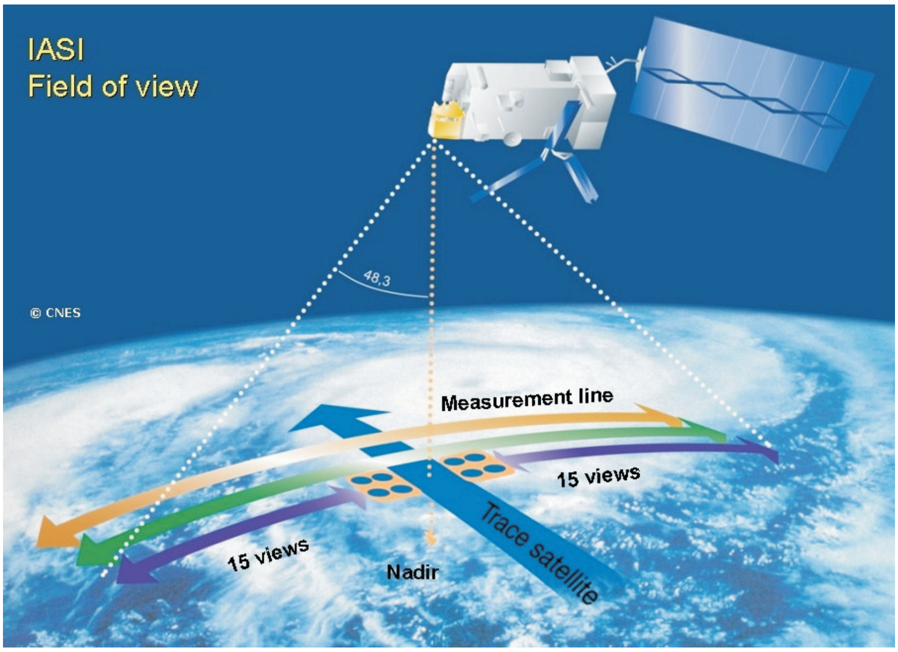
Use of IASI data in the IPY-THORPEX/Norway

IASI – new sensor onboard the MetOp/A Satellite

Infrared Atmospheric Sounding Interferometer (IASI) is a new sensor onboard the first European polar-orbiting satellite dedicated to operational meteorology – the MetOp satellite, which was launched on 19 October 2006 and with lifetime expected to be 5 years. IASI sensor has a broad spectral range from 3.62 µm (2760 cm^{-1}) up to 15.5 µm (645 cm^{-1}) with spectral resolution of about 0.5 cm^{-1}. Hence it has more than eight thousand channels. IASI is a good instrument for temperature and humidity (water vapour) sounding. It is also an excellent sensor for surface and cloud properties, and good instrument for the surveillance of trace gas (O_3, N_2O, CH_4 and SO_2) evolution. To achieve global coverage, the IASI instrument observes the Earth until an angle of 48.3 degrees on either side of the satellite track. Scene scanning is stepped with field motion compensation.



Scanning characteristics of the IASI instrument

For each view, the instrument analyses an atmospheric cell of about 3.3 degrees x 3.3 degrees, or 50 km x 50 km at nadir. Each cell is analysed simultaneously by a 2 x 2 array of detectors. IASI swath is about 2200 km, ensuring global coverage twice a day. For more information about the IASI instrument, visit http://smsc.cnes.fr/IASI/

