



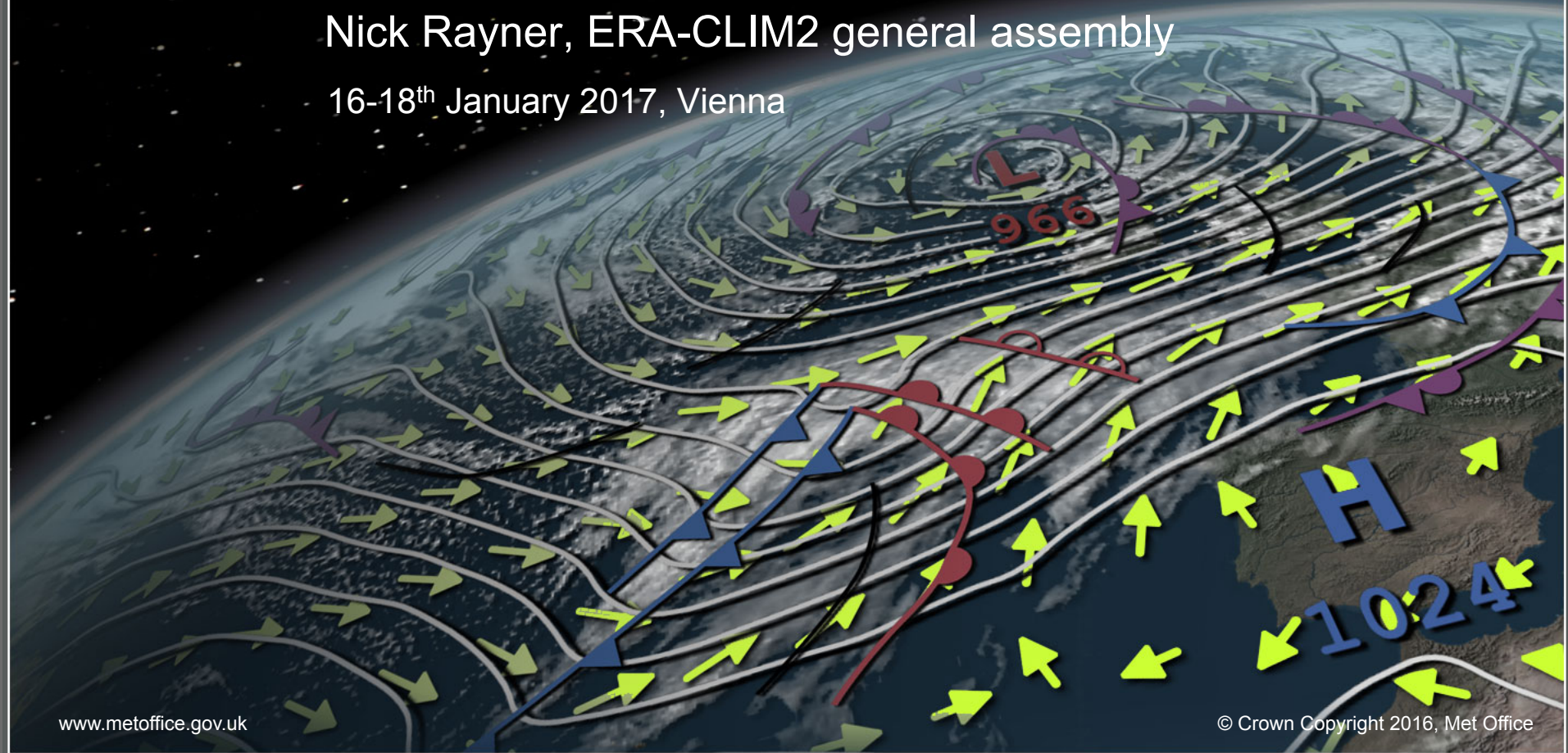
Met Office  
Hadley Centre



# Data rescue, use of satellites and integrating surface and sub-surface ocean temperature and salinity

Nick Rayner, ERA-CLIM2 general assembly

16-18<sup>th</sup> January 2017, Vienna





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# Overview

Met Office contribution to WP3 (Earth System Observations)

