## Coastal Climate Change Projection at the end of 21st century



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## Backgroud

#### Japan

- Coastline: 33,889km
- •400 million people below sea level
- Static change
  - Sea level rise

#### Dynamic change

- Storm surge
  - ✓ i.e. Isewan typhoon/Vera (1959) 895 hPa
     5,098 casualties
- Ocean wave
  - 200 casualties/year by marine accident in Japan.











### Future Typhoon/Storm Surge Projection

**Stochastic downscaling?** 



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## Agenda for Storm Surge





# Stochastic Typhoon Model



- Mote Carlo simulation of typhoon for given pdfs such as
  - Direction  $d_2 = d_1 + \Delta d \cdot \Delta t$
  - •Speed  $v_2 = v_1 + \Delta v \cdot \Delta t$





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For 10,000-100,000yrs





## Validation: Present Climate TC Passing number





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Frequency



## Concept of Projection of Future TC





∆TC Cyclogenesis location
 ∆TC Cyclolysis location
 ∆TC Pressure
 ∆TC Moving speed
 ∆TC Direction

#### Observed data



Simulated TC in Future Climate





## Cyclogenesis





## Frequency of TC passing





#### Frequency









# Concept of Projection of TC





∆TC Cyclogenesis location
 ∆TC Cyclolysis location
 ∆TC Pressure
 ∆TC Moving speed
 ∆TC Direction

#### Observed data



Simulated TC in Future Climate



#### Typhoon Numbers/yr: Present Climate





# Future Ocean Wave Projection

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# Ocean Wave Modeling





2075 Jan

2099 Dec

25 years

- Spectral wave model
  - Delft SWAN version 40.51AB
- Configuration
  - Sin: Komen
  - Snl: DIA+HJ Limiter
  - Sds: WAM4
- Bathymetry
  - BODC 10min data
- Resolution
  - 1.25 deg., -80S-66.25N (289X126)

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Future





### Extreme Wave Height Change







### Future Sea Level Rise by CMIP3 ensemble







### World Coastal Assessment due to SLR and Wave Climate Change



# Summary



#### ■Typhoon

- Stochastic typhoon model has been developed in global scale.
- Analysis TC characteristics change has been finished

### Storm Surge

#### Ocean waves

- Mean wave
  - ✓ Clear dependence of latitude
  - ✓ Increased: mid-latitude westerlies and the Antarctic sea
  - ✓ **Decreased**: the Equator
- Extreme wave
  - Tropical cyclone dependence
  - ✓ Increased: The Northwest Pacific, Indian Sea

# Outlook



- Stochastic typhoon model (STM)
  - A series of numerical experiments changing parameters
  - The intensity and radius change are necessary to be considered.
  - Further validation and modification
- STM+Storm surge projection
  - Asia mega delta
  - Unstructured grid model in global scale
- Ocean wave projection
  - Down scaling to fine resolution in bay scale
  - Inter forcing comparison (different scenario, models)

#### Multi-physics projections

- SLR+Wave+Surge
- Stability of coastal structures
- Coastal bathymetry change

Data: http://www.oceanwave.jp/



# THE END

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