IASI FM2 on METOP A
In-Flight Calibration

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Outline

- IASI Project status
- Overview of the IASI L1 Cal/Val
- Implementation
  - Partnerships
  - Planning

Since last ITSC conference

❑ Instruments

- ➢ IASI FM2 on METOP A : ready for launch
- ➢ FM3 Vacuum Test completed in October 2005 (see results synthesis)
- ➢ PFM Refurbishment (PFM is the first IASI model → tested in 2003)
  - Anti-contamination bellow, detectors
- ➢ PFM-Refurbished Vacuum Test on-going
  - Beginning of pumping : 6th of October 2006
  - First optical measurement awaited on 14th of October

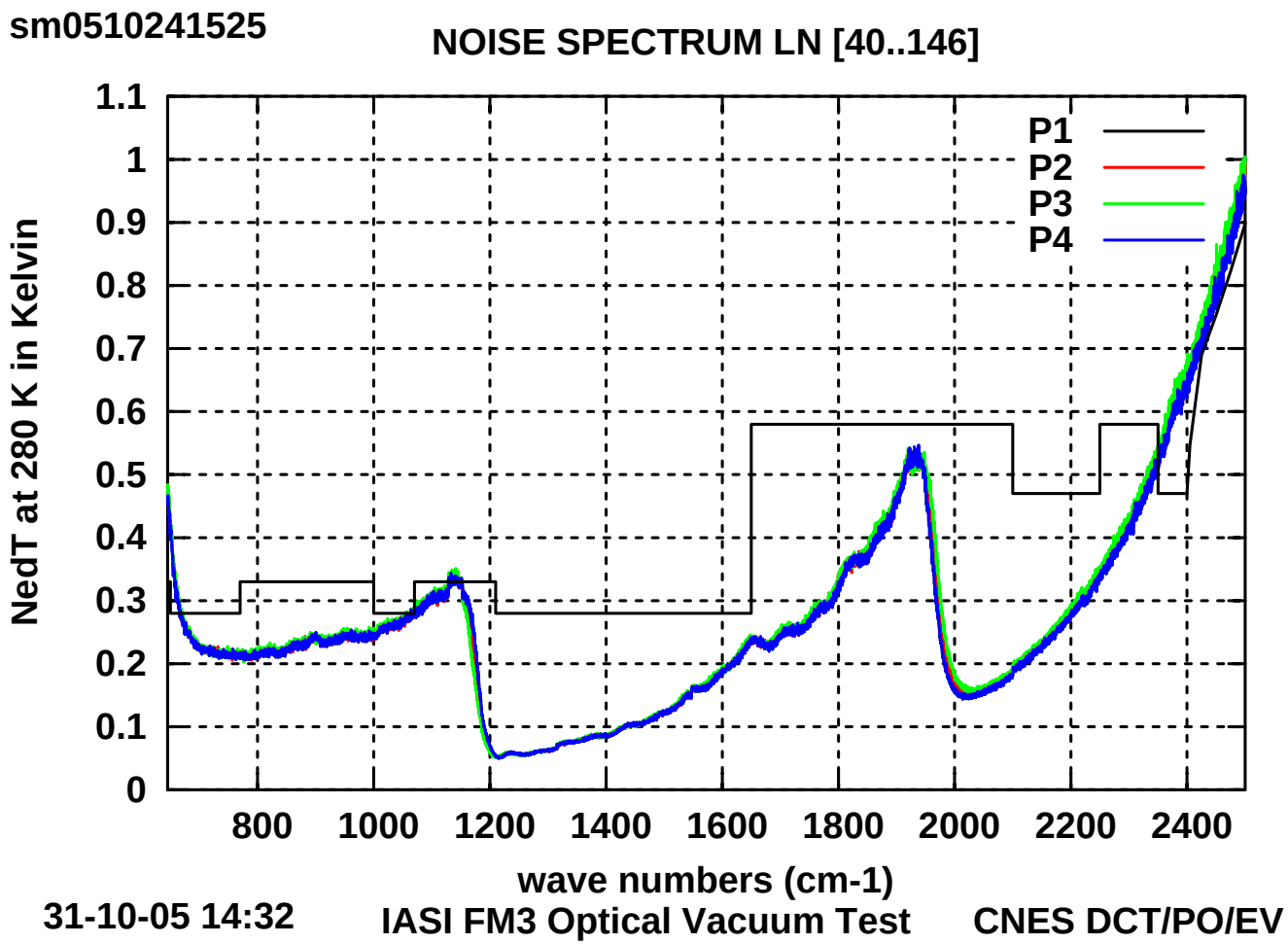
❑ System

- ➢ Validation as part of the EPS system validation : start in October 2005
  - Reception and processing of IASI L0 data (Eumetcast terminal) : OK
  - Participation to SSVT (end-to-end tests with the satellite) : OK
