HadISST.2.1.0.0: the Met Office Hadley Centre Sea Ice and Sea-Surface Temperature data set

J.J. Kennedy, N.A. Rayner, H.A. Titchner, S. Millington, R.O. Smith and M. Saunby

Met Office
Hadley Centre

Sea ice

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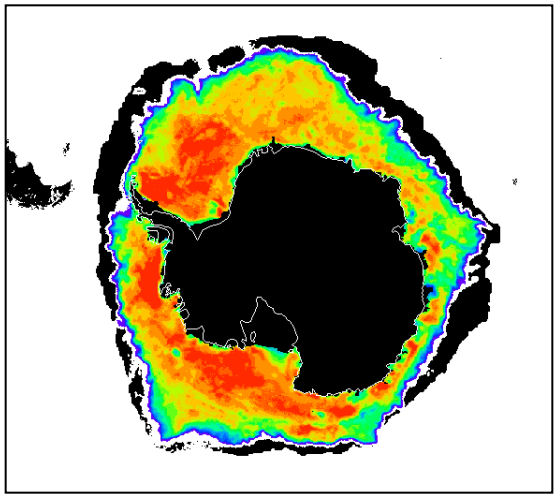
Hadley Centre

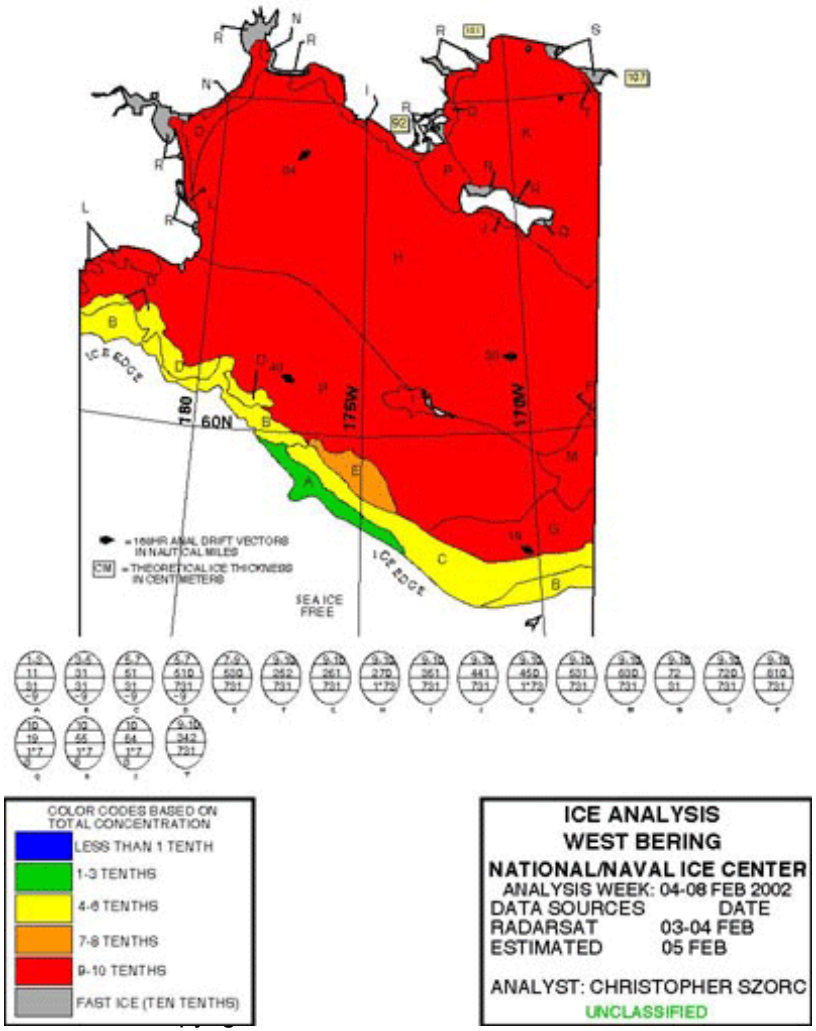
Data Sources

Passive microwave data 1978-present

- Sea ice concentrations are derived from passive microwave retrievals using an algorithm
- EUMETSAT OSI SAF have reprocessed passive microwave retrievals back to 1978 and have produced error estimates
- Homogeneous in time
- Known problems include underestimation of concentration due to melt ponds in the Arctic and wet snow in the Antarctic



Sea ice charts 1972-1994



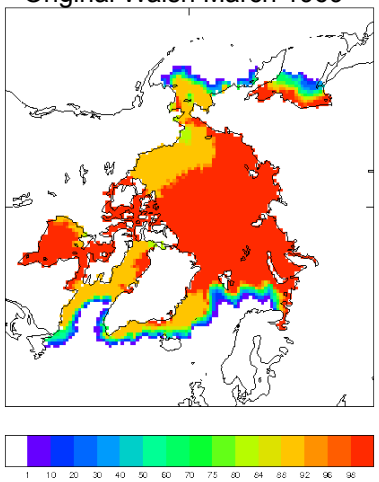
- Produced by an ice analyst by manually interpreting multiple data sources available
- Early charts hand drawn and based on aerial recon, ship obs. etc.
- Later charts produced digitally and based on remote sensing data
- Produced every 7-14 days (depending on Ice Service)
- Heterogeneous in time

Recent sea ice charts 1995-2007

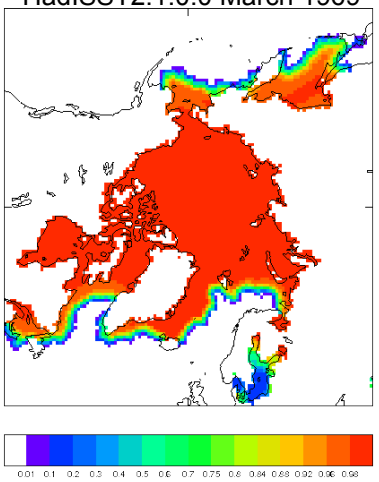
- Higher resolution imagery (e.g. SAR) became available around 1995
- Ice Analysts were able to produce more accurate analyses – higher confidence in concentrations
- Comparisons of Arctic NIC sea ice charts with passive microwave clearly highlight a discontinuity in 1995 – record stable after this
- Decision to adjust record relative to post 1994 NIC sea ice charts where possible, by comparing data overlap periods

Walsh data set 1901-1971

Original Walsh March 1969



HadISST2.1.0.0 March 1969



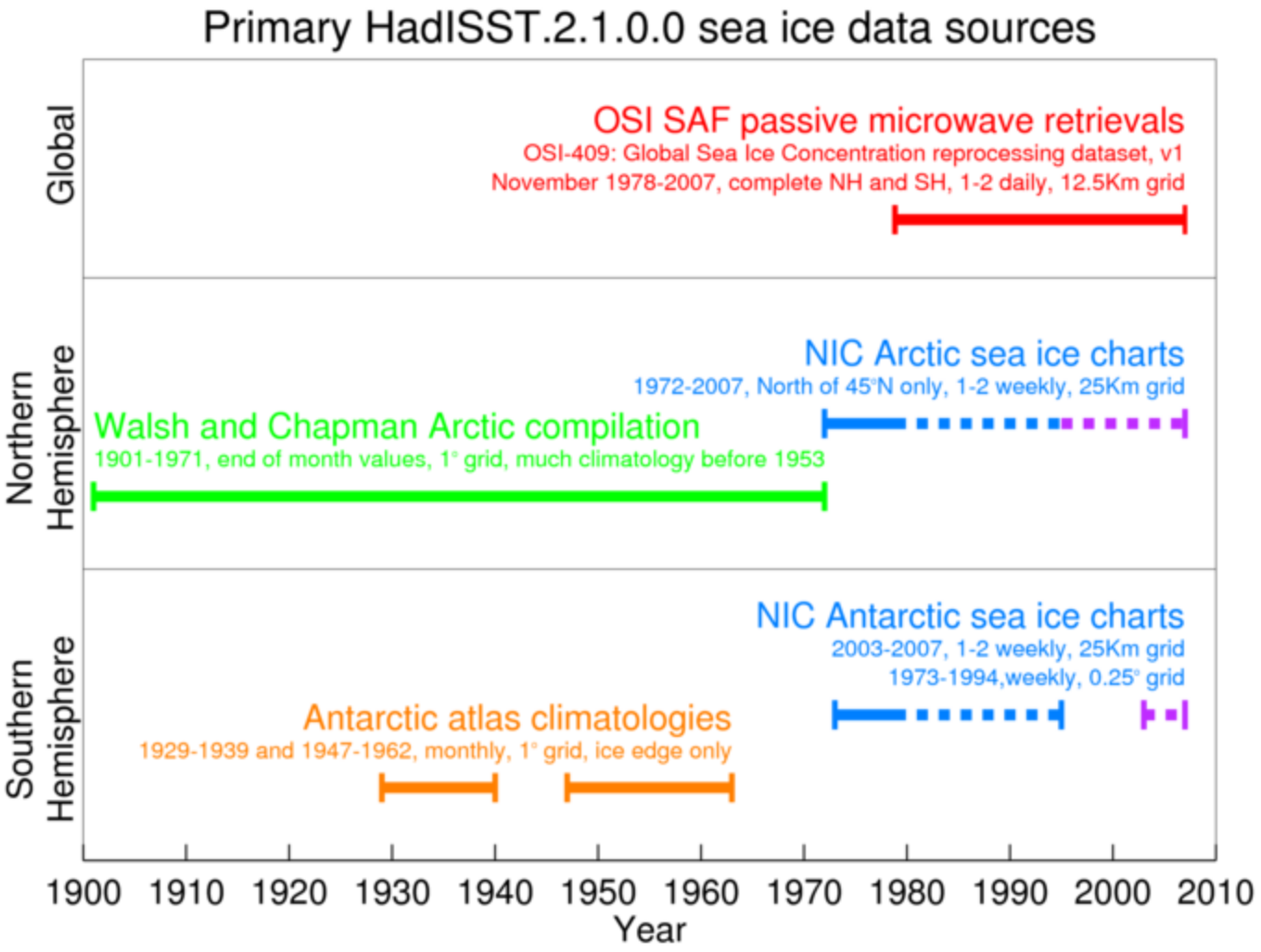
- Same version used as for HadISST1
- Concentrations known to be heterogeneous in time and space
- Extents believed to be more consistent, therefore ice edge only now used
- Concentrations estimated using method dependent on longitude and distance from the ice edge – based on concentrations from the adjusted passive microwave data
- Sea of Okhotsk, Sea of Japan and Gulf of St. Lawrence replaced with adjusted passive microwave climatology (1979-1993)

