Enhanced 30+ year global snow and ice dataset and climatology

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Outline

Motivation

Approach

Source datasets

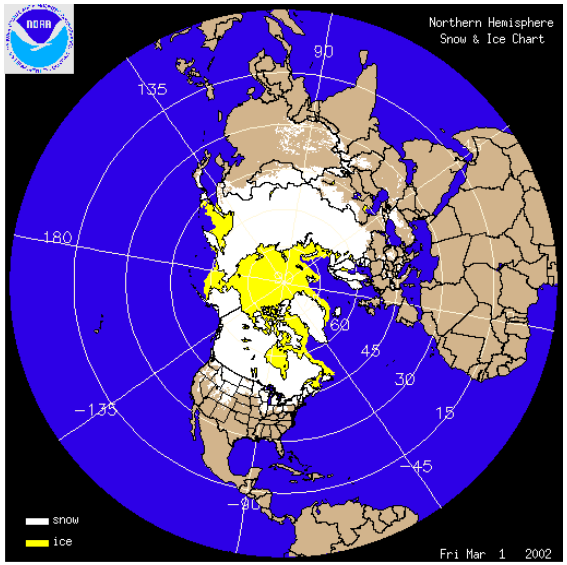
Accuracy assessment

Application

Summary

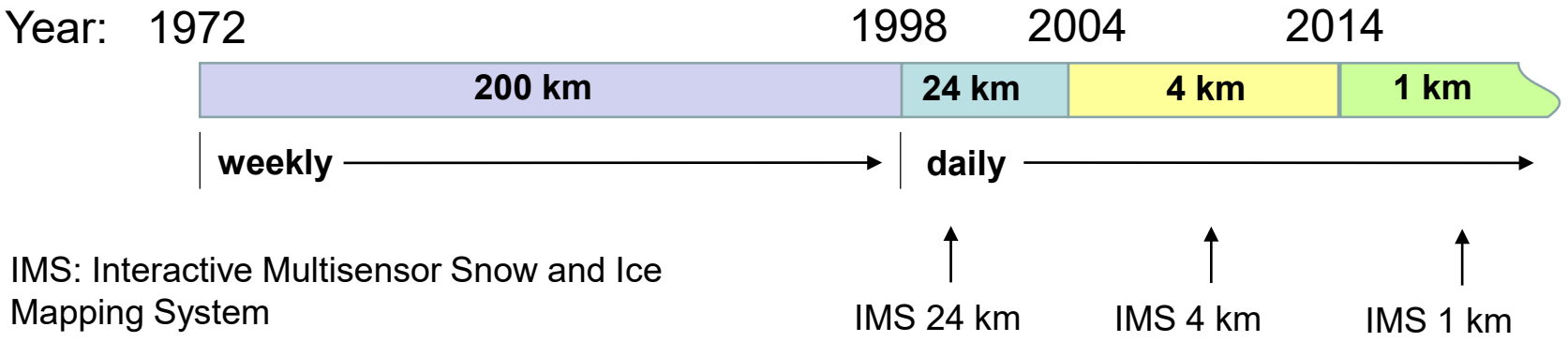
- Focus on the snow cover component

NOAA Interactive Snow Mapping



- Based on visual analysis of satellite imagery
- Deliver snow and ice extent over NH
- Operationally generated since early 1970s
- Used in most NOAA operational NWP models

