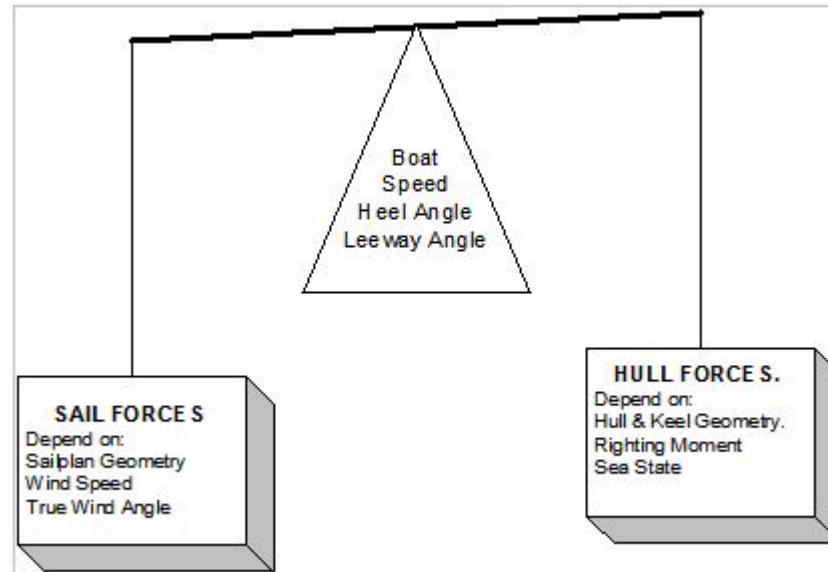# WASPP:
WIND ASSISTED SHIP PERFORMANCE PREDICTION

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University of Strathclyde

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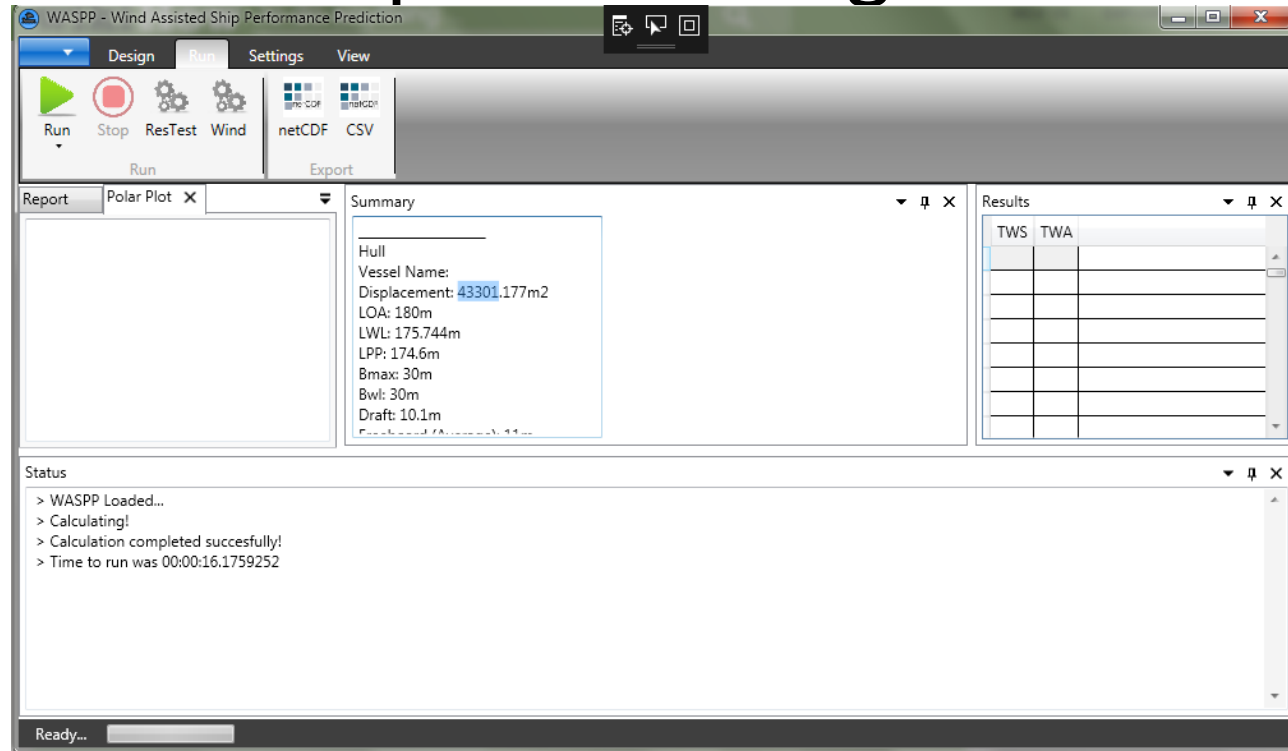
benjamin.hobin@strath.ac.uk