Timeline of data sources

solid = main input data sources

dashed = data used for calculation of bias adjustments only (using overlap periods)

purple = reference against which bias adjustments were calculated



From Titchner and Rayner, submitted to JGR

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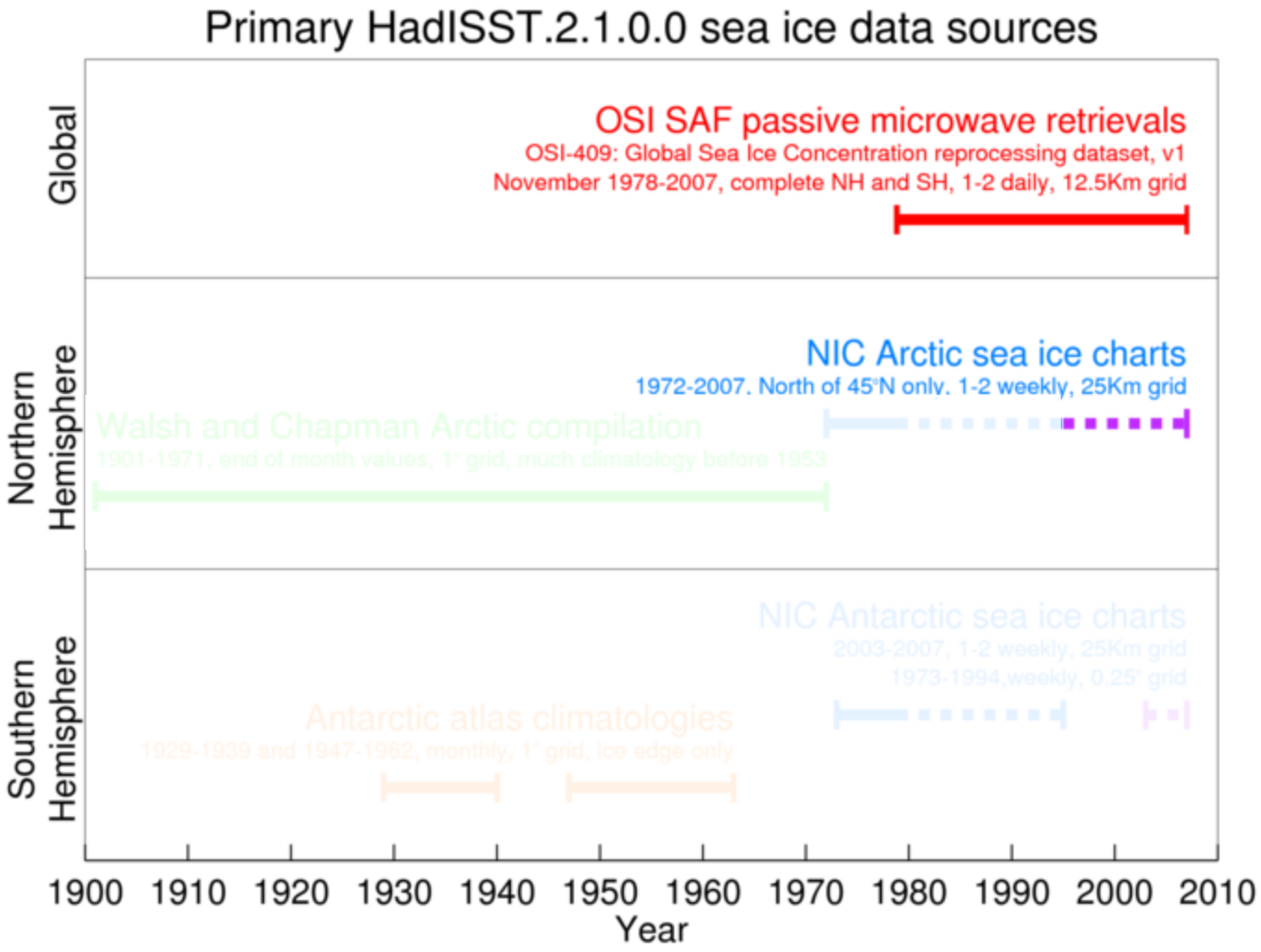
Arctic

Step 1 - adjust OSISAF to NIC charts using overlap 1995-2007

OSI SAF
- Daily
- 12.5 km grid
- Take any value

NIC charts
- 1-2 weekly
- 25 km grid
- 'quantized'



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Bias adjustments

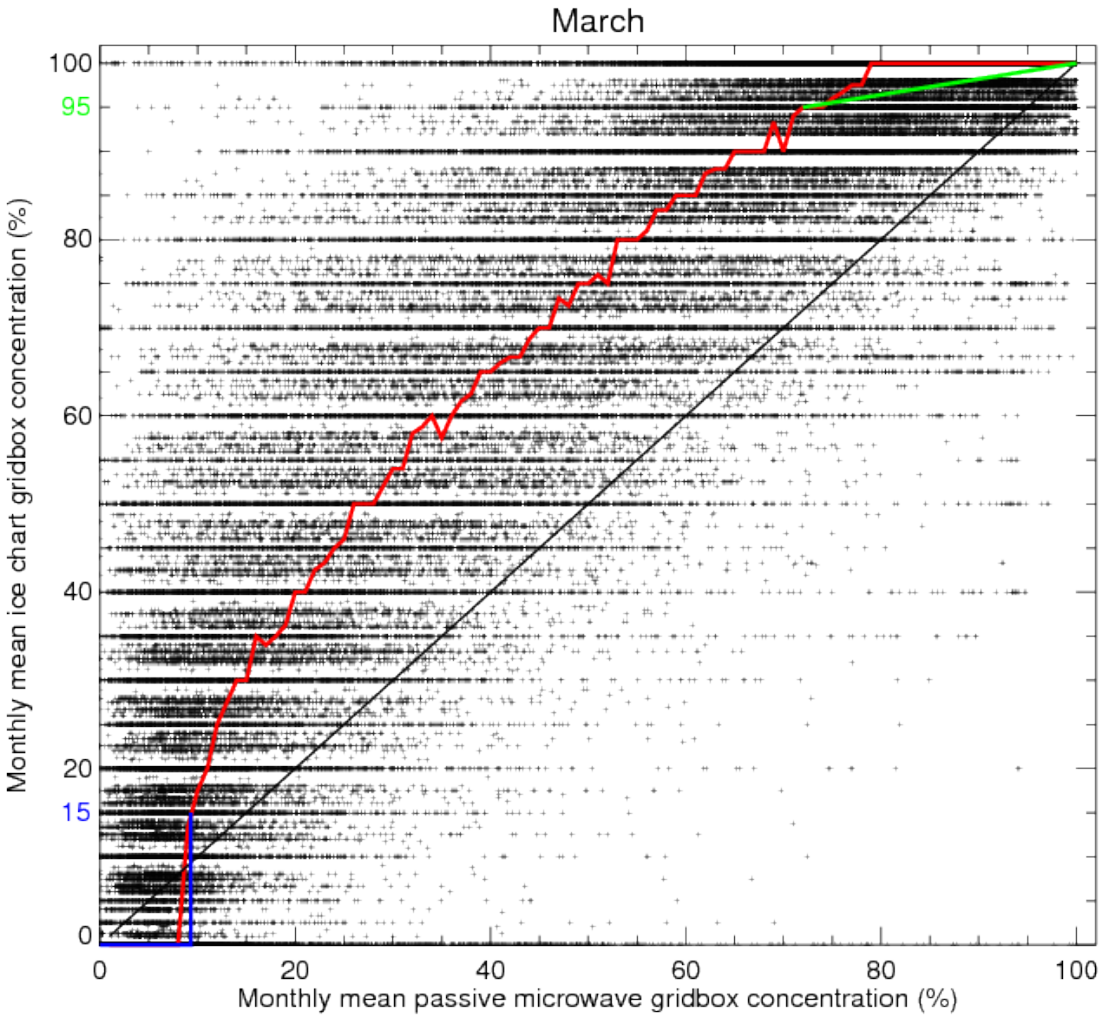
Example shows Northern Hemisphere passive microwave adjustments (made relative to 1995-2007 NIC ice chart data)

Adjustments
(the data to be adjusted are binned and medians are calculated from the reference data set using a bootstrap approach)

High concentrations
(adjusted concentrations above 95% are reset as linearly interpolated values between 95 and 100% to retain spatial variability in high arctic)

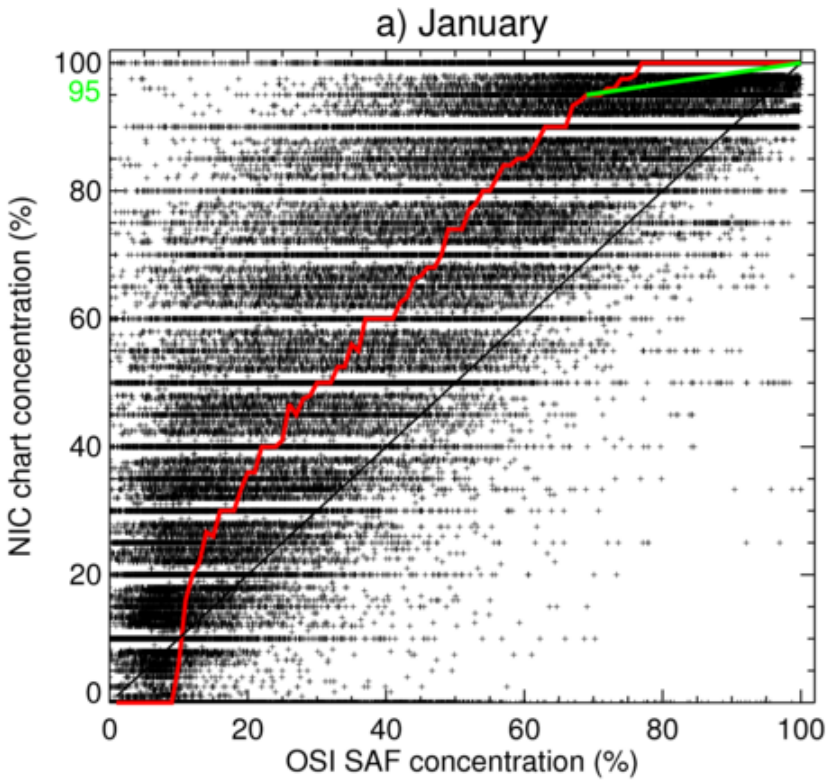
Small concentrations
(adjusted concentrations below 15% are reset as water/0%)

