# Usage of IASI at global NWP centres and intercomparison of IASI impact assessment

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IASI on board Metop-A has been assimilated in a global Numerical Weather Prediction (NWP) system as early as June 2007 at the ECMWF. Shortly after, numerous NWP centres started the assimilation of IASI in global models with various settings. This keynote presentation will give an overview of the operational usage of IASI in global models at NWP centres: channel selections, observation errors, cloud parameter retrievals, surface property retrievals, etc. Scientific topics for remaining challenges will be introduced.
An inter-comparison of IASI impact has been set up among several NWP centres. The assessment is based on Observing System Experiments (OSEs), which means that all participating centres carried out twin experiments using their operational observation settings, one with IASI, the other one without IASI.Various diagnostics are computed homogeneously for all centres, such as forecast error reduction, modification of other observation usage, etc. Common features will be exhibited to

**Accounting for IASI Correlated Observation Error in NAVGEM**

**William F. Campbell and Elizabeth A. Satterfield**
**Naval Research Laboratory, Marine Meteorology Division,**
**Data Assimilation Section,**
**Monterey, CA., USA, 93941.**

We will show results from the inclusion of vertical (interchannel) correlation terms in the observation error covariance matrix (denoted **R**) for the (IASI) instruments in the Navy's 4D-Var data assimilation system (NAVDAS-AR). Our dual formulation 4D-Var data assimilation scheme make NRL uniquely well suited to explore correlated observation error, and the closely related problem of error of representation.

Until recently, most operational NWP centers assumed that observation errors were uncorrelated (a notable exception is the Met Office, which has been using vertically correlated observation error for IASI since January 2013 (Weston et al., 2014)). Typically, when observation errors are actually correlated, techniques such as thinning (discarding) or averaging data, and/or inflation of the assigned observation error variance, must be used to compensate. Such techniques are suboptimal and can be rendered unnecessary by correctly accounting for correlated error.

The vertical observation error covariance for IASI was estimated using the Desroziers method (Desroziers et al., 2005) and an archive of historical satellite and NAVGEM model data. The results suggest lowering the error variance (diagonal of **R**) and introducing strong correlations (off-diagonal terms), especially in the moisture-sensitive channels. Because of the dual formulation of our data assimilation scheme, the inverse of the **R** matrix is not required, which has benefits both in reduced computation time and in solver convergence.

The convergence rate of the solver, which varies inversely with the condition number of the representer matrix in the dual formulation, is an important issue. The condition number of the **R** matrix derived from the Desroziers method can be quite large. We used a procedure that optimizes the approximation to a poorly conditioned matrix in a given norm and allows the user to choose any condition number required.

Full cycling data assimilation experiments using standard forecast metrics for two-month boreal winter and summer cases were run with approximate interchannel correlation matrices for IASI. In addition, we ran the same experiments with reduced observation error variances, which are suggested by the Desroziers diagnostic and the fact that the error variances had been artificially inflated partly to compensate for correlated error. The inclusion of correlation terms typically statistically significant positive results vs. both ECMWF analyses and radiosondes at most levels and lead times. Future work will include vertically correlated **R** for other instruments such as CrIS.

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Preference for oral presentation in Weather forecasting (global NWP).

# Approaches to accounting for spectrally-correlated observation errors at ECMWF

**Reima Eresmaa [(1)], Niels Bormann [(1)], Hyoung-Wook Chun [(2)] , Tony McNally [(1)]**

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*Seoul, Korea*

## ABSTRACT

There is a global trend towards explicit treatment for correlated observation errors in the assimilation of infrared radiances for Numerical Weather Prediction (NWP). Currently available methods allow one to account for spectral (inter-channel) error correlations with negligible impact on computing time. Recently, substantial progress has been made in diagnosis of the full observation error covariance for infrared sounder data. In parallel to the diagnostic work, understanding of error sources such as instrument noise, residual cloud contamination, and radiative transfer modelling, has been greatly improved, which allows one to specify observation error statistics in a situation-dependent way. At the same time, channel selections for the use in NWP are being optimized for the presence of known sources of correlated observation error.

