Royal Netherlands
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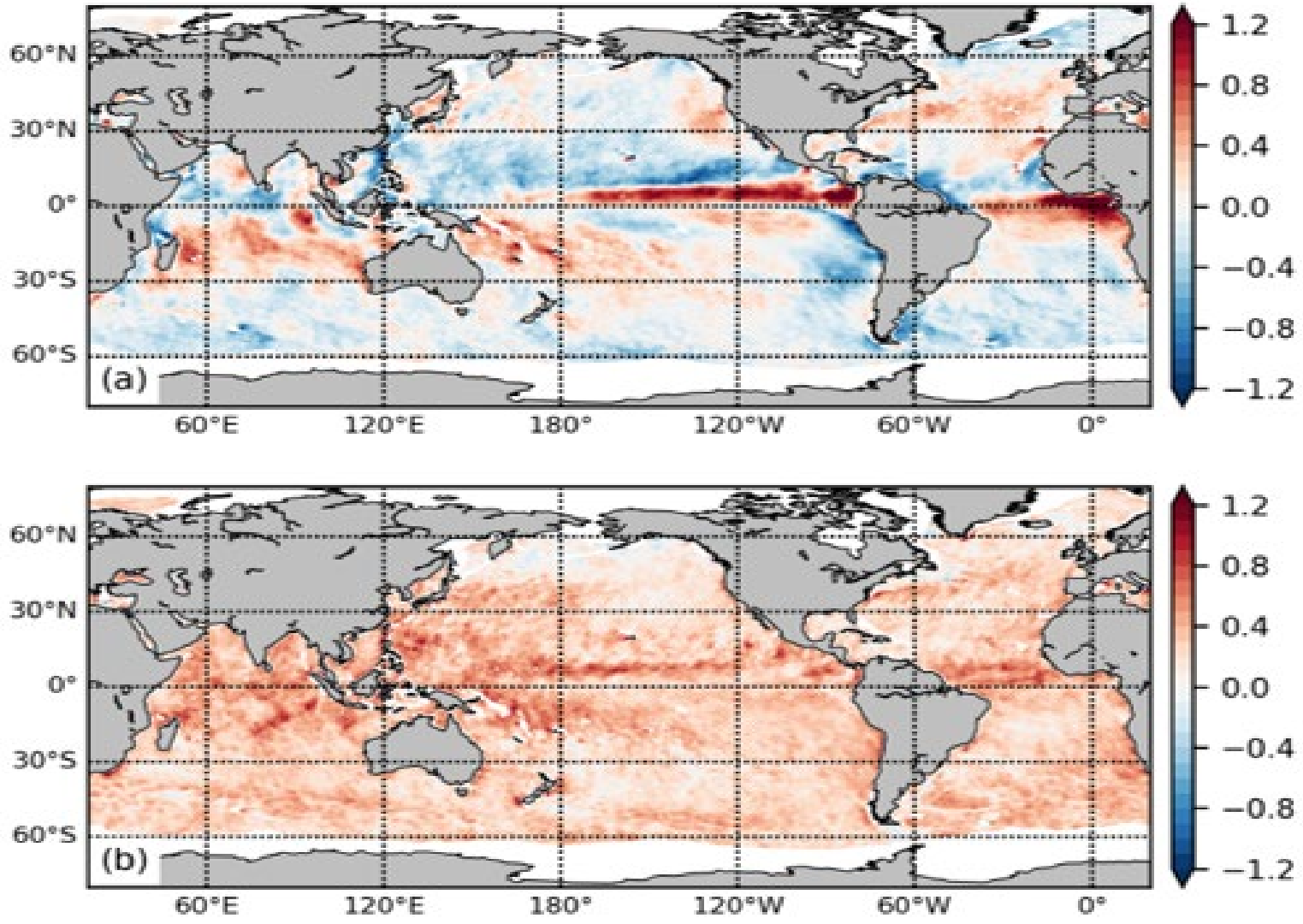
ESA EE10 HARMONY, EE11 SeaStar

