Creating a Marine Humidity Monitoring Product

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WHAT IS SO IMPORTANT ABOUT SURFACE HUMIDITY?

Surface water vapour is a fundamental component of the *hydrological cycle*, *earth energy budget*, *radiation budget* and important to *human comfort and health*. Its spatial distribution and temporal variation from diurnal to multi-decadal underlies our ability to understand our climate system.

Humidity is an essential climate variable. Multiple products estimating near-real time surface humidity over LAND and OCEAN are long overdue and will provide a valuable climate service.

1. Big Qs for specific humidity (*q*)?

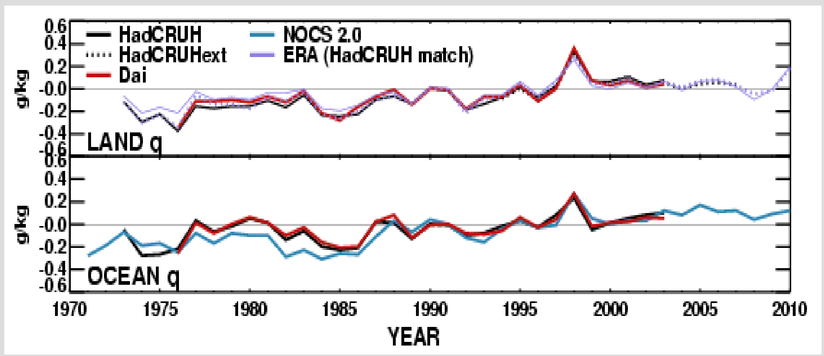


Figure 1) Global annual mean anomaly surface specific humidity for 2 in situ land and 3 in situ ocean datasets and ERA Reanalyses over land. All datasets have been adjusted to have a mean of zero over the common period 1989-2001.

Increases over recent decades are widespread and significant (1%) over large scales but smaller over OCEAN: WHY?

Generally good agreement over LAND with ERA Reanalyses and CMIP3 Climate of the 20th Century All Forcings GCMs over large scales *(Simmons et al. 2010, Willett et al. 2010)* **– No such comparisons over OCEANS**

Plateauing 1998-2009 over LAND *(Simmons et al. 2010)***, steady increase over OCEAN: WHY THE DIVERGENCE OVER THIS PERIOD?**

NOCS 2.0 differs from Dai and HadCRUH pre-1988 – NOCS 2.0 applies bias correction, does not use buoy data and excludes data over regions with low confidence in quality *(Berry & Kent 2009)* **– MORE INVESTIGATION NEEDED**

2. Big Qs for relative humidity (RH)?

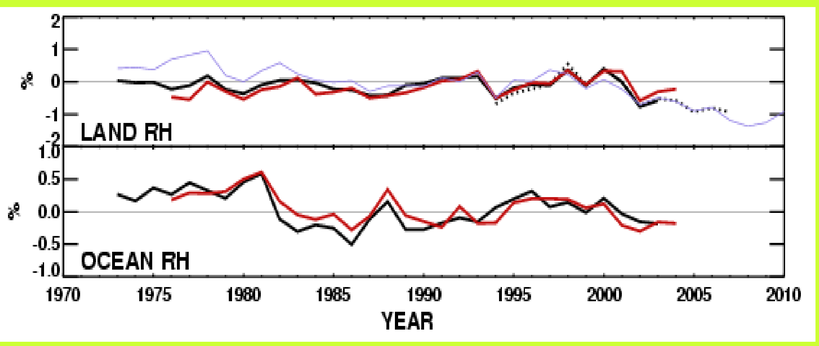


Figure 2) Global annual mean anomaly surface relative humidity for 2 in situ land and 2 in situ ocean datasets and ERA Reanalyses over land. All datasets have been adjusted to have a mean of zero over the common period 1989-2001. (Key as in Fig. 1)

No change in LAND RH 1973-2003 *(Willett et al. 2008)***, significant (1%) drying over OCEAN with strong pre-1982 moist signal - a period where Dai and HadCRUH differ from NOCS 2.0: ARE THERE DATA ISSUES pre-1982 WITH Dai AND HadCRUH?**

Drying shown by ERA-Interim and HadCRUHext from 2000 onwards over LAND *(Simmons et al. 2010):* **WHAT IS OCEAN RH DOING OVER RECENT YEARS?**

Recent years show divergent warming over LAND and OCEAN (*Simmons et al. 2010***; Fig. 3). This has important implications for the energetics of the atmosphere** *(Joshi et al. 2008)* **– humidity has a key role to play.**