# IASI 2016 Abstract

## IASI at high spatial resolution in Météo-France regional models

Nadia Fourrié, Vincent Guidard, Pierre Brousseau, Ghislain Faure

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## Abstract:

The Infrared Atmospheric Sounding Interferometer (IASI) onboard Metop-A and Metop-B belongs to a new generation of advanced satellite sounding instruments. It provides information with spectral resolution far exceeding that of previous sounders (HIRS). IASI observations are assimilated for clear sky and low-level and mid-level opaque clouds in the French Numerical Weather Prediction models. Currently, IASI channels are assimilated in operations, in the global model ARPEGE 4D-Var and in the limited-area models AROME and ALADIN. The presentation will focus on the 3D-Var assimilation of IASI observations in the regional models AROME and ALADIN.

Up to the last version of the operational AROME model, the same channel dataset as in the global model was used in the AROME 3D-Var. However, the top of the model is now lowered to 10hPa and this implies changes in the radiative transfer simulation of IASI channels. The number of assimilated channels was thus reduced to discard high peaking channels. The challenges implied by the modification of the top of the model will be discussed (cloud detection, bias correction…).

Contrary to the global model, IASI observations of all detectors are assimilated in regional models with an horizontal thinning of 70 km. Examples of the IASI observation benefit in the overseas ALADIN model will be illustrated with the forecast of tropical cyclones.

Preference of presentation: oral

The ECMWF operational ECMWF 4D-Var has been adapted to allow the direct assimilation of principal component (PC) scores derived from high spectral resolution infrared sounders radiances. The primary aim of this development is towards an efficient use of the entire measured spectrum that could not be achieved by traditional radiance assimilation. We present a system where we assimilate truncated PC scores representing the information contained in the 5421 spectral radiances from IASI Band 1 and Band 2. The new scheme has been extensively tested in a full data assimilation system that uses all operational observations (satellite and conventional). In our presentation we discuss the quality of the analysis produced by the assimilation of the truncated PC scores and the verification of the forecasts launched from these test analyses. Finally, we discuss the work needed to take this system forward to a stage where it can be considered as an option for the safe and efficient operational exploitation of high spectral resolution infrared sounders radiances.

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# A cross-validation method for observational data and its application to IASI cloud screening

Olaf Stiller, Deutscher Wetterdienst, Offenbach, Germany

The exploitation of remote sensing data for NWP strongly relies on quality control (QC) methods including (often quite sophisticated) screening procedures aimed at identifying observations affected by influences (as, e.g., from clouds or land surfaces) for which the employed observation operator is not adequate. Improving such QC (or screening) methods may be essential for an increased and/or more efficient use of this observation type. Apart from the most simple QC checks (which only check the magnitude of the first guess departures of the individual observations) most screening methods consider collective properties of groups of observations for which they impose thresholds. In a more general sense, such QC schemes can be considered as cross-validation methods as the validity of observations is assessed from their consistency with other observations (plus the model background).

While these consistency assessments are generally quite heuristic, the work presented here gives a mathematically rigorous framework for computing the conditional probability of observations (or subsets of observations) given the background and other observations. While a straight forward computation of such probabilities would involve a large number of analysis (i.e., data denial) experiments, the method proposed here is extremely cost effective and aimed for operational use prior to the DA minimization step. Applications include the identification of (i) outliers and (ii) breaches in data sets (i.e., groups of observations affected by systematic influences like, e.g., clouds). The difference between observations and their expectation values (given other observations) as well as the corresponding standard deviations are derived. For the case of uncorrelated observation errors, the "expectation values" can be identified as the analysis values which would be obtained when assimilating only the "other observations".

As an example for an application of the method, the construction of a cloud screening scheme for IASI data is described.

# Assimilation of Reconstructed Radiances in the AROME mesoscale convection-permitted NWP model

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## ABSTRACT

With the arrival of hyperspectral infra-red sounders like Atmospheric Infrared Sounder (AIRS), Infrared Atmospheric Sounding Interferometer (IASI) or Cross-track Infrared Sounder (CrIS) on board different polar-orbiting satellites, there has been a huge increase in the number of satellite radiances available to the user community. Such observations have been very helpful for the Numerical Weather Prediction (NWP) models (Hilton et al., 2009; Collard and McNally, 2009; Guidard et al., 2011; Hilton et al., 2012; Joo et al., 2013) at both global and regional scales but the large volume of data raises technical issues for both retransmission and archiving services. That is why only 324 AIRS channels, 331 CrIS channels and 500 IASI channels are distributed on the Global Telecommunication System (GTS). Moreover, for scientific and technical reasons, only a small sub-set of the measured radiances in the infra-red spectrum can be assimilated. For example, only about 130 IASI channels are currently used among the 8461 in the NWP Météo- France models. Given the redundancy of information contained in the thousands of channels from hyperspectral instruments, a Principal Component Analysis (PCA) seems to be a rather natural technique to compress data by keeping the most informative linear combinations (Huang and Antonelli, 2001; Liu et al., 2006).

