Network expansion progress report

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Overview

Holger has already covered the status of where we are with GRUAN site assessment and certification and so this talk will cover:

- Status of the report on the outcomes of the GRUAN Network Expansion Workshop
- Current status of potential new sites that could be coming into GRUAN

The goals of the workshop

- 13-15 June 2012 in Fürstenwalde.
- Define the scientific basis to guide the expansion of GRUAN from its then 15 sites (Ny Ålesund now added), to the expected 35-40 over the next few years.
- The emphasis was on defining the criteria by which network expansion should occur and to consider prospective sites. Little or no consideration given to what they should measure or how they should measure it.
- Bring the workshop white papers to a nearly completed state.
- Entrain additional expertise into GRUAN.
- Use quantitative & objective approach to determine how to augment the current GRUAN network with additional sites and to provide recommendations for new sites identified during the workshop & in the resultant White Papers.

Network Expansion Workshop report

- All four white papers
  - Climate change detection and attribution
  - Satellite calibration and validation
  - Atmospheric process studies
  - Numerical weather prediction.

  that were written in support of the workshop have now been amalgamated into a single document → thanks to Anna Mikalsen.
- The report is close to being in a state where it can be circulated amongst workshop attendees.
- Significant additional analyses were undertaken to provide input to this GRUAN report. One example to follow. These could potential feed a peer reviewed publication.

Key outcomes (1 of 4)

- *Global coverage*: The complete range of atmospheric variability should be sampled by having sites in each of the major climate regions (polar, mid-latitude, subtropical and tropical) in both hemispheres.
- *Environment*: Sites should cover a variety of surfaces such as forest, deserts, snow and ice as well as stations on small, remote islands to represent surrounding ocean conditions, remote mountain top sites but also regions such as the Mediterranean basin with influences of urban pollution.
- *Use of quantitative analyses*: quantitative, objective methods can be used to identify the most favourable locations to detect phenomena of interest e.g. trends in mid-troposphere temperatures. Selecting sites that exhibit little short-term atmospheric variability is not the only requirement for best detecting trends as auto-correlation (the degree of persistence in variability) also plays a key role in trend calculations.

Key outcomes (2 of 4)

- *Weather conditions*: It would be beneficial if most of the atmospheric measurements were made under clear-sky conditions to minimise the uncertainties introduced by radiative transfer modelling in the presence of clouds, and that relatively simple, climatological vertical profiles of temperature and humidity are observed to avoid complicated features that make trend determination difficult. Measurements under clear-sky conditions are also preferable for satellite calibration and validation (cal/val; see below). For process studies, sites exhibiting a wide range of phenomena over a short period of time are preferable.
- *Historical record*: For monitoring changes in climate, long-term, stable, and homogeneous time series of measurements are required from sites with a long-term commitment to the network and consistent operational practices that meet GRUAN standards. All else being equal, sites with an existing history of such measurements should be selected over those sites with no historical record

Key outcomes (3 of 4)

- *Determining required measurement frequency*: Analyses can and should also be performed to define measurement regimens required to meet certain needs and to avoid making measurements more often than is required e.g. for the calculation of months means for trend analysis, the number of measurements required to define the monthly mean within some random uncertainty bound must be quantitatively established.
- *Modes of variability*: Sites should cover a wide variety of different climate regimes and large scale modes of variability such as the SAM, NAM, ENSO, QBO, and should also permit detection of expansion of the tropics, changes in the strength of the Brewer-Dobson circulation, and the monsoon. To detect changes in modes of variability, measurements are required both where the amplitude of the pattern peaks, and at the nodes of the patterns.

Key outcomes (4 of 4)

- *Satellite cal/val*: For the calibration and validation of satellite observations it is essential that the validation measurements are temporally and spatially co-located with the satellite-based measurements. It is preferable to have a smaller number of good quality and easily maintained sites in places where satellite overpasses coincide with regular GRUAN sonde launches rather than a large number of sites.
- *Simulation experiments*: Observing System Simulation Experiments (OSSEs) and Observing System Experiments (OSEs) can and should be used to identify how the inclusion or exclusion of a site might affect the quality of a numerical weather prediction. Such simulation experiments should include the 'indirect' effects of the inclusion of a GRUAN station e.g. inclusion of a GRUAN station in some region may indirectly lead to an improvement in the quality of observations at other nearby sites. The use of OSSEs and OSEs to assess the utility of new sites joining GRUAN needs to be done in collaboration with the NWP community.

