Supplement of Geosci. Model Dev., 8, 3163–3178, 2015
http://www.geosci-model-dev.net/8/3163/2015/
doi:10.5194/gmd-8-3163-2015-supplement

Geoscientific Model Development
Open Access

Supplement of

S2P3-R (v1.0): a framework for efficient regional modelling of physical and biological structures and processes in shelf seas

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A. Supplementary Figures

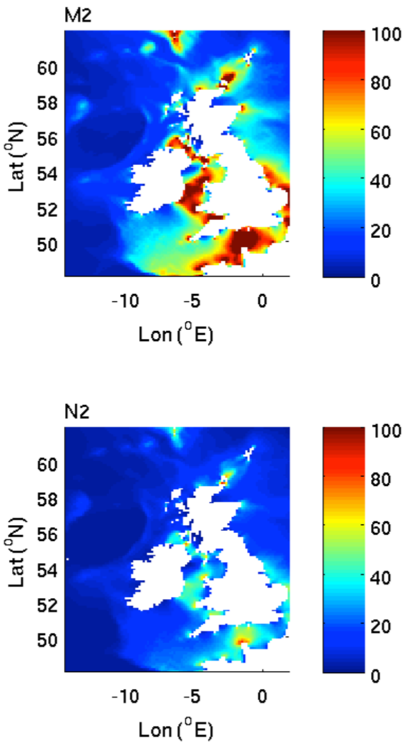

Figure S1. Amplitudes (cm s^{-1}) of the M2, S2 and N2 constituents of the local tidal current vector on and around the northwest European shelf (as also used for the configurations around Scotland and in the Western English Channel).

