Empirical Studies of Upper-Air Climate Changes: problems, status, prospects

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Plan of presentation

- A brief digression: APN (Asia-Pacific Network on Global Change)
- Main topics: Upper-Air (U/A) temperature changes.
- Epilogue: WMO Effort on Third Edition of “Guide on Climatological Practices” (GCP)

APN (Asia-Pacific Network on Global Change)

- What is APN?
- APN web site:
- http://www.apn-gcr.org/en/indexe.html
- APN Calls for Proposals (Pre-proposal stage is optional)
- Three APN countries are minimally needed (two developing countries plus one developed country

Main topics: Upper-Air (U/A) temperature changes

- Datasets available now for the upper-air climate studies, their pluses and minuses;
- Periods in the U/A climate (temperature et al) studies
- Reanalysis outputs and their possible role in the empirical studies of U/A climate – how much we can believe to reanalysis outputs?
- Do the years of early XXI century change the long-period trends of U/A temperature?
- Are there long-period trends in the parameters of variability of the U/A temperature? A step from trends in mean state to trends in variability – is it possible for U/A climate?

Datasets available now for the upper-air climate studies

- RADIOSONDE:
- CARDS (Comprehensive Aerological Reference Data Set)
- AEROSTAB (RIHMI-WDC)
- IGRA (NCDC) – Integrated Global Radiosonde Dataset:
- ftp://ftp.ncdc.noaa.gov/pub/data/igra
- GCOS GUAN (Global Upper Air Network) -150 stations
- LKS (Lanzante-Klein-Seidel) subset of stations – homogenized temperature data

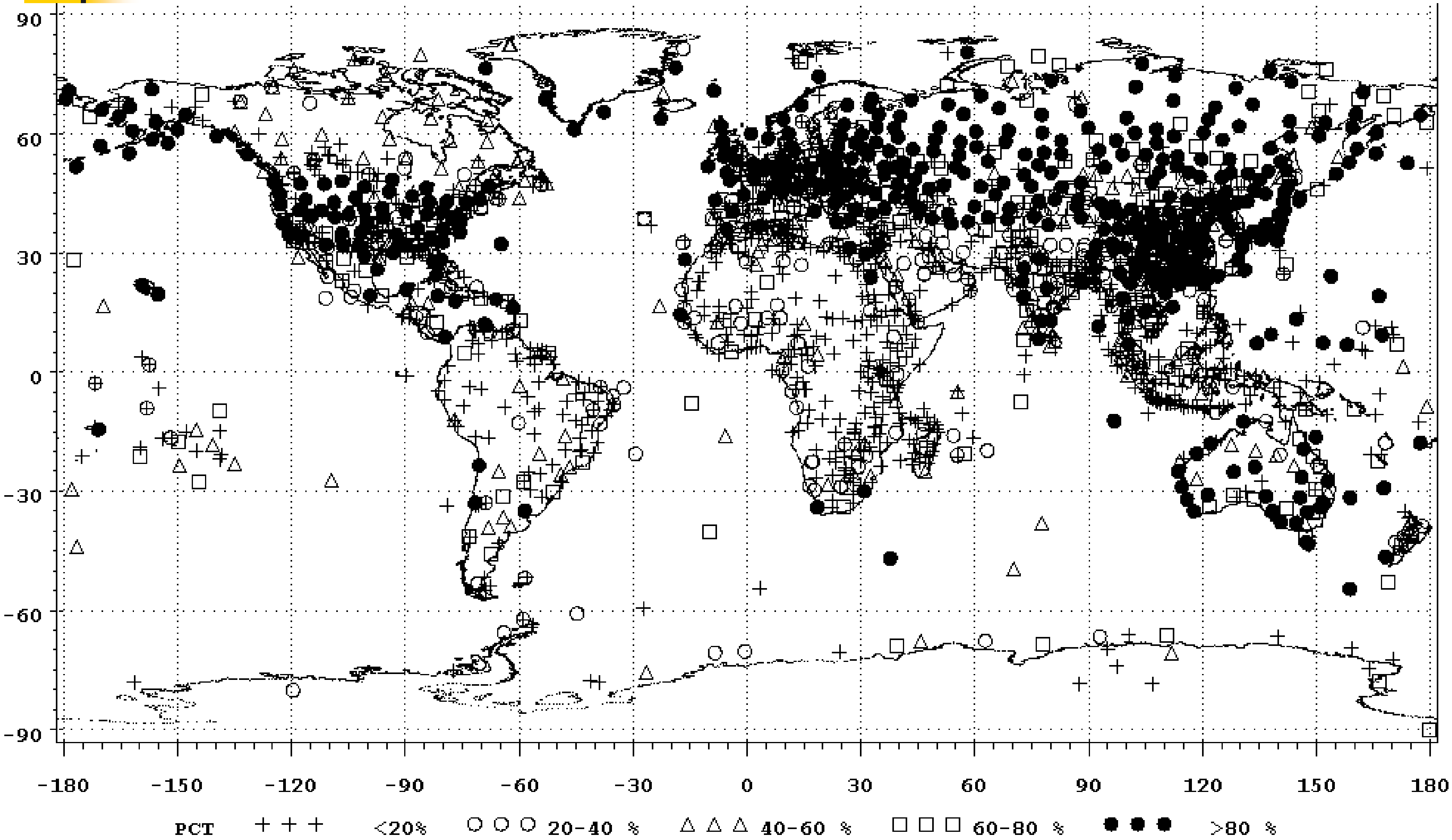
Datasets available now for the upper-air climate studies

