Variability of the Sea Ice Cover from AMSR and Historical Satellite Data

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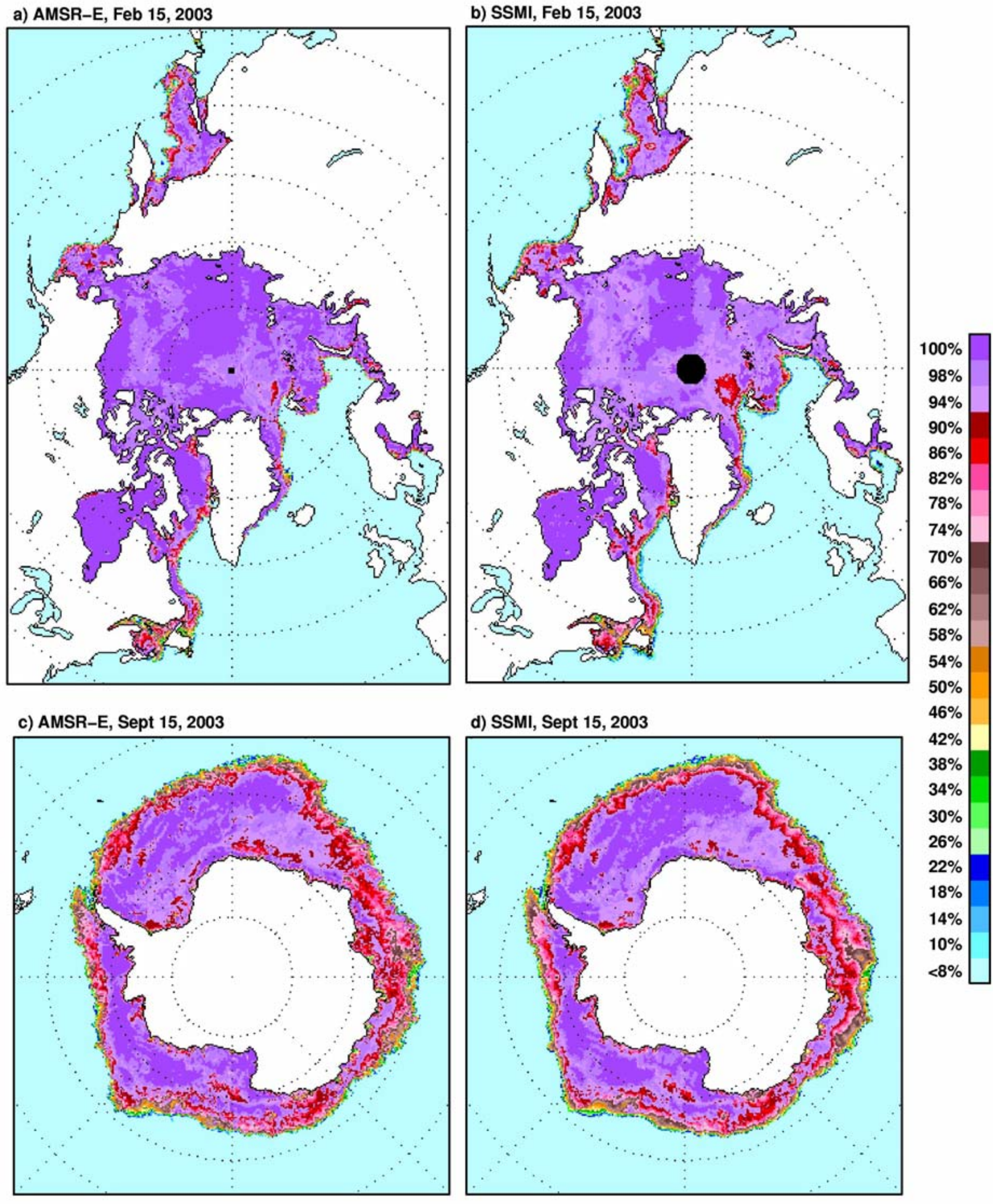
Motivations for using AMSR Data for Sea Ice Studies

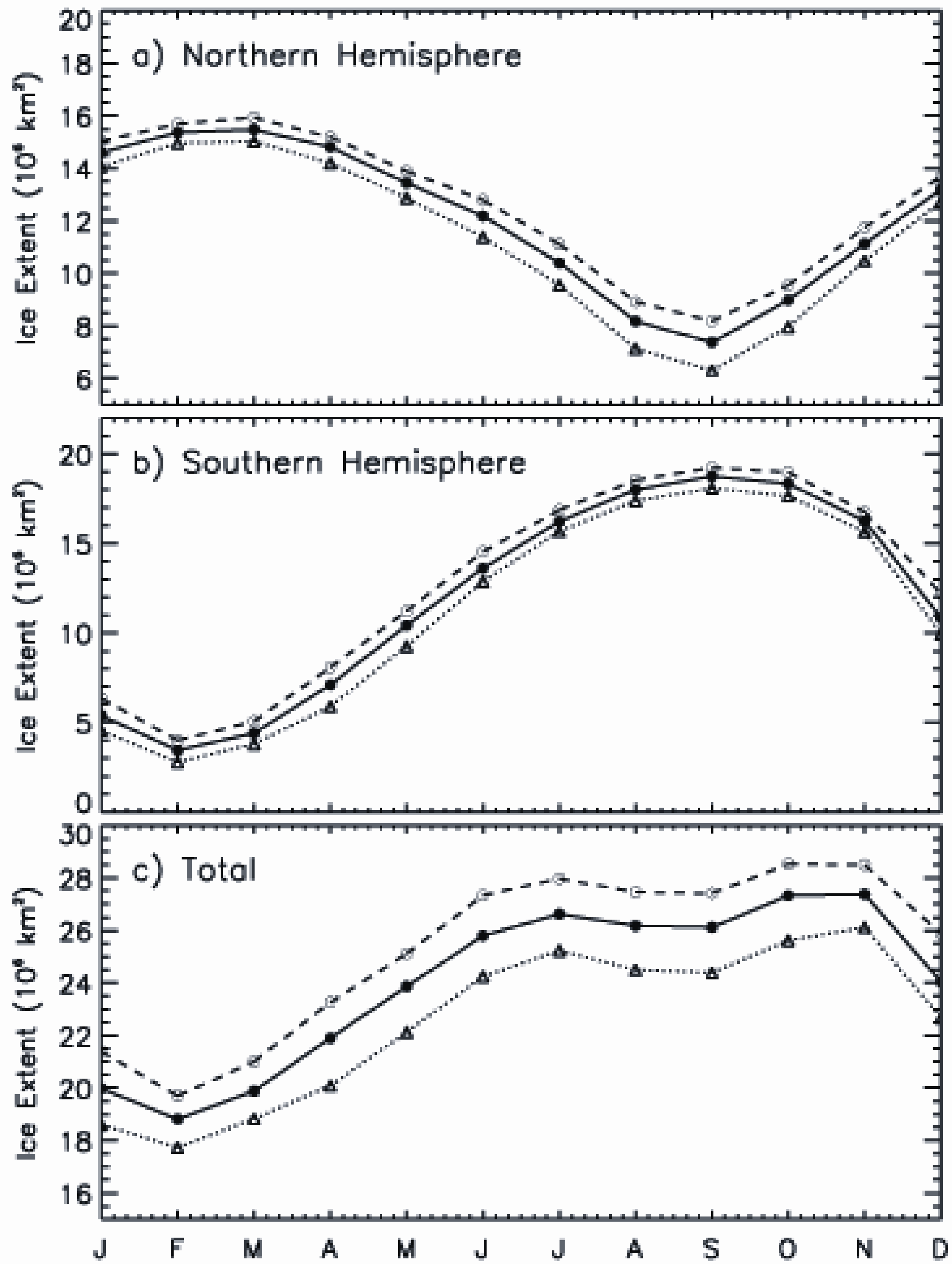
- We expect that the high resolution AMSR data would enable improved flux and air-sea ice-ocean studies.
- Wider spectral range and improved resolution should allow for more accurate and less ambiguous determination of geophysical variables.
- The data could provide the baseline for climate change studies and the means to evaluate historical data.

Ice Concentration AMSR vs SSMI

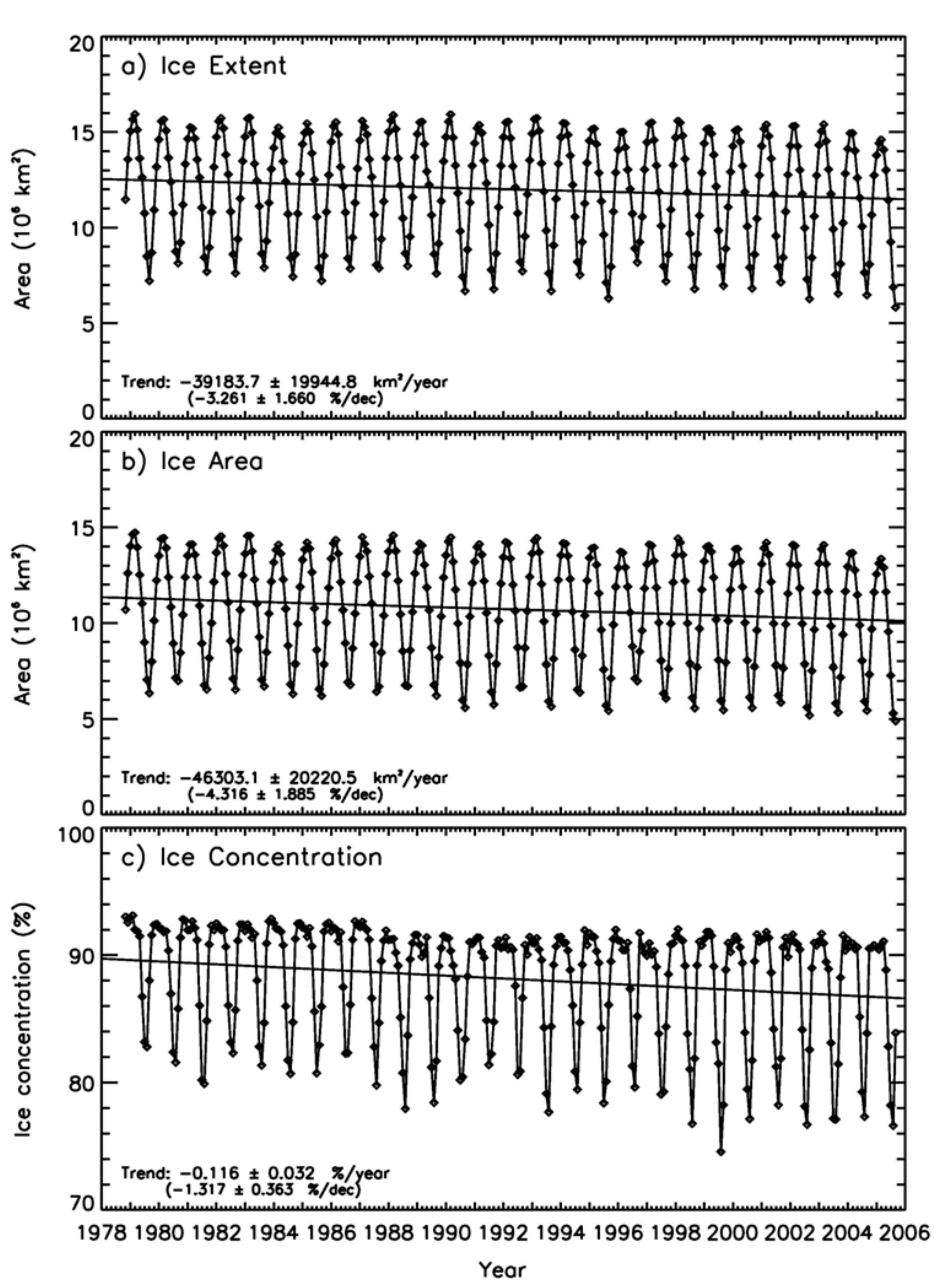
- General patterns are basically the same but sensitivity to small changes in surface properties are better for AMSR.
- Area of no data (near NP) is much smaller for AMSR
- Sharper and improved ice edge characteristics for AMSR



