On the retrieval of total surface current using dual-polarized along-track interferometry

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General context

- Scientific need to directly measure (Total) Surface Currents (TSC).
- ATI/Doppler measurements directly sensitive, but

$$v_{\mathrm{Doppler}} = v_{\mathrm{Wave-Bias}} + v_{\mathrm{TSC}}$$

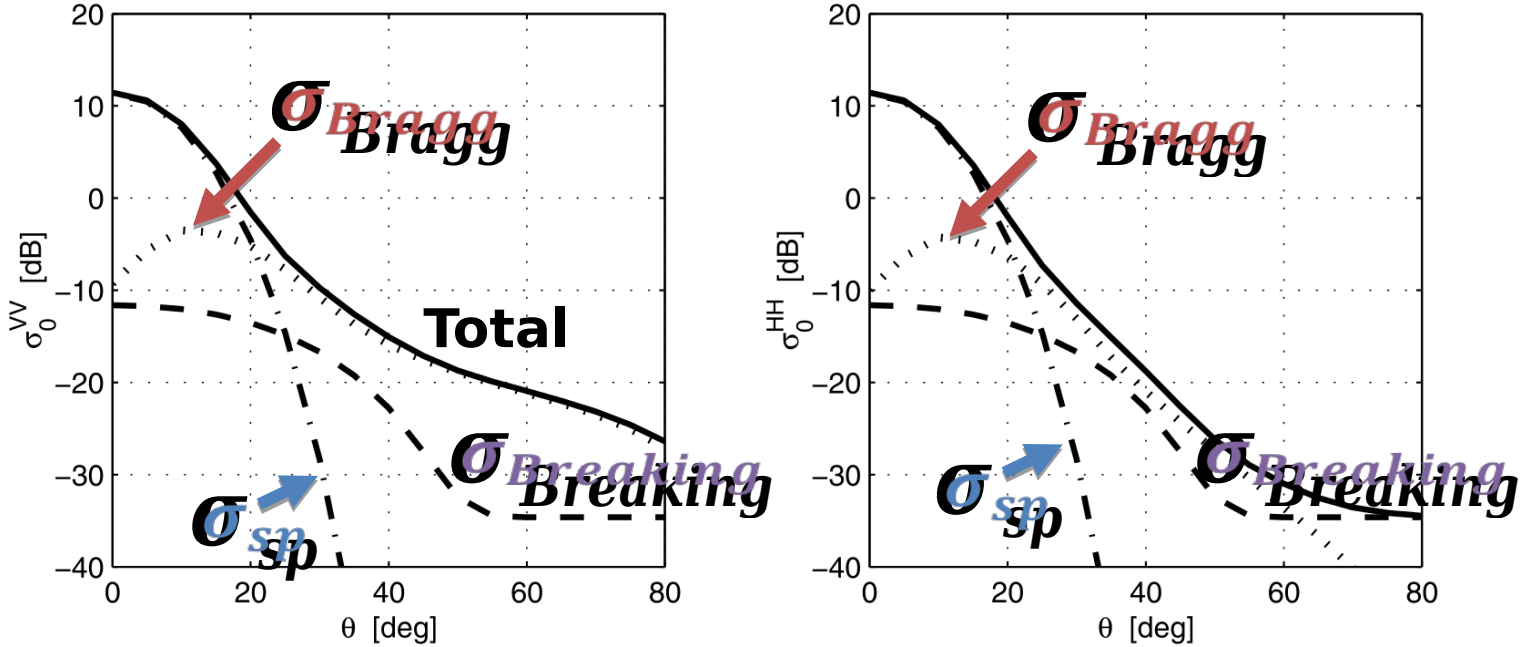
- Strategies to remove wave-bias:
  - Don't even try, this just doesn't work
  - Estimate surface wind from σ_0, use models to predict bias
  - Estimate wave-spectrum from image, use it to predict bias
  - Or:::

Dual-Polarized data can be the key to eliminate the wave-bias from ATI or DCA Doppler velocity measurements

A bit of theoretical background

$$\sigma_{0,PP} = \sigma_{Bragg,PP} + \sigma_{sp} + \sigma_{Breaking}$$

Non-polarized σ_s



Kudryavtsev et al., 2005

A bit of theoretical background

- $$\sigma_{0,PP} = \sigma_{Bragg,PP} + \sigma_s$$

For Doppler velocity:

$$v_{D,PP} = \frac{\sigma_{Bragg,PP} \cdot v_{Bragg,PP} + \sigma_s \cdot v_s}{\sigma_{Bragg,PP} + \sigma_s} + v_{D,TSC}$$

Things to play with:

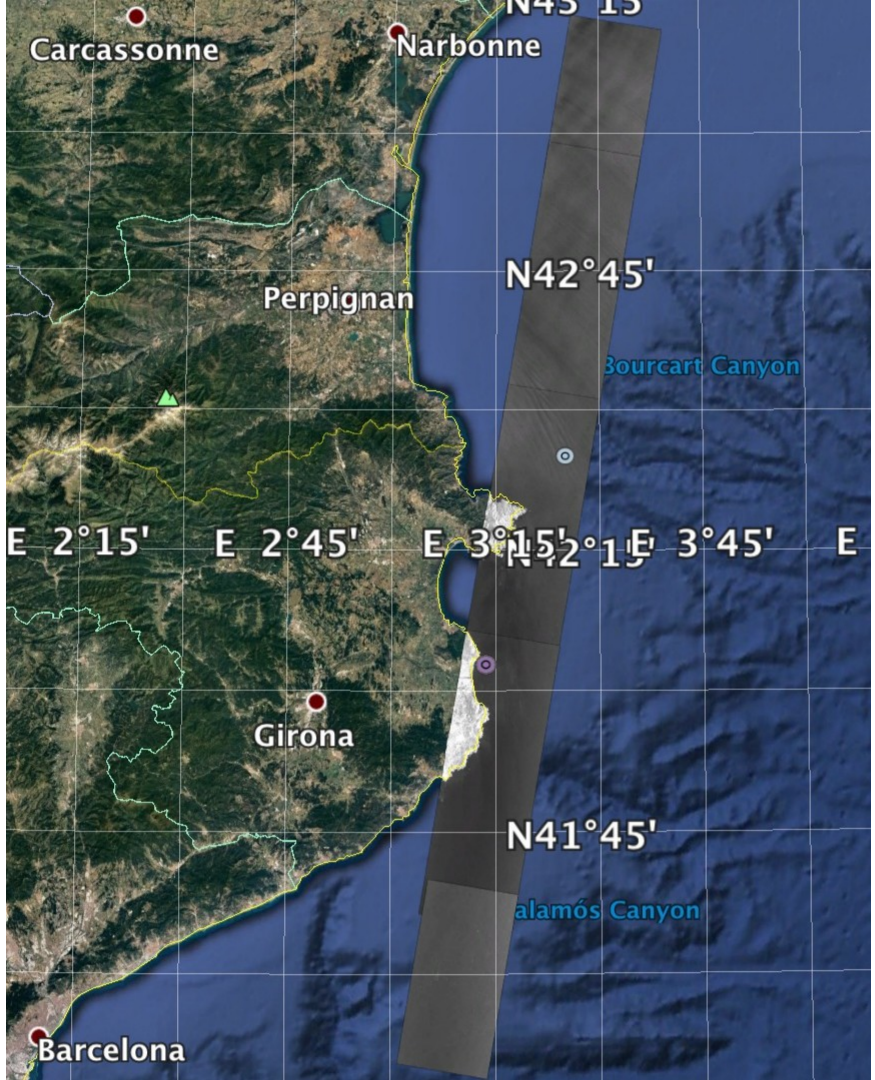
- Polarization ratio
- $v_{D,HH} - v_{D,VV}$

