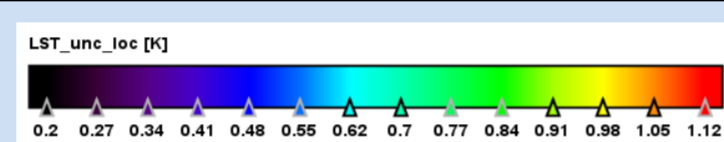
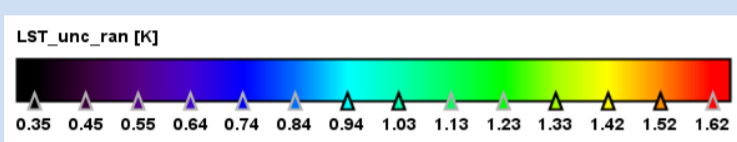
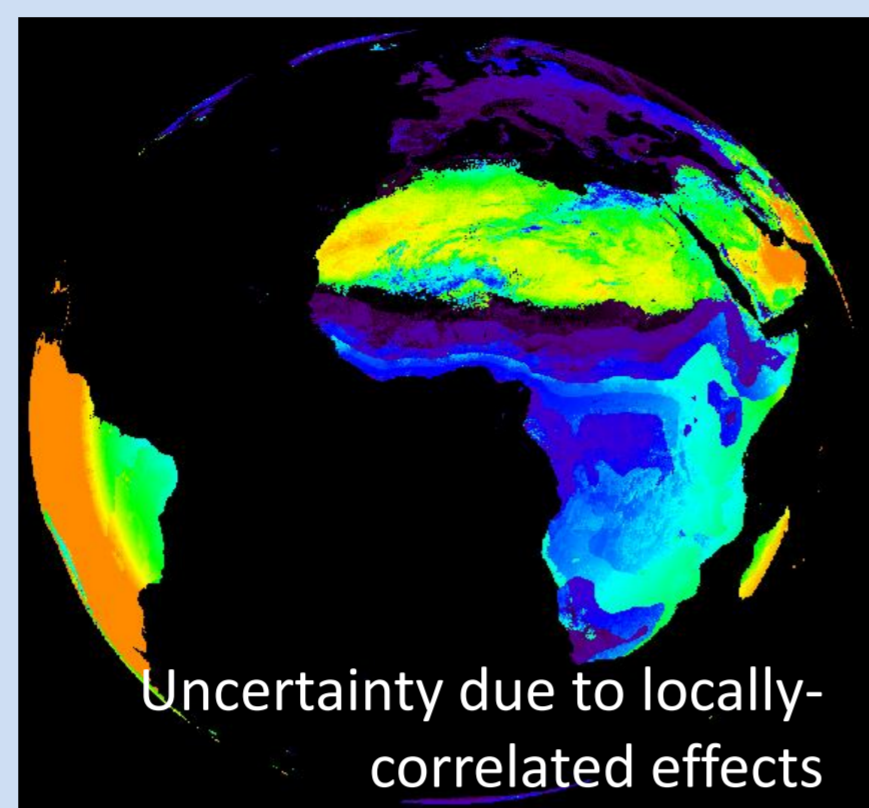
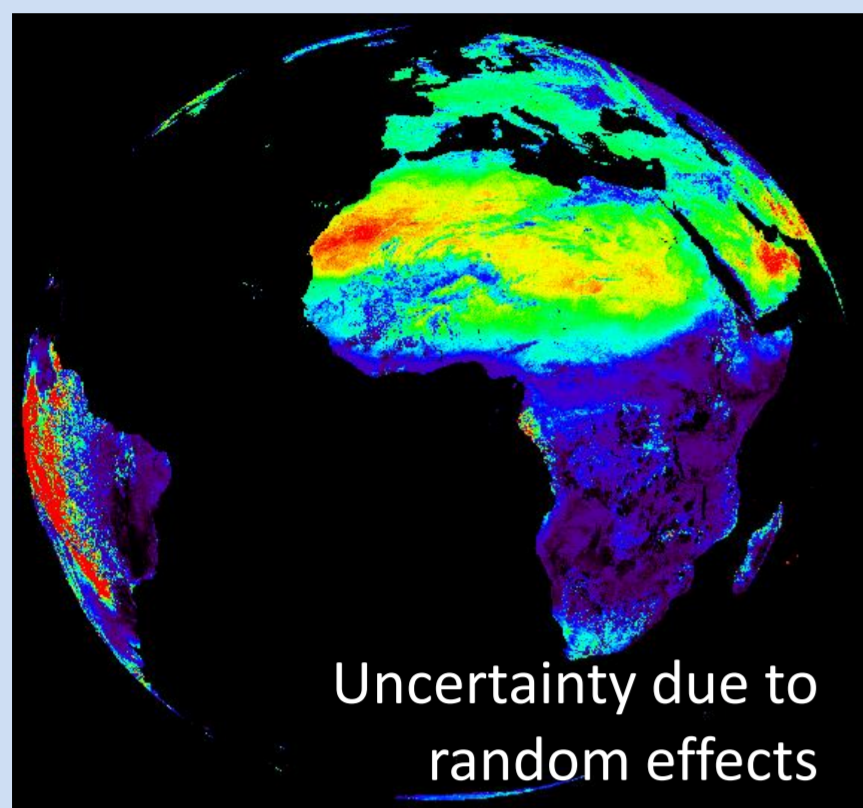