- ➢ Rehearsal for in-flight commissioning activities : OK
- ➢ System : ready for launch

- Radiometic noise
  - Better than FM2 especially in B1
- Calibration
  - Spectral and
  - Radiometric

very good (as FM2)

- Low rate of ice contamination
  - As for FM2



Overview of the IASI L1 Cal/Val (1/3)

- The IASI L1 CalVal Plan describes the process, methods and data that will allow
  - To obtain the ultimate performances of Level 1 IASI products (calibration),
  - To demonstrate these performances (validation)

  during flight operations

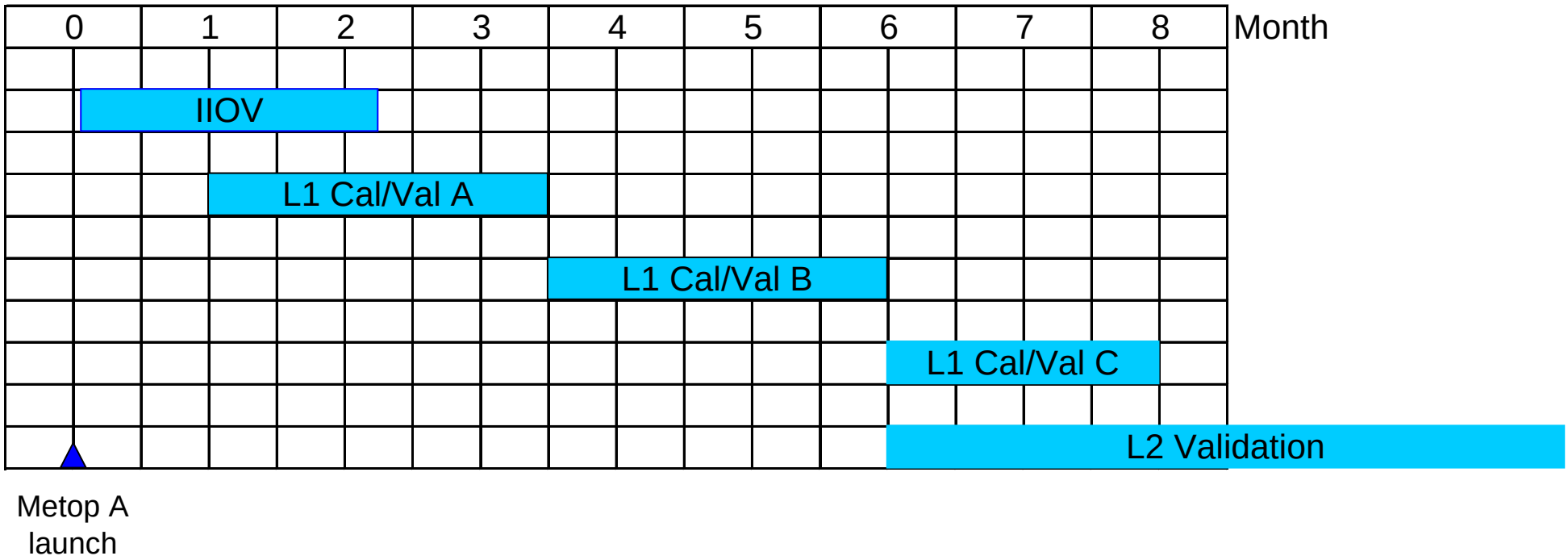
- General goal of the Level 1 Cal/Val activities is to ensure that
  - after the commissioning and thereafter during the mission lifetime,
  - the IASI Level 1 products are compliant with their specifications
    - radiometric, spectral and geometric performances