DATA

Data

- Dual-pol (VV, HH) TanDEM-X data
- During ocean-ATI mission phase
- Very small cross-track baselines.
- Near optimal ATI baseline ($\sim 2000\lambda$)

Date	Mean τ_{ATI} [ms]	Incident angle [deg]
2014/08/30	4.6	41
2014/09/04	2.6	26
2014/09/10	3.9	41
2014/09/15	3.3	26



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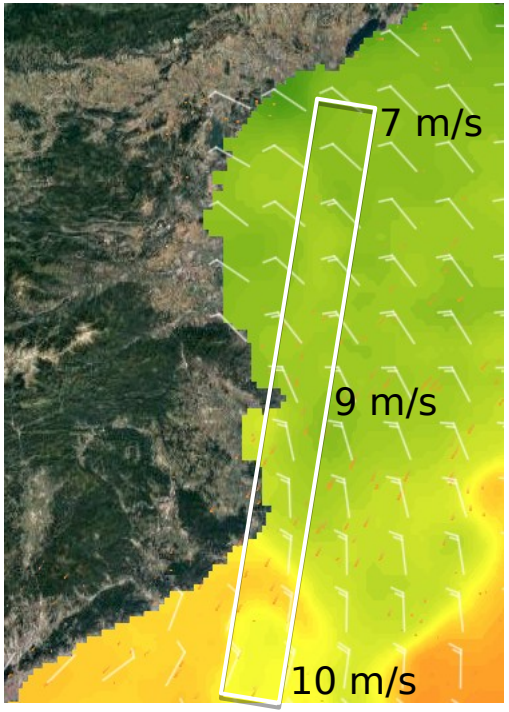
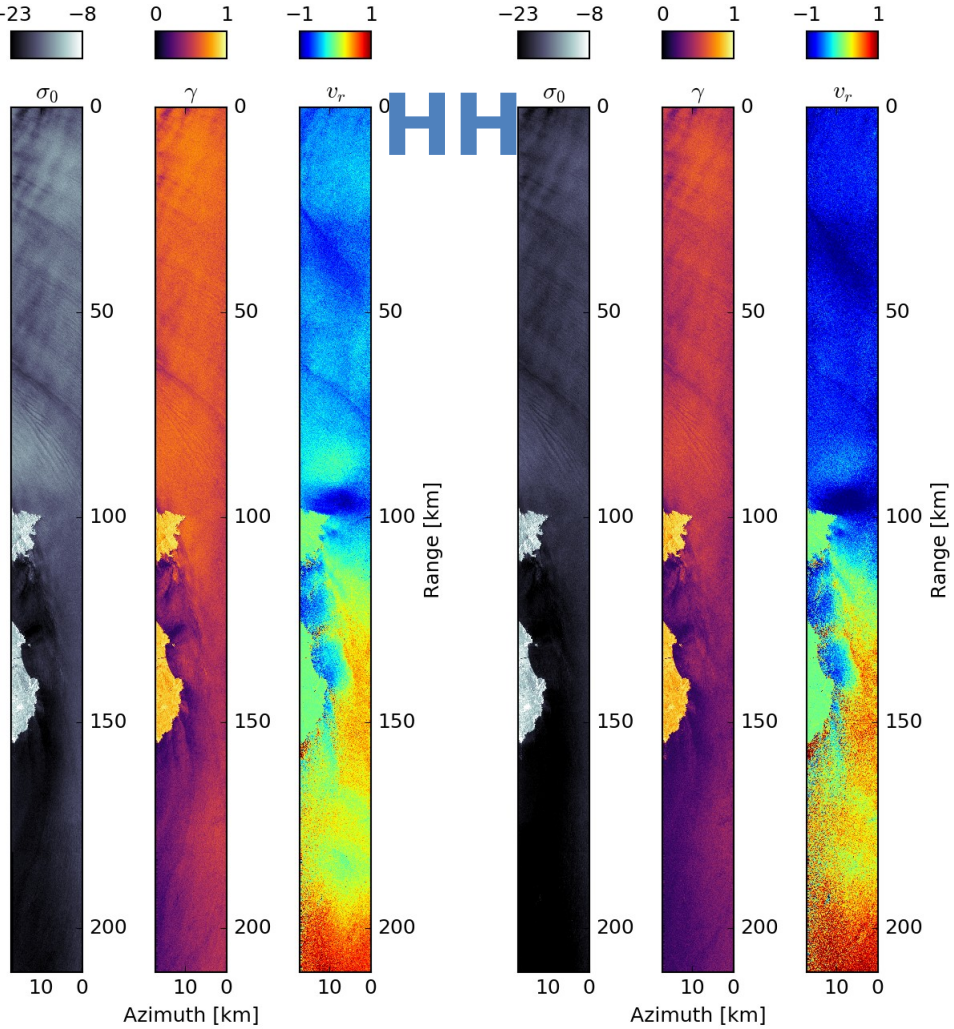


30th August

$\theta_i = 41°$

VV

HH



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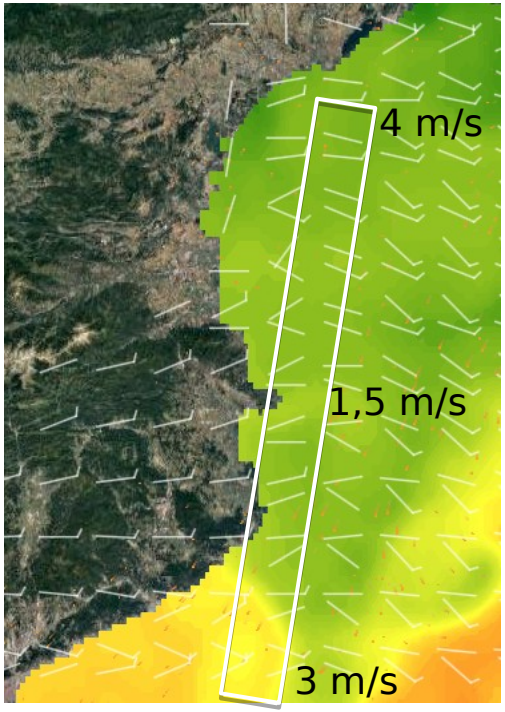
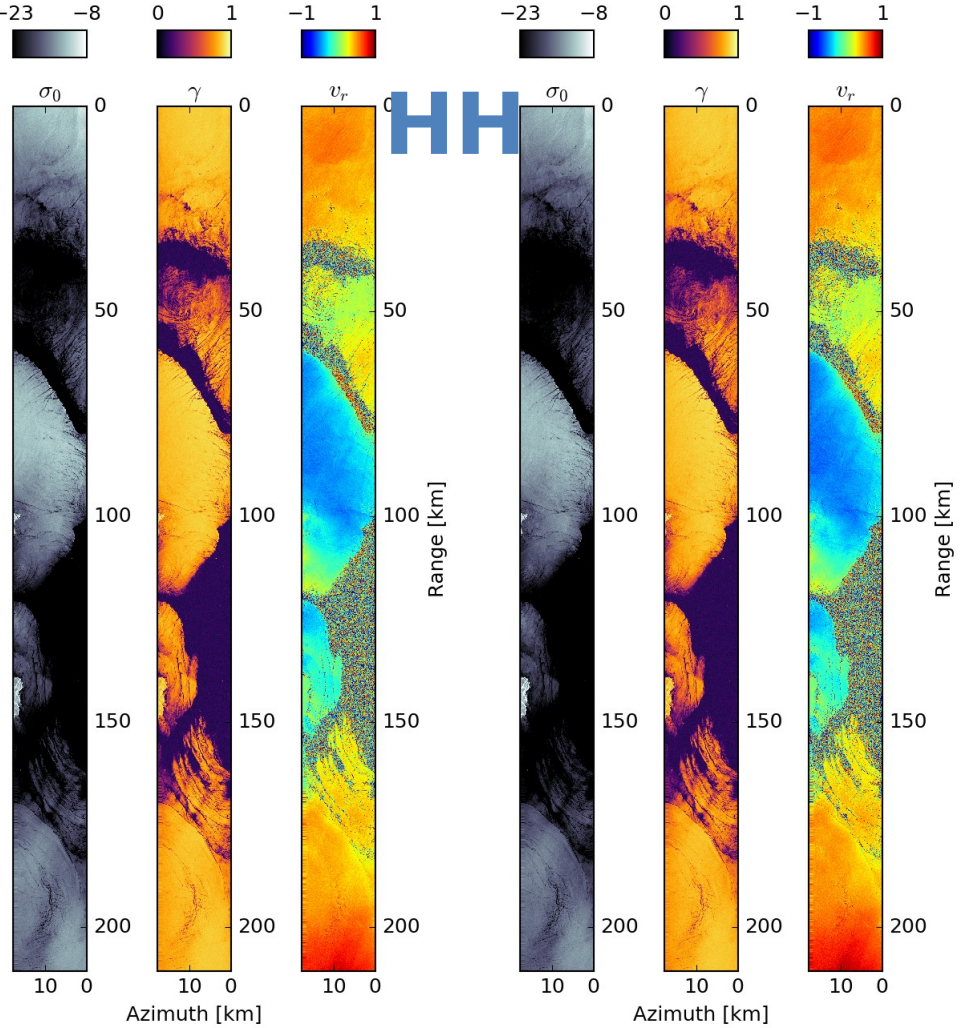
4th September

