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Recent changes in tropospheric water vapor over the Arctic as assessed from radiosondes and atmospheric reanalyses

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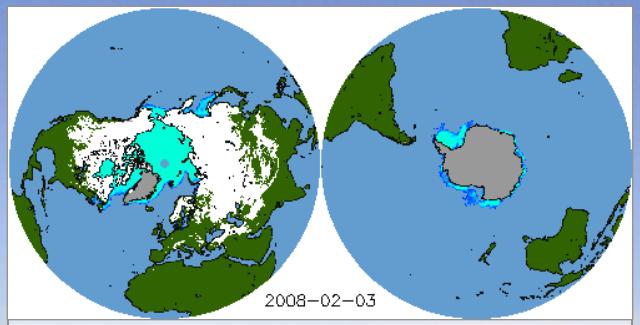
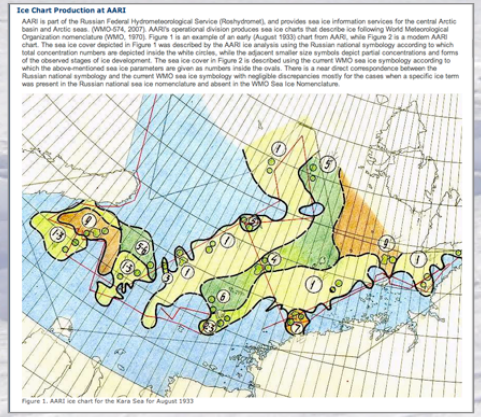
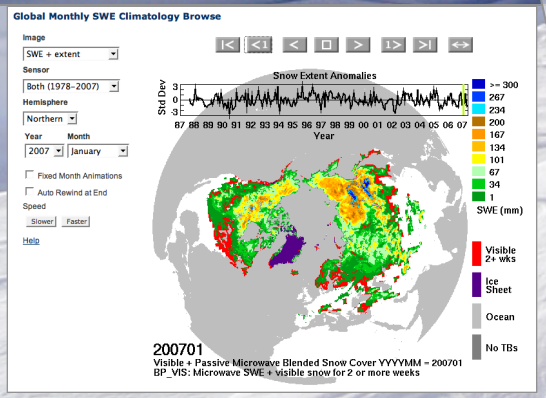


