



Estimate of Carbon-sink for Global Carbon Management System

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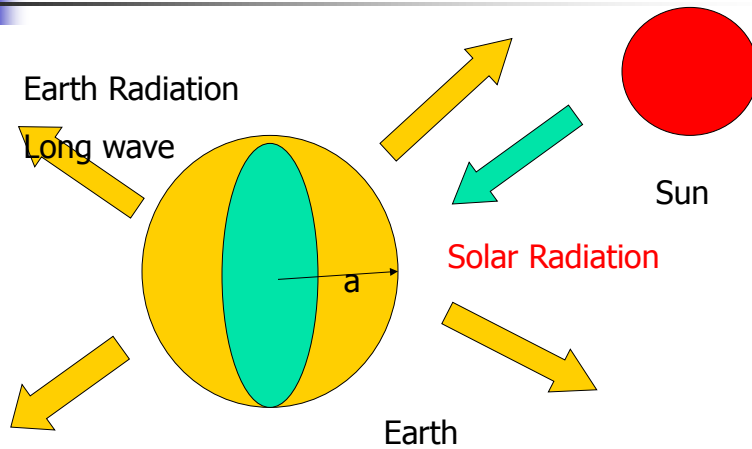
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 - Global Warming is real!
 - Theoretical bases for global warming effects
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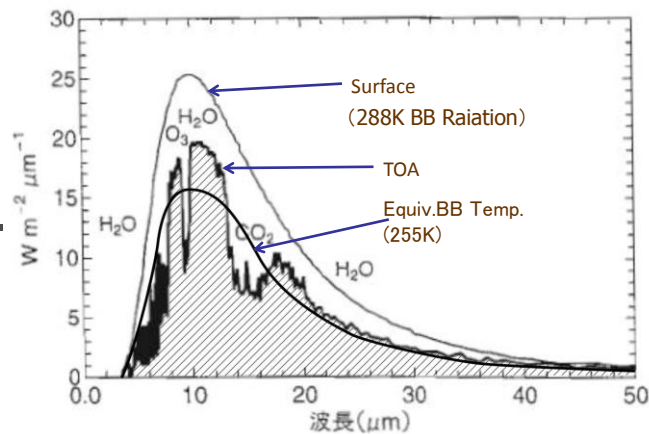
Radiation Balance on the Earth

放射収支



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Green-House Effect shown by IR Spectrum Global Mean OLR Spectrum (Kiehl and Trenberth, 1997)

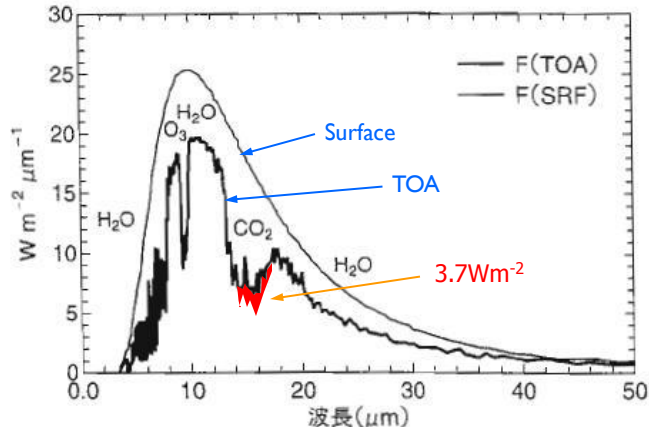


- ・ 大気上端からの全放射量は地表面からの放射の約60%
→ 温室効果
- ・ CO_2 の効果は全温室効果(2つの線の間)の面積)のおよそ25%
- ・ 大気上端からの赤外線放射は衛星観測により高精度で実証

