

Display Material

Sea ice advance influenced by continentality in the Southern Ocean

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Context

What are the drivers of sea-ice advance in the Southern Ocean ?

- Changes in Antarctic sea ice seasonality have been documented
(*Parkinson, 1994, Stammerjohn et al., 2008, 2012*)
- The strongest regional trends are observed for sea-ice advance date
(*Simpkins et al., 2013*)
- But the underlying mechanisms behind the temporality of sea ice advance are not completely understood, even in the mean state
- This work-in-progress study aims to better understand the drivers of sea-ice advance temporality in the Southern ocean.

Sources

Sea-ice concentration

OSI-SAF (PMW)

25km resolution

Daily 1979-2019

Sea Surface Temperature

OSTIA Reanalysis

0.05° resolution

Daily 1982-2017

2m-air temperature

ERA5 Reanalysis

0.25° resolution

Hourly 1979-2020

Radiative surface fluxes

ISCCP (Satellite product)

10km resolution

3-hourly 1983-2017

Methods

Advance dates

- 15-day smoothing to filter high frequency events
- First day SI concentration > 15% between January and December

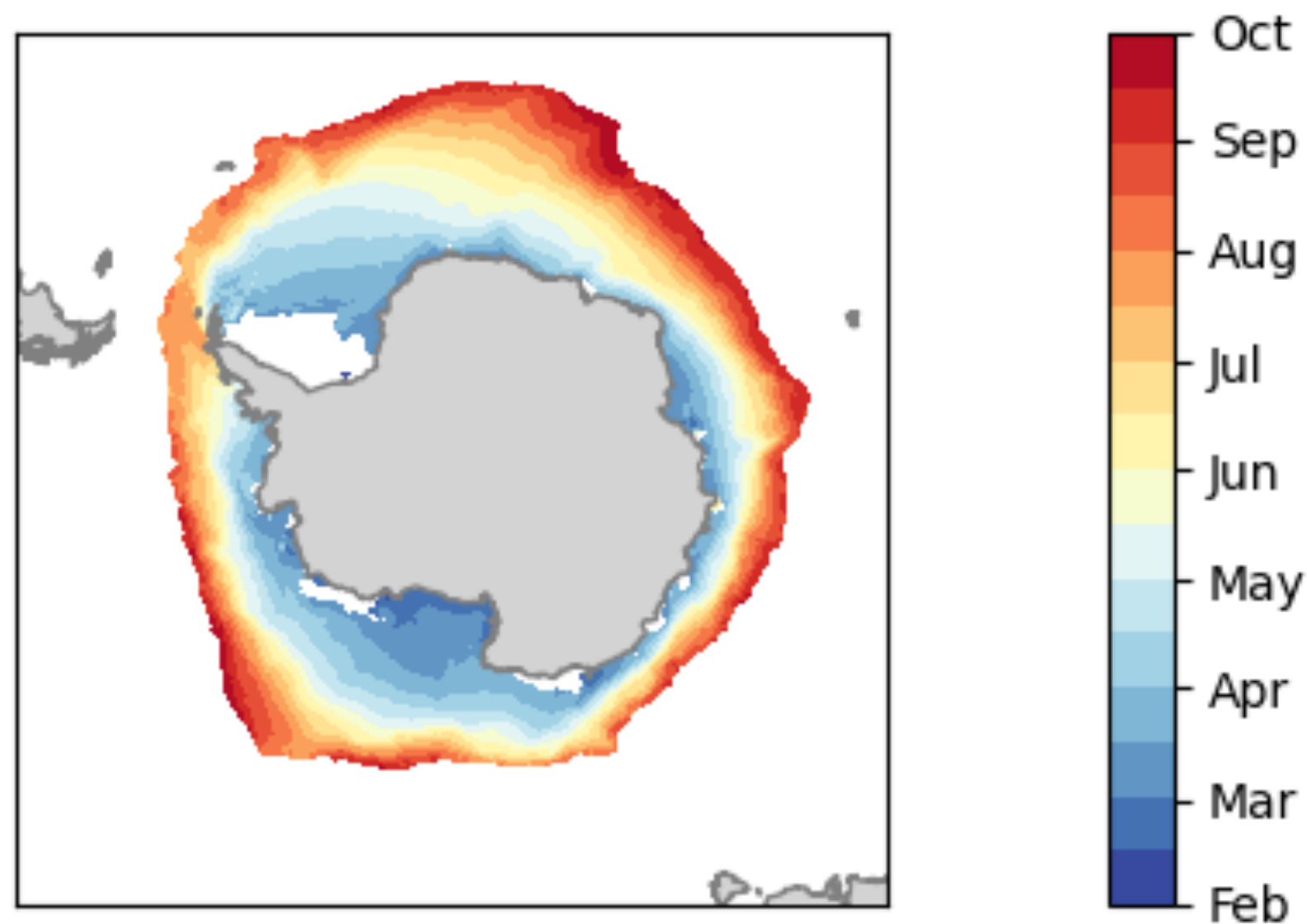
Index of continentality (CI)

