Air-Sea Interaction in Extreme Weather Conditions

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Motivation

- Safety of the coast of the Netherlands for storm surge
- Models not prepared for $U_{10} \gtrsim 30$ m/s
- Might occur more frequently in a changed climate
- Investigate alternative drag relation
- Identical in NWP and storm surge model
Storm surge forecasts (in the North Sea)

\[ \vec{\tau} = \rho_a C_D |\vec{u}_{10}| \vec{u}_{10} \]

\[ p_{msl} \]
Alternative drag relations

\[ C_{D10} \times 10^3 \]

- Powell et al. (2003)
- Holthuijsen et al. (2012)
- Charnock
- Extended Charnock
- Spray stress model

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Extended Charnock relation

- Include the effect of spray and air-flow separation
- Build into HIRLAM
- Apply in the Gulf of Mexico
Hurricane tracks

**Ivan (2004)**

**Katrina (2005)**

- NHC obs
- Charnock
- New
- T+48
- T+72
- T+96
Hurricane intensity

Ivan

Katrina

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But...

- Lower drag means lower storm surge

- Exchange of heat and moisture should be larger
Spray stress model

- Parametrization based on spray stress model
- Enhanced exchange of heat and moisture
- Artificial reduction of SSTs below the storm
Hurricane intensity

Ivan

Katrina

Observed (NHC)

KMZ2012

KMZ2012, SSTs reduced

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Conclusions

- New drag relation produces realistic hurricane wind speed and pressure
- Momentum flux needs also update of heat and moisture fluxes
- Sea surface temperature also plays significant role
- Next step: couple ocean model
Thank you