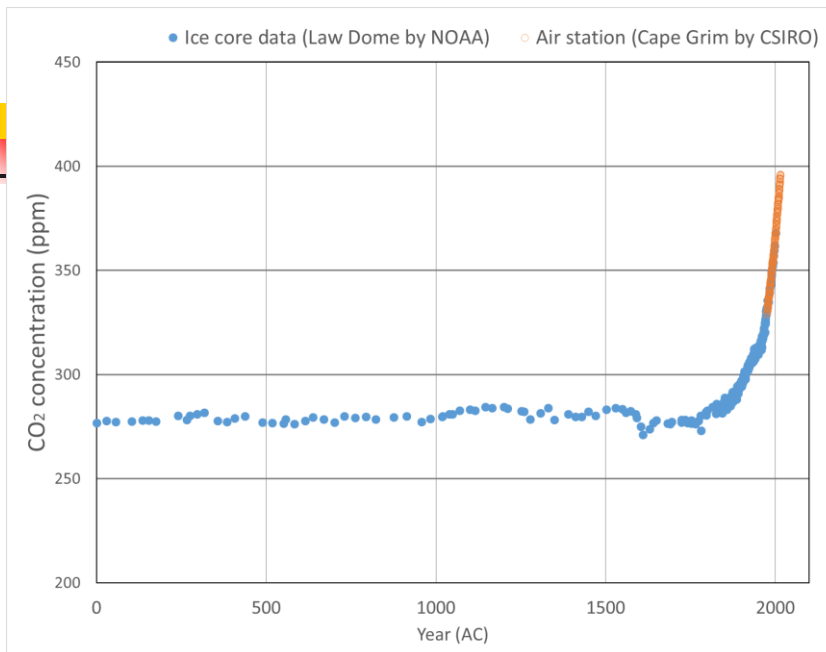
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Radiative Forcing due to doubling CO2

CO₂が2倍になると15 μm帯の放射(大気上端)が3.7W/m²減少

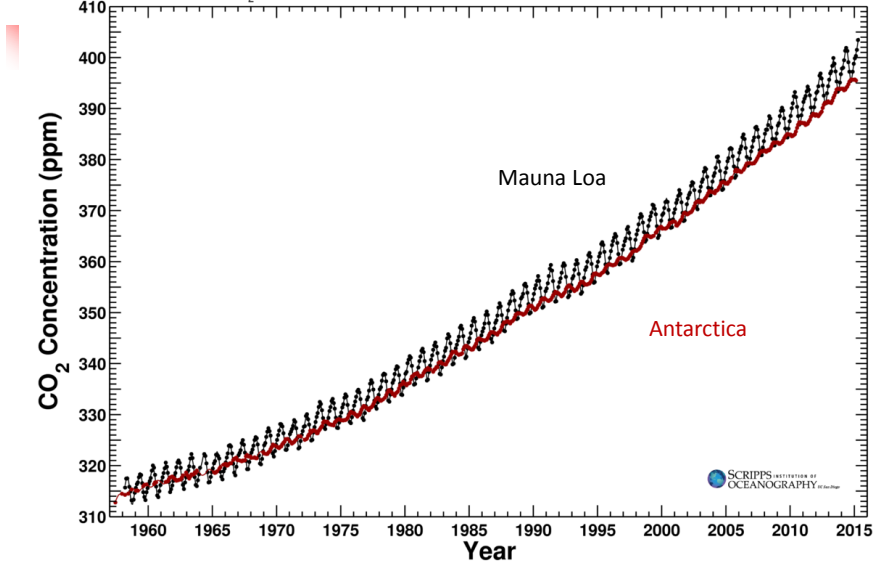


エネルギー流出が減少 → バランスがくずれ加熱
→ 地表面が高温に → 約1.3K高温でバランス [→ 水蒸気増加
→ H₂Oによる温室効果 → さらに高温(1.9~2.4K)でバランス] 5



