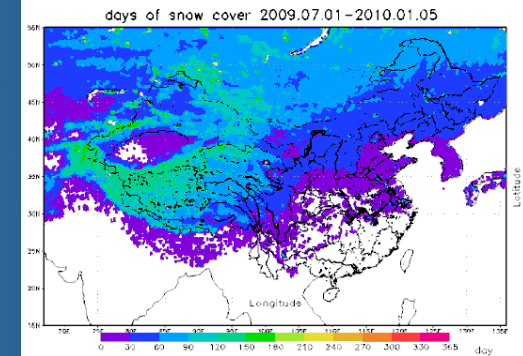




中国科学院数字地球重点实验室

Key Laboratory of Digital Earth Science
Center for Earth Observation and Digital Earth
Chinese Academy of Sciences



Climatological Analysis of Satellite-based Snow Cover Parameters

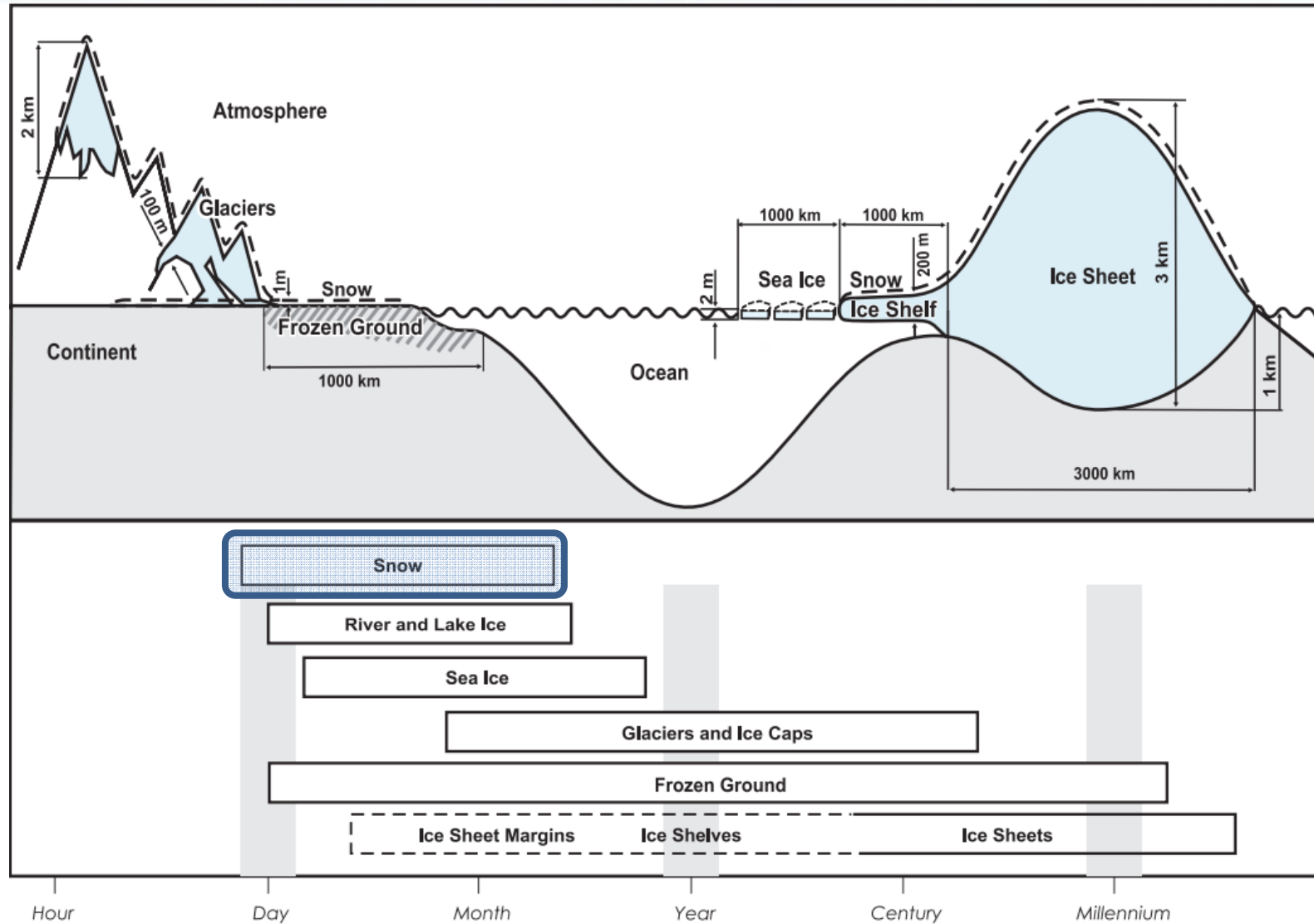
Y.B. Qiu¹, H.D. Guo¹, S.C. Kang², D. Chu³, J. Lemmetyinen⁴,
X.W. Li¹

Center of Earth Observation and Digital Earth, CAS, China
ABCC workshop

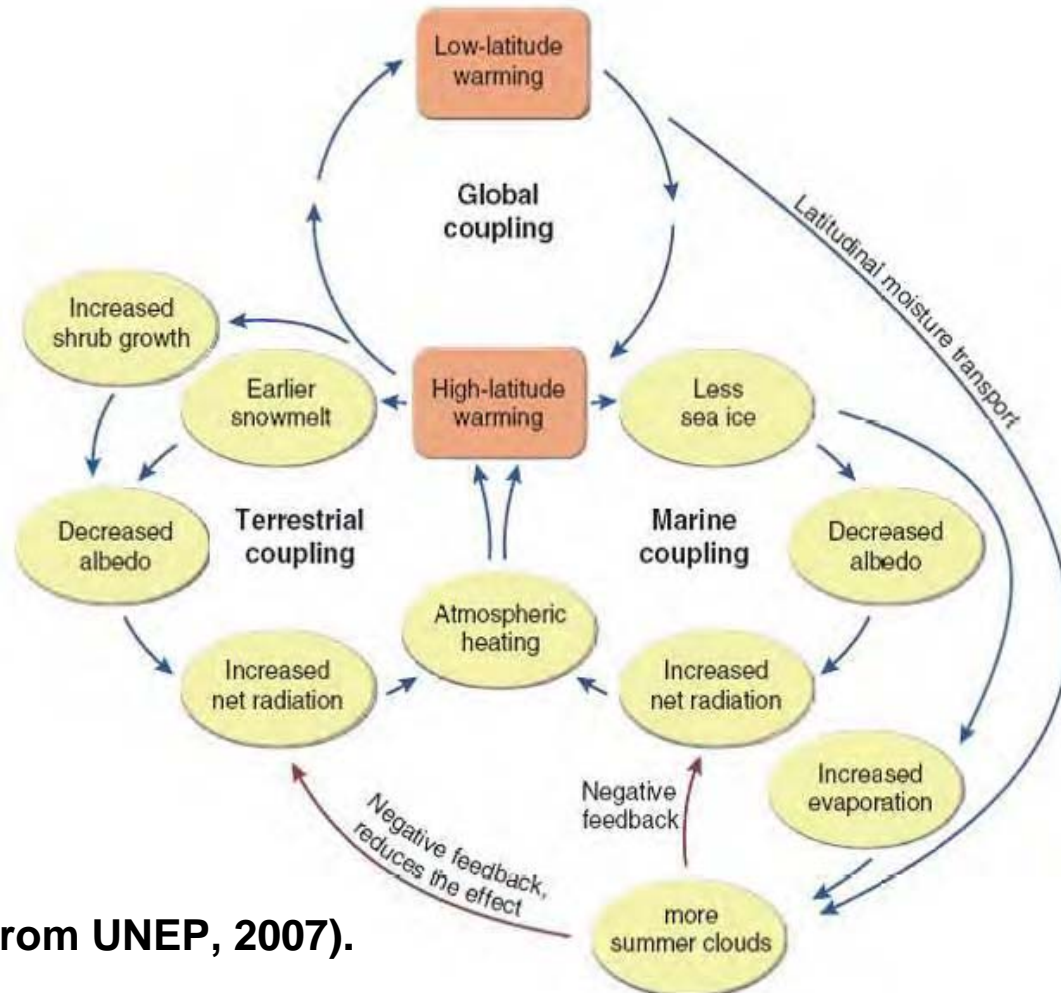
2011.8.24
Perth, Australia

- **Why snow?**
 - Importance - IPCC AR4,
 - Potentially sensitive factor of climate change
 - China 's View on snow work, a basic knowledge
- **Satellite-based Snow Products and processing method**
 - Satellite-based snow Products
 - Processing methods
- **Climatological Analysis over China**
 - SCA: snow onset, duration and end of the snow seasons
 - SWE: monthly average climatology
 - Nearly: AMSR-E SWE and MODIS SCF's trend view
- **Conclusion and future plan**

Snow Cover is a critical parameter in global changing



Snow, climate and water cycle --Global warming--



Conceptual diagram on the connectivity of the positive **ice/snow albedo feedback**, **terrestrial snow and vegetation feedbacks** and the **negative cloud/radiation feedback**

(From UNEP, 2007).



Terrestrial Essential Climate Variables

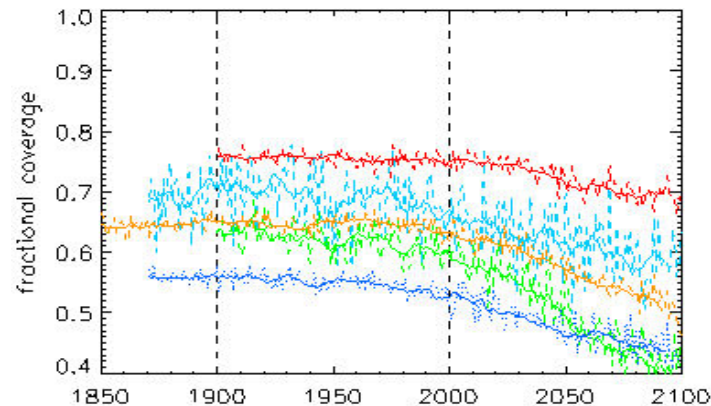
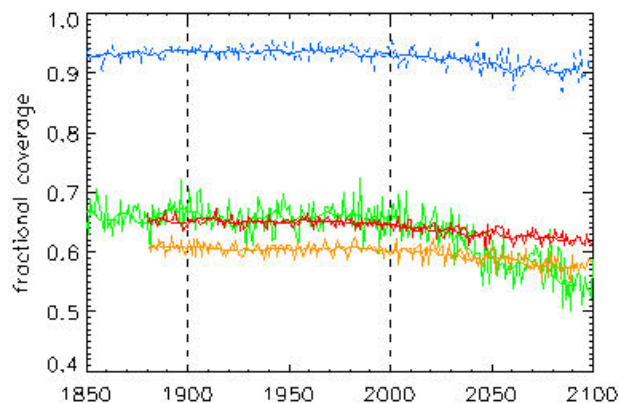
SNOW

Snow cover

Snow - a potentially sensitive factor of climate change



- Snow – very important
 - IPCC AR4(2007): Continental-scale snow cover extent (SCE) is a **potentially sensitive indicator of climate change**.
 - (Foster et al. 1982; Namias 1985; Gleick, 1987) said: **Snow is not only a sensitive indicator of climate change, but makes feedbacks to it.**
 - Snow has been proposed as a useful **indicator** in testing and monitoring **global climate change** (Robinson et al. 1990).
 - ...
- Works support IPCC-AR4



Nine GCM model:
shrinking snow cover
over Northern
American

Frei, A. and G. Gong,
2005.

- Data : *SMMR-SD, NOAA-SCA*

QIN DAHE, 2006

- Results show that **western** China **did not** experience a continual **decrease** in snow cover during the great warming period of the 1980s and 1990s. The **positive trend** of the western China snow cover is consistent with increasing **snowfall**, but is **in contradiction to regional warming**.