- SATELLITE:
- MSU based temperature series:
- UAH (University Alabama at Huntsville) available at VORTEX.NSSTC.UAH.EDU/DATA/MSU/, WWW.NSSTC.UAH.EDU/DATA/MSU/
- RSS (Remote Sensing Systems, Inc.) available at HTTP://WWW.SSMI.COM/MSU/DATA/,
- FTP://FTP.SSMI.COM/MSU/DATA/
- Reanalysis Outputs (Are they Data??? Are they appropriate???)
- Derivaties (monthly statistics) (IGRA-monthly, MONADS)

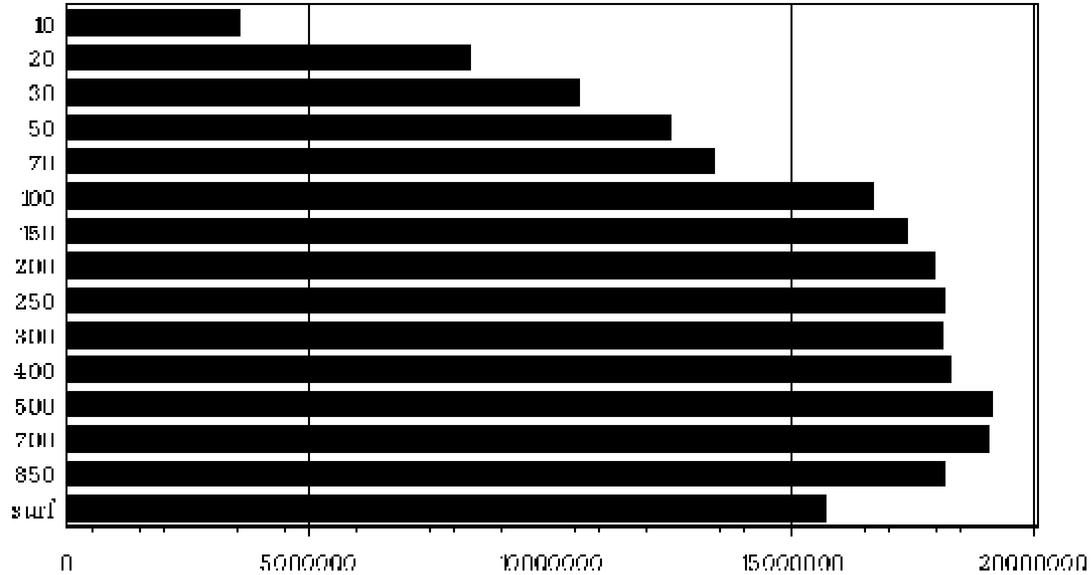
Periods in the U/A climate (temperature et al) studies

PERIOD	OBSERVATIONS	RESEARCH	DATASETS
Period 1 (early 1950 – mid 1960)	Beginning of regular worldwide radiosonde observations.	Accumulation of data, knowledge. First estimates of trends (5 year period!)	First radiosonde data in hardcopies and machine media
Period 2 (mid 1960 – end 1980)	Continued regular radiosonde observations. In december 1978 – beginning of NOAA polar orbital MSU data collection	Advanced studies of spatial climate patterns. 15 year trends were estimated.	Essential collections on machine media
Period 3 (early 1990 – late 1990)	Reducing observational network in Russia Regular MSU obs Beginning AMSU	Differences between trend estimates in MSU UAH series for troposphere and surface T were detected. Many questions were asked…	CARDS Project started CARDS and MONADS Reanalyses UAH MSU series
Period 4 (late 1990 – current)	Reviving Russia network Search of decisions on future U/A climate obs systems (three levels of networks, special requirements to device designers, new platforms including unmanned	1998 El Nino warming smoothed the discussion. Tried to detect inhomogeneities in radiosonde and MSU data (Asheville 2000 Workshop).	IGRA dataset RSS MSU series Reanalyses outputs

Global Radiosonde Network (% of max possible obs)(CARDS, 1958-2001)

