Observations and the Parameterisation of Air-Sea Fluxes during DIAMET

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The DIAMET Project

- Storms are well forecast on the synopic-scale, but the mesoscale structures that produce strong winds and intense precipitation remain uncertain
- So we need to parameterise the key processes, including air-sea fluxes, to better understand and forecast severe storms over the UK
- Here we are using aircraft measurements at very low altitude to determine the air-sea fluxes

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Aircraft Measurements

- Facility for Airborne Atmospheric Measurements (FAAM) uses a specially built BAe-146 aircraft, operated by the UK Met Office and NERC
- Able to fly at 30-40 m in strong wind
- Measures wind speed, updraft, temperature and humidity at 32 Hz (so ~3 m spatial resolution)
- Measures sea surface temperature remotely
- Now have data from 5 flights during DIAMET, plus 19 other low level flights

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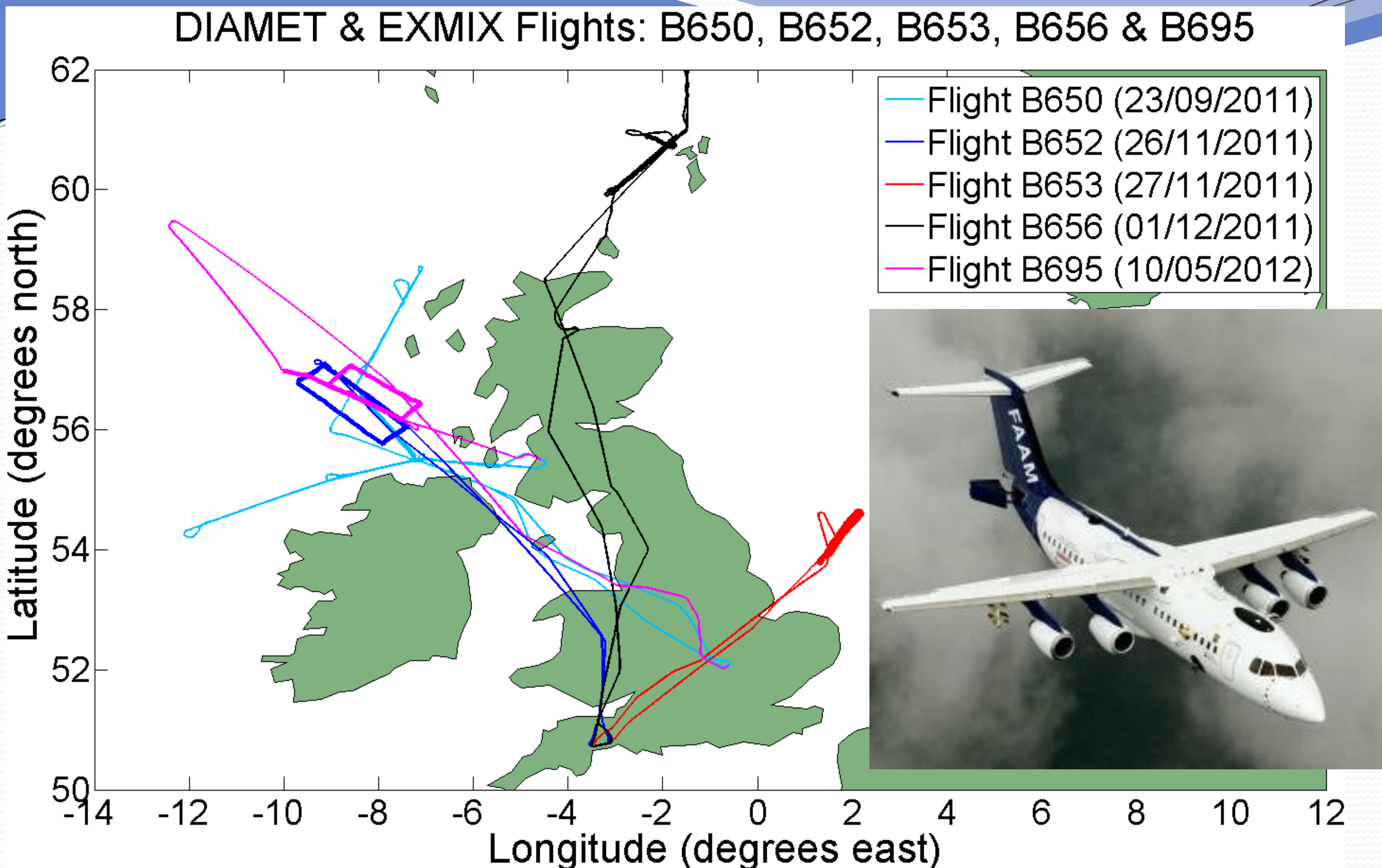

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Calculating the air-sea fluxes