Seasonality of the Arctic, Antarctic and Total Sea Ice Cover

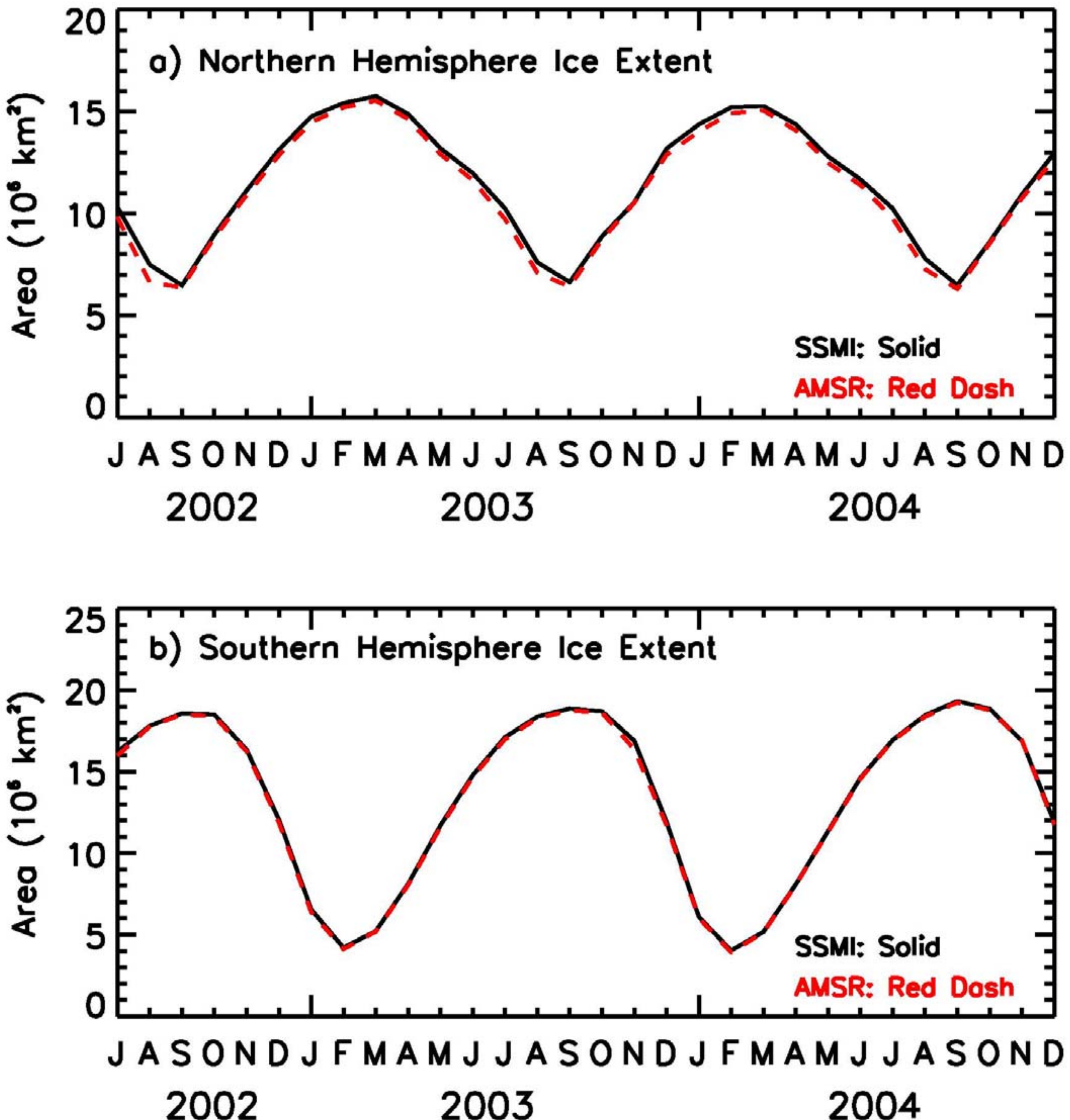


Monthly extent, area, and concentration of Arctic sea ice



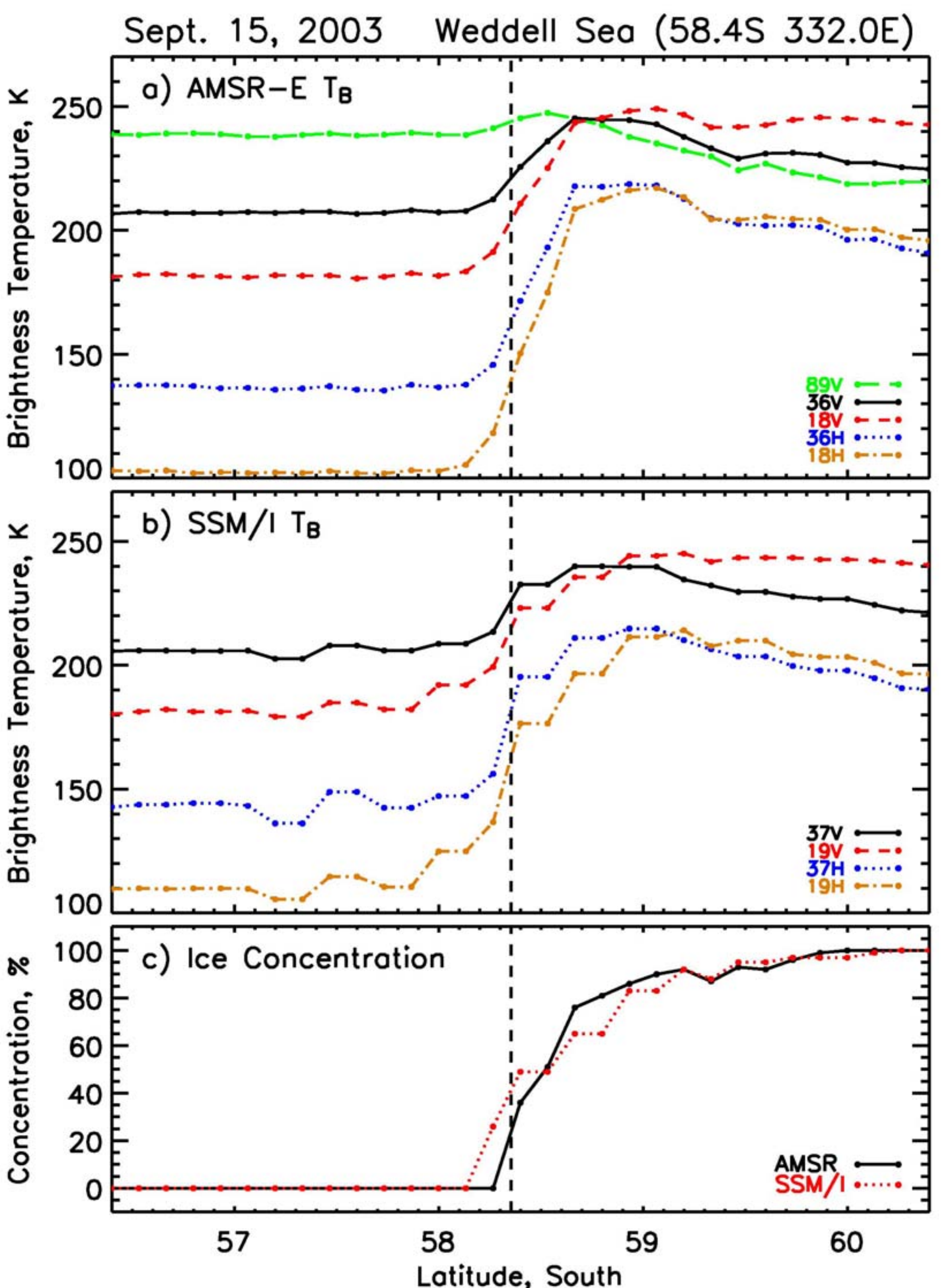
Ice extent comparisons

- A small bias is apparent with AMSR showing less extent than SSMI
- Bias is smaller in the SH than in the NH



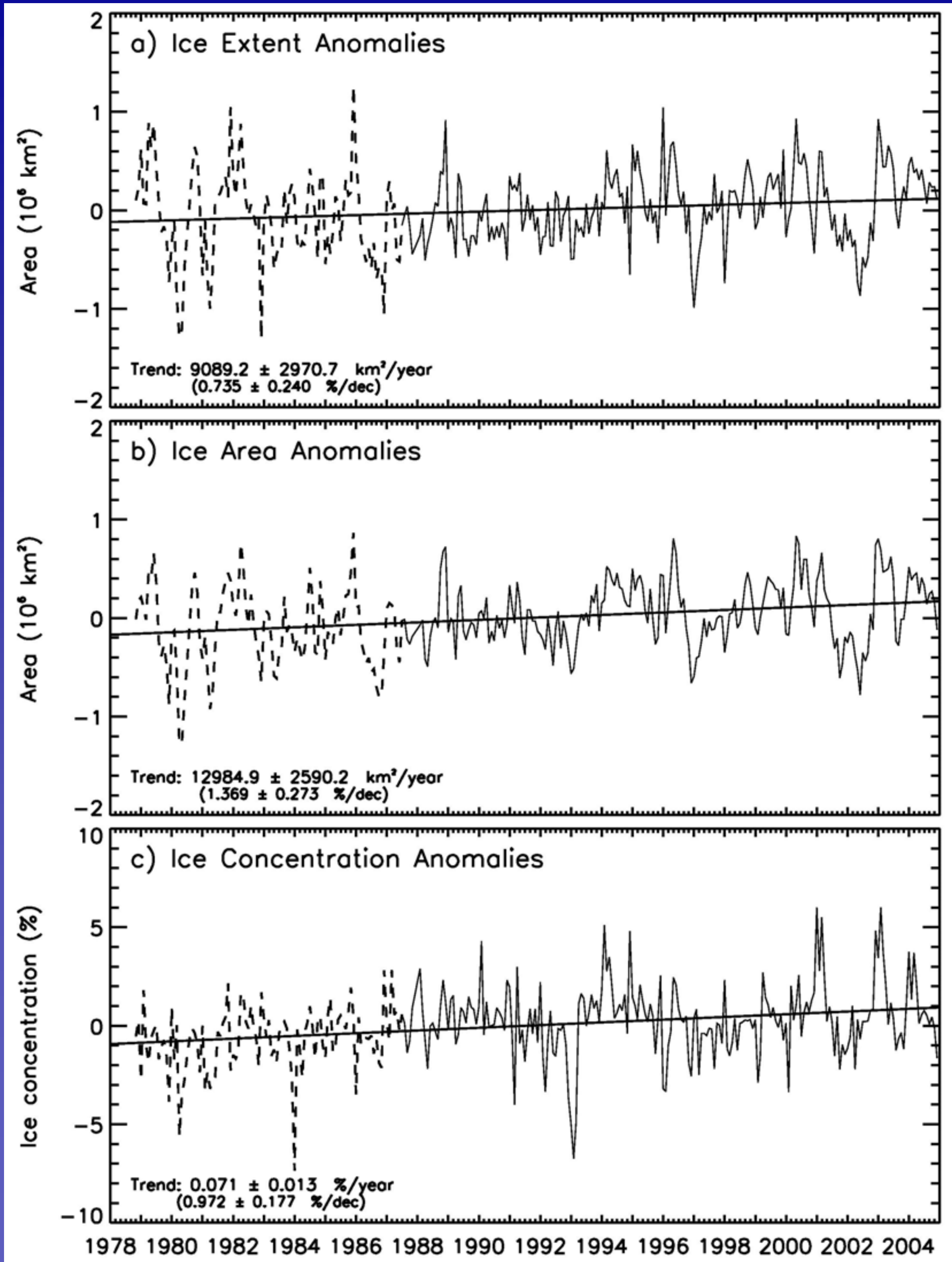
Ice Edge Characterization

- All channels from AMSR are coherent. The ice edge location is almost frequency independent
- Effect of resolution and sidelobes are more apparent with SSMI
- Errors of about 12 km is possible in some locations for SSMI data