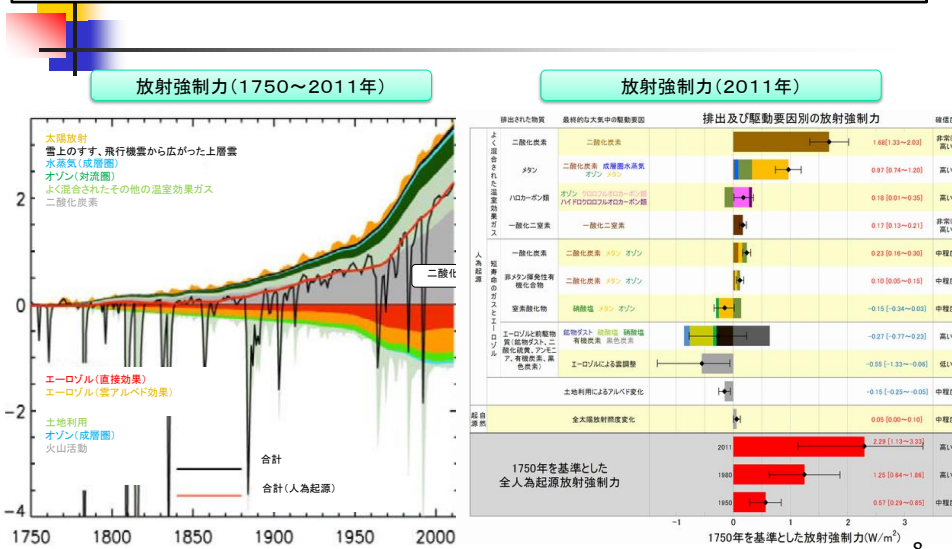
Mauna Loa Observatory, Hawaii and South Pole, Antarctica Monthly Average Carbon Dioxide Concentration

Data from Scripps CO₂ Program Last updated May 2015



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CO₂ is mostly contributing to warming
Aerosols have a large ambiguity! (IPCC AR5)



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Climate is changing!

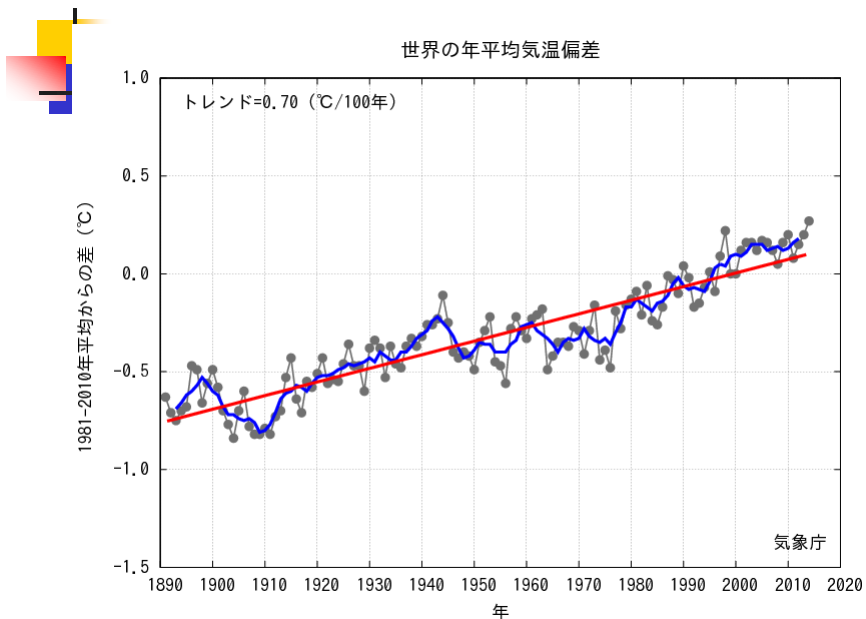
SPM 1. Observed Changes and their Causes

Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems. {1}

SPM 1.1 Observed changes in the climate system

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen. {1.1}

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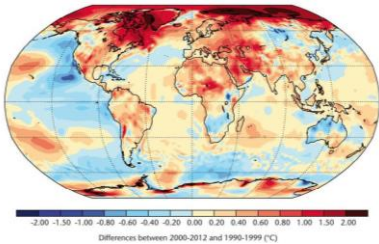


