Objectives of GOSAT and the Data Application

「いぶき」(GOSAT)の目的とデータ利用

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Background of measurement requirement 背景

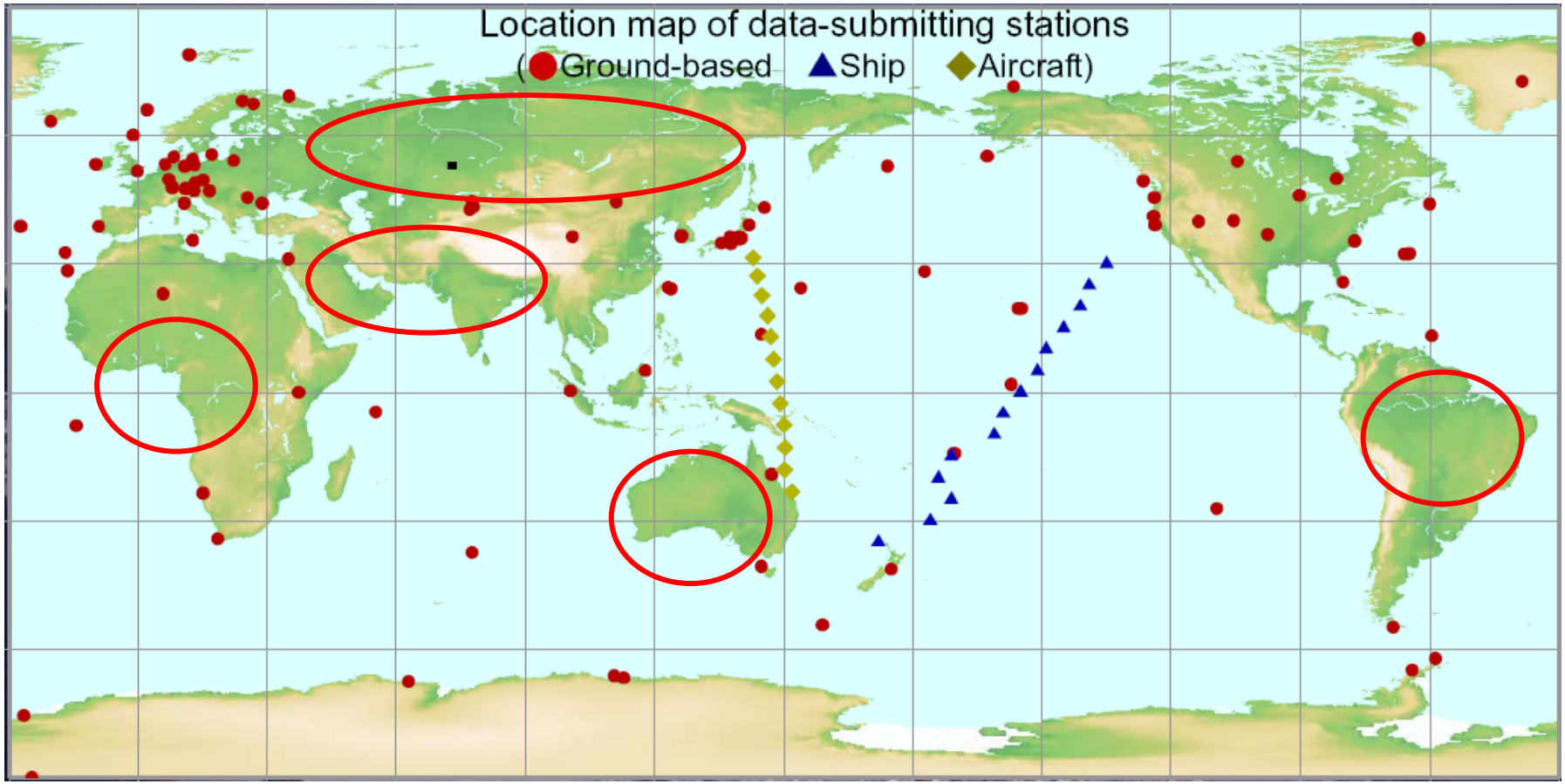
- Observed increase in global average temperature since mid-20th century ←(very likely due to) increase in anthropogenic GHG concentration in the atmosphere (IPCC Fourth Assessment Report (2007))
- Imperative to **balance**
  - the emission due to human activities and
  - the absorption by the nature (land ecosystem, ocean, …)
  - **for stabilizing the climate for the future**
- Insufficient knowledge (lack of understanding) of
  - Absorption mechanisms of the land ecosystem and ocean
  - Climatological feedback in the carbon cycle involving **atmosphere, land ecosystem, and ocean**
  - ➔ substantial part of the uncertainty in predicting future climate change
- Needs of **global, uniform, and frequent** observation of CO_2 and CH_4
  - Spatial distribution and temporal variation
  - ➔ Carbon flux (source/sink) estimation ➔ attainment of adequate scientific knowledge on the underlying mechanisms