For the previous given reasons, EUMETSAT has decided to apply the PCA technique to the data dissemination of the upcoming hyperspectral sounder *InfraRed Sounder* (IRS) on board the MeteoSat Third Generation-Sounding (MTG-S). The expected launching date for the first MTG-S is around 2020. At a regional scale, the impact of IRS on limited-area models is expected to be more important than IASI because of its highest spatial and temporal resolution (Europe area will be covered each 30 minutes versus two overpasses per day available from Low Earth Orbiting (LEO) satellites). The spatial resolution of MTG-IRS will be of 4 km for the 12 km pixel size of IASI (nadir viewing). IRS will be made of 1738 channels.

In this work, the impact of using reconstructed radiances at the place of the observed IASI radiances in cloud properties retrievals, statistics on used observations and numerical weather prediction quality is investigated to prepare the arrival of IRS. The assimilation of reconstructed radiances was tested in the mesoscale model AROME. In particular, the impact of having lowered the top of a mesoscale model will be assessed.

# Towards the assimilation of all-sky infrared radiances of selected humidity sensitive IASI channels at NCEP/EMC

**Li Bi [(1)], Andrew Collard [(2)] , Emily Liu [(3)], James Jung [(4)], John Derber [(5)]**

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## ABSTRACT

This work focuses on the step towards the assimilation of all-sky infrared radiances of selected humidity sensitive Infrared Atmospheric Sounding Interferometer (IASI) channels using NCEP GFS model. Radiances simulation are implemented using Community Radiative Transfer Model (CRTM) that includes profiles for liquid-water content and ice-water content. Statistical analysis that over the ocean of observation minus background departure (O-F) are evaluated for selected water vapor channels. The observation screening procedure was developed to improve the cloudy scenes selection. Cloud-dependent quality controls and observation error are evaluated in this study. The goal for this preliminary work is to extend the microwave (MW) all sky radiances assimilation at NCEP/EMC to infrared (IR) all sky assimilation for the channel that are suited in all sky conditions.

# Increasing the utility of real-time IASI moisture and temperature soundings In very-short-range forecasting

Ralph A. Petersen[1], Lee M. Cronce[1], William E. Line[2], Thomas August[3] and Tim Hultberg[3]
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Extensive testing has shown that a new, very-short-range prediction system that focuses on retaining the maximum amount of information from GOES and SEVIRI provides important information to the operational forecasters. Although these tests focused on where/when deep convection will/will not occur and in which areas convection is likely to become severe, additional new applications and data sources are explored in this presentation that further expand the utility of the 1-9 hour products from this NearCast system.

Earlier tests at the European Severe Storms Laboratory (ESSL) and NOAA's Storm Prediction Center (SPC) and Aviation Weather Center (AWC) have identified the need for obtaining more information about changes in vertical moisture and stability structures prior to storm development. This information should be present from hyper-spectral infrared (IR) sounders. In addition, forecasters in the high-latitude regions, where GEO data coverage is limited, have requested that the NearCast techniques be applied to hyper-spectral soundings from the multiple Low Earth Orbiting (LEO) satellites that make frequent overpasses there. A wide range of forecasters have also noted the additional need for short-range guidance using full resolution satellite observations in *cloudy* conditions (not included in IR-only satellite products) for application to a variety of problems, especially those related to heavy precipitation events.

In this presentation, techniques are demonstrated over Europe using different combinations of hyper-spectral retrievals obtained from Infrared Atmospheric Sounding Interferometer (IASI) and Cross-track Infrared Sounder (CrIS) observations. Although these hyper-spectral IR observations lack the spatial coverage and temporal detail of GEO data, the enhanced accuracy and vertical resolution provided by the LEO products partially compensates these deficiencies and complements more frequent SEVIRI products. Tests conducted are planned in cooperation with ESSL to compare the impact of higher-time-frequency SEVIRI data to the less-frequently-updated hyper-spectral LEO observations. The increased vertical sounding resolution should be especially useful in areas where radar coverage or other asynoptic observations are limited and in instances when conventional NWP (numerical weather prediction) guidance is questioned. The higher vertical resolution will also support provision of more reasonable and realistic analysis and forecast products, such as near-surface moisture features, more physically-based stability indices (e.g., Convective Available Potential Energy (CAPE)), and better estimation of tropopause locations and expected maximum storm heights.