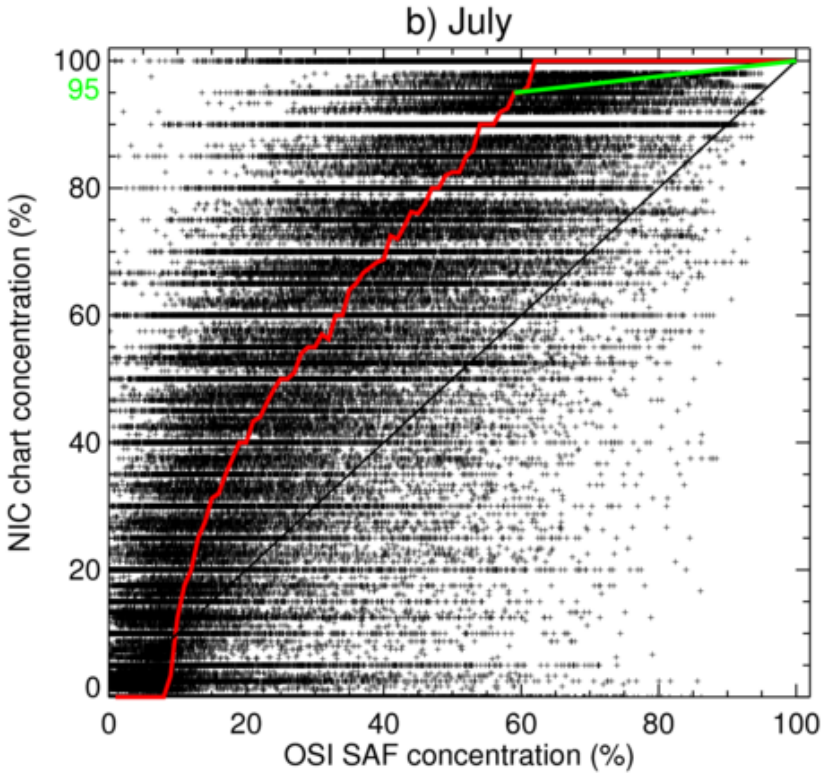
All bias adjustments are made using this method



Bias adjustment method

Northern hemisphere
OSI SAF passive
microwave adjustments





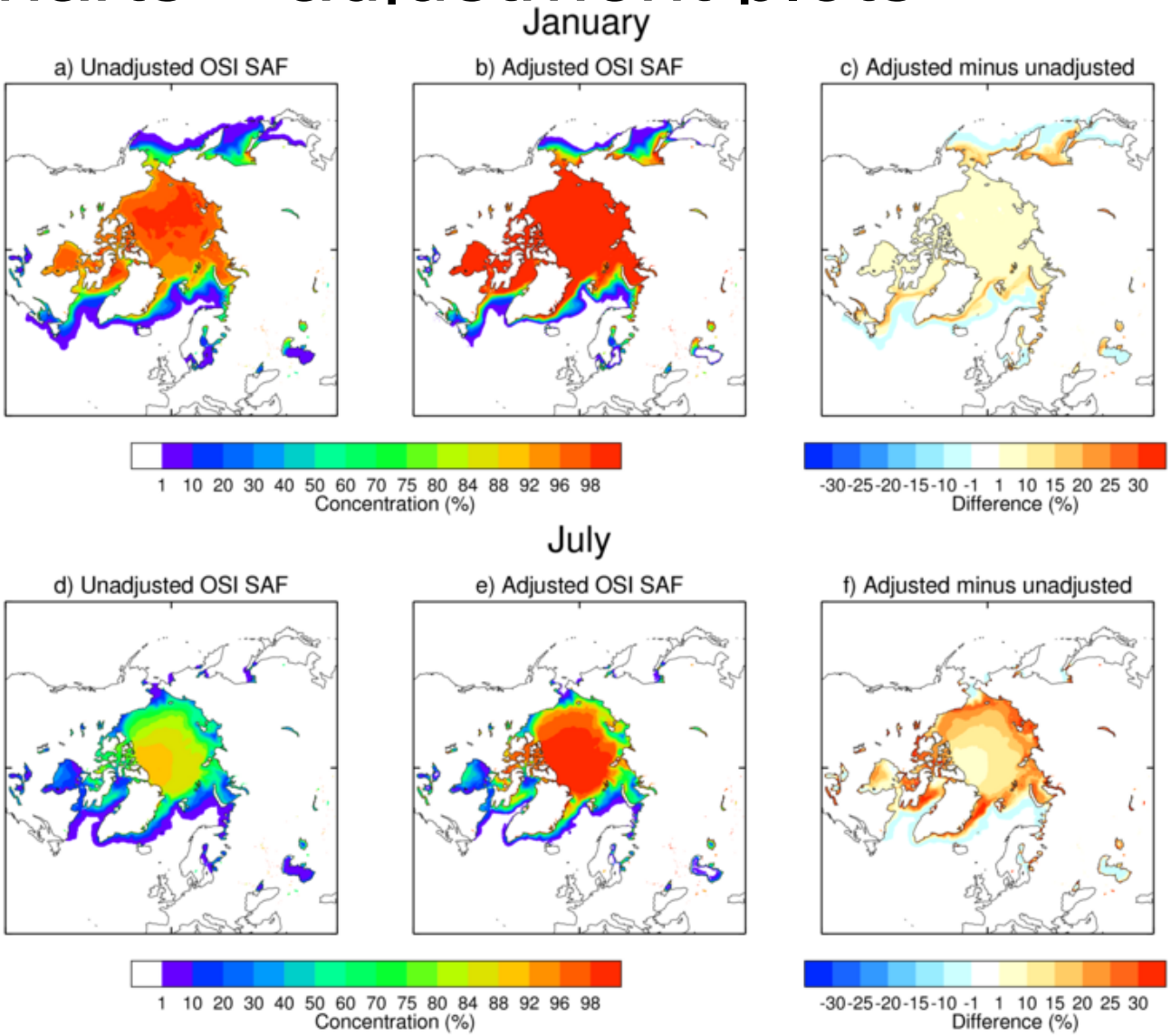
Larger extents and concs from NIC charts – adjustment plots

Mean fields for 1979-2007

Higher concentrations

Stronger gradients in marginal ice zone

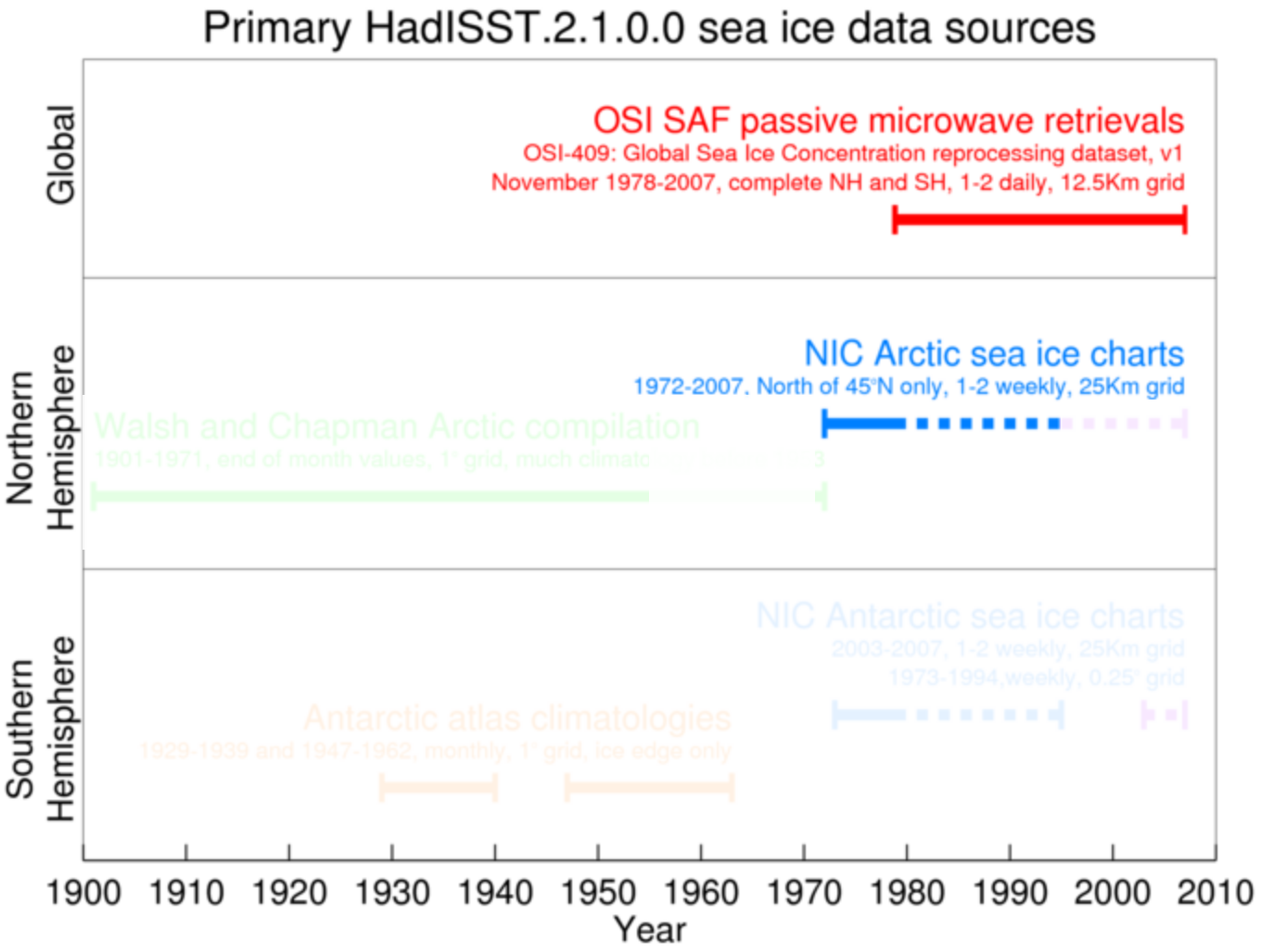
Higher extents



Step 2 – adjust NIC charts to OSISAF using overlap 1979-1994

OSI SAF
- Daily
- 12.5 km grid
- Take any value

NIC charts
- 1-2 weekly
- 25 km grid
- 'quantized'

