Use of Satellite Observation in National GHG Inventories

“Satellites in support of national Greenhouse Gases reporting and Global Stocktake”

Side Event at COP25/CMP15/CMA2

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Paris Agreement and National GHG Inventory

- In order to build mutual trust and confidence among the Parties and to promote effective implementation of the Paris Agreement, a transparency framework for action needs to be enhanced.

Enhanced Transparency Framework (Art.13) to inform the **Global Stocktake** (Art.14)

- To that end, it is essential that all the Parties produce and report high-quality and reliable national GHG inventories (national emission data).

- Paris Agreement
  Article 13, paragraph 7:
  - Each Party shall regularly provide …:
    (a) A national inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases, prepared using good practice methodologies accepted by the Intergovernmental Panel on Climate Change and…

Source: IISD/ENB

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UNFCCC and IPCC Inventory Guidelines

New Supplementary Guidance in 2013

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Currently, Non Annex I Parties use these under the UNFCCC.

Annex I Parties must use from 2015

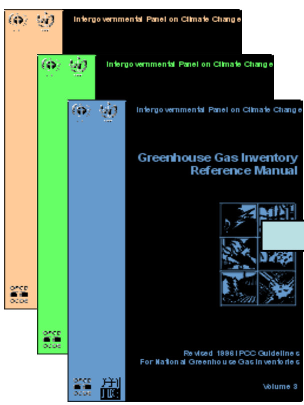
Non-Annex I Parties are encouraged to use GPGs.

GPG2000 (non-LULUCF)

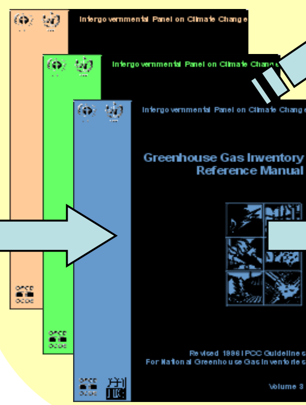
GPG2003 (LULUCF)

2006 IPCC Guidelines

1995 IPCC Guidelines



Revised 1996 IPCC Guidelines



Actually, 2006 Guidelines are being used by more and more Non-Annex I Parties.

Revision/Update by the IPCC

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2019 Refinement to the 2006 IPCC Guidelines

- **Aim:**
  - to provide an **updated and sound scientific basis** for supporting the preparation and continuous improvement of national GHG inventories;
  - **not to revise** the 2006 IPCC Guidelines, but **update, supplement and/or elaborate** the 2006 IPCC Guidelines where gaps or out-of-date science have been identified.
- **Adopted/Accepted by the IPCC in May 2019** (Decision IPCC-XLIX-9)
- Scientific and other technical advances that had matured sufficiently since 2006 are taken into account.

280 Prepared by over 280 scientists and experts

47 Participated by authors from 47 countries

10,000 More than 10,000 review comments from governments and experts were considered by authors

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2019 Refinement and Paris Agreement

- "Katowice Climate Package" was adopted by the UNFCCC COP24/CMA1 in December 2018 to operationalize the Paris Agreement. It stipulates:
  – Each Party shall use the *2006 IPCC Guidelines*, and shall use *any subsequent version or refinement of the IPCC guidelines* agreed upon by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA).

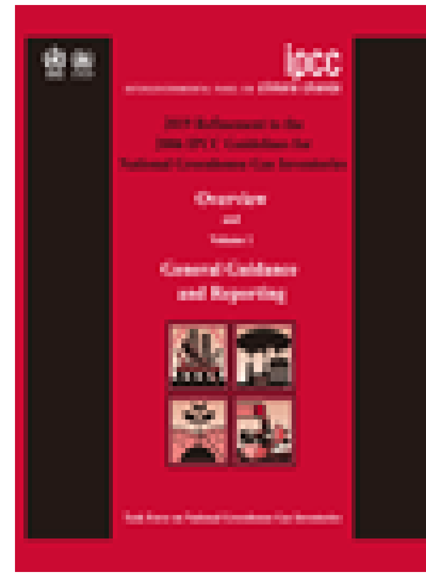
Source: IISD/ENB

The 2019 Refinement which was adopted/accepted at IPCC-49 in Kyoto is nothing but this "subsequent version or refinement of the IPCC Guidelines"!!