- Fluxes of momentum, sensible heat and latent heat calculated by the eddy covariance technique, using the measured high frequency perturbations
- However NWP models require bulk fluxes that depend on wind speed at 10 m (U_{10N}), and the differences in temperature and humidity
- Careful quality control was carried out on the data from each 2 minute run (~12 km) by examining the spectra and co-spectra

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Eddy Covariance Fluxes

$$\text{Momentum Flux } (\tau) = \bar{\rho} \sqrt{\overline{u'w'}^2 + \overline{v'w'}^2}$$

$$\text{Sensible Heat} = \bar{\rho}\, C_p\, \overline{w'\Theta'}$$

$$\text{Latent Heat} = \bar{\rho}\, L_v\, \overline{w'q'}$$

Bulk Fluxes at 10 m from surface

$$\text{Momentum Flux } (\tau) = \bar{\rho}\, C_{DN}\, (U_{10N} - U_s)^2$$

$$\text{Sensible Heat} = \bar{\rho}\, C_p\, C_{HN}\, (U_{10N} - U_s)(\Theta_s - \Theta_{10N})$$

$$\text{Latent Heat} = \bar{\rho}\, L_v\, C_{EN}\, (U_{10N} - U_s)(q_s - q_{10N})$$

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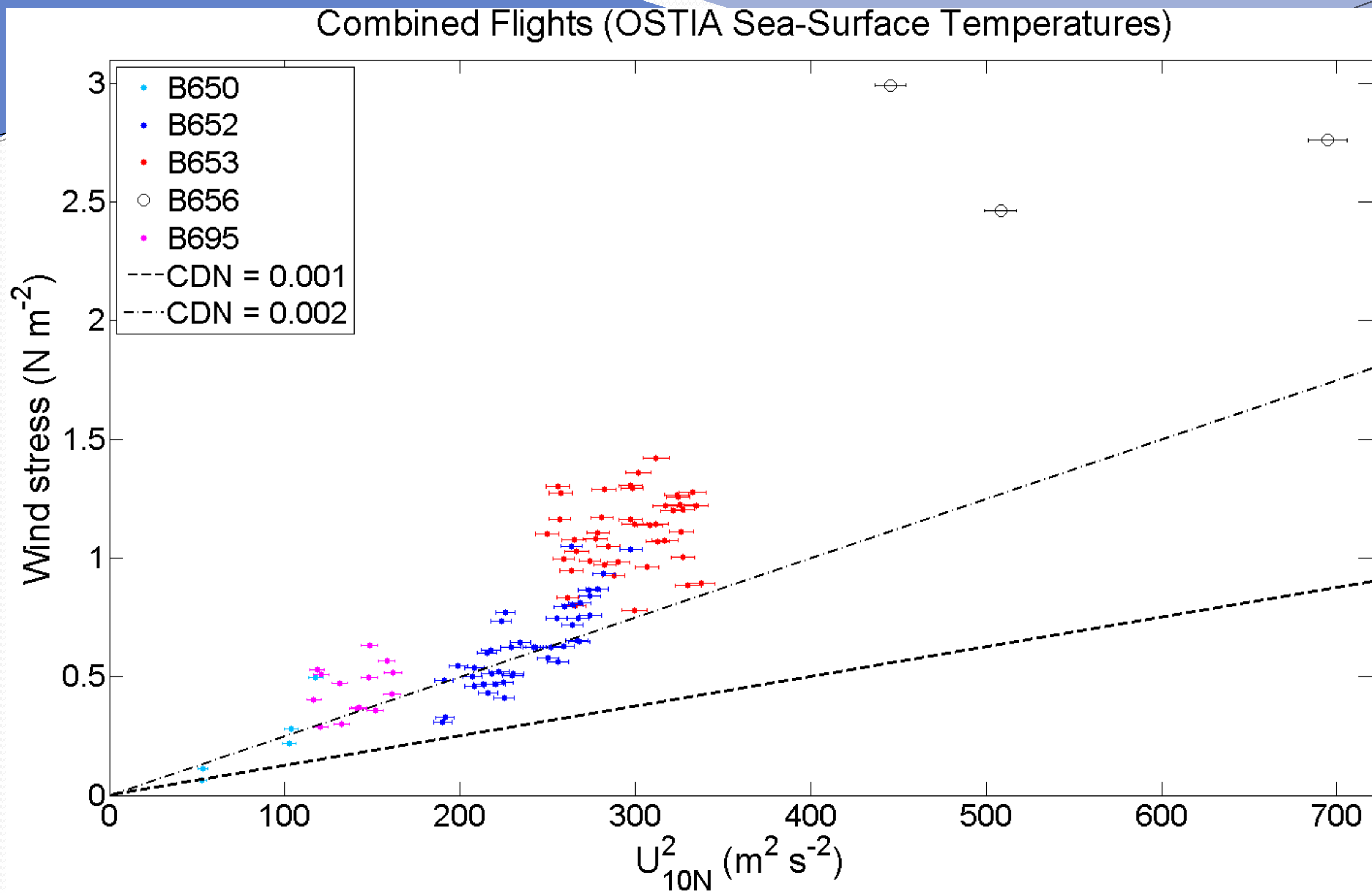