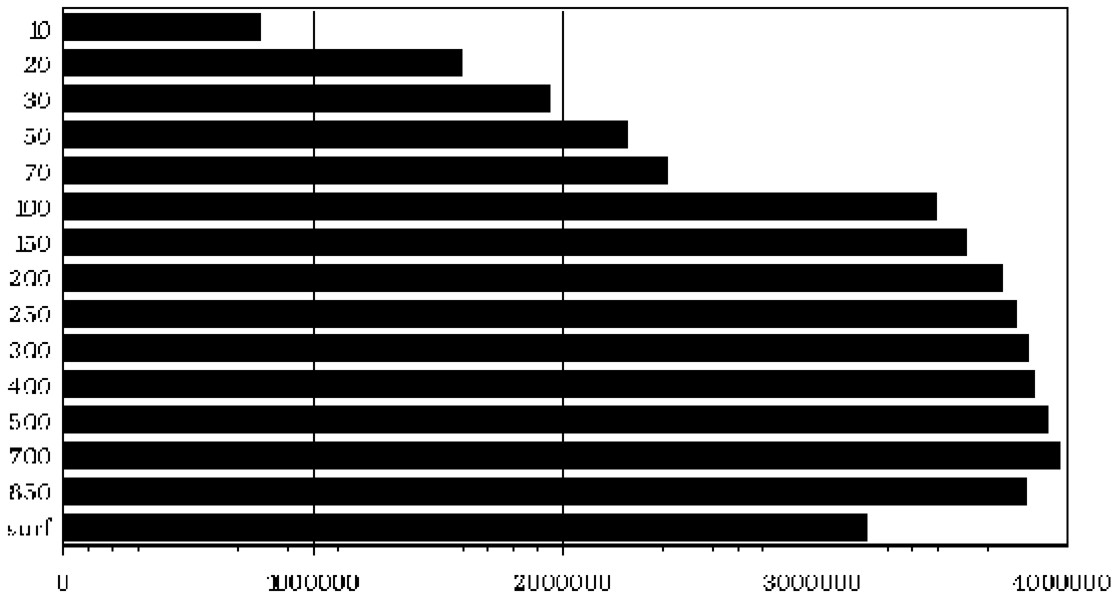


GLOBE, 1958-2001



RUSSIAN FEDERATION,

1958-2001



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