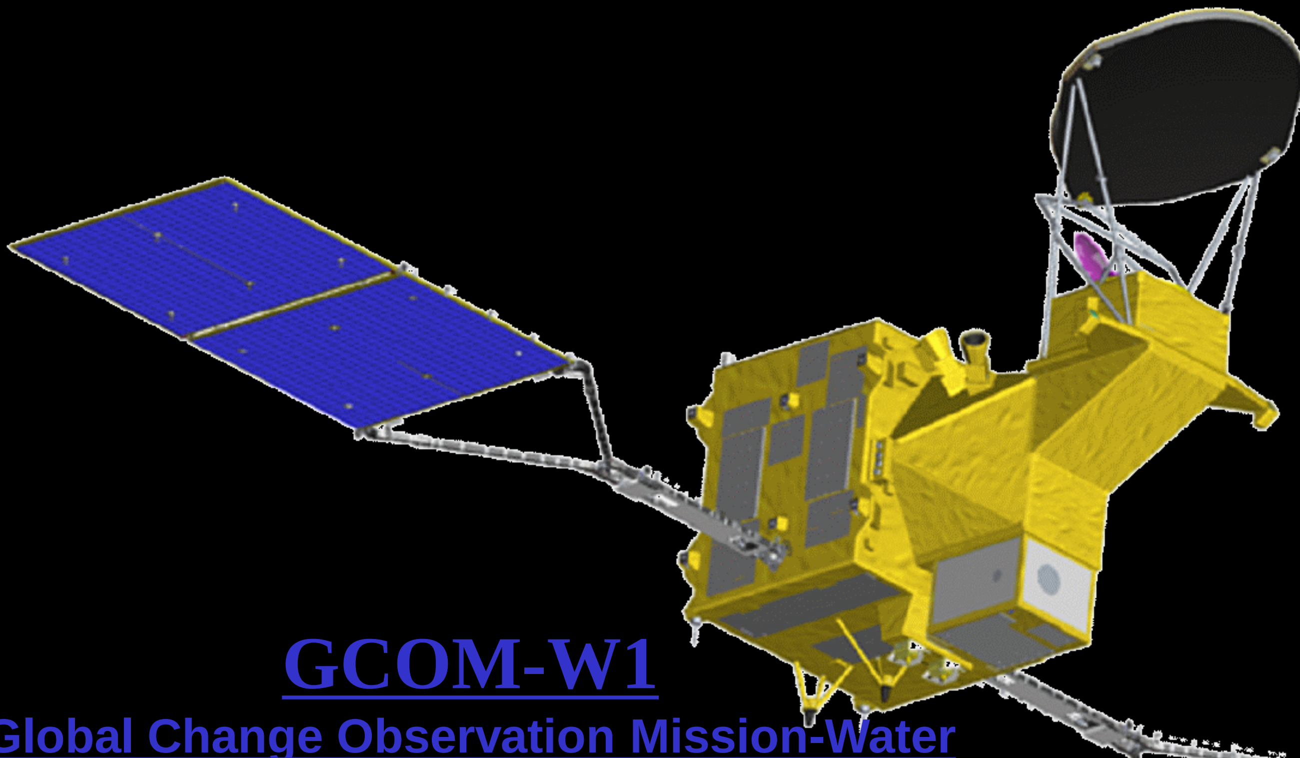
http://hydro.iis.u-tokyo.ac.jp/

GCOM-W1 now on the A-Train



GCOM-W1

Global Change Observation Mission-Water

Taikan Oki, K. Imaoka, and M. Kachi

JAXA/EORC (& IIS/The University of Tokyo)

Mini-Workshop on A-Train Science, March 8th, 2013

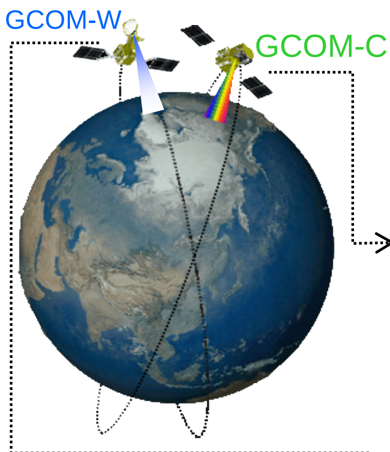
The University of Tokyo, Tokyo, Japan

GCOM Science Target

- *Monitor "Global Change" by continuous (>10yr) and consistent observations.*
- *Estimate model parameters with satellite observations and products.*

Satellite/sensor and algorithm development

GCOM observation



Frequent and long-term (>10yer) global observation system required for earth environment change monitoring and prediction

GCOM observation

Radiation budget
- Surface albedo
- Snow ice
- Cloud/ aerosol
- SST/ LST

Carbon cycle
- Vegetation cover
- Primary production
- Coastal environment

Water cycle
- Water vapor, cloud, precipitation
- Soil moisture
- Sea ice, snow
- SST, wind

Input

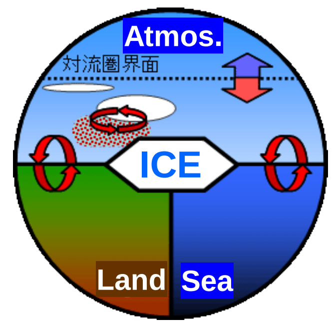
Comparison

Products or radiance with radiative transfer

Cooperation with the climate model research institutions

Model prediction

Climate system model

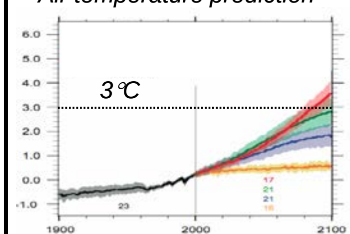


- Improvement of parameterization about radiation budget and carbon cycle, etc. in climate prediction model.
- Verification and improvement of prediction of the earth environment change including the water cycle by comparison with the satellite observation.

Improve accuracy

Prediction results
- Surface temperature
- Sea level
- Snow and sea ice area
- Environmental change
  - Rain/drought distribution
  - Extreme weather frequency
  - Land cover

Air temperature prediction



Data application

Operational use for fishery, sea route, weather forecast, and climate monitoring

Knowledge

Understanding of the climate system and the climate change (global warming)

Future prediction

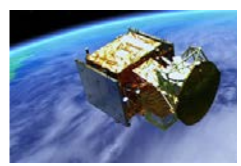
Policy design through prediction improvement

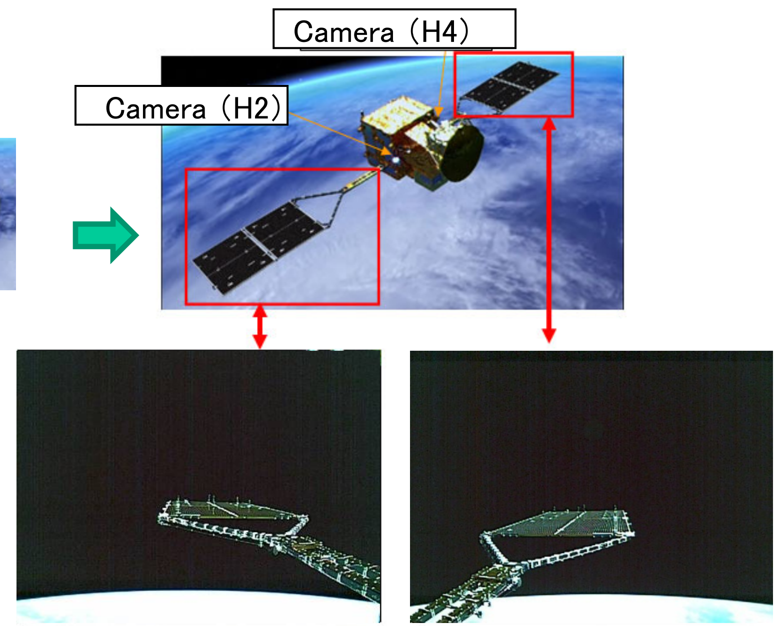
GCOM-W1 Status

- **16:39 UT, May 17th, 2012: GCOM-W1 was launched at Tanegashima-island. ･･･(1)**
- **17:02 UT: Separated from H-IIA Rocket. ･･･(2)**
- **17:05 UT: Deployed solar paddles. ･･･(3)**

