

EU SURFACE TEMPERATURE FOR ALL CORNERS OF EARTH (EUSTACE)

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EUSTACE Splinter Session, 19th April 2016

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EUSTACE AIMS

EUSTACE will give publicly available daily estimates of surface air temperature since 1850 across the globe for the first time by combining surface and satellite data using novel statistical techniques.

To do this, we need to:

- Identify non-climatic discontinuities in daily weather station data, *so users can trust the changes our records show*
- Produce consistent uncertainty estimates for satellite skin temperature retrievals over all surfaces (land, ocean, ice and lakes), *so we know how far to trust the estimates everywhere*
- Understand how surface temperature measured *in situ* and by satellite relates, *to estimate air from skin temperature*
- Estimate values in areas where we have no *in situ* or satellite data, *so users can have daily information here*



CURRENTLY AVAILABLE SURFACE AIR TEMPERATURE DATA

Source	Type	Region / time period	Daily?	Publicly available?	Spatially complete?
ERA-Interim, NCEP/NCAR, JRA-55, 20CR, etc	Dynamic reanalysis, uses model	Global / various	Yes	Yes	Yes
Berkley	Gridded, uses statistics	Land only / from C19th	Yes	Yes	Yes
HadCRUT4, MLOST, GISTEMP, Berkley, etc	Gridded, uses statistics	Global / from C19th (uses SST)	No	Yes	Sometimes
E-OBS, etc	Gridded, uses statistics	Regional land only / from 1950	Yes	Yes	Yes
ISTI, GHCN, ECA&D, etc	Station, obs only	Regional land only / various	Yes	Yes	No
Other data from satellites	Gridded	Global & regional / a few years	Yes	?	Sometimes

EUSTACE SURFACE AIR TEMPERATURE DATA

Source	Type	Region / time period	Daily?	Publicly available?	Spatially complete?
EUSTACE station series	Station, obs only	Global / from C19th	Yes	Yes	No
EUSTACE update to E- OBS	Gridded, uses statistics	Europe / from 1950	Yes	Yes	Yes
EUSTACE air temperature estimates from satellites	Gridded, obs only	Global / last decade or two	Yes	Yes	No
EUSTACE complete air temperature fields	Gridded, uses statistics	Global / from C19th	Yes	Yes	Yes



COMPARISON TO OTHER GLOBAL SURFACE TEMPERATURE PRODUCTS

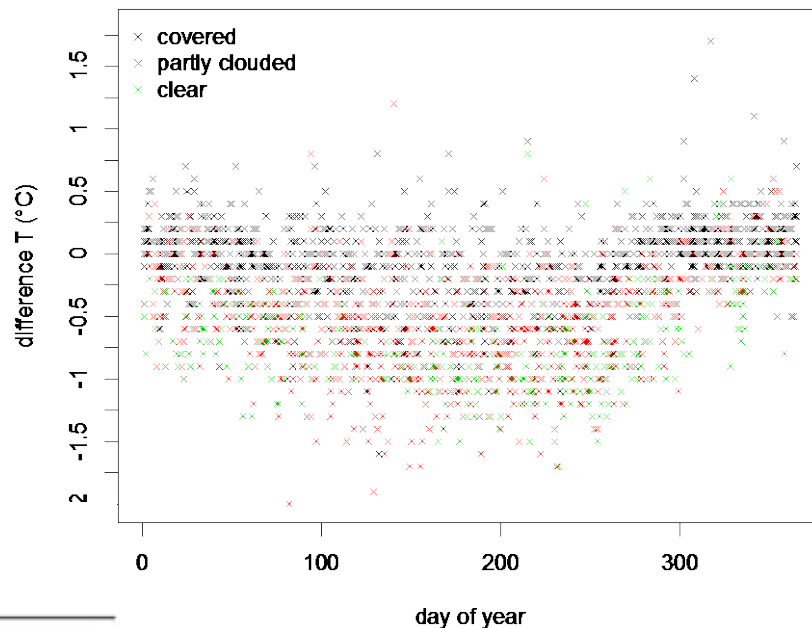
EUSTACE products will differ from others by:

- Being designed in collaboration with users;
- Using an understanding of the relationship between skin and air temperature to estimate air temperature over the whole globe for a long time period;
- Providing daily, globally-complete estimates of surface air temperature over all surfaces of Earth (land, ocean, ice and lakes) since 1850;
- Clearly indicating where these estimates are reliable, probably using an ensemble;
- Presenting air temperature over the ocean, rather than SST;
- Including fully-homogenised daily station data over Europe;
- Being validated (air temperatures and uncertainties) by comparison to independent data;
- Being documented in a Product User Guide