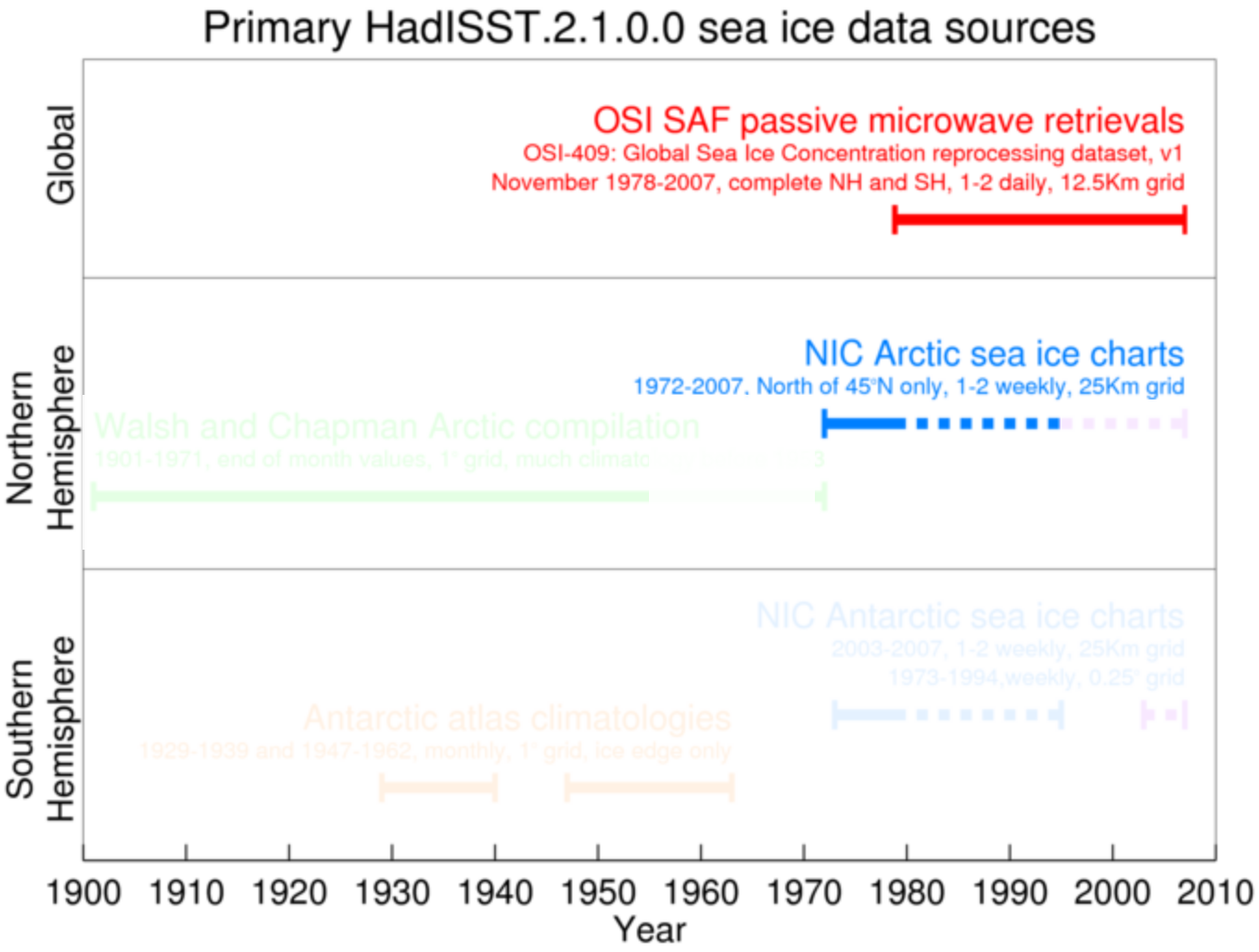


From Titchner and Rayner, submitted to JGR

Step 3 – temporal sampling bias in early NIC charts estimated from OSI SAF

OSI SAF
- Daily
- 12.5 km grid
- Take any value

NIC charts
- 1-2 weekly
- 25 km grid
- 'quantized'



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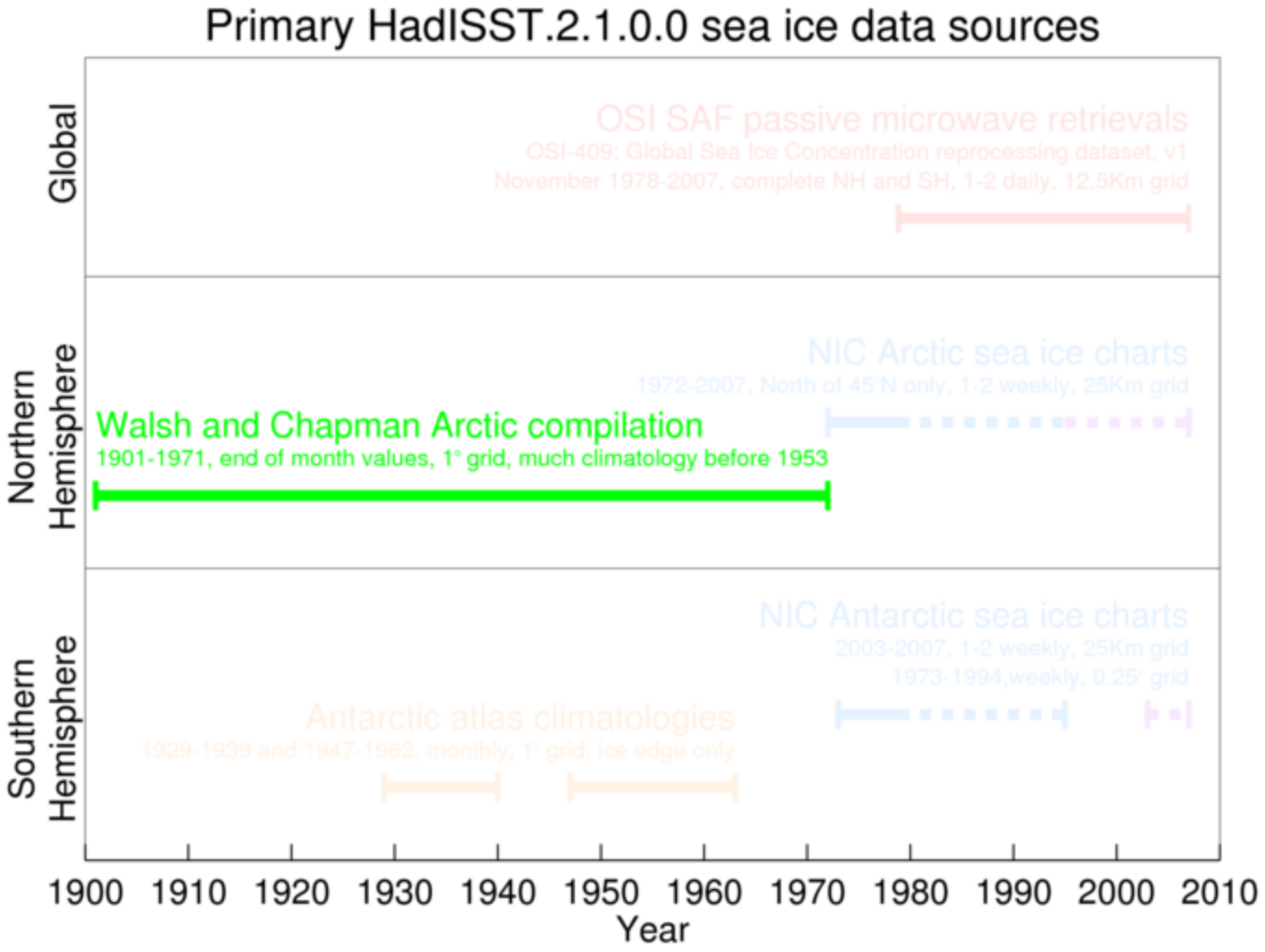
Step 4 – Walsh Charts

Walsh

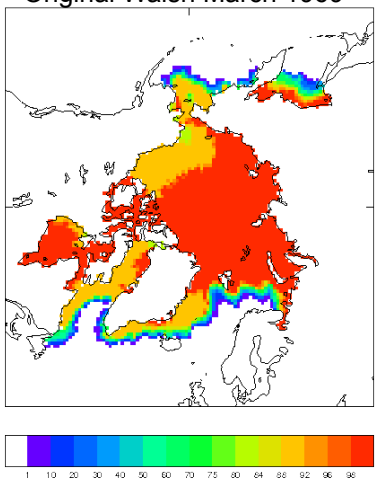
- End of month
- Heterogeneous concentrations
- Use extents only



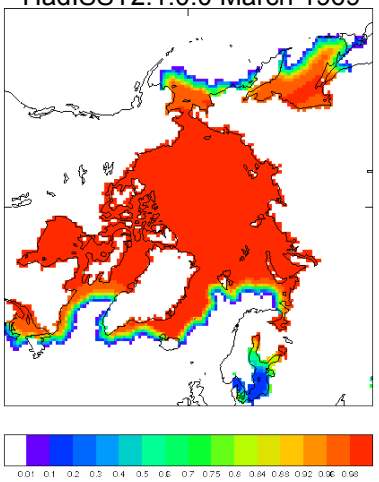
From Titchner and Rayner, submitted to JGR