(1) Launch

(2) Separation from H-IIA

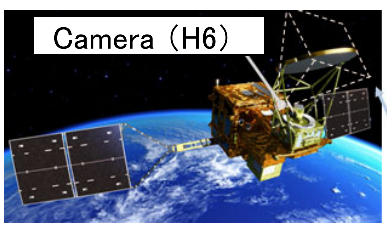




(3) Solar paddles deployment

GCOM-W1 Status

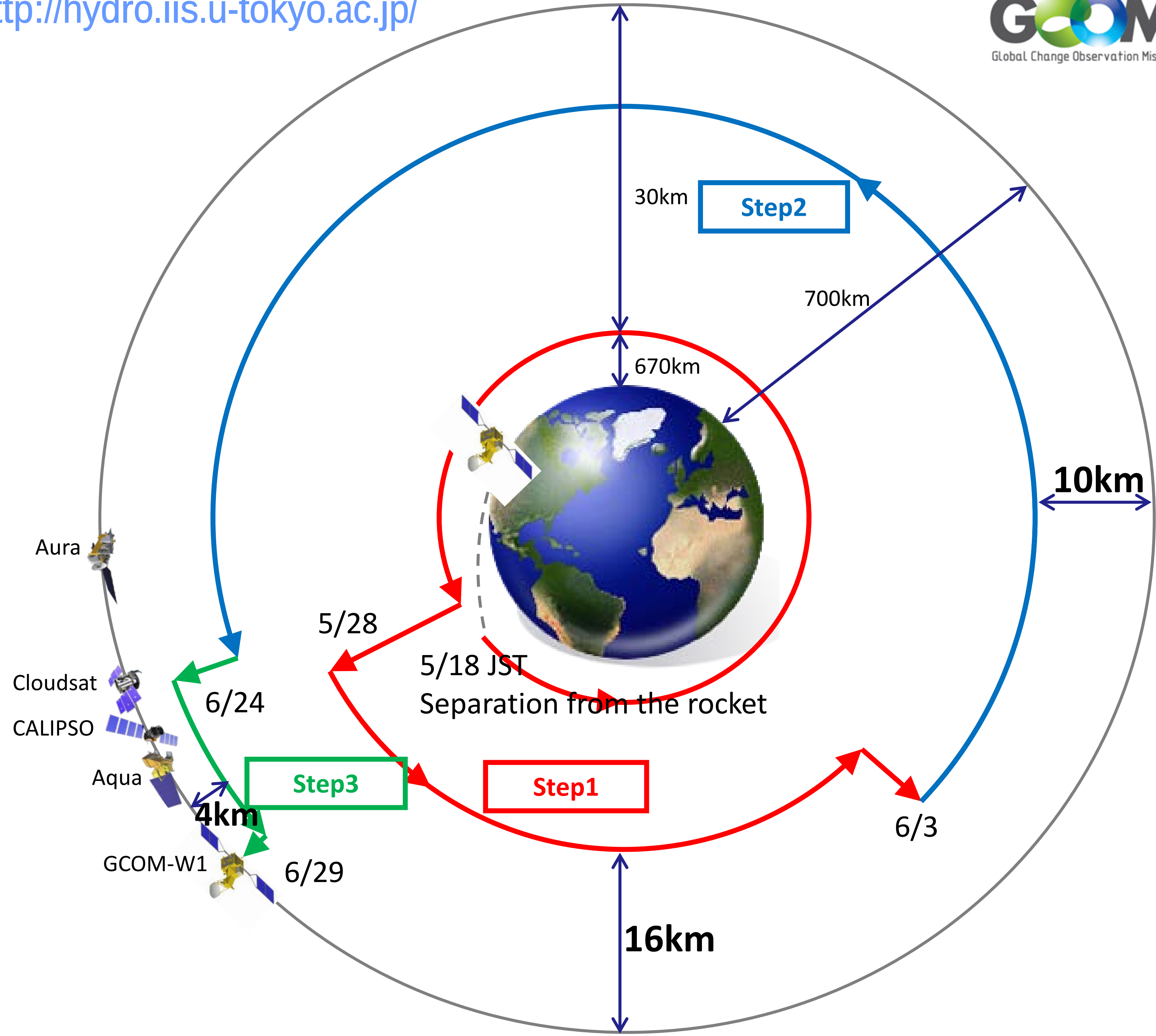
- 3:43 UT, May 18th, 2012: The antenna of AMSR2 was deployed. ・・・(4)
- 13:34 UT: AMSR2 started rotation in 4 rpm. ・・・(5)
- 17:00 UT: The Critical Operation Phase was finished.



(4) AMSR2 antenna deployment

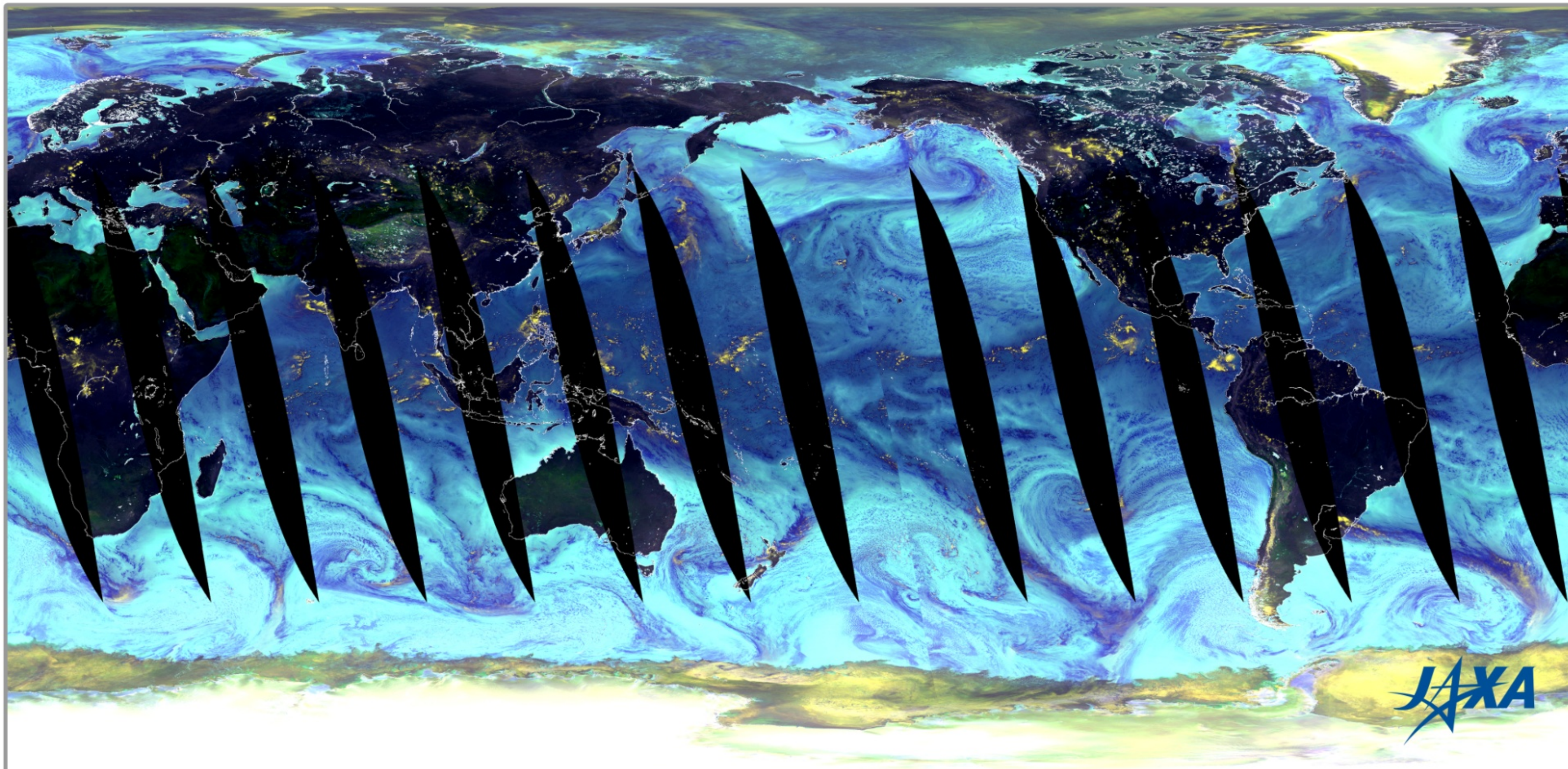
(5) AMSR2 rotation in 4 rpm

http://hydro.iis.u-tokyo.ac.jp/



第一期水循環変動観測衛星「しずく」
Global Change Observation Mission 1st-Water "SHIZUKU"

AMSR2 による地球全体の擬似カラー合成画像
Color composite image of global Earth by AMSR2



図は、平成 24 年 7 月 3 日午前 9 時頃から 7 月 4 日午前 9 時頃(日本時間)にかけての約 1 日間に、「しずく」搭載の AMSR2 が地球の全体を観測した擬似カラー合成画像で、89.0GHz 垂直・水平偏波、23.8GHz 垂直偏波の輝度温度を使用しています。

Figure is one-day color composite image of global Earth by the AMSR2 on-board the SHIZUKU on July 3, 2012 (UTC). Brightness temperatures of 89.0-GHz (both vertical and horizontal polarization) and 23.8-GHz (vertical polarization) channels were used.

