Introduction to session D

Earth surface (land and water) temperature

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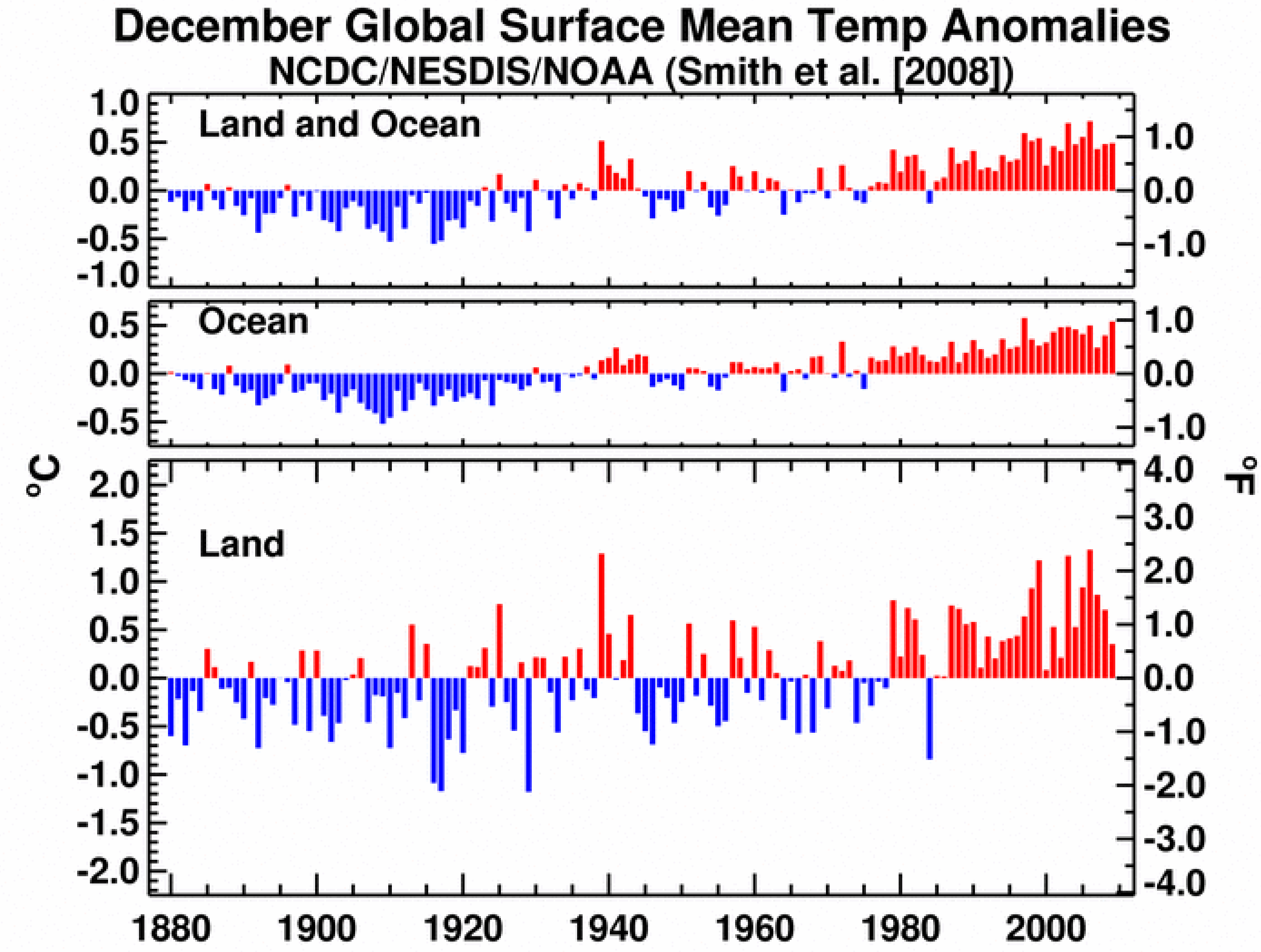
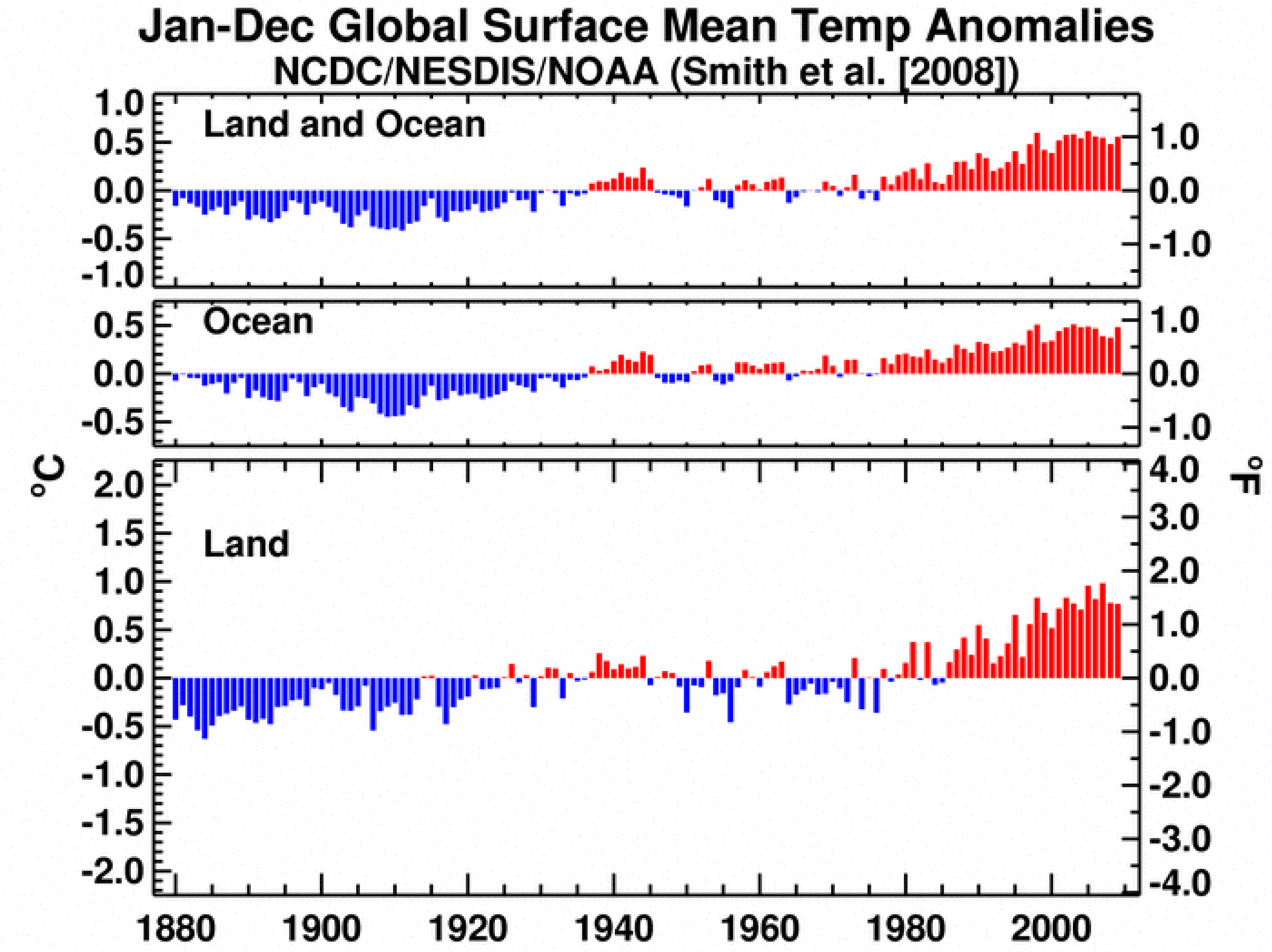
The Issues

