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Exploring marine heatwave drivers and predictability using *OceanParcels*

What is *OceanParcels*?

- A freely available set of Python classes and methods for Lagrangian ocean analysis (Lange & van Sebille, 2017; Delandmeter & van Sebille, 2019).
- It can be used to create customisable particle tracking simulations from ocean model output.
- Examples of its application include the tracking of passive and active particulates, such as water masses, plankton, plastic, and fish (e.g. van Sebille et al., 2018).

OceanParcels

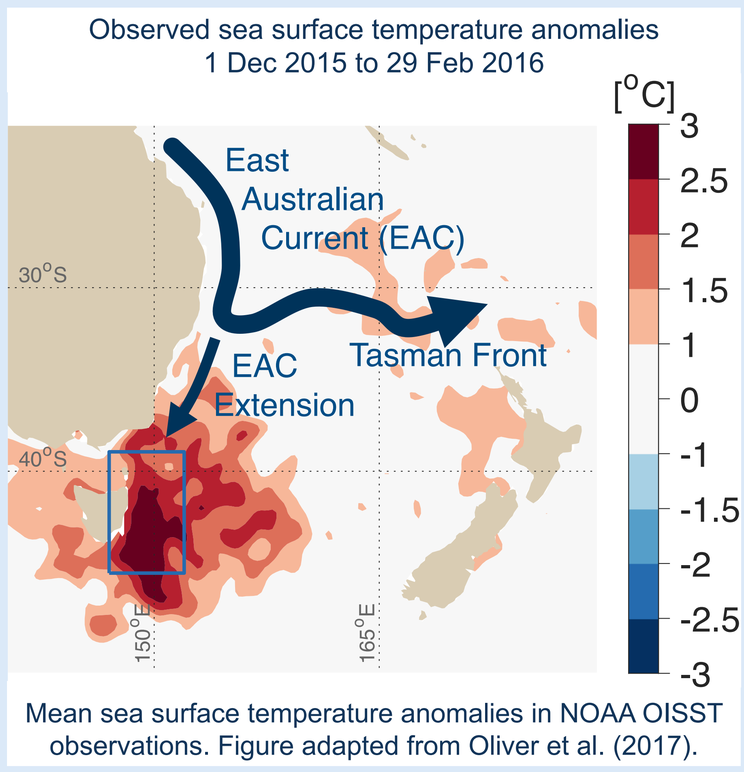
https://oceanparcels.org

How will we use *OceanParcels*?

- OceanParcels analysis will be conducted on output from the ACCESS-OM2 ocean-sea ice model, which is driven by a prescribed reanalysis atmosphere from JRA55-do (Kiss et al. 2020).
- Daily output of ocean velocity and temperature is available from historical simulations at three resolutions: 1°, 0.25°, and 0.1°. The latter will be used.
- Trajectories of parcels, as well as their associated anomalous temperatures, will be analysed with the aim of **exploring the drivers and predictability of marine heatwaves**.

A case study: The 2015/16 Tasman Sea marine heatwave

- An unprecedented marine heatwave occurred near Eastern Tasmania during the austral summer of 2015/16. Sea surface temperature anomalies of 2-3°C above average were recorded over large areas, and the marine heatwave persisted for over 8 months (Oliver et al. 2017).
- It is known to have been driven by changes to the East Australian Current (EAC) system, which more typically peels off towards New Zealand as the Tasman Front, but in 2015/16 there was an intensification of the EAC extension. Hence, more warm water was transported from the north into the region near Tasmania.
- As yet it is not well understood whether the more significant driver was:
  - anomalously strong transport of waters with usual temperature, or,
  - usual currents transporting anomalously warm water.

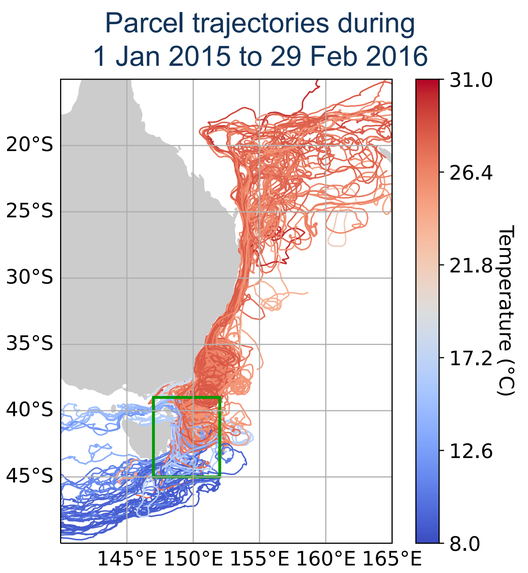


Mean sea surface temperature anomalies in NOAA OISST observations. Figure adapted from Oliver et al. (2017).

A first look

Seeded particles in the Eastern Tasmanian domain, initially:

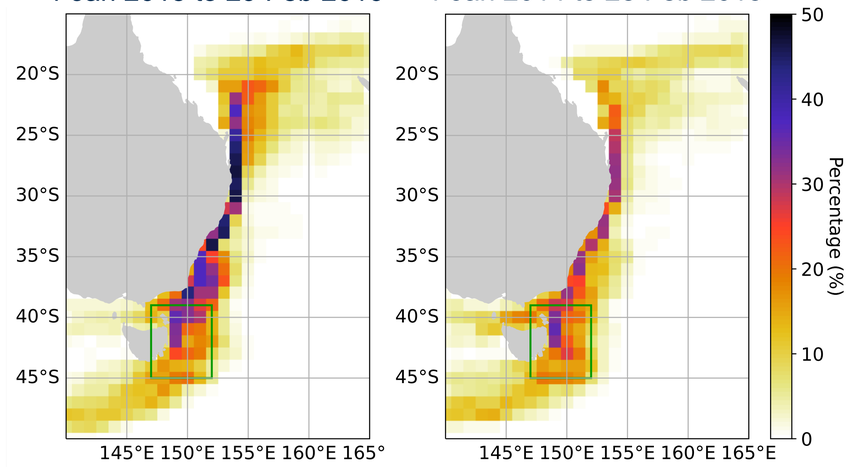
- at 1° horizontal spacing
- to 300m depth at 50m spacing
- released daily during 1 Dec 2015 to 29 Feb 2016
- **backtracked** to 1 Jan 2015



A random sample of ~5% of parcel trajectories that end at the surface layer in the marine heatwave domain. Each trajectory is coloured by the parcel's initial temperature. The green box indicates the Eastern Tasmanian domain, from which the parcels were released.

How was 2015/16 different from other years?

- We have also run a simulation for the previous year (with no marine heatwave).
- Initial finding: a greater number of parcels traverse the EAC in the marine heatwave year → greater source from warm water regions.



Percentage of all parcels traversing given grid cells, over two 14-month periods, one with a marine heatwave (left panel) and the other without (right). Shown only for surface level parcels.

Next steps

- Track the advection of temperature anomalies.
- Try to understand the extent to which the marine heatwave could have been predicted.
- Develop a general framework for analysing marine heatwave drivers and predictability with *OceanParcels*.

References

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