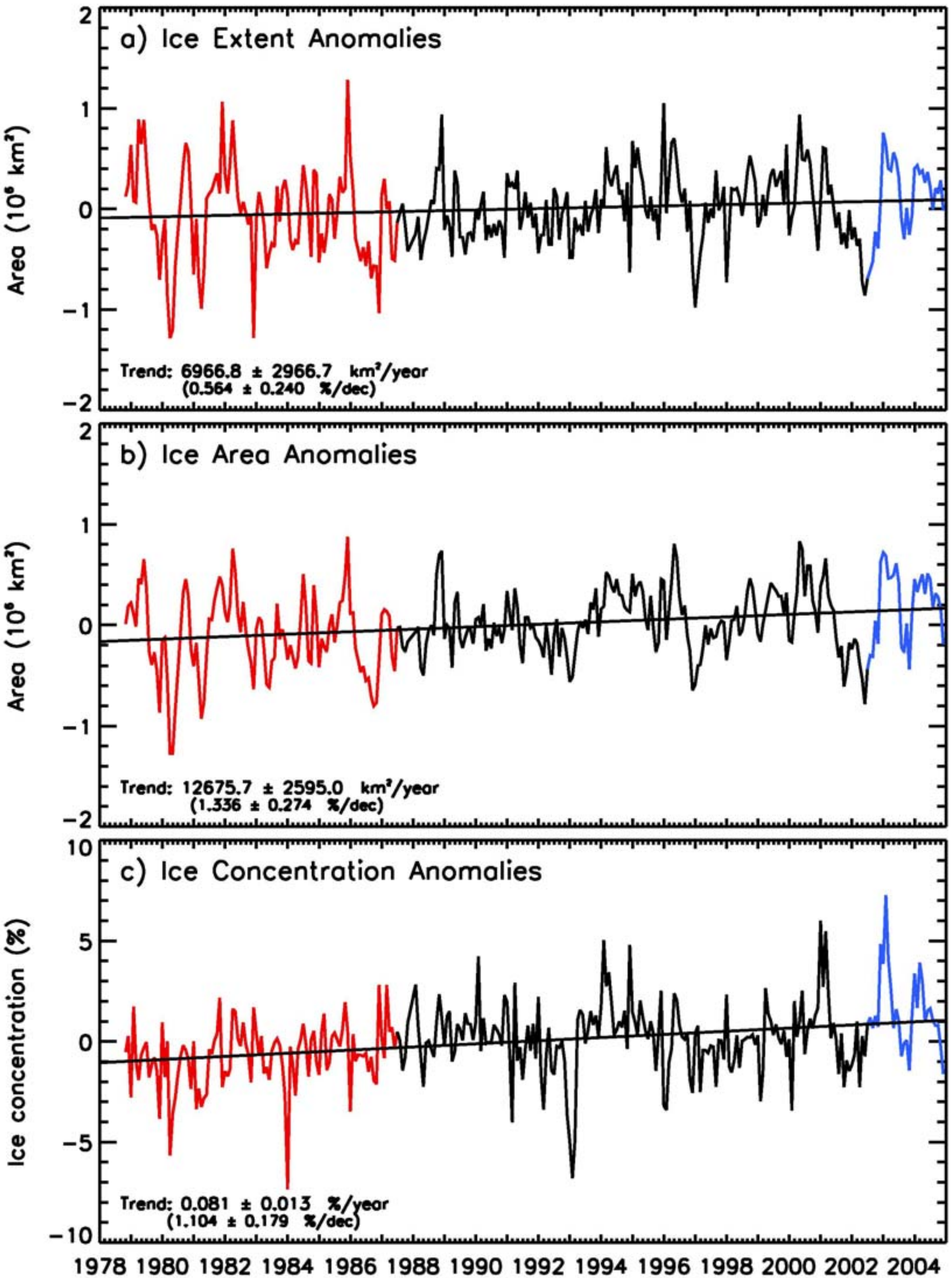
Annomaly/Trend Studies - SH

- An increasing percentage in average ice concentration is observed
- As a result, the trend in ice area is higher than that in ice extent

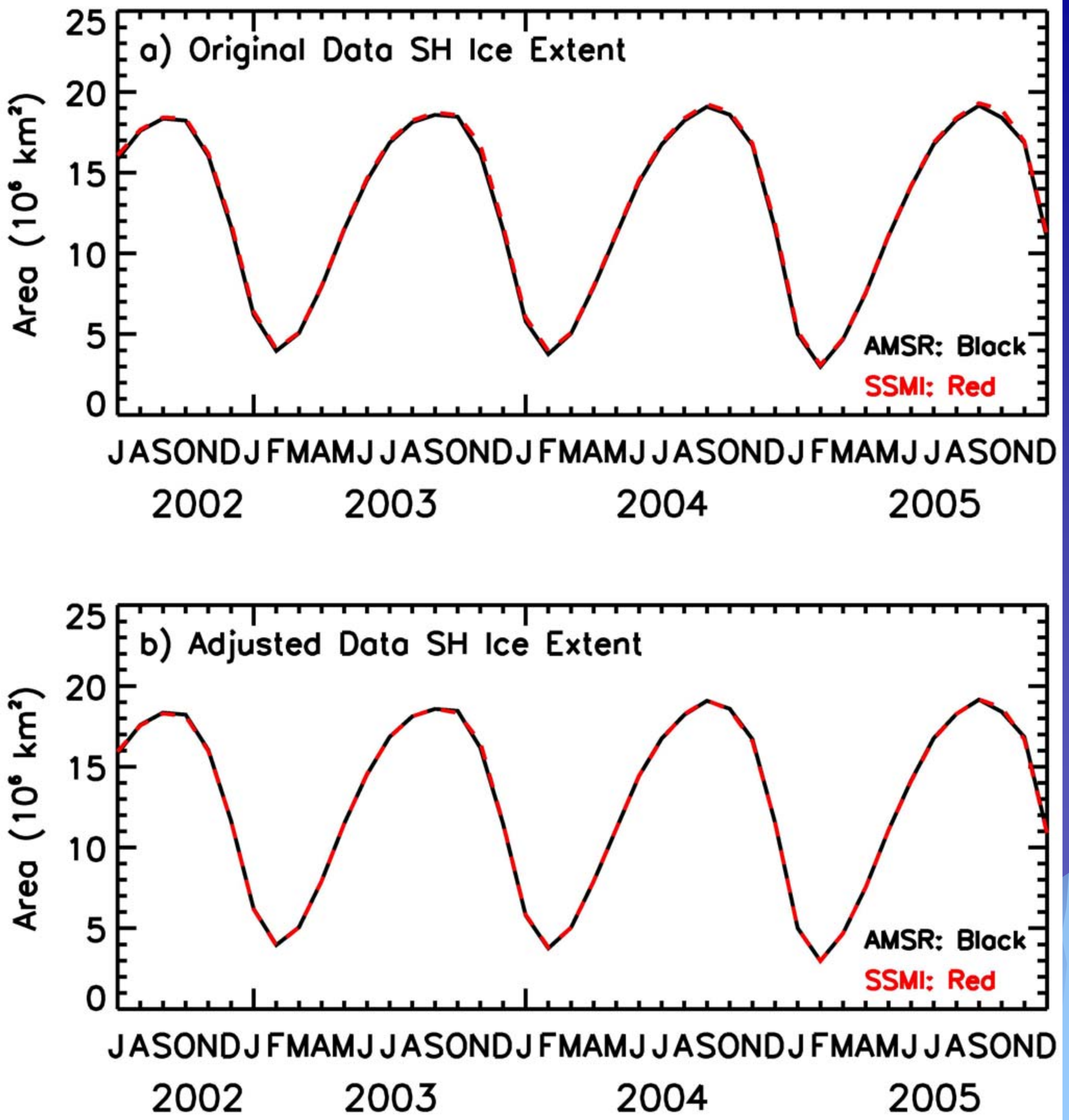


Annomaly/Trend Studies - SH

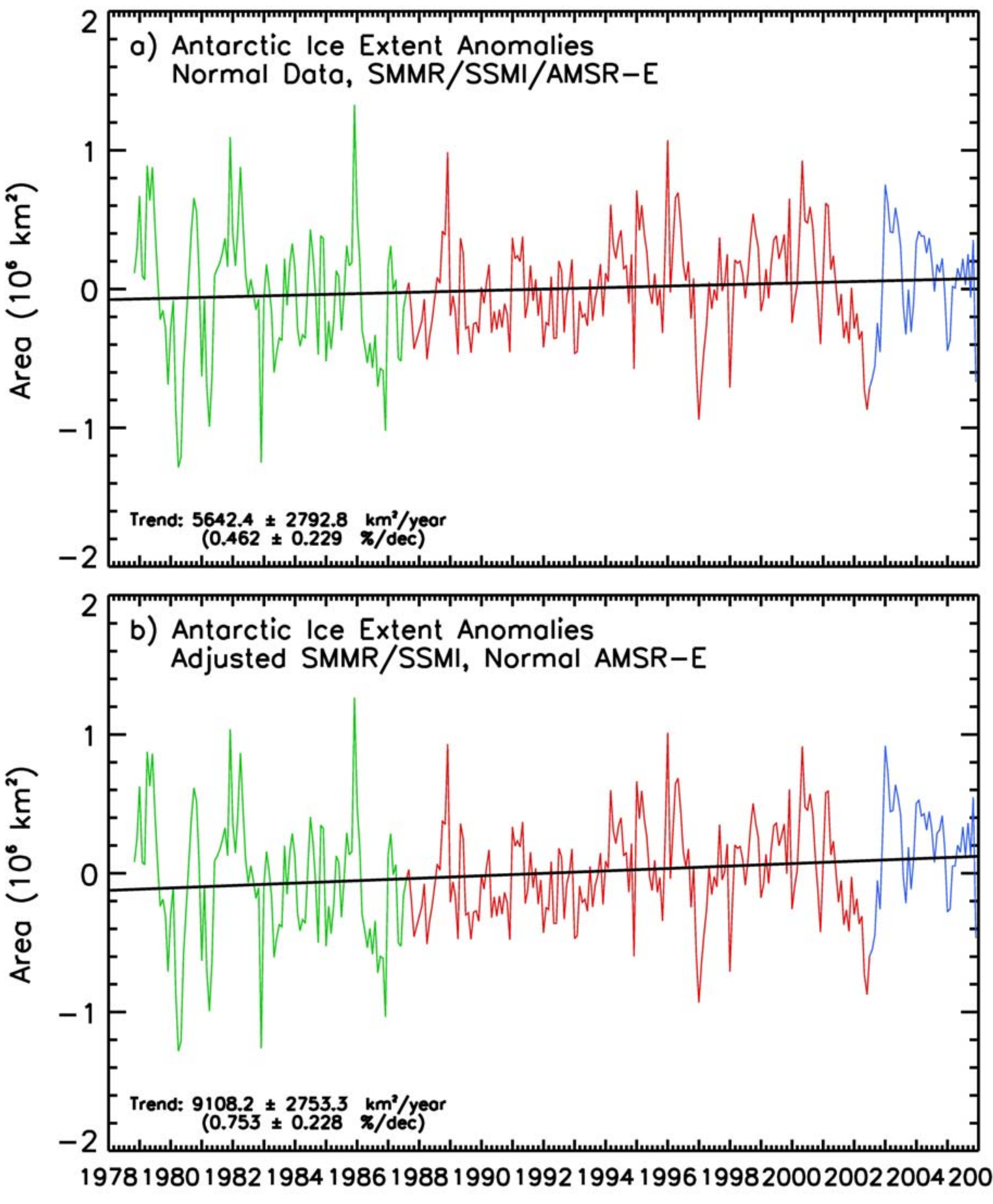
- Smaller trend in ice extent is observed with the use of AMSR data instead of SSM/I reflecting some bias
- Again, the trends in ice area are almost the same for AMSR and SSMI



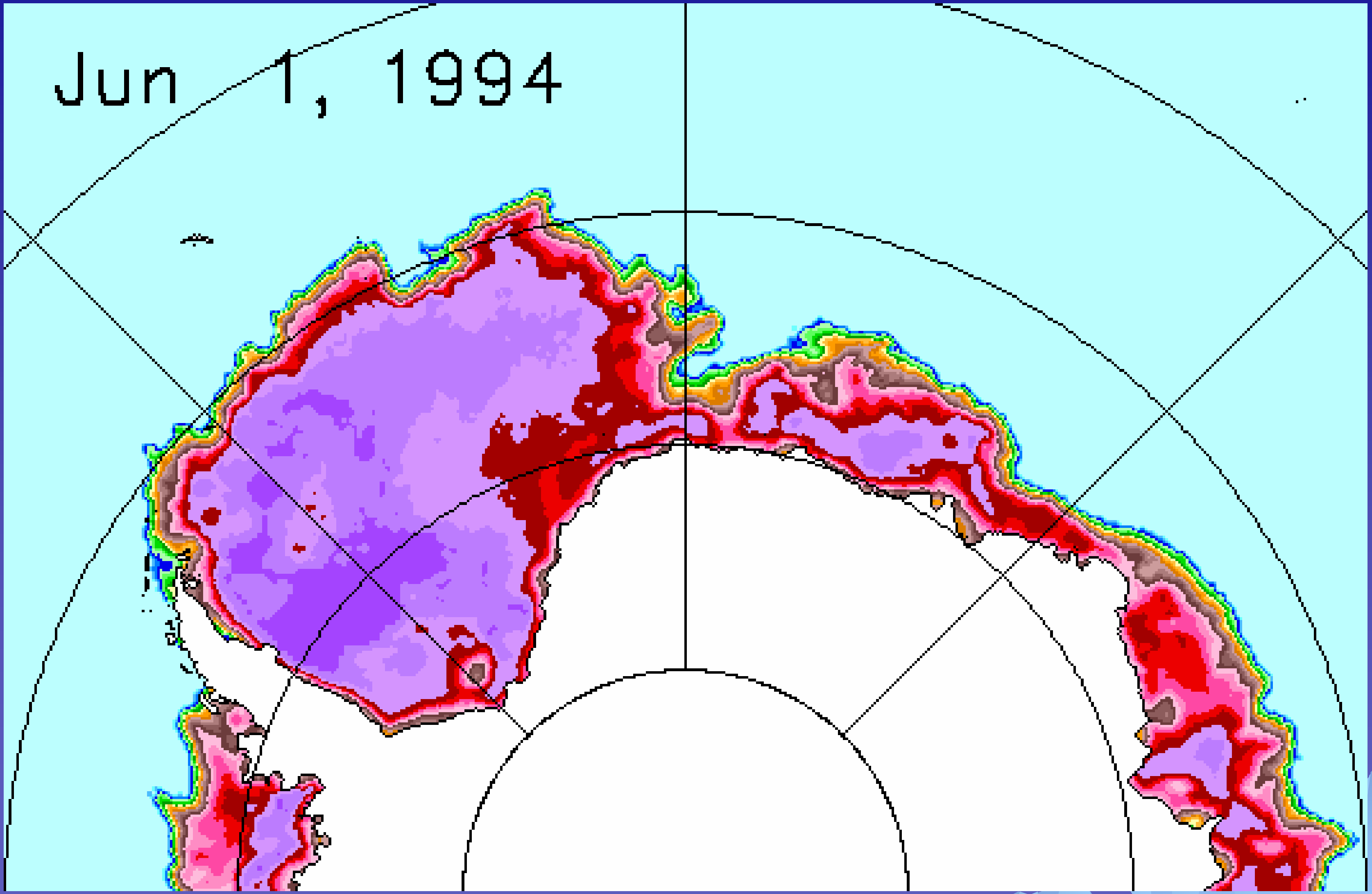
Unadjusted versus adjusted ice extent data for SMM/I and AMSR



