

**UPDATE ON THE STATUS OF THE INITIATIVE FOR AN  
INTERNATIONAL GEOSTATIONARY LABORATORY (IGeoLab)**

*(Submitted by WMO)*

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**Summary and purpose of document**

WMO-WP-22 reviews the events following the CGMS-XXXII decision to promote international cooperation for implementing demonstration missions according to the International Geostationary Laboratory concept (IGeoLab). After a Preparatory Task Team meeting held in Geneva in December 2004, the IGEOlab concept was approved by the 5<sup>th</sup> Consultative Meeting on High-level Policy on Satellite Matters held in Geneva in January 2005. Two Focus Group were established for the GIFTS and GOMAS proposals respectively.

The Geostationary Imaging Fourier Transform Spectrometer (GIFTS) was rated as a valuable risk-reduction project for future geostationary infrared hyperspectral sounders and could be accommodated aboard Russian Elektro-L spacecraft to be launched in 2008-2009. It could also support satellite inter-calibration and complement operational atmospheric motion wind observations in support of GEOSS. The feasibility and cost of GIFTS flight is being investigated in further details.

It was acknowledged that the Geostationary Observatory for Microwave Atmospheric Sounding (GOMAS) addressed an essential parameter (precipitation), with a promising technology (microwave in GEO orbit). Further developments are needed both on scientific and technical aspects and were expected to be pursued in the framework of the R&D programme of a Space Agency.

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**ACTIONS PROPOSED**

CGMS to note the report and discuss as appropriate.

## BACKGROUND

- IGeoLab Preparatory Task Team meeting, (Geneva, 13-14 December 2004);
- 5th session of the WMO Consultative Meetings on High-level Policy on Satellite Matters (CM-5, Geneva 24-25 January 2005);
- 1st meeting of the IGeoLab Focus Group on GIFTS (Washington DC, 6 June 2005);
- 1st meeting of the IGeoLab Focus Group on GOMAS (Washington DC, 7 June 2005).
- Bilateral contacts USA-Russia for possible embarkation of GIFTS on Elektro-L;
- 2nd GOMAS Focus Group meeting (Rome, 24-25 October 2005). Due to the late date of GOMAS FG-2, follow-on activities will be reported as a separate addendum.

## INTRODUCTION

1. At the 32<sup>nd</sup> session of CGMS held in Sochi, Russia, 17-20 May 2004, CGMS discussed the concept of the International Geostationary Laboratory (IGeoLab) as a mean to implement demonstration missions in geostationary orbit in preparation for future operational systems that would be part of the space-based component of the Global Observing System. The demonstration mission should be implemented through international cooperation amongst space agencies each contributing to one, or more, system element(s) (instrument, platform, launch service, ground segment, etc). In order to demonstrate the concept, two test cases were selected:

- GIFTS (Geostationary Imaging Fourier Transform Spectrometer), for frequent profiling of atmospheric temperature and humidity (and, derived, wind) through infrared spectroscopy;
- GOMAS (Geostationary Observatory for Microwave Atmospheric Sounding), for frequent observation of precipitation by sounding in the millimetre and submillimetre wave ranges.

2. The two test cases represent two potential demonstration missions with different levels of maturity. GIFTS should be launched within the 2007-2009 timeframe, as a risk-reduction mission in respect to future hyperspectral sounders in geostationary orbit, in particular for guidance to next generation geostationary satellites in the USA and Europe. Additionally, GIFTS could also serve as a reference instrument within the Global Space-based Inter-Calibration System (GSICS) (see CGMS-XXXIII WMO WP 21). The instrument has been developed to a large extent, the scientific aspects are fully understood and the mission could be implemented if other system elements were provided by cooperating agencies. GOMAS, on the other hand, is an end-to-end undertaking, including both technological and scientific developments, to be carried out in view of a possible launch in the 2011-2013 timeframe.