An example of quantitative analysis

The number of years of measurements required to detect a trend at the 95% confidence level with a probability of 0.9 can be approximated by (Whiteman et al., 2011):

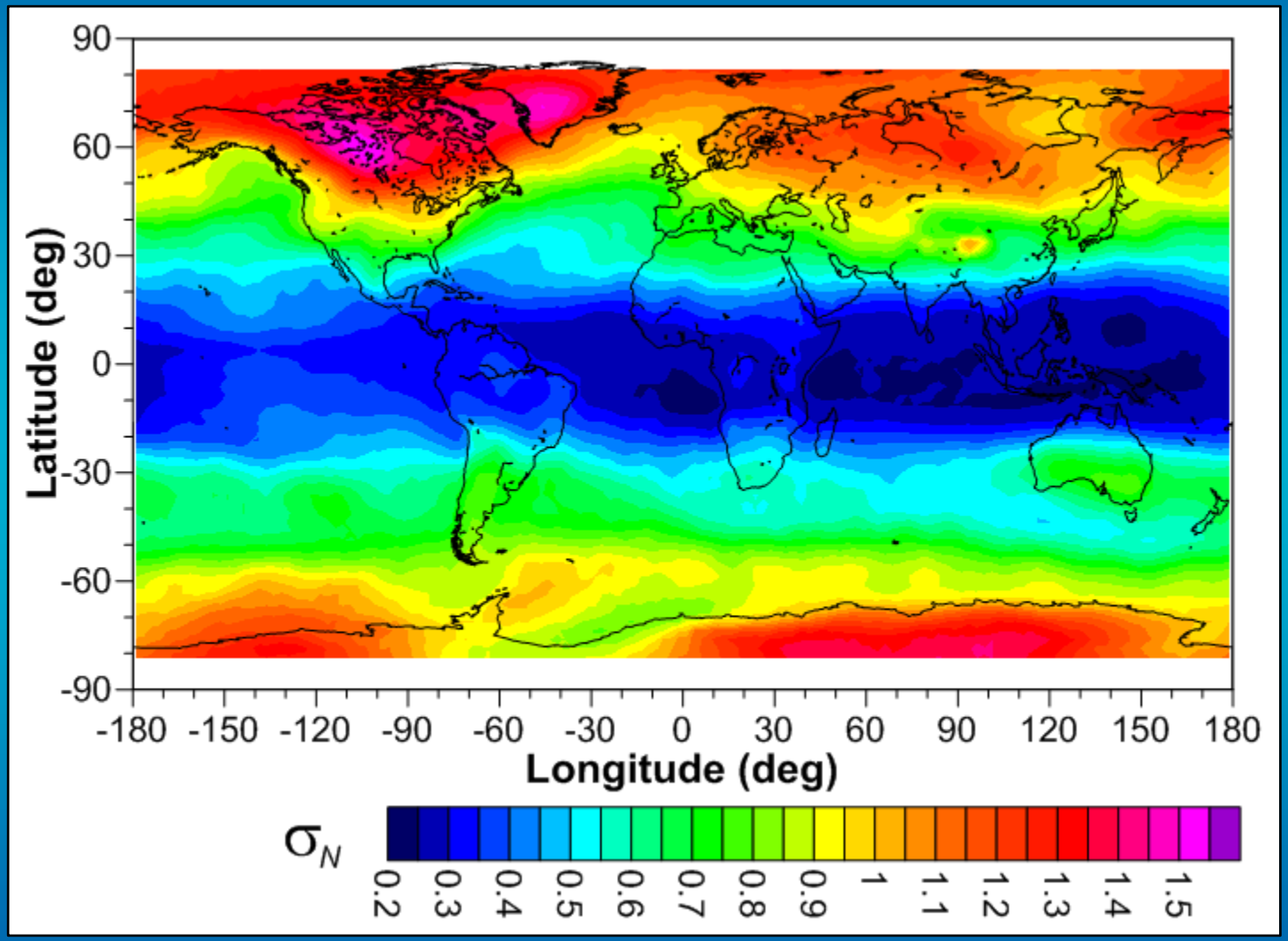
$$n = \left[\frac{3.3\sigma_N}{|\omega_0|} \sqrt{\frac{1+\phi_N}{1-\phi_N}} \right]^{2/3}$$

where σ_N is the standard deviation of the total noise in the time series, i.e. the standard deviation of the residuals after the application of the trend regression model, ω_0 is the trend magnitude, and φ_N is the autocorrelation of the noise.

