Collaborative Research: Arctic Surface Air Temperatures (SAT): Analysis and Reconstruction of Integrated Data Sets for Arctic System Science

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# **Outline of Work**

**Reconcile** differences in SAT data sets during data-rich period 1979 -2006 and produce "best estimate" (ARCSS-SAT)

**Reconstruct** SAT during 1901-1978 based on EOFs of ARCSS-SAT and available station data (ARCSS-SAT-REC) (a) Observed January 1990 (def statume 507)) Reconstruction - Jan 1990 (add on 85 January 507)) (add on 85 January 807) (add o



**Blend** with global SAT of *Jones* (ARCSS-SAT-REC-GLOBAL)

## **Science Questions**

What are the links between SAT and sea ice extent?

Are changes in SAT related to large-scale modes of variability (e.g. AO) over the longer record?



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Do global climate models get Arctic SAT variability right?

## SAT Data Sets 1982-2001

Tair NCEP\_R1 1982-2001 : Jan



225 230 235 240 245 250 255 280 265 270 275 280 285 290



NCEP R1 NCEP R2 ERA-40 IABP TOVS PP APP-X AVHRR-C

Mean SATs agree reasonably well

20-year mean January SATs

225 230 235 240 245 250 255 260 265 270 275 280 285 290

### Mean January Difference from NCEP R1

DeltaT COMISO- NCEP(R1) 1982-2001 : Jan



-8.0-6.8-5.5-4.3-3.1-1.8-0.6 0.6 1.8 3.1 4.3 5.5 6.8 8.0

DeltaT APPX- NCEP(R1) 1982-2001 : Jan



-8.0-6.8-5.5-4.3-3.1-1.8-0.6 0.6 1.8 3.1 4.3 5.5 6.8 8.0

DeltaT NCEP\_R2- NCEP(R1) 1982-2001 : Jan



-8.0-6.8-6.5-4.3-3.1-1.8-0.60.6 1.8 3.1 4.3 5.5 6.8 8.0 DeltaT IABP— NCEP(R1)

1982–2001 : Jan



#### -8.0-6.8-5.5-4.3-3.1-1.8-0.6 0.6 1.8 3.1 4.3 5.5 6.8 8.0

### **Reconciliation Steps**

- •Quality-check *in-situ* buoy and land station data
- •Correct biases in reanalysis and satellite SAT fields
- •Select bias-corrected background field (e.g. NCEP R1)
- •Compute anomalies from background for all SATs
- •Estimate error covariances
- •Apply optimal interpolation to get "best" anomaly fields
- •Verify error estimates against actual errors (OI data)
- •Add anomalies to background to get ARCSS-SAT

## **Reconstruction of SAT**

Compute Empirical Orthogonal Functions (EOFs) from ARCSS-SAT (1979-2006)

Represent each field of SAT during the data-sparse period as a linear combination of the EOFs, with unknown coefficients

Determine the coefficients by minimizing the discrepancy with existing station data

#### Assumption

Patterns of SAT variability during the early period can be adequately represented in terms of patterns present during the later period

**RED DOTS:** "super stations" reporting since 1901



### EOF Reconstruction of January 1990 SAT Field based on stations reporting in 1950

(a) Observed - January 1990 (454 Stations > 50°N)

(b) Reconstruction - Jan 1990 (Based on 83 Stations established by 1950)



## **Data Products**



### **ARCSS-SAT-REC**

**ARCSS-SAT** 

**Reconstructed SAT for 1901-present** 100-km EASE grid / monthly / 50°N–90°N Status: preliminary version / not released yet

**ARCSS-SAT-REC-GLOBAL** Global SAT for 1901-present Blend Jones et al. with **ARCSS-SAT-REC** 5° lat-lon grid / monthly







### **Potential Linkages to SASS I Projects**

SAT

SAT

- A Heat Budget Analysis of the Arctic Climate System
  as validation data set, 1979-2006
- Sunlight and the Arctic Atmosphere-Ice-Ocean System as input or validation data set
- Synthesis of Modes of Ocean-Ice-Atmosphere Covariability in the Arctic System from Multivariate Century-Scale Observations
   Share pre-1979 SAT data for assimilation or validation
- Synthesis of Arctic System Carbon Cycle Research Through Model-Data Fusion Studies Using Atmospheric Inversion and Process-Based Approaches Compare changes in CO<sub>2</sub> fluxes to changes in SAT
- Greening of the Arctic-Synthesis and Models to Examine the Effects of Climate, Sea-Ice, and Terrain on Circumpolar Vegetation Changes
   Changes in vegetation are intimately linked to changes in land SAT.
   Compare SAT data sets; provide pre-1979 SAT
- •A Synthesis of Rapid Meltwater and Ice Discharge Changes: Large Forcings from the Ice with Impacts on Global Sea Level and North Atlantic Freshwater Budgets Share coastal weather station data back to 1901
- Humans and Hydrology at High Latitudes
  Link between SAT and hydrological changes

## Potential linkages of SASS projects



### **Potential Linkages to SASS II Projects**

Complete fields of Arctic SAT are likely to be useful to many of these projects

- The Roles of Clouds and their Accomplices in Modulating the Trajectory of the Arctic System
- Toward Reanalysis of the Arctic Climate System Sea Ice and Ocean Reconstruction with Data Assimilation
- Climate Response to Future Changes in Arctic Snow Cover and Sea Ice: A New Perspective from the High-Resolution NCAR CCSM3
- The White Arctic: A Snow-Impacts Synthesis for the Terrestrial Arctic
- Understanding Change in the Climate and Hydrology of the Arctic Land Region: Synthesizing the Results of the ARCSS Fresh Water Initiative Projects
- The Impact of Changes in Arctic Sea Ice on the Marine Planktonic Ecosystem -Synthesis and Modeling of Retrospective and Future Conditions
- Producing an Updated Synthesis of the Arctic's Marine Primary Production Regime and Its Controls
- Synthesis of Sea Ice, Climate, and Human Systems in the Arctic and Subarctic (SYNICE)