- The issues associated with establishing long-term base measurements of surface temperature (Land/Ocean) at climate level uncertainties.
- Next generation of satellite sensors for surface temperature measurements and their pre-/post-launch traceability.
- *In situ* measurements and their traceability: buoys, ships
- Establishing an internationally acceptable operational SST product
- Metrological barriers to achieving quality climate data
- Reliability and issues with historical temperature records

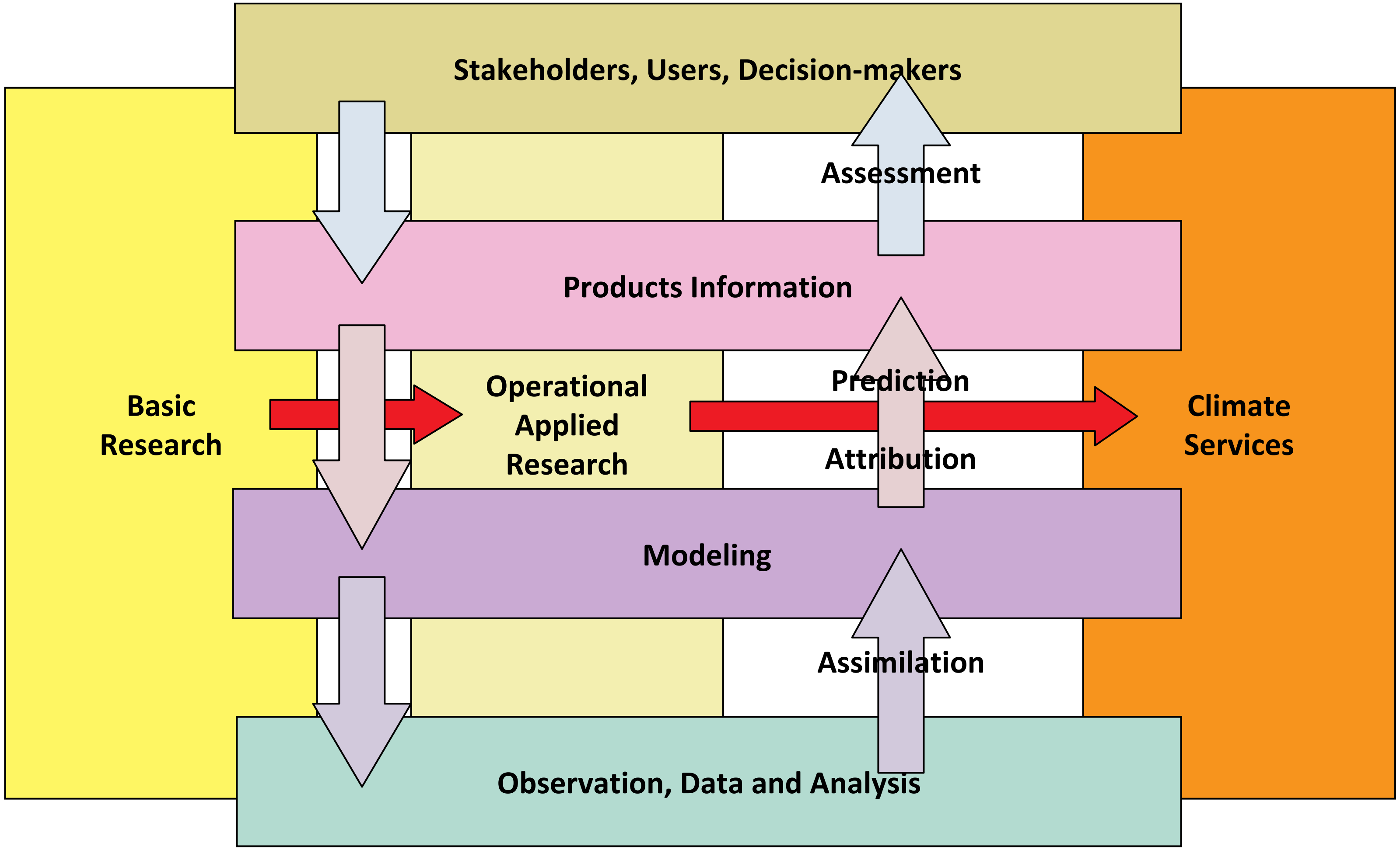
Land and Sea Surface Temperature



Land and Sea Surface Temperature



Climate Observations



