P4 Assignment

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Chosen Region: Coastal Region surrounding Cape Agulhas (19.349°E - 22.019°E and from 34.305°S – 35.413°S)

I have chosen an approximately 300km wide coastal region with the far-left encompassing Cape Agulhas. I chose this region because for my mini-dissertation I will be extending an existing ocean model (from Durban to Port Elizabeth) from Port Elizabeth to Cape Agulhas so I want to learn as much as I can about the oceanography of this region. I was curious to see what the bathymetry and chlorophyll-a concentrations of this region looked like.

Data Description

Throughout this assignment, two datasets are used.

Global Multi-Resolution Topography Data Synthesis (GMRT) elevation map combined with high resolution sound data from the General Bathymetric Chart of the Ocean (GEBCO):

- I used the GMRT map application to select the bathymetry/topography map for the chosen region and downloaded the data as a netCDF compatible file, in the Climate & Forecast convention. The file was opened as an x-array.
- The grid resolution is 489.20m/node.
- The data was released October 2024 (version 4.3).
- Projection: Cylindrical Equidistant
- Extracted from the Global Multi-Resolution Topography (GMRT) Synthesis v2.7: (http://gmrt.marine-geo.org)
- Created with GMRT GridServer: (http://www.marinegeo.org/tools/gridserverinfo.php)
- Dimensions: (lon: 608, lat: 308)
- Data variable used:
    - “altitude”, with associated lat, lon coordinates. Units m, datatype float64
- Reference: Ryan, W.B.F., S.M. Carbotte, J.O. Coplan, S. O'Hara, A. Melkonian, R. Arko, R.A. Weissel, V. Ferrini, A. Goodwillie, F. Nitsche, J. Bonczkowski, and R. Zemsky (2009), Global Multi-Resolution Topography synthesis, Geochem. Geophys. Geosyst., 10, Q03014, doi: 10.1029/2008GC002332

ESA-CCI Ocean Colour data

- Ocean Colour Climate Change Initiative dataset, Version 6.0 European Space Ag ency, available online at http://www.esa-oceancolour-cci.org.
- Data products generated by the Ocean Colour component of the European Space Agency Climate Change Initiative project. These files are monthly composites of merged sensor (MERIS, MODIS Aqua, SeaWiFS LAC & GAC, VIIRS, OLCI) products. This dataset contains the climatological monthly means of the satellite-derived chlorophyll concentration for the world ocean, with a very high spatial resolution. I downloaded the data file in netCDF format and opened as an x-array.

- Resolution: 4km
- Dimensions: (time: 12, lon: 8640, lat: 4320) – the data file contained monthly data from September 1997 to August 1998.
- Data variable used:
    - “chlor_a” with associated coordinates in space and time. Units mg/m^3, datatype float32. Chlorophyll-a concentration in seawater (not log-transformed), generated by as a blended combination of OCI, OCI2, OC2 and OCx algorithms, depending on water class memberships.
- License: ESA CCI Data Policy: free and open access.
- Reference: Sathyendranath, S.; Jackson, T.; Brockmann, C.; Brotas, V.; Calton, B .; Chuprin, A.; Clements, O.; Cipollini, P.; Danne, O.; Dingle, J.; Donlon, C.; Grant , M.; Groom, S.; Krasemann, H.; Lavender, S.; Mazeran, C.; Mélin, F.; Müller, D.; Steinmetz, F.; Valente, A.; Zühlke, M.; Feldman, G.; Franz, B.; Frouin, R.; Werdell, J.; Platt, T. (2023): ESA Ocean Colour Climate Change Initiative (Ocean_Colour_c ci): Monthly climatology of global ocean colour data products at 4km resolution, Version 6.0. NERC EDS Centre for Environmental Data Analysis, date of citation. https://catalogue.ceda.ac.uk/uuid/690fdf8f229c4d04a2aa68de67beb733/