Potential impact of climate change on snow cover area in the **Tarim River** basin

Xu Changchun, 2007

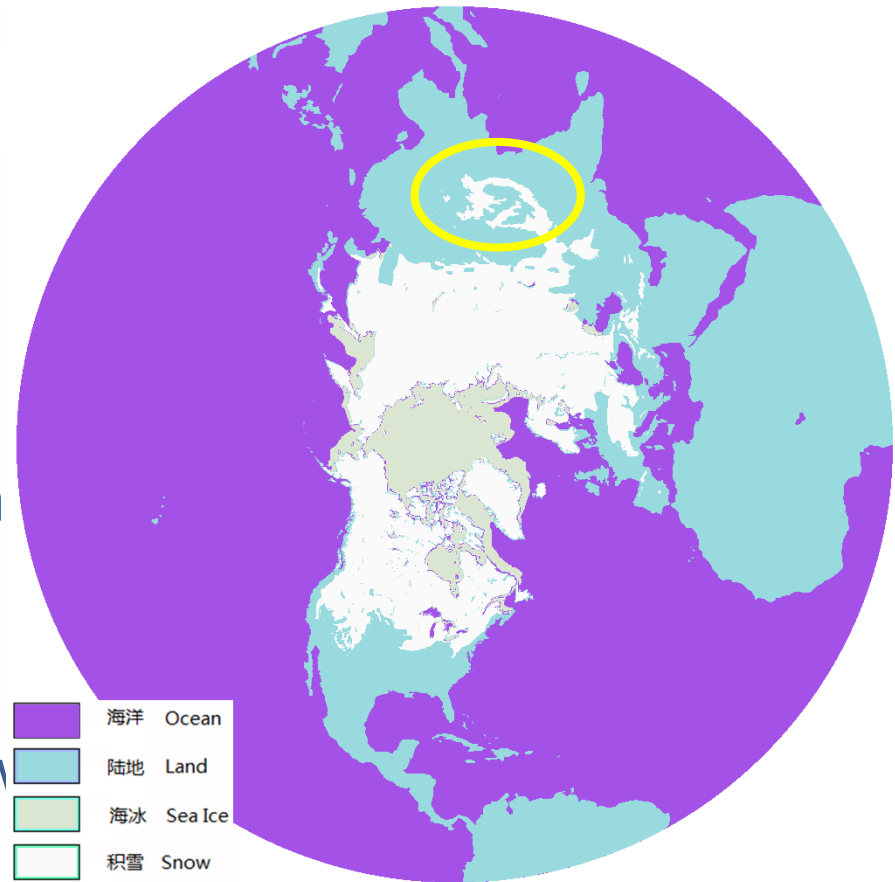
- ◆ Data: 1982–2001, station data

- The SCA of the entire basin showed a **slowly increasing trend**.
- Correlation analysis implied that the SCA change in the cold season was positively correlated with the contemporary **precipitation** change, but had no strong correlation with the contemporary **temperature** change.

Satellite-based Snow Products



- SCA – snow cover area
 - Snow extent
 - Time: 1997~2011
 - Polar Stereographic Proj.
 - 1024*1024 grid
 - Spatial Resolution :~24km
 - Daily
 - Four types:
 - Ocean\Land\Sea ice\Snow
 - Optical and other sources
 - Distort in China area



24 km daily Northern Hemisphere snow and ice coverage

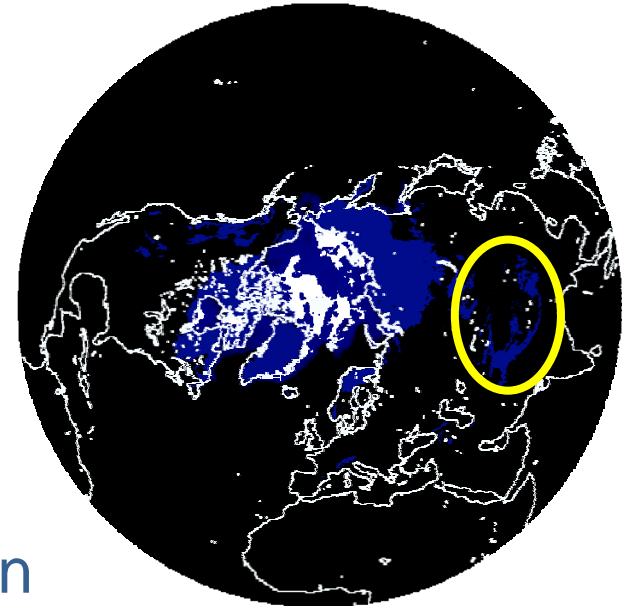
by the NOAA/NESDIS Interactive Multisensor Snow and Ice Mapping System(IMS)

National Snow and Ice Data Center

Satellite-based Snow Products



- **SCA** — Near-Real-Time SSM/I-SSMIS EASE-Grid Daily Global Ice Concentration and Snow Extent
 - Snow extent
 - Time: 1995.05~2011.08
 - EASE-Grid Proj.
 - Spatial Resolution :~25km
 - Distort in China area
 - Snow extent, sea ice concentration
 - NISE product : passive microwave data from the Special Sensor Microwave Imager/Sounder (SSMIS) on board the Defense Meteorological Satellite Program (DMSP) F17 satellite
 - Provide a best estimate of current ice and snow conditions



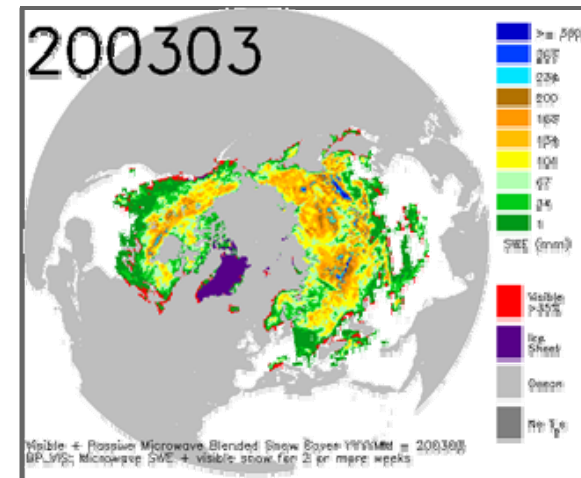
Satellite-based Snow Products



- **SWE** - Global Monthly EASE-Grid Snow Water Equivalent

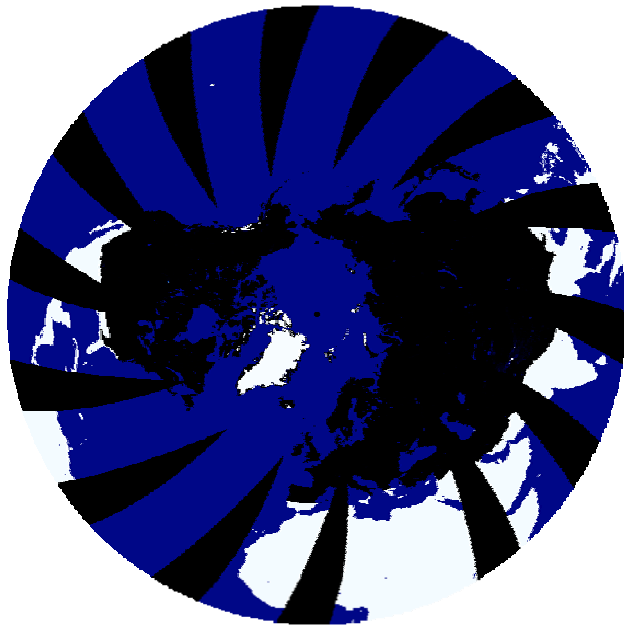
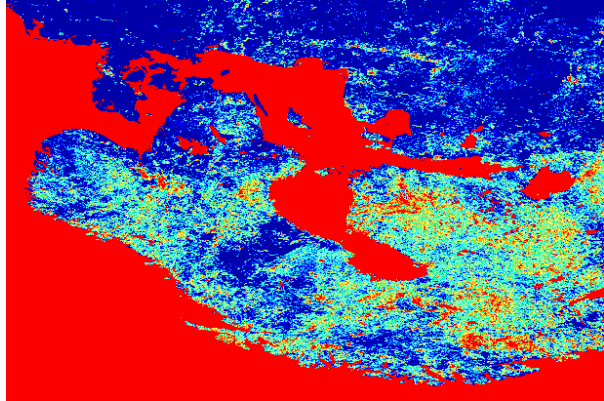
Climatology

- Time: 1978 – 2007
- Monthly
- EASE-Grid Proj.
- Spatial Resolution :~25km
- Distort in China area
- Snow water equivalent and
- Snow cover frequency of occurrence
- By Scanning Multichannel Microwave Radiometer (SMMR) and selected Special Sensor Microwave/Imagers (SSM/I)
- Visible snow parameters as a factor



Northern Hemisphere average snow water equivalent (mm) from passive microwave, with additional area indicated as snow by Northern Hemisphere EASE-Grid weekly snow cover in red, March, 2003.

Satellite-based Snow Products

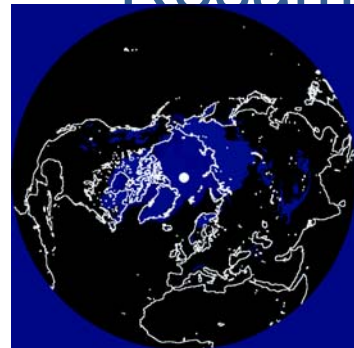


- MOIDIS and AMSR-E
 - SCF – snow cover fraction
 - Aqua 2002~ now
 - Terra 1999~ now
 - 8 days products
 - Percent rate of snow cover
 - SWE – snow water equivalent
 - Ease-Grid
 - ~25km
 - Daily, 5days and monthly

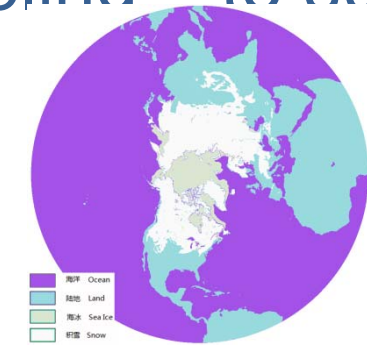
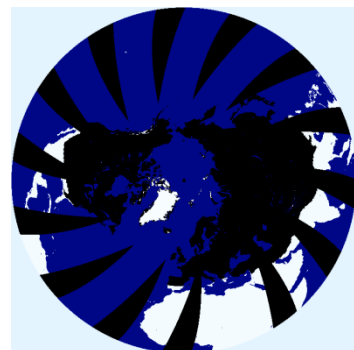
Processing methods



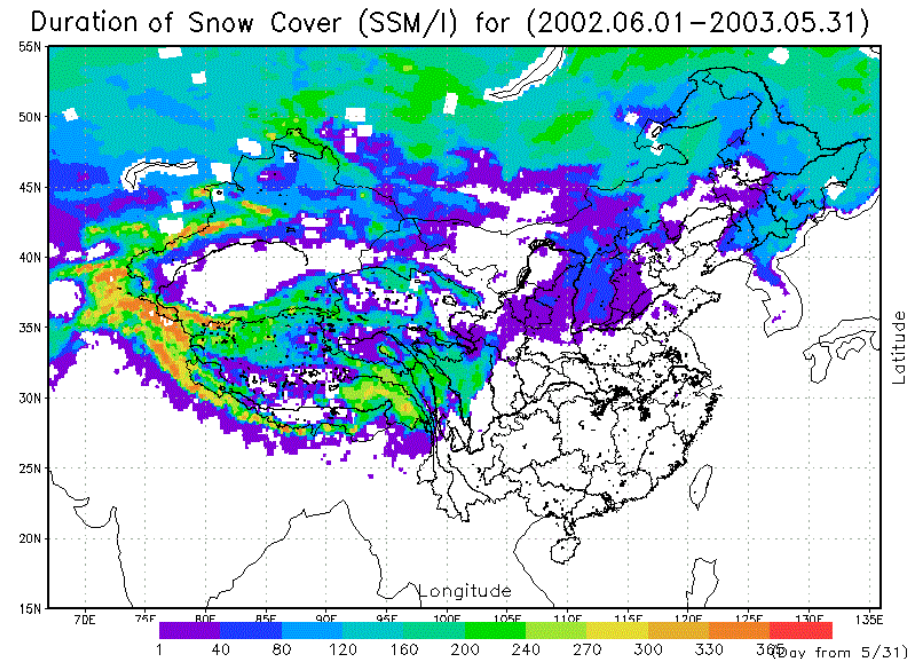
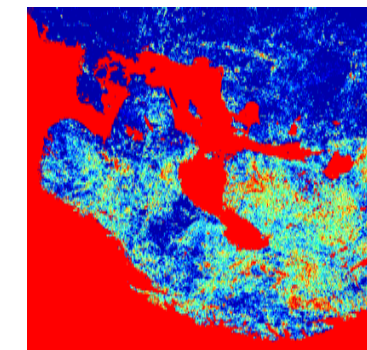
- Projection transfer to a relative high resolution grid
- Latitude and longitude grid: $0.1^{\circ} \times 0.1^{\circ}$
- Resampling = to suit for China area



