

Diurnal Variability Working Group

Meeting report of the 5th workshop, Rome, Feb. 2009-02-26

Chair:	C J Merchant	Edinburgh, UK
Attending:	S Castro	Boulder, US
	G Wick	Boulder, US
	D Poulter	NOCS, UK
	P Le Borgne	Meteo-France, Fr
	H Beggs	Bluelink, Aus
	C-A Clayson	Florida SU, US
	S Marullo	ENEA, It
	R Santoreli	CNR, It
	B Nardelli	CNR, It
	S Eastwood	Met No, Norway
	A Harris	NOAA, US
	M Filipiak	Edinburgh, UK
	Y Kawai	JAMSTEC, Jpn

Day 1 Updates presentations from members

There was a warm welcome from our hosts, and CM thanked the hosts on behalf of the WG, and introduced the structure of the meeting.

MODELS OF DIURNAL VARIABILITY

GW reminded the WG about the Kantha-Clayson turbulence models (original, with enhanced wave-generated mixing, and blended model) and proceeded to discuss the creation of look-up tables based on full modelling. Use of idealized and actual forcing gives very different LUTs; the latter are more realistic, although only the former can readily give filled LUTs. Progress since DVWG4:

- Increased resolution (needed to avoid abrupt transitions) of LUT derived from theoretical forcing data
- Generation of new LUT from real forcing for all table formulations
- Evaluated accuracy of new LUT for application to both cruise and model data
- Application of LUT to gridded SEVIRI data
- Explored impact of temporal resolution of forcing data on LUT accuracy

Use of LUTs gives bias <0.1 K and adds 0.5 K noise on average (across the table) but is much faster than use of the full model. Use of integrated drivers is not significantly more efficient in fitting the results than use of instantaneous fields, as formulated.

MF presented the distributionally-based approach to a DV model which is able to be driven from NWP (ECMWF) and captures all sizes of warming events. This has coefficients defining a DSST v. wind relationship for each hour of local time for various bins of integrated positive surface heating.

YK presented experience with the Godfrey Schiller model. It is being run without any lower wind limit, which may cause “blow-ups” occasionally. There were interesting differences in the NWP model run with and without the GS parameterisation, moving locations of precipitation, and, rather surprisingly, impact on the minimum central pressure of a typhoon (provisional result) – see Figure 1.

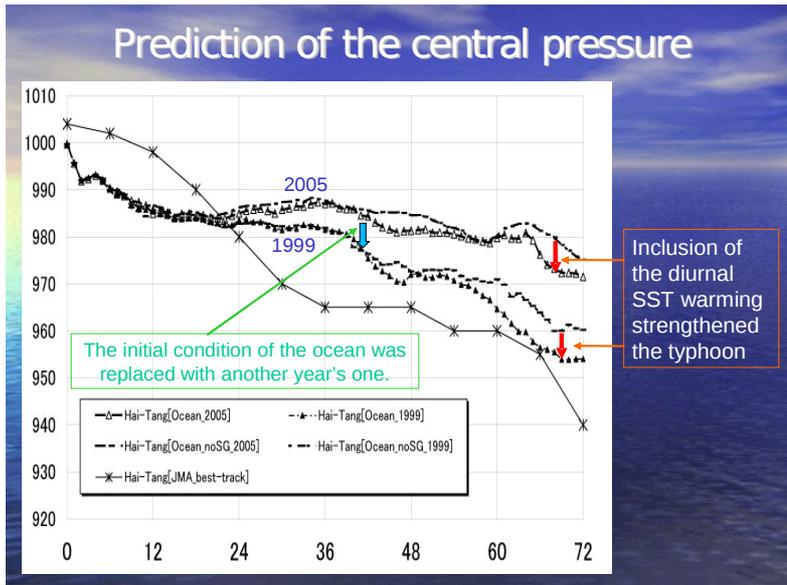
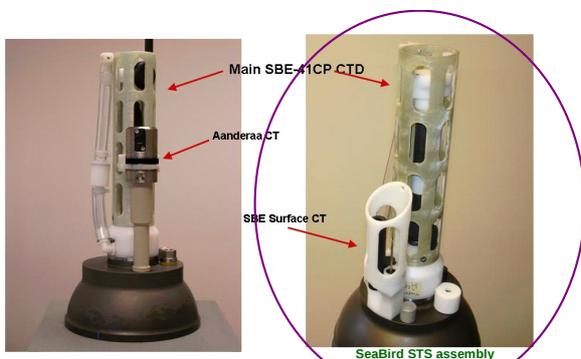


Figure 1 – effect of inclusion of diurnal SST warming in model affects the central pressure of a typhoon in the model, towards reality. This is a provisional result, yet to be explained.

