“Big data and supercomputing for a sustainable and resilient society”

Global warming is having a remarkable effect on developing countries. These countries depend on agriculture which is fragile in extreme weather, and this damage becomes the cause of poverty. 17 new sustainable development goals from the United Nations are largely related to disasters, especially in developing countries.

Technology development shows new possibilities to reduce damage by early notification and to design social infrastructures/systems adaptable for global change by observation and simulation.

The presenter is engaged in designing for the operational organization of Japan the climate change adaptation program "DIAS: Data Integration and Analysis System". DIAS integrates various observation/ simulation data and social data using 25 petabyte huge data storage, PC-clusters and a high speed network to develop solutions for various social issues.

(Check Voice chat and “YouTube on a Prim”)
Welcome to **The Science Circle** presentation! I’m a curator of Abyss Observatory, the Modern Museum and the Education Portal in SL, and in RL, I’m working at JAMSTEC.
I’m not a scientist but a project manager of many kind of Earth science research, so I could learn science from many scientists in personally. And Earth science is related with many field, and its purpose is for society and need to collaborate with society, and scientist are not specialist for outside their field, so I don’t hesitate with scientists.
But be careful for what I talk today. Scientists teach me only good things for them and they don’t teach me “inconvenient truth”. I learned how to find “inconvenient truth” but please confirm and judge by yourself.

And question is welcome in any time. please type in Nearby chat. If I don’t realize your question, please copy & paste again.

1. Is climate changing?

1st, I’ll talk about climate change.
Many anti climate change books have been published before.

“Is climate changing?” or

“Is recent global warming caused not by CO2 but by solar activity or natural variation?” or

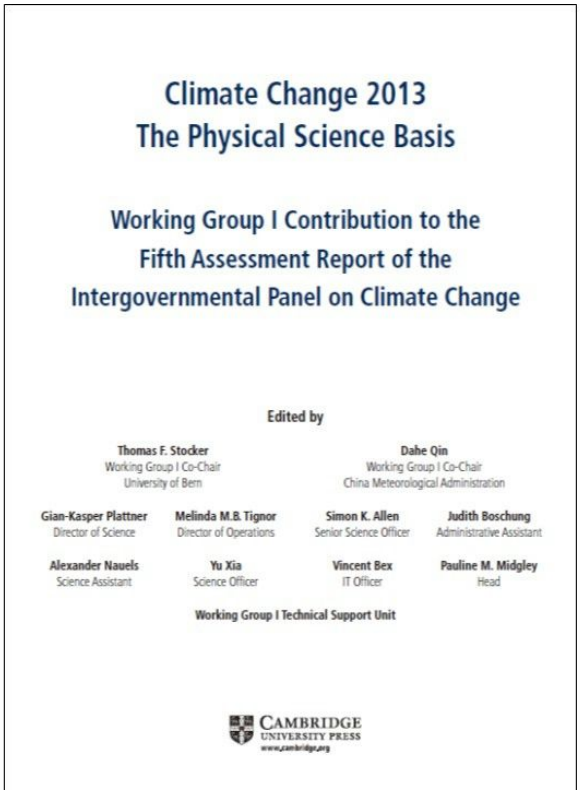
“Doesn’t IPCC hide inconvenient truth?”

are frequently asked. Please type do you agree IPCC or doubt?

I’ve given up to purchase all of those books because all of the counter-opinions are the same on these books. It is strange.

I simply recommend you two things.

First is to read Technical Summary of 5th Assessment Report of IPCC Working Group 1.



Climate Change 2013
The Physical Science Basis

Working Group I Contribution to the
Fifth Assessment Report of the
Intergovernmental Panel on Climate Change