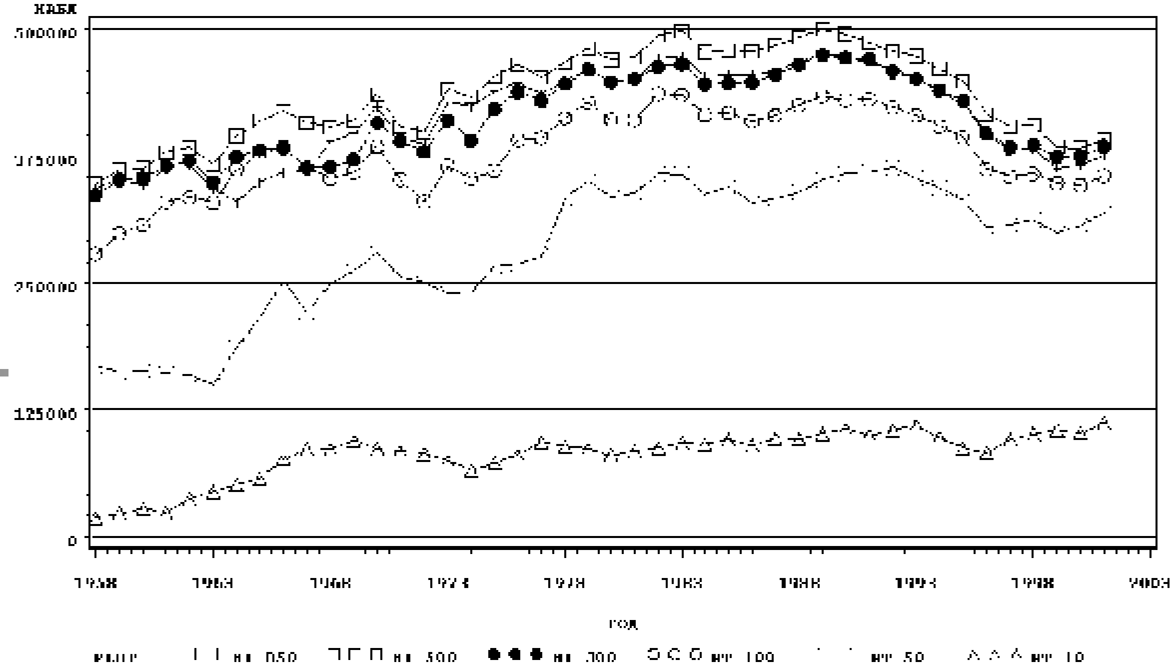
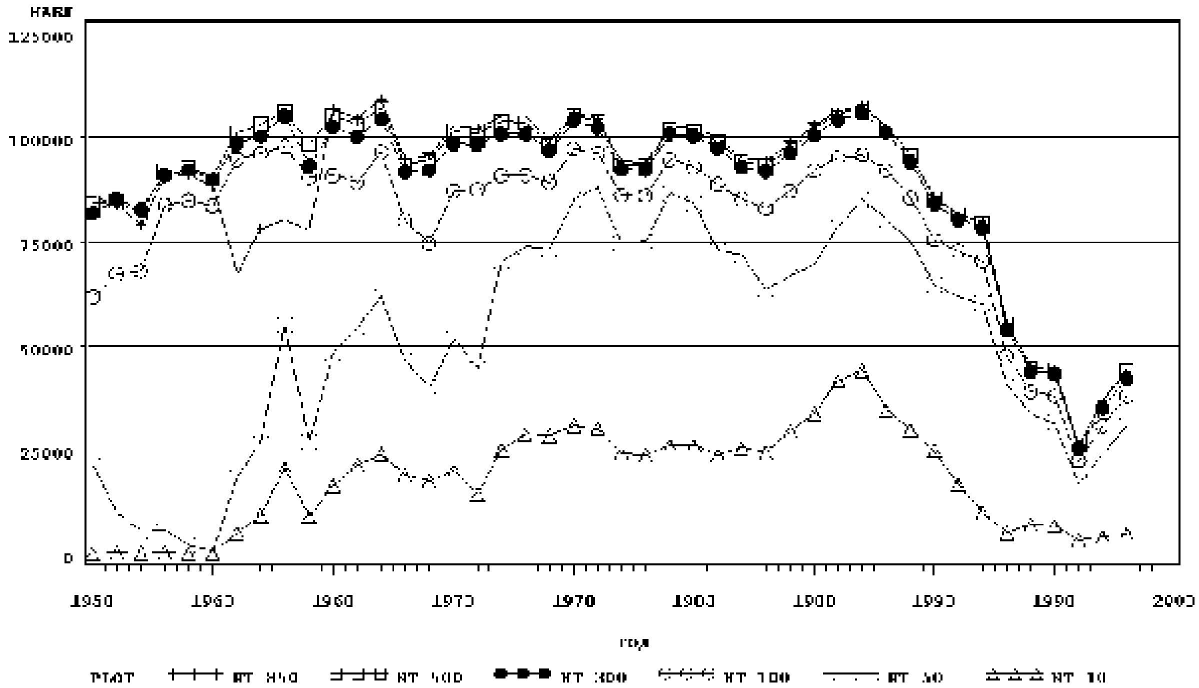
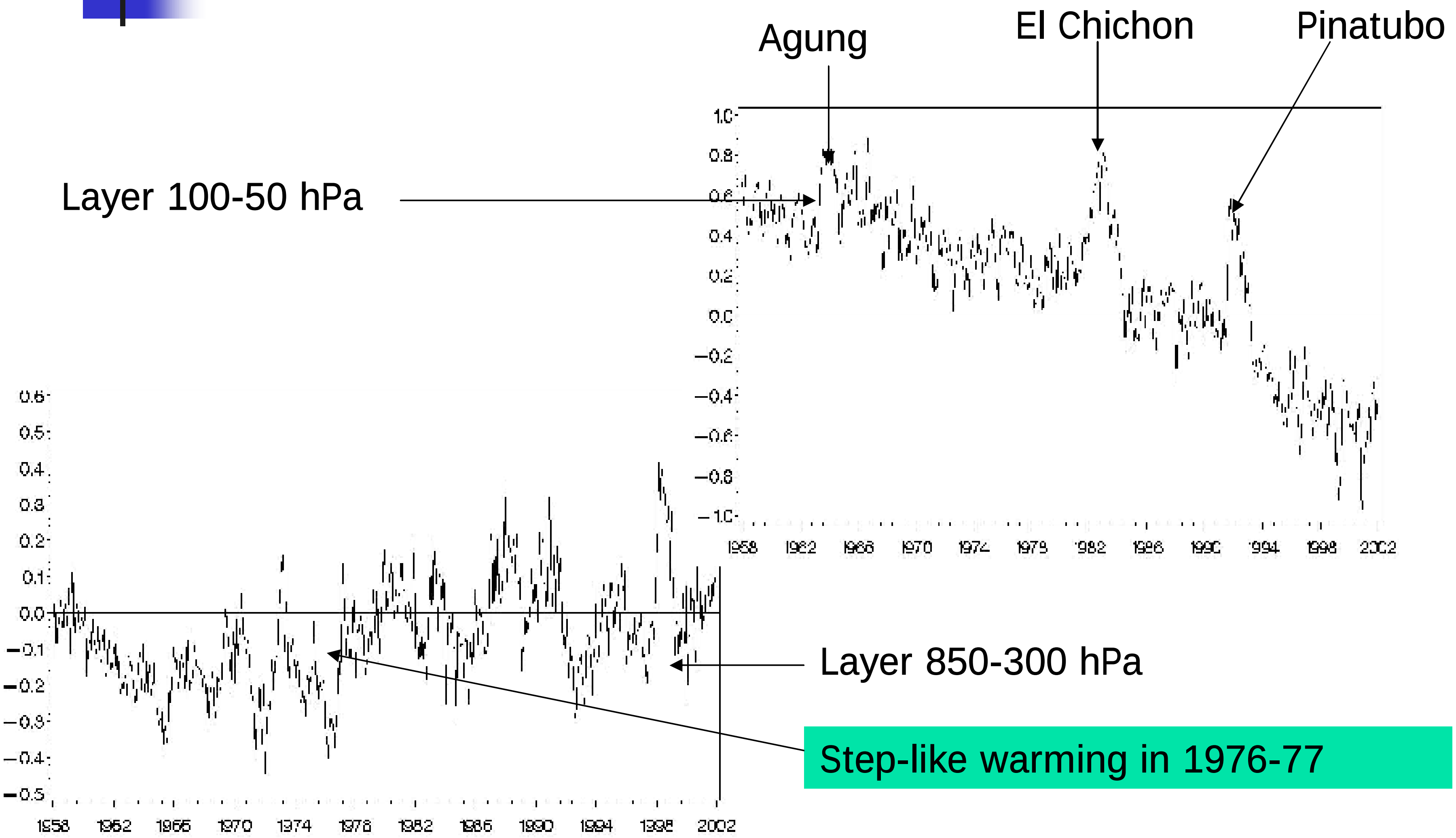