(*from K. Trenberth: Observational needs for climate prediction and adaptation, WMO Bulletin 57(1), January 2008*)

GCOS Requirements for SST

Requirements	Sea Surface Temperature
Accuracy	0.25 K
Spatial resolution	1 km, particularly in the coastal zone
Temporal resolution	3 hour observing cycle
Stability	0.1 K (see note)
Spatial coverage	Global

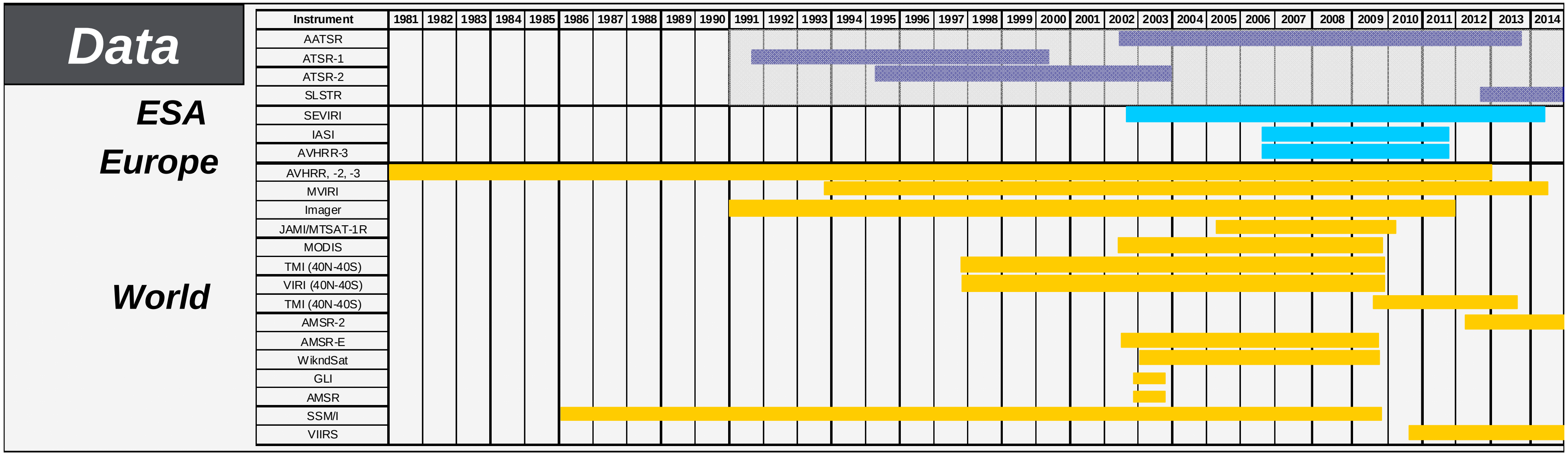
GCOS – 107 Systematic Observation Requirements for Satellite-Based Product for Climate Page 34

- Stability requirements, as expressed by GCOS, are marginal: the current expected signal is a global warming of ~0.05 K/decade which ideally requires an SST stability of 0.02 K/decade for model verification (certainly 0.1K/decade is marginal).

