Overview of the Center for Computational Sciences

Summary of Activities for 2008 to 2013

Division of Global Environmental Science

Atmospheric Science Group

Hiroshi L. Tanaka

(Group Leader)

Group Member

- Hiroshi L. Tanaka, Prof. CCS Staff (Since 2004)
- Hiroyuki Kusaka, Assoc. Prof. CCS Staff (Since 2006)
- Hiroaki Ueda, Affiliated Prof. University of Tsukuba
- Yasutaka Wakazuki, Affiliated Asst. Prof. U. Tsukuba
- Researchers in CCS : Drs. Akimoto, Ikeda, (Terasaki)

Graduate Student in CCS:

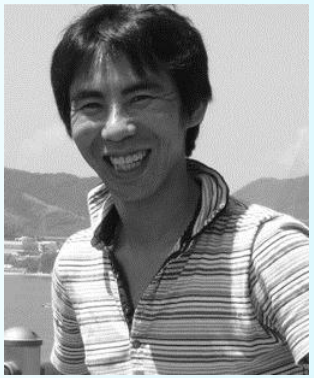
DC: (7) Kondo, Aizawa, Yamagami, Koshiba, Katoh, Doan, Nishi

MS:(10) Umino, Kino, Baba, Kudoh, Kuno, Fujita, and others

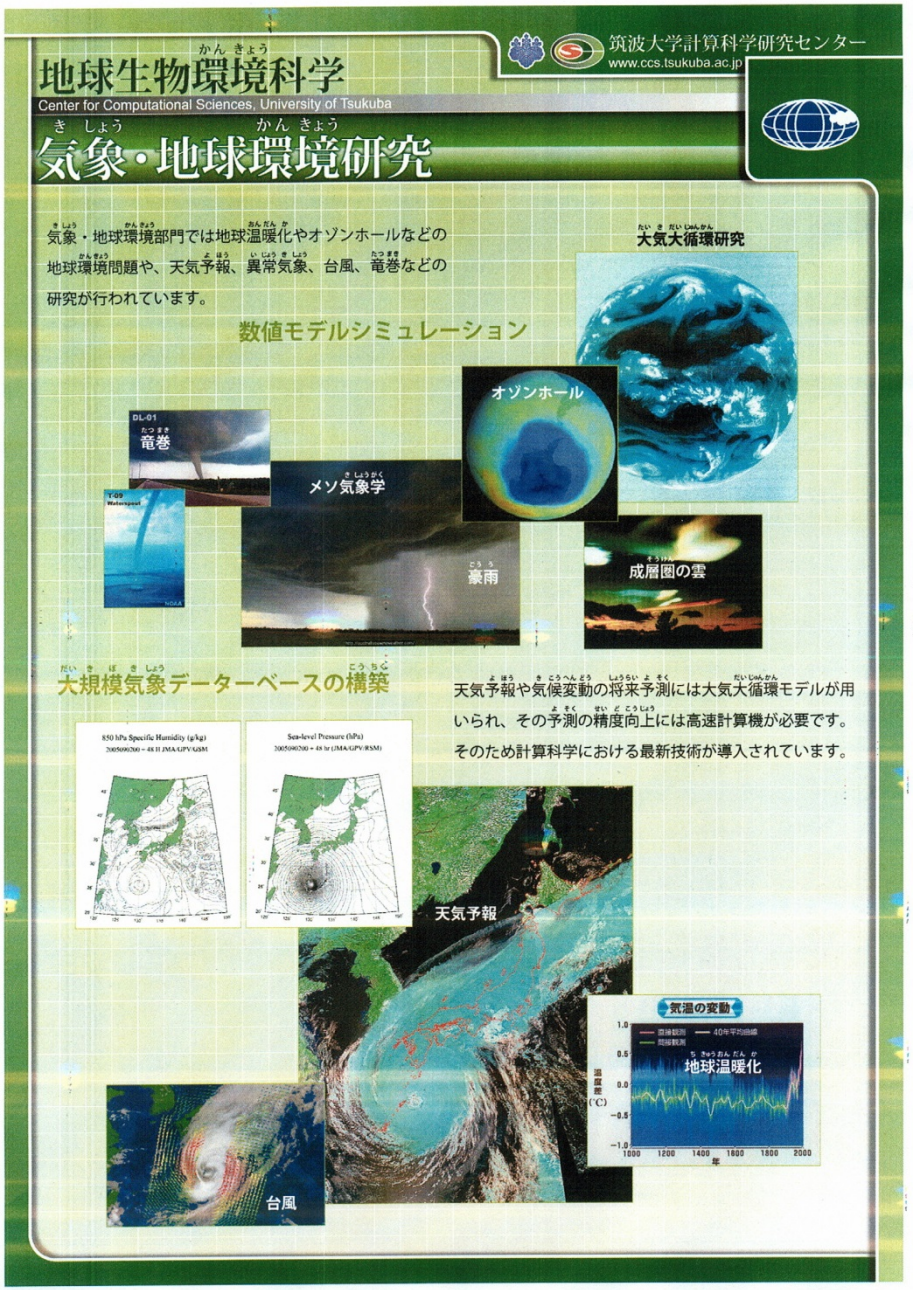
Tanaka

Kusaka

Ueda



Wakazuki



Research activity (H.L. Tanaka)

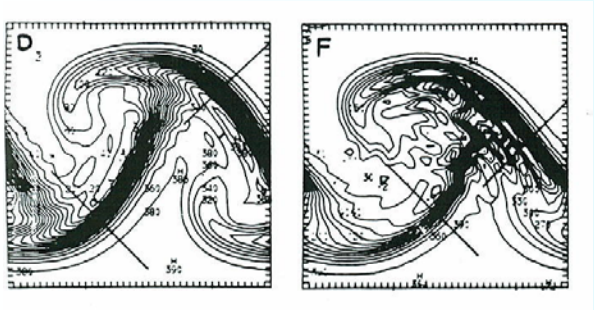
- General circulation of the atmosphere
- Global warming and Arctic Oscillation
- Global warming and tropical circulation
- Global spectral energetics
- Blocking and abnormal weather
- Dynamics of baroclinic waves

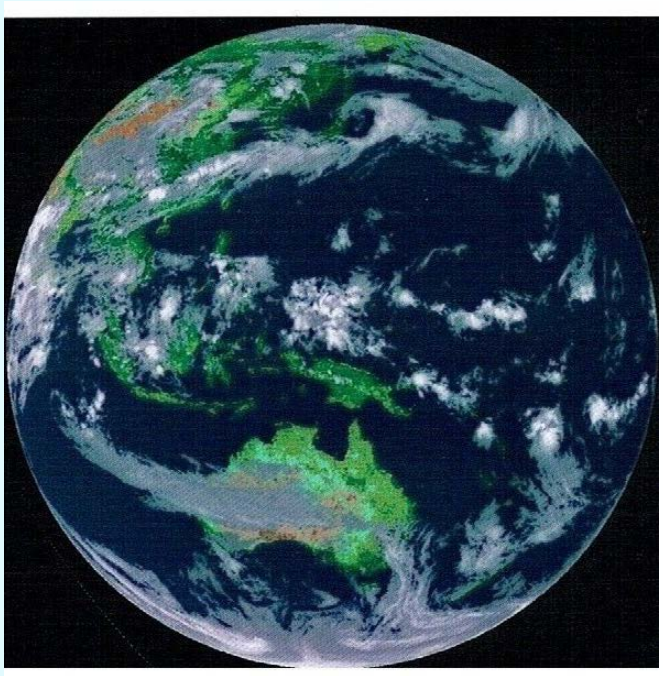
Research activity (H. Kusaka)

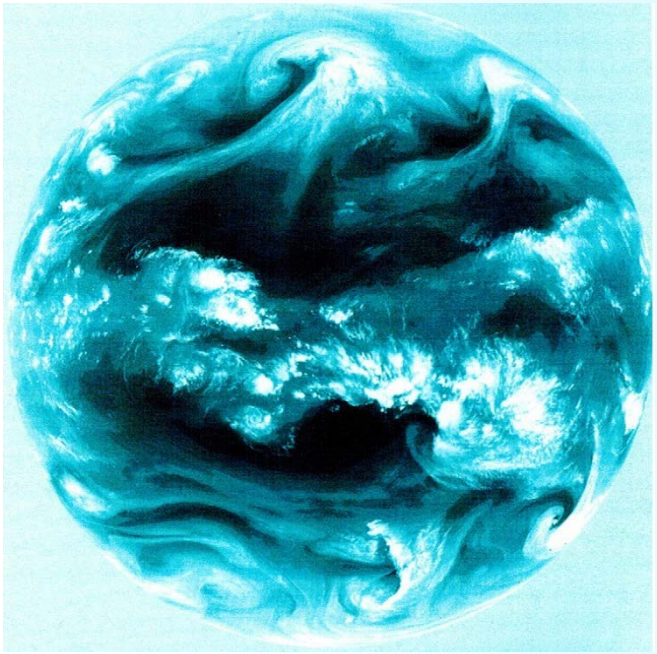
- Regional modeling using WRF
- Urban climate modeling
- Meso-scale precipitation system
- GPS and data assimilation
- Surface heat budget and radiation
- Real-time regional prediction system

General Circulation Study

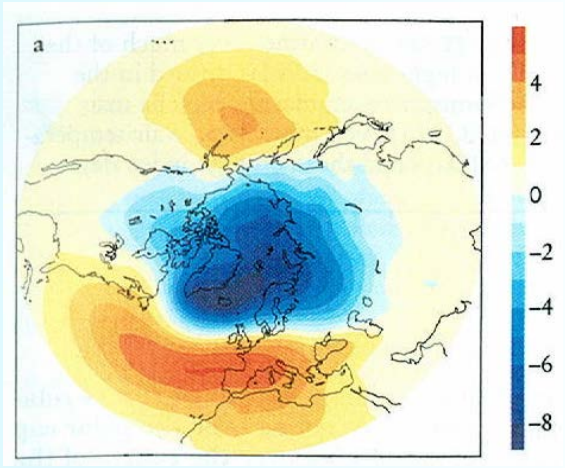
- Data analysis
- Dynamical theories
- Numerical modeling

