Effects of specular point inaccuracies on ocean DDM shape

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Overview

- Motivation
- Dataset & methodology
- Results
- Preliminary conclusions

Motivation

- Δf_{SP} are correlated with DDM distortions in TDS-1 [1]
- Is that true also for CYGNSS?
- What is the rationale of such shape asymmetries?
- What is their impact on DDM observables? (See my poster)
- And on wind speed retrievals? (Future work)

[1] G. Grieco, et al., "Quality control of delay-doppler maps for stareprocessing. IEEE Transactions on Geoscience and Remote Sensing,57(5):2990–3000, 2019"

CYGNSS-SCAT dataset

- Period: 1^{st} April 2017 - 30^{th} June 2017
- Collocation with ASCAT-A/B and OSCAT
- Collocation criteria: $\Delta t \leq 20$ min, $\Delta x \leq 25$ km
- QC [1]; QC^{CY}; QC^{SCAT}; $\theta \leq 40^o$
- N≈5e6 (20%)

CYGNSS raw IF

- two 60 sec tracks of raw CYGNSS data:
  - Harvey (25 August 2017) $|\Delta f_{SP}| \approx 150$ Hz
  - Irma (8 September 2017) $|\Delta f_{SP}| \approx 15$ Hz
- $\Delta f_{SP} = \hat{f}_{SP} - f_{SP}$
- $\hat{f}_{SP}$ estimated onboard (Quasi-Spherical approximation)
- f_{SP} estimated a-posteriori (geoid)

What am I talking about?

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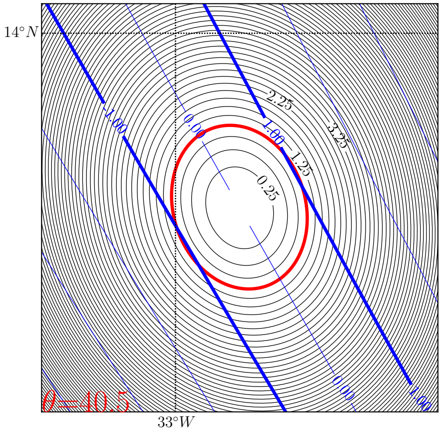

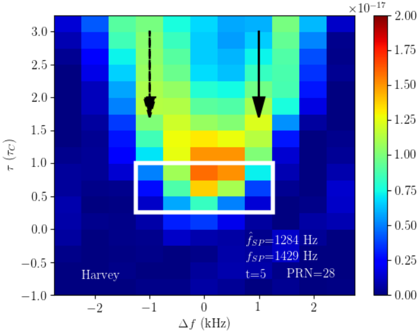

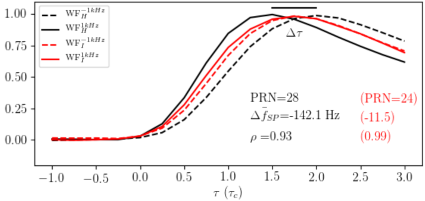

Implication for wind speed retrievals

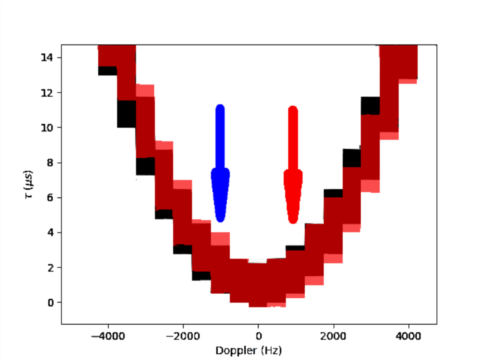

Figure 1: Red: free or ambiguity line (horse-shoe). Black: position of HS effective area bins

- Mis-aligment between HS and effective area $\Rightarrow$ mis-calibration of HS
- Multi-look approaches can be affected by such distortions [2]

[2] J. Tye, P. Jales, M. Unwin, and C. Underwood.The first application of stare processing to retrievemean square slope using the sgr-resi gnss-rexperiment on tds-1.

Synoptic view of distortions

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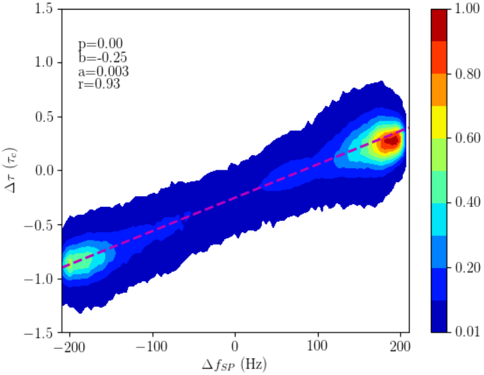

Figure 2: TDS-1 [1]

