Overlooked Issues in the Climate Change Debate

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Knowledge to Go Places

Policy Statement on Climate Variability and Change by the American Association of State Climatologists

1. Past climate is a useful guide to the future - Assessing past climate conditions provides a very effective analysis tool to assess societal and environmental vulnerability to future climate, regardless of the extent the future climate is altered by human activity. Our current and future vulnerability, however, will be different than in the past, even if climate were not to change, because society and the environment change as well. Decision makers need assessments of how climate vulnerability has changed.

2. Climate prediction is complex with many uncertainties. The AASC recognizes climate prediction is an extremely difficult undertaking. For time scales of a decade or more, understanding the empirical accuracy of such predictions - called "verification" - is simply impossible, since we have to wait a decade or longer to assess the accuracy of the forecasts.

Available at: http://ccc.atmos.colostate.edu/policystatement.php

Views of Climate Change Science

- Climate change including regional impacts can be skillfully predicted by knowledge of the concentration of well-mixed greenhouse gases.
- Surface temperatures are the most appropriate metric to assess “global warming.”
- The global average temperature provides a useful assessment of climate.
- The surface temperature data has been adequately homogenized in the regional scale using adjustments such as time of observations, instrument changes, and urbanizations.
- Arctic sea-ice cover and Northern Hemisphere snow cover are continuously diminishing in areal coverage.

- The atmospheric hydrological cycle is accelerating.
- The earth’s atmosphere is warmer today than it was in 1979 when accurate global satellite coverage became available.
- The GCM models have skillfully predicted the evolution of the earth’s atmospheric temperature since 1979.
- We understand climate change and can introduce policies to prevent our “dangerous intervention in the climate system.”
- The IPCC and U.S. National Assessment document a clear scientific understanding of the human disturbance of the climate system.

1

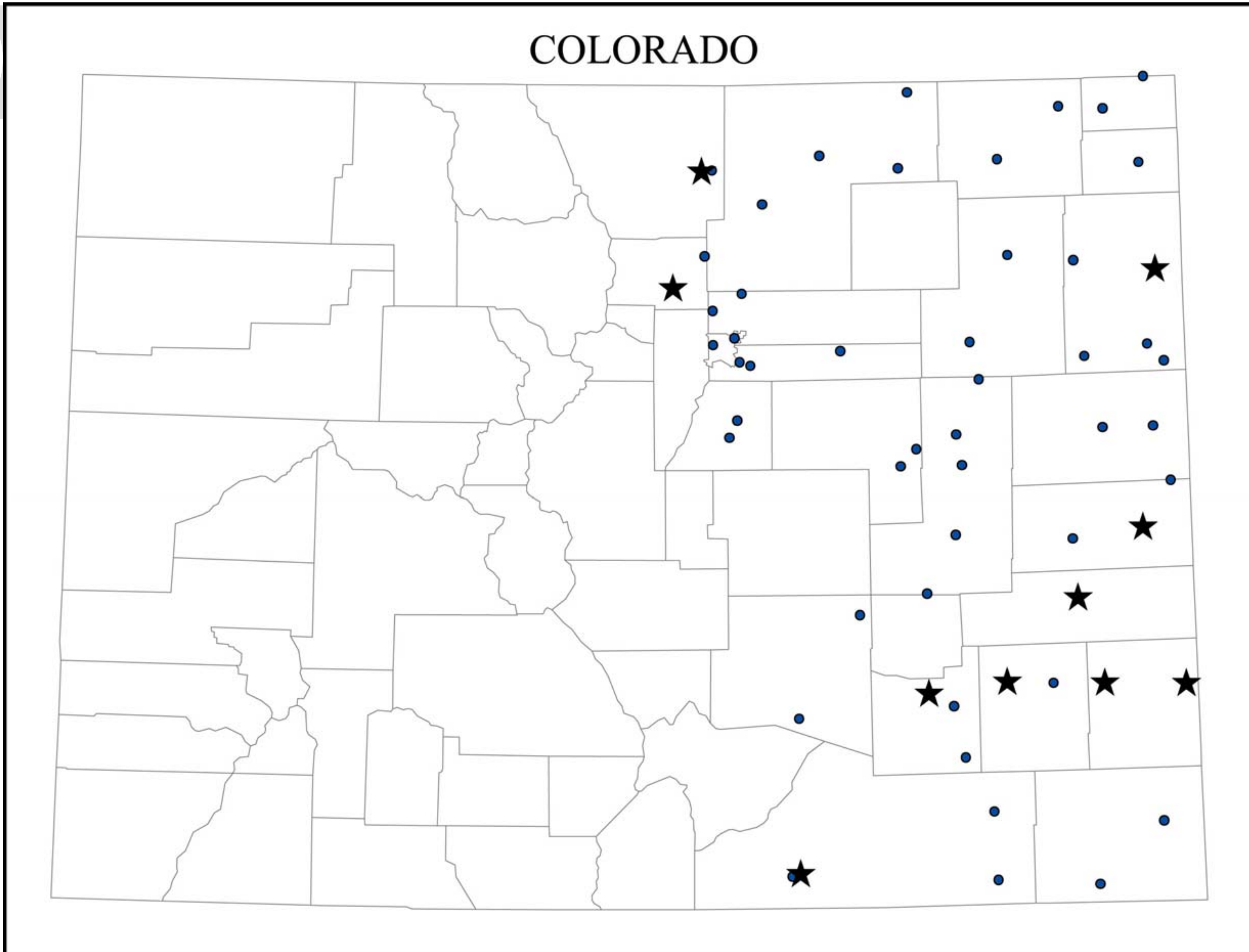
The Lack of Spatial Representativeness of Surface Temperature

From Davey, C.A., and R.A. Pielke Sr., 2004: Microclimate exposures of surface-based weather stations - implications for the assessment of long-term temperature trends. Bull. Amer. Meteor. Soc., submitted.
http://blue.atmos.colostate.edu/publications/pdf/R-274.pdf

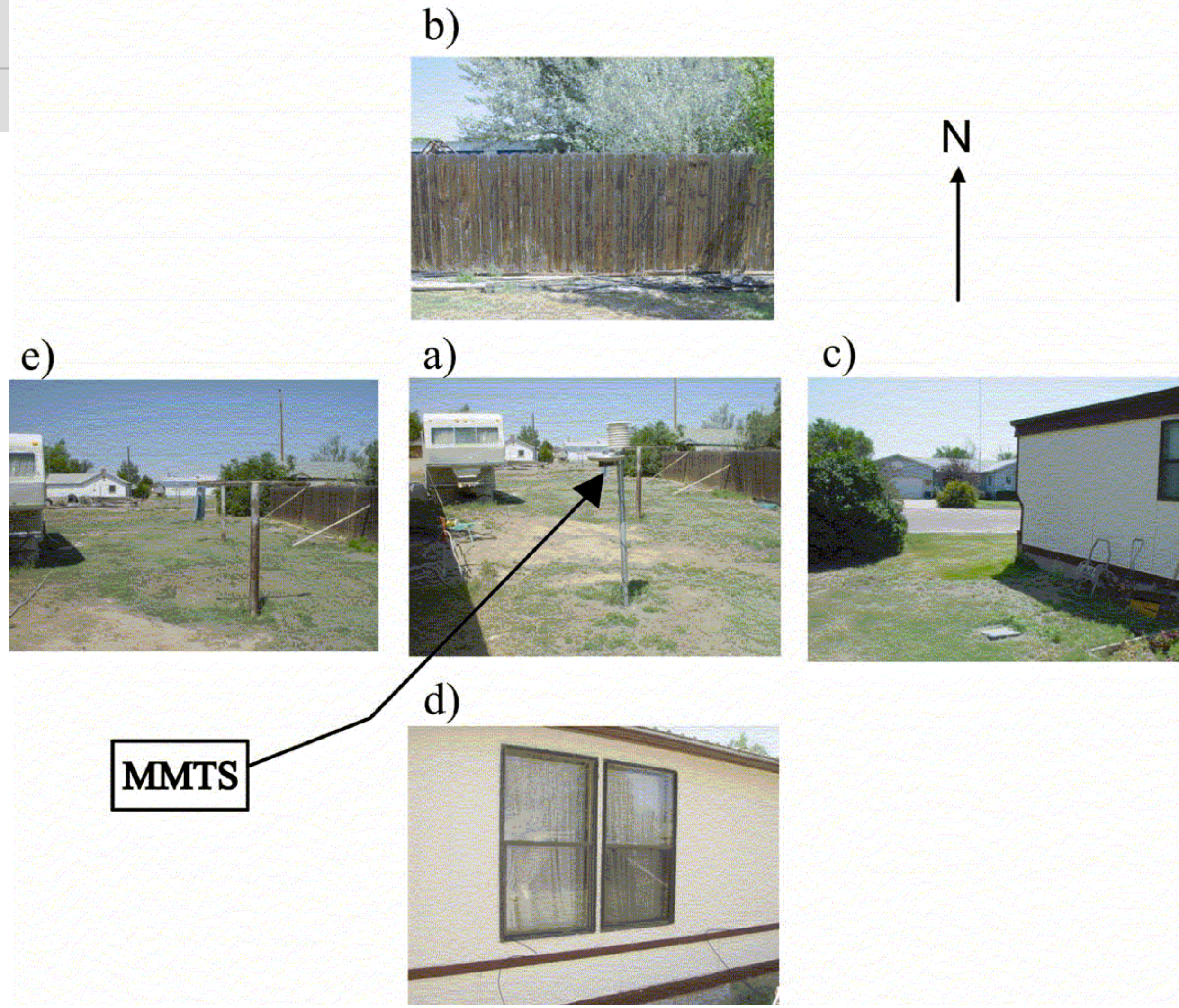
Hanamean, J.R. Jr., R.A. Pielke Sr., C.L. Castro, D.S. Ojima, B.C. Reed, and Z. Gao, 2003: Vegetation impacts on maximum and minimum temperatures in northeast Colorado. Meteorological Applications, 10, 203-215.
http://blue.atmos.colostate.edu/publications/pdf/R-254.pdf

Maximum-minimum temperature sensor (MMTS) installation near Lindon, Colorado.

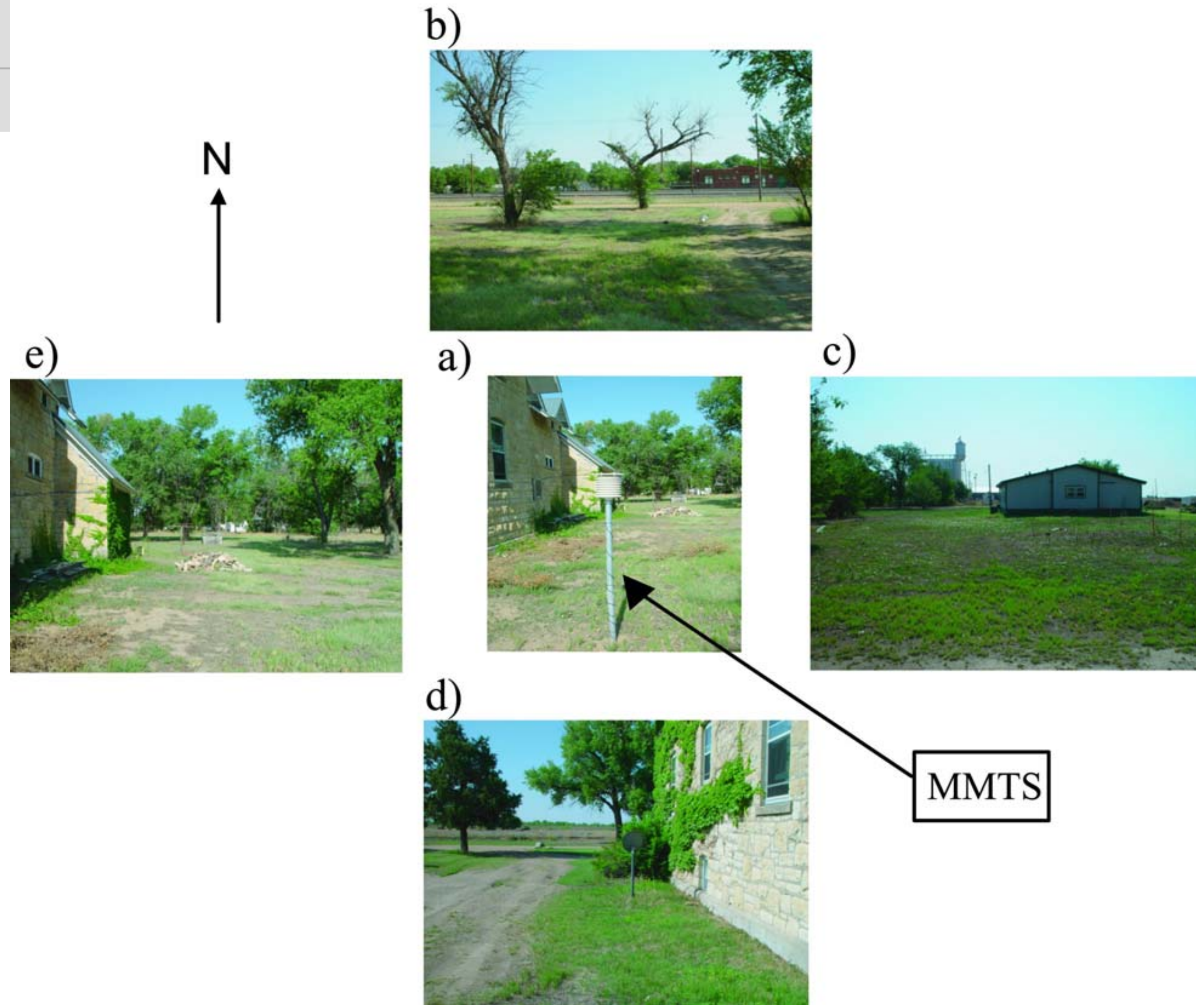
MMTS installation near John Martin Reservoir, Colorado.



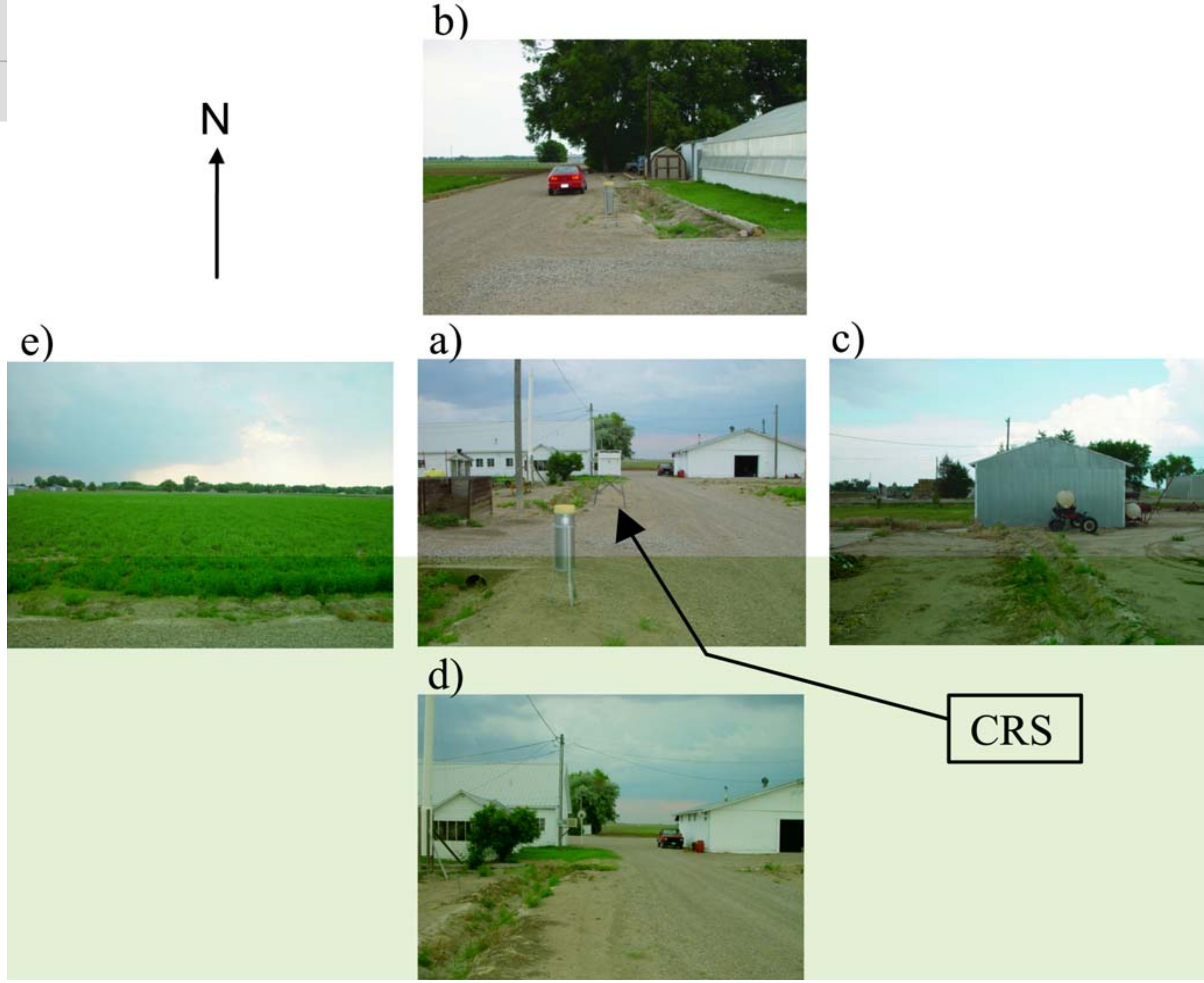
Map of study region, showing all surveyed COOP sites. The USHCN sites are indicated by stars. The following photos are for HCN sites.



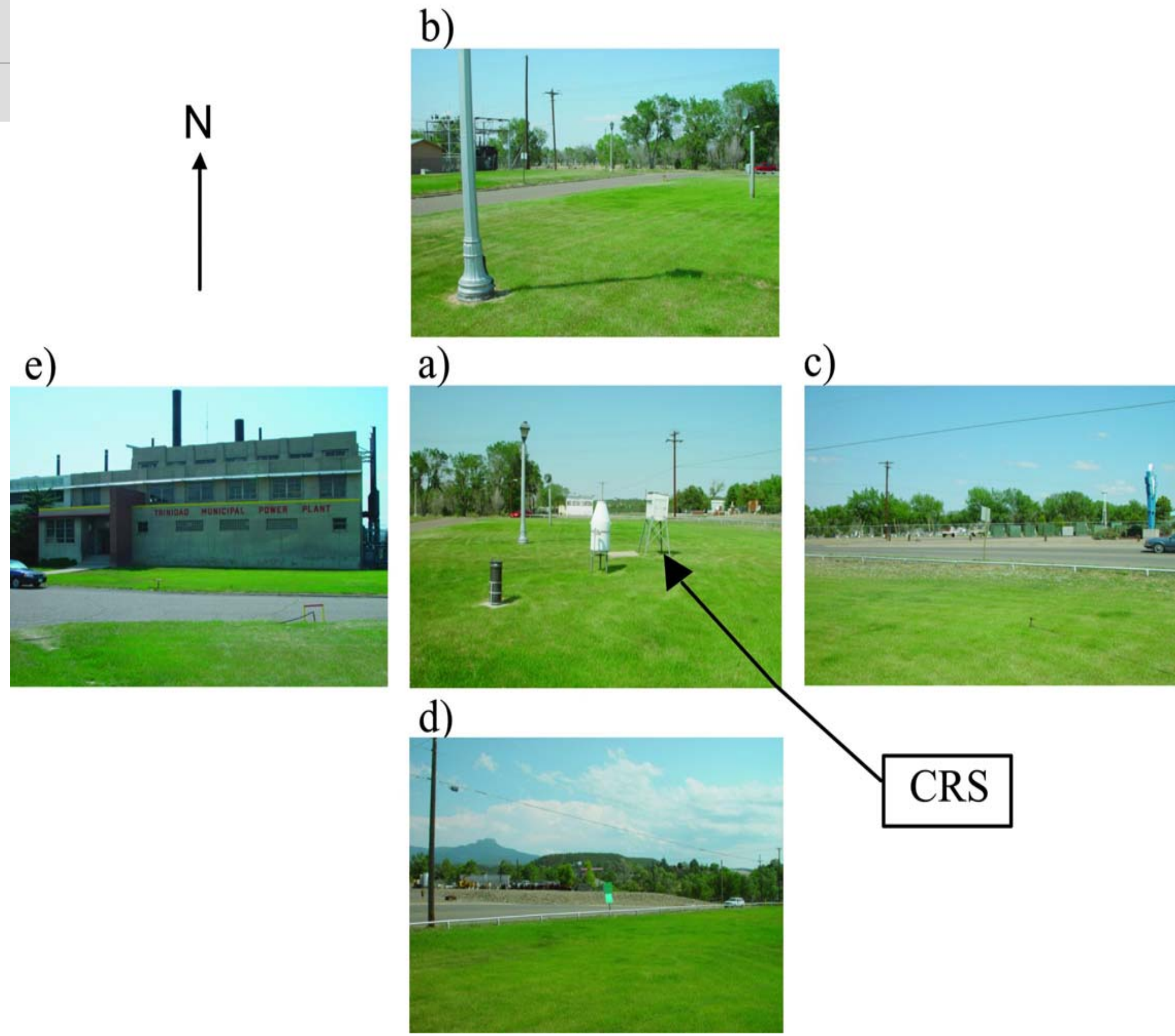
Photographs of the temperature sensor exposure characteristics of the NWS COOP station at Eads, CO. Panel a) shows the temperature sensor, while panels b)-e) illustrate the exposures viewed from the temperature sensor looking N, E, S, and W, respectively.