Ad.Stoffelen@knmi.nl, fellow IEEE
Leader active sensing
R&D satellites (RDSW)

Scatterometer and model differences



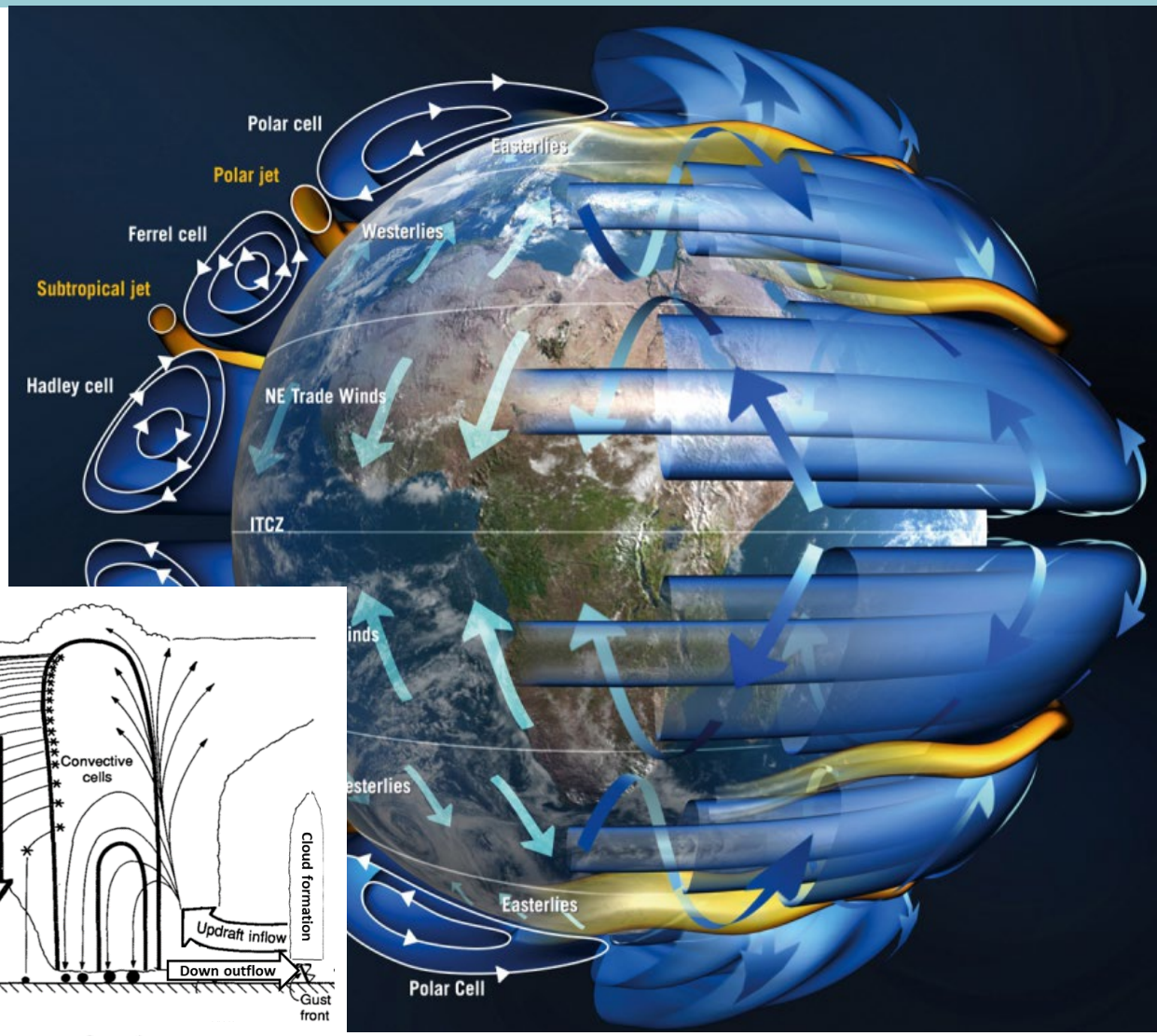
- Models have large (20%) errors

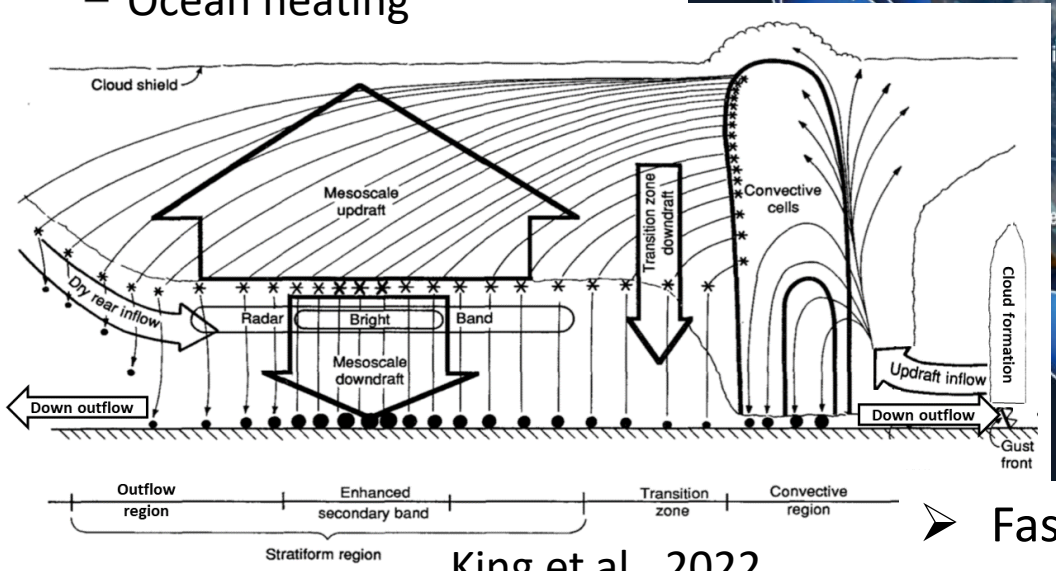
Giesen, 2021

Figure 2: Annual mean meridional (a) wind speed difference and (b) transient wind speed difference between scatterometer (Metop-A ASCAT) and collocated ECMWF ERA5 for 2018.

Earth dynamics

- Climate change
  - Temperature/radiation?
  - Atmospheric stability?
  - Humidity/clouds/rain?
- Dynamics change?
  - Hurricanes/tornado's
  - Jet streams/climate zones
  - Ocean carbon exchange
  - Ocean heating



