Title of your paper: Hervey Bay: An Inverse Subtropical Estuary

Abstract: Declining rainfall, persistent drought conditions along Queensland coasts and increasing temperatures are impacting upon hydrological and coastal marine conditions. During a four day hydrographic survey into Hervey Bay, near-coast salinity values were found to be higher than those of oceanic water. This distribution of salinity is indicative of an inverse circulation within the Bay. The evaporation-precipitation-runoff balance which is dominated by a net loss of freshwater leading to the production of high salinity water during the period of the survey yields further evidence of a possible inverse circulation within the Bay. To compensate for the export of this high salinity water, oceanic water with lower salinity is entering the Bay at the surface. Analysis of the historical water balance indicates that the inverse circulation is likely to be a climatological feature of this estuary which is not limited to the dry season of the year. Simple physical modelling of the oceanic circulation led to some insight into Bay flushing and water exchange time scales between Bay and oceanic water. Due to declining rainfall in coastal northeast Australia, inverse circulation conditions are likely to persist into the near future and should to be considered for coastal management.

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Introduction:

The marine environment of Hervey Bay is like many other Australian coastal regions impacted upon by climate variability and change. Since 1950, rainfall in the region has declined by about 250 mm which is about 25 % of the climatological mean. In addition to the storage of rainfall within the region's major catchments for agricultural usage, the decline of rainfall and river runoff reduces the amount of freshwater entering Hervey Bay. Sea water salinity is one of the key ocean climate elements that are controlled by changes in precipitation, river-runoff and evaporation as well as ocean dynamics. In our work, we are interested in better understanding the impact of climate variability and changes in the hydrological cycle upon the physical environment of the coastal ocean.

Objectives*: What problem was it that you are facing or have you overcome? What did you set out to do? What's your group's story? 50-100 words*

Environmental policy, economic and natural resource management activities need to be informed by a better understanding of the physical forces that contribute to shaping the natural marine environment of Hervey Bay. We aim to contribute to the decision making process by providing insight into the circulation of the Bay, the exchange of coastal water with the open ocean and the impact of climate variability upon climatological conditions. This will be achieved by establishing a data base. It can be consulted in natural management decision making processes and will aid the development of a regional ocean climate model yielding further insight into the marine environmental conditions of the Bay.

Theory: *Was there any policy, legislation, issue or a catalyst that lead you to take the action that you did? 50-100 words*

Previous scientific reports of high salinity water observed to the east of Fraser Island and at a depth of about 150-200 m provided some incentive to explore the possibility that this dense water is produced in Hervey Bay and ejected into the ocean.

Methodology: *How did you undertake what you did? 50-100 words*

Information about the impact of changes in the hydrological cycle upon physical conditions in Hervey Bay was obtained from hydrographic observations and a simple salt balance model

which accounts for changes in the hydrological cycle. The general circulation of the Bay as well as the exchange of Bay water with the open ocean was investigated in a series of idealised ocean general circulation modelling experiments. This research has been documented in several publications including Ribbe (2006) and Ribbe et al. (In preparation).

Results or outcomes: *What did you discover? 50-100 words.*

A hydrographic survey traced a subsurface salinity maximum that was found in earlier studies within the East Australia Current east of Hervey Bay to the shallow southwest regions within Hervey Bay. These are identified as the most likely source region for locally produced saline Hervey Bay Water. Utilising a simple box model, mean evaporation rates and historical river run-off data, it is demonstrated that the production of high salinity Hervey Bay Water is likely to be a climatological feature. Modelling studies reveal water exchange time scales between the Bay and the open ocean in the order of about 90 days.

*What do you plan to do in the future? Where do you go from here? What help do you need? *50-100 words*

We anticipated that further hydrographic surveys will be carried which will confirm the physical characteristics of an inverse circulation within the Bay. The ocean model under development will be refined and validated using the established hydrographic data base.

*What worked for your group – what are the lessons that you learned or what helped? *50-100 words*

*What were the mistakes that you made that you wouldn't want anyone else to repeat? *50-100 words*

Conclusion: *Refer back to your introduction and objectives and how these were met. 50-100 words.*

This study and ongoing work has contributed to a better understanding of the physical characteristics of Hervey Bay. The knowledge and data are available to the community for consultation for natural resource management activities.

Photos: *Insert photos of your group doing this task.*

Participants of a hydrographic survey with the Department of Primary Industries and Fisheries research catamaran *Tom Marshall*. From left to right: (*)Dr. Ian Brown, (**) Mr. Vincent Rossi, (*) Mr. Skipper, (***) Mr. Emlyn Jones, (***) Dr. Jochen Kaempf, (**) A/Professor Joachim Ribbe, and (*) Mr. Matthew Campbell. (*) Department of Primary Industries & Fisheries, Queensland, (**) University of Southern Queensland, (***) Flinders University of South Australia.

Other information: *Is there any further details that you would like to share with the conference participants? 50-100 words*

References and Bibliography: *Are there any reference sources, methods etc. that you referred to for help?*

Ribbe, J. (2006). A study into the export of saline water from Hervey Bay, Australia. *Estuarine, Coastal and Shelf Science*. 66, 550-558. doi:10.1016/j.ecss.2005.10.012. Available from http://eprints.usq.edu.au/.

Ribbe, J., Wolff, J.-O., Staneva, J. and Graeve, U. (2007). Flushing time scales of a large Australian coastal ocean embayment from hydro-dynamic modelling. *Environmental Modelling and Simulation*, Under revision.

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** These sections are optional.*

Congratulations you have completed your Case Study!