Satellite Remote Sensing of GHGs　衛星観測の特徴

- Satellite remote sensing of the atmosphere
  - Advantages:
    - Globally (uniformly)
    - Unique sensors ➔ detectable relative differences
    - Frequently repeat observation
  - Weak points:
    - Absolute value measurement of physical parameters
    - Several disturbances (error sources)
      - (ex. Clouds, aerosols, precipitation, ground surface, …)

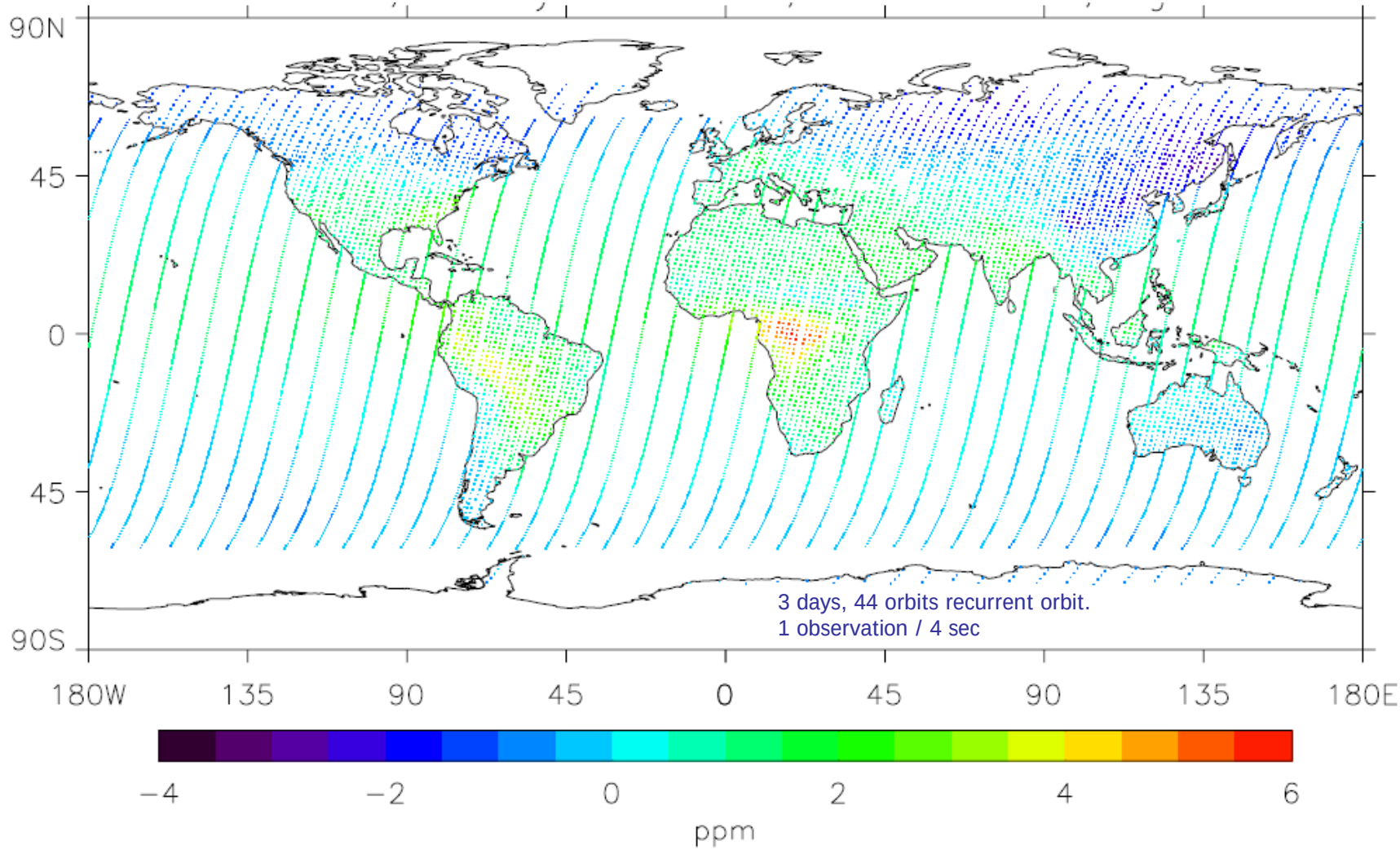
Status of ground measurements of GHGs　温室効果ガスの地上観測の現状

