学術会議公開シンポジウム
「Future Earth時代における地球表層システム科学と防災・減災研究」

地球科学と大気科学の100年史から見た現代的課題

中島映至
JAXA Earth Observation Research Center, Chief Scientist
前IAMAS事務局長

IUGG, IAMAS, AMS Centennial Celebrations

- IUGG100, IAMAS100 articles
  - Hist. Geo Space Sci., 10, 2019
  - IAMAS: a century of international cooperation in atmospheric sciences by M.C. MacCracken and H. Volkert
- AMS100 celebration
  - https://journals.ametsoc.org/doi/10.1175/AMSMONOGRAPHS-D-18-0020.1
  - 100 Years of Progress in Forecasting and NWP Applications by S.G. Benjamin, J.M. Brown, G. Brunet, P. Lynch, K. Saito, T.W. Schlatter

Development of Meteorology and Atmospheric Sciences

Boyle's law 1662

Industrial revolution mid 17C

Hadley circulation 1735

Barometer, Torricelli 1643

Mercury thermometer, Fahrenheit 1714

Fourier, radiation effect 1824

Arrhenius, global warming 1896

IMO 1879

Frontal activity, Bjerknes 1917

IUGG 1919

6 sections w Meteorology

8th meeting of the International Commission for the Scientific Investigation of the Upper Air, on 25 July 1921, Bergen, Norway (Volkert, ASS'17)

Int. Assoc. Meteorol. 1933

Failure of Richardson's experiment ~1920

6 hour forecast for 2 month hand calculation

he wrote "64,000 calculators work"

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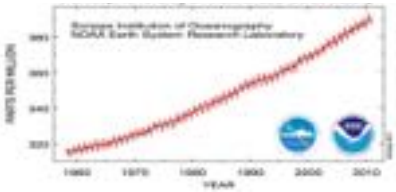
Int. Assoc. Meteorol. 1933

Richardson's experiment ~1920



Radiation, Ozone commissions 1948

IGY 1957-58

WMO 1950

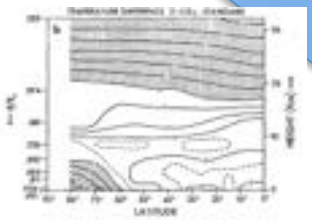
CO2 monitoring at Mauna Loa 1958

IAMAP 1957

TIROS-1 meteorol. satellite, 1960

WCRP 1980

Global warming GCM,
Manabe, Wetherald 1975

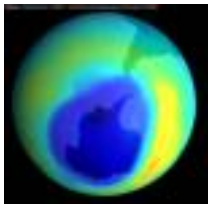


IPCC 1988

IAMAS 1991

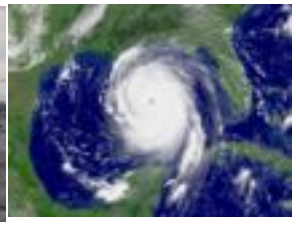
Ozone hole, Farman et al 1985

Crutzen, Molina, Rowland,
Nobel Prize in Chemistry 1995



Earth Simulator
2002, 36TF

ISC 2018



Hurricane Katrina 2005
Extreme weather increase

IPCC-AR5 2013

Development of Meteorology and Atmospheric Sciences

Boyle's law 1662

Industrial

Hadley circulation 1735

IMO 1879

IUGG 1919

Int. Assoc. Meteorol. 1933

1917

Society affected by weather and climate

Establishment of Meteorology as a natural science

Richardson's experiment ~1920

nmissions 1948

CO2 monitoring at Mauna Loa 1958

TIROS-1 meteorol. satellite, 1960

WCRP 1980

Global warming GCM,

IPCC 1988

IAMAS 1991

Ozone hole, Farman et al 1985

Crutzen, Molina, F

Nobel Prize in Chemistry 1995

2002, 36TF

Community formation

International frameworks and services

International Geophysical Year (IGY)

