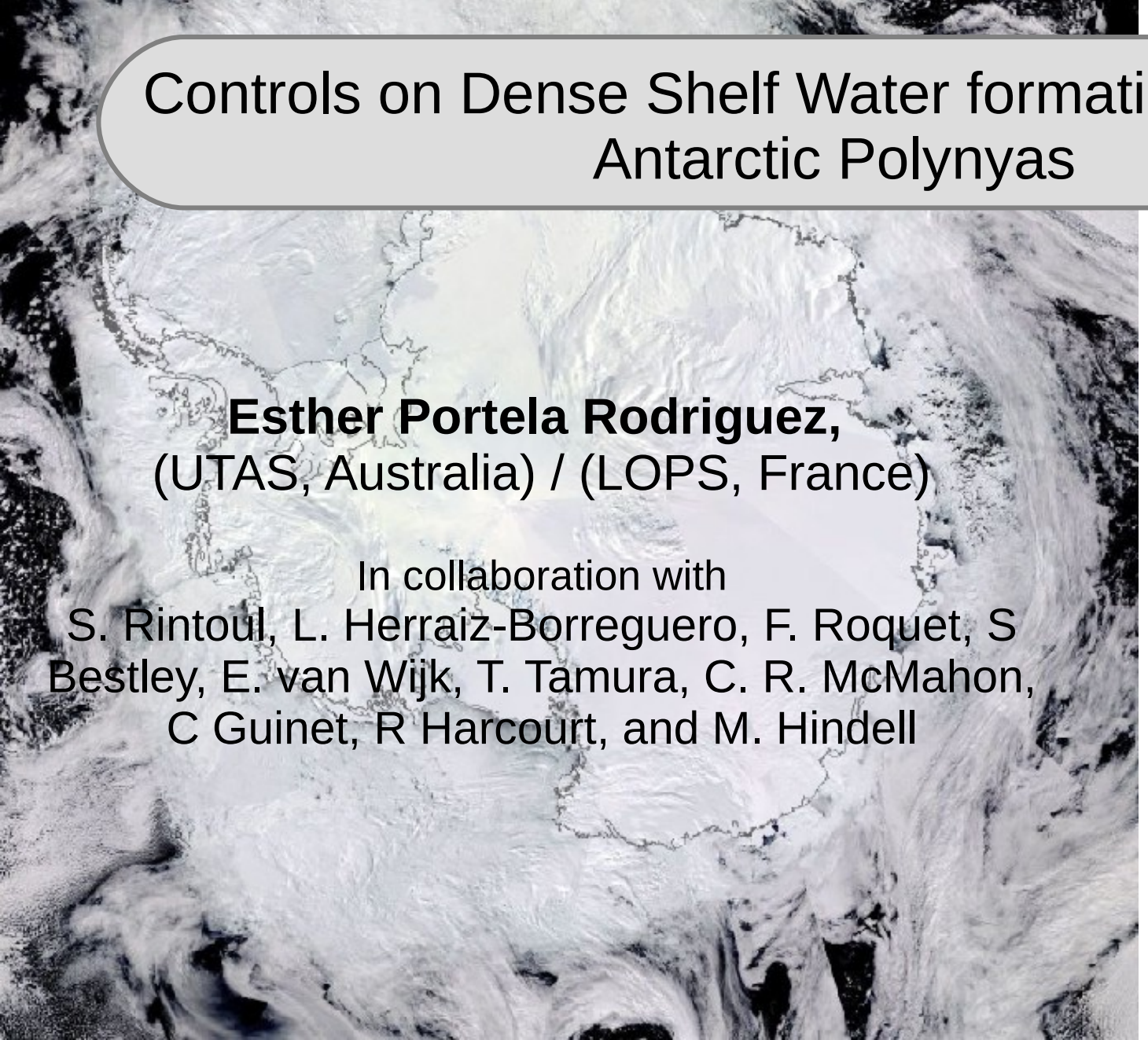
Controls on Dense Shelf Water formation in four East Antarctic Polynyas



