

# The active dispersal scenario of juvenile North Pacific loggerhead turtles revealed by historical tracking data and recent operational oceanography products

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- 1) Based on satellite tracking data, can we reliably determine whether juvenile sea turtles are passive drifters or active swimmers ?
- 2) If active, what is their swimming « routine » ?

**Simple questions – long debated – no definitive answers**

**Here we come with clear answers, but only for the NP loggerhead population**

For details see our recent paper in Movement Ecology (open access)

In theory:

$$V_g = V_s + V_d \Rightarrow V_s = V_g - V_d$$

In practice:

Only  $\hat{V}_d$  an (ocean-model-based) estimate of the drift velocity is known, with  $V_d = \hat{V}_d + V'_d$

**THUS** the only estimate of  $V_s$  we have access to is :

$$\hat{V}_s = V_g - \hat{V}_d = V_{DC} = V_s + V'_d$$

To make this « practical » estimate of the swimming velocity vector reliable we have to :

- 1) Obtain the best possible estimate of the drift velocity  $\hat{V}_d$  so as to minimize  $V'_d$
- 2) Quantify  $V'_d$  to allow separation of this estimation noise from the swimming velocity signal

## Improve the drift velocity estimate $\widehat{V}_d$

$$\widehat{V}_d = \widehat{V}_c + \widehat{V}_w + \widehat{V}_{st}$$

Current    windage    Stokes drift

- Forget about the usual approximation  $\widehat{V}_d = \widehat{V}_{co}$ , this is **OK for adults**, **not for juveniles**
- Use a more complete estimate including the effect of the wind and the waves. This became possible only recently as operational oceanography centers made available reliable estimates of  $\widehat{V}_{sto}$

## Characterize $V'_d$

In turtles :

$$V_g - \widehat{V}_d = V_{DC} = V_s + V'_d$$

In drifters,  $V_s = 0 \Rightarrow$

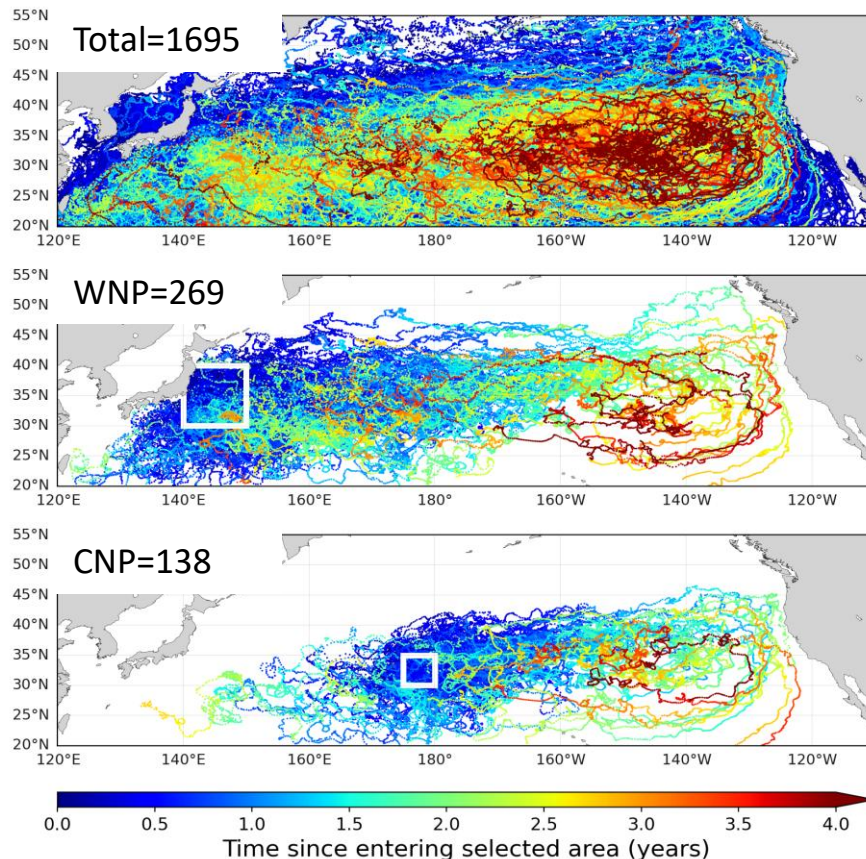
$$V_{DC} = V'_d$$

- In a given area, errors affecting the DC-velocities of surface drifters are not the identical to those affecting the DC-velocities of sea turtles but their statistical distributions shall be similar as these errors are generated by the same inputs (modeled currents & Stokes drift) going through the same estimation model
- Knowing how  $V'_d$  behaves, it becomes possible to separate the swimming signal  $V_s$  from the estimation noise  $V'_d$