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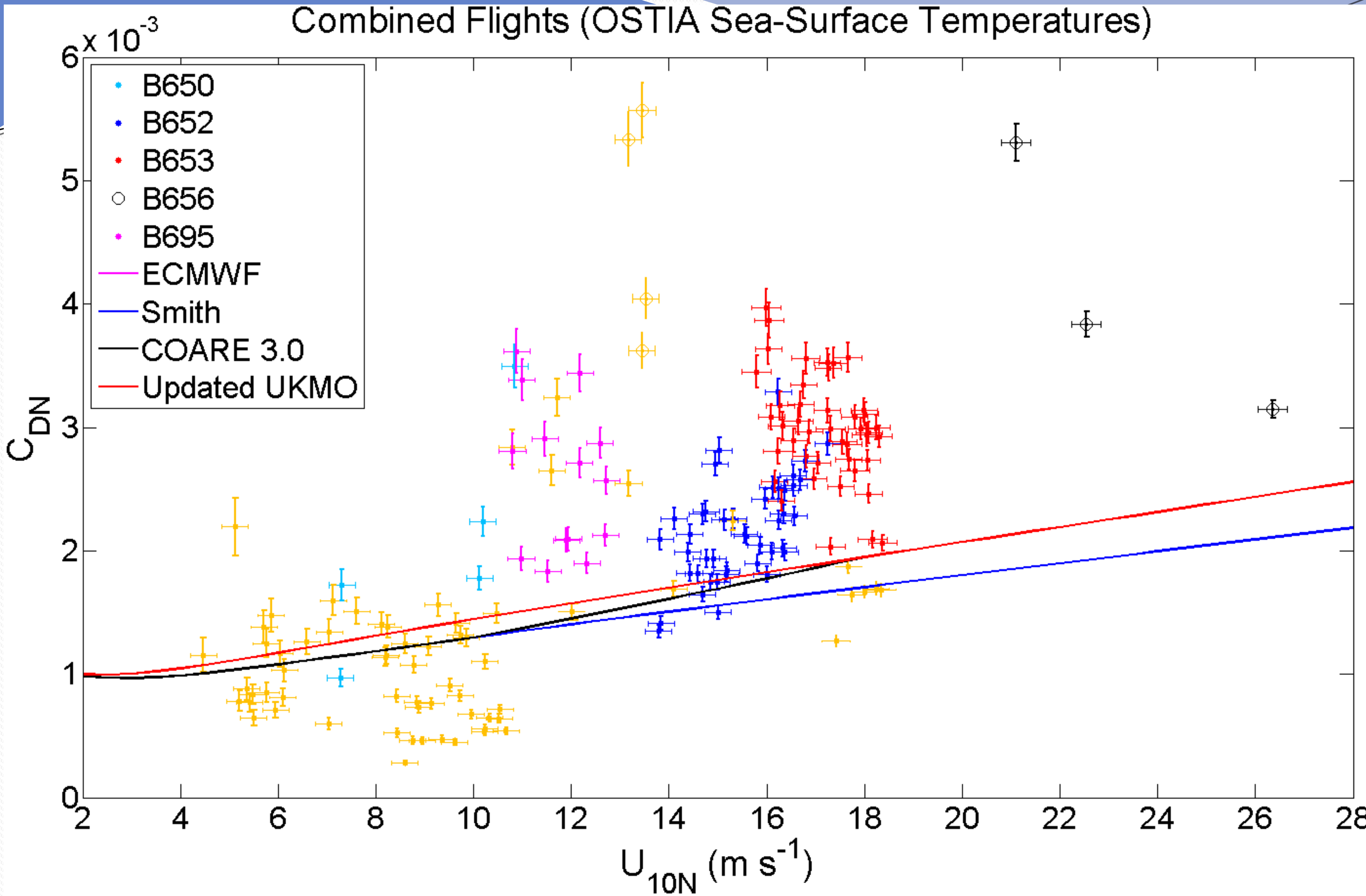

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Momentum flux coefficient values

- Many of the C_{DN} values are significantly larger (~50%) than the estimates from algorithms developed in previous studies
- Perhaps due to the stability of the boundary layer
- Flights within unstable air (e.g. B656 and B695) produce large C_{DN} values, but those within stable air (e.g. B650 and B652) produce small values