- Rescue of historical data, including coordination of the international ACRE initiative and imaging of Southern Ocean data for the early 20<sup>th</sup> century
- Developments of new RTTOV coefficients to enable effective assimilation of various satellite data sets, plus advice on use of early data (D3.8 and D3.9)
- Bringing together surface and sub-surface ocean temperature and salinity with bias corrections and uncertainty estimates for each observation, the HadIOD data set (D3.17)



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# Historical data rescue

Rob Allan and Clive Wilkinson



# ERA-CLIM2 supports ACRE coordination



This includes:

- Assessing international holdings of historical observations to enable prioritisation and avoid duplication of effort
- Placing and managing contracts with specialists in cataloguing, imaging and digitisation
- Obtaining other funding for digitisation work
  - e.g. engage the National Meteorological and Hydrological Services of various countries in the Indian region in aiding the digitization and QC of terrestrial and marine surface daily data in the Indian Daily Weather Reports (IDWR).
- Discussing activities with other international data rescue bodies

Historical Weather Stations in Iran with long records (International Surface Pressure Database [ISPD] holdings used in 20CR) **Blue** = coverage back into the 19th C; **Green** = coverage in the 19th C, but 20th C unknown; **Red** = coverage from at least 1930s-60s



Also starting to explore potential for digitisation of observations from Iranian stations via INDARE proposal to GFCS



# Southern Ocean data rescue

Sub-contracted to Clive Wilkinson

**Aim:** Make inventories and undertake imaging, in various archives of historical observations of sea-ice and atmospheric variables from ships in the Antarctic-Southern Ocean region.

## **Sources:**

- Christian Salvesen Archive, U of Edinburgh;
- Sea Mammal Research Unit, U. of St Andrews;
- National Meteorological Archive (Met Office);
- Whaling Museum and the Vestfold Archive, Sandefjord, Norway;
- Maritime Museum, Mareihamn, Finland
- Chilean National Maritime Museum

# Data Sources for the Southern Ocean -1

## Data imaged and awaiting digitization

### 1. **British Antarctic Survey, Cambridge** – 15,000 images

All research vessels and supply ships, selected shore stations with meteorology and ice reports – 1946-1980, mostly Weddell Sea and Bellingshausen Sea.

### 2. **UK National Archives, Kew** – 5,500 images

All Royal Navy vessels in Antarctic waters -1902-1970

### 3. **Scott Polar Research Institute** – 6,500 images

Selected vessels of research and exploration 1839-1957

**27K** images recording sub-daily data, including barometric pressure , air temperature, wind direction and wind force, sea temperatures and ice observations.

Assessment, inventory and imaging was funded by the Met Office Hadley Centre

## Data Sources for the Southern Ocean - 2

### Vestfold Archive Sandefjord, Norway (now includes the archive of the Whaling Museum)

(Feb, May 2016) - **31K images captured for period 1907-1962**, mostly from Thor Dahl Whaling Company..

Material includes Ships' Logbooks, Catch Books and Day Reports, all with ice and sub-daily meteorological observations, from factory ships, whale catchers and some land stations such as Deception Island. Also data from the 1940-1945 period

The Archive has material from other Norwegian whaling companies as yet uncatalogued. Quantity as yet (2016) undetermined

There is more material in other Norwegian archives such as the Riksarchivet in Oslo.

Potentially a further 1-2,000 document sets may be found



# Example Document: Logbook *Norvegia* - 4 December 1928 Vestfold Archive, Sandefjord

**Aar** 1928      **Skibets sted** *Lys* *o* *Hlaunern*      *Uudusökelsen* *21* *paa* *flugstfeltet*

*dage siden sidste stansbestemmelse*      *Paa reise fra*

1	2	3	4	5	6
Maaned <i>Decebr</i>	Klokkeslag	Patentloggen viate	Vind. Styrke Veir.	Sjegang Baro- meter Termo- meter	pr. styrekor
<i>Tirs</i> dag <i>4 de</i> den	1				
	2				
	3				
	4	<i>SW 7/8</i> <i>1-d 0°</i>			
	5				

