on Svalbard representing the hub for European Arctic environmental research requires additional infrastructure in a variety of fields. All such new research and monitoring activities addressing gaps in the knowledge base (some were identified in NAP, 2006 and SSF, 2006) and providing better temporal or spatial resolution of measurements or involving new technologies are welcome to contribute and benefit from the SIAEOS. Among the needs that emerge are:

Sea observatories: There is a great potential in establishing a Svalbard Marine observatory system based on the ARCTOS mooring network, the Hausgarten mooring system and long term hydrography, benthos and zooplankton data series. Buoys deployed during the IPY will have to be extended and replaced as part of the effort, others have to be installed. (Appendix 3)

Air and space research: The Svalbard environment offers a unique combination of location (geographic and geomagnetic) and infrastructure to study the energy budget and dissipation of solar wind energy in the circumpolar regions. Several groups have programs and infrastructure that will be coordinated and

integrated. Some supplementary infrastructure is required in addition to extending the capabilities of existing facilities. This includes lidars, radars and sounding rockets. (Appendix 4)

Validation programs: There is a pressing need for individual sets of measurements to be systematically tested for representativity in space and time. This requires campaigns of “over-sampling” to determine the resolution required for sustained acquiring of representative monitoring data. The main effort is twofold; to use an extended set of automated field stations in comparison with existing infrastructure and to integrate space based monitoring with the field measurements for mutual validation and calibration. (Appendix 5)

Knowledge Centre: All activities of the SIAEOS initiative will be coordinated and all research and monitoring data shared at the SIAEOS Knowledge Centre located in the Svalbard Science Centre in Longyearbyen. The Knowledge Centre comprises of divisions for (1) data handling, storage and delivery, (2) data assimilation including the integration of satellite and field data, (3) space and time integrating facility, (4) input to Earth System Modeling, and (5) outreach and information. All participating nations will have equal influence on priorities and equal access to results. In the operational phase, we foresee a small organisation/facility with a permanent staff of 6-10 persons (more people may be needed during the construction phase) who are linked up to collaborating networks elsewhere. A Board should be established with representatives from the major research institutions in Svalbard. (Appendix 6)

5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

As a core node in a Sustainable Arctic Observing System (SAON), the SIAEOS will establish a framework of database and metadatabase tools offered to the circumarctic and European research communities. The database services will aim at the full and open access and exchange of the temporal and spatial resolved data within multiple disciplines which constitute the 4 dimensional SIAEOS knowledge base. The first entry point to these data is the *Research in Svalbard (RiS)* database (www.ssf.npolar.no/pages/database.htm). At present, a searchable project database is operative offering information about all research projects in Svalbard, as well as offering a tool for facilitating the necessary coordination of the research and field activities. In addition, a metadatabase is under development which will provide information on the historical and existing scientific datasets, important time series and data repositories collected in Svalbard (http://www.ssf.npolar.no/documents/database_sketch.pdf). The dataformat of the metadatabase content is compatible with the Global Change Master Directory (http://gcmd.nasa.gov/) and it is planned to add the Svalbard data information to this international metadatabase, as well as in compliance with the Norwegian national data management plan and contribution to the International Polar Year (IPY 2007-08).

The data management principles of SIAEOS will address the needs for Earth System Modelling by incorporating tools for data harmonisation, joint protocols, principles for QA/QC, common standards/formats as well as repositories for data storage and maintenance, across the disciplines. The system complements the US funded Cooperative Arctic Data and Information Service (CADIS; http://www.eol.ucar.edu/projects/aon-cadis/), which supports the Arctic Observing Network (AON), and builds on previous European (FP4-6) funded activities like the AMAP/ENVINET Site specific information and project directory databases (www.amap.no/envinet; www.envinet.npolar.no; http://pusnes.grida.no/amap). The SIAEOS will offer a portal for online earth observation system (EOS) data in Svalbard, in close collaboration with the European and circum-arctic research community, as well as in close coordination with and links to global and circum-arctic initiatives and databases like AMAP Thematic Data Centres (www.amap.no; http://www.ices.dk/env; http://www.amap.no/AboutAMAP/Data.htm), GEOSS (http://usgeo.gov/docs/EOCStrategic_Plan.pdf) and a number of other relevant networks and repositories for arctic environmental data.