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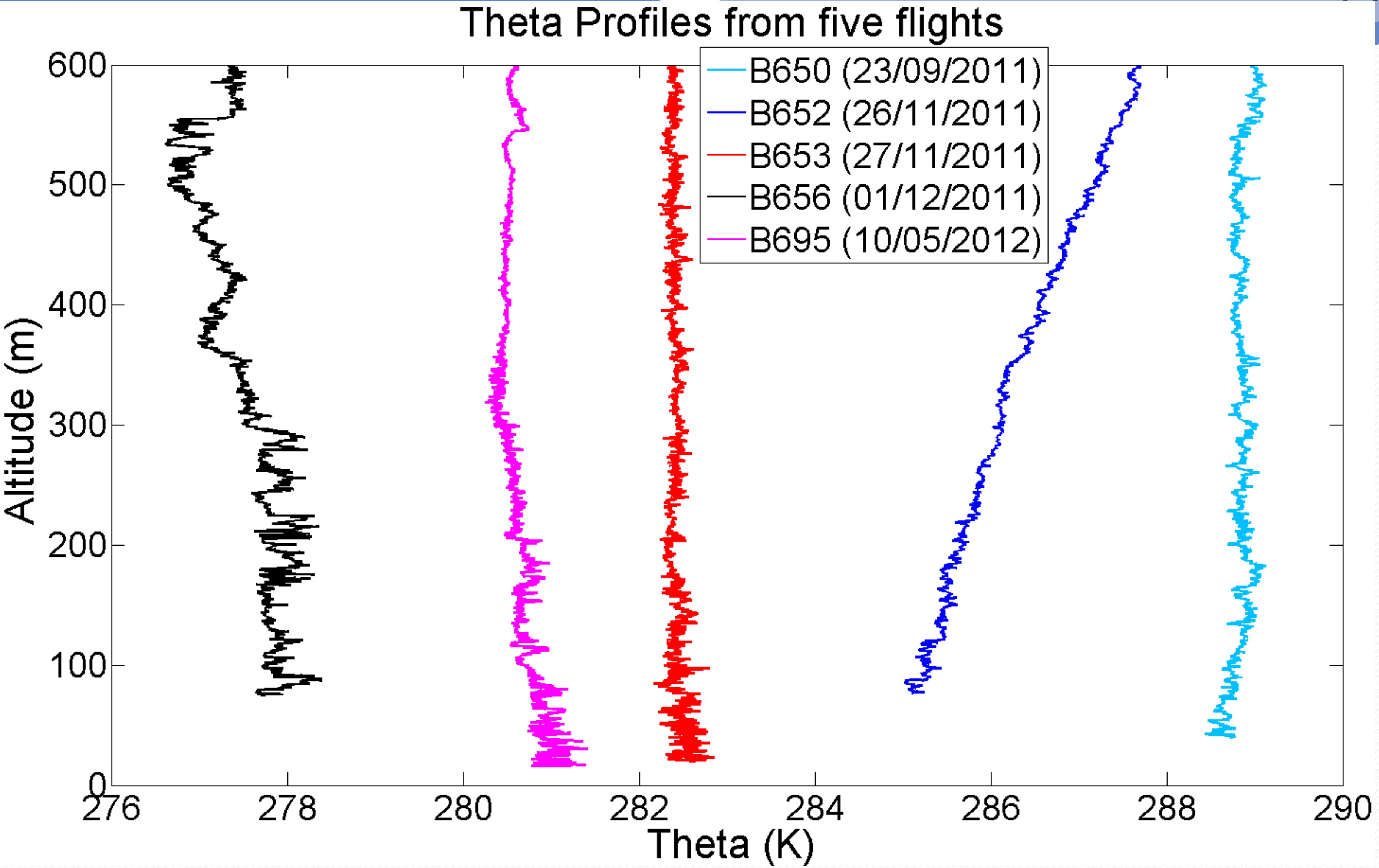