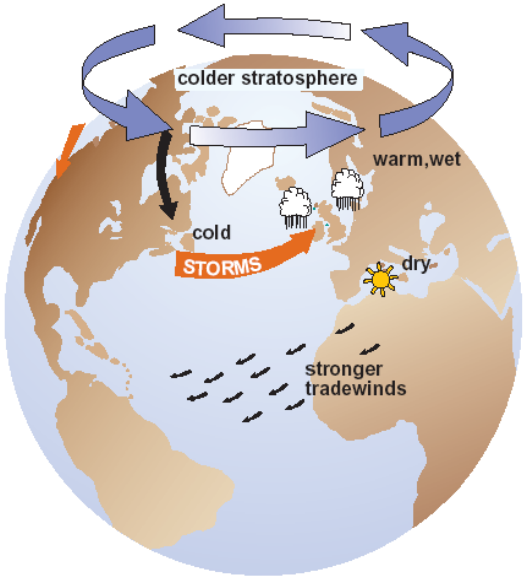


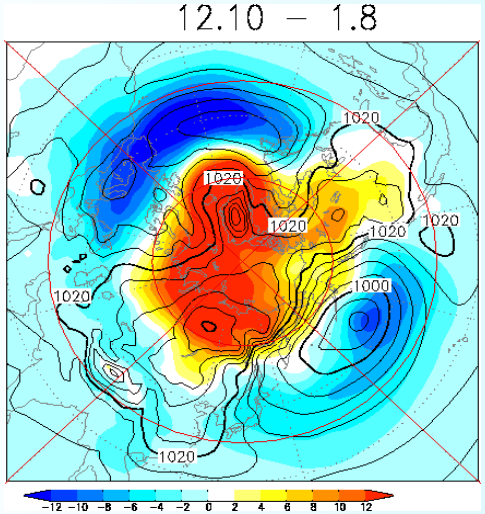


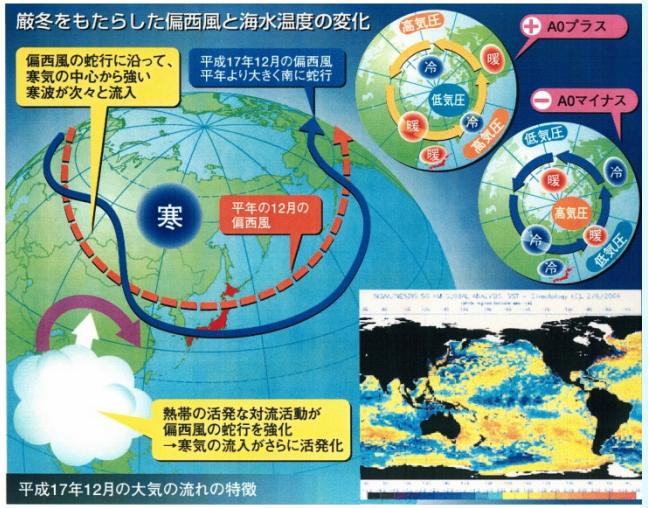


Global warming and Arctic Oscilation



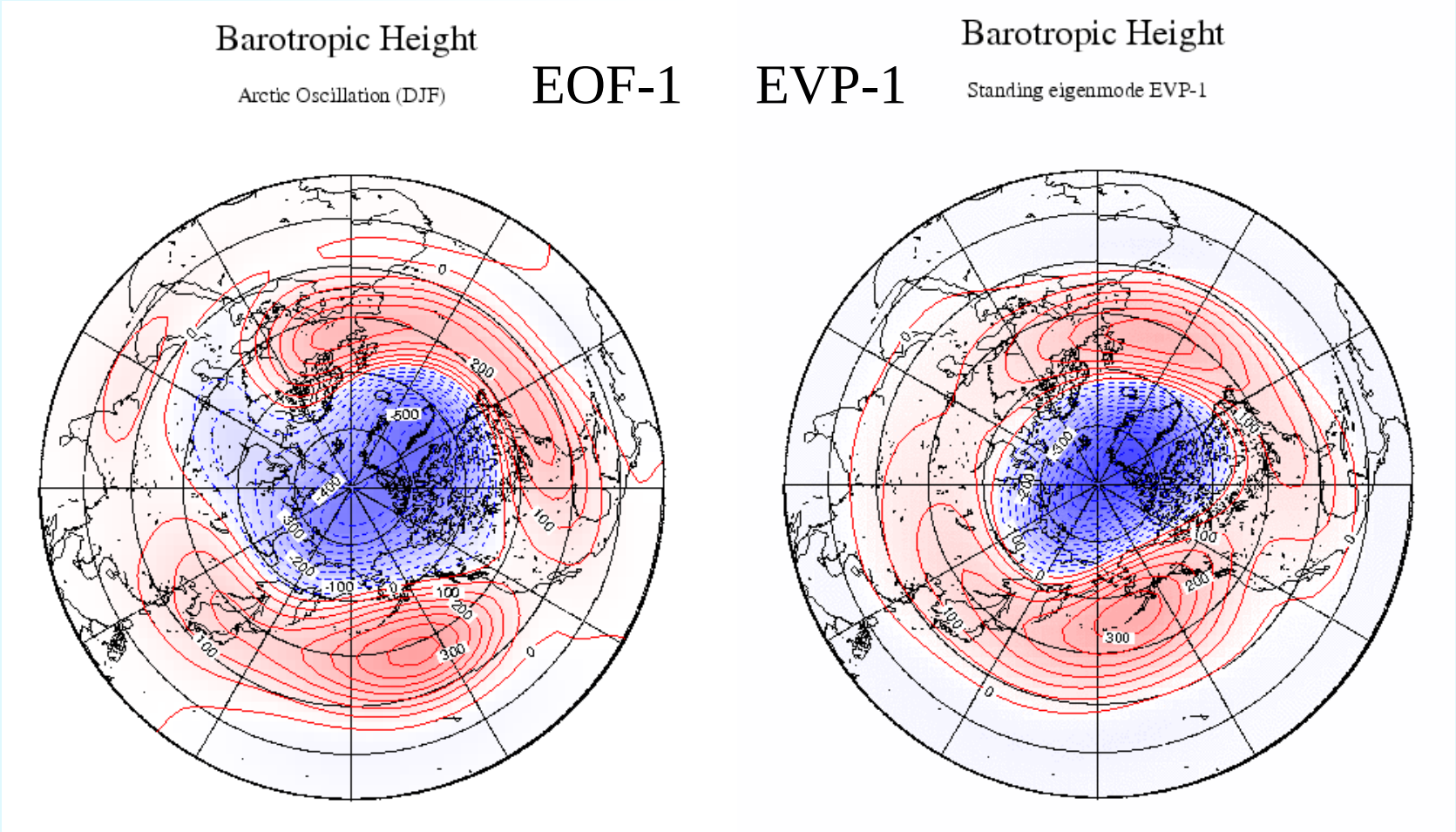






Arctic Oscillation
Singular eigenmode theory

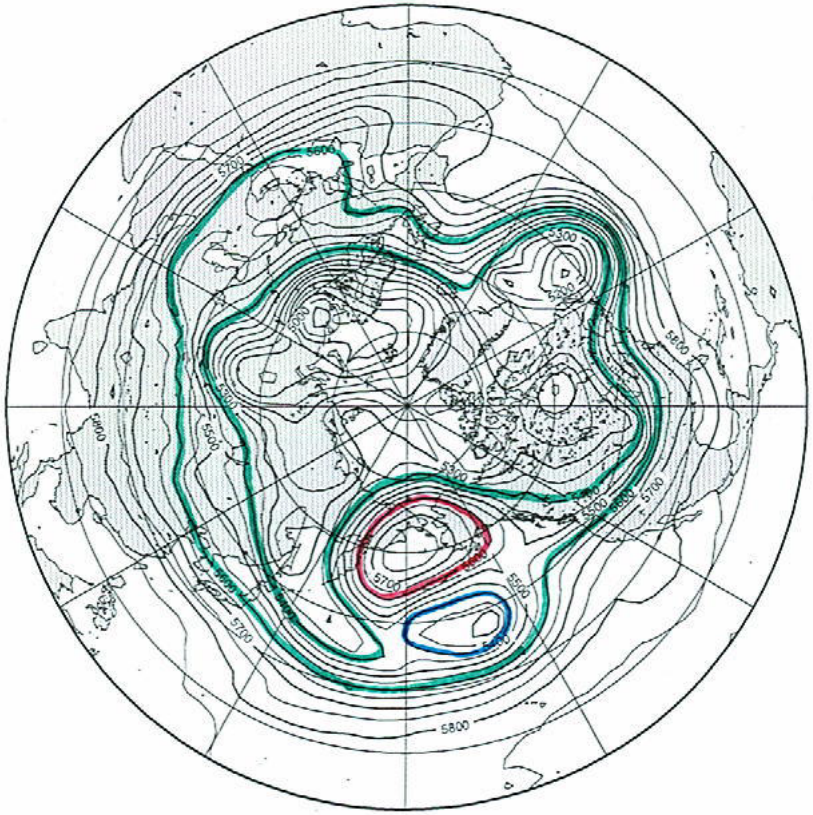
AO (DJF) **Eigenmode**



Blocking in the Barotropic S-model

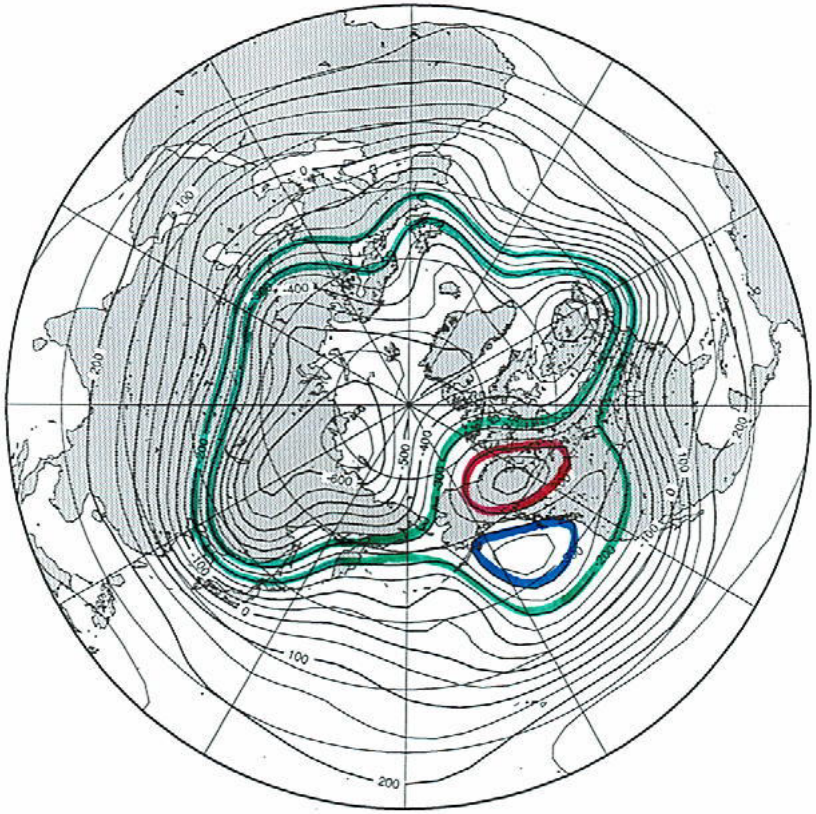
500 hPa Height

JMA GPV 97031412+00



Geopotential Height

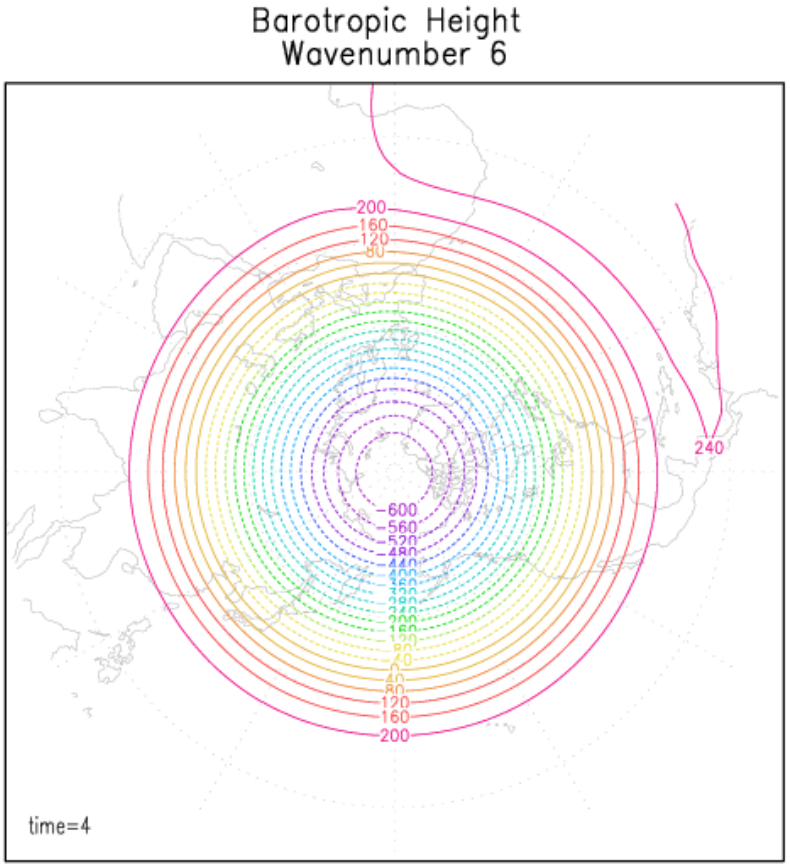
Run-02 Day 955

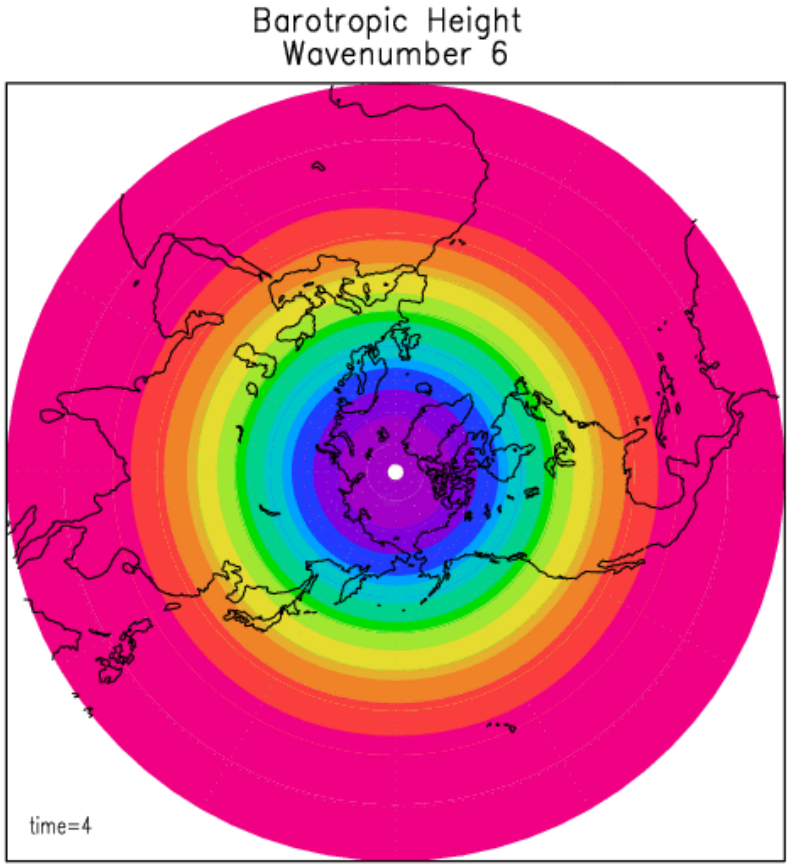


Up-scale energy cascade

Rossby wave breaking for n=6

Growth rate × 1.7





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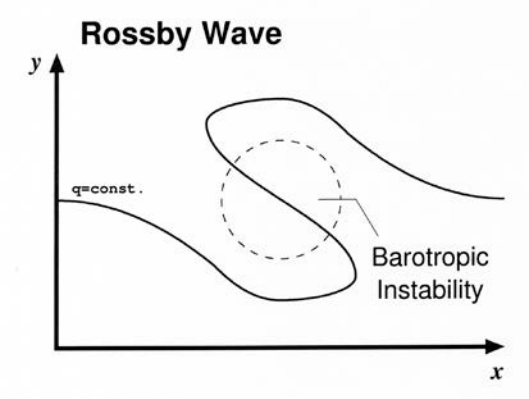
Global energy spectrum of $E = mc^2$