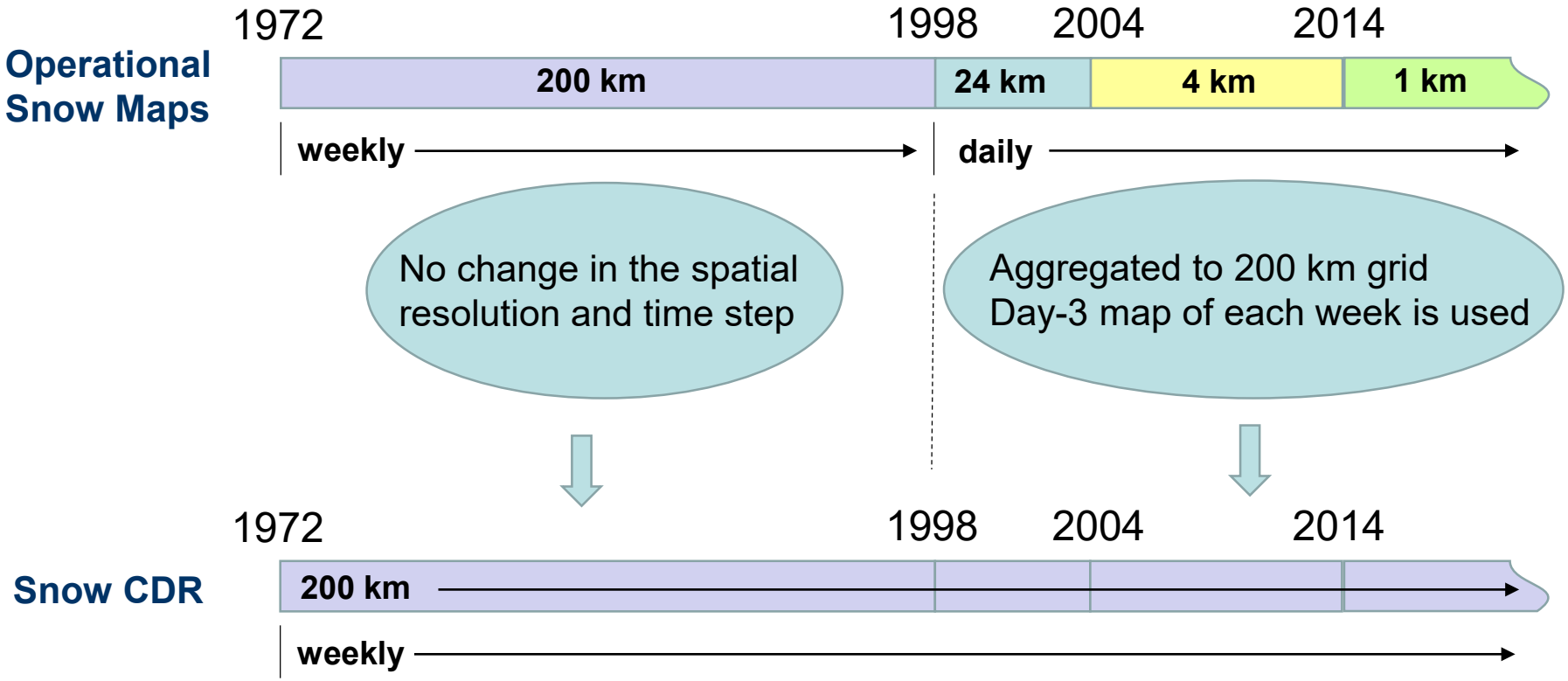
Operational map spatial resolution and update time period



IMS: Interactive Multisensor Snow and Ice Mapping System

NOAA Snow Climate Data Records (CDR)

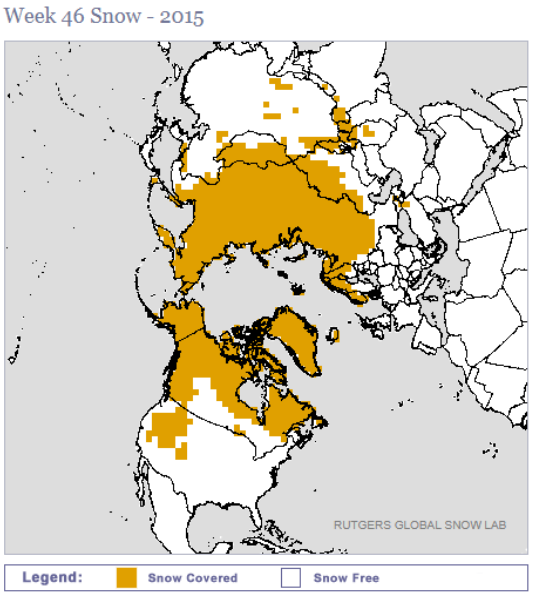
- Operational to Snow CDR conversion at Rutgers University

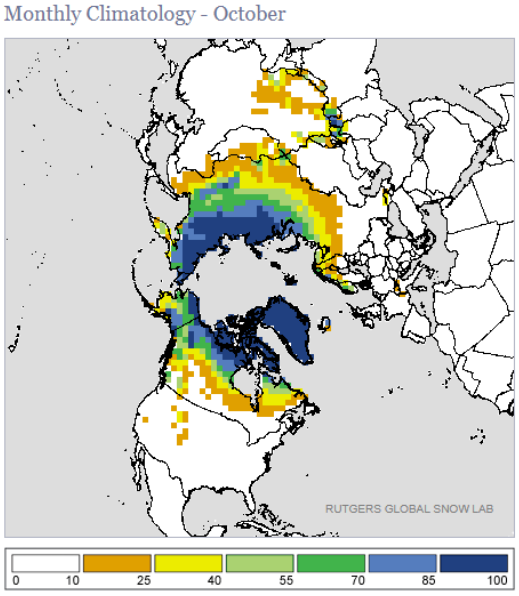


NOAA Snow CDR: 200 km spatial resolution at weekly time step

NOAA Snow CDR: Weaknesses and Concerns

- Coarse spatial (200 km) and temporal (weekly) resolution
- Inconsistency/inhomogeneity due to changes in the source maps
- Limited area coverage
  - Northern Hemisphere only