- (GHG monitoring stations: 282,　CO_2 measurement: 182)



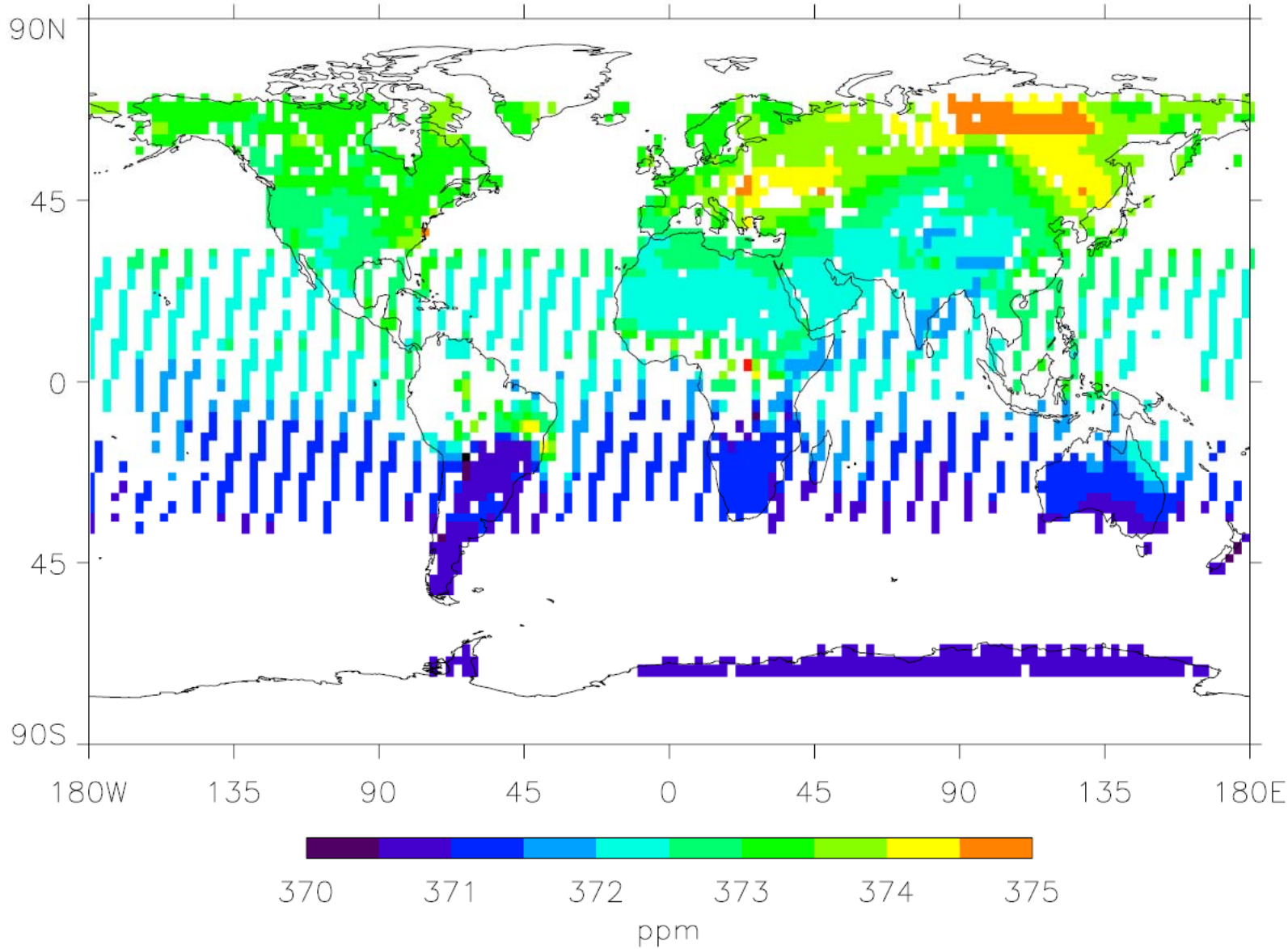
(byWDCGG)