Manages and distributes scientific data

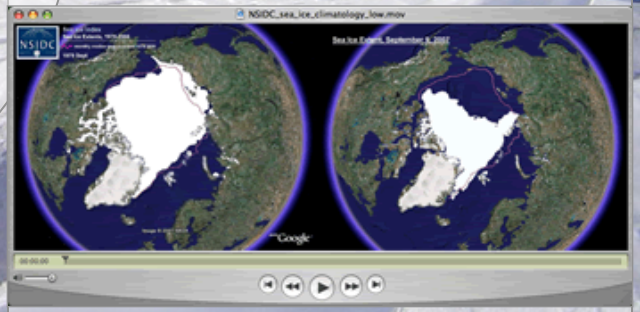
Performs scientific research



Supports data users

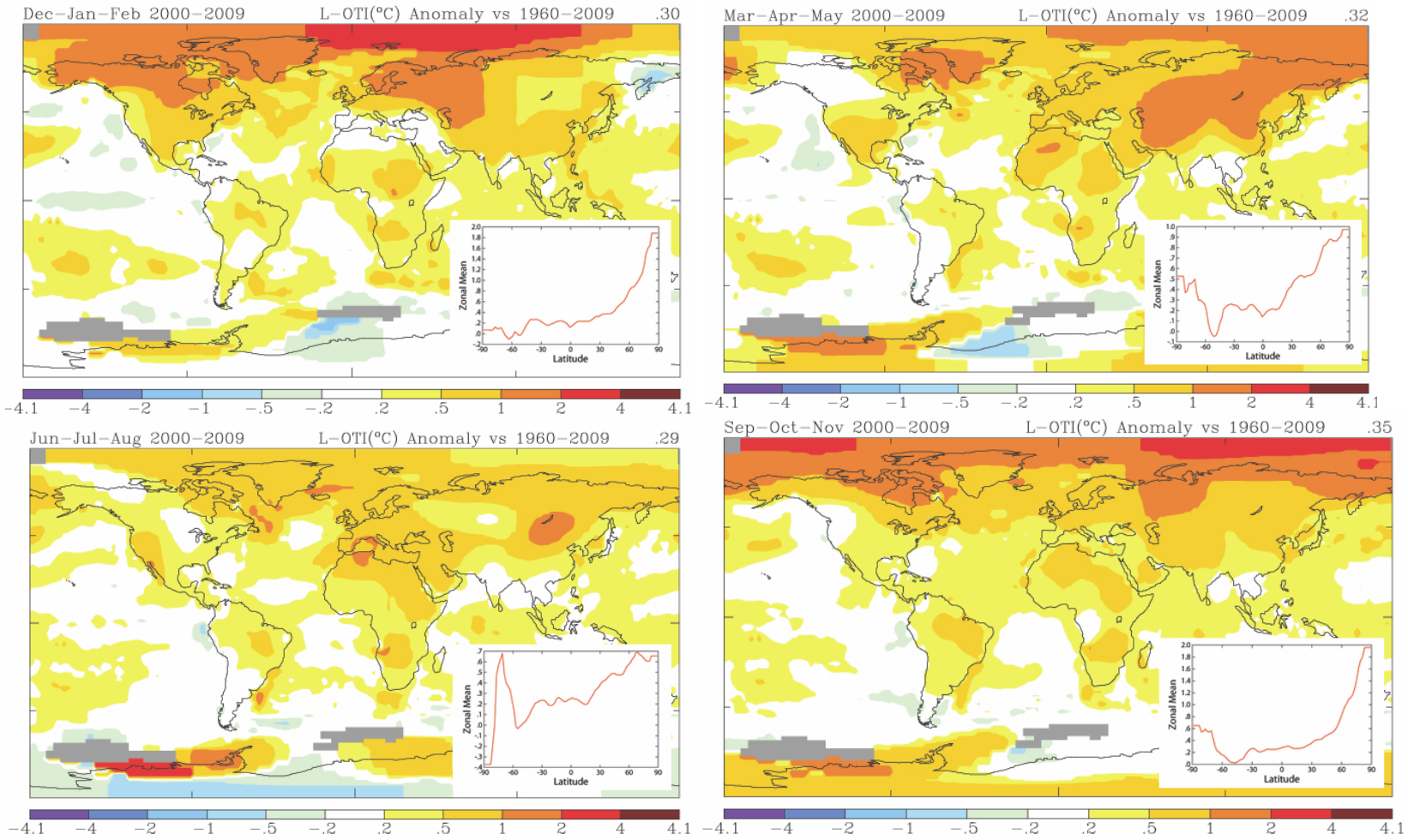


Creates tools for data access



Educates the public about the cryosphere

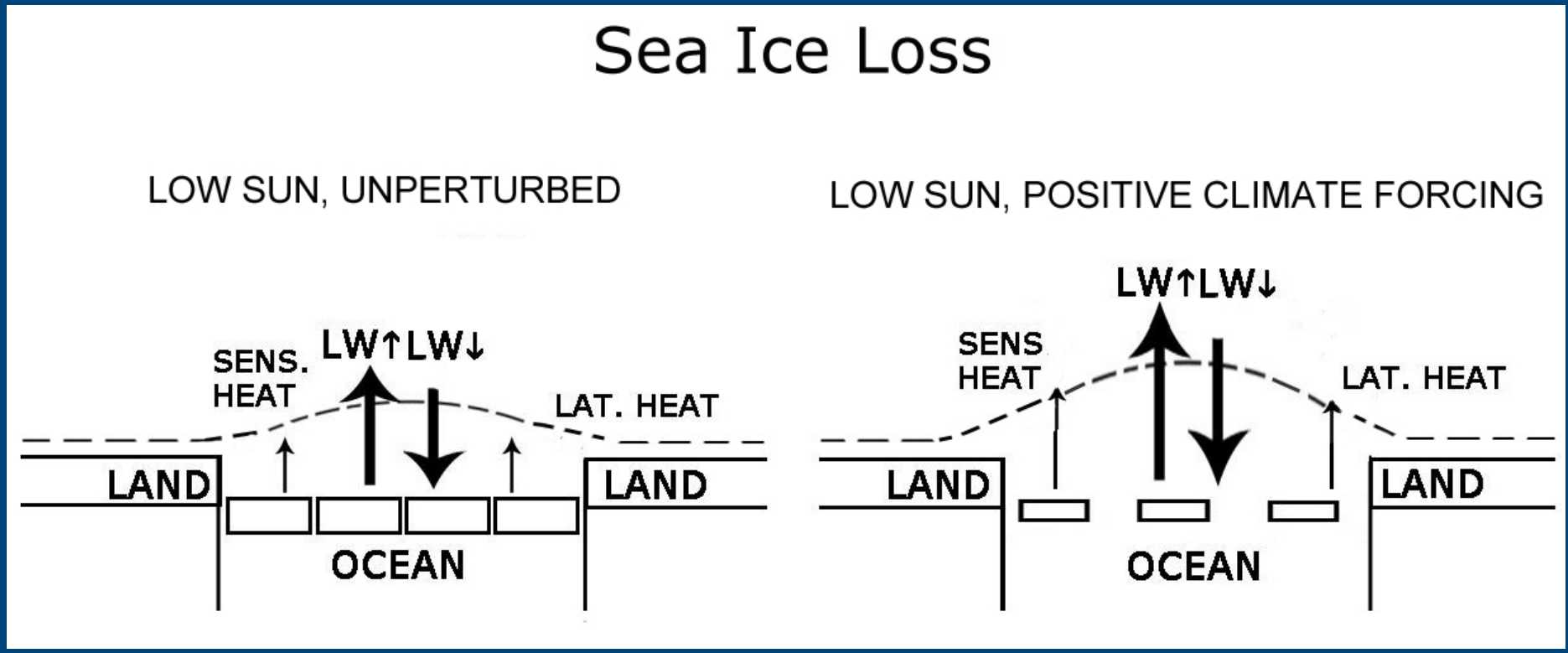
SAT anomalies, 2000-2009, from GISS analysis



Obvious Arctic amplification, with general autumn/winter maximum

http://data.giss.nasa.gov/gistemp/

Effects of sea ice loss



- Ocean picks up more heat in summer
- Releases more heat back to the atmosphere in autumn and winter
- We ought to see increases in tropospheric water vapor

(Serreze and Barry, 2011)

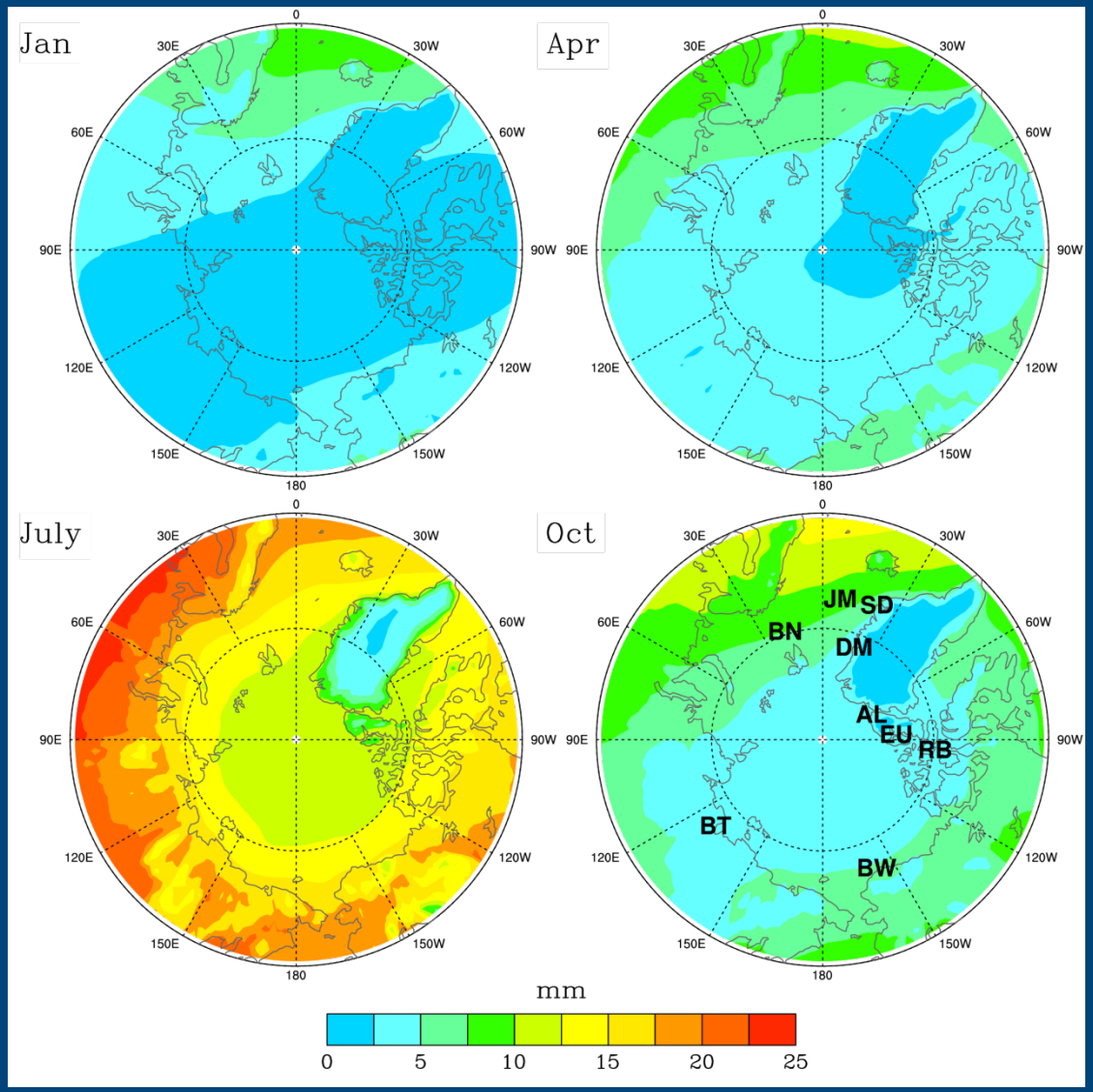
The present study

Examine recent trends in tropospheric water vapor over the Arctic for the period 1979-2010 using data from radiosondes and atmospheric reanalyses

- Radiosonde data: The Dai et al. [2011] homogenized database, and comparisons with raw IGRA (Integrated Global Radiosonde Archive) profiles (mandatory level data)

- Reanalyses: MERRA, ERA-I, CFSR, ERA-40, NCEP-1, JRA-25, but emphasizing the three newest efforts