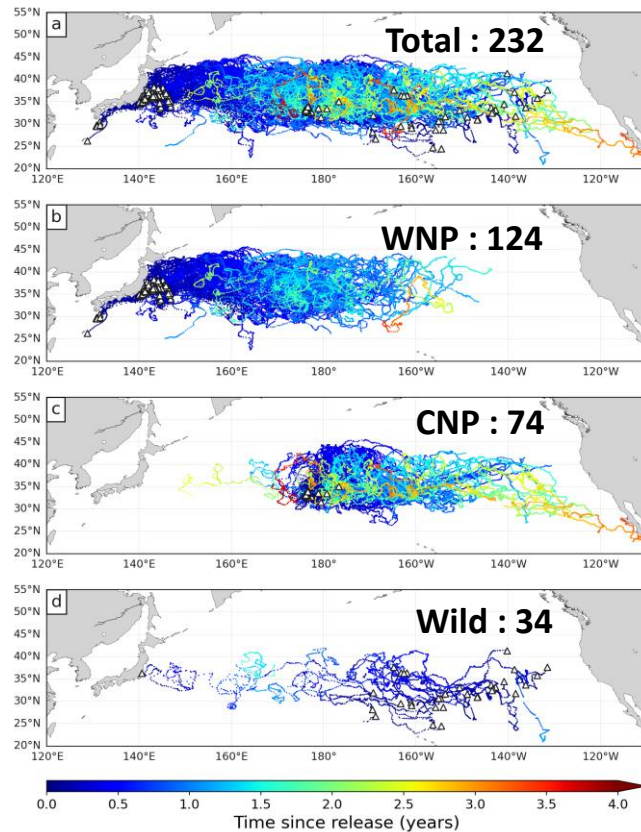
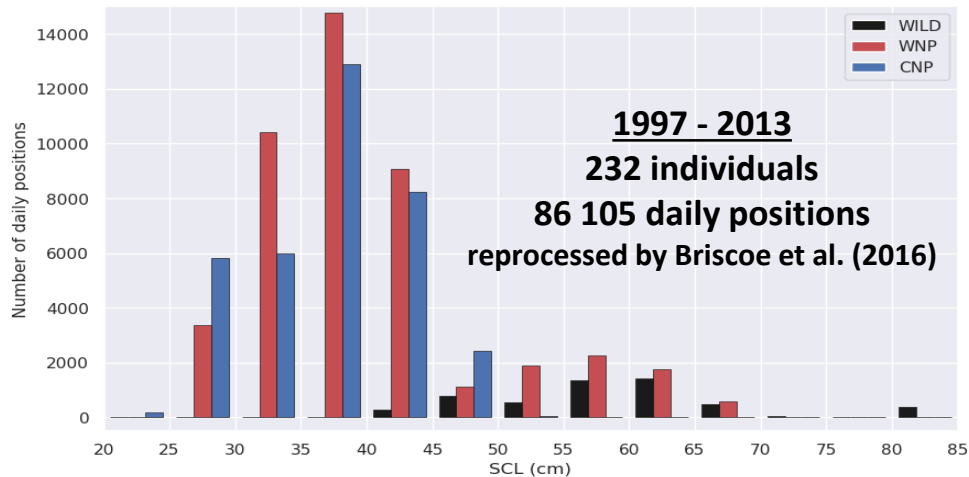
A very large volume of data is available from the Global Drifter Program (GDP).

From 1997 to 2013

- ✓ 1695 surface drifters tracked after having lost their drogue
- ✓ ~500 000 daily positions