$\theta_i = 26°$



VV

HH



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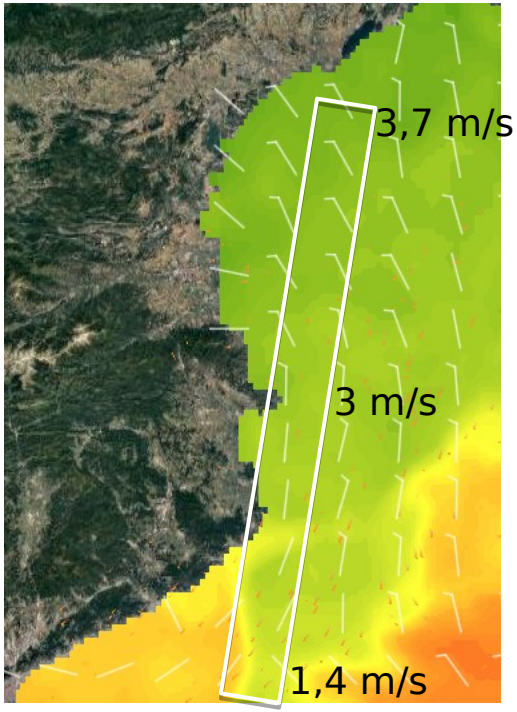
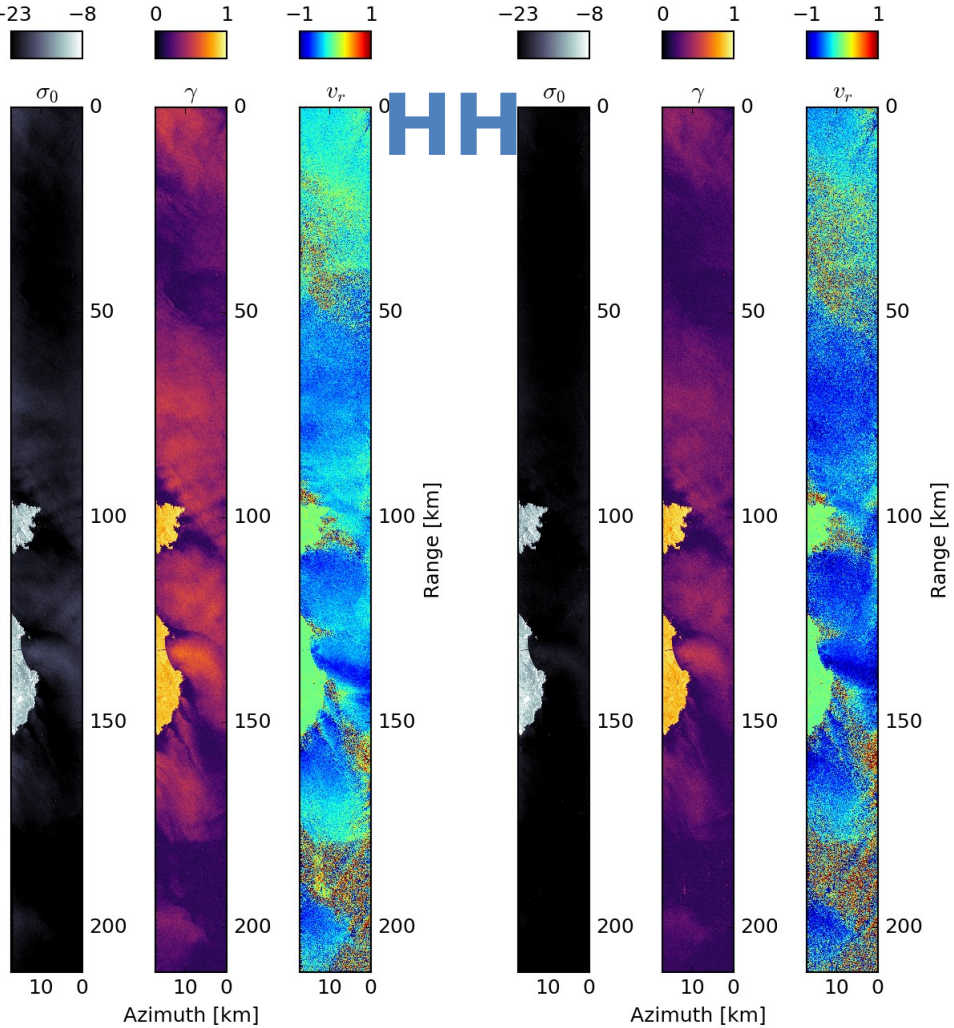
10th September