Setting the stage

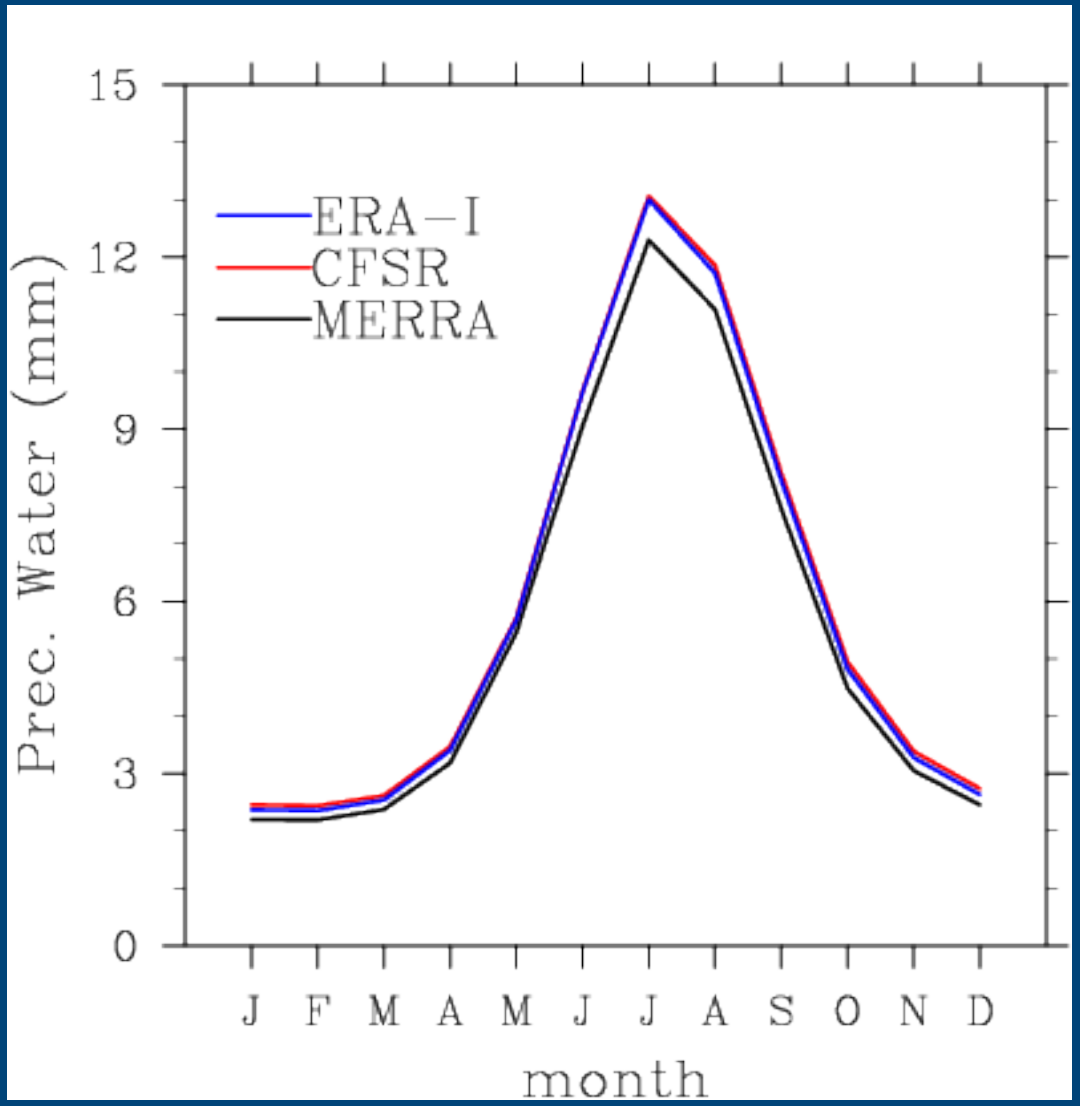


Mean surface to 500 hPa precipitable water for the four mid season months for the region north of 60°N based on MERRA data for 1979-2010

We use data from nine radiosonde sites with nearly complete records.

(Serreze, Barrett and Stroeve, in press)

Annual cycle of precipitable water for polar cap

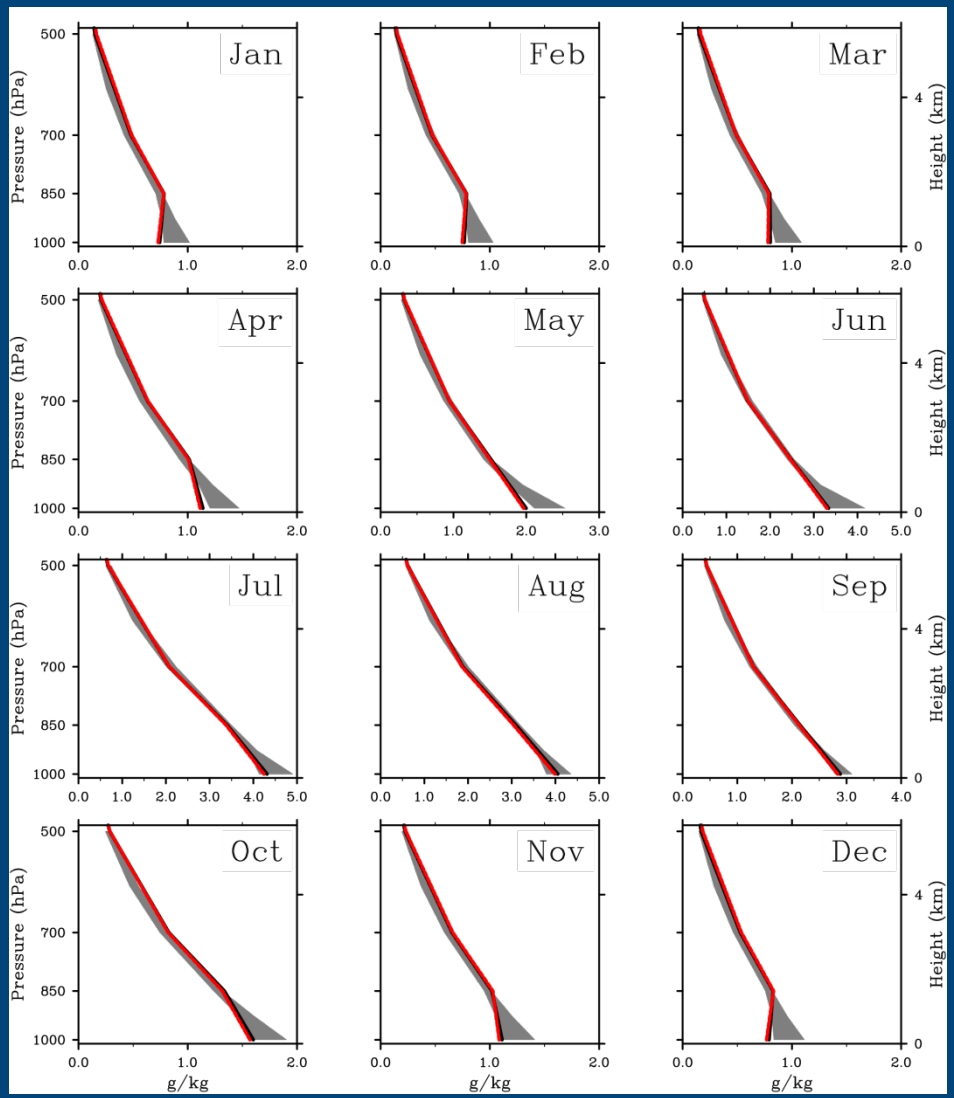


Mean annual cycle of precipitable water (surface to 500 hPa) for the polar cap (the region north of 70°N) based on MERRA, CFSR and ERA-I data for the period 1979-2010

MERRA is somewhat dry compared to the other two reanalyses

(Serreze, Barrett and Stroeve, in press)