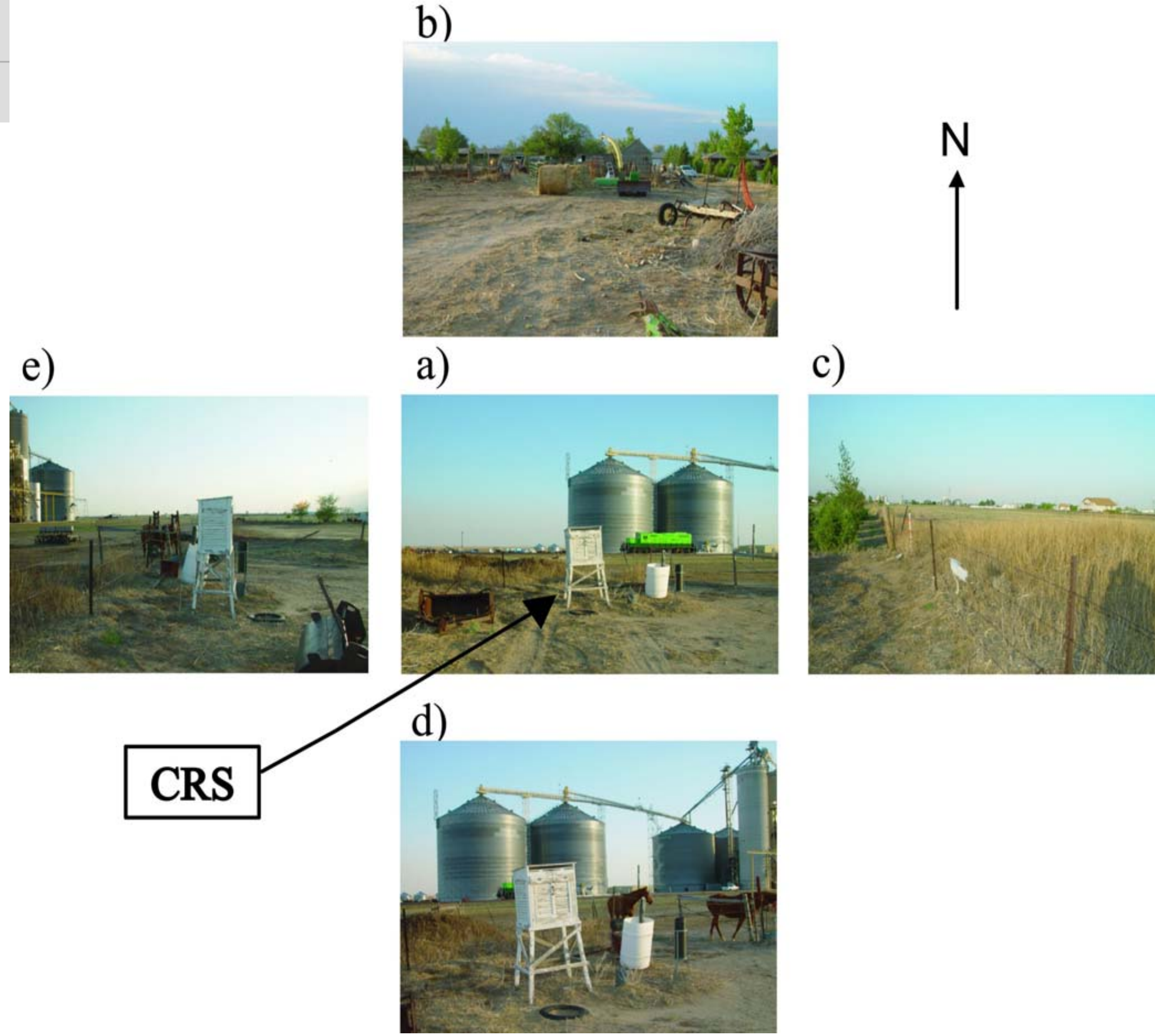
Photographs of the temperature sensor exposure characteristics of the NWS COOP station at Holly, CO. Panel a) shows the temperature sensor, while panels b)-e) illustrate the exposures viewed from the temperature sensor looking N, E, S, and W, respectively.



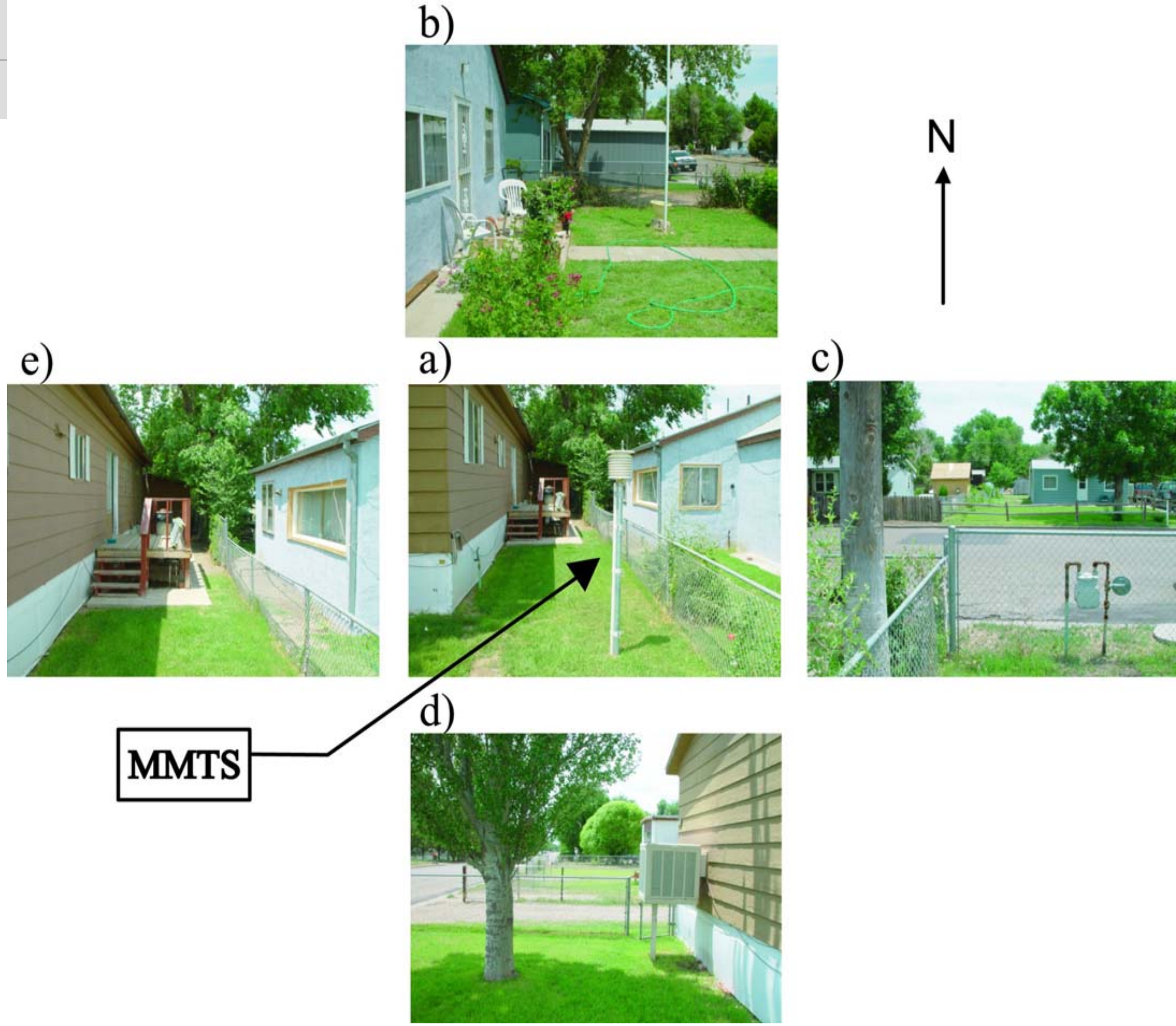
Photographs of the temperature sensor exposure characteristics for the NWS COOP station near Rocky Ford, Colorado. Panel a) shows the temperature sensor, while panels b)-e) illustrate the exposures viewed from the temperature sensor looking N, E, S, and W, respectively. (CRS-Cotton Region Shelter)



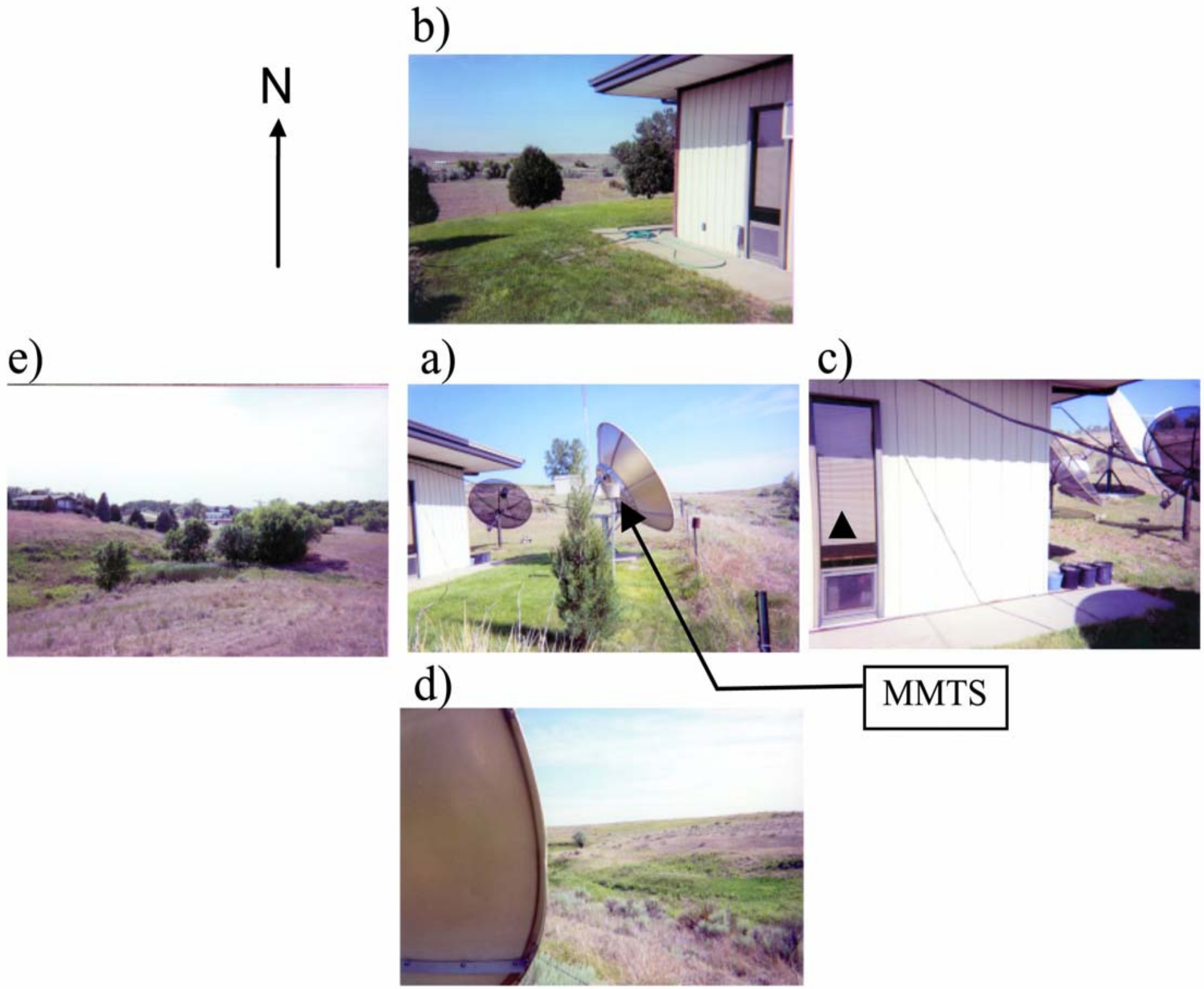
Photographs of the temperature sensor exposure characteristics of the NWS COOP station at Trinidad, CO. Panel a) shows the temperature sensor, while panels b)-e) illustrate the exposures viewed from the sensor looking N, E, S, and W, respectively.



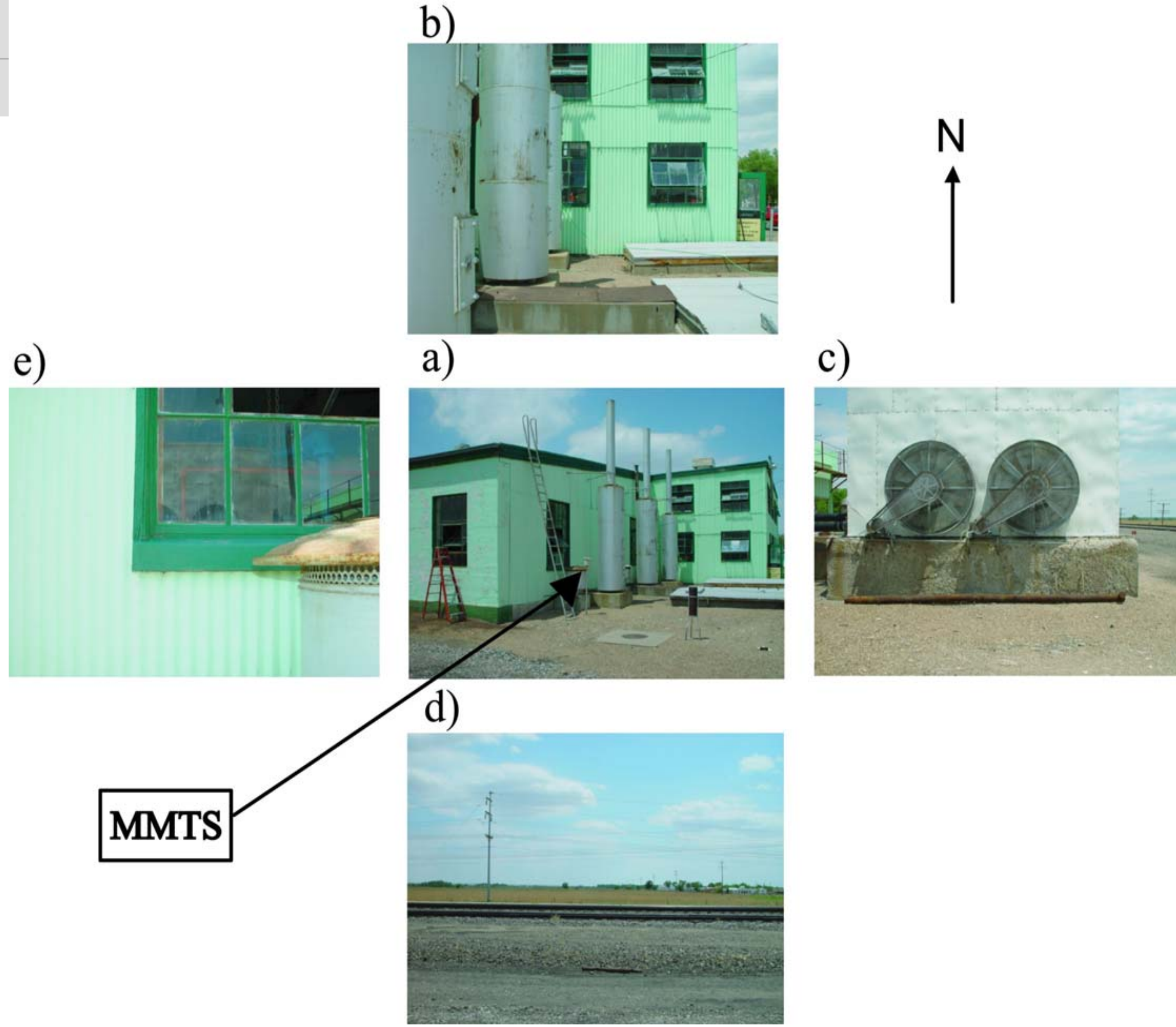
Photographs of the temperature sensor exposure characteristics of the NWS COOP station at Cheyenne Wells, CO. Panel a) shows the temperature sensor, while panels b)-e) illustrate the exposures viewed from the sensor looking N, E, S, and W, respectively.



Photographs of the temperature sensor exposure characteristics of the NWS COOP station at Lamar, CO. Panel a) shows the temperature sensor, while panels b)-e) illustrate the exposures viewed from the sensor looking N, E, S, and W, respectively.



Photographs of the temperature sensor exposure characteristics of the NWS COOP station at Wray, CO. Panel a) shows the temperature sensor, while panels b)-e) illustrate the exposures viewed from the sensor looking N, E, S, and W, respectively.



Photographs of the temperature sensor exposure characteristics of the NWS COOP station at Las Animas, CO. Panel a) shows the temperature sensor, while panels b)-e) illustrate the exposures viewed from the sensor looking N, E, S, and W, respectively.

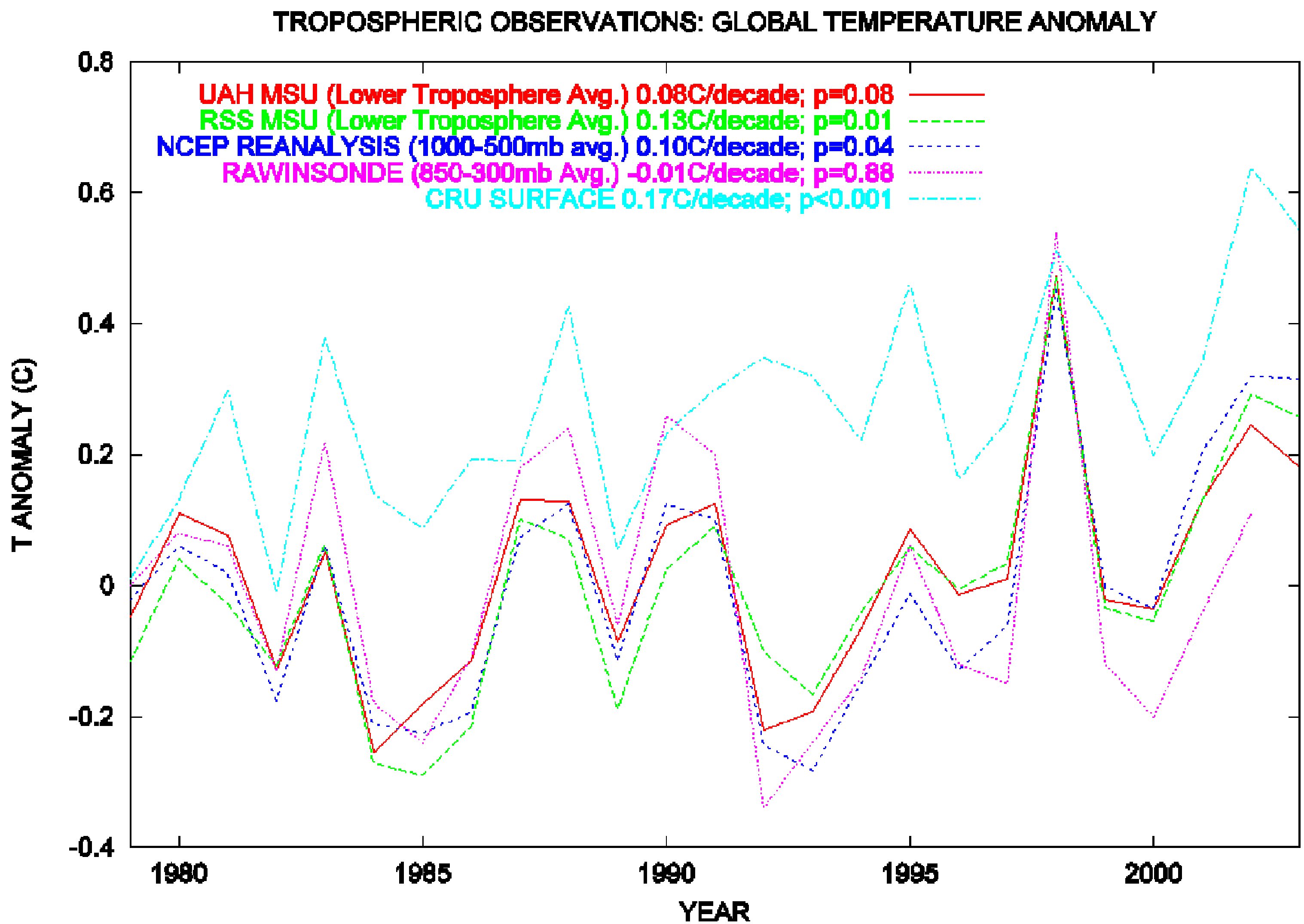
Fort Morgan site showing images of the cardinal directions from the sensor (from Hanamean et al. 2003)

2

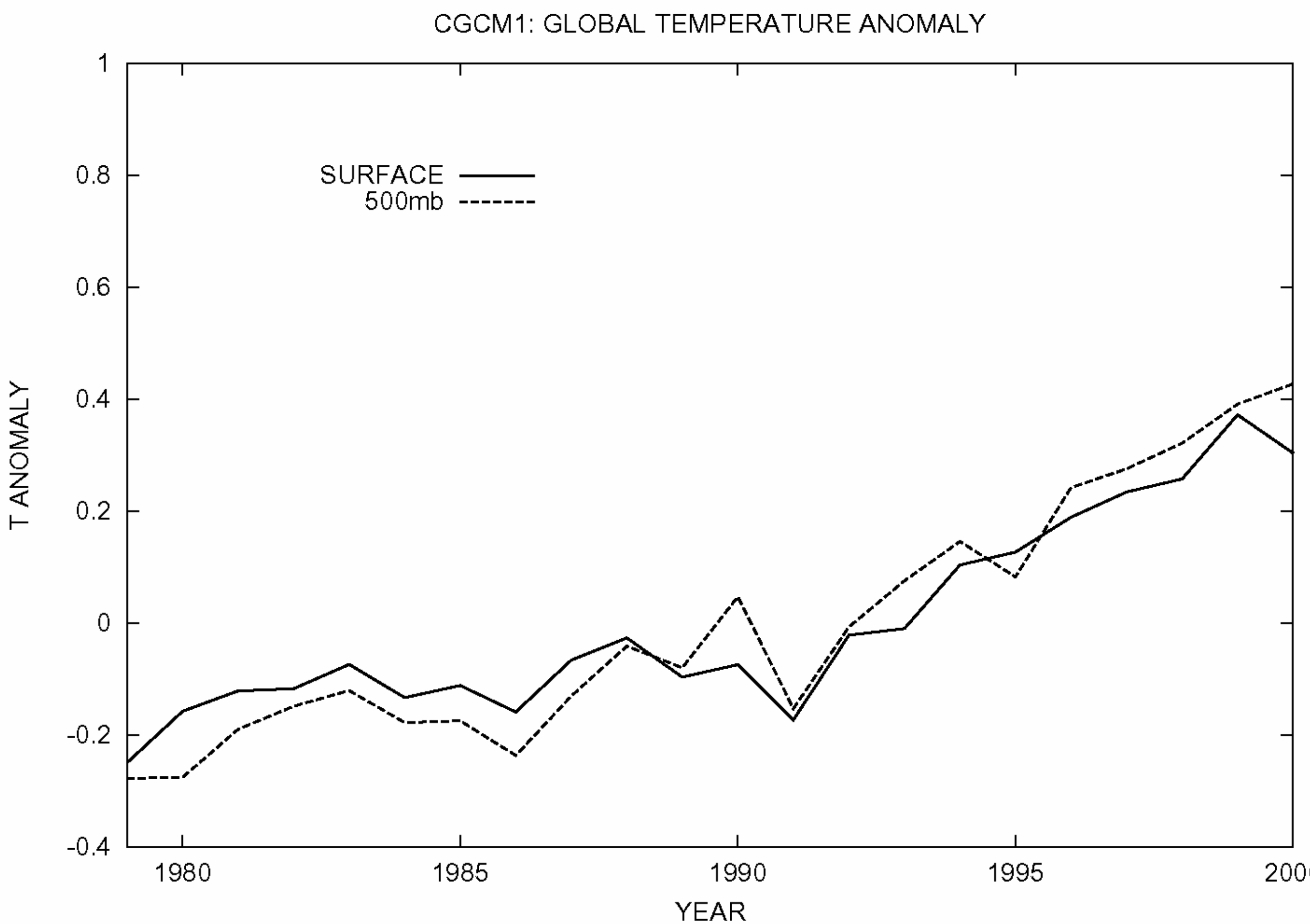
GCM Models Have Not Yet Succeeded In Skillfully Predicting 1980-2000 Global Climate

Chase, T.N., R.A. Pielke Sr., B. Herman, and X. Zeng, 2004: Likelihood of rapidly increasing surface temperatures unaccompanied by strong warming in the free troposphere. Climate Res., 25, 185-190.

http://blue.atmos.colostate.edu/publications/pdf/R-271.pdf



Courtesy of Thomas N. Chase, University of Colorado, Boulder.