# The juvenile NP loggerhead tracking data set (legacy)



# Comparing the DC-trajectories of drifters and turtles

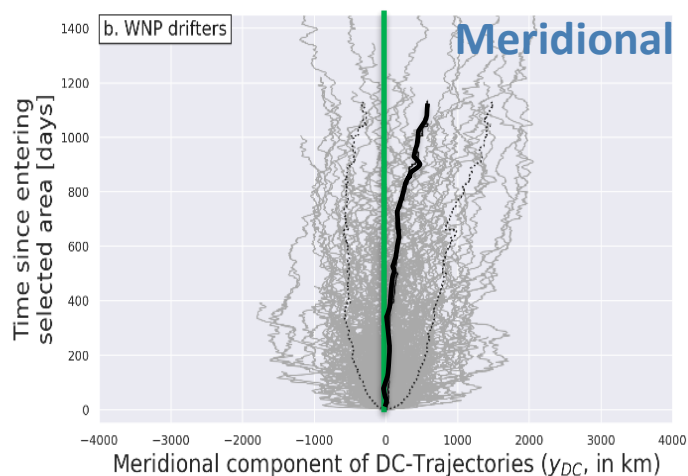
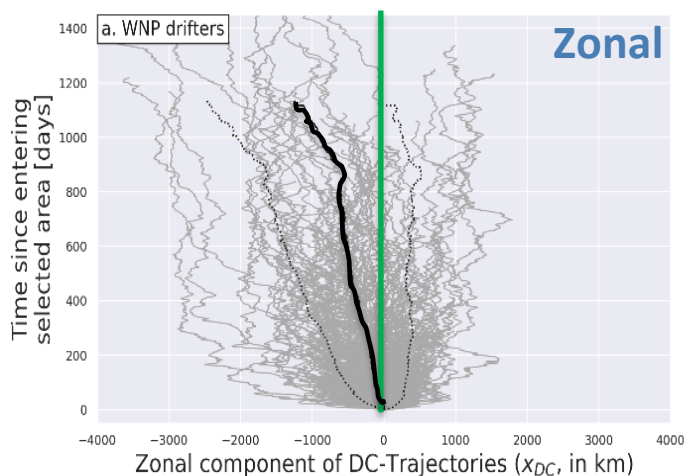
$$\mathbf{X}_{DC}(t) = \int_{t_0}^t \mathbf{V}_{DC} dt = \int_{t_0}^t (\mathbf{V}_s + \mathbf{V}'_d) dt = \int_{t_0}^t \mathbf{V}_s dt + \int_{t_0}^t \mathbf{V}'_d dt$$

Trajectory component generated by the true swimming velocity

Trajectory component generated by the estimation errors

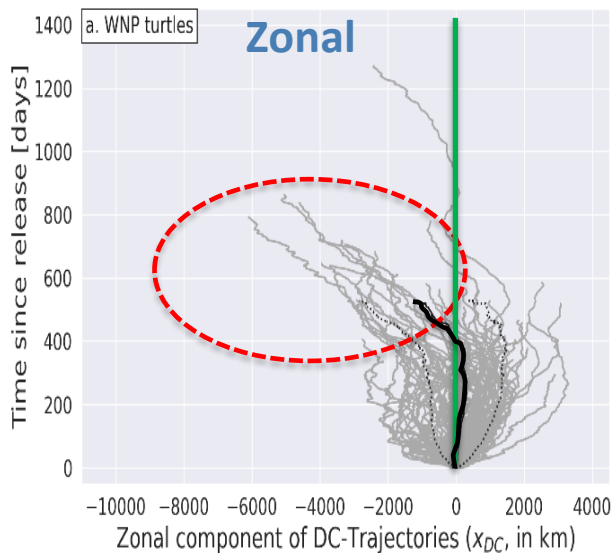
A separate look at the zonal (E-W) and the meridional (N-S) components of the DC-trajectories

DC- trajectories of undrogued drifters in the WNP

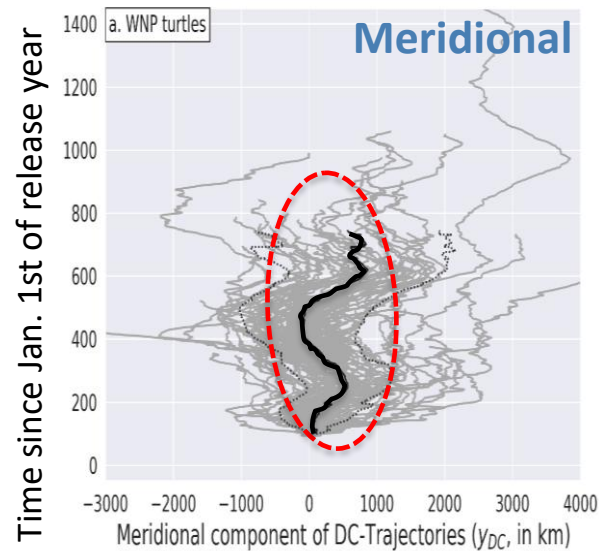


Note : a bias of 1 cm/s in  $\hat{\mathbf{V}}_d$  tilts the DC-trajectory of 315 km/ year