$\theta_i = 41°$



VV

HH



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15th September

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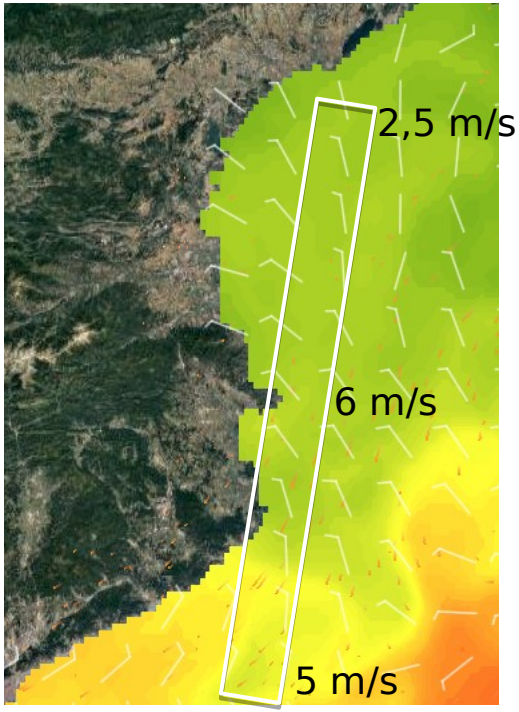
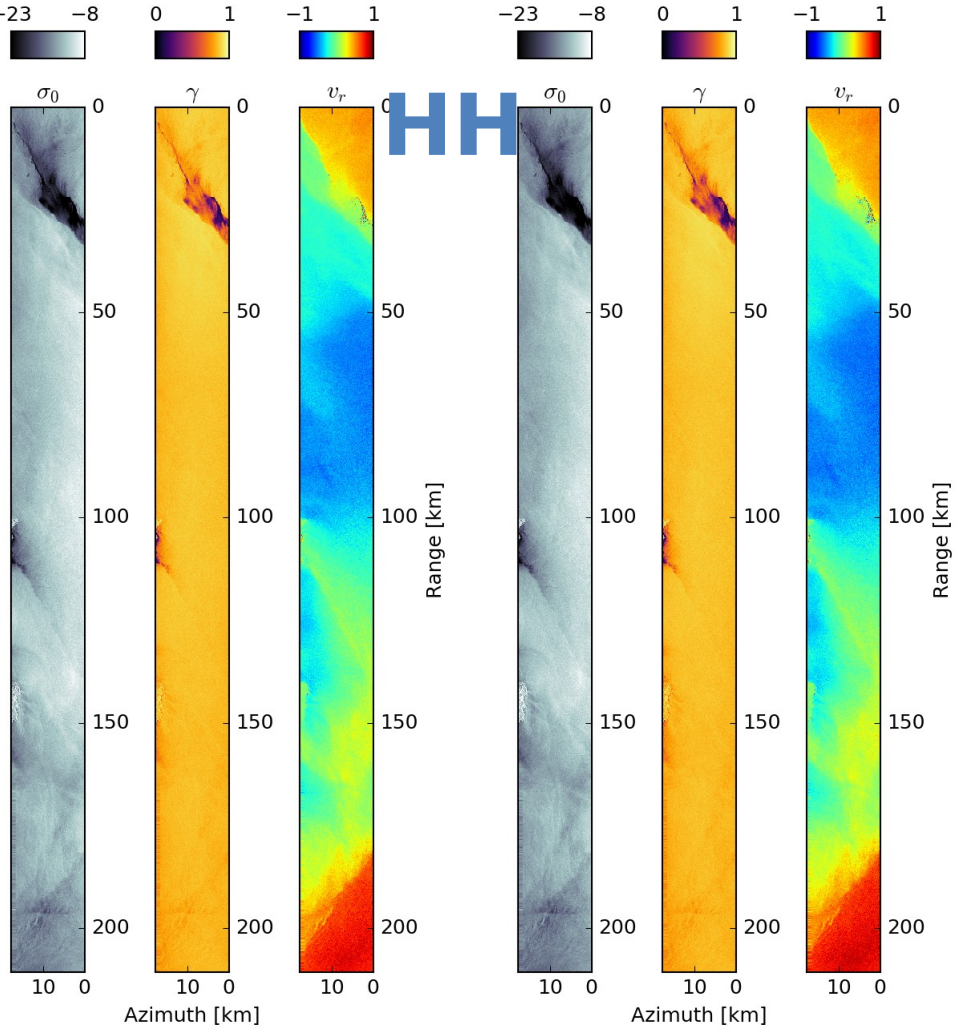


VV

HH



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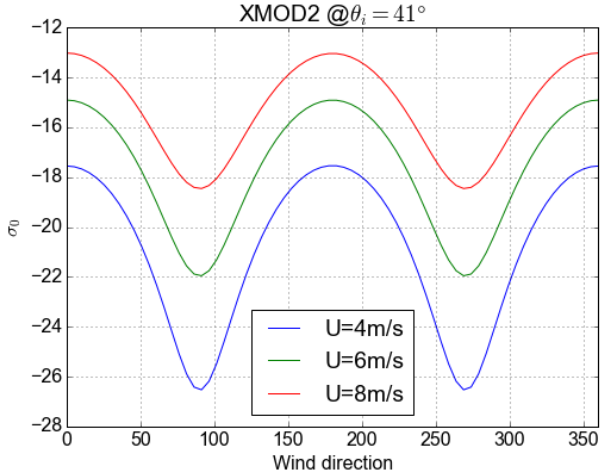
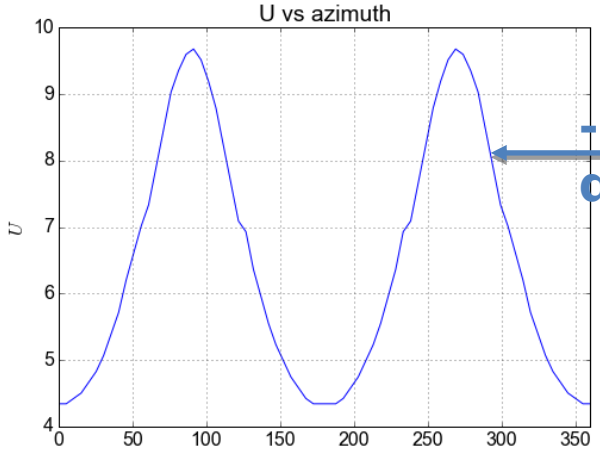
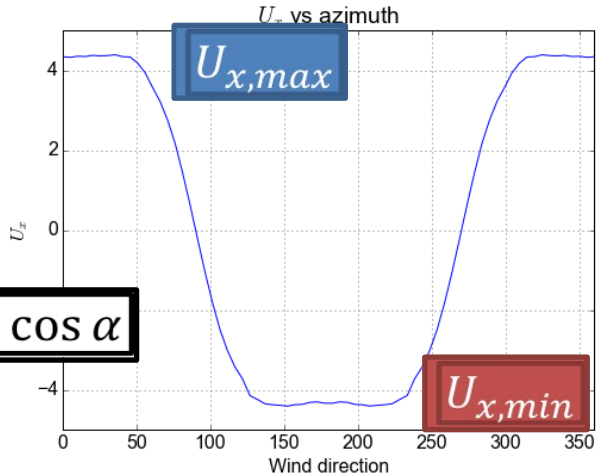
Doppler (radial) velocities