Walsh data set processing

Original Walsh March 1969



HadISST2.1.0.0 March 1969



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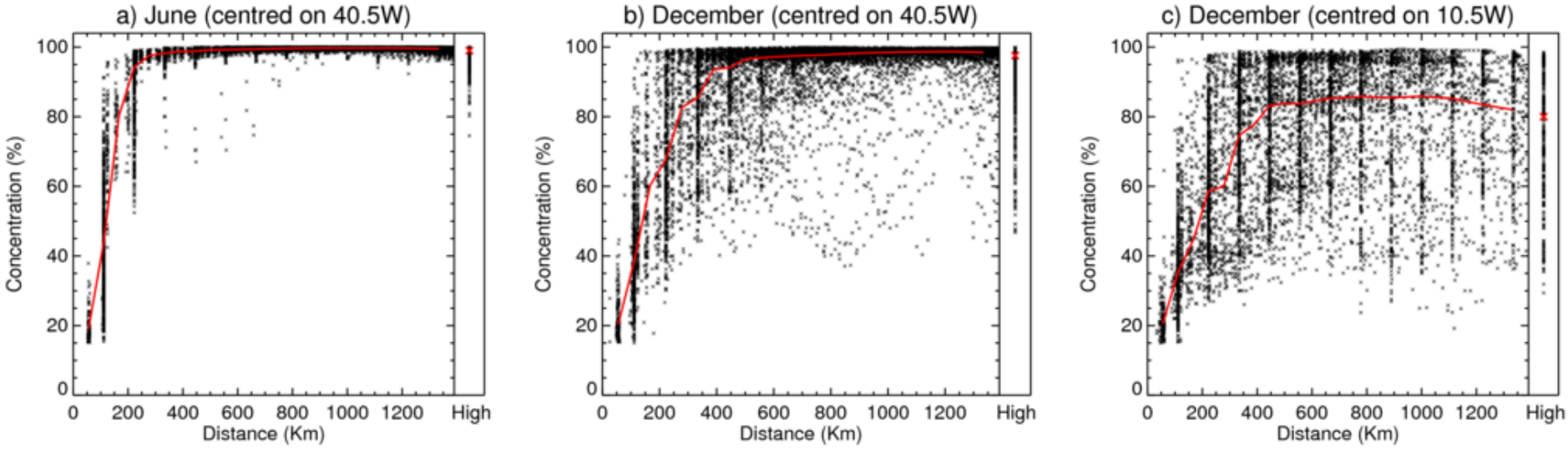
Infilling from ice-edge (example from Antarctic ice)



Each of these is a 21° longitude wide area (10° either side of grid box)

Distance is distance to nearest ice free pixel.

Separate panel on each diagram for ‘Long’ distances.

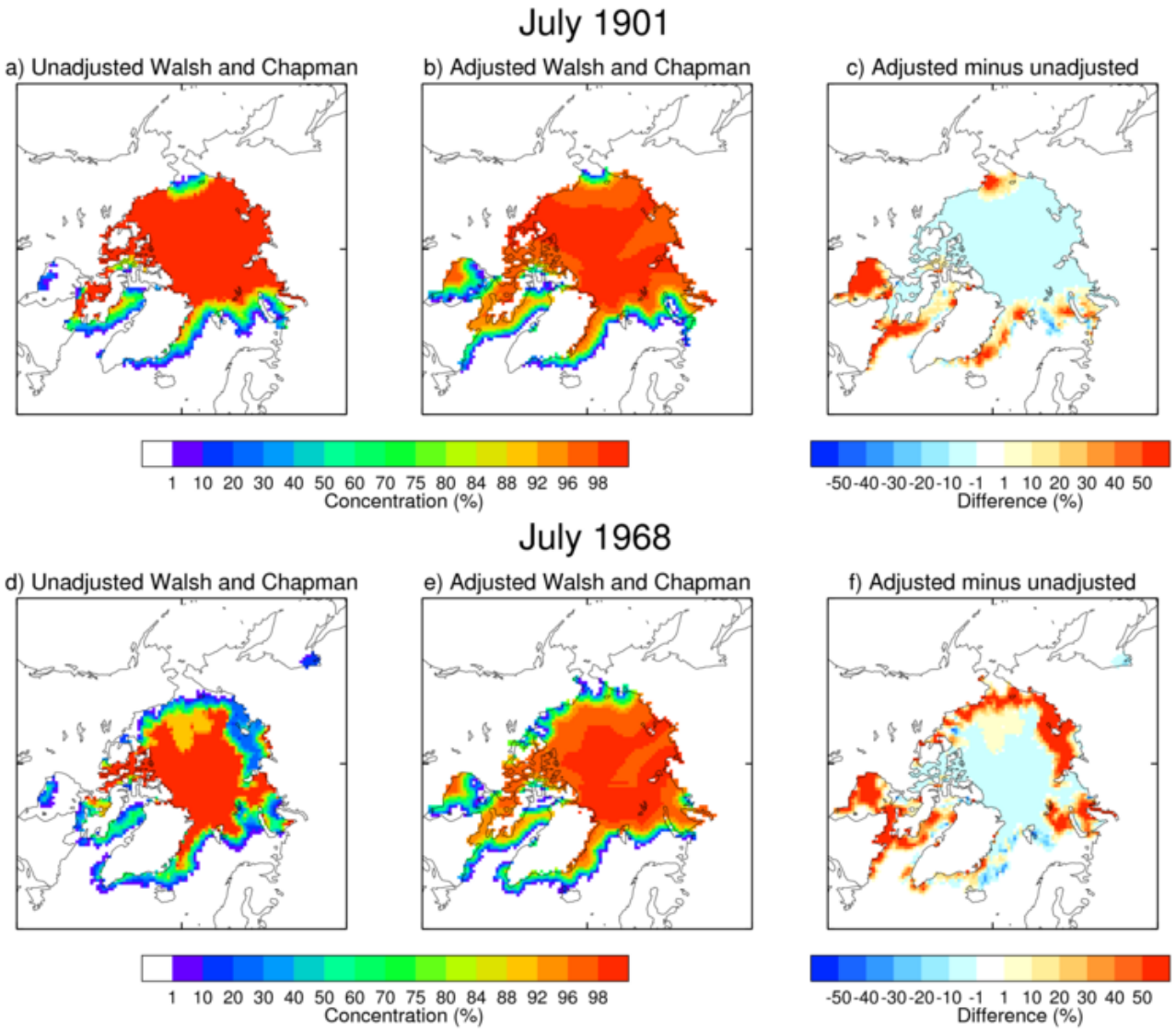
Calculate median in each bin

Effects of infilling from ice edge

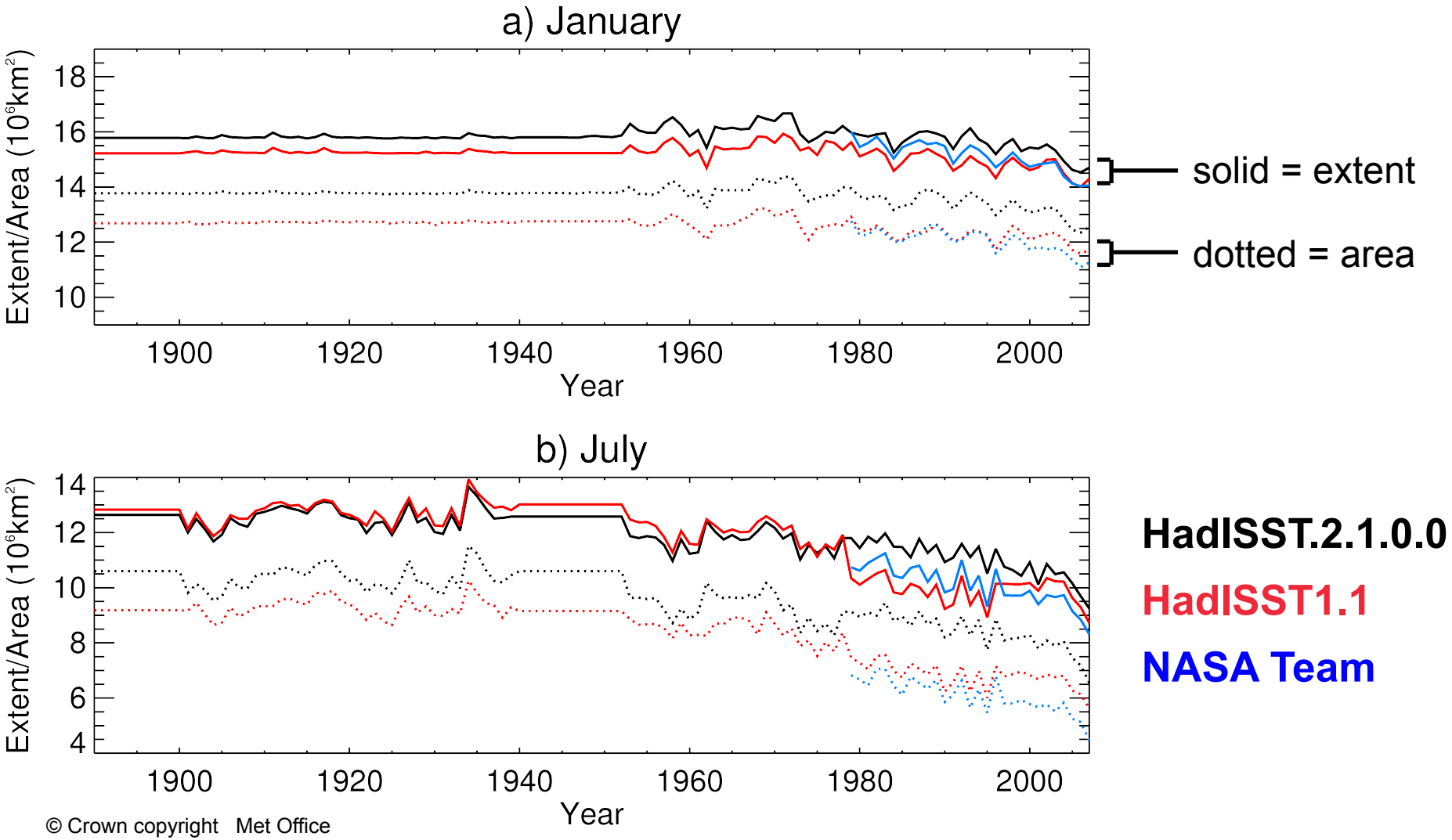
Walsh has higher concentrations at higher concentrations

Some areas, particularly at ice edges, where Walsh has lower concentrations.