GCOM-W1 Data Products

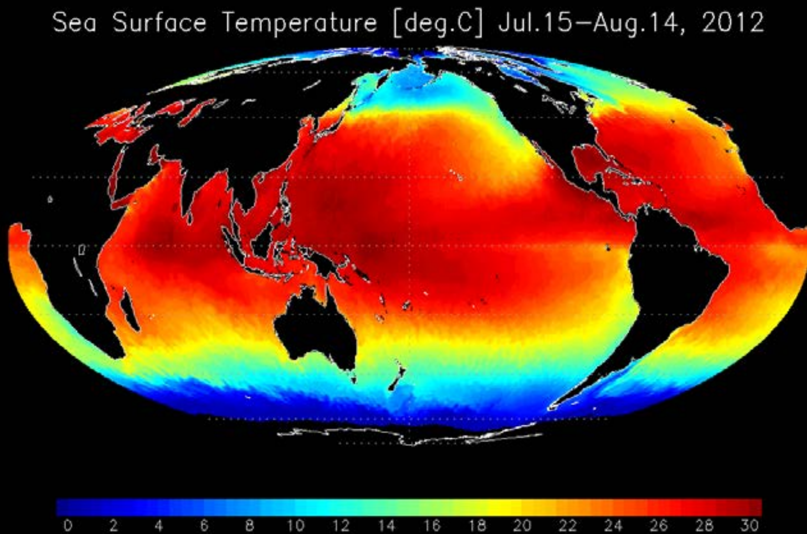
Standard Products

Products		Areas	Res.	Accuracy			Range
				Release	Standard	Goal	
Brightness Temperature		Global	5-50km	±1.5K	±1.5K	±1.0K (systematic) ±0.3K (random)	2.7-340K
GEO	Integrated water vapor	Global, over ocean	15km	±3.5kg/m^2	±3.5kg/m^2	±2.0 kg/m^2	0-70kg/m^2
GEO	Integrated cloud liquid water	Global, over ocean	15km	±0.10kg/ m^2	±0.05kg/ m^2	±0.02kg/ m^2	0-1.0kg/m^2
GEO	Precipitation	Global, except cold latitude	15km	Ocean ±50% Land ±120%	Ocean ±50% Land ±120%	Ocean ±20% Land ±80%	0-20mm h^{-1}
GEO	Sea surface temperature	Global, over ocean	50km	±0.8℃	±0.5℃	±0.2℃	-2-35℃
GEO	Sea surface wind speed	Global, over ocean	15km	±1.5m s^{-1}	±1.0m s^{-1}	±1.0m s^{-1}	0-30m s^{-1}
GEO	Sea ice concentration	Polar region, over ocean	15km	±10%	±10%	±5%	0-100%
GEO	Snow depth	Land	30km	±20cm	±20cm	±10cm	0-100 cm
GEO	Soil moisture	Land	50km	±10%	±10%	±5%	0-40%

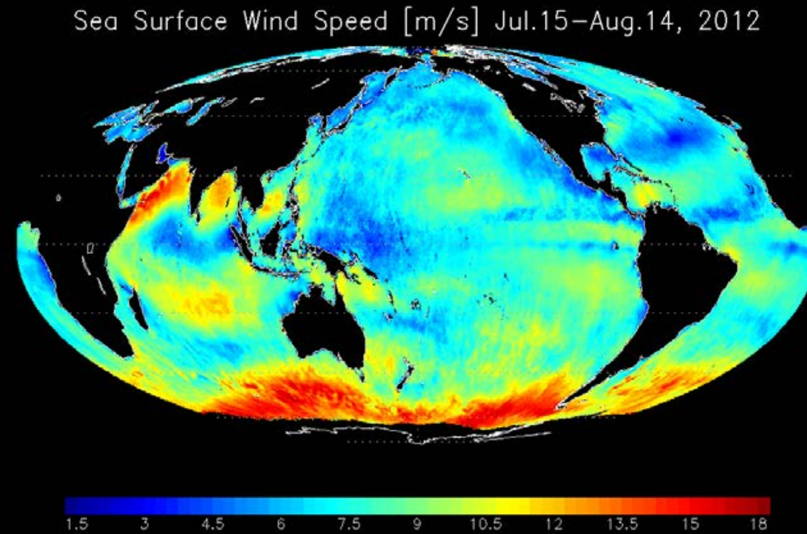
Research Products: all-weather sea surface wind speed, sea ice moving vector, sea ice thickness, land hydrological assimilated products, etc.

Monthly AMSR2 Images (unvalidated)

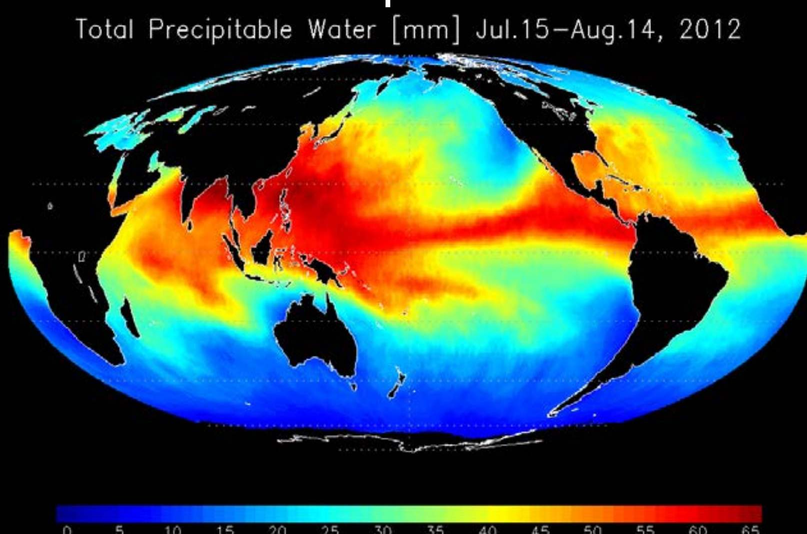
Sea Surface Temperature



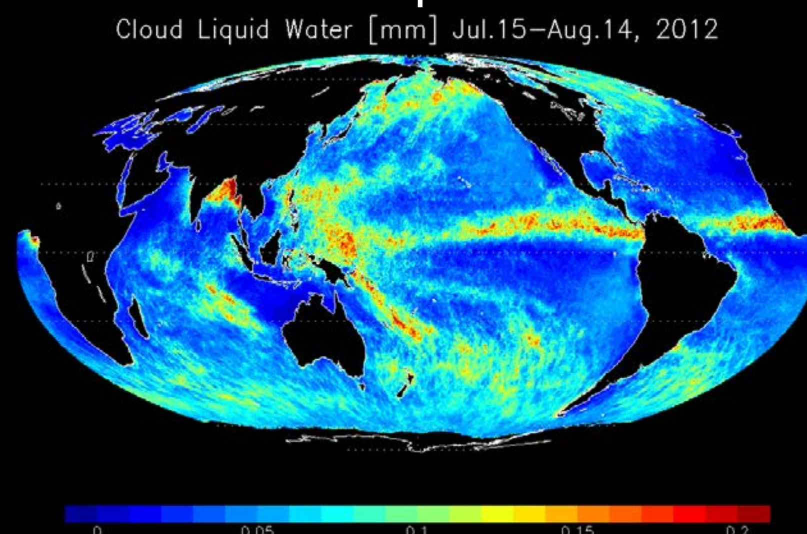
Sea Surface Wind Speed



Total Precipitable Water



Cloud Liquid Water



Monthly average (July 15 – August 14, 2012)

GCOM-W1 and A-Train

- **Continuity from AMSR-E on Aqua**
  - **Stable observation from the same orbit and local observing time.**
  - **Direct cross-calibration with AMSR-E.**
- **Atmosphere**
  - **Snow fall detection by combining CloudSat and AMSR2.**
  - **Validation of cloud liquid water by MODIS, AMSR2, and CloudSat.**
  - **Aerosol-Cloud-Rain science by MODIS, CloudSat, AMSR2, and Aura.**
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  - **Validation of AMSR2 sea ice concentration by using MODIS, thin ice detection by combining MODIS and AMSR2, and advanced sea ice research by adding the information of surface roughness from CALIPSO/CloudSat.**

Status of Aqua/AMSR-E

http://aqua.nasa.gov/animations.html

Caution! Real AMSR-E rotates its antenna counterclockwise about an axis parallel to the geocentric direction.

