

Added-value and shortcomings of ERA5 for Wind- and Metocean Site Conditions Assessments

Rémi Gandoin, eo-winds.net (Offshore Wind engineering)

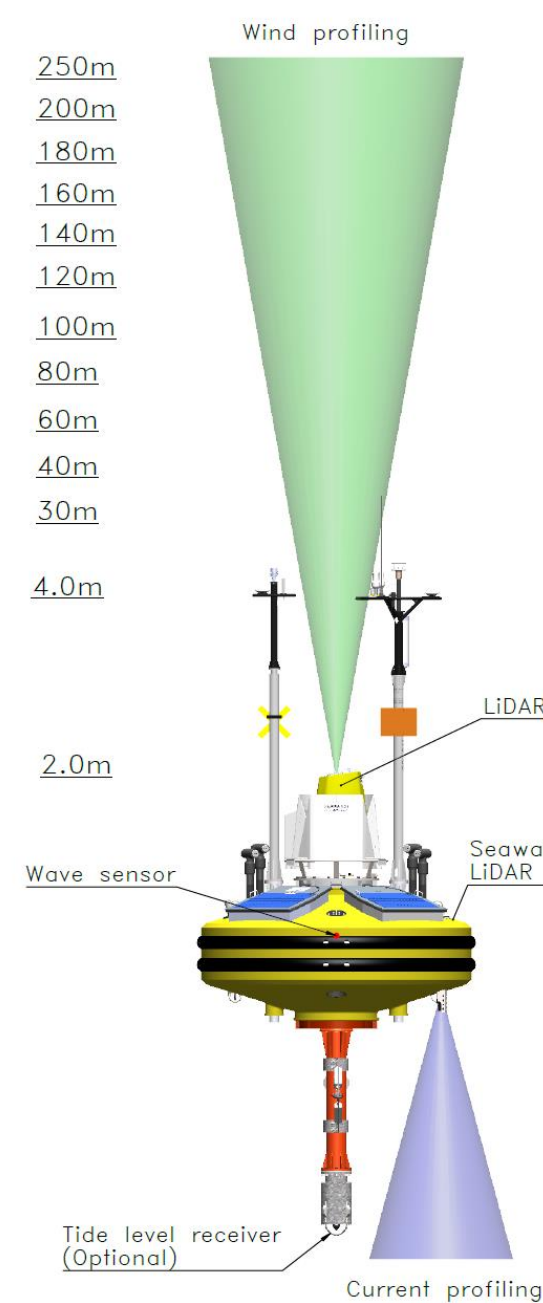
ERA5 performs better than the other global reanalyses wrt resolution, accuracy, length, data management. It is the preferred choice for most Offshore Wind analyses but one: the characterization of strong/extreme wind- and sea state conditions.