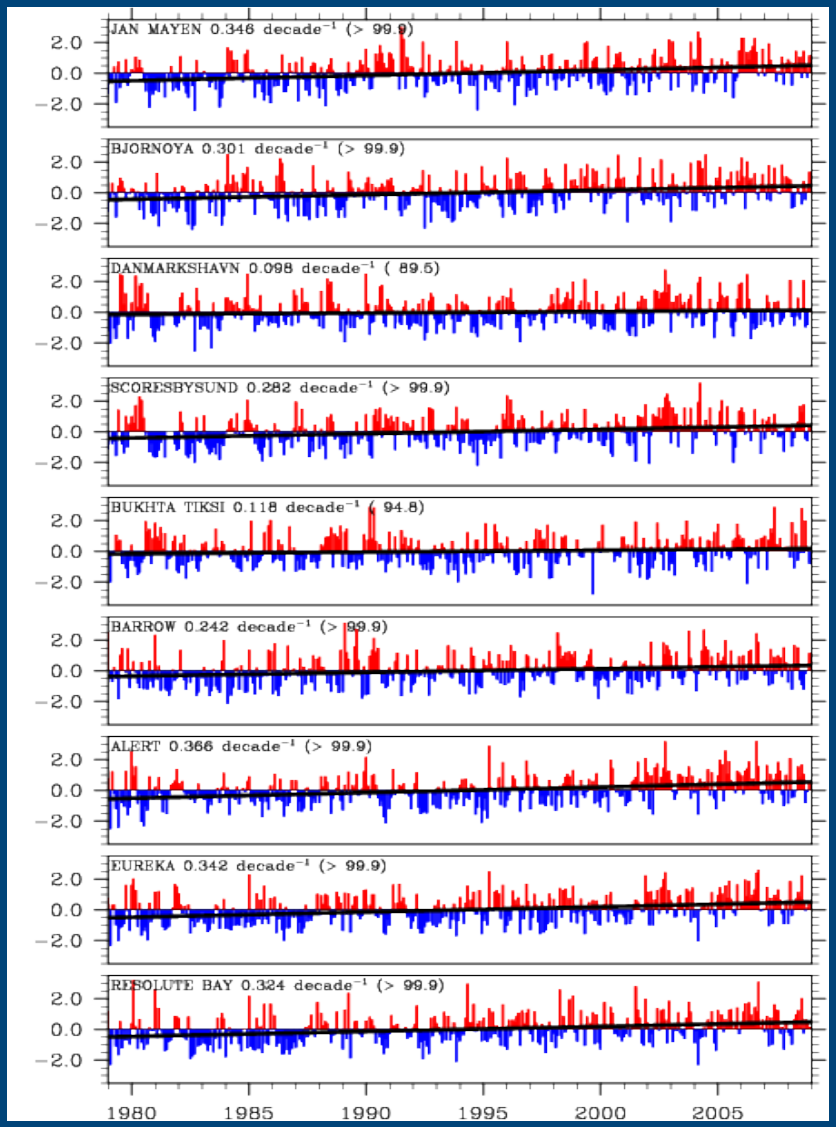
Warm and moist biases in the reanalyses



Monthly mean profiles of specific humidity from the radiosonde profiles (red and black, corresponding to homogenized and raw IGRA records) and reanalyses at the closest grid points (gray shading showing the range). All of the reanalyses have a moist and warm bias at low levels.

(Serreze, Barrett and Stroeve, in press)

Positive trends at the radiosonde sites

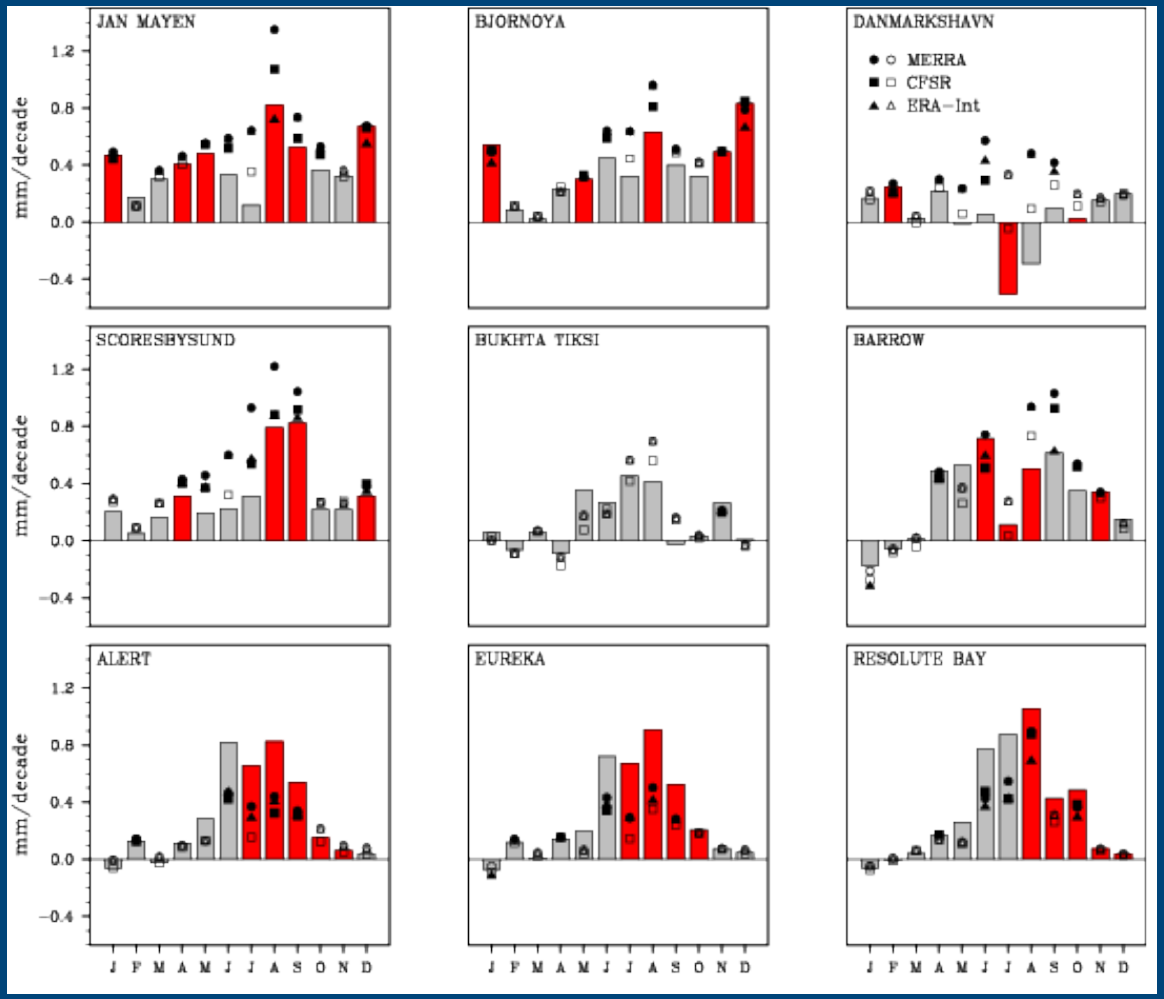


Standardized anomalies of surface to 500 hPa precipitable water based on the radiosonde data

Trends are small but positive, and statistically significant at all sites except Denmarkshavn.

(Serreze, Barrett and Stroeve, in press)

Monthly trends are mostly positive



Monthly trends in surface-500 hPa precipitable water from radiosonde profiles and from MERRA, CFSR and ERA-I at the closest grid point