RUSSIAN FEDERATION,

1958-2001



Global U/A Temperature Anomalies (Radiosondes)



Do the years of early XXI century change the long-period trends of U/A temperature?

- Late 90's of XX century – early XXI demonstrated many outstanding record phenomena in surface and in tropospheric temperature – can they change long period trends?
- The period of U/A temperature monitoring is very short – 7-8 years is an essential update of series
- The homogenizing process for U/A series is not clear and not rapid
- The most comprehensive comparison was done in (Seidel et al., 2003, Journ. Climate), but some series were finishing in 1998
- Only series that are operationally updated, can be used for this study
- We used RIHMI radiosonde, UAH and RSS MSU series, plus Jones' series for surface temperature (for comparing with tropospheric series)
- Robust statistics were used in parallel with traditional, to reduce the effect of possible extremes at ends of series

	Correlations: Global Troposphere, series for January 1979-December 1998 Above diagonal –Pearson, below - Spearman			
	RIH_T (GL,1979,1998)	JON_T (GL,1979,1998)	UAH_T (GL,1979,1998)	RSS_T (GL,1979,1998)
RIH_T (GL,1979,1998)		0.57	0.87	0.74
JON_T (GL,1979,1998)	0.49		0.73	0.81
UAH_T (GL,1979,1998)	0.84	0.67		0.95
RSS_T (GL,1979,1998)	0.74	0.78	0.92	

Correlations JON-RIH,

Series beginning 1958

Zone, endYR	r
GL, 1998	0.74
GL, 2005	0.76
NH, 1998	0.70
NH, 2005	0.73
SH, 1998	0.64
SH, 2005	0.66

	Correlations: Global Troposphere, series for January 1979-September 2005 Above diagonal –Pearson, below - Spearman			
	RIH_T (GL,1979,2005)	JON_T (GL,1979,2005)	UAH_T (GL,1979,2005)	RSS_T (GL,1979,2005)
RIH_T (GL,1979,2005)		0.57	0.85	0.77
JON_T (GL,1979,2005)	0.53		0.77	0.85
UAH_T (GL,1979,2005)	0.83	0.73		0.95
RSS_T (GL,1979,2005)	0.74	0.84	0.93	

	Correlations: Global Lower Stratosphere, series for January 1979-December 1998 Above diagonal –Pearson, below - Spearman		
	RIH_S(GL,1979, 1998)	**UAH_S(GL,1979, 1998)**	**RSS_S(GL,1979,1998)**
RIH_S(GL,1979,1998)		**0.92**	**0.88**
UAH_S(GL,1979,1998)	**0.92**		**0.98**
RSS_S(GL,1979,1998)	**0.90**	**0.98**	

	Correlations: Global Lower Stratosphere, series for January 1979-September 2005 Above diagonal –Pearson, below - Spearman		
	RIH_S(GL,1979,2005)	**UAH_S(GL,1979,2005)**	**RSS_S(GL,1979,2005)**
RIH_S(GL,1979,2005)		**0.91**	**0.86**
UAH_S(GL,1979,2005)	**0.91**		**0.98**
RSS_S(GL,1979,2005)	**0.86**	**0.96**	

Robust Trend Estimates-why we use them and what to select?