- IASI Level 1 Cal/Val performed under CNES responsibility
  - In close cooperation with EUMETSAT
  - IASI TEC

Overview of the IASI L1 Cal/Val (2/3)

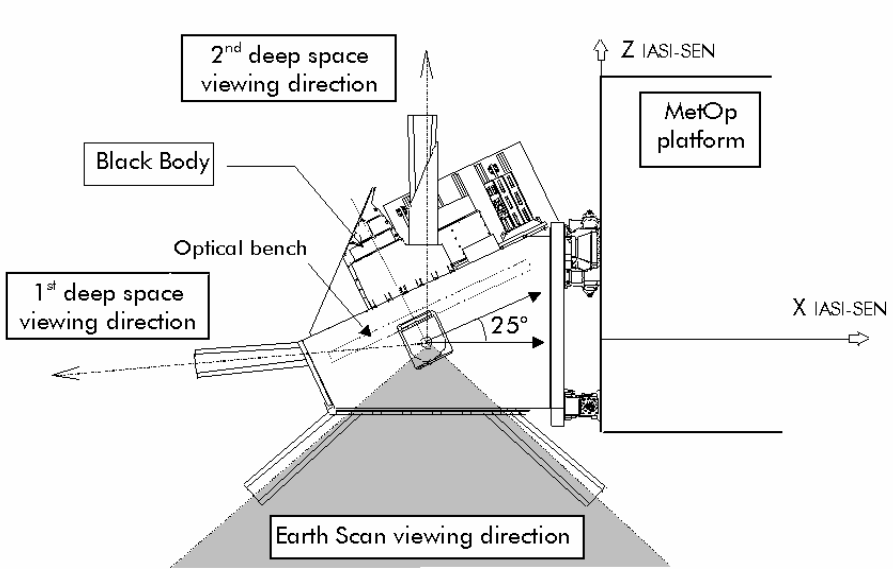
- Use of already developed, state-of-the-art methods applicable to every infrared sounder of the same class of performance
- Cal/Val activities will begin when first goal of the commissioning phase will be achieved : to establish a stable and nominal behavior of the system
  - Health parameters of the instrument monitored by the EPS/CGS
  - All the needed products verified and available in the IASI TEC
  - Problems, if any, either from hardware or processing clearly identified and flagged
- IASI Level 1 Cal/Val activities and performance monitoring will be mostly performed in the IASI TEC using
  - Products obtained via a Eumetcast terminal (PFS format)
  - Reference version (latest update) of the Level 1 processing software
- In-flight Cal/Val activities broken in 3 (approx.) independent classes
  - Geometry, spectral and radiometry (see next slides)

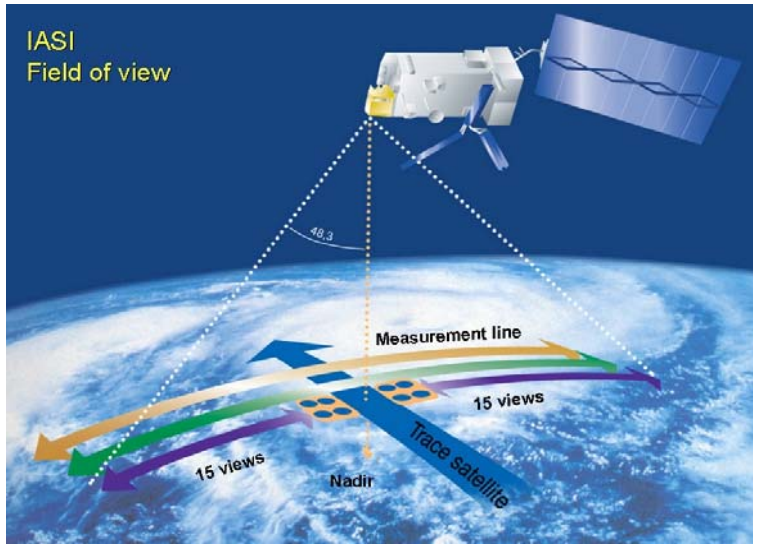
Overview of the IASI L1 Cal/Val (3/3)