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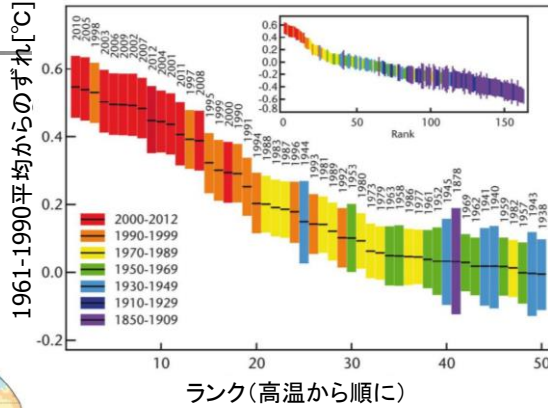
Climate is warming!

- 1998年以外のTop 10は全て21世紀になってからの記録
- 2000年以降は、1961-1990年に比べ平均して約0.5°C気温が高い

最近の地表気温変化
(1990-1999年平均と
2000-2012年平均の差)



1850年以降の全球平均地表気温のランキング

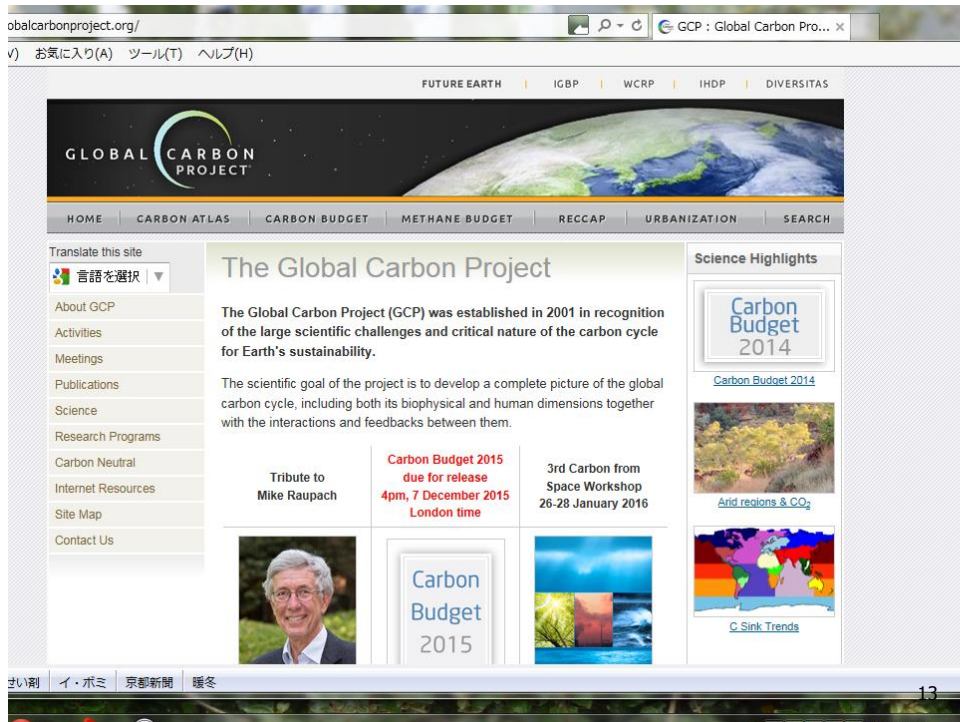


- 北極周辺および大陸上の昇温が大きい

UK Met Office (2013) & Courtesy of ECMW ¹¹

Global Carbon Project(GCP) has been conducted!