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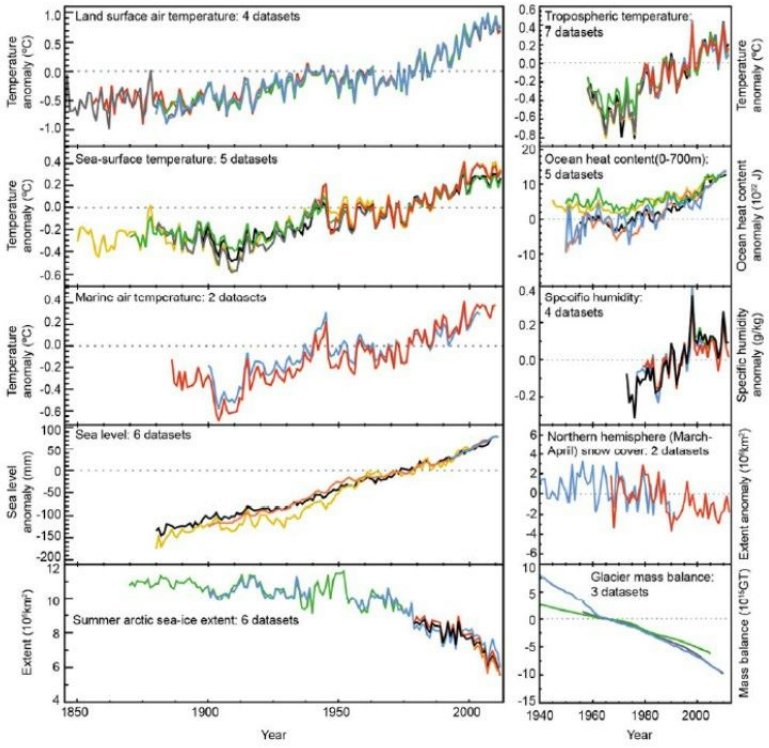
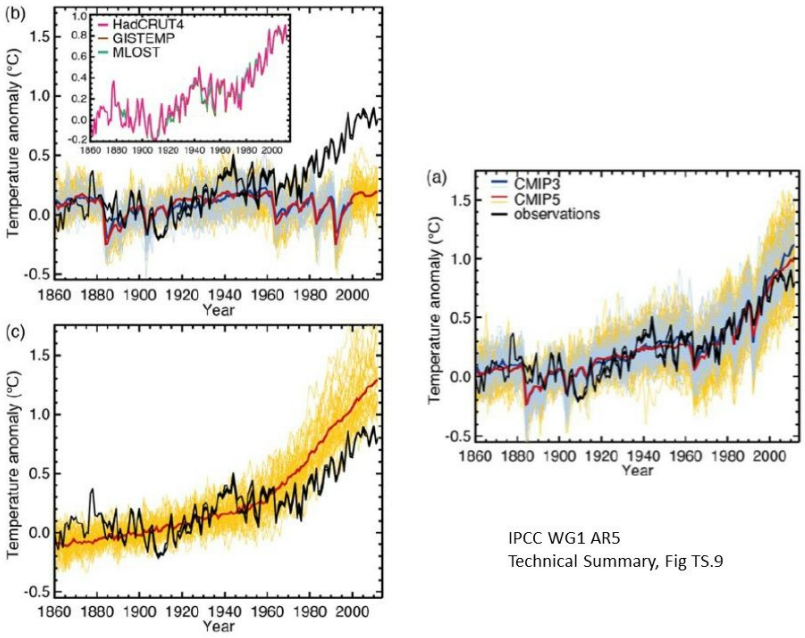
There are many kind of data, temperature on land and Sea, Sea level and extent of sea-ice.