Measurement locations of GOSAT　　観測位置

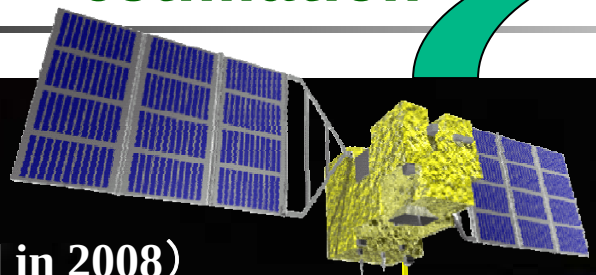


Monthly mean (July) CO_2 concentration along GOSAT orbit, with global offset subtracted

Example of GOSAT monthly map (Level 3)
GOSATの月別二酸化炭素観測マップのイメージ



GOSAT contribution to carbon flux estimation



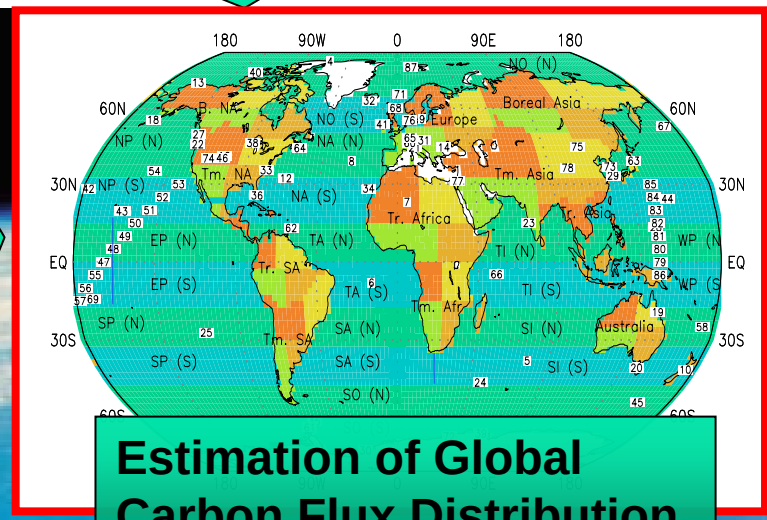
GOSAT
(launch planned in 2008)