EASE-Grid



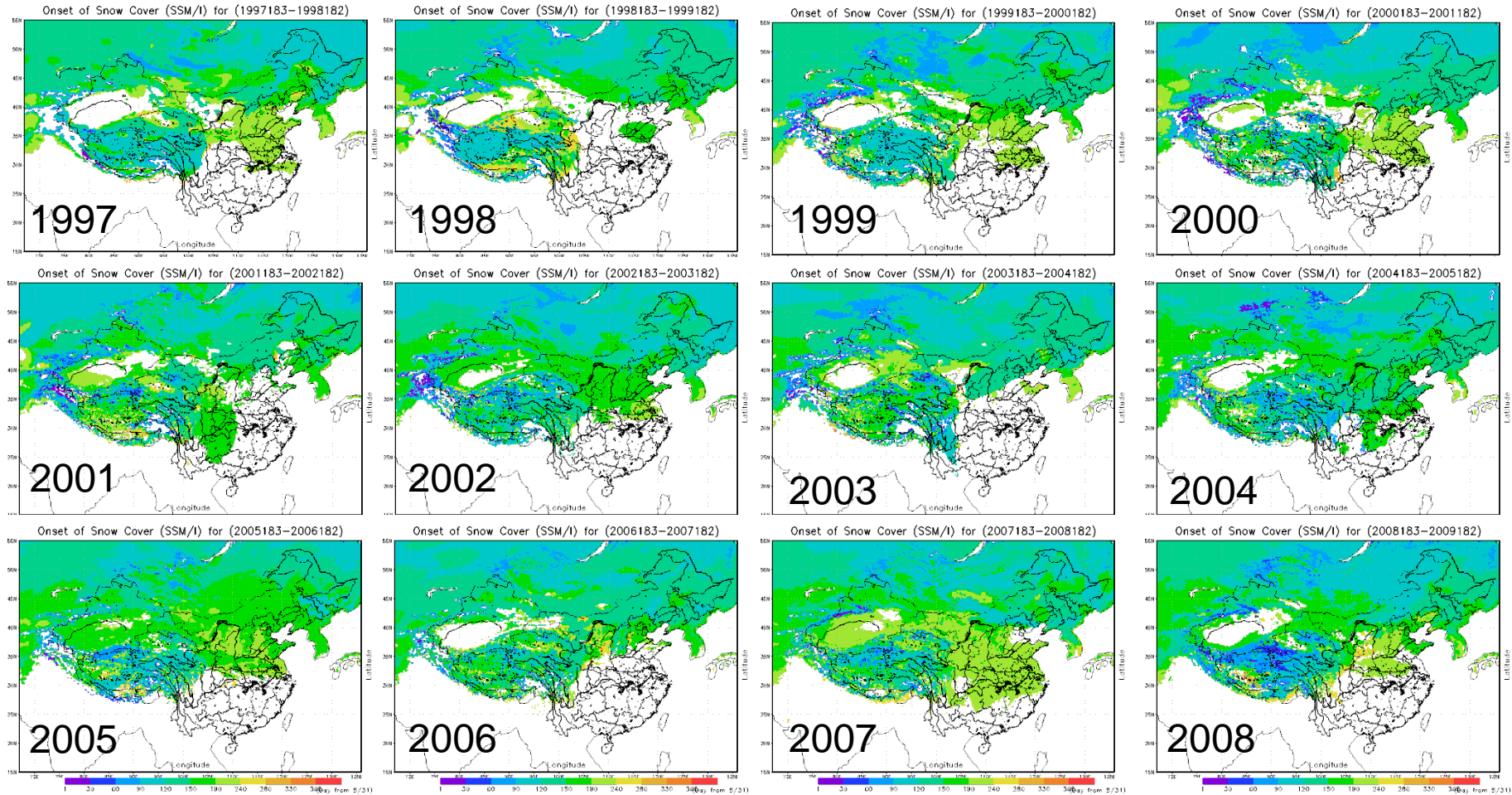
Grid with Lat/Lon



Result analysis



- Onset of Snow cover - IMS

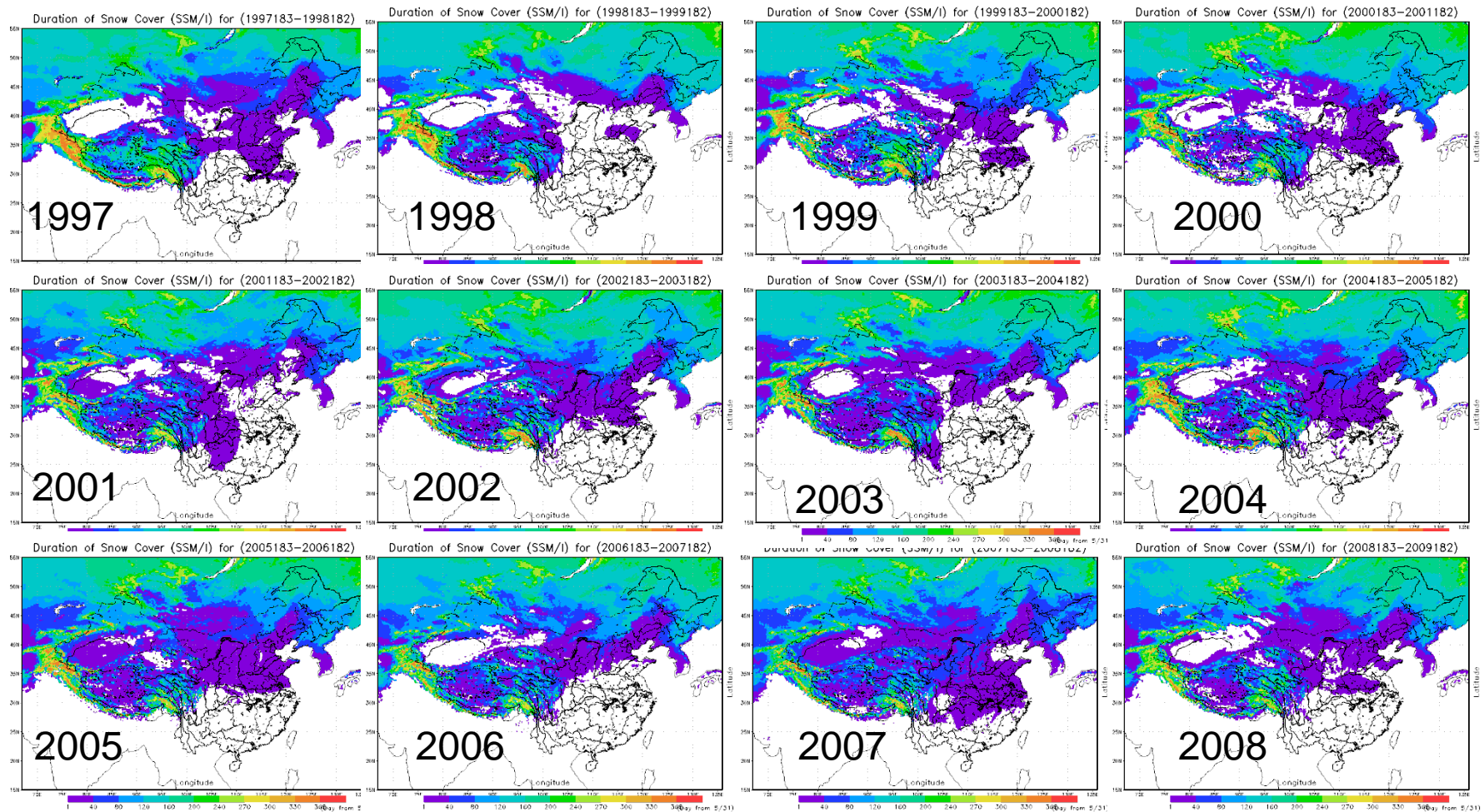


A long time comparison of onset date (refer to May.31): relatively postpone

Result analysis



- Duration of Snow cover - IMS

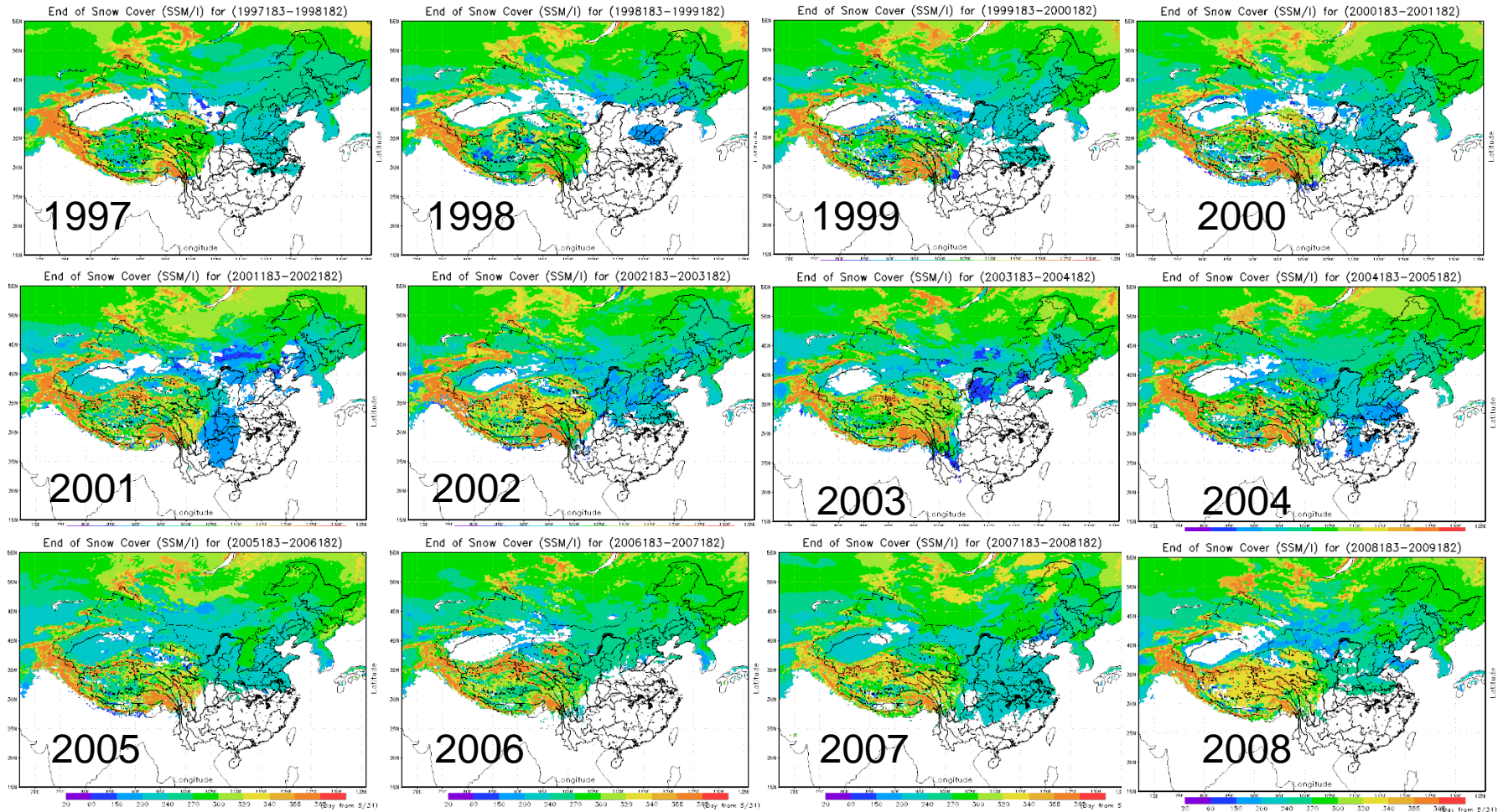


A long time comparison of snow duration:

Result analysis



- End of Snow cover - IMS

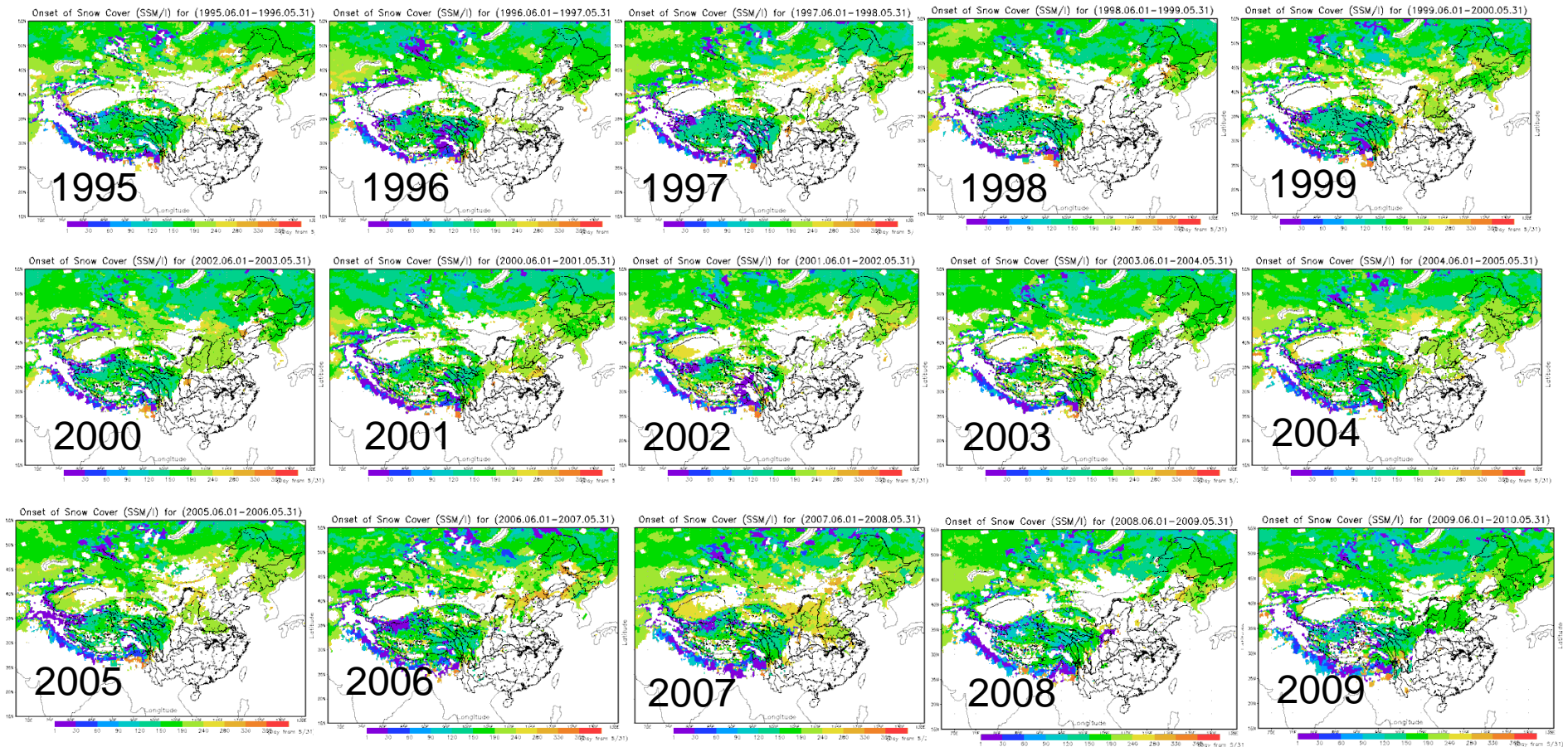


A long time comparison of end date (refer to May.31): relative postpone over Tibet

