CONCEPTUAL OVERVIEW

Regional Ocean Modeling for the Arabian Gulf

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This goal of this Regional Climate Change Modeling study was to develop projections of regional changes in the Arabian Gulf due to climate change. To achieve this, a regional ocean model (ROM) was developed that was able to realistically capture local oceanographic processes and characteristics including sea surface temperature profiles, circulation patterns, fresher water influxes, balancing of ocean currents, and topographical features of the bottom of the Arabian Gulf. The outputs generated by the modeling can be used in support of the other climate change impact, vulnerability and adaptation assessments.

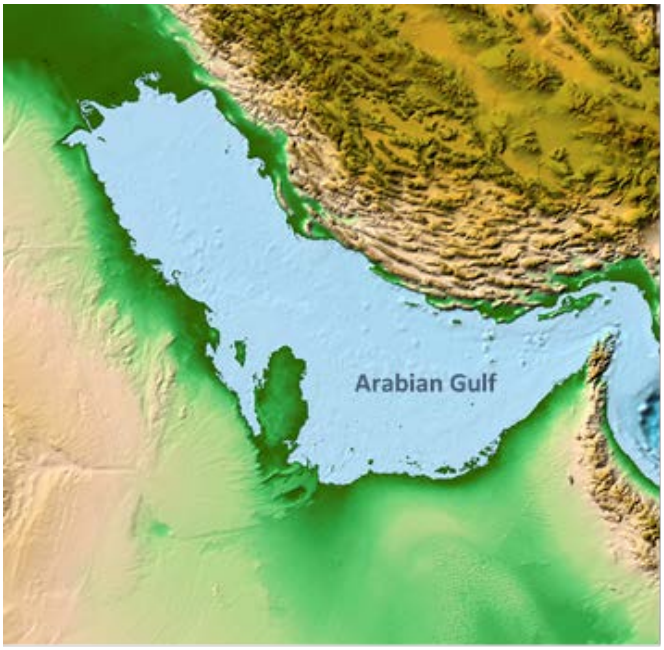

Figure 1 - Boundaries of the Arabian Gulf

Specifically, the focus was on the Arabian Gulf itself, a semi-enclosed, highly saline sea between latitudes 24°N and 30°N surrounded by a hyper-arid environment (see Figure 1). Its bathymetry shows large areas of shallow water (less than 10 metres deep) with a maximum depth of about 110 metres near central areas. Northwesterly Shamal winds affect Gulf waters in the winter, while southeasterly Shamal winds dominate in the summer. Such winds affect the Gulf's circulation patterns leading to seasonally stratified waters.

The ROM for the Arabian Gulf was first validated for historical conditions for the period 2000-2004. It was then used to make climate change projections for the future period based on downscaling boundary conditions of the MPI global circulation model and local data. Two future periods were considered – 2040-2044 and 2095 - 2099. One greenhouse emission scenario was modelled that assumed a business-as-usual trajectory of global greenhouse gas emissions (i.e., RCP8.5). It is the more aggressive greenhouse gas emissions trajectory most similar to

humankind's current trajectory, and as such, provides a useful basis by which to understand potential climate change implication for the Gulf.

Several climatic variables were projected, including sea surface temperature, salinity, sea level rise, circulation dynamics, turbulence, and mixing processes. By 2100, the results show sharp changes in the Gulf compared to historical trends, as climate change unevenly disrupts some key processes at specific locations within the Gulf. For sea level rise, efforts were focused on a single contributor, namely Dynamic Sea Level (DSL) – the smallest of three major factors that contribute to sea level rise (with the other major factors being global thermal expansion and deglaciation) – and the only factor capable of being suitably incorporated in current global circulation models. The resulting projected future conditions indicate significant changes in temperature, salinity, mixing processes and circulation patterns in the Arabian Gulf, including:

- Sea surface temperatures are projected to increase throughout the Arabian Gulf, from 1°C by mid-century, to up to 2.8°C by late century
- Sea surface salinity is projected to both decrease and increase, depending on location; by mid-century, an uneven distribution of salinity is observed throughout the Arabian Gulf, and by late century, areas showing decreasing salinity are located along the entire length of the deep channel from the Strait of Hormuz to Iraq, while areas showing modest increases in salinity are located along the UAE coast south of the Northern emirates and in Salwa Dawhat, a bay west of Qatar
- During winter months, salinity on the eastern side of the Gulf is typically higher than summer months
- Sea level is projected to rise throughout the Gulf – by mid-century, dynamic sea level (DSL) rise is highest in the northern area of the Gulf, and by late century, the areas showing the lowest increases are in the central Gulf area. The areas showing the largest are located at the Strait of Hormuz and in Salwa Dawhat
- Annual circulation dynamics are expected to change in two zones – a deep zone located in the central area, and a shallow zone located along the UAE coat
- Seasonal changes in turbulence are anticipated across the entire Arabian Gulf
- Global climate change effects from wind patterns will have impacts on Gulf coastal currents for two locations near Qatar and UAE, with wind effects being more evident in shallow areas, where the coastal currents are well defined and highly correlated with wind, especially regarding Northward winds

A full discussion of the results as well as an interactive visualization of the outputs can be accessed at AGEDI's Climate Change Inspector website (http://www.ccr-group.org/#!agedi-climate-change-inspectors/bmhq7). It should be noted that the data archive from this regional ocean modeling experiment is quite large, roughly 30 Terra-Bytes.