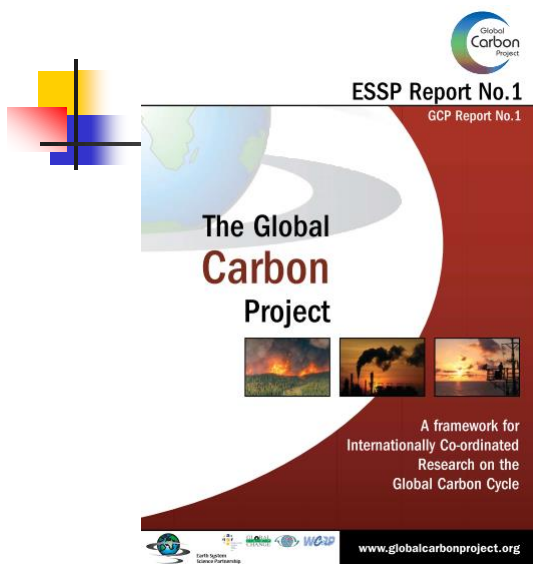
- “The Global Carbon Project” ESSP Report No.1(2003)
- Theme 1 Pattern and Variability
- Theme2 Process and Interactions
- Theme3 Carbon Management



Policy-relevant understanding

The Vision

The central vision of the GCP is to develop comprehensive, policy-relevant understanding of the global carbon cycle, encompassing its natural and human dimension and their interactions.



1. Pattern and Variability
2. Processes and Interaction
3. Global Carbon Management
 - 3.1 Points of intervention and option of mitigation
 - 3.2 Carbon Management in the context of the whole Earth system
 - 3.3 Carbon consequences of regional development pathways

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Something should be done!

- International Diplomatic Negotiations
- COP21
- IPCC activities
- Pleateau periods

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International Collaboration
is critical !



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Paris Agreement (COP21)

A balance between anthropogenic **emissions by sources** and removals by **sinks of greenhouse gases** = CCS or Biosphere(?)

Article 4

In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty

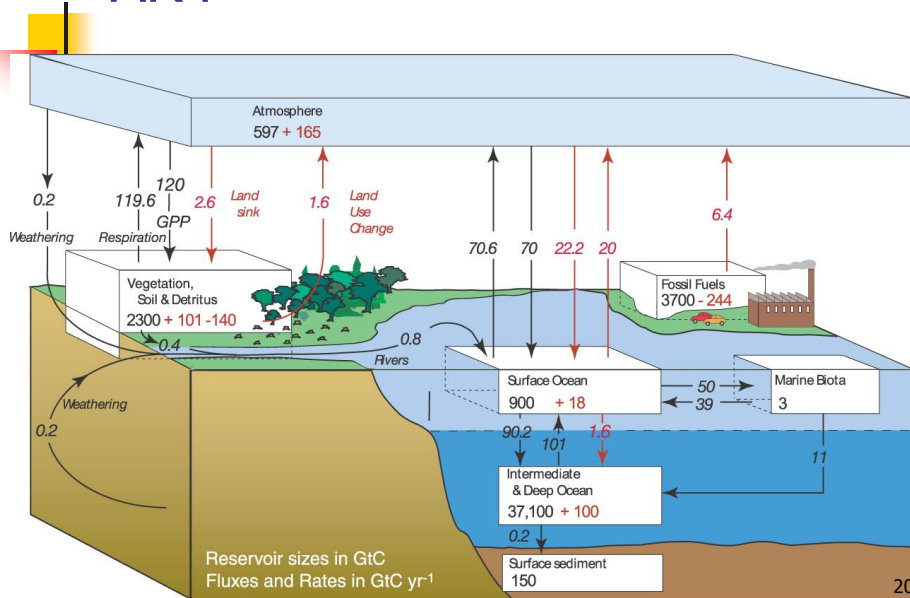
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In order to control a man-made emission,

- Accurate estimate of the natural carbon cycle
- Estimate of bio-mass and CO₂ in soil
- Many trials

