SPECIAL PROJECT FINAL REPORT

All the following mandatory information needs to be provided.

Project Title:	Interactions between the Atlantic Ocean, African monsoon, the Indian and Pacific Oceans using the EC-Earth and IFS modelling systems
Computer Project Account:	spitdipo…
Start Year - End Year :	30.04.2013 – 30.12.2015
Principal Investigator(s)	Fred Kucharski
Affiliation/Address:	Abdus Salam International Centre for Theoretical Physics (ICTP)………………………………………………………..……
Other Researchers (Name/Affiliation):	

The following should cover the entire project duration.

Summary of project objectives

(10 lines max)

Previous work has shown the possibility that the tropical Atlantic has an unexpectedly strong Influence on the Indian Ocean, Indian Monsoon and Pacific Ocean.
Since most of these studies are based only on observational data and intermediate complexity model simulations, the aim of this project is to use the latest state-of-the-art modelling systems EC-Earth and/or the IFS to confirm and refine the various hypothesises that have been made previously. Relatively high-resolution and complex physics simulations are essential to increase confidence in the hypothesis that the tropical Atlantic may have a much stronger impact on the surrounding ocean and land masses than previously thought. However, also simulations with the intermediate complexity ICTPAGCM coupled to OPA/NEMO will be performed, because the efficiency of this model enables to assess and validate new techniques quickly………………

Summary of problems encountered

(If you encountered any problems of a more technical nature, please describe them here.)

…None……………………………………………………………………………………

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Experience with the Special Project framework

(Please let us know about your experience with administrative aspects like the application procedure, progress reporting etc.)

Everything was smooth……………

Summary of results

(This section should comprise up to 10 pages and can be replaced by a short summary plus an existing scientific report on the project.)

In this project SPEEDY-NEMO Atlantic Pacemaker experiments have been analyze to investigate the impact of diverse Atlantic SST variability modes on the Indo-Pacific climate variability. In the study Kucharski et al. (2015) the Atlantic Multidecadal Oscillation (AMO) influence on Pacific decadal climate variability and *climate shifts.* It has been found that the AMO has a substantial influence on Pacific Decadal variability, with the positive AMO phase leading to an overall warmer tropical Atlantic, modification of the Walker circulation that leads to rising motion in the tropical Atlantic, sinking motion in the central Pacific. This chain of events eventually lead to easterly wind anomalies in the central-western Pacific in the positive AMO phase that initiate upwelling oceanic Kelvin waves that ultimately cause the central-eastern Pacific to cool during the positive AMO phase. The opposite happens during the negative AMO phase. Fig. 1 shows a central equatorial Pacific wind index (CPWI) from observations (black curve), the Atlantic Pacemaker experiment (red curve), together with the AMO index (green curve), which clearly exhibit the expected anti-correlation between the AMO index and the CPWI. Fig. 2 shows the regression of the AMO index onto a) observed SSTs and low-level winds, b) model SSTs and low-level winds, c) model 200 hPa velocity potential and low-level winds. Finally Fig. 3 shows the regression of the AMO index onto the equatorial ocean temperature and zonal flow and indicates the indeed ocean dynamics plays a crucial role in the mechanisms described above. In Kucharski et al. (2016), in addition to the AMO the same simulations used for the Kucharski et al. (2015) study have been used to investigate the impact of i) tropical North Atlantic interannual SST variability, ii) Atlantic Nino-related interannual SST variability on the Indo-Pacific regions. It is shown that both SST modes (i) and (ii) have a time-delayed impact on the Indo-Pacific region, inducing anti-correlation of the ocean basins after about 6-10 months (Figs. 5 and 6). It is also shown that at centennial time scales the stronger warming of the Atlantic region may have substantially reduced the surface warming in the eastern Pacifci and may have caused a substantial subsurface cooling also (Fig. 7)