Some areas replaced with climatology



Arctic sea ice extent and area



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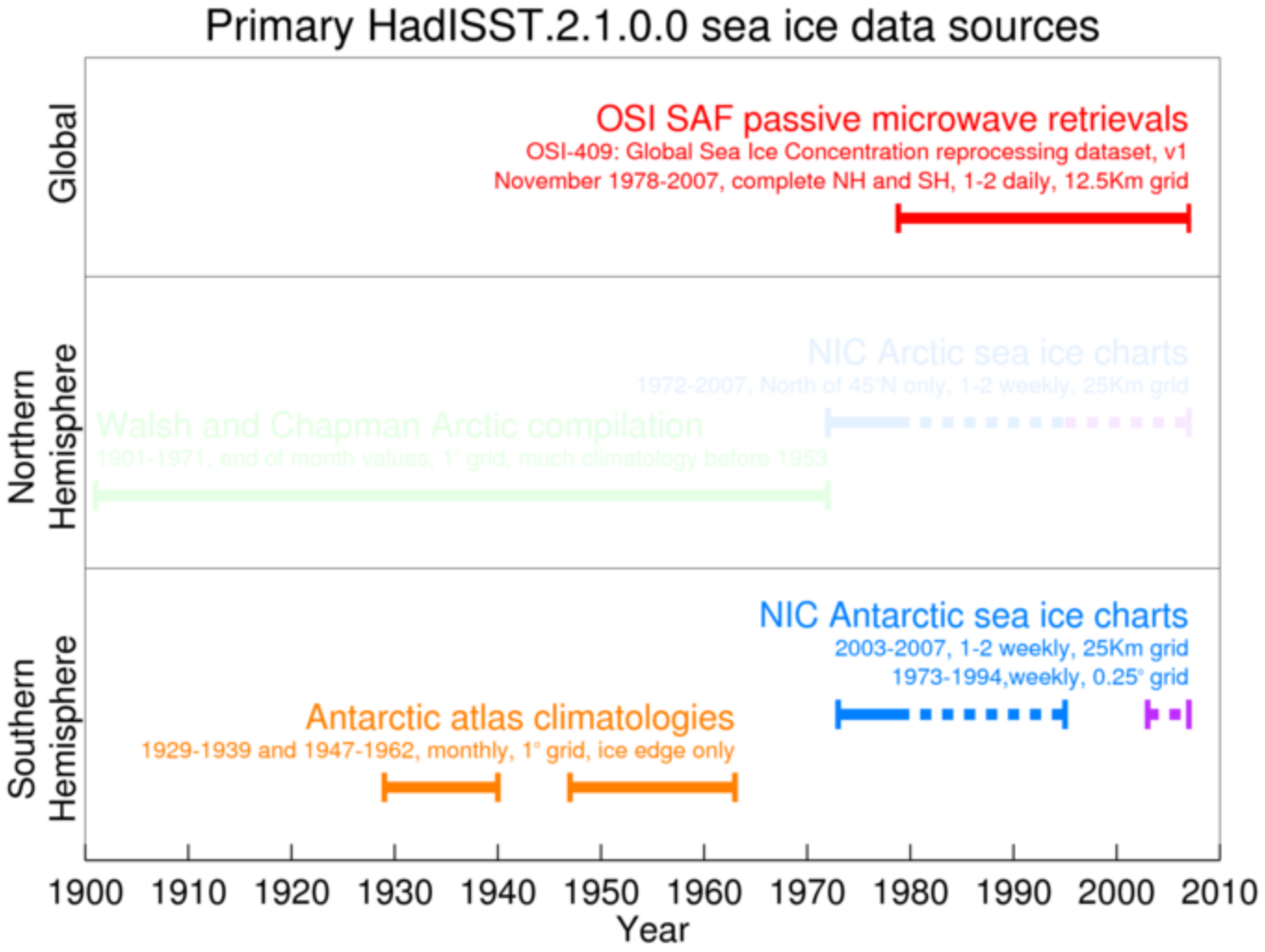
Antarctic

Data sources



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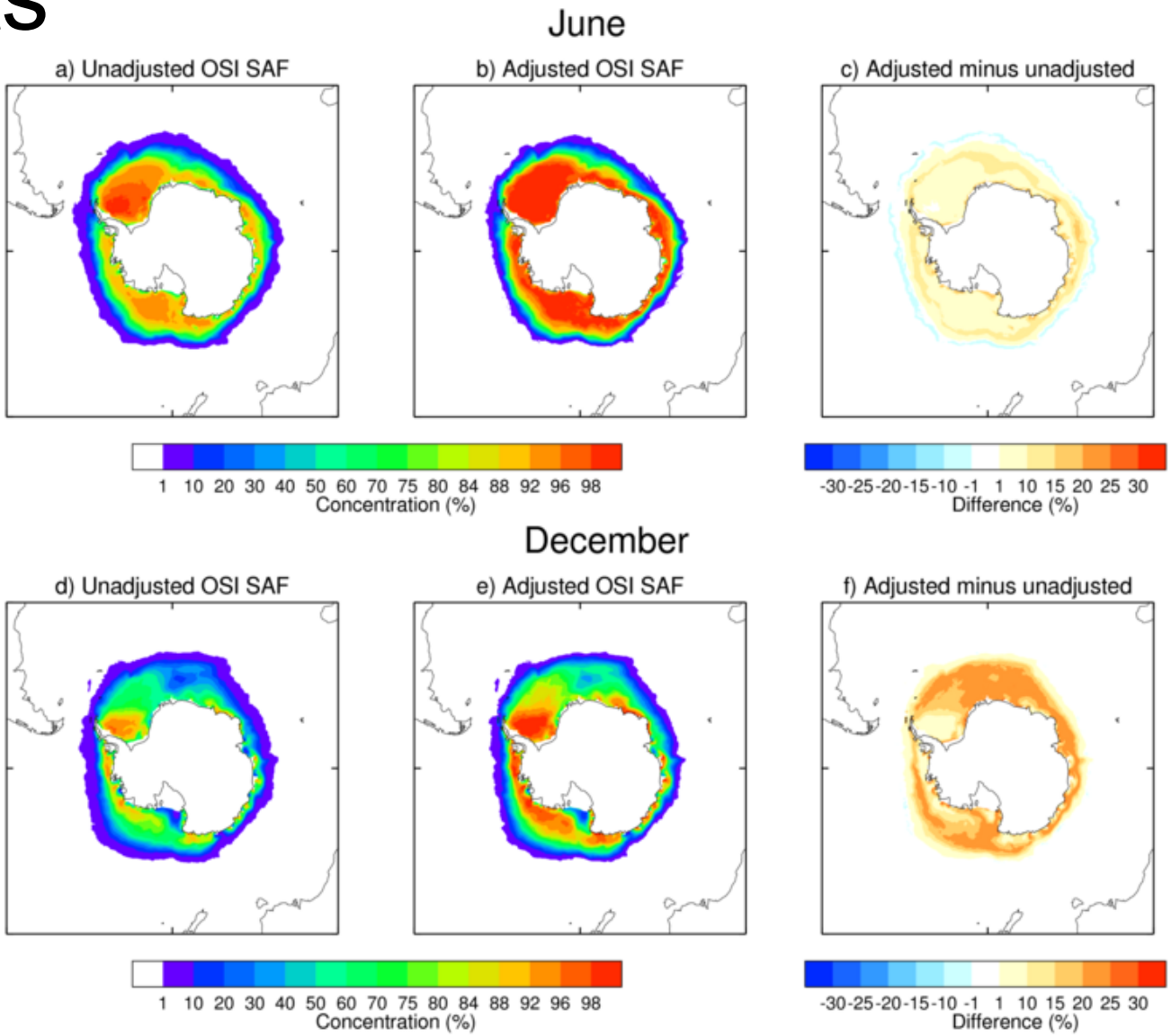
OSI SAF adjusted to ice charts

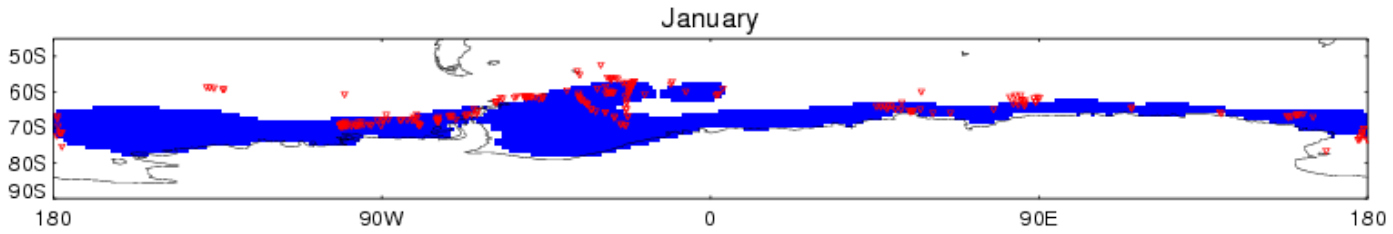
Adjustments made relative to the 2003-2007 NIC chart data

Largest adjustments made to low concentrations, near the ice edge

Larger adjustments in summer than in winter, particularly at high ice concentrations