CGCM1: GLOBAL TEMPERATURE ANOMALY
SURFACE
500mb
T ANOMALY
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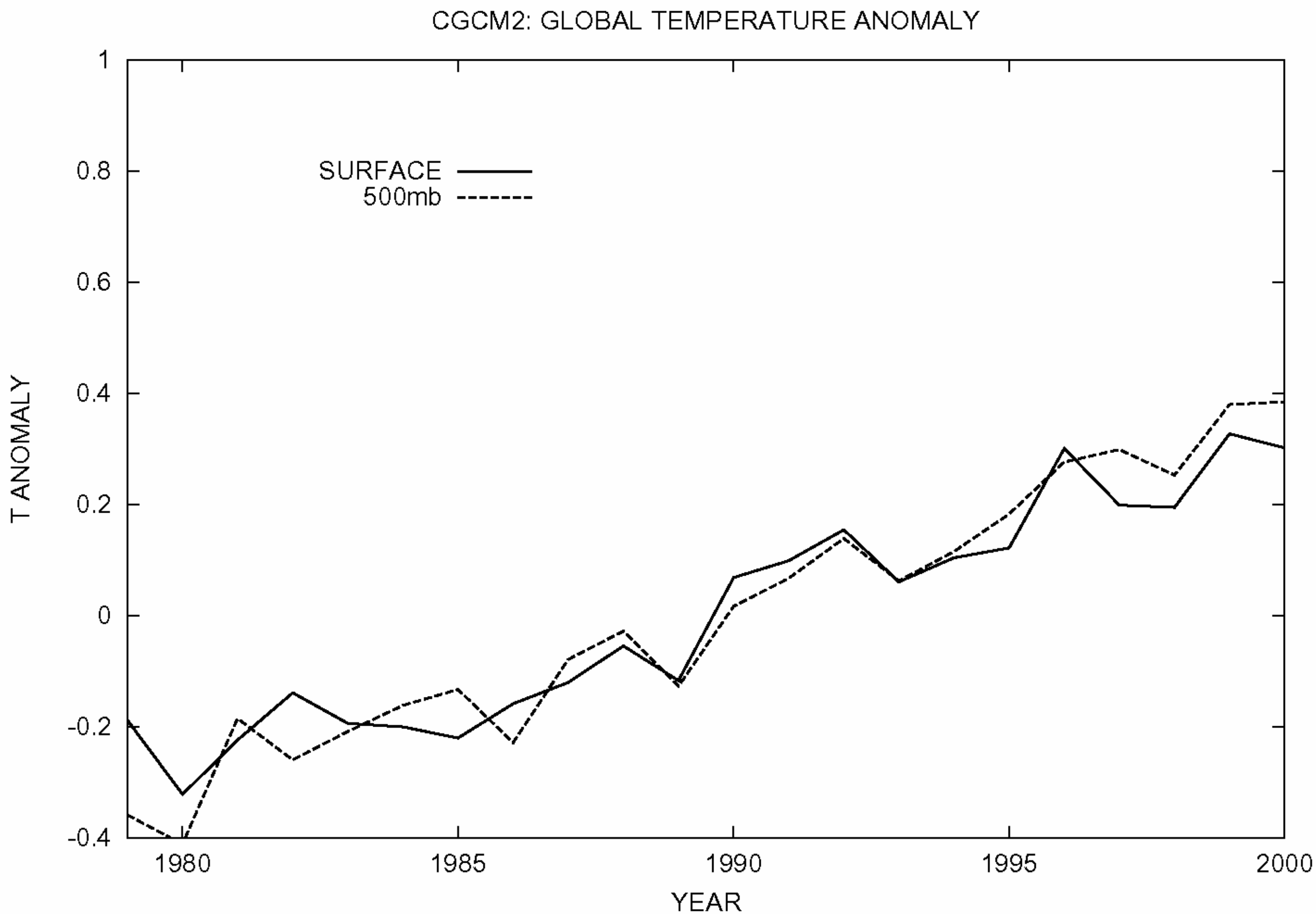
0.6
0.4
0.2
0
-0.2
-0.4
1980
1985
1990
1995
2000
YEAR



CGCM2: GLOBAL TEMPERATURE ANOMALY
SURFACE
500mb
T ANOMALY
YEAR
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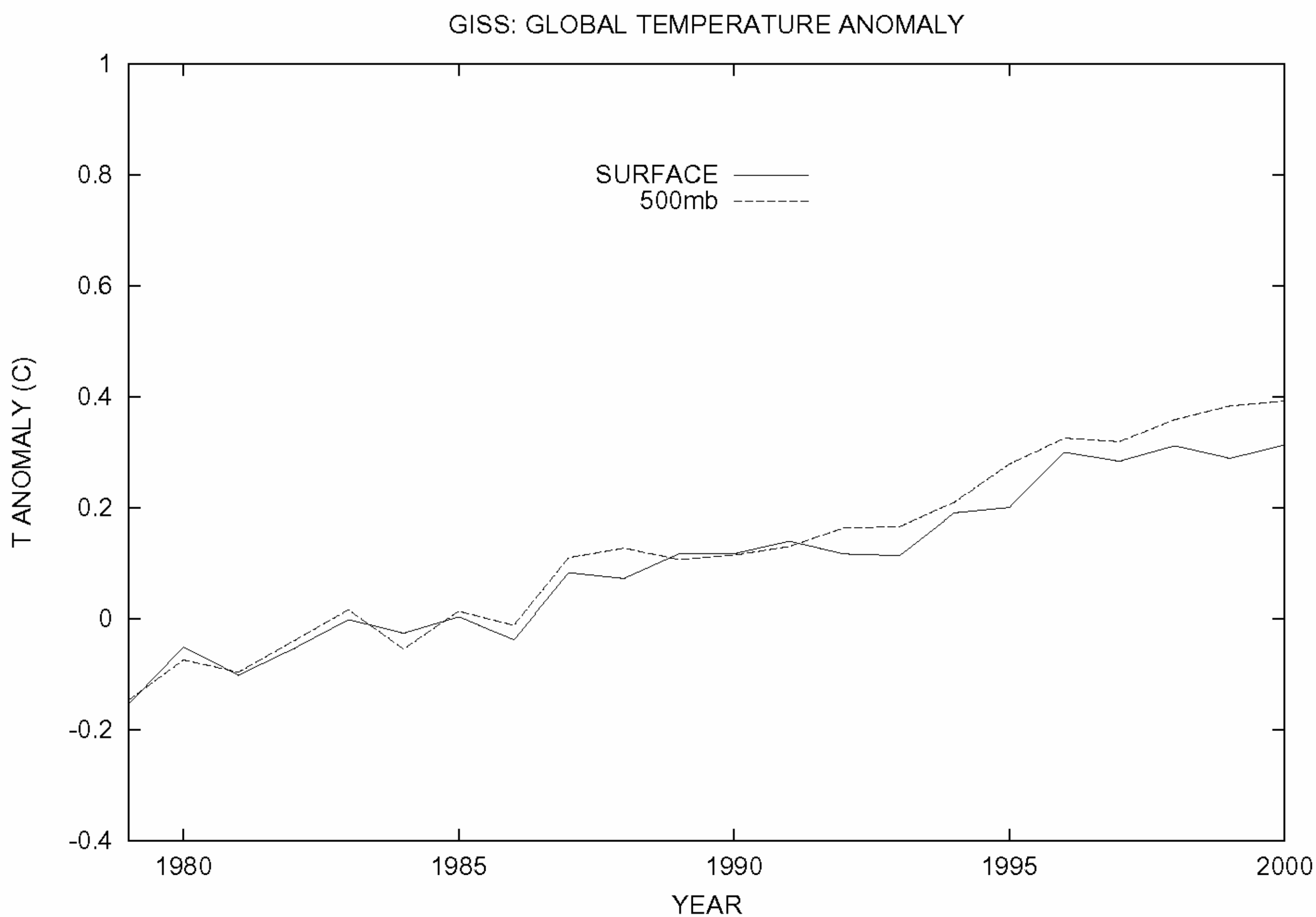
0.8
0.6
0.4
0.2
0
-0.2
-0.4
1980
1985
1990
1995
2000



GISS: GLOBAL TEMPERATURE ANOMALY
SURFACE
500mb
T ANOMALY (C)
1
0.8
0.6
0.4
0.2
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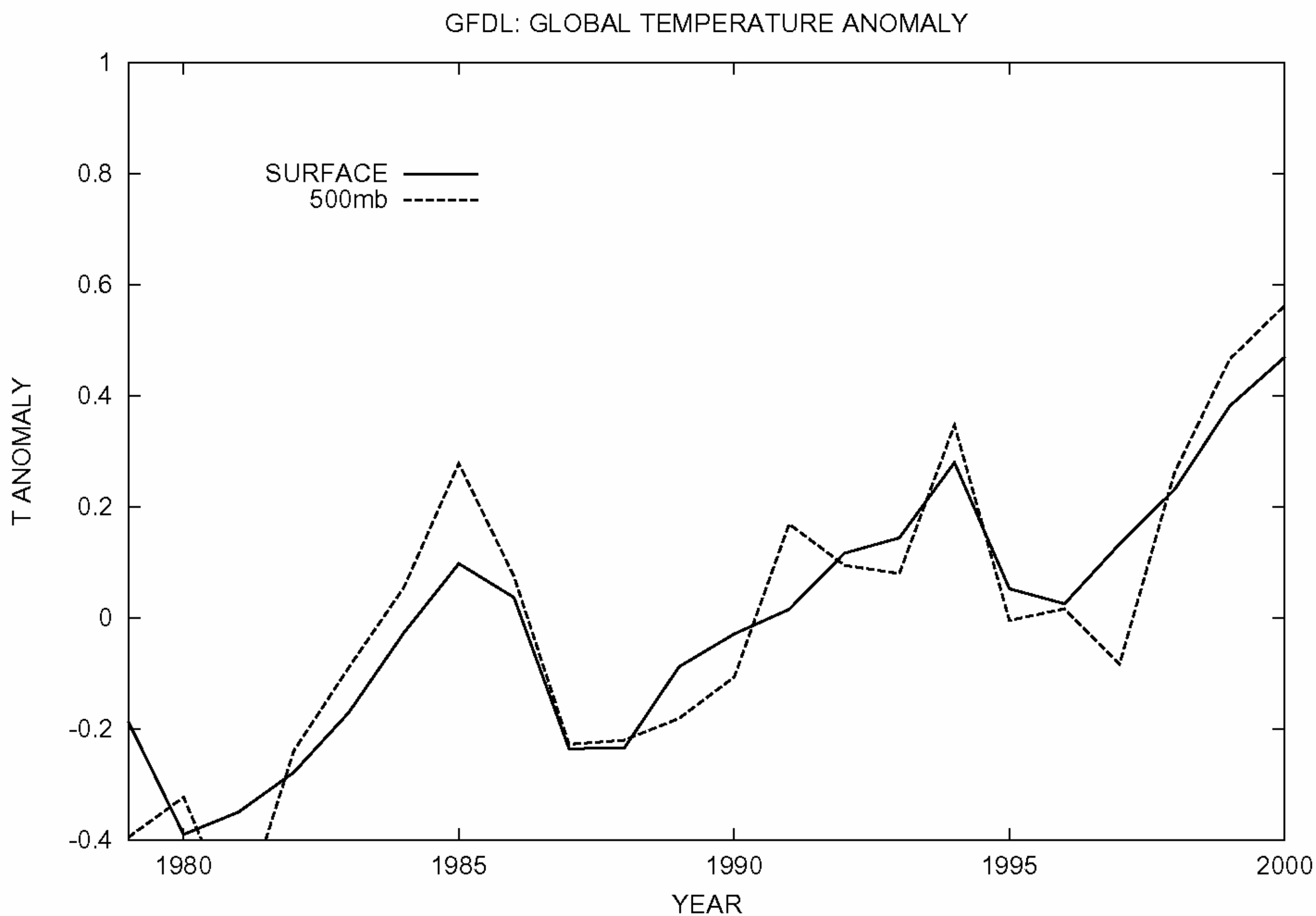
-0.2
-0.4
1980
1985
1990
1995
2000
YEAR


GFDL: GLOBAL TEMPERATURE ANOMALY
SURFACE
500mb
T ANOMALY
YEAR
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
1980
1985
1990
1995
2000

From: Chase, T.N., R.A. Pielke, J.A. Knaff, T.G.F. Kittel, and J.L. Eastman, 2000: A comparison of regional trends in 1979-1997 depth-averaged tropospheric temperatures. Int. J. Climatology, 20, 503-518.

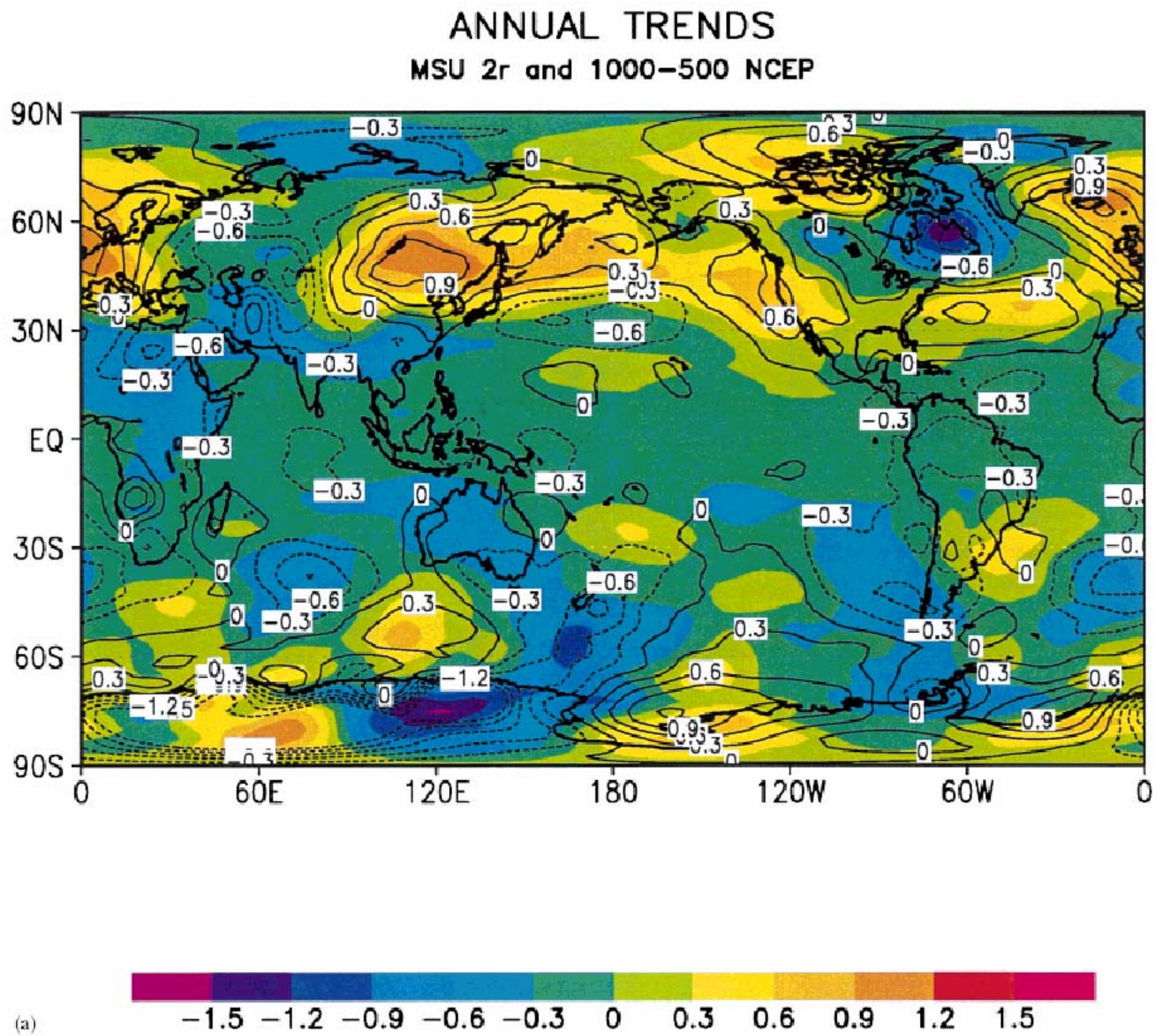
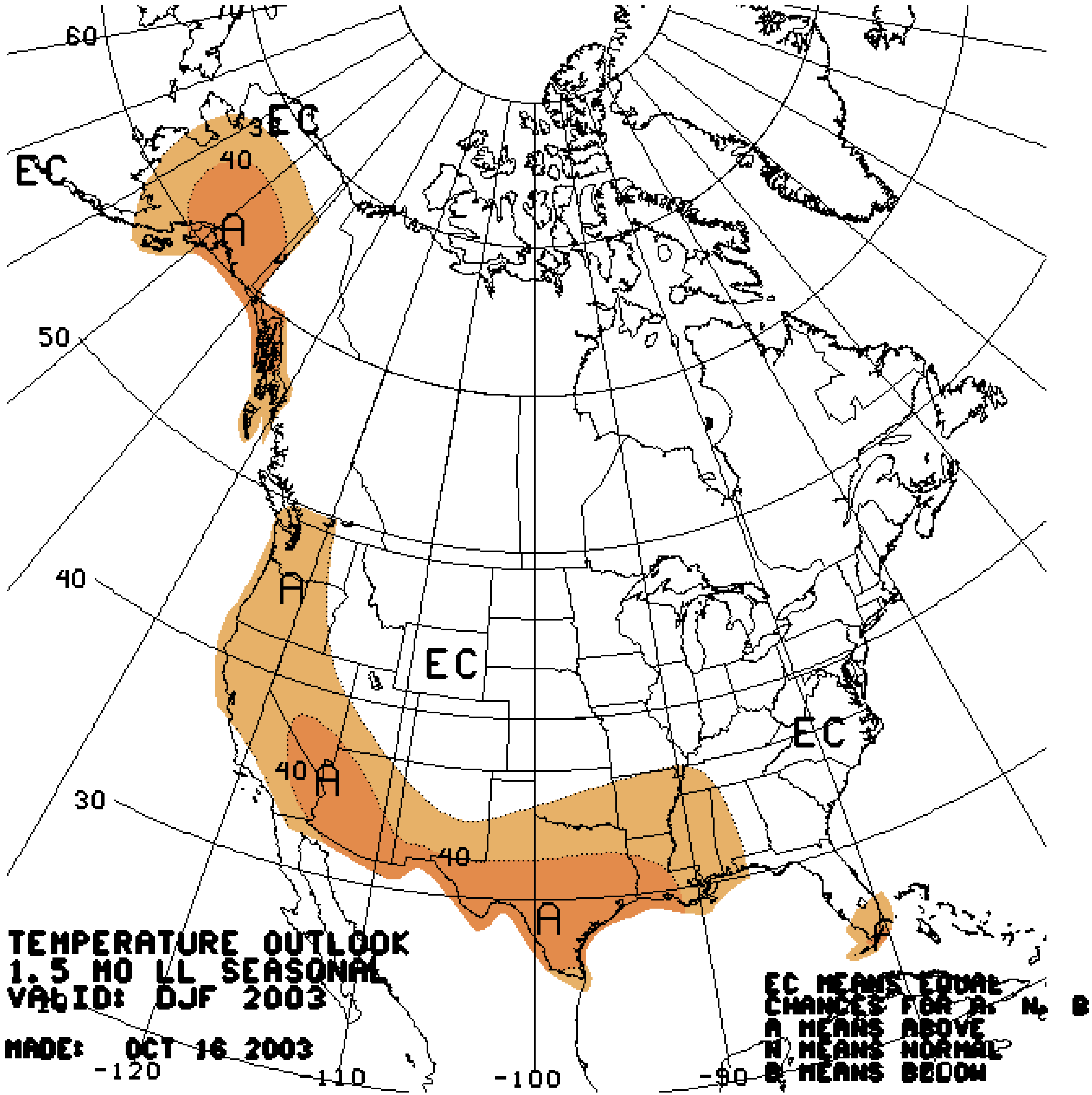