- M: Instead of minimizing a sum of squares of the residuals, a Huber-type M estimator minimizes a sum of less rapidly increasing functions of the residuals. Bisquare Tukey's

  weighting function is used.
- MM: combination of iterations consisting of S or LTS minimization steps and M steps – provides high breakdown value and high efficiency
- S: minimizes the dispersion of specially constructed estimate expression.
- LTS: h ordered least squares residuals for estimates are used instead of all the n residuals – h observations are used instead of all n observations

TRENDS FOR GLOBAL TROPOSPHERE + JONES T surf

Series	σ	τ(1)	Linear trend, deg.C/decade					
			OLS	M	MM	S	LTS	
RIH_T(GL,1979,1998)	0.13	0.72	0.03(0.05)	-0.01	-0.02	-0.03	-0.04	
JON_T(GL,1979,1998)	0.17	0.72	0.19(0.05)	0.17	0.17	0.16	0.16	
UAH_T(GL,1979,1998)	0.20	0.70	0.03(0.06)	0.07	0.05	0.04	0.01	
RSS_T(GL,1979,1998)	0.22	0.79	0.21(0.08)	0.16	0.14	0.14	0.14	
RIH_T(GL,1979,2005)	0.13	0.69	0.04 (0.03)	0.03	0.03	0.03	0.03	
JON_T(GL,1979,2005)	0.18	0.66	0.17(0.03)	0.17	0.17	0.17	0.17	
UAH_T(GL,1979,2005)	0.20	0.69	0.05(0.04)	0.12	0.11	0.11	0.14	
RSS_T(GL,1979,2005)	0.23	0.77	0.19(0.05)	0.19	0.19	0.19	0.22	

TRENDS FOR GLOBAL LOWER STRATOSPHERE

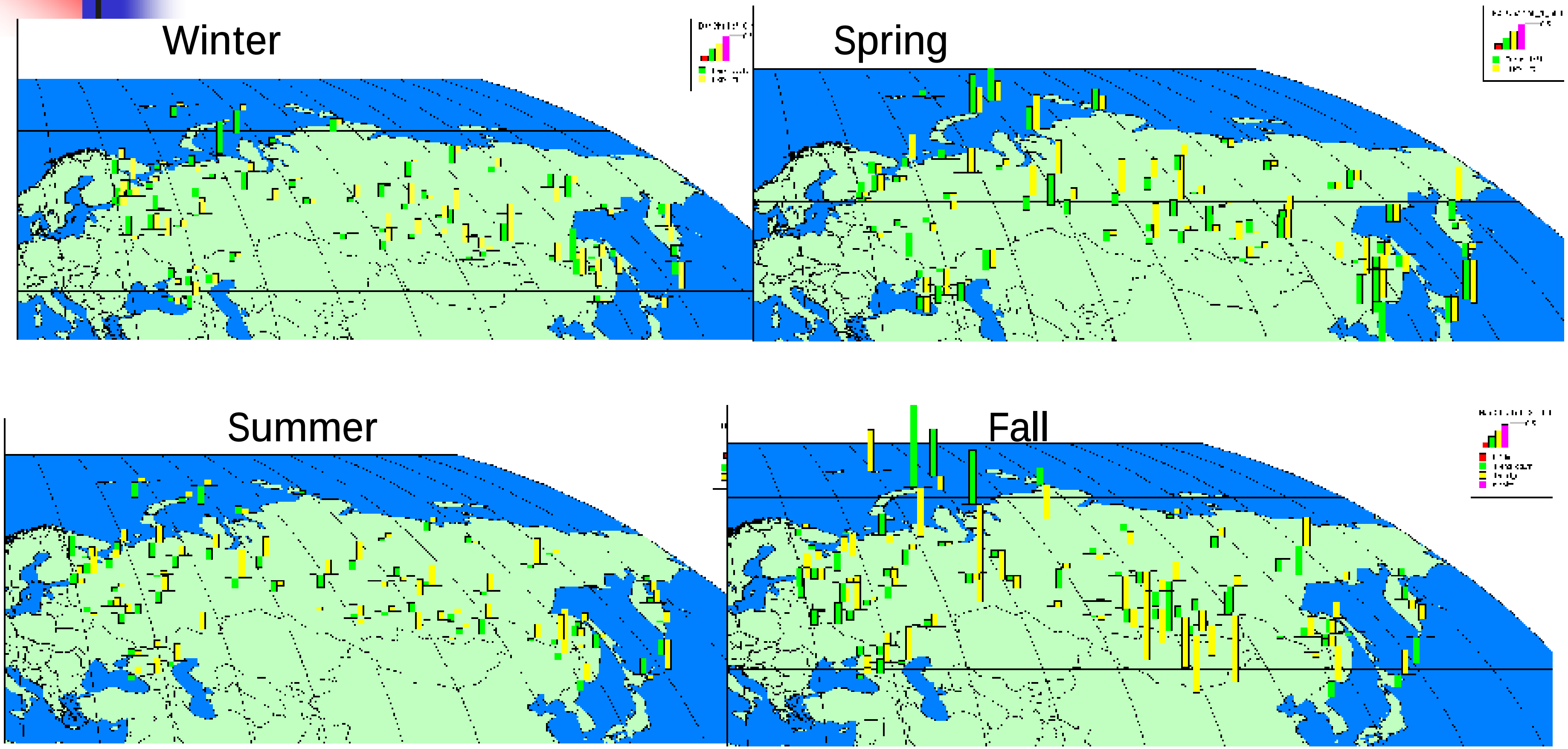
Series	σ	τ(1)	Linear trend, deg.C/decade					
			OLS	M	MM	S	LTS	
RIH$_S$(GL,1979,1998)	0.33	0.88	-0.43(0.10)	-0.44	-0.43	-0.43	-0.41	
UAH$_S$(GL,1979,1998)	0.50	0.81	-0.54(0.17)	-0.57	-0.56	-0.55	-0.52	
RSS$_S$(GL,1979,1998)	0.45	0.96	-0.50(0.19)	-0.44	-0.43	-0.43	-0.40	
RIH$_S$(GL,1979,2005)	0.39	0.86	-0.40(0.06)	-0.40	-0.38	-0.37	-0.36	
UAH$_S$(GL,1979,2005)	0.49	0.81	-0.42(0.10)	-0.40	-0.39	-0.38	-0.34	
RSS$_S$(GL,1979,2005)	0.43	0.95	-0.36(0.11)	-0.29	-0.27	-0.26	-0.22	