Atlas climatologies



German Atlas climatology

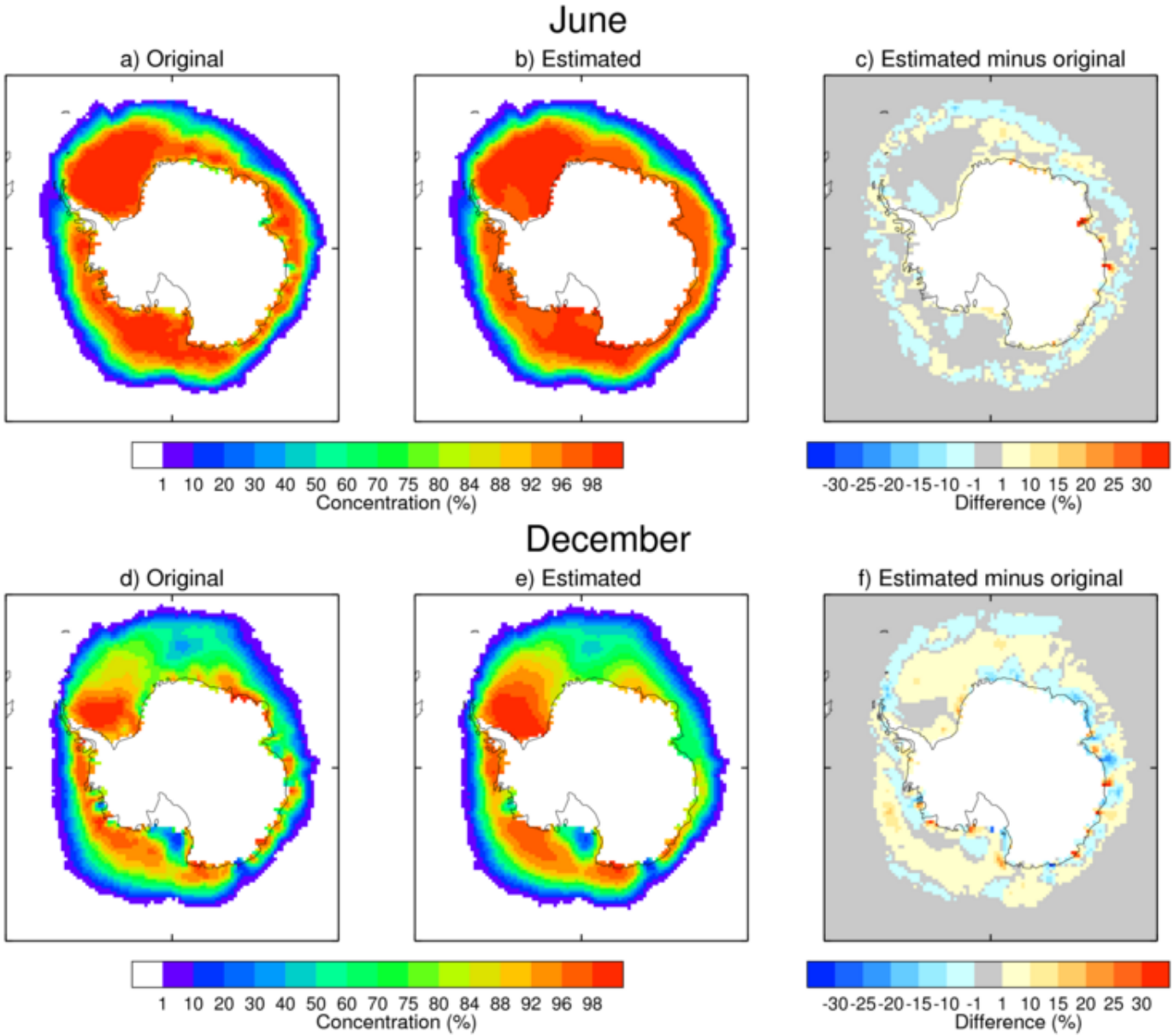
Ship observations from 1922-38 (Southern Ocean Ice Reports)

- 1929-39 German Atlas climatology *(Deutsches Hydrographisches Institute, 1950)*
- 1947-62 Russian Atlas climatology *(Tolstikov, 1966)*
- Ice edges only – concentrations estimated using same method as for Walsh data
- Pre-1929 set as German climatology
- Other missing periods uses linear interpolation of mean concentrations either side - extents taken and concentrations then re-estimated

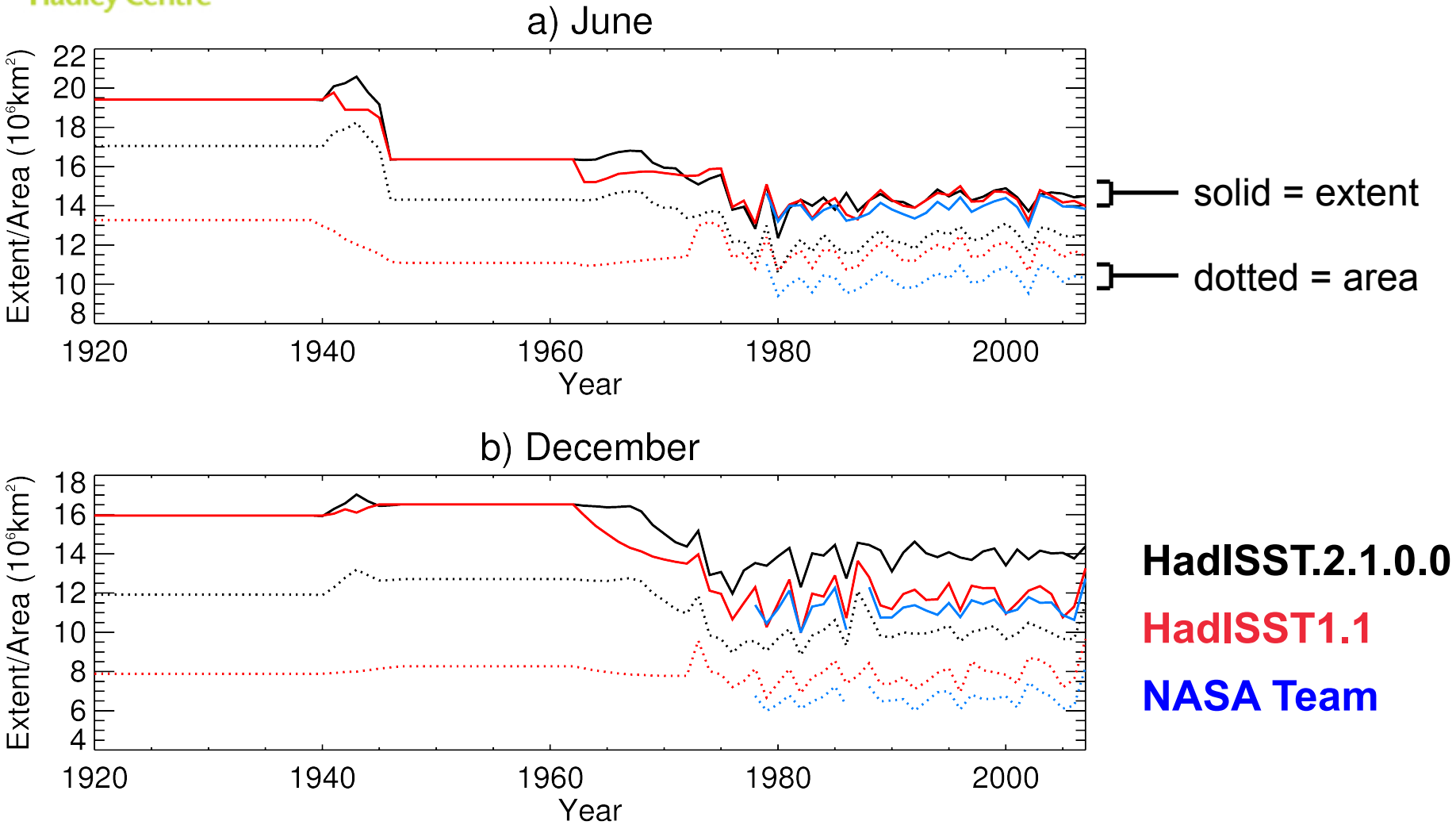
Effect of infilling from ice edge

Compare OSI SAF with OSI SAF estimated from ice edge.

Mean differences vary with season and location.