Golden era of earth observation

Climate simulations and awareness to global warming

New sciences and applications

Hurricane Katrina 2005

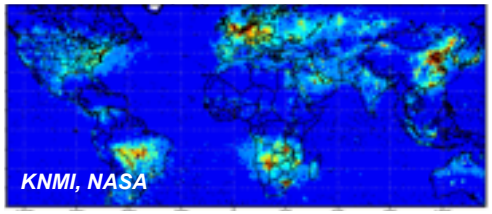
Ext

Data nexus and Earth Science/AI modeling

Kei Yoshimura@UT

Air quality change and climate forcing

GOME('95—'11),SCIAMACHY('02-'12), OMI ('04-), GOME-2 ('06-) etc
TEMPO-Sentinel4-GEMS Geo system

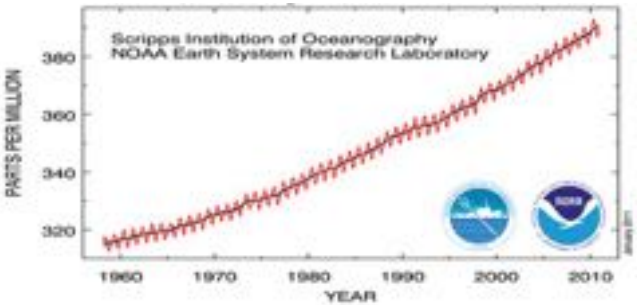


Short-lived pollutants measurements from space (SO2, NO2, HCHO, NH3 etc)

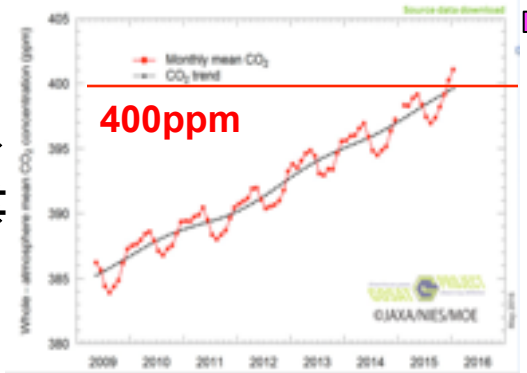
High resolution modeling

sulfate sea salt dust carbonaceous cloud

Long term surface monitoring

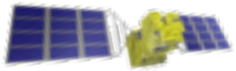


CO2 column mean (ppm)



GHGs monitoring from space (CO2, CH4 etc)

GOSAT ('09-)
OCO2 ('14-)
TanSat ('16-) etc



Air pollution

Physics and chemistry process
Health impacts etc

Climate forcing

Global warming

Radiative forcing: Greenhouse effect, Parasol effect etc

GHGs SLCPs emission

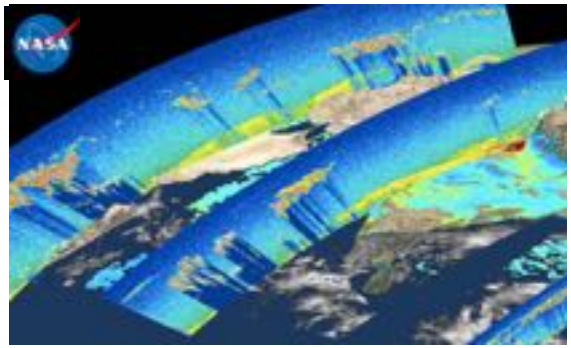
Natural and human activities

Atmospheric feedbacks and impacts

Vertical profiling of the atmosphere

CALIPSO ('06-)
CLOUDSAT/ ('06-)
EarthCARE

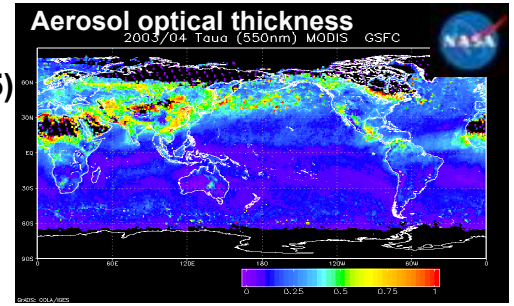
TRMM/PR ('97-'15)
GPM/DPR ('14-)