Please try Floating LiDAR data ♥

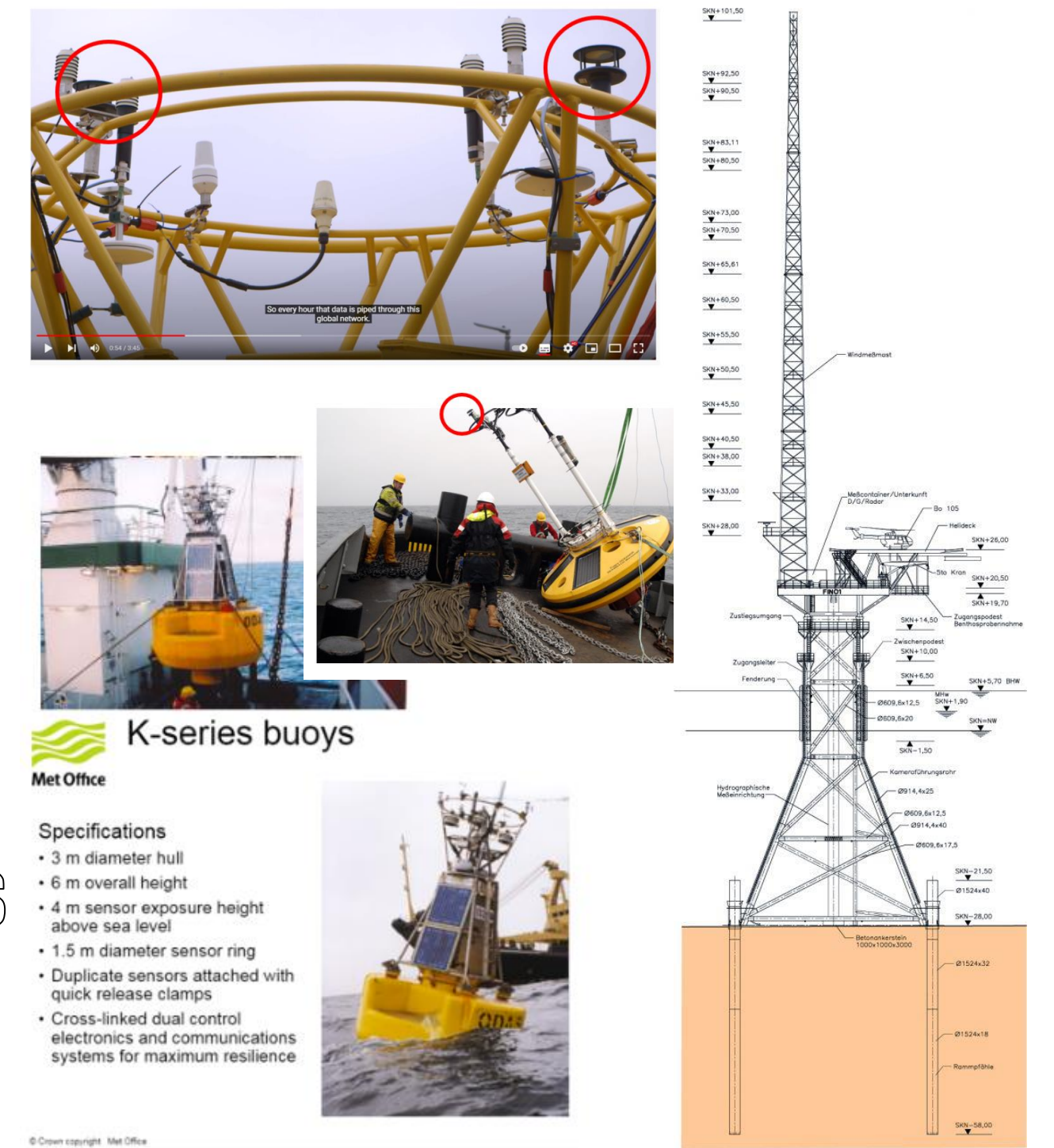