# Needs for Fiducial Reference Temperature Measurements in the EUSTACE project

Creating publicly available daily estimates of surface air temperature since 1850 across the globe by: (i) estimating consistent uncertainties for skin temperature retrievals; (ii) identifying break points in station data; (iii) estimating air temperature from satellite data and (iv) developing novel statistical techniques for combination and infilling.

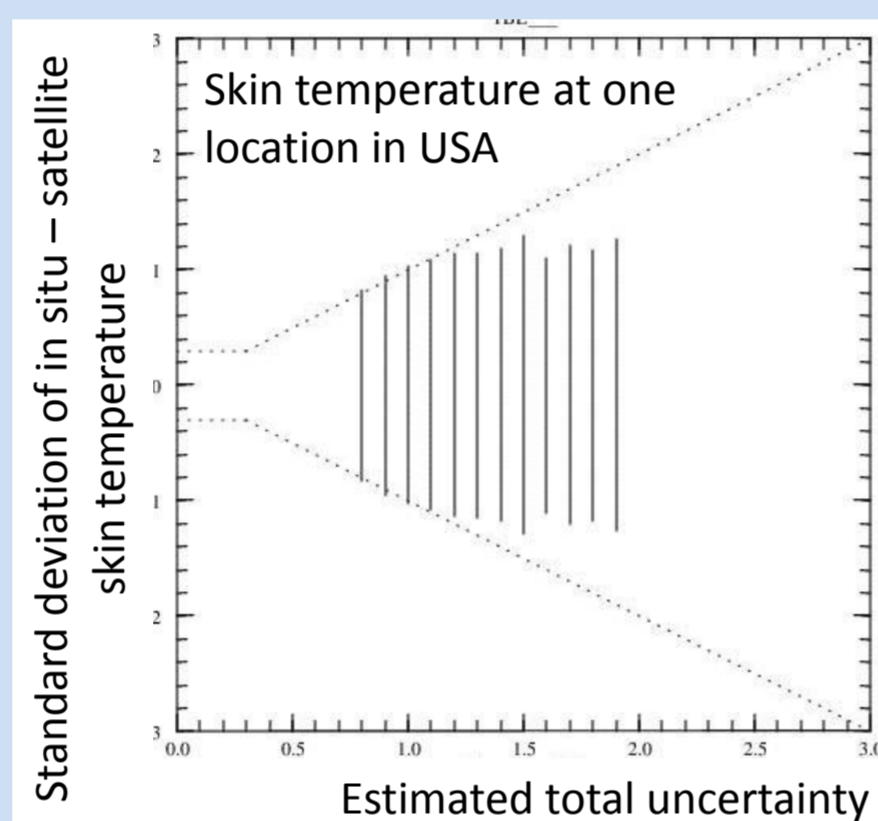
## Estimating and validating uncertainties