# DC-trajectories of turtles



- Initial zonal DC-trajectories similar to that of drifters (**drifting**)
- Then clear steady westward (**homing**) movements (  $\sim 10$  cm/s) towards the end of several trajectories



- Large synchronized periodic N/S movement (km) with northward movements during spring & summer, southward during fall & winter (**seasonal migrations**)

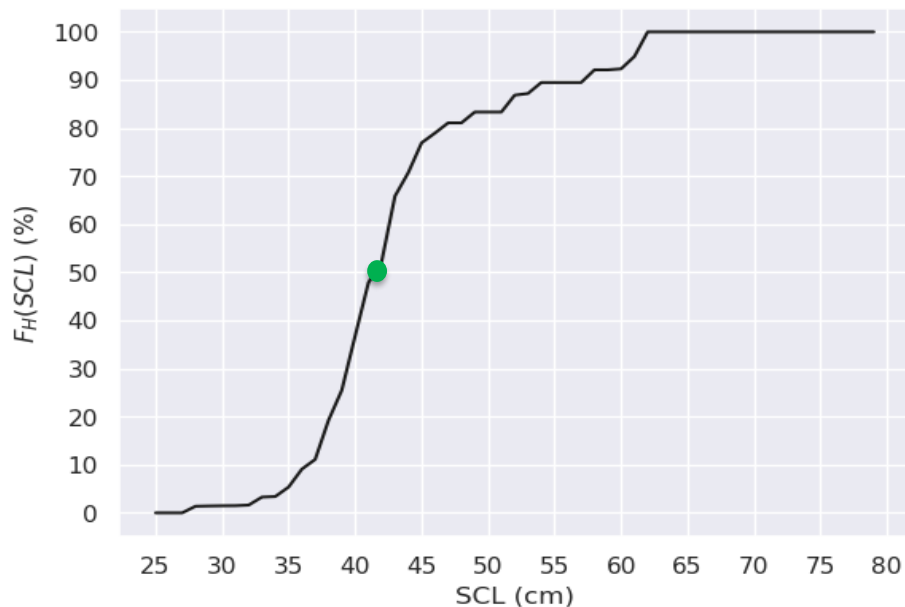
Automatic segmentation of trajectories and classification of segments into Homing (**H**) or Drifting (**D**) segments is performed and shows that :

- **D only** is observed in most trajectories
- **D to H** transition is observed in 30 trajectories
- **H** segments appear at the end of the trajectories and are more frequent among the largest individuals

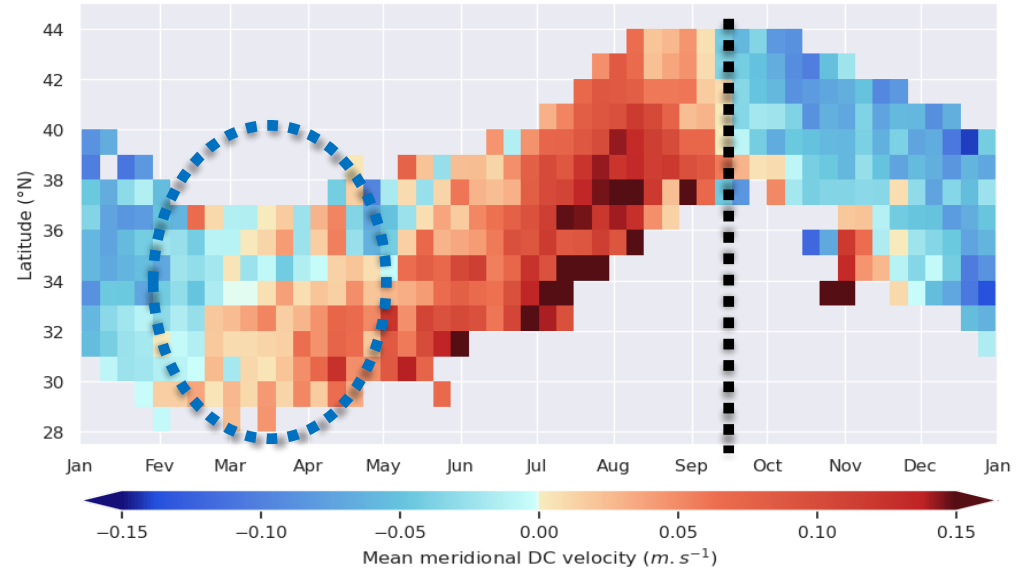
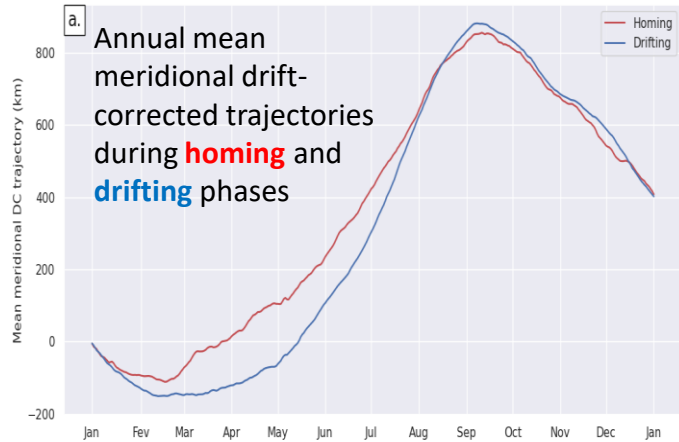
Using these results it is possible to estimate the probability that individuals initiate homing before a given size .