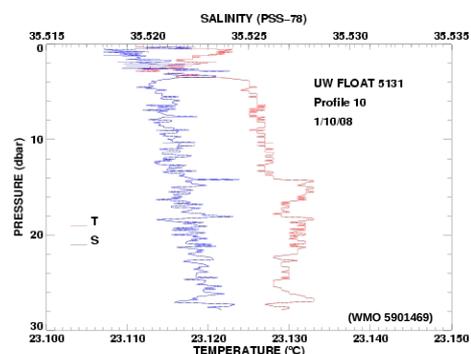
OBSERVATIONS

HB updated the group on the fields to be included in the Tropical Warm Pool Plus experiment (intensive observation data set for diurnal variation). The limitations of MTSAT calibration were discussed. The calibration is diurnally aliased. It was decided to proceed with a re-run of the generation using a consistent algorithm day and night, and that a post-hoc SST correction could be devised on an hourly basis by empirical means. Two new geostationary satellites (COMS and MTSAT 2) that cover the TWP+ area are being launched in 2009 / 2010. A sub-group met on day 3 to finalize the gridding details.

CM summarized the conclusions of Gentemann, Minnet, Le Borgne and Merchant, 2008. There was discussion about the finding that large events are clustered in mid-latitudes, and nearly absent in the equatorial Atlantic. This is not surprising in the trade wind regions. The general view was that the possible explanations of the rarity of equatorial large events are (i) the wind doesn't drop to <2 m/s on a sustained basis very often here, (ii) the amplitudes of warming events in SEVIRI are underestimated by algorithmic insensitivity in this region, because of high water vapour, (iii) events are less likely to be sampled from satellite because of high cloud cover in the ITCZ. Possibly all of these factors contribute.



To examine the relationship between the near surface (5 m) values of T and S and the true sea surface values, we have recently deployed an Argo-type float with a 2nd CTD sensor that can continue to collect CTD data all the way to the sea surface, known as the STS (surface temperature/salinity) unit. This work as been funded by NASA in anticipation of the Aquarius program.



This is an example of typical temperature and salinity profiles from the STS sensors. Note that the measurements continue to be collected until the float breaks the sea surface during its ascent.

Figure 2. The additional STS sensor on an Argo-type float, and an example T-S profile in the top 30 m.

YK presented (actually on day 4) some information about and observations by modified ARGO floats, including slides prepared by S Riser – Figure 2. This caused considerable interest and initiated many questions about the data, particularly the depth determination. **ACTION CM:** Arrange an expert on ARGO floats / STS to have detailed technical discussions with DVWG at GHRSS 10.

YK also presented cruises and radiometric SST measurements undertaken by JAMSTEC. Some of these, and the Noh model, can be used in the model inter-comparison exercise to be led by GW.

SM presented his diurnal cycle optimal interpolation scheme for the tropical Atlantic, using OSI SAF, MODIS, AMSR SSTs with in situ including PIRATA moorings. He outlined the spatial bias pattern in SEVIRI SSTs well known to PLB – e.g. Figure 3. He showed the diurnal cycle in the SAF products are minimal, however. The approach being taken to diurnal OISST caused interest, since the cycle is estimated over an 11 day window and correlations of cycle between days are assumed. This may be proved reasonable for the tropics, but the concept’s applicability to mid-latitudes was generally viewed with scepticism.