Plate 1. MSU (coloured) and NCEP 1000–500 mb (contoured) trends in °C/19 years for (a) annual average, (b) DJF average and (c) JJA average

http://blue.atmos.colostate.edu/publications/pdf/R-224.pdf


TEMPERATURE OUTLOOK
1.5 MO LL SEASONAL
VALID: DJF 2003
MADE: OCT 16 2003
EC MEANS EQUAL CHANCES FOR A, N, B
A MEANS ABOVE
N MEANS NORMAL
B MEANS BELOW
EC
EC
EC
EC
A
A
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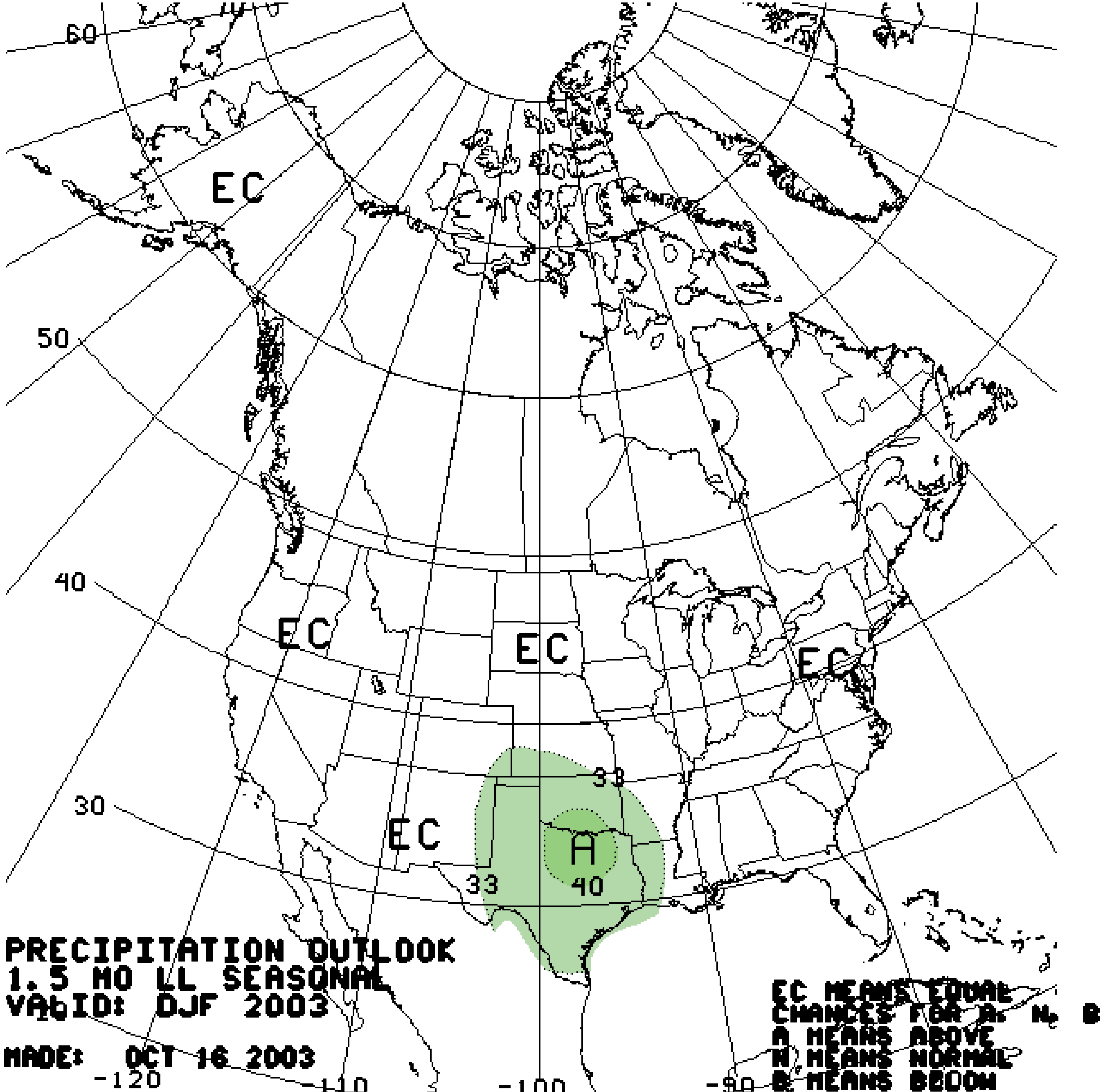
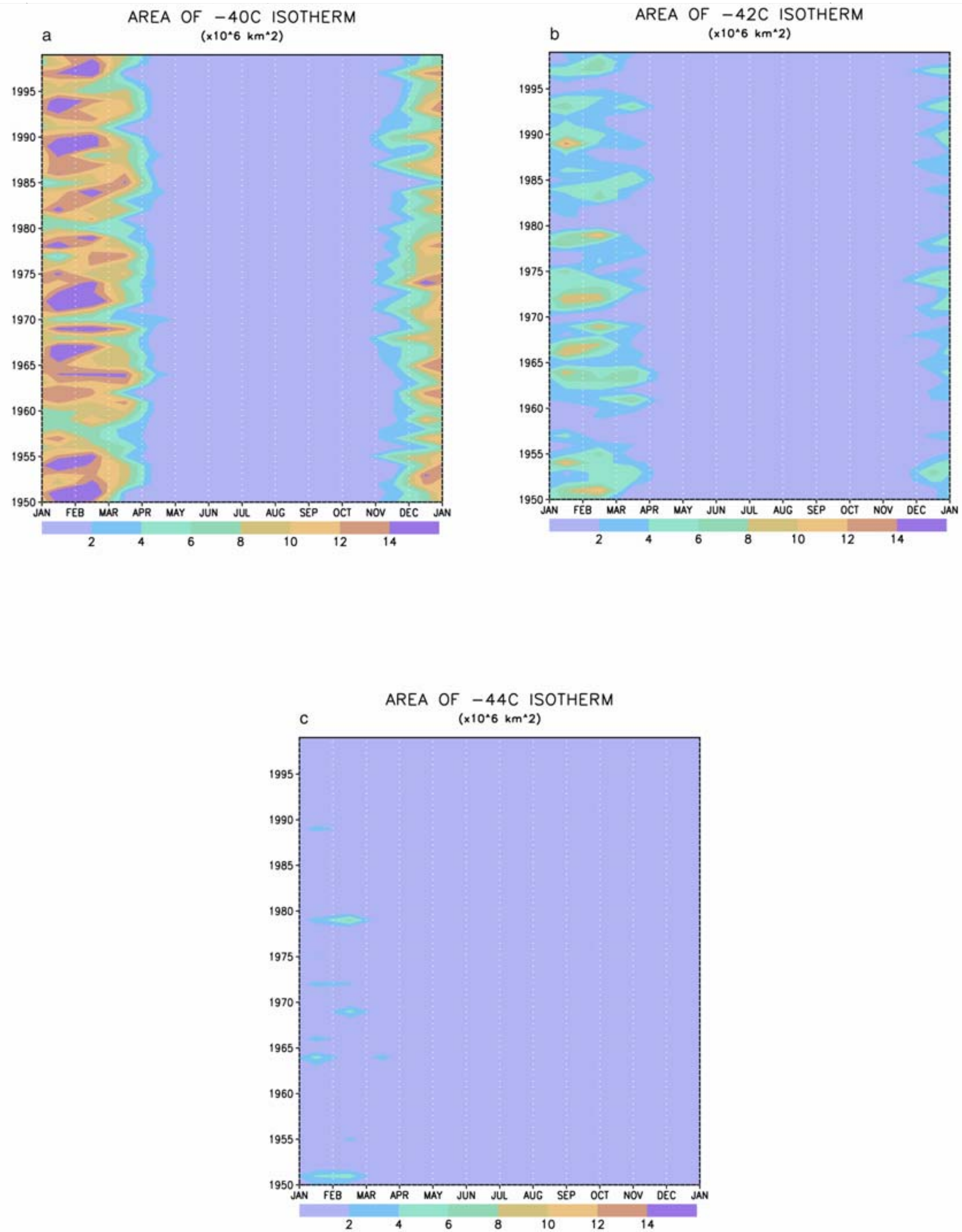
A
40
40
40
40
60
50
40
30
-120
-110
-100
-90


EC
EC
EC
EC
EC
33
33
A
40
60
50
40
30
-120
-110
-100
-90
PRECIPITATION OUTLOOK
1.5 MO LL SEASONAL
VALID: DJF 2003
MADE: OCT 16 2003
EC MEANS EQUAL
CHANCES FOR A, N, B
A MEANS ABOVE
N MEANS NORMAL
B MEANS BELOW

The Lack of Warming in the Arctic Troposphere

From Chase, T.N., B. Herman, R.A. Pielke Sr., X. Zeng, and M. Leuthold, 2002: A proposed mechanism for the regulation of minimum midtropospheric temperatures in the Arctic. J. Geophys. Res., 107(D14), 10.10291/ 2001JD001425.

http://blue.atmos.colostate.edu/publications/pdf/R-246.pdf
http://www.atmo.arizona.edu/gifs/500mb_t.gif



Reanalysis monthly-averaged area enclosed by indicated isotherm during the period 1950-1998 north of 60°N.
(a) -40°C isotherm,
(b) -42°C isotherm, and
(c) -44°C isotherm.

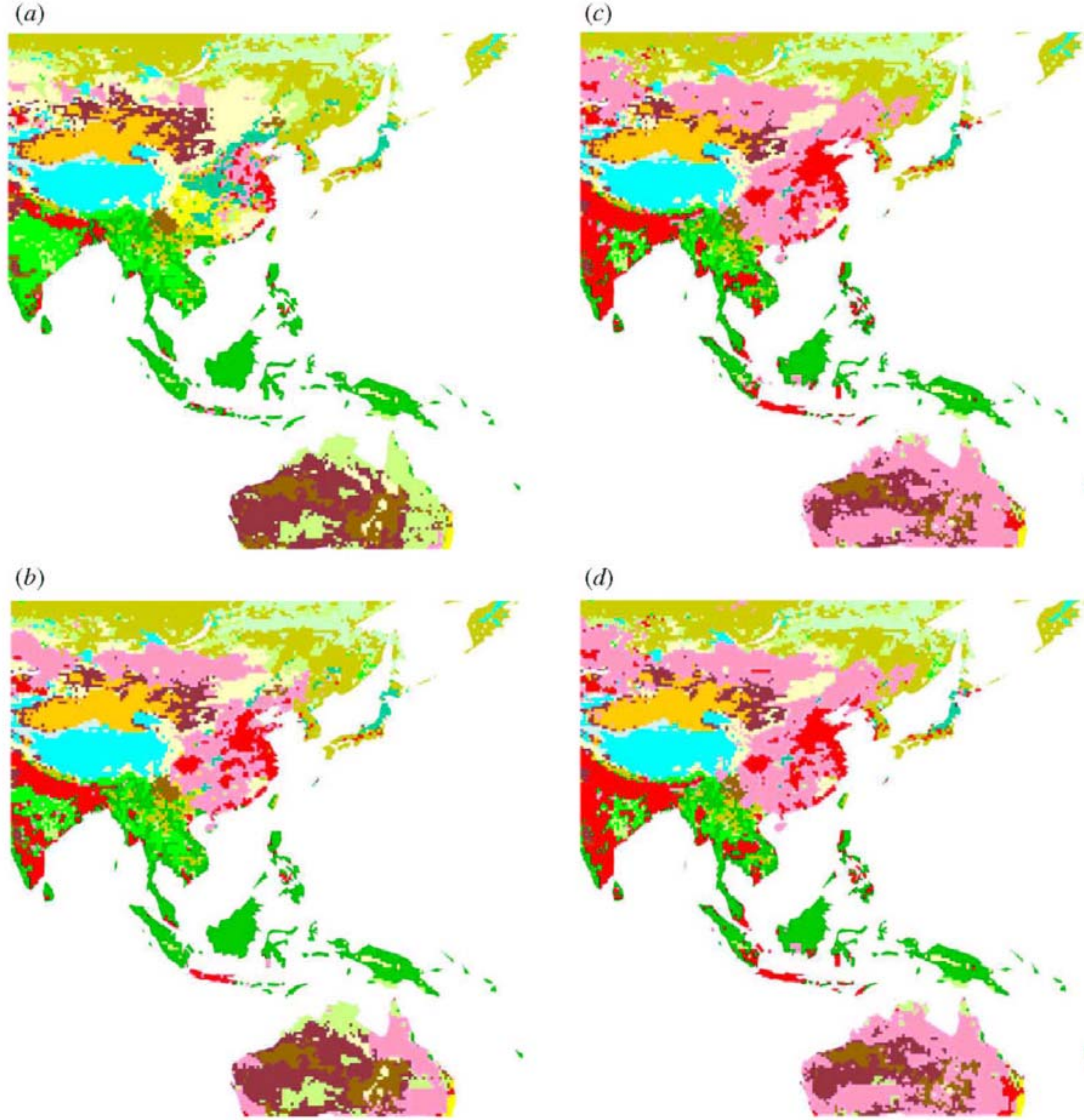
4

The Global Spatial Redistribution of Energy by Human-Caused Landscape Change

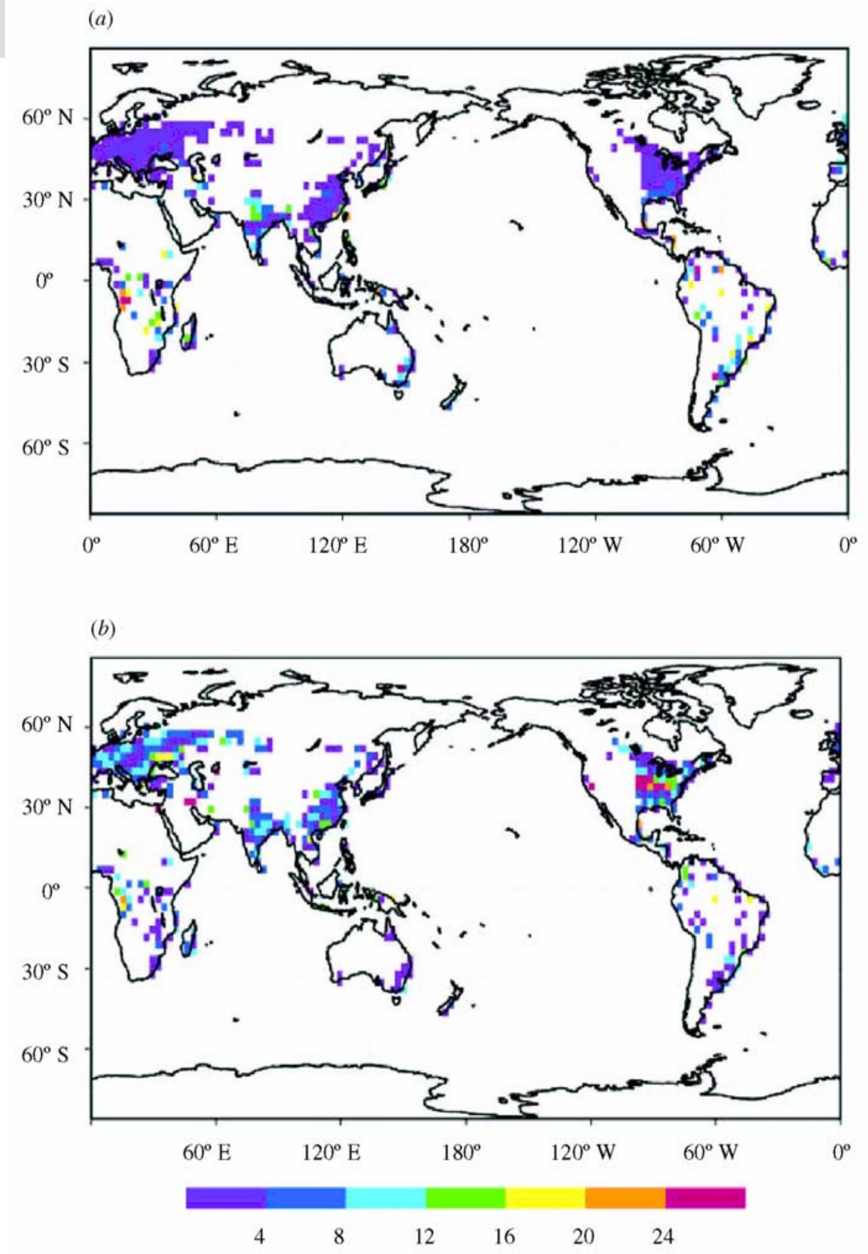
From Pielke Sr., R.A., G. Marland, R.A. Betts, T.N. Chase, J.L. Eastman, J.O. Niles, D. Niyogi, and S. Running, 2002: The influence of land-use change and landscape dynamics on the climate system- relevance to climate change policy beyond the radiative effect of greenhouse gases. *Phil. Trans. A. Special Theme Issue*, 360, 1705-1719.

http://blue.atmos.colostate.edu/publications/pdf/R-258.pdf

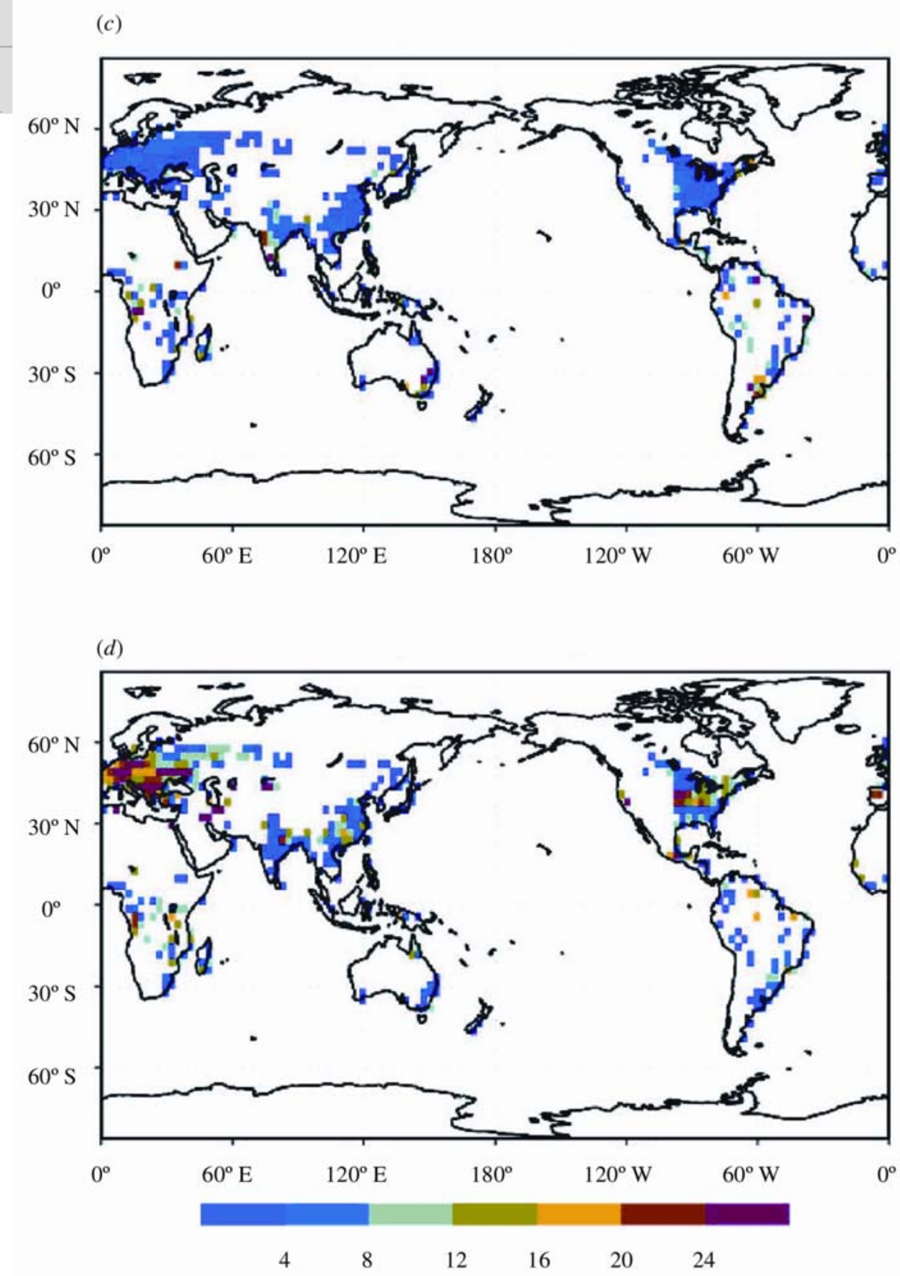
Examples of land-use change from (a) 1700, (b) 1900, (c) 1970, and (d) 1990. The human-disturbed landscape includes intensive cropland (red) and marginal cropland used for grazing (pink). Other landscape includes tropical evergreen forest and deciduous forest (dark green), savannah (light green), grassland and steppe (yellow), open shrubland (maroon), temperate deciduous forest (blue), temperate needleleaf evergreen forest (light yellow) and hot desert (orange). Note the expansion of cropland and grazed land between 1700 and 1900. (Reproduced with permission from Klein Goldewijk 2001.)



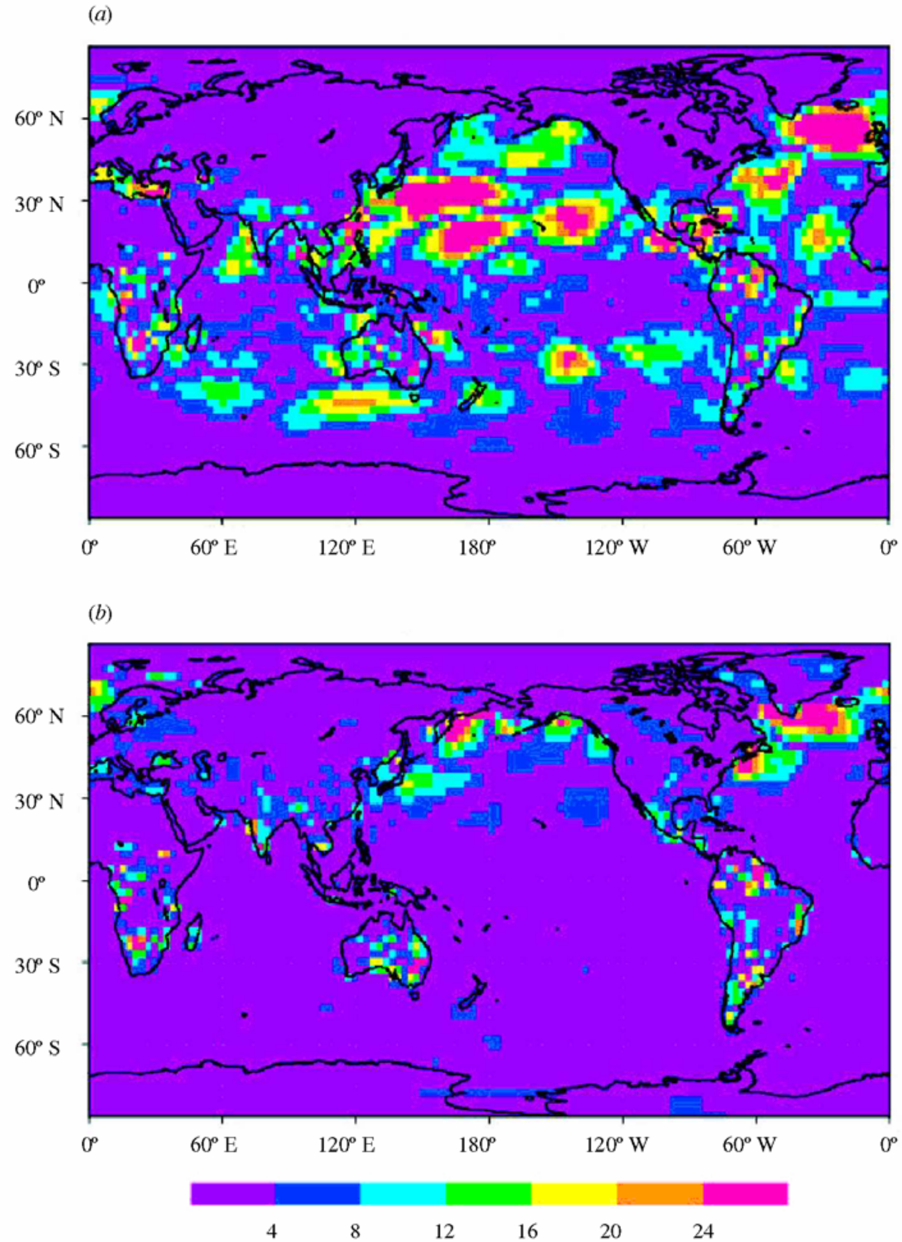
The ten-year average absolute-value change in surface latent turbulent heat flux in W m^{-2} at the locations where land-use change occurred for (a) January, and (b) July. (Adapted from Chase et al. 2000.)