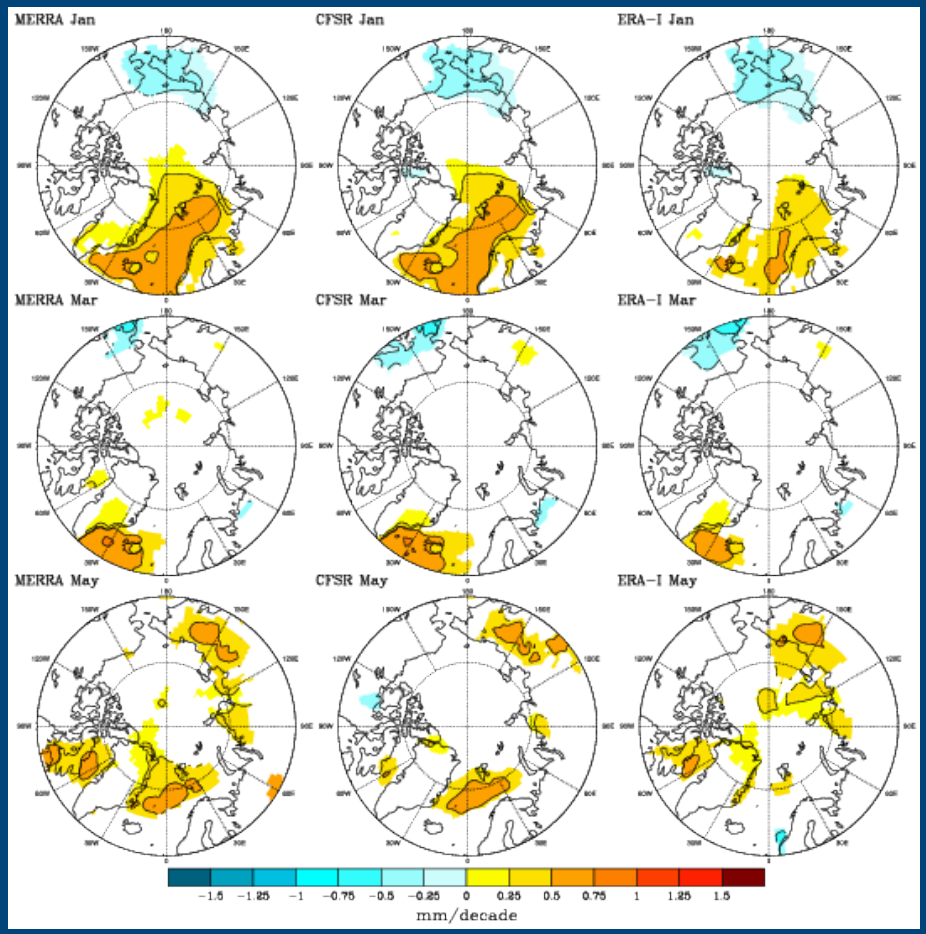
Strongest radiosonde-based trends in summer are at Canadian stations.

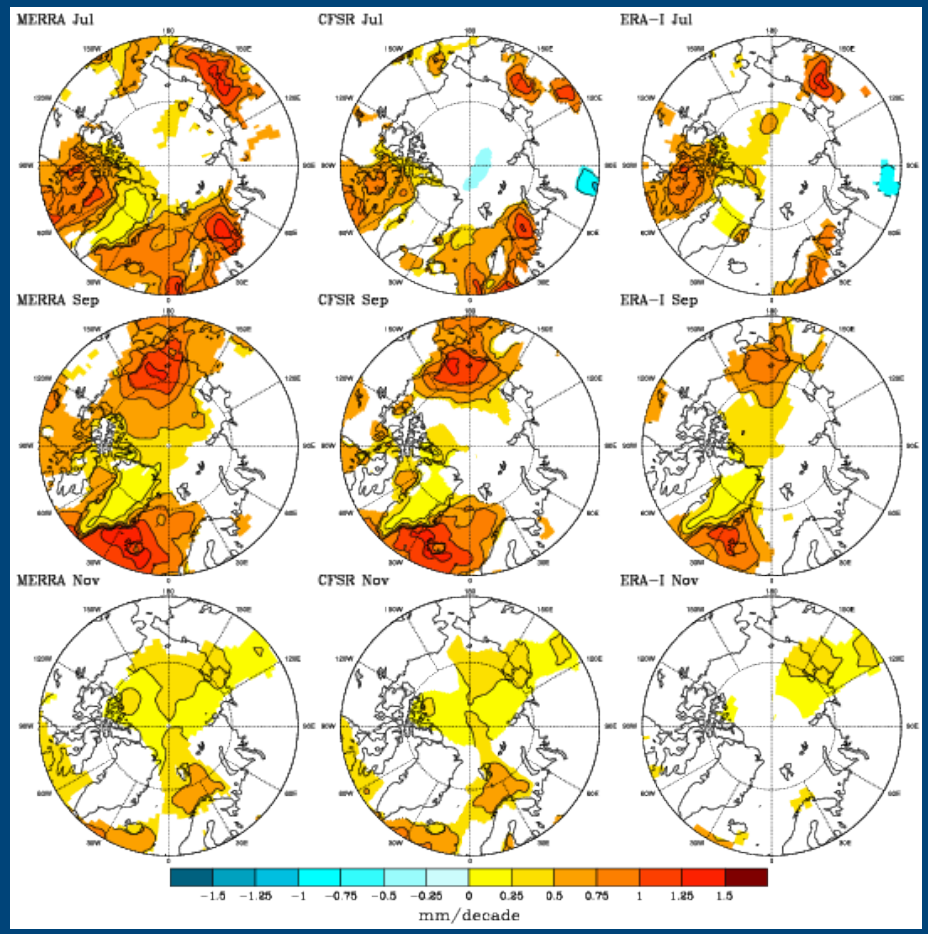
Reanalyses trends are also mostly positive. Significant trends are shown in red.

No one reanalysis has systematically stronger or weaker trends.

(Serreze, Barrett and Stroeve, in press)

Positive trends correspond to ice loss and increasing SST

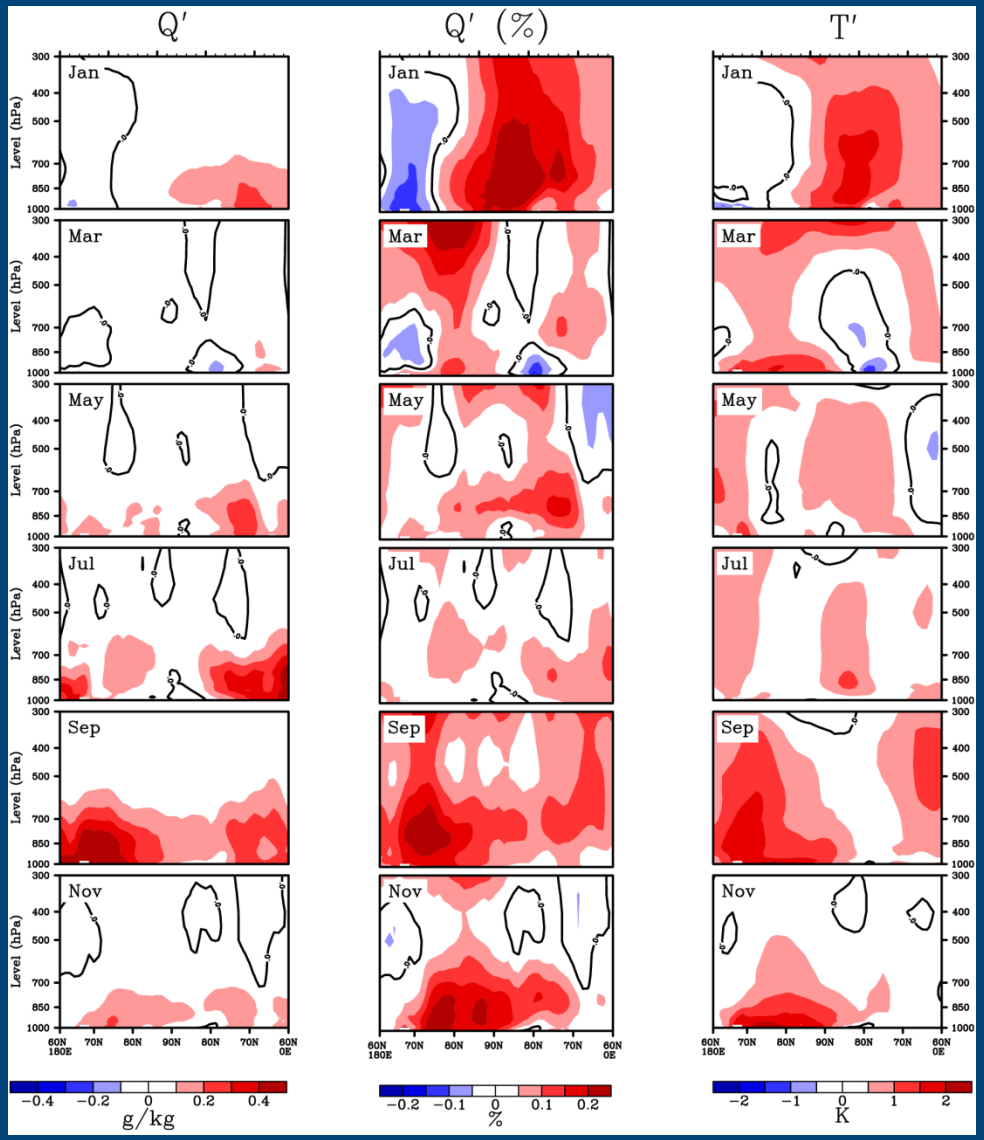




Only areas with significant trends are shown in color

(Serreze, Barrett and Stroeve, in press)