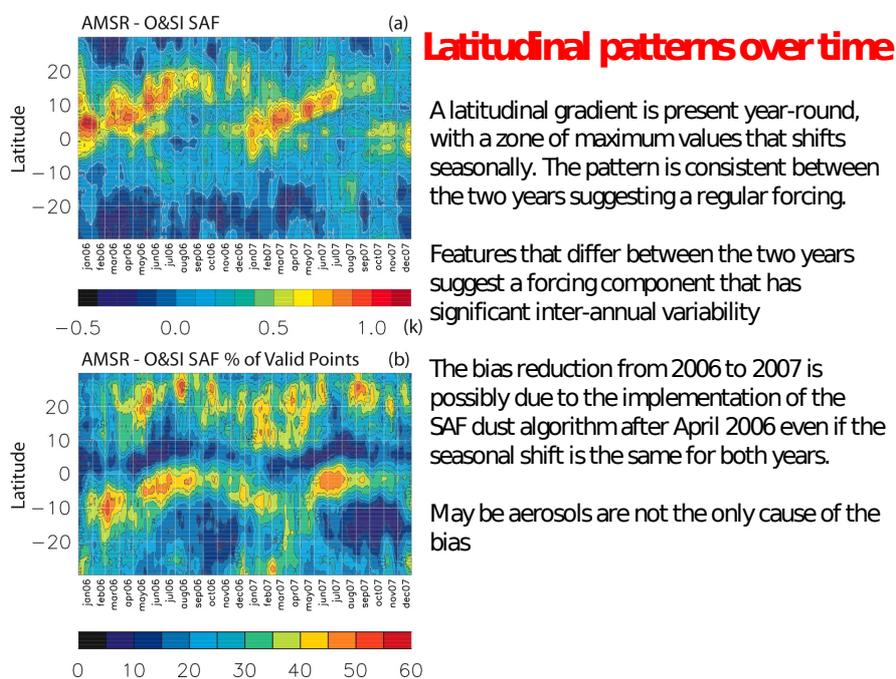


Figure 3. Spatial patterns in inter-satellite biases in Atlantic have seasonal variability.

SE presented some cases where two or more satellite SST fields indicated sub-daily variability of SST by >1 K at high latitudes ($>60^\circ\text{N}$). These also correlated with relatively low HIRLAM, ECMWF and AMSRE winds (1 to 3 m/s, depending on the data source). Likewise, there was evidence of 1 K variations in moored buoy data (Figure 4).



Moored buoy data (2)

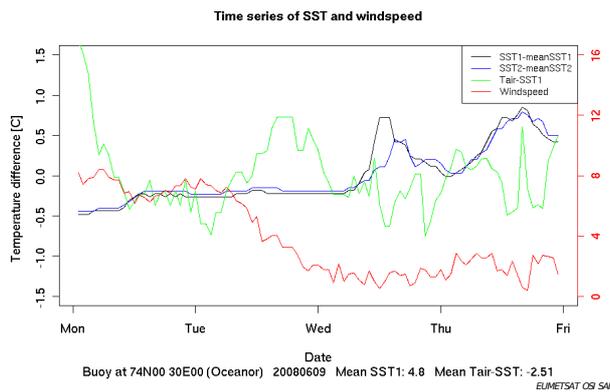


Figure 4. ~1 K warming cycle at moored buoy at 74°N, in low winds. Sun is always above the horizon at this time and place, and peak insolation is only $\sim 500 \text{ W m}^{-2}$, both factors that would tend to make significant diurnal variation less likely.

DIURNAL VARIABILITY ANALYSIS

This is the concept that the best estimate of DV will come from combining multiple satellite observations and/or models forced by satellite/NWP winds and fluxes.

PLB presented a DT (SST – SST-ref) analysis based on SEVIRI observations, with some spatial extrapolation to cloud-screened pixels. Routine application has shown apparently sensible results for areas around the Brazil coast and the Mozambique coast.

MF presented an empirical (SEVIRI-based) model that estimates DSST from NWP winds and surface fluxes. It is designed to capture large event amplitudes with a realistic frequency of incidence.

HB presented the analysis of skin SST at the BoM, based on a foundation analysis supplemented by Gentemann's DSST model and a skin effect model. The skin-foundation analysis difference is therefore worth assessing as a Dv analysis.

MISC

CM presented a “depth of heated layer” product available from GlobColour.

CAC presented the interest of the SEAFlux community in DV. Seaflux goals are: improvement in turbulent flux models, SST analysis including diurnal cycle, and $\frac{1}{4}^\circ$ 3 hourly flux data consistent with GEWEX radiation. Including, or not, the diurnal cycle can modify atmospheric temperature profiles in the TOGA COARE region by $>1 \text{ K}$ in simulation. The Seaflux DSST is a daily peak, which may be scaled to other times of day. Flux differences from neglecting DSST can be climatologically important, particularly in the Tropical Warm Pool area (Figure 5). In terms of diurnal SST, Seaflux are looking for better skin pre-dawn SST estimates and improved simple parameterisations.

SC presented work looking at wind and DSST spatial length scales assuming self-similarity. The self-similarity approximation looks reasonable for the zero-crossing correlation length.