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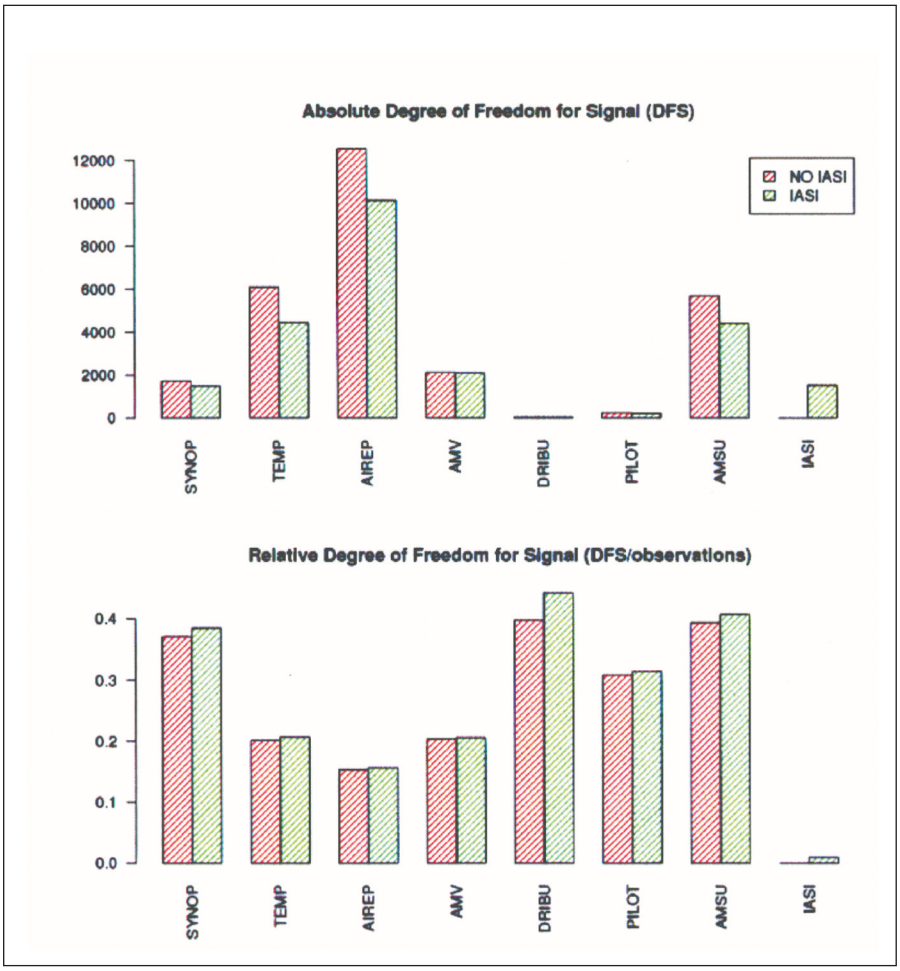
I was born in Madagascar. I completed MSc degree in Meteorology in Leningrad (Hydro-Meteorological Institute of Leningrad, former Soviet Union, in 1991), and my PhD in St Petersburg (in the same institute, in 1995). I started my scientific carrier at the Satellite Research Laboratory of the Hungarian Meteorological Service in 1994, and then moved to the division for Numerical Weather Prediction in 2000, where my main duty was the development and implementation of the ALADIN limited area data assimilation system. My work focused mainly on observations processing/assimilation. I have been working with wind profilers, aircraft data, atmospheric motion vectors, and the last few years I concentrated more on the assimilation of satellite radiances. Since 2007, I work at the Norwegian Meteorological Institute (Met.no) in the division for remote sensing.

Role of IASI in the Norwegian THORPEX-IPY

THORPEX-IPY is the Arctic component of the international program THORPEX (The Observing System Research and Predictability Program) under the Word Meteorological Organisation World Weather Research Program. Like the other THORPEX projects, the main objective of the

Norwegian one is to significantly improve forecasts of high-impact weather events in the Arctic region for the benefit of society, the economy and the environment. To reach the objectives of the program, among other scientific challenges, campaign measurements, observations exploitation and development of data assimilation system are envisaged. In particular, working package five of the Norwegian program will exploit the assimilation of IASI data to improve the HARMONIE numerical weather prediction analysis and the forcast system, and the HIRLAM ensemble prediction system. The THORPEX-IPY/Norway is a four-year project from 2007 till 2010.



Degrees of freedom for signals computed in the systems with (green bars) and without (red bars) IASI data. SYNOP stands for all surface measurements including manual, SHIP and automatic stations; TEMP stands for all radiosonde measurements, including manual, SHIP and automatic stations; AIREP stands for all aircraft measurements, including AMDAR, ACARS and AIREP data; AMV stands for all atmospheric motion vectors available inside the model domain; and AMSU stands for ATOVS microwave radiances, including AMSU-A, AMSU-B and MHS data.

IASI for a Better Analysis and Forecast of the HARMONIE Numerical Weather Prediction System

In the framework of the HIRLAM-ALADIN cooperation agreement, a new assimilation and forecast system is currently under development, with special focus on data assimilation and forecast in high-resolution. The joint efforts of HIRLAM and ALADIN community aim to create a common basic system suitable for use in operational mode. The system has been called HARMONIE (Hirlam Aladin Regional/Meso-scale Operational NWP In Europe). The THORPEX program is under progress, so the assimilation of the IASI data at Met.no is under development. IASI data is being exploited together with most of conventional (radiosonde, Pilot, aircraft, and surface observations) and satellite observations (atmospheric motion vectors and ATOVS radiances).