GHG Observations

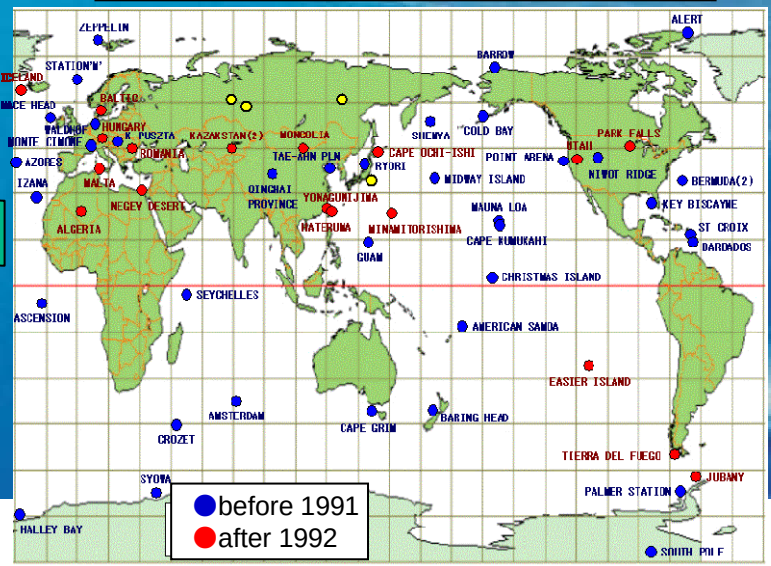
Solar Radiation

Altitude
666 km

IFOV: 10 km ϕ



Estimation of Global Carbon Flux Distribution

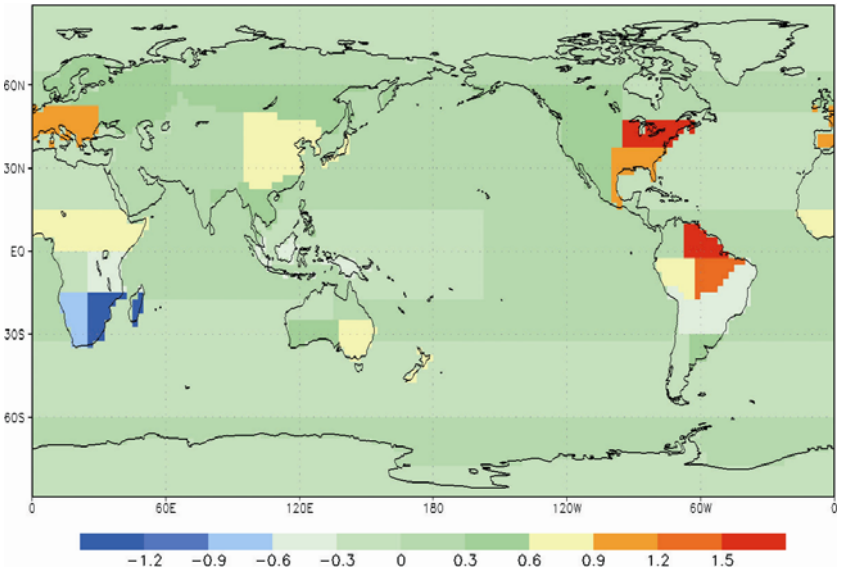


Ground Monitoring Stations

To apply the observational data from GOSAT and ground-based data to an inverse model to give global distribution of carbon sources and sinks

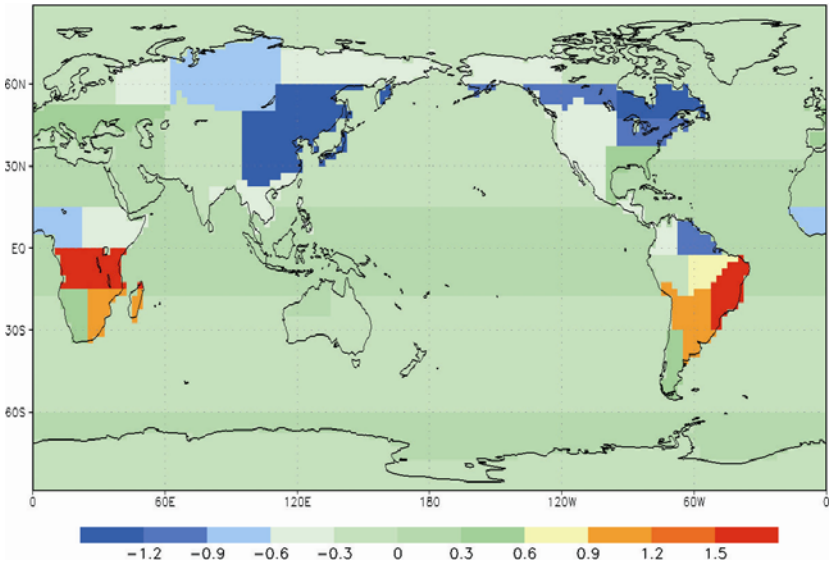
Images of monthly carbon flux map (Level 4A)　炭素吸収排出量マップ例

（February　2月）



←Absorption 吸収 [gC/m^2/day]　emission 排出→

（August，8月）



←Absorption 吸収 [gC/m^2/day]　emission 排出→

- Integrate scientific knowledge of carbon cycle including land and ocean
  → Advancing carbon cycle models → Increase precision of climate change projection models
  → Detailed study on determining cutback levels of emissions, (contribution to political decision making)
- 陸域・海域を含む炭素循環に係る科学的知見の蓄積
  → 炭素循環モデルの高度化　→　気候変動予測モデルの予測精度の向上
  → 長期的には排出削減レベルの精緻化（合理的な温暖化対策の立案への貢献）

Project Objectives (1)
「いぶき」の目的 (1)

- To measure the global distribution of GHG concentrations (i.e. CO_2 and CH_4) and its temporal variation
  温室効果ガスの全球の濃度分布とその時間的変動を測定

- To increase the accuracy of the flux (source and sink) estimation of GHGs on the sub-continent scale (a few thousand kilometer square),
  亜大陸レベルでの吸収排出量の推定精度を高める

  - → contributing to the sustention and development of systemized observation in accordance with the Kyoto Protocol, while at the same time facilitating the environmental administration efforts, including ascertainment of the flux per region and evaluation of the carbon balance in forests during the first period (2008-2012) as specified by the Protocol.