Low Frequency Signal in the Intraseasonal Variability Parameters

- IPCC 1995 SAR, 2001 TAR: Is Climate becoming more variable and more extremal?
- Is connected to the problem of extremal events, natural disasters, etc.
- Iskenderian & Rosen (Journ. Climate, 2000) used Oort's statistics and NCAR/NCEP reanalyses
- For the station data: series of monthly and seasonal STD and monthly & seasonal Adjusted Interquartile range (special selection of stations needed); gaps in data make this problem difficult
- But plus is that inhomogeneities of level shift type do not affect the trends

Trends in seasonal 500 hPa temperature mean (yellow) and seasonal Adjusted Interquartile Ranges (AdjIQR)(green),1964-2003

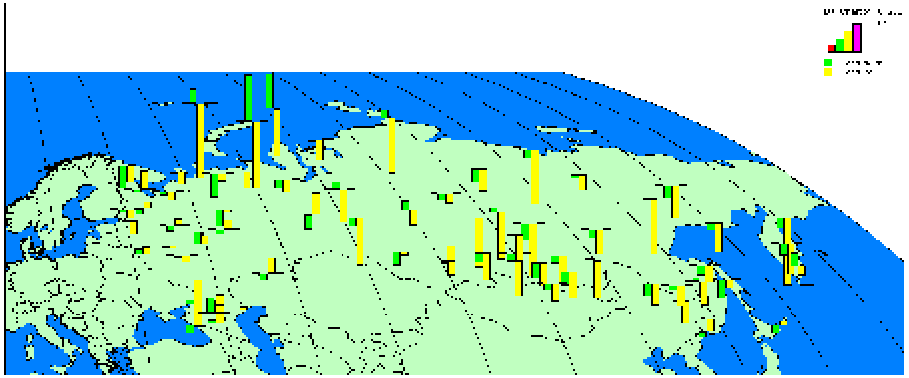
(separate ENVIROMIS 2006 poster with A. Timofeev)