Result analysis



- Onset of Snow cover - NISE

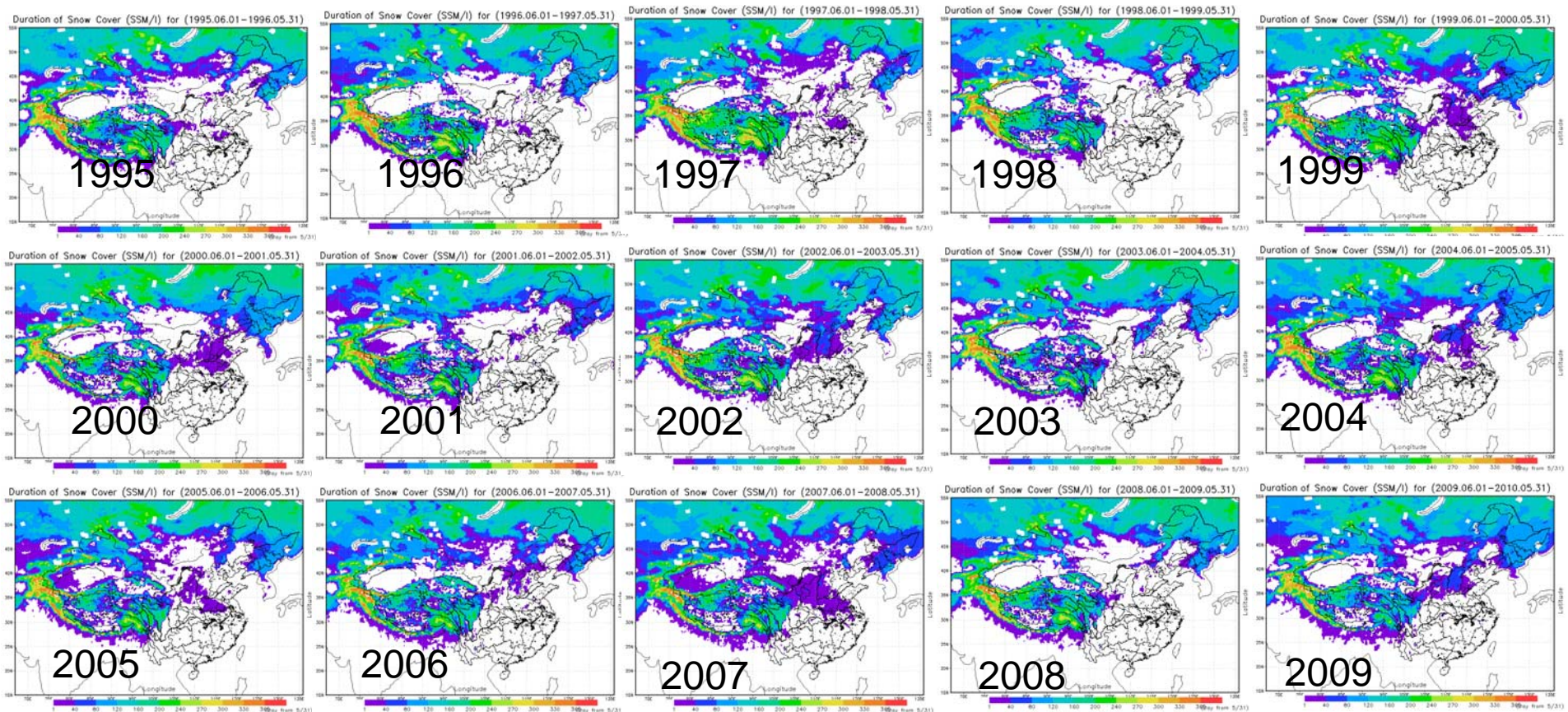


A long time comparison of onset date (refer to May.31)

Result analysis



- Duration of Snow cover - NISE

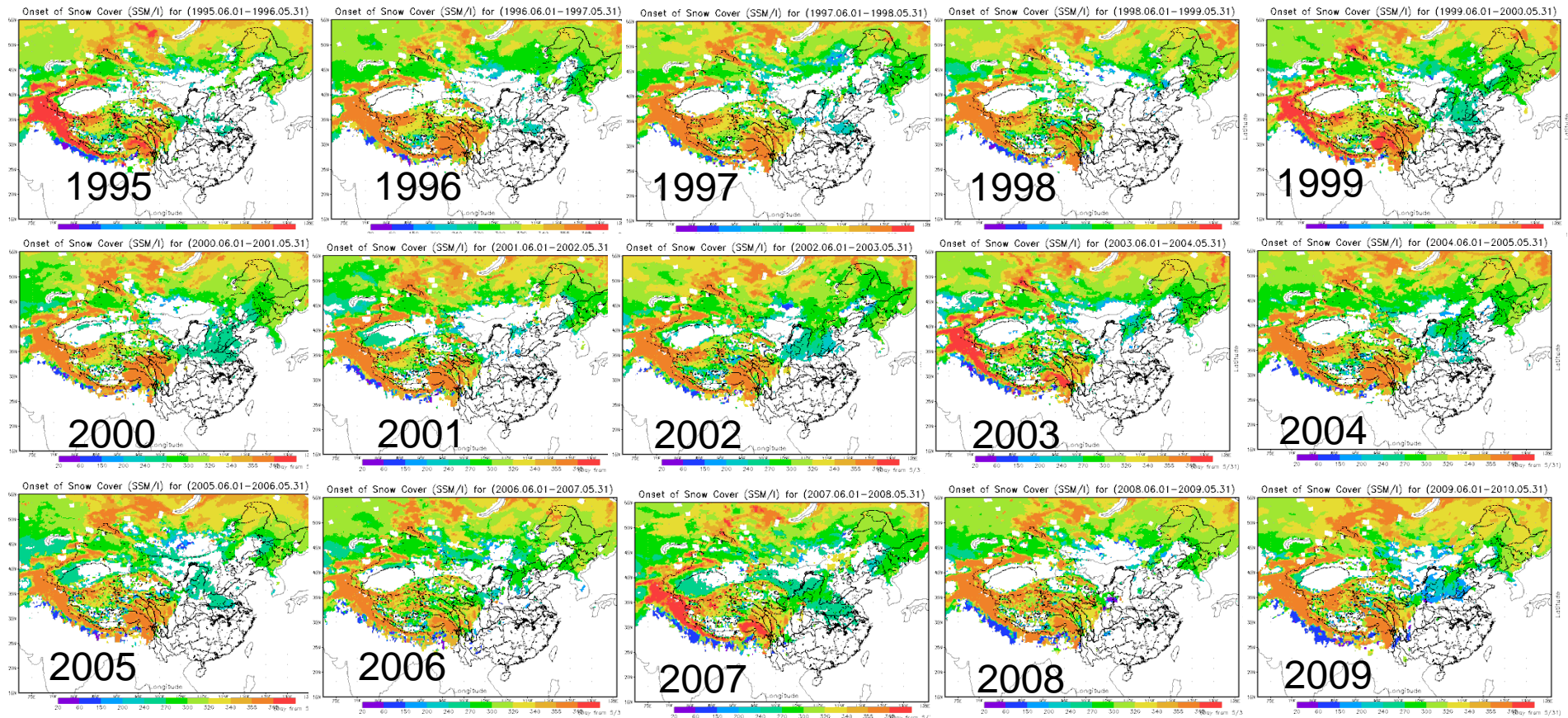


A long time comparison of snow duration: Northern East, longer

Result analysis



- End of Snow cover - IMS

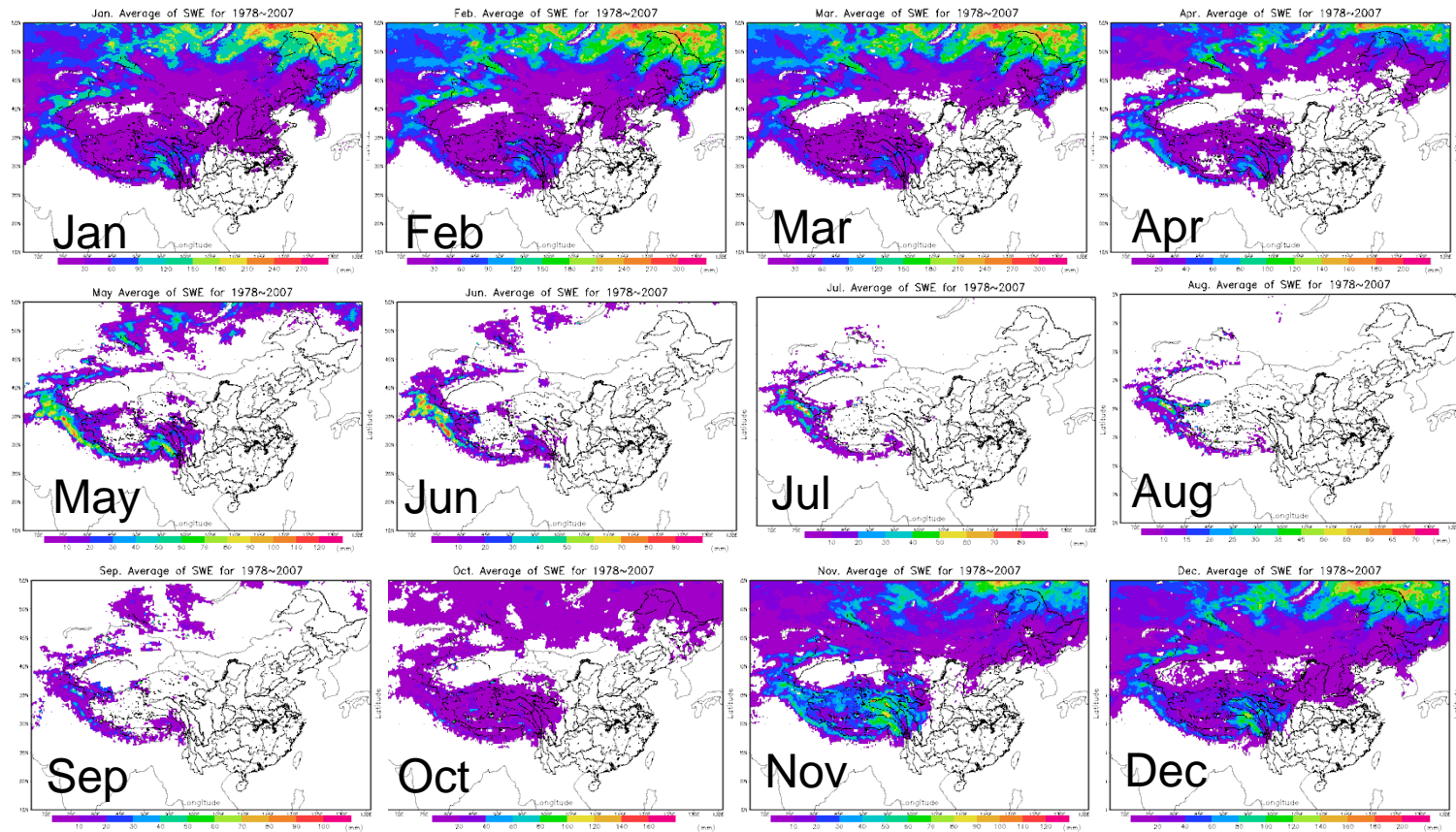


A long time comparison of end of snow cover:

Result analysis

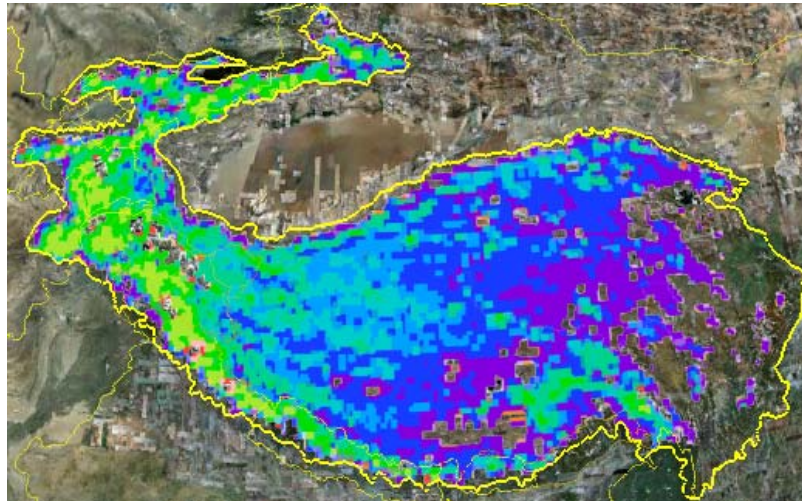


- SWE – 1978~2007



SWE(mm) climatological characteristics over China

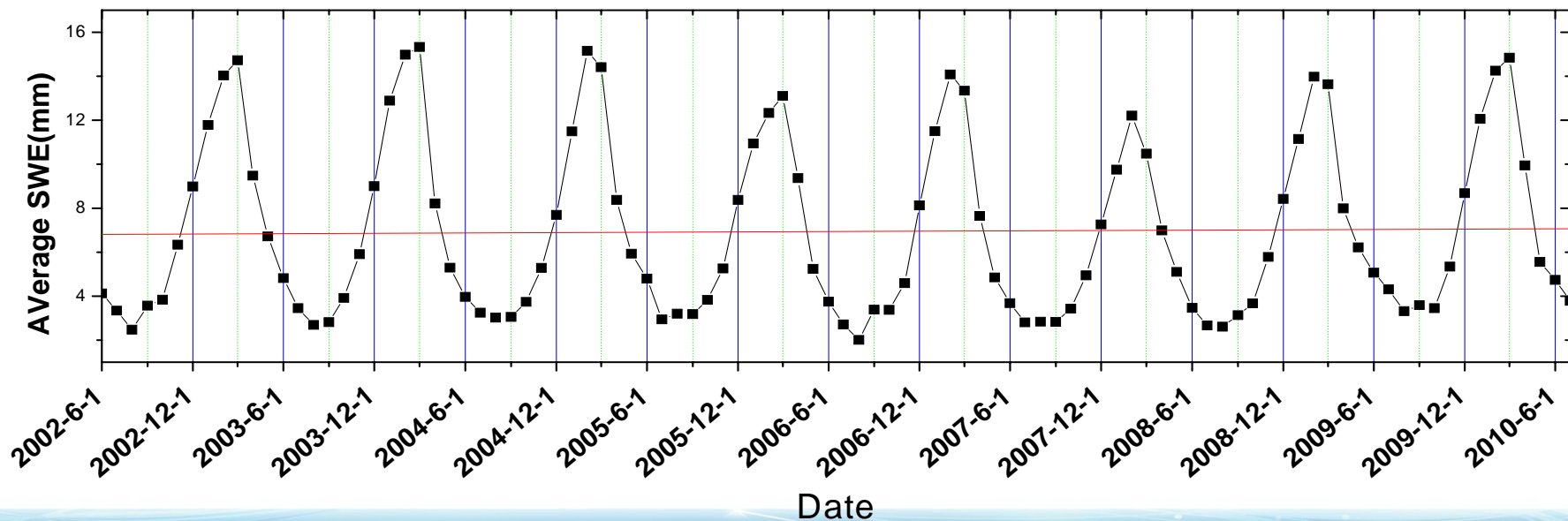
More Detail over Tibet Plateau - AMSR-E SWE product and MODIS SCF

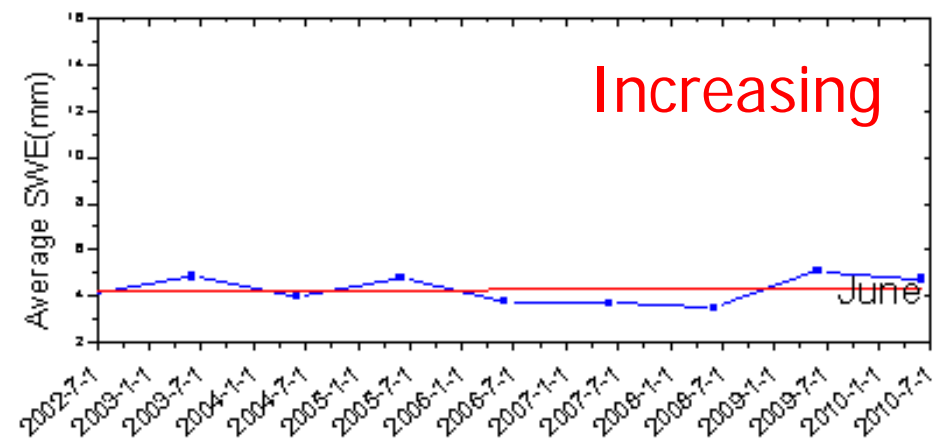
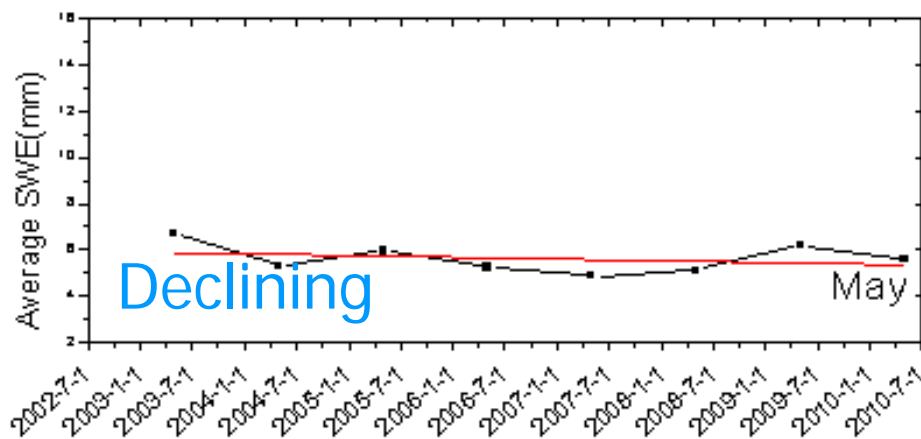
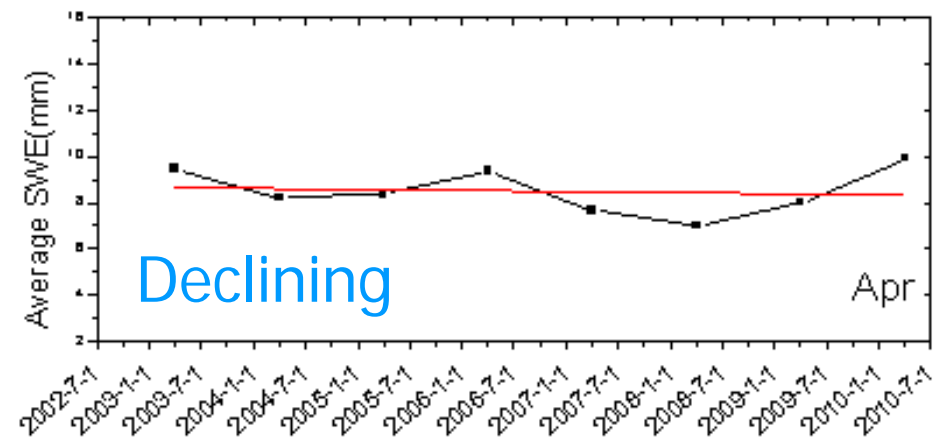
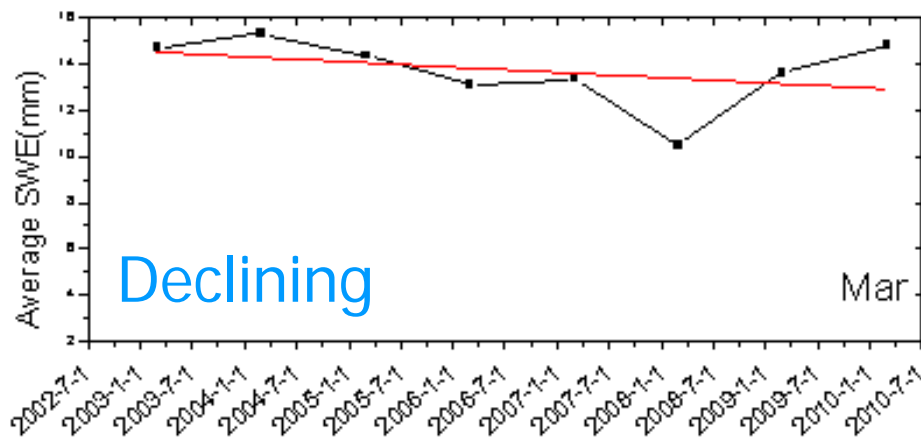
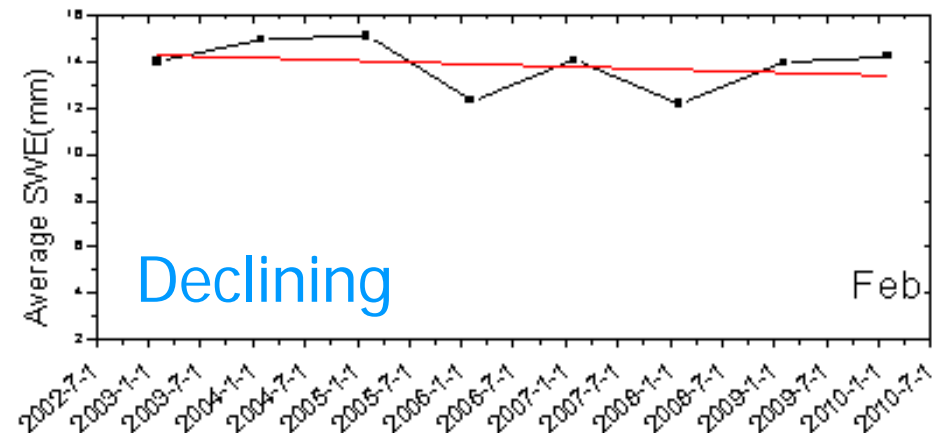
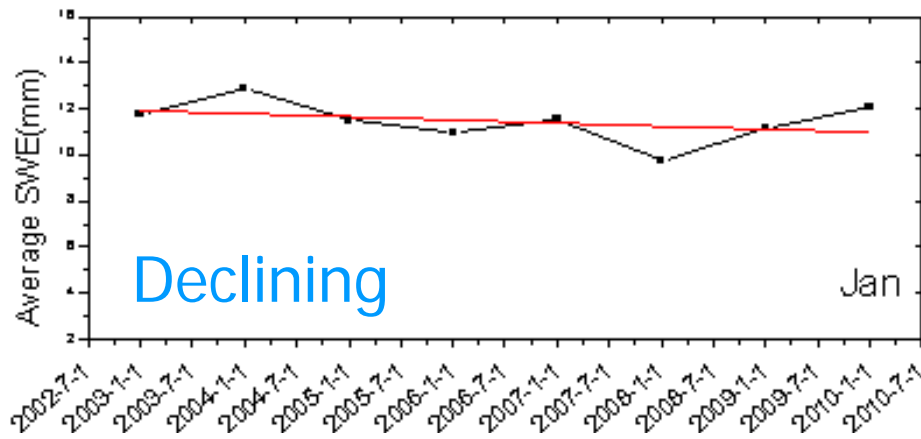


Tibet Plateau - according to the air pressure (<700hpa)