3. CGMS requested WMO to act as catalyst to further the IGeoLab concept. In response, the WMO Space Programme organized a Preparatory Task Team meeting (Geneva, 13-14 December 2004) where:

- the Principal Investigators of the two proposals (Dr William Smith for GIFTS and Dr Bizzarro Bizzarri for GOMAS) provided detailed presentations to representatives of a few interested space agencies;
- the representatives of a few CGMS members or observers (ESA, EUMETSAT, NOAA, Rosaviakosmos, CMA, KMA) highlighted their activity and/or interest for either GIFTS and/or GOMAS;
- a report was agreed and delivered to the 5<sup>th</sup> session of the WMO Consultative Meeting on High-level Policy on Satellite Matters (CM-5).

4. The Agenda, basic documents on GIFTS and GOMAS, presentations delivered and Final Report of the Task Team meeting are available at the following site:

<ftp://bizzarri@albert.ifa.rm.cnr.it>

username: bizzarri

password: bproject

directory: IGeoLab

sub-directory: Task-Team.

5. CM-5 held in Geneva, 24-25 January 2005, approved the IGeoLab concept and established two Focus Groups to make progress with the first two test proposals. The Terms of Reference for the Focus Groups were:

- to evaluate the technical aspects of the test proposals;
- to identify components of a space qualified system including associated ground systems that can be accomplished through international partnership;
- to identify opportunities and prospective partners;
- to draft a proposal to the group of prospective partners including the identification of a lead agency to implement the proposal;
- to outline a time-table for accomplishing the mission plan.

6. Following CM-5, the WMO Space Programme, with the help of the two P.I.'s, organized the first meetings of the two Focus Groups, that were facilitated by NOAA/NESDIS in Washington DC, sequentially on 6 June and 7 June 2005.

#### **Report of the 1<sup>st</sup> meeting of the IGeoLab GIFTS Focus Group**

7. The Final Agenda of GIFTS FG-1 is reproduced in Annex I.

8. The following is a summary of the meeting:

- Both NOAA and EUMETSAT had identified strong support for the IGeoLab GIFTS mission as risk reduction for the GOES-R and Meteosat Third Generation (MTG) missions;
- The introduction of hyperspectral sounding in GEO orbit has been indicated by WMO as one of the highest priorities for the development of the new generation of geostationary meteorological satellites (see WMO Technical Document No. 1267 issued in April 2005) (the other priorities are: advanced imagery and microwave precipitation measurements).
- The GIFTS Engineering Demonstration Unit (EDU) is available for space qualification after May 2006, when NASA is finished with its use for GOES-R technology risk reduction. However, a considerable amount of funding (estimates vary from less than 30 million US\$ to 75 million US\$, depending on the specific approach taken) is required for the space qualification of the GIFTS instrument, particularly for the development of the spacecraft/instrument Control Module Interface. Thus, innovative alternative internationally shared approaches to the space qualification need to be considered in order to lower the actual cost of the space qualification to any one nation. One approach suggested, although not evaluated further, involved the development of a space qualified control module by an international partner who would seek to advance its internal capabilities for producing space instruments;
- The Russian Elektro-L satellite is the prime candidate as a space vehicle to conduct the IGeoLab GIFTS mission. Details of the spacecraft accommodation approach need to be defined in order to confirm the feasibility of the Elektro-L approach. However, a preliminary analysis suggested that the approach was feasible and achievable. A 2008-2009 launch of the GIFTS on Elektro-L is also feasible, and would provide several years

of experience with geostationary satellite hyperspectral sounding observations prior to the launch of the GOES-R and Meteosat Third Generation satellites. Additionally, if the launch of an IGeoLab GIFTS mission were to be delayed beyond 2009, it would still be valuable to put GIFTS in orbit since it would most likely be placed in a geographical position which would complement the GOES-R and MTG for providing global wind profile data in support of the Global Earth Observation System of Systems (GEOSS).

9. In summary, it was felt that considerable progress in the IGeoLab GIFTS project was achieved at the 1<sup>st</sup> Focus Group meeting. Specifically, the importance of a GIFTS space mission for the development of the next generation satellite component of the WMO World Weather Watch Global Observing System, particularly in the context of the GEOSS, was reaffirmed by all the space agency participants. Moreover, considerable progress has been made in the GIFTS instrument completion, with ground tests of the instrument soon to be underway to demonstrate the radiometric measurement capabilities of this revolutionary remote sensing technology.

10. The full Report and the presentations delivered at GIFTS FG-1 are available from the IGeoLab web site mentioned in paragraph 4 under the sub-directory "GIFTS", folder "FG-1".