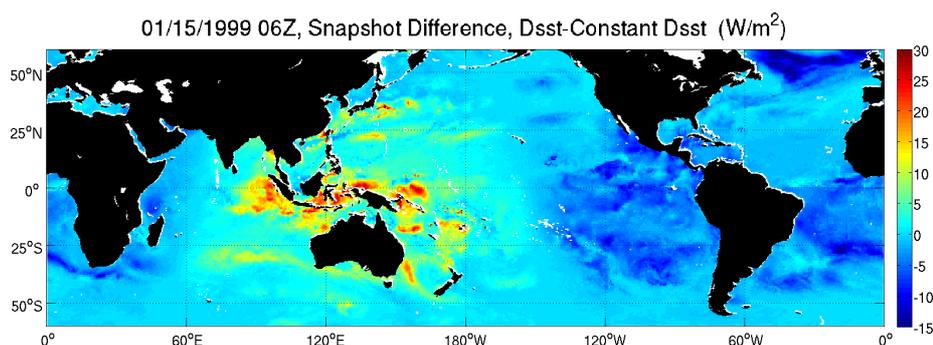


Figure 5. Example of difference in net flux across the ocean from accounting for subdaily DSST.

WORKING SESSIONS

Following the update session, there were two days of collaborative working sessions with activities and discussions including:

- Further data analysis of Arctic warm spots
- Initial modelling of Arctic warm spots
- Definition of a wind-blending experiment for DV analysis
- Final definition of the fields for the TWP+ experiment
- Definition of two regional/global comparisons of DSST fields
- Analysis of DSST correlation lengths
- Definition of a model comparison exercise
- Discussion of DSST-relevant optical property products

FEEDBACK AND RESULTS

SE presented slides showing that a warm spot event seen previously in METOP is present in other AVHRRs and confirmed also by MODIS SSTs. It appears also to be co-incident with a phytoplankton bloom. CM and GW presented model simulations (Zeng and Beljaars, Kantha & Clayson respectively) supporting diurnal cycles in the 0.5 to 1 K range for very low winds in Arctic Summer – but it looked difficult to model greater amplitudes. A key factor is the large non-solar outward flux, that is only overcome by insolation during the high-elevation part of the day. However, with a stronger attenuation of the visible insolation, such as may be reasonable for a bloom, excursions rather greater could be simulated – up to 1.5 K.

SM likewise showed some tropical Atlantic results showing long term modulation of SST by bio-feedbacks.

In that context the Zhl product from GlobColour was discussed. The consensus is that it is suited to mixed-layer studies, but not so much for diurnal time-scales. AH is defining a set of optical property assumptions for the DSST modelling comparison, and will be bands optimized for DSST modelling. These could be the basis for a proposal for a product based on ocean colour. $1/e$ attenuation depth is preferred to “heated layer” since that is what models take in. In the mean-time, KdPAR is probably the nearest to what is needed for DSST work. **ACTION CM** Feedback to GlobColour contacts.

SC showed that further analysis predicted a DSST correlation length of ~ 130 km for 5 km resolution of DSST (Figure 6). This is the zero crossing, suggesting the $1/e$ length is shorter. However, the $1/e$ length doesn't look self-similar (mysteriously).

DTW Correlation Lengths

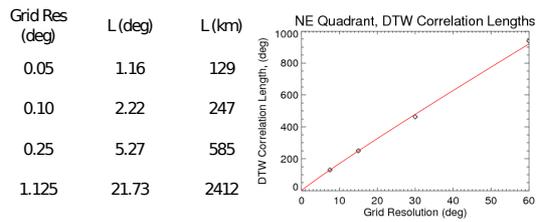


Figure 6. SEVIRI-based DSST correlation lengths.

The final session also reviewed the following topics:

- the model comparison project definition (“DVMIP?”) **GW** to lead; **AH** to define optical model (number of bands, etc.)
- the DV field/product comparison project definition **MF** to lead
- plans for a BAMS article on the DV progress **CM** to lead
- wind blending experiment **MF/PLB**
- funding opportunities
 - **RS** Look ahead on possible EU/STREPS calls & advise EU colleagues
- the TWP+ plans **HB** to lead; **AH** to devise MTSAT correction
- plans for Arctic+ and Antarctic+ data sets
 - **HB** Advise on Antarctic+ feasibility; **SE/PLB/DP** Arctic+ data set development