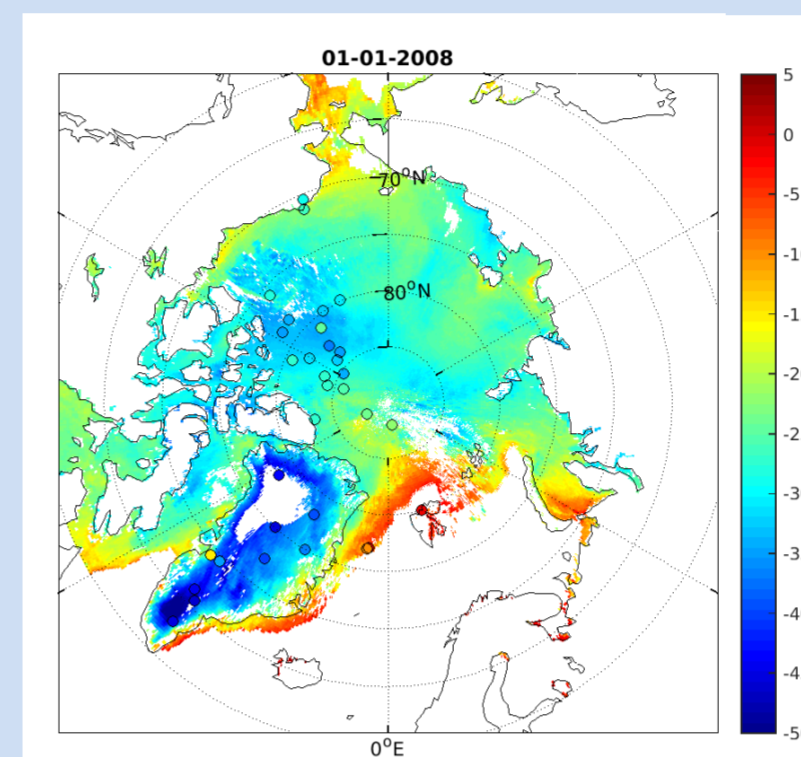
Multi-component uncertainties in satellite measurements of skin temperature consistent over all surfaces of Earth have been estimated and validated for the first time

**Above:** selected uncertainty components for SEVIRI LST on an example day.

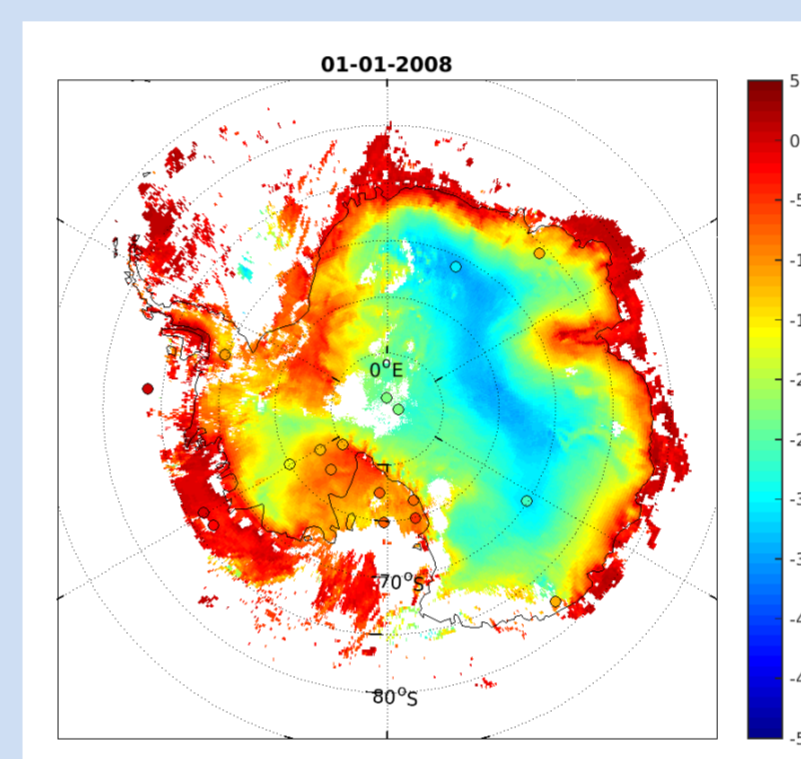
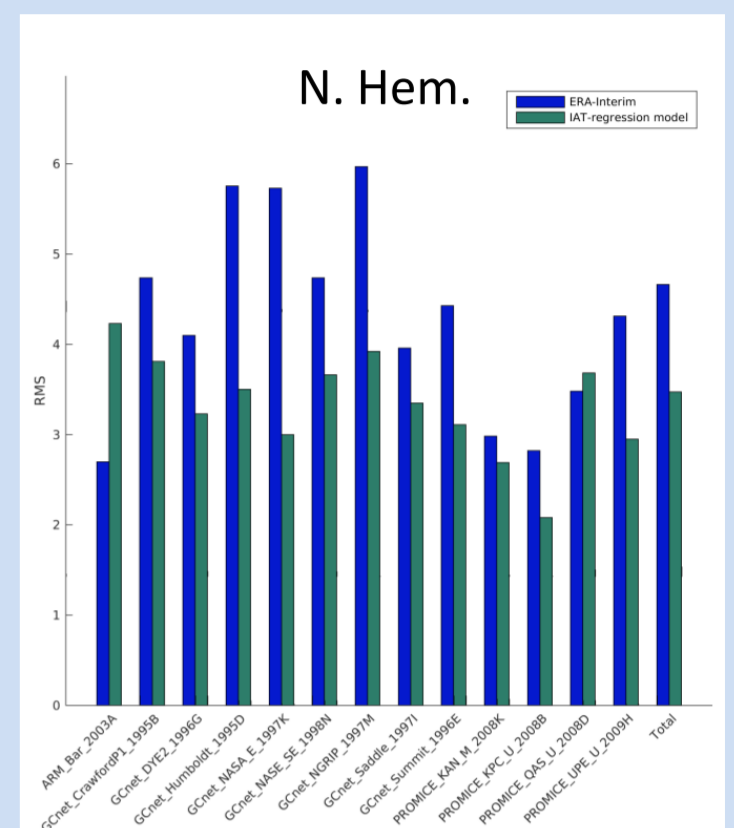
**Right:** MODIS Aqua compared to SURFRAD in situ measurements, 2011