11. After GIFTS FG-1, the GIFTS Project Team and RosAviaKosmos, with the assistance of WMO, have intensified dialogue aimed at establishing the feasibility of flying GIFTS on the Elektro-L spacecraft. In particular, Rosviakosmos had offered to host further coordination meetings in Moscow or alternatively in St Petersburg in August of the Autumn of 2005. The Director-General of FSA- SPA Lavochkin also contacted WMO stressing the importance for a Critical Design Review (CDR) meeting of clarification of the availability of GIFTS for flight on ELECTRO/GOMS-2. The WMO Space Programme was requested to facilitate the necessary action. In September the WMO Space Programme Office contacted NASA's new Director of Earth-Sun Division Science Mission Directorate and encouraged her to give favourable consideration to completing GIFTS as a demonstration mission in geostationary orbit through an international partnership. WMO is aware of several capable and very interested partners. This could help serve to achieve NASA's goals and most certainly would be a major contribution towards establishing a Global Earth Observation System of Systems (GEOSS). The next full GIFTS FG-2 meeting in 2006 has not yet been identified.

### **Report of the 1<sup>st</sup> meeting of the IGeoLab GOMAS Focus Group**

12. The Final Agenda of GOMAS FG-1 is reproduced in Annex II.

13. The meeting concluded that:

- WMO, EUMETSAT and NOAA had identified a strong requirement for frequent precipitation observation, in the framework of their respective process of defining the WMO observational data requirements, and the Meteosat Third Generation and GOES-R missions;
- The introduction of MW in GEO has been indicated by WMO as one of the priorities for the development of the new generations of geostationary meteorological satellites (see WMO Technical Document No. 1267 issued in April 2005) (the other priorities are: advanced imagery and hyperspectral sounding);
- The subject of mm-submm sounding in GEO is being actively pursued in the USA and in Europe. However, whilst in Europe the activities are pursued at the institutional level, i.e., by awarding focused study contracts to industry (ESA) and scientific institutes (ESA and EUMETSAT), in the USA the activity is spread among several scientific institutes mostly operating on their own initiative (though with occasional support from R&D agencies through the ordinary mechanisms for science support);

- Leadership by ESA could appear to be a possibility, but ESA is currently in progress of defining the new projects for Earth Explorer Core Missions, thus any commitment is impossible before the procedure is accomplished (after February 2006);
- China is considering a microwave payload in GEO in the 2015 timeframe in the context of the new generation FY-4 to replace the current FY-2; therefore partnership in IGeoLab could be an interesting opportunity;
- Great progress has been achieved in the development of the instrument concept originated from the American GEM. Specifically, solutions have been designed for the critical areas of the antenna and the scanning mechanism. The radiometric performances have been evaluated, showing that it is possible to meet the most ambitious performances (including full temperature and humidity sounding) over a limited area or, alternatively, to extend the area up to the full disk at the expenses of some product features;
- In addition, concepts alternative to the “classical” one based on a filled-aperture antenna with mechanical scanning have been proposed and are being studied, both in USA and in Europe. Synthetic aperture antennas implementing correlation interferometry would avoid mechanical scanning (USA project) or make it simpler (a rotation, European project). The price to be paid is in terms of number of bands that can be implemented, with the highest frequencies being penalized. Also, more technological development is required. Accommodation on a multi-purpose satellite could be attempted, that would be difficult for a filled-aperture 3-m antenna;
- Great progress also has taken place in modelling the precipitation field in the mm-submm range. From the initial doubts on the possibility to relate submillimetre brightness temperatures, mostly controlled by ice scattering in the mid-high portion of the cloud, with the precipitation reaching the ground, the situation is now that, for any of the proposed bands or group of bands, enough evidence has been collected on the fact that the information content is there (different bands or combination of bands being sensitive to different precipitation types);
- However, since different scientific groups have focused on different bands or different types of precipitation, or simply have used/developed different radiative transfer models, an organic assessment of the results is still missing. Specifically, the relative merits of different bands (also accounting for their different resolution), the optimal number of channels per band, the need for additional window channels, etc., have still to be consolidated. For a demonstration mission, it would be desirable to keep on-board all potentially useful features, and to delay possible optimisation exercises to the time when an operational flight model has to be produced. However, also for the prototype, features that are demonstrated to be of marginal use should be dropped and, anyway, prioritisation is useful for the case of forced descoping because of affordability reasons.