The e-infrastructure framework of SIAEOS is connected to Europe with the world's northernmost gigabit connection. Two parallel fibre cables at the bottom of the sea between Norway and Svalbard (1400 kilometers) integrates the arctic research and education community on Svalbard with Europe, providing the same high performance and high capacity connection as the European and global research and educational communities on the mainland (www.telenor.com/telektronikk/volumes/pdf/3.2004/Page_140-152.pdf). No additional upgrade is required on the network side from the archipelago. Between the different sites on Svalbard some bandwidth upgrade may be required, this is currently being studied. The Knowledge Centre will require computer hardware and software investments, these will be based on well established architecture and solutions and can thus be easily integrated to existing infrastructure.

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other (one page, references).

Effects on training: The location of the SIAEOS Knowledge Centre on the campus of the University Centre in Svalbard enables the transition of lessons learned from research and monitoring activities to education of students on Bachelor, Master and PhD-levels. In establishing the centre, a special effort will be made to engage the international body of students at UNIS in every stage of the work as well as in all field activities. This will enable the next generation of researchers and policy makers to have first hand experience with research and monitoring activities as well as the evolving Arctic Earth Observing System.

Involvement of industries: Several international companies, among them ConocoPhillips, StatoilHydro, Store Norske and Total, are active in research that is relevant to this ESFRI effort. Their main areas of interest have been marine life and environment and technologies related to energy and the environment. As StatoilHydro and Total have been chosen as Gazproms partners in developing the Stokhman field, one must expect their interests in a High Arctic Observation System to increase.

Local impacts: Longyearbyen has a strong tradition of interaction between the local population and the scientific communities of the Svalbard Science Centre. Seminars that are open to the local community are arranged weekly through the winter season. Svalbard is also visited by a large number of tourists from all over the world, and UNIS works with the local tourist operators to give visitors access to research facilities and take part in the scientific results that are produced. It will be a goal of this ESFRI effort to follow these traditions. Policy makers from all over the world also visit Svalbard frequently and will in the future have the opportunity to meet with the scientific communities and study their results directly in the Knowledge Centre.

Environment: It is a primary goal for environment conservation in Svalbard to preserve the unique wildlife in the archipelago. For that reason, the Norwegian government has decided that Svalbard shall be one of the world's best managed wildlife preserves. This represents an important framework for all activities in Svalbard, including research and monitoring activities. On the other hand, this demonstrates the urgency of the effort to understand and to act upon issues related to climate change and global warming, and it makes sense to use Svalbard as the hub for the SIAEOS initiative.

7. Commitments / maturity: which States / Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?

20 nationalities of researchers are present in Svalbard on a regular basis and will be invited to take part in the SIAEOS effort. Most of these are European, but there are also institutions present from Japan, China and South Korea. (Appendix 7)

Research organisations from Germany, France, UK, The Netherlands, Italy, Poland, Korea and Japan in the Ny-Ålesund Scientific Managers Committee (NysMAC) gave at their meeting in Cambridge in October 2007 positive support to the Svalbard ESFRI proposal. Official commitments from organizations supporting the proposal will appear on our web-site at www.unis.no/SIAEOS.

8. Costs for construction, operation and decommissioning, indications on project financing (half page, with references/links). Give budget info in M€

The available infrastructure in Svalbard is extensive, mature and well functioning. It is a major task of this initiative to pool these resources and add more infrastructures in order to have the earth observation system and the research activities as complete as possible. A detailed gap analysis will be carried out during the preparatory phase of the process for this purpose.