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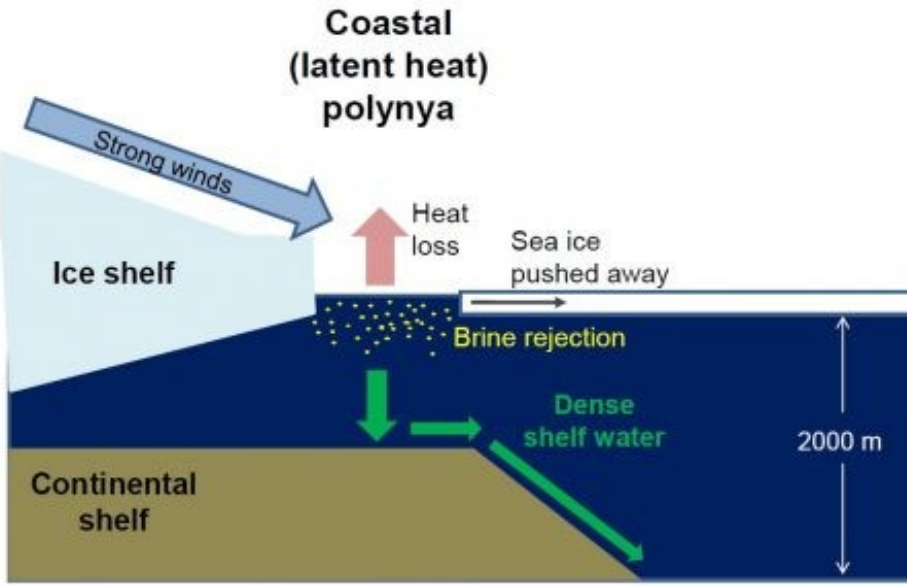
Introduction/Motivation

- Coastal polynyas are regions of open water surrounded by sea ice.



Credit: Céline Heuzé

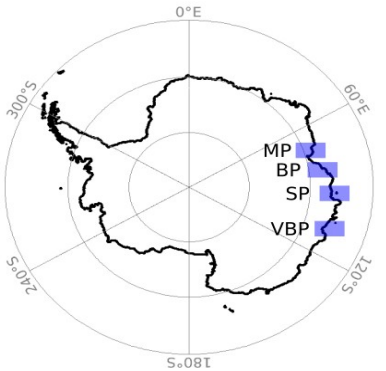
Climate signals are imprinted into the Dense Shelf Water (DSW) that cascades downslope and transforms in AABW, the densest water mass in the global ocean.

Question What are the factors that favor/hinder DSW formation in East Antarctic polynyas?

Motivation Response of DSW formation to future changes in climate influencing the heat transport to Antarctica

Methods

- Seals sampling in four East Antacrtic coastal polynyas

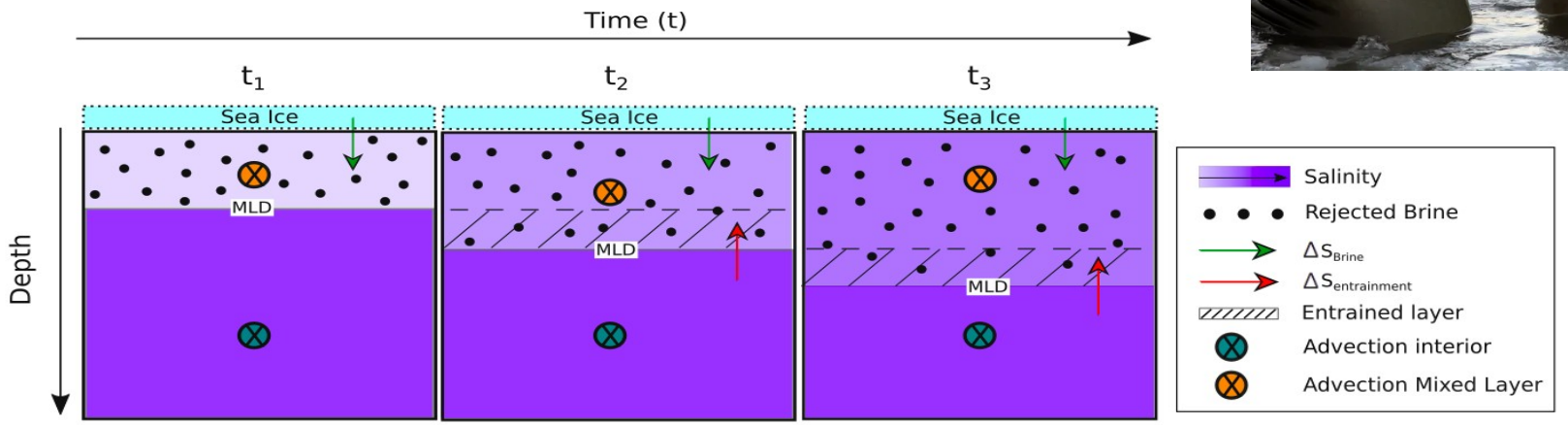


Analysis of different factors

- Physiographic features
- Water-mass properties
- Stratification
- Sea-Ice Production rates