Vertical structure of recent anomalies



Cross sections of humidity anomalies for the decade 2001-2010 relative to 1979-2010 (means in absolute values and percent) and temperature anomalies based on MERRA

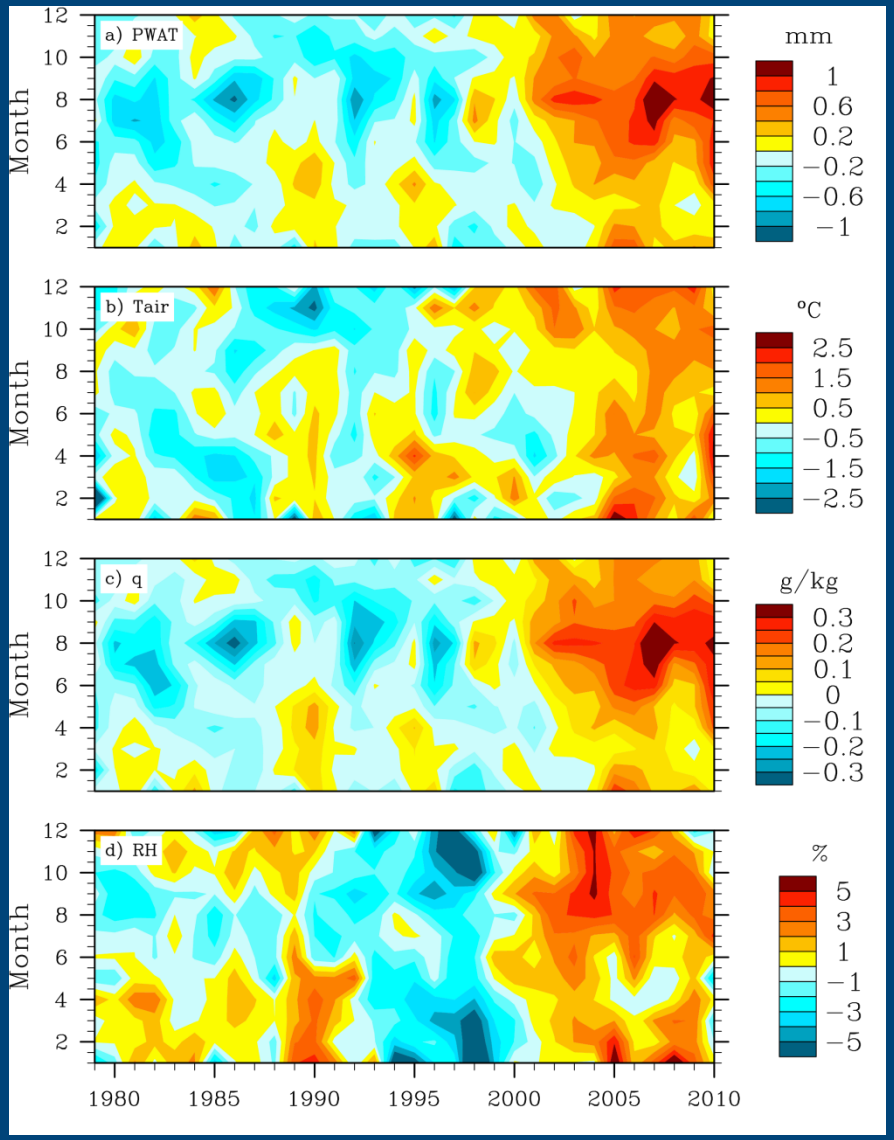
Largest absolute anomalies are near the surface

Largest percentage changes are in the mid-troposphere

CFSR shows similar patterns but ERA-I shows somewhat different patterns

(Serreze, Barrett and Stroeve, in press)

Time evolution of anomalies



Hovmoller plots of surface to 500 hPa precipitable water, 850 hPa air temperature, specific humidity and RH from MERRA

Strongest recent anomalies occur in August and September.

Artifacts from changes in data streams are apparent

(Serreze, Barrett and Stroeve, in press)

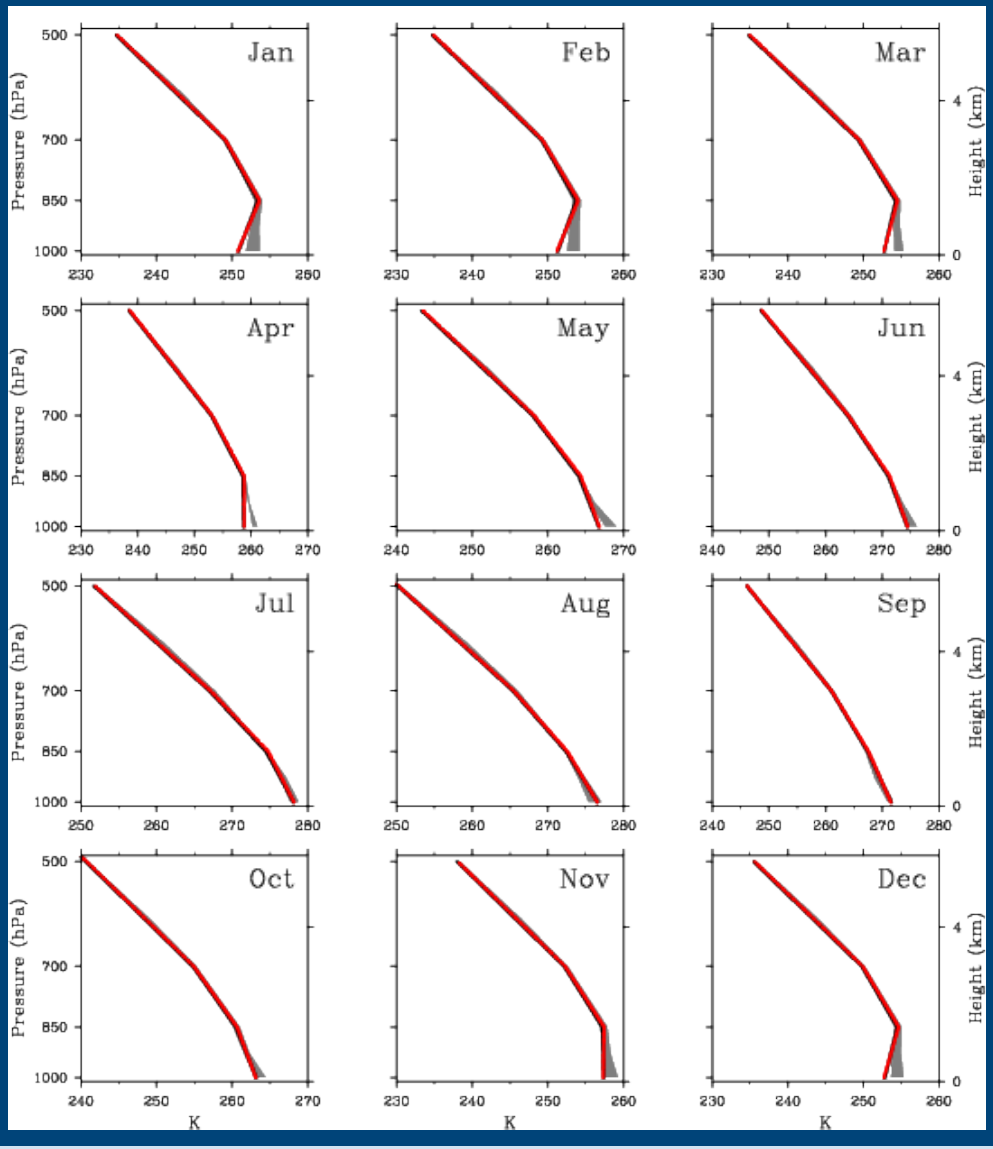
Conclusions

- The Arctic is warming strongly, especially in autumn and winter; it follows that we should be seeing attendant increases in tropospheric water vapor.