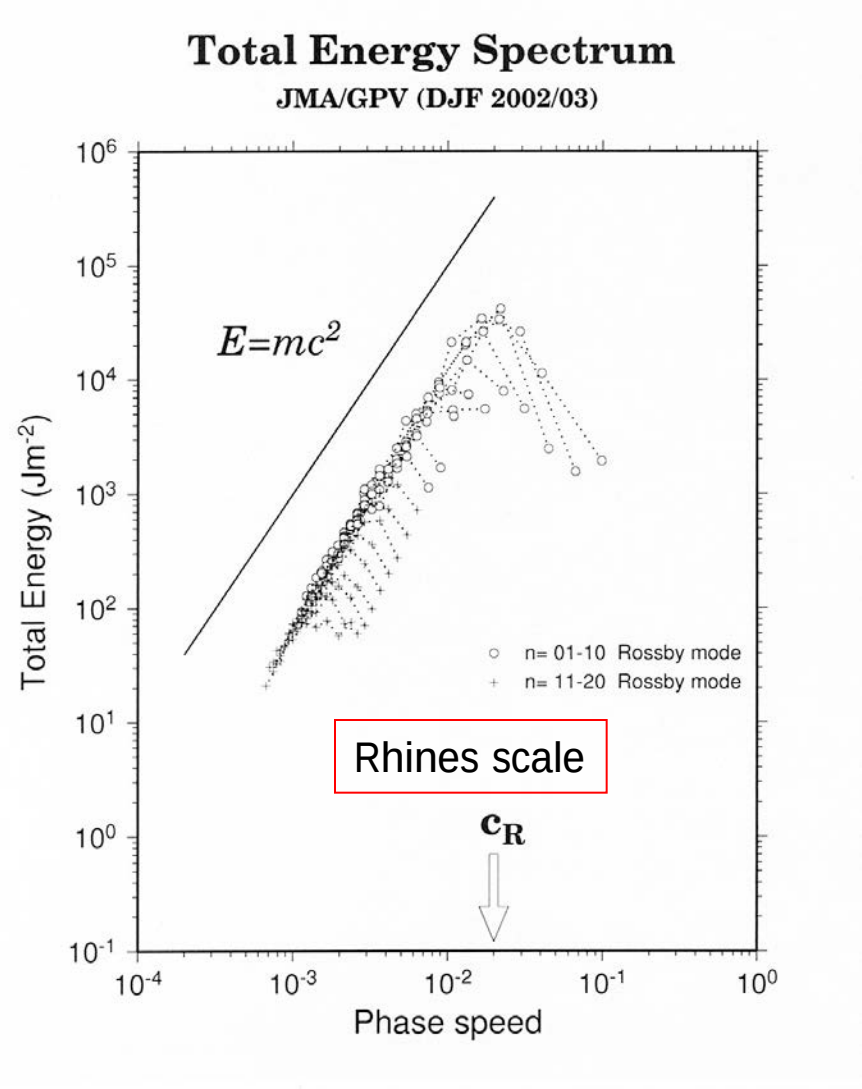
（Tanaka et al. 2004 GRL)



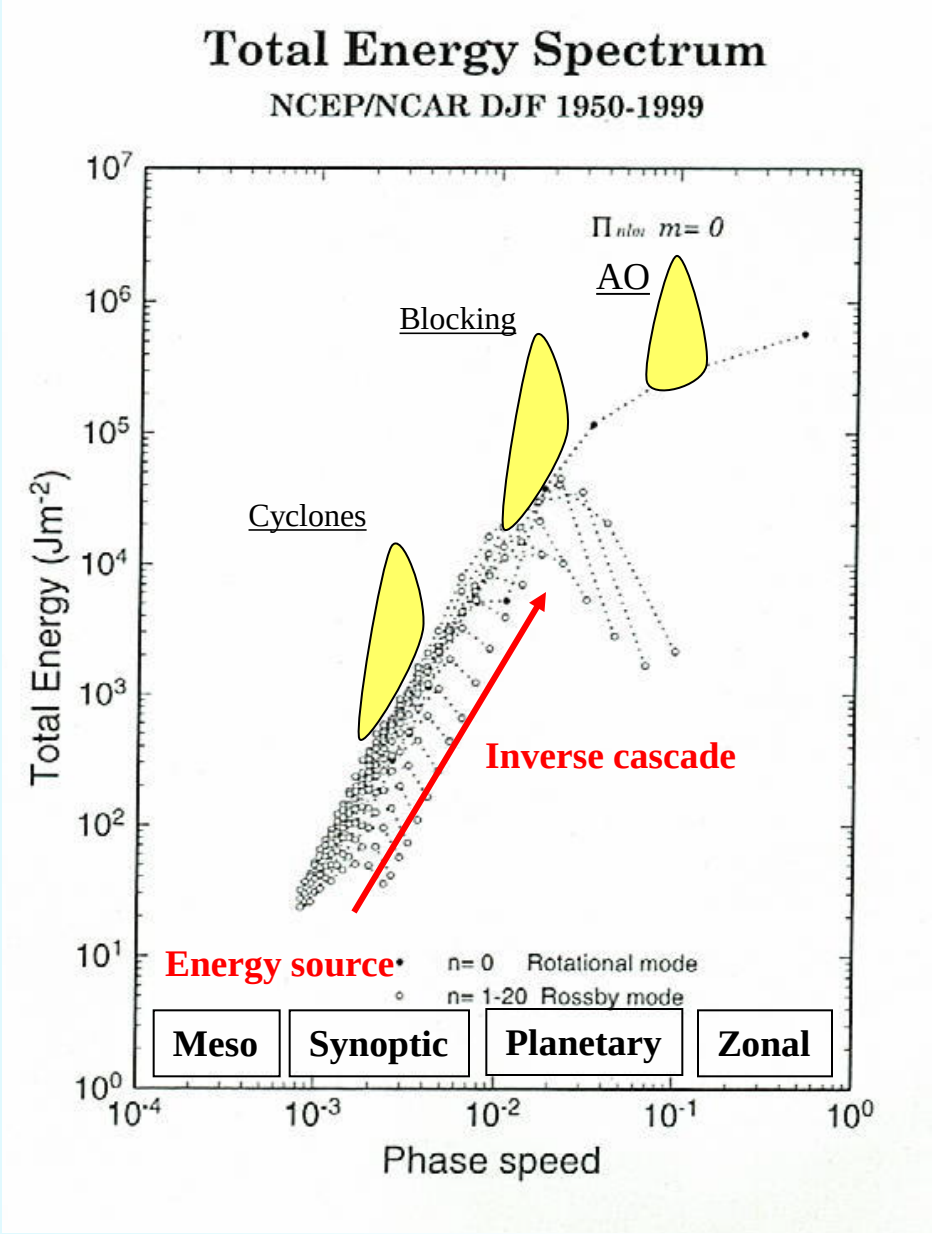
$$\frac{\partial q}{\partial y} < 0 \quad \Rightarrow \quad E = mc^2$$

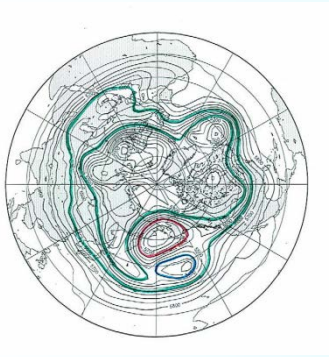
c Rossby phase speed

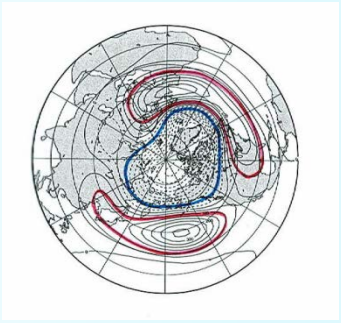
$m = p_s / g$ Mass of the air

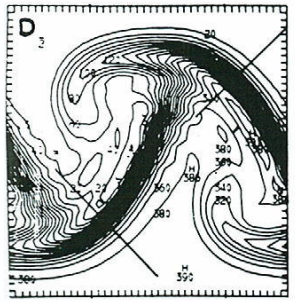


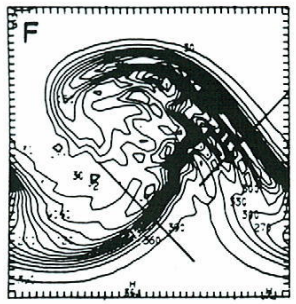
Low-frequency variability of the atmosphere

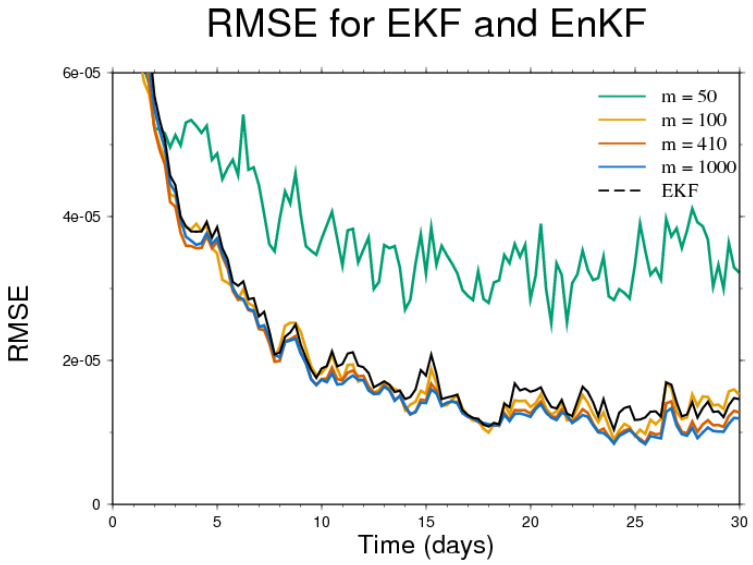










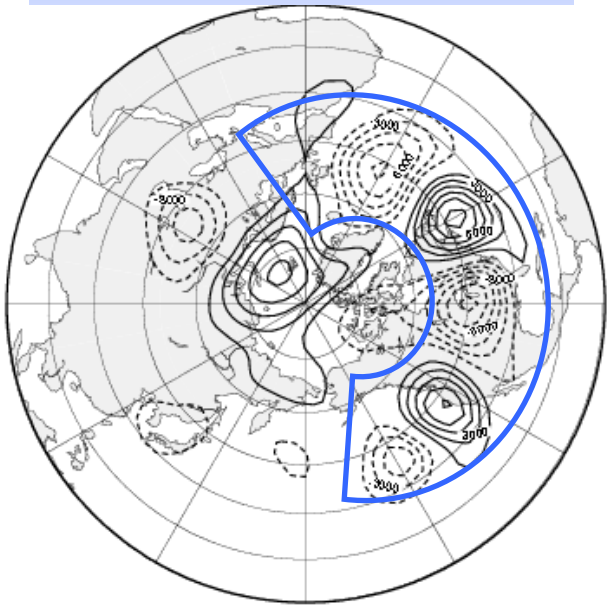


Data Assimilation

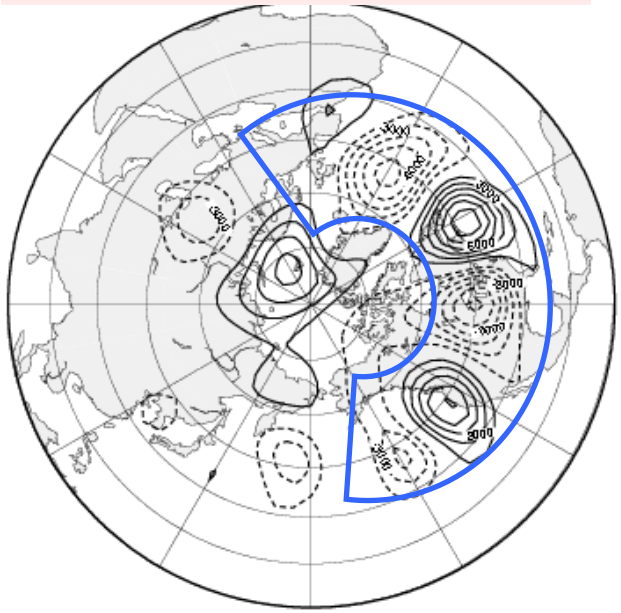
By Kalman Filter and Ensemble Kalman Filter