Finally, the advantage of including microwave observations in these forecaster tools provided through the EUMETSAT and NOAA NUCAPS retrieval algorithms will also be demonstrated. NearCasts using these data offer the opportunity to add short-range forecast information in cloudy areas where IR instruments (LEO and GEO) are unable to fully penetrate. Short-range projections of these less-frequent LEO observations at full resolution have the potential of providing a long-lasting complement to MTG-IRS well into the future, filling gaps in the MTG IR-only products.

# Improving thermodynamic retrievals using realistic ozone and ozone-sensitive channels

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Hyperspectral infrared sensors like IASI on board Metop polar-orbiting European satellites cover a wide range of the infrared spectrum. Parts of this spectrum is sensitive to ozone. During the assimilation process, a priori profiles of temperature, humidity, etc. are mandatory, including ozone profiles. In Meteo-France operational system, information on ozone within the numerical weather prediction (NWP) process is a climatological profile, constant in space and in time. In this study, we present the use of realistic ozone fields of the day from the French Chemistry model MOCAGE to replace the climatological ozone profile. Impacts on observations minus model will be described. Impact on the assimilation process and the temporal evolution of the bias correction will be highlighted.
Once realistic ozone is provided, channels sensitive to ozone can be used to retrieve information on atmospheric temperature. This poster will present results of ozone-sensitive channel selection for NWP. The impact on temperature retrievals will be assessed using 1D-VAR studies and possibly

**IASI 2016** abstract

# Looking backwards: 20 years of hard work on IASI for NWP at Météo-France!

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Abstract:

The Infrared Atmospheric Sounding Interferometer (IASI) onboard Metop satellite belong to a new generation of advanced satellite sounding instruments and was developed by CNES and EUMETSAT. The aim of this paper is to propose a review of the work done at Météo-France for the preparation before the launch of Metop satellite and the assimilation of IASI observations in the NWP models.

At the late of the 90's and the beginning of the 2000's, there were many studies to assess the information content of clear sky radiances (Prunet et al 1998) and to propose methods for the IASI channel selections in clear (Rabier et al 2002) and cloudy sky (Fourrié and Rabier 2004).

IASI observations are operationaly assimilated in the Météo-France models since 2008 and the number of assimilated channels is regularly increasing. Now 123 channels are providing information on temperature and humidity in the NWP analyses at global and regional scales.

In order to better represent the sensitivity of the satellite measurement to the whole atmosphere within its footprint, new observation operators were designed for mesoscale model such as AROME (Duffourg et al, 2010). They aggregated the model information contained within the satellite field of view. And improve the simulation of water vapour channels.

Studies on the assimilation of cloudy radiances were carried out. In a first step simple cloud parameters were retrieved with a CO2 slicing method (Guidard et al 2011) for the operational assimilation. Faijan et al, 2012 studied the simulation accuracy of cloudy radiances with radiative transfer models including cloud microphysical properties. IASI can provide information on liquid and ice cloud water profiles as shown in an one-dimensional framework by Martinet et al (2013, 2014).

The assimilation over land was also developed in the global model (Vincensini, 2013) and in the mesoscale model AROME (see presentation by Boukachaba) by retrieving the surface temperature from the IASI observations.

The international Concordiasi campaign led by Météo-France (Rabier et al 2010) provided validation data to improve the usage of polar-orbiting satellite data over Antarctica, in particular IASI radiances. Three field experiments were part of Concordiasi, two which have occurred during the autumn 2008 and 2009 (Austral spring) in Antarctica and a third one during Austral spring 2010.

Presentation preference : poster

# Use of IASI data for early detection of convective systems

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## ABSTRACT

The analysis of the pre-convective tropospheric environment by means of modern hyperspectral sounders observations – such as current IASI on board METOP-A/B and CrIS on Suomi NPP, and future IRS on MTG – plays a crucial role to characterize the atmospheric instability for nowcasting and very-short range forecast activities.

