GEWEX SSG, Feb 2019, Geneva

JAXA EO Program and Opportunities for GEWEX

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EO Satellites

Earth CARE/CPR
(TBD)

Advanced Optical Satellite (ALOS-3)
(JFY 2020)

Advanced SAR Satellite (ALOS-4)
(JFY 2020)

GOSAT-2
(JFY 2018)

GCOM-C
(JFY 2017)

Multi-footprint Observation LIDAR and Imager (MOLI)
(JFY 2020, proposed)

ALOS-2
(CY 2014)

DAICHI (ALOS)
(CY 2006)

Aqua/AMSR-E
(CY 2002)

GPM/DPR
(CY 2014)

ADEOS/ADEOS-II
(CY 1996/CY 2002)

TRMM/PR
(CY 1997)

JERS-1
(CY 1992)

MOS-1/MOS-1b
(CY 1987/ CY 1990)

SHIZUKU (GCOM-W)
(CY 2012)

IBUKI (GOSAT)
(CY 2009)

JMA Geostationary

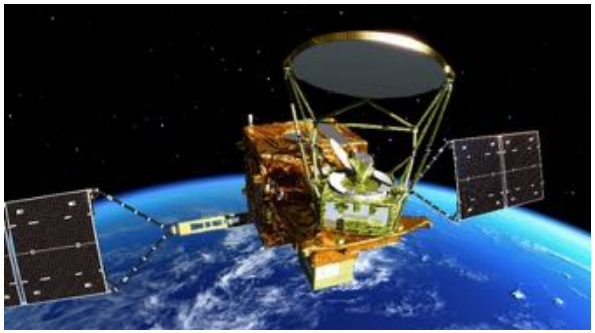
GMS ('77)-GMS-5 ('95) (Himawari, -5)

MTSAT-1R, 2 ('05, '06) (-6,7)

Himawari-8, 9 ('14, '16)

Himawari-10, 11

Global Change Observation Mission - Water "SHIZUKU" (GCOM-W)



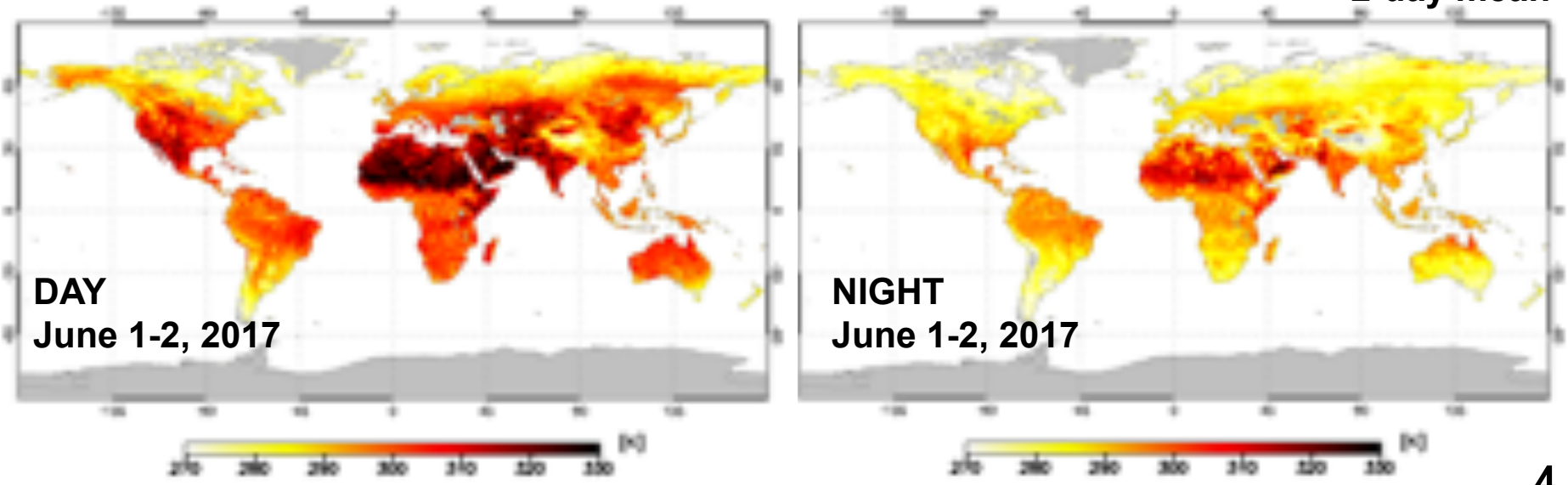
AMSR2 Products	
STD	Brightness Temperature
	Total Precipitable Water (over Ocean)
	Total Cloud Liquid Water Content
	Precipitation
	Sea Surface Temperature
	Sea Surface Wind Speed
	Sea Ice Concentration
	Snow Depth
	Soil Moisture Content
RES	All-weather Sea Surface Wind Speed
	10-GHz Sea Surface Temperature
	Land Surface Temperature
	Thin Ice Detection
	Total Precipitable Water over Land

- Successor of Aqua/AMSR-E (launched in May 2002), providing continuous data for climate studies and operational applications
- Joining A-train constellation and also GPM constellation
- GCOM-W/AMSR2, May 2012: a multi-polarization and multi-frequency microwave imager
- Observing various water-related ECVs over atmosphere, land, ocean and cryosphere in high spatial resolution
- Improving on-board calibration target has resulted reduction of annual TB variation due to calibration and improvement of TB stability
- Achieved design mission life (5-year) on May 18, 2017, and continues observation.
- AMSR2 F(O (AMSR3) has been in Pre-project phase (Phase A) since Sep. 2018.

AMSR2 Land Surface Temperature

- Algorithm provided by Tom Jackson (USDA) based on Holmes et al. (2009)
- Retrieval of LST by single equation using 36 GHz V TB
  - Equation is obtained by using linear regression between AMSR2 LST and LST at ground observation sites in Europe and US
- Observing top of forest over forest area
- Capable to obtain frequent LST for both day & night
- Released in Feb 2018 through the Research Product web site (http://suzaku.eorc.jaxa.jp/GCOM_W/research/resdist.html)
  - Detailed validation results are also available at the web site
- Production of AMSR-E LST is now considering.

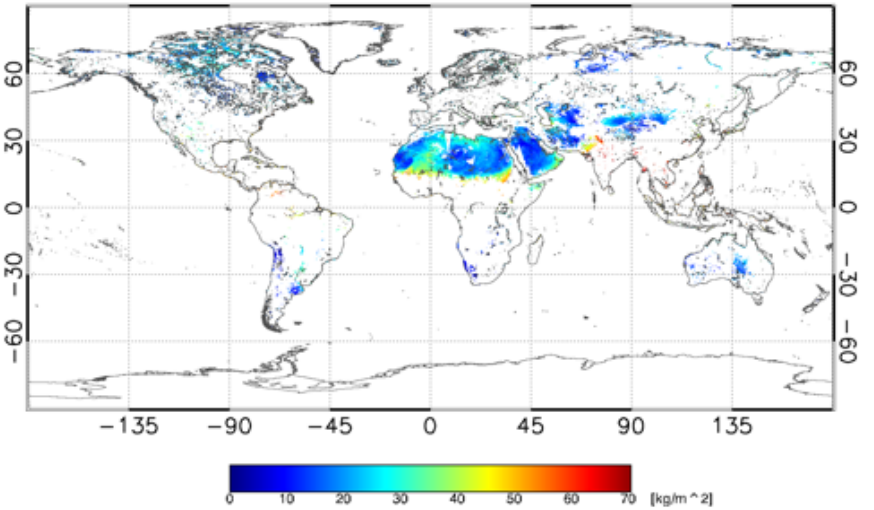
2-day mean



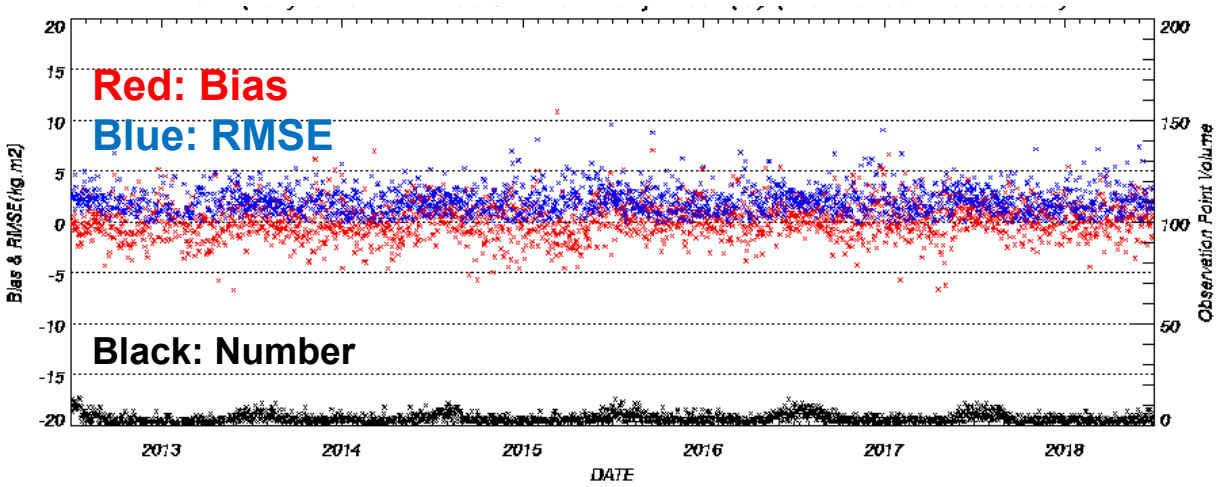
AMSR2 Total Precipitable Water over Land