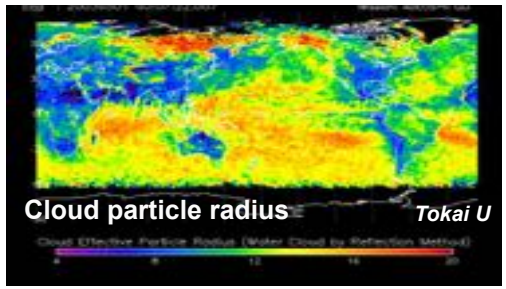


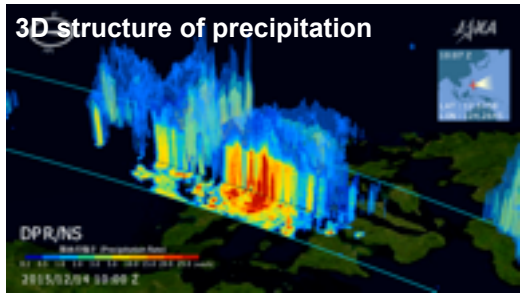
Aerosol and cloud interaction

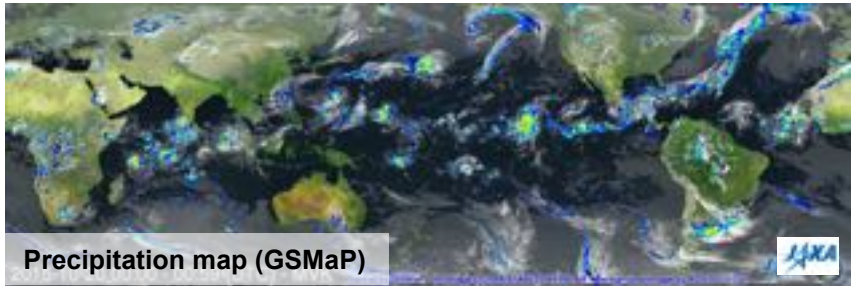
TERRA/MODIS('99-), SUOMI ('11-),
GCOM-C ('17-) etc

AQUA/AMSR-E ('02-'15)
GCOM-W/AMSR2 ('11-)