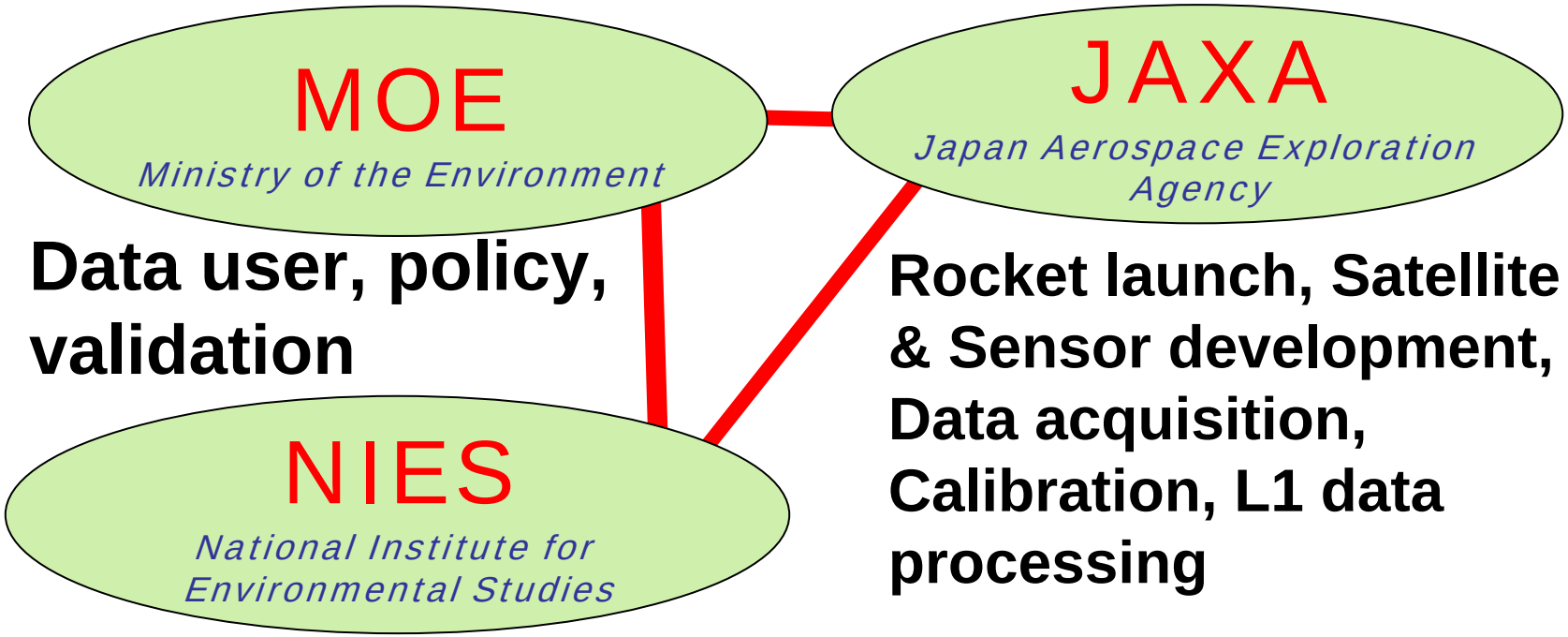
  - →京都議定書に基づく組織的観測の維持及び開発の促進に貢献するとともに、京都議定書第1約束期間(2008～2012年)における地域ごとの吸収排出量の把握や森林炭素収支の評価等の環境行政に貢献する。

Project Objectives (2)
「いぶき」の目的 (2)

- The Project is intended to develop GHG measurement technologies and other technologies necessary for future earth-observing satellites, by standing on and further evolving the existing earth-observing technologies.
- これまでの地球観測技術を継承・発展させ、温室効果ガスの測定技術を開発するとともに、将来の地球観測衛星に必要な技術開発を行う。