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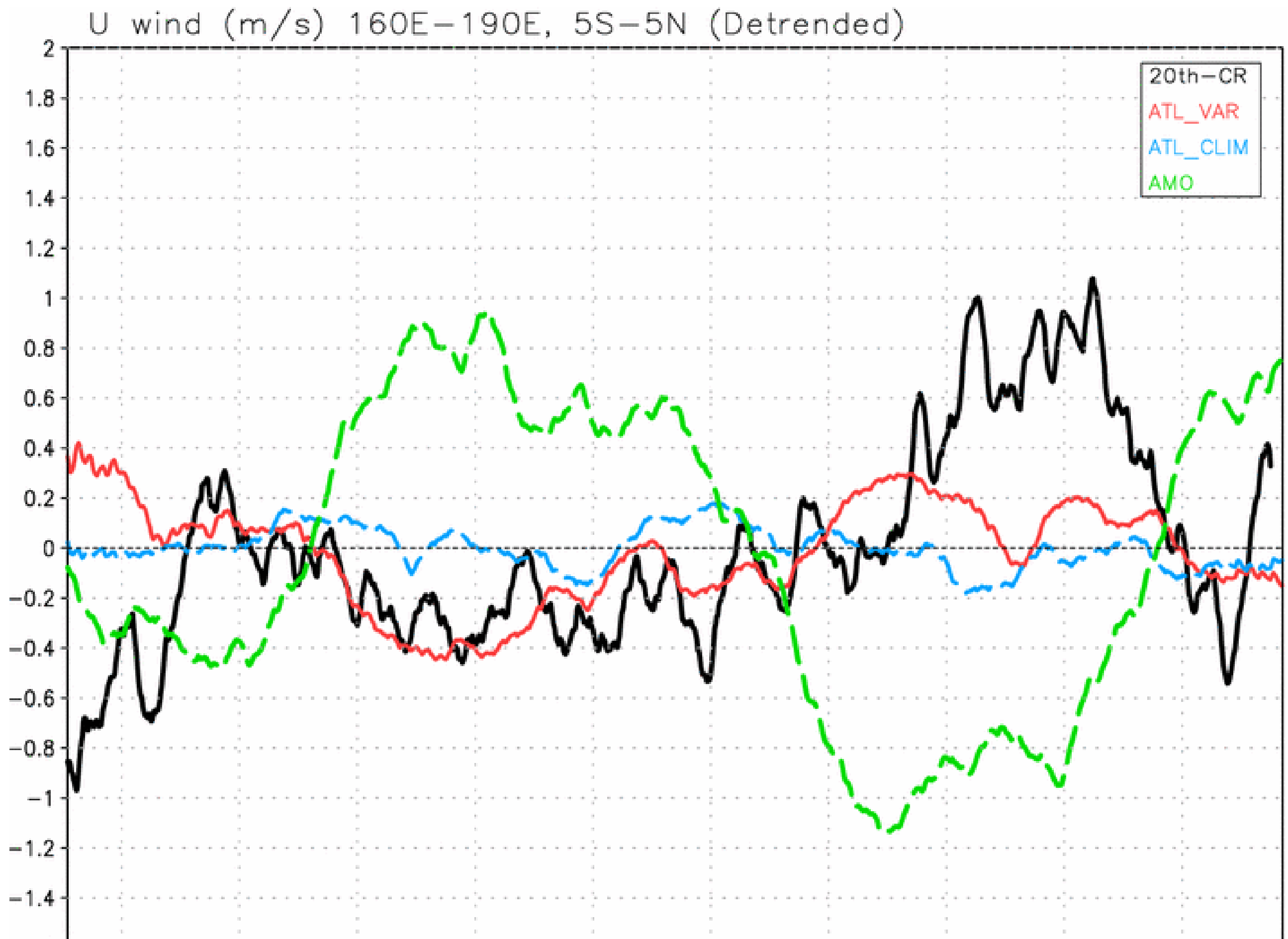

Figure 1: Central equatorial zonal near surface wind anomaly index (CPWI; averaged over area 160°E–190°E, 5°S–5°N). The anomaly time series have been filtered by a 10-year running mean. Shown are observations (black line), ATL_VAR ensemble mean (red line). The ATL_CLIM ensemble mean (dashed blue line). The AMO index is also plotted in the figure, multiplied by 4 as green dashed line. Units are m/s for all wind indexes, and K for the AMO index.