*Meget pakkis*  
*Pid. fart.*

—	—	—	—	—
<i>575°0</i>	<i>595°0</i>	<i>579°0</i>	<i>—</i>	<i>—</i>
—	—	—	—	—
—	—	—	—	—

*Fra kl 3 saa man  
pant onis hval*

*JL*

*Bestikopgjør til middag.*

<i>3°0</i> $\Delta$ br. <i>N=57.4</i>	Mbr. <i>55°33'</i>	Br. ifølge bestik md. <i>55°00'</i>	Br. ifølge obs. md. <i>55°30'</i>
Avv. <i>0=101</i>	$\Delta$ lgd. <i>107</i>	Lgd. ifølge bestik md. <i>0=10°37'</i>	Lgd. ifølge obs. md. <i>11°8'</i>

*John Peter Nilan*

Dagbokførereens underskrift.

Forevist den *15-12*, 19*28*

*Nils Larsen*  
Skibets fører.

4-Hourly  
Wind direction  
Wind force  
Weather  
Sea state  
Pressure  
Temperature

Duplicate

REVISED 1935

# WHALE FISHERY

CATCH LOGBOOK

## Whale Fishery Catch Book Factory Ship Terje Viken Nov/Dec 1937

Hubert. Lamb Archive, CRU/UEA

5

### DAILY RECORD

DAY	LINK No.	SUNDAY 28th	MONDAY 29th	TUESDAY 30th	WEDNESDAY 1st.	THURSDAY 2nd
LATITUDE	1	58-48 S	58-50 S	S 58-15	58-21 S	58
LONGITUDE	2	45-20 E	45-50 E	E 46-37	47-16 E	48
BAROMETER. THERMOMETER. <i>Delius Centigrade</i>	3	73.98 ÷ 1.5°C.	73.80 ÷ 1°C	73.81 ÷ 1°C	73.00 ÷ 2°	73.00
WIND. DIRECTION. FORCE	4	NW - 5	NNW - 4	NW - 5	SW - 2	W 2 37
WEATHER	5	drizzle-snowsqualls fog & snowsqualls in the packice	S - close	Swell, overcast, clear	clear - overcast	SN 45
PACK ICE. BEARING. DISTANCE	6	some small	some small.	some small	few small	S 88
BERGS. NUMBER. SIZE	7					
WHALES	8	B F H S	B F H S	B F H S	B F H S	B 3870

Spermwhale  
FOR THE

	190	600	100	405	160	330	200	3870
OIL TOTALS	495	600	750	405	160	330	200	3870
OIL TOTAL	495	600	750	405	160	330	200	3870
WHALE OIL								
SPEER OIL								
MEAL								
MEAL								
GUANO								

REMARKS 28/11. Tor 2 left for Capton. She has cut her propellershaft. Repairs will be carried out at Capton.

*Hubert Lamb*  
LOGKEEPER

AVERAGE BARRELS per Spermwhale - 63.7

NOTE - Headings B, F, H & S, indicate Blue, Fin, Humpback & Sperm.



## Data Sources for the Southern Ocean - 3

### Data Identified and Assessed that will be imaged 2016-2017

#### 1. Museo Marítimo Nacional, Valparaiso

Armada de Chile – 80 sets of logbooks 1947-1970 from Antarctic waters. **8-10K images estimated** – Imaging Nov 2016-Mar 2017

#### 2. Christian Salvesen Archive, University of Edinburgh.

Logbooks and catch books and ice charts from whale factory ships 1932-1936 & 1950-1959. **2,700 images captured Oct 2016.**