30th August - $\theta_i = 41°$

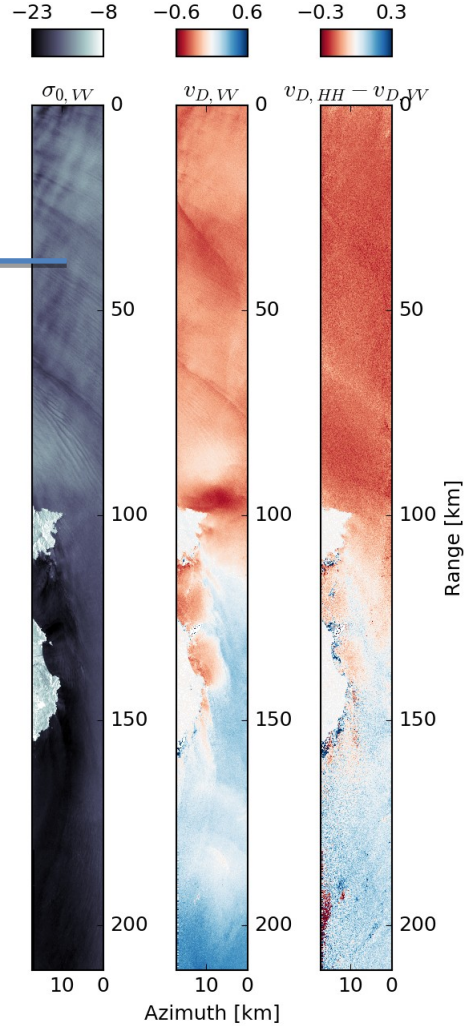






-17 dB

$$U_x = U \cdot \cos\alpha$$



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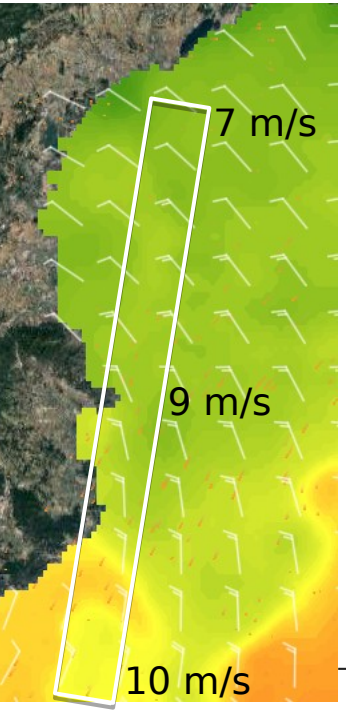
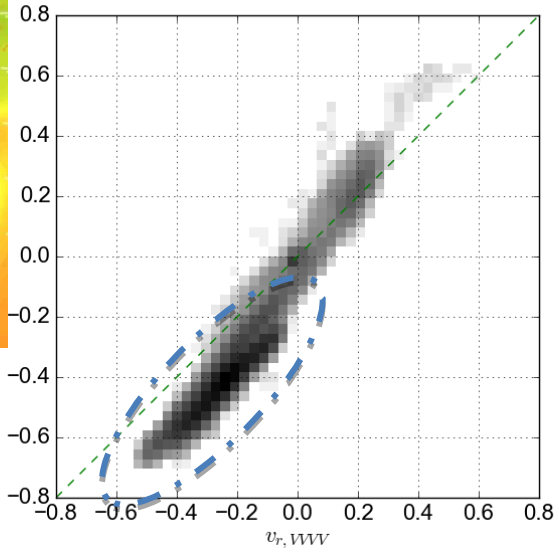
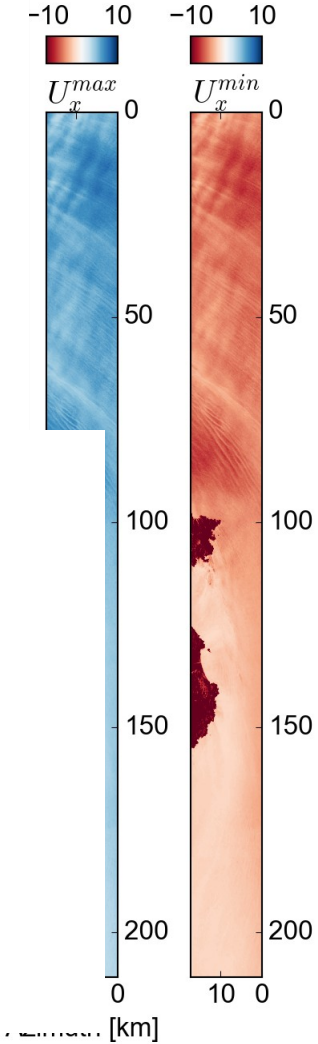
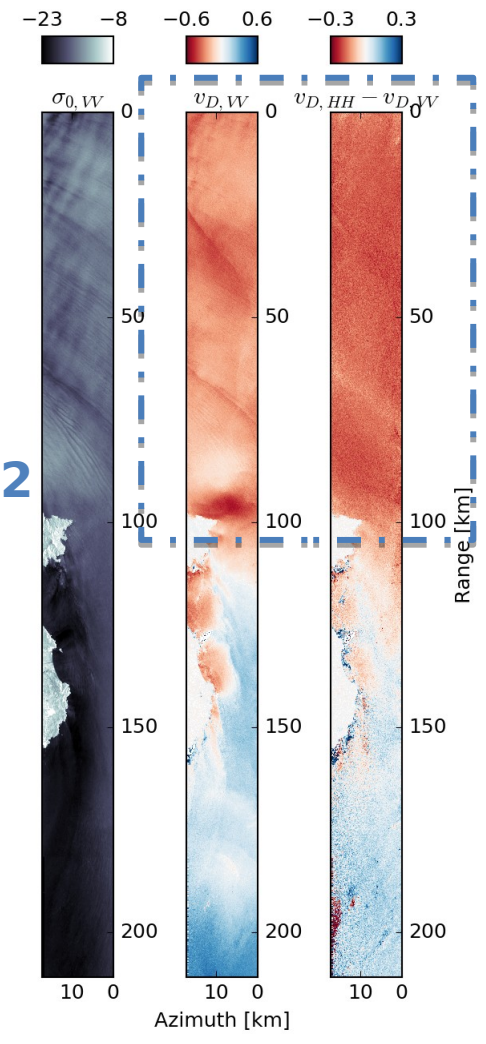