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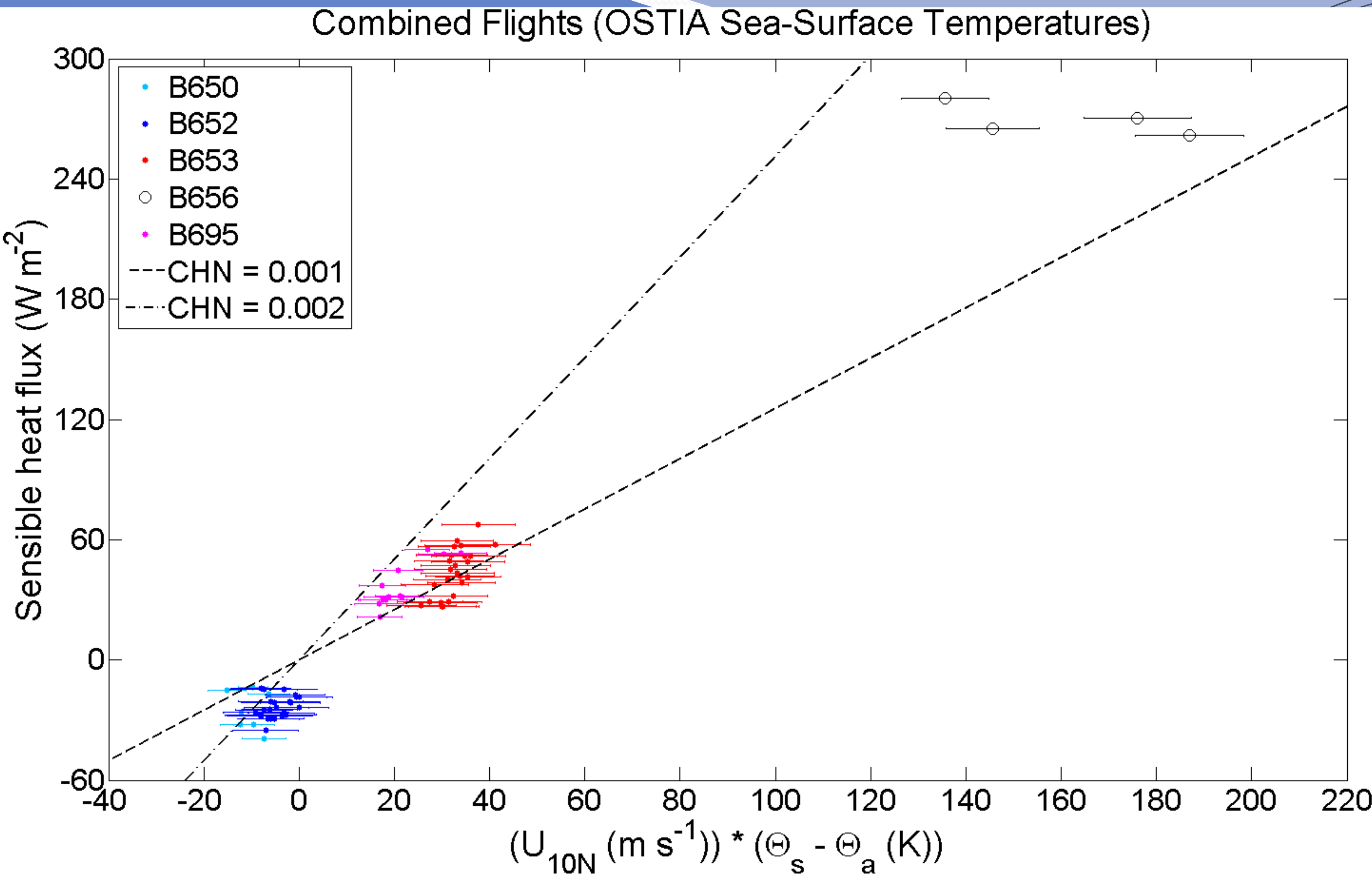