#### 3. National Oceanographic Centre, Southampton

Logbooks of research vessels and other material

#### 4. Archive of the Sea Mammal Research Unit, University of St.

**Andrews**, Catch books, Inspectors' diaries and field notes from whale factory ships 1930s-1960s

## Example Documents: Christian Salvesen Archive, Edinburgh

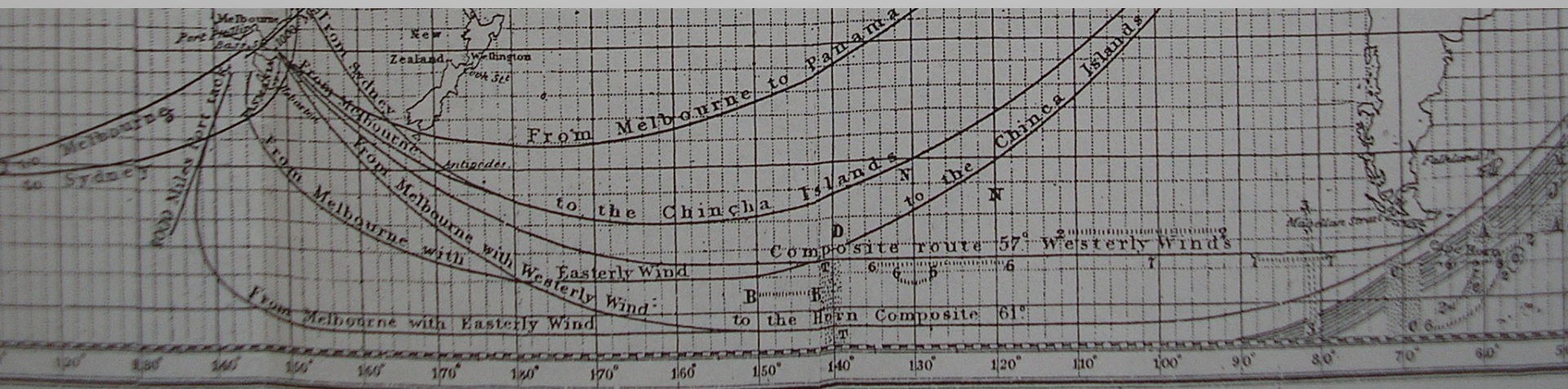
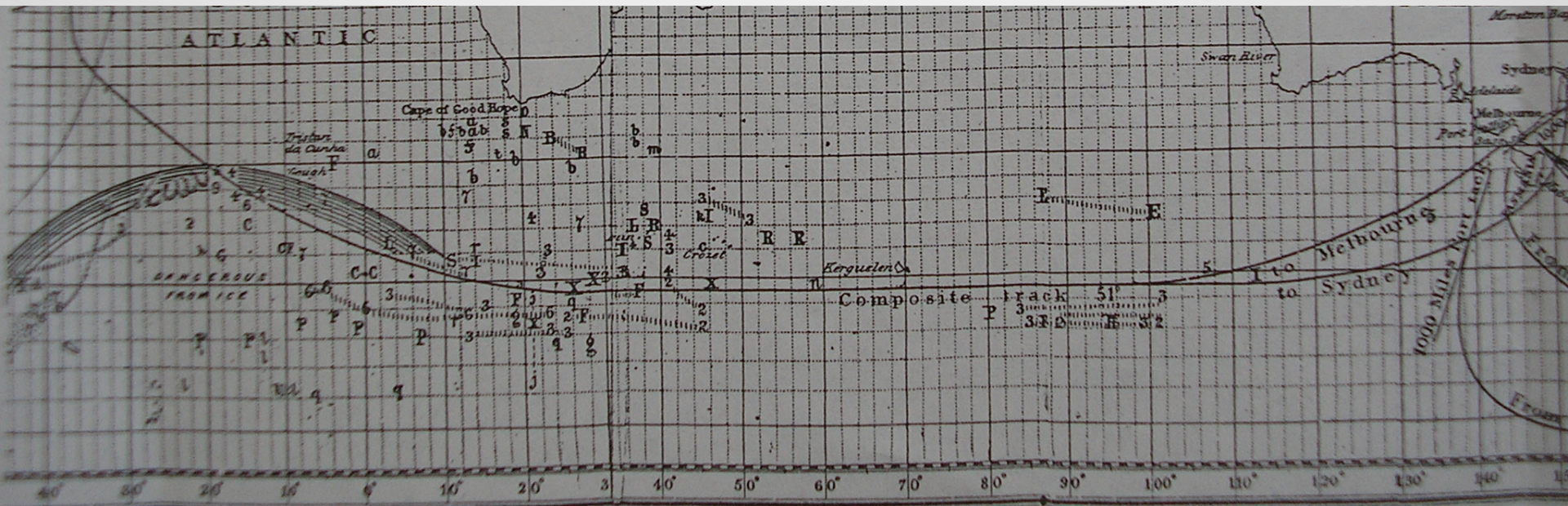
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### Driftsoversikt for <sup>F</sup>/<sub>K</sub> SOURABAYA