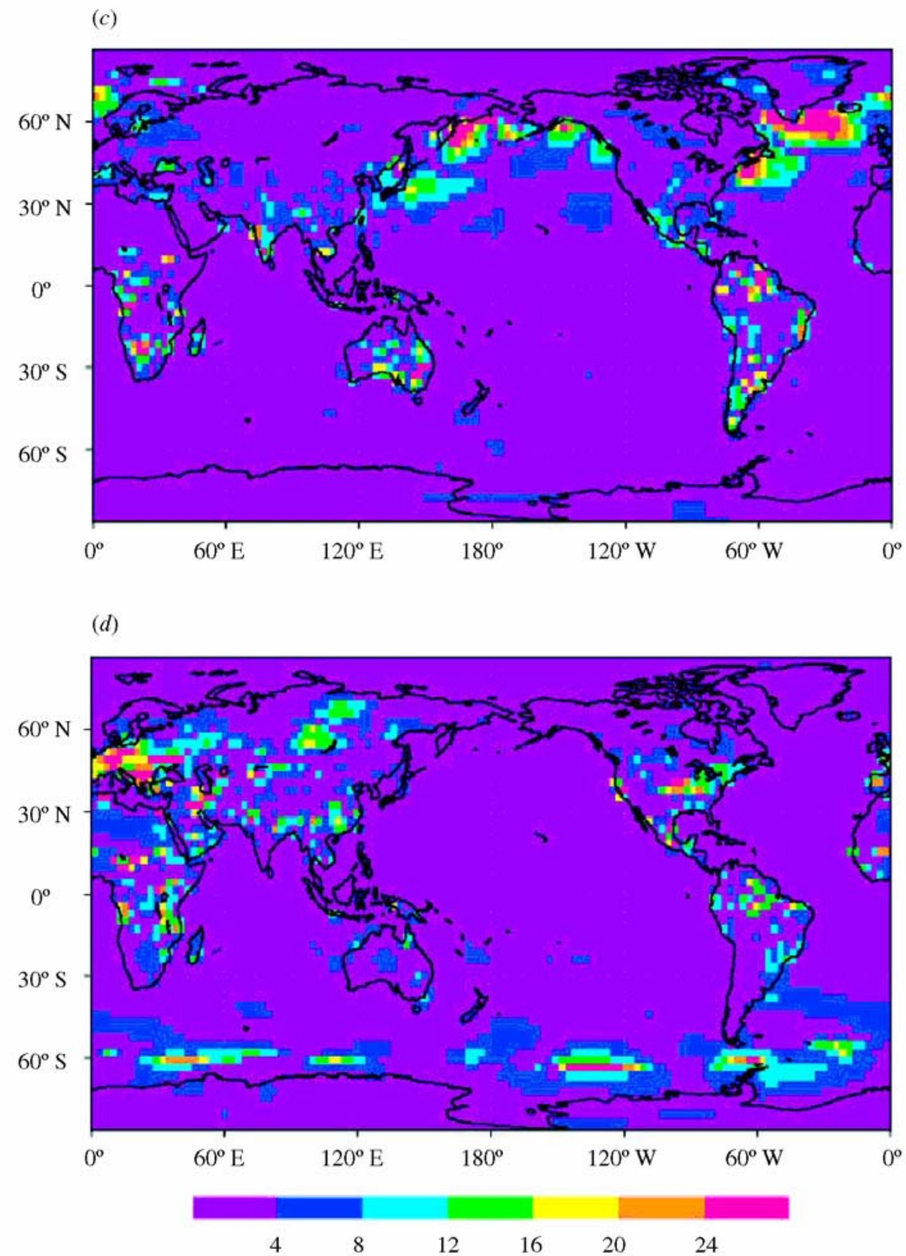
The ten-year average absolute-value change in surface sensible heat flux in W m^{-2} at the locations where land-use change occurred for (c) January, and (d) July. (Adapted from Chase et al. 2000.)



The ten-year average absolute-value change in surface latent turbulent heat flux in W m^{-2} worldwide as a result of the land-use changes for (a) January, and (b) July. (Adapted from Chase et al. 2000.)



The ten-year average absolute-value change in sensible turbulent heat flux in W m^{-2} worldwide as a result of the land-use changes for (c) January, and (d) July. (Adapted from Chase et al. 2000.)



Redistribution of Heat Due to the Human Disturbance of the Earth's Climate System

Globally-Average Absolute Value of Sensible Heat Plus Latent Heat		
Only Where Land Use Occurs	July January	1.9 Watts m^{-2} 0.7 Watts m^{-2}
Teleconnections Included	July January	8.9 Watts m^{-2} 9.5 Watts m^{-2}

"HOT TOWERS"

"As shown in the pioneering study by Riehl and Malkus (1958) and by Riehl and Simpson (1979), 1500-5000 thunderstorms (which they refer to as 'hot towers') are the conduit to transport this heat, moisture, and wind energy to higher latitudes. Since thunderstorms occur only in a relatively small percentage of the area of the tropics, a change in their spatial patterns would be expected to have global consequences."

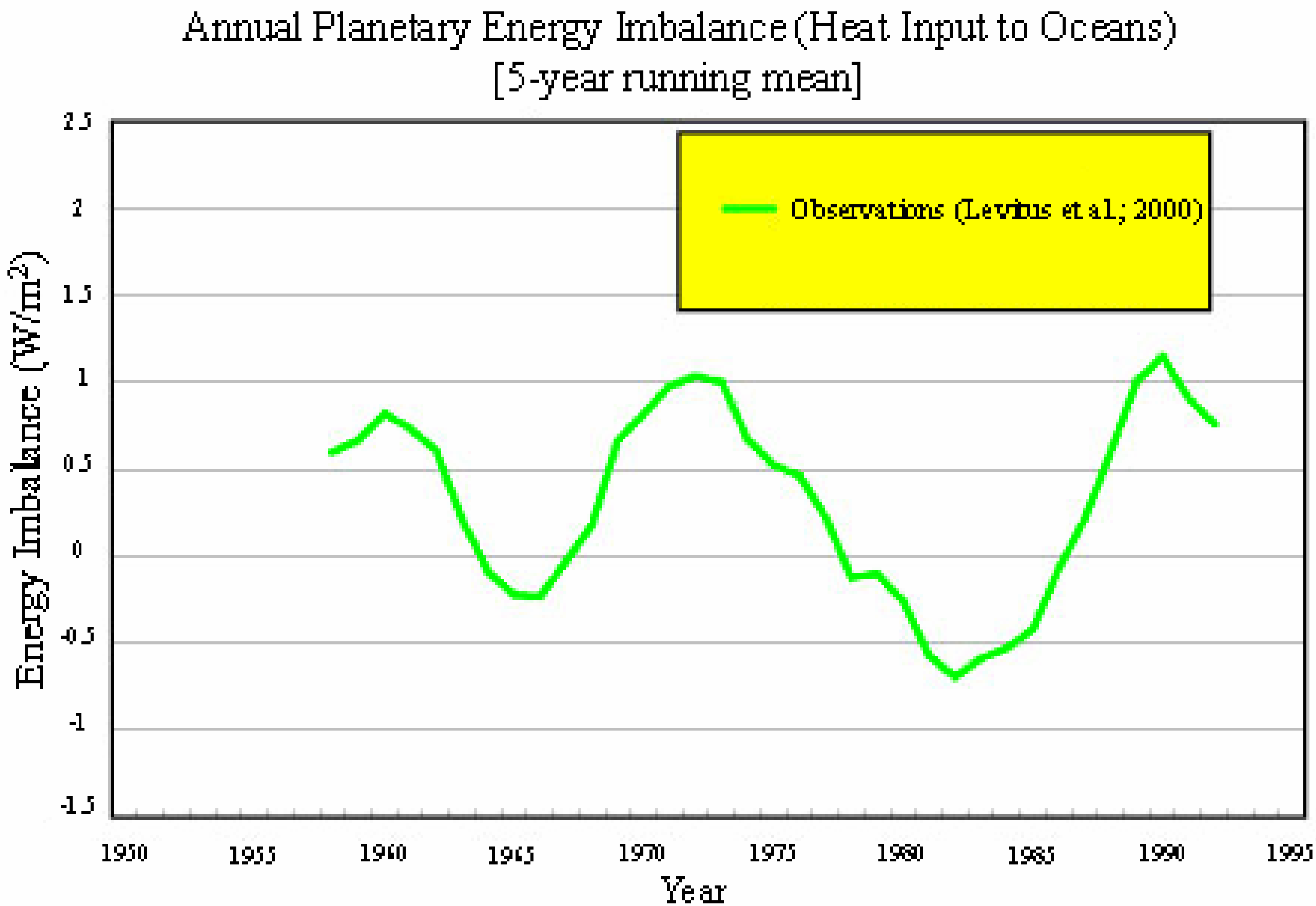
From Pielke Sr., R.A., 2001: Influence of the spatial distribution of vegetation and soils on the prediction of cumulus convective rainfall. Rev. Geophys., 39,151-177.

5

The Adoption of a More Appropriate Metric to Monitor "Global Warming (or Cooling)"

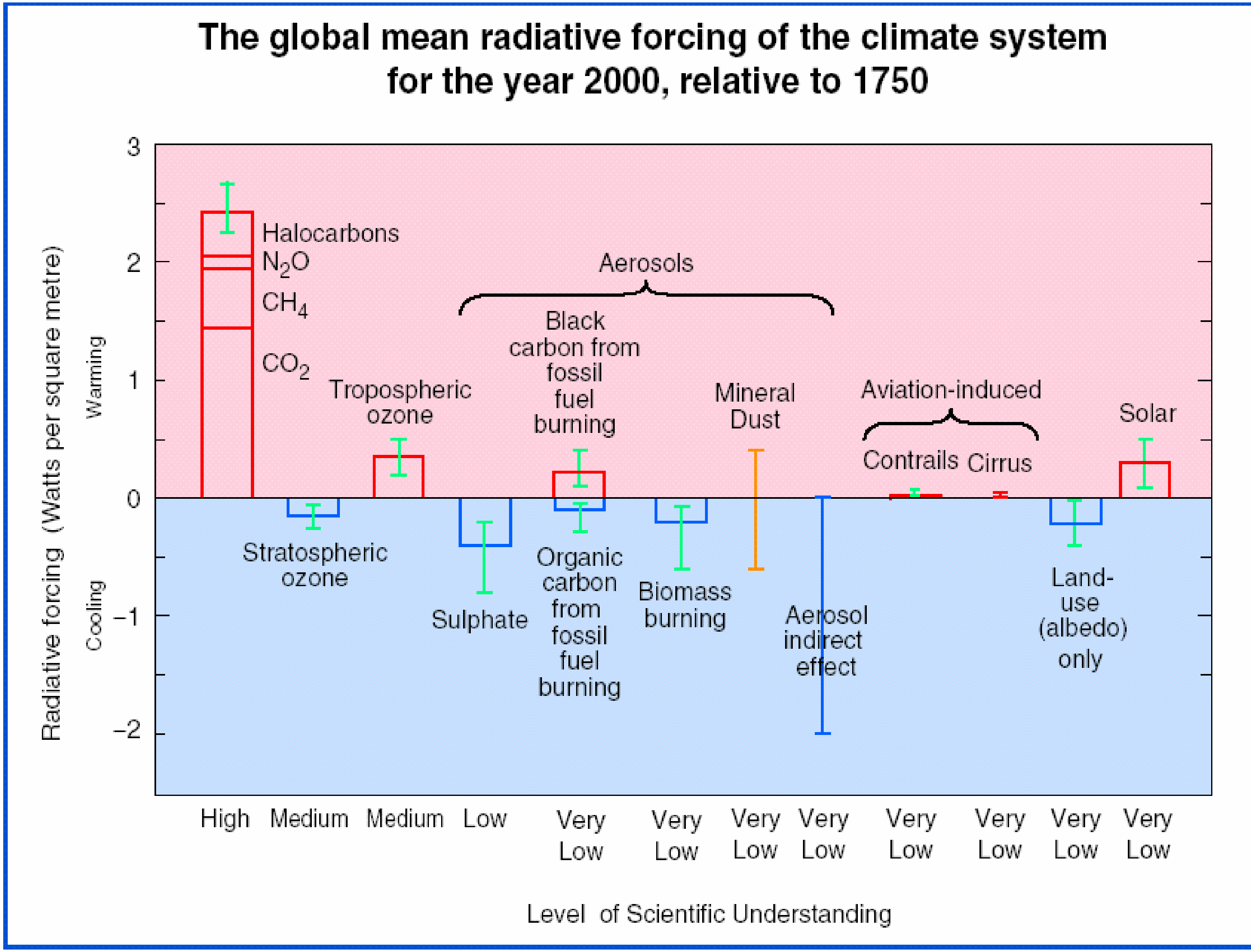
Pielke Sr., R.A., 2003: Heat storage within the earth system. *Bull. Amer. Meteor. Soc.*, 84, 331-335.

http://blue.atmos.colostate.edu/publications/pdf/R-247.pdf



Planetary energy imbalance (heat storage in the upper 3 km of the world ocean) observations expressed in units of watts m^{-2} (adapted from Levitus et al. 2001). (Figure prepared by Alan Robock, Rutgers University, 2001, personal communication.)

Mid 1950s	to	Mid-1990s
~ 0.15 Watts m^{-2}		surface - 300 meters
~ 0.15 Watts m^{-2}		300 meters – 3 km



Estimate of actual climate system heat change from the early 1950s-1995 is 0.3 Watts per meter squared (Pielke 2003) based on ocean heat storage changes (Levitus et al. 2000). Figure from Houghton et al. Eds., 2001: Summary for Policymakers: http://www.ipcc.ch

Climate as an Initial Value Problem

Pielke, R.A. Sr., 2002: Overlooked issues in the U.S. National Climate and IPCC assessments. *Climatic Change*, 52, 1-11.

http://blue.atmos.colostate.edu/publications/pdf/R-225.pdf

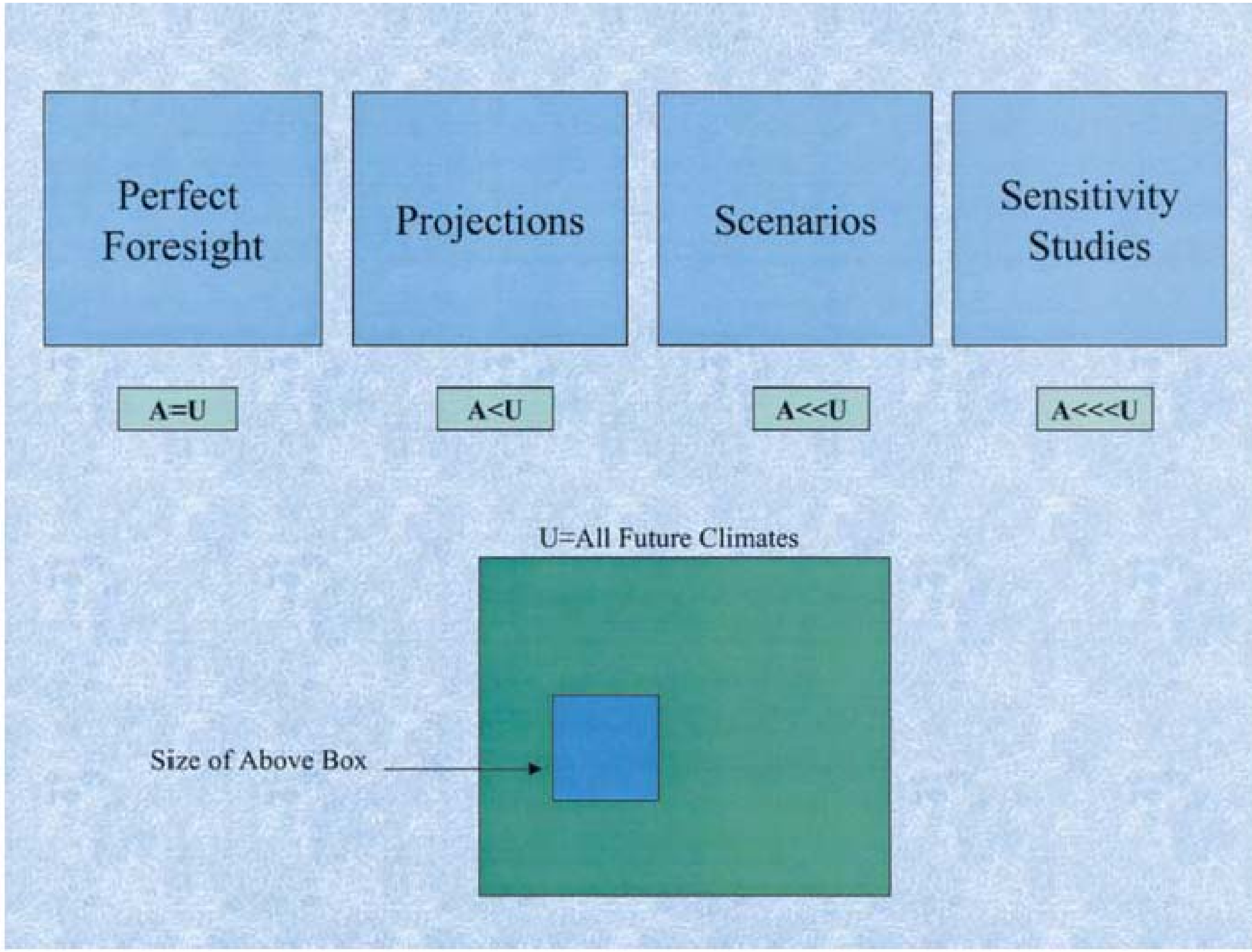
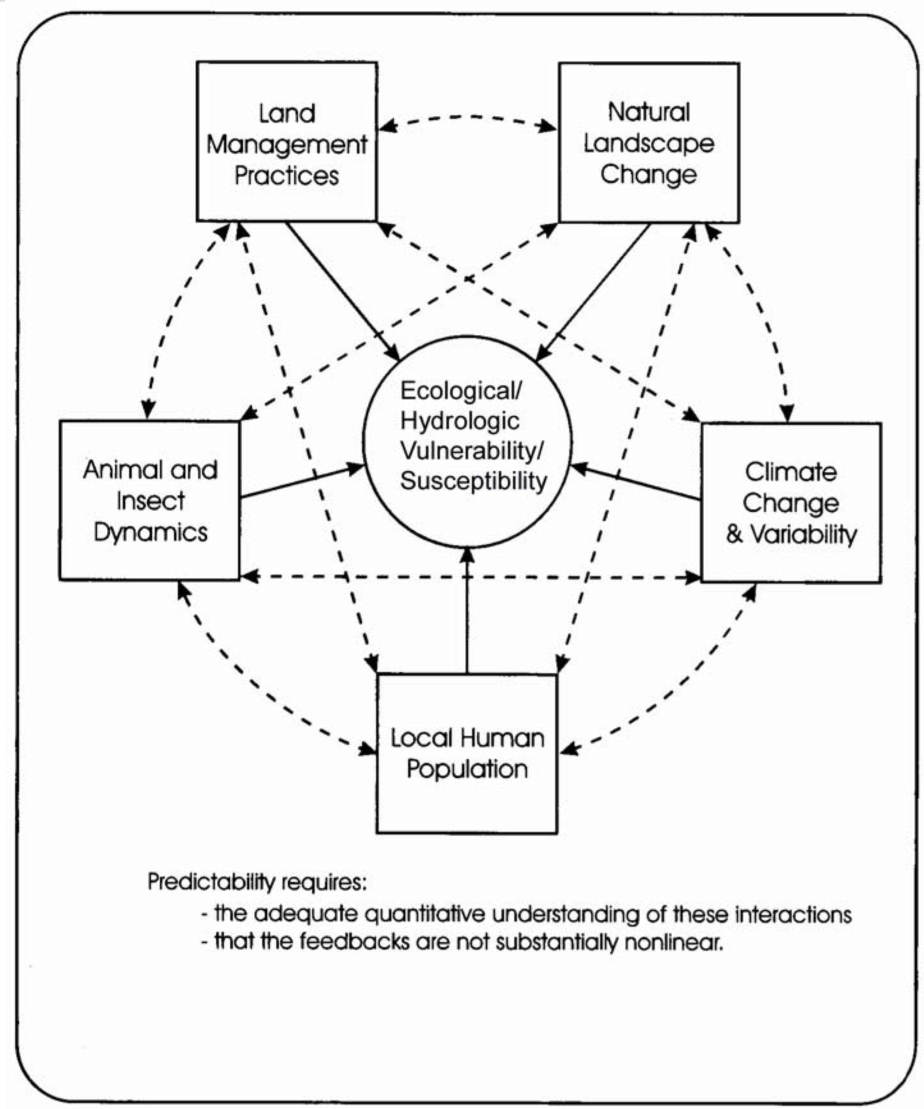


Figure 6. Schematic of different classes of prediction. The size of the box labeled 'U' represents the range of future climate, while the box labeled 'A' indicates the relative subset of possible future climate that are estimated using the different classes of prediction (adapted from Pielke Sr., 2001).