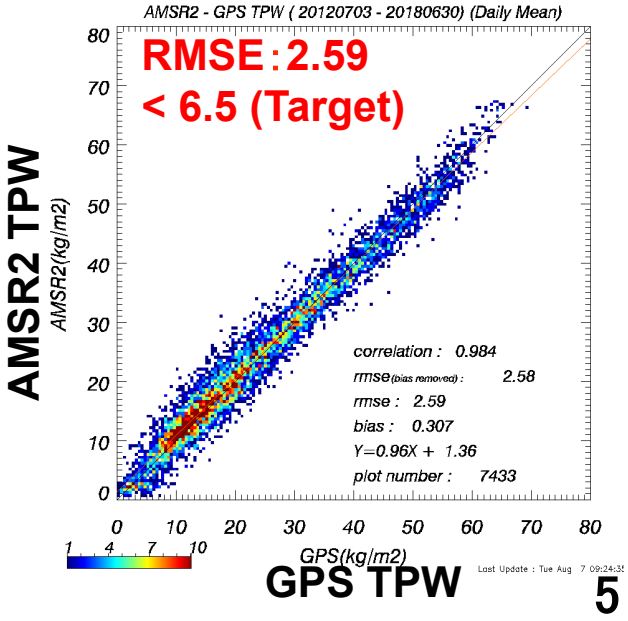
- Algorithm provided by M. Kazumori (JMA) based on Deeter (2017), Kazumori and Kachi (2017)
  - Retrieve TPW over land (except ice and vegetation area) using polarization differences of 18 and 23 GHz respectively
- Validation versus GPS and radio sonde
- Complement to standard TPW over ocean
- Released in Jan. 2019 through the Research Product web site. (http://suzaku.eorc.jaxa.jp/GCOM_W/research/resdist.html)

Ascending + Descending Average on Jul. 15, 2014



Validation vs. GPS TPW:
Global (Ascending + Descending) during 2012-2018

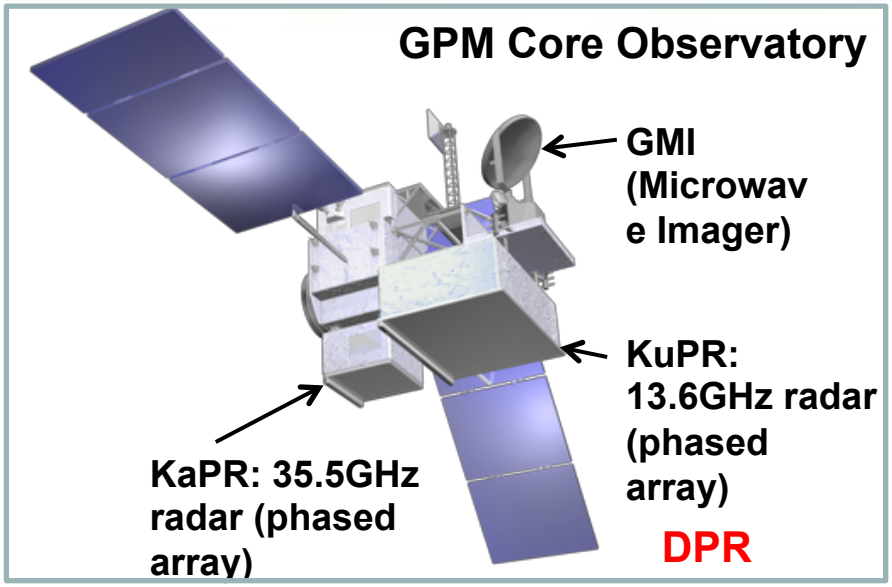


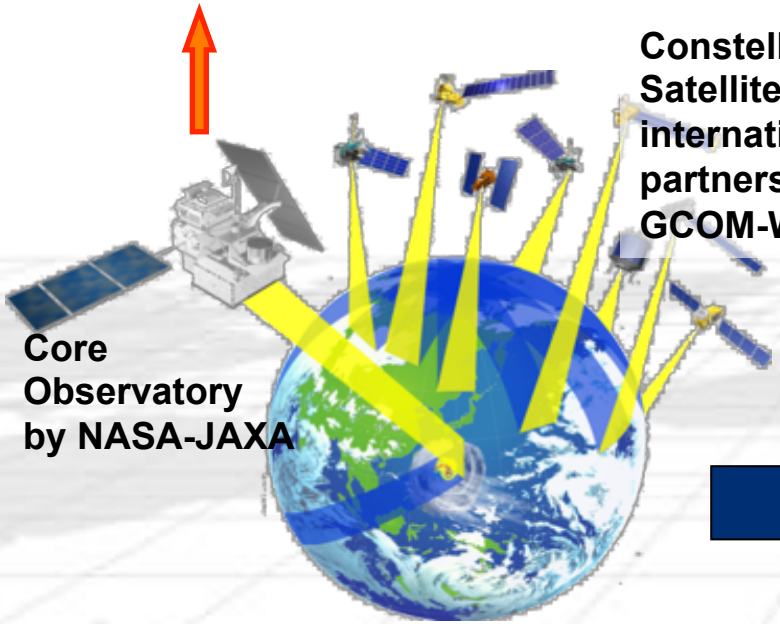


AMSR-E Reprocess Product Status

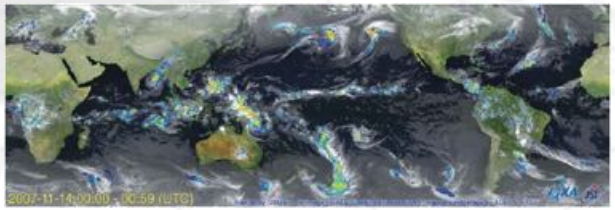
- **Reprocessing of AMSR-E products applying the latest AMSR2 algorithms and format** is underway to provide consistent for long-term analysis.
  - **Brightness temperature (L1B, L1R, L3TB)**: Released from the G-Portal (https://www.gportal.jaxa.jp/gp/)
    - Applying the current AMSR2 L1 format (HDF5).
    - Brightness temperature (TB) between AMSR-E and AMSR2 is not adjusted.
    - AMSR-E L1R (resampling) products are newly developed
    - **Swath width** of AMSR-E (**1450km**) is **extended to be equivalent to that of AMSR2** (**1620km**) by applying bias correction at scan edge.
    - Improved hot load calibration method.
    - Improved geometric parameters.
  - **Geophysical parameters (L2, L3GEO)**: Public **release in mid-2019**
    - Applying the current (latest) AMSR2 L2 algorithms and format (HDF5).
    - Validation is underway.

Global Precipitation Measurement (GPM)





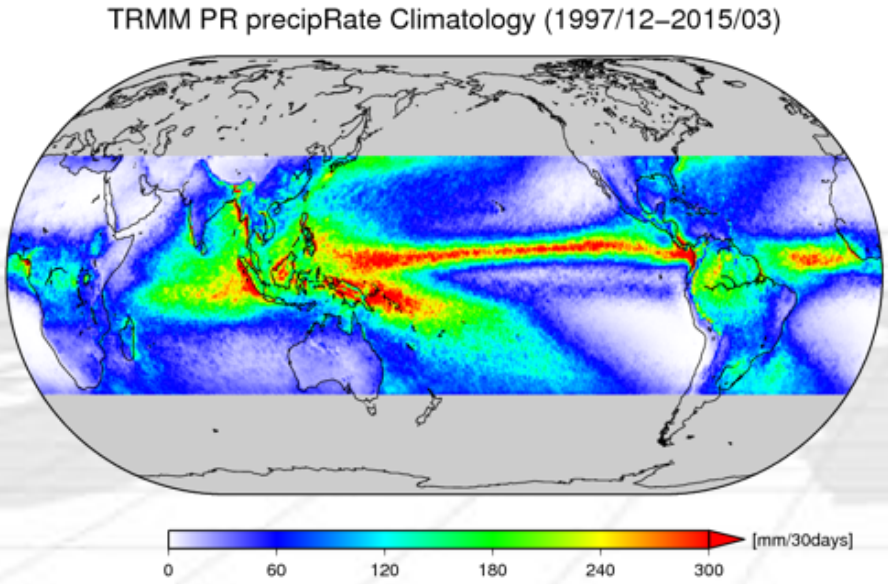
- GPM launched in Feb 2014
  - Core Observatory: developed under NASA and JAXA equal partnership
  - Constellation satellites: provided by international partners (including GCOM-W1)
- Dual-frequency Precipitation Radar (DPR)
  - developed by JAXA and NICT
  - DPR composed of two radars: KuPR & KaPR
- JAXA completed the End of Prime mission review of the GPM/DPR on June 19th 2017 to confirm achievements of the mission requirement.
- GPM/DPR management review was held on 26th October 2017 for approval to move extended mission phase.



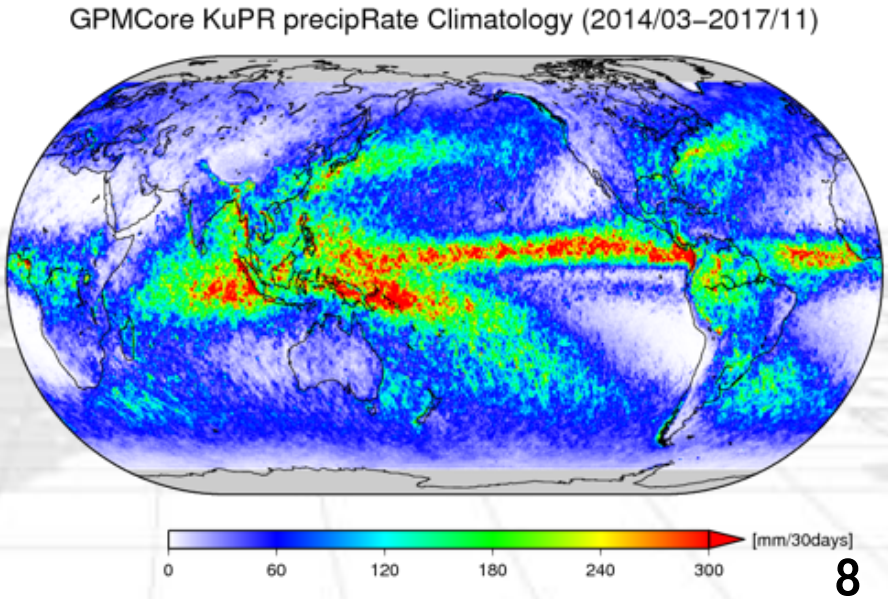
Wider coverages by GPM/DPR observations

- Climatological distribution of surface precipitation amount for TRMM/PR vs. GPM/DPR
- **→Wider coverages by GPM/DPR observations**

Surface precipitation distribution byTRMM/PR (Dec. 1997-Mar.2015)