1. Dag	2. Datum	3. Middagsposisjon		TERMO = METER	BARO- METER	4. Værforhold	
		Bredde SYD	Lengde VEST				
Søndag	23/12	59°50'	30°41'	38°	29.26	frisk vind <sup>fra</sup> sørøst.	Pakis rent.
Mandag	24/12	58°36'	29°55'	38°	29.47	Javn bris overkylt.	— " —
Tirsdag	25/12	58°37'	29°14'	36°	29.22	Løi med blandet luft.	— " —
Onsdag	26/12	58°41'	29°00'	37°	29.25	Lille drig luft.	Pakis i S. endel isfjell.
Torsdag	27/12	57°45'	27°49'	37°	29.10	Løi drig luft	Pakis.
Fredag	28/12	57°43'	28°01'	36°	29.15	Løi vind fakte.	— " —
Lørdag	29/12	57°41'	28°19'	35°	29.14	— " — lett fakte	Skiltret is.
						Sum	
7. Påfyllinger							

High Southern Latitude Transits of Indian and Pacific Oceans c. 1856-1900

400+ Met Logs, with four-hourly pressure, temperature, SST and other data



## High Southern Latitude Meteorology – Imaging programme 2015-2017



Most source materials are merchant vessels with 4-hourly observations of pressure, temperature, wind direction and force, weather and SST. Many also include wet and dry bulb temperatures, cloud cover, salinity, some include current speed, set and drift, ice reports biological observations, aurora, meteors, etc.

### **National Meteorological Archive – Exeter**

(Imaging 2015-2017) – c. **14K images captured for vessels 1900-1955.**

logbooks, met forms and ice reports

Typical route for New Zealand passage: Out via Panama, return via Drake Passage

A further 10K images expected for the 1905-1920 & 1946-1960 period

An additional 500 logs cover the period 1855-1899.

### **Åland Maritime Museum, Mariehamn, Finland**

Åland sailing fleet of Gustaf Erikson - routes to and from Australia and Chile,,  
via Drake passage, 1890-1947

**27K-30K images to be captured May-Jul 2017**



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# Use of satellite data

Roger Saunders, Peter Rayer, Viju John and Pascal Brunel



## Activities

- Provide advice on use of satellite datasets
- Maintenance and development of RTTOV coefficients for satellites used in reanalysis
- Assist in provision of old satellite datasets of value for reanalyses



# Update to RTTOV coefficients (D3.8 – delivered)

There are several motivations to update the RTTOV coefficients for radiance assimilation:

- Benefit from updated radiative transfer models from which RTTOV is referenced to (i.e. LBLRTM v12.2 together with the MT\_CKD continuum version 2.5.2)
- Use improved instrument spectral response functions (e.g. HIRS, AMSU-A, allow for SSU cell pressure changes, etc)
- Better atmospheric state (i.e. Allow for changes in GHG concentrations over period analysed) and more vertical levels 43→54
- Addition of Zeeman effect for SSMIS and AMSU-A upper peaking channels
- Use latest version of RTTOV (i.e. Version 11) which requires newer file formats and coefficients

# Update to RTTOV coefficients (D3.8 – delivered)

Sensor	Platforms	Period	Measured primary variables	Status
SMMR	Nimbus-7	1975-1983	Sea-ice, total col water vapour, ocean surface wind, cloud LWP	Available with RTTOV-11/12
SSM/T-2	DMSP-F8→F14	1992-2008	Upper tropospheric humidity	Available with RTTOV-11/12
PMR	Nimbus-6	1975-1976	Stratospheric temperature	To be made available on RTTOV web site by end of Feb 2017.
THIR	Nimbus-4→7	1970-1980	Surface/cloud top temperature and upper tropospheric humidity	Available with RTTOV-11/12
HIRS-1	Nimbus-6	1975-1976	Temperature and humidity profiles	Available with RTTOV-11/12
MVIRI	Meteosat-1→4	1978-1995	Surface/cloud top temperature and upper tropospheric humidity	Available with RTTOV-11/12
G O E S - Imager	GOES-4→7	1980-1996	Surface/cloud top temperature and upper tropospheric humidity	Available with RTTOV-11/12
SCAMS	Nimbus-6	1975-1976	Temperature profiles and total column water vapour	To be made available on RTTOV web site by end of Feb 2017.