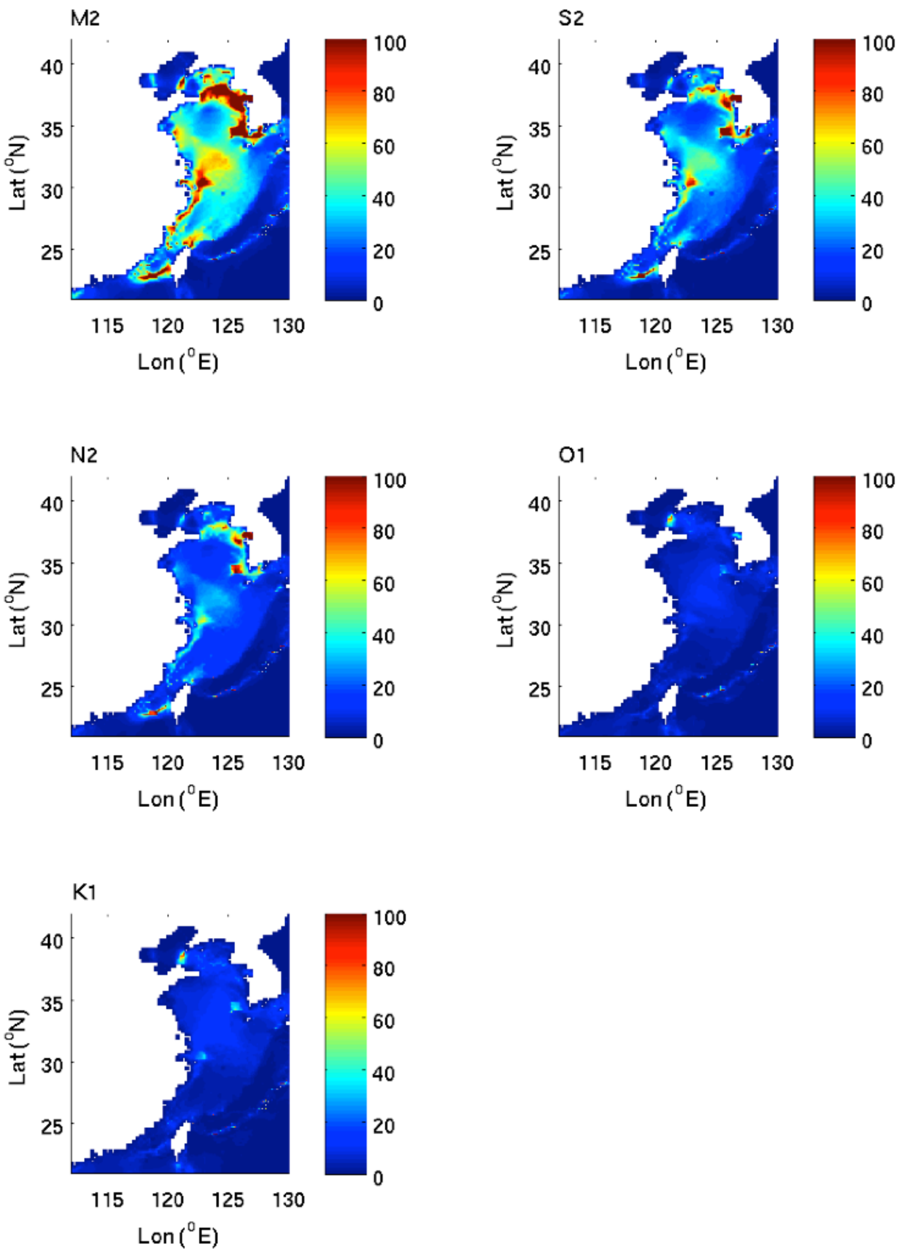

Figure S2. Amplitudes (cm s^{-1}) of the M2, S2, N2, O1 and K1 constituents of the local tidal current vector, in the shelf seas around China.

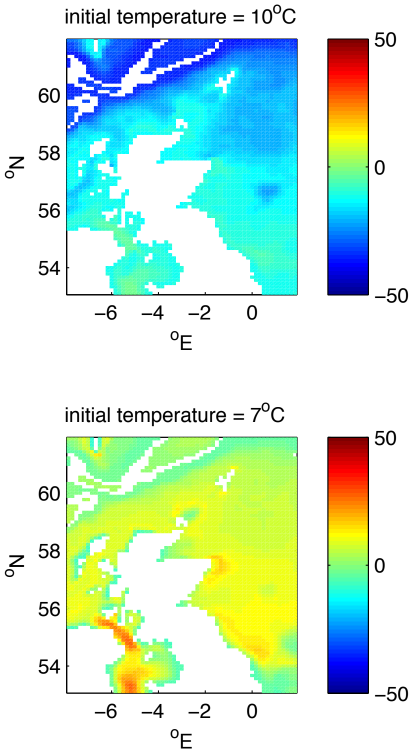

Figure S3. Annual-mean heat flux (W m^{-2}) for a domain around Scotland, specifying different temperatures on 1 January 2009: 10°C (upper left panel); 5°C (upper right panel); 7°C (lower left panel).