$$CI = m \cdot (t2m_{max} - t2m_{min}) + p$$

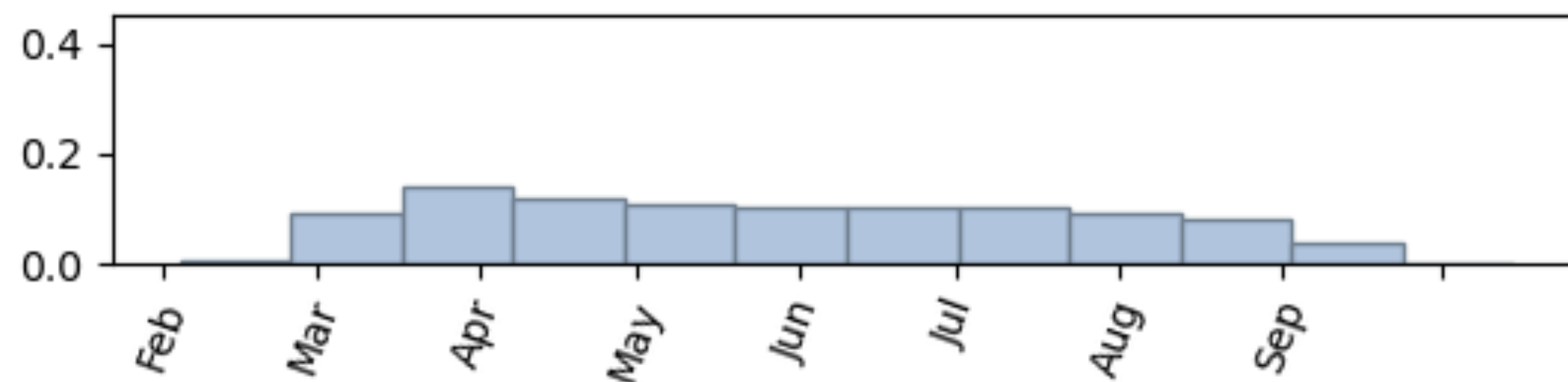
- m , p chosen to get CI = 100% at the continent & CI = 0% in the ice-free ocean
- Arbitrary threshold at CI = 40% to separate continental and oceanic zones
- Polynyas are removed from continental zone

Preliminary results

Mean state of SI advance



- Characteristics of SI advance date spatial distribution :
- Regularity
 - 2 regimes : faster SI advance near the continent