In particular, thanks to the scan strategy and timeliness of the IASI instrument and its spectral resolution, and to the recent improvements of the EUMETSAT Level 2 Product Processing Facility (L2PPF, currently version 6), IASI near real time data provide added value for retrieving information on horizontal and vertical gradients of moisture and temperature, known as decisive factors for the initiation of severe weather phaenomena.

The proposed poster is intended to give an overview of the development activities carried out at the Italian Air Force Meteorological Centre (COMET, Rome) and aiming at the exploitation of the IASI information content from the Numerical Weather Prediction (NWP) perspective.

As an example of ongoing research topic, the setup of an expert system experiment – making use of either real (observed, IASI/CrIS) or simulated (proxy) hyperspectral data, as well as of auxiliary colocated data, coming from observations and model data available at the Centre – is shown as a possible approach to assess the correlation between the signal (the “signature”, i.e. the information content of level 2 products) and the phaenomenon (the triggering of convective instability).

Special consideration is given to the potential applications to enhance the capacity and user-readiness of modern, operational Meteorological Services (MSs) with respect to the early detection of severe weather.

# A physically based observation error covariance matrix for IASI

Hyoung-Wook Chun[1], Reima Eresmaa[2], Anthony P. McNally[2], Niels Bormann[2], and Marco Matricardi[2]

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This presentation describes efforts to construct an observation error covariance matrix for IASI radiance assimilation from a knowledge of individual sources of error. This physically based approach differs from the practice of diagnosing estimates of the covariance from data assimilation innovation departure statistics. In the current study uncertainties due to instrument noise, imperfect cloud detection, inaccurate radiative transfer and representativeness are explicitly estimated for IASI radiance data. The combination of these produces a covariance with larger errors (diagonal elements) than those diagnosed from innovations and stronger inter-channel correlations. The physically based error estimate performs well in assimilation tests, comparable to that of an empirically tuned covariance based on innovation diagnosis.

# The assimilation of IASI at KIAPS

Hyoung-Wook Chun, Ji-Hyun Ha, Seoleun Shin, and In-Hyuk Kwon

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The assimilation of IASI radiances at the Korea Institute of Atmospheric Prediction Systems (KIAPS) is introduced. For real data assimilation test, we use three dimension variational (3DVAR) and Local Ensemble Transform Kalman Filter (LETKF) data assimilation systems implemented to the KIAPS Integrated Model (KIM). In order to deal with real observation, the KIAPS Package for Observation Processing (KPOP) has been developed. The KPOP transforms background field in observation space and conducts quality control, bias correction, and thinning to provide observation to those assimilation systems with good quality. The KPOP has enlarged its ability to handle more satellite observations such as AMSU-A, MHS, ATMS, IASI, AMV, and GPS-RO. In this presentation, we focus on IASI assimilation by using 100 temperature sounding channels. Performance of IASI assimilation with 3DVAR and LETKF implemented to the KIM model is verified using the ECMWF reanalysis data.

# Recent Advances in Cloud-Clearing using CrIS Partially Cloudy Data

**Haixia Liu[1,2], Andrew Collard[1,2] and John Derber[2]**

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## ABSTRACT

An inline "cloud-clearing" algorithm has been developed and improved continuously at NCEP to utilize the observed radiances from the CrIS instrument in partly cloudy areas by removing cloud radiative effects. This algorithm differs from other existing cloud-clearing systems in that it is integrated to the GSI system itself. The reconstructed clear-column radiances are estimated in each GSI outer loop and then assimilated together with all other observations in the inner loop. The parallel experiment result with the NCEP's full-data assimilation system has shown basically neutral impact from assimilating the CrIS cloud-cleared radiances on the global forecast skills. Thus, some advances have been planned on improving the usage of the cloud-cleared radiances, including the consideration of observation error correlation from the reconstructed cloud-cleared radiances using Desroziers method, the utilization of more aggressive CrIS observation errors and conducting additional experiment with reduced-data system to re-evaluate the impact from the cloud-cleared radiances.