- Accuracy of the validation and diversity of the conditions in which the validations are performed increase with time
  - Type of reference measurements and their accuracy evolve accordingly
    - stand alone IASI measurements
    - comparison with other spaceborne instruments
    - meteorological soundings and dedicated correlative measurements
      - balloon, aircraft TBC in // with L2 validation

Instrument features supporting Cal/Val activities (1/2)





- Normal Operation mode : 30 ground footprints (4 pixels each) every cycle (8 sec)

- 2 features of the instrument will be used intensively for Cal/Val activities
  - External Calibration Mode ➔ Viewing dir. (i.e. Scan Position : SP) remains fixed
    - On-board radiometric calibration is performed as in N.Op mode
    - Fixed position can be changed at each cycle : SP=1..30 (30 Earth Views), BB, CS1, CS2 or SM
  - Verification Data Selection (in N.OP mode and in E.Cal mode)
    - 1 raw interferogram (over 408) is available in scientific telemetry every 8 sec
    - Pixel Number, Step Number and Spectral Band (PN, SN, SB) which define this interferogram can be modified every 8 sec (periodic pattern modified by TC VDS)

Instrument features supporting Cal/Val activities (2/2)

- Raw interferograms transmitted to the ground (sampled : 1/408)
  - Including continuous part of the signal (for NL correction)
- Synthesis of imaginary part of the on-board calibrated spectra
- Spectral Overlaps B1/B2, B2/B3 (under sampled : 1/120)
  - Direct comparison of the calibrated spectra measured by 2 different detectors
    - Spectral
    - Radiometric
- 2 Cold Space Calibration Views : CS1, CS2
- External Calibration Mode with Earth View Target
  - Spatial Oversampling
  - (Quasi) Simultaneous measurement of the same scene by 2 different pixels
- IASI Integrated Imager (IIS)

- Objective
  - Putting IASI into functional mode
  - Functional verification of instrument behavior
  - Commandability/Observability

- Instrument performance not necessarily optimal
  - Instrument state as seen during ground testing (as close as possible)
    - Detectors temperature
    - On-board processing parameters
  - Transition to optimal detectors temperature at the end of IIOV phase

- Overlap between Cal/Val Phase A and IIOV
  - Assessing some instrument performances with preliminary measurements
  - On board processing parameter optimization (uploaded at the end of IIOV)
    - Mainly : NL corrections, Band Limits, Coding Tables

Geometrical performances assessment

		Activation & Evaluation	Early validation	in depth validation
Geometry	Localisation	- co-registration IIS/AVHRR - co-registration IIS/sounder - validation of navigation - validation of radiance spatial distribution in sounder IFOV - line of sight short term stability	- co-registration IIS/AVHRR → stability check - co-registration IIS/sounder→ stability check	- validation of radiance spatial distribution in sounder IFOV (from Level 2 feedback)
	IPSF	- approximate check	- sounder inter band co-registration	- sounder inter band co-registration → stability check

- Navigation of IASI products based on co-registration of IIS images and soundings with AVHRR products (Level 1B AVHRR full resolution, fully navigated)
- First version of IIS-sounder co-registration offset available from on-ground calibration
- Validation done wrt to highly contrasted scenes (e.g. coastlines)