picture from ISS

Iren Petrova@GATAG

Climate sensitivity

Severe weather

Disaster reduction

Dynamics Feedbacks

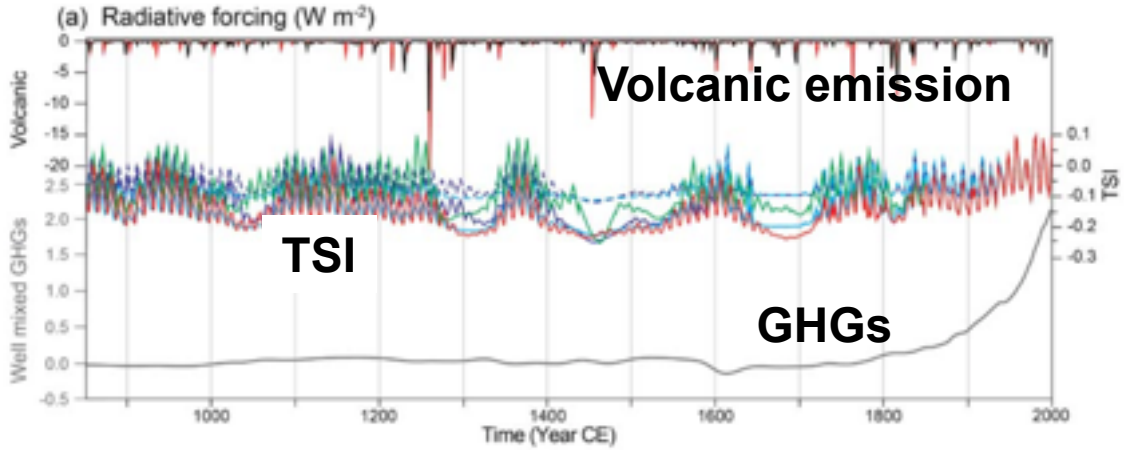
Precipitation Water cycle

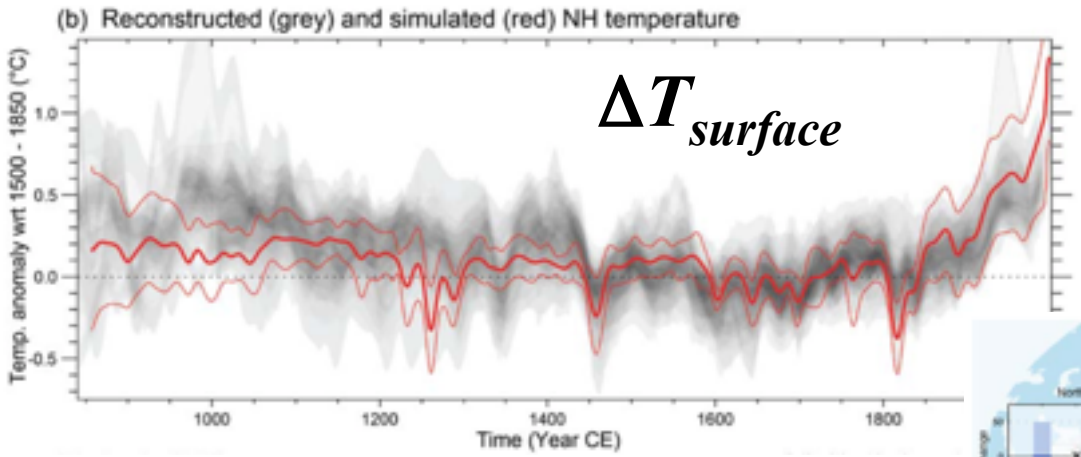
Impacts

Human society and ecosystem

Kei Yoshimura@U

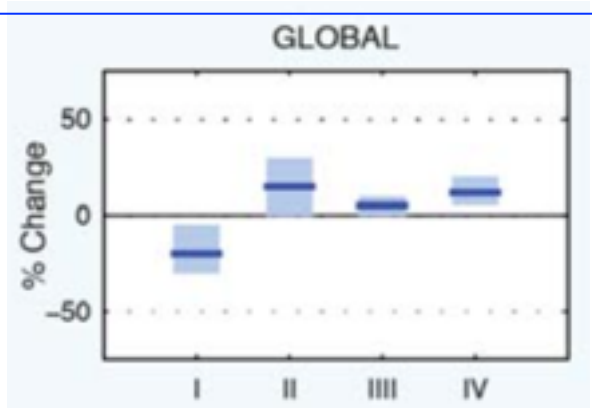
Improved understanding in climate change mechanisms

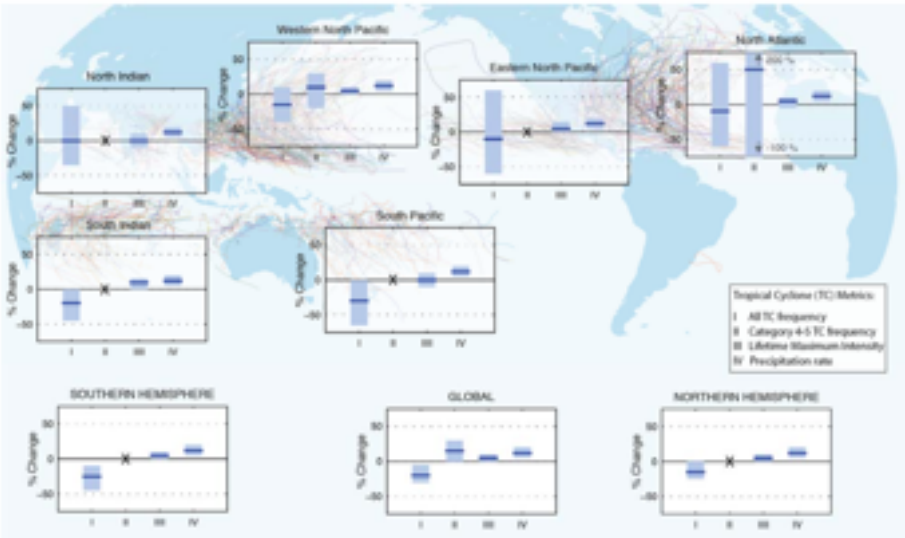




Recent topics:

- **Black carbon reduction decrease surface temperature???**
- **Air pollution decrease low level cloud???**

