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Measurements of solar erythemal UV irradiance and dose on seamen

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Seamen working on decks of ships that cruise in subtropical and tropical latitudes can receive a significant additional dose of solar UV radiation during their working hours than the dose they would have received at mid-latitudes, particularly during the winter season. Due to the higher total accumulated life time UV doses, their risk of developing skin cancer may be enhanced.
Solar erythemal UV irradiance and erythemal doses were measured during selected typical ship cruises in 2009, 2010 and 2011 from Tarragona (Spain) across the Atlantic to Santos (Brazil), from Panama in the Caribbean to Zeebrugge (Belgium) in Europe, on a Mediterranean circle cruise from Naples (Italy) via Barcelona (Spain) to Piraeus (Greece), and finally on a South-East-Asia cruise from Koper (Slovenia) via Port Said (Suez Canal) across the Arabian Sea and the Indian Ocean to Singapore. Erythemal irradiance and dose sensors were i) placed at a stationary place on the observation deck that was least obstructed by the vessel's construction elements, and ii) fixed to different parts of the body (head, shoulder, chest, back) of a person doing typical work on deck.
Calibrations of the irradiance sensors used on board were performed by concurrent solar UV measurements using fast scanning UV spectroradiometers of the type SPECTRO 320 D before departure at the Lindenberg Observatory. The spectroradiometers are calibrated and regularly checked by 1000 W FEL quartz halogen lamps calibrated by the German National Metrological Institute (PTB) to ensure traceability to the SI. After the cruises, the instruments were checked again by comparisons with the reference instrument. Radiative transfer model calculations along the ships' routes provided valuable auxiliary information on the reliability of the solar UV measurements. Modelled irradiances have also been used as background material to estimate likely maximum individual UV exposure.
Measured UV index values according to the action spectrum by CIE (1987) referred to the horizontal receiver surface for conditions of both clear sky and optically thin clouds reached 14 to 16 around local noon time at subtropical and tropical latitudes, which corresponds to almost double the amount of maximum UV index values reached in Central Europe during summer time. Referred to a minimum erythemal dose (MED) of 250 (J m-2)ER required for skin type II to develop an erythema, daily maximum hourly doses reached values between 2.8 and 4.8 MED for the stationary horizontal surface, and between 1.6 and 2.3 MED at the person's head. The respective daily doses for an 8 hour time period were 14 to 24 MED for the horizontal surface and 7 to 11 MED for the person's head. On the average, about 60 $\pm$15 % of the daily erythemal dose of the value referring to the stationary horizontal surface is received on the person's head working on deck. Lower percentages are reached for erythemal radiation incident on other parts of the body.
Our data base of measured and modelled erythemal radiation values in combination with individual seamens' record books will be used to derive estimates of erythemal dose ranges for outdoor work on deck.