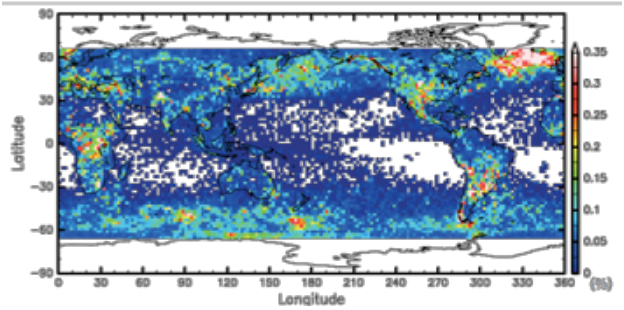
Surface precipitation distribution byGPM/DPR (Mar.2014-Nov.2017)



Distribution of intense solid precipitation （hail and graupel etc.）retrieved by DPR

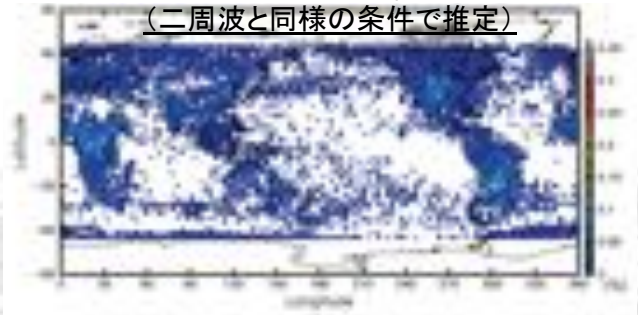
Iguchi et al. (2018, *JTECH*)

Percentage of intense solid precipitation retrieved from dual frequency information



Percentage of intense solid precipitation, but from single（KuPR) frequency

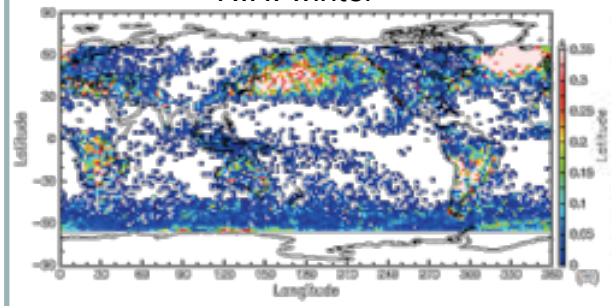
（二周波と同様の条件で推定）



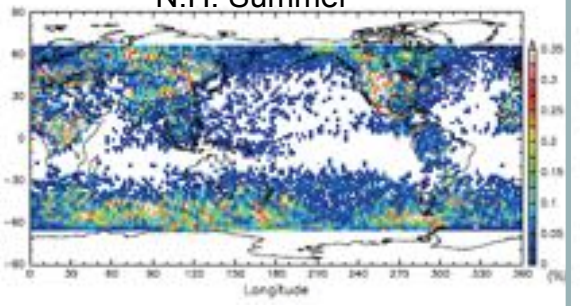
could get new information by using dual frequcies

Percentage of intense solid precipitation in column

N.H. winter

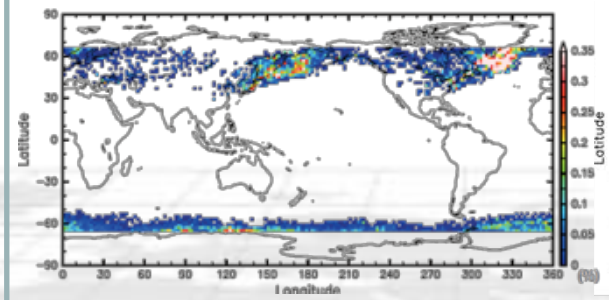


N.H. Summer

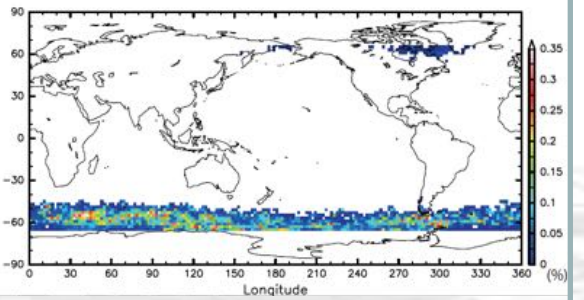


Percentatge of intense solid precipitation that reaches the ground surface

N.H. winter



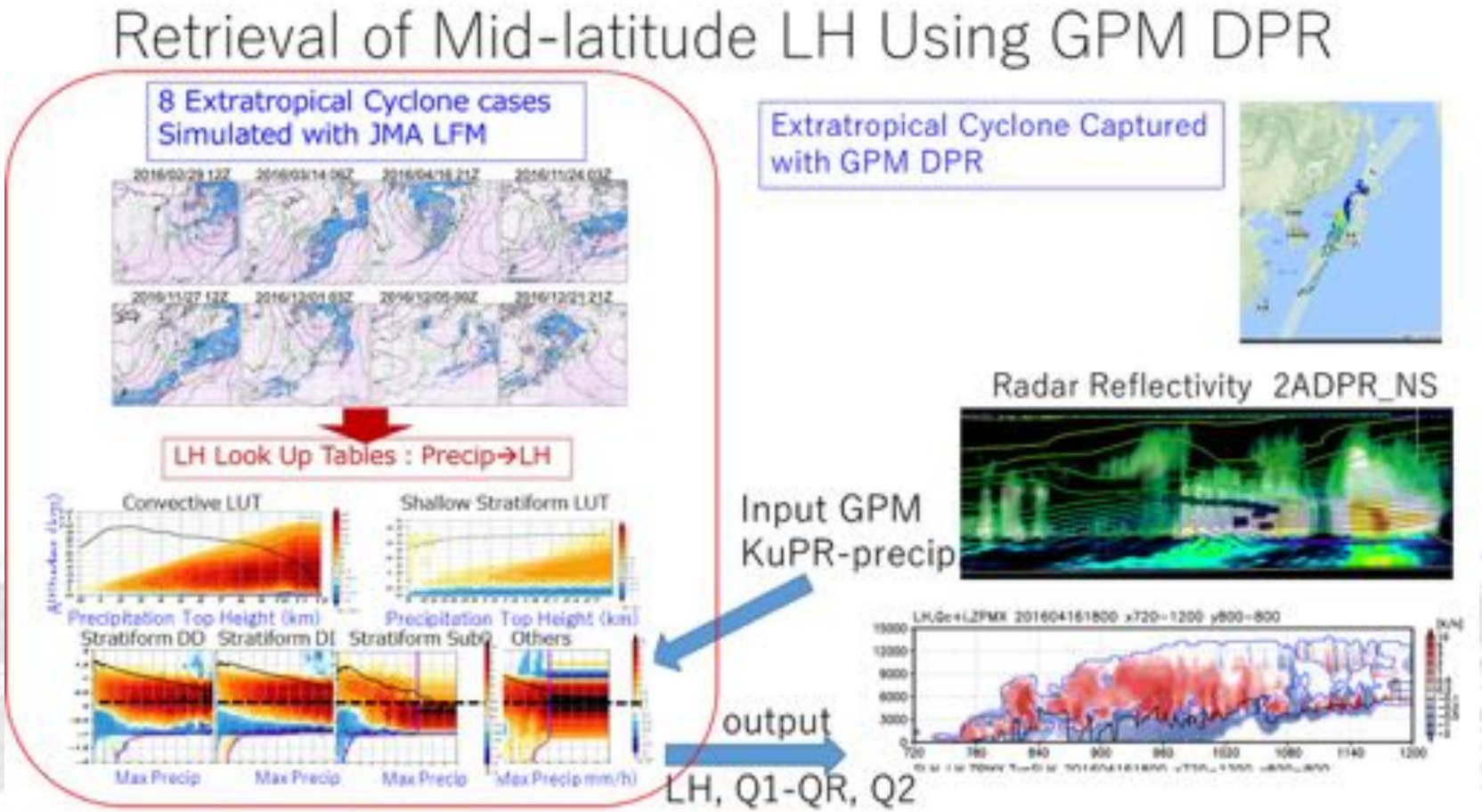
N.H. summer



Solid precipitation that reaches the surface can be seen over ocean than land in the winter of Northern Hemisphere. Especially over north western Pacific and north western Atlantic

DPR SLH V05 product

- GPM latent heating V05 product released in Jul. (SLH) and Aug. (CSH) 2017 included LH retrievals over mid-latitudes.

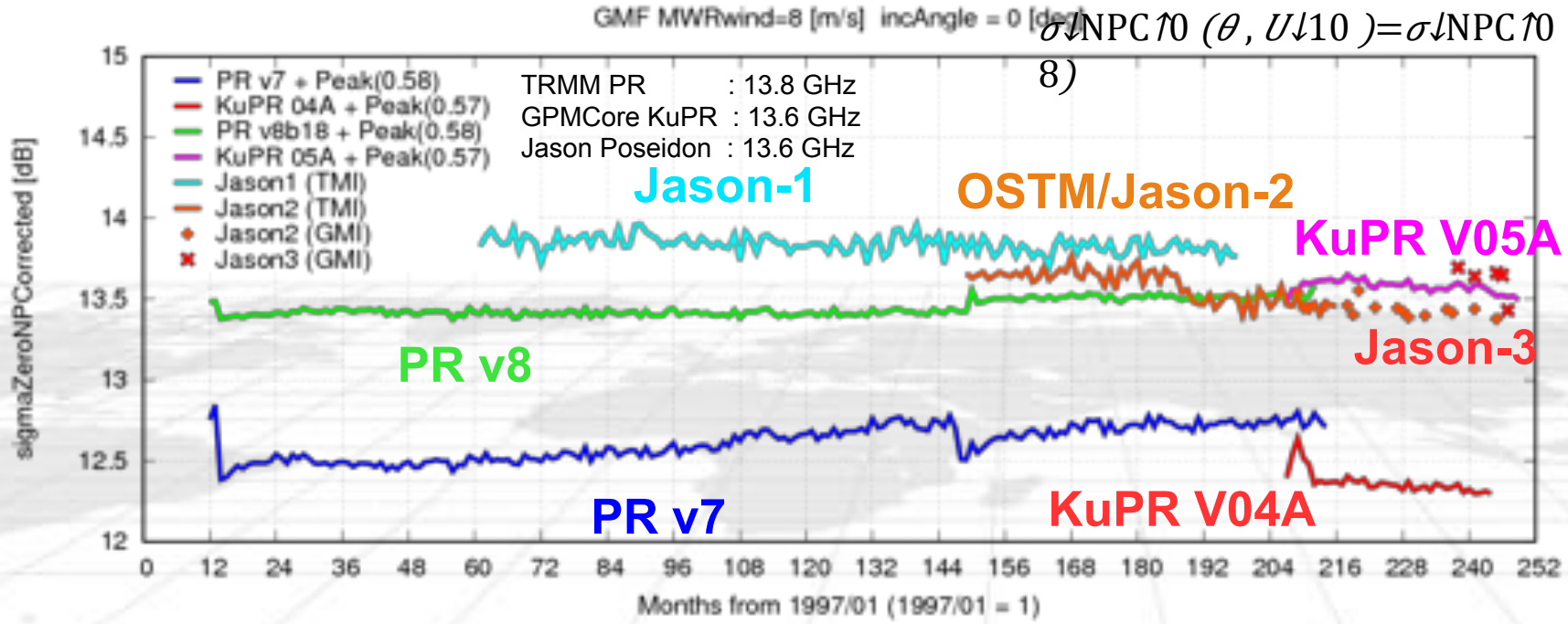


(provided by Prof. Takayabu, Univ. Tokyo)