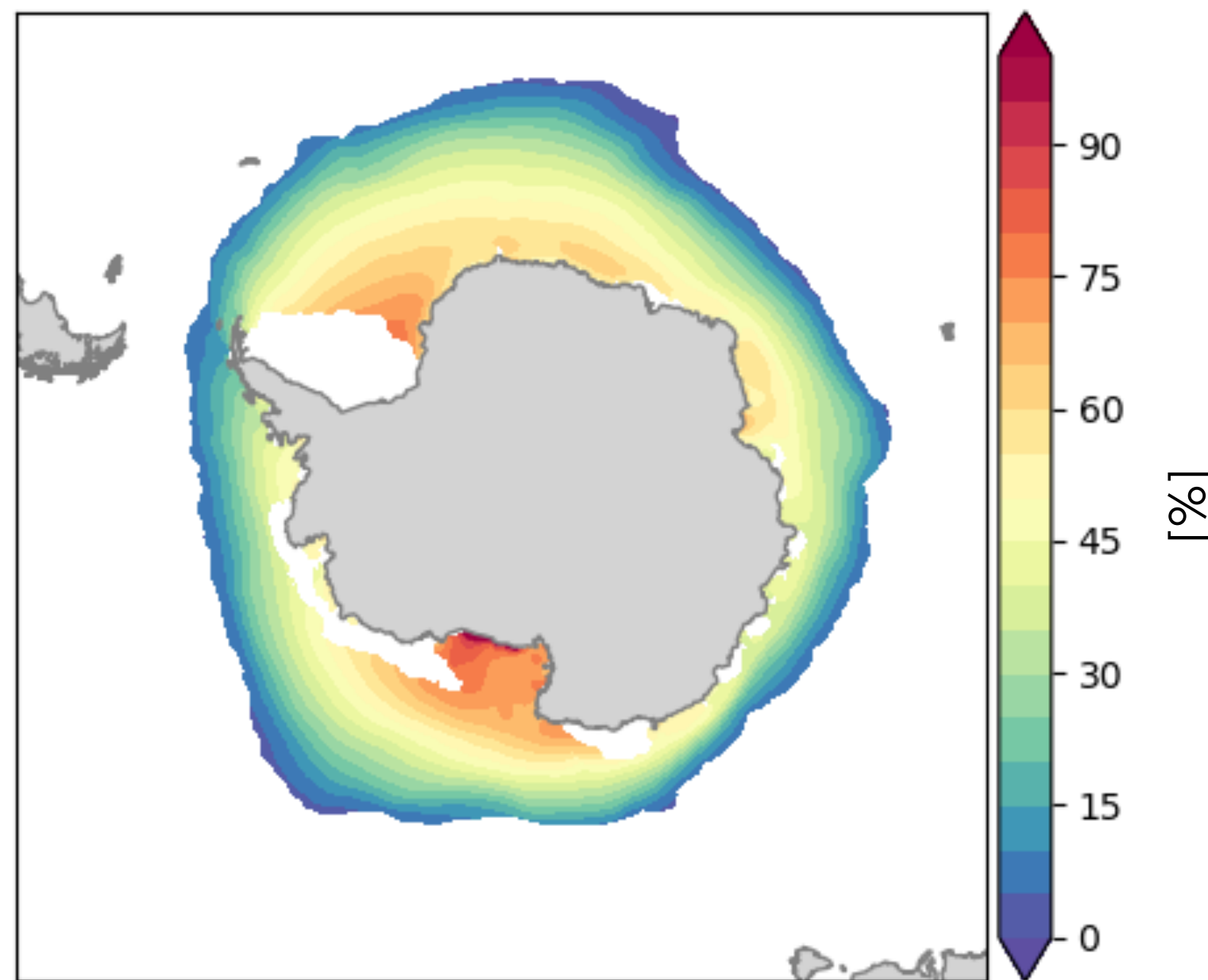


Mean sea-ice advance dates (1984-2016).