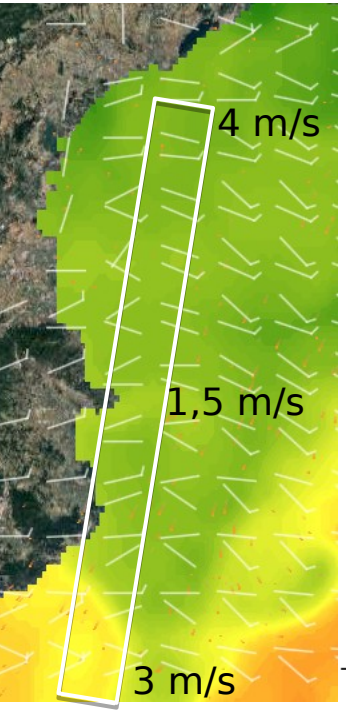


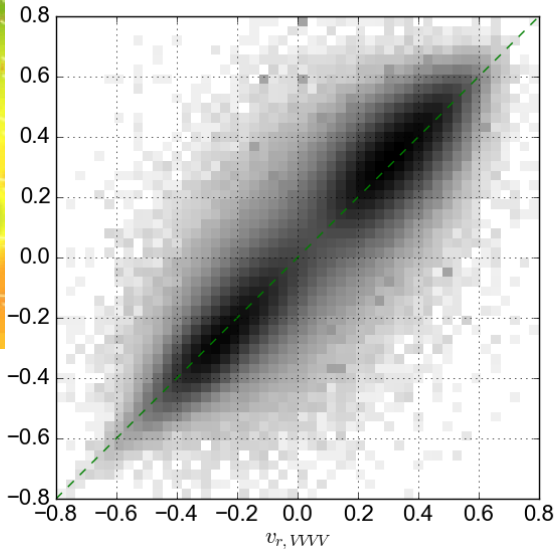
XMOD2

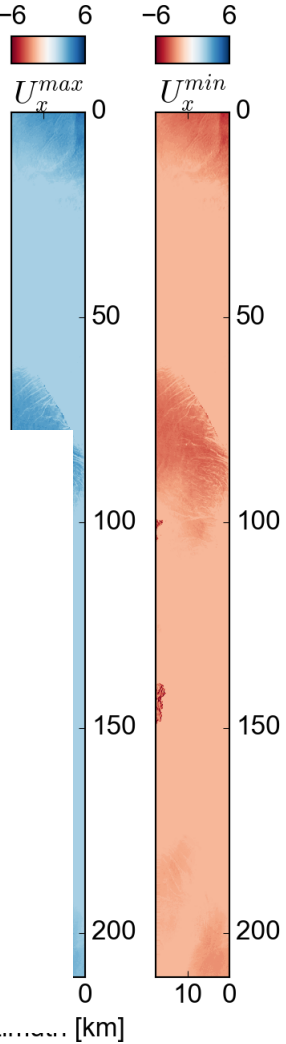




4th September -- $\theta_i = 26°$







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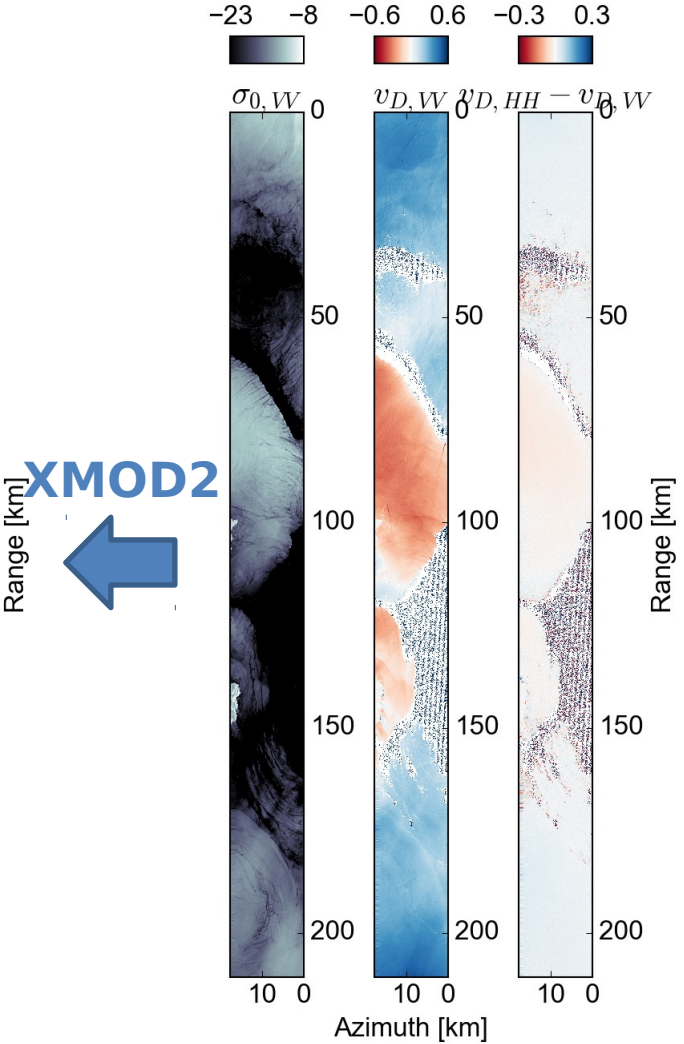

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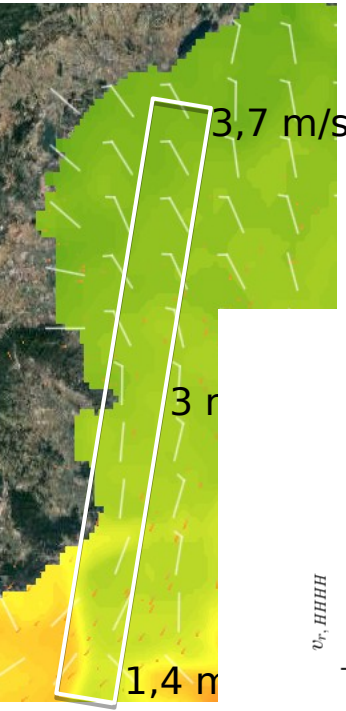
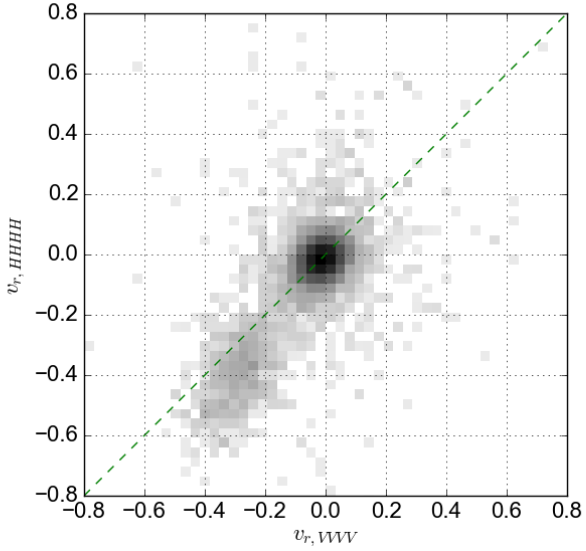
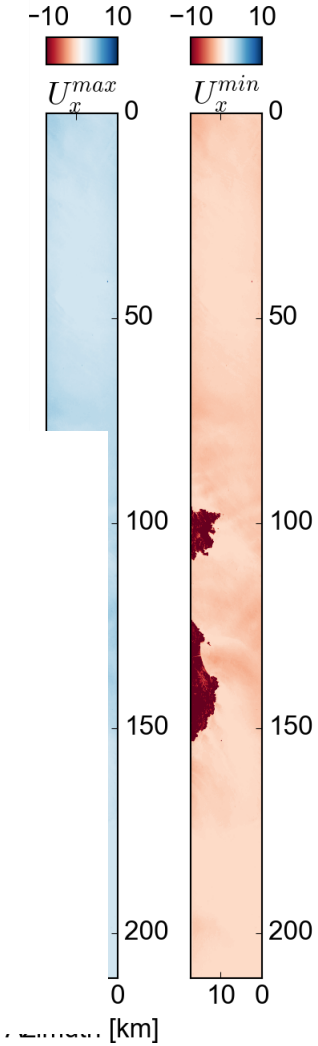
10th September -- $\theta_i = 41°$







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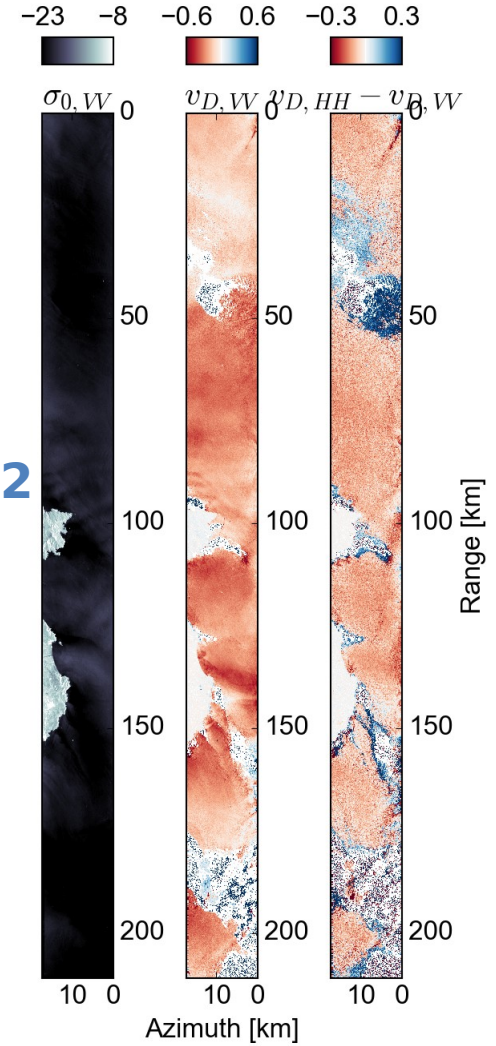
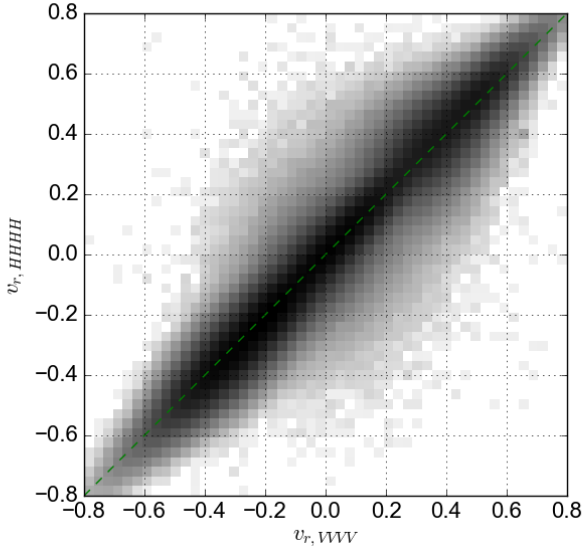
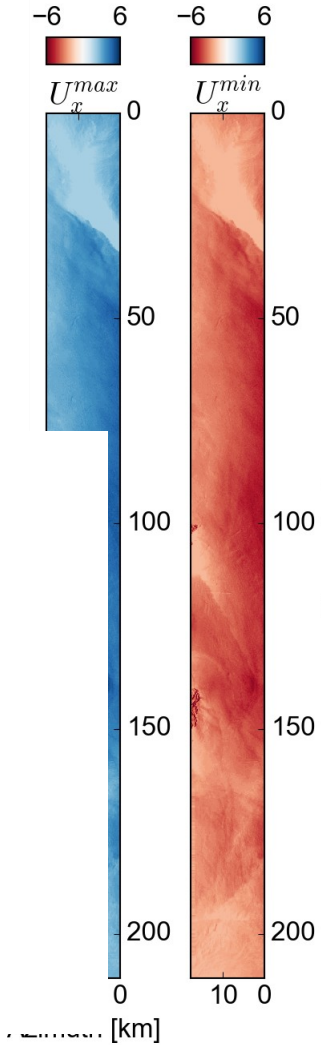