Spectral performances assessment

		Activation & Evaluation	Early validation	in depth validation
Spectral	calibration	- verify operational calibration (B3) - approximate validation in B1, B2 using synthetic spectra (climatology)	- validation of spectral calibration in B1,B2,B3 (use of NWP profiles)	- validation w.r.t. IASI balloon spectra
	ISRF	- Cube Corner Offset → stability check	- validation of ISRF not considered as part of "early validation"	- analysis of residuals w.r.t. IASI balloon spectra

- Use of off-axis detectors induces possible spectral calibration defects
  - Correction achieved by using the atmosphere itself (CO2 2350-2380 cm-1 in B3 band)
  - This correction is extrapolated to the whole IASI spectral band (very few parameters are needed to model the Michelson interferometer)
- GEISA/IASI used as the reference spectroscopic database
- It is expected that validation can be achieved using a Line by line radiative transfert model (4A will be used for validation at 3 wavenumbers in each 3 bands)
  - Selection of scenes with very good spatial uniformity (clear sky on sea) is necessary
    - AVHRR images analysis and subsequent selection of the corresponding IASI products

Radiometric performances assessment

	Activation & Evaluation	Early validation	in depth validation
Radiometry	- non-linearity in-flight estimation - noise (sounder & IIS) - residual analysis of the on-board radiometric calibration - inter pixel calibration - inter band calibration	- Cold Space views CS1 /CS2 verification - approximate validation of calibration w.r.t. AVHRR (B1 & B3). - limited validation of B2 through interband B1/B2 & B2/B3 overlaps - idem w.r.t. HIRS - direct comparison w.r.t AIRS radiance - micro-window analysis - IIS calib. w.r.t AVHRR	- intercalibration with AIRS radiances - statistical analysis of the residuals from radiance assimilation in NWP models - sounder noise covariance matrix in-flight