# Exploitation of Hyperspectral Infrared Radiance Data at NCEP

**Andrew Collard [(1)], Jim Jung[(2)], Kristen Bathmann[(1)],**

**Haixia Liu[(1)], Li Bi[(1)], Emily Liu[(3)] and John Derber[(4)]**

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In this presentation we explore various avenues to increase impact from this class of instruments. This includes a re-evaluation of and improvement on the cloud-detection technique, including the use of imager data to further constrain the retrieval (where these data are available in the BUFR stream); an extension of channel usage to include more water vapour sensitive channels; and a re-examination of the thinning density.

In addition, the availability of CrIS Full Spectral Resolution (FSR) data, as well as a modification to the NCEP data ingest process, has motivated a restructuring of our data assimilation code to allow more flexible use of channels including a new channel selection for CrIS.

Projects to use correlated observation errors; to assimilate cloud information from hyperspectral infrared data; and to exploit partially cloudy scenes with variations cloud cleared radiances are also in progress.

# A cross-validation method for observational data and its application to IASI cloud screening

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The exploitation of remote sensing data for NWP strongly relies on quality control (QC) methods including (often quite sophisticated) screening procedures aimed at identifying observations affected by influences (as, e.g., from clouds or land surfaces) for which the employed observation operator is not adequate. Improving such QC (or screening) methods may be essential for an increased and/or more efficient use of this observation type. Apart from the most simple QC checks (which only check the magnitude of the first guess departures of the individual observations) most screening methods consider collective properties of groups of observations for which they impose thresholds. In a more general sense, such QC schemes can be considered as cross-validation methods as the validity of observations is assessed from their consistency with other observations (plus the model background).

While these consistency assessments are generally quite heuristic, the work presented here gives a mathematically rigorous framework for computing the conditional probability of observations (or subsets of observations) given the background and other observations. While a straight forward computation of such probabilities would involve a large number of analysis (i.e., data denial) experiments, the method proposed here is extremely cost effective and aimed for operational use prior to the DA minimization step. Applications include the identification of (i) outliers and (ii) breaches in data sets (i.e., groups of observations affected by systematic influences like, e.g., clouds). The difference between observations and their expectation values (given other observations) as well as the corresponding standard deviations are derived. For the case of uncorrelated observation errors, the "expectation values" can be identified as the analysis values which would be obtained when assimilating only the "other observations".

As an example for an application of the method, the construction of a cloud screening scheme for IASI data is described.

# Assimilation of Reconstructed Radiances in the AROME mesoscale convection-permitted NWP model

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## ABSTRACT

With the arrival of hyperspectral infra-red sounders like Atmospheric Infrared Sounder (AIRS), Infrared Atmospheric Sounding Interferometer (IASI) or Cross-track Infrared Sounder (CrIS) on board different polar-orbiting satellites, there has been a huge increase in the number of satellite radiances available to the user community. Such observations have been very helpful for the Numerical Weather Prediction (NWP) models (Hilton et al., 2009; Collard and McNally, 2009; Guidard et al., 2011; Hilton et al., 2012; Joo et al., 2013) at both global and regional scales but the large volume of data raises technical issues for both retransmission and archiving services. That is why only 324 AIRS channels, 331 CrIS channels and 500 IASI channels are distributed on the Global Telecommunication System (GTS). Moreover, for scientific and technical reasons, only a small sub-set of the measured radiances in the infra-red spectrum can be assimilated. For example, only about 130 IASI channels are currently used among the 8461 in the NWP Météo- France models. Given the redundancy of information contained in the thousands of channels from hyperspectral instruments, a Principal Component Analysis (PCA) seems to be a rather natural technique to compress data by keeping the most informative linear combinations (Huang and Antonelli, 2001; Liu et al., 2006).

For the previous given reasons, EUMETSAT has decided to apply the PCA technique to the data dissemination of the upcoming hyperspectral sounder *InfraRed Sounder* (IRS) on board the MeteoSat Third Generation-Sounding (MTG-S). The expected launching date for the first MTG-S is around 2020. At a regional scale, the impact of IRS on limited-area models is expected to be more important than IASI because of its highest spatial and temporal resolution (Europe area will be covered each 30 minutes versus two overpasses per day available from Low Earth Orbiting (LEO) satellites). The spatial resolution of MTG-IRS will be of 4 km for the 12 km pixel size of IASI (nadir viewing). IRS will be made of 1738 channels.

In this work, the impact of using reconstructed radiances at the place of the observed IASI radiances in cloud properties retrievals, statistics on used observations and numerical weather prediction quality is investigated to prepare the arrival of IRS. The assimilation of reconstructed radiances was tested in the mesoscale model AROME. In particular, the impact of having lowered the top of a mesoscale model will be assessed.