Better continuity of the TRMM/PR V8 and the GPM/KuPR V05

- GPM/DPR's calibration factors was changed in V05 released in May 2017, and TRMM/PR's calibration factors was also changed in TRMM V8 released in Oct. 2017.
- Better continuity was realized in the GPM/KuPR V05 and the TRMM/PR V8.

Comparisons of the NRCS (σ^0) with various sensors



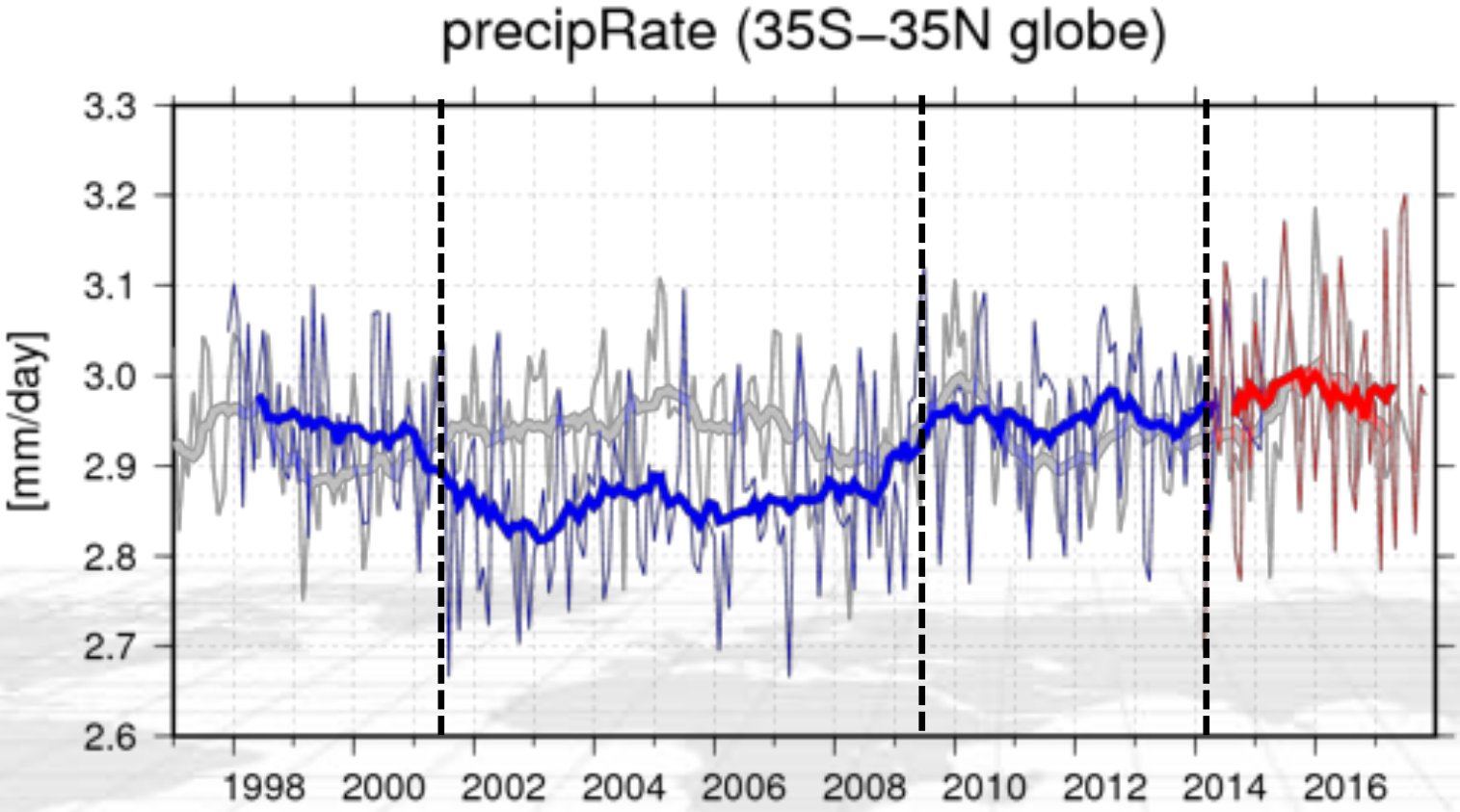
20-year Precipitation time series by TRMM/ GPM spaceborne radars

GPCP V2.3 (Adler et al., 2017)

PR v8b18 nadir (test version)→ *open to the public in June 2018*

KuPR V05A nadir

Heavy lines denote 13-month running mean

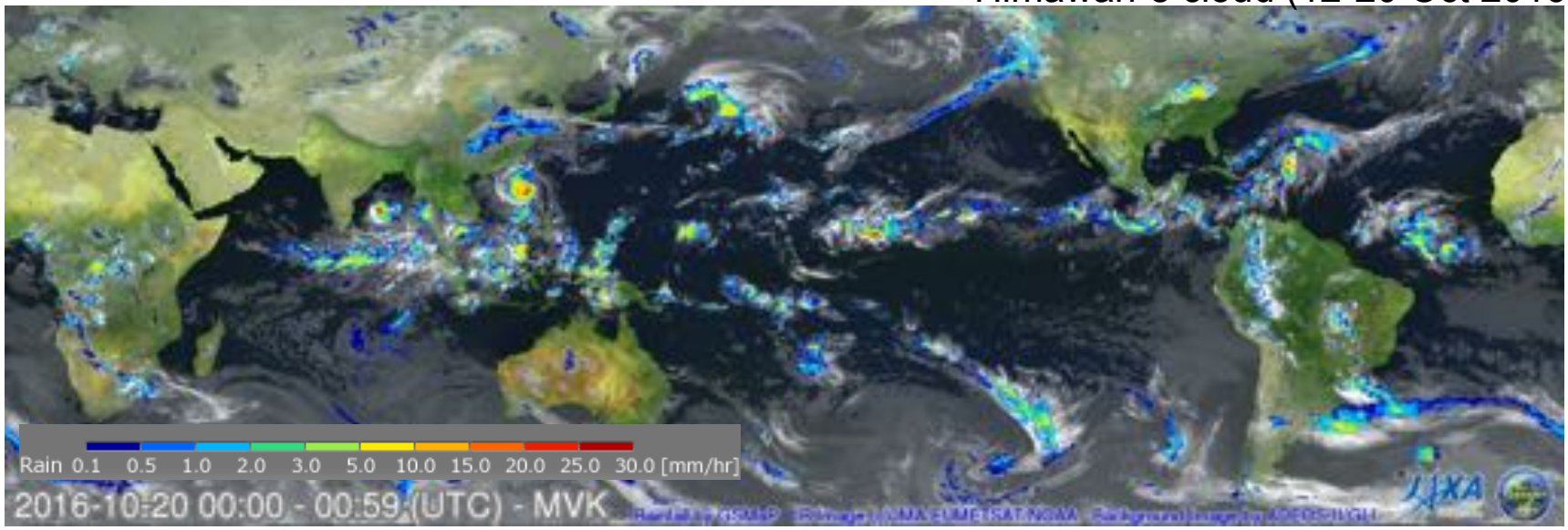


TRMM boost PR A/B switch GPM-Core launch

Global Satellite Mapping of Precipitation (GSMaP)

http://sharaku.eorc.jaxa.jp/GSMaP/

GSMaP_NRT hourly rain with Himawari-8 cloud (12-20 Oct 2016)



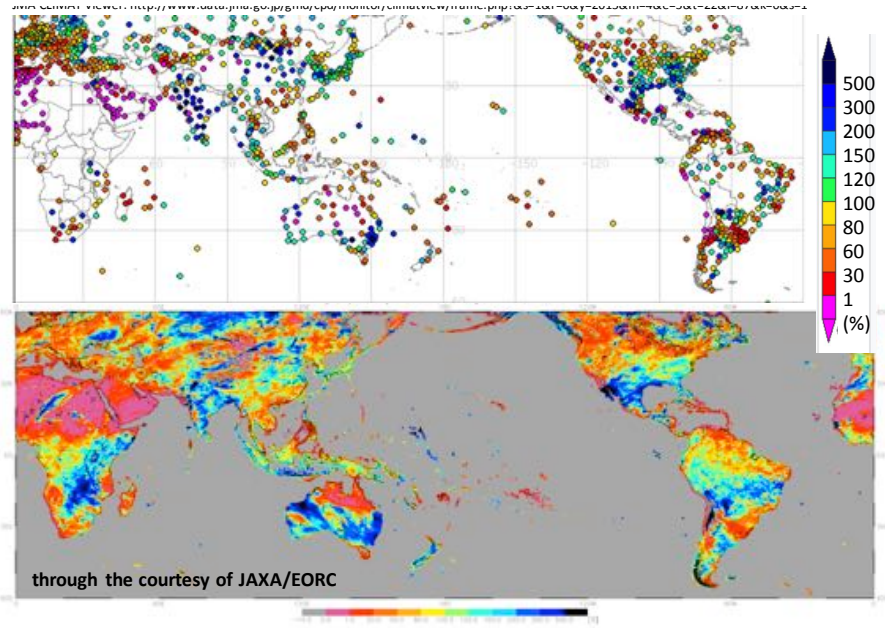
- GSMaP is a blended Microwave-IR product and has been developed in Japan toward the GPM mission.
  - U.S. counterpart is “IMERG”
  - GSMaP (v6) data was reprocessed as reanalysis version (GSMaP_RNL) since Mar. 2000 period , and was open to the public in Apr. 2016, and new version, GSMaP (v7) was released in 17 Jan. 2017.
  - GSMaP realtime product (GSMaP_NOW) in the domain of GEO-Himawari, GSMaP Riken Nowcast (GSMaP_RNC) data developed by RIKEN/AICS (Otsuka et al. 2016) are now available from JAXA/EORC ftp site.