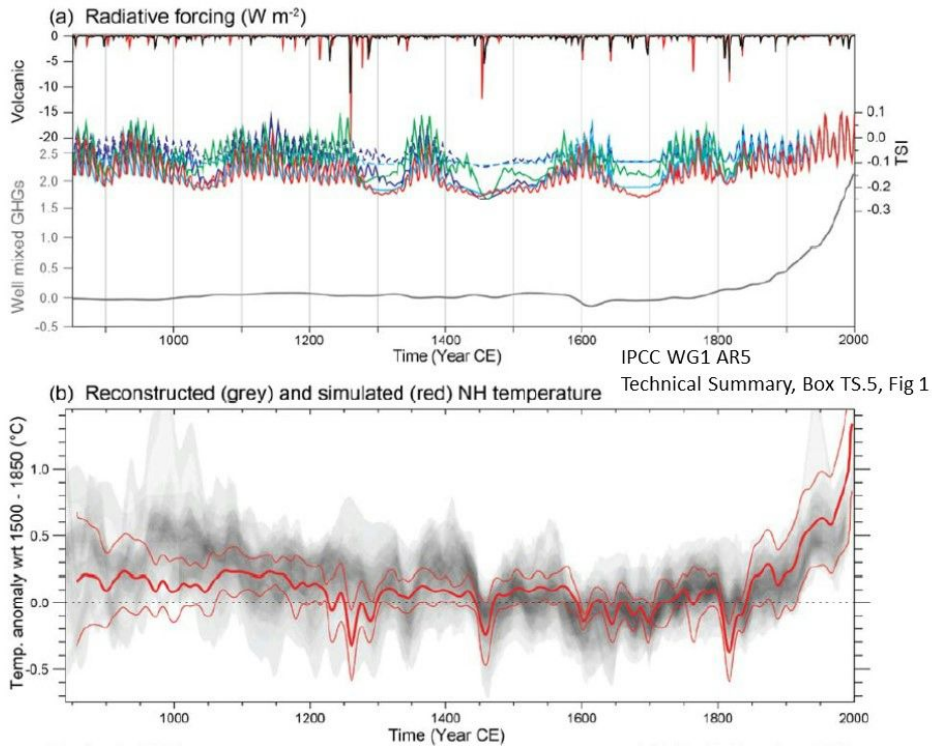
IPCC WG1 AR5
Technical Summary,
Fig TS.1

Black line is observation, red line is Natural Variation only by model (red line of upper graph) and Anthropogenic Variation only (red line of lower graph). Combine of them coincident with observation (Black line) wel.l



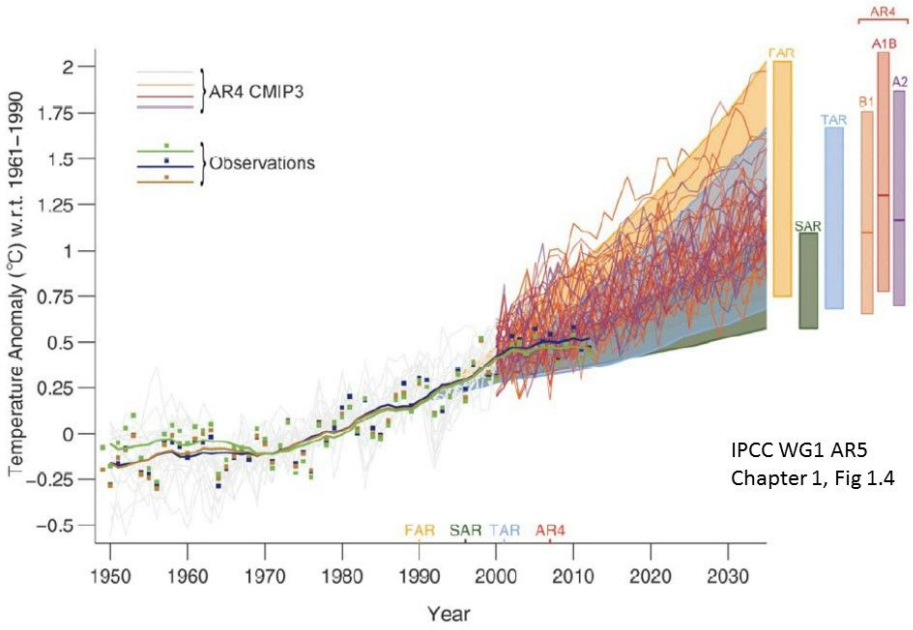
IPCC WG1 AR5
Technical Summary, Fig TS.9

Every models consider Solar and Volcano activities. Grey is more than 1000 years observation data or proxy data like tree-rings, pollen, stalactite, historical documents, etc. Model Result coincident with past data well.



IPCC WG1 AR5
Technical Summary, Box TS.5, Fig 1

And IPCC doesn't hide "inconvenient truth". Last 10 years, temperature rise seems stagnate. It is said "**Global Warming Hiatus**". Many models are still not enough for natural variation, especially ocean vertical circulation.



IPCC WG1 AR5
Chapter 1, Fig 1.4

I said “I recommend you two things”. Second is to check references of anti-climate change books. Please search each reference by internet, and think these references are really evidence for counter-opinions by your knowledge.