Barotropic S-Model at University of Taukuba

EnKF (m=1000), 12.6%



EKF (linear model), 8.8%



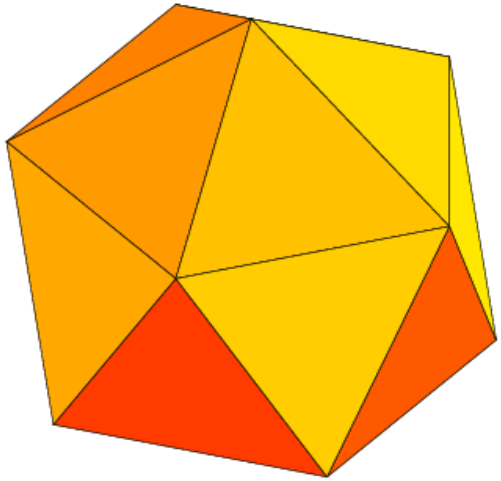
NICAM

by T2K-Tsukuba

Original Icosahedron

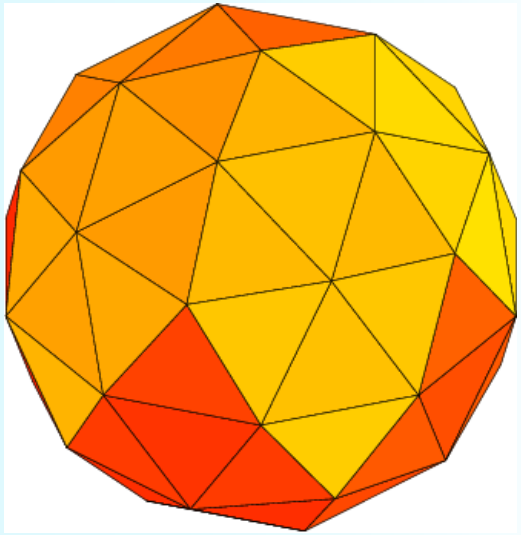
Satoh et al. AORI

Glevel-0

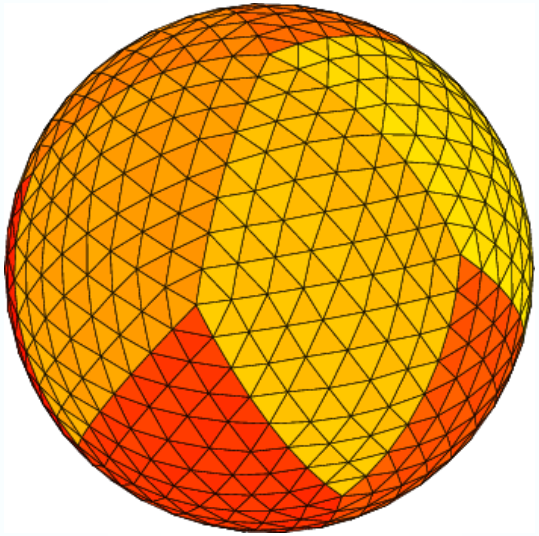


Glevel-5: Δx=250km
Glevel-6: Δx=120km
Glevel-7: Δx= 60km
Glevel-8: Δx= 28km
Glevel-9: Δx= 14km
Glevel-10: Δx= 7km
Glevel-11: Δx=3.5km