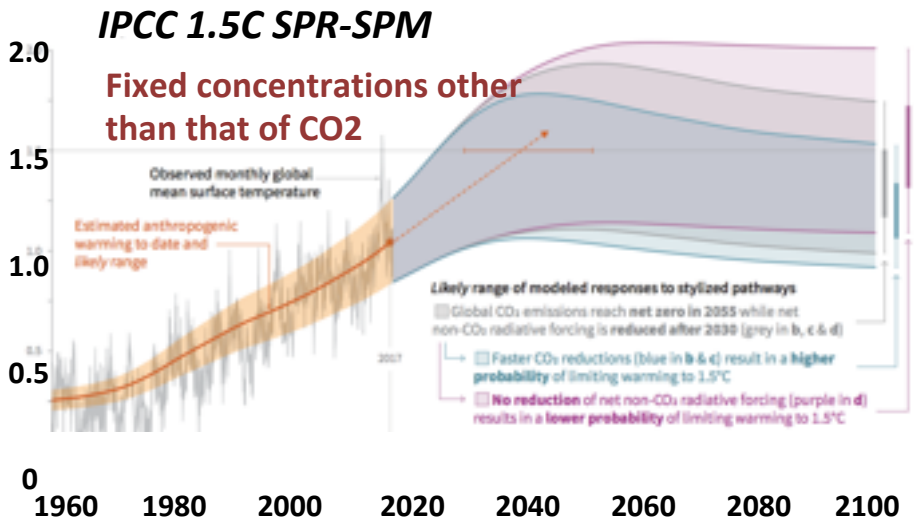


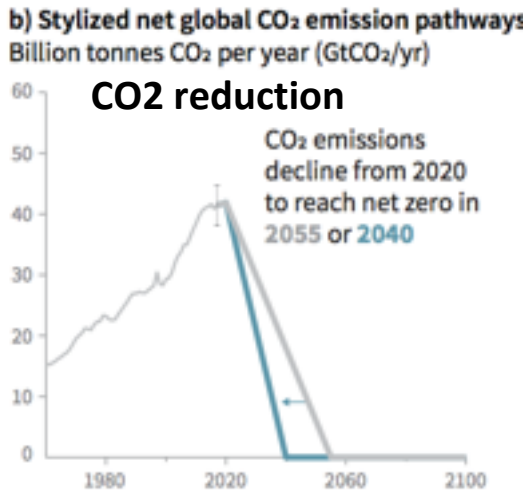


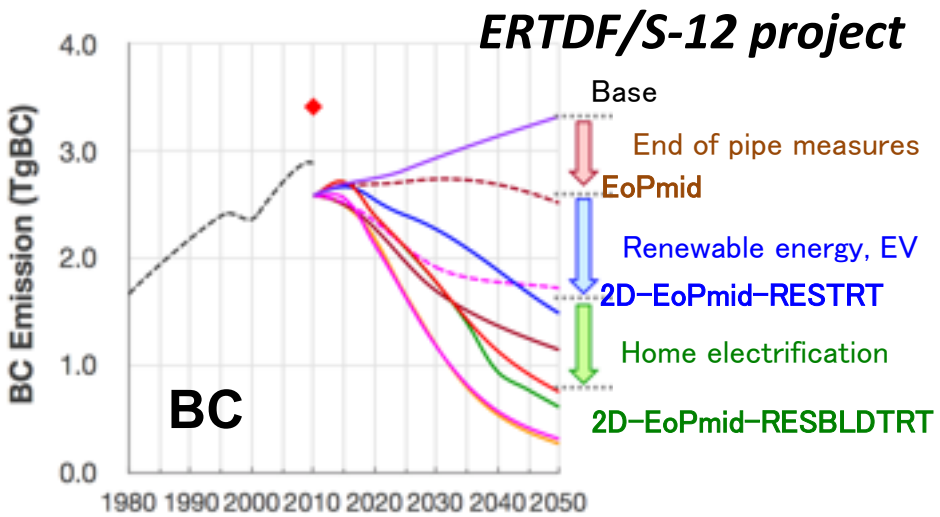
Projected changes in tropizcal cyclone statistics