Use of Satellite Observation in 2019 Refinement

Volume 1: General Guidance and Reporting

Chapter 6: Quality Assurance/Quality Control and Verification



- Guidance on comparison of GHG emission estimates with atmospheric measurement (including satellite observation) has been updated and elaborated.
- The most notable advances were achieved in the application of inverse models of atmospheric transport for emission estimates.
- The guidance highlights key components and steps that can be applied when using atmospheric measurements and inverse models for comparison with inventory emission estimates as part of a country's overall QA/QC and verification system.

Use of Satellite Observation in 2019 Refinement

TABLE 6.2 (NEW)
STRENGTHS, PROBLEMS AND PROSPECTS OF USING ATMOSPHERIC MEASUREMENTS FOR VERIFICATION OF GHG EMISSIONS

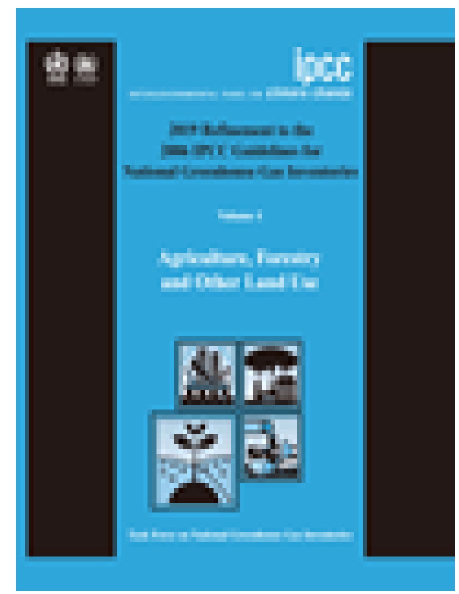
Gas	Strengths/Successes[13]	Problems/Weaknesses	Future Development/Possibilities
CO_2	Large number of observations, although historically focusing on natural fluxes.	With sparse observing networks, uncertainties of models may be significantly higher than those of national anthropogenic CO_2 emission inventories.	Need more CO_2 observations targeting anthropogenic emissions, complemented by APO and radiocarbon observations.
CO_2 city-scale	City-scale studies show some degree of success. Inventory uncertainties are relatively larger than at national scale.	Even with dense observation networks, errors in emission estimates are large, due to interference from strong vegetation fluxes. Not used in national reporting.	Large efforts are ongoing to develop observation networks, pilot projects for tracking urban emissions, trends. Radiocarbon, APO, satellite observations also expected to contribute.
CH_4	Large anthropogenic emission fraction. National reporting[14]: UK, Switzerland. National-scale emission estimates[15]: EU-28, USA, India, China and others.	Few countries have observations, transport and inverse models have uncertainties, interference from natural emissions (wetlands) cited.	Regional observation networks and satellite observations are expanding.
N_2O	National reporting: UK	Observation sites are few, gridded inventories are simplified, large	Expansion of surface networks will contribute to better model

Use of Satellite Observation in 2019 Refinement

Volume 4: Agriculture, Forestry and Other Land Use (AFOLU)

Chapter 2: Generic Methodologies Applicable to Multiple Land-use Categories

Biomass Density Map for Biomass Estimation



- Biomass density maps are wall-to-wall, polygon- or pixel-based predictions of above-ground biomass for woody plants and trees.
- Biomass density maps are constructed by combining remotely sensed data and field observations.
- An example from Brazilian Amazon is introduced to explain how such a biomass density map can be used for estimation of GHG emissions/removals.

Use of Satellite Observation in 2019 Refinement

BOX 2.0D (NEW)
REMOTE SENSING TECHNOLOGIES

Optical, Synthetic Aperture Radar (SAR) and Light Detection and Ranging (Lidar) sensors are available currently as remote sensing data sources for producing biomass density maps. Data from optical satellite sensors are classified into three types on the basis of their spatial resolution; coarse resolution data with a pixel size greater than about 250 m (e.g., MODIS), medium resolution data with a pixel size of 10-80 m (e.g., Landsat and Sentinel 1 and 2), and fine resolution data with a pixel size smaller than 10 m (e.g., Rapideye or SPOT and ALOS-2).