WASPP: Background

- Variant on a traditional yacht Velocity prediction program

- Calculates all Aerodynamic and Hydrodynamic forces
- Resolves force vectors and moments around ship axis
- Balances forces so accelerations are zero
- 4 DOF solution – (Surge), Sway, Roll, Yaw

WASPP: Development Background

- Developed in C# using .NET Framework 4.5
  - Currently compiled for windows only
- Possible to use Mono for OSX / Linux

- Full GUI
- Some functionality also exposed to .dll interface to link with external programs

WASPP: Background

- *Fleet*
  - *Ship parameters*

- *Design Conditions*
  - *Rig Size*
  - *Rig layout*

- *Operating Conditions*
  - *Ship speed*
  - *Draft?*

- *Environment Conditions*
  - *True wind speed*
  - *True wind angle*
  - *Significant wave height*
  - *True wave angle*

- *Inputs*
  - *Heel*
  - *Leeway*
  - *Engine power*
  - *Rudder angle*
  - *Sail Trim*

6 Degrees of Freedom
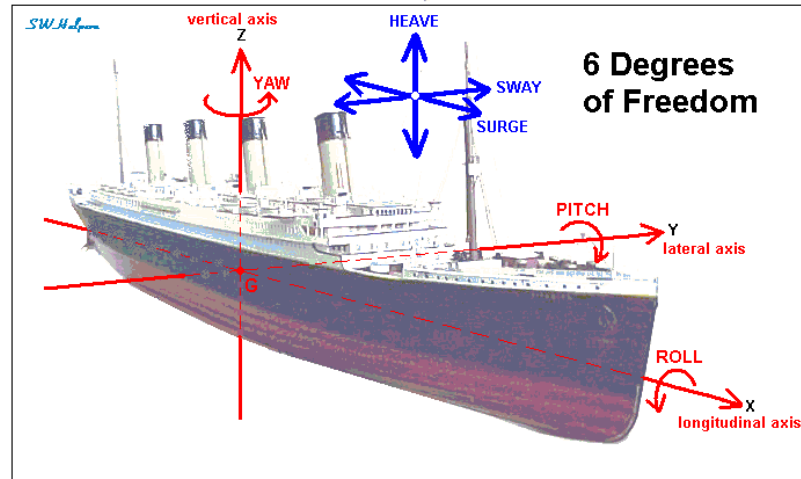
- *Driving force – Drag = 0*
- *Heeling moment – Righting moment = 0*
- *Aero side force – Hydro side force = 0*
- *Aero yaw force – Hydro yaw force = 0*

- *Pitch?*
- *Heave?*
  - *Would require full LPP to recalculate hullform parameters at each condition*
  - *Could be simplified and approximated with change in Sc*
  - *Effects too small to consider*

WASPP: Resistance & Powering

- Hull
  - Calm water Upright Resistance
    - **Holtrop 1984**
    - Holtrop & Mennen 1982
    - Resistance curve input
  - Added resistance in waves
    - **Modified Kwons Method - Lu 2014**
    - Resistance polar input
  - Added resistance due to wind
    - **Blendermann 1996**
    - Fujiwara 2006
  - Added Resistance due to Heel
    - **Approximation based on changing wetted surface area**
  - Sideforce & Added resistance due to Yaw
    - **Journee & Clarke 2005**
    - Fujiwara 2006
    - Shentzle 1985, Kuttenkueler 2007

- Rudder
  - **Assumed NACA 0018 section**
  - Fujiwara et al 2005

- Propeller
  - **Wageningen B-series**

WASPP: Sizing

- Can accept direct dimensional inputs

- …or if needed it can also create an assumed 'ideal' sailplan.
  - Traditionally sailing yachts make use of two principle methods for initial sizing of sailplans.
    - Stability at large heel angles
    - *Sail Area/Displacement* and *Sail Area/Wetted Surface Area*.