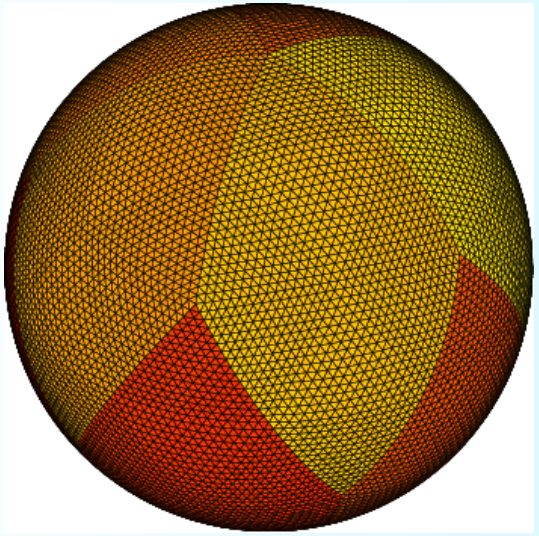
Glevel-1



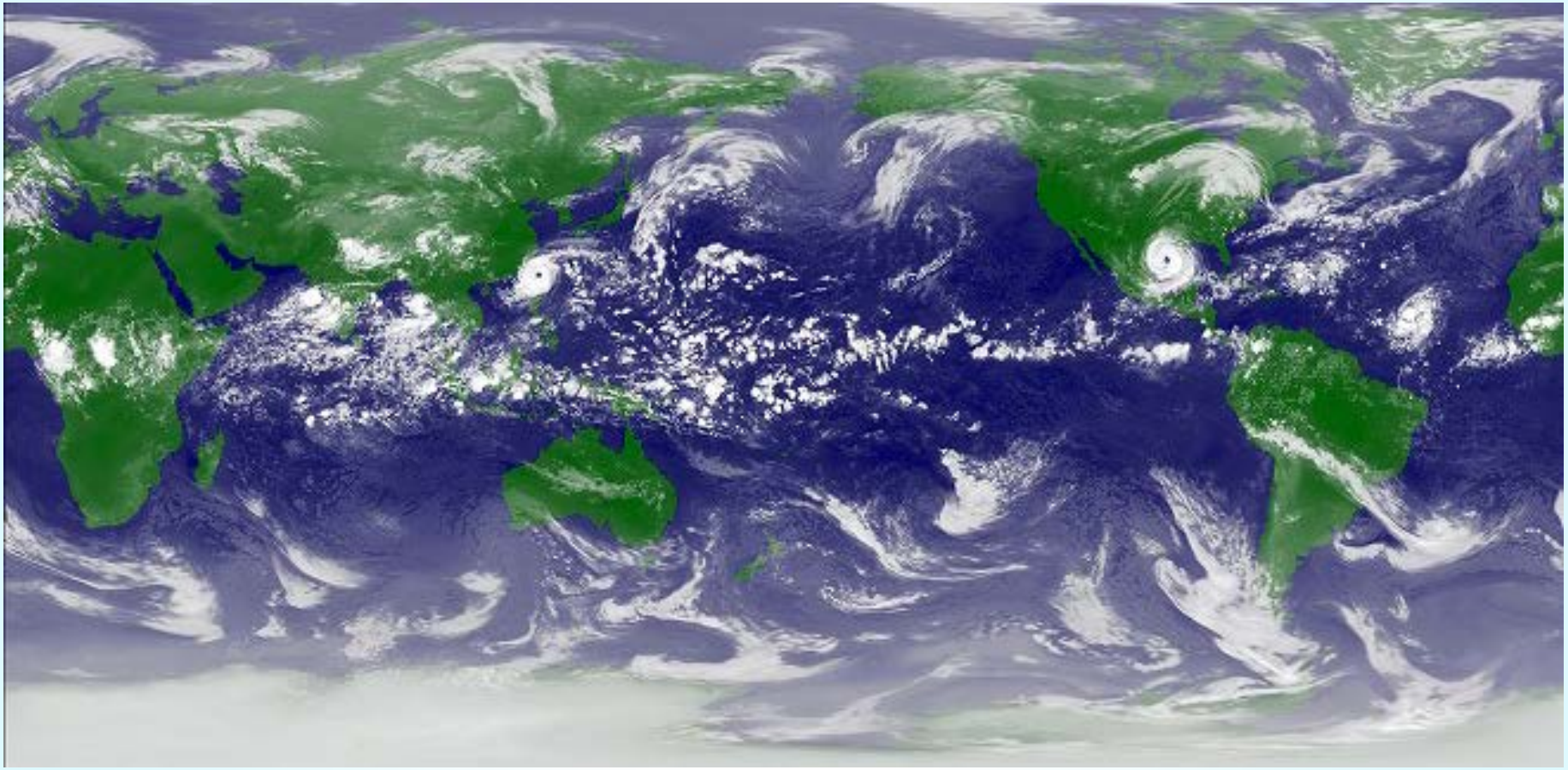
Glevel-3



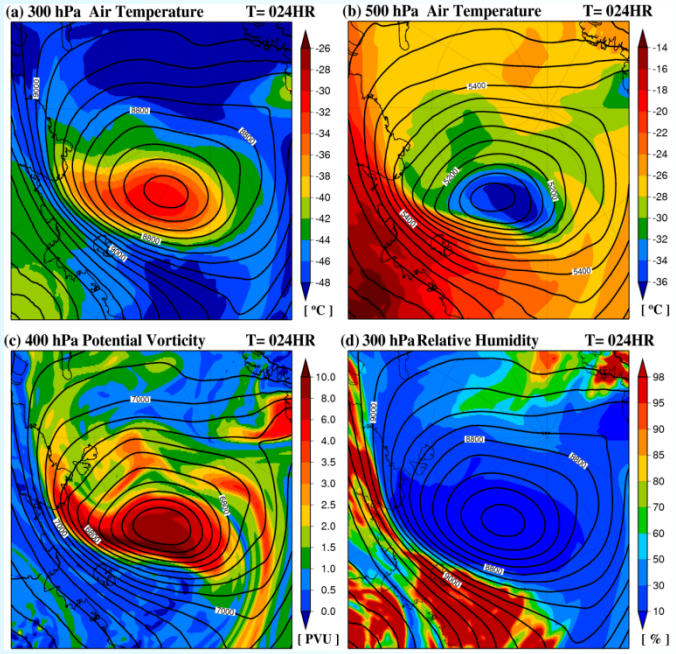
Glevel-5



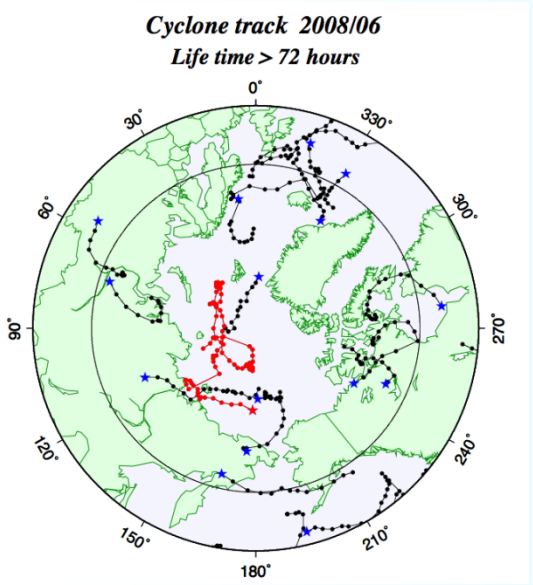
Study of cyclones using NICAM

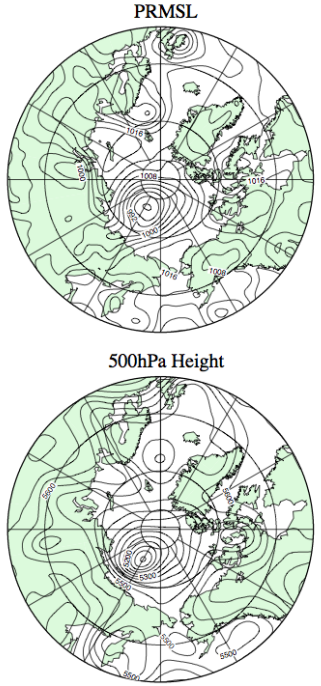


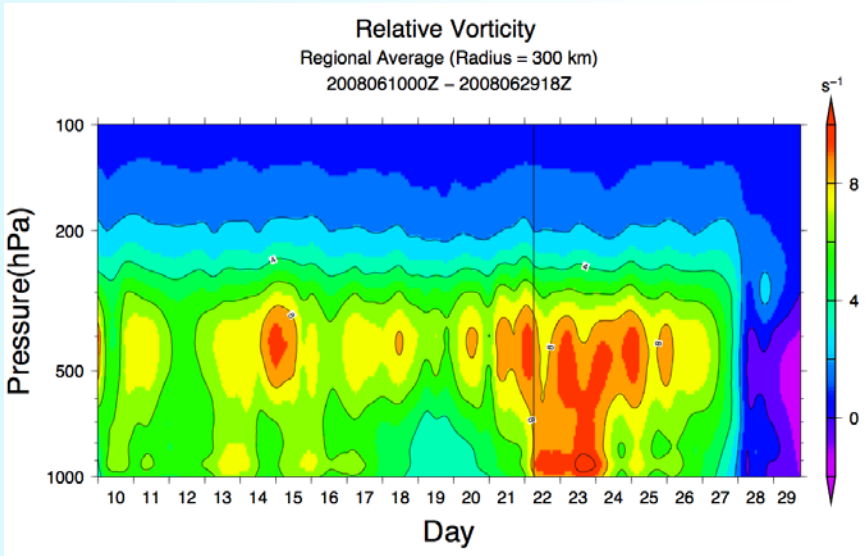
Arctic Cyclone in JRA-25 and NICAM

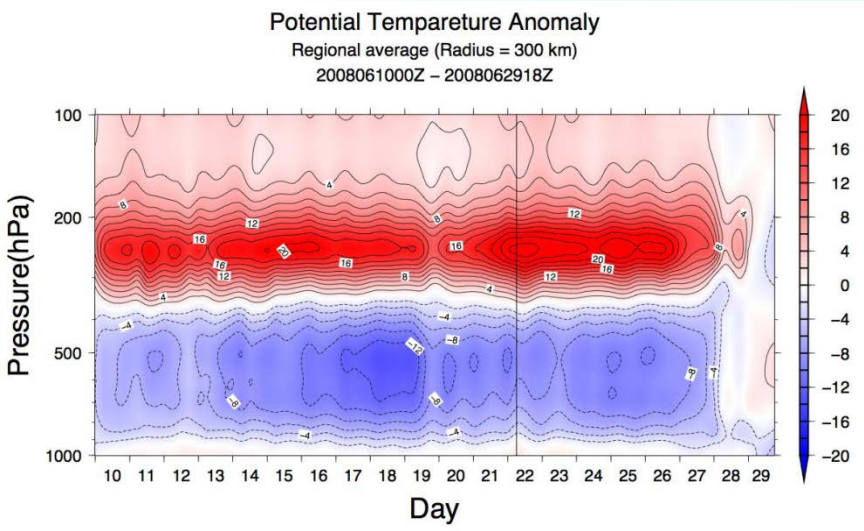


Tanaka and Yamagami 2012

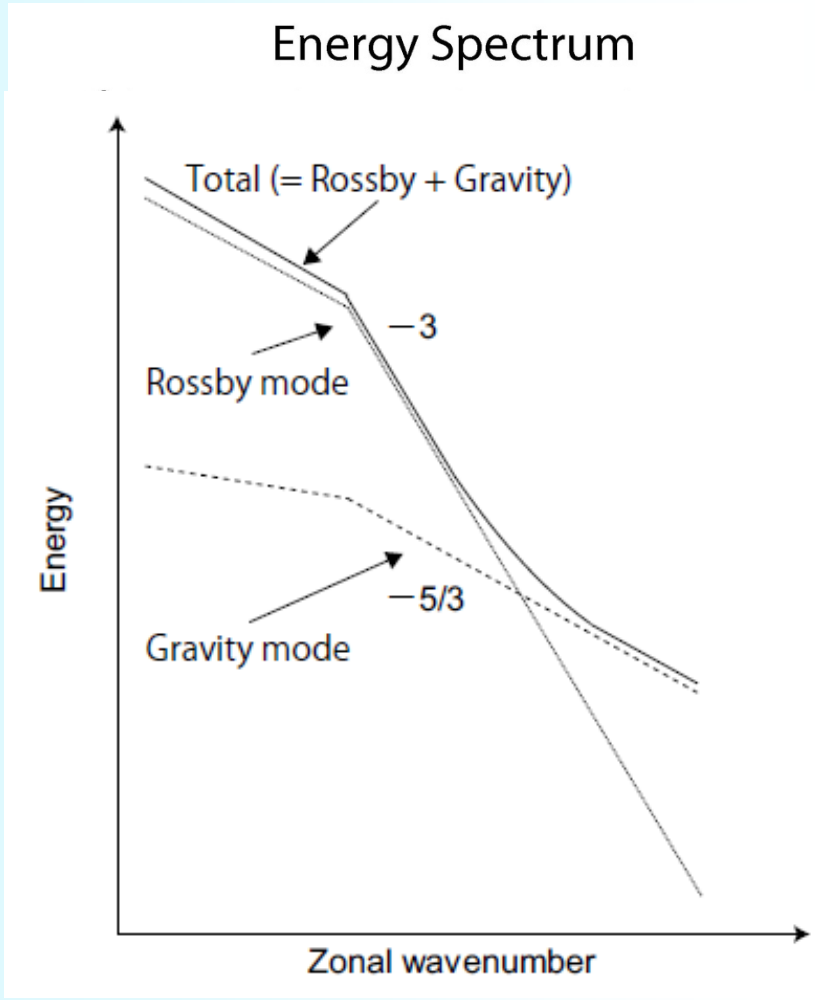


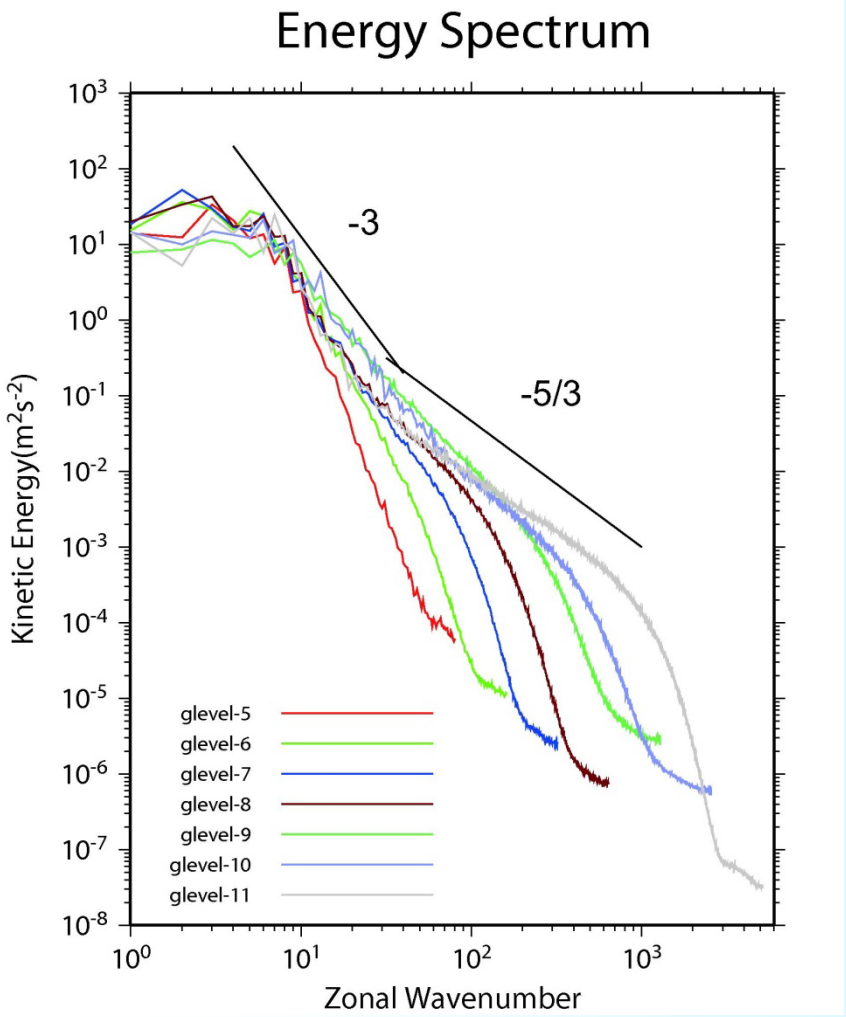






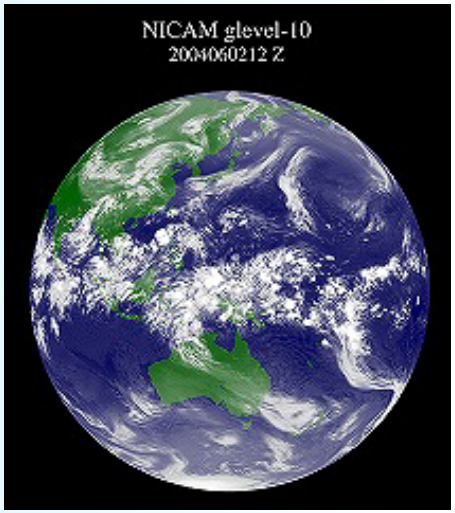
Global Energy Spectrum of NICAM
Normal mode energetics analysis

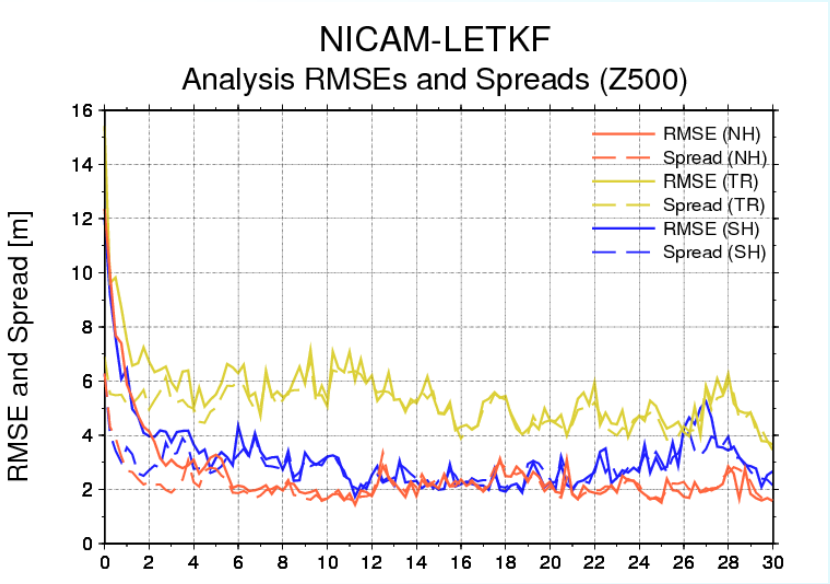




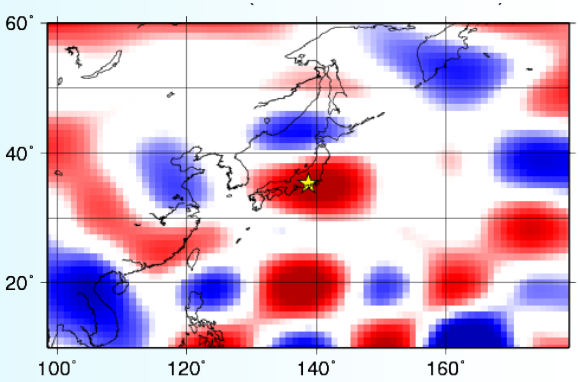
(Terasaki, Tanaka, and Satoh 2009, SOLA)

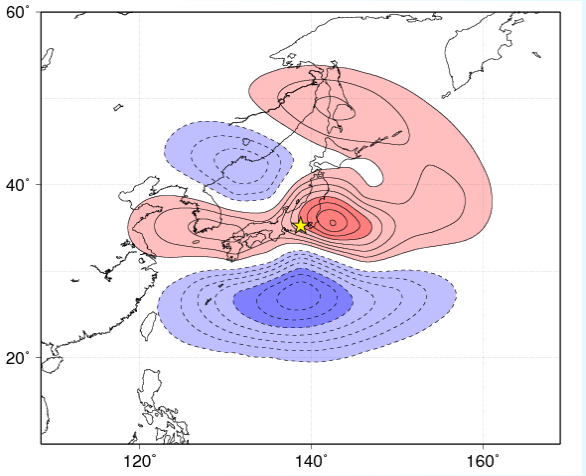
Developing NICAM-LETKF





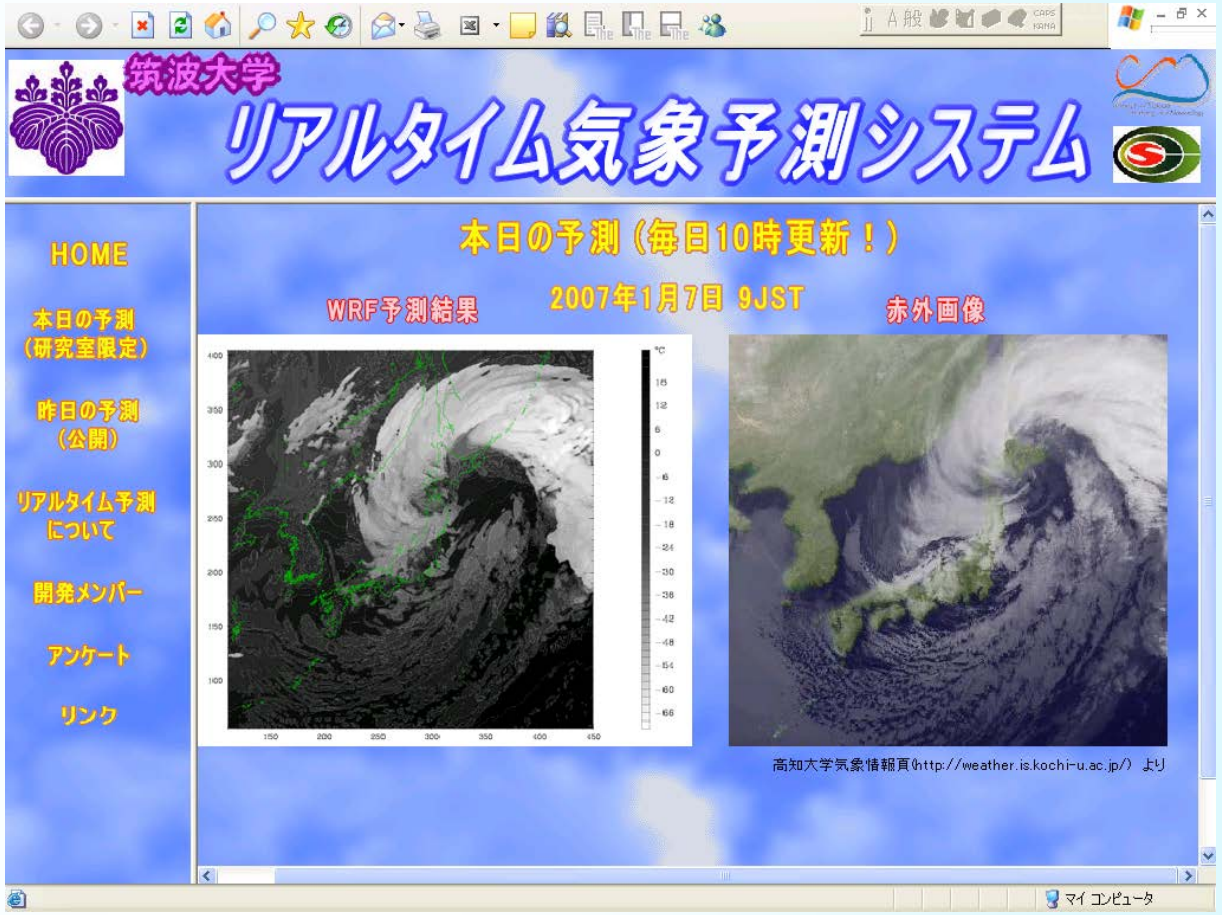
Multi-scale localization



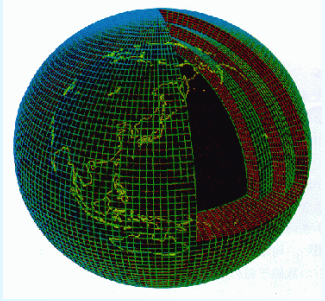


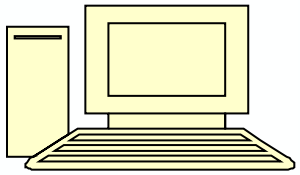
Realtime weather prediction sysytem

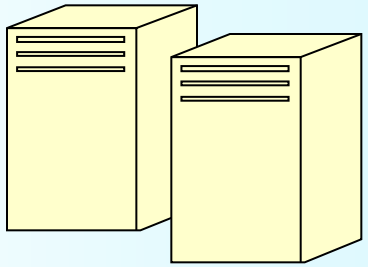
1. WRF with urban model
2. Data analysis and assimilation
3. Initial data by JMA/GPV data