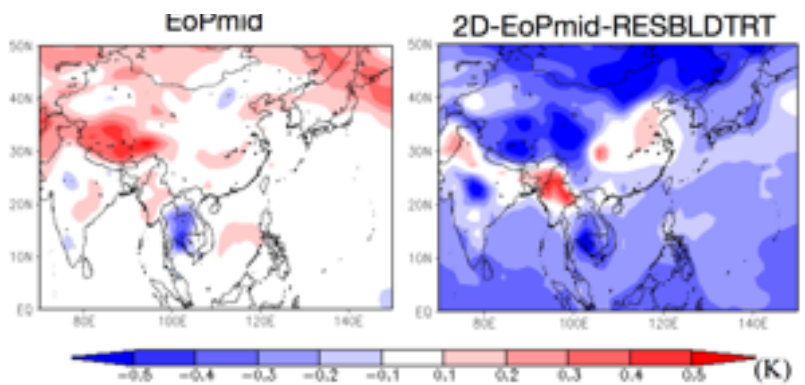
IPCC-AR5 to future AR6

Proposals of mitigation scenario





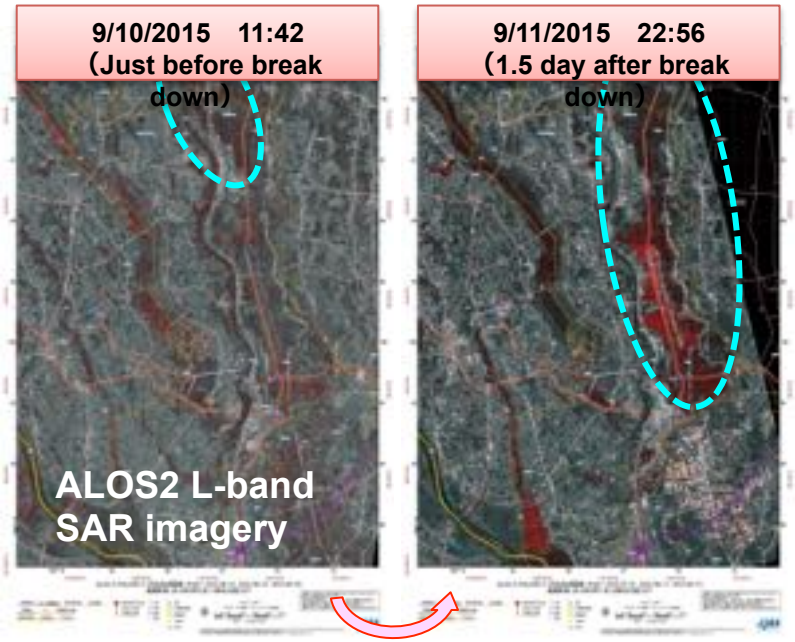




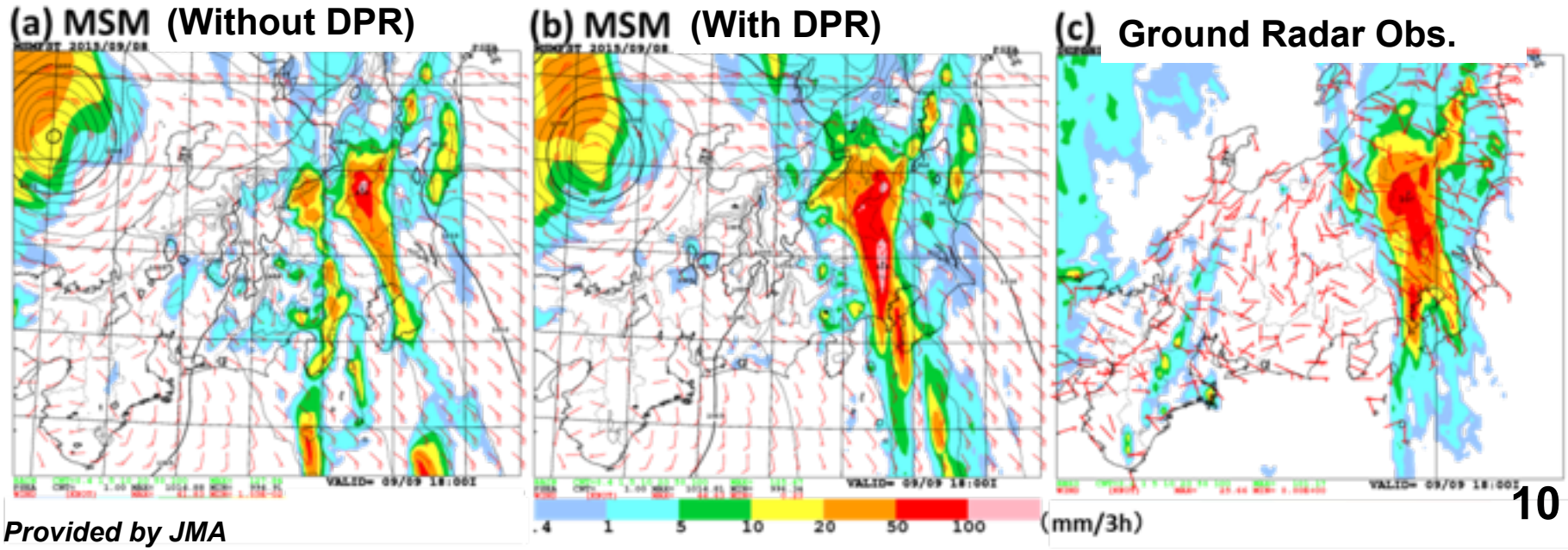
- Large CO2 reduction needed
- Total effect of other material reductions positive, but large variability of 0.5C
- -0.5C very important
- Short Lived Climate Pollutants (SLCP), UNEP/CCAC, BC not effective
- Need an optimum SLCP reduction scenario (suitable SO2, BC, NOx, CH4 combination)