# Towards the assimilation of all-sky infrared radiances of selected humidity sensitive IASI channels at NCEP/EMC

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## ABSTRACT

This work focuses on the step towards the assimilation of all-sky infrared radiances of selected humidity sensitive Infrared Atmospheric Sounding Interferometer (IASI) channels using NCEP GFS model. Radiances simulation are implemented using Community Radiative Transfer Model (CRTM) that includes profiles for liquid-water content and ice-water content. Statistical analysis that over the ocean of observation minus background departure (O-F) are evaluated for selected water vapor channels. The observation screening procedure was developed to improve the cloudy scenes selection. Cloud-dependent quality controls and observation error are evaluated in this study. The goal for this preliminary work is to extend the microwave (MW) all sky radiances assimilation at NCEP/EMC to infrared (IR) all sky assimilation for the channel that are suited in all sky conditions.

# Increasing the utility of real-time IASI moisture and temperature soundings In very-short-range forecasting

Ralph A. Petersen[1], Lee M. Cronce[1], William E. Line[2], Thomas August[3] and Tim Hultberg[3]
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Extensive testing has shown that a new, very-short-range prediction system that focuses on retaining the maximum amount of information from GOES and SEVIRI provides important information to the operational forecasters. Although these tests focused on where/when deep convection will/will not occur and in which areas convection is likely to become severe, additional new applications and data sources are explored in this presentation that further expand the utility of the 1-9 hour products from this NearCast system.

Earlier tests at the European Severe Storms Laboratory (ESSL) and NOAA's Storm Prediction Center (SPC) and Aviation Weather Center (AWC) have identified the need for obtaining more information about changes in vertical moisture and stability structures prior to storm development. This information should be present from hyper-spectral infrared (IR) sounders. In addition, forecasters in the high-latitude regions, where GEO data coverage is limited, have requested that the NearCast techniques be applied to hyper-spectral soundings from the multiple Low Earth Orbiting (LEO) satellites that make frequent overpasses there. A wide range of forecasters have also noted the additional need for short-range guidance using full resolution satellite observations in *cloudy* conditions (not included in IR-only satellite products) for application to a variety of problems, especially those related to heavy precipitation events.

In this presentation, techniques are demonstrated over Europe using different combinations of hyper-spectral retrievals obtained from Infrared Atmospheric Sounding Interferometer (IASI) and Cross-track Infrared Sounder (CrIS) observations. Although these hyper-spectral IR observations lack the spatial coverage and temporal detail of GEO data, the enhanced accuracy and vertical resolution provided by the LEO products partially compensates these deficiencies and complements more frequent SEVIRI products. Tests conducted are planned in cooperation with ESSL to compare the impact of higher-time-frequency SEVIRI data to the less-frequently-updated hyper-spectral LEO observations. The increased vertical sounding resolution should be especially useful in areas where radar coverage or other asynoptic observations are limited and in instances when conventional NWP (numerical weather prediction) guidance is questioned. The higher vertical resolution will also support provision of more reasonable and realistic analysis and forecast products, such as near-surface moisture features, more physically-based stability indices (e.g., Convective Available Potential Energy (CAPE)), and better estimation of tropopause locations and expected maximum storm heights.

Finally, the advantage of including microwave observations in these forecaster tools provided through the EUMETSAT and NOAA NUCAPS retrieval algorithms will also be demonstrated. NearCasts using these data offer the opportunity to add short-range forecast information in cloudy areas where IR instruments (LEO and GEO) are unable to fully penetrate. Short-range projections of these less-frequent LEO observations at full resolution have the potential of providing a long-lasting complement to MTG-IRS well into the future, filling gaps in the MTG IR-only products.