15th September -- $\theta_i = 26°$





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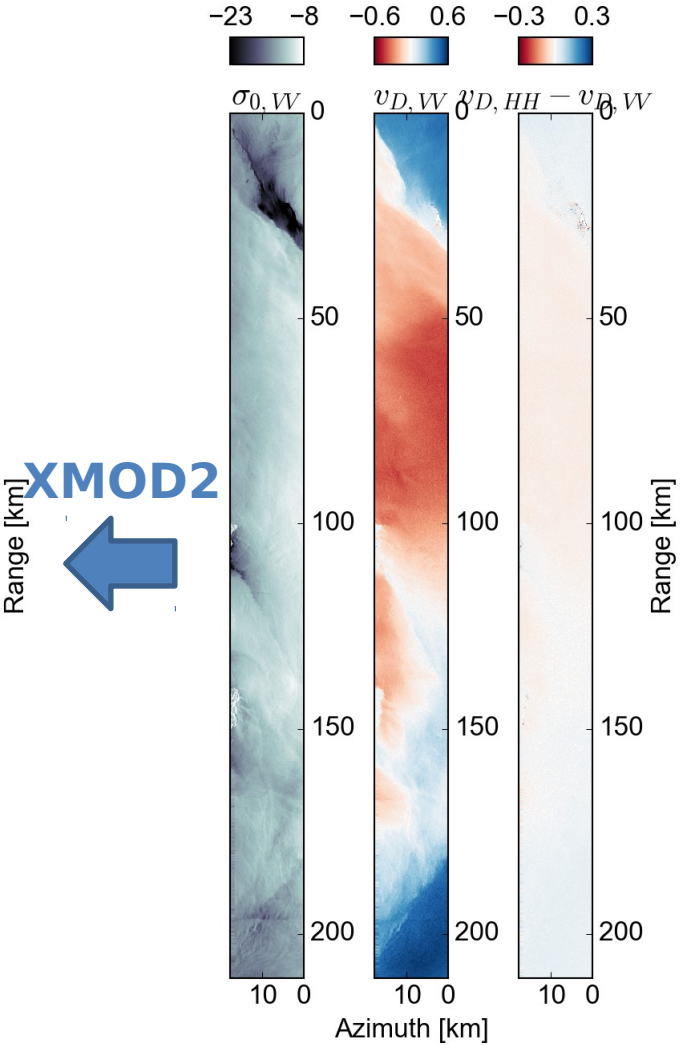

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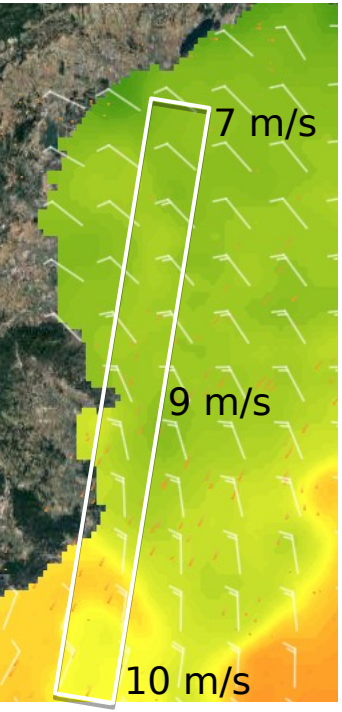
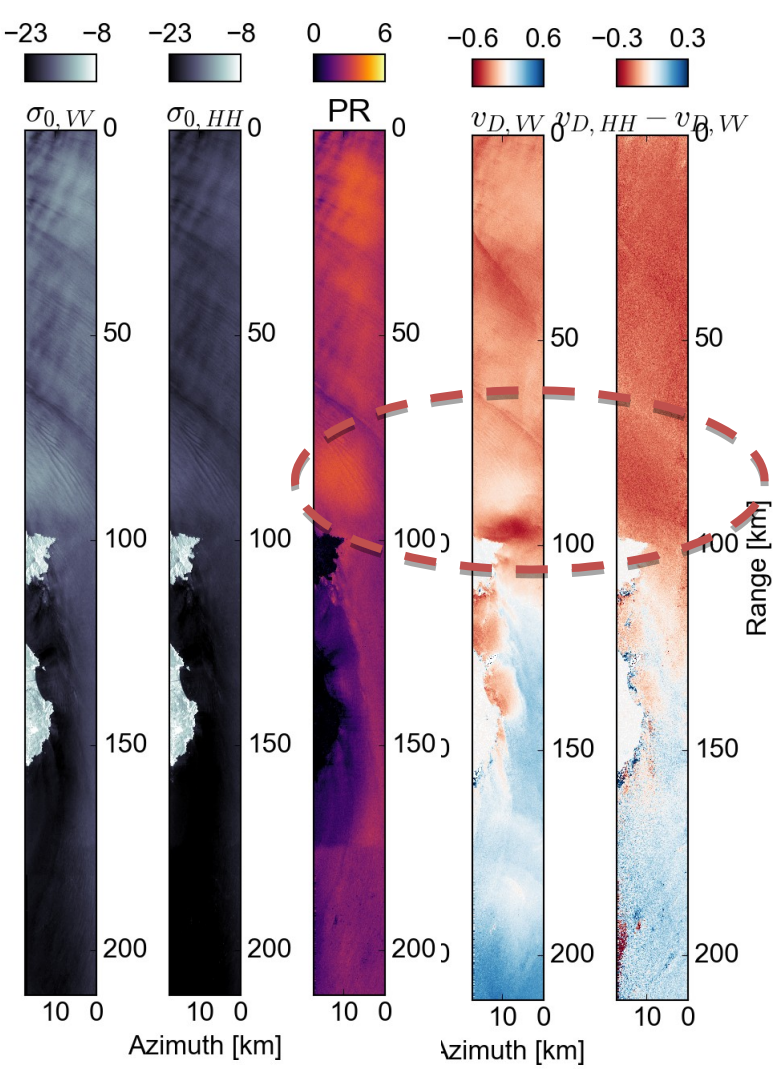
30th August - $\theta_i = 41°$