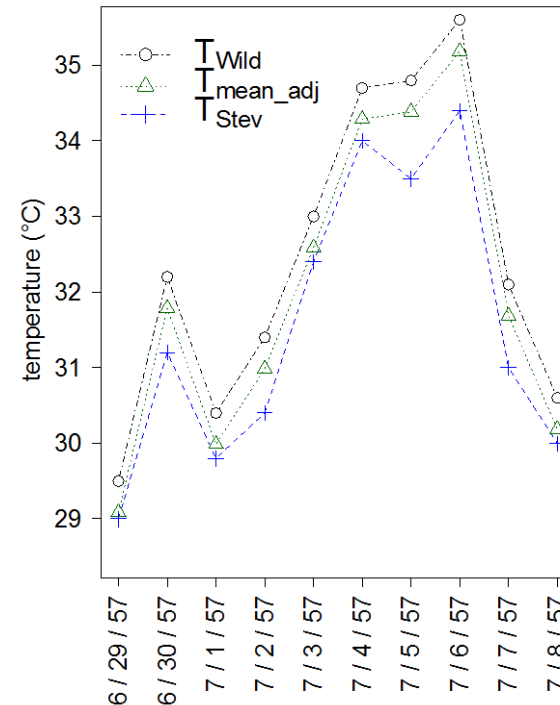
DETECTING DISCONTINUITIES IN DAILY LAND STATION DATA

- signal-to-noise ratio is small
- non-linear effects result in changes to the distribution as well as the mean

Parallel measurements: Stevenson – Wild screens



Inadequacy of simple adjustments to the mean

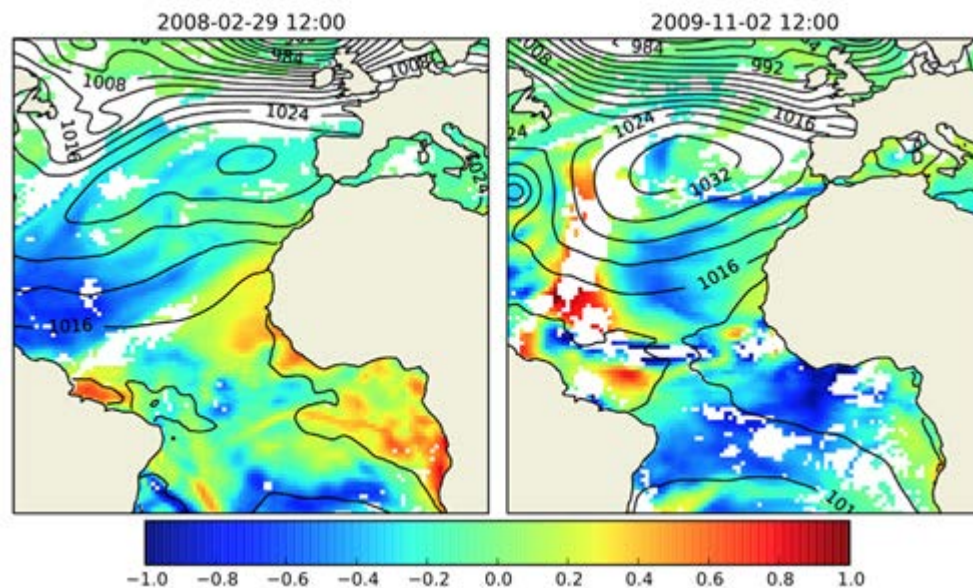


Courtesy Renate Auchmann, Uni Bern

NEED TO CONSISTENTLY ESTIMATE SATELLITE RETRIEVAL UNCERTAINTY

Different sources of uncertainty in satellite surface temperatures:

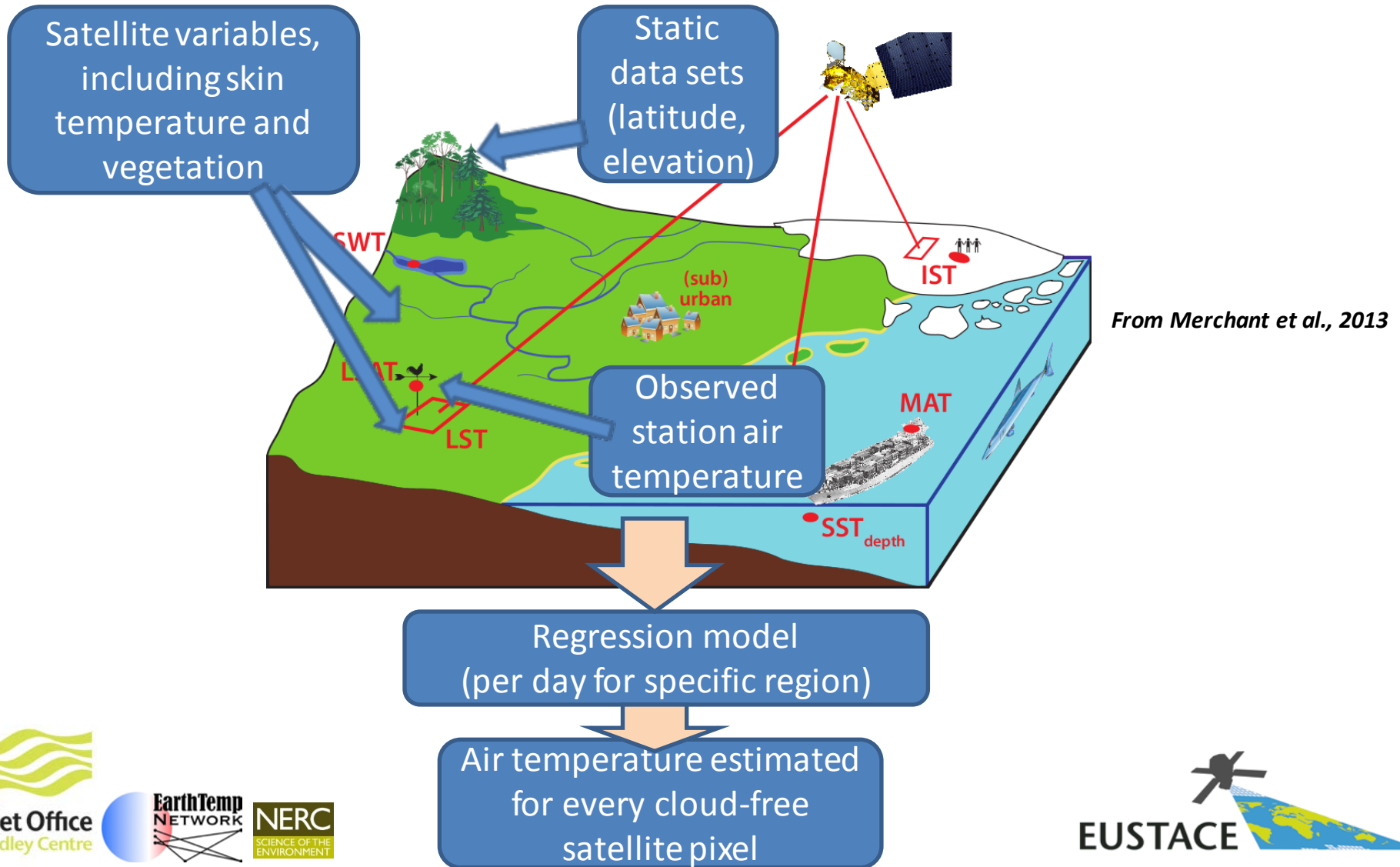
- Random uncertainty from noise in satellite radiances.
- Systematic uncertainty from uncertainty in calibration etc.
- Locally systematic errors are usual (e.g. figure). These arise from effects intrinsic to satellite retrieval



Simulation of intrinsic SST retrieval error on two different days. Although errors arise because of atmospheric variability, there is no simple relationship or correction.

[Merchant, C. J.](#) and [Embury, O.](#) (2014) [Simulation and inversion of satellite thermal measurements](#). In: Zibordi, G., Donlon, C. J. and Parr, A. C. (eds.) *Optical radiometry for ocean climate measurements. Experimental methods in the physical sciences*, 47 (47). Academic Press, pp. 489-526. ISBN 9780124170117 doi: [10.1016/B978-0-12-417011-7.00015-5](https://doi.org/10.1016/B978-0-12-417011-7.00015-5)