From: Pielke, R.A. Sr., 2002: Overlooked issues in the U.S. National Climate and IPCC assessments. *Climatic Change*, 52, 1-11.
http://blue.atmos.colostate.edu/publications/pdf/R-225.pdf

* Note that more appropriately, it is weather change and variability



7a

Regional Land-Use Change Effects on Climate in the Winter

Marshall, C.H. Jr., R.A. Pielke Sr., and L.T. Steyaert, 2003: Crop freezes and land-use change. *Nature*, 426, 29-30.
http://blue.atmos.colostate.edu/publications/pdf/R-277.pdf

Marshall, C.H., R.A. Pielke Sr., and L.T. Steyaert, 2004: Has the conversion of natural wetlands to agricultural land increased the incidence and severity of damaging freezes in south Florida? Mon. Wea. Rev., submitted.
http://blue.atmos.colostate.edu/publications/pdf/R-281.pdf

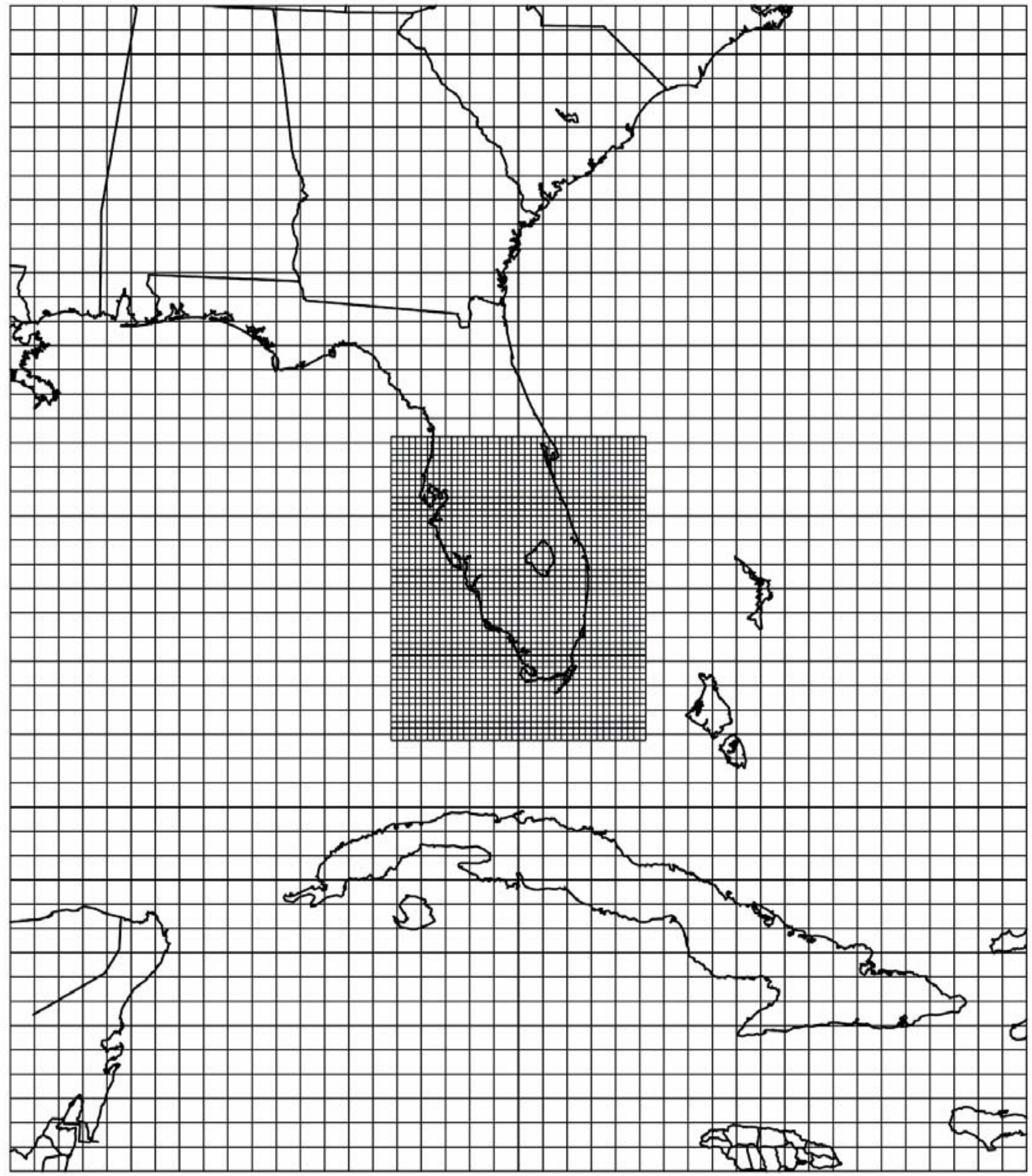


Fig. 2. Outer and inner grid configurations for RAMS domain centered on south Florida.

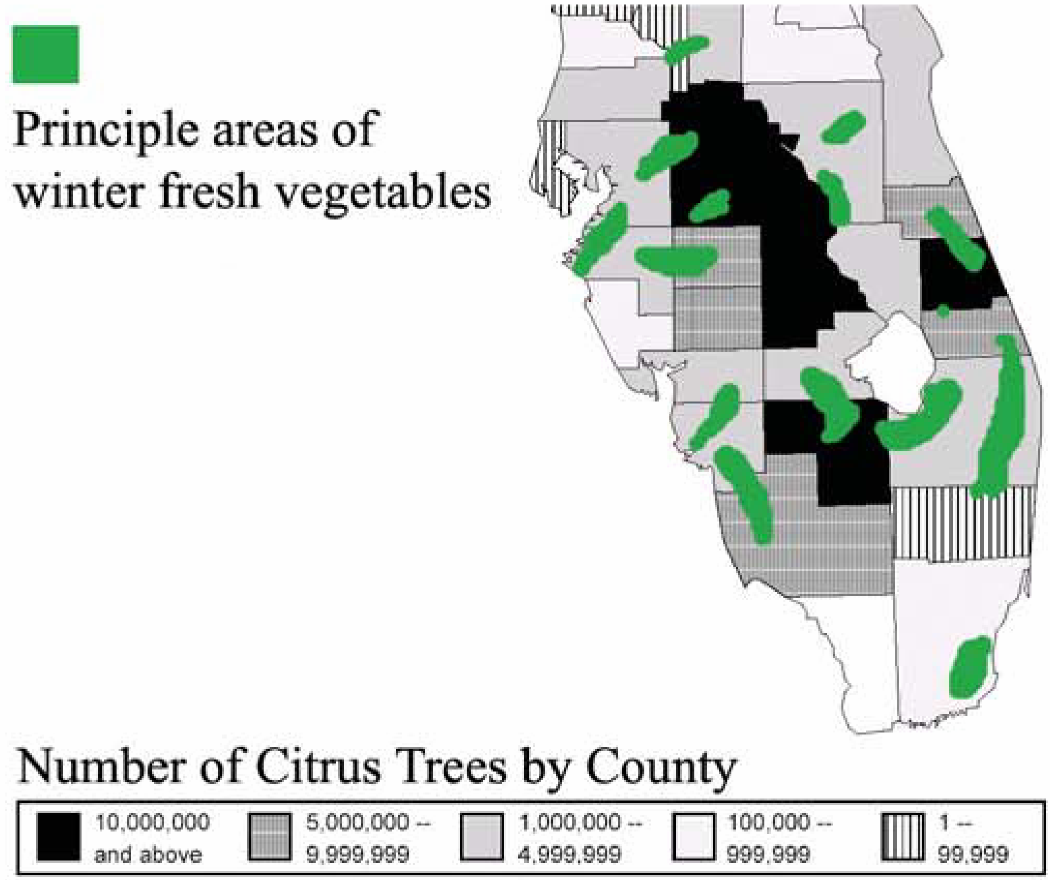


Fig. 1. Number of citrus trees per county and principle areas of winter fresh vegetable production. Figure adapted from Florida Agriculture Facts Directory 2002.

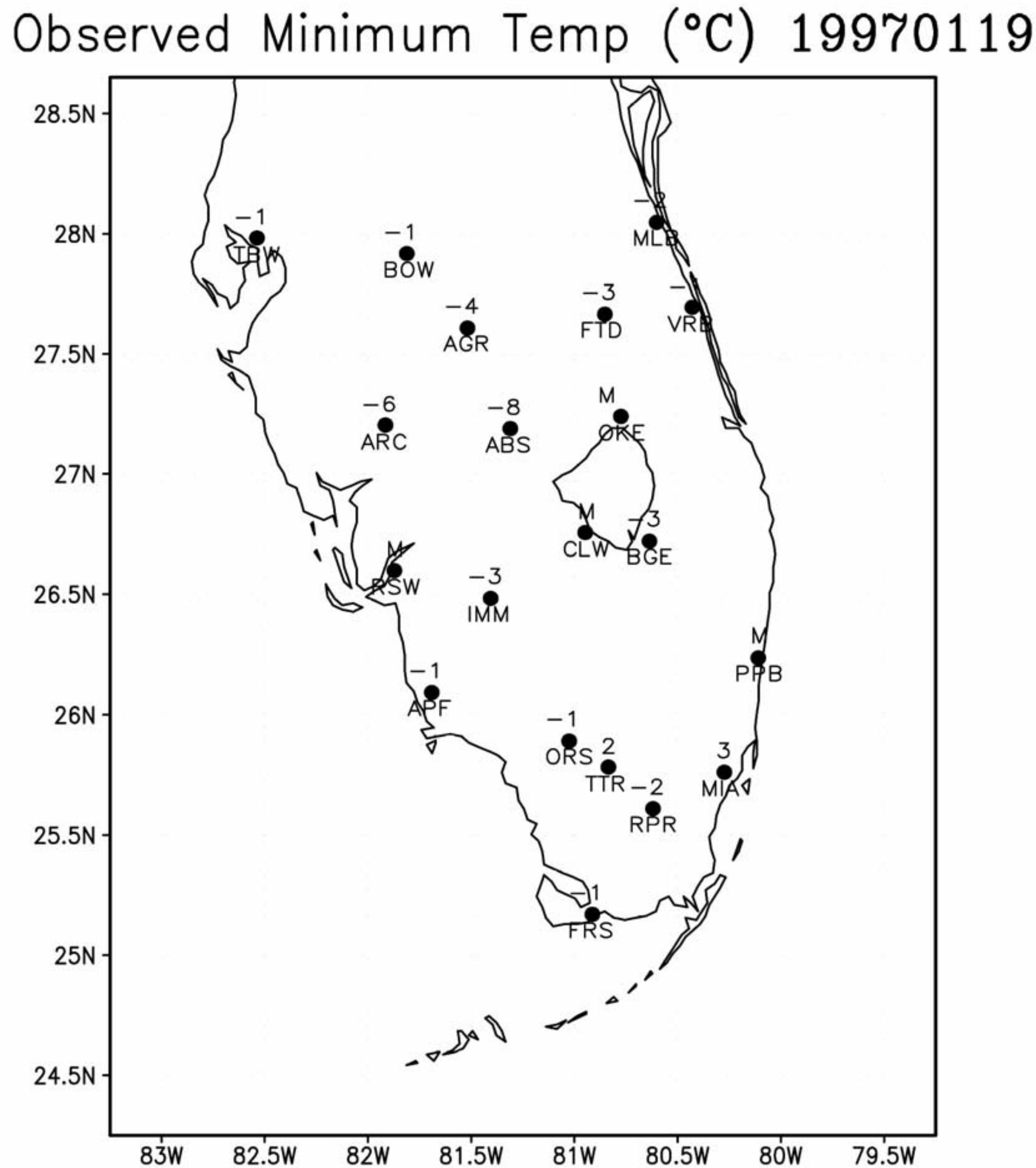


Fig. 2. Observations of minimum temperature from the National Weather Service Cooperative Observer Network on the morning of January 19, 1997.

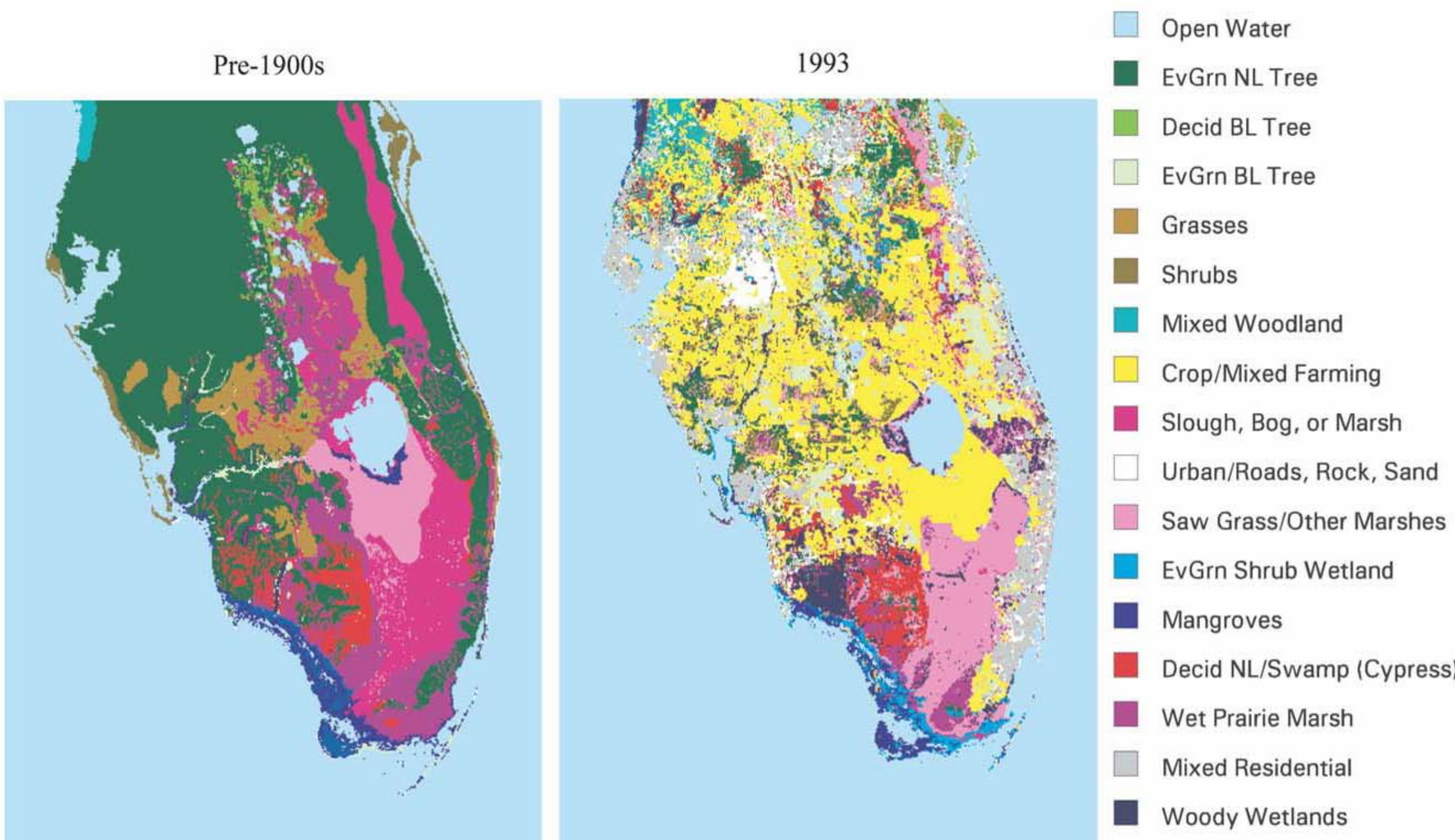


Fig. 3. U.S. Geological Survey land cover classes for pre-1900s natural conditions (left) and 1993 land use patterns.

1997

Min T

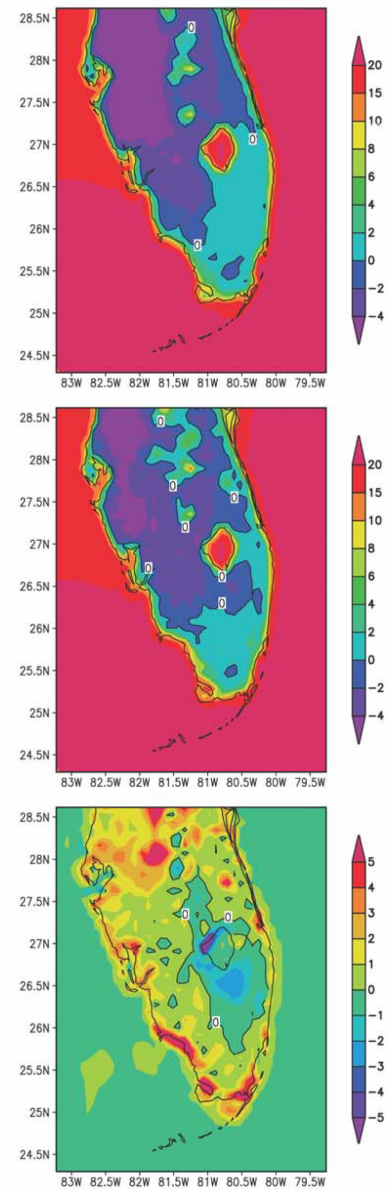


Fig. 4. Model simulated 2 meter minimum temperatures on the morning of January 19, 1997 for the pre-1900s scenario (top panel), the1993 sceanrio (middle panel), and the difference of the two (1993 minus pre-1900s scenario; bottom panel).

1997

duration

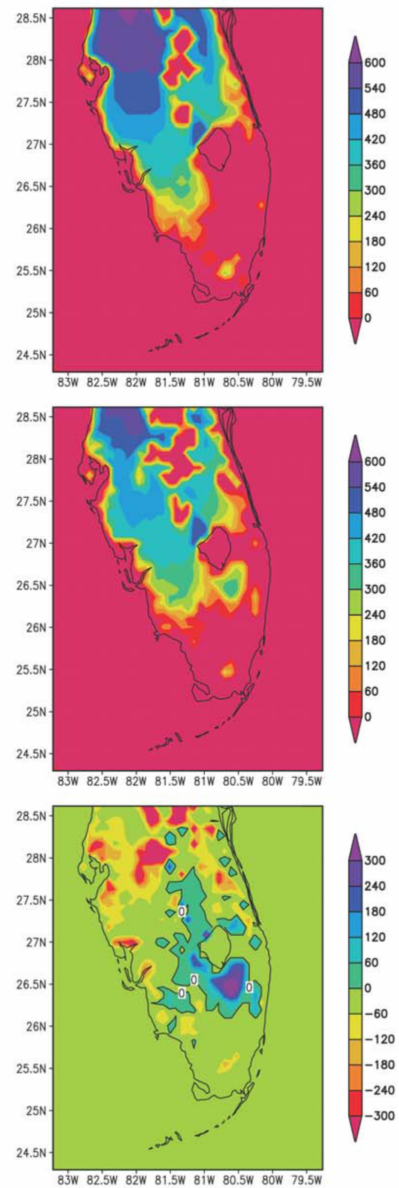


Fig. 5. Time spent below freezing (minutes) for the night prior to the morning of January 19. 1997, for the pre-1900s land cover scenario (top), the 1993 land cover scenario (middle) and the difference of the two (bottom).

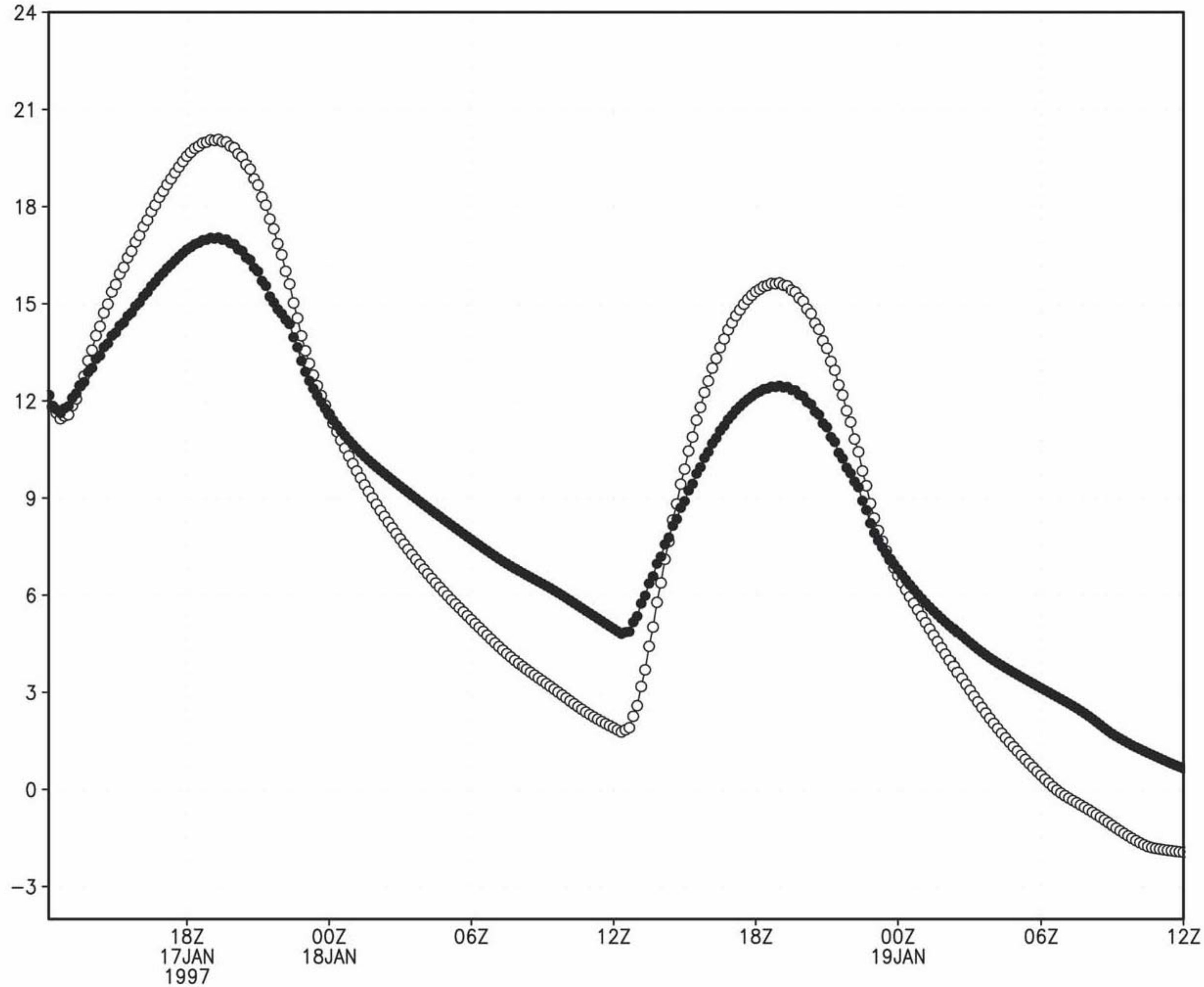


Fig. 7. Time series of 2 meter temperature for a model grid point located just south of Lake Okeechobee for the pre-1900s land cover scenario (filled circles) and the 1993 land cover scenario (open circles).