# Update to RTTOV coefficients (D3.8 – delivered)

Sensor	Platforms	Measured primary variables	Reason for update
HIRS	TIROS-N → NOAA-14, METOP-A/B	Temperature and humidity profiles	Shifted spectral response functions. More levels, better CO <sub>2</sub> .
SSMI(S)	DMSP-F15 → F19	Temperature profiles, upper tropospheric humidity, total column water vapour, surface wind, cloud LWP	Revised treatment of Zeeman effect for mesospheric channels. Improved pressure levels.
AMSU-A <sup>1</sup>	NOAA-15-19 METOP-A/B	Temperature profile	Shifted pass-bands, better treatment of AMSU-A ch 14 for Zeeman more levels
SSU	TIROS-N → NOAA-14	Stratospheric temperature profile	Allowance for cell pressure variations which affect spectral response.
MODIS	Terra, Aqua	Surface and temperature and humidity profiles	Shifted spectral response functions. More levels, better CO <sub>2</sub> .

<sup>1</sup>The AMSU-A band shifted coefficients are not part of RTTOV-12 release and should be requested.

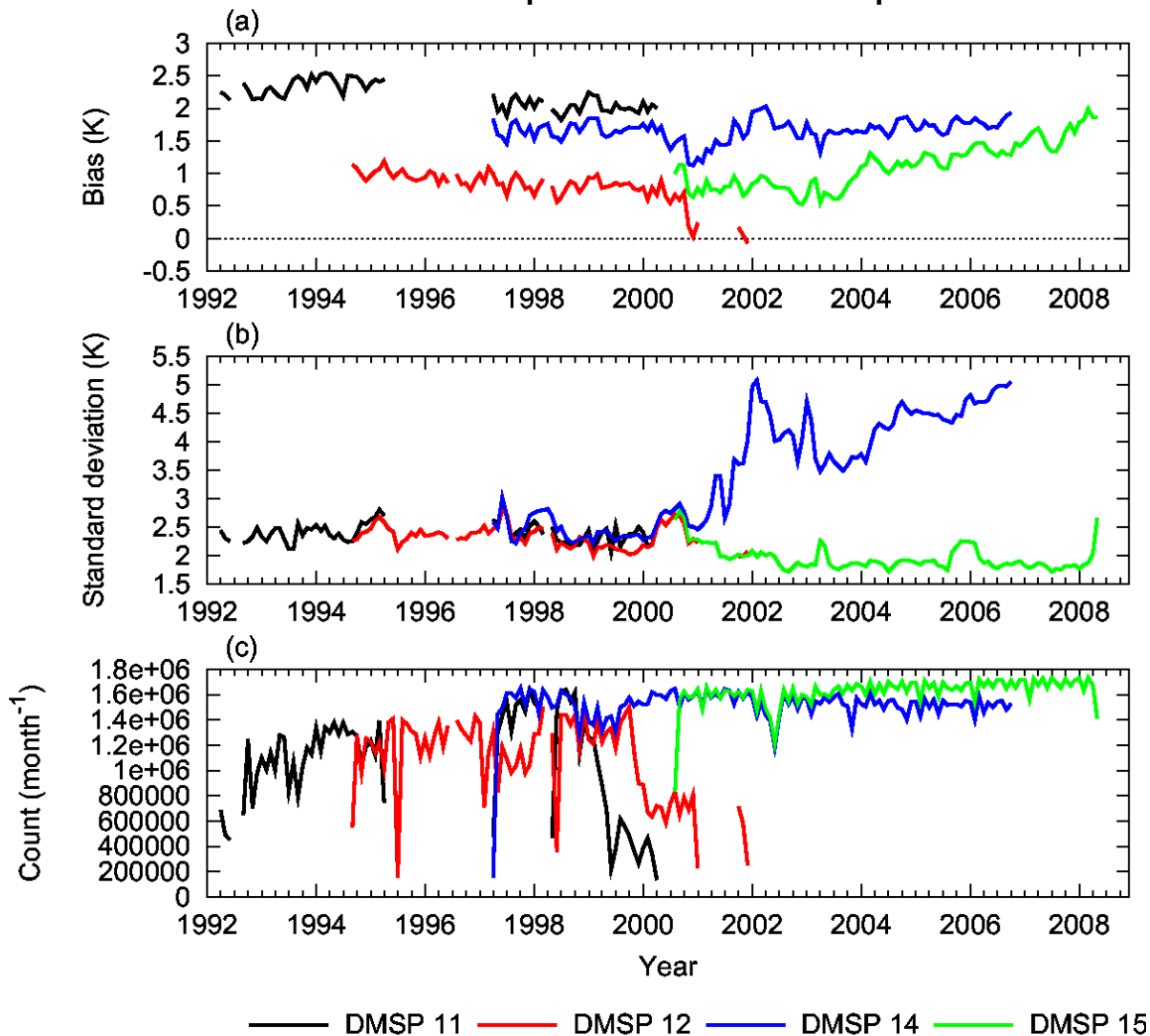
# Provision of old satellite datasets (D3.9) – will be delivered 23-27 Jan 2017