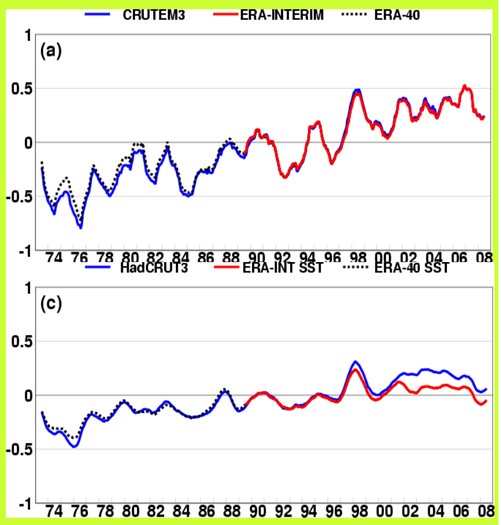
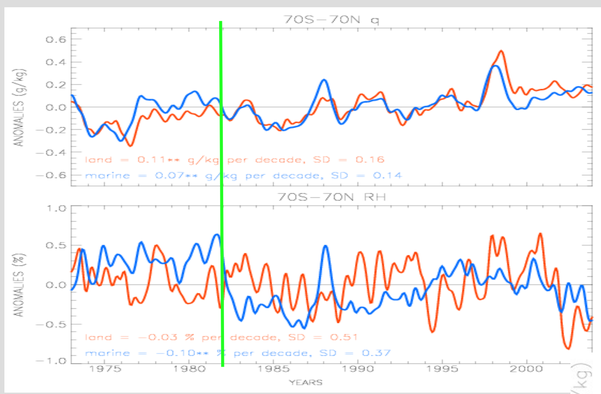


Figure 3) Global monthly mean anomaly surface temperature over land (a) and ocean (b) for 1 in situ dataset and ERA Reanalyses. All datasets have been adjusted to have a mean of zero over the common period 1989-1998.

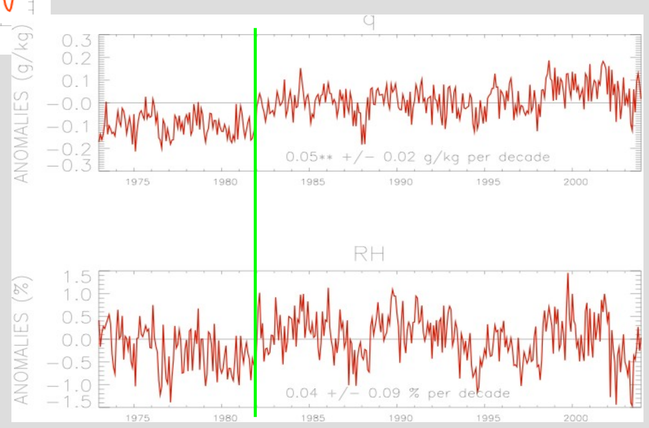
3. Issues specific to marine humidity data



← Figure 4) HadCRUH Globally averaged land (red) and marine (blue) specific humidity (top) and relative humidity (bottom) from 1973 to 2003

There is a pre-1982 moist signal (green line) **clear in HadCRUH OCEAN RH and apparent in *q*, no such feature over LAND (Fig. 4)**

Figure 5) HadCRUH Globally averaged land → minus marine specific humidity (top) and relative humidity (bottom) for all coastal grid-boxes from 1973 to 2003



This signal is also clear in LAND minus OCEAN differences averaged over all coastal grid-boxes for HadCRUH *q* and RH (Fig. 5)

This could be due to:

- **changes in atmospheric dynamics between the LAND and OCEAN which can be linked to modes of natural variability** *(Berry 2009)*
- **changes in observing systems practices**
- **changes in proportional contributions of sources of OCEAN humidity data – ships, buoys (moored and drifting) – NOCS 2.0 do not include buoy data due to questionable quality**
- **changes to ship observing height over time**
- **changes to instrument type over time with known biases between screened wet-bulb and dry-bulb thermometers and whirling psychrometers** *(Berry & Kent 2009)***.**
- **changes in sampling density and data sparse regions**

NONE OF THE ABOVE ARE TRULY ACCOUNTED FOR IN HADCRUH

4) Plans for HadCRUH2 – including OCEAN humidity

BIG Qs THAT NEED TO BE ANSWERED

Is recent drying persisting?

What is the global picture behind this – including OCEAN humidity?

Do historically forced CMIP5 GCMs concur with observations, over OCEANS too?

How do *in situ* surface RH and GCMs compare, over LAND and OCEAN?

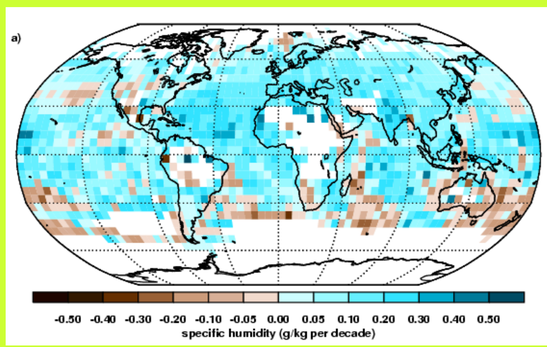


Figure 6) HadCRUH trends in surface specific humidity for the period 1973-2003.

What is the structural uncertainty in humidity estimates? This can be better understood by having multiple independent data-products to compare.

HadCRUH2 – WHAT WILL IT BE?

- global LAND and OCEAN surface dataset of *q*, RH, $T_{dewpoint}$ and $T_{wet\text{-}bulb}$
- quality controlled and homogenised product – at 5 day mean and monthly resolution
- gridded product – 1°x1° over data-rich areas, 5°x5° standard
- uncertainty grids based on measurement, sampling and structural uncertainties
- monitoring product – updated at least annually)

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