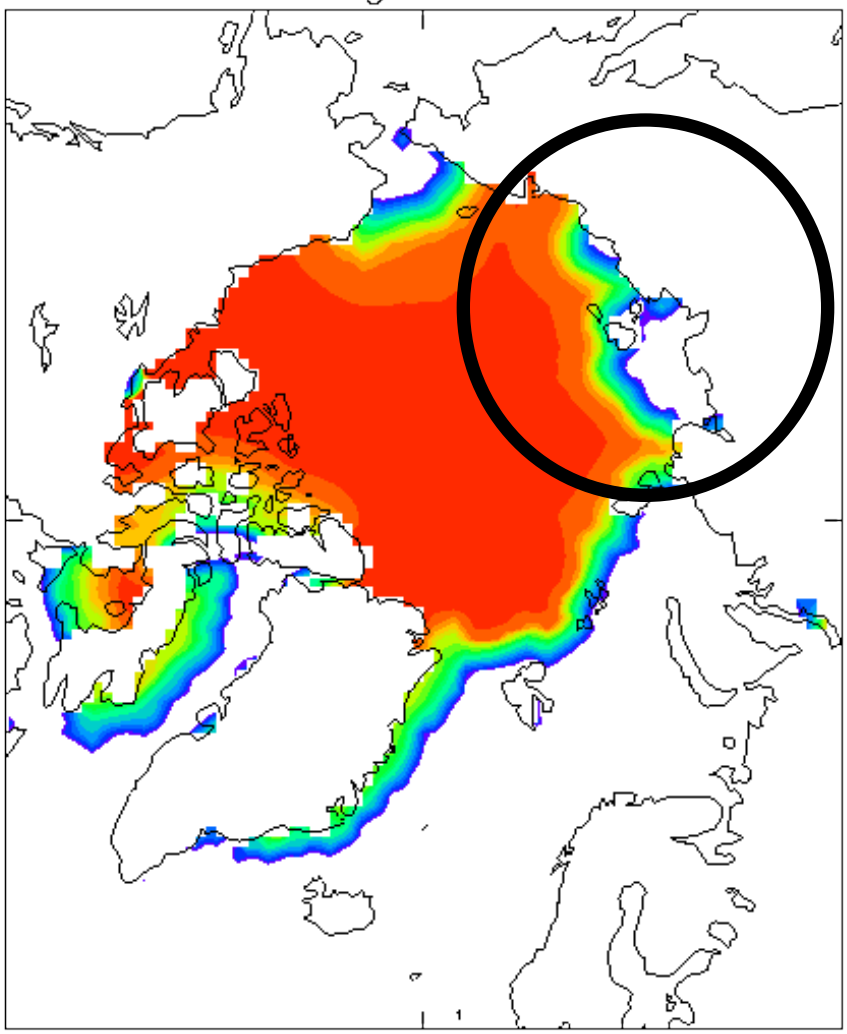


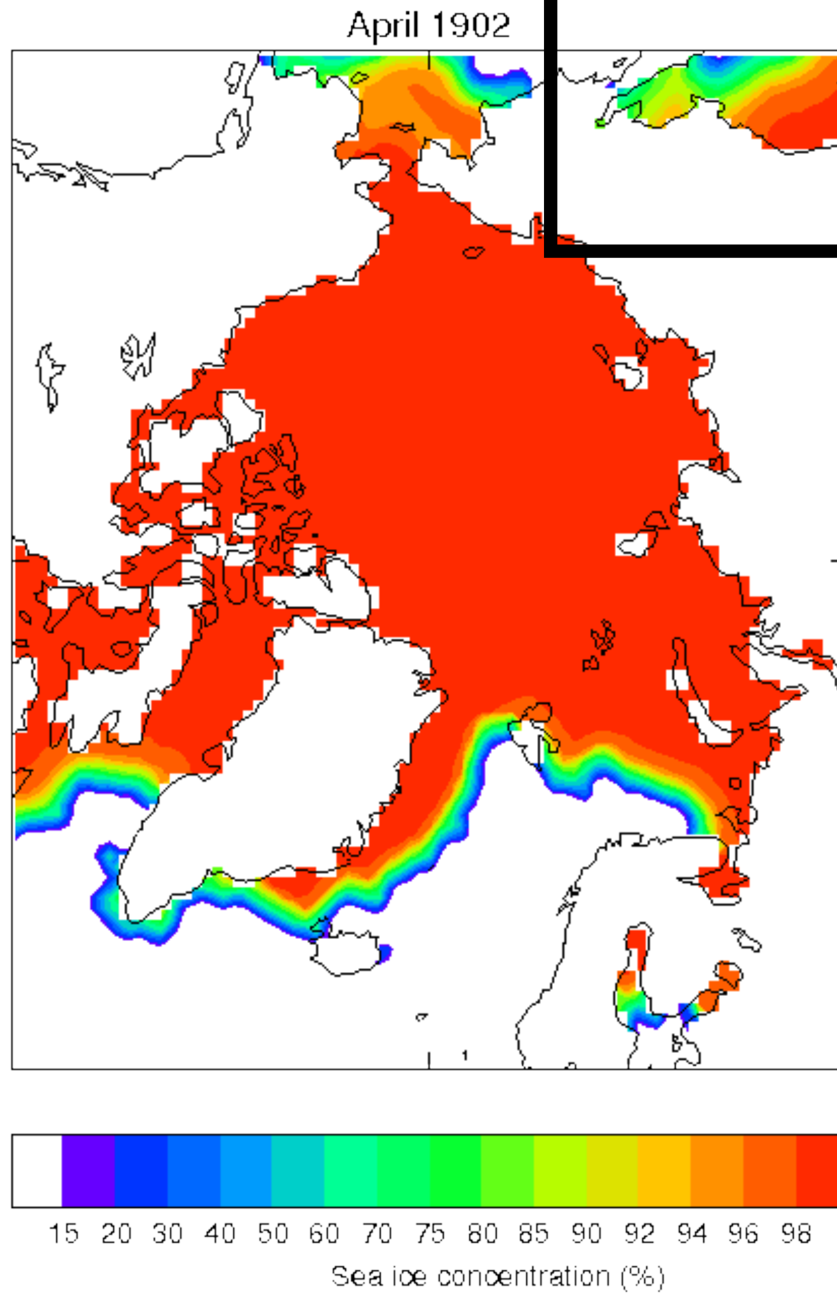
Antarctic sea ice extent and area



Comparisons with other sources

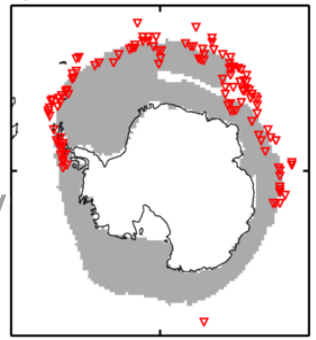

INFORMATION RECEIVED CONCERNING THE ICE, 1938.
AUGUST
NOTE
unbroken polar ice
landfloe
great ice-fields
tight ice
open ice
young ice and brash
iceberg
The red curves indicate the observed limits between open sea and ice. No colour indicates ice supposed but no information at hand.
------Average limit of ice 1898 – 1922.
Bering Sea
Okhotsk Sea
Beaufort Sea
NORTH POLE
SEVERNAJA ZEMLJA
NOVAJA ZEMLJA
FR. JOSEPH LD.
New Siberia Is.
Barents Sea
Greenland Sea
GREENLAND
ICELAND
NORWAY
SWEDEN
FINLAND
Baffin Land
Baffin Bay
Lapland
Yalmal
Kara Sea
Baltic Sea
North Sea
Denmark Str.
Davis Str.

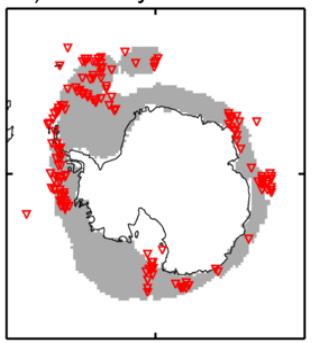

August 1938
15 20 30 40 50 60 70 75 80 85 90 92 94 96 98
Sea ice concentration (%)

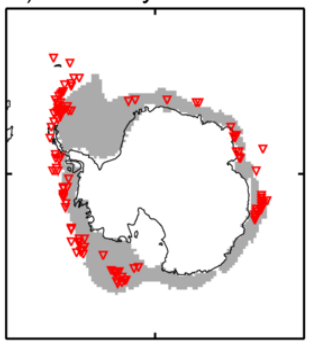

THE STATE OF THE ICE IN THE ARCTIC SEAS 1902
PUBLISHED BY THE DANISH METEOROLOGICAL INSTITUTE.
APRIL.
NOTE.
store Ismarker - great ice fields.
tæt Drivis - tight pack-
spredt Drivis - open ice.
Nyis og Sjapis - bay-ice and brash.
Isfjeld - iceberg.
De røde Linier angive de iagttagne Grænser mellem aabent Hav og Is. Fra de ufarvede Partier mangle Iagttagelser, men Tilstedeværelse af Is formodes.
The red curves indicate the observed limits between open sea and ice. No colour indicates: ice supposed but no information at hand.
Okhotsk-Sea
Bering-Sea
Beaufort-Sea
NORTH-POLE
GREENLAND
Greenland-Sea
Barents-Sea
Kara-Sea
ICELAND
NORWAY
SWEDEN
FINLAND
North-Sea
Baffin-Bay
Davis-Strait
St. of ice unkn.
PACHT & CRONE

April 1902
15
20
30
40
50
60
70
75
80
85
90
92
94
96
98
Sea ice concentration (%)

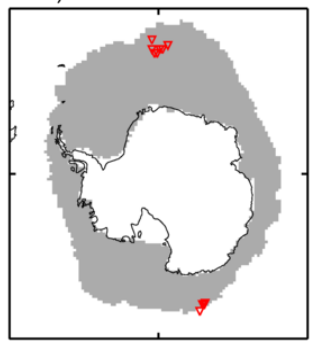
Comparison with Southern Ocean Ice Reports (red)

German Climatology

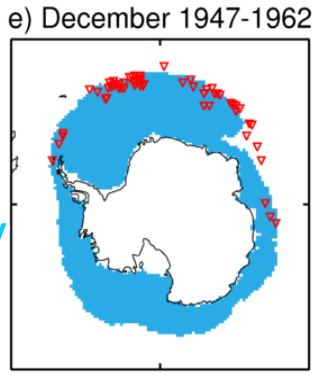


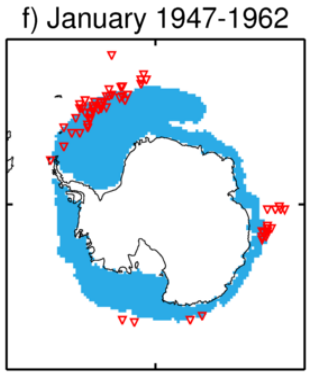


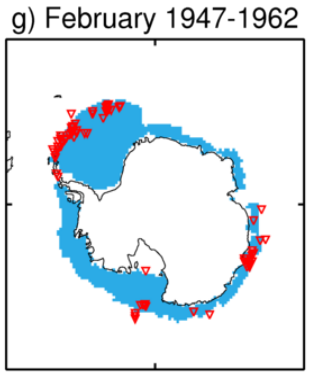


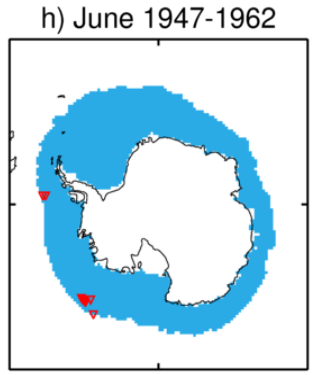


Russian Climatology









Summary

- More consistent concentrations and extents through time.
- Some discontinuities in HadISST1.1 have been addressed e.g. 1979 satellite/ice chart break.
- HadISST.2.1.0.0 is not ‘Frozen’
- We aim to improve the product over time
  - OSI SAF updates
  - Southern Hemisphere ice observations
  - Walsh and Fetterer are redigitising and reprocessing ice charts
  - Uncertainty information

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Questions and answers