JMA/GPV → WPS → WRF





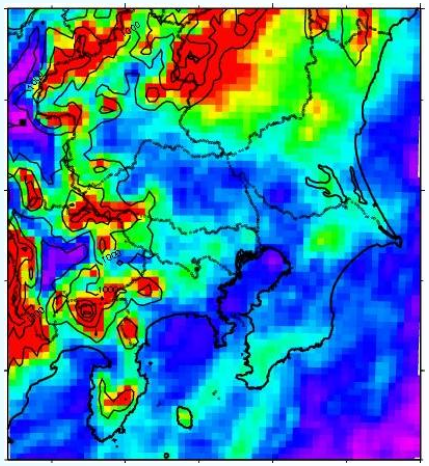


WRF simulation on urban precipitation

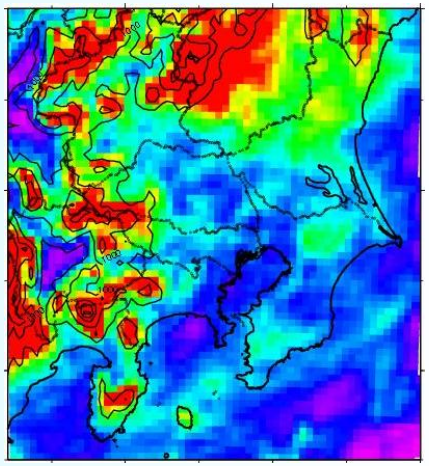
WRF with PACS-CS and T2K-Tsukuba

Urban Canopy Model

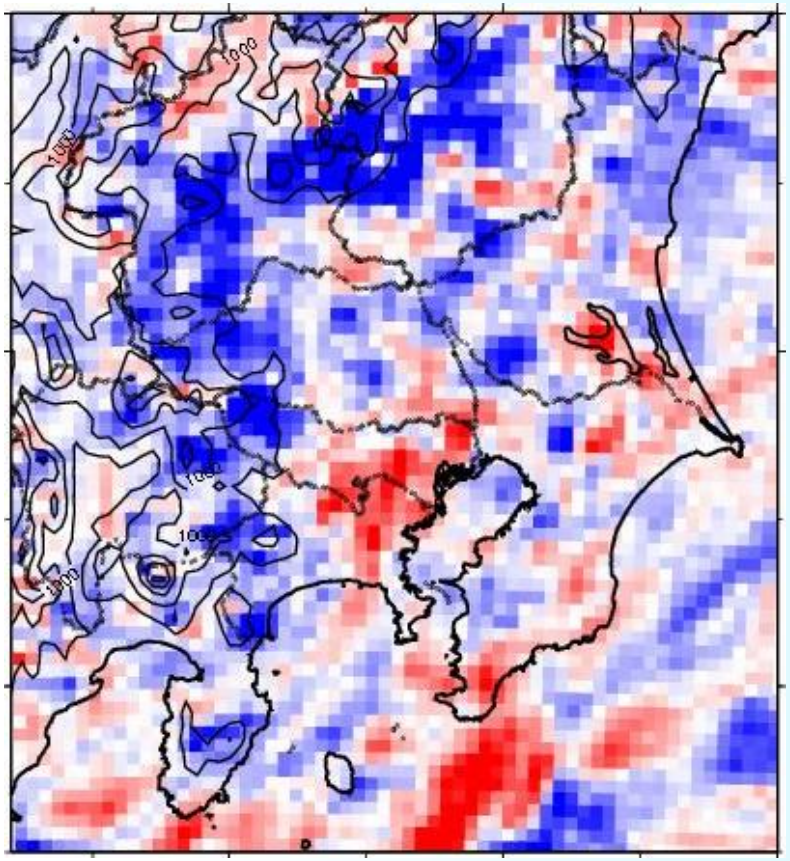
Urban Model

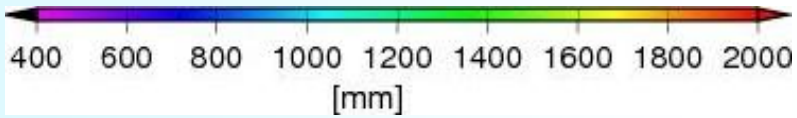


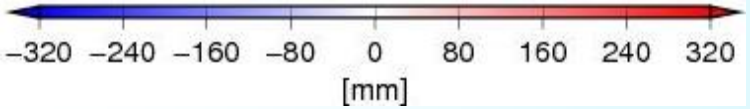
No Urban Model



Difference

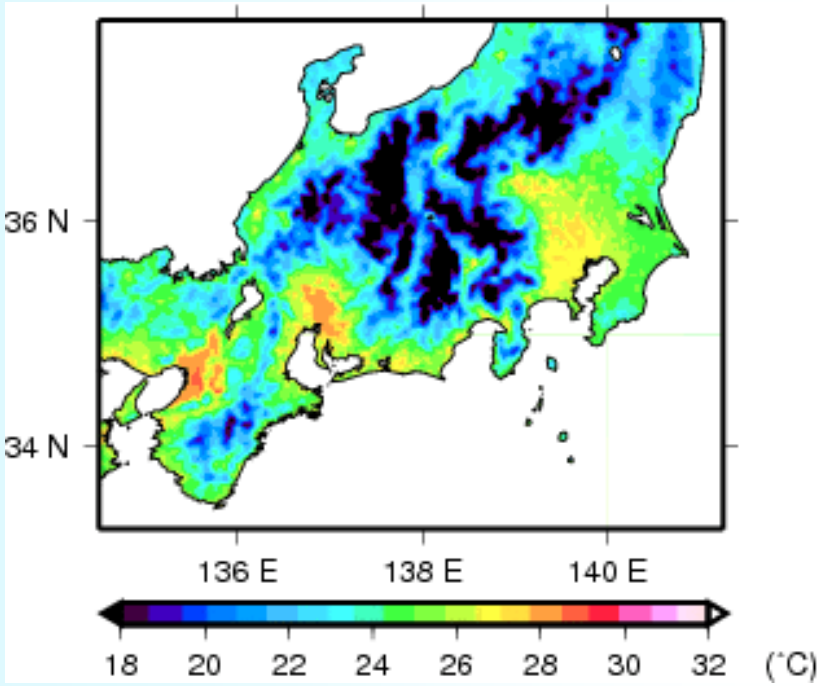




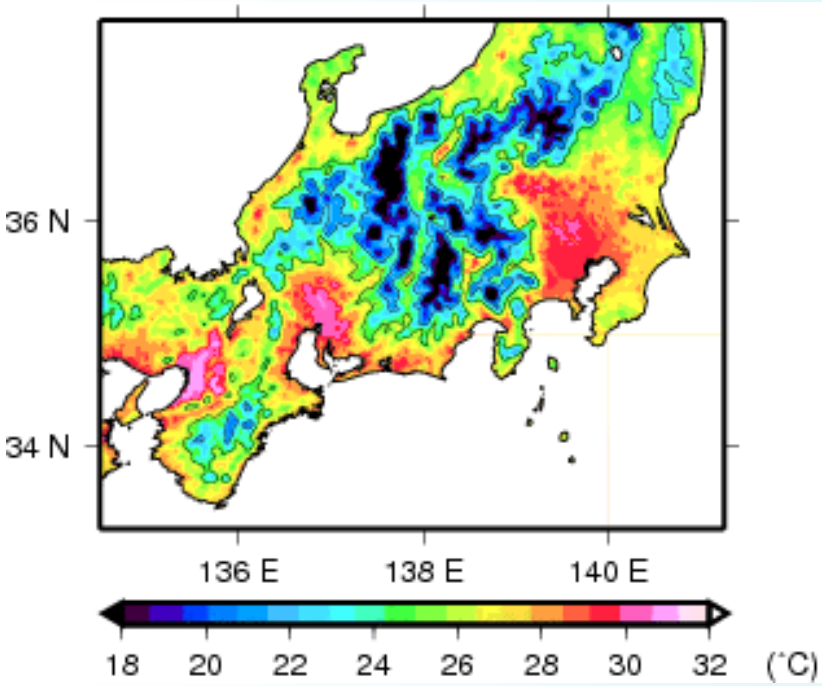


WRF Simulation of climate for 2070

August 2010

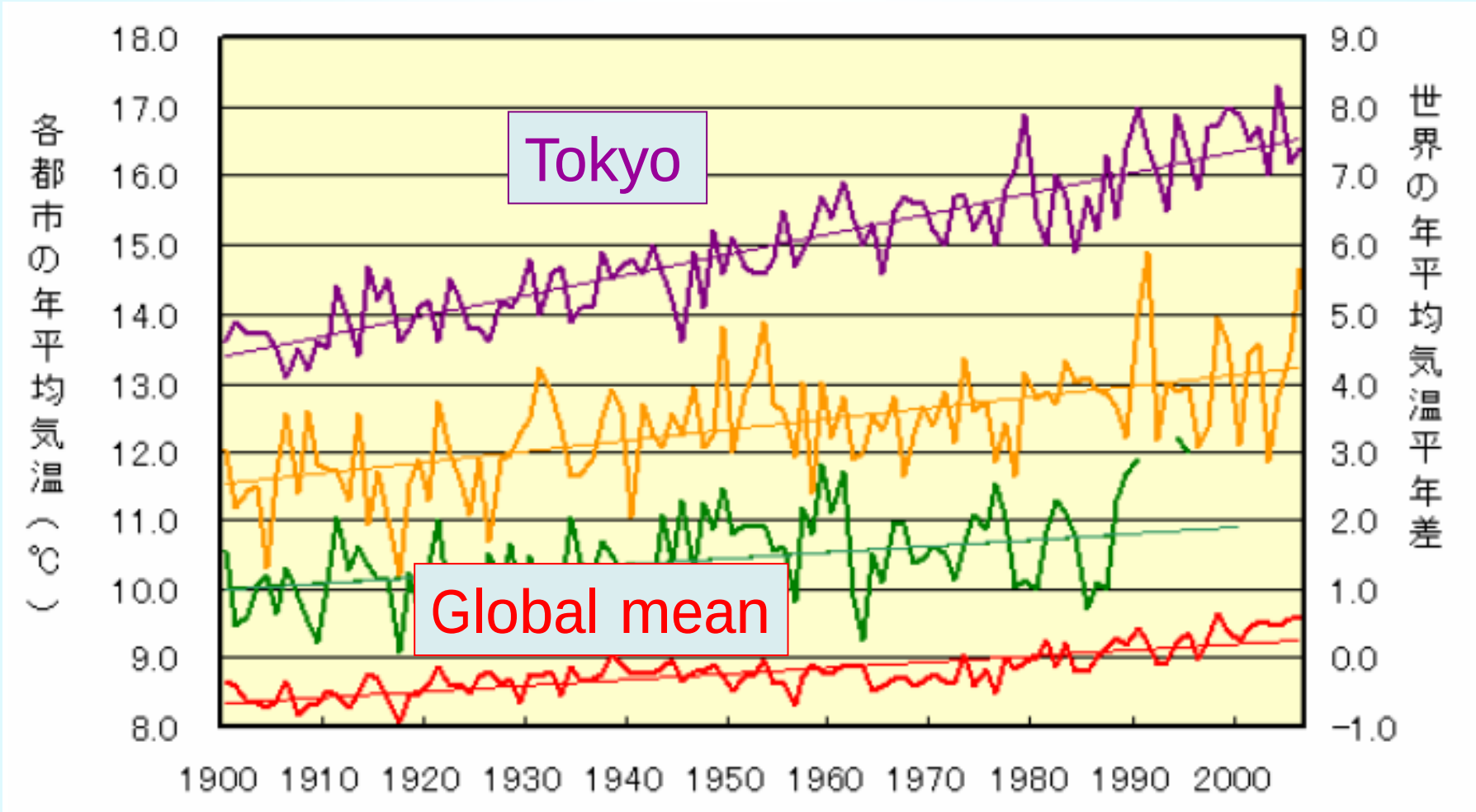


August 2070



Tokyo, Osaka and Nagoya metropolitan warming

Urban climate and heat island

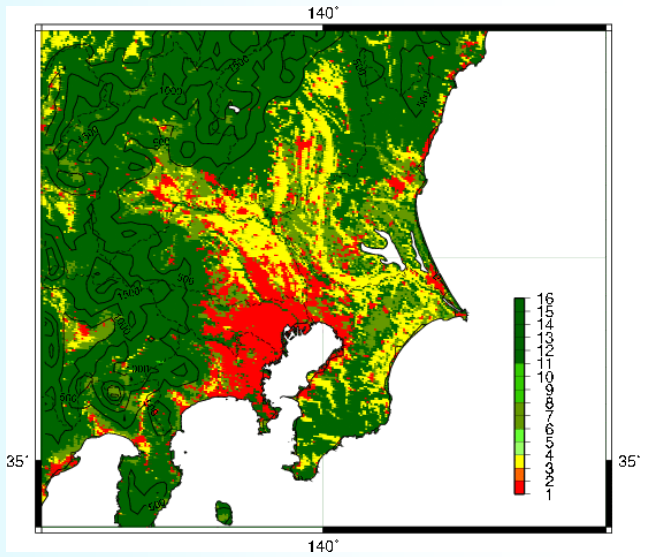