14. In summary, and with regards to the technological aspects, the Focus Group considered that its contribution could only be effective if framed within the activity of the R&D space agency undertaking the instrument development. Therefore, work on this subject should wait for the current mission selection procedure for ESA Earth Explorers. As for the scientific aspects, a clear need to consolidate findings (at various confidence level) and identify outstanding items on which to intensify efforts has emerged. This could be the subject for the next Focus Group meeting.

15. It was therefore decided that the next Focus Group meeting (GOMAS FG-2) should be devoted to reviewing and consolidating the scientific knowledge so far acquired on millimetre-submillimetre wave sounding from the GEO orbit. The purpose is to collect and understand experiences, identify and consolidate issues on which consensus is collected, and define follow-on work necessary to consolidate further issues currently controversial or not yet faced.

16. On the subject of the need for experimental data from airborne campaign in support of model development and tuning/verification, and of instrument definition, it was felt that little progress can be achieved before the lead agency is identified. The matter is on the Agenda of GOMAS FG-2.

17. The full Report and the presentations delivered at GOMAS FG-1 are available from the IGeoLab web site mentioned earlier, under the sub-directory "GOMAS", folder "FG-1".

18. The date of GOMAS FG-2 has been fixed to 24-25 October 2005, in Rome, Italy just in time to enable reporting to CGMS-XXXIII. The report will be an addendum to this document.

19. The meeting, sponsored by the WMO Space Programme and the International Precipitation Working Group (IPWG), will be hosted by the current leader of the GOMAS Team, at the Istituto di Scienze dell'Atmosfera e del Clima (ISAC) of the Italian Consiglio Nazionale delle Ricerche (CNR), in Rome.

## **Conclusion**

20. Within all limitations stemming from the general financial situation, not only for projects implementation but even for attending meetings, the overall status of the IGeoLab initiative can be considered more than satisfactory. For GIFTS a definite flight opportunity has been identified and bilateral contacts to sort out the technical issues are running. For GOMAS, much progress is detected in the maturity of both the technological and scientific aspects. The foreseen addendum to this document will provide more detailed results.

## 1<sup>ST</sup> MEETING OF THE IGEOLAB GIFTS FOCUS GROUP

### AGENDA

#### Welcome from the facilitating Agency

Gregory Withee  
(NOAA/NESDIS)

#### 1. Short description of the IGEOLAB concept and progress to date

- 1.1 The IGeoLab concept Tillmann Mohr (for WMO)
- 1.2 The role of the WMO Space Programme in the IGeoLab concept implementation Donald Hinsman (WMO)

#### 2. Short introduction to the GIFTS science opportunities

- 2.1 Science measurement concept, objectives and capabilities William Smith (Hampton University)
- 2.2 Advanced instrument technology demonstration Gail Bingham (Space Dynamics Lab)
- 2.3 A calibration transfer standard for GEOSS Henry Revercomb (Univ. Wisconsin)
- 2.4 Risk reduction mission for GOES-R James Gurka (NOAA/NESDIS)
- 2.5 Requirements for observations from the geostationary orbit: EUMETSAT Perspective on Measurements in the MTG Timeframe Ken Ashworth (for EUMETSAT)
- 2.6 Global Numerical Weather Prediction John LeMarshall (JCSDA)

#### 3. GIFTS instrument status and resource requirements

- 3.1 GIFTS Engineering Demonstration Unit program status Robert Reisse (NASA/LaRC)
- 3.3 NASA statement on availability of GIFTS for IGeoLab demonstration Granville Paules (NASA/HQ)
- 3.4 GIFTS space qualification and platform requirements Steve Brown (Space Dynamics Lab)

#### 4. Implementation plan discussion

- 4.1 Information on Elektro-GOMS status of development Gail Bingham (for RosAviaKosmos)
- 4.2 Information on China plans for second-generation satellites in GEO Paul Menzel (for CMA)
- 4.3 Australian Bureau of Meteorology preparation John LeMarshall (for BoM)
- 4.4 Short statements of interest from the Korea Meteorological Administration Kum-Lan Kim (KMA)