AMSR-E SWE

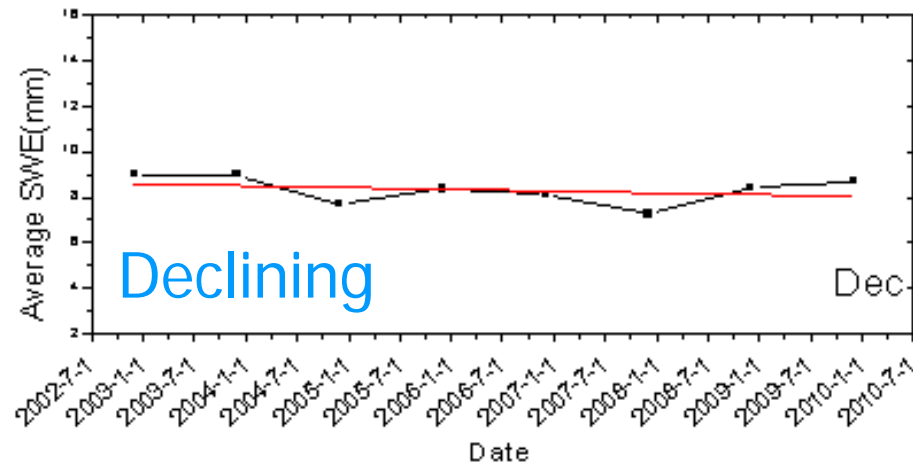
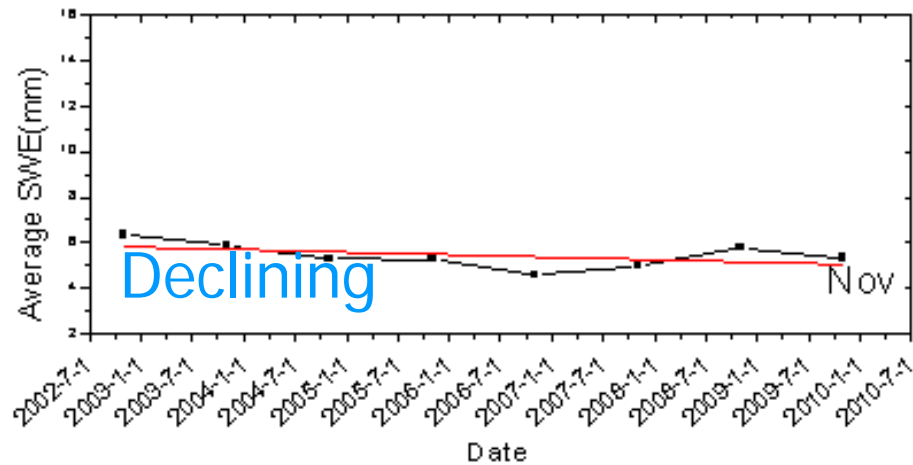
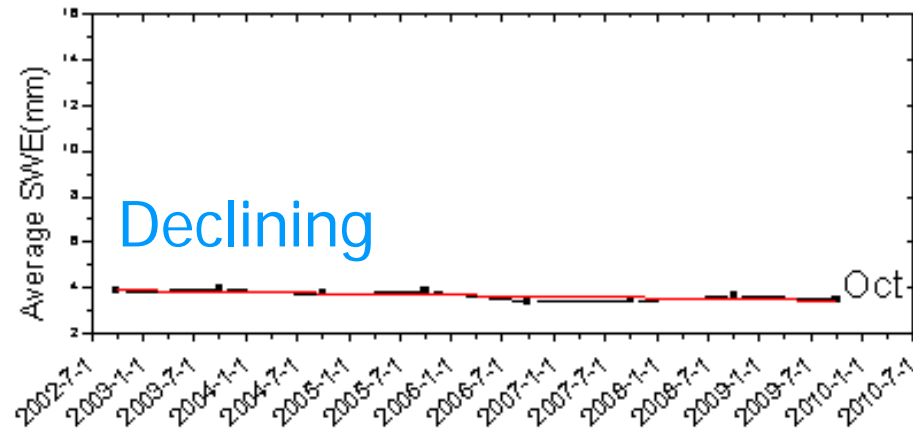
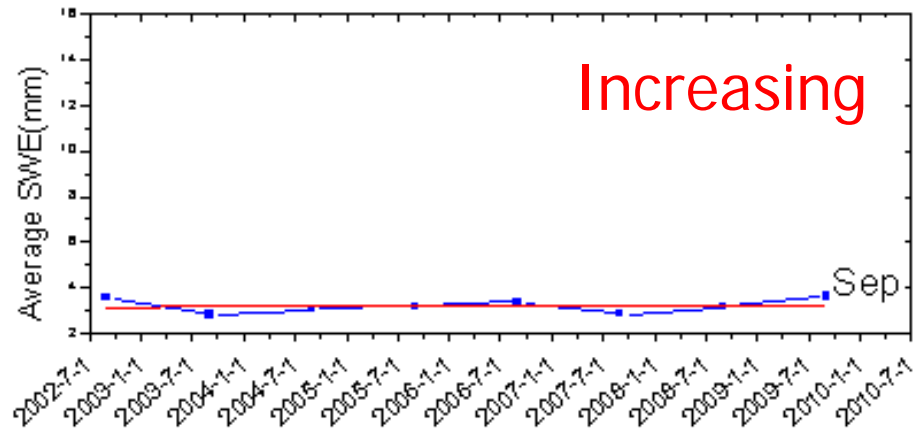
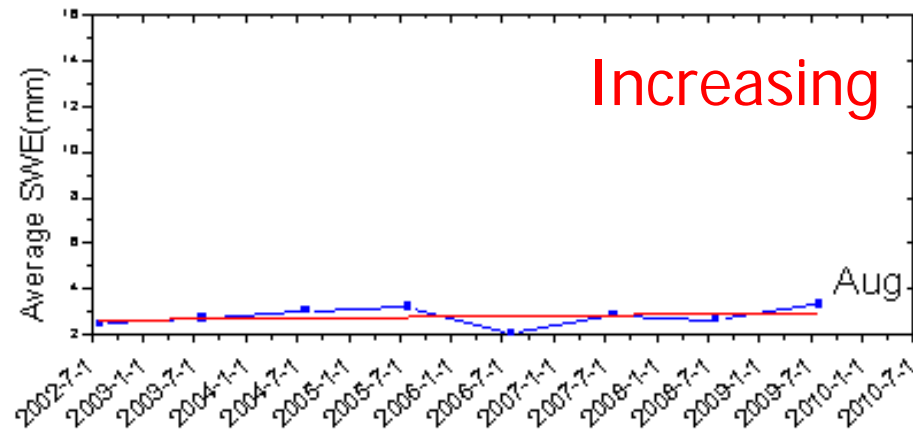
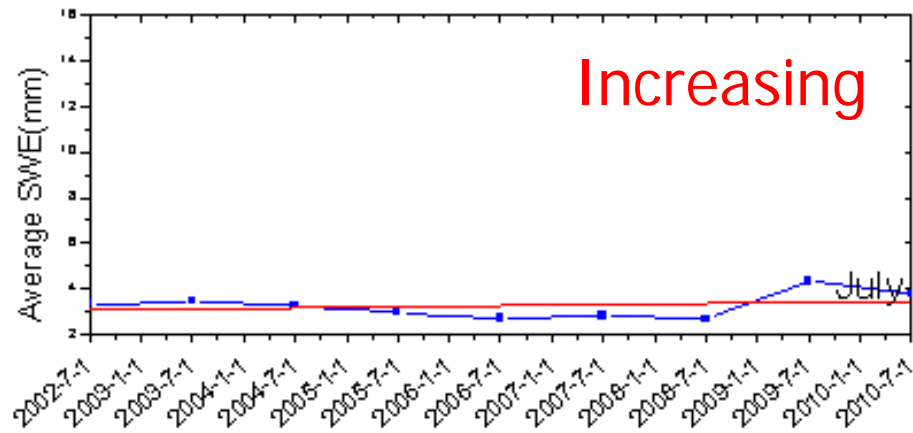
Trend of average AMSR-E SWE(mm) from 2002.6 to 2010.7