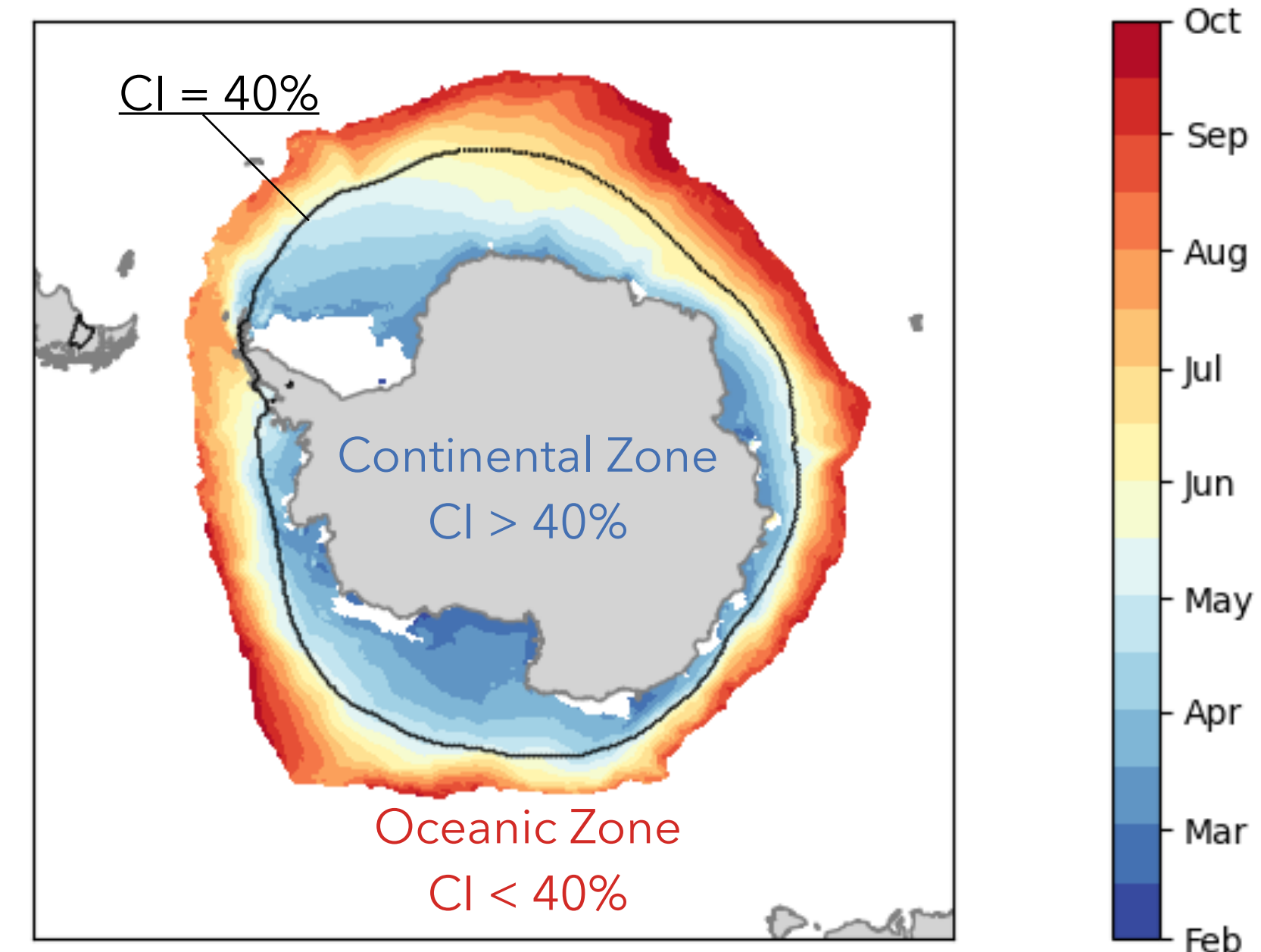
First panel shows spatial distribution of dates. Second panel is a frequency histogram.

Close link between SI advance regimes and continentality

- SI advance date distribution is close to the CI distribution
- The 2 advance regimes seem to correspond to a 40% threshold of the CI