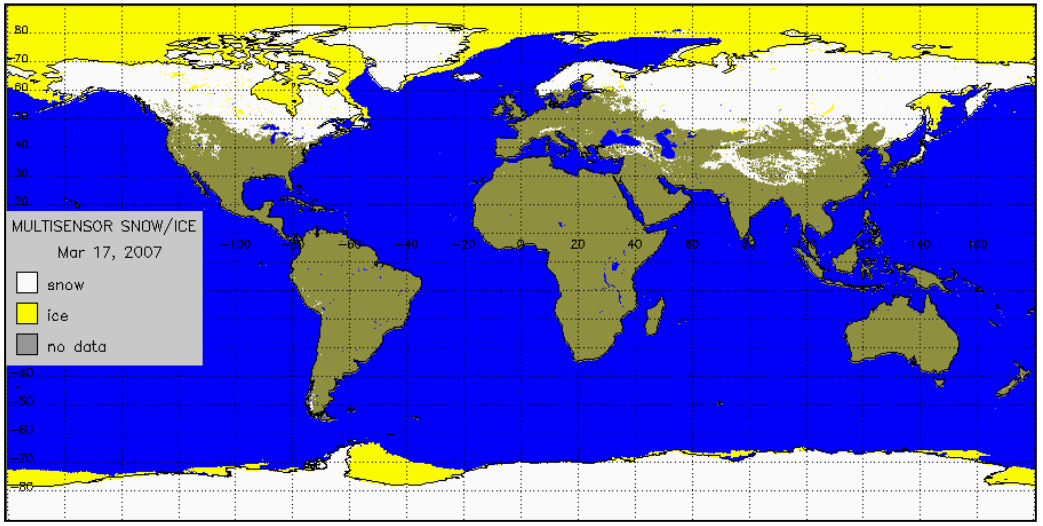




Snow occurrence, %

Global Multisensor Automated Snow and Ice Mapping System (GMASI)

- Fully automated
- Combines optical (AVHRR) and PMW (SSMI/SSMIS) satellite data
- Output: Global daily maps of snow and ice cover at 4 km resolution
- Operational at NESDIS since 2006



Objective of this work:

- Apply GMASI to consistently process historical satellite observations since 1987
- Develop 30+ year enhanced daily snow and ice cover dataset and climatology
- Compare with the exiting coarse resolution snow cover climatology

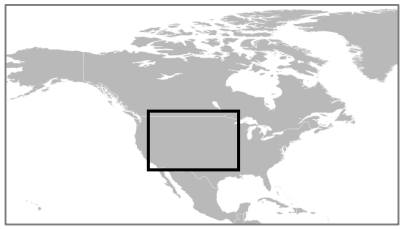
Source Satellite Data

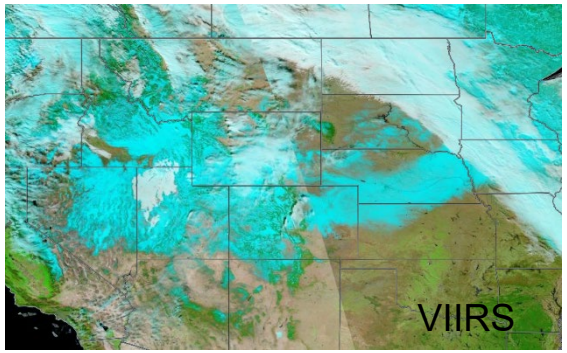
Year	AVHRR Platform	Number of SSMI(S)	SSMI/SSMIS Platform									
			F-08	F-10	F-11	F-13	F-14	F-15	F-16	F-17	F-18	F-19
1987	NOAA-09	1										
1988		1										
1989	NOAA-11	1										
1990		1										
1991		2										
1992		2										
1993		2										
1994	NOAA-12	2										
1995	NOAA-14	3										
1996		3										
1997		4										
1998		3										
1999		3										
2000		3										
2001	NOAA-16	3										
2002		3										