WMO SEMDP

- **WMO Space-based Weather and Climate Extremes Monitoring (SWCEM) Demonstration Project (SEMDP) planned by Mr. Kurino (WMO)**

(i) monitoring **persistent heavy precipitation** and **droughts**;
(ii) making best use of existing and newly developed satellite derived products and time series of measurements;
(iii) making best use of products that combine satellite information with in-situ and/or model reanalysis data;
(iv) recommendations as to which products should be transitioned from research to operations, including an assessment of those products.

CLIMAT-GSMaP climate analysis



Monthly mean precipitation ratio (%) in April 2015-CLIMAT (30-yr normal) vs GSMaP (17yr normal)

Water Cycle research task at EORC

R&D phase | Operation phase

steps	～3rd year	～7th year	～10th year
	Global 50km/Japan 1km Land area simulation	Global 10km Land area simulation	Globa1km simulation
models・input data	GSMaP, MODIS, GMS8 etc.	GSMaP, GCOM-C, GMS8 etc.	GSMaP, GCOM-C, GMS8 etc.
	Global 50km Land surface model; Japan 1km Land surface model	Global 10km Land surface model; Satellite-Ground gauge merged data	Global 1km land surface model; Integration with information of Ecosystem
output	Global 50km/Japan 1km land surface data sets	Global 10km land surface data set/hazard indices	Global 1km land surface Data sets/hazard indices
purposes/user	Monitoring Water disaster in Global large river basins	Water disaster in middle size river basins	Local scale water disaster/water resources・agriculture
	hydrological agencies managing International river, big river basins	Hydrological agencies managing middle size river basins	Hydrological agencies, hydrology and agricultural division of local Municipality, international food security agency

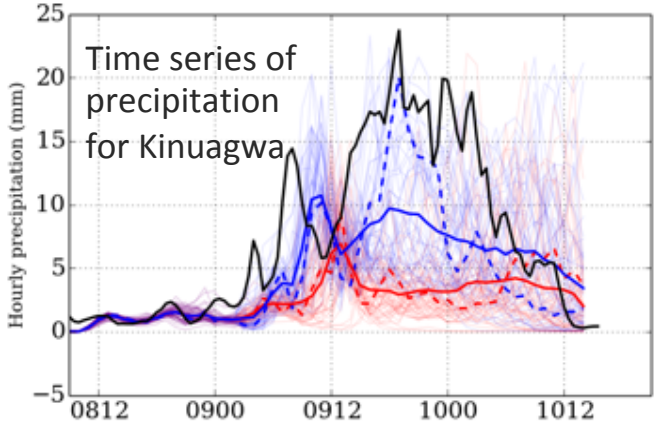
Now here

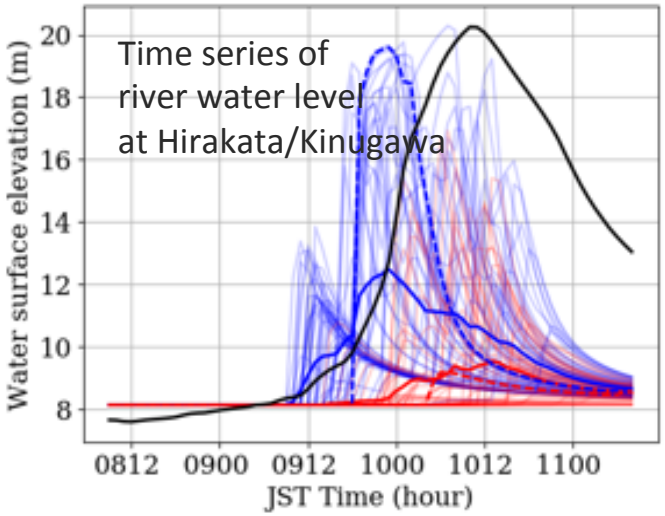
Aiming to develop hyper-resolutional (global 1km) model

JAXA's Land Simulation System *"Today's Earth (TE)" in collaboration with U. Tokyo*

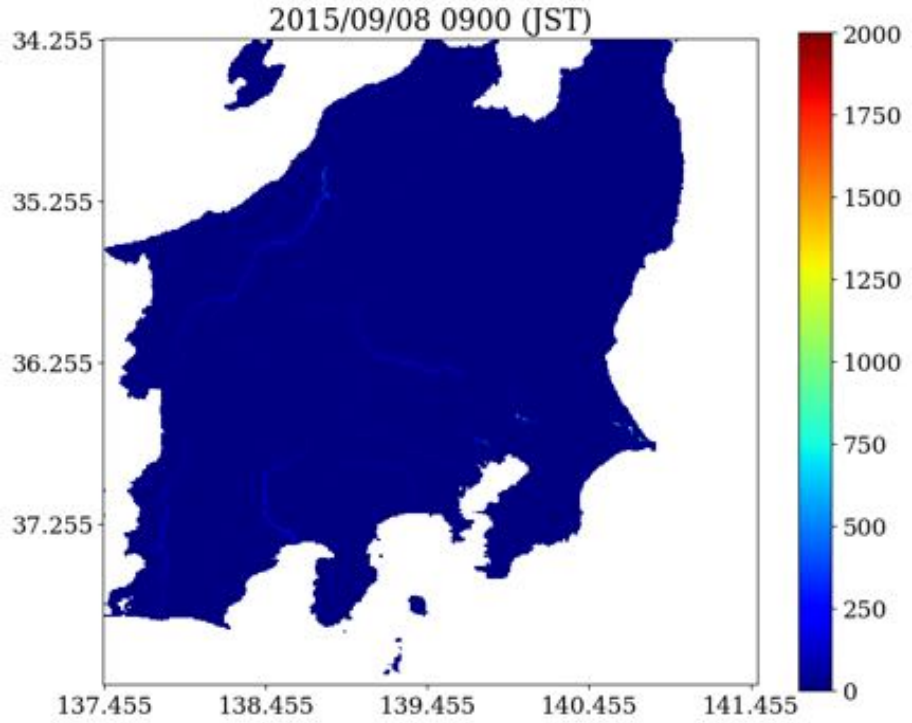
Hind cast experiment of Kinugawa Flooding case in Sep. 9, 2015

High-resolution (1km) ensemble simulation using satellite assimilated meteorological data





Blue/Red: with/without data assimilation
Black: observation

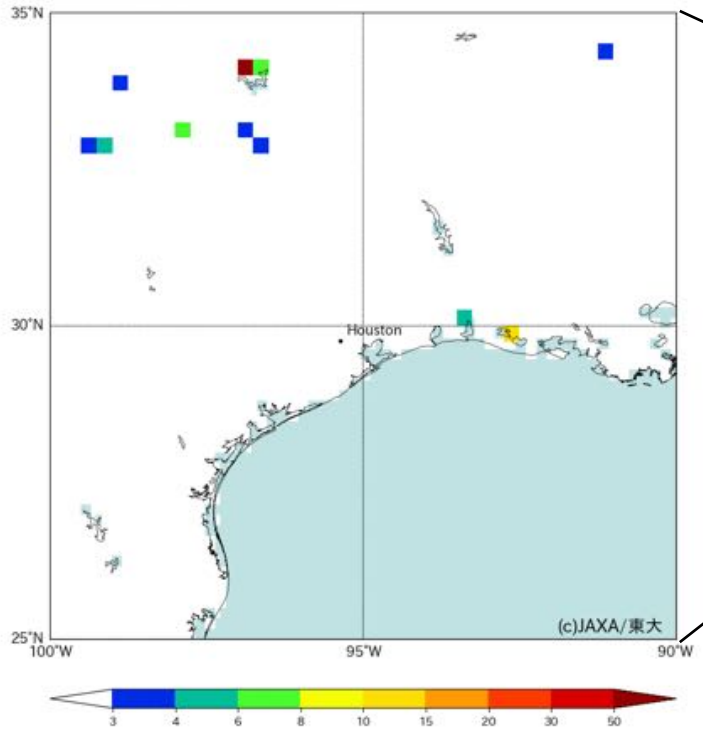


- Satellite data assimilation improved the precipitation and water level results.
- More improvements (ex. peak time of water level) are needed.

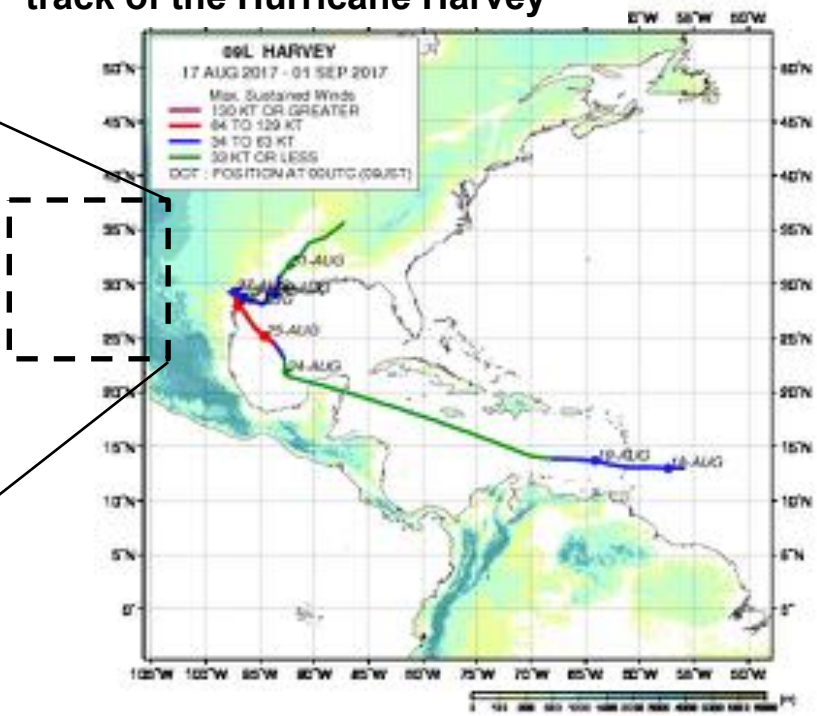
Global Land Simulation System
"Today's Earth – Global (TE-Global)"

- TE-Global reproduced flood severity well in the case of Hurricane Harvey at the end of August, 2017.
  - System efficiently shows the severity of the situation by describing the increase in the number of reddish grids indicating "very severe" (return period of over 30 years) as the hurricane passes over Houston, Texas.