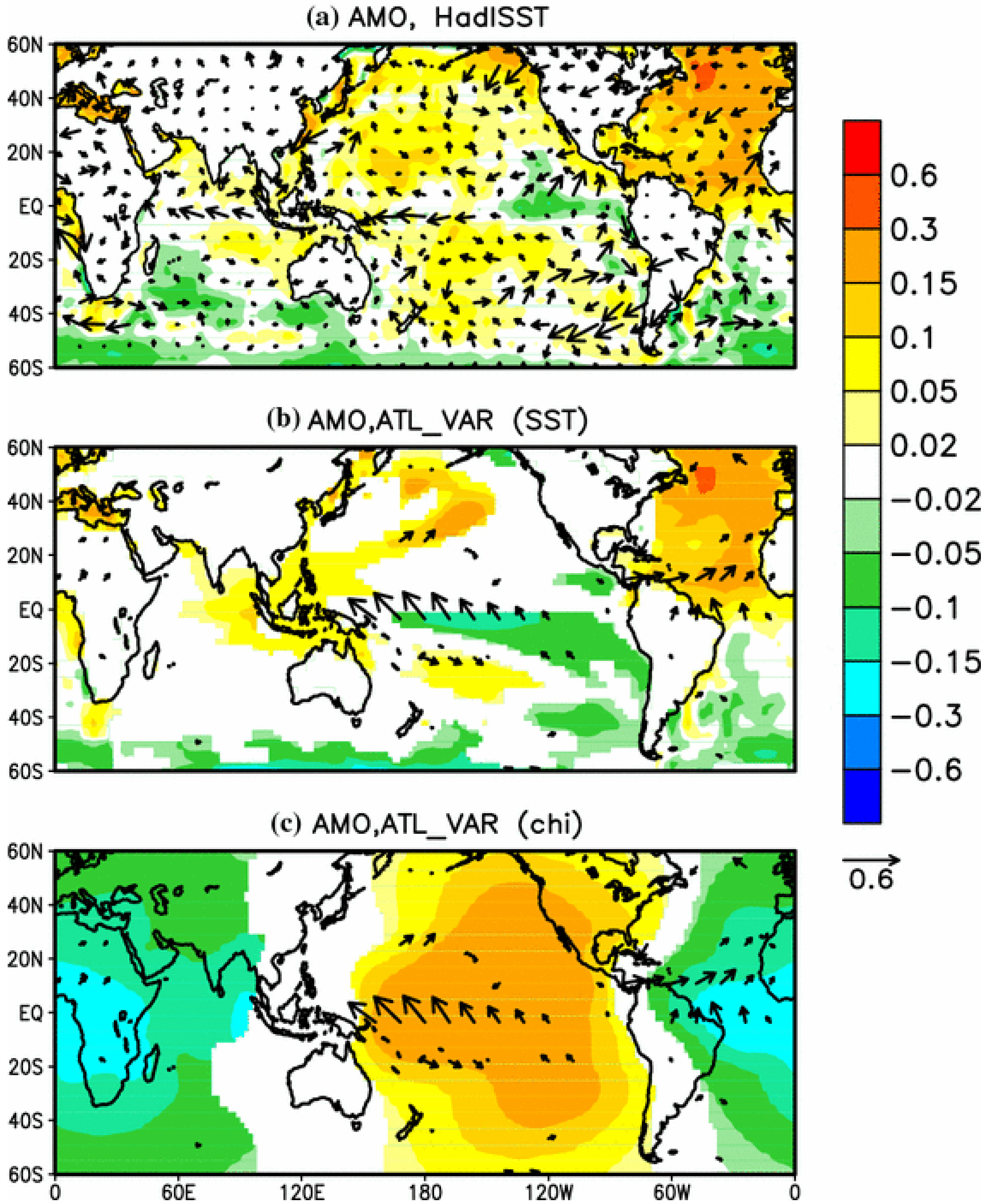

Figure 2: Regression of a observed SSTs and near surface winds, b ATL_VAR ensemble mean SSTs and near surface winds, c ATL_VAR ensemble mean 200 hPa velocity potential and near surface winds onto the AMO index for the period 1910–2008. In b and c only values that are significant at the 95 % significance level are shown. Units are K for SSTs, m/s for wind and 106 m2/s for velocity potential