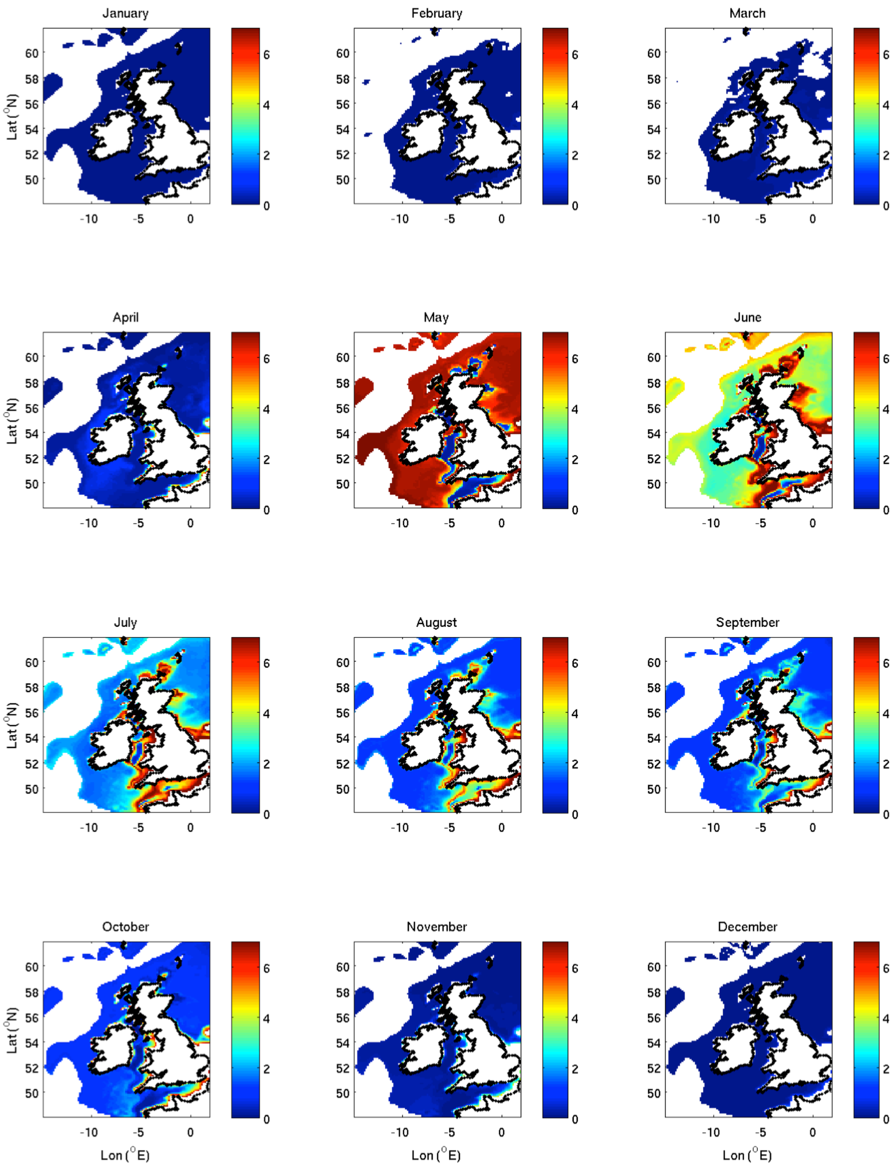

Figure S4. Monthly-mean surface chl-a (mg chl-a m^{-3}), simulated with climatological meteorological forcing for the Northwest European shelf domain.