Return period of river discharge (2017/08/23 00Z)
(DPI)

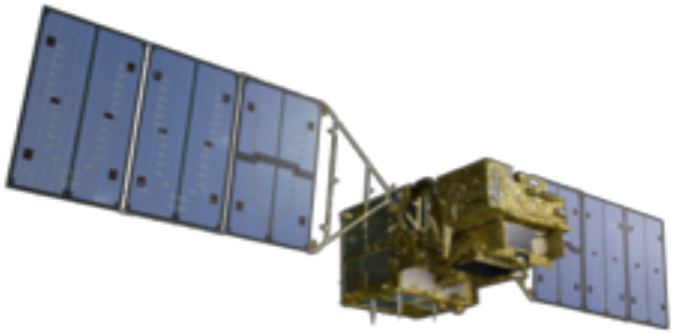


track of the Hurricane Harvey



Himwari-8/9 Geo (2014) JMA

Geo AHI: Full disk scan every 10min, Rapid scan 2.5 min
0.5km: 0.64μm
1km: 0.47, 0.51, 0.86
2km: 1.6, 2.3, 3.9, 6.2, 6.9, 7.3, 8.6, 9.6, 10.4, 11.2, 12.3, 13.3μm

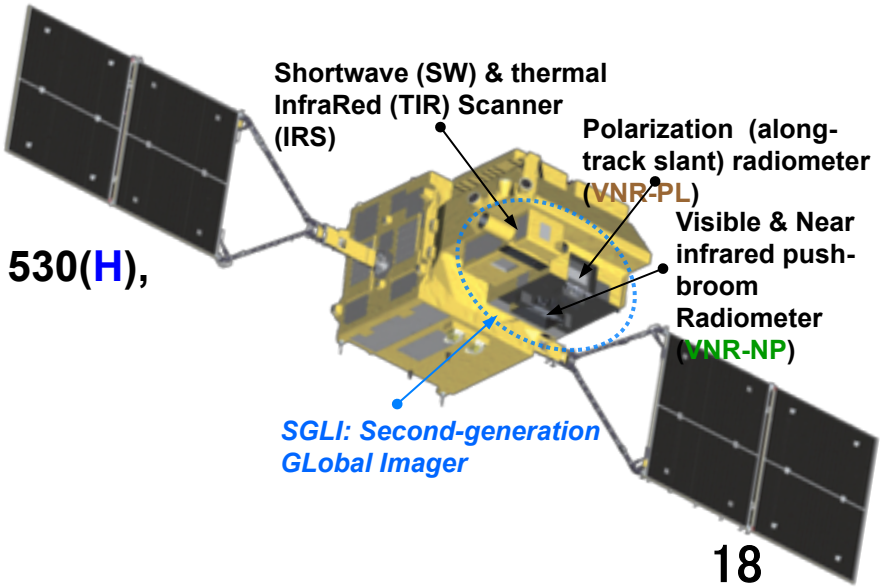


FTS, FTS2: CO_2, CH_4, O_2, O_3, H_2O, CO; 9/7kmϕ, ±40° (AT), Intelligent pointing
CAI, CAI2: FOV 0.5km
fwrd (+20°):
343, 443, 674, 869, 1630
bwrd(-20°):
380, 550, 674, 869, 1630 nm

GOSAT (2009), GOSAT-2 (2018)

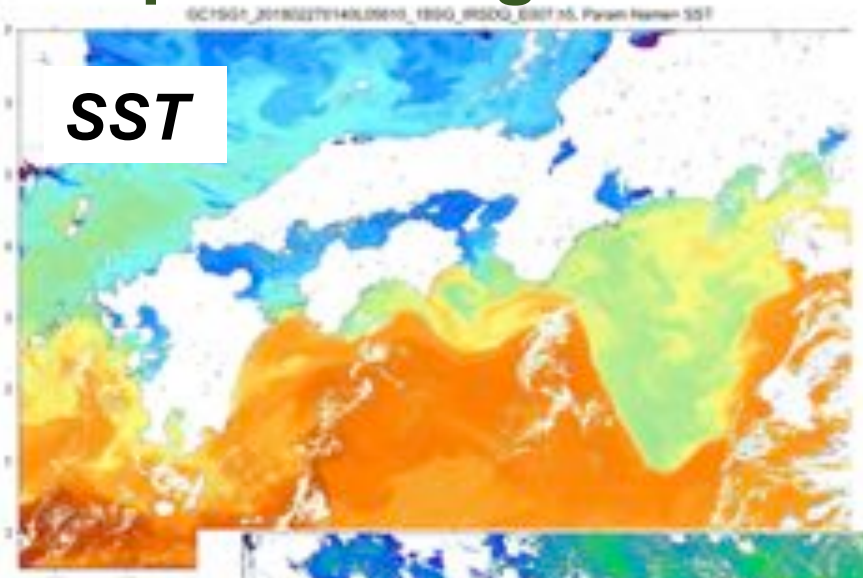
JAXA- MOE-NIES; 13:00

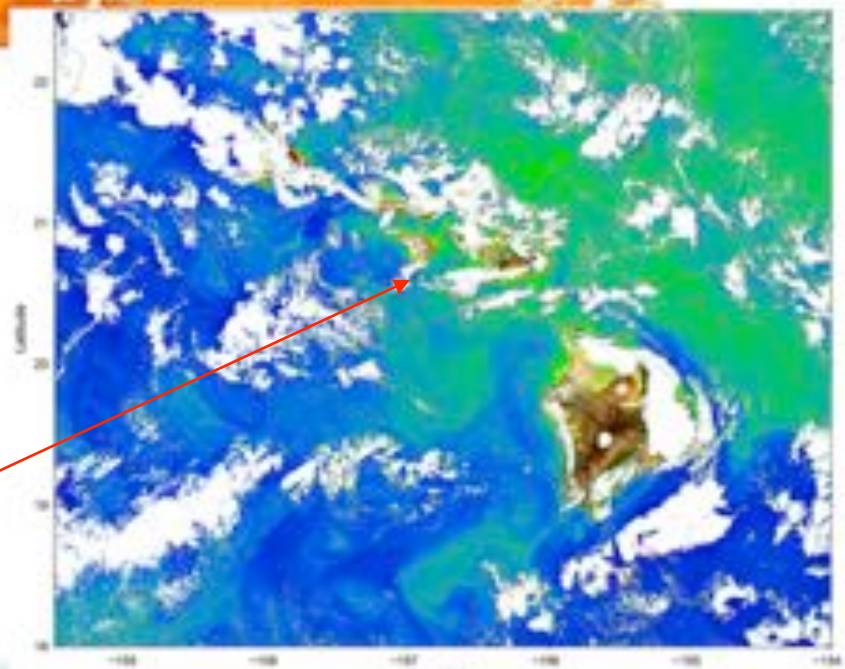
GCOM-C (Dec 2017); 10:30, SGLI



19 channels
VNR 1/0.25km (-24, 0, 24°): 380, 412(H),443, 490, 530(H), 565, 674(HL), 763, 869(HL)
VIR Polarization (±45° tilt) 1km: 674, 869
IRS (80° scan)
SW: 1050, 1380, 2210 (1km), 1630 nm (1km/250)
TIR 1/0.5/0.25: 10.8, 12.0

GCOM-C/SGLI 250m acquired images



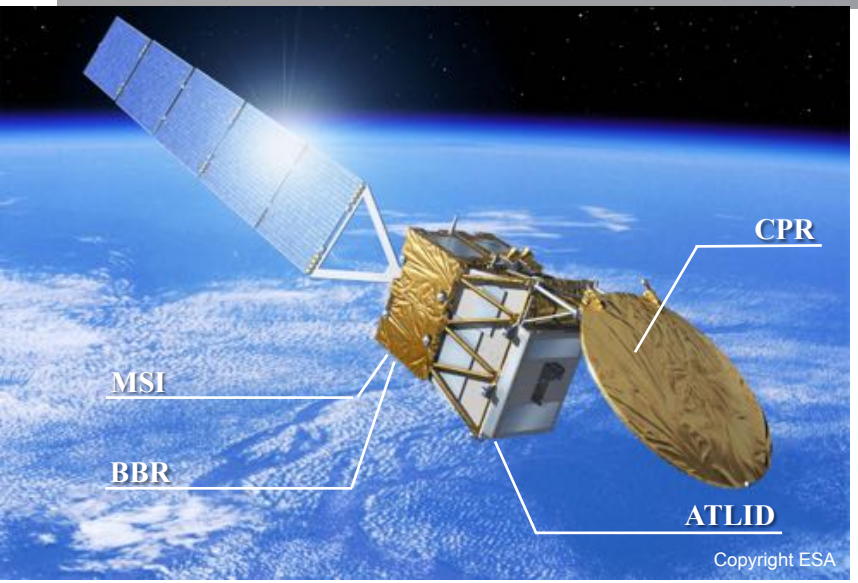


MOBY
20.82N
157.19W

19

Earth Cloud, Aerosol and Radiation Explorer (EarthCARE)