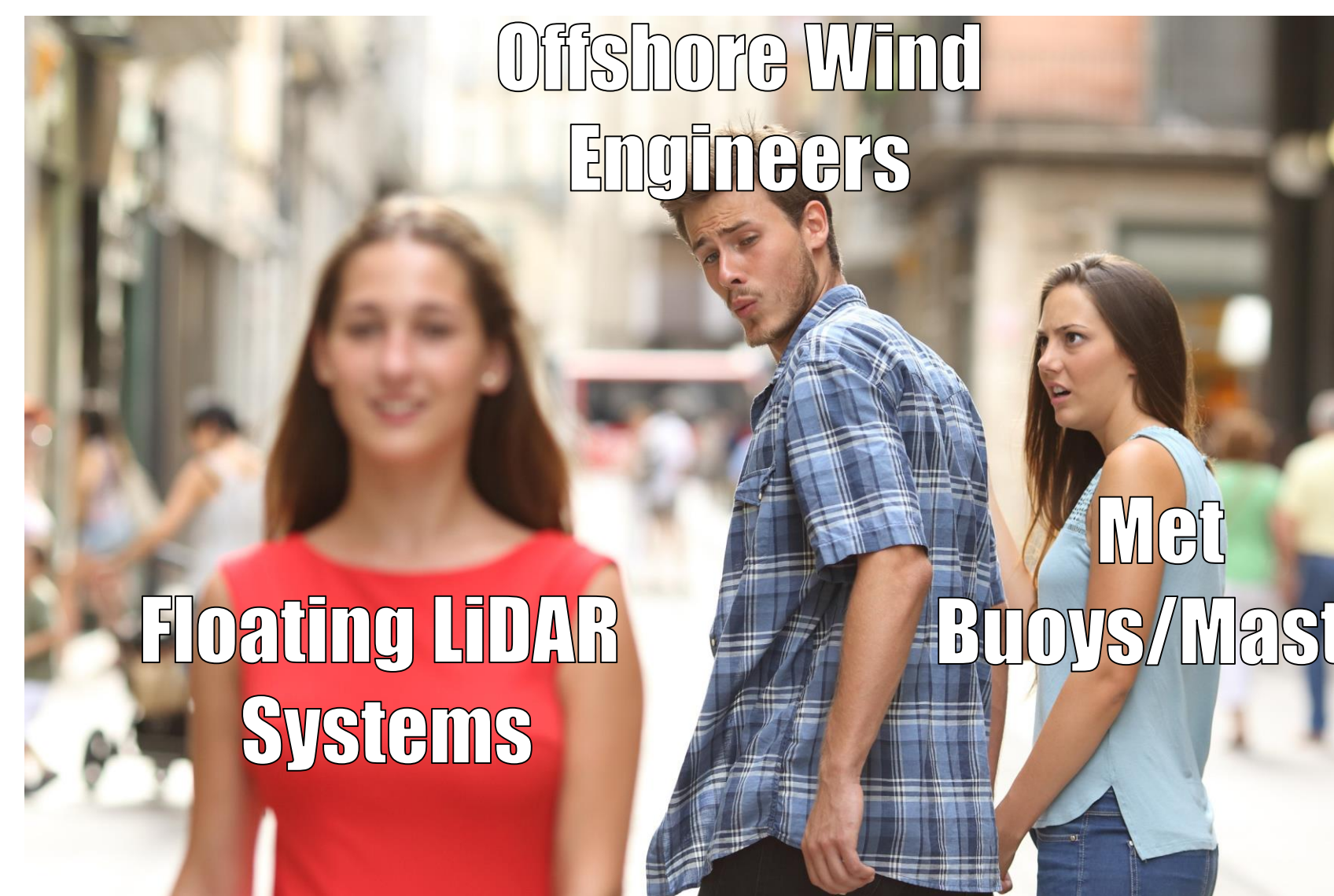
Preferred wind & wave measurements:

- ✓ Robust and accurate (*)
- ✓ Publicly available datasets (**)
- ✓ At the wind farm location

	Pro	Con
Met buoys	Cost 5+ years	Accuracy ~4 mASL
Floating LiDARs	Accuracy 200+ mASL	Cost <3 years



Back then, in 2012...

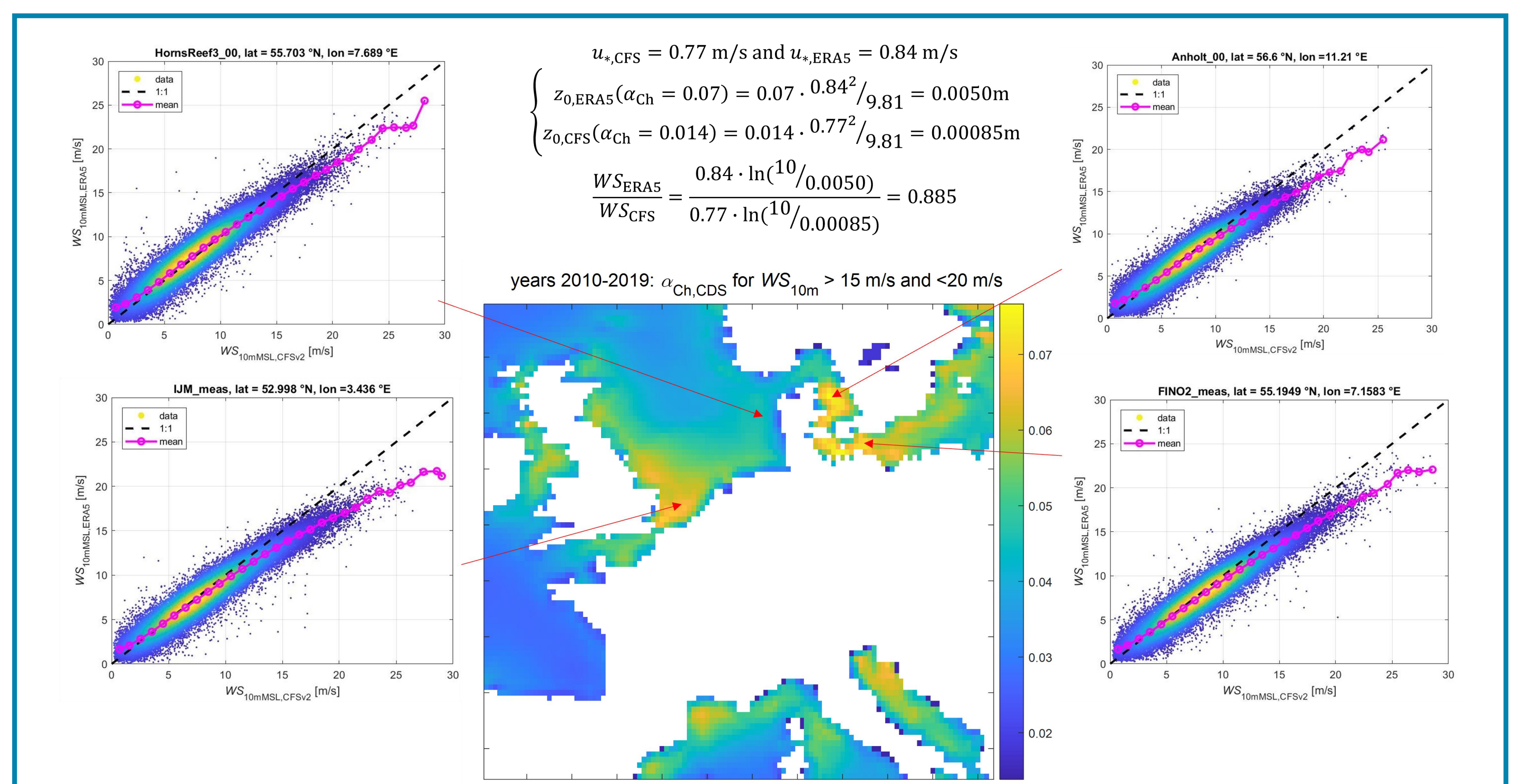


ERA5 underestimation of strong wind speeds for young wind-sea

α_{Ch} links roughness and friction:

$$WS(z) = \frac{u_{*,0}}{\kappa} \left(\ln\left(\frac{z}{z_0}\right) + \dots \right) \text{ with } z_0 = \alpha_{Ch} \frac{u_{*,0}^2}{g} = \alpha_{Ch} \frac{\tau}{g}$$

	Pro	Con
Simple (CFS): $\alpha_{Ch} \in [0.011; 0.018]$	Easy to tune for engineering applications	Not easy to tune for high fidelity, coupled air-sea models.
ERA5 (IFS): $\alpha_{Ch} = \frac{\hat{\alpha}}{\sqrt{1 - \tau_w/\tau}}$	More physical	Requires a spectral wave model. Still needs tuning