- Salinity balance -

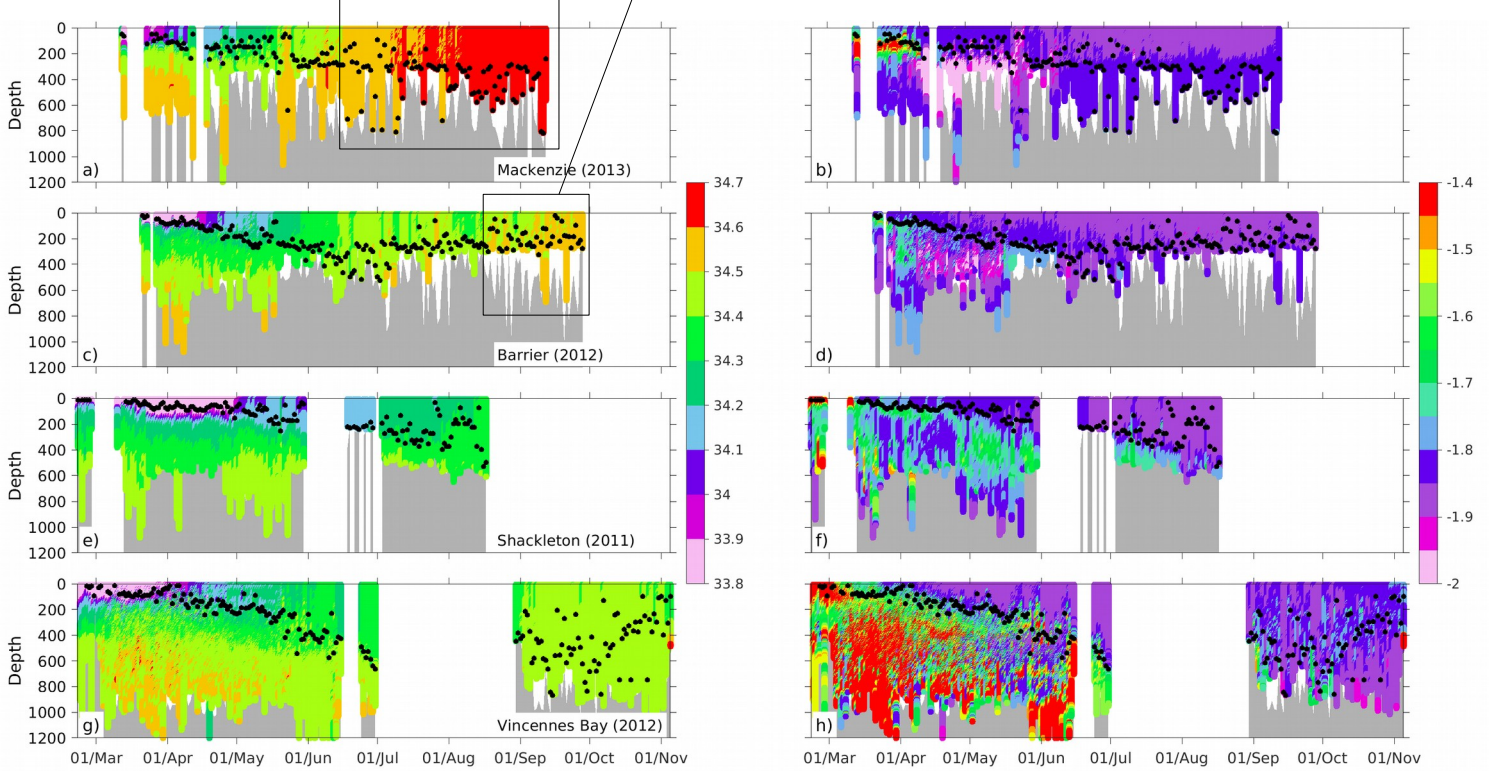
$$\Delta S_{Obs} = \Delta S_{Brine} + \Delta S_{Entrainment} + \Delta S_{Advection}$$



Results

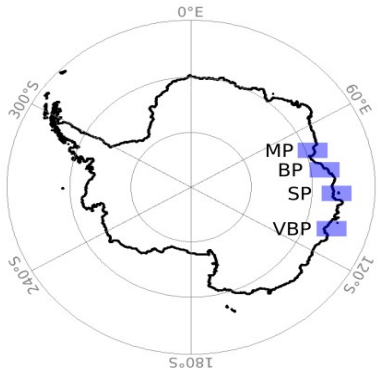
DSW forms in Mackenzie polynya (MP)