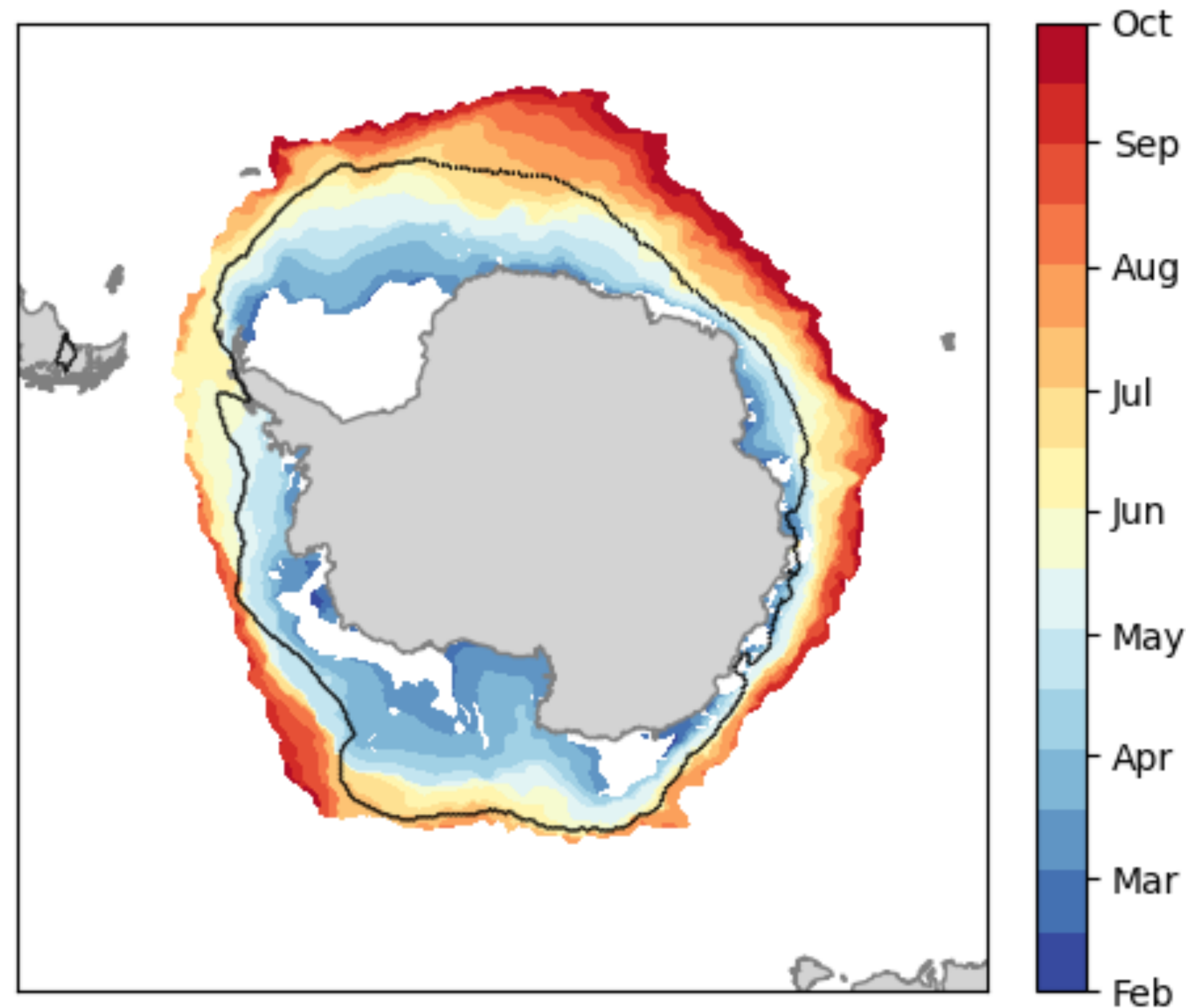


**Map of mean Continentality Index (CI)
(1984-2016).**



Map of sea-ice advance date (1984-2016). The black contour delimits the region where CI > 40% (continental zone) and CI < 40% (oceanic zone)