  - Polynomial fit from database of ~100 sailing yachts >50m
  - Modified based on wind assist assumptions
  - Verified against known vessels
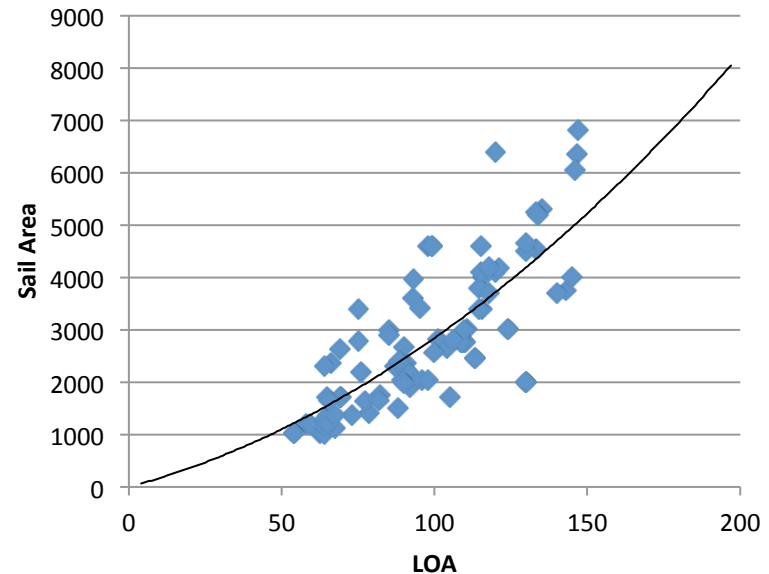
WASPP: Rotor

- **Model:**
  - **Wind tunnel data** (Prandtl & Betz 1932)
  - Single coefficient input (Traut 2014)
  - Lift Coefficient Curve (Craft 2012)
- **Parameters:**
  - Rotational Speed
  - Stow
- **Sizing:**

