A global study of the impact of climate change on wave climate using ECHAM5 and WAM

Ocean surface waves are one of the most obvious and fundamental phenomena present at the air-sea interface. In terms of energy the ocean wave spectrum is dominated by surface gravity waves, accounting for more than half of the energy carried by all waves in the ocean surface, surpassing the contribution of tides, tsunamis, coastal surges, etc. Therefore most of the studies available in the scientific literature are focused on surface gravity waves (henceforth designated simply as “waves”): their generation, evolution and propagation, and interaction with the oceanic and the atmospheric environment.

The issue of the possible impact of climate changes in the global wave climate has been investigated in recent years by several researchers (see, e.g., WASA group, 1998; Wang et al., 2003; Grabemann and Weisse, 2009).

Nevertheless theses studies have looked at the problem from a regional perspective, using, in most cases, statistical tools to assess the impact of climate change scenarios in the regional wave climate.

Although extremely important, a global study of the impact of climate change on wave climate is still missing.

The relevance of such a study, from a global perspective, lies in the fact that waves propagate away from their generation area, traveling thousands of kilometers, sometimes across different ocean basins (Alves, 2006).

Therefore changes in the strength, frequency, and track of winter mid-latitude cyclones, in one hemisphere, for example, will have an impact in the wave climate of the opposite hemisphere.

The impact of the changes of the wind climate, due to intense mid-latitude storms triggered by a warmer climate (Bengtsson et al., 2009), in the global wave climate is a question that remains opened.

The answer to such a question is rather important; not only to the public opinion, but also from an economical and practical point of view: marine and coastal infra-structure design; ship design and routing, offshore oil drilling, off shore wind farms, future wave energy farms, etc.

Goals of the study:

- Use the high resolution version of the ECHAM5 global climate model (spectral resolution of T213, ~63 km) to force the wave model WAM. (The ECHAM5 model was integrated for the IPCC A1B scenario; see Bengtsoon et al. 2009 for further details about the ECHAM5 high resolution experiment.)

- Validate the WAM output for the 32-yr twentieth century period (against existing wave reanalysis, buoy observations, and/or remote sensing data, and/or reanalysis).
  (It is assumed that the U10 wind field from ECHAM5 has already been validated for the same period.)

- Assess the impact of the changes in the lower atmosphere wind climate in the global wave climate.

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Possible studies:

- Impact of climate change in the global wind and wave climate (significant wave height and mean period).
- Impact of climate change on the global swell and wind sea wave climate (significant wave heights and mean periods).
- Variability of the wave climate (present versus future climate).
- Variability of swell and wind sea wave climate (present versus future climate).
- Impact of climate change in the extreme wave heights.
- Impact of climate change on the global wave energy balance.

Computer costs:

- Storage: ~10-15 TB (U10 and wave parameters)

– CPU time: ~40 days to run 64 years (32 + 32) (depending on the wave model set up, number of processors, etc.)

References

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