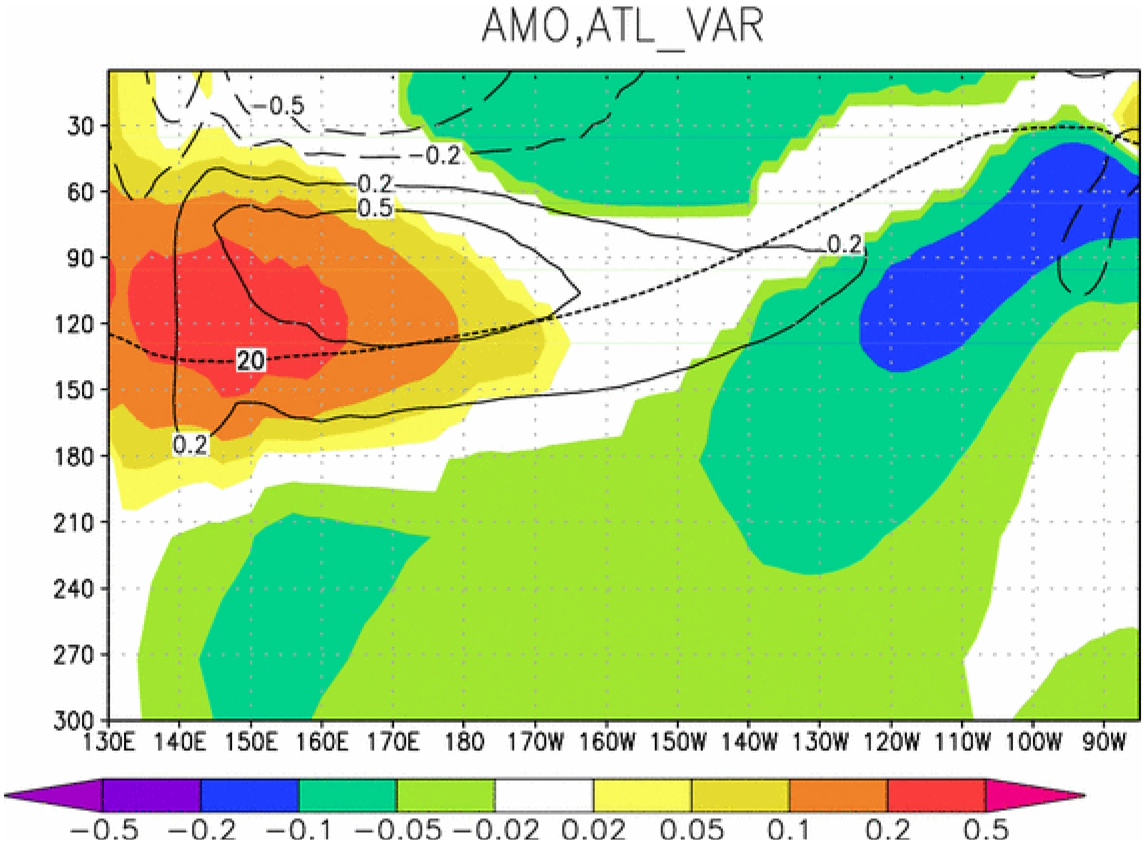

Figure 3: Regression of temperature (shading) and zonal current (contours) near the equator (averaged from 5°S to 5°N) onto the AMO index for the period 1910–2008. Only values that are significant at the 95 % significance level are shown. Units are K for temperature and cm/s for zonal current