(for ~180m Bulk Carrier)
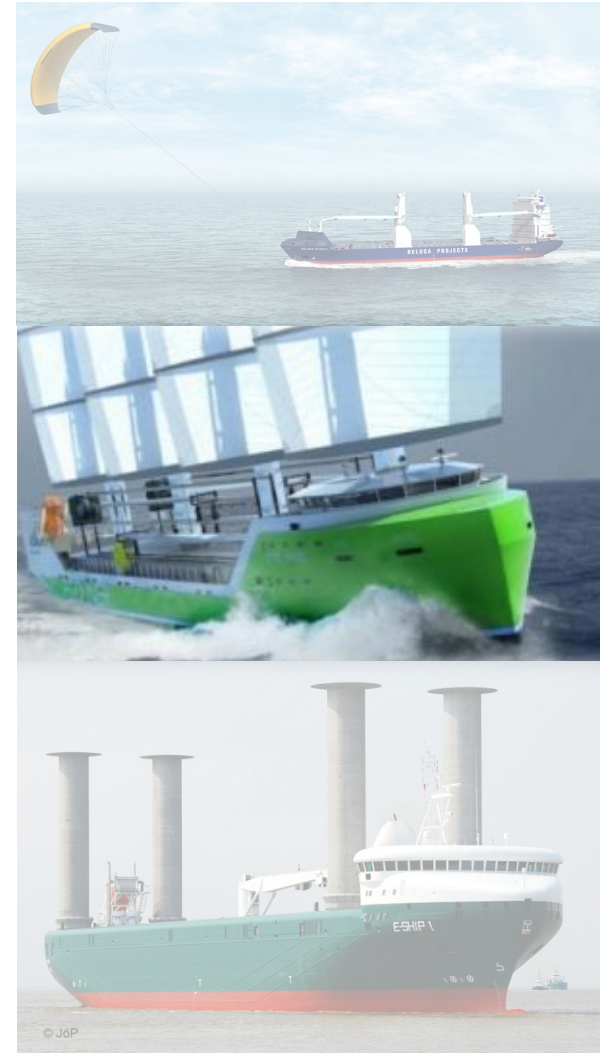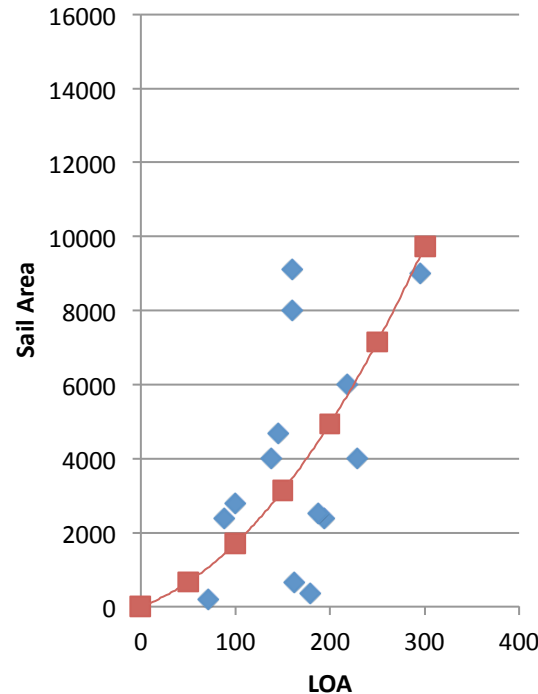
- Total area:
- Height :
- Width:
- Stack:
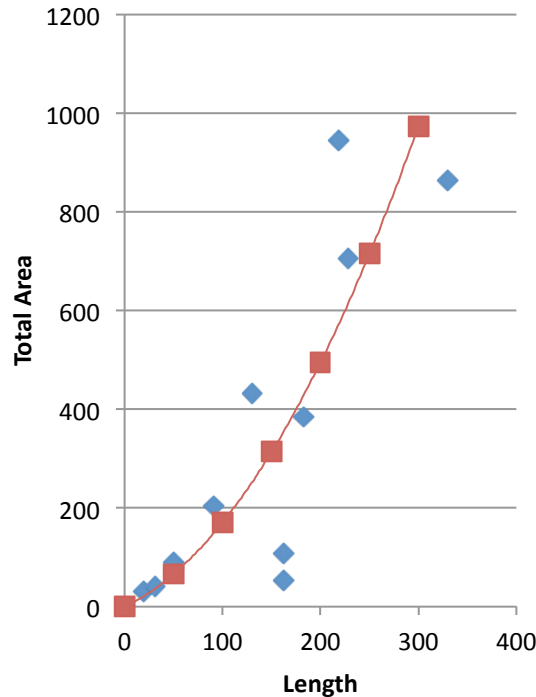
WASPP: Sail

- **Model**
  - **Gretch La Rossa 2012**
  - Fugiwara 2005
- **Parameters**
  - Reef
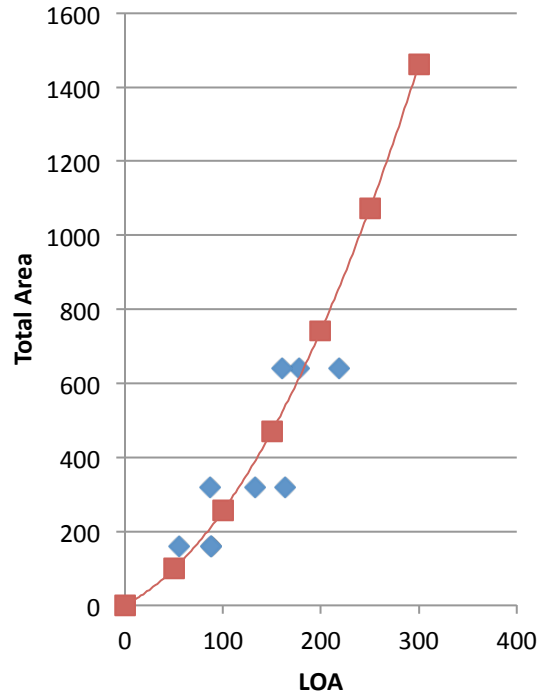- **Sizing**