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TSC retrieval

Assumption:

$$\sigma_{0,\mathrm{HH}} \approx \sigma_s$$

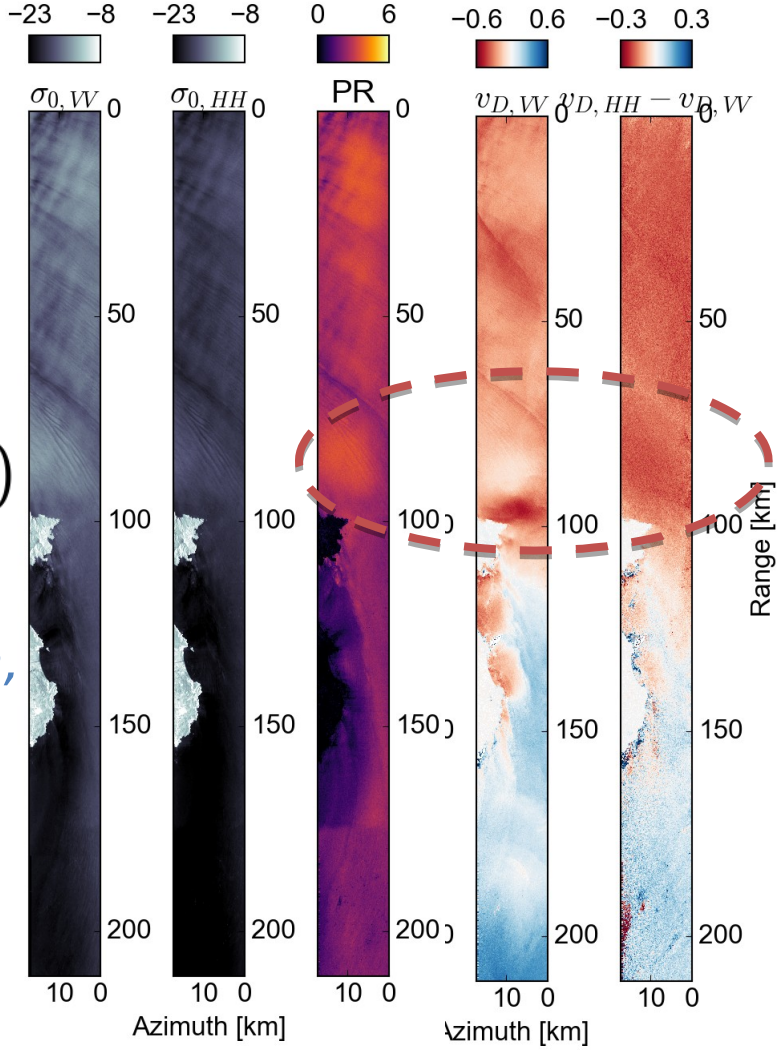
Resulting model:

$$v_{\mathrm{wb,HH}} = \frac{\mathrm{PR}}{\mathrm{PR}-1} \cdot \frac{K_s}{K_s - 1} \left(v_{\mathrm{D,HH}} - v_{\mathrm{D,VV}}\right)$$

Estimated from data, 1.12 (r=0.78)

Retrieval (TSC component):

$$v_{\mathrm{TSC}} = \frac{v_{D,HH} - \hat{v}_{wb,HH}}{\sin\theta_{inc}}$$



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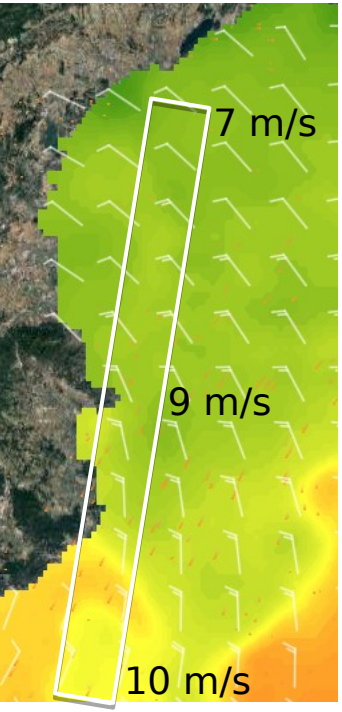

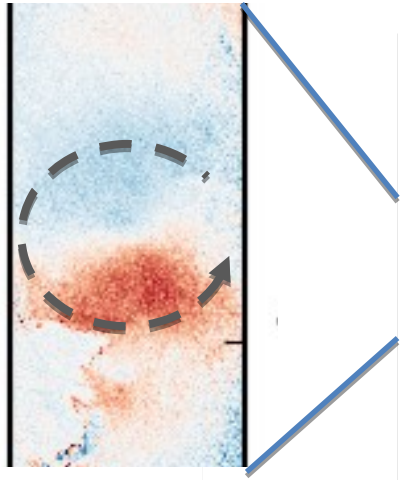

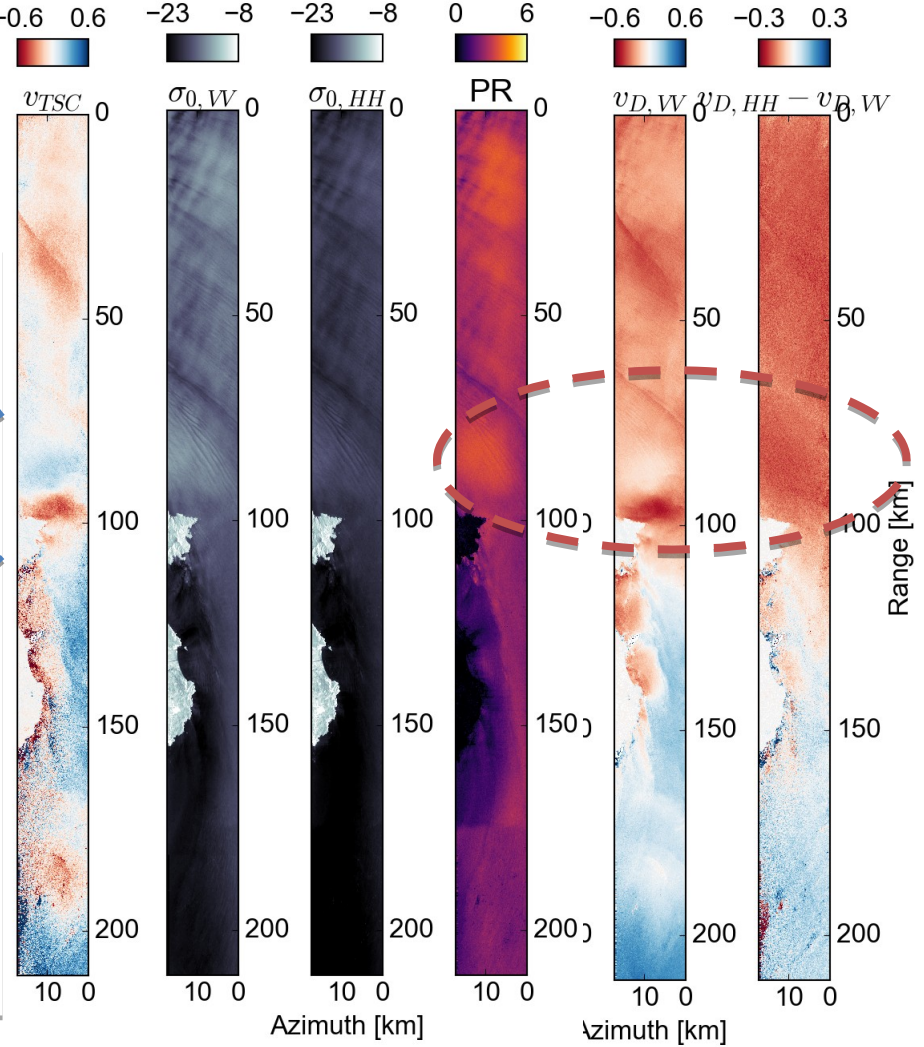

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Outlook

- $v_{eff} - u_{10}$ seems to be good proxy of wave-bias
- Some assumptions need to be revised:
  - e.g. $\sigma_{0_{HH}} \approx \sigma_{0_{VV}}$ ← Questionable, certainly at lower incident angles
  - Deal with differences in *Bragg Doppler* at different polarizations
- We need to analyze much more data, and have some validation.