Synergetic Observation by Four Instruments

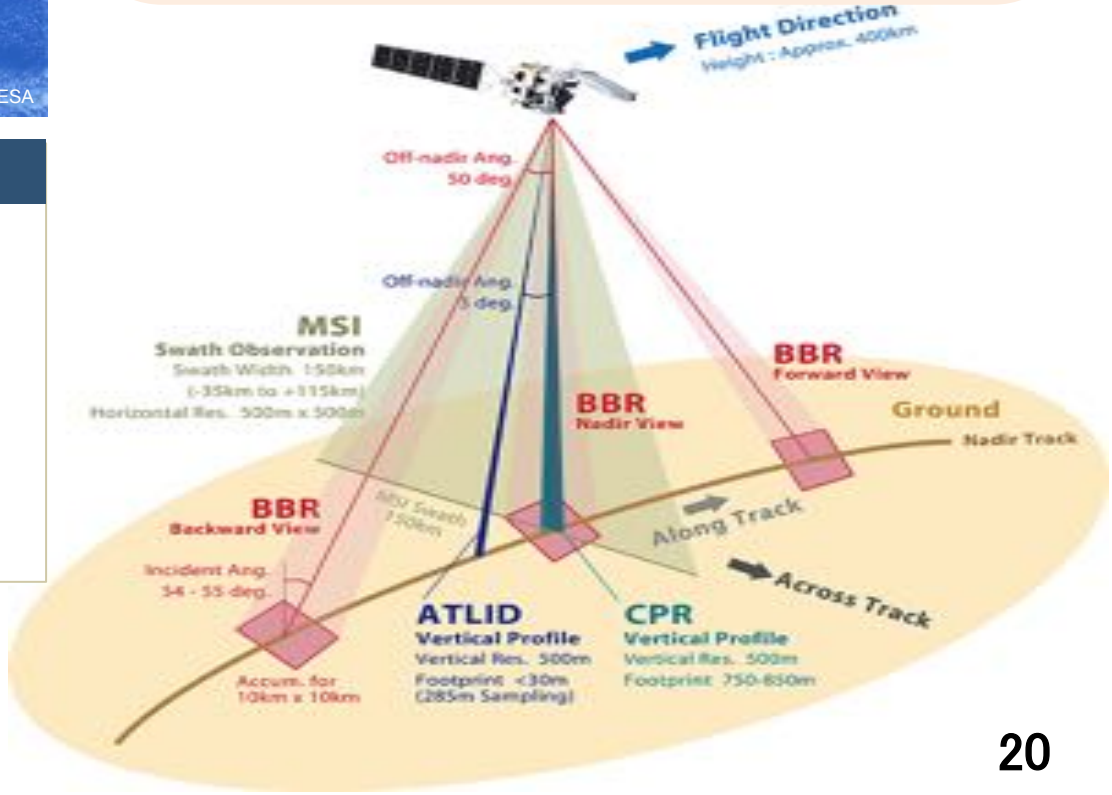


Synergetic Observation by Four Instruments on Global Scale

- Three-dimensional structure of aerosol and cloud including vertical motion
- Radiation flux at top of atmosphere
- Aerosol – cloud – radiation interactions

Observation Instruments on EarthCARE

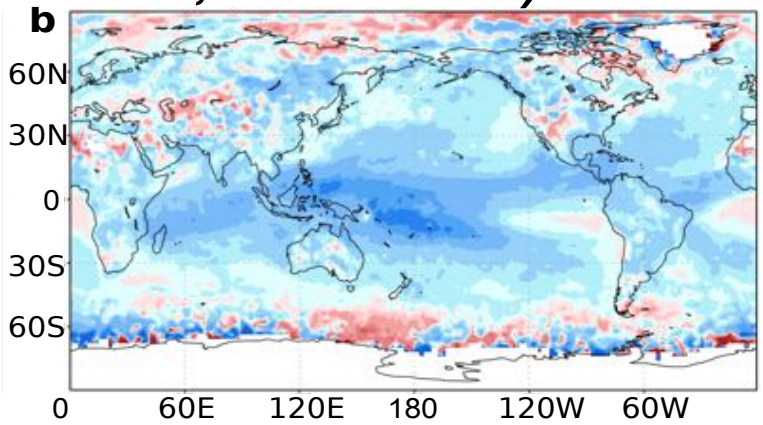
CPR	Cloud Profiling Radar
ATLID	Atmospheric Lidar
MSI	Multi-Spectral Imager
BBR	Broadband Radiometer



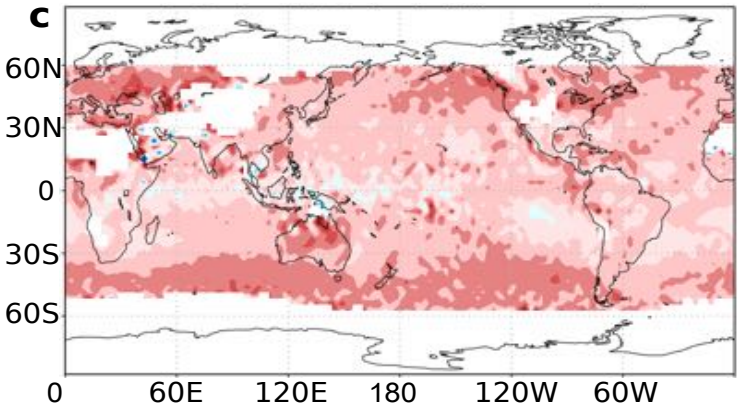
? Sensitivity slope of low-level cloud susceptibility?

$$b(LWP) = d\ln(LWP)/d\ln(Na)$$

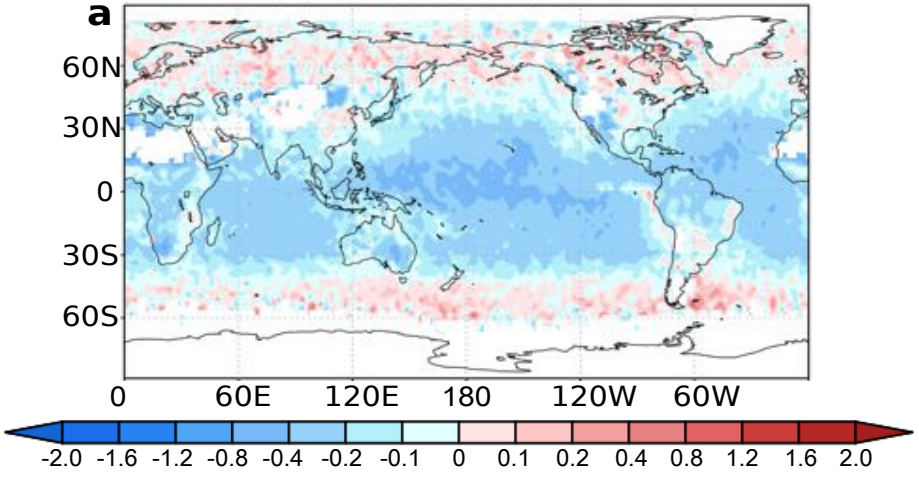
NICAM-Chem (14km)
(Sato et al., Nature-C'18) **~-0.1**



MIROC-SPRINTARS (300km) ~+0.1



Satellite Obs. (A-Train)
(Michibata et al., ACP'16) **~-0.05**



d*ln*(*LWP*)/d*ln*(*Nc*)= 2**b*(*LWP*)

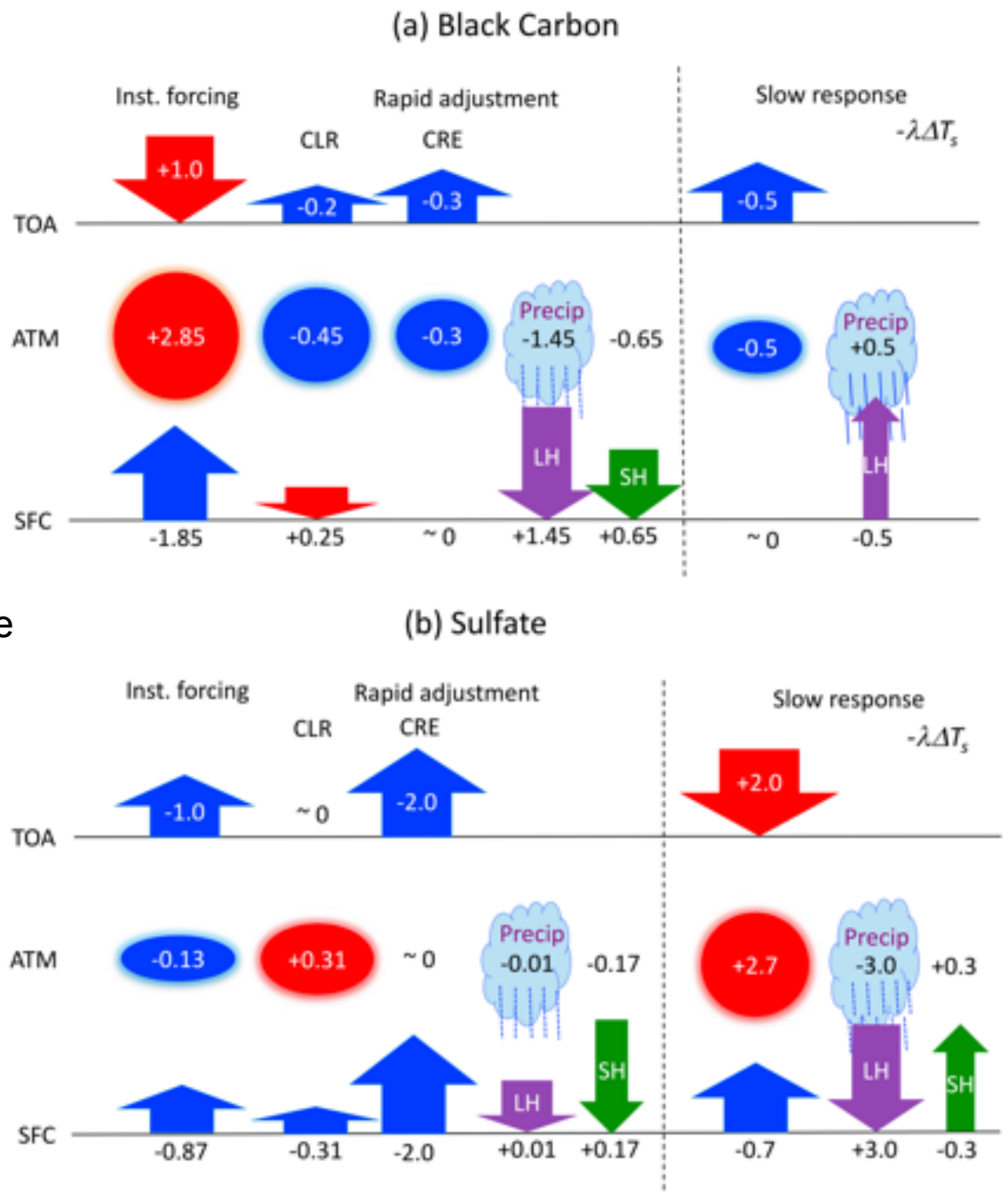
$$N_c \propto N_a^{\beta}$$

β= 0.26-0.8
~ 0.50 *Nakajima (GRL'01)*
AVHRR global

- **Horizontal resolution**
- **Cloud m-physics (incl. evaporation)**
- **Rain scheme: DIAG vs PROG**
- **Other processes (Entrainment, cloud top evaporation)**
- **Sampling methods (time, location)**
- **Ice cloud?**