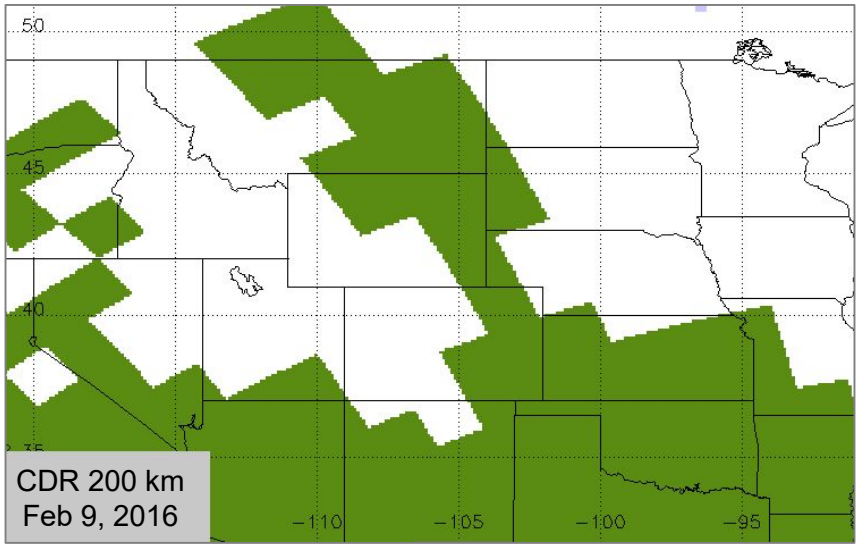
Year	AVHRR Platform	Number of SSMI(S)	SSMI/SSMIS Platform									
			F-08	F-10	F-11	F-13	F-14	F-15	F-16	F-17	F-18	F-19
2003	NOAA-17	3										
2004		3										
2005		3										
2006		4										
2007	METOP-A	4										
2008		4										
2009		4										
2010		3										
2011		4										
2012		4										
2013	METOP-B	4										
2014		4										
2015		5										
2016		5										
2017		4										
2018		4										

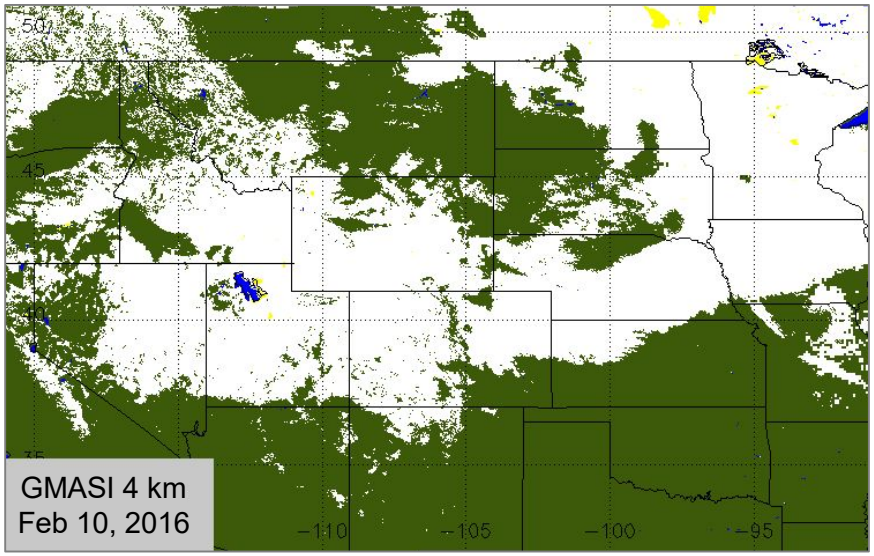
- All data are processed from Level 1B
- Corrected calibration is applied to all sensor data