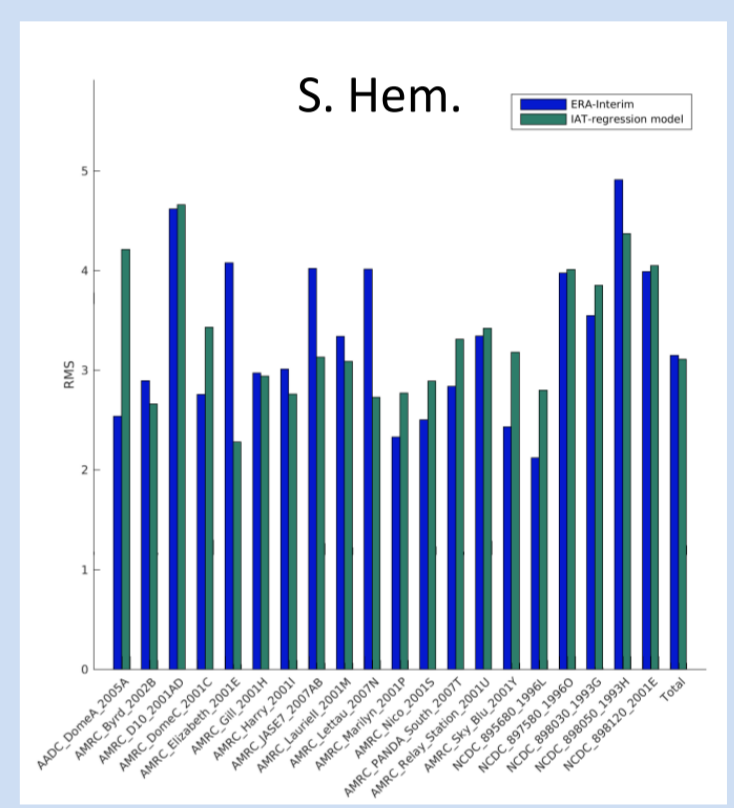
## Validating air temperature estimated from satellite skin temperature