7b

Regional Land-Use Change Effects on Climate in the Summer

Marshall, C.H. Jr., R.A. Pielke Sr., L.T. Steyaert, and D.A. Willard, 2004: The impact of anthropogenic land cover change on warm season sensible weather and sea-breeze convection over the Florida peninsula. *Mon. Wea Rev.*, 132, 28-52.

http://blue.atmos.colostate.edu/publications/pdf/R-272.pdf

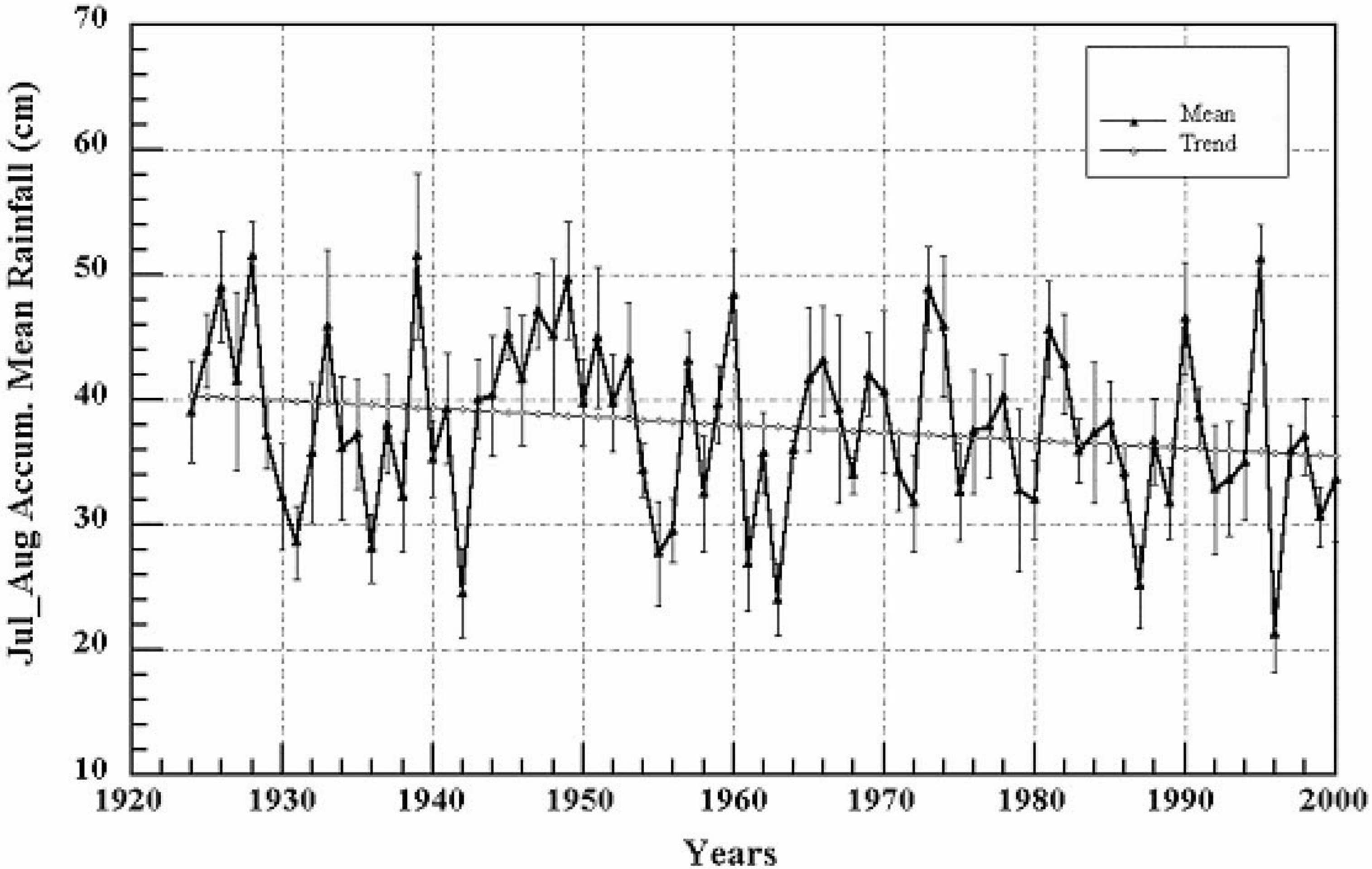


FIG. 25. Regional average time series of accumulated convective rainfall (cm) from 1924 to 2000, with corresponding trend based on linear regression of all July-August amounts. The vertical bars overlain on the raw time series indicate the value of the standard error of the July-August regional mean.

Max and Min Temp Trends

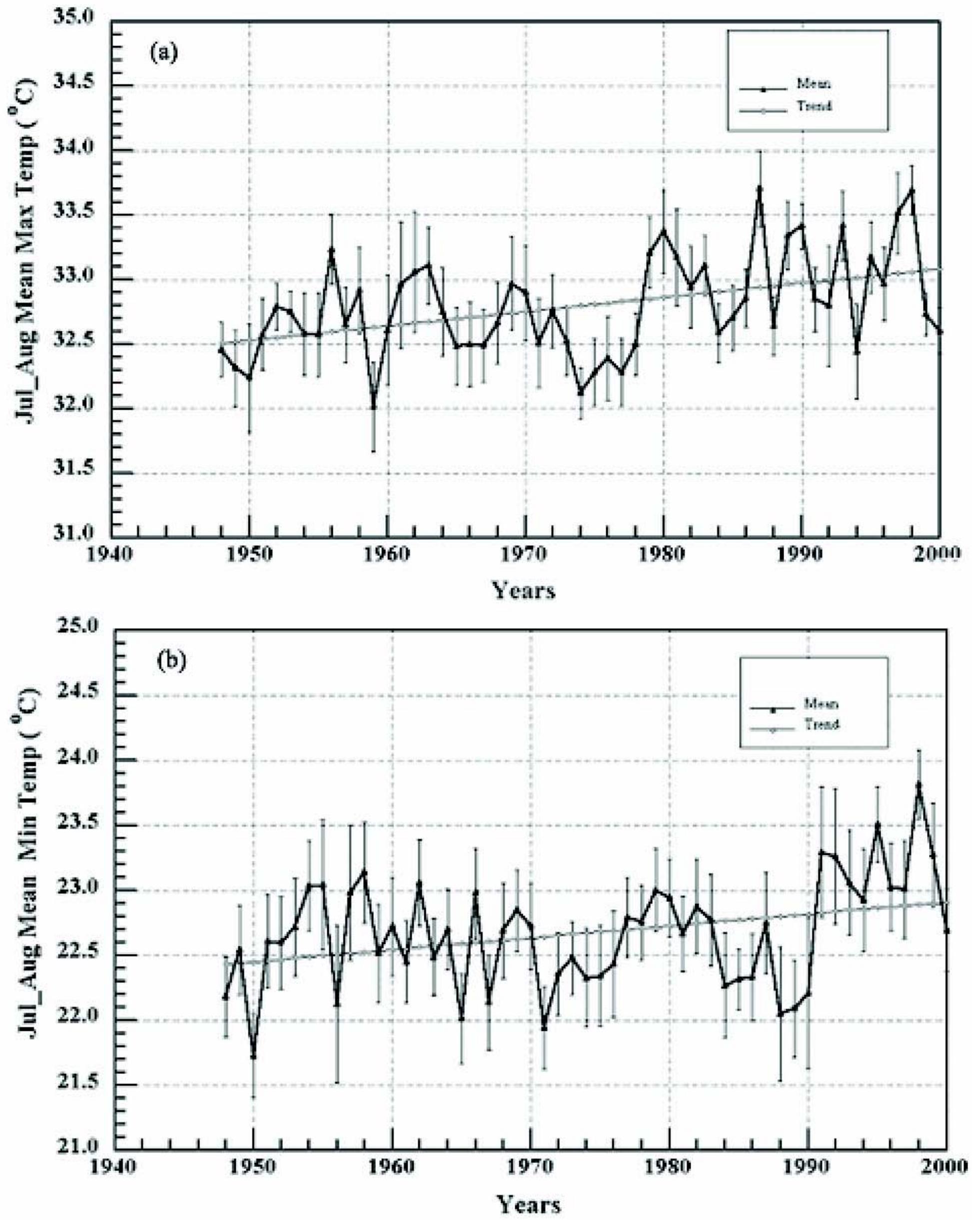


FIG. 26. Same as in Figure 25, except for daily (a) maximum and (b) minimum shelter-level temperature (°C)

1973

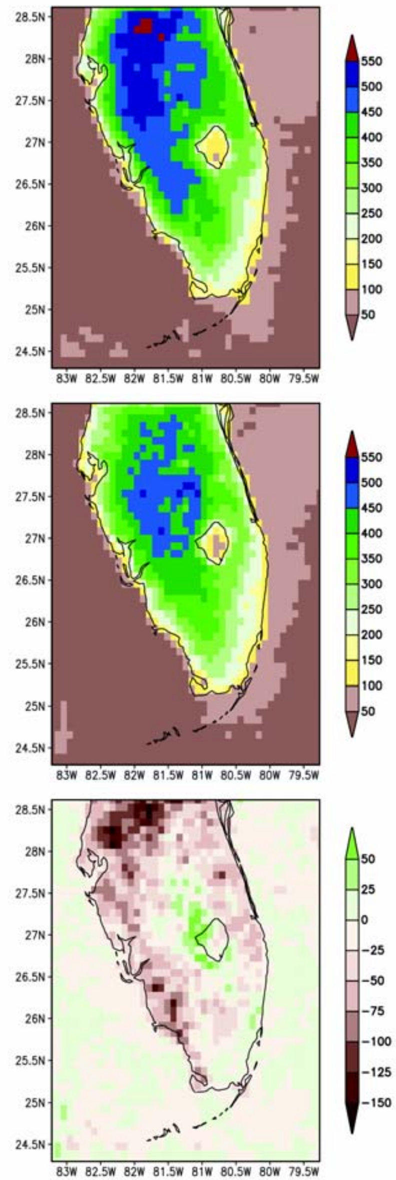


FIG. 4. Accumulated convective rainfall (mm) from the model simulations of July-August 1973 with pre-1900s land cover (top), 1993 land use (middle), and the difference field for the two (bottom panel; 1993 minus pre-1900s case).

1989

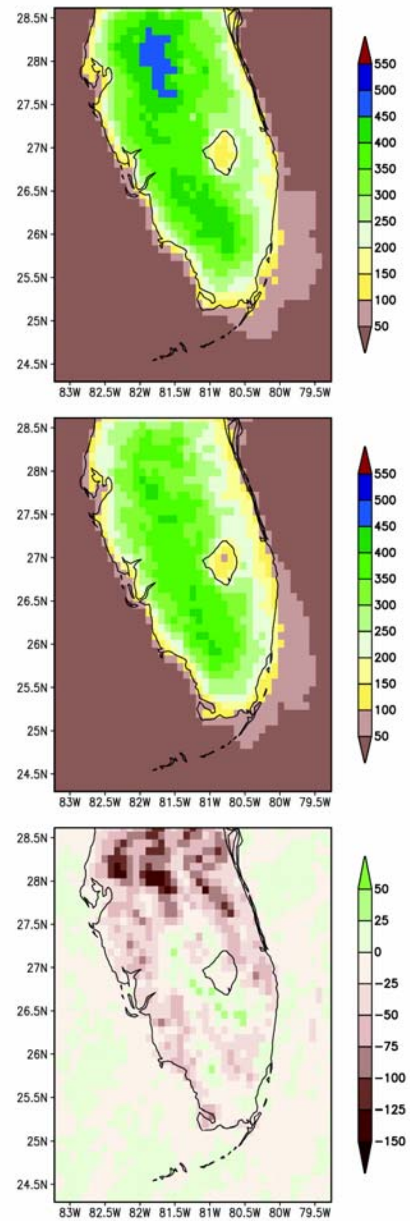


FIG. 5. Same as in Figure 4, except for July-August 1989.

1994

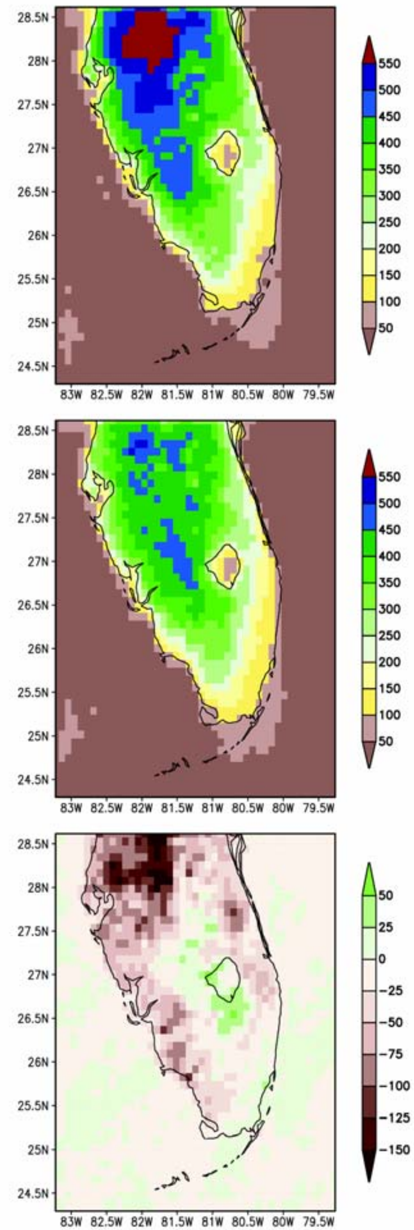
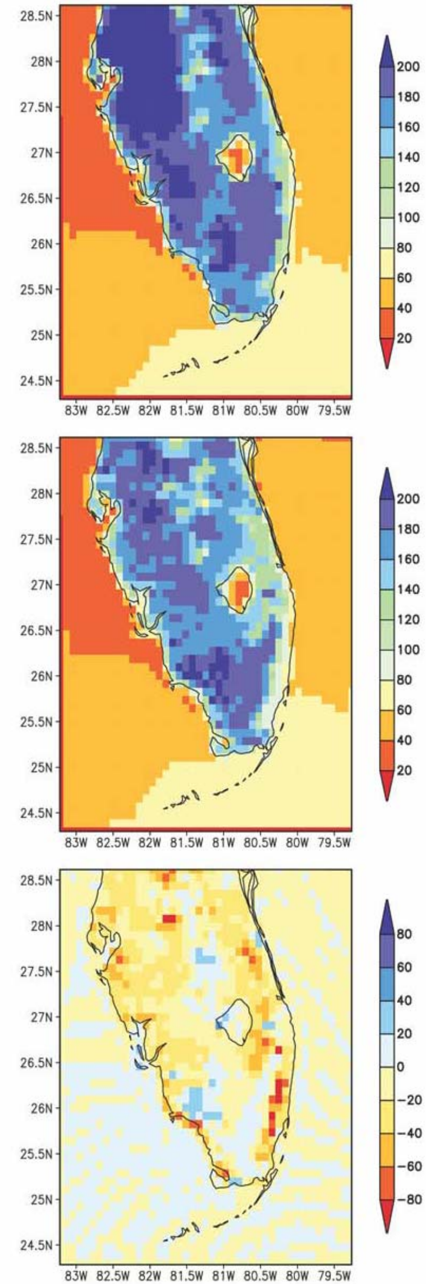


FIG. 6. Same as in Figure 4, except for July-August 1994.

Two-month average of the surface latent heat flux (W m^{-2}) from the model simulations of July and August 1994 with pre-1900s land cover (top), 1994 land use (middle), and the difference field for the two (bottom; 1994 minus pre-1900s case).



1989

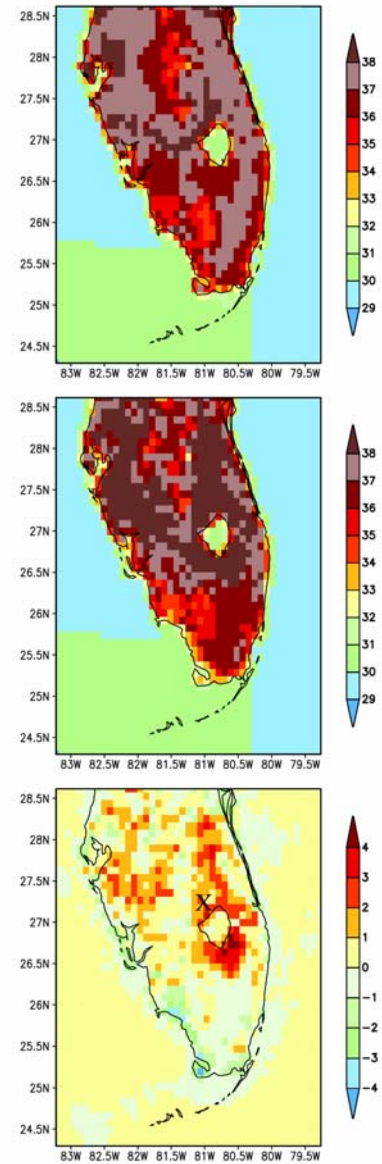


FIG. 13. Two-month average of the daily maximum shelter-level temperature from the model simulations of July-August 1989 with pre-1900s land cover (top), 1993 land use (middle), and the difference field for the two (bottom panel; 1993 minus pre-1900s case).

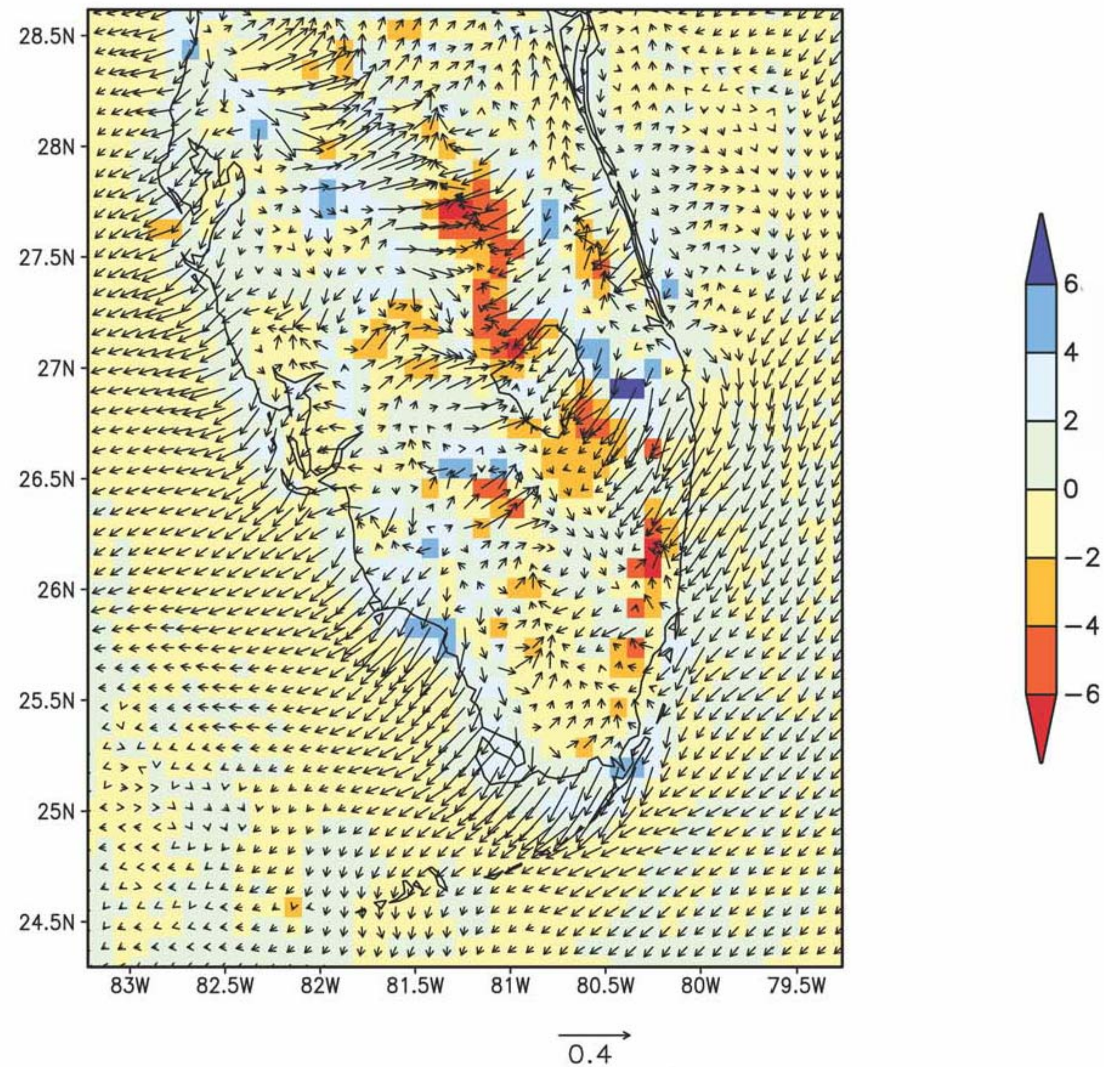


FIG. 17. Difference (1993 minus pre-1900s case) of the fields shown in Figure 16.

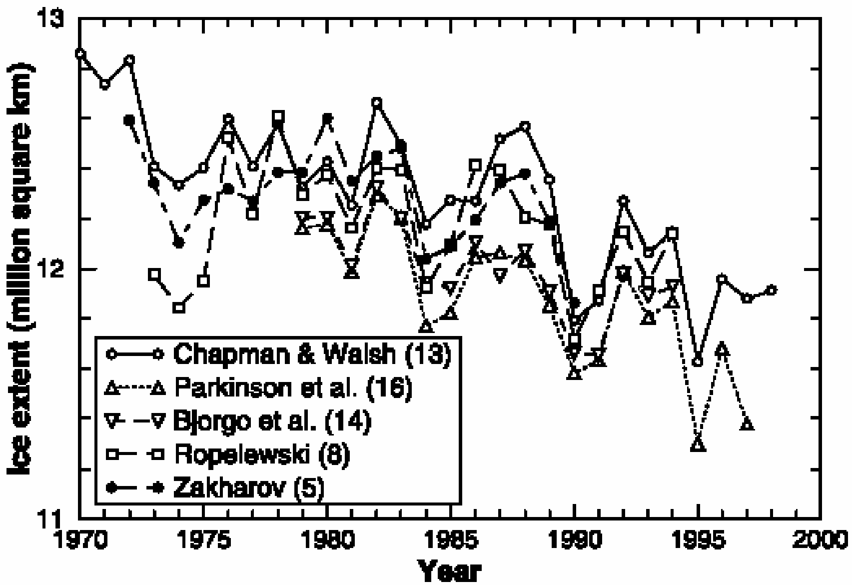
8

Arctic Sea Ice and Northern Hemispheric Snow-Cover Changes

Pielke Sr., R.A., G.E. Liston, W.L. Chapman, and D.A. Robinson, 2004: Actual and insolation-weighted Northern Hemisphere snow cover and sea ice -- 1974-2002. Climate Dynamics, in press.

http://blue.atmos.colostate.edu/publications/pdf/R-256.pdf

Projected Sea Ice Changes (from Vinnikov et al. 1999, Science, 286, 1934-1937).