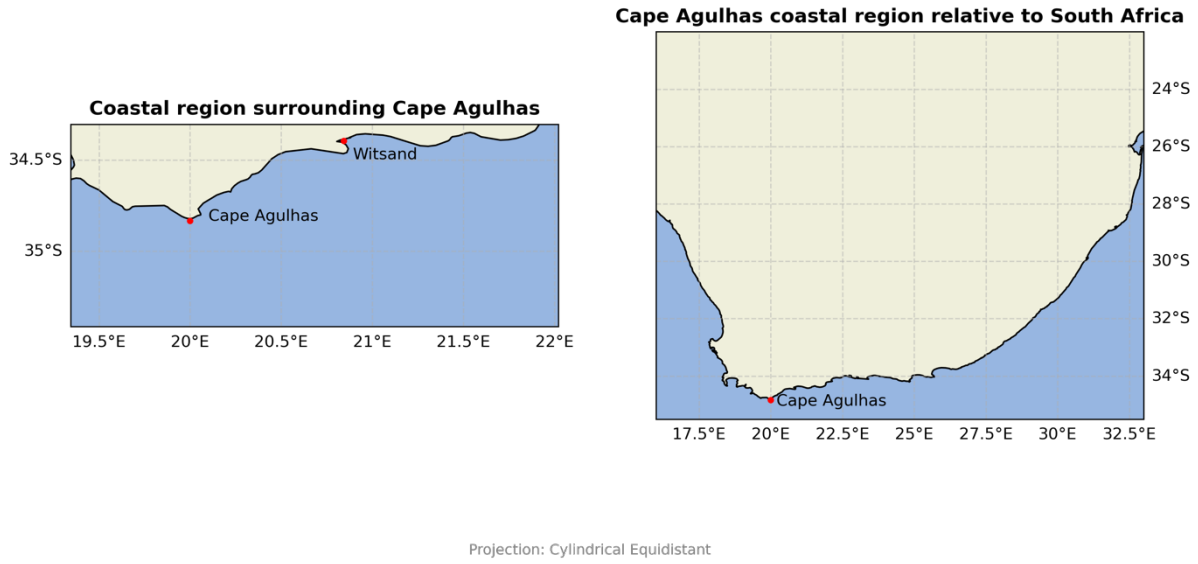

Figure 1: This figure shows the selected coastal region surrounding Cape Agulhas. The region is roughly 300km wide, and 150km in height. Its spans from 19.349°E - 22.019°E and from 34.305°S – 35.413°S.