The HARMONIE Assimilation and Forecast System

Two domains of the HARMONIE model – a bigger and a smaller one with horizontal resolutions of 16 and 11 km, respectively - have been installed at Met.no. Both the domains were chosen so, that their geometry would match as close as possible that of the operational HIRLAM12 and HIRLAM8 in order to have similar domains for comparison purposes, and to be able to perform higher resolution data assimilation. For both the domains, the vertical discretization consists of 60 eta levels, using the former L60 level definitions of the ECMWF/IFS global model. The three-dimensional variational (3DVAR) assimilation scheme is applied for the upper-air analysis, while an optimum interpolation scheme is used for the surface analysis. 6-hourly cycling is used to have four analyses a day at 00, 06, 12 and 18 UTC. Therefore, 6-hour forecasts are performed at 06 and 18 UTC as background for the next assimilation cycle, but longer range forecasts are done at 00 and 12 UTC for verification purposes. The RTTOV-8.7 fast radiative transfer model is used as observation operator for ATOVS and IASI data, and the bias of the radiance data is handled using variational technique.

Pre-Processing of the IASI Data

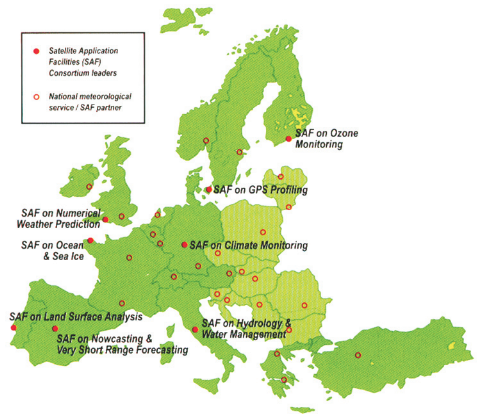
Although IASI has thousands of channels, only 366 channels are extracted for the observation database. Selection of the active channels (channels contributing to the analysis) is the most important task when assimilating the IASI data. Two-steps monitoring technique was used to select the active channels. The first step was based on the analysis of bias and standard deviation of the analysis departures after bias correction (observation-minus-background values), while the second section took into account biases before and after the bias correction. The second selection guarantees that selected channels “obey” the bias correction scheme used in the system.

Assimilation Trial

Different sets of active channels were tested. Common conclusion from the analysis of the impact of the IASI data on analysis is well shown on the respective values of DFS (Degrees of Freedom for Signal) computed using information from analysis with and without IASI data. We see that the relative values of most of the observations were higher when assimilated with IASI data than without them. This means that most of the assimilated observations were better used in the analysis system with IASI data probably due to better background fields (in our case 6-hour forecasts). Preliminary impact studies showed slightly positive and negative impact of IASI data on forecasts of wind, geopotential ans temperature for a summer and winter period, respectively. Thus, further tuning of IASI assimilation scheme should be done to ensure positive impact of the AISI data during both winter and summer periods.

The Satellite Application Facilities (SAFs)

Satellite Application Facilities (SAFs) are specialised development and processing centres within the EUMETSAT Applications Ground Segment. Utilising specialised expertise in Member States, they complement the production of standard meteorological products derived from satellite data at EUMETSATs Central Facilities in Darmstadt and distribute user software packages.



Network of Satellite Application Facilities in Europe

The overall objective of a SAF is the provision of operational services, ensuring a cost-effective and synergetic balance between the central and distributed services. The SAF services are an integral part of the overall EUMETSAT operational services.

In this context, the objective of a SAF is to undertake, on a distributed basis, the necessary research and development to deliver services and products aimed at enhancing the value and use of data for applications, which are a common need of EUMETSAT Member States and Cooperating States.

There are a number of specific benefits arising from the SAFs, including:

Improvements to short-range forecasting of severe weather hazards;

Benefits to the aviation, agriculture, construction, gas, water and electricity industries;

Better understanding of causes and effects of pollution of the upper atmosphere and the depletion of ozone;

Early warning of hazards;

Better data for climate monitoring;

Improved information for land use, ecology, disaster monitoring and agricultural forecasting;

Benefits for sea transport, fishing and offshore industries;

Improved data for input to Numerical Weather Prediction and the availability of user software packages for operational applications.

SAFs providing with end of 2008 following operational products:

Support to Nowcasting and Very Short Range Forecasting
Ocean and Sea Ice
Climate Monitoring
Numerical Weather Prediction
Land Surface Analysis
Land Surface Analysis
GRAS Meteorology

SAFs under Development

Support to Operational Hydrology and Water Management