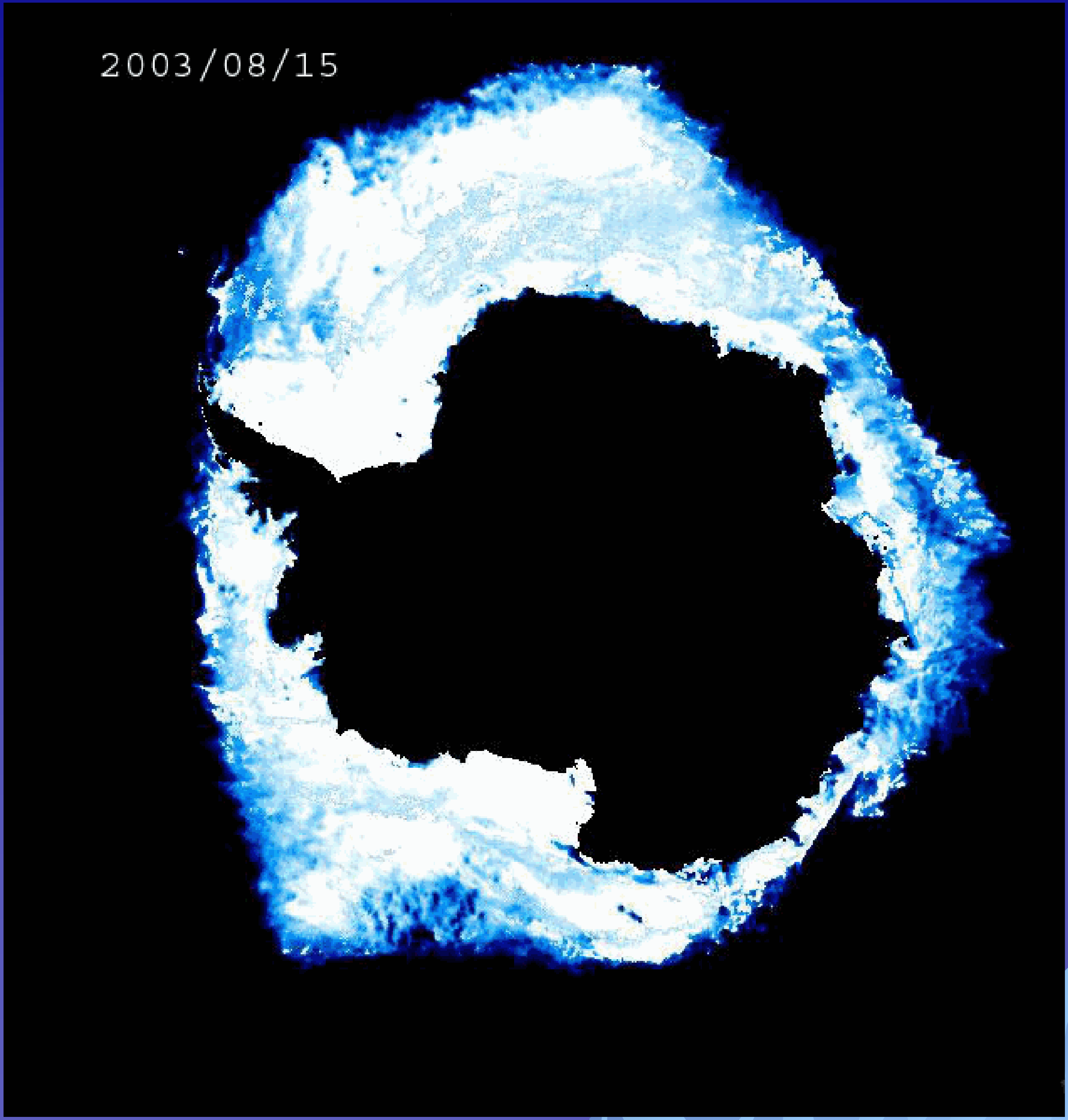
Using the three years of data overlap to adjust SMMR and SSM/I data on a month-by-month basis, the trend becomes more similar to the original. However, the AMSR part of the time series is more accurate.



