Appendix 5: Validation programs

Objectives:

Remote sensing satellites are now capable of providing important data about the atmosphere, ocean, cryosphere, vegetation and solid earth processes. The Polar Regions have the best coverage and repetition rate from polar orbiting satellites. For any given number of available satellites, the high latitude regions are the best suited for satellite surveillance and measurements from polar orbiting satellites. However, satellite missions need ground measurements for validation and calibration. A combination of satellite measurements with the already extensive field work being carried out in the Svalbard archipelago will provide mutual benefit for the scientists in the field and the polar orbiting satellite operators and users. The field work will provide calibration and validation for the satellite measurements so they can be used more reliably in other similar regions and in the same region outside the field work. This increases both the spatial and temporal sampling in a manner that is crucial for the study of global change. Additionally, the amount of field work needed may be reduced by extensive use of satellite data, thus minimizing the wear on a very sensitive and vulnerable landscape.

Observational methods for biogeophysical parameters vary in temporal and spatial resolution. Ground based measurements are typically of high temporal resolution over a limited time period, but with limited spatial coverage. Mobil platforms (surface vessels and vehicles, airborne vessels, balloons and drop sonds (and their equivalents in the ocean), rockets, and others) give better spatial coverage or resolution (in at least one dimension) but will as a rule have limited or intermittent temporal coverage.

There is a very large (25+) and steadily increasing number of satellites where the data are being collected over and read down to Svalbard. These satellites are providing a vast potential source of information for Earth System Studies. Examples of these satellites are the NASA satellites TERRA, AQUA, AURA, EO1 and ICESAT. The ESA satellites ERS-2 and ENVISAT have for several years provided essential knowledge of the European Artic. The data from these as well as many other satellites are freely available. However, due to a lack of resources and electronic infrastructure, only a minor part of this source is currently explored and integrated with other measurements. For other high-resolution optical satellites there is additionally a cost to the satellite owners for the data.

Examples of upcoming new Canadian and European satellites where such synergy can be exploited for validation purposes are: Radarsat-2 (2007), RapidEye (2008), CryoSat (2009), Pleiades (2009), SARAL/AltiKa (2009), Sentinel-1 (2011), Sentinel-2 (2012) and Sentinel-3 (2012). The GMES programme of ESA and the EU will the operational series of Sentinel satellites give a long term guarantee of data availability. Already the Norwegian Space Centre and ESA have initiated preparatory calibration and validation measurements for CryoSat on Svalbard.

The challenge in the European Arctic is to merge these measurements and measurement platforms of incongruent resolution (in the four dimensions) into a concerted infrastructure facility that is capable of addressing the grand interdisciplinary scientific issues at stake.

A function of integrating the different datasets from ground and space based data platforms would clearly give an added value for all involved communities. This function as an "Arctic Research Satellite Data Centre" would be an integral part of the "Knowledge Centre" presented in this proposal. It would be located at Svalbard and would serve an important function in ensuring better interplay between satellite and in-situ measurements in the Arctic.

Individual sets of measurements are seldom systematically tested for representativity in space and time. There is a pressing need to perform representativity studies that allow quantitative statements regarding the outer limits of the degrees of freedom within the realms that are not sampled with direct measurements. This will require specific studies with campaigns of "over-sampling" in space and time to determine the resolution required for sustained acquiring of representative monitoring data.

Models can bridge between the data of mixed resolution provided that they have been verified for the scales where used to fill in data gaps. Over-sampling campaigns are also here the required endeavour in order to reach a verified monitoring infrastructure that allows addressing interdisciplinary multi-parameter questions where data are compatible and devoid of aliasing effects and other deficiencies of fragmented data.

The individual measurement programs on Svalbard are generally mature, well established, under the auspices of highly regarded institutions and of high international quality. The need is to build a knowledge based monitoring facility. Such a holistic approach to monitoring infrastructures is to an extent innovative and a step towards establishing biogeophysical monitoring as a field of knowledge conception in its own right. The proposed infrastructure is a facility that attends to the whole line of production from sampling strategy formulation, the actual detectors and instruments, the data acquisition and storage, the data interpolation between measurements to verifying if the scientific questions asked of the data are well posed based on the resolution and representativity of the final product.

Such an infrastructure will comprise of contributed existing monitoring facilities, data handling and storage facilities and new monitoring measurements.

Essential to making decisions regarding new measurements (and discontinuing obsolete measurements) is the work performed in the knowledge centre. Core activities in the knowledge centre must therefore be to perform representativity campaigns where all four dimensions are thoroughly over-sampled. A key goal of the knowledge centres model treatment of the data is that it then can provide quantitative estimates of the uncertainty of interpolated data which is a prerequisite for all attempts to utilize the monitoring data for scientific deductions.

This concerted monitoring infrastructure for Svalbard will provide for new large scale interdisciplinary research and conclusions. The infrastructure will substantially increase the cost efficiency of monitoring and will also ensure that national and institutional efforts are contributing proficiently to knowledge accruement worldwide. This infrastructure will set a new standard for building monitoring facilities that can be adopted elsewhere. It is, however, pertinent that this standard is first achieved in the European Arctic which is of paramount importance in the global climate system and where biogeophysical changes are expected to give the earliest and most dramatic consequences for the environment and biodiversity.

Investments and operating costs:

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.