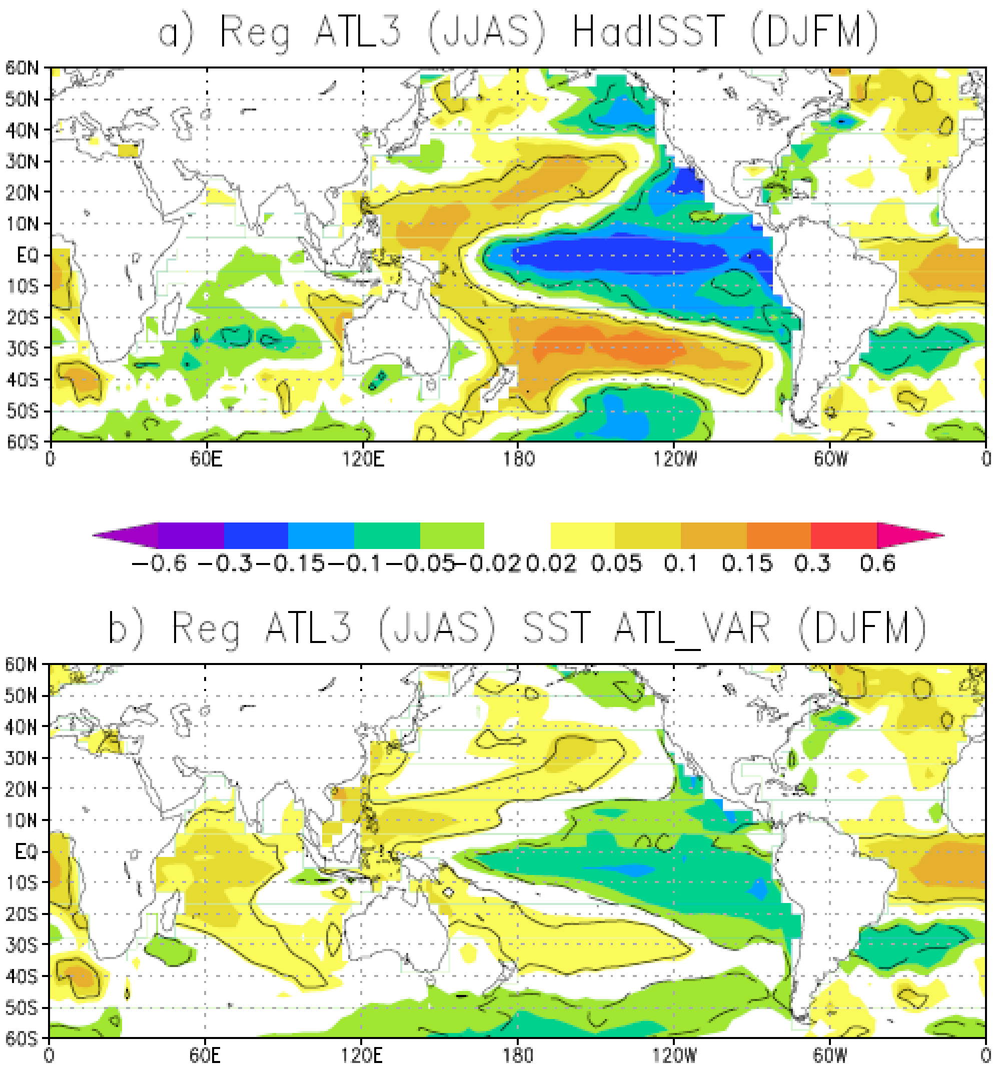

Figure5. Regression of (a) observed and (b) ATL_VAR SSTs (DJFM) onto the preceeding JJAS ATL3 index. Anomalies that are 95% statistically significant are indicated by contours. Units are K.