(for ~180m Bulk Carrier)
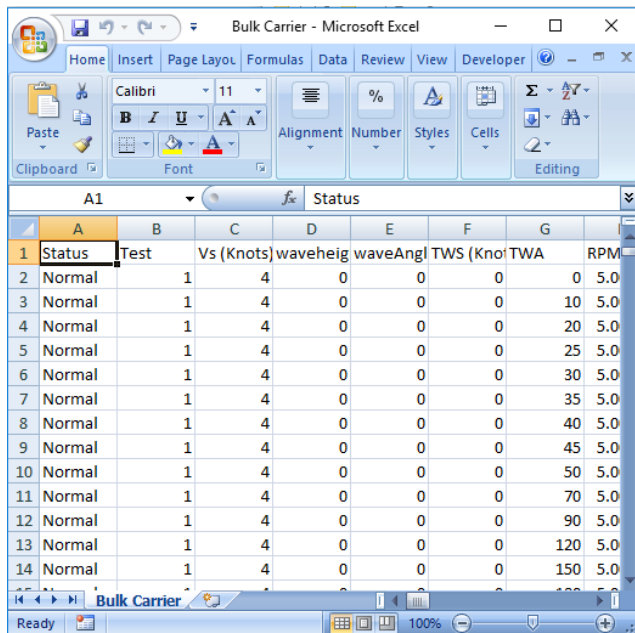
  - Area = 1686m^2
  - Masts = 2
  - Mast height = 46m
  - Yard length = 18m

WASPP: Kite

- **Model**
  - **Zero Mass Model (Wellicome, Dadd and Hudson 2009)**
    - Parametric figure-8 flightpath (Dadd 2012)
  - Lift Coefficient Polar (Dadd 2012)
- **Parameters**
  - Drop!
  - Line Length? Flight Path?
- **Sizing**

(for ~180m Bulk Carrier)

  - Total Area: 257m^2
  - Line Length: 300m

WASPP: Outputs

- *Outputs*
  - *Results can be analysed within WASPP or exported to either the popular*
  - *CSV (comma separated variable)*
  - *netCDF (multidimensional scientific data matrix*
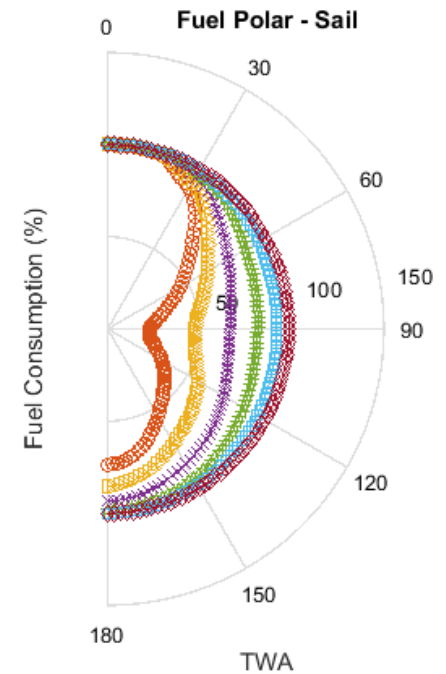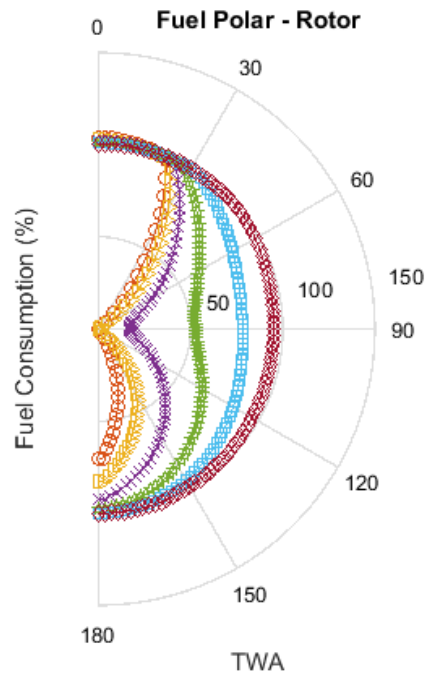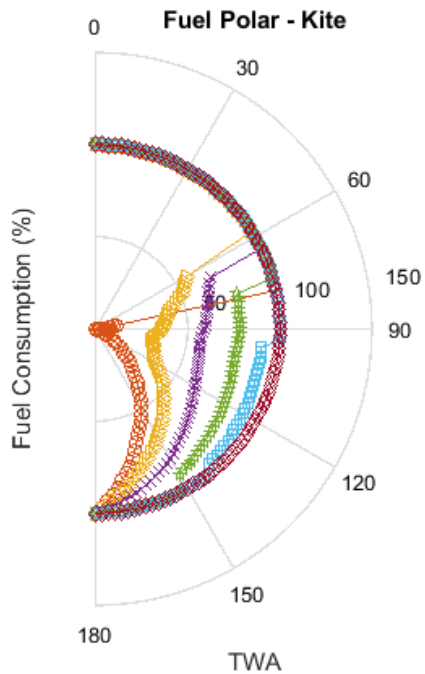 - *dll interface (run analysis from other programs - eg excel VBA)*