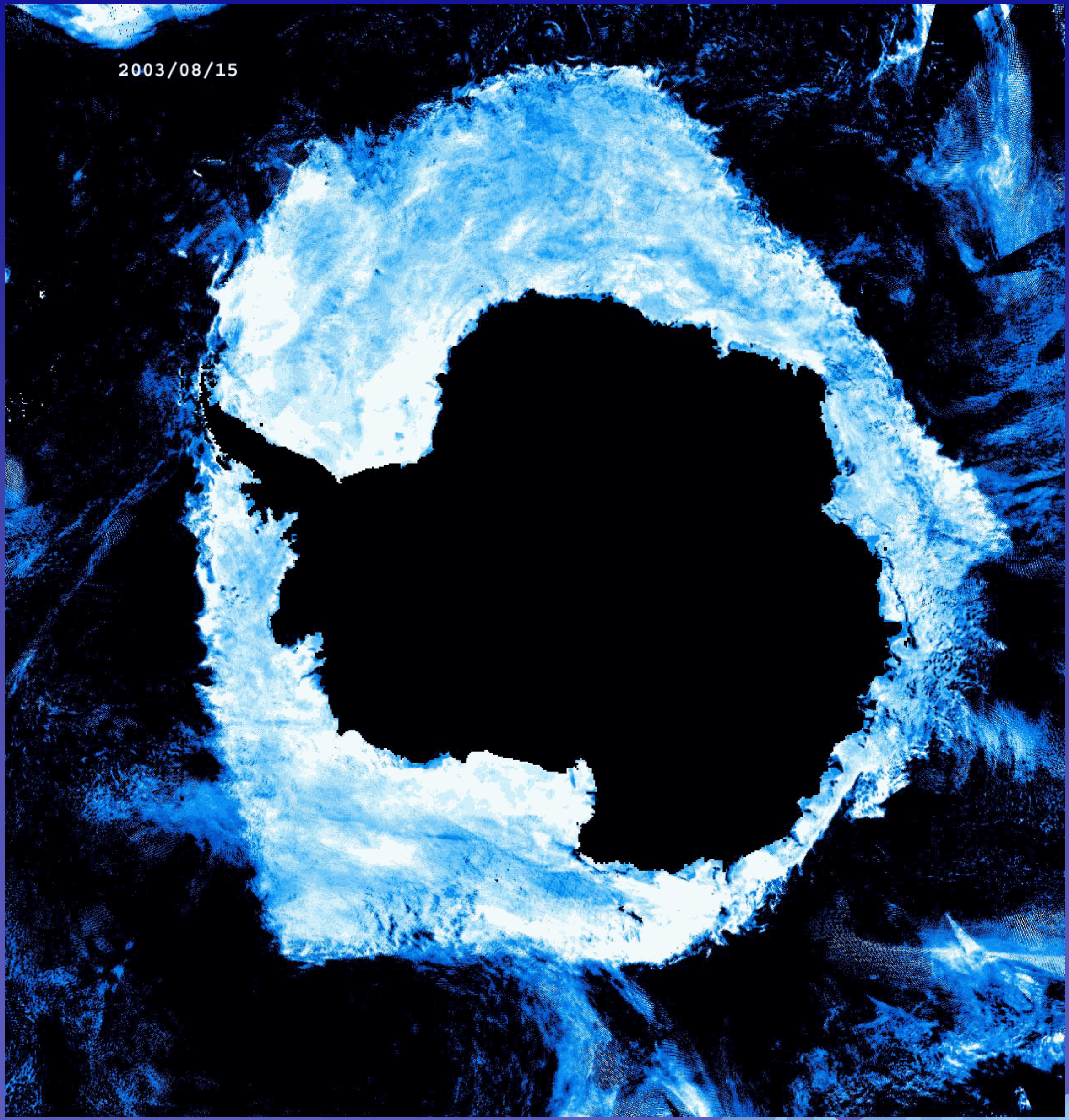
Transient sensible heat polynyas



15 August – 15 September 2003 AMSR 12.5 km IC

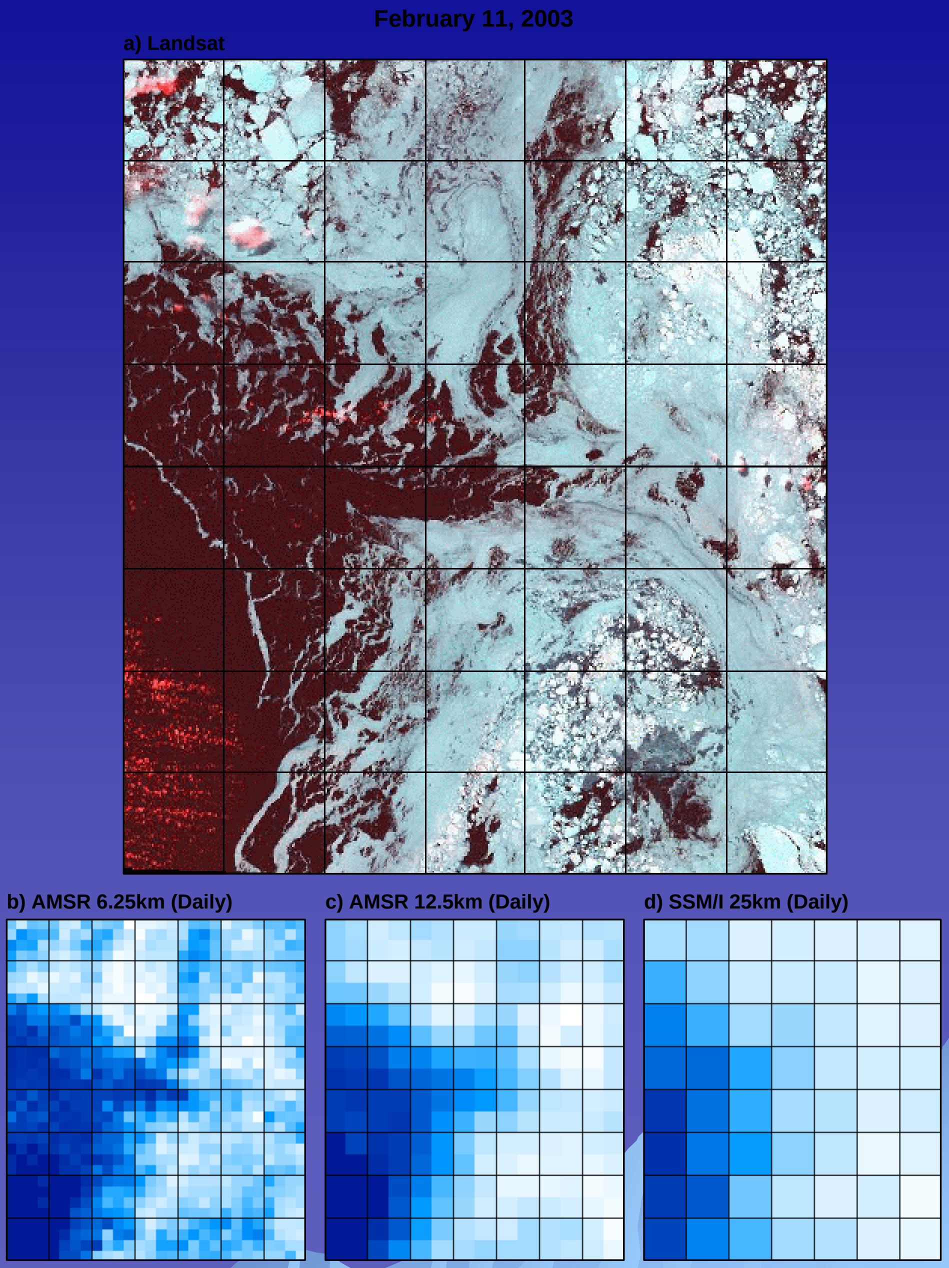


15 August – 15 September 2003 AMSR 6.25 km IC

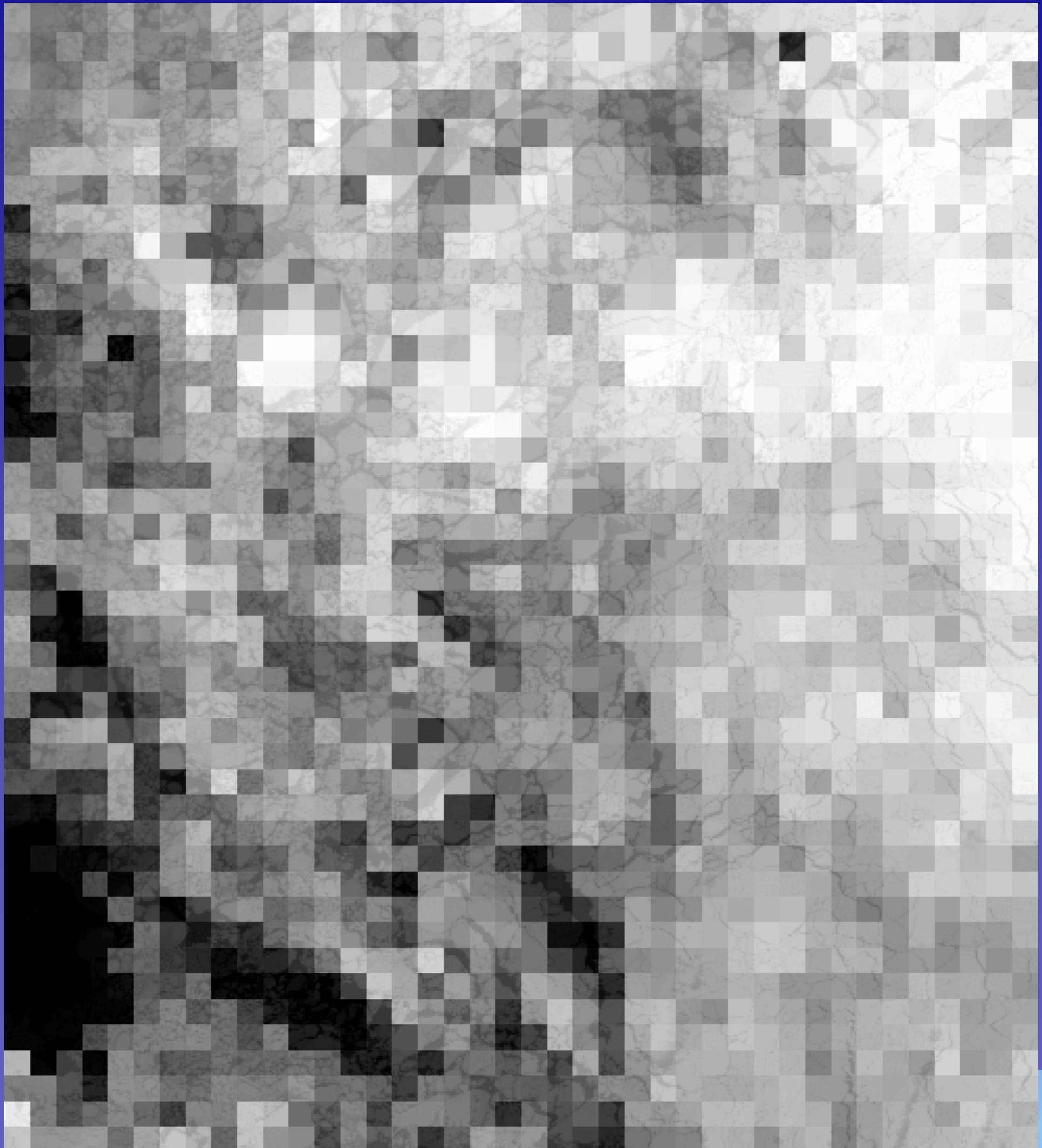


AMSR-E versus Landsat

- Landsat data provide information that can be very useful in the interpretation of AMSR-E data
- The concentration of new ice depends on thickness and stage of growth
- The higher resolution of AMSR enables more detailed comparison of spatial features



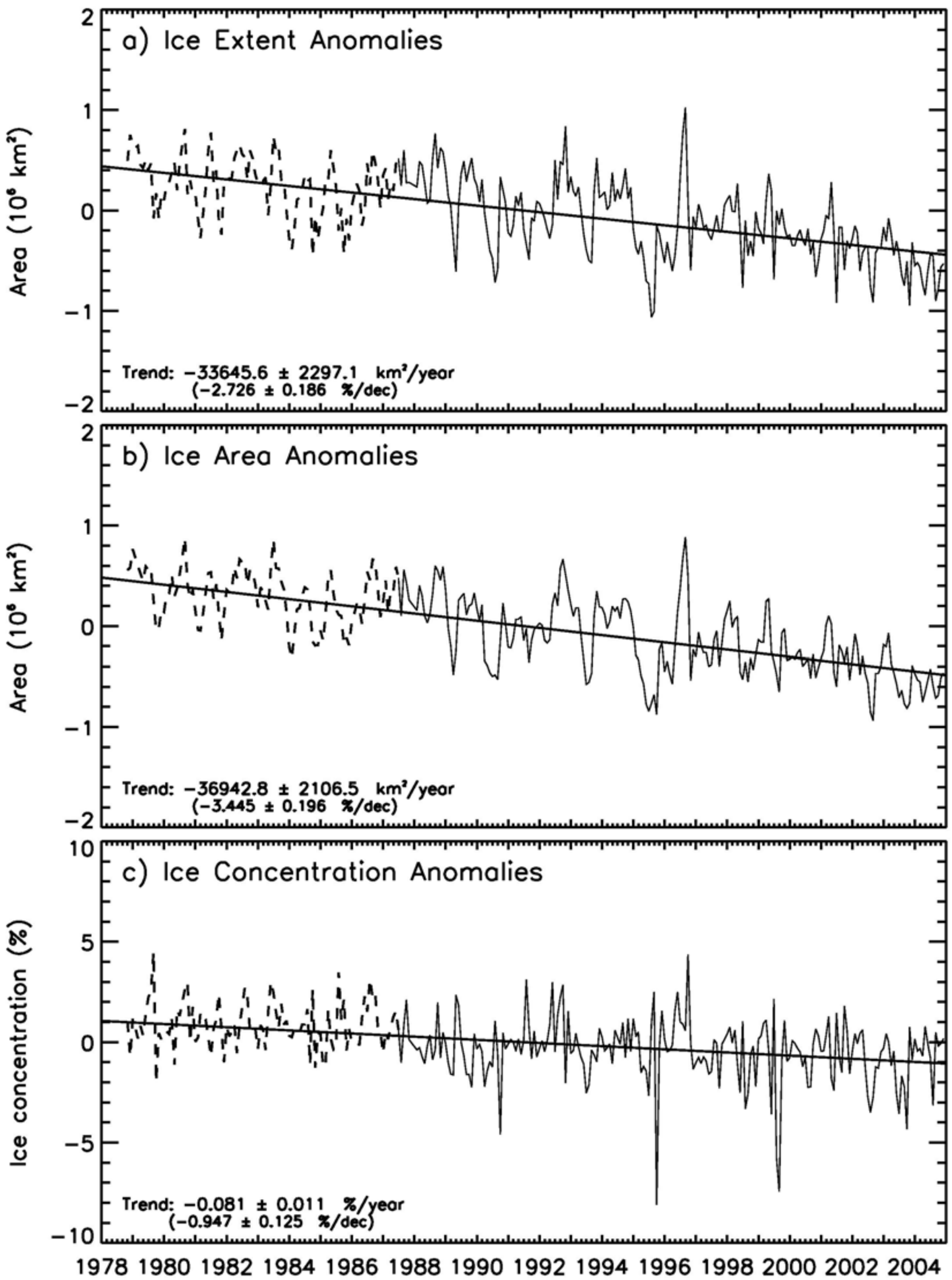
Blending AMSR-E to MODIS



Annomaly/Trend Studies - NH

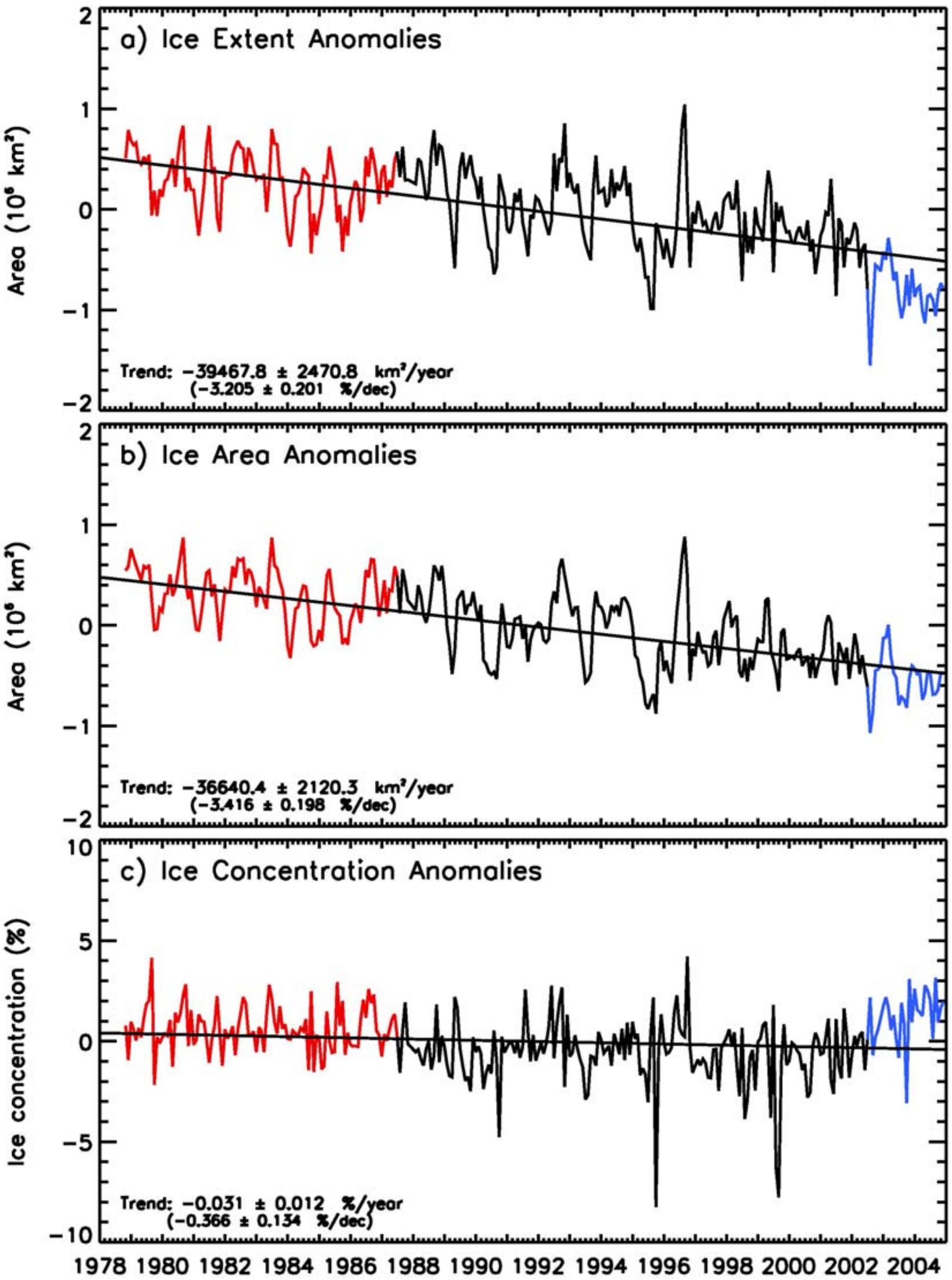
- Potential errors associated with biases due to different resolution and characteristics of different sensors
- Ideally, a change in sensor type must be avoided if possible.