The costs of construction, operation and decommissioning depend very much on the initial assessment. At this stage we can only offer approximate calculations on what will be needed.

Sea based infrastructure:

The sea based research and monitoring platform will need additional instruments to be complete. We see the need to add a number of moorings (1,5 M€), balloons and drones (1,5 M€) and instruments for remote sensing (1 M€). To secure continuous operation and continuous time series from these instruments, we foresee operating costs of another 1 M€ a year. These costs come in addition to ongoing research and monitoring programs and infrastructure that is already in place. Total investments: 4 M€. Operational costs:

1 M€/year.

Space and air based infrastructure:

Based on a preliminary assessment there seems to be a need for: (1) An interferometer antenna system (under development at ESR) linked up to high resolution auroral cameras that will make it possible to observe detailed plasma structures and associated filamentary currents connected to the creation of narrow field aligned auroral features. Total investments: 1.5 M€. (2) A mobile radar for mesospheric research (Morro) tuned at 56 MHz (under development at UiT) to be deployed at different positions in Svalbard and the Arctic to obtain broader geographical distribution of observational points. Total: 5 M€. (3) Two middle atmosphere rockets and one upper atmosphere rocket per year for 7 years (12-14 M€). (4) New instruments for Auroral measurements (10 M€). Total investments: 28 M€. Operating costs: 1 M€/y.

Land based and ice/glacier-based platforms:

These parts of the future system are very fragmented today and need a thorough assessment before the nature and size of additional investments can be stated. Our approximate calculation is a need for 4 M€ of investments and 1,5 M€/y in operating costs.

Validation infrastructure

Five to ten larger mobile automated land based measurement stations to validate spatial representativity of existing time series as well as increasing spatial resolution. Parameters to be measured are atmospheric and terrestrial. These should be placed at selected land points along the 80-degree latitude. The validation infrastructure will be an integral part of the Knowledge Centre and will require annual investments of 2.8 M€ to cover data access and integration. Total investments: 5-10 M€. Operation costs: 3 M€/year.

Knowledge Centre:

The Knowledge Centre as described in the appendix will need 5 M€ in initial investments, 4M€/y for operational costs the first five years, thereafter 2 M€/y. The physical construction of the centre not included.

Preparatory phase:

We calculate the initial assessment of the present situation, the design of the platform-based system and the identification of gaps and weaknesses to require costs of approx. 2 M€.

Total preparatory cost	Total construction cost	Operation cost /year	Decommissioning cost
(of which already spent or committed): 2 M€.	(specify contributions committed or indicated by possible funders): 50 M€.	(specify contributions by possible funders) 9,5 M€/y	(possible funders)

9. Timetable for construction, operation and decommissioning (half page, with references/links) with duration and possible starting dates.

Preparatory phase 2008-2010:

- Gap analysis and technical design studies of all observational platforms under the Norwegian national infrastructure roadmap.
- Designing and organizing the Knowledge Centre, setting up the board and recruiting management.

Construction phase 2010->:

- Implementing new instruments and validation programs, based on gap analysis.
- Establishing integrated database services.
- Recruiting personnel and starting up the Knowledge Centre.

Operation 2012->:

- Full operation of the European Hub and Node in SAON.

Decommissioning:

- Ny-Ålesund Science Plan (http://ssf.npolar.no).
- Norwegian Strategy for Polar Research (updated 2008).
- Svalbard Environmental Act (www.sysselmannen.svalbard.no/eng).

Preparatory phase 2008-2010	Construction phase 2010-2012	Operation 2012 →	Decommissioning

10. Reference: Person who has submitted the proposal, and will follow up in ESFRI

Gunnar Sand, director of the University Centre in Svalbard (host institution) *in collaboration with Bo Andersen, Norwegian Space Centre, Asgeir Brekke, Univ. of Tromsø and Kim Holmén, Norwegian Polar Institute.*

SIAEOS web page: www.unis.no/SIAEOS.
All appendices and related and updated documentation and references can be found on this website.

References:

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