The Met Office Hadley Centre Sea Ice and Sea-surface Temperature Dataset, HadISST.2.2.0.0

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Consistent data sets across a range of applications

- **HadIOD** (Atkinson et al. 2014)
  - Integrated Ocean Database
  - Designed for assimilation into reanalysis

- **HadSST.3.2.0.0**
  - Lower resolution, missing data
  - Incorporates in situ data only
  - Fully bias adjusted, uncertainty estimates
  - Designed for monitoring long-term change
  - Incorporated in HadCRUT4, used in Detection and Attribution

- **HadISST.2.2.0.0**
  - High-resolution, globally complete analysis
  - Incorporates in situ and satellite data
  - Designed for forcing Reanalysis, Atmospheric-only runs
  - Turns out to be useful for a wide range of applications
HadISST.2.2.0.0

5-day 1°x1° lat-lon,
1961-2010
10 Ensemble members
Interpolated to 0.25° daily resolution

1. Input datasets
2. Bias adjustments of data sets
3. Blending of data sets
4. 2-step reconstruction technique
5. Ensemble production
6. Results
Build from the strengths of the input data sets

- **In Situ**
  - HadSST3 from 1850-present
    - Poor coverage, low accuracy, long record

- **Satellite**
  - ARC - ATSR Reprocessing for Climate, 1996-2010
    - Lower coverage, short record, high accuracy, stable
  - SST CCI AVHRR, 1991-2010
    - Excellent coverage, long record, lower accuracy

- **Bias adjust then blend**
ARC – ATSR Reprocessing for Climate

- Based on Along-Track Scanning Radiometer series of instruments
- Almost independent of in situ measurements
- Shown to have biases of <0.1K
- And drifts of <0.1K decade 1995-2010
- Very small random errors also.
- Agrees with in situ record within (much larger) uncertainties of in situ record.

SST anomaly (°C)

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IPCC AR5
In situ data -

- **Buckets**
- **ERI**
- **Buoys**

Graph showing time series data with labels:
- Absolute Bias (°C)
- Global average SST anomaly (°C)

Data range from 1860 to 2000.
In situ data

- Improvements to in situ ensemble
- Baseline relative to drifters
- Improved ship bias estimates using drifter-ship comparisons
Ship-by-ship adjustments

- Based on in situ data only
- Uses low-res interpolation from HadSST3
- Can be applied whenever we have ship IDs/tracks

Difference for 2004
- Persistent ship tracks and low quality drifters
  - Can affect EOF estimation, AVHRR adjustments
  - Also affects local interpolation
- Run through processing to identify areas with non-climatic features
- Use estimated micro biases to screen for very bad observations and exclude
- Rerun analysis
- In addition, some ship tracks were manually masked during certain periods
  - Western Pacific 1880s, Hawaii 1980s onwards, some buoys during AVHRR period
AVHRR from SST CCI

- SST CCI has improved L2 AVHRR data
  - Improved homogeneity
  - Improved uncertainty estimation with a breakdown into random, locally systematic (100km, 1 day) and globally systematic
- Still has residual biases with structure between local and global
  ~1000km 5-30 day
- Adjust AVHRR relative to in situ and ATSR data
  - Smoothed Zonal-mean adjustment for each 5-day period
  - EOF based analysis using VBPCA with 25 EOFs
AVHRR data

Full coverage data sets

Colocated with in situ data

Colocated with ATSR

IN SITU - HadSST

AVHRR RAW – SST CCI

AVHRR ADJUSTED

ATSR - ARC

ARC IN SITU AVHRR BLEND
Marginal Ice Zone SST and sea ice concentration

- Spatially and monthly varying relationships between ARC SST and sea ice concentration
- Used to specify the SST

21° longitude region centred on 0.5°E
Blending Data Sources
Blending satellites - daily

AVHRR

ATSR

BLEND
Blending satellite and in situ - pentad
2-Step Reconstruction Technique

Large scale – Small scale
1. Variational Bayesian Principal Component Analysis VBPCA

- EOF-based
- Iterative
- Uses all available data
- Doesn’t mind gappy data
- Provides consistent reconstruction, EOFs and uncertainties
- Fast

GUESS EOFS

project on to OBSERVATIONS

AT EACH TIME STEP

BROAD-SCALE RECONSTRUCTION &

time series of weights of EOFs

Bayesian PCA
Weights of EOFs project on to OBS at each location for new EOFs.

Bayesian PCA
NEW EOFs

project on to

OBSERVATIONS

AT EACH TIME STEP

BROAD-SCALE RECONSTRUCTION

&

time series of weights of EOFs

Bayesian PCA
EOFs

EOFs taken from estimated covariance matrix

Number of EOFs used is an input to the algorithm

Use 45 EOFs
EOF

Principal Component

Red – RAW PC
Black - Smoothed

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Sampling from large scale reconstruction

- This is very cheap and efficient
- We have a set of mean weights for each EOF
- And a covariance matrix for the uncertainty in those weights
- Sampling from a 50x50 matrix is easy

- In practice, the reconstruction uncertainty is too small.
  - Correlated observational uncertainty
  - Uncertainty in the EOF patterns not represented
  - Residual noise term uncorrelated also
Local Optimal Interpolation

• Analyse residual difference
• Use local OI
• Angular length scales and angle vary with location
• Covariances based on Karspeck et al. 2012

Non-stationary local covariances

\[ L_x \]

\[ L_y \]

\[ \theta \]
Drawing samples from Local
Multi step reconstruction, January 1-5 2004
Multi step reconstruction, January 1-5 2004
Summary and plans

HadISST.2.2.0.0
5-day 1°x1° lat-lon, 1961-2010
10 Ensemble members
Bias adjustments for inputs
2-Step Reconstruction
Just finished extension to 2016 using METOP
Monthly 1850-2016 version soon

HadISST.2.1.0.0
Monthly 1°x1° lat-lon, 1850-2010
10 Ensemble members
Questions! Answers?