  However, sensors have finite lifetimes and new ones should take advantage of new technologies

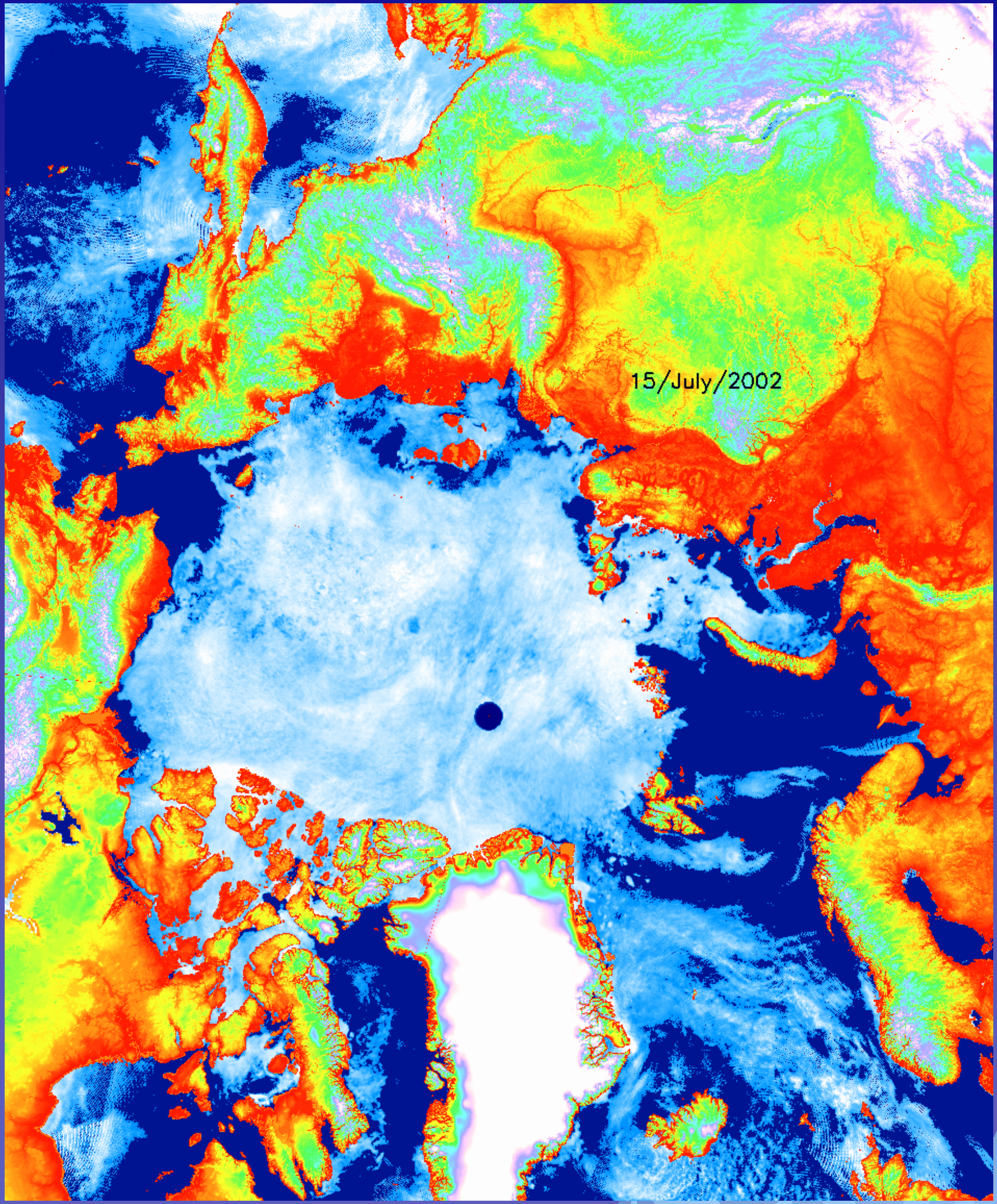


Anomaly/Trend Studies - NH

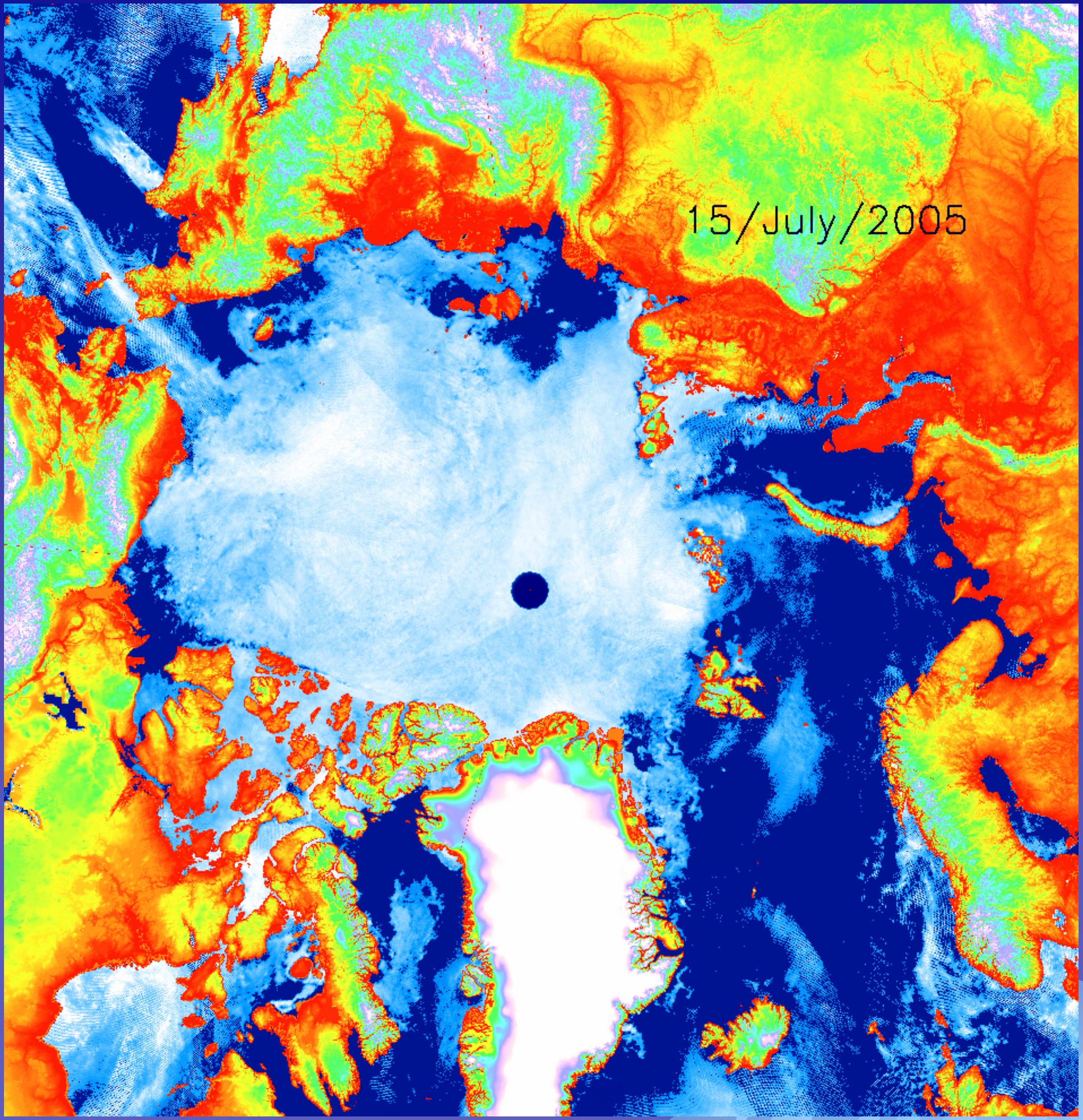
- Long term studies requires consistency checks specially during periods of overlap
- Use of AMSR provides a means of improving accuracy in trend analysis but biases should be removed first
- Ice area values are more stable because of less dependency to ice edge location



2002 perennial ice using 89 GHz IC Data



2005 perennial ice using 89 GHz IC Data



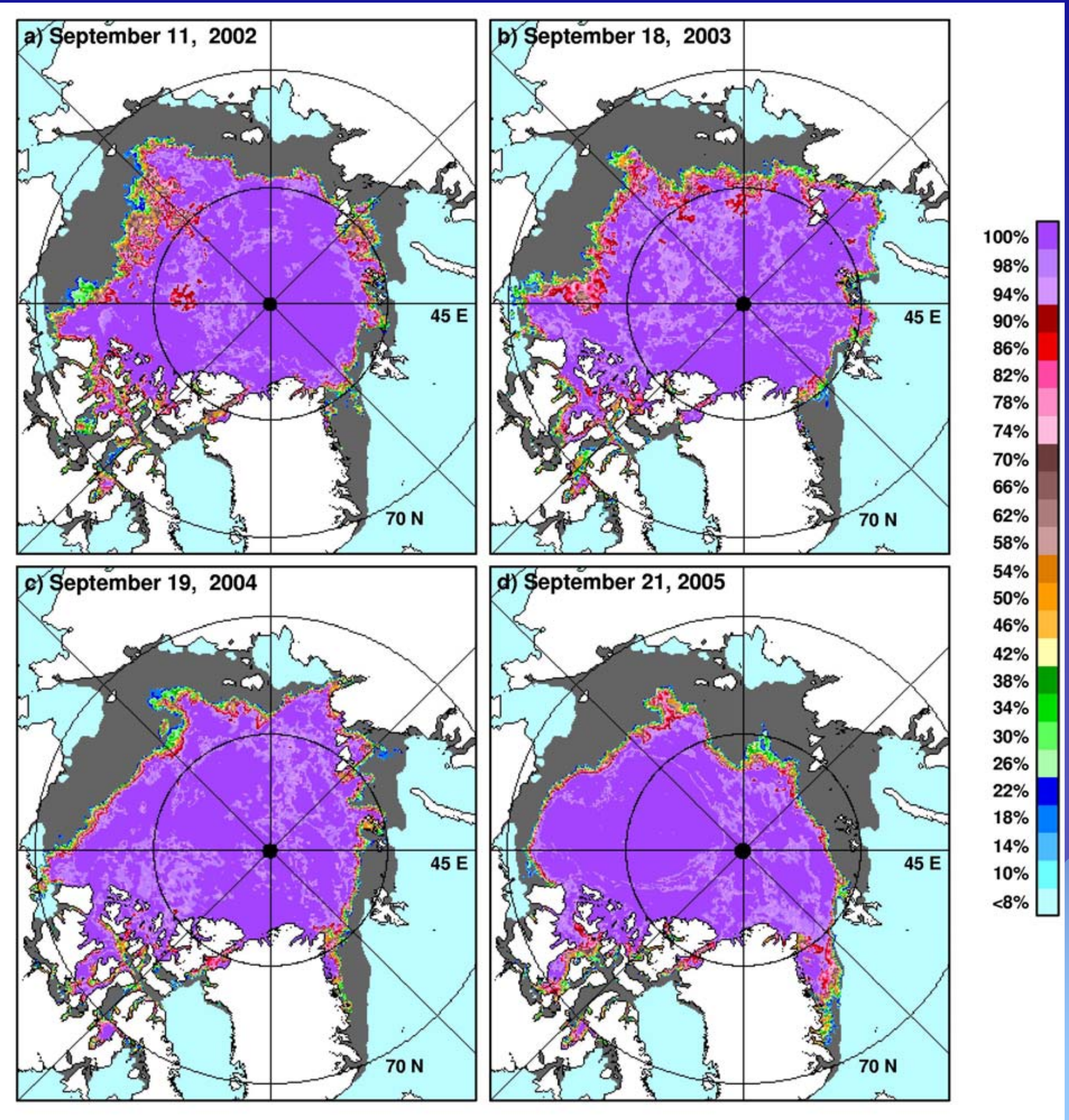
The perennial ice cover using AMSR-E data - last 4 years

Statistics:

A (1979-1982) is 6.33×10^6 km^2

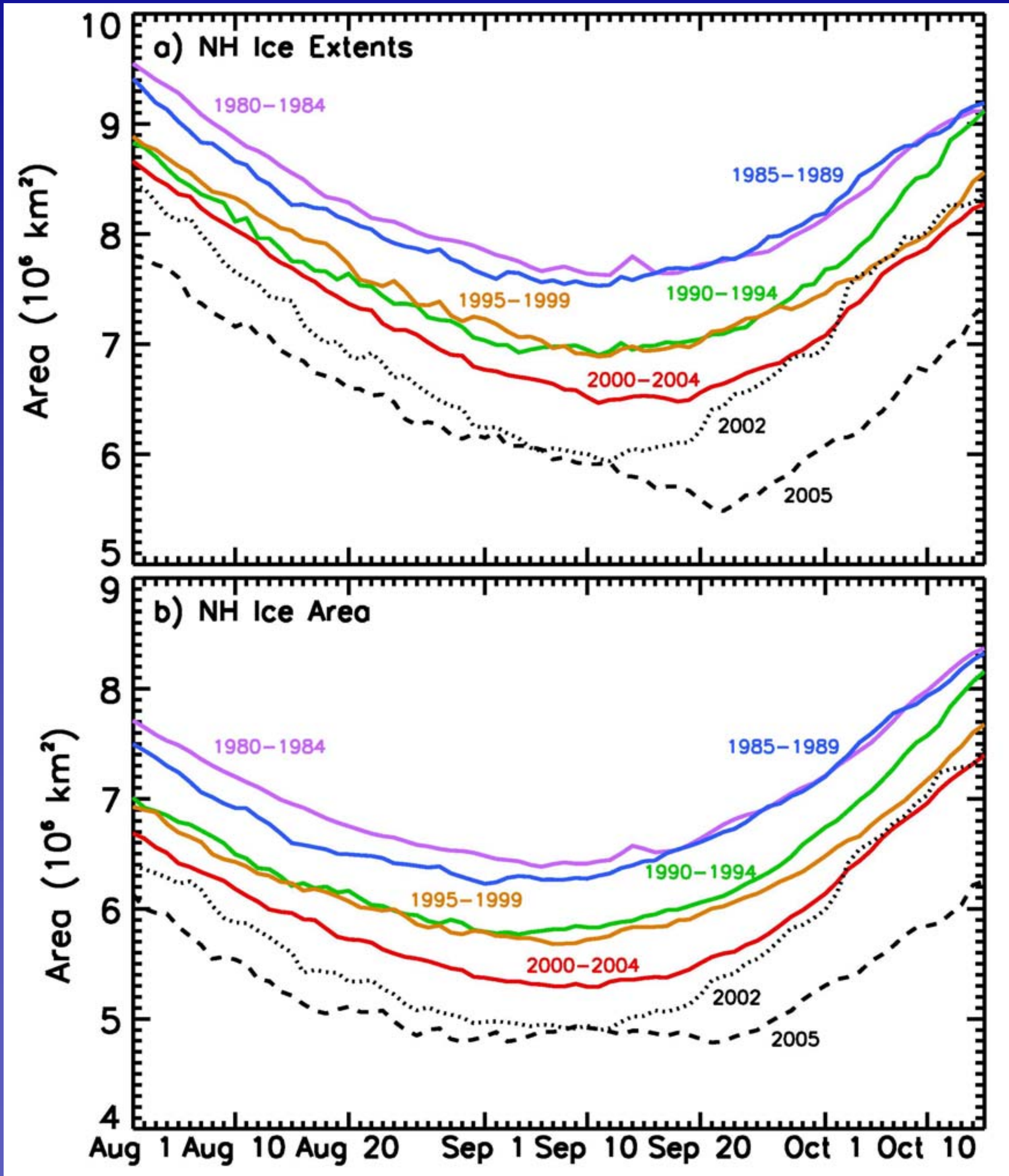
A (2002-2005) is 4.95×10^6 km^2

δA is 1.38×10^6 km^2 or 9.9%/dec



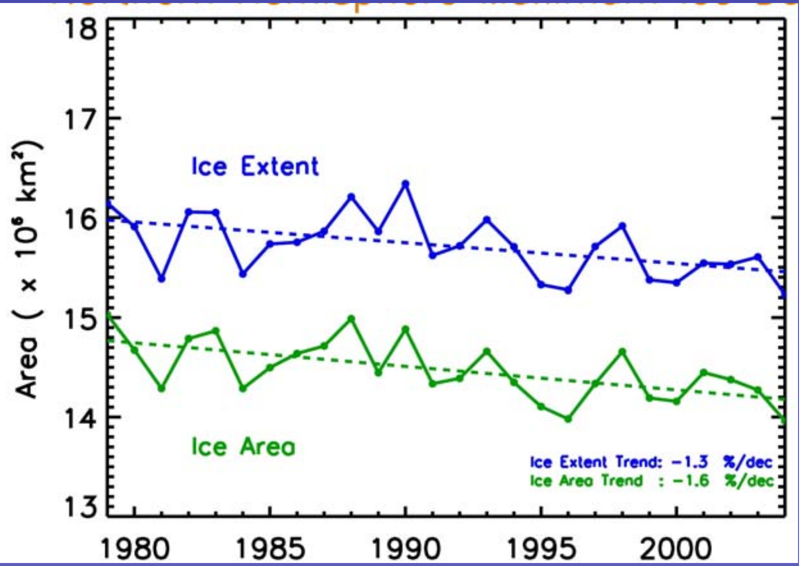
5-year mean in summer extent and area (1980 to 2005)

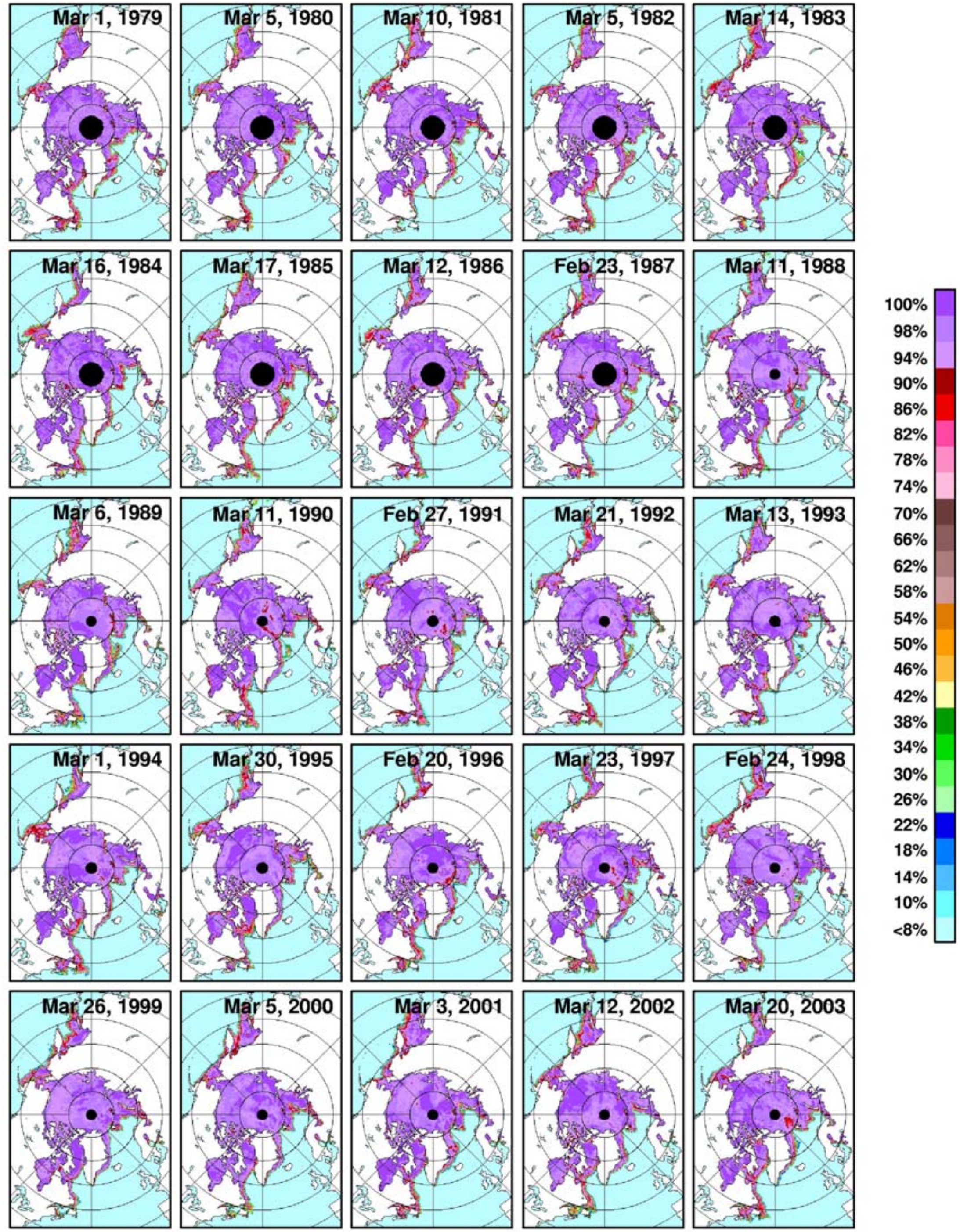
- Big change every 10 years
- Phase shift towards a later date of summer minimum
- Big drop during the summer and autumn in 2005