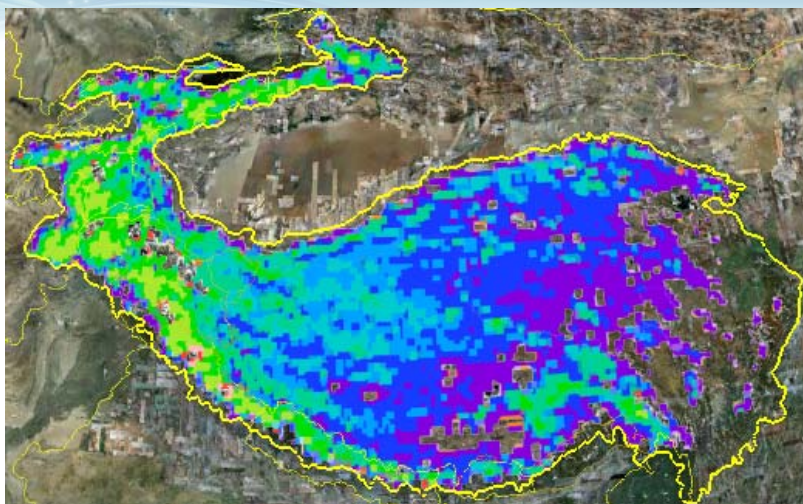




Date

Date

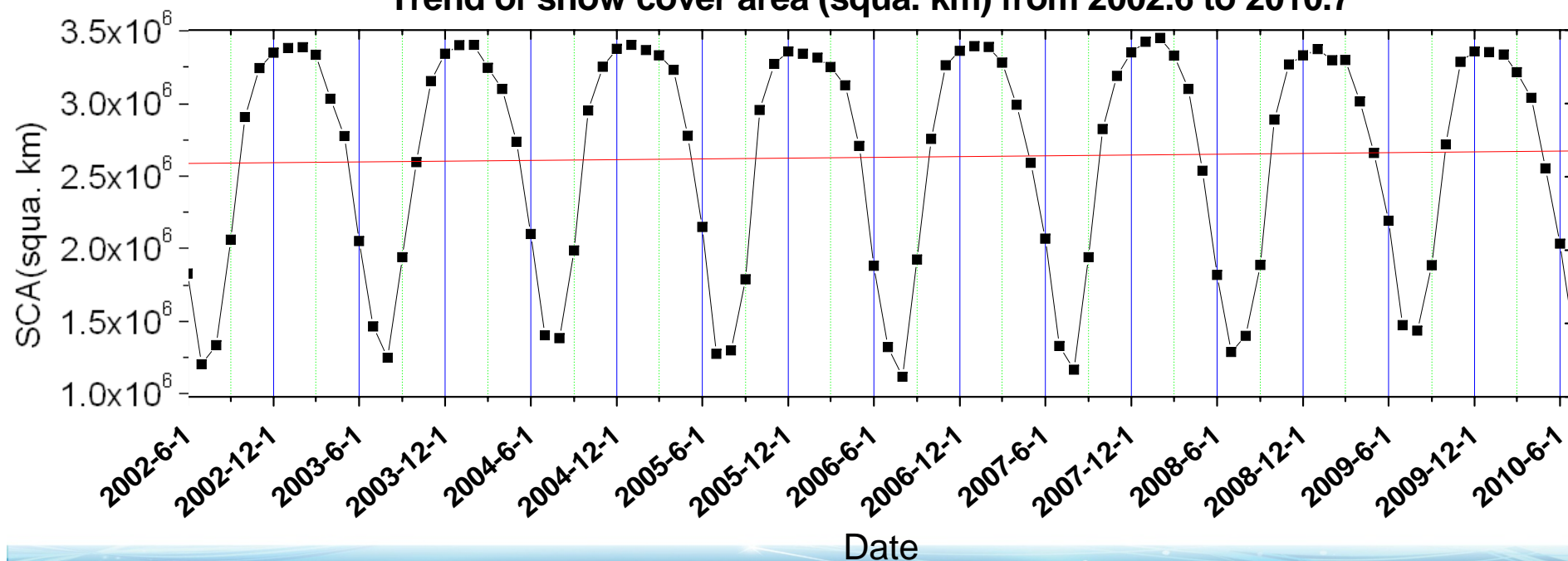


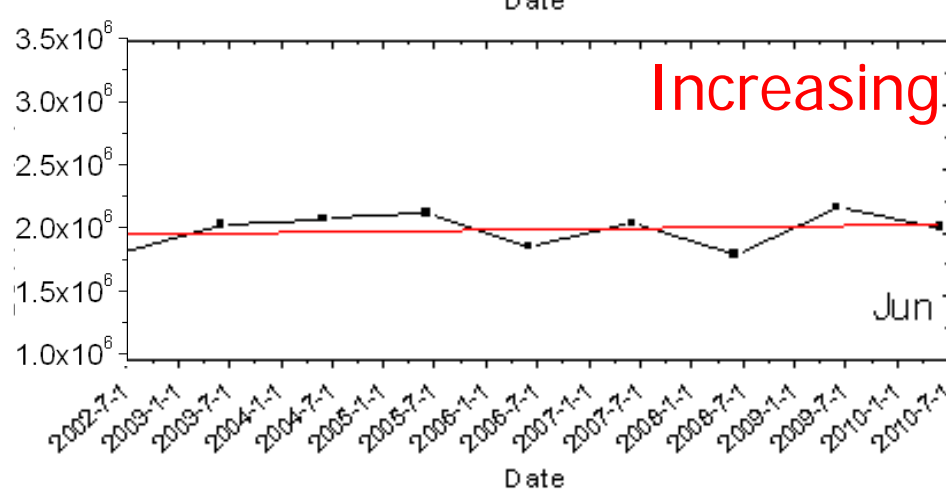
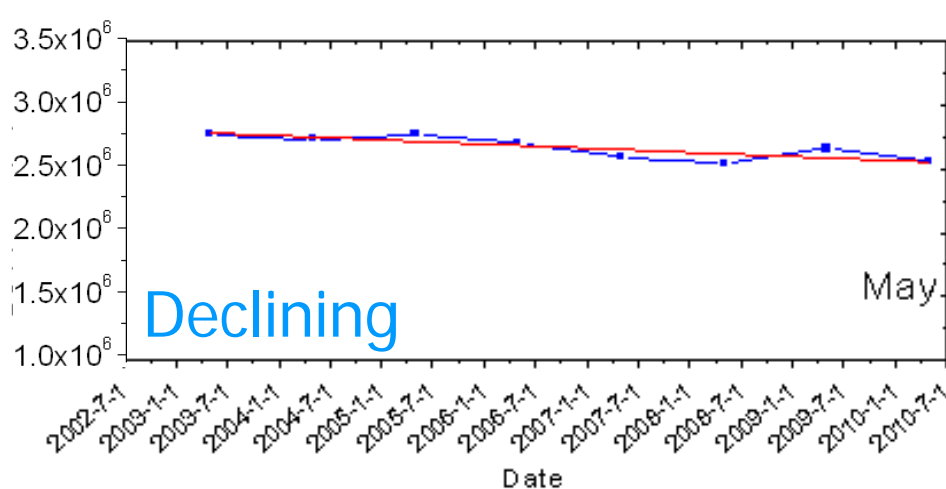
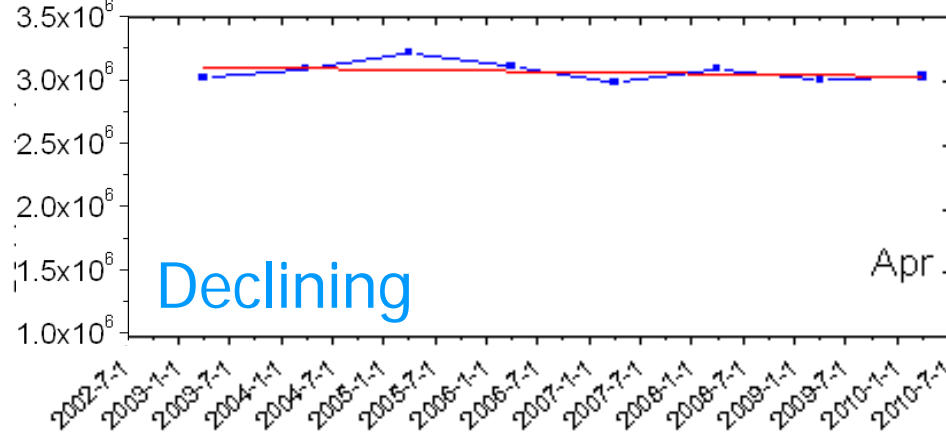
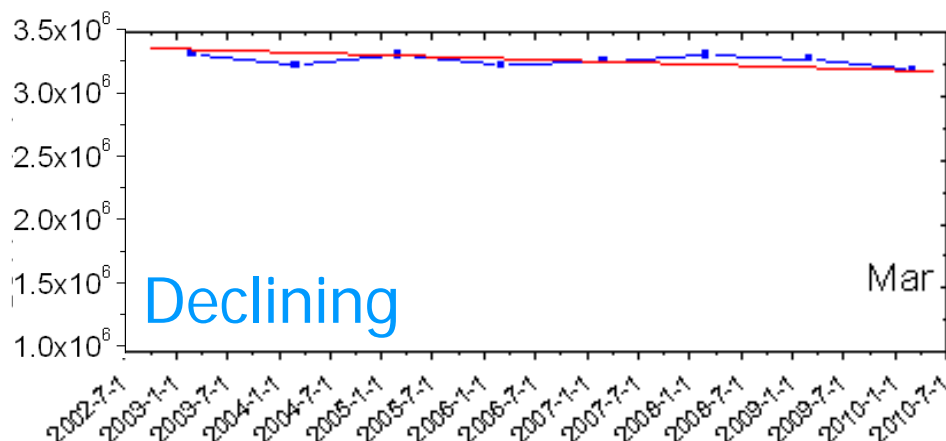
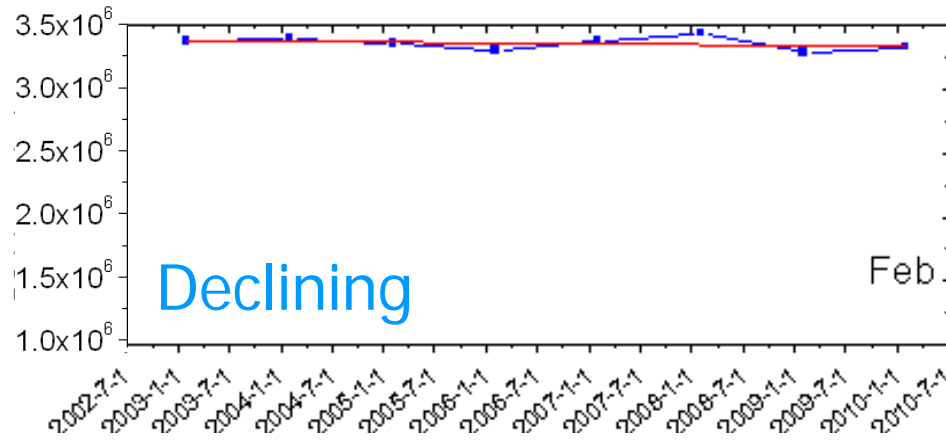
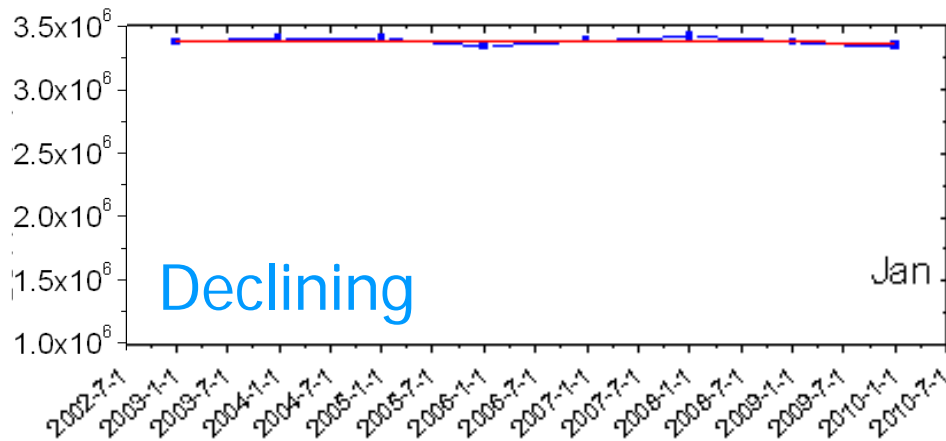


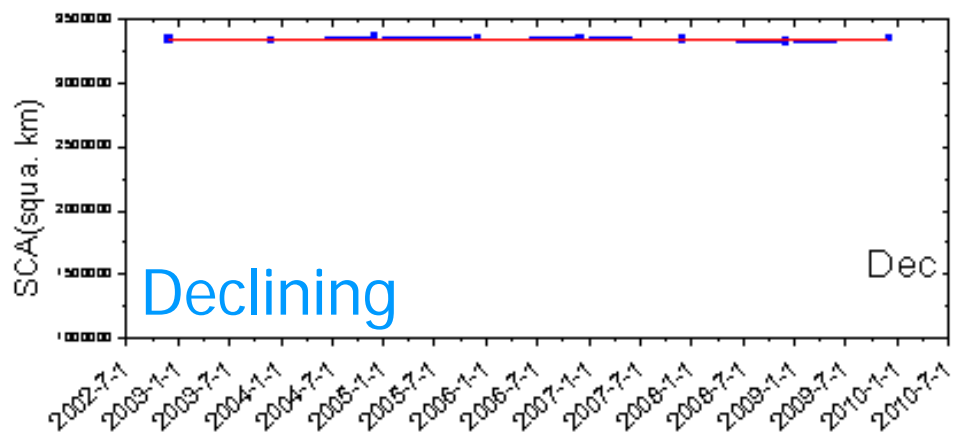
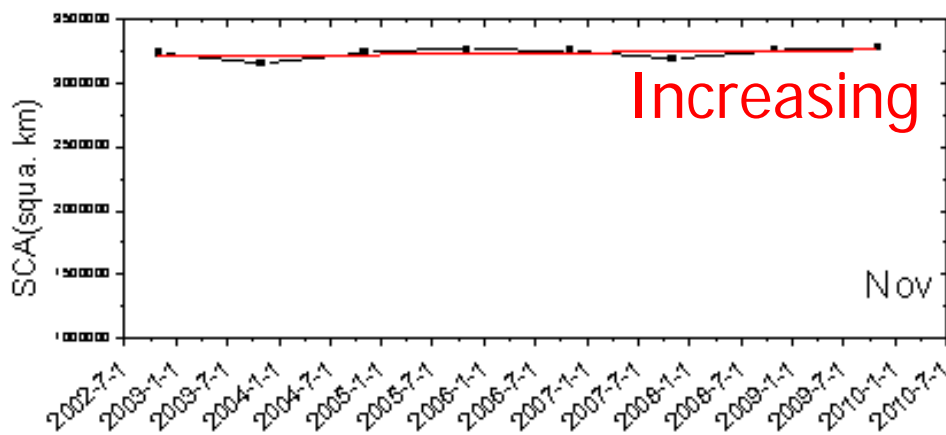
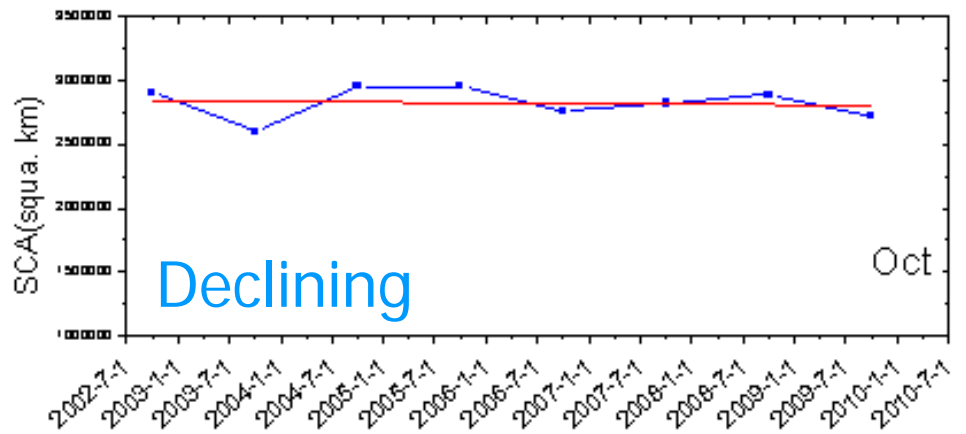
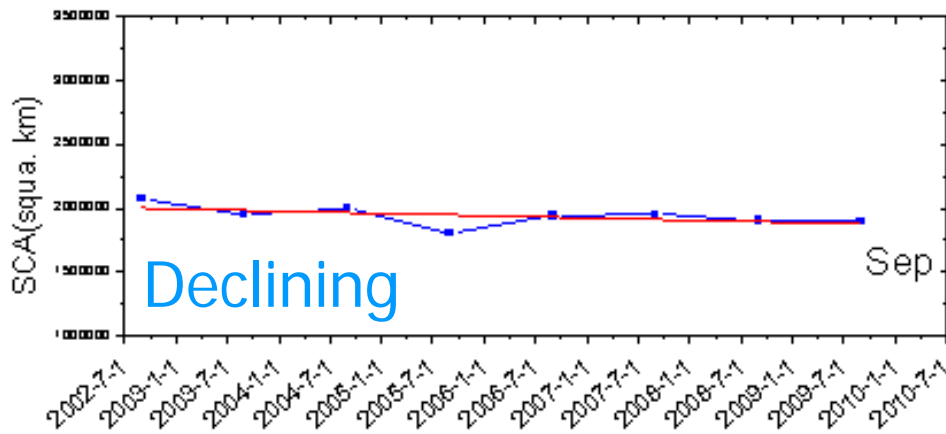
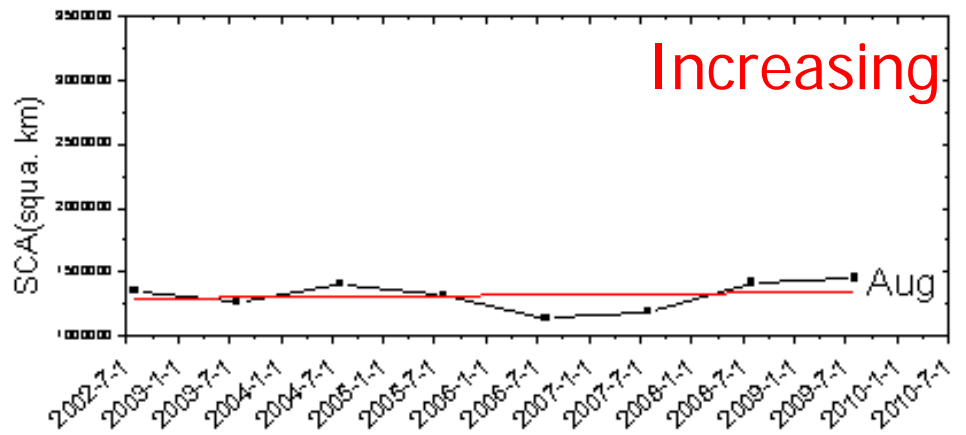
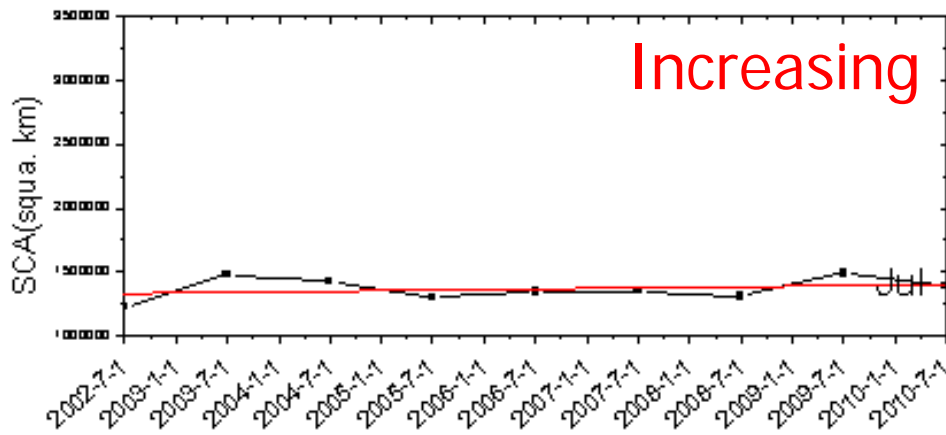
Tibet Plateau - according to the air pressure (<700hpa)