Instrument characteristics

- Multifrequency, dual polarization microwave radiometer system developed by JAXA.
- Sister instrument of AMSR on ADEOS-II.
- Large main reflector with diameter of 1.6m, which realizes higher spatial resolution.
- Channels at 6.9GHz for retrieving SST and soil moisture content.
- Afternoon (1:30pm) equatorial crossing time, where only AMSR-E is observing.

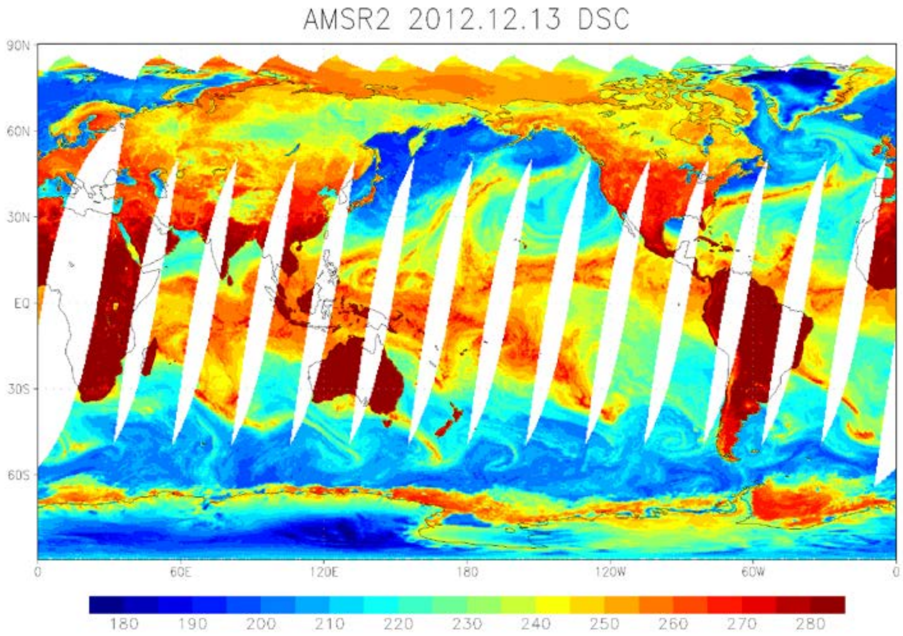
Mission status

- After 9.5-years of observation onboard Aqua satellite, observation halted in October 2011 due to the increase of motor rotation torque.
- Discussions and efforts are being made for potential slow rotation for cross calibration.

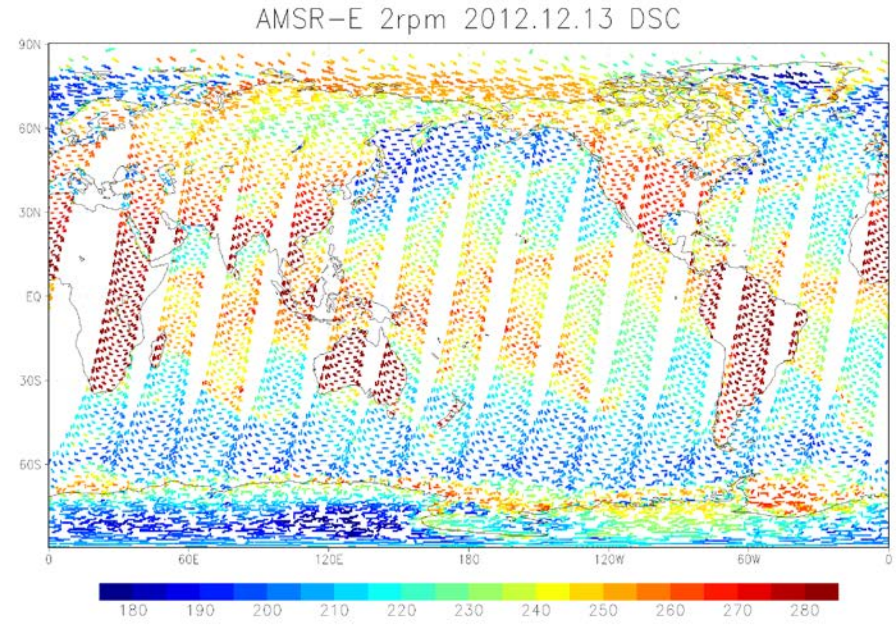
Pre-launch AMSR-E in Tsukuba Space Center

Direct comparison with AMSR-E

- **Orbits and frequency channel sets are almost identical: no corrections are needed for center frequency, incidence angle, and observing local time. It enables cross calibration in wide range of Tbs over land, ice, and ocean.**
- **AMSR-E observations resumed from December 4, 2012 with 2rpm rotation speed. Geolocation and Tbs are computed by modified software.**
- **Observation is sparse, but reasonable for global-scale comparison.**
- **Calibration improvement of 2rpm mode data is underway.**