Scientists have already answered their counter-opinions but these authors don’t make mention the answers or reply to the answers. It is also very strange.

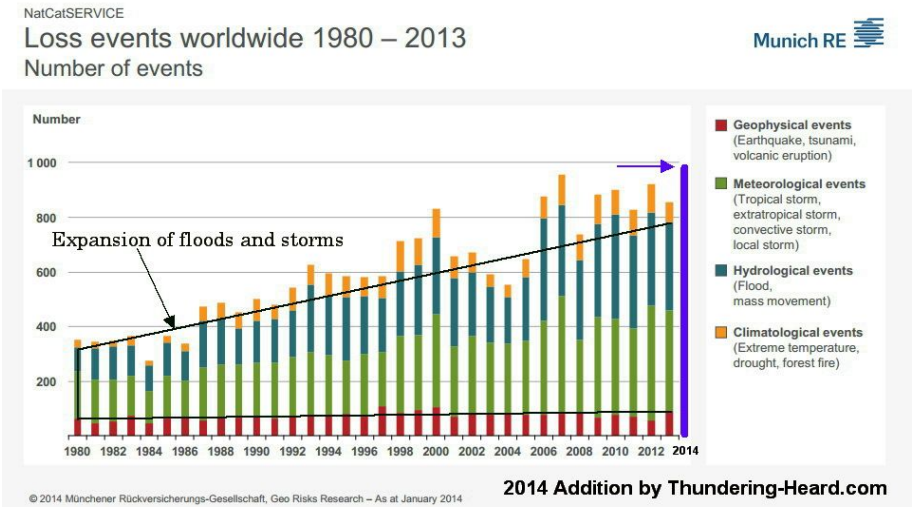
2. Impact of climate change?

Then, Climate is changing. but how about the Affection or impact of Climate change?

I am 60 years old, so I know first-hand temperature rises and extreme weather increases, but I’m not certain how such a change have affected Japan. East-Asia and India scientists have also said “Climate is changing” and they feel their environment becomes worse.

Local impacts are complicated. Sea level rise is the same everywhere in the world. The Arctic is the most sensitive area to temperature rise, but in terms of overall human societal impact, rainfall pattern change and extreme weather or natural disaster is more important and needs more accurate climate prediction. Also natural variations like El Nino events make the impact more complicated.

Please see following chart;



This is the number of natural disasters in the world over 35 years by Munich Re-insurance.
Please note Red (Earthquake, tsunami and volcano) increases a little, but Green (Storm) + Blue (Flood, mass movement) + Yellow parts (Extreme temperature, drought, forest fire) increased 2.6 times.
Of course, these are caused not only by climate change but also by the expansion of human activity into fragile areas or other reasons. Anyway, a casualty insurance company also said to me that casualty insurance payouts for unknown factors have increased in these years.

We can say that in the past, our society could be managed by knowledge learned from past, but in these days, we need to manage not only by experience but also by observation and simulation.

3. Sustainable Development Goals

Developing countries will be damaged more seriously by Extreme weather or natural disaster, because these countries largely depend on agriculture which is the most fragile for weather.

This is new 17 sustainable development goals from the United Nations. Then

1. **No Poverty**: Natural disaster can be a cause of Poverty by loss of wage-worker in a family.
2. **Zero Hunger**: same as No.1 by loss of income.
3. **Good Health and Well-Being**: Flooding is a cause of Infection if there isn't Sanitary System
4. **Quality Education**: Poverty is a cause of lost of educational opportunity
5. **Gender Equality**: Poverty preys on women and children.
6. **Clean Water and Sanitation**: same as No.3
7. **Affordable and Clean Energy**: Fossil Energy is a cause of Global Warming
8. **Decent Works and Economic Grows**: Natural Disaster is a cause of unemployment and Economic difficulty
9. **Industry, Innovation and Infrastructure**: -
10. **Reduced Inequality**: Same as No. 5
11. **Sustainable Cities and Community**: Sustainability is depend on long term environmental change
12. **Responsible Consumption and Production**: depends on sustainable agriculture
13. **Climate Action**
14. **Life below Water**: climate change affect on not only sea surface temperature but also neutrient upwelling and ocean acidification.
15. **Life on Land**: Long term rainfall pattern change affects too much
16. **Peace, Justice and Strong Institutions**: Poverty is a cause of political confusion.
17. **Partnerships for the Goals**

So we can say almost goals are related with natural disaster or climate change directly or indirectly.