Large differences in climate responses by sulfate and BC aerosols

- BC reduction to cool the system?
- COP21, Paris Agreement: Importance in 0.5C mitigation by SLCP
- Summary for decision makers of the integrated assessment of black carbon and tropospheric ozone (UNEP, 2011)
- Air Pollution in Asia and the Pacific: Science-based solutions (UN CCAC, 2019)

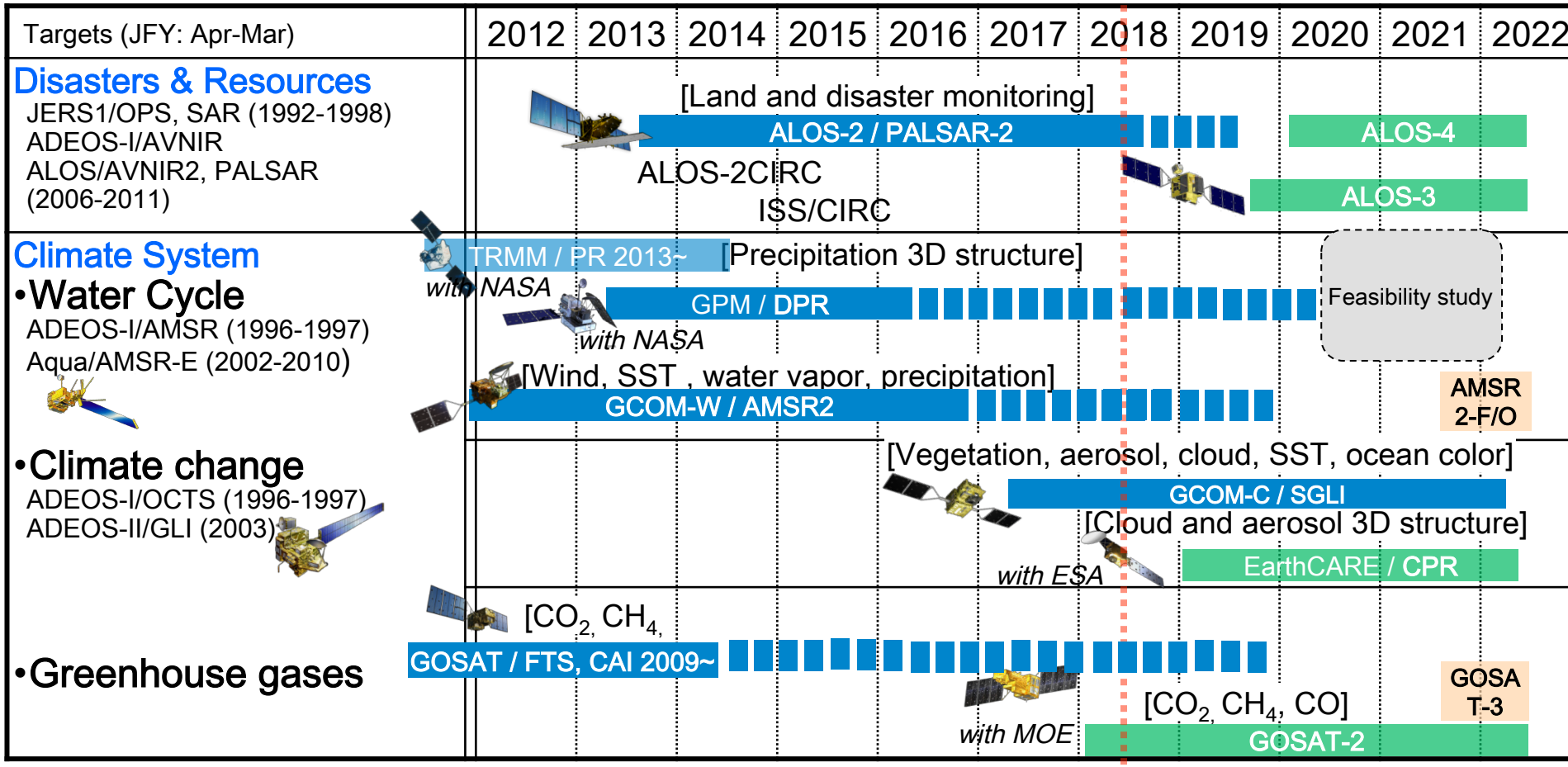


Suzuki and Takemura (JGR'18)

Status of collaboration with other space agencies

Agency	Collaboration
JMA	Data exchange, algorithm development, CAL/VAL, utilization in operational activities
NASA	Joint development/operation of GPM, CAL/VAL for GOSAT-1&2/OCO-2, A-CCP mission studies, collaboration in disaster monitoring
NOAA	GCOM-W&C/JPSS collaboration, utilization in operational activities, GCOM-W data distribution to US agencies
ESA	Joint development of EarthCARE, collaboration in GHGs related missions
EUMETSAT	Data exchange, GCOM-W data distribution to member countries via EUMETCast, partnership in GPM (MetOp)
DLR	Collaboration in Strategic Dialogue (EO sub working group consists of 6 themes), collaboration in GHGs related missions
CNES	Collaboration in GHGs related missions, partnership in GPM (Megha-Tropiques), ALOS-2/Sentinel-1 collaboration
CSA	Collaboration in disaster monitoring
ISRO	Collaboration in improvement/validation of rainfall products, partnership in GPM (Megha-Tropiques)

Japanese Earth Observation Satellite Lineup



AMSR2 follow-on Mission (AMSR3)

- In response to those requirements, AMSR3 has been in pre-project phase since September 1, 2018.
  - Mission Definition Reviews (MDR): April to June 2018 – COMPLETED
  - System Requirement Review (SRR): January 2019 - COMPLETED
  - System Definition Review (SDR): Autumn 2019
  - The new satellite (tentatively called as GOSAT-3) will become a joint mission of GOSAT-2/TANSO-2 successor sensor (advanced spectrometer to monitor greenhouse gases) and AMSR3 (advanced microwave radiometer).
  - Orbit will be 666 km altitude (same as GOSAT-1) and 13:30 LT in Ascending node (same as GCOM-W)
- AMSR2 follow-on sensor specification
  - Almost equivalent sensor specification to the current AMSR2 (antenna size, channels) except additional higher frequency channels of 166 & 183 GHz for snowfall retrievals
  - New products including snowfall, TPW over land, high-resolution SST, all-weather sea surface wind speed & high-resolution sea ice concentration
  - Near-real-time data distribution capability will be the same as AMSR2

Future mission planning (Japan)

- Decision system changed aft the Basic Plan on Space Policy (2008)
- Science Council of Japan (SCJ) and Remote Sensing TF (23 academic societies and 2 groups) started discussion
  - Understanding global scale climate change and water cycle mechanisms
  - Forest biomass estimation
  - SLCP reduction
  - Understanding cloud and precipitation processes
  - Monitoring global environmental changes

Summary (Satellites)

- **GCOM-C was successfully launched**
  - **SGLI products will be released at the end of this year via G-Portal.**
- **GCOM-W and GPM achieved designed mission life in May 2017, and transferred to Extended Mission period.**
  - **Long term record of AMSR sensor series and PR-DPR series can contribute GEWEX science**
  - **(for GCOM-W/AMSR2 results, please check Kachi's presentation on Thursday)**
- **GOSAT-2 will be launched in 2018. EarthCARE will be launched in 2020.**
- **Mission Definition Review of AMSR2 follow-on sensor (AMSR3) is currently on going**

Summary (Researches)

- **Results of GPM/DPR**
  - Accumulating 3-dimentional precipitation data including mid latitude.
  - Differences of precipitation features between the tropics and extratropic revealed by GPM/DPR
  - Distribution of intense solid precipitation（hail and graupel etc.）
  - DPR Latent heating profile product was released
  - Continuous Precip. Radar data from TRMM to DPR will be released
- **GSMaP**
  - WMO Space-based Weather and Climate Extremes Monitoring (SWCEM) Demonstration Project (SEMDP)
- **JAXA global hydrological simulation model “Today’s Earth (TE)”**
  - YEE utilizes both global reanalysis data and satellite observation data aiming to produce more reliable hydrological dataset and risk indices.
  - Japan(local) 1-km model is also about to release.
- **2ndJAXA EO Research Opportunities will be Announce in 2018**

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27th IUGG General Assembly

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Beyond 100: The next century in Earth and Space Science

The 27th IUGG General Assembly will be held July 8-18, 2019 at the Palais des Congrès in Montréal, Québec, Canada. This is a special opportunity for participants from Canada and from around the world to come together and share their science and culture. 2019 marks the 100th anniversary of IUGG; we will look back on the accomplishments of the previous century of E... and space science research, and forward to the next century of scientific advanc... for a host of scientific activities, including special public lectures, key... wide variety of themed sessions.

During your stay, you will have the o... widely renowned across North America a... social and culinary scene. July is a particular... outdoor dining and the many festivals tak...

In co... IUGG General Assembly, a number of scientific workshops and cultural event... planned. We will also be offering the chance to explore the geological treasures of our region through a number of field trips ranging from half-day to multi-day excursions.

General questions: please contact us at:
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iugg2019.abstracts@c...

...e decision to ...adline for submission of ...racts to March 1, 2019 at 12:00 Central European Time (CET).

The extension is to accommodate many researchers, who have been affected by technical difficulties, and national governmental regulations.

ONLINE ABSTRACT SUBMISSION

IUGG, IAMAS 100 years anniversary!