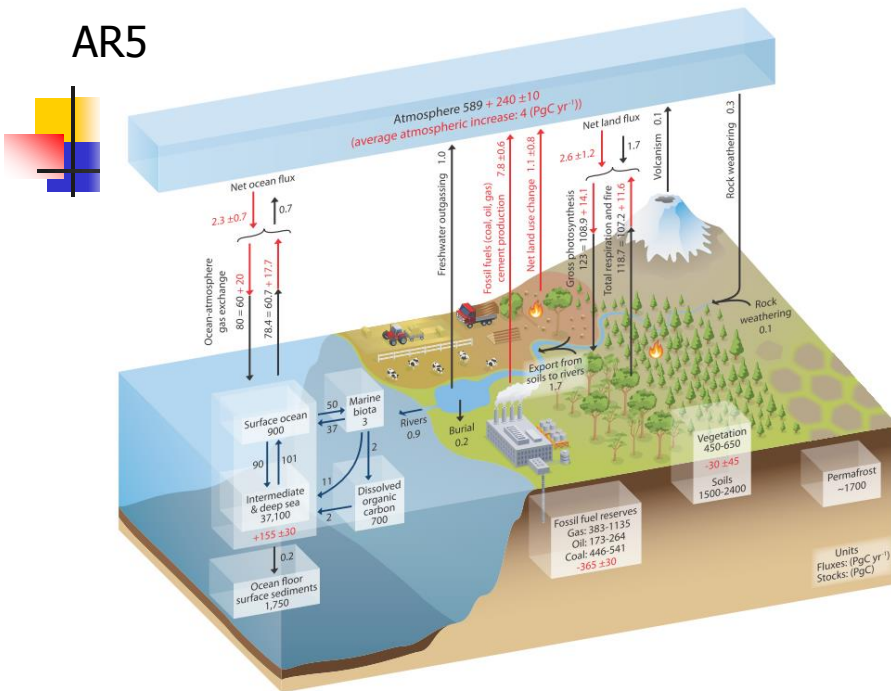
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AR4



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AR5



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Global Carbon Management System Again!

- Control of emissions !
- Development of sinks!
- How?
- International agreement is critical
- Accurate and reliable estimate of Natural Carbon Cycle and man-made emission!
- Sink due to bio-sphere is a key!

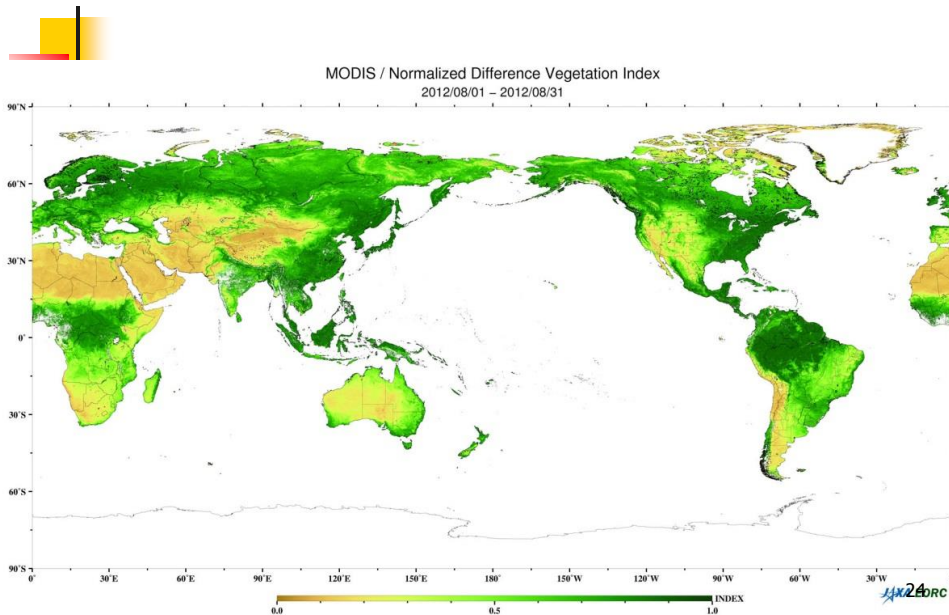
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Eco-system or Biosphere observed from "Space"

- Marine Eco-System
 - Ocean Color Sensors
- Land Eco-system
 - Vegetation Index or RAR etc. IR-data
 - ALOS SAR data
- Accuracy?

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Vegetation Index





New Challenge

- Lidar observation of tree-height
- Good try
- Integration of existing different data
- Up-scaling and down-scaling