A new science: First data assimilation of satellite radar precipitation data (GPM/DPR) for NWP

- **One hour precipitation more than 50mm/hr increased 1.4 times in the last decade in Japan, (2008-2017)/(1976-1985)**
  (JMA Climate change monitoring report)

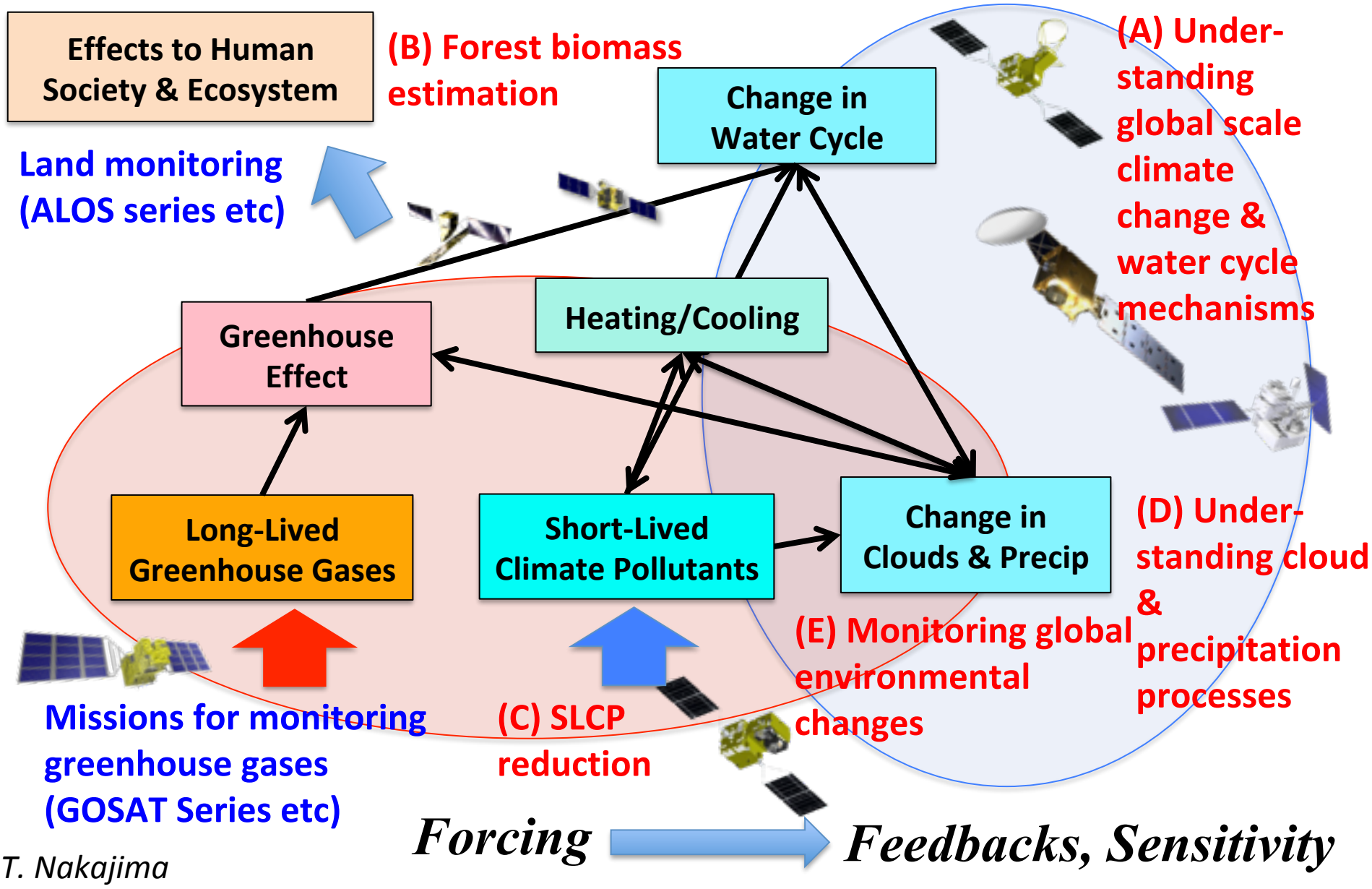


Kinu river flood in Sept. 2015



Provided by JMA

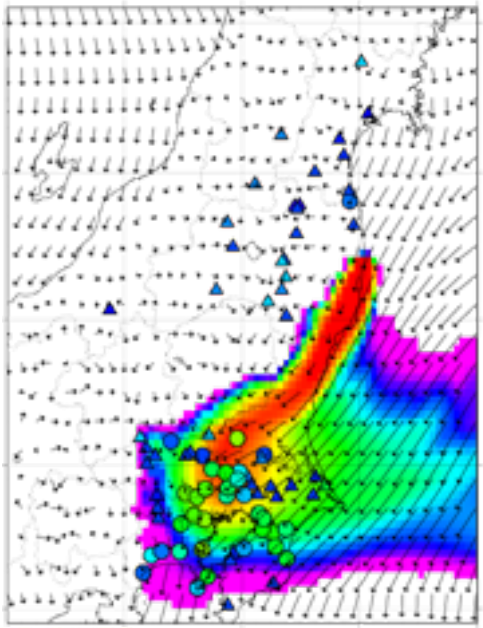
Mission recommendations by Remote sensing TF (25 societies)



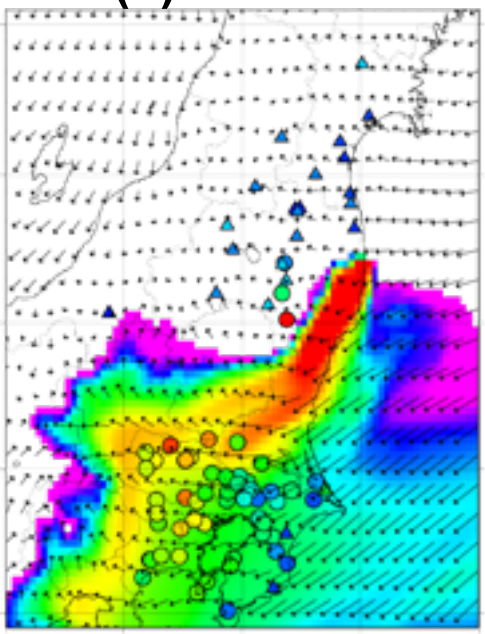
T. Nakajima

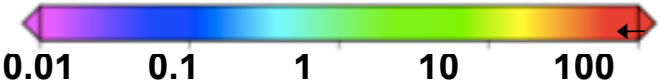
Radio-Cs transportation from Fukushima accident

(a) 3/15/6h



(c) 3/15/12h





Atmospheric concentration (^{137}Cs, Bq m^{-3})

フィルターテープに捕集されたSPMのスポット

Beta-ray type SPM monitoring sites

Tsuruta+ (Sci. Rep'14)

Nakajima+ (PEPS'17): **most downloaded paper, most cited paper in 2019**

Future prospects

- Climate change projection still has large uncertainties: Forcing by GHGs and SLCP (Short-Lived Climate Pollutants), Climate sensitivities (convection, cloud feedbacks)
- New sciences and applications w other fields (ocean, hydrology, cryosphere, ecosphere etc.)
- More societal applications: Disaster reduction, food, SDGs etc.
- High resolution modeling, Human dimension; Combination of first principle models and AI technology
- Sustainable observation system, esp. satellite systems
- 2021: IAMAS-IAPSO-IACS, Busan, Korea