A closer look at a particular year to understand

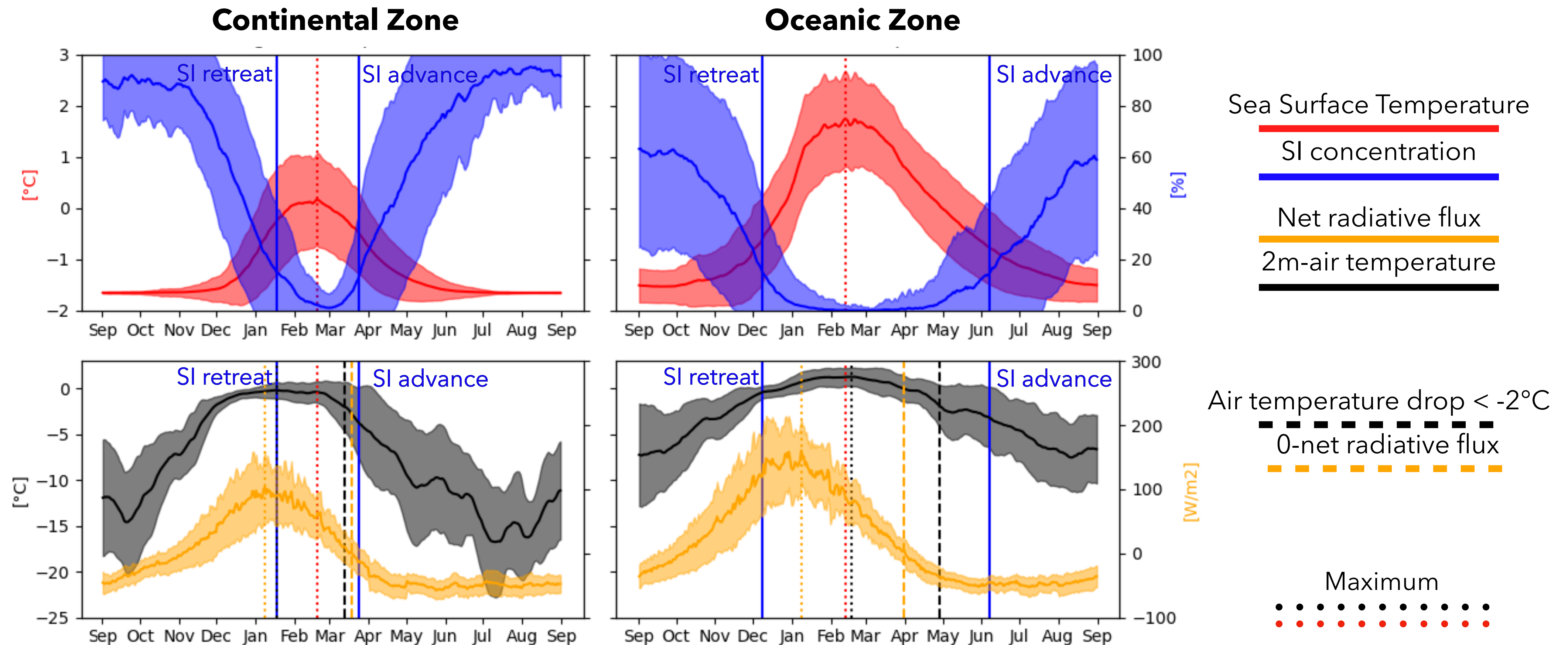


Map of sea-ice advance date for 1991

The black contour delimits the region where $CI > 40\%$ (continental zone) and $CI < 40\%$ (oceanic zone) for this particular year

- Preliminary analysis on 1 year
- The regularity and transition between fast / slow advance regime are less pronounced but still visible