Sea Surface Temperature

- Peter Minnett
  - What is SST?
    - Skin effect
    - Diurnal heating
  - Atmospheric effects
    - Water vapor
    - Aerosols
  - Sea ice effects
    - Generate ice mask at high resolution
    - Anomalous atmospheric effects in the vicinity of sea ice
  - Absolute accuracies
    - How to determine accuracies?
    - How to generate a Climate Data Record?
  - Characteristics of different sensors

Next generation of satellite sensors



- Dave Smith:
  - To meet its scientific goals, the instrument must measure radiances to an accuracy equivalent to a temperature error less than 0.1 K for all pixels with radiometric noise must be less than 0.08 K at 3.7 µm and 0.05 K at 11 µm and 12 µm, for a scene temperature of 270 K.

In situ measurements

- The problem of Surface Temperature for Climate monitoring
  - Etienne Charpentier:
    - The Data Buoy Cooperation Panel is regularly conducting intercomparisons of drifters from different manufacturers, and is keeping track of the quality of the observations. Recent studies indicate a quality of SST observations in the order of 0.2K RMS.
    - Observations from moored buoys are normally more accurate (in the order to 0.1K RMS).
    - Efforts remain to be made to ensure better traceability of the SST measurements from meteorological buoys and coastal moorings.
  - Dick Reynolds
    - Each type of measurement has biases associated with it. Unfortunately, metadata are often missing so correction is difficult.

Establishing an International SST product

- Reconciliation of *in situ* and satellite observations
  - Chris Merchant
    - Analyses challenge the traditional view of "validation".
    - Rather, the need is for a two-way flow of information between satellite and in situ systems to assist uncertainty characterisation and quality control.
- GHRSST
  - Peter Minnett
    - GHRSST provides a new generation of global high-resolution (<10km) SST products to the operational oceanographic, meteorological, climate and general scientific community.
- Some Recent Climate Initiatives in CEOS Agencies
  - ESA Climate Change Initiative
  - NOAA Climate Services
  - NPOESS Restructure

Climate Change Initiative

- The objective of Climate Change Initiative is to realize the full potential of the long-term global Earth Observation archives that ESA together with its Member states have established over the last thirty years, as a significant and timely contribution to the ECV databases required by UNFCCC. It will ensure that full capital is derived from ongoing and planned ESA missions for climate purposes, including ERS, Envisat, the Earth Explorer missions, relevant ESA-managed archives of Third-Party Mission data and, in due course, the GMES Space Component.

- Based on this analysis the following five main activities will be implemented to achieve the overall objective:
  - Gathering, collating and preserving the long-term time series in ESA's distributed archives.
  - (Re-)Processing periodically the basic EO-data sets from each individual mission and applying the most up-to-date algorithms and cal/val corrections.
  - Integrating the calibrated data sets derived from individual contributing EO mission and sensors to constitute the most comprehensive and well-characterized global long term records possible for each ECV.
  - Assessing the trends and consistency of the ECV records in the context of climate models and assimilation schemes.
  - Developing improved algorithms and data models for production of the required variables from emerging data sources, consistent with the long term record

Metrological barriers

- The importance of calibration traceably to SI units.
  - David Llewellyn-Jones
    - For climate applications, long time-series of data requires records from a series of sensors from separate agencies using different engineering designs and different procedures for characterisation and calibration of the sensors. For climate applications, especially, this can be a major obstacle to acceptance by the user communities of satellite data-records.
- Intercomparison experiments
  - Evangelos Theocharous (talking about Field-deployed infrared radiometers)
    - It is essential for the integrity of their use, that any differences in their measurements are understood, so that any potential biases are removed and are not transferred to satellite sensors.