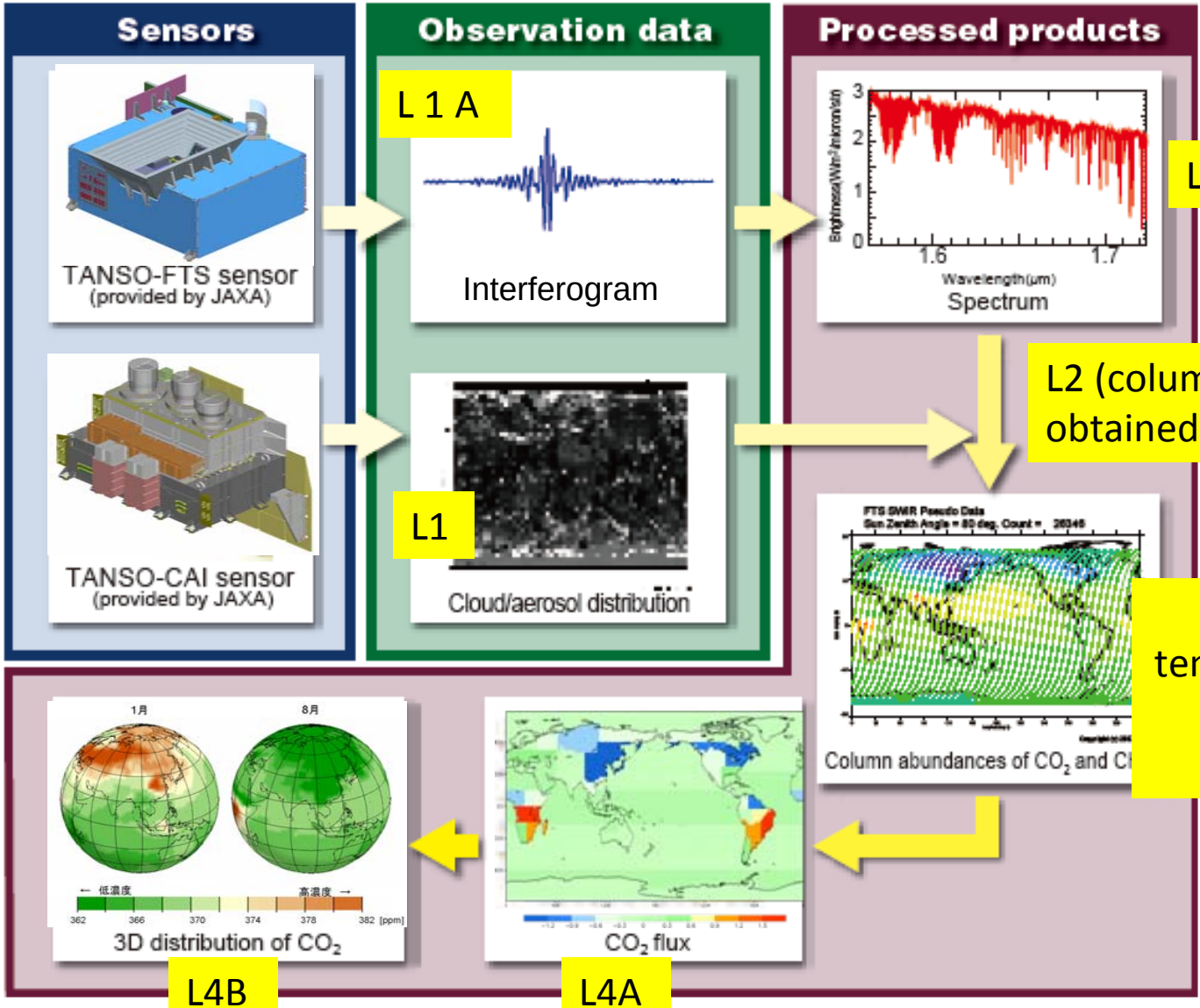
Organizational Structure of GOSAT Project

- The first GHGs observing satellite sensor mission promoted by JAXA, MOE, and NIES.



Data processing algorithms, Scientific data use, L2, L3 data processing and distribution, Validation

Outline of GOSAT data processing



Source: NIES GOSAT pamphlet

GOSAT Data Products (L1 & L2)

Processing level	Sensor /band	Product Name	Category	Unit
L1A	FTS	FTS L1A data	Internal	FTS scene
	CAI	CAI L1A data	Internal	CAI scene
L1B	FTS	FTS L1B data	Standard	FTS scene
	CAI	CAI L1B data	Standard	CAI frame
L1B+	CAI	CAI L1B+ data	Standard	
L2	FTS SWIR	L2 CO2 column amount (SWIR)	Standard	Any (on-demand)
		L2 CH4 column amount (SWIR)	Standard	
		L2 H2O column amount (SWIR)	Research	
	FTS TIR	L2 CO2 profile (TIR)	Standard	
		L2 CH4 profie (TIR)	Standard	
		L2 CO2 column amount (TIR)	Research	
		L2 CH4 column amount (TIR)	Research	
		L2 temperature profile (TIR)	Research	
		L2 H2O profile (TIR)	Research	
		L2 H2O column amount (TIR)	Research	
	CAI	L2 cloud flag	Standard	CAI frame
		L2 aerosol property	Research	