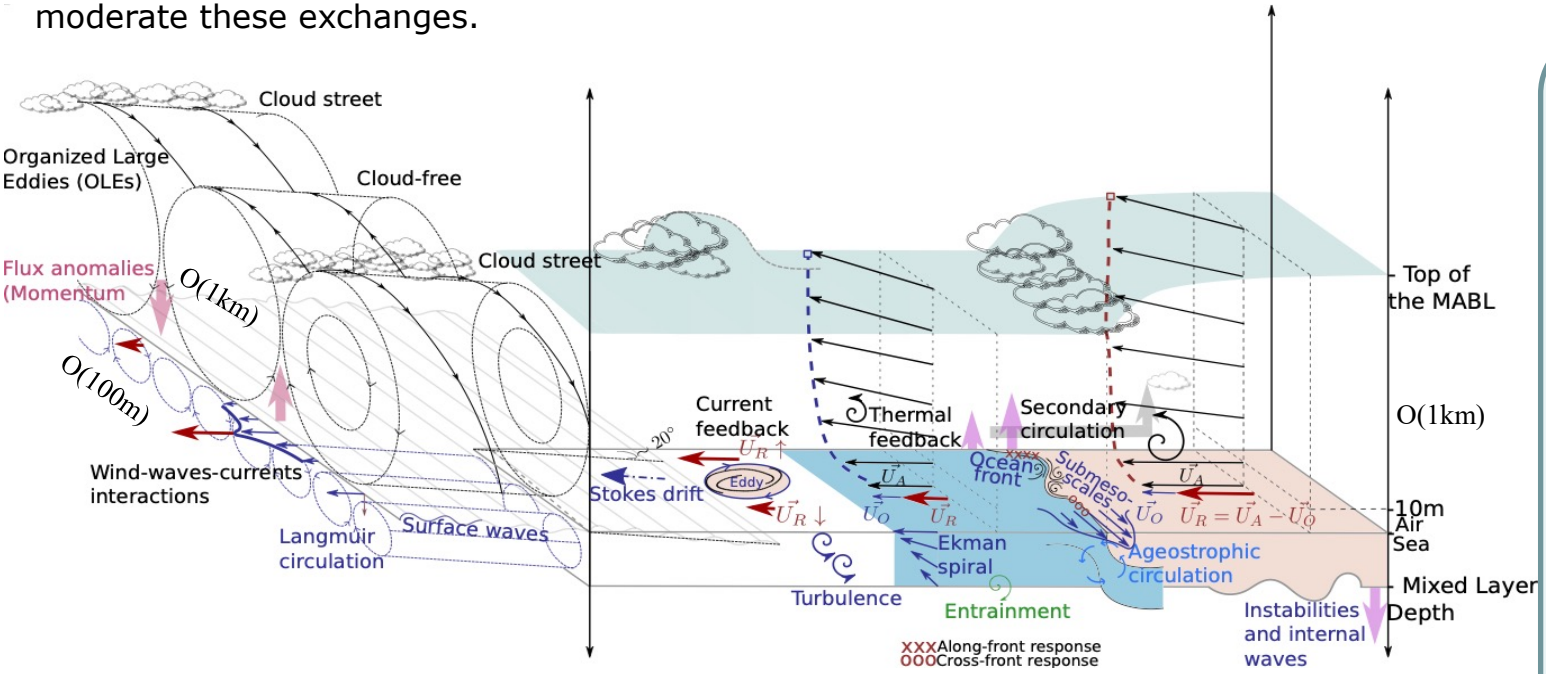


King et al., 2022

➢ Fast mixing processes not well resolved

Processes at the air-sea interface

Exchanges of **heat**, **gas**, **momentum** at the air-sea interface depend on the **thermal**, **chemical**, **kinematic** unbalance between ocean and atmosphere that are modulated by many **small-scale processes** that substantially moderate these exchanges.