(Question?)

4. Observation Data and Simulation

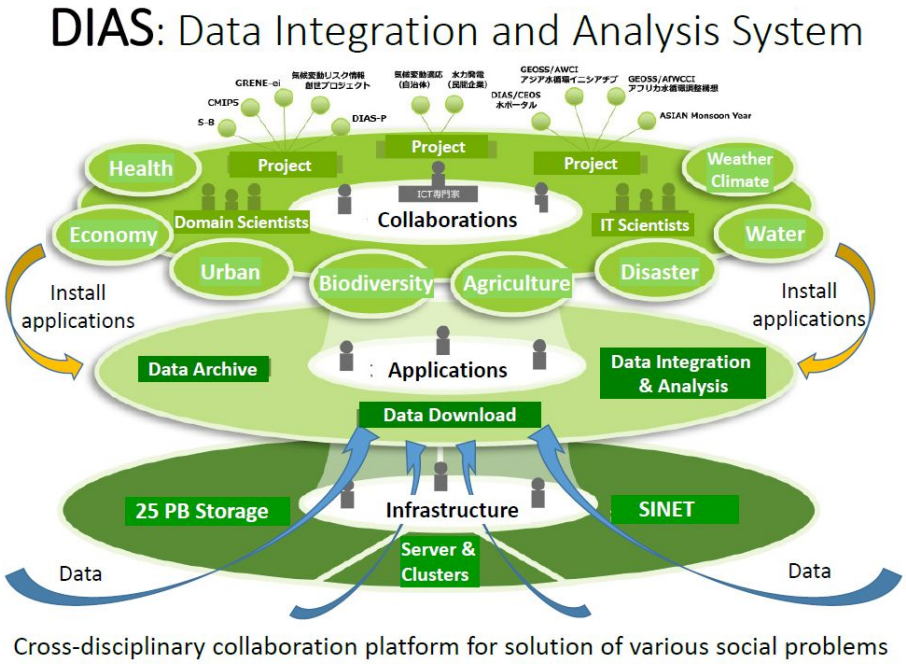
please stand up and come on.
You can see various global observation data, mainly satellite data on left side of this floor.

Center of this floor, there is Earth Simulator, 3rd renewal of my research institute, JAMSTEC.
Top500 supercomputer ranking is no means for climate prediction because LINPAC benchmark test mainly depend on number of computing cores. So No.1 machine of latest Top500 has 3 million cores.
But climate prediction including ocean circulation depends on performance as ONE MACHINE.
New Earth Simulator has only 20,480 cores but practically No.1 in the world for Earth system simulation.

And this is simulation data. simulation data show more information than observation data.

5. What is DIAS?

I'm working in designing of the operational organization of Japan climate change adaptation program "DIAS: Data Integration and Analysis System."



This is concept of DIAS mechanism. DIAS consists by three layers. Lower layer is 25 petabyte huge data storage, PC-clusters and high speed network
Upper layer is various collaboration projects in which decision maker is involved from initial stage and integrates various observation/ simulation data and social data to develop solutions for various social issues..
Middle layer is a team of IT researchers and programmers. They help install output of projects into DIAS system so that outputs can be shared and improved.