GOSAT Data Products (L3 & L4)

Processing level	Sensor /band	Product Name	Category	Unit
L3	FTS SWIR	L3 global CO2 distribution (SWIR)	Standard	Global (monthly average)
		L3 global CH4 distribution (SWIR)	Standard	
	FTS TIR	L3 global CO2 distribution (TIR)	Standard	
		L3 global CH4 distribution (TIR)	Standard	
	CAI	L3 global radiance distribution (all pixels)	Standard	Global (every 3 days)
		L3 global reflectance distribution (clear sky)	Standard	
		L3 global cloud property	Research	Global (monthly average)
		L3 global aerosol property	Research	
		L3 global NDVI	Standard	Lat. 30° × Lon. 60° (every 15 days)
L4A	–	L4A global CO2 flux	Standard	64 locations across the globe (annually)
		L4A global CH4 flux	Research	
L4B	–	L4B global CH4 distribution	Research	Global 2.5° mesh (monthly)

Data Utilization （Research Categories）

- (1) Sensor calibration 校正
- (2) Data processing algorithms ｱﾙｺﾞﾘｽﾞﾑ
- (3) Carbon flux estimation, atmospheric transport models モデル
- (4) Data product validation 検証
- (5) Data application 応用

Research Topics planned by the GOSAT Project

- Calibration
  - interferogram ➔ spectra
  - correction of the variation of the observation sensors' field of view,
  - TANSO-FTS: instrument function calibration, radiance calibration, etc.
  - TNASO-CAI: radiometric calibration, geometric correction, calibration of the sensor sensitivity, etc.

Research Topics planned by the GOSAT Project

- Data processing algorithms
  - Development of fast data processing algorithms,
  - Sunglint observation data processing methods
  - Processing algorithms using polarized data
  - Extract parameters from thermal-infrared data
  - Evaluation of spectral parameters of gaseous molecules and sunlight spectra,
  - Combined use of short wavelength infrared and thermal infrared data, etc.

Research Topics planned by the GOSAT Project

- Carbon flux estimation, atmospheric transport models
  - Development and refining of source inventory databases
  - Refining of atmospheric transport and land ecosystem models, etc.
  - Development of carbon flux estimation models with high temporal/spatial resolution, etc

Research Topics planned by the GOSAT Project

- Validation
  - Before the launch
    - Ground-based high-resolution and by small-sized FTSs with airborne in-situ instruments
    - Evaluation of sunglint observation algorithms using airborne or ground-based FTSs
    - Development of validation methods based on data taken by LIDAR, sky radiometers or other equipment for validating aerosol, etc.
  - After the launch
    - Acquisition and analytical validation of data taken at validation sites on land and on ocean (including island and cape),
    - Analytical validation of data taken by instruments on board private aircraft
    - Comparison with data taken by other satellites or computed by models, etc., for the purpose of validating the quality of data on the CO_2 and CH_4 column abundances, as well as validating the quality of data on vertical distributions of CO2 and CH4 concentrations to be derived from the thermal-infrared data.
    - Validation of CAI data products.

Research Topics planned by the GOSAT Project

- Data application
  - FTS:
    - Analysis of basic phenomena that have influence on evaluation of the characteristics and quality of data such as temporal/spatial variation of concentration distributions and carbon balance distributions
    - Possible advanced applications, such as detection of CH4 leak from pipelines and local high-volume exhaust due to forest fires, possibility of observing atmospheric trace components, such as N2O, CFC, etc., and so on.
  - CAI:
    - Generation and utilization of the global vegetation index map based on the CAI data.

Concluding Remarks

- GOSAT data products are categorized in
  - **Standard products**: open to the public after calibration and validation
  - **Research products**: open to the registered researches for sensor calibration, data validation, algorithm development/improvement, and scientific use
  - Some research products would be upgraded as standard products after confirming their reliability
- A part of the GOSAT data utilization will be done by the project members, the science team members, and collaborators under the data policy restriction.
- We expect wider utilization by the world-wide users to contribute to many fields of the data applications.
- International collaborations are expected.