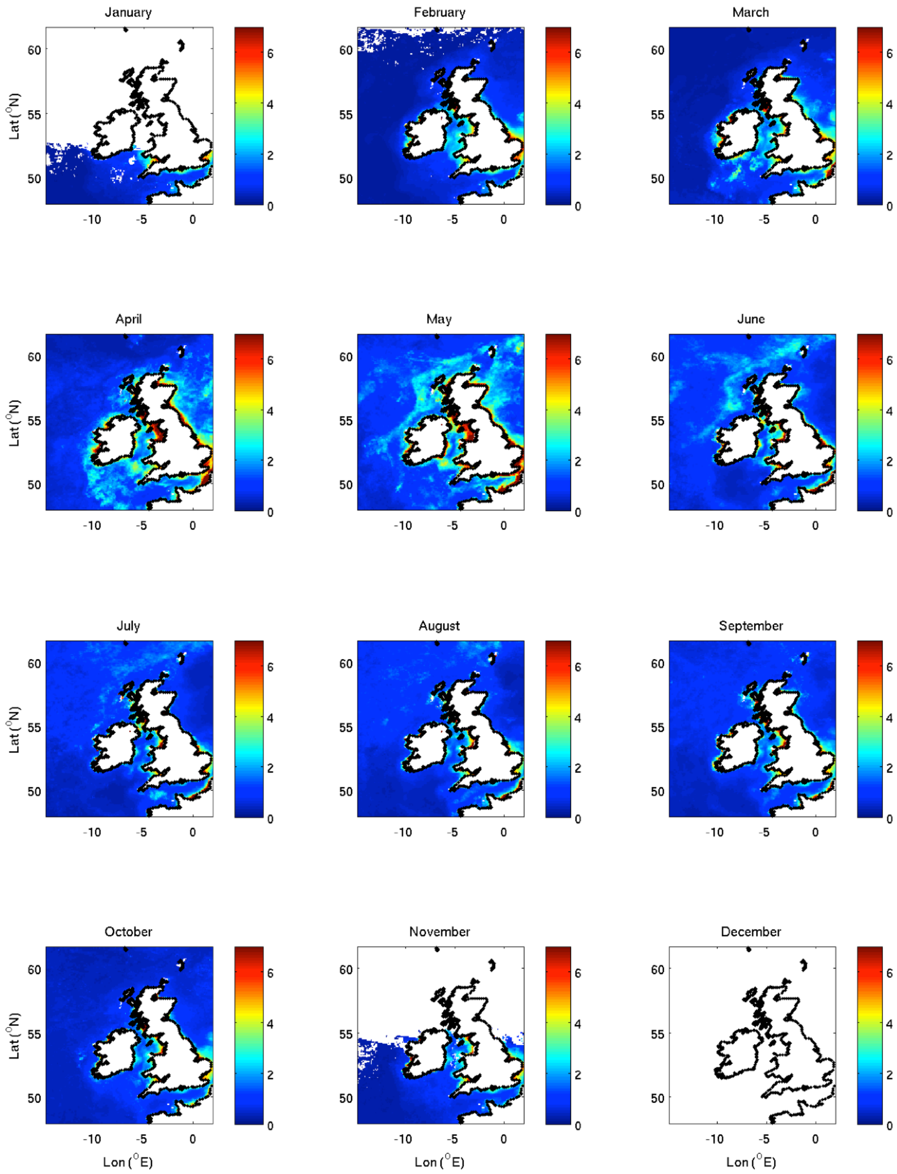

Figure S5. Monthly-mean surface chl-a (mg chl-a m^{-3}), averaged over 2002-12, derived from MODIS ocean colour satellite (http://oceancolor.gsfc.nasa.gov), for the Northwest European shelf domain. Missing data during winter is due to satellite coverage.