WASPP: Usage
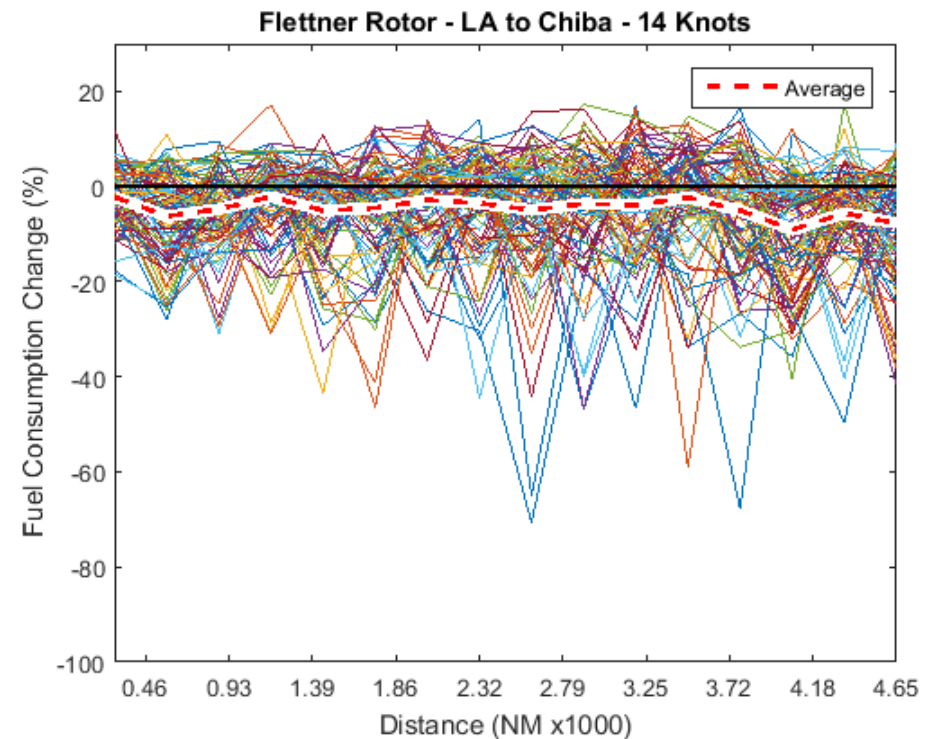
- Individual case analysis

Fuel Polar - Kite

Fuel Polar - Rotor

Fuel Polar - Sail
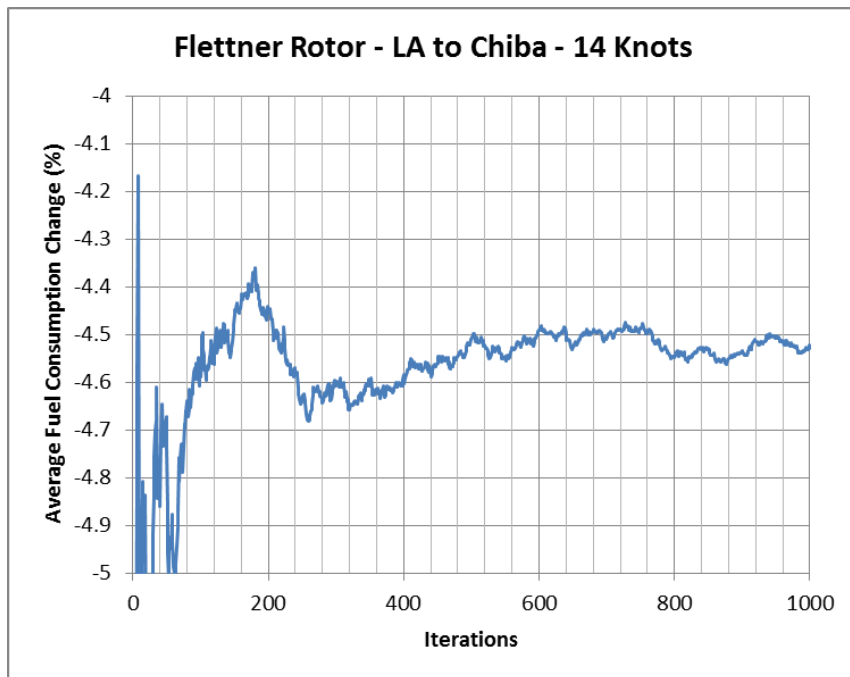
WASPP: Usage

- Global performance analysis
- Voyage Level Model
    - Evaluates performance across many voyages