Consider the temperature of the mid-troposphere: MSU2 + AMSU5 around 5 km…

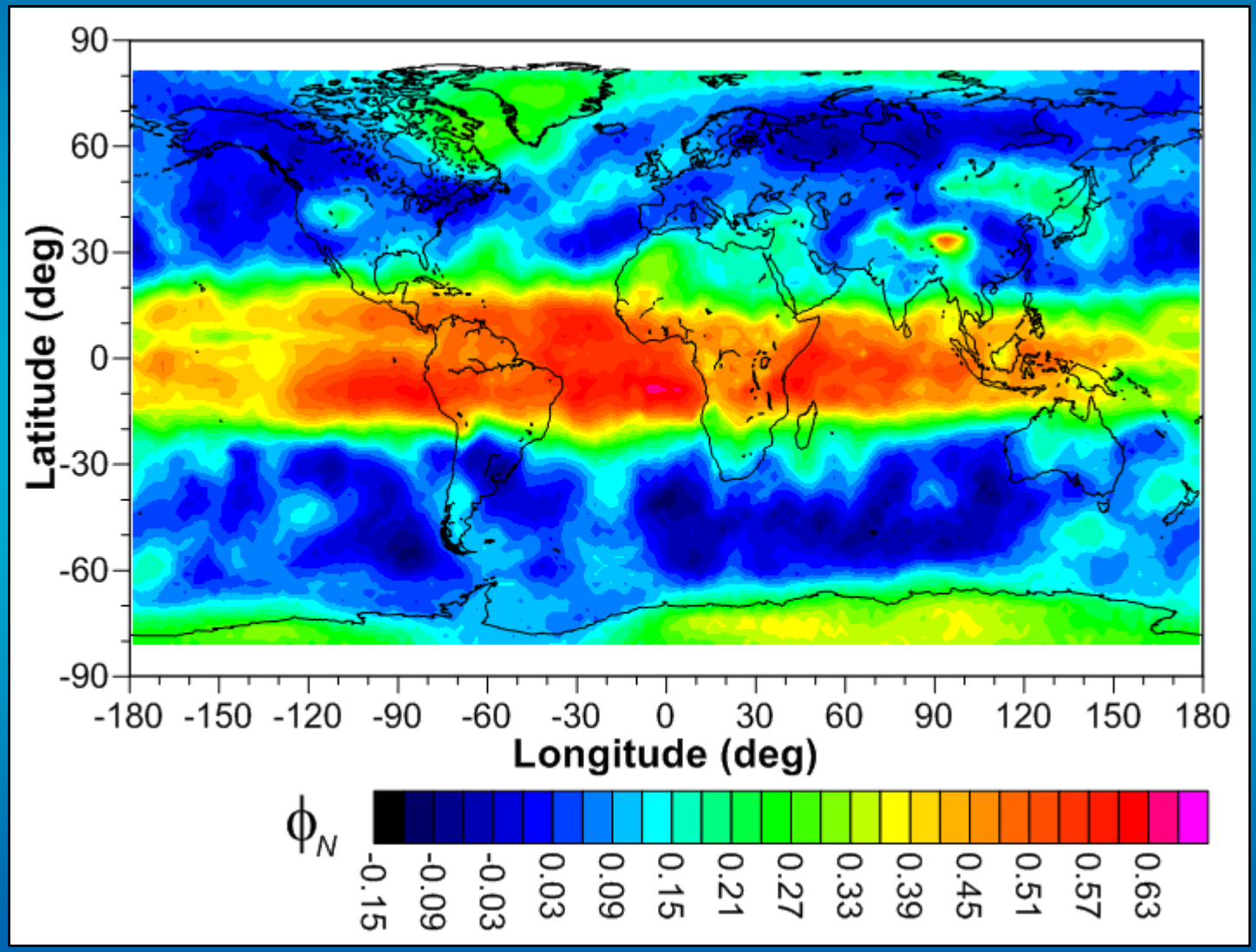
Temperature of the mid-troposphere

Standard deviation of the monthly means (1978 to 2013)