NOAA Snow CDR vs GMASI





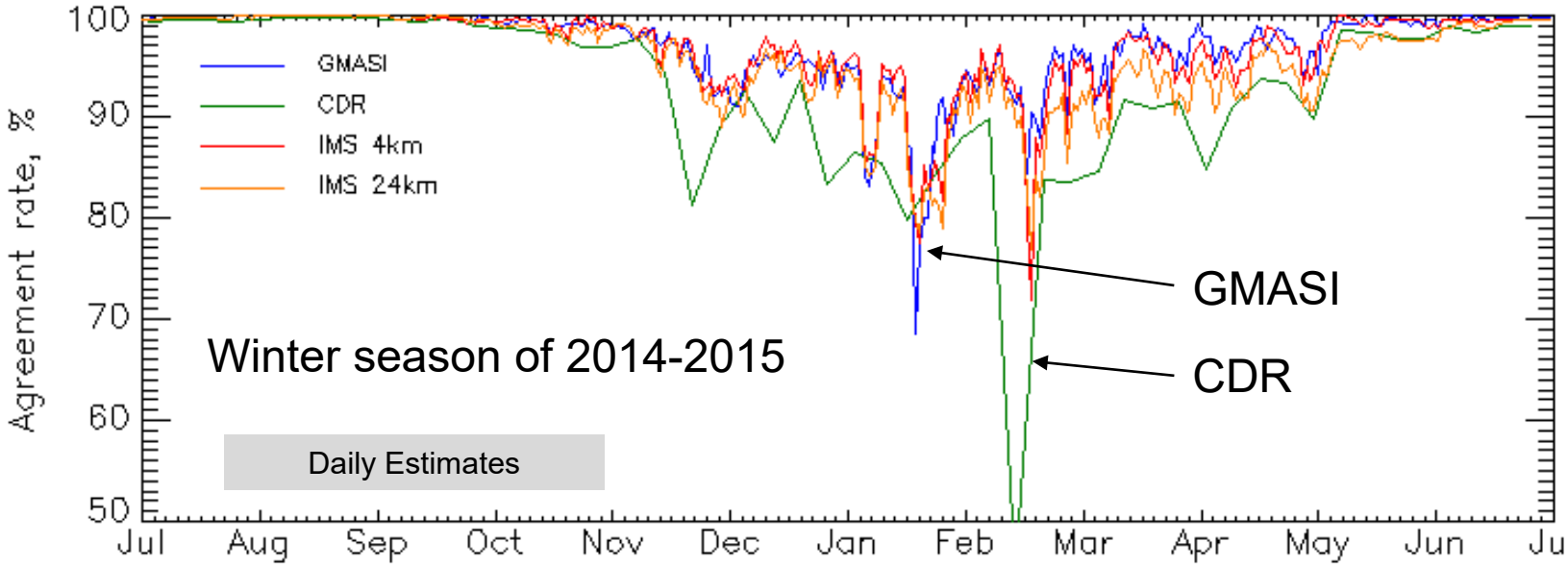


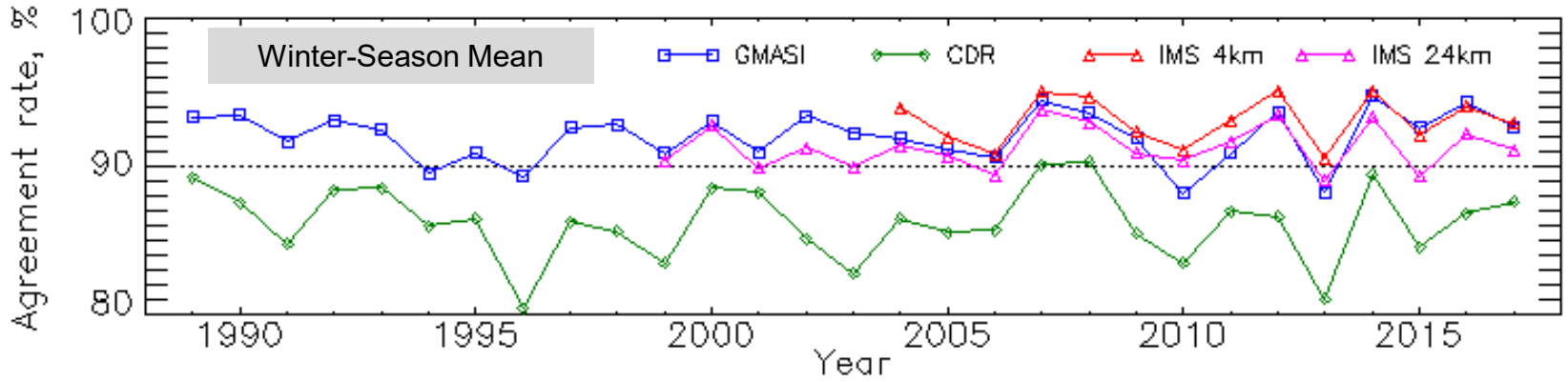


NOAA Snow CDR (weekly, 200 km, NH)

GMASI dataset (daily, 4km, global)