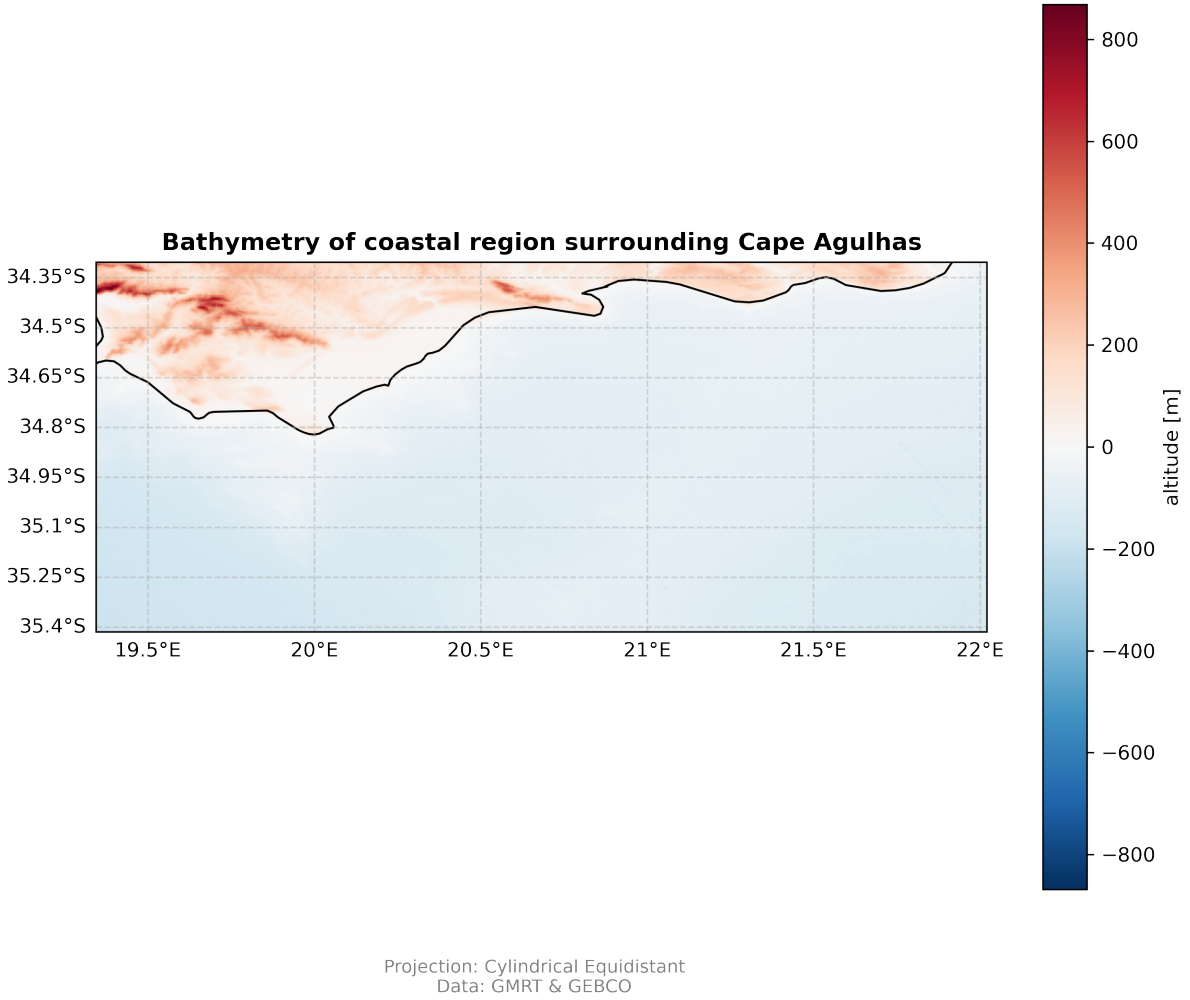

Figure 2: Region bathymetry with associated colour bar.

Figure 2 shows that the bathymetry in the chosen region is predominantly within the 0-200m depth region. The ocean floor is shallower towards the coast, it seems to remain quite constant offshore. The area around 35.25°S, 19.5°E seems to be slightly deeper.