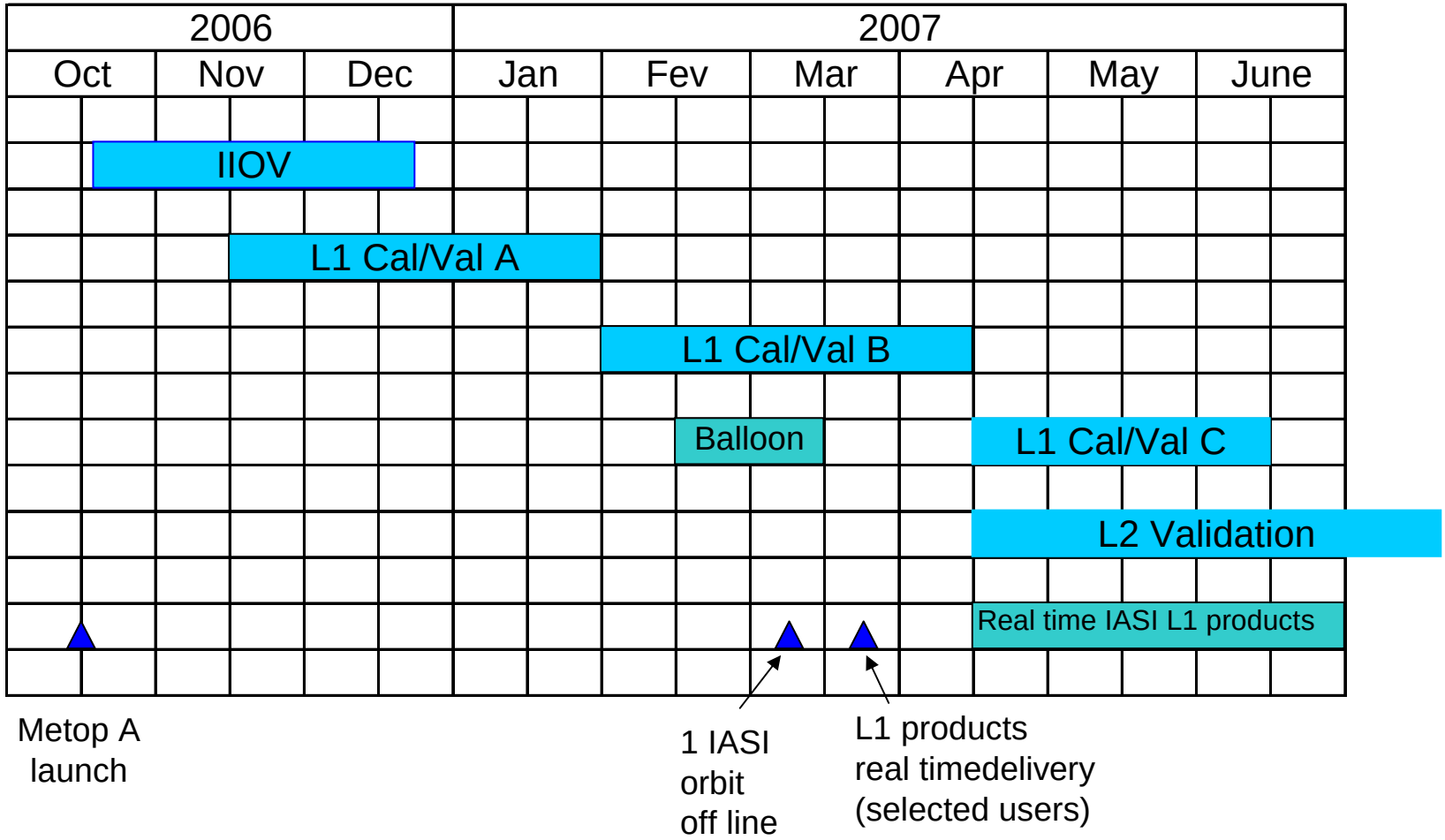
- Radiometric calibration of the IASI sounder level 1 products based on
  - Cold and Hot calibration views measured each 8 sec
  - Non-Linearity correction performed on the raw interferograms (on-board)
  - Initial radiometric calibration (on-board) and post-calibration (in level 1 processing)
    - First version of lookup tables used to implement these corrections known from the pre-launch calibration of the instrument ➔ to be updated in-flight (detectors temperature, etc.)
- Early validation of the radiometry based on comparison between IASI and other instruments on-board METOP + other sounder (AIRS)
  - when geometry allows it
- In depth validation ➔see slide on analysis of NWP assimilation residuals

How can NWP Centers support L1 Cal/Val activities ?

- IASI Radiometric calibration accuracy specifications very stringent
  - Absolute : 0.5 K
  - Relative :
    - 0.2 K between the 120 soundings of a scan line and all 8500 channels
    - 0.15 K short term drift (orbital period)
    - 0.15 K long term drift (lifetime)
- It is believed that validation at these level of accuracy can be approached through statistical analysis of NWP residuals
  - Diversity of geophysical conditions
  - Diversity of models and radiative transfer models
- Please, consider joining the effort already initiated with ECMWF, UK MetOffice, Meteo France and EUMETSAT
  - Thomas Auligne paper will be redistributed on ITWG NWP mailing list
  - Fiona Hilton presentation

- METEO FRANCE (CMS)
  - Cloud Mask software (MAIA) implemented in TEC
  - Cloud Mask, expertise for Clear Sky Validation
  - Radiometric Intercalibration with HIRS, AVHRR
  - NWP 3D fields
- Laboratoire de Physique Moléculaire et Applications (CNRS/LPMAA)
  - IASI Balloon (mainly spectral validation)
- ECMWF, UK MetOffice, METEO FRANCE and others
  - Daily Monitoring of NWP residuals
  - Providing if necessary detailed residuals files for investigation

Planning



- IASI Balloon campaign belongs logically to Cal/Val C
  - Has been advanced for operational constraints
  - Key point planned in January to confirm the flight

- Visit the CNES IASI Web site
  - http://smsc.cnes.fr/IASI

Thank you