The occurrence of radiation fog and mist at the SMJP airport in Suriname

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Problem statement:

• Fog is one of the most significant problems for pilots in Suriname. Airmen (pilots) in Suriname complain mostly about problems with early morning landing and take-off.

Approach to the problem

• I did a research on the occurrence of fog and mist over a period of 12 years (2000 – 2011).
• Objectives:
  1) Construction of the Diurnal cycle (Preferred time of the day for formation and dissipation)
  2) Construction of the Annual cycle (Monthly evolution).
  3) Definition of visibility thresholds/limits for take off and landing.
  4) Study of a few special cases.
Definitions:

- Fog: visibility < 1000m.
- Mist: visibility 1000 – 5000m.

GENERATION PROCESS

- Mist and fog created by the cooling of moist air to near or slightly below the dew point temperature.

TYPES

- Radiation fog
- Advection fog
- Ditch fog
- Sea fog
- Valley fog
- Rain fog
- Slope fog
- Stratus fog

- Rapid surface cooling in clear nights with weak winds and large moisture availability (e.g. after heavy showers)
Geographical Background

Relevant weather features

- Trade winds:
  - Tropical Waves
  - Easterly Waves
  - Induced Waves

- I.T.C.Z.

- Low level troughs
- Mid/upper troughs (TUTTS)

- Sea breeze fronts

SMJP: Zanderij Airport
Lat: 5.27N  Lon: 55.11W  Alt: 16mASL
Diurnal Cycle: 
- Densest fog occurs in the morning between 6 am and 8 am.
- Can form as early as 9pm and dissipate as late as 9am.
Annual Cycle of Fog and Mist

Fog and mist monthly frequencies (2000-2011)
Cases with visibility below 2500m

Fog and mist monthly frequencies (2000-2011)
Cases with visibility below 2500m

Monthly Frequency

<table>
<thead>
<tr>
<th>Months</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<tbody>
<tr>
<td>Min</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>4</td>
<td>6</td>
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<td>Ave</td>
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<td>14</td>
<td>18</td>
<td>15</td>
<td>10</td>
<td>9</td>
<td>17</td>
<td>15</td>
<td>16</td>
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<tr>
<td>Max</td>
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<td>9</td>
<td>18</td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>9</td>
<td>17</td>
<td>15</td>
<td>16</td>
</tr>
</tbody>
</table>

Min, Ave, Max
Annual Cycle of dense fog
(Visibility < 500m)

Average frequency of days with fog:
2000-2011

<table>
<thead>
<tr>
<th>Months</th>
<th>Frequency</th>
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</thead>
<tbody>
<tr>
<td>Jan</td>
<td>2.8</td>
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<tr>
<td>Feb</td>
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<tr>
<td>Mar</td>
<td>1.3</td>
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<td>Apr</td>
<td>2.1</td>
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<tr>
<td>May</td>
<td>2.5</td>
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<tr>
<td>Jun</td>
<td>4.4</td>
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<td>Jul</td>
<td>3.3</td>
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<tr>
<td>Aug</td>
<td>2.8</td>
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<tr>
<td>Sep</td>
<td>6.3</td>
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<tr>
<td>Oct</td>
<td>6.0</td>
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<tr>
<td>Nov</td>
<td>5.1</td>
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<tr>
<td>Dec</td>
<td></td>
</tr>
</tbody>
</table>

Peak
Four different visibility ranges

Average frequencies of different ranges:
0-2500m

Frequencies

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Months

0-500
500-800
800-1500
1500-2500
What drives the annual cycle?

• Oct-Dec: Highest Frequency
  → ITCZ periodically over Suriname when retreating southward.
    → ITCZ provides weak wind environment and high sfc dewpoints.
    → Frequent cloud-free periods at night from stable/dry mid-levels.
    → Cooler temps advected from the NE can increase relative humidity near sfc.

  → Ideal setup: Diurnal ITCZ rains increase sfc dewpoint, weak ITCZ winds, and clouds clear rapidly in the evening, setting a fast radiative cooling process.

• Jun-Jul: Secondary Max
  → Ill-defined ITCZ positions over Suriname as it migrates northward.
    → Similar mechanism, but relatively less rad. cooling due to the high frequency of convection and clouds.
Special Cases

Identification of predictors for fog formation.

Goal: Improve our forecasts.
Charts we will use and what do they contain

- **SHADE**: GDI (Stability)
- **YELLOW**: WINDS <4KT
- **BLUE**: RH > 99.5%
- **WHITE**: CLOUDS (AVR RH 925-850-700MB)
- **RED**: SAT DEFICIT

Suriname
Special Case I: Dec 07/08, 2014

METAR SMJP 081000Z VRB01KT 0900 FG BKN002 23/23 Q1011 TEMPO 1500=

Wind Speed (kt)

Saturation Deficit = T - Td (C)

Visibility (m)

Fog/mist occurrence

*Local time = UTC-3
SATELLITE ANIMATION DEC 08, 2014.

GFS, Dec 08 at 06UTC (3am LST)

YELLOW: WINDS <4KT >> Almost calm.
BLUE: RH > 99.5% >> close to.
WHITE: CLOUDS >> Few clouds
RED: SAT DEFICIT >> Yes.

Ill-defined ITCZ
Special Case II: Dec 17/18

Wind Speed (kt)

Saturation Deficit (C)

Visibility (m)

METAR SMJP 180700Z 00000KT 2500 BKN002 23/22 Q1011 TEMPO 0800 FG=

Fog/mist occurrence

Vis. >10km.

Sunset

Sunrise

Time in UTC

Time in UTC

Time in UTC
SATELLITE ANIMATION DEC 17/18, 2014

YELLOW: WINDS <4KT>> Yes
BLUE: RH > 99.5% >> Yes
WHITE: CLOUDS>> Clear
RED: SAT DEFICIT>> Yes

GFS, Dec 18, 06UTC. (03.00LST)
Special Case III: Dec 24/25, 2014

SPECI SMJP 251034Z 26002KT 0600 FG BKN002 21/21 Q1013 FM1115 2000 BR=

Sunset
Sunrise
Fog/mist occurrence

Visibility (m)

showers
Fog/mist occurrence

Time in UTC -3= ..It
YELLOW: WINDS <4KT>> Yes
BLUE: RH> 99.5% >>Almost
WHITE: CLOUDS >> Clear
RED: SAT DEFICIT >> Yes
Summary

1) Construction of the Diurnal cycle
   → Dense fogs develop ~3am LST, their peak starts at ~7am and they dissipate by 8-9 am.

2) Construction of the Annual cycle
   → Peaks when ITCZ positions over Suriname. May-Jul and Oct-Dec. Major peak Oct-Dec also influenced by strong radiational cooling from frequent clear skies at night.

3) Definition of visibility thresholds/limits for take off and landing.
   → 800m with instruments
   → 2300m without instruments

4) Ideal weather evolution for fog formation
   Afternoon ITCZ showers / Tstorms increase dewpoint /saturation
   Ill-defined ITCZ= spotty to isolated convection → rapid clearing after sunset sets up radiational cooling process

ITCZ convergence provides synoptic environment of weak winds
Thank you for your attention

Questions???????