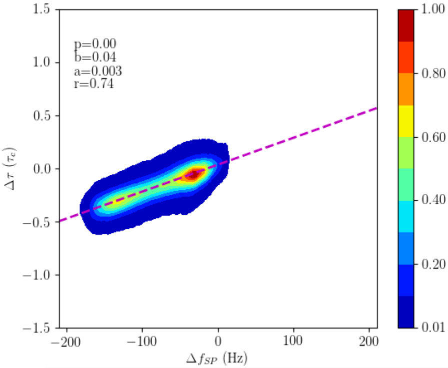

Figure 3: CYGNSS

Geographycal distribution of Δf_{SP}

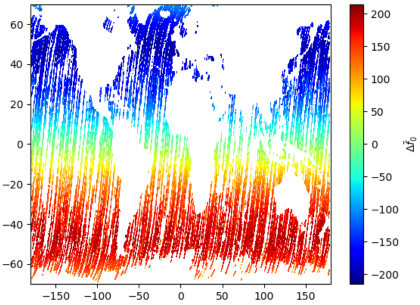

Figure 4: TDS-1

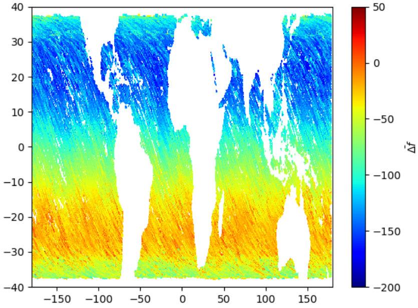

Figure 5: CYGNSS

Geographycal distribution of $\Delta\tau$

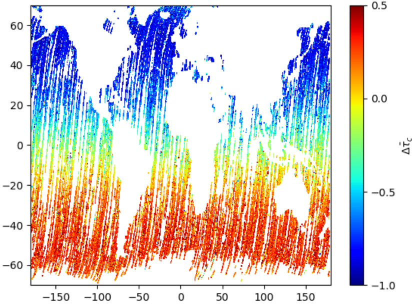

Figure 6: TDS-1

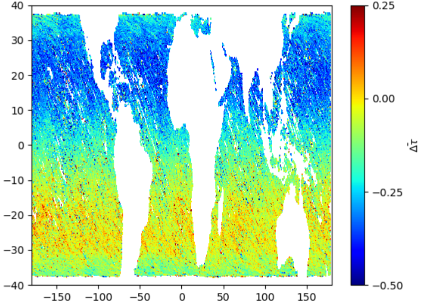

Figure 7: CYGNSS

Trend with time

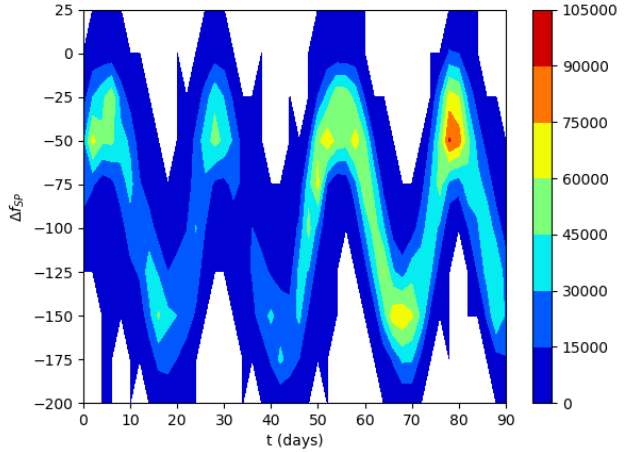

Figure 8: CYGNSS

Discussion

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- corr(Δf_{SP},$\Delta\tau$) is high
- Geo distributions of Δf_{SP} and $\Delta\tau$ are consistent
- TDS-1 and CYGNSS have similar features (SGR-ReSI in common)
- Orbital characteristics (altitude, inclination) seem to modulate the distortions
- Δf_{SP} seems to be highly predictable (correctable?)

Rationale of the distortions: demonstration

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$Y(\tau, \Delta f) = \int_0^T s(t' + \tau) a(t') \exp[-i2\pi(f_{IF} + f_{SP} + \Delta f)t'] dt'$
[3]

- Re-compression of raw IF echo:
    - by means of a raw IF processor (by Scott Gleason)
    - $\Delta f_{SP} \in [-250, 250]$ Hz
    - evaluation of relative shift of WFs @ ± 1 kHz

Harvey's track

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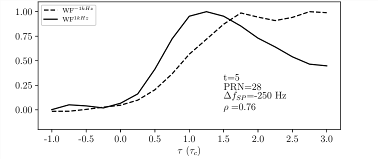