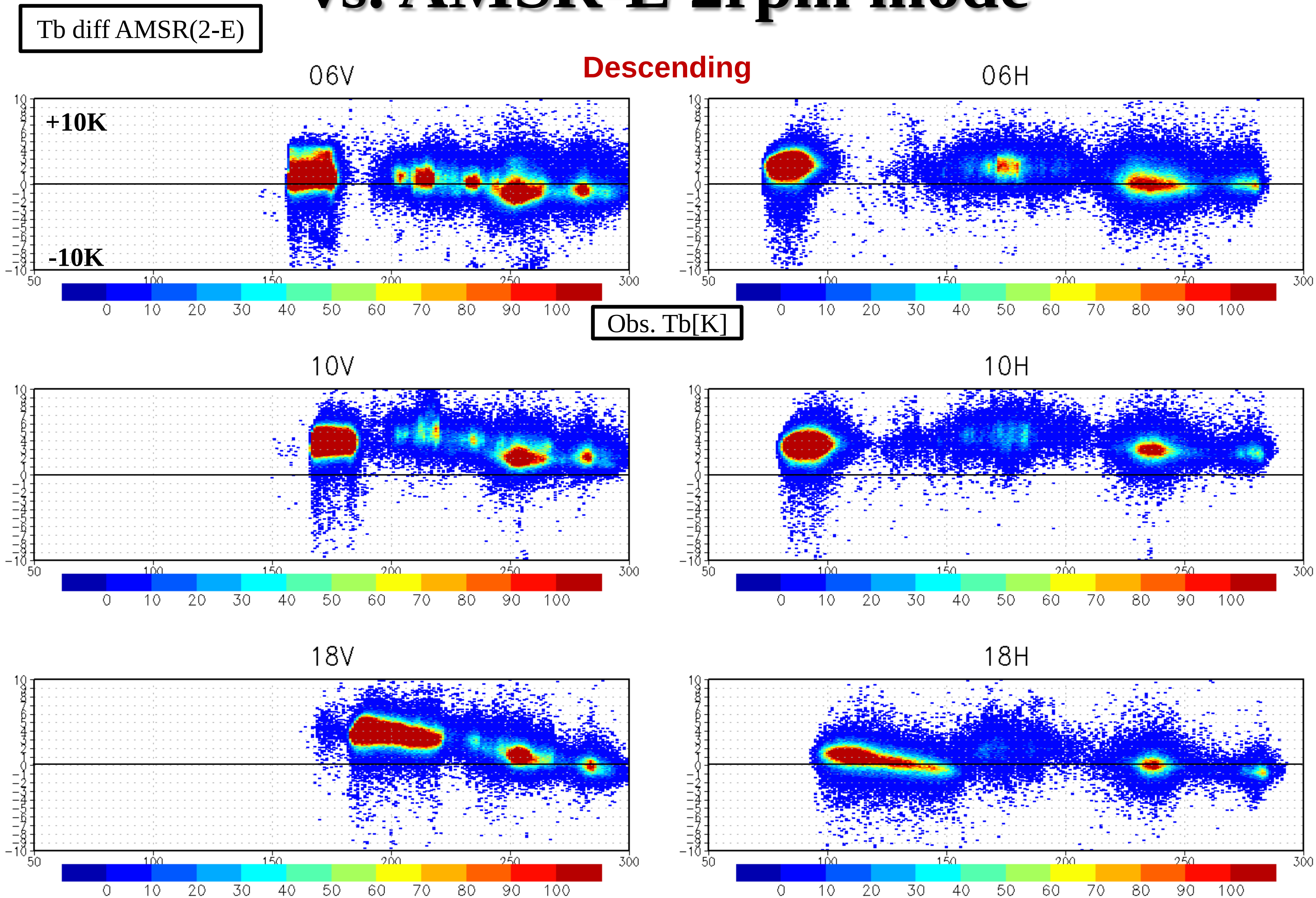
AMSR2 23V Descending



AMSR-E 2rpm 23V Descending

http://hydro.iis.u-tokyo.ac.jp/

vs. AMSR-E 2rpm mode

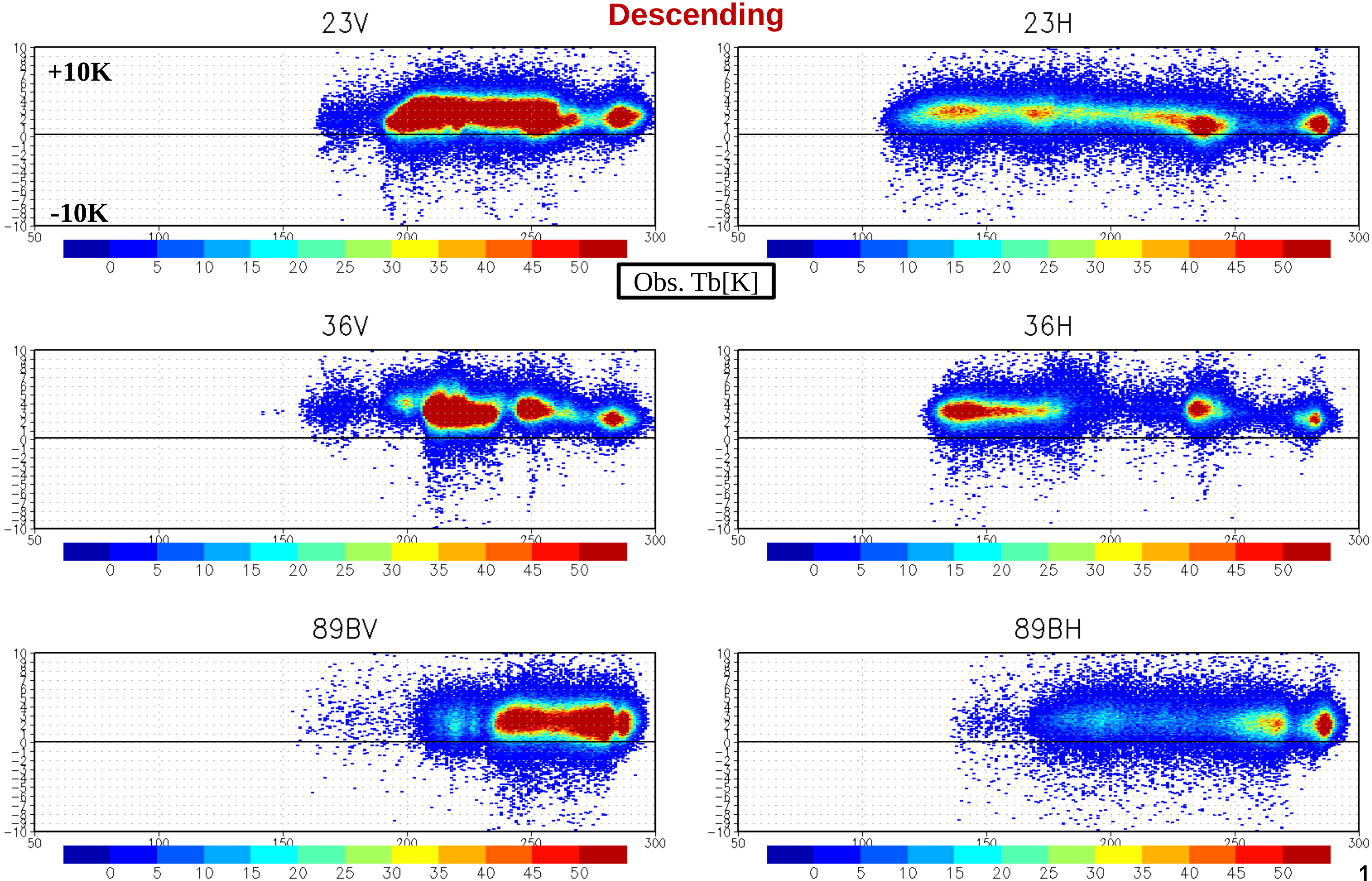


http://hydro.iis.u-tokyo.ac.jp/

GCOM[13] JAXA
Global Change Observation Mission

vs. AMSR-E 2rpm mode

Tb diff AMSR(2-E)



GCOM-W1 and A-Train

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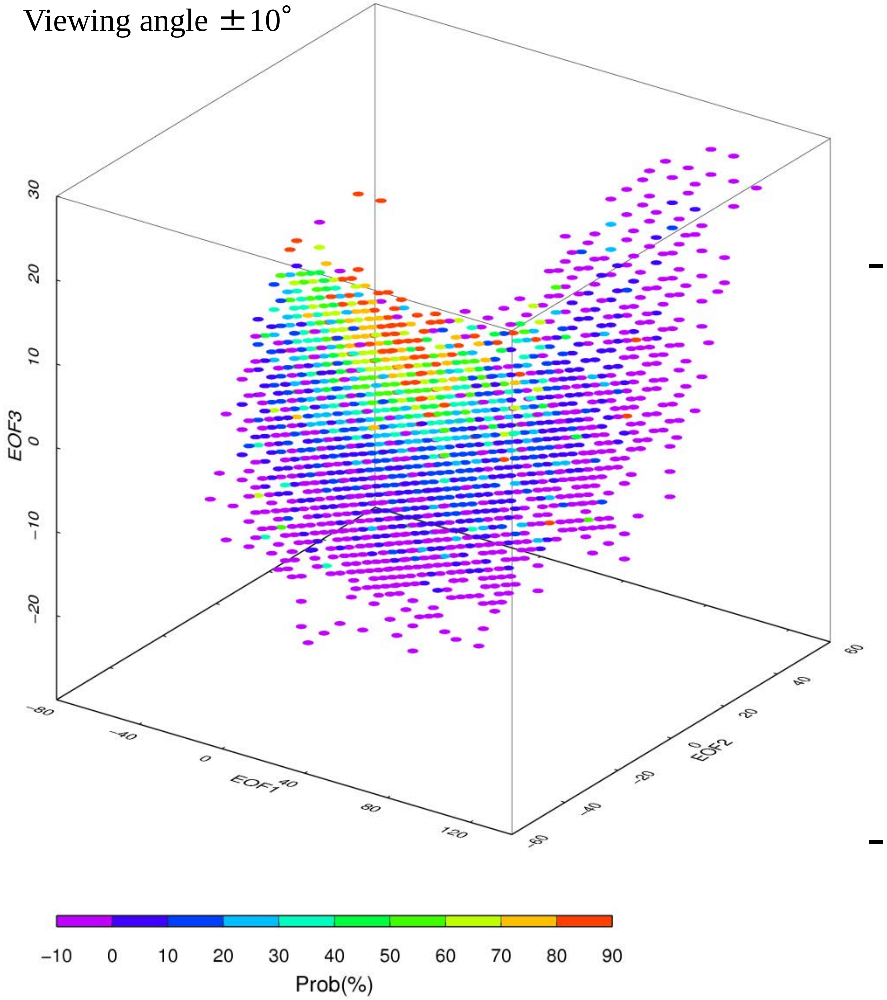
Lookup Table based on MHS-CloudSat Matchups – 4.5 years data, North America