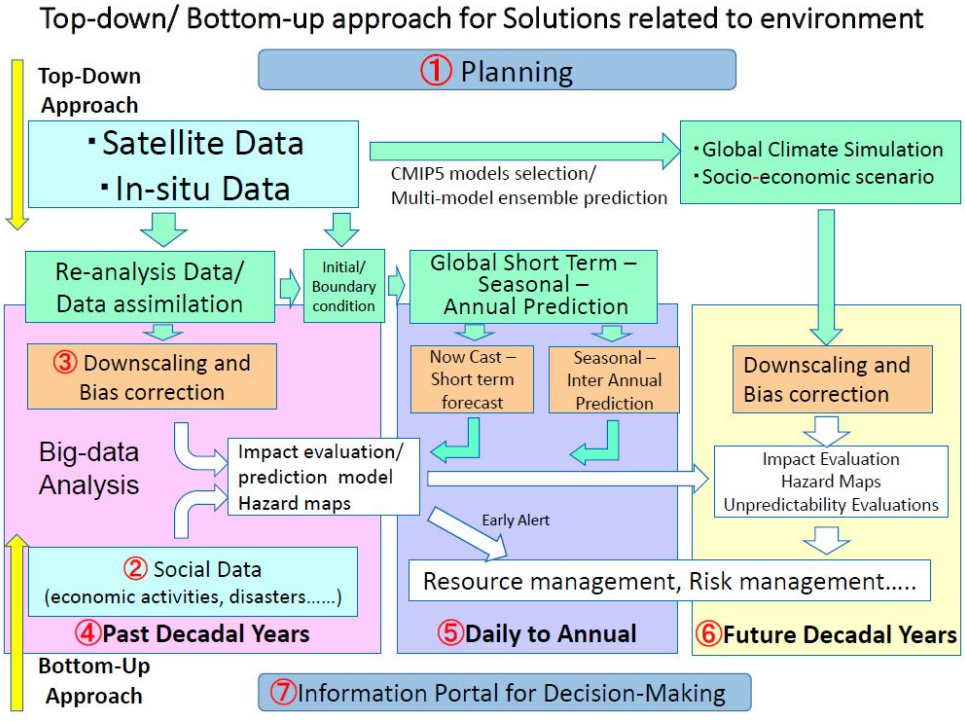
In this way, DIAS is expand its data and functions gradually for various social fields.

a) How to develop solutions?

Where Do We Come From?
What Are We?
Where Are We Going?

Paul Gauguin 1897-98

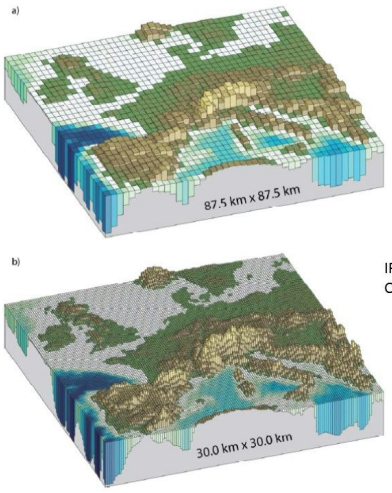
This painting by Guguin is very famous for its long title, “Where Do We Come From? What Are We? Where Are We Going?”. By leaning past to know present and future prediction. This strategy is same as climate change adaptation.



Pink is past, purple is present or near term and yellow is long-term future.

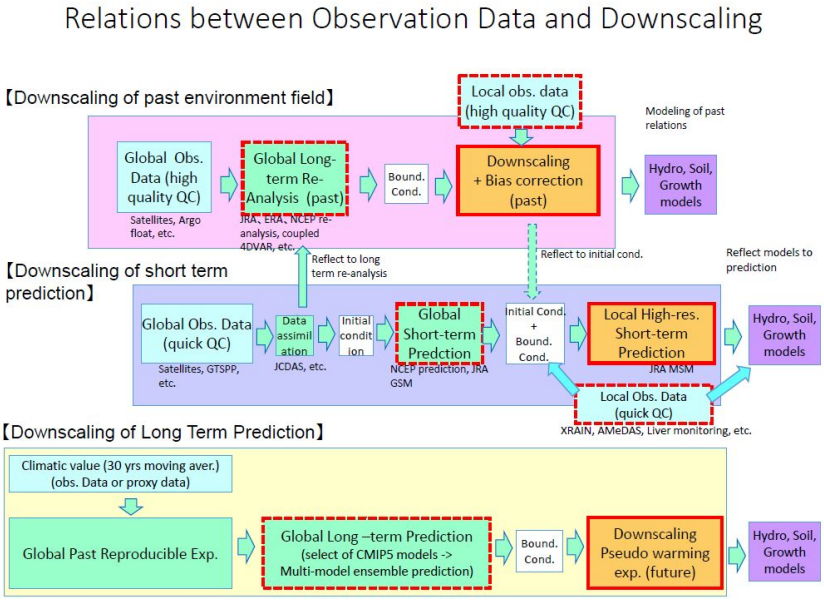
There are two approach, Bottom-Up Approach from concerned people side, and Top-down approach from climate researchers.
Bottom-Up Approach is gathering existing data both observation data and social data or disaster events, so prediction is weak point.
Top-down approach is possible to predict short-term and long-term, but resolution isn't enough for social and disaster events. It means there is a gap like orange parts.

b) Downscaling?