# Improving thermodynamic retrievals using realistic ozone and ozone-sensitive channels

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Hyperspectral infrared sensors like IASI on board Metop polar-orbiting European satellites cover a wide range of the infrared spectrum. Parts of this spectrum is sensitive to ozone. During the assimilation process, a priori profiles of temperature, humidity, etc. are mandatory, including ozone profiles. In Meteo-France operational system, information on ozone within the numerical weather prediction (NWP) process is a climatological profile, constant in space and in time. In this study, we present the use of realistic ozone fields of the day from the French Chemistry model MOCAGE to replace the climatological ozone profile. Impacts on observations minus model will be described. Impact on the assimilation process and the temporal evolution of the bias correction will be highlighted.
Once realistic ozone is provided, channels sensitive to ozone can be used to retrieve information on atmospheric temperature. This poster will present results of ozone-sensitive channel selection for NWP. The impact on temperature retrievals will be assessed using 1D-VAR studies and possibly

**IASI 2016** abstract

# Looking backwards: 20 years of hard work on IASI for NWP at Météo-France!

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Abstract:

The Infrared Atmospheric Sounding Interferometer (IASI) onboard Metop satellite belong to a new generation of advanced satellite sounding instruments and was developed by CNES and EUMETSAT. The aim of this paper is to propose a review of the work done at Météo-France for the preparation before the launch of Metop satellite and the assimilation of IASI observations in the NWP models.

At the late of the 90's and the beginning of the 2000's, there were many studies to assess the information content of clear sky radiances (Prunet et al 1998) and to propose methods for the IASI channel selections in clear (Rabier et al 2002) and cloudy sky (Fourrié and Rabier 2004).

IASI observations are operationaly assimilated in the Météo-France models since 2008 and the number of assimilated channels is regularly increasing. Now 123 channels are providing information on temperature and humidity in the NWP analyses at global and regional scales.

In order to better represent the sensitivity of the satellite measurement to the whole atmosphere within its footprint, new observation operators were designed for mesoscale model such as AROME (Duffourg et al, 2010). They aggregated the model information contained within the satellite field of view. And improve the simulation of water vapour channels.

Studies on the assimilation of cloudy radiances were carried out. In a first step simple cloud parameters were retrieved with a CO2 slicing method (Guidard et al 2011) for the operational assimilation. Faijan et al, 2012 studied the simulation accuracy of cloudy radiances with radiative transfer models including cloud microphysical properties. IASI can provide information on liquid and ice cloud water profiles as shown in an one-dimensional framework by Martinet et al (2013, 2014).

The assimilation over land was also developed in the global model (Vincensini, 2013) and in the mesoscale model AROME (see presentation by Boukachaba) by retrieving the surface temperature from the IASI observations.

The international Concordiasi campaign led by Météo-France (Rabier et al 2010) provided validation data to improve the usage of polar-orbiting satellite data over Antarctica, in particular IASI radiances. Three field experiments were part of Concordiasi, two which have occurred during the autumn 2008 and 2009 (Austral spring) in Antarctica and a third one during Austral spring 2010.

Presentation preference : poster

# Use of IASI data for early detection of convective systems

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## ABSTRACT

The analysis of the pre-convective tropospheric environment by means of modern hyperspectral sounders observations – such as current IASI on board METOP-A/B and CrIS on Suomi NPP, and future IRS on MTG – plays a crucial role to characterize the atmospheric instability for nowcasting and very-short range forecast activities.

In particular, thanks to the scan strategy and timeliness of the IASI instrument and its spectral resolution, and to the recent improvements of the EUMETSAT Level 2 Product Processing Facility (L2PPF, currently version 6), IASI near real time data provide added value for retrieving information on horizontal and vertical gradients of moisture and temperature, known as decisive factors for the initiation of severe weather phaenomena.

The proposed poster is intended to give an overview of the development activities carried out at the Italian Air Force Meteorological Centre (COMET, Rome) and aiming at the exploitation of the IASI information content from the Numerical Weather Prediction (NWP) perspective.

As an example of ongoing research topic, the setup of an expert system experiment – making use of either real (observed, IASI/CrIS) or simulated (proxy) hyperspectral data, as well as of auxiliary colocated data, coming from observations and model data available at the Centre – is shown as a possible approach to assess the correlation between the signal (the “signature”, i.e. the information content of level 2 products) and the phaenomenon (the triggering of convective instability).

Special consideration is given to the potential applications to enhance the capacity and user-readiness of modern, operational Meteorological Services (MSs) with respect to the early detection of severe weather.

# A physically based observation error covariance matrix for IASI

Hyoung-Wook Chun[1], Reima Eresmaa[2], Anthony P. McNally[2], Niels Bormann[2], and Marco Matricardi[2]

[1]Korea Institute of Atmospheric Prediction Systems (KIAPS), Seoul, Korea
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