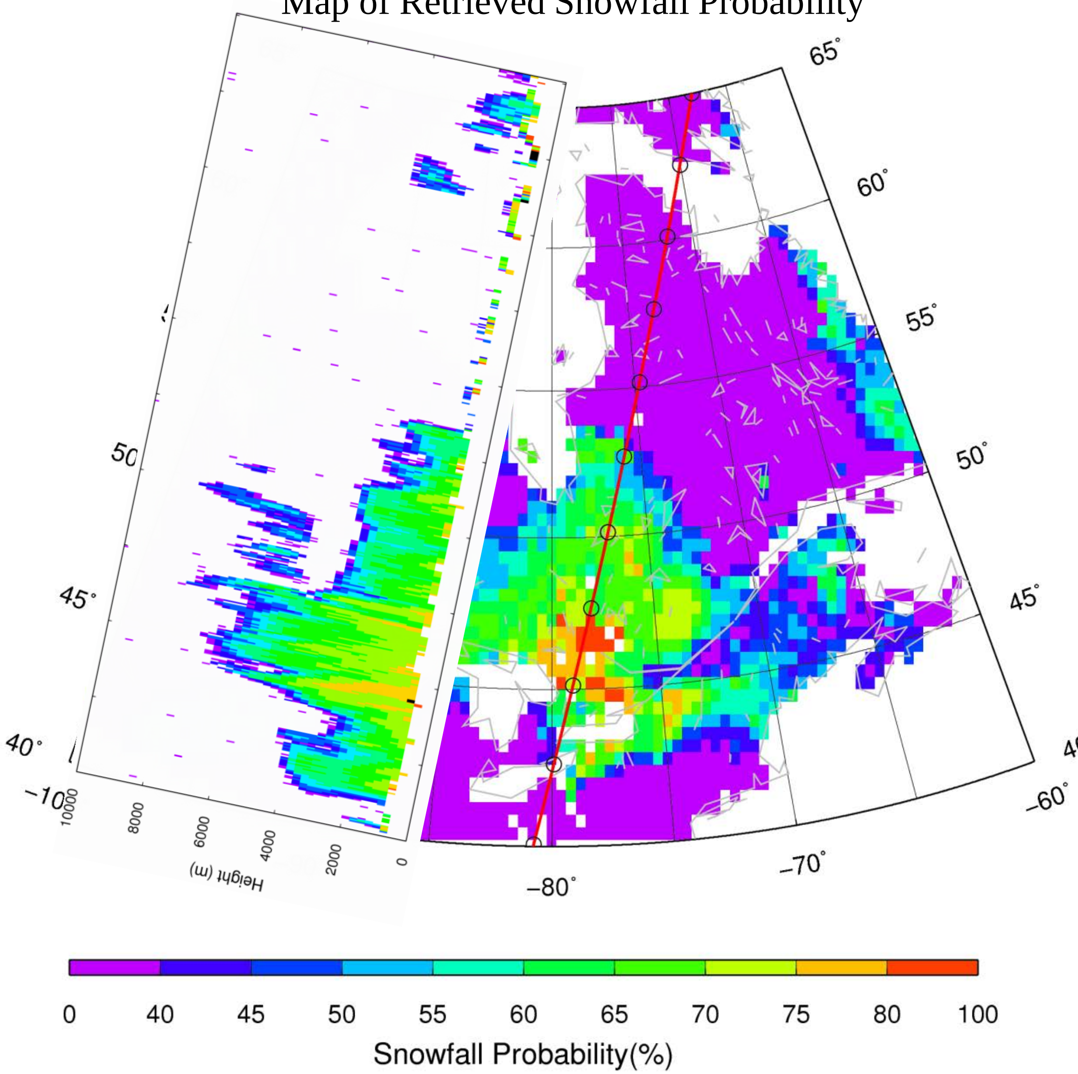
40-65° N, 50-170° W
Land, T2m<0° C
Viewing angle ±10°



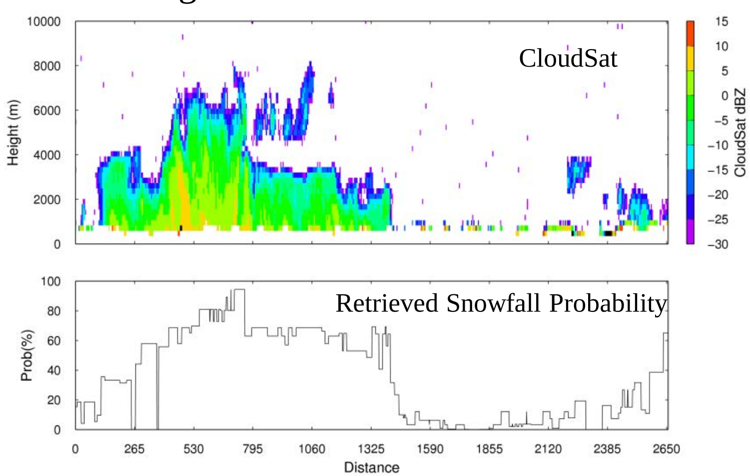
- EOF analysis to MHS data:
  - First 3 PCs – 88.6%, 8.2% and 2.1% of variances
  - PC3 had the best correlation Coeff to CloudSat reflectivity
- Lookup Table:
  - Project observed TBs to the first 3 PCs
  - In the 3-d EOF space, using MHS-CloudSat matchups, compute the probability of snowfall (CloudSat near-surface dBZe>-15)
  - Lookup tables for different MHS viewing angles
- Retrieve snowfall probability using the above lookup table; Use a Z-S relation, we can retrieve snowfall rate as well

Snowfall detection result - C3VP Case – 2007.1.22

Map of Retrieved Snowfall Probability



Along CloudSat Track



Use CloudSat to train passive microwave observations (done MHS, working on AMSR-E/AMSR2) for snowfall detection. This example shows that the trained passive microwave algorithm correctly identified snowfall area, and is potentially able to estimate snowfall intensity as well.

GCOM-W1 and A-Train

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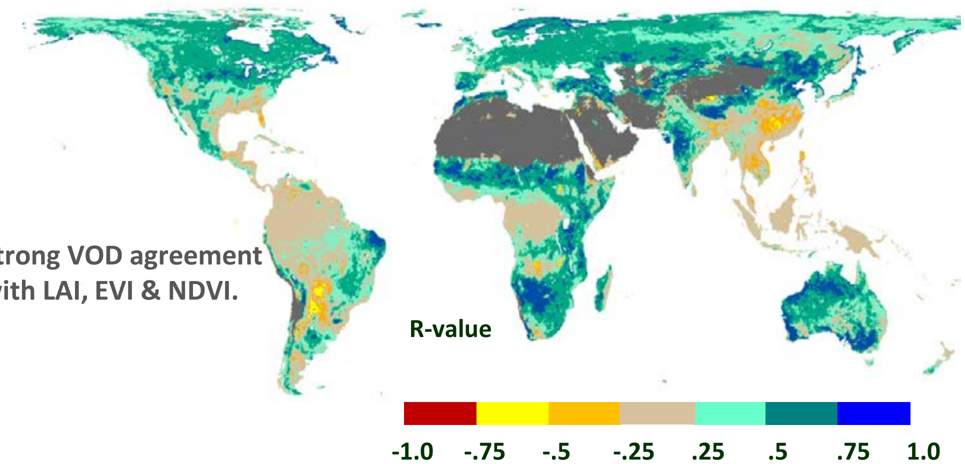
Global Phenology Monitoring using Vegetation Optical Depth (VOD) from AMSR-E

- **Microwave provides enhanced temporal fidelity, especially over cloud dominated regions.**
- **VOD provides synergistic canopy biomass & water content information relative to optical-IR greenness data.**

MODIS LAI & AMSR-E VOD Correlation 2003-2008

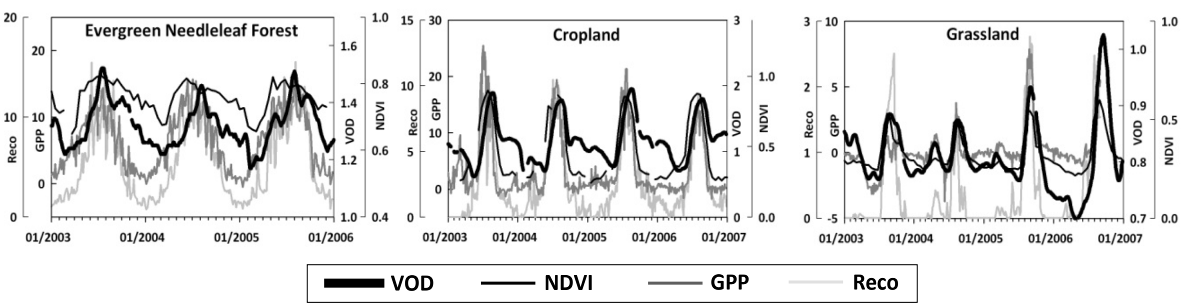
Jones et al. 2011, *Rem. Sens. Environ.* 155

- Strong VOD agreement with LAI, EVI & NDVI.