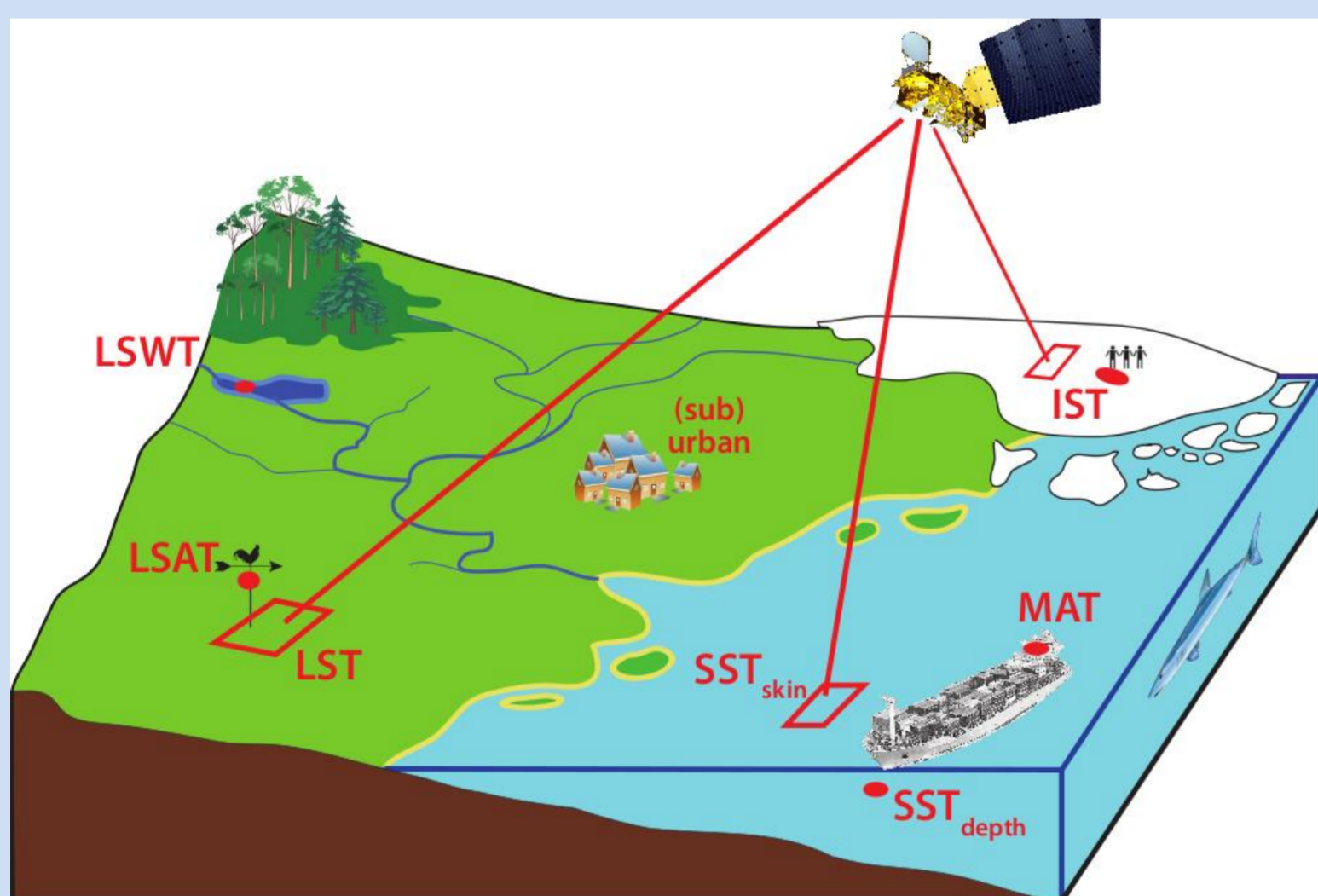
**Left:** Estimated daily mean surface air temperature (°C) over land ice and sea ice from January 1, 2008. Circles show in situ measurements



**Right:** RMS differences (°C) over land ice. in situ vs ERA-Interim (blue). in situ vs EUSTACE satellite-derived air temperature (green).