#### 5 Discussion towards defining a flight of opportunity and assessing the requirements for programme implementation

- Activities required for a fast assessment of feasibility of the baseline plan
  - Activities to make progress with alternative plans in parallel with the baseline
  - Identification of a lead agency to draft a proposal and foster its implementation
  - Outline time-table for accomplishing the mission plan
- Moderators:**  
Tillmann Mohr (for WMO)  
Paul Menzel (NOAA/NESDIS)

#### Closure of the meeting

Donald Hinsman (WMO)

**1<sup>st</sup> meeting of the IGeoLab GOMAS Focus Group****AGENDA****Welcome from the Facilitating Agency**Gregory Withee  
(NOAA/NESDIS)**1. Short description of the IGEOLAB concept and progress to date**

- 1.1 The IGeoLab concept Tillmann Mohr (for WMO)
- 1.2 The role of the WMO Space Programme in the IGeoLab concept implementation Donald Hinsman (WMO)

**2. Short introduction to the GOMAS mission and to instrument preliminary concepts**

- 2.1 Requirements for Observations from the Geostationary Orbit: EUMETSAT Perspective on Measurements in the MTG Timeframe Ken Ashworth (for EUMETSAT)
- 2.2 Microwave / submillimetre wave activities at ESA relevant to IGeoLab (note: this presentation also covers items 3.3 and 5.1) Amnon Ginati (ESA)
- 2.3 Requirements for frequent precipitation observation in the GOES-R context James Gurka (NOAA/NESDIS)
- 2.4 Early thoughts in the USA about MW in GEO: the GEM concept David Staelin (MIT/RLE)
- 2.5 Introduction to the GOMAS mission and its general instrument/system concept Bizzarro Bizzarri (for GOMAS Team)
- 2.6 Synergy with the Global Precipitation Measurement mission Eric Smith (NASA/GSFC)

**3. Instrument requirements for platform resources according to current preliminary concepts:**

- mass, volume, antenna diameter, field-of-regard for Earth viewing and calibration
- electric power, on-board processing, data transmission pointing accuracy, pointing stability

- 3.1 Highlights of GEM technology William Blackwell (MIT/LL)
- 3.2 Example of instrument requirements for platform resources: GOMAS Bizzarro Bizzarri (for GOMAS Team)
- 3.3 Review of ESA studies on system and instrument concepts, and on critical technologies Covered under item 2.2
- 3.4 Review of NASA studies Bjorn Lambrigtsen (NASA/JPL)

**4. Approach to the realisation of a bus to support GOMAS and the IGeoLab concept in general:**

- possible availability or tailored configuration of an existing bus
  - fast assembling of modern existing sub-systems for implementing optimised satellites.
- Shortest overview of other system elements (launcher, ground segment, operations plan)

- 4.1 Information on Elektro-GOMS status of development Gail Bingham (for RosKosmos)
- 4.2 Information on China plans for second-generation satellites in GEO Paul Menzel (for CMA)
- 4.3 Short statements of interest from the Korea Meteorological Administration Kum-Lan Kim (KMA)

**5. Identification of necessary scientific activities**

- 5.1 Modelling cloud-ice-radiation-precipitation relationships - Review of ESA studies Covered under item 2.2
- 5.2 Current Sub-mm status within EUMETSAT activities Bizzarro Bizzarri (for EUMETSAT)
- 5.3 Development of retrieval algorithms Alberto Mugnai (CNR/ISAC)
- 5.4 Development of image processing techniques to enhance resolution and retrievals David Staelin (MIT/RLE)
- 5.5 Collection of evidence by airborne campaigns, simulations, assimilation exercises Albin Gasiewski (NOAA/ETL)

**6. Discussion towards definition of a roadmap for an end-to-end programme development**

- Identification of opportunities and prospective partners
- Identification of a lead agency to draft a proposal and foster its implementation
- Outline time-table for accomplishing the mission plan

**Moderators:**Tillmann Mohr (for WMO)  
Paul Menzel  
(NOAA/NESDIS)**Closure of the meeting**

Donald Hinsman (WMO)