ESTIMATING AIR TEMPERATURE FROM SKIN TEMPERATURE

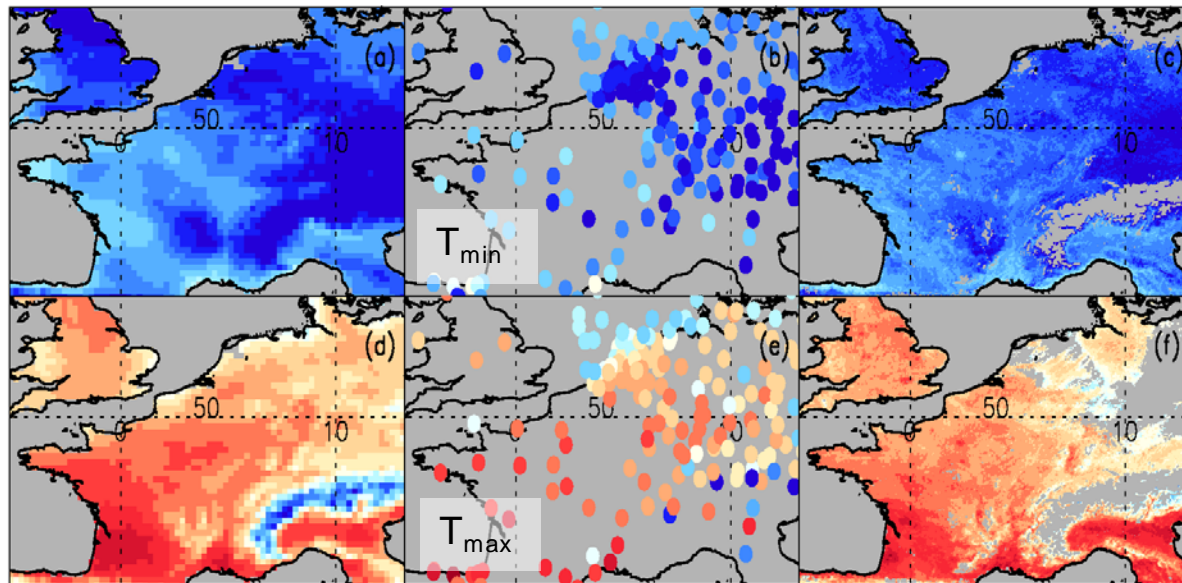


ESTIMATING AIR TEMPERATURE FROM SKIN TEMPERATURE

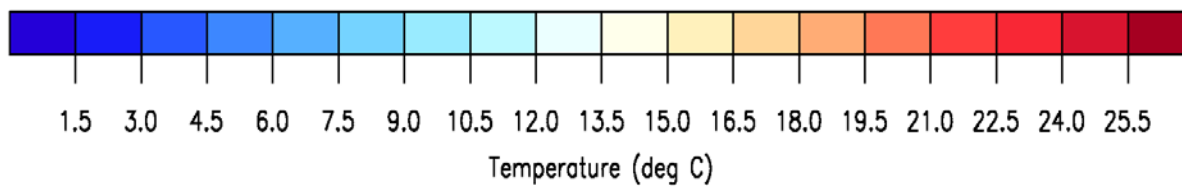
Publicly available weather station records