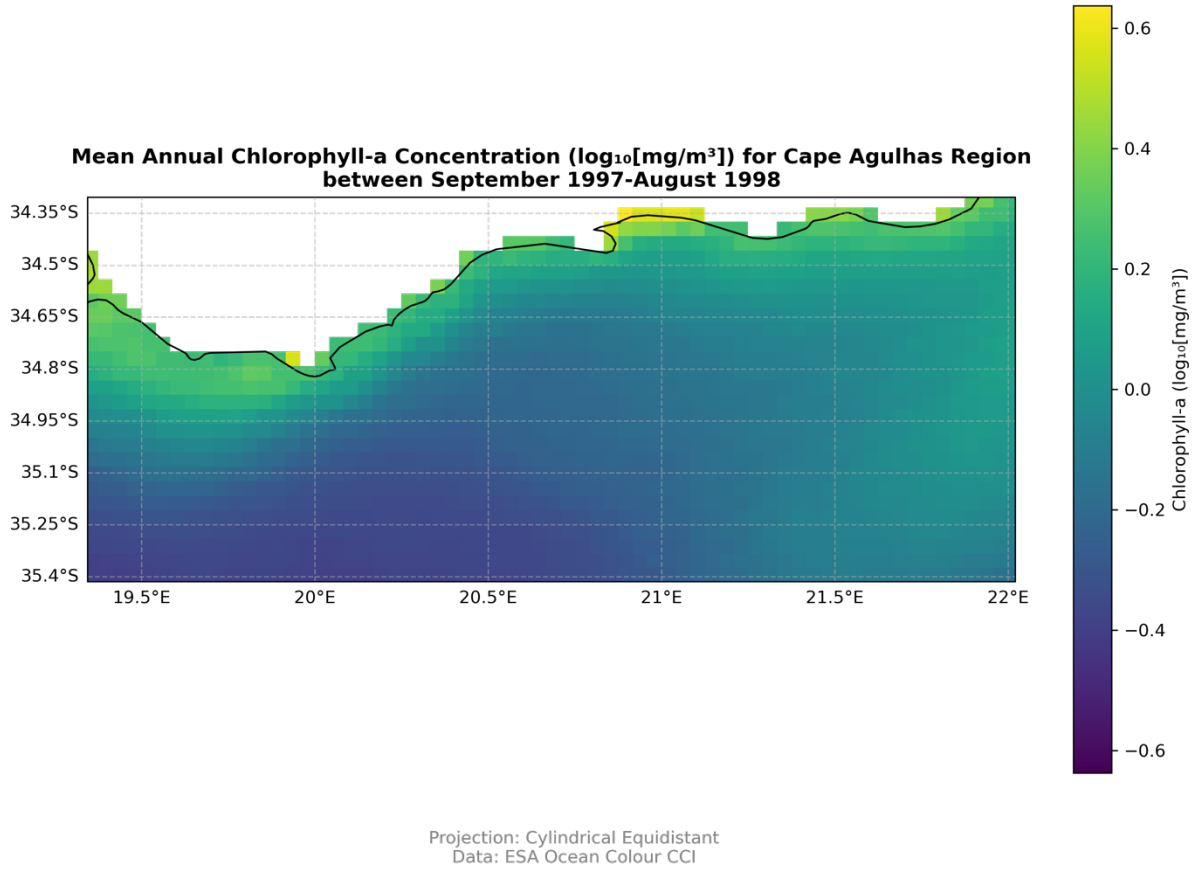

Figure 3: Mean annual Chlorophyll-a concentration ($log_{10}[mg/m^3]$) for the selected coastal region surrounding Cape Agulhas, from data collected between September 1997 and August 1998.

Figure 3 shows that the higher chlorophyll-a concentrations are generally found closer to the coast, particularly around the Witsand area, where the concentration seems to peak. The concentration around the Hermanus area and the general area to the left of Cape Agulhas has quite a high chlorophyll-a concentration. The chlorophyll-a concentration is generally lower offshore, particularly from 35.1°S-35.4°S and 19.5°E-21°E. Heading east, the concentration seems to increase offshore.

The chlorophyll concentration values were log transformed to show the variation in concentrations more clearly. Note: land has been left white to clearly show all the chlorophyll concentration data.