IPCC WG1 AR5
Chapter 1, Fig 1.14

Above is resolution of global climate model, **GCM**, by high level supercomputer. So we need at least 30 km resolution to predict local weather. 10 km or 1 km for other social issues. This is "**downscaling**"
This is last sheet.



Pink is Downscaling for past. We can find relation between social issues and environment field variation.

This is most important process with concerned community or decision maker. Due to limitation of supercomputer, there isn't all-purpose downscaling. It needs optimize for concerned issue, flooding, land sliding, sustainable farming. So Inter-disciplinary/ Trans-disciplinary collaboration or involvement of decision makers are essential. And when we developed **Affection or Impact model** for evaluation or prediction of concerning issues, then,

Purple is Downscaling for near-term prediction. We can take decision making to save lives by early alert.
This is very important. Long term prediction still has lot of unknown factor and can differ according to economical development scenario. On the other hand, we feel weather becomes unstable than before. It is difficult to construct perfect wall for flooding, but if we can alert people to evacuation enough early, we can save human life and reconstruct infrastructures again.
This is **resilient society**. We develop high resolution short term forecasting, and connect above Affection or Impact model, then people can make decision adequately.

and last,
Yellow is Downscaling for long-term prediction.
For decadal years. rainfall patterns will change, high immersion risk area will expand by sea level rise, and therefore we need to relocate farming land and cities and re-design infrastructures. This is **Sustainable society.**

At first, GCM (General Climate Model) modelers execute "Global Past Reproducible Experiment" and optimize parameters of each model by past data.
Then, run each GCM 50 years to the future. so it is difficult to obtain intentional result. 27 instituts submitted such a data to ICPP,
and user select several GCM which represent concerned region well, and make average from them, it is said "multi-model ensemble prediction". and downscaling for development of adaptation tactics.

Summarization

- How to judge science results as one of citizen
- Climate is changing, but Affection/ impact of climate change is complicate
- Developing Country and UN's Sustainable Development Goals
- What we are doing to realize Resilient and Sustainable Society
- Collaborate with society

(Memo, note)
Development of solutions for social problems needs both inter-disciplinary collaboration and trans-disciplinary collaboration. It needs participation of decision makers, supercomputing programmers, modelers who develop relation between social problems and climate change and extreme weather, social workers who interpret to citizen's action.

Research focus was moved from "prediction" to "mitigation" to "adaptation".

I'm engaging the design of sustainable organization and cyber infrastructure for incubation/ prototyping solutions to social problems by inter/ trans-disciplinary collaboration now.
Key technology is "downscaling" of simulated data so that we can resolve social activities and disaster events to find evaluate and predict relationships between them.

Ocean covers 70 % of Earth's surface and the ocean preserves a lot of heat and CO2, so it is impossible to understand climate change without deployment of observation system in ocean. More than 3000 profiling floats in the Argo program and Satellite observation (radiometer for sea surface temperature, microwave radiometer for precipitation and moisture, Altimeter for ocean circulation, scatterometer for sea surface wind, Ocean color for phytoplankton, etc.) enable us to simulate Earth Systems.

We are also gradually understanding carbon cycle feedback, but my biggest concern is the impact of acidification of the ocean for marine ecosystems. We need to develop a new in-situ dynamic observation system suite for phytoplankton and other marine eco-systems.

Since the 3.11 Japan quake, almost nuclear power plants in Japan are still under review. Wind generator plants and water generator plants (including small size) are the next choice in cost/performance, but they are dependent on weather conditions. So we are planning development of a management system using observational data, high resolution short term prediction, electricity storage systems and steam-power generator plants.

I am proud of Japanese energy saving cars, but I think in local regions we need to realize smarter, smaller urban designs where people can depend on local traffic systems instead of cars for energy saving.