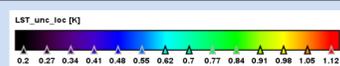
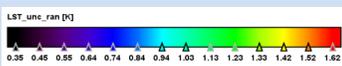
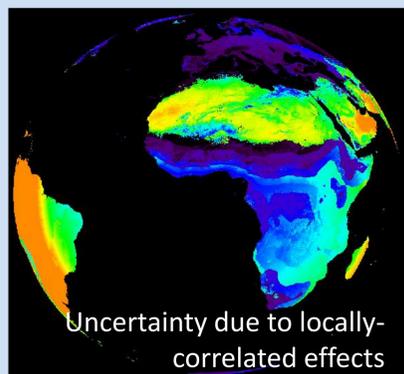
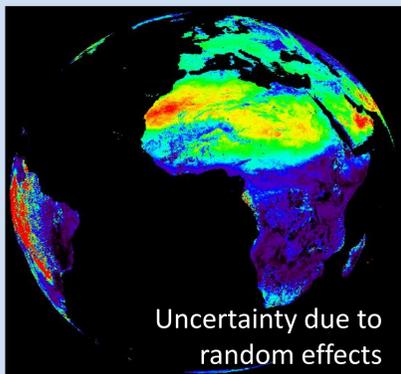


# Needs for Fiducial Reference Temperature Measurements in the EUSTACE project

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.

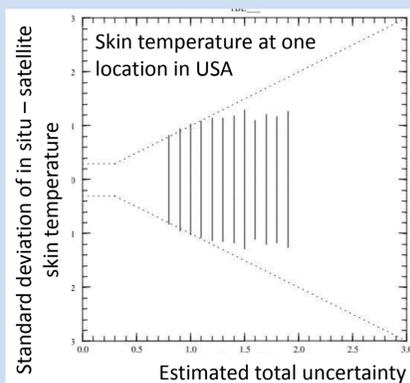
## Estimating and validating uncertainties



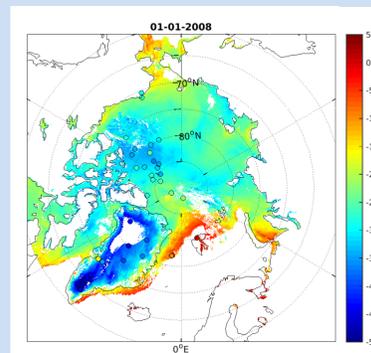
Multi-component uncertainties in satellite measurements of skin temperature consistent over all surfaces of Earth have been estimated and validated for the first time

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

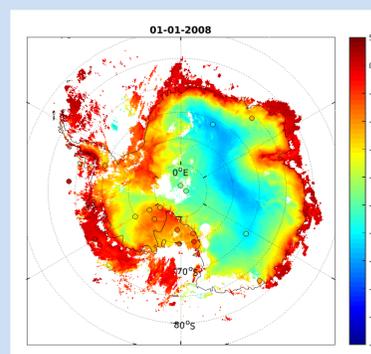
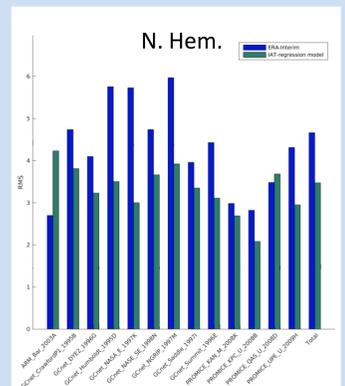
**Right:** MODIS Aqua compared to SURFRAD in situ measurements, 2011



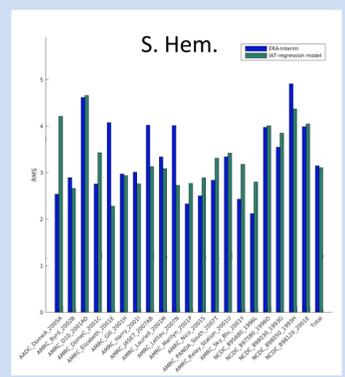
## Validating air temperature estimated from satellite skin temperature



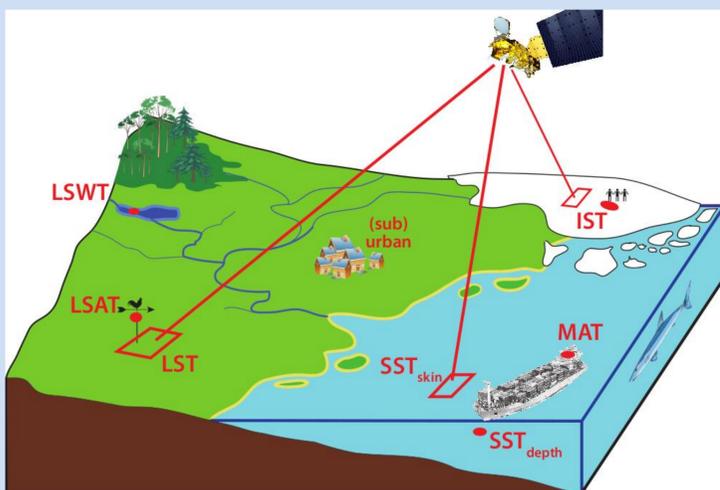
Left: Estimated daily mean surface air temperature (°C) over land ice and sea ice from January 1, 2008. Circles show in situ measurements



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>

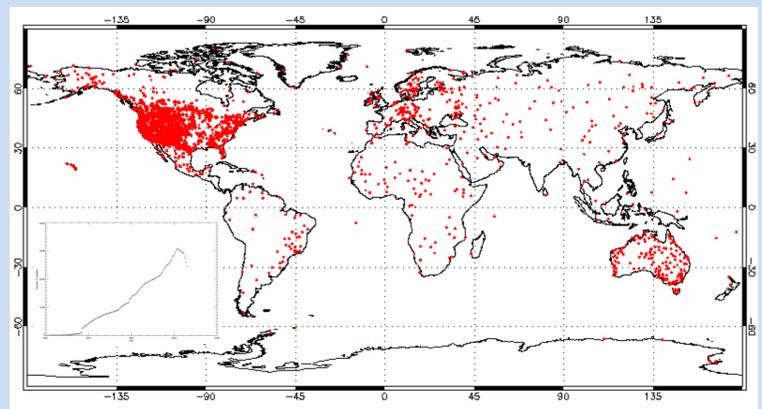
There is a need for a global network of in situ reference sites where relationships between different types of surface temperature can be characterised over land, ocean, ice and lakes.

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.)



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