Far-reaching Hawaiian Lee Countercurrent forced by SSTA driven local wind stress

H. Sasaki\textsuperscript{1} and M. Nonaka\textsuperscript{2}

1: Earth Simulator Center/JAMSTEC
2: Frontier Research Center for Global Change
Introduction

- The Hawaiian Lee Countercurrent (HLCC) is a narrow eastward current to the west of the Hawaiian Islands distributed in the wide westward North Equatorial Current. [Qiu et al. 1997; Flament et al. 1998; Xie et al. 2001; Kobashi and Kawamura 2001].

- Xie et al. [2001] suggested that the HLCC and its far-reaching extension is a response to orographic wind stress curls in the lee of the Hawaiian Islands, and it is confirmed using a CGCM [Sakamoto et al., 2004].
Air-Sea interactions associated with the HLCC

- Hafner and Xie [2003]

*Thermal responses* of wind-induced evaporations and negative feedback from the cloud band based on regional atmospheric simulations.

Dynamical ocean response to atmosphere?
Meridionally high pass filtered wind stress and SST

**Observation**
QuickSCAT wind stress and TRMM SST (2001-2004)

**Reanalysis**
Wind stress and SST of the NCEP/NCAR reanalysis (2001-2004)

*TRMM: Tropical Rain Measuring Mission*
Simulation Configurations of QuikSCAT Run and NCEP Run

- **Model**: OFES [Masumoto et al., 2004]
- **Model Domain**: 75°S-75°N
- **Horizontal Resolution**: 0.1 degree
- **Vertical Levels**: 54 (5m – 330m thickness)
- **Horizontal Mixing**: Bi-harmonic
- **Vertical Mixing**: KPP [Large et al., 1994]
- **Heat and salinity flux**: Daily mean NCEP/NCAR reanalysis and the model SST using bulk formulas

**Wind stress:**
- **NCEP run**: Daily mean NCEP/NCAR reanalysis for 1950-2004 [Sasaki et al. 2006]
- **QuikSCAT run**: Daily mean observed by QuikSCAT satellite from July 1999 to 2004 provided from J-OFURO datatset [Kutsuwada, 1998; Kubota et al. 2002]
Current vectors at 38-m depth and wind stress curl averaged from August to October

**QuikSCAT run**

(a) QS run (2001)
(b) QS run (2002)
(c) QS run (2003)
(d) QS run (2004)

**NCEP run**

(a) NCEP run (2001)
(b) NCEP run (2002)
(c) NCEP run (2003)
(d) NCEP run (2004)
Current vectors at 38-m depth and wind stress curl averaged from 2001 to 2004

QuikSCAT run

NCEP run
Eastward Current Velocity and Ekman Pumping Velocity averaged from 2001 to 2004

QuikSCAT run (2001–2004)

NCEP run (2001–2004)
Current vectors at 38-m depth and wind stress curl averaged from August to October

Wind Stress Curl (MJJ) & Current (ASO)

(a) QS run (Vector: ASO, WC:MJJ, 2001)
(b) QS run (Vector: ASO, WC:MJJ, 2002)
(c) QS run (Vector: ASO, WC:MJJ, 2003)
(d) QS run (Vector: ASO, WC:MJJ, 2004)

Wind Stress Curl & Current (ASO)

(a) QS run (2001)
(b) QS run (2002)
(c) QS run (2003)
(d) QS run (2004)
Vertical Distribution of Eastward Current and Temperature averaged from 2001 to 2004

165-160W
QuikSCAT run (165-160W) NCEP run (165-160W)

Ekman Pumping

Wind Stress Curl & Current Vectors

175-170W
QuikSCAT run (175-170W) NCEP run (175-170W)

Ekman Pumping

Wind Stress Curl & Current Vectors
Summary

We have investigated dynamical oceanic response to atmospheric field associated with the far-reaching HLCC by comparing eddy-resolving ocean simulations driven by two different wind stress fields.

- In the QuikSCAT run, the far-reaching HLCC extends west-southwestward realistically across the dateline, while the far-reaching HLCC is not represented well in the NCEP run.

- Interannual variability of the HLCC are suggested, although the simulation period is relatively short to discuss the variation.

- Meridional distribution of the simulated HLCC relative to wind stress curls is fairly consistent with the linear theory.

- The comparison suggests that the zonally band-like structures of wind stress curls induced by the warm HLCC in turn play a role to drive further the HLCC, which follows the atmosphere-to-ocean and ocean-to-atmosphere feedbacks triggered by the Hawaiian Islands suggested by Xie et al. [2001].
The comparison between eddy-resolving simulations driven by the two different wind fields suggests that there are possible two-way air-sea interactions associated with the HLCC.
Future Works

• Interannual variability is suggested in the wind field and the simulated HLCC in the QuikSCAT run, and it is also found in the SST field observed by TRMM satellite [personal comm. from S.P. Xie]. And there are also seasonal variations in the simulated HLCC.

Detailed investigations for variability in the air-sea interaction system associated with the HLCC are left for future works.
TRMM SST (Contour) and Cloud Liquid Water (Color) [personal comm. from S.-P. Xie]