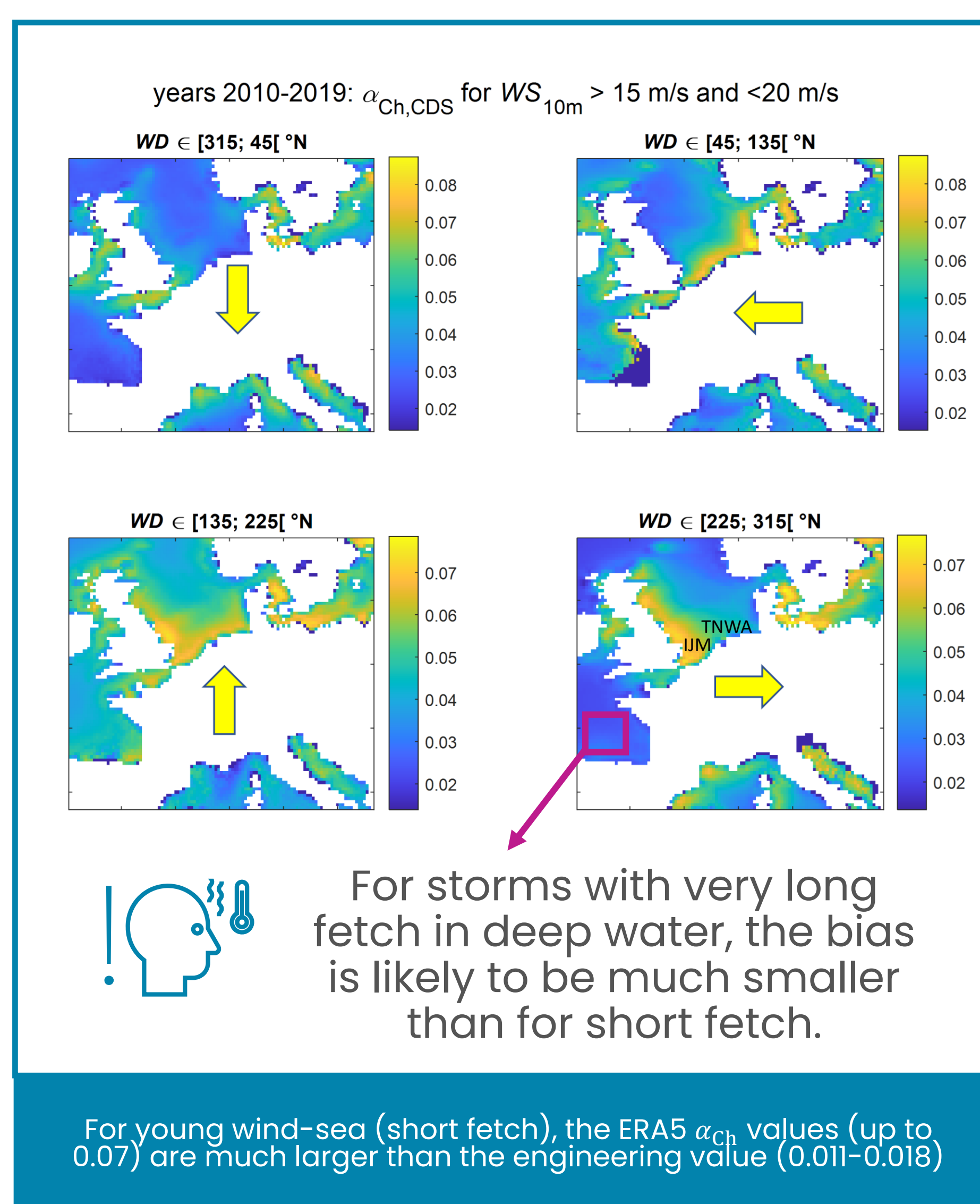
For two very similar values of τ , ERA5 shows noticeably smaller 10 mASL wind speeds than CFSv2.

ERA5 surface wind speeds are too small in strong wind conditions.