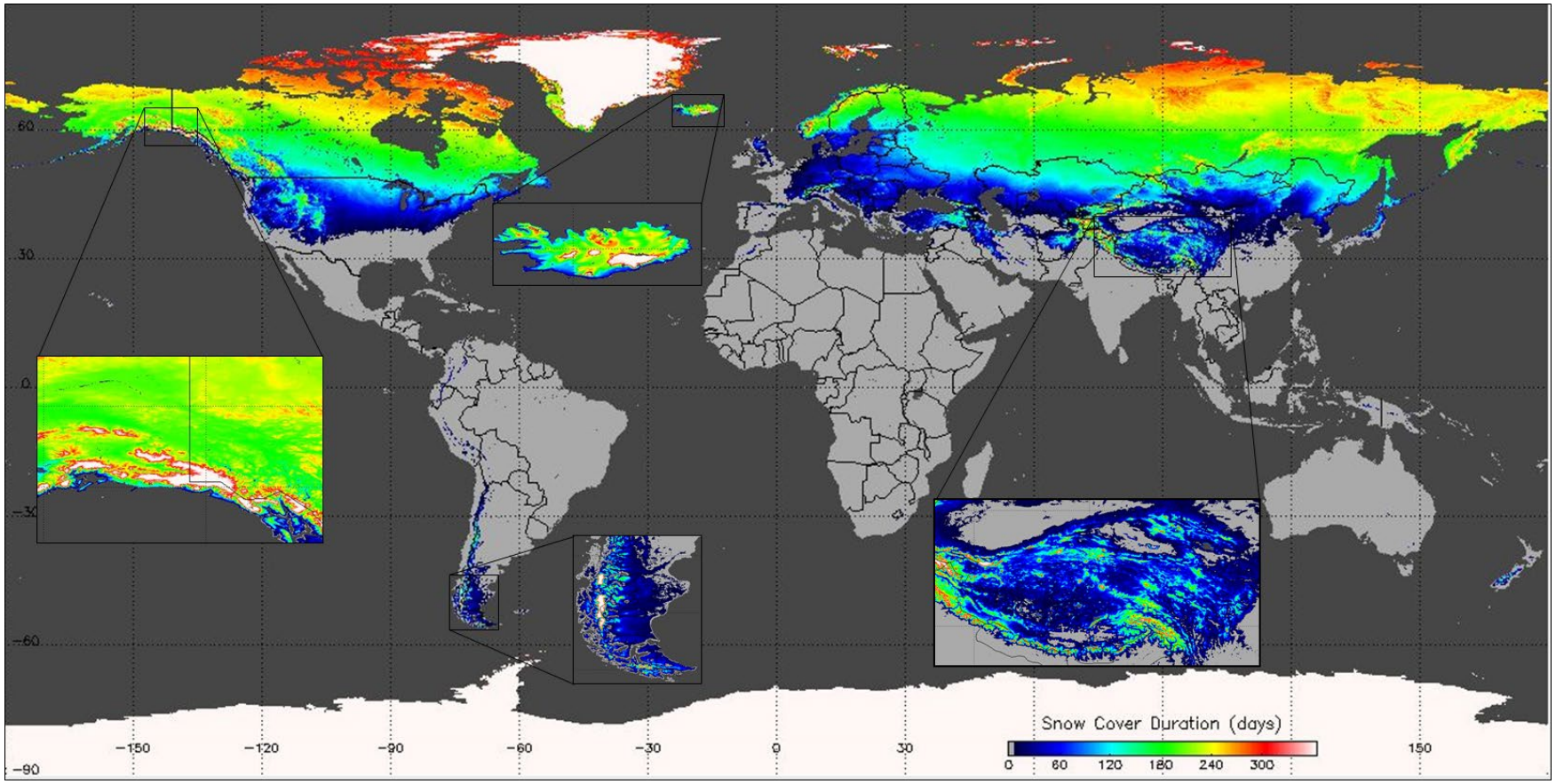
CDR, GMASI, IMS vs in situ data





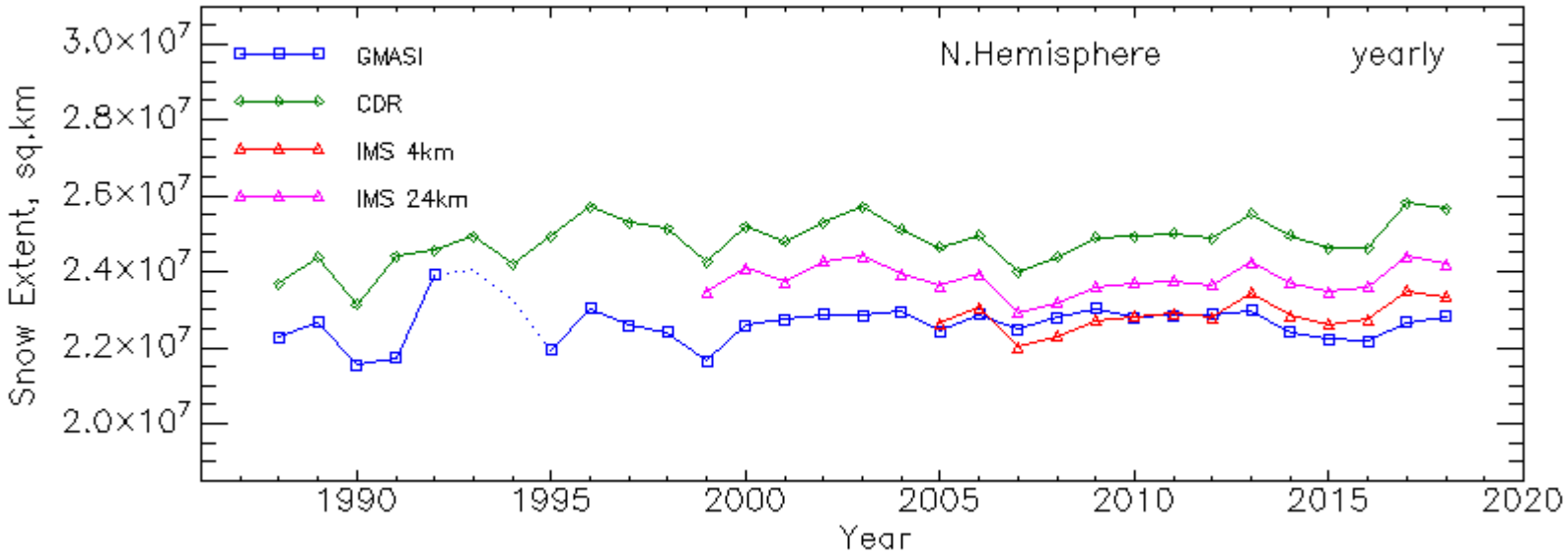
- GMASI Snow Mapping Accuracy: better than CDR, close to 4 km IMS