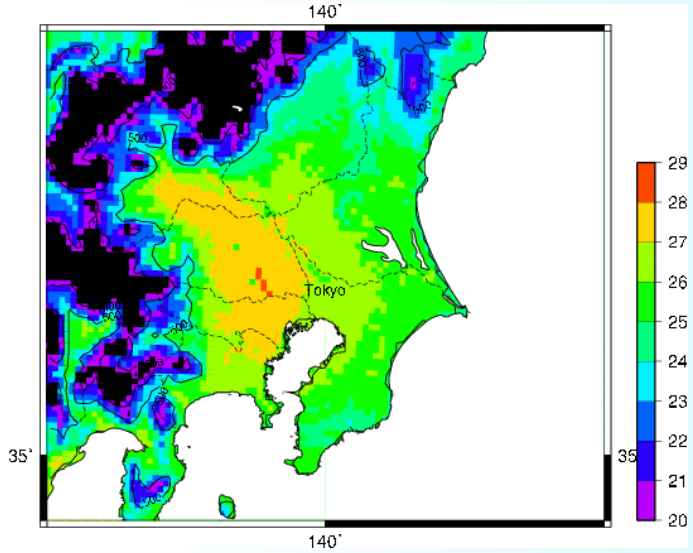
By JMAHP

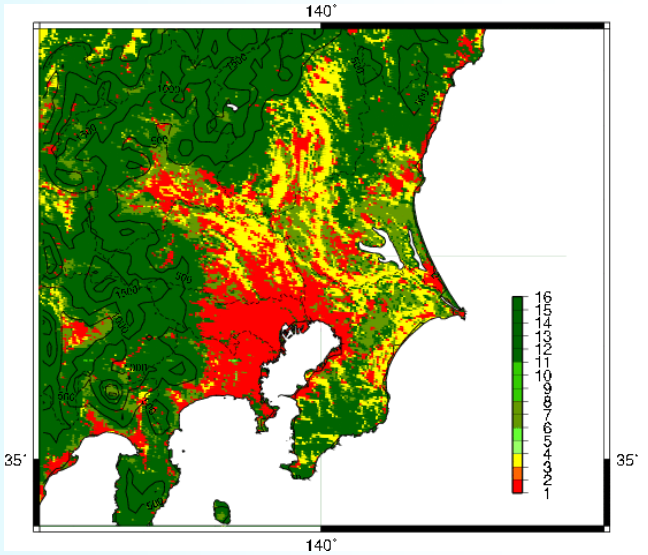
Urban climate simulation with 3km-WRF in August for last 30 years

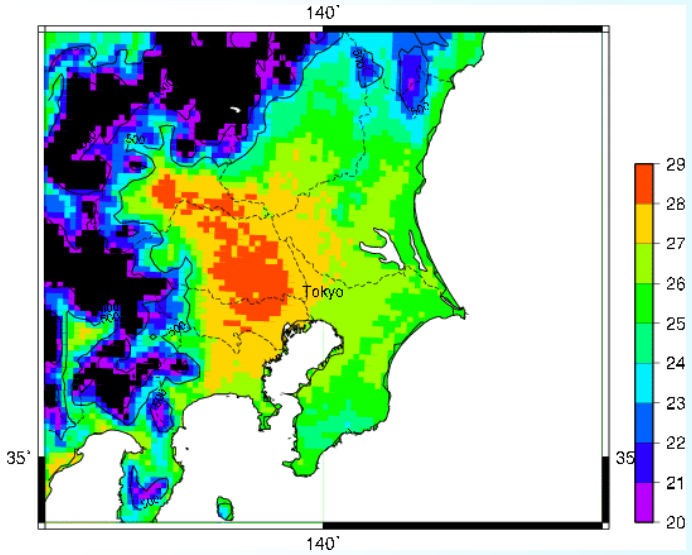
1970s

2000s





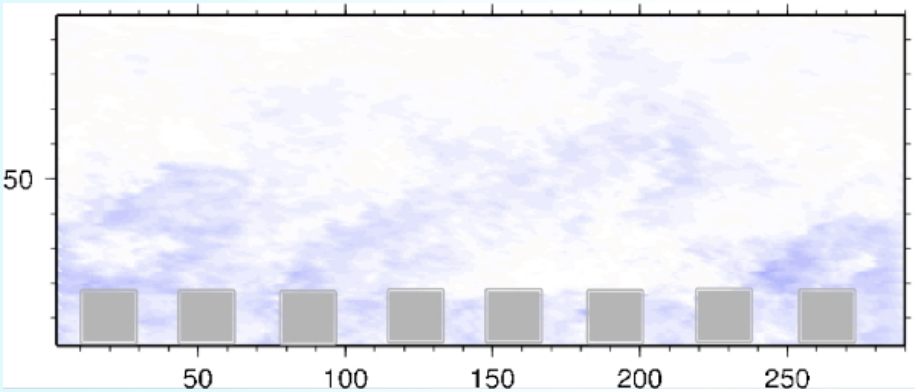


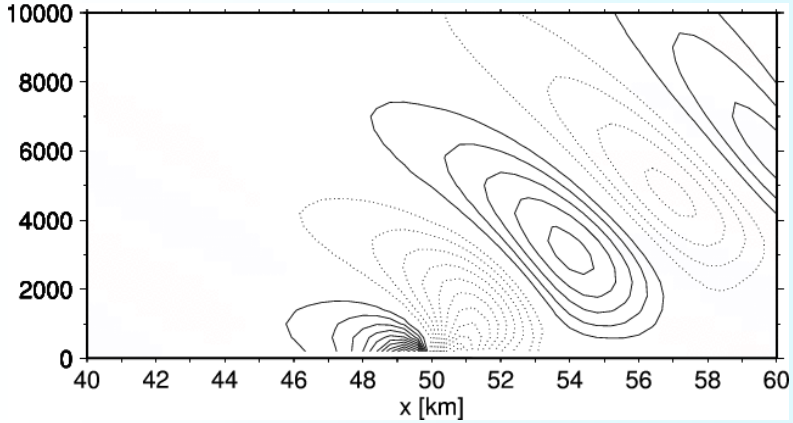


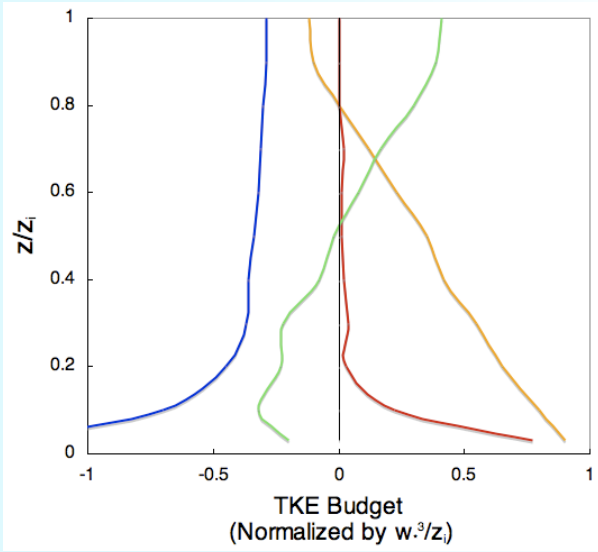
Urban in red

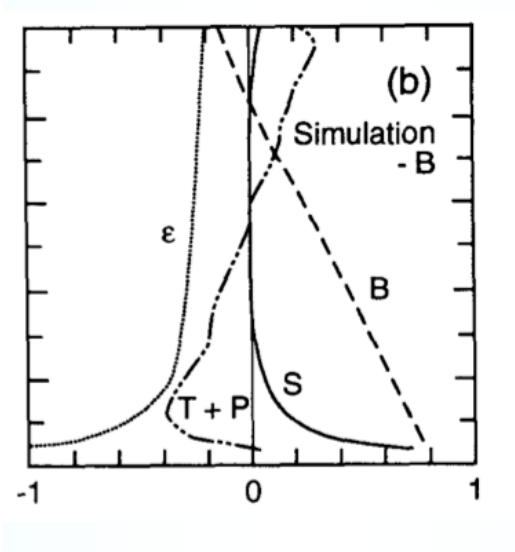
Surface temperature

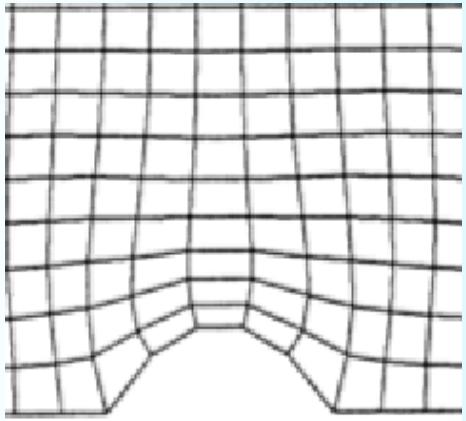
Development of new LES model



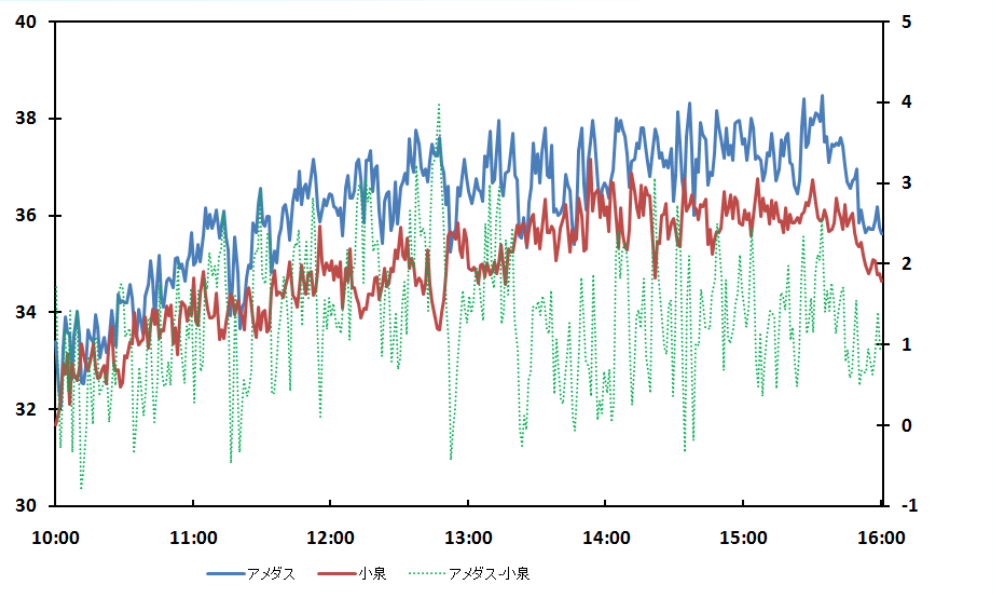








Extreme record hot in Aug. 2007

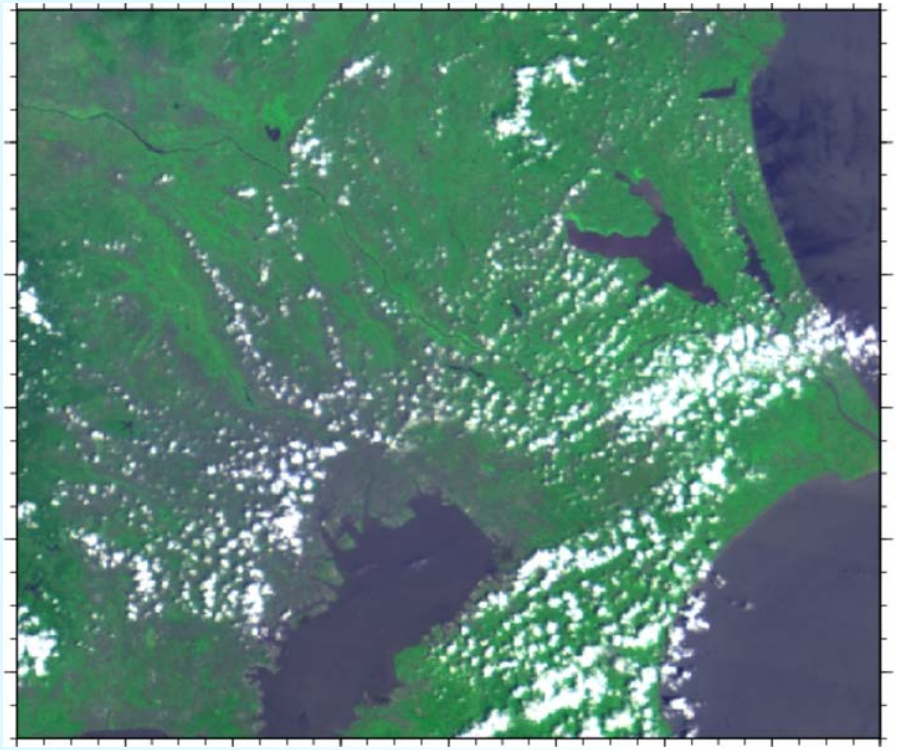


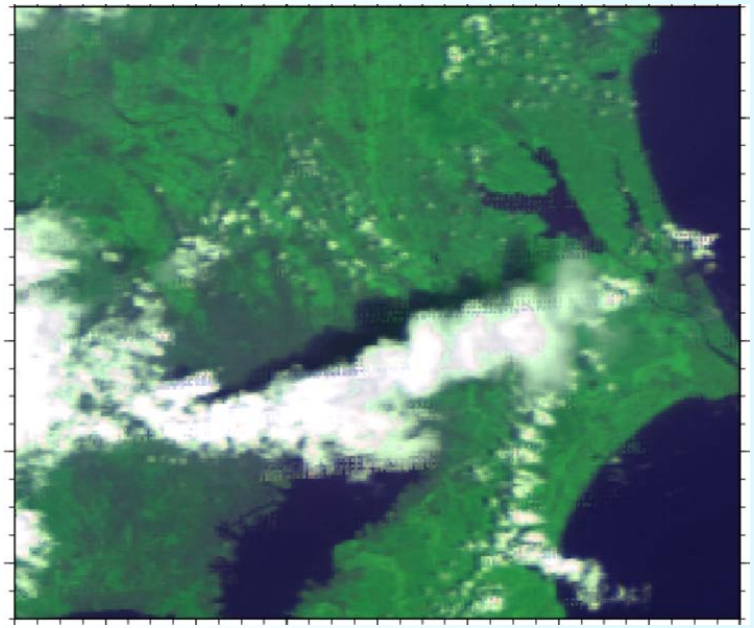
Tajimi AMeDAS Observation

is hotter than city park (red)