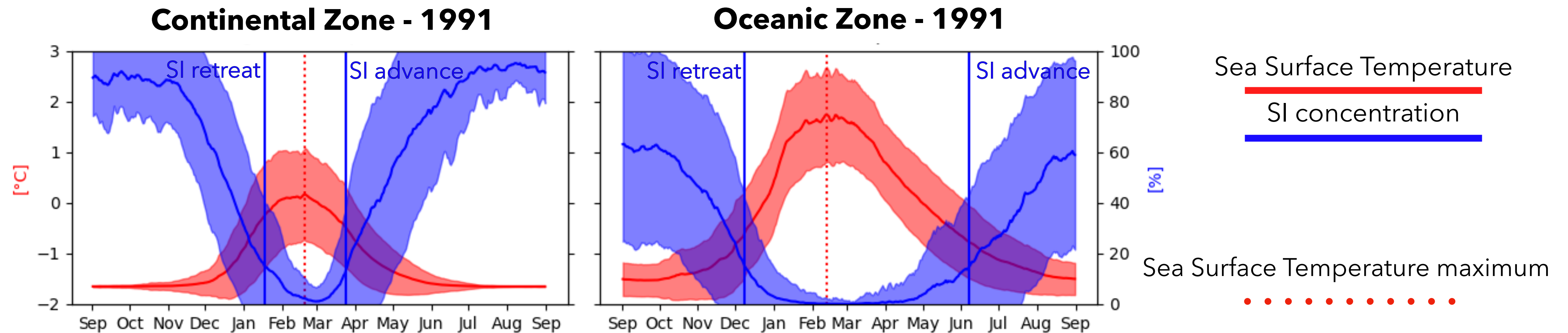
Sea-ice advance influenced by continentality



1991 mean seasonal cycle over the continental and oceanic zones of key variables for sea-ice advance.

The next slides will focus on each part of the figure.

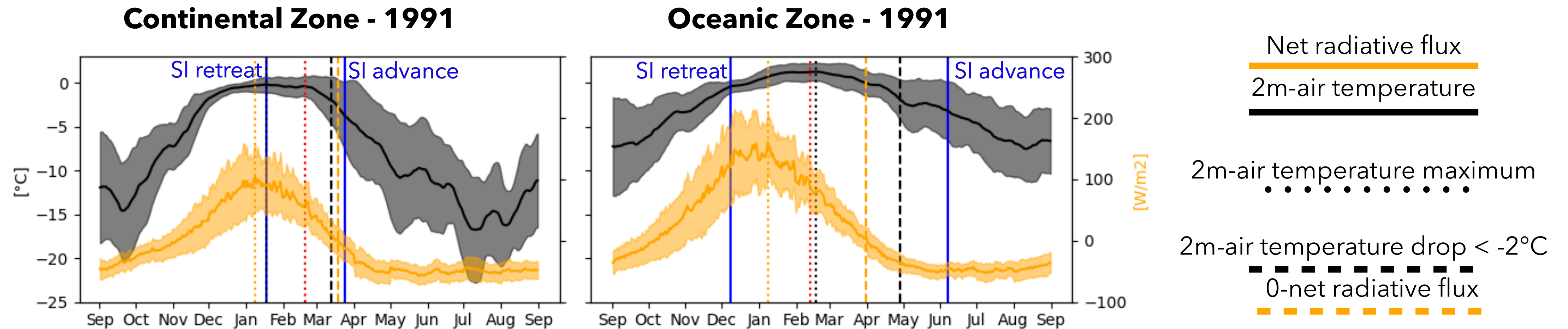
Fast SST cooling and fast SI advance in the continental zone



- Faster SST cooling and SI advance in the continental zone
- Opposite asymmetry between the 2 zones :
 - SST cooling is faster than heating in the continental zone
 - SST heating is faster than cooling in the oceanic zone

SI advance is accelerated in the continental zone.

Radiative fluxes are do not dominate SST cooling



In both zones :

- Air temperature drops below -2°C before SI advance
- SST reaches maximum value before the sign inversion of net radiative flux

Turbulent heat loss must have an important role in SST cooling.

Discussion & Perspectives

The previous preliminary results indicate that :

- Turbulent cold air coming from the continent must have a dominant role in sea surface cooling.
- Near the continent, sea-ice advance must be accelerated by stronger cooling near the continent, resulting in the fast advance regime.
- The slow SST cooling / fast SST heating in the oceanic zone is similar to the Arctic (*Lebrun et al., 2018*).
- The opposite asymmetric regime in the continental zone is a particularity of the Antarctic.

The same analysis will be applied to more years for a more thorough validation of these conclusions. The final outcome will be a step forward in understanding the mean state of sea-ice seasonality in the Southern Ocean. And it may also help better understand the observed changes and trends in seasonality of this region.