    - Multiple Departure dates / Weather conditions
    - Multiple Routes

Flettner Rotor - LA to Chiba - 14 Knots
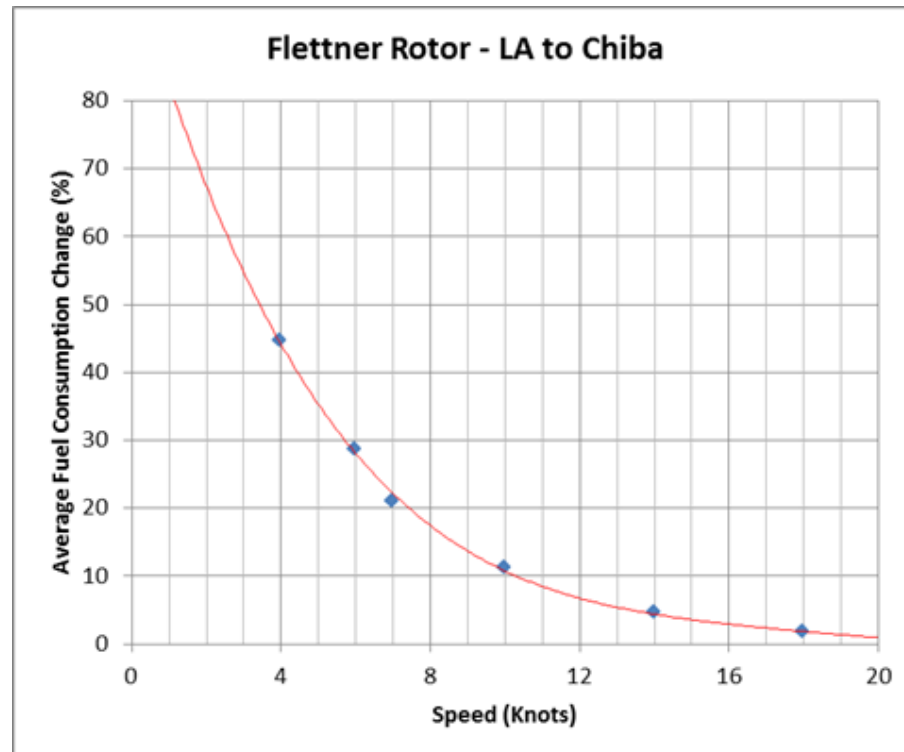

Flettner Rotor - LA to Chiba - 14 Knots

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