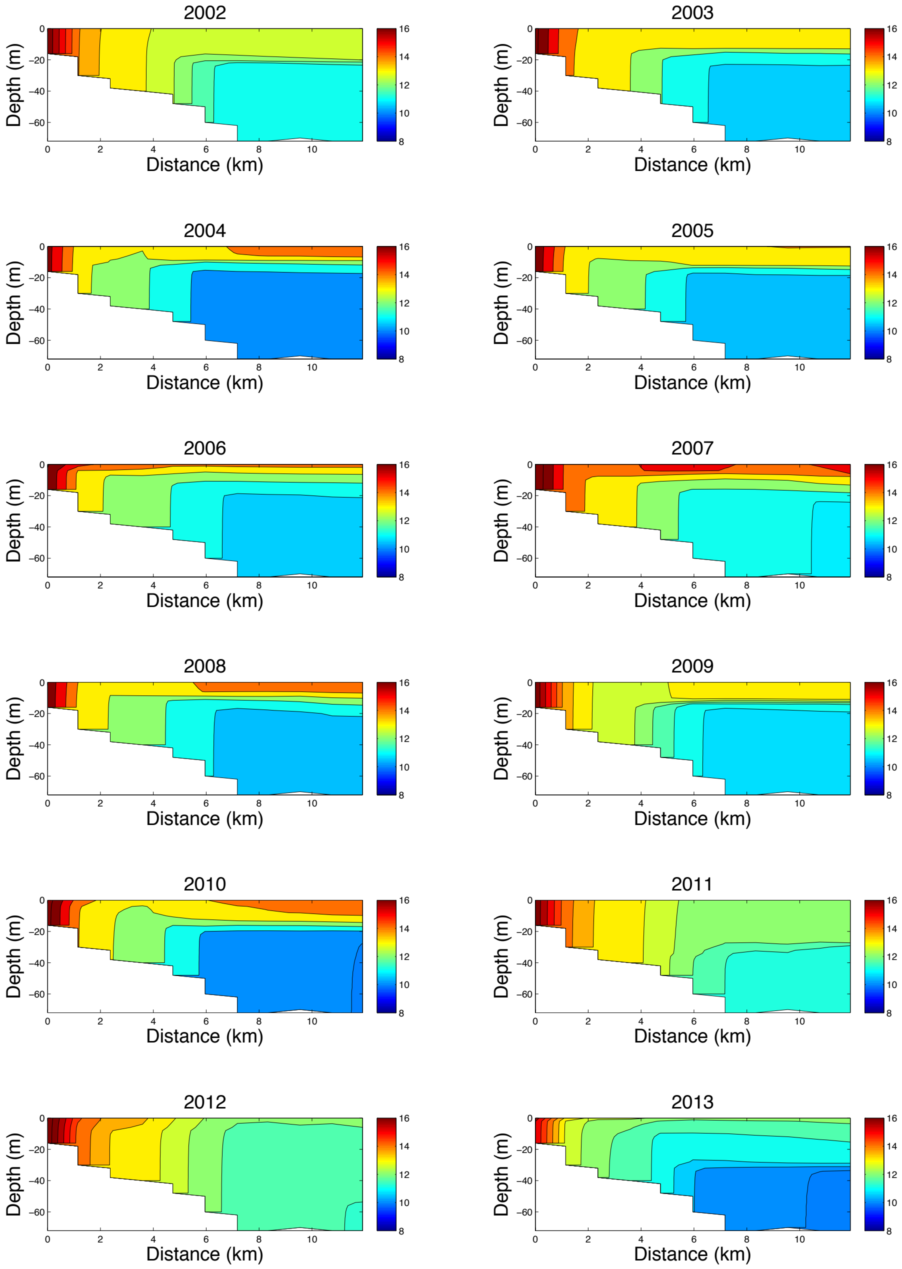

Figure S6. Temperature sections through the tidal mixing front east of Lizard peninsula, along 50.017°N, on day 169 of 2002-13.