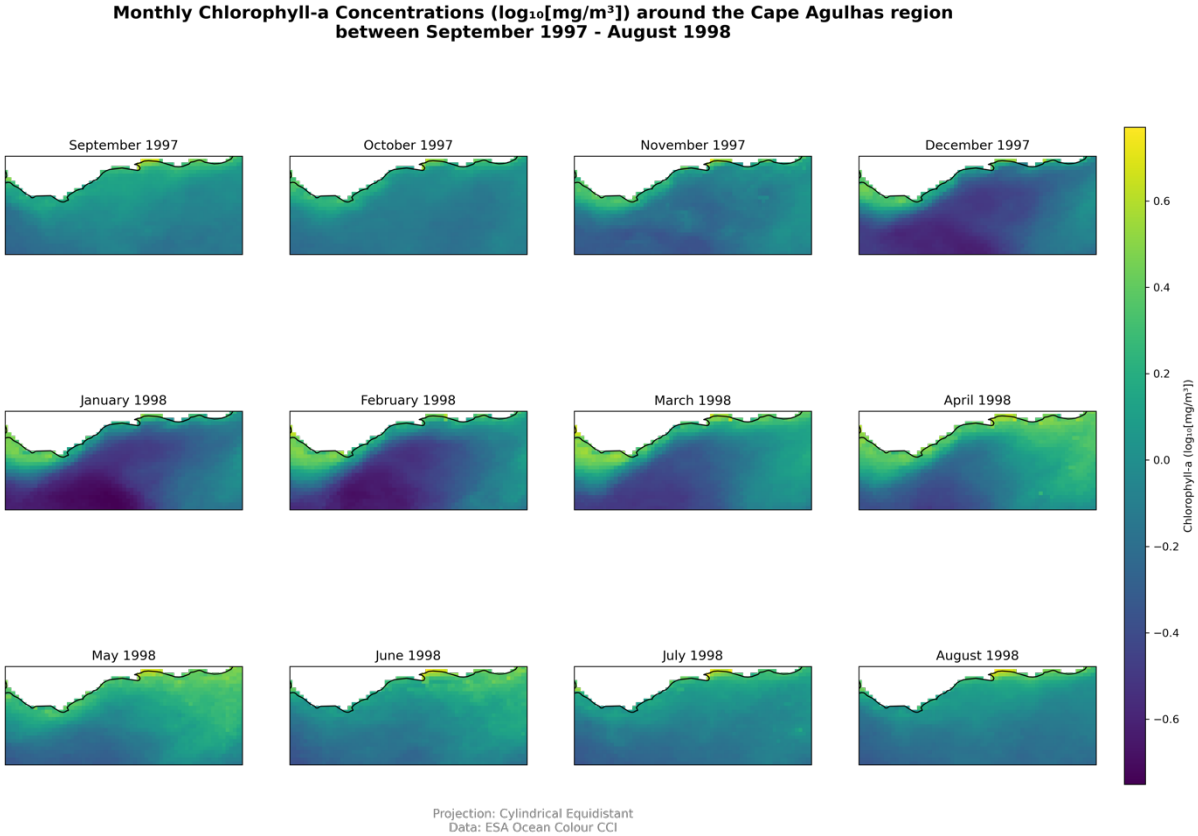

Figure 4: 12 subplots spanning from September 1997- August 1998 showing monthly chlorophyll-a concentration ($log_{10}[mg/m^3]$) for the selected region.

Figure 4 shows the chlorophyll-a concentration seems to shift throughout the region seasonally. The concentration visually looks lowest throughout the summer months, with an area of higher concentration sitting west of Cape Agulhas. As autumn starts, the concentration seems to increase from the east and gradually throughout the winter months the entire region has a higher average chlorophyll-a concentration. The area of high concentration to the west of Cape Agulhas seems to dissipate in the winter months and the peak seems to shift towards Witsand. As spring begins, the concentration through the whole region starts gradually decreasing again and the high concentration west of Cape Agulhas seems to form shape again and gradually grow through the summer months. Throughout all the seasons, the concentration remains higher at the coast than offshore.

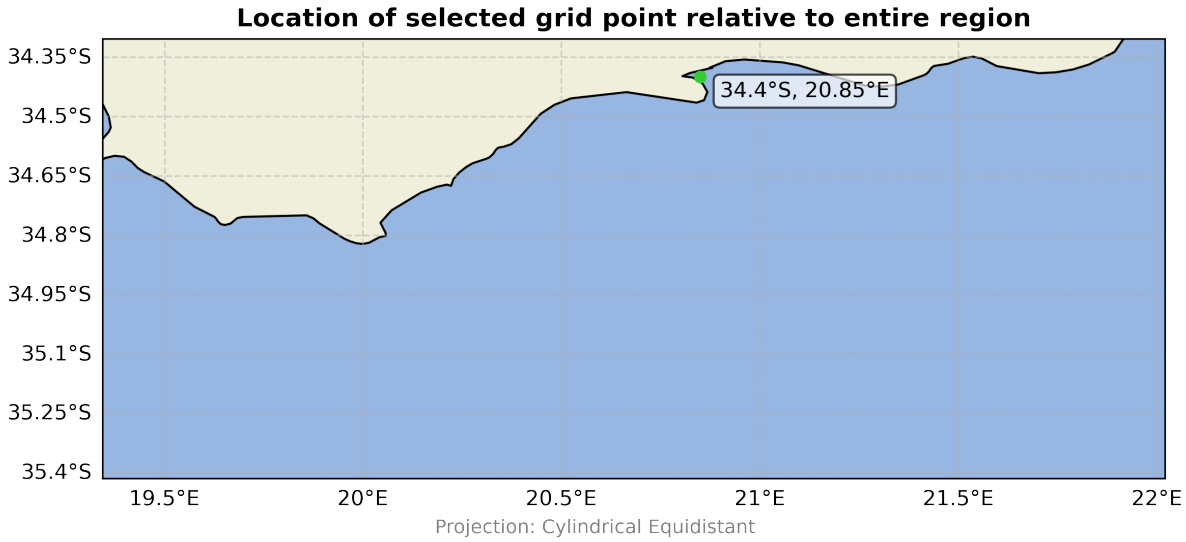

Figure 5: Location of single grid point from region chosen to compare timeseries with regional mean timeseries of chlorophyll-a concentration. This point is an area of high chlorophyll concentration in comparison to the rest of the region.