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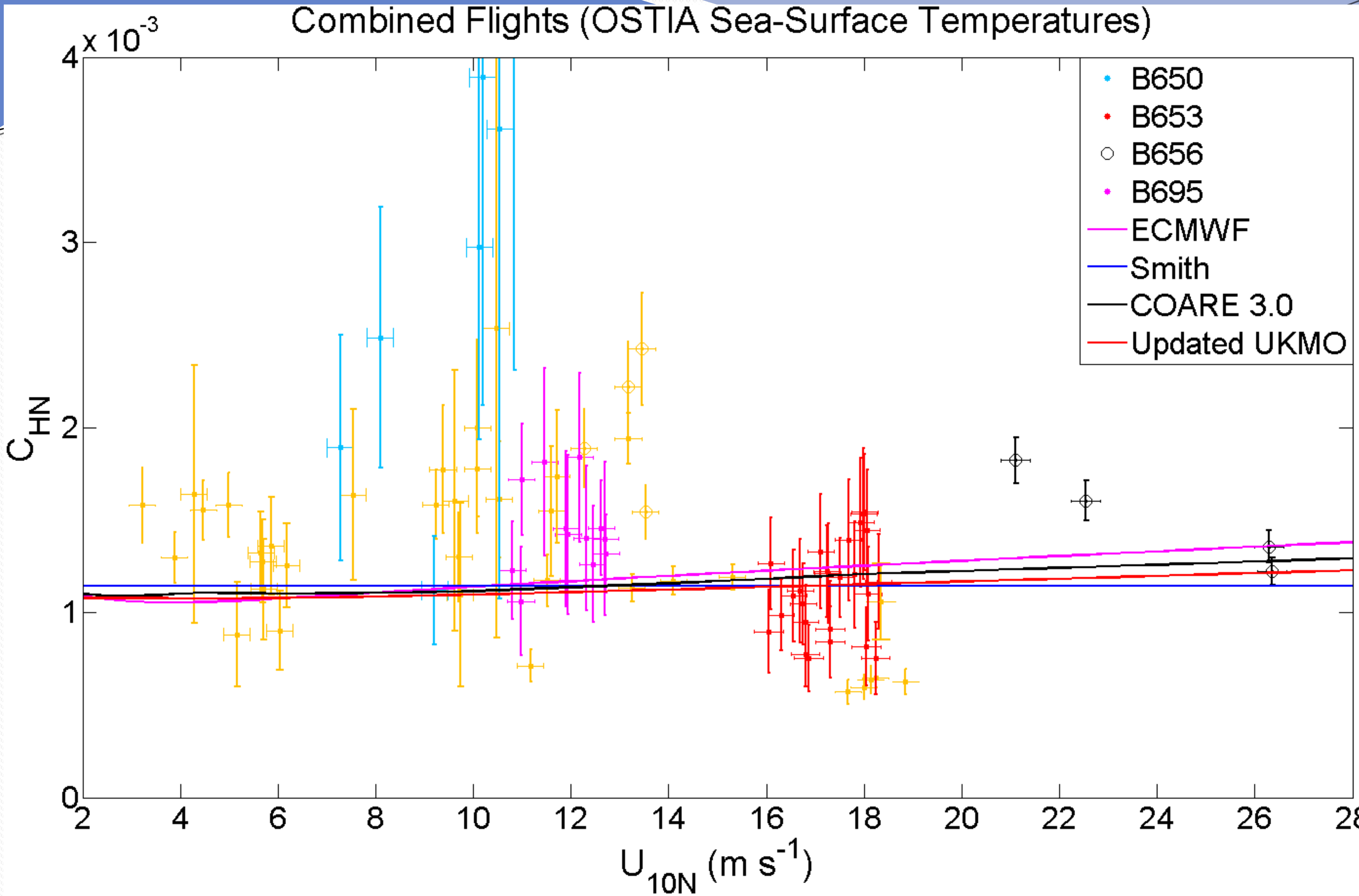

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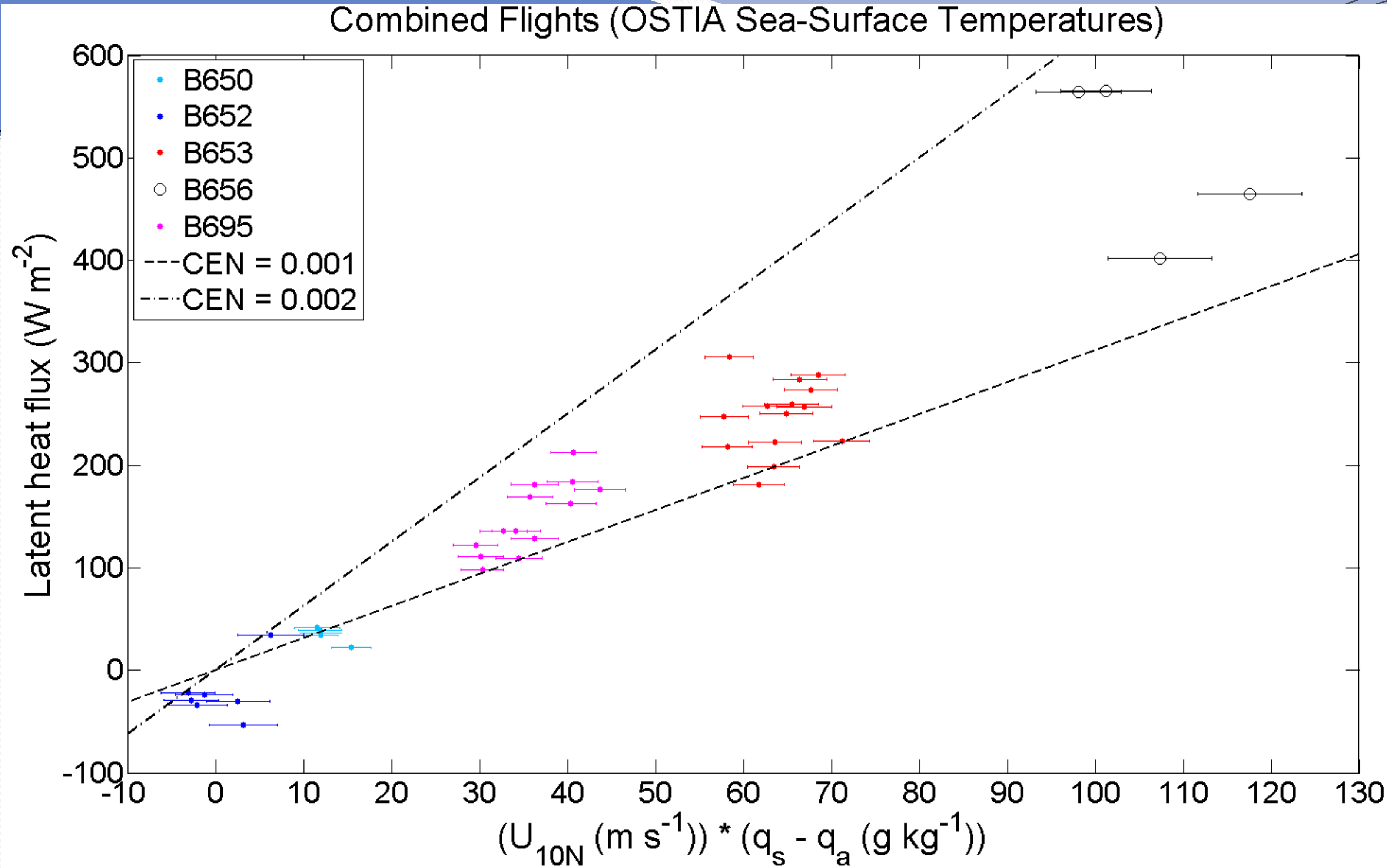