Air-sea fluxes

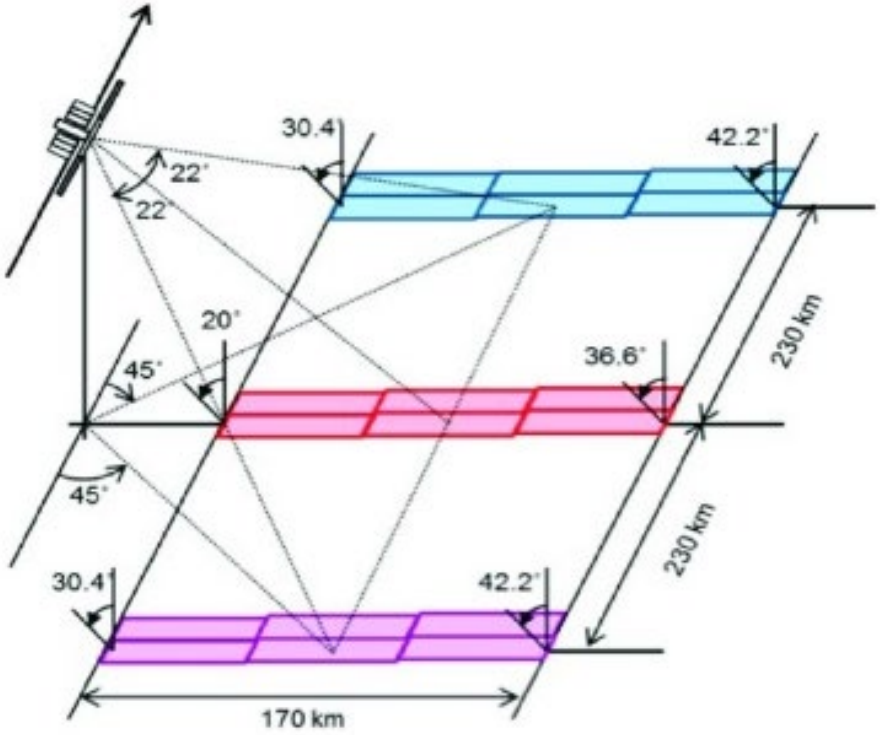
depend on

- **Surface stress** (impacted by ocean velocity and by air velocity, which is affected by SST)
- **Boundary layer thickness** (which varies by 2 orders of magnitude in different stability conditions)
- **Km-scale** ocean (eddy) dynamical circulations and phenomena

- Atmosphere and ocean are dynamically coupled through parameterizations with errors
- > 70% of earth's surface
- Tropical modes are poorly described (El Nino, MJO, Tropical Instability Waves, ..)
- Will these modes change in a changing climate? With what consequence?

Km-scale ocean wind and motion

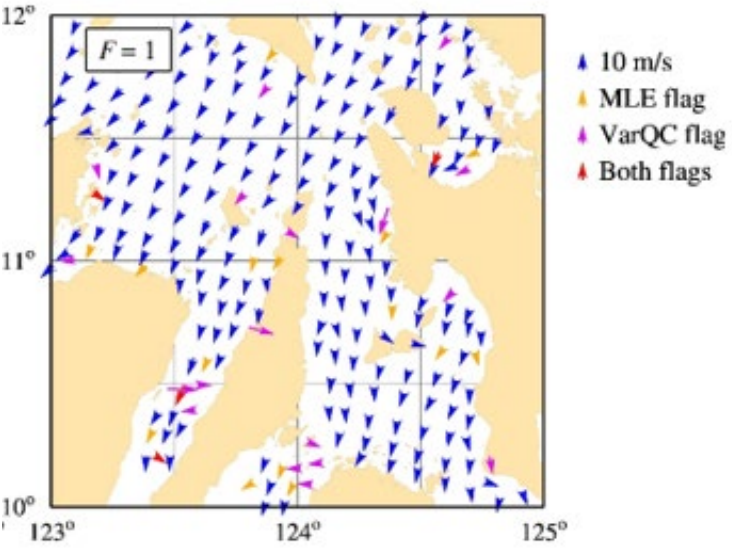
- ESA Earth Explorer 10 HARMONY
- Only EE10 mission left (2030)
- Wind/stress, ocean motion, SST
- TIR clouds and motion
- Trio satellite convoy with S-1
- S-1 ocean coverage (only)



- SeaStar in ESA EE11 competition (4 left)
- Wind/stress, ocean motion
- Coasts, shelf seas, marginal ice zones
- Three squinted Ka (?) beams
- Two interferometric antennae

Exploit ASCAT scientific readiness level

- Develop cone metrics for relative calibration and GMF development
- Extend KNMI GenScat library for public wind processors
- Produce a 20-km product for reference to scatterometry
- Use the same processor for 1-km winds
- Evaluate residuals of the 1-km products with respect to scatterometers to identify sub-scale processes
- Triple collocation
- Relate to Doppler (H&S), SST gradients, TIR cloud heights and motion (Harmony)



Subset	Buoys		ASCAT-A		ScatSat		ECMWF	
	σ_u	σ_v	σ_u	σ_v	σ_u	σ_v	σ_u	σ_v
bAS	1.03	1.12	0.41	0.49	0.78	0.65	--	--
bAE	1.06	1.15	0.34	0.41	--	--	0.94	1.03
bSE	1.09	1.21	--	--	0.72	0.59	0.92	1.03
ASE	--	--	0.43	0.49	0.76	0.65	0.90	0.98
range	0.06	0.09	0.09	0.08	0.06	0.06	0.04	0.05

Vogelzang et al., 2021, 2022


SeaStar
10 km
harmony
TO RESOLVE STRESS
IN THE EARTH SYSTEM