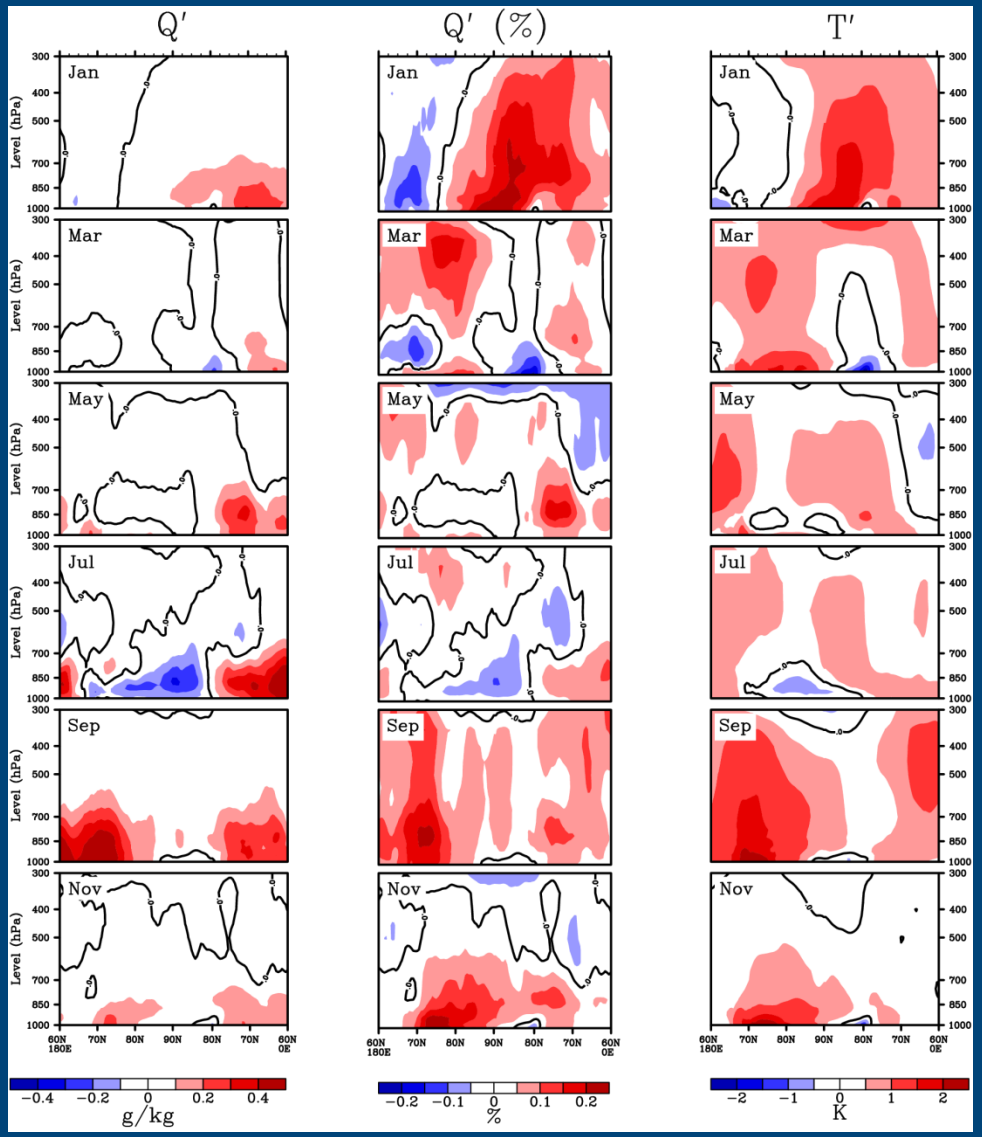
- Data from six reanalyses (CFSR, MERRA, JRA-25, NCEP, ERA-40, ERA-Interim) and from radiosonde profiles are in general agreement in showing recent increases in tropospheric water vapor, which should be acting as a feedback to amplify warming.

- However, there are substantial differences between different data sources, linked to issues of data assimilation (in the reanalyses) and uncertainties in the radiosonde data themselves.