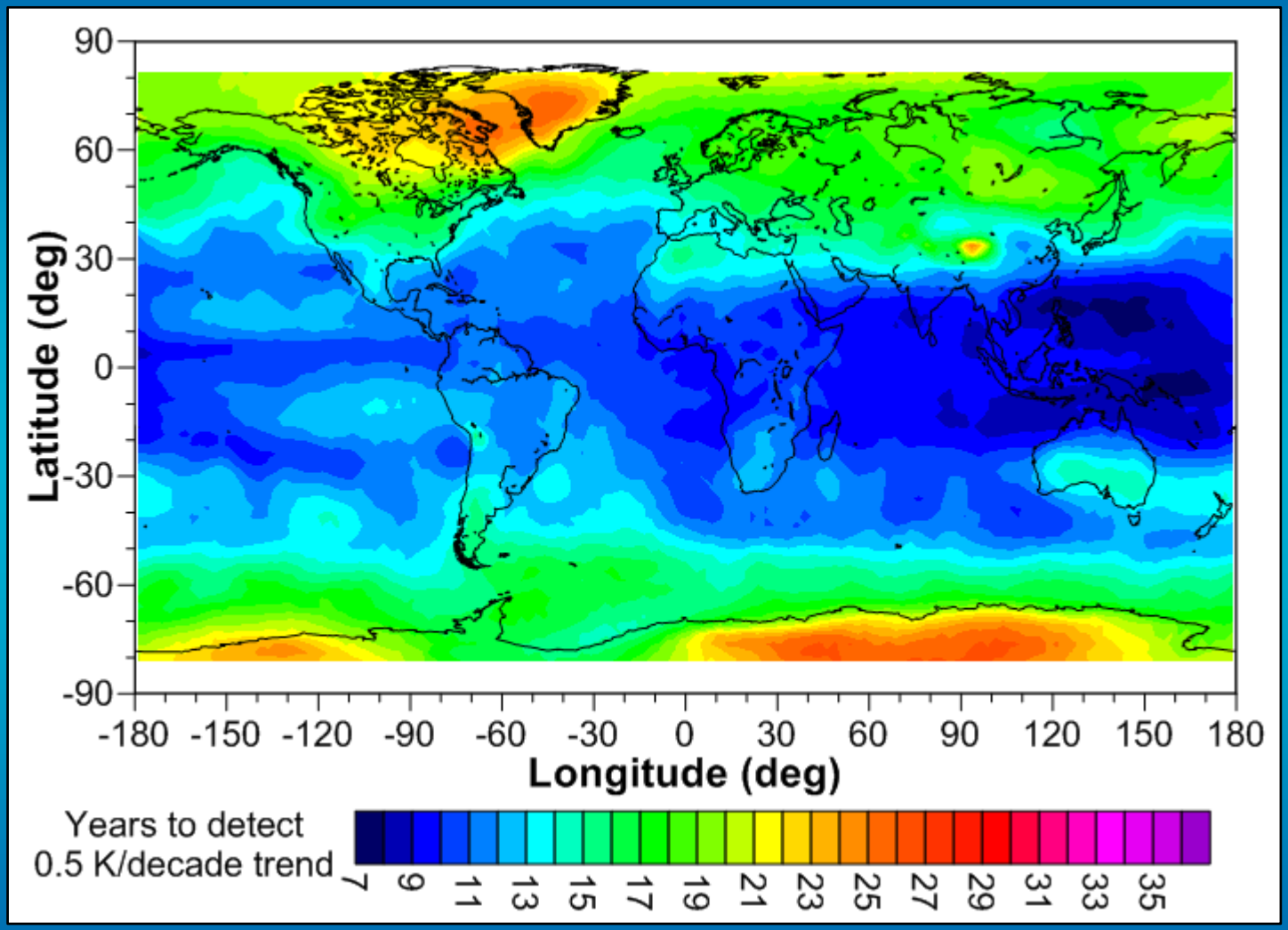
Temperature of the mid-troposphere

Autocorrelation on the residuals



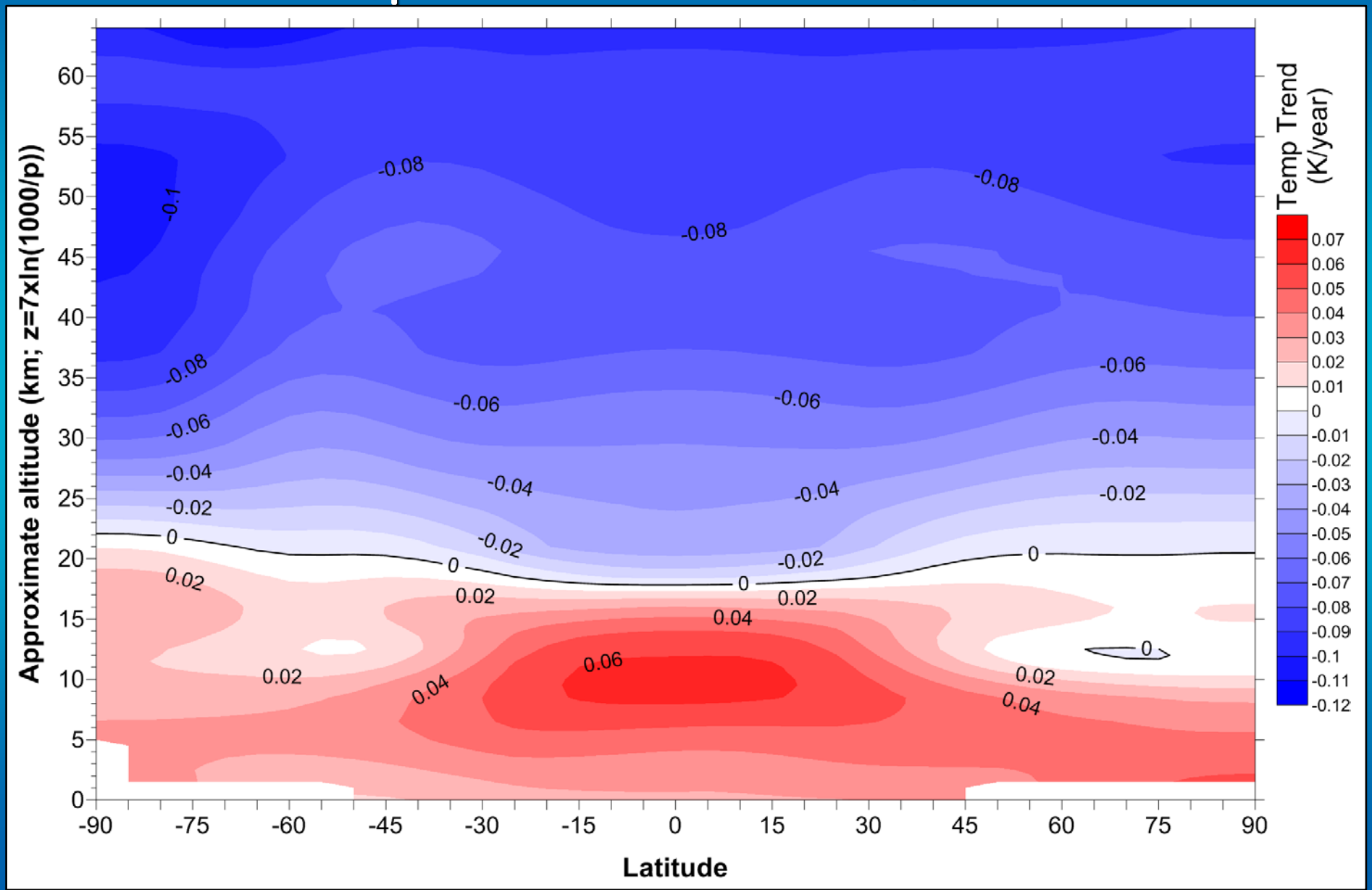
Temperature of the mid-troposphere