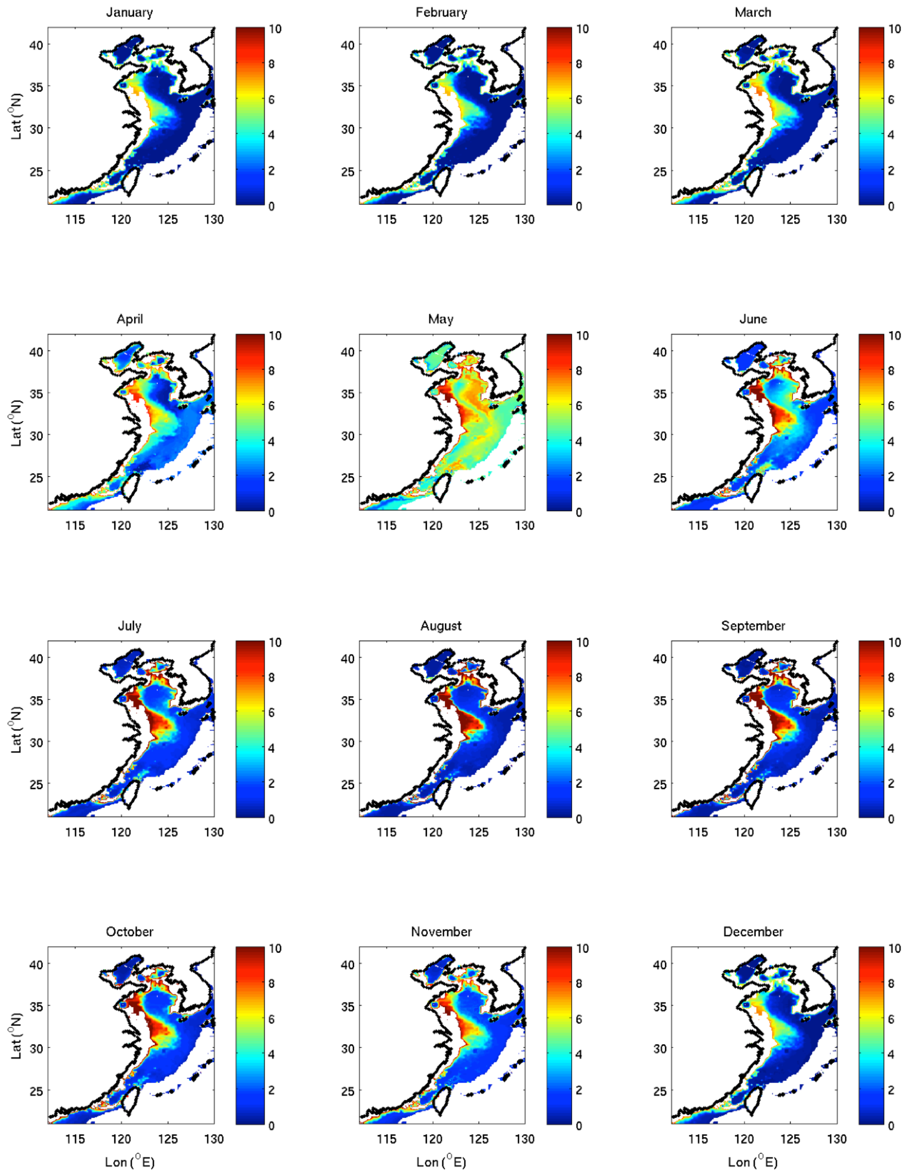

Figure S7. Monthly-mean surface chl-a (mg chl-a m^{-3}), simulated for the East China and Yellow Seas domain in 2013.