AMSR-E SCA

Trend of snow cover area (squa. km) from 2002.6 to 2010.7





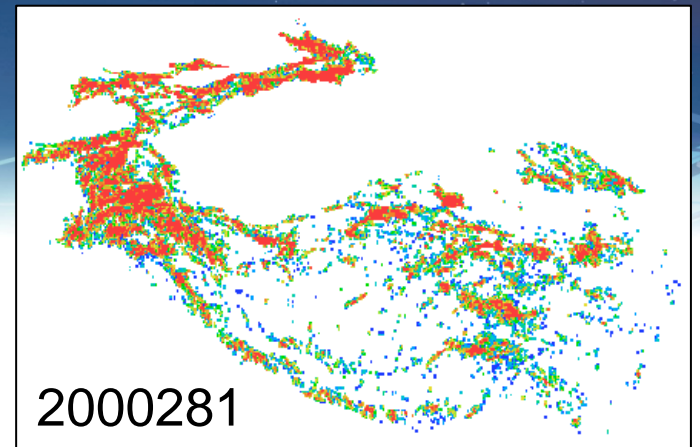


Date

Date

MODIS SCF - SCA

MODIS SCF – SCA - Terra



Trend Slope

3.94271

2.15802

1.63373

1.41097

1.41097

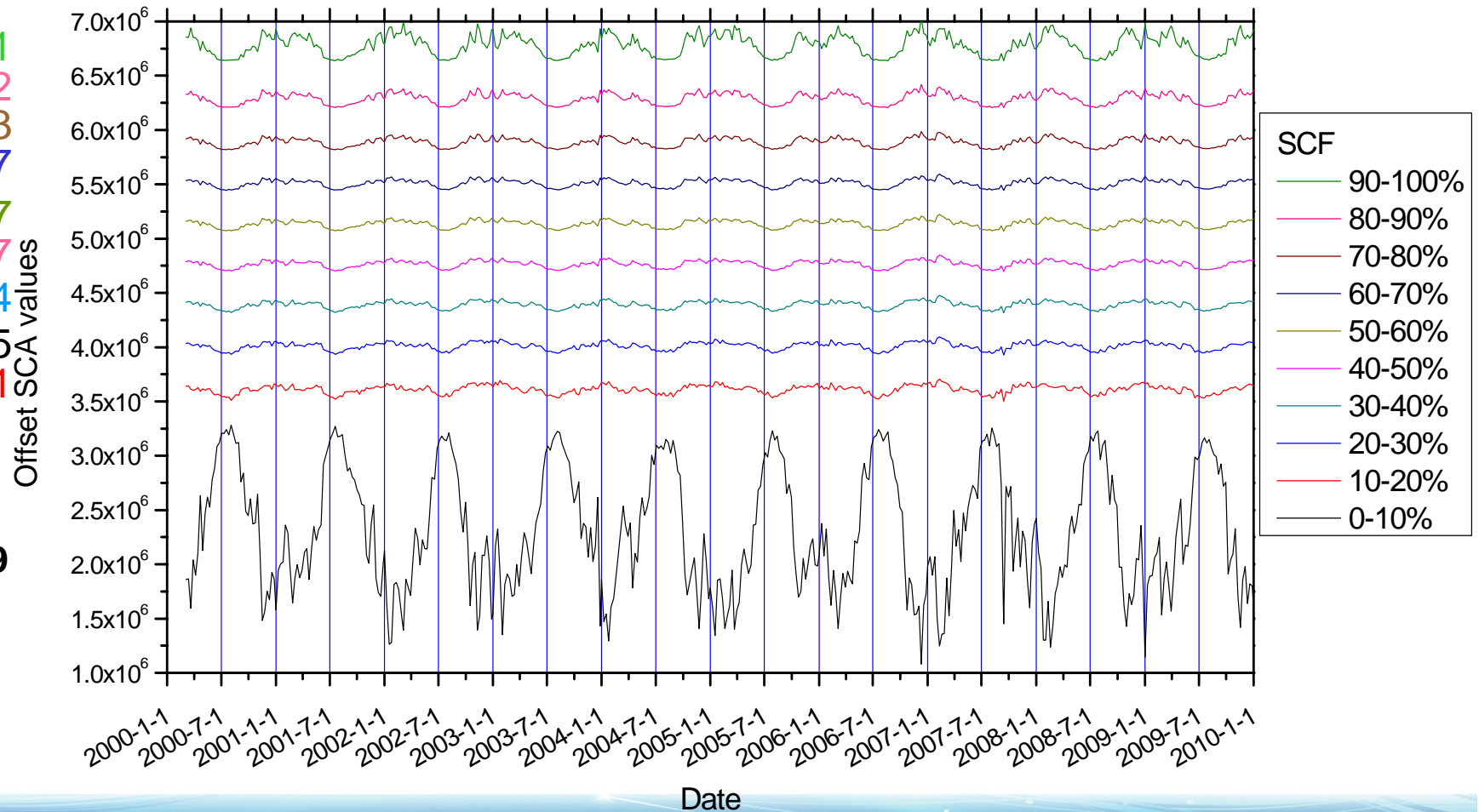
1.22657

1.26444

1.21955

1.57501

-24.41329



MODIS SCF - SCA



MODIS SCF – SCA - Aqua

Trend Slope

5.58434

2.89257

2.13665

1.60258

1.60258

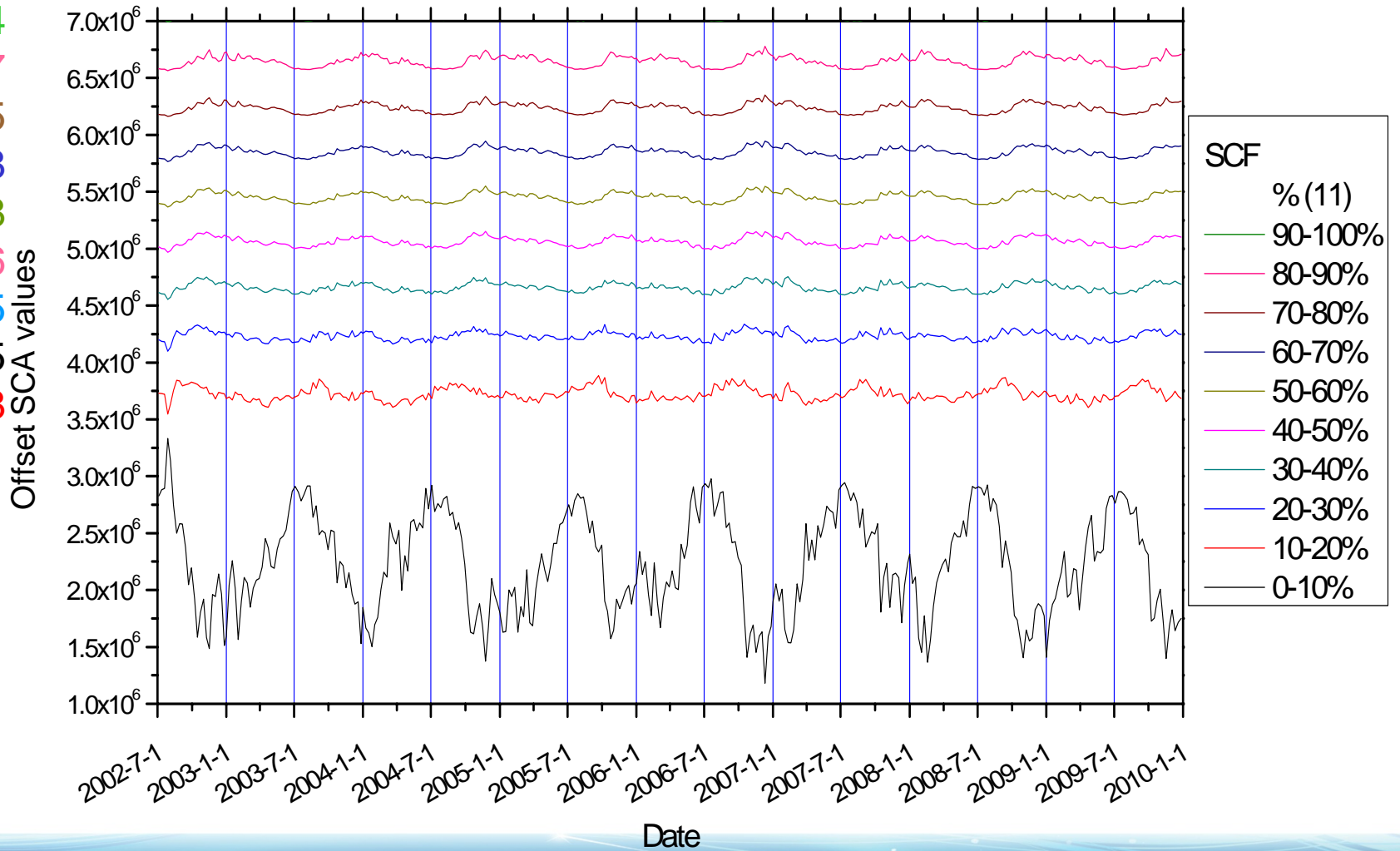
1.43406

1.82755

1.69405

1.73758

-23.16836



Conclusion

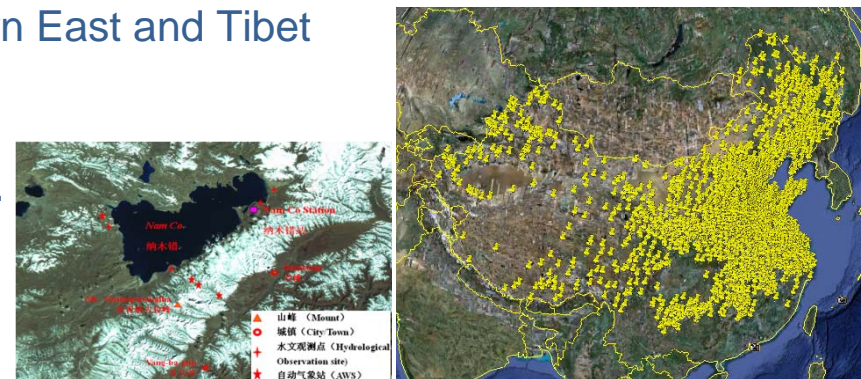


- The products of SCA and SWE could provide a long time series data and derived snow climatological analysis
 - IMS SCA and NISE SCA are not quite validated over China
 - The blank area in Tibet and Northern West of China could not enough to provide analytical result, though these is some clue on it.
- Over Tibet Plateau
 - AMSR-E and MODIS data show the increasing trend on SWE and SCA from the nowadays satellite data.
 - AMSR-E SWE and SCA are typically increasing in the summer time and decreasing in the winter time
 - MODIS SCA shows a increasing trend over the relative permanent snow cover area and only the SCF is less than 10% are quickly decreasing
- That indicates,
 - Snow cover over Plateau is quite different with other place over Northern Hemisphere
 - Need accuracy estimation of the snow cover parameters for a long time to convince the trend analysis to corresponding the global environment change

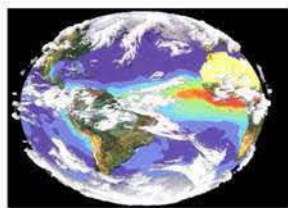
Future work ...



- Plan to investigate more accuracy snow product over Tibet area, China
 - Under the framework of ABCC program
 - Do comparative study with Finland, and Canada team worker, this winter, we could have a campaign over Tibet or western China
 - Have submitted a proposal to investigate Tibet snow, and make more ground data collection
- Now, We've get almost two winter time ground dataset (snow depth)
 - More than 1000 station over China
 - And one location snow pit work in Northern East and Tibet
- Ask our programmer in ABCC
 - Sharing this find and try to improve it.
 - comment?



谢谢!



9 100094

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