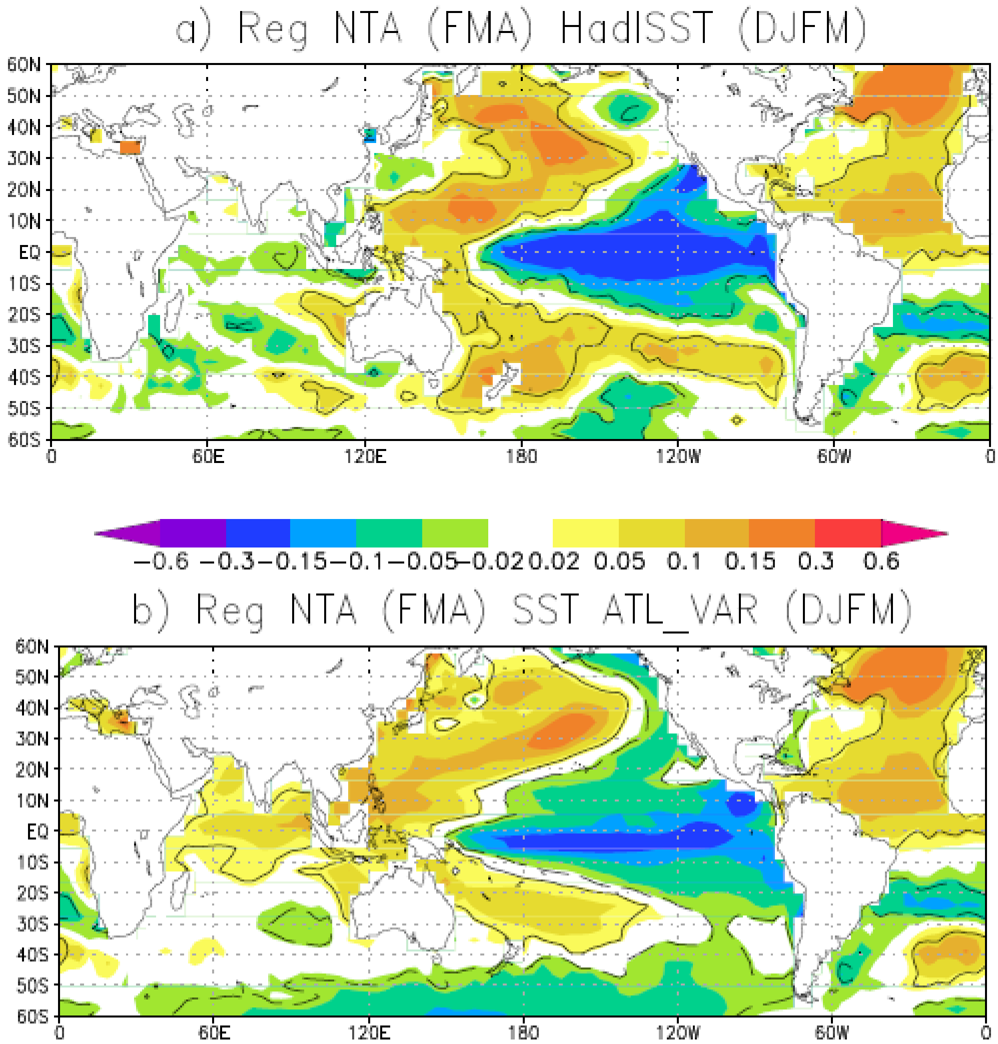

Figure 5. Regression of (a) observed and (b) ATL_VAR SSTs (DJFM) onto preceding (FMA) NTA index. Anomalies that are 95% statistically significant are indicated by contours. Units are K.