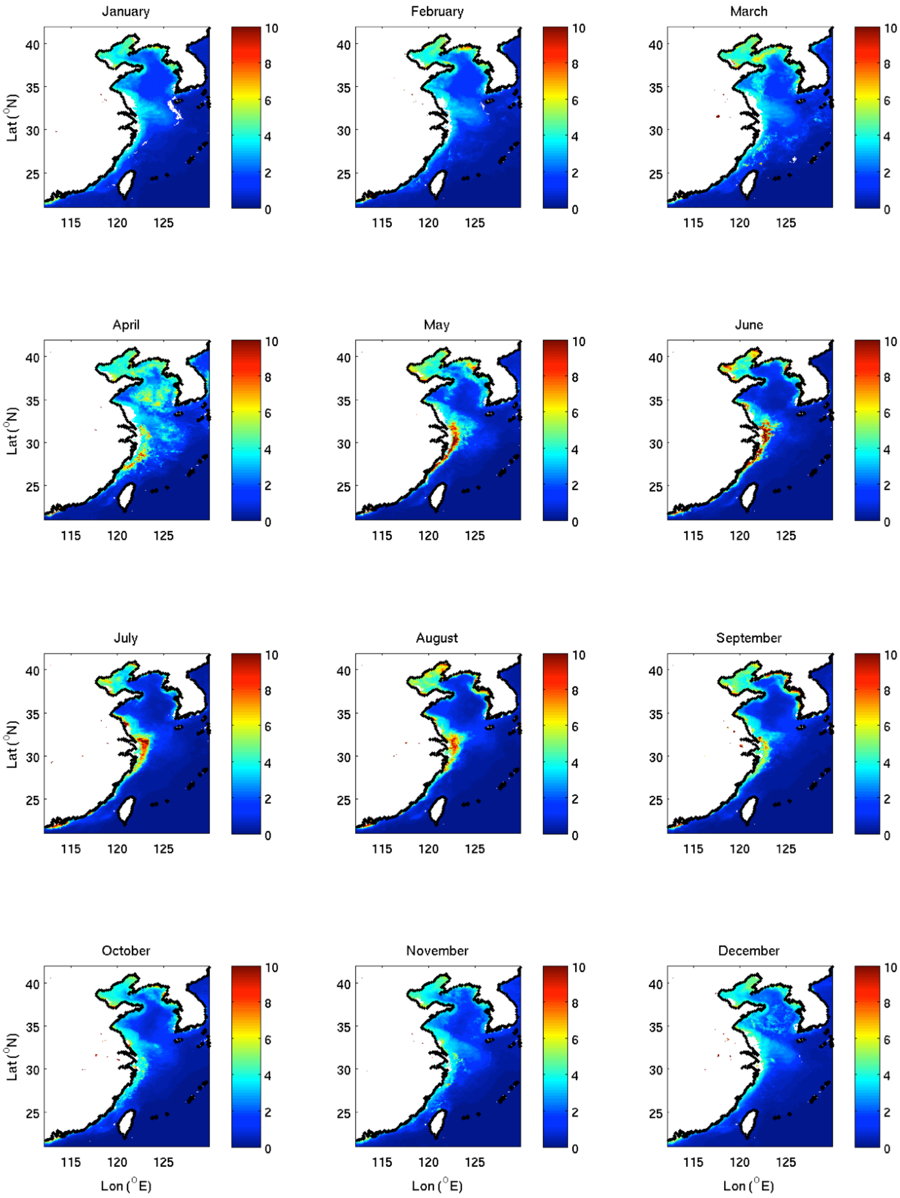

Figure S8. Monthly-mean surface chl-a (mg chl-a m^{-3}), averaged over 2002-12, estimated from MODIS satellite colour, for the East China and Yellow Seas domain.

B. Example Animation

In `ftp://ftp.noc.soton.ac.uk/pub/rma/kernow_movie_6fps.mov`, we show an animation of the "Western English Channel" simulation for 9 May to 7 October of 2013. The fields are daily fields of SST (upper left), surface-bottom temperature difference (upper right), surface DIN (lower left), and surface chl-a concentration (lower right). The date is updated at the centre of the four panels.

Initially, in May, SST is in the range 9-10°C and temperature difference is close to zero at most locations, while surface DIN and chl-a are around 7 mmol m^{-3} and zero respectively where water depth exceeds the critical depth for photosynthesis. In shallower water, light levels by May are high enough to sustain photosynthesis, so surface DIN is near zero (although constantly replenished by upward mixing from the seabed source) and chl-a levels exceed 10 mg chl-a m^{-3} in some coastal locations.

Running the movie, note how surface warming and stratification develop most notably in June. Maximum surface chl-a in offshore waters – a particularly late spring bloom in 2013 – occurs around 10-11 June, simultaneous with modest stratification of 2-3°C and a collapse of surface DIN to near-zero everywhere at this time. Subsequent summer variability of temperature differences and chl-a is attributed to irregular synoptic meteorological conditions in combination with the spring-neap "beating" of tidal mixing, on a near-fortnightly timescale. Offshore temperature differences remain as high as 5-6°C at many offshore locations by late August, coincident with peak SST at this time, but this stratification is substantially weakened during September, while SST falls by around 2°C. Associated with the return of near-mixed conditions is a modest offshore autumn bloom in late September. Surface DIN levels finally start to recover again in the southeast corner of the region by early October with the return of fully mixed conditions.