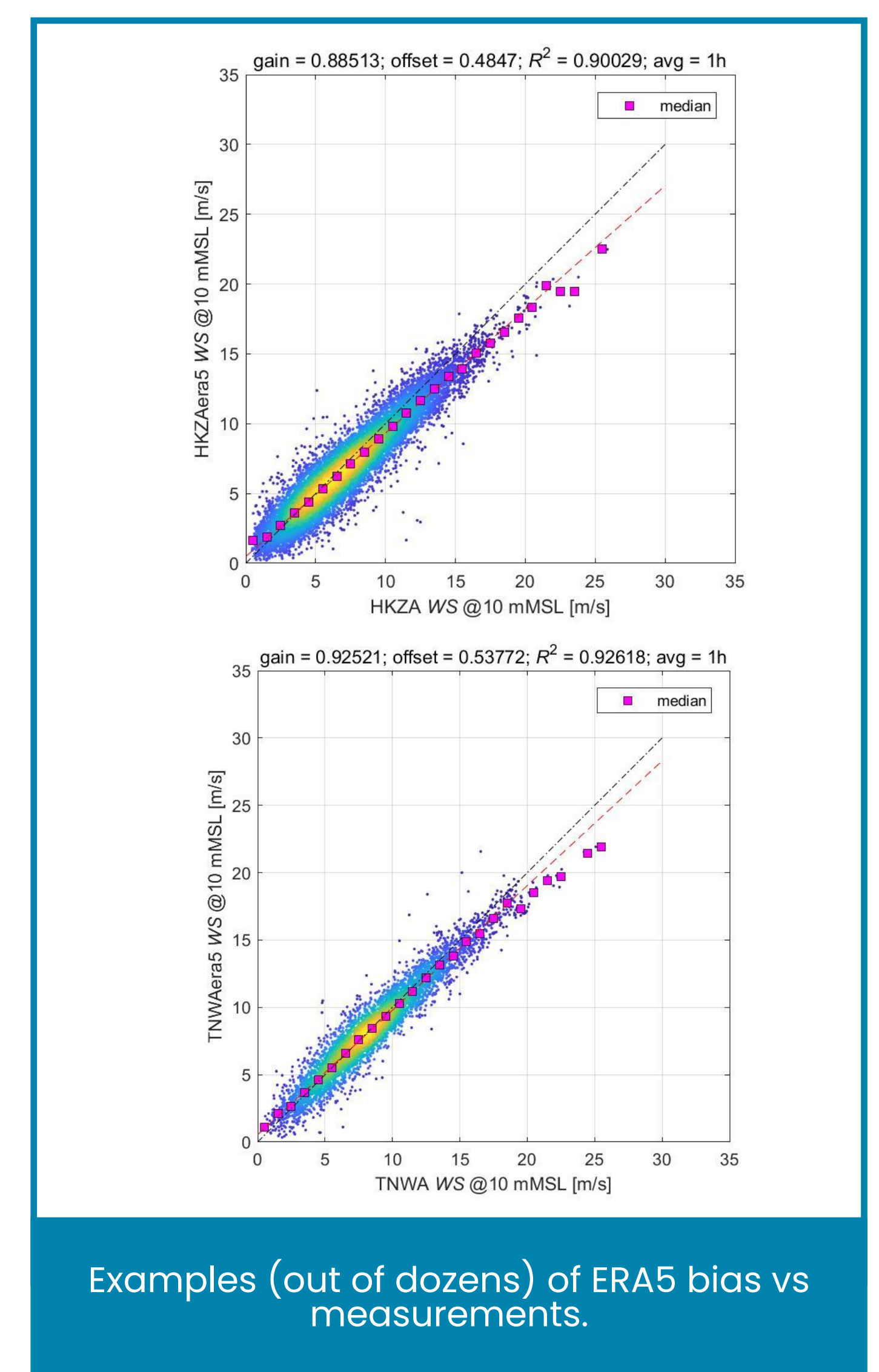
- Unconservative extreme values for design (wind speeds between 10 and 30 m/s matter too ☺)
- Correction of wind field required prior to using ERA5 for spectral wave modelling
- Makes ERA5 unpractical compared with {CFSr; CFSv2} despite CFS's shortcomings (land/sea masks, length, only surface level data)

ERA6: a wish-list

- Slightly conservative strong wind values
- Time series from 10 to 500 mASL
- Validation runs using Wind Energy specific, high quality, publicly available measurements (**)
- See also: (***)



For young wind-sea (short fetch), the ERA5 α_{Ch} values (up to 0.07) are much larger than the engineering value (0.01-0.018)



Examples (out of dozens) of ERA5 bias vs measurements.

Links and References

(*) 100+ LiDAR validation reports at <https://shorturl.at/dMTZ2>
 (**) high quality publicly available measurements: <https://groups.io/g/wrag/wiki/13236> (including map)
 (***) "Wind Energy practitioners, ERA5 and the Copernicus Data Store" <https://shorturl.at/adqXZ>
 All references to literature (journal papers, IFS documentation) can be found on www.eo-winds.net.
 Please get in touch with Wind Resource Assessment Group <https://groups.io/g/wrag/> if interested.

Rémi Gandoin
Senior Engineer

✉ regen@orsted.com
 🐦 remi_wnd