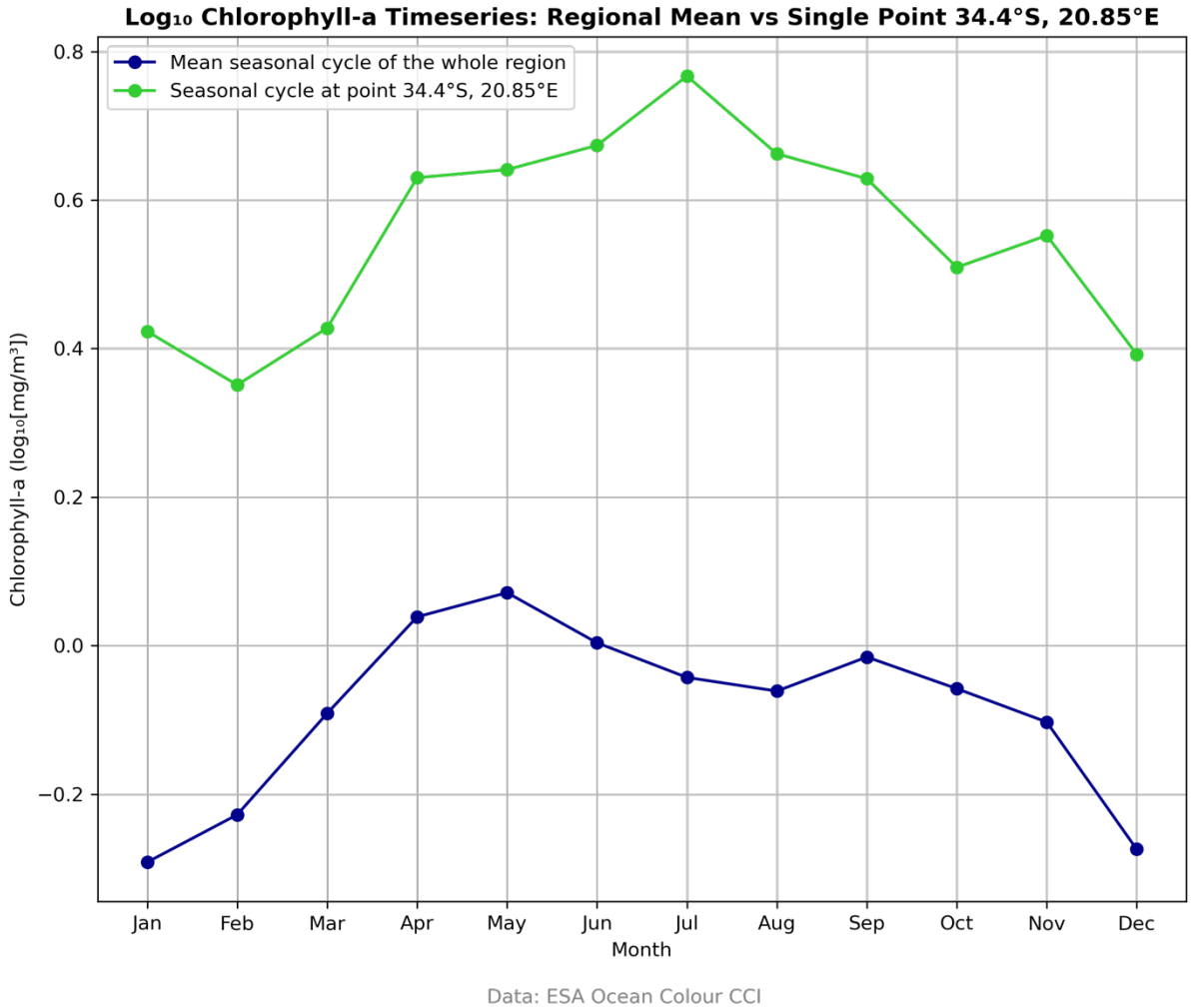

Figure 6: Timeseries of regional mean chlorophyll-a concentration ($log_{10}[mg/m^3]$) vs the timeseries of the single point near Witsand at 34.4°S, 20.85°E.

Figure 6 shows that overall, the chlorophyll-a concentration is much higher year round for the single point chosen near Witsand. For the whole region, the chlorophyll-a concentration appears to increase gradually from January to April (summer and autumn), and peaks in May. The concentration then seems to gradually decrease throughout the winter months, with a slight rise in September before decreasing through the spring months towards a low in December, at the start of summer. For the single point at 34.3°S, 20.85°E, the concentration seems to be lowest in February (end of summer), and highest in July (middle of winter). The changes between seasons appear to be sharper for this single point with the lows in summer and highs in winter. There is a sharp increase between March and April, and a sharp decrease between November and December. For both the whole region and this single point, chlorophyll-a concentration is lowest in the summer months (Dec-Feb). However, for the single point near Witsand, the concentration peaks sharply in July whereas for the whole region, the concentration peaks slightly in May.