AMSR-E VOD, MODIS NDVI & Tower C-flux Seasonality

Jones et al. 2012, *Rem. Sens. Environ.* 123

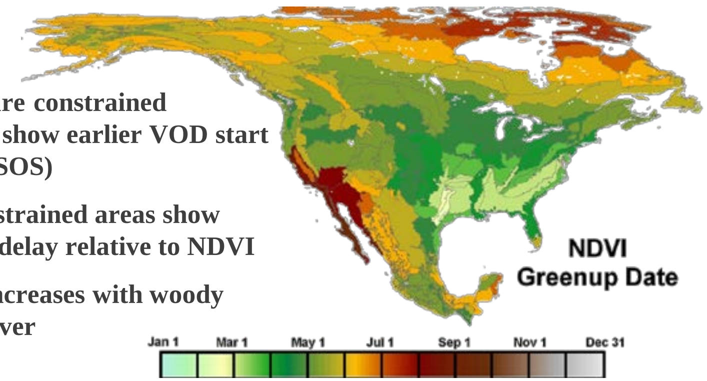


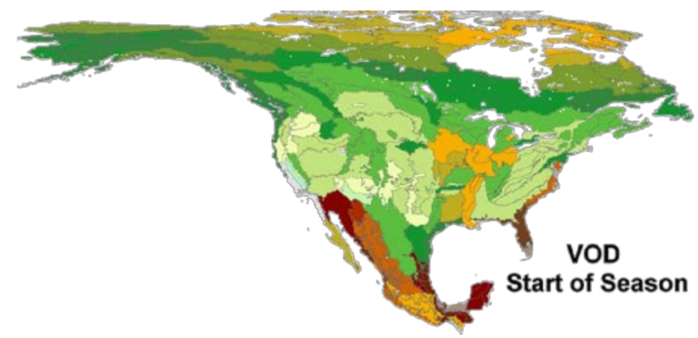
- VOD tracks canopy biomass change & seasonal shifts in land-atmosphere carbon fluxes.

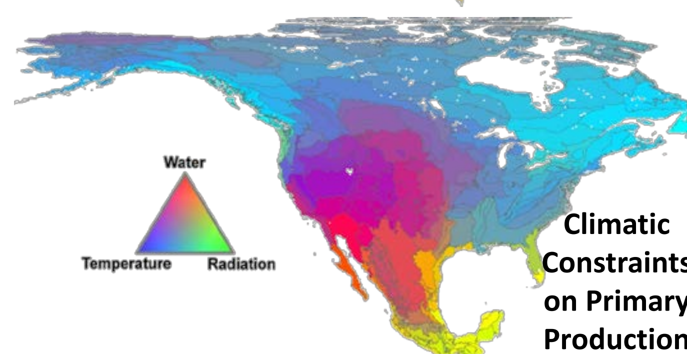
VOD & NDVI Phenology Metrics 2004-2007

Jones et al. 2012, *Rem. Sens. Environ.* 123

- Temperature constrained ecoregions show earlier VOD start of season (SOS)
- Water constrained areas show VOD SOS delay relative to NDVI
- VOD lag increases with woody biomass cover







Provided by Dr. John S. Kimball of the University of Montana

GCOM-W1 and A-Train

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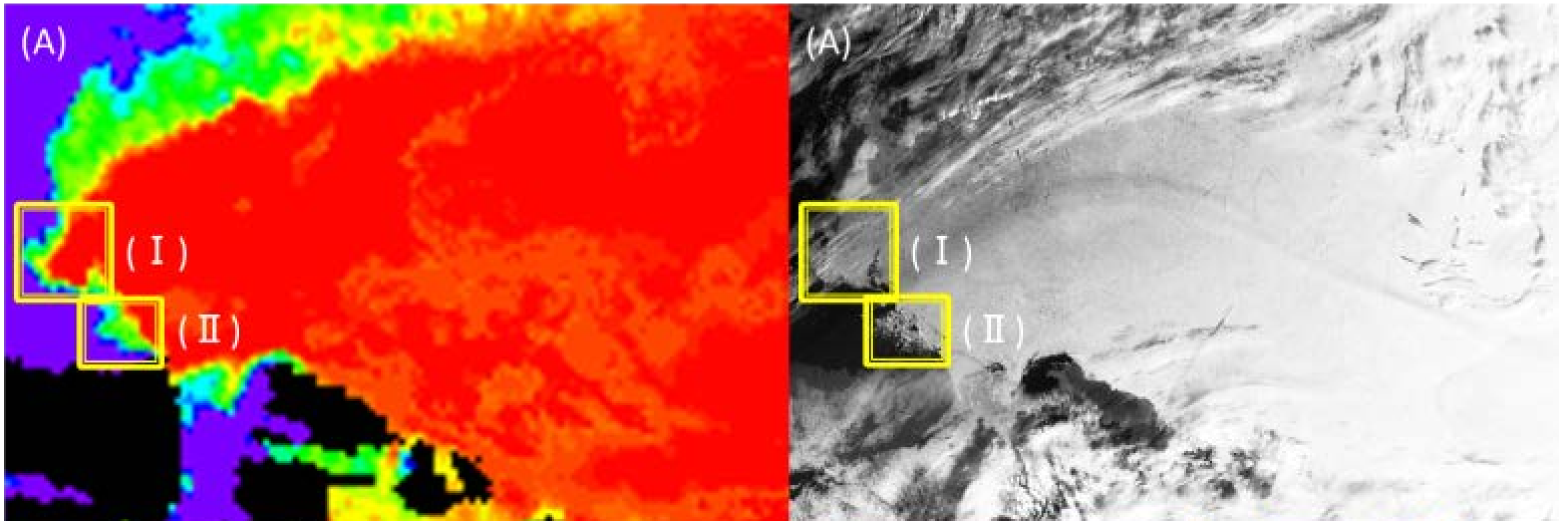
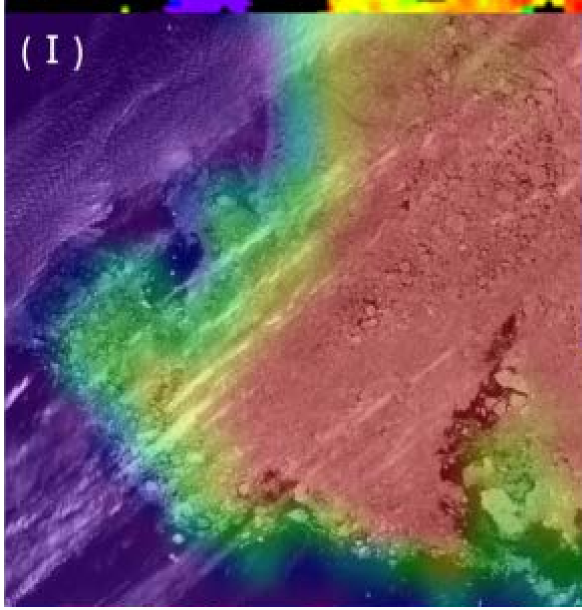
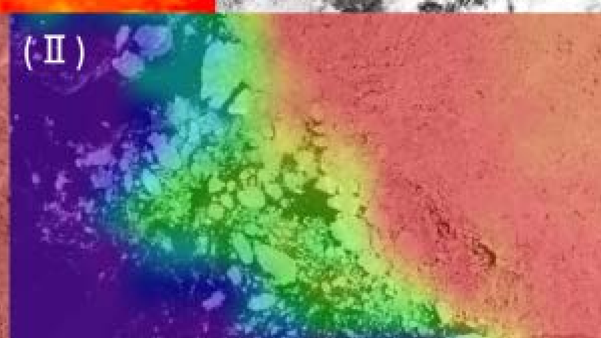
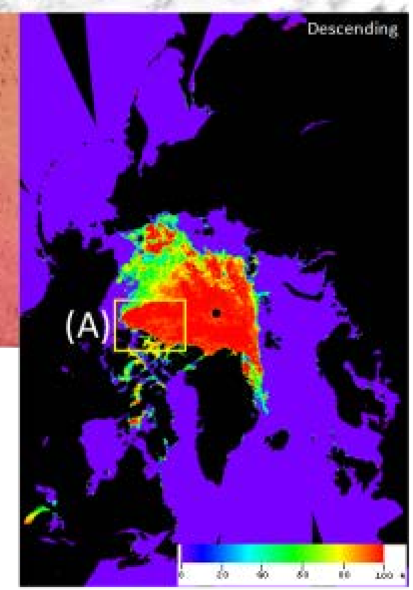
Comparing AMSR2 sea ice concentration with MODIS visible/IR images