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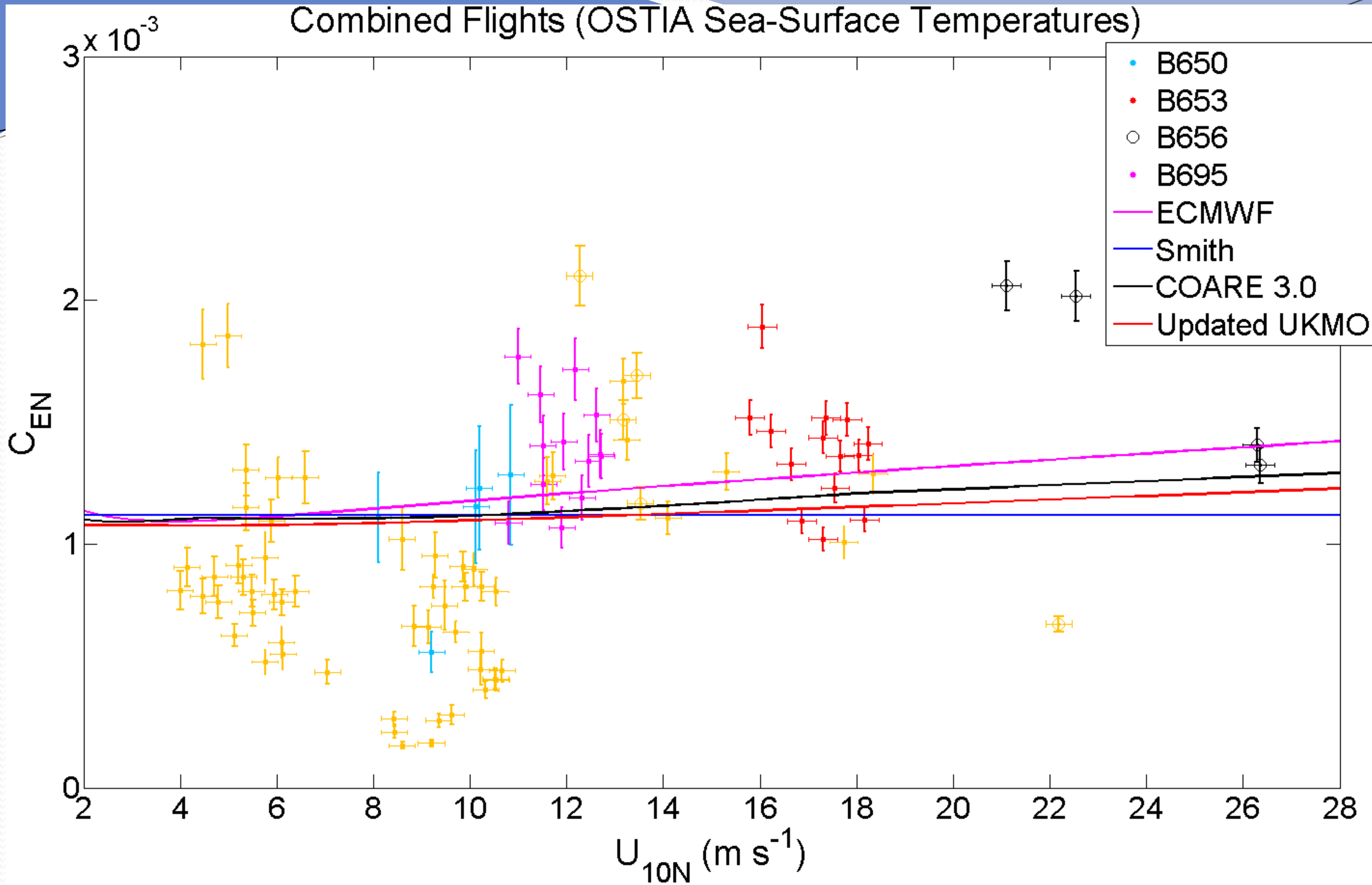