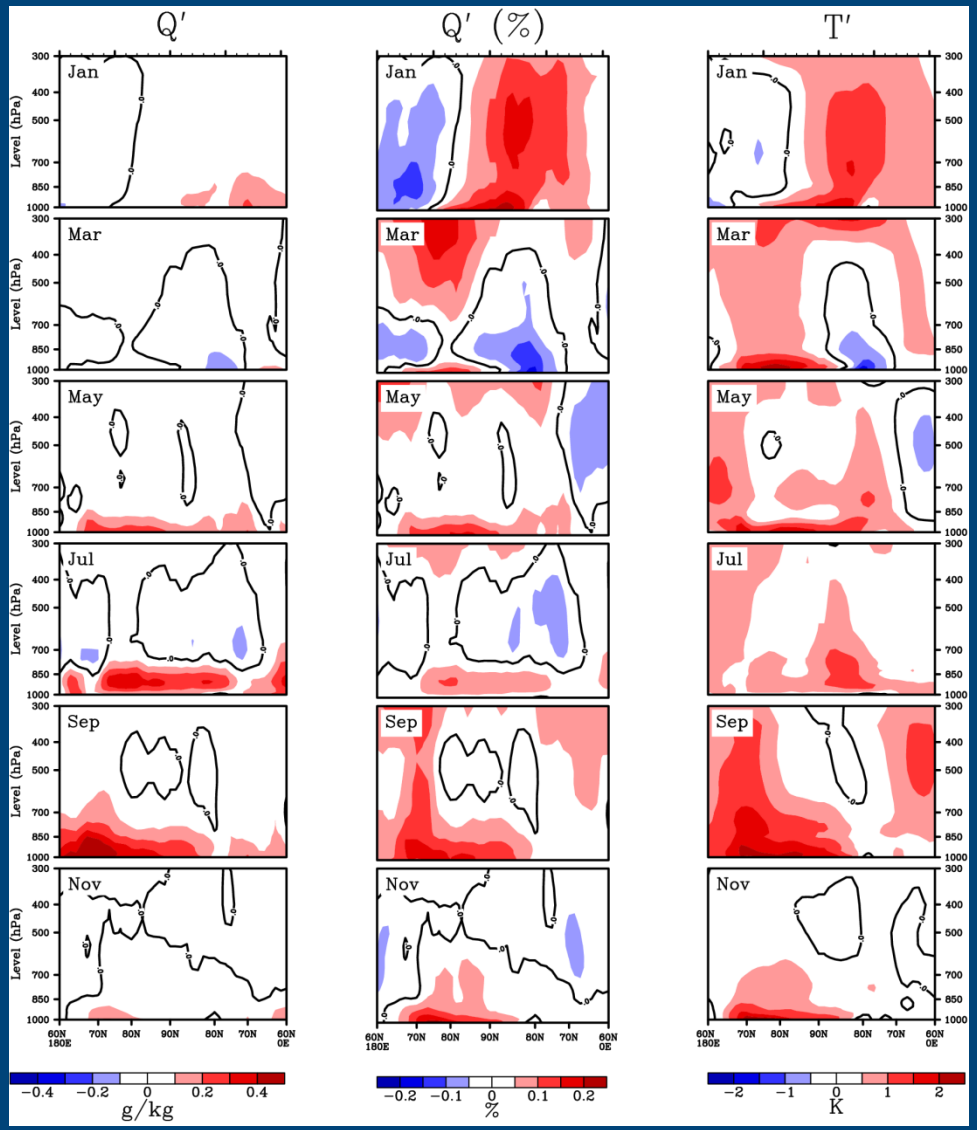

Thank You
04.10.2008



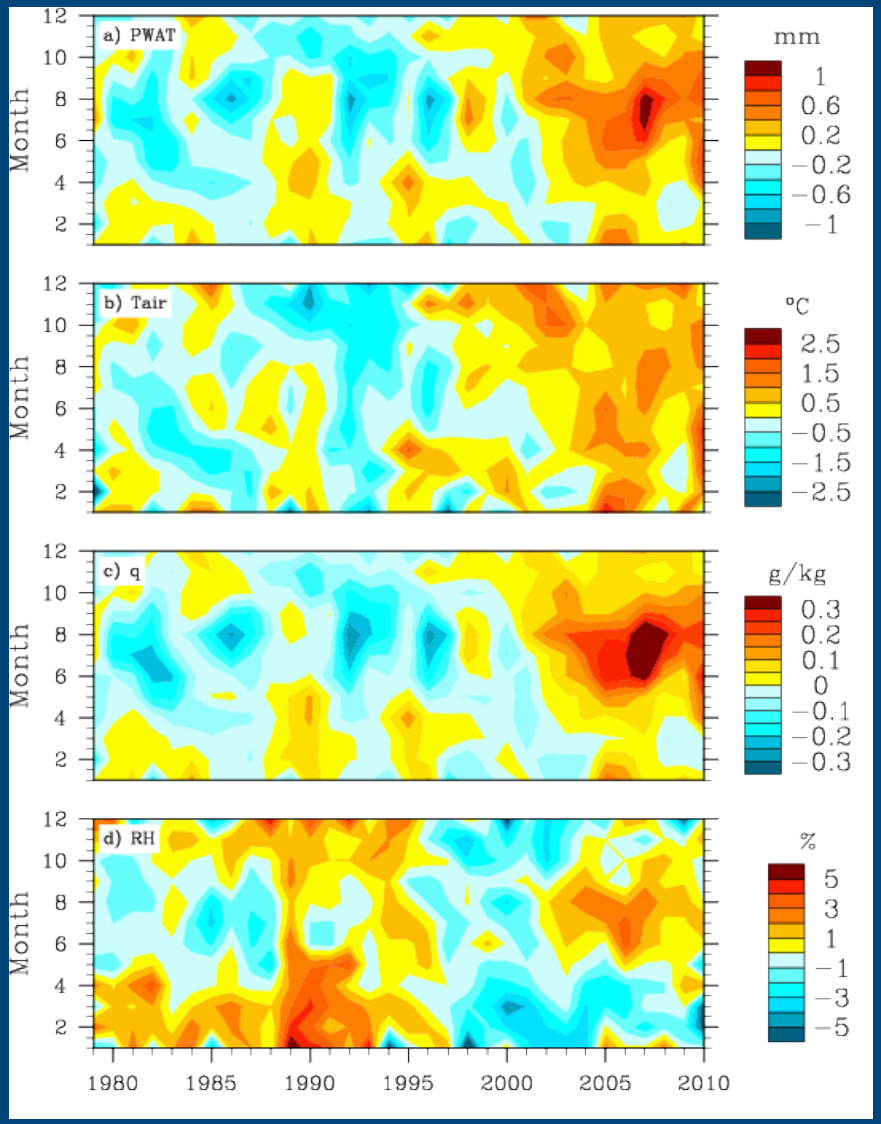
Monthly mean profiles of air temperature from radiosonde stations (red and black) and reanalyses (gray shading).



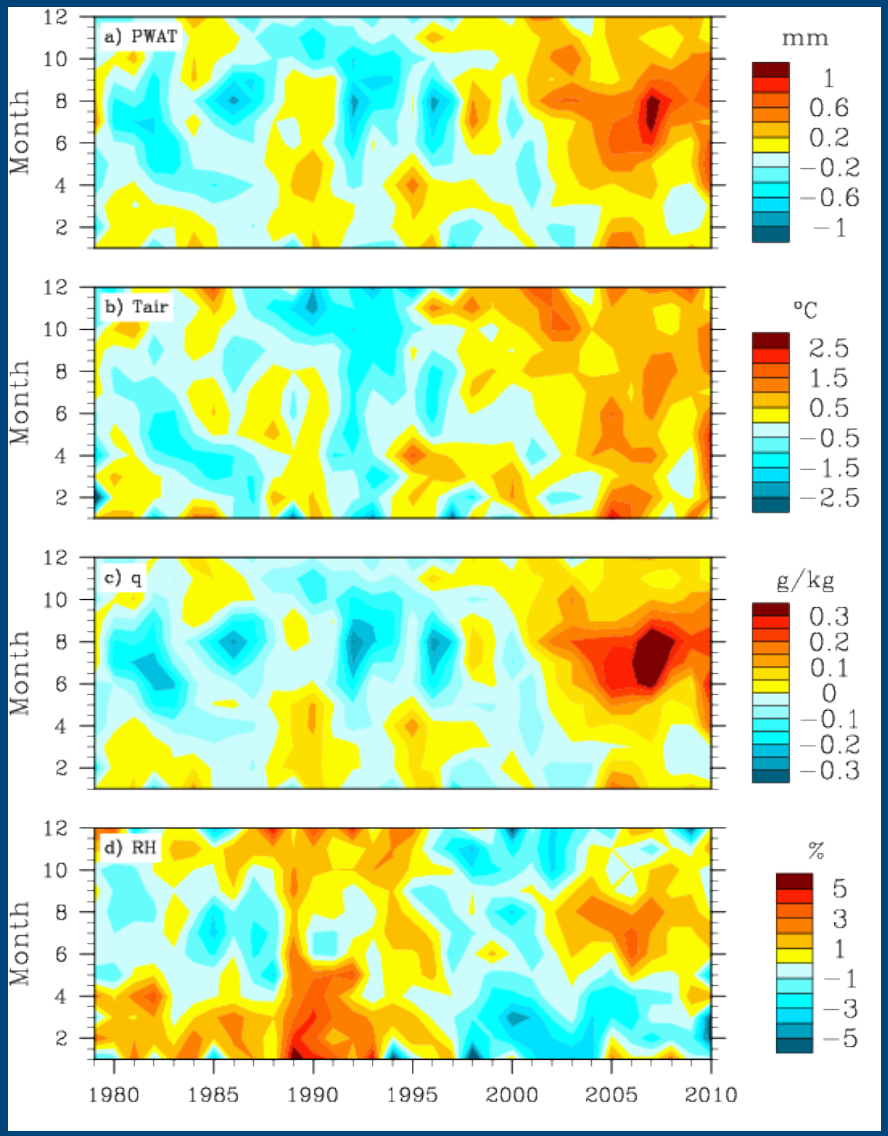
Cross sections of specific humidity and air temperature based on CFSR.



Cross sections of specific humidity and air temperature based on ERA-I.



Hovmoller plots of surface to 500 hPa precipitable water, 850 hPa air temperature, specific humidity and RH based on CFSR.



Hovmoller plots of surface to 500 hPa precipitable water, 850 hPa air temperature, specific humidity and RH based on ERA-I.