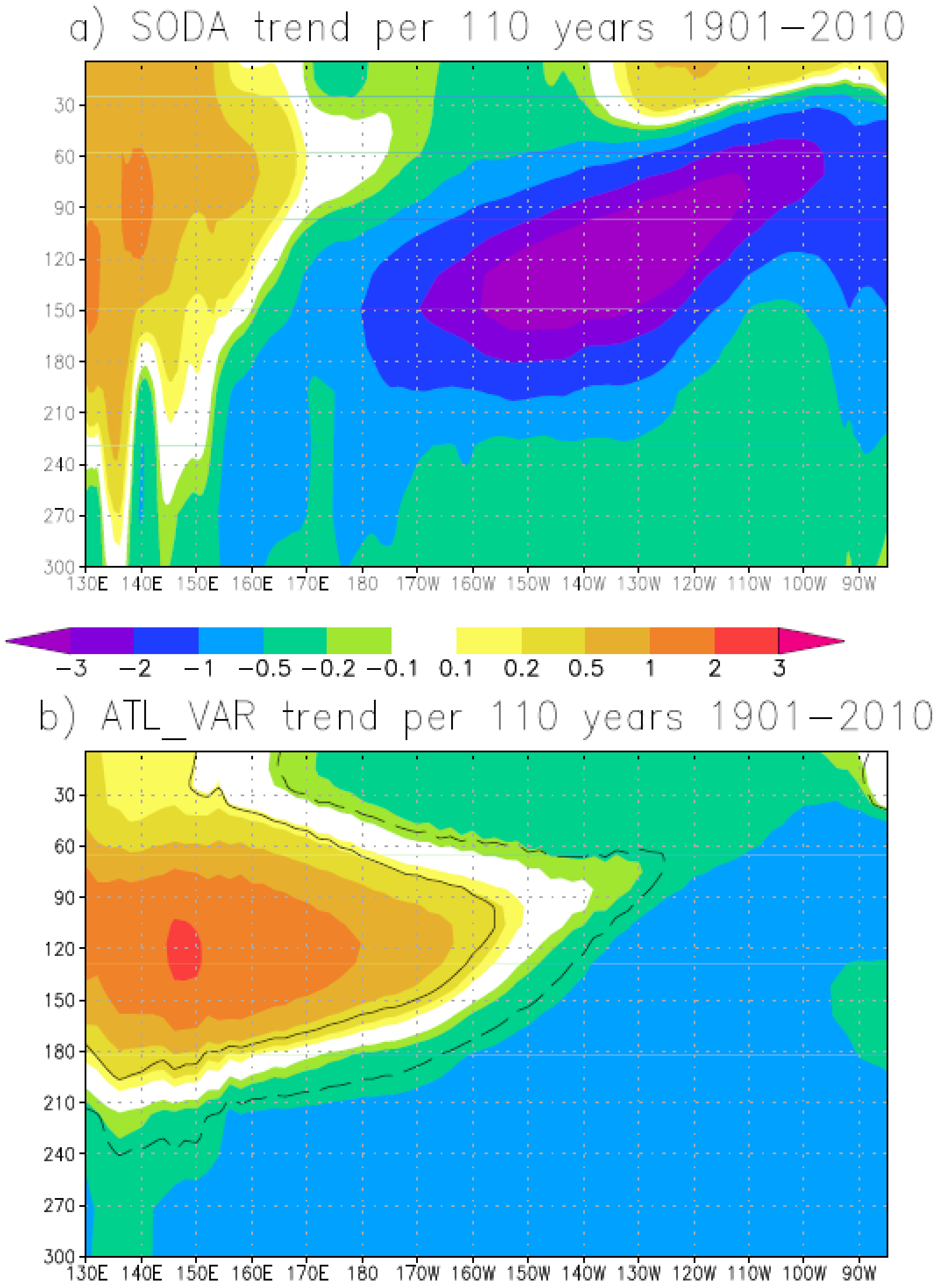

Figure 7. Linear trend of temperature near the equator (averaged from 5_S to 5_N) for the period 1901 to 2010 per 110 years for (a) observed and (b) ATL_VAR. In (b), anomalies that are 95% statistically significant are indicated by contours. Units are K.

List of publications/reports from the project with complete references

Kucharski F., F. Ikram, F. Molteni, R. Farneti, I.-S. Kang, H.-H. No, M. P. King, G. Giuliani and K. Mogensen, 2015: Atlantic forcing of Pacific decadal variability. *Climate Dynamics*, DOI: 10.1007/s00382-015-2705-z

Kucharski, F. et al., 2016: The teleconnection of the Tropical Atlantic to Indo-Pacific Sea Surface Temperature on inter-annual to Centennial time scales: A review of recent findings, *Atmosphere*, 7, 29; doi:10.3390/atmos7020029

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Future plans

(Please let us know of any imminent plans regarding a continuation of this research activity, in particular if they are linked to another/new Special Project.)

I'll continue to work on the topic of the Atlantic influence on Indo-Pacific climate variability. I am looking foreward to use the open-IFS system, because it may be installed at ICTP during a workshop in 2017, and this system may be easier to use than the full ECMWF model which was initially planned to use at ECMW.