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Heat flux coefficient values

- Many of the C_{HN} and C_{EN} values are larger (~20%) than in the previously developed algorithms
- These strongly depend on sea surface temperature
- The aircraft uses a Heimann radiometer to measure surface temperature, and in many recent flights an interferometer (ARIES) to check the Heimann
- But the 2 sets of measurements are often different and also differ from the SST values from OSTIA

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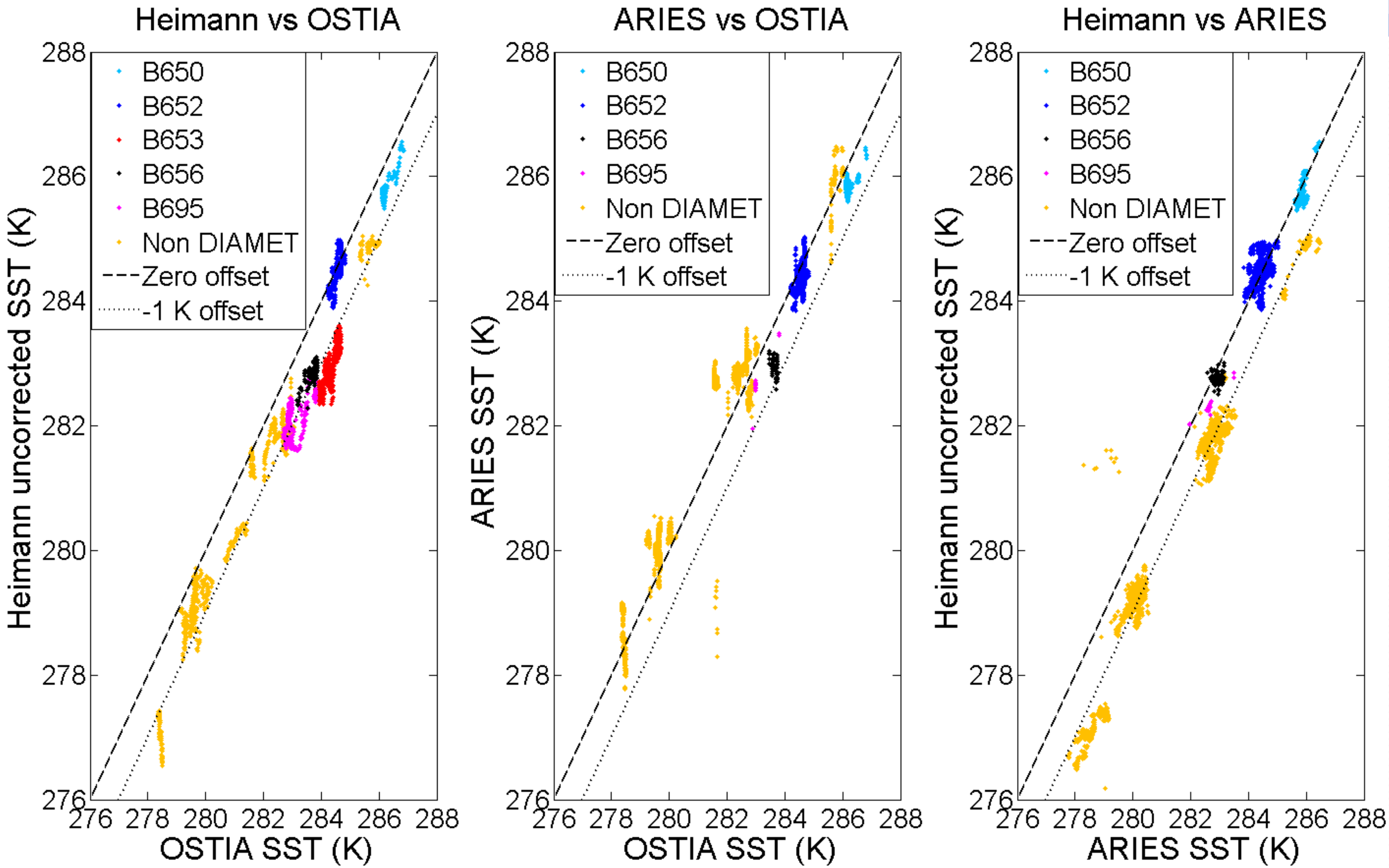

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Summary

- Good quality measurements have been obtained at low levels in a variety of wind speeds
- Initial results show coefficients that are ~50% and ~20% greater at large wind speeds (>10 m/s) than those in previously developed algorithms
- C_{DN} values may depend on boundary layer stability
- Still need to determine the most accurate SST measurements to use in the calculations

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