SAR and LiDAR are active sensors available as air borne and space borne instruments whose derived metrics are used to predict height, volume or biomass of woody plants and trees. SAR emits microwave pulses obliquely and measures attributes of the pulses that are reflected back from the Earth's surface towards the sensor. In forest land, emitted pulses reflect from the ground, or canopy or trunk of woody plants and trees. Using the strength of the signal of the reflected pulses, volume or biomass of woody plants and trees can be predicted as demonstrated for satellite data from ALOS-PALSAR and Sentinel 1 (Santoro and Cartus, 2018). LiDAR emits laser pulses and measures the traveling time from the sensor to the target which can be converted to distance. When the LiDAR emitter is aimed at woody plants and trees, these laser pulses can be reflected by the woody components, the leaves within the canopy, or the ground surface. Using the difference of a laser pulse reflected from canopy and ground surface, the height, volume or biomass of woody plants and trees can be predicted (Næsset 1997a,b, Lim et al 2003). Starting in 2019, a series of targeted space-based missions will improve the capabilities for forest biomass predictions from LiDAR (e.g. GEDI, ICESAT-2) and SAR (e.g. BIOMASS, NISAR), that might be found useful for national purposes (Herold et al. 2019).

Use of Satellite Observation in 2019 Refinement

Volume 4: Agriculture, Forestry and Other Land Use (AFOLU)

Chapter 3: Consistent Representation of Lands

Development of land cover datasets

- In recent decades, satellite remote sensing has become the primary source of data for developing for global estimates of land cover.

TABLE 3A.1.1 (UPDATED)
EXAMPLES OF GLOBAL LAND COVER DATASETS IN 2017

	(A)	(B)	(C)	(D)
Dataset name	ESA Climate Change Initiative – Global Land Cover Products (CCI – LC)	Global Forest Change Global Forest Watch	MODIS Land Cover Type Product (MCD12Q1)	Global PALSAR-2/PALSAR/JERS-1 Forest/Non-Forest Map
Author	European Space Agency (ESA)	University of Maryland (UMD) World Resources Institute (WRI)	NASA / US Geological Survey	Japan Aerospace Exploration Agency (JAXA)
Brief description of contents	Consistent global land cover maps at 300 m spatial resolution on an annual basis from 1992 to 2015.	Global forest extent, forest cover loss and gain based on land cover information from 2000 to 2017 using Landsat.	Time-series analysis of MODIS data at 500 m spatial resolution to characterize global land cover from 2001-2013.	The global forest/non-forest map (FNF) generated by classifying the backscattering intensity values at 25 m spatial

Refinement in relation to Satellite Data

Volume 4: Agriculture, Forestry and Other Land Use (AFOLU)

Chapter 3: Consistent Representation of Lands

Attribution of satellite derived land cover change

- While two dates of satellite imagery may be useful for quickly depicting land cover change, identification of permanent land-use changes may require more data and analysis.
- It is therefore *good practice* to ensure that all land cover changes identified by satellite data are verified using sufficient spatial and temporal resolution imagery, ground reference and other auxiliary datasets to isolate permanent land-use change from that of temporary loss of forest cover.
- This process helps to identify human induced land-use change.

Summary

- National GHG inventories are essential to successful enhancement of transparency framework and Global Stocktake under the Paris Agreement.
- The IPCC has recently released the "***2019 Refinement***" to update, supplement and/or elaborate the 2006 IPCC Guidelines.
- Guidance on use of satellite observation in national GHG inventories has been enhanced in the 2019 Refinement.
  - For QA/QC and verification through comparison of GHG emission estimates with atmospheric measurement using inverse models (Vol.1)
  - For estimation of GHG emissions/removals from land, through biomass density map for biomass estimation and land cover datasets for identification of human induced land-use change (Vol.4)
- Better use of satellite observation is expected to improve the quality of national GHG inventories and contribute to successful implementation of the Paris Agreement.

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Thank you for your attention.

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