Light DSW forms in Barrier polynya



Salinity

Temperature



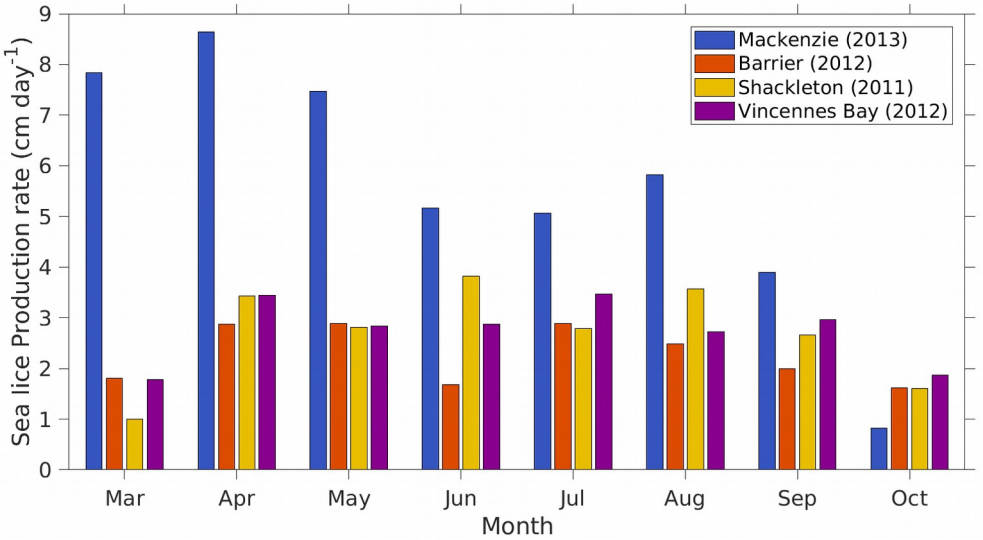
Mackenzie (MP)

Barrier (BP)

Shackleton (BP)

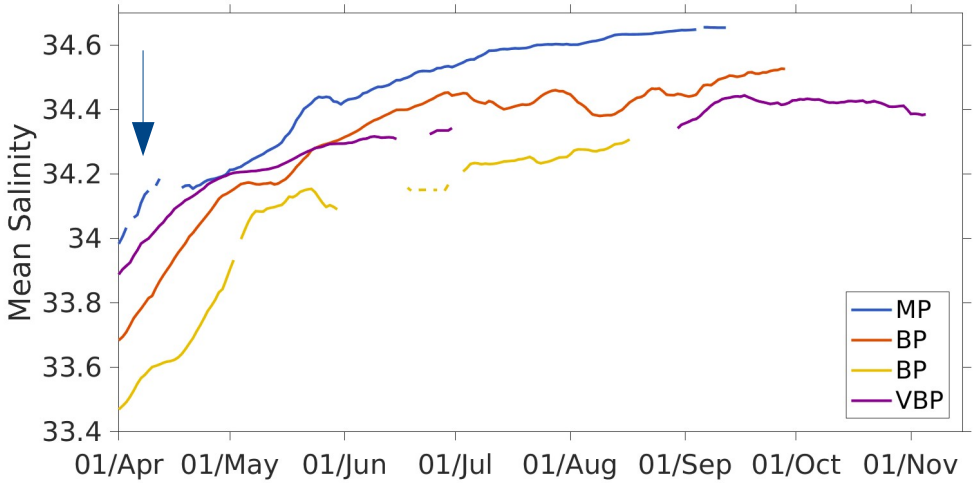
Vincennes Bay (BP)