For example :

- $p(\text{homing occurs before SCL}=42 \text{ cm})= 0.5$

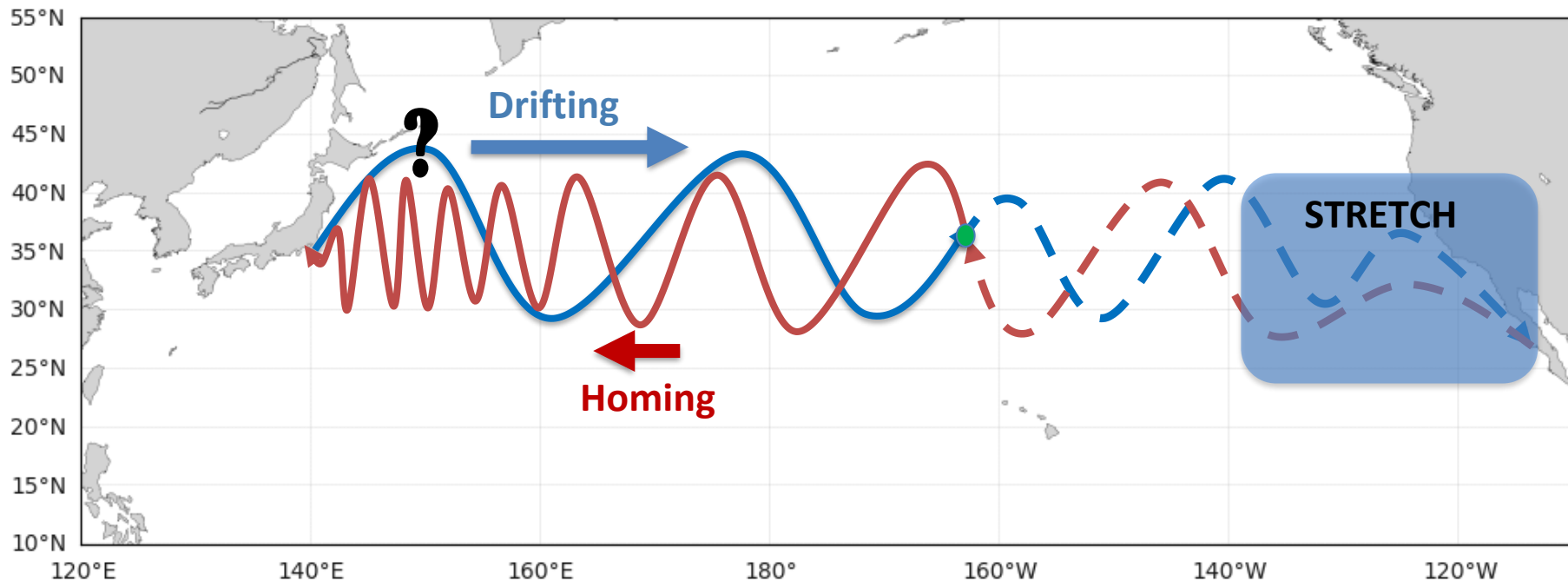


- Seasonal migrations are always present (min/mean migration distance = 260/880 km)
- The amplitude & phasing of these migrations is similar during the drifting and homing phases



- Strong interindividual synchronicity of the swimming direction reversal (N → S) near the fall equinox, at all latitudes
- Likely cue for this reversal : day length (more than SST)
- Reversal much less clearcut around the spring equinox

# Drifting then Homing Seasonal Migrations (DHSM)





Thank you