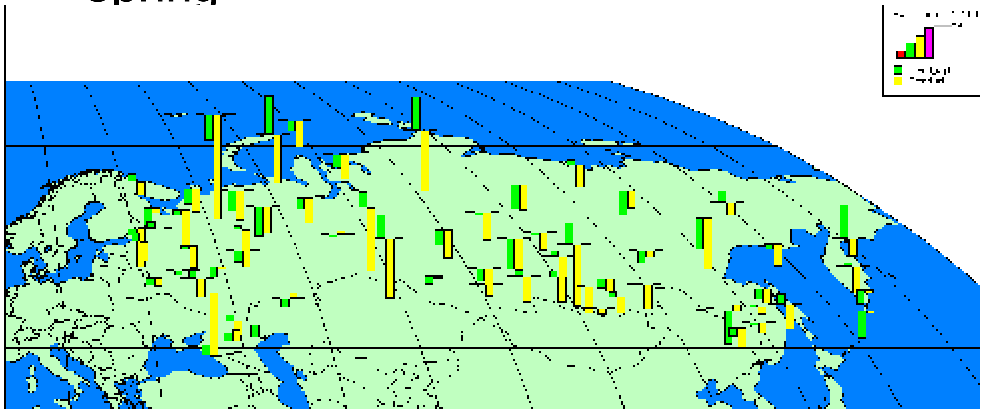
Trends in seasonal 200 hPa temperature mean (yellow) and seasonal Adjusted Interquartile Ranges (AdjIQR)(green),1964-2003

(separate ENVIROMIS 2006 poster with A. Timofeev)

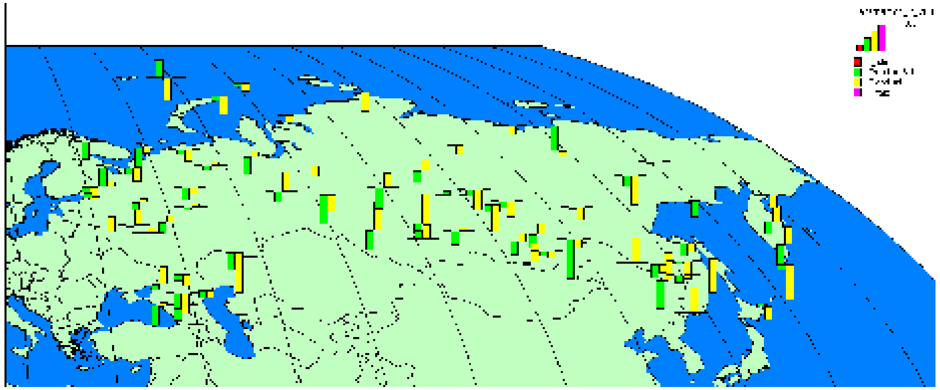
Winter



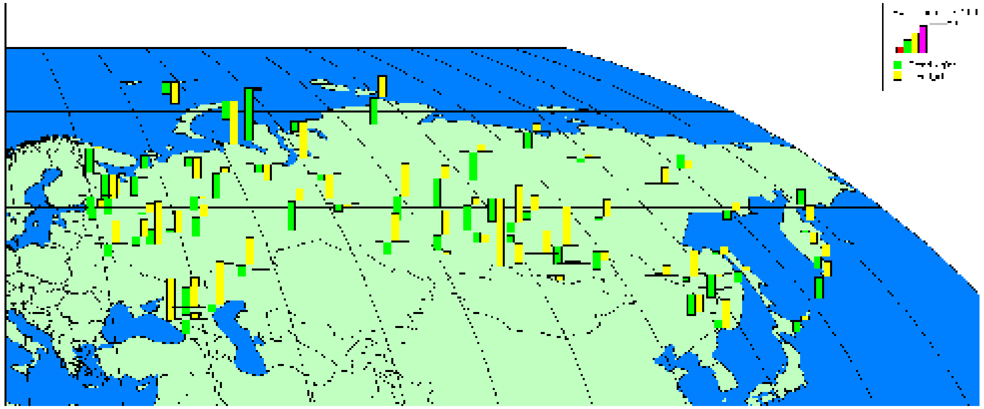
Spring



Summer



Fall



Low Frequency Signal in the Intraseasonal Variability Parameters for Upper Air (U/A) T: Some Patterns for the Territory of Russian Federation

- For winter, at 500 hPa, in the northern territories of Europe and Asia, the trends in intraseasonal variability of T are negative. For the other main part of European Russia they are positive, for the other main part of Asian Russia, including Kamchatka, they are negative. They are positive in Primor'e region.
- For summer, at 500 hPa, trends in IQR are mainly insignificant, excluding northern part of European Russia (negative).
- For winter at 200 hPa, over the most part of Russian territory, slight negative trend in IQR, excluding north of Europe (slight positive).
- For summer at 200 hPa – also slight minus over the most territory.
- Trend in intraseasonal variability of the U/A T are stronger in spring and fall than in winter and summer.

Epilogue: WMO Effort on Third Edition of "Guide on Climatological Practices" (GCP)

- Reasons for Third Edition
- Content of Third Edition of GCP
- Schedule of preparation: will be presented to WMO Congress in summer of 2007

- THANK YOU FOR ATTENTION!