AMSR2海氷密接度とMODIS Band1の比較（2012年7月28日）









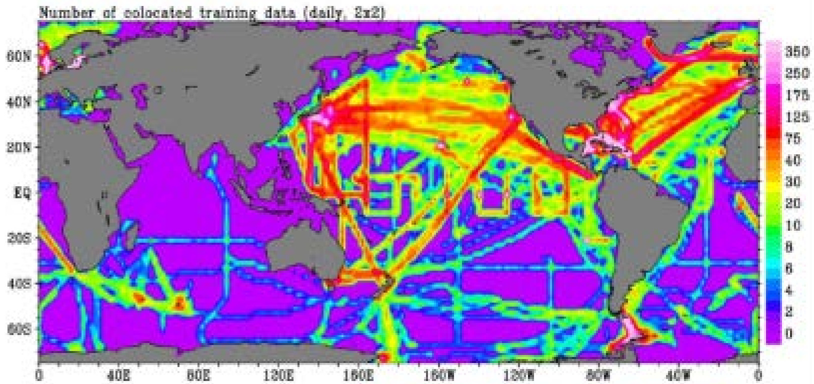
- ✓ AMSR2海氷分布はMODIS海氷分布と良く一致。
- ✓ 両センサはA-Train参加衛星に搭載されており、同時観測が可能。

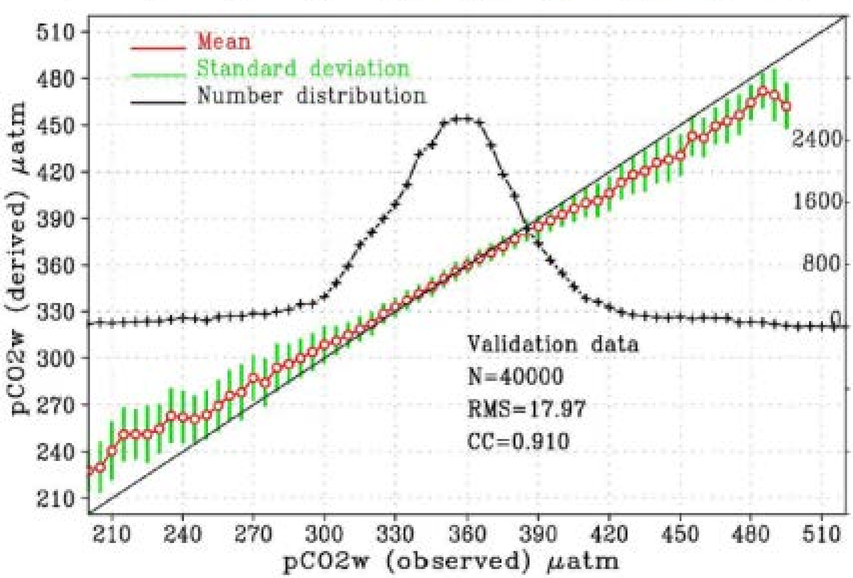
GCOM-W1 and A-Train

- Ocean (cont'd)
  - Detailed analysis of SST stratification by using MODIS skin SST, AMSR2 subskin SST, and Argo/buoy/ship bulk SST, in comparison with AMSR2 wind, and MTSAT solar radiation with a 1-D simple ocean model.
  - Air-sea exchange of CO2 by using MODIS Chl-a, AMSR2 SST and winds, and OCO-2 CO2.
  - Studies on wind-wave field and surface roughness by combining AMSR2 wind with data from CALIPSO/CloudSat.

An example of statistical model for sea surface pCO2 derived from remotely-sensed SST, SSHA, Chl-a, and SSS

Number of colocated daily, 2°x2° training data points
SOCAT+CDIAC





❑Statistical model was developed using support vector regression

❑Input (3-day): sin(day), cos(day), lat, sin(lon), cos(lon), AMSR-E SST, AVISO SLHA, SeaWiFS+MODIS TERRA+MODIS Aqua Chl-a, Argo SSS

❑206265 data groups found 2002-2010 40,000 randomly selected for training and 40,000 for validation

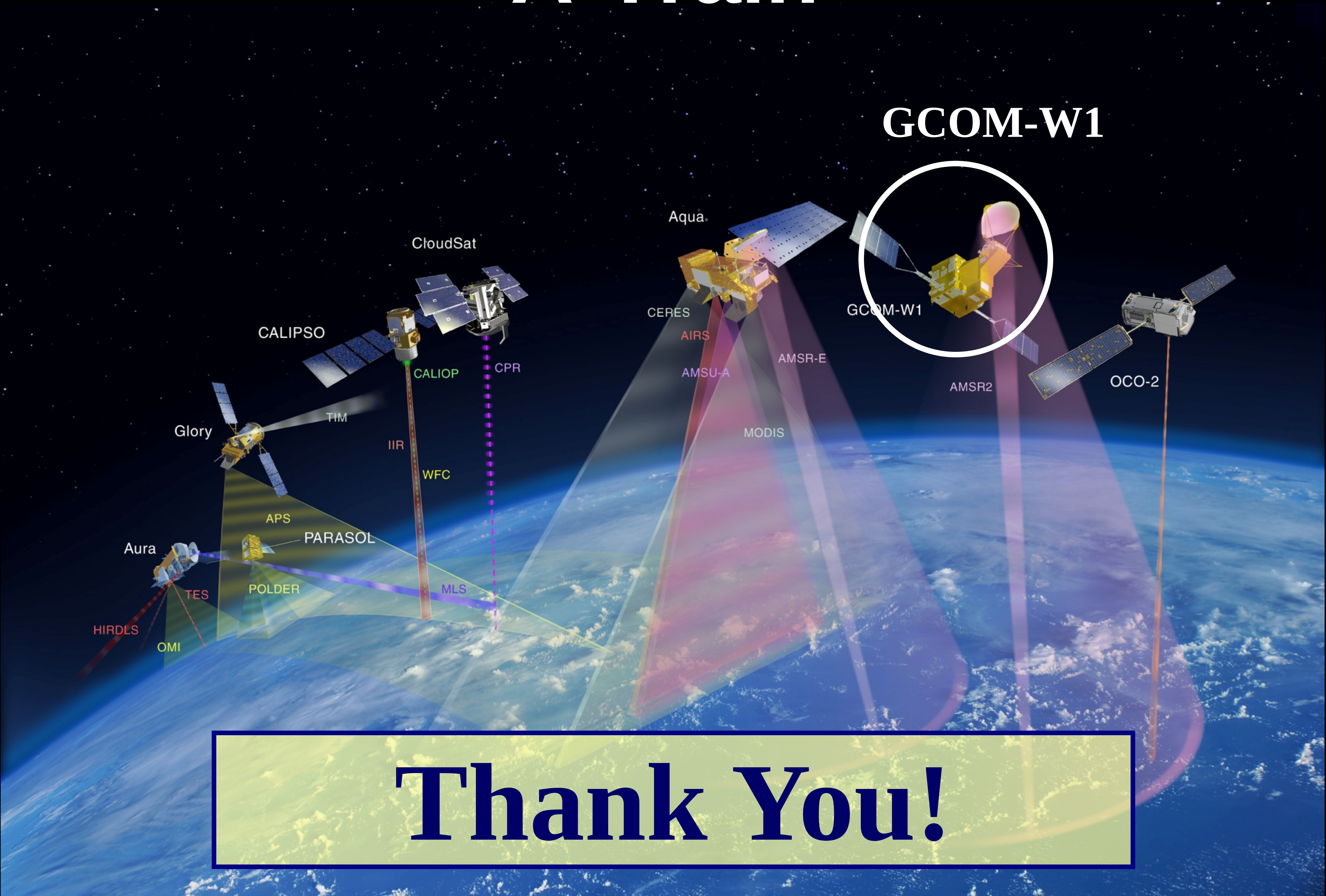
❑Output: 9 year $pCO2_{sea}$ at 0.5°, 3-day resolution

Liu et al. (20**)

Summary

- **GCOM-W1 and AMSR2 are in good shape.**
- **GCOM-W1 "SHIZUKU"**
  - **Launched on May 18, 2012 (JST).**
  - **Joined A-Train constellation.**
  - **Completed the initial checkout phase on August 10, 2012.**
- **AMSR2**
  - **Started continuous observation from July 3, 2012 (JST).**
  - **Calibration and validation activities are ongoing.**
  - **Preliminary products were already made available to PIs and collaborating agencies.**
  - **Product release to public will be 8-months and 12-months after launch for brightness temperatures and geophysical parameters.**
  - **GCOM Data Providing Service at http://gcom-w1.jaxa.jp.**
  - **Seeking various opportunities on the A-Train**
- **Will participate in GPM constellation.**

A-Train



Thank You!