- Use of satellite datasets not exploited in ERA-40 primarily:
  - **SSM/T-2** Characterisation of Special Sensor Microwave Water Vapour Profiler (SSM/T-2) radiances using radiative transfer simulations from global atmospheric reanalyses Kobayashi *et. al.* 2016
  - **PMR** Rayer Met Office Report.
  - **HIRS-1**
  - **IRIS** Recent advances in satellite data rescue. Poli *et. al.* 2017
  - **SMMR FCDR** CMSAF report
- Use of reprocessed radiances into FCDRs:
  - **AMSU-B/MHS FCDR (EUMETSAT)** Several papers by John *et. al.*
  - **SSU FCDR (Met Office/NOAA)** Nash and Saunders, 2015, Zou *et. al.* 2014
  - **SSM/I FCDR (CMSAF)** CMSAF report



# Provision of old satellite datasets

SSM/T-2 upper tropospheric humidity channel  
Radiances departures over tropical ocean.



(a) Monthly mean and  
(b) standard deviation of departures from the ERA-Interim analysis, and  
(c) monthly counts for the upper tropospheric humidity channel (2) over the tropical ocean (30°N to 30°S). The statistics were computed using clear-sky data only.



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# Integrating surface and sub- surface ocean temperature and salinity

Chris Atkinson



# Updates to Marine Database

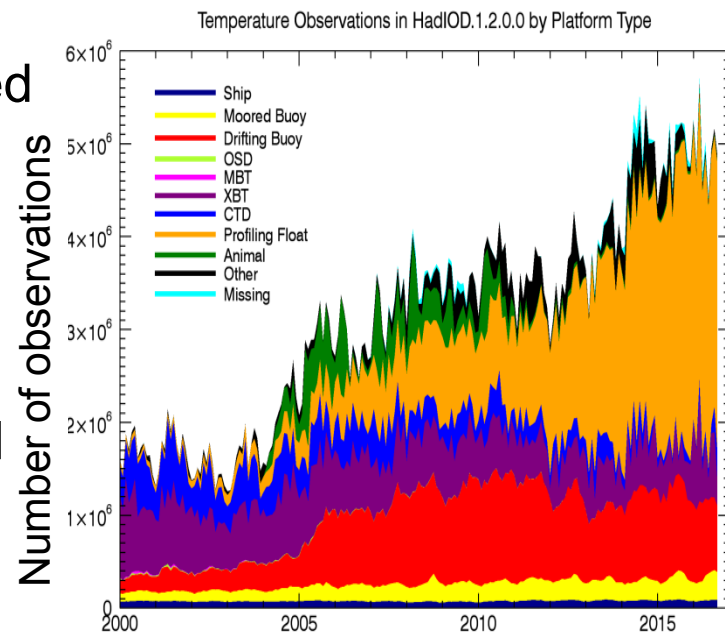
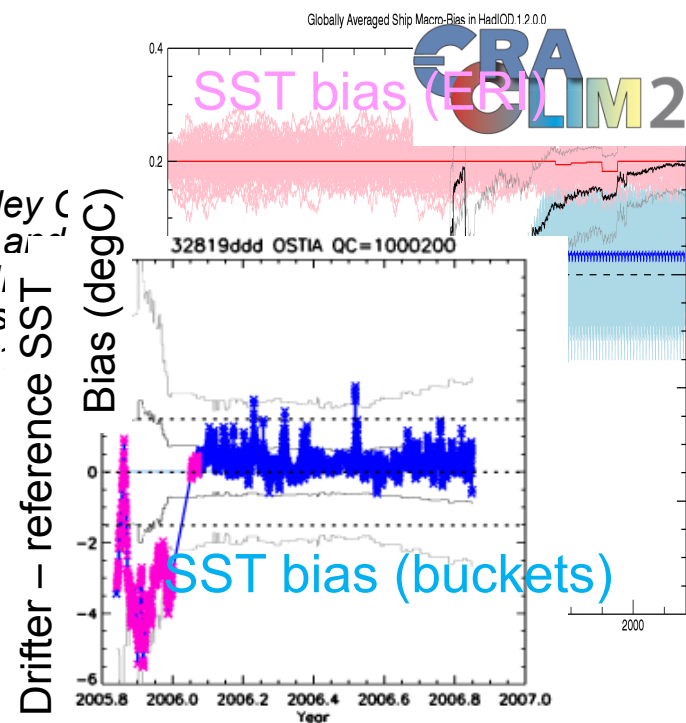
\*HadIOD is the **Hadley** Centre database of surface air and sea surface temperature estimates. It covers

HadIOD\* version 1.2.0.0 created:

*Improvements c.f. version 1.1.0.0:*

- Clean re-run of SST QC and unmasked ship call signs
- Latest EN.4.2.0 profile data (with multiple XBT correction schemes)
- Multiple ship SST correction realisations based HadSST3.1.1.0 ensemble
- Improved drifter/ship SST tracking QC with periodic updates
- Improved quality assurance
- High temporal resolution GTMBA data (added for SST CCI II)