Yearly Arctic Ice Cover during Maximum Extents 1979-2003

Arctic Extents and Areas during Ice Maxima

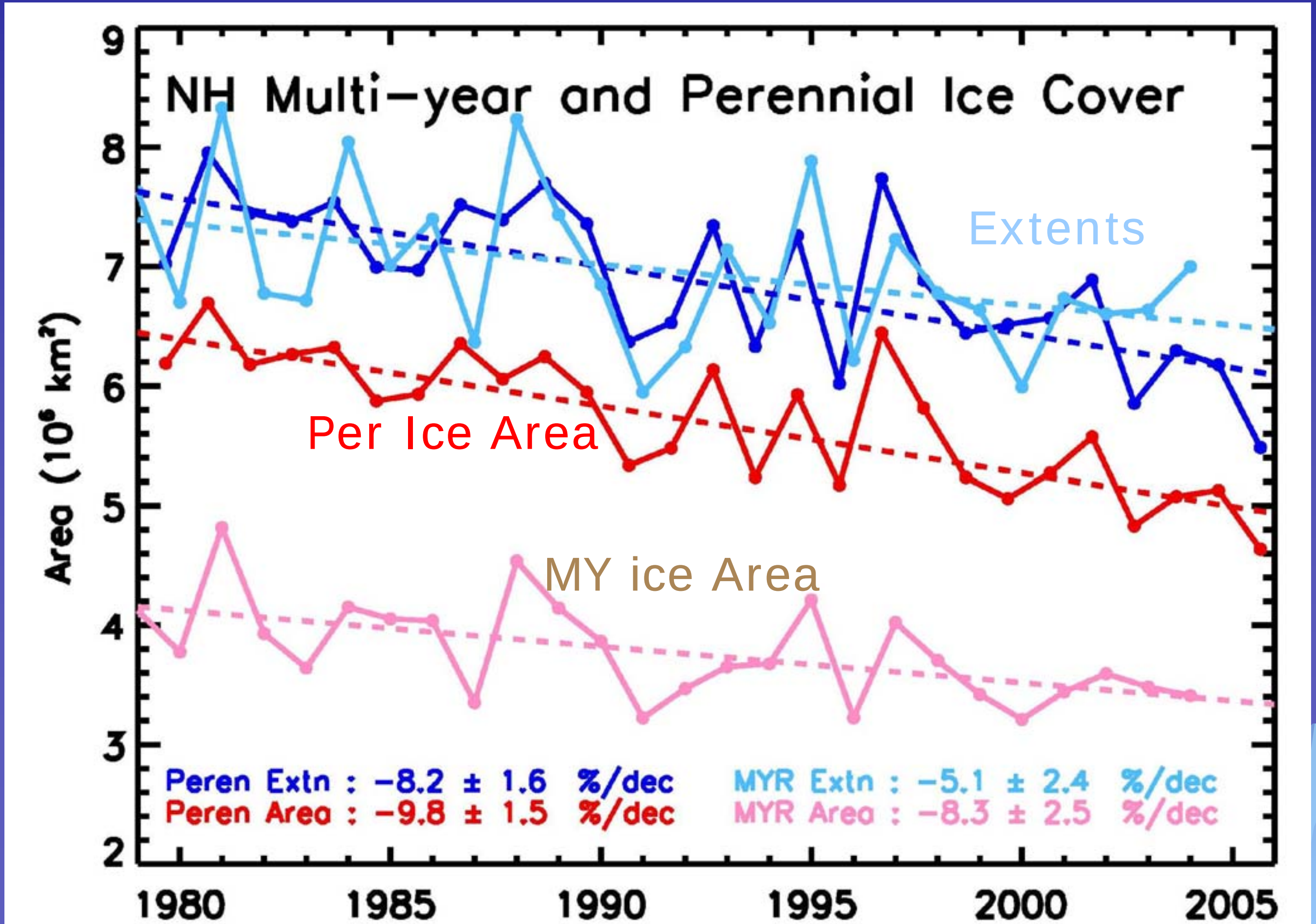




Arctic Perennial Ice, 1979 to 2005

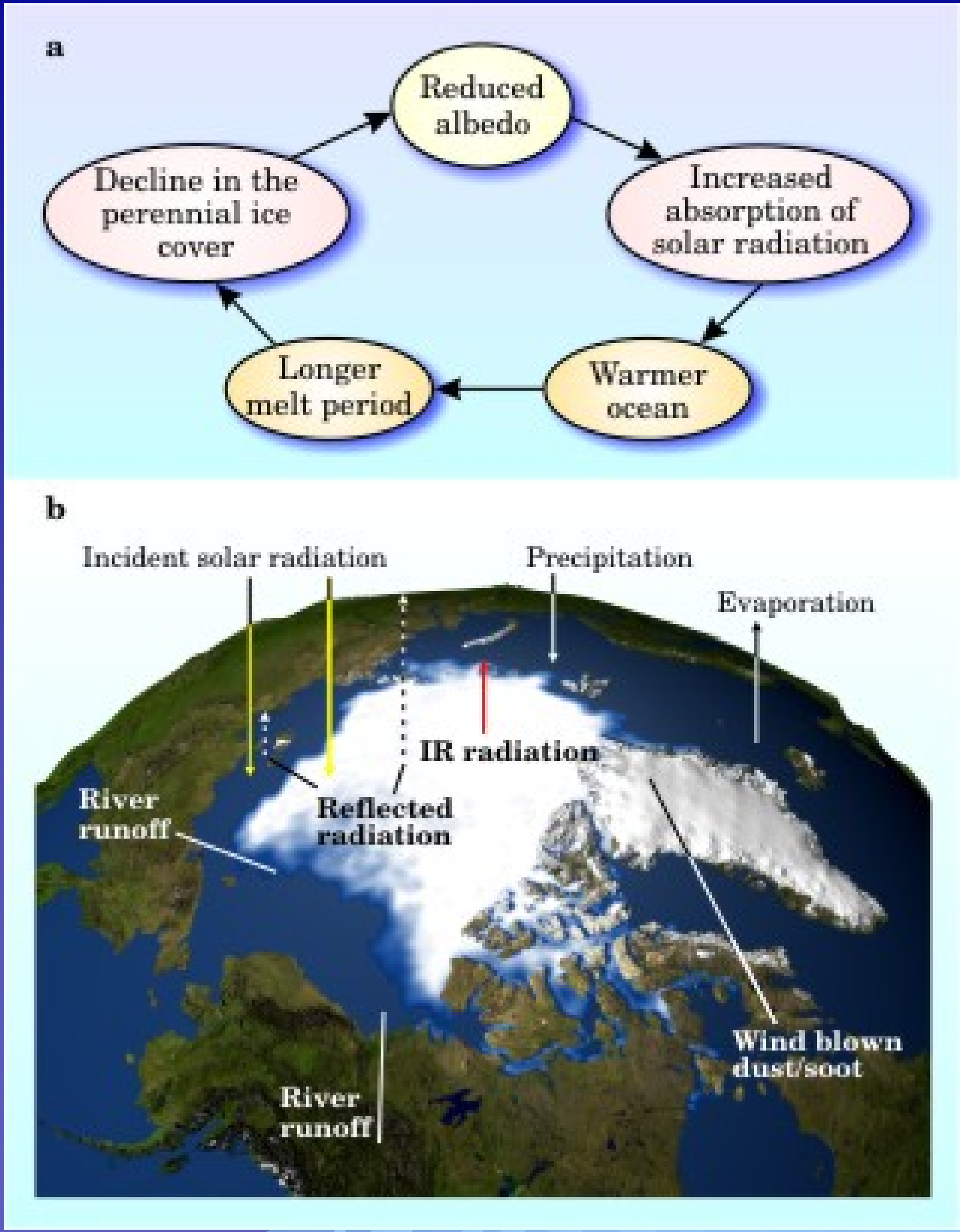
Retrieved Multiyear Ice in Winter vs Perennial Sea Ice Extent and Area

- Extents are pretty similar in magnitude but variability is not the same
- Area are very different – this is mainly in part because of different signature of the 2nd year floes
- Trends are similar but not of the same magnitude because of the variable contribution of the 2nd year ice cover.



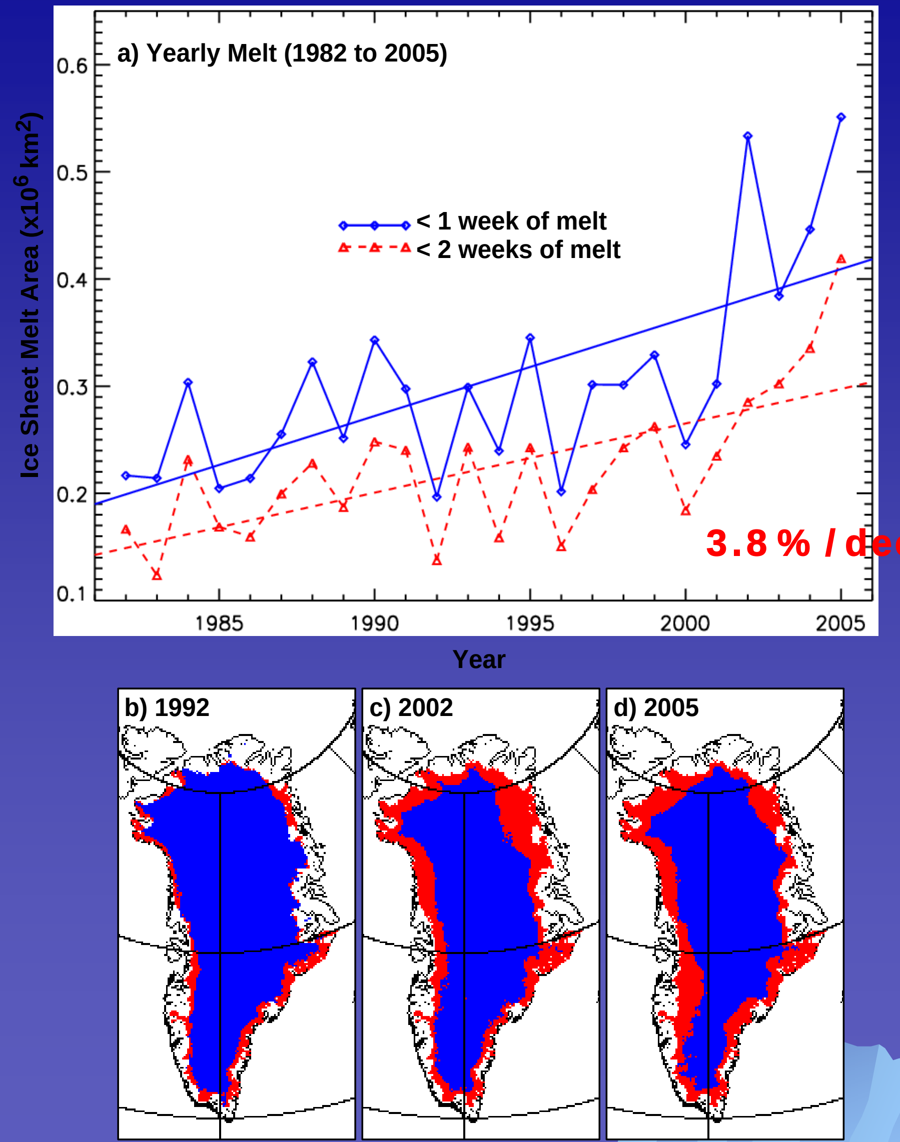
Polar Amplification-Feedbacks

- Ice-Albedo Feedback –relevant to retreating perennial ice cover and also over land
- Cloud feedback – positive or negative, depending on the height of clouds
- Other feedbacks are mainly positive



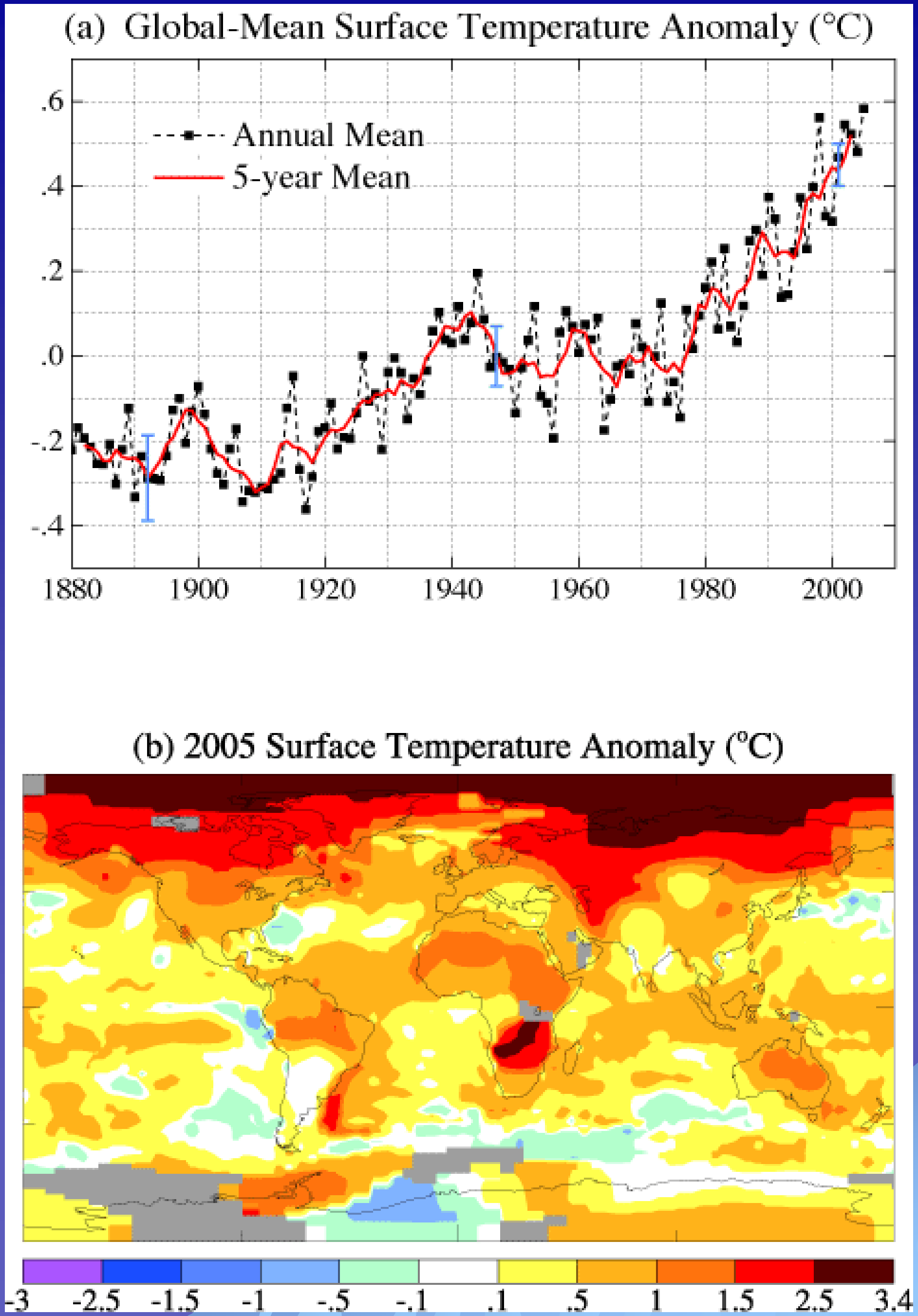
Area of melt increased dramatically (IR data) in Greenland during the last four years. Impacts on sea level is a concern (up to 7 m).

5.4 % / dec



9G3 f

Since the satellite era, global surface temperature has been going up almost consistently. We now know that 2005 is the warmest year since modern temperature measurement techniques have been implemented.



Summary and Conclusions

- AMSR provides the expected improvements in the large scale characterization of the sea ice cover.
- AMSR shows spatial details of the ice cover that have never been observed before and will enable more accurate heat flux, polynya, and Odden studies .
- AMSR provides better ice edge and divergence information and has the potential of improving the accuracy of long term variability and trend estimates in the ice cover
- AMSR could rightfully serve as the baseline for future sea ice studies.