Results



- Sea-Ice Production (SIP) rates -

- MP has the highest SIP rate



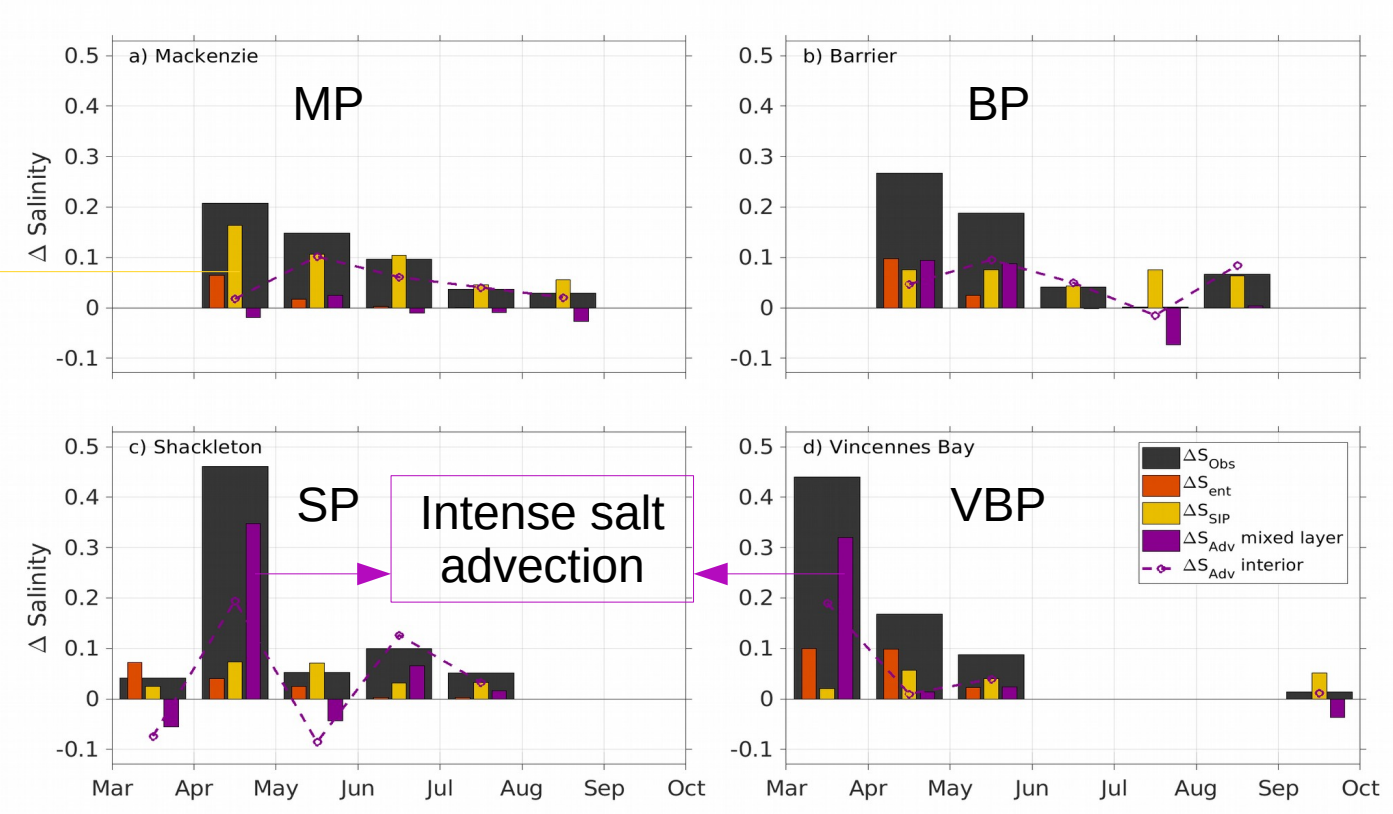
- Mixed layer salinity -

- MP has the highest salinity in early winter

Results

- Salinity Balance -

High SIP dominates salinity increase in MP



Total ΔS over winter

- MP=0.49
- BP= 0.50
- SP= 0.67
- VBP= ----

Despite having the highest SIP rate, **the total ΔS in MP is the smallest of all polynyas**

Key findings

	Mackenzie	Barrier	Shackleton	Vincennes Bay
Year	2013	2012	2011	2012
Period	Mar-Sep	Mar Sep	Feb-Aug	Feb-Nov
Area	3000 km^2	15000 km^2	28000 km^2	14000 km^2
Bathymetry	300-600	300-600	600	> 1000
DSW formation	Yes	Little	No	No
Ice shelf	Yes	Yes	Yes	Yes, small
Continental shelf	Wide	Narrow	Narrow	Narrow
DSW Remnant	Yes	Minor	No	No
Initial Salinity (Interior)	High (34.4)	Medium (34.15)	Low (33.8)	Medium (34.15)
Initial Salinity (ML)	High (34)	Medium (33.7)	Low (33.5)	Medium (33.85)
ISW	Yes, salty	Yes, fresh	No	No
mCDW	Little, early	Little, cold	Little, fresh	Strong, warm, salty
AASW	Little, cold, salty	Yes	Yes, fresh	Yes, fresh
Full convection	July	June	Never	Uncertain (August)
Stratification	Medium	Medium	Weak	Strong
Mean SIP rate (cm day^{-1})	High (5.6)	Medium (2.3)	Medium (2.7)	Medium (2.7)

- The properties and volume of DSW formed in a coastal polynya depend on a combination of (**green**) factors
- **Relatively high salinity in early winter and high sea-ice formation** favored Dense Shelf Water formation in Mackenzie Polynya

Contact

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Thank you !

References

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