Metrological barriers

- A Quality Assurance Framework for Earth Observation
  - David Llewelling-Jones
    - The QA4EO Initiative has led to a set of guidelines which aims to set out realistic and practical procedures which can be followed in the calibration and validation of earth-observing (satellite) sensors

QA4EO
A QUALITY ASSURANCE
FRAMEWORK FOR
EARTH OBSERVATION

QA4EO Background

- The Global Earth Observation System of Systems (GEOSS) must deliver "timely, quality, long-term, global information " to meet the needs of its nine "societal benefit areas".
- This will be achieved through the synergistic use of data derived from a variety of sources (satellite, airborne and surface-based) and the coordination of resources and efforts of the members.
- Accomplishing this vision, starting from a system of disparate systems that were built for a multitude of applications, requires the establishment of an internationally coordinated framework to facilitate interoperability and harmonisation.
- The success of this framework is dependent upon the successful implementation of a single key principle:
  - all EO data and derived products shall have associated with it a documented and fully traceable quality indicator (QI).
- Success also necessitates the means to efficiently communicate this attributes to all stakeholders.

QA4EO Essential Principle

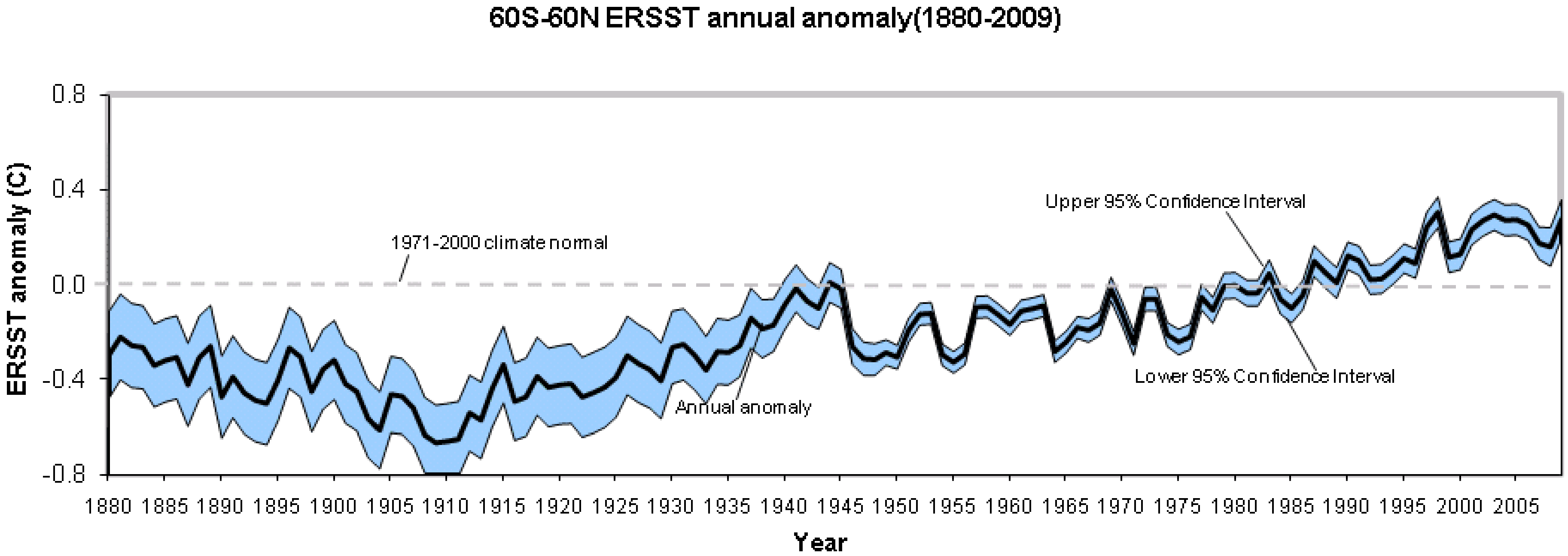
QA4EO

Essential Principle

Quality Indicators

Traceability

Reliability and issues with historical temperature records



- Dick Reynolds
  - Over land measurements are produced at stations. It is important to correct biases caused by changes in station location and to eliminate any individual observations with large errors. Processing of SST observations is more complicated than land because of large instrumental changes.