EOBS ECA&D Satellite LSAT

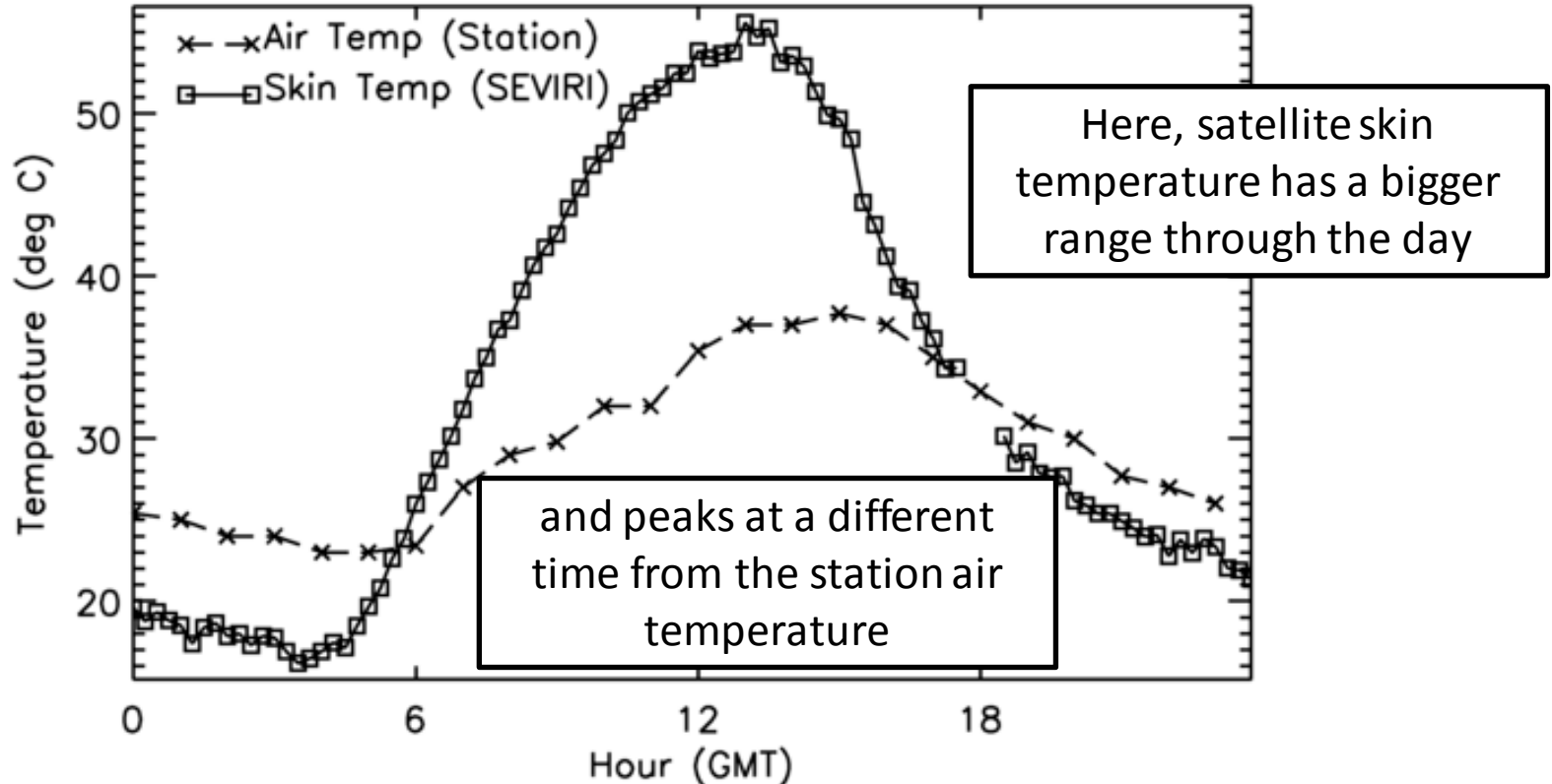
Highest available resolution in-filled air temperature analysis from weather station measurements



Higher resolution information on air temperature estimated using surface (skin) temperature from satellites



CHALLENGES – DIFFERENCES IN TEMPERATURE EVOLUTION THROUGH THE DAY



Extreme case of the diurnal cycle on 2 July 2011 of surface skin temperature (from the SEVIRI satellite) and surface air temperature (at a weather station) in Kairouan, Tunisia

Courtesy Lizzie Good, Met Office



STATISTICAL ANALYSIS METHODS

Global temperature data sets have either been based on simple aggregation of data in grid boxes or on statistical techniques developed in geosciences in the 1980s and 1990s.

The state-of-the-art in the spatial statistics research community is far ahead of the methods generally used in the Earth sciences.

Two approaches will be investigated in EUSTACE:

1. An “advanced standard” method based upon the more advanced methods currently used in surface temperature data set construction.
2. State-of-the-art novel spatial statistics.