Mean Snow Cover Duration 1988-2017



- Local-scale features are resolved in the new dataset

Yearly Mean Snow Extent 1988-2018



- Close agreement on year-to-year changes between datasets
- Coarser resolution products map more snow
- GMASI fits best IMS 4 km snow extent

Snow extent trends (% per year) 1988-2018

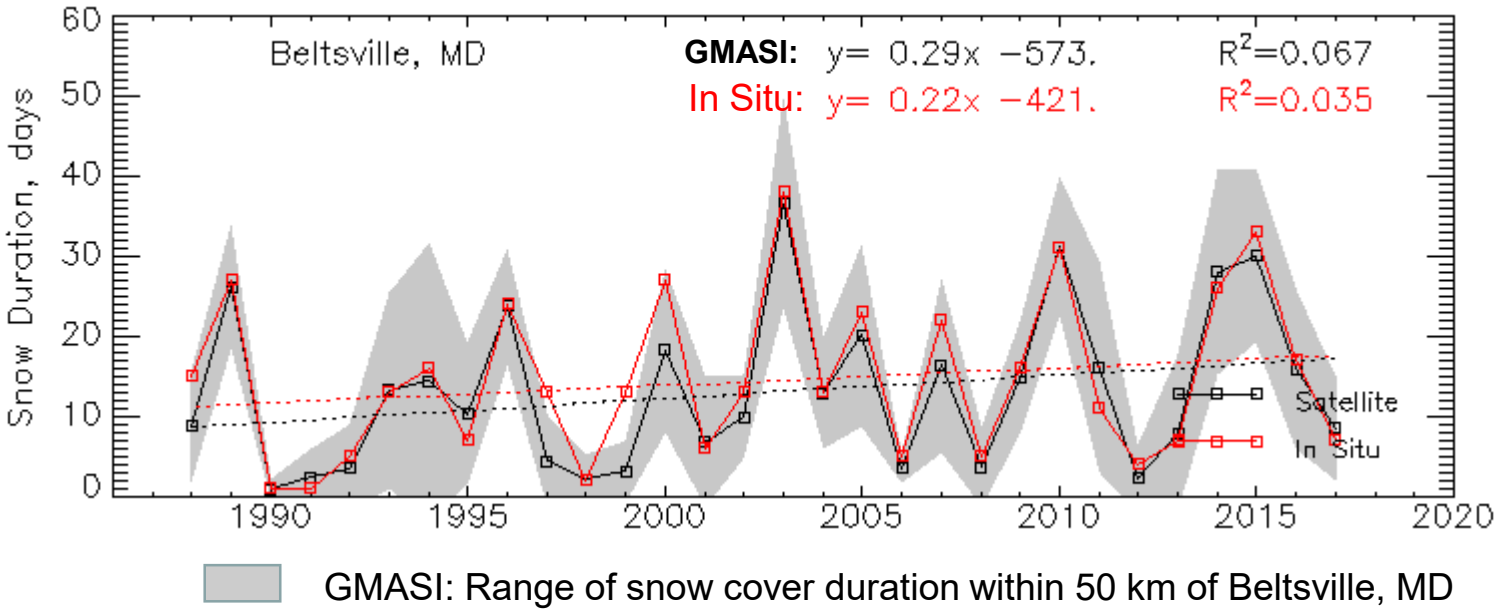
	N. Hemisphere		Eurasia		North America	
	GMASI	CDR	GMASI	CDR	GMASI	CDR
Jan	0.09	0.19	0.07	0.24	0.11	0.11
Feb	0.10	0.19	0.06	0.20	0.17	0.16
Mar	-0.00	0.07	-0.12	0.05	0.18	0.09
Apr	0.01	-0.01	-0.12	-0.07	0.18	0.07
May	-0.17	-0.37	-0.30	-0.48	-0.05	-0.26
Jun	-0.38	-1.46	-0.65	-2.40	-0.23	-0.94
Jul	-0.32	-1.17	-0.66	-5.54	-0.25	-0.29
Aug	-0.28	-0.24	-1.05	-4.11	-0.19	0.23
Sep	-0.43	0.38	-0.67	0.32	-0.33	0.41
Oct	0.13	1.11	0.30	1.62	-0.08	0.48
Nov	-0.00	0.27	0.00	0.38	-0.01	0.11
Dec	0.11	0.10	0.08	0.07	0.16	0.16
Yearly	0.04	0.11	0.02	0.14	0.06	0.07