Years to detect 0.5K/decade trend



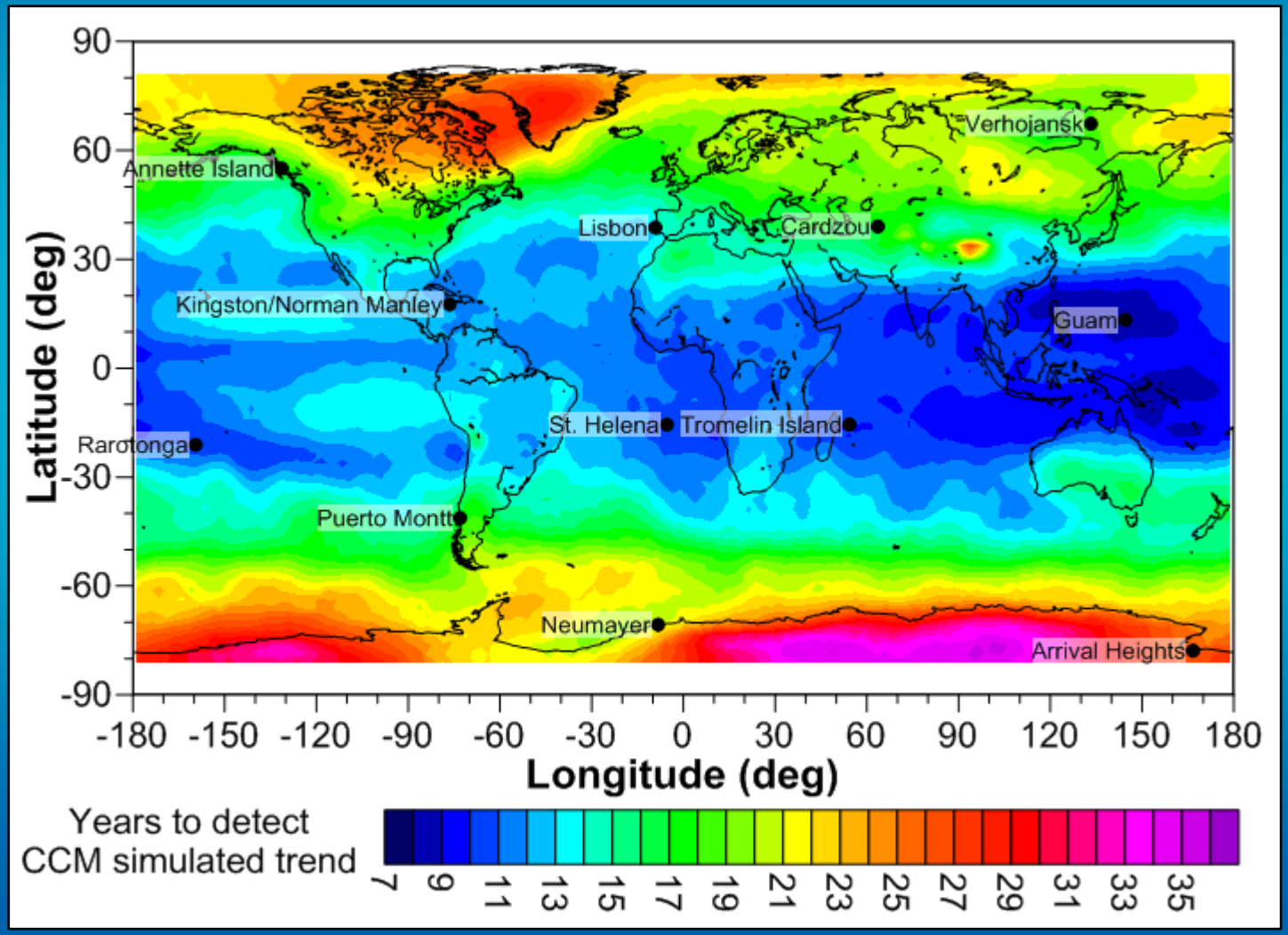
Temperature of the mid-troposphere

Actual temperature trends derived from 11 CCMs



Temperature of the mid-troposphere

Sites for optimally detecting mid-tropospheric temperature trends. Does this mean that if your site is not on this maps that it's useless. Of course not.