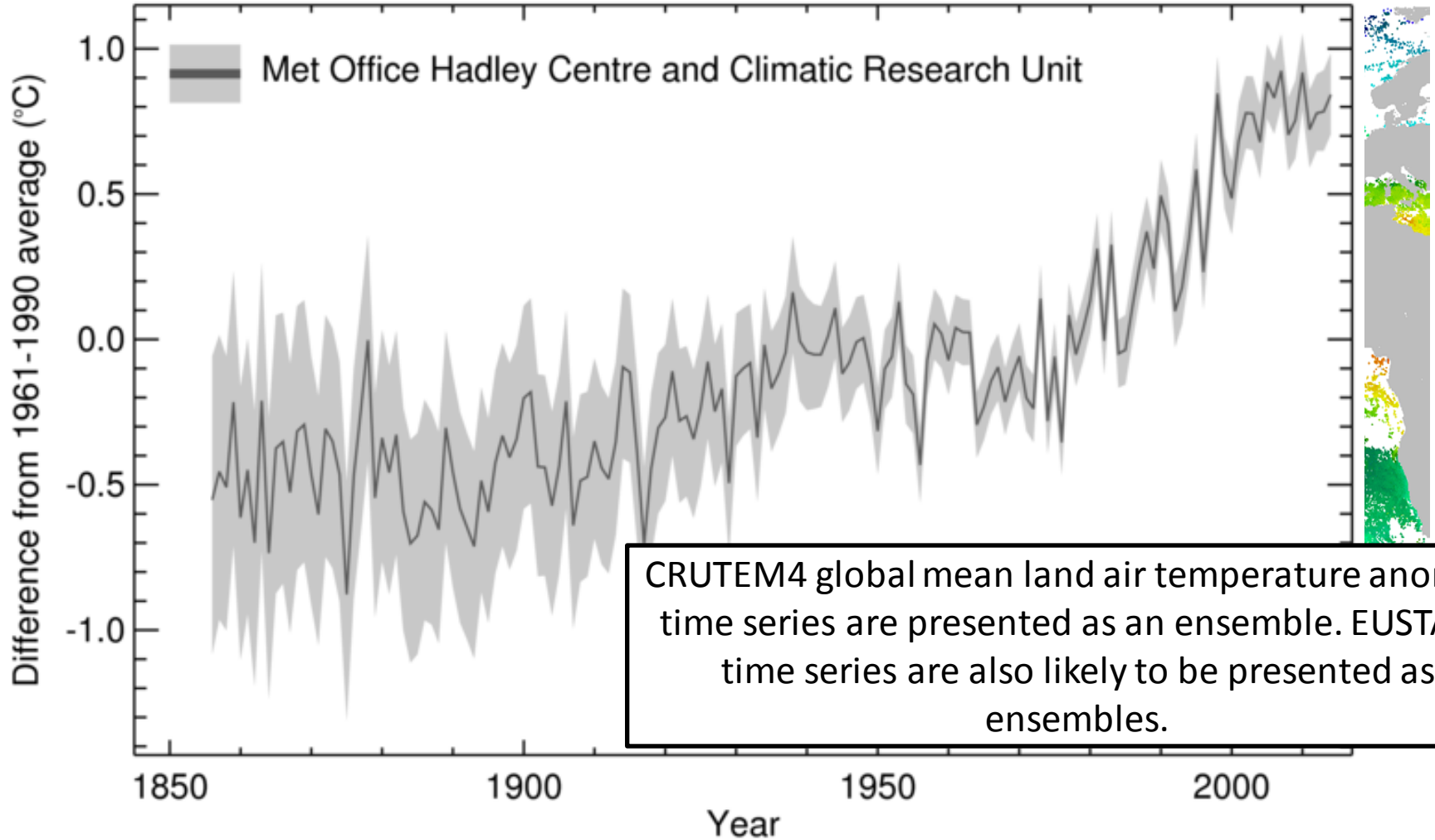
EUSTACE PRODUCTS

Product	Description	Date
Station series and E-OBS update	Global data set of daily weather station air temperature measurements (Tmax and Tmin) with non-climatic breaks identified – Station time series and gridded for Europe	Dec 2016
Satellite skin temperature retrievals	Daily satellite skin temperature estimates for all surfaces of Earth with consistent uncertainty estimates – Gridded or along satellite's track	Apr-May 2016
Skin/air temperature relationships	Understanding of the relationship between surface skin and surface air temperature over all surfaces of Earth and in different seasons – A report	Dec 2016
Air temperature estimates from satellites	Daily estimates of surface air temperature from skin temperature retrievals - Gridded or along satellite's track (TBD)	Jun 2017
Globally complete air temperature fields	Globally-complete daily fields of surface air temperature over all corners of Earth since 1850 – Gridded (0.25° lat/lon) perhaps an ensemble. (Tmax and Tmin over land, Tmean elsewhere.)	May 2018
Derived products	For example, global means and climatologies	May 2018

WHAT EUSTACE PRODUCTS MIGHT LOOK LIKE



Global average air temperature anomaly over land
(1856 - 2014)



CRUTEM4 global mean land air temperature anomaly time series are presented as an ensemble. EUSTACE time series are also likely to be presented as ensembles.

ocean will have less than this coverage.

EUSTACE



MANY THANKS FOR LISTENING

TIME FOR QUESTIONS



EUSTACE has received funding from the European Union's Horizon 2020 Programme for Research and Innovation, under Grant Agreement no 640171