## Understanding relationships between skin and air temperature



**Left:** from Merchant et al., 2013: <http://www.geosci-instrument-method-syst.net/2/305/2013/gi-2-305-2013.html>

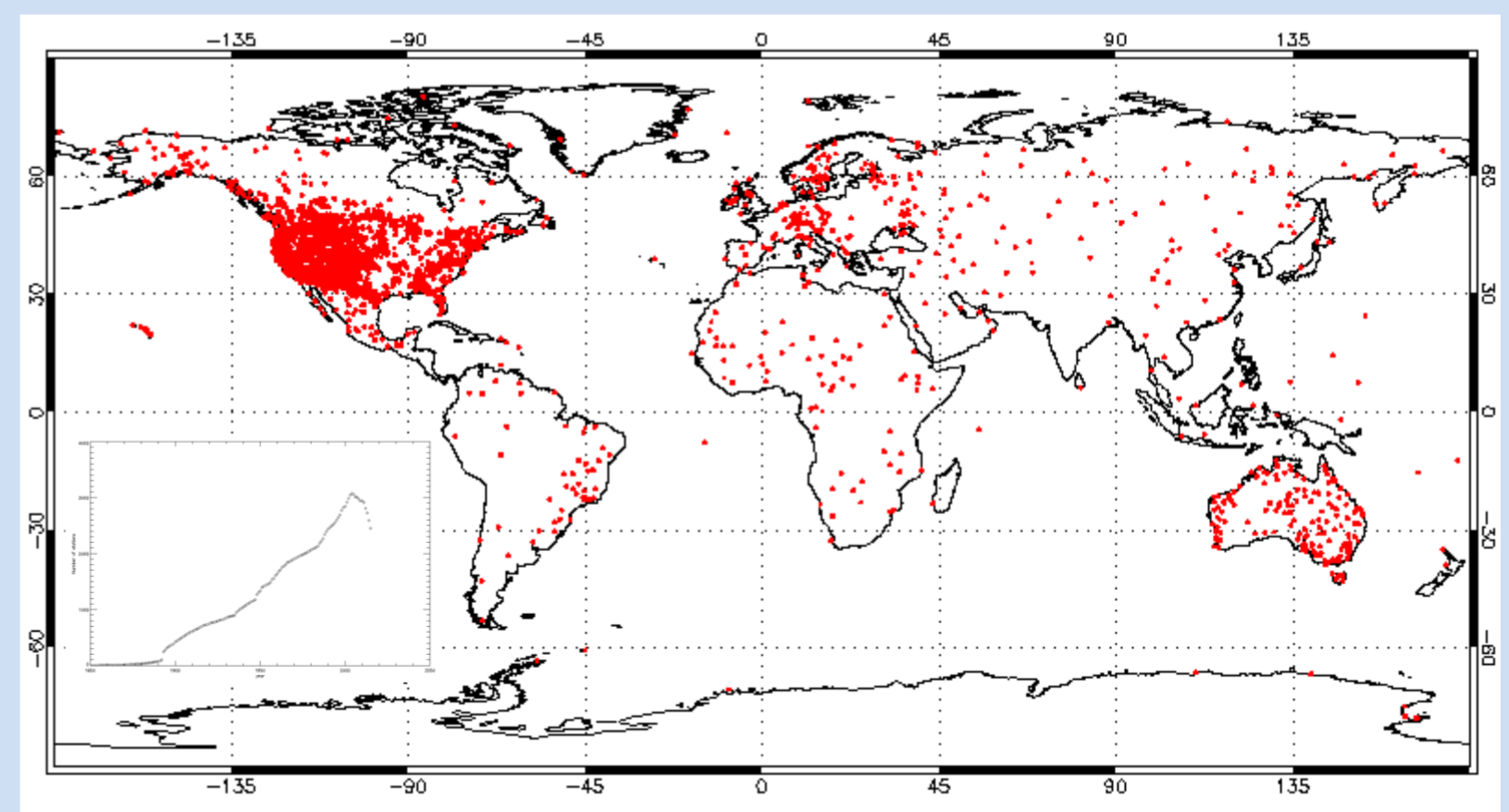
There is a need for a global network of in situ reference sites where relationships between different types of surface temperature can be characterised over land, ocean, ice and lakes.

Oceanic and desert regions, ice-covered surfaces, high elevation and high latitudes generally are currently poorly represented.

## General validation needs

- Stable air temperature measurement stations for validation of global in-filled product
- More in situ skin temperature measurements generally for the routine verification of satellite LST and IST retrievals and their uncertainties. Using air temperature to validate IST (or LST) introduces a seasonally-varying bias of several degrees.
- More high latitude reference stations, in particular.

**Below:** stations reserved for independent validation of EUSTACE air temperature products. Inset is a time series showing the evolution of this station network from 1850 onwards. (Peak number of stations is 3,000.)



Nick A. Rayner, Renate Auchmann, Janette Bessembinder, Stefan Brönnimann, Yuri Brugnara, Esther Conway, Pia Englyst, Darren Ghent, Elizabeth Good, Jacob Høyer, John Kennedy, Albert Klein Tank, Paul van der Linden, Finn Lindgren, Kristine Madsen, Chris Merchant, Joel Mitchelson, Colin Morice, Patricio Ortiz, John Remedios, Gerard van der Schrier, Antonello Squintu, Ag Stephens, Rasmus Tonboe, Karen Veal, Alison Waterfall and Iestyn Woolway

contact: [nick.rayner@metoffice.gov.uk](mailto:nick.rayner@metoffice.gov.uk)

<https://www.eustaceproject.eu/>