increase decrease significant decrease

GMASI:

- Smaller decreasing trends in the warm season of the year
- Longer period of the year associated with general snow loss
- Similar to CDR small increase in the yearly mean snow extent

Snow Cover Duration: Beltsville, MD



Mean increase of snow cover duration: 2-3 days per decade

Summary

GMASI snow dataset

- Improves characterization of historical changes of NH snow cover over CDR
- Allows for a wider range of applications (local climate, alpine snow)
- Can be used for establishing climate normals (over 30-years duration)

GMASI dataset provides more consistent snow data vs CDR

- Better consistency implies more accurate trend estimates

GMASI snow extent trends

- Agree to CDR on the sign of seasonal changes
- Indicate much slower loss of snow in summer

The GMASI dataset may be extended back to 1982 (but can not match 47 years of CDR). Ice cover component needs detailed evaluation.

Links

Dataset is available for download from

NOAA-CREST Data Repository
https://datadb.noaacrest.org/public/snow-ice-cover

NOAA-STAR ftp
ftp://ftp.star.nesdis.noaa.gov/pub/smcd/emb/snow/gmasi_reprocessing/

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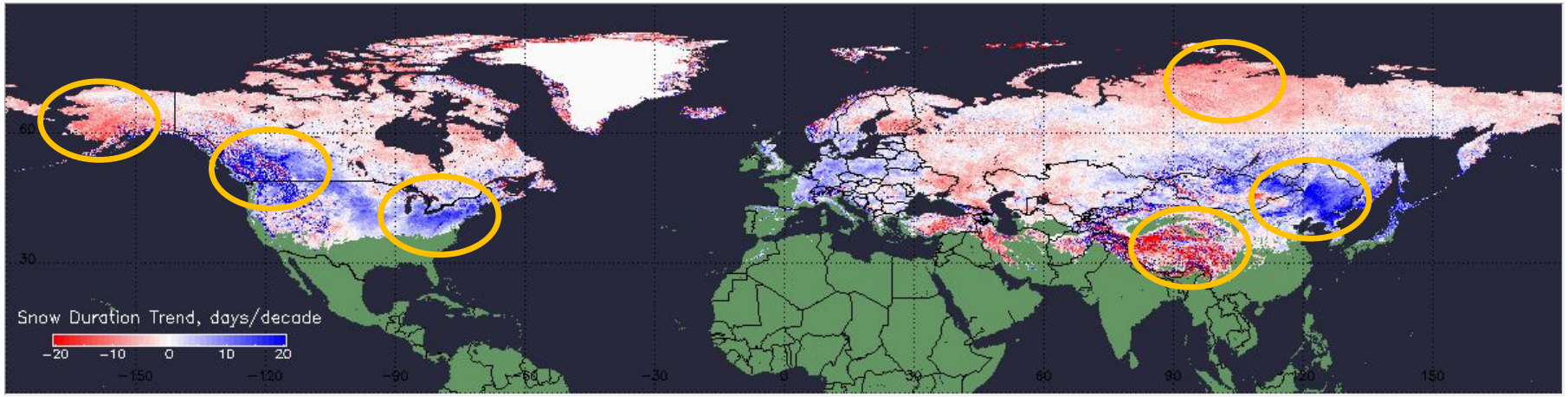
THANK YOU !

Backup Slides

Snow cover duration trends 1988-2018



Trends statistically significant

Snow cover duration in "hot spots"