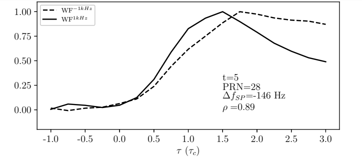

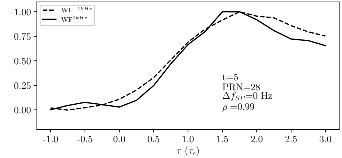

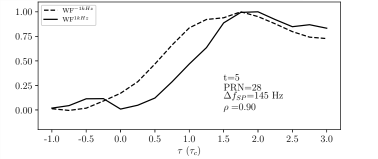

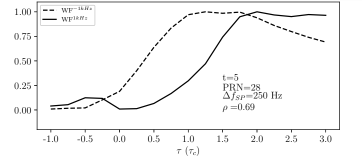

Invariance of correlation integral with Δf

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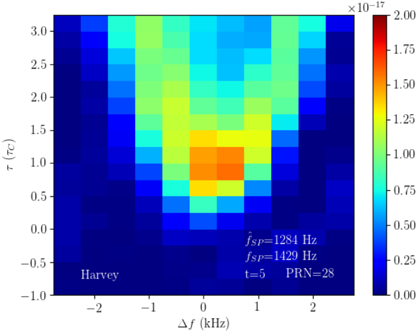

Figure 9: $\Delta f_{SP} = -250$ Hz

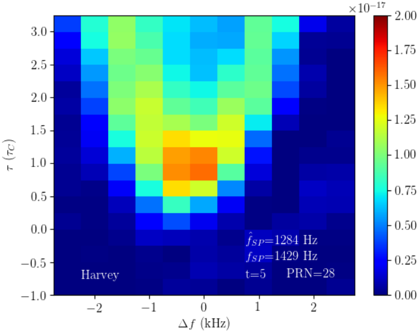

Figure 10: $\Delta f_{SP} = 250$ Hz

Discussion

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- The higher $|\Delta f_{SP}|$ the higher $\Delta\tau$ (demonstrated)
- The invariance of correlation integral happens for $\Delta f_{SP} = \Delta f$

How can we get rid of distortions? f_{SP} forecast

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- Δf_{SP} seems to be predictable
- Uploading of f_{SP}. Is it feasible?

...or oversampling

- $\Delta f = \frac{\delta f}{n}$, $n \in \mathbb{N}$
- If $n = 10$, $\Delta f = 50$ Hz $\Rightarrow |\Delta f_{SP}|_{MAX} = 25$ Hz
- Data burden to download increases by n times

Oversampling

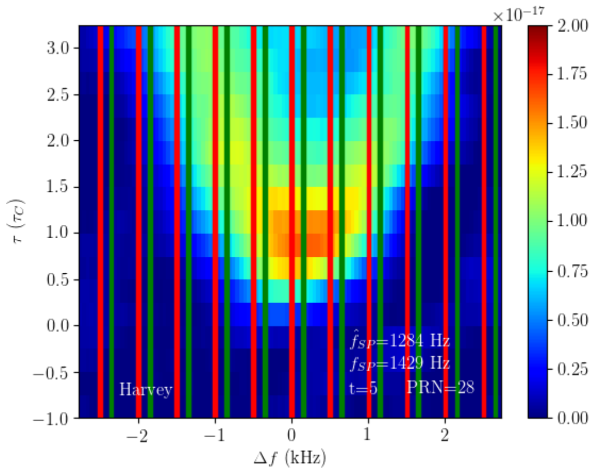

Figure 11: $\Delta f = 50$ Hz. Red: Regular; Green: optimal choice

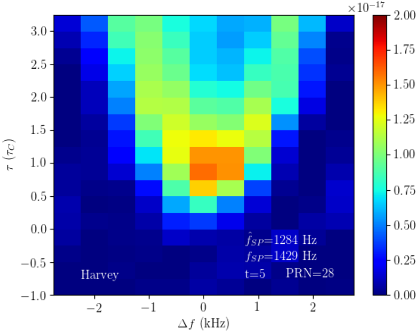

Figure 12: Regular

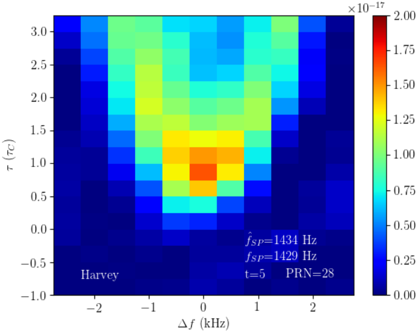

Figure 13: Optimal choice

Conclusions

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- CYGNSS and TDS-1 suffer from same kind of distortions
- Rationale of distortions is demonstrated
- How do such distortions impact DDM observables? (look at my poster)
- How do they impact wind speed retrievals (routine and multi-look)? (future work)
- Risk of modulation of geophysical signals (future work)

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