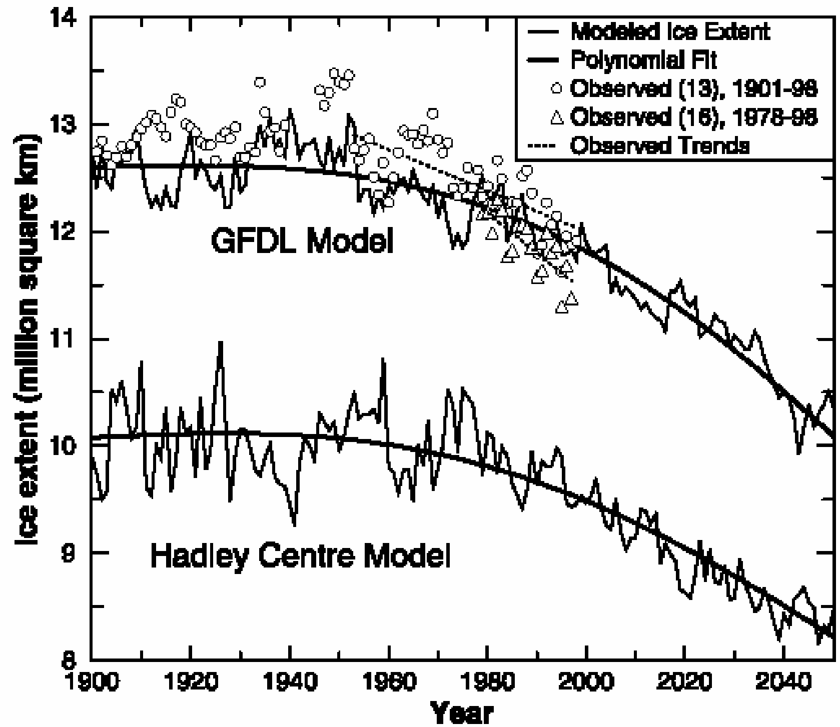
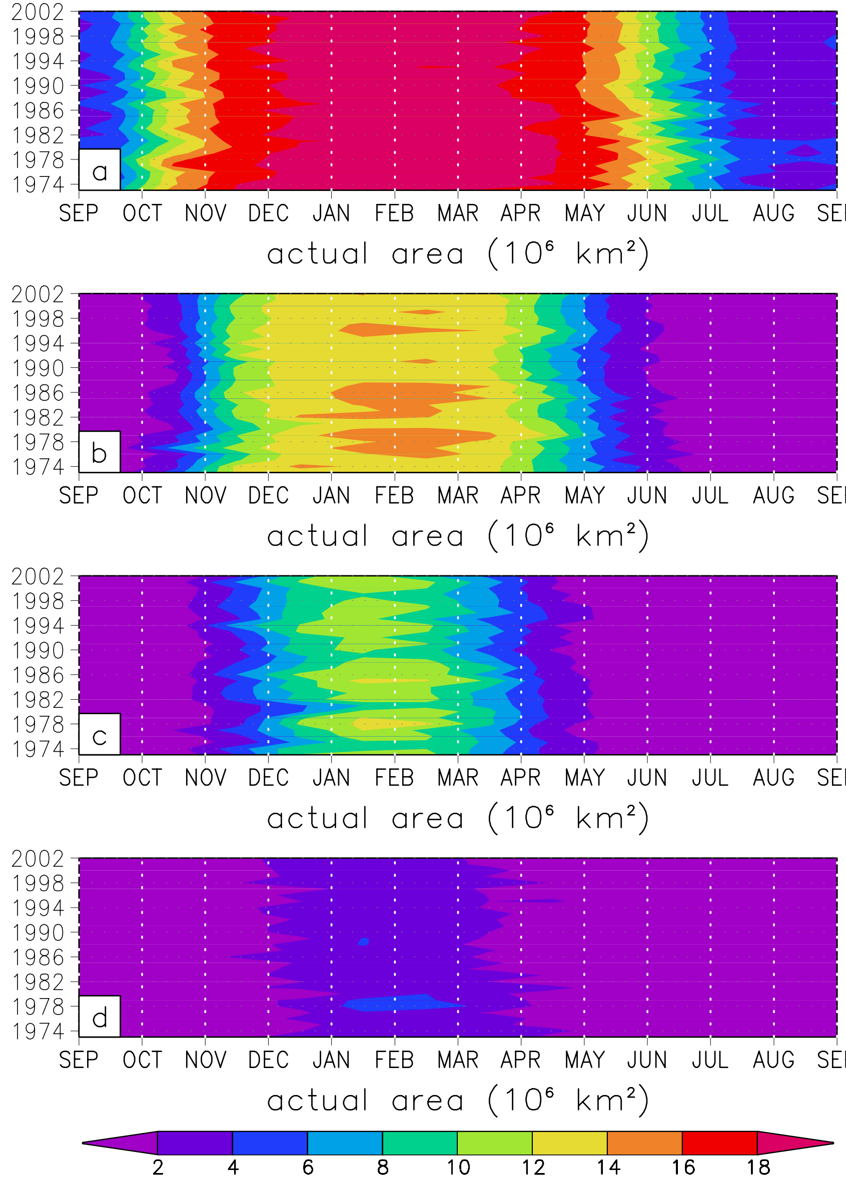
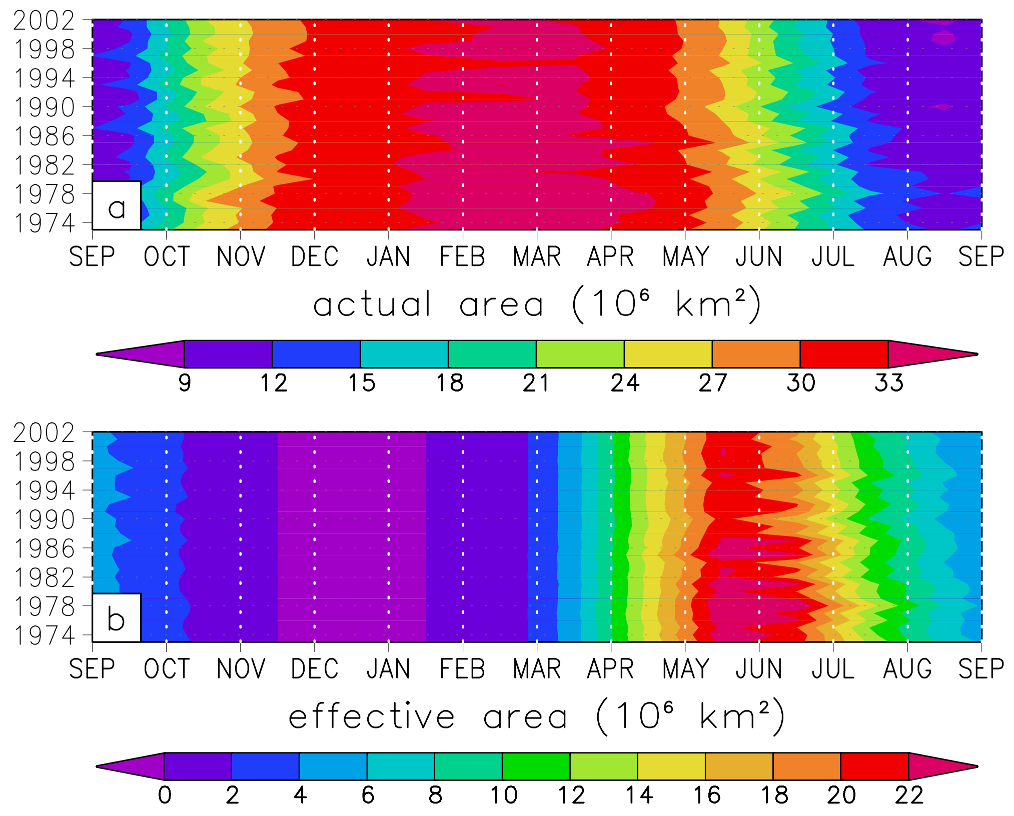


Fig. 1 (**left**). Observed decrease of NH sea ice extent during the past 25 years. **Fig. 2** (**right**). Observed and modeled variations of annual averages of NH sea ice extent. Observed data for 1901–98 are from Chapman and Walsh (*13*). Observed data for 1978–98 are from Parkinson *et al.* (*16*). The modeled sea ice extents are from the GFDL and Hadley Centre climate model runs forced by observed CO_2 and aerosols. Modeled data for ~250 years are smoothed by polynomials of degree 10 to estimate nonlinear trends caused by a change of external radiative forcing.

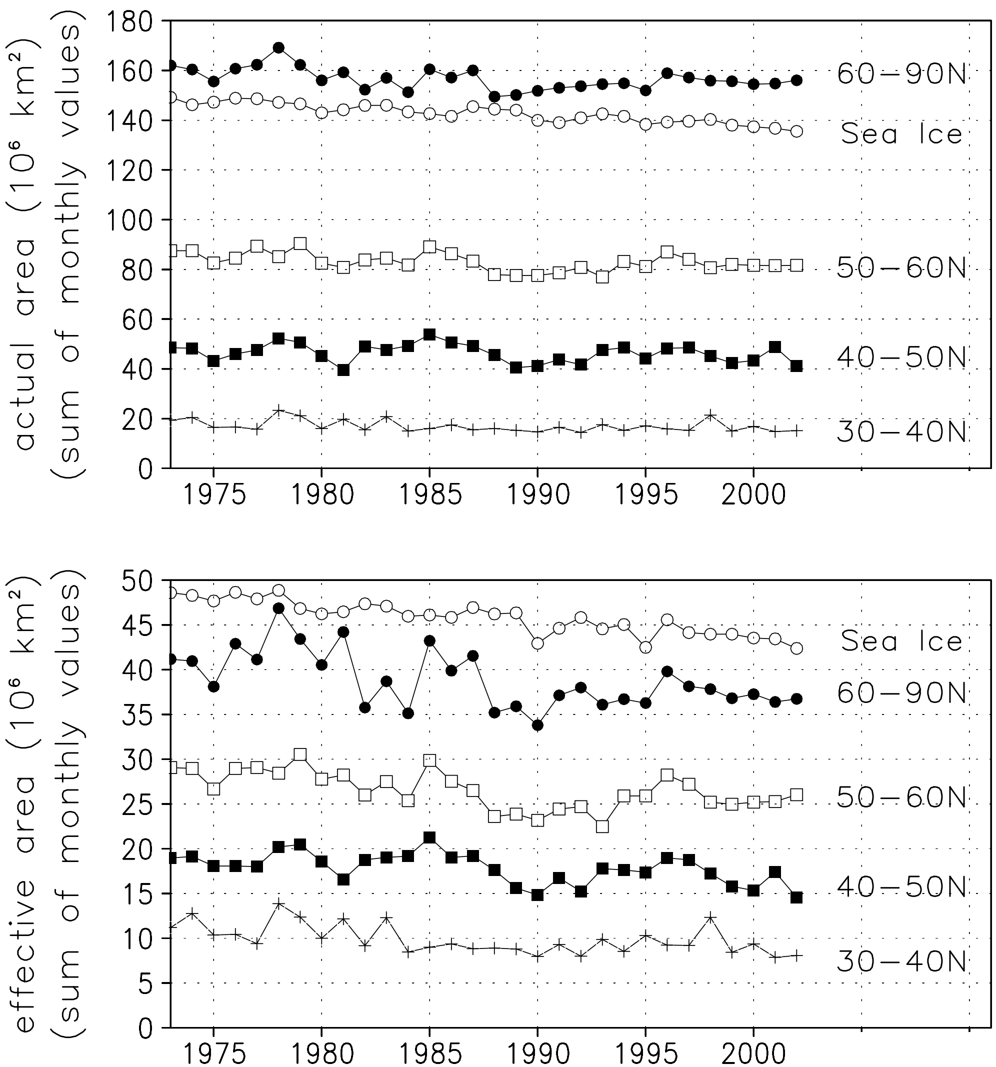
Actual snow cover by latitude bands
(a) 60-90°N;
(b) 50-60°N;
(c) 40-50°N; and
(d) 30-40°N.



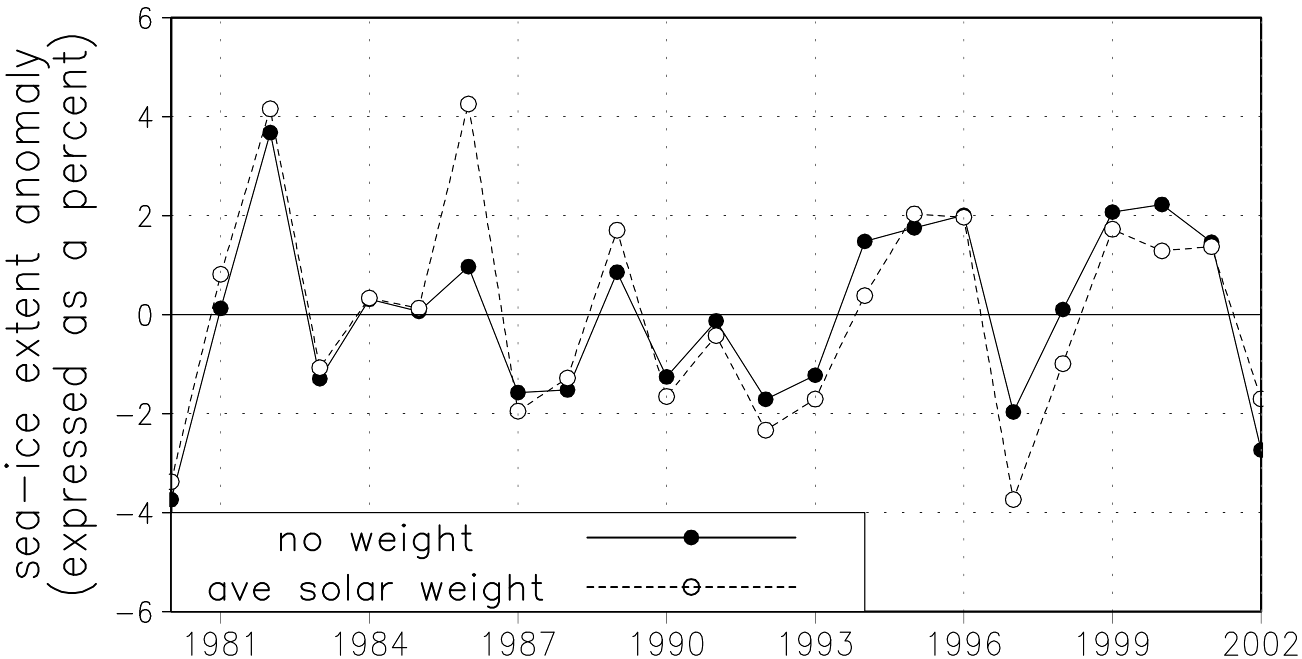
Actual and insolation-weighted values with Arctic sea ice and snow (60-90°N) included together.



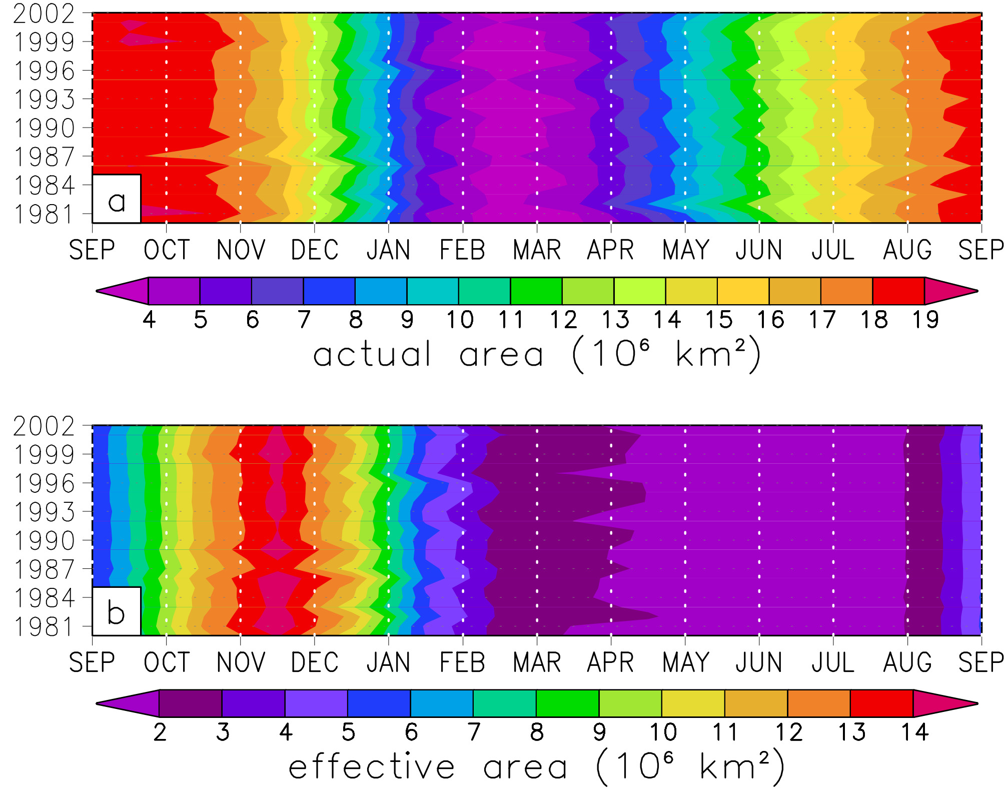
Actual and insolation-weighted values with Arctic sea ice and snow (60-90°N) included together.



Antarctic annual averaged sea-ice extent, 1980-2002, for the cases of no weighting and average daily solar weighting. Plotted are the values minus the 23-year mean, with that quantity divided by the mean.



(a) Actual and (b) insolation-weighted monthly Antarctic sea-ice extent for 1980-2002.



CONCLUSION

The earth's climate system and human disturbance of the climate system is more complicated and multi-dimensional than commonly assumed. This may make skillful prediction of the future climate impossible!

There is a new direction emerging.

Kabat, P., M. Claussen, P.A. Dirmeyer, J.H.C. Gash, L. Bravo de Guenni, M. Meybeck, R.A. Pielke Sr., C.J. Vorosmarty, R.W.A. Hutjes, and S. Lutkemeier, Editors, 2004: *Vegetation, water, humans and the climate: A new perspective on an interactive system*. Global Change - The IGBP Series, Springer, in press.

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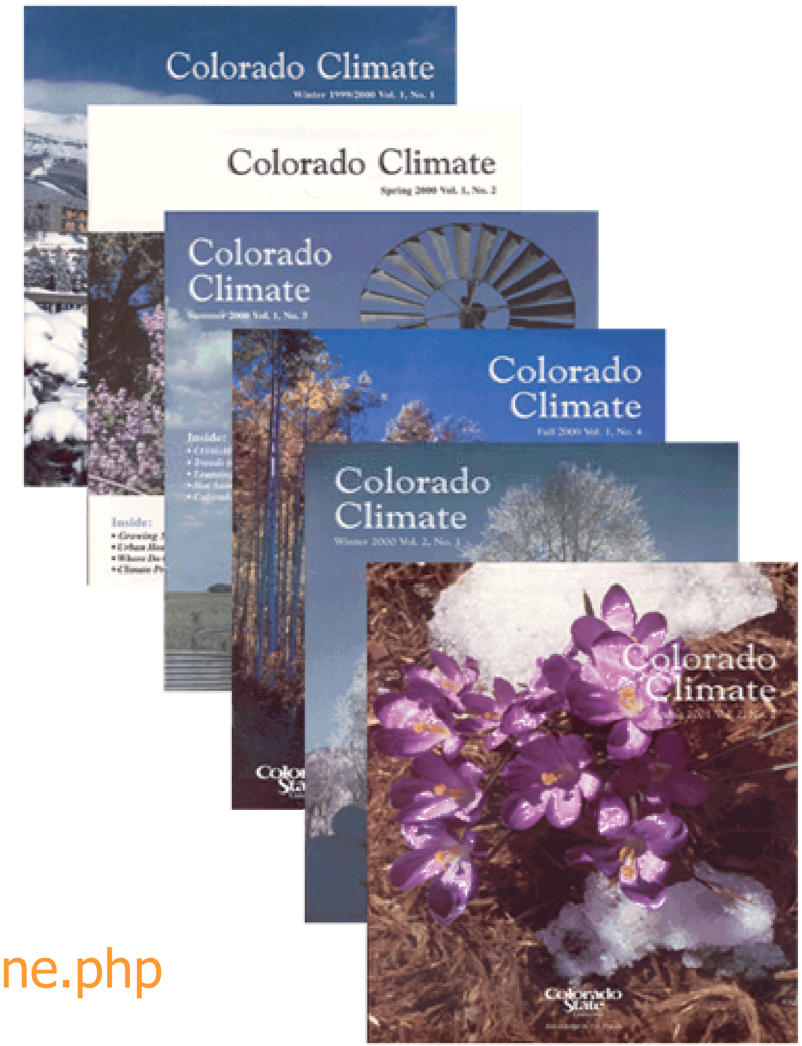

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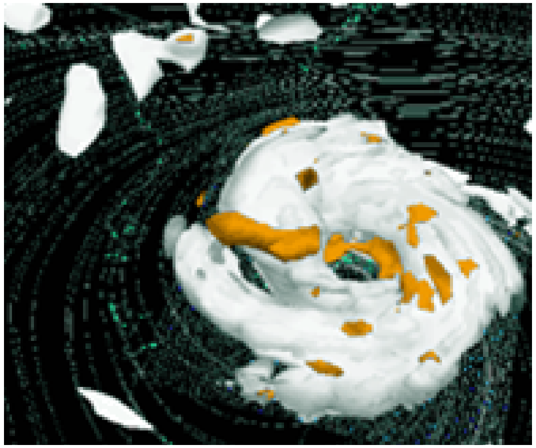

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Sunday February 22, 2004
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http://observer.guardian.co.uk/international/story/0,6903,1153513,00.html