D3.17 - delivered



# Updates to Marine Database (ongoing work)

- HadIOD.1.2.0.0 is intended as the first public release (aiming for Spring 2017)
- At present data can be extracted from HadIOD into NetCDF feedback format for ERA-CLIM2 users
- We plan to make HadIOD.1.2.0.0 data available in ‘non-feedback’ NetCDF format and distribute via Met Office Hadley Centre dataset webpage: <http://www.metoffice.gov.uk/hadobs/>
- Ongoing monthly updates will be maintained
- Hope to continue HadIOD development beyond ERA-CLIM2 and release new versions via HadOBS (e.g. by adding new observation datasets, improving QC or incorporating latest instrument bias corrections and uncertainty estimates).
- Remaining project time will be used to explore feedback information from CERA-20C from an observational perspective.

Any feedback is welcome: [chris.atkinson@metoffice.gov.uk](mailto:chris.atkinson@metoffice.gov.uk)



# Summary

Met Office contribution to WP3

- Various strands of work communicating understanding on both in situ and satellite observations are drawing to an end, or continuing in 2017 (in the case of ocean data)
- Data rescue for the Southern Ocean has started and will continue through 2017.
- Updated RTTOV coefficients for a number of satellite data sets have been delivered and can be used with RTTOV-11 and (soon) RTTOV-12



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Questions?

## Norwegian Whaling Ships – Wind Scales



Before 1935  
Seven point  
Wind Scale

### VINDSTYRKE

Tegn	Betydning
0.	stille
1.	svak
2.	lett
3.	frisk
4.	sterk
5.	storm
6.	orkan

1935 and after  
Thirteen point  
Wind Scale

### VINDSTYRKE

Tegn	Betydning
0	stille
1	flau vind
2	svak »
3	lett bris
4	laber »
5	frisk »
6	liten kuling
7	stiv »
8	sterk »
9	liten storm
10	full »
11	sterk »
12	orkan

VÆRET