Field observations

Urban effects on local clouds

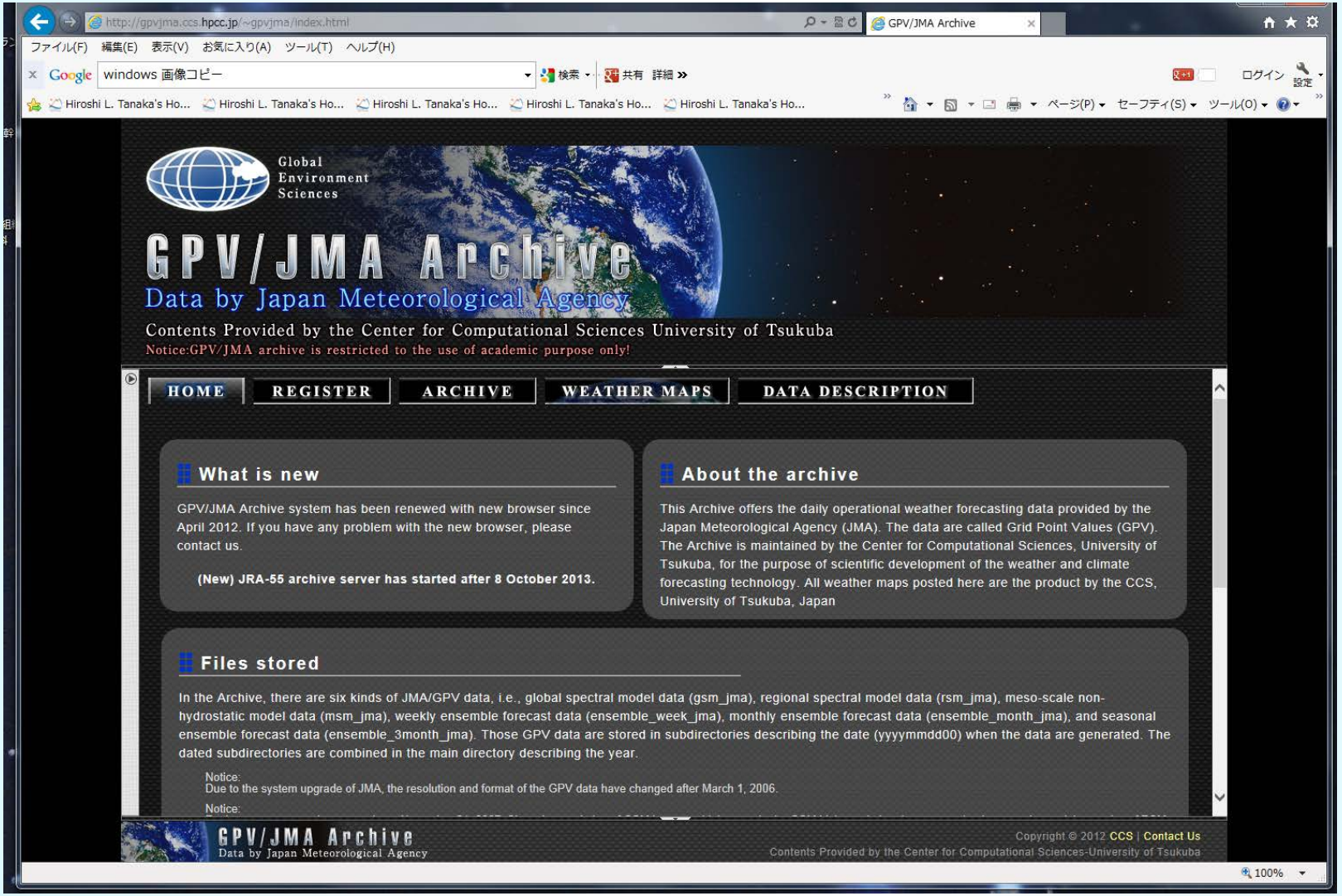




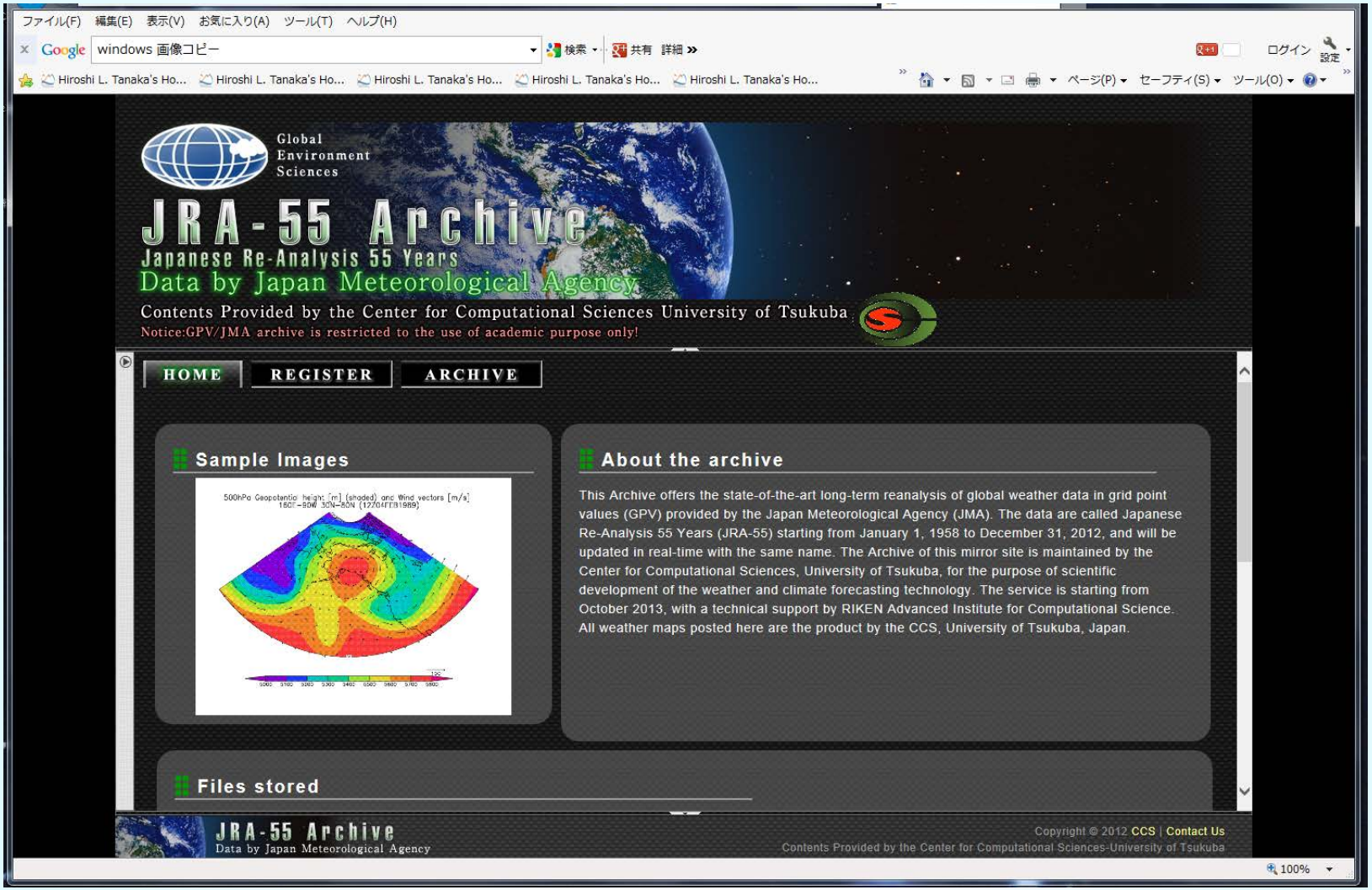
Collaborations with other Divisions

- Division of Computational Informatics
  => JMA/GPV Data archive project
- Division of High Performance Computing Systems
  => LES, WRF and NICAM with T2K-Tsukuba
- Division of Astrophysics and Nuclear Physics
  => Life in universe project, planetary atmosphere

Joint work with Computational Informatics
GPV/JMA Archive



Joint work with Computational Informatics
JRA-55 Archive



Collaborations with other Agency

- Collaborative Research with Japan Weather Association (JWA) => improvement of WRF, weather prediction, disaster analysis
- Collaborative Research with Toshiba => improvement of weather prediction.
- Collaborative Research with Tajimi City => to clarify the formation mechanism of the extreme heat.
- Collaborative Research with Academia Science, Taiwan => regional future climate projection for Taipei
- Collaborative Research with Weather News Inc. (WNI) => fog forecast and the discrimination of precipitation (rainfall, snowfall forecast).

Collaborations with other Agency

- Collaborative Research with Nippon Telegraph and Telephone Corporation. (NTT) => Research about down scalar using WRF with NTT
- Collaborative Research with Meteorological Research Institute for Technology Corporation. (MERIT) => Research about prediction of snow damage to influence on power line
- Collaborative Research with MRI for Atmosphere-Ocean coupled model => Research about future projection including paleo-climate study
- Palaeoclimate Modeling Intercomparison Project (PMIP) => Research about paleo-climate modeling across the globe

Collaborations

- JMA: Thorpex ensemble prediction technique
- MRI: Data assimilation and Kalman filter
- NIPR: Arctic amplification and AO studies
- IARC: Global change connection to the Arctic
- AORI: NICAM by PACS-CS and T2K
- DPRI: PUFF model for volcanic ash transport
- AWI: Normal mode energetics and stability
- Pukyong National University : Ice dynamics

Outside Funds

- Environment Research and Technology Development Fund of the Ministry of the Environment, Japan 2010-2014. (S-8-1). (JPY 115,586,000)
- Research Program on Climate Change Adaptation, Initiative for Strategic Adaptation to Climate Change (RECCA). The Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT). 2010-2014. (JPY 56,200,000)
- Analysis of urban air temperature. Grant-in-Aid for Scientific Research B of the Japan Science and Technology Agency (JST), Japan. 2010-2012. (JPY 1,400,000)
- Urban precipitation observations. Grant-in-Aid for Scientific Research B (22300316) of the Japan Science and Technology Agency (JST), Japan.2010-2012. (JPY 800,000)
- Urban precipitation observations. Grant-in-Aid for Scientific Research A of the Japan Science and Technology Agency (JST), Japan.2013-2017. (JPY 20,000,000)
- Environment Research and Technology Development Fund of the Ministry of the Environment, Japan.2007-2011. (S-5-3) (JPY 74,138,000)
- Actual condition and mechanism of urban heat island of Tsukuba city.
- The Grant-in-Aid for Young Scientists B of the Japan Science and Technology Agency (JST), Japan. 2007-2010. (JPY 4000,000)
- Green network of excellence (GRENE) of Arctic Climate Study under Ministry of Education, Culture Sports, Science and Technology (MEXT), Japan. 2011-2015. (PI: J. Ukita, JPY 500,000,000)
- Environment Research and Technology Development Fund of the Ministry of the Environment, Japan 2008-2013. (S-5-2; A1201). (JPY 45,000,000)
- Program for Risk Information on Climate Change, Ministry of Education, Culture, Sports, Science and Technology, 2012-2013. (JPY 440,000,000).

Future Plan of Research

- New multi-layer vegetation canopy model considering rainfall interception and dew deposition.
- Vegetation model to our LES model.
- Evaluate the degree of impact of buildings, parks, and trees on the local temperature distribution using our LES model.
- Interdisciplinary research activities in climate-health interaction.
- Expanding our research activities in this arena, especially in conjunction with global warming projections and mitigation/adaptation planning.

Future Plan of Research

- Cloud resolving global mode NICAM for the study of arctic climate change, especially for the arctic amplification, arctic oscillation, and arctic cyclone under the collaboration with AORI.
- Expand the 3D normal mode energetics study not only for Rossby wave world, but also for gravity wave world. The tropical low-frequency variability, like MJO, is expected to be normal mode solutions.
- International collaboration is planned for implementing the volcanic ash dispersal model PUFF for volcanos in Indonesia under the collaboration with DPRI of Kyoto University.

END

Thanks !