Acknowedgement

GRUAN network design team

Anna Mikalsen, Xavier Calbet, Michael Kurylo, William Lahoz, Karen Rosenlof, Thomas August, Bill Bell, Stephan Bojinski, Bojan Bojkov, Andrew Charlton-Perez, Domenico Cimini, Belay Demoz, Rudd Dirksen, Tim Hewison, Dale Hurst, Anthony Illingworth, Philippe Keckhut, Rao Kotamarthi, Thierry Leblanc, Ulrich Löhnert, Craig Long, Fabio Madonna, , Gelsomina Pappalardo, Thomas Peter, Tony Reale, Carl Schreck, Marc Schröder, Dian Seidel, Mi-chael Sommer, David Tan, Anne Thompson, Peter Thorne, Holger Vömel, June Wang, Elizabeth Weatherhead, David Whiteman

Leads on potential sites to join GRUAN

The process would benefit from having designated 'sponsors' from within the WG who will act as primary contacts for site reps and who will 'shepherd' new sites into GRUAN.

Chinese sites

GRUAN contacts: Greg Bodeker, Holger Vömel, June Wang

Institution contact: Yang Rongkang

Status: On 16 July 2012 Greg, together with Wenjian Zhang, Ghassem Asrar, Adrian Simmons and June Wang met with senior officials at the China Meteorological Administration, including Datong Zhao, Yongqing Chen, Xiaoyun Wang, Kejun Wu, Yong Qin and Wei Li to discuss possibility of China increasing its support of GRUAN by hosting additional GRUAN sites. The meeting finished with the CMA officials agreeing to host an additional 3 GRUAN stations within China (in addition to the site at Xilin Hot) at Nagqu (4500m above sea-level on the Tibetan Plateau), Kunming and Mt. Waliguan.

Follow-up letter to Datong Zhao from GCOS secretariat (signed by Carolin Richter and Holger Vömel) sent on 10 October last year. No response received.

La Paz

GRUAN contacts: Dave Whiteman, Greg Bodeker

Institution contact: Marcos Andrade

Site description: High altitude site in Bolivia (3420 m). Access to measurement station at Chataltaya (5240 m). They have experience in launching balloons (Ricardo Forno works with NASA/GSFC every year during the WAVES campaigns). Dave Whiteman has a collaboration with them to develop a lidar system.

Status: Marcos is here at ICM-6 with support from Dave Whiteman and Greg Bodeker. Funding is a clear hurdle. We have been exploring the option of crowd-funding for support for one year, or for ongoing support. Greg Bodeker and Stefanie Kremser have been in contact with Jai Ranganathan from SciFund and are in the process of developing a crowd-funded project.

Cuba

GRUAN contacts: Dian Seidel, Peter Thorne

Institution contact: Juan Carlos Antuña Marrero

Site description: Would fill a clear gap in the network i.e. a site in the Caribbean.

Status: Juan Carlos has had discussions with Dian and Peter but there is currently no possibility for financial support for GRUAN operations in Cuba.

Australia

GRUAN contacts: Greg Bodeker

Institution contact: Matt Tully and Russell Stringer

Site description: Attractive sites would be Alice Springs, Melbourne, Macquarie Island, Davis (Antarctica). Possibility of shoring up GRUAN operations at Darwin following the departure of ARM.

Status: Greg met with Matt Tully and Russell Stringer at Bureau of Meteorology, Melbourne, on 15 February last year to discuss GRUAN options. Matt is here this week and we look forward to some productive discussions.

South Africa

GRUAN contacts: Belay Demoz

Institution contact: interest from a university and a branch of the South African Weather Service. Contact is Mark Majodina

Site description: Would be the first GRUAN site on the African continent and a valuable addition as a southern hemisphere site.

Status: Anything to report Belay?

Senegal

GRUAN contacts: Belay Demoz

Institution contact: Seydi Ababacar Ndiaye

Site description: Dakar

Status: Belay was to forward a write-up by a scientist from the Dakar station to the Lead Centre.

Canada

GRUAN contacts: Holger Vömel

Institution contact: Info available in Holger's office

Site description: Eureka and Sandy Lake

Status: nil